Apollo
Navigation Management Computer
Model 2001TSO / 2001GPS
Installation Manual

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HISTORY OF REVISIONS

Revision	Date	Description
-00	Jan 19, 1996	Original release.
-A	Dec. 19, 1996	Added SL40 Comm Serial Data Information
-01	June 25, 1997	Added reference to TSO-C129a, N8110.60, and RNP-10. Added A-34
-01 A	July 12, 1999	Map output, comm data output, annunciator output, fuel air data input, and Apollo ACU added

IMPORTANT NOTE

"The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install this article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within TSO standards. The article may be installed only if further evaluation by the applicant documents an acceptable installation and is approved by the Administrator."

Source: FAA TSO-C115b and TSO-C129a

ORDERING INFORMATION

To receive additional copies of this publication, order part # **560-0161-01A,** *Apollo 2001TSO / 2001GPS Installation Manual*.

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SECTION 1 - INTRODUCTION

ABOUT THIS MANUAL

This manual describes the installation of the Apollo 2001TSO Navigation Management Computer and 2001GPS Navigation Management Computer with GPS. This manual is for all versions of the Apollo 2001 meeting TSO-C129a, N8110.60, RNP-10, and TSO-C115b requirements. References to the 2001 throughout this manual are for both the 2001TSO and 2001GPS unless otherwise specified.

This manual is intended for use by persons certified by the Federal Aviation Administration (FAA) to install aircraft navigation devices. It includes installation and checkout procedures for the 2001 unit to standards described in FAA advisory circulars AC 20-130A and AC 20-138.

Section 1 provides an **INTRODUCTION** to the Apollo 2001 unit. TSO certification information is also included in this section.

Section 2 includes **INSTALLATION** and checkout procedures.

Section 3 includes complete **SPECIFICATIONS**.

Section 4 includes **LIMITATIONS** for the equipment and installation.

Appendix A includes **TROUBLESHOOTING** information.

Appendix B includes **PERIODIC MAINTENANCE** requirements.

Appendix C includes the **ENVIRONMENTAL QUALIFICATION FORM**.

Appendix D includes information on **ACCESSORIES**.

Appendix E includes **SERIAL INTERFACE** specifications.

APOLLO 2001 DESCRIPTION

The Apollo 2001 Navigation Management Computer (NMC) is the main control, display, and navigation computer for the Apollo Navigation Management System (NMS). The 2001 can be used as a multi-sensor system with remotely mounted position sensors connected on NAVNET, a II Morrow local area network for communicating with remote mounted sensors, or as a stand-alone GPS navigation receiver. Used with either the internal or remotely mounted GPS sensor, the 2001 can be used for supplemental IFR en route, terminal, and non-precision approach, or primary oceanic/remote airspace operation. The 2001 includes full

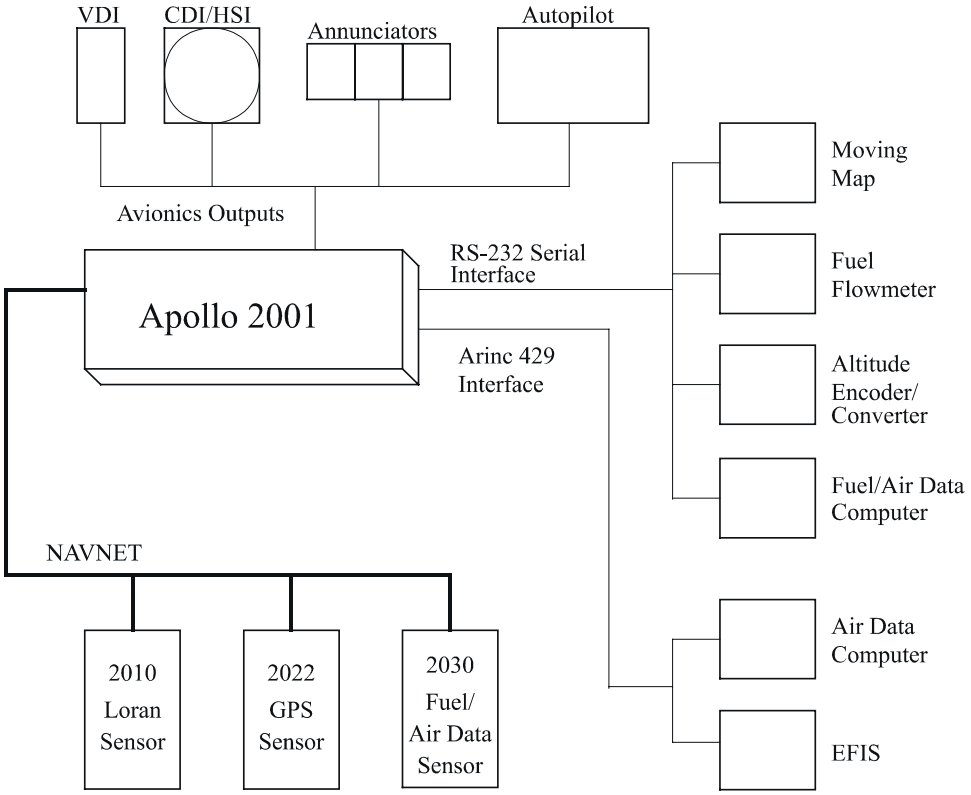
navigation capabilities with avionics outputs. The 2001GPS includes an internal GPS sensor. Optionally, the 2001 can also include Arinc 429 input and output. The available configurations of the 2001 are listed in Table 1.

Table 1 Apollo 2001 Unit Configurations

Model #	Options	Part Number	Comment
2001TSO	none	430-0267-5XX	
2001TSO	Arinc 429	430-0267-6XX	
2001GPS	Internal GPS	430-0267-7XX	
2001GPS	Internal GPS & Arinc 429	430-0267-8XX	
Notes: The particular configuration option is noted by the -5, -6, -7, or -8 in the suffix of the part number. The "XX" is used to denote the version of the unit.			

Complete database capabilities are part of the Apollo NMS system using II Morrow Flybrary datacards programmed with up-to-date data on airports, approaches, VORs, NDBs, intersections, and restricted airspace. Contact II Morrow for the latest information on available datacards and revision service.

A block diagram of the Apollo NMS system is illustrated in Figure 1.



Notes: The 2001GPS does not require the 2022 GPS sensor.
The 2010TSO loran sensor is optional when using GPS.
The 2030 F/ADS is available from Shadin.

Figure 1 Apollo NMS Block Diagram

FEATURES

Features of the Apollo NMS include:

- Modular design allows connection of one or more NMCs and one or more remote sensors for co-pilot convenience and system redundancy
- System configuration can be customized to suit individual requirements
- The system can be upgraded in the future

Apollo 2001 features include:

- Non-precision approach operation with a TSO-C129a GPS sensor (internal or remote)
- Direct To navigation
- Emergency search
- 30 flight plans of 20 waypoints each with automatic waypoint sequencing
- 200 user waypoints
- Custom navigation display pages
- Flybrary database cards
- Internal simulation software
- Password protected owner information pages
- Serial data inputs and outputs
- Automatic LED brightness control
- Parallel track offset
- CDI/HSI/Autopilot outputs

Additional features when connected to a compatible fuel / air data computer include:

- Heading information
- Wind speeds and direction
- Altitude (MSL, density, pressure)
- TAS
- Climb/descent rate
- Fuel flow and management information
- Outside air temp

SYSTEM CONFIGURATIONS

The 2001 can be installed in many configurations depending upon individual requirements. Several Apollo NMS system configurations using the 2001 are illustrated in the following figures. Minimum configurations and equipment for IFR and oceanic/remote airspace installations, as well as optional connections are listed in Table 2 on page 6.

A typical Apollo NMS installation is illustrated in Figure 2.

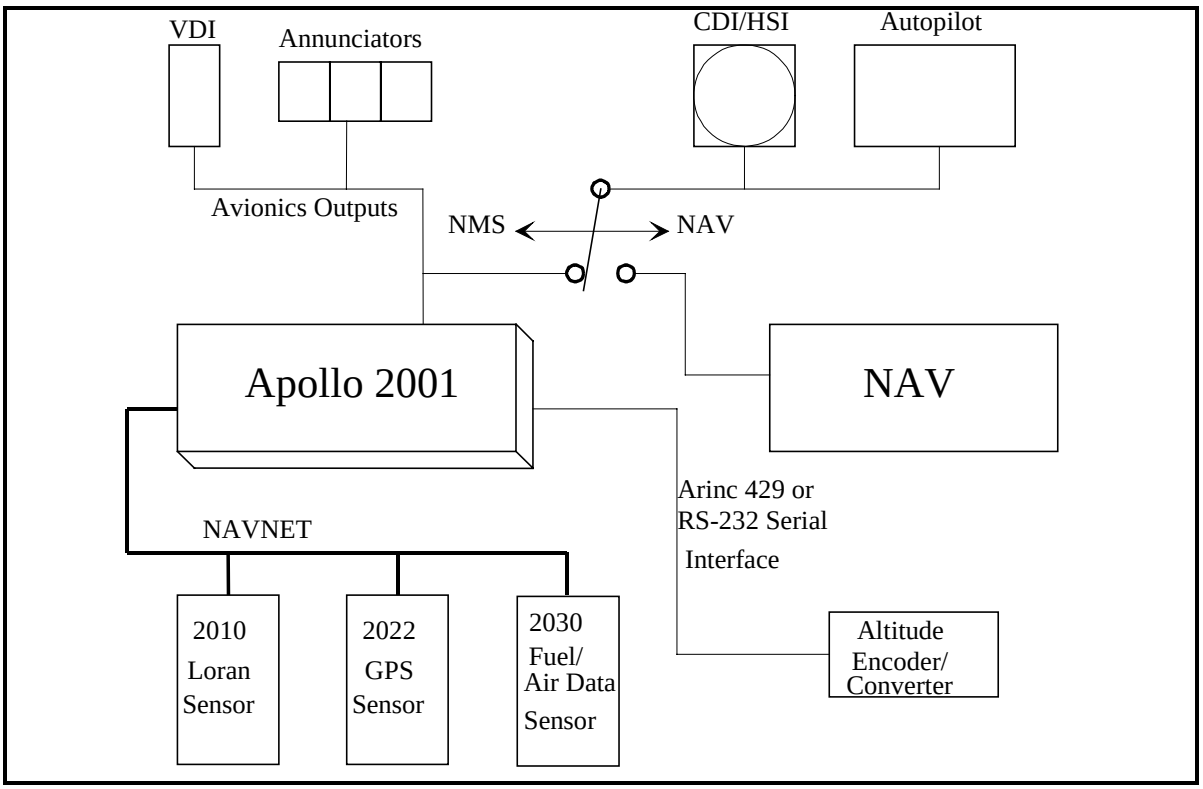


Figure 2 Apollo NMS Typical Installation

A minimum 2001GPS installation is illustrated in Figure 3. This is the minimum configuration required for an IFR installation. A similar installation can be made with a 2001TSO using an external position sensor, such as the 2022 GPS sensor, in place of the 2001GPS.

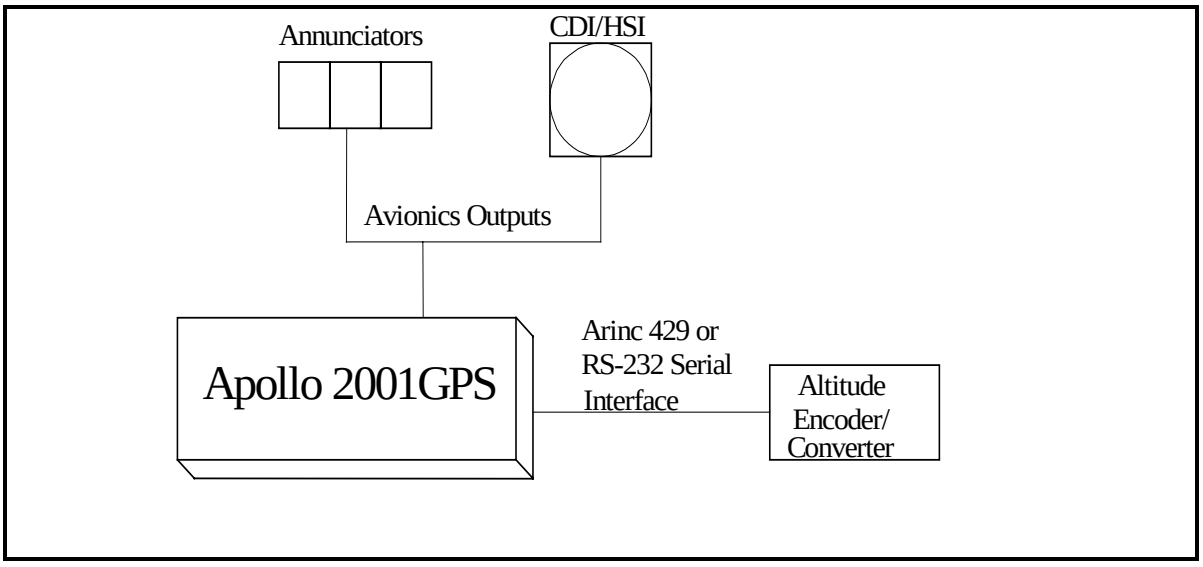


Figure 3 Minimum 2001GPS Installation

For complete system redundancy, dual NMS systems may be desired in some applications. Primary oceanic or remote airspace operation requires dual independent, redundant systems. Installing two systems, as depicted in Figure 3, can be a means of implementing a dual redundant system configuration.

A system with redundant features is illustrated in Figure 4. The Apollo NMS can be installed with several NMC units connected on NAVNET, as well as redundant sensors. The Apollo NMS supports up to two NMCs, two 2010 loran sensors, and a GPS sensor for each NMC (internal in 2001GPS or on NAVNET). A system with two NMCs with GPS can include:

- two 2001GPS units
- one 2001GPS, one 2001TSO, and one 2022 GPS Sensor; or
- two 2001TSO units with two 2022 GPS Sensors.

