ADS-B FDL-978 Series
and FDL-978 Lite Series
Installation Manual

Part Numbers

P/N 87098-XX-XXXX

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SECTION 1 GENERAL INFORMATION

1.1 Introduction

This document contains installation data, specifications, and instructions for operating the FreeFlight Systems (FFS) Universal Access Transceiver (UAT) Automatic Dependent Surveillance – Broadcast (ADS-B) FDL-978 Series and FDL-978 Lite Series. This manual contains information about the following:

- FDL-978 Series
  - FDL-978-XVR Transceivers
  - FDL-978-RX Receivers
- FDL-978 Lite Series
  - FDL-978-XVRL Transceiver
  - FDL-978-TXL Transmitter

The FDL-978-XVR and FDL-978-XVRL with identical information will be referred to as the “FDL-978-XVR(L)” from this point forward, unless otherwise specified.

The FDL-978 Series and FDL-978 Lite Series are UAT equipment class A1H/A1S 978 Megahertz (MHz) equipment that meet the requirements of TSO-C154c, TSO-C157a, and TSO-C195a. When equipped with the internal class Beta 1 Global Positioning System (GPS), the systems also meet the requirements of TSO-C145c.

Sections 1 through 11 contain information and installation details for the FDL-978 Series with general references to information and installation details that are common with the FDL-978 Lite Series. Specific information and installation details for the FDL-978 Lite Series is contained in Section 12. The FDL-978 Lite Series Section 12 contains the appropriate references to Section 1 through 11 information and installation details that are common with the FDL-978 Series. Therefore for FDL-978 Series installation start with Section 1 and for FDL-978 Lite Series installation start with Section 12.

1.2 Acronyms and Abbreviations

All acronyms and abbreviations used within this manual are defined upon initial use and followed by their shortened version in parentheses as used in the remainder of the manual. Items used within document numbers or quoted material are not included.

Item	Definition
ADF	Automatic Direction Finder
ADS	altitude/air data sensor
ADS-B	Automatic Dependent Surveillance-Broadcast
ARINC	Aeronautical Radio Incorporated
AS	Associated

Item	Definition
ATC	Air Traffic Control
AWG	American Wire Gauge
bps	bits per second
C	Celsius
CSA	Conflict Situation Awareness
COMM	Communications Receiver
dB	decibel
dBm	decibel-milliwatts
DC	Direct Current
DME	Distance Measuring Equipment
ETSO	European Technical Standard Order
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FFS	FreeFlight Systems
FMS	Flight Management System
ft	feet
g	grams
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IP	Internet Protocol
hg	hectogram
HIL	Horizontal Integrity Limit
hPa	hectopascal
in	inch(es)
lb	pound(s)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MHz	megahertz
M	meter
mm	millimeter
MPI	Maintenance Port Interface

Item	Definition
NACv	Navigational Accuracy Category for velocity
P/N	Part Number
PBIT	Periodic Built-In Test
PC	Personal Computer
PED	Personal Electronic Device
PM	Personality Module
POST	power-on self-test
PPS	pulse-per-second
PRAIM	Predictive RAIM
RAIM	Receiver Autonomous Integrity Monitoring
Rx	Receive
SBAS	Satellite Based Augmentation System
SSI	signal strength indication
STC	Supplemental Type Certificate
TC	Type Certificate
TCAS	Traffic Collision Avoidance System
TIS	Traffic Information Service
TNC	Threaded Neill–Concelman
TSO	Technical Standard Orders
Tx	Transmit
UAT	Universal Access Transceiver
USB	Universal Serial Bus
UHF	Ultra High Frequency
V	volts
VDC	volts direct current
VFR	Visual Flight Rules
VIL	Vertical Integrity Limit
VSWR	Voltage-Standing Wave Ratio
W	watts
WAAS	Wide Area Augmentation System

1.3 Alert Symbol Usage

The following Warning, Caution, and Note symbols are used throughout this manual and their hierarchy is structured as shown below. When an item applies to an entire section it will be identified at the beginning of the applicable section. Otherwise, it will immediately precede the information for which it applies.

Warnings are identified when failure to properly following the instructions provided may cause serious injury to personnel or damage to equipment if not followed.

Cautions are identified when failure to properly following the instructions provided may cause serious damage to equipment if not followed.

Notes are identified to provide additional information or explanation to the user.

1.4 General System Description

Information about the FDL-978.

The FDL-978-XVR(L) (*ADS-B In & Out)* transmits and receives position, velocity, and other flight information to and from other aircraft and ground station equipment via a UAT data link. The FDL-978-RX (*ADS-B In only*) receives position, velocity, and other flight information from other aircraft and ground station equipment via a UAT data link. The FDL-978-TXL (*ADS-B Out only)* transmits position, velocity, and other flight information to other aircraft and ground station equipment via a UAT data link. The FDL-978 Series and FDL-978 Lite Series satisfy the Technical Standard Order (TSO) requirements referenced in Section 1.1 and the associated MOPS for UAT ADS-B class A1H/A1S/B1S equipment.

The FDL-978-XVR Transceivers provide both UAT transmit (*ADS-B Out*) and UAT receive (*ADS-B In*) capability. The transceiver part numbers covered by this installation manual are:

The -FX models include RS-232 (Port 5) on DB-44 connector.

- **87098-00** FDL-978-XVR Transceiver with GPS
- **87098-10** FDL-978-XVR Transceiver without GPS
- **87098-00-FX00** FDL-978-XVR Transceiver with GPS
- **87098-10-FX10** FDL-978-XVR Transceiver without GPS

The FDL-978-RX Receivers provide UAT receive (*ADS-B In*) capability *only* and are intended for use with external ADS-B Out transmitters, including Mode-S Transponders with built-in *ADS-B Out*. The receiver part numbers covered by this installation manual are:

Receiver models include RS-232 Port 5 on DB-44.

- **87098-00-FR00** FDL-978-RX Receiver with GPS
- **87098-10-FR10** FDL-978-RX Receiver without GPS

GPS data, pressure altitude data, Traffic Collision Avoidance System (TCAS), and pilot control inputs are received by the FDL-978 Series through configurable RS-232/422 serial, ARINC 429, and/or discrete interfaces. ADS-B and TCAS Traffic, FIS-B (NEXRAD, METARs, NOTAMs, SIGMETs, etc.) information, system health/status, etc. are output on multiple configured serial links and/or discrete signals to be connected to pilot displays.

The FDL-978-XVR and transponder must receive altitude data obtained from the same pressure altitude sensor.

Installations where the transponder and/or display cannot provide the required control and status, the TC978 Controller (FDL-978-XVR optional) can be used to control the UAT transmitter and display status. The TC978 Controller also contains a TSO-C88b/ETSO-C88a certified pressure altitude encoder and RS-232 serial output to share altitude sensor data with a transponder. The TC978 Controller also displays the pressure altitude received directly by the FDL-978-XVR and outputs the altitude on its RS-232 serial output.

The systems can also be installed with a single bottom UAT antenna in installations where the Federal Aviation Administration (FAA) does not require antenna diversity.

The installation drawing shown in Figure 1 identifies a TC978 Controller, FDL-978-XVR Transceiver, two UAT antennas, FWF-125 Wi-Fi Transceiver, MPI Module, connected to an Android tablet ADS-B Maintenance Port Interface (MPI) app, and a GPS antenna. Additionally, connections are shown to an external altitude sensor (shared with the transponder), the transponder suppression bus, and an air/ground detection switch. The GPS data can optionally be provided by an existing aircraft GPS source if it meets the interface requirements of the FDL-978-XVR (FFS Navigation Interface Protocol (RS-232 or RS-422) such as the FFS 1201, Garmin series 400/500 with GPS ADS-B Plus interface, or ARINC 743B compatible GPS (e.g. 1203/1203C) through an ARINC 429 bus.

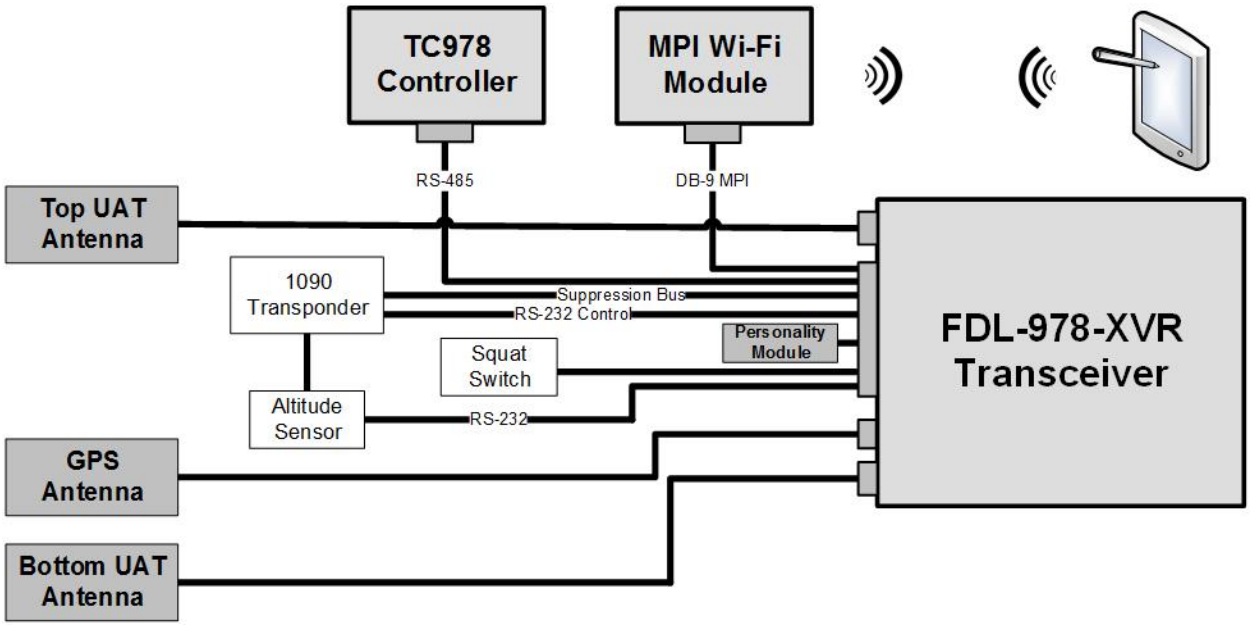


Figure 1. FDL-978-XVR Wi-Fi MPI Block Diagram (Typical)

