

CHAPTER

34



MAINTENANCE MANUAL

CHAPTER 34

NAVIGATION

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- 1 TCA LX-N20198, LX-N20199
- 2 RTCA LX-N19997, LX-N20000



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MISCELLANEOUS NAVIGATION INSTRUMENTS - DESCRIPTIONS AND OPERATION

1 General

- A The miscellaneous navigation instruments are those instruments which are not directly associated with any specific navigation devices or systems. These instruments provide auxiliary sources of navigation data, and include clocks, magnetic compass, rate-of-climb indicators, ram air temperature indicator, navigation true airspeed indicator and altimeter.

2 Clocks

A Pilot's, Copilot's Clocks

- (1) Individual clocks are provided for the pilot, copilot and installed in their respective instrument panels. Each clock has a 12-hour dial and a sweep second-hand. A knob at the lower left edge of the clocks is used for winding and setting.

3 Magnetic Standby Compass

- A A magnetic standby compass is mounted forward of the pilots near the upper center of the windshield. When the compass is not being used, the hinged compass support may be folded to clear the windshield of any obstructions. The compass correction card is on a folding bracket which extends below compass.
- B Compensator screws on the face of the compass provide "N-S" and "E-W" adjustment.
- C A red light in the compass is controlled by a switch on the overhead panel (P13). Power for the light is obtained from a circuit breaker on the essential 28-volt circuit breaker panel (P6).
- D The compass support bracket is spring loaded so that it will remain in a retracted position or in an extended position. When in a retracted position, the compass and correction card are flush with the lower forward edge of the overhead panel (P13).



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4 Rate of Climb Indicators

- A Rate of climb, or vertical speed, indicators are in both the pilot's and copilot's instrument panels. These indicators are operated by static pressure applied to the inside of the instrument case through a capillary tube and to the inside of a flexible diaphragm which is inside the case. As the air-plane changes altitude, the pressure inside the diaphragm changes more rapidly than the pressure inside the instrument case. The resulting differential pressure causes the diaphragm to expand or contract. The amount of expansion or contraction is proportional to the rate change of altitude and is indicated by a radial pointer in thousands of feet per minute.

5 Ram Air Temperature Indicator (TURBOJET only)

- A Two ram air temperature indicators are provided. One for the pilots and one for the navigator. Each indicator receives temperature information from a separate flush mounted temperature sensitive resistance bulb, located in the slipstream. Shields over the bulbs protect them from physical damage. The resistance of the bulb varies proportionally to temperature changes at the bulb's surface. These variations in resistance at the bulb are electrically fed to the indicator where they are displayed by a pointer and dial calibrated for temperature readings in degrees Centigrade (°C).
- B The pilot's indicator is mounted in the engine instrument panel and the navigator's indicator is mounted in the navigator's instrument panel. The temperature bulbs are installed at body station 200 and are accessible from inside the lower nose section.
- C Electrical power for operation of the indicators is 28-volts, 400-cycles, and is obtained from a circuit breaker on the 28 volt A-C circuit breaker panel (P7).

6 Total Air Temperature Indicator (TURBOFAN only)

- A A total air temperature indicator is located on the copilot's instrument panel. Each indicator receives information from separate temperature sensitive resistance elements mounted in a single probe located on the right side of the fuselage at station 268.
- B Electrical power for the operation of the indicators is 115-volts ac from ac circuit breaker on circuit breaker panel P3.

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8. Navigator's Airspeed Indicator

- A. The navigator is provided with an airspeed indicator which shows true airspeed by the use of a pointer and dial. The indicator is mounted on the navigator's instrument panel.
- B. Information for obtaining a true airspeed reading is supplied to three separate diaphragms contained within the instrument. Each diaphragm is progressively connected through mechanical linkage to the pointer. The first diaphragm, airspeed diaphragm, is actuated by dynamic pressure from the airplane's pitot system. This information is transferred to the second diaphragm, the altitude diaphragm. The altitude diaphragm receives ambient pressure information from the airplane's static system and corrects the airspeed for altitude pressure change. The third diaphragm, the temperature diaphragm, is actuated by an externally located temperature bulb. This corrects the information previously obtained by adding temperature change and transfers the final true airspeed reading to the pointer.

9. Navigator's Altimeter

- A. The navigator's altimeter has three concentrically arranged pointers that indicate altitude on a common dial. The altimeter is manually set by rotating the knob at the lower left of the instrument face. Altimeter setting is indicated in inches of mercury and millibars on subdials visible through slots in the altitude dial.
- B. Ambient pressure information is sensed by the altimeter from the airplanes pitot-static systems. Pressure variations cause the altimeter's diaphragm to expand and contract in proportion to the change. These changes are transferred to the pointers through the use of mechanical linkage. The altimeter is installed in the navigator's instrument panel.

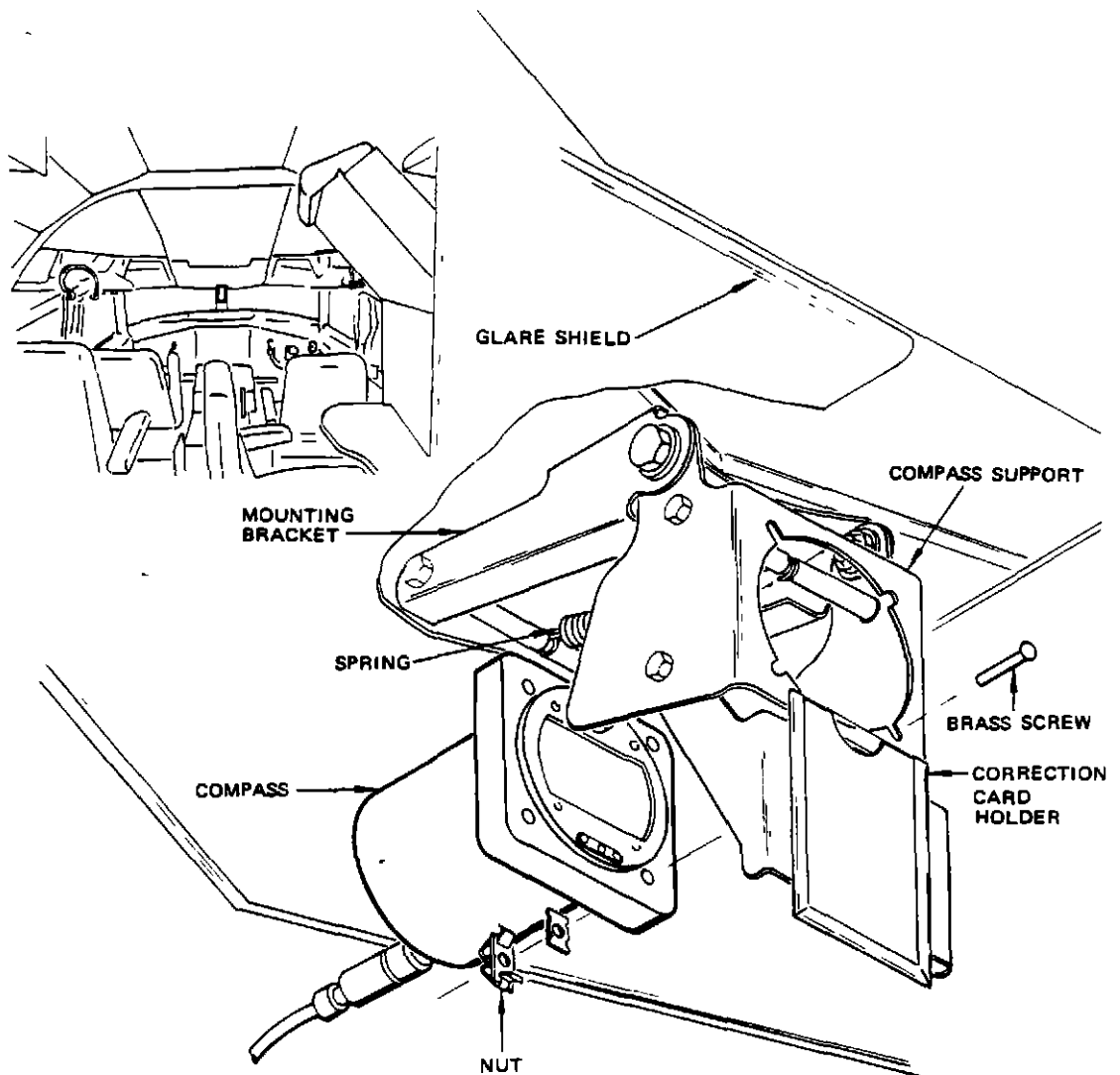
10. Total Air Temperature Indicator (TURBOFAN only)

- A. Two total air temperature indicators are provided. One is located on the copilot's instrument panel and the other is on the navigator's instrument panel. Each indicator receives information from separate temperature sensitive resistance elements mounted in a single probe located on the right side of the fuselage at station 268.
- B. Electrical power for the operation of the indicators is 115-volts ac from a circuit breaker on circuit breaker panel P3.

MAGNETIC STANDBY COMPASS - REMOVAL/INSTALLATION

1. Remove Magnetic Compass (See figure 401.)
 - A. Support compass and remove four brass screws and nuts holding compass to mount.
 - B. Remove compass.
2. Install Magnetic Compass (See figure 401.)
 - A. Insert compass in cutout in support.
 - B. Install brass mounting screws and nuts.

CAUTION. DO NOT USE STEEL SCREWS TO ATTACH COMPASS TO MOUNT.



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MAGNETIC STANDBY COMPASS - ADJUSTMENT/TEST

1. General

- A. Magnetic standby compass should be adjusted whenever swinging navigation compass system. Refer to Compass System - Maintenance Practices.

RAM AIR TEMPERATURE BULB - MAINTENANCE PRACTICES

1. Removal/Installation Temperature Bulb

A. Remove Temperature Bulb (See figure 201.)

- (1) Remove four screws from base of temperature bulb.

NOTE Screws are accessible from outside the airplane at body station 200.

- (2) Remove screws holding temperature bulb guard to structure.

NOTE Temperature bulb guard is accessible from inside the lower nose compartment.

- (3) Disconnect electrical connector from temperature bulb.

- (4) Remove temperature bulb and rubber gaskets.

CAUTION: THE FACE OF TEMPERATURE BULB IS EXTREMELY FRAGILE. DO NOT TAP OR EXERT FORCE ON THIS SURFACE.

B Install Temperature Bulb.

- (1) Place temperature bulb in position over opening in skin, using rubber gaskets as required to make sensitive surface of bulb flush within -0.005 to -0.015 inch of outside contour of skin.

NOTE Three rubber gaskets are furnished with the temperature bulb.

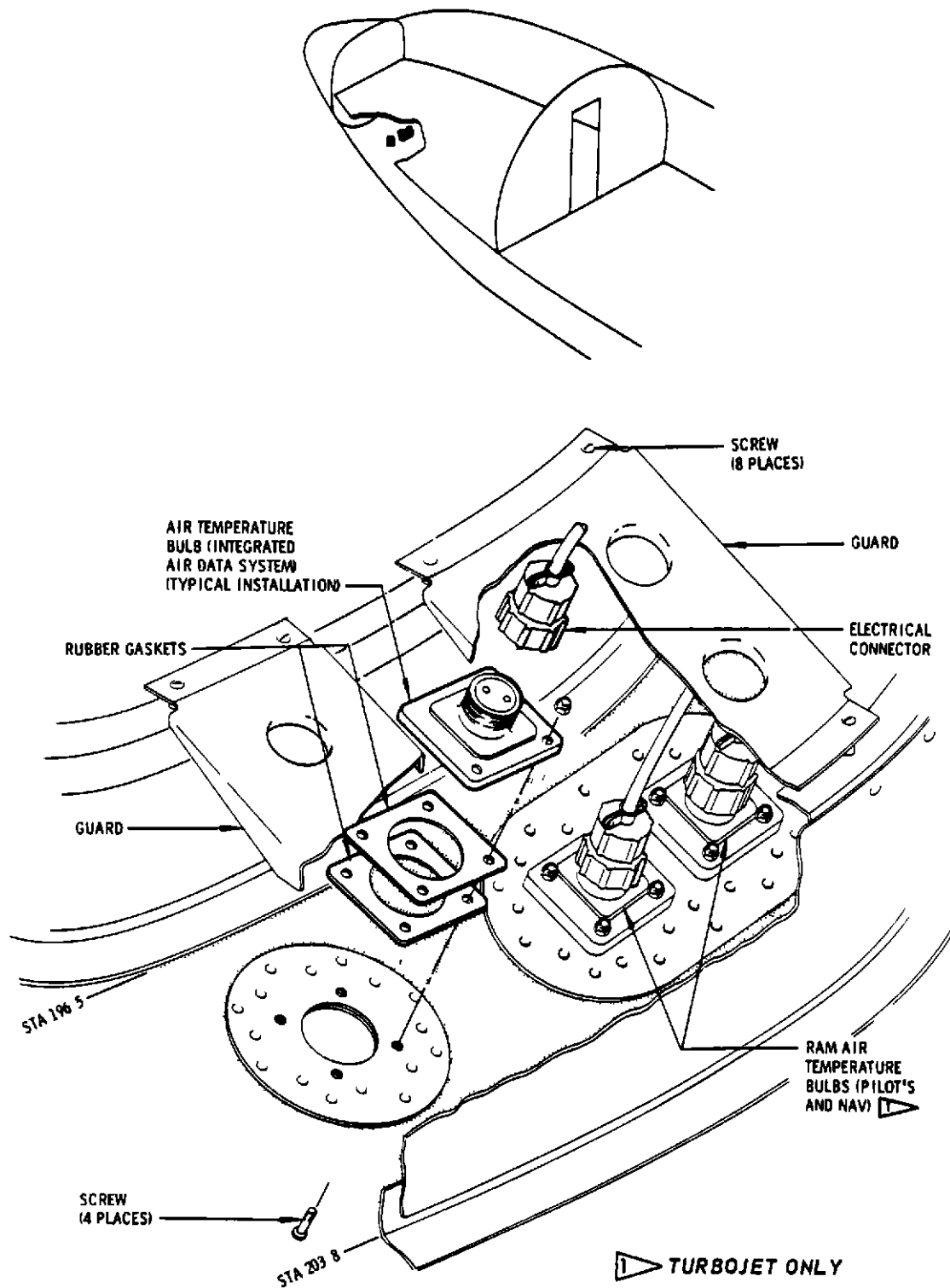
- (2) Install four mounting screws.

- (3) Check that sensitive surface of bulb is flush with skin outside contour within limits specified in step (1).

- (4) Install electrical connector on bulb.

- (5) Install guard over temperature bulbs.

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Air Temperature Bulbs Installation
 Figure 201

PITOT STATIC SYSTEM - DESCRIPTION AND OPERATION

1. General

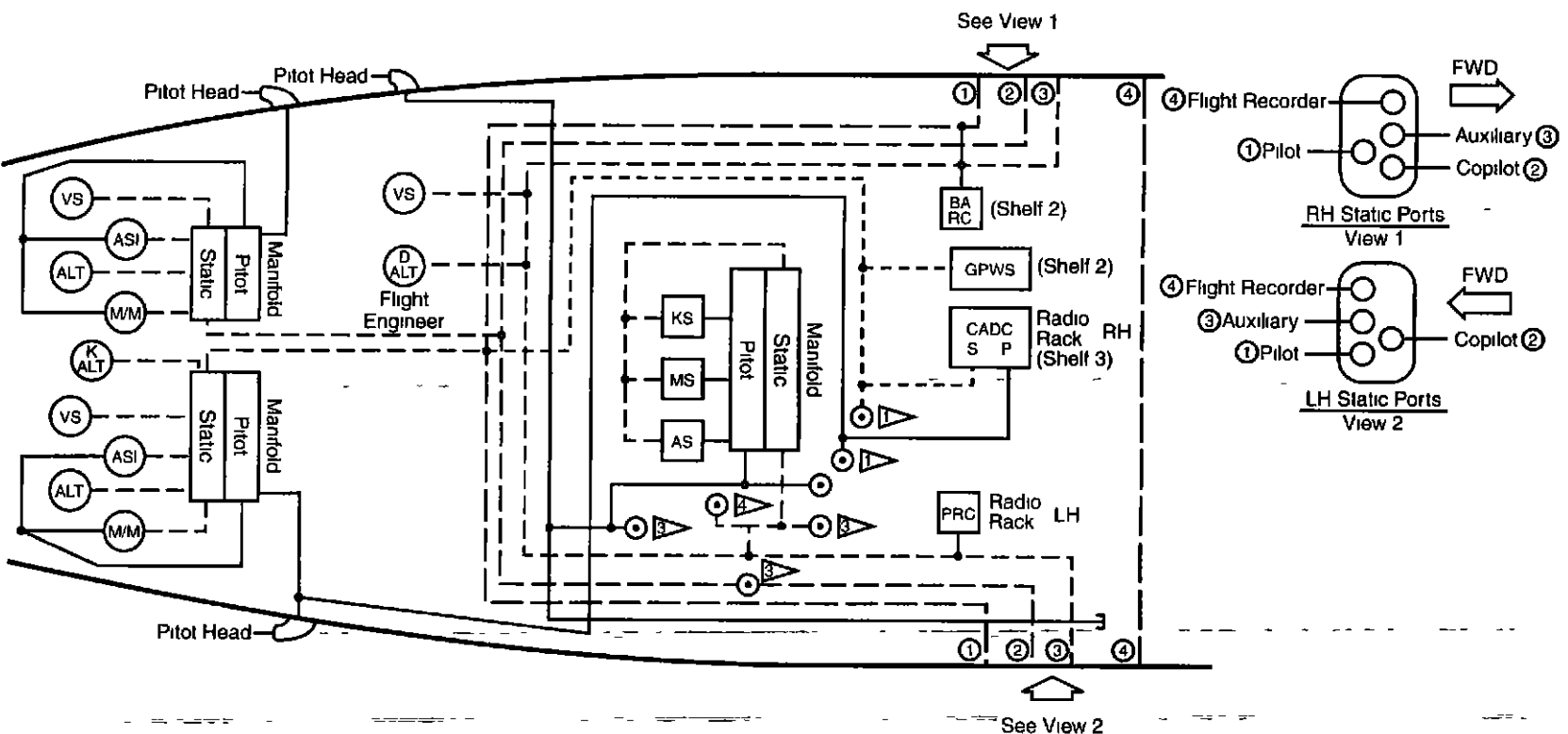
- A. The pitot static system is an installation of pitot heads and static ports connected by tubing to instruments for measuring or indicating dynamic and ambient air pressures. These pressures are used for determining airplane rate of climb, airspeed, altitude and mach number
- B. Dynamic air pressure from the pitot heads or ambient pressure from the static ports or both are supplied to the following instruments and equipment: Airspeed Indicators, Vertical Speed Indicators, Altimeters, Machmeters, Cabin Pressure Automatic Controller, Differential Pressure Switches, Rudder Hydraulic Pressure Control Airspeed Switch, and Mach/Airspeed Warning Switch, Flight Recorder, KIFIS Altimeter, Ground Proximity Warning System, Central Air Data Computer and Air Data Computers (see fig. 1).

2 Static System

- A Static or ambient pressure is sensed through eight ports, four ports on the right side and four on the left side of the fuselage. The eight ports are connected in four pairs so that the ports in each pair are on opposite sides of the fuselage.
- B. One of the four pairs is connected through a manifold to the pilot's instruments, the second pair goes to the copilot's manifold and instruments and the third pair is connected to the navigator's instruments, Differential Pressure Switches, Dual Altimeter, Rudder Hydraulic Pressure Control Airspeed Switch, and Mach/Airspeed Warning Switch.
- C. The fourth pair, designated as Flight Recorder, is installed but not used (see fig. 1).

3. Pitot System

- A. Three separate heads are used to sense dynamic air pressure. The pitot heads are mounted externally on each side of the forward part of the fuselage. The pitot heads are not connected to each other.



- VS Vertical Speed Indicator
- M/M Machmeter
- ALT Altimeter
- ASI Airspeed Indicator
- D ALT Dual Altimeter Differential Pressure Gage
- K ALT Kifis Altimeter

- MS Mach-Airspeed Warning Switch
- AS Rudder Control Airspeed Switch
- PRC Cabin Air Pressure Controller
- BA RC Baro Rate Computer (GPWS)
- KS Kifis Machmeter Indicator Switch (Mach Synchrotel XMTR Pitot and Static Comp)

- Pitot
- - - Static
- - - Auxiliary

- ⊙ Drain Trap and Test Fitting
- ⊕ Test Fitting

- ▷ On RH Radio Rack
- ▷ In Front of LH Radio Rack
- ▷ Lwr nose sect - Left side of Nose Wheel Well
- ▷ On LH Radio Rack

Pitot Static System Schematic
Fig 1



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- B. The pitot head on the left supplies dynamic air pressure to the pilot's pitot static operated instruments. The second pitot head, on the right supplies dynamic pressure to the copilot's instruments. A third pitot head on the right side furnishes dynamic air pressure to Rudder Hydraulic Pressure Control Airspeed Switch, K115 Machmeter Indicator Switch and Mach/Airspeed Warning Switch.
- C. A heater circuit provides a means of deicing the pitot heads when in flight. Control for the heaters is located on the overhead panel (P13).

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PITOT STATIC SYSTEM - DESCRIPTION AND OPERATION

1. General

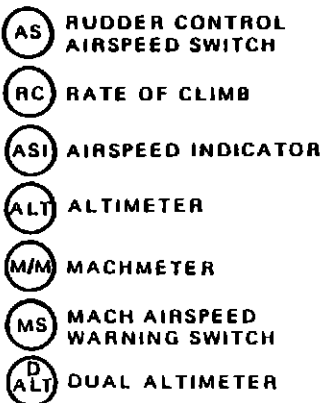
- A. The pitot static system is an installation of pitot heads and static ports connected by tubing to instruments for measuring or indicating dynamic and ambient air pressures. These pressures are used for determining airplane rate of climb, airspeed, altitude and mach number.
- B. Dynamic air pressure from the pitot heads or ambient pressure from the static ports or both are supplied to the following instruments and equipment: airspeed indicators, airplane rate-of-climb indicators, altimeters, mach meters, cabin pressure automatic controller, autopilot air data sensor, autopilot comparison unit (OO-SJA thru OO-SJE), differential pressure switches, rudder hydraulic pressure control airspeed switch (OO-SJE and on), and mach/airspeed warning switch. (See figure 1.)

2. Static System

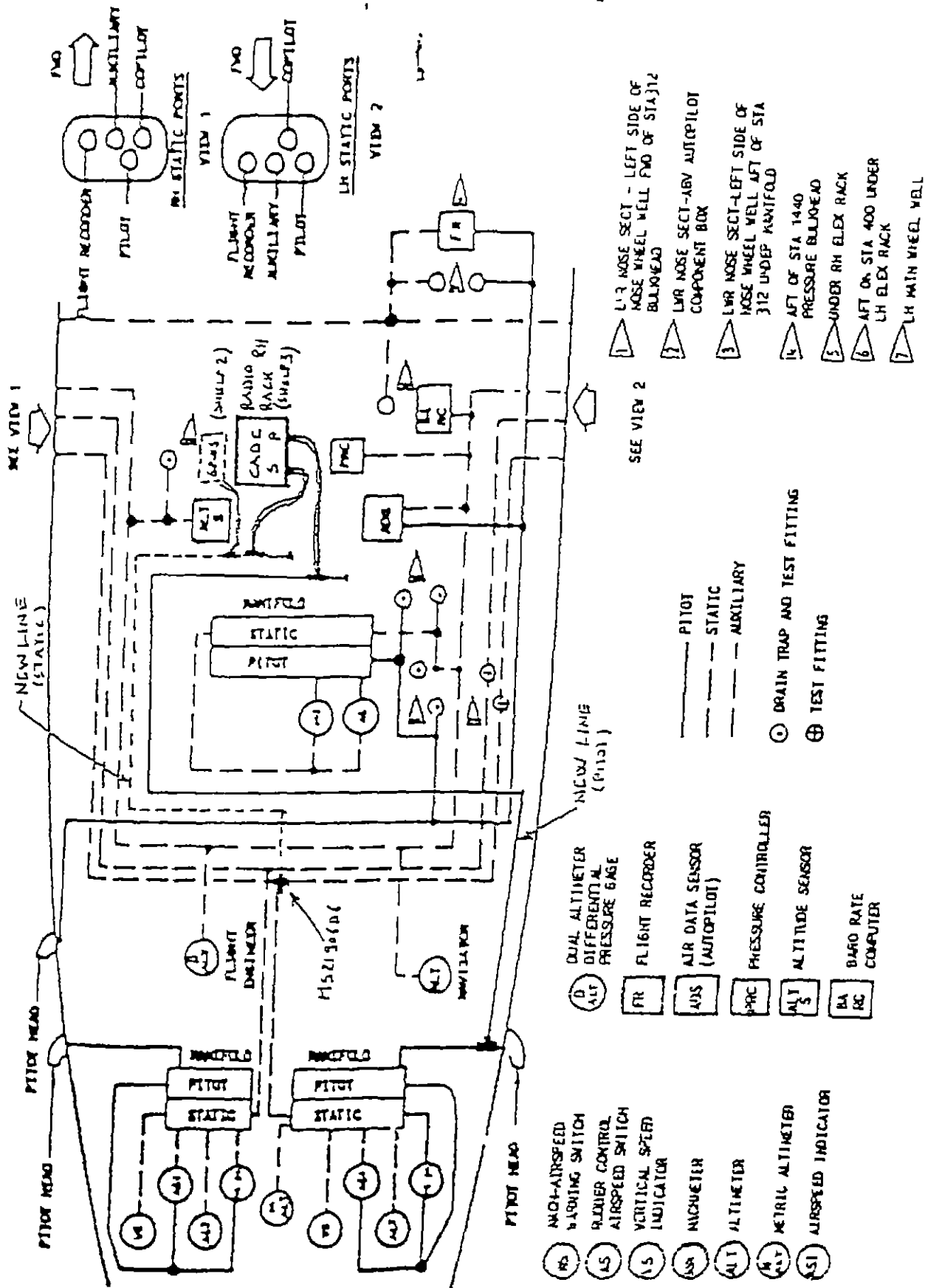
- A. Static or ambient pressure is sensed through six ports, three ports on the right side and three on the left side of the fuselage. The six ports are connected in three pairs so that the ports in each pair are on opposite sides of the fuselage. On OO-SJA thru OO-SJK a seventh port is added on the right side of the fuselage and is connected to the cabin pressure automatic controller.
- B. One of the three pairs is connected through a manifold to the pilot's instruments, the second pair goes to the copilot's manifold and instruments and the third pair is connected to the navigator's instruments, autopilot air data sensor, autopilot comparison unit (OO-SJA thru OO-SJE), differential pressure switches, dual altimeter, rudder hydraulic pressure control airspeed switch (OO-SJE and on), and mach/airspeed warning switch.
- C. On OO-SJL and on, a separate static source supplies information to the flight recorder (if installed). (See figure 1.)

3. Pitot System

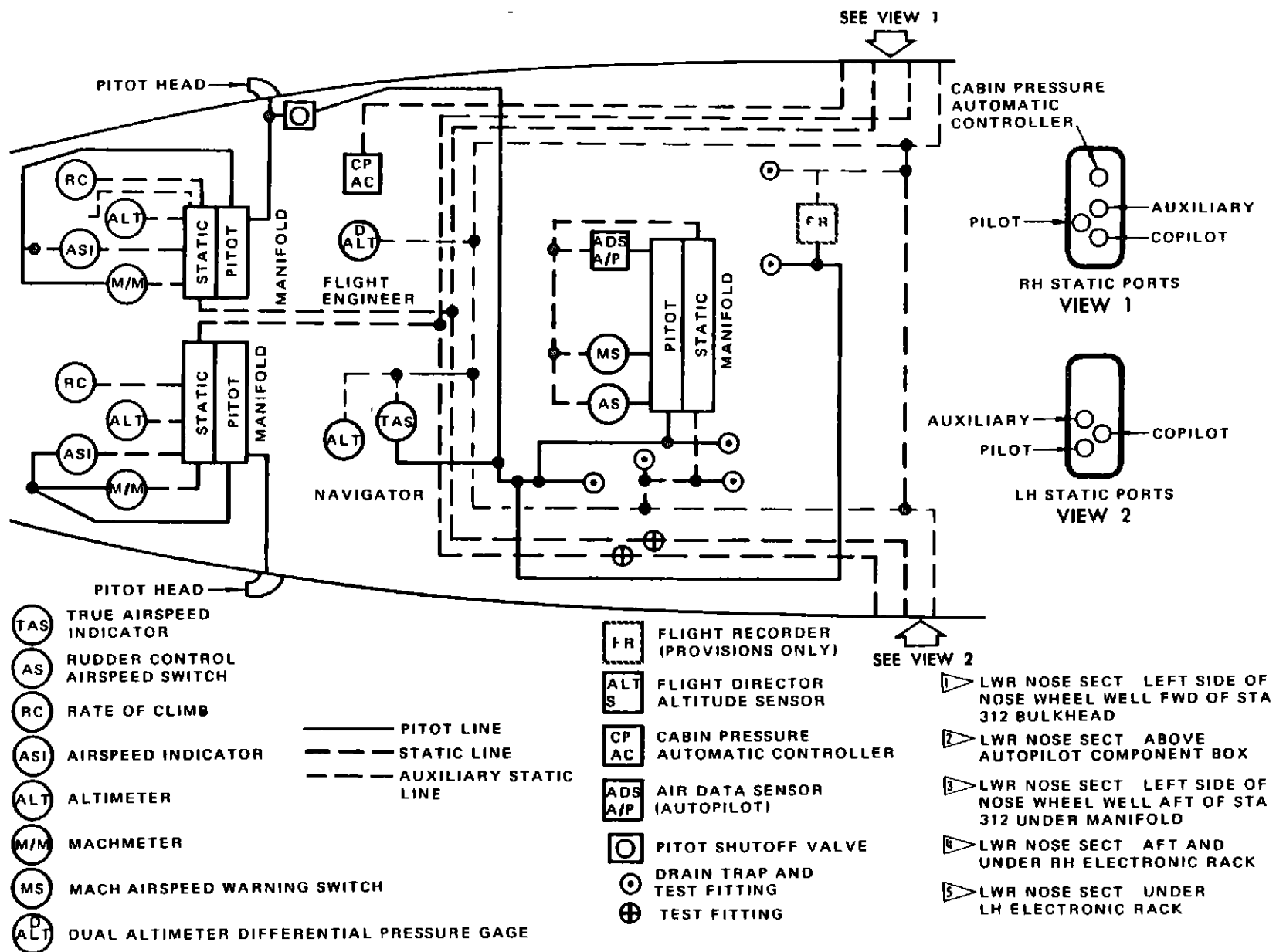
- A. Two separate heads are used to sense dynamic air pressure. The pitot heads are mounted externally on each side of the forward part of the fuselage. The pitot heads are not connected to each other.



Pitot Static System Schematic
Figure 1 (Sheet 1)

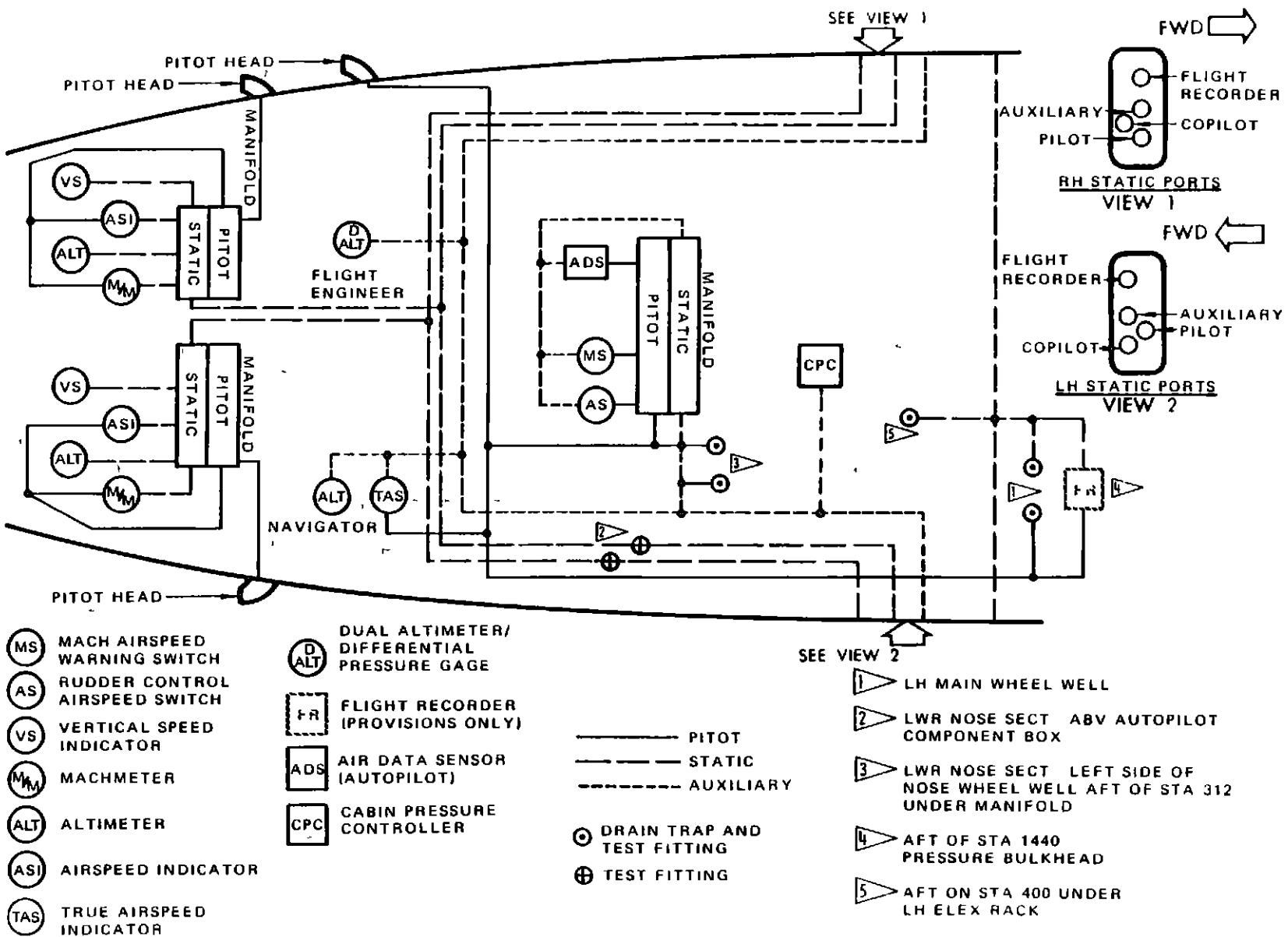


Pitot Static System Schematic
figure 1



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Pitot Static System Schematic
Figure 1 (Sheet 2)



Pitot Static System Schematic
Figure 1 (Sheet 3)



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- B. The pitot head on the left supplies dynamic air pressure to the pilot's pitot static operated instruments. The second pitot head, on the right supplies dynamic pressure to the copilot's instruments. On all airplanes except 00-SJL, the copilot's pitot head also furnishes dynamic air pressure through a shutoff valve to the navigator's instruments, autopilot air data sensor, rudder hydraulic pressure control airspeed switch (00-SJE and on), and mach/airspeed warning switch. On airplanes 00-SJL and on, a third pitot head on the right side is installed to supply dynamic pressure to these instruments and provision for flight recorder.
- C. A heater circuit provides a means of deicing the pitot heads when in flight. Control for the heaters is located on the overhead panel (Pl3).



PITOT STATIC SYSTEMS - MAINTENANCE PRACTICES

1. Adjustment/Test Pitot Static System

A. General

CAUTION: THE FOLLOWING STEPS ARE REQUIRED TO PREVENT INSTRUMENT DAMAGE, AND/OR TO ENSURE VALID READINGS.

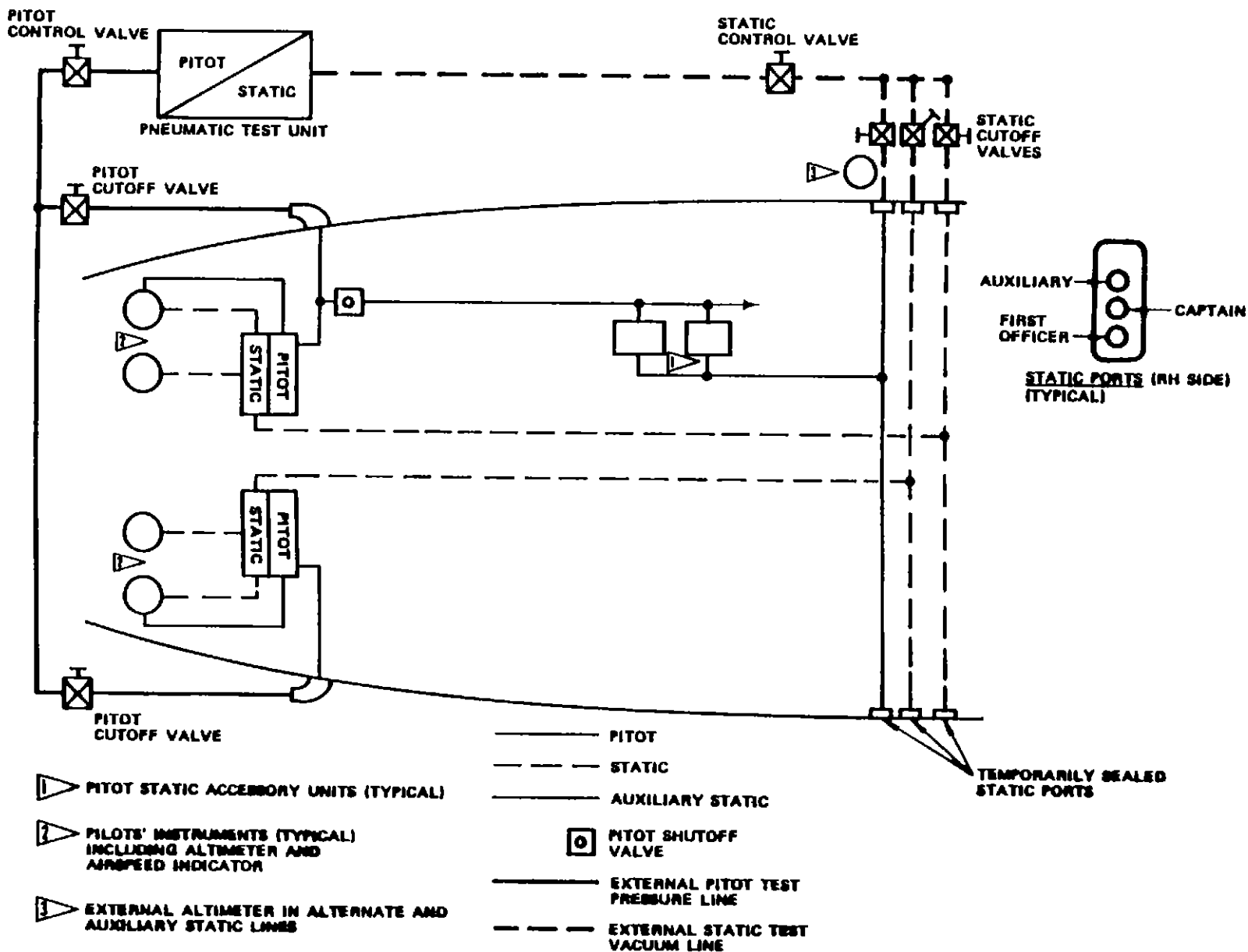
- (1) Any application or release of vacuum or pressure shall be made at a rate of climb or descent less than 5000 feet per minute.
- (2) The pressure in the pitot lines shall always be greater than or equal to the pressure in the static lines and the difference shall be within machmeter and airspeed indicator limitations.
- (3) Do not apply positive pressure to the static lines.
- (4) Electrical power to the autopilot shall be OFF.
- (5) In airplanes where more than one static source is employed in conjunction with one pitot source, the static sources must be evacuated simultaneously.

B. Equipment and Materials

- (1) Air pressure source, 0-15 inches of mercury, with adapter hose for connection to pitot head and gauge for measuring pressure. (See figure 201.)
- (2) Vacuum source, 0-19 inches of mercury, with fittings for connection to static line test fittings, pitot head, and gauges for measuring pressures. (See figure 201.)

C. Test Pitot Static System

- (1) Flush pitot static system.
 - (a) Disconnect all instruments and equipment connected to pitot or static lines. Disconnect the pitot tubes and static ports. Restrain all hoses to prevent whipping. Cap each hose or line and each tube or hose outlet.



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REVISION NOTICE NO.707-110

PITOT STATIC SYSTEM - ADJUSTMENT/TEST

Reason: Added the warning to remove the covers from the static ports.

Effectivity: All 707 Airplanes

When performing the PITOT-STATIC SYSTEM - ADJUSTMENT/TEST, do the following:

- (1) Remove the covers or vinyl adhesive tape from the static ports.

WARNING: FAILURE TO REMOVE THE VINYL ADHESIVE TAPE FROM STATIC PORTS BEFORE FLIGHT MAY CAUSE LARGE ERRORS IN AIRSPEED SENSING AND ALTITUDE SENSING SIGNALS, WHICH MAY LEAD TO LOSS OF SAFE FLIGHT.



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- (b) Uncap each pitot and static system line in turn and flush line with high flow rates for three minutes, but do not exceed 15 psig, and then recap.
 - (c) Uncap each static port and static port hose in turn, flush with high flow rates for three minutes, but do not exceed 15 psig, and then recap.
 - (d) Return all systems to normal.
- (2) Test pilot's pitot system for leakage.

- (a) Temporarily seal pressure chamber drain hole in the left pitot head and connect the air pressure supply to that pitot head.

CAUTION: THE PITOT PRESSURE SHALL ALWAYS EQUAL OR EXCEED STATIC LINE PRESSURE AND THE DIFFERENCE (DIFFERENTIAL PRESSURE) SHALL NOT EXCEED 10.00 INCHES OF MERCURY. THE DIFFERENTIAL PRESSURE DESCRIBED ABOVE SHALL NEVER FALL BELOW ZERO.

- (b) Gradually apply pressure of sufficient magnitude to cause the airspeed indicator to read approximately $3/4$ of full scale (approximately 300 knots, or 4.5 in. of Hg) and cut off the pressure source after the system has stabilized.
- (c) After one minute, airspeed indicator shall not have decreased more than five knots (.157 in. Hg).
- (d) Return system to normal.



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- (3) Test copilot's pitot system for leakage.
 - (a) Temporarily seal the pressure chamber drain hole in the right pitot head and connect the air pressure supply to that pitot head.
 - (b) Open the pitot shutoff valve.
 - (c) Repeat steps 1.C.(2)(b) thru (d) for copilot's pitot system.
- (4) Test pitot shutoff valve for leakage.
 - (a) Close pitot shutoff valve.
 - (b) Connect pressure gauge to test fitting on copilot's pitot line on remote side of pitot shutoff valve.
 - (c) Temporarily seal pressure chamber drain hole in the left pitot head and connect air pressure supply to that pitot head.
 - (d) Gradually apply air pressure of sufficient magnitude to cause airspeed to read approximately $3/4$ full scale approximately 300 knots, or 4.5 in. Hg. Observe pressure gauge on test fitting. Reading should be zero.
 - (e) Return system to normal.
- (5) Test pilot's static system for leakage.
 - (a) Connect test equipment static line to pilot's static system.
 - (b) Temporarily seal all the flush static ports for the static systems in such a manner that the seal will not extend into the ports more than the thickness of the skin.
 - (c) All instruments, sensors, pressure switches, flight recorders, etc., must be connected to the system for the following leakage test.

CAUTION: THE PITOT PRESSURE SHALL ALWAYS EQUAL OR EXCEED STATIC LINE PRESSURE AND THE DIFFERENCE (DIFFERENTIAL PRESSURE) SHALL NOT EXCEED 10.00 INCHES OF MERCURY. THE DIFFERENTIAL PRESSURE DESCRIBED ABOVE SHALL NEVER FALL BELOW ZERO. THE ABOVE PROCEDURE MUST BE CAREFULLY FOLLOWED TO PREVENT EXCESSIVE DIFFERENTIAL PRESSURES THAT WOULD CAUSE INSTRUMENT DAMAGE, AND/OR TO ENSURE VALID READINGS.



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- (d) Gradually apply a vacuum sufficient to cause the altimeter to indicate 22,500 feet (6.075 psi)
 - (e) During a one minute period, the altimeter reading shall not decrease more than 400 feet (6.180 psi).
 - (f) Return system to normal.
- (6) Test copilot's and auxiliary static systems for leakage.
- (a) Open pitot shutoff valve.
 - (b) Repeat steps 1 C (5)(a) thru (f) for copilot's and auxiliary static systems.

PITOT/STATIC SYSTEM - REMOVAL/INSTALLATION1. LEAK CHECK AFTER REMOVAL/INSTALLATION OF AIR DATA PRESSURE INSTRUMENTS

A Leak check is not required if only quick disconnects have been disconnected and reconnected for removal/installation of pitot/static equipments (Air Data Instruments included) provided the following conditions are fulfilled

- (1) Visual check of quick disconnect
- (2) Double check of actual mounting of replaced component
- (3) Check for proper mating of quick disconnects
- (4) Absence of leak check must be specified in the documents given to the crew

NOTE Deletion of leak check is never admitted if Removal/Installation of pitot/static equipment involves two independent systems

PITOT-STATIC SYSTEM MANIFOLD - MAINTENANCE PRACTICES

1. Removal/Installation Pitot-Static System Manifold

A Remove Manifold

- (1) Disconnect all tubing from manifold.
- (2) Remove two fastening bolts
- (3) Remove manifold.

NOTE. All ports shall be covered so that no foreign matter will contaminate the manifold or tubing.

B Prepare to Install Manifold

- (1) Remove protective covers
- (2) Check for any foreign matter in manifold or tubing

C. Install Manifold

- (1) Mount and secure manifold with two bolts
- (2) Connect all tubing

END

PITOT SHUTOFF VALVE - MAINTENANCE PRACTICES

1 Removal/Installation Pitot Shutoff Valve and Control Linkage

A Remove Pitot Shutoff Valve and Control Linkage (See figure 201)

- (1) Remove Vibrex fasteners from plastic panel around pitot shutoff valve operating handle. See Chapter 25, Equipment and Furnishings
- (2) Remove plastic panel
- (3) Disconnect actuator rod from yoke on shutoff valve.
- (4) Disconnect tubing from shutoff valve
- (5) Remove four mounting screws fastening shutoff valve to bracket.
- (6) Remove shutoff valve.
- (7) Remove control switch on pitot shutoff valve support in control cabin
- (8) Remove four bolts fastening support to airframe

CAUTION ELECTRICAL LEADS WILL BE DAMAGED IF SUPPORT TREATED ROUGHLY.

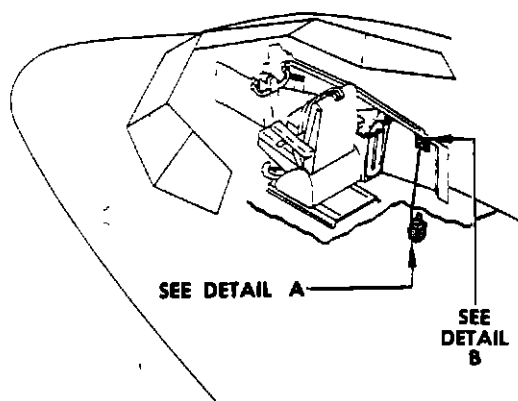
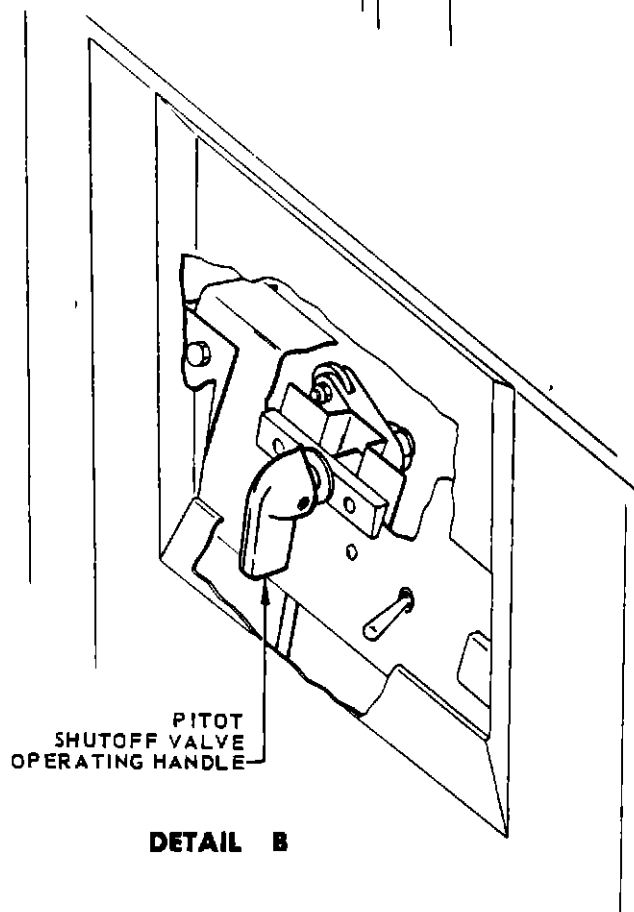
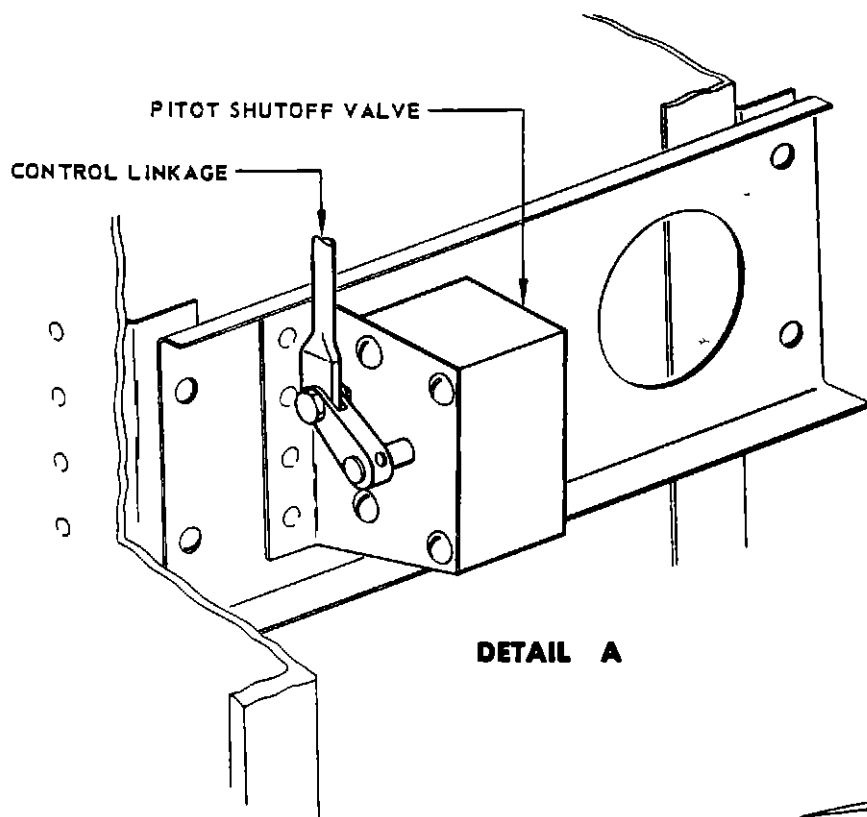
- (9) Remove cotter pin, nut, and shaft which fastens actuator rod to yoke

NOTE Hold actuator rod so it will not fall into lower 41 section

- (10) Remove nut from the control switch shaft Remove yoke. Remove control switch shaft

B Prepare to Install Pitot Shutoff Valve and Control Linkage

- (1) Remove all protective covers from ports on shutoff valve and tubing.



Pitot Shutoff Valve and Control Linkage Installation
Figure 201

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C Install Pitot Shutoff Valve and Control Linkage

- (1) Place shutoff valve on support bracket and mount with four mounting screws
- (2) Connect tubing to shutoff valve
- (3) Install yoke on shutoff valve shaft
- (4) Place actuator rod in position through deck (ends are reversible) and connect to yoke on shutoff valve shaft
- (5) Place shaft through support with shoulder against wedge, place washer on threaded end, and press yoke on to key. Install nut on shaft and locking screw on yoke
- (6) Connect yoke to actuator rod
- (7) Mount support to airframe with four bolts
- (8) Replace plastic panel.
- (9) Replace and tighten Vibrex fasteners.

24 AVR. 2003

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J. S. G. RUCS

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REVISION NOTICE 707-122

PITOT HEAD AND STATIC PRESSURE PORT

Reason: Added a bonding resistance check to the Pitot Head Removal/Installation procedure AMM 34-2-21/401 and the Static Pressure Port Removal/Installation procedure AMM 34-2-31/401.

Effectivity. All 707 airplanes.

Add these steps to the Pitot Head and Static Pressure Port installation procedures after the steps where you secure the head to the airplane with three mounting bolts and the port to the airplane with six rivets:

(1) For the Pitot Head (AMM 34-2-21/401):

- (a) Measure the resistance between the Pitot Head and the airplane skin with a bonding meter.
- (b) Make sure that the resistance is less than 0.010 ohm.

(2) For the Static Pressure Port (AMM 34-2-31/401):

- (a) Measure the resistance between the Static Pressure Port and the airplane skin with a bonding meter.
- (b) Make sure that the resistance is less than 0.010 ohm.

Jan 09/03

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2002/12/30 18 00.00 UTC

Chapter 34
Page 1 of 1

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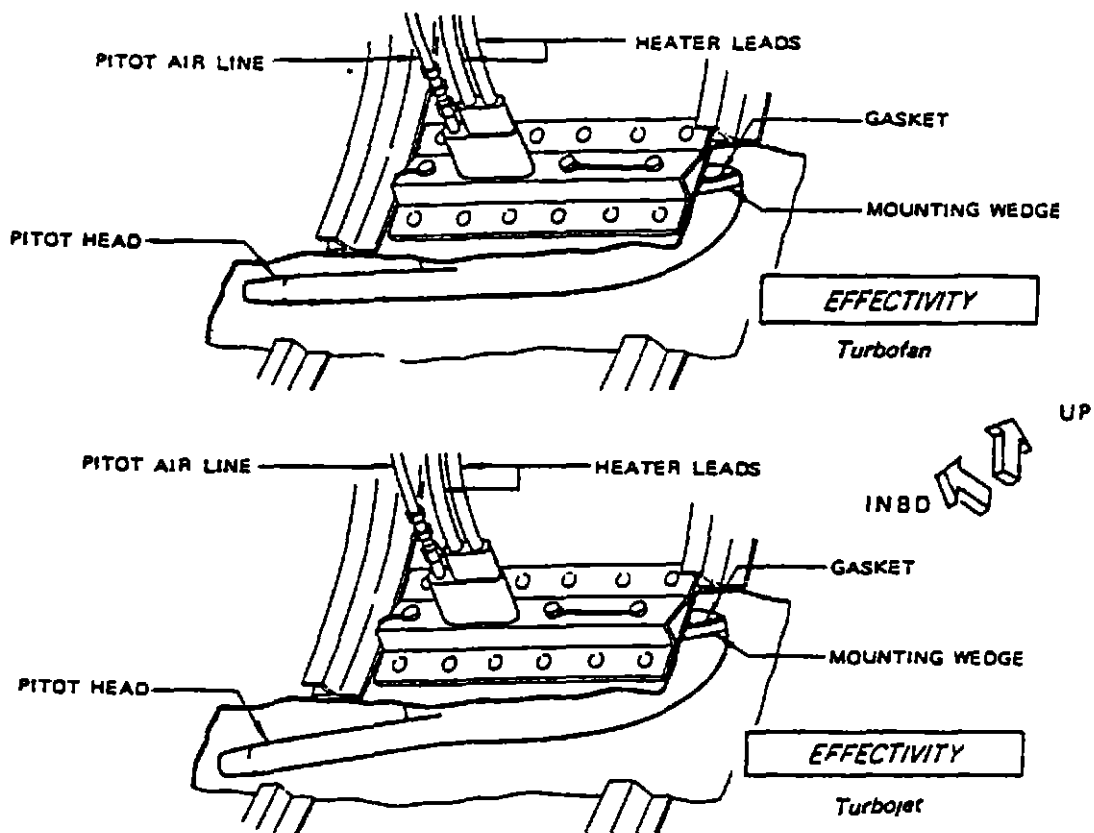
PITOT HEAD - REMOVAL/INSTALLATION

1. Equipment and Material

A. Bevel protractor and plumb bob.

2. Remove Pitot Head

- A. Hold pitot head to skin of airplane so it will not fall when unfastened.
B. Disconnect electrical and pitot air connectors. (See figure 401)
C. Remove three mounting bolts.
D. Remove pitot head, gasket, and mounting wedge.
E. Cap pitot line and cover electrical connector with protective cover.



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3. Prepare to Install Pitot Head

- A. Check gasket for aging and wear.
- B. Level airplane or determine relationship of waterline to level by hanging plumb bob in left wheel well. (See Chapter 8, Leveling and Weighing.)

4. Install Pitot Head

- A. Position mounting wedge and gasket on pitot head base.
- B. Position pitot head and install mounting bolts finger-tight.
- C. Calculate pitot head setting with respect to level.
 - (1) On airplanes with turbojet engines, with the pitot head P/N 10-60001-1 or 10-60001-2, the required pitot head setting is 6 (+ 1) degrees down from waterline reference. Angular variation between left and right pitot heads should not exceed 1 degree.
 - (2) On airplanes with turbojet engines, with the pitot head P/N 10-60702-2 or 10-60702-3, the required pitot head setting is from 2 to 6 degrees down from waterline reference. Angular variation between left and right pitot heads should not exceed 1°30' maximum.
 - (3) On airplanes with turbofan engines the required pitot head setting is 8 (+ 2) degrees down from waterline reference. Angular variation between left and right pitot heads should not exceed 2 degrees.

Example:

Relationship of waterline reference to level (as determined by plumb bob): 2 degrees tail down (if airplane is level, the angle is 0 degree).

Required pitot head setting with respect to waterline reference (see (2)): 8 degrees down.

Calculated pitot head setting with respect to level: 6 degrees down.

- D. On Turbojet airplanes, insert a 1/4-inch diameter straight rod approximately 12 inches long into the pitot head. On Turbofan airplanes, use a 3/16-inch diameter rod.
- E. Place the bevel protractor in a vertical position with protractor base in contact with the upper surface of the rod. Rotate pitot head assembly so that the forward end of the rod is inclined at the angle determined in 4.C.

NOTE: The mounting holes may be slotted to a maximum of 0.375 inches major diameter if required.

STATIC PRESSURE PORTS - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Leather Gasket (1) - MS28777-6
- B. O-ring (1) - MS28778-6
- C. Rivets (6) - MS20426D3

2. Remove Static Pressure Port

- A. Remove forward cargo compartment lining to gain access to static ports. See Chapter 25, Equipment and Furnishings.
- B. Disconnect static line tube from elbow.
- C. Loosen retaining nut and remove elbow from static port.
- D. Remove six rivets holding static port flange. See Chapter 51, Structural Repair Manual.
- E. Remove static port from interior of airplane.

3. Install Static Pressure Port

- A. Insert static port from interior of airplane.
- B. Rivet static port. See Chapter 51, Structural Repair Manual.
- C. Install new leather gasket and O-ring on threaded elbow connector.
- D. Screw elbow connector into static port and tighten retaining nut. (Assemble per AND10064).
- G. Deleted.
- H. Connect static line tube to elbow.
- I. Perform static system leakage test as outlined in 34-2-0 Page 201, Pitot Static System - Maintenance Practices.
- J. Install cargo compartment lining. See Chapter 25, Equipment and Furnishings.

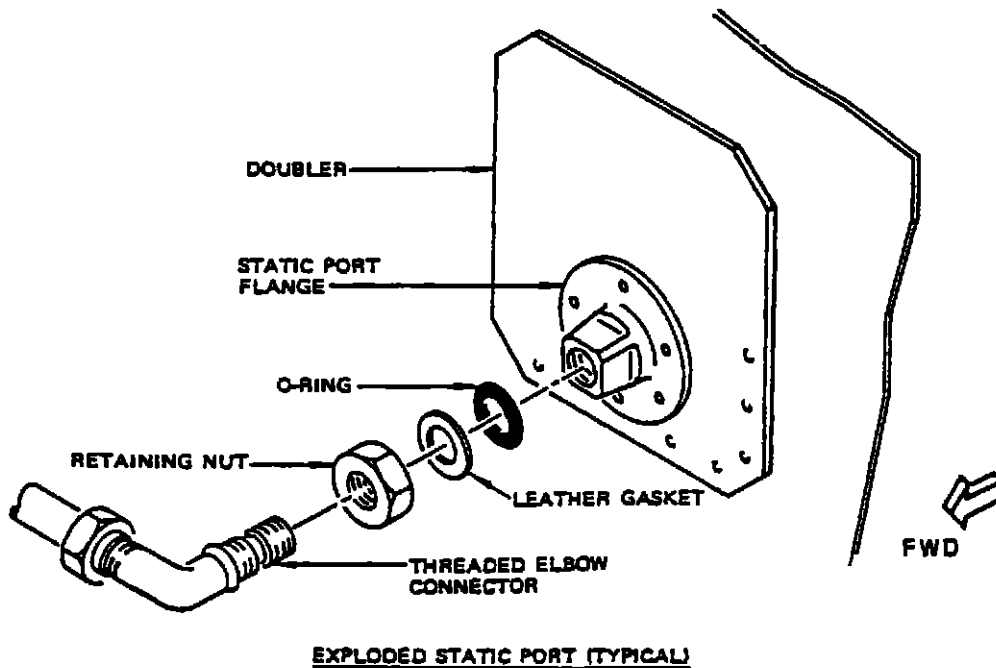
MAINTENANCE MANUAL

- K. Check RVSM Critical Area (Ref. to SRM 53-2-1) on both sides of aircraft.

NOTE: Dents must be smooth and free from sharp creases, gouges, or cracks and showing no evidence of pulled or loose rivets. If any, even the smallest damage is visible, check Structural Repair Manual for limits and repair solutions. Any airflow change in this area has a vital impact to accuracy of the RVSM system and may exclude operation in RVSM airspace.

- L. Perform static system leakage test as outlined in 34-2-0 Page 201, Pitot Static System - Maintenance Practices.

IICN 1P-AMMX-34-0030-01



Static Port Installation
Fig. 401

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REVISION NOTICE 707-122

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Effectivity All 707 airplanes.

Add these steps to the Pitot Head and Static Pressure Port installation procedures after the steps where you secure the head to the airplane with three mounting bolts and the port to the airplane with six rivets:

(1) For the Pitot Head (AMM 34-2-21/401).

- (a) Measure the resistance between the Pitot Head and the airplane skin with a bonding meter.
- (b) Make sure that the resistance is less than 0.010 ohm.

(2) For the Static Pressure Port (AMM 34-2-31/401):

- (a) Measure the resistance between the Static Pressure Port and the airplane skin with a bonding meter.
- (b) Make sure that the resistance is less than 0.010 ohm.

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STATIC PRESSURE PORT - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Leather Gasket (1) - MS28777-6
- B. O-ring (1) - MS28778-6
- C. Rivets (6) - MS20426D3

2. Remove Static Pressure Port

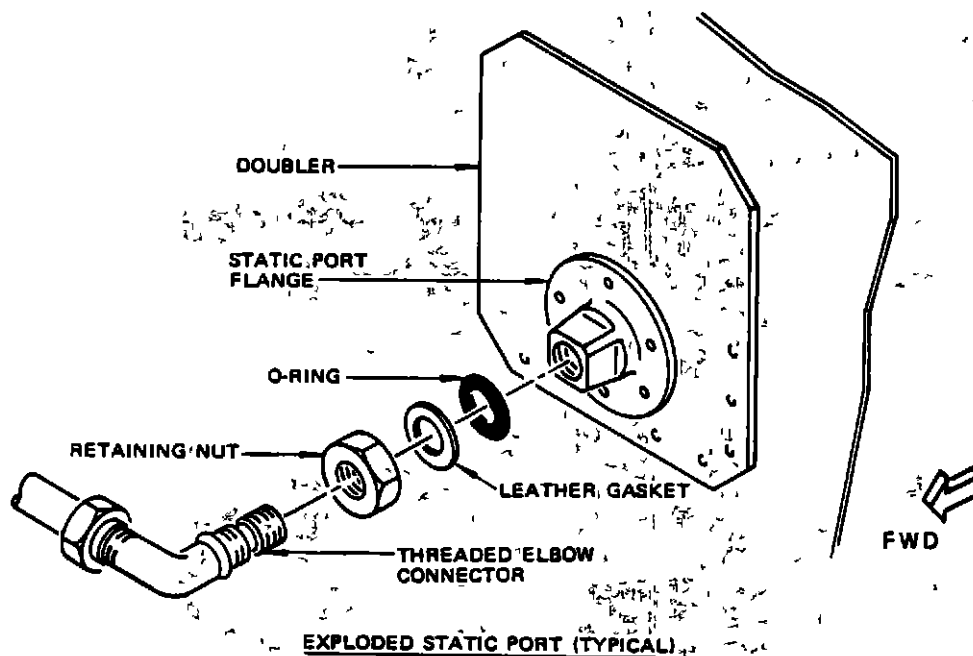
- A. Remove forward cargo compartment lining to gain access to static ports. See Chapter 25, Equipment and Furnishings.
- B. Disconnect static line tube from elbow.
- C. Loosen retaining nut and remove elbow from static port.
- D. Remove six rivets holding static port flange. See Chapter 51, Structural Repair Manual.
- E. Remove static port from interior of airplane.

3. Install Static Pressure Port

- A. Insert static port from interior of airplane.
- B. Rivet static port. See Chapter 51, Structural Repair Manual.
- C. Install new leather gasket and O-ring on threaded elbow connector.
- D. Screw elbow connector into static port and tighten retaining nut. (Assemble per AND10064.)
- E. Ports shall be shaved flush with the skin within +0.001/-0.000 inch.
- F. After installation, the surface of the skin and ports, for a distance of 3 inches forward and aft of each port centerline, shall be flush within 0.015 inch maximum, measured as the clearance between the skin and the edge of a 6-inch straightedge placed horizontally against the skin and centered on the port centerline. This measurement shall be taken across the center of the port and 1 inch above and below the port. All rivets within a 3-inch radius of each port shall be flush with the skin within +0.001/-0.000 inch.

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- G. On installation of the alternate static port, the surface of the port and the skin, for a distance of 3 inches forward and aft of the port centerline, shall be flush with the contour within ± 0.001 inch. The rivets shall be flush within $+0.001/-0.000$ inch. The port shall be shaved flush with the skin within $+0.001/-0.000$ inch.
- H. Connect static line tube to elbow.
- I. Install cargo compartment lining. See Chapter 25, Equipment and Furnishings.
- J. Perform static system leakage test as outlined in 34-2-0, Pitot Static System - Maintenance Practices.



Static Port Installation
Figure 401

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PITOT TUBE - INSPECTION/CHECK

1 Pitot Tube Inspection

When you perform the pitot tube-inspection/check, observe the steps that follow

A General

Fly Back limits

- (1) Replace the pitot tube for one or more of the conditions that follow
 - (a) The flight crew finds a cross-panel airspeed or attitude difference
 - (b) The pitot tube is out of tolerance
 - (c) There is mechanical damage
- (2) Do these steps when you see deterioration of the pitot tube
 - (a) You can dispatch the airplane from a base without maintenance facilities until one of the conditions that follow occur
 - 1) 24 hours elapse
 - 2) The airplane gets to a maintenance base
- (3) Listed below are the limits for damage to the inlet of pitot tubes
Any damage exceeding these limits is cause for removal of the pitot tube See 34-2-21, Pitot Head - Removal/Installation

NOTE All limits given below include tolerances caused by measurement techniques

B Equipment and Material

- (1) Optical micrometer or other suitable instrument

C Examine Pitot Tube

- (1) Transverse dents
 - (a) Directly measure diameter at the dented location and compare with the diameter of a dent-free region Depth of dents should not exceed 0.02 inch (See figure 601)

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(2) Axial erosion or dents

- (a) Measure and note the thickness of the leading edge at several places on the circumference of the inlet except those areas affected by local erosion or axial dents. If any of the measurements is greater than 0.01 inch, remove the pitot tube. If the measurements are less than 0.01 inch, place a suitable flat surface against the leading edge for reference purposes. Insert assorted Sages of wire, 0.02 inch diameter or less as determined from TABLE 1, between the flat plate and the inlet to determine the depth of the dent or axial erosion.
- (b) The depth of the dent should not exceed 0.02 inch when the inlet leading edge thickness is 0.004 (+ 0.001) inch. Refer to TABLE 1 for allowable dent depth with different leading edge thickness.

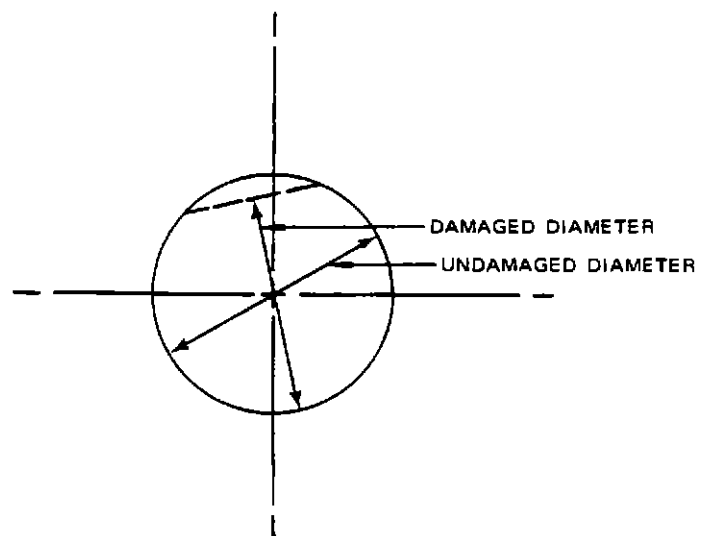
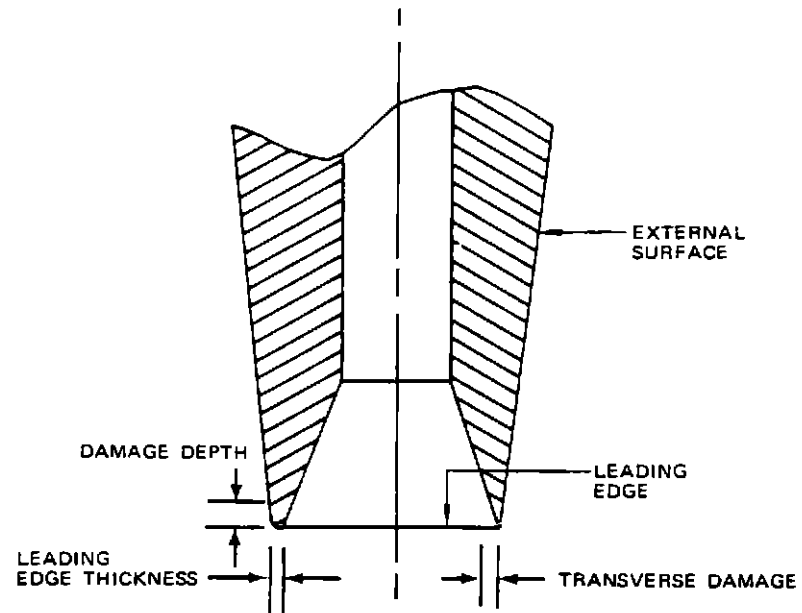
(3) Uniform erosion or uniform blunting

- (a) Directly measure the leading edge thickness. This should not exceed 0.01 inch.

TABLE 1

(All measurements in inches)

Measured Leading Edge Thickness	Allowable Dent Depth
0.0040	0.020
0.0050	0.018
0.0055	0.016
0.0065	0.014
0.0075	0.012
0.0080	0.010
0.0085	0.008
0.0095	0.006
0.0100	0.004





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PITOT-STATIC SYSTEM - DESCRIPTION AND OPERATION

EFFECTIVITY RTCA

LX-N19997

LX-N20000

1 General

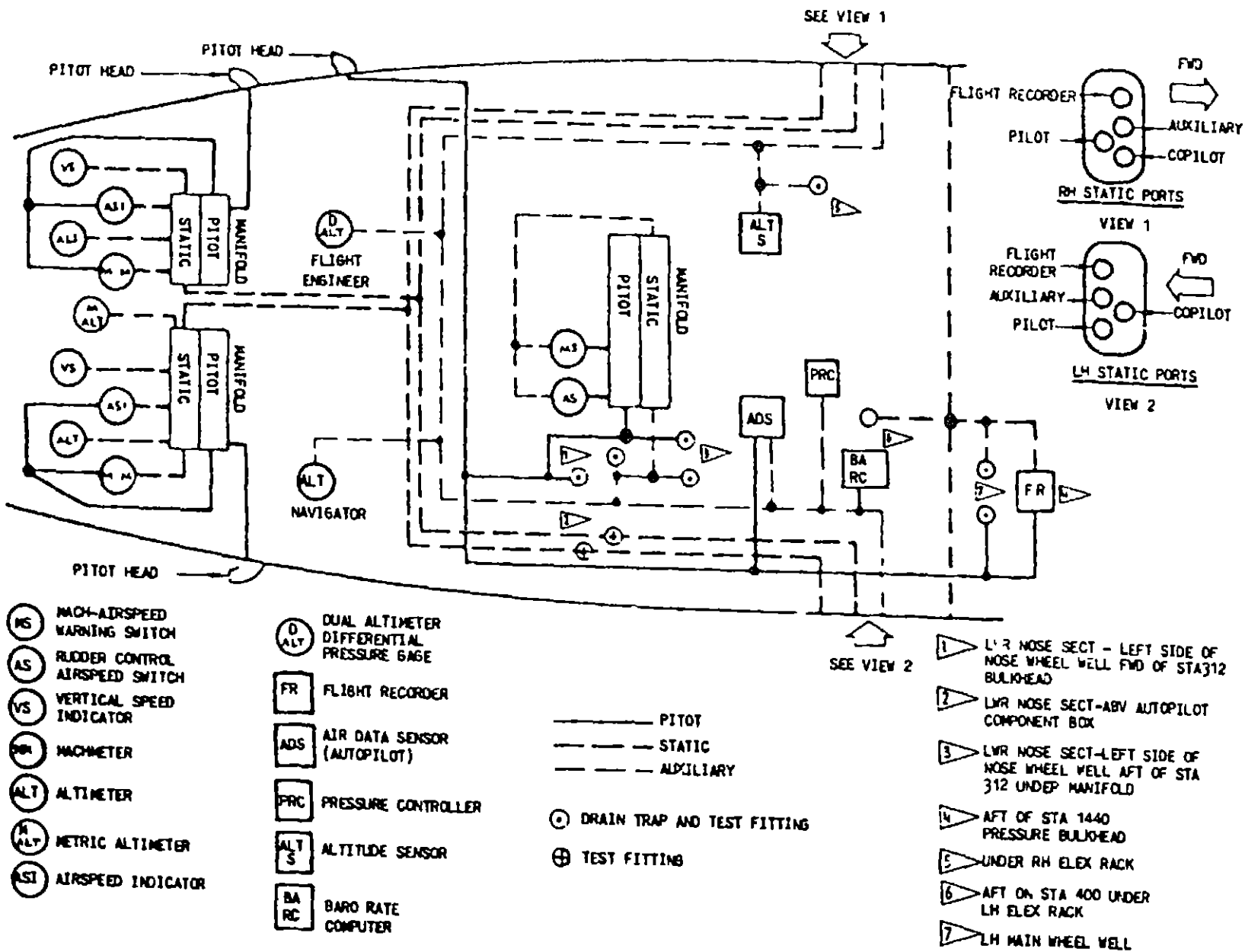
- A The pitot-static system is an installation of pitot heads and static ports connected by tubing to instruments for measuring or indicating dynamic and ambient air pressures. These pressures are used for determining airplane rate of climb, airspeed, altitude and mach number.
- B Dynamic air pressure from the pitot heads or ambient pressure from the static ports, or both, are supplied to the following instruments: airspeed indicators, airplane rate-of-climb indicators, altimeters, machmeters, flight recorder, cabin pressure automatic controller, autopilot air data sensor and the flight steering computer (see Fig 1).

2 Static System

- A Static pressure is sensed through the static ports. The location and connections to these static ports are shown in Figure 1.

3 Pitot System

- A The pitot heads are used to sense dynamic air pressure. The pitot heads are mounted externally on each side of the forward part of the fuselage. The pitot heads are not connected to each other. The location and connections are shown in Figure 1.
- B To de-ice the pitot heads during flight, a heater circuit is installed. The switch for the heaters is located on the overhead panel (P13).



Pitot Static System Schematic
Figure 1



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PITOT STATIC SYSTEMS - MAINTENANCE PRACTICES

EFFECTIVITY RTCA LX-N19997
 LX-N20000

1 Adjustment/Test Pitot Static System

A General

CAUTION THE FOLLOWING STAPS ARE REQUIRED TO PREVENT INSTRUMENT DAMAGE
 AND/OR TO ENSURE VALID HEADINGS

- (1) Any application or release of vacuum or pressure shall be made at a rate of climb or descent less than 5000 feet per minute
- (2) The pressure in the pitot lines shall always be greater than or equal to the pressure in the static lines and the difference shall be within machmeter and airspeed indicator limitations
- (3) Do not apply positive pressure to the static lines
- (4) Electrical power to the autopilot must be ON
- (5) In airplanes where more than one static source is employed in conjunction with one pitot source, the static sources must be evacuated simultaneously

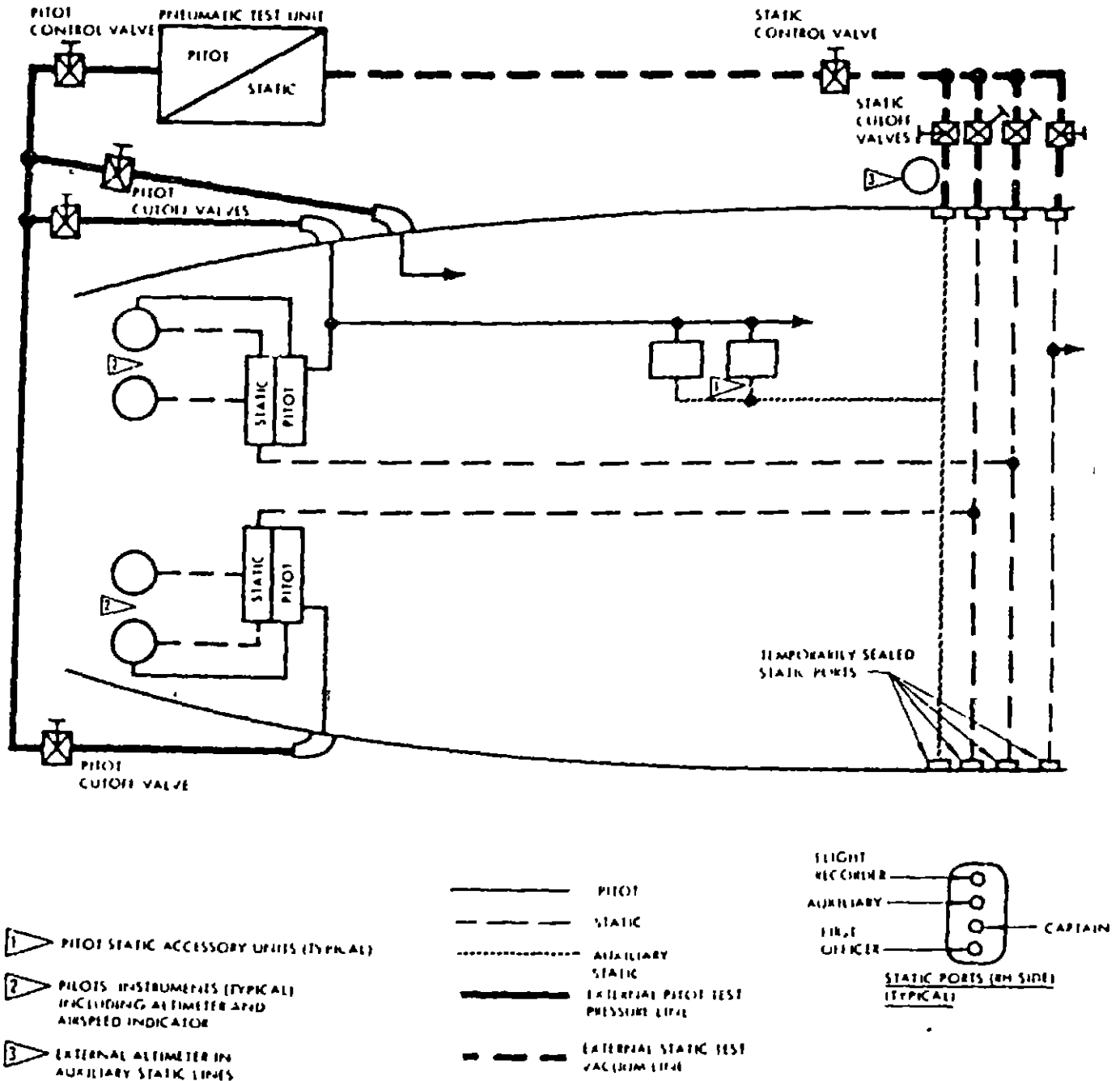
B Equipment and Materials

- (1) Air pressure source, 0-15 inches of mercury, with adapter hose for connection to pitot head and gauge for measuring pressure (See Figure 201)
- (2) Vacuum source, 0-19 inches of mercury, with fittings for connection to static line test fittings, pitot head, and gauges for measuring pressures (See Figure 201)

C Test Pitot Static System

- (1) Flush pitot static system
 - (a) Disconnect all instruments and equipment connected to pitot or static lines. Disconnect the pitot tubes and static ports. Restrain all hoses to prevent whipping. Cap each hose or line and each tube or hose outlet.

CAUTION EXERCISE CARE WHEN DISCONNECTING OR RECONNECTING
 FLIGHT RECORDER THAT FITTINGS IN RECORDER ARE NOT
 ALLOWED TO TURN. GOOD CONNECTIONS MUST BE MADE SINCE
 THERE IS NO MEANS OF TESTING CONNECTIONS FOR LEAKAGE



Pitot Static System Test Apparatus Schematic
(Typical)
Figure 201



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- (b) Uncap each pitot and static system line in turn and flush line with high flow rates for three minutes, but do not exceed 15 psig, and then recap
 - (c) Uncap each static port and static port hose in turn, flush with high flow rates for three minutes, but do not exceed 15 psig, and then recap
 - (d) Return all systems to normal
- (2) Test pilot's system for leakage
- (a) Temporarily seal pressure chamber drain hole in the left pitot head and connect the air pressure supply to that pitot head
- CAUTION** THE PITOT PRESSURE SHALL ALWAYS BE EQUAL OR EXCEED STATIC LINE PRESSURE AND THE DIFFERENCE (DIFFERENTIAL PRESSURE) SHALL NOT EXCEED 10 00 INCHES OF MERCURY THE DIFFERENTIAL PRESSURE DESCRIBED ABOVE SHALL NEVER FALL BELOW ZERO
- (b) Gradually apply pressure of sufficient magnitude to cause the airspeed indicator to read approximately 3/4 of full scale (approximately 300 knots, or 4 5 in of Hg) and cut off the pressure source after the system has stabilized.
 - (c) After one minute, airspeed indicator shall not have decreased more than five knots (157 in Hg)
 - (d) Return system to normal
- (3) Test copilot's pitot system and third pitot system for leakage
- (a) Temporarily seal pressure chamber drain hole in the right pitot heads and connect the air pressure supply to each pitot head in turn
 - (b) Repeat steps 1 C (2) (b) thru (d) for copilot's pitot system and for third pitot system
- (4) Test pilot's static system for leakage
- (a) Connect test equipment static line to pilot's static system
 - (b) Temporarily seal all the flush static ports for the static systems in such a manner that the seal will not extend into the ports more than the thickness of the skin
 - (c) All instruments, sensors, pressure switches , etc , must be connected to the system for the following leakage tests



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CAUTION

THE PITOT PRESSURE SHALL ALWAYS EQUAL OR EXCEED STATIC LINE PRESSURE AND THE DIFFERENCE (DIFFERENTIAL PRESSURE) SHALL NOT EXCEED 10 00 INCHES OF MERCURY THE DIFFERENTIAL PRESSURE DESCRIBED ABOVE SHALL NEVER FALL BELOW ZERO THE ABOVE PROCEDURE MUST BE CAREFULLY FOLLOWED TO PREVENT EXCESSIVE DIFFERENTIAL PRESSURES THAT WOULD CAUSE INSTRUMENT DAMAGE AND/OR TO ENSURE VALID READINGS

- (d)* Gradually apply a vacuum sufficient to cause the altimeter to indicate 7000 After the vacuum pressure has stabilized, cut off the vacuum.
- (e)* During a three minute period, the altimeter reading shall not decrease more than 100 feet
- (f) Return system to normal
- (5) Test copilot's and auxiliary static systems for leakage
 - (a) Repeat steps 1 C (4) (a) thru (f) for copilot's and auxiliary static systems
- (6) Test Flight Recorder Static Source
 - (a) Flight recorder must be ON or tape removed
 - (b) Repeat steps 1 C (4) (c) thru (f) for flight recorder static source
- * For S Check
 - Altitude 23000 ft
 - Leak 100 ft/min

PITOT HEAD - MAINTENANCE PRACTICES

**EFFECTIVITY RTCA LX-N19997
LX-N20000**

1 Removal and Installation of Pitot Head

A Equipment and Material

- (1) Bevel protractor with spirit level
- (2) Plumb bob to ascertain pitch angle of airplane
- (3) Sealant BMS 5-12, type B Sealant-Minnesota, Mining & Mfg Co ,
St Paul, Minnesota, P/N EC-1239-B-8 (or similar)

B Removal of Pitot Head

- (1) Hold pitot head to outer skin of airplane using insulation tape so
that it will not fall when unfastened from inside
- (2) Disconnect electrical and pitot air connections
- (3) Remove three mounting bolts
- (4) Remove pitot head gasket and mounting wedge
- (5) Cap pitot line and cover electrical connections with protective cover

C Prepare to Install Pitot Head

- (1) Check gasket for ageing and wear Do not use again if brittle
- (2) Level airplane or determine relationship of waterline to level by
hanging plumb bob in left wheel well (See Chapter 8 Leveling and
Weighing)
- (3) Remove all remains of the gasket from the outer skin of the airplane
and from the mounting wedge

D Install Pitot Head

- (1) Position mounting wedge and gasket on pitot head base
- (2) Position pitot head and install three mounting bolts finger-tight so
that the pitot head can still be moved slightly
- (3) On pitot heads P/N H-1027-1 and -2 insert a 1/4" (= 0 3 mm) diameter

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ANGLE OF ATTACK INDICATION - DESCRIPTION AND OPERATION

1 General

A The angle of attack indicating system consists of two transmitters with heated probes, one on each side of the forward fuselage, and two indicators mounted on the pilot and copilot panels. The indicators display relative angle of attack data by combining analog signals from the angle of attack transmitters and flap position transmitters. The two indicator systems are completely independent and isolated from one another. There is no averaging of indications for sideslip.

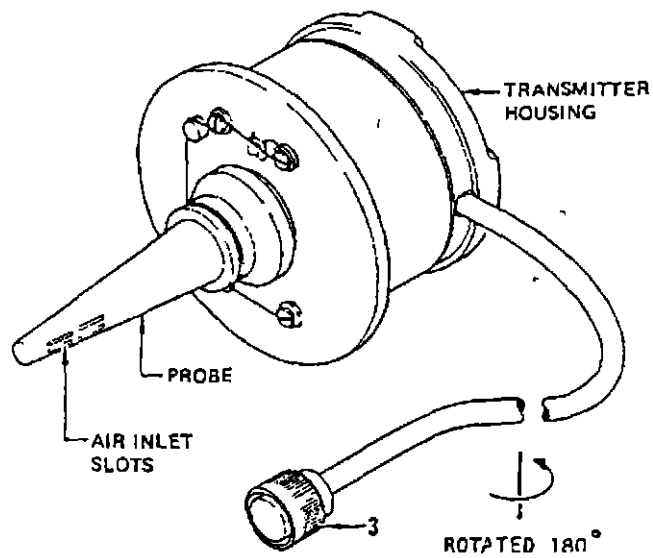
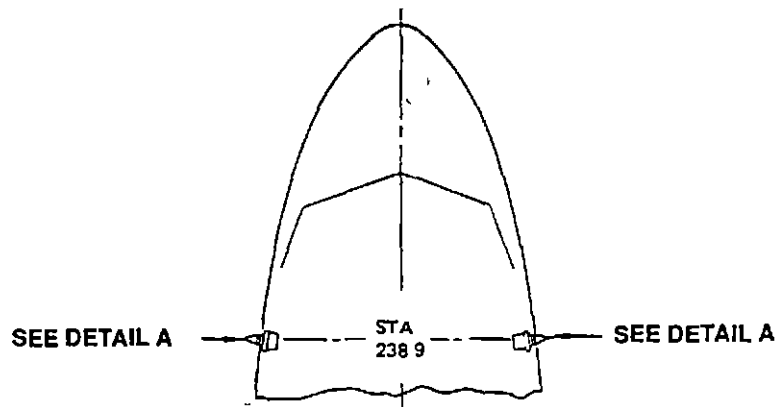
B Angle of Attack Transmitters

Each angle of attack transmitter is mounted internally with its probe projecting into the airstream to detect and transmit changes in local angle of attack. (See figure 1.) As the local airflow about the airplane fuselage changes, the probe paddle rotates, driving the wiper arms of the potentiometers clockwise or counterclockwise, depending on the directional airflow. The voltages at the wiper arms reflect the angle of local airflow relative to the fuselage referenced within ± 0.2 degree, provided the airspeed is above 90 knots. Two heater circuits are provided, one for the transmitter case and one for the probe. (See figure 3.) The heater power is 115-volts ac, 400 Hz. The left and right transmitters are interchangeable.

C Angle of Attack Indicators

Two angle of attack indicators are installed, one on the pilot panel and one on the copilot panel. (See figure 2.) The indicators display relative angle of attack data by combining analog signals from the external angle of attack transmitter and flap position switches, and positioning a closed servo-loop indicator. The transmitter signals are modified by the flap position signals to provide a normalized display on the indicator dial. (See figure 4.) An interface senses changes in the position of the followup potentiometer and drives the FAST-SLOW indicator on the flight director to indicate the appropriate speed needed to hold the approach angle of attack. The FAST-SLOW indicator functions only at 50° flaps, otherwise it is biased out of view.

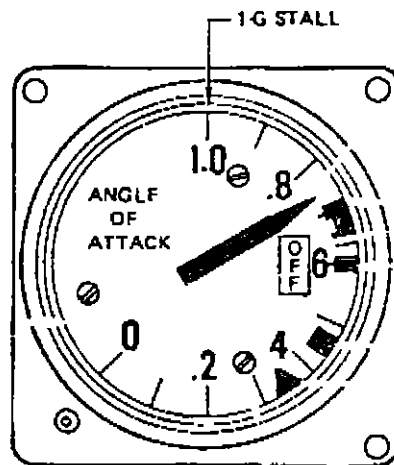
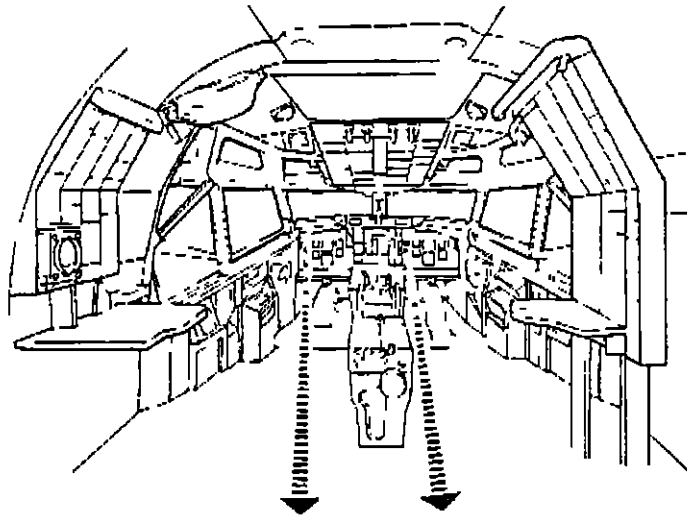
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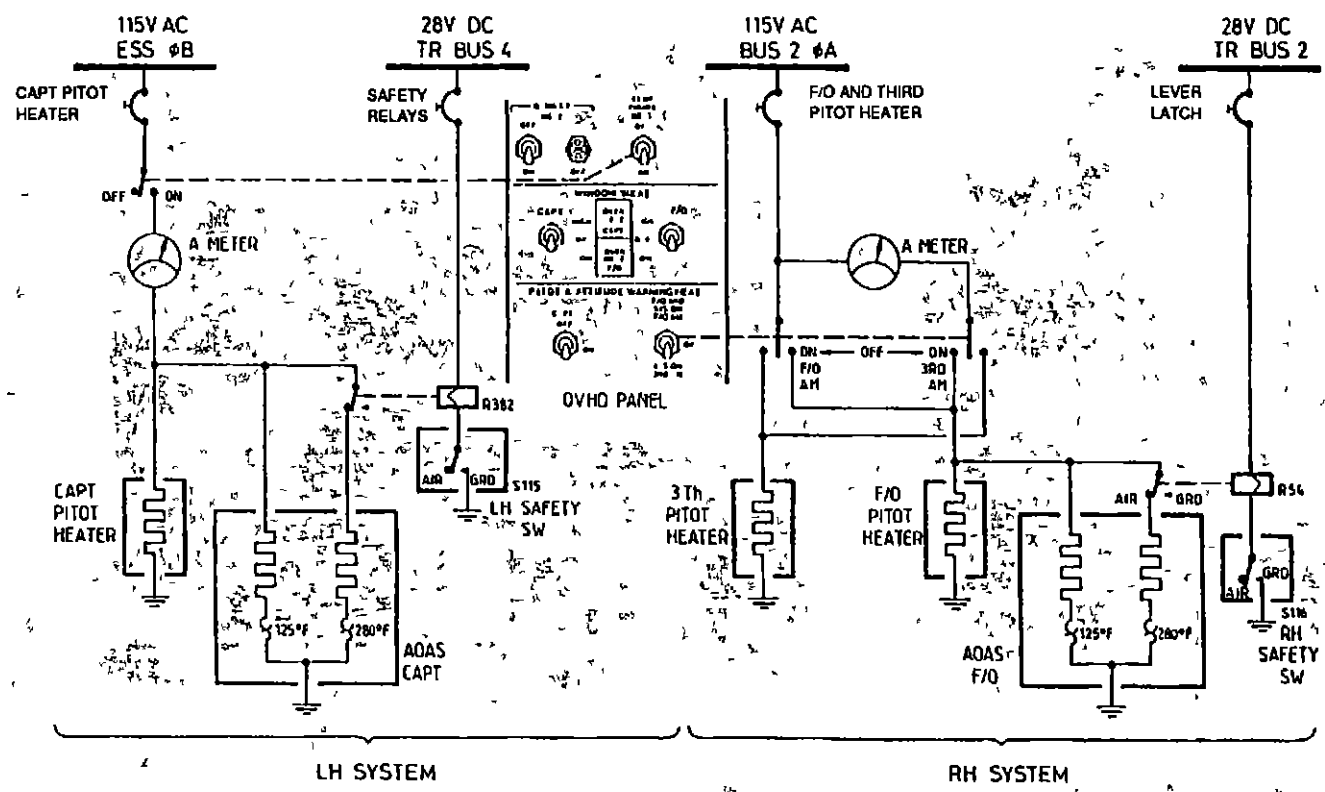
DETAIL A

Angle of Attack Transmitters
 Figure 1

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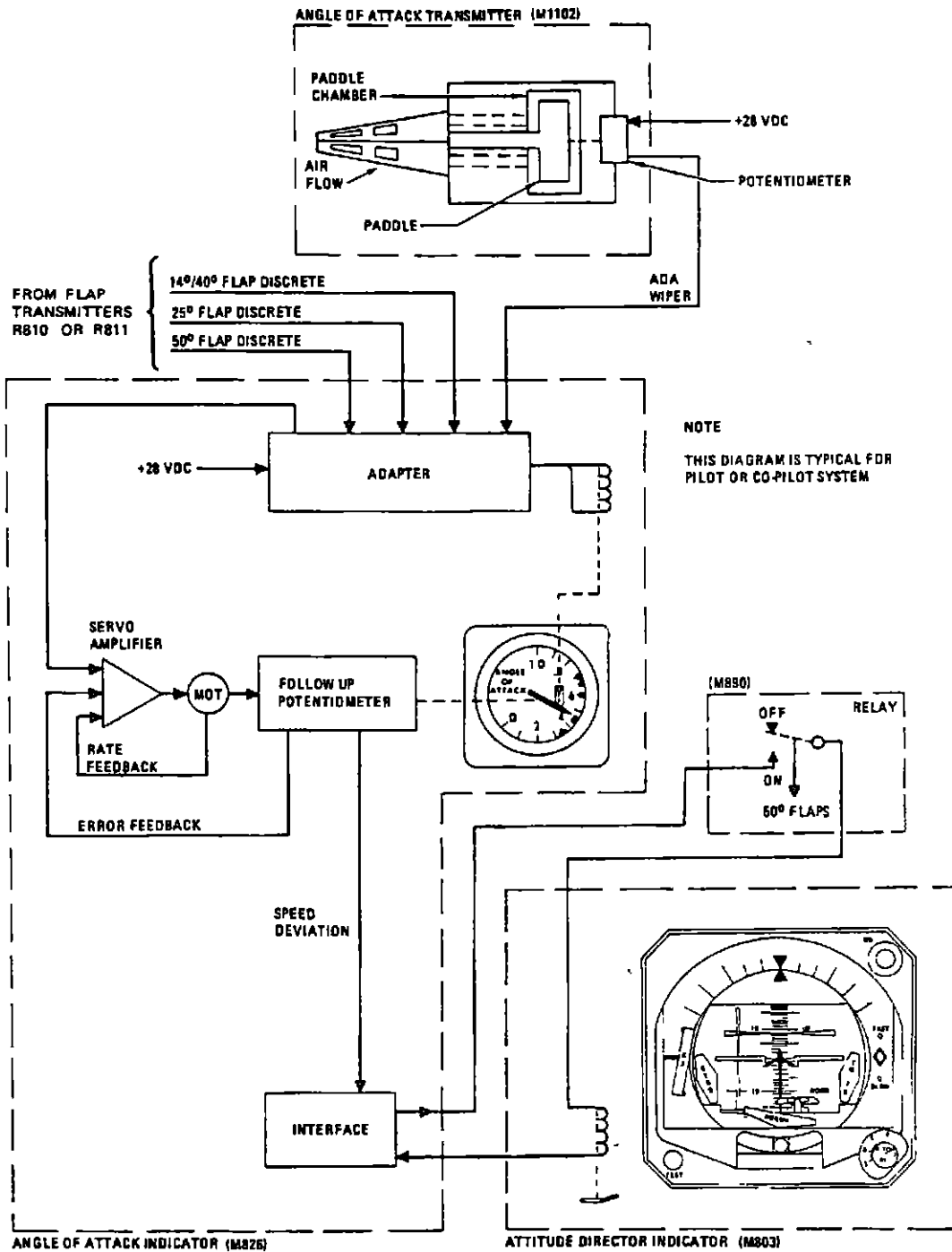


Angle of Attack Indicators
Figure 2



Angle of Attack - Probe heating
Figure 3

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Angle of Attack - Schematic
Figure 4

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ANGLE OF ATTACK INDICATING SYSTEM - TROUBLE SHOOTING

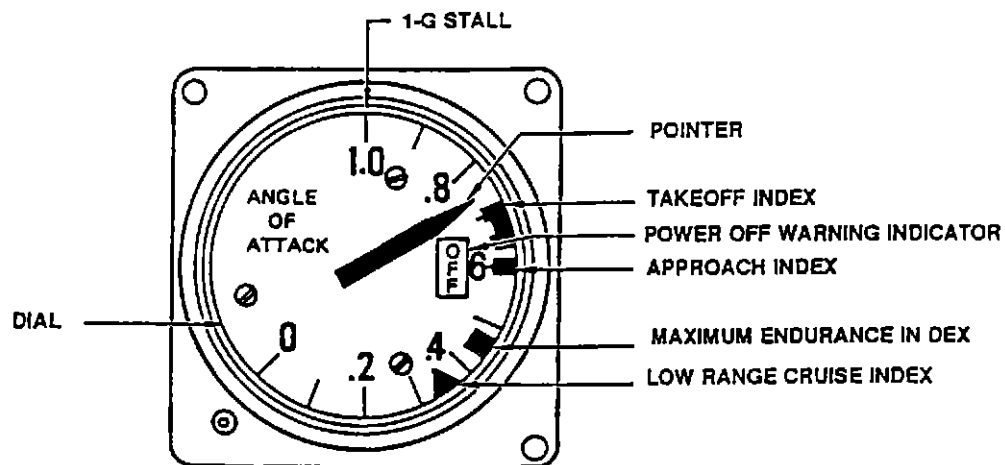
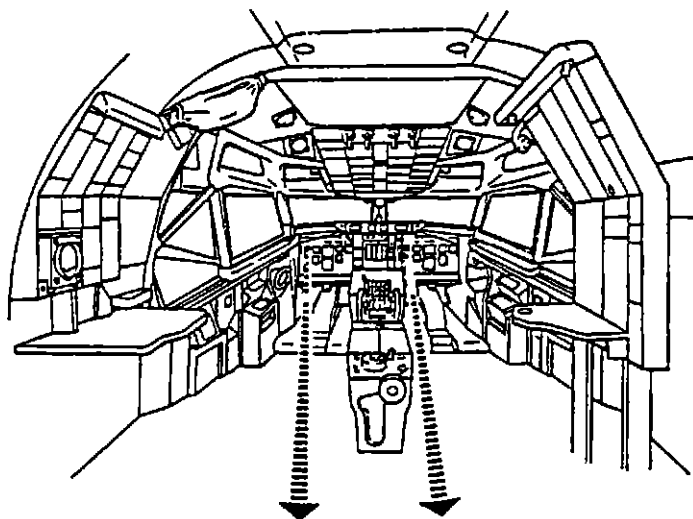
REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Indicator pointer does not move when power is on	Open power circuit.	Check ANGLE ATTACK CAPT and F/O circuit breakers on P5 circuit breaker panel	Close circuit breaker. Observe power off flag on indicator
	Defective transmitter	Disconnect electrical connector from transmitter. Check transmitter with multimeter between pins A and B of transmitter. Meter indication should indicate 2200 ± 300 ohms. Check pins A to C with multimeter and slowly rotate probe. Multimeter indicator should vary from 0 to 2000 ohms, if transmitter checks OK. If no indication on multimeter	Replace indicator Replace transmitter
	Defective indicator		Replace indicator
	Open circuit	Check TAT, CAPT & F/O ANGLE ATTACK circuit breakers respectively on P3 and P5 panels	Close circuit breaker
Probe heater or transmitter case heater does not heat	Defective probe heater	Disconnect electrical connector from transmitter and place a multimeter between pins H and M of transmitter. Meter indication should be 117.5 ± 22.5 ohms. If no indication on multimeter either probe heater or thermal switch is fault.	Replace transmitter
	Defective transmitter case heater	Disconnect electrical connector from transmitter and place a multimeter between pins G and M of transmitter. Multimeter indication should be 260 ± 26 ohms. If no indication on multimeter either probe heater or thermal switch is faulty.	Replace transmitter
	Defective wiring	Check wiring.	Repair wiring

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ANGLE OF ATTACK INDICATING SYSTEM - REMOVAL/INSTALLATION

- 1 Angle of Attack Indicator Removal. (See figure 401.)
 - A Open applicable ANGLE ATTACK-CAPT or -F/O circuit breaker on P5 circuit breaker panel
 - B. Remove the three retaining screws on the face of the indicator and carefully pull indicator out of pilot or copilot panel until connector clears the panel.
 - C Disconnect electrical connector and install protective cap, ensuring that it remains accessible.
- 2 Angle of Attack Indicator Installation. (See figure 401.)
 - A Verify that the applicable ANGLE ATTACK-CAPT or -F/O circuit breaker on P5 overhead panel is open
 - B. Remove protective cap from connector and connect to indicator
 - C Insert the angle of attack indicator into its place in the applicable pilot or copilot panel and secure with the three retaining screws
 - D. Reset circuit breaker called out in step A
 - E. Perform operational checkout of indicators per 34-3-71 Adjustment/Test.
 - F. Remove electrical power from aircraft, if no longer required for other maintenance.
- 3 Angle of Attack Transmitter Removal (See figure 402)
 - A. Open applicable ANGLE ATTACK CAPT or F/O circuit breaker (Left No. 1, Right N° 2) on the P5 circuit breaker panel. Open CAPT PITOT HEATER (P2 panel) -F/O AND THIRD PITOT HEATER (P2 panel) and TAT (P3 panel) circuit breakers
 - B. Remove the six screws on the sidewall cover plate (5, figure 402) behind the pilot or copilot seat at floor level. Retain hardware for reinstallation.
 - C. Remove the bonding jumper (4) from the attaching lug on the inboard side of the transmitter housing. Retain hardware for reinstallation.
 - D. Disconnect the electrical connector (3) from the mating receptacle on the airplane structure forward of the transmitter. Disconnect harness clamp on lead and cap aircraft wiring connector.

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Angle of Attack Indicator
Figure 401

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- E Remove the four self-locking nuts (6) and step washers (7) from the holddown studs retaining the transmitter.

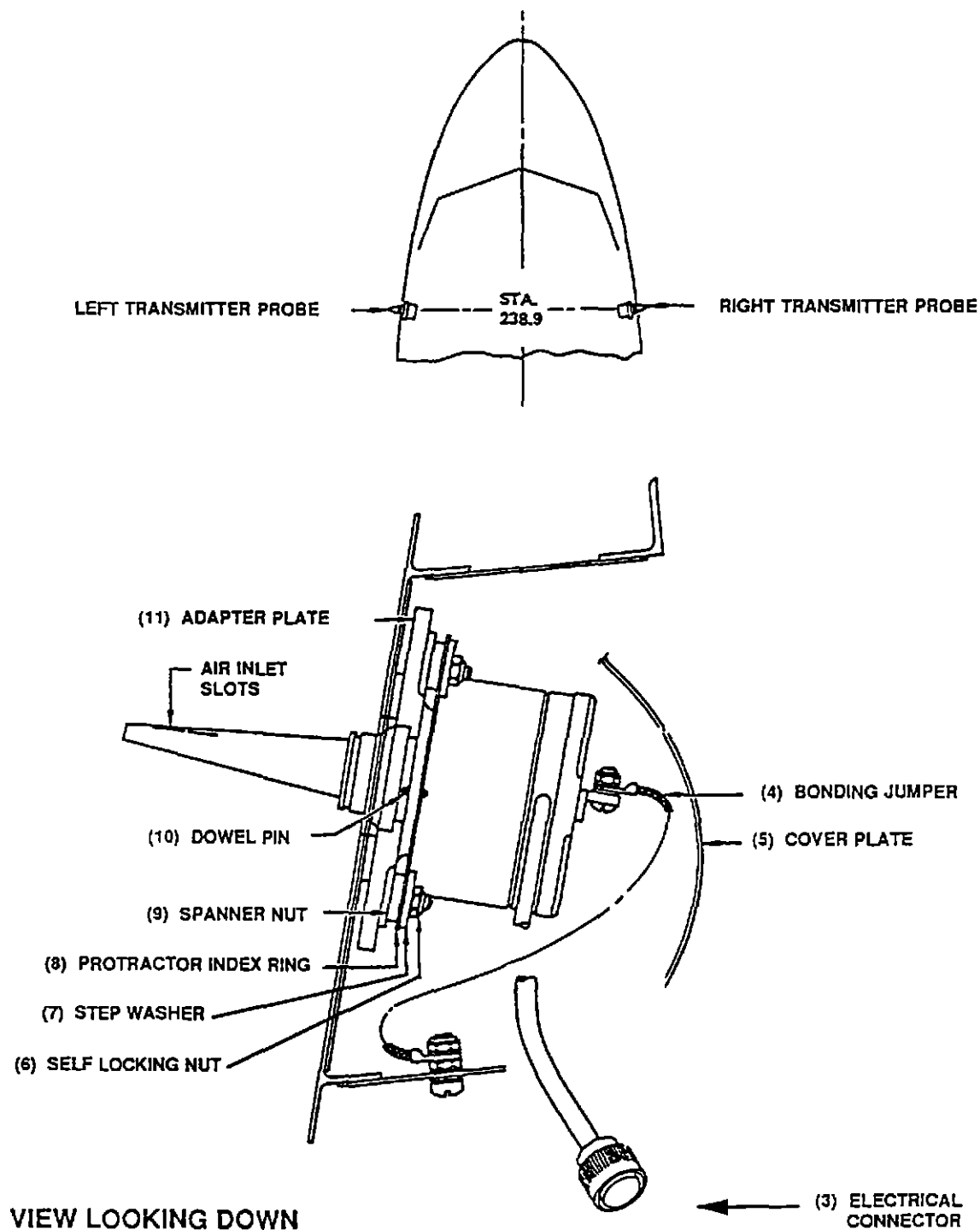
CAUTION: AT THIS POINT DO NOT MOVE THE LARGER SPANNER NUTS (9) RETAINING THE ADAPTER PLATE (11) UNDER THE INDEX RING (8)

- F Move inboard the inner protractor index ring (8) from around the transmitter housing approximately one inch.
- G Carefully pull the transmitter inboard from its position in the adapter plate and remove together with the protractor index ring

4 Angle of Attack Transmitter Installation. (See figure 402)

- A. Verify that the applicable ANGLE ATTACK CAPT or F/O circuit breaker on the P5 circuit breaker panel and the CAPT PITOT HEATER (P2 panel) -F/O AND THIRD PITOT HEATER (P2 panel) and TAT (P3 panel) circuit breakers are open
- B Position the transmitter with the protractor index ring loose around the housing into the adapter plate (11, figure 402), carefully aligning the two dowel pins (10) at the upper and lower sides of the transmitter, with the probe slots facing forward.
- C. Position the index ring (8) over the inner ends of the dowel pins (10). The upper dowel pin will be placed through the 10° mark on the protractor scale.
- D Install four step washers (7) and self-lock nuts (6) on the retainer studs and tighten.
- E Clean bonding surfaces. Attach the bonding jumper (4) to the transmitter lug, utilizing hardware previously removed.
- F. Uncap aircraft wiring connector and connect to transmitter. Attach harness clamp on lead.
- G. Replace sidewall cover utilizing six screws.
- H. Reset circuit breakers called out in step A.
- I. Perform operational check of transmitter per 34-3-71- Adjustment/Test

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Angle of Attack Transmitter
 Figure 402

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ANGLE OF ATTACK INDICATING SYSTEM - ADJUSTMENT/TEST

1 Tools and Test Equipment

A Refer to Figure 501 for a listing of the required tools and test equipment

PART NO OR TYPE DESIGNATOR	FIGURE AND INDEX NO	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation			
<u>TOOLS</u>			
GGG-W-00686		Torque Wrench (0 to 150 inch-pounds)	Flap position trans- mitter adjustments
<u>TEST EQUIPMENT</u>			
TTU-23/E		Synchro Test Set	Check flap position indicator
204-91926-5 (No Substitute)		Synchro Cable Set	Check flap position indicator
123T105 Teledyne		Torque Tester	Check angle of attack probe
AN/PSM-6 (Simpson 260)		Multimeter	Flap position checkout
B1		Maintenance Platform	Angle of attack checkout.
H133C/AIC (2 required)		Headset and Microphone	Interphone communi- cations
F52266		Microphone Headset Cordage	Used with headset
MIL-S-14823		Stopwatch	Timing procedures for flight instru- ments

Flight Instruments Tools and Equipment

Figure 501

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2 Operational Checkout.

A Check angle of attack transmitter and indicator as follows

WARNING - ENSURE THAT PROBE HEATERS HAVE BEEN OFF AT LEAST 30 MINUTES PRIOR TO CHECKOUT. USE EXTREME CAUTION WHEN TOUCHING PROBES TO AVOID PERSONNAL INJURY

(1) Provide electrical power to aircraft.

(2) Establish communications.

WARNING. VERIFY THAT WING AREAS ARE CLEAR OF PERSONNEL, WORK STANDS, TOOLS AND OTHER EQUIPMENT TO ENSURE SAFE OPERATION OF THE WING FLAP SYSTEM BEFORE EXTENDING OR RETRACTING FLAPS

(3) Press HYDRAULIC - AUXILIARY - PUMP 1 RUD/SPOIL switch

(4) Set HYDRAULIC - INTCON VALVE switch to SYS position

(5) Verify RUD HYD PRESS gage indicates approximately 2800 PSI

(6) Verify that the flaps are up and the flap control handle is at 0°

(7) Verify that ANGLE ATTACK CAPT and F/O, FLIGHT INSTRUMENT NO 1 - FLT DIR - DC and FLIGHT INSTRUMENT NO 2 - FLT DIR - DC circuit breakers on P5 circuit breaker panel are closed

(8) Verify that the red OFF flag on each indicator has disappeared

NOTE: Perform step (9) for left angle of attack transmitter and indicator checkout. Perform step (10) for right angle of attack transmitter and indicator checkout

(9) Check left angle of attack transmitter and indicator as follows:

(a) Slide 123T105 torque tester over left angle of attack transmitter probe. Verify that probe rotates freely to its mechanical stops approximately ± 20 degrees. When probe is rotated to full counter-clockwise position, the indicator shall read more than 10. When tester is reversed and probe is rotated to full clockwise position, the indicator shall read less than 0.1

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NOTE To hold probe fully clockwise, position torque tester so that built-in lead weight is at 3 o'clock position

- (b) While holding probe at full clockwise position, set flaps to positions listed below. Verify that angle of attack indicator pointer is within ± 0.05 of each listing

Flap Position	AOA Indicator
14°	0.275
25°	0.3
40°	0.275
50°	0.225

- (c) Remove torque tester from angle of attack probe

- (d) While rotating the probe slowly by hand, in order to move the angle of attack indicator pointer through the range of 0.5 to 0.7, observe that the attitude director fast-slow pointer moves as shown below

AOA Indicator	Fast-Slow Pointer
0.5	Aligned with FAST (+ one pointer width)
0.6	Centered (+ 1/2 pointer width)
0.7	Aligned with LOW (+ one pointer width)

- (e) With angle of attack indicator pointer set to 0.7, set flaps to 40°, 25°, 14°, 0°. The flight director fast-slow pointer shall be biased out of view at each position (in view only at 50°)
- (f) Set flaps to zero
- (g) Perform steps 11, 12 and 13 if the right system is not being checked

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(10) Check right angle of attack transmitter and indicator as follows

- (a) Slide 123T105 torque tester over right angle of attack transmitter probe. Verify that probe rotates freely to its mechanical stops, approximately ± 20 degrees. When probe is rotated to full clockwise position, the indicator shall read more than 10. When tester is reversed and probe is rotated to full counterclockwise position, the indicator shall read less than 0.1.

NOTE: To hold probe fully counterclockwise, position torque tester so that built-in lead weight is at 9 o'clock position.

- (b) While holding probe at the full counterclockwise position, set flaps as described in step 9 (b) above and note the corresponding indicator reading.
- (c) Remove torque tester from angle of attack probe.
- (d) While rotating the right probe slowly by hand, repeat the procedure described in step 9 (d) above.
- (e) With angle of attack indicator pointer set to 0.7, set flaps to 40°, 25°, 14°, 0°. The fast-slow pointer on the flight director shall be biased out of view at each position (in view only at 50°).
- (f) Set flaps to zero.
- (11) Open ANGLE ATTACK CAPT and F/O, FLIGHT INSTRUMENT NO. 1 - FLT DIR - DC and FLIGHT INSTRUMENT NO. 2 - FLT DIR - DC circuit breakers on P5 overhead panel.
- (a) Press HYDRAULIC - AUX PUMPS - 1 RUD/SPOIL switchlight to deenergize auxiliary pump number 1.
- (b) Set HYDRAULIC - INTCON VALVE switch to OFF.

(12) Check probe heating as follows

CAUTION ENSURE PITOT PROBE COVERS ARE REMOVED BEFORE TURNING ON PROBE HEATERS.

- (a) Ensure that the CAPT PITOT and F/O & THIRD PITOT HEATER circuit breakers located on P2 panel are closed.

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(b) RIGHT TAT & ANGLE ATTACK F/O

(c) CMDR PITOT & ANGLE ATTACK CAPT

WARNING USE EXTREME CAUTION WHEN TOUCHING PROBES TO AVOID PERSONNEL INJURY

(d) Set both PROBE HEATERS switches on P-13 overhead panel to ON and immediately touch each probe to verify that they are starting to warm up Set probe heater switches OFF

(13) Remove electrical power from aircraft if not required for other maintenance



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VERTICAL GYRO SYSTEM - DESCRIPTION AND OPERATION

1 General

- A The vertical gyros provide both a roll and a pitch reference for the instruments in the flight director system, weather radar antenna tilt control system and the autopilot
- B. Two vertical gyros are installed in the airplane

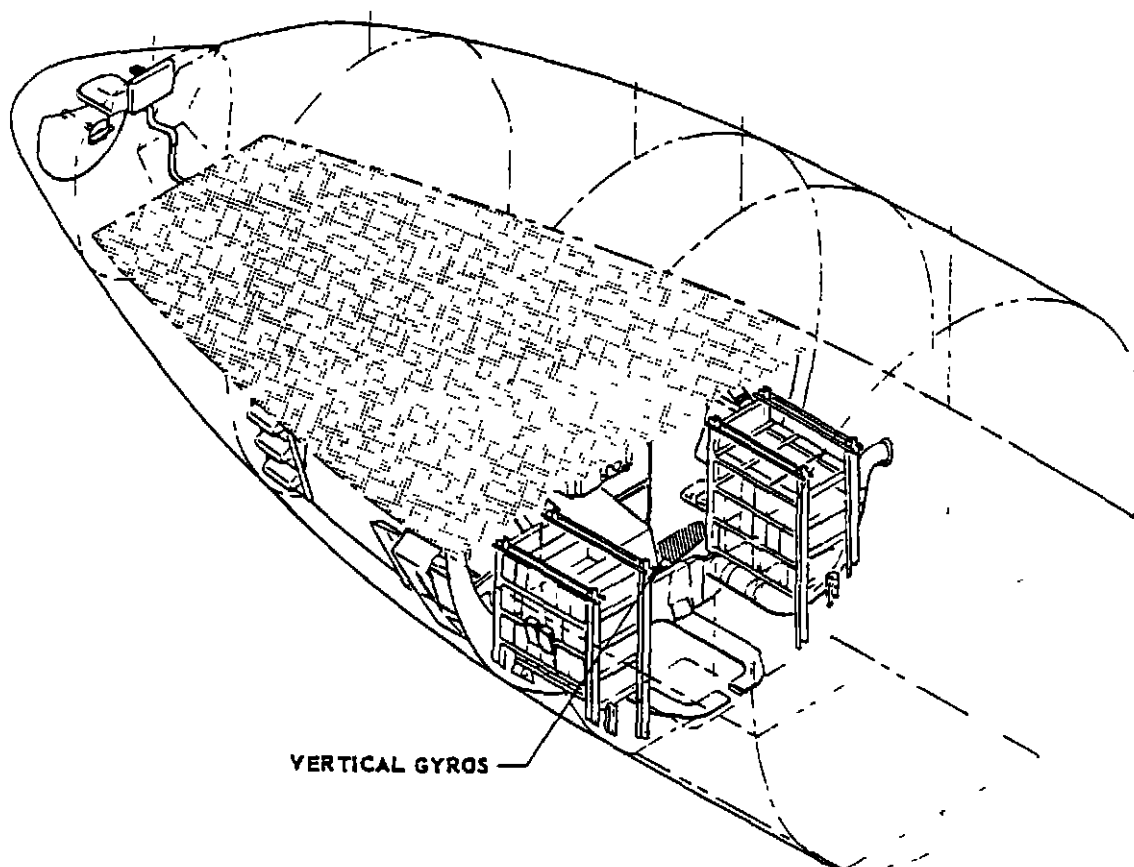
2 Vertical Gyros

- A The gyros have 360 degrees of freedom about the roll axis, and 85 degrees of freedom about the pitch axis. Initial erection of the gyros is accomplished by internal circuits. No manual caging device is used. The erection system maintains verticality within 1/4 degree during unaccelerated flight, and within one degree during maneuvers, or in turbulent air. The gyros are mounted in the lower nose compartment aft of the electrical equipment rack. (See figure 1)

3 Vertical Gyro System Operation

- A 115-volt, 400-cps, power is supplied both gyros through circuit breakers on circuit breaker panel P5. Roll and pitch signals from either gyro is available to the pilot's attitude director indicator (ADI), through actuation of the ADI switch on the pilot's instrument panel
- B During turns exceeding 15 degrees per minute, the erection circuits are made inoperative in order to prevent slaving the gyro to a false vertical due to acceleration forces
- C A malfunction relay in N° 1 gyro provides an interlock switch for the autopilot. On malfunction of the gyro the autopilot will automatically disengage. Power for operation of the gyro OFF warning flags in the ADI's is taken from both gyros. Power failure to either gyro will cause the flag to show on the appropriate ADI. Power for operation of the computer OFF warning flags is supplied from the flight steering computer through No 1 gyro malfunction relay. On malfunction of N° 1 gyro both warning flags will appear

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Vertical Gyro - Location Diagram
Figure 1

VERTICAL GYROS - TROUBLE SHOOTING

1 General

- A Trouble in the vertical gyros will affect operation of the autopilot system, flight director system and weather radar antenna tilt control system. Malfunction of the gyros will be indicated by the appearance of the warning flags on the horizon indicators in the flight director system. Also, the autopilot will disengage if the associated gyro malfunctions.
- B The most rapid method of isolating trouble in the vertical gyros is to perform the test given under "Vertical Gyro System - Maintenance Practices," and to observe the results on the attitude indicators.
- C To isolate troubles to a particular component interchange the gyros and the instrument amplifiers. The faulty component can be located by comparison of the test results while using different combinations of gyro and instrument amplifier.



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VERTICAL GYRO SYSTEM - MAINTENANCE PRACTICES

1 Adjustment/Test Vertical Gyro System

A Prepare to Test Vertical Gyros

- (1) Remove covers from gyros
- (2) Level gyros (or airplane) within one degree

B Test Vertical Gyro System

- (1) Connect external electrical power and energize radio and T-R circuit breaker panel (P5)
- (2) Check that the following circuit breakers on panel (P5) are closed
FLT INST NO 1 (3), VG NO 1 , VG NO 2, and FLT INST NO 2 (3)
- (3) Place attitude switch to VG position (Pilot's for VG1 and copilot's for VG2)
- (4) Set pitch trim knobs on attitude director indicator to zero (Pilot's ADI for VG1 and copilot's for VG2)

NOTE The sphere in the ADI should immediately follow the motion of the gyro while starting. After about 10 seconds the gyro should settle to a near vertical position, and continue to erect rapidly as shown by the sphere approaching level conditions. Level should be indicated within 2° in both pitch and roll.

- (5) Remove gyro mounting bolts for gyro under test
- (6) Tip gyro forward and observe ADI (Pilot's for VG1 and copilot's for VG2)
 - (a) Spheres should move up (indicating dive)
- (7) Tip gyro aft
 - (a) Spheres should move down (indicating climb)
- (8) Return gyro to level
 - (a) Spheres should return to level position
- (9) Tip gyro toward right side of airplane
 - (a) Spheres should rotate to left (indicating right wing down)

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(10) Tip gyro toward left side of airplane

(a) Spheres should rotate to right (indicating left wing down)

(11) Return gyro to level

(12) Open circuit breaker closed in step B (2)

(a) Gyro OFF warning flags should appear

C Close Up

(1) Replace covers on gyros

(2) Determine if there is any further need for electrical power on airplane, if not, remove external electrical power



VERTICAL GYRO - MAINTENANCE PRACTICES

1. Removal/Installation Vertical Gyro

A Remove Vertical Gyro (See figure 201)

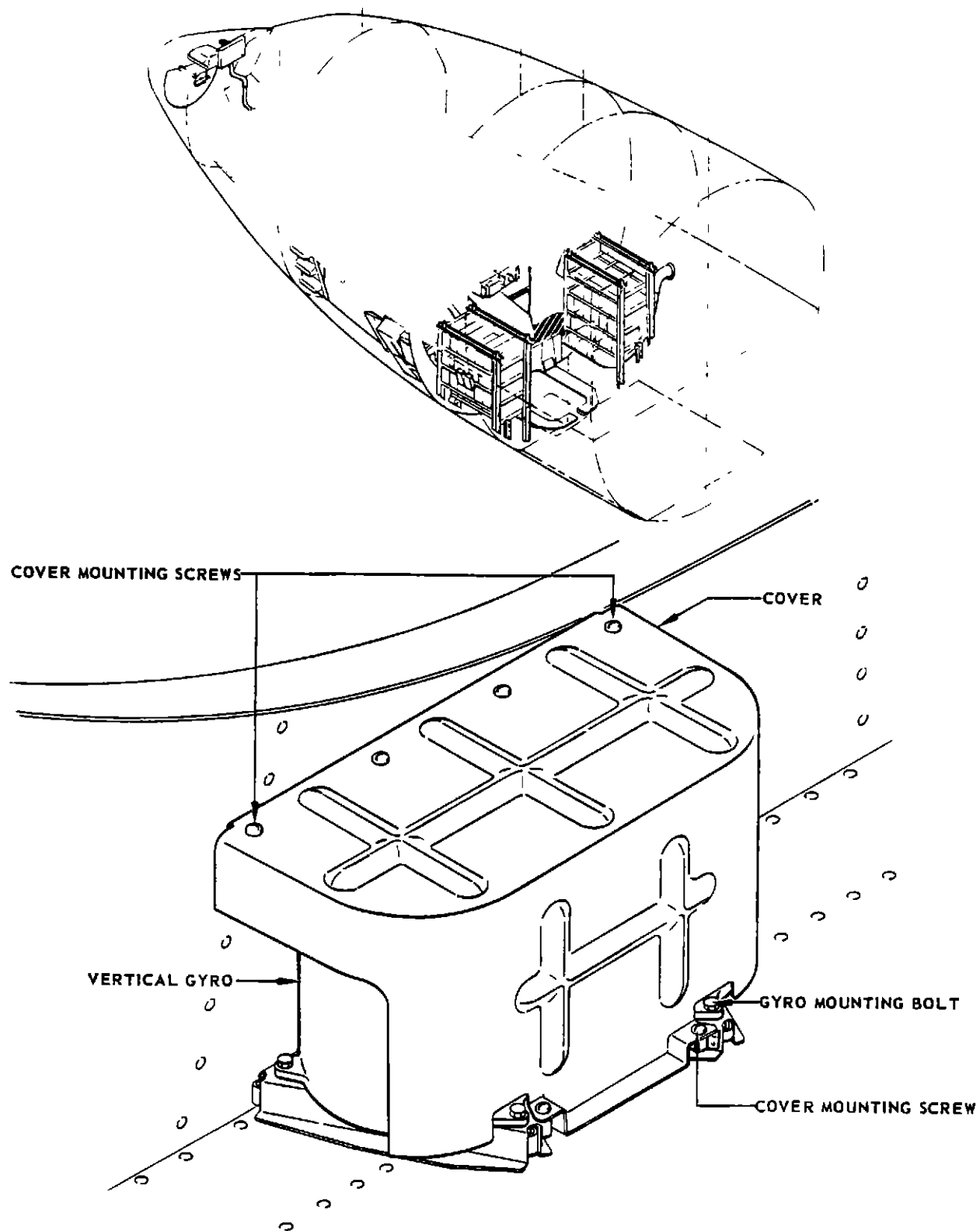
- (1) Remove cover from vertical gyros.
- (2) Disconnect electrical connectors from gyro to be removed.
- (3) Remove three bolts attaching gyro to mounting bracket.
- (4) Remove gyro.

B Install Vertical Gyro

- (1) Place vertical gyro on mounting bracket with arrow on top of unit pointing forward
- (2) Install mounting bolts
- (3) Connect electrical connectors at end of cables extending from gyro
- (4) Install cover over gyros.

CAUTION: DO NOT PERMIT ANY DIRECT CURRENT TO PASS THROUGH THE ELECTROLYTIC SWITCHES IN THE ERECTION CIRCUIT. DO NOT TEST CONTINUITY WITH OHMMETER WHERE THE CURRENT WILL BE COMPLETED THROUGH AN ELECTROLYTIC SWITCH.

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CENTRAL AIR DATA COMPUTER - DESCRIPTION AND OPERATION

1. General.

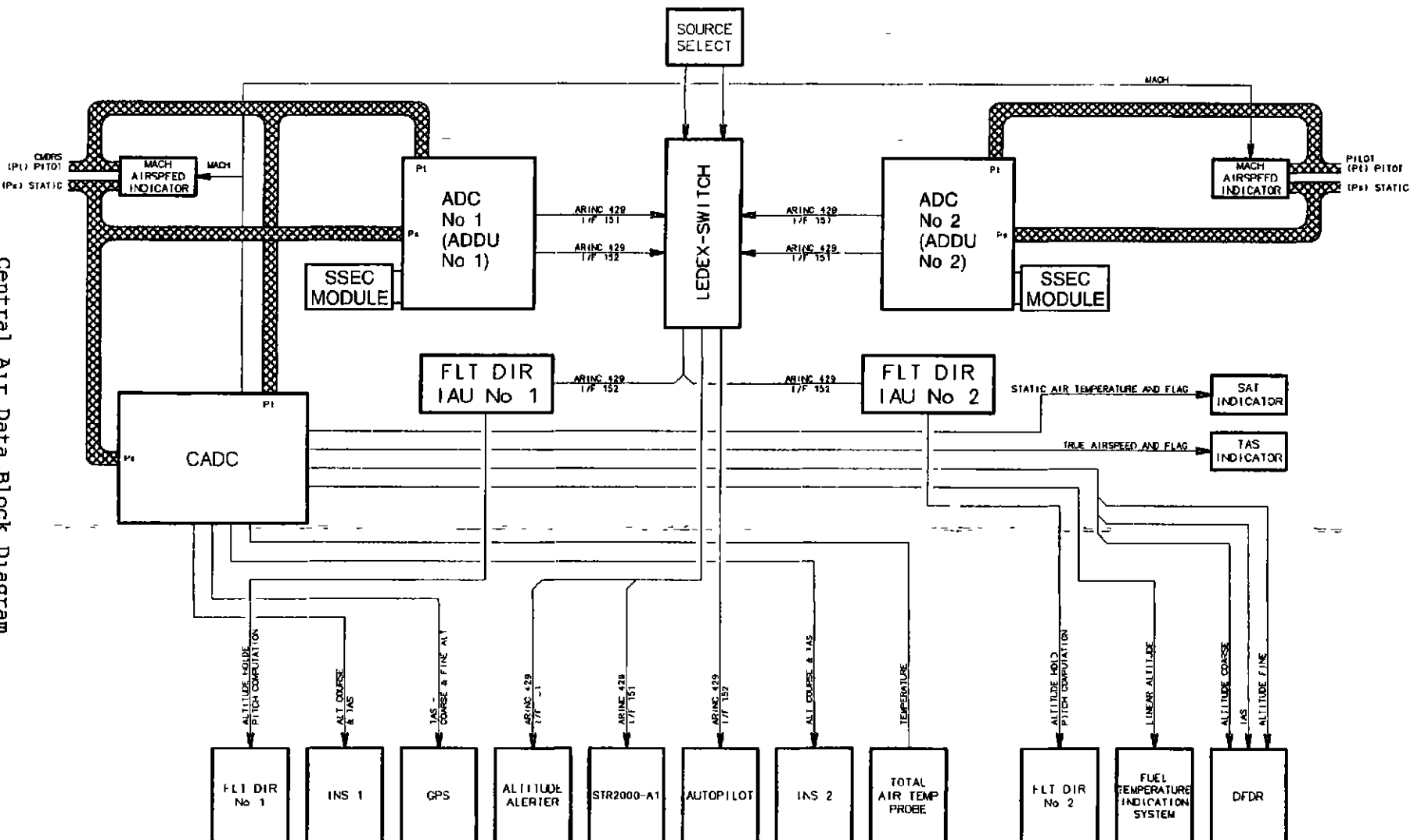
This section describes the Central Air Data Computer (CADC) and the flight instruments that receive data from the CADC. They are the Mach/Airspeed Indicators, True Airspeed Indicator (TAS), Static Air Temperature (SAT), Fuel Temperature Indication System, Inertial Navigation System (INS), Global Positioning System (GPS), Total Air Temperature Probe (TAT) and the Digital Flight Data Recorder (DFDR).

2. Description.

The Central Air Data Computer (CADC) is a unit which computes and provides air data information required for cockpit instruments and systems such as the GPS and INS. In computing, it uses pitot and static pressure and total temperature as inputs (see fig. 1). The air data information is furnished as output parameters of voltage and resistance, representing combinations of altitude, Mach number, true airspeed, computed airspeed, and static air temperature. Located in the electronics compartment on RH radio rack shelf 3, the CADC is of modular construction consisting of a chassis assembly and three plug-in modules. The modules are the Altitude Module, Indicated Airspeed Module and the Mach Module. Maintenance and preflight self-test is a built-in capability of the CADC (see fig. 2).

A. Chassis Assembly.

The chassis assembly is essentially a mounting rack containing the wiring harness and pneumatic plumbing required to interconnect the plug-in modules. Quick-release latching handles mounted on the sides of the chassis assembly hold the plug-in modules securely in place. When the handles are in the locked position, the chassis assembly dust cover acts as a safety retainer. If the handles are in the unlocked position, however, the cover cannot be installed. The chassis assembly contains an altitude reporting readout assembly installed in the front panel which is used to check operation of altitude encoders in the altitude module. The chassis assembly also contains a Master Failure Monitor, a Failure Annunciator Assembly, a Self-test Circuit Components Assembly and Aircraft Configuration Customizing Adapter Unit.



Central Air Data Block Diagram
Fig. 1

TCA: LX-N20199
RTCA: LX-N19997, LX-N20000

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B. Altitude Reporting Readout Assembly.

The Altitude Reporting Readout Assembly includes 10 indicator lamps mounted in a panel on the front of the computer, marked with letter/number codes reflecting the altitude encoder pulse assignments of mode C (see fig. 2, sheet 2 of 2). When the ALTITUDE READ self-test function is selected, the lamps light to display altitude, encoded in accordance with mode C.

C. Altitude Module and Indicated Airspeed Module.

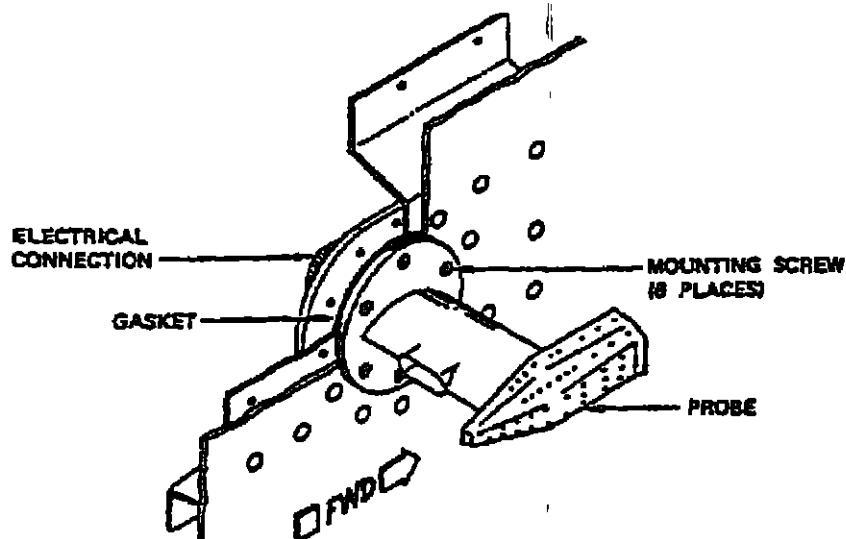
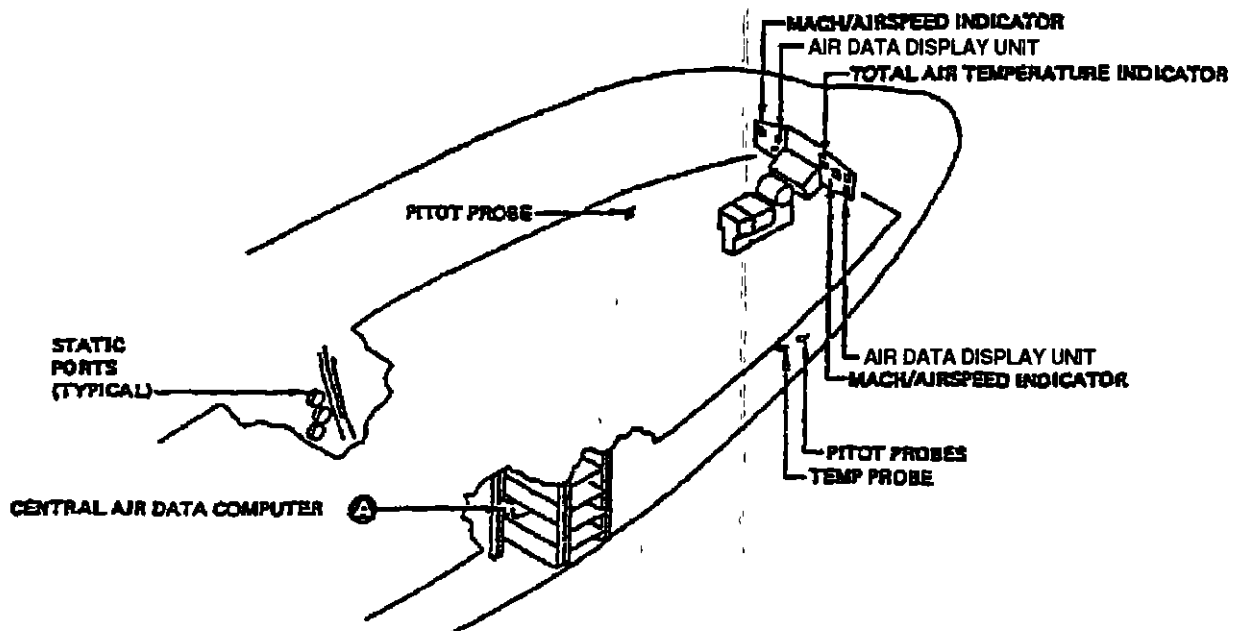
The Altitude Module and the Indicated Airspeed Module are similar in design and operation. They have essentially the same external appearance, having the same covers, base castings, and electrical connectors. The Indicated Airspeed Module, however, uses two pressure connections, total pressure (P_t), and static pressure, whereas the Altitude Module uses only a P_s connection. The upper (rectangular) cover on each of these plug-in-modules encloses a signal amplifier, a gear train, a failure monitor, and output devices. The lower (cylindrical) cover houses the transmitter assembly, which is essentially a pressure sensing and transducing device.

D. Mach Module

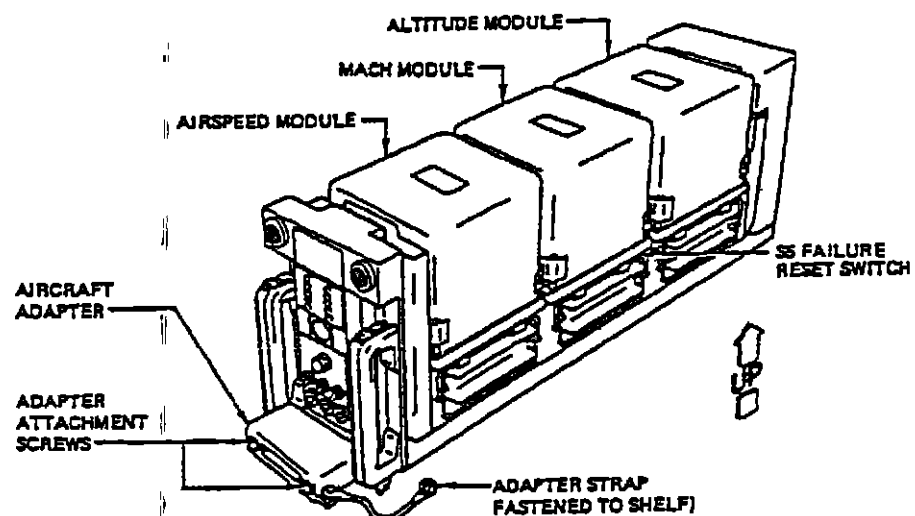
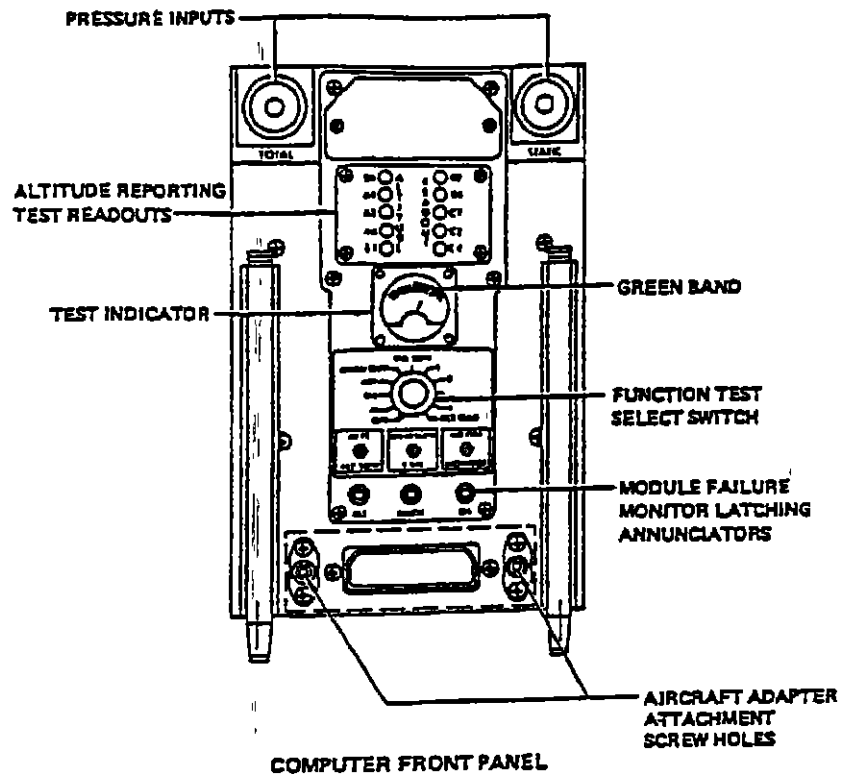
The Mach Module has essentially the same external appearance as the Altitude and Indicated Airspeed Modules. The significant difference is that it is not operated by input pressures, but rather by electrical inputs from the other two modules. As a result, it contains no transmitter assembly and has no cylindrical cover. The Mach Module contains a signal amplifier, a gear train, a failure monitor, and output devices. The True Airspeed (TAS) computer is also housed in the Mach Module. The TAS computer consists of a servomotor, gear train, rebalance variable resistor, output synchro and board-mounted electrical components.

E. Failure Monitors.

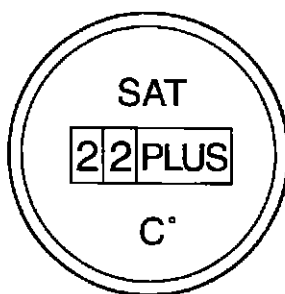
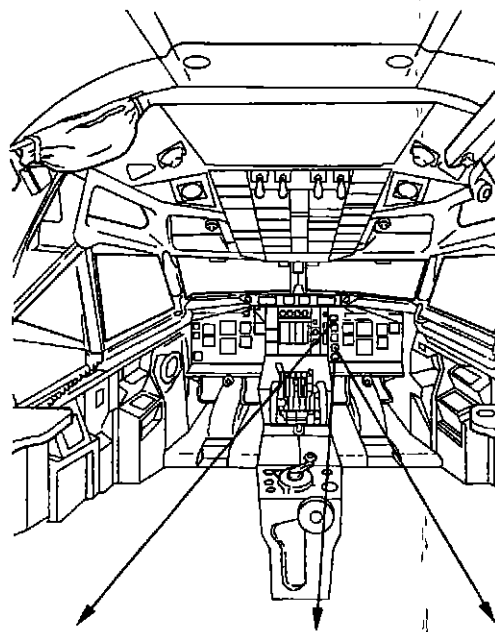
There is one Master Failure Monitor in the computer plus a Failure Monitor in each module of the computer. The Master Failure Monitor is a plug-in assembly consisting of board-mounted electrical components. Part of the assembly consists of a transistorized flag driver and relay driver circuit operated by a three-input AND gate. Another part of the assembly comprises a holding circuit which prevents cockpit instruments warning flags from releasing during test of the altitude module failure monitor. The circuit also applies an inhibiting voltage which prevents the altitude annunciator from tripping during the same test. The assembly also contains a portion of the logic gate circuits associated with the failure annunciator assembly. Each of the plug-in modules contains an identical failure monitor.



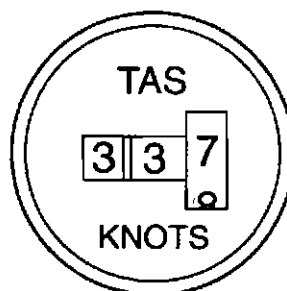
Central Air Data Computer System
Fig. 2 (Sheet 1 of 2)



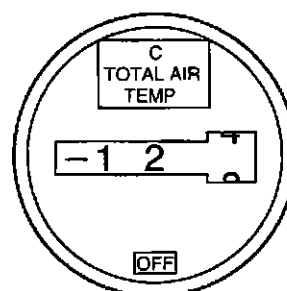
Central Air Data Computer System
Fig. 2 (Sheet 2 of 2)



COPLOT'S
STATIC AIR
TEMPERATURE
GAGE



COPLOT'S
TRUE AIRSPEED
INDICATOR



TOTAL AIR
TEMPERATURE
INDICATOR

Central Air Data Computer System
Fig. 3



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These monitors, used in conjunction with the Master Failure Monitor, the annunciators, and indicating devices external to the CADC comprise the CADC failure indicating system. The monitors sense the following failures:

- (1) Loss of 28-volt dc supply.
- (2) Loss of 26-volt 400-Hz synchro supply.
- (3) Loss of 115-volt 400-Hz supply (indirectly, since the 115-volt 400-Hz supply is used as primary power for the 28-volt dc power supply circuit internal to the CADC).
- (4) Pickoff primary voltage failure and open primary coils.
- (5) Excessively high pickoff signal voltage caused by excessive error in servo loop, shorted pickoff primary coil, or shorted or open pickoff secondary coils.
- (6) Motor or gear train failure (by monitoring pickoff signal).
- (7) Loss of bridge excitation voltage such as static source error correction (SSEC) bridge or Mach computing network excitation.

F. Self-Test.

The self-test circuit provides the following: failure monitor check, altitude read check, operational checks (servomotor/gear train checks) of altitude, indicated airspeed, and Mach modules. 60-foot increasing altitude check; 600 foot-per-minute altitude rate check; and 5-knot indicated airspeed check.

G. Aircraft Adapter.

The Aircraft Configuration Customizing Adapter, on the Air Data Computer front panel, provides characterization of selected outputs and static source error correction which is required for matching the Air Data Computer to the aircraft. The adapter also contains the required interlock circuits for proper operation of the computer.

3. TOTAL AIR TEMPERATURE INDICATION.

The Total Air Temperature (TAT) indicator located on the copilot panel receives temperature information from a sensor in a temperature probe located in the slipstream (see fig. 2, sheet 1 of 2). It does not receive correct information from the CADC but a second sensor in the same probe provides inputs to the CADC for the static air temperature and true airspeed computation. The electrical resistance of the sensor varies proportionally to air temperature change over the surface.



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These variations in resistance are electrically fed to the indicators where they are displayed by digital readouts in degrees centigrade (see fig. 4).

A. TAT Probe.

The probe is mounted below the flight deck on the forward right side of the fuselage. An OFF flag will appear in a cutout at bottom center of the dial in the event that the indicator circuits malfunction or disconnection of electrical power to the indicator occurs. A heater circuit is provided for probe anti-icing when in flight and is controlled by a switch on the overhead panel. Electrical power for operation of the heater and indicator is 115-volts, 400 (± 5) Hz.

B. Static Air Temperature Indication.

Static Air Temperature (SAT) is displayed on the copilot's instrument panel. Multidrum digital readout indicate ambient (outside) air temperature in the range of -99°C to $+50^{\circ}\text{C}$ (see fig. 3). The indicator is driven directly by the Central Air Data Computer which modifies temperature signals from the TAT probe. For above 0°C indication the readout displays PLUS at the right end, and below 0°C indicates MINUS at the left end. The indicator receives a dc voltage input signal, which is proportional to static air temperature, from the CADC. The CADC also provides a +20 volt dc reference voltage to a bias network resistor in the indicator modulator. The input signal from the CADC is filtered, and compared with the reference voltage of the bias resistor. The voltage difference is modulated, amplified, and applied to a servomotor. The servomotor, through the gear train, drives a variable resistor to null out the voltage difference. The counter is also driven by the gear train to provide an indication of temperature to the dial of the indicator. External power (26 volts ac) to the indicator provides the line voltage to the servomotor and power to the transformer of the bridge, failure monitor, and internal dc power supply. The failure monitor includes a flag annunciator which is energized to hold the flag out of view during normal operation. When the flag annunciator is deenergized, the flag will appear in the dial window indicating a failure. This failure indication occurs if the external power fails, if the CADC monitor circuit shows a failure, or if the signal differences cannot be nulled out by the variable resistor.

C. True Airspeed Indication.

A True Airspeed Indicator, mounted on the copilots instrument panel, displays true airspeed between 150 and 650 (± 4.5) knots on a three drum digital readout (see fig. 3). The indicator receives a dc voltage input signal, which is a function of airspeed, from the Central Air Data Computer (CADC). The CADC also provides a +20 volt dc reference voltage to a bias network resistor in the indicator modulator. The input signal from the CADC is filtered and compared with the reference voltage of the bias network resistor.

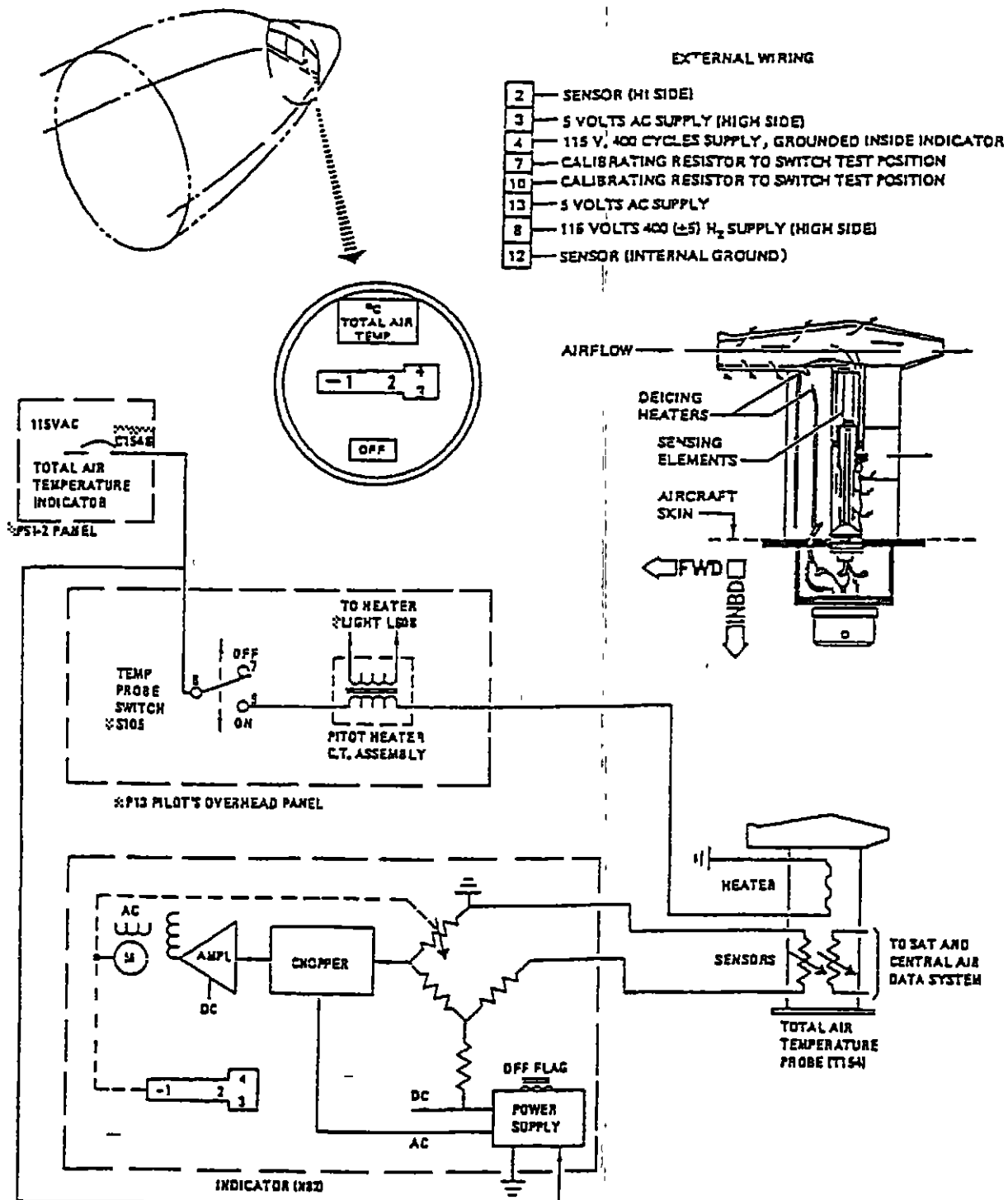


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The voltage difference is modulated, amplified, and applied to a servomotor. The servomotor drives a variable resistor to null out the voltage difference. External power (26 volts ac) to the indicator provides the line voltage to the servomotor and power to the transformer of the bridge, failure monitor and internal dc power supply. The failure monitor includes a flag annunciator, which is energized to hold a red and white flag out of view during normal operation. When the flag annunciator is deenergized, the flag will appear in the dial window indicating a failure. This failure indicator occurs if the external power fails, if the CADC monitor indicates a failure, or if the signal differences are greater than 18 knots.

4. MACH/AIRSPEED INDICATION

- A. Two Mach/Airspeed Indicators located on the pilot (P8) and copilot (P10) panels, present a display of indicated airspeed and Mach number.
- B. The indicator is a combined instrument in which the airspeed assembly is operated by direct pitot and static pressure, and the mach assembly is operated from the Air Data Computer.
- C. From direct pitot and static pressure, a precision single revolution mechanism drives the indicated airspeed pointer from 60 through 420 knots range of airspeed. The mechanism produces rotation of the pointer in 2-knot calibration increments between 60 and 160 knots, and in 10-knot increments between 160 and 420 knots.
- D. Mach number indication is presented on a three drum digital readout through the range .400 to .999 mach. Below 400 mach the readout is covered by a black flag. The mach readout mechanism is driven by corrected electronic mach number signals processed by the air data computer. There is no pitot or static pressure input to the machmeter portion of the Mach/Airspeed Indicator. Upon failure, or loss of 28 volts dc from the Air Data Computer, a striped red and white OFF flag will appear to cover the digital mach readout.
- E. The coloured pointer on the indicator shows the maximum operating speed of the aircraft as a function of altitude. One white peripheral pointer may be set manually to any desired airspeed.



Total Air Temperature Indicating System
Fig. 4 (Sheet 1 of 2)

TEMPERATURE VS. RESISTANCE CURVE			
TEMP °C	RESISTANCE OHMS	TEMP °C	RESISTANCE OHMS
-70	361,64	0	500,00
-60	381,65	10	519,47
-50	401,56	20	538,88
-40	421,40	30	558,21
-30	441,16	40	577,47
-20	460,85	50	596,67
-10	480,46	60	615,79
		70	634,85

Temperature vs. Resistance Curve
Fig 4 (Sheet 2 of 2)

ICN 1P-AMMX-34-0024-01

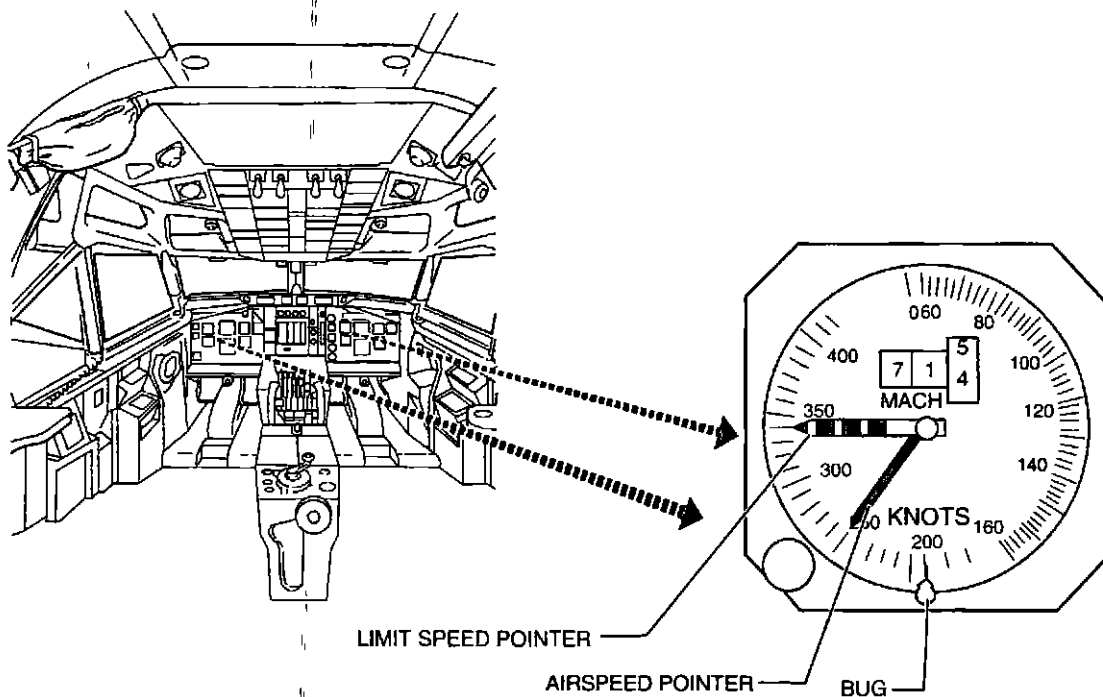


Fig 5

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MAINTENANCE MANUAL

CENTRAL AIR DATA COMPUTER - DESCRIPTION AND OPERATION

1 GENERAL

This section describes the central air data computer (CADC) and the flight instruments that receive data from the CADC. They are the servo-pneumatic altimeter, Mach/airspeed indicator, the true airspeed (TAS), static air temperature (SAT) and the total air temperature (TAT) instrument.

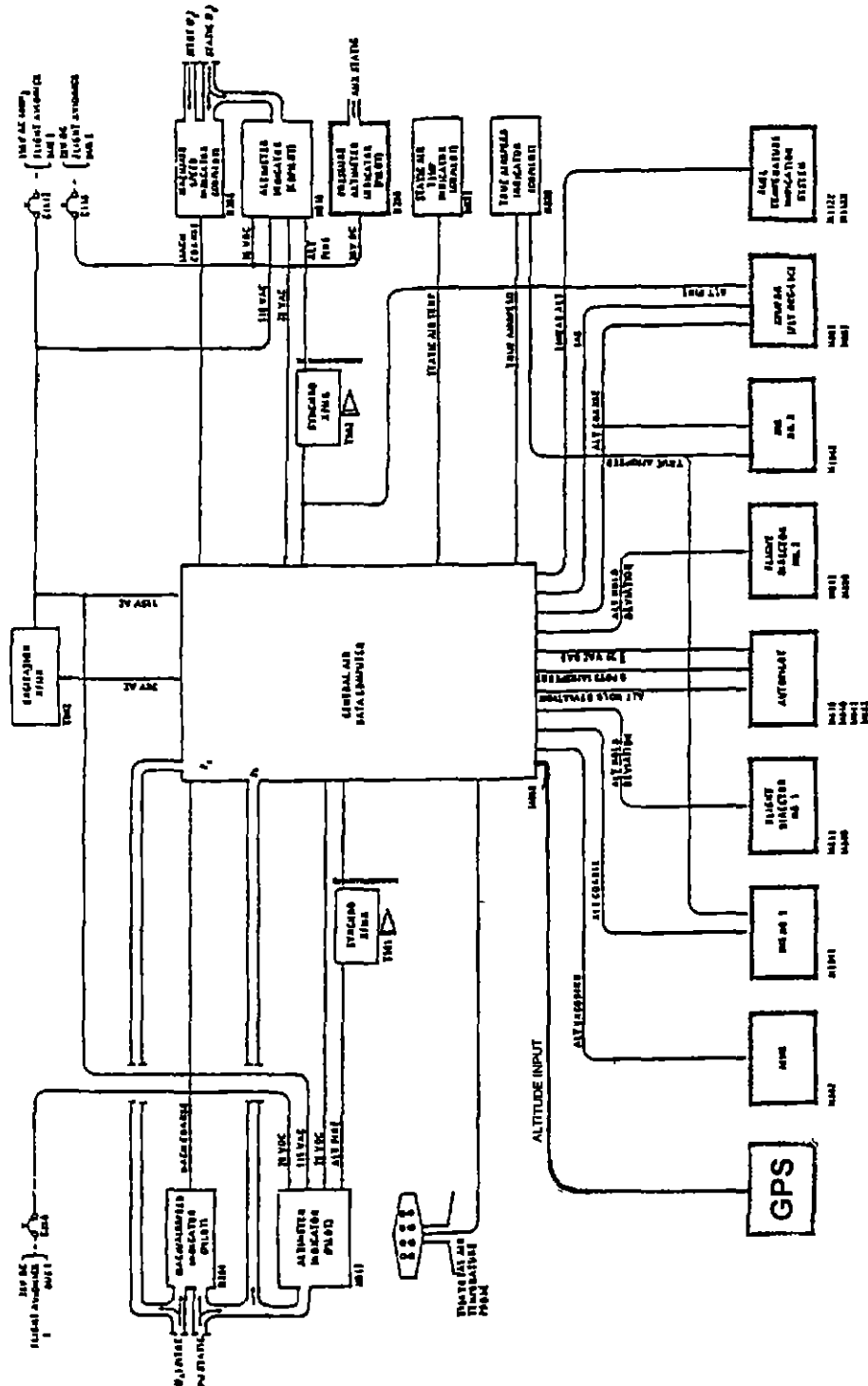
2 DESCRIPTION

The central air data computer (CADC) is a unit which computes and provides air data information required for cockpit instruments and systems such as the GPS autopilot, flight director, INS and AIMS. In computing, it uses pitot and static pressure and total temperature as inputs. (See figure 1) The air data information is furnished as output parameters of voltage and resistance, representing combinations of altitude, Mach number, true airspeed, computed airspeed, and static air temperature. Located in the electronics compartment on RH radio rack shelf 3, the CADC is of modular construction consisting of a chassis assembly and three plug-in modules. The modules are the altitude module, indicated airspeed module and the Mach module. Maintenance and preflight self-test is a built-in capability of the CADC (see figure 2).

A Chassis Assembly

The chassis assembly is essentially a mounting rack containing the wiring harness and pneumatic plumbing required to interconnect the plug-in modules. Quick-release latching handles mounted on the sides of the chassis assembly hold the plug-in modules securely in place. When the handles are in the locked position, the chassis assembly dust cover acts as a safety retainer. If the handles are in the unlocked position, however, the cover cannot be installed. The chassis assembly contains an altitude reporting readout assembly installed in the front panel which is used to check operation of altitude encoders in the altitude module. The chassis assembly also contains a master failure monitor, a failure annunciator assembly, a self-test circuit components assembly, and aircraft configuration customizing adapter unit.

Ref T O. 1E-3A-2-31-1
Page 4-1 Change 4



Central Air Data System Block Diagram
Figure 1

Ref · T O 1E-3A-2-31-1
Page 4-5 Change 19

B Altitude Reporting Readout Assembly

The altitude reporting readout assembly includes 10 indicator lamps mounted in a panel on the front of the computer marked with letter/number codes reflecting the altitude encoder pulse assignments of mode C (see figure 2, sheet 2 of 2) When the ALTITUDE READ self-test function is selected, the lamps light to display altitude, encoded in accordance with mode C

C Altitude Module and Indicated Airspeed Module

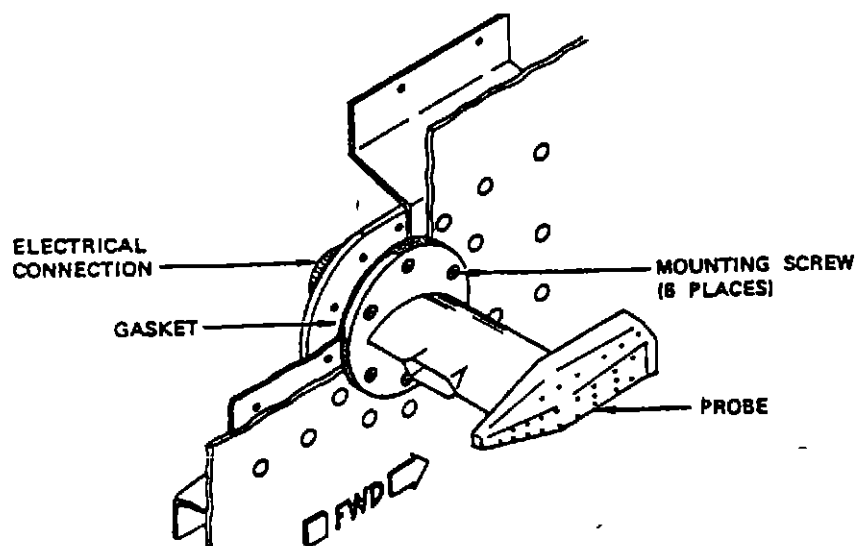
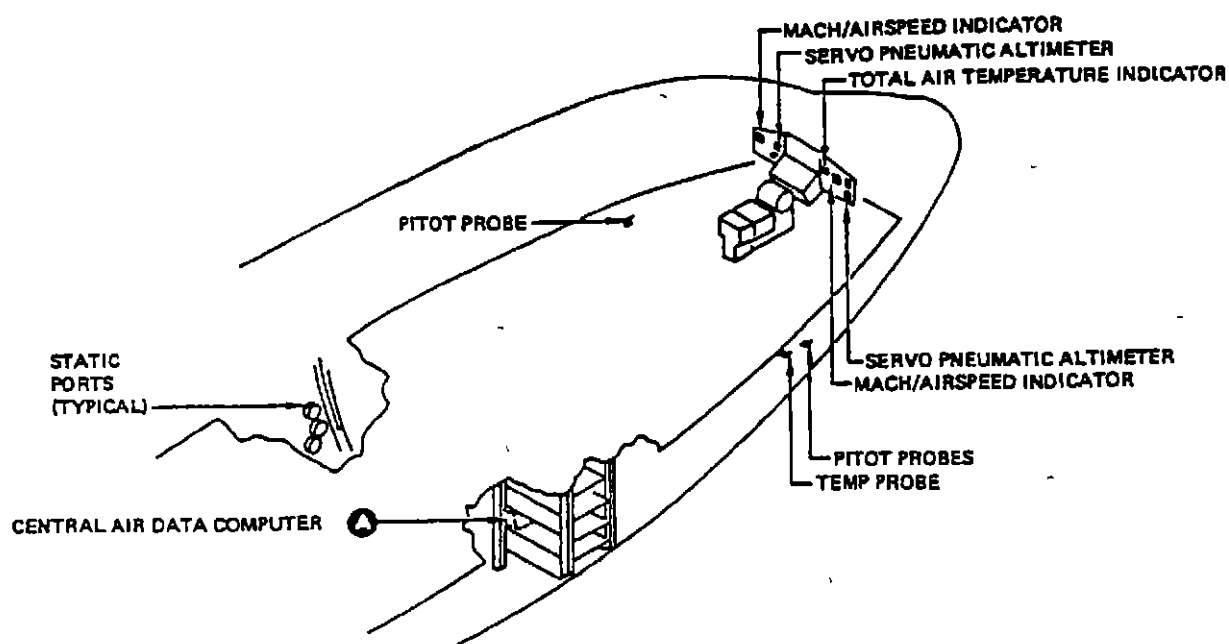
The altitude module and the indicated airspeed module are similar in design and operation They have essentially the same external appearance, having the same covers, base castings, and electrical connectors The indicated airspeed module, however, uses two pressure connections, total pressure (P_t), and static pressure, whereas the altitude module uses only a P_s connection The upper (rectangular) cover on each of these plug-in modules encloses a signal amplifier, a gear train, a failure monitor, and output devices The lower (cylindrical) cover houses the transmitter assembly, which is essentially a pressure sensing and transducing device

D Mach Module

The Mach module has essentially the same external appearance as the altitude and indicated airspeed modules The significant difference is that it is not operated by input pressures, but rather by electrical inputs from the other two modules As a result, it contains no transmitter assembly and has no cylindrical cover The Mach module contains a signal amplifier, a gear train, a failure monitor, and output devices The true airspeed (TAS) computer also is housed in the Mach module The TAS computer consists of a servomotor, gear train, rebalance variable resistor, output synchro and board-mounted electrical components

E Failure Monitors

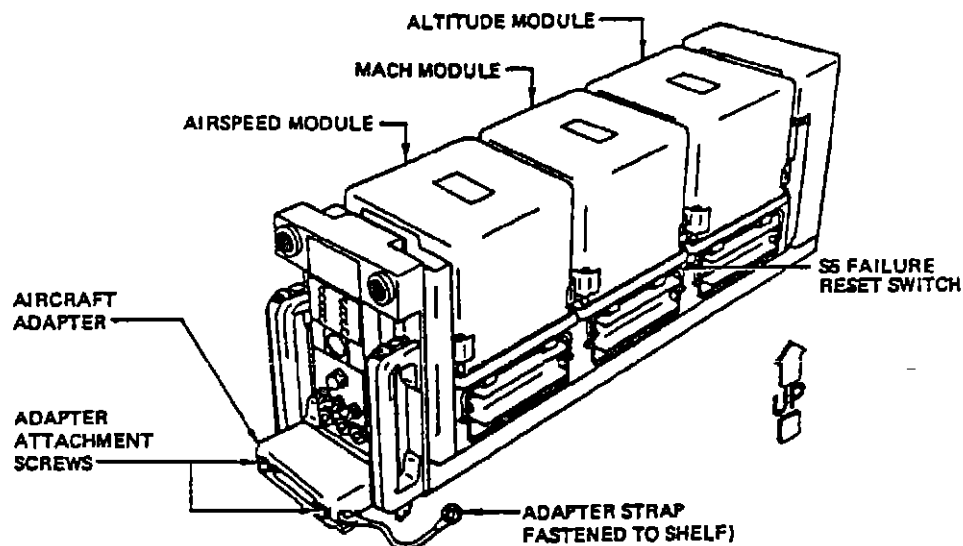
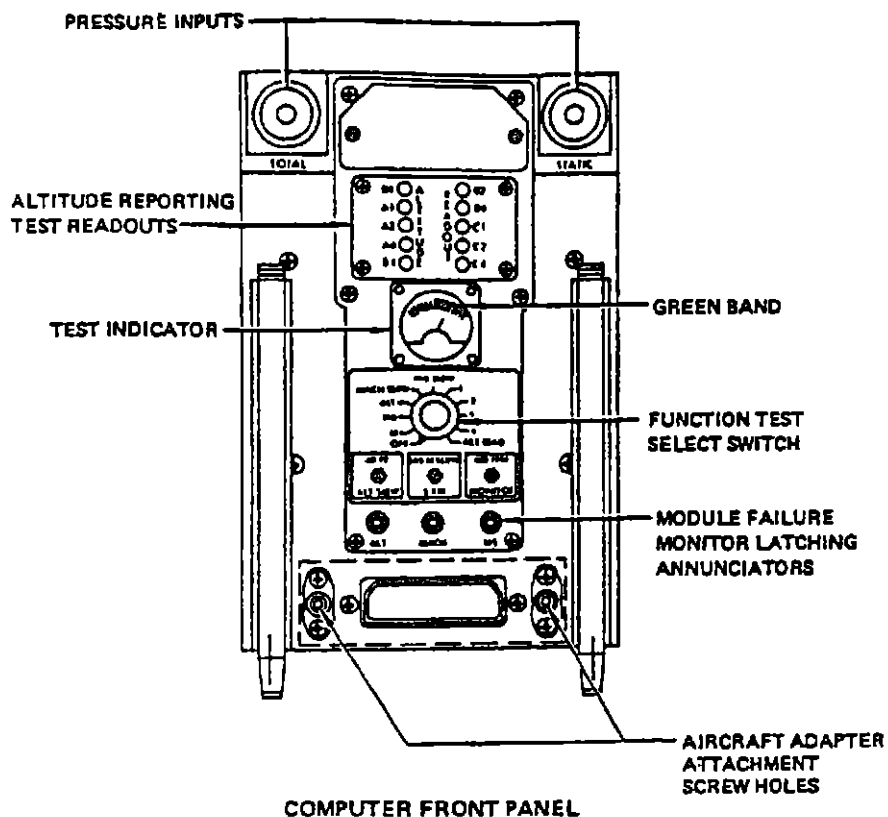
There is one master failure monitor in the computer plus a failure monitor in each module of the computer The master failure monitor is a plug-in assembly consisting of board-mounted electrical components Part of the assembly consists of a transistorized flag driver and relay driver circuit operated by a three-input AND gate Another part of the assembly comprises a holding circuit which prevents cockpit instrument warning flags from releasing during test of the altitude module failure monitor The circuit also applies an inhibiting voltage which prevents the altitude annunciator from tripping during the same test The assembly also contains a portion of the logic gate circuits associated with the failure annunciator assembly Each of the plug-in modules contains an identical failure monitor



Central Air Data Computer System
Figure 2 (Sheet 1 of 2)

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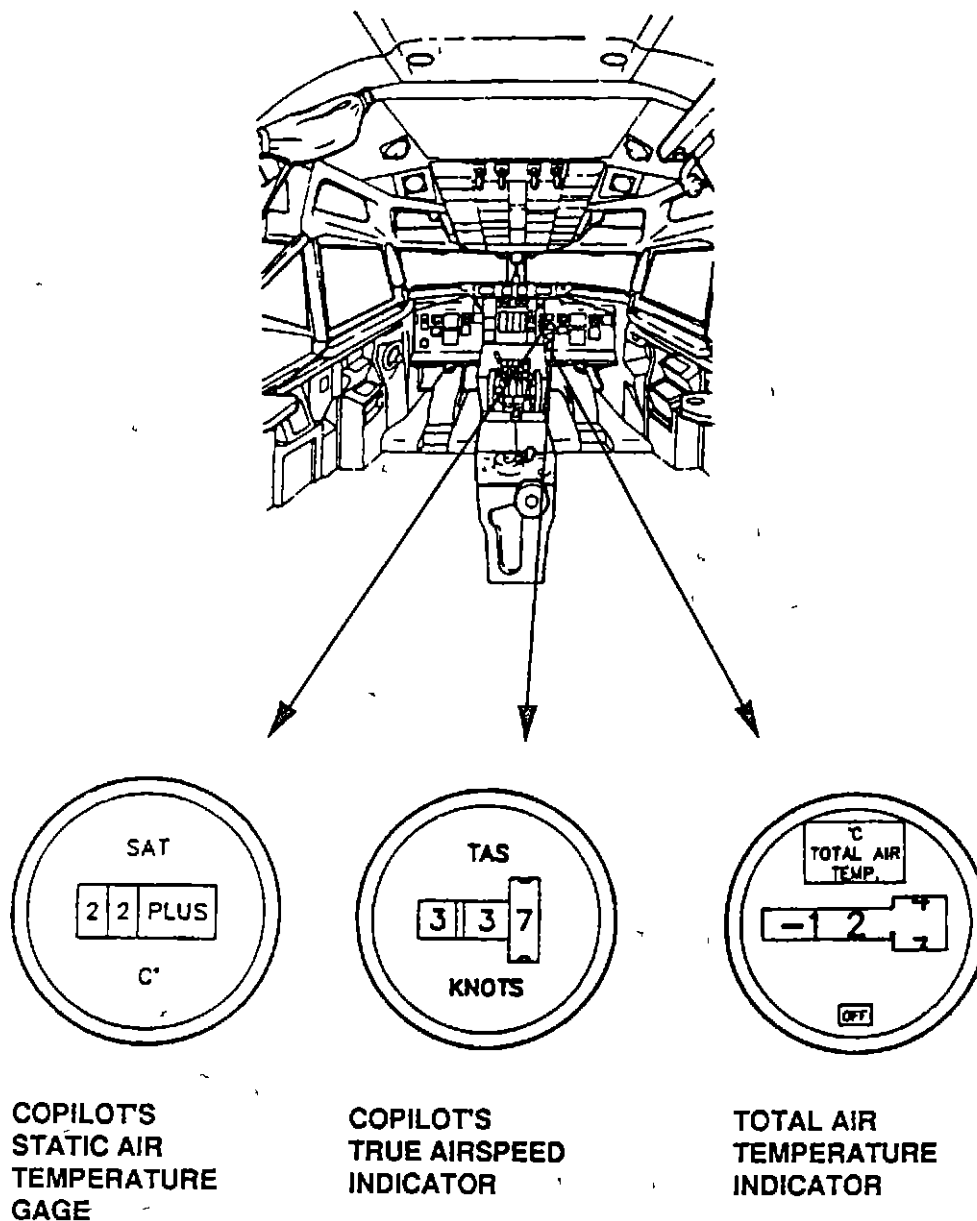


DETAIL A

**COMPUTER MODULE LOCATION
(DUST COVER REMOVED)**

Central Air Data Computer System
 Figure 2 (Sheet 2 of 2)

Ref : T O 1E-3A-2-31-1
 Page 4-2 Change 4



Central Air Data Computer System
Figure 3

Ref T O 1E-3A-2-31-1

These monitors, used in conjunction with the master failure monitor, the annunciators, and indicating devices external to the CADC comprise the CADC failure indicating system. The monitors sense the following failures:

- (1) Loss of 28-volt dc supply
- (2) Loss of 26-volt 400-Hz synchro supply.
- (3) Loss of 115-volt 400-Hz supply (indirectly, since the 115-volt 400-Hz supply is used as primary power for the 28-volt dc power supply circuit internal to the CADC)
- (4) Pickoff primary voltage failure and open primary coils
- (5) Excessively high pickoff signal voltage caused by excessive error in servo loop, shorted pickoff primary coil, or shorted or open pickoff secondary coils
- (6) Motor or gear train failure (by monitoring pickoff signal)
- (7) Loss of bridge excitation voltage such as static source error correction (SSEC) bridge or Mach computing network excitation

F Self-Test

The self-test circuit provides the following failure monitor check, altitude read check, operational checks (servomotor/gear train checks) of altitude, indicated airspeed, and Mach modules, 60-foot increasing altitude check, 600 foot-per-minute altitude rate check, and 5-knot indicated airspeed check

G Aircraft Adapter.

The aircraft configuration customizing adapter, on the air data computer front panel, provides characterization of selected outputs and static source error correction which is required for matching the air data computer to the TCA aircraft. The adapter also contains the required interlock circuits for proper operation of the computer.

3 TOTAL AIR TEMPERATURE INDICATION

The total air temperature (TAT) indicator located on the copilot panel receives temperature information from a sensor in a temperature probe located in the slipstream (see figure 2, sheet 1 of 2). It does not receive corrected information from the CADC but a second sensor in the same probe provides inputs to the CADC for the static air temperature and true airspeed computation. The electrical resistance of the sensor varies proportionally to air temperature change over the surface.

These variations in resistance are electrically fed to the indicator where they are displayed by digital readouts in degrees centigrade (See figure 4)

A TAT Probe

The probe is mounted below the flight deck on the forward right side of the fuselage. An OFF flag will appear in a cutout at bottom center of the dial in the event that the indicator circuits malfunction or disconnection of electrical power to the indicator occurs. A heater circuit is provided for probe anti-icing when in flight and is controlled by a switch on the overhead panel. Electrical power for operation of the heater and indicator is 115 volts, 400 (± 5) Hz.

B Static Air Temperature Indication

Static air temperature (SAT) is displayed on the co-pilot's instrument panel. Multidrum digital readouts indicate ambient (outside) air temperature in the range of -99°C to $+50^{\circ}\text{C}$ (See figure 3). The indicator is driven directly by the central air data computer which modifies temperature signals from the TAT probe. For above 0°C indication the readout displays PLUS at the right end, and below 0°C indicates MINUS at the left end. The indicator receives a dc voltage input signal, which is proportional to static air temperature, from the CADC. The CADC also provides a +20 volt dc reference voltage to a bias network resistor in the indicator modulator. The input signal from the CADC is filtered, and compared with the reference voltage of the bias resistor. The voltage difference is modulated, amplified, and applied to a servomotor. The servomotor, through the gear train, drives a variable resistor to null out the voltage difference. The counter is also driven by the gear train to provide an indication of temperature to the dial of the indicator. External power (26 volts ac) to the indicator provides the line voltage to the servomotor and power to the transformer of the bridge, failure monitor, and internal dc power supply. The failure monitor includes a flag annunciator which is energized to hold the flag out of view during normal operation. When the flag annunciator is deenergized, the flag will appear in the dial window indicating a failure. This failure indication occurs if the external power fails, if the CADC monitor circuit shows a failure, or if the signal differences cannot be nulled out by the variable resistor.

C True Airspeed Indication.

A true airspeed indicator, mounted on the co-pilot's instrument panel, displays true airspeed between 150 and 650 (± 4.5) knots on a three drum digital readout (See figure 3). The indicator receives a dc voltage input signal, which is a function of airspeed, from the central air data computer (CADC). The CADC also provides a +20 volt dc reference voltage to a bias network resistor in the indicator modulator. The input signal from the CADC is filtered and compared with the reference voltage of the bias network resistor.

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The voltage difference is modulated, amplified, and applied to a servomotor. The servomotor drives a variable resistor to null out the voltage difference. External power (26 volts ac) to the indicator provides the line voltage to the servomotor and power to the transformer of the bridge, failure monitor and internal dc power supply. The failure monitor includes a flag annunciator which is energized to hold a red and white flag out of view during normal operation. When the flag annunciator is deenergized, the flag will appear in the dial window indicating a failure. This failure indicator occurs if the external power fails, if the CADC monitor indicates a failure, or if the signal differences are greater than 18 knots.

4 MACH/AIRSPEED INDICATION

- A Two Mach/Airspeed indicators located on the pilot (P8) and copilot (P10) panels, present a display of indicated airspeed and Mach number.
- B The indicator is a combined instrument in which the airspeed assembly is operated by direct pitot and static pressure, and the mach assembly is operated from the air data computer.
- C From direct pitot and static pressure, a precision single revolution mechanism drives the indicated airspeed pointer from 60 through 420 knots range of airspeed. The mechanism produces rotation of the pointer in 2-knot calibration increments between 60 and 160 knots, and in 10-knot increments between 160 and 420 knots.
- D Mach number indication is presented on a three drum digital readout through the range 400 to 999 mach. Below 400 mach the readout is covered by a black flag. The mach readout mechanism is driven by corrected electronic mach number signals processed by the air data computer. There is no pitot or static pressure input to the machmeter portion of the mach/airspeed indicator. Upon failure, or loss of 28 volts DC from the air data computer, a striped red and white OFF flag will appear to cover the digital mach readout.
- E The colored pointer on the indicator shows the maximum operating speed of the aircraft as a function of altitude. One white peripheral pointer may be set manually to any desired airspeed.

Ref Telex GLK 054429 dtd May 28/92

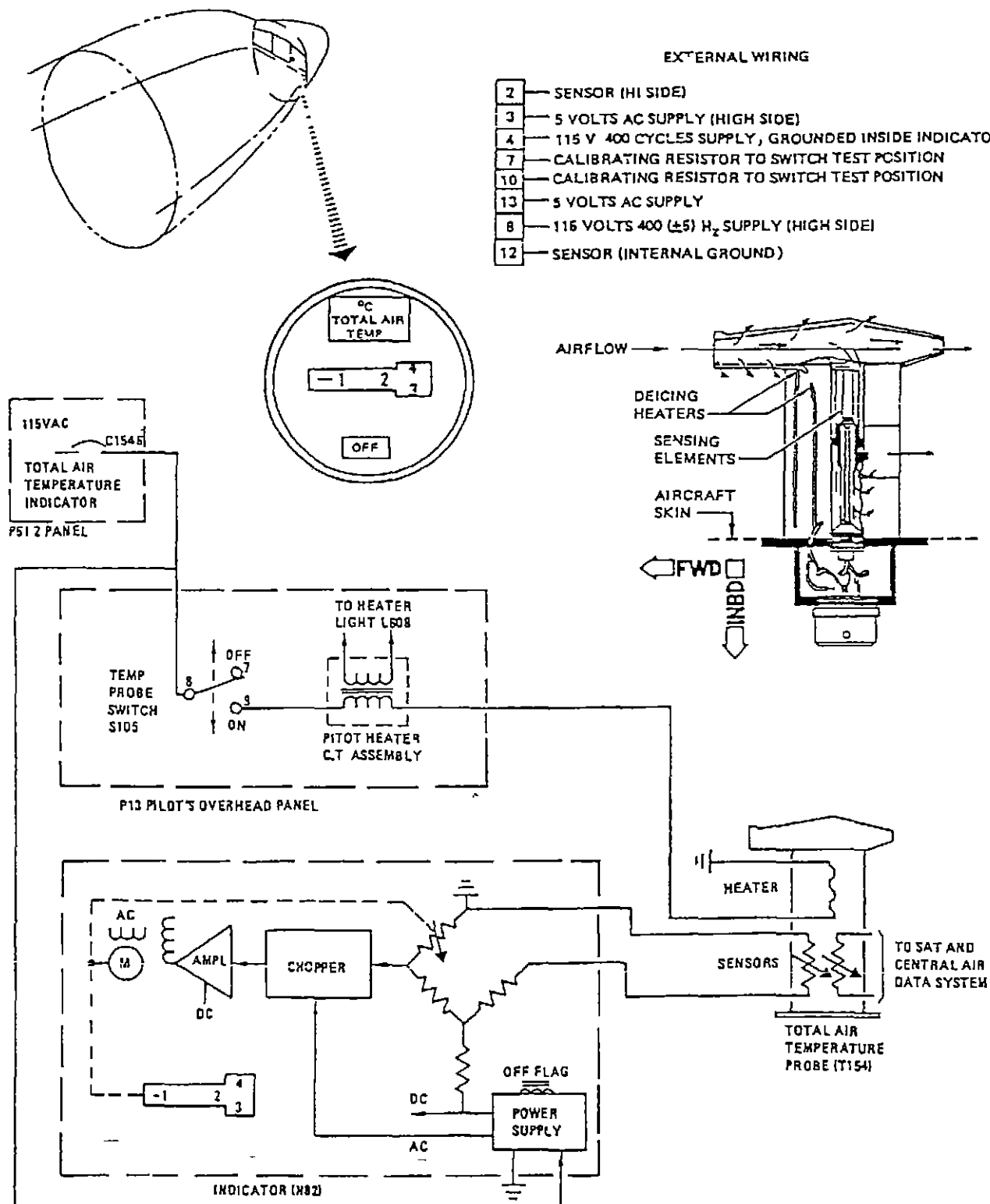
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EXTERNAL WIRING

2	— SENSOR (HI SIDE)
3	— 5 VOLTS AC SUPPLY (HIGH SIDE)
4	— 115 V 400 CYCLES SUPPLY, GROUNDED INSIDE INDICATOR
7	— CALIBRATING RESISTOR TO SWITCH TEST POSITION
10	— CALIBRATING RESISTOR TO SWITCH TEST POSITION
13	— 5 VOLTS AC SUPPLY
8	— 115 VOLTS 400 (±5) H _z SUPPLY (HIGH SIDE)
12	— SENSOR (INTERNAL GROUND)



Total Air Temperature Indicating System

Figure 4 (Sheet 1 of 2)

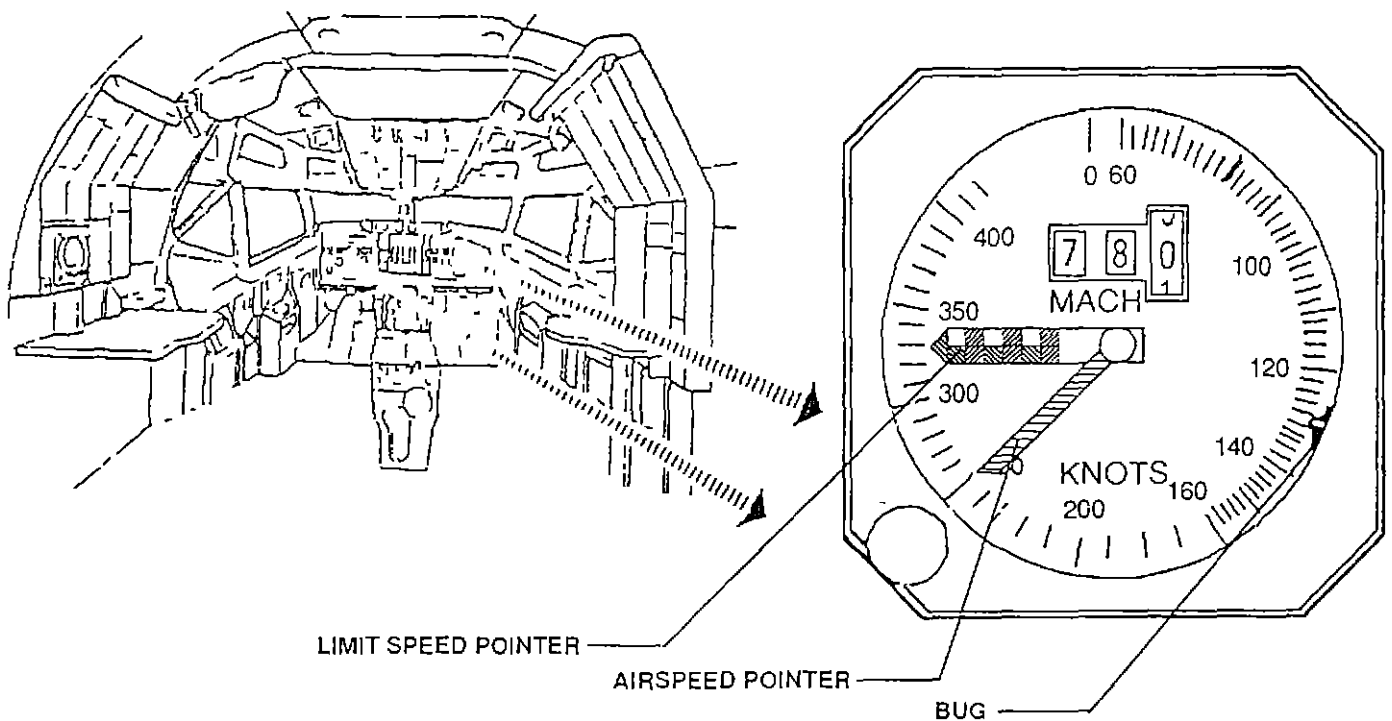
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Page 4-11 Change 4

TEMPERATURE VS RESISTANCE CURVE

TEMP °C	RESISTANCE OHMS	TEMP °C	RESISTANCE OHMS
-70	361 64	0	500 00
-60	381 65	10	519 47
50	401 56	20	538 88
-40	421 40	30	558 21
-30	441 16	40	577 47
-20	460 85	50	596 67
-10	480 46	60	615 79
		70	634 85

Temperature VS Resistance Curve
Figure 4 (Sheet 2 of 2)



Mach/Airspeed indicators
Figure 5

Ref Telex GLK 054429 dtd May 28/93

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CENTRAL AIR DATA COMPUTER - TROUBLE SHOOTING

Refer to table 101 for trouble analysis information.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
<u>NOTE.</u> Only limited isolation checks are required for the CADC since the self-test checkout procedure presented in page 502 § 1 is designed to isolate a fault down to a specific module. If replacement of the module, identified as malfunctioning during self-test, does not cure the original problem, the problem can then be attributed to internal CADC interconnect circuitry. In such cases, the entire CADC unit should be replaced.			
All failure annunciators are displayed	Failure to reset, annunciators.	1. Reset and perform CADC checkout per page 401 § 1, 2. If problem is not corrected, replace failed Logic module	Replace entire CADC. As second choice alternate, replace chassis and repeat self-check. Replace faulty IAS, Mach, or Altitude module.
One failure annunciator displays a red center	Module has experienced failure	Reset per page 401 § 1. If red indication appears, module can be considered faulty.	Replace appropriate module and reset per page 401 § 1.
Incorrect meter indication is obtained during a failure monitor check	Malfunctioning module	If the meter indications are normal during failure monitor checks of the remaining modules, the malfunctioning module should be replaced.	Replace appropriate module.
Incorrect meter indication is obtained for all failure monitor checks.	Malfunctioning meter circuit	None required	Replace entire CADC.