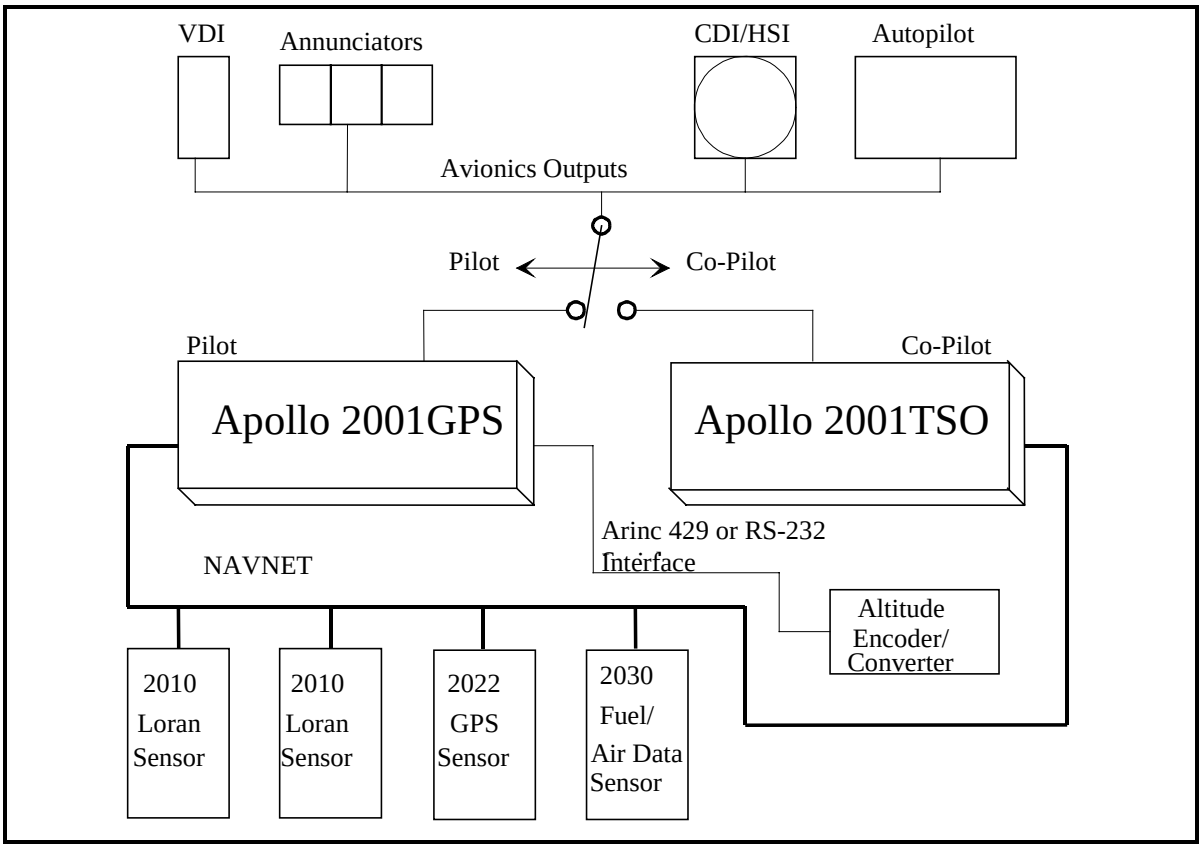


Figure 4 Redundant Installation

Table 2 System Configurations (IFR)

NMC	2001TSO	2001TSO	2001TSO	2001GPS	2001GPS	2001GPS
Operation	En route & terminal	En route, terminal, & approach	En route, terminal, approach, & primary oceanic	En route, terminal, approach	En route & terminal	En route, terminal, & approach, & primary oceanic
Minimum Required Equipment and Connections						
Position Sensor	2010 or 2022	2022	2022	N/A	N/A	N/A
Altitude Input	Required with GPS	Required	Required	Required	Required	Required
Annunciators	See Note 2	See Note 3	See Note 3	See Note 3	See Note 2	See Note 3
CDI or HSI	Required	Required	Required	Required	Required	Required
Data card	Required	Required	Required	Required	Required	Required
Optional Equipment and Connections						
Redundant Sensors	2010 or 2022	2010 (1 or 2)	2010 (1 or 2)	2010 (1 or 2)	2010 (1 or 2)	2010 (1 or 2)
Annunciators	OBS/HLD	N/A	N/A	N/A	OBS/HLD	N/A
Indicators	VDI (requires altitude input)	VDI	VDI	VDI	VDI (requires altitude input)	VDI
Coupling	Autopilot	Autopilot	Autopilot	Autopilot	Autopilot	Autopilot
F/ADS	2030	2030	2030	2030	2030	2030
RS-232 (standard)	Moving map Fuel flowmeter Altitude Fuel Air Data	Moving map Fuel flowmeter Fuel Air Data	Moving map Fuel flowmeter Fuel Air Data	Moving map Fuel flowmeter Fuel Air Data	Moving map Fuel flowmeter Fuel Air Data	Moving map Fuel flowmeter Fuel Air Data
Arinc 429 (optional)	Air data computer EFIS interface	Air data computer EFIS interface	Air data computer EFIS interface	Air data computer EFIS interface	Air data computer EFIS interface	Air data computer EFIS interface

Notes:

1. N/A is for not applicable.
2. En route annunciators include MSG, PTK, and GPS.
3. Approach annunciators include MSG, PTK, GPS, APPRCH, ACTIVE, and OBS/HLD as well as a hold momentary switch for input.
4. The GPS annunciator is required for multi-sensor installations only. It is not required for GPS only or Loran-C only installations.
5. Refer to Altitude Input on page 9 for altitude sources.
6. The data card must be current for non-precision approach operation.

For VFR installations, the 2001GPS can be installed with only power and antenna connections. The 2001TSO requires a position sensor, either a 2010 MCLS or 2022 GPS.

CERTIFICATION

The Apollo 2001TSO is designed and tested to meet the requirements of FAA TSO-C129a, N8220.60, RNP-10, and C115b and is authorized for supplemental IFR en route, terminal, non-precision approach, and primary oceanic/remote airspace operation using a TSO-C129a(B1) GPS sensor and for IFR en route and terminal operation using a TSO-C60b Loran-C sensor.

The Apollo 2001GPS is designed and tested to meet the requirements of FAA TSO-C129a, N8220.60, RNP-10, and C115b is authorized for supplemental IFR en route, terminal, non-precision approach, and primary oceanic/remote airspace operation using its internal GPS

sensor and for IFR en route and terminal operation using an external TSO-C60b Loran-C sensor.

UNPACKING THE EQUIPMENT

Carefully unpack the equipment. Visually inspect the package contents for any evidence of shipping damage. Retain all shipping containers and packaging material in case reshipment is necessary.

PACKAGE CONTENTS

As shipped from the II Morrow factory, the Apollo 2001 package includes most necessary items for installation other than supplies normally available at the installation shop, such as wire, cable ties, and required indicators and annunciators. The items included in the package are listed in Table 3. Additional items required for an IFR installation are listed in the section Other Required Materials on page 8.

Table 3 Package Contents

Part #	Description	Qty	
		2001TSO	2001GPS
Nav Management Computer			
430-0267-YXX	Apollo 2001TSO/2001GPS (See Table 1)	1	1
Apollo 2001 Installation Kit, Part #424-1204-xx (2001TSO), #424-1099-xx (2001GPS)			
123-1009	In-line power filter	1	1
162-1008	Right angle coax plug		1
162-1060	TNC straight taper grip coax plug		1
162-3502	50 pin female solder cup connector	1	1
172-1702	7 amp fast blow fuse (spare internal fuse)	1	1
201-0009	Pneumatic sleeve fitting	1	1
202-0001	Cable tie, 3.62” x 0.94”	4	6
202-0005	Cable tie mount	4	4
221-0304	Screw, pan head Phillips, 3-48 x 1/4”, SS	2	2
221-0400	Screw, pan head Phillips, 4-40 x 1/4”, SS	2	2
221-0406	Screw, pan head Phillips, 4-40 x 3/8”, SS		2
229-0608	Screw, button head Phillips, 6-32 x 1/2”, SS	6	6
240-0310	Washer, internal tooth lock, #3, SS	2	2
240-0410	Washer, internal tooth lock, #4, SS		2
308-0070	Air flow connector	2	2
310-1227	Connector cover	1	1
310-2032	Shoulder bushing		2
500-2143	3” ground wire with lug	2	2
608-0009	Ferrite bead, split with clamp	2	2

Apollo NMS NAVNET Kit, Passive, Part #424-0607-xx			
500-2135	NAVNET passive terminator	2	
500-2134	NAVNET cable	1	
561-1060-00	Compliance certificate	1	
Apollo 2001 Manual Kit, Part #564-0056-xx			
555-0500	Screwdriver	1	1
560-0161-xx	Apollo 2001 install manual	1	1
560-0164-xx	Apollo NMS user's manual	1	1
560-9005	Binder, 5½ x 8½ x 2, 3 ring	1	1
561-0228-xx	Apollo NMS quick reference guide	1	1
565-1029	Apollo logo label	1	1
561-1039-xx	Approach checklist	1	1
Apollo 2001 Accessories			
--	Flybrary data card	1	1
148-1033	Power supply, 110VAC to 28VDC	1	1
418-0203	Mounting frame	1	1
560-0949	A-33 Installation Guide		1
564-0057-xx	STC kit, Apollo NMS C129	1	1
590-1104	A-33 antenna		1
560-5047	A-34 Installation Guide (approved alternate)		
590-1112	A-34 Antenna (approved alternate)		

OTHER REQUIRED MATERIALS

Additional items required for an IFR and/or oceanic installation of the 2001 are as follows.

- Annunciators with the legends as defined in the Avionics Outputs specifications on page 28.
- CDI or HSI (can be shared with existing nav equipment if connected through a relay switching network) or an EFIS display.
- Relay switching and NAV/NMS selector switch if using a shared CDI or HSI.
- A remote sensor if installing the 2001TSO.

Current FAA guidelines for installation approvals should be available for reference.

- AC 20-130A (multi-sensor systems)
- AC 20-138 (GPS installations)
- AC 20-121A (Loran-C installations)

SECTION 2 - INSTALLATION

This section describes the installation of the Apollo 2001 including mounting, wiring, and connections. A post-installation check-out procedure is included at the end of this section.

PRE-INSTALLATION INFORMATION

Always follow good avionics installation practices per FAA Advisory Circulars (AC) 43.13-1A, 43.13-2A, AC 20-130A, AC 20-138, and AC 20-121A ,or later FAA approved revisions of these documents.

Follow the installation procedure in this section as it is presented for a successful installation. Read the entire section before beginning the procedure. Perform the post-installation check-out before closing the work area in case problems occur.

INSTALLATION OVERVIEW

A successful installation should start with careful planning including determination of mounting locations for the 2001, antennas, and accessory items as well as required and optional connections and cable routing. Once the mounting location has been determined, prepare the mounting frame for installation. It may be easier to complete the wiring harness and attach the connectors to the mounting frame before installing the mounting frame.

INSTALLATION CONSIDERATIONS

MOUNTING CONSIDERATIONS

The 2001 is designed to mount in the avionics stack in the aircraft instrument panel within easy view and reach of the pilot. The standard package includes a mounting frame for ease of mounting, connections, and service of the unit. Allow an additional 1” clearance to the rear of the mounting frame for connectors.

For typical installations, the 2001 does not require external cooling. When mounting the 2001, leave a clearance of 1/4 inch between avionics to allow for air circulation. If the 2001 is mounted near other equipment that generates significant heat that would cause the 2001 to operate in an ambient environment greater than 55°C for longer than 30 minutes, forced air cooling should be provided. Refer to the Environmental specifications on page 27 for guidance.

ALTITUDE INPUT

Altitude input is required for installation of the 2001 for IFR and/or oceanic GPS operation. It is used by the GPS sensor in the RAIM calculations. Altitude input is optional for other installations. An altitude input will enable several useful altitude assist features, such as altitude preset and hold and 3D airspace alerts. Altitude input to the 2001 can be connected using one of the following inputs:

- serial encoder or converter connected to an RS-232 input
- 2030 F/ADS connected on NAVNET
- a suitable air/data computer connected to an Arinc 429 input

The minimum requirements for the altitude input are listed in the Specifications section on page 30.

ANTENNA (2001GPS ONLY)

The 2001GPS comes standard with the A-33 antenna. The A-34 antenna may also be used and is designed to replace II Morrow Loran-C antennas. The antenna must be mounted on the top of the aircraft with clear visibility of the satellites. Shadowing from such items as vertical stabilizers, wings, other antennas, engines or propellers, or the aircraft itself should be avoided. For complete installation instructions, refer to the antenna installation manual.

Contact II Morrow for information regarding the use of antennas other than the A-33 or A-34.

EQUIPMENT MOUNTING

Once the cable assemblies have been made, attach the main 50 pin connector and coax connector (for the 2001GPS) to the rear of the mounting frame as illustrated in Figure 5 and Figure 6. Attach the connector cover over the 50 pin connector and connect any shield connections, such as for NAVNET or serial cables, as illustrated. Route the wiring bundle to each side as appropriate and secure to the mounting frame using the cable tie mounts and cable ties provided.

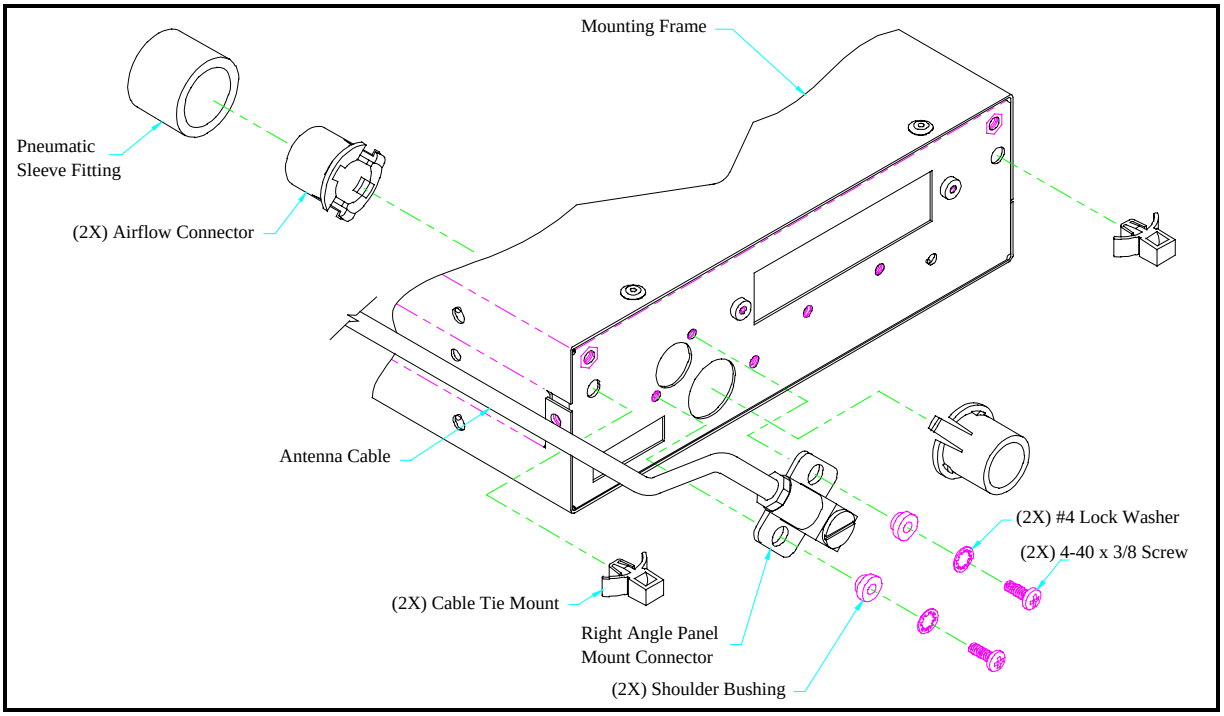


Figure 5 Rear Frame Assembly

If air cooling is provided, it can be either from ram air or an equipment cooling fan. If ram air is used, it should provide water-free filtered air. To connect the cooling air, use the two air fittings provided, inserting one from the rear of the mounting frame and one from inside the mounting frame. Connect to the air fitting using standard air hose and clamps. Slide the foam rubber sleeve over the inside airflow fitting.