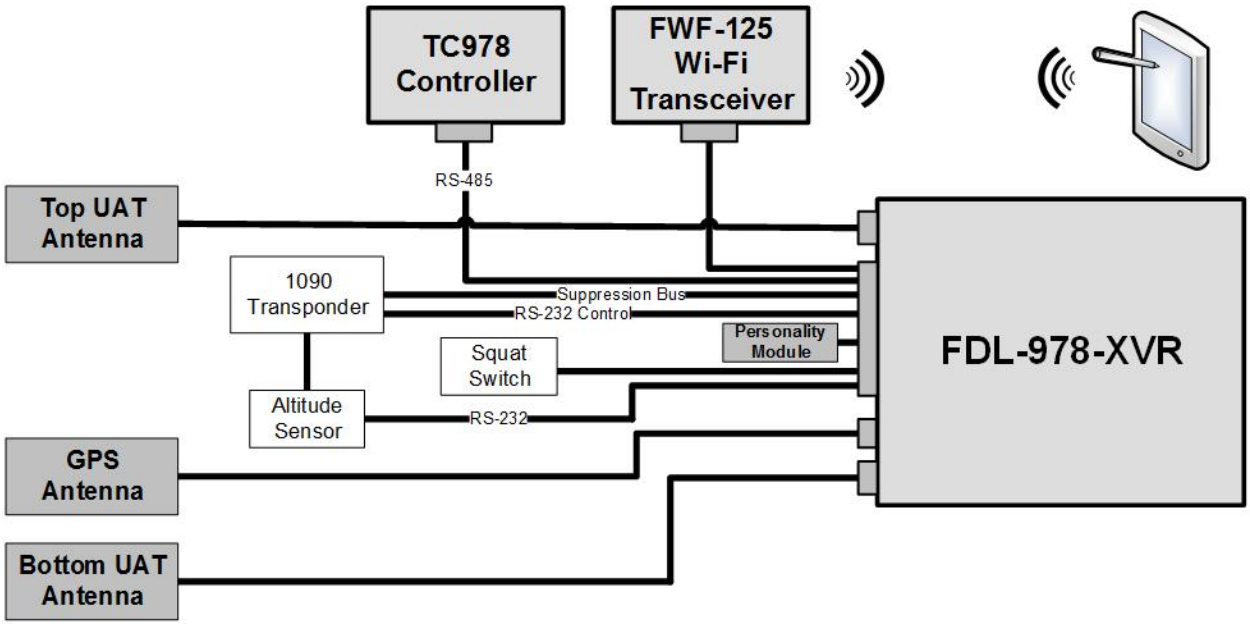


Figure 2. FDL-978-XVR Wi-Fi Transceiver Block Diagram (Typical)

The FDL-978-RX must receive pressure altitude data; however, it does not have to be from the same pressure altitude sensor to the transponder.

The installation drawing shown in Figure 3 identifies the main difference between the FDL-978-XVR and FDL-978-RX installations. The receiver installation does not require any connections to a transponder or transponder transmit control. GPS data and pressure altitude sensor data are required for receivers as well as transceivers.

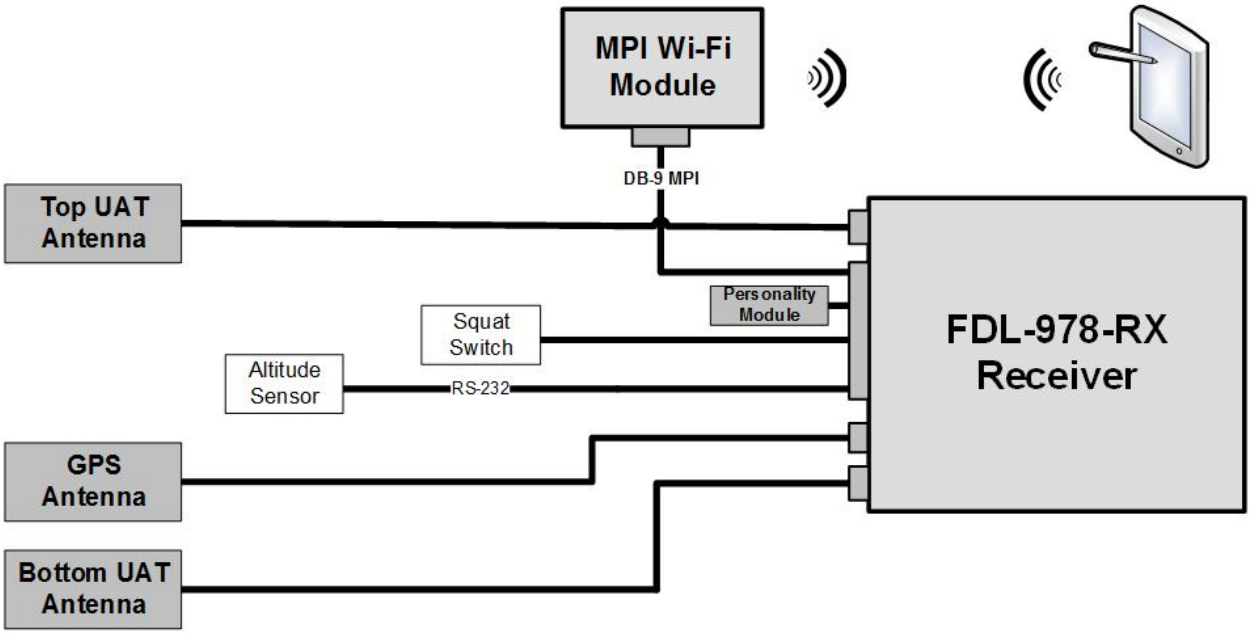


Figure 3. FDL-978-RX Block Diagram (Typical)

Figure 4. FDL-978 Series

The main components of the FDL-978 Series are the FFS ADS-B Receiver and Transceiver Systems. They have identical connectors, pin-outs, size, and mounting requirements. These models have a DB-44 female connector, a Universal Serial Bus (USB) micro-AB maintenance connector, one Threaded Neill–Concelman (TNC) GPS antenna connector (87098-00-XXXX only), and two TNC UAT antenna connectors.

These units also include four status Light Emitting Diodes (LED), configurable serial interfaces (controller input, GPS input/output, Altitude/Air Data input, TCAS input, multiple display outputs, and Maintenance Port Interface), Discrete input/output, and a Personality Module interface.

Satellite Based Augmentation System (SBAS) is referred to as Wide Area Augmentation System (WAAS) in the U.S. and throughout this manual. All internal GPS/WAAS sensors in the FDL-978 and FDL-978 Lite Series are compatible with other SBAS's (for example, EGNOS, MSAS, etc.).

The following is a short summary of the transceiver and receiver features:

Optional Internal GPS

Models with the optional internal GPS/WAAS sensor have a single antenna input with an additional TNC connector. The internal GPS models (P/N 87098-00, 87098-00-FX00, and 87098-00-FR00) provide a TSO-C145c Class Beta 1 certified GPS/WAAS data output on serial port 1. FFS/Chelton navigation protocol is output on RS-232 serial output port 1 allowing it to interface with other external equipment. ARINC 743B GPS output labels can also be configured for output on ARINC output port 1. In addition, the internal GPS models (P/N 87098-00, 87098-00-FX00, 87098-00-FR00) can be configured to output GTX Remote (GPS) protocol data to interface with the GTX 330ES on the output serial port (typically port 2)

External GPS Input

The FDL-978 Series can connect to any FFS navigation protocol compliant GPS (e.g. FFS 1201) or Garmin series 400(W)/500(W) with GPS ADS-B Plus interface through an RS-232 serial port or an ARINC 743B compatible GPS (e.g. 1203/1203C) through an ARINC 429 bus.

Status LEDs

Four status LEDs (ST – UAT Status, GPS – GPS Status, TX – UAT Transmit, and RX – UAT Receive) indicate the operational status during installation.

TC978 Controller Interface

A TC978 Controller interface provides low voltage power, system on/off discrete control, and a communication interface on Serial Port 3. The system can also be configured using the TC978. When a TC978 is not installed, Serial Port 3 (RS-232) can be used as a display port and/or a maintenance port.

Configurable Serial Interfaces

Five RS-232 serial ports, one RS-422 port (that can be configured as an additional RS-232 port), two ARINC-429 input ports, and one ARINC-429 output port can be installation configured to interface to transponder controllers, GPS input/output, Altitude/Air Data input, TCAS Input, multiple Display outputs, and Maintenance Personal Computer (PC)/tablet.

Discrete Inputs/Outputs

Three discrete inputs (Air/Ground Switch, Traffic Test, and Anonymous Mode) and two discrete outputs (Transmit Suppression and UAT Status) provide control and status feedback.

UAT Antennas

There are two (top and bottom) UAT antenna connectors. The units can be configured to use the top, bottom, or both (diversity) antennas.

Personality Module Interface

A personality module installed in the aircraft connector allows configuration settings to automatically be retrieved and set when a transceiver or receiver unit is removed and replaced in the aircraft.

1.4.1 TC978 Controller

Figure 5. TC978 Controller

The TC978 Controller provides operational functionality, status display, and limited serial port setup for the FDL-978 Lite Series. It is optional for the FDL-978-XVR control and status interface.

The controller has a DB-9 connector for electrical interface and a static pressure port. The controller contains a Liquid Crystal Display (LCD) with controls, built-in Altitude Encoder, low voltage input power provided by the applicable FDL-978 equipment, FDL-978 Lite Series and FDL-978-XVR serial interface, remote on/off power control, and serial altitude output.

The following is a short summary of the TC978 Controller features:

Display and Controls

The TC978 has an LCD status display, IDT (identify) button, VFR (Visual Flight Rules) button, FN (function) button, ENT (enter) button, Mode Selection knob, and CODE knob.

Altitude Encoder

The TC978 has a built-in altitude encoder to measure pressure altitude.

Input Power

The TC978 receives low-voltage power from the FDL-978-TXL and FDL-978-XVR(L).

Serial Interface

An RS-485 serial data link is used to connect the TC978 to the FDL-978-TXL and FDL-978-XVR(L).

Remote On/Off

System on/off power is controlled with the Mode Selection knob.

Altitude Output

Pressure altitude data is output on an RS-232 serial port.

