Apollo
Mode A/C Transponder
Model SL70
Installation Manual

Final Draft

August 11, 1999

UPS Aviation Technologies SM

A subsidiary of United Parcel Service

HISTORY OF REVISIONS

Revision	Date	Description
Draft	8/11/99	Final draft.

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 on or within a specific type or class of aircraft to determine that the aircraft operating 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.

ORDERING INFORMATION

To receive additional copies of this publication, order part # **560-0402,** *Apollo SL70 Mode A/C Transponder Installation Manual*.

REFERENCE PUBLICATIONS

Following are other publications referenced in this guide.

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SECTION 1 - INTRODUCTION

ABOUT THIS MANUAL

This manual describes the installation of the Apollo SL70 transponder . It is intended for use by persons certified by the Federal Aviation Administration (FAA) to install aircraft avionics.

Section 1   Provides an **introduction** to the Apollo SL70 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 E   Includes **serial data protocol** specifications.

APOLLO SL70 DESCRIPTION

The Apollo SL70 is a TSO-C74c, Class A2, mode A/C transponder. The SL70, in addition to providing replies to ATC interrogations, includes an altitude display and altitude hold function and user-friendly interface features including rotary knob squawk code selection, a VFR button, and built-in self-test and diagnostics.
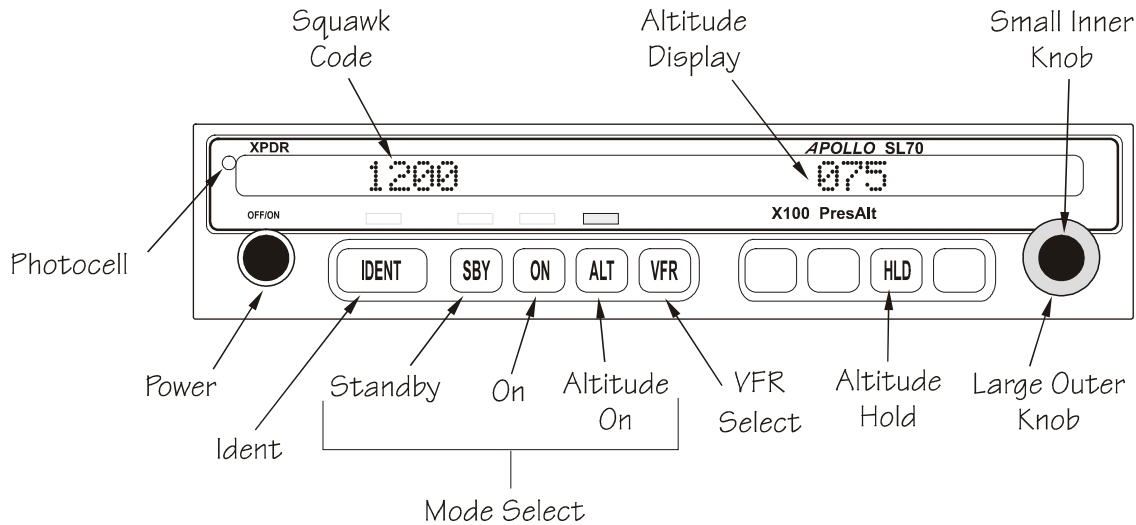
Figure 1 SL70 Front Panel

FEATURES

- small size 1.3" panel height

- full range input supply voltage

- high brightness LED display

- altitude display

- altitude hold function

- gray code or RS-232 serial data altitude input

- RS-232 altitude data output

- built-in self-test and diagnostics

REGULATORY COMPLIANCE

The Apollo SL70 is designed and tested to meet the following TSO:

- FAA TSO-C74c, Class A2

The SL70 complies with the FCC requirements specified in:

- CFR 47, Part 87, Aviation Services, Subpart D, Technical Requirements

The SL70 software is designed and tested to RTCA/DO-178B, level C.

> *Note: Un-authorized changes or modifications to the SL70 may void the compliance to regulatory agency requirements and authorization for continued equipment usage.*

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 UPS Aviation Technologies factory, the Apollo SL70 package includes most necessary items for installation other than supplies normally available at the installation shop, such as wire and coax cable, the antenna, or any optional switches. The items included in the package are listed in Table 1.

Table 1 Package Contents		
Part #	Description	Qty
Apollo SL70 Installation Kit, Part # 424-0306-xx		
162-0103	37 pin dsub connector shell	1
162-0043	Right angle coax plug	1
202-0001	Cable tie	2
204-0037	Edge grommet	6"
221-0400	4-40 x ¼ SS pan head Phillips machine screw with lock washer	10
224-0404	4-40 x ¼ flat head Phillips machine screw	2
240-0008	9/16 OD flat washer	1
245-0022	Crimp contact for dsub, 20 to 24 awg wire	37
265-0007	7/16" retaining ring	1
310-2295-00	Connector mounting bracket	1
310-5181-00	Mounting frame	1
998-0048	3/32 hex driver	1
Apollo SL70 Manual Kit, Part # 564-0072-xx		
560-0401-00	SL70 User's Manual	1
560-0402-00	SL70 Installation Manual	1

OTHER REQUIRED MATERIALS

In addition to the materials supplied with the SL70, the following is required.

- a suitable 2A circuit breaker
- an altitude data source – either gray code or RS232
- a standard transponder antenna

SPECIAL TOOLS REQUIRED

Crimp Tool

A crimp tool meeting MIL specification M22520/1-01 and a positioner are required to ensure consistent, reliable crimp contact connections for the rear 37 pin dsub connector. These tools are available from:

Astro Tool Corp.   Phone (503)642-9853
21615 SW TV Highway   Fax (503)591-7766
Beaverton, OR 97006

Crimp tool: Astro Tool part #615708
Positioner: Astro Tool part #616356

SECTION 2 - INSTALLATION

This section describes the installation of the Apollo SL70 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 43.13-1B, 43.13-2A, or current FAA guidance.