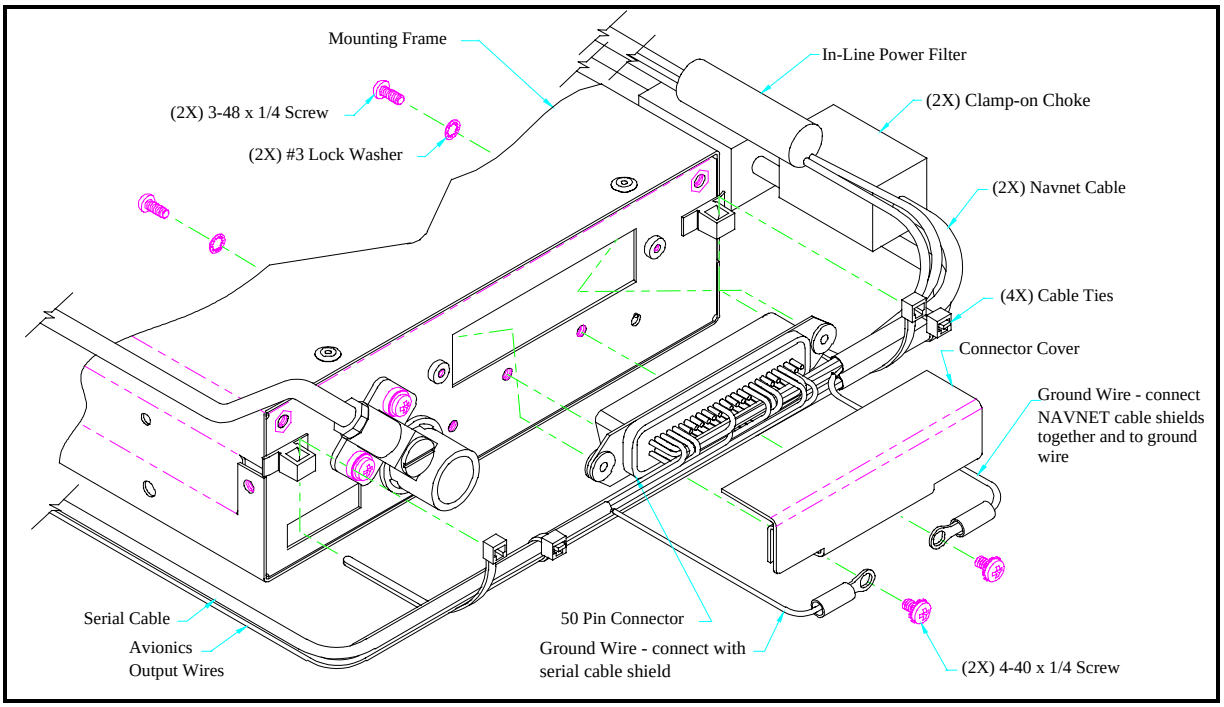


Figure 6 Rear Connector Wiring

> ***Important:*** *The 50 pin connector must be able to float freely to ensure easy insertion of the 2001 and mating of the connector. Cable strain pulling the connector up or down will make unit insertion difficult.*

Once the connectors are attached to the mounting frame, install the mounting frame assembly in the instrument panel. Then, slide in the 2001 and tighten the unit using a small flat bladed screwdriver in the mounting rod holes at the upper right and left corners on the front panel.

ELECTRICAL CONNECTIONS

POWER

The 2001 is internally fused at 7 amps. A separate 5 amp (maximum) circuit breaker or fuse should be installed for downline overload and short circuit protection. Make the power connections to the 2001 using the in-line power filter (#123-1009) supplied. Connect the red wire to pins 25 and 50 (+ input) and the black wire to pins 24 and 49 (- input). Use 20 AWG or larger wire to make connections from the in-line filter to the aircraft power connection.

Note: *Circuits should be protected in accordance with guidelines in AC 43.13-1A, chapter 11, section 2, paragraph 429.*

NAVNET

The NAVNET cable should be routed to any locations where NAVNET remote sensors or NMC units are to be located. The cable must be routed in a “daisy chain” fashion, not spliced and branched off. Avoid routing the cable near motors or other strong sources of

electromagnetic interference. A network terminator, part #500-2135, must be installed at both ends of the cable. See Figure 7 for typical NAVNET routing.

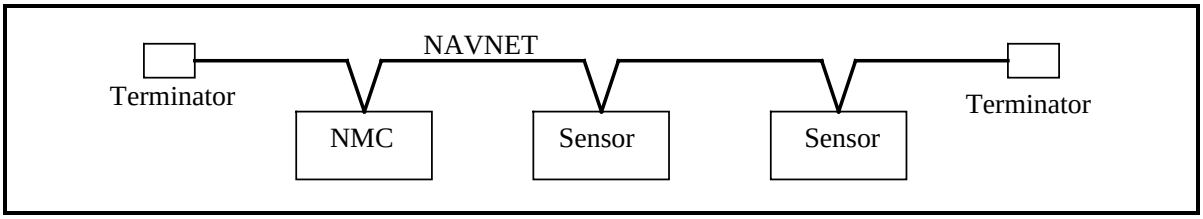


Figure 7 Typical NAVNET Routing

The cable, part #500-2134, available from II Morrow, is a twisted pair shielded cable with power control wire included. Connect the white wire to NAVNET A, brown to NAVNET B, and blue to power control connections. The power control connection is used to automatically turn on remote sensors when the 2001 is turned on. The shield must be connected to the rear of the mounting frame using one of the ground wires supplied. See Figure 9 for typical NMS NAVNET connections.

Special care must be taken when connecting the NAVNET cable at each NMC or sensor. When connecting units to the cable, the conductors may be spliced directly to the connector, or a short stub six inches or less may be used. Make sure to connect the shields of each splice together and ground to the mounting frame. The RF suppression chokes supplied, part #608-0009, must be clamped over both leads of the cable within six inches of the shield splice connection. The chokes are to reduce EMI emissions from the NAVNET cable.

Note: *NAVNET is not required with the 2001GPS unless remote sensors are to be connected.*

AVIONICS OUTPUTS

The 2001 includes full avionics outputs for CDI/HSI indicators, autopilot, and annunciators. These outputs must be connected as appropriate for the particular installation. The CDI/HSI outputs may be connected to a dedicated CDI or HSI or to a shared indicator using an appropriate switching relay. The avionics outputs available are listed in the Avionics Outputs specifications on page 28. Connect the annunciator outputs to lamp indicators as described in the specifications. The minimum connections required for different installations are listed in Table 2.

If a switching relay is used to make connections to a shared CDI/HSI, it should be a minimum of an eight pole relay box along with an appropriate selector switch with annunciation. Several suitable relays and switches are listed in Appendix D.

SERIAL INTERFACE

The 2001TSO includes two RS-232 serial port connections. The 2001GPS includes one. The serial ports can be used for connecting to such devices as the Shadin Digiflow or Miniflow Fuel Flowmeter, Argus moving map display, Stormscope, an altitude encoder, or gray code converter. For systems including a TSO-C129a GPS sensor, RxD2 must be connected to an altitude encoder or converter unless a suitable air data computer is connected either on

NAVNET or an Arinc 429 input. The inputs and outputs may be connected to separate units. See Figure 10 for typical serial connections.

Make serial interface connections using shielded 22 AWG two conductor (for TxD or RxD and ground connections) or three conductor (for RxD, TxD, and ground connections) cable. The ground lead should be connected to the serial ground pin on the connector and the shield should be connected to the rear of the mounting frame using one of the ground wires supplied. Once serial port connections are made, the serial ports must be configured. This is done during the post installation check out procedure and is included on page 21. Complete serial protocol specifications are included in Appendix E.

ARINC 429 INTERFACE

For 2001 units that include the optional Arinc 429 interface, it includes one transmit channel and one receive channel. **Do not connect to Arinc channel 1 input**. The Arinc interface can be set to low speed, 12,500 bits/second, or high speed, 100,000 bits/second. See Figure 10 for typical Arinc 429 connections.

Make Arinc connections using 22 AWG twisted pair shielded cable. Connect the shield to the rear of the mounting frame using one of the ground wires supplied. Once the Arinc connections are made, the Arinc ports must be configured. This is done during the post installation check out procedure and is included on page 20. Complete Arinc protocol specifications are included in Appendix E.

TAKE HOME SENSE INPUT

Connect the take home sense input on pin 29 to ground on pin 30. If this pin is left open, the 2001 will only operate in the simulation mode.

ANTENNA INSTALLATION AND CONNECTIONS (2001GPS ONLY)

The mounting location and cable connections for the GPS antenna are very important. The antenna should be mounted no closer than two feet from VHF COM transmitter antennas, six inches from other transmitter antennas emitting less than 25 watts, and two feet from higher power antennas. Special care should be taken to ensure that the GPS antenna is not mounted in close proximity to antennas that may emit harmonic interference at the L1 frequency of 1575.42MHz. Refer to the antenna installation manual for installation instructions. The connectors are included in the installation kit.

Suggestion: *Temporarily locate the GPS antenna with coax connected to the 2001GPS and check the GPS performance as described in the GPS Operation and Position (2001GPS* or 2001TSO with 2022) *test in the Post-Installation Checkout on page 23. Once a suitable location has been verified, then permanently mount the antenna.*

Note: *If using an antenna that was already on the aircraft, or if mounting the antenna closer than two feet from a COM antenna, conduct the GPS Operation and Position (2001GPS* or 2001TSO with 2022) *test in the Post-Installation Checkout on page 23. If the 2001 passes the test, then moving the antenna is not necessary.*

Once the antenna mounting location has been prepared, route a coax cable from the antenna to the 2001GPS. Proper selection of coax cable and assembly of connectors is critical to GPS signal performance. The cable loss from the antenna to the 2001GPS should be limited to a maximum of 4 dB. Minimize the coax length for optimum performance and **DO NOT** coil excess cable. Leave only enough for service loops.

When selecting a coax cable, select coax cable with 50 ohms impedance and a signal loss less than 4 dB. A TNC connector is required at the antenna and the right angle panel mount connector supplied is required at the 2001GPS. The vendors listed in Table 4 can prepare cables in custom lengths with connectors if desired. Because the cables listed have different diameters, consult with the vendor for proper connectors.

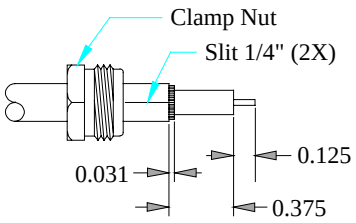
Table 4 Alternative Coax Cables

Part Number	Loss dB/100ft	OD (inches)	Weight lbs/100ft	Cable Length (feet)		
				Good 4 dB loss	Better 3 dB loss	Best 2 dB loss
Electronic Cable Specialists 1-800-ECS-WIRE FAX 414-529-5505						
3C142B	18.50	0.195	4.0	21	15	10
311601	10.72	0.229	5.0	36	27	18
311201	7.24	0.317	8.6	54	40	26
310801	4.88	0.452	15.0	80	60	39
PIC Wire & Cable 1-800-742-3191 FAX 414-246-0450						
M17/060-RG142	19.0	0.195	5.0	21	16	11
S44191	14.0	0.195	4.4	29	21	14
S33141	8.2	0.270	6.5	51	38	25
S55122	6.6	0.300	8.2	62	46	32
S22089	4.6	0.435	15.0	87	65	43

The coaxial connectors and adapters, such as TNC to BNC, add additional loss to the cable and should be considered when computing the maximum 4 dB loss. A typical loss of 0.2 dB can be used for each connection. The typical cable loss for 20 feet of RG-142B coax with the supplied connectors is 4 dB.

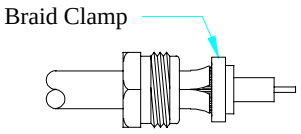
During the post-installation checkout, susceptibility to harmonics of VHF COM transmitters will be evaluated. If problems arise, then better isolation, or increased distance, may be required between the GPS antenna and other transmitting antennas, or a notch filter may be installed in series with the antenna coax of the VHF COM transceiver to reduce or eliminate the harmonic interference. A notch filter for this use (part #162-1059) is available from II Morrow.

Step 1.



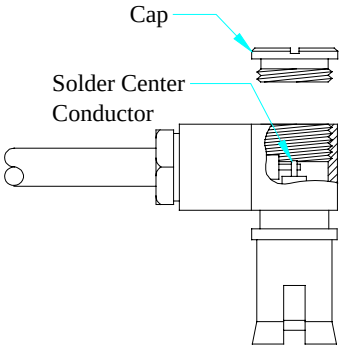
- Slide clamp nut over coax.
- Strip coax as illustrated.
- Cut two 1/4" slits in jacket 180 degrees apart.

Step 2.



- Slide braid clamp over end of coax and under the braid.

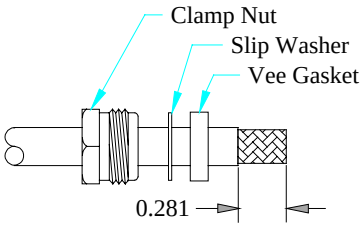
Step 3.



- Insert coax with braid clamp into connector and tighten clamp nut securely.
- Solder the center conductor of the coax to the contact as illustrated.
- Attach the cap and secure tightly.

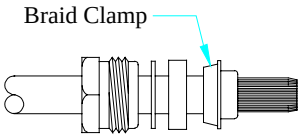
Assembly instructions for right angle connector part #162-1008

Step 1.



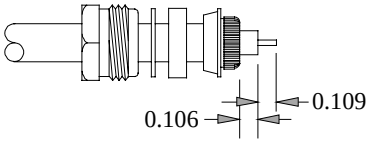
- Slide clamp nut, slip washer, and vee gasket over end of coax.
- Strip jacket as illustrated.

Step 2.



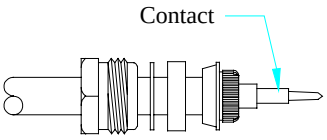
- Comb out braid.
- Slip braid clamp on and push back against coax jacket.

Step 3.



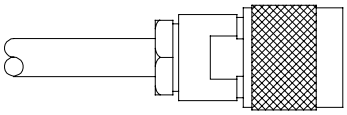
- Fold back braid wires as illustrated, trim to proper length, and form over clamp.
- Strip center conductor as illustrated.

Step 4.



- Solder center conductor to contact.

Step 5.



- Insert coax with braid clamp and contact into connector and tighten the clamp nut securely.