The TC978 is not required if the FDL-978-XVR is connected to a transmit controller (transponder) and/or display that can provide, as a minimum:

- Mode A code entry and display
- IDENT control and display
- ADS-B transmit and ADS-B position failure status
- If connected, the TC978 will not accept control inputs and will mirror the transponder or primary controller. If communication with the primary controller is lost for 60 seconds, then the TC978 will assume the role of the controller and allow control inputs (squawk, IDENT). If the TC978 is used in this manner, it is strongly recommended to set the squawk code first on the transponder.

1.4.2 UAT Antenna Requirements

The FDL-978 Series and FDL-978 Lite Series require a TSO-C66, C74, C112, or C154 Ultra High Frequency (UHF) antenna(s). Ensure that the antenna has 50Ω impedance with a Voltage Standing Wave Ratio (VSWR) < 1.7:1 at 978 MHz. The Comant CI-101 and RA Miller AV-22 ball antennas and the Comant CI-105 blade antenna meet these requirements. In Class A1H ADS-B equipment (TSO-C154c) installations, antenna diversity (meaning a top and bottom antenna) is required. In Class A1S (single antenna) installations only one antenna (bottom) is used. For airworthiness approval of ADS-B out systems (AC 20-165A) single bottom mounted antenna (TSO-C154c Class A1S) installations are allowed.

1.4.3 GPS Antenna Requirements

The FDL-978 Series (with internal GPS) and FDL-978 Lite Series require a TSO-C144 (DO-228) antenna. A TSO-C190 (DO-301) compliant GPS antenna may be used for the FDL-978 or FDL-978 Lite Series. Installation of a TSO-C190 antenna is only recommended for anticipated future upgrades to TSO-C145c Class Beta 2, 3, or 4 navigation sensors and avoids the need for a GPS antenna change at that time.

The performance of the internal GPS is affected by the gain, noise figure, impedance, and frequency selectivity characteristics of the antenna. They should be used only with the recommended antenna and cable (See Section 1.7.1). Use of other antennas or cables may not meet all the performance characteristics required by TSO-C145c.

1.5 Technical Characteristics

U.S. standard units of measure are the primary means of identifying dimensions, weights, etc. The equivalent metric values may also be shown in brackets (e.g. 1.9 in [48 mm]).

1.5.1 FDL-978 Series

Transceiver (P/N 87098-00, 87098-10, 87098-00-FX00, and 87098-10-FX10) and Receiver (P/N 87098-00-FR00 and 87098-10-FR10) Characteristics

Specification	Characteristics
ENVIRONMENTAL COMPLIANCE	See Section 5.1
TSO COMPLIANCE	C154c (A1H/A1S) C157a (Class 1) Incomplete System C195a (Class C1) C145c (Beta 1) – Internal GPS models only (PNs 87098-00, 87098-00-FX00, 87098-00-FR00)
FCC IDENTIFICATION	T7YFDL978XXXX
SOFTWARE	RTCA/DO-178B Level C
HARDWARE	RTCA/DO-254 Level C
PHYSICAL DIMENSIONS	
Height	1.7 in [43.18 mm]
Width	5.0 in [127 mm]
Depth	5.5 in [139.7 mm]
WEIGHT	0.86 lb [364 g]/0.98 lb [454 g] with internal GPS
OPERATING TEMPERATURE	-40°F to +158°F [-40°C to +70°C]
STORAGE TEMPERATURE	-67°F to +185°F [-55°C to +85°C]
ALTITUDE	50,000 feet
POWER REQUIREMENTS	10 – 40 Volts DC, Typical 0.22 A (0.34 A with GPS) @ 28 VDC, Peak 0.72 A (0.84 A with GPS) @ 28 VDC
TRANSCEIVER FREQUENCY	978 MHz
TRANSMITTER POWER	40 Watts max at antenna after 2dB connector/cable loses
RECEIVER SENSITIVITY	-99 dBm

Avionics Interface		
Type	**I/O**	**Description**
Controller	Input/ Output	7 VDC power output, remote on/off discrete input, RS-485 serial interface to the TC978
GPS Input	Input	Serial (RS-232, RS-422, or RS-485) or ARINC 429 (ARINC 743B) and PPS (RS-422)
ADS/Altitude Input	Input	Serial (RS-232, RS-422, or RS-485) or ARINC 429
Display Output	Output	Serial (RS-232, RS-422, or RS-485) or ARINC 429
Discrete Inputs	Input	3 (Air/Ground, Traffic Test, and Anonymous Mode)
Discrete Outputs	Output	2 (Transmit Suppression and UAT Status)
GPS Output	Output	Serial RS-232 or ARINC 429 – Internal GPS models only (P/N 87098-00, 87098-00-FX00, and 87098-00-FR00)

1.5.2 TC978 Controller

Specification	Characteristics
ENVIRONMENTAL COMPLIANCE	See Section 5.2
TSO COMPLIANCE	C154c (Incomplete System) C88b
ETSO COMPLIANCE	C88a
SOFTWARE	RTCA/DO-178B Level B
PHYSICAL DIMENSIONS	
Height	1.8 in [45.3 mm]
Width	2.5 in [61.0 mm]
Depth	2.8 in [71.1 mm]
WEIGHT	0.11 lbs [49.9 g]
OPERATING TEMPERATURE	-4°F to +131°F [-20°C to +55°C]
ALTITUDE	35,000 feet
POWER REQUIREMENTS	5.5 – 10 Volts DC, 0.3A max @ 6.5VDC, powered by FDL-978 Lite Series and FDL-978-XVR
Interfaces:	
Type	**I/O**
Controller	RS-485 Input/ Output
Altitude Output	RS-232 Output

1.6 Parts and Equipment

1.6.1 FDL-978 Series Items

*Models 87098-00 and 87098-10 are not recommended for new installations.

The FDL-978 Series and optional installation kit part numbers are listed below:

Part Number	Qty	Description
87098-00*	1	FDL-978-XVR Transceiver with GPS
87098-10*	1	FDL-978-XVR Transceiver without GPS
87098-00-FX00	1	FDL-978-XVR Transceiver with GPS
87098-10-FX10	1	FDL-978-XVR Transceiver without GPS
87098-00-FR00	1	FDL-978-RX Receiver with GPS
87098-10-FR10	1	FDL-978-RX Receiver without GPS
85935-00	1	FDL-978-XVR Installation Kit (optional)
87349	1	TC978 Controller (optional)
86964	1	TC978 Installation Kit (optional)
87002-00	1	Personality Module Installation Kit (optional)
87002-10	1	(Female) Personality Module Installation Kit (optional)
87003-00	1	Blade Type Antenna Installation Kit (optional)
87004-00	1	Ball and Stick Type Antenna Installation Kit (optional)
87360-10	1	TSO C-144 GPS Type Antenna Installation Kit (optional)
87360-00	1	TSO C-190 GPS Type Antenna Installation Kit (optional)

1.6.2 FDL-978 Series Installation Kits

The items included in the FDL-978-XVR Installation Kit **(P/N 85935-00)** are listed below:

Part Number	Qty	Description
86945	1	DB-44 Male Crimp Connector
85942	1	DB-44 Backshell
86967	50	Crimp Pin 24-28 AWG
83145	50	Crimp Pin 24-28 AWG

The items included in the TC978 Installation Kit **(P/N 86964)** are listed below:

Item	Qty	Description
1	1	TC978 Mounting Adapter Bracket (circular hole adapter)
2	1	Hose EPDM Rubber 5 mm ID – 8 mm OD
3	1	Hose Connector 3/16 in Nylon Tee
4	2	Hose Adapter Straight Nylon 3/16 – 1/4 in
5	6	Constant Tension Clamp Application Dia 8.5 – 9 mm
6	2	Constant Tension Clamp Application Dia 9.5 – 10.3 mm
7	4	Screw, Brass Cross recessed Csk Head Black 4-40 UNC x 1.5 in Lg
8	4	Screw, Brass Cross recessed Csk Head Black 4-40 UNC x 0.625 in Lg
9	1	Connector Accessory Backshell, 9 Way D-Sub, 3 Way Entry, 4-40UN Jackscrew
10	1	Connector Standard Mount 9 Way D receptacle to M24308
11	9	Crimp Socket Contact, Wire Size 20-24 AWG

The items included in the Personality Module Installation Kit (Male) **(P/N 87002-00)** are listed below:

Part Number	Qty	Description
85945-00-A	1	Personality Module
86967	6	Male Crimp Pin 24-28 AWG
83145	6	Male Crimp Pin 24-28 AWG
87006	1	Adhesive Double Sided Tape (0.5 in x 0.5 in)

The items included in the Personality Module Installation Kit (Female) **(P/N 87002-10)** are listed below:

Part Number	Qty	Description
85945-00-A	1	Personality Module
84141	6	Female Crimp Pin 24-28 AWG
87006	1	Adhesive Double Sided Tape (0.5 in x 0.5 in)

The items included in the Blade Type Antenna Installation Kit **(P/N 87003-00)** are listed below:

Part Number	Qty	Description
87005	1	Blade Type UAT Antenna
86966	1	BNC RG142 Male Crimp Connector
0129-0017-00	1	TNC Connector
0123-0012-00	25 ft	RG-142 Coax Cable

The items included in the Ball and Stick Type Antenna Installation Kit **(P/N 87004-00)** are listed below:

Part Number	Qty	Description
85937	1	Ball and Stick Type UAT Antenna
86966	1	BNC RG142 Male Crimp Connector
0129-0017-00	1	TNC Connector

The items for the FDL-978 Series included in the TSO-C190 GPS Antenna Installation Kit **(P/N 87360-00)** are listed below. The TSO-C190 antenna is only recommended to accommodate future upgrades with TSO-C145c Class 2, 3, and 4 navigation sensors in the transceiver system.

Part Number	Qty	Description
86735	1	Antenna GPS SBAS (WAAS) DO-301 TSO-C190 and TSO-C144
0129-0017-00	2	TNC Connector Male RG-142 Crimp
0123-0012-00	25 ft	RG-142 Coax Cable

The items for the FDL-978 Series included in the TSO-C144 GPS Antenna Installation Kit **(P/N 87360-10)** are listed below.