C.A.D.C. - Trouble Shooting
Table 101 - (Sheet 1 of 4)

Ref. T.O. 1E-3A-2-31-1
Page 4-20 Change 4

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
Failure annunciator trips from white to red indication during failure monitor check	Malfunctioning module	None required.	Replace faulty module
External flag does not trip properly during failure monitor check.	a. Malfunctioning failure monitor or the IAS, Mach, or Altitude module.	Perform checkout per page 502 § 1. If the monitor check meter indications are normal, the failure monitor is faulty.	Replace entire CADC unit
		If meter indications are incorrect, the module under test is faulty.	Replace faulty module
	b. Faulty flag circuit in external system and/or indicator	Check external circuits per applicable trouble analysis procedures	Replace component or repair aircraft wiring, as required
Incorrect or marginal meter indications are obtained for all self-checks	Malfunctioning chassis	Verify that the 115V, 400 (±5) Hz, input is correct. If it is, the CADC can be considered faulty.	Replace entire CADC unit
Incorrect meter indication is obtained for Mach module slew check.	Malfunctioning Mach module	If meter indications for other modules are normal, the Mach module is faulty.	Replace Mach module
Incorrect meter indication is obtained for indicated airspeed module slew check	Malfunctioning indicated airspeed module	If meter indications for other modules are normal, the Airspeed module is faulty.	Replace indicated airspeed module
Incorrect meter indication is obtained for altitude rate check	Malfunctioning altitude module.	None required	Replace altitude module
One or more lamps do not light during altitude readout check	Malfunctioning altitude module	None required	Replace altitude module and repeat check

C A.D C - Trouble Shooting
 Table 101 - (Sheet 2 of 4)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
CADC fails delta 60-foot check.	Malfunctioning altitude module	None required.	Replace altitude module
CADC fails altitude change rate check	Malfunctioning altitude module	None required	Replace altitude module
TAT indicator pointer remains on mechanical zero	Open power circuit, poor ground connection or defective indicator	Check circuit breaker Disconnect indicator plug and test for 115 vac from pin 4 to pin 8	If voltages are correct replace indicator
TAT indicator pointer forced off top end of scale	Probe sensing unit open or break in probe lead	Disconnect electrical connector plug and check wiring for open circuit and check probe for open circuit pins 3 and 4	Replace probe or repair wiring
TAT indicator pointer forced off bottom end of scale	Probe leads short circuited	Disconnect indicator connector plug and check for a short If shorted, disconnect probe connector and check for short between pins	Replace probe if shorted, or repair wiring
Erratic TAT indicator readings	Defective wiring, or indicator	Check wiring for loose connection	Repair wiring or replace indicator
	Defective probe	Use multimeter & 204-91961-1 adapter to check front temperature sensor in probe by measuring resistance between pins 2 and 5	Resistance shall read per fig 4, sheet 2 of 2 (± 10 ohms) or replace pin
		Check the rear sensor by measuring resistance between pins 3 and 4	Resistance shall read per fig 4, sheet 2 of 2 (± 10 ohms) or replace pin
		Measure from either pin 2 or 5 to probe case	Resistance shall be greater than 10 MEG ohms or replace probe
		Measure from either pin 3 to 5 to probe case	Resistance shall be greater than 10 MEG ohms or replace probe
		Check probe heater element between pins 1 and 6	Resistance shall be 20 (± 3) ohms or replace probe
		Measure from either pin 1 to 6 to probe case	Resistance shall be greater than 5 meg ohms or replace probe

C A D C - Trouble Shooting
Table 101 - (Sheet 3 of 4)

Ref T O 1E-3A-2-31-1
Page 4-22 Change 6

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
TAT indicator pointer remains on scale with power off	Indicator	Disconnect indicator	If pointer remains on scale, replace indicator
TAT indicator readings inaccurate	Defective indicator		Replace indicator
No airspeed (TAS) indication	Loss of power or an open circuit.	Check continuity.	Repair wiring
	Plugged pitot static lines	Leak check pitot static lines for obstructions	Remove obstruction from pitot static system
Incorrect airspeed indication at high altitude	Defective temperature probe heater	Check continuity of heater element. Apply power to the probe heater circuit and check for heating	Replace defective probe
TAS indicator does not start to slew after ADC-ALT SLEW switch is depressed for 60 seconds	Defective indicator		Replace indicator
	Defective CADC altitude module	Perform CADC altitude module self-test	Replace altitude module
	Defective CADC airspeed module	Perform CADC airspeed module self-test	Replace airspeed module
TAS indicator does not increase after CADC-ALT-SLEW switch is depressed 60 seconds and slews	Defective indicator		Replace indicator
	Defective CADC altitude module	Perform CADC altitude module self-test	Replace altitude module
	Defective CADC mach module	Perform CADC Mach module self-test	Replace mach module

C A D C - Trouble Shooting
Table 101 - (Sheet 4 of 4)

Ref T O 1E-3A-2-31-1
Page 4-23 Change 4

CENTRAL AIR DATA COMPUTER - REMOVAL/INSTALLATION

1 CADC FAILURE ANNUNCIATOR RESET.

A failure annunciator is reset by accomplishing step A or step B below. Step A is for air data computers with an access hole in the dust cover to provide access to the SS switch on the right side of the chassis frame. Step B is for air data computers with no access hole.

A Reset failure annunciator on CADC having an access hole as follows.

- (1) Provide electrical power.
- (2) Verify that CADC AC circuit breaker on P5 overhead panel is closed.
- (3) Reach through access hole on right hand side of dust cover and press SS reset switch.
- (4) Verify that all annunciators indicate white. Red is a failure indication.
- (5) Perform self-test per page 501 § 1.
- (6) Remove electrical power, if no longer required for other maintenance.

B Reset failure annunciator on CADC without access hole as follows.

CAUTION NEVER REMOVE A CADC WHILE POWER IS ON

- (1) Open CADC AC circuit breaker on P5 overhead panel.
- (2) Disconnect TOTAL and STATIC lines at the pressure connections on the front panel of the CADC and place protective covers on disconnected lines.

NOTE Aircraft adapter shall remain (or be) attached to avionics shelf by its strap unless adapter itself requires maintenance.

- (3) Loosen aircraft adapter mounting screws and remove adapter from front CADC connector.
- (4) Press locks on latching handles and rotate handles to the horizontal position to disengage the rear connectors.
- (5) Carefully remove CADC from the mounting rack.
- (6) Remove the dust cover by turning the four quick-release fasteners.

Ref.: T.O. 1E-3A-2-31-1
Page 4-18 Change 33
Page 4-19 Change 4

CAUTION NEVER INSTALL A CADC WHILE POWER IS ON.

- (7) Place CADC on mounting rack and slide completely in to engage electrical connectors at opposite end of chassis
- (8) Place adapter on CADC and tighten screws
- (9) Close circuit breaker opened in step 1.
- (10) Provide electrical power
- (11) Press RESET S5 switch located on lower right side of CADC chassis (see figure 2, sheet 2 of 2).
- (12) Verify that all annunciators indicate white. Red is a failure indication.

CAUTION NEVER REMOVE A CADC WHILE POWER IS ON

- (13) Open CADC AC circuit breaker on P5 overhead panel
- (14) Remove adapter and slide CADC out of rack
- (15) Install dust cover and secure with the four quick-release fasteners.

CAUTION NEVER INSTALL A CADC WHILE POWER IS ON

- (16) Verify that CADC AC circuit breaker on P5 panel is open
- (17) Place CADC on mounting rack
- (18) Slide CADC completely in to engage electrical connectors at rear of the chassis
- (19) Secure CADC to mounting rack by raising the lock handles until the latches engage

CAUTION NEVER INSTALL AN ADAPTER WHILE POWER IS ON

- (20) Install aircraft adapter and tighten mounting screws
- (21) Remove protective caps and connect TOTAL and STATIC pressure lines to connections on front panel
- (22) Perform leak test of pitot static system.
- (23) Perform self-test per page 502 § 1.
- (24) Remove electrical power, if no longer required for other maintenance

2. CENTRAL AIR DATA COMPUTER REMOVAL. (See Figure 2.)

CAUTION. NEVER REMOVE A CADC WHILE POWER IS ON.

- A Open CADC circuit breaker on the P5 overhead panel
- B. Disconnect TOTAL and STATIC lines at the pressure connections on the front panel of the CADC and place protective covers on lines.

NOTE. Aircraft adapter shall remain attached to avionics shelf by its strap unless adapter itself requires maintenance.

- C. Loosen aircraft adapter mounting screws, remove adapter from front CADC connector.
- D Press locks of latching handles and move CADC handles to the horizontal position to disengage the rear connectors.
- E Carefully remove CADC from the mounting rack.

3 AIRSPEED, MACH, AND ALTITUDE MODULES REMOVAL. (See Figure 2.)

- A Remove Central Air Data Computer per page 403 § 2.
- B. Turn the four quick-release fasteners at the sides of the CADC and remove dust cover.
- C Release applicable latching assembly on each side of the chassis to free the module to be removed.
- D Carefully lift module to disengage electrical connector and pressure connections on the base.

4 AIRSPEED, MACH AND ALTITUDE MODULES INSTALLATION. (See Figure 2.)

- A Ensure Central Air Data Computer is removed per page 403 § 2.
- B. Ensure dust cover is removed by having turned the four quick-release fasteners at the sides of the CADC dust cover.
- C. Lower module into air data computer chassis
- D. Carefully position module to engage the pressure connections and the electrical connector on the base.
- E Seat module firmly against chassis and secure it in place, using the latching assembly on each side of chassis.

Ref.: T.O. 1E-3A-2-31-1
Page 4-19 Change 4
Page 4-24 Change 32

F. Place dust cover in position over chassis and secure it in place with quick-release fasteners.

G. Install central air data computer per 404 & 5

5 CENTRAL AIR DATA COMPUTER INSTALLATION (See Figure 2)

A Ensure that CADC AC circuit breaker on the P5 overhead panel is open

CAUTION DO NOT INSTALL A CADC WHILE POWER IS ON.

B. Lift CADC onto mounting rack.

C Carefully slide CADC to the rear to engage electrical connectors at rear of the chassis. Seat module firmly in place.

D Secure CADC in the mounting rack by raising the lock handles until the latches engage.

CAUTION DO NOT INSTALL THE ADAPTER WHILE POWER IS ON.

E Install the adapter and tighten the adapter mounting screws

F Connect the TOTAL and STATIC pressure lines to the appropriate pressure connections on front panel

G Perform leak test of pitot and static system.

H Perform self-test per page 502 § 1

6 TOTAL AIR TEMPERATURE INDICATOR REMOVAL (See Figure 2)

A. Open Total Air TEMP 2 circuit breaker on P3 panel

B In the copilot panel release the indicator mounting clamp by loosening the round-head screw adjacent to the TAT indicator.

C Carefully pull the indicator out of the panel until the connector is accessible

D. Disconnect electrical connector and install protective cap of wiring connector ensuring that it remains accessible

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7 TOTAL AIR TEMPERATURE INDICATOR INSTALLATION (See Figure 2.)

- A Verify that Total Air Temp circuit breaker on P3 panel is open
- B In the copilot panel, remove protective cap from TAT wiring connector and connect to TAT indicator.
- C Carefully slide indicator into its place in the panel
- D Secure the TAT indicator mounting clamp by tightening the adjacent round-head screw.
- E Close Total Air Temp. circuit breaker on P3 panel
- F Provide electrical power.
- G Place a thermometer adjacent to TAT probe. Shield from wind and direct sunlight and note ambient temperature.
- H Check that TAT indicator shows ambient temperature within $\pm 2^{\circ}\text{C}$
- I Remove electrical power, if no longer required for other maintenance

8. TAT PROBE REMOVAL. (See Figure 2, Sheet 1 of 2.)

- A Open Total Air Temp circuit breaker on P3 panel
- B Support probe and remove six mounting screws.
- C Carefully pull probe until electrical connector is accessible.
- D Disconnect electrical connector from probe and remove the gasket.
- E Install protective cap on connector ensuring that it remains accessible.

9. TAT PROBE INSTALLATION. (See Figure 2, Sheet 1 of 2.)

- A Verify that Total Air Temp circuit breaker on P3 panel is open
- B Install serviceable gasket on in-board side of probe flange
- C Connect electrical connector to probe.

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Page 4-24 Change 32
Page 4-25 Change 1

D Position probe so that the wide orifice is pointed forward and install six mounting screws

E Close Total Air Temp circuit breaker on P3 panel

F. Perform operational checkout of probe as described on page 504 § 2

10 TAT PROBE CLEANING

CAUTION CARE MUST BE USED IN REMOVING FOREIGN MATERIAL THAT MAY BE LODGED WITHIN THE AIR INLET SCOOP.

A. To remove foreign material, blow compressed air in a reverse direction through the air exit hole

B If this method fails, flush the interior of the air inlet scoop with water

C. When the foreign material has become dislodged, blow compressed air through the scoop in a reverse direction.

D. After cleaning, perform the operational checkout described on page 504 § 2

11 STATIC AIR TEMPERATURE INDICATOR REMOVAL (See Figure 2.)

A Open CADC AC circuit breaker on the P5 overhead panel

B In the copilot panel, release the indicator mounting clamp by loosening the round-head screw adjacent to the SAT indicator.

C. Carefully pull the indicator out of the panel until the connector is accessible

D Disconnect electrical connector and install protective cap on aircraft wiring connector ensuring that it remains accessible.

12 STATIC AIR TEMPERATURE INDICATOR INSTALLATION. (See Figure 2)

A. Verify that CADC AC circuit breaker on the P5 overhead panel is open

B Remove protective cap from SAT wiring connector in the copilot panel and connect SAT indicator.

C Carefully slide indicator into its position in the panel.

D Secure the SAT indicator mounting clamp by tightening the round-head screw adjacent to the indicator

Ref : T O. 1E-3A-2-31-1

Page 4-25 Change 1

- | E Close CADC AC circuit breaker on the P5 overhead panel
- F. Provide electrical power
- G Place a thermometer adjacent to the TAT probe Shield from wind and direct sunlight and note ambient temperature
- H Verify that SAT indicator on copilot panel indicates ambient temperature within $\pm 2^{\circ}\text{C}$
- I. Remove electrical power, if no longer required for other maintenance.

13 TRUE AIRSPEED INDICATOR REMOVAL (See Figure 2)

- | A. Open CADC AC circuit breaker on the P5 overhead panel
- B Loosen the one round-head screw adjacent to the TAS indicator and carefully pull indicator out of copilot panel until electrical connector is accessible.
- C. Disconnect electrical connector, install protective cap, and ensure that connector remains accessible

14 TRUE AIRSPEED INDICATOR INSTALLATION (See Figure 2)

- | A Verify that the CADC AC circuit breaker on P5 panel is open
- B Remove protective cap from TAS wiring connector and connect TAS indicator
- C Insert TAS indicator into its place in the copilot panel.
- D Secure the indicator mounting clamp by tightening the round-head screw adjacent to the indicator
- E. Perform operational checkout of TAS indicator per page 305 § 4

15 MACH/AIRSPEED INDICATOR REMOVAL (See Figure 5)

A. General

The captain's Mach/Airspeed indicator (RN61) is installed on the captain's instrument panel P8. The first officer's Mach/Airspeed indicator (RN62) is installed on the first officer's instrument panel P10. The circuit breaker CADC AC (C9017) is installed on the P5 circuit breaker panel

B Procedure

- (1) Open CADC AC circuit breaker on P5 panel
- (2) Open captain's (first officer's) instrument panel
- (3) Disconnect electrical connector RD 9105 (or 9126 for F/O) and hoses from the Mach/Airspeed indicator. Place protective caps on connector and hoses
- (4) Release instrument mounting clamp by loosening the upper-right and lower-left round-head screws adjacent to the indicator
- (5) Carefully slide the indicator out of the panel

16 MACH/AIRSPEED INDICATOR INSTALLATION (See figure 5)

- A Verify that the CADC AC circuit breaker on the P5 overhead panel is open
- B Open captain's (First officer's) instrument panel
- C Insert mach/airspeed indicator through the front of the panel and secure the indicator mounting clamp by tightening the upper-right and lower-left round-head screws adjacent to the indicator
- D Remove protective cap from connector and hoses and connect the electrical connector and hoses to the mach/airspeed indicator
- E Close and secure the captain's (first officer's) instrument panel
- F Reset the CADC AC circuit breaker on P5 overhead panel
- G Perform pitot/static system leak test as outlined in 34-2-0, Page 201 - Adjustment/Test of Pitot/static System
- H Check out mach/airspeed operation per Chapter 34-10-01, page 506 - Adjustment/Test of the Mach/Airspeed indicator

NOTE When using quick disconnects, refer to Pitot/Static System - Removal/Installation outlined in Chapter 34-2-0, page 401

Ref. Telex GLK 054429 dtd May 28/93

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CENTRAL AIR DATA COMPUTER - ADJUSTMENT/TEST

Refer to table 501 for a listing of the required tools and test equipment. There are no consumables required for this system.

PART NO. OR TYPE DESIGNATOR	FIGURE AND INDEX NO.	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation			
P/N 77 Princo Inst.		Thermometer set (-36 to 680°F)	Check total air temperature probe and indicator.
AN/USM-341		Digital Multi-meter	Check total air temperature probe.
204-91961-1		TAT Adapter Assembly	Connect TAT probe to digital voltmeter.

CADC Flight Instrument Tools and Test Equipment
Table 501



MAINTENANCE MANUAL

1. OPERATIONAL CHECKOUT

A. Central Air Data Computer Self-Test.

The following is an operational checkout of the Central Air Data Computer and its associated air data flight instruments. Except where specifically stated, all references to switches, controls, indicators and legends apply to the self-test panel on the front of the CADC.

- (1) Provide electrical power to airplane.
- (2) Provide communication between flight deck and lower forward lobe.
- (3) Verify that CADC circuit breaker, located on P5 circuit breaker panel, are closed.
- (4) Failure Annunciator Check. Check the condition of the three Failure Annunciators. The annunciators are the circular indicating devices on the front panel marked ALT, MACH and IAS. Each annunciator shall display a white center. If the center is red, the failure monitor in the corresponding altitude, Mach or indicated airspeed module has sensed a failure condition during flight or ground run-up.

NOTE: During the following failure monitor checks the external flag excitation is removed. This can be noted by direct observation of the failure flags in the True Airspeed (TAS), Static Air Temperature (SAT), and Machmeter part of the Mach/Air-speed Indicators.

- (5) Failure Monitor Check (Altitude Module). Set Rotary Selector Switch to ALT MONITOR. The meter needle shall move into the green area on the scale, indicating a failure monitor output of approximately 28 volts dc. Set and hold 600 FPM/MONITOR switch to MONITOR. After a delay, meter indication shall drop to approximately zero (lower 5 percent of scale), indicating that the failure monitor is operating properly. Release switch. After a delay, meter indication shall return to green area of scale. ALT failure annunciator shall not indicate a failure condition as a result of this test being performed.
- (6) Failure Monitor Check (Indicated Airspeed Module). Repeat the test described in step (4) above except set Rotary Selector Switch to IAS MONITOR. The IAS failure annunciator shall not indicate a failure condition as a result of this test being performed.
- (7) Failure Monitor Check (Mach Module). Repeat the test described in step (4) above except set Rotary Selector Switch to M (Mach) MONITOR. The MACH failure annunciator shall not indicate a failure condition as a result of this test being performed.



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- (8) Altitude Readout Checkout.

CAUTION CAUTION THE ALT SLEW SWITCH SHALL BE RELEASED WHEN THE MACHMETERS STOP SLEWING TO PREVENT EXCESSIVE CLUTCH WEAR (2 MINUTES MAXIMUM)

- (9) With CADC Rotary Selector Switch at ALTITUDE READ, press and hold 60 FT/ALT SLEW Switch at ALT SLEW and check following:
- (a) Observe that each digitizer lamp eventually illuminates.
 - (b) Aircraft True Airspeed (TAS) and Static Air Temperature (SAT) indicators will start to slew after ALT SLEW Switch is depressed for 60 seconds.
 - (c) True Airspeed (TAS) shall increase
 - (d) Static Air Temperature (SAT) shall decrease.
 - (e) The machmeter part of the Mach/Airspeed indicator shall start slewing but will be covered by a flag until 0.40 Mach is reached. Mach meter shall slew up to a reading between 0.47 and 0.50 Mach.
 - (f) Release switch.
- (10) Wait 2 minutes before the next step to allow the CADC drive to return to initial position.
- (11) Altitude Rate Check. Set Rotary Selector Switch to ALT RATE 1. Set and hold the 60 FT/ALT SLEW Switch at ALT SLEW. The meter needle shall move into the green area on the scale, indicating that the velocity generator is driving the number 1 altitude rate amplifier properly. Release switch.
- (12) Indicated Airspeed Module Slew Check. Set Rotary Selector Switch to IAS SLEW Set IAS-M SLEW/ 5 KN switch at IAS-M SLEW and hold for 10 seconds. The meter needle shall move into the green area on the scale. Release switch. After a delay, the meter needle shall drop to approximately zero.
- (13) Mach Module Slew Check. Set Rotary Selector Switch to MACH SLEW Set and hold IAS-M SLEW/ 5 KN switch at IAS-M SLEW. After a delay the meter needle shall first move into the green area on the scale, then drop to approximately zero as the servo loop drives to rebalance. Release switch. After a delay, the meter needle shall again move into the green area on the scale (since removal of the test signal again unbalances the loop) then drop to approximately zero once again as the motor drives the loop to a rebalanced condition.
- (14) Set Rotary Selector Switch to OFF.



MAINTENANCE MANUAL

2. TOTAL AIR TEMPERATURE INDICATOR CHECK

Check the total air temperature indicating system as follows:

- A. Verify that Total Air Temp. circuit breaker on P3 panel is closed.
- B. Place a thermometer (table 501) adjacent to the TAT probe and shield both from wind and direct sunlight.
- C. The Total Air Temperature Indicator should read ambient temperature at the probe within $\pm 2^{\circ}\text{C}$

CAUTION IF PROBE HEATER SWITCH IS LEFT ON WHILE THE AIRCRAFT IS NOT MOVING THE TEMPERATURE PROBE WILL BE DAMAGED
ENSURE PITOT COVERS ARE REMOVED FROM THE PROBES BEFORE HEATER SWITCH IS TURNED ON

- D. Set Total Temperature Probe Heater Switch on overhead panel to ON.
- E. Check that the temperature on the Total Air Temperature Indicator starts to rise Immediately set Probe Heater Switch to OFF.



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3. STATIC AIR TEMPERATURE INDICATION CHECK.

Check Static Air Temperature Indicator as follows:

- A. Verify the Probe Heater Switch on overhead panel is OFF.
- B. Verify that CADC circuit breaker on P5 panel is closed.
- C. Place a thermometer (table 501) adjacent to the TAT probe and shield both from wind and direct sunlight.
- D. Verify that SAT indicator on copilot panel indicates ambient temperature with $\pm 2^{\circ}\text{C}$ of thermometer indication and that striped flag is removed from view.
- E. Verify that Total Air Temperature circuit breaker on P3 circuit breaker panel is closed.

CAUTION IF THE TOTAL TEMPERATURE PROBE HEATER SWITCH IS LEFT ON WHILE THE AIRCRAFT IS NOT MOVING, THE TOTAL TEMPERATURE PROBE WILL BE DAMAGED

- F. Set Total Temperature Probe Heater Switch on overhead panel to ON.
- G. Check that the temperature on the SAT indicator starts to rise. Immediately set Total Temperature Probe Heater Switch to OFF.

4. TRUE AIRSPEED INDICATION CHECK.

The True Airspeed Indicator is checked as follows

NOTE: The True Airspeed Indicator can be functionally checked during the Central Air Data Computer checkout (refer to paragraph 1.A.).

- A. Verify that Total Air Temp. circuit breaker on P3 circuit breaker panel is closed.
- B. Verify that CADC circuit breaker on P5 circuit breaker panel is closed.
- C. Set Total Air Temperature Probe Heater Switch, located on overhead panel, to ON.
- D. The True Airspeed Indicator will start to count.

NOTE: When the aircraft is not moving, the TAS indicator is meaningless. It will vary according to temperature and wind gusts.



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- E. When a speed indication is obtained, immediately set Probe Heater Switch to OFF.
- F. Remove electrical power, if no longer required for other maintenance.

1. MACH/AIRSPEED INDICATOR CHECK

- A. Prepare for checkout per AMM 34-2-0, paragraphs 1.A. and 1.B..
- B. Verify that CADC AC, ADC 1 and ADC 2 circuit breakers on circuit breaker panel P5 are closed.
- C. Set Probe Heater Switches on P5 overhead panel to OFF.
- D. Open all 5 PROBE HEAT circuit breakers on P6-1 and P6-2 panel.
- E. Set pilots and copilots ADC barometric correction to 29,92 inHg.

NOTE: Allow CADC 5 minutes to warm up.

- F. Set pitot/static testset ALTITUDE and AIRSPEED controls to each position listed in column 1 of the table below and verify for correct Mach and Airspeed indications.

COLUMN 1			COLUMN 2	COLUMN 3 ^②
ALTITUDE	AIRSPEED	MACH	TOLERANCE ^①	INSTRUMENT COMPARISON
0	130		± 2 Knots	3 Knots
0	250		± 3 Knots	5 Knots
5 000	300	495	± 4 Knots, Mach 01	6 Knots, Mach 015
10 000	325	585	± 4 Knots, Mach 01	6 Knots, Mach 015
25 000	328,5	78	± 4 Knots, Mach 01	6 Knots, Mach 015
35 000	257	76	± 4 Knots, Mach 01	6 Knots, Mach 015
			^① Between test set and each flight deck indicator	^② Maximum difference between pilot's and copilot's indicator

- G. After test, return testset altitude to field elevation and set airspeed to zero knots. Disconnect the pitot/static testset and remove also the seals from the static port and pitot drain hole.
- H. Close the PROBE HEAT circuit breakers opened in step D.
- I. Restore aircraft to normal configuration.

END

CENTRAL AIR DATA COMPUTER - ADJUSTMENT/TEST

Refer to table 501 for a listing of the required tools and test equipment.
There are no consumables required for this system.

PART NO OR TYPE DESIGNATOR	FIGURE AND INDEX NO	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation			
P/N 77 Princo Inst		Thermometer Set (-36 to 680°F)	Check total air temperature probe and indicator
AN/USM-341		Digital Multimeter	Check total air temperature probe
204-91961-1		Tat Adapter Assembly	Connect TAT probe to digital voltmeter.

C A.D.C. Flight Instrument Tools And Test Equipment
Table 501

Ref. T O. 1E-3A-2-31-1
 Page 4-12 Change 4
 Page 4-18 Change 33

1. OPERATIONAL CHECKOUT.

A Central Air Data Computer Self-Test

The following is an operational checkout of the central air data computer and its associated air data flight instruments. Except where specifically stated, all references to switches, controls, indicators and legends apply to the self-test panel on the front of the CADC

- (1) Provide electrical power to airplane
- (2) Provide communication between flight deck and lower forward lobe
- (3) Verify that CADC and ALTM VIB N° 1 and N° 2 circuit breakers, located on P5 circuit breaker panel, are closed
- (4) Failure Annunciators Check Check the condition of the three failure annunciators. The annunciators are the circular indicating devices on the front panel marked ALT, MACH, and IAS. Each annunciator shall display a white center. If the center is red, the failure monitor in the corresponding altitude, Mach, or indicated airspeed module has sensed a failure condition during flight or ground runup.

NOTE During the following failure monitor checks the external flag excitation is removed. This can be noted by direct observation of the failure flags in the true airspeed (TAS), static air temperature (SAT), and machmeter part of the Mach/airspeed indicators.

- (5) Failure Monitor Check (Altitude Module) Set rotary selector switch to ALT MONITOR. The meter needle shall move into the green area on the scale, indicating a failure monitor output of approximately 28 volts dc. Set and hold 600 FPM/MONITOR switch at MONITOR. After a delay, meter indication shall drop to approximately zero (lower 5 percent of scale), indicating that the failure monitor is operating properly. Release switch. After a delay, meter indication shall return to green area of scale. ALT failure annunciator shall not indicate a failure condition as a result of this test being performed.
- (6) Failure Monitor Check (Indicated Airspeed Module) Repeat the test described in step (4) above except set rotary switch to IAS MONITOR. The IAS failure annunciator shall not indicate a failure condition as a result of this test being performed.
- (7) Failure Monitor Check (Mach Module) Repeat the test described in step (4) above except set rotary selector switch to M (Mach) MONITOR. The MACH failure annunciator shall not indicate a failure condition as a result of this test being performed.

Ref.: DRW CDRL 43/44
Paragraph 7.22-Issue D dtd 19 May 1988

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- (8) Altitude Readout Checkout.

CAUTION. THE ALT SLEW SWITCH SHALL BE RELEASED WHEN THE ALTIMETERS STOP SLEWING TO PREVENT EXCESSIVE CLUTCH WEAR (2 MINUTES MAXIMUM)

- (9) Set AAU-19/A altimeter to RESET mode.
- (10) With CADC rotary selector at ALTITUDE READ, press and hold 60 FT/ALT SLEW switch at ALT SLEW and check the following:
- (a) Observe that each digitizer lamp eventually illuminates.
 - (b) While ALT SLEW switch is depressed, the aircraft altimeter will increase and eventually return to STANDBY
 - (c) Aircraft true airspeed (TAS) and static air temperature (SAT) indicators will start to slew after ALT SLEW switch is depressed for 60 seconds
 - (d) True airspeed (TAS) shall increase.
 - (e) Static air temperature (SAT) shall decrease.
 - (f) The machmeter part of the Mach/airspeed indicator shall start slewing but will be covered by d flag until 0.40 Mach is reached Mach meter shall slew up to a reading between 0.47 and 0.50 Mach
 - (g) Release switch.
- (11) Wait 2 minutes before the next step to allow the CADC drive to return to initial position.
- (12) Altitude Rate Check. Set rotary selector switch to ALT RATE 1. Set and hold the 60 FT/ALT SLEW switch at ALT SLEW. The meter needle shall move into the green area on the scale, indicating that the velocity generator is driving the number 1 altitude rate amplifier properly Release switch.
- (13) Place altimeter in RESET.
- (14) Delta 60-Foot Check. Set rotary selector switch to OFF. Set and hold the 60 FT/ALT SLEW switch at 60 FT. This applies a signal which drives the gear train in the altitude module to a position equivalent to an altitude approximately 60 feet above ambient pressure altitude. Check for response on the pilot or copilot altimeters. Release switch. The altitude module servo loop will rebalance at the pressure altitude.

Ref. DRW CDRL 43/44
Paragraph 7 22-Issue D dtd. 19 May 1988

(15) Indicated Airspeed Module Slew Check Set rotary selector switch to IAS SLEW Set IAS-M SLEW/5 KN switch at IAS-M SLEW and hold for 10 seconds The meter needle shall move into the green area on the scale Release switch After a delay, the meter needle shall drop to approximately zero.

(16) Mach Module Slew Check Set rotary selector switch to MACH SLEW Set and hold IAS-M SLEW/5 KN switch at IAS-M SLEW After a delay the meter needle shall first move into the green area on the scale then drop to approximately zero as the servo loop drives to rebalance Release switch After a delay, the meter needle shall again move into the green area on the scale (since removal of the test signal again unbalances the loop) then drop to approximately zero once again as the motor drives the loop to a rebalanced condition

(17) Set rotary selector to OFF.

2 TOTAL AIR TEMPERATURE INDICATOR CHECK.

Check the total air temperature indicating system as follows.

- A Verify that Total Air Temp circuit breaker on P3 panel is closed
- B Place a thermometer (table 501) adjacent to the TAT probe and shield both from wind and direct sunlight.
- C The total air temperature indicator should read ambient temperature at the probe within $\pm 2^{\circ}\text{C}$

CAUTION IF PROBE HEATER SWITCH IS LEFT ON WHILE THE AIRCRAFT IS NOT MOVING THE TEMPERATURE PROBE WILL BE DAMAGED.

ENSURE PITOT COVERS ARE REMOVED FROM THE PROBES BEFORE HEATER SWITCH IS TURNED ON.

- D Set total temperature probe heater switch on overhead panel to ON
- E Check that the temperature on the total air temperature indicator starts to rise Immediately set PROBE HEATER switch to OFF.

Ref : DRW CDRL 43/44

Paragraph 7.22- Issue D dtd. 19 May 1988

3. STATIC AIR TEMPERATURE INDICATION CHECK

Check static air temperature indicator as follows

- A Verify the PROBE HEATER switch on overhead panel is OFF
- B Verify that CADC circuit breaker on P5 panel is closed
- C Place a thermometer (table 501) adjacent to the TAT probe and shield both from wind and direct sunlight
- D Verify that SAT indicator on copilot panel indicates ambient temperature with $\pm 2^{\circ}\text{C}$ of thermometer indication and that striped flag is removed from view
- E Verify that TOTAL AIR TEMP circuit breaker on P3 circuit breaker panel is closed

CAUTION IF THE TOTAL TEMPERATURE PROBE HEATER SWITCH IS LEFT ON WHILE THE AIRCRAFT IS NOT MOVING, THE TOTAL TEMPERATURE PROBE WILL BE DAMAGED

- F Set total temperature probe heater switch on the overhead panel to ON
- G Check that the temperature on the SAT indicator starts to rise Immediately set total temperature probe heater switch to OFF

4. TRUE AIRSPEED INDICATION CHECK

The true airspeed indicator is checked as follows

NOTE The true airspeed indicator can be functionally checked during the Central Air Data Computer checkout (refer to paragraph 1 A)

- A Verify that Total Air Temp circuit breaker on P3 circuit breaker panel is closed
- B Verify that CADC circuit breaker on P5 circuit breaker panel is closed
- C Set Total Temperature Probe Heater switch, located on overhead panel, to ON
- D The true airspeed indicator will start to count

NOTE When the aircraft is not moving the TAS indicator is meaningless It will vary according to temperature and wind gusts

Ref DRW CDRL 43/44
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E When a speed indication is obtained, immediately set PROBE HEATER switch to OFF

F Remove electrical power, if no longer required for other maintenance

5 MACH/AIRSPEED INDICATOR CHECK

A Prepare for checkout per AMM 34-2-0, paragraphs 1 A and 1 B .

B Verify that CADC AC - ALTM VIB 1 and 2 circuit breakers are closed

C Set probe heater switches on P5 overhead panel to OFF.

D Open all 5 PROBE HEAT circuit breakers on P6-1 and P6-2 panel.

E. Set pilot and copilot altimeters to STBY mode, and set the altimeters barometric correction to 29.92

NOTE. Allow CADC 5 minutes to warm up.

F Set pitot/static testset ALTITUDE and AIRSPEED controls to each position listed in column 1 of the table below and verify for correct MACH and AIRSPEED indications

COLUMN 1			COLUMN 2	COLUMN 3 ②
ALTITUDE	AIRSPEED	MACH	TOLERANCE ①	INSTRUMENT COMPARISON
0	130		± 2 Knots	3 Knots
0	250		± 3 Knots	5 Knots
5 000	300	495	± 4 Knots Mach 01	6 Knots Mach 015
10 000	325	585	± 4 Knots Mach 01	6 Knots Mach 015
25 000	328.5	78	± 4 Knots, Mach 01	6 Knots, Mach 015
35 000	257	76	± 4 Knots, Mach 01	6 Knots Mach 015
			① Between test set and each flight deck indicator	② Maximum difference between pilot's and copilot's indicator

G After test, return testset altitude to field elevation and set airspeed to zero knots. Disconnect the pitot/static testset and remove also the seals from the static port and pitot drain hole

H Close the PROBE HEAT circuit breakers opened in step D

I Restore aircraft to normal configuration

Ref Telex GLK 054429 dtd May 28/93



MAINTENANCE MANUAL

AIR DATA DISPLAY UNITS - DESCRIPTION AND OPERATION

1. General.

This section describes the Air Data Display Units (ADDU) which act as an altimeter indicator for indication purposes and as a complex Air Data Computer (ADC) as well.

2. Description.

The Air Data Display Unit (ADDU) is a combined air data computer (ADC) and altimeter indicator that is installed one each at the pilot's and co-pilot's instrument panel. The units are microprocessor based instruments. The processor is responsible for performing all control, logic, sequencing, computation, and fault diagnostic functions required to accurately calculate and display the altitude and baro setting information. It determines the system integrity, and indicates operational status of the instrument.

The integrally-lighted indicator with a Liquid Cristal Display (LCD) provides digital altitude information.

In addition the unit features all characteristics of an Air Data Computer (ADC) as it is connected to the pitot / static system of the aircraft. Static Source Error Correction (SSEC) is obtained by an Installation Configuration Module (ICM) (See Fig. 6) mounted on the rear of the unit, providing aircraft unique SSEC correction data for L/H and R/H pitot/static system

The barometric altitude display range is from -3,000 ft (-914 m) through +55,000 ft (+16,764 m) indicated by the Altitude Counter. The Altitude Pointer repeats the 100-foot indication of the Altitude Counter. Barometric pressure, shown on the Barometric Pressure Indicator, can be selected over a range of 22.00 through 31.00 IN.HG respectively 745 through 1050 hPa via the BARO Pressure Setting Knob. This knob is also used to set desired barometric (IN HG/hPa) and height (FT/M) units. The selected units are shown on the Altitude and Barometric Pressure Scale Indicator.

The Air Data Display Units provide an altitude signal (pressure altitude, label 203, resolution 1 ft) via an ARINC 429 bus interface. Depending on air data source selection, the altitude information from the respective ADDU is sent to the STR2000-A1 transponder for Mode C and Mode S transmission.

The instruments are also connected to the Altitude Alerter on the Center Instrument Panel. Approaching or diverging from a selected altitude is indicated by the ALT Alert Light.

NOTE: Ensure that OFF/STBY/NORM/EMER Switch on the CADU is set to OFF or STBY while TEST Switch is actuated, to avoid inadvertently transmitting an altitude signal. A fixed altitude signal of 10,000 ft will be transmitted from the selected ADDU to the STR 2000-A1 transponder, via the ARINC 429 data bus.

Failure conditions of the unit are indicated by the STBY flags and failure mode indications. The indicator units feature a self test capability initiated by the bezel TEST Switch.



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Redundancy of the two ADDU's is provided by the separation of the aircraft's pitot / static system, and the electrical power sources for the pilot's and copilot's indicators. The units are primarily supplied with 28 V DC through a circuit breaker labeled ADC 1 or ADC 2 on the P5 panel. ADDU1 is connected to the ESS FLT INSTR BUS, ADDU 2 is connected to the ESS RADIO BUS. In emergency case both ADDUs can be supplied with 28 VDC from Battery Bus.

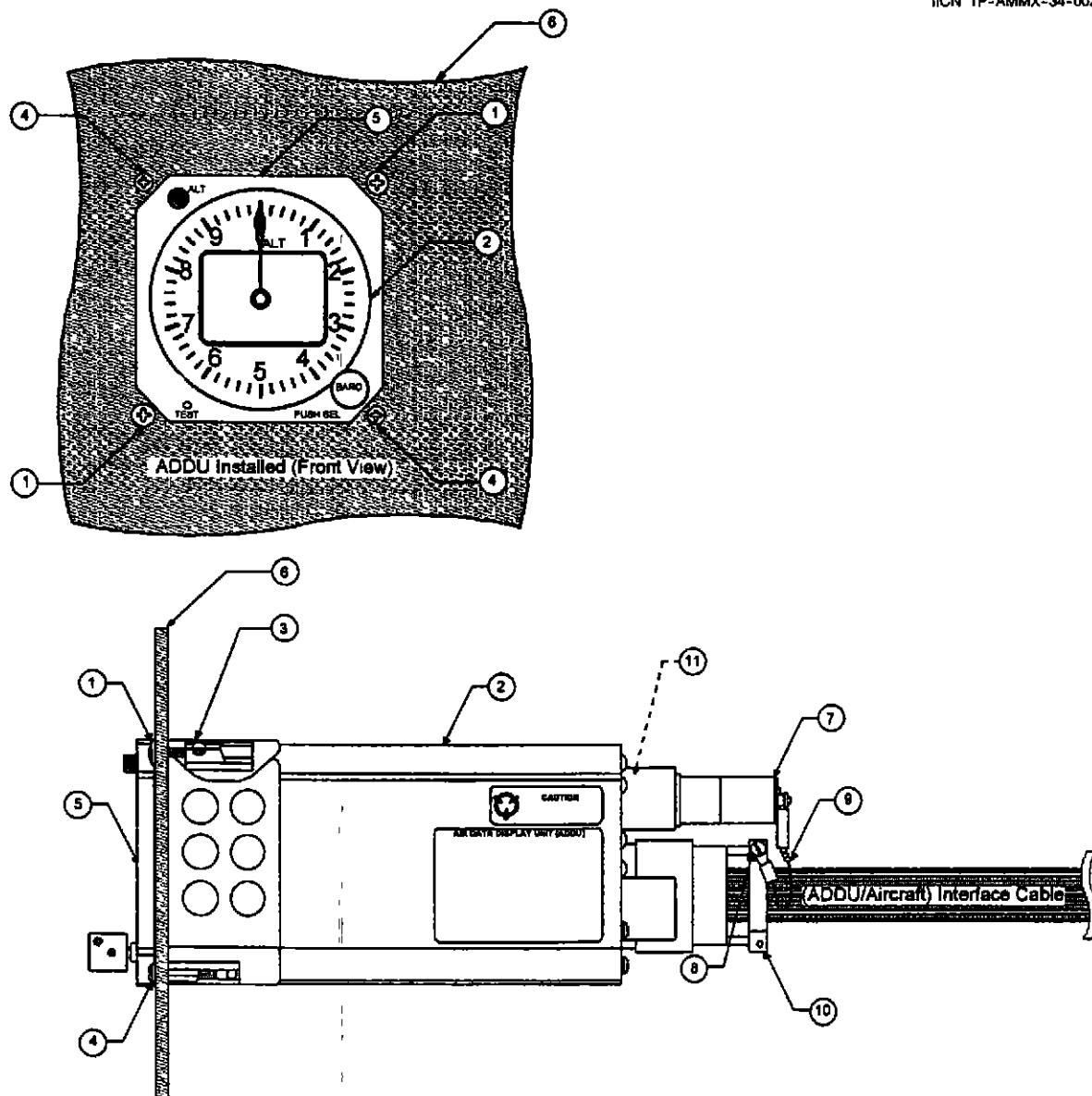
In case of erroneous altitude indication or failure of one instrument it is possible to select the other alternate air data source via the ADC Source Select Switch.

With the ADC Source Select Switch one of the two ADDUs will be selected as the primary source for ARINC 429 data for the Altitude Alerter, STR 2000-A1 Transponder, Autopilot and Flight Director Interface Unit. ALT HOLD error signal and ADC/IU valid signal for the flight director systems are converted from digital ARINC 429 signals to analog signals via two Interface Units IU-87A Data Converter, one for each ADDU.

With the ADDU Test Switch a self test can be performed as described in chapter AIR DATA COMPUTER - ADJUSTMENT/TEST.

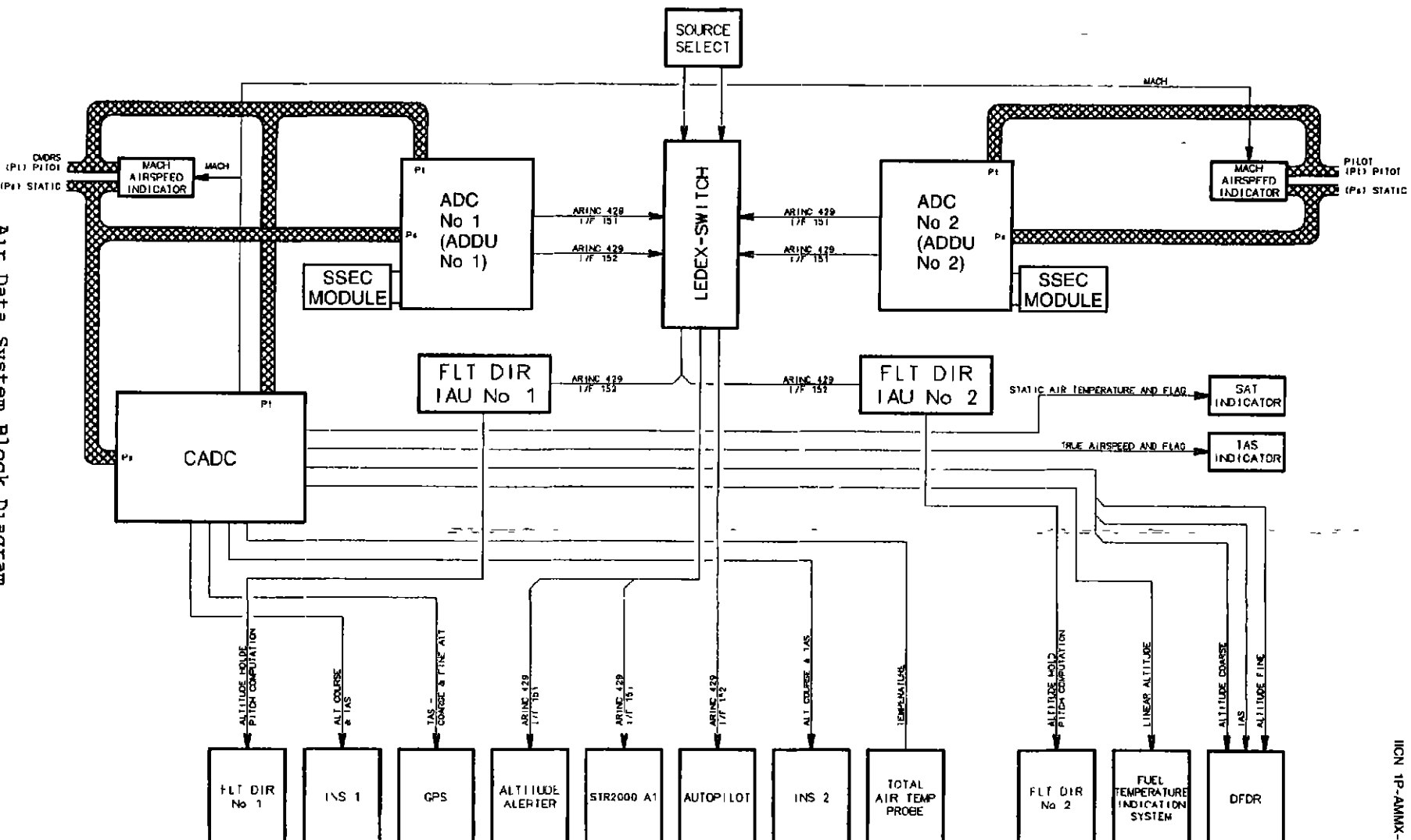
3. Installation

The ADDU is standard panel mounted. The clamp mount fixes the ADDU to the instrument panel. Unlocking 2 screws enables to slide out the ADDU and gain access to the electrical and pneumatic quick connectors.

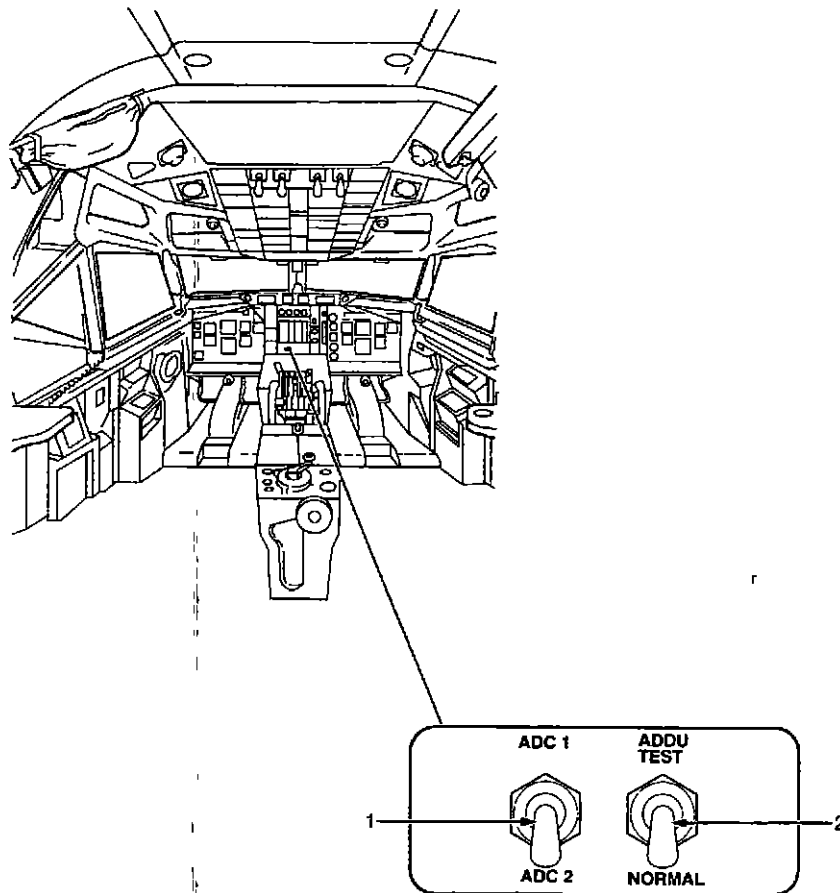


- 1 Instrument mounting screws
- 2 ADDU
- 3 Instrument mounting clamp
- 4 Clamp mounting screws
- 5 Bezel
- 6 Instrument panel
- 7 Installation configuration module
- 8 Connector backshell screw
- 9 Lanyard
- 10 Connector backshell
- 11 J2 Interface (Not shown) is located behind the Pt interface

Air Data Display Unit Installation
Fig. 1



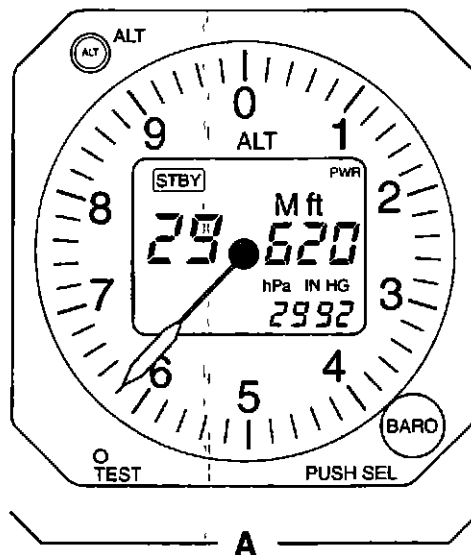
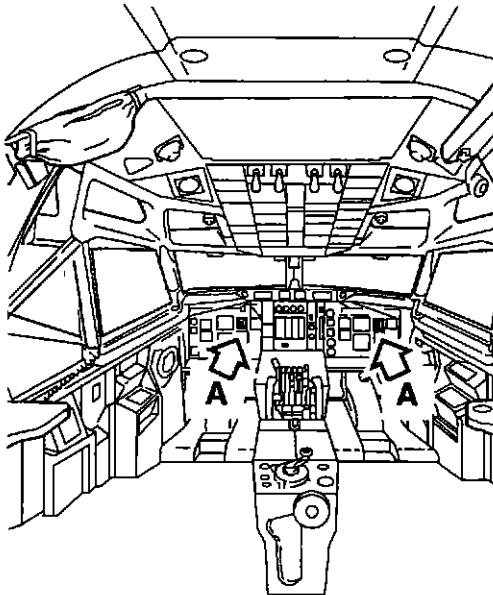
Air Data System Block Diagram
Fig. 2



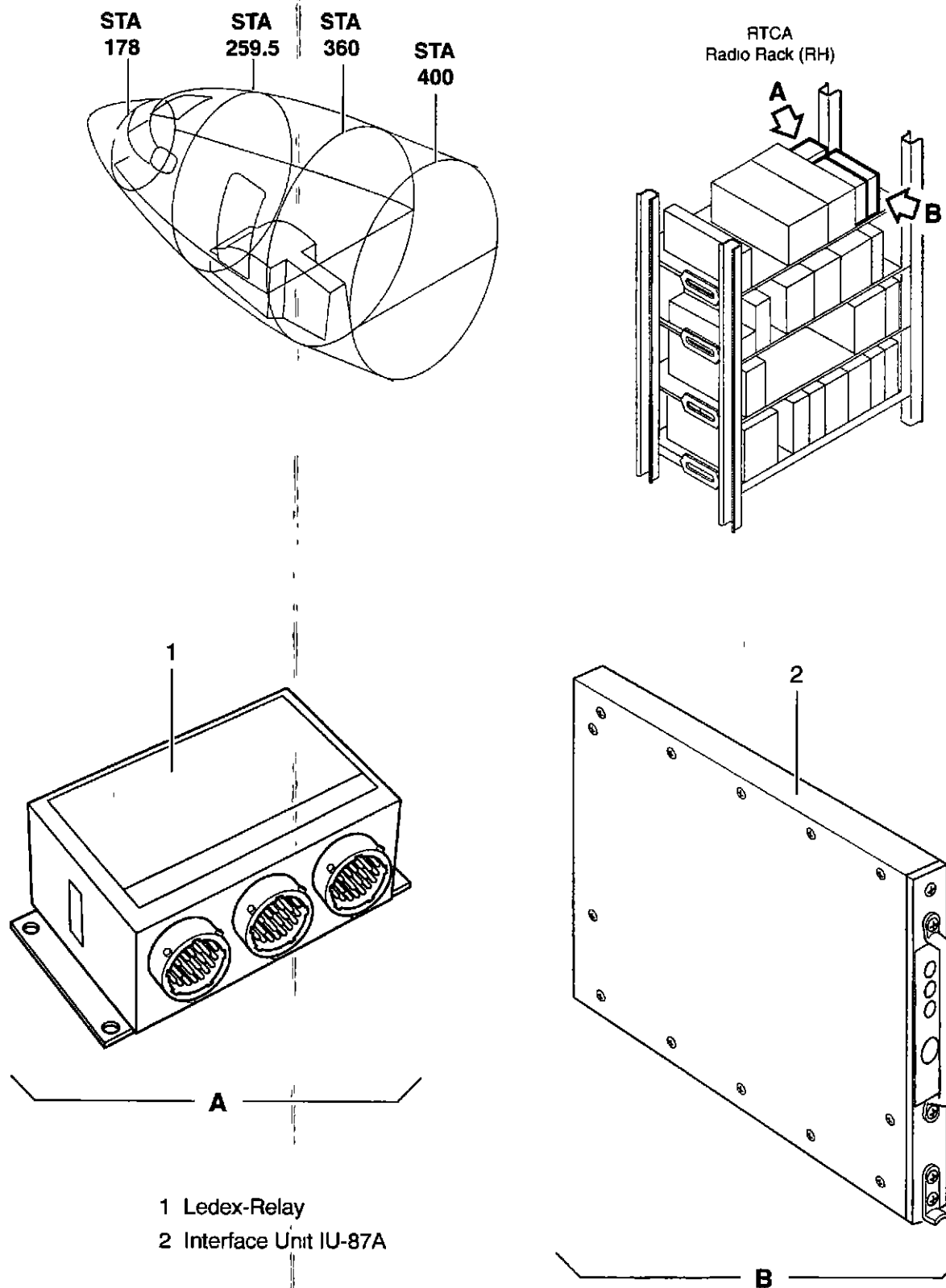
- 1 Air Data Computer Source Select Switch
- 2 Air Data Display Unit Test Switch

The ADC Source Select Switch and the ADDU Test Switch are located on the Center Instrument Panel P9, accessible for both, pilot and copilot.

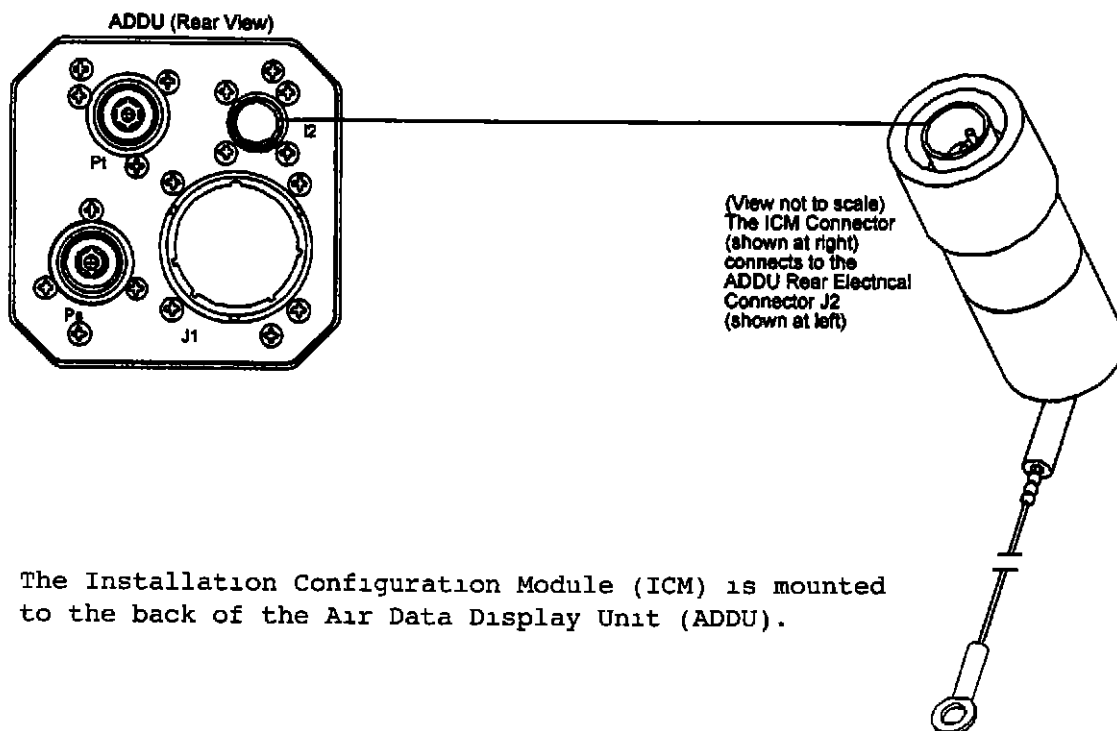
ADC Source Select Switch and ADDU Test Switch
Fig. 3



Air Data Display Unit Location
 Fig. 4



Location of Ledex-Relay and Interface Unit IU-87A
 Fig. 5



Installation Configuration Module (ICM)
Fig. 6



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AIR DATA DISPLAY UNITS - TROUBLESHOOTING

Refer to chapter 34-45-03 for trouble analysis information.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
NOTE Only limited isolation checks are required for the ADDU since the self-test checkout procedure presented in page 502 § 1 is designed to isolate a fault. In such cases, the entire ADDU unit should be replaced.			
CAUTION. Prior flushing the static system with nitrogen, disconnect all affected devices.			
No altitude indication on ADDU 1 or ADDU 2	Static line blocked up	Perform functional check on affected static system	Flush affected static system with Nitrogen
	ADDU 1 or ADDU 2 defective	Perform cross change of ADDUs	If ok now, check static system If not ok, replace ADDU
Faulty indication on ADDU 1 or ADDU 2	Water in static line	Drain affected static system	Drain affected static system and flush with nitrogen
	Static line leaks	Perform leak check on affected static system	Repair static system
	ADDU 1 or ADDU 2 defective	Perform cross change of ADDUs	If ok now, check static system If not ok, replace ADDU
No or faulty ARINC 429 label 203 signal output	ADDU 1 or ADDU 2 defective	Perform functional check on affected ADDU	If not ok, replace ADDU

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Following error codes ADDU may show. Codes FC03 until FC10 are not shown, but stored internally.

Error code	PROBABLE CAUSE	REMEDY
FC00* (add OFF-in Altitude indication)	Ps Transducer Calibration Data Fault	Replace ADDU
FC01* (add OFF-in Altitude indication)	Ps Transducer Pressure Range Fault	Replace ADDU
FC02* (add OFF-in Altitude indication)	Ps Transducer Temperature Range Fault	Replace ADDU
STBY-Flag (FC03)	Qc Transducer Calibration Data Fault	Replace ADDU
STBY-Flag (FC04)	Qc Transducer Pressure Range Fault (no SSEC correction)	Replace ADDU
STBY-Flag (FC05)	Qc Transducer Temperature Range Fault (no SSEC correction)	Replace ADDU
Digital Altimeter Indicator blank (FC06)	Data Memory Fault	Replace ADDU
Digital Altimeter Indicator blank (FC07)	Program Memory Fault	Replace ADDU
Digital Altimeter Indicator blank (FC08)	Read/Write Fault	Replace ADDU
Digital Altimeter Indicator blank (FC09)	Factory Calibration Data Fault	Replace ADDU
Digital Altimeter Indicator shows OFF (FC10)	Pointer Positioning Fault	Replace ADDU

*May be indicated during self test.

AIR DATA DISPLAY UNIT - REMOVAL/INSTALLATION

1. Removal/Installation of Air Data Display Unit

CAUTION WHEN REMOVING THE ADDU ENSURE THE INSTALLATION CONFIGURATION MODULE (ICM) WILL BE REMOVED FROM THE ADDU PRIOR TO RETURNING ADDU TO MANUFACTURER IN CASE OF EXCHANGE. THE ICM CONTAINS AIRCRAFT SPECIFIC DATA (SSEC AND VMO) AND MUST STAY WITH THE AIRCRAFT

A. Remove Air Data Display Unit.

- (1) Open and tag circuit breaker ADC 1 or resp. ADC 2 on CB panel P5.
- (2) Loosen mounting screws of ADDU mounting slightly.
- (3) Pull ADDU out of mounting to gain access to connectors.
- (4) Remove electrical connector.
- (5) Remove pneumatic quick connectors.
- (6) Cap all electrical and pneumatic connectors.
- (7) Remove ICM.
- (8) Store ADDU safely.

B. Install Air Data Display Unit

- (1) Ensure the circuit breaker ADC 1 or resp. ADC 2 on CB panel P5 are open and tagged.
- (2) Uncap all electrical and pneumatic connectors.
- (3) Connect pneumatic quick connectors to ADDU
- (4) Connect electrical connector to ADDU.
- (5) Reinstall ICM.
- (6) Slide ADDU careful into mounting.
- (7) Tighten the mounting screws of ADDU mounting carefully.
- (8) Close the circuit breaker ADC1 or resp. ADC2 on CB panel P5.
- (9) Perform static leak test on pilots and/or copilots static pressure system (Refer to Chapter 34-2-51 Pitot Static Systems - Maintenance Practices).



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NOTE: Ensure the STR 2000-A1 transponder is switched to OFF or STBY, to avoid inadvertently transmitting an altitude signal during next step. A fixed altitude signal of 10.000 ft will be transmitted via the ARINC 429 data bus to the STR 2000-A1 transponder.

- (10) Press the bezel mounted TEST Switch on each ADDU with the tip of a ballpen for less than 1 sec. This initiates a self test, which lasts between 18 and 45 seconds. The self test function is limited to ground operations only (e.g. IAS <40kts). The digits "1" to "9" will be shown in sequence in the display as well as failure flags and all indicators. Fault codes of current errors will be displayed. At the end of the test the installation configuration is shown for 5 seconds. After completion the ADDU returns to regular indication and operation.
- (11) Press ADDU TEST Switch and watch for ALT Alert Light on ADDUs to illuminate and LCDs showing configuration code. After 3 seconds the displays blank for 1 second and show all LCD elements thereafter, as long as the switch is in TEST mode.

END



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AIR DATA DISPLAY UNIT - ADJUSTMENT/TEST

1. OPERATIONAL CHECKOUT.

A ADDU Self-Test.

NOTE: Ensure the STR 2000-A1 transponder is switched to STBY, to avoid inadvertently transmitting an altitude signal during next step. A fixed altitude signal of 10.000 ft will be transmitted via the ARINC 429 data bus to the STR 2000-A1 transponder.

NOTE: Ensure aircraft electrical power is switched ON, circuit breaker ADC 1 and ADC 2 on circuit breaker panel P5 are closed and circuit breaker COCKPIT LIGHTS FWD CTR Panel on circuit breaker panel P7 is closed

- (1) Press the bezel mounted TEST Switch on each ADDU for less than 1 sec. This will sequence the ADDU display as described in Table 1. The digits "1" to "9" will count up at 1 sec intervals.

NOTE: The self test function is only allowed during ground based operations (e.g IAS <40kts).

Pointer	Indicating time	Altitude Counter	Supplemental Display	Barometric Pressure Counter
	2.5 sec	Operating time in hours	-blank display-	-blank display-
	1.0 sec	-blank display-	-blank display-	-blank display-
0	1.0 sec	00000	00000	3000
1	1.0 sec	11110	11110	1111
2	1.0 sec	22220	22220	2222
3	1.0 sec	33330	33330	3333
4	1.0 sec	44440	44440	3444
5	1.0 sec	55550	55550	3555
6	1.0 sec	66660	66660	3666
7	1.0 sec	77770	77770	3777
8	1.0 sec	88880	88880	3888
9	1.0 sec	99990	99990	3999

Table 1

Fault codes of current errors will be displayed. At the end of the test the installation configuration is shown for 5 seconds in the Barometric Pressure Counter (see table 2.). After completion, the ADDU returns to regular indication and operation.

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A/C	ADDU1 configuration	ADDU2 configuration
LX 19997	170	171
LX 20000	172	173
LX 20199	174	175

Table 2

- (2) Toggle ADDU TEST Switch on the center instrument panel and watch for ALT ALERT Light on ADDUs to illuminate and LCDs showing configuration code. After 3 seconds the displays blank for 1 second and show all LCD elements thereafter, as long as the switch is in TEST mode.

B. Barometric Pressure Setting Function Checkout.

- (1) With the instrument powered, rotate the knob clockwise (CW) to increase and counterclockwise (CCW) to decrease the input baro setting displayed in the Baro Counter. Ensure the full range of values can be input (22.00 In.HG to 31.00 In.HG and 745 hPa to 1050 hPa). Malfunctions of the BARO Knob, which prevent the operation of the functions listed above, constitute equipment failure requiring the replacement of the ADDU.

C. Metric/English Select Function Checkout.

- (1) With the instrument powered, activate the BARO Knob while inspecting to ensure the three Metric/English combinations are displayed in the altitude and baro setting displays. Pressing the knob in for longer than four seconds while in feet mode ("ft" displayed), selects the units of the barometric setting display. Each press of the knob of more than 4 seconds each, toggles the units display between ft/In.HG or ft/hPa. If the knob is pressed in for longer than 8 seconds while in feet mode (ft/In.HG or ft/hPa), the altitude units display changes from feet to meters. Feet to meters transition of the following is allowed:

- ft/In.HG to ft/hPa and then to M/hPa
- ft/hPa to ft/In.HG and then to M/hPa

Pressing the knob for longer than 8 seconds while in meters mode (M/hPa) toggles the altitude display between meters and feet (M/hPa to ft/hPa) for each new press of the knob.

D. Default Baro Setting Function Checkout.

- (1) With the instrument powered, activate the BARO Knob (press for less than 2 seconds) and ensure that the default baro setting is selected Or, if the default setting is already active, ensure that the display automatically reverts to the previous setting. If the Barometric Pressure Setting Knob is turned while the default baro setting is active, the default barometric setting is canceled and any barometric setting can be selected.



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E. Installation Configuration Module Checkout.

The cylindrical shaped Installation Configuration Module (ICM) is connected to the back of each ADDU to the rear electrical connector J2. The ICM provides SSEC and Vmo data that is specific to the aircraft configuration which the ADDU is installed to. System fault detection is performed by the host ADDU to which the ICM is installed. On power up, the host ADDU downloads the data stored in the ICM and reads the checksum contained in the data provided. From this data, the host unit can determine if the data is corrupted (using the stored checksum value) and if the correct ICM has been installed (using the stored module part number data stored in the module software identifier data). The ADDU will display dashes (-----) in the upper display counter if the wrong ICM is installed or if valid data is not provided.

NOTE: The configuration number of the ICM is displayed at the end of the test in par. A (1). Table 2 provides the correct configuration per effectivity and ADDU position.

F. Static Leak Test.

- (1) Perform static leak test on pilots and/or copilots static pressure system (ref. AMM 34-2-0 Page 401).

G. Functional Test.

NOTE: Following procedure has to be performed for each ADDU separately. Select the appropriate ADDU with the ADDU Select Switch.

NOTE: Self-test STR 2000-A1 can only check if stream of data bus is there (parity), but is unable to check altitude accuracy

- (1) Activate STR 2000-A1

Ensure self-test OK, CADU FAIL Indicator extinguished

- Ensure TTU-205 Test Set is hooked-up to the left and right pitot static system
- Close ADC 1, ADC 2 and KIFIS circuit breaker on circuit breaker panel P5.
- Place CADU Rotary Switch to the NORM position.
- If Mode C and Mode S are not activated, select both modes at the CADU.
- Select TEST position on the TEST/NORM Switch.
- Adjust TTU-205 test set sequentially to the altitudes and airspeeds shown in altitude column tables.

NOTE: The Constant Cruise Mach No. for the A/C with all four engines in operation is 0.82. Monitor the A/C Machmeter

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at each altitude setting and ensure, that the Mach No. never exceeds 0.82. Erroneous altitude readings may occur if this Mach No. is exceeded. Adjust the test set airspeed accordingly.

- Select ATRBS REPLY TEST at the IFF-701 test set and interrogate STR 2000-A1 via the lower antenna as follows:
 - Press RUN/STOP, TEST RUNNING will be displayed.
 - Select each altitude level in sequence and verify that the displayed Mode C altitude on the screen equals with the altitude setting on TTU-205. Verify the cockpit indicated altitude is within tolerance for each altitude setting. Altimeter accuracy tolerance is given in table 4, 5, 6, 7.

** ATRBS REPLY TEST - Passed **		
F1 to F2 SPACING	3: **** μ S	C 20,30 μ S $\pm$ 0,1 μ S
F1 PULSE WIDTH	3: **** μ S	C: 0,30 μ S $\pm$ 0,1 μ S
F2 PULSE WIDTH	3: **** μ S	C: 0,30 μ S $\pm$ 0,1 μ S
CODE = ****	ALT = FT	(----)
Press RUN to start		

Table 3

Altitude Column Tables

NOTE: SSEC does not affect values below 25000 ft and below Mach 0.5.

TTU-205 ALTI- TUDE (ft) at AIRSPEED 300 KTS	ADDU 1 (ft)		ADDU 2 (ft)	
	Tolerance		Tolerance	
500	$\pm$ 15 ft		$\pm$ 15 ft	
1000	$\pm$ 15 ft		$\pm$ 15 ft	
1500	$\pm$ 15 ft		$\pm$ 15 ft	
2000	$\pm$ 15 ft		$\pm$ 15 ft	
4000	$\pm$ 15 ft		$\pm$ 15 ft	
6000	$\pm$ 15 ft		$\pm$ 15 ft	
8000	$\pm$ 15 ft		$\pm$ 15 ft	
10000	$\pm$ 20 ft		$\pm$ 20 ft	
15000	$\pm$ 20 ft		$\pm$ 20 ft	
20000	$\pm$ 30 ft		$\pm$ 30 ft	
25000	$\pm$ 30 ft		$\pm$ 30 ft	

Table 4

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NOTE: Following table shows the SSEC corrected values for A/C LX-N 19997.

TTU-205 Test Set Setting		Pilot System ICM P/N 9B-03508-170		Copilot System ICM P/N 9B-03508-171	
Altitude (ft)	Airspeed (knots)	Nominal ADDU 1 Pointer indication (ft) / allowable tolerance	ADDU 1 Pointer indication (ft) QNH 29,92 InHg	Nominal ADDU 2 Pointer indication (ft) / allowable tolerance	ADDU 2 Pointer indication (ft) QNH 29,92 InHg
30000	203	30011 / ± 30		30005 / ± 30	
30000	243	30005 / ± 30		30004 / ± 30	
30000	283	30019 / ± 30		30016 / ± 30	
30000	325	30065 / ± 30		30052 / ± 30	
35000	199	35006 / $\pm 32,5$		35004 / $\pm 32,5$	
35000	217	35005 / $\pm 32,5$		35004 / $\pm 32,5$	
35000	253	35018 / $\pm 32,5$		35016 / $\pm 32,5$	
35000	291	35063 / $\pm 32,5$		35050 / $\pm 32,5$	
40000	193	40005 / ± 35		40004 / ± 35	
40000	225	40018 / ± 35		40016 / ± 35	
40000	259	40062 / ± 35		40049 / ± 35	

Table 5

NOTE: Following table shows the SSEC corrected values for A/C LX-N 20000.

TTU-205 Test Set Setting		Pilot System ICM P/N 9B-03508-172		Copilot System ICM P/N 9B-03508-173	
Altitude (ft)	Airspeed (knots)	Nominal ADDU 1 Pointer indication (ft) / allowable tolerance	ADDU 1 Pointer indication (ft) QNH 29,92 InHg	Nominal ADDU 2 Pointer indication (ft) / allowable tolerance	ADDU 2 Pointer indication (ft) QNH 29,92 InHg
30000	203	29989 / ± 30		29981 / ± 30	
30000	243	29986 / ± 30		29974 / ± 30	
30000	283	29994 / ± 30		29975 / ± 30	
30000	325	30021 / ± 30		29994 / ± 30	
35000	199	34987 / $\pm 32,5$		34978 / $\pm 32,5$	
35000	217	34987 / $\pm 32,5$		34975 / $\pm 32,5$	
35000	253	34994 / $\pm 32,5$		34976 / $\pm 32,5$	
35000	291	35020 / $\pm 32,5$		34994 / $\pm 32,5$	
40000	193	39987 / ± 35		39975 / ± 35	
40000	225	39994 / ± 35		39977 / ± 35	
40000	259	40020 / ± 35		39994 / ± 35	

Table 6

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NOTE: Following table shows the SSEC corrected values for A/C LX-N 20199

TTU-205 Test Set Setting		Pilot System ICM P/N 9B-03508-174		Copilot System ICM P/N 9B-03508-175	
Altitude (ft)	Airspeed (knots)	Nominal ADDU 1 Pointer indication (ft) / allowable tolerance	ADDU 1 Pointer indication (ft) QNH 29,92 InHg	Nominal ADDU 2 Pointer indication (ft) / allowable tolerance	ADDU 2 Pointer indication (ft) QNH 29,92 InHg
30000	203	30003 / ± 30		30013 / ± 30	
30000	243	30006 / ± 30		30020 / ± 30	
30000	283	30028 / ± 30		30045 / ± 30	
30000	325	30083 / ± 30		30099 / ± 30	
35000	199	35003 / $\pm 32,5$		35014 / $\pm 32,5$	
35000	217	35006 / $\pm 32,5$		35019 / $\pm 32,5$	
35000	253	35027 / $\pm 32,5$		35043 / $\pm 32,5$	
35000	291	35080 / $\pm 32,5$		35095 / $\pm 32,5$	
40000	193	40006 / ± 35		40019 / ± 35	
40000	225	40027 / ± 35		40042 / ± 35	
40000	259	40079 / ± 35		40094 / ± 35	

Table 7

END



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SPERRY HIGH LATITUDE COMPASS SYSTEM - DESCRIPTION AND OPERATION

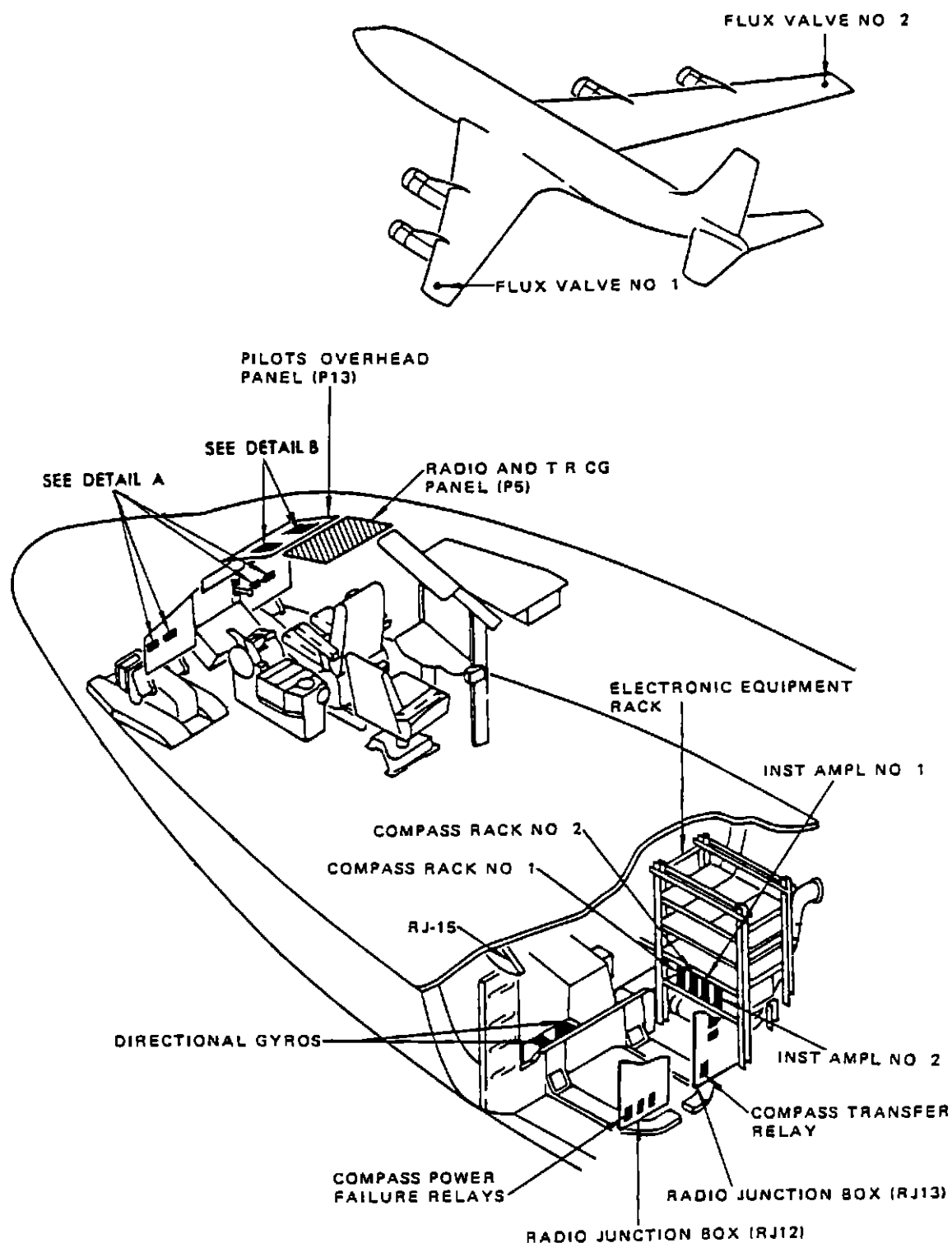
1 General

- A The compass system is designed primarily to furnish the pilot and copilot with information concerning the airplane's magnetic heading at all times during flight. Heading information is displayed on the airplane's RMI compass cards and on the cards of the deviation indicators. Heading information is also fed to the autopilot, flight recorder, navigation systems and steering computers.
- B Each compass system essentially consists of a directional gyro (DG), a magnetic azimuth detector (flux valve), a master indicator, and a compass controller. The controller only provides limited control of the directional gyro. Refer to figure 1 for the location of the equipment.
- C Magnetic heading data from the compass system N° 1 is sent to TACAN and VHF NAV one, autopilot and INS one. N° 1 compass system magnetic heading signals are displayed on the copilot's RMI and, when the pilot's NAV MODE selector is set to TACAN or VOR/LOC, on the pilot's HSI.
- D Magnetic heading data from the compass system N° 2 is sent to TACAN and VHF NAV two, DFDR/CVR/CPL, ONS and INS two, if installed. N° 2 compass system magnetic heading signals are displayed on the pilot's RMI and, when the copilot's NAV MODE selector is set to TACAN or VOR/LOC, on the copilot's HSI.

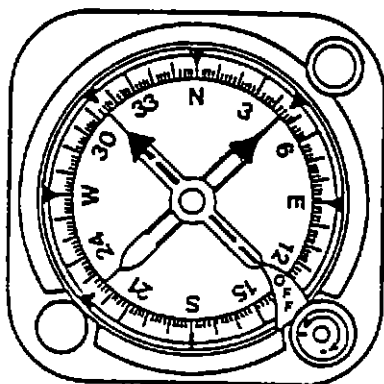
2 Remote Compass Transmitter (Flux Valve) and Compensator

- A The flux valve contains a pendulous magnetic detector which senses the direction of the horizontal component of the earth's magnetic field and utilizes this reference to generate an ac signal representative of the airplane's magnetic heading.
- B The compensator is mounted on the flux valve. It is a separate unit which is designed to counteract the effect of any stray magnetic fields in the vicinity of the flux valve. N-S and E-W adjustment screws are provided on the unit for this purpose.

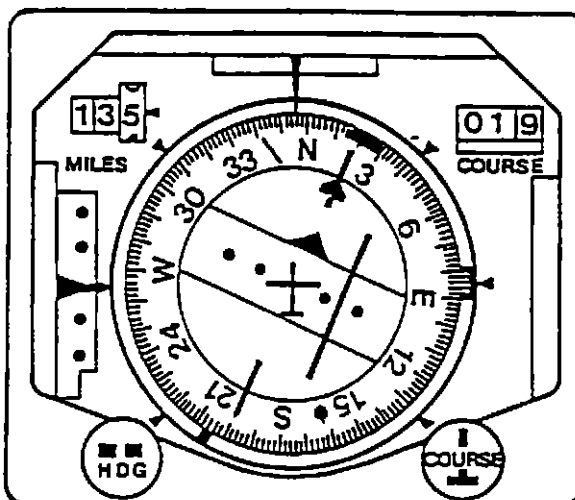
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Compass System Component Location
Figure 1 (Sheet 1)

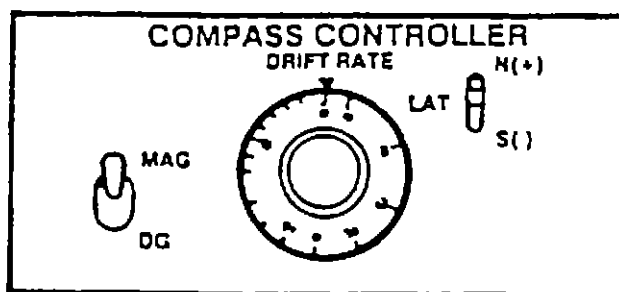


VOR ADF TACAN RMI



HSI

DETAIL A



DETAIL B



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3 Directional Gyros

- A The directional gyro provides the heading reference for the compass system. Its gimbals may be torqued by two torquemotors, the slaving torquemotor being used to precess the gyro to the magnetic reference generated in the flux valve, and the leveling torquemotor to level the gyro with respect to gravity. The former motor is driven by the slaving amplifier and the latter is controlled by means of an electrolytic switch. A third and entirely independent precession device is also fitted to the gyro. It consists mainly of two latitude correction coils, one of which will carry current which is passed through it to change the flux on the gyro rotor. The direction of precession will depend upon which coil is selected to carry the current, and the rate of precession will depend upon the amount of that current.
- B A spin-down brake in the directional gyro prevents nutation of the gyro by holding the outer gimbal steady for 10 seconds after power is applied. At shutdown, the brake is reapplied to the gimbal 30 seconds after power is removed. This prevents the gyro from spinning around its vertical axis. The 30-second time delay of the spin-down brake at shutdown also prevents momentary power interruptions (such as changing inverters) from introducing errors into the heading information.
- C A logic circuit is used to operate failure monitor relays. The contacts of these relays are used in the ADF RMI and CDI flags circuit.
- D. A synchro in directional gyro N° 2 provides the autopilot with a heading reference.

4 Radio Magnetic Indicator (RMI)

- A Each pilot's RMI receives heading information from the other pilot's compass system. The RMI is denominated "master" indicator which means that the RMI heading data are always a repetition of the directional gyro information. With MAG/DG switch of (other pilot's) compass controller set to "DG" this information is unslaved. With MAG/DG switch of (other pilot's) compass controller on "MAG" this information is slaved to (other pilot's) flux valve signals provided "+/o" not in view.
- B The SET HDG knob allows fast compass synchronization and setting the compass card to any desired reference heading. An OFF flag appears in case of compass power failure or error in directional gyro repetition.



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8

6 Horizontal Situation Indicator

- A The magnetic heading from the compass system N° 1 is displayed on the pilot's HSI.
- B The magnetic heading from the compass system N° 2 is displayed on the co-pilot's HSI

7 Rack Mountings

- A The compass racks provide "plug-in" mountings for the servo-amplifiers and slaving amplifiers. Each rack is wired into its own compass system.
- B The ILS racks provide similar mountings for the CDI servo-amplifiers, each with its associated system wiring.

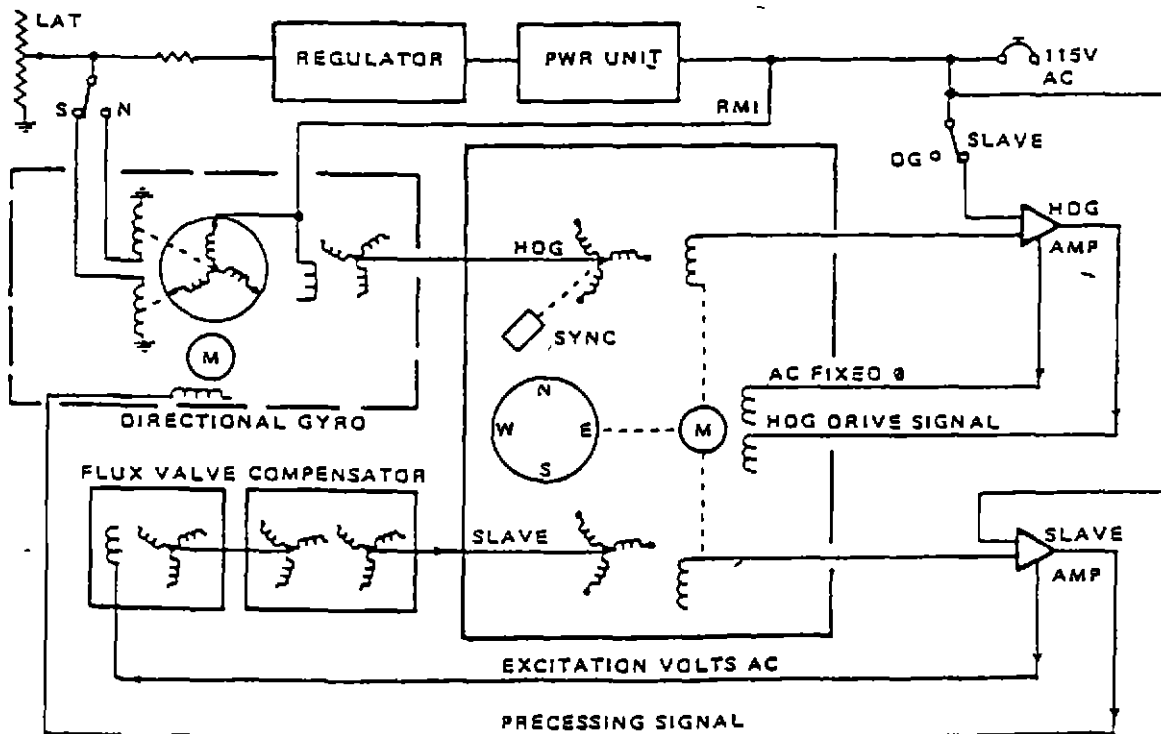
8 Compass Controller

- A The unit is fitted with the following controls:
 - (1) The MAG/DG is used to activate the slaving amplifier when in the magnetic heading mode. In the DG mode, power is removed from this amplifier, so that it could not then be used to precess the gyro. (See figure 2)
 - (2) The latitude setting control enables the operator to adjust the latitude potentiometer to operate at the level required by the airplane's position.
 - (3) The N/S switch controls the direction in which the gyro is precessed for high latitude flying.

9 Operation

- A Both systems are made operational by closing the circuit breakers compass N° 1 and compass N° 2 on P5 pannel. After a brief period of time the gyros will run up and the compass cards will reflect the magnetic heading of the airplane (Refer to figure 2)

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Basic Compass System Schematic
Figure 2

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- B. In the magnetic mode each system operates as follows. Assume that the airplane heading is magnetic north, and that the RMI and CDI compass cards reflect this heading. Assume that the airplane now turns 10° to the left. The synchro in the directional gyro immediately transmits an error signal which is relative to the direction and magnitude of the angular movement which produces it. This error signal is fed to the servo-amplifier via the heading synchro in the RMI. The servo-amplifier then drives the servomotor in the RMI (which is geared to the compass card) towards the new heading, and at the same time turns the rotor of the heading synchro in such a direction as to null out the error signal. When the motor stops, the error signal from the synchro in the directional gyro has been nulled out in the RMI heading synchro, and the compass card in the RMI reflects the new airplane heading. The sensing element in the flux valve will also reflect this change in heading in the form of an error signal which is fed to the slaving amplifier via the slaving synchro in the RMI. However this error is also nulled out by the servomotor in the RMI since both synchro rotors are driven simultaneously by the same servomotor. Random drift in the gyro is overcome by means of the flux valve and servo slaving circuits. Assume there are no error signals in the system and that the airplane is headed towards magnetic north once more. The gyro now drifts slightly off course. This results in an error signal being generated in the gyro synchro which is passed to the servo-amplifier via the heading synchro in the RMI. As in the case of the heading change the servo-amplifier drives the servomotor to null out the error in the heading synchro and automatically turns the rotor of the slaving synchro in the RMI along with it. However in this case the stator of the slaving synchro is still referenced to north by the flux valve; hence an error signal is now generated in the slaving synchro which is amplified by the slaving amplifier and fed to the torquemotor to precess the gyro back to a northerly heading. The error in the gyro synchro is thus nulled out and the system returns to its original zero error condition with the gyro again "pointing" north. When the compass system is first activated, there will usually be some disagreement between the airplane heading and that of the directional gyro. The system will immediately start to precess the gyro to take out this error, but the precession rate for the slaving circuits is a relatively slow one. A "manual" method of synchronizing the system has been devised. The method used is to introduce an artificial error signal into the heading servo circuit which rapidly produces the desired results. Assume that the system has been activated and that the aircraft heading is magnetic north, and the compass cards are 10° "out of line." A cross or dot in the annunciator window will indicate that the slaving circuits are operating, and will also serve to indicate which way the HDG/SYNC knob should be turned to synchronize the system. When the knob is turned, it turns the stator of the heading synchro, generating an error voltage in its rotor which is amplified by the servo-amplifier and drives the servomotor and compass cards to the correct airplane heading (and nulls out the error in the heading synchro). Since the servo-amplifier circuit is able to respond far more rapidly to an error signal than the slaving circuit, the "manual" method of synchronizing the system is preferred.



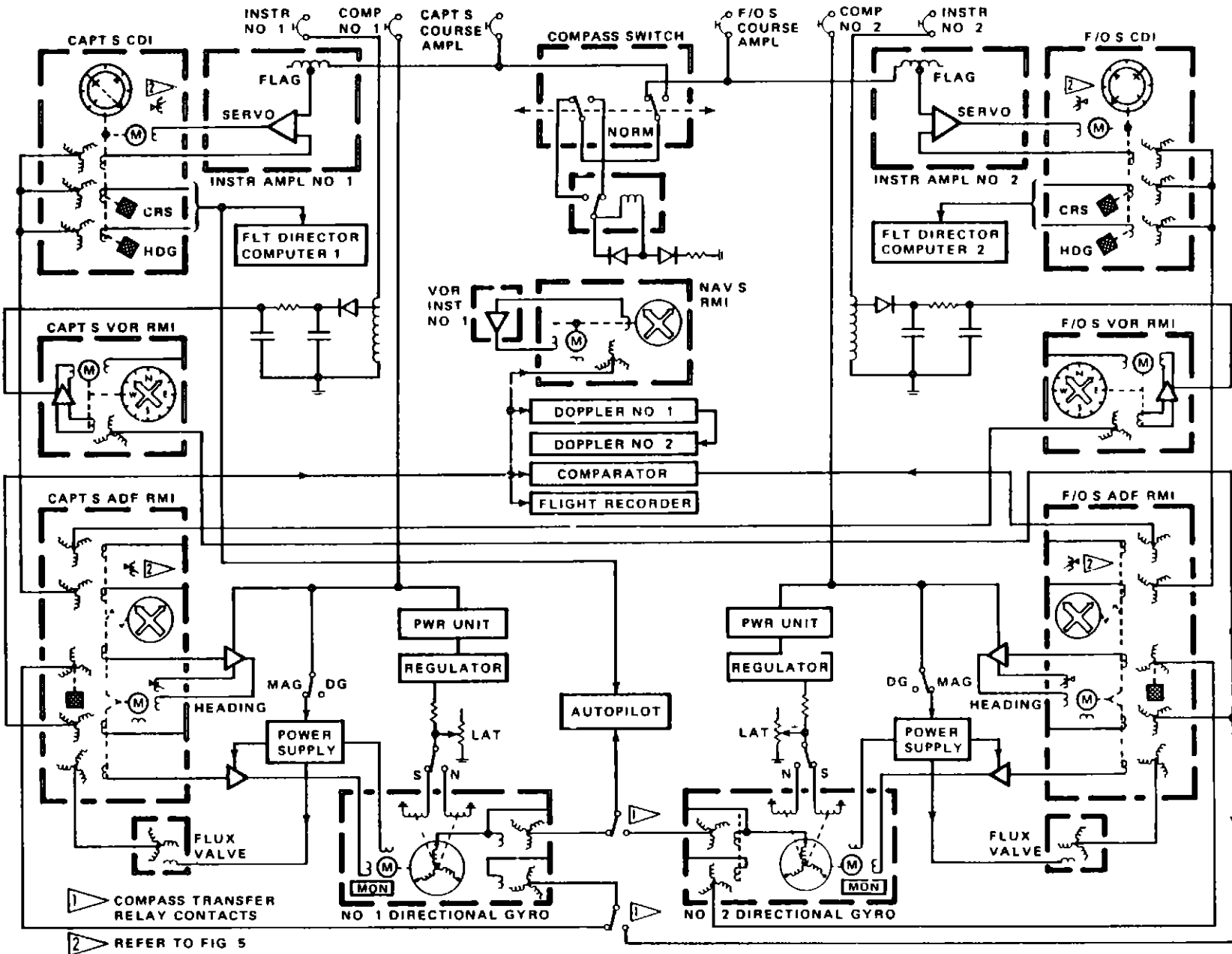
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C When the system is switched to the DG mode, power is removed from the slaving amplifier, and excitation voltage from the flux valve. The directional gyro is free to drift, except that the latitude control device precesses the gyro at a rate equal and opposite to the drift rate induced by the earth's rotation. The direction of drift in the northern hemisphere is diametrically opposite that in the southern hemisphere, and the rate of drift increases as the latitude of the gyro's position is increased. The latitude control potentiometer in the latitude controller allows the pilot to set in the appropriate latitude to ensure the correct precessing voltage (and rate) for that latitude. The NORTH - SOUTH switch ensures that the direction of precession may be switched to offset the direction of drift in either hemisphere. The system should be set to the DG mode in latitudes of 65 degrees and above, since the earth's magnetic field in these latitudes will not provide a sufficiently accurate reference to north. In latitudes below 65 degrees (when the system is in the MAG mode) it is still necessary to set the latitude controls since the system is now precessed by both the slaving circuits and the latitude controller. The former removes random drift, while the latter compensates for drift due to the airplane's geographical location. This combination of controlling devices provides a more accurate compass system.

D Figure 4 is a simplified schematic of the compass system.

Each pilot's RMI receives heading information from the other pilot's compass system. The RMI is denominated "master" indicator which means that the RMI heading data are always a repetition of the directional gyro information. With MAG/DG switch of (other pilot's) compass controller set to "DG" this information is unslaved. With MAG/DG switch of (other pilot's) compass controller on "MAG" this information is slaved to (other pilot's) flux valve signals provided "+/o" not in view.

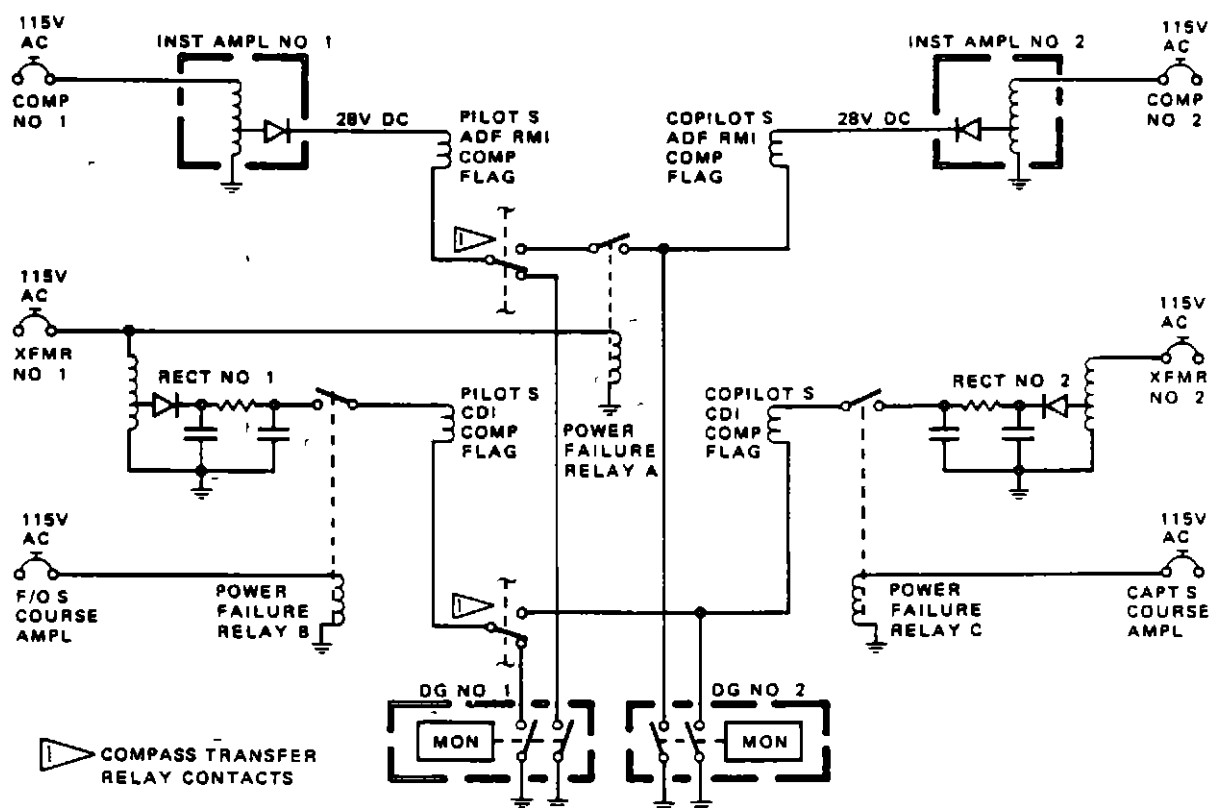
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Compass System Schematic
Figure 4

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Flag Monitor Circuit
 Figure 5

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- E. Figure 4 is a simplified schematic of the compass system. The copilot's ADF RMI receives its heading signals direct from the directional gyro No. 2. The pilot's ADF RMI is able to receive its heading from either the directional gyro No. 1 or the copilot's ADF RMI by means of the compass transfer switch when switched from position 1 to position 2.
- F. The pilot's VOR RMI repeats heading information from the copilot's ADF RMI. The copilot's VOR RMI and the navigator RMI repeats the heading information from the pilot's ADF RMI.
- G. Figure 5 shows the manner in which the ADF RMI and CDI flags circuits are monitored.
 - (1) The dc references for the pilot and copilot ADF RMI flags are taken at all times from their respective pilot and copilot instrument amplifiers.
 - (a) The pilot's flag current return path is routed via the compass transfer relay contacts; when position 1 is selected the path is through No. 1 DG failure monitor relay contact X, when position 2 is selected the path is transferred to No. 2 DG failure monitor relay contacts X via the contacts of power failure relay A. This relay is operated by the No. 1 transformer 115 volt ac supply.
 - (b) The copilot's flag current return path is only through No. 2 DG failure monitor relay contacts.
 - (2) The dc references for the pilot and copilot CDI flags are taken at all times from the rectified output of their respective transformer No. 1 and No. 2.
 - (a) The pilot's flag current return path is routed via power failure relay B contacts; its path goes also through the compass transfer relay. When position 1 is selected the path is through No. 1 DG failure monitor relay contacts Y, when position 2 is selected the path is transferred to No. 2 DG failure monitor contact Y. Relay B is operated by the pilot course amplifier 115 volt ac supply.
 - (b) The copilot's flag, current return path is routed via power failure relay C contacts, and No. 2 DG failure monitor relay contacts Y. Relay C is operated by the copilot course amplifier 115 volt ac supply.



SPERRY HIGH LATITUDE COMPASS SYSTEM - TROUBLE SHOOTING

1. General

- A. Refer to electronic wiring diagram for specific details concerning the wiring of the test receptacles associated with the compass system.
- B. The serviceability of any suspect units may be checked by substituting a similar proven spare or a unit from another system which has been functioning correctly.

CAUTION: DO NOT CHECK OUT THE FLUX VALVE WITH AN OHMMETER. THE RESULTANT DIRECT CURRENT IN THE WINDINGS MAY IMPAIR THE MAGNETIC PROPERTIES OF THE CORE.

- C. The flux valve is extremely sensitive to magnetic fields and may easily be adversely affected by any that are man-made in its immediate vicinity. So, since the compass system depends upon it for an accurate reference to magnetic north, it is of paramount importance that the following caution be strictly observed:

CAUTION: DO NOT OPERATE ANY ELECTRICAL EQUIPMENT IN THE IMMEDIATE VICINITY OF THE FLUX VALVE IF THAT EQUIPMENT IS LIKELY TO SET UP STRONG MAGNETIC FIELDS.

2. Power Supplies

- A. Check for 115 volt ac supplies from the following circuit breakers:

COMP-1	Radio Junction Box RJ14, Terminal	AP3
COMP-2	"	AR5
INST XFMR-1	"	AP9
INST XFMR-2	"	AR11
COURSE AMP NO. 1	"	AP6
COURSE AMP NO. 2	"	AR22

3. Flux Valve

- A. Check for flux valve primary excitation voltage, 23.5 volts ac, at terminals A10 and E10 in RJ15. Source of power supply is the system's compass rack.
- B. Substitute proven unit for suspect unit.

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C. Check wiring to the unit if necessary, with unit disconnected.

NOTE: If the flux valve is replaced by another unit, the previous compass swing for that airplane is no longer valid. It is necessary therefore to carry out a new and complete compass swing after any such change has been made.

4. Radio Magnetic Deviation Indicator (RMI) and Amplifiers

- A. Turn manual sync knob on RMI in direction of dot. Annunciator signal should indicate a cross. After system has synchronized turn knob in direction of cross. Annunciator signal should indicate a dot.
- B. Replace slaving amplifier if necessary.
- C. Repeat tests with sync knob and observe that compass card on RMI responds at the rate of at least 40 degrees per second in either direction.
- D. Replace servo-amplifier if necessary.
- E. Replace RMI if necessary.
- F. Check all associated wiring; point-to-point with the power OFF, or by monitoring the signal lines with the system "live."

5. Directional Gyro

- A. Turn manual sync knob on the RMI in direction of dot, and observe the rate of gyro precession; 10 degrees in 5 to 10 minutes.
- B. Turn manual sync knob in direction of cross and check precession rate in opposite direction.
- C. Compare respective drift rates for the two gyros. Refer to Compass System Adjustment/Test.
- D. Replace controller, compass rack (power unit) or directional gyro itself.
- E. Make point-to-point wiring checks with power OFF or monitor signal lines with system "live."

6. Course Deviation Indicators and Amplifiers

- A. Check for servomotor ac power supply.

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- B. Replace associated servo-amplifier if necessary.
 - C. Replace CDI if necessary.
 - D. Make point-to-point wiring checks with power OFF or monitor signal lines with system "live."
7. Navigator's RMI
- A Replace RMI servo-amplifier in RJ13.
 - B. Substitute proven unit for suspect unit.
 - C Check wiring to amplifier and to unit.



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COMPASS SYSTEM - MAINTENANCE PRACTICES

1. General

- A This section deals with the airplane compass system swinging and compensation procedures. There are two main systems, No. 1 and No. 2, plus a standby compass system.
- B The swinging procedure for the standby compass system is described separately from that of the main systems; all systems may be swung simultaneously if so desired. It is recommended that demagnetization of airplane structure be carried out before compass swing. Refer to 34-13-71, Demagnetization of Airplane Structure.
- C The process of "ground swinging" an airplane consists of observing accurately the deviation between known heading and compass heading, at different points around the compass rose. The results are tabulated, errors calculated, and corrections applied. Swinging and correction procedures are repeated until the required accuracy is reached.

2. Swing Main Compass System

A. General

- (1) Tests described under Compass System - Adjustment/Test are to be performed prior to this procedure, to verify that a serviceable compass system is being swung.
- (2) Compass system errors are compensated by adjusting controls on system's compensator, either by a flux valve compensator or a remote compensator.
 - (a) The flux valve compensator is located on top of flux valve and contains a N-S and E-W control for one cycle error compensation

NOTE: Flux valve and compensator assembly is turned in its mount for index error compensation.

- (b) The remote compensator is located on navigator's panel. This unit contains a N-S and E-W control for one cycle error compensation, a direction and magnitude TRANSMISSION control for transmission (two cycle) error compensation, and an INDEX adjustment for index error compensation.

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- (3) The same swinging procedure is followed using either compensator; additional steps are given to compensate for transmission error when remote compensator is used.

B Equipment and Materials

- (1) Compass swinging site (compass rose) certified to MIL-STD-765A or equivalent
- (2) Baseplate
- (3) Two heading markers (or more) whose directions from baseplate are known to 1 minute or better
- (4) Tow tractor equipped with interphone
- (5) Surveyor transit, with an accuracy of one minute or less
- (6) Compass swinging fixture kit F70036. (See figure 201).
- (7) Nonmagnetic tools (for adjusting the flux valve compensator when installed)
- (8) Compass repeater accurate to ± 5 minutes of arc
- (9) Multimeter Simpson 260 or equivalent

C. Prepare for Main Compass Swing

- (1) Ensure that parked vehicles are at least 300 feet away from compass rose center.
- (2) Set transit (theodolite) above baseplate.
- (3) Sight transit telescope on one of the heading markers.
- (4) Set transit scale to read marker direction plus 90 degrees.
- (5) Verify transit alignment by sighting on an alternate marker. Check that known marker heading plus 90 degrees is read on transit scale within ± 0.1 degree.
- (6) Install compass swinging target fixture on wheel well bulkhead and target mark at forward jack pad position using lower aft bolt holes.
- (7) Adjust tangent screw to align target telescope with target mark.
- (8) Adjust level screw to align crosshair and fixture scale with transit telescope.

- (9) Set MAG/DG switch on compass controller to MAG.
- (10) Set compass switch to normal position
- (11) Connect compass repeater wires to the following airplane terminals located in RJ-13

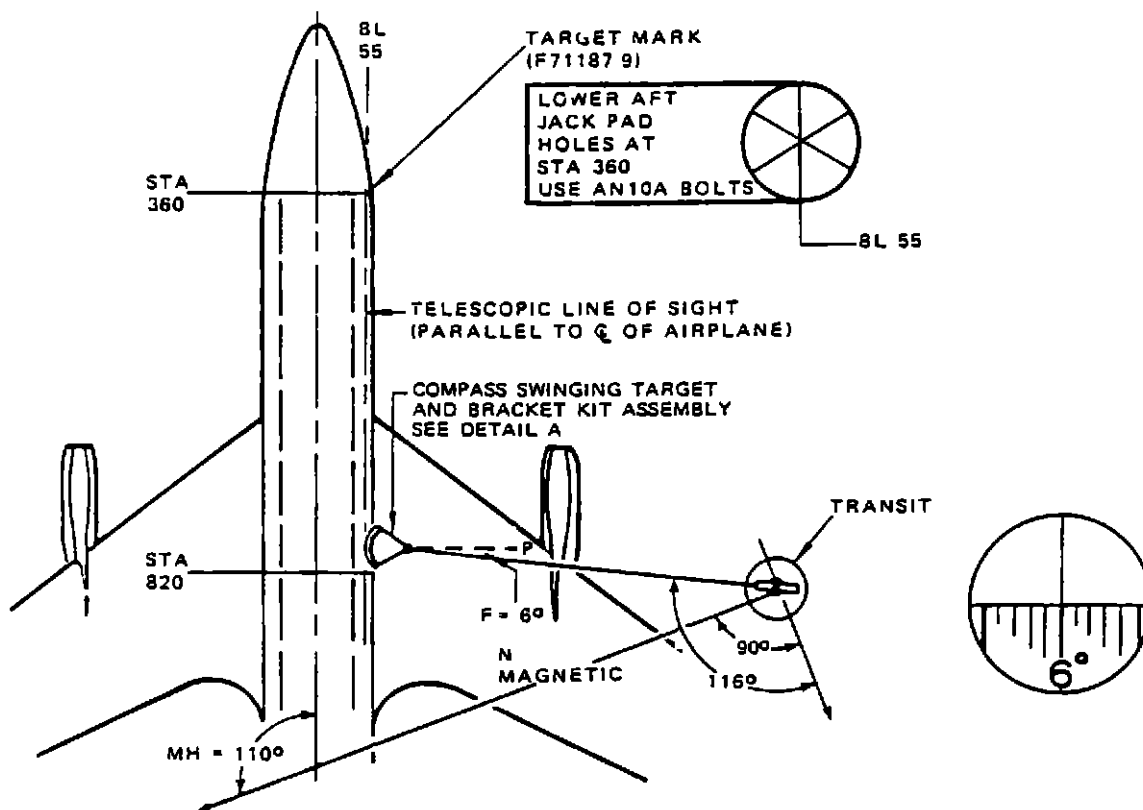
	N° 1 System			N° 2 System		
Repeater wires	X	Y	Z	X	Y	Z
Airplane terminals	BN4	BN5	BN6	BK4	BK22	BK23

- (12) Energize P5 load control center by means of external power
- (13) Check that all necessary circuit breakers for operation of compass systems are closed
- (14) Compensator controls preswing settings

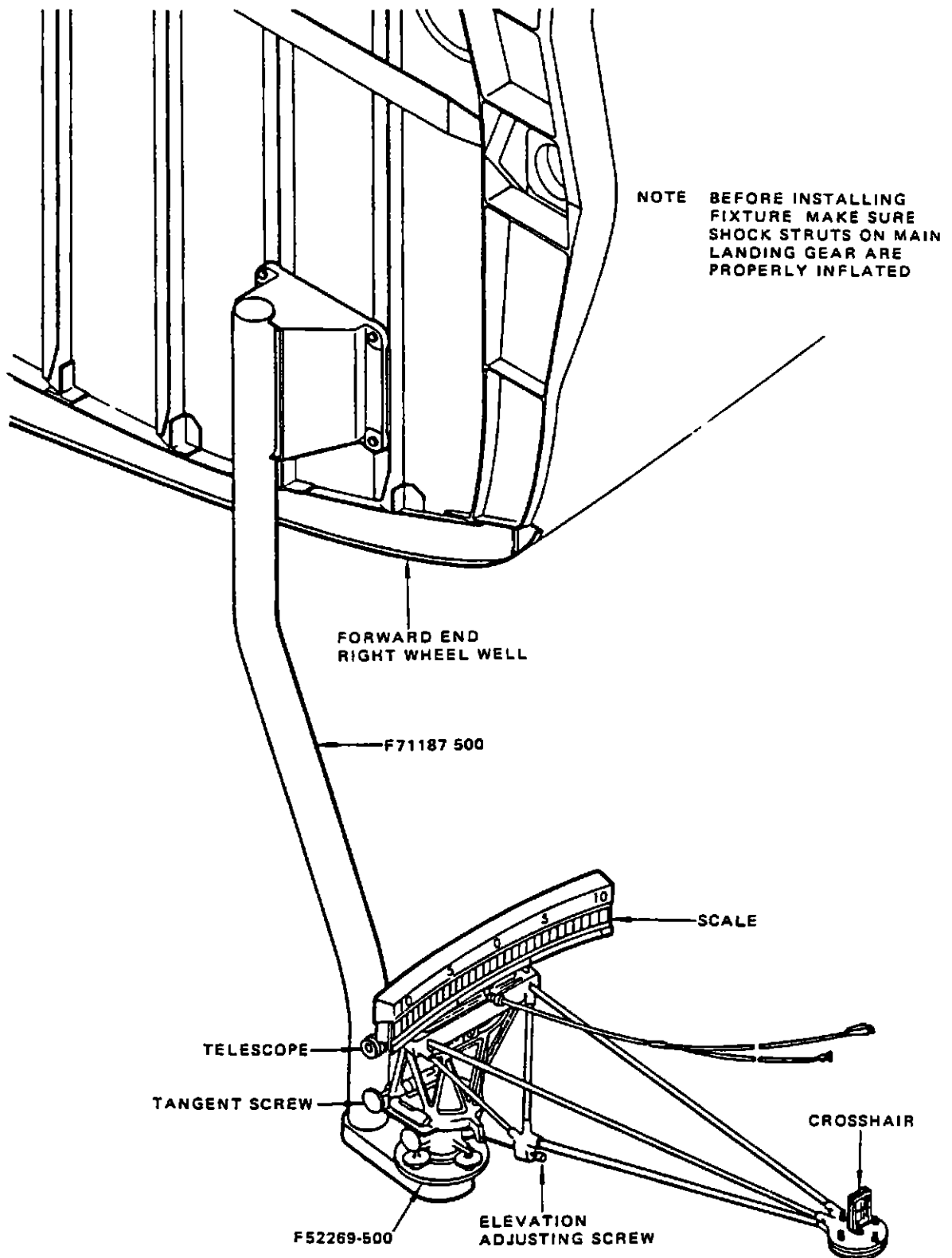
NOTE On a scheduled compass swing, it is not necessary to make null and zero adjustments given in following steps (a) and (b)

(a) Using flux valve compensator, set N-S and E-W controls to neutral position by lining up the two dots on adjusting shaft and compensator case

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Compass Swing Kit Assembly
 Figure 201 (Sheet 1)



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FIGURE 202 DELETED



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- (15) Place SWING/NORMAL switch (when applicable) to SWING position.
- (16) Synchronize compass systems.

NOTE: Synchronization knobs must not be used for duration of swing.

D Swing Main Compass (Refer to figure 3.)

- (1) The compass deviation in any selected direction (x) required to calculate the following compass errors, is determined as follows:
 - (a) Sight transit telescope on fixture crosshair.
 - (b) Read and record fixture angle.
 - (c) Read and record transit angle.
 - (d) Transit angle (T) minus fixture angle (F) equals airplane magnetic heading (MH)x. $(Tx - Sx = (MH)x$.
 - (e) Read and record the compass heading (CH)x for No. 1 and No. 2 systems on repeater.
 - (f) Magnetic heading (MH)x minus compass heading (CH)x equals compass deviation (Dx), $(MH)x - (CH)x = Dx$
- (2) Determine and compensate one cycle error (hard iron compensation).
 - (a) Tow airplane around swinging base transit. Complete at least one full turn.
 - (b) Tow airplane to within 2 degrees of North (n) and calculate Dn. Refer to (1).
 - (c) Tow airplane to within 2 degrees of East (e) and calculate De.
 - (d) Tow airplane to within 2 degrees of South (s) and calculate Ds.
 - (e) Calculate and record one cycle error coefficient C1 and C2 for No. 1 and No. 2 systems respectively, where $C = 1/2(Dn - Ds)$.
 - (f) While still at South heading, adjust N-S control on No. 1 and No. 2 systems' compensators until corrected compass headings (CH)s1 - C1 and (CH)s2 - C2 are obtained in turn on repeater.

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ONE CYCLE ERROR COMPENSATION

NOMINAL HEADING α	NORTH	EAST	SOUTH	WEST
TRANSIT ANGLE T_x				
FIXTURE ANGLE F_x				
MAGNETIC HEADING $(MH)_x = T_x - F_x$				
NO 1 COMPASS HEADING $(CH)_x1$				
NO 2 COMPASS HEADING $(CH)_x2$				
STBY COMPASS HEADING $(CH)_x3$				
NO 1 COMPASS DEVIATION $D_{x1} = (MH)_x - (CH)_x1$				
NO 2 COMPASS DEVIATION $D_{x2} = (MH)_x - (CH)_x2$				
STBY COMPASS DEVIATION $D_{x3} = (MH)_x - (CH)_x3$				

	COEFFICIENT $C = 1/2 (D_n - D_s)$	AT SOUTH ADJUST N-S CONTROL TO OBTAIN $(CH)_s = (CH)_n - C$
NO 1 COMPASS SYSTEM		
NO 2 COMPASS SYSTEM		
STANDBY COMPASS		

	COEFFICIENT $B = 1/2 (D_e - D_w)$	AT WEST ADJUST E-W CONTROL TO OBTAIN $(CH)_w = (CH)_e + B$
NO 1 COMPASS SYSTEM		
NO 2 COMPASS SYSTEM		
STANDBY COMPASS		

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INDEX ERROR COMPENSATION

NOMINAL HEADING x_1	30	60	90	120	150	180
TRANSIT ANGLE T_x						
FIXTURE ANGLE F_x						
MAGNETIC HEADING $(MH)_x = T_x F_x$						
NO 1 COMPASS HEADING $(CH)_x1$						
NO 2 COMPASS HEADING $(CH)_x2$						
NO 1 COMPASS DEVIATION $D_x1 = (MH)_x (CH)_x1$						
NO 2 COMPASS DEVIATION $D_x2 = (MH)_x (CH)_x2$						

NOMINAL HEADING x	210	240	270	300	330	000
TRANSIT ANGLE T_x						
FIXTURE ANGLE F_x						
MAGNETIC HEADING $(MH)_x = T_x F_x$						
NO 1 COMPASS HEADING $(CH)_x1$						
NO 2 COMPASS HEADING $(CH)_x2$						
NO 1 COMPASS DEVIATION $D_x1 = (MH)_x (CH)_x1$						
NO 2 COMPASS DEVIATION $D_x2 = (MH)_x (CH)_x2$						

	COEFFICIENT A = $1/12 \sum D_x$	ADJUST INDEX CONTROL OR FLUX VALVE TO OBTAIN $(CH)_x = (CH)_x + A$
NO 1 COMPASS SYSTEM		
NO 2 COMPASS SYSTEM		



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TRANSMISSION ERROR COMPENSATION

NOMINAL HEADING x	000°	045°	090°	135°
TRANSIT ANGLE Tx				
FIXTURE ANGLE Fx				
MAGNETIC HEADING (MH)x = Tx Fx				
NO 1 COMPASS HEADING (CH)x1				
NO 2 COMPASS HEADING (CH)x2				
NO 1 COMPASS DEVIATION Dx1 = (MH)x (CH)x1				
NO 2 COMPASS DEVIATION Dx2 = (MH)x (CH)x2				

NOMINAL HEADING x	180°	225°	270°	315°
TRANSIT ANGLE Tx				
FIXTURE ANGLE Fx				
MAGNETIC HEADING (MH)x = Tx Fx				
NO 1 COMPASS HEADING (CH)x1				
NO 2 COMPASS HEADING (CH)x2				
NO 1 COMPASS DEVIATION Dx1 = (MH)x (CH)x1				
NO 2 COMPASS DEVIATION Dx2 = (MH)x (CH)x2				

	F = D000 + D180	E = D045 + D225	F = D090 + D270	E = D135 + D315
NO 1 COMPASS SYSTEM				
NO 2 COMPASS SYSTEM				

	COEFFICIENT E = 1/4 (E E)	COEFFICIENT F = (F F)
NO 1 COMPASS SYSTEM		
NO 2 COMPASS SYSTEM		

	MAGNITUDE OF TRANSMISSION ERROR M = $\sqrt{E^2 + F^2}$		DIRECTION OF TRANSMISSION ERROR H = $\tan^{-1} E/F$	
NO 1 COMPASS SYSTEM	M1		H1	
NO 2 COMPASS SYSTEM	M2		H2	

TOW AND ALIGN AIRPLANE TO	H1		H2	
ADJUST DIRECTION TRANSMISSION CONTROL TO	H1		H2	
RECORD COMPASS HEADING (CH) H	(CH)H1		(CH)H2	
ADJUST MAGNITUDE CONTROL TO OBTAIN	(CH) H1 = (CH)H1 - M1			

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RESIDUAL ERROR CHECK

NOMINAL HEADING α	000	015	030			315	330
TRANSIT ANGLE T_x							
FIXTURE ANGLE F_x							
MAGNETIC HEADING $(MH)_x = T_x - F_x$							
NO 1 COMPASS HEADING $(CH)_x1$							
NO 2 COMPASS HEADING $(CH)_x2$							
NO 1 COMPASS RESIDUAL DEVIATION $Dx1 = (MH)_x - (CH)_x1$							
NO 2 COMPASS RESIDUAL DEVIATION $Dx2 = (MH)_x - (CH)_x2$							
PILOT RMI R1							
COPILOT RMI R2							
PILOT CDI C1							
COPILOT CDI C2							
PILOT RMI RESIDUAL DEVIATION $Dx1 = (MH)_x - R1$							
COPILOT RMI RESIDUAL DEVIATION $Dx2 = (MH)_x - R2$							
PILOT CDI RESIDUAL DEVIATION $Dx1 = (MH)_x - C1$							
COPILOT RMI RESIDUAL DEVIATION $Dx2 = (MH)_x - C2$							
STANDBY COMPASS $(CH)_x3$							
STANDBY COMPASS RESIDUAL DEVIATION $Dx3 = (MH)_x - (CH)_x3$							
STANDBY COMPASS TO STEER HEADING $\alpha - Dx3$							

	NO 1 COMPASS SYSTEM	NO 2 COMPASS SYSTEM
MAX RESID HDG DEVIATION		
MAX RMI HDG POS DEV $ +Dx $		
MAX RMI HDG NEG DEV $ Dx $		
MAX RMI DEV DIFF $= +Dx - Dx $		
MAX CDI HDG POS DEV $ +Dx $		
MAX CDI HDG NEG DEV $ Dx $		
MAX CDI DEV DIFF $= +Dx - Dx $		



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- (g) Tow airplane to within 2 degrees of West (w) and calculate Dw.
 - (h) Calculate and record one cycle error coefficient B1 and B2 for No. 1 and No. 2 systems respectively where $B = 1/2(Dw - De)$.
 - (i) While still at West, adjust E-W control on No. 1 and No. 2 systems' compensators until corrected compass headings (CH)w1 - B1 and (CH)w2 - B2 are obtained in turn on repeater.
- (3) Determine and compensate index error.
- (a) Make a 12 points swing at 30 degrees interval to calculate index error coefficient A1 and A2 for No. 1 and No. 2 systems' respectively where $A = 1/12(D0 + D30 + ...D330)$.
 - (b) Compensate for index error by rotating either flux valve (and compensator if used) or index control on No. 1 and No. 2 systems' magnetic compensators; clockwise if error is positive and counterclockwise if error is negative. Rotate until corrected heading (CH)1 + A1 and (CH)2 + A2 are obtained on repeater.

NOTE. When preindexed flux valve is used, flux valve adjusting screws should not be removed or loosened for adjustment. Fine adjustment of index control only is required.

- (4) Determine and compensate transmission error.
- (a) Make an 8 points swing, at 45 degrees interval, to calculate transmission error coefficients E1, F1 and E2, F2 for No. 1 and No. 2 systems respectively where.
$$E = 1/4 (D045 - D135 + D225 - D315)$$
$$F = 1/4 (D000 - D090 + D180 - D270)$$
 - (b) Determine magnitude of transmission error M1 and M2 where $M = \sqrt{E^2 + F^2}$. (Refer to figure 204.)
 - (c) Determine direction of transmission error H1 and H2 where $H = 1/2 \tan^{-1} E/F$.
 - (d) Align the airplane to the exact magnetic heading H1 calculated in step (c) above. Read and record compass heading (CH)1.



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- (e) Rotate direction transmission control H1 degrees.
- (f) Adjust magnitude transmission control until corrected heading (CH)1 - M1 (M1 calculated in (b) above) is obtained on repeater.
- (g) Similarly repeat steps (d) through (h) for No. 2 system.

(5) Determine Residual deviation.

- (a) Make a 24 points residual swing, at 15 degrees intervals and calculate residual deviations.
- (b) Check that residual deviations at each of the 24 points for both systems are within $\pm$ (2 degrees 0 minutes).

NOTE: If changes in earth's magnetic field are measured and necessary correction made for each reading, tolerances may be increased to $\pm$ (2 degrees 12 minutes).

- (c) Check that indications given on RMI and CDI at each of the 24 points for both systems are within $\pm$ 3 degrees of true magnetic heading.

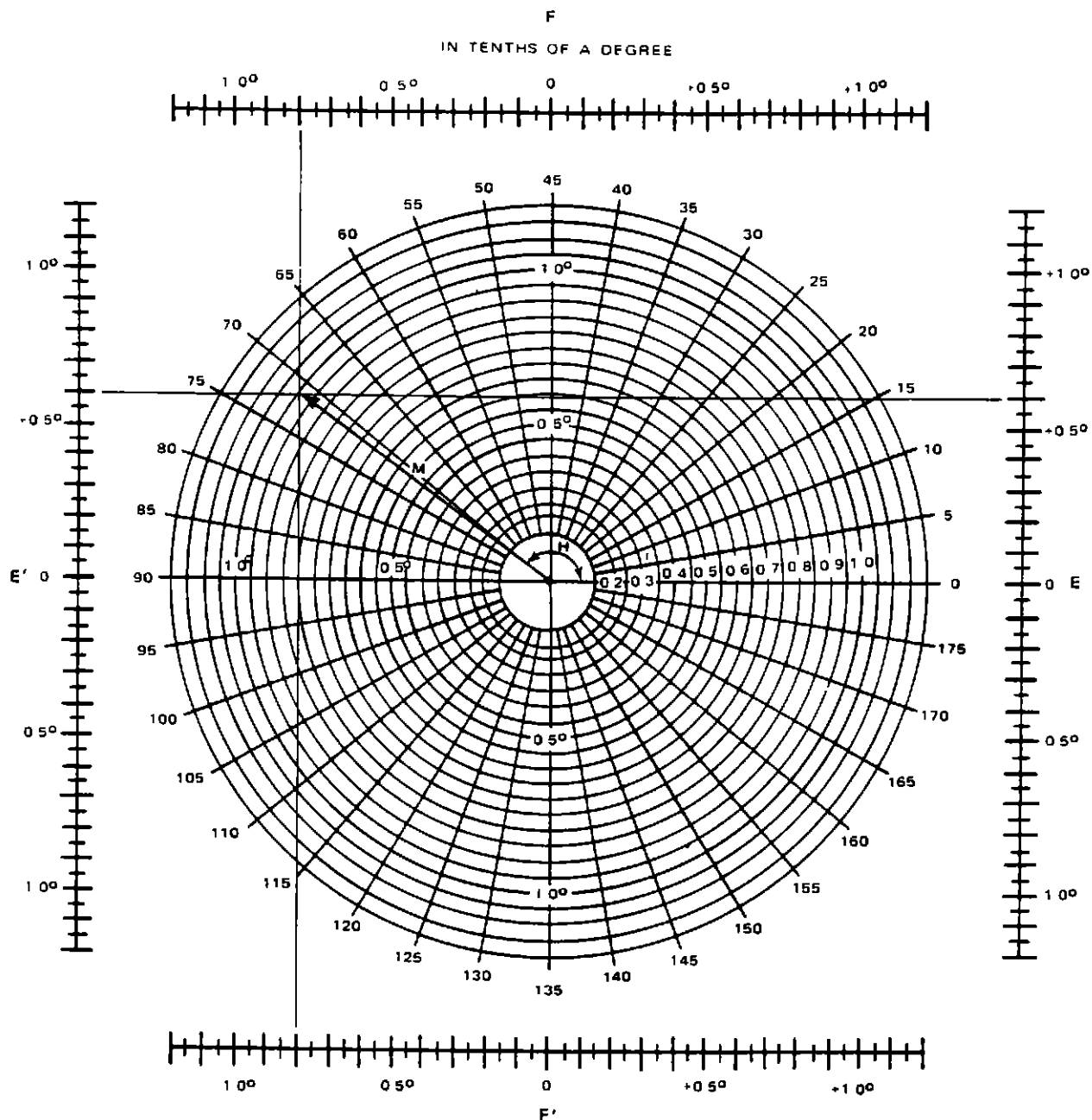
(6) Fixture and transit check.

- (a) Recheck transit alignment and fixture alignment.
- (b) Verify that with misalignments (if any), the tolerances specified in (5)(b) above are not exceeded at any point. If exceeded, the swing must be repeated.

E Restore Airplane to Normal

- (1) Remove transit and fixture.
- (2) Return swing switch (when applicable) to NORMAL and lockwire in this position.
- (3) Determine if there is further need for electrical power, if not, remove power.

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SCALE THE DIRECTION (H) AND MAGNITUDE (M) OF THE TRANSMISSION ERROR FROM GRAPH AS FOLLOWS

- 1 DRAW A LINE BETWEEN THE VALUE OF E ON THE E AND E' SCALES
- 2 DRAW A LINE BETWEEN THE VALUE OF F ON THE F AND F' SCALES
3. AT THE INTERSECTION OF THE TWO LINES READ THE MAGNITUDE OF THE SCALE ON THE CIRCULAR SCALE
- 4 DRAW A LINE FROM THE ORIGIN TO THE INTERSECTION OF THE LINES JUST DRAWN READ THE DIRECTION OF THE ERROR ON THE POLAR SCALE
- 5 EXAMPLE IF E = +0.6 DEGREE AND F = -0.8 DEGREE THE MAGNITUDE M = 1.0 DEGREE AND THE DIRECTION H = 71 DEGREES

Determination of Direction and Magnitude
of Transmission Error
Figure 204



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3. Swing Standby Compass

A General

- (1) The standby compass is compensated for one cycle error only.

B Equipment and Materials

- (1) Those listed in steps 2.B (1) through 2.B.(7)
- (2) Compass correction card

C. Prepare for Compass Swing.

- (1) Check that landing gear down locks are in place.
- (2) Energize landing gear lever latch solenoid. (Solenoid may be energized by grounding at the nose gear centering switch. Refer to Chapter 32-6-0, Landing Gear Control Handle Lock System.)
- (3) Allow at least 20 minutes after solenoid has been energized before proceeding.

CAUTION: DO NOT MOVE LANDING GEAR LEVER WHILE THE SOLENOID IS ENERGIZED

D. Swing Standby Compass (Refer to figure 203 for suggested recording forms.)

- (1) Determine and compensate one cycle error.
 - (a) Tow airplane to within 2 degrees of North (n) and calculate Dn. Refer to 2.D.(1).

NOTE: If tow tractor affects the readings by more than one degree it must be removed from the area while taking readings.

- (b) Tow airplane to within 2 degrees of East (e) and calculate and record De.
 - (c) Tow airplane to within 2 degrees of South (s) and calculate and record Ds.
 - (d) Calculate and record coefficient $C = 1/2(Dn - Ds)$ and adjust N-S control to obtain $CHx - C$.
 - (e) Tow airplane to within 2 degrees of West (w) and calculate and record Dw.

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- (f) Calculate and record coefficient $B = 1/2(D_e - D_w)$ and adjust E-W control to obtain CHW - B
- (2) Determine Residual Error
 - (a) Make a 12 point swing, at 30 degrees interval, calculate and record the residual deviations.
 - (b) Check that deviation at each point does not exceed 8 degrees.
 - (c) Check that difference between maximum positive and maximum negative deviation does not exceed 10 degrees.
- (3) Compass Correction Card (Refer to figure 205.)
 - (a) Prepare compass correction card as follows:
 - 1) Calculate and record to STEER heading, approximated to closest degree, at each of the 12 (TO FLY) nominal swinging points (0, 30, 60 ... 330) by subtracting from the nominal heading, the corresponding deviation ((0 - D_n), (30 - D₃₀), ..., (330 - D₃₃₀)).
 - 2) Fill steer column with results obtained in 1).
- D. Restore Airplane to Normal
 - (1) De-energize landing gear lever latch solenoid. (Refer to step C.(2).)
 - (2) Remove transit and fixture.
 - (3) Determine if there is further need for electrical power, if not, remove power.

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COMPASS			
SWUNG		BY	
TO FLY	STEER	TO FLY	STEER
000		180	
015		195	
030		210	
045		225	
060		240	
075		255	
090		270	
105		285	
120		300	
135		315	
150		330	
165		345	



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COMPASS SYSTEM - ADJUSTMENT/TEST

1. Compass System Test

A. General

- (1) The following tests are designed to check out the serviceability of the system, and not its accuracy. (Refer to Compass System Maintenance Practices.)

B. Prepare for System Test

- (1) Energize the P5 load control center by means of the external power.
- (2) Check that all necessary circuit breakers for the operation of the compass systems are closed and select (if applicable) the slaved mode.
- (3) Ensure compass light (if installed) are operable.
- (4) Allow a few minutes for gyros to run up and synchronize both systems.

C. Test Compass System

- (1) Check synchronization as follows.
 - (a) Set compass transfer switch to NORMAL.
 - (b) Push and turn SYNC knob on captain's RMI counterclockwise. A cross should appear in annunciator window and compass card should rotate clockwise, at a speed of at least 40 degrees per second.
 - (c) Repeat for clockwise rotation of SYNC knob. A dot should now appear in annunciator window and the card should rotate counterclockwise (40 degrees per second minimum).
 - (d) Repeat steps (b) and (c) for the first officer's RMI.
- (2) Check slaving circuits.
 - (a) By means of the synchronizing knob, offset pilot's RMI compass card plus 3 to 4 degrees from airplane heading. Check that annunciator shows a dot while card precesses back to original heading, then indicates a null (stationary or alternating between symbols) in less than 5 minutes.



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- (b) Repeat step (a) for a minus setting. Check that annunciator shows a cross.
- (c) Repeat steps (a) and (b) using copilot RMI.
- (3) Check repeater operation of RMI and CDI cards.
 - (a) Set compass transfer switch to normal and perform following:
 - 1) Rotate pilot's ADF RMI compass card by means of its synchronizing knob. Check that pilot's CDI and copilot's VOR RMI cards are following smoothly with an accuracy of ± 1 degree.
 - 2) Rotate copilot's RMI compass card by means of its synchronizing knob. Check that copilot's CDI, pilot's VOR RMI and navigator's RMI cards are following smoothly with an accuracy of ± 1 degree.
 - (b) Set the compass transfer switch to No. 1 and:
 - 1) Rotate pilot's ADF RMI compass card. Check that pilot's CDI, copilot's VOR RMI and navigator's RMI cards are following smoothly and accurately within ± 1 degree.
 - 2) Rotate copilot's ADF RMI compass card. Check that captain's VOR RMI and copilot CDI cards are following smoothly and accurately within ± 1 degree.
 - (c) Set compass transfer switch to No. 2 and rotate copilot's ADF RMI card. Check that pilot's ADF RMI, VOR RMI and CDI, copilot's VOR RMI and CDI, navigator's RMI cards are following smoothly and accurately within ± 1 degree.
 - (d) Return compass transfer switch to normal.
- (4) Check latitude (rate) compensation.
 - (a) Set mode selector switch to directional gyro mode and set drift rate controller to local drift rate which is equal to $15 \sin A$ where A degrees is local latitude. Check that compass indication of magvar does not move by more than ± 10 minutes of arc per minute.
 - (b) Set drift rate controller to 13 degrees/hour and north-south switch to south/north (opposite to local latitude). Check that compass indication decreases/increases $(13 + \sin A) \pm 10$ minutes of arc per minute.
 - (c) Repeat steps (a) and (b) using the copilot instruments.

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(5) Check DG mode.

- (a) Set the compass mode selector switch to the directional gyro mode and rotate pilot's RMI card +10 degrees by means of synchronizing knob. Check that RMI card heading indication has no effect on compass annunciator.
- (b) Return the pilot's compass mode selector switch to the slaved compass mode. Check that compass annunciator shows a dot.
- (c) Synchronize pilot's compass system.
- (d) Repeat steps (a) through (c) using the copilot instruments.

(6) Check failure warning.

- (a) Carry out the checks described as tabulated below.

OPEN THE FOLLOWING CIRCUIT BREAKERS ONE AT A TIME. CHECK THAT THE FLAG(S) CALLED FOR EACH STEP ARE IN VIEW.	CAPTAIN'S INSTRUMENTS				FIRST OFFICER'S INSTRUMENTS			
	RDI		CDI		RDI		CDI	
	NO. 1	NO. 2	NO. 1	NO. 2	NO. 1	NO. 2	NO. 1	NO. 2
COMPASS NO. 1	X		X					
COMPASS NO. 2		X		X	X	X	X	X
INST XMFR NO. 1		X					X	X
INST XMFR NO. 2								X
PILOT COURSE AMPLIFIER			X	X				
COPILOT COURSE AMPLIFIER							X	X

- (7) Determine if there is further need for electrical power, if not, remove power.

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DIRECTIONAL GYRO - MAINTENANCE PRACTICES

1. Removal/Installation Directional Gyro

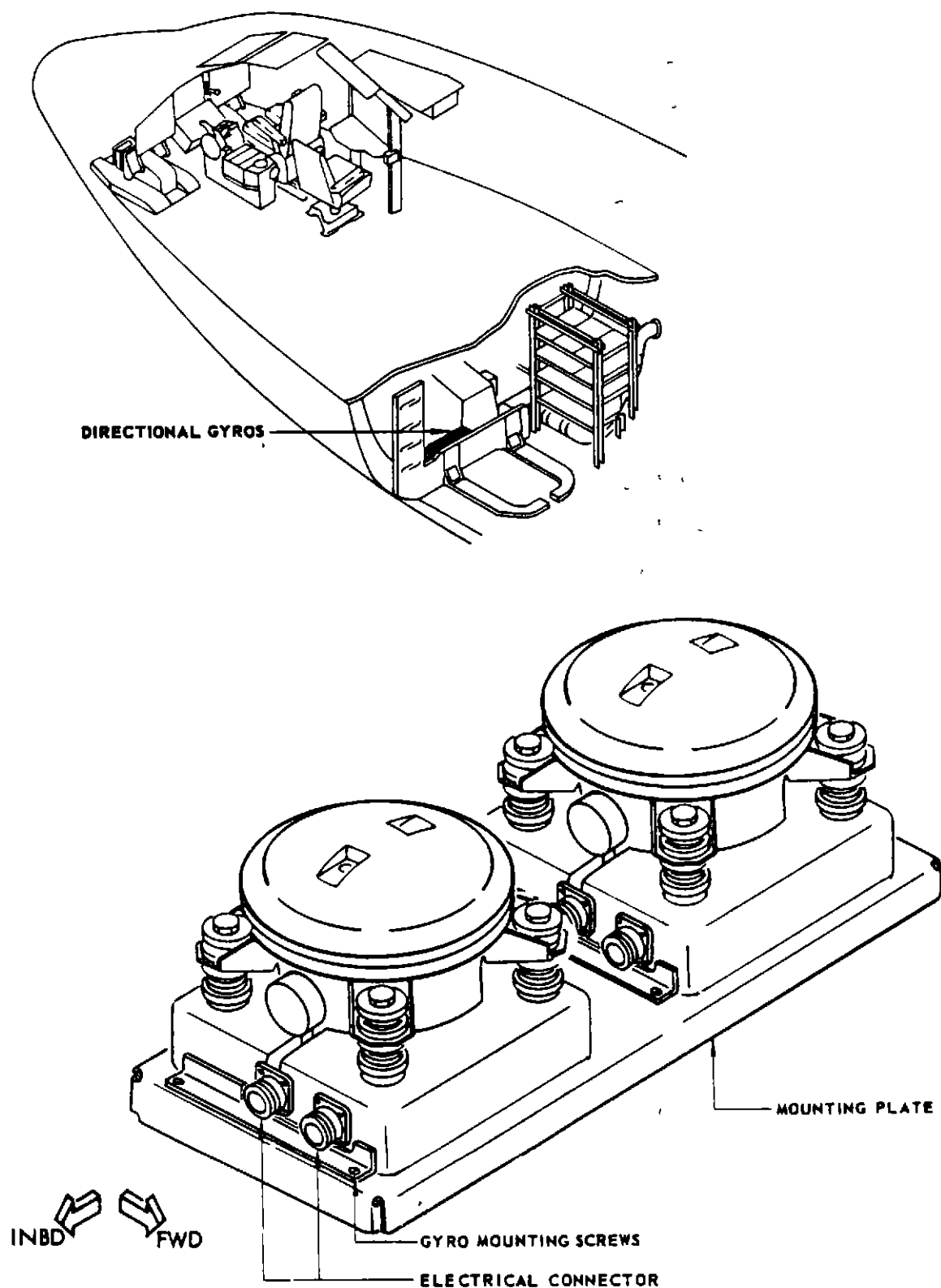
A. Remove Directional Gyro (See figure 201.)

- (1) Remove screws from directional gyro protective cover assembly.
- (2) Remove cover assembly.
- (3) Disconnect electrical connectors from gyro to be removed.
- (4) Remove four screws attaching gyro to mounting plate.
- (5) Remove gyro.

B. Install Directional Gyro

- (1) Place directional gyro on mounting plate and align holes in gyro base with nutplates on plate.
- (2) Install mounting screws.
- (3) Connect electrical connectors.
- (4) Install cover over directional gyros.

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Directional Gyro Installation
Figure 201



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REMOTE COMPASS TRANSMITTER - MAINTENANCE PRACTICES

1. Removal/Installation Remote Compass Transmitter

A. Prepare to Remove Remote Compass Transmitter

- (1) A stand of sufficient height to gain access to the upper surface of the wing tip is required.

B. Remove Remote Compass Transmitter

- (1) Remove wing tip access panel (1420) to gain access to compass transmitter. Refer to Chapter 12, Access Doors and Panels.
- (2) Remove four slotted nuts holding compensator assembly on transmitter, and remove compensator. (See figure 201.)
- (3) Disconnect electrical wires from transmitter terminal board.
- (4) Remove three screws holding transmitter on mounting plate and remove transmitter.

C. Install Compass Transmitter

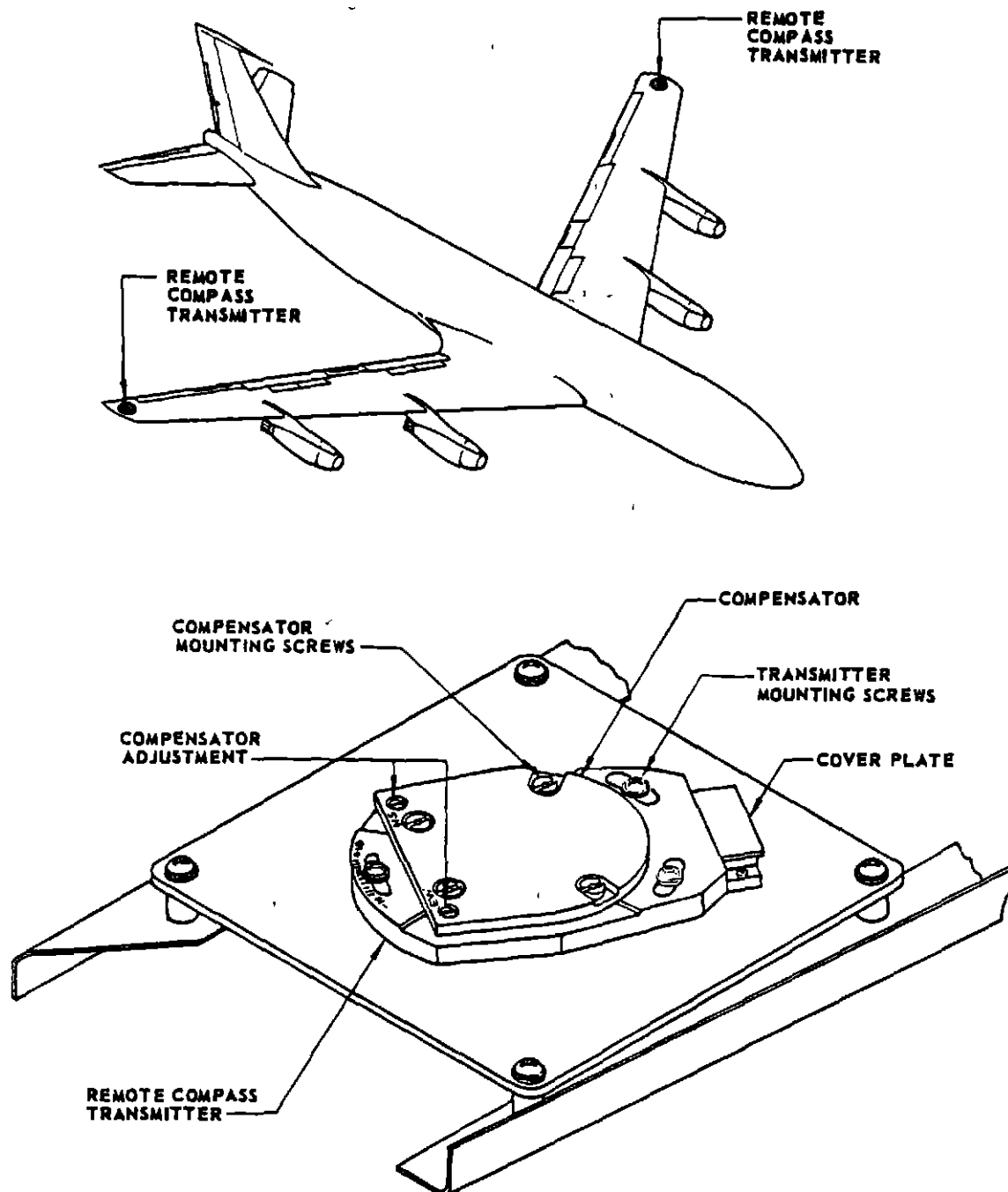
- (1) Place compass transmitter in position on mounting plate and install three screws.

NOTE: Use nonmagnetic screws only.

- (2) Remove coverplate, if installed, and connect electrical leads to terminals. Check wiring carefully to ensure leads are fastened to proper terminals.
- (3) Install compensator assembly on transmitter and install four nuts.
- (4) Align compass transmitter index mark with guide post on mounting plate.

D. Swing compass as described in 34-12-0, Compass System - Maintenance Practices.

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Remote Compass Transmitter Installation
 Figure 201

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COMPASS SWINGING - ADJUSTMENT/TEST

1. General

- A. The compass swinging procedure allows the adjustment and test of the Bendix Polar Path Compass Systems and the Magnetic Standby Compass at the same time. A complete compass swing is necessary when a remote compass transmitter is changed. The other components may be changed without a compass swing. See special procedure for the compass coupler.
- B. Compass system No. 1 controls the compass card on the copilot's ADF-RMI and may be selected to drive the pilot's Course Deviation Indicator (CDI) and pilot's VOR-RMI. Compass system No. 2 controls the pilot's ADF-RMI, navigator's RMI, copilot's CDI, copilot's VOR-RMI and may be selected to drive the pilot's CDI and pilot's VOR-RMI

2. Equipment and Materials

- A. Compass swinging base (compass rose), with the following features
- (1) A circular area at least 300 feet in radius about the rose center, to preclude parking of aircraft or other vehicles in that area during a compass swing.
 - (2) Center area must be level and large enough to permit towing the airplane in a circle about the center with a minimum of 25 feet between the compass transmitter and the outer extremes. In this area the horizontal component of earth's magnetic field shall be constant within 0.2 degrees. If the area is limited in size, the systems shall be compensated singly. These requirements shall apply to the transmitter of the system being compensated that is nearest the center of the towing circle.
 - (3) Base plate located and marked to identify the center transit position.
 - (4) Heading markers for use in transit alignment.

NOTE Base plate and markers must be accurately located so heading of airplane with respect to magnetic north can be determined to within 0.1 degree using transit, and compass swinging kit.

- B. Tow tractor
- C. Surveyor's transit capable of being read to one minute or less.

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- D Compass swinging kit F-70036 or equivalent. (Kit consists of F-52269-500 compass swinging target, F-71187-500 target mark, and F-71187 bracket assembly) (See figure 501.)
- E. Non-magnetic tools for adjusting the remote compass transmitters and magnetic standby compass.
- F. Compass correction cards.

3. Prepare for Adjustment

- A. Connect external power.
- B. Check Compass System No. 1

(1) Check Synchronization

- (a) Set the "COMPASS" switch to "No. 1" position, the mode selector switch to the "SLA" position, and turn on all compass system power.
- (b) Set the compass cards to the approximate heading of the airplane, by use of "SET" knobs, then allow the cards to slave to the stationary position.
- (c) Turn the "SET" knobs on the compass controllers clockwise. The compass cards shall rotate counterclockwise and the annunciators shall deflect left.
- (d) Repeat for counterclockwise rotation of the "SET" knobs. The cards shall rotate clockwise and the annunciators shall deflect right.

(2) Check Slaving

- (a) Set the cards several degrees away from the slaved position and release the "SET" knob. The cards shall rotate toward the stationary position.
- (b) Hold the mode selector switch in "SYN" position. The rotation rate of the cards shall increase and the cards shall slave back to the stationary positions. The annunciator shall be centered when this condition is reached.

C. Check Compass System No 2

- (1) Repeat B. (1) and (2) above for compass system No. 2 by setting "COMPASS" switch in position "No. 2."

NOTE Oscillation of the annunciator (sync indicator) on the compass controller, about a mean deflection, is not sufficient cause to reject a compass coupler.

D. Check Associated Systems

- (1) Autopilot operational test, when required, will include a check of the heading signal which goes to the autopilot. (See Autopilot System, Chapter 22.)
- (2) Bendix Flight Director Instrument System operational test, when required, will include a check of the heading signals, which are used in that system. (See Bendix Flight Director Instrument System, 34-5-0.)

E. Check Power Failure Warning

- (1) Switch the compass power on and close the circuit breakers. The pilot's and copilot's CDI compass power failure warning flags shall be out of view.
- (2) Set the "COMPASS" switch in the "No. 1" position.
- (3) Open, then close the pilot's "COMPASS NO. 1 ØA", "TRANS NO. 1 AC," "COURSE DEV AC" and "COMPASS NO. 1 ØB breakers, one at a time. As each breaker is opened and closed, the pilot's warning flag shall appear and disappear
- (4) Open, then close the copilot's "COMPASS NO. 2 ØA" "TRANS NO. 2 AC," "COURSE DEV AC" and "COMPASS NO 2 ØB breakers, one at a time. As each breaker is opened and closed the copilot's warning flag shall appear and disappear.
- (5) Open the pilot's "COMPASS NO. 1 ØA, COMPASS NO 1 ØB and TRANS NO. 1 AC" breakers. The pilot's flag shall appear.
- (6) Set the "COMPASS" switch to the No. 2 position. The flag shall disappear.

F. Check Directional Gyro Drift

(1) Determine Drift Rate

- (a) Establish two latitude setting points meeting the following requirements:
- 1) The two test points shall be for opposite hemispheres i.e , one for north and one for south latitude.
 - 2) One test point shall be within 20° of a polar setting, i.e., 70 to 90 degrees north or south latitude.
 - 3) The second test point shall be at least 30° less than the first in absolute value (i.e., neglecting whether it is north or south latitude) and not less than 10° from the equatorial setting (i.e., at least 10° north or 10° south latitude)

NOTE One of the test points may be the latitude of the test site if it meets the above requirements. In this case the computed drift rate is zero.

(b) Compute the drift rate as follows:

rate setting - 15 sin local latitude = drift angle
per hour

(compensated rate) (earth's rate) (computed rate)

(c) Observe Drift Rate

- 1) Position the mode selector switches to "SLA."
- 2) Position the "COMPASS" switch to "No 1" position
- 3) Set the "RATE COR" dial to one test point.
- 4) With the system slaved (and synchronized), set the mode selector switch to "DG."
- 5) Observe drift of the compass card for at least 30 minutes. Observed drift rate shall not exceed the computed drift rate by more than 2 5° per hour

NOTE Airplane must not be moved during this time interval. A negative drift rate means a decreasing compass reading. The value of earth's rotation rate at Seattle is 11 1 degrees per hour.

(2) Check drift rate with other test point in same manner.



G. Set up Transit and Compass Swing Kit

- (1) Accurately position transit at center of compass swinging base and check its position with respect to the base and targets both before and after each airplane calibration as follows.
 - (a) Unlock upper motion of transit and rotate telescope until transit scale reads an angle of 90 degrees plus the known magnetic heading of the heading marker. If the total is greater than 360 degrees, subtract 360 degrees to obtain scale reading.
 - (b) Lock upper motion and unlock lower motion of transit. Align transit crosshairs on center of the above marker and lock lower motion.
 - (c) Verify transit alignment by sighting on alternate target. The known marker heading plus 90° should be read on the transit scale.

- (2) Attach compass swinging target fixture on the wheel well bulkhead and the target mark at the forward jack pad position using the lower aft bolt holes. (See figure 501.)
- (3) Adjust tangent screw to align target fixture telescope with target mark, and adjust lever screws to align crosshair and scale with transit telescope. (See figure 501.)
- (4) Close all circuit breakers and switches necessary to operate the compass systems. The pilot's CDI should be connected to compass system No. 1 (LH compass system) and the copilot's CDI to compass system No. 2 (RH compass system.) Allow system to warm up for 10 minutes before starting compensation procedure.
- (5) Set the compass controller switches to "SLA" position and be sure the systems are synchronized.

NOTE: Magnetic standby compass should be adjusted at the same time the Bendix Plar Path Compass systems are compensated.

CAUTION: BE SURE THAT THE GROUND DOWN LOCKS ARE IN PLACE BEFORE PROCEEDING OR THE LANDING GEAR WILL BE IN DANGER OF COLLAPSE.

- (6) Energize the landing gear lever latch solenoid after observing above caution (Solenoid may be energized by grounding at the nose gear centering switch.)

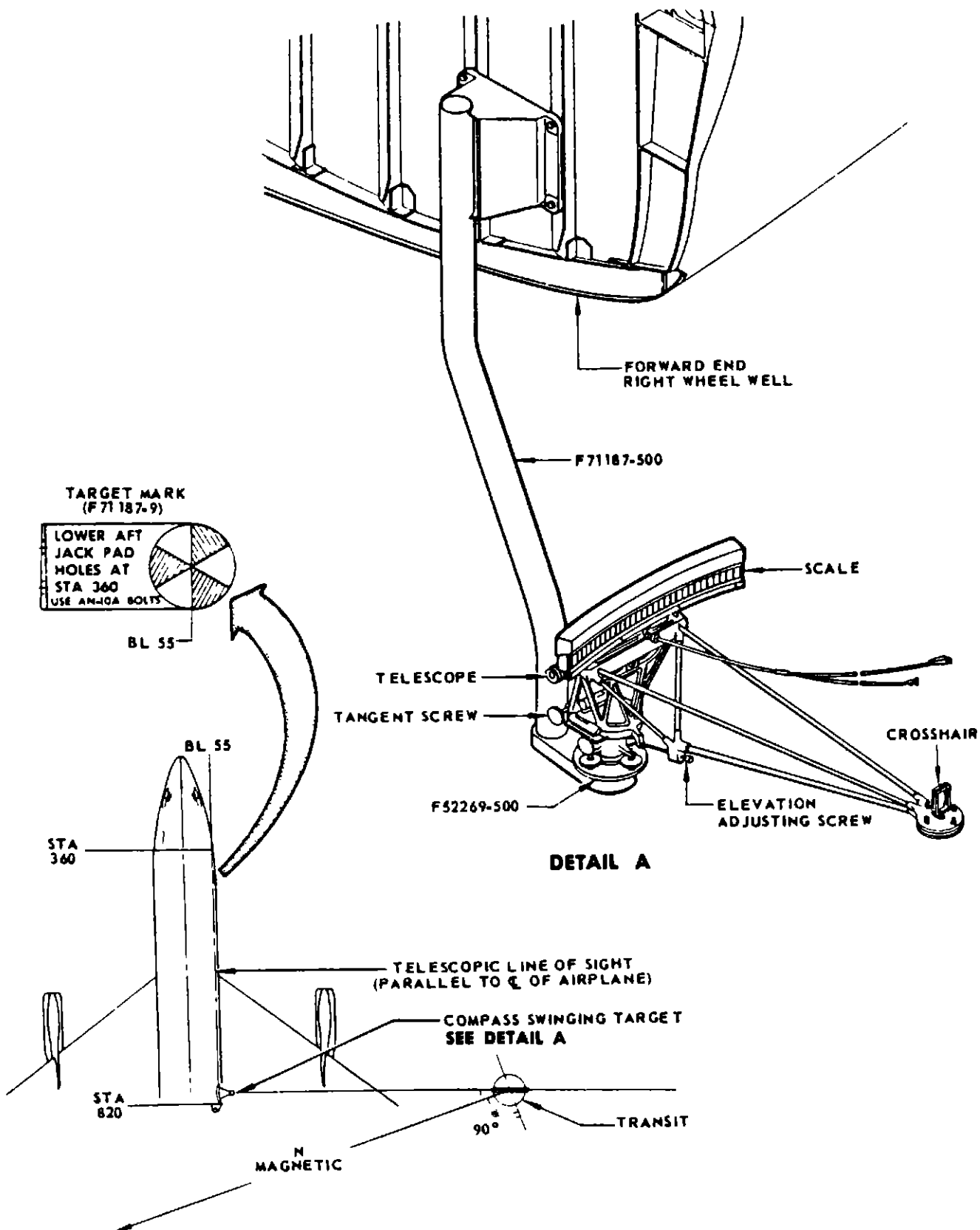
CAUTION : DO NOT MOVE THE LANDING GEAR LEVER WHILE THE SOLENOID IS ENERGIZED.

NOTE : Allow at least 20 minutes after the solenoid has been energized before proceeding.

- (7) Radio receivers must be ON during calibration.

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Compass Swing Kit Assembly
Figure 501

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H. Make Preliminary Adjustment of Magnetic Standby Compass

- (1) Adjust the compensators to align the dots prior to swinging. The compass compensators shall be adjusted for the single cycle errors (coefficients B & C) as outlined below, except that after compensation, the difference between the maximum positive and maximum negative deviation shall not exceed 10 degrees.

NOTE: If the tow tractor affects the readings more than $\pm 1^\circ$, it must be removed from the area while taking readings. Index errors cannot be removed from the standby compass. If a reswing is necessary for the standby compass, it shall be done at 12 points only.

4. Adjust (Compensate) Compass Systems

A. Determine magnetic heading of airplane.

- (1) Unlock upper motion of transit and align transit telescope crosshair on target fixture crosshair.
- (2) Read and record fixture scale angle "F." (See figure 502.)

NOTE: Angles on right side of scale are positive and angle on left side of scale are negative, as seen from the transit telescope.

- (3) Read and record transit angle "G" on clockwise scale.
- (4) Calculate true magnetic heading (MH) as follows:

MH = Transit angle - fixture angle, "G-F."

Example: Transit angle = 005 degrees 35 minutes
Fixture angle = 003 degrees 38 minutes
MH - $005^\circ 35' - 003^\circ 38' = 001^\circ 57'$

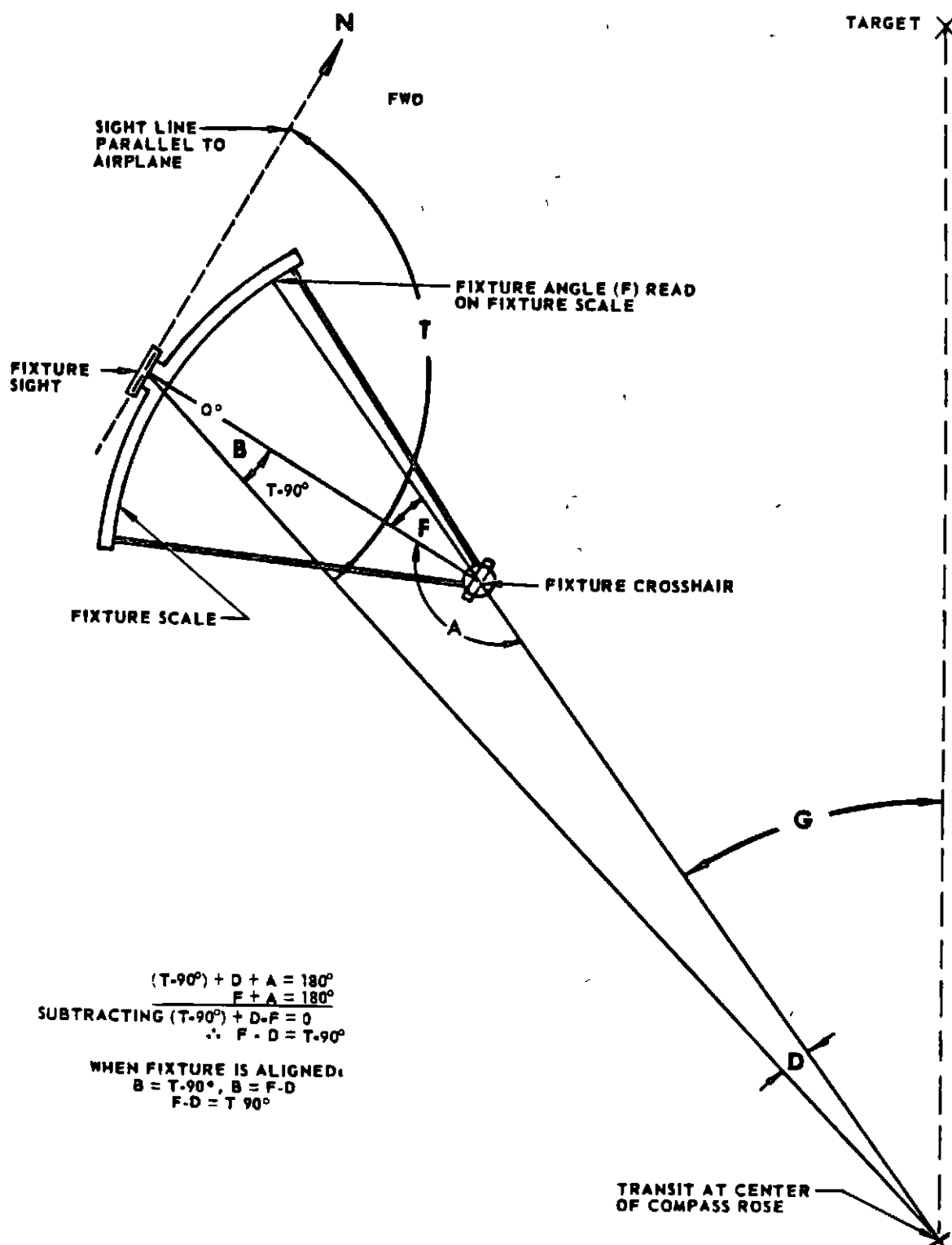
B. Adjust (Index) Flux Gates, and Magnetic Standby Compass.

NOTE. The dual compass system has a flux gate mounted on opposite sides of the body at approximately STA 600. No. 1 Compass Coupler receives its compass information from the LH flux gate and the No. 2 Compass Coupler receives its signals from RH flux gate.

- (1) Check that remote compass transmitters are indexed at zero, and adjust if necessary.

NOTE. Use non-magnetic tools for all adjustments.

- (2) Set all the compensators (cams) on the compass couplers to neutral (See figure 503.)
- (3) Set "RATE COR" dial on compass controllers to zero



Swing Fixture and Transit Arrangement
Figure 502

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- (4) Tow airplane around base positioning airplane within two degrees of magnetic north.
- (5) Read and record compass heading (CH) of each compass indicator, and record magnetic heading (MH) as determined by transit.

NOTE Erratic variations may be caused by movement of vehicles or other airplanes through or near compass swinging base. Allow time for indicator dials to settle before taking readings.

- (6) Calculate and record north heading deviation (Dn) and its sign for each compass system as follows:

$$Dn = (MH)n - (CH)n$$

- (7) Tow airplane to within two degrees at South heading. Repeat above steps at the south compass heading. Calculate south heading deviation (Ds) and calculate and record the single cycle error coefficient "C" as follows:

$$C = \frac{Dn - Ds}{2}$$

- (8) With airplane at south heading, adjust the N-S compensator on magnetic standby compass to a compass heading of (CH)s - C.
- (9) Tow airplane to within two degrees at east then a west heading. Calculate and record (De) and (Dw). Calculate and record single cycle error coefficient "B" as follows.

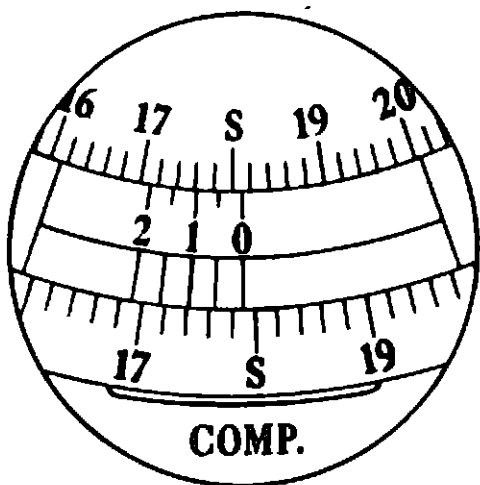
$$B = \frac{De - Dw}{2}$$

- (10) With airplane on west or east heading, adjust E-W compensator on the magnetic standby compass to a heading of (CH)w-B.
- (11) Calculate index error coefficient "A" as follows:

$$A = \frac{Dn + Ds + Dw + De}{4}$$

- (12) Adjust indexing of remote compass transmitter by loosening screws and rotating remote compass transmitter. Rotate remote compass transmitter clockwise if error coefficient is positive, and counterclockwise if error coefficient is negative. Amount of rotation is equal to coefficient "A." Tighten the screws after adjustment.

Compass Coupler Vernier Dials
Figure 503



Uncompensated (upper) dial
reading to left of vernier
zero index

180°

Vernier increment (more than
1° and less than 1½°)

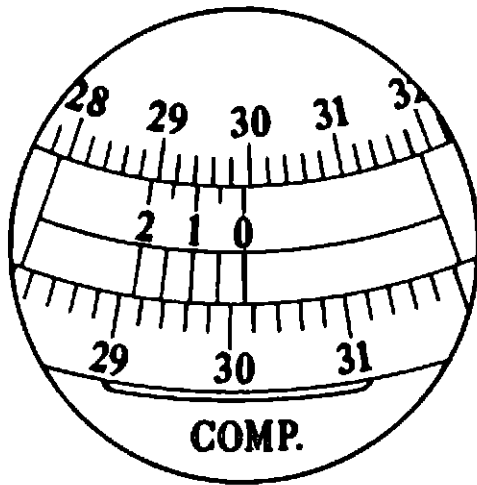
1° to 1½°
181° to 181½°

Compensated dial reading to
left of vernier zero index

178°

Vernier increment (more than
1° and less than 1½°)

1° to 1½°
179° to 179½°



Uncompensated (upper) dial
reading to left of vernier
zero index

298°

Vernier increment (more than
1° and less than 1½°)

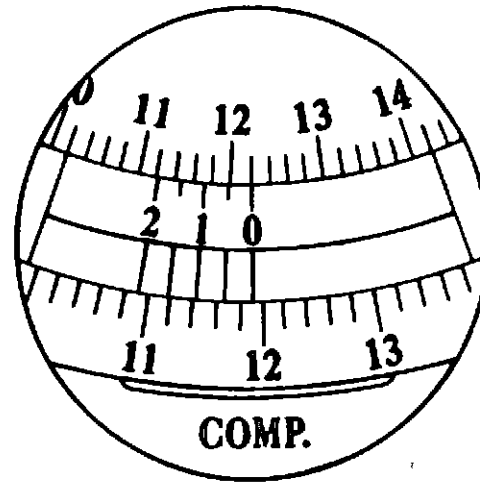
1° to 1½°
299° to 299½°

Compensated dial reading to
left of vernier zero index

300°

Vernier increment (slightly
more than 1° and less than
than 1½°)

1° to 1½°
301° to 301½°



Uncompensated (upper) dial
reading to left of vernier
zero index

122°

Vernier increment (less
than ½°)

0° to ½°
122° to 122½°

Compensated dial reading to
left of vernier zero index

118°

Vernier increment (more than
1° and slightly less than 1½°)

1° to 1½°
119° to 119½°

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NAVIGATION
Compass Swinging
Adjustment/Test

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C. Compensate (Cam) Compass Couplers

- (1) Tow airplane around the compass rose. Complete at least one full swing and position airplane on north magnetic heading within 2 degrees. Set the 0° compensator adjustment on the compass coupler to remove the heading error. Repeat the compensation (camming) for 30° intervals through a complete swing. (See figure 503.)

CAUTION IF ADJACENT COMPENSATING SCREWS ARE ADJUSTED FOR A DIFFERENCE GREATER THAN 2 DEGREES, THE COMPASS COUPLER MAY BE DAMAGED.

NOTE: If a compass coupler has been compensated (cammed) to a particular remote compass transmitter, then it may be replaced by another coupler, if the adjustment readings on the faulty coupler's dial are transferred to the replacement coupler's dial.

5. Prepare Compass Correction Cards

- A. Make a 24-point residual swing positioning the airplane on each 15° heading and calculate the residual deviation. The residual deviation shall not exceed 10° for the standby compass or 3° for each individual RMI and CDI on their respective compass system. If deviations are in excess, the compass systems shall be compensated again.
- B. On compass correction card fill in columns under "Compensating Swing" and "Residual Swing" with necessary data.
- C. Record the 24-point residual swing of the compass heading listed under "To Fly" column on correction card. Read and record on work sheet actual headings (MH) and compass headings (CH).
- D. Calculate heading to be recorded in "Steer" column as follows:

"Steer" heading = "To Fly" heading + Compass heading - actual heading.

NOTE. Headings recorded in "Steer" column should be to closest one-half degree for the Bendix Polar Path compass systems, and to the closest one (1) degree for the Standby compass.

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6. Recheck Fixture and Transit

- A. Recheck transit alignment.
- B. Recheck fixture alignment.
- C. If transit and fixture do not check within limits, swing procedure must be repeated.

7 Close Up

- A. Check the landing gear lever for down (DN) position. If it is not, move it to this position. After this, restore the landing gear lever latch solenoid circuit to its normal condition.
- B. Check all access panels properly secured.
- C. Disconnect external power.
- D. Remove and stow target fixture and target mark.
- E. Install placard BAC27CEQ205 (BAC27DCG707 optional) "RADIO RECEIVERS ON" on the standby compass correction card mounting bracket.

Ref : SB 3081



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DEMAGNETIZATION OF AIRPLANE STRUCTURE - MAINTENANCE PRACTICES

1. General

- A. Demagnetization of certain parts of the airplane may be necessary after it has been exposed to heavy static or has been struck by lightning. Evidence of magnetization may show up in the magnetic standby compass, in the gyro compass system, or in both, in the form of excessive errors in the compass readouts. When necessary, a handheld compass, such as the standby compass, may be used to detect the presence of any unduly large magnetic fields in the airplane structure.
- B. If such magnetic fields are found, it will be necessary to demagnetize the area in the immediate vicinity using a degausser. Suitable degaussers are;
 - (1) Ideal Industries Degausser. Model 13-001 (60 cps 115 volt)
 - (2) Ideal Industries Degausser. Model 13-1000 (400 cps 155 volt)

2. Precautions

- A. Do not permit the degausser to remain within 10 feet of any part of the airplane UNLESS IT IS ENERGIZED.
- B. DO NOT operate the degausser in the vicinity of the magnetic compass or remote compass transmitter (flux gate or flux valve).
- C. Care should be taken to ensure that the degausser is not actually in contact with the surface when it is used. (To be effective, it should however, be used as close to the surface as possible.)

3. Demagnetization of Windshield and Control Cabin Structure Area

- a. remove the magnetic compass from its mount and place it carefully in a safe place.
- B. Energize the degausser at a distance of at least 10 feet away from the airplane, and move it in slowly towards the area to be demagnetized.
- C. When the degausser is almost touching the surface, move it in a series of parallel strokes over the entire area from the top of the windshield, aft for a distance of 36 inches and bounded on each side by the tops of the left and right sliding windshields.
- D. Demagnetize all windshield bolts, and the steel strip along the bottom of the windshield.



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- E. Check for any magnetized areas inside the control cabin wall with a small compass (some parts of the metallic framework are made of steel). Degauss areas as necessary.

CAUTION: REMOVE REMOTE COMPASS TRANSMITTER BEFORE DEGAUSSING IN THE CONTROL CABIN FOR THOSE AIRPLANES WITH THE TRANSMITTER INSTALLED IN THE UPPER CENTER BODY SECTION TO PREVENT CHANGING MAGNETIC CHARACTERISTICS OF THE TRANSMITTER.

- F. Withdraw the degausser to a point at least 10 feet from the structure before switching OFF.
- G. Check the windshield area and control cabin walls from inside the control cabin with a magnetic compass. If evidence of magnetization still exists, repeat the degaussing process as described above.
- H. When area is satisfactorily demagnetized, reinstall standby magnetic compass, and/or remove compass transmitters.

4. Demagnetization of the Nose Gear Strut Assembly

- A. Energize the degausser at a distance of at least 10 feet away from the airplane, and move it in slowly from the side of the airplane towards the nose gear strut assembly.
- B. When the degausser is almost touching the surface of the strut, move it up and down in parallel strokes, while gradually working around it, and over its entire length. Include the steering cylinders and supporting braces.
- C. Withdraw the degausser to approximately 1 inch from the strut and repeat the process, working around the strut in the opposite direction.
- D. Withdraw the degausser to a point at least 10 feet from the airplane and switch OFF.
- E. Check the strut for residual magnetism with a magnetic compass. There should be no compass deflection when it is held 3 feet from the strut and moved about in this vicinity.
- F. Repeat the degaussing process until area is satisfactorily demagnetized.

NOTE: The following additional check should be made where practical:

Jack up the nose of the airplane, and check the airplane magnetic compass for deviation when the nose gear is retracted. There should be none. Lower the gear and remove jack when strut is found to be properly demagnetized.



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5. Demagnetization of Remote Compass Transmitter Area

- A. Remove the transmitter and compensator (if installed) from its mounting, and place it carefully in a safe place. Refer to Remote Compass Transmitter - Removal/Installation.
- B. Energize the degausser at a distance of at least 10 feet away from the airplane and move it towards the appropriate transmitter area in the wing, or body center section.
- C. Demagnetize all steel bolts and screws in the area.
- D. Withdraw the degausser to a point at least 10 feet from the airplane and switch OFF.
- E. Check area for residual magnetism with handheld magnetic compass and repeat step C as necessary.
- F. Repeat steps A through E for the other transmitter area.

NOTE If the transmitter is not reinstalled exactly in its original index position it will be necessary to swing the compass to verify the accuracy of the system.

- G Perform operational check of compass system. Refer to Compass Swinging or Compass System - Adjustment/Test, whichever is applicable.

RADIO MAGNETIC INDICATION SYSTEM
DESCRIPTION AND OPERATION

1 General

Two RMIs (figure 1) are installed, one each at the pilot's stations

2 Radio Magnetic Indicator

The explanation of the instrument shown in figure 1 is shown in the table below

NO	CONTROL/INDICATOR	FUNCTION
4	OFF Flag	In view in case of compass power failure, error in DG repetition, or during fast rotation of SET HDG knob Very sensitive to voltage and frequency
5	Compass Card	Repetition of other pilot's directional gyro with/without flux valve signal correction depending on mode (MAG or DG) of system operation
6	Synchronization Indicator (for other pilot's compass system)	Indicates direction of gyro slaving signal Pointer is displaced to + or When gyro is not synchronized Pointer at mark midway between + and indicates gyro is synchronized Indicator is inoperative in DG mode
7	SET HDG Knob (for other pilot's compass system)	When pushed and turned, the RMI and other pilot's HSI compass card will turn Used for fast compass synchronization in MAG mode and for compass setting to any desired reference heading in DG mode
		CAUTION During compass synchronization, check against other magnetic heading reference to avoid 180° error



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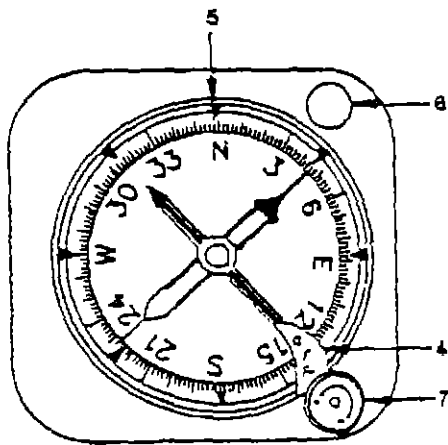
3 Operation

TACAN bearing is supplied to the pilot and copilot RMI bearing pointer number two if the NAV MODE selectors are set to VOR/LOC or INS - in case of single INS installation only if the other pilot's NAV MODE selector has not been set to INS already. The number one needle on the pilot and copilot respective RMIs receive TACAN bearing if the NAV MODE selectors are set to VOR/LOC or INS - in case of single INS installation only if the other pilot's NAV MODE selector has not been set to INS already - and the RMI mode selectors are set to TACAN/VOR. Both the pilot and copilot can select ADF for display on their respective RMIs, number one bearing pointer by setting their RMI mode selectors to ADF.

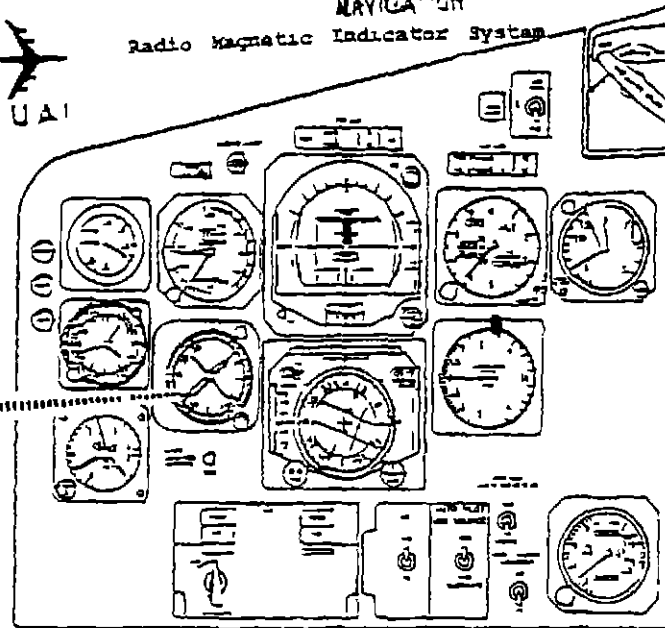
Each pilot's RMI receives heading information from the other pilot's compass system. The RMI is denominated "master" indicator which means that the RMI heading data are always a repetition of the directional gyro information. With MAG/DG switch of (other pilot's) compass controller set to "DG" this information is unslaved. With MAG/DG switch of (other pilot's) compass controller on "MAG" this information is slaved to (other pilot's) flux valve signals provided "+/o" not in view.

The SET HDG knob allows fast compass synchronization and setting the compass card to any desired reference heading. An OFF flag appears in case of compass power failure or error in directional gyro repetition.

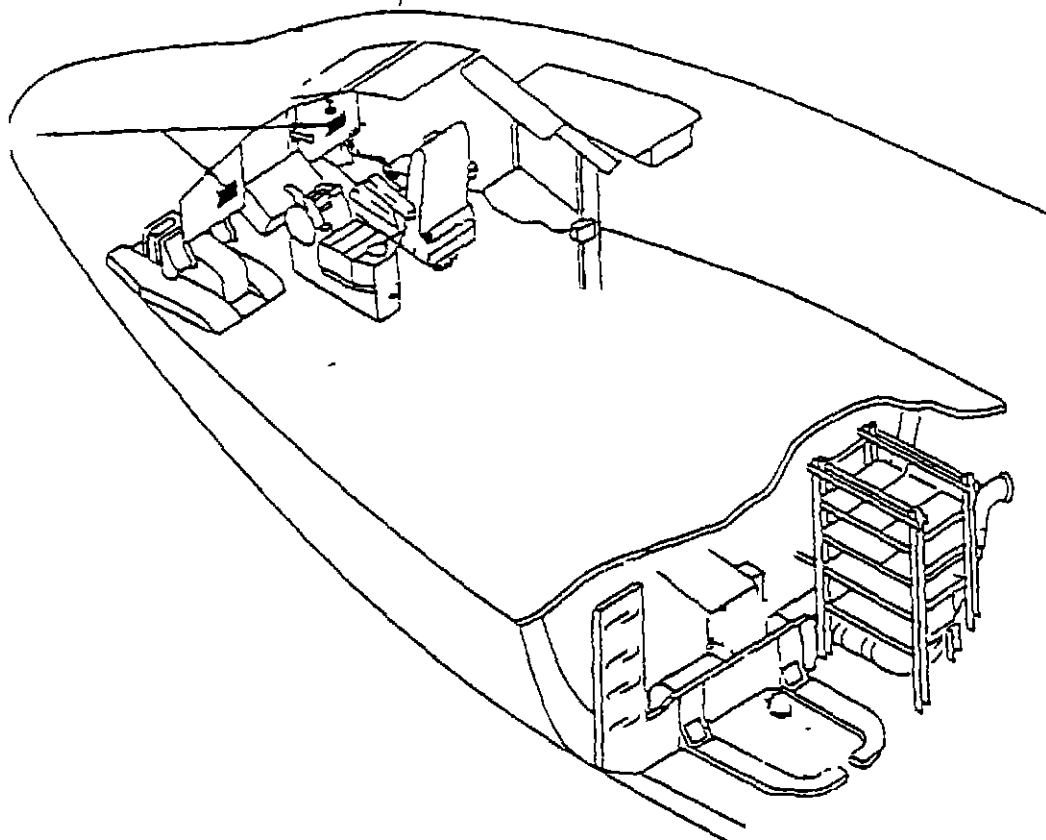
The RMI annunciators illuminate when a valid TACAN or VOR signal is present and selected. If TACAN or VOR signal is selected and the appropriate annunciator fails to illuminate, the signal is not being received. This indicates a possible failure of the selected radio.



DETAIL A



SEE DETAIL A



Radio Magnetic Indicator System Component Location
 Figure 1



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STANDBY ARTIFICIAL HORIZON SYSTEM - DESCRIPTION AND OPERATION

EFFECTIVITY

00-SJJ and on

1. General

- A. The standby artificial horizon indicator is fitted to the airplane as a back-up system for the vertical gyro reference system. It functions as a completely independent system which provides its own visual indication of airplane attitude in pitch and roll at all times during flight.
- B. The system consists of the standby artificial horizon indicator and a phase adapter unit.
- C. The power supply for the system is provided from the STDBY HORIZON circuit breaker, situated on the P5 CB panel.

2. Standby Artificial Horizon Indicator

- A. The standby artificial horizon indicator contains an electrically driven gyro and the necessary mechanism for its erection, plus a power failure motor which operates the flag. The gyro has 360° freedom of movement in roll, and $\pm 80^\circ$ to 85° in pitch.
- B. The face of the instrument is shown in figure 1. The power failure flag will show in the event of power failure or incorrect phase rotation.

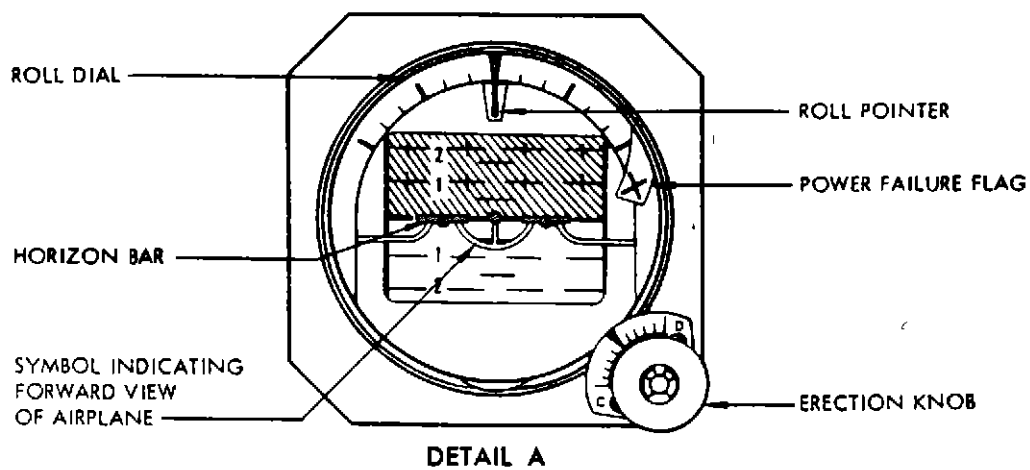
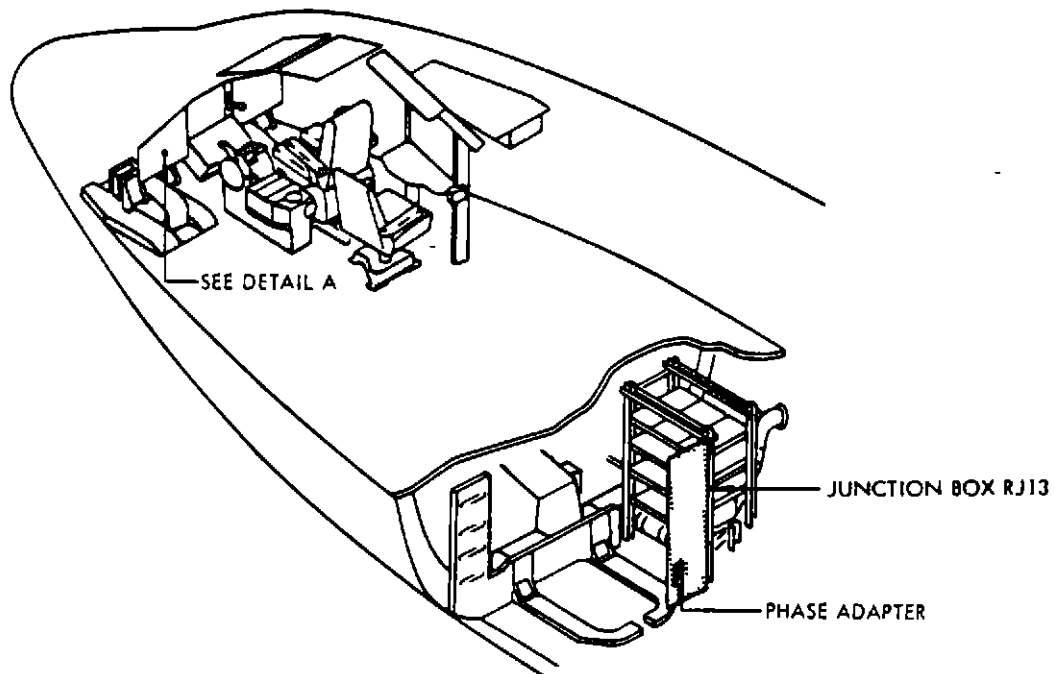
3. Phase Adapter

- A. The phase adapter contains the phase splitting network which provides the 3 phase ac power for the gyro motor. Input to the phase adapter is single phase 115 volts ac power.

4. Operation

- A. The gyro warning flag should disappear from view when power is applied and the gyro should reach operational speed within 60 seconds. The normal rate of erection is 2.75° per minute but a rapid erection device is fitted to bring about erection within a few seconds. The mechanism for rapid erection is actuated by pulling gently on the knob which is fitted to the front panel of the instrument. This operation should only be attempted when the airplane is in straight and level flight. When at rest the knob may be used to adjust the horizon line to zero pitch by turning the knob clockwise or counterclockwise. The gyro takes approximately 13 minutes to come to rest after power has been switched off.

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Standby Artificial Horizon System Component Location
 Figure 1

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ALTITUDE ALERT SYSTEM - DESCRIPTION AND OPERATION

1. The altitude alert system alarms the crew if the airplane altitude, which is measured by one of the Air Data Display Units, is approaching or diverging from a preselected altitude. The warning is indicated by an aural warning via a Sonalert installed in the center instrument panel P9 and an alarm light on the altitude alert system control panel and on the ADDUs (see fig. 1, 2).

There are two operational modes: Altitude Alert Mode and Minimum Descend Alert (MDA) Mode. When MDA is engaged "MDA" is shown in the Altitude Alert Display. If "MDA" indication is not visible, then Altitude Alert Mode is active.