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 location for the SL70, antenna location and mounting, connections to an altitude data source, power, cable routing, and other required modifications.

Once the mounting location has been determined, prepare the mounting frame for installation. If may be easier to complete the wiring harness and attach the connectors to the mounting frame prior to installing the mounting frame in the aircraft.

INSTALLATION CONSIDERATIONS

MOUNTING CONSIDERATIONS

The SL70 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 the mounting frame for ease of mounting, connections, and service of the unit. Allow an additional one inch clearance to the rear of the mounting frame for connections and cables.

For typical installations, the SL70 does not require external cooling. When mounting the unit, leave a clearance of 1/8 to 1/4 inch between avionics to allow for air circulation.

MINIMUM SYSTEM CONFIGURATION

The SL70 requires connections to the following equipment as a minimum:

- power input
- altitude data – gray code or RS232
- a standard transponder antenna

ALTITUDE INPUT

The SL70 can use either a standard altitude gray code input from an encoding altimeter or an RS-232 input from a serial encoder. For new installations, a serial encoder is recommended because it simplifies the wiring and is more reliable. The SL70 can detect failures on the RS-232 input, thereby eliminating erroneous mode C altitude replies.

The altitude source must be accurate to within ±125 feet, 95% probability, and have a resolution of 100 feet (the serial input resolution may be better than 100feet).

ANTENNA

The antenna shall be a standard transponder quarter wave monopole antenna, such as the TED #104-12 or Comant CI-101.

EQUIPMENT MOUNTING

Once the cable assemblies have been made, attach the 37 pin dsub and coaxial cable connectors to the rear connector mounting plate and the mounting frame as illustrated in Figure 2 and Figure 3. Route the wiring bundle as appropriate. The rear connector plate should be attached to the mounting frame before installing the frame in the instrument panel. The rear connector plate can be used to tie down the cable assemblies. Connect the shields on any shielded cables directly to the connector mounting plate.
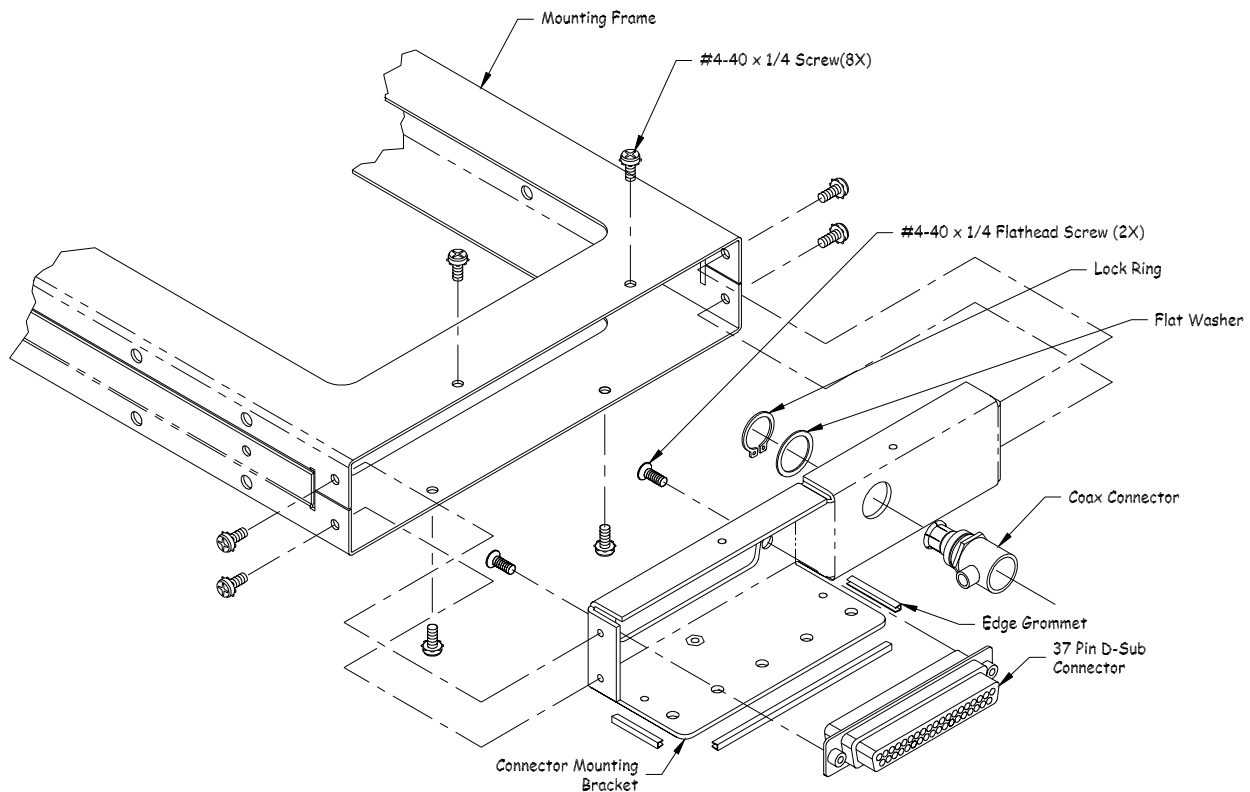
Figure 2 Mounting Frame Assembly
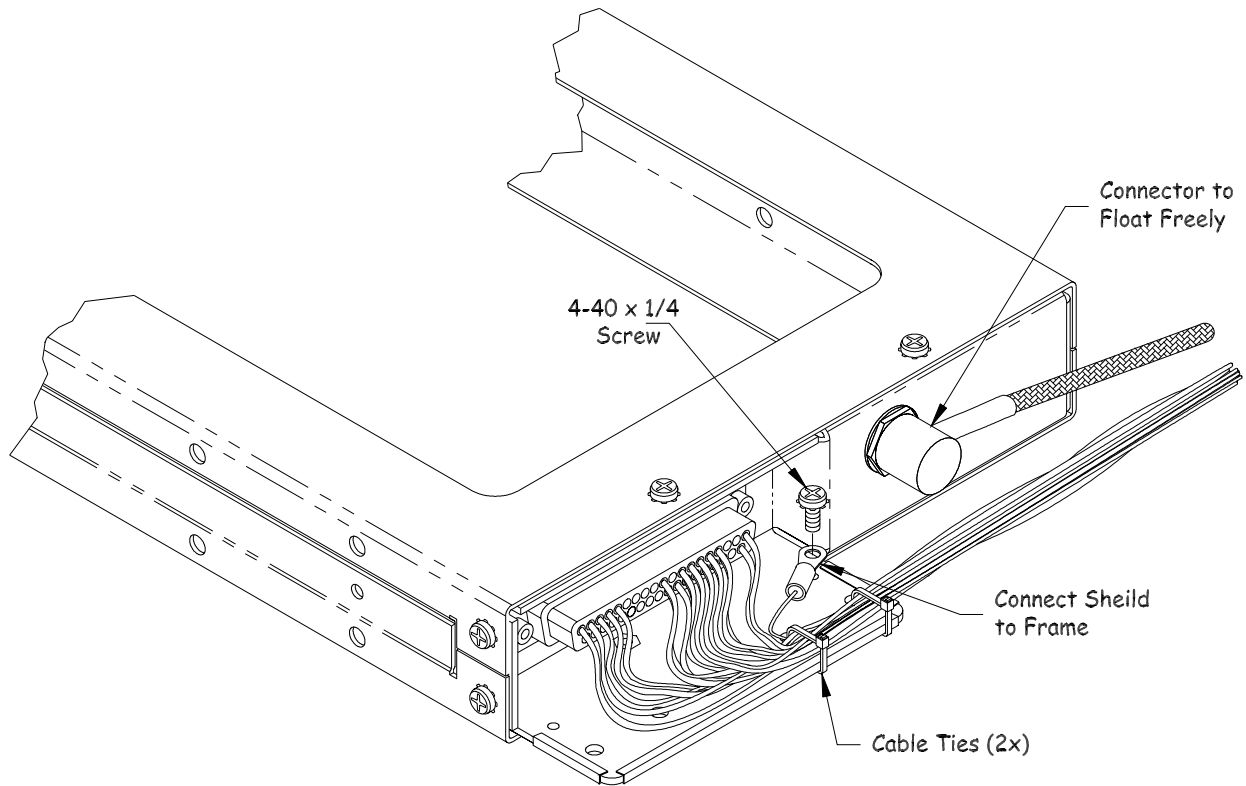
Figure 3 Cable Routing