Assembly instructions for straight TNC connector part #162-1060

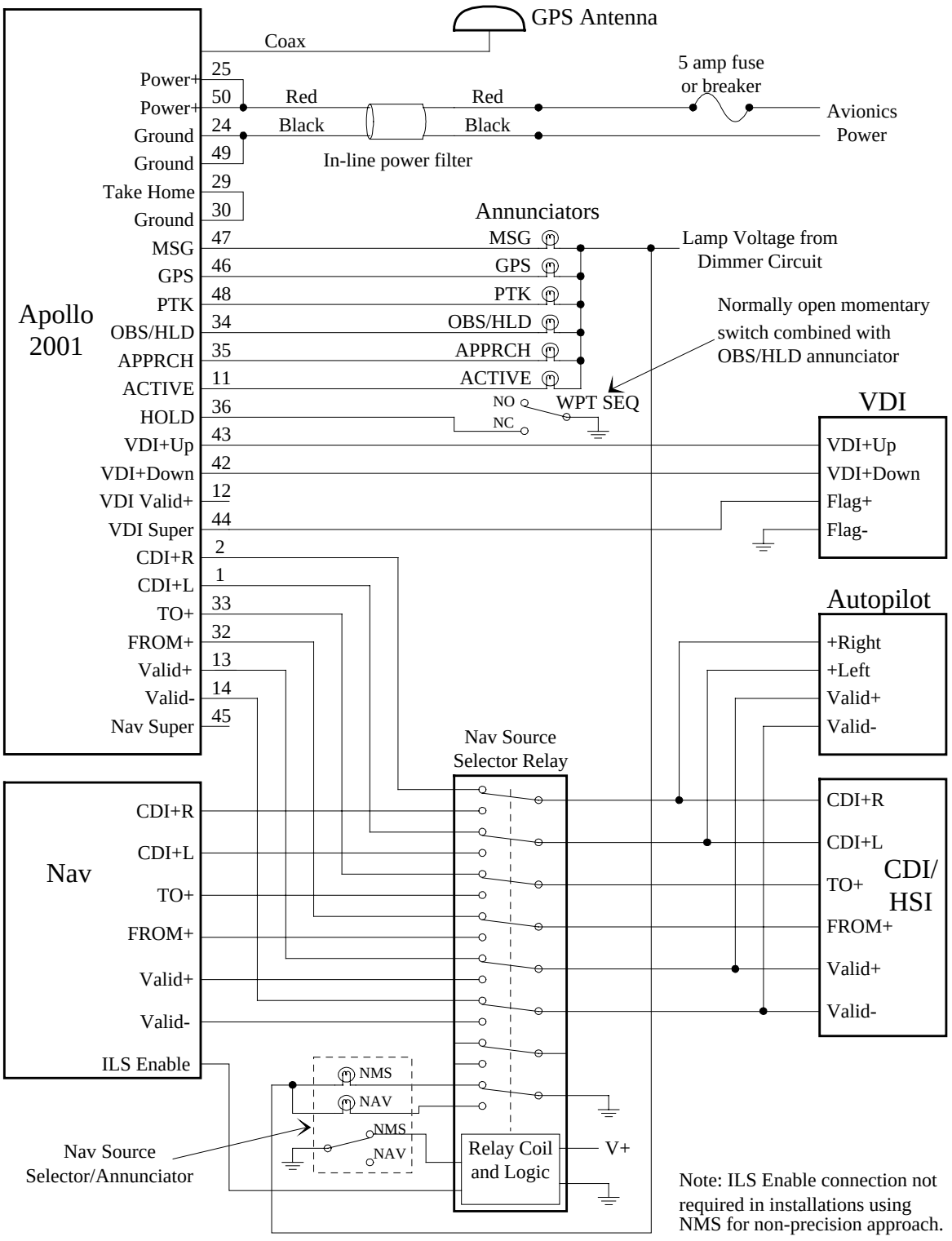
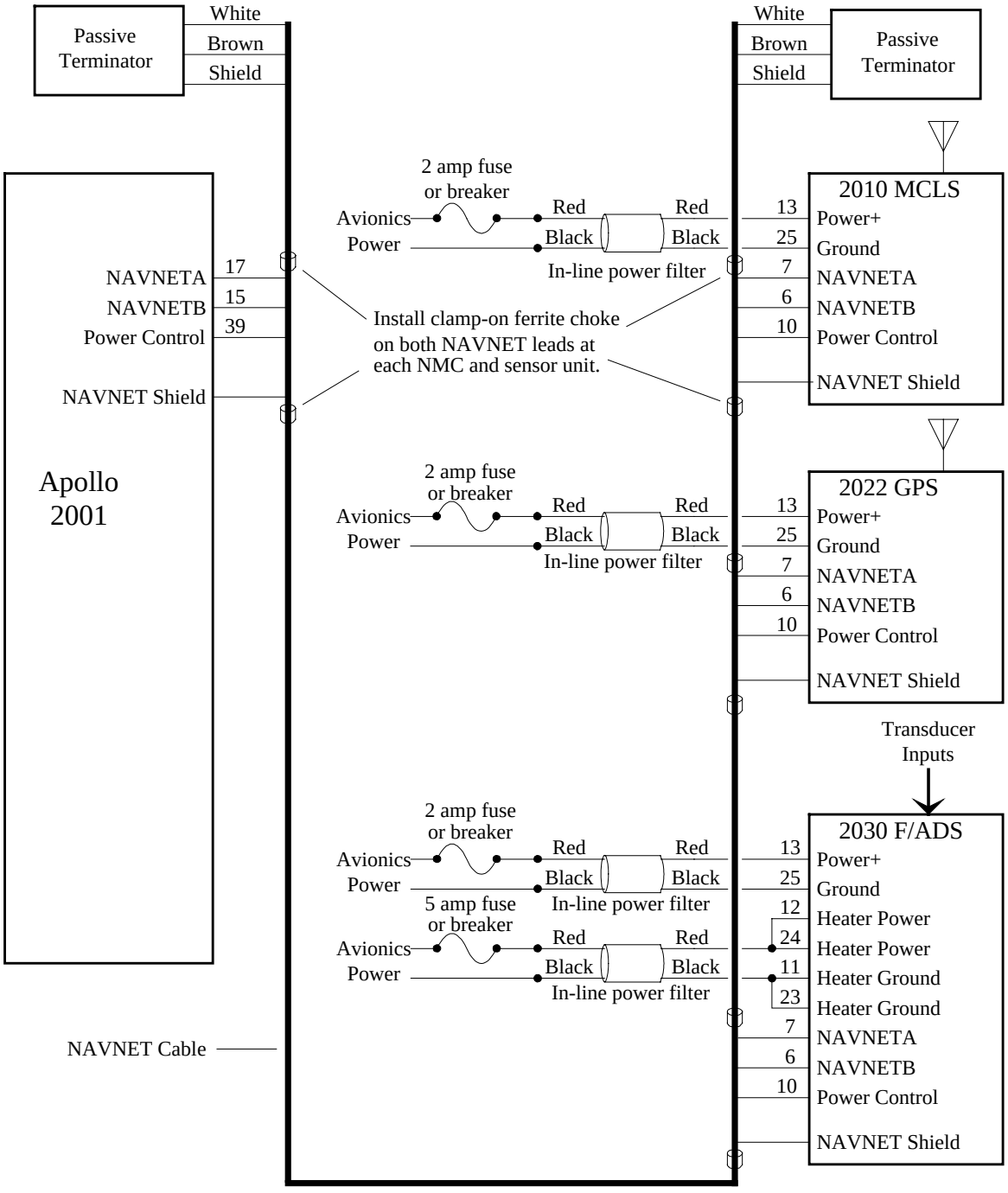


Figure 8 Power and Avionics Connections

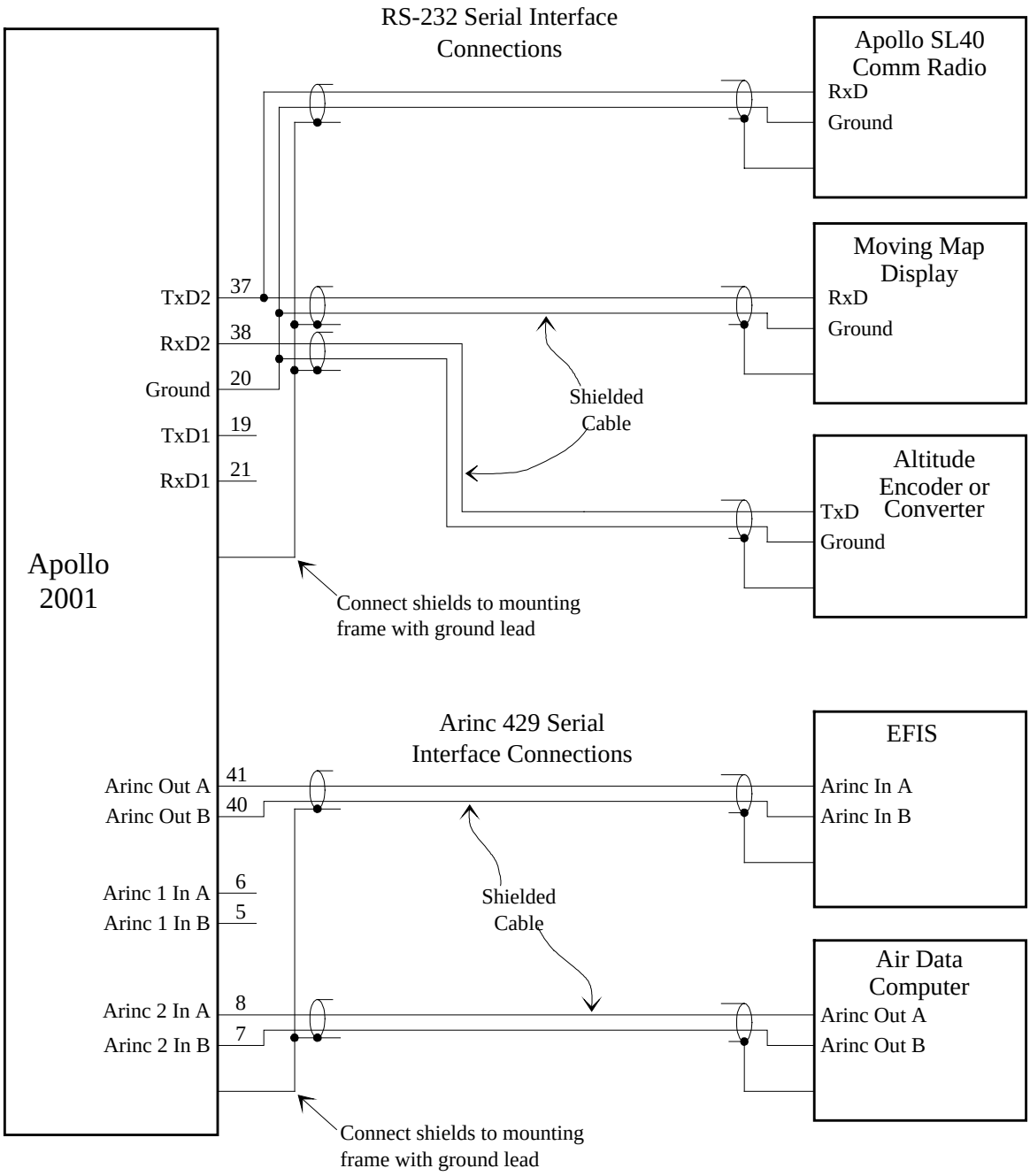


Notes: Make NAVNET connections as follows: White wire to NAVNETA
Brown wire to NAVNETB
Blue wire to power control connections
Connect shields to mounting frame on 2001 and to mounting tray on sensors.

A passive terminator must be installed at each end of the NAVNET cable.

The 2022 is not required with the 2001GPS.

Figure 9 NMS NAVNET Connections



Notes: TxD1 and RxD1 are not available with the 2001GPS.

Figure 10 Serial Interface Connections

POST-INSTALLATION CHECKOUT

Once the unit is installed, complete the checkout procedure to verify proper operation. Refer to the User's Guide for operating instructions. Skip the steps that are not applicable to a particular installation. A checkout log sheet is included on page 26 to fill out during the checkout procedure. Make a photocopy of the log sheet for ease of use if desired. The Normal Mode Checkout, the Remote Sensor Setup and Checkout, and the Final System Check portions of the post-installation checkout should be completed with the aircraft moved clear of hangars and other structures.

TEST MODE CHECKOUT AND SETUP

The 2001 has a built-in test mode to simplify the checkout. To operate the 2001 in the test mode, hold down the NAV and SYS buttons while switching on the power. To return to normal operation, switch the power off, then back on.

Avionics Outputs

Check the avionics output connections by using the test mode as follows. Rotate the LARGE knob to select each test.

1. Using the "CDI TRIANGLE" page, rotate the SMALL knob to check left, mid, and right.
2. Using the "VDI TRIANGLE" page, rotate the SMALL knob to check down, mid, and up.
3. Using the "TO/FROM FLAG" page, rotate the SMALL knob to check the Off, To, and From outputs.
4. Using the "LAMP OUTPUTS" page, rotate the SMALL knob to check all annunciators.
5. Using the "VALID FLAG PAGES" page, rotate the SMALL knob check all valid flag outputs.

Installation Configuration

The NMC must be configured to match the operation supported by the installation. This includes IFR/VFR, approach, and oceanic/remote operation selections.

1. In test mode, rotate the LARGE knob to the "INSTALL OPTIONS" page.
2. Press SEL, rotate the SMALL knob to select IFR operation (YES or NO), rotate the LARGE knob for APPR selection, rotate the SMALL knob to select approach operation (YES or NO), rotate the LARGE knob to select OCN (for Oceanic or Remote airspace) operation (YES or NO), then press ENT when complete. (Note: APPR can only be set to YES when IFR is set to YES.)

Note: *Make sure that all installation requirements are complete for the selected operation mode. Refer to* ***Table 2****.*

Arinc 429 Output Configuration

1. In test mode, rotate the LARGE knob to the "ARINC-429 OUTPUT LABELS" page to configure the Arinc 429 output.
2. Press SEL, rotate the SMALL knob to select the desired configuration, then press ENT when complete. Refer to Appendix E for available selections.
3. To set the Arinc 429 output speed, rotate the LARGE knob to the "ARINC-429 RX/TX SPEEDS" page.
4. Press SEL, rotate the SMALL knob to select low speed (12.5kbps) or high speed (100kbps), then press ENT when complete. (Note: Only the TX speed can be changed.)

Note: *This configuration can only be changed in NMCs with the optional Arinc 429 interface.*

Air Data Computer Selection

The 2001 can be used with the 2030 F/ADS connected on NAVNET or to a compatible Arinc 429 air data computer. To select the air data computer:

1. In test mode, rotate the LARGE knob to the "AIRDATA COMPUTER" page.
2. Press SEL, rotate the SMALL knob to the desired selection, then press ENT when complete.

The air data selections are:

"NONE" ..... no air data computer connected
"2030 FADC" ..... for connection to the 2030 F/ADS on NAVNET
"A429 ADC - L204" ..... for connection to an Arinc 429 compatible air data computer using label #204 (baro altitude)
"A429 ADC - L203" ..... for connection to an Arinc 429 compatible air data computer using label #203 (pressure altitude)

NAVNET Interface (if installed)

To check and configure the NAVNET interface:

1. Make sure all connections have been made and that the terminators are installed on the ends of the network cable.
2. If more than one NMC is connected, disconnect or remove all but one NMC.
3. Turn power off to all remote sensors (turn off at breaker or remove fuses).
4. In test mode, rotate the LARGE knob to the "NAVNET TEST" page, then press ENT to test the network. The 2001 will display either a pass or fail message. If a fail message is displayed, refer to Appendix A - Troubleshooting. Expected voltages are:
   Va = 2.6 ± 0.4 volts DC
   Vb = 2.4 ± 0.4 volts DC
   Vab = 0.2 ± 0.04 volts DC.
5. If more than one NMC is installed on NAVNET, select a different network address for each. In test mode, rotate the LARGE knob to the "NET NMC" page, press SEL, rotate the SMALL knob to change the address, then press ENT to save the new address. The primary NMC should be set to address "0," the second NMC to address "1."

Serial Interface Configuration

1. In test mode, rotate the LARGE knob to the "CH RX TX" page to configure the serial inputs and outputs.
2. Press SEL, then rotate the LARGE knob to select the serial channel field, rotate the SMALL knob to make the selection, then press ENT when complete. Refer to Appendix E for available selections.