Part Number	Qty	Description
81194	1	Antenna GPS SBAS (WAAS) DO-228 TSO-C144
0129-0017-00	2	TNC Connector Male RG-142 Crimp
0123-0012-00	25 ft	RG-142 Coax Cable

1.7 Materials Required But Not Supplied

The following items are required for proper installation but not supplied:

- Wire and shielded wire
- Circuit breaker
- Ground terminals

For the FDL-978-XVR, a valid GPS receiver with appropriate serial or ARINC 743 interface is required for the ADS-B Transceivers (87098-10, 87098-10-FX10) and Receivers (87098-10-FR10) without a GPS. The following GPS receivers have been verified to provide position, velocity, position accuracy, position integrity and velocity accuracy information properly interpreted by the FDL-978-XVR:

1. FFS 1201 (P/N 84100-XX-XXXX)
2. FFS 1203/C (P/N 84327-XX-XXXX)
3. Garmin Series 400/500 GPS with ADS-B Plus Interface

1.7.1 List of Other Approved GPS Antennas

The FDL-978 Lite Series and FDL-978-XVRL with GPS may be installed with the following GPS antennas (not supplied by FFS) summarized below:

Model/Description	Mount Style	Manufacturer	Part Number
A-33, GPS WAAS Antenna	Screw Mount	Aero Antenna	575-9
		Garmin AT	590-1104
A-34, GPS WAAS Antenna	Screw Mount Teardrop Footprint	Aero Antenna	575-93
		Garmin AT	590-1112

To use the above antennas they must be connected with a cable having a maximum of 5dB loss and 1-Ohm DC resistance.

1.7.2 FT-9000 RAMP Tester

For FDL-978 Series and FDL-978 Lite Series installation checkout, troubleshooting, and system operation verification as necessary it is recommended to use the FFS FT-9000 Ramp Tester.

The FT-9000 ramp tester kit part number can be ordered as an optional item using the part number specified in the table below:

Part Number	Qty	Description
87579-00	1	FT-9000 ADS-B RAMP Tester Kit

SECTION 2 FDL-978 SERIES INSTALLATION

This section provides general information for installing the FDL-978 Series and TC978 Controller into an aircraft. This section contains mounting dimensions, pin outs, and interface details pertaining to installation. Adherence to these installation procedures and information will assure satisfactory system performance.

FAA AC 20-165A requires certified installations with ADS-B Out Transmitters (FDL-978-XVR) and any transponder on the aircraft to transmit pressure altitude data obtained from the same altitude sensor source. Installations must therefore ensure that the transponder and FDL-978-XVR receive altitude data from the same altitude sensor.

FAA AC 20-165A HIGHLY recommends that the ADS-B transmitter and transponder share a single point of entry for Mode A (Squawk Code) and IDENT. Dual entry installations are allowed but discouraged and must ensure that the transponder and UAT transmit the same Mode A and IDENT without increased pilot workload. Transponders with serial control data out capability (like the GTX-330/327/32/33 and SL-70/R) should be connected via an FDL-978-XVR serial port to control Mode A code and IDENT. Mode A/C transponders without serial control out can use the FDL-978-XVR internal Mode A receiver (configuration setting) which receives on-board Mode A/C transponder transmissions to automatically set Mode A code and IDENT control data transmit. Mode A receive is *not* compatible with Mode S transponders.

FDL-978-RX Receivers don't require transponder control data. Receivers require pressure altitude input, but aren't required to obtain the pressure altitude from the same altitude sensor as the transponder.

2.1 Unpacking and Inspecting Equipment

Exercise care when unpacking each item. Visually inspect each item for evidence of damage incurred during shipment. If a damage claim must be filed, save the shipping container to substantiate the claim. When all equipment and the installation kit have been inspected, save the packing material and container in case the unit is to be stored or reshipped. See paragraph 1.4 for parts and equipment.

2.2 Equipment Mounting

Installation procedures should be followed closely allowing adequate space for installation of cables and connectors.

U.S. standard units of measure are the primary means of identifying dimensions, weights, etc. The equivalent metric values may also be shown in brackets (e.g. 1.9 in [48 mm]).

2.2.1 FDL-978 Series

The FDL-978 equipment is designed to be mounted in any convenient location in the cockpit, the cabin, or an avionics bay.

Select a position in the aircraft that is not too close to any high external heat source. (The FDL-978 Series and FDL-978 Lite Series are not a significant heat source itself).

Avoid sharp bends and placing the cables too near to the aircraft control cables.

Secure the FDL-978 Series and FDL-978 Lite Series on a flat surface according to the mounting requirements illustrated below in Figure 5 and in the installation drawing in SECTION 8.

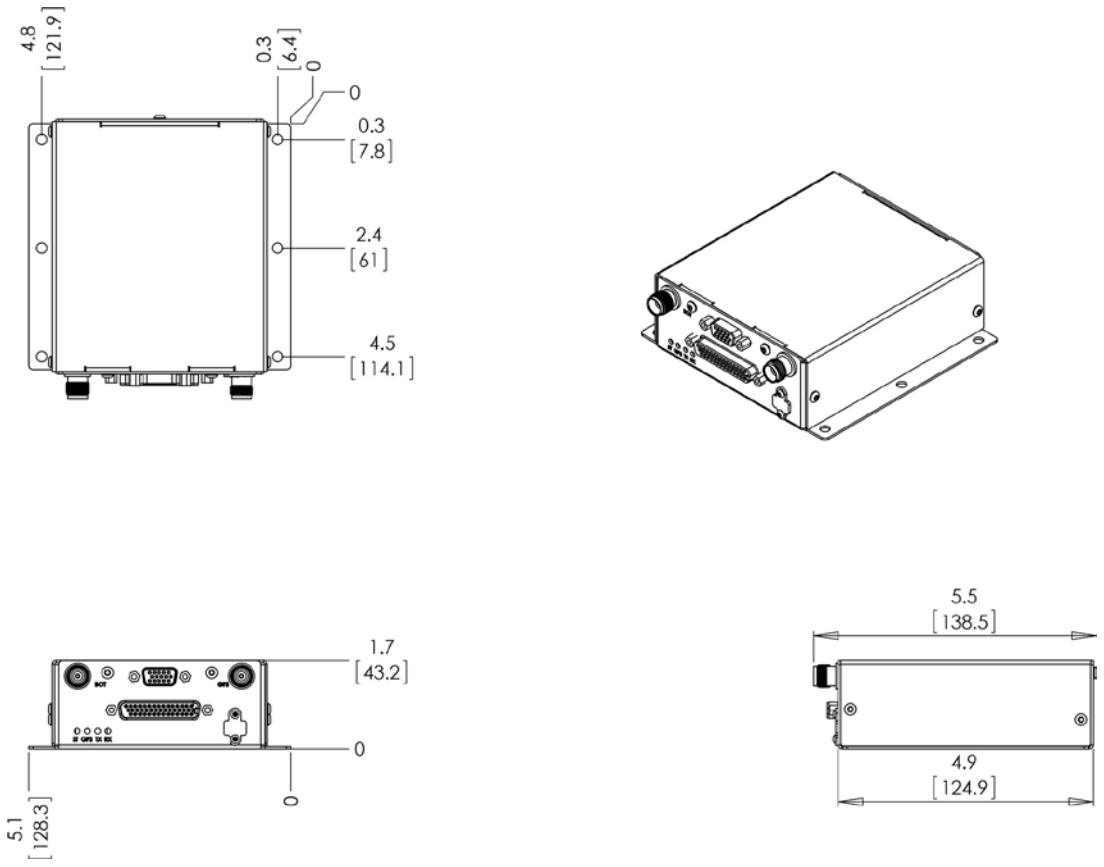


Figure 6. FDL-978 Series Mounting Dimensions

2.2.2 TC978 Controller

The TC978 Controller must be mounted rigidly in the aircraft panel. The Controller can be mounted in the ultra-compact mounting or conventional 2.25 in [57mm] instrument cut-out.

Select a position in the panel that is not too close to any high external heat source. (The TC978 is not a significant heat source itself).

Avoid sharp bends and placing the cables too near to the aircraft control cables.

If using a 2.25 in instrument cut-out, first clip the two mounting adapters to the Controller. The Controller should then be mounted using the four LONG screws provided. If using the FFS compact cutout, you do not need the mounting adapters. The Controller should be mounted using the four SHORT screws provided. If alternate screws are required, please note that the mounting thread in each case is 4-40.

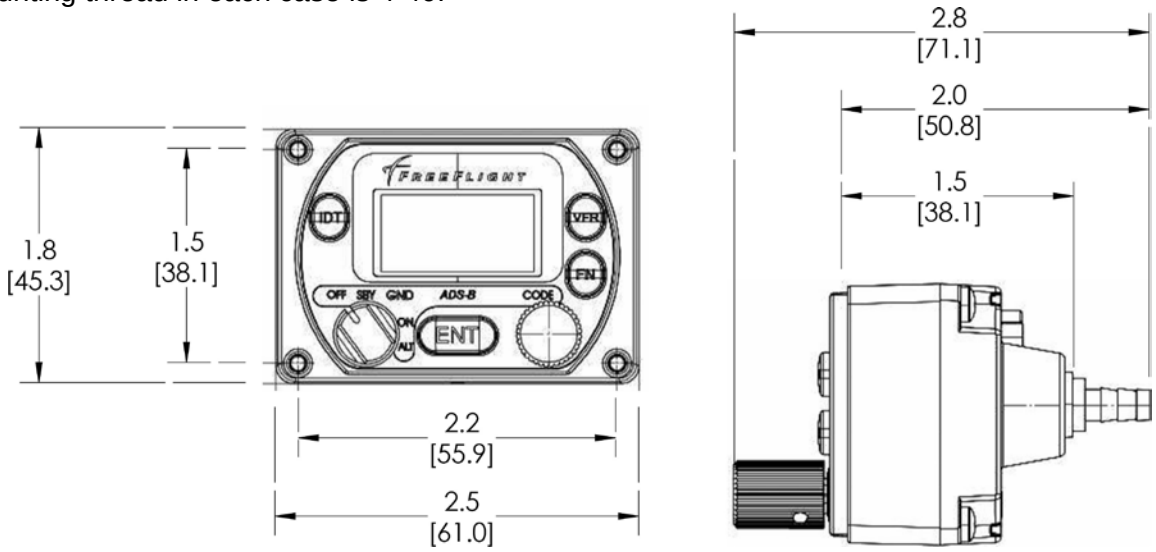


Figure 7. TC978 Dimensions

2.3 Cooling Requirements

Failure to provide adequate cooling may lead to increased avionics maintenance costs and may void the FFS Warranty.

The FDL-978 Series and TC978 meet all Technical Standard Order (TSO) requirements without forced air cooling. While each individual unit does not require forced air cooling, the combined heat load of several units operating in a typical avionics location may significantly degrade the reliability of avionics if provisions for cooling are not incorporated in the initial installation.