Once the cable assemblies are complete and the connectors are attached to the mounting frame, install the mounting frame assembly in the aircraft instrument panel. Be sure to use low profile head screws so the unit will slide in and out freely. Attach the front of the mounting frame to the instrument panel. Use support brackets to attach the rear of the frame to the aircraft.

UNIT INSTALLATION / REMOVAL

To install the SL70 in the mounting frame, make sure the cam lock is rotated so the rear part is up, then slide the unit into the frame and tighten with the 3/32 hex tool. The unit will be pulled into the frame by the cam lock and the connectors will fully engage.

To remove the SL70 from the mounting frame, use the hex tool and turn the tool CCW. The unit will be pushed out of the frame by the cam lock assembly. No special extraction tools are required.

ELECTRICAL CONNECTIONS

The SL70 installation kit includes a 37 pin dsub shell and crimp contacts. The crimp contacts are specified for 20 to 24 AWG wire. Make the crimp connections with a crimp tool as specified in the Special Tools Required section on page 4. All wires should be 20 to 24 AWG unless otherwise specified. Wiring diagrams are included on pages 10 and 11.

POWER

The SL70 is internally fused at 3 amps. A separate 2 amp circuit breaker or fuse should be installed for downline overload or short circuit protection. Make the power connections to the SL70 using 20 AWG wire.

Note: Circuits should be protected in accordance with guidelines in AC 43.13-1B, chapter 11, section 4.

ALTITUDE INPUT

If using the gray code altitude input, connections can be made directly from the SL70 to the altitude source. Isolation diodes are included within the SL70. Make sure a common ground connection exists, or connect a ground wire between the source and the SL70.

If using the RS-232 serial altitude input, make the connections as described in the following section.

SERIAL INTERFACE

The SL70 includes an RS-232 serial port which can be used for inputting or outputting altitude data. This is an optional connection if the altitude gray code input is used.

When making serial connections to the SL70, use a shielded two or three conductor cable. Make the RxD, TxD, and serial ground connections on the 37 pin dsub connector. Connect the shield to the rear of the mounting frame on the connector plate.

Complete serial interface specifications are included in Appendix E.

DISCRETE INPUTS

Remote Ident
The ident input can be connected to a remotely mounted momentary switch to initiate the ident function the same as using the front panel IDENT button.

When using the ident input, connect it to a remotely mounted momentary switch, and connect the other terminal of the switch to ground.

Remote Standby
The standby input is for use when the installation includes more than one transponder. When two transponders are installed, connect the standby input to a two position selector switch, with the common on the switch connected to ground. The SL70 will be in standby when the input is pulled low to ground.

Suppresion Input
The suppress input is used when installed with a DME that includes a suppression output. The transponder will be suppressed, or will not generate replies, when the input is driven high from the DME (or other source). To use the suppression input, connect it to the suppression output on a DME (or other appropriate suppression source).

ANTENNA INSTALLATION AND CONNECTIONS

The antenna should be mounted in a vertical position in an area on the bottom of the aircraft away from other antennas or landing gear.

The antenna coax cable should be a double shielded low loss cable and must have a cable loss of < 3 dB, including connectors. A typical installation should have a cable loss of 1½ to 2 dB. Several suitable coaxes are RG142B and RG400.