Note: *The input (RX) and output (TX) for channel 1 will be set to "GPS" on the 2001GPS and cannot be changed.*

Other Test Mode Pages

The test mode includes several pages that are not necessary for the checkout. They are as follows:

"TO TEST DISPLAY" ..... Can be used to check the 2001 front panel displays by pressing ENT.

"TEST CONTROLS"	Can be used to check the 2001 front panel controls. Press each button and rotate the SMALL knob to check the controls.
"OPERATION STATUS".....	Factory use only. Should be set to "STANDARD."
"SYSTEM INITIALIZATION"	Used to reset all internal memory including user waypoints, flight plans, and configuration data. **All user data will be lost!**
"ARINC-561"	Not used in 2001.
"SYSTEM DEFAULTS".....	Should be set to "NORMAL."
"RAMCARD SETUPS".....	Factory use only.
"SERIAL PORT TEST".....	Test use only. Used to test the serial ports by connecting the outputs back to the inputs.

SYS Mode & Setup Mode configuration
The Disable SYS Mode option allows you to disable viewing of the System Mode features in normal operation. The Setup Mode option allows you to disable access to the Setup pages when the unit is installed in the aircraft. In the test mode, rotate the LARGE knob to the "Disable: SYS Mode Setup Mode" page, press SEL. Rotate the SMALL knob to disable (YES) or enable (NO) the SYS mode. Rotate the LARGE knob to select the Setup mode. Rotate the SMALL knob to disable (YES) or enable (NO) the Setup mode. Press ENT when you are finished.

Disable Altitude and Arc Assist Nav Pages
The Disable Altitude and Arc Assist NAV pages option allows you to not display the Altitude Assist and/or Arc Assist pages in the NAV mode during normal operation. In the test mode, rotate the LARGE knob to the "Disable Alt Assist Arc Assist" page. Press SEL. Rotate the SMALL knob to disable (YES) or enable (NO) the Alt Assist NAV page. Rotate the LARGE knob to select the Disable Arc Assist NAV page option and rotate the SMALL knob to disable (YES) or enable (NO) the Arc Assist NAV page. Press ENT when you are finished.

NORMAL MODE CHECKOUT

The SYS Mode and Altitude Assist NAV pages must be enabled to perform the normal mode checkout. Reconfigure these two settings to the desired operation after completing the Final System Check.

Switch on the 2001 in the normal mode to complete the rest of the checkout. The 2001 will go through a sequence of self tests.

Enter Time, Date, and Position
The 2001 requires a "seed" position, time, and date to initialize the position sensors. The GPS sensor requires this to know which satellites to look for. The loran sensor requires this to know which loran chains to look for. Once this is entered, it will be saved and updated internally in the 2001. (Note: If the 2001 is moved without being turned on, the seed position may have to be reentered.)

1. Enter the current time and date. During the startup sequence, press SEL when the "DATE" and "TIME" page is displayed. Rotate the LARGE knob to select different fields, rotate the

SMALL knob to change the information, then press ENT to save the changes. The time and date can also be changed in System mode.

2. Enter the seed position. During the startup sequence, press SEL when the "PPOS" page is displayed (either the distance to the nearest waypoint or a lat/lon will be displayed on the "PPOS" page). The seed position can be input either by lat/lon or airport ident.
   a) To input the seed by using the lat/lon coordinate for the aircraft position, rotate the LARGE knob to select different fields, rotate the SMALL knob to change the information, and press ENT to save the new seed position. The seed position should be within 60 nm of the actual position.
   b) To input the seed by airport ident, rotate the LARGE knob to highlight the reference position ident, press ENT, use the LARGE and SMALL knobs to select the ident, then press ENT. Entry by ident requires that a datacard be installed in the 2001.

GPS Operation and Position (2001GPS or 2001TSO with 2022)

This checkout is to be completed with the aircraft moved away from hangars and other structures that may obstruct the view of the satellites.

1. Turn on the 2001GPS (or 2001TSO with 2022) and allow the unit to acquire a position. Other equipment should be left off for this part of the test.
2. Check the position using the lat/lon navigation page. Press NAV and rotate the LARGE knob to the lat/lon page. The lat/lon should agree with a known reference position.
3. Check the signal reception using the GPS sensor displays in System mode. Press SYS, rotate the LARGE knob to the "POSITION SENSORS" page, and press ENT. Then rotate the SMALL knob to display the GPS info. Typical signal levels are 50 or better.
4. Turn on other avionics one at a time and check the GPS signal reception to make sure it is not affected.
5. For IFR installations, check for VHF COM transmitter interference.
   a) Verify that 5 to 8 satellites are in DATA and the NAV flag is out of view.
   b) Tune the COM to 121.150 MHz and transmit for 20 seconds.
   c) Verify that the position is not lost.
   d) Repeat for additional frequencies as follows.

121.125 MHz	131.225 MHz
121.175 MHz	131.250 MHz
121.200 MHz	131.275 MHz
121.225 MHz	131.300 MHz
121.250 MHz	131.325 MHz
131.200 MHz	131.350 MHz

   e) Repeat for each COM transmitter.
   f) If the 2001GPS is susceptible to VHF COM transmitter interference, then better isolation, or distance, may be required between the GPS and VHF antennas, or a notch filter may be required in series with the VHF COM antenna coax.

   Note: *Older VHF COM transmitters may emit higher levels of harmonic interference causing greater problems that may be more difficult to fix.*

Interface Checks

The interfaces to other equipment, such as an altitude encoder, moving map display, or Arinc 429 air data computer, should be checked. Refer to the Apollo NMS User's Guide for

operating instructions for this part of the checkout. Make sure the other equipment is connected and switched on.

1. To check the serial input, verify that altitude data from the serial device can be displayed on the 2001. Press NAV, rotate the LARGE knob to the "ALTITUDE ASSIST" page, then rotate the SMALL knob to display the encoder altitude.
2. To check the serial output, verify that the data from the 2001 can be displayed on the other unit, such as a moving map display.
3. To check the Arinc 429 input, verify that the altitude data can be displayed on the 2001 from the Arinc 429 air data computer input. Press NAV, rotate the LARGE knob to the "ALTITUDE ASSIST" page, then rotate the SMALL knob to display the airdata altitude.
4. To check the Arinc 429 output, verify that the data from the 2001 can be displayed on the other unit, such as an EFIS display.

REMOTE SENSOR SETUP AND CHECKOUT

2010 Loran Sensor (if installed)

Refer to the 2010 install manual for setup and checkout instructions.

1. In test mode, rotate the LARGE knob to display the "LORAN 1 SETUP" page, then rotate the SMALL knob to the setup pages and make any changes appropriate for the installation (press SEL, rotating SMALL knob, pressing ENT).
2. In normal mode, verify that the seed position was entered, then check the loran sensor operation as described in the 2010 install manual.
3. If a second 2010 is installed, repeat the checkout using the "LORAN 2 SETUP" page.

2022 GPS Sensor (if installed)

Refer to the 2022 install manual for setup and checkout instructions.

1. Verify that the time, date, and seed position were entered.
2. Check out the sensor operation as described in the 2022 install manual.

Note: *The NAVNET address on the 2022 must be setup to match the corresponding address of the NMC.*

2030 F/ADS (if installed)

Refer to the 2030 install manual for setup and checkout instructions.

1. Make sure the "2030 FADC" selection was made for the Air Data Computer Selection on page 21.
2. Complete the setup and checkout as described in the 2030 install manual.

Shadin 200 Fuel/Air Data Computer (if installed)

Refer to the Shadin 200 install manual for setup and checkout instructions.

1. Make sure the "FADC" selection was made in the Serial Interface Configuration as shown in Table 7 on page 47.
2. Complete the setup and checkout as described in the Shadin install manual.

FINAL SYSTEM CHECK

The 2001 system should be fully functional at this time. The final check includes checking the position from each sensor, checking the database, entering a direct to waypoint, and checking the navigation functions. Start with the 2001 turned on and operating in the normal mode and a datacard inserted. Refer to the Apollo NMS User's Manual for operating instructions.

1. Verify a valid position is displayed from each position sensor connected to the 2001. Press NAV, rotate the LARGE knob to the "IN USE" lat/lon page in Nav, then rotate the SMALL knob to display the position from each sensor.
2. To check the database:
   a) Press SYS, rotate the LARGE knob to the "SYSTEM INFO" page, and press ENT.
   b) Rotate the LARGE knob to display the "APOLLO NMC" software version page, then rotate the SMALL knob to display the database information page. The database name, expiration date, and version will be displayed.
3. Enter a direct to waypoint. Press the DIRECT-TO button, use the LARGE and SMALL knobs to select a nearby waypoint, then press ENT, or press the EMG button (emergency search), rotate the LARGE knob to select a waypoint, press the DIRECT-TO button, then press ENT.
4. Verify the bearing and distance to the selected waypoint.

If the database is expired, or if a different coverage area is needed, contact the II Morrow factory for an update or replacement.

Note: *Each time the 2001 is turned on, the database expiration date will be checked automatically. This requires that the date be set correctly.*

APOLLO 2001 POST-INSTALLATION CHECKOUT LOG Date: ___/___/___

AIRPLANE MAKE/MODEL: _____ TAIL NO.: _____ By: _____

CONFIGURATION INFORMATION:

☐ 2001TSO 430-0267-1__ Mod __ Serial # _____

☐ 2001TSO w Arinc 430-0267-2__ Mod __ Antenna _____

☐ 2001GPS 430-0267-3__ Mod __

☐ 2001GPS w Arinc 430-0267-4__ Mod __

TEST MODE CHECKOUT:

Avionics Outputs:

☐ [☐ N/A] CDI (left, mid, right)

☐ [☐ N/A] VDI (down, mid, up)

☐ [☐ N/A] TO/FROM flag (OFF, TO, FROM)

☐ [☐ N/A] External annunciators

☐ [☐ N/A] Valid flags

Installation Configuration:

IFR?: ☐ Yes, ☐ No

APPR?: ☐ Yes, ☐ No

OCN?: ☐ Yes, ☐ No

Arinc 429 Configuration: [☐ N/A]

Output Labels: ☐ None ☐All

Speed: ☐ Low ☐ High

Air Data Computer Selection:

☐ None

☐ 2030 FADC

☐ A429 ADC - L204

☐ A429 ADC - L203

NAVNET Interface:

☐ Installed

☐ Tested

Address ____

Serial Interface Configuration:

Ch 1 RX _____ TX _____

Ch 2 RX _____ TX _____

NORMAL MODE CHECKOUT:

Time, Date, and Position:

☐ Entered

GPS Operation: (2001GPS)

☐ Position check

☐ Signal reception check

☐ Interference from other avionics checked

☐ VHF COM interference check

Interface Checks:

☐ [☐ N/A] Serial input checked

☐ [☐ N/A] Serial output checked

☐ [☐ N/A] Arinc 429 input checked

☐ [☐ N/A] Arinc 429 output checked

REMOTE SENSOR SETUP AND CHECKOUT:

2010 MCLS: ☐ Installed ☐ Checked P/N 430-_____-___ S/N _____ Antenna _____

2022 GPS: ☐ Installed ☐ Checked P/N 430-_____-___ S/N _____ Antenna _____

2030 F/ADS: ☐ Installed ☐ Checked P/N _____ S/N _____

FINAL SYSTEM CHECK:

☐ Position sensors checked

☐ Database checked

☐ Direct To waypoint entered

☐ Navigation data checked

COMMENTS:

SECTION 3 - SPECIFICATIONS

This section includes detailed electrical, physical, environmental, and performance specifications for the Apollo 2001.

ELECTRICAL

Input voltage	10 VDC to 40 VDC, reverse polarity protected
Input current	1A at 14 VDC (875 mA for 2001TSO) 525 mA at 28 VDC (475 mA for 2001TSO)
Input power	12 watts typical, 15 watts maximum
Internal fuse	7 amp fast blow, II Morrow #172-1702, Buss #GMA7, or equivalent
Memory backup	Internal lithium battery with a service life of approximately 4 to 6 years

Note: *The Apollo 2001 will provide a message on the display when the lithium battery is running low and should be replaced. See Appendix B for battery replacement instructions.*

PHYSICAL

Height	2.00 inches (5.08 cm)
Width	6.25 inches (15.88 cm)
Depth	10.43 inches (26.49 cm) behind panel, including mounting frame
Weight (with mounting tube)	3.8 lb.(1.72kg) for 2001GPS 3.7 lb.(1.68kg) for 2001TSO
Required clearance	Allow 1 inch (2.54 cm) behind unit for connector and cable clearance

Units dimensions are illustrated in Figure 11 on page 28.

ENVIRONMENTAL

The Apollo 2001 unit is designed and tested to meet appropriate categories of RTCA/DO-160C. The Environmental Qualification Form is included in Appendix C.

Operating temperature	-20°C to +70°C
Storage temperature	-55°C to +85°C
Temperature variation	2°C per minute
Humidity	95% at 50°C for 6 hours (2 day cycle) **Note:** The display filter is specified for <15%RH at 74°C for 120 hours and 50%RH at 49°C for 120 hours.

Maximum altitude ..... 70,000 feet

Cooling ..... Recommended for operation above +55°C

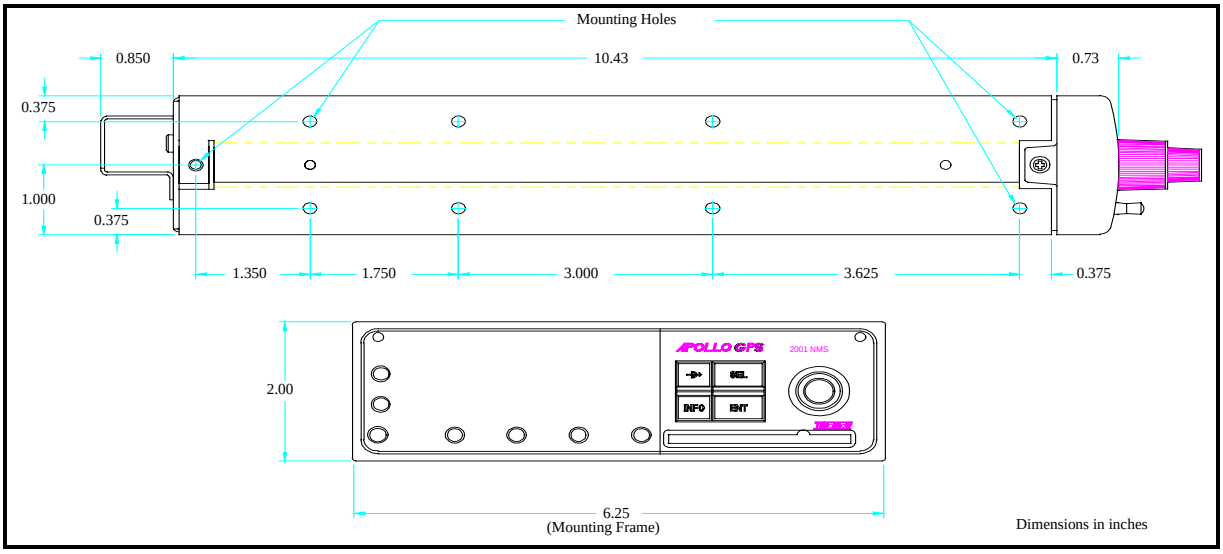


Figure 11 Unit Dimensions

AVIONICS OUTPUTS

CDI L/R deviation ..... ±150 mv full scale, will drive up to 200 ohm load

TO/OFF/FROM flag..... ±250 mv, TO/FROM indication, will drive up to 200 ohm load

Nav valid flag ..... +300 mv for valid indication, will drive up to 100 ohm load

Nav superflag ..... Vin - 2 volts minimum for valid, source capability of 400 mA

VDI up/down ..... ±150 mv full scale, will drive up to 200 ohm load

VDI valid flag..... +300 mv for valid indication, will drive up to 100 ohm load

VDI superflag ..... Vin - 2 volts minimum for valid, source capability of 400 mA

Annunciators ..... Open collector outputs capable of sinking up to 400 mA for turning ON annunciator lamps.