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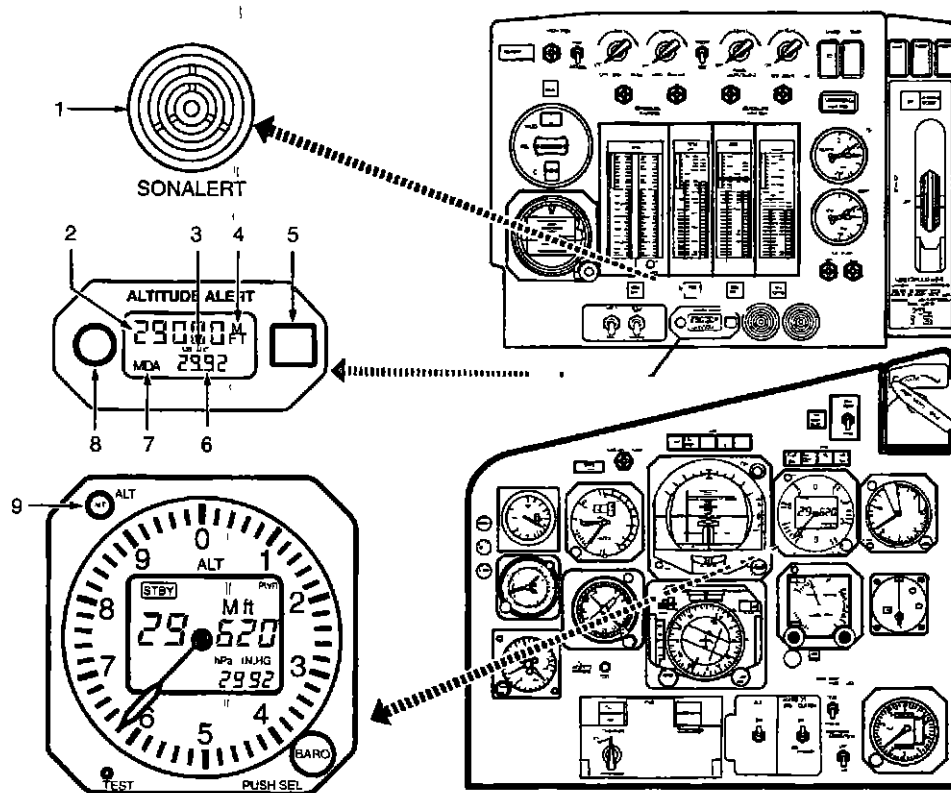
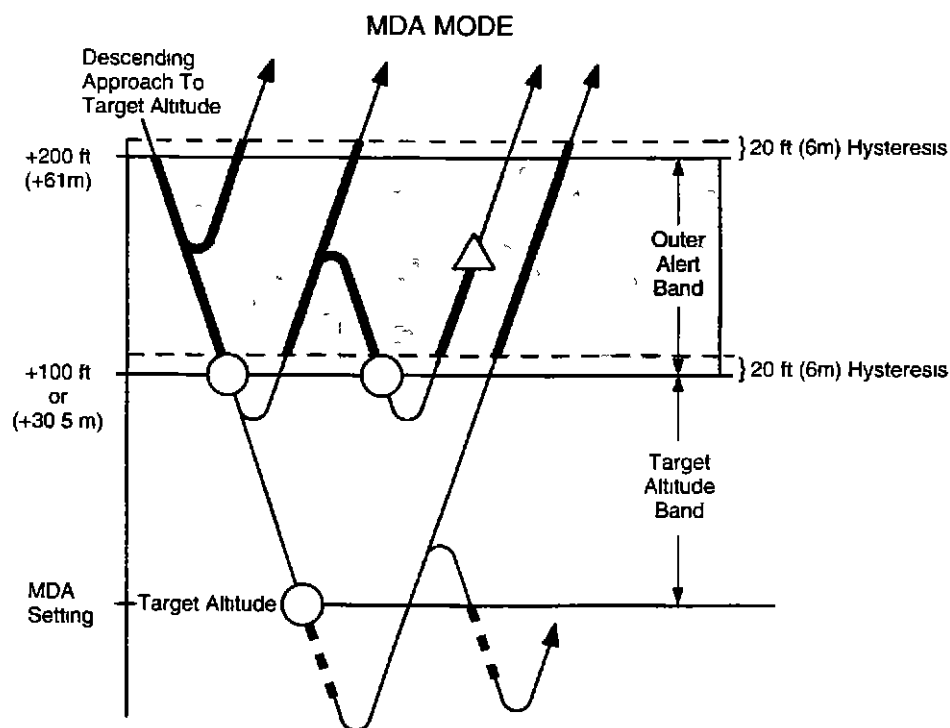
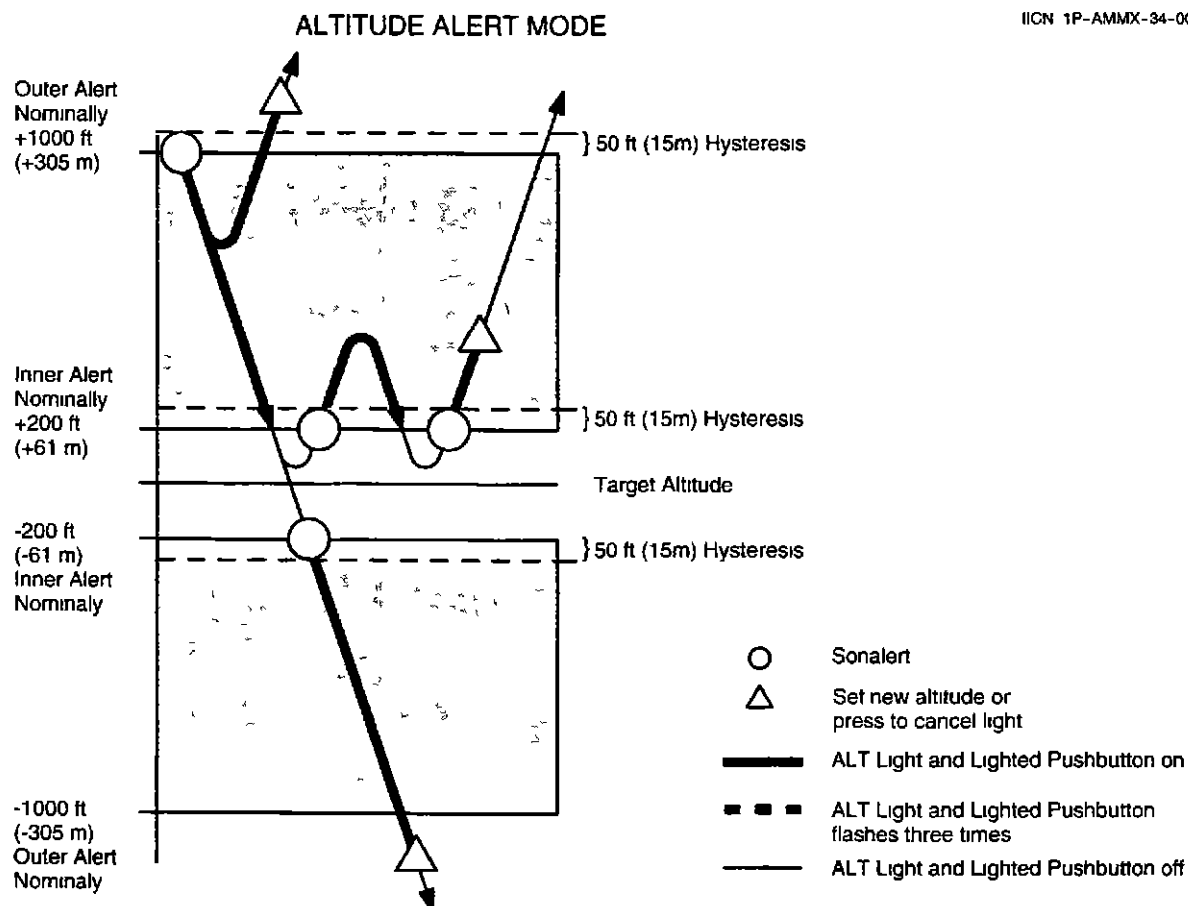


Fig 1

NO	CONTROL/INDICATOR	FUNCTION
1	Sonalert	See Fig 1 for function
2	Target Altitude Indicator	Indicates preselected altitude
3	Barometric Scale Indicator	Shows barometric pressure manually set via the Rotary Knob and Switch
4	Altitude Scale Indicator	Shows altitude scale units in M or FT as selected via the Rotary Knob and Switch

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5	Lighted Pushbutton	Provides visual alerting for Altitude/MDA alerts
	With visual alert present	Short press cancels alert
	With no alert present	- Press for lamp test of Lighted Pushbutton - Press shortly (< 1sec) toggles between MDA and Altitude Alert Mode - Press and hold knob pressed during power-up (or press for 5±1 sec once operation is established) to release an audio alert and then initiate unit display test - The digits "1" through "9" will be shown in sequence for 1 sec. Operation will return to normal after the display of all 9's unless the pushbutton is pressed and held, which initiates the configuration mode. Press Lighted Pushbutton to confirm selected operation - If pressed for more than 25 ±5sec , BIT function assumes a failed switch and operation reverts to Altitude Alerting mode
6	Barometric Pressure Indicator	Shows barometric pressure as selected via the Rotary Knob and Switch
7	MDA (Minimum Descent Altitude)	If MDA is indicated, MDA Mode is selected. If MDA is not visible, Altitude Alert Mode is active. Press Lighted Pushbutton to toggle between the two modes.
8	Rotary Knob and Switch Target Altitude Setting Baro Setting Barometric/Altitude scale Unit Setting	Provides following functions Without pressing turn knob to set desired altitude Press knob for less than 3 sec to adjust Barometric Pressure Indicator. Press knob again to avoid that after 5 sec. alerter operation resumes Press and hold knob pressed for ≥3 sec toggles units in intervals of 3 sec as follows FT IN HG, FT MB, M MB, FT IN HG Release knob at the desired setting. Pressing knob for more than 2 complete cycles (≥18 sec) causes unit to assume a defective setting knob and switches automatically to FT IN HG as default setting. Current baro setting remains unchanged
9	ALT Alert Light	Duplicates function of Altitude Alerter Lighted Pushbutton



Altitude Alert / MDA Mode Profile

Fig 2

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ALTITUDE ALERT SYSTEM - DESCRIPTION AND OPERATION

- 1 The altitude alert system alarms the crew if the airplane altitude, which is measured by a KIFIS corrected altimeter, is approaching or diverging from a preselected altitude. The warning is indicated by two alert lights located on both pilots instruments panels, by an alarm light on the control panel, and by a aural horn signal of 1 1/2 second duration. (See Fig 1, 2 and 3)

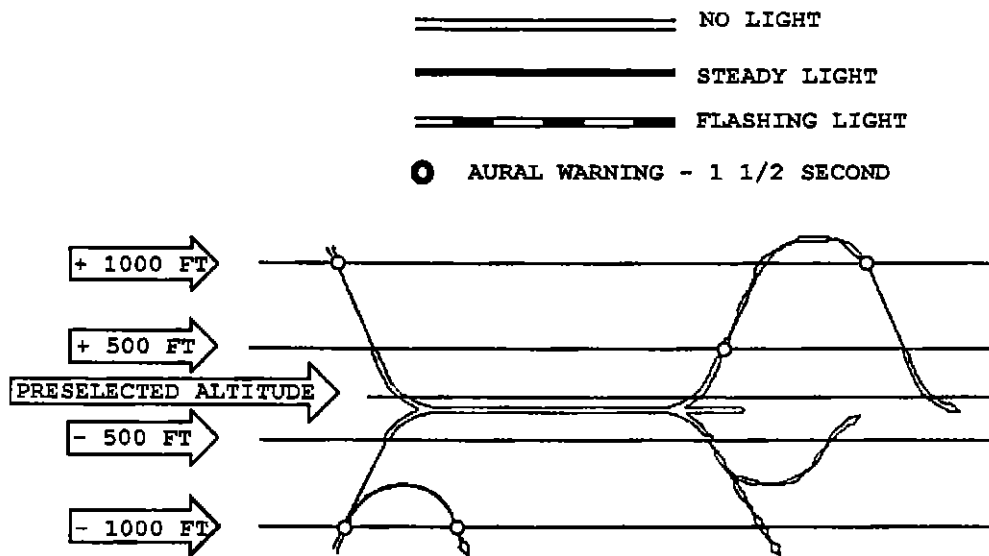


FIGURE 1

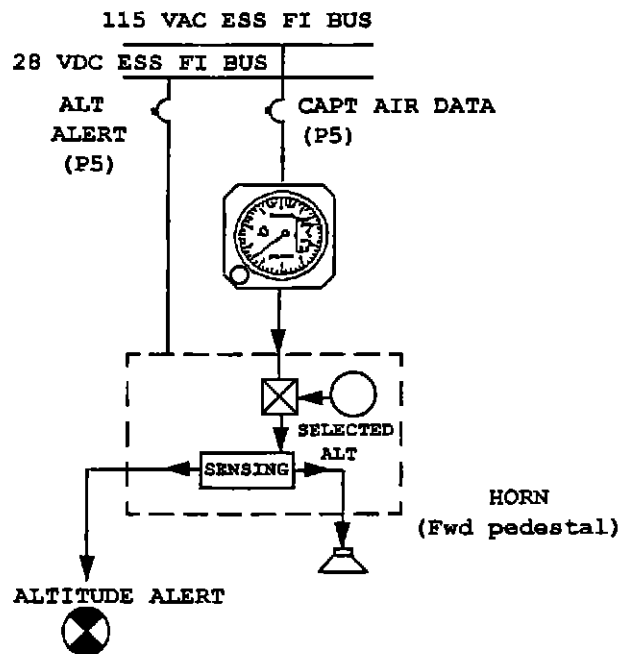
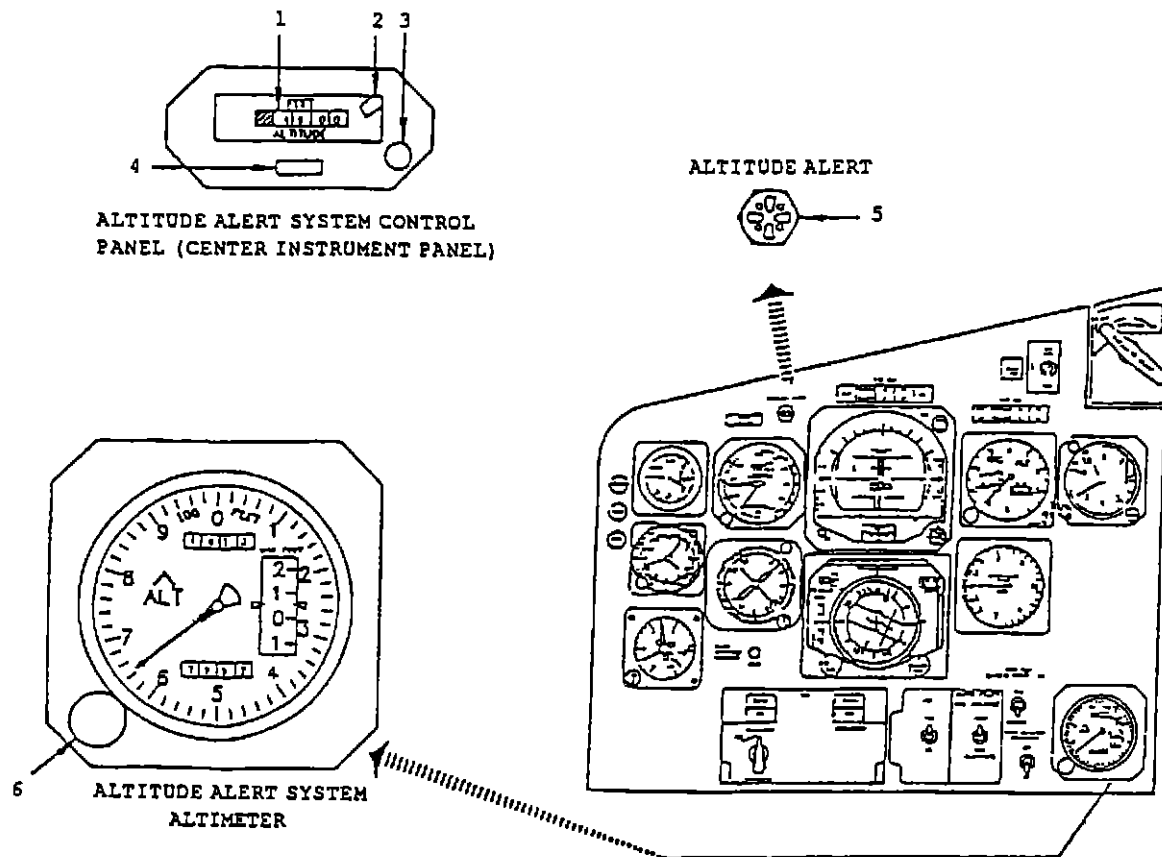


Figure 2

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NO.	CONTROL/INDICATOR	FUNCTION
1	PRESELECTED ALTITUDE INDICATOR	INDICATES PRESELECTED ALTITUDE IN HUNDREDS OF FEET
2	WARNING FLAG	APPEARS IN CASE OF AC POWER LOSS, DEFECTIVE ALTITUDE SIGNAL, OR IF THE ALTITUDE SELECTOR HAS BEEN PUSHED
3	ALTITUDE SELECTOR	ALLOWS SETTING OR PRESELECTED ALTITUDE DURING KNOB ROTATION ALERT CIRCUIT IS DEACTIVATED WHEN PUSHED, ALERT CIRCUIT REMAINS ACTIVATED DURING KNOB ROTATION
4	ALARM LIGHT	RESETS AUTOMATICALLY BECOMES STEADY IF PUSHED IN FLASHING CONDITION.
5	ALTITUDE ALERT LIGHT	DUPLICATES FUNCTION OF CONTROL PANEL ALARM LIGHT (4)
6	BAROMETRIC CORRECTION KNOB	MUST BE USED TO SET BAROMETRIC PRESSURE ACCORDING TO COUNTER-DRUM-POINTER ALTIMETERS SETTING



MAINTENANCE MANUAL

ALTITUDE ALERTING SYSTEM - TROUBLE SHOOTING

1. GENERAL.

- A. Trouble shooting the altitude alerting system is best accomplished by performing the system test (Ref MM 34-17-0). Satisfactory completion of the system test procedure indicates that the system is operating properly. When satisfactory operation is not obtained, the tabulated data below should be consulted. If using the tabulated data fails to correct the trouble, airplane wiring should be suspect and repaired or replaced as necessary.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
System completely inoperative	Circuit breaker No power available to Altitude Alerter	Check that ALT ALERT circuit breaker on P7 panel is closed Check 26 V AC is available between Pin U (hot) and Pin W (cold) at plug If power is available If power is not available	Close circuit breaker Replace Altitude Alerter Troubelshoot wiring
Display shows "OFF"	28 V DC annunciator lamp power is below 1 V Invalid ARINC 429 signal	Check that ALT ALERT circuit breaker on P5 panel is closed Check 28 V DC is available on Pin P* at plug If power is available If power is not available Set ADC Source Select Switch to other ADC If display operates normal If display still shows "OFF" Check wiring for ARINC 429 signal between ADC/Ledex Relais/Altitude Alerter	Close circuit breaker Replace Altitude Alerter Troubelshoot wiring Check Altitude Alerter display Replace faulty ADDU Troubelshoot wiring
Display is blank	Hardware failure detected		Replace Altitude Alerter
Alert signals do not reset	Controller reset circuit faulty		Replace controller

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
Lighted Pushbutton lamp does not operate	Lamp faulty	Press Lighted Pushbutton for lamp test. If lamp remains off, but aural alert sounds, controller is faulty. If lamp lights up and aural alert sounds, controller is faulty. If lamp remains off, and no aural alert sounds, controller is faulty.	Replace controller Replace controller Replace controller
Aural alert does not operate	Sonalert defective	Press Lighted Pushbutton for lamp test. If aural alert remains off, check for 28 V DC on contacts of Sonalert. If power is available, Sonalert is faulty. If power is not available, wiring or altitude alerter is faulty.	Replace Sonalert Refer to wiring diagram and check audio alert signal out of altitude alerter

MAINTENANCE MANUAL

ALTITUDE ALERTING SYSTEM - TROUBLE SHOOTING

1 General

A Trouble shooting the altitude alerting system is best accomplished by performing the system test (Ref 34-17-0, Adjustment/Test) Satisfactory completion of the system test procedure indicates that the system is operating properly When satisfactory operation is not obtained, the tabulated data below should be consulted If using the tabulated data fails to correct the trouble, airplane wiring should be suspect and repaired or replaced as necessary

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
System completely inoperative	Circuit breaker	Check that system circuit breakers are closed	Close circuit breaker(s)
	No power available to controller	Check 26V AC is available at plug connected to controller If power is available, controller is faulty	Replace controller
		If power not available, airplane wiring at fault	Refer to wiring diagram
Altitude alert flag in view	Loss of 28V DC validity signal input	Check that 28V DC available at pins 20 (high) and 8 (low) of plug connected to controller	Refer to wiring diagram 23-6-1 Breaker Alt Alert on P5 panel
	Loss of 26V AC to controller	Check that 26V AC power available at plug connected to controller If not	Close circuit breaker Replace Kifis control unit

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	REMEDY
Altitude alert flag in view (Cont)	Loss of controller input or output synchro signals	Check proper operation of Air Data Input If Air Data Input operates properly	Refer to 34-12-0, Air Data Pressure Instruments Replace controller
Improper alerting signal	Air Data Input defective or out of calculation	Check proper operation of Captain's altimeter If above procedures OK If not	Replace controller Replace Captain's altimeter
Alert signals do not reset	Controller reset circuit faulty		Replace controller
Visual alert signals do not operate	Defective light bulb or Controller output circuit faulty		Replace defective light bulb Replace controller
Aural alert does not operate	Defective loud speaker or Defective controller		Replace loud speaker Replace controller



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ALTITUDE ALERTING SYSTEM -ADJUSTMENT/TEST

1. Altitude Alerting System Test

A. Equipment and Materials

- (1) Air pressure and vacuum source, 5 to 40 inches of mercury absolute, and gage for measuring differential pressure, accurate within ± 0.015 inch of mercury.
Range should be at least 10 inches of mercury.
- (2) Air pressure and vacuum source, 5 to 30 inches of mercury absolute.
- (3) Pressure gage accurate to within ± 0.03 inch of mercury.
- (4) Appropriate gage saver restrictors.
- (5) Adequate length of hose to couple pressure source with pitot tubes and vacuum source with static ports or drains.

B. Prepare to Test Altitude Alerting System

- (1) To prevent damage to equipment and instruments, check following precautions before applying pressures to pitot static system.
 - (a) Apply or release vacuum or pressure at rate of climb or descent less than 3000 feet per minute for static system and 300 knots per minute for pitot system between test points. (Appropriate gauge saver restrictors should be used).
At each test point, pressure should be reduced slowly to desired level without overshoot
 - (b) Pressure in pitot lines should always be greater than or equal to pressure in static lines. Differential pressure should never exceed 10.00 inches of mercury or fall below zero.
 - (c) Absolute pressure applied to static system should never exceed ambient absolute pressure when any instrument is connected to static system
 - (d) Switch off autopilot electrical power.



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- (e) Do not change setting of Static Source Selector Valve while vacuum is on static system. Check that Selector Valve remains in NORMAL position unless test procedures specify otherwise.
- (f) Check that pitot static probe heaters remain off during tests.
- (g) Inspect each pitot static probe head both before and after these tests for evidence of damage to circular leading edge of its barrel.
- (h) Do not apply pressure in excess of 31 inches of mercury absolute to static lines.

CAUTION IF THE ABOVE PROCEDURES ARE NOT OBSERVED, EQUIPMENT AND INSTRUMENTS WILL BE DAMAGED

- (2) Connect static source to Captain's (F/O's) static source.
- (3) Provide electrical power.

C. Test Altitude Alerting System

WARNING ENSURE STR 2000-A1 IS SWITCHED OFF FOR THE FOLLOWING TEST PROCEDURE TO AVOID UNINTENDED TRANSMITTING AND THUS UNWANTED INFLUENCE TO AIR TRAFFIC

- (1) Ensure following circuit breakers are engaged: ALT ALERT and COCKPIT LIGHTS FWD CTR Panel on circuit breaker panel P7, ALT ALERT and ADC 1 (ADC 2) on circuit breaker panel P5. Ensure ADC 2 (ADC 1) circuit breaker on circuit breaker panel P5 is pulled open.
- (2) Shut down indication and lighting test
 - (a) Check display of Altitude Alerter for indication to verify it is on.
 - (b) Pull circuit breaker ALT ALERT on P7.
 - (c) Check display of Altitude Alerter for indication to verify it is off and shows a blank screen.
 - (d) Pull circuit breaker ALT ALERT on panel P5.
 - (e) Check display of Altitude Alerter for indication to verify it is completely off and shows no indication or function.
 - (f) Press circuit breaker ALT ALERT on P5 and P7.
 - (g) Check display of Altitude Alerter for indication to verify it is on.

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- (h) Adjust Cockpit Instrument Lighting Dimmer in FWD center panel from min. to max.. The altitude alerter instrument lighting must illuminate from low to bright, according to Dimmer position.
- (i) Adjust Cockpit Instrument Lighting Dimmer in FWD center panel to full OFF. The altitude alerter high intensity lighting must come on.
- (3) Self Test
 - (a) Ensure Altitude Alerter is in altitude alert mode (MDA flag not visible).
 - (b) Press and hold pressed Lighted Pushbutton for 5+1 sec. to release an audio alert and unit display test. The unit display test must show following sequential indication:

Upper Counter	Lower Counter	Flag	Sonalert
11110	1111	FT	X
22220	2222	R	X
33330	3333	MDA	-
44440	444	-	-
55550	555	M	-
66660	666	-	-
77770	777	-	-
88880	888	MB	-
99990	9.99	IN.HG	-

Operation returns to normal after this sequence.

- (4) Altitude/Barometric Selector Test
 - (a) Press Rotary Knob for less than 3 sec. Turn Rotary Knob to set barometric scale setting on the Altitude Alerter to 29.92 in.HG (or 1013 MB).
 - (b) Press Rotary Knob again to return to altitude mode.

(5) Altitude Test

NOTE: In every of the following steps where the Lighted Pushbutton lights up, on both ADDUS the ALT Lamp shall illuminate too.

- (a) Pull circuit breaker ADC 2 (or ADC 1) on panel P5.
- (b) Set barometric scale setting on the captain's (or F/O's) ADDU to 29.92 in.HG (or 1013 millibars).



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- (c) Set barometric scale setting on the altitude alerter to 29,92 in.HG (or 1013 millibars).
- (d) Set Air Data Source Select switch to ADC 1 (or ADC 2).
- (e) Set Altitude Alerter to altitude alert mode (MDA flag not visible)
- (f) Set alert altitude on Altitude Alerter Rotary Knob to 12000 ft.
- (g) Apply a pressure equivalent to 12000 ft to captain's (or F/O's) static system.
- (h) Slowly (500 ft/min) decrease pressure to approach 12000 ft. Check for following switching points:
 - 11000 ft, short aural warning and Lighted Pushbutton illuminates.
 - 11800 ft (± 50 ft), illuminated Lighted Pushbutton extinguishes.
- (i) When 12000 ft are reached, wait until Testset has stabilized.
- (j) Slowly (500 ft/min) increase pressure to approach 11800 ft (± 50 ft) The Lighted Pushbutton shall illuminate.
- (k) Slowly (500 ft/min) decrease pressure to approach 12000 ft (± 50 ft). The illuminated Lighted Pushbutton shall extinguish
- (l) When 12000 ft are reached, wait until Testset has stabilized.
- (m) Slowly (500 ft/min) decrease pressure to approach 12200 ft (± 50 ft). The Lighted Pushbutton shall illuminate and short aural warning sounds.
- (n) Press the Lighted Pushbutton to quit warning. The illuminated Lighted Pushbutton shall extinguish.

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- (o) Slowly (500 ft/min) decrease pressure to approach 12000 ft. Repeat steps (e) to (n) with following altitude levels 21000 ft, 31000 ft and 41000 ft target altitude and note results.

Altitude Test	ADDU 1		ADDU 2	
Simulated Altitude	Test Result		Test Result	
	Alerter	ADDU ALT Lamp	Alerter	ADDU ALT Lamp
12000 ft				
21000 ft				
31000 ft				
41000 ft				

(6) Minimum Descent Altitude (MDA)

The purpose of this test is to verify that the Altitude Alerter provides the required alarm when the altitude approaches the preselected minimum descent altitude.

- (a) Pull circuit breaker ADC 2 (or ADC 1) on panel P5.
- (b) Set barometric scale setting on the captain's (or F/O's) ADDU to 29,92 in.HG (or 1013 millibars).
- (c) Set barometric scale setting on the altitude alerter to 29,92 in.HG (or 1013 millibars).
- (d) Set Air Data Source Select Switch to ADC 1 (or ADC 2).
- (e) Set Altitude Alerter to MDA mode (MDA flag visible).
- (f) Decrease pressure (max. 3000 ft/min) to approach 20000 ft.
- (g) Set alert altitude on Altitude Alerter Rotary Knob to 9000 ft.
- (h) Slowly (max. 500 ft/min) decrease altitude on Testset to 6000 ft.
 - When reaching 9200 ft (+20 ft Hysteresis) the Lighted Pushbutton illuminates.
 - When reaching 9100 ft (+20 ft Hysteresis) the Lighted Pushbutton extinguishes, but aural warning sounds.
 - When reaching 9000 ft and below, the Lighted Pushbutton flashes ON/OFF three times, the aural warning remains on.
- (i) Set alert altitude on Altitude Alerter Rotary Knob to 3000 ft

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(J) Slowly (max. 500 ft/min) decrease altitude on Testset to ambient.

- When reaching 3200 ft (+20 ft Hysteresis) the Lighted Pushbutton illuminates.
- When reaching 3100 ft (+20 ft Hysteresis) the Lighted Pushbutton extinguishes, but aural warning sounds.
- When reaching 3000 ft and below, the Lighted Pushbutton flashes ON/OFF three times, the aural warning remains on.

MDA Test	ADDU 1	ADDU 2
Simulated Altitude	Alerter Test Result	Alerter Test Result
9000 ft		
3000 ft		

D. Restore Air Data and Pitot Static Systems to NORMAL.

- (1) Slowly decrease pitot static pressure to ambient.
- (2) Disconnect pitot and static test equipment and remove all seals on static ports.
- (3) If no longer required, remove electrical power.

ALTITUDE ALERTING SYSTEM - ADJUSTMENT/TEST

1 Altitude Alerting System Test

A Equipment and Materials

- (1) Air pressure and vacuum source, 5 to 40 inches of mercury absolute, and gage for measuring differential pressure, accurate within ± 0.015 inch of mercury
Range should be at least 10 inches of mercury
- (2) Air pressure and vacuum source, 5 to 30 inches of mercury absolute
- (3) Pressure gage accurate to within ± 0.03 inch of mercury
- (4) Appropriate gage saver restrictors
- (5) Adequate lengths of hose to couple pressure source with pitot tubes and vacuum source with static ports or drains

B Prepare to Test Altitude Alerting System

- (1) To prevent damage to equipment and instruments, check following precautions before applying pressures to pitot static system
 - (a) Apply or release vacuum or pressure at rate of climb or descent less than 3000 feet per minute for static system and 300 knots per minute for pitot system between test points
(Appropriate gauge saver restrictors should be used)
At each test point, pressure should be reduced slowly to desired level without overshoot
 - (b) Pressure in pitot lines should always be greater than or equal to pressure in static lines. Differential pressure should never exceed 10.00 inches of mercury or fall below zero
 - (c) Absolute pressure applied to static system should never exceed ambient absolute pressure when any instrument is connected to static system

- (d) Do not change setting of static source selector valve while vacuum is on static system. Check that selector valve remains in NORMAL position unless test procedures specify otherwise.
- (e) Check that pitot static probe heaters remain off during tests.
- (f) Inspect each pitot static probe head both before and after these tests for evidence of damage to circular leading edge of its barrel.
- (g) Do not apply pressure in excess of 31 inches of mercury absolute to static lines.

**CAUTION IF THE ABOVE PROCEDURES ARE NOT OBSERVED,
EQUIPMENT AND INSTRUMENTS WILL BE DAMAGED**

- (2) Connect static source to Captain's static source.
- (3) Provide electrical power.

C Test Altitude Alerting System

- (1) Open the following circuit breakers on panel P5:
 - (a) ALT ALERT 28V DC
 - (b) Kifis control unit (FO's Air Data) 115V AC
- (2) Check that altitude select control warning flag is in view.
- (3) Set barometric scale setting on the captain's altimeter to 29.92 inches of mercury (or 1013 millibars), and altitude select control to 1013 mb.
- (4) Close circuit breakers opened in step (1). Check that failure warning flag in altitude select control is not in view.
- (5) Set altitude select control to 10,000 feet.
- (6) Apply a pressure equivalent to 8,000 feet to captain's static system.
- (7) Slowly decrease pressure to approach 10,000 feet.
- (8) Check that aural alerting unit sounds for 1 to 2 seconds and altitude alert annunciators come on STEADY at 9,000 $\pm$ 150 feet, and annunciators go off at 9,500 $\pm$ 150 feet as indicated on captain's altimeter.



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- (9) Further decrease static pressure. Check that aural alerting unit sounds for 1 to 2 seconds and annunciators come on flashing at $10,500 \pm 150$ feet as indicated on captain's altimeter.
- (10) Slowly decrease static pressure beyond 11,500 feet as indicated on captain's altimeter. Check that annunciators remain flashing.
- (11) Slowly increase static pressure. Check that aural alerting unit sounds for 1 to 2 seconds and annunciators come on steady at $11,000 \pm 150$ feet, and annunciators go off at $10,500 \pm 150$ feet as indicated on captain's altimeter.
- (12) Slowly increase static pressure. Check that aural alerting unit sounds for 1 to 2 seconds and annunciators come on flashing at $9,500 \pm 150$ feet as indicated on captain's altimeter and remain flashing at $9,000 \pm 150$ feet.
- (13) Slowly increase static pressure beyond 8,000 feet as indicated on captain's altimeter. Check that annunciators remain flashing.
- (14) Slowly decrease pressure to approach 10,000 feet.
- (15) Check that aural alerting unit sounds for 1 to 2 seconds and altitude alert annunciators come on steady at $9,000 \pm 150$ feet, and annunciators go off at $9,500 \pm 150$ feet as indicated on captain's altimeter.
- (16) Further decrease static pressure. Check that aural alerting unit sounds for 1 to 2 seconds and annunciators come on flashing at $10,500 \pm 150$ feet as indicated on captain's altimeter.
- (17) Press ALARM LIGHT on control altitude select. Check that annunciators come on steady and go **FLASHING AGAIN** at $11,000 \pm 150$ feet as indicated on captain's altimeter.
- (18) Slowly decrease static pressure beyond 11,500 feet as indicated on captain's altimeter. Check that annunciators remain **FLASHING**.
- (19) Slowly increase static pressure. Check that aural alerting unit sounds for 1 to 2 seconds and annunciators come on **STEADY** at $11,000 \pm 150$ feet, and annunciators go off at $10,500 \pm 150$ feet as indicated on captain's altimeter.

- (20) Slowly increase static pressure. Check that aural alerting unit sounds for 1 to 2 seconds and annunciators come on flashing at 9,500 $\pm$ 150 feet as indicated on captain's altimeter.

D Restore Air Data and Pitot Static Systems to NORMAL

- (1) Slowly release pitot static pressure
- (2) Disconnect pitot and static test equipment and remove all seals on static ports
- (3) If no longer required, remove electrical power

ATTITUDE WARNING SYSTEM - DESCRIPTION AND OPERATION

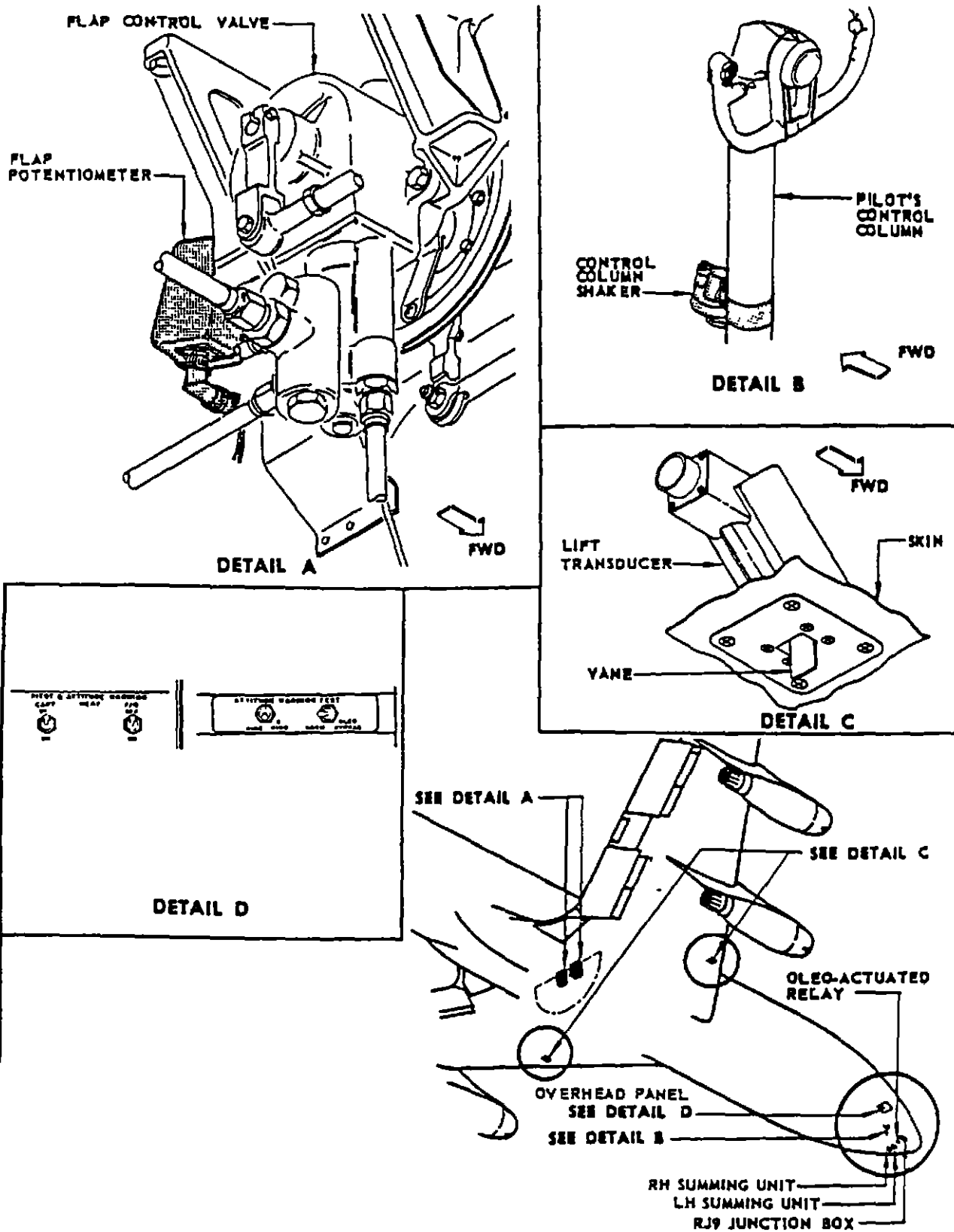
1 General

- A The attitude warning system is provided to alert the pilot when the airplane approaches an undesirable flight attitude condition. The warning is accomplished by vibrating the pilot's control column with the control column shaker. The system consists of two lift transducers, two flap potentiometers, two signal summing units, one control column shaker, one attitude warning junction box (RJ9), and associated electrical control circuits consisting of switches and an oleo actuated relay. (See figure 1)
- B Two "ALTITUDE WARNING TEST" switches are installed on the overhead panel (PI3). The two position switch allows the oleo actuated relay to be overridden in the "OLEO BYPASS" position, for checking and adjusting the system on the ground. The three position switch has a center off position and "L WING" and "R WING" positions for checking LH and RH units respectively.
- C The junction box RJ9 provides convenient interconnections and test points for the system and the oleo actuated relay and the N° 3 thrust lever switch provide control of the system on the ground.

2 Lift Transducer

- A The lift transducers are mounted on the lower left and right wing surfaces near the leading edge at approximately wing station 187. The lift transducers sense the airflow pattern in the vicinity of the stagnation point and respond to the movement of the point.
- B The lift transducers consist of a vane which is spring loaded to a central position and a transformer with an "E" type core. The excitation winding, on the central core of the transformer, is provided with 27.5 volts ac from the summing unit. The output signal windings are wound on the outer cores. The vane moves an armature across the face of the poles of the "E" type transformer, changing the magnetic coupling between the excitation winding and the output windings. This provides the lift signal that is sent to the summing units.
- C A heater is provided for de-icing the vane. 115-volt a-c power or 28-volt d-c power is supplied to the heaters through the oleo actuated relay and is controlled by the pitot heat switches on the overhead panel. (See figure 2)

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Attitude Warning System Component Location
Figure 1

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3. Flap Potentiometer

- A. The flap potentiometers are mounted on the flap control valves which are located on the front wall of the main wheel wells, next to the keel beam. The moving arm of the potentiometer is positioned by the flap control valve. Refer to Chapter 27, "Wing Flaps and Flap Control System." The flap potentiometer thus becomes a flap position transmitter, modifying the bridge circuit within the summing unit for various flap positions. This provides a compensating circuit to maintain calibration of the system at all flap positions.

4. Signal Summing Unit

- A. The signal summing units are mounted on a rack, in the lower nose section of the airplane, aft of the radome. The summing units contain a transistor, seven diodes, two relays and a power transformer.
- B. The signal summing unit receives signals from the lift transducer, provides 27.5 volts ac to the excitation winding of the lift transducer and controls the 28 volts dc that is sent to the motor of the control column shaker.
- C. Three adjustments are included in the summing unit. The null "N" adjustment provides for the initial balancing of the bridge and the flaps "F" adjustment allows for compensation of the flap potentiometer. The sensitivity "S" adjustment is not used.

5. Control Column Shaker

- A. The control column shaker is a motor driven unit that is mounted on the front side of the pilot's control column. The unit consists of a coaxially mounted 28-volt d-c motor and weighted ring assembly. Vibrations of the weighted ring are transferred to the control column to give the shaking action. The 28-volt d-c power is obtained from the radio and T-R circuit breaker panel (P5).

6. Oleo Actuated Relay

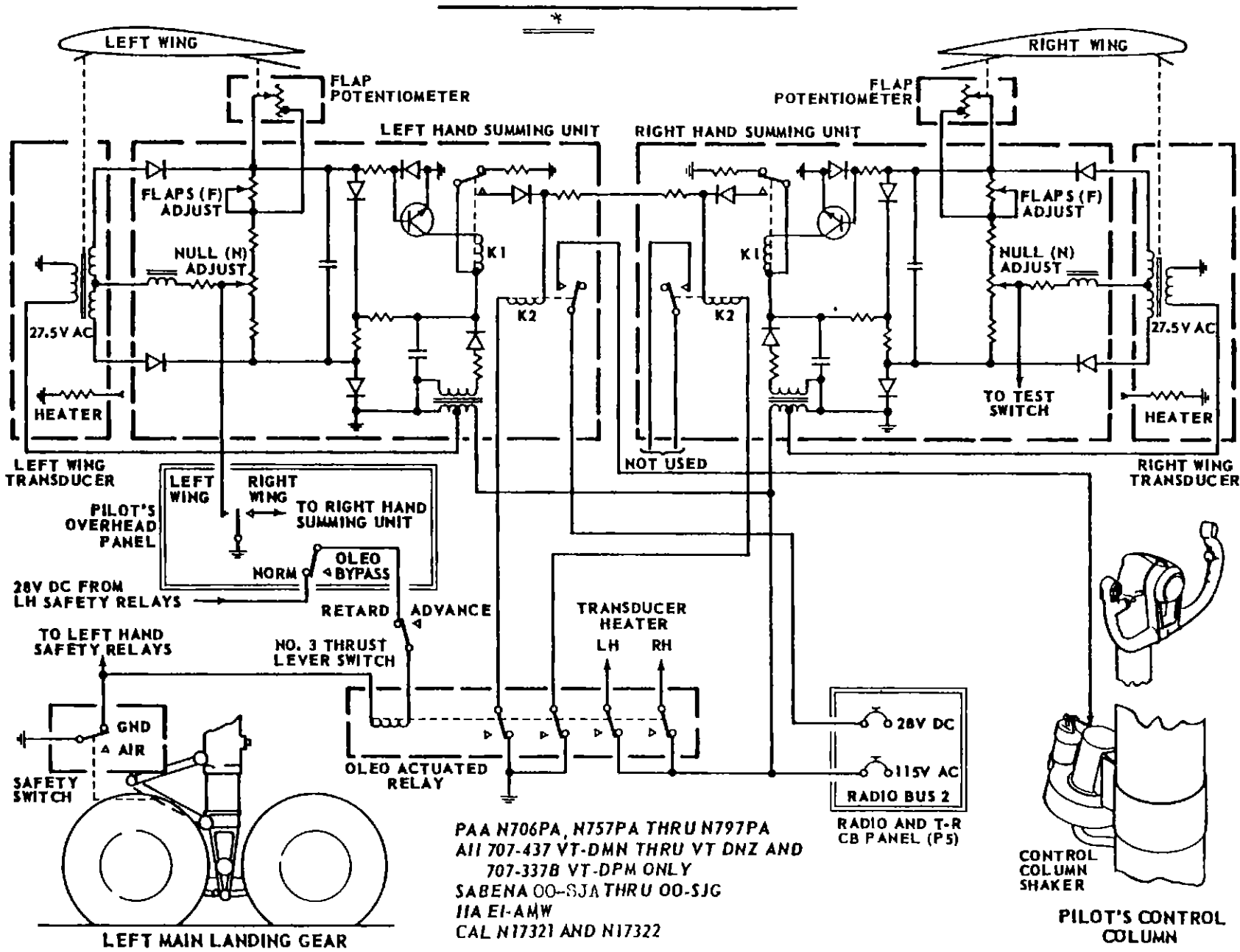
- A. The oleo actuated relay and the junction box (RJ9) are mounted on the same rack as the signal summing units. The oleo actuated relay is controlled by the attitude warning oleo bypass switch, the No. 3 thrust lever switch and the left hand safety switch. For information on the thrust lever switch (flap and speed brake warning switch), refer to Chapter 27, "Flap Position Warning Components." For information on the safety switch (main gear oleo safety switch), refer to Chapter 32, "Landing Gear and Door Control System."

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7. Operation

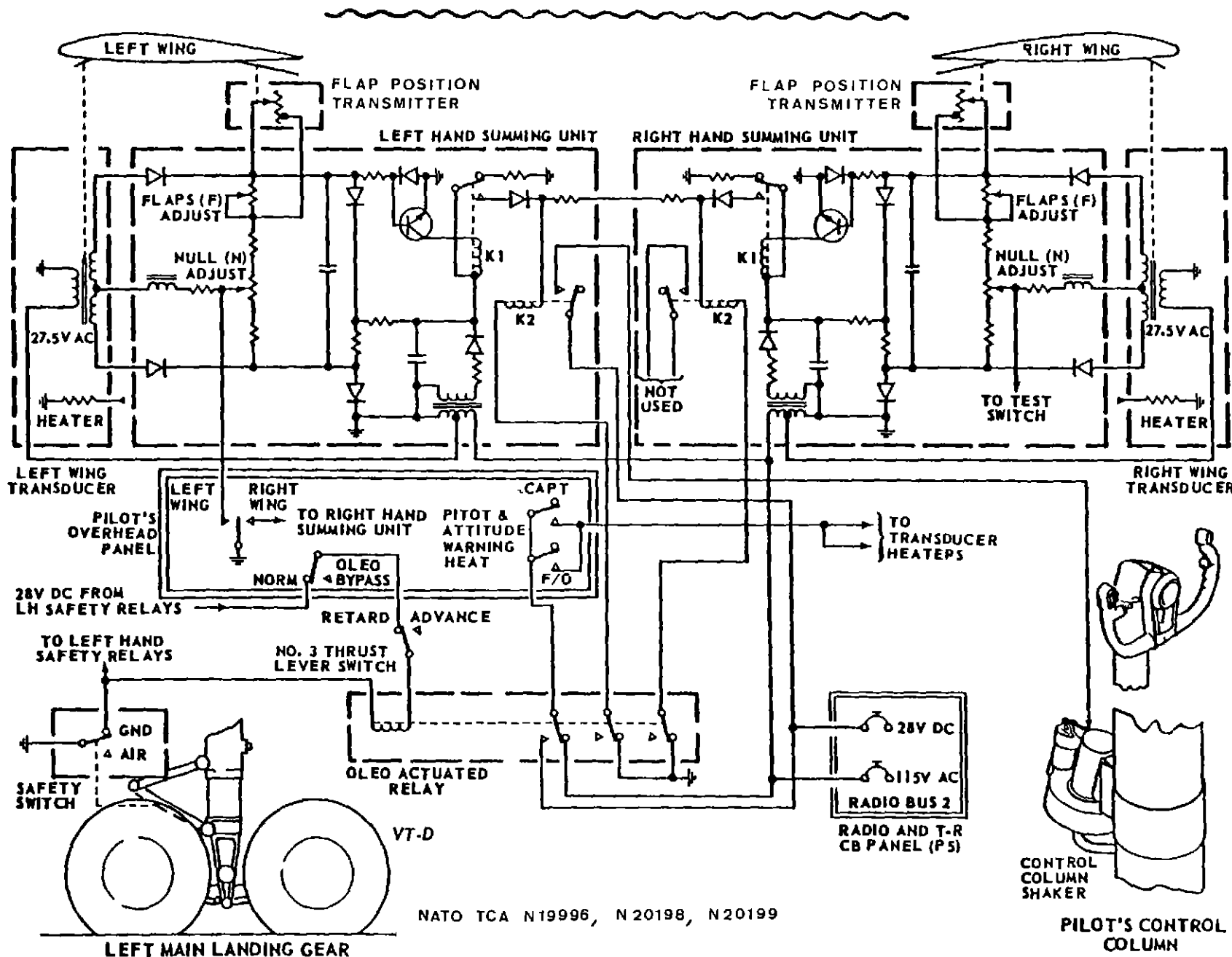
- A. Pressure stemming from the airflow on the vane of the lift transducer moves the armature within the transducer to produce the lift signal that is sent to the summing unit bridge circuit. (See figure 2.) The 400 cps a-c signal is converted to dc and applied to the transistor. A positive voltage of sufficient amplitude applied to the base of the transistor will cause the transistor to conduct and operate a relay K1. Twenty six volts dc from the power supply in the summing unit is made available to operate a second relay K2. When the second relay is properly grounded through the contacts of the oleo actuated relay, 28 volts dc is applied to the motor in the control column shaker to provide the warning signal.
- B. The control column shaker is operated by a signal from either lift transducer. Relay K2 is not used in the RH summing unit. When relay K1 in RH summing unit operates, 26 volts dc is applied to the relay K2 in the LH summing unit, which in turn supplies the necessary power to the control column shaker motor.
- C. The attitude warning system is placed in operation during take-off when the No. 3 thrust lever is advanced to take-off position. This overrides the oleo actuated relay. In the air the oleo actuated relay is automatically de-energized for proper operation of the system.



PAA N706PA, N757PA THRU N797PA
 AII 707-437 VT-DMN THRU VT DNZ AND
 707-337B VT-DPM ONLY
 SABENA OO-SJA THRU OO-SJG
 IIA EI-AMW
 CAL N17321 AND N17322

10
 Dec 15/64
 Sab Rev
 July 27 1965

Attitude Warning System Circuit
 Figure 2 (Sheet 1)
 * SB 1046 - 8707



NATO TCA N19996, N20198, N20199

ATTITUDE WARNING SYSTEM - TROUBLE SHOOTING

1 General

- A Trouble shooting the attitude warning system is comparatively simple because the major components, where trouble is most likely to develop, are interchangeable
- B Isolating a trouble in any one of these components is simply a matter of interchanging these components, one at a time, between the operating and nonoperating systems. If the operating system becomes inoperative after interchange of a component, the malfunctioning component is located and can be replaced
- C In every case in which a system does not operate, the first check should determine whether or not operating power is available to the affected unit. Power measurements can be made at the terminals in the attitude warning junction box (RJ-9). The following table indicates which terminals should be used for making power checks

	115V AG at terminals	28V DG at terminals
Left Wing Signal Summing Unit	B15	
Control Column Shaker		B16
Right Wing Signal Summing Unit	B15	

ATTITUDE WARNING SYSTEM - MAINTENANCE PRACTICES1. Adjustment/Test Attitude Warning System

A. Equipment and Materials

- (1) Ohmmeter

B. Check Flap Potentiometer Alignment

- (1) Check that both a-c and d-c circuit breakers on radio and T-R circuit breaker panel (P5) are open.
- (2) Disconnect connector from right hand flap potentiometer and connect on ohmmeter between pins B and C of potentiometer.
- (3) With flaps at 20°, resistance should be 500 ($\pm$ 50) ohms.
- (4) Lower flaps to 30° and 50° and check that resistance is 500 ($\pm$ 50) ohms
- (5) Raise flaps to 0° and check that resistance is no greater than 10 ohms
- (6) Restore system to normal and check left hand flap potentiometer in same manner.

C. Check Test Switches

- (1) Close attitude warning system and safety and oil cooler relay circuit breakers on radio and T-R circuit breaker panel (P5).
- (2) Hold oleo test switch in "BYPASS" position and select "LEFT WING" on wing test switch. Check that control shaker operates.
- (3) Release "LEFT WING" test switch and control shaker should stop shaking within 10 seconds.
- (4) Repeat steps (2) and (3) above but select "RIGHT WING" position on wing test switch
- (5) Release oleo switch and wing test switch.
- (6) Hold the wing test switch in "LEFT WING" position, advance No. 3 throttle and check that control shaker operates when throttle reaches "TAKE OFF" position.

- (7) Return No. 3 throttle to "SHUT DOWN" position and release hold on wing test switch.
- (8) Select "RIGHT WING" on wing test switch and check that control shaker does not operate.
- (9) through (11) deleted.

D. Check Transducer Operation

- (1) With flaps at 0°, hold oleo switch in "BYPASS" position and check that control shaker does not operate.
- (2) With oleo switch in "BYPASS," apply a small pressure force forward to left wing transducer vane and check that control shaker operates.

CAUTION: TRANSDUCER WILL BE HOT.

- (3) Remove pressure on transducer vane and shaker will stop. Release oleo switch.
- (4) Repeat steps (2) and (3) above but using right wing transducer.
- (5) Lower flaps to 20°, 30°, and 50° and repeat steps (2), (3), and (4) above for each flaps position.
- (6) Raise flaps and release oleo switch.
- (7) Check that both transducer heaters operate when oleo switch is in "BYPASS" position.

CAUTION: TRANSDUCERS WILL BE HOT.

- (8) Open system a-c and d-c circuit breakers.

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FIELD SERVICE MEMORANDUM

N° 63-57

November 4, 1963

ATA : 3418
Model : 707/720

To : MESSRS	DENGIS	T.EG.SUMV
	MASSON	T.ENT.8
	VIGNE	T.REV.CEL
	VAN DEN HECKE	T.EG.REI
	LAMI	T.EG.INFO

Subject : Attitude Warning System.

Reference : 707/720 Maintenance Manual 34-18-1.

The reference section of the Maintenance Manual outlines a "go-no-go" method of functionally checking the operation of the transducer and "stick shaker" of the attitude warning system.

A number of airlines, from time to time, have queried Boeing on a more detailed ground functional check on the airplane utilizing known gram forces applied to the transducer vane. While this can be satisfactorily performed on the aircraft, the airline should be made aware of the fact that the actuation points will only be within the tolerances when the transducer heaters are deactivated. With the heaters on, the actuation points can shift as much as two to four grams.

The transducer heater power should be removed by disconnecting wires 1RA735B18 from terminal B14 in RJ9 (attitude warning junction box, Loc. Sta 200) and wire 2RA735B18 from terminal D14 in RJ9.

In the air, the transducer output is not influenced by the heaters and the system will operate as calibrated on the bench with a cold transducer.

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ACG:mr

P.C. Baker
Senior Service Engineer - Only



MAINTENANCE MANUAL

ATTITUDE WARNING SYSTEM - MAINTENANCE PRACTICES

1 Adjustment/Test Attitude Warning System

A Equipment and Materials

- (1) Ohmmeter

B Check Flap Potentiometers Alignment

- (1) Check that both a-c and d-c circuit breakers for system on radio and T-R circuit breaker panel (P5) are open
- (2) Disconnect connector from right hand flap potentiometer and connect an ohmmeter between pins J and K of potentiometer
- (3) With flaps at 0°, the resistance should be 3175 (+/- 120) ohms
- (4) Lower flaps from 0° to 14° and check that above resistance decreases smoothly to less than 5 ohms at a flap position of 14°
- (5) Lower flaps from 14° to 25° and check that resistance remains at less 5 ohms throughout the 11° travel of flaps
- (6) Lower flaps from 25° to 50° and check that at 50° the resistance is 120 (+/- 12) ohms
- (7) Return flaps to full up position and restore system to normal
- (8) Repeat procedure for left hand flap potentiometer

C Check Test Switches

- (1) Close circuit breakers for attitude warning system and safety and oil cooler relay on radio and T-R circuit breaker panel (P5) Open pitot heater circuit breakers on circuit breaker panel (P2) and position captain's and first officer's pitot and attitude warning heat switches to "OFF"
- (2) Position flaps to 25°
- (3) Hold the oleo test switch in "BYPASS" position and select "LEFT WING" on wing test switch Check that control shaker operates

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- (4) Release "LEFT WING" test switch and control shaker should stop shaking within 10 seconds.
- (5) Repeat steps (3) and (4) above but select "RIGHT WING" position.
- (6) Release oleo test switch and wing switch.
- (7) Hold wing switch in "LEFT WING" position, advance No. 3 throttle and check that control shaker operates when throttle reaches "TAKE OFF" position.
- (8) Return No. 3 throttle to "SHUT DOWN" position and release wing switch.
- (9) Select "RIGHT WING" on wing test switch and check that control shaker does not operate.
- (10) Return flaps to 0°.

D. Check Transducer Operation

- (1) With flaps at 0°, hold oleo switch in "BYPASS" position and check that control shaker operates.
- (2) Release oleo switch.
- (3) Open a-c circuit breaker for system on radio and T-R circuit breaker panel (P5).
- (4) Hold right wing transducer vane in aft position. This can best be accomplished by placing a loop of wire and taping wire to wing skin.
- (5) Close a-c circuit breaker and hold oleo switch in "BYPASS" position. Check that control shaker operates.
- (6) Apply a small pressure force aft to left wing transducer vane and check that control shaker stops vibrating.

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- (7) Remove pressure on transducer and release oleo switch.
- (8) Remove tape and wire from right wing transducer vane and apply it to left wing transducer vane.
- (9) Repeat steps (5), (6), and (7) above except apply force to right wing transducer.
- (10) Restore system to normal.
- (11) Lower flaps to 25° and hold oleo switch in "BYPASS" position.
- (12) Apply a small pressure force forward to left wing transducer vane and check that control shaker operates.
- (13) Repeat step (12) above for right wing transducer.
- (14) Lower flaps to 50° and hold oleo switch in "BYPASS" position.
- (15) Repeat steps (12) and (13) above.
- (16) Raise flaps and return oleo switch to "NORMAL" position.

E. Check Transducer Heater Operation

CAUTION: TRANSDUCERS WILL BE HOT.

- (1) Position captain's pitot and attitude warning heat switch to "ON" and check that both transducer heaters operate.

NOTE: 28 volt d-c power is being supplied to the heaters.

- (2) Position oleo switch to "BYPASS," and check that both transducer heaters operate.

NOTE: 115 volt a-c power is being supplied to the heaters.

- (3) Return oleo switch to NORMAL and position pitot and attitude warning heat switch to "OFF."



MAINTENANCE MANUAL

LOW FREQUENCY AUTOMATIC DIRECTION FINDER - DESCRIPTION AND OPERATION

1 SAFETY PRECAUTIONS

Refer to introduction for general safety precautions to be observed when operating or performing maintenance on the low frequency automatic direction finder system. All caution notes pertaining to installation or removal of antennas must also be observed.

2 DESCRIPTION

A General

All TCA aircraft have a low frequency automatic direction finder (LF/ADF) system consisting of a 614L-8 control panel, a 51Y-4 receiver, an LPA-73A-1 loop antenna, a QCA-73B-1-30U6P quadrantal error corrector, a sense antenna and a CUA-73A-190 coupler (See table 1 for equipment list). The ADF system receives radio signals in the frequency band of 190 to 1750 kHz to provide a bearing readout indicating the direction towards the transmitting ground station. The bearing readout can be displayed on the left (pilot) or right (co pilot) radio magnetic indicator (RMI) or simultaneously on both RMIs which are located on the flight instrument panels. As an automatic direction finder, the system continuously indicates the bearing of received radio station and provides aural reception of audio transmission from the station. If used as a manual direction finder, the operator finds the direction of the radio station by manually controlling the null direction of the ADF loop antenna. As an aural navigation receiver, the operator is able to determine whether he is approaching or going away from a station. The system can be used as a low frequency aural receiver of AM voice and unmodulated transmissions. The dc supply voltage for the receiver is provided by a voltage regulator. The voltage regulator receives 28-volt dc power from a circuit breaker marked (LF) /ADF on the P5 circuit breaker panel, essential radio bus. The excitation voltage for the bearing synchro and for tuning power comes from the P5 circuit breaker panel through the FLT INST No 1 BRG EXC circuit breaker and the FLT INST No 2 DRG EXC circuit breakers.

B Receiver

The LF/ADF receiver is located on the RH radio rack shelf 3 (figure 2). The receiver is completely transistorized and employs a single conversion super heterodyne circuit in the receiver portion. The receiver operates in the range of 190 to 1750 kHz. Tuning is by servomotor. Band and function switching is solid state. The receiver has rf signal inputs from the loop antenna through the quadrantal error corrector and from the sense antenna and sense antenna coupler. These signals are applied through cables connected to the front panel of the receiver. The power, audio and indicators are connected to the rear of the receiver, where the rear connector of the receiver mates with a connector in the rack mount. The receiver converts the received radio signal to a synchro output, to operate the radio magnetic indicators, and an audio signal that is distributed through the flight crew intercom system.

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C Control Panel

The LF/ADF system control panel is located in the overhead panel (figure 1). The panel performs electronic logic switching of receiver bands, tuning of operational modes, and provides digital readouts of selected frequencies. The panel has a mode selector, loop control, tuning control, band selector, gain control, beat frequency oscillator (BFO) switch, tuning meter and frequency indicator dial. See figure 1 and table 2 for a description of the LF/ADF system controls and displays.

D Loop Antenna

The fixed loop antenna is surface mounted on the bottom centerline of the fuselage at station 600E+10 (figure 3). The antenna consists of two loop coils wound on fiberglass reinforced ferrite bars which are sealed in a rigid fiberglass shell. The loop antenna contains no moving parts. The ferrite bars are mounted at right angles to each other so that the magnitude of the voltage induced in either coil by an incoming magnetic radio signal depends on the direction of the transmitting station with respect to the antenna. The signal received by the antenna is transmitted to the quadrantal error corrector.

E Quadrantal Error Corrector

The quadrantal error corrector is located just above the loop antenna and is connected between the antenna and the receiver transmission line. The quadrantal error corrector compensates for the error in the loop antenna signal due to the electromagnetic field distortion around the antenna caused by the wings and fuselage of the aircraft. Inside the corrector is a network composed of inductors and capacitors, with characteristics selected for the TCA aircraft configuration.

F Sense Antenna

The sense antenna is on the bottom centerline of the fuselage extending forward of the main landing gear wells (figure 3). The antenna is made of metal wire cloth supported with reinforced plastic and attached to the inside of the antenna door. The antenna is approximately 87 inches long and 17 inches wide. The sense antenna provides a nondirectional, high strength signal to the receiver.

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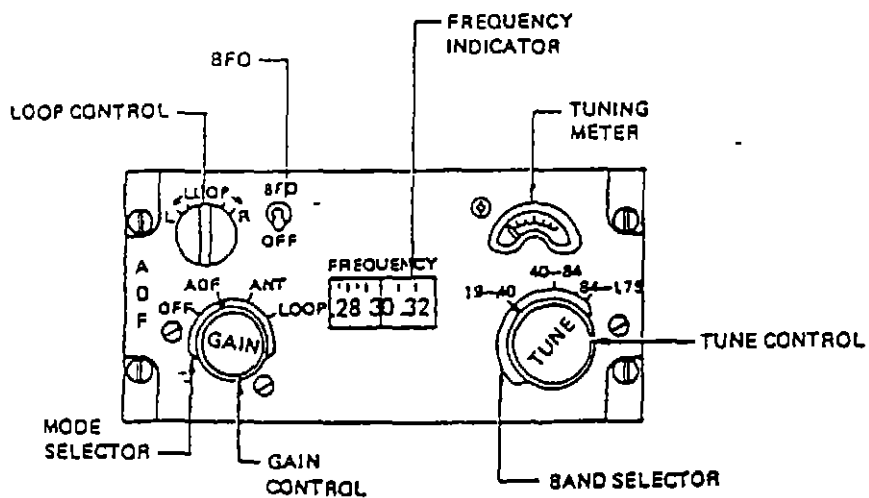
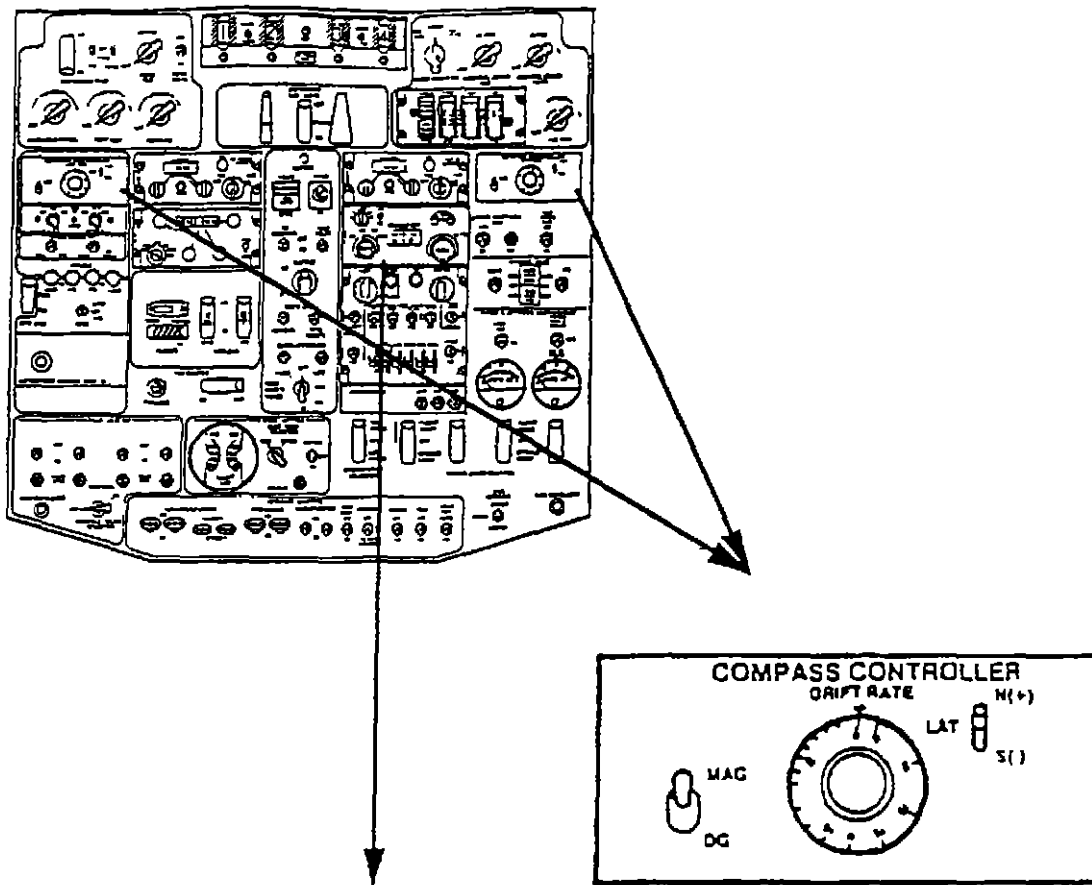
G Sense Antenna Coupler

The sense antenna coupler matches the impedance of the sense antenna to the transmission line going to the receiver. The coupler contains an impedance-matching device called a susceptiformer and a lightning protector. There are three electrical connections on the coupler: a ground stud, an antenna stud, and a triaxial output receptacle. The ground stud is used for attaching a bonding strap and the electrical receptacle is for the triaxial transmission line. The sense antenna coupler is mounted on the forward end of the sense antenna door and is electrically bonded to structure through a ground strap.

NOMENCLATURE		COMMON NAME	LOCATION
OFFICIAL	DRAWING		
(LF)/ADF			
Control, Direction Finder 614L-8 Panel		Control panel	Overhead
Receiver, Direction Finder 51Y4		Receiver	RH radio rack shelf 3
Antenna, Loop, ADF LPA-73A-1		Loop Antenna	Station 600E +10
Quadrantal Error Corrector QCA-738-1-30U6P		Quadrantal Error Corrector	Station 600E +10
Antenna, Sense, ADF		Sense Antenna	Station 727
Coupler, ANT, ADF CUA-73A-190		Antenna Coupler	Station 720

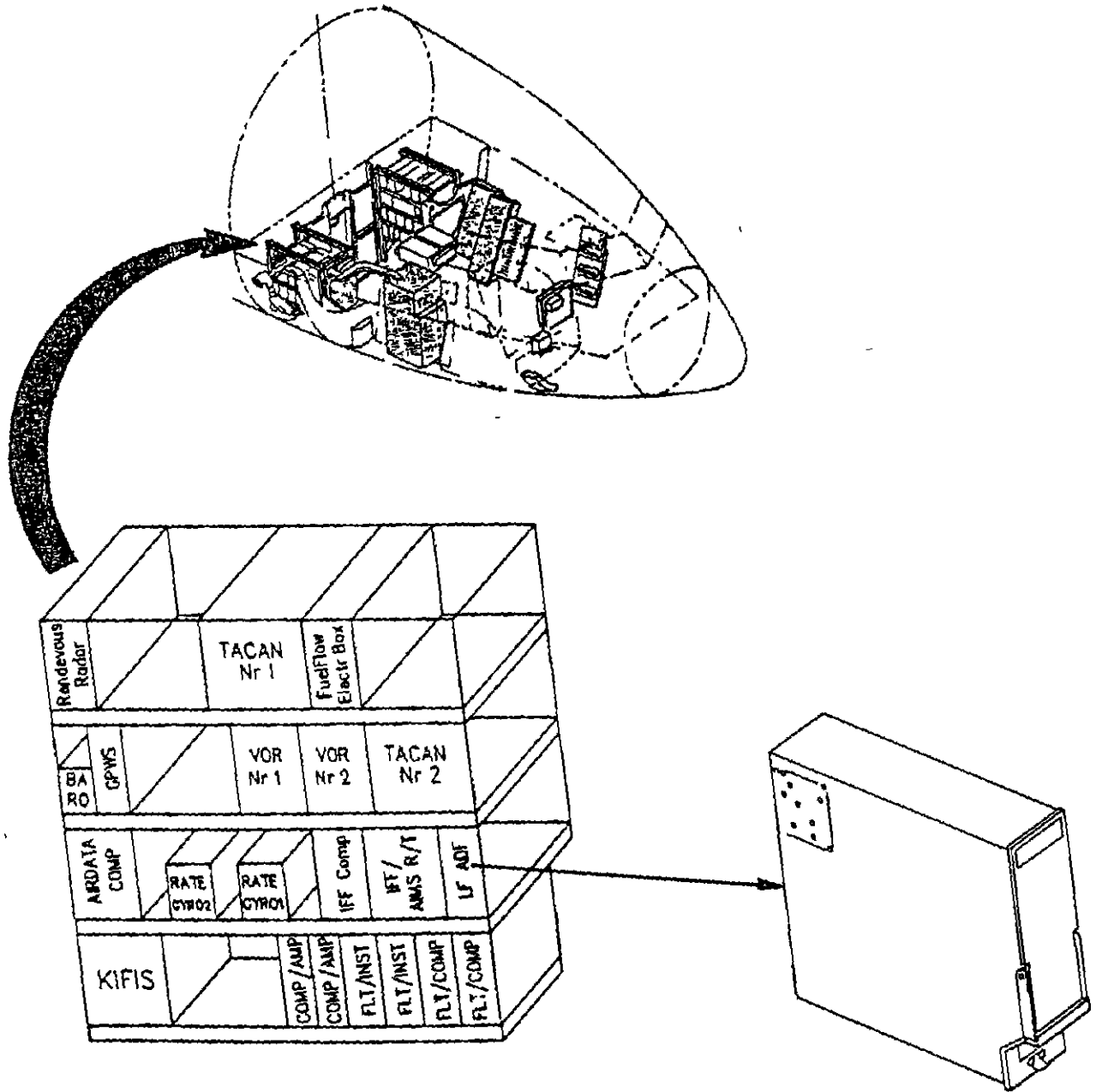
LF/ADF System Equipment
Table 1

Ref T O 1E-3A-2-34-1
Page 5-6 Change 0
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LF/ADF Control Panel
Fig 1

Ref. T O 1E-3A-2-34-1
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RH Radio Rack
 Fig 2

Ref . T O 1E-3A-2-34-1
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CONTROL/INDICATOR	FUNCTION
LOOP Control	Used for manual determination of bearing to the station being received. Used also for audio reception under conditions of severe atmospheric noise. <u>NOTE</u> The LOOP control should not be used to determine direction on radio ranges
BFO (Beat Frequency Oscillator) Switch	BFO (up) position mixes beat frequency oscillator with continuous wave signal to produce audio for accurate determination of true null
FREQUENCY Indicator	Indicates the frequency being received, and is read directly from the dial
Tuning Meter	Provides a relative indication of received signal strength. Provides an accurate determination of null during manual direction finding
TUNE Control	Adjusts the receiver frequency within the band selected by the band selector switch
Band Selector	Provides for the selection of one of three available frequency ranges: 0.19 to 0.40 MHz, 0.40 to 0.85 MHz and 0.84 to 1.75 MHz. The selected frequency range is displayed by the frequency indicator.
Mode Selector Switch	Provides selection of the ADF modes of operation as follows:
OFF	Deenergize the system
ADF	Energizes the receiver. Selects the circuits to automatically determine the bearing to the station being received
ANT	Selects only the sense antenna circuit for reception of weather broadcasts and radio range signals
LOOP	Used for manual determination of bearing to the station being received
GAIN Control Knob	Controls the receiver gain in the ANT or LOOP modes
No. 1 Bearing Pointers (Located on RMI's)	The No. 1 pointer on the RMI displays the bearing obtained through the ADF system,
TACAN/VOR-ADF Switches (Located on RMI Selector Switch Panels)	When set to ADF, selects LF/ADF for bearing display on the RMI No. 1 pointer

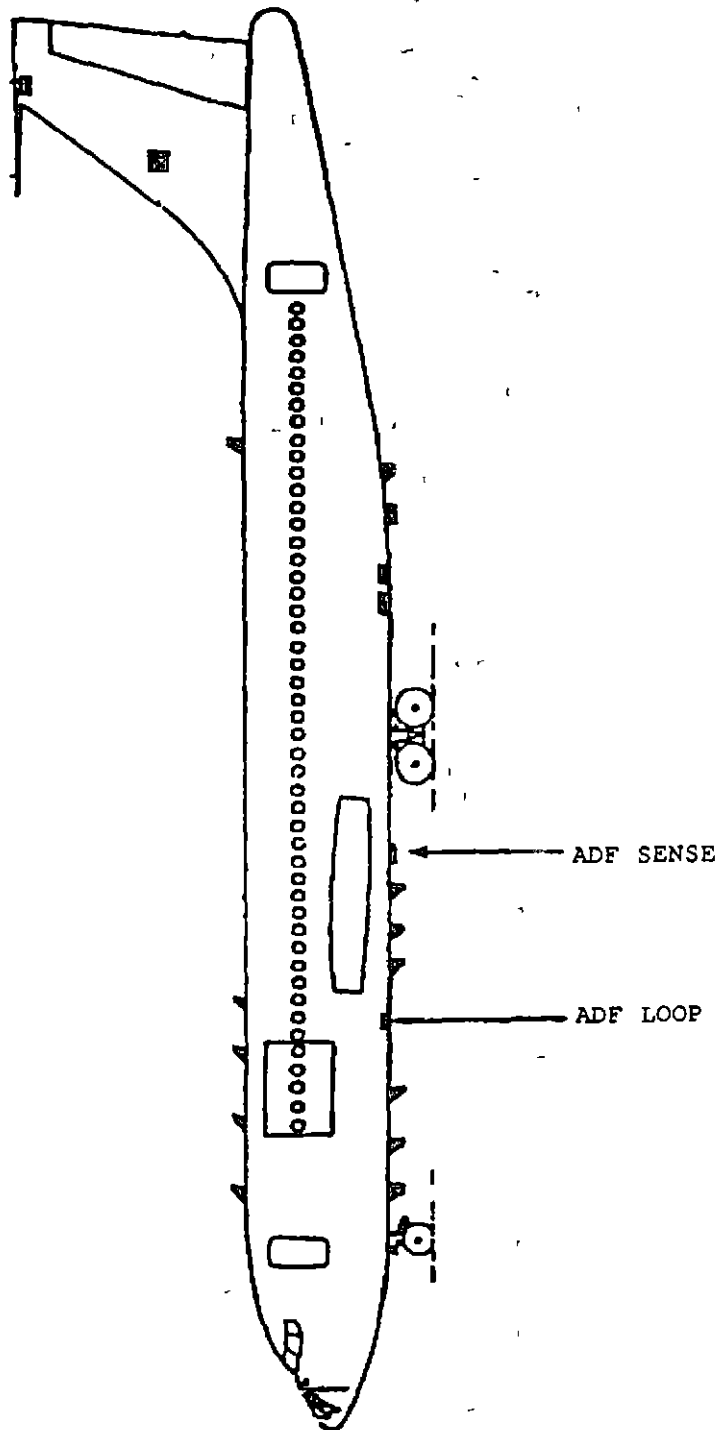
LF/ADF System Control Panel Functions
Table 2

Ref. TO 1E-3A-2-34-1
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3 OPERATION

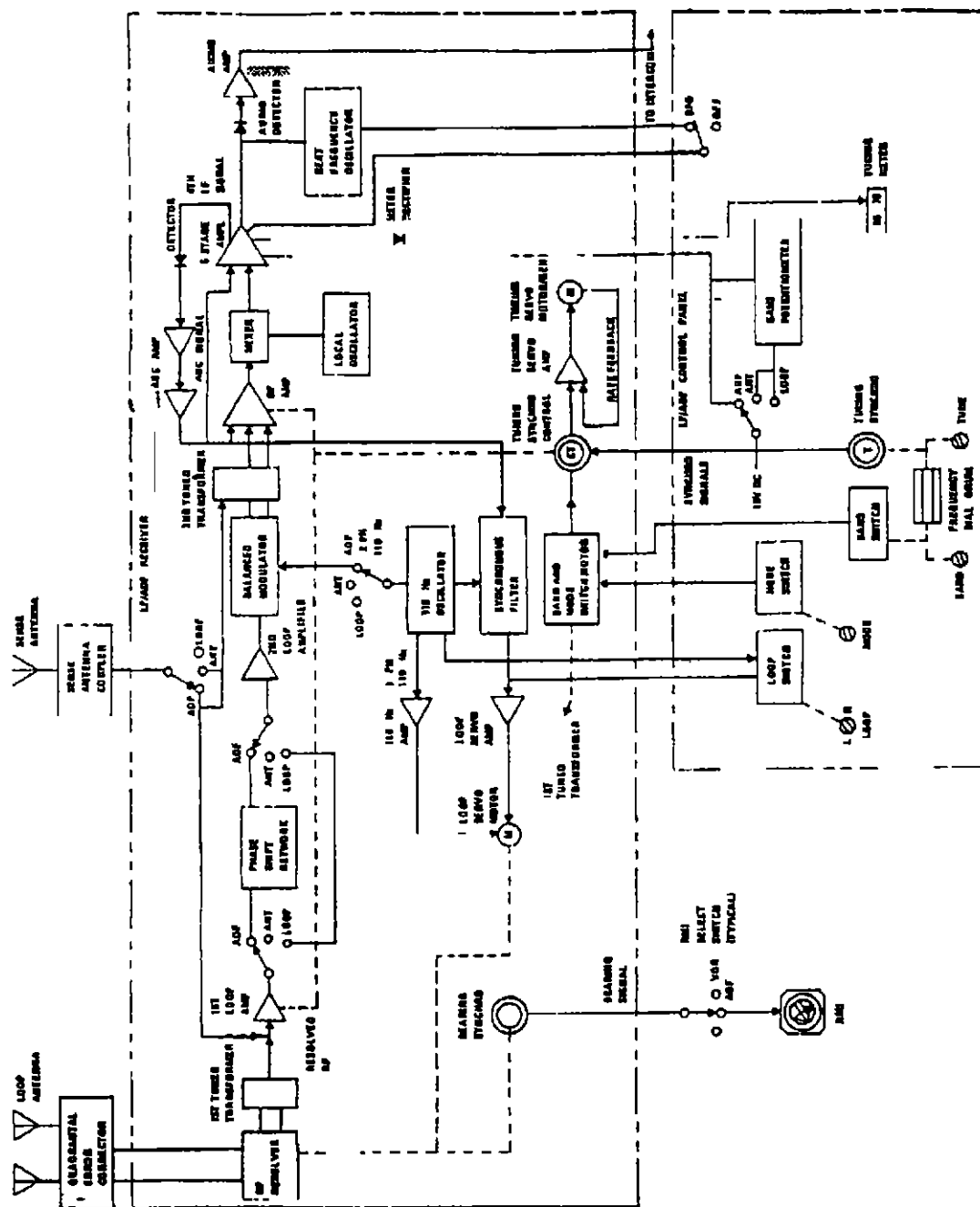
- A The LF/ADF system block diagram is shown in figure 4. The rf signal is coupled from the loop antenna through the quadrantal error corrector to the rf resolver in the receiver. The angular position of the resolver rotor determines the amplitude and phase of the loop rf signal reaching the first tuned transformer. The first tuned transformer is selected by the band/mode switch motor from three transformers that cover the three frequency bands of the receiver: 190 to 400 kHz, 400 to 840 kHz, and 840 to 1750 kHz. A phase shift is applied to the output of the first loop amplifier in ADF mode. Only the sense antenna signal is used in ANT mode. In the ADF mode, the loop signal is double-sideband suppressed-carrier modulated at 110-Hz.
- B The loop and sense signals are mixed in the second tuned transformer in ADF mode. The combined sense antenna carrier signal and double-sideband suppressed carrier loop signal forms an amplitude modulated signal with depth of modulation determined by the rf resolver rotor position and the phase determined by the direction from the null position of the rf resolver rotor.
- C The combined sense and loop antenna signal is amplified in the rf amplifier and applied to the mixer where the signal is mixed with the output of a local oscillator. The intermediate frequency is 142.5 kHz. The five IF amplifier stages drive an audio detector. The audio signal is amplified in an audio amplifier which is connected to the ADF control panel and to the intercom system.
- D The audio output level is controlled by the intercom system. In the ANT and LOOP modes, receiver gain is controlled at the rf and IF stages by a dc bias voltage from the GAIN potentiometer in the control panel. In the ADF mode, the control panel GAIN potentiometer does not affect rf and IF gain. The output of the fourth IF amplifier stage is demodulated with a diode detector and applied to the agc amplifier and loop servoamplifier. The fourth IF amplifier signal is also applied to the meter rectifier which causes the control panel tuning meter to deflect in proportion to the IF signal strength.
- E The 110-Hz ac signal from the detector is amplified in the loop servoamplifier, shifted in phase, and applied to the control winding of the loop servomotor. A synchronous filter in the low-level loop servoamplifier provides a very narrow passband. The center frequency of the passband is automatically synchronized with the 110-Hz oscillator frequency. Audio signals other than 110-Hz are rejected to improve ADF performance. The resolver rotor can rotate in either direction and always seeks a null toward the signal source. Positioning of the rotor null toward the signal direction is accomplished automatically in ADF mode. In LOOP mode, the loop servomotor and the rotor position are controlled manually from the LOOP L/R switch in the control panel. The rotor position is coupled to external indicators by the bearing synchro system.
- F The beat-frequency oscillator (BFO) injects a 142.5-kHz signal into the IF. The BFO is switched on or off by the BFO/OFF switch on the control panel.

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Antenna Locations
Figure 3

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LF/ADF System Block Diagram
Figure 4

Ref. T.O 1E-3A-2-34-1
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LOW FREQUENCY/AUTOMATIC DIRECTION FINDER-TROUBLE SHOOTING

Table 101 lists symptoms, probable causes isolation procedures and corrective actions as an aid in isolating causes of LF/ADF system failures. The reference procedure column lists the related test steps in the checkout procedure. This correlates the symptoms with failures that may be encountered during the checkout. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation. The schematic diagram, figure 4 will also aid trouble analysis.



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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
SYSTEM COMPLETELY INOPERATIVE	Dial Light		Replace dial light
Table 502 Step 6	Circuit breaker open	Check that system circuit breaker on P5 panel is closed	Close circuit breaker
	No power to receiver	Remove receiver from its mounting. Check that 28 vdc is available at pin 26 of mount plug. If power is available, receiver is faulty.	Replace receiver
		Check for 28 vdc at pin L of plug disconnected from LF/ADF control panel. If available control panel is faulty	Replace control panel
NO AUDIO AT ONE ADS PANEL			
Table 502 Step 10	Defective intercom system	Check that audio is available at another ADS	Repair defective intercom
NO AUDIO AT ANY ADS PANELS			
Table 502 Step 10	Defective control panel, receiver, or antennna	Replace units in order listed	Replace control panel, receiver, loop antenna
LOOP CONTROL INOPERATIVE			
Table 502 Step 12	Defective control panel or receiver	Check another ADS	Replace control panel if loop control, OK Replace receiver
INCORRECT READING ON ONE RMI	Defective RMI		Replace RMI
Table 502 Steps 13,16			
INCORRECT READING ON BOTH RMI's			
Table 502 Steps 13,16	Defective receiver, control panel, quadrantal error corrector or loop antenna	Replace units in order listed	Replace receiver, control panel, quadrantal error corrector, loop antenna
NO ZERO BEAT TONE			
Table 502 Step 18	Defective receiver or control panel	Check another ADS	Replace receiver if no beat tone Replace control panel

LF/ADF System Trouble Shooting
Table 101

Ref T O 1E-3A-2-34-1
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LF/ADF SYSTEM-REMOVAL/INSTALLATION

When opening the sense antenna, or when removing its the piano hinge pins should be removed from the left side so the antenna is suspended along the right side. This allows removal of the antenna coupler and cables prior to removal of the panels. To remove a left side hinge wire, remove securing screw at hinge end and remove hinge wire.

1. LF/ADF Sense Antenna and Coupler - Removal

A The sense antenna and antenna coupler may be removed from the aircraft as an assembly or the antenna coupler may be removed by itself.

B Open and tag essential radio bus (LF)/ADF DC circuit breaker on panel P5.

CAUTION CAREFULLY OPEN ANTENNA PANEL TO PREVENT DAMAGE TO GROUND STRAP ON AIRCRAFT NOT HAVING RESTRAINING STRAPS INSTALLED

C Remove two hinge pins from piano hinge (figure 401) on left edge of antenna panel.

D Unfasten four aft and four forward quarter-turn fasteners and lower left edge of antenna panel.

E Disconnect electrical connectors and jumper wire from antenna coupler.

F Remove cable clamp.

G Remove grounding strap.

H Refasten eight quarter-turn fasteners.

CAUTION SUPPORT ANTENNA PANEL WHEN REMOVING HINGE PINS TO PREVENT DROPPING ANTENNA ON RAMP

I Remove hinge pin from piano hinge on right edge of antenna panel, unfasten, fasteners, and remove antenna panel.

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2 LF/ADF Sense Antenna and Coupler - Installation

- A Hold antenna panel in position so that piano hinge (figure 401) segments on right edge of panel are properly aligned with piano hinge segments on aircraft structure
- B Insert hinge pin
- C Connect electrical connectors and jumper to antenna coupler
- D Connect grounding strap
- E Install cable clamp
- F Swing antenna panel to closed position, install hinge pins in left edge of antenna, and fasten eight quarter-turn fasteners
- G Close (LF)/ADF DC circuit breaker

3 LF/ADF Sense Antenna Coupler - Removal

- A Remove two hinge pins on left edge of antenna panel (figure 401)
- B Lower left edge of antenna panel
- C Disconnect electrical connectors, jumper wire and bonding strap from antenna coupler
- D Remove mounting screws from base of coupler and remove coupler

4 LF/ADF Sense Antenna Coupler - Installation

- A Place coupler on antenna panel and install mounting screws (figure 401)
- B Connect electrical connectors, electrical jumper, and bonding strap to coupler.
- C Swing antenna panel to closed position and install hinge pins

5 LF/ADF Loop Antenna - Removal

- A Remove aerodynamic smoother seal from antenna and heads of screws
- B Remove seven mounting screws holding antenna (figure 402)
- C Hold antenna and disconnect antenna connector from quadrantal error corrector assembly

Ref T.O 1E-3A-2-34-1
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- D Remove antenna
- 6 LF/ADF Loop Antenna - Installation
 - A. Clean faying (mating) surface of antenna with solvent (See figure 402)
 - B Mix 100 parts SR-529 resin with 4 parts SRC-18 catalyst and apply continuous coat to faying surface of antenna and gasket
 - (1) Allow to air dry for 10 to 30 minutes
 - (2) Bond antenna and gasket together
 - C Position antenna and connect electrical connector
 - D Hold antenna in mounting position and install and tighten mounting screws
 - E Clean edge of loop antenna and area around antenna. Mix and apply a thin coat of parting agent solution to cleaned area
 - F Apply a fillet of aerodynamic smoother to antenna edge and aircraft skin
- 7 Quadrantal Error Corrector - Removal
 - A Remove loop antenna Refer to paragraph 5
 - B Reach into opening uncovered by the loop antenna, and remove the quadrantal error corrector by unscrewing the gripper adapter which attaches the corrector to a bulkhead receptacle
- 8 Quadrantal Error Corrector - Installation
 - A Place the corrector into the bulkhead receptacle, inside of the pressure box, and connect it by tightening the gripper adapter
 - B Install loop antenna Refer to paragraph 6.
- 9 Component Replacement Checkout
 - A The following checkout procedures ensure that replaced components operate properly in the system

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NOTE The following procedures do not check the system completely. For a complete operational checkout of the system, refer to table 502

10 Receiver

Perform system test per table 502, steps 1 through 5, 9, and 17 through 23

11 Loop Antenna and Quadrantal Error Corrector

Perform system test per table 502, steps 1 through 5 and 11 through 23

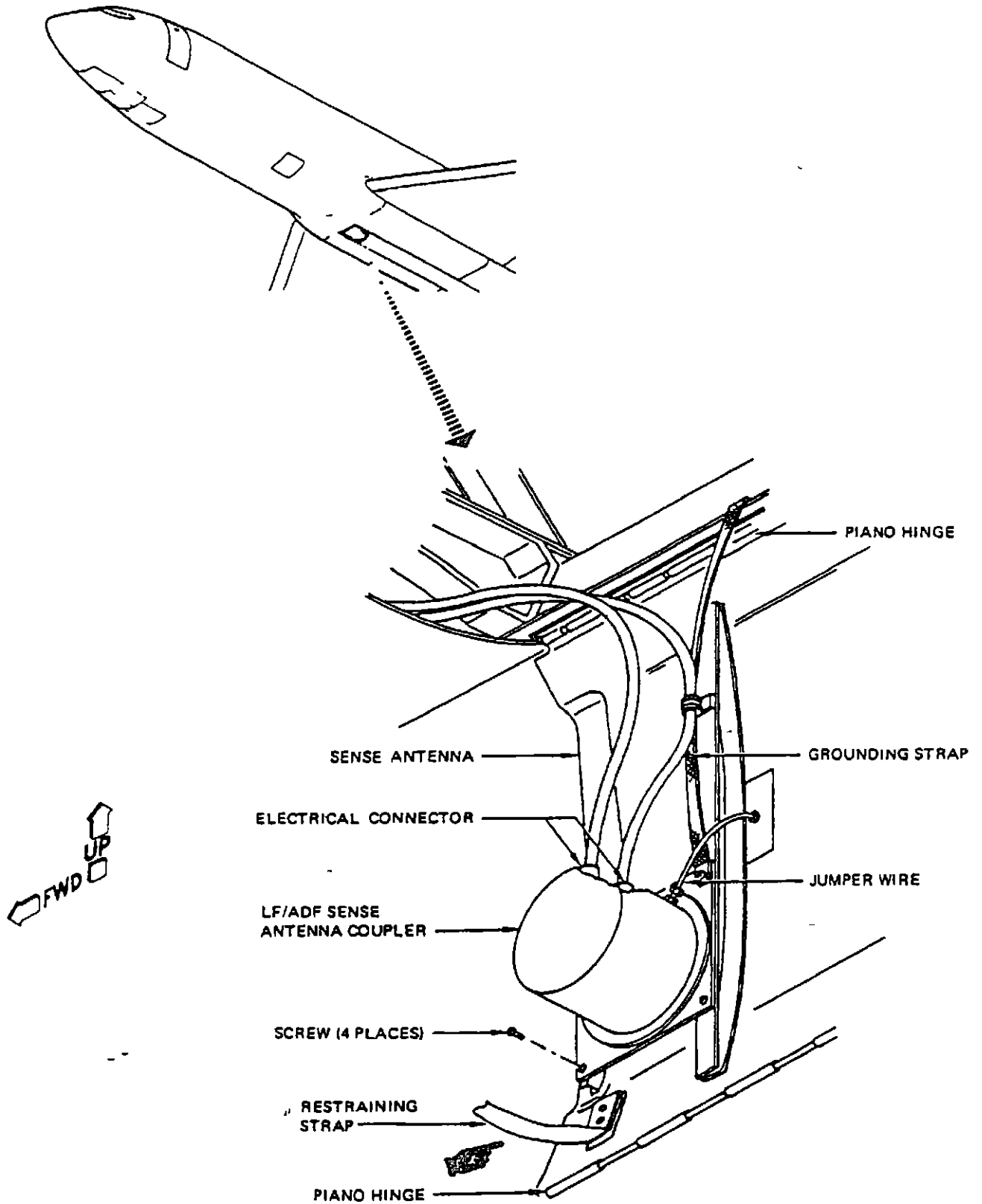
12 Sense Antenna and Coupler

Perform system test per table 502, steps 1 through 10 and 19 through 23

13 Control Panel

Perform system test per table 502

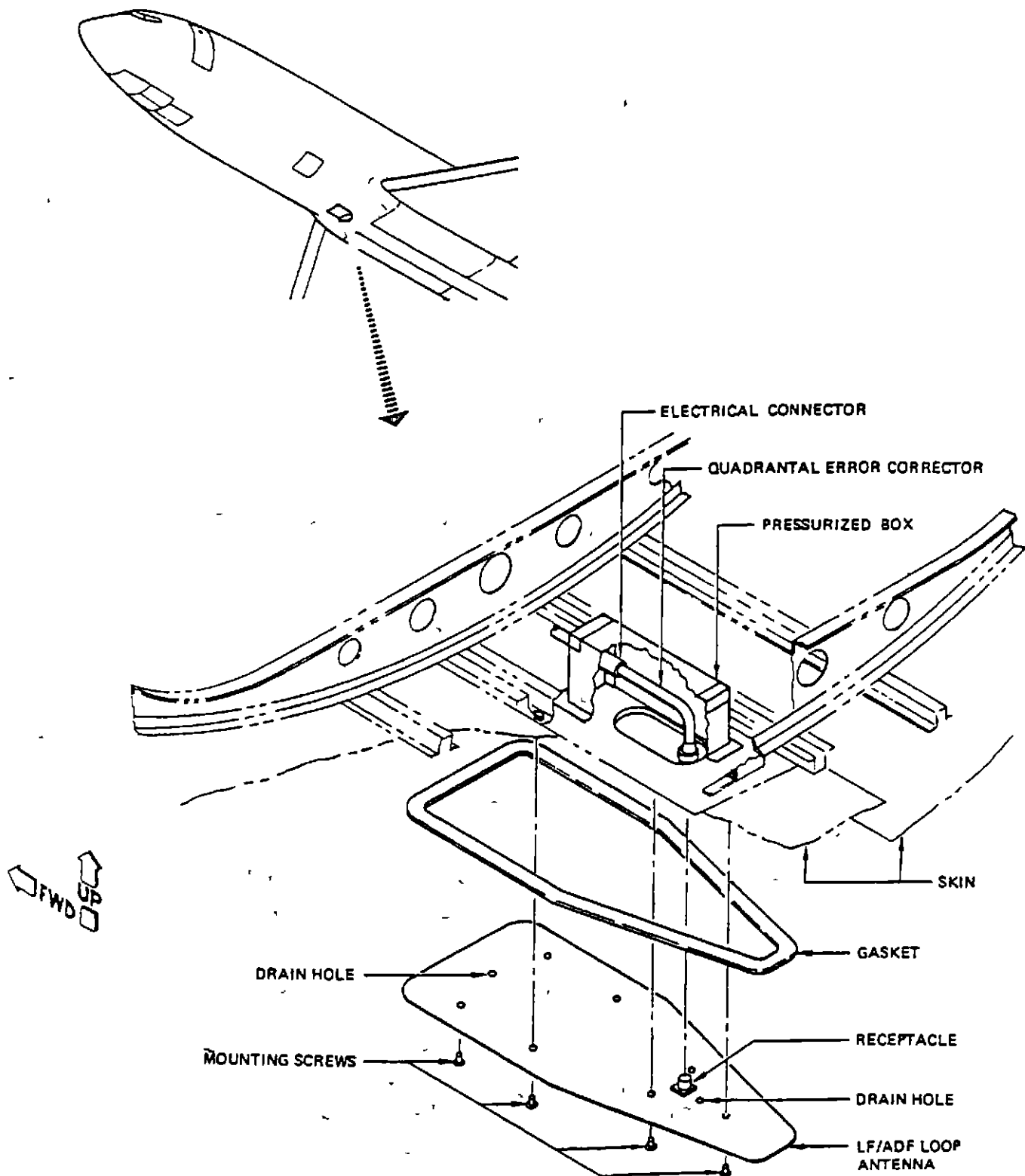
Ref. T.O. 1E-3A-2-34-1
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LF/ADF Sense Antenna and Coupler
Figure 401

Ref T O. 1E-3A-2-34-1
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LF/ADF Loop Antenna
 Figure 402

Ref: T O 1E-3A-2-34-1
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LOW FREQUENCY/AUTOMATIC DIRECTION FINDER - ADJUSTMENT/TEST

1. Tools and Test Equipment.

Table 501 lists tools and test equipment required for flight-line maintenance of the LF/ADF system.

2. Checkout.

The checkout procedure (table 502) verifies proper operation and adjustment of the LF/ADF system. The procedure requires the reception of standard broadcast and low frequency transmitting stations in the area and an operating interphone system. Bearing checks made with the aircraft inside the hangar may be unreliable. The procedure is performed in the flight deck. When out of tolerance conditions are encountered, refer to trouble analysis for corrective action.

PART No OR TYPE DESIGNATOR	FIGURE AND INDEX No	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation			
<u>TOOLS</u>			
No Special Tools Required			
<u>TEST EQUIPMENT</u>			
TC-149 Instrument Systems or H-133AIC		Headset	Operational checkout of audio portion of the LF/ADF.
Model 260 Simpson		Multimeter	Voltage and continuity tests

LF/ADF System Tools And Test Equipment
Table 501

Ref.: T.O. 1E-3A-2-34-1
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STEP	RESULT
1 Apply aircraft electrical power 2 Ensure that following circuit breakers on circuit breaker panel, P5 are closed (LF)/ADF DC XFMR (No 1 and No 2) XFMR (No 1 and No 2) COMPASS (No 1 and No 2) BRG EXC (No 1 and No 2) BRG EXC (No 1 and No 2) 3 Set RMI selector switch on pilot and copilot instrument panels to ADF 4 On compass controllers, set mode selector to MAG 5 Rotate OVHD PANEL control knob clockwise from OFF 6 Rotate mode selector on LF/ADF control panel through ADF, ANT, and LOOP positions 7 Set mode selector to ANT 8 Set BFO/OFF switch to OFF Allow a 10 minute warmup period 9 Connect headset and extension cable to pilot intrecom jack 10 Tune in several stations on each band 11 Set LF/ADF control panel mode selector to LOOP 12 Tune in station on each band and using LOOP L/R control, rotate RMI through 360 degrees (narrow pointer) 13 Set LF/ADF control panel mode selector to ADF and tune in a station	Check that control panel lights are on FREQUENCY dial lights are on in each switch position Reception of AM stations is satisfactory. Two nulls of audible signal are present for each station 180 degrees apart RMI narrow pointers move faster when LOOP control is in extreme L and R positions Pilot and copilot RMI narrow pointers agree within 4 degrees and indicate bearing to received station Note bearing for comparison in later steps

LF/ADDF System Test
 Table 502 (Sheet 1 of 2)

Ref T.O 1E-3A-2-34-1

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STEP	RESULT
14 Return mode selector to LOOP	Narrow pointers return to position noted in step 13
15 Using LOOP L/R control, rotate loop 170 degrees as indicated on RMI narrow pointer	
16 Set LF/ADF control panel mode selector to ADF <u>NOTE</u> GAIN control is inoperative in ADF mode	
17 Set LF/ADF control panel mode selector to ANT and BFO, switch to BFO	Audio zero beat occurs where tuning meter deflection is greatest to right
18 Tune in station	
19 Set control panel mode selector to OFF	
20 Set control panel BFO/OFF switch to OFF	
21 Open COMPASS circuit breakers on P5 circuit breaker panel	
22 Rotate OVHD PANEL control counterclockwise to OFF	
23 Remove aircraft electrical power if no longer required for other maintenance	

LF/ADF System Test
Table 502 (Sheet 2 of 2)

Ref T O 1E-3A-2-34~1
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FLIGHT DIRECTOR SYSTEM - DESCRIPTION AND OPERATION

1 SAFETY PRECAUTIONS

Refer to introduction for general safety precautions to be observed when operating or performing maintenance on the flight director system

Observe all CAUTION notes when performing tests on static pressure system

2 DESCRIPTION

- A. The dual flight director (F/D) system computes lateral (roll) and vertical (pitch) steering commands displayed to the pilot and the copilot. The steering command displays direct the pilots to maintain a specified attitude and heading for a selected mode of operation. The system includes two steering computers, two attitude director indicators (ADI), two horizontal situation indicators (HSI), two NAV MODE selector panels, two flight director annunciators and two flight instrument accessory units (See figure 1 for equipment location)
- B. The system has two independent subsystems F/D No 1 for the pilot and F/D No 2 for the copilot. Each flight director computer receives input signals from its associated VOR/ILS navigation system (GS or VOR/LOC deviation signals) or TACAN system, attitude reference system or INS (roll and pitch displacement error signals), marker beacon, air data computer, low range ratio altimeter and VG. Selected heading error and course error signals are also fed to each computer from its associated HSI. These error signals are developed with reference to aircraft magnetic heading when the desired magnetic heading or course is selected. The selected heading or course error signals, in combination with pressure altitude and the radio deviation, roll, or pitch signals are fed to the computer, which then develops the roll and pitch steering signals. The roll and pitch steering commands are displayed by the pitch and roll command bars in the ADI. The command bars are servo-operated and move to indicate the desired attitude in roll and pitch. The aircraft is then maneuvered so as to align the command bars against the miniature aircraft symbol. When the command bars are aligned with the miniature aircraft symbol, the aircraft will be in the correct attitude to intercept or remain on the desired flight path. Signal or power failure in a system along with failure in any one of the data supplying systems, is monitored through a warning flag circuit in the computer that displays the CMPTR warning flag in the ADI.

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3 FLIGHT DIRECTOR COMPUTER.

- A. The computer provides the roll and pitch steering commands displayed by the command bars in the ADI. These commands are dc signals, and are fed to operate the roll and pitch steering command servos in the ADI. Input signals for radio deviation, selected magnetic heading and roll angle are used in the computation of the roll steering command signal. Inputs of pitch attitude, glide slope deviation, or altitude information are used in the computation of the pitch steering command signal. There are two signal flow channels in the computer, roll and pitch, for these input signals. The computer contains two power supply circuits, attitude and heading power. The power supply inputs however are connected together, and power to the computer is from a single source. The computer also contains a warning flag circuit. The computer logic circuits are used in switching of the computer to the various modes of operation. Some of these logic circuits are controlled from the flight director control panel, and others are controlled internally in the computer. The CMPTR warning flag is actuated by a warning flag signal fed from the warning flag circuit. This circuit, in addition to monitoring all of the various input warning signals, also monitors power to the computer. Both flight director computers are installed in the RH Radio Rack Shelf 4 (See Figure 1).

4 FLIGHT DIRECTOR CONTROL PANEL

- A. The flight director control panel on the glare shield (figure 2) enables switching of the computer to operate in any one of the following modes: go-around, heading, navigation localizer, auto approach, and manual glideslope. It contains the mode selector switch, altitude hold switch and manual pitch command knob. The mode selector switch has the following positions: GA, OFF, HDG, NAV LOC, AUTO APP, or MAN GS. The switch will automatically return to the GA position from AUTO APP or MAN GS position when the go-around switch on either control wheel is pressed. The VOR/LOC ARM (V/L ARM) submode is selected by turning the mode selector switch to the HDG mode before turning to NAV LOC mode. When this is done, the amber VL indicator light in the display annunciator will come on and remain on until the display is switched to the green VL indicator light by mode signals from the computer. This happens when the appropriate beam is sensed. When GS ARM submode is selected by turning the mode selector switch to AUTO APP, the amber GS light will appear at the annunciator. The mode and annunciation will automatically switch to the green GS light when the GS beam capture sensor is operated. Alternatively, GS mode can be obtained by turning the mode selector switch to MAN GS.
- B. Altitude hold selection is provided by the altitude hold toggle switch, which is solenoid held in the ON position. If the mode selector switch is in either the AUTO APP or MAN GS mode, and the glide slope has been intercepted, the solenoid circuit will be opened and the altitude hold switch released from the ON position. The manual pitch command synchro, controlled by the manual PITCH CMD knob, supplies the manual pitch command signal to the computer.

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5. FLIGHT INSTRUMENT ACCESSORY UNITS.

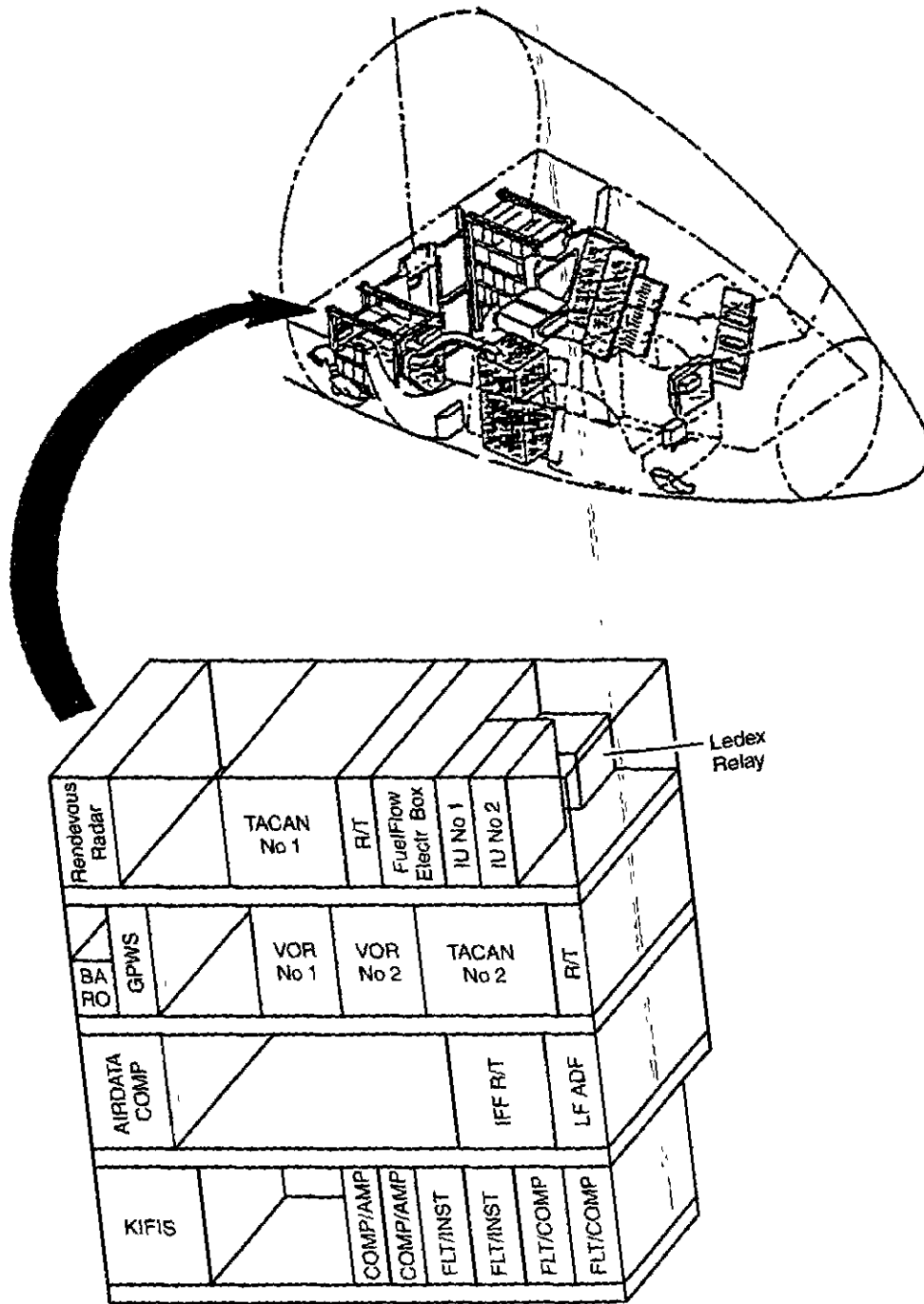
- A. Two flight instrument accessory units, No. 1 and No. 2, contain circuit elements required to adapt the flight director and other instruments to the outputs of the various navigation systems. Each accessory unit contains two printed circuit boards, three autotransformers and two relays. The relays are part of the attitude warning system and angle of attack system. The printed circuit boards contain loading resistors, isolation diodes, attitude and heading gain programming and monitor circuits and flight instrument switching valid logic. The three autotransformers provide 26 vac excitation for attitude, heading and bearing synchros. Two circuit breakers on the front of the unit protect bearing and heading excitation circuits of system that are cross fed. Two flight instrument accessory units are installed in the RH Radio Rack Shelf 4. (See figure 1).

6. FLIGHT DIRECTOR ANNUNCIATORS.

- A. A flight director annunciator is mounted on the pilot and copilot flight instrument panels. (See figure 1.) Each annunciator is a set of indicator lamps that display status of the flight director system. The green GA light indicates that the system is in or has reverted to go-around mode. The amber sections of the GS, VL and TACAN lights indicate selection of glide slope, VBOR/ILS or TACAN mode for the flight director but that the desired signal has not been acquired. The green sections of these indicators come on when the signal has been acquired. The TEST switch/indicator can be pressed to test the annunciators. Dimming of the annunciators is provided through the flight instrument panel dimming circuit.

7. FLIGHT DIRECTOR INTERFACE UNITS

- A. Two Flight Director Interface Units (IU), No. 1 and No. 2, are installed to provide the Flight Director Computers with the ALT HOLD error signal and the ADC/IU valid signal. These two signals provided by the Air Data Display Units (ADDUs) are routed via a Ledex Relay to the IUs and finally to the Flight Director Computers. Each Interface Unit receives the ARINC 429 signal from its respective ADDU and transmits an analog signal to the associated FDC (See Chapter 34-10-02, ADDU Block Diagram). The Interface Units are located in the RH Radio Rack.



RH RADIO RACK
 Flight Director System Equipment Location
 Fig 1

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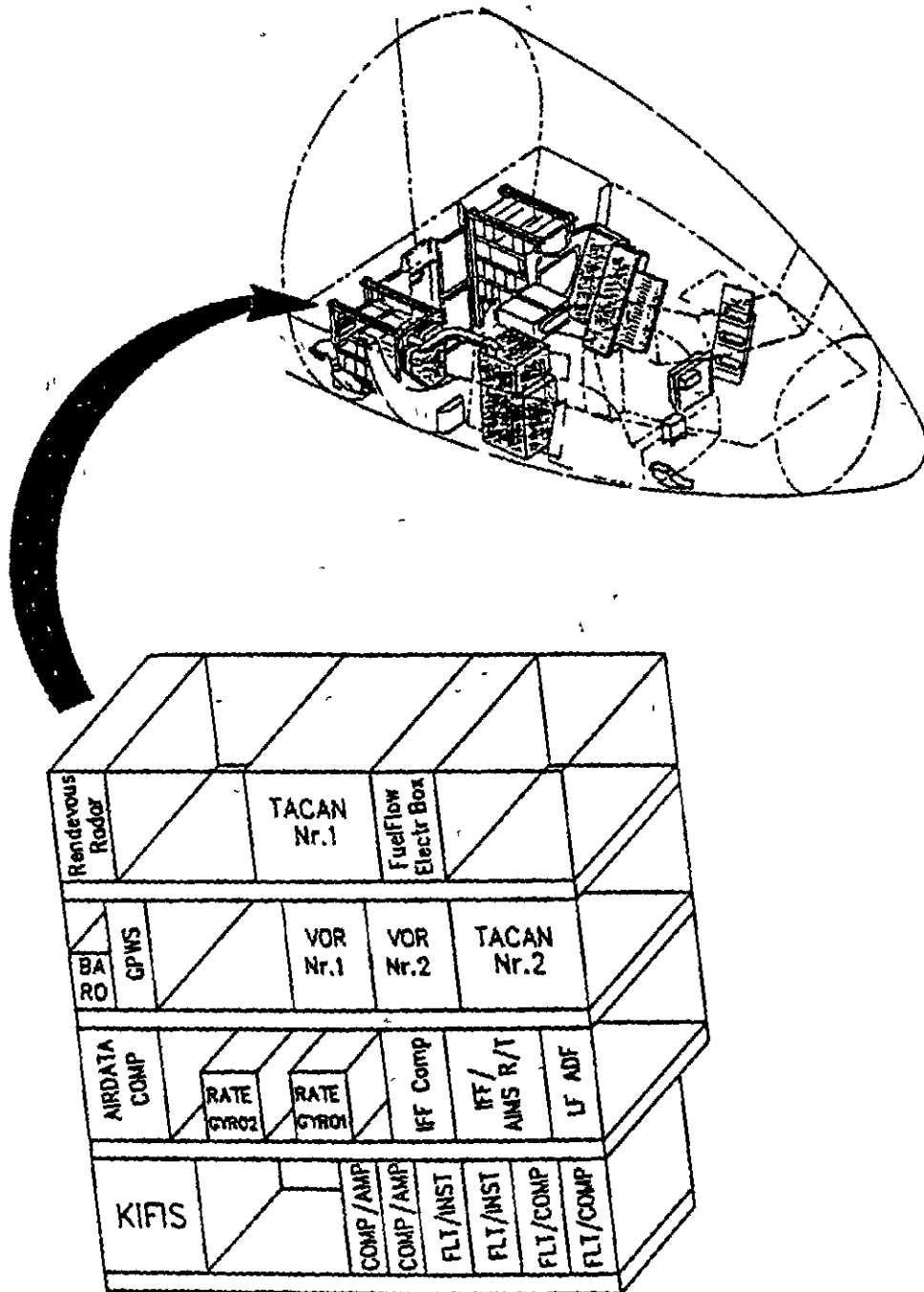
5 FLIGHT INSTRUMENT ACCESSORY UNITS

- A Two flight instrument accessory units, No 1 and No 2, contain circuit elements required to adapt the flight director and other instruments to the outputs of the various navigation systems. Each accessory unit contains two printed circuit boards, three autotransformers and two relays. The relays are part of the attitude warning system and angle of attack system. The printed circuit boards contain loading resistors, isolation diodes, attitude and heading gain programming and monitor circuits and flight instrument switching valid logic. The three autotransformers provide 26 vac excitation for attitude, heading and bearing synchros. Two circuit breakers on the front of the unit protect bearing and heading excitation circuits of systems that are cross fed. Two flight instrument accessory units are installed in the RH Radio Rack Shelf 4 (See figure 1)

6 FLIGHT DIRECTOR ANNUNCIATORS

- A A flight director annunciator is mounted on the pilot and copilot flight instrument panels (See figure 1). Each annunciator is a set of indicator lamps that display status of the flight director system. The green GA light indicates that the system is in or has reverted to go-around mode. The amber sections of the GS, VL and TACAN lights indicate selection of glide slope, VOR/ILS or TACAN mode for the flight director but that the desired signal has not been acquired. The green sections of these indicators come on when the signal has been acquired. The TEST switch/indicator can be pressed to test the annunciators. Dimming of the annunciators is provided through the flight instrument panel dimming circuit.

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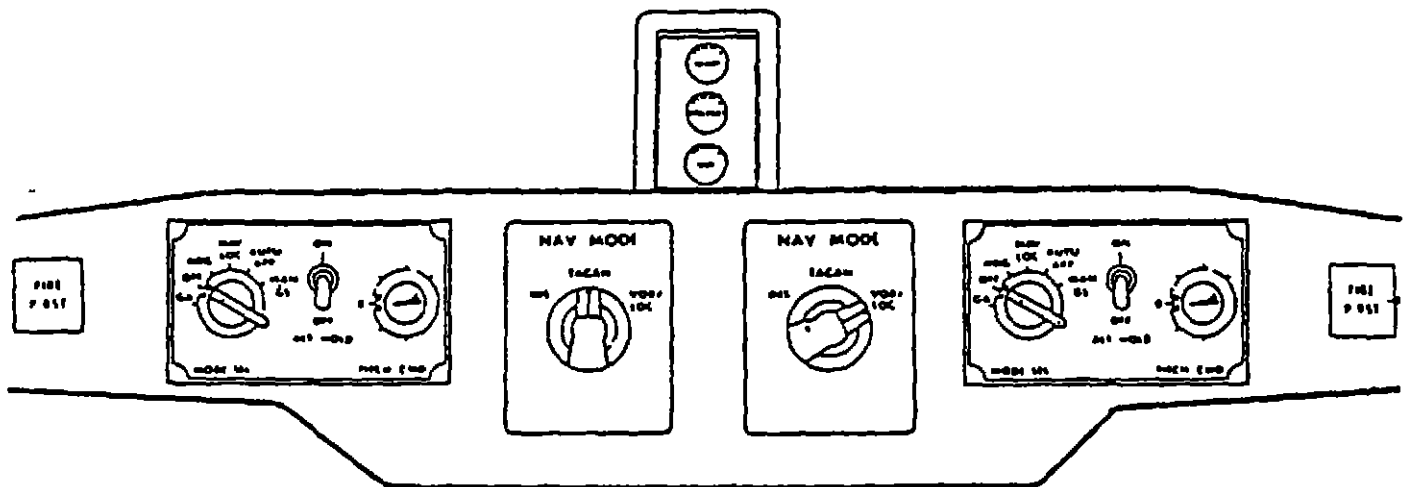


RH RADIO RACK
Flight Director System Equipment Location
Figure 1

Ref : CDRL 45 Issue D dtd Sep 30/88

SN REV. Dec 1/89

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Flight Director System Equipment Location
Figure 2

Ref.: CDRL 45 Issue D dtd. Sep 30/88

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7 OPERATION

A Before the flight director systems can be operated, the attitude reference, TACAN and VHF navigation circuit breakers must be closed and the systems must be operational. Closing the 28 vdc and 115 vac FLT DIR circuit breakers provides power to the flight director system. When power is applied to a system, if the mode selector is in OFF position, the command bars and the CMPTR warning flag in the ADI move out of sight. In this mode, as well as in all other modes, the CMPTR warning flag monitors power to the computer. Turning the mode selector switch to the GA mode, or any one of the other modes causes the command bars to come into sight. In the roll channel, the roll error signal, which is developed in the vertical gyro when the aircraft is rolled, is compared against the computed roll command signal to yield the roll steering command signal. In the pitch channel, the pitch error signal, or altitude error signal, is compared against the computed pitch command signal to yield the pitch steering command signal.

8 GA MODE

A The GA (go-around) mode of operation is used for an aborted approach. When initiated, the roll channel commands wings level and the pitch channel commands 8 degrees pitchup angle. The system can be switched to GA, from either of the glide slope modes, by pressing the AUTO PILOT RELEASE switch on either control wheel. This energizes the switch release solenoid and permits the mode selector to spring back to the GA position. When the flight director system is in GA mode, the annunciator shows GA green and the computer produces steering commands in the roll and pitch channels. In the roll channel, the computer receives roll error signals from the vertical gyro which are used for roll steering commands to the ADI. The command bar indicates the corrections necessary to keep the aircraft level. In the pitch channel, the computer receives and mixes pitch error signals from the AMPS vertical gyro with an 8 degree pitchup bias to produce pitch steering command signals. These steering command signals are supplied to the command bars in the ADI. The command bars then indicate the necessary corrections to keep the aircraft on the desired level flight path.

9 HDG MODE

A In the HDG mode of operation, the selected heading error signal is fed to the computer from the heading select synchro (heading error) in the HSI. The signal is limited and becomes the roll command signal. The roll error signal is fed from the vertical gyro. The steering commands are limited to 30 degrees in roll and 12 degrees in pitch. In the pitch channel, the pitch error signal and the manual pitch command signals are mixed together to provide the pitch steering command signal. The altitude error signal may be used in place of the manual pitch command signal. The CMPTR warning flag monitors power to the computer, gyro and compass inputs, and the steering command display system command bars (null detector).

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10. NAV/LOC MODE.

- A. In the NAV/LOC mode, the roll steering command signal provides steering command information to intercept and hold the selected TACAN, VOR, or LOC course. The steering commands are limited to 25 degrees in roll (in the 30° roll limiter) and 12 degrees in pitch. The action is the same for TACAN and VOR and similar for LOC courses. Tighter coupling is provided for LOC courses by logic circuits that alter the various gains and limits of the circuits. In this mode, course rate, TACAN, VOR, or LOC deviation rate, and roll rate signals are applied to the complementary filter to develop a synthetic radio deviation damping signal which opposes the TACAN, VOR, or LOC deviation signal in order to prevent overshoot in following the command and also provides error offset to allow a crab angle. The course cut limiter combines the output signal from the complementary filter with the TACAN, VOR, or LOC deviation signal and the course error signal to produce the roll command signal. The action of the limiter is to command interception of the selected course at an angle of 30 degrees before beam capture.

11. The VOR/LOC beam sensor is activated by VOR/LOC SUPER FLAG and NAV/LOC inputs.

- A. When the aircraft is within 5 degrees of a selected TACAN or VOR radial, a nav-capture signal, generated at the VOR/LOC beam sensor, changes the course out limiter output and reduces the command intercept angle from 30 to 17 degrees. At the same time, the complementary filter in the computer is producing a rate damping signal that opposes the roll command. As the aircraft path follows the command bar roll commands, the resultant flight path will be a smooth flare-in to the course. At the same time, the nav-capture signal activates a timer which, after a 90-second delay, also provides a nav-capture output and through an inverter produces a 0-volt level track-off signal. The timer output is provided to maintain nav-capture switching during temporary loss of a VOR/LOC beam sensor input.

12. V/L ARM SUBMODE.

- A. In the V/L arm submode, the pilot or copilot may choose the angle of capture for a TACAN, VOR or LOC course through selection of a desired heading. This is different from NAV/LOC mode, where an intercept angle of 30 degrees is maintained by the course out limiter. V/L arm submode is engaged by turning the mode selector switch momentarily to the HDG position and then to the NAV/LOC position. When this is done, the amber VL indicator lights at the annunciator, and the system operates initially as in HDG mode. When nav-capture is generated at the VOR/LOC beam sensor, the computer is automatically switched to either the NAV or LOC mode of operation. The annunciation amber VL, light goes out and the green VL light comes on. At this time the CMPTR warning flag will also begin monitoring NAV information from the navigation unit. The identical CMPTR warning flag action takes place when capturing a LOC beam, except that the warning flag circuit now monitors LOC inputs instead of VOR. In this mode, pitch channel operation is the same as that described for HDG mode.

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13 AUTO APP MODE

A. In the AUTO APP mode, roll channel operation is as described for V/L arm submode in NAV or LOC mode. In the initial phase of the GS mode, the amber GS arm light comes on at the annunciator, providing a GS SUPER FLAG signal is generated by the GS receiver and a LOC frequency select signal is delivered from the VRF navigation receiver. When the center of the glide slope beam is reached, a GS capture signal is generated in the GS beam sensor and the computer is automatically switched to the final approach phase. The CMPTR warning flag at this time begins monitoring glide slope information in addition to its other inputs. At this time also, the green GS light comes on in the annunciator. In the final approach phase, the roll channel utilizes the same signals as described for LOC mode and the roll commands are limited to 15 degrees. At glide slope capture, a pitchdown bias causes an approximate 2-degree pitchdown command. The complementary filter provides for crosswind correction. Glide slope gain programming is utilized to provide optimum control on the approach to the runway. The program is initiated after GS capture by the 1500 foot radio altimeter trip or by an R/A valid signal and is re-fined when the middle marker signal is received.

14 MAN GS MODE

A. In this mode of operation, automatic sensing of the glide slope beam, through the GS beam sensor, is eliminated. A voltage from the mode selector switch replaces the GS capture signal, and loss of GS AUTO mode voltage deactivates the sensor. Also, the annunciator will show green GS. Other than this, the operation remains identical to that in GS AUTO mode.

15 ALTITUDE HOLD SUBMODE

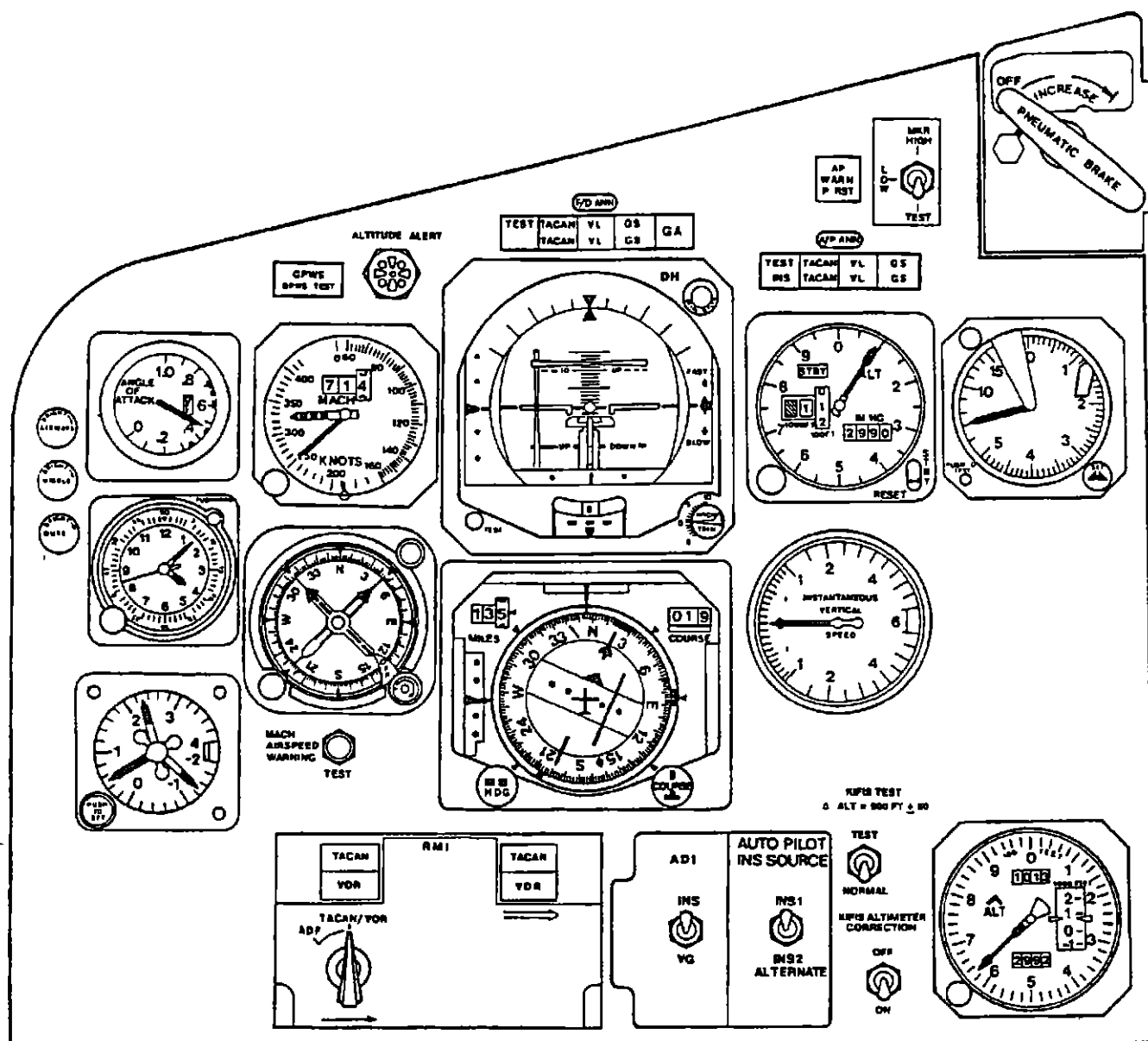
A. The altitude hold submode can be used in HDG, NAV LOC and GS AUTO modes. If the air data computer fails, a warning flag voltage switches off the altitude hold circuit and the ALTITUDE HOLD switch returns to the OFF position. In GS AUTO mode, as soon as glide slope capture is generated, the ALTITUDE HOLD switch springs to the OFF position. This enables glide slope deviation signals to be used in the pitch channel.

16 COMPUTER FLAG CIRCUIT OPERATION

A. The computer flag circuit provides a ground to operate the computer flag in the ADI. If the various inputs to the computer are correct and the computer is functioning properly, the ground is applied to the ADI to hold CMPTR flag out of view.

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Page 11-8 Change 2

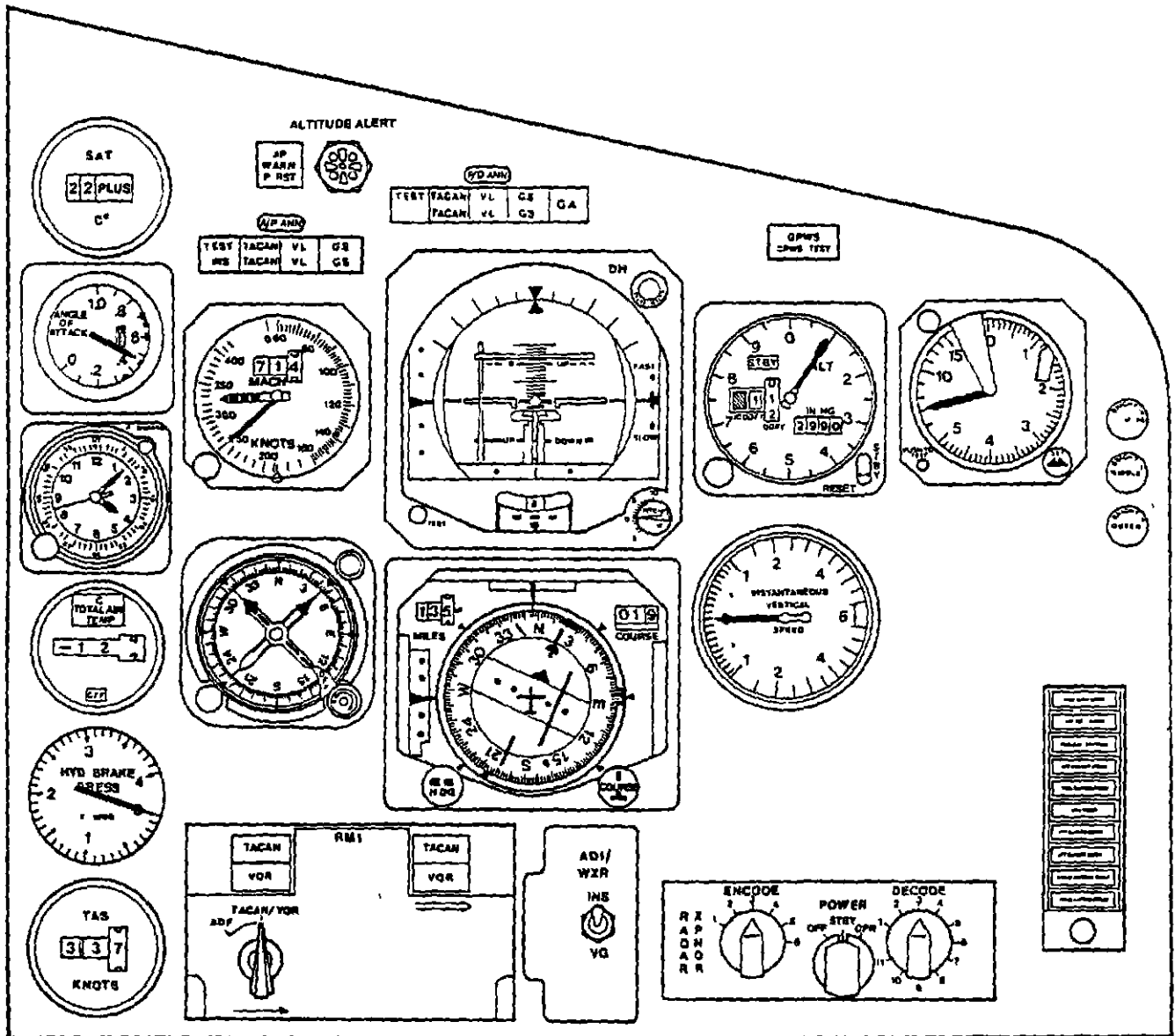
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Pilot's Instrument Panel
Figure 3

Ref. CDRL 45 Issue D dtd Sep 30/88

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Copilot's Instrument Panel
Figure 4

Ref CDRL 45 Issue D dtd. Sep 30/88



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FLIGHT DIRECTOR SYSTEM - TROUBLE SHOOTING

- A. Table 101 lists symptoms, probable causes, isolation procedures and corrective actions for failures observed in the flight director system. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
CMPTR flag does not appear when specified circuit breaker is opened	Defective Steering Computer or ADI	If flag responds correctly for all but one or two circuit breakers, computer is faulty	Replace computer or ADI
One annunciator light does not come on when Test/Switch Indicator is pressed	Burned out light bulb		Replace bulb
No annunciator lights come on for test	Defective Test/Switch indicator	Check for 28 vdc on normally open terminal of switch. If present, switch is defective	Replace Test/Switch Indicator

Flight Director System Trouble Analysis
Table 101 (Sheet 1 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Command bars do not stabilize	Defective ADI	Interchange ADIs	If OK, replace defective ADI
	Defective or loose tilt table	Check that tilt table is steady	Repeat test after steadying tilt table
	Defective VG	Turn on and initialize INS Check that command bars stabilize with Attitude Source Switch in INS position	If steady on INS, trouble was VG
	Defective Steering Computer	If unsteady on both VG and INS, trouble is probably in computer	Replace Steering Computer
Tilt table pitch more than 0 (± 3) degrees with pitch command bar centered	Defective ADI	Interchange ADIs	If OK, replace defective ADI
		Turn on and initialize INS Check pitch command bar position on INS attitude input	If OK now, troubleshoot VG
	Defective ADI or Steering Computer	Interchange ADIs	If other ADI OK, replace defective ADI
		Replace Steering Computer	Replace Steering Computer
Roll command bar does not move correctly for attitude displacement	Defective ADI	Interchange ADIs	If OK, replace defective ADI
	Defective Steering Computer	Interchange Steering Computers	If OK, replace defective Steering Computer
	Defective VG		Troubleshoot VG
	Defective HSI or Steering Computer	Interchange HSIs	1 If OK, replace defective HSI 2 Replace Steering Computer
Pitch command bar does not respond correctly to pitch CMD knob movement	Defective flight director mode selector panel	Interchange mode selector panels	If OK now, replace defective mode selector panel
	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective ADI		Replace ADI

Flight Director System Trouble Analysis
Table 101 (Sheet 2 of 9)



MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Pitch command bar does not respond correctly to altitude changes	Defective ADC	Switch ADC Source Select Switch to other ADC	If OK now, replace defective ADDU. If still incorrect, troubleshoot Interface Unit.
	Defective Interface Unit	Interchange Interface Unit	If OK now, replace defective Interface Unit.
	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer.
	Defective VG		Troubleshoot VG.
ALT Hold Switch does not spring off when ADC circuit breaker is opened	Defective Flight Instrument Accessory Unit, Flight Director Mode Selector Panel, Interface Unit or ADDU	Interchange Flight Instrument Accessory Unit, Interface Unit, ADDU one at a time to isolate the problem.	If OK now, replace defective unit.
		Interchange Mode Selector Panels	If OK now, replace defective Mode Selector Panel.
Amber VL or TACAN annunciator does not come on	Defective Steering Computer, Mode Selector Panel or VHF navigation system	Interchange Steering Computers	If OK now, replace defective Steering Computer.
		Interchange Mode Selector Panels	If OK now, replace defective Mode Selector Panels.
			Troubleshoot VHF navigation system.
Course deviation bar cannot be centered	Defective HSI	Interchange HSIs	If OK now, replace defective HSI.
Roll command bar responds incorrectly to HSI HDG knob	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer.
	Defective Mode Selector Panel	Interchange Mode Selector Panels	If OK now, replace defective Mode Selector Panel.
	Defective HSI	Interchange HSIs	If OK now, replace defective HSI.
Roll command bar responds incorrectly to VOR or TACAN inputs	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer.
	Defective HSI	Interchange HSIs	If OK now, replace defective HSI.

Flight Director System Trouble Analysis
Table 101 (Sheet 3 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Green VL annunciator does not come on when specified	Defective Steering Computer	If OK with alternate system, Steering Computer is defective	Replace Steering Computer
	Defective VHF navigation system	If not OK with alternate system, troubleshoot VHF navigation system	Troubleshoot VHF navigation or TACAN
Tilt table roll scale indicates more than ± 3 degrees from zero, 2 minutes after VOR or TACAN	Defective Steering Computer		Replace Steering Computer
Tilt table roll scale not 0 (± 3) degrees with roll command bar centered for 2 minutes on localizer signal	Defective Steering Computer		Replace Steering Computer
Amber VL annunciator not on when receiving localizer signal and more than two dots deviation	Defective VHF navigation system	If NAV flag is visible on HSI, VHF navigation system is faulty	Repair VHF navigation system
	Defective Steering Computer		Replace Steering Computer
Green VL annunciator does not come on when localizer deviation 2 0 (± 5) dots	Defective Steering Computer		Replace Steering Computer

Flight Director System Trouble Analysis
Table 101 (Sheet 4 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Roll command bar does not indicate correct command for localizer deviation	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective ADI		Replace defective ADI
Rising runway or flag incorrect	Defective ADI	Interchange ADIs	If OK now, replace defective ADI
	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective VHF navigation system		Troubleshoot VHF navigation system
Amber GS annunciator does not come on when receiving localizer and glide slope signals, 2000 feet radio altitude, more than two dots glide slope deviation	Defective Steering Computer		Replace Steering Computer
Roll command bar does not respond to pitch CMD signals in AUTO approach mode with more than two dots deviation	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective Mode Selector Panel	Interchange Mode Selector Panels	If OK now, replace defective Mode Selector Panel
	Defective ADI		Replace defective ADI

Flight Director System Trouble Analysis
Table 101 (Sheet 5 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
ALT hold switch springs off in AUTO approach mode, two dots GS deviation	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective Mode Selector Panel		Replace defective Mode Selector Panel
Annunciator or pitch command bar responds to glide slope signals in ALT hold mode	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective Mode Selector Panel		Replace defective Mode Selector Panel
VL Annunciator does not change from amber to green in AUTO approach when localizer deviation is reduced to less than two dots	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective Mode Selector Panel		Replace defective Mode Selector Panel
GS annunciator does not go green and ALT hold switch does not spring off when GS deviation is reduced to less than 0.5 dot in AUTO approach	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective Mode Selector Panel		Replace defective Mode Selector Panel

Flight Director System Trouble Analysis
Table 101 (Sheet 6 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Pitch command bar does not respond properly to glide slope	Defective Steering Computer or Flight Instrument Accessory Unit	Interchange Steering Computers	If OK now, replace defective Steering Computer
Pitch command does not decrease in 120 (± 12) seconds when Radio Altimeter is turned off at 2500 foot altitude in AUTO approach	Defective Steering Computer	Interchange Steering Computers	Replace defective Flight Instrument Accessory Unit If OK now, replace defective Steering Computer
	Defective Flight Instrument Accessory Unit	Interchange Flight Instrument Accessory Unit	If OK now, replace defective Flight Instrument Accessory Unit
	Defective Radio Altimeter		Troubleshoot Radio Altimeter
GS Annunciator incorrect	Defective Mode Selector Panel	Interchange Mode Selector Panels	If OK now, replace defective Mode Selector Panel
	Defective Steering Computer	Interchange Steering Computers	If OK now, replace defective Steering Computer
	Defective VHF navigation system		Troubleshoot VHF navigation system
Pitch channel does not respond to system middle marker	Defective marker beacon system	If middle marker lights come on, receiver is good	If middle marker lights are not on, troubleshoot marker beacon
	Defective Steering Computer		Replace defective Steering Computer

Flight Director System Trouble Analysis
Table 101 (Sheet 7 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
VL and GS Annunciators and command bars do not indicate localizer glide slope capture in man GS mode	Defective Steering Computer or Mode Selector Panel	Interchange Steering Computers	If OK now, replace defective Steering Computer
Incorrect tilt table roll with one dot localizer signal in man GS	Defective Steering Computer		Replace defective Mode Selector Panel Replace Steering Computer
Pitch channel gain does not decrease when mode is changed from auto APP to man GS	Defective Steering Computer		Replace Steering Computer
Pitch channel gain does not decrease when middle marker signal is applied	Defective Marker Beacon Receiver	If middle marker lights come on, receiver is good	
	Defective Steering Computer		Replace Steering Computer

Flight Director System Trouble Analysis
Table 101 (Sheet 8 of 9)

MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
GA Annunciator does not come on when Dis-connect Switch is pressed in MAN GS or AUTO approach	Defective Disconnect Switch or relay	Fault is probably in control panel	Check disconnect circuit per wiring diagram
Mode SEL Switch does not rotate to GA when Disconnect Switch is pressed	Defective Steering Computer		Replace Steering Computer
Tilt table does not indicate 8 (±2) degrees pitch up with pitch command bar centered in GA mode	Defective Mode Selector Panel or Steering Computer		Replace control panel or Steering Computer as required
GA Annunciator does not go out	Defective Steering Computer	Interchange Mode Selector Panel	Replace Steering Computer
	Defective Mode Selector Panel		If OK now, replace defective Mode Selector Panel

Flight Director System Trouble Analysis
Table 101 (Sheet 9 of 9)

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FLIGHT DIRECTOR SYSTEM.- TROUBLE SHOOTING

A Table 101 lists symptoms, probable causes, isolation procedures and corrective actions for failures observed in the flight director system. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
CMPTR flag does not appear when specified Circuit breaker is opened	Defective steering computer or ADI.	If flag responds correctly for all but one or two circuit breakers, computer is faulty	Replace computer or ADI
One annunciator light does not come on when test/switch indicator is pressed	Burned out light bulb		Replace bulb
No annunciator lights come on for test	Defective TEST/switch indicator	Check for 28 vdc on normally open terminal of switch. If present, switch is defective	Replace switch/indicator

Flight Director System Trouble Analysis
Table 101 (Sheet 1 of 9)

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Page 11-9 Change 19
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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Command bars do not stabilize	Defective ADI	Interchange ADI's	If OK replace defective
	Defective or loose tilt table	Check that tilt table is steady	Repeat test after steady-ing tilt table
	Defective VG	Turn on and initialize INS, Check that command bars stabilize with attitude source switch in INS position	If steady on INS, trouble was VG
	Defective steering computer	If unsteady on both VG INS, trouble is probably in computer	Replace steering computer
Tilt table pitch more than 0 (±3) degrees with pitch command bar centered	Defective ADI	Interchange ADI's	If OK, replace ADI
	Defective ADI or steering computer	Turn on and initialize INS Check pitch command bar position on INS attitude input	If OK now, troubleshoot VG
Roll command bar does not move correctly for attitude displacement	Defective ADI	Interchange ADI's	If other ADI OK, replace
	Defective steering computer	Replace steering computer	Replace steering computer
	Defective VG	Interchange ADI's	Troubleshoot VG
Roll command bar does not respond correctly to heading change	Defective HSI or steering computer	Interchange steering computers	If OK, replace defective HSI
	Defective VG	Interchange HSI's	2 Replace steering computer
Pitch command bar does not respond correctly to pitch CMD knob movement	Defective flight director mode selector panel.	Interchange mode selector panels.	If OK now, replace defective mode selector panel
	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective ADI	Interchange ADI's	Replace ADI

Flight Director System Trouble Analysis
Table 101 (Sheet 2 of 9)

Ref T O 1E-3A-2-31-1
Page 11-25 Change 0



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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Pitch command bar does not respond correctly to altitude changes	Defective CADC Defective steering computer Defective VG	Check CADC readouts on altimeter Interchange steering computer steering computer	If incorrect, troubleshoot CADC If OK now, replace steering computer Troubleshoot VG
ALT hold switch does not spring off when CADC circuit breaker is opened	Defective flight instrument accessory unit, flight director Mode selector panel or CADC.	Interchange flight instrument accessory units Interchange mode selector panels	If OK now, replace defective flight accessory unit If OK now, replace defective mode selector panel Troubleshoot CADC
Amber VL or TACAN annunciator does not come on	Defective steering computer mode selector panel or vhf navigation system	Interchange steering computers Interchange mode selector panels	If OK now, replace defective steering computer If OK now, replace mode selector panel Troubleshoot vhf navigation system
Course deviation bar cannot be centered	Defective HSI	Interchange HSI's If OK now, HSI is defective	Replace defective HSI
Roll command bar responds incorrectly to HSI HDG' knob	Defective steering computer Defective mode selector panel. Defective HSI	Interchange steering computers Interchange mode selector panels	If OK now, replace defective steering computer. If OK now, replace defective mode selector panel Replace HSI
Roll command bar does not respond correctly to VOR or TACAN inputs	Defective steering computer Defective HSI	Interchange steering computers If OK now, steering computer is defective	Replace defective steering computer Replace HSI

Flight Director System Trouble Analysis
Table 101 (Sheet 3 of 9)

Ref.. T O 1E-3A-2-31-1
Page 11-26 Change 0

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Green VL annunciator does not come on when specified	Defective steering computer	If OK with alternate system, steering computer is defective	Replace steering computer
	Defective VHF navigation system	If not OK with alternate system, troubleshoot VHF navigation system	Troubleshoot VHF navigation or TACAN
Tilt table roll scale indicates more than ± 3 degrees from zero, 2 minutes after VOR or TACAN	Defective steering computer		Replace steering computer
Tilt table roll scale not 0 (± 3) degrees with roll command bar centered for 2 minutes on localizer signal	Defective steering computer		Replace steering computer
Amber VL annunciator not on when receiving localizer signal and more than two dots deviation	Defective VHF navigation system	If NAV flag is visible on HSI VHF navigation system is faulty	Repair VHF navigation system
	Defective steering computer		Replace steering computer
Green VL annunciator does not come on when localizer deviation 2 0 (± 5) dots	Defective steering computer		Replace steering computer

Flight Director System Trouble Analysis
Table 101 (Sheet 4 of 9)

Ref T O 1E-3A-2-31-1
Page 11-27 Change 0



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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Roll command bar does not indicate correct command for localizer deviation	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective ADI.		Replace defective ADI
Rising runway or flag incorrect	Defective ADI	Interchange ADI's	If OK now, replace defective ADI
	Defective steering computer	Interchange steering computer	If OK now, replace defective steering computer
	Defective VHF navigation system		Troubleshoot VHF navigation system
Amber GS annunciator does not come on when receiving localizer and glide slope signals, 2000 feet radio altitude, more than two dots glide slope deviation	Defective steering computer		Replace steering computer
Roll command bar does not respond to pitch CMD signals in AUTO approach mode with more than two dots deviation	Defective steering computer	Interchange steering computer	If OK now, replace defective steering computer
	Defective mode selector panel	Interchange mode selector panels	If OK now, replace defective mode selector panel
	Defective ADI		Replace ADI

Flight Director System Trouble Analysis
Table 101 (Sheet 5 of 9)

Ref T O 1E-3A-2-31-1
Page 11-28 Change 0



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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
ALL hold switch springs off in AUTO approach mode, two dots GS deviation	Defective steering computer Defective mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
Annunciator or pitch command bar responds to glide slope signals in ALT hold mode	Defective steering computer Defective mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
VL annunciator does not change from amber to green in AUTO approach when localizer deviation is reduced to less than two dot	Defective steering computer Defective mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
GS annunciator does not go green and ALD hold switch does not spring off then GS deviation is reduced to less than 0.5 dot in AUTO approach.	Defective steering computer Defective mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel

Flight Director System Trouble Analysis
Table 101 (Sheet 6 of 9)

Ref. T O 1E-3A-2-31-1
Page 11-29 Change 0



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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Pitch command bar does not respond properly to glide slope	Defective steering computer or flight instrument accessory unit	Interchange steering computers	If OK now, replace defective steering computer Replace defective flight instrument accessory unit
Pitch command does not decrease in 120 (± 12) seconds when radio altimeter is turned off at 2500 foot altitude in AUTO approach	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective flight instrument accessory unit	Interchange flight instrument accessory units	If OK now, replace defective flight instrument accessory unit,
	Defective radio altimeter		Troubleshoot radio altimeter
GS annunciator incorrect	Defective mode selector panel	Interchange mode selector panels	If OK now, replace defective mode selector panel
	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective VHF navigation system.		Troubleshoot VHF navigation system
Pitch channel does not respond to system middle marker	Defective marker beacon system on,	If middle marker lights come receiver is good	If middle marker lights are not on, troubleshoot marker beacon
	Defective steering computer		Replace defective steering computer

Flight Director System Trouble Analysis
Table 101 (Sheet 7 of 9)

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MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
VL and GS annunciators and command bars do not indicate localizer glide slope capture in man GS mode	Defective steering computer or mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
Incorrect tilt table roll with one dot localizer signal in man GS	Defective steering computer		Replace steering computer
Pitch channel gain does not decrease when mode is changed from auto APP to MAN GS	Defective steering computer		Replace steering computer
Pitch channel gain does not decrease when middle marker signal is applied	Defective marker beacon receiver. Defective steering computer	If middle marker lights come on, receiver is good	 Replace steering computer

Flight Director System Trouble Analysis
Table 101 (Sheet 8 of 9)

Ref. T.O. 1E-3A-2-31-1
Page 11-31 Change 0



MAINTENANCE MANUAL

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
GA annunciator does not come on when disconnect switch is pressed in MAN GS or AUTO approach	Defective disconnect switch or relay Defective steering computer		Check disconnect circuit per wiring diagram Replace steering computer
Mode SEL switch does not rotate to GA when disconnect switch is pressed	Defective mode selector panel or steering computer	Fault is probably in control panel	Replace control panel or steering computer as required
Tilt table does not indicate 8 (± 2) degrees pitch up with pitch command bar centered in GA mode	Defective steering computer		Replace steering computer
GA annunciator does not go out	Defective mode selector panel	Interchange mode selector panel	If OK now, replace defective mode selector panel

Flight Director System Trouble Analysis
Table 101 (Sheet 9 of 9)

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Page 11-32 Change 0

FLIGHT DIRECTOR SYSTEM - REMOVAL/INSTALLATION

1. CONTROL PANEL REMOVAL.

NOTE: Flight Director Control Panel is located on the glare shield.

- A. Open FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel.
- B. Disconnect electrical connector on back of panel.
- C. Remove four screws from front of panel.
- D. Pull panel from mounting space.

2. CONTROL PANEL INSTALLATION.

NOTE: Flight Director Control Panel is located on the glare shield.

- A. Check that FLT DIR CMPTR and DC circuit breakers are open on P5 circuit breaker panel.
- B. Insert panel into mounting space.
- C. Fasten with four screws.
- D. Connect electrical connector on back of panel.
- E. Close FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel.

3. FLIGHT DIRECTOR COMPUTER REMOVAL.

- A. Open and tag FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel.
- B. Loosen restraining thumbnuts by unscrewing far enough to drop the securing bolts clear of the lip on the end of the computer.
- C. Pull computer straight out without lifting the end up. Bending or twisting the unit will increase the friction of the rear connectors. Be careful because the friction will suddenly decrease when connector comes loose.



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4. FLIGHT DIRECTOR COMPUTER INSTALLATION.

- A. Check that FLT DIR CMPTR and DC circuit breakers are open on P5 circuit breaker panel.
- B. Check rear electrical connector to be sure shipping cover is removed and all pins are straight and clean.
- C. Slide computer straight into rack until connector starts to engage.
- D. Tighten restraining thumbscrews evenly, taking care not to apply excessive pressure. If unit seems difficult to seat properly, remove unit and check for bending and proper alignment.
- E. Close FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel.

5. FLIGHT DIRECTOR ANNUNCIATOR REMOVAL.

- A. Open CENTER PNL IND circuit breaker on P7 cockpit lighting circuit breaker panel.
- B. Disengage quick-release fasteners on section of instrument panel containing annunciator.
- C. Slide out instrument panel section to gain access to rear of panel.
- D. Disconnect electrical connector from flight director annunciator.
- E. Support annunciator module and remove four mounting screws.
- F. Remove annunciator module.

6. FLIGHT DIRECTOR ANNUNCIATOR INSTALLATION.

- A. Check that CENTER PNL IND circuit breaker is open on P7 cockpit lighting circuit breaker panel.
- B. Place Flight Director Annunciator in mounting position in instrument panel and install four mounting screws. Make sure that TOP legend on module is facing up.
- C. Connect electrical connector.
- D. Close CENTER PNL IND circuit breaker on P7 cockpit lighting circuit breaker panel.
- E. Press TEST Annunciator. All flight director annunciators light.

7. ATTITUDE DIRECTOR INDICATOR REMOVAL.

- A. Open pilot or copilot HDG, BRG, ATTD, XMFR, RATE, TURN and FLT DIR DC circuit breaker on P5 circuit breaker panel.



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- B. Loosen indicator mounting clamp adjustment screws, about 1/4-inch (figure 401).
- C. Press on clamp adjustment screws to loosen clamp.
- D. Slide indicator out of panel and disconnect electrical connectors.

NOTE: It may be necessary to slide instrument panel section out to gain access to electrical connector.

8. ATTITUDE DIRECTOR INDICATOR, INSTALLATION

- A. Align indicator with panel cutout and connect electrical connectors.
- B. Insert indicator into panel.

CAUTION DO NOT OVERTIGHTEN CLAMP ADJUSTMENT SCREWS OR INSTRUMENT MAY BE DAMAGED

- C. Tighten mounting clamp adjustment screws (figure 401).
- D. Close HDG, BRG, ATTD, XMFR, RATE, TURN and FLT DIR DC circuit breakers if required.

NOTE: These procedures do not check the system completely. Refer to Adjustment/Test for a complete system checkout.

9. STEERING COMPUTER, MODE SELECTOR PANEL OR DIRECTOR INDICATOR.

- A. Provide electrical power.
- B. Close HDG EXC and ATTD EXC circuit breakers on head circuit breaker panel P5.
- C. Check that following circuit breakers on circuit breaker panel P5 are closed:

ADC 1; IU No. 1

CADC

TACAN No. 1

Low Range Altm No.1

VOR No. 1; GS No. 1

ADC 2; IU No. 2

TACAN No. 2



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VOR No. 2; GS No. 2

FLT INST No. 1 FD No. 1 DC

FLIGHT DIR COMPTR No. 1 and No. 2

BRG EXC

FLIGHT INSTRUMENTS No. 1

BRG EXC

FLIGHT INSTRUMENTS No. 2

XMFR No. 1

XMFR No. 2

MARKER BEACON

Radio bus No. 2

- D. Set flight director MODE SEL switch to HDG. CMPTR flag in ADI appears when each of the following circuit breakers is momentarily opened: FLT INST No. 1, FD No. 1, F/D COMPTR No. 1, FLT INST No. 2, F/D COMPTR No. 2
- E. Set flight director MODE SEL to OFF.
- F. Remove electrical power, if no longer required for maintenance.



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10. HORIZONTAL SITUATION INDICATOR.

- A. Provide electrical power.
- B. Close HDG EXC and ATTD EXC circuit breakers on circuit breaker panel P5.
- C. Check that following circuit breakers on circuit breaker panel P5 are closed:

ADC 1; IU No. 1

CADC

TACAN No. 1

Low Range Altm No. 1

VOR No. 1; GS No. 1

ADC 2; IU No. 2

TACAN No. 2

VOR No 2; GS No. 2

FLT INST No. 1, FD No 1 DC

FLIGHT DIR CMPTR No. 1 and No. 2

BRG EXC

FLIGHT INSTRUMENTS No 1

BRG EXC

FLIGHT INSTRUMENTS No 2

XMFR No. 1

XMFR No. 2

MARKER BEACON

RADIO BUS No. 2

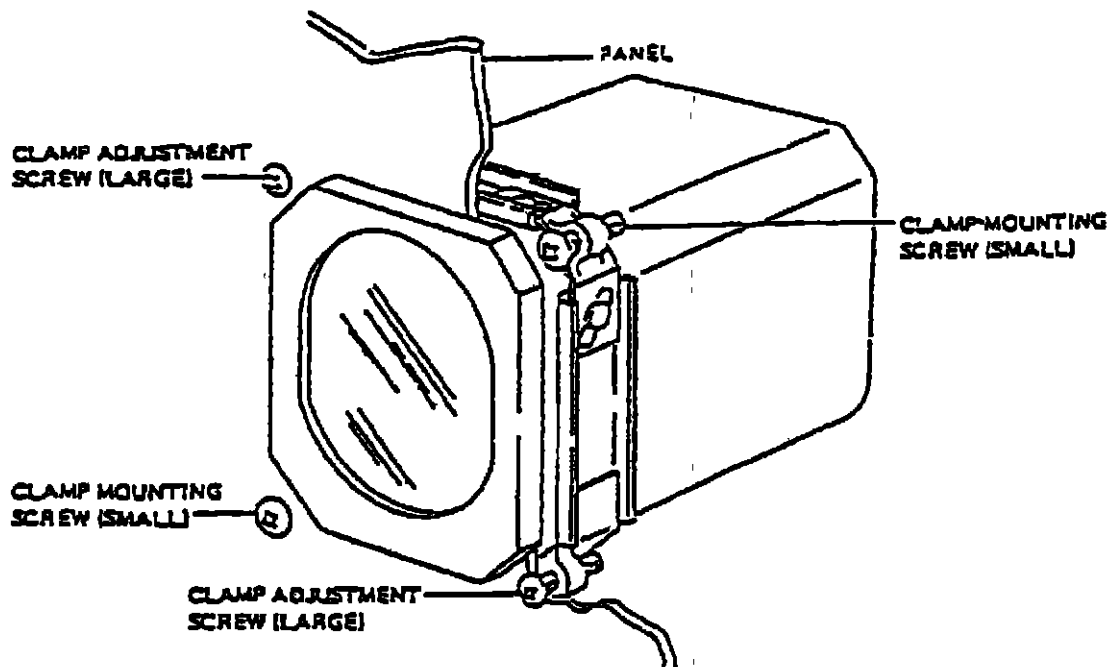
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- D. Set flight director MODE SEL switch to FGD
- E. Turn HSI SET HDG control. Compass card on HSI moves in proper direction required by set HDG control.
- F. Set flight director MODE SEL to OFF
- G. Open previously closed circuit breaker on overhead circuit breaker panel.
- H. Remove electrical power, if no longer required for other maintenance.

11. FLIGHT DIRECTOR ANNUNCIATOR.

- A. Press TEST Annunciator.
All flight director annunciators light.

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Attitude Director Indicator (ADI) Installation
Fig. 401

END



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FLIGHT DIRECTOR SYSTEM - REMOVAL/INSTALLATION

1. CONTROL PANEL REMOVAL

NOTE Flight Director control panel is located on the glare shield

- A Open FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel
- B Disconnect electrical connector on back of panel
- C Remove four screws from front of panel
- D Pull panel from mounting space

2. CONTROL PANEL INSTALLATION

NOTE Flight Director control panel is located on the glare shield

- A Check that FLT DIR CMPTR and DC circuit breakers are open on P5 circuit breaker panel
- B Insert panel into mounting space
- C Fasten with-four screws
- D Connect electrical connector on back of panel
- E Close FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel

3. FLIGHT DIRECTOR COMPUTER REMOVAL

- A Open and tag FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel
- B Loosen restraining thumbnuts by unscrewing far enough to drop the securing bolts clear of the lip on the end of computer
- C Pull computer straight out without lifting the end up. Bending or twisting the unit will increase the friction of the rear connectors. Be careful because the friction will suddenly decrease when connector comes loose

4. FLIGHT DIRECTOR COMPUTER INSTALLATION

- A Check that FLT DIR CMPTR and DC circuit breakers are open on P5 circuit breaker panel.
- B Check rear electrical connector to be sure shipping cover is removed and all pins are straight and clean
- C Slide computer straight into rack until connector starts to engage.

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D Tighten restraining thumbscrews evenly, taking care not to apply excessive pressure. If unit seems difficult to seat properly, remove unit and check for binding and proper alignment.

E Close FLT DIR CMPTR and DC circuit breakers on P5 circuit breaker panel.

5 FLIGHT DIRECTOR ANNUNCIATOR REMOVAL

A Open CENTER PNL IND circuit breaker on P7 cockpit lighting circuit breaker panel.

B Disengage quick-release fasteners on section of instrument panel containing annunciator.

C Slide out instrument panel section to gain access to rear of panel.

D Disconnect electrical connector from flight director annunciator.

E Support annunciator module and remove four mounting screws.

F Remove annunciator module.

6 FLIGHT DIRECTOR ANNUNCIATOR INSTALLATION

A Check that CENTER PNL IND circuit breaker is open on P7 cockpit lighting circuit breaker panel.

B Place flight director annunciator in mounting position in instrument panel and install four mounting screws. Make sure that TOP legend on module is facing up.

C Connect electrical connector.

D Close and secure instrument panel.

E Close CENTER PNL IND circuit breaker on P7 cockpit lighting circuit breaker panel.

F Press Test annunciator. All flight director annunciators light.

7 ATTITUDE DIRECTOR INDICATOR REMOVAL

A Open pilot or copilot HDG, BRG, ATTD, XFMR, RATE, TURN and FLT DIR DC circuit breaker on P5 circuit breaker panel.

CAUTION LOOSEN ONLY LARGER SCREWS. CLAMP MAY DETACH FROM PANEL IF SMALLER SCREWS ARE LOOSENED.

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- B Loosen indicator mounting clamp adjustment screws, about 1/4-inch (figure 401)
- C Press on clamp adjustment screws to loosen clamp
- D Slide indicator out of panel and disconnect electrical connectors

NOTE It may be necessary to slide instrument panel section out to gain access to electrical connector

8 ATTITUDE DIRECTOR INDICATOR, INSTALLATION

- A Align indicator with panel cutout and connect electrical connectors
- B Insert indicator into panel

CAUTION DO NOT OVERTIGHTEN CLAMP ADJUSTMENT SCREWS OR INSTRUMENT MAY BE DAMAGED

- C Tighten mounting clamp adjustment screws (figure 401)
- D Close HDG, BRG, ATTD, XMFR, RATE, TURN and FLT DIR DC circuit breakers if required

NOTE These procedures do not check the system completely Refer to Adjustment/Test for a complete system checkout

9 STEERING COMPUTER, MODE SELECTOR PANEL OR DIRECTOR INDICATOR

- A Provide electrical power
- B Close HDG EXC and ATTD EXC circuit breakers on head circuit breaker panel P5
- C Check that following circuit breakers on circuit breaker panel P5 are closed

CADC

TACAN No 1

Low Range Altm No 1

VOR No 1 , GS No 1

TACAN No 2

VOR No 2 , GS No 2

FLT INST No. 1 FD No 1 DC

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FLIGHT DIR COMPTR No 1 and No 2

BRG EXC

FLIGHT INSTRUMENTS No 1

BRG EXC

FLIGHT INSTRUMENTS No 2

XMFR No 2

XMFR No 2

MARKER BEACON

Radio bus No 2

- D Set flight director MODE SEL switch to HDG COMPTR flag in ADI appears when each of the following circuit breakers is momentarily opened
FLT INST No 1 FD No 1, F/D COMPTR No 1, FLT INST No 2, F/D COMPTR No 2

- E Set flight director MODE SEL to OFF

- F Remove electrical power, no longer required for maintenance

10 HORIZONTAL SITUATION INDICATOR

- A Provide electrical power

- B Close HDG EXC and ATTD EXC circuit breakers on circuit breaker panel P5

- C Check that following circuit breakers on circuit breaker panel P5 are closed

CADC

TACAN No 1

Low Range Altm No 1

VOR No 1; GS No 1

TACAN No 2

VOR No 2, GS No 2

FLT INST No 1 FD No 1 DC

FLIGHT DIR COMPTR No 1 and No 2

BRG EXC

FLIGHT INSTRUMENTS No 1

BRG EXC

FLIGHT INSTRUMENTS No 2

XMFR No 1

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XMER No 2

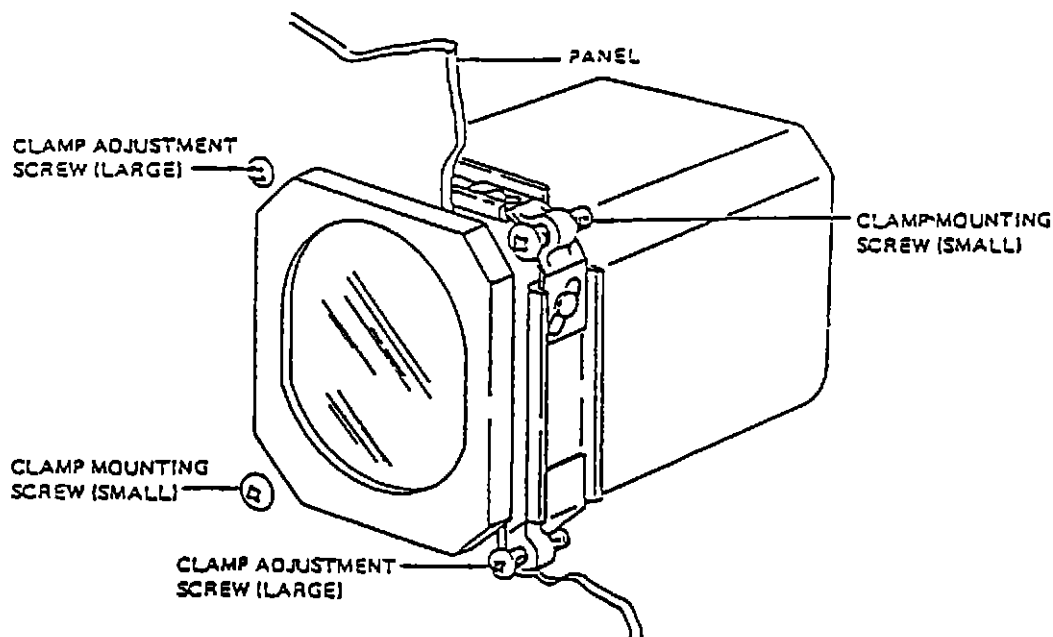
MARKER BEACON

RADIO BUS No 2

- D Set flight director MODE SEL switch to FGD
- E Turn HSI SET HDG control. Compass card on HSI moves in proper direction required by set HDG control.
- F Set flight director MODE sel to OFF
- G Open previously closed circuit breaker on overhead circuit breaker panel
- H Remove electrical power, if no longer required for other maintenanc

11 FLIGHT DIRECTOR ANNUNCIATOR

- A Press TEST annunciator
All flight director annunciators light



Attitude Director Indicator (ADI) Installation
Figure 401

Ref . T O. 1E-3-2-31-1
Page 11-10 Change 3
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FLIGHT DIRECTOR SYSTEM - ADJUSTMENT/TEST

1. FLIGHT DIRECTOR SYSTEM TEST.

FLIGHT DIRECTOR SYSTEM, Collins Radio Company, composed of Steering Computer 562A-5F4, Controller 614E-10D, Horizontal Situation Indicator 331A-8H, and Attitude (Flight) Director Indicator 329B-9A.

A. General Information

- (1) There are two independent flight director systems installed on the airplane to supply guidance commands to the pilot and copilot. The guidance commands are a function of flight director mode selection and the subsystem supplying raw data. Raw data is supplied from the following systems as selected: VG, Compass, VHF NAV system, TACAN, radio altimeter system, marker beacon system and air data computer system. The system functional tests for the above systems shall have been completed as necessary to accomplish this test
- (2) It is required that power be available at the associated power busses and that the flight deck lighting be operating.
- (3) This test establishes the requirements for installation and airplane test of the flight director system. No adjustments shall be made except as stated herein

B Test Equipment Required

- (1) IFR Model NAV-401L Test Set or equivalent, 2 required. One unit is used to generate a VOR, LOC, or GS test signal, and the other to generate a middle marker test signal
- (2) TACAN Flight Line Tester. .Federal Telecon NUS-3156 or AN/ARM-25C Ramp Test Set, one required or equivalent.
- (3) Test Oscillator Cossor FT113 or equivalent, one required. Used to generate a middle marker test signal.
- (4) FD1104-12-15 Universal Radio Altimeter Simulator or equivalent, one required. Used to simulate airplane altitude in the Radio Altimeter Receiver/Transmitter unit.
- (5) Air Pressure Test Set, one required. Used to provide static pressure to the Air Data Computer for Altitude Hold tests.
- (6) Tilt turn table, FD500-1886 or equivalent, one required.



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C. Test Requirements

- (1) Prepare for test. Remove vertical gyros from airplane and install on calibrated tilt tables and level in roll and pitch ($0^\circ \pm 1^\circ$).

CAUTION ALLOW GYROS TO RUN DOWN BEFORE MOVING TO PREVENT TUMBLING GIMBALS

- (2) Close the following circuit breakers on the P5 overhead panel:

<u>ESSENTIAL FLIGHT INSTR BUS</u>	<u>FLIGHT INSTRU- MENT BUS NO 2</u>	<u>ESSENTIAL RADIO BUS</u>	<u>RADIO BUS NO 2</u>
ADC 1 DC		ADC 2 DC	IU NO 2 DC
RATE OF TURN CAPT DC	RATE OF TURN F/O DC	IU NO 1 DC	ADC XFER DC
FLT INSTR NO 1 FD NO 1 DC	XMFR NO 2 AC	LOW RANGE ALTM NO. 1	TACAN NO 2 DC
COMPTR NO 1 DC (LX-N 20199)	FLT INST NO 2 DC	TACAN NO 1 DC	TACAN NO 2 AC
F/D COMPTR NO 1 DC (LX-N 19997, LX-N 20000)			
FLT INST NO 1 HDG EXC AC	COMPTR NO 2 AC (LX-N 20199) F/O COMPTR NO 2 AC (LX-N 19997, LX-N 20000)	TACAN NO 1 AC	VOR NO 2 DC
XMFR NO 1 AC	FLT INST NO 2 BRG EXC AC	VOR NO 1 DC	VOR NO 2 AC
VERT GYRO NO 1 AC	FLT INST NO 2 HDG EXC AC	VOR NO 1 AC	GS NO 2 DC
COMPASS NO 1 AC	FLT INST NO 2 ATT EXC AC	GS NO 1 DC	
FLT INST NO 1 ATT EXC AC	NAV XFER RLY NO 2 DC		
NAV XFER RLY NO 1 DC			
CADC AC			

- (3) Set Pitch Trim Control on both ADIs to "0".
- (4) Set up one NAV-401L Test Set, or equivalent, for VOR test signal: Set Test Set to VOR XTL (108,0 MHz), or for LOC and GS signals: Set Test Set to GS XTL (108,1 MHz, LOC and 334,7 MHz, GS) and adjust for proper power output.
- (5) Tune both VHF NAV systems to localizer frequency selected on test set.
- (6) Set a TACAN test signal in TACAN test set.



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- (7) Tune TACAN receiver to test channel.
- (8) Synchronize compass systems and allow a few minutes for gyros to stabilize
- (9) Set both NAV MODE Selectors to VOR/LOC.
- (10) Set the heading marker and the course arrow on both HSIs to airplane heading. Pull out HDG and COURSE knobs for manual selection.
- (11) Set the PITCH CMD Knob on both Mode Selectors to zero.

D Flight Director System Monitor

NOTE:

- (1) Return circuit breakers to initial conditions after each step unless otherwise noted.
- (2) The flight director command bars shall be in view and the CMPTR flags shall be out of view in both ADIs unless otherwise noted.

E. Command and Annunciation

NOTE:

- (1) The following tests may be performed on the Capt and F/O side separately or simultaneously.
- (2) Unless otherwise stated, the following equipment shall be utilized for test pertaining to the Captain's side: Captain Flight Director Mode Selector, ADI, HSI, NAV MODE Selector, Flight Director Annunciator; Displacement Gyro No. 1, VHF NAV No. 1, Radio Altimeter No. 1, Marker Beacon and Air Data Computer No. 1.
- (3) Unless otherwise stated, the following equipment shall be utilized for test pertaining to the F/O side: F/O Flight Director Mode Selector, ADI, HSI, NAV MODE Selector, Flight Director Annunciator, Displacement Gyro No. 2, VHF NAV No. 2, Radio Altimeter No. 1, Marker Beacon and Air Data Computer No. 2.



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STEP	CONDITION	OPEN CIRCUIT BREAKER	CMPTR FLAG IN VIEW	COMMAND BARS OUT OF VIEW
(1)	Place both mode selectors to HDG mode			
(2)		CMPTR NO 1 AC	CAPT	CAPT
(3)		FLT INSTR NO 1 FD NO 1 DC	CAPT	CAPT
(4)		COMPASS NO 1 AC	CAPT	CAPT
(5)		FLT INSTR NO 1 ATT EXC AC	CAPT	
(6)		FLT INSTR NO 1 HDG EXC AC	CAPT	CAPT
(7)		(FD) CMPTR NO 2 AC	F/O	F/O
(8)		FLT INST NO 2 DC	F/O	F/O
(9)		COMPASS NO 2 AC	F/O	F/O
(10)		FLT INSTR NO 2 ATT EXC AC	F/O	F/O
(11)		FLT INSTR NO 2 HDG EXC AC	F/O	F/O

F. Place both Mode Selectors to MAN GS Mode

(1)		GS No 1 DC	CAPT	CAPT
(2)		TACAN AC NO 1 AC		
		TACAN AC NO 1 DC		
(3)		GS NO 2 DC	F/O	F/O

G. OPEN NAV XFER
RLY NO 1 and
NAV XFER RLY
NO 2 cir-
cuit breakers.

H. Set both NAV
MODE selectors
to TACAN.

I. Close NAV XFER
RLY NO 1 and
NAV XFER RLY
NO 2 circuit
breakers.

J. TACAN AC

BOTH

BOTH

K. Set both NAV
MODE selectors
to VOR/LOC
mode

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RE- SUL T
L	OFF MODE				
(1)	Set Flight Director Mode Selector to OFF mode	---	Pitch and Roll command bars and CMPTR flag out of view in ADI.	Check	
(2)	Press TEST Light/Switch on FLT DIR Annunciator.	All light up	All annunciators, upper and lower, light up dim.	Check	
M	HDG MODE				
(1)	Set Flight Director Mode Selector to HDG mode	---	Pitch and Roll command bars are in view and ADI warning flags are out of view.	Record	
(2)	Set the heading marker on the HSI to 10° greater than airplane heading	---	Roll command bar shall indicate fly right command.	Check	
(3)	Tilt the Gyro in right roll until the roll command bar indicates zero command.	---	Gyro tilt shall be 15° ±5° right roll.	Record	
(4)	Set the heading marker to 90° greater than airplane heading and tilt Gyro in right roll to center roll command bar.	---	Gyro tilt shall be 27,5° ±5° right roll.	Record	
(5)	Repeat steps 2, 3 and 4 above for less than airplane heading (counterclockwise direction) and left roll.	---	Same results with left roll.	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RE- SUL T
(6)	Return the heading marker to airplane heading and Gyro to level.	---	Pitch and roll command bars shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ of Gyro tilt.	Record	
N	PITCH COMMAND MODE				
(1)	Rotate the PITCH CMD knob on the Mode Selector 90° clockwise	---	The pitch command bar shall indicate pitch up command.	Check	
(2)	Tilt the Gyro pitch up until the pitch command bar indicates zero command.	---	The gyro tilt shall be $10^{\circ} \pm 5^{\circ}$ pitch up.	Record	
(3)	Level the Gyro. Rotate the PITCH CMD Knob counterclockwise until the mechanical stop is reached.		The pitch command bar shall indicate pitch down command.	Check	
(4)	Return the PITCH CMD Knob to zero.	---			
O	ALTITUDE HOLD MODE				
(1)	Apply a 2,000 ft static pressure and then set the ALT HOLD Switch on the Flight Director Control Panel to on. (Apply static pressure to Capt's static system only).	---	The pitch command bar shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ Gyro tilt.	Record	
(2)	Rotate the PITCH CMD Knob throughout its range and return to zero.	---	The pitch command bar shall not respond.	Check	
(3)	Slowly increase the static pressure to 2250 ft	---	The pitch command bar shall indicate $7^{\circ} \pm 2^{\circ}$ pitch down command.	Record	
(4)	Slowly increase the static pressure to 1750 ft	---	The pitch command bar shall indicate $7^{\circ} \pm 2^{\circ}$ pitch up command.	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RE-SULT
(6)	After 45 seconds, slowly reduce the Gyro tilt until the pitch command bar indicates zero command	---	The Gyro tilt shall be $12^{\circ} \pm 3^{\circ}$ pitch up.	Record	
(7)	Return the static pressure to ambient. Return the Gyro to level. Open ADC 1 DC circuit breaker.	---	The ALT HOLD Switch on the Flight Director Control Panel shall return to OFF and pitch command bar shall indicate zero command.	Check	
P	NAV/LOC MODE (VHF, NAV)				
(1)	Apply a VOR test signal (108.0 MHz) with the selected omniradial closest to airplane heading plus 180° . Tune the VHF NAV Receiver to the VOR test frequency. Turn the COURSE Knob on the HSI until the lateral deviation bar is deflected left 2 dots.	---	The TO-FROM arrow shall indicate TO. ADI RUNWAY flag and rising runway shall be out of view.	Check	
(2)	Set the Flight Director Mode Selector to NAV/LOC. Rotate the HDG Knob on the HSI and then reset heading marker to airplane heading.	VL (VOR/LOC) (AMBER)	The roll command bar shall respond to the heading knob for roll commands.	Check	
(3)	Rotate the COURSE Knob so that the lateral deviation bar moves toward zero deviation. Stop when FLT DIR Annunciator VL changes to green.	VL (GREEN)	The lateral deviation bar shall indicate 1 ± 0.5 dot deviation. Roll command bar indicates fly left.	Check Record	
(4)	Continue to reduce the lateral deviation to zero. Wait 2 minutes. Tilt the gyro in roll to center roll command bar.	VL (GREEN)	The roll command bar shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ Gyro tilt.	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RE-SULT
(5)	Set the Flight Director Mode Selector to HDG. Tune the VHF NAV Receiver to a localizer test frequency and apply a fly left localizer test signal such that the lateral deviation bar is deflected more than 2.5 dots. Rotate the COURSE Knob until the course arrow indicated 30° greater than the airplane heading. Turn the Flight Director Mode Selector to MAN GS and then to NAV/LOC.	VL (GREEN)			
(6)	Wait 2 minutes. Slowly adjust the COURSE Knob until the roll command bar indicates zero roll command.	VL (GREEN)	The course arrow shall indicate 30° ±5° greater than airplane heading	Record	
(7)	Rotate the COURSE Knob until the course arrow indicates 45° greater than airplane heading.	VL (GREEN)	The roll command bar shall indicate a fly right command.	Check	
(8)	Rotate the COURSE Knob until the course arrow indicates 15° greater than airplane heading.	VL (GREEN)	The roll command bar shall indicate a fly left command.	Check	
(9)	Return the course arrow to airplane heading. Tilt the Gyro in left roll until the roll bar indicates zero command.	VL (GREEN)	The Gyro tilt shall be 25° ±5° left roll.	Record	
(10)	Turn the Flight Director Mode Selector to HDG and return to NAV/LOC. Return Gyro to level.	VL (AMBER)			
(11)	Slowly reduce the localizer signal until the FLT DIR Annunciator changes to indicate VL (GREEN)	VL (GREEN)	The lateral deviation bar shall indicate 2 ±0.5 dot deviation. The roll command bar shall indicate a fly left command.	Check Record	
Q	NAV/LOC MODE (TACAN)				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RE- SUL T
(1)	Set the Flight Director Mode Selector to HDG and the NAV MODE Selector to TACAN. Apply a TACAN test signal and set the TACAN Receiver to the test channel. Rotate the COURSE Knob until the lateral deviation bar is deflected left 2 dots and the TO-FROM arrow indicates TO.	---			
(2)	Set the Flight Director Mode Selector to NAV/LOC. Rotate the HDG Knob and then return heading marker to airplane heading.	TACAN (AMBER)	The roll command bar shall respond to rotation of the HDG Knob.	Check	
(3)	Rotate the COURSE Knob so that the lateral deviation bar moves toward zero deviation. Stop when Flt. Dir. Annunciator TACAN changes to green.	TACAN (GREEN)	The lateral deviation bar shall indicate 1 ± 0.5 dot deviation.	Record	
(4)	Reduce the lateral deviation to zero, wait 2 minutes.	TACAN (GREEN)	The roll command bar shall indicate zero command within $0^\circ \pm 3^\circ$ Gyro.	Record	
(5)	Rotate the COURSE Knob until the lateral deviation bar is deflected left one dot.	TACAN (GREEN)	The roll command bar shall indicate a fly left command.	Check	
(6)	Rotate the COURSE Knob until the lateral deviation bar is deflected right one dot.		The roll command bar shall indicate a fly right command.	Check	
(7)	Return course arrow to airplane heading and set NAV MODE selector to VOR/LOC mode.				
R	AUTO APP MODE				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RE- SUL T
(1)	Set the Flight Director Mode Selector to HDG. Apply fly up glideslope and fly left localizer test signals such that the glideslope needle and lateral deviation bar are deflected more than 2.5 dots. Set the Mode Selector to AUTO APP.	VL (AMBER)	ADI RUNWAY flag will be out of view and rising runway shall be in view and deflected left greater than one dot.	Check	
(2)	Rotate the HDG Knob and then return heading marker to airplane heading.	VL (AMBER)	The roll command bar shall respond to rotation of the HDG Knob	Check	
(3)	Reduce the localizer signal to zero. Using the Radio Altimeter Simulator, apply an altitude of 2.000 ft as read on the Radio Altimeter Indicator. Rotate the HDG Knob and then return heading marker to airplane heading.	VL (GREEN) GS (AMBER)	The roll command bar shall not respond to the HDG Knob for roll commands. ADI rising runway shall be centered.	Check	
(4)	Reduce the glideslope signal to zero.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate a small pitch down command and shall reduce to zero within 30 seconds.	Check RECORD	
(5)	Apply a one dot fly down glideslope signal.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate $9^{\circ} \pm 2^{\circ}$ pitch down command as read against the attitude tape.	RECORD	
(6)	Apply a one dot fly up glideslope signal.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate $9^{\circ} \pm 2^{\circ}$ pitch up command	RECORD	
(7)	Adjust the glideslope signal to provide 7° pitch up command. Using the Radio Altimeter Simulator, reduce the altit. to 1400 ft.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ pitch up within 120 ± 12 seconds.	RECORD	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RE- SUL T
(8)	Apply a glideslope signal to give 6° pitch up command. Using the Radio Altimeter Simulator reduce the altitude to 150 ft.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ±1° pitch up in 7.5 ±2 seconds. ADI rising runway shall indicate 150 ft approximately.	Record	
(9)	Using the Radio Altimeter Simulator set an altitude, read on Radio Altimeter, of 50 ft.	VL (GREEN) GS (AMBER)	ADI rising runway shall indicate 50 ft approx.	Record	
(10)	Set the Flight Director Mode Selector to HDG Reset radio altitude to 2000 ft. Set the Mode Selector to AUTO APP.	VL (GREEN) GS (AMBER)			
(11)	Reduce the glideslope signal to zero.	VL (GREEN) GS (AMBER)			
(12)	Apply a glideslope signal to give 7° pitch up command. Open Low Range ALTM No 1 circuit breaker.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ±1° pitch up in 120 ±12 seconds.	Record	
(13)	Apply a glideslope signal to give 6° pitch up command. Set the MARKER BEACON switch (Pilots instrument panel) to LOW and apply a simulated middle marker signal for 3 seconds.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ±1° pitch up in 7.5 ±2 seconds.	Record	
(14)	Close Low Range ALTM No. 1 circuit breaker.	VL (GREEN) GS (GREEN)			
S	MAN GS MODE				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RE-SULT
(1)	Set the Flight Director Mode Selector to HDG. Apply 2 dots fly right localizer signal and 2 dots fly down glideslope signal. Set the Flight Director Mode Selector to MAN GS.	VL (GREEN) GS (GREEN)	The command bars shall indicate pitch down and fly right command.	Check	
(2)	Reduce glideslope deviation to zero. Wait 2 minutes. Tilt the Gyro in right roll until the roll command bar indicates zero roll command	VL (GREEN) GS (GREEN)	The gyro tilt shall be $15^{\circ} \pm 3^{\circ}$ right roll.	Record	
(3)	Return Gyro to level. Reduce the localizer signal to zero. Set the Flight Director Mode Selector to AUTO APP. Apply a fly up glideslope signal to provide 7° of pitch command as read against the attitude tape. Set the Flight Director Mode Selector to MAN GS.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ pitch up immediately.	Record	
(4)	Apply a glideslope signal to give 6° pitch up command. Apply a simulated middle marker signal for 3 seconds.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ pitch up within 7.5 ± 2 seconds.	Record	
T	GO AROUND (GA) MODE				
(1)	Set the Flight Director Mode Selector to MAN GS. Press the Autopilot Disconnect Button on the A/C commander's control wheel. Rotate PITCH CMD Knob and then return to zero. Rotate HDG Knob and then return heading marker to airplane heading.	GA (GREEN)	The Mode Selector shall return to GA position. The pitch command bar shall indicate $8^{\circ} \pm 2^{\circ}$ pitch up command and shall not respond to rotation of the PITCH CMD Knob. The roll command bar shall indicate zero roll command (wings level) and shall not respond to rotation of the HDG Knob.	Check Record	

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(2)	Tilt the Gyro pitch up until the pitch command bar indicates zero pitch command.	GA (GREEN)	The Gyro tilt shall be $8^{\circ} \pm 2^{\circ}$ pitch up.	Record	
(3)	Return the Gyro to level. Set the Flight Director Mode Selector to GS and then AUTO APP.	VL (GREEN) GS (AMBER)		Record	
(4)	Press the Autopilot Disconnect Button on the pilot's control wheel.	GA (GREEN)	The Mode Selector shall remain in the NAV/LOC position.	Check	
(5)	Reduce the localizer signal to zero. Set the Flight Director Mode Selector to NAV/LOC position. Press the Autopilot Disconnect Button on the pilot's control wheel.	VL (GREEN)	The Mode Selector shall remain in the NAV/LOC.	Check	
(6)	Set the Flight Director Mode Selector to HDG. Press the Autopilot disconnect button on the pilot's control wheel.	---	The Mode Selector shall remain in the HDG position.	Check	

U. Open VERT GYRO No. 1 and No. 2 AC circuit breakers.

CAUTION DO NOT HANDLE GYRO UNTIL 30 MINUTES AFTER DISCONNECTING POWER TO ALLOW GYRO TO RUN DOWN

V. Remove both Gyros from tilt table and reinstall in the airplane.

W. Close VERT GYRO No. 1 and No. 2 AC circuit breakers.



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2. Flight Director Interface Unit Self Test

A. General Information

- (1) Each of the two Interface Units has a Built In Test (BIT) function
- (2) It is required that power be available at the associated power busses.

B. Test Requirements

- (1) Close the following circuit breakers on the P5 overhead panel:
 - ADC 1 DC
 - ADC 2 DC
 - IU NO 1 DC
 - IU NO 2 DC
- (2) Get access to the main electronic compartment.
- (3) Press the self test pushbutton on the front panel of the IU.
- (4) Check all LEDs on the front panel are illuminated.
- (5) After completion of the self test check LEDs on the front panel of the IU for test result:
 - Green LED PASS will be illuminated if no faults are detected.
 - Red LED FAIL will be illuminated if an internal fault exists.
 - Red LED DATA IN will be illuminated if the ARINC 429 signal from the Air Data Display Unit is not present



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FLIGHT DIRECTOR SYSTEM - ADJUSTMENT/TEST

1 FLIGHT DIRECTOR SYSTEM TEST

FLIGHT DIRECTOR SYSTEM, Collins Radio Company, composed of Steering Computer 562A-5F4, Controller 614E-10D, Horizontal Situation Indicator 331A-8H, and Attitude (Flight) Director Indicator 329B-9A

A General Information

- (1) There are two independent Flight Director Systems installed on the airplane to supply guidance commands to the pilot and co-pilot. The guidance commands are a function of flight director mode selection and the sub-system supplying raw data. Raw data is supplied from the following systems as selected: VG, Compass, VHF NAV SYSTEM, TACAN, RADIO ALTIMETER SYSTEM, MARKER BEACON SYSTEM, and AIR DATA COMPUTER SYSTEM. The System Functional Tests for the above systems shall have been completed as necessary to accomplish this test.
- (2) It is required that power be available at the associated power busses and that the Flight Deck lighting be operating.
- (3) This Test establishes the requirements for installation and airplane test of the Flight Director System. No adjustments shall be made except as stated herein.

B Test Equipment Required

- (1) IFR Model NAV-401L Test Set or equivalent, 2 required. One unit is used to generate a VOR, LOC, or GS test signal, and the other to generate a Middle Marker test signal.
- (2) TACAN Flight Line Tester. Federal Telecon NUS-3156 or AN/ARM-25C Ramp Test Set, one required or equivalent.
- (3) Test oscillator, Cossor FT113 or equivalent, one required. Used to generate a middle marker test signal.
- (4) FD1104-12-15 Universal Radio Altimeter Simulator or equivalent, one required. Used to simulate airplane altitude in the Radio Altimeter Receiver/Transmitter unit.
- (5) Air Pressure Test Set, one required. Used to provide static pressure to the Air Data Computer for Altitude Hold tests.
- (6) Tilt turn table, FD500-1886 or equivalent, one required.