2.4 Electrical Connections

2.4.1 Interface – DB-44 Pinout

*Serial Port 5 is not available on the 87098-00 and 87098-10 Transceivers.

**Serial Port 6 can be optionally configured for RS-232 serial interface on pins J1-8 and J1-38.

J1 – Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
1	Vin	10-40 VDC	Pwr	Aircraft Power Input
2	GND	Ground	Gnd	TC978 Controller Power Return
3	232 RxD2	RS-232	I	Serial Port 2 RS-232 Data In
4	232 RxD1	RS-232	I	Serial Port 1 RS-232 Data In
5	232 TxD1	RS-232	O	Serial Port 1 RS-232 Data Out
6	429 IN 2A	ARINC 429	I	ARINC 429 Input Port 2A
7	TxD6+	RS-422	O	Serial Port 6 Data Out+
8	TxD6-**	RS-422/RS-232	O	Serial Port 6 Data Out-
9	SGND4	Serial Ground	Gnd	Serial Port Ground
10	429 OUT 1A	ARINC 429	O	ARINC 429 Output Port 1A
11	429 OUT 1B	ARINC 429	O	ARINC 429 Output Port 1B
12	ANON MODE	Open/Ground	I	Anonymous Mode, Active Low
13	Reserved	N/A	-	N/A
14	Vpm	3.0 -3.6 VDC	O	Personality Module Power Output
15	TRAF TEST	Open/Ground	I	Traffic Test
16	Vin	10-40 VDC	Pwr	Aircraft Power Input
17	RTRN	Ground	Gnd	Aircraft Power Return
18	Vcp	5.5-10 VDC	O	TC978 Controller Power Output
19	SGND2	Serial Ground	Gnd	Serial Port Ground
20	TRxD3+	RS-485	I/O	Serial Port 3 RS-485 Data+
21	TRxD3-	RS-485	I/O	Serial Port 3 RS-485 Data-
22	GND	Gnd	Gnd	Ground Reference
23	232 RxD3	RS-232	I	Serial Port 3 RS-232 Data In (Not used with TC978)
24	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data Out (Not used with TC978)
25	232 RxD4	RS-232	I	Serial Port 4 RS-232 Data In
26	232 RxD5	RS-232	I	Serial Port 5 RS-232 Data In
27	AIR/GND	Open/Ground	I	Air/Ground In (Squat Switch – configurable)
28	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
29	Reserved	N/A	-	N/A
30	GND	Ground	Gnd	Personality Module Power Return
31	RTRN	Ground	Gnd	Aircraft Power Return
32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
33	232 TxD2	RS-232	O	Serial Port 2 RS-232 Data Out
34	429 IN 1B	ARINC 429	I	ARINC 429 Input Port 1B

J1 – Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
35	429 IN 1A	ARINC 429	I	ARINC 429 Input Port 1A
36	429 IN 2B	ARINC 429	I	ARINC 429 Input Port 2B
37	RxD6+	RS-422	I	Serial Port 6 Data In+
38	RxD6-**	RS-422/RS-232	I	Serial Port 6 Data In-
39	PPS IO+	ARINC 743B	I/O	Internal/External GPS Pulse Per Second Out/In+
40	PPS IO-	ARINC 743B	I/O	Internal/External GPS Pulse Per Second Out/In-
41	UAT STATUS	Open/Ground	O	ADS-B Status
42	232 TxD5	RS-232	O	Serial Port 5 RS Data Out
43	CLK_PM	I^2C	I	Personality Module Clock
44	DATA_PM	I^2C	I/O	Personality Module Data

2.5 Interface Details

2.5.1 Power Input

Aircraft power is provided to the FDL-978 Series through the J1 Power and I/O connector. The power supply input can be 10 – 40 Volts DC. Use a 2 Amp circuit breaker for power supply protection. Power input resides on the following pins:

Power Input				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-1	Vin	10-40 VDC	Pwr	Aircraft Power Input
J1-16	Vin	10-40 VDC	Pwr	Aircraft Power Input
J1-17	RTRN	Ground	Gnd	Aircraft Power Return
J1-31	RTRN	Ground	Gnd	Aircraft Power Return
J1-32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)

REM_ON must be tied to TC978 pin 7 for remote on/off control or tied to ground for the FDL-978-XVR to power up.

2.5.2 Personality Module

The Personality Module (PM) is installed to simplify FDL-978 Series service replacement.

The PM eliminates the need to re-configure the FDL-978 Series if replaced with a new unit for any reason after initial configuration. Installation specific configuration data is stored in the PM

as well as in the FDL-978 Series. The installation configuration data in the PM (if present) is copied to the FDL-978 Series at power-up. Both the PM and the FDL-978-RX/XVR configuration data are stored during the installation configuration process. The PM module is *optional* but simplifies the process to replace a serviced FDL-978 Series. Section 2.8 details installation of the PM.

The TC978 Controller (if used in the installation) also contains a *back-up* copy of the installation configuration data. If the PM is not installed the TC978 Controller will automatically re-configure the FDL-978-XVR if it is replaced in the installation. However, if the TC978 Controller is replaced in an installation without the PM, the FDL-978-XVR MUST be re-configured.

The PM connections are on the following pins:

Personality Module Interface				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-14	Vpm	3.0 -3.6 VDC	O	Personality Module Power Output
J1-30	GND	Ground	Gnd	Personality Module Power Return
J1-43	CLK_PM	I^2C	I	Personality Module Clock
J1-44	DATA_PM	I^2C	I/O	Personality Module Data

The PM has no lightning protection. The wire length between the PM and Power and I/O connector should be less than 4 in.

2.5.3 Status LEDs

Four external LEDs on the front of the enclosure indicate general system status to the installer. The following table describes the LED states that can be observed:

Name	Description	
STATUS	***UAT System Status (RED)***	
	ON	UAT failure. Troubleshoot system.
	OFF	UAT is operating normally.
	Flash Fast	GPS fault condition or no position available
GPS	***GPS Status (GREEN)***	
	Flash Slow	GPS is acquiring satellites and determining position.
	Flash Fast	GPS reporting a fault condition.
	ON	GPS has acquired satellites and is operating normally.
	OFF	GPS is not communicating.
TX	***UAT Transmit (GREEN)***	
	Blink ON	Blinks ON when ADS-B data is transmitted (once per second)
	OFF	No UAT transmissions

Name	Description
RX	***UAT Receive (GREEN)***
	Blink ON Blinks ON when ADS-B data is received
	OFF No UAT receptions

2.5.4 Remote Power Control

The REM ON pin (J1-32) MUST be connected to ground when not using remote power control or a TC978 is not installed for the system to power on.

System ON/OFF power is remotely controlled using the REM ON pin (J1-32). The system will power on when REM ON is grounded and power off when REM ON is open.

2.5.5 TC978 Controller Interface

The TC978 Controller uses the following FDL-978-XVR interfaces when installed:

- System ON/OFF remote power control, REM ON (J1-32)
- Low voltage +7 VDC power (J1-18 & J1-2)
- Serial Port 3 RS-485 communication (J1-20 & J1-28)

The TC978 uses Serial Port 3 so when it is installed, the Serial Port 3 RS-232 pins (J1-23 & J1-24) must not be connected to other equipment (Display, etc.).

The TC978 Controller interface connections are as follows:

Controller Interface				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-18	Vcp	+7 VDC	O	TC978 Controller Power Output
J1-2	GND	Ground	Gnd	TC978 Controller Power Return
J1-32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
J1-20	TRxD3+	RS-485	I/O	Serial Channel 3 RS-485 Data+
J1-21	TRxD3-	RS-485	I/O	Serial Channel 3 RS-485 Data-

The REM ON pin (J1-32) MUST be connected to ground when not using remote power control or a TC978 is not installed for the system to power on.

Do NOT connect Serial Port 3 RS-232 pins to other devices (Display, etc.) when the TC978 Controller is installed.

2.5.6 Configurable Serial Interfaces

There are nine configurable *Serial Interfaces* available on the FDL-978 Series: Six UART style Serial Port Interfaces (Ports 1, 2, 3, 4, 5, and 6), two ARINC 429 Input Interfaces (429 IN1 and 429 IN2), and one ARINC 429 Output Interface (429 OUT1).

Refer to Section 3.3.2 for detailed Serial and ARINC port configuration information.

2.5.6.1 Serial Ports – RS-232/RS-422

Six UART style Serial Ports are available on the FDL-978 Series:

Serial Port 1 – RS-232 transmit and receive capability.
Serial Port 2 – RS-232 transmit and receive capability.
Serial Port 3 – RS-232 transmit and receive capability.
Serial Port 4 – RS-232 receive-only capability.
Serial Port 5***** – RS-232 transmit and receive capability.
Serial Port 6** – RS-232 or RS-422 bi-directional (transmit and receive) capability.

The Serial Ports can be software configured for various protocols and baud rates.

Refer to Section 3.3.2 for detailed information about serial and ARINC port configuration.

*Serial Port 5 is not available on the 87098-00 and 87098-10 Transceivers.

**Serial Port 6 can be optionally configured for RS-232 serial interface on pins J1-8 and J1-38.

The UART style *Serial Interface* pin connections are as follows:

Serial Channels				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-4	232 RxD1	RS-232	I	Serial Port 1 RS-232 Data In
J1-5	232 TxD1	RS-232	O	Serial Port 1 RS-232 Data Out
J1-3	232 RxD2	RS-232	I	Serial Port 2 RS-232 Data In
J1-33	232 TxD2	RS-232	O	Serial Port 2 RS-232 Data Out
J1-23	232 RxD3	RS-232	I	Serial Port 3 RS-232 Data Out
J1-24	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data In
J1-19	SGND2	Serial Ground	Gnd	Serial Ground
J1-25	232 RxD4	RS-232	I	Serial Port 4 RS-232 Data In
J1-26 *	232 RxD5	RS-232	I	Serial Port 5 RS-232 Data In
J1-42 *	232 TxD5	RS-232	O	Serial Port 5 RS-232 Data Out

Serial Channels				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-9	SGND4	Serial Ground	Gnd	Serial Ground
J1-7	TxD6+	RS-422	O	Serial Port 6 Data Out+
J1-8**	TxD6-	RS-422/RS-232	O	Serial Port 6 Data Out-
J1-37	RxD6+	RS-422	I	Serial Port 6 Data In+
J1-38**	RxD6-	RS-422/RS-232	I	Serial Port 6 Data In-

2.5.6.2 ARINC 429 Ports

Two ARINC 429 Input *Serial Interfaces* are available on the FDL-978 Series. The ARINC 429 Input channels are 429 IN 1 and 429 IN 2. The FDL-978 Series has one ARINC 429 Output which is 429 OUT 1. The ARINC channels can be software configured for various label interfaces and as either high-speed or low-speed.