The assembly of the rear panel coax connector included with the installation kit is illustrated in the following figure.
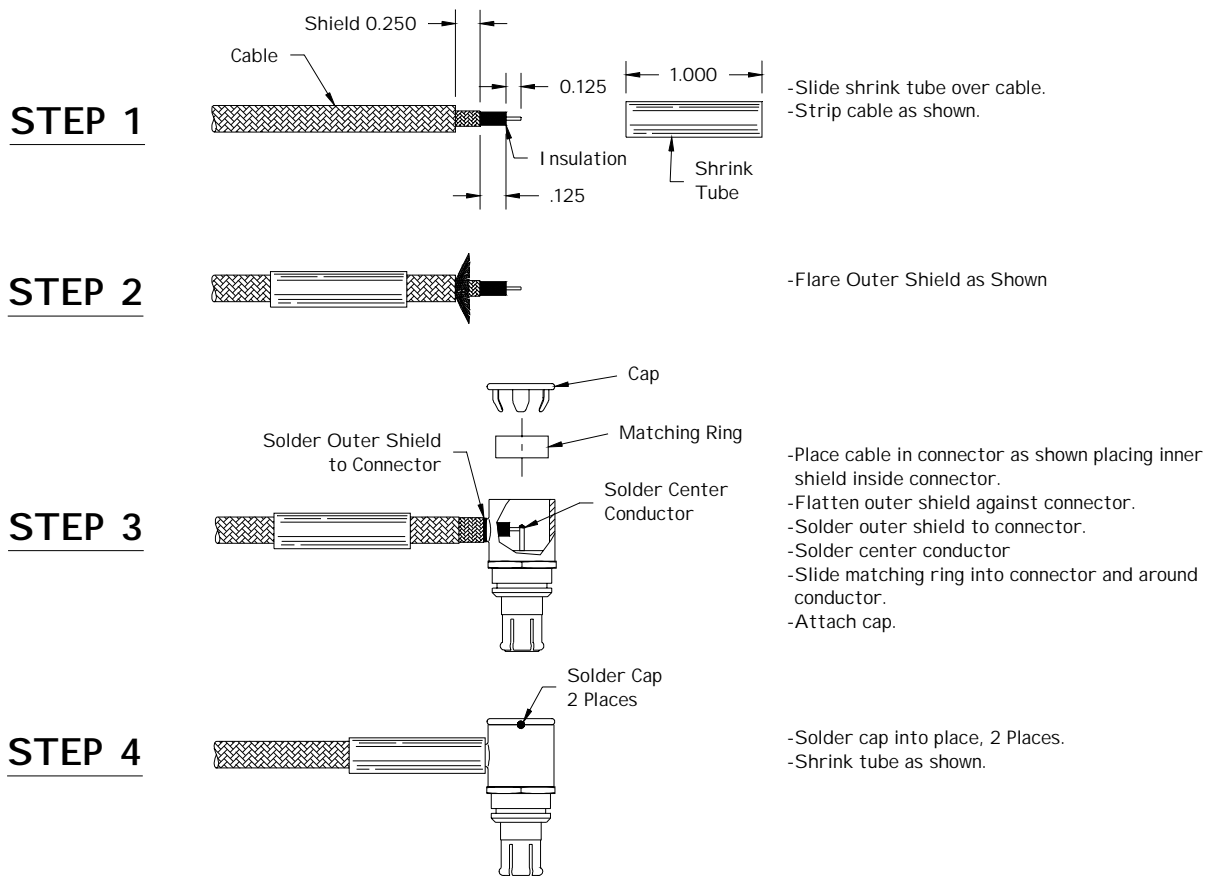
Figure 4 Coax Cable Assembly
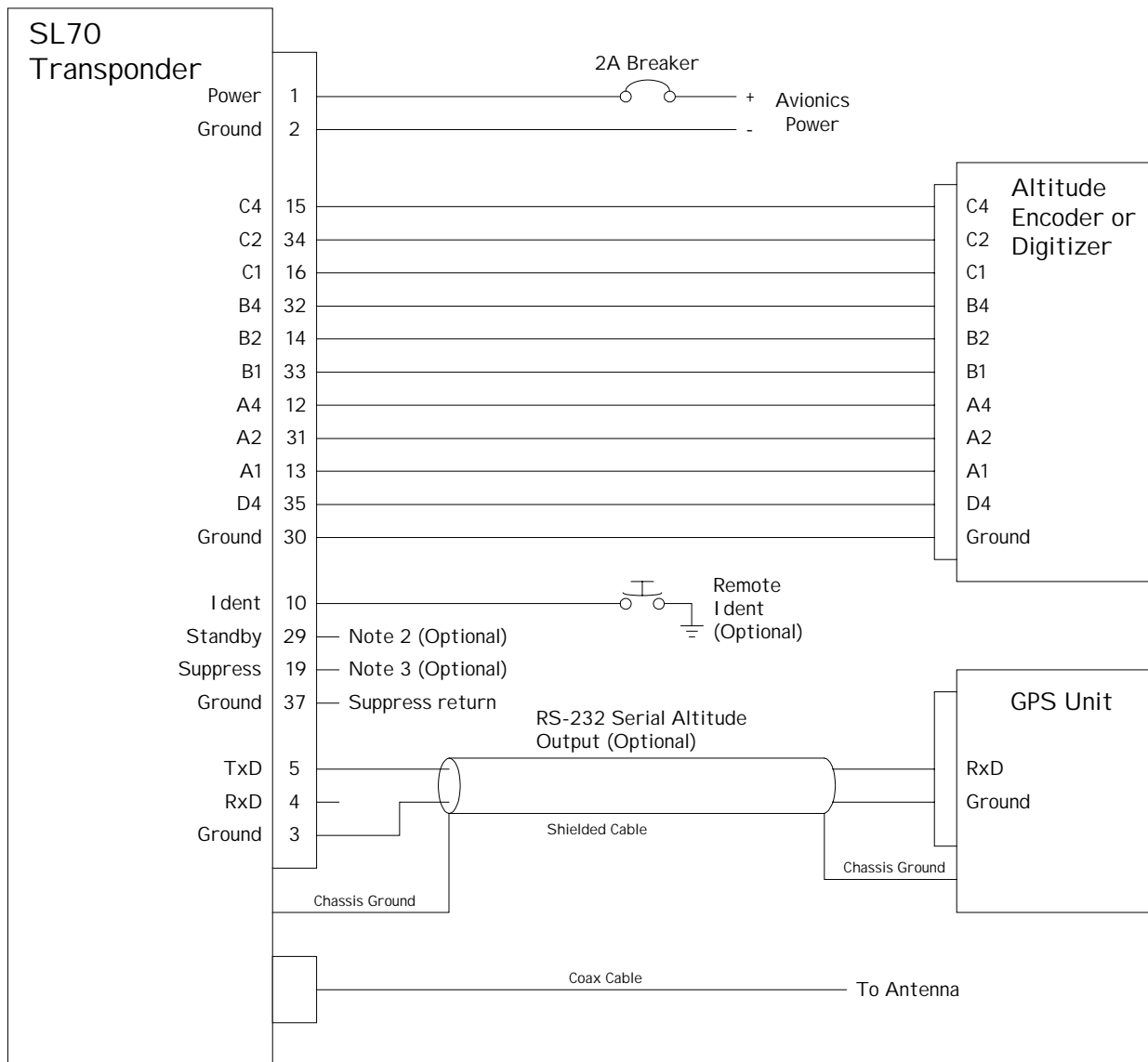
Notes:

    1. Select the gray code input in the setup mode when using the parallel gray code altitude input.

    2. Use standby input to select between two transponders using a selector switch. Unit is in standby when input switched to ground.

    3. Suppression input, typically connected to DME suppression output. Transponder is suppressed when input is high.

Figure 5 Wiring Diagram - Gray Code Altitude Input

SL70 Transponder

Signal	Pin
Power	1
Ground	2
C4	15
C2	34
C1	16
B4	32
B2	14
B1	33
A4	12
A2	31
A1	13
D4	35
Ground	30
Ident	10
Standby	29
Suppress	19
Ground	37
TxD	5
RxD	4
Ground	3

2A Breaker

+ Avionics
- Power

Remote Ident (Optional)

Note 2 (Optional)
Note 3 (Optional)
Suppress return

RS-232 Serial Altitude Input

Shielded Cable

Chassis Ground

Coax Cable — To Antenna

Altitude Encoder or Serializer

TxD
Ground

Chassis Ground
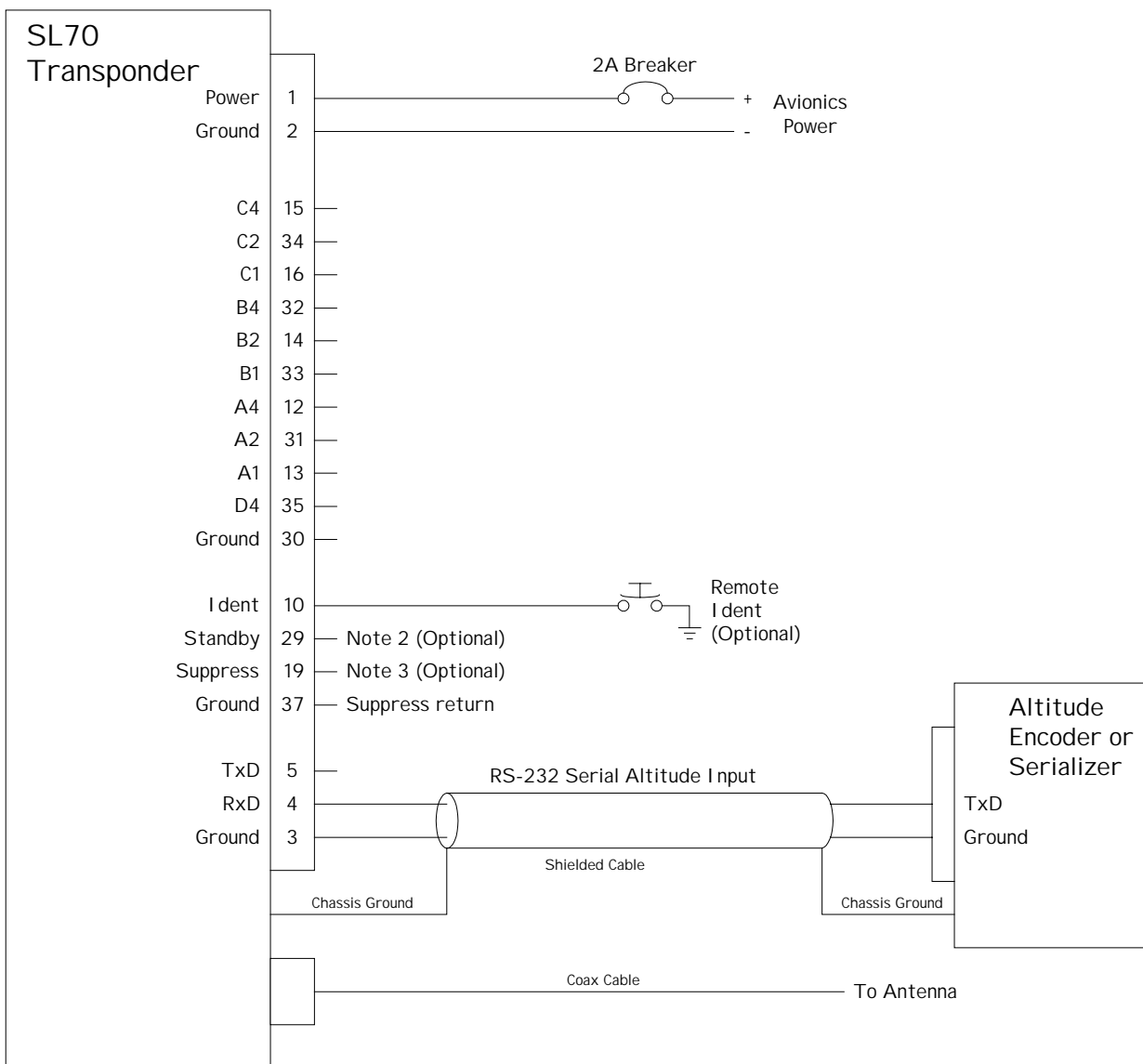
Notes:

1. Select altitude input in the setup mode when using RS-232 serial altitude input.

2. Use standby input to select between two transponders using a selector switch. Unit is in standby when input switched to ground.

3. Suppression input, typically connected to DME suppression output. Transponder is suppressed when input is high.

Figure 6 Wiring Diagram - Serial Altitude Input

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.

The steps that are not applicable to a particular installation may be skipped. A checkout log sheet is included on page 14 to fill out during the checkout procedure. Make a photocopy of the log sheet for ease of use if desired.

Mounting / Wiring Check
Verify that all cables are properly secured and shields are connected to the rear of the mounting frame. Check the movement of the aircraft controls to verify that there is not interference.

TEST MODE CHECKOUT AND SETUP

The SL70 has a built-in setup mode to simplify the checkout. To operate the SL70 in the setup mode, hold down the "IDENT" and "ALT" buttons while switching on the power. To return to normal operation, switch the power off, then back on.

Altitude Input Source Selection
The SL70 altitude input type must be selected. To select the altitude input type:

1. In test mode, rotate the LARGE knob to the "SL70 CONF" (SL70 Configuration) page, then rotate the SMALL knob to the "ASRC" (Altitude source) page.

2. Press IDENT (the altitude type field will start to flash), rotate the SMALL knob to select the altitude type, then press IDENT to save the selection.

The altitude types that can be selected are:

GRAY .... to use the parallel gray code input

SER .... to use the RS-232 serial altitude input

RS-232 Baud Rate Selection
If using the RS-232 serial interface, the baud rate must be selected to match the connected equipment. To select the baud rate:

1. In test mode, rotate the LARGE knob to the "SL70 CONF" (SL70 Configuration) page, then rotate the SMALL knob to the "BAUD" (baud rate) page.

2. Press IDENT (the baud rate field will start to flash), rotate the SMALL knob to select the desired baud rate, then press IDENT to save the selection.

The baud rates available are 1200, 2400, 4800, 9600, and 19200.

VFR Code Selection
The VFR code used by the SL70 when pressing the "VFR" button can be selected as appropriate for the aircraft's operating area. To change the VFR code:

1. In test mode, rotate the LARGE knob to the "SL70 CONF" (SL70 Configuration) page, then rotate the SMALL knob to the "VFR" (VFR code selection) page.

2. Press IDENT (the first VFR code character will start to flash).

3. Rotate the SMALL knob to change the character, rotate the LARGE knob to move the cursor.

4. Press IDENT to save the selection.

OPERATION / PERFORMANCE CHECKOUT

Self Test
The SL70 includes a self test that is executed every time the unit is turned on that checks the receiver and transmitter operation as well as other internal functions.

Verify that the unit does not display a failure indication when turned on.

Altitude Input
Verify that the displayed altitude matches the altimeter pressure altitude (at 29.92).

External Inputs
If the external ident or standby inputs are connected, verify operation by:

a) Verify that the unit goes to standby when the external standby input is pulled low.

b) Verify that the ident LED turns on when the external ident button is pressed (must be in the "ON" or "ALT" modes).

Performance (Ramp) Test
After installation, the transponder should be tested as specified in Appendix F of CFR 14 part 43, to AC 43-6A, and/or other appropriate regulations. The test is typically done as a ramp test using a transponder ramp test set, such as the IFR ATC-600A. The ramp test includes checks as follows.

Reference part 43 Appendix F:

a) reply frequency

b) suppression

c) receiver sensitivity

d) reply RF output power

Reference AC 43-6A:

• altitude reporting

APOLLO SL70 POST-INSTALLATION CHECKOUT LOG	Date: ___/___/___ By: _____

CONFIGURATION INFORMATION:

Apollo SL70 430-6090-____ Mod ___

Serial #_____

TEST MODE CHECKOUT AND SETUP:

Self Test:
 [ ] Pass
 [ ] Fail

Altitude source:	**RS-232 baud rate:** _____
[ ] Gray code (GRAY)	**VFR Code:** _____
[ ] Serial RS-232 (SER)	

OPERATION / PERFORMANCE CHECK:

Altitude data (on display):	**Performance verification:**
[ ] Pass	[ ] Pass

External inputs:
 [ ] Remote ident checked   [ ] N/A
 [ ] External standby   [ ] N/A

COMMENTS:

SECTION 3 - SPECIFICATIONS

This section includes detailed electrical, physical, environmental, and performance specifications for the Apollo SL70.