Ref. DRW CDRL 43/44
Paragraph 7 39-Issue D dtd 19 May 1988



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C Test Requirements

- (1) Prepare for Test Remove vertical Gyros from airplane and install on calibrated tilt tables and level in roll and pitch ($0^\circ \pm 1^\circ$)

CAUTION ALLOW GYROS TO RUN DOWN BEFORE MOVING TO PREVENT TUMBLING OF GIMBELS

- (2) Close the following circuit breakers on the P5 circuit breaker panel

Essential radio bus

Low range altm No 1
TACAR No 1
VOR No 1
GS No 1

Essential flight instr bus

Rate of turn capt
FLT INSTR No 1 - FD No 1
COMPTR No 1
FLT INST No 1 HDG EXC
XMFR No 1
VERT GYRO No 1
COMPASS No 1
FLT INST No 1 ATT EXC
NAV XFER RLY No 1

Flight instr bus No 2

Rate of turn F/O
XMFR No 2
FLT INSTR No 2
COMPTR No 2
FLT INST No 2 BRG EXC
FLT INST No 2 HDG EXC
FLT INST No 2 ATT EXC
NAV XFER RLY No 2

Radio bus No 2

TACAN No 2
VOR No 2
GS No 2

- (3) Set PITCH TRIM CONTROL ON BOTH ADI'S to "0"
- (4) Set up one NAV-401L Test Set, or equivalent, for VCR test signal Set Test Set to VCR XTL (108 0 MHz), or for LOC and GS signals Set test set to G/S XTL (108 1 MHz, LOC and 334 7 MHz, GS) and adjust for proper power output
- (5) Tune both VHF NAV systems to localizer frequency selected on test set
- (6) Set a TACAN test signal in TACAN test set
- (7) Tune TACAN receiver to test channel

Ref DRW CDRL 43/44
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- (6) Set a TACAN test signal in TACAN test set
- (7) Tune TACAN receiver to test channel
- (8) Synchronize compass systems and allow a few minutes for gyros to stabilize
- (9) Set Both NAV MODE selectors to VCR/LOC.
- (10) Set the heading marker and the course arrow on both HSI'S to airplane heading Pull out HDG and COURSE knobs for manual selection
- (11) Set the PITCH CMD knob on both Mode Selectors to zero

D Flight Director System Monitor

NOTES

- (1) Return circuit breakers to initial conditions after each step unless otherwise noted
- (2) The Flight Director Command Bars shall be in view and the CMPTR flags shall be out of view in both ADIs unless otherwise noted

E Command and Annunciation

NOTES

- (1) The following tests may be performed on the Capt and F/O side separately or simultaneously
- (2) Unless otherwise stated, the following equipment shall be utilized for test pertaining to the Captain's side Captain Flight Director mode Selector, ADI, HSI, NAV MODE selector, flight-Director Annunciator, vertical gyro No 1, VHF NAV No 1, Radio Altimeter #1, Marker Beacon, and Air Data Computer
- (3) Unless otherwise stated, the following equipment shall be utilized for tests pertaining to the F/O side F/O Flight Director Mode Selector, ADI, HSI, NAV MODE Selector, Flight Director Annunciator, vertical gyro VHF NAV No 2, Radio Altimeter #1, Marker Beacon, and Air Data Computer

Ref DRW CDRL 43/44
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STEP	CONDITION	OPEN . CIRCUIT BREAKER	CMPTR FLAG IN VIEW	COMMAND BARS OUT OF VIEW
(1)	Place both	Mode Selectors to HDG mode		
(2)		FLT DIR CMPTR-1 AC	CAPT	CAPT
(3)		FLT DIR-1 DC	CAPT	CAPT
(4)		COMPASS-1 AC,	CAPT	CAPT
(5)		No 1 ATTD AC EXC	CAPT	
(6)		HDG-1 AC EXC	CAPT	CAPT
(7)		FLT DIR CMPTR-2 AC	F/O	F/O
(8)		FLT DIR-2 DC	F/O	F/O
(9)		COMPASS-2 AC	F/O	F/O
(10)		No 2 ATTD AC EXC	F/O	F/O
(11)		HDG-2 AC EXC	F/O	F/O
F Place both flight director Mode Selectors to MAN GS Mode				
(1)		GS No 1 DC	CAPT	CAPT
(2)		TACAN AC		
(3)		GS No 2 DC	F/O	F/O
G	Open NAV XFR RELAY CAPT and NAV XFR RELAY F/O INST circuit breakers	-----	-----	-----
H	Set both NAV MODE selectors to TACAN	-----	-----	-----
I	Close NAV XFR RELAY CAPT 1INST AND NAV XFER RELAY F/O INST circuit breakers	-----	-----	-----
J		TACAN AC	BOTH	BOTH
K	Set both NAV MODE selectors to VOR/LOC mode	-----	-----	-----

Ref DRW CDRL 43/44
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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
L	OFF MODE				
(1)	Set flight director Mode Selector to OFF mode	---	Pitch and Roll command bars and CMPTR flag out of view in ADI	Check	
(2)	Press TEST light/switch on FLT DIR annunciator	All light up	All annunciators, upper and lower, light up	Check	
(M)	HDG MODE				
(1)	Set flight director Mode Selector to HDGmode	---	Pitch and roll command bars are in view and ADI warning flags are out of view	Check	
(2)	Set the heading marker on the HSI to 10° greater than airplane heading	---	Roll command bar shall indicate fly right command	Check	
(3)	Tilt the Gyro in right roll until the roll command bar indicates zero command	---	Gyro tilt shall be 15° ±5° right roll	Record	
(4)	Set the heading marker to 90° greater than airplane heading and tilt Gyro in right roll to center roll command bar	---	Gyro tilt shall be 27 5° ±5° right roll	Record	
(5)	Repeat steps 2, 3, and 4 above for less than airplane heading counter-clockwise direction and left roll.	---	Same results with left roll	Record	

Ref DRW CDRL 43/44
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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(6)	Return the heading marker to airplane heading and Gyro to level	---	Pitch and roll command bars shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ of Gyro tilt	Record	
N	PITCH COMMAND MODE				
(1)	Rotate the PITCH CMD knob on the Flight Director Control Panel 90° clockwise	---	The pitch command bar shall indicate pitch up command	Check	
(2)	Tilt the Gyro pitch up until the pitch command bar indicates zero command.	---	The Gyro tilt shall be $10^{\circ} \pm 5^{\circ}$ pitch up	Record	
(3)	Level the Gyro Rotate the PITCH CMD knob counterclockwise until the mechanical stop is reached		The pitch command bar shall indicate pitch down command	Check	
(4)	Return the PITCH CMD knob to zero	---			
0	ALTITUDE HOLD MODE				
(1)	Apply a 2,000 ft static pressure and then set the ALT HOLD switch on the Flight Director Control Panel to ON (Apply static pressure to Capt's static system only)	---	The pitch command bar shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ Gyro tilt	Record	
(2)	Rotate the PITCH CMD knob throughout its range and return to zero	---	The pitch command bar shall not respond	Check	
(3)	Slowly increase the static pressure to 2250 feet Pitch down command	---	The pitch command bar shall indicate $7^{\circ} \pm 20$	Record	
(4)	Slowly increase the static pressure to 1750 feet pitch up command	---	The pitch command bar shall indicate $7^{\circ} \pm 2^{\circ}$	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(6)	After 45 seconds, slowly reduce the Gyro tilt until the pitch command bar indicates zero command	---	The Gyro tilt shall be $12^{\circ} \pm 3^{\circ}$ pitch up	Record	
(7)	Return the static pressure to ambient. Return the Gyro to level Open CADC AC circuit breaker	---	The ALT HOLD switch on the Flight Directore C/P shall return to OFF and pitch command bar shall indicate zero command	Check	
P	NAV/LOC MODE (VHF NAV)				
(1)	Apply a VOR test signal (108.0 MHz) with the selected omniradial closest to airplane heading plus 180° . Tune the VHF NAV receiver to the VOR test frequency. Turn the course knob on the HSI until the lateral deviation bar is deflected left 2 dots	---	The TO FROM arrow shall indicate TO ADI RUNWAY flag and rising runway shall be out of view	Check	
(2)	Set the Flight Director Mode Selector to NAV/LOC Rotate the HDG knob on the HSI and then reset heading marker to airplane heading	VL (VOR/LOC) (AMBER)	The roll command bar shall respond to the heading knob for roll commands	Check	
(3)	Rotate the COURSE knob so that the lateral deviation bar moves toward zero deviation. Stop when Flt Dir Annunciator VL changes to green	VL (GREEN)	The lateral deviation bar shall indicate 1 ± 0.5 dot deviation. Roll command bar indicates fly left	Check Record	
(4)	Continue to reduce the lateral deviation to zero. wait 2 minutes Tilt the gyro in roll to center roll command bar	VL (GREEN)	The roll command bar shall indicate zero command within $0 \pm 3^{\circ}$ Gyro tilt	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(5)	Set the Flight Director Selector to HDG Tune the VHF NAV receiver to a localizer test frequency and apply a fly left localizer test signal such that the lateral deviation bar is deflected ore than 2 5 dots Rotate the COURSE knob until the course arrow indicated 30-greater than the airplane heading Turn the Flight director mode Selector to MAN GS and then to NAV/LOC	VL (GREEN)			
(6)	Wait two minutes Slowly adjust the COURSE knob until the roll command bar indicates zero roll command	VL (GREEN)	The course arrow shall indicate $30^{\circ} \pm 5^{\circ}$ greater than airplane heading	Record	
(7)	Rotate the COURSE knob until the course arrow indicates 450 greater than airplane heading	VL (GREEN)	The roll command bar shall indicate a fly right command	Check	
(8)	Rotate the course knob until the course arrow indicates 15° greater than airplane heading	VL (GREEN)	The roll command bar shall indicate a fly left ccommand	Check	
(9)	Return the course arrow to airplane heading Tilt the Gyro in left roll until the roll bar indicates zero command	VL (GREEN)	The Gyro tilt shall be $25^{\circ} \pm 5^{\circ}$ left, roll	Record	
(10)	Turn the Flight Director Mode Selector to HOG and return to NAV/LOC Return Gyro to level	VL (AMBER)			
(11)	Slowly reduce the localizer signal until the Flt Dir. annunciator changes to indicate VL (Green)	VL (GREEN)	The lateral deviation bar shall indicate 2 ± 0.5 dot deviation The roll command bar shall indicate a fly left command	Check Record	
0	NAV/LOC MODE (TACAN)				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(1)	Set the Flight Director Mode Selector to HDG and the NAV MODE Selector to TACAN Apply a TACAN test signal and set the TACAN receiver to the test channel Rotate the course knob until the lateral deviation bar is deflected left 2 dots and the TO- FROM arrow indicates TO	---			
(2)	Set the Flight director Mode NAV/LOC Rotate the HDG knob and then return heading marker to airplane heading	TACAN (AMBER)	The roll command bar shall respond to rotation of the heading knob	Check	
(3)	Rotate the COURSE knob so that the lateral deviation bar moves toward zero deviation Stop when Flt Dir Annunciator TACAN changes to green	TACAN (GREEN)	The lateral deviation bar shall indicate 1 $\pm$ 0 5 dot deviation	Record	
(4)	Reduce the lateral deviation to zero, wait 2 minutes	TACAN (GREEN)	The roll command bar shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ Gyro	Record	
(5)	Rotate the COURSE knob until the lateral deviation bar is deflected left one dot.	TACAN (GREEN)	The roll command bar shall indicate a fly left command	Check	
(6)	Rotate the COURSE knob until the lateral deviation bar is deflected right one dot	TACAN (GREEN)	The roll command bar shall indicate a fly right command	Check	
(7)	Return COURSE arrow to airplane heading and set NAV MODE selector to VOR/LOC mode				
R	AUTO APP MODE				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(1)	Set the Flight Director Mode Selector to HDG. Apply fly up glideslope and fly left localizer test signals such that the glidescope needle and lateral deviation bar are deflected more than 2.5 dots. Set the Flight Director Mode Selector to AUTO APP.	VL (AMBER)	ADI RUNWAY flag will be out of view and rising runway shall be in view and deflected left greater than one dot.	Check	
(2)	Rotate the HDG knob and then return heading marker to airplane heading.	VL (AMBER)	The roll command bar shall respond to rotation of the heading knob.	Check	
(3)	Reduce the localizer signal to zero. Using the Radio Altimeter Simulator, apply an altitude of 2,000 feet as read on the radio altimeter indicator. Rotate the HDG knob and then return heading marker to airplane heading.	VL (GREEN) GS (AMBER)	The roll command bar shall not respond to the HDG knob for roll commands. ADI rising runway shall be centered.	Check	
(4)	Reduce the glideslope signal to zero.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate a small Pitch down command with shall reduce to zero within 30 seconds.	Check Record	
(5)	Apply a one dot fly down glideslope signal.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate $9^\circ \pm 2^\circ$ pitch down command as read against the attitude tape.	Record	
(6)	Apply a one dot fly up glideslope signal.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate $9^\circ \pm 2^\circ$ pitch up command.	Record	
(7)	Adjust the glideslope signal to provide 7° pitch up command. Using the Radio Altimeter Simulator, reduce the altitude to 1400 feet.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^\circ \pm 1^\circ$ pitch up within 120 ± 12 seconds.	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(8)	Apply a glideslope signal to give 6° pitch up command Using the Radio Altimeter Simulator, reduce the altitude to 150 feet	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ± 1° pitch up in 7.5 ± 2 seconds ADI rising runway shall indicate 150 feet approximately	Record	
(9)	Using the Radio Altimeter Simulator set an altitude, read on Radio Altimeter, of 50 feet	VL (GREEN) GS (AMBER)	ADI rising runway shall indicate 50 feet approx	Record	
(10)	Set the Flight Director Mode Selector to HDG Reset radio altitude to 2000 feet Set the Mode Flight Director Selector to AUTO APP	VL (GREEN) GS (AMBER)			
(11)	Reduce the glideslope signal to zero	VL (GREEN) GS (AMBER)			
(12)	Apply to glideslope signal to give 7° pitch up command Open Low Range ALTM No 1 circuit breaker	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° + 1° pitch up within 120 ± 12 seconds	Record	
(13)	Apply a glideslope signal to give 6° pitch up command Set the MARKER BEACON switch (Pilot's Instrument panel) to LOW and apply a simulated middle marker signal for 3 seconds	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ± 1° pitch up in 7.5 ± 2 seconds	Record	
(14)	Close Low Range Altm No 1 circuitbreaker	VL (GREEN) GS (GREEN)			
S	MAN GS MODE				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(1)	Set the Flight Director Mode Selector to HDG Apply 2 dots fly right localizer signal and 2 dots fly down glide-slope signal Set the Flight Director Mode Selector to MAN GS	VL (GREEN) GS (GREEN)	The command bars shall indicate pitch down and fly right command	Check	
(2)	Reduce glideslope deviation to zero Wait 2 minutes Tilt the Gyro in right roll until the roll command bar indicates zero roll command	VL (GREEN) GS (GREEN)	The Gyro tilt shall be $15^{\circ} \pm 3^{\circ}$ right roll	Record	
(3)	Return Gyro to level Reduce the localizer signal to zero Set the Flight Director Mode Selector to AUTO APP Apply a fly up glideslope signal to provide 7° of pitch command as read against the attitude tape Set the Flight Director Mode Selector to MAN GS	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ pitch up immediately	Record	
(4)	Apply a glideslope signal to give 6° pitch up command Apply a simulated middle marker signal for 3 seconds	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ Pitch up within 7.5 ± 2 seconds	Record	
T	GO AROUND (GA) MODE				
(1)	Set the Flight Director Mode Selector to MAN GS Press the Autopilot disconnect button to the A/C commander's control wheel Rotate PITCH CMD knob and then return to zero Rotate HDG knob and then return heading marker to airplane heading	GA (GREEN)	The Mode Selector shall return to GA position The pitch command bar shall indicate $8^{\circ} \pm 2^{\circ}$ pitch up command and shall not respond to rotation of the PITCH CMD knob The roll command bar shall indicate zero roll command (wings level) and shall not respond to rotation of the HDG knob.	Check Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(2)	Tilt the Gyro pitch up until the pitch command bar indicates zero pitch command	GA (GREEN)	The Gyro tilt shall be $8^{\circ} \pm 2^{\circ}$ pitch up	Record	
(3)	Return the Gyro to level Set the Flight Director Mode GS an then AUTO APP	VL (GREEN) GS (AMBER)		Check	
(4)	Press the Autopilot disconnect button on the Pilot's control wheel	GA (GREEN)	The Mode Selector shall remain in the NAV/LOC position	Check	
(5)	Reduce the localizer signal to zero Set the Flight Director Mode Selector to NAV/LOC position. NAV/LOC Press the Autopilot diston-nect button on the A/C commander's control wheel	VL (GREEN)	The Mode Selector shall remain in the	Check	
(6)	Set the Flight Director mode Selector to HDG Press the Autopilot disconnect button on the Pilot's control wheel.	----	The Mode Selector shall remain in the HDG position	Check	

U Open VERT GYRO No 1 and No 2 AC circuit breakers

CAUTION DO NOT HANDLE GYRO UNTIL 30 MINUTES AFTER DISCONNECTING POWER TO ALLOW GYRO'S to RUN DOWN

V Remove both Gyro's from tilt table and reinstall in the airplane

W Close VERT GYRO No 1 and No 2 AC circuit breakers

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RMI MODE SELECTOR - DESCRIPTION AND OPERATION

1 NAV MODE SWITCHING

- A Selector switches located on the glare shield (figure 1 Sheet 1 of 2) and on the pilot's (figure 1 Sheet 1 of 2) and copilot's (figure 1 Sheet 1 of 2) instrument panels allow selection of VOR, TACAN, INS or VG outputs for use by the flight directors, flight instruments, and autopilot. There are no provisions for cross-switching the copilot's (number two) radios to the autopilot.

The following section describe each of the selector switches and its function.

(1) Pilot's Nav Mode Selector

- a The pilot's nav mode selector controls the signal source for the autopilot steering input, pilot's HSI and RMI, and the pilot's flight director.

(2) INS Position

a Dual INS installations

When set to INS, the nav mode selector routes steering signals from the INS selected by the autopilot INS source selector to the autopilot. When in the INS position, the nav mode selector routes INS number one signals (such as true heading and course deviation) to the pilot's HSI. Also, in the INS position, the nav mode selector limits the choice of inputs to the pilot's RMI bearing pointer number one to either ADF signals or signals from number one TACAN set, and automatically routes TACAN two signals to the pilot's RMI bearing pointer number two which causes the pilot's RMI bearing pointer number two annunciator TACAN indicator to illuminate. The position of the pilot's RMI mode selector determines whether the ADF or TACAN signal is actually displayed by the pilot's RMI bearing pointer number one. If the pilot's RMI mode selector is set to TACAN/VOR, with the pilot's nav mode selector set to INS, TACAN one signals are routed to the pilot's RMI bearing pointer number one, which causes the pilot's RMI bearing pointer number one TACAN annunciator to illuminate.

b Single INS installation.

In case of single INS installation, the same applies as for dual INS installation, provided that the co-pilot's NAV MODE selector is not set to INS, or, that the pilot's NAV MODE selector has been set to INS first. Switching to INS after the co-pilot, the pilot will utilize the steering signal from the source selected prior switching to INS. In this case also the RMI bearing pointer indication corresponds to the NAV MODE selector position prior switching to INS.

(3) TACAN Position

- a When set to TACAN, the nav mode selector routes TACAN one signals to the autopilot, pilot's flight director, pilot's HSI, ADI and illuminates the pilot's flight director annunciator and TACAN indicator. From the No 1 compass system, magnetic heading data is sent to the autopilot and to the HSI compass card when the pilot's nav mode selector is set to TACAN.

In the TACAN position, the nav mode selector routes TACAN two signals to the pilot's HSI number two, and number two VHF nav set VOR signals to the pilot's RMI number two, which causes the pilot's RMI number two annunciator, VOR indicator to illuminate. If the pilot's RMI mode selector is set to TACAN/VOR, with the nav mode selector is set to TACAN, VOR signals from the number one VHF nav set are routed to the pilot's RMI number one which causes the pilot's RMI number one annunciator, VOR indicator to illuminate.

(4) VOR/LOC Position

- a When set to VOR/LOC, the nav mode selector routes signals from VHF nav set number one to the autopilot, pilot's flight director, HSI bearing pointer number one and causes the pilot's flight director annunciator, VL indicator to illuminate. Compass system number one magnetic heading data is sent to the autopilot and the pilot's HSI compass card when the pilot's nav mode selector is set to VOR/LOC. In the VOR/LOC position, the nav mode selector routes VHF nav set number two VOR signals to the pilot's HSI bearing pointer number two, and TACAN set two, signals to the pilot's RMI bearing pointer number two which causes the pilot's RMI bearing pointer number two annunciator, TACAN indicator

to illuminate. The position of the pilot's RMI mode selector determines whether ADF or TACAN signals are routed to the pilot's RMI bearing pointer number one. If the pilot's RMI mode selector is set to TACAN/VOR with the nav mode selector set to VOR/LOC, signals from the number one TACAN set are routed to the pilot's RMI bearing pointer number one which causes the pilot's RMI bearing pointer number one annunciator TACAN indicator to illuminate.

(5) Pilot's RMI Mode Selector

- a The pilot's RMI mode selector (figure 1 Sheet 1 of 2) selects input signals for display on the pilot's RMI bearing pointer number one, from sources other than those determined by the pilot's nav mode selector. The selector has two positions, ADF, TACAN/VOR. When set to ADF, signals from the ADF set are routed to the pilot's RMI bearing pointer number one, regardless of the pilot's nav mode selector setting. When set to TACAN/VOR, the pilot's nav mode selector determines whether VOR or TACAN data is displayed and causes the appropriate pilot's RMI bearing pointer number one annunciator to illuminate if a reliable signal is received. Copilot's RMI mode selector function is similar for the No 2 systems.



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(6) Pilot's Attitude Source (ADI) Switch

- a The pilot's ADI switch is located on the pilot's (P8) panel (figure 1 Sheet 1 of 2)
The ADI switch selects the attitude source for the pilot's ADI and flight director. When set to VG, attitude signal from the number one VG are routed to the pilot's flight director and ADI.
When set to INS, attitude signals from number one INS are routed to the pilot's flight director and ADI.

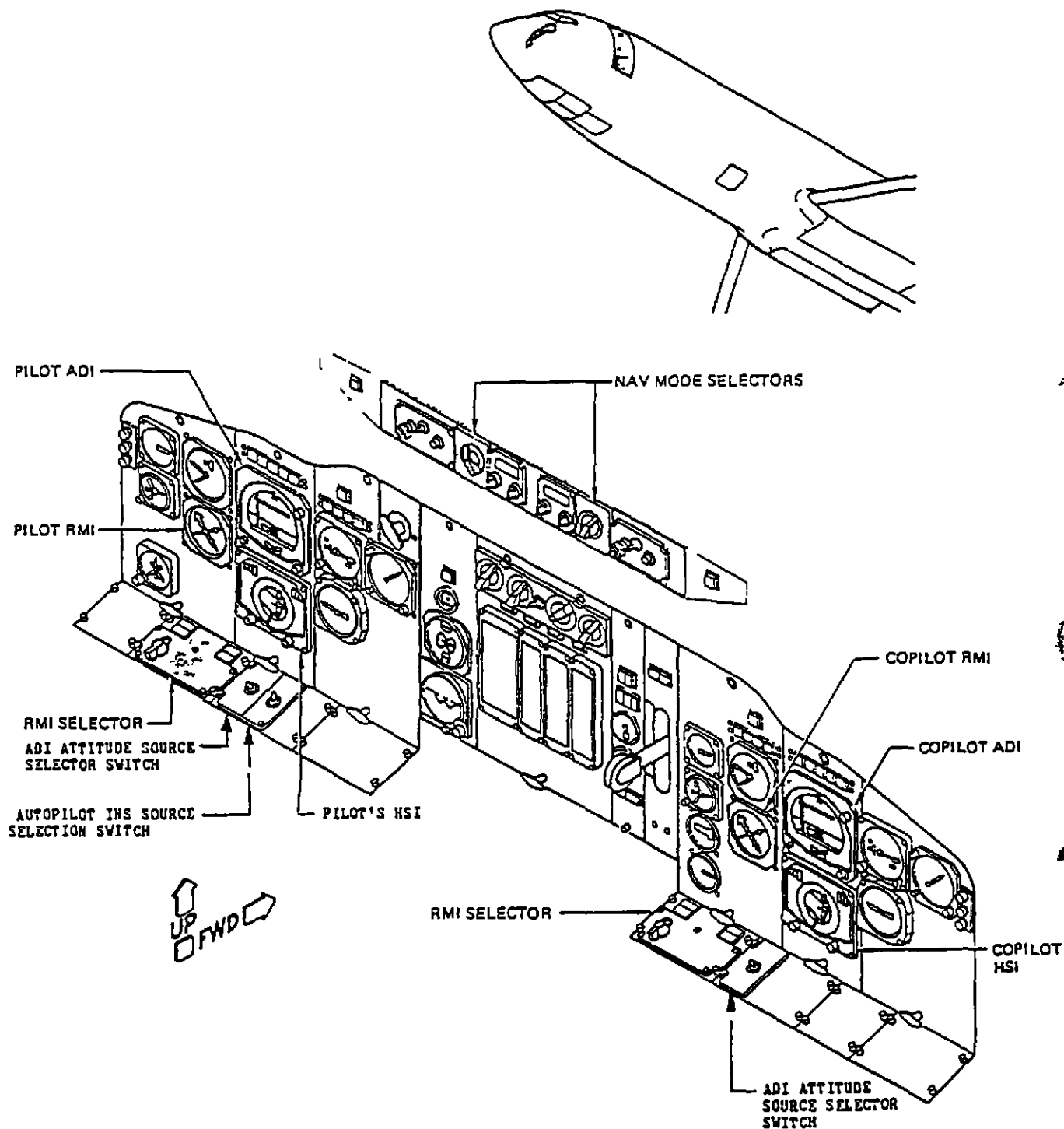
(7) Copilot's Attitude Source (ADI/WXR) Switch

- a The copilot's attitude source (ADI/WXR) switch is located on the copilot's (P10) panel (figure 1 Sheet 2 of 2). The copilot's ADI/WXR switch selects the attitude source for copilot's ADI, copilot's flight director, and weather radar.

(8) Autopilot INS Source Selector

- a The autopilot INS source selector is located on the pilot's P8 panel (figure 1 Sheet 2 of 2). The autopilot INS source selector provides the means to switch steering signals to the autopilot between INS one and INS two, if installed. If the pilot's nav mode selector is set to INS, the autopilot INS source selector also determines which INS provides steering inputs to the autopilot.

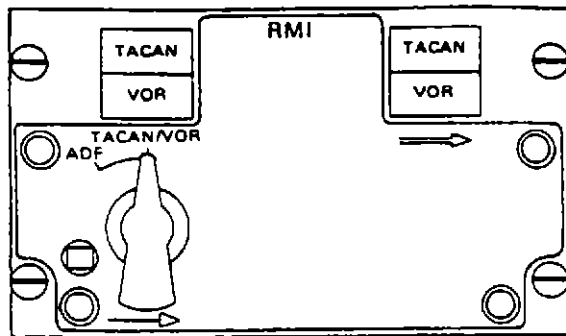
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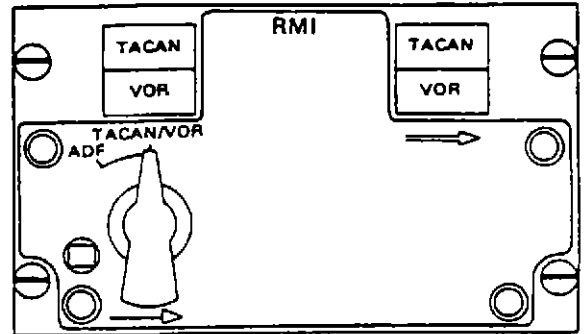
Navigation Instrument Location And Displays
Figure 1 (Sheet 1 of 2)

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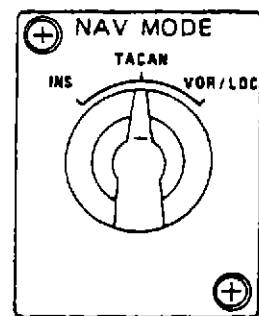
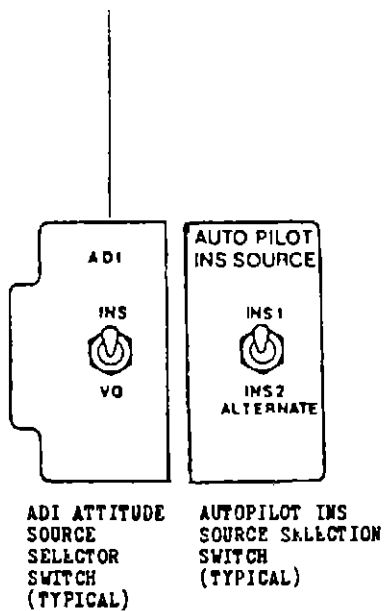
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PILOT RMI SELECTOR



COPILOT RMI SELECTOR



NAV MODE SELECTOR (TYPICAL)

Navigation Instrument Location And Displays
 Figure 1 (Sheet 2 of 2)

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RMI MODE SELECTOR - TROUBLE SHOOTING

A Table 101 lists symptoms, probable causes, isolation procedures and corrective actions for failures observed in the flight director system. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation.

TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
CMPTR flag does not appear when specified circuit breaker is opened	Defective steering computer or ADI.	If flag responds correctly for all but one or two circuit breakers, computer is faulty	Replace computer or ADI
One annunciator light does not come on when test/switch indicator is pressed	Burned out light bulb		Replace bulb
No annunciator lights come on for test	Defective TEST/switch indicator	Check for 28 vdc on normally open terminal of switch. If present, switch is defective.	Replace switch/indicator

Flight Director System Trouble Analysis
Table 101 (Sheet 1 of 9)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Command bars do not stabilize	Defective ADI	Interchange ADI's	If OK, replace defective ADI
	Defective or loose tilt table.	Check that tilt table is steady	Repeat test after steady- ing tilt table
	Defective AHRS	Turn on and initialize INS Check that command bars stabilize with attitude source switch in INS position	If steady on INS, trouble is in AHRS
	Defective steering computer.	If unsteady on both AHRS and INS, trouble is proba- bly in computer	Replace steering computer
	Defective ADI	Interchange ADI's.	If OK, replace ADI
Tilt table pitch more than 0 (±3) degrees with pitch command bar centered	Defective AHRS	Turn on and initialize INS Check pitch command bar position on INE atti- tude input	If OK now, troubleshoot AHRS
	Defective ADI or steering computer.	Interchange ADI's	If other ADI OK, replace defective ADI
		Replace steering computer	Replace steering computer.
Roll command bar does not move correctly for attitude displacement.	Defective ADI	Interchange ADI's	If OK, replace defective ADI
	Defective steering computer	Interchange steering com- puters	If OK, replace defective steering computer
	Defective AHRS		Troubleshoot AHRS
Roll com- mand bar does not respond correctly to heading change	Defective HSI or steering computer	Interchange HSI's	1 If OK, replace defective HSI 2 Replace steering computer
Pitch com- mand bar does not respond correctly to pitch CMD knob movement.	Defective flight director mode selector panel	Interchange mode selector panels	If OK now, replace defective mode selector panel
	Defective steering computer.	Interchange steering computers	If OK now, replace defective steering com- puter Replace ADI
	Defective ADI		

Flight Director System Trouble Analysis
Table 101 (Sheet 2 of 9)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Pitch command bar does not respond correctly to altitude changes	Defective CADC Defective steering computer Defective AHRS	Check CADC readouts on altimeter Interchange steering computer	If incorrect, troubleshoot CADC If OK now, replace steering computer Troubleshoot AHRS
ALT hold switch does not spring off when CADC circuit breaker is opened	Defective flight instrument accessory unit, flight director Mode selector panel or CADC	Interchange flight instrument accessory units Interchange mode selector panels	If OK now, replace defective flight accessory unit per paragraphs 12 and 13. If OK now, replace defective mode selector panel Troubleshoot CADC
Amber VL or TACAN annunciator does not come on	Defective steering computer mode selector panel or vhf navigation system	Interchange steering computers Interchange mode selector panels.	If OK now, replace defective steering computer If OK now, replace mode selector panel Troubleshoot vhf navigation system
Course deviation bar cannot be centered	Defective HSI	Interchange HSI's If OK now, HSI is defective	Replace defective HSI
Roll command bar responds incorrectly to HSI HDG knob	Defective steering computer Defective mode selector panel Defective HSI	Interchange steering computers Interchange mode selector panels	If OK now, replace defective steering computer If OK now, replace defective mode selector panel Replace HSI
Roll command bar does not respond correctly to VOR or TACAN inputs.	Defective steering computer Defective HSI	Interchange steering computers. If OK now, steering computer is defective	Replace defective steering computer Replace HSI

Flight Director System Trouble Analysis
Table 101 (Sheet 3 of 9)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Green VL annunciator does not come on when specified.	Defective steering computer	If OK with alternate system, steering computer is defective	Replace steering computer
	Defective VHF navigation system.	If not OK with alternate system, troubleshoot VHF navigation system	Troubleshoot VHF navigation or TACAN
Tilt table roll scale indicates more than ± 3 degrees from zero, 2 minutes after VOR or TACAN.	Defective steering computer		Replace steering computer
Tilt table roll scale not 0 (± 3) degrees with roll command bar centered for 2 minutes on localizer signal	Defective steering computer		Replace steering computer
Amber VL annunciator not on when receiving localizer signal and more than two dots deviation.	Defective VHF navigation system	If NAV flag is visible on HSI, VHF navigation system is faulty	Repair VHF navigation system
	Defective steering computer		Replace steering computer
Green VL annunciator does not come on when localizer deviation 2.0 (± 0.5) dots.	Defective steering computer		Replace steering computer

Flight Director System Trouble Analysis
Table 101 (Sheet 4 of 9)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Roll command bar does not indicate correct command for localizer deviation	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective ADI		Replace defective ADI
Rising runway or flag incorrect	Defective ADI	Interchange ADI's	If OK now, replace defective ADI
	Defective steering computer	Interchange steering computer	If OK now, replace defective steering computer
	Defective VHF navigation system		Troubleshoot VHF navigation system
Amber GS annunciator does not come on when receiving localizer and glide slope signals, 2000 feet radio altitude, more than two dots glide slope deviation	Defective steering computer		Replace steering computer
Roll command bar does not respond to pitch CMD signals in AUTO approach mode with more than two dots deviation	Defective steering computer	Interchange steering computer	If OK now, replace defective steering computer
	Defective mode selector panel	Interchange mode selector panels	If OK now, replace defective mode selector panel
	Defective ADI		Replace ADI

Flight Director System Trouble Analysis
Table 101 (Sheet 5 of 9)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
ALL hold switch springs off in AUTO approach mode, two dots GS deviation	Defective steering computer Defective mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
Annunciator or pitch command bar responds to glide slope signals in ALT hold mode	Defective steering computer. Defective mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel.
VL annunciator does not change from amber to green in AUTO approach when localizer deviation is reduced to less than two dot	Defective steering computer Defective mode selector panel.	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
GS annunciator does not go green and ALD hold switch does not spring off then GS deviation is reduced to less than 0.5 dot in AUTO approach	Defective steering computer Defective mode selector panel	Interchange steering computers.	If OK now, replace defective steering computer Replace defective mode selector panel

Flight Director System Trouble Analysis
Table 101 (Sheet 6 of 9)

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
Pitch command bar does not respond properly to glide slope	Defective steering computer or flight instrument accessory unit	Interchange steering computers	If OK now, replace defective steering computer. Replace defective flight instrument accessory unit per paragraphs 12 and 13
Pitch command does not decrease in 120 (± 12) seconds when radio altimeter is turned off at 2500 foot altitude in AUTO approach	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective flight instrument accessory unit	Interchange flight instrument accessory units	If OK now, replace defective flight instrument accessory unit per paragraphs 12 and 13
	Defective radio altimeter		Troubleshoot radio altimeter
GS annunciator incorrect	Defective mode selector panel	Interchange mode selector panels	If OK now, replace defective mode selector panel
	Defective steering computer	Interchange steering computers	If OK now, replace defective steering computer
	Defective VHF navigation system		Troubleshoot VHF navigation system.
Pitch channel does not respond to middle marker	Defective marker beacon system	If middle marker lights come on, receiver is good	If middle marker lights are not on, troubleshoot marker beacon system.
	Defective steering computer		Replace defective steering computer

Flight Director System Trouble Analysis
Table 101 (Sheet 7 of 9)

Ref T O 1E-3A-2-31-1
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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
VL and GS annunciators and command bars do not indicate localizer glide slope capture in man GS mode	Defective steering computer or mode selector panel	Interchange steering computers	If OK now, replace defective steering computer Replace defective mode selector panel
Incorrect tilt table roll with one dot localizer signal in man GS	Defective steering computer		Replace steering computer
Pitch channel gain does not decrease when mode is changed from auto APP to MAN GS.	Defective steering computer		Replace steering computer
Pitch channel gain does not decrease when middle marker signal is applied.	Defective marker beacon receiver Defective steering computer	If middle marker lights come on, receiver is good	 Replace steering computer.

Flight Director System Trouble Analysis
Table 101 (Sheet 8 of 9)

Ref. T.O 1E-3A-2-31-1
Page 11-31 Change 0

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TROUBLE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
GA annunciator does not come on when disconnect switch is pressed in MAN GS or AUTO approach	Defective disconnect switch or relay. Defective steering computer.		Check disconnect circuit per wiring diagram Replace steering computer
Mode SEL switch does not rotate to GA when disconnect switch is pressed	Defective mode selector panel or steering computer	Fault is probably in control panel.	Replace control panel or steering computer as required
Tilt table does not indicate 8 (± 2) degrees pitch up with pitch command bar centered in GA mode	Defective steering computer		Replace steering computer
GA annunciator does not go out.	Defective mode selector panel	Interchange mode selector panel	If OK now, replace defective mode selector panel

Flight Director System Trouble Analysis
Table 101 (Sheet 9 of 9)

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RMI MODE SELECTOR INSTALLATION - REMOVAL/INSTALLATION

1 CONTROL PANELS - REMOVAL

- A Release quick-release fasteners at edge of panel. Fasteners require one-quarter turn counterclockwise to release, and may pop out by spring action when released
- B Pull panel out of mounting area far enough to disconnect electrical connectors
- C Disconnect electrical connectors

2 CONTROL PANELS - INSTALLATION

- A Connect electrical connectors to panel
- B Place panel in mounting area
- C Fasten quick-release fasteners by pushing in and turning one-quarter turn clockwise. The fasteners can only be pushed completely in when they are correctly aligned to engage the wire in the mounting rail

Ref T O 1E-3A-2-34-1
Page 1-11 Change 23



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NAV INSTRUMENT SWITCHING - ADJUSTMENT/TEST

1. SYSTEM TEST.

A. General Information

- (1) There are two independent NAV instrument switching systems installed on the airplane to supply guidance commands to the pilot and copilot. Raw data is supplied from the following systems as selected: VG, Compass, INS, VHF NAV System, and TACAN.
- (2) It is required that power be available at the associated power busses and that the flight deck lighting be operating.

B. Test Equipment Required

- (1) IFR Model NAV-401L Test Set or equivalent, is used to generate a VOR or LOC test signal.
- (2) TACAN Flight Line Tester...Federal Telecon NUS-3156 or AN/ARM-25C Ramp Test Set, one required or equivalent.

C. Test Requirements

- (1) Close the following circuit breakers on the P5 overhead panel:

<u>ESSENTIAL FLIGHT INSTR</u> <u>BUS</u>	<u>FLIGHT INSTRUMENT</u> <u>BUS NO 2</u>	<u>ESSENTIAL RADIO</u> <u>BUS</u>	<u>RADIO BUS</u> <u>NO 2</u>
ADC 1 DC		ADC 2 DC	IU NO 2 DC
RATE OF TURN CAPT DC	RATE OF TURN F/O DC	IU NO 1 DC	ADC XFER
FLT INSTR NO 1 FD NO 1 DC	XMFR NO. 2 AC	LOW RANGE ALTM NO. 1 AC	VOR NO 2 AC
XMFR NO 1 AC	VERT GYRO NO 2 AC	TACAN NO 1 AC	VOR NO 2 DC
VERT GYRO NO 1 AC	COMPTR NO 2 AC (LX-N 20199) F/O COMPTR NO 2 AC (LX-N 19997, LX-N 20000)	TACAN NO 1 DC	
COMPASS NO 1 AC	FLT INSTR HDG EXC AC	MARKER BEACON DC	
NAV XFER RLY NO 1 DC	NAV XFER RLY NO 2 DC	GS NO 1 DC	
FLT INSTR ATT EXC AC	FLT INSTR ATT EXC AC	VOR NO 1 AC	
FLT INSTR HDG EXC AC	COMPASS NO 2 AC	VOR NO 1 DC	
(FD) COMPTR NO 1 AC	FLT INST NO 2 DC		

TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

34-22-01

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- (3) Set up one NAV-401L Test Set, or equivalent, for VOR test signal: Set Test Set to VOR XTAL (108,0 MHz).
- (4) Tune both VHF NAV systems to VOR frequency selected on test set.
- (5) Set a TACAN test signal in TACAN test set.
- (6) Tune TACAN receiver to test channel.
- (7) Synchronize compass systems and allow a few minutes for gyros to stabilize.
- (8) Set both NAV Mode Selectors to VOR/LOC.

E. Command and Annunciation

NOTE:

- (1) The following tests may be performed on the Capt and F/O side separately or simultaneously.
- (2) Unless otherwise stated, the following equipment shall be utilized for test pertaining to the captain's side: HSI, NAV MODE selector, Flight Director Annunciator, VHF NAV No. 1, RMI and RMI mode selector panel.
- (3) Unless otherwise stated, the following equipment shall be utilized for test pertaining to the F/O's side: HSI, NAV MODE Selector, Flight Director Annunciator, VHF NAV No. 2, RMI and RMI mode selector panel.

STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS
L	OFF MODE		
(1)	Place BRT/DIM/TEST Switch to TEST	All light up	All annunciators, upper-amber and lower-green, light up bright
(2)	Place BRT/DIM/TEST Switch to DIM	---	All annunciators off.
(3)	Press TEST Light/Switch on FLT DIR annunciator.	All light up	All annunciators, upper and lower, light up dim.
(4)	Place BRT/DIM/TEST Switch to BRT	---	

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F. NAV Instrument Switching - Adjustment/Test

The following table explains the switching of the RMI 1 pointer on the pilots and co-pilots RMI.

NAV MODE Selector Panel	RMI Selector Panel	RMI Pointer 1	RMI Pointer 2	HSI Bearing 1 Pointer	HSI Bearing 2 Pointer	RMI Bearing Pointer Annun- ciator	Heading Source
INS	ADF	ADF	TACAN 2	TACAN 1	TACAN 2	TACAN 2	INS True heading
INS	TACAN/ VOR	TACAN 1	TACAN 2	TACAN 1	TACAN 2	TACAN 1	INS True heading
TACAN	ADF	ADF	VOR 2	VOR 1	VOR 2	VOR 2	Compass 1 for Pilot and Com- pass 2 for Co- pilot
TACAN	TACAN/ VOR	VOR 1	VOR 2	VOR 1	VOR 2	VOR 1	Compass 1 for Pilot and Com- pass 2 for Co- pilot
VOR/LOC	ADF	ADF	TACAN 2	TACAN 1	TACAN 2	TACAN 2	Compass 1 for Pilot and Com- pass 2 for Co- pilot
VOR/LOC	TACAN/ VOR	TACAN 1	TACAN 2	TACAN 1	TACAN 2	TACAN 1	Compass 1 for Pilot and Com- pass 2 for Co- pilot

- (1) Check on the pilots RMI with the on site HSI with valid TACAN signals ref. 34-50-01, VOR signals ref. 34-41-01 and ADF signals ref. 34-20-1 .
- (2) With the NAV mode selector in INS and RMI selector panel in TACAN/VOR.
 - (a) The RMI Bearing Pointer 1 display the same bearing information as the HSI Bearing pointer 1.
 - (b) The compass card of HSI and RMI show the same heading (True INS).
 - (c) RMI bearing pointer annunciator TACAN 1 illuminate.



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- (3) With the NAV mode selector in TACAN and RMI selector panel in TACAN/VOR
 - (a) The RMI Bearing Pointer 1 displays the same bearing information as the HSI Bearing pointer 1.
 - (b) The compass card of HSI and RMI show the same heading (COMPASS 1 heading for pilot and Compass 2 for co-pilot).
 - (c) RMI bearing pointer annunciator VOR 1 illuminates.
- (4) With the NAV mode selector in VOR/LOC and RMI selector panel in TACAN/VOR
 - (a) The RMI Bearing Pointer 1 displays the same bearing information as the HSI Bearing pointer 1
 - (b) The compass card of HSI and RMI show the same heading (COMPASS #1 heading for pilot and Compass 2 for co-pilot).
 - (c) RMI bearing pointer annunciator TACAN 2 illuminates.
- (5) With the NAV mode selector in INS and RMI selector in ADF.
 - (a) The RMI Bearing Pointer 1 displays the ADF bearing information.
 - (b) The compass card of HSI and RMI show the same heading (True INS).
 - (c) RMI bearing pointer annunciator TACAN 2 illuminates.
- (6) With the NAV mode selector in TACAN and RMI selector in ADF.
 - (a) The RMI Bearing Pointer 1 displays the ADF bearing information
 - (b) The compass card of HSI and RMI show the same heading (COMPASS 1 heading for pilot and Compass 2 for co-pilot).
 - (c) RMI bearing pointer annunciator VOR 2 illuminates.
- (7) With the NAV mode selector in VOR/LOC and RMI selector in ADF.
 - (a) The RMI Bearing Pointer 1 displays the the ADF bearing information.
 - (b) The compass card of HSI and RMI show the same heading (COMPASS #1 heading for pilot and Compass 2 for co-pilot).
 - (c) RMI bearing pointer annunciator TACAN 2 illuminates.

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RMI MODE SELECTOR - ADJUSTMENT/TEST

1 FLIGHT DIRECTOR SYSTEM TEST

FLIGHT DIRECTOR SYSTEM, Collins Radio Company, composed of Steering Computer 562A-5F4, Controller 614E-10D, Horizontal Situation Indicator 331A-8H, and Attitude (Flight) Director Indicator 329B-9A

A General Information

- (1) There are two independent Flight Director Systems installed on the airplane to supply guidance commands to the pilot and co-pilot. The guidance commands are a function of flight director mode selection and the sub-system supplying raw data. Raw data is supplied from the following systems as selected: VG, Compass, VHF NAV SYSTEM, TACAN, RADIO ALTIMETER SYSTEM, MARKER BEACON SYSTEM, and AIR DATA COMPUTER SYSTEM. The System Functional Tests for the above systems shall have been completed as necessary to accomplish this test.
- (2) It is required that power be available at the associated power busses and that the Flight Deck lighting be operating.
- (3) This Test establishes the requirements for installation and airplane test of the Flight Director System. No adjustments shall be made except as stated herein.

B Test Equipment Required

- (1) IFR Model NAV-401L Test Set or equivalent, 2 required. One unit is used to generate a VOR, LOC, or GS test signal, and the other to generate a Middle Marker test signal.
- (2) TACAN Flight Line Tester. Federal Telecon NUS-3156 or AN/ARM-25C Ramp Test Set, one required or equivalent.
- (3) Test Oscillator, Cossor FT113 or equivalent, one required. Used to generate a middle marker test signal.
- (4) FD1104-12-15 Universal Radio Altimeter Simulator or equivalent, one required. Used to simulate airplane altitude in the Radio Altimeter Receiver/Transmitter unit.
- (5) Air Pressure Test Set, one required. Used to provide static pressure to the Air Data Computer for Altitude Hold tests.
- (6) Tilt turn table, FD500-1886 or equivalent, one required.

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- (7) Adapter cables between tilt table and vertical Gyroscope plugs in airplane
- (8) Hilger and Watts Model B inclinometer or equivalent, used to measure tilt table horizontal inclination (optional)
- (9) Stop watch, one required (two optional)

C Test Requirements

- (1) Prepare for Test Remove vertical Gyros from airplane and install on calibrated tilt tables and level in roll and pitch ($0^\circ \pm 1^\circ$)

CAUTION ALLOW GYROS TO RUN DOWN BEFORE MOVING TO PREVENT TUMBLING OF GIMBELS

- (2) Close the following circuit breakers on the P5 overhead panel

FLT INSTR ESS BUS

RADIO ALTM AC NO 1
 TURN RATE DC
 TACAN AC
 FLT DIR DC
 FLT DIR CMPTR AC
 XFMR HDG AC
 XFMR NO 1
 VERT GYRO 1
 CCMPASS NO 1
 NO 1 ATTD AC
 CAPT NAV XFER RLY
 VHF NAV NO. 1 DC

FLT INSTR BUS 2

AIR DATA AC
 TURN RATE DC
 VHF NAV DC
 XFMR NO 2
 FLT DIR DC
 FLT DIR CMPTR AC
 XFMR HDG AC
 XFMR ATTD AC
 XFMR BRG
 F/O NAV XFER RLY

- (3) Set PITCH TRIM CONTROL ON BOTH ADI's to "0"
- (4) Set up one NAV-401L Test Set, or equivalent, for VOR test signal Set Test Set to VOR XTL (108 0 MHz), or for LOC and GS signals Set test set to G/S XTL (108 1 MHz, LOC and 334 7 MHz, GS) and adjust for proper power output.
- (5) Tune both VHF NAV systems to localizer frequency selected on test set
- (6) Set a TACAN test signal in TACAN test set
- (7) Tune TACAN receiver to test channel

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- (8) Synchronize compass systems and allow a few minutes for gyros to stabilize
- (9) Set Both NAV MODE selectors to VOR/LOC
- (10) Set the heading marker and the course arrow on both HSI'S to airplane heading Pull out HDG and COURSE knobs for manual selection
- (11) Set the PITCH CMD knob on both Mode Selectors to zero

D Flight Director System Monitor

NOTES.

- (1) Return circuit breakers to initial conditions after each step unless otherwise noted
- (2) The Flight Director Command Bars shall be in view and the CMPTR flags shall be out of view in both ADIs unless otherwise noted

E. Command and Annunciation

NOTES-

- (1) The following tests may be performed on the Capt and F/O side separately or simultaneously
- (2) Unless otherwise stated, the following equipment shall be utilized for test pertaining to the Captain's side Captain Flight Director Mode Selector, ADI, HSI, NAV MODE selector, Flight-Director Annunciator, Displacement Gyro No 1, VHF NAV No 1, Radio Altimeter #1, Marker Beacon, and Air Data Computer
- (3) Unless otherwise stated, the following equipment shall be utilized for tests pertaining to the F/O side F/O Flight Director Mode Selector, ADI, HSI, NAV MODE Selector, Flight Director Annunciator, Displacement Gyro No 2, VHF NAV No 2, Radio Altimeter #1, Marker Beacon, and Air Data Computer

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STEP	CONDITION	OPEN CIRCUIT BREAKER	CMPTR FLAG IN VIEW	COMMAND BARS OUT OF VIEW
(1)	Place both Mode Selectors to HDG mode			
(2)		FLT DIR CMPTR-1 AC	CAPT	CAPT
(3)		FLT DIR-1 DC	CAPT	CAPT
(4)		COMPASS-1 39	CAPT	CAPT
(5)		No 1 ATTD AC EXC	CAPT	
(6)		HDG-1 AC EXC	CAPT	CAPT
(7)		FLT DIR CMPTR-2 AC	F/O	F/O
(8)		FLT DIR-2 DC	F/O	F/O
(9)		COMPASS-2 39	F/O	F/O
(10)		No 2 ATTD AC EXC	F/O	F/O
(11)		HDG-2 AC EXC	F/O	F/O
F Place both Mode Selectors to MAN GS Mode				
(1)		VHF NAV No 1 DC	CAPT	CAPT
(2)		TACAN AC		
(3)		VHF NAV No 2 DC	F/O	F/O
G	Open NAV XFR RELAY CAPT and NAV XFR RELAY F/O INST circuit breakers	-----	-----	-----
H	Set both NAV MOOE selectors to TACAN	-----	-----	-----
I	Close NAV XFR RELAY CAPT INST AND NAV XFR RELAY F/O INST circuit breakers.	-----	-----	-----
J		TACAN AC	BOTH	BOTH
K	Set both NAV MODE selectors to VOR/LOC mode	-----	-----	-----

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
L	OFF MODE				
(1)	Set Mode Selector to OFF mode	---	Pitch and Roll command bars and CMPTR flag out of view in ADI	Check	
(2)	Place BRT/DIM/TEST switch to TEST	All light up	All annunciators, upper-amber and lower-green, light up bright	Check	
(3)	Place BRT/DIM/TEST switch to DIM	---	All annunciators off	Check	
(4)	Press TEST light/switch on FLT DIR annunciator	All light up	All annunciators, upper and lower, light up dim	Check	
(5)	PLACE BRT/DIM/TEST SWITCH TO BRT	---			
M	HDG MODE				
(1)	Set Mode Selector to HDG mode	---	Pitch and roll command bars shall indicate zero command within $0^{\circ} \pm 3^{\circ}$ of Displacement Gyro tilt	Record	
(2)	Set the heading marker on the HSI to 10° greater than airplane heading	---	Roll command bar shall indicate fly right command	Check	
(3)	Tilt the Gyro in right roll until the roll command bar indicates zero command	---	Gyro tilt shall be $15^{\circ} \pm 5^{\circ}$ right roll	Record	
(4)	Set the heading marker to 90° greater than airplane heading and tilt Gyro in right roll to center roll command bar	---	Gyro tilt shall be $27.5^{\circ} \pm 5^{\circ}$ right roll	Record	
(5)	Repeat steps 2, 3, and 4 above for less than airplane heading counterclockwise direction) and left roll	---	Same results with left roll	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(6)	Return the heading marker to airplane heading and Gyro to level	---	Pitch and roll command bars shall indicate zero command within $0^\circ \pm 3^\circ$ of Gyro tilt	Record	
N	PITCH COMMAND MODE				
(1)	Rotate the PITCH CMD knob on the Mode Selector 90° clockwise	---	The pitch command bar shall indicate pitch up command	Check	
(2)	Tilt the Gyro pitch up until the pitch command bar indicates zero command	---	The Gyro tilt shall be $10^\circ \pm 5^\circ$ pitch up	Record	
(3)	Level the Gyro Rotate the PITCH CMD knob counterclockwise until the mechanical stop is reached	---	The pitch command bar shall indicate pitch down command	Check	
(4)	Return the PITCH CMD knob to zero	---			
O	ALTITUDE HOLD MODE				
(1)	Apply a 2,000 ft static pressure and then set the ALT HOLD switch on the Mode Selector to ON (Apply static pressure to Capt's static system only)	---	The pitch command bar shall indicate zero command within $0^\circ \pm 3^\circ$ of Gyro tilt	Record	
(2)	Rotate the PITCH CMD knob throughout its range and return to zero.	---	The pitch command bar shall not respond	Check	
(3)	Slowly increase the static pressure to 2250 feet	---	The pitch command bar shall indicate $7^\circ \pm 2^\circ$ pitch down command	Record	
(4)	Slowly increase the static pressure to 1750 feet	---	The pitch command bar shall indicate $7^\circ \pm 2^\circ$ pitch up command.	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(5)	Return the static pressure to 2000 feet Tilt the Gyro to 20° pitch up	---	The pitch command bar shall indicate pitch down command	Check	
(6)	After 45 seconds, slowly reduce the Gyro tilt until the pitch command bar indicates zero command	---	The Gyro tilt shall be 12° ± 3° pitch up	Record	
(7)	Return the static pressure to ambient Return the Gyro to level Open AIR DATA AC circuit breaker	---	The ALT HOLD switch on the Mode Selector shall return to OFF and pitch command bar shall indicate zero command	Check	
P	NAVILOC MODE (VHF NAV)				
(1)	Apply a VOR test signal (108.0 MHz) with the selected omniradial closest to airplane heading plus 180° Tune the VHF NAV receiver to the VOR test frequency. Turn the course knob on the HSI until the lateral deviation bar is deflected left 2 dots	---	The TO-FROM arrow shall indicate TO ADI RUNWAY flag and rising runway shall be out of view	Check	
(2)	Set the Mode Selector to NAV/LOC Rotate the HDG knob on the HSI and then reset heading marker to airplane heading	VL (VOR/LOC) (AMBER)	The roll command bar shall respond to the heading knob for roll commands	Check	
(3)	Rotate the COURSE knob so that the lateral deviation bar moves toward zero deviation. Stop when Flt Dir Annunciator VL changes to green	VL (GREEN)	The lateral deviation bar shall indicate 1 ± 0.5 dot deviation Roll command bar indicates fly left	Check Record	
(4)	Continue to reduce the lateral deviation to zero Wait 2 minutes Tilt the gyro in roll to center roll command bar	VL (GREEN)	The roll command bar shall indicate zero command within 0° ± 3° Gyro tilt	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(5)	Set the Mode Selector to HDG Tune the VHF NAV receiver to a localizer test frequency and apply a fly left localizer test signal such that the lateral deviation bar is deflected more than 2 5 dots Rotate the COURSE knob until the course arrow indicated 30° greater than the airplane heading. Turn the Mode Selector to MAN GS and then to NAV/LOC	VL (GREEN)			
(6)	Wait two minutes Slowly adjust the COURSE knob until the roll command bar indicates zero roll command	VL (GREEN)	The course arrow shall indicate $30^{\circ} \pm 5^{\circ}$ greater than airplane heading	Record	
(7)	Rotate the COURSE knob until the course arrow indicates 45° greater than airplane heading	VL (GREEN)	The roll command bar shall indicate a fly right command	Check	
(8)	Rotate the course knob until the course arrow indicates 15° greater than airplane heading	VL (GREEN)	The roll command bar shall indicate a fly left command	Check	
(9)	Return the course arrow to airplane heading Tilt the Gyro in left roll until the roll bar indicates zero command	VL (GREEN)	The Gyro tilt shall be $25^{\circ} \pm 5^{\circ}$ left roll	Record	
(10)	Turn the Mode Selector to HDG and return to NAV/LOC Return Gyro to level	VL (AMBER)			
(11)	Slowly reduce the localizer signal until the Flt Dir annunciator changes to indicate VL (Green)	VL (GREEN)	The lateral deviation bar shall indicate 2 ± 0.5 dot deviation The roll command bar shall indicate a fly left command	Check Record	
Q	NAV/LOC MODE (TACAN)				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(1)	Set the Mode Selector to HDG and the NAV MODE Selector to TACAN Apply a TACAN test signal and set the TACAN receiver to the test channel. Rotate the course knob until the lateral deviation bar is deflected left 2 dots and the TO- FROM arrow indicates TO	---			
(2)	Set the Mode Selector to NAV/LOC Rotate the HDG knob and then return heading marker to airplane heading	TACAN (AMBER)	The roll command bar shall respond to rotation of the heading knob	Check	
(3)	Rotate the COURSE knob so that the lateral deviation bar moves toward zero deviation. Stop when Flt Dir Annunciator TACAN changes to green	TACAN (GREEN)	The lateral deviation bar shall indicate 1 ± 0.5 dot deviation	Record	
(4)	Reduce the lateral deviation to zero, wait 2 minutes	TACAN (GREEN)	The roll command bar shall indicate zero command within $0^\circ \pm 3^\circ$ Gyro	Record	
(5)	Rotate the COURSE knob until the lateral deviation bar is deflected left one dot	TACAN (GREEN)	The roll command bar shall indicate a fly left command	Check	
(6)	Rotate the COURSE knob until the lateral deviation bar is deflected right one dot	TACAN (GREEN)	The roll command bar shall indicate a fly right command	Check	
(7)	Return COURSE arrow to airplane heading and set NAV MODE selector to VOR/LOC mode				
R	AUTO APP MODE				

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(1)	Set the Mode Selector to HDG. Apply fly up glideslope and fly left localizer test signals such that the glidescope needle and lateral deviation bar are deflected more than 2.5 dots. Set the Mode Selector to AUTO APP.	VL (AMBER)	ADI RUNWAY flag will be out of view and rising runway shall be in view and deflected left greater than one dot.	Check	
(2)	Rotate the HDG knob and then return heading marker to airplane heading.	VL (AMBER)	The roll command bar shall respond to rotation of the heading knob.	Check	
(3)	Reduce the localizer signal to zero. Using the Radio Altimeter Simulator, apply an altitude of 2,000 feet as read on the radio altimeter indicator. Rotate the HDG knob and then return heading marker to airplane heading.	VL (GREEN) GS (AMBER)	The roll command bar shall not respond to the HDG knob for roll commands. ADI rising runway shall be centered.	Check	
(4)	Reduce the glideslope signal to zero.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate a small pitch down command which shall reduce to zero within 30 seconds.	Check Record	
(5)	Apply a one dot fly down glideslope signal.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate $9^\circ \pm 2^\circ$ pitch down command as read against the attitude tape.	Record	
(6)	Apply a one dot fly up glideslope signal.	VL (GREEN) GS (GREEN)	The pitch command bar shall indicate $9^\circ \pm 2^\circ$ pitch up command.	Record	
(7)	Adjust the glideslope signal to provide 7° pitch up command. Using the Radio Altimeter Simulator, reduce the altitude to 1400 feet.	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^\circ \pm 1^\circ$ pitch up within 120 ± 12 seconds.	Record	

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(8)	Apply a glideslope signal to give 6° pitch up command Using the Radio Altimeter Simulator, reduce the altitude to 150 feet	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ± 1° pitch up in 7.5 ± 2 seconds ADI rising runway shall indicate 150 feet approximately	Record	
(9)	Using the Radio Altimeter Simulator set an altitude, read on Radio Altimeter, of 50 feet	VL (GREEN) GS (AMBER)	ADI rising runway shall indicate 50 feet approx	Record	
(10)	Set the Mode Selector to HDG. Reset radio altitude to 2000 feet. Set the Mode Selector to AUTO APP	VL (GREEN) GS (AMBER)			
(11)	Reduce the glideslope signal to zero	VL (GREEN) GS (AMBER)			
(12)	Apply to glideslope signal to give 7° pitch up command Open RADIO ALTIMETER circuit breaker	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ± 1° pitch up within 120 ± 12 seconds	Record	
(13)	Apply a glideslope signal to give 6° pitch up command. Set the MARKER BEACON switch (overhead panel) to LOW and apply a simulated middle marker signal for 3 seconds	VL (GREEN) GS (GREEN)	The pitch command shall reduce to 3° ± 1° pitch up in 7.5 ± 2 seconds	Record	
(14)	Close RADIO ALTIMETER circuit breaker	VL (GREEN) GS (GREEN)			
S	MAN GS MODE				
(1)	Set the Mode Selector to HDG. Apply 2 dots fly right localizer signal and 2 dots fly down glideslope signal. Set the Mode Selector to MAN GS	VL (GREEN) GS (GREEN)	The command bars shall indicate pitch down and fly right command	Check	

Ref DRW CDRL 43/44

Paragraph 7 39-Issue D dtd 19 May 1988

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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/ RECORD	RESULT
(2)	Reduce glideslope deviation to zero Wait 2 minutes Tilt the Gyro in right roll until the roll command bar indicates zero roll command	VL (GREEN) GS (GREEN)	The Gyro tilt shall be $15^{\circ} \pm 3^{\circ}$ right roll	Record	
(3)	Return Gyro to level Reduce the localizer signal to zero Set the Mode Selector to AUTO APP Apply a fly up glideslope signal to provide 7° of pitch command as read against the attitude tape Set the Mode Selector to MAN GS	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ pitch up immediately	Record	
(4)	Apply a glideslope signal to give 6° pitch up command Apply a simulated middle marker signal for 3 seconds	VL (GREEN) GS (GREEN)	The pitch command shall reduce to $3^{\circ} \pm 1^{\circ}$ pitch up within 7.5 + 2 seconds	Record	
T	GO AROUND (GA) MODE				
(1)	Set the Mode Selector to MAN GS. Press the Autopilot disconnect button to the A/C commander's control wheel Rotate PITCH CMD knob and then return to zero Rotate HDG knob and then return heading marker to airplane heading	GA (GREEN)	The Mode Selector shall return to GA position The pitch command bar shall indicate $8^{\circ} \pm 2^{\circ}$ pitch up command and shall not respond to rotation of the PITCH CMD knob The roll command bar shall indicate zero roll command (wings level) and shall not respond to rotation of the HDG knob	Check Record	
(2)	Tilt the Gyro pitch up until the pitch command bar indicates zero pitch command	GA (GREEN)	The Gyro tilt shall be $8^{\circ} \pm 2^{\circ}$ pitch up	Record	
(3)	Return the Gyro to level Set the Mode Selector to MAN GS and then AUTO APP	VL (GREEN) GS (AMBER)		Check	

Ref DRW CDRL 43/44
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STEP	PROCEDURE	FLT ANNUNCIATOR	RESULTS	CHECKED/RECORD	RESULT
(4)	Press the Autopilot disconnect button on the Pilot's control wheel	GA (GREEN)	The Mode Selector shall remain in the NAV/LOC position	Check	
(5)	Reduce the localizer signal to zero Set the Mode Selector to NAV/LOC Press the Autopilot disconnect button on the A/C commander's control wheel	VL (GREEN)	The Mode Selector shall remain in the NAV/LOC position	Check	
(6)	Set the mode Selector to HDG Press the Autopilot disconnect button on the Pilot's control wheel	---	The Mode Selector shall remain in the HDG position	Check	

U Open VERT GYRO No 1 and No 2 AC circuit breakers

CAUTION DO NOT HANDLE GYRO UNTIL 30 MINUTES AFTER DISCONNECTING POWER TO ALLOW GYRO'S to RUN DOWN

V Remove both Gyro's from tilt table and reinstall in the airplane

W Close VERT GYRO No 1 and No 2 AC circuit breakers

Ref DRW CDRL 43/44
Paragraph 7 39-Issue D dtd 19 May 1988



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MARKER BEACON ANTENNA - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Self Leveling Green Sealant (P/N HT3326-5-50).
- B. Tape Stretch Seal (P/N AD89503/01-36).

2. Remove Marker Beacon Antenna

- A. Open Marker Beacon circuit breaker on P5 overhead circuit breaker panel.
- B. Locate the Marker Beacon Antenna station 650 (bottom).
- C. Open forward antenna door on fuselage bottom centerline.
- D. Unfasten cowl-type fasteners in cover plate at right side of antenna. (See figure 401.)
- E. Remove cover plate.
- F. Remove lock wire from six screws attaching antenna to mounting plate, remove screws and detach antenna from plate.
- G. Pull antenna out far enough to disconnect coaxial cable connector.
- H. Disconnect coaxial cable connector from antenna.

3. Install Marker Beacon Antenna

- A. Place the antenna gasket on the antenna.
- B. Apply self leveling green sealant to connector base. Allow the sealant to cure for 30 minutes before mounting the antenna to the aircraft.
- C. Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- D. Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- E. Prime and paint all bare metal outside the original footprint and decrease the original footprint by 0,2 inch using paint per AMM 51-90-00.

NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

TR-Nr. DFW 34-26

TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

34-24-21

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May 15/2007



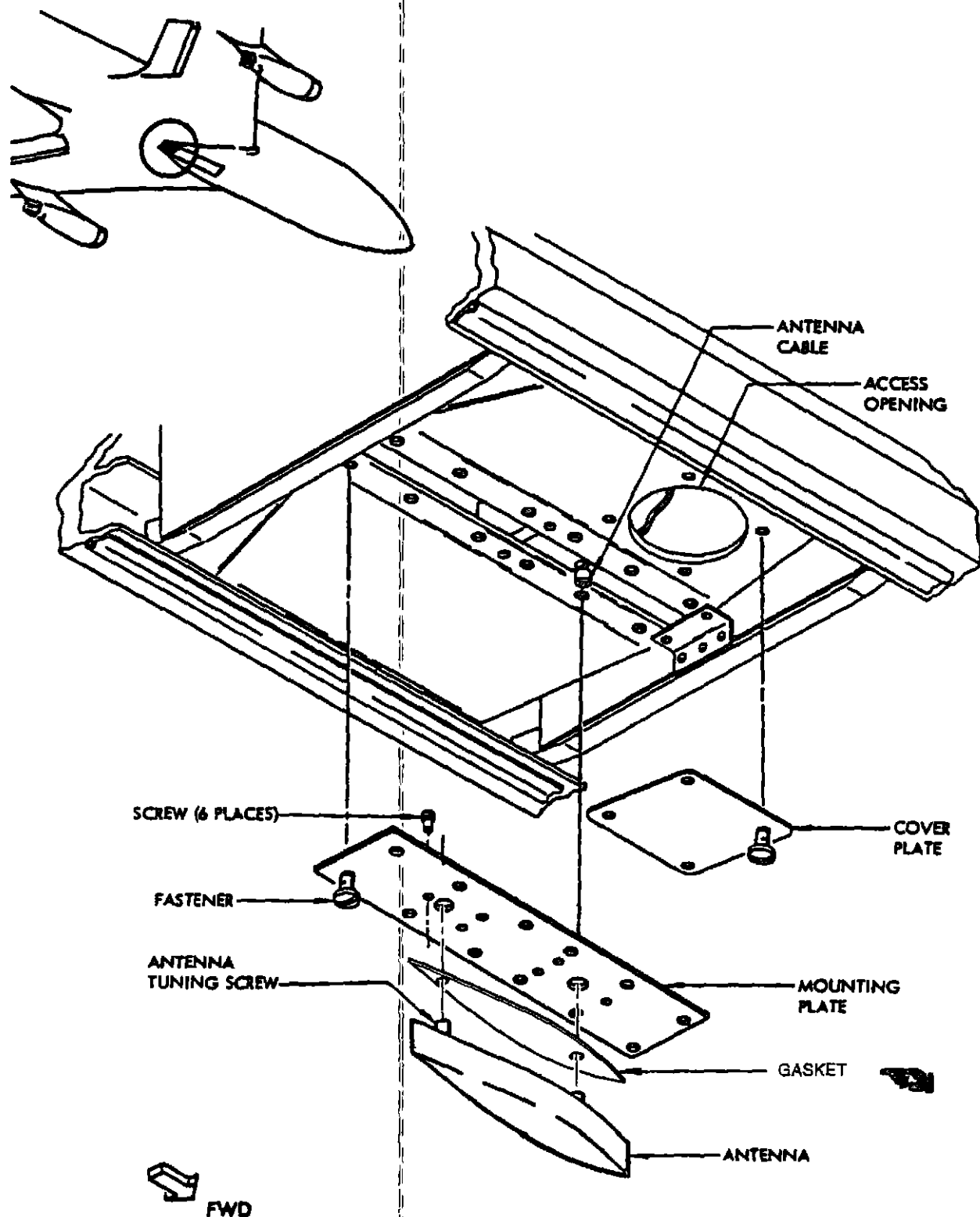
MAINTENANCE MANUAL

- F. Clean the antenna and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- G. Remove the aliphatic naphtha with a clean cloth.
- H. Place antenna near mounting location and connect coaxial cable to antenna.
- I. Wind stretch seal tape around the connector until it is 1.5 inch above the connector, covering the coax cable.

NOTE: Make sure that the adhesive side of the tape is pointing to the coaxial cable and the connector. This provides for a tight seal.

CAUTION DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACES

- J. Place antenna in position ensuring the antenna gasket is positioned correctly.
- K. Secure antenna with six mounting screws. Ensure that a Teflon washer is placed under each screw.
- L. Tighten antenna screws so that antenna gasket is compressed evenly.
- M. Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- N. Measure electrical bond resistance between antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- O. Close the Marker Beacon circuit breaker on P5 overhead circuit breaker panel.
- P. Perform operational test per AMM 34-24-0 page 201.



Marker Beacon Antenna Installation
Figure 401



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MARKER BEACON SYSTEM - DESCRIPTION AND OPERATION

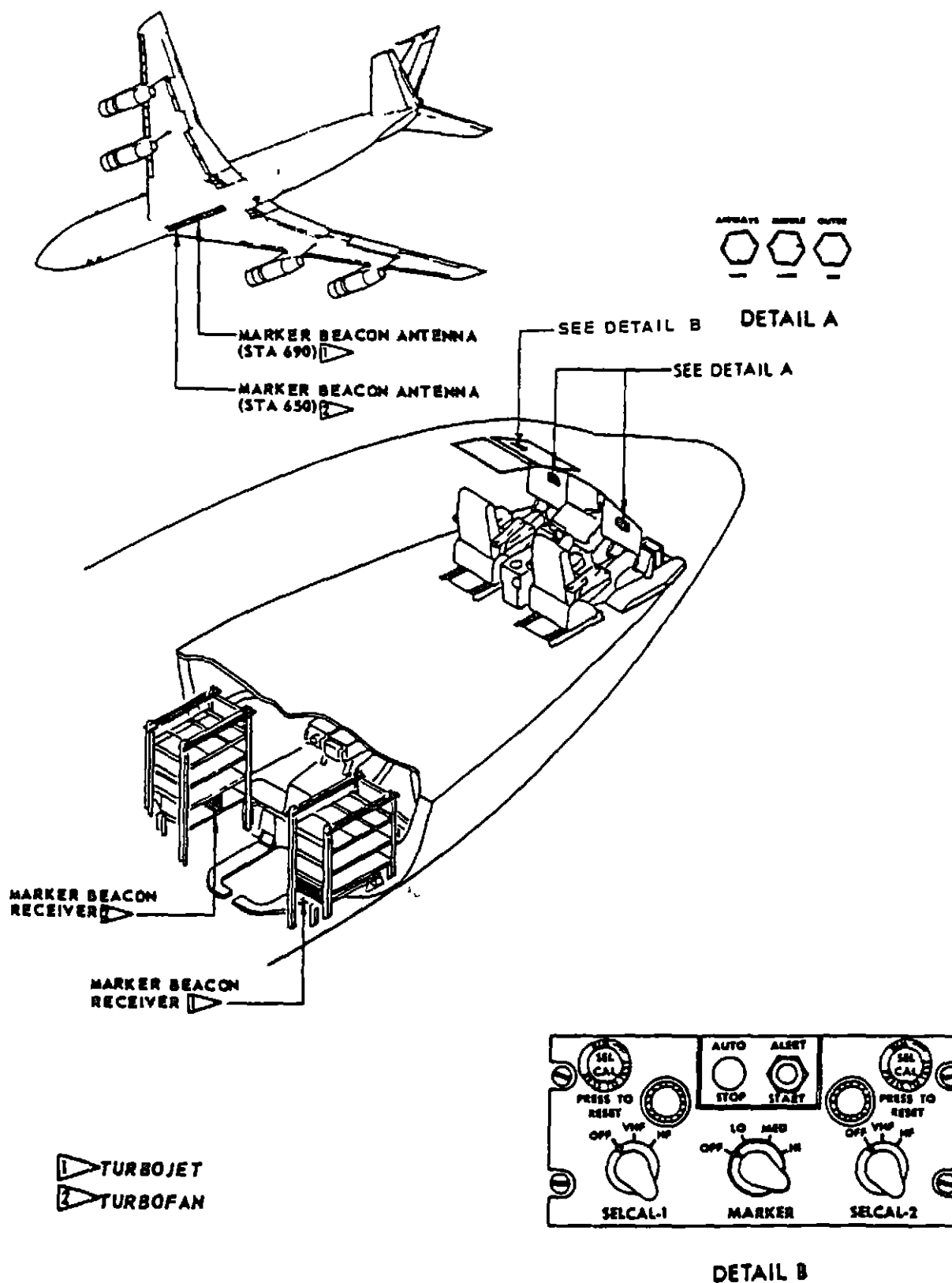
1 General

- A The marker beacon system provides the pilots with both visual and aural indication of airplane passage over airways fan markers, station location Z markers and instrument landing system (ILS) middle and outer markers
- B The marker beacon system consists of a receiver, an antenna, indicator lights, and a sensitivity switch (See figure 1)
- C The ground marker beacon transmitters all operate on a fixed frequency of 75 MHz and are modulated by one of four audio signals, depending on the type of marker beacon. The signals, received by the airborne receiver as the airplane passes over the transmitter, are made to light indicator lights. The audio signal is also made available to the crew by actuation of the MKR control on the audio selector panels. Following are the four types of marker beacons with their tone frequency and indicator light color
 - (1) ILS Outer Marker - An intermittent 400-cycle tone with the blue light flashing
 - (2) ILS Middle Marker - An intermittent 1300-cycle tone with the amber light flashing
 - (3) Airways Fan Marker - An intermittent 3000-cycle tone with the clear (or white) light flashing
 - (4) Station Location Z Marker - A steady 3000-cycle tone with the clear (or white) light steadily lighted

2 Marker Beacon Receiver

- A The receiver (Collins 51Z-4 or Marconi 6403) is a single conversion crystal controlled superheterodyne operating at a fixed frequency of 75 MHz. Sensitivity of the receiver is variable and controlled by a switch located on the pilot's instrument panel. Audio filters tuned to 400-cycles, 1300-cycles and 3000-cycles are used for separation of the three types of tone modulation used by the beacons. The receiver is installed on the electronic equipment rack.
- B The receiver (Bendix MKA series) is a tuned radio frequency (TRF) transistorized receiver that operates at a fixed frequency of 75 megacycles. A crystal filter provides the selectivity. From the crystal filter, the signal is applied to the RF amplifier and detector where the signal is amplified and the 75 megacycle RF component is removed. The output of the RF amplifier and detector (400, 1300 or 3000 cycles) is fed to the audio amplifier. The audio amplifier output is applied to the input filters of the lamp amplifier circuits. Each lamp circuit responds to the frequency to which it is fix-tuned, and applies a signal to the corresponding indicator and to the audio output amplifier. The audio output amplifier provides an aural indication of the particular marker beacon the aircraft is monitoring.

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Marker Beacon System Component Locations
 Figure 1



MAINTENANCE MANUAL

3 Antenna

- A The antenna for the system is located on the bottom of the airplane at body station 650 and is covered by the antenna door. The antenna is connected to the receiver by a coaxial cable.

4 Indicator Lights

- A There are three indicator lights. (See figure 1) The lights are covered by white (or clear), blue and amber lenses and are the push-to-test type.

5 Operation

- A The marker sensitivity switch is located on the pilot's instrument panel (figure 1) and has LOW, HIGH and TEST (where installed) position. When held in TEST, this causes marker beacon lights to illuminate in sequence and also generates appropriate tone for each marker beacon light. Test lasts 5 seconds.
With the switch set to LOW or HI, power is applied to the receiver. The sensitivity is variable from low to high by use of LOW, HI positions of switch.

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MARKER BEACON SYSTEM - TROUBLE SHOOTING

1 General

- A Trouble shooting the marker beacon system is best accomplished by performing a test as described in the "Marker Beacon System - Maintenance Practices " Operation of the indicator lamps and audible tone signals indicate satisfactory operation of the system
- B Lack of audible tones may indicate that the particular interphone control used for monitoring is faulty, and a second station should be used if the tones cannot be heard



MAINTENANCE MANUAL

MARKER BEACON SYSTEM - MAINTENANCE PRACTICES

I Adjustment/Test Marker Beacon System

A Test Equipment Required

- (1) Test Oscillator BC-376 or equivalent

B System Test

- (1) Supply external power to airplane and energize circuit breaker panel P-5 Close marker beacon circuit breakers
- (2) Set the sensitivity switch for maximum sensitivity and allow system to warm up
- (3) Place the test oscillator on the ground approximately 15 feet from the marker beacon antenna Extend the test oscillator antenna to its full length and place parallel to the fore and aft axis of the aircraft
- (4) Turn the test oscillator ON and set the modulation to 400 cps The carrier frequency should be 75 mc The blue lights on the instrument panel should be on
- (5) Connect a headphone to the interphone system and energize the system A 400 cps note should be heard
- (6) Repeat steps (5) and (6) with the modulation set at 1300 cps and 3000 cps The amber and white lights respectively should go on and the respective tones should be audible
- (7) Repeat steps (5) thru (7) with the sensitivity switch set for minimum sensitivity If necessary, move test oscillator closer to marker beacon antenna to obtain sufficient coupling
- (8) Determine if there is further need for external power If not, remove power from airplane

MARKER BEACON ANTENNA - REMOVAL/INSTALLATION

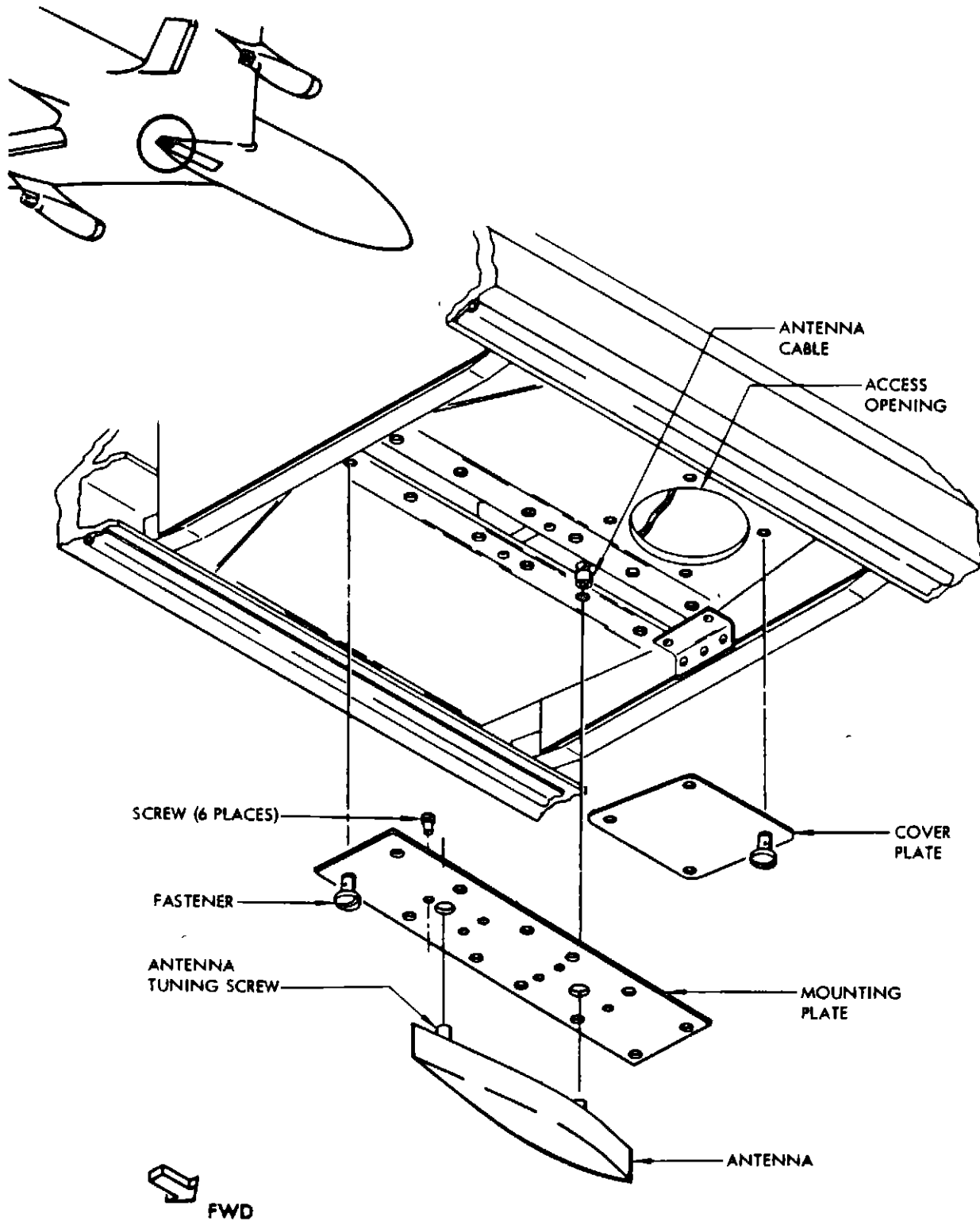
1. Remove Marker Beacon Antenna

- A. Open forward antenna door on fuselage bottom centerline.
- B. Unfasten cowl-type fasteners in cover plate at right side of antenna.
(See figure 401.)
- C. Remove cover plate.
- D. Reach through access opening and disconnect antenna cable from antenna.
- E. Unfasten cowl-type fasteners attaching antenna mounting plate, and remove antenna mount assembly.
- F. Remove lockwire from six screws attaching antenna to mounting plate, remove screws and detach antenna from plate.

2. Install Marker Beacon Antenna

- A. Place antenna on mounting plate with antenna cable connector extending through large hole in plate, and antenna tuning screw extending through the small hole.
- B. Install six screws and lockwire.
- C. Place antenna mounting assembly with cable connector up and forward.
- D. Fasten cowl-type fasteners.
- E. Reach through access opening at right of antenna and connect antenna cable to connector.
- F. Place cover plate over access opening and fasten cowl-type fasteners.
- G. Close antenna door.
- H. Perform operational test of marker beacon system. Refer to 34-24-0, Marker Beacon System - Adjustment/Test.

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Intercontinental
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MAINTENANCE MANUAL

RADIO ALTIMETER - DESCRIPTION AND OPERATION

EFFECTIVITY

00-SJA thru 00-SJL only

1 General

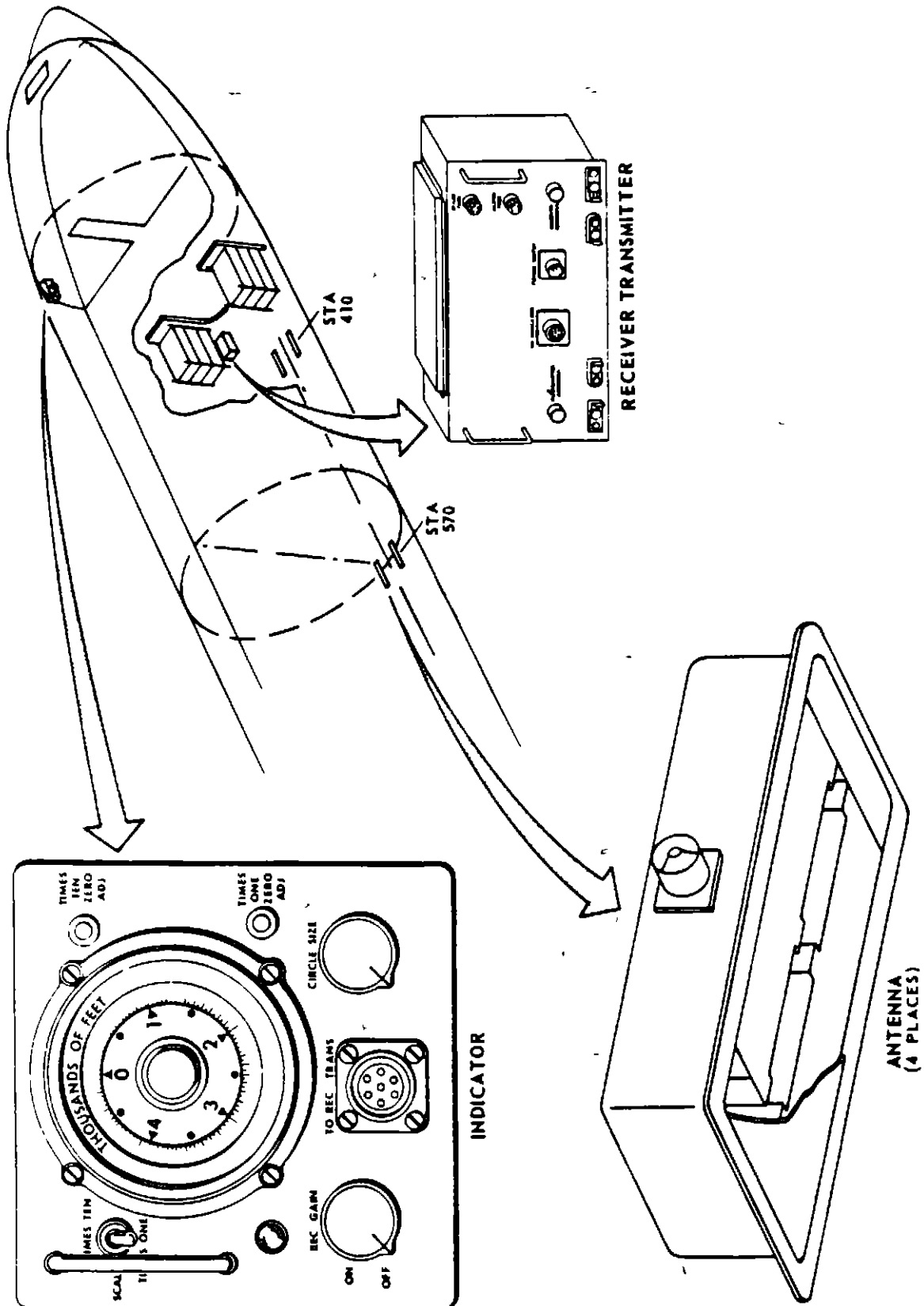
- A. The radio altimeter transmits a signal earthward from the airplane and then receives the same signal as it is reflected back from the earth. The length of time required for the signal to follow the path is measured, and presented as a lobe on a circle on the face of the indicator tube which is calibrated to be read in feet of altitude directly.
- B. The radio altimeter installation consists of the receiver and transmitter unit, indicator, two dipole antennas and a r-f filter. The receiver and transmitter unit is located on the floor in front of the left hand electronics rack and the indicator is installed at the navigation station. Power for the radio altimeter is supplied from the radio and T-R circuit breaker panel (P5). (See figure 1)

2. Radio Altimeter Receiver and Transmitter Unit

- A. The receiver and transmitter is electrically composed of two main units and a low voltage power supply common to both. The low voltage power supply is a conventional type and also furnishes low voltage B+ to the indicator.
- B. The transmitting signal originates in the timing oscillator which is crystal controlled. Part of the timing oscillator output is sent to the indicator as a time reference signal and the rest is applied to a clipper stage to produce a series of pulses with a carrier frequency of 440 MHz. These pulses are reflected upward from the earth and picked up by the receiver antenna. The received signal is mixed in the converter stage with a 410 MHz local oscillator to produce a 30 MHz IF signal. The output of the IF amplifier is detected and applied to the indicator.

3. Radio Altimeter Indicator

- A. The indicator is divided electrically into two main sections with an integral high-voltage power supply. One main section produces the necessary voltages, wave shapes and phase angles to produce a circular trace on the screen of the cathode-ray tube. The other main section amplifies pulses from the receiver, and places these pulses on the circular trace appearing on the cathode-ray tube. The application of these pulses to the cathode-ray tube causes them to appear as lobes on the circular trace on the screen. The point at which the lobe appears on the circle corresponds to the time it takes for the pulse to complete its trip. Reading the position of the lobe on the screen from the calibration marks gives the height of the airplane in feet.



Radio Altimeter Component Location
 Figure 1

- B All operating controls for the radio altimeter are located on the front panel of the indicator unit. An on-off switch on the "REC. GAIN" control turns on power to all components. The "SCALE" control selects the desired altitude scale to be used. The "TIMES ONE" position is for altitudes of 0-5000 feet and the "TIMES TEN" position is for altitudes of 0-50,000 feet. The "REC. GAIN" control adjusts the height of the reflected pulse lobe and the "CIRCLE SIZE" control adjusts the size of the circle on the face of the cathode-ray tube. The "TIMES ONE ZERO ADJ." and "TIMES TEN ZERO ADJ." sets the reference pulse at zero for the corresponding "SCALE" switch position.

4 Radio Altimeter Antennas

- A Separate dipole antennas are used for the transmitter and receiver sections of the radio altimeter. The transmitter antenna is located on the bottom of the fuselage at station 410 and the receiver antenna is behind it at station 570. A radio interference filter is installed under the receiver and transmitter unit.

END



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RADIO ALTIMETER - TROUBLE SHOOTING

EFFECTIVITY

00-SJA thru 00-SJL only

1. General

- A. Trouble shooting the Radio Altimeter is best accomplished by performing the tests described in Radio Altimeter - Maintenance Practices. Trouble in the system can be isolated by substituting components.
- B. Power for the system is taken from radio and T-R circuit breaker panel (P5). 115 volts ac should be available at terminal AW21 in the radio junction box (RJ2) on the Turbojet airplanes and at terminal T2 in radio junction box (RJ-12) on the Turbofan airplanes.

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RADIO ALTIMETER - MAINTENANCE PRACTICES

EFFECTIVITY

00-SJA thru 00-SJL only

1. Adjustment/Test Radio Altimeter

A Test Equipment Required

- (1) Field Indicator ID-98/APM (Part of test set TS-10C/APN) or equivalent.

B. Test Radio Altimeter

- (1) Supply ground power to airplane and energize radio bus No. 2 on Radio and T-R Circuit Breaker Panel (P5).
- (2) Close radio altimeter circuit breaker.
- (3) Turn on radio altimeter and allow for a 3 minute warm-up.
- (4) Check zero adjustment.
 - (a) Advance REC GAIN until zero lobe is seen near zero.
 - (b) Operate scale switch in the TIMES ONE and TIMES TEN positions and adjust corresponding zero adjustments as necessary to zero lobe in each position of scale switch.
- (5) Test Antenna Feed.
 - (a) With radio altimeter turned on, calibrate field indicator (ID-98/APN) by depressing adjust button and adjusting rheostat until lamp just goes out.
 - (b) Hold indicator near transmitting antenna. Lamp should light when indicator button is depressed.
 - (c) Test receiving antenna by temporarily reversing antenna cables (coax) to radio altimeter and repeating steps 1.B.(5)(a) and 1.B.(5)(b) above. After completing test, restore antenna cables to proper hookup.

RADIO ALTIMETER ANTENNA - MAINTENANCE PRACTICES

EFFECTIVITY

00-SJA thru 00-SJL only

1. Removal/Installation Radio Altimeter Antenna

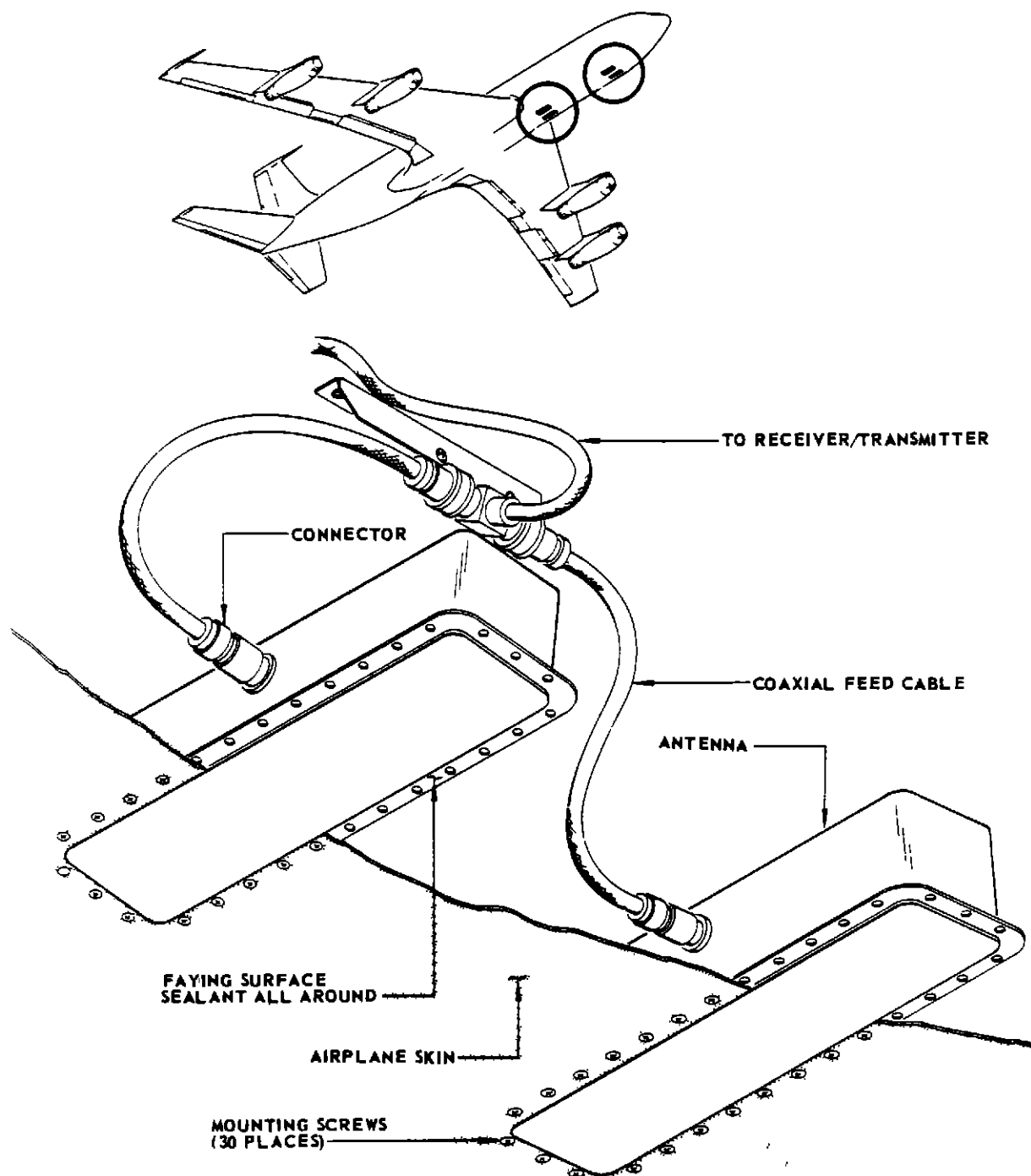
A. Remove Antenna (See figure 201.)

- (1) Remove screws around antenna.
- (2) Push upward on antenna until hand can reach through opening, and undo cable connector.
- (3) Turn antenna on its side and slip it through opening.

B Install Antenna

- (1) Pass antenna through opening and connect cable to antenna.
- (2) Apply faying surface sealant all around antenna seating. Refer to Chapter 51, Sealing.
- (3) Position antenna in opening and install mounting screws.

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WEATHER RADAR SYSTEM - DESCRIPTION AND OPERATION

1 SAFETY PRECAUTIONS

Refer to introduction for general safety precautions to be observed when performing weather radar system operations or maintenance. Verify that all personnel in the antenna radiation pattern are a minimum distance of 60 feet away from the weather radar antenna when antenna is radiating. Tests involving radiation of rf energy must not be made within 300 feet of fueling/defueling operations, or within 100 feet of an ungrounded electro-explosive device (EED). Do not operate radar while aircraft is being fueled or defueled. See figure 1 for radiation hazard distances.

2 DESCRIPTION

A General

An aircraft, equipped with the AN/APS-133 (V) weather radar system, consists of a receiver-transmitter, a dual unit RT mounting tray, an antenna, an indicator, a control panel, and interconnecting waveguide (receiver-transmitter to antenna). Radar system equipment is listed in table 1. See figure 2 for component location. System features and characteristics are included in table 2.

The weather radar is an X-band airborne radar with weather detection, mapping, and beacon interrogation capabilities. The radar indicator displays rainfall and storm formations when operated in the weather mode and prominent terrain features when operated in the mapping mode. The system transmits an interrogating signal and displays coded replies as arcs spaced according to the code identification of the responding beacon when operated in the beacon mode. These codes are displayed at the relative bearing and distance to the beacon. An indicator range delay circuit enables the sweep display to be expanded for greater separation of received codes. The system provides for close range beacon interrogation for the purpose of inflight rendezvous by allowing manual gain adjustment in the beacon mode.

The weather radar indicator displays a 180-degree scan in five ranges: 5, 25, 50, 150 and 300 nautical miles. The antenna is stabilized by vertical gyro N° 2 on INS N° 2—in case of single INS installation by the INS—, as selected in the copilot's ADI source selector switch, to hold the antenna angle steady during aircraft maneuvering when ANT STAB ON (Stabilization) is selected. This enables the antenna to maintain scanning the section of air space previously selected.

B Receiver-Transmitter.

The weather radar receiver-transmitter, figure 2, is mounted in the dual RT mounting tray, located in the forward lower compartment.

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The receiver-transmitter contains receiver, modulator, transmitter duplexer, stabilization, power supply, and control circuits. All electrical connections are completed through two electrical connectors in the rear of the receiver-transmitter. The receiver-transmitter operates from 115 vac aircraft power. An internal rectifier and power supplies reduce the input to the proper operating voltages. In addition, the receiver-transmitter provides a delayed 115 vac input to the antenna. The receiver-transmitter is connected to the waveguide through a quick disconnect in the rear of the mounting tray. Receiver-transmitter features and characteristics are included in table 2.

Receiver-transmitter controls and indicators are located on the front panel and are listed and described in table 3.

C. Receiver-Transmitter Mounting Tray

The RT mounting tray, figure 2, is a dual-unit tray which provides for receiver-transmitter shock mounting, connection to two electrical connectors, and antenna waveguide interface. The antenna waveguide interface provides the means of connecting the RT to the antenna waveguide during normal operations or to a dummy load during test operations. Although the mounting tray is capable of holding two RT units, only the left side of the tray is electrically active.

D. Control Panel

The control panel, figure 2, located on the Forward Electronic Panel, controls the weather radar system. Controls are provided for controlling the mode of operation, radar gain, and antenna tilt, stabilization, and pattern. Two fault lamps indicate weather radar system malfunctions. Control panel features and characteristics are included in table 2. Control panel control and indicator functions are described in table 3.

E. Antenna.

The weather radar antenna, figure 2, is located inside the radome on the nose of the aircraft. As selected by the control panel PENCIL/FAN switch, the antenna emits a thin pencil shape (pencil) beam, or a wide cosecant squared (fan) beam. The antenna receives either the reflected weather or ground returns, or the reply codes of an interrogated beacon. Motors, resolvers, and synchros move the antenna about the roll, azimuth, and pitch axes. Antenna driving mechanism power is provided by the receiver-transmitter through one electrical connector. The receiver-transmitter rf input is carried by a pressure vented waveguide that is connected to the antenna through a quick disconnect. Antenna features and characteristics are included in table 2.

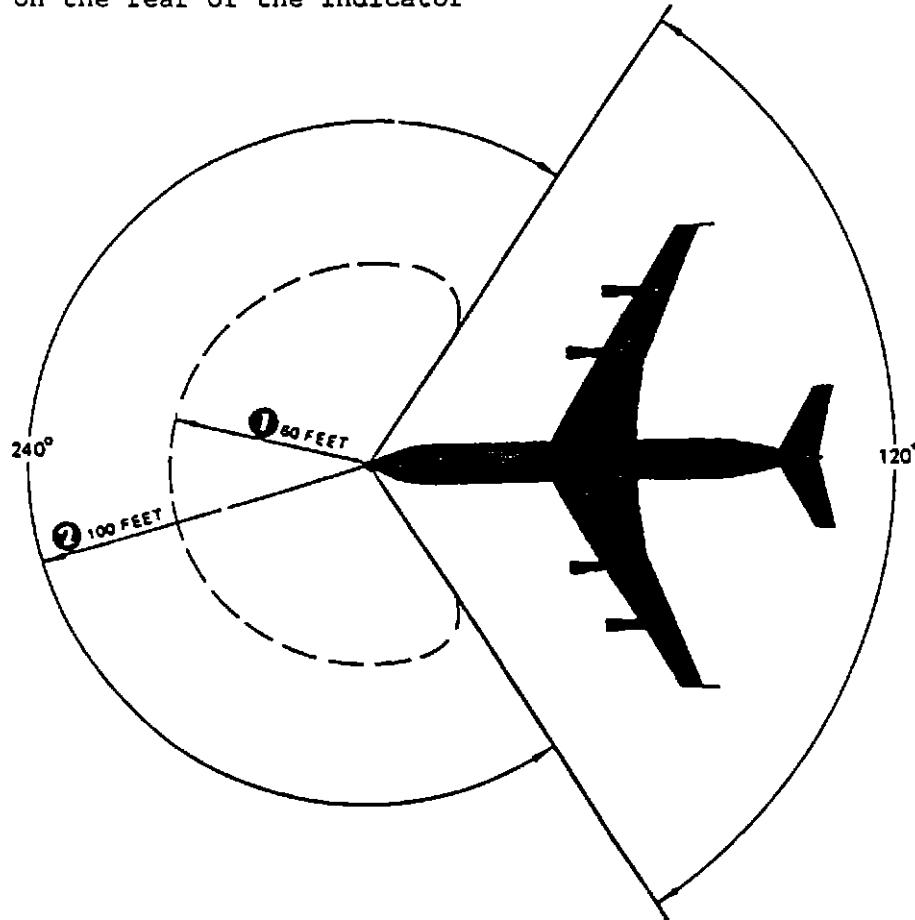
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F INDICATORS

The weather radar system contains one indicator, figure 2, located on the forward electronic panel. The indicator has a 4 3 by 3 3 inch display-storage cathode ray tube that presents an offset plan position indicator display of 180-degree scan, at a rate of 8 cycles per minute. Indicator features and characteristics are included in table 2. Indicator control functions are described in table 3. System electrical connections are completed through one connector on the rear of the indicator.



NOTE. 60 FOOT AREA HAZARDOUS TO PERSONNEL

1 100 FOOT AREA HAZARDOUS TO PERSONNEL
AND AREA OF POSSIBLE ELECTRO EXPLOSIVE
DEVICE DETONATION

300 FOOT AREA HAZARDOUS TO PERSONNEL
AND AREA OF POSSIBLE FUEL IGNITION

Weather Radar System Radiation Hazard Distances
Figure 1

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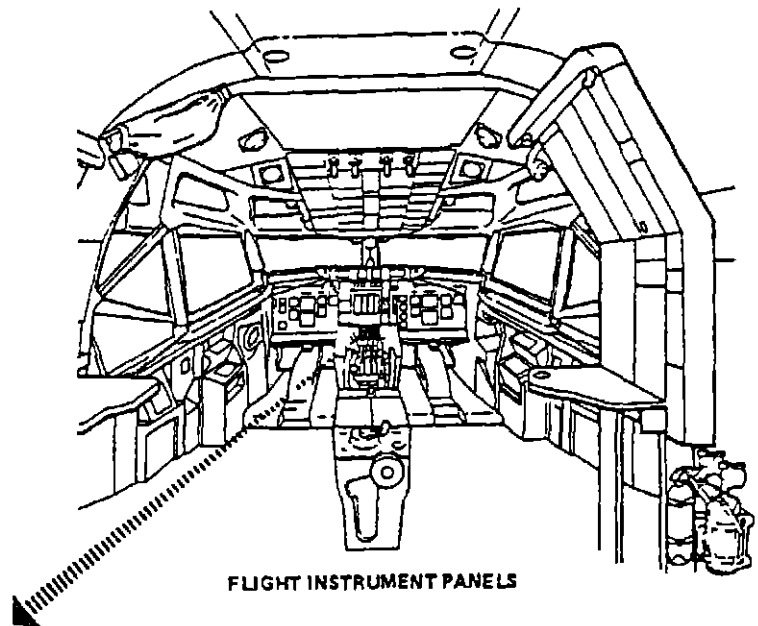
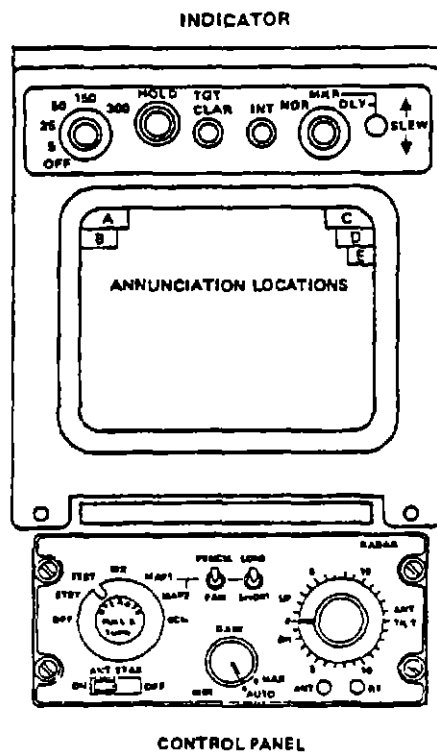
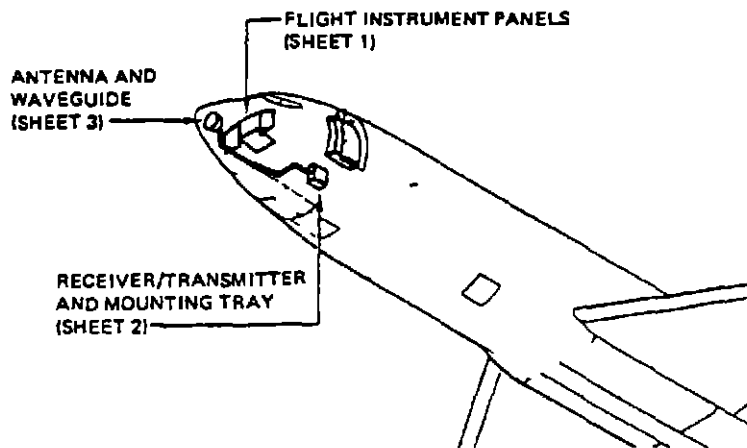
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NOMENCLATURE		COMMON NAME	LOCATION
OFFICIAL	DRAWING		
Weather Radar System AN/APS-133(V)			
Receiver-Transmitter AN/APS-133(V)		Receiver-Transmitter	Weather Radar Shelf Station 320
Receiver-Transmitter Mounting Tray AN/APS-133(V)		Receiver-Transmitter Mounting Tray	Weather Radar Shelf Station 320
Antenna AN/APS-133(V)		Antenna	Station 178
Indicator AN/APS-133(V)		Indicator	Panel P16
Indicator Mount AN/APS-133(V)		Indicator Mount	Panel P16
Control Panel AN/APS-133(V)		Control Panel	Panel P16
Waveguide Flex + Rigid AN/APS-133(V)		Waveguide Section 4	Station 320
Waveguide Rigid AN/APS-133(V)		Waveguide Section 3	
Waveguide Rigid AN/APS-133(V)		Waveguide Section 2	
Waveguide Rigid AN/APS-133(V)		Waveguide Section 1	Station 178

AN/APS-133(V) Weather Radar System Equipment
Table 1

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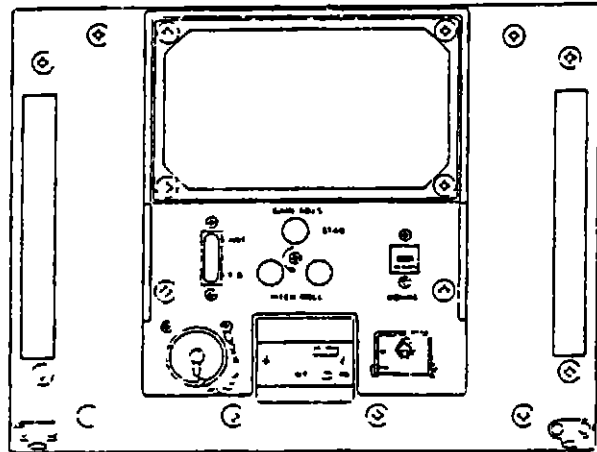
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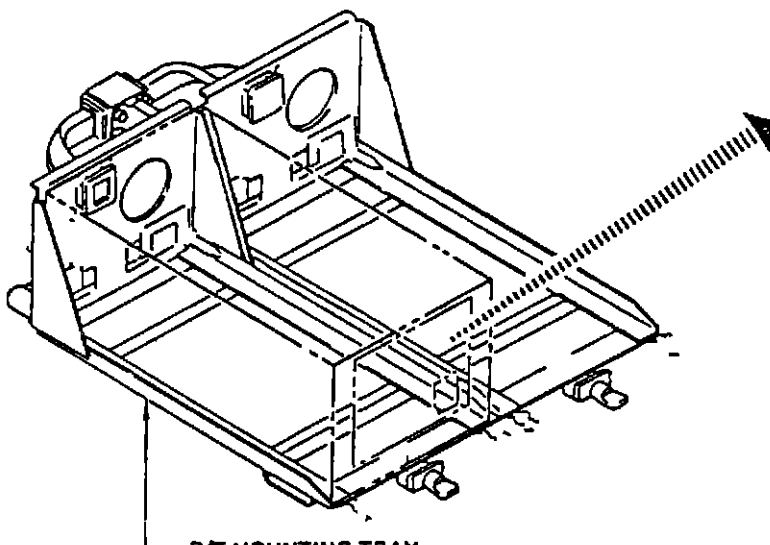
Weather Radar System Equipment And Location
Figure 2 - (Sheet 1 of 3)

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RECEIVER/TRANSMITTER

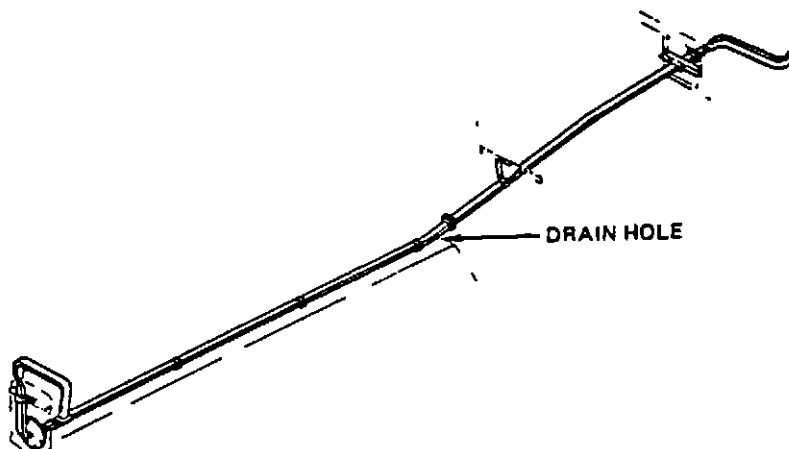


**R/T MOUNTING TRAY
 FORWARD LOWER COMPARTMENT**

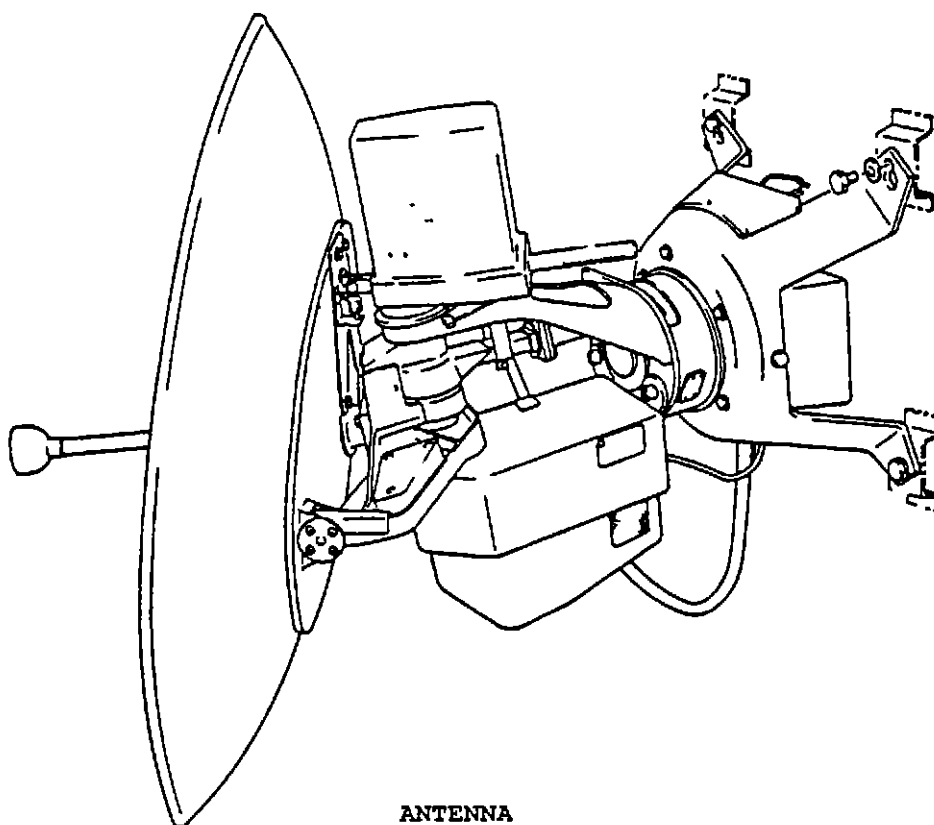
**Weather Radar System Equipment And Location
 Figure 2 - (Sheet 2 of 3)**

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WAVEGUIDE



ANTENNA

Weather Radar System Equipment And Location
Figure 2 - (Sheet 3 of 3)

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MAINTENANCE MANUAL

FEATURE/CHARACTERISTIC	DESCRIPTION
<u>SYSTEM</u>	
Operating Characteristics	FAA TSO C63b, Class 6 (also conforms to ARINC characteristic 564)
Ranges	5, 25, 50, 150 and 300 nautical miles
Operating Modes	Standby, weather, map, beacon and test
Primary Power Input	115 volts, 400 (± 20) Hz
Power Consumption	200 volt-amperes (160 watts), Standby mode, one indicator 715 volt-amperes (540 watts), Operating modes, two indicators
<u>RECEIVER-TRANSMITTER</u>	
Power Input	600 volt-amperes, 115 volts, 400 (± 20) Hz
Cooling	Internal blowers
Peak Power Output	65 kw, nominal
Pulse Repetition Frequency	200 pps (synchronized to input line frequency)
Transmitting Frequency	9375 MHz, weather, and map modes 9310 MHz, beacon mode
Gain	Automatic or manual in weather and map modes Manual in beacon mode
Size	7.625 by 10 28 by 22 187 inches
Weight	55 0 pounds
<u>MOUNTING TRAY</u>	
Power Input (Switching)	28 vdc
Size	9 by 21 1/4 by 27 1/4 inches
Weight	13 5 pounds

AN/APS-133(V) Weather Radar System Features And Characteristics
Table 2 - (Sheet 1 of 2)

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FEATURE/CHARACTERISTIC	DESCRIPTION
<u>CONTROL PANEL</u>	
Power Input (Panel Lights)	28 vdc
Size	2.62 by 5.75 by 5.68 inches
Weight	2.0 pounds
<u>ANTENNA</u>	
Power Input, AC	600 volt-amperes, 115 volts, 400 (± 20) Hz
Power Input, DC	28 vdc
Antenna Beam Pattern	Pencil Beam 3.0 degrees Mapping Beam Coscant squared pattern (3 dB points, 3 to 40 degrees)
Size	30-inch diameter, 29 14 inches deep
Weight	37.0 pounds
<u>INDICATOR</u>	
Power Input	115 volts, 0 50 amps, 400 (± 20) Hz
Power Dissipated	55 watts
Presentation	PPI
Size	6.78 by 6.25 by 16.46 inches
Weight	13.8 pounds

AN/APS-133(V) Weather Radar System Features And Characteristics
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NO	CONTROL/INDICATOR	FUNCTION
	<u>RECEIVER-TRANSMITTER</u>	
	ANT indicator	Antenna fault indicator lamp
	T/R indicator	Receiver-transmitter fault indicator lamp
	GAIN ADJ's (STAB, PITCH, and ROLL)	Stabilization, pitch, and roll gain adjustment access holes
	HOURS meter	Elapsed time meter records total receiver-transmitter operating time
	XMTR switch	Controls transmitting function
	ON	Activates transmitting function
	OFF	Disables transmitter preventing unit from transmitting when system power is applied
	<u>INDICATOR</u>	
1	Indicator PWR/Range Knob	Rotary switch selects range to be displayed and spacing of range marks, or turns indicator off. Selected range and range mark spacing are displayed in location (7). For example 150/30
	OFF	Indicator power is off. R/T unit power is controlled by mode selector (14)
	5	Selects 25 NM range and 1 NM range mark spacing
	25	Selects 25 NM range and 5 NM range marks spacing
	50	Selects 50 NM range and 10 NM range marks spacing
	150	Selects 150 NM range and 30 NM range marks spacing
	300	Selects 300 NM range and 60 NM range marks spacing
		NOTE
		Target visibility on 150 and 300 NM ranges depends on line of sight distance and target altitude
2	Hold Pushbutton	When pressed "freezes" display, and HOLD is displayed (alternating once per second with selected mode) in mode display (13). When pressed again or range selector is moved, display returns to normal

AN/APS-133(V) Weather Radar System Controls And Displays
Table 3 - (Sheet 1 of 3)

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NO	CONTROL/INDICATOR	FUNCTION
3	TGT CLAR (Target Clarity) Knob	Rotating knob sets clockwise increases amount of low intensity echoes displayed (green in WX or BCN modes, blue in MAP 1 or MAP 2)
4	INT (intensity) Knob	Adjusts brightness of display Rotate clockwise to increase brightness
5	NOR-MKR-DLY (Sweep Delay) Switch	Selects normal display or variable range delay
	NOR (Normal)	Normal display Range begins at zero
	MKR (Marker)	Adds variable (yellow) marker (11) to display Range to marker controlled by SLEW switch (6) and displayed in upper right corner (8) of display
	DLY (Delay) Sets sweep delay	Display range begins at marker (11) setting displayed in location (8) Sweep extends for number of NM selected on range knob (1) For example, if marker (11) set to 100 NM and range knob is set to 25 display extends from 100 to 125 NM
		NOTE
		Delay is mainly used to identify beacon returns and to expand distant weather echoes Target shape is distorted
6	SLEW Switch (Momentary, spring-loaded to neutral)	Moves range marker (11) if Sweep Delay Switch (5) set to MKR or DLY Setting switch to up () increases range Setting switch to down () decreases range Range to marker is displayed in upper right corner of indicator in location (8) Speed of marker movement increases as switch is moved from neutral
7	Range Selection Display (Blue in TEST, WX, or BCN, Green in MAP)	Numbers to left of slash (1) are range selected by range knob (1) Numbers to right of slash are spacing of range marks
8	Marker Range Display (Blue in TEST, WX, or BCN; Green in MAP)	When MKR or DLY selected by range delay switch, (5), shows range to range marker (11)
9	Colour Bar	Shows the colours used in mode selected by mode selector (14). In WX mode, displays red (heavy) with letter H, yellow (medium), and green (light) with letter L In MAP, displays red (heaviest) with letter H, yellow (medium), and blue (lightest) with letter L In BCN, bar is green
10	Range Marks (5) (Blue in TEST, WX, or BCN, Green in MAP)	5 dashed arcs, spaced 1/5 of range selected by range knob. Spacing is displayed in range selection display (7).

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NO	CONTROL/INDICATOR	FUNCTION
11	Range Marker (Yellow)	Displayed in MKR and DLY settings of range delay knob (5) Position of marker controlled by SLEW switch (6)
12	Azimuth Markers (Blue in TEST, WX, or BCN, Green in MAP)	5 markers, representing airplane centerline (0°), 30°, and 60° left and right centerline
13	Mode Display (Blue in TEST, WX, or BCN, Green in MAP)	Upper location displays TEST, WX, or BCN to show mode selected by mode selector (14) Displays HOLD when HOLD button is pressed Lower location shows sweep delay mode (MKR or DLY)
<u>WEATHER RADAR CONTROL PANEL</u>		
14	Mode Selector Switch	Seven position rotary switch Must be pulled out to turn
	OFF	All power to system is removed No antenna stabilization
	STBY (Standby)	Used for warmup or when antenna radiation is not desired Antenna stabilization can be used
	TEST	System self-test with no radiated signal Test pattern is displayed TEST is displayed in mode display (13)
	WX (Weather)	Displays weather returns in green (low), yellow (medium) and red (highest intensity) WX display in mode display (13) Pencil beam selected automatically
		WARNING Erroneous colour intensities may be displayed in other than auto gain setting

AN/APS-133(v) Weather Radar System Controls And Displays
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NO	CONTROL/INDICATOR	FUNCTION
	MAP 1	Used primarily for long range ground mapping and "skin paint". Sensitivity-time control (STC) circuit is disabled. Returns displayed in red (most reflective), yellow (medium) and blue (least). MAP 1 is displayed in mode display (13). Beam width selectable by PENCIL-FAN switch (15).
	MAP 2	Used for "skin paint" at very short ranges. May also be used for ground mapping. MAP 2 displayed in mode display (13). Display colours same as MAP 1. Beam width selectable by PENCIL-FAN switch (15).
	BCN	Beacon targets are displayed in green. "BCN" is displayed in mode display (13). Pencil beam selected automatically.
15	PENCIL-FAN Switch	Selects pencil or fan beam for mapping modes.
16	LONG-SHORT Switch	Selects pulse length for mapping mode (inoperative in WX or BCN).
17	Tilt Knob	Selects antenna pitch direction relative to horizon (0). Maximum tilt is 15° up or down. If stabilization switch (21) is off, 0° is airplane pitch axis.
18	RT Fault Light (Yellow)	Illuminates in test mode or to show fault in R/T unit. NOTE A fault is detected by an improper display and only illuminates in the test mode. Switch to test mode to determine lighted fault indications.
19	ANT Fault Light (Yellow)	Illuminates in test mode or to show fault in antenna. See also NOTE above.
20	GAIN Knob	Adjusts receiver gain. MIN is minimum. MAX is maximum. AUTO gives automatic gain control.
21	ANT STAB (Stabilization) Switch	When set to ON, antenna is stabilized using horizontal reference from INS 2 or VG 2 as selected by copilot's attitude source selector switch (22). When set to OFF, antenna reference is airplane pitch axis.
22	<u>ANTENNA</u>	
	EL, AZ, and ROLL switches	Controls elevation, azimuth, and roll drive systems, which are enabled when corresponding switch is in up (on) position.

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3 OPERATION

- A The modulator, consisting of the pulse forming network and pulse transformer, develops high voltage pulses for the magnetron. These pulses have a pulse repetition rate of 200 pulses per second, synchronized with the aircraft 400 Hz power system. Upon receipt of a pulse from the modulator, the magnetron fires a pulse of microwave energy at 9375 MHz. The pulse width is determined by the mode selected.
- From the magnetron, the transmitter pulse enters the circulator which provides high isolation from the receiver in the transmit mode and low isolation in the receive mode. The transmitter pulse is coupled from the circulator through the waveguide switch to the dummy load (in test) or to the antenna. Fan or pencil shaped beam is selectable in any mode. During rf transmission, blanking signals are sent to the indicator, inhibiting the video and resetting the sweep trigger. Blanking signals are sent to, and received from, the onboard radar transponder. Self-test circuitry monitors the antenna and receiver-transmitter performance and generates a test pattern in TEST mode.
- B Returned echo signals reaching the circulator are ported to the limiter which protects the receiver from undesired high power levels. From the circulator, the received signal is coupled to the mixer where it beats with a local oscillator output to produce an if signal for the if amplifier stages. The detected video signal is coupled to the indicator through the video amplifier. The sensitivity time control provides increased gain for increasing distance.
- C The stabilization circuitry receives roll and pitch signals from VG N° 2 or INS N° 2. These signals are applied to the stabilization circuits as roll and elevation commands to the antenna servomotors to compensate for attitude changes. Antenna position is detected by the sweep resolvers and used to synchronize indicator sweep position.
- D By pressing the control panel BCN pushbutton, an interrogating pulse is transmitted at a frequency of 9375 MHz. The beacon local oscillator, at 9280 MHz, is used to receive the interrogated beacon-coded reply at a frequency of 9310 MHz. These coded replies are displayed on the indicator. When in the beacon mode, reflected signals are not displayed. Sweep display, and display offset circuits control the origin of the display on the indicator. Beacon mode gain and sensitivity time control circuitry may be adjusted manually with the control panel GAIN control to reduce receiver sensitivity for strong signal returns and improve azimuth resolution of the coded beacon display. This allows for improved beacon mode short range rendezvous navigation. The range gate controls the amount of distance displayed on the indicator. Marker circuitry generates range markers.

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WEATHER RADAR SYSTEM - TROUBLE SHOOTING

- A The trouble analysis chart, table 101, lists symptoms, probable causes, isolation procedures, and corrective actions. The reference procedure column lists related test steps in the checkout procedure. This correlates the symptoms with failures that may be encountered during checkout. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation. If performing the listed corrective actions does not correct the trouble, check the aircraft wiring.
- B Most weather radar system faults will be revealed in TEST mode by observation of the test pattern (figure 101). However, tests depending on observation of radar video from target echoes cannot be accomplished in TEST mode, since the receiver-transmitter transmits into the dummy load. When operation of the WX mode is considered necessary for testing, the aircraft must be situated in an area safe for rf radiation from the antenna. See figure 1. Also, for reception of radar video when the aircraft is on the ground, the aircraft should be pointed in a direction that will afford suitable (and safe) radar targets and/or weather rainfall cells at various distances.
- C Before replacing a component suggested in the troubleshooting table, confirm faults by checking the receiver-transmitter and control panel fault lights. In the WX mode (or any other operating mode) the control panel RT and ANT lights come on and remain on only when a fault exists in the radar system. Momentary illumination (test) of the fault lamps occurs only during initial selection of the TEST mode.
- D If RT and/or ANT fault lights remain on after the TEST mode is selected, proceed as follows:
- (1) If RT fault light remains on, replace RT unit.
 - (2) If ANT and RT fault lights remain on, a fault most likely exists in the antenna; however, the RT unit should be replaced first to preclude an antenna removal that might not be justified if the fault was within the RT unit monitor circuitry.

A high VSWR in an operating mode (WX, MAP1, MAP2, or BCN) will shut down the transmitting section of the receiver-transmitter, resulting in no indicator video and the control panel ANT light being continuously on. To isolate the source of a VSWR fault to the waveguide, waveguide switch, waveguide manifold-ing, or the antenna, perform the following:

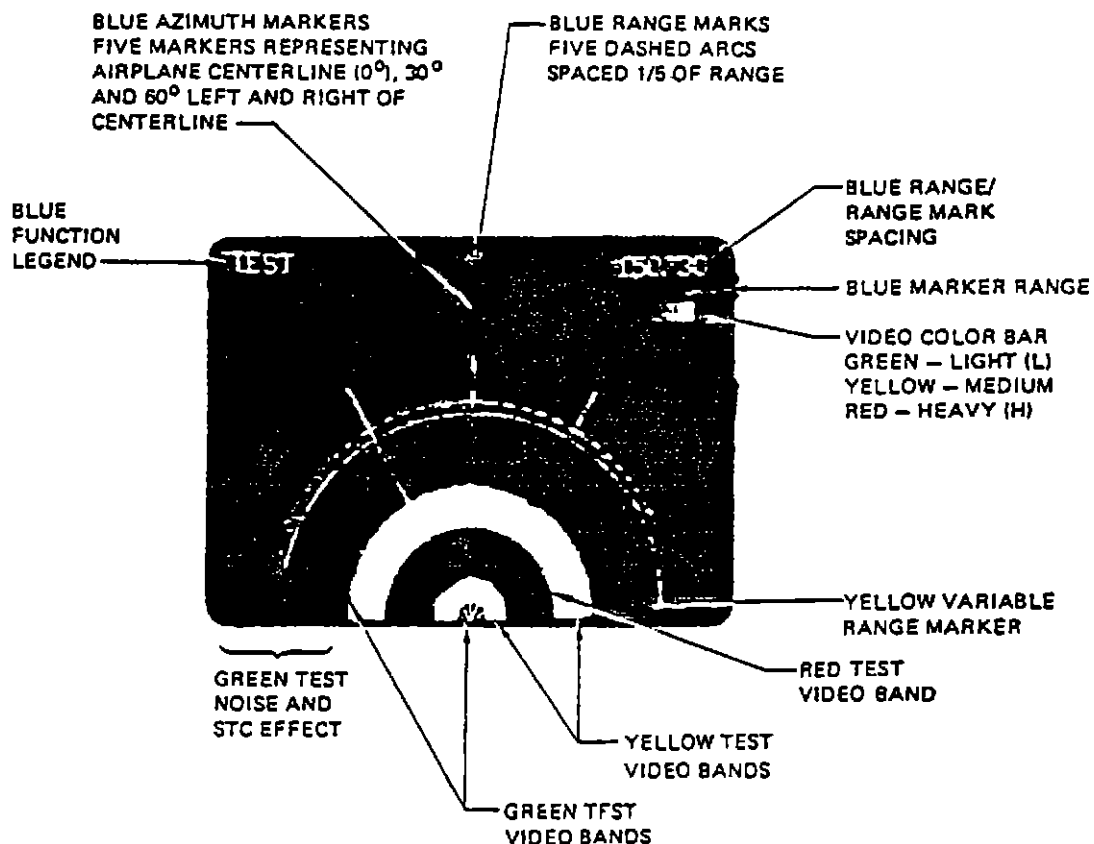
- (1) Select TEST mode on the control panel. If ANT light on control panel goes out and remains out, the VSWR fault exists in the antenna or in the waveguide run between the antenna and the waveguide switch at the receiver-transmitter. The timesaving procedure is to inspect the antenna, the waveguide connections to the antenna, and the aircraft waveguide run to the waveguide switch for damage, looseness, or misalignment.

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Replace defective components or correct defects Retest in WX and TEST modes.

NOTE Moisture of significant quantity may become trapped in the waveguide if the pressure vent hole in the waveguide becomes plugged Check section of waveguide containing the vent hole (See figure 2) Unplug vent hole carefully with a plastic rod or equivalent If moisture runs out of un plugged vent hole, this may have caused the VSWR fault

- (2) If the same combination of events occur again in the WX mode, after corrective measures or replacement of components in step 1, replace the antenna and retest the system If problem remaining, replace the receiver-transmitter unit It is possible for the VSWR monitoring circuits in the receiver-transmitter to be faulty or set at too sensitive a reflective power level.



Weather Radar System Indicator Test Pattern
Figure 101

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
BLOWERS DO NOT OPERATE			
	Defective control panel or receiver-transmitter.	Check control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch OFF position continuity in all modes. Refer to wiring diagram. If continuity is OK, receiver-transmitter is defective	If continuity not OK, replace control panel. Replace receiver-transmitter.
SCREEN DOES NOT ILLUMINATE			
	Defective indicator	Check other indicator.	If other indicator OK, replace defective indicator.
SCREEN DOES NOT SWEEP			
	Defective indicator	Check other indicator	If other indicator OK, replace defective indicator
	Defective antenna	Proceed as follows. <u>WARNING:</u> DO NOT OPERATE IN MODES OTHER THAN TEST OR STBY WHEN PERSONNEL ARE WITHIN 60 FEET OF THE ANTENNA.	If other indicator OK, replace defective indicator
	Defective receiver-transmitter.	Select TEST mode and check that antenna is scanning.	If not, replace antenna. Replace receiver-transmitter.
INDICATOR CONTROLS DO NOT OPERATE PROPERLY			
	Defective indicator.		Replace indicator.
SWEEP OR RANGE MARK INTENSITY NOT AS SPECIFIED			
	Defective indicator		Replace indicator.

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
<u>INDICATOR SWITCHES DO NOT FUNCTION PROPERLY</u>			
	Defective indicator		Replace indicator
<u>TEST PATTERN IN OPERATIONAL MODES</u>			
	Defective control panel or waveguide switch	Check for 28 vdc on RD9123 for S/N 20199, RD9472 for S/N 19997, 20000 pin E with operational mode selected. If voltage is present, control panel is defective. If voltage is not present, waveguide switch is defective.	Replace control panel Replace waveguide switch. If still not ok, check aircraft wiring.
<u>GROUND TARGETS REMAIN</u>			
	Defective indicator	Check other indicator	Replace bad indicator
	Defective control panel	Check control panel continuity. Refer to wiring diagram.	Replace control panel
	Defective receiver-transmitter		Replace receiver-transmitter
<u>RT FAULT LAMP ON</u>			
	Defective receiver-transmitter or antenna		Replace receiver-transmitter

AN/APS-133(V) Weather Radar System Trouble Analysis
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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
<u>RT AND ANT FAULT LAMP ON</u>			
	Defective receiver-transmitter, antenna, or waveguide	Select TEST, and WX, one at a time until failure is noted	If RT fault comes on and stays on, replace receiver-transmitter If both ANT and RT fault lights stay on, replace units in order listed in probable cause column
<u>ANTENNA DOES NOT TRACK TILT CONTROL</u>			
	Defective control panel, antenna, receiver-transmitter	Select STBY Open radome Select TEST Manually tilt antenna against pressure and release If no pressure is noted or antenna does not return to normal when released antenna is bad	If antenna follows gyro, replace control panel Replace defective antenna
	Defective receiver-transmitter or antenna		Replace units in order listed in probable cause column
<u>ANTENNA DOES NOT TRACK GYRO</u>			
	Defective VG 2 system receiver-transmitter, or control panel.	Check pilot ADI Select STBY Open radome Select TEST. Manually tilt antenna against pressure and release If no pressure is noted or antenna does not return to normal when released antenna is bad	If ADI does not follow gyro, troubleshoot VG system Refer to MM 34-8-0 Replace defective antenna

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Antenna or receiver-transmitter	Check continuity of ANT STAB switch on control panel Refer to wiring diagram manual	If continuity not OK, replace control panel. Replace units in order listed in probable cause column
<u>ANTENNA DOES NOT STABILIZE</u>			
	Defective antenna.		Replace antenna.
<u>DEPENDENT BEACON NOT FUNCTIONING</u>			
			Replace receiver-transmitter

AN/APS-133(V) Weather Radar System Trouble Analysis
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WEATHER RADAR - REMOVAL/INSTALLATION

Maintenance of the weather radar system consists only of removal and installation of system components. Before performing maintenance, open radio bus NO 2 WEATHER RADAR circuit breaker on P5 circuit breaker panel. Tag if circuit breaker panel will not be under continuous observation.

CAUTION BAG AND STOW CONNECTOR PLUGS IN UPRIGHT (UNMATED FACE OF PLUG IS UP) POSITION TO PREVENT MOISTURE OR CORROSION PROBLEMS WHEN THE MATING EQUIPMENT IS NOT INSTALLED.

1 RECEIVER-TRANSMITTER REMOVAL

Remove the receiver-transmitter as follows.

WARNING TWO MAN LIFT RECEIVER-TRANSMITTER WEIGHS 55 POUNDS

- A Open and tag Radio Bus No 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel.
- B Gains access to weather radar rack located at BS 380.
- C Loosen and disengage two hold down knobs securing receiver-transmitter to mounting tray.
- D Rotate extractor wingscrew until electrical connectors, waveguide flange, and index pins on rear of receiver-transmitter are completely disengaged.
- E Using handles on front panel, lift receiver-transmitter free of extractor assembly and pull it aft from mounting tray.
- F Cover mounting tray and receiver-transmitter waveguide flanges using waveguide flange covers or other suitable covers tied or taped over flanges. Do not apply tape directly over flange openings.

2 RECEIVER-TRANSMITTER INSTALLATION

Install receiver-transmitter as follows.

WARNING TWO MAN LIFT RECEIVER-TRANSMITTER WEIGHS 55 POUNDS

- A Remove protective covers from receiver-transmitter and mounting tray waveguide flanges.
- B Place receiver-transmitter on mounting tray.
- C Position bottom edge of front panel into slot provided on extractor mechanism.
- D Align electrical connectors, waveguide flange, and index pins.

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- E Rotate wingscrew until receiver-transmitter is firmly in place
- F Position holddown knobs
- G Tighten holddown knobs
- H Set RT ON/OFF switch to ON and secure switch positioning screw
- I Remove tag and close Radio Bus No 2 / WEATHER RADAR circuit breaker

3 INDICATOR REMOVAL

Remove the indicator as follows

CAUTION DO NOT PLACE INDICATOR FACE DOWN AS PARTICLES WITHIN DISPLAY STORAGE TUBES CAN FALL UPON THE STORAGE MESH AND CAUSE HOTSPOTS OR OTHER DAMAGE ALWAYS HANDLE INDICATOR IN A FACE UP OR HORIZONTAL POSITION AVOID PLACING IT WITHIN 2 FEET OF THE RECEIVER-TRANSMITTER BECAUSE THE MAGNETIC FIELD OF THE MAGNETRON TUBE IN THE RECEIVER-TRANSMITTER MAY DAMAGE THE DISPLAY

- A Open and tag Radio Bus NO 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Pull out handle on indicator bottom Extractor type lock mechanism will be accessible See figure 401 for lock mechanism illustration
- C Grasp lock mechanism by finger hold and exert left to right pulling force
- D After indicator has moved forward, disengage from lock mechanism and hold down pins, pull indicator forward and lift from mounting tray

4 INDICATOR INSTALLATION

Install the indicator as follows

- A Turn lock mechanism (figure 401) on mounting tray to extreme counterclockwise or open position
- B Place indicator on mounting tray and slide backwards until connector on rear is aligned with mating connector on mounting tray
- C Using finger hole, turn lock mechanism slowly clockwise, making certain that connectors are engaging properly Turn lock mechanism a full 90 degrees clockwise to locked position. Ensure that holddown pins in mounting tray are engaged with holes in extractor plate assembly of indicator and that unit is firmly in place
- D Remove tag and close Radio Bus No 2 / WEATHER RADAR circuit breaker

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5 ANTENNA REMOVAL

Remove the antenna as follows

- A Open and tag Radio Bus No 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Remove mounting screws on aft end of radome

CAUTION DO NOT ATTEMPT TO OPEN RADOME IN WIND CONDITIONS EXCEEDING 25 KNOTS (30 MPH)

- D Swing radome up and support radome open with support rods
- E Tighten antenna roll axis locking screw to immobilize antenna (figure 402)
- F Disengage electrical connector on bottom of antenna mounting base
- G Disconnect waveguide at quick-disconnect flange

CAUTION ENSURE ANTENNA IS SUPPORTED AGAINST BULKHEAD WHILE REMOVING BOLTS AND WASHERS

- H Remove safety wire, bolts, and washers securing antenna to bulkhead

6 ANTENNA INSTALLATION.

Install the antenna as follows:

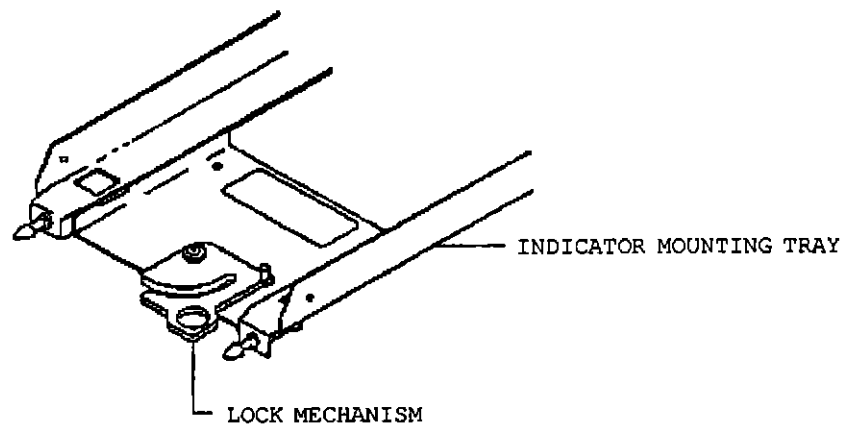
- A Open and tag Radio Bus 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Remove mounting screws on aft end of radome

CAUTION DO NOT ATTEMPT TO OPEN RADOME IN WIND CONDITIONS EXCEEDING 25 KNOTS (30 MPH).

- D Swing radome up and support radome open with support-rods
- E Position and support antenna to bulkhead
- F Secure antenna to bulkhead with four safety wired bolts and washers
- G Install serviceable O-ring seal
- H Connect waveguide with quick-disconnect flange to antenna

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Weather Radar System Indicator Lock Mechanism
Figure 401

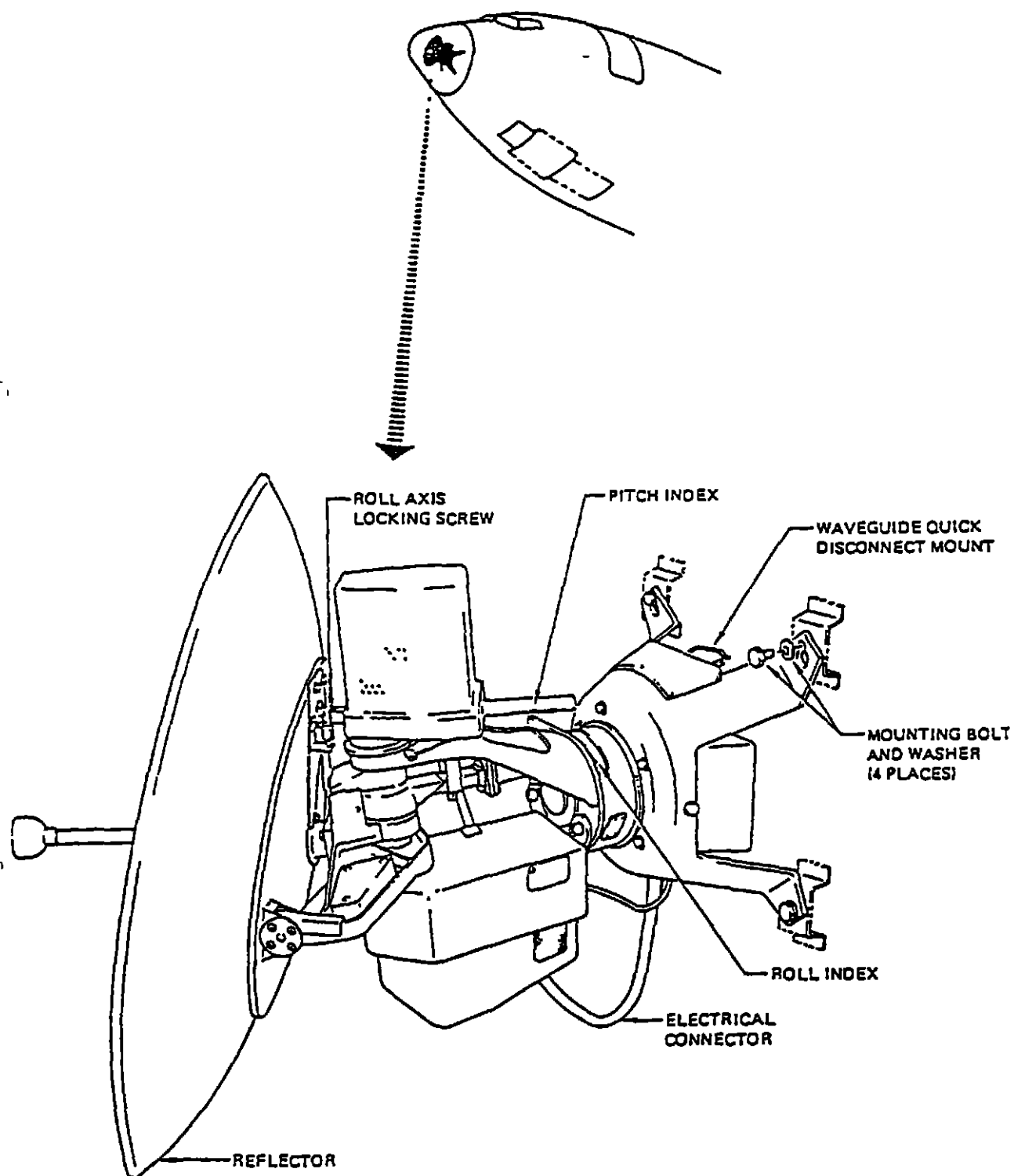
- I Connect electrical connector on bottom of antenna mounting base
- J Loosen roll axis locking screw
- K Lift radome and remove support rods
- L Ensure that antenna EL, AZ, and ROLL switches are in up (on) position, and secure switch positioning screw
- M Lower radome to closed position
- N Apply antiseize compound to mounting screws and install in aft end of radome
- O Remove tag and close Radio Bus 2 / WEATHER RADAR circuit breaker

7 WAVEGUIDE MAINTENANCE

The waveguide transmission line consists of rigid and flexible waveguide sections. Figure 403 identifies waveguide sections. Figure 404 illustrates clamps and pressure seals. The entire waveguide need not be replaced, but only sections which require obvious repair. When connecting waveguide sections make sure that the gaskets are replaced at every joint.

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Weather Radar System Antenna Installation
Figure 402

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8 WAVEGUIDE SECTION 1 REMOVAL.

Remove waveguide section 1 as follows

- A Open and tag Radio Bus No 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Remove mounting screws on aft end of radome

CAUTION DO NOT ATTEMPT TO OPEN RADOME IN WIND CONDITIONS EXCEEDING 25 KNOTS (30 MPH)

- D Swing radome up and support radome open with support rods
- E Release quick-disconnect from antenna waveguide (figure 402)
- F Remove two screws and nuts, and quick clamp from forward bulkhead
- G Remove eight screws attaching pressure seal on waveguide section No 1 to forward bulkhead and break seal
- H On aft side of nose bulkhead, remove four screws and washers securing flanges of section No 1 to section No 2 waveguide. Carefully pull waveguide section No 1 through forward bulkhead

9 WAVEGUIDE SECTION 1 INSTALLATION

Install waveguide section 1 as follows:

- A Clean forward bulkhead port mating surface and remove any foreign matter from waveguide
- B Place waveguide section No 1 through hole in forward bulkhead
- C Apply a removable facing surface seal between forward bulkhead and entire surface of pressure seal. Apply sealant to pressure seal and parting agent to forward bulkhead
- D Carefully move waveguide section into position and secure pressure seal to bulkhead with six screws, leaving two screws out as shown on figure 404
- E Remove corrosion and protective coating around remaining two screw holes using rotary stainless steel wire brush
- F Install two remaining mounting screws
- G Check that bonding resistance between waveguide flange and bulkhead is less than 0.0025 ohms

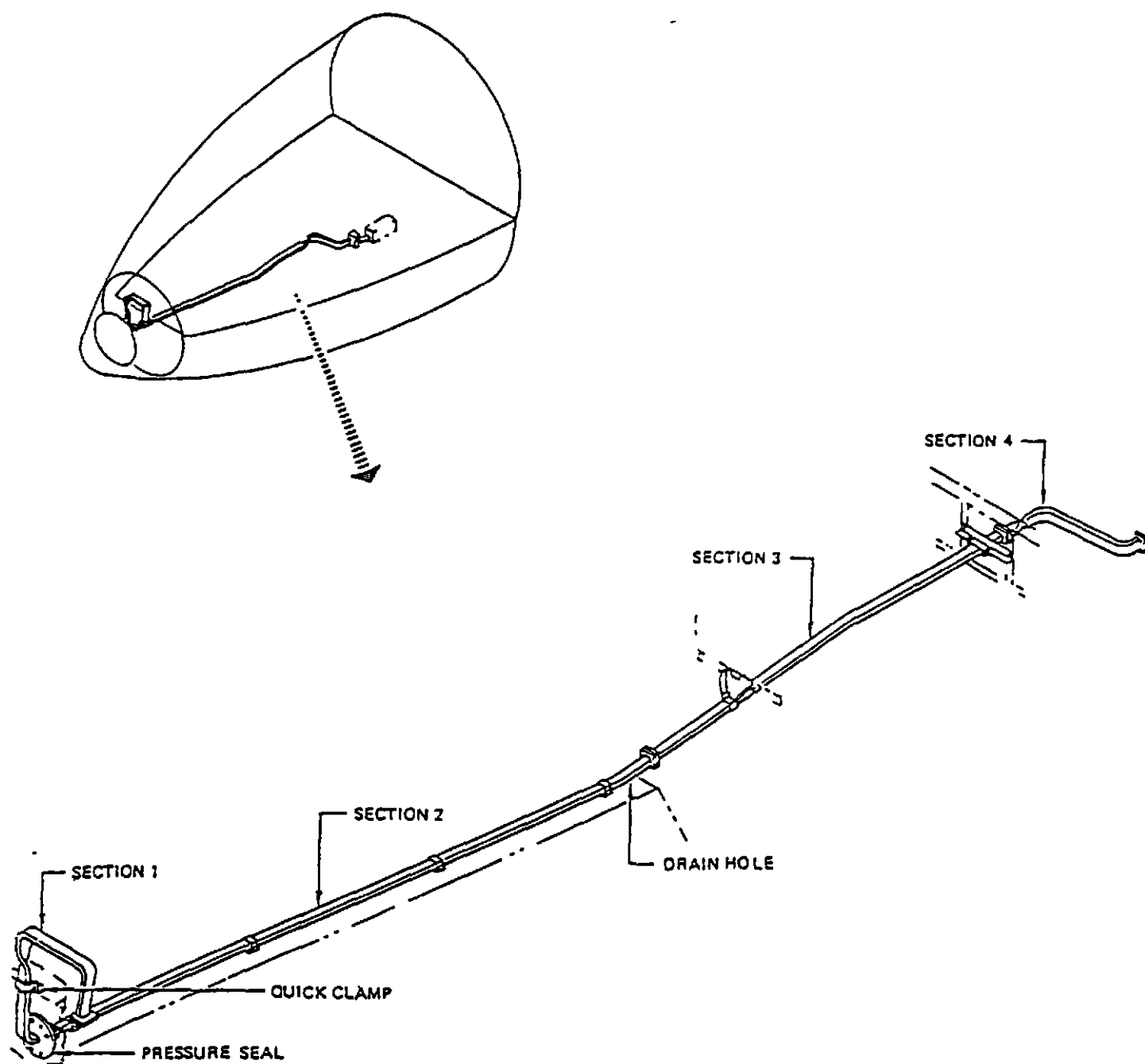
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- H Install waveguide gasket, then install four screws and washers securing flanges of section No 1 waveguide to section No 2 waveguide on aft side of nose bulkhead
- I Secure waveguide to forward nose bulkhead with two screws and nuts using a quick clamp
- J Install waveguide gasket, then secure waveguide disconnect to antenna
- K Lift radome and remove support rods
- L Ensure that antenna EL, AZ, and ROLL switches are in up (on) position, and secure switch positioning screw
- M Lower radome to closed position
- N Apply antiseize compound to mounting screws and install in aft end of radome
- O Remove tag and close Radio Bus NO 2 / WEATHER RADAR circuit breaker.

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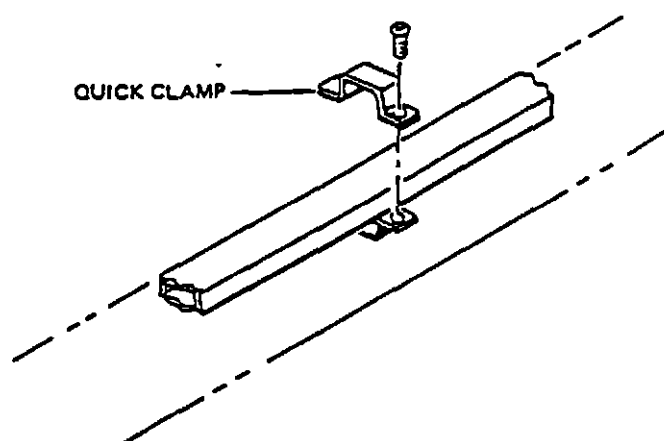
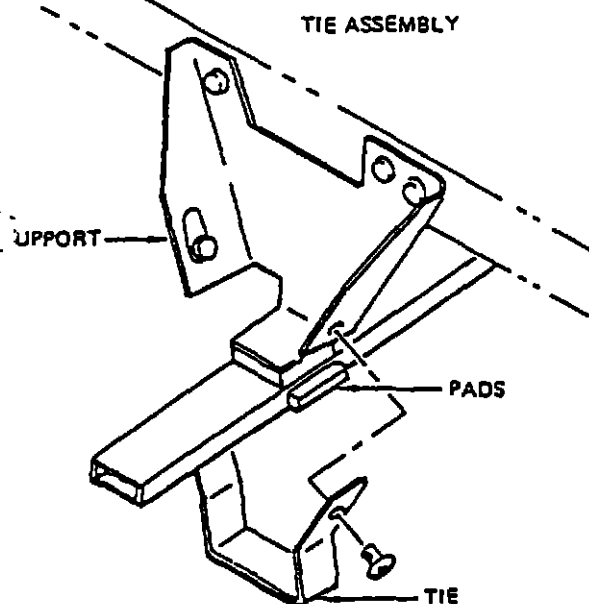
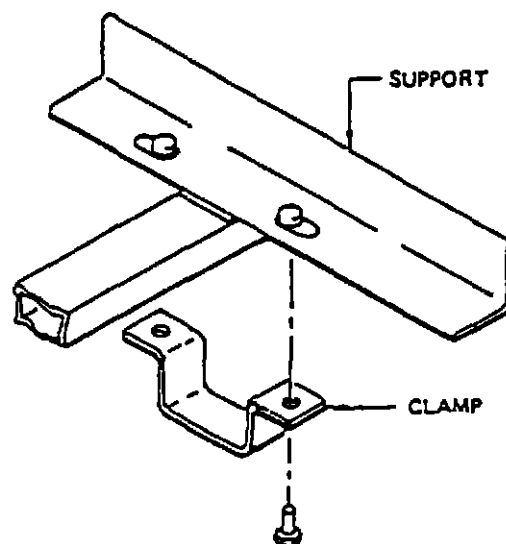
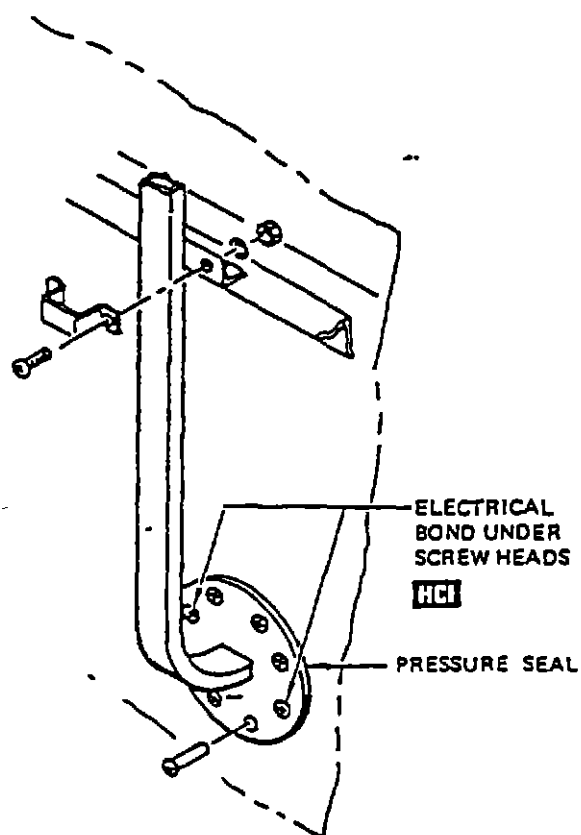
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Weather Radar System Waveguide Installation
Figure 403

Ref.: T.O. 1E-3A-2-34-1
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Weather Radar System Waveguide Clamps Installation
Figure 404

Ref.: T.O. 1E-3A-2-34-1
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10 WAVEGUIDE SECTION 2 REMOVAL

Remove waveguide section 2 as follows

- A Open and tag Radio Bus NO 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Remove four screws and washers securing waveguide section No 1 flange to section No 2 flange
- C Remove four raceway quick clamps by removing two screws, nuts and washers at each clamp
- D Remove four screws and washers securing waveguide section No 2 flange to section No 3 flange and remove waveguide section No 2

11 WAVEGUIDE SECTION 2 INSTALLATION

Install waveguide section 2 as follows

- A Inspect waveguide for foreign material Place waveguide section No 2 forward of wheel well and slide into appropriate position
- B Replace flange gasket and connect waveguide section No 1 to section No 2 using four screws and washers
- C Replace flange gasket and connect waveguide section No 2 to section No 3 using four screws and washers
- D Secure waveguide section No 2 to raceway with four quick clamps, using two screws, washers, and nuts at each clamp
- E Remove tag and close Radio Bus NO 2 / WEATHER RADAR circuit breaker

12 WAVEGUIDE SECTION 3 REMOVAL

Remove waveguide section 3 as follows

- A Open and tag Radio Bus NO 2 / WEATHER RADAR, circuit breaker on P5 circuit breaker panel
- B Remove four screws and washers securing waveguide section No 2 flange to section No 3 flange
- C Remove two screws, nuts, and washers from waveguide section No 3 tie clamp
- D Remove two screws, nuts, and washers for quick clamps securing waveguide to raceway

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- E Remove four screws and lockwashers securing waveguide section No 3 to section No 4 and remove section No 3

13 WAVEGUIDE SECTION 3 INSTALLATION

Install wave guide section 3 as follows

- A Inspect waveguide section for foreign material, replace flange gasket, and secure waveguide section No 3 to section No 2 using four screws and lockwashers
- B Replace flange gasket and secure waveguide section No 3 to section No 4 using four screws and lockwashers
- C Secure waveguide to the clamp using two screws, washers, and nuts
- D Secure waveguide to bulkhead raceway using two screws, nuts, and washers at each quick clamp
- E Remove tag and close Radio Bus No 2 / WEATHER RADAR circuit breaker

14 WAVEGUIDE SECTION 4 REMOVAL

Remove waveguide section 4 as follows

- A Open and tag Radio Bus No 2 WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Remove four screws and washers securing waveguide section No 3 to section No 4
- C Remove four screws and washers securing waveguide section No 4 to receiver-transmitter, and remove waveguide

15 WAVEGUIDE SECTION 4 INSTALLATION

Install waveguide section 4 as follows

- A Inspect waveguide section for foreign material, replace flange gasket and secure, waveguide section No 4 to section No. 3 using four screws and lockwashers
- B Secure waveguide section No 4 to receiver-transmitter using four screws and washers
- C Remove tag and close Radio Bus NO 2 / WEATHER RADAR circuit breaker

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Page 11-45 Change 17

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16 RT MOUNTING TRAY REMOVAL

Remove RT mounting tray as follows

- A Open and tag Radio Bus NO 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel
- B Gain access to WEATHER RADAR rack located at BS380
- C Loosen and disengage two holddown knobs securing receiver-transmitter to mounting tray
- D Rotate extractor wingscrew until electrical connectors, waveguide flange, and index pins on rear of unit are completely disengaged

CAUTION TWO MAN LIFT RECEIVER-TRANSMITTER WEIGHS 55 POUNDS

- E Using handles on front panel, lift receive-transmitter free of extractor assembly and pull it aft from mounting tray
- F Disconnect mount waveguide from aircraft at quick-disconnect flange
- G Disconnect seven connectors from rear of mounting tray
- H Remove four allen head screws securing shock mounts to aircraft and retain hardware
- I Slide mounting tray forward.
- J Secure aircraft cables and cover all waveguide flanges with proper cover

17 RT MOUNING TRAY INSTALLATION

Install RT mounting tray as follows

- A Place mounting tray an airframe
- B Align shock mounts and ground straps to proper holes on airframe and secure with four allen head screws.
- C Remove waveguide covers and install serviceable O-ring seal Reconnect waveguide flange
- D Remove cable covers and connect seven connectors to mounting tray

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11-46 Change 20



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CAUTION TWO MAN LIFT RECEIVER-TRANSMITTER WEIGHS 55 POUNDS

- F Place receiver-transmitter on mounting tray
- G Position bottom edge of front panel into slot provided on extractor mechanism
- H Align electrical connectors, waveguide flange and index pins and rotate extractor wingscrew until receiver-transmitter is firmly in place
- I Position and tighten holddown knobs
- J Remove tag and close Radio Bus NO 2 / WEATHER RADAR circuit breaker on P5 circuit breaker panel

18 WAVEGUIDE SWITCH REMOVAL

Remove waveguide switch as follows

- A Remove receiver-transmitter per paragraph 1
- B Disconnect cannon plug from bottom of waveguide switch
- C Remove allen screws securing waveguide to ports No 2 and No 3 on the waveguide switch (figure 405)
- D Unfasten quick-disconnect from waveguide section No 4 (figure 403)
- E Remove screws that secure the dummy load to RT mounting tray (figure 405)
- F Remove waveguide switch assembly
- G Remove waveguide section No 4 from waveguide switch port No 1
- H Remove dummy load from waveguide switch port No 4
- I Inspect all disconnected waveguide components and waveguide switch parts for corrosion and damage.

19 WAVEGUIDE SWITCH INSTALLATION.

Install waveguide switch as follows

- A Inspect all waveguide components and waveguide switch parts for corrosion and damage
- B Connect dummy load to waveguide switch port No 4
- C Secure waveguide section No 4 to waveguide switch port No 1

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- D Align waveguide switch assembly to RT mounting tray and secure dummy load using three screws (figure 405)
- E Fasten quick-disconnect to waveguide section No 4 (figure 403)
- F Secure waveguide to ports No 2 and No 3 using eight allen screws (figure 405)
- G Connect cannon plug to connector on bottom of waveguide switch
- H Install receiver-transmitter per paragraph 2

20 COMPONENT REPLACEMENT CHECKOUT

The following checkout procedures ensure that replaced components operate properly in the system. Perform applicable parts of 34-40-01 page 501 item 3 preparation to test, and 34-40-01 page 514 item 4, restore aircraft to normal, in conjunction with the following

The following procedures do not check the system completely. For a complete operational checkout of the system, refer to paragraph 11-22

21 INDICATOR

Perform indicator test per table 502

22 ANTENNA

Perform antenna stabilization procedure per tables 503 and 504

23 RECEIVER-TRANSMITTER AND WAVEGUIDE SWITCH

Perform self check procedures per 34-40-01 page 502 item H

24 CONTROL PANEL

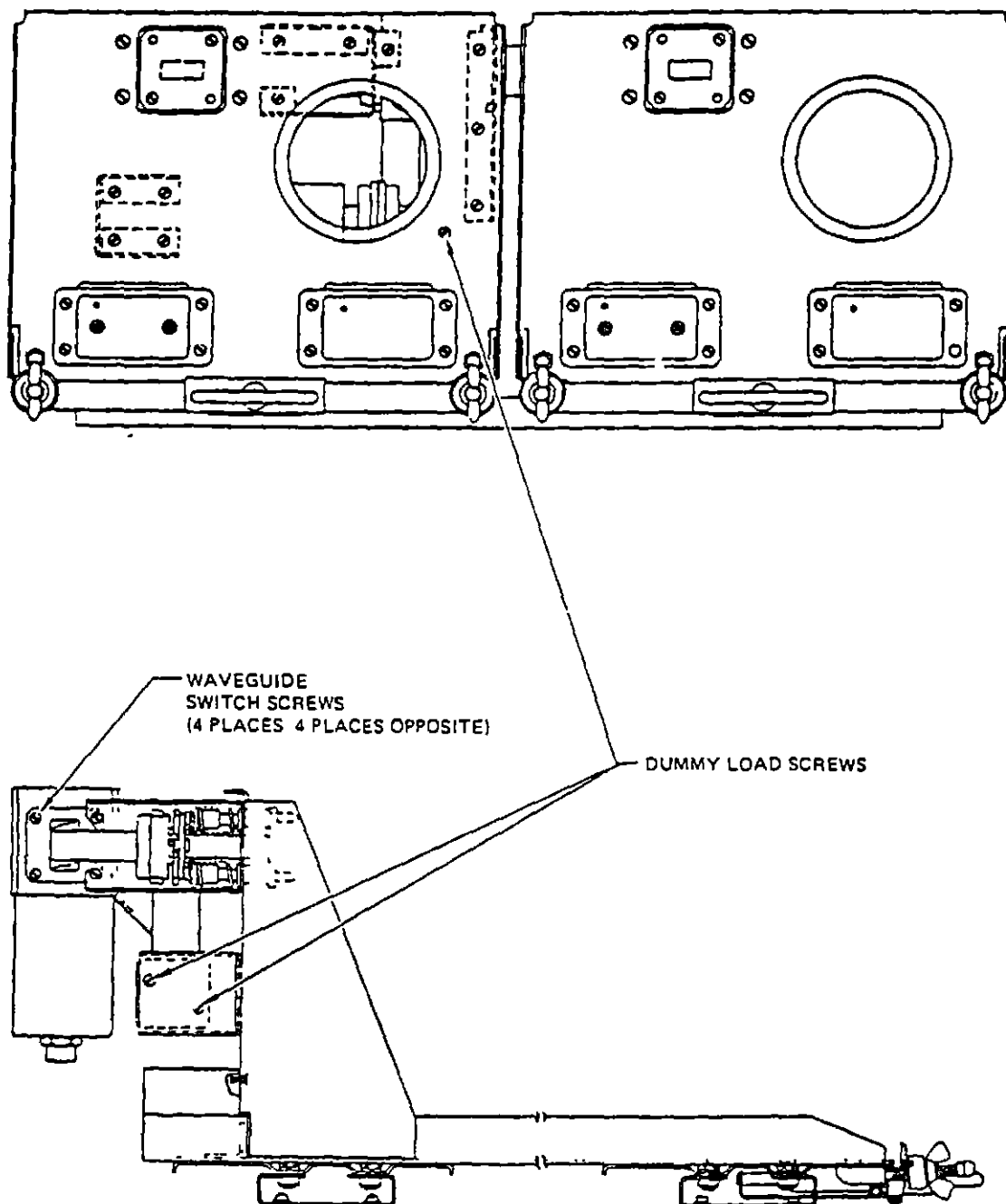
Perform self-check procedures per 34-40-01 page 502 item H

25 WAVEGUIDE

Perform antenna stabilization procedure per tables 503 and 504

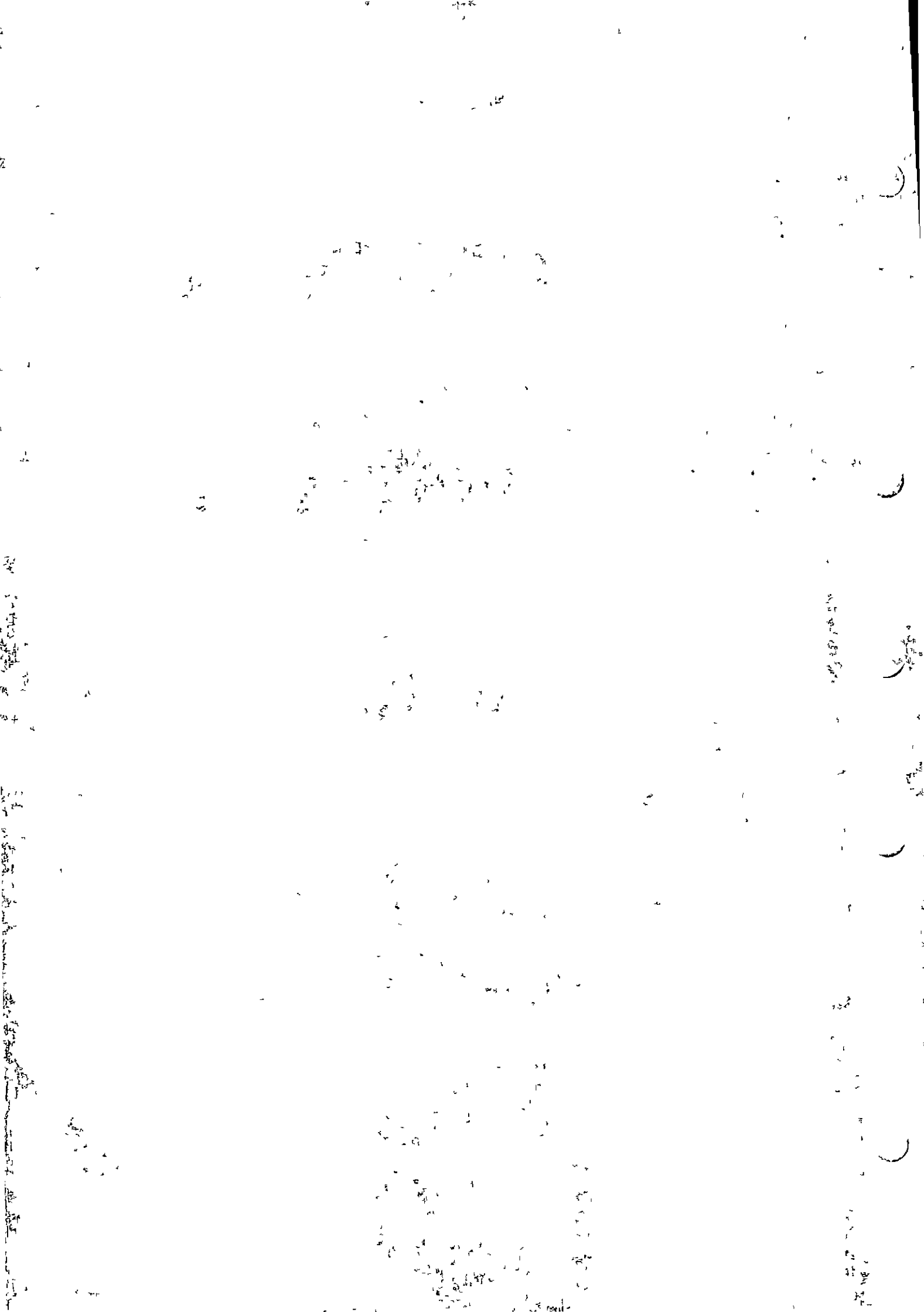
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Weather Radar Waveguide Switch Installation
Figure 405

Ref T O 1E-3A-2-34-1
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WEATHER RADAR SYSTEM - ADJUSTMENT/ TEST

1 TOOLS AND TEST EQUIPMENT

Table 501 lists the tools and test equipment required for weather radar system maintenance

2 CHECKOUT

Checkout of the weather radar system includes indicator tests, table 502, antenna stabilization tests, tables 503 and 504, and beacon mode tests, table 505. These checks may be performed individually or concurrently following preparation to test. After all testing has been completed, the aircraft must be restored to normal configuration. When the radar is operated in the WX, MAP1, MAP2 or BCN mode, direct the nose of the aircraft so that the forward 180 degree sector is free of large metallic objects, such as hangars or other aircraft, within a 100-yard range and free of personnel for 60 feet. Tilt the antenna upward 14 degrees with the control panel ANT TILT control. This checkout requires concurrent operations in the flight deck compartment, at the equipment rack, and at the antenna outside the aircraft.

3 PREPARATION TO TEST

WARNING VERIFY THAT ALL PERSONNEL IN ANTENNA RADIATION PATTERN ARE A MINIMUM DISTANCE OF 60 FEET AWAY FROM WEATHER RADAR ANTENNA IF OPERATED IN MODES OTHER THAN TEST OR STBY

TESTS INVOLVING RADIATION OF RF ENERGY MUST NOT BE MADE WITHIN 300 FEET OF FUELING/DEFUELING OPERATIONS OR WITHIN 100 FEET OF AN UNGROUNDED ELECTRO-EXPLOSIVE DEVICE (EED). DO NOT OPERATE RADAR WHILE AIRCRAFT IS BEING FUELED OR DEFUELED

CAUTION POSITION FORWARD 180(±6) DEGREE SECTOR OF AIRPLANE FREE OF LARGE METALLIC OBJECTS FOR A DISTANCE OF 300 FEET, WHEN RADAR IS OPERATED IN MODES OTHER THAN STBY OR TEST

DO NOT OPERATE RADAR UNLESS ANTENNA ROLL-LOCKING BRACKET IS REMOVED AND STOWED

KEEP RADOME CLOSED AS A WIND SHIELD EXCEPT WHEN NECESSARY FOR ACCESS TO ANTENNA

A Provide aircraft electrical power

B Check that WEATHER RADAR circuit breaker on P5 circuit breaker panel is closed

C Set copilot ADI attitude source selector switch to VG 1. On P5 circuit breaker panel, close FLIGHT INSTRUMENT Bus No 2 / VG 2 and FLT inst Bus No 2 att exc circuit breakers.

Ref DRW CDRL 43/44

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D Establish interphone communications.

E. Set control panel controls as follows

- (1) OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to OFF
- (2) GAIN to AUTO.
- (3) ANT TILT to 0 degrees.
- (4) ANT STAB to ON
- (5) PENCIL/FAN switch to PENCIL.

F. Set indicator controls as follows

- (1) OFF/5/25/50/150/300 SWITCH TO OFF
- (2) INT to midrange.
- (3) TGT CLAR to midrange
- (4) NOR/MKR/DLY to NOR

G Rotate control panel. OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to STBY and OFF/5/25/50/150/300 switch to 150. Check that elapsed time meter on RT is running. Wait 4 minutes for equipment warmup

H. Rotate control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to TEST. Check that blowers in receiver-transmitter come on.

I. Adjust indicator INT control for convenient viewing.

J Check that indicator displays correct test pattern Any absent test pattern band indicates a possible fault.

K Check that control panel and receiver-transmitter fault indicators lamps are off.

L. Check that GYRO flag is out of view on copilot flight instrument panel ADI.

M. Perform required tests in tables 502, 503, 504 or 505.

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PART NO OR TYPE DESIGNATOR	NOMENCLATURE	USE AND APPLICATION
<u>TOOLS</u>		
<u>TEST EQUIPMENT</u>		
VEGA model 229X-1 with 511-1 Battery Pack and 835X-7 Antenna	Tilt Table	Table used in testing antenna response to VG signals
204-91950-1	Transponder Test Set	To checkout the beacon mode short range rendezvous navigation equipment
TC- 149 Instrument Systems or i-133AIC	INS mounting adapter and extension harness	Used with tilt table to test INS unit
	Headset	Interphone communications
05AK 80 Switchcraft Corp (82389)	Extension Cable	Used with headset

AN/APS - 133(V) Weather Radar System Tools And Test Equipment
Table 501

Ref DRW CDRL 43/44
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STEP	RESULT
<u>Note</u> Unless otherwise specified, all controls are on the indicator	
1 Rotate INT control clockwise	Test pattern intensity increases.
2 Rotate INT control counterclockwise	Test pattern intensity decreases
3. Adjust INT control for convenient test pattern viewing level	
4 Rotate TGT CLAR control clockwise the counterclockwise	Noise between 50 and 80 nautical miles changes intensity
5 Set TGT CLAR control to midrange.	
6. Set OFF/5/25/50/150/300 switch to following positions and observe that test pattern changes scale and correct leg end is displayed.	
SWITCH POSITION 5 25 50 150 300	SWITCH POSITION 5/1 25/5 50/10 150/30 300/60
7. Rotate OFF/5/25/50/150/300 switch to 150	
8. Rotate NOR/MKR/DLY switch to MKR.	Blue 0 1 displayed in upper right of indicator
9 Press SLEW control up	Yellow variable range marker moves out in range and displayed range increments accordingly
10 Using SLEW control, position yellow variable marker near outer edge of red test video ring	

Indicator Tests
Table 502

Ref DRW CDRL 43/44
Paragraph 7 15-Issue D dtd 19 May 1988

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STEP	RESULT
11. Rotate NOR/MKR/DLY switch to DLY	Three segment color bar displayed is red, yellow, and green. Five segmented blue range marks are displayed at 30 nautical mile intervals. Legends TEST and DLY are displayed in upper left of indicator.
12. Rotate NOR/MKR/DLY switch to NOR	Test pattern returns to normal. Delay range is no longer displayed.
13. Rotate control panel OFF/STBY/TEST/WX MAP1/MAP2/BCN switch to WX and OFF/5/25/50/150/300 switch to 25	
14. Adjust control panel ANT TILT control until normal ground clutter and returns are visible and clearly defined on indicator	
15. Press then release HOLD pushbutton	Indicator display freezes. Legends HOLD and WX alternate.
16. Adjust control panel ANT TILT control to UP 10	Indicator display does no change.
17. Press then release HOLD pushbutton	Most ground returns disappear and only legend WX is displayed on indicator.
18. Adjust control panel ANT TILT control until normal ground clutter and returns are clearly defined	
19. Rotate control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to MAP1 and PENCIL/FAN switch to PENCIL	Legend MAP1 displayed in upper left of indicator. Three segment color bar is red/yellow/blue. Targets displayed in red, yellow, and blue. Range marks, azimuth cursors, and alphanumerics are green.
20. Rotate control panel GAIN control slowly counterclockwise	Intensity of returns is reduced and ground returns gradually disappear.
21. Rotate control panel GAIN control clockwise until normal returns are clearly defined	
22. Rotate control panel ANT TILT control slowly to UP 14 and then to DN 14	Target return intensity decreases as ANT TILT is increased (UP) and decreased (DN).

Indicator Tests
Table 502

Ref. DRW CDRL 43/44
Paragraph 7.15-Issue D dtd 19 May 1988

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STEP	RESULT
23 Return control panel ANT TILT to 0.	
24 Set control panel ANT STAB switch to OFF	Target intensity does not change radically
25 Set control panel PENCIL/FAN switch to PENCIL then back to FAN.	Indicator video presentation changes
26 Rotate control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to MAP2	MAP2 displayed in upper left of indicator
27 Rotate control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to BCN and OFF/5/25/50/150/300 switch to 300	Color bar in upper right of display is solid green Range marks, azimuth cursors, and alphanumerics are blue Legend is now BCN No ground returns or clutter displayed
28 Set TGT CLR control and INT control fully counterclockwise	
29 Set OFF/5/25/50/150/300 switch to OFF	
30 Set control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to OFF	

Indicator Tests
Table 502

Ref . DRW CDRL 43/44
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MAINTENANCE MANUAL

STEP	RESULT
<u>WARNING:</u> DO NOT OPERATE IN MODES OTHER THAN TEST OR STBY WHEN PERSONNEL ARE WITHIN 60 FEET OF WEATHER RADAR ANTENNA. <u>CAUTION:</u> DO NOT ATTEMPT TO OPEN RADOME IN WIND CONDITIONS EXCEEDING 25 KNOTS (30 MPH). 1 Remove attachment screws attaching aft end of radome. 2. Lift radome up and support with support rods. 3. Release antenna locking screw disengage switch positioning screw and place A2 switch in OFF position. 4. Set control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to STBY 5. Set each indicator OFF/5/25/50/150/300 switch to 150 and INT control to full counterclockwise.	

VG Antenna Stabilization Tests
Table 503

Ref. DRW CDRL 43/44
Paragraph 7.15-Issue D dtd. 19 May 1988

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STEP	RESULT
CAUTION	
WAIT 30 MINUTES AFTER REMOVING POWER BEFORE REMOVING GYRO TO ALLOW GYROS TO RUN DOWN	
6 Remove VERTICAL GYRO NO 2 place it on level tilt table and connect with extension cable	
7 Close FLIGHT INSTRUMENTS Bus NO 2/VG2 circuit breaker on P5 circuit breaker panel Allow 5 minutes for gyroscope to stabilize	
8 Set copilot ADI SWITCH MDL TO VG2	
9 Disengage RT XMTR ON/OFF switch positioning screw and set switch to OFF	
10 Set control panel OFF/STBY/TEST/WS/MAP1/MAP2/BCN switch to WX and antenna reflector to 0 degree azimuth position.	
11 Rotate ANT TILT control on control panel slowly through its full range	Check that antenna tracks ANT TILT control ± 1 degree (as indicated on the antenna elevation indicator) and that it has a smooth response
12 Set ANT TILT control to 0 degrees	
13 Tilt gyro in forward direction to simulate a 20-degree aircraft pitch down	Check that antenna tilts up 20 (± 2) degrees using tilt scale on antenna Adjust pitch gain on front of RT if required
14 Tilt gyro in aft direction to simulate a 20-degree aircraft pitch up	Check that antenna tilts down 20 (± 2) degrees Adjust pitch gain on front of RT if required
15 Tilt gyro to simulate aircraft 20-degree left roll.	Check that antenna rotates 20 (± 2) degrees right
16 Tilt gyro to simulate aircraft 20-degree right roll	Check that antenna rotates 20 (± 2) degrees left

VG Antenna Stabilization Tests

Table 503

Ref DRW CDRL 43/44

Paragraph 7 15-Issue D dtd 19 May 1988



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STEP	RESULT
17 Set control panel ANT STAB switch to OFF	Check that antenna rotates back to 0 (± 2) degrees
18 Set control panel ANT STAB switch to ON	Check that antenna rotates 20 (± 2) degrees left
19 Level tilt table	
20 Set control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN switch to OFF and indicator OFF/5/25/50/150/300 switch to OFF	
21 Open FLIGHT INSTRUMENTS Bus NO 2/VG 2 circuit breaker	
<u>CAUTION</u> Wait 30 minutes after removing power before moving gyro, to allow gyros to run down	
22 Remove gyro from tilt table and reinstall in aircraft	
23 Set TR XMTR ON/OFF switch to ON and secure switch positioning screw	
24 Set antenna AZ switch to on position and secure switch positioning screw	
25 Lift radome, remove support rods, and lower radome.	
26 Store support rods in lower nose compartment forward of nose wheel well.	

VG Antenna Stabilization Tests
Table 503

Ref DRW CDRL 43/44
Paragraph 7 15-Issue D dtd 19 May 1988



MAINTENANCE MANUAL

STEP	RESULT
<u>WARNING</u> DO NOT OPERATE IN MODES OTHER THAN TEST OR STBY WHEN PERSONNEL ARE WITHIN 60 FEET OF WEATHER RADAR ANTENNA <u>CAUTION</u> DO NOT ATTEMPT TO OPEN RADOME IN WIND CCNDITIONS EXCEEDING 25 KNOTS (30 MPH) 1 REMOVE ATTACHMEINT SCREWS ATTACHING AFT END OF RADOME 2 LIFT RADOME UP AND SUPPORT WITH SUPPORT RODS 3 RELEASE ANTENNA LOCKING SCREW 4 TURN ON EQUIPMENT COOLING FAN	

INS Antenna Stabilization Tests
Table 504

Ref DRW CDRL 43/44
Paragraph 7 15-Issue D dtd 19 May 1988



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STEP	RESULT
5 Open INS circuit breakers and turn inertial navigation set (INS) off <u>CAUTION</u> Wait a minimum of 5 minutes before proceeding	
6 Remove INS No 2 navigation unit from INS rack, install on calibrated tilt table, and level in pitch and roll 0 (± 1) degree <u>CAUTION</u> Provide cooling to INS units on tilt table during test to prevent overheating and equipment damage	
7 Connect extension harness from INS to airplane wiring	
8 On P5 circuit breaket panel, position Radio BUS NO 2 switch to ON - position	
9 On P5 panel, close the following NAVIGATION INS circuit breakers NO 2 PWR NO 2 HTR XFER INS	
10 On BATTERY UNIT located on INS rack, close circuit breaker	
11 Set NO 2 INS MODE SELECT to ALIGN	

INS Antenna Stabilization Tests
Table 504

Ref. DRW CDRL 43/44
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MAINTENANCE MANUAL

STEP	RESULT
<u>NOTE</u> To ensure valid test results, the following actions must be observed Wait 10 minutes before performing step 13 Do not move aircraft or tilt table until step 13 has been performed	
12 Set NO 2 INS MODE SELECT to ATT	
13 Set control panel OFF/STBY/TEST/WXI MAP1/MAP2/BCN switch to STBY	
14 Set indicator OFF/15/25/50/150/300 switch to 150	
15 Set INT control fully counterclockwise	
16 On antenna, disengage switch positioning screw, and set AZ switch to OFF.	
17 Set copilot ADI SWITCH MDL to INS	
18 Disengage RT XMTR ON/OFF switch positioning screw and set switch to OFF	
19 SET CONTROL PANEL OFF/ STBY/TEST/WX MAP1/MAP2/BCN switch to WX	
20 Position antenna to 0 degree azimuth	
21 Rotate ANT TILT control-on control panel slowly through its full range	Check that antenna tracks ANT TILT control ± 1 degree (as indicated on the antenna elevation indicator) and that it has a smooth response
22 Set ANT TILT control to 0 degrees	
23 Tilt INS in forward direction to simulate aircraft 20-degree pitch down	Check that antenna tilts up 20 (± 2) degrees. Adjust pitch gain on front of RT if required
24 Tilt INS in aft direction to simulate aircraft 20-degree pitch up	Check that antenna tilts down 20 (± 2) degrees. Adjust pitch gain on front of RT if required

INS Antenna Stabilization Tests
Table 504

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STEP	RESULT
25 Tilt INS to simulate aircraft 20-degree left roll	Check that antenna rotates 20 (± 2) degrees right
26 Tilt INS to simulate aircraft 20-degree right roll	Check that antenna rotates 20 (± 2) degrees left
27 Set control panel ANT STAB switch to OFF	Check that antenna rotates back 0 (± 2) degrees
28 Set control panel ANT STAB switch to ON	Check that antenna rotates 20 (± 2) degrees left
29 Level tilt table.	
30 Set control panel OFF/STBY/TEST/WA MAP1/MAP2/BCN switch of OFF and indicator OFF/5/25/50/150/300 switch of OFF	
31 Turn INS No 2 navigation unit off	
32 On P5 panel, open the following NAVIGATION INS circuit breakers NO 2 PWR NO 2 HTR XFER INS	
33 On BATTERY UNIT located on INS rack, open circuit breaker <u>CAUTION</u> WAIT 30 MINUTES AFTER REMOVING POWER BEFORE MOVING GYRO, TO ALLOW GYROS TO RUN DOWN	
34 Reinstall INS navigation unit in INS rack and close circuit breaker on BATTERY UNIT	
35 Set RT XMTR ON/OFF switch to ON and secure switch positioning screw	
36 Set Antenna AZ switch to on position and secure switch positioning screw	
37 Lift radome, remove support rods, and lower radome	

INS Antenna Stabilization Tests
Table 504

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STEP	RESULT
1 Place VEGA transponder at least 200 feet in front of airplane and a minimum of 6 feet above ground, then turn it on	
2 Set control panel OFF/STBY/TEST/WX/ MAP1/MAP2/BCN switch to BCN, PENCIL/FAN switch to FAN, and indicator OFF/5/25/50/150/300 switch to 25 then 5	Verify transponder reply (two pulses) reception on both indicators First pulse may be hidden in ground clutter Second pulse is near 3 nautical miles
3 Adjust gain control as required to obtain a target size between 1/8 and 3/8 inches in azimuth	Azimuth location depends on position of transponder relative to airplane
4 Set control panel OFF/STBY/TEST/WX/ MAP1/MAP2/BCN switch to OFF	

Beacon Mode Tests
Table 505

4 RESTORE AIRCRAFT TO NORMAL

- A Set control panel OFF/STBY/TEST/WX/MAP1/MAP2/BCN SWITCH to OFF
- B Open FLIGHT INSTRUMENTS Bus NO 2 / VG 2 CIRCUIT BREAKER
- C Remove aircraft electrical power if no longer required for other maintenance

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MAINTENANCE MANUAL

RENDEZ-VOUS RADAR - DESCRIPTION AND OPERATION

1 SAFETY PRECAUTIONS

- A Refer to introduction for general safety precautions to be observed when operating or performing maintenance on the radar transponder. Observe all caution notes when performing tests on radar transponder and when preparing faying surfaces for bonding.

2 DESCRIPTION

- A All TCA aircraft have a radar transponder consisting of a control panel, antenna, and a radar transponder, RT-871/APX-78. Radar transponder system equipment is listed in table 1. The radar transponder responds to X-band radar interrogators by transmitting replies. The system operates in either a single-pulse or one of 10 double-pulse interrogation modes and either a single-pulse or one of 5 double-pulse reply modes. Code pulse spacing is fixed for each decode or encode double-pulse mode. The encoding single- and double-pulse widths are 0.3 (± 0.1) microseconds. The decode signal-pulse width is 0.25 to 5.0 microseconds, and the width of the double-pulse is 0.25 to 0.5 microseconds. The radar sends blanking output signals to, and receives suppression input from, the weather radar. Figure 1 shows the radar transponder equipment location.

(1) Radar Transponder

The radar transponder is located on the RH radio rack shelf 1 (figure 1). The radar transponder is a solid state decoder/encoder receiver transmitter (except for the magnetron). The transponder receives interrogation signals at the frequency of 9375 (± 5) MHz, decodes the signals, encodes and transmits replies on 9310 (± 5) MHz. The radar transponder operates on 28 volts dc.

(2) Control Panel

The control panel (figure 1) is located on the co-pilot's instrument panel. The POWER, ENCODE, and DECODE selector switches on the control panel control 28 vdc primary power and code selection. The control panel is marked RADAR XPNDR. Table 2 lists the controls and their descriptions. Refer to table 3 for pulse code spacing.

(3) Antenna

The radar transponder blade antenna (figure 2) is located on the bottom of the fuselage, at Station 550 doors. The antenna receives interrogations and transmits reply rf signals. A coaxial cable connects the antenna to the transponder.

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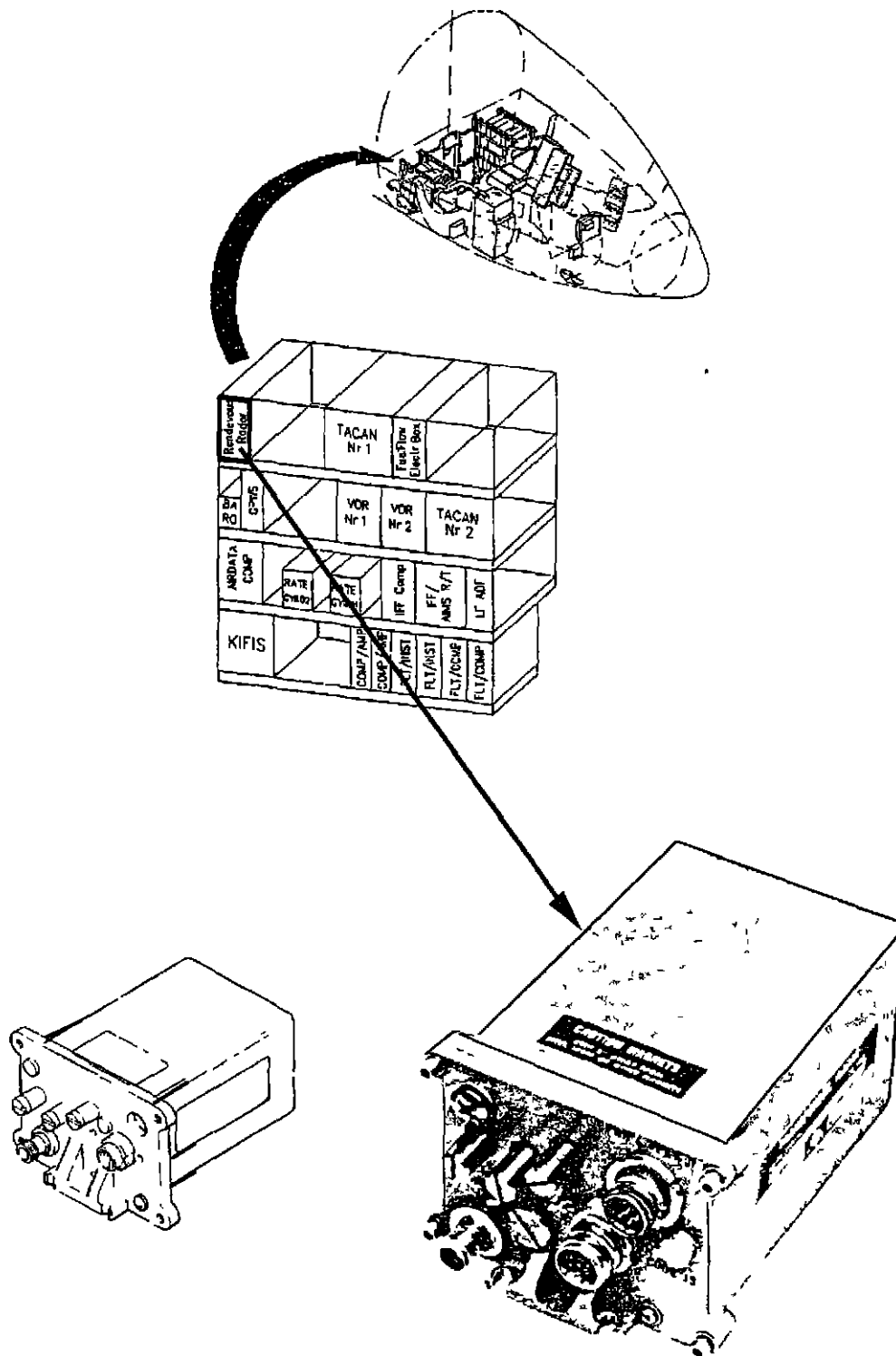
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NOMENCLATURE		COMMON NAME	LOCATION
OFFICIAL	DRAWING		
Radar Transponder T-871/AP-78			
Control XPDR - Radar AN/APX-78	Control	Control Panel	F/O instrument Panel P10
Antenna Radar XPDR	X-Band Antenna	Antenna	Station 550
XPDR Set - Radar AN/APX-78	Radar RT-871/APX-78	Radar Transponder	RH radio rack shelf 1

Rendez-Vous Radar Transponder System Equipment
Table 1

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Rendez-Vous Radar Transponder System Equipment Location
Figure 1 (Sheet 1 of 2)

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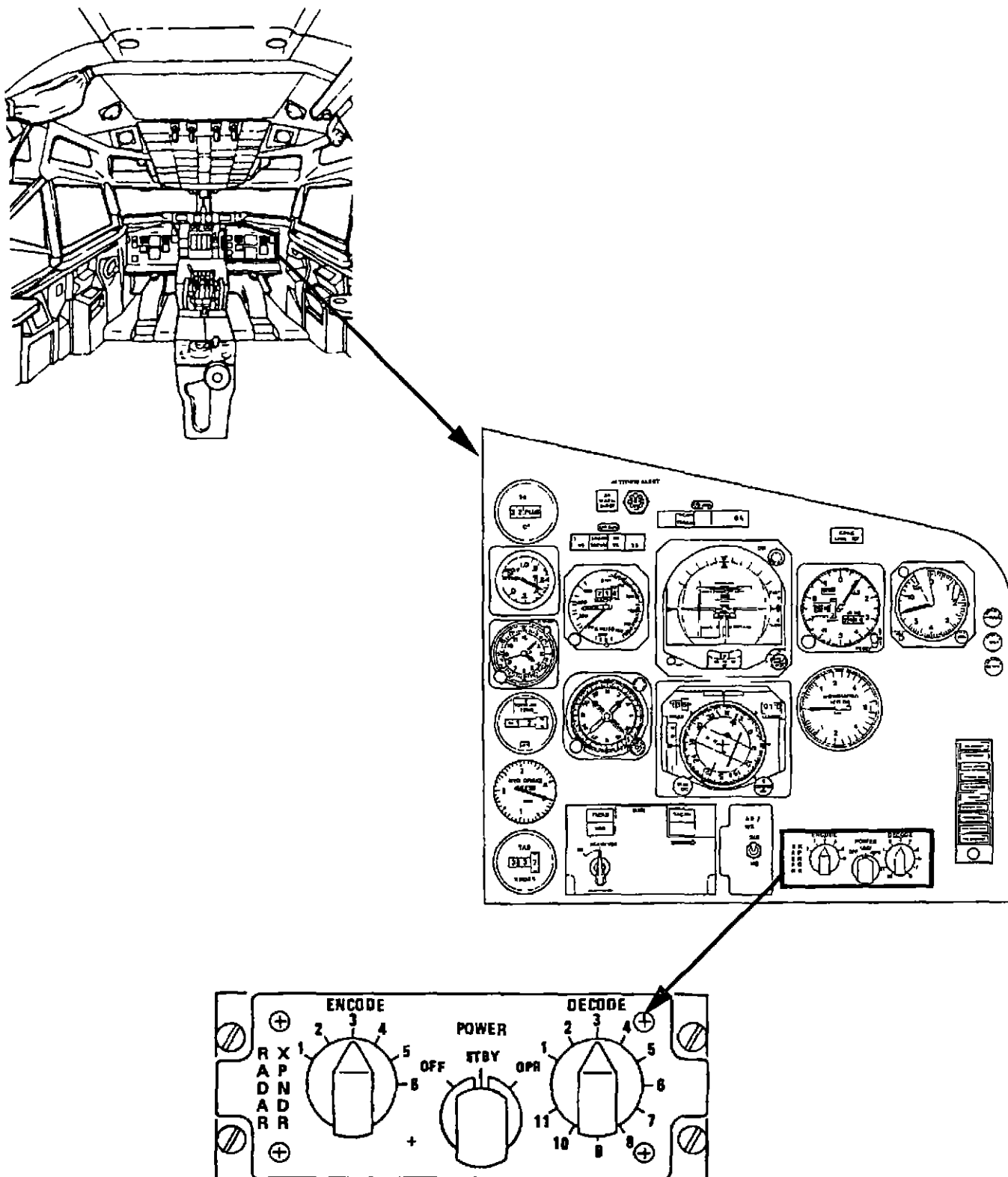
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CONTROL	FUNCTION
ENCODE selector	Selects the identifying signal to be transmitted to an interrogating radar. One of six different identifying signals may be selected.
DECODE selector	Selects the interrogating code to which a reply will be made. One of eleven interrogating codes may be selected.
POWER switch: OFF	Power off
STBY	Three to 5 minute warmup, no encoding or transmission from transponder, but transponder magnetron filaments are energized.
OPR	Transponder receives and transmits signals selected by the ENCODE and DECODE selectors.