Refer to Section 3.3.2 for additional detailed information about serial and ARINC port configuration.

The ARINC 429 *Serial Interface* pin connections are as follows:

ARINC 429 Channels				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-35	429 IN 1A	ARINC 429	I	ARINC 429 Input Port 1A
J1-34	429 IN 1B	ARINC 429	I	ARINC 429 Input Port 1B
J1-6	429 IN 2A	ARINC 429	I	ARINC 429 Input Port 2A
J1-36	429 IN 2B	ARINC 429	I	ARINC 429 Input Port 2B
J1-10	429 OUT 1A	ARINC 429	O	ARINC 429 Output Port 1A
J1-11	429 OUT 1B	ARINC 429	O	ARINC 429 Output Port 1B

2.5.7 Discrete Inputs

Input pins are pre-configured active low. See SECTION 10 for a wiring diagram reference

Three discrete inputs are available to provide control inputs to the UAT. The discrete input connection pins are as follows:

Discrete Inputs				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-27	AIR/GND	Open/Ground	I	Air/Ground In (Squat Switch – configurable)
J1-15	TRAF TEST	Open/Ground	I	Traffic Test
J1-12	ANONYMOUS MODE	Open/Ground		Anonymous Mode

2.5.7.1 Air/Ground Input

The Air/Ground discrete input can be connected to an open/ground Squat Switch or other Air/Ground discrete indication. The Air/Ground discrete is configurable to be either Not Connected, High when Airborne, or Low (ground) when Airborne. The FDL-978 Series and FDL-978 Lite Series automatically determines air/ground state based on several factors: Emitter Category type, Airspeed (if available), groundspeed, and Air/Ground discrete input (if configured). Airborne or On Ground status affects ADS-B message transmission behaviour.

Air/Ground determination is required for Transceiver, Transmitter and Receiver installations.

2.5.7.2 Traffic Test Input

The Traffic Test Input indicates the traffic test status of a 429 traffic display. The FDL-978 Series and Lite Series will send traffic test data to ARINC OUT 1 when the traffic test input is active low.

2.5.7.3 Anonymous Mode Input

ADS-B Out messages broadcast the registered ICAO address and call sign to identify the aircraft for the purpose of utilizing ATC services. The FDL-978 systems have an Anonymous Mode feature that will broadcast a random, temporary, ICAO address and no call sign when enabled. This feature can only be enabled through a dedicated pilot interface.

When Anonymous mode is enabled the previous call sign will continue to be displayed in the TC978, but will not be broadcast. When Anonymous Mode is disabled, the FDL-978 resumes broadcasting the registered ICAO address and call sign. Anonymous Mode can be disabled by the pilot, or whenever the squawk code is changed from 1200.

Anonymous Mode is not available in aircraft with a Mode S transponder.

The Anonymous Mode can only be enabled when the squawk code is set to 1200, no flight plan is filed, and ATC services are not requested.

The FDL-978 equipment defaults to the registered aircraft ICAO address and call sign when initially powered on. Anonymous Mode will not be enabled within the first 90 seconds after the FDL-978 is powered on.

The FDL-978 equipment will automatically revert back to the default ICAO address and call sign when the squawk code is changed from 1200.

In Anonymous Mode you are unable to receive Instrument Flight Rule (IFR) or Visual Flight Rule (VFR) separation services. Also potential loss of enhanced search and rescue benefits, and potential negative impacts to ADS-B IN applications could occur.

2.5.8 Discrete Output

Refer to SECTION 10 for a wiring diagram reference.

Two discrete outputs are available to provide UAT status and operational information to other equipment. The two discrete output connection pins are as follows:

Discrete Outputs				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-28	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
J1-41	UAT STATUS	Open/Ground	O	ADS-B Status

2.5.8.1 UAT Status Output

Failure status of the UAT as well as loss of UAT position data must be annunciated to the pilot. The connected display (or TC978) typically provides annunciation. This discrete can be used to drive an annunciator when a display or TC978 is not installed or capable of displaying status.

The UAT Status output is an active low, open collector output capable of sinking a maximum of 100 mA. The UAT status output indicates a UAT transmit or receive system failure when continuously grounded. UAT status output also indicates the loss of valid GPS data from an internal or external GPS. If the internal or external GPS is not functioning, reporting a failure, or reporting invalid GPS position data, this discrete will toggle between ground and open at a rate of approximately four times per second.

2.5.9 TX Suppression Output

The TX Suppress output is for suppressing other L-band equipment during UAT transmissions. TX Suppress outputs a high (Vin – 1.5 V) only during UAT ADS-B message transmissions and is low otherwise. The TX Suppress output is typically connected to the transponder suppression bus.

Receiver only installations do not need to connect to the transponder suppression bus.

2.5.10 Time Mark Input/Output

For the FDL-978 Series, the Time Mark Input/Output is an RS-422 differential pair for the one pulse-per-second (PPS) input from an external GPS or output when the Transceiver/Receiver has an internal GPS. The Time Mark input/output from a GPS provides the timing synchronization for sending ADS-B messages.

Time Mark from a GPS provides timing synchronization for ADS-B transmit messages. The Time Mark from an external GPS MUST be synchronized to UTC second epoch to operate correctly with the FDL-978-XVR.

Time Mark inputs from a single ended PPS source (e.g. Garmin Series 400/500 GPS) must be properly interfaced to the differential interface for reliable operation. Refer to SECTION 9 for suggested connection.

The Time Mark input/output pin connections are as follows:

Time Mark Input				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-39	PPS IO+	ARINC 743B	I/O	Internal/External GPS Pulse Per Second Out/In+
J1-40	PPS IO-	ARINC 743B	I/O	Internal/External GPS Pulse Per Second Out/In-

2.5.11 Maintenance Port Interface

The Maintenance Port Interface (MPI) can be used to configure the system, provide installation status information, and update system software/firmware. The MPI should be used by qualified installation personnel to configure and update the system.

MPI functionality is provided through Serial Port 3 or Serial Port 5 on the FDL-978 Series DB-44 connector. A female DB-9 connector can be mounted in the aircraft for easy MPI access to one of these ports if not connected to other equipment. If both ports are configured and connected to other aircraft equipment, the MPI can still be accessed if the configured device is not actively connected. Therefore, an inline connector can be used to temporarily disconnect the configured device and permit external MPI access. Standard RS-232 DB-9 connections are shown in the table below:

Female DB-9		**Port 5 (DB-44)**		**Port 3 (DB-44)**	
PIN	**SIGNAL**	**PIN**	**SIGNAL**	**PIN**	**SIGNAL**
2	Tx	J1-42	232 TxD5	J1-24	232 TxD3
3	Rx	J1-26	232 RxD5	J1-23	232 RxD3
5	GND	J1-9	SGND4	J1-19	SGND2

The female DB-9 connector can be connected to a PC using an off-the-shelf RS-232 to USB converter. A battery powered Serial-to-Wi-Fi MPI Module, MPI Module (P/N 87710-00), and an Android tablet ADS-B MPI app is also available from FFS that can connect to the DB-9 MPI and provide significantly easier MPI installation configuration and troubleshooting.

The FDL-978 Series also has a USB micro-AB connector which provides an alternate Serial Port 5 connection but is ***not*** recommended for use. This interface should only be used for FDL-978 Series units running software versions 1.7 and earlier. The MPI Module can also connect to the USB micro-AB port for wireless Wi-Fi connection.

Alternately a FFS fixed installation Serial-to-Wi-Fi Transceiver (P/N 86943-00) can be connected to Port 3 or Port 5. The MPI functionality can then be accessed wirelessly using the ADS-B MPI app.

When Port 3 and Port 5 are configured and interfaced to other equipment (TC978 or display) the connections to the configured device must be temporarily disconnected to use the port for MPI purposes.

A rechargeable battery powered MPI Module (P/N 87710-00) and Android tablet ADS-B MPI app are available for significantly easier and improved MPI configuration and troubleshooting.

Refer to Section 3.4 for more information on MPI Module usage, installation, configuration, and troubleshooting.

2.6 TC978 Controller Electrical Connections

2.6.1 TC978 Interface – DB-9 Pinout

TC978 Connections (DB-9)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
1	GND	Ground	Gnd	Signal Common
2	TMAPA	RS-485	I/O	Controller Serial Bus (+)
3	TMAPB	RS-485	I/O	Controller Serial Bus (-)
4	ALT_OUT	RS-232	O	Pressure Altitude Out
5	Reserved	-	-	-
6	GND	Ground	Gnd	Signal Common
7	REM ON	Open/Gnd	O	Remote Power Control (Ground: ON, Open: OFF)
8	POWER	6 – 10 VDC	Pwr	Controller Power
9	GND	Ground	Gnd	Controller Power Common

2.7 TC978 Controller Interface Details

2.7.1 Power

Do NOT connect to aircraft input power.

The TC978 uses 5.5 – 10 volts from the FDL-978 Lite Series and FDL-978-XVR (typically ~7 volts).

2.7.2 Remote ON

The Remote ON output controls the power to the FDL-978 Lite Series and FDL-978-XVR. This is connected to the REM ON input (J1-32) to remotely control power to both units.

2.7.3 TMAP Bus

TMAP is a proprietary protocol using RS-485 bi-directional serial bus between the TC978 and FDL-978-XVR. The TC978 RS-485 lines (TMAPA and TMAPB) are connected to the FDL-978-XVR RS-485 lines (TRxD3+ and TRxD3-) respectively.

2.7.4 Altitude Out

The TC978 outputs pressure altitude data on this RS-232 serial output pin (ALT_OUT) at 9600 baud using the “Icarus” format (See Section 6.1.1). The pressure altitude data output depends on the Altitude input configuration. If an external Altitude/Air Data Input is configured to a FDL-978 Lite Series or FDL-978-XVR ARINC (FDL-978-XVR only) or Serial port, then the pressure altitude data output from the TC978 will pass through data from that sensor. If an Altitude/Air Data Input is *not* configured, then the pressure output defaults to the TC978 built-in altitude encoder. If used, this output should feed the aircraft transponder so they share the same altitude source.