- MSG (message) ON indicates message(s) active
- PTK (parallel track) ON indicates parallel track is enabled
- GPS ON indicates the NMC is **not** using the GPS sensor for navigation

- OBS/HLD (waypoint sequencing hold) ON indicates waypoint sequencing is on hold
- APPRCH (approach enabled) ON indicates the approach has been enabled
- ACTIVE (approach active) ON indicates the approach is active

CONTROL INPUTS

Take home sense	Connect to ground for normal operation, leave open for "take home" simulation operation
Waypoint sequencing hold	Connect to momentary button to ground for hold input operation

SERIAL INTERFACE

RS-232	Defined in Appendix E - Serial Interface Specifications
Arinc 429	Defined in Appendix E - Serial Interface Specifications

RECEIVER PERFORMANCE (2001GPS)

Number of channels	8
Frequency	1575.42 MHz L1, C/A code
Sensitivity (acquisition)	-135 dBm
Sensitivity (drop lock)	-142 dBm
Dynamic range	>20 dB
Lat/lon position accuracy	15 meters RMS typical 25 meters, SEP, without SA 100 meters 2DRMS with SA
Velocity	1000 knots maximum
Acceleration	4G maximum
TTFF (Time to first fix)	25 seconds typical with current almanac, position, time, and ephemeris 55 seconds typical with current almanac, position, and time
Reacquisition	2.5 seconds typical
Position update interval	1 second typical
Datum	WGS-84

ALTITUDE INPUT REQUIREMENTS

The minimum requirements of the altitude data input is as follows:

Input method ..... RS-232, NAVNET (from 2030), or Arinc 429

Type..... pressure altitude (on RS-232, NAVNET, or Arinc 429 interface), or baro altitude (on Arinc 429 interface)

Resolution ..... 100 feet minimum

Accuracy..... must meet accuracy requirements of TSO-C88a

Note: *Installation of altitude input equipment, such as encoders or air data computers, must be done according to their installation instructions.*

Note: *Specifications for the RS-232 altitude input are included on page 50, for the Arinc 429 input on page 55.*

ANNUNCIATOR REQUIREMENTS

The 2001 installed for IFR non-precision approach and/or oceanic/remote airspace operation requires annunciators as described here. Each annunciator should include a lamp of the proper voltage for the installation and legends as follows:

Legend	Color
MSG	amber
GPS	amber
PTK	blue
OBS/HLD	blue - with included momentary switch
APPRCH	blue
ACTIVE	green

The annunciators should be connected to a suitable dimming circuit for night time operation. An example of appropriate annunciators is included in Appendix D - Accessories.

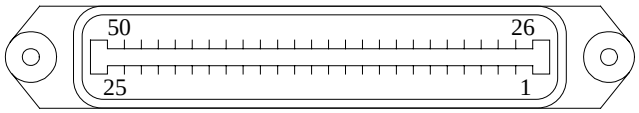
REAR CONNECTOR PINOUT

Table 5 Connector Pinout

Pin #	I/O	Connection	Function
1	O	CDI+Left	CDI + left output
2	O	CDI+Right	CDI + right output
3		NC	
4		NC	
5	I	Arinc 1 In B	Arinc 429 channel 1 input B, **do not connect**
6	I	Arinc 1 In A	Arinc 429 channel 1 input A, **do not connect**
7	I	Arinc 2 In B	Arinc 429 channel 2 input B
8	I	Arinc 2 In A	Arinc 429 channel 2 input A
9		NC	
10		NC	
11	O	ACTIVE annunciator	"Approach Active" annunciator output, pulled low to turn lamp on
12	O	VDI + valid flag	Low level VDI valid flag
13	O	NAV + valid flag	Low level NAV valid flag
14	O	NAV/VDI valid flag ground	Low level NAV / VDI valid flag return
15	I/O	NAVNET B	NAVNET B connection
16		NC	Reserved
17	I/O	NAVNET A	NAVNET A connection
18		NC	
19	O	TxD1	Channel 1 RS-232 serial data output, **not available on 2001GPS**
20	O	Serial ground	Serial data ground connection
21	I	RxD1	Channel 1 RS-232 serial data input, **not available on 2001GPS**
22		NC	
23		NC	
24	I	Power ground	Main power ground connection
25	I	Power +	Main DC power input
26		NC	
27		NC	
28		NC	
29	I	Take home sense	Tie to ground for normal operation
30	O	Ground	Take home ground connection
31		NC	
32	O	FROM+	TO/FROM flag FROM+ output
33	O	TO+	TO/FROM flag TO+ output
34	O	OBS/HLD annunciator	"Hold" annunciator output, pulled low to turn lamp on
35	O	APPRCH annunciator	"Approach Enabled" annunciator output, pulled low to turn lamp on
36	I	Hold	Waypoint sequencing hold input, connect to momentary switch to ground
37	O	TxD2	Channel 2 RS-232 serial data output
38	I	RxD2	Channel 2 RS-232 serial data input
39	O	Power Control	System power control output, connect to power control input on sensor units for remote power on control
40	O	Arinc Out B	Arinc 429 output B

Table 5 Connector Pinout

Pin #	I/O	Connection	Function
41	O	Arinc Out A	Arinc 429 output A
42	O	VDI+ Down	VDI+ down output
43	O	VDI+ Up	VDI+ up output
44	O	VDI Superflag	High level VDI superflag output, pulled high for valid
45	O	NAV Superflag	High level NAV superflag output, pulled high for valid
46	O	GPS Annunciator	“GPS” in use annunciator output, pulled low to turn lamp on
47	O	MSG Annunciator	“Message” annunciator output, pulled low to turn lamp on
48	O	PTK Annunciator	“Parallel Track” annunciator output, pulled low to turn lamp on
49	I	Power Ground	Main power ground connection
50	I	Power +	Main DC power input



Viewed from rear of mounting frame

Notes:
NC: no connection, DO NOT CONNECT.

SECTION 4 - LIMITATIONS

INSTALLATION

For minimum equipment and connections required for IFR and/or oceanic/remote airspace installations, refer to Table 2.

Installations are to be made in accordance with AC 20-138 (for systems using GPS), AC 20-121A (for systems using loran-C), and AC 20-130A (for systems using external or multiple position sensors).

For all Primary Oceanic navigation operations, the aircraft must have at least two independent primary navigation systems appropriate to the intended route. Each system must have an estimated Mean Time Between Failures (MTBF) value of at least 1000 hours.

Note: *This requirement may be satisfied by the installation of two Apollo 2001 systems.*

OPERATIONAL

An approved Aircraft Flight Manual Supplement is required for IFR and/or oceanic/remote airspace installations.

Note: *A sample AFM Supplement is available from II Morrow listing operational limitations.*

NOTES

APPENDIX A - TROUBLESHOOTING

This appendix provides information to assist troubleshooting if problems occur after completing the installation. Use Table 6 to assist in troubleshooting.

Table 6 Troubleshooting Guide

Problem	Cause	Solution
The 2001 does not power on.	The unit is not getting power.	Check power connections, fuses, and main avionics switch.
NAVNET checkout fails.	Test not conducted correctly or improper connections or terminators.	Make sure all other NMS equipment is turned off and only one NMC is connected to NAVNET when testing. Make sure one passive terminator is installed at each end of NAVNET cable and double check connections at each unit.
The 2001 does not compute a position.	Not receiving signals, or incorrect seed position, time, and date.	Make sure a correct position and time/date have been entered. Check antenna connections. Make sure the aircraft is clear of hangers, buildings, trees, etc.
Signal levels are very low.	Improper antenna installation or coax routing.	Check antenna installation, connections, and cable routing. The GPS antenna must be mounted on the top of the aircraft.
	Antenna shaded from satellites.	Make sure the aircraft is clear of hangers, buildings, trees, etc.
	RF interference at 1575.42MHz from COM.	Move GPS antenna further from COM antenna. Add 1575.42MHz notch filter in COM coax. Fix or replace COM.
Signal levels drop when avionics are powered on.	Noise interference from avionics.	Turn all avionics OFF, then turn on each piece of equipment one at a time to isolate the source of interference. Route cable and antenna away from sources of interference.
Communications failures to NAVNET sensors.	No power to sensors.	Check power connections, fuses, and power control connections.
	Incorrect NAVNET addresses.	If more than one NMC is installed, check network addresses. See NAVNET checkout on page 21.
	Improper NAVNET connections.	Double check NAVNET connections and make sure terminators are installed at each end of the NAVNET cable. See NAVNET checkout on page 21.

CONTACTING THE FACTORY FOR ASSISTANCE

If the Apollo 2001 unit fails to operate despite troubleshooting efforts, contact the II Morrow factory for assistance. Ask for "Technical Support."

II Morrow Inc.
2345 Turner Rd. SE
Salem, Oregon 97302
U.S.A.

Phone (503)581-8101
In USA 1-800-525-6726
In Canada 1-800-654-3415
FAX (503)364-2138

Be prepared to offer the following information about the installation:

- Installation configuration (accessories, antenna, ...)
- Model number, part number with mod levels, and serial number
- Software versions
- Description of problem
- Efforts made to isolate the problem

APPENDIX B - PERIODIC MAINTENANCE

The Apollo 2001 unit is designed not to require any regular general maintenance. There are no adjustments requiring calibration.

LITHIUM BATTERY REPLACEMENT

The internal keep alive battery will require replacement after 4 to 6 years. Regular planned replacement is not necessary. The Apollo 2001 will display a “low battery” message when replacement is required. Once the message is displayed, the battery should be replaced within 1 to 2 months. If the battery is not replaced, internal ram memory and the system clock information may be lost.

When the “low battery” message appears, return the 2001 to the factory or an authorized II Morrow service center for battery replacement.

CLEANING THE FRONT PANEL

The front bezel, keypad, and display can be cleaned with a soft cotton cloth dampened with clean water. DO NOT use any chemical cleaning agents. Extreme care must be taken to avoid scratching the surface of the display.

NOTES

APPENDIX C - ENVIRONMENTAL QUALIFICATIONS

The Apollo 2001 has been tested to the following environmental categories per procedures defined in RTCA/DO-160C.

Environmental Qualification Form		
Nomenclature: Apollo 2001GPS Apollo 2001TSO Part No.: 430-0267-yxx TSO No.:TSO-C115b, TSO-C129		Manufacturer: II Morrow Inc. 2345 Turner Road S.E. Salem, Oregon 97302
Conditions	Section	Description of Conducted Tests
Temperature and Altitude	4.0	Equipment tested to Category F1 with high operating temperature of +70°C
In-flight Loss of Cooling	4.5.4	No cooling required
Altitude	4.6.1	Equipment tested to 70,000 feet
Decompression	4.6.2	Equipment tested for decompression to 55,000 feet
Overpressure	4.6.3	Equipment tested for overpressure
Temperature Variation	5.0	Equipment tested to Category C, 2°C/min
Humidity	6.0	Equipment tested to Category A, standard humidity environment. Equipment performance and operation not affected. Display filter may degrade by high humidity.
Operational Shocks and Crash Safety	7	Equipment tested for both operational and crash safety shocks. Equipment operates normally during and after both operational and crash safety shocks.
Vibration	8.0	Equipment tested without shock mounts to Categories B, M, N, P, S, & Y
Explosion Proofness	9.0	Equipment identified as Category X, no test required
Waterproofness	10.0	Equipment identified as Category X, no test required
Fluids Susceptibility	11.0	Equipment identified as Category X, no test required
Sand and Dust	12.0	Equipment identified as Category X, no test required
Fungus Resistance	13.0	Equipment identified as Category X, no test required
Salt Spray	14.0	Equipment identified as Category X, no test required
Magnetic Effect	15.0	Equipment is Class Z
Power Input Momentary Power Interruptions	16.0 16.5.2.3.b	Equipment tested to Categories A, B, & Z Interruptions greater than 200msec at 28V, 30msec at 14V, may cause an automatic equipment reset.
Voltage Spike	17.0	Equipment tested to Category A
Audio Frequency Conducted Susceptibility - Power Inputs	18.0	Equipment tested to Categories A, B and Z
Induced Signal Susceptibility	19.0	Equipment tested to Category Z
Radio Frequency Susceptibility (Radiated and Conducted)	20	Equipment tested to Category U
Emission of Radio Frequency Energy	21	Equipment tested to Category Z
Lightning Induced Transient Susceptibility	22.0	Equipment tested to Category M
Lightning Direct Effects	23.0	Equipment identified as Category X, no test required
Icing	24.0	Equipment identified as Category X, no test required
Remarks:		

NOTES

APPENDIX D - ACCESSORIES

This appendix includes information on accessory items available for the Apollo 2001. Refer to the information that comes with these items for complete specifications and installation instructions.

FROM II MORROW

The following accessories and equipment are available from II Morrow.

Annunciators

These Apollo ACU annunciators provide the required annunciation for IFR en route, terminal, and non-precision approach operation. See the instructions provided with the annunciator module for complete specifications and installation instructions.