Rendez-Vous Radar Transponder System Controls and Displays
Table 2

Ref: T O 1E-3A-2-34-1
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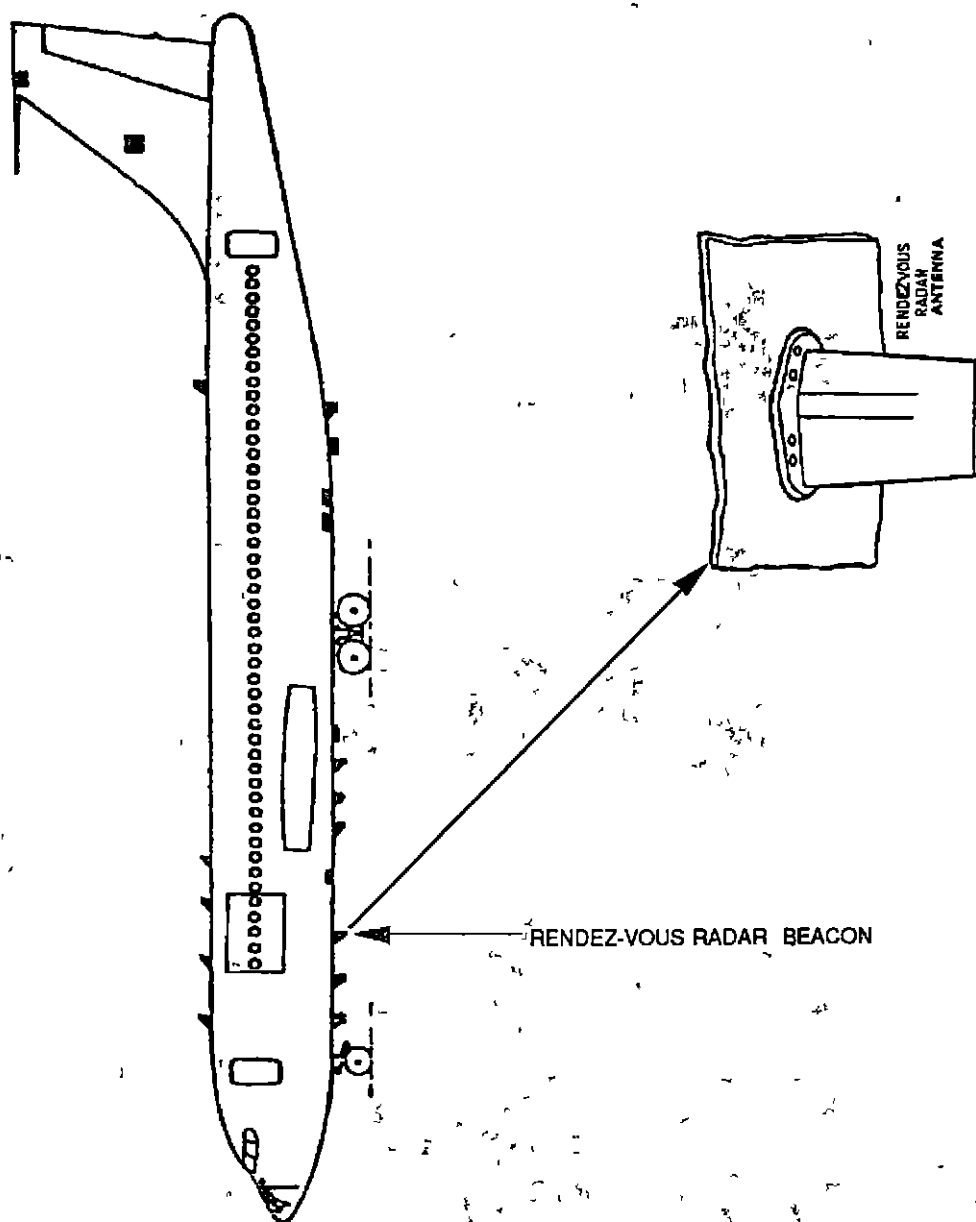
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Rendez-Vous Radar Transponder System Equipment Location
 Figure 1 (Sheet 2 of 2)

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Antenna Location
Figure 2

AN/APX-78 TRANSPONDER

DECODING	
CODE	SPACING (μ SEC)
1	SINGLE-PULSE
2	3
3	4
4	5
5	6
6	7
7	8
8	9
9	10
10	11
11	12
ENCODING	
CODE	SPACING (μ SEC)
1	SINGLE-PULSE
2	48 8
3	73 2
4	97 6
5	122 0
6	146 4

AN/UPM-138 TEST SET

BEACON INTERROGATION	
CODE	SPACING (μ SEC)
SINGLE	SINGLE
1	3
2	4
3	5
4	6
5	7
6	8
7	9
8	10
9	11
10	12
BEACON REPLY	
CODE	SPACING (μ SEC)
SINGLE	SINGLE
1	48 8
3	73 2
5	97 6
7	122 0
9	146 4

Pulse Code Spacing
Table 3

Ref. T O 1E-3A-2-34-1
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3 OPERATION

- A When the POWER selector switch on the control panel (figures 1 and 3) is set to STBY or OPR, 20 volts dc is applied to the transponder. In the STBY position, +28 volt dc received from the transponder power supply is switched to the encode pulse generator and clamps the output stage to inhibit any encoded outputs. In the OPR position, the clamp is removed from the output stage of the encode pulse generator, and the decoder mode (single- or double-pulse) is selectable with the DECODE switch. Resistors in the decode switch form a voltage divider network between the -10 volts dc and the +20 volts dc supplied by the transponder power supply. In the double-pulse interrogation mode, the DECODE selector switch (in positions 2 through 11) selects a specific voltage level which is applied to the code selection circuits of the decoder module. This voltage level, referred to as decode control double pulse, determines the code (pulse) spacing of the interrogation pulses to be decoded.
- B Resistors in the encode switch form a voltage divider network between the +20 volts dc, supplied by the transponder power supply, and ground. When the ENCODE selector switch is in position 1 (single-pulse reply mode), the encode control line to the encode pulse generator is connected to ground by the ENCODE switch. In positions 2 through 6 (double-pulse reply modes) the ENCODE switch selects a specific positive-voltage level which is applied to the encode circuits of the encode pulse generator. This voltage level is applied to a retiming network in the encode pulse generator which determines the pulse spacing of the reply code.
- C Interrogation signals received are coupled from the antenna to the circulator. The circulator directs the signals to the preselector, which passes only those signals that are within its receive bandpass to the mixer. In the mixer, the output of the preselector and the local oscillator signals are heterodyned to produce the 60 MHz (nominal) IF signal. The local oscillator is a variable-frequency generator capable of operating at frequencies between 8800 and 9500 MHz.
- D The 60 MHz IF signal output is directed to the IF amplifier module. The video pulse output of the IF amplifier drives the delay stabilizer.
- E The delay stabilizer circuit shapes the video pulses and standardizes the leading edge of the pulses to compensate for variations in signal level. The shaped pulses trigger a standard pulse generator. The decode pulse generator will produce an output if the video pulses are of sufficient amplitude, and if the code spacing (in double-pulse mode) is correct. Single-pulse mode and each of 10 double-pulse decode operating modes are selectable using the DECODE selector switch. The single-pulse output of the decode circuit is used to trigger the encode pulse generator.

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- F When the encode pulse generator receives a trigger pulse, it will produce a single-pulse output if the ENCODE selector switch is in position 1, or a coded double-pulse output if the ENCODE selector switch is in positions 2 through 6. The encode pulse generator will respond to each decoded output pulse if the spacing between pulses is 50 microseconds or more plus the encode pulse generator spacing. Encode pulse generator operation is inhibited by a suppression pulse from the weather radar or if the transponder is in standby. An internal blanking pulse, produced by the blanking encode pulse generator, inhibits the encode pulse generator for approximately 46 microseconds. This pulse prevents the encode pulse generator from producing an output that would trigger the blanking encode pulse generator during this period of time and cause a false blanking pulse to be produced. The single-pulse or double-pulse blanking trigger output of the emitter follower is used to trigger the modulator.
- G The modulator produces precisely shaped and delayed pulse voltages when triggered by the trigger input through the delay generator, differentiator and switch. These pulses are used to drive the magnetron. The modulator also contains an overinterrogation control circuit that limits the reply pulse repetition frequency (prf) to avoid exceeding the duty cycle of the magnetron.
- H The magnetron produces the transmitted reply pulses when driven by the pulse voltage output of the modulator. The high power output (300 W peak, minimum) of the magnetron is coupled through the circulator to the antenna.
- I The solid-state power supply module operates from a 28-volt dc input. The input voltage is regulated and then applied to a dc-to-dc converter which, in turn, produces a chopped dc voltage output to a transformer. The output of the transformer is rectified and filtered to provide dc voltages required to power the transponder circuits. A 5-volt winding on the power transformer provides ac voltage for the filament of the magnetron. An overvoltage protection circuit protects the power supply from damage when a momentary surge of primary power in excess of 28.5 volts dc occurs.

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Figure 3 (Sheet 2 of 2)

REF E O TCA 34/15

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RENDEZ-VOUS RADAR TRANSPONDER - TROUBLE SHOOTING

1. GENERAL

A The trouble analysis chart, table 101, lists symptoms, probable causes, isolation procedures and corrective actions. The reference procedure column lists the related test steps in the checkout procedure. This correlates the symptoms with failures that may be encountered during checkout. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation. If performing the listed corrective action does not correct the trouble, check wiring

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
NO RECEPTION OF INTERROGATION SIGNALS			
Table 502 Steps 17 18	Defective transponder, control panel or antenna	Check other codes.	Replace in order listed Transponder Control panel Antenna
NO TRANSMISSION OF REPLY SIGNALS			
Table 502 Step 17	Defective transponder, control panel or antenna	Check other codes	Replace in order listed Transponder Control panel Antenna
WORKS ON SOME CODES, NOT ON OTHERS			
Table 502 Step 17	Defective control panel or transponder		Replace control panel Replace transponder
INCORRECT OPERATING FREQUENCY			
Table 521 Step 19			Replace transponder

Rendez-Vous Radar Transponder System Trouble Shooting
Table 101

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RENDEZ-VOUS RADAR TRANSPONDER SYSTEM - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Self Leveling Green Sealant (P/N HT3326-5-50).
- B. Tape Stretch Seal (P/N AD89503/01-36).

2. Antenna - Removal

- A. Open the Rendez-Vous radar circuit breaker on P5 overhead circuit breaker panel.
- B. Locate the Rendez-Vous radar antenna at station 550 (bottom).
- C. Remove eight screws that attach the antenna to the fuselage.
- D. Pull antenna out far enough to disconnect coaxial cable connector.
- E. Disconnect coaxial cable connector from antenna.
- F. Discard O-ring.

3. Antenna - Installation

- A. Place the antenna gasket on the antenna.
- B. Apply self leveling green sealant to connector base. Allow sealant to cure for 30 minutes before mounting the antenna to the aircraft.
- C. Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- D. Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- E. Prime and paint all bare metal outside the original footprint and decrease the original footprint by 0,2 inch per AMM 51-90-00.

NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

- F. Clean the antenna footprint and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- G. Remove the aliphatic naphtha with a clean cloth.
- H. Place antenna near mounting location and connect coaxial cable to antenna.
- I. Wind stretch seal tape around the connector until it is 1.5 inch above the connector, covering the coax cable.

NOTE: Make sure that the adhesive side of the tape is pointing to the coaxial cable and the connector. This provides for a tight seal.

TR-Nr. DFW 34-27

TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

34-41-01

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CAUTION DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACES

- J. Place antenna in position ensuring the antenna gasket is positioned correctly.
- K. Secure antenna with four mounting screws. Ensure that a Teflon washer is placed under each screw.
- L. Tighten antenna screws so that antenna gasket is compressed evenly.
- M. Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- N. Measure electrical bond resistance between antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- O. Close the Rendez-Vous radar circuit breaker on P5 overhead circuit breaker panel.
- P. Perform an operational test per AMM 3-41-01, table 501.

4. Radar Transponder - Removal

- A. Disconnect ANT, CODE, PWR and TEST cables.
- B. Remove four bolts.
- C. Remove transponder.

5. Radar Transponder - Installation

- A. Place transponder in position
- B. Secure transponder to communication cabinet E4 with four bolts.
- C. Connect ANT, CODE, PWR and TEST cables.

6. Component Replacement Checkout

- A. The following checkout procedures ensure that replaced components operate properly in the system.

(1) Antenna

(a) Perform system test per table 502.



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- (2) Radar Transponder.
 - (a) Perform system test per table 502.
- (3) Control Panel.
 - (a) Perform system test per table 502.

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RENDEZ-VOUS RADAR TRANSPONDER SYSTEM - REMOVAL/INSTALLATION

1 Antenna - Removal

- A. Remove eight bolts securing antenna
- B. Lower antenna and remove coaxial cable connector
- C. Remove antenna

2 Antenna - Installation

- A. Remove oxide or paint from faying (mating) surface with an aluminum oxide abrasive cloth until both surfaces are bright. Do not remove more material than necessary
- B. Apply corrosion preventive compound liberally over faying surface. Allow one hour before wiping excess compound off, leaving a thin coating of compound on faying surface
- C. Connect coaxial cable connector to antenna.
- D. Place antenna in position and secure to aircraft structure with eight bolts

3 Radar Transponder - Removal

- A. Disconnect ANT, CODE, PWR and TEST cables.
- B. Remove four bolts
- C. Remove transponder

4 Radar Transponder - Installation

- A. Place transponder in position
- B. Secure transponder to communication cabinet E4 with four bolts
- C. Connect ANT, CODE, PWR and TEST cables

5 Component Replacement Checkout

- A. The following checkout procedures ensure that replaced components operate properly in the system

(1) Antenna

- (a) Perform system test per table 502

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(b) Radar Transponder

(1) Perform system test per table 502.

(c) Control Panel.

(1) Perform system test per table 502

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RENDEZ-VOUS RADAR TRANSPONDER - ADJUSTMENT/TEST

1. Tools And Test Equipment

A. Tools and test equipment are listed in table 501.

2. Checkout

A. The procedure in table 502 tests the radar transponder. When out of tolerance conditions are encountered, refer to trouble analysis for corrective action.

PART NO. OR DESIGNATOR	FIGURE AND INDEX NO	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation.			
<u>TOOLS</u>			
<u>TEST EQUIPMENT</u>			
AN/UPM-138		Radar Beacon Test Set	Provides test signals and measures transponder performance for system checkout.
TC-149 Instrument Systems or H-133AIC		Headset	Operational checkout of aural signals from the radar transponder.
O5AK80 Switchcraft Corp. (82389)		Extension Cable	Used with headset.
204-92002-1		Power Cable Assembly, 400 Hz	75 foot power cable for AN/UMP-138.
4585-9, General Electric		Adapter, Power Cable, 400 Hz	Connects AN/UPM-138 to power cable assembly.

Rendez-Vous Radar Transponder System - Tools and Test Equipment
Table 501

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STEP	RESULT
1 Apply aircraft electrical power Check that the RENDEZ VOUS BEACON circuit breaker in the P5 circuit breaker panel is closed 2 Establish interphone communications 3 Position radar transponder control panel POWER switch to STBY for 3 minutes and then to OPR 4 Place radar beacon test set 50 (± 5) feet from radar transponder antenna to be tested 5 Remove antenna and mast from cover of test set case Assemble and secure antenna assembly to mounting base on control panel of test set 6 Point test set antenna directly at radar transponder antenna, ensuring there are no obstructions between the test set and transponder antenna <u>NOTE</u> Polarization of test set antenna must be horizontal to match transponder antenna polarization See figure 501 for proper orientation of test set antenna <u>CAUTION</u> DO NOT MAKE DIRECT CONNECTION BETWEEN TEST SET AND TRANSPONDER RF POWER OUTPUT OF TRANSPONDER IS SUFFICIENT TO DAMAGE TEST SET 7 Connect antenna cable assembly from antenna to ANT connector on test set control panel 8 Connect test set power cable to primary power source if 400-Hz primary power is available, use the 60/400-Hz adapter provided with test set 9 Connect headset to radar beacon test set	

Rendez-Vous-Radar Transponder System Checkout

Table 502 (Sheet 1 of 3)

Ref T O IE-3A-2-34-1

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STEP	RESULT
10 Set test set AC POWER ON/OFF switch to ON position and allow a 5 minute warmup period before operating test set (Under extreme cold conditions, allow 15 minute warmup period)	
11 Set test set BEACON INTERROG CODE to 3, BEACON REPLY CODE to 5, aircraft RADAR XPDR control panel ENCODE and DECODE switches to 4, POWER to OPR.	
12 Set test set TEST FUNCTION selector switch to CAL FREQ	
<u>NOTE</u> When the TEST FUNCTION selector switch is in the CAL FREQ, OPR FREQ, or MON position and the pointer of the RF POWER meter is off scale, use the METER OFFSET control to position pointer on scale	
13 Initially set METER OFFSET to PWR SET LINE Adjust FREQUENCY (MHz) dial to obtain a dip indication on RF POWER meter to determine interrogation frequency of test set Adjust METER OFFSET control so that dip indication occurs at approximately one-third scale	FREQUENCY (MHz) dial indicates 9375 (± 5) MHz at dip If indication on FREQUENCY (MHz) dial is not 9375 (± 5) MHz, proceed to step 14 If indication is 9375 (± 5) MHz, proceed to step 15
14 Observe test set INCR (increase) arrow over FREQ ADJ INTERROGATION control; rotate control slightly in the proper direction to increase or decrease interrogation frequency toward setting desired Repeat steps 13 and 14 until interrogation frequency is 9375 (± 5) MHz	
15 Detune FREQUENCY (MHz) dial 10 MHz off frequency	
16. Set TEST FUNCTION switch to CAL POWER. Adjust INTERROGATION POWER SET control to position pointer of RF POWER meter to PWR SET	

Rendez-Vous Radar Transponder System Checkout
Table 502 (Sheet 2 of 3)

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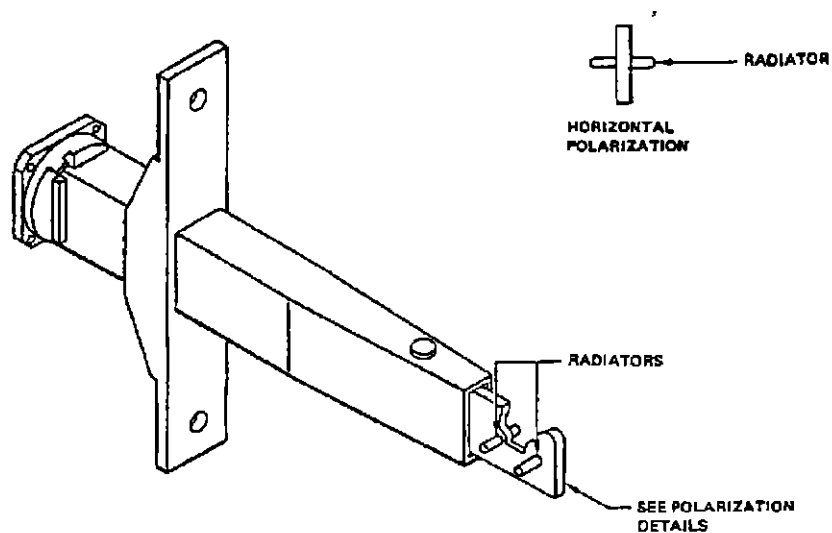
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STEP	RESULT
17 Set TEST FUNCTION selector switch to OPR POWER. Point antenna toward transponder antenna to obtain signal in headphones of test set, and a maximum indication on RF POWER meter.	Pointer of RF POWER meter indicates in green sector of meter scale. CODE CORRECT indicator is on. Tone is heard in headset.
18 Repeat steps 11 through 17 with test set BEACON INTERROG CODE to 5, BEACON REPLY CODE to 7, aircraft RADAR XPDR control panel ENCODE to 5, DECODE to 6.	
<u>NOTE</u> If test set CODE CORRECT indicator flickers on and off and a steady 1200 Hz (approximately) tone is not audible in the headset, other interrogating radars may be operating on that code.	
19. Set TEST FUNCTION selector switch to OPR FREQ. While observing RF POWER meter, adjust FREQUENCY (MHz) dial to obtain dip.	FREQUENCY MHz dial indicates 9310 (± 5) MHz.
20. Set POWER switch on control panel to OFF.	
21 Turn off and repack test set.	
22 Remove aircraft electrical power if no longer required for other maintenance.	

Rendez-Vous Radar Transpondert System Checkout
Table 502 (Sheet 3 of 3)

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Rendez-Vous Radar Transponder Test Set Antenna Polarization
Figure 501

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VOR/GS NAVIGATION SYSTEM - DESCRIPTION AND OPERATION

1 General

- A The VHF omnidirectional range (VOR) and glide slope (GS) navigation systems provide information of airplane position with respect to, and deviation from, a selected VOR course, or localizer (LOC) and glide slope approach beams. Airplane magnetic bearing to VOR ground station under reception is also provided.
- B Two systems, captain's and first officer's, are installed. Each is comprised of the following units: receiver, VOR antenna, GS antenna and control panel. Location of the components is shown in figure 1.
- C. VOR/LOC course deviation information is displayed by the course deviation bar in the horizontal situation indicator (HSI) also called course deviation indicator (CDI). GS deviation is displayed by the glide slope pointer in the CDI. VOR station bearing information is displayed by the single and double pointers in the VOR radio magnetic indicators (RMI) which are installed on the captain's, first officer's instrument panel. VOR/LOC, and GS deviation information is also fed to the flight director computer in the flight director systems, and to the autopilot.
- D The VOR/LOC and GS warning flags are provided to give an indication of associated system malfunction. The flags appear in view whenever power is lost to the systems, or whenever the input signals fail, or fall below a certain predetermined value.
- E Frequency selection, in a navigation unit, is accomplished at the control panel. The GS portion of the unit becomes operative only when a localizer frequency is selected. The RF carrier is radiated from 108.00 to 118.00 MHz (VOR/LOC) and 329.3 to 335.0 MHz (glide slope). Localizer frequencies extend from 108.10 to 111.90 MHz, with channels spaced on odd tenths of a megahertz.

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VHF NAVIGATION SYSTEM POWER

Power for the VOR/ILS system is 28 VDC. Power is supplied through circuit breakers on the P5 panel. Additional 26 VAC power for instrument indications is supplied through instrument transformers.

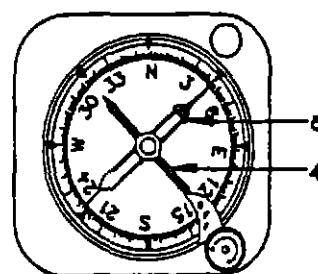
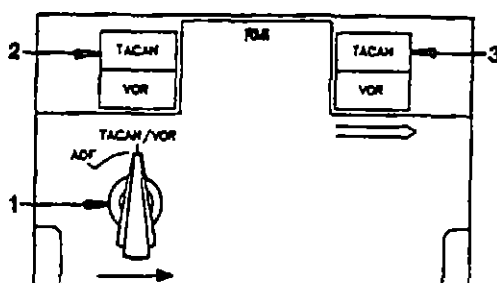
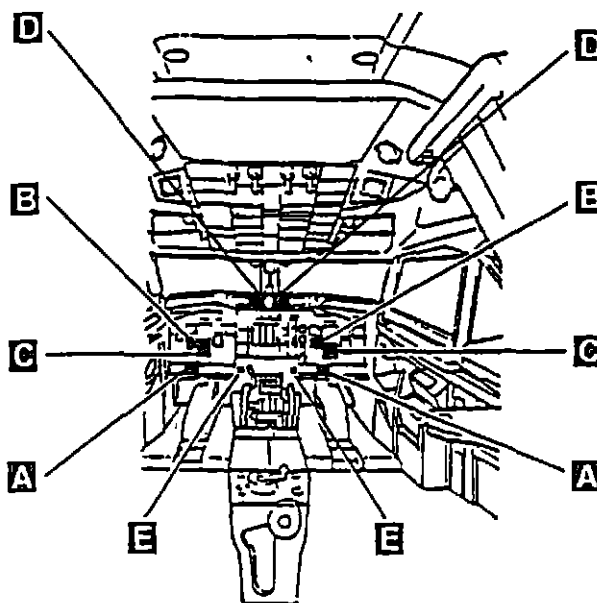
VHF NAVIGATION SYSTEM SIGNAL FLOW AND DISPLAY

The VOR/ILS aural identification signal is received at the respective receiver unit and transmitted through the VHF NAV control panel to the airplane interphone system. VOR and heading reference signals are processed by the receiver unit to generate a bearing output. VOR bearing information is supplied to the pilot and copilot HSI bearing pointers by the respective NAV MODE selector.

In VOR operation, course information is supplied to the HSIs to enable pilots to select, identify and maintain a predetermined course by electronically referring to a VOR ground station. Annunciators indicate when VOR or localizer is selected for use with each flight director and the autopilot. In ILS operation, information is supplied for lateral and vertical guidance of the airplane during an instrument landing approach. The localizer and glideslope signals are fed to each pilot's flight director system (Pilot NAV MODE selector must be in VOR/LOC, and the flight director mode selector must be in NAV/LOC) and, when coupled, from VHF/NAV receiver number one to the autopilot.

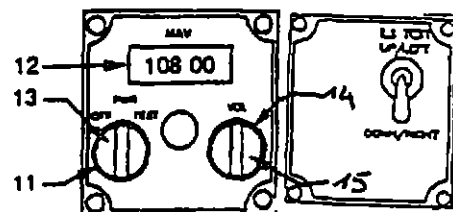
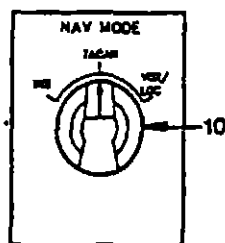
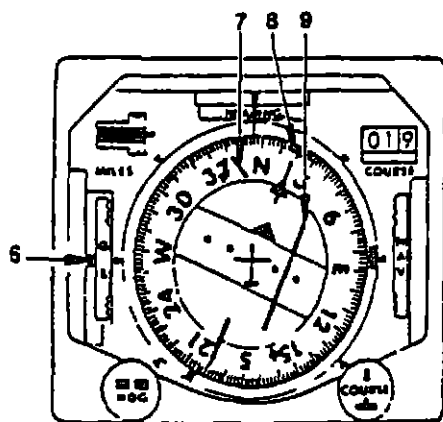
A glide slope receiver in each VHF/NAV receiver is automatically powered when a localizer frequency is selected. The glide slope receivers operate in a frequency range of 329.3 to 335 MHz and provide vertical guidance during airplane descent. Selection of a localizer frequency automatically selects the paired glide slope frequency.

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A RMI MODE SELECTOR PANEL
(PILOT AND COPILOT)

B RMI
(PILOT AND COPILOT)



C HORIZONTAL SITUATION
INDICATOR (TYPICAL)

D NAV MODE SELECTOR
(PILOT AND COPILOT)

E VHF NAV CONTROL
PANEL (TYPICAL)

VOR/GS Navigation System Component Location
Figure 1 (Sheet 1 of 3)

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NO	CONTROL/INDICATOR	FUNCTION
D RMI MODE SELECTOR PANEL (PILOT AND COPILOT)		
1	RMI Mode Selector	See paragraph 34-22-01
2	VOR Annunciator (VHF NAV No 1) (Green)	When illuminated, indicates reliable VOR information from VHF NAV number one is displayed by number one bearing pointer and signal has adequate strength
3	VOR Annunciator (VHF NAV No 2) (Green)	When illuminated, indicates reliable VOR information from VHF NAV number two is displayed by number two bearing pointer and signal has adequate strength
E RMI (PILOT AND COPILOT)		
4	No 1 Bearing Pointer	Indicates magnetic bearing to VOR station tuned in number one VHF NAV when respective NAV MODE selector is set to TACAN and respective RMI mode selector is set to TACAN. Stows at 3 o'clock case position when localizer is tuned. If reliable bearing signal not received or no station tuned, pointer rotates continuously.
5	No 2 Bearing Pointer	Indicates magnetic bearing to VOR station tuned in number two VHF NAV when respective NAV MODE selector is set to TACAN. Stows at 3 o'clock case position when localizer is tuned. If reliable bearing signal not received or no station tuned, pointer rotates continuously.
C HORIZONTAL SITUATION INDICATOR (TYPICAL)		
6	Glide Slope Pointer	Indicates airplane deviation from center of glide slope beam. Pointer is centered when airplane is on glide slope, deflected up when airplane is below glide slope, and deflected down when airplane is above glide slope. Pointer is in view when respective VHF NAV is tuned to localizer frequency and reliable signal is received.
7	HSI Bearing Pointer No 2	Indicates magnetic bearing to VOR station tuned in number two VHF NAV when associated NAV MODE selector is set to VOR/LOC.
8	HSI Bearing Pointer No 1	Indicates magnetic bearing to VOR station tuned in number one VHF NAV when associated NAV MODE selector is set to VOR/LOC.
9	Course Deviation Indicator (CDI)	Movable center portion of course arrow represents segment of selected VOR or localizer course when NAV MODE selector is set to VOR/LOC. Rotates with compass card. Relationship of CDI to scale shows airplane position with respect to selected course. Pilot's CDI connected to No 1 VHF NAV radio. Copilot's CDI connected to No 2 VHF NAV radio.
F NAV MODE SELECTOR (PILOT AND COPILOT)		
10	NAV MODE Selector	See paragraph 34-22-01

Figure 1 (Sheet 2 of 3)

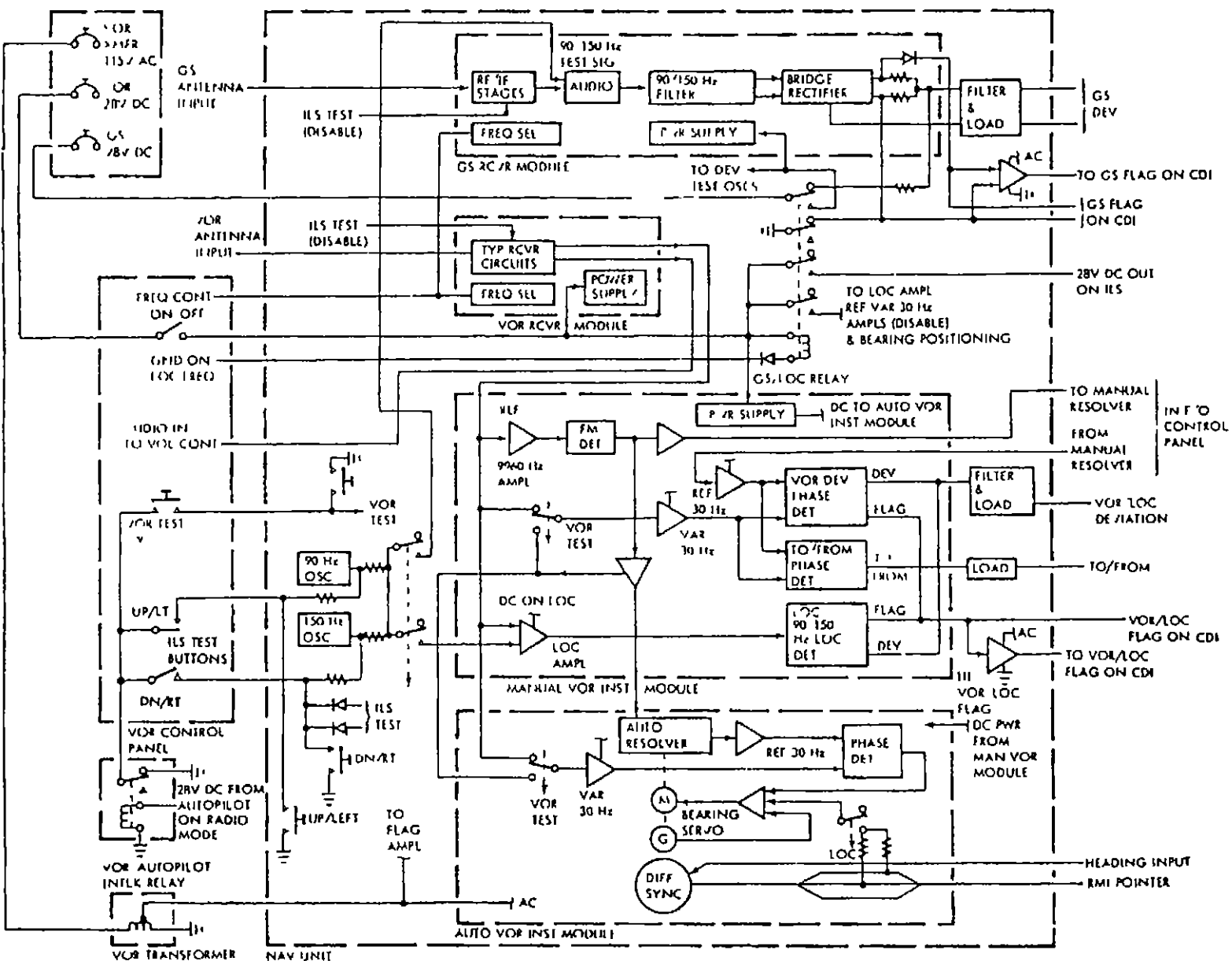
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NO	CONTROL/INDICATOR	FUNCTION
	 VHF NAV CONTROL PANEL (TYPICAL)	
11	Power control	Controls the application of power to the associated receiver and test function
12	Frequency Indicator	Displays selected frequency in MHz as set by frequency selectors
13	Megacycle control	Changes the frequency of operation in 1 MHz steps over the range of 108 00 to 117 95 MHz
14	Volume control	Varies the audio gain of the associated receiver
15	Kilocycle control	Changes frequency of operation in 50-Kc steps over the range of the control

Figure 1 (Sheet 3 of 3)

Ref. Maint Manual B 707 (34-21-01)

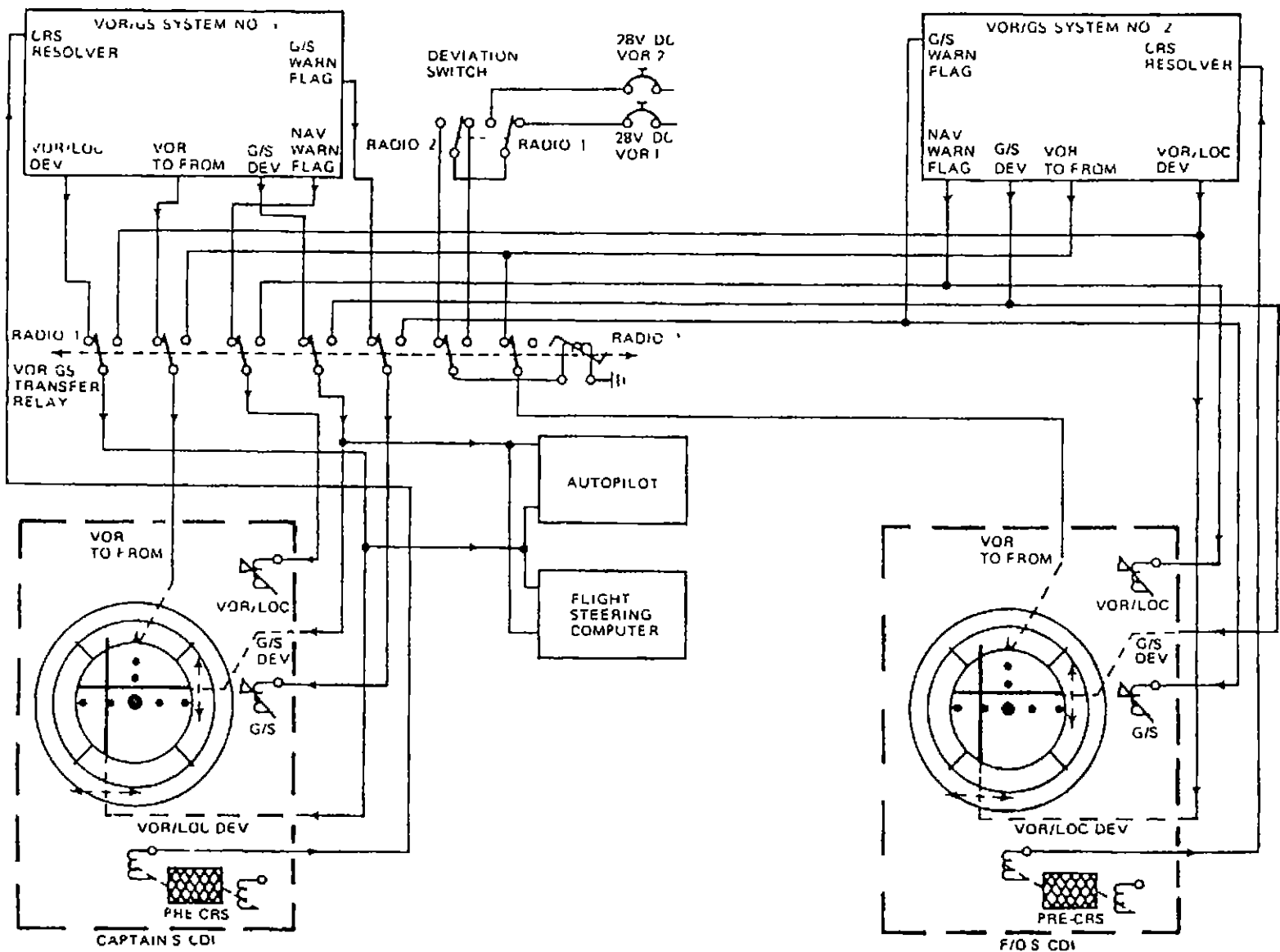


VOR/GS Navigation Unit Schematic
Figure 2

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7 Operation

- A Refer to figures 2 and 3. Frequencies in the VOR/LOC bands are selected by rotating the frequency selectors on the control panel. The audio output of the signal is available through the interphone system. Volume output is controlled through the volume control on the control panel.
- B In VOR operation, two signals (30-Hz reference and 30-Hz variable), as radiated by a VOR ground station, are fed to both the manual and automatic sections of a navigation unit. The 30-Hz reference signal is fed to both automatic and manual resolvers. The signal from each resolver is then phase compared against the 30-Hz VAR signal to produce the station bearing, VOR deviation, and TO/FROM signals. In LOC operation, the deviation signal is produced by a comparison of the amplitude difference between two tone-modulated signals (90 and 150 Hz) as radiated by a runway localizer transmitter. Portions of these signals are summed to produce the warning flag signals. The GS deviation and warning flag signals are produced in the same manner as the LOC deviation and warning flag signals.
- C In one system, for example, position of the CDI course deviation bar with respect to the miniature airplane, shows real airplane position with respect to the selected course. The course deviation dots are reference points showing airplane angular displacement from the selected course. To/from indication is shown by the TO-FROM pointer. As the airplane passes over the selected VOR ground station the pointer reverses 180 degrees.
- D Glide slope deviation information is displayed by the glide slope pointer in the CDI. The pointers remain horizontal, and move vertically across the glide slope scale to show airplane deviation from the glide path.
- E Rotation of the CDI heading select knob selects the desired VOR/LOC course through positioning of the course arrow. At the time the course arrow is positioned, the selected course is also displayed in decimal form on the course counter. The manual resolver and course select synchro are also positioned according to the course selected.
- F The VOR/LOC warning flag signal and the GS warning flag signal are fed to the flight director computer and utilized as monitoring signals by the computer warning flag circuit.



VOR/GS Navigation Switching Schematic
Figure 3

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- G When both systems are operating at the same LOC frequency, LOC and GS deviation signals, along with control signals (GS super flag and ILS 28V dc), which are used for switching, are fed to the comparator warning unit in the navigation warning system
- H In the VOR test, a VOR station is tuned in and a course of 000° is selected on the CDI. When the VOR test button is pressed, the course deviation bar centers, the FROM pointer becomes visible, and the associated RMI pointers take up a heading of 180 degrees. If the course arrow is now moved 5 degrees on either side of the selected course, the course deviation bar will deflect to the appropriate first-dot position on the course deviation scale. In an ILS test, when the UP/LT test button is pressed, the CDI course deviation bar will deflect left, and the glide slope bar will move upward. When the DN/RT button is pressed, the course deviation bar will deflect right, and the glide slope bar will move downward.

NOTE A system self-test cannot be performed if the autopilot is in a radio mode



VOR/GS NAVIGATION SYSTEMS - TROUBLE SHOOTING

1 General

- A The most effective method of trouble shooting a defective VOR navigation system is to perform the tests described in the VOR Navigation Systems - Adjustment/Tests
- B. First check for power to the defective system, and establish that power is available. Next, substitute units, or outputs of units, from the operating system where possible. After each change note whether the defective system becomes operative. If this does not clear the trouble, system wiring should be checked for continuity and the connectors for security of connection.

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VOR NAVIGATION ANTENNA - MAINTENANCE PRACTICES

1 General

- A The VOR antenna assembly panels are a part of the primary structure of the vertical fin and are not interchangeable between airplanes. The mounting holes have a close tolerance fit designated Class I. When installing a new panel, 10 holes may deviate to a Class II fit. The tolerances for these two classes of fit are given in figure 201.

2 Removal/Installation VOR Navigation Antenna

A Remove VOR Navigation Antenna

- (1) Remove screws from edge of VOR antenna (See figure 201)

CAUTION DO NOT PULL ANTENNA ASSEMBLY PANELS AWAY FROM THE VERTICAL FIN MORE THAN A FEW INCHES OR THE CO-AXIAL CABLES ATTACHED TO THEIR FORWARD EDGES WILL BE DAMAGED

- (2) Disconnect antenna feed cable and phasing cable
(3) Remove antenna

B Installation previously drilled VOR navigation antenna

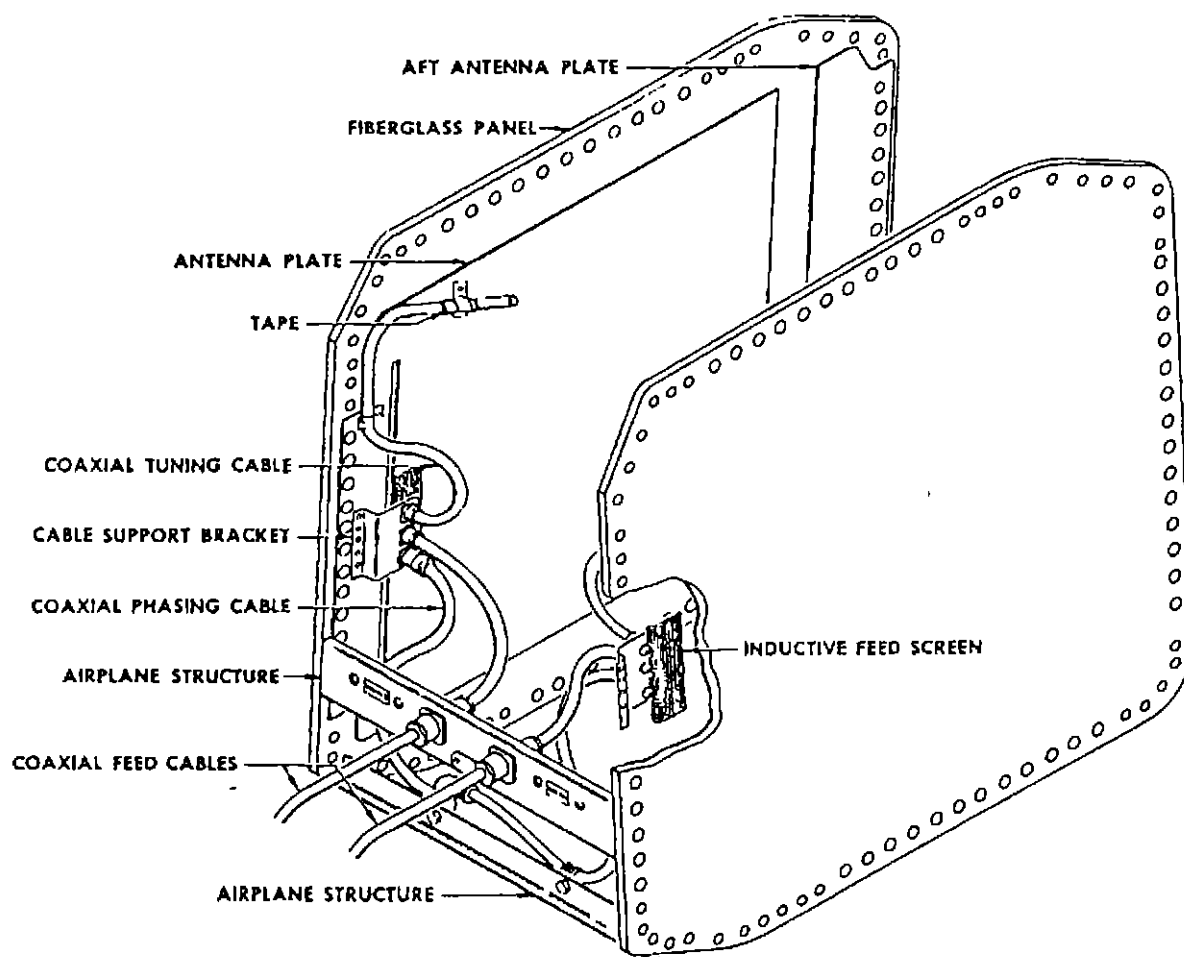
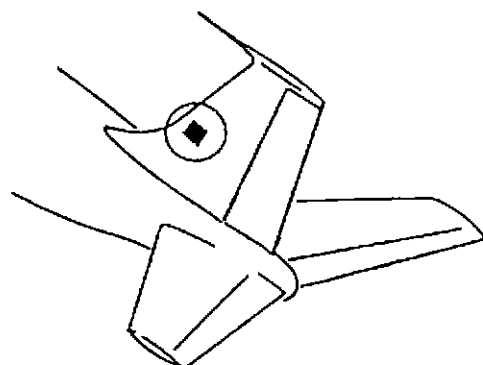
(1) General

- (a) The following installation procedure refers to a VOR antenna assembly that has been removed for inspection purposes

(2) Install VOR Navigation Antenna

- (a) Clean metal faying surfaces between antenna panel and fin structure with a suitable cleaning solvent to provide an electrical bond with a maximum resistance of 0.001 ohm
- (b) Clean fiberglass faying surfaces which contact fin structure with a suitable cleaning solvent and then protect with BMS 10-11, Type I primer per 51-2-51, Chemical and Solvent Resistant Finish - Cleaning/Painting
- (c) Apply a protective coating of BMS 3-23 corrosion preventive compound to mating surfaces of antenna and airplane structure per 51-2-151, Water Displacing Corrosion Inhibiting Compound - Cleaning/Painting
- (d) Hold antenna in approximate mounting position and connect antenna feed cables and phasing cable
- (e) Insert antenna in cutout and install mounting screws. See Fig. 201 for screw location diagram.

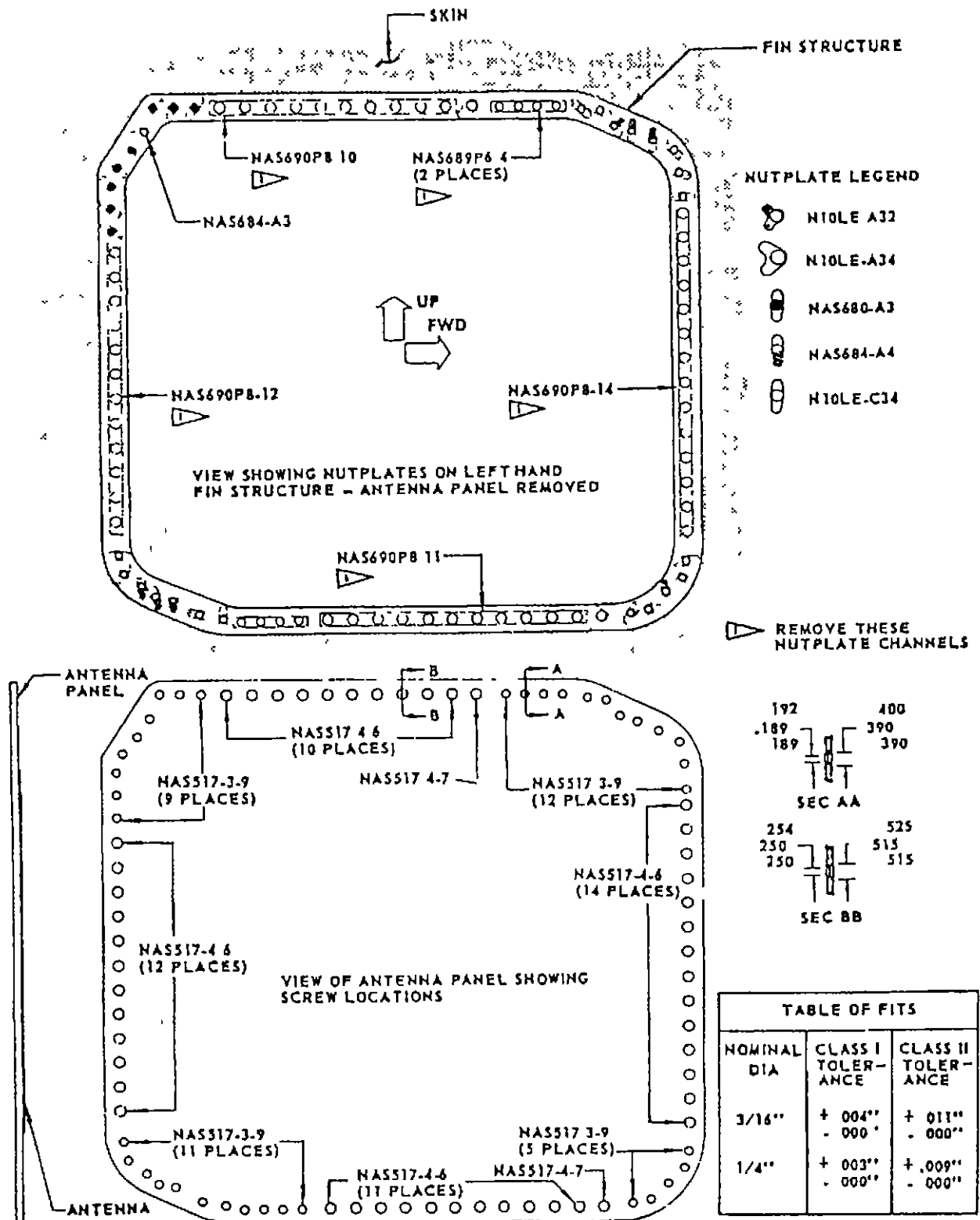
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VOR Navigation Antenna Installation
Figure 201 (Sheet 1 of 2)

Ref Maint Manual B 707 (34-21-01)

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VOR Navigation Antenna Installation
Figure 201 (Sheet 2 of 2)

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C. Installation Undrilled VOR Navigation Antenna

(1) General

- (a) The following installation procedure refers to a new VOR antenna assembly that is undrilled

(2) Equipment and Materials

- (a) Two drill bushings (to protect the 1/4 dia and 3/16 dia mounting holes in the fin structure)
- (b) Two reamers (to size the mounting holes in the antenna panel)
- (c) 100° Countersink
- (d) Sealant No 1 made from 100 parts Epon 828 resin and from 15 to 25 parts curing agent "T" (Shell Chemical Corp, 100 Bush Street, San Francisco 6, Calif) or sealant No 2 made from 100 parts Paraplex P43 resin (Rohm and Haas Co, Philadelphia, Pa), 2 parts ATC paste catalyst (Lucidol Div, Wallace and Tiernan Inc, Buffalo, N Y) and 4 parts solvent (5 % diethylaniline, 95 % styrene)

(3) Install VOR navigation antenna

- (a) If necessary file edge of antenna panel to clear edge of adjoining fin structure. Maximum allowable gap between antenna panel and fin structure is 0.06 inch
- (b) Remove opposite antenna panel per paragraph 2 A
- (c) Remove channel nut plates from fin structure (For removal of rivets, see Structural Repair Manual, 51-2-2)
- (d) Remove one rivet from each single nut plate and swing nut plate to expose mounting hole in fin structure
- (e) Drill four 1/4 inch dia mounting holes to a Class II fit (figure 201) in the antenna panel, one each at the top, bottom and sides of the panel. Temporarily secure panel to fin structure with clico fasteners or equivalent
- (f) Using appropriate bushings, back drill panel
- (g) Remove antenna panel

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- (h) Ream and countersink holes in antenna panel to dimensions for Class I fit as shown in Sec AA and Sec BB, figure 201
- (i) Seal holes and filed edges of antenna panel with sealant, wiping off excess sealant Sealant No 1 with 25 parts of curing agent has a work life of approximately 15 mins at 70°F To increase work life curing agent may be reduced
- (j) Cure sealant No 1 at 70°F for three hours with 25 parts of curing agent or 12 hours with 15 parts of curing agent Cure sealant No 2 at 100°F for one hour
- (k) Rerivet nut plates and nut plate channels
- (l) Reinstall opposite antenna panel per paragraph 2 B
- (m) Reinstall new antenna panel per paragraph 2 B.



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VOR/GS NAVIGATION SYSTEMS - ADJUSTMENT/TEST

1 Test VOR/GS Navigation Systems

A Equipment and Materials

- (1) Signal Generator - Collins Type 479T-2 or equivalent

B Prepare to Test VOR/GS Systems

- (1) Provide electrical power
- (2) Check that essential flight instrument bus, flight instrument bus N° 2, essential radio bus and radio bus N° 2 circuit breakers for compass, interphone, VOR/GS navigation, flight director, and flight instrument systems are closed
- (3) With both systems ON, place signal generator approximately 75 feet from VOR antenna
- (4) Operate signal generator to supply maximum RF output with audio modulation of approximately 1000 Hz
- (5) With pilot's NAV mode selector in VOR/LOC, select either 108.00 MHz for VOR tests or 108.1 MHz for LOC tests (VHF NAV switches on audio selector panels should be placed in ON position) Audio tone should not be available when signal generator and receiver are at different frequencies
- (6) Repeat above step using No. 2 navigation system
- (7) Repeat step (5) with co-pilot's NAV mode selector in VOR/LOC

C Check LOC Function.

- (1) Set signal generator for maximum localizer output.
- (2) Select ON COURSE output at signal generator
- (3) Tune No. 1 system to 108.1 MHz.
- (4) Rotate course selector on captain's CDI to bring course arrow in line with lubber line at top of indicator

Ref. Maint. Manual B.707 (34-21-01)



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- (5) Check that course deviation bar in pilot's CDJ is centered, and VOR/LOC flag is out of view. Observe that single pointer in RMI's point right (relative east)
- (6) Press UP/LT test button on captain's VHF navigation control panel. Check that course deviation bar in captain's CDI deflects left.
- (7) Press DN/RT test button. Check that course deviation bar deflects right.
- (8) Repeat steps (3) through (8) for No 2 navigation system. Observe double pointers in RMI's.
- (9) Repeat steps (3) through (7) co-pilot's NAV mode selector in VOR / LOC position.

D Check VOR Function

- (1) To test the HSI bearing pointers, ensure both NAV MODE selectors are set to VOR / LOC before proceeding with test. To test the RMI's bearing pointer ensure both RMI mode selectors are set to TACAN / VOR before proceeding with test.
- (2) Set signal generator for maximum VOR output on omniradial 000 degrees.

NOTE Omniradial specifically means the signal as it exists along a line in a magnetic direction from the station as specified by the number of the radial. (For example, 0 degree radial is north of the station, and 90 degree radial is east of the station.)
- (3) Tune No 1 navigation system to signal generator frequency 108.0 MHz. Compass system need not be operating but must indicate a heading of 000 degrees.
- (4) Observe single pointers in RMI's. Observe that pointers indicate 180 degrees magnetic bearing within 3 degrees.
- (5) Turn course selector on pilot's CDI until course deviation bar is centered. Check that course counter reads 000 (+ 2) degrees. Carriage on which course deviation bar is mounted should be in a position such that course deviation bar is parallel to the single pointers in RMI's.
- (6) Rotate course selector until course deviation bar is over second left dot. Check that course counter reads 350 (+ 4) degrees.
- (7) Rotate course selector until course deviation bar is over second right dot. Check that course counter reads 010 (+ 4) degrees.

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- (8) Rotate course selector until course counter reads 000 degrees
- (9) Set signal generator to transmit 315 degrees omniradial
- (10) Observe single pointers in RMI's. Check that pointers indicate 135 degrees magnetic bearing within 3 degrees. Observe that course deviation bar is deflected full scale right and FROM pointer is visible
- (11) Repeat steps (9) and (10) for left deflection. In step (9) select 45 degrees omniradial. Check that VOR NO 1 needle indicates 225 (± 3) degrees.
- (12) Repeat steps (3) through (11) for No 2 navigation system. Observe double pointers in RMI's
- (13) Repeat steps (3) through (11) for co-pilot's instruments

E Check VOR Test Function

- 1 Set 000 in course selector windows on pilots HSI's
- 2 Set NAV MODE selectors to VOR / LOC for HSI test or TACAN for RMI test
- 3 Set NAV control panel OFF/PWR/TEST to TEST and hold HSI NAV flag in view for up 9 seconds. Then course deviation bar centers and RMI bearing pointer indicates 180 degrees. After 23 seconds with OFF/ PWR/TEST in TEST, HSI NAV flag return to view
- 4 Release the VOR test button. HSI's or RMI's return to pretest condition

F Check GS Function

- (1) Place signal generator approximately 50 feet from glide slope antenna and operate generator. Antenna should be connected to GS connector, retracted and positioned at right angles to the longitudinal axis of the airplane
- (2) Tune No 1 system to 108.1 MHz and signal generator to 334.7 MHz
- (3) Set NAV-GS control on generator to GS and audio selector to GS. Press DN/RT test button on captain's VHF navigation control panel. Check that glide slope pointer in captain's CDI defelects downward

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- (4) Press UP/LT button. Check that G/S pointer deflects upward
- (5) Turn off glide slope carrier Check that GS flag appears in view
- (6) Repeat steps (2) through (5) for No 2 navigation system
- (7) Repeat steps (2) through (5) with for co-pilot's instruments
- (8) Tune both systems to VOR frequency Check that glide slope pointers and warning flags go out of view
- (9) If no longer required, remove electrical power from airplane

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GROUND PROXIMITY WARNING SYSTEM-- DESCRIPTION AND OPERATION

1 General

- A The ground proximity warning system (GPWS) provides the pilots with aural and visual warning of potentially dangerous flight paths relative to the ground. The GPWS processes radio altitude information from the No. 1 low range radio altimeter (LRRRA), altitude rate information from the BARO unit and landing gear and landing flap position signals to provide warnings of the following hazards:
- (1) Excessive rate of descent
 - (2) Level flight or too shallow climb towards rising terrain
 - (3) Altitude loss after takeoff
 - (4) Unsafe terrain clearance
- B The GPWS consists of a ground proximity computer, two warning lights labeled GPWS/GPWS TEST, a warning speaker, GPWS flap logic switch (only on S/N 19997 and 20000). Equipment location is shown in Fig. 1, 2, 3, 4.
- C Primary power for the system is 115 volts ac supplied from the essential radio bus in panel P5 through a circuit breaker labeled GROUND PROXIMITY WARN, and from the 28 DC essential bus breaker located on P5 panel.
- D 26 volts ac is also received from the central air data system as a reference voltage for the altitude rate circuits.

2 Computer

- A The ground proximity warning computer (GPWC) and BARO unit are rack-mounted on shelf No. 2 RH electronic equipment rack. The GPWC consists of a logic and power supply module, a comparator and closure warning module and an audio module. A power transformer and an interference capacitor are also mounted in the rear of the chassis above the electrical connector. In addition, a test switch, master annunciators, reset switch, and fault indicators are installed on the front panel.
- B The functions and displays of the indicators and switches are as follows:
- (1) The four magnetic latching annunciators, labeled HI SINK, TAKE OFF, GEAR/FLAP, will change from black to white color when modes 1, 2, 3, 4, warnings are activated, respectively.
 - (2) The WARNING MODE RESET switch may be pressed to reset the magnetic latching mode annunciators from white to black.
 - (3) The SELF-TEST switch permits a system confidence check when pressed.
 - (4) The red fault indicators, labeled RADIO ALT, GEAR, AIR DATA, FLAP DN, will come on for one second when the SELF-TEST switch is pressed. If the indicator comes on again when the TEST switch is pressed, a circuit failure that indicated by the indicator may have occurred. The Green GPWC OK indicator light comes on when warning modes 1, 2, 3, and 4 are tested satisfactorily.

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GPWS
 GPWS TEST

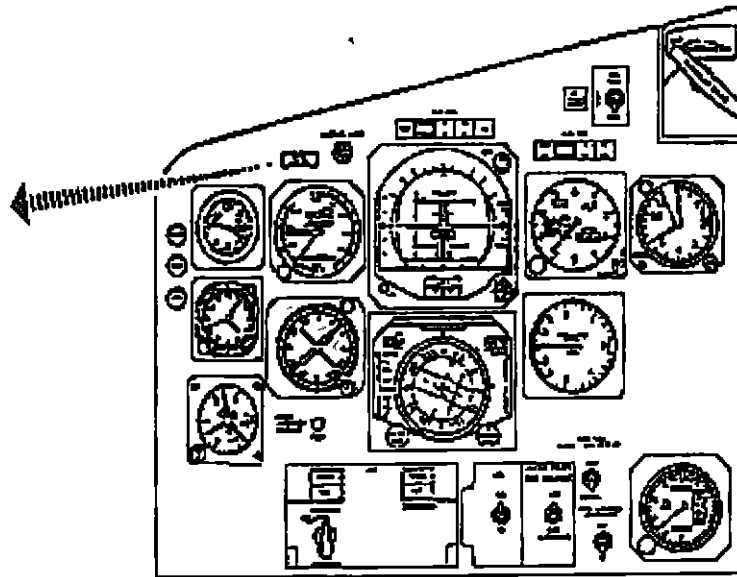


Fig 1 pilot's instrument panel

GPWS
 GPWS TEST

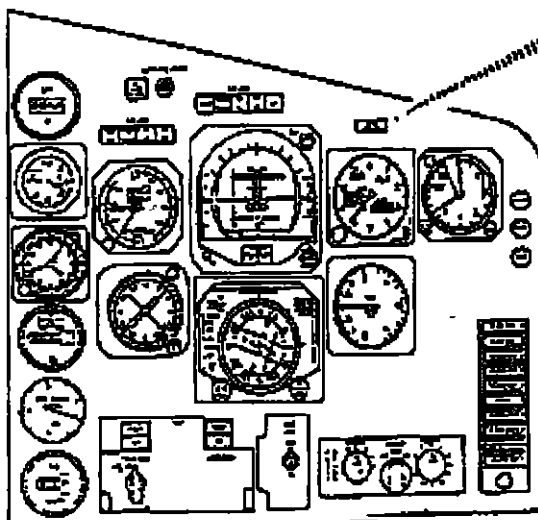
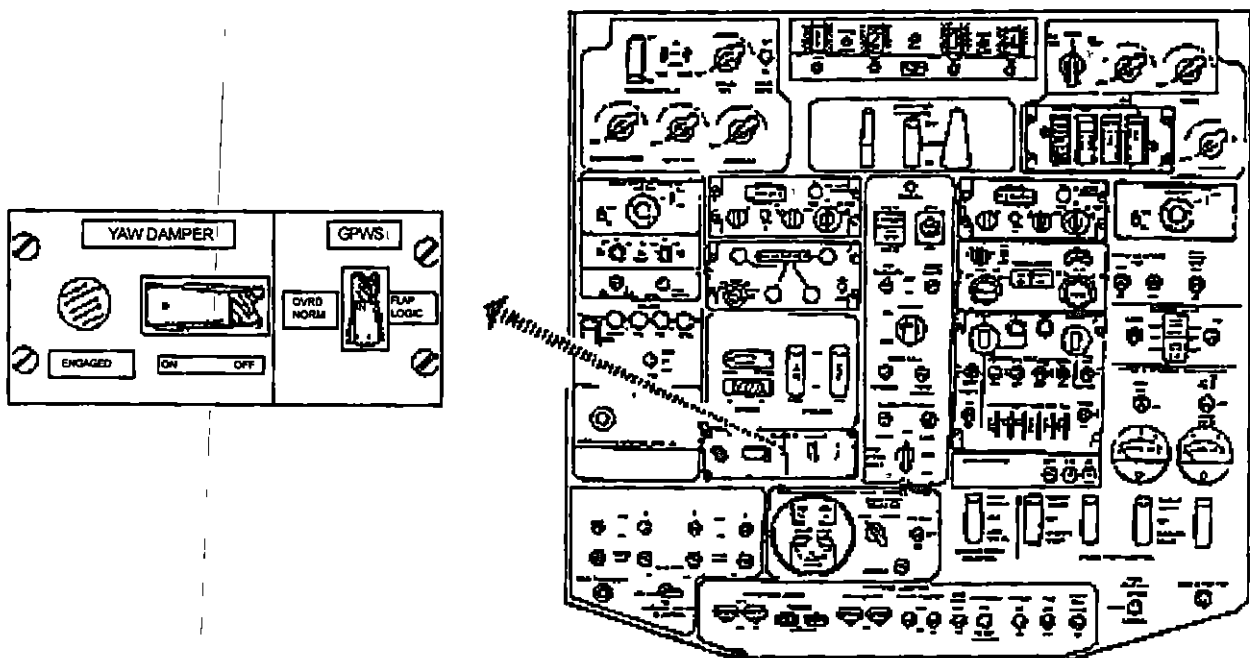


Fig 2 co-pilot's instruments panel

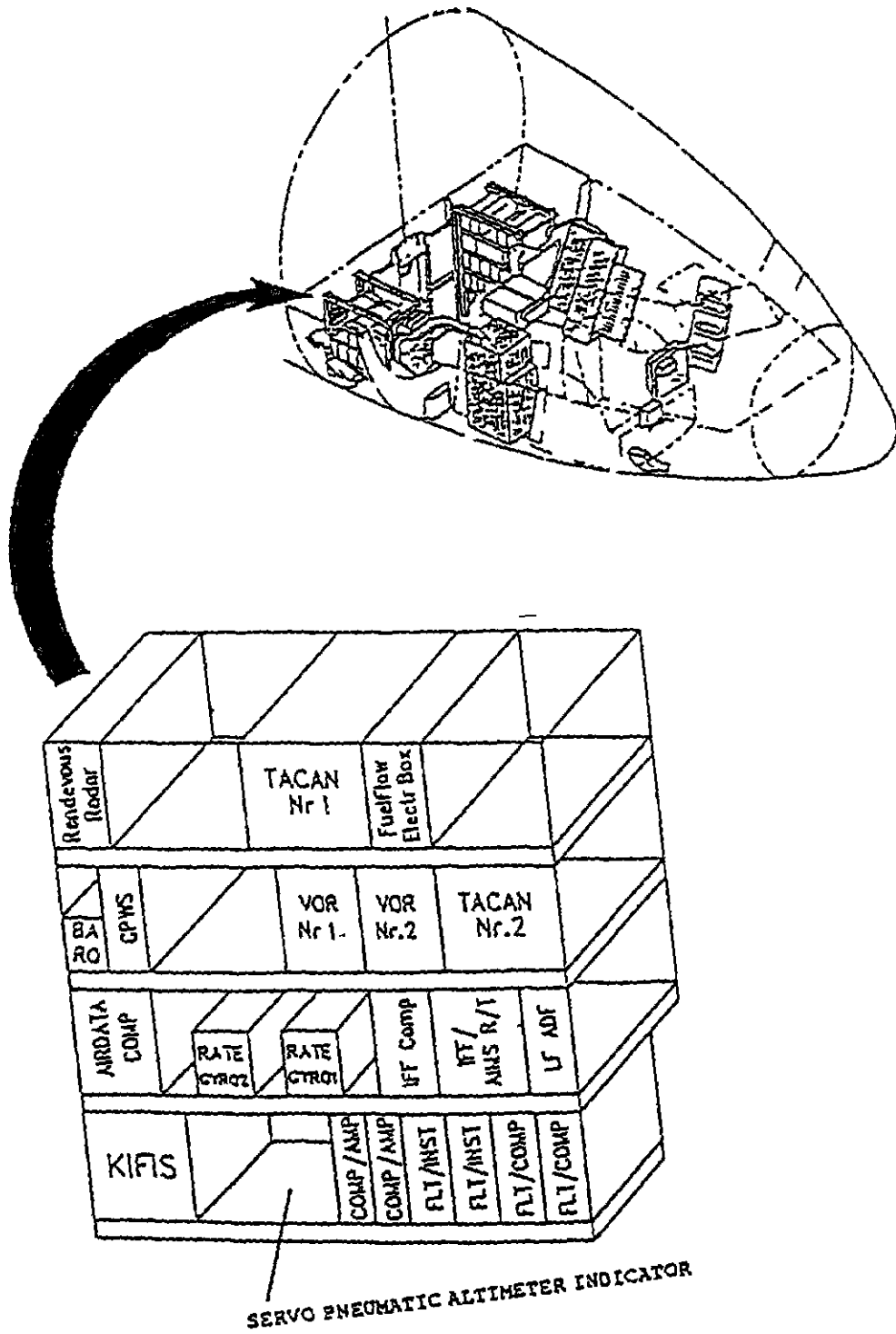
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(* = only on S/N 19997 and 20000)

Figure 3 . Pilot's overhead panel

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RH Radio Rack
 Figure 4

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3 GPWS Warning Lights

- A A rectangular shaped red warning light labeled GPWS/GPWS TEST is installed on each pilot's flight instrument panel. The light has a press-to-test feature which is actuated by pushing on the lens cover. Access to the bulbs and a fuse within the light assembly is provided by removing the lens cover.
- B The Lights come on to provide a visual indication that the GPWC has generated a warning of an unsafe flight path.

4 Warning Speaker

- A A warning speaker is installed at the flight engineer station. The speaker provides an aural indication that the GPWC has generated a warning of an unsafe flight path.

5 GPWS Flap Logic Switch (only on S/N 19997 and 20000)

This switch is located on the pilot's overhead panel. When placed in the over-ride (OVRD) position it allows the use of the GPWS, even with a flap selection less than 33°.

6 Operation

- A The GPWS is operational when essential radio busses 28 VDC/115 AC are energized and the GPWS, and LRRA circuit breakers are closed.
- B Signal inputs to the GPWC consist of radio altitude information from LRRA No 1 and altitude rate information. The radio altitude signal is a dc voltage which is a function of airplane height above ground level and is useful to approximately 2500 feet. The barometric rate signal is ac with a scale of 2500 mv/1000 fpm altitude change. See GPWS warning curves Figure 4, page 6.
- C Binary inputs to the GPWC consist of a landing gear and landing flap position signal and 28-volt dc radio altimeter valid, glide slope valid, and air data computer valid signals. The landing gear position signal is open when the landing gear is in any position other than down and locked on ground potential when the landing gear is down and locked. The landing flap position signal is ground potential when the flaps are less than 30 degrees, and open when the flaps are extended more than 30 degrees.

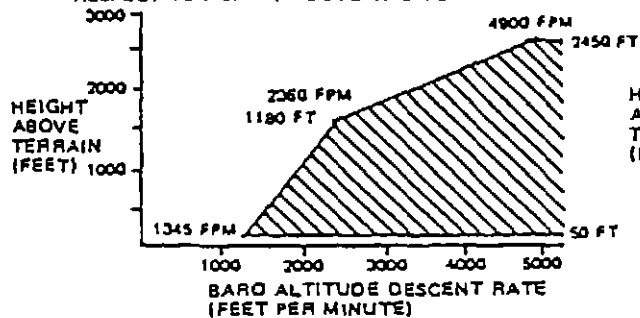
NOTE On aircraft S/N 19997 and 20000 only.

By placing the GPWS flap logic switch in the OVRD-position, the landing flap position signal is open even with the flaps extended less than 33 degrees.

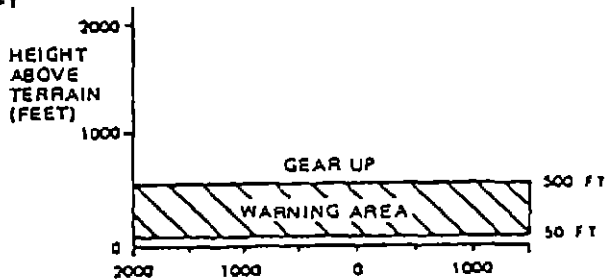
- D The GPWC processes the input signals to provide warning outputs during the following flight conditions:
 - (1) Excessive sink rate warning (Mode 1)
 - (a) The barometric sink rate and the 2400-foot radius altitude detector signal to switch the gate on and indicate excessive sink rate.

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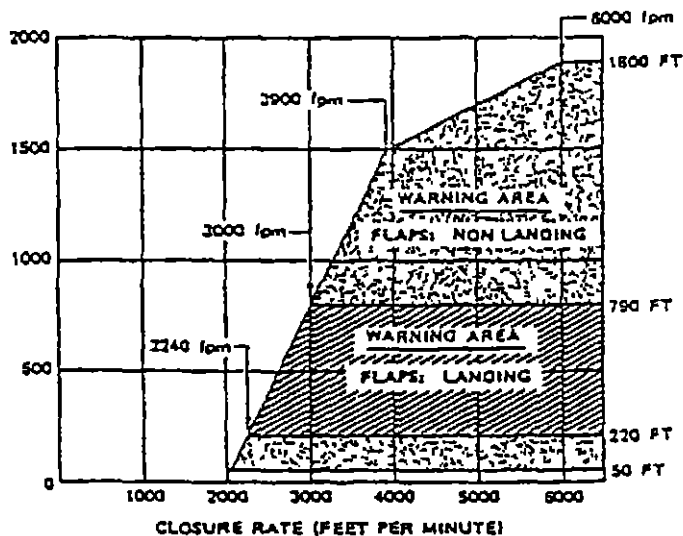
EXCESSIVE BARO ALTITUDE RATE OF DESCENT WITH RESPECT TO HEIGHT ABOVE THE TERRAIN



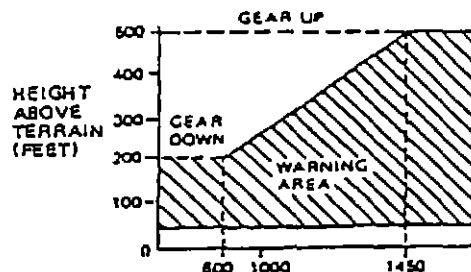
EXCESSIVE SINK RATE
MODE 1



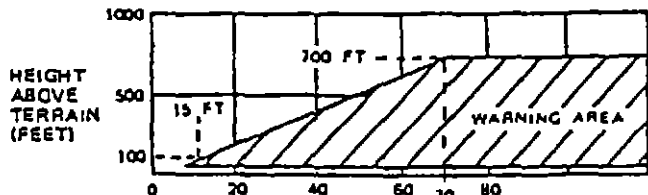
UNSAFE TERRAIN CLEARANCE
MODE 4A



CLOSURE WARNING
MODE 2



UNSAFE TERRAIN CLEARANCE
MODE 4B



NEGATIVE CLIMB RATE
MODE 3

Ground Proximity Warning Curves
Figure 4



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- (b) The system provides a minimum warning time of approximately 30 seconds at radio altitude between 2450 and 1180 feet prior to predicted terrain impact. Less warning time is provided below 1180 feet of radio altitude.
- (2) Closure warning (Mode 2)
 - (a) The terrain closure rate detector combines the output of the radio altitude linerized, flap logic and the unsafe descent rate to provide a warning as shown in the curve.
- (3) Takeoff altitude loss warning (Mode 3)
 - (a) A warning is provided when the airplane is at a less than 700-foot terrain clearance, landing gear or flaps up in takeoff/landing mode, and a barometric altitude loss is detected. The altitude loss required to activate the GPWS warning varies with the height of the airplane above the ground at the time of inadvertent descent occurs. At a climbout altitude of 100 feet, any loss of altitude will activate the warning. At 700 feet, an altitude loss of 70 feet will activate the warning.
 - (b) The flip flop is set to takeoff/landing mode when the radio altitude is less than 700 feet, with landing gears down and flaps down.
- (4) Unsafe terrain clearance warning (Mode 4)
 - (a) A warning is provided when the airplane is in cruise mode 500 feet with gears up, or in cruise mode with gears down, flaps up between 200 and 500 feet of radio altitude and unsafe descent rate is detected, or in cruise mode at a radio altitude below 200 feet with gears down and flaps not in landing range.
 - (b) The flip-flop is set to cruise mode when the radio altitude is greater than 700 feet. In the event of missed approach, the flip-flop is set to the takeoff (mode 3) warning within 2 seconds to flap lever being moved out of the landing range.
- E The GPWC warning output provides an aural warning WHOOP-WHOOP PULL UP broadcast over the warning speaker, and illuminates the GPWS warning light on the pilot's instrument panels.
- F System self-test may be initiated by pressing either of the GPWS warning lights for test purposes. During self-test, the GPWS light comes on, and the aural warning consists of WHOOP-WHOOP PULL UP, broadcast over the warning speaker.
- G Self-test may also be initiated by means of the test switch in front of the computer. Pressing the test switch will turn on the visual and aural warning as described in step F., except that the aural warnings come on at a reduced level. The fault indicator lamps on the computer come on flashing momentarily indicating signals are valid, and the mode annunciators on the computer will display white as each mode is exercised and checked. The GPWC OK light comes on momentarily when all modes are valid. The annunciators may be reset manually by means of the RESET switch on the computer or automatically when the radio altitude is greater than 50 feet.



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GROUND PROXIMITY WARNING SYSTEM - TROUBLE SHOOTING

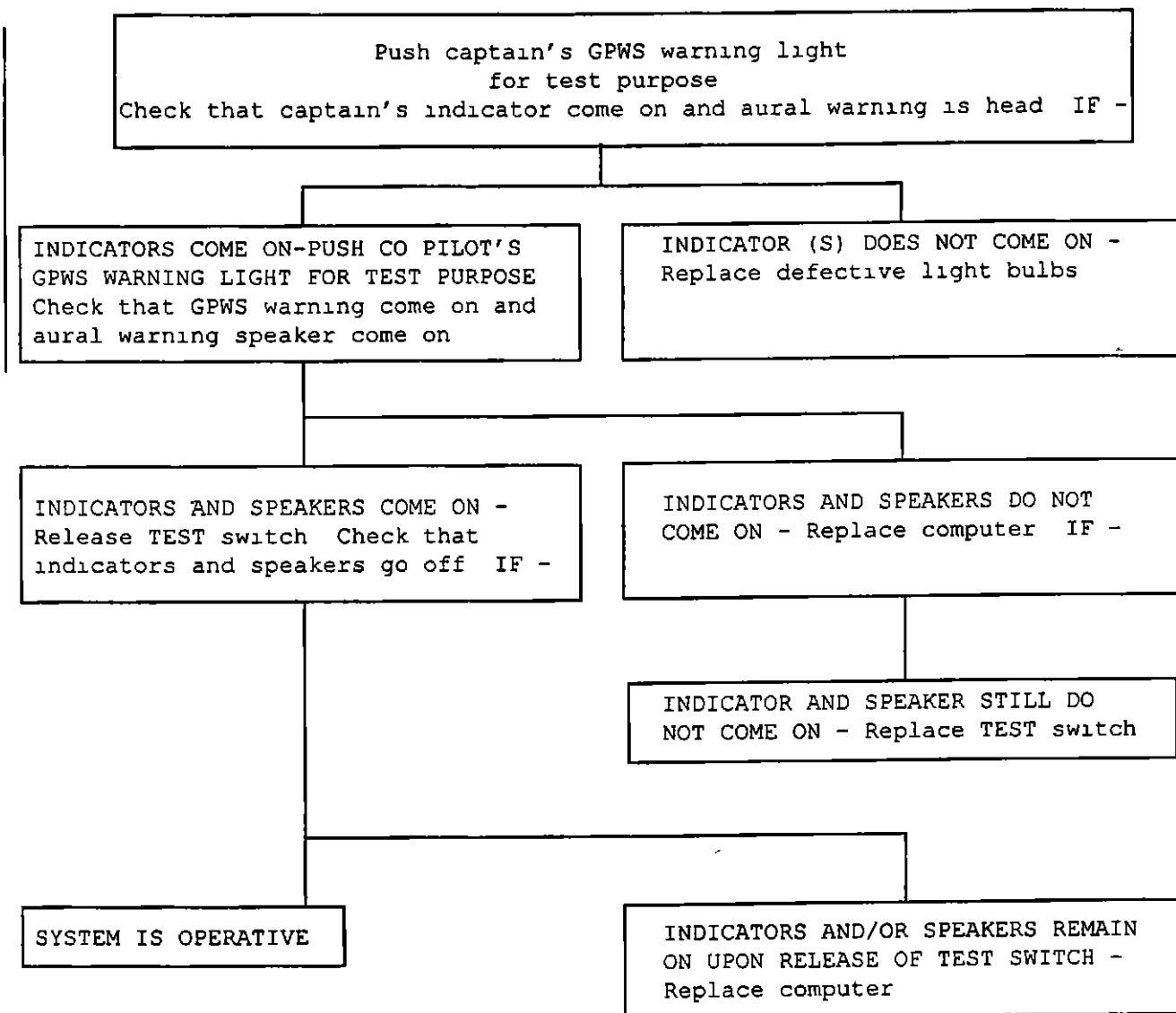
1 General

- A The following trouble shooting procedures are based on performance of the system operational test and are presented in tree-type format. The test steps (heavy-line boxes) are connected by shaded arrows to show the OK condition path. When all steps in the OK condition path check out, the system is operable.
- B When a test step does not check out, follow the NOT OK line to the box containing the trouble symptom. Turn to the procedure indicated and continue to follow a single line by analyzing the results of each test step until the required corrective action is determined. Perform the specified corrective action; then repeat the step at which the failure was encountered.
- C All trouble shooting procedures are based on the assumption that wiring is OK and that electrical power is available. If the corrective action in the procedure does not correct the problem, check wiring using the wiring diagram.

2 Prepare for Trouble shooting

- A Verify that GPWS, Low Range Altm No 1 circuit breakers are closed.
- B Provide electrical power.
- C Verify that failure warning flag in captain's height indicator and altimeter are not in view.

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NOTE The GPWS aural warning consist of two cycles of tone increasing in volume and frequency (400 to 800 HZ) followed by voice warning FULL UP



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GROUND PROXIMITY WARNING SYSTEM - ADJUSTMENT/TEST

1 Test Ground Proximity Warning System

A Equipment and Materials

(1) Pitot static test set with hoses and adapters adequate for connection to captain's pitot static system.

(2) Radio altimeter test set (simulator)

B Prepare to Test

(1) Verify that GPWS Low Range Altm No 1 circuit breakers are closed

(2) Verify that failure flags on captain's and first officer's radio altimeter indicators are not in view, and altitude pointers indicate 0 to -10 feet

(3) Verify that both ground proximity warning indicators are off

(4) Install ground lock pins in landing gear The landing gear hydraulic systems must be off

WARNING THIS MUST BE ACCOMPLISHED BEFORE OPERATING LANDING GEAR LEVER

(5) Activate electrical drive for flap system (Ref Chapter 27)

WARNING ENSURE THAT NO PERSONNEL ARE WORKING ON OR NEAR FLAP SYSTEM OR INJURIES TO PERSONNEL MAY RESULT

(6) Set landing flaps to UP position

(7) Connect pressure source to pitot static systems that provides information to BARO unit

(8) Connect radio altimeter simulator to radio altimeter receiver/transmitter.

C System Self-Test

(1) Push pilot's and co pilot's GPWS warning lights

(2) Check that lights come on and that loud aural warning consist of WHOOP-WHOOP PULL UP occur

NOTE The WHOOP-WHOOP PULL UP aural warning may repeat up to 7 times

(3) Release warning lights, check that all GPWS indicators go off.

D System Test

(1) Test Take Off Altitude Loss Warning

NOTE GPWS warning referred to from here on consists of GPWS indicator lights and WHOOP-WHOOP PULL UP aural warning

- (a) Using radio altimeter test set, simulate a radio altitude of 0 feet, then to 400 feet
- (b) Pull landing gear override trigger and set landing gear lever to OFF position
- (c) Using pitot static test set, set an altitude of 600 feet. Simulate a barometric sink rate of 500 feet per minute. Check that GPWS warning comes on between 4 to 9 seconds from start of sink rate simulation

NOTE Stop watch should be used to check the time requirement

- (d) Increase radio altitude to 750 feet. Check that GPWS warning goes off

(2) Test Excessive Sink Rate warning

- (a) Simulate a radio altitude of approximately 1500 feet and a barometric altitude of 10,000 feet
- (b) Simulate a barometric sink rate of 4500 feet per minute. Check that GPWS warning comes on
- (c) Return barometric altitude to 10,000 feet and simulate a radio altitude of 1500 feet. Check that GPWS warning goes off when above conditions are established
- (d) Simulate a barometric sink rate of 3200 feet per minute. Check that GPWS warning comes on
- (e) Adjust barometric sink rate to 2500 feet per minute. Check that GPWS warning goes out
- (f) Return barometric altitude to 10,000 feet, and simulate a radio altitude of 600 feet. Check that no warning occurs
- (g) Simulate a barometric sink rate of 2000 feet per minute. Check that GPWS warning comes on
- (h) Adjust barometric sink rate to 1500 feet per minute. Check that GPWS warning goes off

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(3) Test Closure Warning

- (a) Set barometric altitude to 5000 feet and radio altitude to 2000 feet
- (b) Gradually reduce simulated radio altitude from 2000 feet to 0 feet in approximately 30 seconds. Check that GPWS warning comes on when radio altitude reaches below 1500 feet

(4) Test Descent in Wrong Configuration

- (a) Set flaps to 10 degrees and landing gear lever to UP position
- (b) Simulate a 750 feet radio altitude
- (c) Slowly reduce radio altitude at a rate not greater than 1000 feet per minute to 400 feet. Check that GPWS warning comes on
- (d) Set landing gear lever to ON position. Check that GPWS warning goes off
- (e) Slowly reduce radio altitude to 180 feet. Check that GPWS warning comes on
- (f) Set flaps to 30 degrees. Check that GPWS warning goes off

* The following steps are to be performed on aircraft
S/N 19997 and 20000 only

- (g) Increase radio altitude to 750 feet
Set GPWS flaps logic switch in OVRD-position and flaps to 10 degrees. Check that no warning occurs
- (h) Slowly reduce radio altitude to 180 feet. Check that no warning occurs
- (i) Set GPWS flap logic switch back in NORM-position
Check that GPWS warning comes on

(5) Restore airplane to normal

- (a) Slowly relieve pitot static system and remove test adapters
- (b) Return flap system to normal
- (c) Reset radio altitude to normal and disconnect test simulator
- (d) If no longer required, remove electrical power



MAINTENANCE MANUAL

ACAS II SYSTEM - DESCRIPTION AND OPERATION

1. General

Mode S is a cooperative surveillance and communication system for air traffic control. It employs ground-based sensors (interrogators) and airborne transponders. Ground-air-ground data link communications can be accommodated integrally with the surveillance interrogation and replies. Mode S interrogators provide surveillance of both Air Traffic Control Radar Beacon system (ATCRBS) equipped aircraft and of aircraft equipped with Mode S transponder equipment. A principle feature of Mode S that differs from ATCRBS is that each aircraft is assigned a unique address code. Using this address code, interrogations can be directed to a particular aircraft, and replies unambiguously identified.

The Mode S data link capability allows it to serve as an essential element of the airborne collision avoidance system (ACAS II), which is a system designed to provide vertical airborne separation assurance, or collision avoidance. The system does this by maintaining a surveillance area around the aircraft, through use of replies received from other aircraft transponders. The system maintains surveillance within a sphere determined by the transmit power and receiver sensitivity of the ACAS R/T. The area in which a threat is imminent depends on the closing speed and path of both aircraft.

The ACAS II system is capable of providing resolution advisories to the flight crew, allowing the pilots to avoid other aircraft equipped with either ATCRBS, or Mode S altitude reporting transponders. The system installed in the NTCA enables up to a maximum of 8 intruder aircraft to be visually tracked and displayed on Vertical Speed Indicators whose central area, when the ACAS mode of operation is selected, functions as a display screen for visual presentation of the ACAS traffic scenario.

2. System description

The ACAS II system comprises the following equipment:

STR 2000-A1 is the Mode S/IFF transponder system which is installed in the lower 41 RH radio rack. The transponder is interfaced to:

- The ADCs, from which own aircraft uncorrected barometric altitude is derived
- TTR-921 TCAS transmitter-receiver
- D-band suppression system linking TACAN; ACAS and transponder together
- Two omni-directional antennas located on the upper and lower fuselage surfaces
- KIT-1C/TSEC, for IFF Mode 4 capability.

MAINTENANCE MANUAL

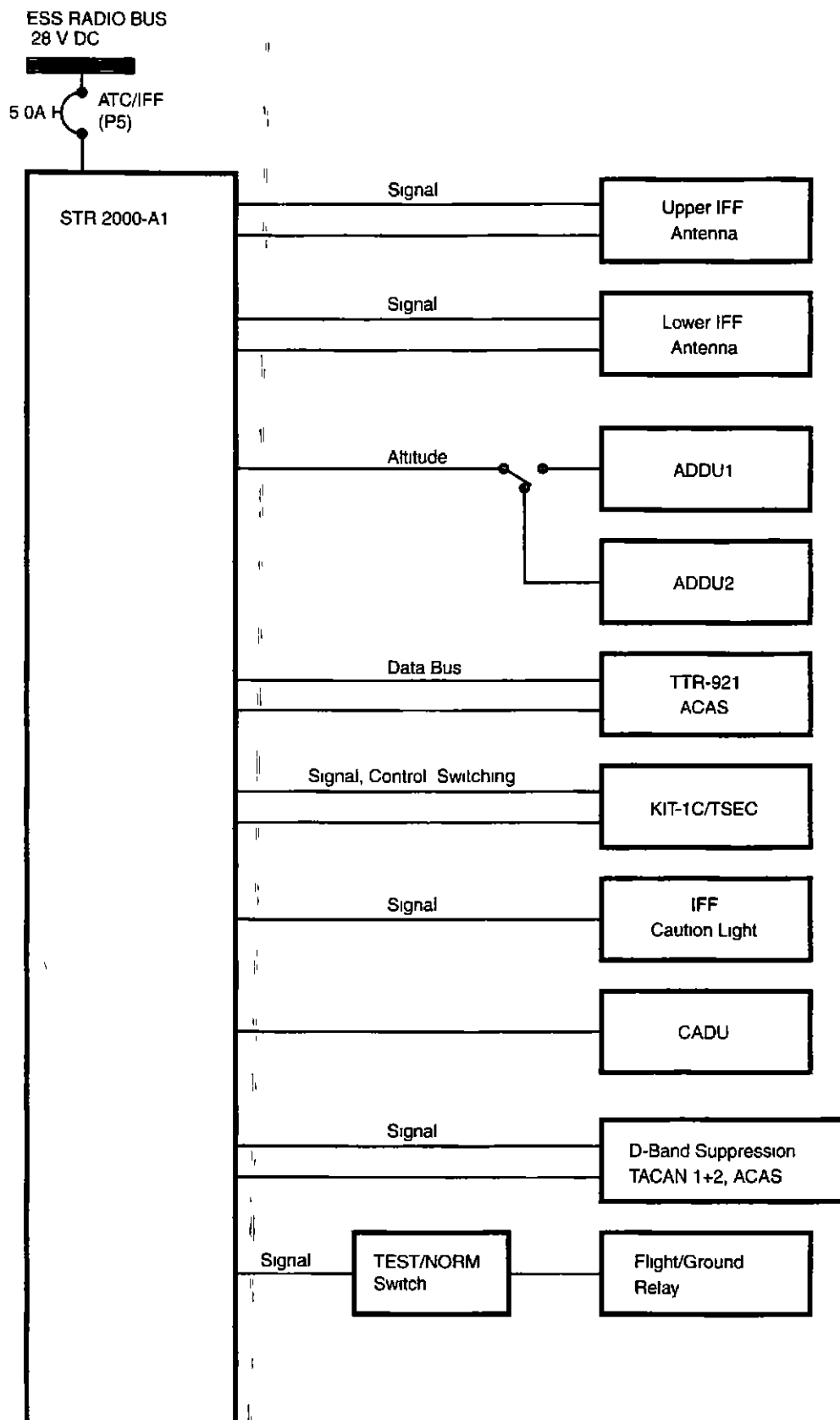
Figure 1 illustrates STR 2000-A1 electrical configuration.

- Lower and upper IFF antenna.
- Arinc 429 Air data input from the ADDU with the ADC selected switch the source to the STR2000-A1 can be selected.
- Arinc 429 interface with ACAS computer. D-band suppression.
- Provisions for the installation of a Kit-IC/TSEC cryptographic unit for Mode 4 when implemented.
- IFF caution light (Mode 4). Flight ground test switch.
- CADU for selection of the various transponder modes.
- STR 2000-A1.
- IFF caution light (Mode 4). Flight ground test switch.
- D-band suppression system linking TACAN; ACAS and transponder together.

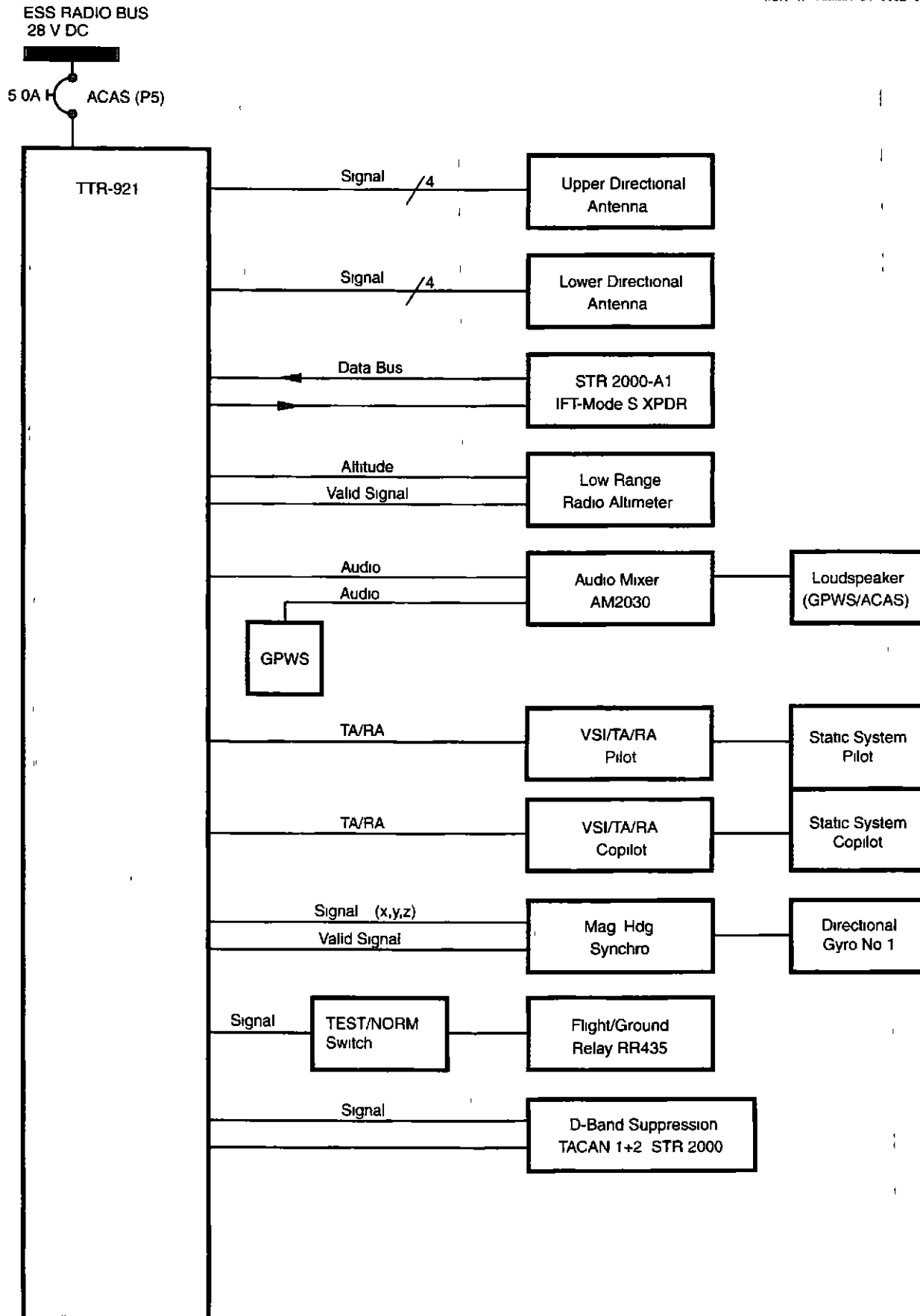
Figure 2 illustrates the ACAS II electrical configuration.

- Lower and upper ACAS antenna.
- Arinc 429 interface with STR2000-A1 transponder.
- Gyrosyn No. 1 from which it derives heading data.
- VSI/TA/RA No. 1 for the display of ACAS II traffic scenarios and vertical manoeuvre advisories for the pilot.
- VSI/TA/RA No. 2 for the display of ACAS II traffic scenarios and vertical manoeuvre advisories for the copilot.
- Cockpit located loudspeaker, via which aural traffic warnings are communicated to the flight crew.
- D-band suppression system linking TACAN; ACAS and transponder together.
- Low range radio altimeter (LRRA) No. 1, from which absolute altitude is provided to TTR-921 for the inhibit of certain ACAS features at lower levels.
- Two directional antennas located on the upper and lower fuselage surfaces which provide ACAS with intruder aircraft positional (bearing) data relative to own aircraft position.

TTR-921 is the principle ACAS II unit and is installed in the lower 41 LH radio rack.



Transponder STR 2000-A1 - Block Diagram
 Fig. 1



ACAS II - Electrical Configuration
Fig. 2

3. LRU Description

A. ACAS II antennas (see fig. 5 for location).

- The upper TCAS antenna (RM9609) is located at STA 408.
- The lower TCAS antenna (RM9610) is located at STA 411.

The TCAS directional antennas are four element, D-band phased array antennas that transmit interrogations sequentially from the four antenna elements. The antennas receive inputs directionally and provide two channels of differential phase data to TTR-921. Antenna line loss for both TCAS directional antenna is carefully selected to provide an attenuation of $-2.5 \text{ dB} \pm 0.5 \text{ dB}$ at 1030 MHz.

The transmit frequency is 1030 MHz

The receive frequency is 1090 MHz.

B. STR 2000-A1 antennas (see fig. 5 for location):

- The upper IFF antenna (RM9603) is located at STA 590
- The lower IFF antenna (RM9604) is located at STA 590.

Both transponder antennas are D-band omni-directional blade antennas that receive SSR, IFF and ACAS interrogations. The two antennas are coupled to STR 2000-A1, which uses diversity techniques for greater efficiency. Replies to interrogations are also transmitted by the antenna which has been selected by diversity.

The transmit frequency is 1090 MHz.

The receive frequency is 1030 MHz.

C. Transponder STR 2000-A1

(1) General

The STR 2000-A1 Mode S / IFF transponder equipment set is installed in the lower 41, RH radio rack (see fig. 6).

STR 2000-A1 provides full capability of Mode S, level 2, as defined in ICAO, Annex 10, Volume IV - July 1998, and STANAG 4193 Part IV including SI code processing and extended squitter transmission.

It also provides full MK XII capability in compliance with STANAG 4193. It consists of a transponder and a dedicated control and display unit (CADU). The CADU is installed on P13 overhead panel, from which the CADU background illumination can also be varied via the Overhead Panel Dim Control.

MAINTENANCE MANUAL

NOTE: For Mode 4 IFF operation, the KIT-1C/TSEC computer may be installed in the lower 41, RH radio rack. Cryptographic keying has to be accomplished prior to flight and Mode 4 activated on the CADU. At all other times, when KIT-1C/TSEC is not installed, Mode 4 should always be de-activated to prevent the CADU FAIL lamp from being continuously illuminated.

(2) Interface flexibility for Mode S and ACAS operation:

The transponder provides 3 bi-directional ARINC 429 ports and one ARINC 429 input port together with a software configurable MIL-STD-1553 data bus. Thus, the STR 2000-A1 provides the platform with all interfaces necessary for the Mode S data links Comm-A, Comm and Comm-C (extended length messages) and for the generation of extended squitter transmissions.

Additionally, the transponder interfaces to the on-board ACAS system via an ARINC 429 bus. The CADU provides the elementary control functions for ACAS II, such as TEST, ON/OFF, TA TA/RA).

The transponder derives uncorrected barometric altitude data required by both Mode C and Mode S, from an Air Data Computer (ADC) via a dedicated ARINC 429 Bus.

(3) Control Functions

See figure 7.

STR 2000-A1 is operated via the CADU. The following control functions can be performed:

- Independent selection of the Modes 1, 2, 3/A, 4, C, S
- OFF/STANDBY/NORMAL/EMERGENCY Switch
- ACAS control functions (ON/OFF TA or TA/RA test)
- Entry of the reply code for Mode 3/A
- Entry of the Mode A aircraft identification (flight plan, ID or tail number)
- Dimming control for the displays and background illumination
- Identification of position (I/P) select.
- Remote I/P select
- BIT initiate
- Diagnosis display select
- Mode S Squitter enable/disable
- Entry of the reply code for Mode 1
- Entry of code lists for Mode 1 and 3/A for rapid and easy code change during flight



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- Military or civil reply priority processing and Mode S level selection
- Selection of military or civil emergency reply mode
- Mode 4 controls and indications including jamming signal detection (Zeroize, hold, Code A/B selection, verification bit, reply light, caution)
- Protected entry of the Mode S address
- Protected entry of the Mode S maximum air speed
- Protected entry of the Mode 2 reply code.

(4) Built-In-Test (BIT)

The extensive BIT eliminates the need for scheduled preventive maintenance activities. Not only equipment failures are detected and localized, but also the external interfaces (antennas including cables, data links, altitude source and cryptographic unit) are tested.

Temporary fault conditions are collected and stored in a non-volatile memory which is accessible by the automatic test system.

The BIT results, including elapsed time indication and general Go/NoGo indication, are available on the CADU front panel by activating the DIAG function of DIAG-OFF-TEST Toggle Switch.

D. Air Data Display Unit (ADDU)

Two Air Data Display Units (ADDU) are installed on the pilot's and copilot's instrument panel (see fig 9).

The ADDU is a combined instrument comprising an Altitude Indicator and Air Data Computer in one housing. It provides SSEC corrected barometric altitude data in label 203, ARINC 429 format via an attached Configuration Module to the transponder, capable of delivering exact data for RVSM. The unit receives its static pressure from the pilot's (copilot's) static pressure line. The ADDU has a self test capability via a test button. Its operational state is constantly selfmonitored and monitored as well by STR 2000-A1. Its functional accuracy may be tested during, and in parallel to ground testing of the transponder system.

E. TCAS Transmitter Receiver (TTR-921)

TTR-921 is installed in the lower 41, LH radio rack (see fig. 7).

The Rockwell-Collins TTR-921 system provides airborne collision avoidance protection independent of ground ATC system. TCAS/ACAS fundamental principles are characterized below:

- System is capable of maintaining 360 degree surveillance within an area determined by TCAS R/T transmit power and receiver sensitivity.

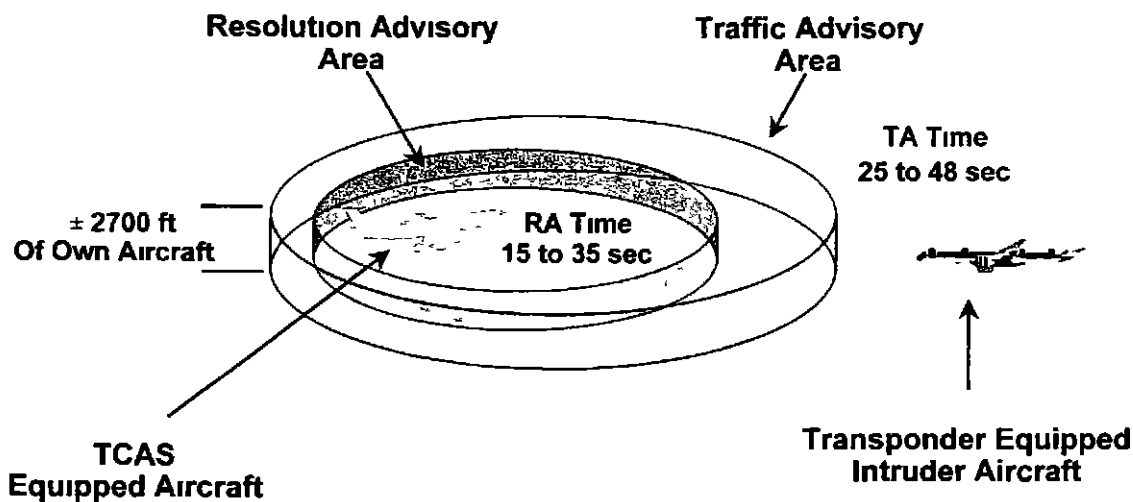
MAINTENANCE MANUAL

- TAU represents this area in which a threat is imminent and the TCAS computer calculates the minimum time for flight crew to discern collision threat and take evasive action.
- Area depends on speed and path of own aircraft and threat aircraft.
- TTR-921 will provide vertical corrective and preventive advisories.
- TTR-921 will provide bearing, range and altitude of aircraft within surveillance area via interrogation of other aircraft ATCRBS/Mode S transponders.

Figure 3 illustrates the collision avoidance principle (TAU) of ACAS II, showing the time parameters for the system to annunciate TAs or RAs.

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Horizontal Protection Zones



Collision Avoidance Principle (TAU)

Fig. 3

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F. Combined Vertical Speed and ACAS II Indicator (VSI/TA/RA)

Two VSI/TA/RAs are installed in the cockpit on the pilot's P8 panel and copilot's P10 panel. Both instruments are independently connected to the aircraft static pressure system. With TTR-921 deactivated, the instrument will behave solely as a vertical velocity indicator. When ACAS is operating, however, the instrument will provide full ACAS traffic indications, accompanied as necessary by vertical change directions in the event of a RA situation.

Illumination of both instruments is supplied by a 5V transformer mounted on the lower 41 LH radio rack. The degree of illumination may be varied by adjustment of the potentiometer mounted on each panel directly adjacent to the instruments.

Each VSI/TA/RA has two switches mounted on the lower bezel. The Range switch on lower left side enables display range on the instrument to be switched from 6 NM to a maximum of 12 NM.

The Abv/Blw Switch enables the ACAS vertical surveillance envelope to be altered from the standard coverage as shown in the table below:

Switch Position	Upper Threshold	Lower Threshold
Normal	-2700 ft	+2700 ft
ABV	+9900 ft	-2700 ft
BLW	+2700 ft	-9900 ft

G. Audio Mixer

- The Audio Mixer is installed in the lower 41, RH radio rack (see fig. 6).
- ACAS II aural annunciations are produced by TTR-921 to warn the flight deck crew of impending airborne collision situations. The audio output from TTR-921 is taken to an audio mixer unit which is located in the lower 41 on the RH radio rack. The GPWS audio output is also taken to the Audio Mixer, from which both audio signals are taken to the GPWS/ACAS Loudspeaker in the cockpit after amplification and impedance matching. Aural annunciations from GPWS and from ACAS II are prioritized. When the GPWS Computer generates an audio output, a discrete signal from this computer is used to suppress TTR-921, preventing any ACAS II aural announcement for the duration of the GPWS signal.

H. ACAS II Circuit Breakers

All circuit breakers for the Mode S/IFF and ACAS II system are located on the P5 overhead panel.

I. Lighting Components

One transformer and one transformer-rectifier provide the voltages required for illumination of the CADU and the VSI/TA/RAs on the



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flight deck. Both components are located in the lower 41 on the LH radio rack (see fig. 8)

The 28 VDC transformer-rectifier (RT9600) converts 28 VAC/400 Hz to 28 VDC. No additional circuit breaker for this transformer is required (see fig. 8).

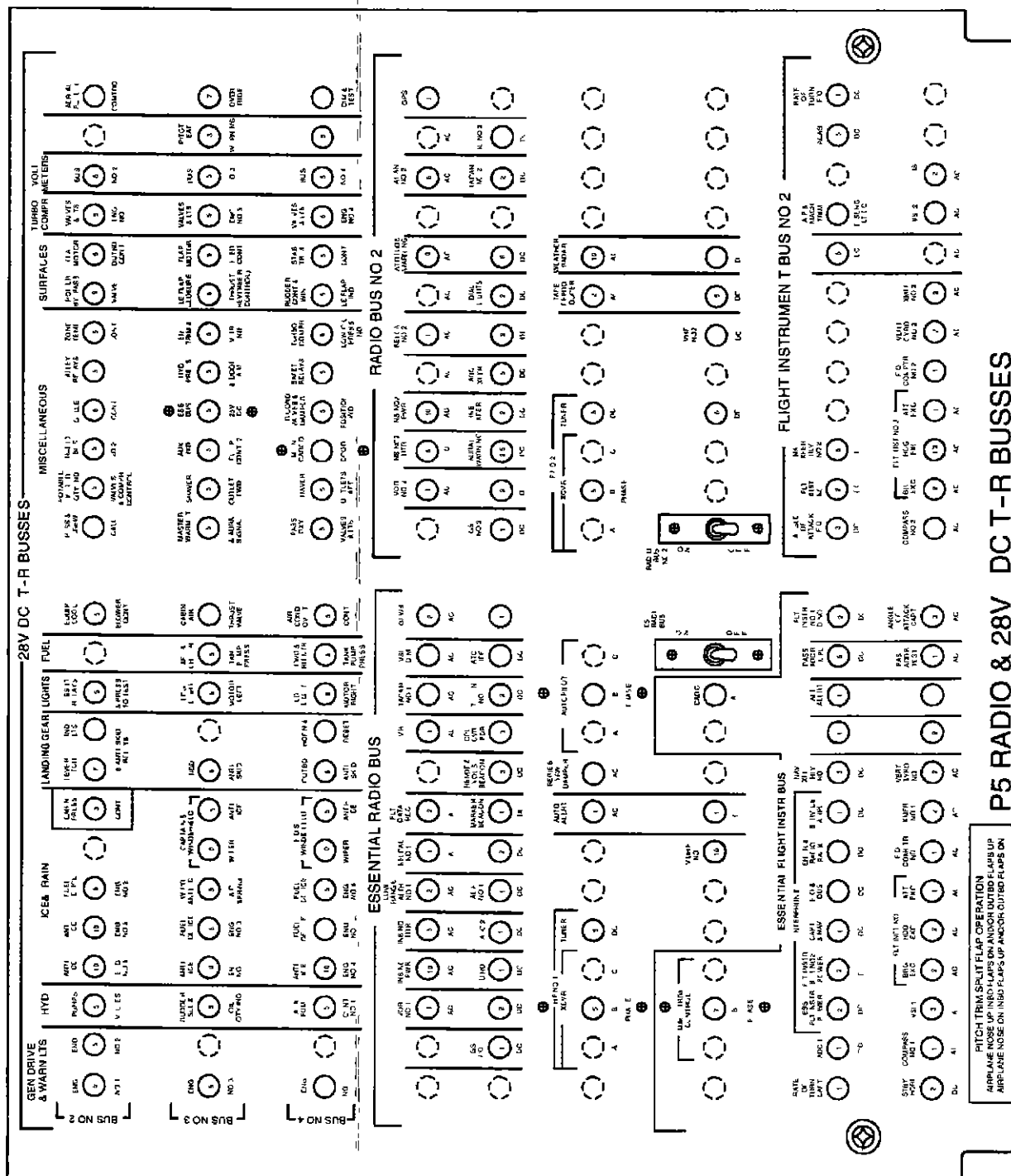
The 5 V transformer (RT9601) is supplied from the ESS RADIO BUS via the circuit breaker VSI DIM on overhead panel P5

J. Ground Test Switch

The Ground Test Switch (see fig. 7) installed on P12 in the cockpit is for use only when STR 2000-A1 and ACAS II ground functional testing using ground test sets TCAS-201 and IFF-701 is to be accomplished.

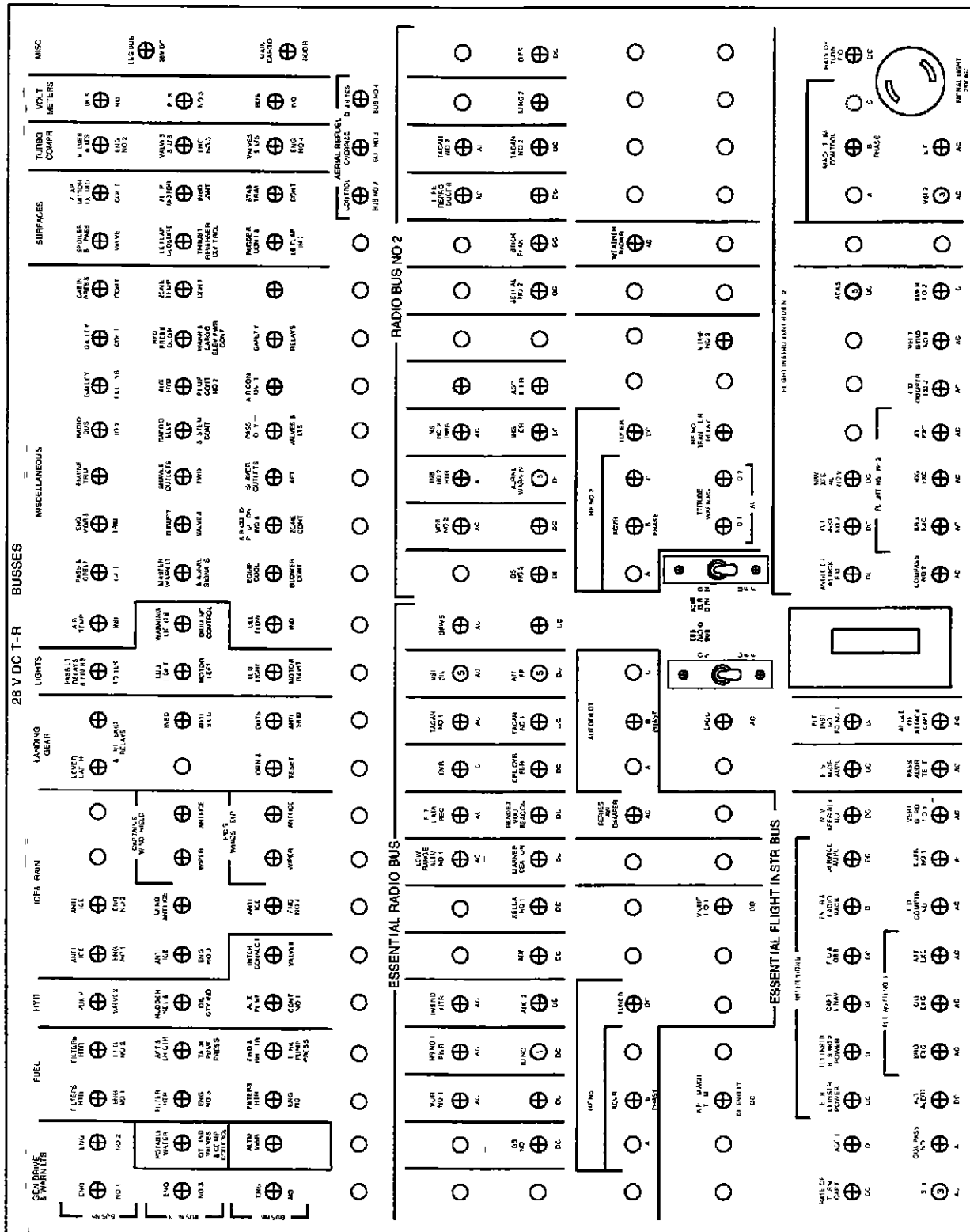
The switch guard ensures that this switch remains in the NORM position when the aircraft is airborne. The switch effectively overrides the ground signal provided by the aircraft Weight On Wheels Switch when the aircraft is on ground, but not jacked. During ground maintenance or troubleshooting, the switch needs to be in the TEST position for the following reasons:

- (1) In order for the aircraft Mode S address to be remotely transferred to the IFF-701 test set when performing STR 2000-A1 in-depth testing.
- (2) In order for TTR-921 to sense an airborne condition required when performing intruder encounter scenario testing using the TCAS-201 ramp test set.

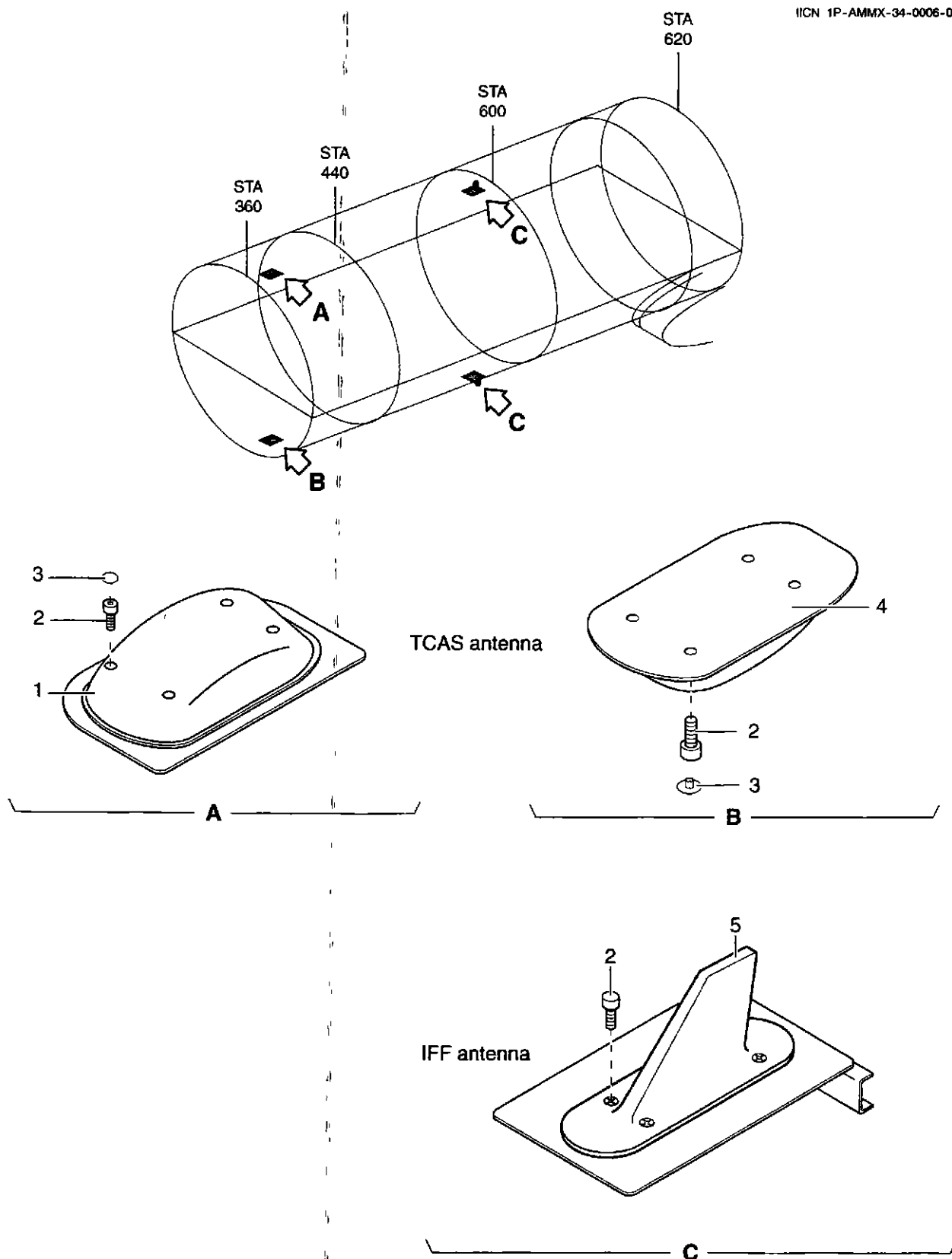


Overhead Panel P5 for SN 20199

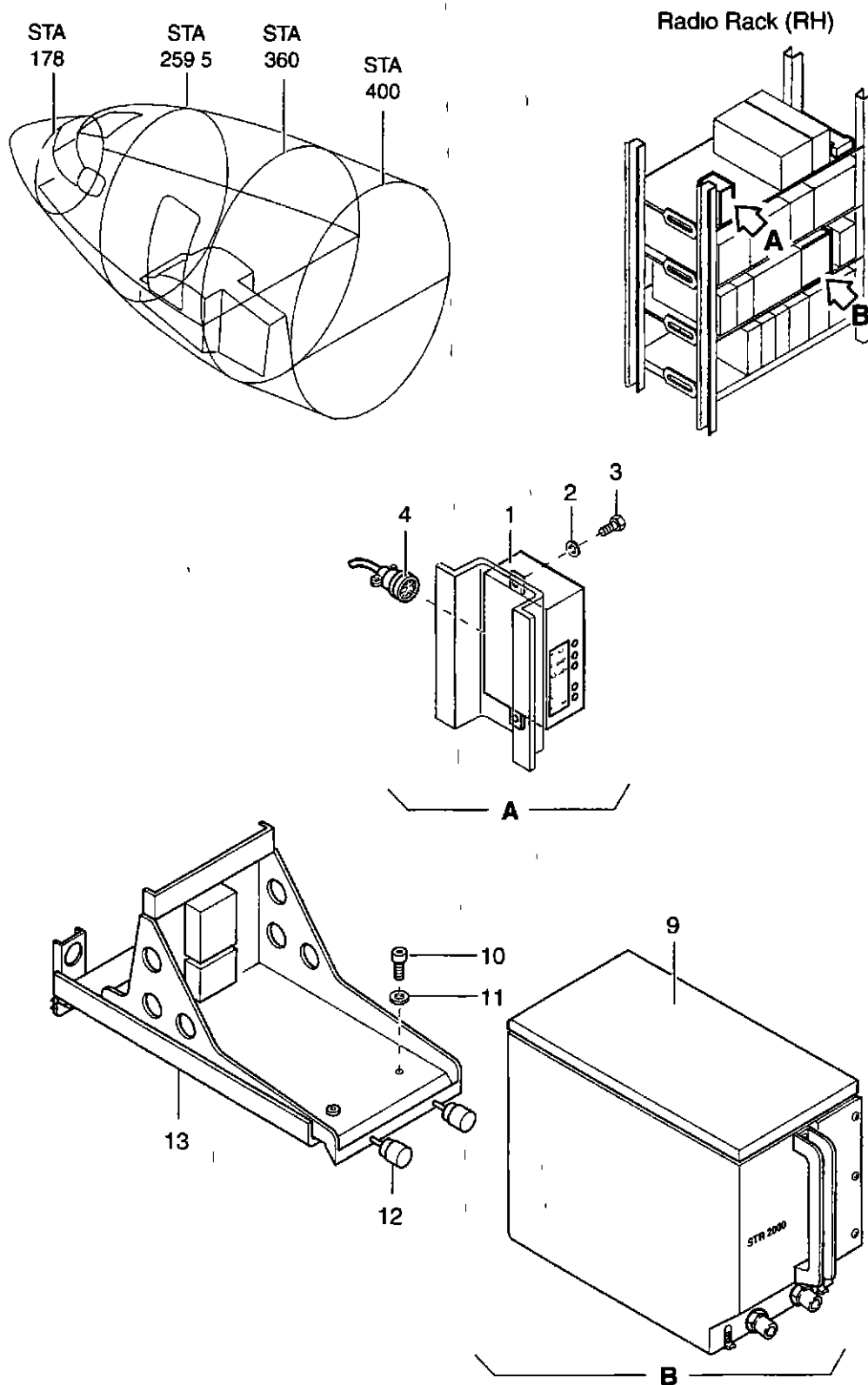
Fig. 4



Overhead Panel P5 for SN 19997 and SN 20000
Fig. 4a

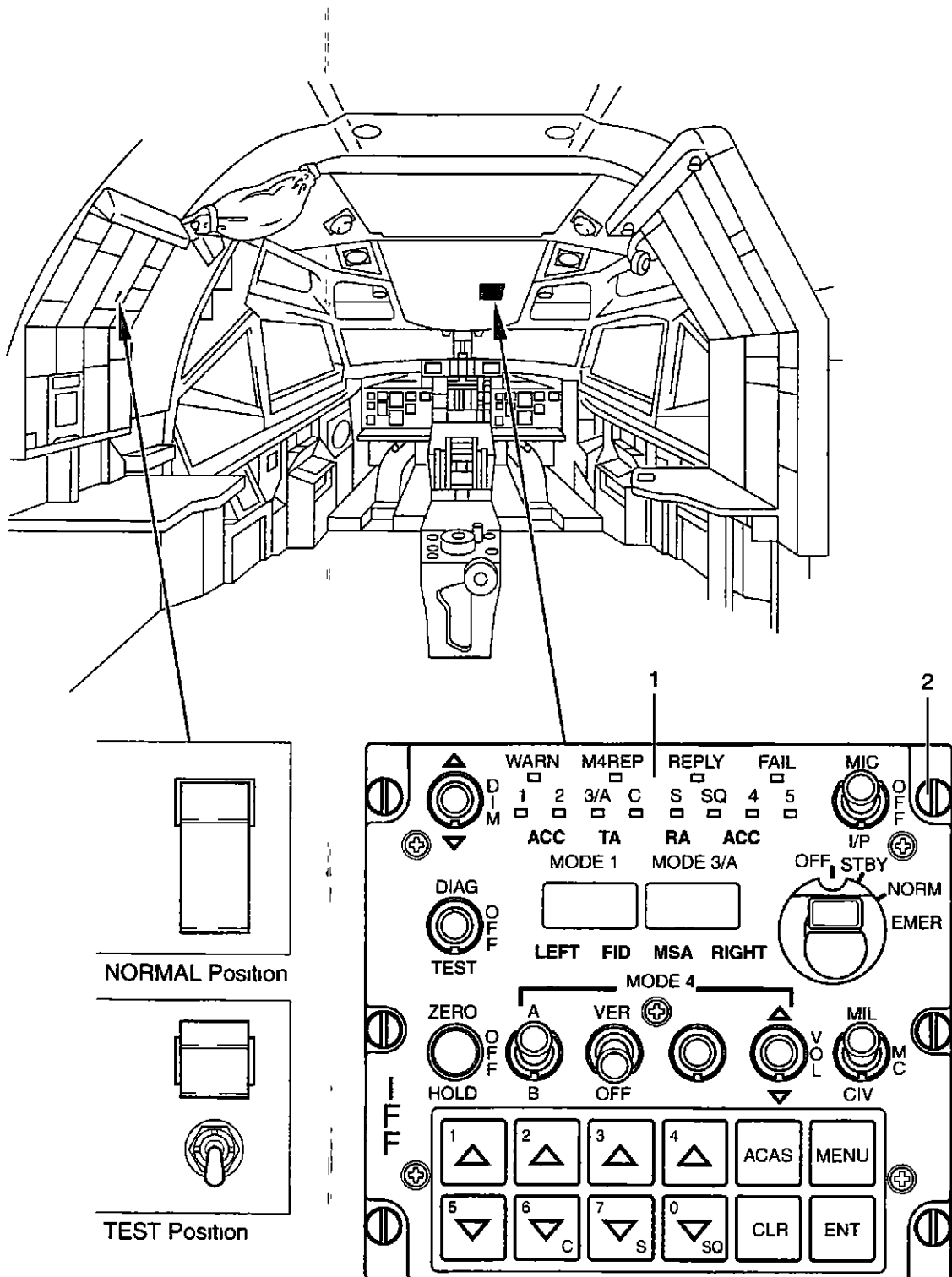


Antenna Location
Fig. 5

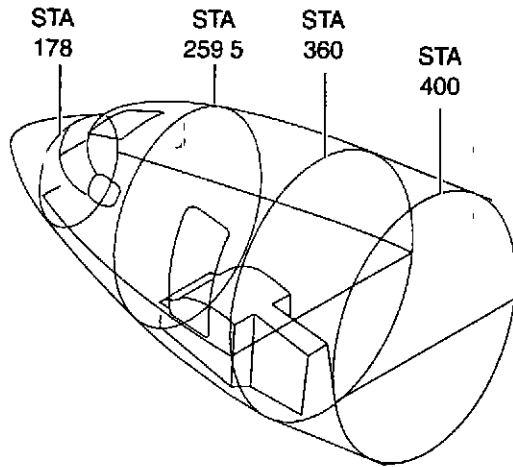


Radio Rack (RH)

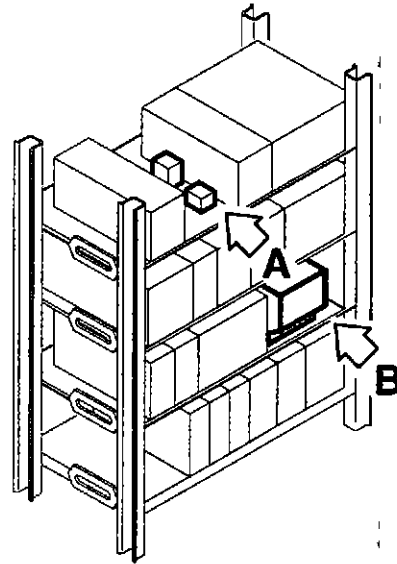
Fig. 6



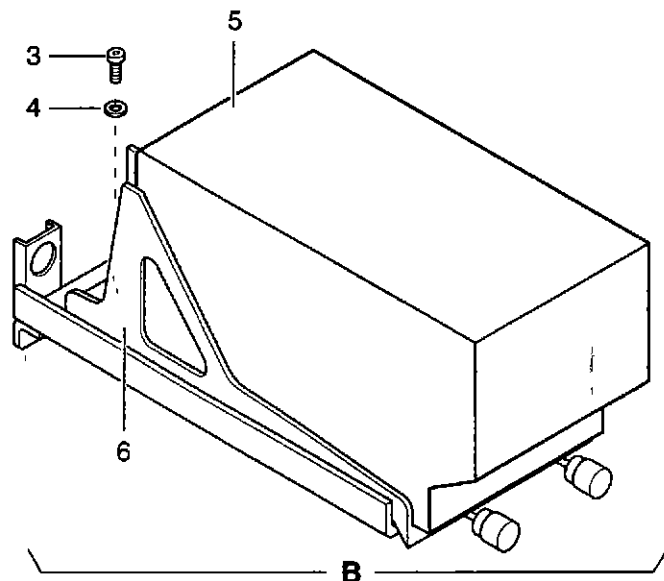
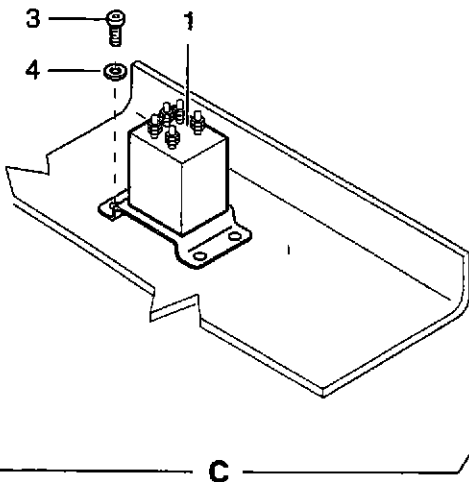
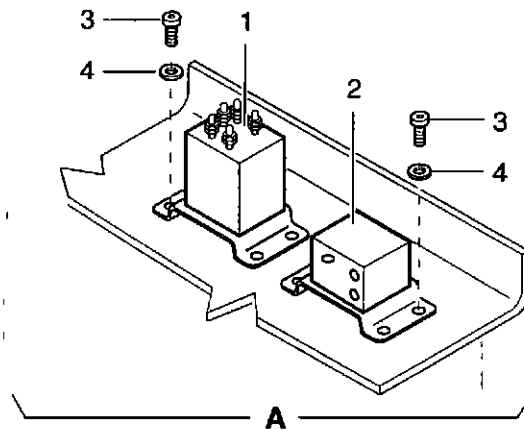
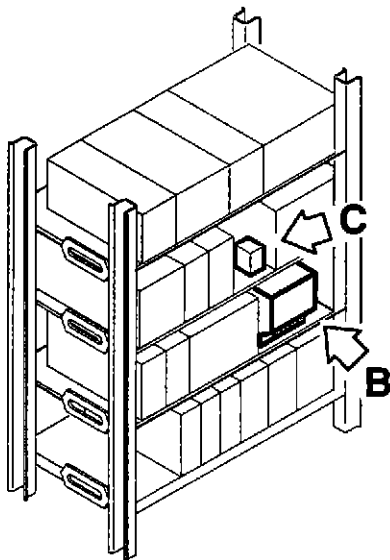
Control and Display Unit (CADU)
 Fig. 7



**TCA
Radio Rack (LH)**

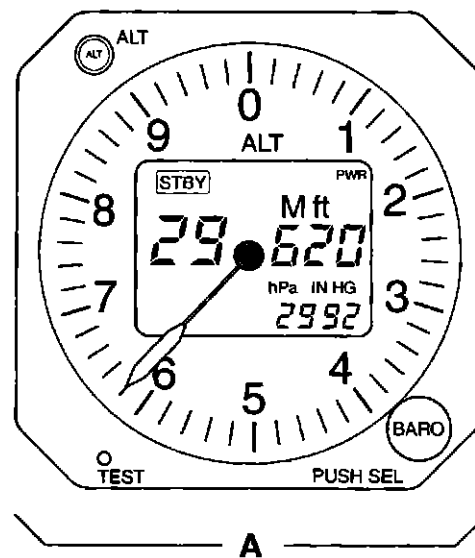
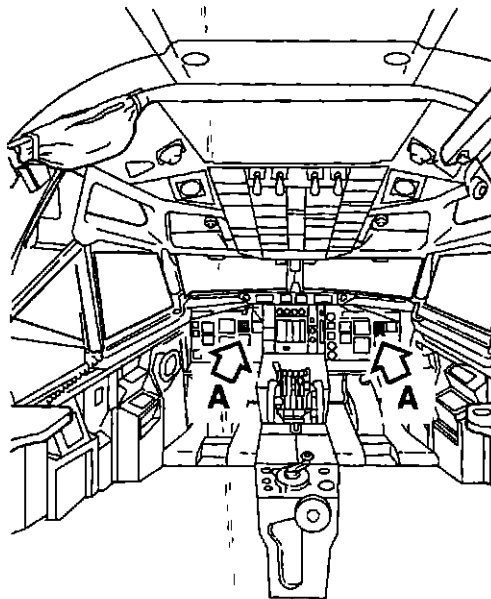


**RTCA
Radio Rack (LH)**



Radio Rack (LH)

Fig. 8



Air Data Display Unit (ADDU)
 Fig. 9

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TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

34-45-00

TR-Nr. 34-22

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Jul 15/2005



MAINTENANCE MANUAL

ACAS II SYSTEM - DESCRIPTION AND OPERATION

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 General

Mode S is a cooperative surveillance and communication system for air traffic control. It employs ground-based sensors (interrogators) and airborne transponders. Ground-air-ground data link communications can be accommodated integrally with the surveillance interrogation and replies. Mode S interrogators provide surveillance of both Air Traffic Control Radar Beacon system (ATCRBS) equipped aircraft and of aircraft equipped with Mode S transponder equipment. A principle feature of Mode S that differs from ATCRBS is that each aircraft is assigned a unique address code. Using this address code, interrogations can be directed to a particular aircraft, and replies unambiguously identified.

The Mode S data link capability allows it to serve as an essential element of the airborne collision avoidance system (ACAS II), which is a system designed to provide vertical airborne separation assurance, or collision avoidance. The system does this by maintaining a surveillance area about the aircraft, through use of replies received from other aircraft transponders. The system maintains surveillance within a sphere determined by the transmit power and receiver sensitivity of the ACAS R/T. The area in which a threat is imminent depends on the closing speed and path of both aircraft.

The ACAS II system is capable of providing resolution advisories to the flight crew, allowing the pilots to avoid other aircraft equipped with either ATCRBS, or Mode S altitude reporting transponders. The system installed in the NTCA enables up to a maximum of 8 intruder aircraft to be visually tracked and displayed on Vertical Speed Indicators whose central area, when the ACAS mode of operation is selected, functions as a display screen for visual presentation of the ACAS traffic scenario.

2 System description

The ACAS II system comprises the following equipment:

STR 2000-A1 is the Mode S/IFF transponder system which is installed in the lower 41 RH radio rack. The transponder is interfaced to

- the MADC, from which own aircraft uncorrected barometric altitude is derived
- TTR-921 TCAS transmitter-receiver
- D-band suppression system linking TACAN, ACAS and transponder together
- two omni-directional antennas located on the upper and lower fuselage surfaces

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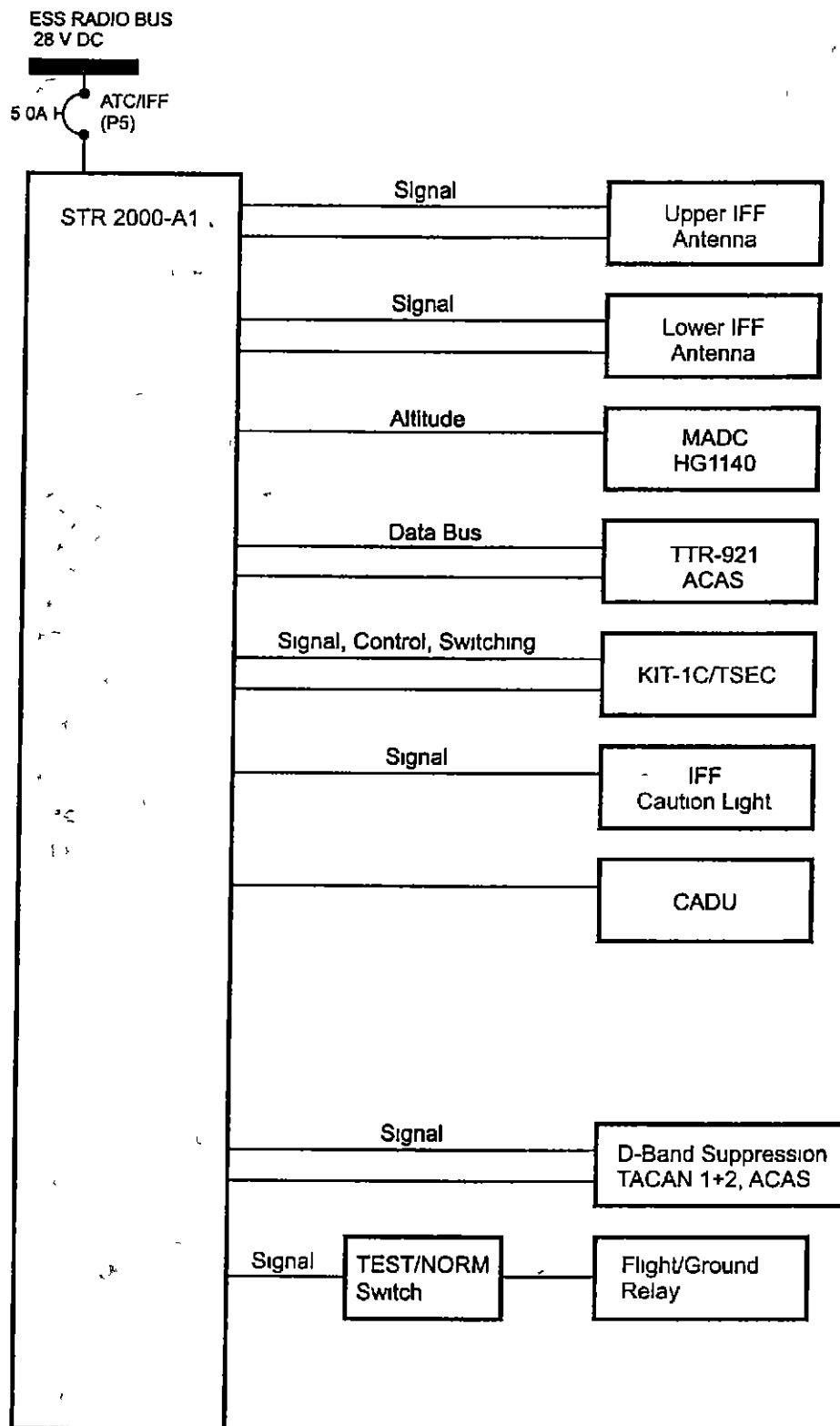
- KIT-1C/TSEC (if installed), for the provision of IFF Mode 4 capability

Figure 1 illustrates STR 2000-A1 electrical configuration.

TTR-921 is the principle ACAS II unit and is installed in the lower 41 LH radio rack TTR-921 is interfaced to:

- Gyrosyn No 1 from which it derives heading data
- VSI/TA/RA No 1, for the display of ACAS II traffic scenarios and vertical manoeuvre advisories for the pilot
- VSI/TA/RA No. 2, for the display of ACAS II traffic scenarios and vertical manoeuvre advisories for the copilot
- cockpit located loudspeaker, via which aural traffic warnings are communicated to the flight crew
- STR 2000-A1
- D-band suppression system linking TACAN, ACAS and transponder together
- Low range radio altimeter (LRRRA) No 1, from which absolute altitude is provided to TTR-921 for the inhibit of certain ACAS features at lower levels
- two directional antennas located on the upper and lower fuselage surfaces which provide ACAS with intruder aircraft positional (bearing) data relative to own aircraft position

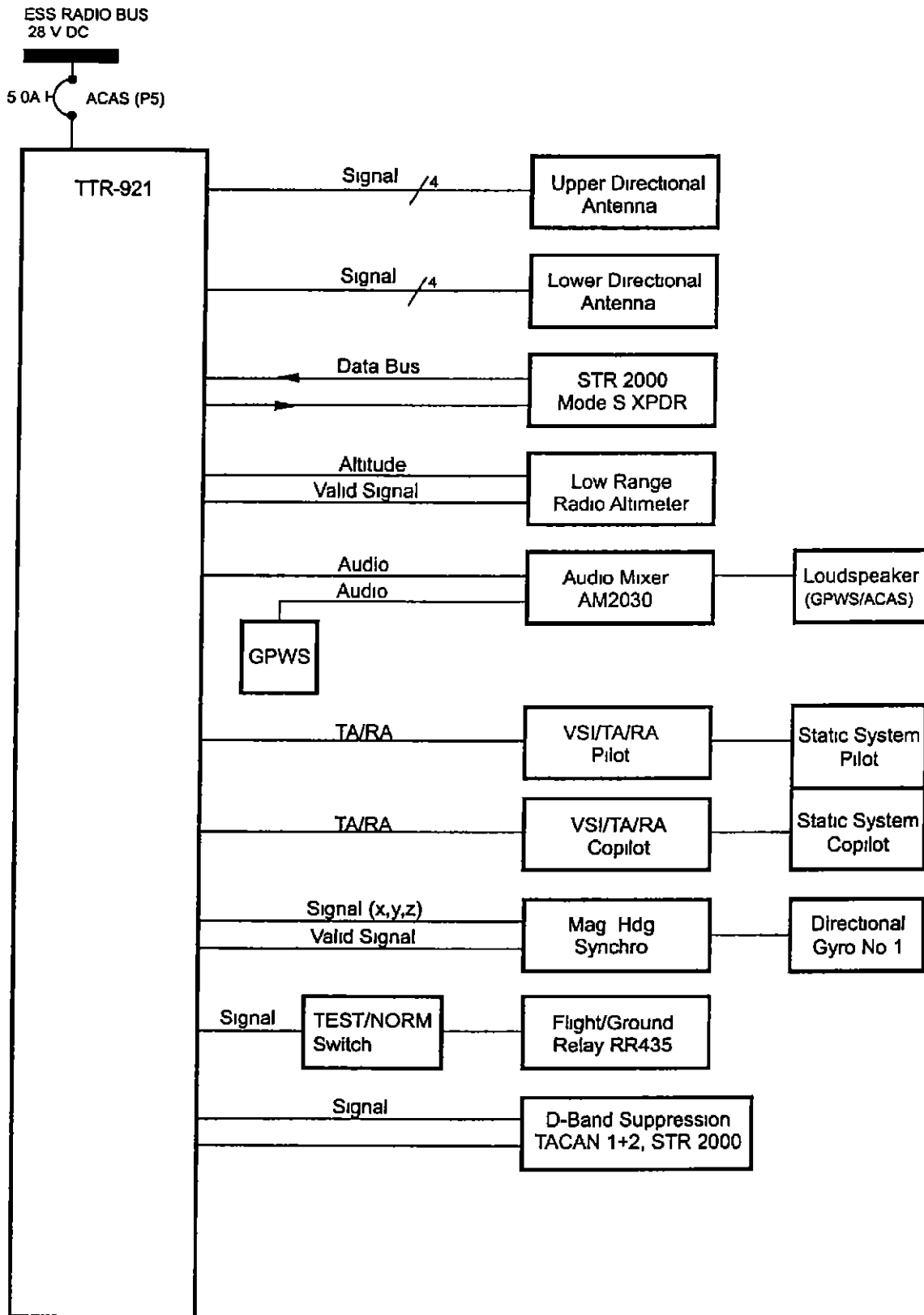
Figure 2 illustrates the ACAS II electrical configuration.



Transponder STR 2000-A1 - Electrical configuration
 Figure 1

BOEING 707
Intercontinental
707

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ACAS II - Electrical configuration
Figure 2



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3 LRU Description

A. ACAS II antennas (see Figure 5 for location).

- The upper TCAS antenna (RM9609) is located at STA 408.
- The lower TCAS antenna (RM9610) is located at STA 411

The TCAS directional antennas are four element, D-band phased array antennas that transmit interrogations sequentially from the four antenna elements. The antennas receive inputs directionally and provide two channels of differential phase data to TTR-921. Antenna line loss for both TCAS directional antenna is carefully selected to provide an attenuation of -2.5 dB +/- 0.5 dB at 1030 MHz.

The transmit frequency is 1030 MHz.

The receive frequency is 1090 MHz.

B. STR 2000-A1 antennas (see Figure 5 for location).

- The upper IFF antenna (RM9603) is located at STA 590
- The lower IFF antenna (RM9604) is located at STA 590

Both transponder antennas are D-band omni-directional blade antennas that receive SSR, IFF and ACAS interrogations. The two antennas are coupled to STR 2000-A1, which uses diversity techniques for greater efficiency. Replies to interrogations are also transmitted by the antenna which has been selected by diversity.

The transmit frequency is 1090 MHz.

The receive frequency is 1030 MHz.

C. Transponder STR 2000-A1

(1) General

The STR 2000 Mode S / IFF transponder equipment set is installed in the lower 41, RH radio rack (see Figure 6).

STR 2000-A1 provides full capability of Mode S, level 2, as defined in ICAO, Annex 10, Volume IV - July 1998, and STANAG 4193 Part IV including SI code processing and extended squitter transmission.

It also provides full MK XII capability in compliance with STANAG 4193. It consists of a transponder and a dedicated control and display unit (CADU). The CADU is installed on P13 overhead panel, from which the CADU background illumination can also be varied via the OVERHEAD PANEL dim control.



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NOTE For Mode 4 IFF operation, the KIT-1C/TSEC computer may be installed in the lower 41, RH radio rack. Cryptographic keying has to be accomplished prior to flight and Mode 4 activated on the CADU. At all other times when KIT-1C/TSEC is not installed, Mode 4 should always be de-activated to prevent the CADU FAIL lamp from being continuously illuminated.

(2) Interface flexibility for Mode S and ACAS operation

The transponder provides 3 bi-directional ARINC 429 ports and one ARINC 429 input ports together with a software configurable Mil-STD-1553 data bus. Thus, the STR 2000 provides the platform with all interfaces necessary for the Mode S data links Comm-A, Comm and Comm-C (extended length messages) and for the generation of extended squitter transmissions.

Additionally, the transponder interfaces to the on-board ACAS system via an ARINC 429 bus. The CADU provides the elementary control functions for ACAS II, such as test, on/off, TA, TA/RA.

The transponder derives uncorrected barometric altitude data, required by both Mode C and Mode S, from a miniturised air data computer, HG1140CA, via a dedicated ARINC 429 bus.

(3) Control Functions

See Figure 7

STR 2000-A1 is operated via the CADU. The following control functions can be performed:

- Independent selection of the Modes 1, 2, 3/A, 4, C, S
- OFF / standby / normal / emergency switch
- ACAS control functions (on/off, TA or TA/RA, test)
- Entry of the reply code for Mode 3/A
- Entry of the Mode S aircraft identification (flight plan, ID or tail number)
- Dimming control for displays and background illumination
- Identification of position (I/P) select
- Remote I/P select
- BIT initiate
- Diagnosis display select
- Mode S Squitter enable / disable
- Entry of the reply code for Mode 1
- Entry of code lists for Mode 1 and 3/A for rapid and easy code change during flight



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- Military or civil reply priority processing and Mode S level selection
- Selection of military or civil emergency reply mode
- Mode 4 controls and indications including jamming signal detection (Zeroize, hold, Code A/B selection, verification bit, reply light, caution)
- Protected entry of the Mode S address
- Protected entry of the Mode S maximum air speed
- Protected entry of the Mode 2 reply code

(4) Built-In-Test (BIT)

The extensive BIT eliminates the need for scheduled preventive maintenance activities. Not only equipment failures are detected and localized, but also the external interfaces (antennas including cables, data links, altitude source and cryptographic unit) are tested.

Temporary fault conditions are collected and stored in a non-volatile memory which is accessible by the automatic test system.

The BIT results, including elapsed time indication and general Go/NoGo indication, are available on the CADU front Panel by activating the DIAG function of toggle switch DIAG-OFF-TEST.

D Multi-role Air Data Computer HG 1140CA (MADC)

The MADC is installed in the lower 41, RH radio rack (see Figure 6)

The Honeywell HG 1140CA MADC provides uncorrected barometric altitude data in Label 203, ARINC 429 format to the transponder. The unit receives its static pressure from the pilot's static pressure line, which is also the static source for the MADC. The MADC has no dedicated intermediate level test capability. Its operational state is constantly monitored by STR 2000-A1 and its functional accuracy may be tested during, and in parallel to ground testing of the transponder system.

E TCAS Transmitter Receiver (TTR-921)

TTR-921 is installed in the lower 41, LH radio rack (see Figure 7)

The Rockwell-Collins TTR-921 system provides airborne collision avoidance protection independent of ground ATC system. TCAS/ACAS fundamental principles are characterized below.

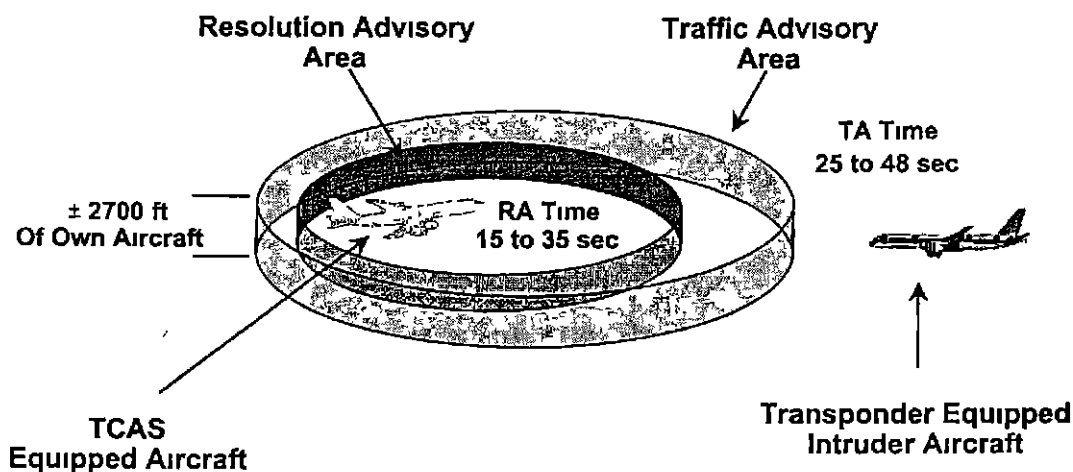
- System is capable of maintaining 360 degree surveillance within an area determined by TCAS R/T transmit power and receiver sensitivity.

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- TAU represents this area in which a threat is imminent and the TCAS computer calculates the minimum time for flight crew to discern collision threat and take evasive action
- Area depends on speed and path of own aircraft and threat aircraft.
- TTR-921 will provide vertical corrective and preventive advisories
- TTR-921 will provide bearing, range, and altitude of aircraft within surveillance area via interrogation of other aircraft ATCRBS/Mode-S transponders

Figure 3 illustrates the collision avoidance principle (TAU) of ACAS II, showing the time parameters for the system to annunciate TA's or RA's

Horizontal Protection Zones



Collision avoidance principle (TAU)

Figure 3



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F Combined Vertical Speed and ACAS II Indicator (VSI/TA/RA)

The two VSI/TA/RA's are installed in the cockpit on the pilot's P8 Panel and copilot's P10 Panel. Both instruments are independently connected to the aircraft static pressure system. With TTR-921 deactivated, the instrument will behave solely as a vertical velocity indicator. When ACAS is operating, however, the instrument will provide full ACAS traffic indications, accompanied as necessary by vertical change directions in the event of a RA situation.

Illumination of both instruments is supplied by a 5 V transformer mounted on the lower 41 LH radio rack. The degree of illumination may be varied by adjustment of the potentiometer mounted on each panel directly adjacent to the instruments.

Each VSI/TA/RA has two switches mounted on the lower bezel. The Range switch on the lower left side enables display range on the instrument to be switched from 6 NM to a maximum of 12 NM. The other control, Abv/Blw, enables the ACAS vertical surveillance envelope to be altered from the standard coverage of + and -2700 ft, to (+9900 ft, -2700 ft) when Abv is selected, and to (+2700 ft, -9900 ft) when in the Blw position.

G Audio Mixer and Cockpit Loudspeaker

- The audio mixer is installed in the lower 41, RH radio rack (see Figure 6)
- ACAS II aural annunciations are produced by TTR-921 to warn the flight deck crew of impending airborne collision situations. The audio output from TTR-921 is taken to an audio mixer unit which is located in the lower 41 on the RH radio rack. The GPWS audio output is also taken to the audio mixer, from which both audio signals are taken to the GPWS/ACAS loudspeaker in the cockpit after amplification and impedance matching. Aural annunciations from GPWS and from ACAS II are prioritized. When the GPWS computer generates an audio output, a discrete signal from this computer is used to suppress TTR-921, preventing any ACAS II aural announcement for the duration of the GPWS signal.

H ACAS II Circuit Breakers

All circuit breakers for the Mode S/IFF and ACAS II system are located on the P5 overhead panel (see NO TAG).

I Lighting Components

One transformer and one transformer-rectifier provide the voltages required for illumination of the CADU and the VSI/TA/RA's on the flight deck. Both components are located in the lower 41 on the LH radio rack (see Figure 8).

The 28 VDC transformer-rectifier (RT9600) converts 28 VAC/400 Hz to 28 VDC. No additional circuit breaker for this transformer is required (see Figure 8).

BOEING *Intercontinental*
MAINTENANCE MANUAL

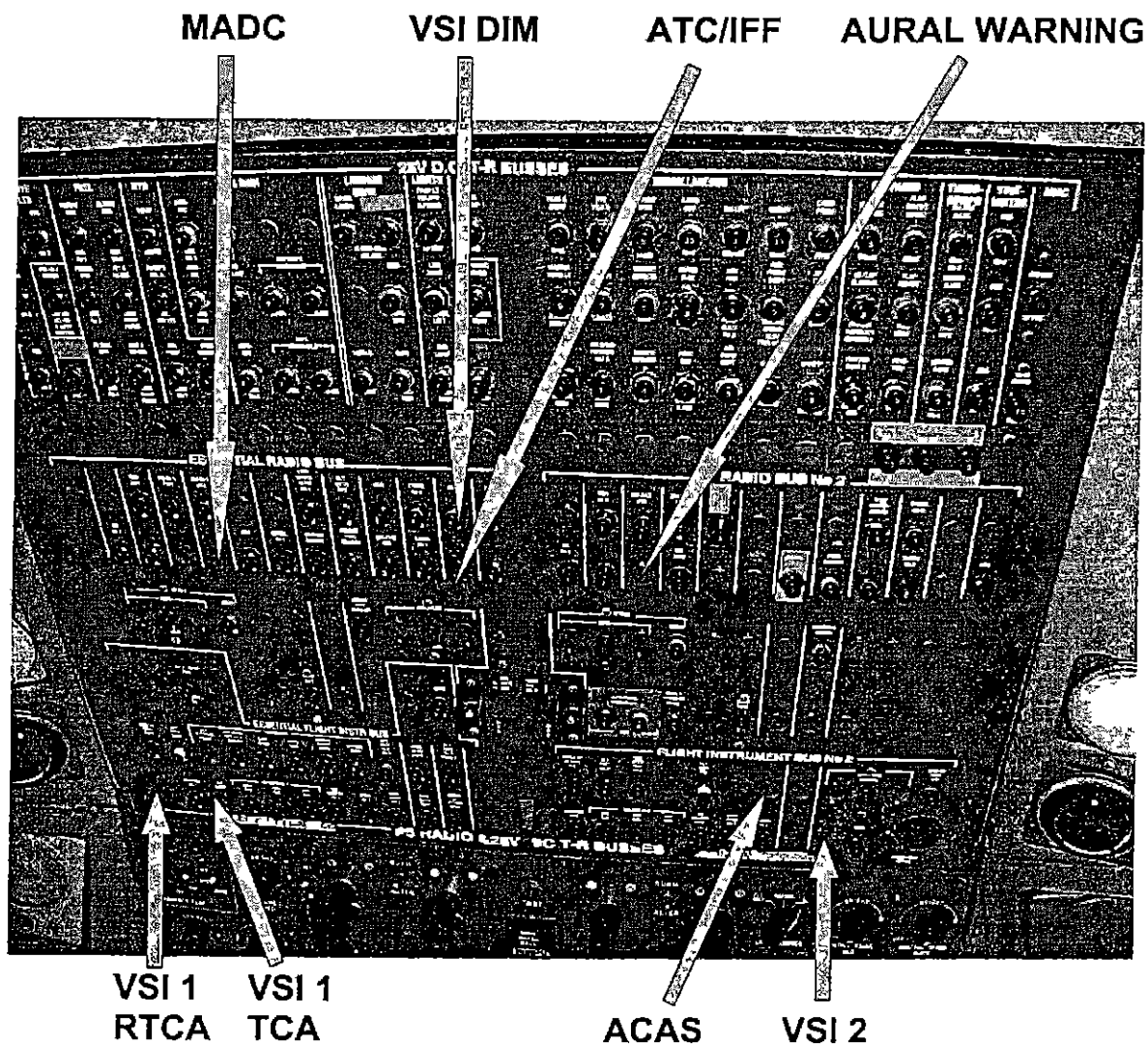
The 5 V transformer (RT9601) is supplied from the ESS RADIO BUS via the circuit breaker VSI DIM on overhead panel P5

J Ground Test Switch

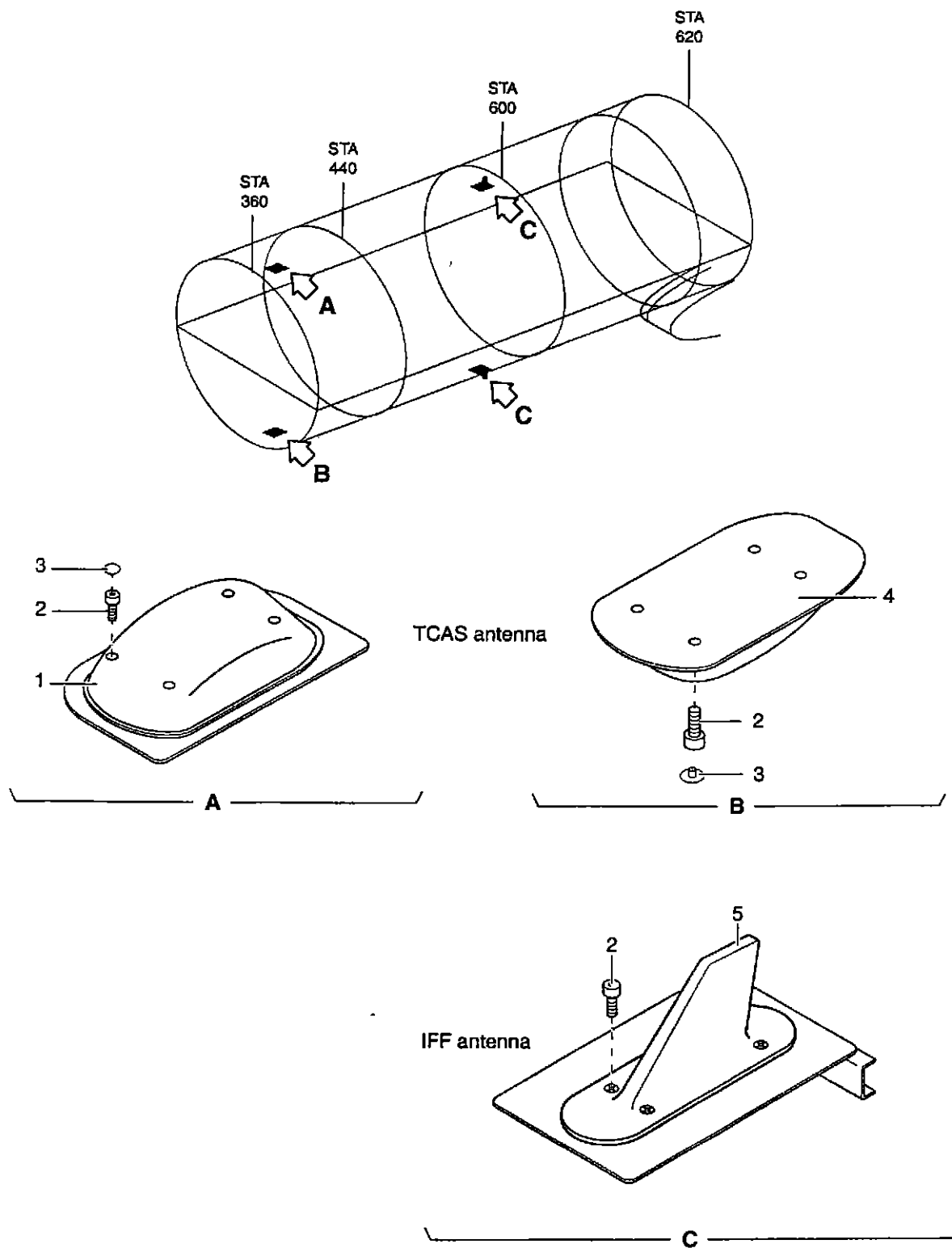
The ground test switch (see Figure 7) installed on P12 in the cockpit is for use only when STR 2000-A1 and ACAS II ground functional testing using ground test sets TCAS-201 and IFF-701 is to be accomplished

The switch guard ensures that this switch remains in the NORM position when the aircraft is airborne. The switch effectively overrides the ground signal provided by the aircraft weight on wheels switch when the aircraft is on ground, but not jacked. During ground maintenance or troubleshooting, the switch needs to be in the TEST position for the following reasons:

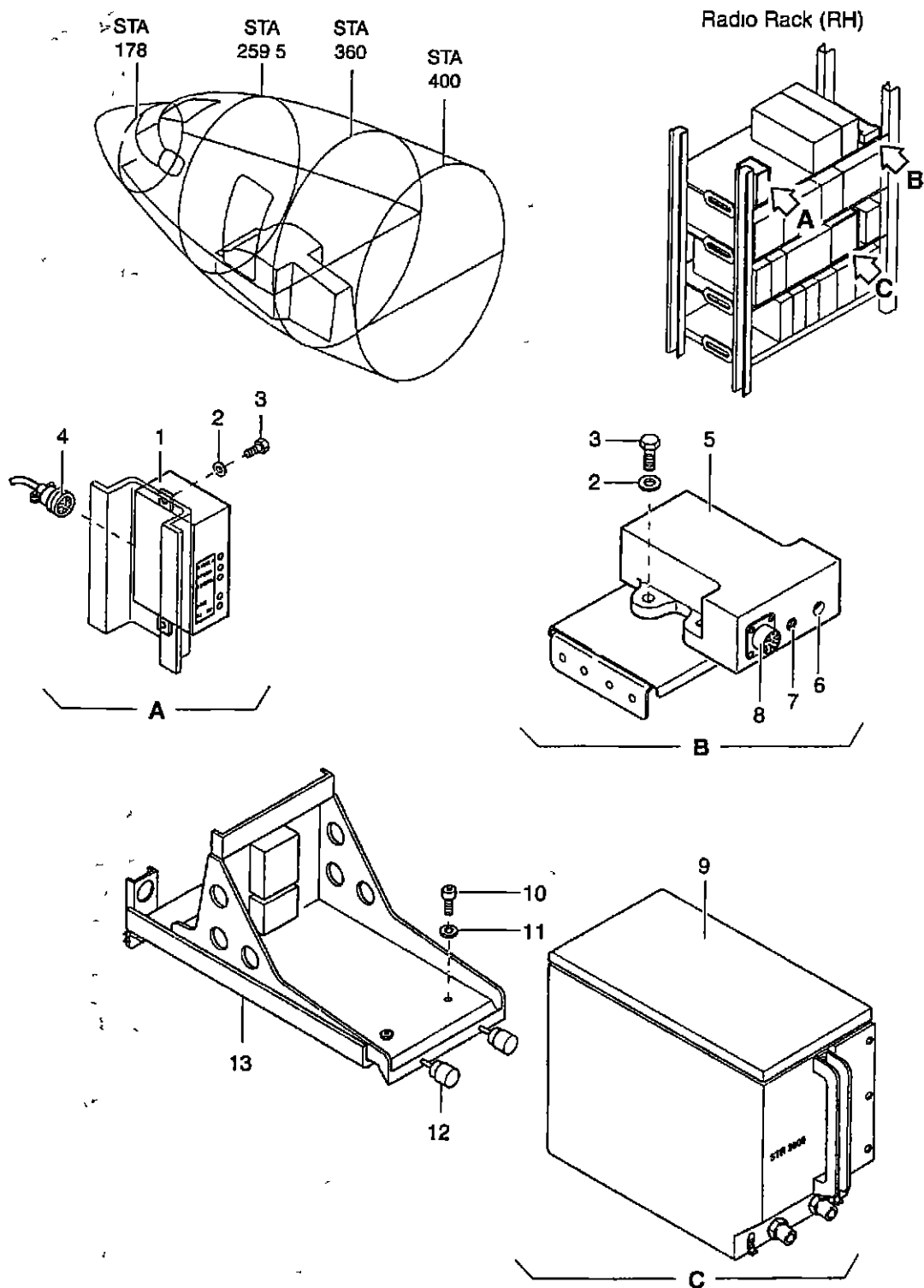
- (1) In order for the aircraft Mode S address to be remotely transferred to the IFF-701 test set when performing STR 2000-A1 in-depth testing
- (2) In order for TTR-921 to sense an airborne condition required when performing intruder encounter scenario testing using the TCAS-201 ramp test set



Overhead Panel P5
 Figure 4



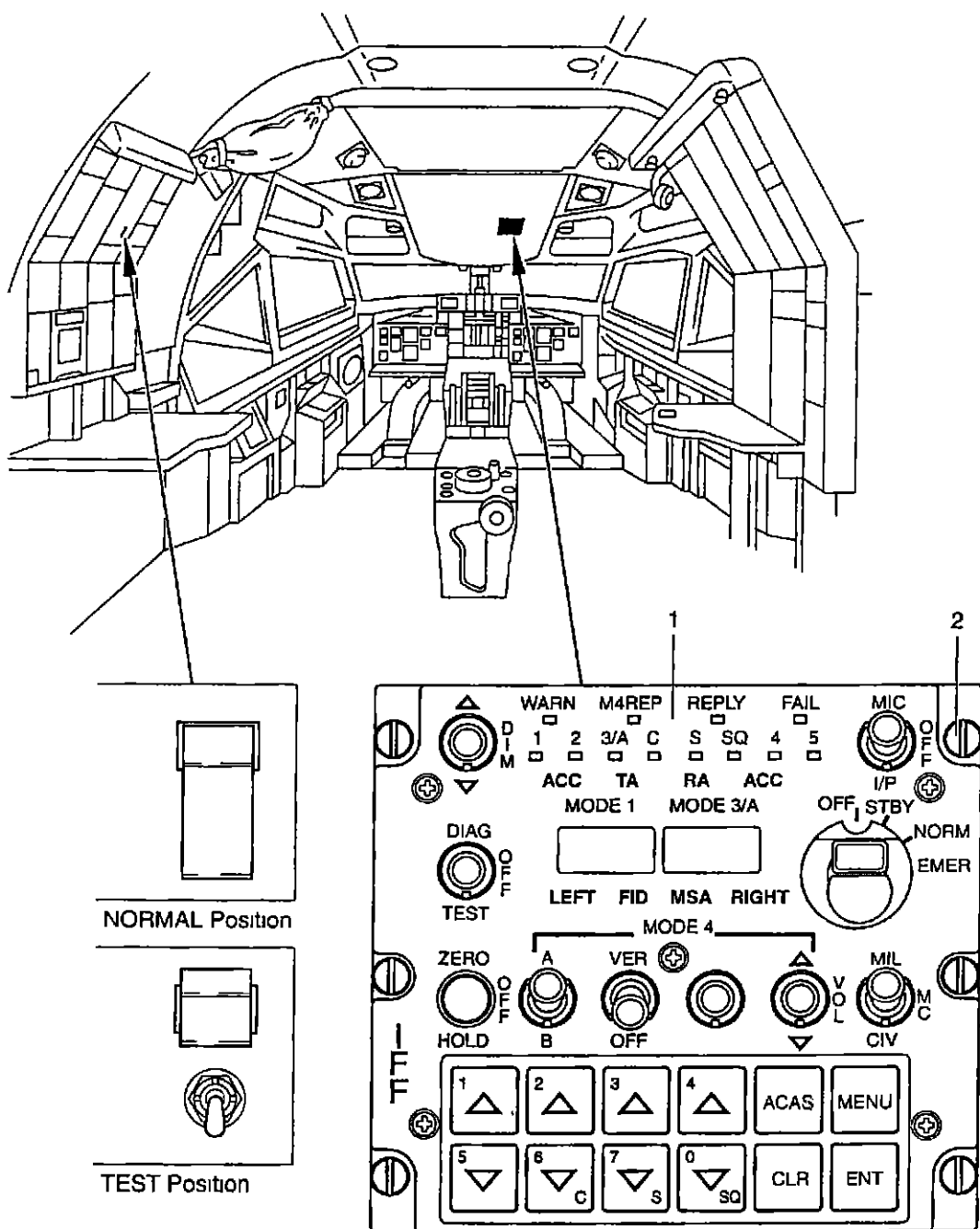
ACAS Antenna
 Figure 5



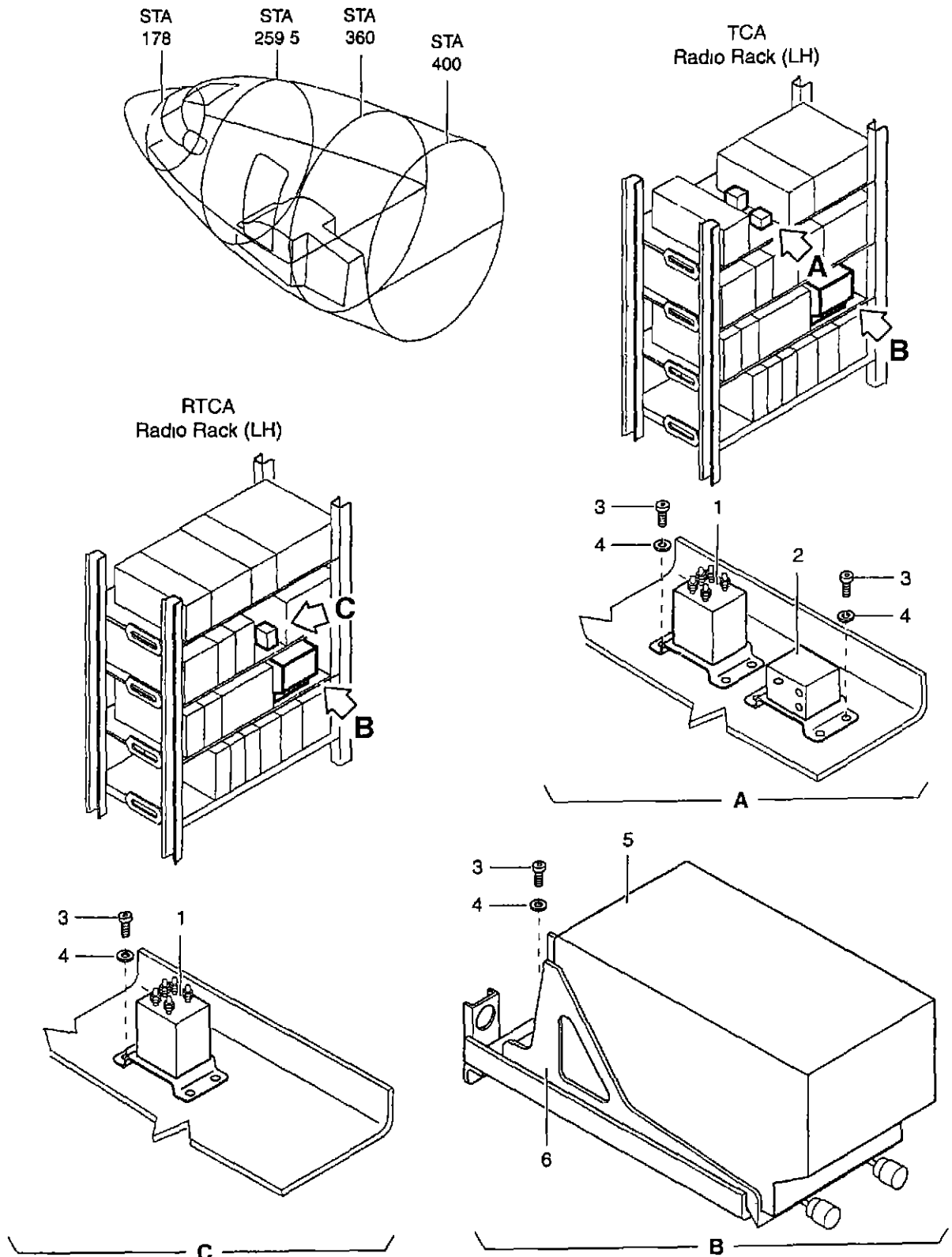
Radio Rack (RH)

Figure 6

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Intercontinental
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Control & Display Unit (CADU)
 Figure 7



Radio Rack (LH)

Figure 8



MAINTENANCE MANUAL

IFF/MODE S TRANSPONDER ACAS II SYSTEM - TROUBLESHOOTING

1. General

The BIT software of both STR 2000-A1 and ACAS II is generally adequate to enable location of any fault down to LRU level. Test sets IFF-701 and TCAS-201 may, nevertheless, be employed, should in-depth troubleshooting of either system be required.

A. STR 2000-A1

If the system is completely inoperative, ensure that the ATC/IFF circuit breaker on P5 is closed and ensure that all voltages are available to the transponder system.

If the flight report indicates that an interface or system sub-module has failed, qualify the defect report by performing the following:

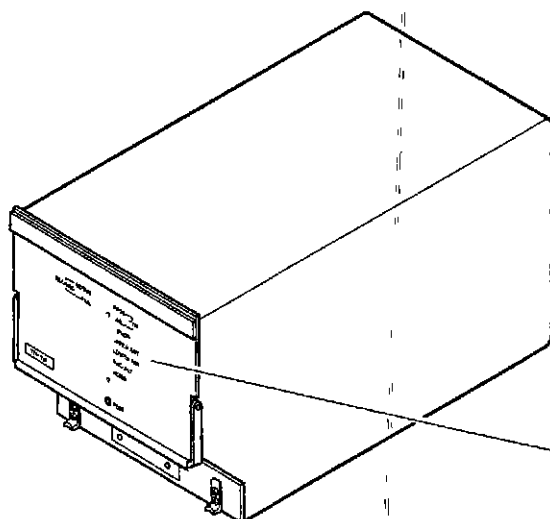
- (1) Select STBY at the CADU main rotary switch. The automatic self-test is started. If this self-test results in a FAIL indication, identify defective component by selecting DIAG on the DIAG/OFF/TEST Toggle Switch, then sequentially scroll through the diagnostic routine by pressing the ENTER key. The routine sequentially checks the following features and displays the status information in the Alpha-Numeric Display:

CAUSE OF FAULT	
XPNDR FAIL	Transponder Fault
CADU FAIL	CADU Fault
ALT1 FAIL	ADC Fault
ACAS FAIL	ACAS ARINC 429 Bus Fault
ADC FAIL	ADC ARINC 429 Bus Fault
BINT FAIL	Bus Interface Module (BINT) Fault
CHAS FAIL	Transponder Chassis Fault
DTR FAIL	Transponder Receiver Module (DTR) Fault
IOCP FAIL	Input/Output Com Processor Module Fault
MSA FAIL	Mode S Fault (0000000 / FFFFFFF)
MSTP FAIL	Mark XII/Mode S Transponder Processor Module Fault
PA FAIL	Power Amplifier Fault
PS5 FAIL	5V Power Supply Fault
PS50 FAIL	50 V Power Supply Fault
LOW FAIL	Lower Antenna Failure
UPP FAIL	Upper Antenna Failure



MAINTENANCE MANUAL

- (2) Continuing to scroll through, after the fault diagnostic list has been completed, will enable the transponder and CADU operating hours to be seen.
- (3) ACAS II
 - (a) If the system is completely inoperative, ensure that the ACAS circuit breaker on P5 is closed and ensure that all voltages are available to the transponder system and to TTR-921.
 - (b) If the flight report indicates that ACAS indicators show FAIL or OFF, perform the following.
 - (c) Ensure all circuit breakers relevant to the operation of ACAS are closed i.e. LRRR, ATC/IFF, VSI No. 1&2, Aural Wrng.
Select NORM at the CADU Main Rotary Switch. Select ACAS "ON" using the CADU soft keys.
 - (d) Press CADU Toggle Switch DIAG/OFF/TEST momentarily to TEST. Verify the functionality of the ACAS system; If the ACAS selftest completes with the announcement "TCAS System Test Fail", continue troubleshooting.
 - (e) Access the lower 41, press the Selftest Button on the front panel of TTR-921 and observe the front panel LED indications. Indicators will momentarily light in any order. Note which fault indicator(s) are illuminated red (see fig. 101).
 - (f) If the fault diagnosis indicates that one of the TCAS Directional Antennas is faulty, carry out replacement in accordance with the instructions for antenna replacement.
 - (g) If the fault diagnosis indicates that the TTR-921 is defective, carry out replacement in accordance with the instructions for TTR-921 replacement.
 - (h) If the fault diagnosis indicates that one of the VSI/TA/RA Indicators is defective, carry out replacement in accordance with the instructions for TVI-920 replacement.
 - (i) If the flight report indicates that aural annunciations from ACAS and GPWS are inaudible, carry out replacement of the audiomixer in accordance with the instructions for audio mixer replacement.



ACTIVE O	O PASS
RECORD	O FAIL TTR
FAIL O	O X PNDR
	O UPPER ANT
	O LOWER ANT
	O RAD ALT
	O HDNG
	O R / A
	O T / A
	⊙ TEST

TTR-921 - Fault Annunciators

Fig. 101

END



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INTENTIONALLY LEFT BLANK



MAINTENANCE MANUAL

ACAS II SYSTEM - TROUBLESHOOTING

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 General

The BIT software of both STR 2000-A1 and ACAS II is generally adequate to enable location of any fault down to LRU level. Test sets IFF-701 and TCAS-201 may, nevertheless, be employed should in-depth troubleshooting of either system be required.

A STR 2001-A1

If the system is completely inoperative, ensure that the ATC/IFF circuit breaker on P5 is closed and ensure that all voltages are available to the transponder system.

If the flight report indicates that an interface or system sub-module has failed, qualify the defect report by performing the following:

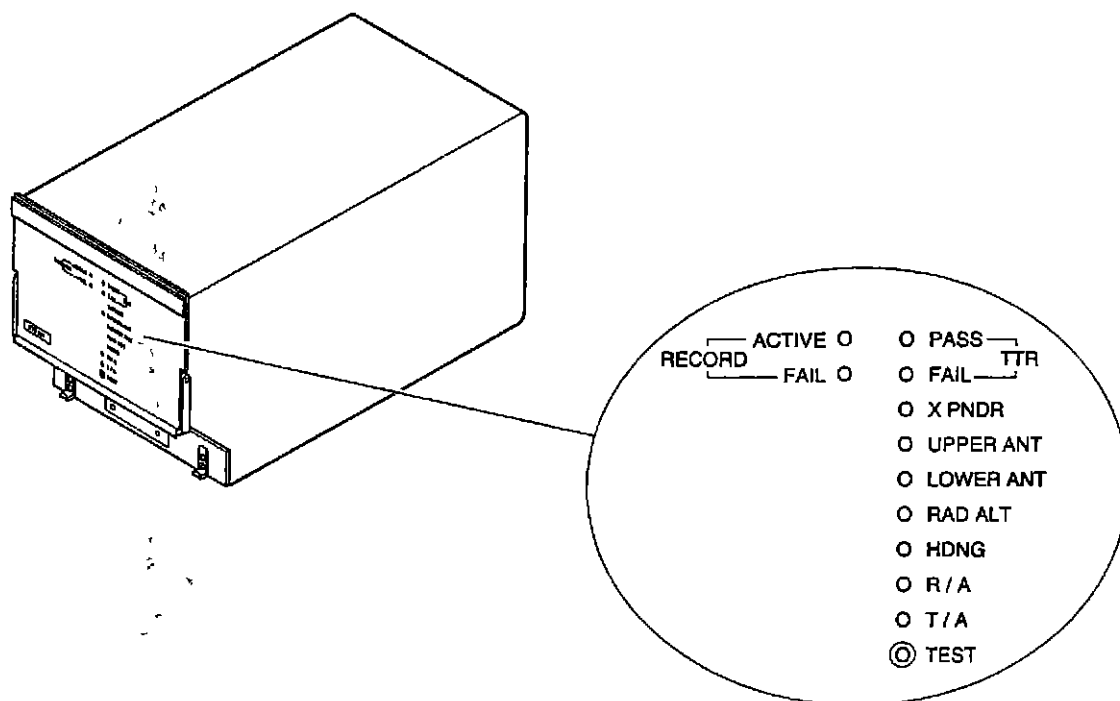
- (1) Select STBY at the CADU main rotary switch. The automatic self-test is started. If this selftest results in a FAIL indication, identify defective component by selecting DIAG on the DIAG-OFF-TEST toggle switch, then sequentially scroll through the diagnostic routine by pressing the ENTER key. The routine sequentially checks the following features and displays the status information in the alpha-numeric display:

CAUSE OF FAULT	
XPNDR FAIL	Transponder Fault
CADU FAIL	CADU Fault
ALT1 FAIL	MADC Fault
ACAS FAIL	ACAS ARINC 429 Bus Fault
ADC FAIL	MADC ARINC 429 Bus Fault
BINT FAIL	Bus Interface Module (BINT) Fault
CHAS FAIL	Transponder Chassis Fault
DTR FAIL	Transponder Receiver Module (DTR) Fault
IOCP FAIL	Input/Output Com Processor Module Fault
MSA FAIL	Mode S Fault (00000000 / FFFFFFFF)
MSTP FAIL	Mark XII/Mode S Transponder Processor Module Fault
PA FAIL	Power Amplifier Fault
PS5 FAIL	5V Power Supply Fault
PS50 FAIL	50V Power Supply Fault
LOW FAIL	Lower Antenna Failure
UPP FAIL	Upper Antenna Failure



MAINTENANCE MANUAL

- (2) Continuing to scroll through, after the fault diagnostic list has been completed, will enable the transponder and CADU operating hours to be seen
- (3) ACAS II
 - (a) If the system is completely inoperative, ensure that the ACAS circuit breaker on P5 is closed and ensure that all voltages are available to the transponder system and to TTR-921
 - (b) If the flight report indicates that ACAS indicators show FAIL or OFF, perform the following:
 - (c) Ensure all circuit breakers relevant to the operation of ACAS are closed i.e. LRRA, ATC/IFF, VSI #1 & 2, Aural Wrng. Select NORM at the CADU main rotary switch. Select ACAS "ON" using the CADU soft keys
 - (d) Press CADU toggle switch DIAG-OFF-TEST momentarily to TEST. Verify the functionality of the ACAS system; If the ACAS selftest completes with the announcement "TCAS System Test Fail", continue troubleshooting.
 - (e) Access the lower 41, press the selftest button on the front panel of TTR-921 and observe the front panel LED indications. Indicators will momentarily light in any order. Note which fault indicator(s) are illuminated red (see Figure 101).
 - (f) If the fault diagnosis indicates that one of the TCAS directional antenna is faulty, carry out replacement in accordance with the instructions for antenna replacement
 - (g) If the fault diagnosis indicates that the TTR-921 is defective, carry out replacement in accordance with the instructions for TTR-921 replacement
 - (h) If the fault diagnosis indicates that one of the VSI/TA/RA indicators is defective, carry out replacement in accordance with the instructions for TVI-920 replacement
 - (i) If the flight report indicates that aural annunciations from ACAS and GPWS are inaudible, carry out replacement of the audio mixer in accordance with the instructions for audio mixer replacement.



TTR-921 - Fault Annunciators

Figure 101



MAINTENANCE MANUAL

ACAS II SYSTEM - ADJUSTMENT/TEST

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1. ACAS II system periodical check

Periodical check of the complete ACAS II function may be accomplished by using the following procedure.

A Support Equipment.

TTU-205

ASI-175

TCAS Ramp Test-Set 201

B Test-set Preparation

(1) General

- (a) Override the aircraft ground safety relay to simulate an airborne condition by placing the TEST/NORM switch on the P12 Nav. Panel to TEST
- (b) Ensure the aircraft flaps are positioned at zero degrees.
- (c) Connect TTU-205 to the aircraft static system, then adjust aircraft barometric altitude for an altitude of 10,000 ft
- (d) Energize the Rad Alt system and by using the Rad Alt test-set ASI-175, apply a signal to the Radio Altimeter to simulate a radio altitude greater than 1500 ft
- (e) Elevate the ramp test-set flat antenna above the aircraft, facing towards the top ACAS directional antenna at a relative bearing of zero degrees

NOTE: Do not position the TCAS-201 test antenna closer than 15 inches (40 cm) from either of the ACAS II antenna

(2) Test-Set TCAS-201

Prepare as follows.