2.7.5 TC978 Connections

DB-44		TC978 (DB-9)	
PIN	**SIGNAL**	**PIN**	**SIGNAL**
J1-18	Vcp	8	POWER
J1-2	GND	1,6,9	GND
J1-32	REM ON	7	REM ON
J1-20	TRxD3+	2	TMAPA
J1-21	TRxD3-	3	TMAPB

2.8 Personality Module Installation

The PM is intended to be installed inside the DB-44 connector backshell of the cable harness in the aircraft. The PM allows the FDL-978 Series and the TC978 to be removed and replaced without having to re-configure the system.

The following install kit parts from the FDL-978 Series PM Install Kit **(P/N 87002-00)** are used to install the personality module in the backshell:

Item	Qty	Description
1	1	Personality Module (P/N 85945-00-A)
2	4	Pin Contact, Crimp 24-28 AWG (P/N 86967)
2	4	Pin Contact, Crimp 24-28 AWG (P/N 83145)
3	1	Double-sided Adhesive Tape (P/N 87006)

The following table shows the PM wire color connections to the DB-44 connector:

Personality Module Interface					
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**	**PM WIRE COLOR**
J1-14	Vpm	3.0 -3.6 VDC	O	Personality Module Power	Red
J1-30	GND	Ground	Gnd	Personality Module Power Return	Black
J1-43	CLK_PM	I^2C	I	Personality Module Clock	Blue
J1-44	DATA_PM	I^2C	I/O	Personality Module Data	White

The PM should be assembled into the backshell of the DB-44 male connector in the aircraft wiring harness as follows:

1. Strip 1/8 in of the insulation from each of the four wires of the PM.
2. Crimp pin contacts onto each of the four wire of the PM.
3. Insert crimped pins into the DB-44 connector housing according to the table above.
4. Adhere one side of the double-sided tape pad to the PM as shown in Figure 6 and the other side should be adhered to one side of the connector backshell as the connector and backshell are assembled together.

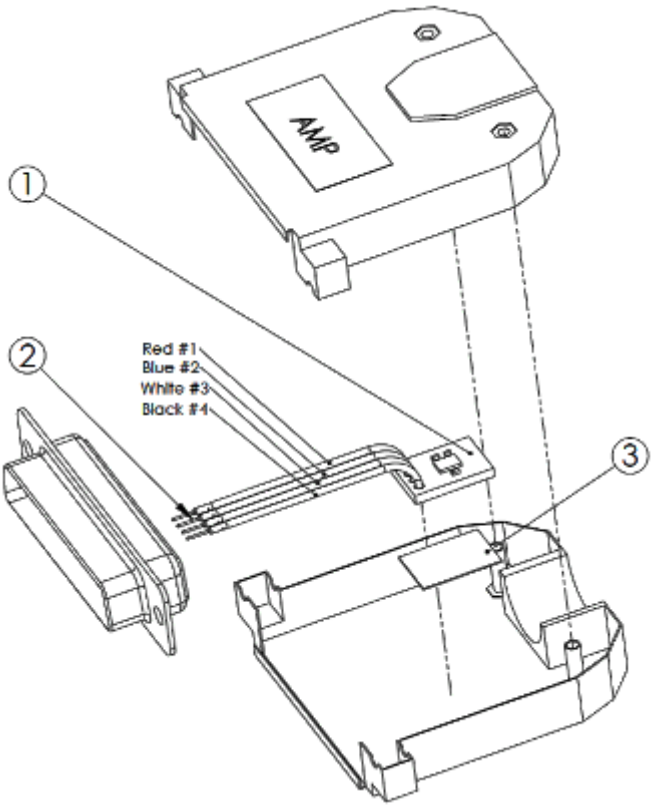


Figure 8. Personality Module Assembly

2.9 Wiring Considerations

Cables with solid cores should not be used. Cables should be selected based on the wear characteristics of their insulation material, including temperature rating, resistance to solvents and oils, and flammability. Most inexpensive commercial data cables have poor flammability properties.

The connection from the FDL-978 Lite Series and FDL-978-XVR Transceivers to the TC978 Controller uses a minimum of six signal lines; the TMAP pair, the Power and Ground pair, and the Remote On discrete line plus associated ground line. In a certified installation, MIL-W-16878E/4 or equivalent wire should be used. Wire gauge should be 24 American Wire Gauge (AWG) for all wires. Shielded, twisted wiring is recommended for the TMAP pair (and all serial data communication pairs) to improve electromagnetic emissions and susceptibility – one twist per 1 to 2 inches is adequate. Other pairs in the bundle can also be twisted, but are not required.

The distance between the FDL-978 Lite Series and FDL-978-XVR Transceivers and the TC978 Controller is limited by the impedance of the wire between them. The TC978 is powered from the transceivers, not from aircraft power. Therefore, the acceptable voltage drop in the power line limits the wire length. The TC978 needs an impedance of less than 1.0 ohm in the power line for satisfactory operation. The following table gives guidelines for typical aircraft hook-up wire.

Different brands may vary – check your supplier for details.

Gauge	Miliohm/ft	Length for 0.5 ohm
24 AWG	30.2	33.2 ft

An alternative to a harness built from individual wires, particularly for a long cable run, is to use a multi-core cable. Aviation grade cable with six or more cores is often more expensive than the individual wires.

2.10 UAT Antenna Installation

The UAT antenna should be installed according to the manufacturer's instructions.

Selecting appropriate UAT antenna locations is critical to the proper performance of the FDL-978 Series and FDL-978 Lite Series. The following considerations should be taken into account when selecting the Antenna location.

- The antennas should be well removed from any projections, the engine(s) and propeller(s). It should also be well removed from landing gear doors, access doors or others openings which will break the ground plane for the antenna.
- The antenna should be mounted on the bottom and or top surface of the aircraft and in a vertical position when the aircraft is in level flight.
- Avoid mounting the antenna within 3 ft of the Automatic Direction Finder (ADF) sense antenna or any Communications Receiver (COMM) antenna and 6 ft from the transponder and Distance Measuring Equipment (DME) antennas.

- In installations without a digital serial interface to the transponder, the FDL-978 and FDL-978 Lite Series contains a Mode A receiver to receive Mode A/C Transponder control data from the transponder antenna through the UAT antennas. Ensure the transponder antenna is on the bottom of the aircraft (same as the UAT antenna). The transponder antenna is recommended to be at least 6 ft and no further than 12 ft away from the UAT antenna. The transponder antenna can be as close as 3 ft if there is at least 2-3 dB of UAT antenna cable loss. Also, there should be a clear line-of-sight between the UAT antenna and transponder antenna with no obstructions or projections.
- Where practical, plan the antenna location to keep the cable lengths as short as possible and avoid sharp bends in the cable to minimize the VSWR.

Electrical connection to the antenna should be protected to avoid loss of efficiency as a result of the presence of liquids or moisture. All antenna feeders shall be installed in such a way that a minimum of RF energy is radiated inside the aircraft.

2.10.1 UAT Antenna Ground Plane

When a conventional aircraft monopole antenna is used it relies on a ground plane for correct operation. For ideal performance the ground plane should be very large compared to the wavelength of the transmission, which is ~12 in. In a metal skinned aircraft this is usually easy to accomplish, but is more difficult in a composite or fabric skinned aircraft. In these cases a metallic ground plane should be fabricated and fitted under the antenna.

As the ground plane is made smaller, the actual dimensions of the ground plane become more critical. Dimensions with small multiples of the wavelength should be avoided, as should circles. Rectangles or squares are much less likely to create a critical dimension that resonates with the transmissions. The smallest practical ground plane is a square around 5.25 in per side; as the size increases the performance may actually get worse, but will be better by the time the ground plane is 30.5 in on each side. Anything much larger than that size is unlikely to show significant further improvement.

The thickness of the material used to construct the ground plane is not critical, providing it is sufficiently conductive. A variety of proprietary metallic mesh and grid solutions are available.

2.10.2 UAT Antenna Cable

The FDL-978 Series and FDL-978 Lite Series are designed to meet Class A1H/A1S requirements with an allowance of 2 – 6 dB for loss in the connectors and cable used to connect it to the antenna. Excessive loss degrades transmitter output power so it is recommended that the installation cable loss be limited to the loss minimum of 2-5.5dB.

Allowing 0.25dB loss for the connector at each end of the antenna cable assembly leaves an allowance of 1.5 – 5.0 dB loss for the cable itself.

An acceptable cable then has:

- A minimum of 1.5dB loss for the run length, but no greater than 5.0dB loss
- A characteristic impedance of 50 Ohms
- Double braid screens or has a foil and braid screen

Once the cable run length is determined, a cable type with the proper attenuation (loss) per foot that meets the above requirements can be chosen. Longer runs require lower loss cable.

Consider moving the FDL-978 Series and FDL-978 Lite Series closer to the antenna to minimize the losses in the antenna cable subject to the limits identified above.

The following table is a guide to the minimum and maximum usable lengths of some common cable types. Actual cable loss varies between manufacturers and the table is based on typical data. Use the table as a guide only and refer to the manufacturer's data sheet for the specific cable chosen to calculate the minimum and maximum lengths.

Cable	Attenuation (dB/100 ft @ 1 GHz)	Min Length (ft)	Max Length (ft)
RG-174	27.1	5.5	18.5
RG-316	25.8	5.8	19.4
RG-400	14.5	10.3	34.5
RG-142	12.8	11.7	39.1
RG-393	7.5	20	66.7

When routing the cable, ensure the following:

- Route the cable away from sources of heat.
- Route the cable away from potential interference sources such as ignition wiring, 400Hz generators, fluorescent lighting, and electric motors.
- Allow a minimum separation of 12 in (300 mm) from an Automatic Direction Finder (ADF) antenna cable.
- Keep the cable run as short as possible.
- Avoid routing the cable around tight bends.
- Avoid kinking the cable even temporarily during installation.
- Secure the cable so that it cannot interfere with other systems.

2.11 GPS Antenna Installation

Shadowing by aircraft structure (and in some cases by rotorcraft blades) can adversely affect operation of the Global Navigation Satellite System (GNSS) equipment.

The antenna should be installed according to the manufacturer's instructions.

Selecting appropriate GPS antenna locations is critical to the proper performance of the FDL-978 Series and FDL-978 Lite Series. The following considerations should be taken into account when selecting the Antenna location.

1. Typically, a GNSS antenna is located forward or aft of the wings on top of the fuselage.
2. GNSS antennas must be installed to provide the widest, unobstructed view of GNSS satellites.