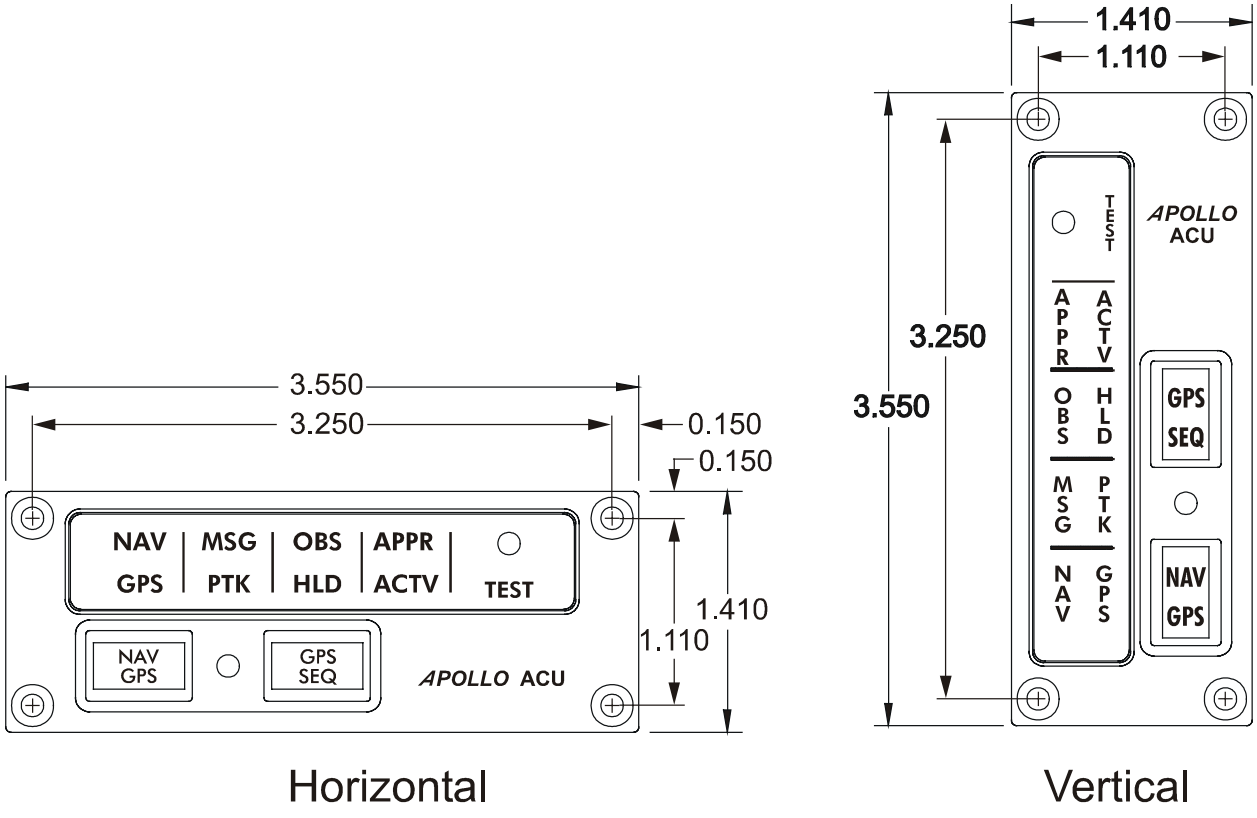
Apollo ACU GPS/NAV Annunciation Control Unit

II Morrow Part #: ..... 430-6080-000 14 VDC Horizontal

430-6080-100 14 VDC Vertical

430-6080-200 28 VDC Horizontal

430-6080-300 28 VDC Vertical



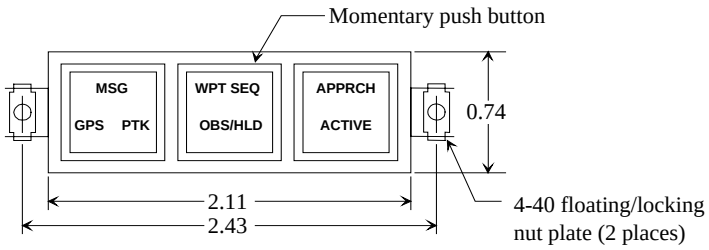
Annunciators

II Morrow Part #:..... 145-2105

Manufacturer:..... West Coast Specialties

Manufacturer #:..... 90-81421-1

These annunciators provide the required annunciation for the 2001 for IFR en route, terminal, and non-precision approach operation. The module is standard with 28 volt bulbs and includes a wiring pigtail. See the instructions provided with the annunciator module for complete specifications and installation instructions.



The 2001 can be installed with other annunciators. Several possible sources of annunciators are listed on page 44.

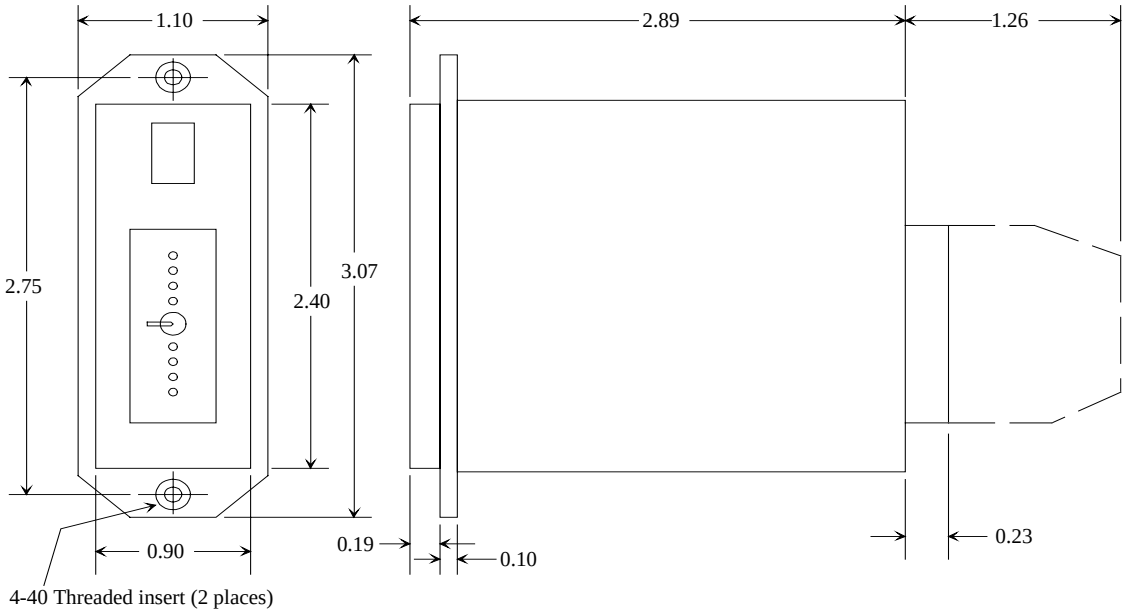
VDI

II Morrow Part #:..... 428-2011

Manufacturer:..... Mid-Continent Instrument Co., Inc.

Manufacturer #:..... MD40-24

The MD40-24 VDI is useful for vertical navigation guidance from the 2001 when altitude data is available. See the instructions provided with the VDI for complete specifications and installation instructions.



Note: Recommended rectangular panel cutout: 2.44 x 0.94 with appropriate clearance holes for 4-40 mounting screws.

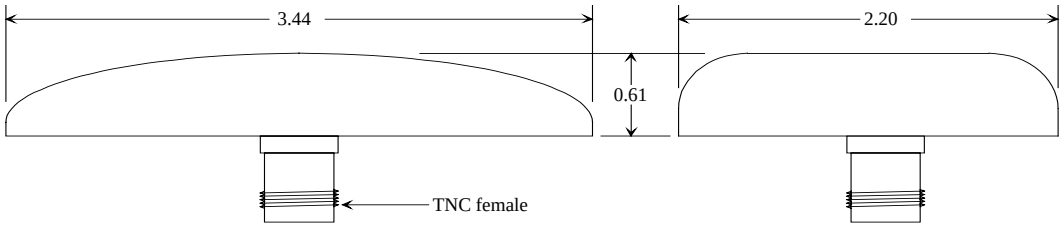
A-33 Antenna

II Morrow Part #: 590-1104

Manufacturer: ..... Aero Antenna

Manufacturer #: AT-575-9

The A-33 antenna is a standard accessory item with the 2001GPS. The A-33 includes a built-in preamp and has a low profile, low drag radome mounted on a die cast aluminum base. It has a maximum altitude of 55,000 feet and weighs only 3.9 oz. See the installation manual for the A-33 for complete specifications and installation instructions.



A-34 Antenna

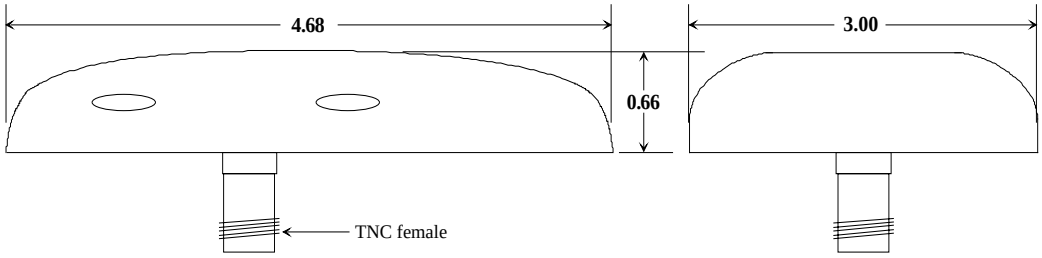
II Morrow Part #: 590-1112

Manufacturer: ..... Aero Antenna

Manufacturer #: AT-575-93

The A-34 GPS antenna is a standard accessory item with the 2001. The A-34 includes a built-in preamp and has a low profile, low drag radome mounted on a die cast aluminum base. It has a maximum altitude of 55,000 feet and weighs only 7.0 ozs. See the installation manual

for the A-34 for complete specifications and installation instructions. The A-34 mounts in the same footprint as the II Morrow A-16 and A-23 Loran antennas to simplify upgrading.



2010 Multi-Chain Loran Sensor

The Apollo 2010 MCLS is a multi-chain loran sensor with TSO-C60b approvals for IFR en-route and terminal operation. The 2010 is intended for remote mounting and connects to the 2001 as part of an Apollo NMS system using NAVNET. It comes complete with mounting tray and antenna. The 2010 is 6.43 inches H x 1.50 inches W x 11.97 inches L with mounting tray. Several antenna options are available for the 2010. For complete information and specifications on the 2010, contact II Morrow.

2022 GPS Sensor

The Apollo 2022 GPS is a high performance GPS sensor with TSO-C129a and TSO-C115b approvals for supplemental IFR en route, terminal, and non-precision approach, and N8110.60 approval for primary oceanic, and remote airspace operation. The 2022 is intended for remote mounting and connects to the 2001 as part of an Apollo NMS system using NAVNET. It comes complete with a mounting tray and antenna. The 2022 is 5.380 inches H x 1.588 inches W x 8.924 inches L with mounting tray. For complete information and specifications on the 2022, contact II Morrow.

Note: *The 2022 is not required with the 2001GPS.*

COMMERCIALLY AVAILABLE

The following accessories and equipment are available from sources other than II Morrow. Other suitable equipment may also be available that is not listed here. Although the 2001 is designed to work with these items, it is the responsibility of the installer to ensure the equipment is suitable for the installation (including that environmental and airworthiness requirements are met), to make proper connections to the equipment, and to ensure proper operation is obtained.

Annunciators

There are a number of sources of suitable annunciators besides the module available directly from II Morrow. Several sources are:

- Series 814 from West Coast Specialties
- Series 582 from Eaton

Switching Relays

Several relays suitable for navigation source selection include:

- RS08 relay (8 pole) from Northern Airborne Technology (NAT)
- RS012 relay (12 pole) from Northern Airborne Technology (NAT)

- AIS 80-1 CDI switch unit (8 pole) from Avionics International Supply
- AIS-12020 remote switch unit (12 pole) from Avionics International Supply

Several switches that can be used to control the relay and for annunciation include:

- PB08 switch/annunciator from Northern Airborne Technology (NAT)
- Series 582 switch/annunciator from Eaton

Altitude Encoders & Converters

The 2001 can use altitude data from encoder or converter units that output information on an RS-232 interface. Check for the altitude input requirements on page 30. The interface specifications required from the encoder or converter units are included in Appendix E.

Several altitude encoders compatible with the 2001 include:

- Part #8800M altitude encoder from Shadin
- Model SSD120-RS232C-1 altitude encoder from Trans-Cal

Several altitude gray code converters compatible with the 2001 include:

- Part #9000 gray code converter from Shadin
- Model IA-RS232C-1 interface adapter from Trans-Cal
- Model 3000U altitude serializer from Icarus

2030 Fuel / Air Data Sensor

The 2030 Fuel / Air Data Sensor provides fuel flow and air data information for the 2001, is intended for remote mounting, and connects to the 2001 as part of an Apollo NMS system using NAVNET. The 2030 is available is several configurations depending on type of fuel flow system that it will be connected to. For complete information and specifications on the 2030, contact Shadin, the manufacturer. The 2030 is available in the following configurations from Shadin:

- Airdata Computer DF #962800-1-3-55 (digital fuel flow)
- Airdata Computer AF #962800-3-3-55 (analog fuel flow)
- Airdata Computer RF #962800-4-3-55 (RF fuel flow)
- Airdata Computer SF #962800-2-3-55 (sine wave fuel flow)

Note: *Previous 2030 air data computers from II Morrow are also compatible with the 2001.*

Accessory Vendors

For West Coast Specialties annunciators:

West Coast Specialties
1105 12th Ave. N.W. Suite 7 - Bldg A
Issaquah, WA 98027

Phone (206)392-3118
Fax (206)391-0535

For Eaton annunciator / switches:

Airtechnics, Inc
230 Ida
Wichita, Kansas 67211

Phone (316)267-2849
(800)544-4070
Fax (316)267-1482

Avionics International Supply, Inc.
4389 Westgrove
Dallas, TX 75248
Phone (214)248-2233
(800)553-2233 (US)
Fax (214)250-2794

For relay switch units:

Avionics International Supply, Inc.
4389 Westgrove
Dallas, TX 75248
Phone (214)248-2233
(800)553-2233 (US)
Fax (214)250-2794

Northern Airborne Technology
1925 Kirschner Road Suite 14
Kelowna, B.C.
Canada VIY 4N7
Phone (604)763-2232
Fax (604)762-3374

For altitude encoders and gray code converters:

Shadin Company Incorporated
6831 Oxford Street
St. Louis Park, Minnesota 55426
Phone (612)927-6500
Fax (612)924-1111

Trans-Cal Industries Inc.
16141 Cohasset Street
Van Nuys, CA 91406
Phone (818)787-1221
Fax (818)787-8916

Icarus Instruments, Inc
7585 Washington Blvd., Suite 108
Baltimore, MD 21227
Phone (301)799-9497
Fax (301)799-8320

APPENDIX E - SERIAL INTERFACE SPECIFICATIONS

This appendix includes the interface specifications for both the RS-232 and Arinc 429 communication ports.

RS-232 INTERFACE

The RS-232 serial interface configurations supported by the 2001 are listed in Table 7. Instructions for configuring the serial ports are included in the checkout procedure on page 21.

Table 7 RS-232 Serial Interface Selections

Selection	RX/TX	Comment
NONE	RX/TX	No input or output
MOVMAP	TX	Moving map data output
ALTENC	RX	Altitude encoder / converter data input
GPSSIM	RX	Used for factory test
GPS	RX/TX	For internal GPS sensor on 2001GPS
NMC	RX/TX	Not used on 2001
KEYPAD	RX	Not used on 2001
PC / SETUP	RX/TX	Used for factory test
FADC	RX	Used for Shadin 200 FADC
Map Com	TX	Moving Map data alternated with SL40 com freq. list data output

Note: *Serial port channel 1 can be used for external connections on the 2001TSO only. It cannot be used on the 2001GPS.*

MOVING MAP OUTPUT

The format of the moving map data output is as follows. Definitions of the output data is included in Table 8 and Table 9. A sample output message is included in Figure 12.

Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: ..... none
Output rate: ..... approx 2 seconds
Message length: ..... variable, approx 83 to 484 characters

The serial output messages are in the following format.

<STX><id><data><it><id><data><it>...<id><data><it><ETX>

<STX> ..... ASCII “start of text” character (1 byte, 02h)
<id> ..... item designator (1 byte, from following table)
<data> ..... item data (format listed in following table)
<it> ..... item terminator (1byte, 0Dh)
<ETX> ..... ASCII “end of text” character (1 byte, 03h)

Table 8 Moving Map ASCII Navigation Data			
ID	**Data Format**	**Length**	**Description**
A	sddmmhh	9	Present latitude s =sign: N for north, S for south dd = degrees mm = minutes hh = hundredths of minutes
B	sdddmmhh	10	Present longitude s = sign: E for east, W for west ddd = degrees mm = minutes hh = hundredths of minutes
C	ddd	3	Track (magnetic): ddd = degrees
D	ddd	3	Ground speed: ddd = knots
E	ddddd	5	Distance to active waypoint: ddddd = nm x 10
G	sdddd	5	Cross track error: s = sign: R for right, L for left of course dddd = distance off course, hundredths of nm
I	dddd	4	Desired track (magnetic): dddd = degrees x 10
K	ddd[dd]	3 to 5	Active waypoint identifier: ddd[dd] = ASCII waypoint identifier
L	dddd	4	Bearing to active waypoint (magnetic): dddd = degrees x 10
Q	sddd	4	Magnetic variation: s = sign: E for east, W for west ddd = degrees x 10
T	---A-----	9	Warnings: The 4th character will be an “A” when the navigation data is flagged, otherwise, all characters will be dashed. All other navigation data will be dashed when it is flagged.