- (a) Press Power and activate the test-set self-test function per IFR Operation Manual, Chapter 3.
- (b) At completion, the test-set display should indicate a PASS for all tests performed as illustrated below:



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```

**      SELF TEST      -      PASSED **

      RF MODULE          PASSED

      DIGITAL MODULE :    PASSED

POWER SUPPLY / BATTERY.  PASSED

```

Press RUN to start

(c) Press SET/CONT twice to access Screen Setup #2

- Set the display parameters to suit current visual conditions using the SELECT and SLEW keys
- Set range and altitude parameters as shown below

```

**          SETUP      # 2      **

CONTRAST  +0                      BACKLIGHT: +0

RANGE MAX  10 nm                  MIN      0 nm

ALT MAX    20000 ft              MIN.     0 ft

```

(d) Press SCEN

- programme the test screen scenario as shown below

```

**          SCENARIO  TEST      **

INTRUDER TYPE : ATCRBS          TIME  -----

RANGE .      8 00 nm            RATE   450 kt

ALT          10100 (ft)         RATE :  0 FPM

STATUS       NON THREAT

```

PRESS RUN TO START

(e) Press SET/CONT

- SETUP #1 Menu will be called-up.
- Set parameters accordingly using the SELECT and SLEW keys. Select a storage location from the numbers 0 - 9, then store the programmed scenario under the chosen location number
- Move the cursor to RECALL, select the stored location number and press RUN



MAINTENANCE MANUAL

**		SETUP		# 1		**	
INTRUDER TYPE .		ATCRBS					
UUT DIST:		HORIZ =		*** ft		VERT = *** ft	
ALT REPORTING		ON					
STORE:		0		RECALL		0	
GAIN _ 1030 =		****dB		LOSS =		**** dB	

(f) Press SCEN

- Confirm the recalled test screen scenario is as shown below

**		SCENARIO TEST		**	
INTRUDER TYPE		ATCRBS		TIME	
RANGE		8.00 nm		RATE 450 kt	
ALT :		10100 (ft)		RATE 0 FPM	
STATUS		NON THREAT			
PRESS RUN TO START					

(3) ACAS II

- (a) Close P5 circuit breakers ACAS and ATC/IFF
- (b) Ensure Low Range Altmtr No 1 and Compass No 1 are turned on
- (c) Set the CADU main rotary switch to STBY and then to NORM (Selecting STBY automatically initializes an internal self test of the transponder prime functions) The self test completes after approx 10 seconds, after which the CADU self test (CBIT) routine is started. On completion, the alpha-numeric displays will show the last selected code for Mode 1 and Mode 3/A

Ensure on completion that the LED FAIL is neither flashing nor permanently illuminated

If LED's TA and RA are not illuminated, perform the following to activate ACAS

- Press softkey MENU, [MODE] and [SEL] appears in the LH and RH alpha-numerical display windows respectively



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- Press softkey ACAS, [MODE] and [INP] appears in the LH and RH alpha-numerical display windows respectively Press softkey ACAS once more Ensure both LED's TA and RA are on.
 - Press softkey ENT, [AC] [CEPT] will be briefly displayed
- (d) With the TCAS-201 flat antenna positioned at 0° relative to the antenna under test, press the TCAS-201 RUN key and verify the following
- The simulated intruder on both VSI/TA/RA indicators is displayed as an Other Traffic symbol with a relative altitude tag of +01 and approaching the own aircraft symbol at a relative bearing of approx 0°
 - That the simulated intruder aircraft is displayed as Proximate Traffic at approx 6 NM from the own aircraft symbol
 - That the simulated intruder aircraft is displayed as a TA at approx 5 NM, and that the audio warning "Traffic, Traffic" can be heard over the audio warning loudspeaker
- (e) Select the 6 NM range on both indicators and verify:
- The simulated intruder changes to a solid red square, a Resolution Advisory (RA), at approx. 3 NM and that the audio warning "Descend, Descend" can be heard over the audio warning loudspeaker.
 - That the red and green circumference arcs on both VSI/TA/RA indicators illuminate to indicate a descend resolution advisory command of 1 500 FPM

If further variations of ACAS II scenarios are required to be performed, or if the system functionality is required to be verified via the other TCAS directional antenna, the test parameters of TCAS-201 and TTU-205 may be varied in any combination to suit the degree of testing desired

If bearing accuracy needs to be verified refer to the retest procedure in this document following replacement of an ACAS antenna for a description of the test method to be employed



MAINTENANCE MANUAL

TRANSPONDER (STR 2000-A1) - MAINTENANCE PRACTICES

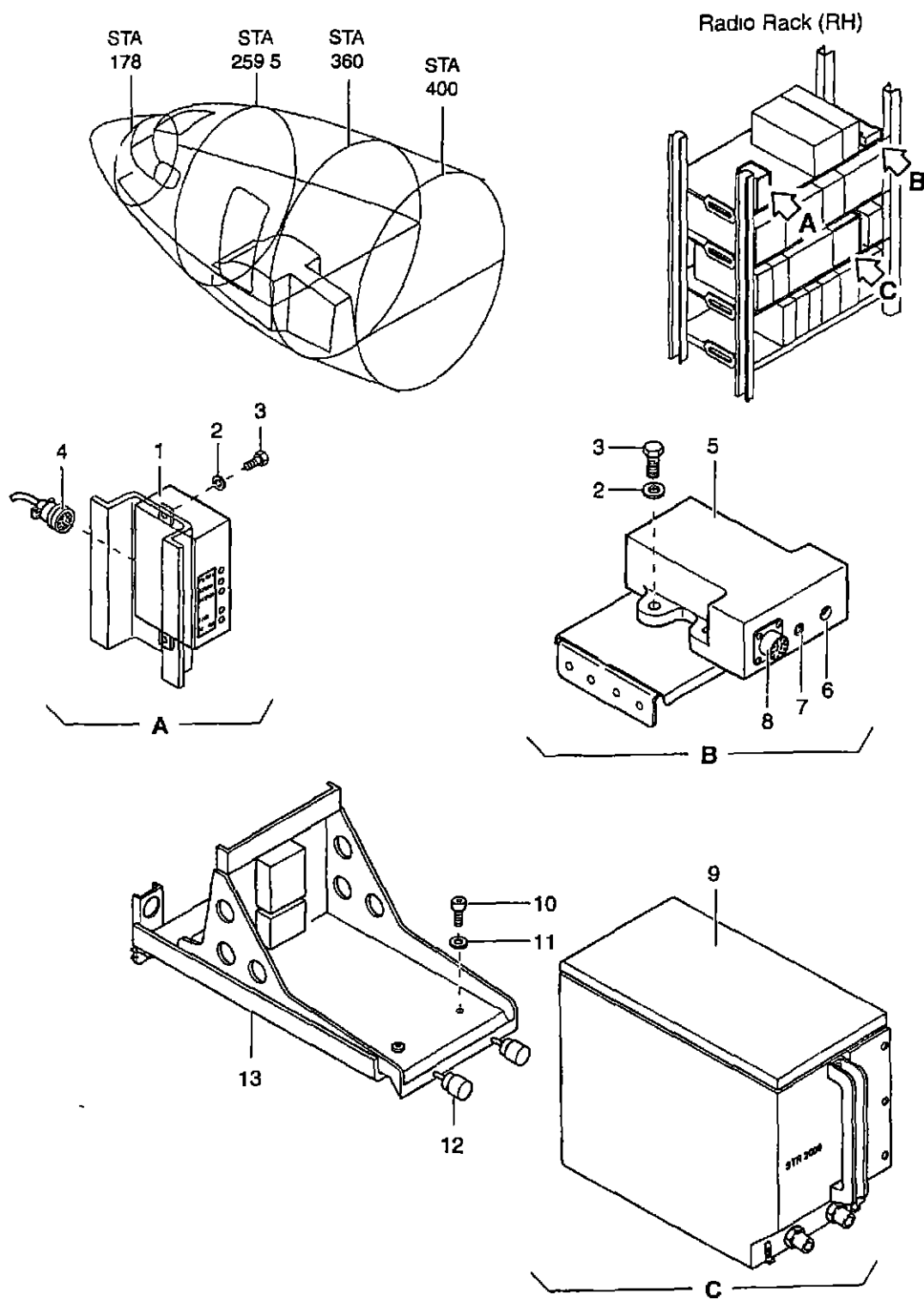
EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1. Removal/Installation of Transponder (STR 2000-A1)
 - A Removal of Transponder (STR 2000-A1) (see Figure 201)
 - (1) Open and tag circuit breaker ATC/IFF on O/head CB panel P5.
 - (2) Open the hatch to the electrical compartment
 - (3) Loosen the thumbscrew clamps (12) on the mounting tray
 - (4) Pull the Transponder (STR 2000-A1) (1) out of the mounting tray and remove it from the aircraft.
 - (5) Fit blanking caps to the electrical connectors
 - B Installation of transponder (STR 2000-A1)
 - (1) Make sure the circuit breaker ATC/IFF on O/head CB panel P5 is open and tagged.
 - (2) Remove blanking caps from the mounting rack connector
 - (3) Install transponder (STR 2000-A1) (9) in place by carefully sliding into the mounting tray
 - (4) Tighten thumbscrew clamps (12) clockwise
 - (5) Remove the tag from the circuit breaker and close it.
 - (6) Perform functional test
 - C Functional test
 - (1) Select STBY at the CADU main rotary switch The automatic self-test is started
 - (2) Wait approx 30 sec
 - (3) On completion of the selftest and if the selftest is successful, the FAIL LED on the CADU should be extinguished.



Radio Rack (RH)
 Figure 201



MAINTENANCE MANUAL

CONTROL & DISPLAY UNIT (CADU) - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 Removal/Installation of Control & Display Unit (CADU)

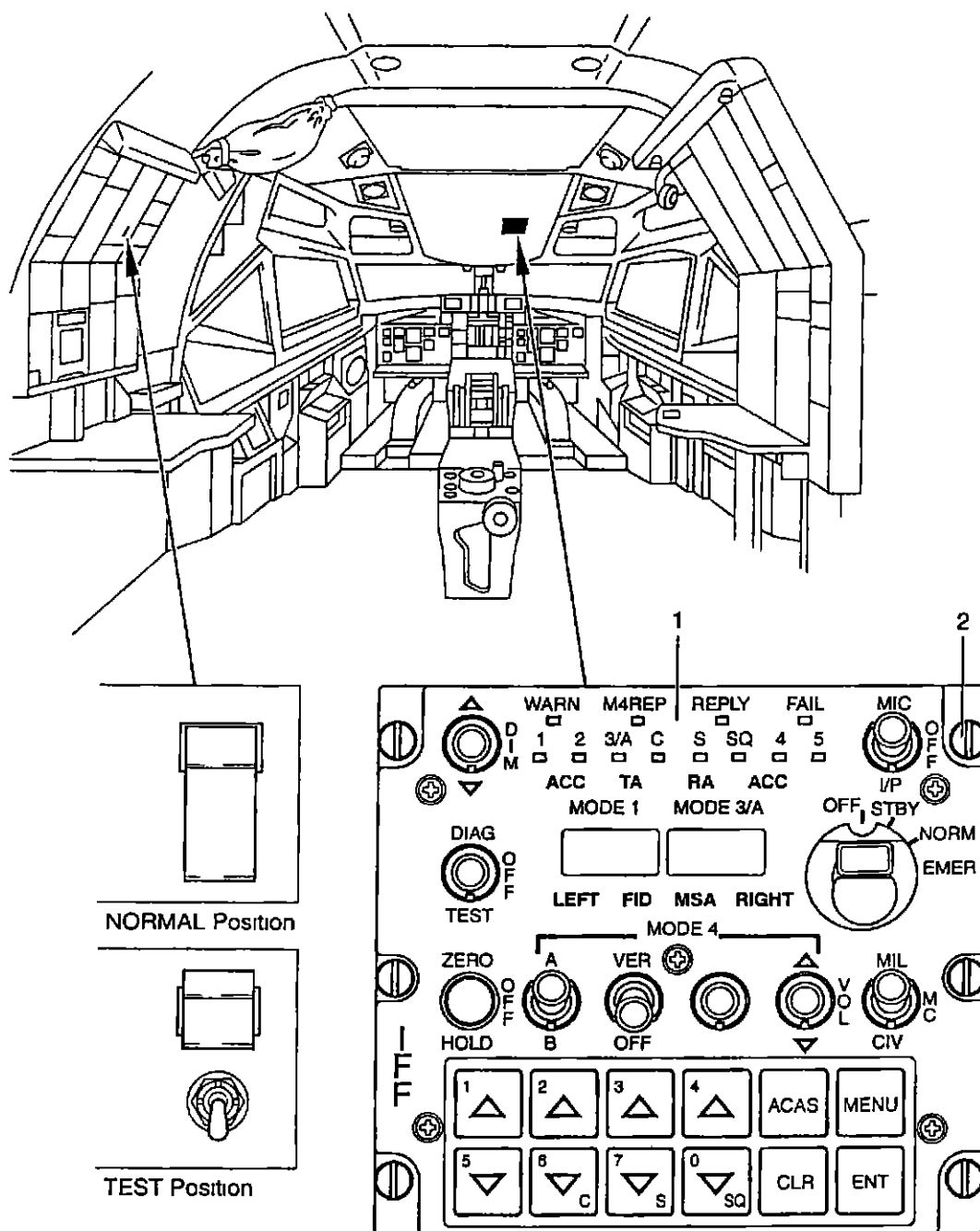
A Removal of Control & Display Unit (CADU) (see Figure 201)

- (1) Open and tag circuit breaker ATC/IFF on O/head CB panel P5.
- (2) Loosen 6 DZUS (2) fasteners holding the CADU (1) in place
- (3) Remove the CADU carefully from the overhead Panel.
- (4) Disconnect connector P4 from the unit (1) and install a blanking cap on the open connector
- (5) Remove the unit (1) from the aircraft

B Installation of Control & Display Unit (CADU)

NOTE If the CADU has to be changed remove the two protective covers from the connectors and install them on the equivalent connectors of the CADU to be installed

- (1) Ensure the circuit breaker ATC/IFF on O/head CB panel P5 is open and tagged
- (2) Remove the blanking cap, connect P4 to the CADU and secure the unit in place in P13 by tightening the 6 DZUS fasteners (2).
- (3) Close circuit breaker ATC/IFF on P5
- (4) Perform transponder functional test



Control & Display Unit (CADU)

Figure 201



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C Functional test

NOTE Following installation of a new CADU it is necessary to set-up the Mode S address and aircraft speed designation applicable to the aircraft

- Select STBY at the CADU main rotary switch. The automatic self-test is started
- Wait approx 30 sec
- On completion of the selftest and if the selftest is successful, the FAIL LED on the CADU should be extinguished

(1) Carry out the following parameter set-up

(a) Program Mode S Address

NOTE Entry of the Mode S address requires prior entry of the Password 4711

The password will be displayed in the alpha-numeric display window

- Press hotkey MENU, [MODE] [SEL] appears in the alpha-numeric display
- Press and hold softkey MENU for longer than 3 secs [FLIT] [ID] appears in the alpha-numeric display
- Press softkey MENU, [MODE] [LST.] appears in the alpha-numeric display
- Press softkey MENU, [ENTR] [PIN] appears in the alpha-numeric display
- Press softkey 4, [ENTR] [___4] appears in the alpha-numeric display.
- Press softkey 7, in the alpha-numeric display will show [ENTR] [__47]
- Press softkey 1, in the alpha-numeric display will show [ENTR] [_471]
- Press softkey 1, in the alpha-numeric display will show [ENTR] [4711]
- Press softkey ENT. If the entry has been accomplished successfully the alpha-numeric display will briefly show [PIN] [OKAY] followed by [MODS] [ADD]
- Press softkey ENT. The display will show [****] [**__]

LED's LEFT and MSA beneath the display windows will be illuminated



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NOTE Each Mode S Address comprises an 6 digit hexadecimal address that can be entered with the softkeys 0 - 7 and is displayed in the alpha-numeric windows.

- Enter the mode S address code for the aircraft by pressing the numerical/scroll softkeys corresponding to the character position in the LH display. When the first four characters of the hexadecimal address have been entered satisfactorily, press ENT. The LED LEFT extinguishes and the LED RIGHT illuminates to indicate that the RH entry may now be performed.
- Enter the remaining characters of the Mode S address into the RH display window using the numerical/scroll softkeys.
- Press softkey ENT. The words [AC] and [CEPT] will appear briefly in the alpha-numeric display signifying that the Mode S address has been stored. The address will remain valid for this aircraft until a further address change using this procedure is performed.

Afterwards the display will automatically change to [AIRS] [COD]

- Press CLR to leave the submenu

(b) Program Mode S Airspeed Settings

NOTE: Entry of the Mode S Airspeed requires prior entry of the Password 4711. The password will be displayed in the alpha-numeric display window

- Press softkey MENU, [MODE] [SEL.] appears in the alpha-numeric display
- Press and hold softkey MENU for longer than 3 secs [FLIT] [ID] appears in the alpha-numeric display
- Press softkey MENU [CODE] [LST.] appears in the alpha-numeric display
- Press softkey MENU [ENTR] [PIN] appears in the alpha-numeric display
- Press softkey MENU. [ENTR] [___4] appears in the alpha-numeric display
- Press softkey 7, the alpha-numeric display will show [ENTR] [__47]
- Press softkey 1, the alpha-numeric display will show [ENTR] [_471]
- Press softkey 1, the alpha-numeric display will show [ENTR] [4711].



MAINTENANCE MANUAL

- Press softkey ENT. If the entry has been accomplished successfully the alpha-numeric display will briefly show [PIN] [OKAY] followed by [MODS] [ADD.]
 - Press softkey MENU. The display will show [AIRS] [COD]
 - Press softkey ENT and verify the airspeed is shown as 4
 - If the displayed airspeed is correct, press softkey ENT. The words [AC] and [CEPT] will appear briefly in the alpha-numeric display. Then press CLR.
 - If the airspeed needs to be altered, press softkey CLR.
 - Press softkey 4 followed by softkey ENT. The words [AC] and [CEPT] will appear briefly in the alpha-numeric display.
 - Press CLR to leave the submenu
- (2) Activate self-test again by selecting TEST on the DIAG-OFF-TEST toggle switch. After the selftest routine has completed the CADU FAIL should be extinguished.



MAINTENANCE MANUAL

MULTI-ROLE AIR DATA COMPUTER HG 1140CA (MADC) - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 Removal/Installation of Multi-role Air Data Computer HG 1140CA (MADC)

A Remove Multi-role Air Data Computer HG 1140CA (MADC) (see Figure 201)

- (1) Open and tag the circuit breaker MADC on O/head CB panel P5.
- (2) Open the access hatch to the electrical compartment to gain access to the RH Radio Rack
- (3) Remove electrical connector RD9607 (8) from the MADC and install blanking caps.
- (4) Remove the static input connector (6) and install blanking cap
- (5) Remove the two quick disconnect screws (3) and washers (2) by turning counterclockwise
- (6) Remove and retain dummy plug from pitot inport port (7). Remove MADC from aircraft

B Install Multi-role Air Data Computer HG 1140CA (MADC)

- (1) Ensure the circuit breaker MADC on O/head CB panel P5 is open and tagged
- (2) Install dummy plug into MADC pitot receptacle
- (3) Install MADC in RH radio rack
- (4) Tighten the two fixing screws (3) and washers (2).
- (5) Install connector RD9607 (8).
- (6) Install the static connector (6) to the MADC static input port
- (7) Close the circuit breakers MADC and ATC/IFF on O/head Panel P5.
- (8) Perform Static Leak Test on pilot's static pressure system (see Ground Test Procedure - Ground Funct Test Chapter - 5 7 30)
- (9) TCA leak test - 1 min
RTCA: leak test - 3 min.



MAINTENANCE MANUAL

C Functional retest (Mode C altitude accuracy check)

NOTE Self-test STR 2000-A1 can only check if stream of DATA BUS is there (parity), but is unable to check altitude accuracy

(1) Activate STR 2000-A1

Ensure self test OK, CADU FAIL indicator extinguished

- Ensure TTU-205 Test Set is hooked-up to the left (pilot) static system.
- Close MADC circuit breaker on P5 O/head circuit breaker panel
- Place CADU rotary switch to the NORM position
- If Mode C and Mode S are not activated, select both modes at the CADU.
- Select TEST position on the TEST/NORM switch.
- Adjust TTU-205 test set sequentially to the altitudes and airspeeds shown in Table 201

NOTE: The Constant Cruise Mach No for the A/C with all four engines in operation is 0.82. Monitor the A/C Machmeter at each altitude setting and ensure that the Mach No. never exceeds 0.82. Erroneous altitude readings may occur if this Mach No is exceeded. Adjust the test set airspeed accordingly

- Select ATCRBS REPLY TEST at the IFF-701 test set and interrogate STR 2000 via the lower antenna as follows.
 - Press RUN/STOP, TEST RUNNING will be displayed
 - Select each altitude level in turn and verify that the displayed Mode C altitude on the screen compares with the altitude setting on TTU-205. Verify the cockpit indicated altitude is within tolerance for each altitude setting. Altimeter accuracy tolerance is given in FAA, DOT, PT 43, App. E

NOTE: The pilots altimeter must be set to RESET and the copilots altimeter to STBY.

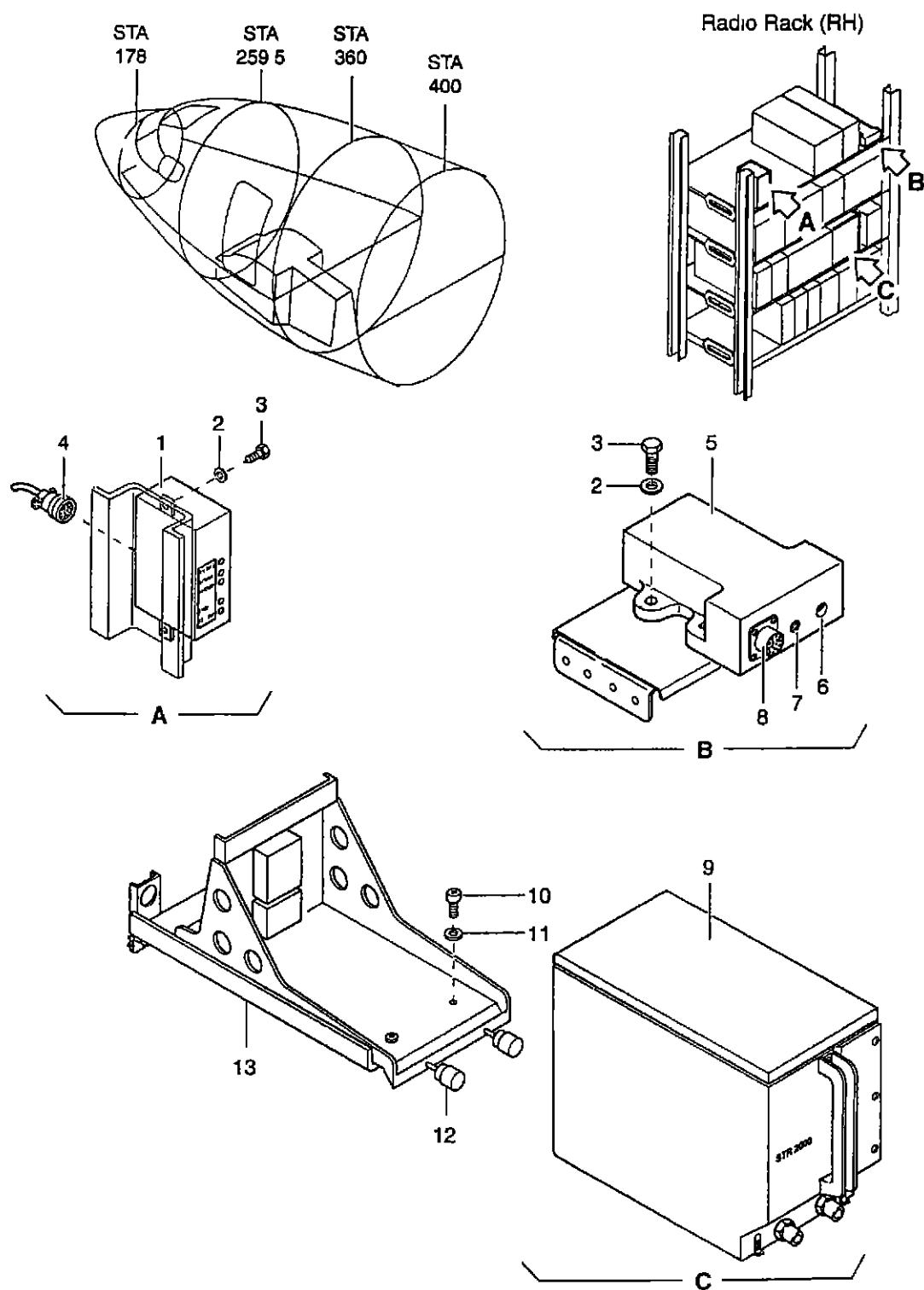
	**	ATCRBS REPLY TEST	- PASSED	**
F1 TO F2 SPACING	3 ****	μ S	C	20 30 μ S +/- 0.1 μ S
F1 PULSE WIDTH	3 ****	μ S	C	0.30 μ S +/- 0.1 μ S
F2 PULSE WIDTH	3 ****	μ S	C	0.30 μ S +/- 0.1 μ S
CODE = ***	ALT =	FT		(----
	Press RUN to start			

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Altitude Column Table

TTU-205 ALTITUDE (ft)	TTU-205 APPROX AIRSPEED (KTS)
1000	100
5000	200
10000	200
12000	200
15000	200
18000	250
20000	270
23000	270
26000	270
29000	270
30000	300
32000	270
35000	270
37000	260
39000	248
40000	248

Altitude Column Table
Table 201



Radio Rack (RH)
 Figure 201



MAINTENANCE MANUAL

ACAS DIRECTIONAL ANTENNA - MAINTENANCE PRACTICES

EFFECTIVITY

RTCA: LX-N19997, LX-N20000

TCA: LX-N20199

1. Equipment and Materials

- A. Self Leveling Green Sealant (P/N HT3326-5-50).
- B. Tape Stretch Seal (P/N AD89503/01-36).

2. Removal/Installation of ACAS directional antenna

NOTE: Removal of an upper antenna requires a work stand high enough to reach the top of the fuselage.

A. Remove ACAS directional antenna

- (1) Open ACAS circuit breaker on P5 overhead circuit breaker panel.
- (2) Locate the two ACAS antennas:
ACAS top at station 408
ACAS bottom at station 411
- (3) Remove four screws that attach the antenna to the fuselage.
- (4) Pull antenna out far enough to disconnect coaxial cable connector.

NOTE: If antenna is located on top of aircraft, secure cable so that it will not fall into aircraft.

- (5) Disconnect coaxial cable connector from antenna.
- (6) Discard O-ring.

B. Install ACAS directional antenna

- (1) Place antenna gasket on antenna.
- (2) Apply self levelling green sealant to connector base. Allow sealant to cure for 30 minutes before mounting antenna to aircraft.
- (3) Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- (4) Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- (5) Prime and paint all bare metal outside original antenna footprint and decrease the original antenna footprint by 0,2 inch per AMM 51-90-00.

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TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

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NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

- (6) Clean the antenna footprint and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- (7) Remove the aliphatic naphtha with a clean cloth.
- (8) Place antenna near mounting location and connect coaxial cable to antenna.
- (9) Wind stretch seal tape around the connector until it is 1.5 inch above the connector, covering the coax cable.

NOTE: Make sure the adhesive side of the tape is pointing to the coaxial cable and connector. This provides for a tight seal.

CAUTION: DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACE.

- (10) Place antenna in position, ensuring the antenna gasket is positioned correctly.
- (11) Secure antenna with four mounting screws. Ensure that a Teflon washer is placed under each screw.
- (12) Tighten antenna screws so that antenna gasket is compressed evenly.
- (13) Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- (14) Measure electrical bond resistance between antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- (15) Close ACAS circuit breaker on P5 overhead circuit breaker panel.
- (16) Perform operational test per AMM 34-45-04 par. 1C.



MAINTENANCE MANUAL

ACAS DIRECTIONAL ANTENNA - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 Removal/Installation of ACAS directional antenna

A Remove ACAS directional antenna (see Figure 201)

NOTE The following procedure is identical for both ACAS Antennas (lower and upper)

- (1) Open and secure circuit breaker ACAS on circuit breaker Panel P5
- (2) Remove existing sealing compound around the antenna plate (4) by use of a Phenol scraper or equivalent tool
- (3) Remove the screw head rubber sealant (3) and withdraw the silicon rubber plugs. Remove the four screws (2) from the antenna (1) and retain for future use
- (4) Carefully remove the antenna (1) from the aircraft structure and disconnect the four coaxial antenna cables from the connectors
- (5) Install dust caps on each antenna connector

B Install ACAS directional antenna

- (1) Ensure circuit breaker ACAS on circuit breaker Panel P5 is pulled and tagged
- (2) Clean sealing compound residue from the aircraft structure around the antenna area
- (3) Make sure that the antenna opening is free of any sealing compound.
- (4) Clean all antenna ground plate mounting holes and ensure no sealing compound residue.
- (5) Make sure that the antenna ground plate (4) and the aircraft fixing structure area is free of corrosion. In case of corrosion, clean the surface and remove corrosion
- (6) Install O ring, then connect all four coaxial cables in accordance with their color coding to the antenna
- (7) Position the antenna (1) in place with the four mounting screws (2). Tighten and torque mounting screws (2)



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- (8) Apply any weather/aerodynamic fillet of sealant to the periphery of the antenna and shape as necessary. The height of the bead should not exceed 2.5 mm.
- (9) Install the four foam rubber plugs (3) in the mounting holes. After pressing them fully down, fill the holes until flush with Dow Corning (gray).
- (10) Check bonding resistance of antenna to aircraft skin < 5 mOhms. Remove safety clip and close circuit breaker ACAS on circuit breaker panel P5.

C Functional test using test-set TCAS-201

Antenna Bearing Accuracy Measurement

- (1) Close P5 circuit breakers ACAS and ATC / IFF
- (2) Ensure Low Range Altmtr No 1 and Compass No 1 are turned on
- (3) Set the CADU main rotary switch to STBY and then to NORM (Selecting STBY automatically initializes an internal self test of the transponder prime functions). The self test completes after approx. 10 seconds, after which the CADU self test (CBIT) routine is started. On completion, the alpha-numeric displays will show the last selected code for Mode 1 and Mode 3/A.

Ensure on completion that the LED FAIL is neither flashing nor permanently illuminated.

If LED's TA and RA are not illuminated, perform the following to activate ACAS:

- Press softkey MENU, [MODE] and [SEL :] appears in the LH and RH alpha-numerical display windows respectively
 - Press softkey ACAS, [MODE] and [INP] appears in the LH and RH alpha-numerical display windows respectively. Press softkey ACAS once more. Ensure both LED's TA and RA are on
 - Press softkey ENT, [AC] [CEPT] will be briefly displayed.
- (4) Using the CADU toggle switch DIAG-OFF-TEST, momentarily select the TEST position, then release the switch. Verify the cockpit loudspeaker announces "TCAS System Test OK"
 - (5) Prepare test set TCAS-201 as follows

Press Power and activate the test set self-test function per IFR Operation Manual, Chap 3.

At completion, the test set display should indicate a PASS for all tests performed as illustrated below



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```

**      SELF TEST      -      PASSED **

      RF MODULE      PASSED

      DIGITAL MODULE      PASSED

POWER SUPPLY / BATTERY.      PASSED
  
```

Press RUN to start

Press SET/CONT twice to access Screen Setup # 2.

- Set the display parameters to suit current visual conditions using the SELECT and SLEW keys
- Set range and altitude parameters as shown below

```

**          SETUP      # 2      **

      CONTRAST      +0      BACKLIGHT      +0

RANGE MAX      10 nm      MIN      0 nm

ALT MAX      20000 ft      MIN      0 ft
  
```

Press SCEN

- Programme the test screen scenario as shown below

```

**          SCENARIO TEST      **

INTRUDER TYPE      ATCRBS      TIME : -----

      RANGE      5 00 nm      RATE      0 kt

      ALT      airfield elevation (ft)      RATE      0 FPM

      STATUS      NON THREAT

      PRESS RUN TO START
  
```

Press SET/CONT

- SETUP #1 Menu will be called-up
- Set parameters accordingly using the SELECT and SLEW keys
Select a storage location from the numbers 0 - 9, then store the programmed scenario under the chosen location number
- Move the cursor to RECALL, select the stored location number and press RUN.

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```

**          SETUP      # 1          **

INTRUDER TYPE          ATCRBS

UUT  DIST              HORIZ =      *** ft          VERT = *** ft

ALT REPORTING          ON

STORE.      0          RECALL:      0

GAIN _ 1030 = ****dB    LOSS  = **** dB

```

Press the RPLY TEST key The following test screen will be displayed.

```

**          ATCRBS  REPLY  TEST          **

RANGE :      5 00 nm          ALTITUDE : airfield elevation (ft)