ELECTRICAL

Input voltage .... 10VDC to 35VDC, reverse polarity protected

Input current.. 500mA typical, 1.4A max at 14VDC
270mA typical, 660mA max at 28VDC

Input power.. 7 watts typical (8 pulse reply, 200 replies / second)
20 watts max (12 pulse reply, 1200 replies / second)
5.8 watts standby

Internal fuse .... 3 amp slow blow (UPS Aviation Technologies #S172-0007-012)

Memory backup .... Internal EEPROM

PHYSICAL

Height .... 1.30 inches (3.30 cm)

Width .... 6.25 inches (15.88 cm)

Depth .... 11.452 inches (29.09cm) behind panel, including mounting frame and connectors

Weight (with mounting frame) .... 2.64 lb. (1.2 kg)

Required clearance.................................... Allow 3 inches behind unit for connector and cable clearance
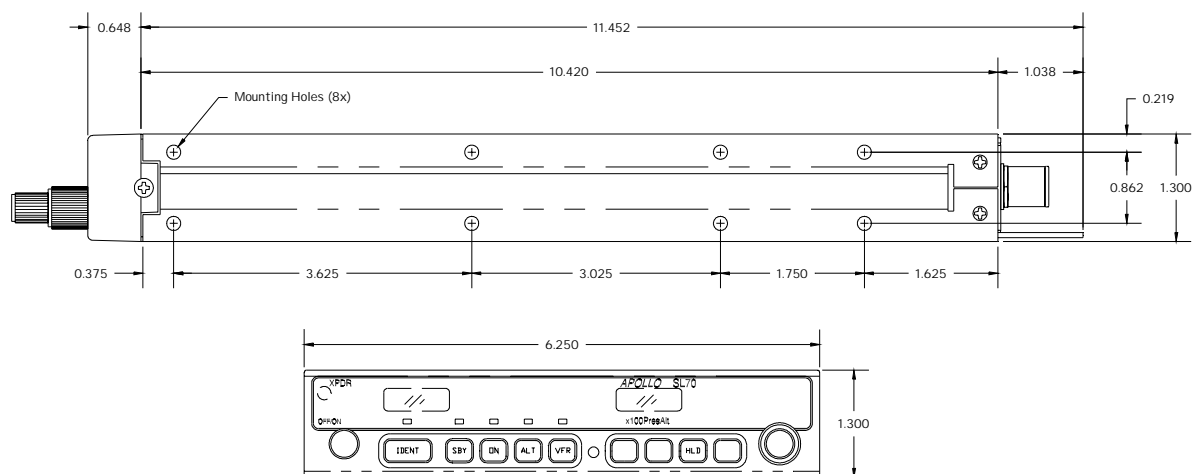
Figure 7 Unit Dimensions

ENVIRONMENTAL

The Apollo SL70 is designed and tested to meet appropriate categories of RTCA/DO-160D. The Environmental Qualification Form is included in Appendix C.

Operating temperature.............................. -20°C to +55°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)

Maximum altitude .... 25,000 feet

Cooling.. Not required

ALTITUDE INPUT

10 bit gray code .... Uses 10 bit gray code altitude data, includes isolation diodes.
Range: -1000feet to 63,000 feet
On: <= 3.5 volts, Off: open

Serial input .... Uses RS-232 serial data input (See Appendix E – Serial Interface Specifications)

Note: The altitude data input type must be selected using the setup function during the post installation checkout.

DISCRETE INPUTS

Remote Ident .... Input pulled low momentarily to initiate ident transmission (same function as front panel button)
On: <= 3.5 volts, Off: open

Standby input... Input pulled low to disable the transponder (will not generate replies)
On: <= 3.5 volts, Off: open

Suppression input .... Input pulled high to initiate suppression – typically connected to DME suppression output
Suppressed: >= 5.0 volts;
Not suppressed: < 2.5 volts (or open)

SERIAL INTERFACE

RS-232.. Defined in Appendix E – Serial Interface Specifications

TRANSPONDER PERFORMANCE

TSO TSO-C74c

TSO Class 2A

Warm-up .... none required

Receiver Frequency .... 1030 MHz

Sensitivity (MTL) .... –72 dBm

Dynamic Range .... > 50 dB

Side Lobe Suppression .... 2 pulse (P1,P2)

Transmitter Frequency .... 1090 MHz +/- 120 kHz

Transmitter Power .... 250 watts minimum, 325 watts typical

Reply rate .... 1200 / second

Mode A Capability .... 4096 codes plus SPI ident pulse

Mode C Capability .... -1000 to 63,000 feet, 100 foot increments, from either gray code or RS-232 serial inputs

ANTENNA REQUIREMENTS

The SL70 requires a standard transponder quarter wave monopole antenna, such as the TED #104-12 or Comant CI-101.

Table 2 Rear Connector Pinout			
Pin #	**I/O**	**Connection**	**Function**
1	I	Power +	main DC power input
2	I	Power ground	main DC power ground
3	O	Serial ground	RS-232 serial ground
4	I	RxD	RS-232 serial data input
5	O	TxD	RS-232 serial data output
6	O	reserved	
7	O	reserved	
8	I	reserved	
9	I	reserved	
10	I	Ident	remote ident input
11	--	NC	no connection
12	I	A4	A4 altitude gray code input
13	I	A1	A1 altitude gray code input
14	I	B2	B2 altitude gray code input
15	I	C4	C4 altitude gray code input
16	I	C1	C1 altitude gray code input
17	--	reserved	
18	--	reserved	
19	I	Suppress	remote suppression input
20	O	NC	no connection
21	I	reserved	
22	O	reserved	
23	--	NC	no connection
24	--	Ground	
25	I	reserved	
26	I	reserved	
27	--	Ground	
28	--	Ground	
29	I	Standby	remote standby input
30	--	Ground	
31	I	A2	A2 altitude gray code input
32	I	B4	B4 altitude gray code input
33	I	B1	B1 altitude gray code input
34	I	C2	C2 altitude gray code input
35	I	D4	D4 altitude gray code input
36	--	reserved	
37	--	Ground	
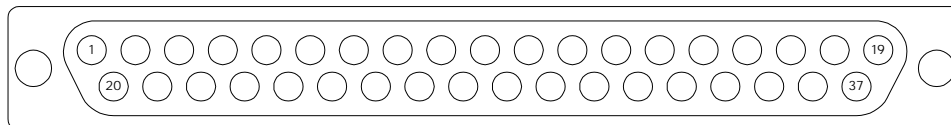
Viewed from rear of unit

SECTION 4 - LIMITATIONS

INSTALLATION

Aircraft installation must be made in accordance with this installation manual and applicable FAA FARs and ACs.