Table 9 Moving Map Binary Route Data		
Byte	**Data Format**	**Description**
1	w	Item designator
2-3	dd	Current waypoint number in ASCII (01h to 20h)
4	xiannnnn	Sequence number x = undefined i = 1 if last waypoint a = 1 if active waypoint nnnnn = unsigned binary waypoint number
5-9	ddddd	ASCII waypoint identifier
10 11 12	sddddddd xxmmmmmm xhhhhhhh	Waypoint latitude - packed, unsigned binary s = sign: 0 for north, 1 for south ddddddd = degrees mmmmmm = minutes hhhhhhh = hundredths of minutes x = undefined
13 14 15 16	sxxxxxxx sddddddd xxmmmmmm xhhhhhhh	Waypoint longitude s = sign: 0 for east, 1 for west ddddddd = degrees mmmmmm = minutes hhhhhhh = hundredths of minutes x = undefined
17 18	nnnnnnnn nnnnnnnn	Magnetic variation at waypoint LS byte (msbit...lsbit) MS byte (msbit...lsbit) Two’s complement binary in sixteenths of degrees, easterly variation is positive.
19	<CR>	ASCII carriage return (0Dh)

Example Moving Map Data Output

`AN 34 1570`	34°15.70’ latitude
`BW 118 4390`	118°43.90’ longitude
`C306`	306° track angle
`D210`	210 knots
`E02682`	268.2nm to waypoint
`GR0006`	0.6nm right of course
`I3059`	305.9° desired track
`KSFO`	SFO waypoint ident
`L3058`	305.8° bearing to waypoint
`QE140`	14.0° east magnetic variation
`T---------`	No alarms, data not flagged
`<binary data>`	From Table 9

Figure 12 Moving Map Data Output

ALTITUDE ENCODER/CONVERTER INPUT

The format of the altitude input is as follows. Definition of the input message is included in Table 10. Several sample messages are illustrated in Figure 13.

Baud rate: 1200
Data bits: 8
Stop bits: 1
Parity: ..... none
Expected input rate: ..... approx 1 second
Message length: ..... 17 characters

Table 10 Altitude Input Data

Byte	Data Format	Description
1	“#”	ASCII “#” (023h)
2	“A”	ASCII “A” (041h)
3	“L”	ASCII “L” (04Ch)
4	“ “	ASCII space (020h)
5	“+” or “-”	Altitude sign: ASCII “+” or “-” (02Bh or 02Dh)
6-10	ddddd	Altitude in feet, right justified with leading zeros
11	“T”	ASCII “T” (054h)
12	“+” or “-”	Temperature sign: ASCII “+” or “-” (02Bh or 02Dh)
13-14	dd	Internal altimeter temperature
15-16	dd	Checksum of bytes 1 thru 14, computed in hex, output in ASCII format (i.e., “FA” hex)
17	<CR>	ASCII carriage return (0Dh)

The altitude input can decode several status or error codes. These codes would be in place of the altitude data in characters 5 - 10 as follows.

"-09980" ..... Heater not ready: expected during encoder warm-up or if there is a loss of signal from the encoder.

"-09981" ..... Possible hardware problem: expected from encoder indicating a temperature greater than 55°C or if data is invalid.

"-09982" ..... Altitude out of range: expected from the encoder indicating that the altitude is outside specified range of the encoder.

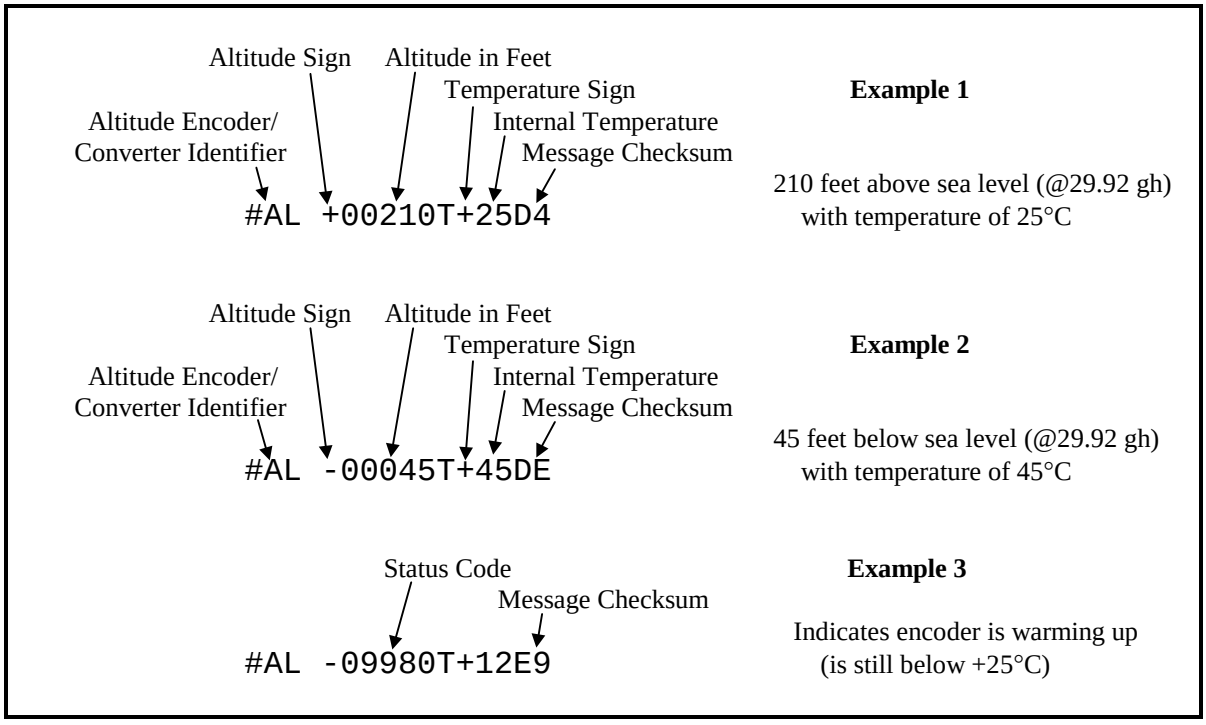


Figure 13 Altitude Data Input

APOLLO SL40 COM SERIAL DATA FORMAT AND INSTALLATION INSTRUCTIONS

The Apollo 2001 interfaces to the Apollo SL40 in a similar way as the moving map.

SL40 INSTALLATION CONFIGURATION

1. Connect the SL40 serial line in parallel with the Moving Map display serial line (if present), TxD2 on pin 37.
2. Connect the SL40 ground to pin 20. Refer to Figure 10 for example installation.
3. Select Map Com as the data output choice for Tx. This will cause moving map and com data to be transmitted out pin 37.

MESSAGE FORMAT

The format of the moving map data output is as follows.

Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: ..... none
Output rate: ..... approx 2 seconds

IDENT OUTPUT

This message is used to output a new ident.

Message Format
$PMRRC04tiiii<chksum><cr>

04..... message id
t..... list type, input 1
iiii ..... ident, four character ascii

Example Message
$PMRRC041SLE<space>99<cr>

Set the remote frequency ident to “SLE.”

FREQUENCY LIST OUTPUT

This message is used to output frequencies for the SL40 remote recall function. One message is sent for each frequency available for the airport ident.

Message Format
$PMRRC05tfmk<chksum><cr>

05.....message id
t .....list type, input 1
f .....frequency type:

0 = TWR, tower frequency	8 = CTF, common traffic advisory frequency
1 = GND, ground frequency	9 = DEP, departure
2 = ATS, for ATIS	: (3Ah) = FSS, flight service station
3 = ATF, air traffic frequency	; (3Bh) = RFS, for remote flight service station
4 = APP, for approach	< (3Ch) = UNI, for unicom
5 = ARR, for arrival	= (3Dh) = MF, mandatory frequency
6 = AWS, automatic weather station	> (3Eh) = not defined, do not use
7 = CLR, clearance/delivery	? (3Fh) = undefined, for other frequency types

mk.....frequency:
m = desired frequency in MHz in hexadecimal, where m = desired frequency - 30h , with desired frequency in range of 118 to 136MHz, or 162MHz.
k = desired frequency in kHz where k = (desired frequency / 25KHz) + 30h, with desired frequency in range of 000 to 975KHz in 25KHz steps, or 0 to 39.

Example Message
$PMRRC0511IT64<cr>

Input a ground frequency type, 121.900MHz.

FUEL / AIR DATA COMPUTER INPUT

The fuel / air data input is used to input fuel flow and airdata computer information from the Shadin ADC-200 fuel / air data computer.

The format of the fuel / air data computer input is as follows, which conforms to the Shadin "S" format serial message. Definition of the input message data that the GX50/60/65 uses is included in Table 11. A sample input message is illustrated in Figure 14.

Baud rate: 9600
Data bits: 8
Stop bits: 1
Parity: .....none
Expected input rate: .....approx. 1 second
Message length: .....variable (512 character max.)

The serial input message string is expected in the following format.
<STX><message><message> ... <message><chksum><ETX>

<STX> .....ASCII "start of text" character (STX = 02h)
<message>.....starts with an ASCII "S", then an ID character, followed by the message data, a carriage return (CR = 0Dh), and a line feed (LF = 0Ah) See the following table.

<checksum>..... the message checksum, same format as message
<ETX>..... ASCII "end of text" character (ETX = 03h)

Table 11 Fuel / Airdata Message Data

Item Desig	Message Format	Message Mnemonic	Field Width	Message Description
SA	ddd	IAS	7	Indicate Air Speed in knots
SB	ddd	TAS	7	True Air Speed in knots
SC	ddd	MACH	7	Mach Speed in thousandths
SD	sdddd	PALT	9	Pressure Altitude in tens of feet, +/- sea level
SE	sdddd	DALT	9	Density Altitude in tens of feet, +/- sea level
SF	sdd	OAT	7	Outside Air Temp - or "Total", in degrees Celsius
SG	sdd	TAT	7	True Air Temp - or "Static", in degrees Celsius
SH	ddd	WDIR	7	Wind Direction, 0 to 359 degrees from true north
SI	ddd	WSPD	7	Wind Speed in knots
SJ	sdd	TURN	7	Rate of Turn in +/- degrees/second, + is right, - is left
SK	sddd	VSPD	8	Vertical speed in tens of feet/minute
SL	ddd	HEAD	7	Heading, 0 to 359 degrees from true north
SM	dddd	RFF	8	Right Engine Fuel Flow in tenths of gallons/hour
SN	ddddd	RFU	9	Right Engine Fuel Used in tenths of gallons
SO	dddd	LFF	8	Left Engine Fuel Flow in tenths of gallons/hour
SP	ddddd	LFU	9	Left Engine Fuel Used in tenths of gallons
SQ	ddd	ERR	7	Error Log / Reason Indicator: 001 = temp sensor error; 000 = no errors
S*	ddd	CKSUM	7	Checksum of all characters preceding this record. The checksum is a one byte checksum (discarding carries) including all characters from the initial STX up to and including the line feed preceding the checksum message.

Example Fuel / Airdata Input Data

`<STX>SA223`	223 knots indicated air speed
`SB230`	230 knots true air speed
`SC101`	0.101 mach
`SD+3200`	32,000 feet pressure altitude
`SE+3312`	33,120 feet density altitude
`SF+05`	+5°C outside air temp
`SG-03`	-3°C true air temp
`SH010`	wind direction at 10° (relative to true north)
`SI015`	wind speed at 15 knots
`SJ+03`	+3° / second right turn
`SK-050`	-50 feet / second vertical air speed
`SL359`	359° heading (relative to true north)
`SM0123`	12.3 gallons / hour - right engine fuel flow
`SN0300`	30.0 gallons used - right engine
`SO0131`	13.1 gallons / hour - left engine fuel flow
`SP0310`	31.0 gallons used - left engine
`SQ000`	no errors
`S*123`	Checksum (example only, not actual)
`<ETX>`	end of message string

Figure 14 Fuel / Airdata Data Input

ARINC 429 INTERFACE

This optional interface of the 2001 is the standard GAMA (General Aviation Manufacturers Association) Arinc 429 interface. The interface can be set to either low speed (12,500 bits/second) or high speed (100,000 bits/second). Instructions for configuring the Arinc 429 interface are included in the checkout procedure on page 20. The Arinc 429 interface configurations supported by the 2001 are listed in Table 12. The input and output labels supported by the 2001 are listed in Table 13. The labels are listed in octal.

Table 12 Arinc 429 Interface Selections

Selection	RX/TX	Comment
NONE	--	Interface does not output or accept inputs
LOOPBACKTEST	RX/TX	Used for factory test
ALL	RX/TX	Outputs all labels listed in Table 13 and accepts inputs
LTN-92	TX	Litton 92 (INS)

Table 13 Arinc 429 GAMA Labels

Label	Input/Output	Description
074	Output	Flight Plan Header Record
075	Output	Active Waypoint From/To Data
100	Output	Selected Course
113	Output	Message Checksum
114	Output	Desired Track (True)
115	Output	Waypoint Bearing (True)
116	Output	Crosstrack Distance
117	Output	Vertical Deviation *(requires altitude input)*
121	Output	Horizontal Command (to autopilot)
125	Output	GMT Time
147	Output	Magnetic Variation
150	Output	UTC Time
203	Input	Pressure Altitude
204	Input	Baro Corrected Altitude #1
210	Input	True Air Speed
251	Output	Distance to Go
252	Output	Time to Go
261	Output	GPS Discrete Word 1 *(requires a GPS sensor)*
275	Output	LRN Status Word
300	Output	STN Declination / Type / Class
303	Output	Message Length / Type / Number
304	Output	Message Characters 1 - 3

Table 13 Arinc 429 GAMA Labels		
Label	**Input/Output**	**Description**
305	Output	Message Characters 4 - 6
306	Output	Nav / Wpt / Ap Latitude
307	Output	Nav / Wpt / Ap Longitude
310	Output	Present Position Latitude
311	Output	Present Position Longitude
312	Output	Ground Speed
313	Output	Track Angle (True)
314	Output	True heading *(requires a 2030 F/ADS)*
315	Output	Wind Speed *(requires a 2030 F/ADS)*
316	Output	Wind Angle (True) *(requires a 2030 F/ADS)*
321	Output	Drift Angle *(requires a 2030 F/ADS)*
326	Output	Lateral Deviation Scale Factor
351	Output	Distance to Destination
352	Output	Estimated Time to Destination
371	Output	Gen AV Equipment and Company Ident Code
377	Output	Gen AV Equipment Ident Code

Note: *For installations with connections to EFIS displays using the Arinc 429 interface, verify that the EFIS is compatible with the variable CDI operation of* TSO-C129a*. The Bendix/King EFIS 40/50 must have software version 11 or later.*

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