% REPLY *      100

PRESS RUN TO START

```

Position the test antenna at the selected horizontal and vertical distances from the antenna under test

- Press RUN to initiate the intruder reply (bearing) test.

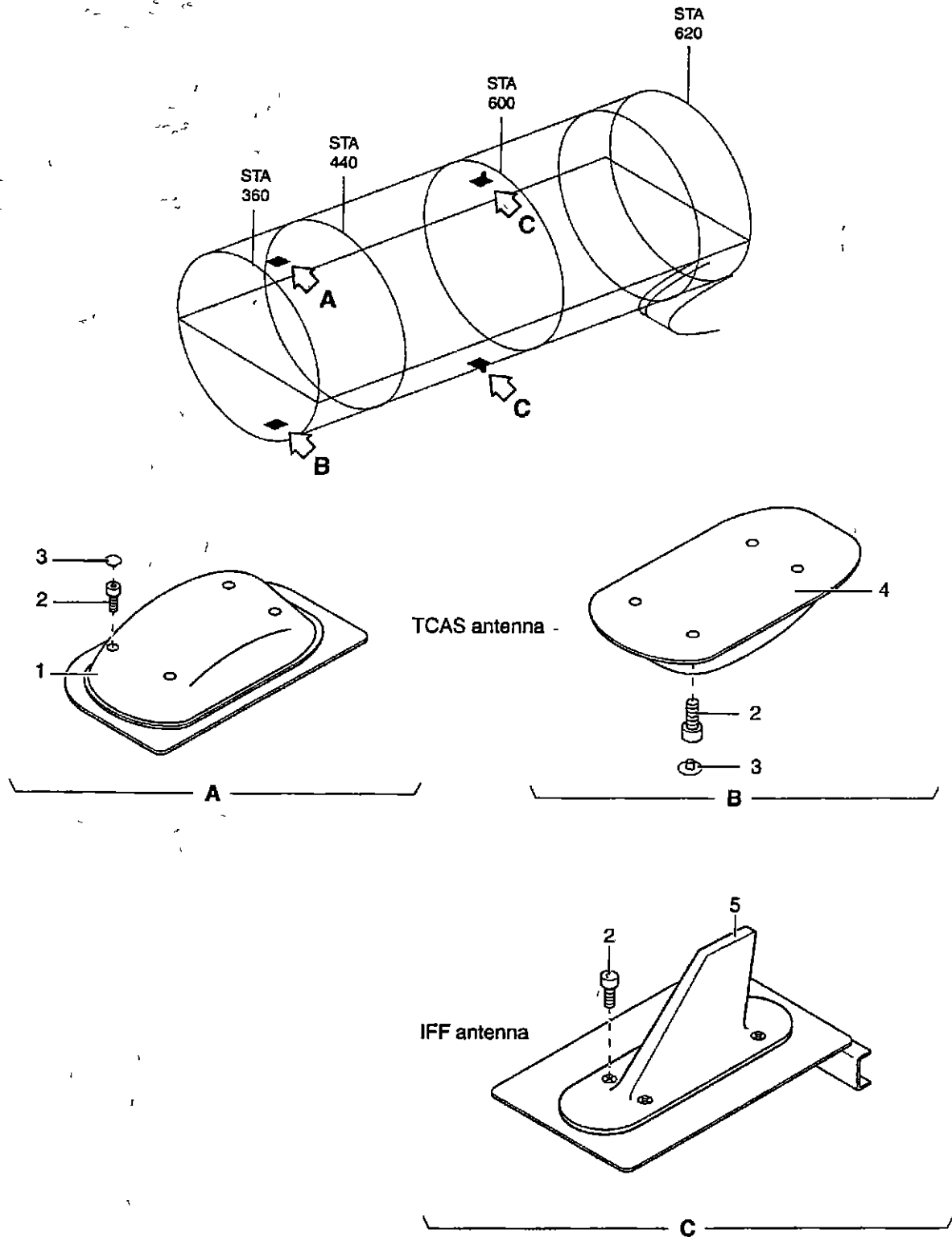
The reply test will display the stationary traffic symbol at an antenna bearing relevant to the azimuth of the interrogation source, in this case the test set flat antenna. Verify on both VSI/TA /RA indicators.

- PROXIMATE TRAFFIC symbols (solid blue diamond) are positioned at a bearing of 0° (+/-15°).
- A data tag, the relative altitude of simulated intruder w r t airfield elevation, is shown beneath the PROXIMATE TRAFFIC symbol.

NOTE The altitude data tag is not a feature of antenna replacement, if required, however, a TTU-205 test-set may be connected to the aircraft static pressure system to verify the system relative altitude reporting function

Terminate the test by pressing STOP on TCAS-201

- (6) Sequentially reposition the test set flat antenna relative to the antenna under test and repeat the bearing test for bearing angles of 45°, 90°, 135°, 180°, 225°, 270° and 315°



ACAS Antenna
 Figure 201



MAINTENANCE MANUAL

TTR-921 - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 Removal/Installation of TTR-921

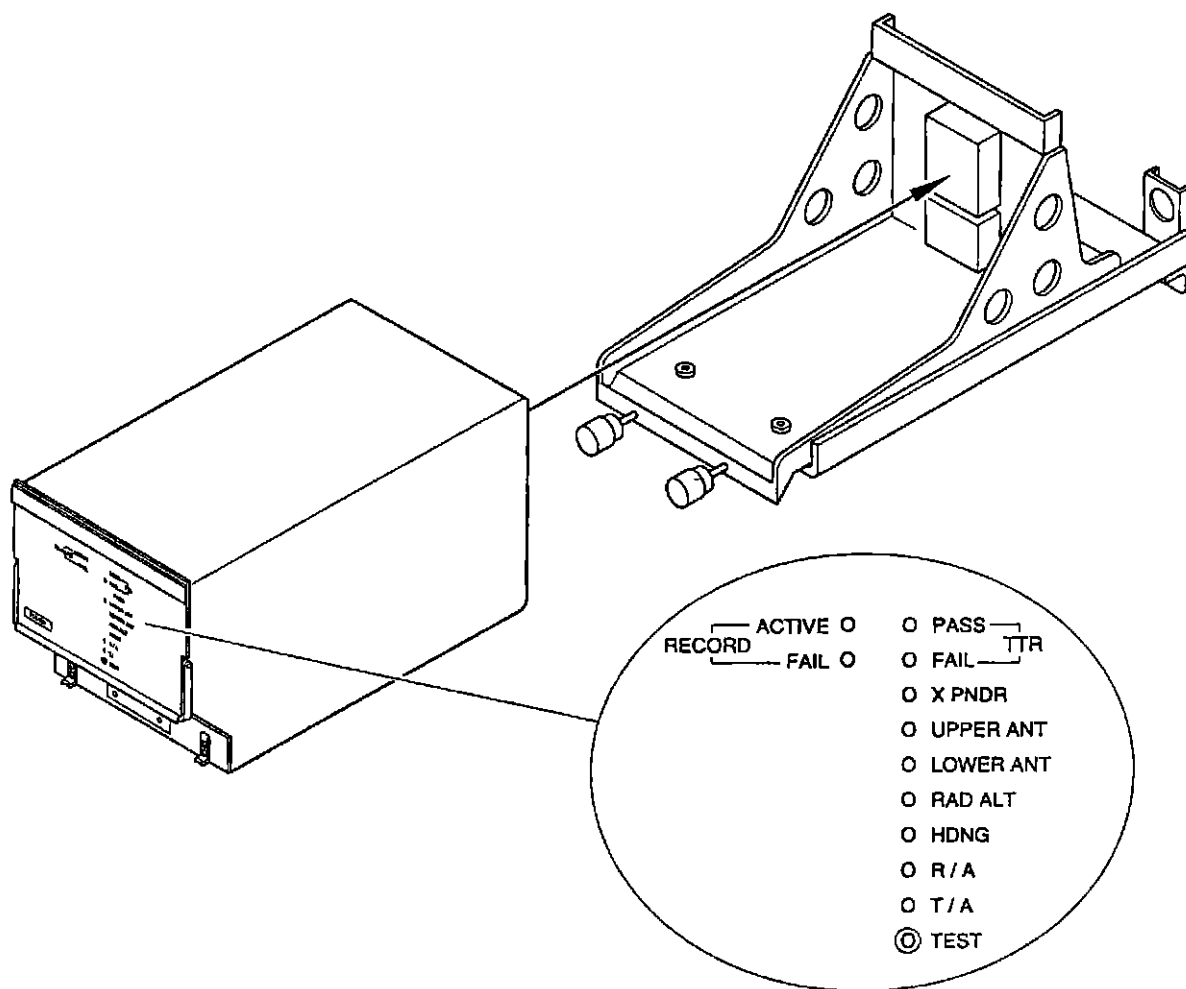
A. Remove TTR-921 (see Figure 201)

- (1) Open and tag circuit breaker ACAS on O/head Panel P5
- (2) Loosen the thumbscrew clamps (4) on the mounting tray (3), and remove TTR-921 from the mounting tray
- (3) Install blanking caps on the ARINC 600 connectors.

B Install TTR-921

- (1) Ensure the circuit breaker ACAS on O/head Panel P5 is open and tagged
- (2) Remove blanking caps from the ARINC 600 connector.
- (3) Install the ACAS TTR-921 by sliding it carefully into the mounting tray (3) until the rear connector mates with the ARINC 600 connector on the mounting.
- (4) Tighten the thumbscrew clamps (4) clockwise
- (5) Remove the tag from the ACAS circuit breaker. Close circuit breakers ACAS and ATC/IFF on O/head Panel P5.
- (6) Ensure Low Range Altmtr No 1 and Compass No 1 are turned on Select STBY on the CADU.
- (7) Press the self test button on the front panel of TTR-921 and observe the front panel LED indications. Indicators will momentarily light in any order. Note which indicators, if any, are lit just before all go out (approx 10 s)

If ACAS II is fully operational the TTR "PASS" LED will briefly illuminate green. Simultaneously, the cockpit loudspeaker will announce "TCAS System Test OK".



TTR-921 - Removal/Installation
 Figure 201

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TVI-920 (VSI/TA/RA) - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

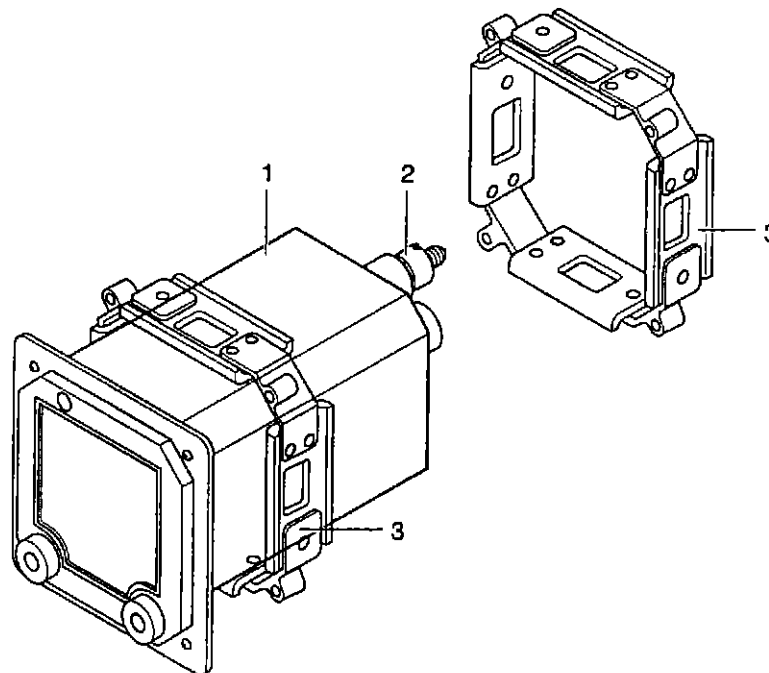
LX - N20000

LX - N20199

1 Removal/Installation of VSI/TA/RA indicator (pilot/copilot)

A Remove VSI/TA/RA Indicator - Pilot/Copilot (see Figure 201)

- (1) Open and tag circuit breakers VSI 1 (pilot), VSI 2 (copilot) and VSI DIMM on O/head Panel P5
- (2) Loosen both Marmon clamp (3) retaining screws through the two holes in the indicator face plate.
- (3) Withdraw the VSI (1) carefully from the panel on pilot/copilot side until the connector (2) is accessible
- (4) Remove the connector (2) from the unit
- (5) Install blanking caps on the connector
- (6) Remove the VSI (1) from the aircraft.



VSI/TA/RA - Removal/Installation

Figure 201

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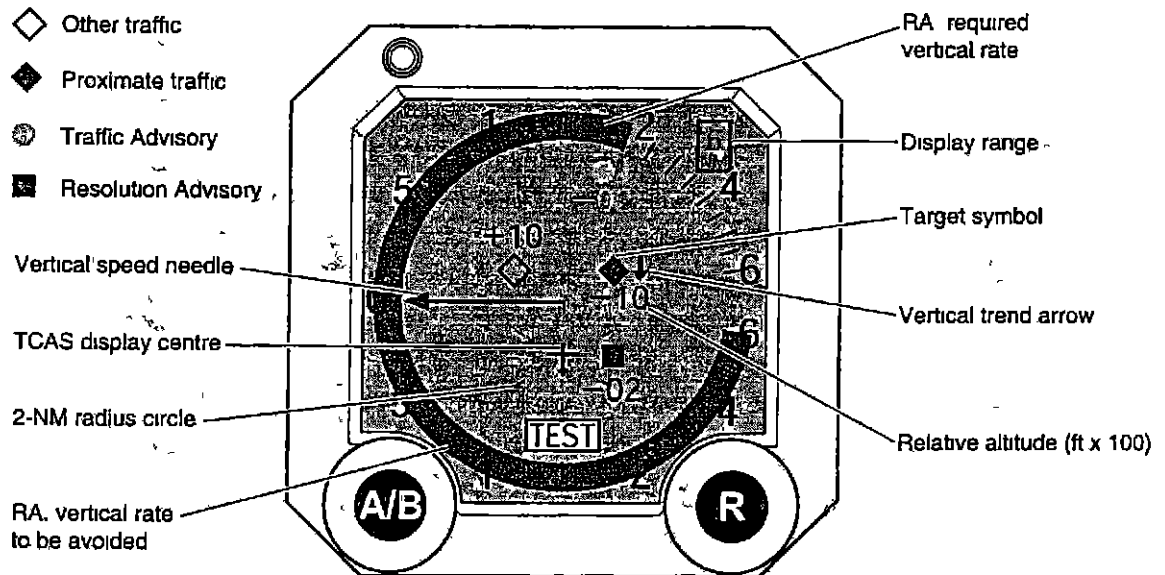
B Install VSI/TA/RA Indicator – Pilot/Copilot

- (1) Ensure the circuit breakers VSI 1 (pilot), VSI 2 (copilot) and VSI DIMM on O/head Panel P5 are open and tagged.
- (2) Remove the blanking cap from the connector (2)
- (3) Install connector (2) to the unit
- (4) Slide the unit carefully into the pilot/copilot Marmon clamp (3).
- (5) Tighten both clamp retaining screws.
- (6) Remove safety tags and close the circuit breakers VSI 1 (pilot), VSI 2 (copilot) and VSI DIMM on O/head Panel P5
- (7) Perform functional test

C Functional test

- (1) Ensure circuit breaker ATC/IFF on O/head Panel P5 is closed
Switch CADU to STBY.
- (2) Activate the ACAS selftest by momentarily selecting TEST on the CADU DIAG-OFF-TEST toggle switch.
- (3) Observe the VSI/TA/RA display as the ACAS selftest is performed
Verify that the standard test picture (see Figure 202) is displayed. Verify that at completion of the selftest, ACAS annunciates "TCAS System Test OK".
- (4) Activate ACAS from the CADU and verify that the VSI/TA/RA Range switch properly changes the traffic display between 6 NM and 12 NM. Verify also that the Above and Below switch operates, as seen by the appearance of ABV or BLW in the top RH corner of the display.
- (5) Verify the VSI Dim control operates over the full illumination range

TCAS RA Display Implemented on an IVSI



VSI/TAS/RA Indicator (Pilot/Copilot) - Test Picture

Figure 202



MAINTENANCE MANUAL

AUDIO MIXER - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

1 Removal/Installation of Audio Mixer

A Remove Audio Mixer (see Figure 201)

- (1) Open and tag the circuit breaker AURAL WARNING on O/head Panel P5
- (2) Remove the screws (3) and washers (2) and retain for future use
- (3) Remove the connector (4) from the Audio Mixer (1) and install blanking cap on the connector
- (4) Remove the Audio Mixer (1) from the aircraft

B. Install Audio Mixer

- (1) Ensure the circuit breaker AURAL WARNING on O/head Panel P5 is open and tagged.
- (2) Remove blanking cap from the connector (4)
- (3) Secure the audio mixer (1) to the upright of the RH radio rack using washers (2) and screws (3).
- (4) Remove safety tag and close the circuit breaker AURAL WARNING on O/head Panel P5.
- (5) Perform functional test.

C Functional test

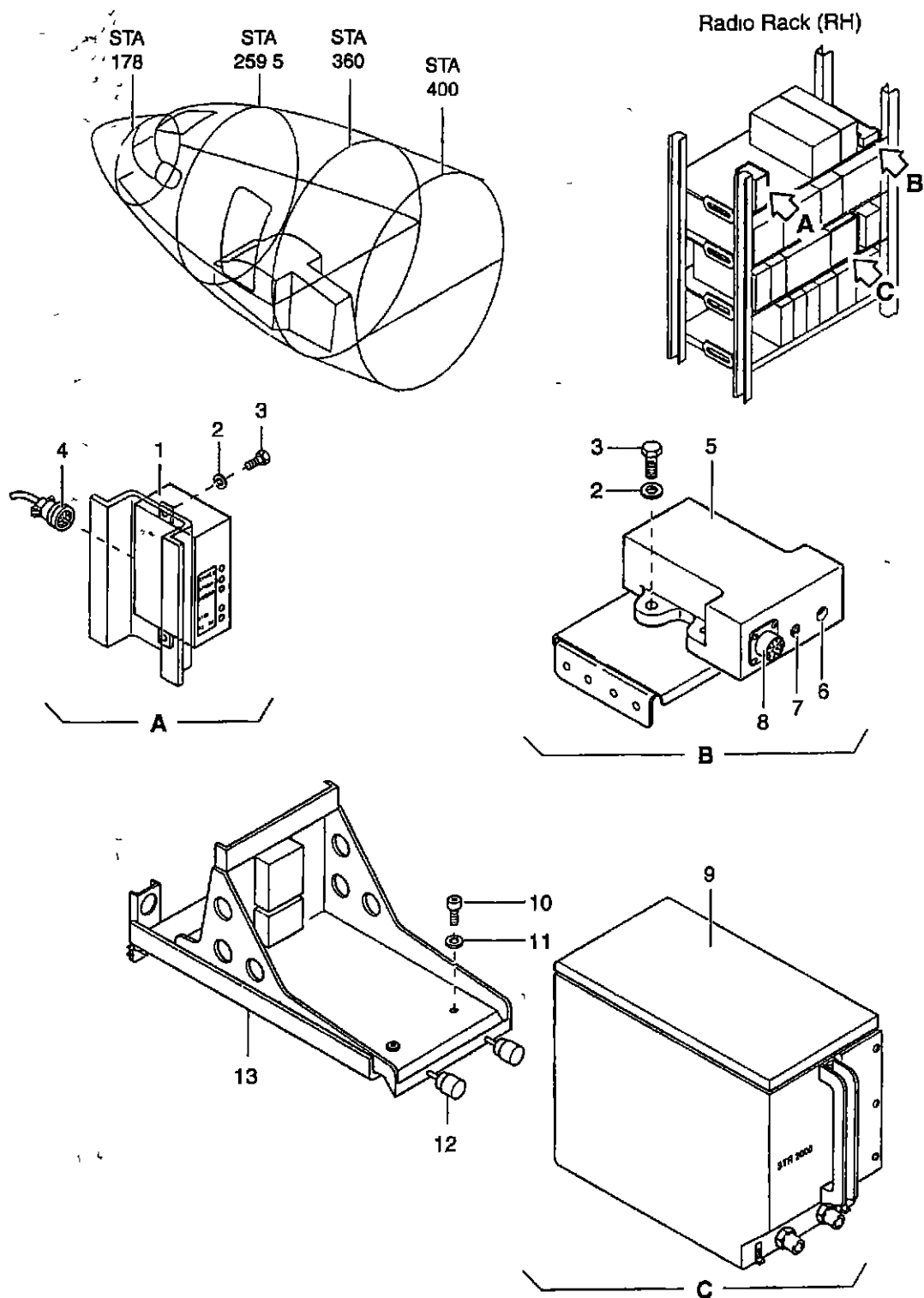
- (1) Ensure circuit breakers Low Range Altmtr, ACAS and ATC/IFF are closed.
- (2) Select STBY at the CADU
- (3) Initiate the ACAS self-test by momentarily selecting TEST with the CADU DIAG-OFF-TEST toggle switch. Adjust R6 on the audio mixer simultaneously with the audio announcement "TCAS System Test OK" until an acceptable undistorted volume level in the cockpit is reached. Operate the selftest as often as required to achieve the adjustment.



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- (4) Initiate self test of the GPWS system by pressing the PTT warning light on the captain's instrument Panel. Adjust audio mixer R1/R3 until an acceptable undistorted volume level in cockpit is reached.

NOTE. If the dynamic range of the potentiometers does not enable acceptable volume levels to be reached, or if voice distortion as a result of the adjustment occurs, the audio level balance and distortion correction can be accomplished by fine tuning the audio mixer potentiometers R1, R3 and R6 in combination with the adjustment of the mixed output power potentiometer R7.



Radio Rack (RH)

Figure 201



MAINTENANCE MANUAL

5 V LIGHTING TRANSFORMER - MAINTENANCE PRACTICES

1. Removal/Installation of 5 V Lighting Transformer (RT9601)

A Remove transformer RT9601 (see Figure 201)

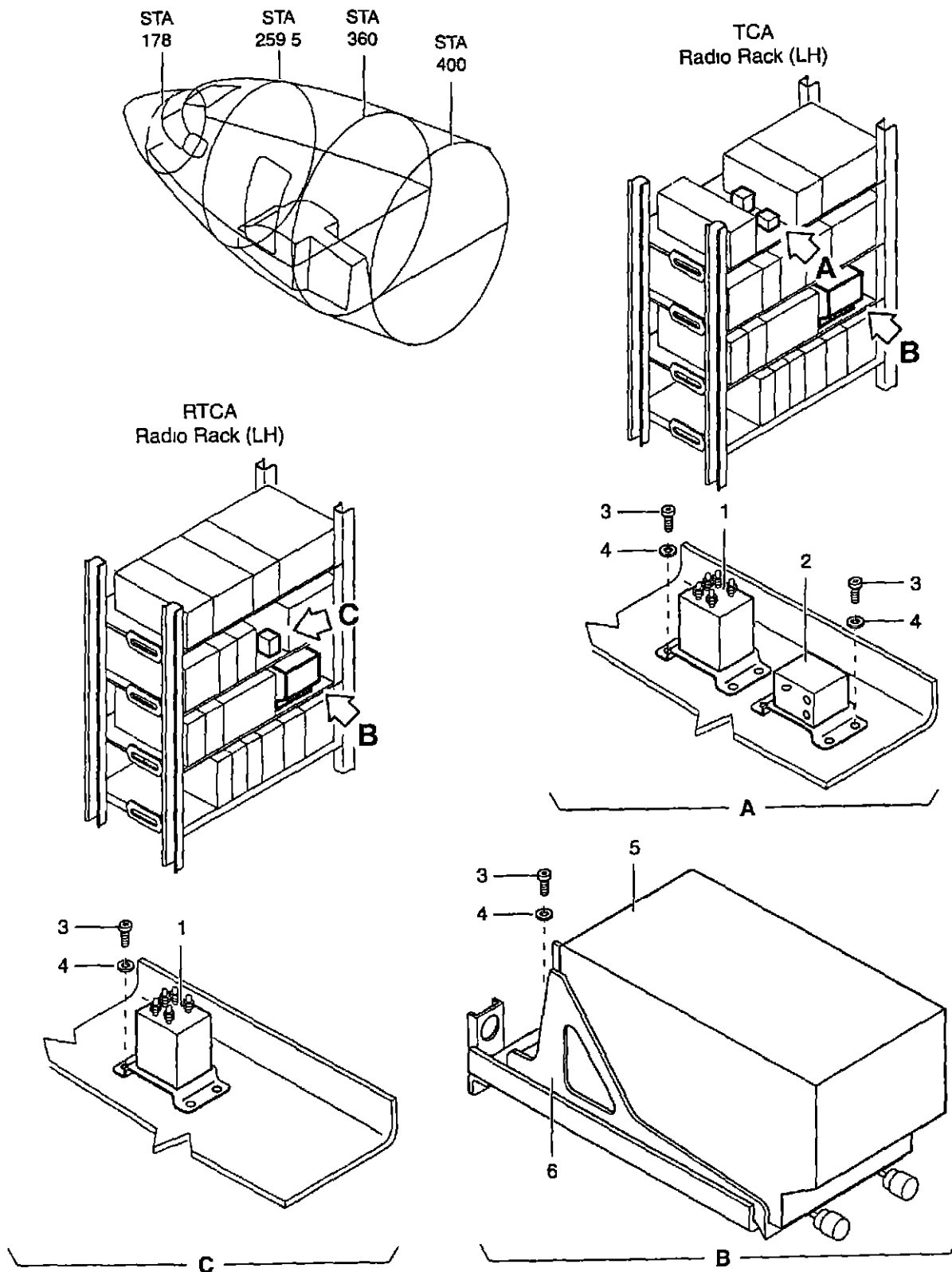
- (1) Open and tag circuit breaker VSI DIMM on O/head Panel P5
- (2) Disconnect wiring, loosen the four screws (3) and washers (4) and remove transformer (1) from the LH radio rack shelf
- (3) Remove transformer (1) from aircraft

B Install transformer RT9601

- (1) Ensure the circuit breaker VSI DIMM on O/head Panel P5 is open and tagged.
- (2) Connect transformer (1) input and output wiring
- (3) Secure new component to the LH radio rack shelf mounting tray using the four screws (3) and washers (4) salvaged during removal
- (4) Remove safety tag and close the following circuit breaker VSI DIMM on O/head Panel P5
- (5) Perform functional check using multimeter.

C Functional check

- (1) If the VSI/TA/RA indicator lighting fails, verify that circuit breaker VSI DIM on P5 is closed
- (2) Measure the voltage at VSI dim potentiometer RR9600/RR9601 (0 - 5 VAC available).



Radio Rack (LH)

Figure 201



MAINTENANCE MANUAL

CADU 28 V LIGHTING TRANSFORMER/RECTIFIER - MAINTENANCE PRACTICES

EFFECTIVITY

LX - N19997

LX - N20000

LX - N20199

2 Removal/Installation of CADU 28 V Lighting Transformer/Rectifier (RT9600)

A Remove transformer/rectifier RT9600 (see Figure 201)

(1) Open and tag the following circuit breaker

(a)	CB Panel P7	Pos	P7-28 V	OVHD PANEL
			AC BUS	
			Cockpit Lights	

(2) Disconnect wiring, loosen the two retaining screws (3) and washers (4) and remove transformer/rectifier (2) from the LH radio rack shelf

(3) Remove transformer/rectifier (2) from the aircraft.

B Install transformer/rectifier RT9600

(1) Ensure the following circuit breaker is open and tagged

(a)	CB Panel P7	Pos	P7-28 V	OVHD PANEL
			AC BUS	
			Cockpit Lights	

(2) Connect transformer/rectifier input and output wiring

(3) Secure new component to the LH radio rack shelf mounting tray using the two screws (3) and washers (4) salvaged during removal

(4) Remove safety tag and close the following circuit breaker.

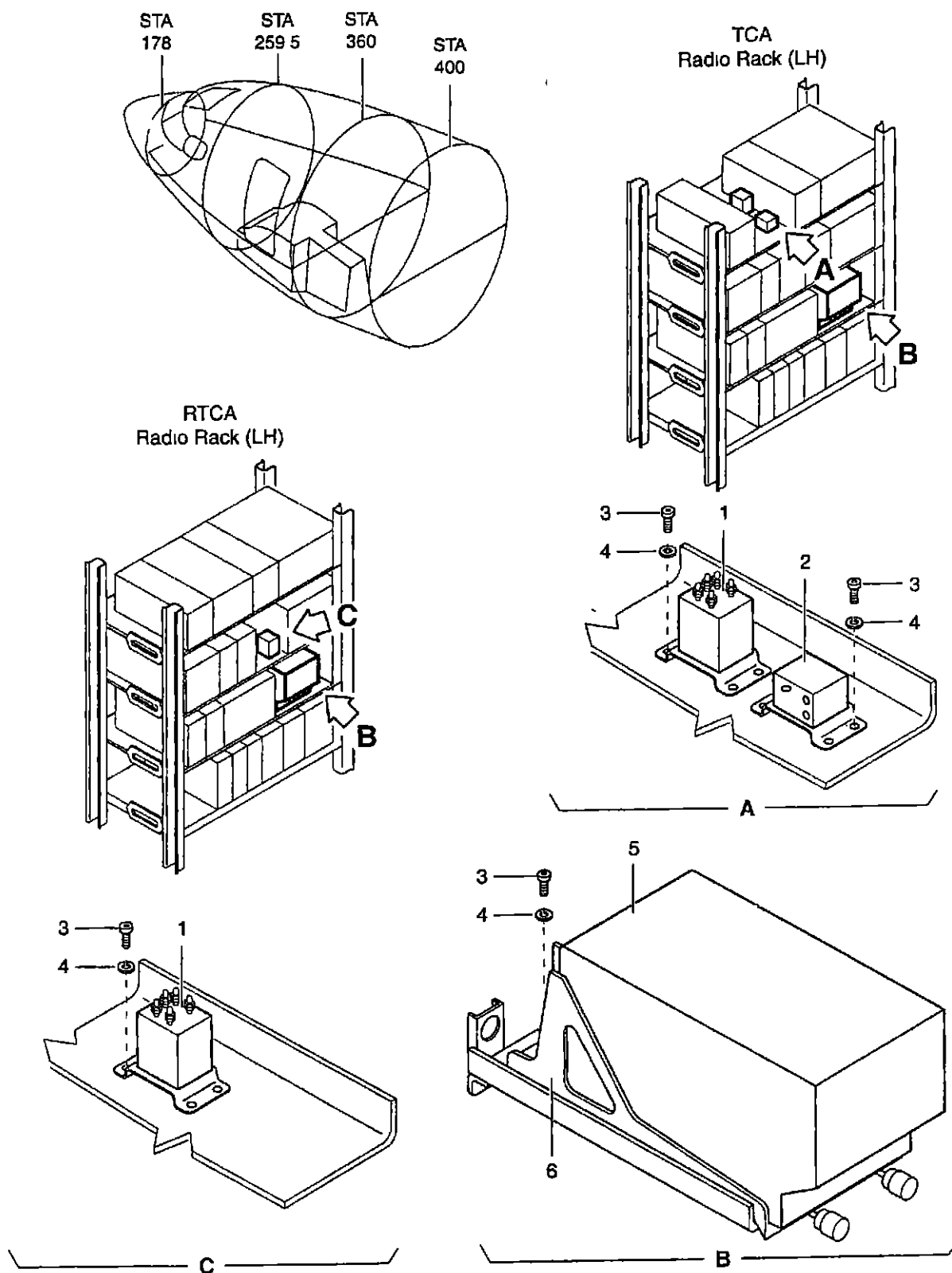
(a)	CB Panel P7	Pos	P7-28 V	OVHD PANEL
			AC BUS	
			Cockpit Lights	

(5) Perform functional check using multimeter

C Functional check

(1) Verify that the P13 background lighting is available and adjustable with the OVERHEAD PANEL control

(2) Measure the output voltage (28 VDC at RD9617) of transformer RT9600





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IFF NO. 1 AND NO. 2 SYSTEM - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Self Leveling Green Sealant (P/N HT3326-5-50).
- B. Tape Stretch Seal (P/N AD89503/01-36).

2. IFF Antenna - Removal

NOTE: Removal of an upper antenna requires a work stand high enough to reach the top of the fuselage.

- A. Open ATC/IFF circuit breakers on P5 overhead circuit breaker panel.
- B. Locate the two IFF antennas:
IFF upper Station 590
IFF lower Station 590
- C. Remove four screws that attach the antenna to the fuselage.
- D. Pull antenna out far enough to disconnect coaxial cable connector.

NOTE: If antenna is located on top of the aircraft, secure cable so that it will not fall into aircraft.

- E. Disconnect coaxial cable connector from antenna.
- F. Discard O-ring.

3. IFF Antenna - Installation

- A. Place antenna gasket on antenna.
- B. Apply self levelling green sealant to connector base. Allow sealant to cure for 30 minutes before mounting antenna to aircraft.
- C. Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- D. Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- E. Prime and paint all bare metal outside the original footprint and decrease the original footprint by 0,2 inch per AMM 51-90-00.

NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

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TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

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- F. Clean the antenna footprint and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- G. Remove the aliphatic naphtha with a clean cloth.
- H. Place antenna near mounting location and connect coaxial cable to antenna.
- I. Wind stretch seal tape around connector until it is 1.5 inch above connector, covering the coax cable.

NOTE: Make sure the adhesive side of the tape is pointing to the coaxial cable and the connector. This provides for a tight seal.

CAUTION DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACES

- J. Place antenna in position ensuring the antenna gasket is positioned correctly.
- K. Secure antenna with four mountings screws. Ensure that a Teflon washer is placed under each screw.
- L. Tighten antenna screws, so that antenna gasket is compressed evenly.
- M. Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- N. Measure electrical bond resistance between the antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- O. Close the ATC/IFF circuit breakers on P5 overhead circuit breaker panel.
- P. Perform IFF operational test per AMM 34-45-02 page 203, paragraph C.



MAINTENANCE MANUAL

LOW RANGE RADIO ALTIMETER SYSTEM - DESCRIPTION AND OPERATION

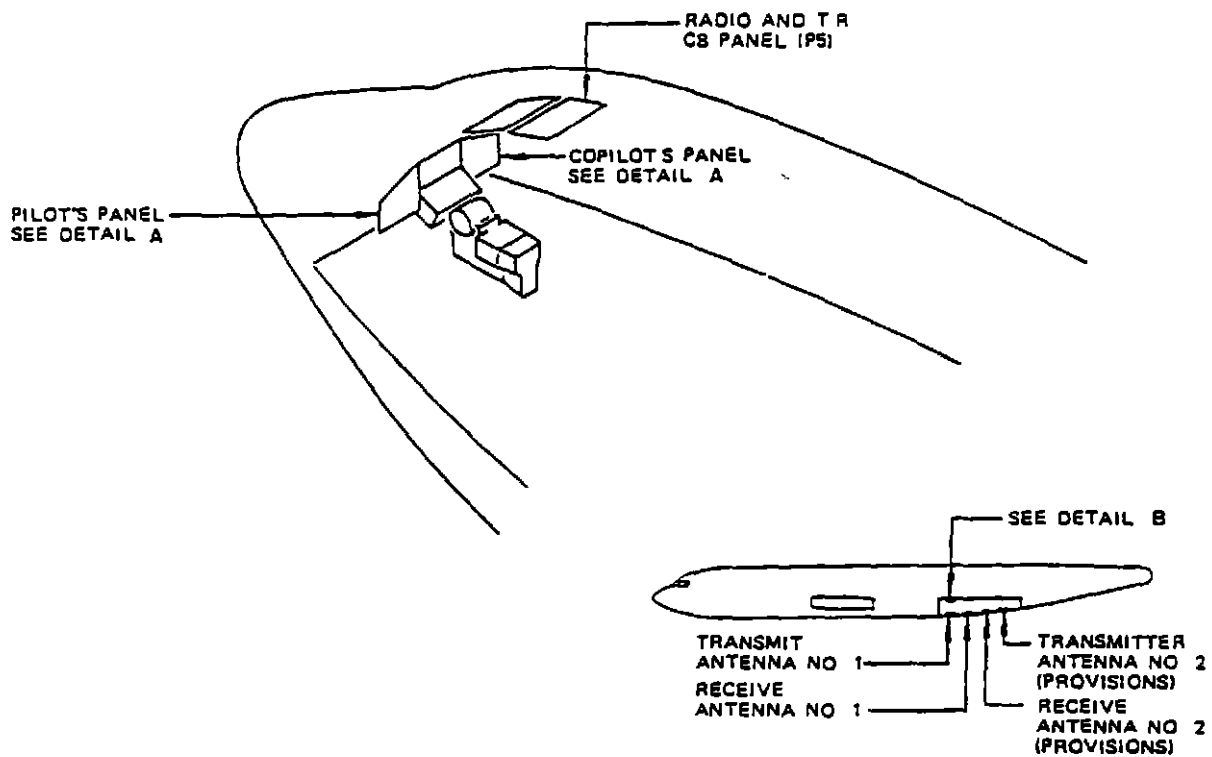
1 General

- A The primary purpose of the radio altimeter is to supply vertical position information, in the form of a dc analog voltage, to the radio altimeter indicator during approach and landing phases of flight operation. The altimeter provides an accurate measurement of absolute altitude (height above terrain) from 1500 feet to touchdown and also provides vertical terrain clearance outputs which can be used in other system. Altitude "trips" within the altimeter may be preset to operate at specific altitudes and activate indicating devices or circuits in other equipment.
- B One complete system is installed and provisions are made for a second system. A system consists of a receiver-transmitter, transmitting antenna, receiving antenna, two radio altimeter indicators with low altitude caution lights and two decision height (DH) lights. Each AD MDA (minimum decision altitude) warning lights are provided on the height indicators. Location of components is shown on figure 1. For a block diagram of the system see figure 2. The copilot's indicator is presently paralleled with the pilot's indicator.

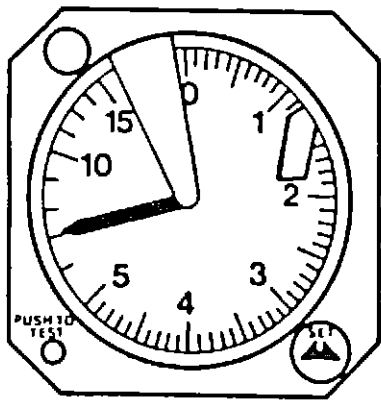
2 Receiver-Transmitter

- A The receiver-transmitter (R-T) is a solid-state unit which transmits frequency sweeps from 4230 to 4370 kHz and back 160 times a second. This unit is made up of the following signal loops and circuits: altitude measurement loop and automatic frequency control circuit, self-calibration loop, integrity monitoring circuits, and trip setting circuits. The receiver-transmitter outputs to the flight director include 200 and 1500-foot trip signals, flag alarm, and an altitude signal if the flight director indicator requires it. (See Flight Director System.) Failure warning signals go to the autopilot and altitude signals to the autopilot and navigation warning system. A trip signal is available for the navigation warning system.
- B The modulator frequency oscillator, wobulation generator, amplifier-squarer, and switch form a square wave whose amplitude is a function of the loop frequency. The signal is compared with a dc reference and fed to a triangular wave generator to form a linear-triangular wave. The emitter follower amplifies the signal to the level required to drive the VHF oscillator. The VHF oscillator generates a 358.3 kHz signal which goes to the driver-amplifier and frequency-multiplier and bandpass filter to form the 4230 to 4370 MHz output frequency. An automatic frequency control loop sets the average level of the triangular modulating signal. The output signal passes through two circulators to the transmit antenna.

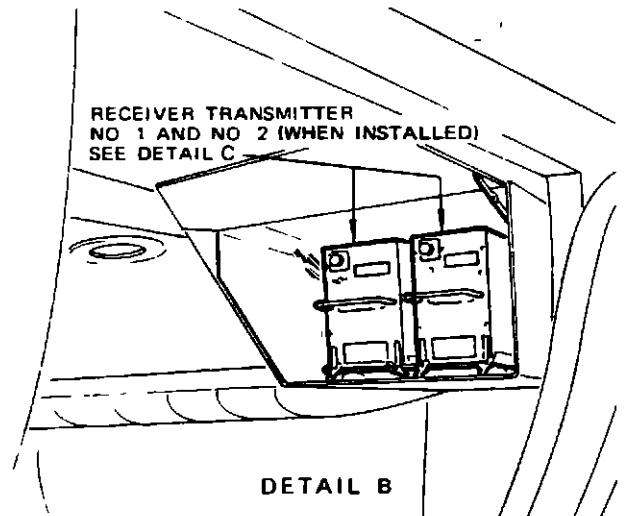
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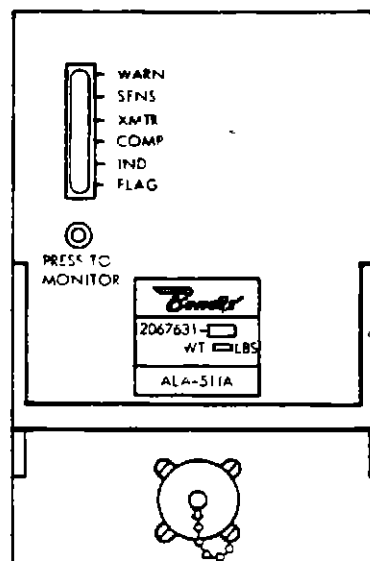
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RADIO ALTIMETER INDICATOR
 DETAIL A



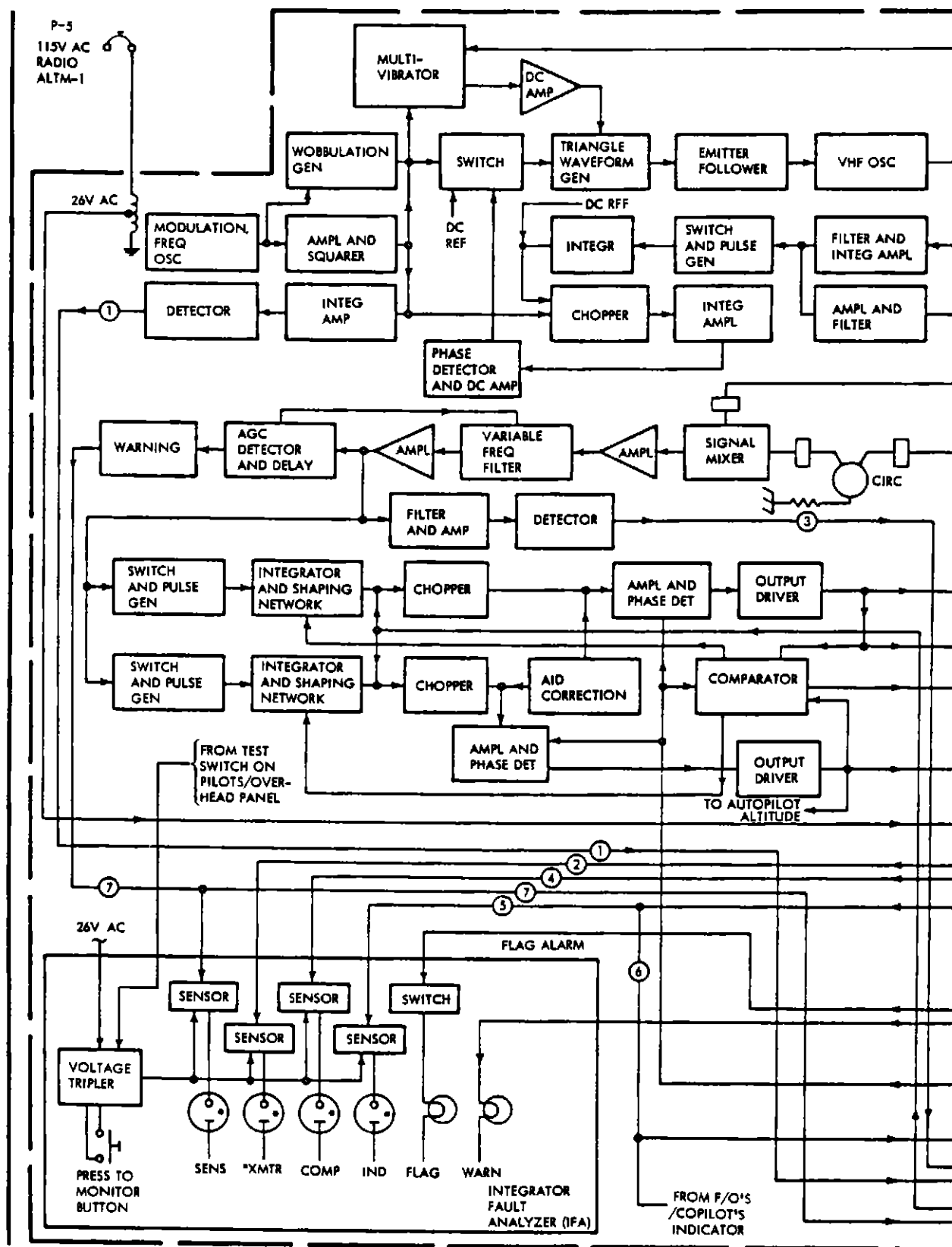
DETAIL B



DETAIL C

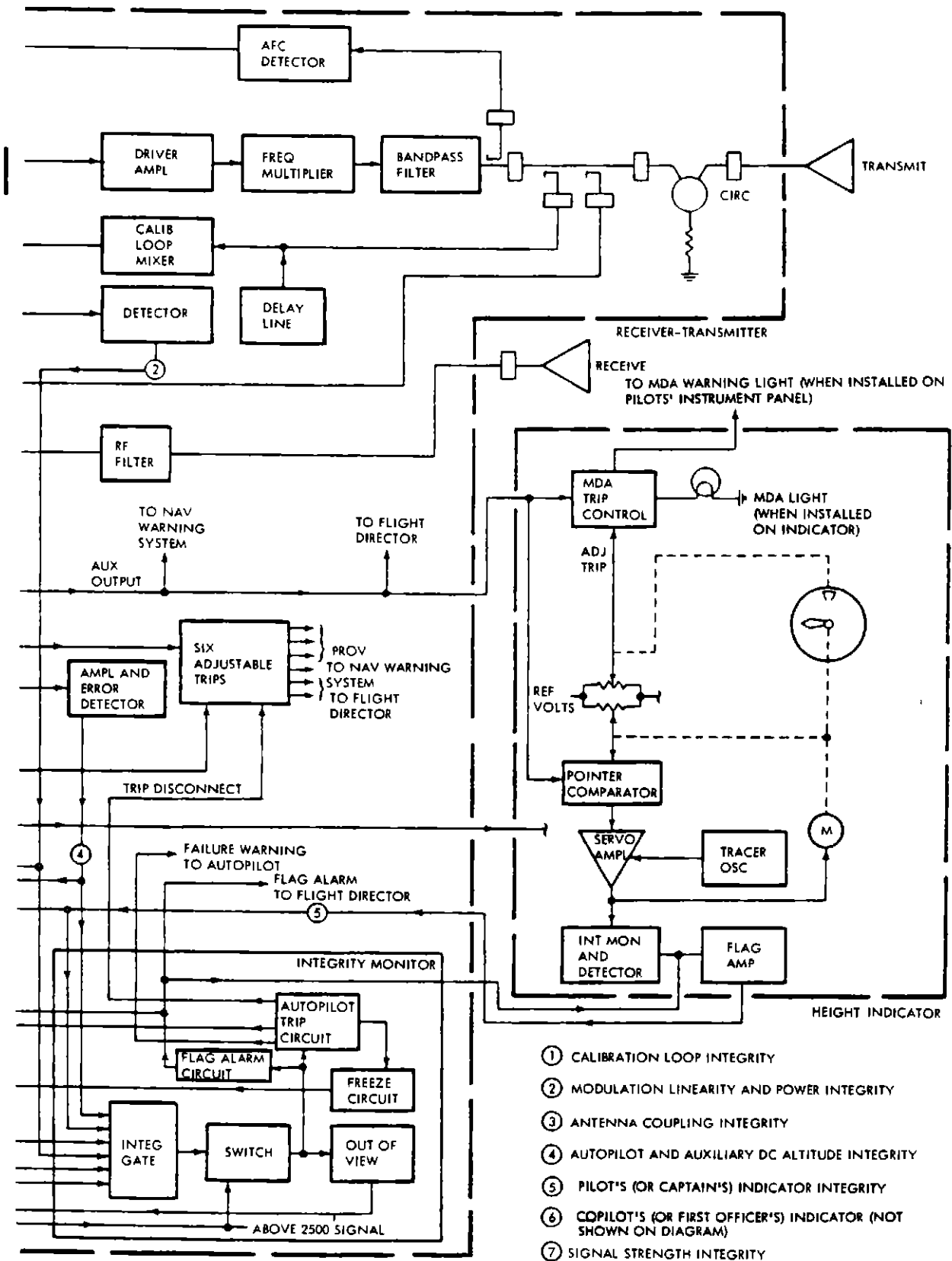
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Low Range Radio Altimeter System Block Diagram
Figure 2 (Sheet 1)

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Low Range Radio Altimeter System Block Diagram
Figure 2 (Sheet 2)

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- C. A sample of the transmitted energy goes through a delay line to the calibration loop mixer. These two signals are mixed to provide a 4.87 kHz loop output to the filter and integrated amplifier. This amplified signal goes to the switch and the modulation-linearity and power-integrity detector. The switch and pulse generator form positive pulses which are changed to a negative dc current proportional to frequency by the integrator. The pulses are compared to a dc reference, and the difference current goes through the chopper, integrated amplifier, and phase detector to a dc amplifier. The amplified signal is sent to the altitude measurement loop switch as inverse feedback to the slope-controlling circuits.
- D. Reflected signals from the earth are received by the receive antenna and fed through the RF filter to the signal mixer. This filter removes the signals from ground radar or other similar sources. The received signal is beat against a sample of transmitted energy in the signal mixer and amplified by a preamplifier. The variable frequency filter contains two high-frequency and one low-frequency filters. The high-pass filter receives the amplified signal and normalizes the amplitude for all altitudes of interest. The low-pass variable filter eliminates any frequency which represents an altitude above system capability. The signals pass through another high-pass filter and then are amplified to a level required to drive the two counter circuits.
- E. Description of the autopilot counter circuit is identical to the auxiliary counter circuit discussed below. The switch and pulse generator convert the ac input signal to a positive pulse. The integrator and shaping network form the pulse into a dc analog voltage proportional to frequency. A chopper, amplifier, and phase detector and output driver form an accurate dc amplifier. Aircraft installation delay (AID), which compensates for the electrical distance between transmit and receive antennas at touchdown, is applied to the integrated amplifier. When the PRESS TO MONITOR button on the receiver-transmitter is pressed, a reference voltage from a test relay is applied to the AID correction unit. This correction is applied to both counter circuits and checks the operation of these circuits and the indicator. The indicator receives a readout of the test altitude from the auxiliary counter circuit. The functional test ground from the indicator goes through the glide slope-engaged relay before going to the test relay in the receiver-transmitter. An output is sent to the flight director when the flight director indicator requires an altitude signal. (See flight director system.) Altitude outputs from the autopilot counter circuit go to the autopilot comparator and adjustable trips. One 200 and one 1500-foot trip signal is sent to the flight director system. One 500-foot trip signal is sent to the navigation warning system.



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- F. The integrity monitor is composed of several circuits which perform the following functions when a malfunction occurs: Removes altimeter from autopilot, disables the trip signals, and drives the indicator pointer out of view after a one-second time delay. The integrator fault analyzer circuits provides a visual display of five altimeter and one indicator malfunctions which can occur.
- G. Whenever the integrity gate denotes a system malfunction, or the altitude signal strength drops below a predetermined level, the following occurs: (1) the integrity-monitor switch is turned off, causing a complete disconnect of the altimeter to flight director and autopilot, (2) the altimeter indicator and the flight director indicator warning flags appear in view, and remain in view until such time as the airplane descends below an altitude of 1500 feet, (3) the autopilot/trip disconnect circuitry causes the freeze circuit to remove, for one second, the square wave being transmitted to the counter circuit, thus causing the indicator pointer to remain at this altitude for one second; at the end of the one-second freeze, the out-of-view circuit causes the counter circuit to drive the indicator pointer behind the mask. The above-1500-foot sensor, located in the altitude measurement loop circuit, causes the warning circuits to operate in the same manner as described above. The sensor is in the off state when the airplane is below 1500 feet, and is in the on state above 1500 feet.
- H. The integral fault analyzer (IFA) is composed of six lights (figure 1) and their respective detectors or monitors. They give a visual display on the front of the receiver-transmitter of a system malfunction. The receiver-transmitter lights are SENS, XMIR, and COMP. The integrity monitor controls the lights marked FLAG and WARN. The IND light denotes an indicator malfunction or that a large altitude output was received from the altimeter. If a malfunction occurs, the SENS, XMIR, COMP, and IND will come on when the PRESS TO MONITOR button is pressed. The FLAG and WARN light will remain on until the malfunction is removed by the integrity monitor gate.
3. Indicator
- A. A visual display of airplane terrain clearance is provided by the height indicator. The indicator is an electromechanical servomechanism which converts an analog dc input voltage to a digital and analog display of altitude. The pointer scale is linear around the face from -10 to +480 feet, and logarithmic for the remainder of the scale. The scale below 500 feet is divided in 10-foot increments, while that above 500 feet is in 100-foot increments. A flag comes into view when the altimeter is not functioning properly. Circuitry incorporated in the indicator consists of a nonlinear potentiometer, modulators, servo-amplifier, flag alarm and trip circuitry, servomotor and rate generator.



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- B An MDA control knob on the indicator is mechanically attached to a potentiometer and an adjustable index (cursor) which travels along the periphery of the dial face. Setting the knob locates the cursor at a predetermined altitude and causes the MDA light to illuminate whenever the pointer indicates an altitude lower than that of the cursor setting.
- C The failure warning flag is retracted when the altimeter is operating properly. It appears in the event of power failure, a loss of return signal or incorrect altitude tracking, during self-test operation or when the airplane is above the operating range of the altimeter.
- D During self-test, the altitude pointer on the indicator should indicate 30 (+5) feet, and the warning flag should come into view if the altimeter is operating properly. If the altimeter is malfunctioning, the warning flag will not come into view and the altitude pointer will be biased out of view after a short delay.

4 Antenna

- A The antennas are flush-mounted probe-fed conical horns. Two identical antennas are used in each system, one for transmitting and one for receiving. The antennas are connected to the receiver-transmitter through coaxial cables. The antennas are flush-mounted on the lower body centerline as follows:

TRANSMIT NO 1	STA 1010	TRANSMIT NO 2	STA 1069 (PROVISIONS)
RECEIVE NO 1	STA 1029	RECEIVE NO 2	STA 1050 (PROVISIONS)

5 CONTROLS

- A The controls used in flight operation of the radio altimeter consist of an MDA control knob on the height indicator, and a PUSH-TO-TEST button on the indicators. (see figure 1.)
- B The MDA control is used to position the MDA cursor on the scale. Rotation of the control will move the index around the periphery of the dial. The MDA light(s) illuminate and a trip is enabled whenever the pointer indicates an altitude lower than that of the cursor setting.



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- C An altimeter test switch on the indicators, enables the flight crew to check the inflight operation of the altimeter system. Whenever the altimeter system is in operation, a check of the system may be made anytime in flight or on the ground. On the ground, when the test (button) switch is pressed, the indicator pointers will drive to an indicated 30 (± 5) feet within one second, and the indicator flag displays will appear, indicating correct operation of the system. Upon release of the test switch, the pointers will drive up slightly, then return to zero altitude indication. In flight, with the airplane above operating range of the altimeter, pressing the test switch will cause the indicator pointers to slew to 30 (± 5) feet, indicating an operable system. Releasing the test button will cause the pointers to drive back up behind the masks.
- D A PRESS TO MONITOR button, located on each receiver-transmitter front face, is used to determine in which altimeter integrity monitor a malfunction exists.

6 Operation

- A The radio altimeter system is supplied 115 volts ac power from the 115 volts ac essential bus. Circuit breaker protection for the system is provided by a circuit breaker located on the P5 circuit breaker panel.
- B Rotation of the MDA knob positions the adjustable altitude cursor to any desired preset altitude. Upon turn-on of the system, the flags will appear. Approximately 30 seconds later the system will lock on the return signal, the pointers will slew to zero altitude, and the flags will retract.
- C To further check a system, the test button on an indicator is pressed, or the PRESS TO MONITOR button on the receiver-transmitter is pressed, and the pointers drive to 30 (± 5) feet within one second, while the flags will again be displayed. Upon release of the button, the pointers first drive up slightly, then return to zero altitude, and the flags again retract.
- D A radio altimeter will continuously display absolute altitude within indicator range. As the airplane climbs above the indicator maximum range, pointer will continue to track up behind the indicator mask. When the airplane descends to the indicator maximum range, the pointer will come into view and track all the way to touchdown.
- E The MDA cursor is adjusted by rotation of the MDA knob. When the altitude pointer descends to the preset altitude, the MDA warning light(s) will illuminate. The light(s) will remain on for all altitudes below the preset altitude.



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LOW RANGE RADIO ALTIMETER SYSTEM - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Tape Stretch Seal (P/N AD89503/01-36).

2. Antenna - Removal

- A. Open Low Range Altm No 1. circuit breaker on P5 overhead circuit breaker panel.
- B. Locate the two Low Range Radio Altimeter antennas at
Station 1010 (bottom)
Station 1029 (bottom)
- C. Remove eight screws that attach the antenna to the fuselage.
- D. Pull antenna out far enough to disconnect coaxial cable connector.
- E. Disconnect coaxial cable connector from antenna.

3. Antenna - Installation

- A. Place the antenna gasket on antenna.
- B. Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- C. Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- D. Prime and paint all bare metal outside the original footprint and decrease original footprint by 0,2 inch per AMM 51-90-00.

NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

- E. Clean antenna footprint and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- F. Remove the aliphatic naphtha with a clean cloth.
- G. Place antenna near mounting location and connect coaxial cable to antenna.
- H. Wind stretch seal tape around the connector until it is 1.5 inch above the connector, covering the coax cable.

NOTE: Make sure that the adhesive side of the tape is pointing to the coaxial cable and the connector. This provides for a tight seal.



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CAUTION. DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACES

- I. Place antenna in position ensuring the antenna gasket is positioned correctly.
- J. Secure antenna with eight mounting screws. Ensure that a Teflon washer is placed under each screw.
- K. Tighten antenna screws so that antenna gasket is compressed evenly.
- L. Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- M. Measure electrical bond resistance between the antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- N. Close Low Range Altm No 1. circuit breaker on P5 overhead circuit breaker panel.
- O. Perform an operational test per AMM 34-48-0 page 501.

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LOW RANGE RADIO ALTIMETER SYSTEM - TROUBLE SHOOTING

1 General

- A If a malfunction occurs in the radio altimeter system the defective component should be replaced with a component known to be in good operating condition
- (1) If system is malfunctioning replace receiver-transmitter with one known to be in good operating condition
 - (2) Perform operational check system If the system is still malfunctioning replace radio altimeter indicator with one known to be in good operating condition
 - (3) If system still malfunctions, inspect antennas for damage, airplane wiring and all connectors for improper connections or damaged items
- B The following malfunctions are directly traceable to the height indicator. If the system operation is normal and one or more of the following malfunctions occur, do not replace the receiver-transmitter. Instead, replace the radio altimeter indicator and check its wiring
- (1) Dial lighting (all malfunction)
 - (2) MDA trip light and associated wiring
 - (3) MDA control knob or bug (all malfunctions)
 - (4) Pointer visible when circuit breaker is pulled
 - (5) Flag not visible when circuit breaker is pulled



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LOW RANGE RADIO ALTIMETER SYSTEM - ADJUSTMENT/TEST

1 Test Low Range Radio Altimeter

- A Connect external power to the airplane
- B Close low range radio altimeter No 1 and No 2 (when installed) system circuit breakers an P5 circuit breaker panel.
- C Allow a warmup time of 15 minutes
- D Set the adjustable trip on the No 1 indicator to -20 feet
- E After warmup, check that warning flag is out of view, pointer indicates 0 (± 3) feet, and MDA light is off.
- F Slowly move MDA adjustable trip clockwise past pointer Check that flag and pointer remain as in step E , and MDA lights illuminate when cursor is within ± 6 feet of pointer

NOTE The Low Range Radio Altimeter System is factory adjusted to the following trip settings However, the settings can be readjusted as found necessary

<u>TRIP NO</u>	<u>TRIP SETTING (feet)</u>
6	30
2	50
5	60
1	200
8	500
7	1500

- G Set adjustable trip to -20 feet Press and hold No 1 indicator test button Cheek that No 1 indicator flag comes into view, pointer indicates 30 (± 4) feet, and MDA light is off
- H Release test button Cheek that flag retracts, pointer indicates 0 (± 3) feet, and MDA light remains off
- I Set adjustable trip to 200 feet Check that flag, pointer and MDA light indicate as in step F
- J Repeat steps D through I for No 2 indicator
- K Open the No 1 circuit breaker Check that flags come into view, MDA lights go off, and pointers continue to indicate 0 (± 3) feet
- L If no longer required remove electrical power from airplane



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- K. Place the altimeter power switch in OFF position. Check that flags go out of view, pointers are masked, and MDA lights are off.
- L. Place power switch in ON position. Check that flags remain out of view, pointers indicate 0 (± 3) feet, and MDA lights illuminate.
- M. Open the No. 1 circuit breaker. Check that flags come into view, MDA lights go off, and pointers continue to indicate 0 (± 3) feet.
- N. If no longer required remove electrical power from airplane.



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TEMPORARY REVISION NR. DFW 34-31

INSERT FACING SUBCHAPTER 34-50-01, PAGE 401

REASON FOR CHANGE: Application of antenna gasket to provide a better skin corrosion protection.

INSTRUCTION: Insert facing to subchapter 34-50-01, page 401.

NOTE: The insertion of this TR has to be listed in the Record of Temporary Revisions at the beginning of Volume 1.

TR-Nr. DFW 34-31

TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

34-50-01

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TACAN NO 1 AND NO 2 SYSTEM - DESCRIPTION/OPERATION

1 SAFETY PRECAUTIONS

A Refer to introduction for general safety precautions to be observed when operating or performing maintenance on the TACAN system

2 DESCRIPTION

A All TCA aircraft have two AN/ARN-118 (V) TACAN navigational sets. Each set includes a control panel, a receive-transmitter, a receiver-transmitter adapter, and two antennas (See table 1). Figure 2 shows location of the equipment in the aircraft. In operation, the navigational set is used to obtain range, bearing, course deviation, and audio beacon identification information from a ground or airborne beacon. The information is displayed on radio navigation instruments (HSI's and RMI's) and is applied as a course control input to the flight director and from TACAN No 1 to the autopilot system. The navigational set operates on any of the 126 standard TACAN channels in either the X or Y mode. It has four operational modes: receive (REC), transmit-receive (T/R), air-to-air receive (A/A REC), and air-to-air transmit/receive (A/A T/R). In the receive mode, the navigational set receives bearing signals from a ground beacon and provides bearing, course deviation, and beacon identification information. In the transmit-receive mode, the navigational set performs all functions described for the receive mode and, in addition, interrogates the ground beacon. The interrogation response is decoded to provide range information. In the air-to-air receive mode, bearing information is received from another aircraft and the relative bearing of the other aircraft is derived.

B In the air-to-air transmit/receive mode, the navigational set interrogates an airborne transponder and receives data from which it decodes range information. It can also receive bearing information from an aircraft that transmits that data, and act as a transponder to interrogation signals from other aircraft. Each TACAN system transmits and receives suppression signals to and from the AIMS system so prevent mutual interference. System operating characteristics are listed in table 3.

C Control Panels

- (1) The No. 1 and No. 2 TACAN navigational set control panels are mounted in the overhead panel (See figure 1). The No. 1 panel is on the left for primary use by the pilot and the No. 2 panel is on the right for primary use by the copilot. Each panel has controls and indicators as described in Table 2.

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D Receiver-Transmitters

- (1) The TACAN receiver-transmitters are mounted in the RH radio rack, No 1 on the shelf 1 and No 2 on the shelf 2 (See figure 2) Each receiver transmitter contains an internal power supply, input and output control circuitry, distance and bearing circuitry, a transmitter, a receiver, an antenna diplexer, and identification circuitry On the front panel are six connectors and an elapsed time indicator The connectors are marked AGE (J1), ANT (J2), SUPPR IN/OUT (J3), SUPPR IN (J4), ANT 1 (J5) and ANT 2 (J6) Except. for connection to the suppression and the antennas, all electrical connections are made through a mount connector at the rear of the unit An air exhaust is located on the rear of the unit

E Receiver-Transmitter Adapters

- (1) The adapter is a signal processor which provides the link between the receiver-transmitter and flight instrumentation The No 1 and No 2 units are mounted on the mounting base next to the No 1 and No 2 receiver-transmitters (See figure 2) The adapter interfaces with the adjacent receiver-transmitter and contains circuits that convert the digital range and bearing outputs of the receiver-transmitter to analogs suitable for the displays Two adjustment controls are accessible from the front of the adapter These controls are used to adjust course deviation These adjustments are not made on the aircraft All electrical connections to the adapter are made through a mount connector at the rear of the unit

F Antennas

- (1) Each TACAN system has two antennas, an upper and a lower The No 1 system upper antenna is on the top centerline of the fuselage at station 510 and the No 1 lower antenna is at station 600L+5 on the bottom fuselage The No 2 upper antenna is on the top centerline of the fuselage at station 600F+10 The No 2 lower antenna is at station 670 on the lower fuselage centerline (See figure 3) The antennas are identical L-band blades Only one antenna is used at a time on a system When signal strength falls too low on one antenna, the receiver-transmitter automatically selects the other antenna If neither antenna provides an adequate signal, the receiver-transmitter selects the upper and lower antenna alternately at 3- to 6- second intervals until an adequate signal is detected

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NOMENCLATURE		COMMON NAME	LOCATION
OFFICIAL	DRAWING		
Control Panel C-9603/A		Control Panel	
Radio Receiver-Transmitter RT-1159/ARN-118 (V)		Receiver-Transmitter	RH radio rack
Receiver-Transmitter Adapter MX-9577/A		Adapter	RH radio rack
Antenna, TACAN TOP N°1		Antenna	Station 510
Antenna, TACAN BOT N°1		Antenna	Station 600L + '5
Antenna, TACAN TOP N°2		Antenna	Station 600F +10
Antenna, TACAN BOT N°2		Antenna	Station 670
Mounting Base, MT-4915/A		Mounting Base	RH radio rack

AN/ARN-118 (V) TACAN System Equipment
Table 1

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3 SYSTEM OPERATION

- A The desired TACAN channel and mode of operation is selected on the control panel. The control panel produces a 16-bit, 400 Hz ternary control word which contains channel, mode, and transmission control information. The control word is supplied to the receiver-transmitter for processing. The VOLUME control is inoperative as audio identification signals are supplied directly from the receiver-transmitter to the aircraft communications system.
- B The receiver-transmitter not only transmits and receives information but also serves as a processor to put together a 32-bit serial word containing distance, frequency, bearing and velocity information, depending on mode of operation. This data is supplied to the receiver-transmitter adapter through the mounting base. The adapter converts the digital input to analog data which is then used to provide indications (depending upon operating mode) on flight instruments. See figure 4 for simplified diagrams of the TACAN system.
- C. Receive Mode
- (1) In the receive (REC) mode, the control word from the control panel is processed in the receiver-transmitter. The receiver section is tuned to the correct frequency for the selected surface beacon channel. Only bearing and beacon station identification information is received in the receive mode. The surface beacon transmits a continuous signal consisting of identification CW and bearing information. The bearing portion of the signal is a composite including a north reference signal, a coarse bearing signal, and a fine bearing signal. The identification signal is processed and sent from the receiver-transmitter to the aircraft communications system (the VOLUME control on the control panel is inoperative). The composite bearing signal is processed in the receiver-transmitter and supplied to the adapter as a 32-bit word. The adapter converts the 32-bit word into analog data which is further processed with aircraft instrument inputs to calculate
 - (1) Relative bearing of the selected surface beacon;
 - (2) Course deviation information (difference between selected aircraft course and relative bearing of surface beacon);
 - (3) To-From information
- D The receiver-transmitter produces a bearing flag signal to raise the COURSE flag on the HSI. If the beacon signal is lost, the bearing flag signal causes the flag to cover the COURSE window on the HSI and the bearing pointers on the HSI's and RMI's to search.

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E Transmit-Receive Mode

- (1) The receiver-transmitter transmits interrogation pulse pairs to the selected surface beacon in the receive-transmit mode. The surface beacon replies with distance reply pulse pairs inserted into the composite bearing signal being transmitted. The bearing information and the identity code is processed the same as in the receive mode except if the identity code received is not from the surface beacon transmitting the bearing signal, the code is garbled, making the identification signal unreadable.
- (2) The distance signal is processed in the receiver-transmitter and is sent to the receiver-transmitter adapter as one of the 32-bit serial words. In the receiver-transmitter, self-test is performed to determine the validity of the distance information. If the distance information is valid, a distance flag signal is developed to raise the distance warning flags on the flight instruments.
- (3) In the receive-transmit mode, information displayed is
 - (a) Relative bearing of the selected surface beacon, and
 - (b) Slant-range distance to or from the surface beacon

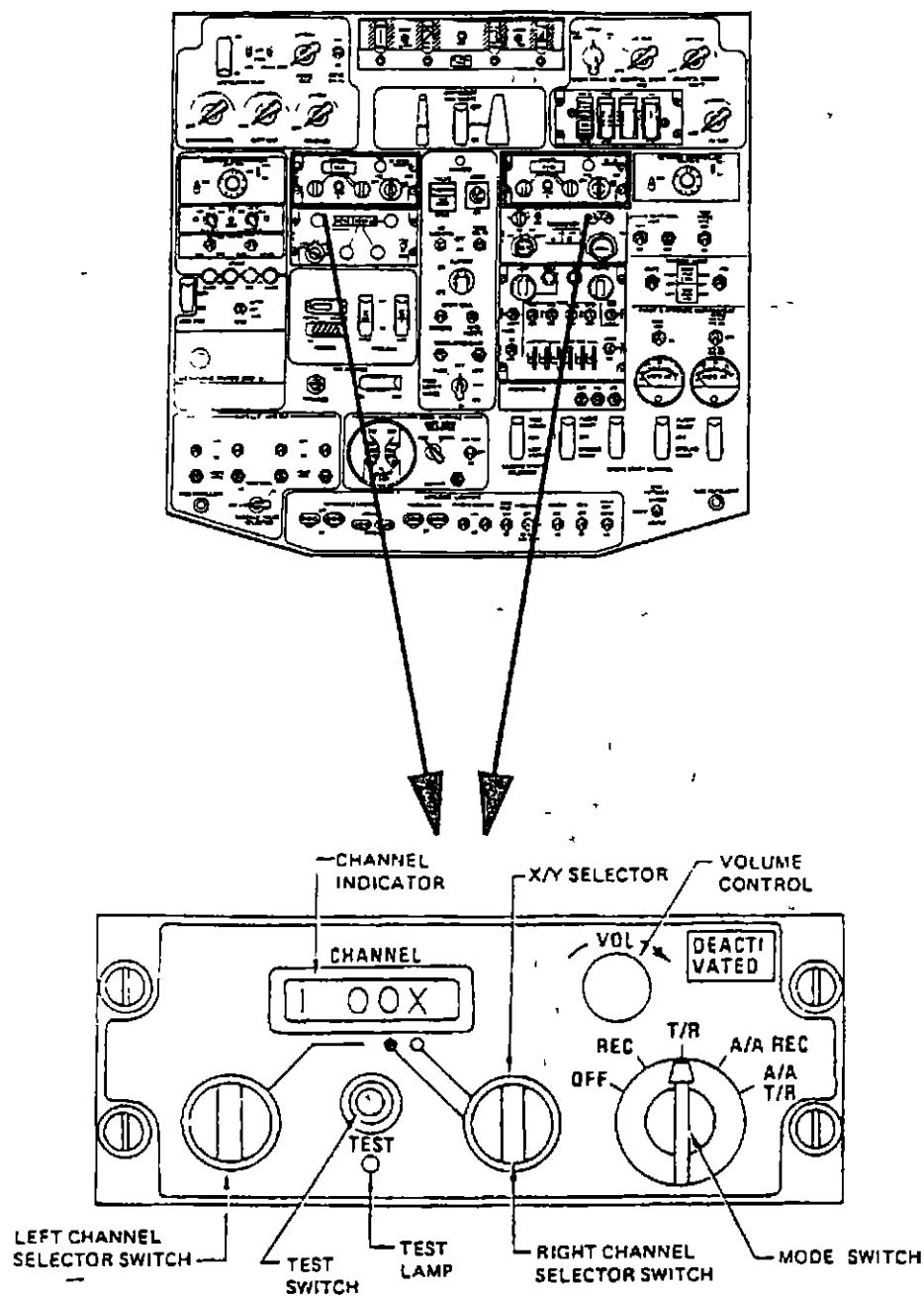
F Air-To-Air Receive Mode

- (1) The air-to-air receive mode (A/A REC) operates similar to the receive mode (surface beacon to air) except that the air beacon transmits only a coarse bearing signal and the aircraft carrying the beacon must be contacted to establish operating channels. The 63 MHz spacing between transmit-receive frequencies simulates the spacing between transmit-receive frequencies when a surface beacon is used for bearing information.

G Air-To-Air Transmit-Receive Mode

- (1) The air-to-air transmit-receive mode (A/A T/R) operates similar to the transmit-receive mode. Both bearing and distance information is received from the cooperating aircraft if that aircraft is properly equipped. If the other aircraft is not equipped to produce a bearing signal, only distance information can be received.

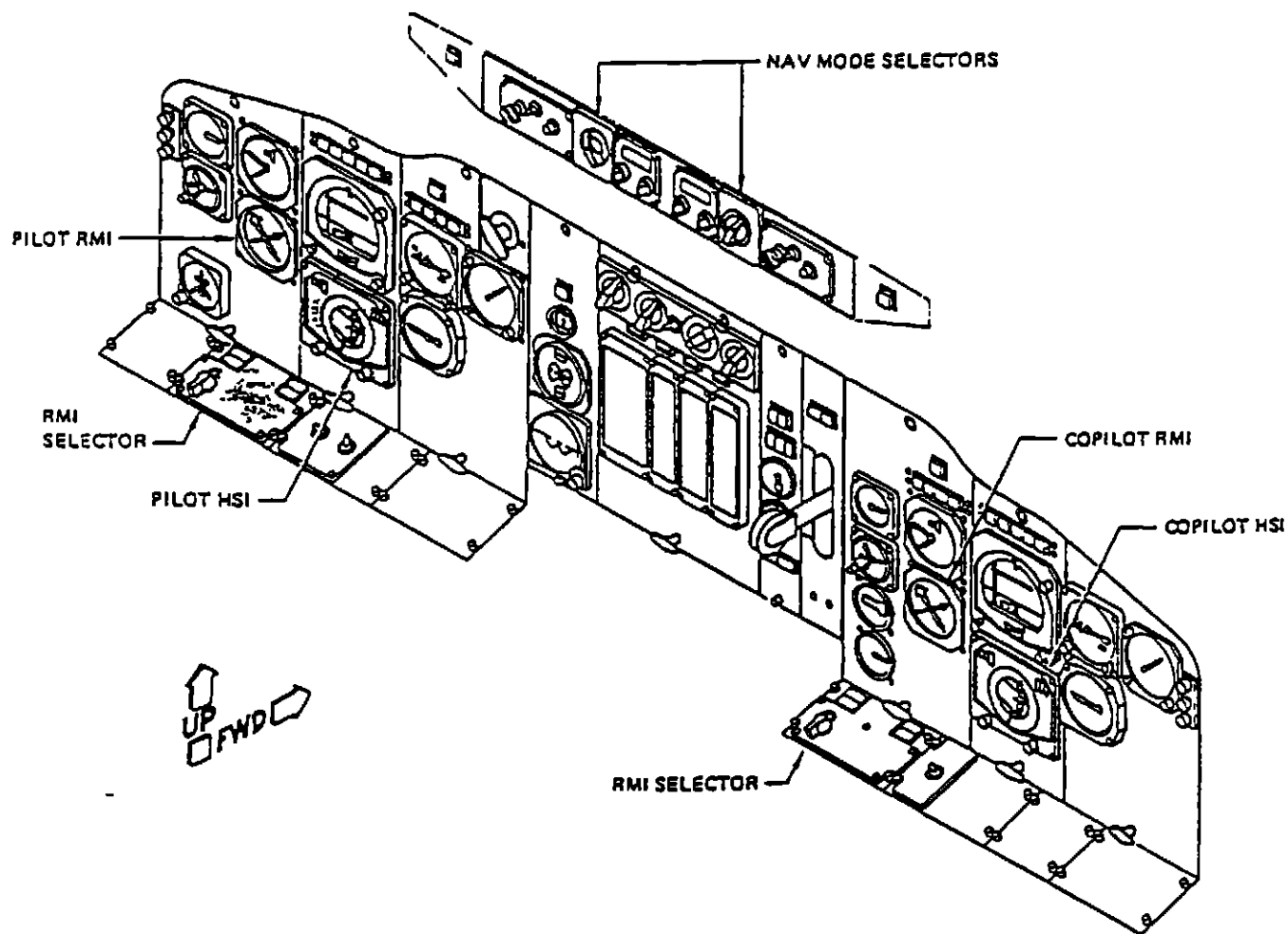
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AN/ARN-118(V) TACAN Control Panel
Figure 1

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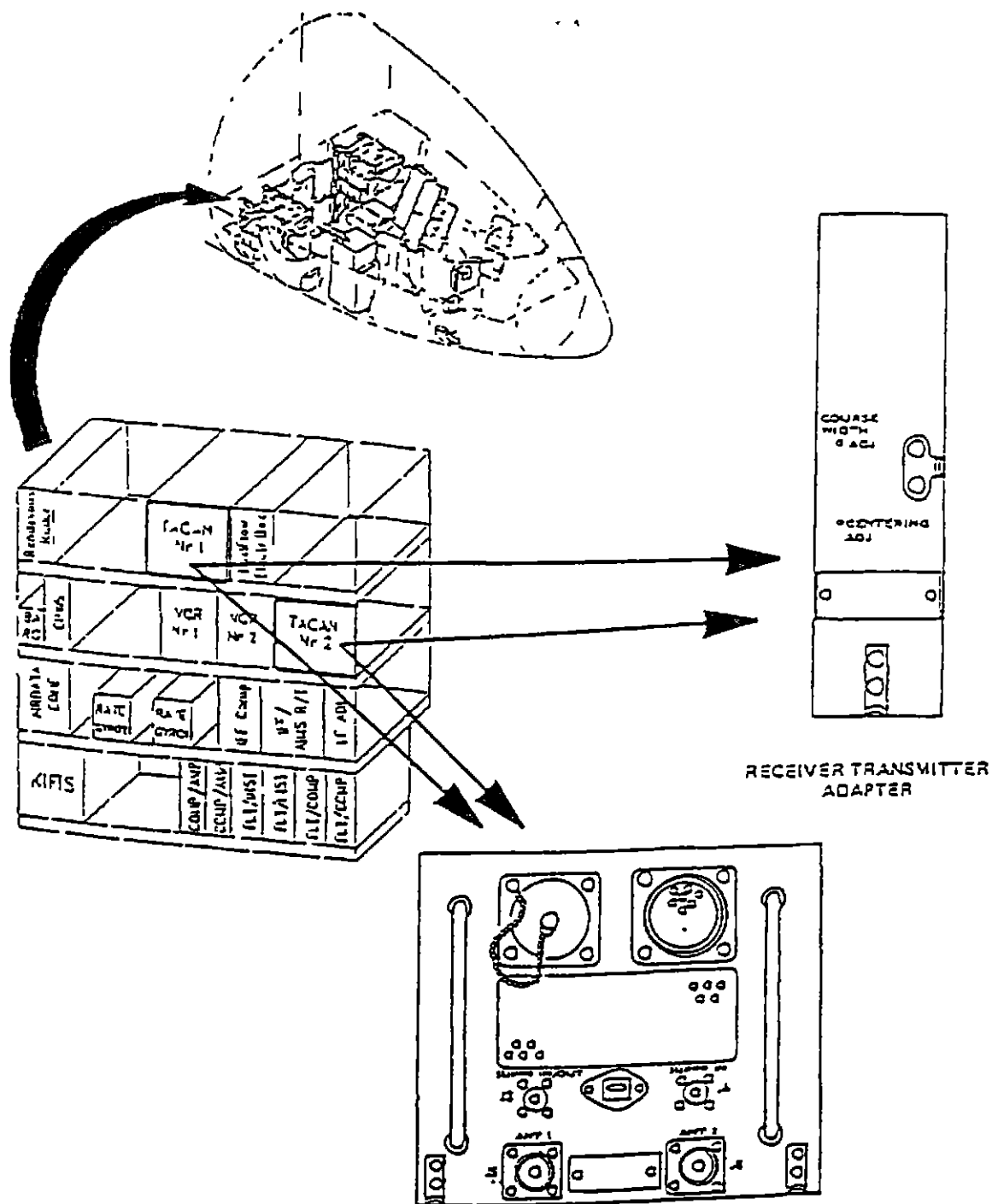
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AN/ARN-118(V) TACAN SYSTEM Component Location
 Figure 2 (Sheet 1 of 2)

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RECEIVER-TRANSMITTER

AN/ARN-118 (V) TACAN System Component Location
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CONTROL/INDICATOR	FUNCTION
Mode Switch (OFF-REC-T/R-A/A REC-A/A T/R)	Applies power to the navigational set, and selects the operational mode receive (REC), transmit-receive (T/R), air-to-air receive (A/A REC), or air-to-air transmit-receive (A/A T/R)
Channel Selector Switches	Two rotary switches used to determine navigational set channel. The left-handed switch determines the tens and/or hundreds digits of the channel, the right-hand switch determines the units digit of the channel.
Channel Indicator	A digital readout, controlled by the CHANNEL switch mechanism, that indicates what channel has been selected. The X/Y mode indicator is also displayed, to the right of the channel indicator, through the CHANNEL indicator window.
X/Y Switch	Outer ring or right channel selector switch selects either X or Y mode of pulse coding.
X/Y Indicator	A digital readout, controlled by the X/Y switch mechanism of the right channel selector switch.
TEST Button	When pressed initiates self-test of system (except antenna). With NAV MODE selectors set to TACAN, HSI COURSE selector set to 180°, and TACAN mode selector set to T/R, test lamp illuminates momentarily (for lamp test), then HSI bearing pointer rotates to 270° for about 7 seconds. Bearing pointer then rotates to 180°. CDI centers with a TO indication, distance displays on HSI indicates 0 ± 5NM for about 7 seconds. Displays then return to pre-test condition. Test lamp illuminates if test is not satisfactory. With NAV MODE selectors set to VOR/LOC, RMI mode selectors set to TACAN/VOR, RMI bearing pointers rotate to 270° and 180° as described above.
Test Lamp (Red)	Illuminates to indicate malfunction in TACAN.

AN/ARN-118 (V) TACAN Control Panel Controls and Indicators
Table 2

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CHARACTERISTICS	VALUES
CHANNELS	252
X channels	126
Y channels	126
PULSE WIDTH	3 5 (± 0.5) μ sec
PULSE CODING	
<u>Ground-to-air (received) signals</u>	
X coding	12 (± 0.5) μ sec between pulses of a pair
Y coding	30 (± 0.5) μ sec between pulses of a pair
<u>Air-to-ground (transmitted) signals</u>	
X coding	12 (± 0.5) μ sec between pulses of a pair
Y coding	36 (± 0.5) μ sec between pulses of a pair
<u>Air-to-air signals</u>	
X coding	12 (± 0.5) μ sec between pulses of a pair
Y coding	24 (± 0.5) μ sec between pulses of a pair
<u>Main reference pulse group</u>	
X coding	12 pulse pairs
Y coding	30 (± 0.1) μ sec between pulse pairs
	13 single pulses
	30 (± 0.1) μ sec between pulses
<u>Auxiliary reference pulse group</u>	
X coding	6 pulse pairs
	24 (± 0.1) μ sec between pulse pairs
Y coding	13 single pulses
	15 (± 0.1) μ sec between pulses
<u>A/A main reference pulse group</u>	
	10 single pulses
	30 (± 0.5) μ sec between pulses
	15 Hz ($\pm 0.2\%$) rate

AN/ARN-118(V) TACAN System Characteristics
Table 3 (Sheet 1 of 3)

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CHARACTERISTICS	VALUES
<u>Transponder time delay</u>	
X coding	50 (± 0.1) μ sec.
Y coding	56 (± 0.1) μ sec (with provisions for 74 (± 0.1) μ sec)
<u>X coding REC mode frequencies</u>	
1 through 63	962 through 1024 MHz
64 through 126	1151 through 1213 MHz
<u>X coding T/R mode frequencies</u>	
Transmit	
1 through 63	1025 through 1087 MHz
64 through 126	1088 through 1150 MHz
Receive	
1 through 63	962 through 1024 MHz
64 through 126	1151 through 1213 MHz
<u>X coding A/A REC mode frequencies</u>	
1 through 63	1088 through 1150 MHz
64 through 126	1025 through 1087 MHz
<u>X coding A/A T/R mode frequencies</u>	
Transmit	
1 through 63	1025 through 1087 MHz
64 through 126	1088 through 1150 MHz
Receive	
1 through 63	1088 through 1150 MHz
64 through 126	1025 through 1087 MHz
<u>Y coding REC mode frequencies</u>	
1 through 63	1088 through 1150 MHz
64 through 126	1025 through 1087 MHz

AN/ARN-118 (V) TACAN System Characteristics

Table 3 (Sheet 2 of 3)

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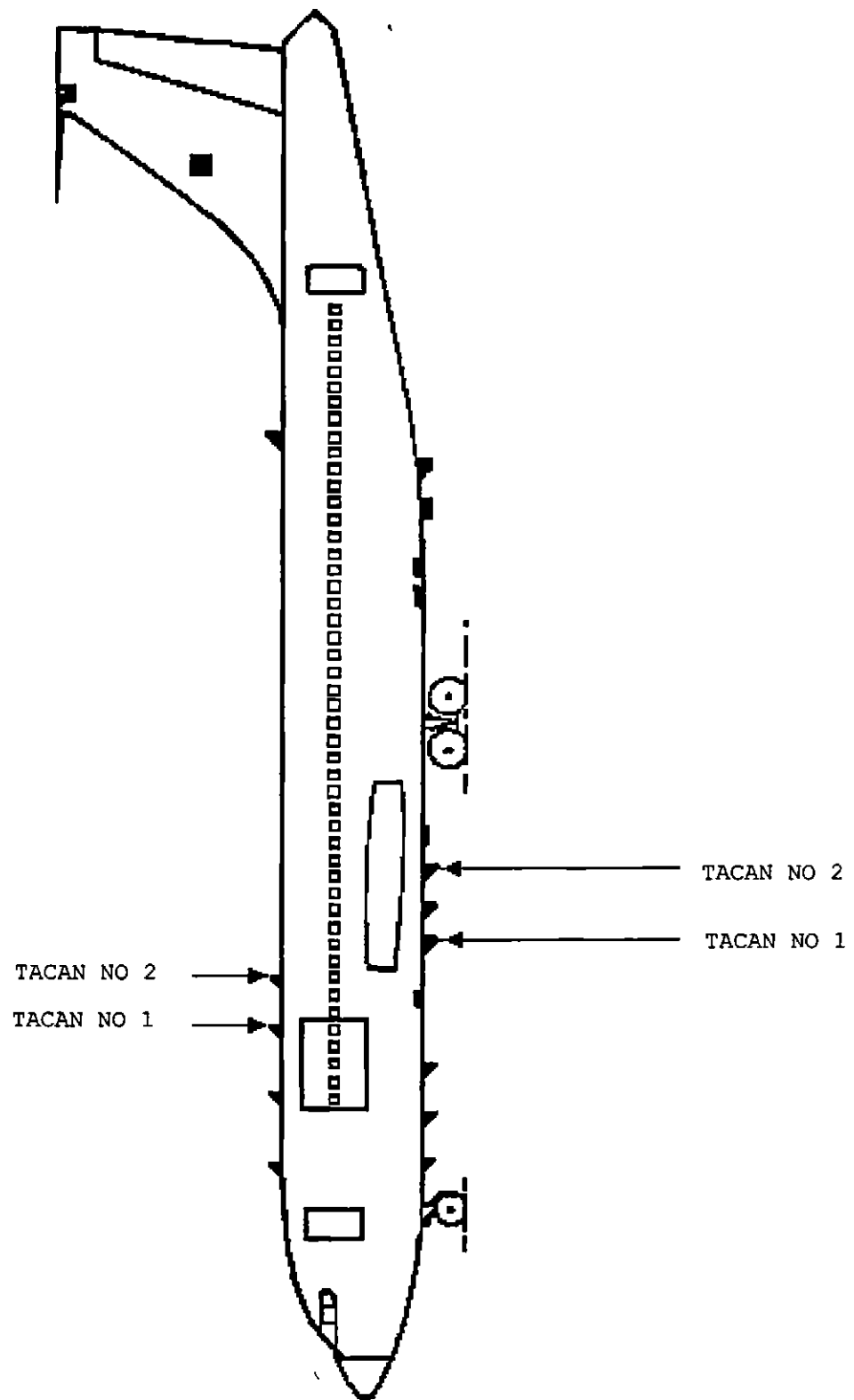
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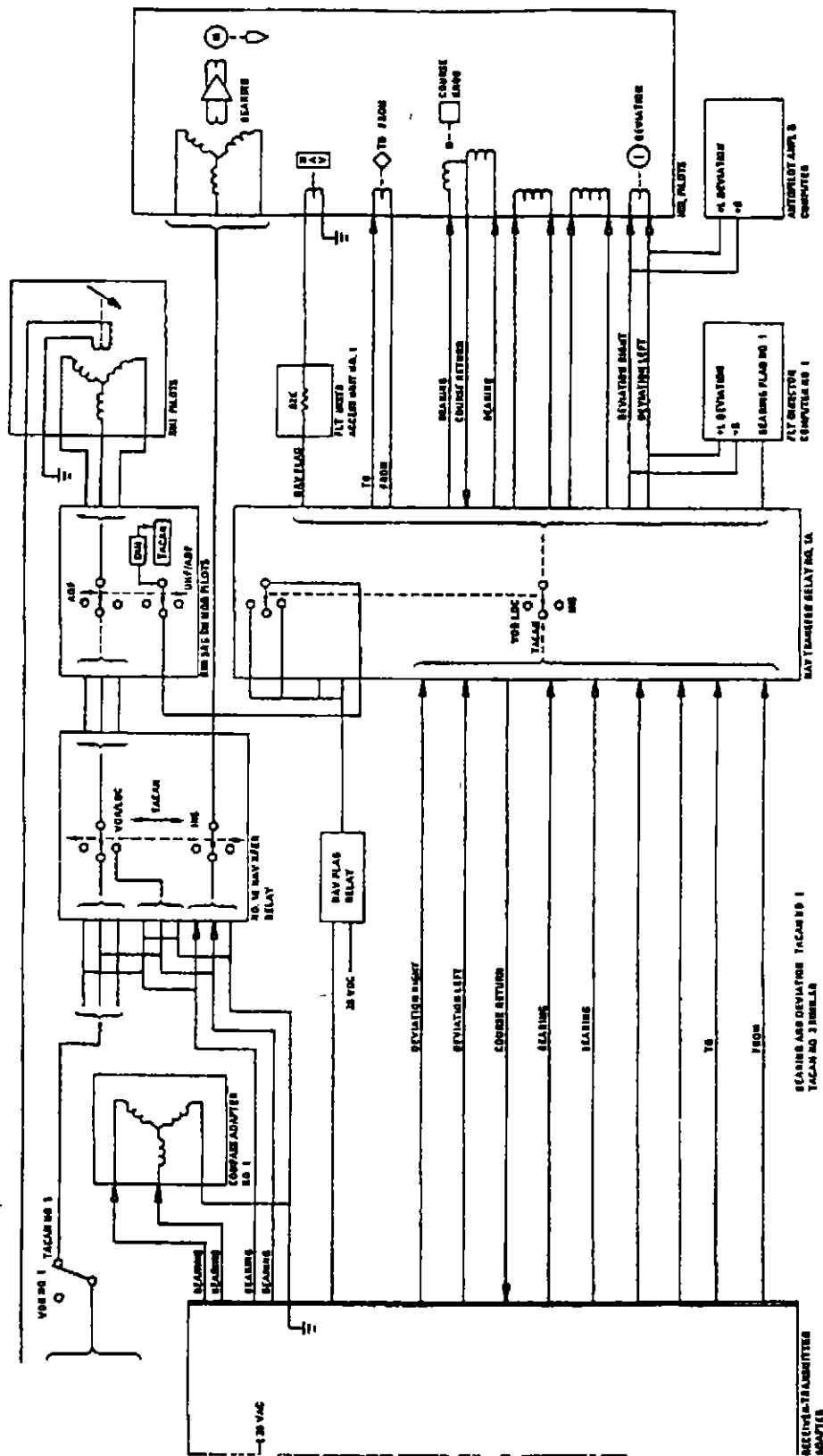
CHARACTERISTICS	VALUES
<u>Y coding (all modes) frequencies</u>	
Transmit	
1 through 63	1025 through 1087 MHz
64 through 126	1088 through 1150 MHz
Receive	
1 through 63	1088 through 1150 MHz
64 through 126	1025 through 1087 MHz
<u>Pulse repetition rate</u>	
Search	142 to 150 pulse pairs/sec
Track	30 pulse pairs/sec max
TRANSMITTER OUTPUT POWER	500 W minimum (250 W minimum in air-to-air mode)

AN/ARN-118(V) TACAN System Characteristics
Table 3 (Sheet 3 of 3)

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Antenna Location
Figure 3



AN/ARN-118(V) TACAN System functional Diagram

Figure 4 (Sheet 2 of 4)

Ref.. T O 1E-3A-2-34-1

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Ref - T O. 1E-3A-2-34-1
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TACAN NO 1 AND NO 2 SYSTEM - TROUBLE ANALYSIS

1 GENERAL

- A Table 101 lists symptoms, probable causes, and corrective actions as an aid in isolating causes of TACAN system test failures. The reference procedure column lists the related test steps in the checkout procedure. This correlates the symptoms that may be encountered during checkout. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation. If performing the listed corrective actions does not correct the fault, check and repair interconnecting wiring per applicable wiring diagrams.

Ref T O 1E-3A-2-34-1
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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
RECEIVER-TRANSMITTER BLOWER DOES NOT OPERATE WHEN MODE SWITCH IS MOVED FROM OFF TO RECEIVE			
Table 502 Steps 9 and 11	Defective control panel or receiver transmitter	Interchange receiver-transmitters	Replace control panel if blower still does not operate. If blower operates, replace receiver-transmitter.
HSI BEARING POINTER DOES NOT SEARCH			
Table 502 Steps 9 and 11	Defective HSI	Select same TACAN bearing on RMI	If RMI pointer searches, replace HSI.
Table 503 step 26	Defective signal data converter	Interchange converters	If HSI now searches, replace defective converter.
	Defective receiver-transmitter	Replace defective receiver-transmitter	
RMI POINTER DOES NOT SEARCH			
Table 502 Steps 9 Table 503 STEP 26	Defective RMI	If HSI heading pointer searches, RMI is defective.	Replace RMI.
HSI OR RMI POINTER DOES NOT INDICATE CORRECTLY			
Table 502 Step 15 Table 503 Steps 28, 30, 31 and 35	Defective RMI or HSI	If other three bearing pointers indicate correctly, trouble is in one that does not.	Replace RMI or HSI.
	Defective receiver transmitter adapter or receiver-transmitter	Interchange receiver-transmitter adapters	If wrong indication remains on same units, replace corresponding receiver-transmitter. If wrong indication changes, replace corresponding receiver-transmitter adapter.

AN/ARN-118(V) TACAN System - Trouble Shooting

Table 101 (Sheet 1 of 3)

Ref T O 1E-3A-2-34-1

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
COURSE DEVIATION BAR NOT CENTERED WITH COURSE SELECTED			
Table 502 Step 15. Table 503 Step 33	Defective HSI.	Check course deviation bar centering with VHF navigation system. If course deviation bar cannot be centered HSI is bad.	Replace HSI.
	Defective receiver-transmitter adapter.	If HSI is good, but TACAN centering cannot be adjusted, receiver-transmitter adapter is bad.	Replace receiver-transmitter adapter
HSI TO-FROM INDICATOR DOES NOT INDICATE PROPERLY			
Table 502 Step 15 Table 503 Step 33.	Defective HSI	Check TO-FROM indication with VHF navigation system . If TO-FROM indicator does not indicate properly, HSI is defective.	Replace HSI
	Defective receiver-transmitter adapter.	If indicator checked good with VHF navigation input, receiver-transmitter adapter is bad.	Replace receiver-transmitter adapter
NO ID TONE RECEPTION FROM LOCAL STATION			
Table 503 Step 21	Defective receiver-transmitter.	Interchange receiver-transmitters.	If OK now, replace defective receiver-transmitter
	Defective intercom	Check intercom.	Troubleshoot intercom
	Defective control panel		Replace faulty control panel.

AN/ARN-118(V) TACAN System - Trouble Shooting
Table 101 (Sheet 2 of 3)

Ref.: T.O. 1E-3A-2-34-1
Page 10-30 Change 11



MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
MILES COUNTER DOES NOT INDICATE CORRECTLY			
Table 503 Step 15, 16, 17, 18, 38, 39, 41 and 42	Defective HSI	Interchange receiver-transmitter	If HSI still indicates wrongly, replace defective HSI
	Defective receiver- transmitter adapter		Replace defective receiver-transmitter adapter
POOR RECEPTION AS NOTED IN FLIGHT REPORT			
	Defective receiver- transmitter	1 If peak power output measured on test set is low, receiver-transmit- ter is defective 2 To isolate weak reception, interchange receiver-transmitters If weak reception moves to other system, fault is in receiver- transmitter If not, check antennas (See below)	Replace defective receiver-transmitter
POOR RECEPTION NOTED OR PULSE REPLY INCORRECT			
	Defective antenna, cable or connector	Disconnect upper and lower antenna cables at receiver-transmitter one at a time to check reception of local TACAN beacon with only one antenna	If no reception on one antenna, check antenna circuit with time domain reflectometer and replace antenna, connector or cable as required
	Defective Control panel	Interchange control panels	If trouble is corrected, replace defective control panel
	Defective receiver- transmitter		If trouble is not cor- rected, replace defective receiver-transmitter

AN/AM-118(V), TACAN System - Trouble Shooting

Table 101 (Sheet 3 of 3)

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TACAN NO. 1 AND NO. 2 SYSTEM - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Self Leveling Green Sealant (P/N HT3326-5-50).
- B. Tape Stretch Seal (P/N AD89503/01-36).

2. Control Panels - Removal

- A. Release quick-release fasteners at edge of panel. Fasteners require one-quarter turn counterclockwise to release, and may pop out by spring action when released.
- B. Pull panel out of mounting area far enough to disconnect electrical connectors.
- C. Disconnect electrical connectors.

3. Control Panels - Installation

- A. Connect electrical connectors to panel.
- B. Place panel in mounting area.
- C. Fasten quick-release fasteners by pushing in and turning one-quarter turn clockwise. The fasteners can only be pushed completely in when they are correctly aligned to engage the wire in the mounting rail.

4. TACAN Antenna - Removal

NOTE: Removal of an upper antenna requires a work stand high enough to reach the top of the fuselage.

- A. Open the AC and DC TACAN 1 and TACAN 2 circuit breakers on P5 overhead circuit breaker panel.
- B. Locate the four TACAN antennas:

TACAN No. 1 top	Station 510
TACAN No. 1 bottom	Station 600L +5
TACAN No. 2 top	Station 600F +10
TACAN No. 2 bottom	Station 670
- C. Remove four screws that attach the antenna to the fuselage.
- D. Pull antenna out far enough to disconnect coaxial cable connector.

NOTE: If antenna is located on top of the aircraft, secure cable so that it will not fall into aircraft.

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- E. Disconnect coaxial cable connector from antenna.
- F. Discard O-ring.

5. TACAN Antenna - Installation

- A. Place antenna gasket on antenna.
- B. Apply self leveling green sealant to connector base. Allow sealant to cure for 30 minutes before mounting antenna to aircraft.
- C. Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- D. Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- E. Prime and paint all bare metal outside the original footprint and decrease the original footprint by 0,2 inch per AMM 51-90-00.

NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

- F. Clean the antenna footprint and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- G. Remove the aliphatic naphtha with a clean cloth.
- H. Place antenna near mounting location and connect coaxial cable to antenna.
- I. Wind stretch seal tape around connector until it is 1.5 inch above connector; covering the coax cable.

NOTE: Make sure the adhesive side of the tape is pointing to the coaxial cable and the connector. This provides for a tight seal.

CAUTION DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACES

- J. Place antenna in position ensuring the antenna gasket is positioned correctly.
- K. Secure antenna with four mountings screws. Ensure that a Teflon washer is placed under each screw.
- L. Tighten antenna screws, so that antenna gasket is compressed evenly.
- M. Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- N. Measure electrical bond resistance between the antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- O. Close the AC and DC TACAN 1 and TACAN 2 circuit breakers on P5 overhead circuit breaker panel.
- P. Perform TACAN operational test per AMM 34-50-01 page 501, par. 4.

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TACAN NO 1 AND NO 2 SYSTEM - REMOVAL/INSTALLATION

1 Control Panels - Removal

- A Release quick-release fasteners at edge of panel. Fasteners require one-quarter turn counterclockwise to release, and may pop out by spring action when released.
- B Pull panel out of mounting area far enough to disconnect electrical connectors.
- C Disconnect electrical connectors.

2 Control Panels - Installation

- A Connect electrical connectors to panel.
- B Place panel in mounting area.
- C Fasten quick-release fasteners by pushing in and turning one-quarter turn clockwise. The fasteners can only be pushed completely in when they are correctly aligned to engage the wire in the mounting rail.

3 TACAN Antenna - Removal

A General

- (1) The following procedure applies to removal of any of the TACAN antennas. Removal of an upper antenna requires a workstand high enough to reach the top of the fuselage.
- (2) Remove four screws that attach antenna to fuselage.
- (3) Pull antenna out far enough to disconnect coaxial cable connector.
- (4) Disconnect coaxial cable connector from antenna. When removing upper antenna, secure end of cable to prevent connector from falling back inside aircraft.

4 TACAN Antenna - Installation

A General

- (1) This procedure applies to any of the TACAN antennas. Installation of the upper antennas requires a workstand high enough to reach the top of the fuselage.

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- (2) Clean faying (mating) surfaces of antenna and fuselage with aluminum oxide abrasive cloth until both surfaces are bright. Do not remove more material than necessary.
- (3) Apply corrosion preventive compound LPS No. 3 to both faying surfaces.
- (4) Check that serviceable O-ring is in place in groove on antenna mounting surface.
- (6) Measure electrical bond resistance between antenna and fuselage using milliohmmeter. Resistance must be less than 0.001 ohm.

5 Component Replacement Checkout

- A The following checkout procedures ensure that replaced components operate properly in the system.

NOTE For a complete operational checkout of the system, perform table 503.

B Receiver-transmitter Perform table 502.

C Receiver-transmitter adapter Perform table 502.

D Control panel Perform table 502.

E Antenna

- (1) Disconnect aircraft wiring plug for antenna that was not replaced from J1 or J2 on receiver-transmitter.
- (2) Perform steps 1 through 3 and 8 of table 502.
- (3) Select channel of local TACAN station and check reception of ID tone.
- (4) Turn off TACAN set.
- (5) Reconnect aircraft wiring plug to J1 or J2 on receiver-transmitter.
- (6) Remove aircraft electrical power if no longer required for other maintenance.

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TACAN NO. 1 AND NO 2 SYSTEM - ADJUSTMENT/ TEST

1 GENERAL

- A Two checkout procedures are provided a self-test (table 502) and a system check (table 503) Passage of the self-test requires that major circuits in the receiver-transmitter and the converter are operating satisfactorily The system check is a complete test The system check requires concurrent operations in the flight deck, to operate system controls and displays, and at the radio rack or outside the aircraft to operate the radio test set Both procedures apply to either TACAN set Close circuit breakers for the navigation instruments and TACAN No 1 or No 2 system that corresponds to the TACAN set being checked When out of tolerance conditions are encountered, refer to trouble analysis for corrective action

2 TOOLS AND TEST EQUIPMENT

- A Table 501 lists tool and test equipment required for line maintenance of the TACAN navigational sets

NOTE Equivalent tools or test equipment are authorized for use unless identified by a no-substitute notation

PART NO. OR TYPE DESIGNATOR	NOMENCLATURE	USE AND APPLICATION
<u>TOOLS</u> <u>TEST EQUIPMENT</u>		
AN/ARM-188	TACAN RAMP TEST SET MODEL MTS-100	Provide test signals for system test

AN/ARN 118(V) TACAN System - Tools and Equipment
Table 501

Ref. T O 1E-3A-2-34-1
Page 11 Change 11
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STEP	RESULT
1 Provide aircraft electrical power 2 Check that following circuit breakers are pushed in a P5 circuit breaker panel TACAN NO 1 (or NO 2) AC TACAN NO 1 (or NO 2) DC FLIGHT INST NO 1 (or NO 2) BRG EXC ATT EXC HDG EXC XFRM NO 1 (or NO 2) 3 On glare shield, set pilots and copilots NAV MODE selector switch to TACAN 4 Set pilots and copilots RMI selector switch to TACAN/VOR 5 On No 1 compass controller (P13 over head panel) a Select aircraft hemisphere b Select aircraft latitude c Set mode selector to DG <u>NOTE.</u> Some readjustment of the compass card may be required throughout the checkout procedure. d Push in HDG set knob and slew compass card to 0° heading under lubber line	RMI compass card at copilot position agrees with pilot HSI $\pm 2^\circ$

AN/ARN-118(V) TACAN System Self-Test
Table 502 (Sheet 1 of 5)

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STEP	RESULT
6 On No 2 compass controller (P13 overhead panel) a Select aircraft hemisphere b Select aircraft latitude c Set mode selector to DG d Push in HDG set knob and slew compass card to 0° heading under lubber line <u>NOTE</u> The TEST indicator on the control panel may come on when system is first turned on. If this occurs, momentarily press TEST pushbutton switch and wait until indicator goes off (end of self test cycle)	RMI compass card at pilots position agrees with copilots HSI $\pm 2^\circ$
7 Set mode switch on pilots TACAN control panel to REC <u>NOTE</u> Allow 2 minute equipment warmup before proceeding	
8 Select channel 1X on pilots TACAN control panel	1 Bearing pointer No 1 (pink) on pilots and copilots HSI rotate clockwise 2 On pilots HSI Range flag covers TACAN distance indicator NAV warning flag is in view 3 Cooling fan of No 1 TACAN RT is operating
9 Set mode switch on copilots TACAN control panel to REC <u>NOTE</u> Allow 2 minute warmup before proceeding	

AN/ARN-118(V) TACAN System Self-Test
Table 502 (Sheet 2 of 5)

Ref T O 1E-3A-2-34-1
Page 10-18 Change 11
Page 10-19 Change 11

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STEP	RESULT
10 Select channel 1X on copilots TACAN control panel <u>NOTE</u> COURSE knob must be pulled out and remain out to select the course	1 Bearing pointer No 2 (green) on pilots and copilots HSI rotates clockwise 2 On copilots HSI Range flag covers TACAN distance indicator NAV warning flag is in view 3 Cooling fan of No 2 TACAN RT is operating
11 Pull out and set COURSE knob on pilots and copilots HSI to 180°	
12 Set autopilot to MAN or HDG mode if energized	
13 Set mode switch to T/R and select channel 64X on pilots TACAN control panel	
14 Momentarily press TEST switch on pilots TACAN control panel	1 TEST indicator on TACAN control panel momentarily flashes and then goes off 2 Range flag and NAV warning flag on pilots HSI come into view (if not already in view) then pull out of view while MILES indicator on pilots HSI indicates 00 0 (± 00 5) nmi (for nominal 15 seconds) Then range flag comes back into view (until system locks onto a TACAN signal) 3 Bearing pointers (pilots and copilots No 1 pointer - pink on HSI may slew to 270 degrees for a nominal 7 seconds but then will indicate 180 (± 4) degrees for a nominal 15 seconds

AN/ARN-118(V) TACAN System Self-Test
 Table 502 (Sheet 3 of 5)

Ref T O. 1E-3A-2-34-1
 Page 10-19 Change 11
 Page 10-20 Change 21



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STEP	RESULT
	4 Course deviation bar on pilots HSI is centered within $\pm$ one-half dot and TO-FROM arrow indicates TO for nominal 15 seconds
	5 TEST indicator on TACAN control panel is off
15 Set mode switch to T/R and select 64X on copilots TACAN control panel	
16 Momentarily press TEST switch on copilots TACAN control panel	1 TEST indicator on TACAN control panel momentarily flashes and then goes off
	2 Range flag and NAV warning flag on copilots HSI comes into view (if not already in view) then pull out of view while MILES indicator on copilots HSI indicates 00 0 ($\pm$ 00 5) nmi (for nominal 15 seconds) Then range flag comes back into view (until system locks onto a TACAN signal)
	3 Bearing pointers (copilots and pilots No 2 pointer on HSI may slew to 270 degrees for a nominal 7 seconds but will then indicate 180 ($\pm$ 4) degrees for a nominal 15 seconds.
	4. Course deviation bar on copilots HSI is centered within $\pm$ one-half dot and TO-FROM arrow indicates TO for nominal 15 seconds
	5 TEST indicator on TACAN control panel is off
17 Set mode switch to OFF on both TACAN control panels	

AN/ARN-118(V) TACAN System Self-Test

Table 502 (Sheet 4 of 5)

Ref T O 15-3A-2-34-1

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STEP	RESULT
18 Open following circuit breakers on P5 circuit breaker panel TACAN N° 1 (or N° 2) AC TACAN N° 1 (or N° 2) DC FLIGHT INST N° 1 (or N° 2) BRG EXC ATT EXC HDG EXC XFRM N° 1 (or N° 2) 19 Remove aircraft electrical power if no longer required for other maintenance	

AN/ARN-118(V) TACAN System Self-Test
Table 502 (Sheet 5 of 5)



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STEP	RESULT
<u>NOTE</u> As a function of bit updating in the TACAN digital processor, the unit digit on the HSI range readout may fluctuate slowly to a maximum of 0.3 nautical miles. This fluctuation, which will appear both in self test and when using the ramp test set, should be within the tolerance stated in this procedure. A distance indication of 300.0 NMI or 399.5 are not malfunctions but indications of negative distance, -0.01 NMI and -0.5 NMI respectively. It is characteristic of this system on occasion, to momentarily delay updating of the 100's digit. The TEST indicator on the TACAN control panel may come on when the system is first turned on. If this occurs, press the TEST button and verify that the indicator is off after completion of the self-test cycle. 1 Provide aircraft electrical power. 2 Establish interphone communications. 3 Check that following circuit breakers are pushed in: - a P5 overhead panel - TACAN N° 1 AC, DC - TACAN N° 2 AC, DC - FLT INS N° 1 (and N° 2) AC - VERT GYRO N° 1 (and N° 2) - COMPASS N° 1 (and N° 2) - XMFR N° 1 (and N° 2) - FLT INST N° 1 - FD N° 1 DC - FLT INST N° 2 DC	

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 1 of 7)

Ref DRW CDRL 43/44
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STEP	RESULT
4 On pilots and copilots TACAN control panel Set mode switch to T/R, select channel 17X 5 On glareshield, set pilots and copilots NAV MODE selector switch to TACAN. 6. On No 1 compass controller (P13 Over head panel) a Select aircraft hemisphere b Select aircraft latitude c Set mode selector to DG <u>NOTE</u> Some readjustment of the compass card may be required throughout the checkout procedure d Push in HDG set knob on F/O's HSI and slew compass card to 0 degree heading 7 On No 2 compass controller (P13 Over head panel) a Select aircraft hemisphere. b Select aircraft latitude c. Set mode selector to DG. d Push in HDG knob on CAPT. HSI and slew compass card to 0 degree heading <u>NOTE.</u> A TACAN can be tested in a radiated mode in all positions of mode/channel control, but W3 must be connected, to RADIATE connector and side rotary switch must be positioned to NORMAL.	

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 2 of 7)

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STEP	RESULT
8 Set up test set as follows for TACAN No 1 System a On test set put mode channel select knob in Bat Test position In this position the test set is powered The meter shall read in the blue region If indication is in red region recharging is necessary <u>NOTE</u> Be sure to turn Mode/Channel control to off position when not in use to minimize power drain if operating from battery pack Use test set upright and keep it a distance of between 10 and 100 feet from the aircraft <u>FOR GROUND TO AIR X MODE</u>	
9 Set TACAN control to channel 31, X Mode, Receive only	
10 Set test set mode/channel control to T/R-31X, 91X and range bearing to 0-0 Set side rotary switch to NORM position The front panel BNC terminated cable should be connected to RADIATE connector	- Check meter reads in the blue zone - Check for continuous identify tone on the intercom system
11 Set TACAN control to T/R (X-mode channel 31)	- Meter should swing to the red zone
<u>NOTE</u> Wait 3 seconds until the meter indicates the black zone Both HSI indicators shall indicate 0 miles 0 degrees bearing	
12 Set Test Set range bearing control to 5-45°	- HSI indicates 5 miles 45°
13 Set range bearing control to 125-135°	- HSI indicates 125 miles 125°
14 Set range bearing control to 283-225°	- HSI indicates 283 miles 225°

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 3 of 7)

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STEP	RESULT
15 Set range bearing control to 389-315°.	- HSI indicates 339 miles 315°
16 Set TACAN control to channel 91-X mode receive only	
17 Repeat steps 12, 13, 14 and 15	- Confirm results same as 12 thru 15
<u>FOR GROUND TO AIR Y MODE</u>	
18 Repeat steps 9 thru 15 except set TACAN control to 29 Y and test set control to 29 Y/93 Y	- Confirm results same as 12 thru 15
a Repeat steps 9 thru 15 except TACAN control to 93 Y	- Confirm results same as 12 thru 15
<u>AIR TO AIR X MODE</u>	
19 Ensure test set side rotary switch set to NORMAL	
20 Set test set mode/channel control to AA-29X, 93X	- Confirm same result as in step 10
21 Set TACAN control to A/A channel 29X, REC	- Confirm same result as in step 11
<u>NOTE.</u> Wait 3 seconds until meter indicates the black zone Both HSI indicators shall indicate 0 miles 0 degrees bearing	
22 Set TACAN control to A/A- channel 29X, T/R	- Confirm same result as in step 11
23 Repeat steps 21 and 22 with TACAN control set to channel 93X.	- Confirm results same as in steps 21 and 22
<u>AIR TO AIR Y MODE</u>	
24 Repeat steps 20 thru 23 except set TACAN controls and test set control to Y-channels	- Confirm results as in steps 21 thru 23
25 Set TACAN control to "OFF"	

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 4 of 7)

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STEP	RESULT																								
<u>PEAK POWER MEASUREMENTS</u>																									
<u>CAUTION</u> DO NOT CONNECT THE TEST SET RF CONNECTOR DIRECTLY TO THE TACAN AT ANY TIME																									
26 Disconnect the antenna input from the TACAN R/T																									
27 Connect 10 foot co-ax test cable between antenna output socket of the TACAN R/T and the TNC socket of the Measurement Attenuator																									
28 Connect the Measurement Attenuator to the RF socket on the MTS-100 test set via the 1 foot coax cable																									
29 Change position of coax cable W3 on the test set from the RADIATE socket to the DIRECT socket																									
30 Set Measurement Attenuator 10 dB																									
31 Set TACAN mode control to T/R or A/A and select suitable channel for peak power measurement test																									
32 Select peak PWR position on test set MODE/CHANNEL switch and adjust measurement attenuator until ramp test set meter indicates the center of the black zone	- Record result and consult table below Attenuator Reading dB																								
<u>ATTENUATOR SETTING VERSUS PEAK POWER</u>																									
<table> <tr> <th>ATTEN. SETTING</th><th>PEAK POWER</th></tr> <tr> <td>0 dB</td><td>500 Watts</td></tr> <tr> <td>1 0</td><td>630</td></tr> <tr> <td>2 0</td><td>790</td></tr> <tr> <td>3 0</td><td>1000</td></tr> <tr> <td>4 0</td><td>1260</td></tr> <tr> <td>5 0</td><td>1580</td></tr> <tr> <td>6 0</td><td>2000</td></tr> <tr> <td>7 0</td><td>2500</td></tr> <tr> <td>8 0</td><td>3160</td></tr> <tr> <td>9 0</td><td>3970</td></tr> <tr> <td>10 0</td><td>5000</td></tr> </table>		ATTEN. SETTING	PEAK POWER	0 dB	500 Watts	1 0	630	2 0	790	3 0	1000	4 0	1260	5 0	1580	6 0	2000	7 0	2500	8 0	3160	9 0	3970	10 0	5000
ATTEN. SETTING	PEAK POWER																								
0 dB	500 Watts																								
1 0	630																								
2 0	790																								
3 0	1000																								
4 0	1260																								
5 0	1580																								
6 0	2000																								
7 0	2500																								
8 0	3160																								
9 0	3970																								
10 0	5000																								

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 5 of 7)

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STEP	RESULT
33 Reconnect the TACAN antenna connector on the TACAN R/T <u>RADIATION TEST</u> 34 Position ramp test set cable W3 to front panel RADIATE connector 35 Select T/R-31X, 91X on the test set mode/channel switch Set TACAN mode control to T/R 31X or 91X 36 Position ramp test between four and ten feet from the TACAN antenna 37 With both TACAN and ramp test operating, verify that the test set indicates it's own transmission per symbolised meter indic 38 Verify that the test set indicates receipt of valid interrogation 39 Verify that the test set indicates range lock-on	RED BLUE Test set transmitting with no valid TACAN interrogations being received Test Set receiving valid TACAN interrogations in search mode. TACAN locked-on in range and reply delay is valid in A/A mode

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 6 of 7)

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STEP	RESULT
40 Select OFF on TACAN No 1 control unit 41 Repeat steps 9 thru 39 TACAN No 2 42 Set mode selector to OFF on pilots and copilots TACAN control panel 43 Turn off test set, disconnect and replace 44 Set compass controllers DG/MAG switch to MAG 45 ON P5 circuit breaker panel, open following circuit breakers TACAN No 1 AC, DC TACAN No 2 AC, DC FLT INST No 1 (and No 2) AC VERT GYRO No 1 (and No 2) COMPASS No 1 (and No 2) XMFR No 1 (and No 2) FLT INST No 1 - FD No 1 DC FLT INST No 2 DC Remove aircraft electrical power if no longer required for other maintenance	Record result of step 32 for TACAN No 2 peak power Attenuator Reading dB

AN/ARN-118(V) TACAN System Check
Table 503 (Sheet 7 of 7)

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AIMS TRANSPONDER SYSTEM - DESCRIPTION AND OPERATION

1 SAFETY PRECAUTIONS

- A Refer to introduction for general safety precautions to be observed when operating or performing maintenance on the AIMS transponder system. Observe caution notes when preparing flying surfaces.

2 DESCRIPTION

- A The AN/APX-101(V) AIMS transponder set, installed on all TCA aircraft, is an identification radar which consists of the airborne (slaved) portion of the IFF Mark XII (SIF) system. The transponder set provides for reception, detection, decoding, encoding and transmission of signals. A ground or airborne control center, which consists of the command portion of the IFT Mark XII (SIF) system, includes interrogating, signal processing, and display equipment. The transponder set receives and decodes pulse-coded signals from the control center interrogator. If the interrogator characteristics are correct, a coded reply is transmitted back to the interrogator. The coded reply is processed and displayed, providing the interrogator with aircraft location information and identification (friend or foe).
- B System equipment consists of a transponder set control, C-6280A(P)/APX, a receiver-transmitter, RT-1063B/APX-101(V), a transponder computer, KIT-1A/TSEC, an upper and lower antenna, an antenna selector switch, and an IFF caution light. (See table 1.) The system receives octal coded pressure altitude data from the CADC (central air data computer) system, a keying signal from the UHF communication system and a ground/air discrete from the landing gear safety switch relay. The system provides an audio output to the crew intercom, and is interconnected for interference suppression with other equipment operating near the IFF frequencies. Figure 1 shows equipment location.
- C The ground station may interrogate in more than one mode. However, the transponder will only reply in those modes that are enabled. Besides the normal replies listed below, the transponder contains provisions for a special emergency mode of operation (EMER position of the master switch), and for transmission of an identification of position (I/P or IDENT) signal. Modes 1, 2, 3/A and C have a self-test capability with either internally generated test interrogations or ground station interrogations. Mode 4 operation requires that the mode 4 transponder computer be installed and when installed, operation is continuously monitored by the caution light. The interrogation and reply modes are as follows:

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INTERROGATION

REPLY

MODE 1	Any one of 32 possible codes, as set on transponder set control
MODE 2	Any one of 4096 possible codes, as set on transponder
MODE 3/A	Any one of 4096 possible codes, as set on transponder set control
MODE C	Standard ATC code for altitude reporting
MODE 4	As determined by mode 4 transponder computer

D. Transponder Set Control

- (1) The transponder set control on the overhead panel (figure 1) has the principal controls and indicators for the AIMS system. The panel is marked IFF on the left edge. On the top of the panel are two rotary selector switches, MASTER and CODE, and two press-to-test indicator lamps, REPLY and TEST. In the middle of the panel are mode enabling test and indication selector switches. On the bottom of the panel are the mode 1 and mode 3/A code selectors
- (2) The MASTER switch is a rotary switch with OFF, STBY, LOW, NORM and EMER positions. In the OFF position, all power is removed from the set, STBY position places the transponder in warmup condition. Warmup requires approximately 3 minutes. LOW position places the transponder in operation with reduced receiver sensitivity. NORM position results in operation with normal receiver sensitivity. EMER position causes automatic transmission of emergency reply signals when interrogated by mode 1, mode 2 or mode 3/A. The MASTER switch must be pulled out to turn to OFF or EMER. Also, the MASTER switch must be in the NORM position for self-test with mode enabling switches. OFF position will zeroize mode 4 code set tings at any time in flight and on the ground unless the CODE switch is placed in the HOLD position while on the ground.
- (3) Four mode enabling switches are marked M-1, M-2, M-3/A and M-C and have positions OUT, ON, and momentary test (up) position. The OUT position prevents the transponder from replying to interrogation signals in that mode. The ON position enables operation in the selected mode. The momentary test (up) position provides for a self-test of the selected mode. When the switch is held in the up position, the transponder generates test interrogations, the transponder response is analyzed, and results are indicated by the TEST light.

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- (4) The CODE switch has four positions marked HOLD, A, B and ZERO. Positions A and B select the preset code stored in the transponder computer for the present and succeeding code period, respectively. ZERO position will zeroize both code settings at any time power is on and the MASTER switch is in any position other than OFF. Inadvertent selection of ZERO is prevented by switch design which requires that the knob be pulled out before it can be turned to ZERO. Both code settings will normally be zeroized when power is turned off after the aircraft has landed. The code settings can be retained by momentarily placing the CODE switch in the spring-loaded HOLD position while the aircraft is on the ground. The hold function is controlled by the landing gear safety switches and requires transponder power to remain on for at least 15 seconds to mechanically latch the code settings.
- NOTE: Once the hold function has been activated on the ground, aircraft power loss or SIF/IFF master switch OFF does not cause loss of the code. If the hold function has been activated, the code must be zeroized by turning the CODE switch to ZERO.
- (5) The green press-to-test light marked TEST comes on when the transponder is responding correctly to mode 1, 2, 3/A or C interrogations. The RAD TEST/MON switch has three positions marked RAD TEST, OUT and MON and is spring-loaded from RAD TEST to OUT. The RAD TEST position is not used. The MON position enables the test light to monitor modes 1, 2, 3/A and C replies generated by the transponder to ground interrogations. This switch must be positioned to OUT when using the mode enabling switch TEST positions.
- (6) The IDENT/MIC switch provides for special identification features which are of use to the air traffic controller. The switch has three positions marked IDENT, OUT and MIC and is spring-loaded from IDENT to OUT position. Momentarily actuating the switch to the IDENT position initiates the identification response. When the switch is placed in the MIC position and UHF has been selected, identification response is initiated whenever the flight deck UHF communication system key line is grounded by a push to talk switch. The response will continue for 30 seconds after the IDENT/MIC switch or the push to talk switch is actuated. The proper mode enabling switch must be turned on (to match the interrogation mode) to allow identification operation.
- (7) The two MODE 1 code selectors are eight-position thumbwheel type selectors with integral indicators. The first digit selector is numbered from 0 through 7, and the second digit selector is numbered 0 through 3. A total of 32 mode 1 code combinations is available. The four MODE 3/A code selectors are eight-position thumbwheel type selectors with integral indicators numbered from 0 through 7. The MODE 3/A selectors allow selection of any octal (base eight) code from 0000 to 7777, for a total of 4096 different codes. Mode 2 also allows selection of 4096 codes by use

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of four eight-position switches at the transponder. There are two mode 4 codes, A and B preset in the transponder computer and selected by the mode 4 CODE switch.

- (8) The MODE 4 ON/OUT switch has two positions marked ON and OUT. With the transponder functioning, mode 4 operation is selected by placing the switch to ON. Transponder functioning is controlled by the MASTER switch for mode 4 as for other modes. Placing the MODE 4 ON/OUT switch to OUT disables mode 4 operation. Accidental selection of OUT is prevented by the switch design, which requires the operator to pull out on the toggle lever before it can be moved to the OUT position.
- (9) The MODE 4 LIGHT/OUT switch has three positions. In the LIGHT position, the mode 4 REPLY light indicates when replies are transmitted. In the OUT position, both light and audio indications are inoperative.
- (10) The mode 4 REPLY light is a green press-to-test light.

E IFF Caution Light

- (1) The amber IFF mode 4 press-to-test caution light (figure 1) is located on the center instrument panel. The caution light comes on whenever a mode 4 fault is detected, provided that the mode 4 transponder computer is installed, aircraft power is on, and the MASTER switch is not OFF. Specific discrepancies monitored by the caution light are:
 - (a) Mode 4 codes zeroized. Computer door must be closed firmly in one continuous motion or zeroize will result.
 - (b) Transponder failure to reply to proper interrogation.
 - (c) Automatic self-test function of the computer reveals a faulty computer.

F AIMS Antenna Switch

- (1) A three-position AIMS ANTENNA switch (figure 1) on the overhead panel allows selection of UPPER, BOTH, or LOWER AIMS antennas. When the AIMS ANTENNA switch is positioned to BOTH, the transponder selects either the top or bottom antenna depending on received signal strength.

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G Receiver-Transmitter

- (1) The AIMS receive-transmitter (figure 1) is mounted on RH radio rack shelf 3. Inside the unit are a receiver-transmitter, a power supply and coder/decoder logic. All electrical connections to the receiver-transmitter are made on the front end. The receptacle marked VIDEO is for interface with the transponder computer. Two coaxial cable receptacles on the bottom of the front panel marked LOWER ANT J3 and UPPER ANT J4 connect to the antennas. There are also an active and a spare fuse, an elapsed time meter, a STATUS indicator and four eight-position selector switches for setting up the mode 2 response pulse train.

H Transponder Computer

- (1) The transponder computer, when installed, is mounted on RH radio rack shelf 3 (See figure 1). This unit is required only for mode 4 responses. The system will operate satisfactorily in modes 1, 2, 3/A and C without it. Inside the transponder computer are pulse coder/decoders that can be encoded for two mode 4 responses. The encoded responses can be removed or zeroized by use of the CODE switch on the transponder set control panel or by removing system power without holding the codes.

I Test Receptacle

- (1) A test receptacle (figure 1) is mounted on RH radio rack shelf 3 for system fault diagnosis. A multimeter can be connected to pins in the receptacle to determine if the cause of a self-test no-go is in the transponder, transponder computer, or one of the antennas.

J Antennas

- (1) The AIMS antennas are mounted on the top and bottom of the fuselage. The top antenna is at station 408 and the bottom antenna is at station 430 (See figure 2). The antennas are identical to the small L-band fin antennas used in the TACAN system.

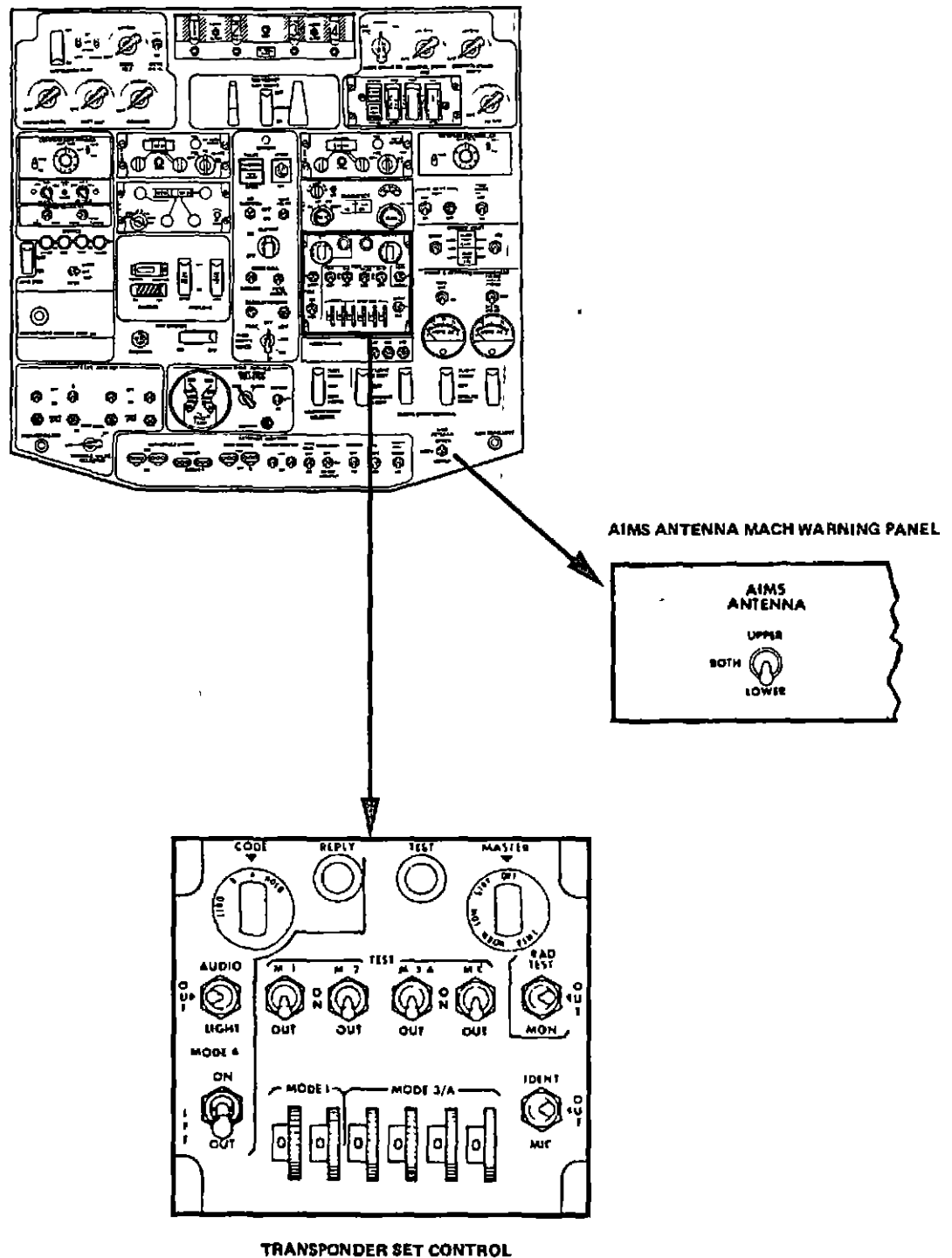
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NOMENCLATURE		COMMON NAME	LOCATION
OFFICIAL	DRAWING		
AIMS Transponder Set AN/APX-101 (V)			
Control XPDR AIMS	Control, Transponder Set C6280A (P)/APX	Control Panel	Panel P13
XPDR R-T AIMS AN/APX-101 (V)	RT AIMS, RT-1063B/APX- 101	Receiver-Transmitter	RH radio rack
XPDR Computer AIMS	XPDR Computer KIT-1A/TSEC	Transponder Computer	RH radio rack
Antenna AIMS, Upper	AIMS Antenna	Antenna (Upper)	Station 408
Antenna AIMS, Lower	AIMS Antenna	Antenna (Lower)	Station 430
AIMS Switch Panel		Antenna Switch Selector	Panel P13
LIGHT - IFF AIMS	IFF Caution Light (Code 4)	IFF Caution Light	Panel P9

AIMS Transponder System Equipment
Table 1

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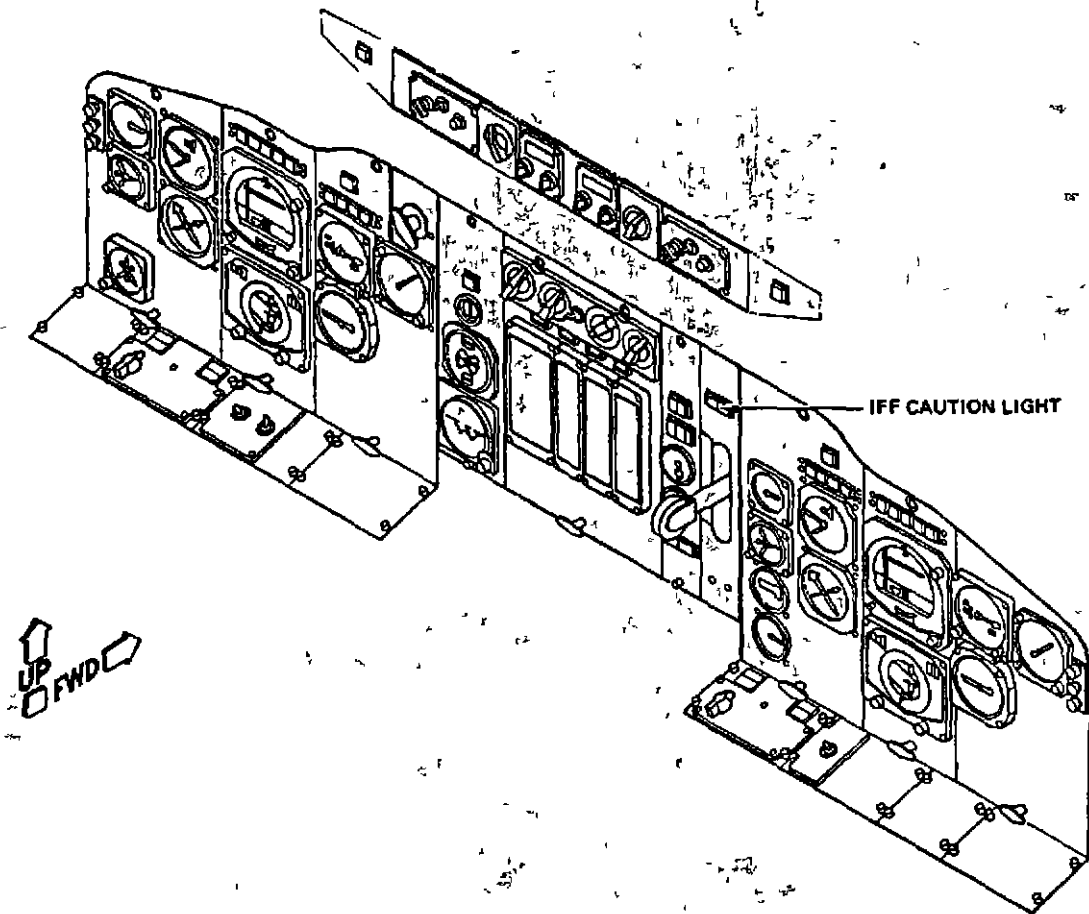
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AIMS Transponder Equipment Location
Figure 1 (Sheet 1 of 3)

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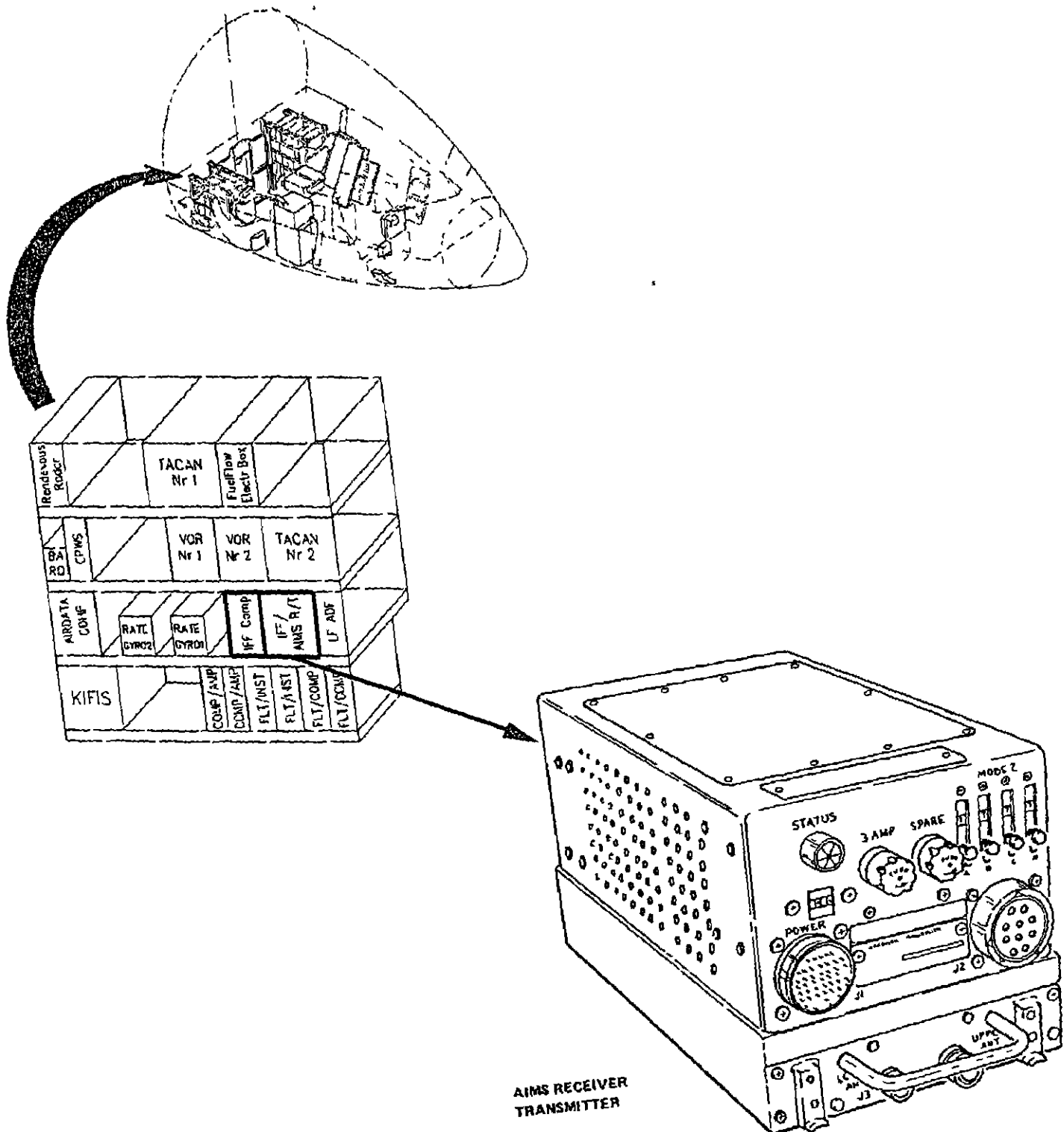
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AIMS Transponder System Equipment Location
Figure 1 (Sheet 2 of 3)

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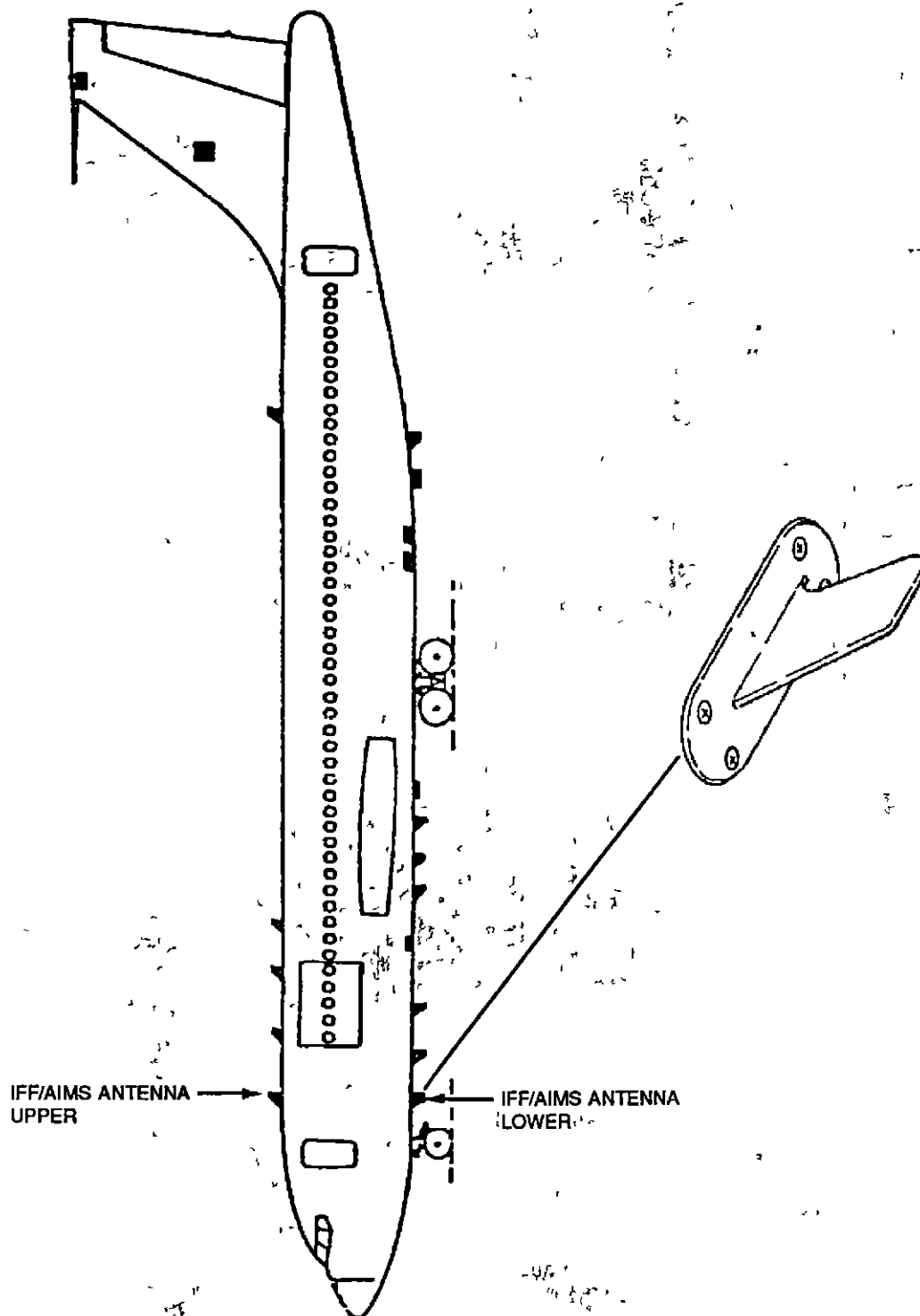


AIMS Transponder Equipment Location
 Figure 1 (Sheet 3 of 3)

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Antenna Location
Figure 2

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3. OPERATION.

- A. The functional block diagram of the AIMS is shown in figure 3. The receiver-transmitter simultaneously receives 1030 MHz rf interrogations from the selected or both antennas, decodes the interrogation, encodes the appropriate reply and transmits the coded rf reply through the proper antenna.
- B. Each channel of the dual channel receiver consists of a diplexer, a tuned radio frequency amplifier and detector, a logarithmic amplifier, a video processor and a pulse width discriminator. The diplexer isolates the receiver input from the transmitter output to permit use of a common input/output transmission line. The receiver amplifies the rf signal and converts it to a video signal. The logarithmic amplifier provides video amplification and logarithmic compression necessary to process the video over the large dynamic range. The video processor performs sensitivity control, channel determination, interfering side lobe rejection and pulse width discrimination. The output from each receiver enters the decoder for further processing.
- C. The decoder and coder section of the receiver-transmitter consists of a crystal controlled clock, a commutator control, decode and code gates and a modulator driver. The crystal controlled clock provides timing references of 50 nsec for the pulse width discriminator, of 200 nsec for the commutator during decoding and of 1.45 μ sec for the commutator during encoding. The commutator, which normally operates as a decoder, receives the digital pulses from each video channel. The pulses are shifted through the commutator and compared with the incoming pulses when they arrive at each mode decode gate. When coincidence occurs, the decoded mode is stored and the associated transmit channel is selected for reply. The commutator, which then operates as a coder, shifts a pulse to each code gate in succession every 1.45 μ sec to generate the code train reply. Each code gate is also enabled by the code control in the mode that has been decoded. The commutator is reset to operate as a decoder after the last pulse has been generated.
- D. With the IDENT (identification of position) control circuits enabled, the coding circuits will generate two complete reply trains required for IDENT operation. IDENT operation is used when it is required to indicate the position of the interrogated aircraft within a group of aircraft. The emergency control circuits are enabled by the MASTER switch on the control. With the emergency control circuits enabled, the coding circuits will generate four complete reply trains required for emergency operation. Emergency operation is used to indicate an aircraft in distress and singles out the aircraft within a group of aircraft.
- E. The reply codes for mode 1 and mode 3/A are manually selected by the MODE 1 and MODE 3/A code selectors on the control. The reply code for mode 2 is manually selected by the MODE 2 code selectors on the receiver transmitter.

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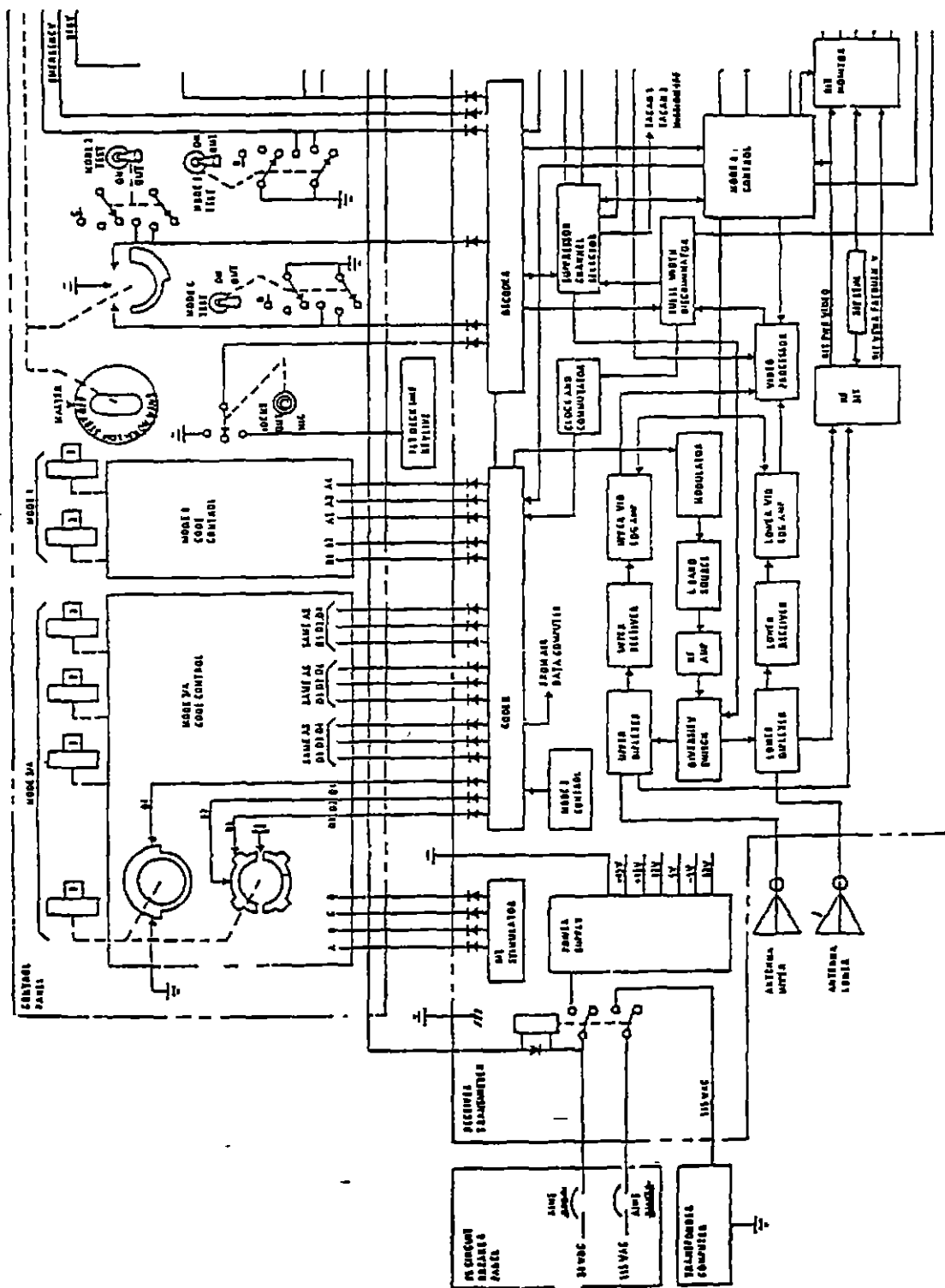
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The reply code for mode C is determined by the digitized altitude information supplied by the altitude computer. The altitude computer senses the pressure altitude and corrects for position error. The corrected pressure altitude is encoded as digitized altitude information in 100-foot increments to the transponder set for determination of the mode C reply code.

- F The transmitter consists of a modulator, 1090 MHz rf oscillator, rf amplifier, isolator and antenna switch. Suppression gates are generated to inhibit SIF (mode 3/A) decodes when an SLS (side lobe suppression) pulse is present or when a mode 4 trigger or external suppression occurs, suppression gates also inhibit SIF decodes during mode 4 replies and provide external decode suppression during SIF and mode 4 replies. Automatic overload control decreases the sensitivity in the dual video processor to limit the rate at which interrogations are recognized. Thus the receiver-transmitter progressively suppresses responses to progressively weaker interrogations and effectively limits the transmitter duty cycle to one percent.
- G Built-in test (BIT) equipment generates rf stimuli in all SIF modes and provides continuous monitoring and evaluation of the rf reply whether the reply is stimulated internally or by interrogation. Receiver frequency, receiver sensitivity, decoder accuracy, transmitter frequency, transmitter power, frame coder accuracy and antenna VSWR are evaluated in a complete end-to-end test. Evaluation of an acceptable condition is performed and GO/NO-GO signals are sent to the test receptacle and to the TEST lamp on the control panel.
- H The operation of the mode 4 circuits is monitored by the IFF caution light and by the REPLY light or by an audio signal. The IFF caution light will come on to indicate that interrogations are not properly decoded by the transponder computer or that replies to properly coded interrogations are not transmitted. Depending on the position of the OUT/LIGHT switch, the REPLY light will come on and an audio signal will be generated when mode 4 replies are transmitted.

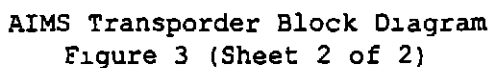
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AIMS Transponder Block Diagram
Figure 3 (Sheet 1 of 2)

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AIMS TRANSPONDER SYSTEM - TROUBLE ANALYSIS

1. General

- A. Table 101 lists trouble symptoms, probable causes, isolation procedures and corrective actions for AIMS failures. The reference procedure column lists the related test steps in the checkout procedure. This correlates the symptoms with failures that may be encountered during checkout. The diagnostic procedures are also valid for the same symptoms when encountered during normal system operation. If performing the corrective actions listed does not correct the fault, check wiring.

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
TEST INDICATOR DOES NOT COME ON WHEN M-1, M-2, M-3/A OR M-C TEST SWITCH IS MOVED TO TEST			
Para 6-36 Step 4	Defective receiver-transmitter	Connect multimeter (ohms x 1) between pins 11 and 7 of AIMS test receptacle. If less than one ohm when test switch is pressed, receiver transmitter is defective.	Replace transmitter
	Defective antenna	Select UPPER or LOWER antenna and check resistance between pins 10 and 7 of test receptacle during test. If less than one ohm, selected antenna is defective. Repeat test for other antenna.	Replace upper or lower as indicated
	Defective IFF control panel	If neither pin 10 or 11 is grounded to pin 7 during preceding test, trouble is in control panel.	Replace control panel
INCORRECT RESPONSE TO MODE 4 INTERROGATIONS			
	Defective transponder computer	Check resistance between pins 9 and 7 of test receptacle with computer installed and M-1 test switch moved to ON. If less than one ohm, computer is faulty.	Replace computer
MODE 4 CODES NOT ZEROIZED WHEN AIRCRAFT LANDS			
	Ground path not made through landing gear switch module	Check for ground at pin 32 of computer mount receptacle.	Replace landing gear switch module

AIMS Transponder System - Trouble Analysis
Table 101 (Sheet 1 of 2)

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
IDENT DOES NOT OPERATE IN MIC MODE	Open connection to UHF radio keyline	Check keyline wiring	Repair wiring
IFF CAUTION LIGHT NOT ON WHEN TRANSPONDER COMPUTER IS INSTALLED AND ENCODED	Defective bulb	Press to test bulb	Replace bulb
	Defective receiver- transmitter		Replace receiver- transmitter
INTERROGATING STATION REPORTS INCORRECT ALTITUDE DATA			
	Defective air data computer		Replace air data computer

AIMS Transponder System - Trouble Analysis
Table 101 (Sheet 2 of 2)

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AIMS TRANSPONDER SYSTEM - REMOVAL/INSTALLATION

1 Control Panels - Removal

- A Release quick-release fasteners at edge of panel. Fasteners require one-quarter turn counterclockwise to release, and may pop out by spring action when released.
- B Pull panel out of mounting area far enough to disconnect electrical connectors.
- C. Disconnect electrical connectors

2 Control Panels - Installation

- A Connect electrical connectors to panel
- B Place panel in mounting area
- C. Fasten quick-release fasteners by pushing in and turning one-quarter turn clockwise. The fasteners can only be pushed completely in when they are correctly aligned to engage the wire in the mounting rail.

3 Receiver-Transmitter - Removal

- A. Disconnect electrical connectors as required
- B Loosen restraining thumbnut by unscrewing far enough to drop the securing bolt clear of the lip on the end of the unit
- C. Pull the unit straight out without lifting the end up. Many units have electrical connectors at the rear of the rack, so that bending or twisting only increases the friction. Also, be careful because the friction will suddenly decrease when the connector pins come loose.

4 Receiver-Transmitter - Installation

- A Check rear electrical connector to be sure shipping cover is removed and that all pins are straight and clean

- B. Slide unit straight into rack until connector starts to engage,

CAUTION· USE CARE IN TIGHTENING THUMBSCREWS TO AVOID DAMAGE TO CONNECTORS

- C. Tighten restraining thumbscrew, taking care not to apply excessive pressure. If unit seems difficult to seat properly, remove unit and check for binding and proper alignment.

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5 Transponder Computer - Removal

- A. Disconnect electrical connectors as required,
- B. Loosen restraining thumbnut by unscrewing far enough to drop the securing bolt clear of the lip on the end of the unit
- C. Pull the unit straight out without lifting the end up. Many units have electrical connectors at the rear of the rack, so that bending or twisting only increases the friction. Also, be careful because the friction will suddenly decrease when the connector pins come loose

6 Transponder Computer - Installation

- A. Check rear electrical connector to be sure shipping cover is removed and that all pins are straight and clean

- B. Slide unit straight into rack until connector starts to engage,

CAUTION. USE CARE IN TIGHTENING THUMBSCREWS TO AVOID DAMAGE TO CONNECTORS

- C. Tighten restraining thumbscrew, taking care not to apply excessive pressure. If unit seems difficult to seat properly, remove unit and check for binding and proper alignment

7. AIMS Antenna - Removal

- A. The following procedure applies to removal of either of the AIMS antennas. Removal of the upper antenna requires a workstand high enough to reach the top of the fuselage

- (1) Remove four bolts that attach antenna to fuselage

- (2) Pull antenna out far enough to disconnect coaxial cable connector

NOTE When removing upper antenna, secure end of cable to prevent connector from falling back inside the aircraft

- (3) Disconnect coaxial cable connector from antenna

8. AIMS Antenna - Installation

- A. The following procedure applies to installation of either of the AIMS antennas. Installation of the upper antenna requires a workstand high enough to reach the top of the fuselage.

- (1) Clean faying (mating) surfaces of antenna and fuselage with aluminum oxide abrasive cloth until both surfaces are bright. Do not remove more material than necessary

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- (2) Apply a wet-coat of LPS No 3 corrosion preventive compound on both faying surfaces Lightly wipe off excess LP5-3
- (3) Check that serviceable O-ring is in place in groove on antenna mounting surface
- (4) Connect coaxial cable connector to antenna
- (5) Place antenna in mounting position and secure with four bolts
- (6) Measure electrical bond resistance between antenna and fuselage using milliohmeter Resistance must be less than 0 001 ohm

9 Component Replacement Checkout

A The following procedures ensure that replaced components operate properly
Provide and remove aircraft electrical power as applicable

B Receiver-Transmitter, Antenna, Transponder Set Control Transponder Computer

- (1) Perform checkout per 34-51-01 item 2 A page 501-502

NOTE This procedure does not check the system completely
Refer to table 502

Refer to table 503 for AIMS system mode 4 tests

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AIMS TRANSPONDER SYSTEM - ADJUSTMENT/TEST

1 TOOLS AND TEST EQUIPMENT.

- A Table 501 lists tools and test equipment required for line maintenance of the AIMS transponder system

2 CHECKOUT

- A Table 502 provides a system, test of the AIMS. Table 503 provides for AIMS system mode 4 tests. Either table may be performed with the test equipment connected directly to the equipment or by utilizing the equipment and test set antennas. Table 502 consists of a series of individual tests that may be performed in sequence or as individual tests as required. A quick checkout (self-test) is provided in the following steps:

- (1) Provide aircraft electrical power
- (2) Close AIMS circuit breaker on P5 circuit breaker panel
- (3) Set AIMS ANTENNA switch to UPPER
- (4) Pull out and set transponder set control panel MASTER switch to NORM. TEST indicator comes on when M-1, M-2, M-3/A and M-C test switches are moved to TEST one at a time.

NOTE TEST indicator may remain on 3 to 5 seconds after test switch is released

- (5) Set MASTER switch to STBY
- (6) Disconnect connector from UPPER ANT receptacle J4 on AIMS receiver-transmitter
- (7) Set MASTER switch to NORM. TEST indicator does not come on when M-1 test switch is moved to TEST
- (8) Set AIMS ANTENNA switch to LOWER. TEST indicator comes on when M-2 test switch is moved to TEST
- (9) Set MASTER switch to STBY
- (10) Reconnect connector to UPPER ANT receptacle J4
- (11) Disconnect connector from LOWER ANT receptacle J3
- (12) Set MASTER switch to NORM. TEST indicator does not come on when M-3/A test switch is moved to TEST

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- (13) Set AIMS ANTENNA switch to UPPER, TEST indicator comes on when M-3A switch is moved to TEST
- (14) Reconnect lower antenna
- (15) Set AIMS ANTENNA switch to LOWER TEST indicator comes on when M-3A switch is moved to TEST
- (16) Set AIMS ANTENNA switch to BOTH
- (17) Set MASTER switch to OFF
- (18) IFF caution light
 - (a) Press light to test lamp filament
- (19) Remove aircraft electrical power if no longer required for other maintenance

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PART NO OR TYPE DESIGNATOR	NOMENCLATURE	USE AND APPLICATION
<u>TEST EQUIPMENT</u>		
Model 260 Simpson	Multimeter	Voltage and continuity tests
TC-149 Instrument Systems or H-133AIC	Headset	Listening to ID tone.
O5AK80 Switchcraft Corp. (82389)	Extension Cable	Connecting headset to intercom jack
Model 502-A Keithley	Milliohmmeter	Measuring bond resistance of antenna after installation.
AN/APM-123(V)	Transponder Test Set	Provides test signals to the AIMS System
CX-12216/APM-123(V)	Cable	Connects test set to AIMS
KIK-18/TSEC	Code Key	Used to insert code into AIMS computer
KIR-1A/TSEC	Computer	Provides coded interrogation signal
TTU-205C/E	Pressure Temperature Test Set	Provide altitude signal to AIMS.
33410-215-375T	Adapter	Adapts TTU-205C/E to aircraft static port.
204-92002-1	Power Cable Assembly, 400 Hz	75 foot power cable for AN/APM-123(V) and TTU-205C/E.
4585-9, General Electric	Adapter, Power Cable, 400 Hz	Connects AN/APM-123(V) to power cable assembly.

Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation.

AIMS Transponder System - Test Tools and Equipment
Table 501

Ref.. DRW CDRL 43/44
Paragraph 7.29 Issue D dtd 19 May 1988



MAINTENANCE MANUAL

STEP	RESULT
1 <u>PREPARE FOR TEST</u> A Provide aircraft electrical power B Disconnect RF cable from PROB jack on AN/APM-123 test set and connect 1 db cable to jack. C Disconnect antenna cable from AIMS transponder LOWER ANT receptacle J3 and connect cable CG-409G/U to J3 using type N to TNC adapter <u>CAUTION</u> DO NOT CONNECT TEST SET TO RECEIVER-TRANSMITTER WITH LESS THAN A TOTAL OF 50 db ATTENUATION INCLUDING CABLE TEST SET MAY BE DAMAGED D Connect the other end of CG-409G/U cable and the 1 db cable to the fixed (50 db) attenuator using N to BNC adapters E Close AIMS circuit breaker and P5 circuit breaker panel	
2 ALTITUDE REPORTING (MODE C) A On AN/APM-123(V) set controls as follows POWER switch - ON FUNCTION - SELF-TEST SIDE LOBE SUPPRESSION - OUT PRESS-TO-TEST - Pressed FUNCTION - SYSTEM MODE-C B Connect TTU-205C/E test set to AIRCRAFT COMMANDER (left) static system C Close CADC circuit breaker on P5 circuit breaker panel	ACCEPT indicator comes on and REJECT indicator remains off

AIMS System Test
Table 502 (Sheet 1 of 4)

Ref. DRW CDRL 43/44
Paragraph 7 29 Issue D dtd 19 May 1988



MAINTENANCE MANUAL

STEP	RESULT
D On AIMS control panel, set controls as follows: MASTER- NORMAL M-C- ON M-1 - OUT M-2 - OUT M-3/A - OUT E Provide static pressure per table 504 in sequence F On AN/APM-123 (V) insert A, B, C and D codes (table 504) corresponding to the altitudes in step E G On AN/APM-123 (V) press PRESS-TO TEST switch for each altitude and code selected in steps E and F H. Remove TTU-205C/E test set	ACCEPT indicator comes on for each test
3 <u>IDENTIFICATION OF POSITION</u> A On AIMS control panel, set controls as follows M-3/A - ON M-1 - OUT M-2 - OUT M-C - OUT MODE 3/A- 7777 B On AN/APM-123 (V), set controls as follows FUNCTION - IDENT MODE - 3A CODE - 7777	
C On AIMS control panel, set IDENT-OUT-MIC switch to INDENT and hold for approximately one second and release Note time of release.	
D Set IDENT-OUT-MIC switch to MIC	

AIMS System Test
Table 502 (Sheet 2 of 4)

Ref DRW CDRL 43/44
Paragraph 7 29 Issue D dtd 19 May 1988

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MAINTENANCE MANUAL

STEP	RESULT
E Close V/UHF circuit breaker on P5 circuit breaker panel	ACCEPT light on AN/APM-123 remains on for 15 to 30 seconds after microphone switch is released
F Turn on flight deck V/UHF communications set	
G Actuate microphone switch for approximately one second	
H Turn off flight deck V/UHF communications set	
I Set IDENT-OUT-MIC switch to OUT	
3 <u>EMERGENCY MODE</u>	
A Set AIMS ANTENNA switch on overhead panel to LOWER	
B On AN/APM-123(V), set controls as follows ABCD Code - 7300 FUNCTION - EMER MODE- 1	
C On AIMS control panel, set controls as follows MODE 1 - 73 M-1 - ON M-2 - OUT M-3A - OUT MASTER - EMER (Pull out)	AN/APM-123 ACCEPT light comes on
D On AIMS control panel, set controls as follows MASTER- NORM M-3/A - 0000	
E On AN/APM-123 set controls as follows A8CD code - 7700 MODE - M-3/A	

AIMS System Test
Table 502 (Sheet 3 of 4)
Ref DRW CDRL 43/44



MAINTENANCE MANUAL

STEP	RESULT
F Set AIMS control panel MASTER selector to EMER. G On AIMS control panel, set controls as follows MASTER- NORM M-3/A - Other than 7600 or 7700 <u>NOTE</u> Do not remain in emergency mode any longer than necessary H Open AIMS circuit breaker I Disconnect AN/APM-123 test set and reconnect antenna cable J Set AIMS ANTENNA switch to BOTH	AN/APM-123 ACCEPT light comes on

AIMS System Test
Table 502 (Sheet 4 of 4)

Ref DRW CDRL 43/44
Paragraph 7 29 Issue D dtd 19 May 1988



MAINTENANCE MANUAL

STEP	RESULT
CAUTION POSITION AN/APM-123(V) TEST SET AT LEAST 30 FEET FROM THE LOWER AIMS ANTENNA TO PROTECT THE TEST SET 1 Position AN/APM-123(V) at a distance of approximately 50 feet within line-of-sight of the lower AIMS antenna NOTE Line of sight path must be free of obstructions 2 Position AN/APM-123(V) test set for vertical polarization and direct the arrow towards aircraft AIMS antenna 3 Connect test set antenna to PROBE jack with short coax 4 Connect KIR-1A computer to MODE 4 connector on AN/APM-123(V) using cable CX-12216/APM-123(V). 5 Set AN/APM-123(V) POWER switch to 115 vac and apply power (115V 400 Hz) Allow 2 minutes warm up time 6 On AN/APM-123(V), set controls as follows FUNCTION - SELF TEST ISLS - OFF PUSH-TO-TEST- Pressed 7 Provide aircraft electrical power 8 Close AIMS 28VDC, AIMS 115 VAC, and SAFETY RLYS circuit breakers on P5 circuit breaker panel 9 On overhead panel, set AIMS ANTENNA switch to BOTH	Test set ACCEPT light comes on, REJECT light remains off

AIMS System Mode 4 Tests
Table 503 (Sheet 1 of 5)

Ref DRW CDRL 43/44
Paragraph 7 29 Issue D dtd 19 May 1988



MAINTENANCE MANUAL

STEP	RESULT
10 Provide interphone communications	
11 On AIMS control panel, set controls as follows MASTER - STBY M-1 - OUT M-2 - OUT M-3A - OUT M-C - OUT MODE 4 - OUT CODE - A LIGHT-Switch-LIGHT	
12 Set AIMS control panel MASTER switch to NORMAL	
13 On AN/APM-123(V), set controls as follows FUNCTION - SYSTEM MODE - 4 CODE A/B - A MODE 4 VER BIT 1 - OFF MODE 4 VER BIT 2 - OFF DIR/RAD - RAD PUSH-TO-TEST - LOCK	Following lights are on a AN/APM-123(V) CODE ZEROIZE b AN/APM-123(V) REJECT c Center instrument panel IFF caution light
14 Using KIK-18 code key, insert test code into KIR-1A transponder computer and close key access door Refer to KAM-225C/TSEC manual	a AN/APM-213(V) CODE ZEROIZE light goes out
15 Using KIK-18 code key, insert test code into KIT-1A transponder computer and close key access door Refer to KAM-225C/TSEC manual	
16 Release AN/APM-123(V) PUSH-TO TEST switch from LOCK	
17 Set AIMS control panel MODE 4 switch to ON	

AIMS System Mode 4 Tests

Table 503 (Sheet 2 of 5)

Ref DRW CDRL 43/44

Paragraph 7 29 Issue D dtd 19 May 1988



MAINTENANCE MANUAL

STEP	RESULT
18 Momentarily press AN/APM-123(V) PUSH-TO-TEST switch	a AN/APM-123(V) ACCEPT light comes on b AIMS control panel REPLY light comes on c Center instrument panel IFF light is off.
19 On AIMS control panel, set controls as follows CODE - B	
20 On AN/APM-123(V), set MODE 4 CODE A/B switch to B	
21 Momentarily press AN/APM-123(V) PUSH-TO-TEST switch	a AN/APM-123(V) ACCEPT light comes on b AIMS control panel REPLY light comes on c Center instrument panel IFF light comes on
22 On AN/APM-123(V), set MODE 4 CODE A/B to A	
23 Momentarily press AP/APM-123(V) PUSH-TO-TEST switch	a AN/APM REJECT light is on b Center instrument panel IFF light is off c AIMS control panel REPLY light is off
24 Set AIMS control panel CODE switch to A CAUTION. OPENING SAFETY RLYS CIRCUIT BREAKER EFFECTS SEVERAL HEATERS AND FORCED AIR COOLING	

AIMS System Mode 4 Tests
Table 503 (Sheet 3 of 5)

Ref. DRW CDRL 43/44
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MAINTENANCE MANUAL

STEP	RESULT
25 Open SAFETY RLYS circuit breaker on P5 panel for a minimum of 15 seconds then close	
26 On AIMS control panel set controls as follows CODE - HOLD for a minimum of 2 seconds then release to A. MASTER - OFF after a minimum of 15 seconds MASTER - NORM after a minimum of 15 seconds	KIT-1A computer does not zeroize
27 Momentarily press AN/APM-123(V) PUSH-TO-TEST switch	AN/APM-123(V) ACCEPT light comes on
28. Open SAFETY RLYS circuit breaker on P5 panel for a minimum of 15 seconds then close	
29. Set AIMS control panel MASTER switch to OFF after a minimum of 15 seconds (KIT-1 A computer zeroizes after 15 seconds)	
30 After KIT-1A computer is zeroized set AIMS control panel MASTER switch to NORM	Center instrument panel IFF light comes on following a short warm up period a AN/APM-123(V) REJECT light comes on b IFF caution light comes on
31 Momentarily press AN/APM-123(V) PUSH-TO-TEST switch	
32. Using KIK-18 reinsert test code in KIT-1A transponder computer and close key access door	
33. Momentarily press AN/APM-123(V) PUSH-TO-TEST switch	a AN/APM-123(V) ACCEPT light comes on b AIMS control panel REPLY light comes on c IFF caution light is off

AIMS System Mode 4 Tests
 Table 503 (Sheet 4 of 5)

Ref DRW CDRL 43/44
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MAINTENANCE MANUAL

STEP	RESULT
34. Set AIMS control panel CODE switch to ZERO 35 Momentarily press AN/APM-123(V) PUSH-TO-TEST switch 36 Set AIMS control panel switches as follows: MODE 4 - OUT CODE - A MASTER - OFF 37 Open following circuit breakers on P5 panel if required AIMS XPDR AIMS CMPTR 38 Restore AN/APM-123(V) test set. 39 Remove electrical power if no longer required.	a AN/APM-123(V) REJECT light comes on b IFF caution light comes on c AIMS control panel REPLY light is off

AIMS System Mode 4 Tests
 Table 503 (Sheet 5 of 5)

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ALTITUDE, FEET	APPROX INCHES OF MERCURY	TEST SET C ODES			
		A	B	C	D
0	29 92	0	6	2	0
4,800	25 08	4	2	4	0
8,000	22 23	6	6	2	0
10,400	20 24	6	1	3	0
12,600	18 57	2	3	6	0
15,500	16 55	3	4	2	0
18,100	14 88	3	5	3	0
20,200	13 64	7	7	1	0
23,200	12 01	5	0	1	0
29,600	9 04	1	6	6	0
35,800	6 78	5	7	4	4
39,900	5 57	7	6	6	4

AIMS Altitudes Codes
 Table 504

Ref . DRW CDRL 43/44
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BOEING *Intercontinental*
MAINTENANCE MANUAL

INERTIAL NAVIGATION SYSTEM - DESCRIPTION AND OPERATION

1 SAFETY PRECAUTIONS

A Observe all caution notes during INS turn on and initialization

2 DESCRIPTION.

The airplane is equipped either with one INS and one GPS or with two INS. Each INS consists of a control/display unit (CDU), a mode selector unit (MSU), a navigation unit (NU) and a battery unit (BU).
The INS rack is located between BS344 and 360.

Figure 2 is a cabling diagram for the inertial navigation system.

INS outputs provide automatic waypoint steering and navigation and attitude data display on the flight instruments. Each INS monitors itself for faults and has its own data display. In case of dual installation, each INS operates independently from the other, and, in case of single installation, independently from the GPS.

Through the CDU, the INS can display the following data: Track angle, groundspeed, aircraft heading, drift angle, cross track distance, track angle error, present position, distance and time to the next selected position, wind direction and speed, desired track angle and INS status. Definitions of these displays are shown in figure 3.

E INS Turn On and Initialization.

- (1) Table 2 gives the procedure for turning on the INS and inserting present position.

Ref. T O. 1E-3A-2-34-2
Page 5-1 Change 20

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CAUTION: THE INU, DNC, AND C/DU ASSEMBLIES AND CIRCUIT CARDS CONTAIN STATIC SENSITIVE DEVICES, THEREFORE, OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONS DURING MAINTENANCE, STORING, AND SHIPPING. AVOID TOUCHING DFX CONNECTOR PINS

F Navigation Units

- (1) The navigation unit (NU) provides the input/output signal interface between the INS and all other aircraft systems. Each unit is supported on three precision rack-mounted pins which slide into bushings in the navigation equipment rack. Two bushings are in the rear and one in the front of the case assembly. The unit slides into the rack over a gasket which seals the case assembly of the unit to the aft forced air cooling system. Cooling air for the navigation equipment rack is passed through the NU for cooling during operation. The CP-1176A/A unit has an air filter located on the top of the unit. The three different model NU's are functionally interchangeable. The CP-1176A/A and CP-1176B/A models contain overheat control circuitry. Inside these two units, a thermal switch will act at 155 (± 3)°F. This action together with the true air speed warning signal in the not valid state (zero volts-aircraft on ground) will activate the overtemperature shutdown circuitry. This causes the NU power input relay to be latched off until the mode selector switch on the mode select unit is set to OFF then back to an on position. Simultaneously, a signal is sent to the control-display unit to turn on the red WARN indicator. In the air, a loss of cooling air and the true air speed warning signal in the valid state does not cause the NU to shut down but a WARN signal is displayed on the control-display unit and if the mode selector switch on the mode select unit is set to NAV or ALIGN, a malfunction code of 39 will be stored in the computer. A thermal indicator decal is located on the handle end of the navigation unit to indicate exposure to overheat. The four temperature sensitive spots are normally light gray and turns black when overheated. The NU contains an inertial reference unit (IRU), an inertial reference unit electronics section (IRUE), and a digital computer unit (DCU).

G Inertial Reference Unit.

- (1) The inertial reference unit contains a gyroscopically stabilized platform that supports three accelerometers. These accelerometers are the inertial sensing elements of the system.

H Accelerometers

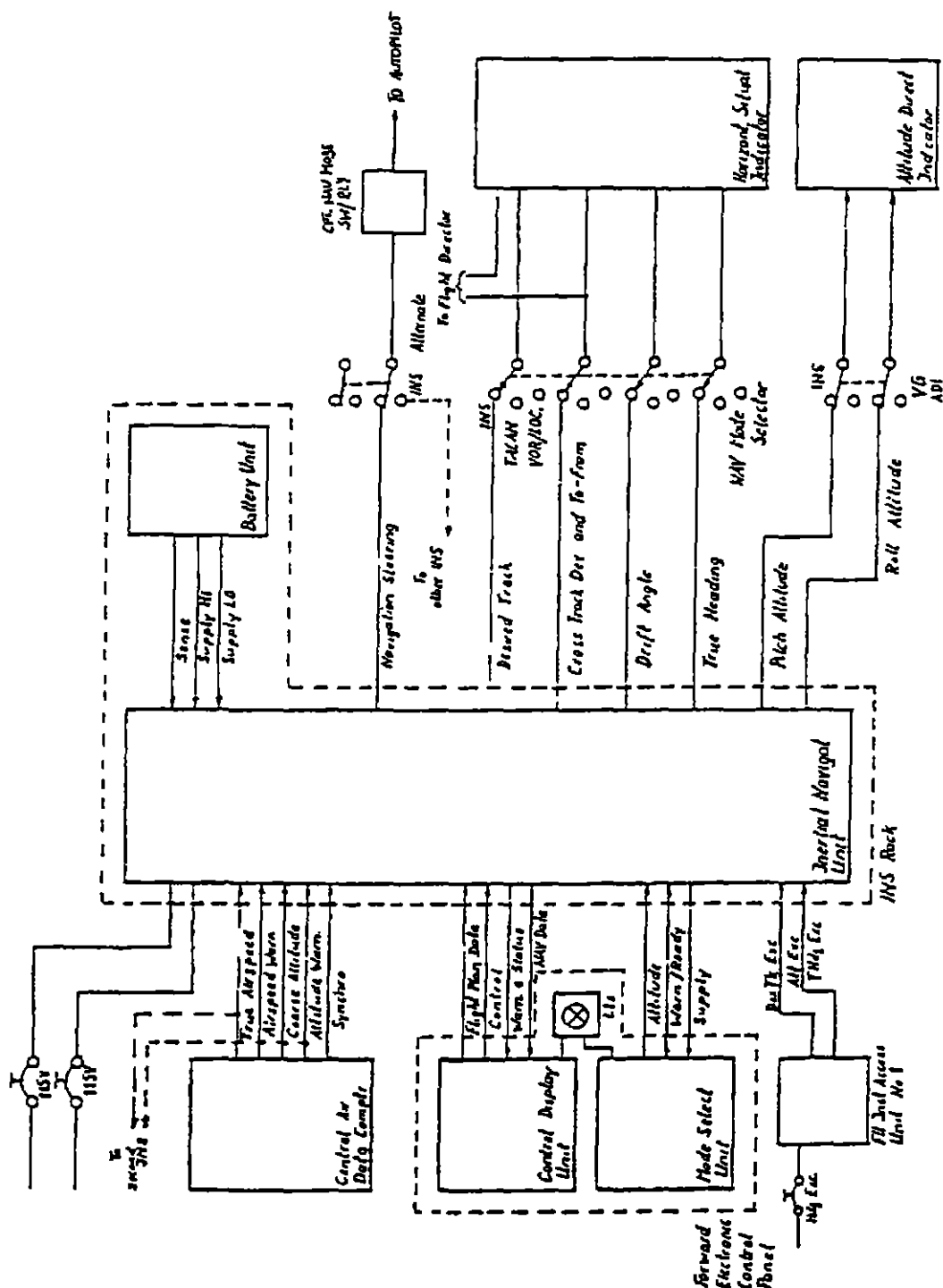
- (1) Each navigation unit contains three accelerometers, designated X, Y, and Z, which sense changes in aircraft velocity. The X accelerometer senses forward and aft acceleration, the Y accelerometer senses lateral acceleration, and the Z accelerometer senses vertical acceleration.

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Page 5-1 Change 20
Page 5-12A Change 14



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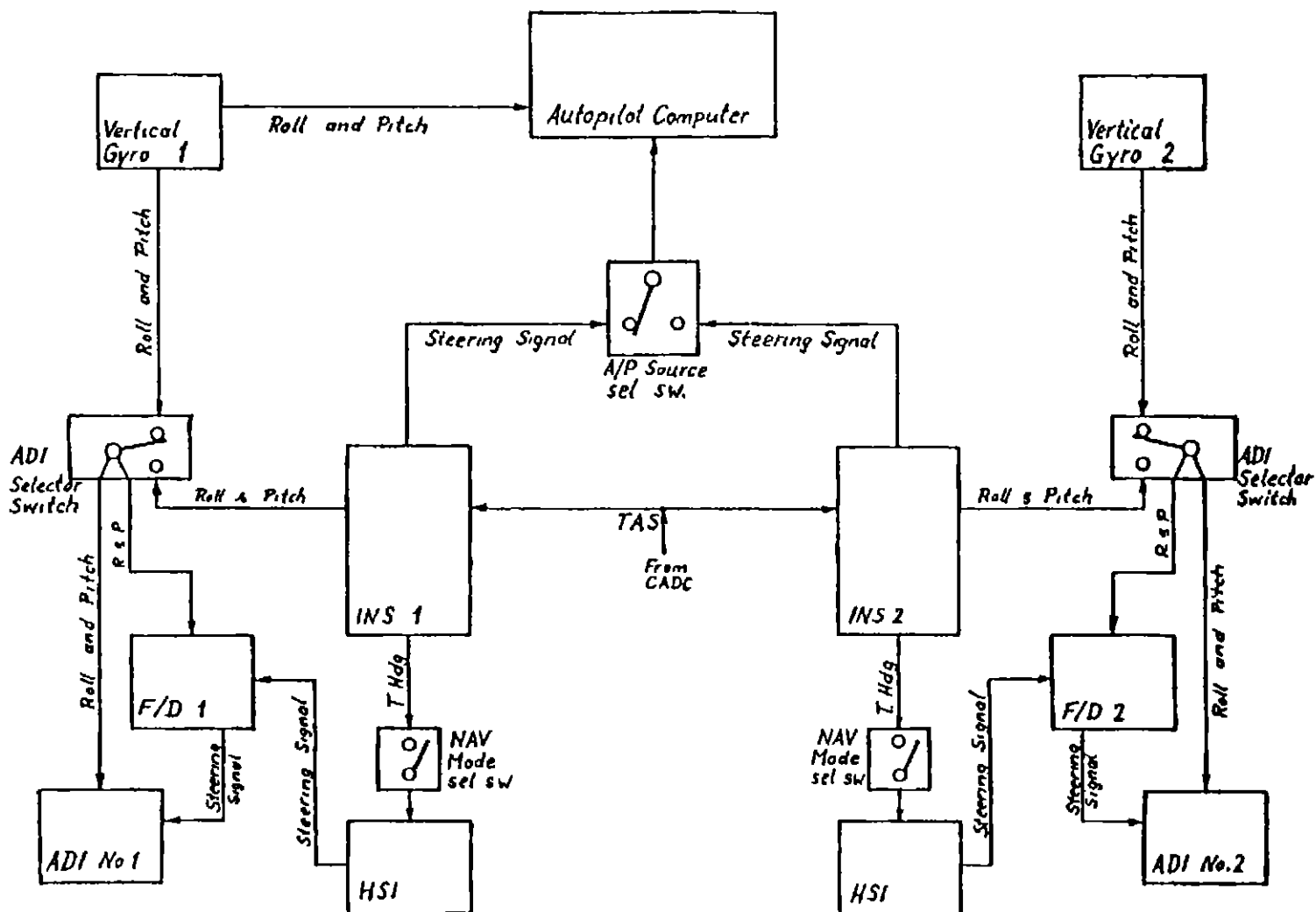


INS

Legend:
--- Perward only

Inertial Navigation System Cabling Diagram
Figure 2 (Sheet 1 of 2)

Ref.: DRW CDRL 45
Issue D dated 30 Sep 1988

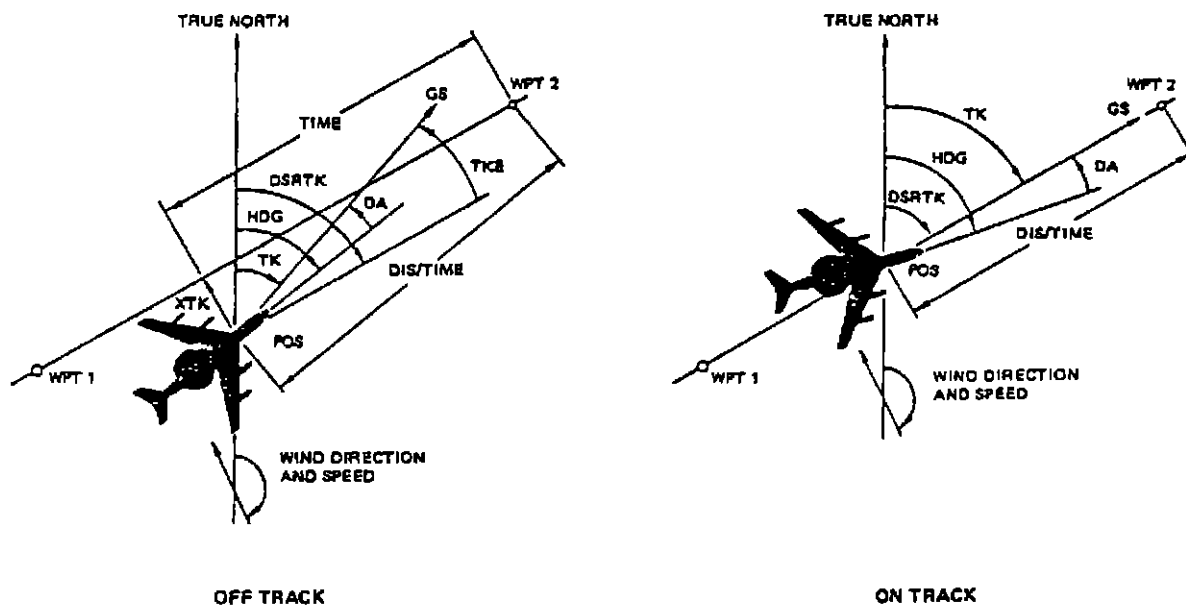


ATTITUDE- AND STEERING-SIGNALFLOW
AT
DUAL INS INSTALLATION

Inertial Navigation System Cabling Diagram
Figure 2 (Sheet 2 of 2)

Ref DRW CDRL 45
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TK - TRACK ANGLE
 GS - GROUND SPEED
 HDG - TRUE HEADING
 DA - DRIFT ANGLE
 XTK - CROSS TRACK DISTANCE
 TKE - TRACK ANGLE ERROR

POS - PRESENT POSITION
 WPT - WAYPOINT
 DIS - DISTANCE
 TIME - TIME
 WIND - WIND SPEED/DIRECTION
 DSRTK - DESIRED TRACK ANGLE

Inertial Navigation Information
 Figure 3

Ref T O 1E-3A-2-34-2
 Page 5-5 Change 0

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CDU DATA SELECTOR POSITION	PARAMETER	DESCRIPTION
TK/GS	Track Angle/Ground Speed	Track angle is the angle between true north and an imaginary line on the earth's surface connecting successive position points over which the aircraft has flown Ground speed is the velocity at which the aircraft is moving over the earth's surface Present track angle is displayed from 0 to 359.9 degrees in the left data display to the nearest tenth of a degree with respect to true north Ground speed is displayed from 0 to 2400 knots in the right data display to the nearest knot The displayed value of ground speed is always actual, but actual true heading is displayed in place of present track angle when ground speed is below 75 knots The INS indicates a malfunction if the displayed ground speed is 910 knots or greater. INS malfunction codes are listed in table 3
HDG DA	Heading Drift Angle	Heading is the clockwise angle between true north and the aircraft centerline Drift angle is the angle between the aircraft heading and track angle Heading is displayed from 0 to 359.9 degrees in the left data display to the nearest tenth of a degree with respect to true north. Drift angle is displayed from 0 to 180 degrees right or left of the aircraft heading in the right data display to the nearest degree The displayed value of heading is always actual, but the displayed drift angle is 0 degrees when ground speed is below 75 knots

Inertial Navigation Information
Table 1 (Sheet 1 of 4)

Ref T O 1E-3A-2-34-2
Page 5-6 Change 0

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CDU DATA SELECTOR POSITION	PARAMETER	DESCRIPTION
ATK TKE	Crosstrack Distance Track Angle Error	The INS will indicate a malfunction if the displayed drift angle is 45 degrees or greater Crosstrack distance is the shortest distance between the aircraft present position and the desired track Track angle error is the angle between the aircraft track angle and the desired track angle Crosstrack distance is displayed from 0 to 999.9 nautical miles right or left of the desired track in the left data display to the nearest tenth of a nautical mile Track angle error is displayed from 0 to 180 degrees right or left of the desired track angle in the right data display to the nearest degree The displayed value of crosstrack distance is always actual, but desired track angle minus heading is displayed in place of track angle error when ground speed is below 75 knots
POS	Position	Present position is the actual latitude and longitude position of the aircraft. Latitude is displayed in the left data display and longitude is displayed in the right data display. Both data displays indicate degrees and minutes to the nearest tenth of a minute. This position is also used in inserting present position coordinates during alignment and position updates.
WAY PT	Waypoint	The WAY PT position, with the waypoint selector, allows waypoint data to be inserted and displayed. Prior to the first insertion after turn on, the data displays will display 0's for all waypoints. Latitude and longitude are loaded and displayed in degrees and minutes to the nearest tenth of a minute.
DIS/TIME	Distance/Time	Distance is the great circle distance between the present position of the aircraft and the next waypoint or destination.

Inertial Navigation Information
Table 1 (Sheet 2 of 4)

Ref T O 1E-3A-2-34-2
Page 5-6 Change 0
Page 5-7 Change 0

MAINTENANCE MANUAL

CDU DATA SELECTOR POSITION	PARAMETER	DESCRIPTION
WIND	Wind	Time is the time required to reach the next waypoint traveling at the present ground speed Distance is displayed from 0 to 5396 nautical miles in the left data display to the nearest nautical mile Time is displayed from 0 to 999 9 minutes in the right data display to the nearest tenth of a minute The displayed value of time is 999 9 minutes when ground speed is below 10 knots Wind speed is the magnitude of the wind velocity vector in knots. Wind direction is the clockwise angle between true north and the wind velocity vector. Wind direction and speed are indicated in the data displays when true airspeed is 150 knots or greater Wind direction is displayed from 0 to 359 degrees in the left data display to the nearest degree Wind speed is displayed from 0 to 650 knots in the right data display to the nearest knot Both wind direction and wind speed indicate 0 when true airspeed is less than 150 knots An airspeed signal exceeding 650 knots or a malfunction warning from the central air data computer also causes both displays to indicate 0. True airspeed is the airspeed of the aircraft with respect to the surrounding air
		Desired track angle (DSRTK) is the clockwise angle from true north to an imaginary line on the surface of the earth connecting successive points over which flight is desired (desired track). This line describes the great circle course between two successive waypoints,

Inertial Navigation Information
Table 1 (Sheet 3 of 4)

Ref T O 1E-3A-2-34-2
Page 5-7 Change 0
Page 5-8 Change 0

MAINTENANCE MANUAL

CDU DATA SELECTOR POSITION	PARAMETER	DESCRIPTION
		Desired track angle is indicated in the left data display from 0 to 359 degrees to the nearest degree with respect to true north. The left data display will indicate 255° when the INS is turned on and no waypoints have been inserted into the INS computer. The right data display indicates system status. During normal operation, two digits are displayed. These digits indicate the DCU operating mode and the actual performance index number. Before the INS is commanded to navigation mode, a third digit is also displayed. This digit is the desired performance index number. The first digit on the left of the right data display is either 0, 1, or blank. When 0 is displayed, the DCU is in standby mode or alignment mode. When 1 is displayed, the DCU is in the navigation mode. When the first digit is blank, the INS is in attitude mode.

Inertial Navigation Information
Table 1 (Sheet 4 of 4)

Ref T.O. 1E-3A-2-34-2
Page 5-8 Change 0



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STEP	RESULT
1 Ensure electrical power is applied to aircraft 2 Ensure air cooling is provided <u>NOTE</u> Close only those circuit breakers for the INS to be operated 3 Check that following circuit breakers are closed. On P5 - panel * Essential Radio Bus INS N° 1 PWR INS N° 1 HTR AUTOPILOT * Radio Bus N° 2 INS N° 2 PWR (if INS N° 2 installed) INS N° 2 HTR (if INS N° 2 installed) INS XFR * Essential Flight Instrument Bus XMFR N° 1 AC FLT INST N° 1 BRG EXC FLT INST N° 2 HDG EXC CADC AC FLT INST N° 1 ATT EXC * Flight Instrument Bus N°2 XMFR N° 2 AC FLT INST N° 2 BRG EXC FLT INST N° 2 HDG EXC FLT INST N° 2 ATT EXC	

INS Turn On and Initialization
Table 2 (Sheet 1 of 4)

Ref . T.O. 1E-3A-2-34-2
Page 5-9 Change 18

STEP	RESULT
* 28 V DC T-R BUSSES LEVER LATCH & ANTI-SKID RELAYS SAFETY RELAYS <u>CAUTION</u> DO NOT PROCEED IF WARN LIGHT ON CONTROL-DISPLAY UNIT COMES ON OR EQUIPMENT MAY BE DAMAGED 4 If WARN light an control-display unit (CDU) comes on, turn INS off by set- ting mode selector on MSU to OFF <u>CAUTION</u> NAVIGATION UNITS WILL OVER HEAT IF OPERATED WITHOUT COOLING AIR <u>NOTES</u> The mode select unit for INS No 1 is located on the forward electronic panel The mode select unit for INS No 2 (if installed) is located on the forward electronic panel	

INS Turn On and Initialization
Table 2 (Sheet 2 of 4)

Ref T O 1E-3A-2-34-2
Page 5-10 Change 19



MAINTENANCE MANUAL

STEP	RESULT
5 Pull and set mode selector to ALIGN on mode select unit of INS to be operated See figure 4	INSERT key an CDU comes on
6 Set data selector to POS on CDU of INS to be operated See figure 4	
7 Press N2 key on CDU keyboard if in northern hemisphere, or 8S key if in southern hemisphere	N or S appears in left data display
<u>NOTE</u> Keys must be pressed until N or S appears in left data display	
8 Load aircraft present latitude as shown in following example: If latitude is 47 degrees 32.0 minutes, the following keys should be pressed in the order shown 4,7,3,2,0	Left data display shows aircraft present latitude
9 If incorrect latitude was keyed in, press CLEAR and repeat steps 8 and 9.	
10 Press INSERT key	
11 Press 6E key if in eastern hemisphere or W4 key if in western hemisphere	E or W appears in right data display
<u>NOTE</u> Keys must be pressed until E or W appears in right data display.	
12 Load aircraft present longitude as shown in following example If longitude is 122 degrees 18 5 minutes, the following keys should be pressed in the order shown: 1, 2, 2, 1, 8, 5	Right data display shows aircraft present longitude.

INS Turn On and Initialization
Table 2 (Sheet 3 of 4)

Ref T O 1E-3A-2-34-2
Page 5-11 Change 5

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STEP	RESULT
13 if incorrect longitude was keyed in, press CLEAR and repeat steps 12 and 13 14 Press INSERT key <u>NOTE</u> READY NAV indicator may take from 20 to 60 minutes to come on depending on the ambient temperature 15 When READY NAV light comes on on mode select unit, set mode selector to NAV until READY NAV indicator goes out, then back to ALIGN 16 When test is completed, turn INS off by setting mode selector on mode select unit to OFF	INSERT key goes out

INS Turn On and Initialization
Table 2 (Sheet 4 of 4)

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MAINTENANCE MANUAL

- (2) Mathematically, it is possible to derive velocity and distance from an acceleration. In this manner, pulse signals representing aircraft acceleration are integrated to obtain aircraft velocity. The aircraft velocity is then integrated to obtain distance traveled.

I Gyros

- (1) The IRU contains three gyros that sense rotational displacement of the aircraft about the inertial platform. The platform is maintained level by torquing signals developed in the IRUE from the displacement output which ensures that the Z gyro spin axis is always vertical.

J Inertial Platform

- (1) An aircraft moving in three dimensions over the surface of the earth has 6 degrees of freedom: three translational (north-south, east-west, and up-down) and three rotational (roll, pitch, and yaw). Actual aircraft motion is a changing combination of all 6 degrees of motion. Sensing of this motion is accomplished in the navigation unit by a gyro stabilized frame of reference known as an inertial platform. The platform consists of a tilt table suspended in a servo-driven gimbal system. The gimbal system isolates the acceleration sensing devices from rotational motion of the aircraft and maintains the platform parallel to the surface of the earth regardless of aircraft motion or earth rotation. The gimbal system effectively decouples the inertial platform from the airframe and provides three single degrees of freedom of motion for the inertial platform.
- (2) Stabilization of the inertial platform establishes a fixed coordinate system in which aircraft accelerations can be measured. This is accomplished by the X, Y and Z accelerometers, mounted with their sense axes mutually perpendicular and aligned with reference axes on the inertial platform. The accelerometers sense aircraft horizontal and vertical motion and are maintained parallel to the surface of the earth.
- (3) Synchro analog outputs of pitch and roll from the inertial platform serve as the primary attitude displacement reference for the autopilot, and as an alternate attitude displacement reference for the flight director computers and the artificial horizon function of the ADIs. The IRU also develops a synchro output of true heading. This output is used as a selectable heading reference for the HSI and consequently for selected course display and for input to the flight director system.

K Inertial Reference Unit Electronics (IRUE)

- (1) The electronics section of the IRU includes assemblies which buffer pitch and roll synchro output signals, amplify stabilization and accelerometer loop signals, and control moding and warning flag signals.

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Page 5-12A Change 14

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- (2) Warning flag logic circuits in the IRUE receive signals from the IRU, DCU, and other assemblies in the electronics sections. The logic circuits control warning flags in the ADI and HSI. The logic circuits also produce a master warning signal for the WARN lamp on the control-display unit.

L Digital Computer Unit

- (1) The inertial navigation system uses continuously changing navigation parameters and system error correction factors to obtain a high degree of accuracy in the attitude and heading computations. The digital computer unit (DCU) in each NU is used as the information processing center for each inertial navigation system.
- (2) The DCU consists of assemblies which make up a digital computer with input/output circuits to perform necessary conversion between analog and digital signals. The latitude and longitude of the flight origin, waypoints, and destination are inserted into the DCU using the control-display unit keyboard. True airspeed and coarse altitude are provided to the DCU from the central air data computer. The latitude and longitude inputs, air data computer inputs, constants contained in the DCU memory, and inputs from the IRU and IRUE are used to continuously solve navigation equations and produce signals for control and display during the NAV mode of operation. The DCU also performs self-tests and comparisons between its output data and the output data of the other INS computer and produces warning signals if tolerances are exceeded.
- (3) The DCU computes crosstrack deviation and track angle error outputs which are transmitted to the autopilot to maintain the aircraft on the desired track during automatic navigation. Navigation data signals are transmitted from the DCU to the horizontal situation indicator (HSI) through the NAV MODE selector and to the control-display unit for visual displays and to the other INS DCU for comparison.

L Battery Unit.

- (1) Each battery unit (BU) provides auxiliary power to initiate INS turn on and to supply essential power to maintain INS operation for 15 minutes when the 115-volt input power is interrupted or drops below the required voltage. The battery unit contains 19 nickel-cadmium cells which are connected in series to furnish a nominal 24 volts dc. A 20-ampere circuit breaker on the front of the battery unit protects it from excessive current flow if a short circuit develops. Power from the battery unit is used momentarily to close a relay which turns on the INS, and also is used for a 12.8-second battery test during INS alignment. Battery unit power is connected to the INS power circuits to sustain INS operation in any operating mode if primary power fails. A battery charger in the navigation unit automatically charges the battery when the INS is operating.

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on ac power Both sufficient battery voltage and 115-volt power must be available before an INS can be turned on

NOTE If battery unit will be exposed to temperatures below 0°F, refer to T O 1E-3A-2-7 for battery operating and handling procedures

M Mode Select Unit

- (1) The mode select unit (MSU) figure 4, contains a mode selector switch and two indicating lamps The mode selector switch has five positions OFF, STBY, ALIGN, NAV, and ATT These positions are used to control operating modes of the INS Mechanical stops prevent the mode selector switch from being turned out of NAV or ALIGN position To switch from ALIGN to STBY or from NAV to ATT, the mode selector switch must be pulled The two indicating lamps indicate operating status The BAT lamp monitors condition of the battery unit The READY NAV lamp comes on when the INS is aligned The mode selector switch then can be advanced to the NAV position Refer to Table 3 for switch/indicator functions

N Control-Display Unit

- (1) The CDU (figure 4) contains a power supply, logic circuits, controls, indicators, and displays for manually inserting information into the INS and for displaying navigation information and system status information Logic circuits in the CDU convert manual control selections and remote control inputs from the NCS into digital data signals and decode digital data signals for display The following description of DCU controls applies to independent INS operation In the NCS application, most insertions will come from the system control-indicator and the displays on the CDU will represent the INS data inputs to the NCS Table 4 gives a quick reference for each of the controls on the CDU

(2) Data Displays

- (a) The data displays are composed of lamps which indicate numbers, decimal points, degree symbols, left and right directions, and latitude or longitude directions The data to be displayed is selected by the eight-position data selector Data to be inserted into the computer is first loaded into the data displays by operating the keyboard Display of the loaded data allows visual verification before inserting it into the computer Pressing the INSERT key inserts the loaded data into the computer memory and the computer then resumes control of the data displays

(3) Alert Lamp

- (a) The ALERT lamp comes on 2 minutes before reaching a waypoint or destination during flight The ALERT lamp flashes on and off after passing a waypoint if the AUTO-MAN switch is in the MAN position In

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this case, the light goes out when either AUTO is selected or a course change is inserted. The ALERT lamp does not come on when ground speed is below 250 knots. The ALERT lamp can be tested at any time by pressing the AUTO-MAN TEST switch

(4) Bat Lamp

- (a) The BAT lamp comes on when the INS is operating on battery power.

(5) Warn Lamp

- (a) The WARN lamp comes on when the INS self-testing circuits detect an out-of-tolerance condition. The WARN lamp can be caused by a continuous or intermittent condition. Intermittent out-of-tolerance conditions detected by the DCU light the WARN lamp until it is reset by the TEST switch. If the WARN lamp is lighted by a continuous condition which does not degrade attitude operation (action codes 02, 04, or 05), the WARN lamp will go out when the mode selector is set to ATT.

(6) Keyboard

- (a) The keyboard consists of 10 keys which are used to load data into the data displays and FROM-TO DISPLAY. The N, S, W, and E on keys 2, 8, 6, and 4 indicate directions of latitude and longitude. Keyboard illumination is controlled by the navigator panel lighting control.

(7) Clear Key

- (a) The CLEAR key is used to cancel a data loading operation when erroneous data is loaded into the left data display, the right data display, or the FROM-TO display. When the CLEAR key is pressed during a data loading operation, the computer resumes control of the applicable display and the loading operation can be restarted. The CLEAR key illumination intensity is controlled by the navigator panel lighting control.

(8) Auto-Man and Test Switch

- (a) The following paragraphs describe this dual function switch.

(b) AUTO-MAN Switch

- 1) The AUTO-MAN switch is normally left at the AUTO position. This allows automatic navigation leg switching during flight. If the MAN position is used, the INS does not switch to the next navigation leg, but continues to furnish steering signals to maintain the desired track for the completed navigation leg. Displayed

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navigation information also remains relative to the completed navigation leg. After a way point is passed with the switch at MAN, automatic leg switching can be resumed by switching to AUTO.

(c) TEST Switch

- 1) The TEST switch is used to test all indicating lamps and displays for the INS and to test the DCU input/output operation. The TEST switch is also used in conjunction with other controls to display numerical codes indicating specific malfunctions and to reset the malfunction warning circuits.
- 2) The TEST switch can be pressed at any time during INS operation to test the indicating lamps and displays on the MSU and CDU and the DCU input/output. Proper operation is indicated by illumination of all lamps, data displays, and FROM-TO display while the switch is pressed. Each digit in the FROM-TO display and data displays indicates an eight. The directional letters (N S E W) and the degree and decimal symbols also come on in the data displays.
- 3) The test switch also tests remote indicators which are connected to the INS. Pressing the TEST switch causes the READY NAV and BAT lights on the MSU to come on.
- 4) Malfunction codes for all DCU detected out-of-tolerance conditions are temporarily stored in the DCU memory. These codes can be displayed by setting the data selector to DSRTK/STS and actuating the TEST switch. The action code is displayed in the second and third digits of the right data display. Pressing and releasing the TEST switch the first time displays the lowest numbered malfunction code which has been recorded since the malfunction warning circuits were last reset. Additional pressing of the TEST switch will display applicable malfunction codes in ascending numerical order if more than one out-of-tolerance condition has been detected. When all recorded malfunction codes have been displayed, the two digits again display the recommended action code or go blank. Actuation of the TEST switch with the data selector at DSRTK/STS not only displays the malfunction codes but also resets the malfunction warning circuits. If the detected out-of-tolerance condition is not continuous, the malfunction code is erased, the recommended action code is erased, and the WARN light goes out due to the reset operation of TEST switch and data selector.

(d) Data Selector

- 1) The data selector has eight positions for selecting data to be displayed. Three of these positions (POS, WAY PT, and DSRTK/STS) also allow data to be loaded into a data display buffer and then

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inserted into the computer memory. The edge lighting intensity is controlled by the navigator panel lighting control.

(e) DIM Knob

- 1) The DIM knob on the data selector is used to vary light intensity of the data displays, the FROM-TO display, the ALERT light, and the HOLD, REMOTE, INSERT, and WYPT CHG keys.

(f) WYPT CHG Key

- 1) The WYPT CHG key is used with the keyboard and INSERT key to make a course change. The WYPT CHG key and INSERT key both light when the WYPT CHG key is pressed. Different waypoint numbers can then be loaded into the FROM-TO display using the keyboard. The first keyboard key pressed loads the FROM side and the second key pressed loads the TO side of the FROM-TO display. Insertion of the different numbers into the DCU using the INSERT key causes the WYPT CHG key and INSERT key lights to go out. Both lights also go out when the CLEAR key is pressed.

(g) Waypoint Selector

- 1) The waypoint selector, with the data selector set to WAY PT, allows waypoint and destination positions to be inserted into the DCU memory in the proper sequence. During flight, the automatic navigation leg switching by the DCU is accomplished in sequence according to the inserted positions from 1 to 9 unless a course change is inserted. The previously inserted latitude and longitude for a waypoint or destination will be indicated in the data displays when the waypoint selector is set to the waypoint number (1 through 9) and the data selector is set to WAY PT. The position coordinates (latitude and longitude) displayed when the waypoint thumbwheel selector is set to 0 are normally those of the original departure point inserted at time of alignment. The displayed coordinates can be changed, however, if a course change is made during flight (0 in FROM display) or a position update is performed after landing.

(h) FROM-TO Display

- 1) The FROM-TO display indicates two numbers which describe the navigation leg of the automatic navigation data being computed. As a flight progresses to a waypoint, and the AUTO MAN switch is set to AUTO, the FROM-TO display automatically changes to indicate the next navigation leg after the TO waypoint is reached. The normal automatic sequence is 12 (from waypoint 1 to waypoint 2), 23, 34, , 89, 91, 12, . by consecutive waypoints. The waypoint sequence can be interrupted at any time by loading dif-

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ferent numbers into the FROM-TO display using the WYPT CHG key and keyboard and inserting them into the DCU with the INSERT key. Loading 0 into the FROM display causes an immediate course change from the present position to the waypoint in the TO display when the INSERT key is pressed. After a course change navigation leg is completed, the INS resumes the automatic sequence starting at the waypoint number used for the leg termination.

(i) HOLD KEY

- 1) The HOLD key is used in conjunction with other CDU controls to stop displayed present position from changing, to perform a position update, to display inertial present position, to eradicate a position update, and to display recorded malfunction codes. The HOLD key comes on when pressed the first time and goes out when pressed the second time or when inserted data is accepted by the DCU.
- 2) Recorded malfunction codes for all out-of-tolerance conditions are semipermanently stored in the DCU memory. These codes are erased when the INS starts fine alignment (performance index decreases from 7 to 6). In addition, malfunction codes for DCU converters are erased when ground speed increases through 10 knots. A new record is started at these points of operation and continues until the next time the fine alignment is started. The malfunction codes for all out-of-tolerance conditions occurring during this period can be displayed in the second and third digits in the right data display.
- 3) The recorded malfunction codes are displayed by rotating the data selector to DSRTK/STS, simultaneously pressing and releasing the HOLD key and TEST switch, and then pressing and releasing the TEST switch for each recorded malfunction code. The recorded malfunction codes will be displayed in numerical sequence starting with the lowest number. After all recorded malfunction codes are displayed, the two digits go blank. The HOLD key does not light during this procedure except while the TEST switch is pressed.

(j) REMOTE Key

- 1) The REMOTE key is used with other controls on the CDU to display instantaneous values of pitch and roll angles.

(k) INSERT Key

- 1) The INSERT key is used to insert loaded data into the computer. The lamp in the INSERT key is controlled by either the computer or by operation of the CDU controls. The lamp in the INSERT key comes on at INS turn on and when the mode selector is downmoded.

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to STBY indicating that present position data must be inserted before automatic alignment can be accomplished. The lamp in the INSERT key will go out after both present position latitude and longitude are inserted.

O. System Status.

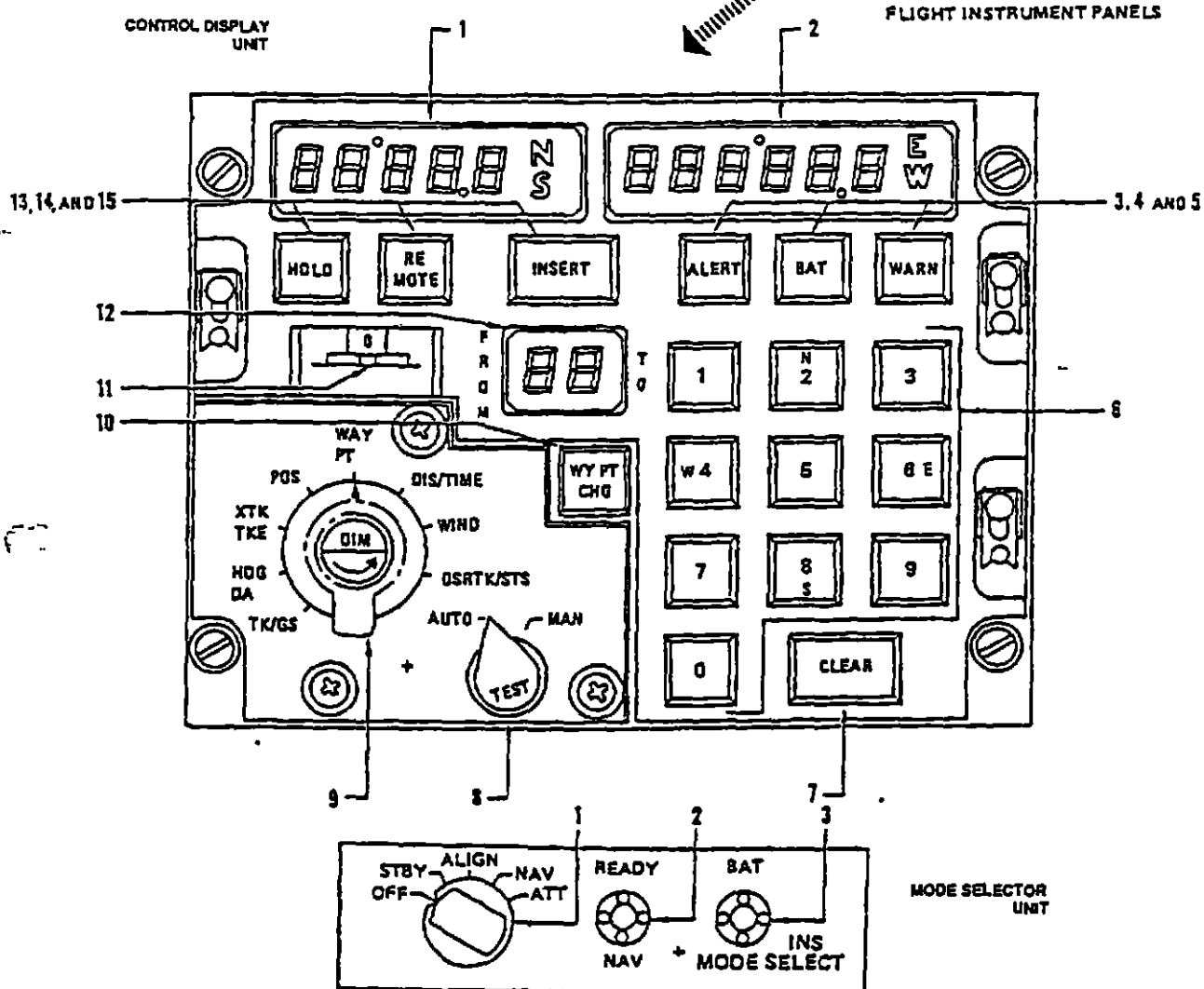
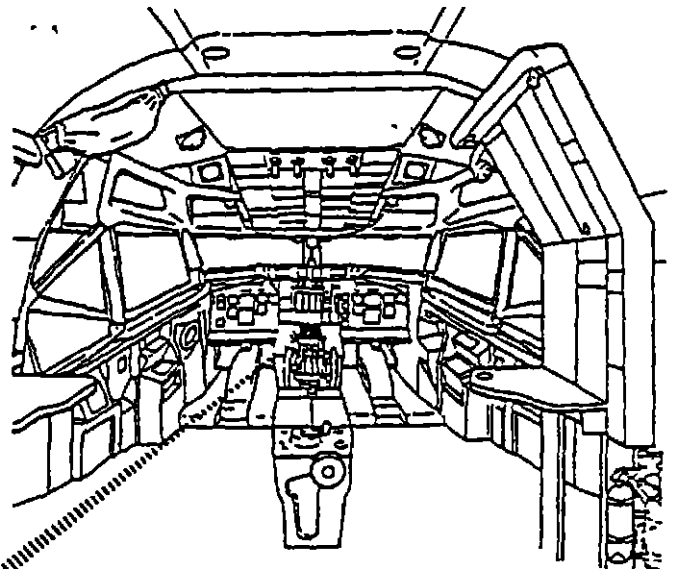
- (1) When the data selector is set to DSRTK/STS, the last digit on the right of the right data display is the desired performance index (PI) number. This digit displays a 5 at turn on and when the INS is downmoded to standby from the navigation mode. The number can be changed by loading a lower number into the display and inserting it into the CDU while the data selector is at DSRTK/STS. A desired PI greater than 5 will not be accepted by the DCU.
- (2) The digit at the left of the desired PI number indicates the computer mode number during standby and alignment, and the actual PI number during fine alignment. Standby mode is represented by 9, coarse leveling operation by 8, coarse azimuth determination by 7, and fine alignment by 6. Numbers 5 through 0 represent the actual performance index number. When the INS is turned on or downmoded to standby operation, a 9 is displayed. The DCU does not enter the navigation mode until the actual PI number is equal to or less than the desired PI number and the mode selector on the MSU is set to NAV.
- (3) The second and third digits from the left in the right data display will display numbers only when a malfunction has occurred. When the WARN lamp comes on, by either a continuous or intermittent DCU detected malfunction, the two digits indicate the following action codes: 01, 02, 04, or 05. Action code 03 is displayed without lighting the WARN lamp but will cause the HEADING flag on the HSI to appear. The recommended action for each code is defined below.

<u>Action Code</u>	<u>Recommended Action</u>
01	Shut down INS
02	Watch for degradation, select ATT if necessary
03	Check output to HSI and autopilot
04	Downmode to STBY and restart

- (4) The second and third digits from the left are also used to display malfunction codes. Refer to table 5 for the malfunction code list. The malfunction codes replace the action codes when the TEST switch is actuated.

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Inertial Navigation System Control and Display Unit
Figure 4

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FIGURE REFERENCE	NOMENCLATURE	FUNCTION
4- 1	Mode Selector	
	OFF	When set to OFF, power is removed from system
	STBY (standby)	When set to STBY, navigation unit begins fast warmup, gyro platform cages to aircraft orientation, gyro spinup begins, CDU is powered to Standby, and CDU is powered for display and insert operation. In standby, INS is not affected by aircraft movement.
	ALIGN	When set to ALIGN from STBY, coarse alignment begins if fast warmup heaters have shut off. Fine alignment begins after present position is inserted at CDU. When set to ALIGN from ATT, alignment begins if fast warmup heaters are off and present position is inserted at CDU. Selecting ALIGN from NAV does not down mode INS. ALIGN position is used only when aircraft is parked. When in ALIGN, the INS will shut down if Navigation Units CP-1176A/A or CP-1176B/A is installed and an overtemperature condition occurs.
	NAV (navigation)	When set to NAV directly from OFF, INS automatically sequences through STBY and ALIGN if present position is inserted and aircraft is parked. NAV position is used for normal operation after alignment is complete and before aircraft is moved. When in NAV, the INS will shut down if Navigation Unit CP-1176A/A or CP-1176B/A is installed and an overtemperature condition occurs with aircraft on ground. Malfunction code 39 and action code 01 will be displayed.
	ATT (attitude)	When set to ATT, only attitude (pitch, roll and heading) information is provided. If ATT is selected from any position, alignment is lost and realignment must be done on the ground.

Mode Select Unit Functions

Table 3 (Sheet 1 of 2)

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FIGURE REFERENCE	NOMENCLATURE	FUNCTION
4- 2	READY NAV indicator (green)	When on, indicates INS alignment is complete Indicator remains on until NAV is selected If mode selector is set to NAV during alignment, READY NAV indicator comes on momentarily when alignment is complete
3	BAT warning indicator (red)	If INS is operating on battery power and low voltage condition is detected, INS shuts down and BAT warning light comes on During coarse alignment, battery is tested During this test if low voltage is detected, INS shuts down and BAT warning light comes on

Mode Select Unit Functions
Table 3 (Sheet 2 of 2)



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FIGURE REFERENCE	NOMENCLATURE	FUNCTION
4-		
1	Left data display	Displays data such as latitude, drift angle, wind velocity, or desired track
2	Right data display	Displays data such as longitude, ground speed, wind direction, or system status
3	ALERT light	Comes on 2 minutes before reaching a waypoint or destination during flight. Does not come on automatically when ground speed is below 250 knots
4	BAT light	Comes on when INS is operating on battery power
5	WARN light	Comes on when INS self-test circuits detect an out-of-tolerance condition
6	Keyboard	Used to enter data into left and right data displays. The 2, 4, 6, and 8 keys are dual function keys in that they also enter the directions of longitude and latitude
7	CLEAR key	Cancels data loaded into left or right data displays or FROM-TO display
8	AUTO MAN and TEST Switch	Selects automatic or manual switching between waypoints during flight. Pressing AUTO MAN switch will test all indicators on the CDU and the MSU
9	Data Selector and DIM control	Selects data to be displayed in left and right data displays. DIM control varies intensity of both data displays, FROM-TO display, ALERT light, and HOLD, REMOTE, INSERT, and WY PT CHG keys
10	WY PT CHG key	Used together with INSERT key (15) to change to change waypoint data
11	Waypoint Selector	Used when data selector (9) is set to WAY PT to insert waypoint and destination locations into DCU memory
12	FROM-TO	Indicates waypoint number aircraft is flying from and waypoint number aircraft is flying towards

Control Display Unit Functions

Table 4 (Sheet 1 of 2)

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FIGURE REFERENCE	NOMENCLATURE	FUNCTION
4- 13	HOLD key	Used together with other controls on CDU to perform functions such as a position update, or displaying recorded malfunction codes
14	REMOTE key	Used together with other controls on CDU to display pitch and roll angles
15	INSERT key	Used to insert data into DCU. If pressed while key is dark, no operation is performed

Control Display Unit Functions
Table 4 (Sheet 2 of 2)

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MALFUNCTION CODE	FAILED TEST	MODES OF OPERATION	ACTION CODE
10	25 ms loop check	STBY, ALIGN, NAV	02
11	50 ms loop or loop sync checks	STBY, ALIGN, NAV	02
12	600 or 200 ms loop check	STBY, ALIGN, NAV	02
13	Y velocity change	NAV	02
14	X velocity change	NAV	02
15	Torque limited	ALIGN, NAV	02
18	Too long in saturation	ALIGN	01
* 22	Desired track feedback	STBY, ALIGN, NAV	03
* 23	Drift angle feedback	STBY, ALIGN, NAV	03
* 24	Roll angle feedback	STBY, ALIGN, NAV	03
* 25	Heading feedback	STBY, ALIGN, NAV	03
* 26	Crosstrack feedback,	STBY, ALIGN, NAV	03
* 27	Tick mark error	STBY, ALIGN, NAV	None
* 31	Groundspeed	STBY, ALIGN, NAV	02
32	Memory parity	STBY, ALIGN, NAV	01
33	Azimuth stab loop noise	STBY, ALIGN, NAV	01
34	Inner roll stab loop noise	STBY, ALIGN, NAV	01
35	Pitch stab loop noise	STBY, ALIGN, NAV	01
36	Accelerometer loop noise	STBY, ALIGN, NAV	01
37	Z platform overtemperature	STBY, ALIGN, NAV	01
38	XY platform overtemperature	STBY, ALIGN, NAV	01

Malfunction Codes
Table 5 (Sheet 1 of 2)

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MALFUNCTION CODE	FAILED TEST	MODES OF OPERATION	ACTION CODE
39	Navigation unit overtemperature	STBY, ALIGN, NAV	01
42	Drift angle greater than 45°	STBY, ALIGN, NAV	02
45	Gyro scale factor update	STBY, ALIGN	04
* 46	TAS from ADC not valid	STBY, ALIGN, NAV	None
* 47	Barometric altitude from ADC not valid	STBY, ALIGN, NAV	None
* 48	Zero roll in process	STBY, ALIGN, NAV	None
49	Fix measurement too large	STBY, ALIGN, NAV	02
57	Azimuth gimbal angle rate	ALIGN	04
60	X or Y sample and hold change	STBY, ALIGN, NAV	04
61	X or Y sample and hold	ALIGN	04
62	Azimuth gimbal angle rate	NAV	02
63	Computer self-checks	STBY, ALIGN, NAV	02
* Failed test does not light WARN lamp in CDU			

Malfunction Codes
 Table 5 (Sheet 2 of 2)

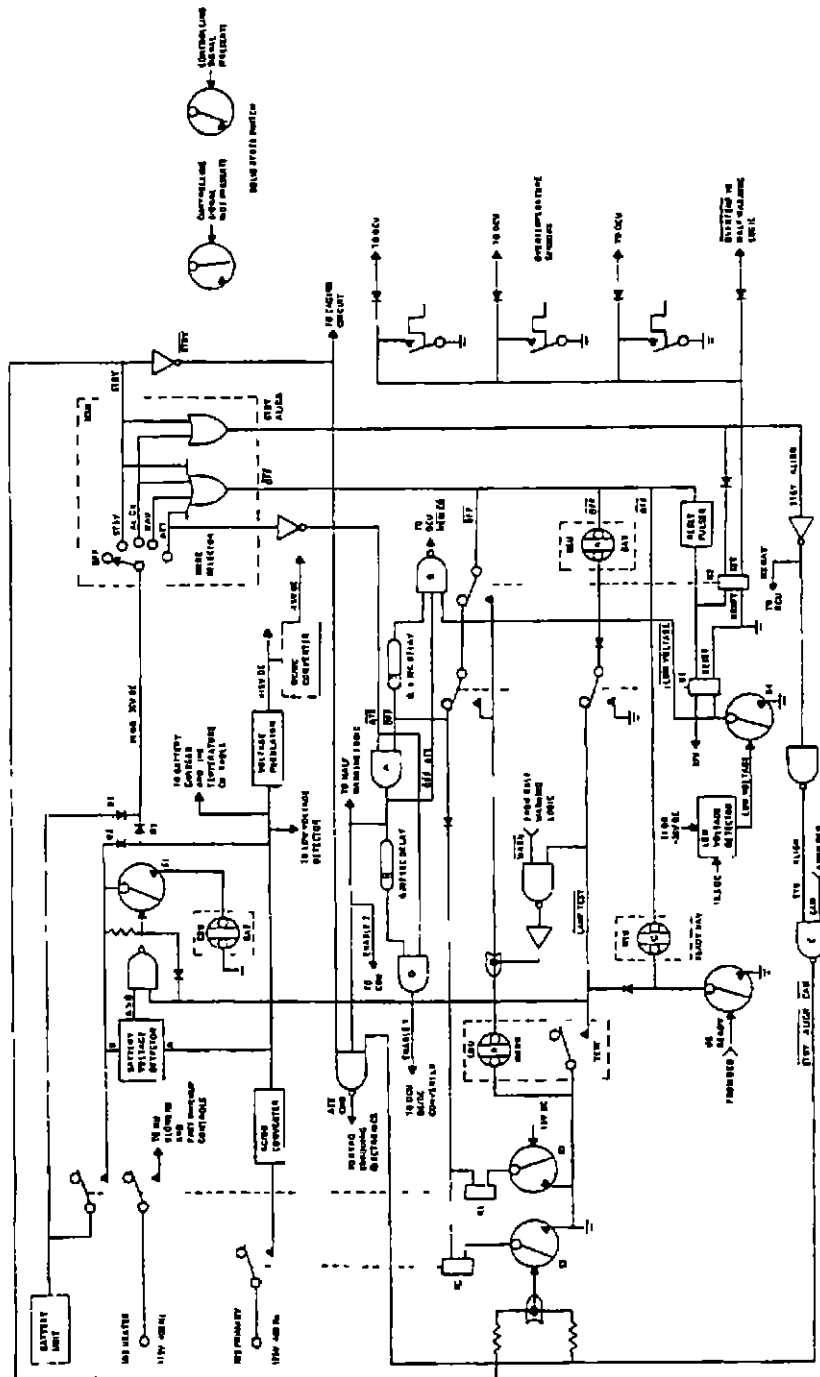
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P. Operating Modes

- (1) The INS has five major modes of operation which are controlled by the mode selector on the MSU. The major operating modes are. off, standby, alignment, navigation, and attitude, selected respectively by the OFF, STBY, ALIGN, NAV and ATT positions of the mode selector. When the INS is turned on for normal operation and the STBY, ALIGN, or NAV position of the mode selector is selected, the INS will automatically sequence to the completion of the mode selected. The attitude mode can be selected directly during turn on if only attitude signals are desired from the INS. By selecting the ATT position of the mode selector from the OFF position, the INS will sequence through standby operation to the attitude mode.
- (2) Downmoding the INS differs from upmoding. Moving the mode selector from NAV to ALIGN during navigation mode of operation will not change the INS operating mode. Downmoding the INS from the navigation mode to the alignment mode can be accomplished during ground operation by inserting present position after setting the mode selector to STBY and then to ALIGN. This causes the INS to restart the alignment process. Moving the mode selector to STBY or ATT while the INS is in the alignment or navigation mode of operation will destroy the INS alignment. Selecting the attitude (ATT) mode shuts off the DCU and CDU.
- (3) **OFF Mode.**
 - (a) The INS is not functional when the mode selector on the MSU is in the OFF position. The +24 vdc battery unit output power is applied through diode D1 to the mode selector to be available at turn on. (See figure 6) The 115 volt ac power from the aircraft power system is applied to the contacts of power relays K1' and K2' in the NU which are open when the mode selector is at the OFF position.
 - (b) The mode selector is a wafer switch which is used to manually initiate INS mode control. The outputs of the mode selector are used to drive the mode control and malfunction warning logic circuits in the NU. Figure 6 illustrates the logic functions of the mode selector for all positions.
- (4) **STANDBY Mode**
 - (a) The standby mode of operation is an optional mode which prepares the INS for automatic alignment, but prevents alignment from being initiated. The standby mode of operation is selected by turning the mode selector on the MSU to STBY. The DCU is always in the standby mode when the mode selector is at STBY. This mode is indicated by a 9 displayed as the next to the last digit on the right in the right data display when the data selector is set to DSRTK/STS.

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- (b) During standby operation, the power supplies in the INS are energized, the fast warm up and fine temperature control circuits are enabled, the battery charger is enabled, the gimbal assembly is caged to the aircraft pitch and roll attitude, the gyro wheels and synchronous motor are started, and the DCU and CDU are enabled to allow insertion of data into the DCU through either the SCI or the CDU
- (c) When the mode selector on the MSU is set to STBY, the +24 vdc battery unit power is transmitted from the MSU to the NU as three logic level one discretes. These discretes are OFF, STBY + ALIGN, and STBY. In addition, an open circuit to the input of an inverter from the ATT position provides a logic level one inverter output representing ATT
- (d) The OFF discrete is applied to a reset pulser which is connected to the reset coils of latch relays K1 and K2. The reset pulser furnishes a pulse at turn on to ensure that the contacts are in the reset position shown in figure 6
- (e) The OFF discrete is also applied to the coils of power relays K1' and K2' through the normally closed contacts of relays K1 and K2. Solid state switch S2 on the lower side of the K2' coil is immediately closed by the STBY discrete through the OR junction when the mode selector is set to STBY. Relay K2' closes, connecting 115 volt primary power to the ac/dc converter. Relay K1' is not closed until +15 vdc is available from the voltage regulator, therefore, startup is not completed unless the 115 volt primary power is available. This prevents large current flow from the battery unit at turn on
- (f) Closure of K2' applies 115 volt INS primary power to the ac/dc converter. The +36 vdc output from the ac/dc converter replaces battery power to the MSU by reverse biasing diode D1 between the battery unit and the MSU. The +36 vdc is also applied to the voltage regulator which in turn furnishes regulated +15 vdc. The +15 vdc voltage regulator output is applied to solid state switch S3 closing both S3 and K1'. The +36 vdc and +15 vdc start operation of the battery charger, fine temperature controllers, power supplies, and the remaining mode control logic
- (g) Closure of K1' applies 115 volt INS heater power to the NU blower thermal switch and to the fast warmup controllers. Relay K1' also connects the battery unit output to the ac/dc converter output through diode D2 which is reverse biased by the +36 vdc. Should the 115 volt INS primary power be interrupted after K1' is closed, the battery unit output line diodes D1 and D2 become forward biased, the battery unit furnishes power to the INS, the battery charger shuts off, and the BAT lamp on the CDU comes on

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- (h) When the mode selector is set to STBY, ALIGN, or NAV from the OFF position, the OFF ATT discrete immediately goes to a logic one. This enables the CDU (ENABLE 2) and the malfunction warning logic. After a 0.007 second delay, the DCU DC/DC converter is enabled (ENABLE 1, AND gate D) which allows the DCU to start functioning. The DCU MEM EN (memory enable not) discrete is held at a logic level one for the first 0.15 seconds after INS turn on. This prevents the DCU memory from operating while the DCU DC/DC converter is stabilizing during turn on. After 0.15 seconds, the DCU memory is enabled and will operate until the mode selector is set to OFF or ATT or until a low voltage is detected. Any one of these conditions will cause the DCU converter. This prevents possible scrambling of the DCU memory during turn on, turn off, attitude mode, and low voltage conditions.
- (i) The STBY + ALIGN discrete from the MSU is used to control the attitude command logic, solid state switch S2 on the low side of relay K2' coil, and the set coil of relay K2. The CAM (command attitude mode) discrete from the DCU is not issued during standby operation, therefore, the STBY + ALIGN + CAM discrete from NAND gate C is held at a logic level one as soon as 15 volts dc is available to the logic circuits. The ATT CMD (attitude command) discrete is issued to the gyro torquing electronics during standby operation. This discrete affects INS operation during standby operation only when down-modding. Switch S2 is held closed to maintain R2' operative during standby operation. The low side of the K2 set coil is connected to the overtemperature switches. The overtemperature switches, located in the IRU and oven, are normally open. If the temperatures in the NU become excessive during standby operation, one or more overtemperature switches close, connecting the low side of R2 to ground. This sets K2 which in turn deenergizes the R1' and K2' coils to shut down the INS. Contacts of K2 also connect the OFF discrete to the WARN lamp on the CDU causing it to come on. Once an overtemperature has set K2, the contacts remain in the set position until they are reset by recycling the mode selector from OFF to STBY.
- (j) The low voltage detector controls solid state switch S4 on the low side of latching relay K1 during all INS operating modes. The +24 or +36 vdc primary power is connected to the low voltage detector. The logic level one low voltage discrete is produced by the low voltage detector if the input drops to 16.5 vdc after turn on. The low voltage detector detects a low battery unit voltage when the INS is operating on battery power, because the battery unit output is used only when the ac/dc converter output voltage is lower than the battery unit potential. If the input to the low voltage detector drops to 16.5 volts, the low voltage discrete closes S4. Closure of S4 sets latching relay K1 which shuts down the INS and causes both the red WARN lamp on the CDU and the red BAT lamp on the MSU to come on. These lamps remain on until the mode selector is rotated to OFF. Once a low battery voltage has set K1, the contacts remain in the

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Page 5-23 Change 0

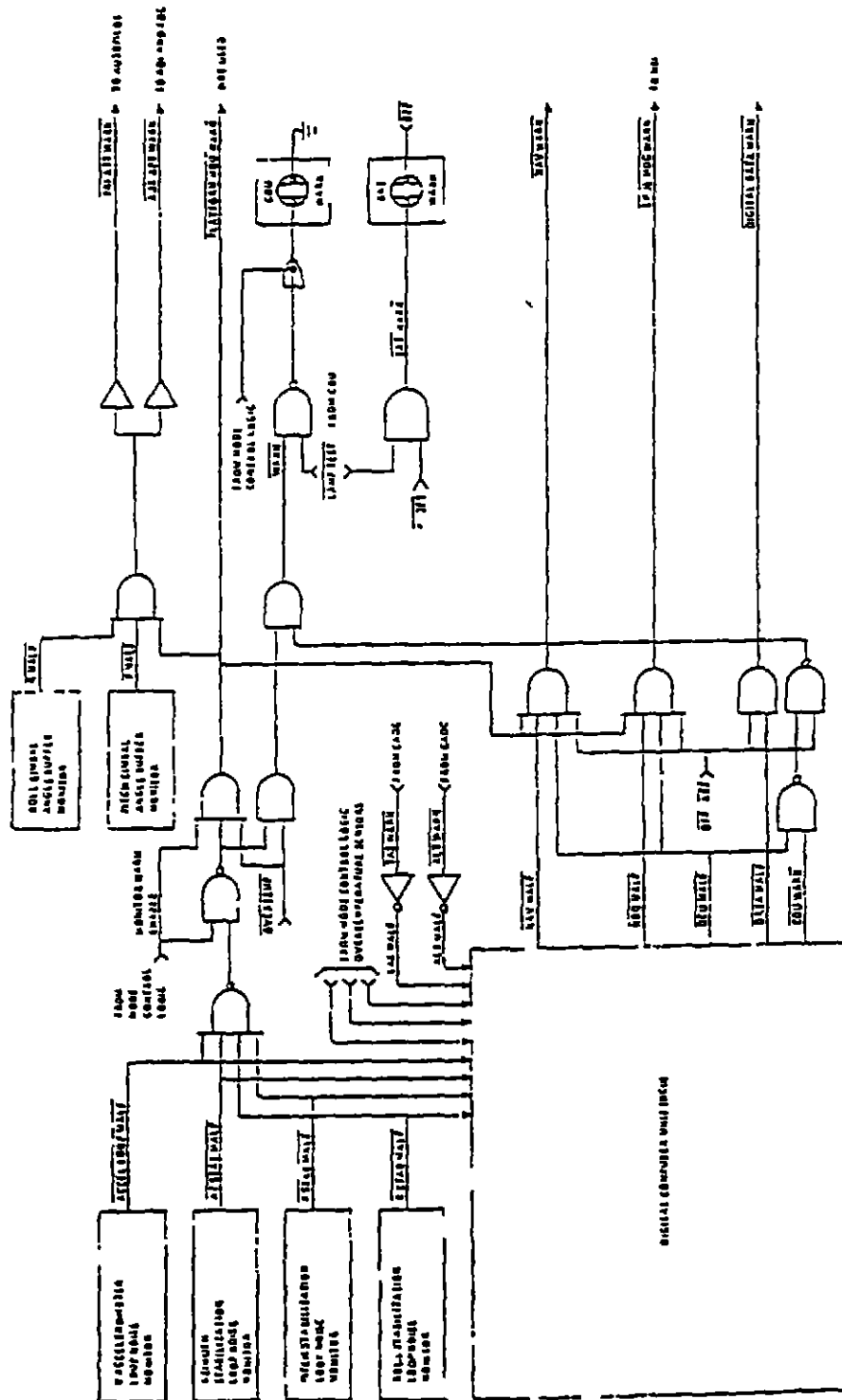
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set position until they are reset by recycling the mode selector from OFF to STBY

- (k) The lamp test circuits are enabled during standby operation. Pressing the TEST switch on the CDU causes all indicating lamps and displays on the CDU and MSU to come on. The TEST switch connects the low side of the red BAT and green READY NAV lamps on the MSU to ground. The ground applies a logic level zero to logic circuits causing the amber BAT and red WARN lamps on the CDU to come on. In addition, pressing the TEST switch controls logic circuits in the CDU which develop digital data output signals to the DCU. Upon receipt of the CDU digital data, the DCU issues digital data to the CDU which causes all CDU indicating lamps and displays except the BAT and WARN lamps to come on.
 - (l) The malfunction warning logic illustrated in figure 7 is only partially operative during standby operation. All warning flag discretes are held at the warning logic level during standby operation. The DCU performs self-test during standby to ensure that the computer program (software) and DCU hardware are functioning. The DCU MALF (DCU malfunction not) discrete is issued when the self-tests are valid. The DATA MALF (data malfunction not) and CDU WARN (CDU warn not) discretes are issued from the DCU when the reasonableness tests are valid. The DCU MALF and CDU WARN discretes are connected to the WARN lamp logic so that DCU detected malfunctions cause the WARN lamp to come on during the standby, alignment, and navigation modes.
- (5) ALIGN Mode
- (a) The alignment mode of the INS is entered when the mode selector is set to ALIGN or directly to NAV from OFF or STBY. The alignment mode of operation is necessary to align the inertial instruments in the vertical and horizontal planes, to allow the computer to determine the exact orientation of the aircraft with respect to true north, and to allow the computer to determine any changes in accelerometer loop, gyro torquing, and stabilization loop errors since the last time the INS was operated.
 - (b) The alignment mode is accomplished by a number of automatic steps identified by the computer mode number. When the code selector is set to ALIGN, the alignment of the system progresses through computer modes 9 through 0. The READY NAV indicator on the MSU comes on when computer mode 5 is reached indicating that the INS can be advanced to the navigation mode. Further refinement of the self-calibration data can be obtained by leaving the mode selector on the MSU set to ALIGN. Typical time to reach mode 0 from mode 5 is 20 minutes.

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Malfunction Warning Logic Diagram

Figure 7

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(c) Computer Mode 9.

- 1) During computer mode 9, present position and waypoint data can be loaded into the computer. The INS remains in the computer mode 9 until fast warmup is completed and the gyro wheels have reached synchronous speed. During this mode, the INS gimbals remain caged with the platform aligned to the aircraft pitch and roll axes.

(d) Computer Mode 8

- 1) Platform coarse leveling, is started in this mode and is controlled by the computer. The battery is tested for 12.8 seconds during mode 8. Also, during this 12.8-second period, leveling is done by a computer commanded attitude mode (CAM). The computer will stay in computer mode 8 until the platform is level enough to start the alignment computations of mode 7. If the time in mode 8 exceeds 5 minutes, the CDU WARN indicator will come on indicating that the platform will not level. Present position and waypoint data can also be loaded in mode 8. The minimum time in this mode is 51 seconds.

(e) Computer Modes 7 and 6

- 1) The system will remain in mode 7 for a minimum of 26 seconds. Entrance to mode 6 is made after the 26 seconds if present position has been loaded. The system will remain in mode 7 until present position is loaded. The total time in modes 7 and 6 will not exceed 8.5 minutes, if present position has been loaded prior to the completion of the 8.5 minute period.
- 2) The mode control logic and malfunction warning logic remain in the same state as that during computer mode 8. During computer modes 7 and 6, the computer checks various data being generated for reasonableness. These checks are in addition to the continuously performed self-checks for software and hardware malfunctions. If any of the values checked for reasonableness are out of tolerance, the CDU WARN discrete from the computer drops to zero causing the WARN lamp on the CDU to come on.

(f) Ready to Navigate.

- 1) The computer checks the mode number against the desired code of 5 in the CDU. The computer will issue the MS READY (mode selection ready) discrete (figure 6) to light the READY NAV lamp on the MSU when the two numbers are equal, indicating that the required degree of alignment has been obtained. If the mode selector is left at ALIGN after the READY NAV lamp comes on, the platform leveling and gyro compassing operations will continue to refine the INS alignment and lower the computer mode number.

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(g) Computer Modes 5 through 0.

- 1) Computer mode 5 indicates all basic alignment computations are accurate enough to advance to the navigate mode. The alignment computations are continuous and continue to improve as long as the system is left in the align mode. During computer modes 7 and 6 and continuing during computer mode 5, the computer monitors the rotation rate of the azimuth gyro. As more and more data is accumulated with respect to the rotation rate of the azimuth gyro, it is compared to the last known drift rate of this gyro and corrected for the vertical component of earth rotation based on loaded latitude. As this data is accumulated and the results of these computations become smooth, the computer mode number is lowered to 4 and below. This indicates that in addition to the heading determination and gyro torquer gain calibration, the azimuth gyro drift rate has also been calibrated. All these terms will be updated upon entry to the navigation mode.

(6) NAVIGATION Mode.

- (a) The system operates in navigation mode when the mode selector is set to NAV, but only after the computer mode number displayed has decreased to 5 or less. When the computer mode number reaches 5 or less, the computer continuously checks for the MS NAV (mode selection navigation) discrete from the mode control logic. Once the MS NAV discrete is present, the computer begins computing navigation data. When navigation mode is entered, the READY NAV light on the MSU goes out. During the first 25 seconds in the mode, the computer uses the data computed during the align mode to remove all tilt from the platform and update all data.
- (b) In the navigation mode, all navigation data is computed and available for display. All warning flags on instruments controlled by the INS disappear from view. Two types of operation are available in the navigation mode: normal inertial operation, and aided inertial operation. In normal inertial operation, each INS operates independently and depends on its own inertial instruments for all position and velocity data. The present position computed by each INS can be updated manually when the aircraft passes over a known position reference. In aided inertial operation, values of position, velocity, heading, tilt, and azimuth gyro drift are received from the omega computer.
- (c) Normal Inertial Navigation.
 - 1) The platform tilt is updated during the first 25 seconds of navigation mode. During navigation, the computer uses the accelerometer output signals to compute navigation and steering information.

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and to develop gyro torquing signals which maintain the IRU oriented to local horizontal. In the navigation mode, all acceleration signals are caused by movement of the aircraft. The computer continuously checks input information and computed information for reasonableness. It also receives warning signals from hardware monitors in the IRU and IRUE. If a failure or out-of-tolerance condition is detected by the computer, it provides output signals which will indicate one or more warnings. The computer will also provide codes to the CDU upon request indicating the recommended action and the failure being detected.

(7) ATTITUDE Mode

- (a) The attitude mode of operation is selected by setting the mode selector to ATT. This mode of operation provides only attitude outputs from the INS. When the attitude mode is selected, the DCU is shut down and the CDU is disabled except for the WARN and BAT lamps. Shutdown of the DCU in the attitude mode of operation destroys alignment and the navigation mode of operation cannot be entered until the INS sequences through the alignment mode. The attitude mode can be selected during ground operation by setting the mode selector directly to ATT from any other position. Setting the mode selector to ATT on the MSU immediately causes the ENABLE 1 discrete (AND gate D, figure 6) to the DCU DC/DC converter to drop to zero and the DCU MEM EN (memory enable) discrete (NAND gate B) to rise to a logic one. The MEM EN discrete prevents the DCU memory from operating.

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while the DC/DC converter is turning off. The ENABLE 2 discrete to the CDU also drops to zero immediately which disables the CDU

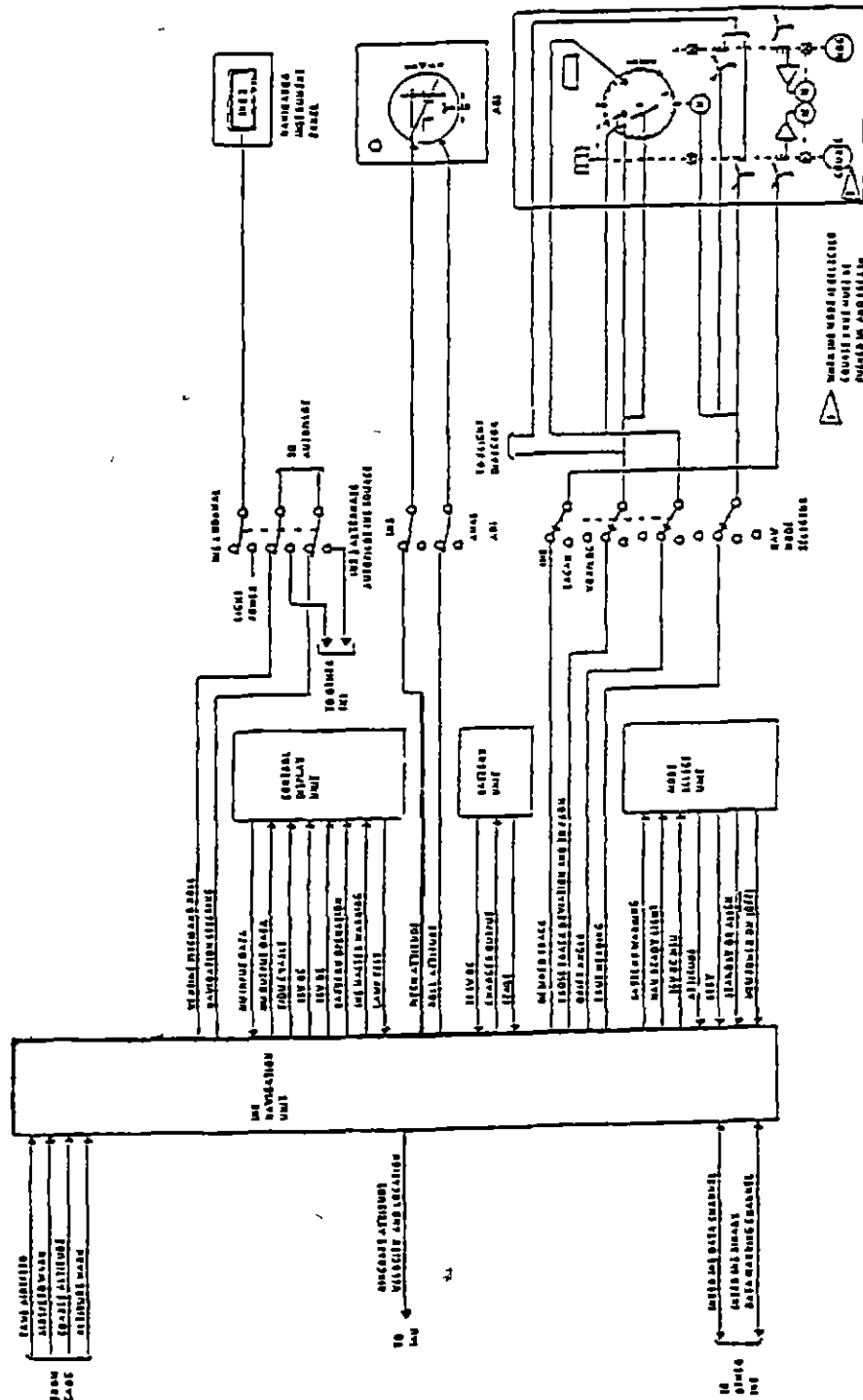
- (b) The OFF ATT discrete (AND gate A, figure 6) dropping to a logic level zero causes the NAV WARN, TRUE HDG WARN, and DIGITAL DATA WARN discretes (figure 7) from the NU to drop to zero. The portion of the logic circuit for the WARN lamp which is controlled by DCU output discretes is disabled so that only the overtemperature monitors can cause the WARN lamp to light during the attitude mode of operation

3. OPERATION

- A Figure 8 shows the interfaces between the two INS's, the NCS and the navigation instruments. The course deviation bar and TO-FROM indicator in the HSI indicate crosstrack deviation when INS is selected on the NAV MODE selector. The course arrow in the HSI is servo driven by the INS to indicate the true bearing of the destination or waypoint when the COURSE knob on the HSI is pushed in. If the COURSE knob is not pushed in, the deviation bar and TO-FROM indicator will operate but, since the course arrow will not be driven, the display can be misleading. The flight director system also uses INS outputs when INS is selected on the NAV MODE selector. The autopilot uses INS versine, attitude and navigation steering commands, selected from either No 1 or 2 INS.

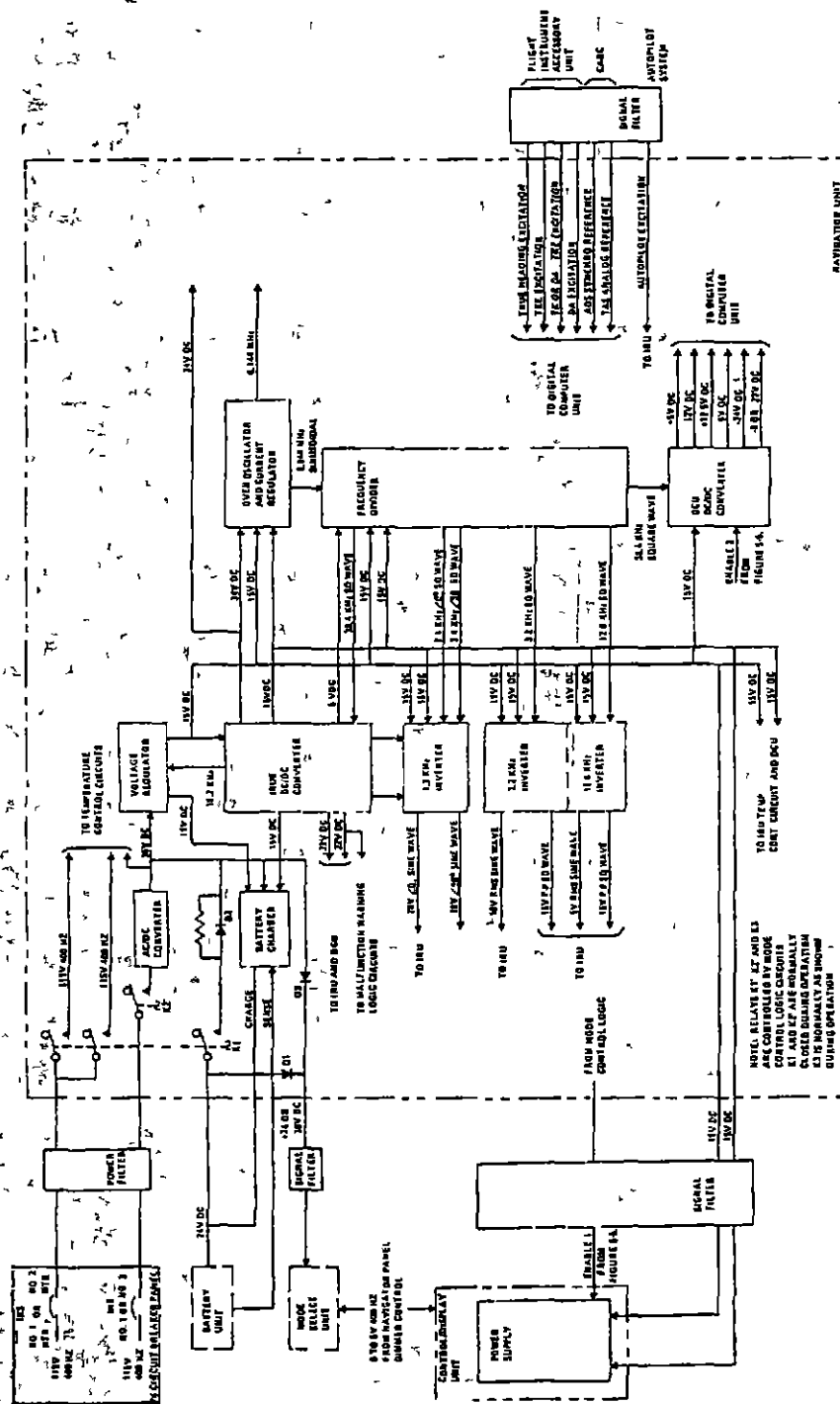
B Power Control and Distribution

- (1) The primary power and heater requirements of each INS are supplied by the 400 Hz aircraft power system. Three types of 400 Hz power (figure 9) are supplied: 115 volt, 26 volt, and variable 0 to 5 volt. The 0 to 5 volt power from the navigator panel lighting circuit is used for panel lighting on the MSU and CDU. The 26 volt power is required for synchro excitation and digital-to-analog converter phase reference. The 115 volt power is provided by two separate circuits, each protected with a circuit breaker. One 115 volt power circuit is used directly in the fast warmup temperature control circuit and the internal fans. All other power requirements of each INS are supplied by conversion of the other 115 volt power circuit. The battery unit will automatically supply all required power for 15 minutes if 115 volt power is interrupted.
- (2) The 24 vdc power from the battery unit is applied to the MSU through diode D1 at all times. The battery power is used to initiate the mode control logic circuits that close relays K1' and K2' when the mode selector is moved away from the OFF position. Relay R2' applies the primary 115 volt power to the ac/dc converter. The ac/dc converter is an unregulated full wave rectifier which produces a +36 vdc output. The +36 volts is applied to the temperature control circuits, the battery charger, the voltage regulator, and through diode D3 to the MSU. The +36 vdc reverse biases diodes D1 and D2 in the battery unit output lines to shut off the battery output. A resistor bypasses diode D2 to provide a 40 ma trickle



INS Signal Interface Diagram
Figure 8

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Power Distribution Diagram
Figure 9

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charge current to the battery unit whenever the NU is turned on. Relay K1' applies the 115 volt heater power to the temperature control circuits and connects the battery unit output through diode D2 to the ac/dc converter output line. If the ac/dc converter output voltage drops below the battery unit potential, the battery unit supplies all the primary power circuits and the battery charger automatically shuts off.

- (3) The voltage regulator produces a +15 vdc output which is regulated to one percent. The regulated +15 vdc is used throughout the IRU, IRUE, DCU, and CDU.
- (4) The power supply in the CDU is a dc/dc converter similar to the IRUE and DCU dc/dc converters. It provides the necessary dc voltages for operation of the CDU as soon as the ± 15 vdc and the enable discrete are available. The enable discrete is from the mode control logic. Both the +15 vdc and -15 vdc input power are fused inside the CDU to protect the NU power circuit from excessive current flow due to a failure in the CDU.
- (5) The battery charger provides a 2-ampere constant current charge for the battery unit. The battery charger operates only when the battery unit potential drops to 24.0 vdc or below providing the battery unit power is not being used. The battery charger automatically shuts off when the battery unit potential reaches 29.0 vdc. The +36 vdc ac/dc converter output is used to produce the battery charging current. If the +36 vdc input drops to the battery unit voltage, the battery charger shuts off.

C Temperature Control

- (1) The temperature of the NU is precisely controlled to maintain the IRU, IRUE, and DCU at temperatures which ensure reliable operation of the INS. Differing temperatures are required at different locations within the NU. The most accurate temperature control is required in the oven, which contains a precision oscillator and precision current regulators, and in the IRU which includes the temperature critical inertial instruments as well as mechanical parts which are machined to close tolerances. Heating is accomplished in the NU by fast warmup temperature control circuits, fine temperature control circuits, and heat dissipation of the electronics within the NU. Cooling provisions are incorporated in the NU to prevent overheating and to provide positive control of the fine temperature control circuits.

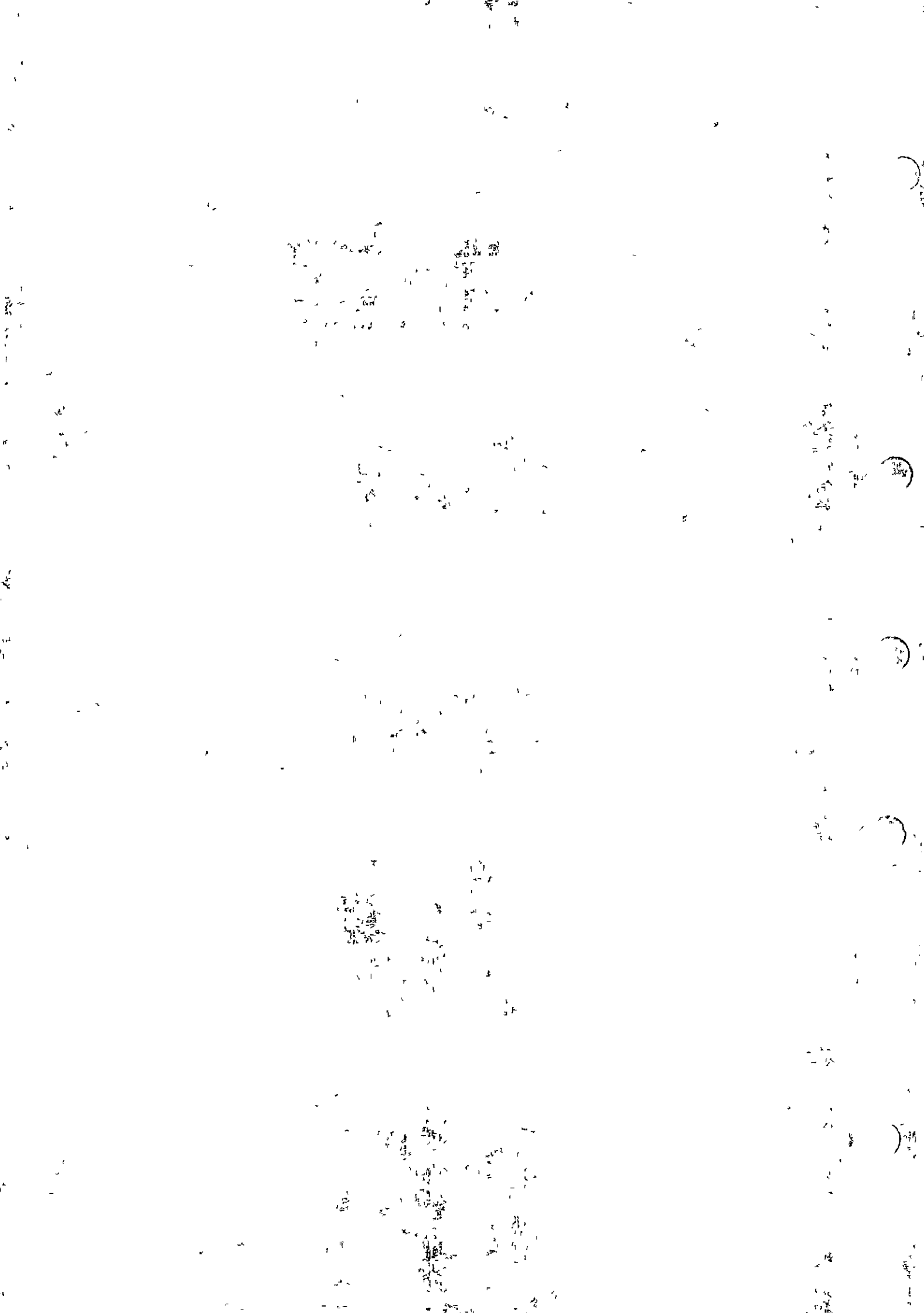
D Data Processing

- (1) Each INS generates high speed output data and transmits it to the data processing system. The primary purpose of the high speed output data is to minimize staleness of roll, pitch, heading, and drift angle digital data. Staleness is defined as the interval between sampling of platform gimbal analog data and the completion of the total digital data message. Staleness of roll angle digital data does not exceed 9 milliseconds. Roll

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and pitch angle data is transmitted every 25 milliseconds, while heading and drift angle data is transmitted every 50 milliseconds

- (2) Each INS generates heading angle, latitude, longitude, north velocity, and east velocity. All are referenced to either the geodetic north pole or to an alternate pole (displaced pole). The INS automatically selects either the geodetic pole or alternate pole according to the latitude at which it is operating. The geodetic north pole is selected for INS determined latitude of less than 40 degrees and the alternate pole reference is selected for INS determined latitude of more than 50 degrees. A manual override control on the NCS control panel provides means for selection of geodetic pole, alternate pole, and automatic selection. When operation is started within the 10-degree band between 40 and 50 degrees, the operator has the option of selecting either the geodetic pole or the alternate pole.





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INERTIAL NAVIGATION SYSTEM - TROUBLE SHOOTING

1 General

A Trouble analysis procedures for the inertial navigation system are listed in table 101. A reference index is given for each fault. All faults with an "A" prefix to the reference index are automatic fault displays which can occur any time during checkout in table 503 or 504. The reference index for all automatic fault displays is as follows:

A	0	1	Omega Status Word 1
A	0	2	Omega Status Word 2
A	0	3	Omega Status Word 3
A	0	4	Omega Status Word 4
A	D		Doppler Status Word
A	1	1	INS 1 Status Word
A	1	2	INS 2 Status Word
A	W		WARN light comes on on CDU

B The following faults cannot be duplicated while the aircraft is on the ground:

F	1	D-MEM came an and stayed on during flight
F	2	Unable to perform inflight alignment during flight
F	3	Unable to enable pattern or waypoint steering during flight
F	4	Excessive drift experienced during flight
F	5	Unable to perform position or velocity updates during flight
F	6	Unable to select doppler land/sea mode during flight
F	7	Unable to insert waypoint data during flight.

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F	8	Unable to perform any display request during flight
F	9	Unable to perform date and GMT update during flight
F	10	Unable to perform present position update during flight
F	11	Excessive track error experienced during pattern steering in flight

C The trouble analysis table lists symptoms, probable causes, isolation procedures and corrective action. Perform isolation procedures in the trouble analysis table only as necessary to locate the malfunction. If performing the listed corrective action does not correct the trouble, consult the associated wiring diagram for checking the aircraft wiring.

WARNING BOTH BATTERY UNIT CIRCUIT BREAKERS MUST BE OPENED AND BOTH BATTERY UNITS REMOVED FROM THE NAVIGATION EQUIPMENT RACK BEFORE TROUBLE SHOOTING ANY WIRING OR FILTER FAULTS OR PERSONAL INJURY AND EQUIPMENT DAMAGE MAY OCCUR.

CAUTION OPENING THE NAVIGATION EQUIPMENT RACK FOR TROUBLESHOOTING WILL AFFECT COOLING AIR DISTRIBUTION TO OTHER EQUIPMENT. OBSERVE RESTRICTIONS ON OPEN RACK MAINTENANCE.

THE INU, DNC, AND C/DU ASSEMBLIES AND CIRCUIT CARDS CONTAIN STATIC SENSITIVE DEVICES, THEREFORE, OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONS DURING MAINTENANCE, STORING, AND SHIPPING. AVOID TOUCHING DPX CONNECTOR PINS.

WHEN MAKING VOLTAGE OR RESISTANCE MEASUREMENTS AT CONNECTOR PINS, USE MATING PINS OF THE PROPER SIZE ATTACHED TO THE METER PROBES OR DAMAGE TO THE CONNECTOR MAY RESULT.

- NAVIGATION UNITS SHOULD BE REMOVED FROM NAVIGATION EQUIPMENT RACK WHEN CHECKING SIGNAL FILTERS OR DAMAGE TO NU'S MAY RESULT.

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	CAUTION THE INU, DNC, AND C/DU ASSEMBLIES AND CIRCUIT CARDS CONTAIN STATIC SENSITIVE DEVICES, THEREFORE, OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONS DURING MAINTENANCE, STORING, AND SHIPPING AVOID TOUCHING DPX CONNECTOR PINS		
A W	WARN LIGHT COMES ON ON CDU		
	Either temporary or permanent out-of-tolerance condition is sensed by NU	1 Set mode selector 02 both MSU's to OFF 2 Restart checkout procedures 3 If WARN annunciator comes on, set data selector to DSRTK/STS on CDU 4 Note number displayed in second and third digits from left in right data display of CDU 5 Press TEST switch for approximately one second then release 6 Repeat steps 4 and 5 until second and third digits from left in right data display are either blank, or repeat display of 01,02,03,04, or 05 The numbers 01 through 05 are action codes Other numbers are malfunction codes 7 Perform step 6 three times 8. If no action codes or malfunction codes other than 46 are displayed after performing step 7,	

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		out-of-tolerance condition was only temporary and NU is now functioning properly 9 If any action codes or malfunction codes are displayed after performing step 7, note these codes 10 If action code 01 is noted, after performing step 9, NU is defective. 11 For malfunction code 47 check CADC Malfunction code 39 12 For malfunction code 48 NU is defective 13. For all other malfunction codes, perform steps 14 through 22	Replace faulty NU Locate and correct cooling air Replace faulty NU
	Navigation unit overheat problem (Models CP-1176A/A and CP-1176B/A only)		

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Page 3-32 Change 20



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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		14 Set mode selector to STBY then ALIGN on MSU of INS indicating a warning 15 Insert present position as follows a Set data selector to POS on CDU displaying action codes b Press N2 key on CDU keyboard if in northern hemisphere, or S8 key if in southern hemisphere until N or S appears in left data display <u>NOTE</u> All keys on CDU keyboard must be pressed for approximately one second so the computer can respond to the pressed key c. Key in aircraft present latitude, correct to 0 1 minute as shown in following example if latitude is 47 degrees 32 0 minutes, the following keys should be pressed in order shown 4,7,3,2,0	

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Page 3-33 Change 0



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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		d. If incorrect latitude was keyed in, press CLEAR and repeat steps b and c e If correct latitude was keyed in, press INSERT key f Press 6E key if in eastern hemisphere or W4 key if in western hemisphere g Key in aircraft present longitude, correct to 0 1 minute as shown in following example If longitude is 122 degrees 18 5 minutes, the following keys should be pressed in order shown 1, 2, 2, 1, 8, 5 h If incorrect longitude was keyed in, press CLEAR and repeat steps f and g i If correct longitude was keyed in, Press INSERT key 16. Set data selector to DSRTK/STS on CDU. 17 Repeat steps 5 and 6 18 Wait until 20 minutes after READY NAV light on MSU comes on, or until second digit from right in right data display indicates	

Inertial Navigation System - Trouble Shooting
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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		zero, and set mode selector on MSU to NAV until READY UAV Indicator goes out, then to STBY, and then to ALIGN <u>NOTE</u> If aircraft is buffeted by winds, cargo loading, or any other motion, the NU may never give a performance index of zero 19 Insert present position per step 16 <u>NOTE</u> Steps 17, 18, and 19 must be performed a total of three times Each time the NU will correct bias errors it has accumulated from use 20 Repeat steps 17, 18, 19, and 20 two more times 21 If any malfunction codes appear after performing steps 17, 18, 19, 20 and 21, NU is defective. 22 If no malfunction codes appear, NU is operating properly	Replace faulty NU
A 0 1	AUTOMATIC FAULT DISPLAY 0 1	APPEARS AS STATUS WORD ON SCI	
	Omega system not installed on aircraft		

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
A 0 2	AUTOMATIC FAULT DISPLAY 0 2 APPEARS AS STATUS WORD ON SCI Omega system not installed on aircraft		
A 0 3	AUTOMATIC FAULT DISPLAY 0 3 APPEARS AS STATUS WORD ON SCI Omega system not installed on aircraft		
A 0 4	AUTOMATIC FAULT DISPLAY 0 4 APPEARS AS STATUS WORD ON SCI Omega system not installed on aircraft		
A D	AUTOMATIC FAULT DISPLAY D APPEARS AS STATUS WORD ON SCI System not installed on aircraft		
A 1 1 OR A 1 2	AUTOMATIC FAULT DISPLAY I 1 OR I 2 APPEARS AS STATUS WORD ON SCI System not installed on aircraft		
F 1	D-MEM INDICATOR CAME ON AND STAYED ON DURING FLIGHT Doppler system not installed on aircraft		
F 2	UNABLE TO PERFORM INFLIGHT ALIGNMENT DURING FLIGHT No installed on aircraft		

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
F 3	UNABLE TO ENABLE PATTERN STEERING OR WAYPOINT STEERING DURING FLIGHT	Perform fast checkout	
F 4	EXCESSIVE DRIFT EXPERIENCED DURING FLIGHT		
	Defective NU	1 Turn on and initialize both INS's 2 Determine maximum allowable error of longitude display per table 102 3 One hour, 19 minutes after turning on and initializing both INS's check latitude displayed in left data display of each CDU If latitude has changed more than ± 3 minutes from latitude inserted in step 1, corresponding NU is defective 4 Check longitude displayed in right data display of CDU If longitude is not within tolerance found in table 102, corresponding NU is defective 5 Ensure that navigation equipment rack is proper mechanical alignment	Replace defective NU Replace defective NU
F 5	Mechanical misalignment of Navigation Equipment Rack		
	UNABLE TO PERFORM POSITION OR VELOCITY UPDATE DURING FLIGHT	Perform fast checkout per Table 503	

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
F 6	UNABLE TO SELECT DOPPLER LAND/SEA MODE DURING FLIGHT. Doppler system not installed on aircraft		
F 7	UNABLE TO INSERT WAYPOINT DATA DURING FLIGHT	Perform fast checkout per Table 503	
F 8	UNABLE TO PERFORM ANY DISPLAY REQUEST DURING FLIGHT	Perform fast checkout per Table 503	
F 9	UNABLE TO PERFORM DATA AND GMT UPDATE DURING FLIGHT	Perform fast checkout per Table 503	
F 10	UNABLE TO PERFORM PRESENT UPDATED DURING FLIGHT	- a Turn on and initialize both INS's - b Set each CDU data selector to DSRTK/STS - c Press HOLD key for one second then release - d Press 0 key until 0 appears in far right of right data display - e Press and release INSERT - f Press HOLD key for one second then release, (HOLD indicator goes off)	

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION														
		g Press HOLD key for one second then release (HOLD indicator comes on) h Press 5 key until 5 appears in far right of right data display i Press and release INSERT j Press HOLD key for one second then release (HOLD indicator goes off) 4. If procedure in step 3 was performed satisfactorily, system is operating properly If procedure was not performed satisfactorily, perform corrective action sists, equipment rack wiring	Interchange CDU's If fault follows CDU replace faulty CDU If fault persists, interchange NU's If fault follows NU, replace faulty NU If fault persists, check navigation														
F 11	EXCESSIVE TRACK ERROR EXPERIENCED DURING PATTERN STEERING IN FLIGHT																
	Aircraft limits exceeded	Check that minimum allowable radius for pattern steering was not exceeded as listed below															
		<table><tr><th>MAXIMUM GROUND SPEED* (KNOTS)</th><th>MIN ALLOWABLE PATTERN STEERING RADIUS (NAUTICAL MILES)</th></tr><tr><td>Less than 350</td><td>3 0</td></tr><tr><td>350 to 399</td><td>6 5</td></tr><tr><td>400 to 449</td><td>8 0</td></tr><tr><td>450 to 499</td><td>10 0</td></tr><tr><td>500 to 550</td><td>12 0</td></tr><tr><td>Greater than 550</td><td>15 0</td></tr></table>	MAXIMUM GROUND SPEED* (KNOTS)	MIN ALLOWABLE PATTERN STEERING RADIUS (NAUTICAL MILES)	Less than 350	3 0	350 to 399	6 5	400 to 449	8 0	450 to 499	10 0	500 to 550	12 0	Greater than 550	15 0	
MAXIMUM GROUND SPEED* (KNOTS)	MIN ALLOWABLE PATTERN STEERING RADIUS (NAUTICAL MILES)																
Less than 350	3 0																
350 to 399	6 5																
400 to 449	8 0																
450 to 499	10 0																
500 to 550	12 0																
Greater than 550	15 0																

Inertial Navigation System - Trouble Shooting

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		*TRUE AIRSPEED PLUS WIND If minimum radius for pattern steering was exceeded, as listed above, the fault was caused by operator action If minimum radius was not exceeded, perform complete checkout per Table 504 Complete Checkout	
	NO DISPLAY IN NO 1 CDU		
1	Defective BU	1 Check that BAT lamp on No. 1 MSU is on If BAT lamp is on, SU is faulty 2. If No 1 INS BAT lamp is not on, and MSU selector is set to any position other than OFF, check that both BU circuit breakers are closed If both circuit breakers are closed, interchange BU's 3 If fault does not follow BU, remove both BU's, close both BU circuit breakers and check for 24 (+) volts dc between pins 1 (+) and 8 (-) an pins 2 (+) and 7 (-) on each BU If voltage is not within tolerance for both measurements, BU is defective	Replace No. 1 BU If fault follows BU, replace BU Replace defective BU

Inertial Nagation System - Trouble Shooting
Table 101 (Sheet 10 of 19)

Ref T O 1E-3A-2-34-2



MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective CDU	4 If BU voltage is within tolerance, reinstall BU and interchange CDU's	If fault follows CDU, replace defective CDU
	Defective MSU	5 If fault does not follow CDU, interchange MSU's	If fault follows MSU, replace defective MSU
	Defective NU	6 If fault does not follow MSU, interchange NU's.	If fault follows NU, replace defective NU
	Defective aircraft wiring	7 If fault does not follow NU, set mode selector or both MSU's to OFF, remove power Check-out aircraft wiring	
2	CDU OR ASSOCIATED MSU INDICATORS FAIL TO COME ON		
	Defective lamp		Replace lamp
	Defective CDU or MSU	1. Interchange No 1 and No 2 units in which failure occurred	If fault follows unit, replace unit
	Defective NU	2 If fault persists, interchange No 1 and No 2 navigation units	If fault follows NU, replace NU
	Defective navigation equipment rack wiring	3 If fault persists, check navigation equipment rack wiring	
3	NO 1 CDU DATA DISPLAYS DO NOT DISPLAY ALL EIGHTS		
	Defective lamp	1 Interchange No. 1 and No 2 CDU data displays.	If fault follows data display, refer to panel relamping procedure

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 11 of 19)

Ref T O 1E-3A-2-34-2
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective CDU	2. If fault persists, interchange No 1 and No. 2 CDU's	If fault follows CDU, replace faulty CDU
	Defective NU.	3 If fault persists, interchange No 1 and No 2 CDU's 4 If fault persists, set mode selector or both MSU's to OFF, remove power Check-out aircraft wiring	If fault follows NU re- place faulty NU
4	NO CDU DIM CONTROL		
	Defective CDU		Replace CDU
5	SECOND AND THIRD DIGITS FROM LEFT IN CDU RIGHT DATA DISPLAY IS OTHER THAN BLANK OR 46		
	Defective NU		Perform isolation pro- cedure A W
6	NO DISPLAY IN NO 2 CDU		
	Defective BU	1 Check that BAT lamp on No 2 MSU is on If lamp is on, BU is faulty 2 If No 2 INS BAT lamp is not on, and MSU selector is set to any position other than OFF, check that BU circuit breakers are closed If both circuit breakers are closed, open both circuit breakers and interchange BU's Close both circuit breakers	Replace No 2 BU If fault follows BU, replace BU

Inertial Navigation System - Trouble Shooting
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Ref T O 1E-3A-2-34-2
Page 3-46 Change 16
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		3 If fault does not follow BU, open both BU circuit breakers, remove both BU's close both BU circuit breakers and check for 24 (± 5) volts dc between pins 1(+) and 8 (-) and pins 2 (+) and 7(-) on each BU If voltage is not within tolerance for both measurements, BU is defective.	Replace defective BU
	Defective CDU	4 If BU voltage is within tolerance, reinstall BU and interchange CDU's	If fault follows CDU, replace defective CDU
	Defective MSU	5 If fault does not follow CDU, interchange MSU's	If fault follows MSU, replace defective MSU
	Defective NU	6 If fault does not follow MSU, interchange NU's	If fault follows NU, defective Nu
	Defective aircraft wiring	7 If fault does not follow NU, set mode selector on both MSU's to OFF remove power	Check aircraft wiring
7	NO 2 CDU DATA DISPLAYS DO NOT DISPLAY ALL EIGHTS		
	Defective lamp.	1 Interchange No 1 and No 2 CDU data displays	If fault follows data display, refer to panel relamping procedures
	Defective CDU.	2 If fault persists, interchange No 1 and No. 2 CDU's	If fault follows CDU, replace faulty CDU

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 13 of 19)

Ref T O 1E-3A-2-34-2
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective NU	3 If fault persists, interchange No 1 and No. 2 NU's	If problem follows NU, replace faulty NU
	Defective signal	4 If fault persists, set mode selector on both MSU's to OFF, remove power	Check aircraft wiring
8	CDU DATA DISPLAY DO NOT GO BLANK		
	Defective MSU	Interchange No 1 and No 2 MSU's	If fault follows MSU, replace faulty MSU
	Defective NU	If fault persists, interchange No 1 and No 2 NU's	If fault follows NU, replace faulty NU If fault persists check navigation equipment rack wiring
9	SECOND DIGIT FROM RIGHT IN NO 1 CDU RIGHT DATA DISPLAY HAS NOT DECREASED BELOW 9		
	Defective CDU	1 Interchange No 1 and No 2 CDU's	If fault follows COU, replace faulty CDU
	Defective NU	2. If fault persists, interchange No 1 and No 2 NU's	If fault follows NU, re- place faulty NU
	Defective aircraft wiring	3 If fault persists, perform following steps a Set mode selector on both MSU's to OFF, remove power.	Check aircraft wiring

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 14 of 19)

Ref T O 1E-3A-2-34-2
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
10	SECOND DIGIT FROM RIGHT IN NO 2 CDU RIGHT DATA DISPLAY HAS NOT DECREASED BELOW 9		
	Defective CDU	1 Interchange No 1 and No 2 CDU's.	If fault follows CDU, replace faulty CDU
	Defective NU.	2. If fault persists, interchange No 1 and No 2 NU's	If fault follows NU, replace faulty NU
	Defective aircraft wiring	3 If fault persists, perform following steps a Set mode selector on both MSU's to OFF, remove power	Check aircraft wiring
11	SCI LEFT DATA REGISTER DOES NOT DISPLAY 94103		
	System not installed on aircraft		
12	SCI RIGHT REGISTER DOES NOT DISPLAY CORRECT MODIFICATION OR CORRECTION NUMBER		
	System not installed on aircraft.		
13	INDICATORS OTHER D-TOT ON SCI DO NOT COME ON PROPERLY		
	Equipment not installed on aircraft		
14	INSERT LIGHT ON CDU DOES NOT GO OUT		
	Temporary communication problem	1 Set data selectors on both MSU's to OFF 2. Restart checkout if both INSERT lights do not go out	If fault persists, check navigation equipment rack wiring
	Defective navigation equipment rack wiring		

Inertial Navigation System - Trouble Shooting
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective CDU Defective NU Defective navigation equipment rack wiring	3 If only one INSERT light does not go out, interchange CDU's.	If fault follows CDU, replace CDU If fault persists, interchange NU's If fault follows NU, replace NU If fault persists, check navigation equipment rack wiring
15	INCORRECT VALUES OF LATITUDE AND OR LONGITUDE ARE DISPLAYED Omega system not installed on aircraft		
16	INDICATORS ON SMC OR D-TOT INDICATOR ON SCI FAIL TO COME ON System not installed on aircraft		
17	D AND T NOT DISPLAYED IN SINGLE CHARACTER DATA INDICATORS Omega system not installed on aircraft		
18	EP/ET LIGHT ON DOES NOT GO OUT Omega system not installed on aircraft		
19	READY NAV INDICATOR FAILS TO COME ON		
	Defective MSU Defective CDU Defective NU	Interchange MSUs	If fault follows MSU, replace MSU If fault does not follow MSU, interchange CDU's If fault follows CDU, replace CDU If fault does not follow CDU, Interchange NUU's If fault follows NU, replace NU If fault persists, check navigation equipment rack cabling

Inertial Navigation System - Trouble Shooting

Table 101 (Sheet 16 of 19)

Ref T O 1E-3A-2-34-2



MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
20	Ω-SIG INDICATOR REMAINS ON LONGER THAN 11 MINUTES AFTER INITIAL TURN ON OR LONGER THAN 5 MINUTES AF MODE CHANGE TO OMEGA OPERATION Omega system not installed on aircraft		
21	READY NAV INDICATOR FAILS TO GO OUT		
	Defective MSU	Interchange MSU's	If fault follows MSU, replace MSU
	Defective NU	If fault persists, interchange NU's	If fault follows NU, replace NU
	Defective cabling in navigation equipment rack	If fault persists, check navigation equipment rack wiring	
22	INDICATOR ON SYSTEM MODE CONTROL FAILS TO COME ON System not installed on aircraft		
23	HSI GIVES IMPROPER INDICATIONS		
	Defective NU.		Replace defective NU If fault persists check navigation equipment rack cabling
24	CONTROL WHEELS DO NOT ROTATE PROPERLY		
	Radio altimeter on	Check RADIO ALTIMETER switch overhead panel P-13	Set RADIO ALTIMETER switch to OFF
	Defective NU.		Replace defective NU If fault persists, check navigation equipment rack cabling
25	BOTH DATA REGISTERS DO NOT INDICATE 000000 Omega system not installed on aircraft		

Inertial Navigation System - Trouble Shooting
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
26	DATA REGISTER DO NOT INDICATE 000000. System not installed on aircraft		
27	DATA REGISTERS DO NOT DISPLAY ZEROS DVS system not installed on aircraft		
28	LEFT DATA REGISTER DOES NOT DISPLAY 014000 System not installed on aircraft		
29	RIGHT DATA REGISTER NOT BLANK Omega system not installed on aircraft		
30	SCI DATA REGISTERS DISPLAY --- OR 9999 System not installed on aircraft		
31	INCORRECT DECIMAL AND DEGREE POSITION INDICATED IN CDU DATA DISPLAYS Defective CDU		Replace CDU
32	NO SMC DIM CONTROL System not installed on aircraft		
33	NO SCI DIM CONTROL System not installed on aircraft.		
34	INCORRECT DISPLAY IN CDU RIGHT DATA REGISTER Defective CDU Defective navigation equipment rack	1. Interchange No 1 and 2 CDU's 2 If fault did not follow CDU, interchange No 1 and No 2 NU's 3 If fault persists, check navigation equipment rack	If fault follows CDU, Replace CDU If fault follows NU, replace NU

Inertial Navigation System - Trouble Shooting
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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
35	SCI DOES NOT RESPOND TO SWITCH-INDICATOR ACTION System not installed on aircraft		
36	INCORRECT DATA DISPLAYED ON SCI Omega system not installed on aircraft		
37	CDU DOES NOT RESPOND TO SWITCH ACTION		
	Defective CDU	1 Interchange CDU's	If fault follows CDU, replace CDU
	Defective NU	2 If fault persists, interchange NU's	If fault follows NU, replace NU
	Defective navigation equipment rack wiring	3 If fault persists, check navigation equipment rack wiring.	
38	SMC DOES NOT RESPOND TO SWITCH ACTION Omega system not installed on aircraft		
39	SCI DISPLAY UNRECOGNIZABLE SYMBOLS. Omega system not installed on aircraft		
40	POOR PERFORMANCE-INDEX/OMEGA MICFIRES, DEFECTIVE NU. Omega system not installed on aircraft		

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 19 of 19)
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BOEING
MAINTENANCE MANUAL

AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE
0°00 0 - 14°35.5	0°03 0	62°57.9 - 63°23 9	0°06.6	72°43.2 - 72°53.6	0°10 1
14°35.6 - 20°21.7	0°03.1	63°24.0 - 63°49.2	0°06.7	72°53.7 - 73°03.9	0°10 2
20°21.8 - 24°37 1	0°03.2	63°49 3 - 64°13.6	0°06 8	73°04 0 - 73°13.9	0°10 3
24°37.2 - 28°04.2	0°03 3	64°13.7 - 64°37.3	0°06 9	73°14.0 - 73°23.8	0°10 4
28°04 3 - 31°00.1	0°03 4	64°37.4 - 65°00 2	0°07 0	73°23.9 - 73°33 5	0°10 5
31°00.2 - 33°33.3	0°03 5				
		65°00.3 - 65°22 4	0°07 1	73°33.6 - 73°42.9	0°10 6
33°33 4 - 35°49 4	0°03 6	65°22 5 - 65°44 0	0°07 2	73°43 0 - 73°52.2	0°10 7
35°49 5 - 37°51.7	0°03 7	65°44.1 - 66°04.9	0°07.3	73°52.3 - 74°01.4	0°10 8
37°51.8 - 39°42.8	0°03 8	66°05.0 - 66°25 2	0°07 4	74°01 5 - 74°10.3	0°10 9
39°42 9 - 41°24.5	0°03.9	66°25 3 - 66°44.9	0°07 5	74°10 4 - 74°19 1	0°11 0
41°24.6 - 42°58 1	0°04.0				
		66°45 0 - 67°04 1	0°07 6	74°19.2 - 74°27 7	0°11.1
42°58 2 - 44°24.8	0°04 1	67°04.2 - 67°22.7	0°07.7	74°27.8 - 74°36.1	0°11 2
44°24 9 - 45°45.5	0°04 2	67°22 8 - 67°40.8	0°07 8	74°36 2 - 74°44.4	0°11 3
45°45.6 - 47°00.7	0°04.3	67°40 9 - 67°58 4	0°07 9	74°44.5 - 74°52 6	0°11 4
47°00 8 - 48°11 3	0°04 4	67°58.5 - 68°15 6	0°08 0	74°52.7 - 75°00.6	0°11 5
48°11 4 - 49°17.6	0°04 5				
		68°15.7 - 68°32.3	0°08.1	75°00.7 - 75°08.5	0°11.6
49°17.7 - 50°20 0	0°04.6	68°32 4 - 68°48 6	0°08 2	75°08.6 - 75°16.2	0°11 7
50°20.1 - 51°19.0	0°04.7	68°48.7 - 69°04 4	0°08.3	75°16.3 - 75°23 8	0°11.8
51°19 1 - 52°14 8	0°04 8	69°04.5 - 69°19.9	0°08.4	75°23.9 - 75°31.2	0°11.9
52°14.9 - 53°07.7	0°04 9	69°20.0 - 69°34 9	0°08.5	75°31.3 - 75°38.7	0°12.0
53°07.8 - 53°58 0	0°05 0				
		69°35 0 - 69°49 6	0°08 6	75°38 7 - 75°45 8	0°12 1
53°58.1 - 54°45.8	0°05.1	69°49.7 - 70°04.0	0°08.7	75°45.9 - 75°52.9	0°12.2
54°45.9 - 55°31.4	0°05.2	70°04.1 - 70°18 0	0°08.8	75°53.0 - 75°59.9	0°12.3
55°31.5 - 56°15.0	0°05.3	70°18.1 - 70°31.6	0°08.9	76°00.0 - 76°06.7	0°12 4
56°15.1 - 56°56.6	0°05 4	70°31.7 - 70°45.0	0°09.0	76°06.8 - 76°13.5	0°12 5
56°56 7 - 57°36.4	0°05.5				
		70°45.1 - 70°58.0	0°09.1	76°13.6 - 76°20.1	0°12.6
57°36.5 - 58°14.5	0°05.6	70°58 1 - 71°10.8	0°09.2	76°20.2 - 76°26.6	0°12.7
58°14.6 - 58°51.1	0°05.7	71°10.9 - 71°23.2	0°09.3	76°26.7 - 76°33.0	0°12 8
58°51.2 - 59°26.2	0°05.8	71°23.3 - 71°35.4	0°09 4	76°33.1 - 76°39.4	0°12 9
59°26 3 - 59°59.9	0°05.9	71°35.5 - 71°47.3	0°09 5	76°39 5 - 76°45.6	0°13 0
60°00.0 - 60°32.3	0°06.0				
		71°47.4 - 71°59.0	0°09.6	76°45.7 - 76°51.7	0°13 1
60°32 4 - 61°03.6	0°06.1	71°59.1 - 72°10.4	0°09 7	76°51.8 - 76°57.6	0°13 2
61°03.7 - 61°33.7	0°06.2	72°10.5 - 72°21.5	0°09 8	76°57.8 - 77°03.7	0°13 3
61°33.8 - 62°02.7	0°06.3	72°21.6 - 72°32.4	0°09.9	77°03.8 - 77°09.5	0°13 4