OPERATIONAL

The SL70 must be operated within the limitations as follows, or by other regulatory guidance as appropriate.

1. The altitude should be verified by comparing the pressure altitude display to the aircraft altimeter relative to barometric setting of 29.92.

2. The transponder is to be operated in compliance with CFR 14 section 91.215 for ATC transponder and altitude reporting equipment.

3. The transponder must be tested as specified in CFR 14 section 91.413 within the previous 24 months.

NOTES

APPENDIX A - TROUBLESHOOTING

This appendix provides information to assist troubleshooting if problems occur after completing the installation. Use Table 3 to assist in troubleshooting.

Table 3 Troubleshooting Guide		
Problem	**Cause**	**Solution**
The SL70 does not power on.	The unit is not getting power.	Check power connections, breakers, and main avionics switch.
The altitude is not correct.	The unit is not getting the correct altitude.	If the gray code inputs are used, check all connections from the altitude source and/or verify the altitude source.
		If the serial altitude input is used, check for the correct baud rate and connections to the altitude source.
The altitude display is "---"	The unit is not getting an altitude, or the altitude is invalid.	Check the connections to the altitude source. Check the altitude source to make sure it is operating correctly.
The unit fails the start-up test.	TX fails.	Check antenna connections.
	Other failure.	The unit may need repair.
The unit does not generate replies.	The unit is in standby.	The unit must be in either the "On" or "Alt" modes to generate replies.
	The unit is not receiving interrogation signals.	Check the antenna connections. If the unit does not "Fail" the receive test, then check antenna connections.
	No interrogation signal available.	Need to either use a ramp test set or climb to altitude where ATC radar service is available.

CONTACTING THE FACTORY FOR ASSISTANCE

If the Apollo SL70 unit fails to operate despite troubleshooting efforts, contact the UPS Aviation Technologies factory for assistance.

UPS Aviation Technologies
2345 Turner Rd. S.E.
Salem, Oregon 97302
U.S.A.

Phone (503)581-8101 or 1-800-525-6726

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 (The software versions can be displayed in the setup mode by rotating the LARGE knob to the "SW VER" page, and rotating the SMALL knob to display the microcontroller and FPGA versions.)

- Description of problem

- Efforts made to isolate the problem

APPENDIX B - PERIODIC MAINTENANCE

The Apollo SL70 is designed to not require any regular general maintenance except as included in this section.

BIENNIAL CHECK

The transponder must be tested within the previous 24 months as specified in 91.413 of the FAA regulations.

No other periodic maintenance is required.

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 SL70 has been tested to the following environmental categories per procedures defined in RTCA/DO-160D.

Environmental Qualification Form		

Nomenclature: Apollo SL70
Part No.: 430-6090-xxx
TSO No.: TSO_C74c
	Manufacturer:
	    UPS Aviation Technologies
	    2345 Turner Road S.E.
	    Salem, Oregon 97302	

Conditions	**Section**	**Description of Conducted Tests**

Temperature and Altitude
   In-flight Loss of Cooling
   Altitude
   Decompression
   Overpressure
	4.0
	4.5.4
	4.6.1
	4.6.2
	4.6.3
		Equipment tested to Category B1 with ....
		No cooling required
		Equipment tested to 25,000 feet
		Equipment tested for decompression to 35,000 feet
		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
Operational Shocks and Crash Safety	7	Equipment tested for both operational and crash safety shocks. (Equipment operates normally after both the crash safety shocks.)
Vibration	8.0	Equipment tested without shock mounts to Categories S(M)
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	16.0	Equipment tested to Categories A (28volt systems) & B (14 and 28 volt systems)
Voltage Spike	17.0	Equipment tested to Category A
Audio Frequency Conducted Susceptibility – Power Inputs	18.0	Equipment tested to Categories A & B
Induced Signal Susceptibility	19.0	Equipment tested to Category Z
Radio Frequency Susceptibility (Radiated and Conducted)	20	Equipment tested to Category V
Emission of Radio Frequency Energy	21	Equipment tested to Category M
Lightning Induced Transient Susceptibility	22.0	Equipment tested to A3 and B2
Lightning Direct Effects	23.0	Equipment identified as Category X, no test required
Icing	24.0	Equipment identified as Category X, no test required
Electrostatic Discharge (ESD)	25.0	Equipment tested to Category A
Remarks:		

NOTES

APPENDIX E - SERIAL DATA PROTOCOL

This appendix includes the RS-232 serial port interface specifications.

ALTITUDE INPUT / OUTPUT

The SL70 will output altitude data whenever it is available, either from the gray code or serial input.

The SL70 will accept altitude input data when the serial altitude data source is selected.

The format for the altitude input and output data is as follows.

Baud rate	1200 to 19200
Data bits	8
Stop bits	1
Parity	none
Message length	17 characters
Expected input rate	once per second
Output rate	once per second

Table 4 Altitude Data Format		
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	Altimeter temperature
15-16	dd	Checksum of bytes 1 through 14, computed in hex, output is ASCII format (i.e., "FA" hex)
17	<CR>	ASCII carriage return (0Dh)

The SL70 will interpret several altitude input codes as status or error codes, in the place of the altitude data, as follows.

"-09980"	Encoder heater not ready, expected during encoder warm-up or if there is a loss of signal from the encoder. The SL70 will reply with only framing pulses to mode C interrogations.

"-09981".................................. Possible hardware problem, expected from the encoder indicating a temperature above normal. The SL70 will reply with only framing pulses to mode C interrogations.

"-09982".................................. Altitude out of range, expected from the encoder indicating that the altitude is out of a valid range. The SL70 will reply with only framing pulses to mode C interrogations.

When the gray code input is selected, the SL70 will output the "-09982" error code in place of the altitude data if an undefined altitude input is detected on the gray code input.

NOTES

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