62°02.8 - 62°30.7	0°06.4	72°32.5 - 72°43.1	0°10.0	77°09.6 - 77°15.3	0°13.5
62°30.8 - 62°57.8	0°06 5				

Inertial Navigation System - Longitude Drift Tolerances
Table 102 (Sheet 1 of 3)

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MAINTENANCE MANUAL

AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE
77° 15 4 - 77° 21.0	0° 13 6	79° 53 7 - 79° 57.2	0° 17 1	81° 37 6 - 81° 39 9	0° 20 6
77° 21 1 - 77° 26.5	0° 13.7	79° 57.3 - 80° 00 7	0° 17.2	81° 40 0 - 81° 42 3	0° 20 7
77° 26 6 - 77° 32.1	0° 13 8	80° 00.8 - 80° 04 2	0° 17 3	81° 42 4 - 81° 44 7	0° 20 8
77° 32 2 - 77° 37.5	0° 13 9	80° 04 3 - 80° 07 6	0° 17 4	81° 44 8 - 81° 47 1	0° 20 9
77° 37 6 - 77° 42 8	0° 14 0	80° 07 7 - 80° 11.0	0° 17 5	81° 47.2 - 81° 49 5	0° 21 0
77° 42 9 - 77° 48 1	0° 14 1	80° 11 1 - 80° 14 4	0° 17.6	81° 49 6 - 81° 51 8	0° 21 1
77° 48 2 - 77° 53.3	0° 14 2	80° 14 5 - 80° 17.7	0° 17.7	81° 51 9 - 81° 54 1	0° 21.2
77° 53 4 - 77° 58.4	0° 14 3	80° 17 8 - 80° 21 0	0° 17 8	81° 54 2 - 81° 56 4	0° 21.3
78° 58 5 - 78° 03 5	0° 14 4	80° 21 1 - 80° 24 3	0° 17 9	81° 56.5 - 81° 58 6	0° 21 4
78° 03.6 - 78° 08 4	0° 14.5	80° 24.4 - 80° 27 5	0° 18.0	81° 58.7 - 82° 00 9	0° 21 5
78° 08 5 - 78° 13.4	0° 14 6	80° 27.6 - 80° 30 6	0° 18 1	82° 01 0 - 82° 03 1	0° 21.6
78° 13.5 - 78° 18.2	0° 14.7	80° 30 7 - 80° 33.8	0° 18 2	82° 03.2 - 82° 05 3	0° 21 7
78° 18.3 - 78° 23.0	0° 14 8	80° 33 9 - 80° 37.0	0° 18.3	82° 05.4 - 82° 07 5	0° 21 8
78° 23 1 - 78° 27.7	0° 14 9	80° 37 0 - 80° 40 0	0° 18 4	82° 07 6 - 82° 09 7	0° 21 9
78° 27 8 - 78° 32 3	0° 15.0	80° 40 1 - 80° 43 0	0° 18 5	82° 09 8 - 82° 11 8	0° 22 0
78° 32 4 - 78° 36 9	0° 15 1	80° 43 1 - 80° 46.0	0° 18 6	82° 11 9 - 82° 13 9	0° 22 1
78° 37 0 - 78° 41.4	0° 15 2	80° 46 1 - 80° 49.0	0° 18.7	82° 14.0 - 82° 16 0	0° 22 2
78° 41 5 - 78° 45 9	0° 15 3	80° 49.1 - 80° 51 9	0° 18 8	82° 16.1 - 82° 18 2	0° 22 3
78° 46.0 - 78° 50 3	0° 15.4	80° 52 0 - 80° 54 8	0° 18 9	82° 18.2 - 82° 20 2	0° 22.4
78° 50 4 - 78° 54 7	0° 15 5	80° 54 9 - 80° 57.7	0° 19.0	82° 20 3 - 82° 22 2	0° 22 5
78° 54 8 - 78° 58.9	0° 15.6	80° 57.8 - 81° 00 5	0° 19 1	82° 22 3 - 82° 24 2	0° 22 6
78° 59 0 - 79° 03 2	0° 15 7	81° 00.6 - 81° 03 4	0° 19 2	82° 24.3 - 82° 26 2	0° 22 7
79° 03.3 - 79° 07.4	0° 15 8	81° 03.5 - 81° 06.1	0° 19 3	82° 26.3 - 82° 28 2	0° 22 8
79° 07.5 - 79° 11 5	0° 15.9	81° 06 2 - 81° 08.9	0° 19.4	82° 28 3 - 82° 30 2	0° 22 9
79° 11.6 - 79° 15.6	0° 16.0	81° 09.0 - 81° 11.6	0° 19.5	82° 30.3 - 82° 32 2	0° 23.0
79° 15.7 - 79° 19.6	0° 16.1	81° 11.7 - 81° 14.3	0° 19 6	82° 32.3 - 82° 34.1	0° 23 1
79° 19.7 - 79° 23.6	0° 16.2	81° 14.4 - 81° 17.0	0° 19.7	82° 34.2 - 82° 36 0	0° 23 2
79° 23.7 - 79° 27 5	0° 16.3	81° 17.1 - 81° 19.7	0° 19.8	82° 36 1 - 82° 37.9	0° 23.3
79° 27.6 - 79° 31.4	0° 16.4	81° 19.8 - 81° 22.3	0° 19.9	82° 38 0 - 82° 39 8	0° 23.4
79° 31.5 - 79° 35.2	0° 16.5	81° 22.4 - 81° 24.9	0° 20 0	82° 39.9 - 82° 41 7	0° 23.5
79° 35.3 - 79° 39 0	0° 16.6	81° 25.0 - 81° 27.4	0° 20.1	82° 41.8 - 82° 43 6	0° 23 6
79° 39.1 - 79° 42.7	0° 16.7	81° 27.5 - 81° 30.0	0° 20.2	82° 43.7 - 82° 45 4	0° 23 7
79° 42.8 - 79° 46.4	0° 16.8	81° 30.1 - 81° 32.5	0° 20.3	82° 45.5 - 82° 47.2	0° 23.8
79° 46.5 - 79° 50.0	0° 16.9	81° 32.6 - 81° 35.0	0° 20.4	82° 47.3 - 82° 49.1	0° 23 9
79° 50.1 - 79° 53 6	0° 17.0	81° 35.1 - 81° 37.5	0° 20.5	82° 49 2 - 82° 50.9	0° 24 0

Inertial Navigation System - Longitude Drift Tolerances
Table 102 (Sheet 1 of 3)

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AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE
82° 51 0 - 82° 52.6	0° 24 1	83° 45 6 - 83° 46 8	0° 27 6
82° 52 7 - 82° 54.4	0° 24 2	83° 46 9 - 83° 48 2	0° 27 7
82° 54 5 - 82° 56.2	0° 24.3	83° 48 3 - 83° 49 5	0° 27 8
82° 56 3 - 82° 57.9	0° 24.4	83° 49 6 - 83° 50 9	0° 27 9
82° 58 0 - 82° 59.6	0° 24 5	83° 51.0 - 83° 52 2	0° 29.0
82° 59 7 - 83° 01 3	0° 24 6	83° 52 3 - 83° 53 5	0° 28 1
83° 01 4 - 83° 03 0	0° 24.7	83° 53 6 - 83° 54 8	0° 28 2
83° 03 1 - 83° 04 7	0° 24 8	83° 54 9 - 83° 56 1	0° 28 3
83° 04 8 - 83° 06 4	0° 24 9	83° 56.2 - 83° 57.4	0° 28 4
83° 06 5 - 83° 08 0	0° 25 0	83° 57.5 - 83° 58 6	0° 28 5
83° 08 1 - 83° 09 7	0° 25 1	83° 58 7 - 83° 59.9	0° 28 6
83° 09 8 - 83° 11 3	0° 25.2	84° 00 0	0° 28 7
83° 11 4 - 83° 12 9	0° 25.3	<u>NOTE</u> : No useful drift data can be ob- tained for latitudes greater than 84 degrees	
83° 13 0 - 83° 14 5	0° 25 4		
83° 14 6 - 83° 16.1	0° 25 5		
83° 16 2 - 83° 17.7	0° 25 6		
83° 17.8 - 83° 19 3	0° 25 7		
83° 19.4 - 83° 20.8	0° 25 8		
83° 20.9 - 83° 22 4	0° 25 9		
83° 22 5 - 83° 23 9	0° 26.0		
83° 24.0 - 83° 25 4	0° 26 1		
83° 25.5 - 83° 26 9	0° 26 2		
83° 27.0 - 83° 28.4	0° 26 3		
83° 28 5 - 83° 29 9	0° 26 4		
83° 30.0 - 83° 31.4	0° 26 5		
83° 31.5 - 83° 32.8	0° 26.6		
83° 32.9 - 83° 34.3	0° 26 7		
83° 34.4 - 83° 35.7	0° 26 8		
83° 35.8 - 83° 37.1	0° 26.9		
83° 37.2 - 83° 38.6	0° 27 0		
83° 38.7 - 83° 40.0	0° 27.1		
83° 40 1 - 83° 41.4	0° 27.2		
83° 41.5 - 83° 42.7	0° 27.3		
83° 42 8 - 83° 44.1	0° 27.4		
83° 44.2 - 83° 45.5	0° 27.5		

Inertial Navigation System - Longitude Drift Tolerances
Table 102 (Sheet 1 of 3)

Ref T O 1E-3A-2-34-2

Page 3-73 Change 0

Page 3-74 Change 0

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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
2	CDU OR ASSOCIATED MSU INDICATORS FAIL TO COME ON		
	Defective lamp		Replace lamp
	Defective CDU or MSU	1 Interchange No 1 and No 2 units in which failure occurred	If fault follows unit, replace unit
	Defective NU	2 If fault persists, interchange No 1 and No 2 navigation units	If fault follows NU, replace NU
3	Defective navigation equipment rack wiring	3 If fault persists, check navigation equipment rack wiring	
	NO 1 CDU DATA DISPLAYS DO NOT DISPLAY ALL EIGHTS		
	Defective lamp	1 Interchange No 1 and No 2 CDU data displays	If fault follows data display, refer to panel relamping procedure
	Defective CDU	2 If fault persists, interchange No 1 and No 2 CDU's	If fault follows CDU, replace faulty CDU
	Defective NU	3 If fault persists, interchange No 1 and No 2 CDU's	If fault follows NU, replace faulty NU
	Defective signal filter	4 If fault persists, set mode selector on SMC and both MSU's to OFF, remove power from NCS by opening NAVIGATION circuit breakers on P6 panel, open E-14 rack and open both NU circuit breakers, remove both BU's and NU's and disconnect cable connector from J13 connector on navigation equipment rack	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 22 of 60)

Ref T O 1E-3A-2-34-2
Page 3-46 Change 16
Page 3-47 Change 15

BOEING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		5 Check for continuity between pins in J13 connector and solder terminals on the M952 filter assembly and isolation between solder terminals on M952 filter assembly and chassis ground. If a suspect measurement is made, disconnect the wire soldered to the filter terminal and repeat the check in order to isolate the problem to the filter or to cabinet wiring. Proceed as follows: - a Remove 22 screws and top access cover from navigation equipment rack - b Make continuity measurements - c Make isolation measurements d. Replace indicated filter if no continuity is measured between pins and solder terminals or no isolation is measured between solder terminals and chassis ground <u>NOTE</u> Continuity is defined as a resistance of 2 ohms or less. Isolation is defined as 100 thousand ohms or more.	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 23 of 60)

Ref . T O 1E-3A-2-34-2
Page 3-47 Change 15

BOEING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION																								
		CONTINUITY <table><tr><td style="text-align: center;"><u>FROM</u></td><td style="text-align: center;"><u>TO</u></td><td></td></tr><tr><td>J13-H</td><td>026</td><td>Filter at 026 terminal</td></tr><tr><td>J13-A</td><td>001</td><td>Filter at 001 terminal</td></tr><tr><td>J13-B</td><td>008</td><td>Filter at 008 terminal</td></tr><tr><td>J13-A*</td><td>005</td><td>Filter at 005 terminal</td></tr><tr><td>J13-K*</td><td>012</td><td>Filter at 012 terminal</td></tr><tr><td>J13-M*</td><td>006</td><td>Filter at 006 terminal</td></tr><tr><td>J13-T*</td><td>013</td><td>Filter at 013 terminal</td></tr></table> <u>NOTE</u> A letter followed by an * indicates a lower case letter 6 If continuity was measured between pins and terminals listed above and no solder terminals were shorted to chassis ground, secure top access cover navigation equipment rack and continue with step 7 7 If fault persists, check navigation equipment rack cabling	<u>FROM</u>	<u>TO</u>		J13-H	026	Filter at 026 terminal	J13-A	001	Filter at 001 terminal	J13-B	008	Filter at 008 terminal	J13-A*	005	Filter at 005 terminal	J13-K*	012	Filter at 012 terminal	J13-M*	006	Filter at 006 terminal	J13-T*	013	Filter at 013 terminal	If no continuity or no isolation to chassis ground, replace
<u>FROM</u>	<u>TO</u>																										
J13-H	026	Filter at 026 terminal																									
J13-A	001	Filter at 001 terminal																									
J13-B	008	Filter at 008 terminal																									
J13-A*	005	Filter at 005 terminal																									
J13-K*	012	Filter at 012 terminal																									
J13-M*	006	Filter at 006 terminal																									
J13-T*	013	Filter at 013 terminal																									
	Defective wiring in navigation equipment rack																										
4	NO CDU DIM CONTROL																										
	Defective CDU		Replace CDU																								
5	SECOND AND THIRD DIGITS FROM LEFT IN CDU RIGHT DATA DISPLAY IS OTHER THAN BLANK OR 46																										
	Defective NU		Perform isolation procedure A W																								

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 24 of 60)

Ref T O 1E-3A-2-34-2
Page 3-48 Change 16

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
6	NO DISPLAY IN NO 2 CDU		
	Defective BU	1 Check that BAT lamp on No 2 MSU is on If lamp is on, BU is faulty 2 If No. 2 INS BAT lamp is not on, and MSU selector is set to any position other than OFF, check that BU circuit breakers are closed. If both circuit breakers are closed, open both circuit breakers and interchange BU's. Close both circuit breakers.	Replace No 2 BU If fault follows BU, replace BU.
		3 If fault does not follow BU, open both BU circuit breakers, remove both BU's, close both BU circuit breakers and check for 24 (± 5) volts dc between pins 1(+) and 8(-) and pins 2(+) and 7(-) on each BU. If voltage is not within tolerance for both measurements, BU is defective.	Replace defective BU
	Defective CDU.	4. If BU voltage is within tolerance, reinstall BU and interchange CDU's	If fault follows CDU, replace defective CDU
	Defective MSU	5 If fault does not follow CDU, interchange MSU's	If fault follows MSU, replace defective MSU

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 25 of 60)

Ref . T O. 1E-3A-2-34-2
 Page 3-48 Change 16
 Page 3-49 Change 16

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective NU	6 If fault does not follow NMSU, interchange NU's	If fault follows NU, defective NU
	Defective aircraft wiring	7 If fault does not follow NU, set mode selector on SMC and both MSU's to OFF, remove power from NCS by opening NAVIGATION circuit breakers on P6 panel and disconnect cable connector from J2 connector on navigation equipment rack	
		<u>WARNING</u> VOLTAGES BEING MEASURED ARE HAZARDOUS TO PERSONNEL 8 Apply power by closing NAVIGATION-INS-NO 2 and No 2 HTR circuit breakers on P6 panel and check for 113(±11) vac between following pins in cable connector removed from J2 A and B B and C C and D A and D M and N 9 If any voltage is not present, check aircraft wiring	
	Defective power filter	10 If 113(±11) vac was measured between all pins listed above, remove power by open-	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 26 of 60)

Ref T O 1E-3A-2-34-2
 Page 3-49 Change 16
 Page 3-50 Change 16

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION								
		ing circuit breakers which were closed in step 8 Check for continuity between pins on J2 connector and solder terminals on M954 filter assembly as follows a.Open rear access door on navigation equipment rack b Open both BU circuit breakers c Remove both NU's d.Replace indicated component if no continuity is measured <u>NOTE</u> Continuity is defined as a resistance of 2 ohms or less <u>CONTINUITY</u> <table><tr><td>FROM</td><td>TO</td></tr><tr><td>J2-A</td><td>C7</td></tr><tr><td>J2-B</td><td>C8</td></tr><tr><td>J2-M</td><td>C9</td></tr></table>	FROM	TO	J2-A	C7	J2-B	C8	J2-M	C9	If no continuity, replace Inductor between capacitor at C7 terminal and J2-A Inductor between capacitor at C8 terminal and J2-B Inductor between capacitor at C9 terminal and J2-M
FROM	TO										
J2-A	C7										
J2-B	C8										
J2-M	C9										

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 27 of 60)

Ref T O 1E-3A-2-34-*2
 Page 3-50 Change 16
 Page 3-50A Change 12

BOEING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		J2-N C10	Inductor between capaci- tor at C10 terminal and J2-N
		11 If continuity was measured between pins and terminals listed above, check for con- tinuity between J2-A and J2-B. If continui- ty was measured bet- ween J2-A and J2-B, capacitor at C7 termi- nal is shorted	Replace capacitor at C7 terminal
		12 Check for continuity between J2-M and J2-N. If continuity was measured between J2-M and J2-N, capacitor at C9 terminal is shorted	Replace capacitor at C9 terminal
		13 If no continuity was measured between J2-A and J2-B, or J2-M and J2-N, reconnect cable connector to J2 con- nector on navigation equipment rack	
	Defective signal filter	14 Disconnect cable connector from J1 connector on naviga- tion equipment rack and check for contin- uity between pins in J1 connector and sol- der terminals on M953 filter assembly and isolation between solder terminals on M953 filter assembly and chassis ground	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 28 of 60)

Ref T O 1E-3A-2-34-2
Page 3-50A Change 12
Page 3-51 Change 15

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		If a suspect measurement is made, disconnect the wire soldered to the filter terminal and repeat the check in order to isolate the problem to the filter or to cabinet wiring Proceed as follows a Remove 22 screws and top access cover from navigation equipment rack b Make continuity measurements c Make isolation measurements d Replace indicated filter if no continuity is measured between pins and solder terminals or no isolation is measured between solder terminals and chassis ground <u>NOTE</u> Continuity is defined as a resistance of 2 ohms or less Isolation is defined as 100 thousand ohms or more	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 29 of 60)

Ref T O. 1E-3A-2-34-2
Page 3-51 Change 15

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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		CONTINUITY	If no continuity or no isolation to chassis ground, replace
		FROM TO	
		J1-K 260	Filter at 260 terminal
		J1-L 253	Filter at 253 terminal
		J1-M 261	Filter at 261 terminal
		J1-N 262	Filter at 262 terminal
		J1-P 263	Filter at 263 terminal
		J1-R 254	Filter at 254 terminal
		J1-S 255	Filter at 255 terminal
		J1-T 256	Filter at 256 terminal
		J1-A 274	Filter at 274 terminal
		J1-B 267	Filter at 267 terminal
		J1-C 275	Filter at 275 terminal
		J1-D 268	Filter at 268 terminal
		J1-E 276	Filter at 276 terminal
		J1-J 264	Filter at 264 terminal
		J1-J 265	Filter at 265 terminal
		J1-V 266	Filter at 266 terminal
		J1-X 269	Filter at 269 terminal
		J1-Y 277	Filter at 277 terminal
		J1-Z 270	Filter at 270 terminal
		J1-A* 278	Filter at 278 terminal
		J1-C* 249	Filter at 249 terminal
		J1-D* 258	Filter at 258 terminal
		J1-E* 250	Filter at 250 terminal
		J1-F* 259	Filter at 246 terminal
		J1-G* 246	Filter at 246 terminal
		J1-H* 247	Filter at 247 terminal
		J1-I* 248	Filter at 248 terminal
		J1-R* 271	Filter at 271 terminal
		J1-M* 279	Filter at 279 terminal
		J1-T* 272	Filter at 272 terminal
		NOTE A letter followed by an * indicates a lower case letter	
		15 If continuity was measured between pins and terminals listed above and no solder terminals were short-	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 30 of 60)

Ref T O 1E-3A-2-34-2
Page 3-51 Change 15
Page 3-52 Change 15

BORING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective wiring in navigation equipment rack	ed to chassis ground, reconnect cable connector to J1 connector on navigation equipment rack, reinstall navigation units, close circuit breakers on both BU's and secure top access cover and rear access door on navigation equipment rack 16 If fault persists, check navigation equipment rack cabling	
7	NO 2 CDU DATA DISPLAYS DO NOT DISPLAY ALL EIGHTS		
	Defective lamp	1 Interchange No 1 and No 2 CDU data displays	If fault follows data display, refer to panel relamping procedures
	Defective CDU	2 If fault persists, interchange No 1 and No 2 CDU's	If fault follows CDU, replace faulty CDU
	Defective NU	3 If fault persists, interchange No 1 and No 2 NU's	If problem follows NU, replace faulty NU
	Defective signal	4 If fault persists, set mode selector on SMC and both MSU's to OFF, remove power from NCS by opening NAVIGATION circuit breakers on P6 panel, disconnect cable connector from J1 connector on navigation equipment rack, open both BU circuit breakers, and remove both BU's and NU's	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 31 of 60)

Ref T O 1E-3A-2-34-2
Page 3-52 Change 15
Page 3-53 Change 15

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		5 Check for continuity between pins in J1 connector and solder terminals on M953 filter assembly and isolation between solder terminals on M953 filter assembly and chassis ground If a suspect measurement is made, disconnect the wire soldered to the filter terminal and repeat the check so as to isolate the problem to the filter or to cabinet wiring Proceed as follows a Remove 22 screws and top access cover from navigation equipment rack b Make continuity and isolation measurements c Make isolation measurements d Replace indicated filter if no continuity is measured between pins and solder terminals or no isolation is measured between solder terminals and chassis ground <u>NOTE</u> Continuity is defined as a resistance of 2 ohms or less Isolation	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 32 of 60)

Ref T O 1E-3A-2-34-2
Page 3-53 Change 15

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 MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		is defined as 100 thousand ohms or less.	
		CONTINUITY	If no continuity or no isolation to chassis ground, replace
		FROM TO	
		J1-H 257	Filter at 257 terminal
		J1-A 274	Filter at 274 terminal
		J1-B 267	Filter at 267 terminal
		J1-A* 278	Filter at 278 terminal
		J1-K* 271	Filter at 271 terminal
		J1-M* 279	Filter at 279 terminal
		J1-T* 272	Filter at 272 terminal
		NOTE: A letter followed by an * indicates a lower case letter	
		6 If continuity was measured between pins and terminals listed above and no solder terminals were shorted to chassis ground, reconnect cable connector to J1 connector in navigation equipment rack, reinstall BU's and NU's and secure top access cover and rear access door on navigation equipment rack	
	Defective wiring in navigation equipment rack	7 If problem persists, check navigation equipment rack cabling	
8	CDU DATA DISPLAYS DO NOT GO BLANK.		
	Defective MSU	Interchange No. 1 and No. 2 MSU's	If fault follows MSU, replace faulty MSU

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Table 101 (Sheet 33 of 60)

Ref • T O 1E-3A-2-34-2
Page 3-54 Change 15

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective NU	If fault persists, interchange No 1 and No 2 NU's	If fault follows NU, replace faulty NU If fault persists check navigation equipment rack wiring
9	SECOND DIGIT FROM RIGHT IN NO. 1 CDU RIGHT DATA DISPLAY HAS NOT DECREASED BELOW 9		
	Defective CDU	1 Interchange No 1 and No 2 CDU's	If fault follows CDU, replace faulty CDU
	Defective NU	2 If fault persists, interchange No 1 and No 2 NU's	If fault follows NU, replace faulty NU
	Defective aircraft wiring	3 If fault persists, perform following steps a Set mode selector on SMC and both MSU's to OFF, remove power from NCS by opening circuit breakers on P6 panel, and disconnect cable connector from J14 connector on navigation equipment rack <u>WARNING</u> VOLTAGES BEING MEASURED ARE HAZARDOUS TO PERSONNEL b Apply power to NCS and check for 113 (± 11) vac between pins E and F of cable connector. If no voltage is indicated, check aircraft wiring	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 34 of 60)

Ref T O 1E-3A-2-34-2
Pages 3-54 and 3-54A Change 15
Page 3-55 Change 16

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION						
	Defective power filter.	c If 113(±11) vac was measured between pins E and F, remove power from NCS and check for continuity between pins in J14 connector and solder terminals on M951 filter assembly as follows Open rear access door on navigation equipment rack Replace indicated component if no continuity is measured <u>NOTE</u> Continuity is defined as a resistance of one ohm or less <u>CONTINUITY</u> <table><tr><td>FROM</td><td>TO</td></tr><tr><td>J14-E</td><td>C3</td></tr><tr><td>J14-F</td><td>C4</td></tr></table> d If continuity was measured between pins and terminals listed above, check for continuity between J14-E and J14-F If continuity was measured	FROM	TO	J14-E	C3	J14-F	C4	If no continuity, replace Inductor between capacitor at C3 terminal and J14-E Inductor between capacitor at C4 terminal and J14-F
FROM	TO								
J14-E	C3								
J14-F	C4								

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 35 of 60)

Ref T O. 1E-3A-2-34-2
Page 3-55 Change 16

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		between J14-E and J14-F, capacitor at C7 terminal is shorted	Replace capacitor at C7 terminal
		e If no continuity was measured between J14-E and J14-F, reconnect cable connector to J14 connector on navigation equipment rack and secure rear access door	
	Defective wiring in navigation equipment rack	f If fault persists, check navigation equipment rack cabling	
10	SECOND DIGIT FROM RIGHT IN NO 2 CDU RIGHT DATA DISPLAY HAS NOT DECREASED BELOW 9		
	Defective CDU	1 Interchange No 1 and No 2 CDU's	If fault follows CDU, replace faulty CDU
	Defective NU	2 If fault persists, interchange No 1 and No 2 NU's	If fault follows NU, replace faulty NU
	Defective aircraft wiring	3 If fault persists, perform following steps a Set mode selector on SMC and both MSU's to OFF, remove power from NCS by opening circuit breakers on P6 panel, and disconnect cable connector from J2 connector on navigation equipment rack	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 36 of 60)

Ref T O 1E-3A-2-34-2
Page 3-55 Change 16
Page 3-56 Change 16

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION				
	Defective power filter	<u>WARNING.</u> VOLTAGES BEING MEASURED ARE HAZARDOUS TO PERSONNEL b Apply power to NCS and check for 113 (±11) vac between pins M and N of cable connector. If no voltage is indicated, check aircraft wiring c.If 113(±11) vac was measured between pins M and N, remove power from NCS and check for continuity between pins in J2 connector and solder terminals on M954 filter assembly as follows. Open rear access door on navigation equipment rack Replace the indicated component if no continuity is measured <u>NOTE</u> Continuity is defined as a resistance of 2 ohms or less CONTINUITY <table><tr><td><u>FROM</u></td><td><u>TO</u></td></tr><tr><td>J2-M</td><td>C9</td></tr></table>	<u>FROM</u>	<u>TO</u>	J2-M	C9	If no continuity, replace Inductor between capacitor at C9 terminal and J2-M
<u>FROM</u>	<u>TO</u>						
J2-M	C9						

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 37 of 60)

Ref T O 1E-3A-2-34-2
 Page 3-56 Change 16
 Page 3-57 Change 23

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MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		J2-N C10 d If continuity was measured between pins and terminals listed above, check for continuity between J2-M and J2-N. If continuity was measured between J2-M and J2-N, capacitor at C9 terminal is shorted. e If no continuity was measured between J2-M and J2-N, reconnect cable connector to J2 receptacle on navigation equipment rack and secure rear access door. f. If fault persists, check navigation equipment rack cabling.	Inductor between capacitor at C10 terminal and J2-N. Replace capacitor at C9 terminal.
11	Defective wiring in navigation equipment rack		
		<u>NOTE</u> When the SMC is set to any position from the OFF position, the SCI may indicate an automatic fault display immediately. 1 If no automatic fault display occurs, but an incorrect program part number, modify-	
	Incorrect omega computer program		Reload omega computer program. If fault persists, check navigation equipment.

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 38 of 60)

Ref T.O 1E-3A-2-34-2
Page 3-57 Change 23

BOEING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective wiring in navigation equipment rack, Defective omega computer	cation number, or correction number is displayed 2 If an automatic fault occurs, refer to reference index in this table which has an "A" followed by the status word indicated by the two single character data indicators on the SCI	rack wiring If fault persists, replace omega receiver-computer
12	SCI RIGHT DATA REGISTER DOES NOT DISPLAY CORRECT MODIFICATION OR CORRECTION NUMBER		
	Incorrect omega computer program Defective wiring in navigation equipment rack Defective omega computer	<u>NOTE</u> When the SMC is set to any posi- tion from the OFF position, the SCI may indicate an automatic fault display immedi- ately 1 If no automatic fault display occurs, but an incorrect program part number, modifi- cation number, or correction number is displayed 2. If an automatic fault occurs, refer to re- ference index in this table which has an "A" followed by the sta- tus word indicated by two single character the data indicators on the SCI	Reload omega computer program If fault persists, check navigation equipment rack wiring If fault persists, replace omega receiver-computer

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 39 of 60)

Ref T O. 1E-3A-2-34-2
Page 3-58 Change 0

BOEING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
13	INDICATORS OTHER THAN D-TOT ON SCI DO NOT COME ON PROPERLY	1 Restart NCS checkout If problem persists, perform steps 2 through 5 2 Press and release PANEL TEST pushbutton on SCI and observe the following events for the next two 4-second intervals First 4 seconds a CMPTR, DPLR, OMEGA and WARN indicators come on b All segments of keyboard pushbut- tons come on c HOLD pushbutton is on d ALIGN, Ω-SIG and D-MEM indicators come on Second 4 seconds a All 16 segments of each single charac- ter data indicator come on b Both data registers display all 8's c. All decimal points and degree indica- tors in both data	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 40 of 60)

Ref T O 1E-3A-2-34-2
Page 3-58 Change 0
Page 3-59 Change 16

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		display registers come on	
	Defective SCI	3 If some but not all lamps come on during panel test sequence, any lamps other than D-TOT which did not come on are defective	Replace defective lamps
	Defective aircraft wiring	4 If no lamps on SCI come on a Check that two of following four indicators on SMC are on POLE - DISP or GEOD and DAPG - INS1 or INS2 b If indicators are on, momentarily press PNL TEST switch on SMC and observe D-TOT indicator on SCI D-TOT indicator is off D-TOT indicator is on	Replace SCI Set mode selector on SMC and both MSU's to OFF, and open all NAVIGATION circuit breakers on P6 panel Remove SCI from panel and disconnect electrical connectors <u>WARNING</u> VOLTAGES BEING MEASURED ARE HAZARDOUS TO PERSONNEL

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 41 of 60)

Ref T O 1E-3A-2-34-2
 Page 3-59 Change 16
 Page 3-60 Change 16

BOEING

MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
			Close NAVIGATION-OMEGA NAV-PANELS circuit breaker on P6 panel and check for 115 vac between pins 1 and 2 on cable connector D7154
			If voltage is present, replace SCI
			If voltage is not present, check aircraft wiring
	Defective omega receiver computer	5 If CMPTR indicator on SCI is only indicator to come on, open navigation equipment rack and ensure that PWR HALF indicator on omega receiver computer is off	Replace receiver computer
		6 If PWR MALF indicator is off, observe that mechanical finger on elapsed time indicator on omega receiver computer is moving	Replace receiver computer
		7 If PWR MALF indicator is off and mechanical finger is not moving	
		a Remove power from NCS by opening NAVIGATION circuit breakers on P6 panel and disconnect cable connector from J2 connector	
		WARNING VOLTAGES BEING MEASURED ARE HAZARDOUS TO PERSONNEL	

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 42 of 60)

Ref T O 1E-3A-2-34-2
Page 3-60 Change 16

BOEING MAINTENANCE MANUAL

REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION				
	Defective power filter	b. Apply power to NCS and check for 113 (± 11) vac between pins F and G of cable connector. If no voltage is indicated, check aircraft wiring. c. If 113 (± 11) vac was measured between pins F and G, remove power from NCS by opening NAVIGATION circuit breakers on P6 panel and check for continuity between pins on J2 connector and solder terminals on M954 filter assembly as follows: Replace indicated component if no continuity is measured. <u>NOTE</u> Continuity is defined as a resistance of 2 ohms or less. Isolation is defined as 100 thousand ohms or more. CONTINUITY <table><tr><td style="text-align: center;">FROM</td><td style="text-align: center;">TO</td></tr><tr><td style="text-align: center;">J2-F</td><td style="text-align: center;">C11</td></tr></table>	FROM	TO	J2-F	C11	If no continuity, replace Inductor between capacitor at C11 terminal and J2-F
FROM	TO						
J2-F	C11						

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 43 of 60)

Ref T O 1E-3A-2-34-2
Pages 3-60 and 3-60A Change 16
Page 3-60B Change 1

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		J2-G C12 d If continuity was measured between pins and terminals listed above, remove omega receiver-computer and check for isolation between J2-F and J2-G. If no isolation was measured between J2-F and J2-G, capacitor at C11 terminal is shorted e If isolation was measured between J2-F and J2-G reconnect cable connector to J2 connector on navigation equipment rack and reinstall omega receiver-computer f Apply power to NCS 8 If 8-second sequence was incorrect as outlined in step 2, perform corrective action in order listed	Inductor between capacitor at C12 terminal and J2-G Replace capacitor at C11 terminal
	Defective SCI		Replace SCI
	Defective omega computer		Replace omega receiver-computer
	Defective navigation equipment rack wiring.		Check navigation equipment rack cabling

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 44 of 60)

Ref T O 1E-3A-2-34-2
Page 3-60B Change 1

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
14	INSERT LIGHT ON CDU DOES NOT GO OUT Temporary communication problem Defective omega computer. Defective navigation equipment rack wiring Defective CDU Defective NU Defective navigation equipment rack wiring	1. Set data selectors on SMC and both MSU's to OFF 2 Restart checkout if both INSERT lights do not go out 3 If only one INSERT light does not go out, interchange CDU's	Replace omega receiver-computer If fault persists, check navigation equipment rack wiring If fault follows CDU, replace CDU If fault persists, interchange NU,s If fault follows NU, replace NU If fault persists, check navigation equipment rack wiring.
15	INCORRECT VALUES OF LATITUDE AND/OR LONGITUDE ARE DISPLAYED. Defective omega computer	1 Press and release DISPLAY on SCI 2 Press and release POS on SCI 3 Verify that latitude and longitude displayed are within 3 minutes of values inserted manually	If values are different replace omega receiver-computer

Inertial Navigation System - Trouble Shooting
Table 101 (Sheet 45 of 60)

Ref.. T O. 1E-3A-2-34-2
Page 3-61 Change 0

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective NU	4 Compare CDU display against SCI display If only one CDU display is not within ± 0.1 minute of SCI display, associated navigation unit is faulty 5 If both CDU displays are not within ± 0.1 minute of SCI display omega receiver-computer is defective	Replace defective NU If fault persists, check navigation equipment rack wiring Replace omega receiver-computer If fault persists, check navigation equipment rack wiring
16	INDICATORS ON SMC OR D-TOT INDICATOR ON SCI FAIL TO COME ON		
	Defective lamps	If a portion of the lamps do come on, remaining lamps are faulty	Replace defective lamps
	Defective SMC	If no lamps come on, SMC is faulty	Replace SMC If fault persists, check navigation equipment rack cabling
17	D AND T NOT DISPLAYED IN SINGLE CHARACTER DATA INDICATORS.		
	Defective omega computer	Set mode selectors on SMC and both MSU's to OFF Restart checkout If fault persists, perform corrective action in order listed	Replace SCI Replace omega receiver-computer If fault persists, check navigation equipment rack cabling
18	EP/ET LIGHT ON SCI DOES NOT GO OUT		
	Defective omega computer	Set mode selectors on SMC and both MSU's to OFF Restart checkout If fault persists, perform corrective action in order listed	Replace SCI Replace omega receiver-computer If fault persists, check navigation equipment rack connector cabling

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Table 101 (Sheet 46 of 60)

Ref. T O 1E-3A-2-34-2
Page 3-61 Change 0
Page 3-62 Change 16

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
19	READY NAV INDICATOR FAILS TO COME ON		
	Defective MSU	Interchange MSU's	If fault follows MSU, replace MSU
	Defective CDU		If fault does not follow MSU, interchange CDU's
	Defective NU.		If fault follows CDU, replace CDU
			If fault does not follow CDU, interchange NU's
			If fault follows NU, replace NU
			If fault persists, check navigation equipment rack cabling
20	Ω-SIG INDICATOR REMAINS ON LONGER THAN 11 MINUTES AFTER INITIAL TURN ON OR LONGER THAN 5 MINUTES AFTER MODE CHANGE TO OMEGA OPERATION		
	Poor omega environment	1 Ensure tail of air- craft is outside of hangar 2 If aircraft was moved outside of hangar after step 1 was performed, restart checkout of NCS 3 If Ω-SIG light does not go out 5 to 11 minutes after it comes on, perform steps 5 through 11 to monitor omega signal synchronization 4 If Ω-SIG light goes out, omega signal environment is good 5 Press CLEAR (if on) DISPLAY LOR/Ω ENTER	

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Table 101 (Sheet 47 of 60)

Ref T O 1E-3A-2-34-2
 Page 3-62 Change 16
 Page 3-63 Change 0

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
	Defective omega receiver	and 1 on SCI If left data register indicates----00 and right data register indicates 99, restart NCS checkout. If fault persists, omega receiver is faulty. <u>NOTE</u> •When synchronization starts, left data register indicates ----XX and right data register indicates ----YY. •The percentage of omega signal on which the omega receiver has synchronized, is indicated by the two digits at XX. •The two digits at YY indicate the number of attempts the omega receiver has made to synchronize. If the digits at YY indicate 30, synchronization has failed and an A 0 1 automatic fault display will occur. 6 Observe that number in right data register on SCI increases	Replace omega receiver-computer

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Ref T O 1E-3A-2-34-2
Page 3-63 Change 0
Page 3-64 Change 16

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		every 10 seconds. If number does increase, perform steps 8 through 10 7 If number in right data register does not increase, omega receiver is faulty 8 Observe that both data registers will switch to following display when omega receiver is synchronized (Left data register approaches 99) Left Data Register ABCD-- Right Data Register EFGH-- Where each position, A through H, represents the number for each burst strength of an omega station A - Norway B - Liberia C - Hawaii D - North Dakota E - LaReunion Island F - Argentina G - Australia H - Japan <u>NOTE</u> The burst strength is displayed as a number between 0 and 9. Zero represents	Replace omega receiver-computer

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Table 101 (Sheet 49 of 60)

Ref : T O 1E-3A-2-34-2
Page 3-64 Change 16

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		sents no signal and 9 represents a strong signal 9 Observe burst strengths of omega stations A burst strength from 3 to 9, which is fairly cons- tant, is a properly received omega sta- tion Varying burst strengths from 0 to 6 for any particular omega station repre- sent noise interfe- rence <u>NOTE</u> The omega re- ceiver must re- ceive fairly constant sig- nals from four omega stations 10 Note the omega sta- tions and burst strengths which have fairly constant burst strengths 11. Press NEXT on SCI and note the omega sta- tions ant burst strengths which have fairly constant burst strengths 12 Repeat step 11 13 The results noted in step 10 are for the 10 20 kHz frequency, step 11 for 13 6 kHz and step 12 for 11 33 kHz Select the four omega stations which	Replace omega antenna If fault persists, replace omega receiver- computer If fault persists, check navigation equipment rack wiring

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Table 101 (Sheet 50 of 60)

Ref T O 1E-3A-2-34-2
Page 3-65 Change 0

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		had the strongest burst strengths for all three frequencies. If no stations had constant burst strengths, perform corrective action 14. If at least 9 of the possible 12 burst strengths are between 3 and 9 and the Ω-SIG light remains on, the omega receiver computer is defective 15 If fewer than 9 of the possible 12 burst strengths are between 3 and 9, the omega environment is too poor for proper signal reception	Replace omega receiver-computer If fault persists, replace SCI
21	READY NAV INDICATOR FAILS TO GO OUT		
	Defective MSU	Interchange MSU's	If fault follows MSU, replace MSU
	Defective NU	If fault persists, interchange NU's	If fault follows NU, replace NU
	Defective cabling in navigation equipment rack	If fault persists, check navigation equipment rack wiring	
22	INDICATOR ON SYSTEM MODE CONTROL FAILS TO COME ON		
	Defective SMC		Replace SMC If fault persists replace omega receiver-computer
	Defective omega computer		If fault persists, check navigation equipment rack cabling

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Table 101 (Sheet 51 of 60)

Ref T O 1E-3A-2-34-2
 Page 3-65 Change 0
 Page 3-66 Change 23

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
23	Defective navigation equipment rack wiring		
	HSI GIVES IMPROPER INDICATIONS		
24	Defective NU		Replace defective NU If fault persists check navigation equipment rack cabling
	CONTROL WHEELS DO NOT ROTATE PROPERLY		
25	Radio altimeter on	Check RADIO ALTIMETER switch overhead panel P-13	Set RADIO ALTIMETER switch to OFF
	Defective NU		Replace defective NU If fault persists, check navigation equipment rack cabling
25	BOTH DATA REGISTERS DO NOT INDICATE 000000		
	Poor omega environment	1 If least significant digit in either data register on SCI is 1, 3, 5 or 7, perform isolation procedure 20 If the fourth digit from the least significant digit in either data register on SCI is 4, 5, 6, or 7 perform isolation procedure 40	
25	Temporary fault in omega receiver	2 If 1, 3, 5, or 7 was not displayed as the least significant digit in either data register of the SCI, or if 4, 5, 6, or 7 was not displayed as the fourth digit in	

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Table 101 (Sheet 52 of 60)

Ref. T O 1E-3A-2-34-2
Page 3-66 Change 23
Page 3-67 Change 23

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		either data register of the SCI, note contents of display 3 Press CLEAR switch on SCI 4 Set mode selector to DPLR on SMC 5 Press MODE ENABLE switch on SMC 6 Set mode selector to DPLR OMEGA on SMC 7 Press MODE ENABLE switch on SMC 8 Press CLEAR (if on) DISPLAY and LOR/ Ω , on SCI	If fault code reappears, reload omega receiver- If fault code reappears, replace omega receiver- computer
	Temporary fault in omega computer	9 If fault code does not reappear, press NEXT key on SCI	If fault code reaprears, reload omega receiver- computer program If fault code reappears, replace omega receiver- computer
	Defective omega antenna	10 If fault persists, perform corrective action	Replace omega antenna
26	DATA REGISTERS DO NOT INDICATE 000000		
	Defective NU	If left data register shows a non-zero number NU No 1 is defective If right data register shows a non-zero number NU No 2 is defective	Replace defective NU

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 Table 101 (Sheet 53 of 60)

Ref : T O 1E-3A-2-34-2
 Page 3-67 Change 23

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
27	DATA REGISTERS DO NOT DISPLAY ZEROS		
	Defective DVS		Replace DVS
28	LEFT DATA REGISTER DOES NOT DISPLAY 014000		
	Temporary fault in DVS	1 If right most three digits in left data register of SCI indicate non-zero numbers, note contents of display 2 Press CLEAR key on SCI 3 Set mode selector to OMEGA on SMC 4 Press MODE ENABLE switch on SMC 5 Set mode selector to DPLR OMEGA on SMC 6 Press MODE ENABLE switch on SMC and wait 2 minutes for DVS self-test to complete before performing step 7 7 Press CLEAR (if on) DISPLAY DPLR NEXT on SCI 8 Observe left data register numbers in following order UVWXYZ U=1	
	Defective AHRS Defective CADC Defective NU Defective DVS		

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Ref. T O 1E-3A-2-34-2
 Page 3-67 Change 23
 Page 3-68 Change 23



REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		Check AHRS V=2 3 6 or 7 Check AHRS 1 V=4 5 6 or 7 Check AHRS 2 V=1 and W=4 3 5 or 7 Check CADC Refer to Chapter 34-10-01 V=1 and W=0 3 5 or 7 No 2 NU is faulty V=0 and W=4 No 1 NU is faulty X or Y displays nonzero number DVS is faulty Z=2 4 or 6 DVS is faulty Z=1 3 5 or 7 Replace components in order listed	Replace No 2 NU Replace No 1 NU Replace DVS Replace DVS Replace doppler power contactor Replace DVS

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Ref. T.O. 1E-3A-2-34-2
Page 3-68 Change 23
Page 3-69 Change 0

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
		If fault persists, check navigation equipment rack cabling	
29	RIGHT DATA REGISTER NOT BLANK		
	Defective omega computer		Replace omega receiver computer
30	SCI DATA REGISTERS DISPLAY ---000 OR 9999		
	Defective NU	If display appears in left data register, NU No 1 is faulty If display appears in right data register, NU No 2 is faulty	Replace faulty NU
31	INCORRECT DECIMAL AND DEGREE POSITIONS INDICATED IN CDU DATA DISPLAYS		
	Defective CDU		Replace CDU
32	NO SMC DIM CONTROL		
	Defective SMC		Replace SMC
33	NO SCI DIM CONTROL		
	Defective SCI		Replace SCI
34	INCORRECT DISPLAY IN CDU RIGHT DATA REGISTER		
	Defective CDU	1 Interchange No 1 and 2 CDU's	If fault follows CDU, replace CDU
	Defective NU	2 If fault did not follow CDU, interchange No 1 and 2 NU's	If fault follows NU, replace NU
	Defective navigation equipment rack cabling	3. If fault persists, check navigation equipment rack wiring	
35	SCI DOES NOT RESPOND TO SWITCH-INDICATOR ACTION		
	Defective SCI	1 Incorrect indication	Replace SCI

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Ref T O 1E-3A-2-34-2
 Page 3-69 Change 0
 Page 3-70 Change 0

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
36	Defective omega computer	2.If fault persists	Replace omega receiver-computer
	Defective navigation equipment rack wiring	3 If fault persists, check navigation equipment rack cabling	
37	INCORRECT DATA DISPLAYED ON SCI		
	Defective omega computer	1 Reload omega receiver-computer program	Replace omega receiver-computer
38		2 If fault persists	
	Defective navigation equipment rack wiring	3 If fault persists, check navigation equipment rack cabling	
37	CDU DOES NOT RESPOND TO SWITCH ACTION		
	Defective CDU	1 Interchange CDU's	If fault follows CDU, replace CDU
38	Defective NU	2 If fault persists, interchange NU's	If fault follows NU, replace NU
	Defective navigation equipment rack wiring	3 If fault persists, check navigation equipment rack wiring	
38	SMC DOES NOT RESPOND TO SWITCH ACTION		
	Defective SMC		Replace SMC
	Defective omega receiver-computer	If fault persists	Replace omega receiver-computer
	Defective navigation equipment rack wiring	If fault persists, check navigation equipment rack wiring	

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Page 3-70 Change 0

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
39	SCI DISPLAYS UNRECOGNIZABLE SYMBOLS.		
	Omega computer memory is scrambled		Reload omega computer memory
40	POOR PERFORMANCE-INDEX/OMEGA MISFIRES, DEFECTIVE NU.		
		To determine misfire status perform follow- ing steps on SCI 1 Press DISPLAY 2 Press LOR/Ω 3 Press ENTER 4 Press numeral 0 5 Press numeral 3 6 Press NEXT 7 Press E 8 Press C 9 Press NEXT 10 Press numeral 4	
		<u>NOTE</u> After step 10, the number of omega misfires appears in the right data register of the SCI Zero indi- cates no misfire	If 0, replace NU
	Omega receiver-computer		If there are misfires, replace omega receiver- computer after further

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Ref T O 1E-3A-2-34-2
Page 3-70A Change 23

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REFERENCE PROCEDURE	PROBABLE CAUSE	ISOLATION PROCEDURE	CORRECTIVE ACTION
			troubleshooting of omega system, if no external causes are found
	<u>FLIGHT SQUAK - OMEGA, DOPPLER OR INS STATUS WORD FAULT INDICATED WITHOUT SPECIFICS</u>		
		Perform complete checkout Recall reported status bits stored since last time omega computer was turned off	As necessary

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Ref T O 1E-3A-2-34-2
 Page 3-70A Change 23

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AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE
0°00 0 - 14°35.5	0°03 0	62°57 9 - 63°23 9	0°06 6	72°43 2 - 72°53 6	0°10 1
14°35 6 - 20°21 7	0°03 1	63°24 0 - 63°49 2	0°06.7	72°53 7 - 73°03 9	0°10 2
20°21 8 - 24°37 1	0°03 2	63°49.3 - 64°13 6	0°06 8	73°04 0 - 73°13 9	0°10 3
24°37 2 - 28°04.2	0°03 3	64°13 7 - 64°37 3	0°06 9	73°14 0 - 73°23 8	0°10 4
28°04 3 - 31°00 1	0°03 4	64°37 4 - 65°00 2	0°07 0	73°23 9 - 73°33 5	0°10 5
31°00 2 - 33°33 3	0°03 5				
		65°00 3 - 65°22 4	0°07 1	73°33.6 - 73°42 9	0°10.6
33°33 4 - 35°49 4	0°03 6	65°22 5 - 65°44 0	0°07 2	73°43 0 - 73°52 2	0°10 7
35°49.5 - 37°51 7	0°03 7	65°44 1 - 66°04 9	0°07 3	73°52 3 - 74°01 4	0°10 8
37°51 8 - 39°42 8	0°03 8	66°05 0 - 66°25 2	0°07 4	74°01 5 - 74°10 3	0°10 9
39°42 9 - 41°24 5	0°03 9	66°25 3 - 66°44 9	0°07 5	74°10 4 - 74°19 1	0°11 0
41°24 6 - 42°58 1	0°04.0				
		66°45 0 - 67°04 1	0°07 6	74°19 2 - 74°27 7	0°11 1
42°58 2 - 44°24 8	0°04 1	67°04 2 - 67°22 7	0°07 7	74°27 8 - 74°36 1	0°11.2
44°24 9 - 45°45 5	0°04 2	67°22 8 - 67°40 8	0°07 8	74°36 2 - 74°44 4	0°11 3
45°45 6 - 47°00 7	0°04.3	67°40 9 - 67°58 4	0°07 9	74°44 5 - 74°52 6	0°11 4
47°00 8 - 48°11 3	0°04 4	67°58 5 - 68°15 6	0°08 0	74°52 7 - 75°00 6	0°11 5
48°11 4 - 49°17 6	0°04.5				
		68°15 7 - 68°32 3	0°08 1	75°00 7 - 75°08 5	0°11 6
49°17 7 - 50°20 0	0°04 6	68°32 4 - 68°48 6	0°08 2	75°08 6 - 75°16 2	0°11 7
50°20 1 - 51°19 0	0°04 7	68°48 7 - 69°04 4	0°08 3	75°16 3 - 75°23 8	0°11 8
51°19 1 - 52°14 8	0°04 8	69°04 5 - 69°19 9	0°08 4	75°23 9 - 75°31 2	0°11 9
52°14 9 - 53°07 7	0°04 9	69°20 0 - 69°34 9	0°08 5	75°31 3 - 75°38 7	0°12 0
53°07 8 - 53°58 0	0°05 0				
		69°35 0 - 69°49 6	0°08 6	75°38 7 - 75°45 8	0°12 1
53°58 1 - 54°45 8	0°05 1	69°49 7 - 70°04 0	0°08 7	75°45 9 - 75°52 9	0°12 2
54°45 9 - 55°31 4	0°05 2	70°04 1 - 70°18 0	0°08 8	75°53 0 - 75°59 9	0°12 3
55°31 5 - 56°15 0	0°05 3	70°18 1 - 70°31 6	0°08 9	76°00 0 - 76°06 7	0°12 4
56°15 1 - 56°56 6	0°05 4	70°31 7 - 70°45 0	0°09 0	76°06 8 - 76°13.5	0°12 5
56°56 7 - 57°36 4	0°05 5				
		70°45 1 - 70°58 0	0°09 1	76°13 6 - 76°20 1	0°12 6
57°36 5 - 58°14.5	0°05 6	70°58 1 - 71°10 8	0°09 2	76°20 2 - 76°26 6	0°12 7
58°14 6 - 58°51 1	0°05 7	71°10 9 - 71°23 2	0°09 3	76°26 7 - 76°33 0	0°12.8
58°51.2 - 59°26 2	0°05 8	71°23 3 - 71°35 4	0°09 4	76°33 1 - 76°39 4	0°12 9
59°26 3 - 59°59 9	0°05 9	71°35 5 - 71°47 3	0°09 5	76°39 5 - 76°45 6	0°13 0
60°00.0 - 60°32 3	0°06 0				
		71°47 4 - 71°59 0	0°09 6	76°45 7 - 76°51 7	0°13 1
60°32 4 - 61°03 6	0°06 1	71°59 1 - 72°10 4	0°09 7	76°51 8 - 76°57 6	0°13 2
61°03 7 - 61°33 7	0°06 2	72°10 5 - 72°21 5	0°09 8	76°57 8 - 77°03 7	0°13 3
61°33 8 - 62°02 7	0°06 3	72°21 6 - 72°32 4	0°09 9	77°03 8 - 77°09 5	0°13 4
62°02 8 - 62°30 7	0°06 4	72°32 5 - 72°43 1	0°10 0	77°09 6 - 77°15.3	0°13 5
62°30 8 - 62°57 8	0°06 5				

Inertial Navigation System - Longitude Drift Tolerances
Table 102 (Sheet 1 of 3)

Ref. T O 1E-3A-2-34-2
Page 3-72 Change 0

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AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE
77°15 4 - 77°21 0	0°13 6	79°53.7 - 79°57 2	0°17 1	81°37 6 - 81°39 9	0°20 6
77°21 1 - 77°26.5	0°13 7	79°57 3 - 80°00 7	0°17.2	81°40 0 - 81°42 3	0°20 7
77°26 6 - 77°32 1	0°13 8	80°00 8 - 80°04.2	0°17 3	81°42 4 - 81°44 7	0°20 8
77°32 2 - 77°37 5	0°13 9	80°04 3 - 80°07 6	0°17 4	81°44 8 - 81°47 1	0°20 9
77°37 6 - 77°42 8	0°14 0	80°07.7 - 80°11 0	0°17 5	81°47 2 - 81°49 5	0°21 0
77°42 9 - 77°48 1	0°14 1	80°11 1 - 80°14.4	0°17 6	81°49 6 - 81°51 8	0°21 1
77°48 2 - 77°53 3	0°14 2	80°14.5 - 80°17 7	0°17 7	81°51.9 - 81°54 1	0°21.2
77°53 4 - 77°58 4	0°14.3	80°17 8 - 80°21 0	0°17.8	81°54 2 - 81°56 4	0°21 3
77°58 5 - 78°03 5	0°14 4	80°21 1 - 80°24 3	0°17 9	81°56 5 - 81°58 6	0°21 4
78°03 6 - 78°08 4	0°14 5	80°24 4 - 80°27 5	0°18 0	81°58 7 - 82°00 9	0°21 5
78°08 5 - 78°13 4	0°14 6	80°27 6 - 80°30 6	0°18 1	82°01 0 - 82°03 1	0°21 6
78°13 5 - 78°18 2	0°14 7	80°30 7 - 80°33 8	0°18 2	82°03 2 - 82°05 3	0°21 7
78°18 3 - 78°23 0	0°14 8	80°33 9 - 80°37 0	0°18 3	82°05 4 - 82°07 5	0°21 8
78°23 1 - 78°27 7	0°14 9	80°37 0 - 80°40 0	0°18 4	82°07 6 - 82°09 7	0°21 9
78°27 8 - 78°32 3	0°15 0	80°40 1 - 80°43 0	0°18 5	82°09 8 - 82°11 8	0°22 0
78°32 4 - 78°36 9	0°15 1	80°43 1 - 80°46 0	0°18 6	82°11 9 - 82°13 9	0°22 1
78°37 0 - 78°41 4	0°15 2	80°46 1 - 80°49 0	0°18 7	82°14 0 - 82°16 0	0°22 2
78°41 5 - 78°45 9	0°15 3	80°49 1 - 80°51 9	0°18 8	82°16 1 - 82°18 2	0°22 3
78°46 0 - 78°50 3	0°15 4	80°52 0 - 80°54 8	0°18 9	82°18 2 - 82°20 2	0°22 4
78°50 4 - 78°54 7	0°15 5	80°54 9 - 80°57 7	0°19 0	82°20 3 - 82°22 2	0°22 5
78°54 8 - 78°58 9	0°15 6	80°57 8 - 81°00 5	0°19 1	82°22 3 - 82°24 2	0°22 6
78°59 0 - 79°03 2	0°15 7	81°00 6 - 81°03 4	0°19 2	82°24 3 - 82°26 2	0°22 7
79°03 3 - 79°07 4	0°15 8	81°03 5 - 81°06 1	0°19 3	82°26 3 - 82°28 2	0°22 8
79°07 5 - 79°11 5	0°15 9	81°06 2 - 81°08 9	0°19 4	82°28 3 - 82°30 2	0°22 9
79°11.6 - 79°15 6	0°16 0	81°09 0 - 81°11 6	0°19 5	82°30.3 - 82°32 2	0°23 0
79°15.7 - 79°19 6	0°16 1	81°11 7 - 81°14 3	0°19 6	82°32 3 - 82°34 1	0°23 1
79°19 7 - 79°23 6	0°16 2	81°14 4 - 81°17 0	0°19 7	82°34 2 - 82°36 0	0°23 2
79°23 7 - 79°27 5	0°16.3	81°17 1 - 81°19 7	0°19 8	82°36 1 - 82°37 9	0°23.3
79°27 6 - 79°31 4	0°16 4	81°19 8 - 81°22 3	0°19 9	82°38 0 - 82°39 8	0°23 4
79°31 5 - 79°35 2	0°16 5	81°22 4 - 81°24 9	0°20.0	82°39 9 - 82°41 7	0°23 5
79°35 3 - 79°39 0	0°16 6	81°25 0 - 81°27 4	0°20 1	82°41 8 - 82°43 5	0°23 6
79°39 1 - 79°42 7	0°16 7	81°27 5 - 81°30 0	0°20 2	82°43 7 - 82°45 4	0°23 7
79°42 8 - 79°46 4	0°16 8	81°30 1 - 81°32 5	0°20 3	82°45 5 - 82°47 2	0°23 8
79°46 5 - 79°50 0	0°16 9	81°32 6 - 81°35 0	0°20 4	82°47 3 - 82°49 1	0°23 9
79°50 1 - 79°53 6	0°17 0	81°35 1 - 81°37 5	0°20 5	82°49 2 - 82°50 9	0°24 0

Inertial Navigation System - Longitude Drift Tolerances
Table 102 (Sheet 2 of 3)

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AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE	AIRCRAFT LATITUDE FROM - TO	LONGITUDE TOLERANCE
82°51 0 - 82°52 6	0°24 1	83°45 6 - 83°46 8	0°27 6
82°52 7 - 82°54 4	0°24 2	83°46 9 - 83°48 2	0°27 7
82°54 5 - 82°56 2	0°24 3	83°48 3 - 83°49 5	0°27 8
82°56 3 - 82°57 9	0°24 4	83°49 6 - 83°50 9	0°27 9
82°58 0 - 82°59 6	0°24 5	83°51 0 - 83°52 2	0°28 0
82°59 7 - 83°01 3	0°24 6	83°52 3 - 83°53 5	0°28 1
83°01 4 - 83°03 0	0°24 7	83°53 6 - 83°54 8	0°28 2
83°03 1 - 83°04 7	0°24 8	83°54 9 - 83°56 1	0°28 3
83°04 8 - 83°06 4	0°24 9	83°56 2 - 83°57 4	0°28 4
85°06 5 - 83°08 0	0°25 0	83°57 5 - 83°58 6	0°28 5
83°08 1 - 83°09 7	0°25 1	83°58 7 - 83°59 9	0°28 6
83°09 8 - 83°11 3	0°25 2	84°00 0	0°28 7
83°11 4 - 83°12 9	0°25 3	NOTE No useful drift data can be ob- tained for latitudes greater than 84 degrees	
83°13 0 - 83°14 5	0°25 4		
83°14 6 - 83°16 1	0°25 5		
83°16 2 - 83°17 7	0°25.6		
83°17 8 - 83°19.3	0°25 7		
83°19 4 - 83°20 8	0°25 8		
83°20 9 - 83°22 4	0°25 9		
83°22 5 - 83°23.9	0°26 0		
83°24 0 - 83°25 4	0°26 1		
83°25 5 - 83°26 9	0°26 2		
83°27 0 - 83°28 4	0°26 3		
83°28 5 - 83°29 9	0°26 4		
83°30 0 - 83°31 4	0°26 5		
83°31 5 - 83°32 8	0°26 6		
83°32 9 - 83°34 3	0°26 7		
83°34 4 - 83°35 7	0°26 8		
83°35 8 - 83°37 1	0°26 9		
83°37 2 - 83°38 6	0°27 0		
83°38 7 - 83°40 0	0°27 1		
83°40 1 - 83°41 4	0°27 2		
83°41 5 - 83°42 7	0°27 3		
83°42 8 - 83°44 1	0°27 4		
83°44 2 - 83°45.5	0°27 5		

Inertial Navigation System - Longitude Drift Tolerances
Table 102 (Sheet 3 of 3)

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INERTIAL NAVIGATION SYSTEM - REMOVAL/INSTALLATION

1 General

- A System maintenance consists of removing and replacing any line replaceable unit (LRU) that has been determined to be faulty and repairing wiring. The system is then checked out with the new unit(s) in place or after wiring repair. The removal and installation procedures for navigation units No. 1 and 2, battery units No. 1 and 2 are included hereafter. Because of their system nature, the removal and installation procedures for the control panels (control display unit, or mode select unit) are also given.
- B Procedures for determining the running time of each NU is included in paragraph 5.

2 Control Panel Removal

- A The system control-display units, and mode select units are all mounted to the forward electronic control panel in the same manner. The following removal procedure applies to any of the panels in the inertial navigation system.

- (1) Set appropriate switches as listed below.

TO REMOVES

SET

No. 1 MSU or
No. 1 CDU

No. 1 MSU mode select switch
to OFF

No. 2 MSU or
No. 2 CDU

No. 2 MSU mode select switch
to OFF

- (2) Open applicable circuit breakers on P5 panel as listed below.

TO REMOVE

OPEN

No. 1 MSU

INS No. 1 PWR and INS No. 1 HTR

No. 2 MSU

INS No. 2 PWR and INS No. 2 HTR

No. 1 CDU

INS No. 1 PWR and INS No. 1 HTR

No. 2 CDU

INS No. 2 PWR and INS No. 2 HTR

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- (c) Disengage captive fasteners on edge of panel by turning them one-quarter turn counterclockwise
- (d) Carefully pull panel from mount and disconnect all electrical connectors at rear of panel

3 Control Panel Installation

A The following installation procedure applies to any of the panels in the navigational computer system

- (1) Ensure that power to panel connector has been removed by opening applicable circuit breaker on P5 panel as listed below

<u>TO INSTALL</u>	<u>OPEN</u>
No 1 MSU	INS No 1 PWR and INS No 1 HTR
No 2 MSU	INS No 2 PWR and INS No 2 HTR
No 1 CDU	INS No 1 PWR and INS No 1 HTR
No 2 CDU	INS No 1 PWR and INS No 1 HTR

- (2) Connect wire bundle connectors to mating receptacles on rear of panel
- (3) Raise panel into position and secure panel by pressing and turning each captive fastener on edge of panel one-quarter turn clockwise

4 Control Panel Relamping

A All single character data indicators, data registers, data displays and FROM-TO displays are referred to as segmented displays Relamping may be performed with power applied to the control panel since low voltage is used for all lamp power

CAUTIONS REPLACE DEFECTIVE LAMPS ONLY WITH LAMPS HAVING PREFERRED PART NUMBER OR LAMPS HAVING THE SAME BASE CONFIGURATION AND IDENTICAL VOLTAGE AND CURRENT RATINGS IMPROPER LAMP REPLACEMENT WILL DAMAGE THE EQUIPMENT

- B System Control-Indicator, Annunciator or Multifunction Key - Relamping
Not installed on aircraft

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- C System Control-Indicator, Segmented Display, Test, or Hold Indicators - Relamping

Not installed on aircraft

- D System Mode Control, select Inflt Align or Mode Enable Switch-Indicators-Relamping

Not installed on aircraft

- E System Mode Control Indicator - Relamping

Not installed on aircraft

- F Control Display Unit, Key and Annunciator - Relamping

- (1) Unfasten three clips on front access panel and remove access panel
- (2) Pull annunciator or key with defective lamp from socket
- (3) Pull defective lamp from annunciator or key
- (4) Insert new lamp in lamp cover or key
- (5) Reinstall annunciator lamp cover or key
- (6) Reinstall front access panel and fasten three clips

- G Control-Display Unit, Segmented Display - Relamping

- (1) Unfasten three clips on front access panel and remove access panel

NOTE The left data display may be grasped more easily if the HOLD and INSERT keys are removed

The right data display may be grasped more easily if the INSERT key and WARN annunciator are removed

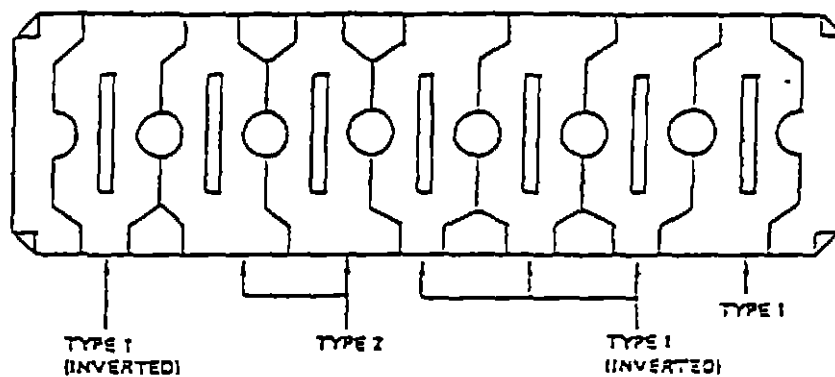
- (2) Remove segmented display
- (3) If replacing lamp module in left or right data display, unfasten retainer clip on rear of segmented display and swing retainer clip out of way
- (4) If replacing lamp module in FROM-TO display, remove three retaining screws

CAUTION LAMP MODULES MAY TEND TO CLING TOGETHER WHEN ONE LAMP MODULE IS BEING REMOVED DO NOT LET LAMP MODULES DROP OR MINIATURE LIGHTS OR CONTACTS MAY BE DAMAGED

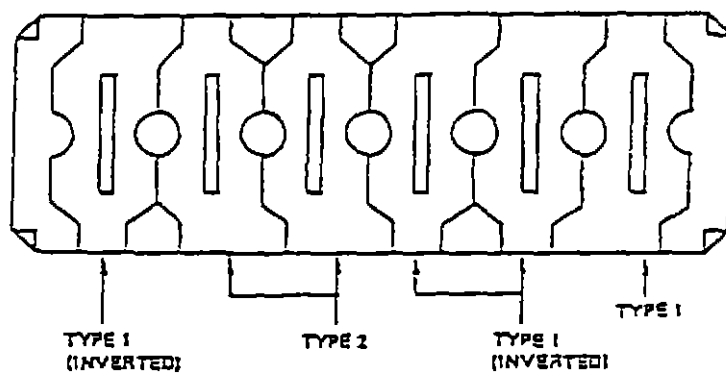
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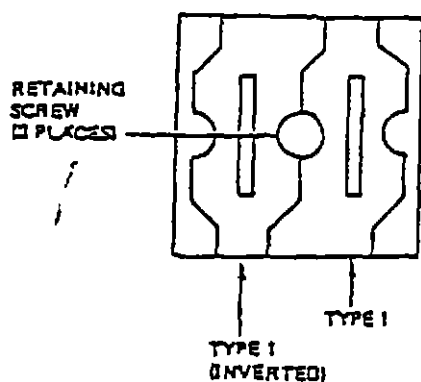
RIGHT DATA DISPLAY (REAR)



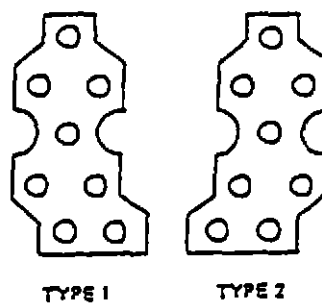
LEFT DATA DISPLAY (REAR)



FROM-TO DISPLAY (REAR)



LAMP MODULES (FRONT)



Lamp Module Placement in INS CDU Displays
Figure 401

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- (5) Carefully remove lamp module containing burned out segment lamp
- (6) Install new lamp module in segmented display observing placement as shown in figure 401
- (7) If replacing lamp module in left or right data display, swing retaining clip over lamp modules and fasten in catch on rear of segmented display

CAUTION DO NOT TIGHTEN RETAINING SCREWS OR MINIATURE LIGHTS IN LAMP MODULE MAY BE DAMAGED

- (8) If replacing lamp module in FROM-TO display, install three retaining screws until head makes contact with lamp module
- (9) Insert segmented display, and press gently but firmly to ensure proper electrical connection between segmented display and electrical connector
- (10) Reinstall front access panel and fasten three clips

H Mode Select Unit, Indicator - Relamping

- (1) Unscrew indicator lens cap and remove
- (2) Pull faulty lamp from lens cap
- (3) Insert new lamp into lens cap
- (4) Reinstall lens cap

NOTE Green lens cap is for READY NAV Red lens cap is for BAT

I Navigation Unit - Removal

- (1) If required, record running time for NU to be removed
34-52-01 page 420
- (2) Set mode selector switch on corresponding MSU to OFF
- (3) Open all INS 1 or INS 2 circuit breakers on P5 circuit breaker panel depending on NU being removed. Tag circuit breakers if circuit breaker panel will not be under continuous observation
- (4) Gain access to the INS rack located

* S/N 201199 FWD lower cargo compartement

* S/N 19997, 20000 between sta 344 and sta 360



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- (5) Open circuit breaker on front panel of battery unit (in navigation equipment rack) associated with NU being removed

WARNING NAVIGATION UNIT WEIGHS APPROXIMATELY 53 POUNDS USE TWO MEN WHEN LIFTING NAVIGATION UNIT

CAUTION ALLOW 2 MINUTES FOR GYROS TO RUN DOWN BEFORE REMOVING NU OR GYRO DAMAGE MAY RESULT USE CARE DURING REMOVAL TO PREVENT DAMAGE TO AIRFLOW SEAL

- (6) Release cam-lock handle locking levers and pull NU out approximately 6 inches

WARNING CAM-LOCK HANDLE LOCKING LEVERS MUST BE CLOSED WHEN HANDLING NU'S TO PREVENT PERSONAL INJURY

- (7) Close cam-lock handle locking levers and remove NU

- (8) Install and secure plenum cover plate

NOTE Plenum cover plate is stowed under second shelf

J Navigation Unit - Installation

WARNING NAVIGATION UNIT WEIGHS APPROXIMATELY 53 POUNDS

CAUTION CARE IS REQUIRED WHEN INSTALLING NAVIGATION UNIT TO PREVENT TEARING AIRFLOW SEAL

- (1) Check that polarizing keys between upper and lower sections of both rack mounted connectors for navigation unit in navigation equipment rack are not loose
- (2) If polarizing keys are loose, perform the following steps.
 - (a) Ensure equipment cooling is removed
 - (b) Ensure interior paneling around right antenna pedestal strut is removed to allow access to all screws on front access panel
 - (c) Remove 50 screws securing front access panel to navigation equipment rack and remove front access panel. Note position of all screws. Three different screw sizes are installed on front access panel
 - (d) Look at polarizing keys through rear access door and verify that polarizing keys are positioned as shown in figure 402

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- (e) If polarizing keys are not positioned as shown in figure 402, loosen retaining nut with slotted flat blade screwdriver (figure 402), pull polarizing keys toward rear of navigation equipment rack, rotate polarizing keys into the proper position, and press polarizing keys back into connector

NOTE Connector is constructed so each polarizing key will only fit in six possible positions

- (f) Tighten retaining nut with slotted flat blade screwdriver

CAUTION THREE DIFFERENT SCREW SIZES ARE INSTALLED ON FRONT ACCESS PANEL CARE SHOULD BE TAKEN TO INSTALL SCREWS PROPERLY

- (g) Install front access panel with 50 screws Torque screws to 4 to 5 inch-pounds
- (h) Ensure equipment cooling is applied
- (i) Ensure interior paneling is reinstalled around right antenna pedestal strut.

- (3) Remove plenum cover plate from NU stall and stow under second shelf if required.
- (4) Apply a thin film of silicon grease to gasket seal on bottom of NU stall to protect air cooling gasket
- (5) Slide navigation unit onto shelf Engage cam-lock locking levers in shelf fork assemblies

CAUTION IMPROPER ADJUSTMENT OF CAM-LOCK LEVER LATCH FORK ASSEMBLIES ON EQUIPMENT SHELF MAY CAUSE SYSTEM MALFUNCTION OR EQUIPMENT DAMAGE

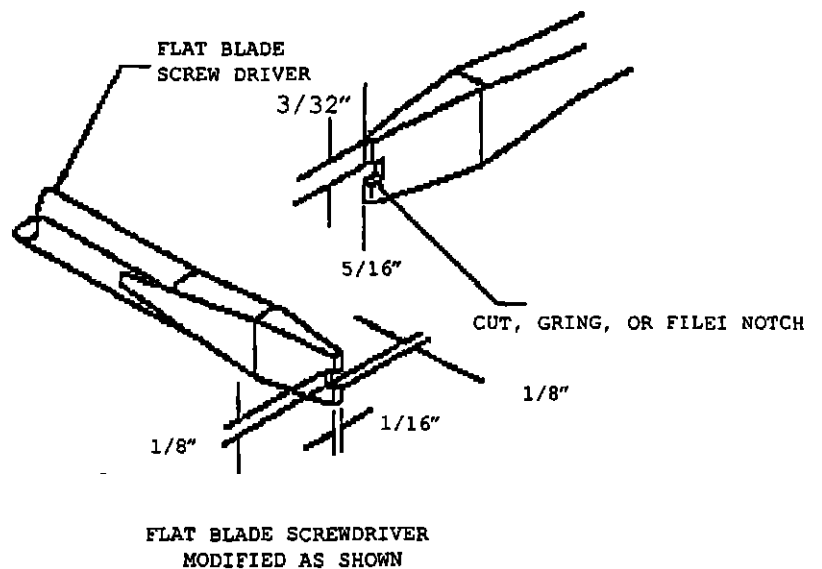
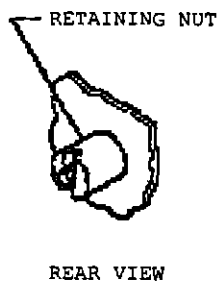
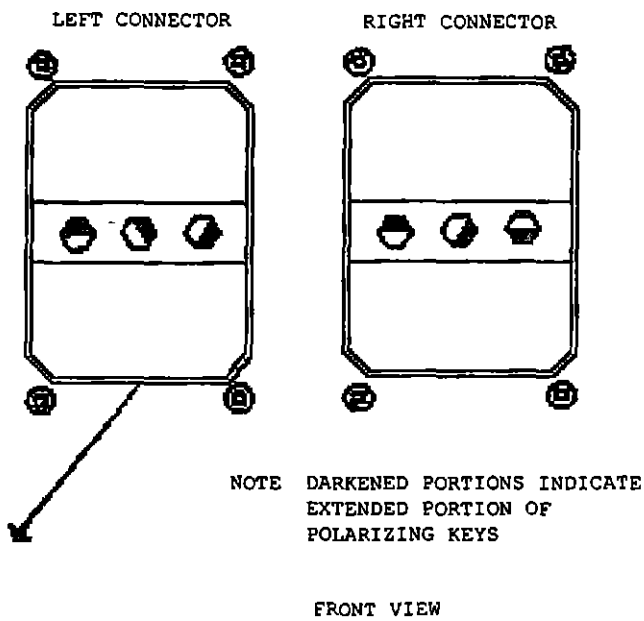
- (6) When connectors are fully seated, a noticeable increase in pressure is felt in locking levers. At this point, check that locking levers are approximately one-quarter inch from locked position (dimension A, figure 403) If not, pull lever down and thread fork assembly in or out to obtain dimension within tolerance
- (7) Seat locking levers into handles
- (8) Close circuit breaker on front panel of applicable battery unit

CAUTION SECURE REAR ACCESS DOOR QUARTER-TURN FASTENERS NEXT TO HINGE LAST TO PREVENT DAMAGE TO REAR ACCESS DOOR

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Polarizing Keys for Rack Mounted Connectors for NU
Figure 402

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- (9) Close rear access door and fasten 28 quick-disconnect fasteners
- (10) Close applicable INS circuit breakers on P5 circuit breaker panel
- (11) Ensure crew rest seats are installed

K Navigation Unit Mounting Base Air Seal - Removal

- (1) Remove two bolts that secure rear of mounting tray to mounting base assembly
- (2) Remove two screws and washers that secure front of mounting tray to mounting base assembly and remove tray
- (3) Remove 24 screws that secure seal retainer to mounting base assembly
- (4) Remove retainer and seal

L Navigational Unit Mounting Base Air Seal - Installation

- (1) Position seal, flat side down, on mounting base assembly
- (2) Position seal retainer over seal and secure with 24 screws
- (3) Position mounting tray on mounting base assembly and secure with two bolts on rear and two screws with washers in front

M Battery Unit - Removal

- (1) Gain access to the INS rack located
 - *S/N 20199 forward lower cargo compartment
 - *S/N 19997 and 20000 between sta 344 and sta 360
- (2) Release 28 quick-disconnect fasteners and open rear access door
- (3) Open circuit breaker on front panel of battery unit being removed
- (4) Release cam-lock handle locking levers and pull battery unit out approximately 4 inches.

WARNING CAM-LOCK HANDLE LOCKING LEVERS MUST BE CLOSED WHEN HANDLING BATTERY UNIT TO PREVENT PERSONAL INJURY

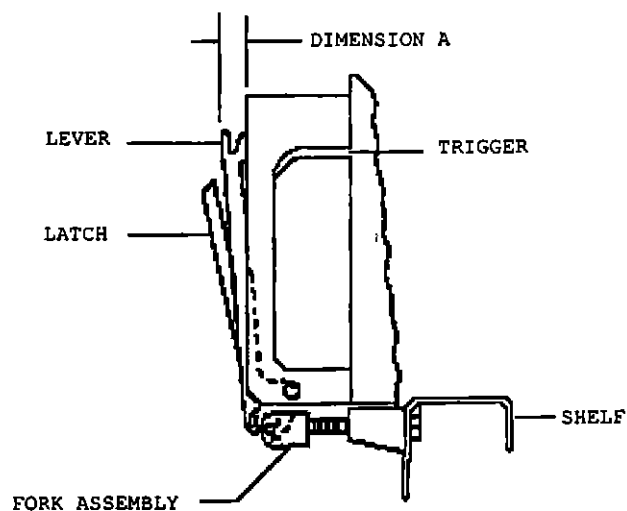
- (5) Close cam-lock handle locking levers and remove battery unit.

N Battery Unit - Installation

- (1) Ensure battery unit circuit breaker is open
- (2) Slide battery unit onto shelf Engage cam-lock locking levers in shelf fork assemblies

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Lever Latch Fork Adjustment
Figure 403

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CAUTION IMPROPER ADJUSTMENT OF CAM-lock LEVER LATCH FORK ASSEMBLIES ON EQUIPMENT SHELF MAY CAUSE SYSTEM MALFUNCTION OR EQUIPMENT DAMAGE

(3) When connector is fully seated, a noticeable increase in pressure is felt in locking levers. At this point check that levers are approximately one-half inch from locked position (dimension A, figure 403) In not, pull lever down and thread fork assembly in or out to obtain dimension within tolerance

(4) Seat locking levers into handles

(5) Close circuit breaker on front panel of battery unit

CAUTION SECURE REAR ACCESS DOOR QUARTER-TURN FASTENERS NEXT TO HINGE LAT TO PREVENT DAMAGE TO REAR ACCESS DOOR

(6) Close rear access door and fasten 28 quick-disconnect fasteners

(7) Install crew rest seats if required

O Filter in M952 or M953 Signal Filter Assembly - Removal

Not installed on aircraft

P Capacitor in M951 or M954 Power Filter Assembly - Installation

Not installed on aircraft

Q Inductor in M951 or M954 Power Filter Assembly - Removal

Not installed on aircraft

R Inductor in M951 or M954 Power Filter Assembly - Installation

Not installed on aircraft

S. Doppler Power Contactor - Removal

Not installed on aircraft

T Doppler Power Connector - Installation

Not installed on aircraft

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5 Recording Running Time

A The running time for each navigation unit is stored internally in the computer memory. The memory location for the running time meter is 236. The running time is set to zero after each overhaul. If the computer memory has been scrambled (CDU does not respond to keyboard commands), running time cannot be recorded.

- (1) Ensure electrical power is applied
- (2) Ensure equipment cooling is applied
- (3) Depending on which navigation unit is to be removed, check that appropriate P5 panel circuit breakers listed below are closed

INS - NO 1 PWR

INS - NO 1 HTR

or

INS - NO 2 PWR

INS - NO 2 HTR

- (4) Set mode selector to STBY on MSU which controls navigation unit to be removed from aircraft
- (5) Press WYPT CBG pushbutton on CDU controlled by navigation unit to be removed from aircraft
- (6) Press 9 key until 9 appears in FROM display
- (7) Press 9 key until 9 appears in TO display
- (8) Press INSERT
- (9) Set data selector switch to WAY PT
- (10) Set waypoint selector thumbwheel to 0
- (11) Press following keys: N2, N2, 3, E6

NOTE The N2 and E6 keys are dual function keys. The N2 key is pressed twice, first to put the CDU into insert mode, and second to insert a 2 into the left data display.

- (12) Observe 236 in left data display

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- (13) Press INSERT and observe 236 in both left and right data displays
- (14) Set data selector to DIS/TIME
- (15) Note all eight digits in both data displays The most significant digit is on the left end, the least significant digit is on the right end

NOTE This display is updated approximately once per second in octal code and must be converted to decimal hours The total running time is obtained by adding the decimal hour equivalents of the octal code

- (16) Refer to table 401 and the following example for converting the eight digit display from octal code to decimal hours

- (a) Example If the number recorded from the display is 0 4 2 7 3 6 5 1, the decimal hour equivalent is found from table 401 in the following manner

0 in 8th position yields	0 000
4 in 7th position yields	174 762
2 in 6th position yields	10 923
7 in 5th position yields	4 779
3 in 4th position yields	0 256
6 in 3rd position yields	0 064
5 in 2nd position yields	0 007
1 in 1st position yields	0 000

Summation of decimal hour equivalents gives	190 791 hours

- (17) Press WYPT CHG pushbutton
- (18) Press 1 key until 1 appears in FROM display
- (19) Press CLEAR key
- (20) Set mode selector to OFF on MSU
- (21) Ensure equipment cooling is applied
- (22) Ensure aircraft electrical power is removed, if no longer required

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NUMBER	POSITION OF NUMBER							
	8	7	6	5	4	3	2	1
0	0 000	0 000	0 000	0 000	0 000	0 000	0.000	0 000
1	349 524	43 691	5 461	0 683	0 085	0 011	0 001	0 000
2	699 047	87 381	10 923	1 365	0 171	0 021	0 003	0 000
3	1048 572	131 071	16 384	2 048	0 256	0 032	0 004	0 001
4	1398 096	174 762	21 845	2 731	0 341	0 043	0 005	0 001
5	1747 620	218 452	27 307	3.413	0 427	0 053	0 007	0 001
6	2097 144	262 143	32 768	4 096	0 512	0 064	0 008	0 001
7	2446 667	305 833	38 229	4 779	0 597	0 075	0 009	0 001
DECIMAL HOUR EQUIVALENT								

Octal Code to Decimal Hour Conversion
Table 401

6 Component Replacement Checkout

A The following checkout procedures perform a minimum operational checkout of the system to ensure that replaced components operate properly in the system

NOTE The following procedures do not check the system completely For a complete operational checkout of the system, refer to Adjustment/Test

(1) Battery Unit

- (a) Perform system test per table 504, steps 1 through 6 Set mode selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which is powered by battery replaced BAT indicator on HSU should remain off, and BAT indicator on CDU should be on for 12 seconds during performance index 8 and then remain off Perform steps 61, 62, 63 and 64 of table 504

(2) Control-Display Unit

- (a) Perform system test per table 504, steps 1 through 6 Set mode selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS

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which has the replacement CDU Perform steps 14, 15, 16 and 61 of table 504 Perform steps 5 through 15 of table 2 Set mode selector to OFF open circuit breakers closed in step 4 of table 504 Perform steps 62, 63, and 64 of table 504

(3) Doppler Velocity Sensor

Not installed on aircraft

(4) Doppler Power Contactor

Not installed on aircraft

(5) Mode Select Unit

- (a) Perform system test per table 504, steps 1 through 6 Set mode selector to ALIGN on HSU and data selector to DSRTK/STS on CDU of INS which has the replacement MSU Perform steps 14, 16, and 19 of table 504 Set mode selector to OFF Perform steps 5 through 15 of table 2 Set data selector on CDU to DSRTK/STS Set mode selector MSU to STBY, CDU right data register changes to 0-95 Perform steps 61, 62, 63 and 64 of table 504

(6) Navigation Unit

- (a) Perform system test per table 504, steps 1, through 6 Set mode selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which has the replacement NU Simultaneously press and release selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which has the replacement NU Simultaneously press and release TEST and HOLD switches on CDU Observe that no malfunction codes other than 46 appear Perform steps 6 through 15 of table 2. Set mode selector to OFF on MSU Perform steps 62, 63 and 64 of table 504

(7) System Control indicator

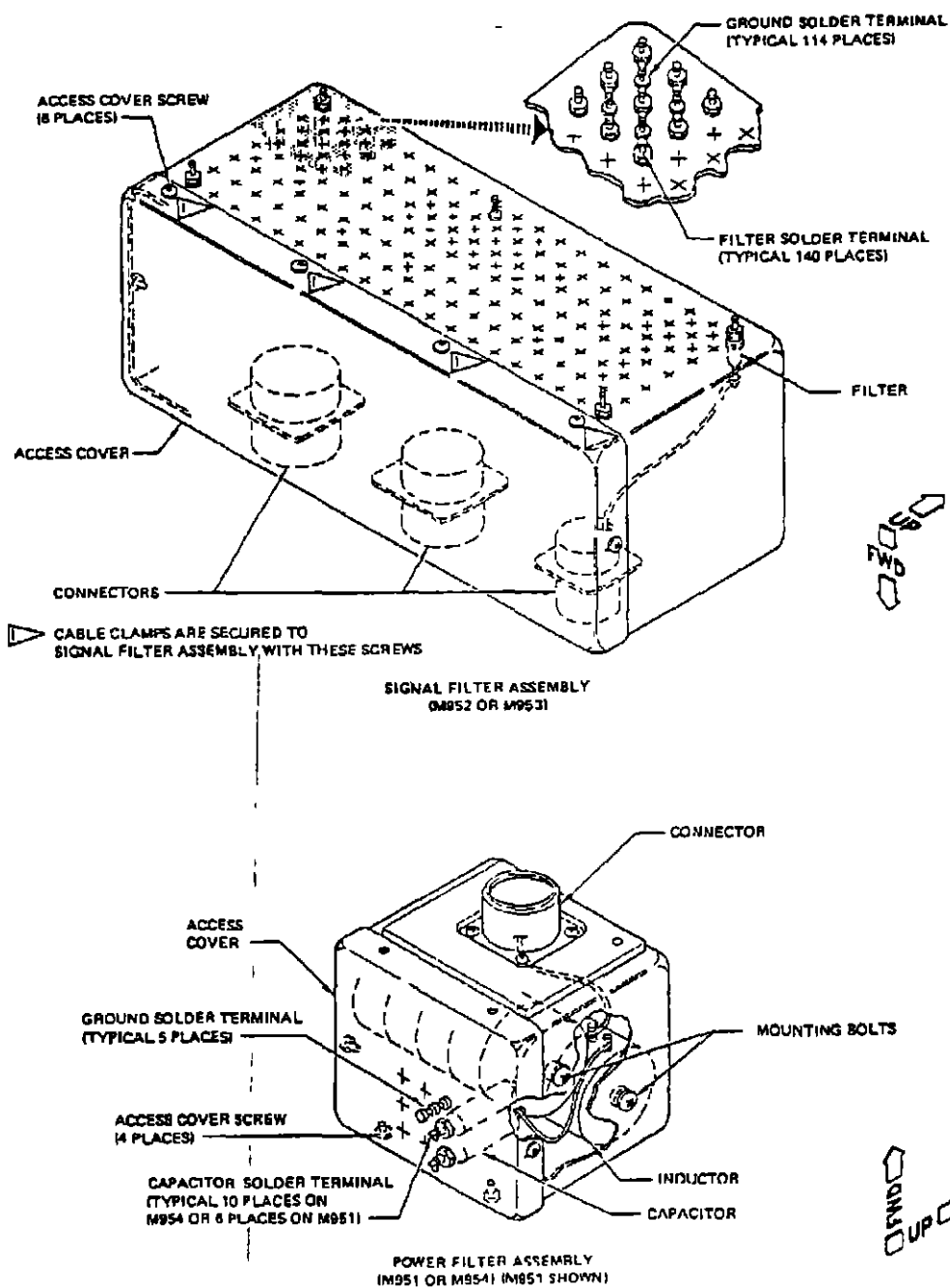
- (a) Not installed on aircraft

(8) System Mode Control

- (a) Not installed on aircraft

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Signal Filter and Power Filter Assembly
Figure 403

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CAUTION DO NOT PULL ON WIRES SOLDERED BETWEEN INDUCTORS IN FILTER ASSEMBLY HOUSING AND CAPACITORS ON ACCESS COVER OR SOLDER CONNECTIONS MAY BE BROKEN

- (11) Remove access cover from power filter assembly
- (12) Remove mounting bolts from inductors as required to remove defective inductor (See figure 403)
- (13) Disconnect wires from both terminals of defective inductor
- (14) Remove defective inductor

R Inductor in M951 or M954 Power Filter Assembly - Installation

- (1) Install new inductor in power filter assembly
- (2) Attach wires to terminals of new inductor
- (3) Install and secure inductor mounting bolts (figure 403)
- (4) Install access cover on power filter assembly with four screws
- (5) Remove old sealant from penthouse electrical connector hole and from around electrical connector on power filter assembly
- (6) Apply sealant around electrical connector on power filter assembly and penthouse hole to prevent cooling air leakage
- (7) Align power filter assembly electrical connector with hole in penthouse
- (8) Reconnect cable clamps to support beam which were removed for power filter assembly access
- (9) Mount power filter assembly with four screws
- (10) Install top access panel on penthouse with 22 screws Torque screws 4 to 5 inch-pounds
- (11) Carefully remove any debris from top shelf and remove protective covering from top shelf.

CAUTION SECURE REAR ACCESS DOOR QUARTER-TURN FASTENERS NEXT TO HINGE LAST TO PREVENT DAMAGE TO ACCESS DOOR

- (12) Close circuit breakers on both battery units, then close rear access door and fasten 28 quick-disconnect fasteners

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- (13) Connect cable to proper electrical connector.
- (14) Close all omega, doppler and INS circuit breakers on P6 circuit breaker panel
- (15) Ensure aft forced air cooling is applied and Air Pressure Warning Alarm System SDU-34/E is turned on, if required

S Doppler Power Contactor - Removal

- (1) Set mode selector on SMC to OFF
- (2) Open NAVIGATION - DOPPLER VEL SENSOR circuit breaker on P6 panel Tag circuit breaker if circuit breaker panel will not be under continuous observation
- (3) Ensure crew rest seats are removed or stowed so rear access door can be opened

CAUTION WHEN OPENING REAR ACCESS DOOR, RELEASE QUARTER-TURN FASTENERS NEXT TO HINGE FIRST TO PREVENT DAMAGE TO REAR ACCESS DOOR

- (4) Release 28 quick-disconnect fasteners and open rear access door
- (5) Remove No 1 and 2 battery units per paragraph 2 M
- (6) Remove omega receiver-computer per Chapter 34-53-01
- (7) Disconnect electrical connector on doppler power contactor
- (8) Remove four mounting screws and remove doppler power contactor

T Doppler Power Connector - Installation

- (1) Support unit in place and install four mounting screws
- (2) Connect electrical connector
- (3) Install No 1 and No 2 battery units per paragraph 2 N
- (4) Install omega receiver-computer per Chapter 34-53-01

CAUTION SECURE REAR ACCESS DOOR QUARTER-TURN FASTENERS NEXT TO HINGE LAST TO PREVENT DAMAGE TO REAR ACCESS DOOR

- (5) Close rear access door and fasten 28 quick-disconnect fasteners

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Page 4-19 Change 16
Page 4-28 Change 22

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(6) Close NAVIGATION - DOPPLER VEL SENSOR circuit breaker on P6 circuit breaker panel

(7) Install crew rest seats if required

5 Recording Running Time

A The running time for each navigation unit is stored internally in the computer memory. The memory location for the running time meter is 236. The running time is set to zero after each overhaul. If the computer memory has been scrambled (CDU does not respond to keyboard commands), running time cannot be recorded.

(1) Ensure electrical power is applied

(2) Ensure aft forced air cooling is applied and Air Pressure Warning Alarm System SDU-34/E is installed and turned on.

(3) Depending on which navigation unit is to be removed, check that appropriate P6 panel circuit breakers listed below are closed

NAVIGATION - INS - NO 1

NAVIGATION - INS - NO 1 HTR

or

NAVIGATION - INS - NO 2

NAVIGATION - INS - NO 2 HTR

(4) Set mode selector to STBY on MSU which controls navigation unit to be removed from aircraft

(5) Press WYPT CBG pushbutton on CDU controlled by navigation unit to be removed from aircraft

(6) Press 9 key until 9 appears in FROM display

(7) Press 9 key until 9 appears in TO display

(8) Press INSERT.

(9) Set data selector switch to WAY PT

(10) Set waypoint selector thumbwheel to 0

(11) Press following keys N2, N2, 3, E6

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NOTE The N2 and E6 keys are dual function keys. The N2 key is pressed twice, first to put the CDU into insert mode, and second to insert a 2 into the left data display.

- (12) Observe 236 in left data display
- (13) Press INSERT and observe 236 in both left and right data displays
- (14) Set data selector to DIS/TIME
- (15) Note all eight digits in both data displays. The most significant digit is on the left end, the least significant digit is on the right end.

NOTE This display is updated approximately once per second in octal code and must be converted to decimal hours. The total running time is obtained by adding the decimal hour equivalents of the octal code.

- (16) Refer to table 401 and the following example for converting the eight digit display from octal code to decimal hours.

(a) Example If the number recorded from the display is 0 4 2 7 3 6 5 1, the decimal hour equivalent is found from table 401 in the following manner:

0 in 8th position yields	0 000
4 in 7th position yields	174 762
2 in 6th position yields	10 923
7 in 5th position yields	4 779
3 in 4th position yields	0 256
6 in 3rd position yields	0 064
5 in 2nd position yields	0 007
1 in 1st position yields	0 000
Summation of decimal hour equivalents gives	190 791 hours

- (17) Press WYPT CHG pushbutton
- (18) Press 1 key until 1 appears in FROM display
- (19) Press CLEAR key.

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 Page 4-20A Change 16
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- (20) Set mode selector to OFF on MSU
- (21) Ensure aft forced air cooling is removed and Air Pressure Warning Alarm System SDU-34/E is shut down, if no longer required
- (22) Ensure aircraft electrical power is removed, if no longer required

NUMBER	POSITION OF NUMBER							
	8	7	6	5	4	3	2	1
0	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
1	349 524	43 691	5 461	0 683	0 085	0 011	0 001	0 000
2	699 047	87 381	10 923	1 365	0 171	0 021	0 003	0 000
3	1048 572	131 071	16 384	2 048	0 256	0 032	0 004	0 001
4	1398 096	174.762	21 845	2 731	0 341	0 043	0 005	0 001
5	1747 620	218.452	27 307	3.413	0 427	0 053	0 007	0 001
6	2097 144	262 143	32 768	4 096	0 512	0 064	0 008	0 001
7	2446 667	305 833	38 229	4 779	0 597	0 075	0 009	0 001
DECIMAL HOUR EQUIVALENT								

Octal Code to Decimal Hour Conversion
Table 401

Ref TO 1E-3A-2-34-2
Page 4-21 Change 9

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6 Component Replacement Checkout

- A** The following checkout procedures perform a minimum operational checkout of the system to ensure that replaced components operate properly in the system

NOTE. The following procedures do not check the system completely For a complete operational checkout of the system, refer to Adjustment/Test

(1) Battery Unit

- (a) Perform system test per table 504, steps 1 through 6 Set mode selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which is powered by battery replaced BAT indicator on MSU should remain off, and BAT indicator on CDU should be on for 12 seconds during performance index 8 and then remain off Perform steps 61, 62, 63 and 64 of table 504

(2) Control-Display Unit

- (a) Perform system test per table 504, steps 1 through 6 Set mode selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which has the replacement CDU Perform steps 14, 15, 16 and 61 of table 504 Perform steps 5 through 15 of table 2 Set mode selector to OFF Open circuit breakers closed in step 4 of table 504 Perform steps 62, 63, and 64 of table 504

(3) Doppler Velocity Sensor

- (a) Perform system test per table 504, steps 1, through 6, 11, 21, 56, 57a, 57f, 57g, and 60 through 64

(4) Doppler Power Contactor

- (a) Perform doppler velocity sensor test per step 4 A (4)

(5) Mode Select Unit

- (a) Perform system test per table 504, steps 1 through 6 Set mode selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which has the replacement MSU Perform steps 14, 16, and 19 of table 504 Set mode selector to OFF Perform steps 5 through 15 of table 2 Set data selector on CDU to DSRTK/STS Set mode selector MSU to STBY, CDU right data register changes to 0-95 Perform steps 61, 62, 63 and 64 of table 504

(6) Navigation Unit

- (a) Perform system test per table 504, steps 1, through 6 Set mode

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Page 3-79 Change 12
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selector to ALIGN on MSU and data selector to DSRTK/STS on CDU of INS which has the replacement NU. Simultaneously press and release TEST and HOLD switches on CDU. Observe that no malfunction codes other than 46 appear. Perform steps 6 through 15 of table 2. Set mode selector to OFF on MSU. Perform steps 62, 63 and 64 of table 504.

(7) System Control Indicator

- (a) Perform system test per table 504, steps 1 through 6, 11, 21, 29 through 35, 43, and 60 through 64.

(8) System Mode Control

- (a) Perform system test per table 504, steps 1 through 6, 11, 21, 30, 42, 55, 60 through 64.

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INERTIAL NAVIGATION SYSTEM - ADJUSTMENT/TEST

1 Tools and Test Equipment

A Tools and test equipment required for checkout, troubleshooting and maintenance of the navigation computer system are listed in table 501

B Consumable Materials

(1) Table 502 lists the consumable material required for system maintenance

C Checkout

(1) Two system checkout procedures are provided. The first is a fast procedure for accomplishment in a minimum of time. The second is more detailed and checks more system functions.

(a) Fast Checkout

- 1) The procedure in table 503 checks its status without directly examining all signal interfaces or secondary functions. The aircraft must be stationary during the procedure. A reference index number (example "12") follows each result and identifies the entry point into the trouble analysis table 101 for fault isolation. Any automatic fault displays which occur during fast checkout are fault isolated by fault isolation reference indexes having an "A" prefix. Refer to Section Trouble Shooting for a complete description of automatic fault displays.

(b) Complete Checkout

- 1) The procedure in table 504 checks its status and examines primary and secondary functions and signal interfaces. The aircraft must be stationary during the procedure. A reference index number (example "7") follows each result and identifies the entry point into the trouble analysis table 101 for fault isolation. Any automatic fault displays which occur during complete checkout are fault isolated by fault isolation reference indexes having an "A" prefix. Refer to Section Trouble Shooting for a complete description of automatic fault displays.

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PART NO OR TYPE DESIGNATOR	FIGURE AND INDEX NO.	NOMENCLATURE	USE AND APPLICATION
Equivalent tools or test equipment are authorized for use unless identified by a no substitute notation			
TOOLS			
None required			
TEST EQUIPMENT			
Simpson 260		Multimeter	Checking voltage and continuity in navigation equipment rack
NF-2		Portable light	Illumination of interior of navigation equipment rack
204-90059-1 Boeing (Local Manufacture)		Extension cord	Use with portable light

Inertial Navigation System - Tools and Test Equipment
Table 501

ITEM	TYPE	MANUFACTURER OR SPECIFICATION	USE
Temperature Indicator		Wahl Temp-Plate Record #240 160-F 170-F, 180-F, 190-F	Monitoring temperature of navigation unit

Consumable Materials
Table 502

Ref T O 1E-3A-2-34-2
Page 3-1 Change 5
Page 3-2 Change 24



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STEP	RESULT
1 Ensure electrical power is applied to aircraft 2 Ensure equipment cooling is applied 3 Close following circuit breakers . (a) On circuit breakers panel P5 INS No 1 PWR INS No 1 HTR AUTOPILOT INS No 2 PWR (if INS 2 installed) INS No 2 HTR (if INS 2 installed) XMFR No 1 AC FLT INST No 1 BRG EXC FLT INST No 2 HDG EXC CADC AC FLT INST No 1 ATT EXC XMFR No 2 AC FLT INST No 2 BRG EXC FLT INST No 2 HDG EXC FLT INST No 2 ATT EXC LEVER LATCH & ANTI-SKID RELAYS SAFETY RELAYS INS XFER	

Inertial Navigation System Fast Checkout
Table 503 (Sheet 1 of 4)

Ref T O 1E-3A-2-34-2



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STEP	RESULT
4 Check that autopilot engage switch is set to OFF on aisle stand. <u>CAUTION</u> DO NOT PROCEED IF WARN LIGHT ON CDU COMES ON EQUIPMENT MAY BE DAMAGED IF CHECKOUT IS CONTINUED	
5 If WARN light on either CDU comes on during fast checkout, refer to trouble analysis reference index A W <u>NOTE</u> The probe heaters must be off during checkout or the CADC may give an erroneous airspeed while the aircraft is on the ground	
6 Set both PROBE HEATERS switches to OFF on overhead panel P13	
7 Set mode selector to ALIGN on each MSU Note time of day accurate to hour and minute to determine speed at which each INS reaches its final alignment stages <u>NOTE</u> In any step, if a fault or action display occurs, do not proceed with fast checkout Perform complete checkout Except for fault displays, disregard unspecified indicators	INSERT light comes on on No 1 CDU 1 2 INSERT light comes on on No 2 CDU 6 2
8 Set data Selector to DSRTK/STS on CDU of INS No 1 <u>NOTE</u> DIM control on CDU may be rotated clockwise to obtain a brighter display	<u>NOTE</u> A dash (-) in any reference to a display designates a blank digit X may be any number between 9 and 0 CDU right data display shows 0---5 2 37

Inertial Navigation System Fast Checkout
Table 503 (Sheet 2 of 4)

Ref. T O 1E-3A-2-34-2



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STEP	RESULT
9 Press TEST switch on CDU of INS No 1	The following indicators come on 37 CDU indicators HOLD, REMOTE, INSERT ALERT, BAT, WARN WYPT CHG MSU indicators READY, NAV, BAT CDU left data display shows 88888 N/S CDU RIGHT DATA DISPLAY SHOWS 88888 E W CDU FROM-TO display shows 88 (37 2 and 7 for No 2 CDU)
10 Release TEST switch on CDU	All CDU and MSU indicators that come on when TEST switch was pressed go off CDU right data display reverts to 046-X5 5
11 Press and release TEST switch on CDU	CDU right data display indicates 0---X5 5 <u>NOTE</u> With climb, the numeral at X will decrease below 9
12 Repeat steps 13, 14, 15, and 16 for CDU of INS No 2	
13 Set mode selector to OFF on each INS mode select unit.	
14. Open following circuit breakers	
(a) On circuit breakers panel P5	
INS No 1 PWR	
INS No 1 HTR	
AUTOPILOT	

Inertial Navigation System Fast Checkout
Table 503 (Sheet 3 of 4)

Ref T O 1E-3A-2-34-2

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STEP	RESULT
INS No 2 PWR INS No 2 HTR XMFR No 1 AC FLT INST No 1 BRG EXC CADC AC FLT INST No 1 ATT EXC XMFR No 2 AC FLT INST No 2 BRG EXC FLT INST No 2 HDG EXC FLT INST No 2 ATT EXC LEVER LATCH & ANTI-SKID RELAYS SAFETY RELAYS INS XFER	
15 If no longer required for other maintenance	
16 Ensure aircraft electrical power is removed if no longer required	

Inertial Navigation System Fast Checkout
 Table 503 (Sheet 4 of 4)

Ref. T.O 1E-3A-2-34-2



MAINTENANCE MANUAL

STEP	RESULT
1 Ensure electrical power is applied to aircraft. 2 Ensure equipment cooling is applied 3 Close the following circuit breaker on P5 Circuit breaker panel : INS No 1 PWR INS No 1 HTR AUTOPILOT INS No 2 PWR (if installed) INS No 2 HTR (if installed) XMFR No 1 AC FLT INST No 1 BRG EXC FLT INST No 1 HDG EXC CADC AC FLT INST No 1 ATT EXC XMFR No 2 AC FLT INST No 2 BRG EXC FLT INST No 2 HDG EXC FLT INST No 2 ATT EXC LEVER LATCH & ANTI-SKID RELAYS SAFETY RELAYS INS XFER	

Inertial Navigation System Fast Checkout
Table 503 (Sheet 1 of 9)

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MAINTENANCE MANUAL

STEP	RESULT
4 Check that autopilot engage switch is set to OFF on aisle stand <u>CAUTION</u> DO NOT PROCEED IF WARM LIGHT ON CDU COMES ON EQUIPMENT MAY BE DAMAGED IF CHECKOUT IS CONTINUED.	
5 If warm light on either CDU comes on during complete checkout, refer to trouble analysis reference index A W <u>NOTE</u> The probe heaters must be off during checkout or the CADC may give an erroneous airspeed while the airspeed is on ground	
6 Set both PROBE HEATERS switches to OFF on overhead panel P13	
7 Set mode selector to ALIGN on each MSU <u>NOTE</u> In any step, if a fault or action display occurs, consult the trouble analysis table Except for fault displays and warning indicators, disregard lighting of unspecified indicators	INSERT light comes on on NO 1 CDU 1 2 INSERT light comes on on NO 2 CDU 6 2
8 Set data selector to DSRTR/STS on CDU of INS NO 1 <u>NOTE</u> DIM control on CDU may be rotated clockwise to obtain a brighter display	<u>NOTE</u> A dash (-) in any reference to a display designates a blank digit x may be any number between 9 and 0 CDU right data display shows 0---X5 2 37

Inertial Navigation System Fast Checkout
Table 503 (Sheet 2 of 9)

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STEP	RESULT
9 Press and hold TEST switch on CDU <u>NOTE</u> When data selector is set to DSRTR/STS and TEST switch is pressed and released, temporary fault in INS will be displayed in second and third digits from left in right data display. If no temporary faults have occurred, the two digits are blank	The following indicators come on 37 CDU indicators, HOLD, REMOTE, INSERT, ALERT, BAT, WARN, WYPT CHG 2 MSU indicators READY NAV, BAT CDU left data display shows 88888° N/S 3 CDU right data display shows 888888 E/W CDU FROM-TO display shows 88 (32 2 and 7 for CDU of INS No 2)
10 Rotate DIM control on CDU	Intensity of lighting for HOLD, REMOTE, INSERT, and ALERT indicators, both data displays, WY PT CHG and the FROM-TO display, will vary in proportion 4
11 Release TEST switch on CDU	All CDU and MSU indicators which came on when TEST switch was pressed go out CDU right data display reverts to 046-X5. 5
12 Press and release TEST switch on CDU	Right data display indicates 0 --- X5 5
	<u>NOTE</u> X may be any number between 9 and 0
13 Repeat steps 13 through 17 for CDU of INS No 2	
14 Pull out mode selector knob and set to ATT on both MSU's	Both data displays and FROM-TO display in each CDU will go blank 8
15 Pull out mode selector knob and set to OFF then to ALIGN on both MSU's Note time of day accurate to the hour and minute to determine the speed at which each INS reaches its final alignment stages	

Inertial Navigation System Fast Checkout
Table 503 (Sheet 3 of 9)

Ref T O 1E-3A-2-34-2

STEP	RESULT																		
16 Set data selector on CDU of INS No 1 to each of the following positions and check that decimal and degree symbols are positioned properly in left and right data displays for each position TK/GS HDG DA XTK TKE POS WAY PT DIS/TIME WIND DSRKT/STS	<u>NOTE</u> Z indicates a blank display, the numbers 0 through 9, or the letters L or R Data Displays <table> <tr> <th>Left</th><th>Right</th></tr> <tr> <td>ZZZZ Z°</td><td>ZZZZZZ</td></tr> <tr> <td>ZZZZ Z°</td><td>ZZZZZZ°</td></tr> <tr> <td>ZZZ.ZZ°</td><td>ZZZZZZ°</td></tr> <tr> <td>ZZ°ZZ Z</td><td>ZZZ°ZZ Z</td></tr> <tr> <td>ZZ°ZZ Z</td><td>ZZZ°ZZ Z</td></tr> <tr> <td>ZZZZZ</td><td>ZZZZZ Z</td></tr> <tr> <td>ZZZZZ°</td><td>ZZZZZZ</td></tr> <tr> <td>ZZZZZ °</td><td>ZZZZZZ</td></tr> </table>	Left	Right	ZZZZ Z°	ZZZZZZ	ZZZZ Z°	ZZZZZZ°	ZZZ.ZZ°	ZZZZZZ°	ZZ°ZZ Z	ZZZ°ZZ Z	ZZ°ZZ Z	ZZZ°ZZ Z	ZZZZZ	ZZZZZ Z	ZZZZZ°	ZZZZZZ	ZZZZZ °	ZZZZZZ
Left	Right																		
ZZZZ Z°	ZZZZZZ																		
ZZZZ Z°	ZZZZZZ°																		
ZZZ.ZZ°	ZZZZZZ°																		
ZZ°ZZ Z	ZZZ°ZZ Z																		
ZZ°ZZ Z	ZZZ°ZZ Z																		
ZZZZZ	ZZZZZ Z																		
ZZZZZ°	ZZZZZZ																		
ZZZZZ °	ZZZZZZ																		
17 Repeat step 22 for CDU of INS No 2																			
18 Check that data selector is set to DSRKT/STS on each CDU	On each CDU, the right data display will display 0 --- X5 5 <u>NOTE</u> In above display, the X is the alignment performance index (PI) indicating start of inertial alignment. With time, the PI will decrease below 9 BAT light on each CDU will come on for approximately 13 seconds during a PI of 8																		
19 Simultaneously press and release TEST and HOLD switches on CDU of INS No 1 <u>NOTE</u> When data selector is set to DSRKT/STS and both TEST and HOLD switches are simultaneously pressed and released, recorded faults in INS since last alignment will be displayed in second and third digits from	On switch release, the right data display will revert to 046-X5 5 <u>NOTE</u> X may be any number between 9 and 0																		



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1

STEP	RESULT
left in right data display If no faults have been recorded, the digits will be blank	
20 Press and release TEST switch on CDU	Right data display indicates 0---X5 5
21 Repeat steps 25 and 26 for CDU of INS No 2	
22 Observe right data display of each CDU	Second digit from right in right data display decreases to 8 or less In CDU of INS No 1 9 In CDU of INS No 2 10
23 Set data selector to POS on both CDU's	
<u>NOTE</u> In following steps, unless otherwise stated, press means press for one second and release Where more than one	
24 Initialize INS according to table 2 step 6 thru 16	
25 Prepare for interface tests as follows	
a Set AUTO MAN switch to MAN on each CDU	
b Set both NAV MODE selectors to INS and both flight director MODE SEL switches to HDG on glare shield	
c Press COURSE knob on HSI's on both instrument panels	
d. Set ADI switch to INS and AUTOPILOT INS SOURCE switch to INS 1 on pilot instrument panel	
e Set YAW DAMPER switch to ON on overhead panel P13	

Inertial Navigation System Complete Checkout
 Table 504 (Sheet 5 of 9)
 Ref T.O 1E-3A-2-34-2



MAINTENANCE MANUAL

STEP	RESULT												
f Set TURN knob to detent (arrow on TURN knob points forward) on AUTOPILOT CONTROLLER panel g Center control wheel on either control column WARNING ENSURE ALL PERSONNEL ARE CLEAR OF CONTROL SURFACES, LINKAGES, AND CONTROL CABLES STEPS 44I THROUGH 51 MAY CAUSE CONTROL SURFACES, LINKAGES, AND CONTROL CABLES TO MOVE WHICH COULD CAUSE INJURY h Set AUTOPILOT switch to on on AUTOPILOT CONTROLLER panel j Set mode selector to NAV LOC on AUTOPILOT CONTROLLER panel													
26 Set data selector to WIND and press and hold TEST switch on CDU of INS NO 1	The following indications occur on pilot HSI 23 <table> <tr> <td>NAV flag</td><td>Retracted</td></tr> <tr> <td>HEADING flag</td><td>Retracted</td></tr> <tr> <td>Bearing pointer No 1</td><td>N</td></tr> <tr> <td>Course deviation bar</td><td>One dot right</td></tr> <tr> <td>Compass card</td><td>N under lubber line</td></tr> <tr> <td>Course arrow</td><td>N</td></tr> </table> Control wheel on each control column rotates clockwise approximately 50 degrees 24	NAV flag	Retracted	HEADING flag	Retracted	Bearing pointer No 1	N	Course deviation bar	One dot right	Compass card	N under lubber line	Course arrow	N
NAV flag	Retracted												
HEADING flag	Retracted												
Bearing pointer No 1	N												
Course deviation bar	One dot right												
Compass card	N under lubber line												
Course arrow	N												
27 Release TEST switch.	Control wheel centers HSI returns to previous indication 24												

Inertial Navigation System Complete Checkout
Table 504 (Sheet 6 of 9)
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STEP	RESULT												
28 Set AUTO MAN switch to AUTO and press and hold TEST switch an CDU of INS NO 1	The following indications occur on pilot HSI 23 <table> <tr> <td>NAV flag</td><td>Retracted</td></tr> <tr> <td>HEADING flag</td><td>Retracted</td></tr> <tr> <td>Bearing pointer No 1</td><td>N</td></tr> <tr> <td>Course deviation bar</td><td>One dot right</td></tr> <tr> <td>Compass card</td><td>N under lubber line</td></tr> <tr> <td>Course arrow</td><td>N</td></tr> </table> Control wheel on each control column rotates counterclockwise approximately 50 degrees 24	NAV flag	Retracted	HEADING flag	Retracted	Bearing pointer No 1	N	Course deviation bar	One dot right	Compass card	N under lubber line	Course arrow	N
NAV flag	Retracted												
HEADING flag	Retracted												
Bearing pointer No 1	N												
Course deviation bar	One dot right												
Compass card	N under lubber line												
Course arrow	N												
29 Release TEST switch	Control wheel centers HSI returns to previous indication 24												
30 Set AUTOPILOT INS SOURCE switch to INS 2 ALTERNATE on pilot instrument panel													
31 Set ADI switch to INS on copilot instrument panel													
32 Repeat steps 441 and j, and 45 through 48 for CDU of INS NO. 2 and copilot HSI													
33 Return interface to normal as follows													
a Set AUTOPILOT INS SOURCE switch to INS 1 on pilot instrument panel													
b Set YAW DAMPER switch to OFF on overhead panel													
34 Test INS No 1 status as follows	Right data display will indicate 0---XS. When 5 number at X (alignment performance index) decreases to-5, READY NAV indicator on associated mode select unit												
a Set data selector to DSRTK/STS on CDU													

Inertial Navigation System Complete Checkout
Table 504 (Sheet 7 of 9)
Ref T O 1E-3A-2-34-2



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STEP	RESULT
	will come on 19 Do not proceed until number at X is 5 or less and READY NAV indicator on MSU comes on <u>NOTE</u> . Performance index may take up to 35 minutes to reach 5 at 68°F or up to 50 minutes at -68°F The measurement of time is started when the mode selector on the MSU is set to ALIGN in step 20
b Press TEST switch and release when all CDU indicators come on	On release, right data display reverts to 046-X5 5
c Press and release TEST switch	Right data display indicates 0 ---,XS
35 Repeat step for for CDU of INS No 2 <u>NOTE</u> To prevent inadvertent setting to ATT, do not pull mote selector knob MSU outward	<u>NOTE</u> X may be any number between 5 and 0
36 Set mote selector on MSU No 1 to NAV until READY NAV indicators on both MSU's go out, then back to ALIGN	On each MSU, READY NAV goes of 21 On each CDU, right data display is 1---X- 34 On system mode control, at DAPG switch, INS 1 indicator comes on 22 <u>NOTE</u> X may be any number between 5 and 0
37 Pull mode selector knob and set to STBY on MSU of INS NO 1	INS 1 indicator goes out and INS 2 indicator comes on on system mode control 16 22
38 Set mode selector to OFF on each MSU	
39 Open following circuit breakers on P5 circuit breakers panel . INS No 1 PWR INS No 1 HTR	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 8 of 9)
Ref . T.O 1E-3A-2-34-2

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STEP	RESULT
AUTOPILOT INS No 2 PWR INS No 2 HTR XMFR No 1 AC FLT INST No 1 BRG EXC FLT INST No 1 HDG EXC CADC AC FLT INST No 1 ATT EXC XMFR No 2 AC FLT INST No 2 BRG EXC FLT INST No 2 HDG EXC FLT INST No 2 ATT EXC LEVER LATCH & ANTI-SKID RELAYS SAFETY RELAYS INS XFER 40 Remove equipment cooling if no longer required 41 Ensure aircraft electrical power is removed if no longer required <u>NOTE</u> If this checkout was performed as a result of observing a black thermal decal on one of the navigation units and this checkout was successful, perform step 65. 42 Apply a thermal indicator decal on navigation unit without removing older one	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 9 of 9)
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STEP	RESULT																		
16 Release TEST switch on CDU	All CDU and MSU indicators which came on when TEST switch was pressed go out CDU right data display reverts to 046-X5 5																		
17 Press and release TEST switch on CDU	Right data display indicates 0---X5 5 <u>NOTE</u> X may be any number between 9 and 0																		
18 Repeat steps 13 through 17 for CDU of INS No 2																			
19 Pull out mode selector knob and set to ATT on both MSU's	Both data displays and FROM-TO display in each CDU will go blank 8																		
20 Pull out mode selector knob and set to OFF then to ALIGN on both MSU's Note time of day accurate to the hour and minute to determine the speed at which each INS reaches its final alignment stages																			
21 Close NAVIGATION-OMEGA NAV RCVR CMPTR circuit breaker on P6 circuit breaker panel																			
22 Set data selector on CDU of INS No 1 to each of the following positions and check that decimal and degree symbols are positioned properly in left and right data displays for each position	<u>NOTE</u> Z indicates a blank display, the numbers 0 through 9, or the letters L or R Data Displays <table> <tr> <td>Left</td><td>Right</td></tr> <tr> <td>TK/GS</td><td>ZZZZZ</td></tr> <tr> <td>HDG DA</td><td>ZZZZZ°</td></tr> <tr> <td>XTK TKE</td><td>ZZZZZ°</td></tr> <tr> <td>POS</td><td>ZZ° ZZ Z</td></tr> <tr> <td>WAY PT</td><td>ZZ° ZZ Z</td></tr> <tr> <td>DIS/TIME</td><td>ZZZZZ Z</td></tr> <tr> <td>WIND</td><td>ZZZZZ</td></tr> <tr> <td>DSRTK/STS</td><td>ZZZZZ °</td></tr> </table>	Left	Right	TK/GS	ZZZZZ	HDG DA	ZZZZZ°	XTK TKE	ZZZZZ°	POS	ZZ° ZZ Z	WAY PT	ZZ° ZZ Z	DIS/TIME	ZZZZZ Z	WIND	ZZZZZ	DSRTK/STS	ZZZZZ °
Left	Right																		
TK/GS	ZZZZZ																		
HDG DA	ZZZZZ°																		
XTK TKE	ZZZZZ°																		
POS	ZZ° ZZ Z																		
WAY PT	ZZ° ZZ Z																		
DIS/TIME	ZZZZZ Z																		
WIND	ZZZZZ																		
DSRTK/STS	ZZZZZ °																		

Inertial Navigation System Complete Checkout
Table 504 (Sheet 5 of 26)

Ref T O 1E-3A-2-34-2
Page 3-14 Change 5
Page 3-15 Chnage 9

MAINTENANCE MANUAL

STEP	RESULT
23 Repeat step 22 for CDU of INS No 2	
24 Check that data selector is set to DSRTK/STS on each CDU	On each CDU, the right data display will display 0---X5. 5
	<u>NOTE</u> • In above display, the X is the alignment performance index (PI) indicating start of inertial alignment. With time, the PI will decrease below 9 • BAT light on each CDU will come on for approximately 13 seconds during a PI of 8.
25 Simultaneously press and release TEST and HOLD switches on CDU of INS No 1	On switch release, the right data display will revert to 046-X5 5
<u>NOTE</u> When data selector is set to DSRTK/STS and both TEST and HOLD switches are simultaneously pressed and released, recorded faults in INS since last alignment will be displayed in second and third digits from left in right data display. If no faults have been recorded, the digits will be blank	<u>NOTE</u> X may be any number between 9 and 0
26 Press and release TEST switch on CDU	Right data display indicates 0---X5 5
27 Repeat steps 25 and 26 for CDU of INS No 2	
28 Observe right data display of each CDU	
29 Set data selector to POS on both CDU's	Second digit from right in right data display decreases to 8 or less. In CDU of INS No 1 9 In CDU of INS No 2 10
<u>NOTE</u> In following steps, unless otherwise stated, press means press for one second and release. Where more than one	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 6 of 26)

Ref . T O 1E-3A-2-34-2
Page 3-15 Change 9
Page 3-16 Change 23

MAINTENANCE MANUAL

STEP	RESULT
switch is listed, press in order listed	
30 Set mode selector to OMEGA on system mode control. Press MODE ENABLE switch-indicator. If indicator comes on, press again so indicator goes off	SCI left single character data indicator displays a D SCI left data register displays 94103-39 41 SCI right single character data indicator displays an M or P SCI CLEAR key and EP/ET indicator come on 13 MODE ENABLE switch-indicator goes off 38
31 Verify correct modification and correction numbers are displayed in right data register	SCI right data register displays XX--YY 12 <u>NOTE</u> Number at XX is modification number of computer program Number at YY is correction number of computer program
32 Press CLEAR key on SCI	SCI left and right data register displays go blank. Following indicators on SCI and segments on SCI keyboard are on 39 35 13 Ω-SIG, EP/ET, DISPLAY, ENTER <u>NOTE</u> Ω-SIG indicator should go off 5 to 11 minutes after it comes on 20
33 Enter present position as follows on system control-indicator a Press ENTER and POS b Press NORTH if in northern hemisphere, or SOUTH if in southern hemisphere c Enter aircraft present latitude, correct to 0.1 minute as shown in	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 7 of 26)

Ref T O 1E-3A-2-34-2
 Page 3-16 Change 23
 Page 3-16 Change 23

MAINTENANCE MANUAL

STEP	RESULT
following example If latitude is 47 degrees 32 0 minutes, the following keys should be pressed in the order shown 4,7,3,2,0. Include leading zero for all latitudes less than 10 degrees d. If left data register displays desired latitude entry, press INSERT If data was entered incorrectly, press CLEAR and repeat steps 33a, b, c, and d. e Press WEST if in western hemisphere, EAST if in eastern hemisphere f. Enter aircraft present longitude, correct to 0 1 minute as shown in following example If longitude is 112 degrees 18 5 minutes, the following keys should be pressed in the order shown: 1,1,2,1,8,5 Include leading zero for all longitudes less than 100 degrees (Two zeros if longitude is less than 10 degrees) g If right data register displays desired longitude entry, press INSERT If data was entered incorrectly, press CLEAR and repeat steps 33e, f, and g	
34 Check that left and right data displays in both CDU's show the same latitude and longitude (± 0 1 minute) as that which was inserted at the SCI	15
35. Insert present time as follows on system control-indicator 39 35	14

Inertial Navigation System Complete Checkout
Table 504 (Sheet 8 of 26)

Ref T O 1E-3A-2-34-2
Page 3-17 Change 11

MAINTENANCE MANUAL

STEP	RESULT
a Press ENTER and D-GMT b Enter Greenwich date by pressing six numbered switches, the first pair designating last digits of the current year, the next pair the month, the last pair the day For example if Greenwich date is July 4, 1976, press 760704. <u>NOTE</u> Greenwich date may differ from local by one day c If left data register displays correct date, press INSERT If data was entered incorrectly, press CLEAR and repeat steps 35a, b, and c d Determine a convenient upcoming Greenwich mean time (GMT) Press six numbered switches, the first pair designating the hours, the next pair the minutes, and the last pair the seconds of the selected GMT e If right data register displays wrong GMT (data entered incorrectly), press CLEAR and repeat steps 35a through e <u>NOTE</u> • A time standard Such as a watch which is within 5 minutes of the actual GMT may be used • GMT insertion into the omega computer must be within 5 seconds of the time standard used This precision is required for checking the omega computer clock accuracy	Left and right single character data indicators will display D and T respectively. 17

Inertial Navigation System Complete Checkout
Table 504 (Sheet 9 of 26)

Ref T O 1E-3A-2-34-2
Page 3-18 Change5

MAINTENANCE MANUAL

STEP	RESULT
f A few seconds before the selected GMT, hold down INSERT switch. Release INSERT switch in synchronism with the time signal marking selected GMT. <u>NOTE</u> • WWV broadcasts omega station status for approximately 40 seconds starting 16 minutes after the hour. • Any omega station which is not operating should be deleted from the Kalman filter process. Omega stations more than 8000 miles from the aircraft may also be deleted. <u>NOTE</u> Status bits, set the last time the computer was turned off, can be recalled at this time if desired for trouble analysis. Refer to Stored Status Word Recall and Translation table.	EP/ET indicator goes out 18
36 Determine status of omega stations as follows on SCI a Press CLEAR (if on) DISPLAY LOR/Ω ENTER 1 b Observe and note burst strengths of 3 to 9 which are fairly constant	Left data register displays burst strength of stations ABCD-- Right data register displays burst strength of stations EFGH-- Burst strength is represented by a number between 0 and 9. Number 4 on SCI comes on showing 10 20 KHz signal is being monitored 20 39 35 <u>NOTE</u> Letters of the omega stations being used for synchronization come on on the SCI for each signal monitored

Inertial Navigation System Complete Checkout
Table 504 (Sheet 10 of 26)

Ref : T O 1E-3A-2-34-2
Page 3-19 Change 23

MAINTENANCE MANUAL

STEP	RESULT
c Press NEXT and repeat step b	Number 5 on SCI comes on, indicating 13 60 KHz signal is being monitored
d Repeat step c	Number 6 on SCI comes on, indicating 11 33 RHz signal is being monitored
e Select four omega stations which have strongest burst strengths for all three frequencies. If no stations are usable, refer to 20	
37 Delete four unusable omega stations as follows on SCI	
a Press CLEAR (if on)	
b Press ENTER LOR/Ω	Letters A through H are displayed on SCI 39 35
c Press letters corresponding to omega stations being deleted	Letters which are pressed go off 39 35
A - Norway B - Liberia C - Hawaii D - North Dakota E - LaReunion Island F - Argentina G - Australia H - Japan	
d Press ENTER	Letters corresponding to omega stations being deleted come on 39 35 Letters corresponding to omega stations not being deleted go off 39 35
e If incorrect omega station deletion data was keyed in, press CLEAR and repeat steps b through d	
f Press INSERT	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 11 of 26)

Ref T O 1E-3A-2-34-2
Page 3-19 Change 23
Page 3-20 Change 16

MAINTENANCE MANUAL

STEP	RESULT
NOTE •The omega stations deleted above will remain deleted until the mode selector on the SMC is set to OFF. If the mode selector is set to any omega mode after being set to OFF, all unusable omega stations must be deleted again •Steering patterns are inserted in steps 38 through 41 only for checking the omega computer and are not recommended steering patterns for flight 38 Insert circle pattern number one steering data as follows on SCI a Press CLEAR (if on) ENTER CIRCLE 1 and INSERT b Press NORTH 4 1 0 7 0 and INSERT c Press WEST 0 9 5 5 5 and 0	N -41°07 0 displayed on SCI ----- 39 35 N W -41°07 0 095°55 0 39 35 displayed on SCI.

Inertial Navigation System Complete Checkout
Table 504 (Sheet 12 of 26)

Ref • T.O 1E-3A-2-34-2
Pages 3-20 and 3-20A Change 16

MAINTENANCE MANUAL

STEP	RESULT
d Press INSERT 0 0 3 and 5	R --003 5 35 ----- 39 displayed on SCI
e Press INSERT	
f Press CW	CCW switch-indicator goes off 39 35
g Press INSERT	REJECT indicator comes on 39 35
	<u>NOTE</u> REJECT indicator came on because radius of circle must be at least 5 nautical miles The radius inserted was 3 5 nautical miles
h Repeat steps a, b, and c	
i Press INSERT 0 9 5 and 0	R --095 0 ----- 39 35
j Press INSERT	
k Press CCW	CW switch-indicator goes off
l Press INSERT	
<u>NOTE</u> Circle pattern number one which has center at 41 de grees 07 minutes north, 95 degrees 55 minutes west, a radius of 95 0 nautical miles, and counterclockwise flight around pattern is now inserted	
39 Insert figure 8 pattern number 3 steering data as follows on SCI	

Inertial Navigation System Complete Checkout
 Table 504 (Sheet 13 of 26)

Ref T O 1E-3A-2-34-2
 Page 3-20A Change 16
 Page 3-21 Change 7

MAINTENANCE MANUAL

STEP	RESULT
a Press ENTER FIG 8 3 and INSERT	
b Press NORTH 4 7 0 9 0 and INSERT	N -47° 09 0 displayed on SCI N ----- 39 35
c Press WEST 1 2 2 2 9 and 0	N W -47° 09 0 122° 29 0 39 35 displayed on SCI
d Press INSERT	
e Press NORTH 4 1 0 7 0 and INSERT	N -41° 07 0 displayed on SCI ----- 39 35
f Press WEST 1 1 1 5 8 and 0	N W -41° 07 0 111° 58 0 39 35 displayed on SCI

Inertial Navigation System Complete Checkout
Table 504 (Sheet 14 of 26)

Ref T O 1E-3A-2-34-2
 Pages 3-21 Change 7
 Page 3-22 Change 7

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MAINTENANCE MANUAL

STEP	RESULT
g Press INSERT 1 2 5 0	R - —125 0 ---- 39 35
h Press INSERT	
i Press CW	CCW switch-indicator goes off 39 35
j Press INSERT	
<u>NOTE</u> •Figure 8 pattern number three which has one lobe at 47 degrees 9 minutes north, 122 degrees 29 minutes west, the other lobe at 41 degrees 7 minutes north, 111 degrees 58 minutes west, a radius of 125 nautical miles for both lobes, and clockwise flight around the first lobe is now inserted •The radius for one lobe cannot be different than the radius of the other lobe	
41 Insert racetrack pattern number one steering data as follows on SCI	
a Press ENTER RCE TK 1 and INSERT	
b Press NORTH 4 3 3 4 0 and INSERT	N - 43° 34 0 ---- 39 35 displayed on SCI

Inertial Navigation System Complete Checkout
 Table 504 (Sheet 15 of 26)

Ref - T O 1E-3A-2-34-2
 Page 3-22 Change 7
 Page 3-23 Change 7

MAINTENANCE MANUAL

STEP	RESULT												
c Press WEST 1 1 6 1 4 and 0	<table><tr><td>N</td><td>W</td><td></td><td></td></tr><tr><td>-43° 34 0</td><td>116° 14 0</td><td>39</td><td>35</td></tr><tr><td>displayed on SCI</td><td>- -</td><td></td><td></td></tr></table>	N	W			-43° 34 0	116° 14 0	39	35	displayed on SCI	- -		
N	W												
-43° 34 0	116° 14 0	39	35										
displayed on SCI	- -												
d Press INSERT													
e Press NORTH 4 1 0 7 0 and INSERT	<table><tr><td>N</td><td>-</td><td></td><td></td></tr><tr><td>-41° 07 0</td><td>-----</td><td>39</td><td>35</td></tr><tr><td>displayed on SCI</td><td></td><td></td><td></td></tr></table>	N	-			-41° 07 0	-----	39	35	displayed on SCI			
N	-												
-41° 07 0	-----	39	35										
displayed on SCI													
f Press WEST 1 1 1 5 8 and 0	<table><tr><td>N</td><td>W</td><td></td><td></td></tr><tr><td>-41° 07 0</td><td>111° 58 0</td><td>39</td><td>35</td></tr><tr><td>displayed on SCI</td><td></td><td></td><td></td></tr></table>	N	W			-41° 07 0	111° 58 0	39	35	displayed on SCI			
N	W												
-41° 07 0	111° 58 0	39	35										
displayed on SCI													
g Press INSERT 0 2 0 and 0	<table><tr><td>R</td><td>-</td><td></td><td></td></tr><tr><td>-020 0</td><td>-----</td><td>39</td><td>35</td></tr></table>	R	-			-020 0	-----	39	35				
R	-												
-020 0	-----	39	35										
h Press INSERT													
i Press CW	CCW switch indicator goes off 39 35												
j Press INSERT													

Inertial Navigation System Complete Checkout
Table 504 (Sheet 16 of 26)

Ref T O 1E-3A-2-34-2
Pages 3-23 Change 7

MAINTENANCE MANUAL

STEP	RESULT
<u>NOTE</u> Racetrack pattern number one which has one lobe at 43 degrees 34 minutes north, 116 degrees 14 minutes west, the other lobe at 41 degrees 7 minutes north, 111 degrees 58 minutes west, a radius of 20 nautical miles for both lobes, and clockwise flight around the racetrack is now inserted	
41 Insert line pattern number two steering data as follows on SCI	
a Press ENTER LINE 2 and INSERT	
b Press NORTH 2 7 5 9 0 and INSERT	N -27° 59 0 displayed on SCI ----- 39 35
c Press WEST 0 8 2 3 2 and 0	N W -27° 59 0 082° 32 0 displayed on SCI 39 35
d Press INSERT NORTH 2 5 4 8	N -25° 48 9 displayed on SCI ----- 39 35

Inertial Navigation System Complete Checkout
Table 504 (Sheet 17 of 26)

Ref T O 1E-3A-2-34-2
Page 3-24 Change 7

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MAINTENANCE MANUAL

STEP	RESULT
9 and INSERT e Press WEST 0 8 0 1 7 and 0 f Press INSERT ant CCW g. Press INSERT and CW h Press INSERT	N -25° 48 9 displayed on SCI W 080° 17 0 39 35 CW switch-indicator goes off 39 35 CCW switch-indicator goes off
<u>NOTE</u> Line pattern number two, which has one end at 27 degrees 59 minutes north, 82 degrees 32 minutes West with a counterclockwise turn-around path, and the other end at 25 degrees 48 minutes north, 80 degrees 17 minutes west with a clockwise turn-around path, is now inserted	
42 Press and hold PNL TEST switch on system mode control. During test, rotate DIM control on SMC Release PNL TEST switch	The following indicators on the system mode control come on DISP and GEOD near the POLE switch, 1 and 2 near the ADC switch, INS 1 and INS 2 near the DAPG switch, SELECT INFLT ALIGN 16 switch-indicator, MODE ENABLE switch-indicator As DIM control is rotated, intensity of all indicators on SMC will vary proportionally 32 D-TOT indicator on system control-indicator comes on 16

Inertial Navigation System Complete Checkout
Table 504 (Sheet 18 of 26)

Ref T O. 1E-3A-2-34-2
Pages 3-24 Change 7
Page 3-25 Change 15

MAINTENANCE MANUAL

STEP	RESULT
43 Press and release PANEL TEST button on system control-indicator. During test, rotate DIM control on SCI <u>NOTE</u> Ignore READY NAV indicators on INS MSUs if on INS #1 and INS #2 must be in ALIGN mode to accomplish autopilot interface tests	During next 8 seconds, following displays come on During first 4-second period ALIGN, -SIG, D-MEM, HOLD, CMPTR, DPLR, OMEGA, WARN, and all segments on keyboard indicators During last 4-second period All 16 segments of each single character data indicator, and 888°8 8 8 in each data register 13 As DIM control is rotated, intensity of all displays and indicators will vary proportionally except edge lighting and CMPTR 33
44 Prepare for interface tests as follows a Set AUTO MAN switch to MAN on each CDU b Set both NAV MODE selectors to INS and both flight director MODE SEL switches to HDG on glare shield c Press COURSE knob on HSI's on both instrument panels d Set ADI switch to INS and AUTOPILOT INS SOURCE switch to INS 1 NORMAL on pilot instrument panel e Set YAW DAMPER SERIES switch to OFF and YAW DAMPER PARALLEL switch to ON on overhead panel P13. f Set STAB TRIM AUTOMATIC switch to NORMAL on control stand g Set TURN knob to detent (arrow on TURN knob points forward) on AUTOPILOT CONTROLLER panel h Center control wheel on either control column	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 19 of 26)

Ref T O 1E-3A-2-34-2
Page 3-25 Change 15
Page 3-26 Change 7

MAINTENANCE MANUAL

STEP	RESULT												
<u>WARNING.</u> ENSURE ALL PERSONNEL ARE CLEAR OF CONTROL SURFACES, LINKAGES, AND CONTROL CABLES STEPS 44I THROUGH 51 MAY CAUSE CONTROL SURFACES, LINKAGES, AND CONTROL CABLES TO MOVE WHICH COULD CAUSE INJURY.													
i Set AUTOPILOT switch to AUTOPILOT on AUTOPILOT CONTROLLER panel													
j Set mode selector to NAV LOC on AUTOPILOT CONTROLLER panel													
k Set RADIO ALTIMETER switch to OFF on overhead panel P-13													
45 Set data selector to WIND and press and hold TEST switch on CDU of INS NO 1	The following indications occur on pilot HSI 23 <table> <tr> <td>NAV flag</td><td>Retracted</td></tr> <tr> <td>HEADING flag</td><td>Retracted</td></tr> <tr> <td>Bearing pointer No 1</td><td>N</td></tr> <tr> <td>Course deviation bar</td><td>One dot right</td></tr> <tr> <td>Compass card</td><td>N under lubber line</td></tr> <tr> <td>Course arrow</td><td>N</td></tr> </table>	NAV flag	Retracted	HEADING flag	Retracted	Bearing pointer No 1	N	Course deviation bar	One dot right	Compass card	N under lubber line	Course arrow	N
NAV flag	Retracted												
HEADING flag	Retracted												
Bearing pointer No 1	N												
Course deviation bar	One dot right												
Compass card	N under lubber line												
Course arrow	N												
46 Release TEST switch	Control wheel on each control column rotates clockwise approximately 50 degrees 24												
47 Set AUTO MAN switch to AUTO and press and hold TEST switch on CDU of INS NO 1.	Control wheel centers HSI returns to previous indication 24 The following indications occur on pilot HSI 23 <table> <tr> <td>NAV flag</td><td>Retracted</td></tr> <tr> <td>HEADING flag</td><td>Retracted</td></tr> <tr> <td>Bearing pointer No 1</td><td>N</td></tr> <tr> <td>Course deviation bar</td><td>One dot right</td></tr> <tr> <td>Compass card</td><td>N under lubber line</td></tr> <tr> <td>Course arrow</td><td>N</td></tr> </table>	NAV flag	Retracted	HEADING flag	Retracted	Bearing pointer No 1	N	Course deviation bar	One dot right	Compass card	N under lubber line	Course arrow	N
NAV flag	Retracted												
HEADING flag	Retracted												
Bearing pointer No 1	N												
Course deviation bar	One dot right												
Compass card	N under lubber line												
Course arrow	N												

Inertial Navigation System Complete Checkout
Table 504 (Sheet 20 of 26)

Ref · T O 1E-3A-2-34-2
Pages 3-26 Change 7
Page 3-27 Change 13

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STEP	RESULT
	Control wheel on each control column rotates counterclockwise approximately 50 degrees 24
48 Release TEST switch	Control wheel centers HSI returns to previous indication 24
49 Set AUTOPILOT INS SOURCE switch to INS 2 ALTERNATE on pilot instrument panel	At navigator station, AUTOPILOT INS SOURCE panel indicates INS2 selected
50 Set ADI switch to INS on copilot instrument panel	
51 Repeat steps 44i and j, and 45 through 48 for CDU of INS NO. 2 and copilot HSI	
52 Return interface to normal as follows	
a Set AUTOPILOT INS SOURCE switch to INS 1 NORMAL on pilot instrument panel	At navigator station, AUTOPILOT INS SOURCE panel, INS2 indicator goes off
b Set YAW DAMPER PARALLEL switch to OFF and YAW DAMPER SERIES switch to ON on overhead panel	
53 Test INS No 1 status as follows	Right data display will indicate 0---XS When 5 number at X (alignment performance index) decreases to 5, READY NAV indicator on associated mode select unit will come on 19
a Set data selector to DSRTK/STS on CDU	Do not proceed until number at X is 5 or less and READY NAV indicator on MSU comes on
	NOTE. Performance index may take up to 35 minutes to reach 5 at 68°F, or up to 50 minutes at -68°F The measurement of time is started when the mode selector on the MSU is set to ALIGN in step 20
b Press TEST switch and release when all CDU indicators come on	On release, right data display reverts to 046-XS 5

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Table 504 (Sheet 21 of 26)

Ref T O 1E-3A-2-34-2
Page 3-26 Change 7
Page 3-27 Change 13

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STEP	RESULT
c Press and release TEST switch	Right data display indicates 0---XS
54 Repeat step for for CDU of INS No 2	<u>NOTE</u> X may be any number between 5 and 0
<u>NOTE</u> To prevent inadvertent setting to ATT, do not pull mote selec tor knob on HSU outward.	
55 Set mote selector on HSU No. 1 to NAV until READY NAV indicators on both MSU's go out, then back to ALIGN	On each MSU, READY NAV goes off 21 On each CDU, right data display is 1---X-34 On system mode control, at DAPG switch, INS 1 indicator comes on 22
	<u>NOTE</u> X may be any number between 5 and 0
56 Set mode selector to DPLR/OMEGA on system mode control Press MODE ENABLE switch-indicator If indicator comes on, press again so indicator goes off	D-MEM light will come on (immediately or at least within 2 minutes) after MODE ENABLE switch-indicator is pressed 13 MODE ENABLE switch-indicator goes off 38
57 Test NCS status hlstory as follows on system control-indicator	
a Press CLEAR (if on) ENTER DPLR 0 and INSERT Note time of day accurate to the minute when INSERT is pressed to monitor end of DVS self-test for step 57f	
b Press CLEAR (if on) DISPLAY and LOR/	Left and right single character data indicators and data registers display 1 2 000000 000000 25 Displays are 3 4 000000 000000 25
c Press NEXT	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 22 of 26)

Ref . T.O. 1E-3A-2-34-2
Pages 3-27 Change 13
Page 3-28 Change 15

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MAINTENANCE MANUAL

STEP	RESULT
d Press CLEAR (if on) DISPLAY and INS	Displays are. 1 2 000000 000000 26
e Press NEXT <u>NOTE</u> The number in each data register is the accuracy potential of each INS	Displays are 1 2 ---XXX ---XXX 30 40 <u>NOTE</u> The three-digit numbers at XXX individually are greater than 000 and are less than 9999 (The two numbers need not be equal)
f Two or more minutes after performing step 57a, press CLEAR (if on) DISPLAY and DPLR	Displays are V R or L 27 -----0 -00°---
g Press NEXT 58 Obtain indications of NCS sensors in use and of NCS accuracy as follows 39 35	Displays are D -- 014000 ----- 28 29
a On system control-indicator, press CLEAR (if on) DISPLAY and POS	INS segment on SCI keyboard will come on In an adequate omega environment, LOR/Ω segment will also come on 13
b Verify that latitude and longitude displayed on SCI are equal to step 33 values (±3 minutes)	Latitude is displayed in left single character data indicator and left data register 13 15 40 Longitude is displayed in right single character data indicator and right data register 13 15 40
c Press DISPLAY and D-GMT	Left and right data registers display year, month, day, hour, minute, and second of GMT, incrementing by one second per second 13

Inertial Navigation System Complete Checkout
Table 504 (Sheet 23 of 26)

Ref T O 1E-3A-2-34-2
Page 3-28 Change 15
Page 3-29 Change 7

MAINTENANCE MANUAL

STEP	RESULT
	<u>NOTE.</u> The following displays are on the SCI single character data indicators and data registers unless noted.
d Press DISPLAY CIRCLE and 1	N W 41°07 0 095°55 0 39 36 CCW switch-indicator comes on
e Press NEXT	R - --095 0 -----
f Press CLEAR DISPLAY FIG 8 and 3	N W 47°09 0 1 22°29 0 39 36 CW switch-indicator comes on
g Press NEXT	N W 41°07 0 111°58 0 39 36 CCW switch-indicator comes on
h Press NEXT	R - -125 0 ----- 39 36
i Press CLEAR DISPLAY LINE and 2	N W 27°59 0 082°32 0 39 36 CCW switch-indicator is on
j Press NEXT	N W 25°48 9 080°17 0 39 36 CW switch-indicator comes on
k Press CLEAR DISPLAY RCE TK and	N W 43°34 0 116°14 0 39 36 CW switch-inticator comes on
l Press NEXT	N W 41°07 0 111°58 0 39 36 CW switch-indicator is on
m Press NEXT	R - --020 0 -----

Inertial Navigation System Complete Checkout
Table 504 (Sheet 24 of 26)

Ref T O 1E-3A-2-34-2
 Pages 3-29 Change 7
 Page 3-30 Change 12

MAINTENANCE MANUAL

STEP	RESULT
n Press CLEAR 59 Pull mode selector knob and set to STBY on MSU of INS No 1. 60 Set mode selector to OFF on SMC 61 Set mode selector to OFF on each MSU 62 Open following circuit breakers (a) On circuit breaker panel P6 NAVIGATION INS NO 1 NO 1 HTR NO 2 NO 2 HTR OMEGA NAV PANELS DOPPLER VEL SENSOR ONE OVEN OMEGA NAV RCVR CMPTR (b) On overheat panel P5 EMERGENCY FLIGHT AVIONICS NO 1 ATTD XFMR AC YAW DAMPER PRL WARN AUTOPILOT WARN FLIGHT INSTRUMENTS NO 1 XFMR BRG HDG AHRS AUTOPILOT 30 YAW DAMPERS-PRL 0A FLIGHT INSTRUMENTS NO 2 AHRS XFMR ATTD HDG BRG AIR DATA 0A	INS 1 indicator goes out and INS 2 indicator comes on on system mode control 16 22

Inertial Navigation System Complete Checkout
Table 504 (Sheet 25 of 26)

Ref T O 1E-3A-2-34-2
Page 3-30 Change 12
Page 3-30A Change 12

MAINTENANCE MANUAL

STEP	RESULT
63 Remove aft forced air cooling and disconnect Air Pressure Warning Alarm System SDU-34/E if no longer required for other maintenance . 64 Ensure aircraft electrical power is removed if no longer required. <u>NOTE</u> If this checkout was performed as a result of observing a black thermal decal on one of the navigation units and this checkout was successful, perform step 65 65 Apply a thermal indicator decal on navigation unit without removing older one	

Inertial Navigation System Complete Checkout
Table 504 (Sheet 26 of 26)

Ref T.O 1E-3A-2-34-2
Pages 3-30A Change 9



MAINTENANCE MANUAL

TEMPORARY REVISION NR. DFW 34-32

INSERT FACING SUBCHAPTER 34-53-01, PAGE 101

REASON FOR CHANGE: Application of antenna gasket to provide a better skin corrosion protection.

INSTRUCTION: Insert facing to subchapter 34-53-01, page 101.

NOTE: The insertion of this TR has to be listed in the Record of Temporary Revisions at the beginning of Volume 1.

TR-Nr. DFW 34-32

TCA: LX-N20199

RTCA: LX-N19997, LX-N20000

34-53-01

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MAINTENANCE MANUAL

GPS NAVIGATION SYSTEM

1 System Description

The TNL8100 is designed to fulfill the navigation requirements of non-FMS equipped aircraft. The system navigates worldwide by processing Global Positioning System (GPS) signal data to compute aircraft position and velocity and a variety of navigation parameters relative to a selected flight plan. The TNL8100 consists of three Line Replaceable Units (LRUs) shown in Figure 1-1: a Navigation Processor Unit (NPU), a Control Display Unit (CDU), and a GPS Antenna/Preamplifier Unit.

1 2 1 Navigation Processor Unit (NPU)

The NPU is the primary processing unit of the TNL8100. It receives and processes GPS signal data from the antenna to compute aircraft position and velocity. The NPU also performs all the processing necessary to provide 4-dimensional aircraft guidance for timed great circle and vertical navigation through the waypoints of a selected flight plan. The NPU sends output data to the connected CDU. All external system interfaces defined in this document are also handled by the NPU.

The NPU is located on the LH radio rack shelf (see figure 1-2).

1 2 2 Control Display Unit (CDU)

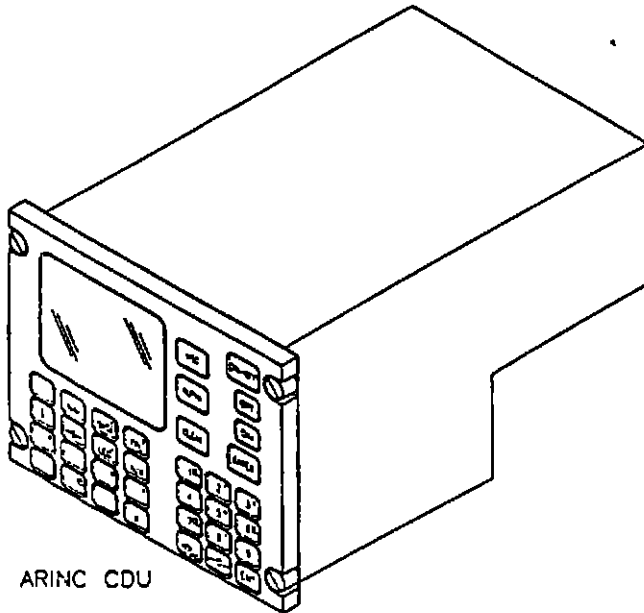
The CDU controls the data entry to the TNL8100, the modes of system operation, and the display of flight plan and other advisory data. The CDU has a 7-color CRT display. The colors are red, green, blue, white, cyan, yellow, and magenta. This eliminates the "clutter" often associated with monochrome displays. The CDU may also be programmed to display in a 2-color, Night Vision Goggle compatible mode for military applications. The CRT is formatted as eight lines of data with 14 characters per line. A graphics mode is also used to display an integral course deviation indicator (CDI). Data input and display selection/control is provided by a 35 key (ARINC CDU) keyboard. The CDU is located on the forward electronic panel (see figure 1-3).

1 2 3 GPS Antenna/Preamplifier Unit

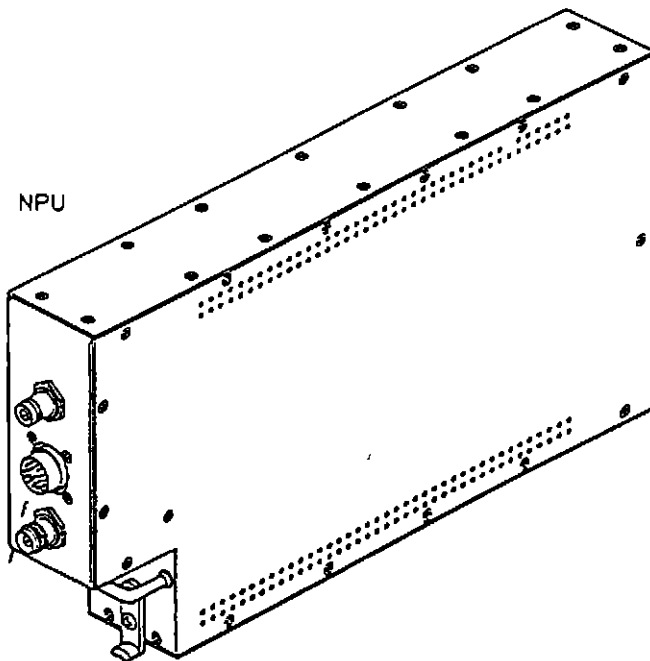
The antenna receives GPS radio wave data and converts it into information that can be processed by the GPS receiver located in the NPU.

The GPS antenna is located on the top fuselage in BS 33885 (see figure 1-4).

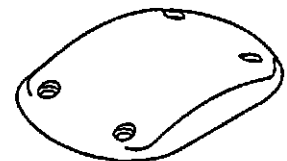
In order to comply with European B-RNAV requirement, a continuous indicator of the aircraft's position relative to track has to be displayed to the pilot flying on a navigation display in his primary field of view. Therefore, two course Deviation Indicators (CDI) are installed in each pilot's primary field of view. Refer to figure 1-65 and 1-6).



ARINC CDU



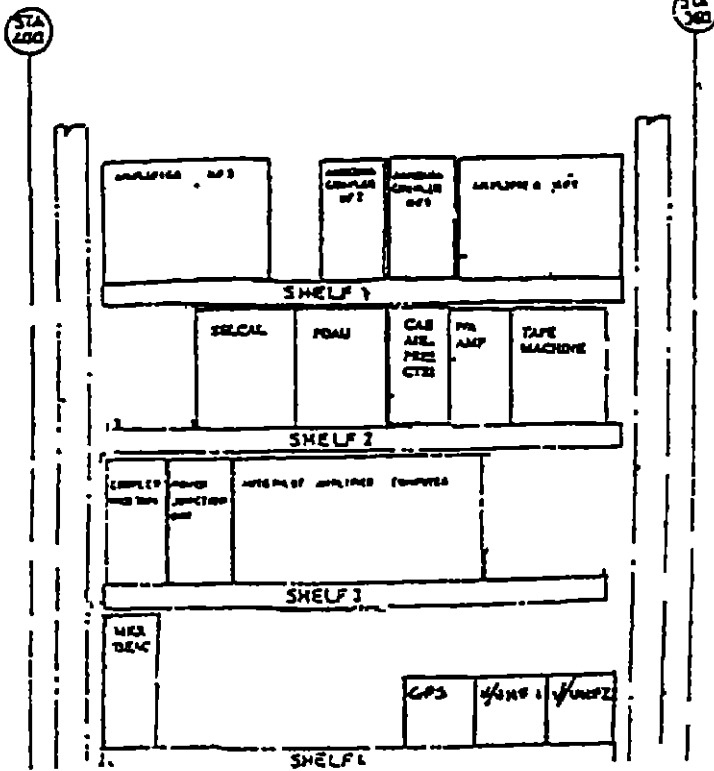
NPU



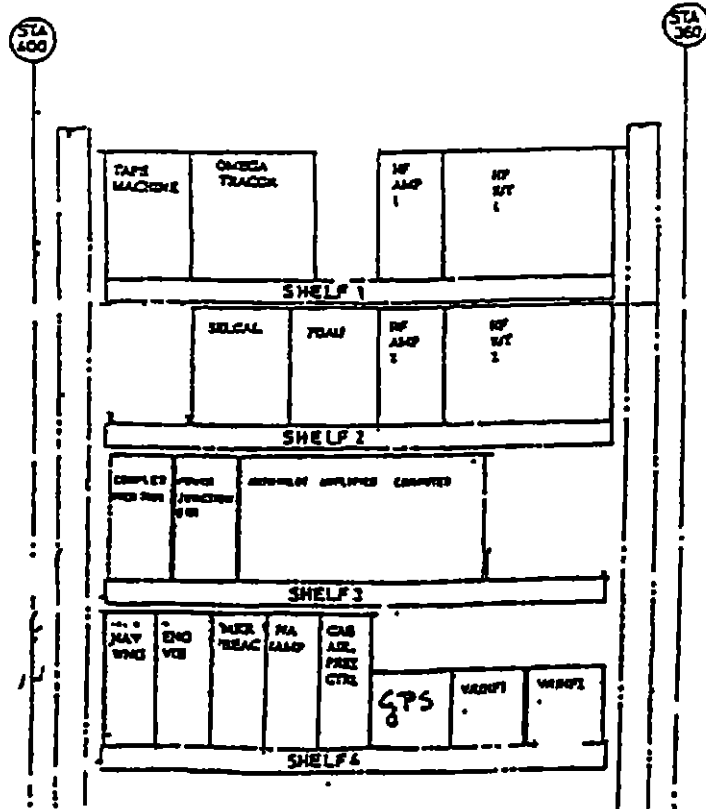
GPS ANTENNA

Figure 1-1 TNL8100 GPS Navigation System

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for S/N 19997 and 2000



for S/N 20199

Figure 1-2: LH radio rack

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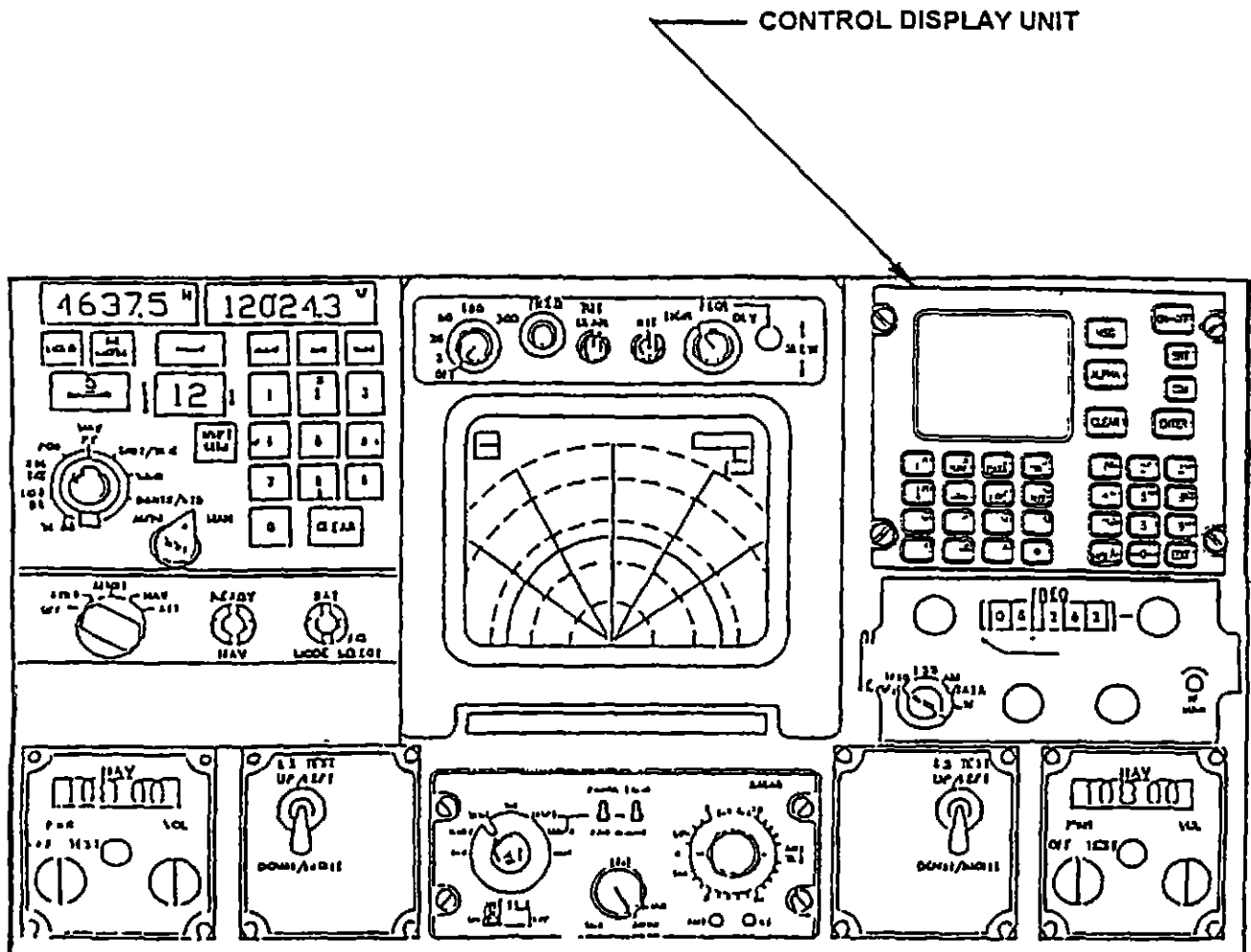


Figure 1-3 forward electric panel

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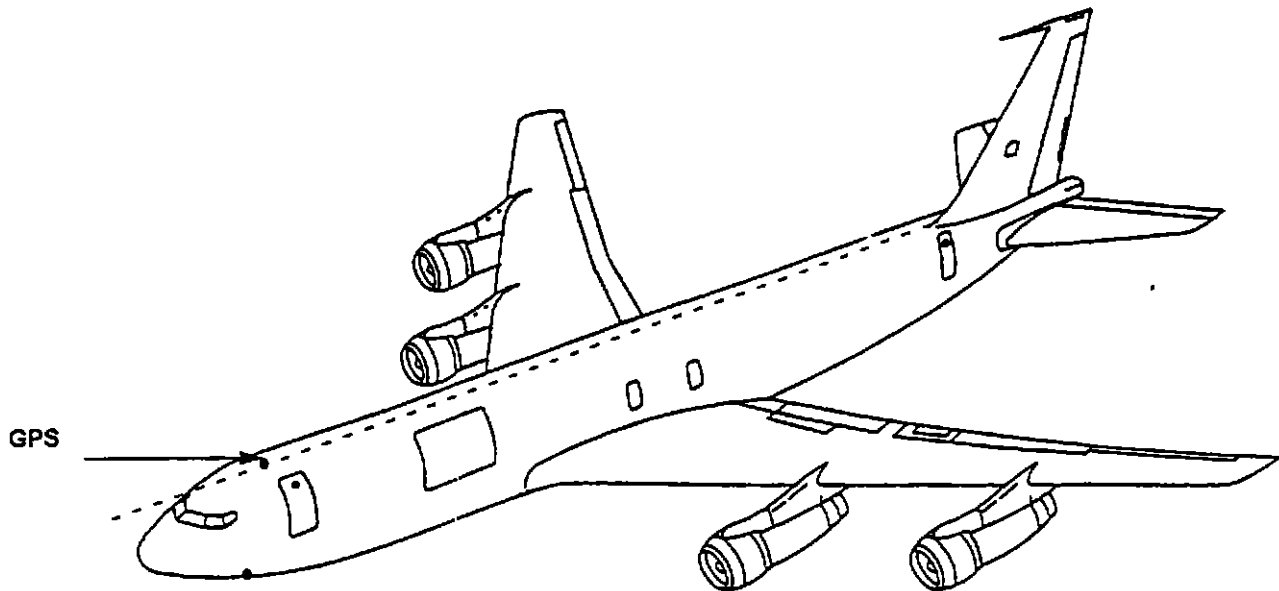


Figure 1-4 GPS antenna location

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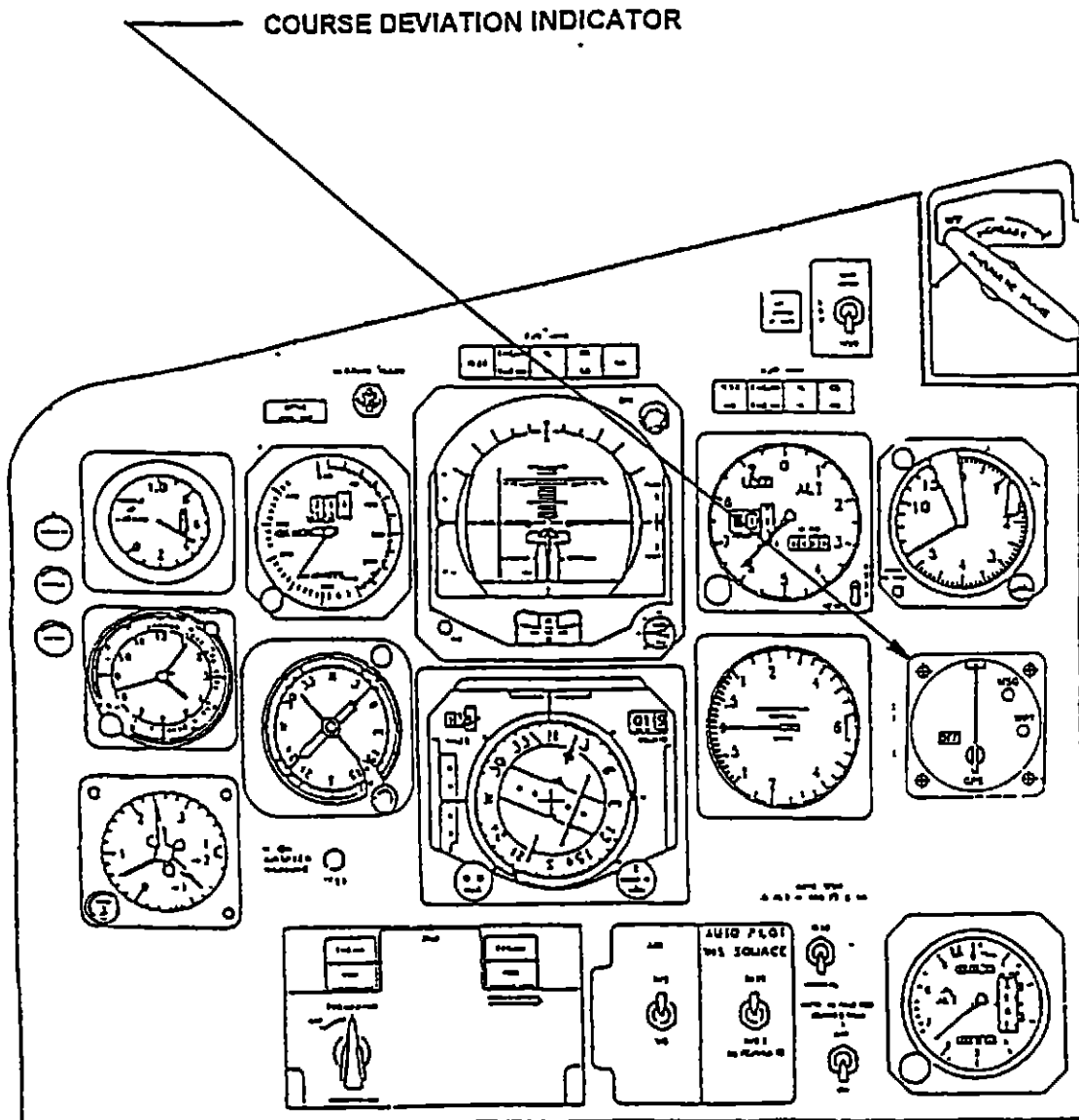


Figure 1-5: pilot's instrument panel

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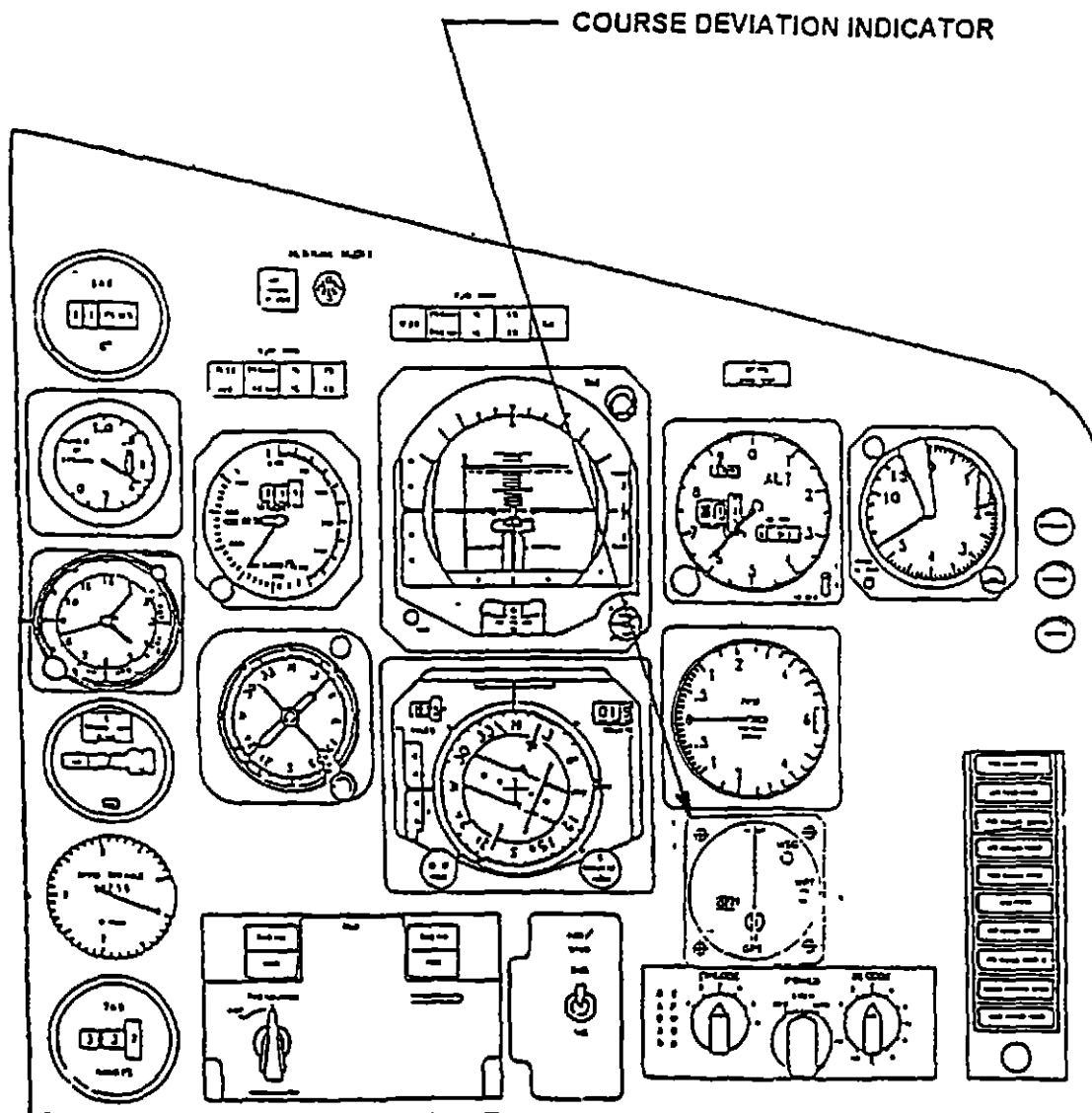


Figure 1-5 co-pilot's instrument panel

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2 System Operation

2.1 CDU Display

The CDU display is a two-by-three inch color CRT. The CRT displays data in seven colors: red, green, blue, white, cyan, yellow, and magenta. Utilization of the seven colors allows the TNL8100 to communicate with the operator by uniquely displaying different functions in different colors. The CRT is formatted in eight 14-character lines in which alpha-numeric data can be displayed. It is also capable of displaying symbolic data which allows the TNL8100 to offer an integral course deviation indicator.

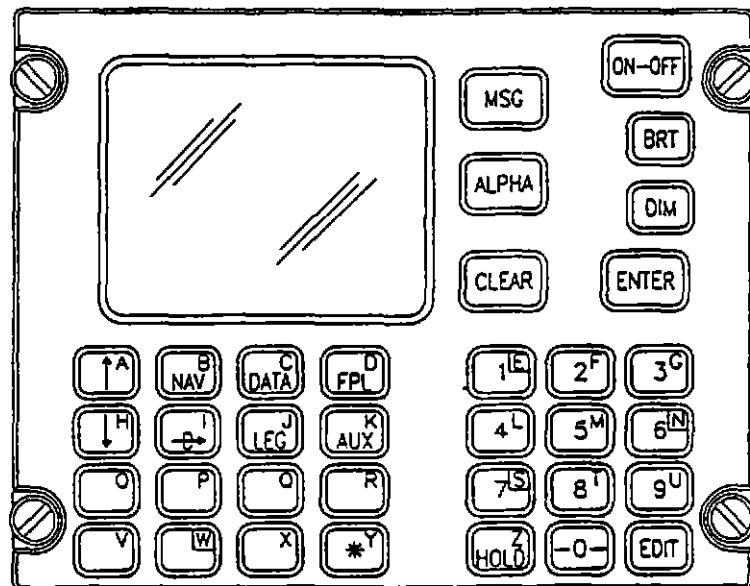


Figure 2-1 ARINC CDU Faceplate



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2 2 CDU Keyboard

Operator input is accomplished by a keyboard consisting of 35 keys (ARINC). The keyboard is laid out for the ease of operator data entry. The three keys for data control and entry are the CLEAR, ENTER and ALPHA keys on the ARINC keyboard. Refer Figure 2-1.

2 3 CDU Keyboard Operation

This section outlines the functions of the various keys of the CDU. Only general information is presented here. Consult the TNL8100 Pilot Guide for more detailed information.

ON/OFF	Applies or removes power from TNL8100
BRT/DIM	Controls intensity of display
CLEAR	Calls up cursor (inverse Video) for data modification or cancels an operation. When cursor has been called up, pressing CLEAR again will move cursor to next data field which can be modified.
ALPHA	This key toggles between the numeric and alphabetic mode of entry. The system automatically assumes logical mode of entry (i.e., alpha mode for ident entry, and numeric for coordinate entry).
ENTER	Enters selected data into NPU memory.
NAV	Accesses several pages of navigational data relative to aircraft position and track leg data. Selected data pertinent to aircraft position and track leg data may be altered through these pages.
AUX	ARINC CDU. Accesses auxiliary functions.
FPL	Accesses flight plan functions.
LEG	Provides for display and selection of active flight plan legs. Provides for display and selection of Track Change Mode.
➔	Provides a means of flying from present position direct to a defined waypoint.
↑↓	Provides a means of displaying additional data when more than eight lines of data are available or when more than one page of data is available.
HLD/HOLD	Provides for the definition and execution of holding patterns.
EDT/EDIT	Provides a backspace function during data entry mode. Provides the capability to change modes of operation (i.e., magnetic, true, etc.) during nondata entry mode.
DAT/DATA	Provides several pages for the selection, display, and entry of data related to flight planning and system status.
MSG	Provides a display of system malfunctions and operator actions required. Displays condition of TNL8100 database.



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3 System Fault Messages

When the system status changes or a fault occurs within the system, the MSG light on the CDU will flash alerting the operator. The following is a list of faults which cause the MSG light to flash. The fault message will appear on the MSG page. To display the fault, press the MSG key. If more than one fault occurs, pressing the MSG key again will display the other faults.

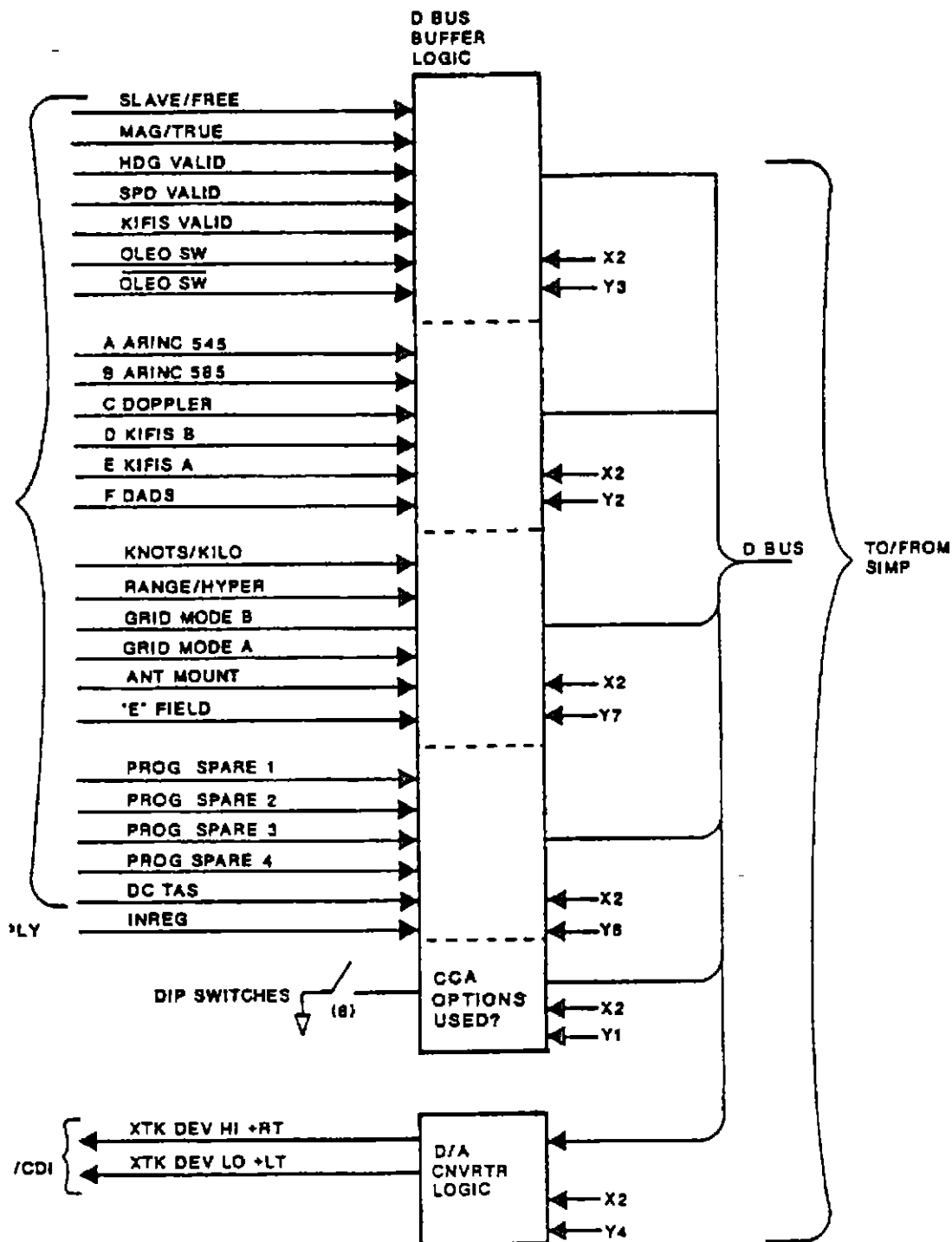
ACTION / MALFUNCTION MESSAGE	ACTION REQUIRED
STANDBY (dual configuration only)	Restart TNL8100. If message repeats, replace NPU.
REAL TIME CLOCK ERROR	GMT will be corrected when GPS begins tracking or may be corrected on DATA Page 5.
POSITION DISCREPANCY BETWEEN SYSTEMS	Verify and correct as necessary position on appropriate system. If message repeats, verify which system is in error and replace NPU or antenna.
OSCILLATOR NEEDS ADJUSTMENT	Restart TNL8100. If message repeats, replace NPU.
TAS TOO BIG ON GROUND	Verify proper air/ground input or trouble shoot ADC source.
NAV STATUS DEAD RECKONING and NAV STATUS MODE VFR	Normal message until unit acquires satellite data (should be less than 2 minutes). Locate aircraft to allow unobstructed view of satellite constellation. Verify antenna coax connections and antenna.
INSUFFICIENT FUEL	Fuel functions are not activated at this time. Check program pins.
VNAV ACTIVE	Normal NAV function initiated by the pilot.
VNAV CANCELED	Normal NAV function initiated by the pilot. Caused by initiating a track offset.
HDG FAIL	Trouble shoot compass input.
TAS FAIL	Trouble shoot TAS input (ADC).
ALT FAIL	Trouble shoot altitude input (Captains Altimeter).
(HOST, DBASE, IO, GPS) PROCESSOR FAIL	Turn TNL8100 power off and restart system. If message repeats, reload affected NPU software (HOST, DBASE, IO, GPS) or replace NPU.
GPS ANT FAIL	Verify antenna coax connections and antenna. Replace Antenna.
GPS RCVR FAIL	Turn TNL8100 power off and restart system. If message repeats, replace NPU.
FUEL INPUT INVALID	Fuel functions are not activated at this time. Check program pins.
SUSPECT DISCRETE O/P SHORT TO GROUND	Output discrete has been detected as shorted to ground. Trouble shoot discrete.

Table 3-1 Status/Warning Indicators

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OMEGA Navigation System - Discrete Interface Block Diagram
Figure 6

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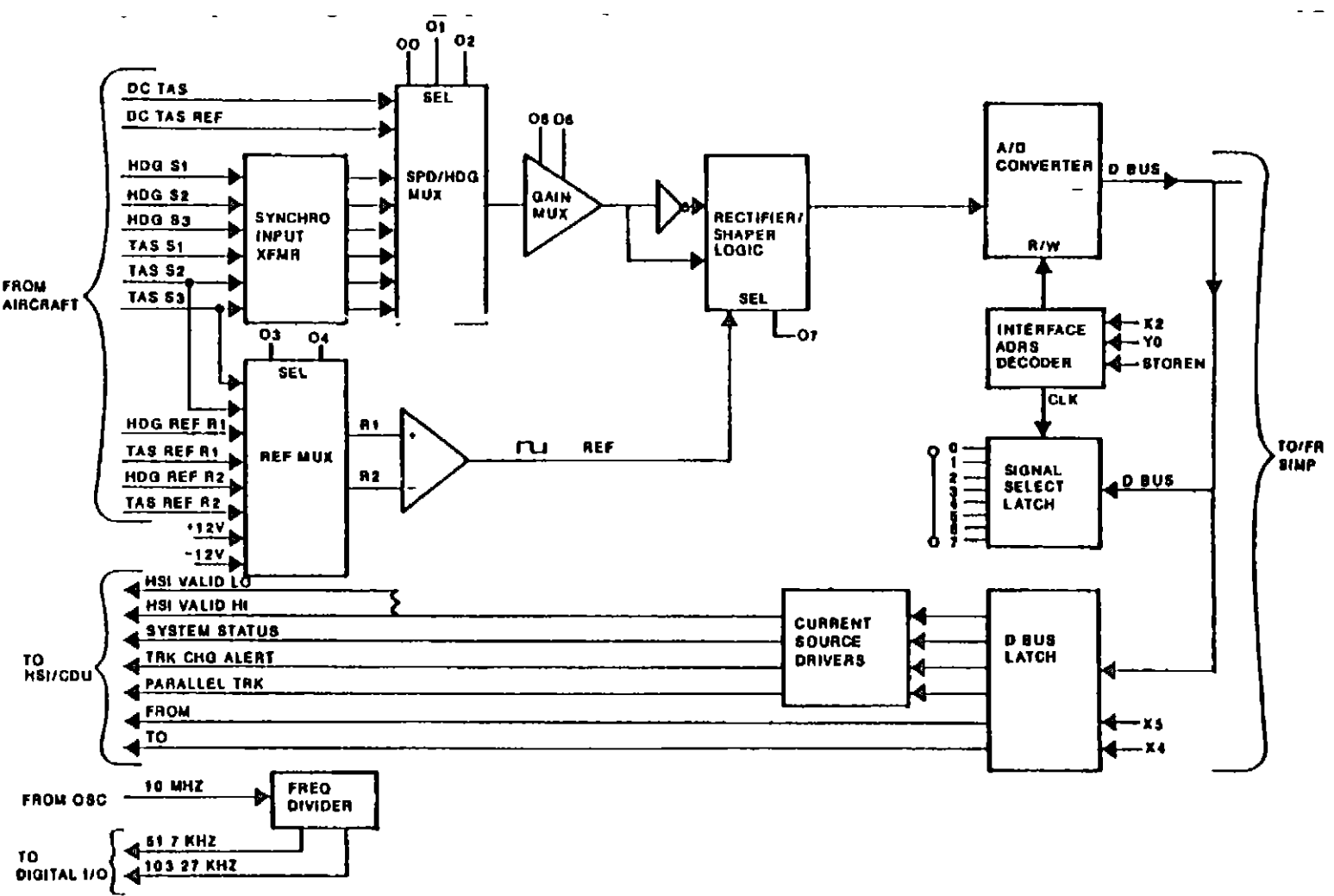
(7) Synchro Interface CCA

- (a) Refer to the synchro interface block diagram shown in Figure 7. This interface converts aircraft speed and heading analog signals into digital data used for SIMP navigation computations. Synchro speed and heading signals are applied to the synchro input transformers and are inductively coupled to the speed/heading multiplexer (mux). DC-type speed inputs are applied directly to the mux. Selection at the mux is made by bus bits 00-02. The eight D bus bits used for selection in this interface are clocked into the signal select latch when SIMP addresses the interface with I/O strobes X2Y0. Signal STOREN is inactive while select bits 00-07 are active. The selected SPD or HDG mux output is applied to a gain amplifier, where the correct gain is introduced with bits 05 and 06. The amplifier output signal is applied to the rectifier/shaper logic to shape the pulses at the input to the A/D converter. Synchro reference inputs from the aircraft are selected at the reference mux by bits 03 and 04. A comparator at the reference mux output uses the two "legs" of the currently selected synchro reference to generate a square wave. This square wave and bit 07 form a 2-bit code used to select the input to the rectifier/shaper logic. This address scheme and an inverter at the rectifier input allow selection of the noninverted input during the positive portion of the synchro input and selection of the inverted input for the negative portion of the input. During DC type inputs, the comparator sums -12V and +12V to generate a constant low output to select the noninverted input at the rectifier. The resultant analog pulses from the rectifier/shaper are converted to digital data by the A/D converter. SIMP strobes the digital SPD/HDG data onto the D bus by strobing both X2Y0 and STOREN. Initially, the SIMP loads the select bits into the interface with X2Y0, but with STOREN inactive to keep the A/D converter in the READ state.
- (b) This interface also provides a data latch to allow the SIMP to provide optional HSI and CDI aircraft position and navigation data. The latch output is made active with discrete output strobe X5Y4. Source current drivers are provided where necessary.
- (c) A frequency divider used to divide the master oscillator frequency into two frequencies used in the optional digital I/O interface, is also mounted on this CCA.

(8) Dual Synchro CCA (Option)

- (a) This interface provides No. 1 and No. 2 of three optional RPU synchro outputs available for use with an HSI. Synchro output No. 1 and No. 2 are intended to drive the HSI azimuth card and heading marker, respectively. Synchro output No. 3, available with the HSI/Autopilot CCA option, is intended to drive the HSI course arrow.

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OMEGA Navigation System - Synchro Interface Block Diagram
Figure 7

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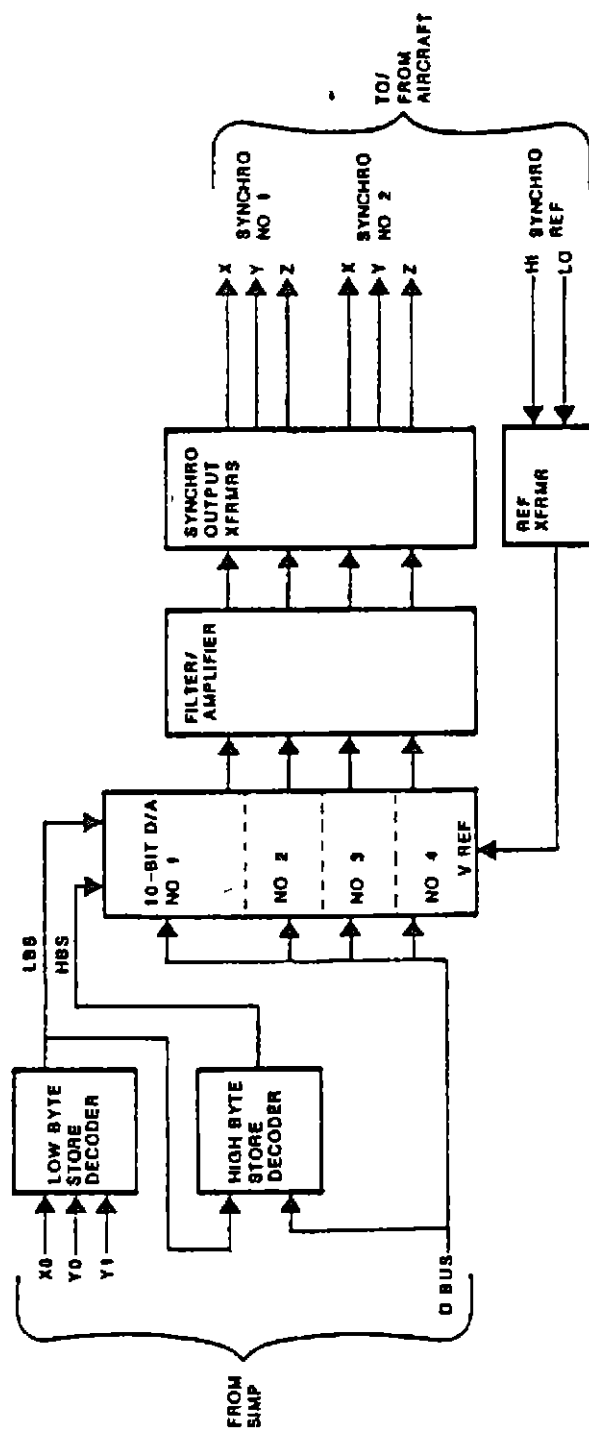
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Theory of operation for all three circuits is the same, therefore only one (typical) circuit is described.

- (b) Refer to the dual synchro block diagram shown in Figure 8. Two D/A converters are required for each synchro circuit. Each D/A converter reads 10 bits of data at a time. Therefore, a two-pass, low byte store (LBS) and high byte store (HBS) load cycle is required. SIMP I/O address XOY1 loads in the low byte and address XOY0, in conjunction with data bus bits D5-D7, load in the high bytes. These digital byte inputs are converted to analog pulses by the D/A converters. A synchro reference voltage received from the aircraft of the same phase as the circuit being driven by the synchro output is used as the D/A converter phase reference. The analog pulses are filtered, amplified and are applied to the synchro output transformers. The outputs of the two transformers are connected in a manner to provide the required 3-wire (XYZ) synchro output voltage.
- (9) HSI/Autopilot CCA (Option)
- (a) Refer to the HSI/autopilot block diagram shown in Figure 9. This interface provides the No. 3 synchro output described with dual synchro outputs No. 1 and No. 2 in preceding step (8). Also included in this interface are the circuits required to generate the STEERING, XTK DEV, and the discrete NPU mode signals.
- (b) The STEERING and XTK DEV circuits function in a similar manner as described for the synchro circuits in that SIMP digital data is converted to analog voltages with D/A converters. Related reference voltages received from the aircraft verify that the analog pulses are in phase with signals of the instruments to be driven. After filtering and amplification, the analog pulses are applied to the respective output circuits. The resultant STEERING signal at the transformer output is an ac rms value, interpreted by an autopilot as a roll command in degrees. Before the autopilot can accept a STEERING command, discrete signal STEERING VALID must go high to flag that the RPU STEERING mode is active. In the same vein, the XTK DEV output drivers, generate the XTK DEV HI and LO outputs to the HSI. The HI output is a voltage value while the alternate LO output is a current value. These values are interpreted by the HSI as distances (left or right) in nautical miles. Before the HSI can accept a XTK DEV input, discrete signal HSI VALID must go high to flag that the RPU HSI mode is active.
- (c) The STEERING and HSI VALID discrete and seven other discrete signals available to the aircraft are loaded from the D bus into the discrete buffer by I/O address X4Y2. From the buffer, the discrete signals are applied to respective output circuits. The output driver for the TO/FROM output provides a polarity-reversing (TO/FROM) low level current source. Discrete DR requires only one open

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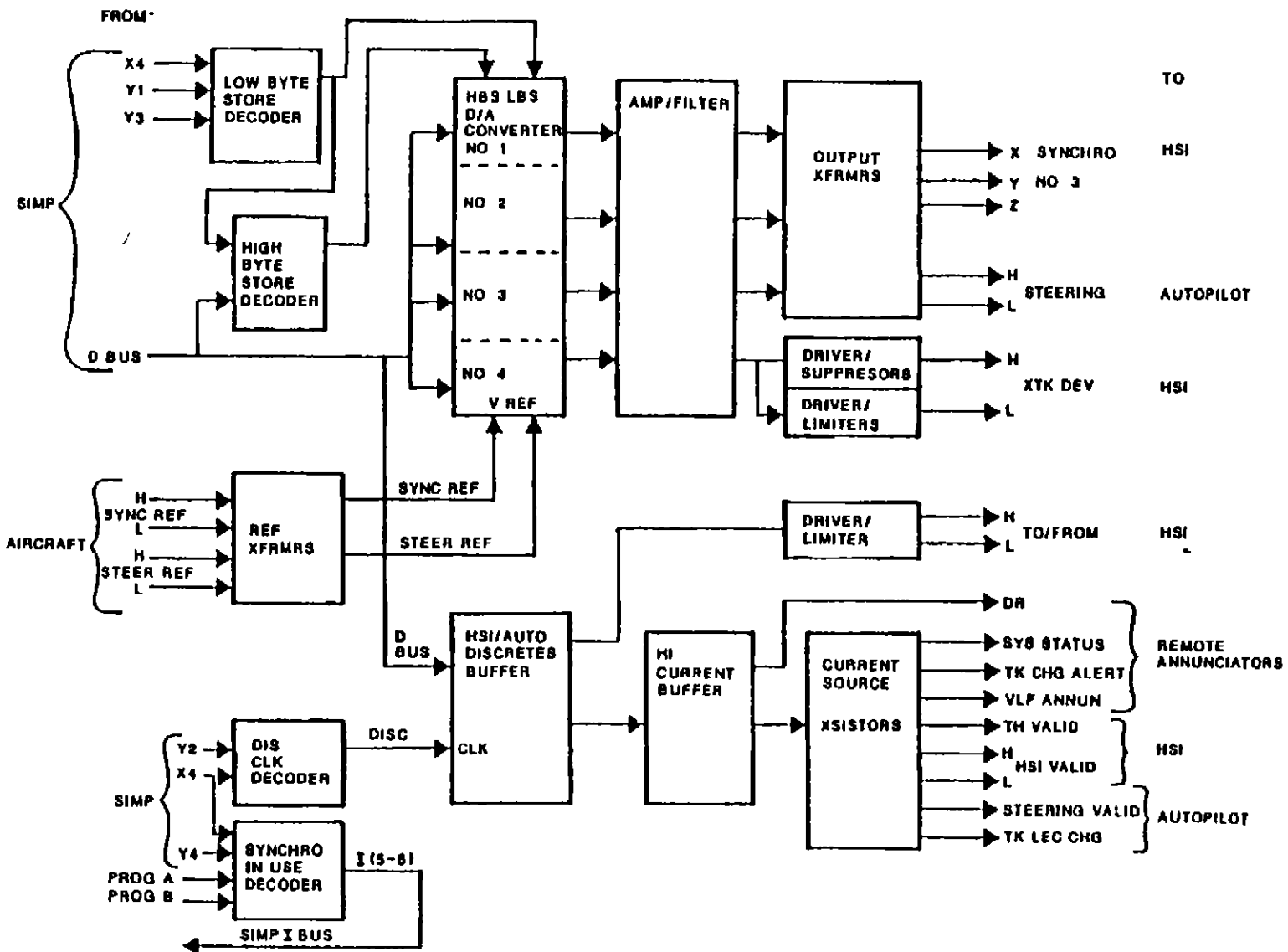
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OMEGA Navigation System - Dual Synchro Block Diagram
Figure 8

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OMEGA Navigation System - HSI/Autopilot Block Diagram
Figure 9

Ref. TRACOR MM

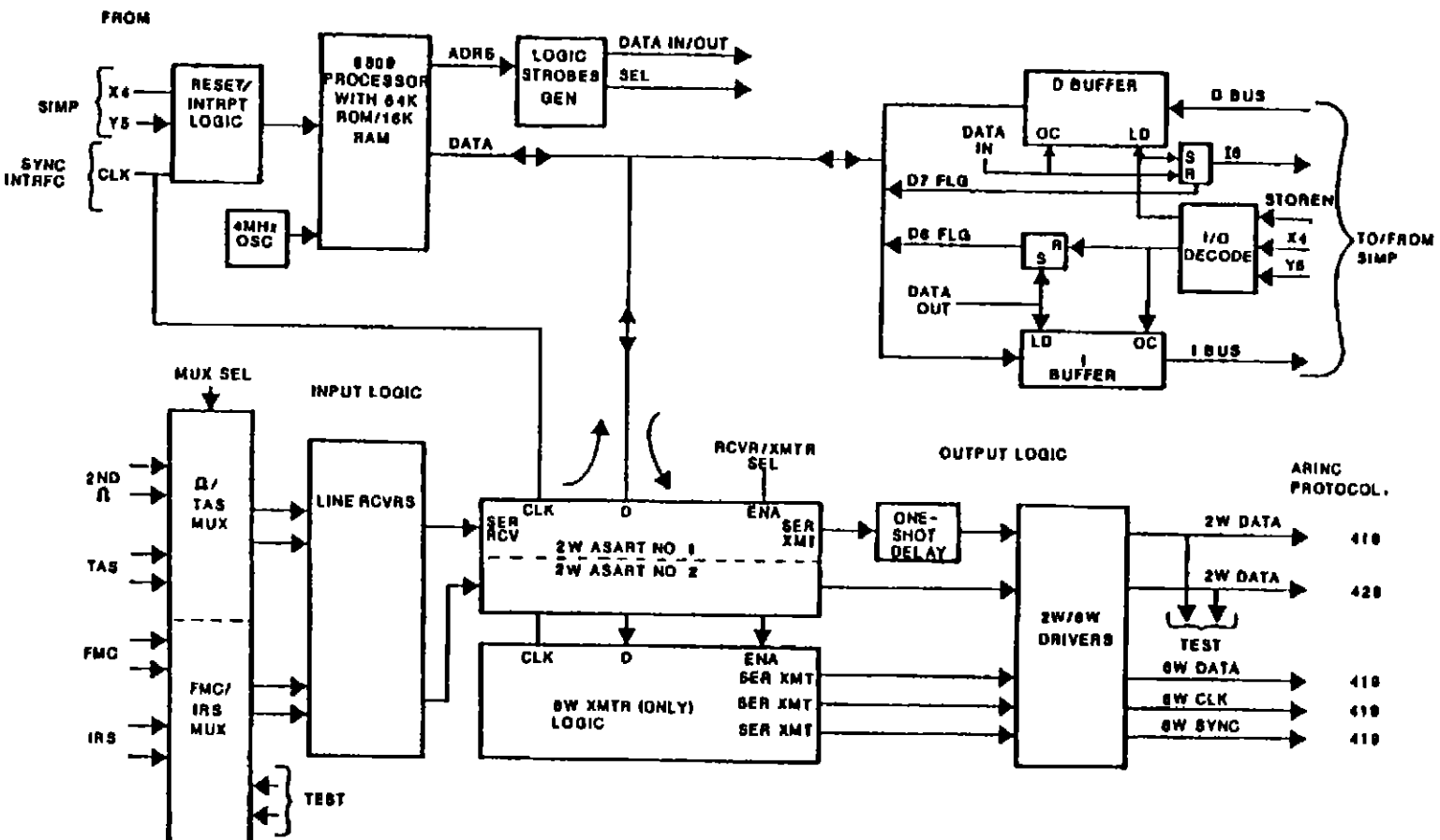
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collector current line to indicate ground (DR) or open (VLF/Omega) modes. The remaining discretes require output transistors to provide a high current source for each line.

- (d) A synchro-in-use decoder, receiving inputs from aircraft connector programming pins, can be read by SIMP with I/O address X4Y4 to verify synchro selection.
- (10) Intelligent Digital I/O CCA (Option) P/N 146970-XXXX
- (a) This interface converts 2-wire BCD/BNR format serial data to SIMP I bus data and SIMP D bus data to 2-wire/6-wire BCD/BNR format serial data.
 - (b) Refer to the intelligent digital I/O block diagram shown in Figure 10. A 6809 processor with 64K ROM and 16K RAM, operating at 4MHz internal timing (provided by an external crystal oscillator), controls all interface internal logic. Two ASART chips are available to provide serial-to-parallel conversion for the selected receive inputs and parallel-to-serial conversion for the 2-wire outputs only. Both ASART chips are designed to operate at the ARINC 429 protocol data bit rate. However, the ARINC 419 protocol 2-wire output requires a slower data bit rate than the ARINC 429 protocol rate. Therefore, a one-shot delay circuit is used on the ARINC 419 line. This circuit introduces the delay necessary to slow down the bit rate to the required ARINC 419 rate. The 6-wire parallel-to-serial, and 6W DATA, 6W CLK and 6W SYNC, transmit only, circuits provide the strict bit/byte control required with 6-wire operation. Note that both 2W outputs are also routed back to the input multiplexer. These two feedback loops allow the 6809 to test the ASART receive and transmit circuits by selecting the test mux inputs.
 - (c) During a receive cycle, data accepted by the 6809 from an active ASART is transferred to SIMP via the I bus buffer. Conversely, validated data to be transmitted serially by either a 2W or 6W serial output must be transferred from SIMP to the 6809 via the D bus buffer. These data transfers are accompanied by some "handshaking" to yield precise current transfer status to both processors. The handshaking is accomplished with two one-bit registers. One register is read by the SIMP via the I8 bit and by the 6809 via the D7 bit and the other register is read by the 6809 via the D6 bit. In the following description assume data words are being transferred from the 6809 to the SIMP in response to SIMP data requests. When the SIMP loads a request into the D buffer with X4Y6 and STOREN, it also sets the I8/D7 bits high. Bit D7 high alerts the 6809 that the next request is in the D buffer. However, the 6809 first writes a data word into the I buffer (in response to the previous request) and sets the D6 bit high. Then the 6809 reads the request in the D buffer and resets the I8/D7 bits low. Next, the SIMP reads the I

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OMEGA Navigation System - Intelligent Digital I/O Block Diagram
Figure 10

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buffer with X4Y6, resets the bit D6 low, and tests the I8 bit. Bit I8 low indicates to the SIMP that the I buffer word is valid and that the 6809 is ready for another request. Bit D6 low indicates to the 6809 that the SIMP has read the I buffer. Both one-bit registers are reset at the start of an operation when the SIMP resets the 6809 with address X4Y5.

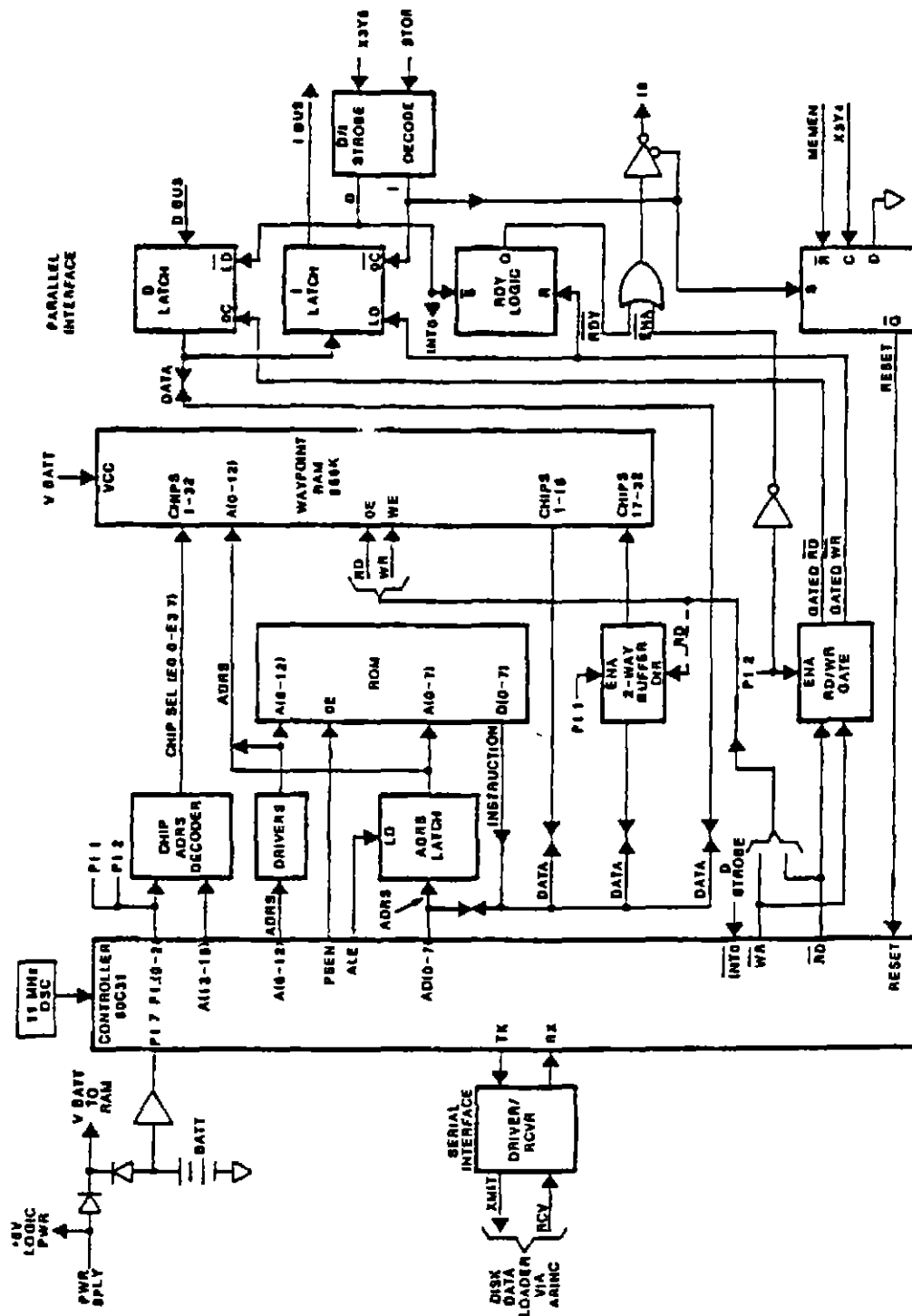
(11) Intelligent DIO CCA (Option) P/N 165508-XXXX

- (a) This CCA functions in a similar manner as described for IDIO P/N 146970-XXXX, except it uses parallel-to-serial and serial-to-parallel shift registers in place of the USART IC chips.

(12) 30K Waypoint Memory CCA (Option) P/N 159707-XXXX

- (a) This CCA, operating under SIMP control, can receive waypoint data directly from an ARINC 424-type disk data loader at 19.2K baud. The received data is stored in waypoint RAM in a record-identified format to provide the SIMP with a NAVAID/AIRPORT/WAYPOINT data base. Refer to the waypoint memory block diagram shown in Figure 11. This circuit consists of an 80C31 microcontroller, an 8K byte ROM, a 256K byte, 32-chip RAM, the serial and parallel interface logic, and miscellaneous gating logic. All 80C31 operations are initiated by SIMP commands. These commands consist of status, waypoint data or data base update requests. In the following operation description, the 80C31/ROM/RAM/loader interactions are described before the 80C31/SIMP exchange description for a better understanding of the 80C31 response to SIMP commands.
- (b) To access the program in ROM, the 80C31 addresses ROM with address bits A(8-12) and AD(0-7). Bits A(8-12) are applied to ROM via line drivers, while bits AD(0-7) are applied via an address latch with the address latch enable (ALE) strobe. Use of the latch is required because the 80C31 bidirectional AD(0-7) port also serves as the 80C31 I/O data port. Thus, when addressed ROM is enabled with the 80C31 PSEN strobe, the ROM program instruction word output is accepted by the 80C31 at the AD(0-7) port. Waypoint RAM is addressed in the same manner as described for ROM, except that one of the 32 RAM chips must be enabled (selected) first. Selection of the RAM chips is performed with address bits A(13-15), port bits P1 0-P1 2, and a chip address decoder. When the selected RAM chip has been addressed, the 80C31 enables RAM with a low RD signal to read data out of RAM or with a low WR signal to write data into RAM. There are two RAM data ports. One port is buffered with a 2-way buffer to avoid having the 80C31 drive both ports at the same time. Chip select signal P1 1 enables the buffer whenever a RAM chip of the 17-32 group is selected. Signal RD controls direction of data flow through the buffer. Flow is from RAM to 80C31 if RD is active low and from 80C31 to RAM if RD is inactive high.

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OMEGA Navigation System - Waypoint Memory Block Diagram
Figure 11

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- (c) During an 80C31 data base update, a UART (onboard the 80C31) provides the parallel-to-serial and serial-to-parallel conversion required to communicate with the loader. Initially, the 80C31 loads a command word into the UART and the UART serially transmits the command via the serial interface driver. The loader acknowledges receipt of the command and starts sending the data bits. As each bit is received via the serial interface receiver, the UART packs the bits into data words. As each word is formed the UART interrupts the 80C31. Thus, the interrupt-driven 80C31 can load each data word into RAM as fast as the UART receives them. A loader status word sent at end of transmission, indicates to the 80C31 whether transmission was completed successfully or if a problem occurred.
- (d) To initiate a data base update or access of waypoint data the SIMP first resets the 80C31 with I/O address X3Y4. In the RESET mode, the 80C31 performs a self test including checking ROM, RAM, and the voltage level (port P1 7) of the RAM backup battery. (This backup battery feature allows the RAM contents to remain unchanged while ONS power is off.) Upon completion of self test, the 80C31 enters the results of the self test in its status register. Then the SIMP places a status request command on the D bus and generates the D strobe at the parallel interface logic with I/O latch, sets the 80C31 "ready" logic to "not ready" and strobes the 80C31 INT0 interrupt. In the INT0 mode, the 80C31 first goes into a read cycle by driving both P1 2 and RD low to generate gated RD. Gated RD strobes the D latch command onto the 80C31 data bus and the 80C31 reads the command into its data port. Since the command is a status request, the 80C31 places its status word as output on its data port lines and drives P1 2 and WR low to generate gated WR. Gated WR loads the status word into the I latch and resets the ready logic to the "ready" state. Next, the P1.2 line is driven high to enable the "ready" output to be active on the I8 line. Then the SIMP generates the I strobe with I/O address X3Y5 (storen inactive) to strobe the I latch contents and the Uready" logic bit onto the I bus. By testing the I8 bit, the SIMP can determine if the I latch data is valid or not. The SIMP can then continue with a command to update the data base or a command requesting specific data records.
- (13) 60K Waypoint Memory CCA (Option) P/N 168629-XXX
- (a) This CCA functions in a similar manner as described for waypoint memory P/N 159707, except this CCA has 60K memory capacity.
- (14) VOR/DME CCA (Option)
- (a) This CCA converts VOR and DME analog signals to digital bearing (in degrees) and distance (in nautical miles) data. This data is avail

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able to the SIMP for navigation computations. All data transfer cycles between the VOR/DME CCA and the SIMP are initiated by, and controlled by, the SIMP.

- (b) Refer to the VOR/DME CCA block diagram shown in Figure 12. Two processors are used in this circuit. An 8741 peripheral interface processor is used to communicate with the SIMP and to function as the CCA data controller. An 8751 processor, controlled by the 8741 via a bus expander, is used to convert VOR analog phase inputs into digital bearing data. VOR identification (amplitude modulated on the VOR signal) is detected and is available to the 8741 via the bus expander. Discrete input data indicating current input status (VOR valid, DME valid, etc.) is also available to the 8741 via the bus expander. The DME ARINC 568 pulse-pair signals are tested at the DME timer logic and the resultant distance data is sent to the 8741. The SIMP uses I/O address strobes XO, Y3, Y4, and STOREN to reset, and to initiate the 8741 read/write cycles. Also to control direction of data transfer through the D bus transceiver (XCVR). SIMP control words indicate to the 8741 the type of data words (status, VOR data, DME data, etc.) the 8741 is to send to the SIMP.

5 CDU Theory

NOTE. The following paragraphs describe the theory of operation of the CDU circuits. For a detailed description of the 7900 CDU controls and display features, refer to the 7900 Pilot's Guide Manual. For external connection requirements, refer to TA7900 Installation Manual.

- A. The CDU provides the ONS/operator interface and displays navigation data in response to RPU commands. To perform these functions, the CDU uses six circuit assemblies. Refer to the CDU block diagram shown in Figure 13. The CDU circuit assemblies include the power supply/motherboard (MBD) CCA, the altitude cutoff CCA, the horizontal/vertical (H/V)/video amplifier CCA, the CRT display circuits, and the keyboard.

B. Power Supply/MBO CCA

- (1) This CCA converts +28V source power to various levels required by the CDU circuits and provides motherboard connectors for other assemblies and for the external connector. Two switching oscillator-type regulators generate the +5V logic power and +12V circuit power under control of the ON/OFF logic. In turn, the ON/OFF logic is controlled from the keyboard ON/OFF switch. CDU power status is available to the RPU via the CDU VALID signal. An HSYNC signal input keeps the regulator oscillators in phase with the CRT horizontal display signals to prevent harmonic distortion at the display.
- (2) High voltages are generated with a flyback transformer circuit. The capacitive/inductive primary network of this circuit is turned on by

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the leading edge of the HDRIVE pulse received from the horizontal amplifier. The trailing edge of HDRIVE turns off the network. The activity of the network causes the transformer to generate linear decaying HYOKE pulses with a sharply rising trailing edge. The result is that each HYOKE pulse causes the CRT deflection coils to move the display beam in linear scan across the screen. Then to "flyback" to begin the next linear scan, etc. Secondary windings are used to pick off synchronized CRT anode and filament voltages and rectified +100V power for the display data control logic. An automatic frequency control (AFC) signal is picked off to phase lock the horizontal amplifier logic to the flyback transformer circuit.

C Altitude Cutoff CCA

- (1) This CCA is used to cutoff (disable) high voltage to the CRT circuits if loss of cabin pressure occurs at a high altitude to prevent high voltage arcing damage. The CCA circuit consists of a transducer, a comparator and a FET gate. When the barometric pressure input to the transducer sensor drops below the sensor threshold, the transducer applies a voltage to the comparator. This voltage exceeds the reference voltage to the comparator and generates a positive bias voltage. In turn, the positive bias voltage causes the FET gate to generate the ground cutoff signal. This signal disables the HDRIVE input to the flyback transformer circuit. The cutoff signal remains active until cabin pressure is restored.

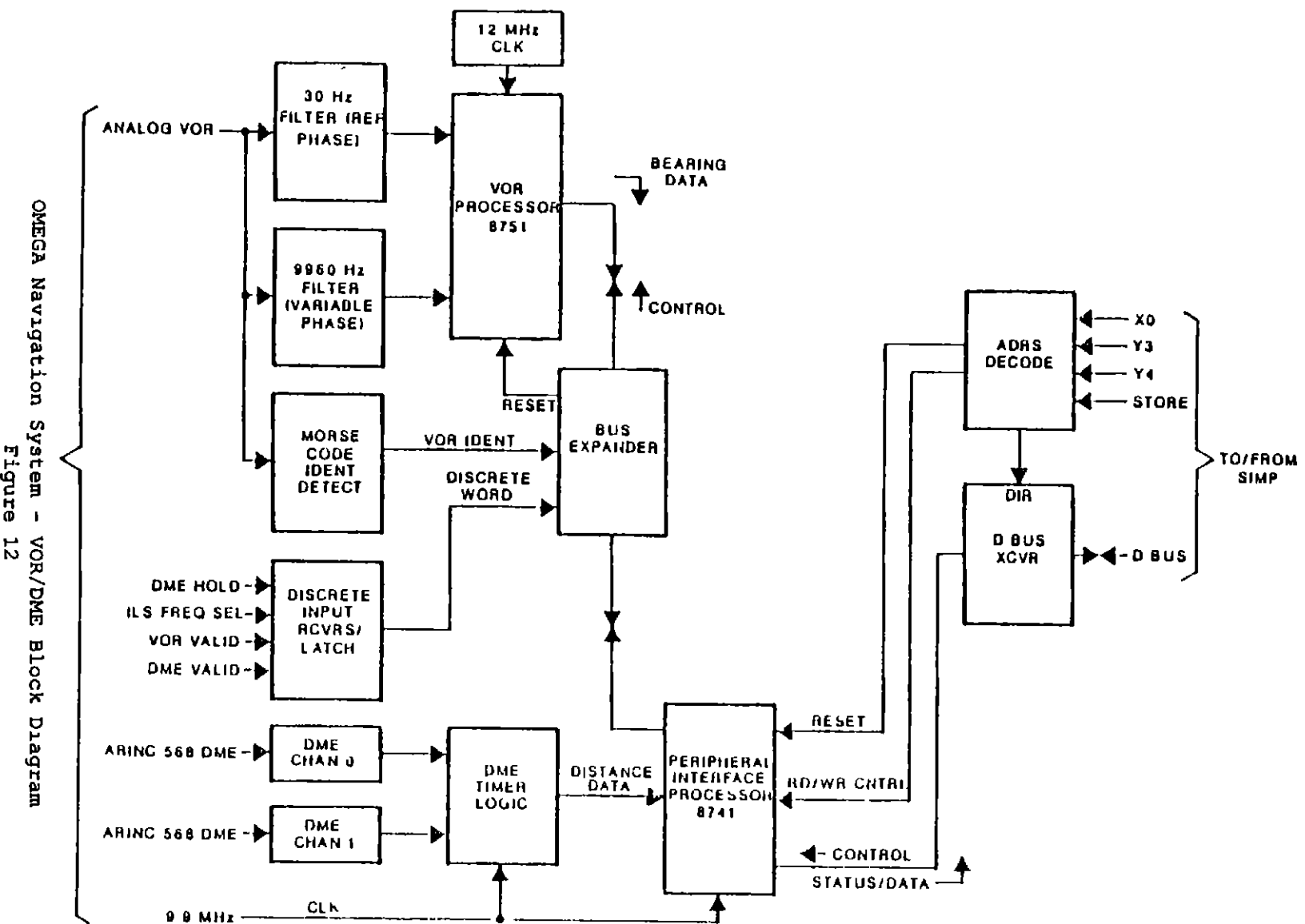
D MCU CCA

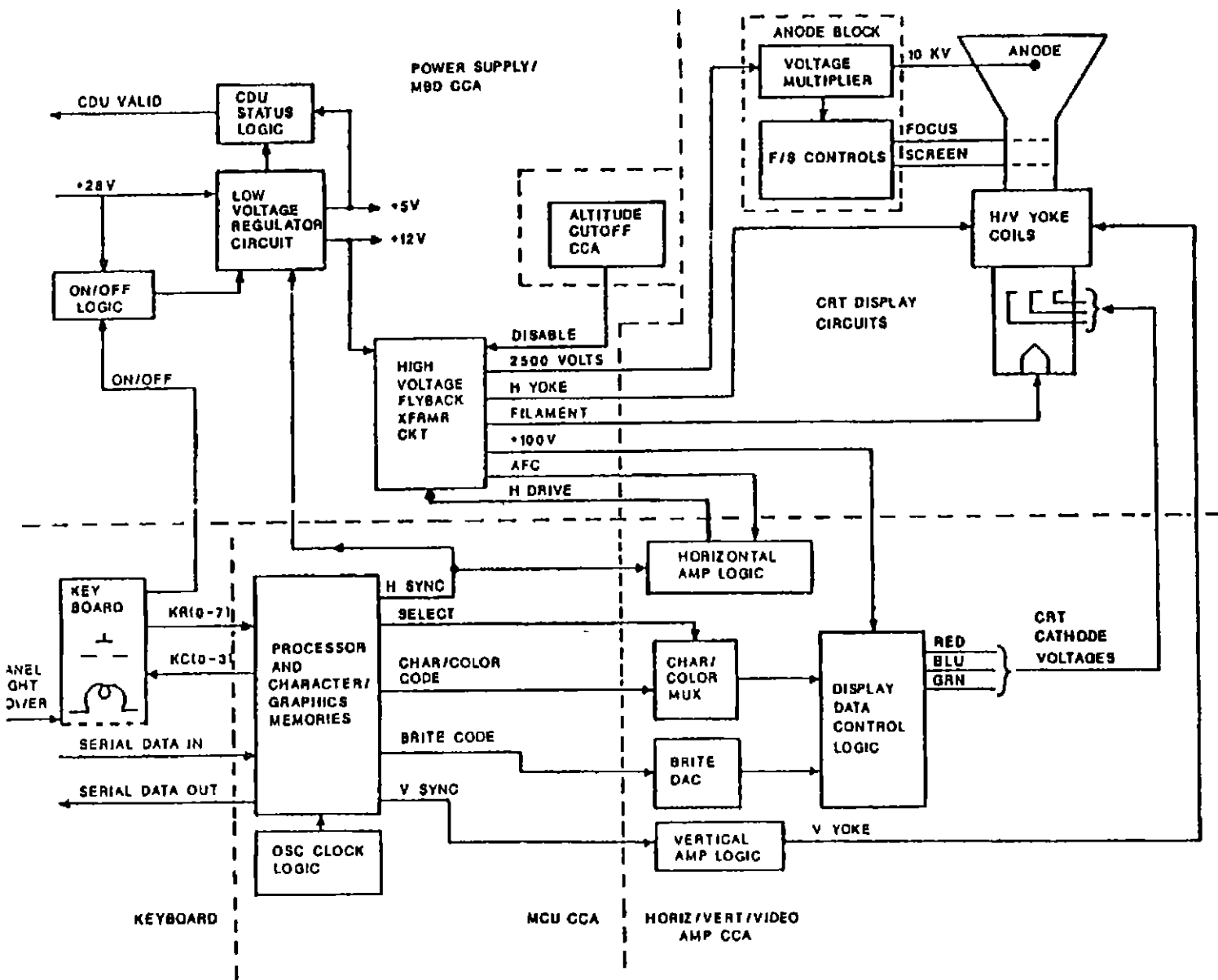
- (1) This CCA receives commands directly from the RPU through serial data lines. In response to these commands, the CCA logic performs a keyboard scan, generates display data and timing signals, and sends serial status words directly back to the RPU. To perform these functions the CCA uses a processor, character and color memories and the CDU clock logic. An ASART in the processor provides the serial I/O interface to the RPU. Keyboard switch matrix scanning is conducted by the processor by monitoring the keyboard KR (0-7) row output lines while sequentially enabling the keyboard KC (0-3) column input lines. The processor addresses character/graphics memories to generate the character/color code requested by the RPU. Intensity (BRITE) code is passed on directly as received. The oscillator clock logic provides overall CDU timing signals and is the basis for the processor-generated VSYNC and HSYNC display timing signals.

E. H/V/Video CCA

- (1) This CCA decodes the character/color code to provide the correct cathode voltages and generates the CRT horizontal and vertical display control voltages. The character/color code signals are applied to the character/color multiplexer (mux) for selection. A digital-to-analog converter

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OMEGA Navigation System - CDU Block Diagram
Figure 13

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(DAC) decodes the BRITE code to generate the analog intensity signal voltage. In the display data control logic, the data and intensity signals are used to generate CRT cathode voltages. These voltages are applied to the correct color cathodes at the correct levels to provide the desired display. The VSYNC signal from the MCU CCA is used by the vertical amplifier logic to generate the vertical yoke (VYOKE) deflection coil signal. Likewise the HSYNC signal is used by the horizontal amplifier logic to generate the HDrive pulses. These pulses activate the flyback transformer into generating the horizontal yoke (HYOKE) deflection coil signal. At the CRT, the VYOKE and HYOKE signals are used to synchronize vertical and horizontal movement of the display beam.

F CRT Display Circuits

- (1) These circuits consist of the anode block voltage multiplexer and focus/screen control circuit, the H/V yoke coils and the CRT. The voltage multiplier receives 2.5 KV from the flyback transformer and generates the rectified 10 KV CRT anode voltage. Focus/screen adjustments for the CRT display are provided by the focus/screen controls circuits. The H/V coils use the HYOKE and VYOKE signals to deflect the display beam horizontally and vertically. Direction of current flow through the coils determines direction of beam deflection. The CRT receives filament voltage to heat up the blue, green, and red cathodes (electron guns). Cathode voltages to the electron guns mix gun selection as necessary to obtain the desired (or lack of) colors at the proper intensity and control on/off (data) intervals. The electron beam generated by the electron guns is attracted to the CRT face by the high positive voltage at the CRT anode.

F Keyboard Circuit

- (1) The keyboard allows the user to control CDU power, to enter data, and to select ONS operational modes and displays. The circuit consists of pushbutton switches and panel lamps. All switches except the ON/OFF switch are connected in a column/row matrix configuration. While the CDU is on, the CDU processor sequentially enables each column with one of four signals, KC0-KC3. At the same time, the processor monitors the row outputs, KR0-KR7, to identify the switch that has been pressed. The ON/OFF switch, not part of the matrix, is used to enable or disable the power supply/MBD CCA ON/OFF logic. The keyboard includes panel lamps. These lamps receive external panel light power to provide panel edge lighting.

6 Antenna Coupler Unit (ACU)

- A The Tracor-designed ACU contains two signal-sensing elements and the first two stages of signal amplification and frequency selection. An orthogonal pair of ferrite rod loop antenna elements are used to sense the H-(mag-

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netic) field component of the VLF/Omega signals. Since loop antennas display an inherent directional sensitivity pattern, orthogonal positioning of the two loops provides omnidirectional coverage. Moreover, through electronic steering of the loop reception pattern, a 6-dB signal-to-noise gain can be achieved. Also loop antennas exhibit relative immunity to noise generated by airframe electrostatic discharges (e.g., precipitation-static discharges)

- B Integral preamplifiers comprise the amplification stages. These two stages amplify the received signals sufficiently to allow the signals to be cable-transmitted to the receiver without significant signal-to-noise degradation. A BITE capability whereby test signals are introduced directly into the ferrite rods, allows monitoring of ACU sense elements and preamplifier stages.
- C Electro-magnetic interference (EMI) protection for the ACU is provided by a combination of filtering and shielding. The frequency response of the ACU provides rejection of any signals outside the VLF/Omega frequency band. All internal circuitry in this unit is shielded by a solid metallic shield whose electrical reference point is floating with respect to the airframe. A circumferentially grounded Faraday shield is provided in the fiberglass cover for the ACU.

7 Omega Navigation Stations

- A The Omega navigation stations provide a worldwide radio aid to navigation by transmitting very low frequency radio waves from eight stations scattered around the world. Refer to Table 1 for letter and number designation and location of each of the eight stations. A pilot with an Omega receiver can take advantage of the stable-properties, long range, and synchronized format of the Omega radio waves as a navigation aid. Each station transmits four basic frequencies 10.2, 13.6, 11 1/3 and 11.05 kHz as well as a unique frequency assigned to each station. (This unique frequency can be tracked by the ONS with the tunable 13.6 kHz VLF receiver channel). To prevent signal interference among stations, the transmission format allows only one station to transmit a particular frequency at a time. Refer to Figure 14 for Omega transmission format.

8 VLF Communication Stations

- A The U.S. Navy operates a worldwide VLF radio communication network. Although not specifically intended as radio-navigation aids, the VLF signals transmitted by these stations are used by the ONS to supplement the Omega station signals. Each VLF station transmits at a different frequency. Table 2 lists the locations, frequencies, and transmission strengths of these stations and a similar one in Great Britain (the term VLF is usually understood to exclude Omega, although the Omega signals are strictly speaking within the VLF band).

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LETTER	NO.	LOCATION	LATITUDE	LONGITUDE
A	1	Aldra, Norway	66° 25' N	13° 08' E
B	2	Monrovia, Liberia	06° 18' N	10° 40' W
C	3	Haiku, Hawaii, U.S A	21° 24' N	157° 50' W
D	4	La Moure, North Dakota, U S A	46° 22' N	98° 20' W
E	5	La Reunion	20° 58' S	55° 17' E
F	6	Golfo Nuevo, Argentina	43° 03' S	65° 11' W
G	7	Australia	38° 29' S	146° 56' E
H	8	Tsushima, Japan	34° 37' N	129° 27' E

Omega Stations
Table 1

NO	LOCATION	LATITUDE	LONGITUDE	FREQUENCY	POWER
1	Maine	44° 39' N	67° 17' W	24 0 kHz	1026 kW
2	Japan	34° 58' N	137° 01' E	17 4 kHz	48 kW
3	Washington	48° 12' N	121° 55' W	24 8 kHz	124 kW
4	Hawaii	21° 26' N	158° 09' W	23 4 kHz	588 kW
5	Maryland	38° 59' N	76° 27' W	21 4 kHz	588 kW
6	Australia	21° 49' S	114° 10' E	22 3 kHz	989 kW
7	Puerto Rico	18° 23' N	67° 11' W	28 5 kHz	100 kW
8	Great Britain	52° 22' N	1° 11' W	16 0 kHz	40 kW

VLF Stations
Table 2

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9 ONS Navigation Algorithms

A. The ONS 6809 receiver processor and the SIMP master processor perform all ONS navigational computation. Basically, the 6809 task is to process Omega/VLF signals and to send phase (a measure of distance to station) and amplitude (signal strength) information to the SIMP. At the SIMP, the information is analyzed to select stations with best signal quality and to derive current position. A detailed description of the algorithms performed by the processor to accomplish these tasks follows.

B Signal Acquisition/Tracking

(1) Auto-Sync

- (a) Following powerup, when the ONS internal oscillator has stabilized, the SIMP commands the 6809 to initiate the auto-sync algorithm. This algorithm, when executed, synchronizes ONS timing to the Omega format. To achieve synchronization the 6809 must receive and verify signals from at least one Omega station at the basic 10.2, 11 1/3, and 13.6 kHz frequencies.
- (b) During auto-sync, the 6809 builds an array of Omega samples taken every 50 milliseconds. Then, at 20 second intervals, the sample array pattern is compared to the standard Omega format for cross-correlation. When sufficient correlation is evident, the 6809 alerts the SIMP that auto-sync is completed and initiates sync-check to verify auto-sync. During sync-check, the receiver VLF channel is used by the 6809 to track the unique frequency of any Omega station. If a unique Omega format is verified, sync-check is completed and the 6809 goes into the NAV mode (signal tracking). If sync-check fails or if the 6809 cannot achieve auto-sync within 650 seconds, auto-sync is restarted.

(2) Signal Tracking

- (a) Once auto-sync is verified, the 6809 begins tracking the 10.2, 11 1/3, and 13.6 kHz frequencies from seven Omega stations and the frequencies of seven VLF stations. One Omega and one VLF station are not tracked so that the 6809 can use these two tracking segments for performing BITE tests.
- (b) Signal tracking is conducted in segments with the three frequencies from one Omega station and the frequency from one VLF station being sampled during one segment. Basically, four 6809 subroutines, PHASER, STEER, RATE-AID, and PHFILT perform the tracking function. During each segment, PHASER samples the signal phases at a 20 Hz rate, groups the phases by station/frequency and averages each group. At the end of the segment, STEER electronically steers

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the antenna for the next segment RATE-AID uses ground speed and track information from the SIMP to apply a phase update to each signal. This action is required to smooth out the response of the phase filters. This response, if not rate-aided, would be distorted due to the slow Omega format 10-second update. PHFLT filters the phase samples from each segment into the two-stage phase filters.

- (c) Stage 1 of the filters is kept in a vector state (phase, magnitude), while stage 2 is in a phase-only state. Phase correction to compensate for oscillator drift is inserted into each new sample in stage 1. Then a difference between new sample and state vector is computed and a percentage of the resultant vector is the update applied to the filter state. Percentages are 1/4 if ONS is on ground or for VLF sample if airborne, and 1/8 for Omega sample if airborne. Stage 1 is the input to stage 2 and the update of stage 2 filter states is similar as for stage 1. To further smooth the filters a patented process called "frequency cross-coupling" is used whereby a percentage of the normal 10-second update to one Omega frequency is also applied to the other frequencies of that station. Subroutines PHASER, STEER, RATE-AID and PHFLT are also used to conduct BITE and auto-sync.
- (d) At the end of each Omega segment, the 6809 transmits phase and signal quality data for each of the 14 stations being tracked to the SIMP for further processing.

B Station Selection

- (1) As the SIMP accepts phase and signal quality data from the 6809, it generates a list of available stations. Stations with sufficient signal quality to be useful in position tracking. Stations deselected by the operator and stations automatically deselected for range (greater than 8,000 nmi. or less than 32 nmi.) cannot be made available.
- (2) Every 10 seconds, each available station is assigned a figure-of-merit (FOM) based on signal quality, signal type and signal stability. The station selection process begins next, using eight stations with the largest FOM's being selected for position determination. During the selection process, stations whose bearings are close to stations already selected have their FOM's adjusted downward to indicate their loss of usefulness in position determination.

(a) Signal Stability

- 1) In the VLF band, transmitters unavoidably transmit their signals in several modes at the same time: the primary mode, and one or more secondary modes that have different phases compared to the primary mode. The secondary modes are normally weaker than the

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primary modes, but as they approach comparable strength (say, half the primary mode level), the difference in phase causes very noisy and erroneous phase measurements. This modal interference is most often observed under certain conditions close to the station, when the signal is traveling at night, or when the signal has crossed discontinuous propagation conditions such as the day/night boundary or land/sea boundary.

- 2) The ONS uses two methods to determine when a station is experiencing modal interference. The first is the "modal map" of geographical regions of known or predicted modal interference problems for each Omega station. When the aircraft is in a station's modal region and there is night in the path to the station, or when the aircraft is within 512 nmi of the station at any time, modal interference is suspected. Omega stations with three usable frequencies are tested for possible modal interference periodically, whether or not they are in regions of predicted modal interference. The ONS computes an "ortho-composite score", which is a measure of disagreement on the range to the station among the three frequencies. If this score is consistently low, the station is considered normal even in modal regions. If the score is high (indicating error of 2.5 nmi or more) and the station is in a modal region, modal interference is assumed and the station's influence on position determination is greatly reduced. Outside the modal region, a station is considered normal even when its ortho-composite score is large, but if selected, its influence on position determination is reduced.
- 3) Signal instability and phase errors are also suspected when a large portion of the path to a station is in twilight, making it difficult to compute accurate sky-wave corrections.

(b) Signal Types

- 1) Stable omega stations with signals available on both the 10.2 and 13.6 kHz frequencies qualify for use as composite stations and are given a bonus in their FOM. Composite omega, a technique for combining 10.2 and 13.6 kHz signals, is less susceptible to sky-wave correction errors and to sudden ionospheric disturbances (SIDs). Omega stations disqualified from normal use because of modal interference and all VLF stations (more susceptible to modal interference) are retained but used in a "viscous" navigation mode. This consists of making small repeated corrections to the signal phases on such stations, to gradually bring them into agreement with all stations being used. Thus much of the usefulness of the affected stations is salvaged without suffering the worst effects of the phase dis-

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turbances. VLF stations also benefit from a "laneless VLF" feature which gives immunity to sudden phase shifts of a complete cycle, or "lane jumps"

C Station Initialization

- (1) Phase can be directly measured only as fractions of a cycle (where one cycle represents a distance the signal has traveled of about 7 to 16 nmi), there is no way to measure the number of full cycles. When a station is selected for use, the ONS initializes its lane count (number of full cycles) so that the phases (lane count plus measured fraction) are within 1/2 cycle of the predicted phase for this position. Thereafter, as long as the station is in use, changes in phase (from measured change, rate-aiding, etc) are applied to this full phase. If the station is initialized, since it may have been too weak or too unstable for accurate phase tracking while it was not in use.
- (2) When the first stations are initialized, clock corrections are also computed for each of the three Omega receiver channels. These clock corrections are estimates of the random phase offset on each receiver channel, relative to the Omega standard, due to the initial state of the local oscillator synthesizer. Each clock correction is computed from the common phase error shown by all stations in use on that frequency. The clock corrections are recomputed whenever there are sufficient signals to compute new values, and there are indications of error in at least one present value. When sufficient data is available to accurately compute all three clock corrections (at least three composite Omega stations in good geometric relationship), the ONS can operate in the absolute mode of navigation. If not, individual phase corrections must be computed for all stations, and the system navigates in the relative mode.

D Position and Oscillator Tracking

- (1) Since three unknowns are to be solved (latitude, longitude and clock phase), three stations are necessary for a complete navigation solution. If only two stations are available for selection, the ONS operates in a degraded RANGE mode, neglecting the solution of clock phase. Providing the system has been able to calibrate the clock beforehand, position accuracy in the degraded RANGE mode should be good for a period of approximately one hour.
- (2) The ONS determines position and clock phase by a conventional weighted least-squares fit mechanism. The error terms to be minimized are derived from the differences between the ranges to the selected stations based on the current position and the ranges based on the signal phase data. Each error term is weighted by the FOM of the station it represents.

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		0	1	2	3	4	5	6	7	8	9	10
	OMEGA SEGMENT	A	B	C	D	E	F	G	H			
	DURATION	08	10	11	12	11	08	12				
STATION	NORWAY A	10 20	13 00	11 15	12 10	12 10	11 05	12 10	12 10			
	LIBERIA B	12 00	10 20	13 00	11 15	12 00	12 00	11 05	12 00			
	HAWAII C	11 50	11 50	10 20	13 00	13 15	11 00	11 50	11 05			
	NORTH DAKOTA D	11 05	13 10	13 10	10 20	13 00	11 15	13 10	13 10			
	LA REUNION E	12 30	11 05	12 30	12 30	10 20	13 00	11 15	12 30			
	ARGENTINA F	12 30	12 30	11 05	12 30	12 30	10 20	13 00	11 15			
	AUSTRALIA G	11 15	13 00	13 00	11 05	13 00	13 00	10 20	13 00			
	JAPAN H	13 00	11 15	12 30	12 30	11 05	12 30	12 30	10 20			

Omega Transmission Format
Figure 14

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- (3) The clock phase is determined separately from position. The vector of 'range error' terms is multiplied by a matrix designed to produce as output the phase offset common to all signals. Since all phase data is measured with respect to a common oscillator (the system 'clock'), this phase offset is attributed to the clock itself. To insure stability in the clock phase estimate, the result of the clock matrix multiplication is fed into a second-order filter (with time constant 15 minutes) to produce a clock phase and phase rate. The clock phase rate is a measurement of the frequency offset in the local oscillator, and is used to continually update the clock phase.
- (4) The same range error vector used in the clock corrector is used to determine latitude and longitude. Position determination is accomplished by multiplying the range error vector by matrices designed to produce the latitude and longitude offsets which would minimize the weighted sum of the squares of the errors. These offsets are used directly to update the current estimate of position. Since position is continually rate-aided, these offsets can also be used to correct any error in the estimated ground speed and track. This is accomplished by implementing a low pass filter on the position errors, creating a stable estimate of the wind. The time constant of the wind filter is approximately eight minutes.
- (5) As previously mentioned, all active filters in the ONS system are rate-aided to insure a smooth response to rapidly changing inputs. The clock rate is used to update the system clock phase, while air speed, heading and wind are used to update position and all phase values. In the absence of sufficient phase data (less than 2 stations selected), this rate-aid operation serves as the back-up dead reckoning (DR) mode for position determination.

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3. GPS Navigation System Removal/Installation.

3.1 Equipment and Materials

- (1) Self Leveling Green Sealant (P/N HT3326-5-50).
- (2) Tape Stretch Seal (P/N AD89503/01-36).

3.2 NPU Installation.

Slide the NPU into the mounting tray and verify proper connection to mounting tray connector (1J1). Secure the NPU into the mounting tray with the hold down mechanism. Connect the GPS antenna cable to the GPS antenna connector (1P2) on the NPU.

3.3 NPU removed.

Disconnect the GPS antenna cable from the GPS antenna connector (1P2) on the NPU. Unfasten the holddown mechanism and slide the NPU out of the mounting tray.

3.4 CDU Installation/Removal.

The CDU is a DZUS mounted display second with DZUS mounting hardware.

3.5 CDI Installation/Removal.

The CDI are installed in the pilots and copilots instrument panels using 4 NAS623-3-7 screws.

3.6 GPS Antenna Removal.

NOTE: Removal of an upper antenna requires a work stand high enough to reach the top of the fuselage.

- (1) Open GPS circuit breaker on P5 overhead circuit breaker panel.
- (2) Locate GPS antenna at station 338 (top).
- (3) Remove four screws that attach the antenna to the fuselage.
- (4) Pull antenna out far enough to disconnect coaxial cable connector.

NOTE: If antenna is located on top of aircraft, secure cable so that it will not fall into aircraft.

- (5) Disconnect coaxial cable connector from antenna.
- (6) Discard O-ring.

3.7 GPS Antenna Installation.

- (1) Place antenna gasket on antenna.



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- (2) Apply self leveling green to connector base. Allow sealant to cure for 30 minutes before mounting antenna to aircraft.
- (3) Remove any remaining aerodynamic sealant from mating surface on aircraft, using a plastic scraper.
- (4) Inspect aircraft skin for corrosion and repair per SRM 51-8-1, using alodine MIL-C 5541 class 3 per SOPM 20-43-03.
- (5) Prime and paint all bare metal outside the original footprint and decrease the original footprint by 0,2 inch per AMM 51-90-00.

NOTE: Ensure all bare metal within antenna footprint is clean, alodined and corrosion free before installing the antenna gasket.

- (6) Clean antenna footprint and skin surfaces with aliphatic naphtha TT-N-95 or equivalent per AMM 13-1-3.
- (7) Remove the aliphatic naphtha with a clean cloth.
- (8) Place antenna near mounting location and connect coaxial cable to antenna.
- (9) Wind stretch seal tape around the connector until it is 1.5 inch above the connector, covering the coax cable.

NOTE: Make sure the adhesive side of the tape is pointing to the coaxial cable and the connector. This provides for a tight seal.

CAUTION DO NOT APPLY AERODYNAMIC SEALANT TO THE EDGES OF THE ANTENNA. AERODYNAMIC SEALANTS PREVENT MOISTURE REMOVAL BY THE GASKET WHICH CAN CAUSE CORROSION DAMAGE TO THE AIRPLANE AND ANTENNA MATING SURFACES

- (10) Place antenna in position ensuring the antenna gasket is positioned correctly.
- (11) Secure antenna with four mounting screws. Ensure that a Teflon washer is placed under each screw.
- (12) Tighten antenna screws so that antenna gasket is compressed evenly.
- (13) Torque screws per AMM 13-9-21. Re-torque after 15 minutes.
- (14) Measure electrical bond resistance between the antenna and fuselage using a milliohm meter. Resistance must be less than 0.001 Ohm.
- (15) Close the GPS circuit breaker on P5 overhead circuit breaker panel.
- (16) Perform an operational test per AMM 34-53-01 page 501, par. 4.

3 GPS Navigation System Removal/Installation

3 1 NPU installation

Slide the NPU into the mounting tray and verify proper connection to mounting tray connector (1J1) Secure the NPU into the mounting tray with the hold down mechanism Connect the GPS antenna cable to the GPS antenna connector (1P2) on the NPU

3 2 NPU removed

Disconnect the GPS antenna cable from the GPS antenna connector (1P2) on the NPU
Unfasten the holddown mechanism and slide the NPU out of the mounting tray

3 3 CDU Installation/Removal

The CDU is a DZUS mounted display second with DZUS mounting hardware

3 4 CDI Installation/Removal

The CDI are installed in the pilot's and co-pilot's instrument panels using 4 NAS623-3-7 screws

3 5 GPS Antenna Removal

The TNL 8100 GPS antenna is installed on the top of the aircraft to provide a clear view for the line of sight GPS satellites

- (1) Remove the 4 screws that attach antenna to fuselage
- (2) Pull antenna out far enough, to disconnect coaxial cable connector
- (3) Disconnect coaxial cable connector from antenna when removing antenna, secure end of cable to prevent connector from falling inside aircraft

3 6 GPS Antenna Installation

- (1) Clear faying (mating) surfaces
- (2) Apply corrosion inhibiting compound on inside surfaces of installation area.
- (3) Connect coaxial cable connector to antenna
- (4) Check that serviceable O-ring is in place in groove on antenna mounting surfaces
- (5) Install the GPS antenna using the 4 mounting screws

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OMEGA NAVIGATION SYSTEM - REMOVAL/INSTALLATION

1 General

- A System maintenance consists of removing and replacing any line replaceable unit (LRU) that has been determined to be faulty and repairing wiring. The system is then checked out with the new unit(s) in place or after wiring repair. The removal and installation procedures for the omega receiver-computer, the omega antenna and the control panels (system mode control, system control-indicator, control-display unit, or mode select unit) are given in this section.
- B Procedures for determining the running time of each NU and for reloading the omega receiver-computer program are included in section 34-52-01 Removal/Installation, Paragraph 5.2 Control Panel Removal.
- C The system control-indicator, system mode control, control-display units, and mode select units are all mounted to the forward electronic control panel in the same manner. The following removal procedure applies to any of the panels in the navigational computer system.

(1) Set appropriate switches as listed below

TO REMOVE	SET
No 1 MSU or No 1 CDU	No 1 MSU mode select switch to OFF
No 2 MSU or No 2 CDU	No 2 MSU mode select switch to OFF
SMC or CDI	SMC mode selector to OFF

(2) Open applicable circuit breakers on P6 panel as listed below

TO REMOVE	OPEN
No 1 MSU	NAVIGATION - INS - No 1 and No 1 HTR No 1 Battery Unit circuit breaker
No 2 MSU	NAVIGATION - INS - No 2 and No 2 HTR No 2 Battery Unit circuit breaker
No 2 CDU	NAVIGATION - INS - No 2

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SMC or SCI

NAVIGATION - OMEGA NAV -
RCVR CMPTR and PANES

- (c) Disengage captive fasteners on edge of panel by turning them one-quarter turn counterclockwise
- (d) Carefully pull panel from mount and disconnect all electrical connectors at rear of panel.

2 Control Panel Installation

A. The following installation procedure applies to any of the panels in the navigational computer system

- (1) Ensure that power to panel connector has been removed by opening applicable circuit breaker on P6 panel as listed below

TO INSTALL

OPEN

No 1 MSU

NAVIGATION - INS - No 1 and No 1
HTR No 1 Battery Unit circuit
breaker

No 2 MSU

NAVIGATION - INS - No 2 and No 2
HTR No 2 Battery Unit circuit
breaker

No. 1 CDU

NAVIGATION - INS - No.1

No 2 CDU

NAVIGATION - INS - No 2

SMC or SCI

NAVIGATION - OMEGA NAV -
RCVR CMPTR and PANELS

- (2) Connect wire bundle connectors to mating receptacles on rear of panel
- (3) Raise panel into position and secure panel by pressing and turning each captive fastener on edge of panel one-quarter turn clockwise

3 Control Panel Relamping

A. All single character data indicators, data registers, data displays and FROM-TO displays are referred to as segmented displays Relamping may be performed with power applied to the control panel since low voltage is used for all lamp power

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CAUTION REPLACE DEFECTIVE LAMPS ONLY WITH LAMPS HAVING PREFERRED PART NUMBER OR LAMPS HAVING THE SAME BASE CONFIGURATION AND IDENTICAL VOLTAGE AND CURRENT RATINGS IMPROPER LAMP REPLACEMENT WILL DAMAGE THE EQUIPMENT

4 Omega Receiver-Computer - Removal

- A Set mode selector on SMC to OFF
- B Open NAVIGATION - ONE OVEN and NAVIGATION - OMEGA NAV - RCVR CMPTR circuit breakers on P6 panel Tag circuit breakers if circuit breaker panel will not be under continuous observation.
- C. Ensure crew rest seats are removed or stowed so rear access door can be opened
- D Ensure interior paneling around right antenna pedestal strut is removed to allow access to all screws on oblong access cover

CAUTION WHEN OPENING REAR ACCESS DOOR, RELEASE QUARTER-TURN FASTENERS NEXT TO HINGE FIRST TO PREVENT DAMAGE TO REAR ACCESS DOOR

- E Release 28 quick-disconnect fasteners and open rear access door
- F Loosen hand nuts enough to drop clear of mounting feet at front of unit.
- G Remove 10 screws securing oblong access cover on front access panel of navigation rack to gain access to rear electrical connectors Remove oblong access cover

WARNING OMEGA RECEIVER-COMPUTER WEIGHS 55 POUNDS USE TWO MEN TO LIFT THE RECEIVER-COMPUTER

- H Disconnect electrical connectors on rear of unit and remove unit

5 Omega Receiver-Computer - Installation

WARNING OMEGA RECEIVER-COMPUTER WEIGHS 55 POUNDS USE TWO MEN TO LIFT THE RECEIVER-COMPUTER

- A Place unit in position on rack and connect electrical connectors to rear of unit
- B Install oblong access cover with 10 screws on front access panel of navigation rack.
- C Engage hand nuts on mounting feet at front of unit and tighten

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CAUTION. SECURE REAR ACCESS DOOR QUARTER-TURN FASTENERS NEXT TO HINGE LAST TO PREVENT DAMAGE TO REAR ACCESS DOOR.

- D Close rear access door and fasten 28 quick-disconnect fasteners
 - E. Install crew rest seats if required.
 - F Ensure interior paneling is reinstalled around right antenna pedestal strut.
 - G. Close NAVIGATION - ONE OVEN and NAVIGATION - OMEGA NAV - RCVR CMPTR circuit breakers on P6 circuit breaker panel
- 6 Omega Receiver-Computer Program - Reloading
- A Ensure electrical power is applied to aircraft
 - B Ensure aft forced air cooling is applied to aircraft
 - C Obtain programmer-controller and cassette tape containing current (MOD 20) omega receiver-computer program
 - D Perform self test of programmer controller
 - E Verify that mode selectors on both MSU's and SMC are set to OFF
 - F Verify following circuit breakers on P6 panel are open

NAVIGATION

OMEGA NAV

RCVR CMPTR

PANELS

ONE OVEN

- G Ensure crew rest seats are removed or stowed so rear access door can be opened

CAUTION WHEN OPENING REAR ACCESS DOOR, RELEASE QUARTER-TURN FASTENERS NEXT TO HINGE FIRST TO PREVENT DAMAGE TO ACCESS DOOR

- H Release 28 quick-disconnect fasteners and open rear access door
- I Verify that POWER switch is set to OFF on programmer-controller

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- J Verify that CONVENIENCE OUTLET - MID MAIN CABIN circuit breaker on P67-2 panel is open

NOTE P67-1, P67-2, and Pt7-3 circuit breaker panels are located just forward of the over-wing emergency exit on right side of aircraft.

- K Using mate-with information, connect cables W1, W2 and W4 as follows

CABLE	FROM	TO
W1	Programmer-controller connector 1J1	Omega receiver-computer connector 1J1
W2	Programmer-controller connector 1J2	Omega receiver-computer connector 1J2

CAUTION DO NOT CONNECT CABLE W4 TO CONVENIENCE OUTLET IF CONVENIENCE OUTLET CIRCUIT BREAKER IS CLOSED OR PROGRAMMER CONTROLLER MAY BE DAMAGED CIRCUIT BREAKER MUST BE OPENED IN STEP J

CABLE	FROM	TO
W4	Programmer-controller connector 1J3	115 volt 400 Hz aircraft power receptacle below P67-3 panel

- L. Close CONVENIENCE OUTLET - MID MAIN CABIN circuit breaker on P67-2 panel
- M Set DIM control to mid range on programmer-controller
- N Set POWER switch to ON on programmer-controller
- O Open drive unit door, insert cassette tape with label giving program part number, modification number, and correction number on top, and close drive unit door
- P Observe that TAPE STATUS CASSETTE LOADED indicator comes on
- NOTE CASSETTE LOADED indicator will only come on if the cassette tape has been properly positioned in the drive unit, and the drive unit door is closed
- Q To ensure a complete reload of omega receiver-computer program, rewind cassette tape as follows:

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- (1) Press and release TEST STATUS AND CONTROL RESET switch.
- (2) Press and release TAPE CONTROL FORWARD REVERSE switch-indicator REVERSE segment comes on
- (3) Press and release TAPE CONTROL RUN switch-indicator

NOTE RUN switch-indicator will go off after cassette tape is rewound

R Close following circuit breakers on P6 panel-

NAVIGATION

OMEGA NAV

RCVR CMPTR

PANELS

ONE OVEN

- S Set mode selector to UNAIDED on SMC
- T Press MODE ENABLE switch on SMC
- U Press and release TAPE CONTROL FORWARD REVERSE switch-indicator FORWARD , segment comes on
- V Press and release TEST STATUS AND CONTROL AUTO SINGLE switch-indicator SINGLE segment comes on
- W Press and release TEST STATUS AND CONTROL RESET switch-indicator
- X Press and release TEST STATUS AND CONTROL AUTO SINGLE switch-indicator AUTO segment comes on
- Y Press and release TEST STATUS AND CONTROL MANUAL/PROGRAM switch-indicator PROGRAM indicator comes on
- Z. Press and release TEST STATUS AND CONTROL TEST INITIATE switch-indicator TEST INITIATE indicator comes on
- AA Verify that TAPE CONTROL RUN switch-indicator is on and tape is in motion
- AB After tape motion has stopped, verify that
- (1) TEST STATUS AND CONTROL GO indicator is on

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(2) TEST ROUTINE displays same modification number as is listed on cassette tape

(3) TAPE CONTROL RUN switch-indicator is off

AC Set mode selector to OFF on SMC

AD Open following circuit breakers on P6 panel:

NAVIGATION

OMEGA NAV

RCVR CMPTR

PANELS

ONE OVEN

AE Set POWER switch to OFF on programmer-controller

AF Disconnect cables W1 and W2 which were connected in step 1K

AG Close rear access door on navigation equipment rack and secure four corner fasteners

AH Perform component replacement checkout for omega receiver-computer

AI If incorrect data is displayed, set mode selector to OFF on SMC and both MSU's and repeat steps F, K, and Q through AH

AJ If incorrect data is again displayed, replace omega receiver-computer

AK. If correct data is displayed, set mode selectors to OFF on SMC and both MSU's

AL Open CONVENIENCE OUTLET - MID MAIN CABIN circuit breaker on P67-2 panel

AM Disconnect cable W4 which was connected in step 1K

AN Open drive unit door, press back eject lever on each side of cassette, remove cassette, and close drive unit door

AO Secure cables, cassette, and programmer-controller

AP Close rear access door and fasten 28 quarter-turn fasteners

AQ Ensure crew rest seats are installed if required

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7. Omega Antenna- Removal

- A Unscrew 7 screws holding antenna in place
- B Reach aft through access opening and disconnect electrical connector from receptacle on top of antenna.
- C Remove antenna from aircraft

8. Omega Antenna - Installation

- A Clean faying surfaces on support assembly and mounting area in aircraft with 400 grit garnet or aluminum oxide sandpaper to ensure proper electrical bond.

CAUTION BE SURE ANTENNA IS ORIENTED CORRECTLY, OTHERWISE COMPUTER WILL RECEIVE ERRONEOUS SIGNALS

- B Connect electrical connector to antenna
- C Position antenna in place and install 7 screws Tighten the screws to a torque value of maximum 10 inc-pounds
- D Check that bond between support assembly and aircraft is less than 0 001 ohm
- E Apply RTV 731 fillet seal around the circumference of the antenna/shim seam

9 Component Replacement Checkout

- A Perform component replacement checkout per Subject 34-52-01 - Adjustment/Test, Table 503 or 504 as required

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and TRACOR Installation Manual
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4 SYSTEM CHECKOUT

The following procedures provide a means of verifying correct operation of the TNL81 00 To check out the operation of the GPS Receiver, the aircraft must be located outside and away from any tall buildings Keep in mind that the antenna must be able to receive line-of-sight GPS transmissions In order to check the TAS input it will be necessary to connect a pitot/ static test set to the aircraft.

4 1 TNL8100 Checkout Procedures

- A Ensure all circuit breakers are set
- B Apply power to the aircraft and the aircraft radio busses
- C. Press the ON/OFF key on the CDU The Initialization page is displayed in approximately three seconds
- D Press and hold the BRT key and the DIM key on the CDU Verify that the CDU brightness changes
- E Press the ENTER function key on the CDU The Flight Plan page is now displayed
- F Press the AUX, ALPHA, M keys on the ARINC CDU Maintenance Menu Page is displayed

MAINTENANCE

1 TAS 8 PINS
 2 HDG 9 HIST
 3 ALT 0 ROLL
 4 P/R
 5 FUEL
 6 DIGITAL IN
 7 DIGITAL OUT]

- G Press the DOWN ARROW key to display the TAS Maintenance Page If the TNL8100 is interfaced to the TAS system, perform the following tests

TAS 234 KTS

TYPE 545

STATUS VALID

MENU

KIFA, KIFB, 56SAC HI, 56BAC LO,
 565DC, 419, 429
 NO DATA, FAIL

- (1) Verify TYPE displays correct True Airspeed Type Selection
 The correct type is "545" See table below for TAS select pin out information or the NPU

TAS Type	TP-49 TAS Sel 1	TP-37 TAS Sel 2	TP-36 TAS Sel 3
Synchro 545	Open	Open	GND

Table 4-1 TAS select pin-out information



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Note If TAS selection pinout is in error, installation-checkout may continue by manually selecting correct TAS TYPE

(Press CLEAR, then EDIT until correct type is displayed, then ENTER)

Program pins must be corrected prior to completing installation-checkout

- (2) Using pitot/static test increase pilot pressure until IAS (Indicated Airspeed displayed on aircraft flight instruments) reads 200 knots

Using Table 4 2 verify TAS reading displayed on the TNL8100 is correct to within ± 10 knots Repeat test for IAS of 300 knots

- (3) Pull circuit breaker for the TAS system Verify TAS status displays FAIL

200K IAS

Pressure Altitude	Outside Air Temperature (C/F)				
	0/32	10/50	20/68	30/86	40/104
0	195	198	202	205	208
1000	198	202	205	209	212
2000	202	205	209	213	216
3000	205	209	213	216	220
4000	209	213	217	220	224
5000	213	217	221	224	228

300K IAS

Pressure Altitude	Outside Air Temperature (C/F)				
	0/32	10/50	20/68	30/86	40/104
0	292	297	303	308	313
1000	297	303	308	313	318
2000	302	308	313	319	324
3000	308	313	319	324	329
4000	313	319	324	330	335
5000	319	324	330	336	341

Table 4-2 TAS Conversion Table



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- H Press the DOWN ARROW key to display the HDG Maintenance Page. If the TNL8100 is interfaced to the Heading system, perform following tests:

HDG	342
SOURCE SYNCHRO	429
REFERENCE TRUE	MAG
STATUS VALID	FAIL, NO DATA
MENU	

- (1) Verify TYPE displays correct HDG Input Type. The correct type is synchro MAG.
- (2) If HDG input source is SYNCHRO, verify North REFERENCE (MAG or TRUE) selection is correct. The correct reference is MAG.

On the NPU pin BP-26 which selects no 1th reference is left open.

- (3) Pull the circuit breaker for the HDG system. Verify HDG system displays FAIL.

- I Press the DOWN ARROW key to display the ALT Maintenance Page.

	ALT		
NONE, DIGITAL	BARO	22500 F_T	FAIL, NO DATA
	SYNCHRO	VALID	
	PRES	17500 F_T	
NONE, DIGITAL	SYNCHRO	VALID	FAIL, NO DATA
	RATE	0 F_T/m	
DIGITAL	COMPUTED	VALID	FAIL
	MENU		

- (1) Verify correct altitude input type selection (SYNCHRO, DIGITAL or NONE). The correct pin selection is given in the table below.

Type	BP-21 ALT Sel 1	BP-22 ALT Sel 2
Synchro (Coarse/Ftne) Press	Open	GNO

Table 4-3 pin selection on NPU

- (2) Verify altitude input is VALID and reading correctly for the current altitude (field elevation).
- (3) Pull the circuit breaker for the ALT input system. Verify ALT status displays FAIL.



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J Press the DOWN ARROW key to display the Pitch/Roll Maintenance Page

PITCH	4°	DOWN	UP, (nothing)
			NOT VALID
ROLL		12°R	L, (nothing)
			NOT VALID
STEER	NORMAL		INVERT
MENU			

Note The vertical gyro (Pitch/Roll) interface capability of the TNL8100 is designed to support additional system functions available in future software releases

N Press the DOWN ARROW key to display the Program PINS Maintenance Page

PINS					
OLEO		GND	AIR		
GO-AROUND		INOP			
ANT		40DB	26DB		
HSI 1	BRG(S/C)		B-H+180	HDG	BRG
HSI 2	DTK		DTK	DA	DTK
HSI 3	DTK-HDG		BRG+180	DTK-HDG	TKE

(1) If interfaced, verify OLEO input reads on ground (GND)

(2) Verify ANTenna select indicates 40DB antenna selected If 26 DB is indicated, remove ground wire from NPU connector pin TP-99

Note Currently, only the high gain antenna is certified for use with the TNL8100

(3) Verify desired synchro output selection is indicated See table below for the pin selector on the NPU

INSTALLATION	A
SYNCHRO #1	BRG
SYNCHRO #2	DTK
SYNCHRO #3	TKE
PROGRAM PIN	Jumper to
BP-23 HSI Sel 1	OPEN
BP-24 HSI Sel 2	OPEN

Table 4-4 pin selector on the NPU

Note If HSI output select pinout is in error, checkout may continue by manually selecting correct synchro outputs



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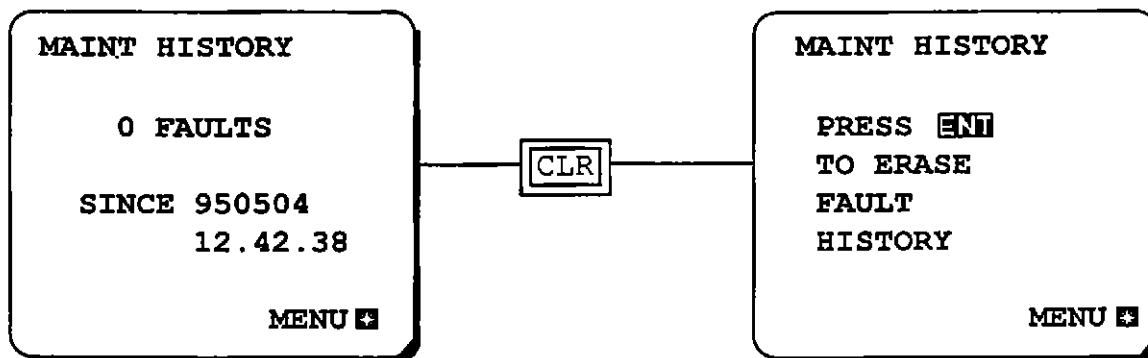
Note If HSI output select pinout is in error, checkout may continue by manually selecting correct synchro outputs

(Press CLEAR twice, then EDIT until correct output selection is displayed, then ENTER)

Program pins must be corrected prior to completing installation-checkout

Note Color coding of the "HSI" labels is used to indicate the North reference used for synchro and CDU outputs. If "HSI" is displayed in cyan, reference used is Magnetic North, if True North is the selected reference, then "HSI" is displayed in white. In this installation the reference is the magnetic north

0 Press the UP ARROW key to display the Maintenance History Page



Q Press the AUX, 1 keys on the ARINC CDU interface Check Page 1. If the TNL8100 is not interfaced to A/P, HSI, or any of the flight instruments proceed to step R

Note In to Interface Check Procedures below, CDI left means the CDI needle moves to the left of center, CDI right means the CDI needle moves to the right of center, GSLOPE up means the glideslope needle moves up, and GSLOPE down means the glideslope needle moves down.

- (1) Select flight instruments to display TNL8100 Nav data
Verify CDI = 1/2 scale left
- (2) Press the * key to display Interface Check Page 2/6
Verify CDI = full scale left
- (3) Press the * key to display Interface Check Page 3/6
Verify CDI = 1/2 scale right
- (4) Press the * key to display Interface Check Page 4/6.
Verify CDI = full scale right
- (5) Press the * key to display Interface Check Page 5/6
Verify CDI = Centered

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(6) Press the * key to display Interface Check Page 6/6
Verify CDI = Centered

Note Selection of Interface Check Page 6 will normally disconnect flight instruments from the TNL8100 system as the flags from the TNL8100 are invalid

Note The Approach Mode flag will be ON for Interface Pages 1, 3 and 5, and OFF for Pages 2 4 and 6

Note When Interface Check is initiated, the TNL8100 will turn on the output flags in sequence, checking each for possible shorts to ground. Because of this, some flags may take up to 4 seconds to be turned on

4 2 GPS Sensor Checkout

To check the GPS Sensor status, press the DATA, 4 keys, then the * key,

GPS					2/2*
SV	2	6	11	16	
	22	27	31		
1 RAIM PREDICT					
2 FPL FDE PRED					

This displays information about the tracked satellites. In the lines under the SV label, the first three lines of the display show the Space Vehicle (SV) number. The white numbers indicate selected satellites and the green numbers indicate tracked satellites. One tracked satellite is required for GPS time and three selected satellites are required for 2-D navigation, four selected satellites are required for 3-D navigation.