3. Antenna placement on the airframe should be optimized to ensure the sensor can take full advantage of a 5 degree mask angle. This includes consideration of antenna location with respect to blockage from all aircraft components at typical level cruising attitude, as well as minimizing the effects of aircraft shadowing during typical maneuvers.
4. The antenna should be separated as much as practical from transmitting antennas. For small aircraft, the antenna should also be separated as much as practical from the windscreen to prevent case-to-antenna coupling.
5. For installations on rotorcraft, the effects of the rotor blades on antenna performance should be considered. This may require additional equipment functional flight evaluation or analytical evaluation to confirm the suitability of antenna location.
6. For multiple-sensor installations, the installer should reduce the likelihood that a single lightning strike affects all the sensors.

2.11.1 Antenna Power

The internal GPS of the FDL-978 Series and FDL-978 Lite Series utilizes an active antenna which means the antenna includes a low noise amplifier. The power for the low noise amplifier is provided from the GPS receiver via the antenna coax cable. No other installation considerations are necessary.

2.11.2 Recommended Cable

RG-400 or RG-142 cable with a maximum length of 50 ft is recommended. The cable, including connectors, loss should not exceed 10dB.

For antennas mentioned in Section 1.7.1, RG-400 or RG-142 cable with a maximum length of 25 ft is recommended. The cable including connectors, loss should not exceed 5dB.

2.11.3 SATCOM Compatibility

The FDL-978 Series and FDL-978 Lite Series internal GPS/WAAS Sensor has been shown via testing to be specification compliant for single-channel SATCOM compatibility per RTCA/DO-229D.

Extra care should be exercised when installing GNSS equipment on aircraft with SATCOM having multiple channels, as cautioned in Sec. 14-1 of AC 20-138B. “GNSS equipment is particularly susceptible to out-of-band SATCOM emissions and in-band inter-modulation between multiple channel SATCOM installations. GNSS equipment must not be installed in aircraft with multiple SATCOM channels unless the simultaneous use of interfering frequencies can either be prevented or demonstrated not to interfere with the operation of the GNSS equipment.”

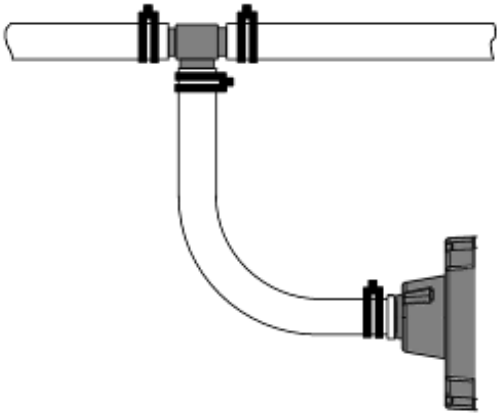
2.12 TC978 Static Pressure Connection

The TC978 Controller includes an altitude encoder which must be connected to the same source of static pressure as the primary altimeter on the aircraft if this sensor is utilized in the installation. The TC978 static pressure port provides a mounting spigot intended for nominal 5 mm or 3/16 in inside diameter tubing. A length of EPDM rubber tubing is included in the installation kit to facilitate connection to the aircraft static system.

Choose a point in the existing static pressure line that is as close as practical to the TC978. Cut the static pressure line, and use the supplied T fitting to connect the altitude encoder. Take care not to contaminate the inside of the static line when cutting or inserting the connectors.

In all cases, the static line should include drainage provisions and should be routed in accordance with CS 23.1325 or other applicable airworthiness provisions for the aircraft.

The following diagram shows the general arrangement, although other combinations may be used:



For aircraft with ¼ in static lines, two adapters are provided which can convert from ¼ in inside diameter hoses to 3/16", compatible with the hose in the install kit.

2.13 Equipment Limitations

For a compliant installation in accordance with the TSO and the Federal Aviation Regulations (FAR), the FDL-978 Series and FDL-978 Lite Series installations must meet the following requirements:

- **TSO-C145c (87098-00, 87098-00-FR00, 87098-00-FX00, 87098-00-FT0L, and 87098-00-FX0L only)**

  "The conditions and tests required for TSO approval of this article are minimum performance standards. Those installing this article, on or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements."

- **TSO-C154c**

  "This article meets the **minimum** performance and quality control standards required by a technical standard order (TSO). If you are installing this article on or in a specific type or class of aircraft, you must obtain separate approval for installation."

- **TSO-C157a**

  "This article meets the minimum performance and quality control standards required by a technical standard order (TSO). Installation of this article requires separate approval."

- **TSO-C195a**

Certified installations must be approved by a Supplemental Type Certificate (STC) or Type Certificate (TC)

"This article meets the minimum performance and quality control standards required by a technical standard order (TSO). Installation of this article requires separate approval."

CDTIs integrated with this article must be analysed for latency. This article's ownship and traffic total latency is <1.25 seconds and the uncompensated latency is 0 seconds from current UTC second (not including serial data transmission time).

- The antenna installation must comply with the specifications in Section 2.11 for UAT antennas and Section 2.12 for GPS antennas.

2.14 Department of Commerce Compliance

The Department of Commerce/Bureau of Export Administration's "Revision of the Commodity Control List" permits shipment of commercial GPS products for General Destination (G-Dest) export only if they contain certain software provisions. To comply with the G-Dest category, the FDL-978 Series with GPS (87098-00, 87098-00-FX00, and 87098-00-FR00), FDL-978-TXL (87098-00-FT0L), and FDL-978-XVRL (87098-00-FX0L) operates neither at altitudes above 18,287 meters (about 60,000 ft) MSL, nor at velocities greater than 513 m/s (about 1,000 knots). If either condition is detected, the GPS discontinues outputting signals and position data on its RS-232 ports."

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SECTION 3 FDL-978 SERIES CONFIGURATION AND CHECKOUT

3.1 General

This section contains installation configuration, checkout, and basic operating procedures. More detailed operating procedures are contained in the Pilot Guide/User Manual.

3.1.1 Continued Airworthiness Requirements

The FDL-978 Series and FDL-978 Lite Series systems require no periodic maintenance or calibration. Maintenance is performed on an on-condition basis only. These units perform a power-on self-test (POST) and is continually tested using a Periodic Built-In Test (PBIT) when the system is in operation. This method of testing will notify the operator of a failure. System software updates are accomplished using the MPI.

Continued airworthiness can also be accomplished by determining the FDL-978 Series and FDL-978 Lite Series installed system performance using the FFS FT-9000 Ramp Tester (see Section 1.7.2 for more information).

3.1.2 TC978 Controller Operation

The FDL-978 Lite Series and FDL-978-XVR can interface to a TC978 Controller used in-flight by the pilot to control output of ADS-B messages. The TC978 receives its power from these units and communicates to them through an RS-485 serial port. The TC978 Controller receives its power from and communicates with the FDL-978-XVR Transceiver. The TC978 Controller consists of the following components:

- Monochrome Liquid Crystal Display (LCD)
- VFR button
- FN button (Function)
- CODE knob
- ENT button (Enter)
- Mode Selection knob
- IDT button (Ident)

Figure 9. TC978 Controller Knobs and Buttons

3.1.2.1 Display

The display shows the operating mode of the FDL-978 Lite Series and FDL-978-XVR, the reported pressure altitude, and the current Squawk Code and Call Sign/Flight ID. The pressure altitude is displayed as a Flight Level, which is the pressure altitude in hundreds of feet. When non-standard atmospheric conditions apply this may not match the altimeter indicated altitude but will be correctly reported in the ADS-B message.

The wave symbol under the aircraft image traveling upward indicates that the FDL-978 equipment is receiving ADS-B messages.

The wave symbol under the aircraft image traveling downward indicates that the FDL-978 equipment is transmitting ADS-B messages.

The Reply Indicator is active when the FDL-978 ADS-B equipment transmits and receives ADS-B messages. The FDL-978 ADS-B Transceiver equipment receives ADS-B transmissions regardless of the transmission mode

Figure 10 shows the FDL-978-XVR powered on in Airborne Transmission mode with a pressure altitude of flight level 400 ft. being displayed. It also shows the ALT Mode display of the FDL-978-XVR:

- Squawk Code
- Call Sign/Flight ID
- Reported pressure altitude in hundreds of feet

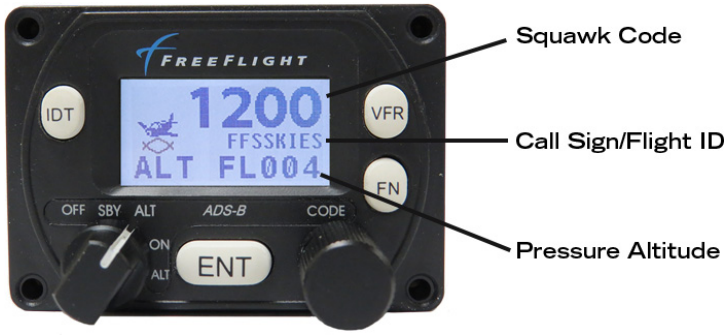


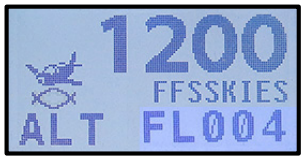
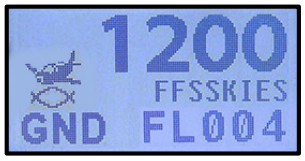
Figure 10. FDL-978 Controller Display (Typical)

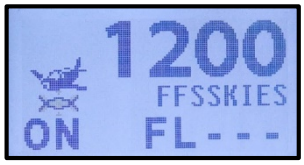
3.1.2.2 Mode Selection Knob

There is no functional difference between the two ALT positions.

When airborne, the Controller should always be set to either ALT position. Aircraft installations should include a ground indication Squat Switch to automatically transmit ADS-B ground messages upon landing.

The Mode Selection knob controls power to the FDL-978 Lite Series and FDL-978-XVR and the operating mode. The knob rotates between the different operating modes as defined in the table below:

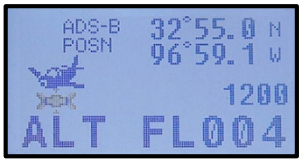
Pos.	Description
OFF	Power is removed from the FDL-978 ADS-B equipment.
SBY	The FDL-978 ADS-B equipment is on and will not transmit any ADS-B messages, but will still receive ADS-B messages if the ADS-B equipment has receive capabilities. 
ALT	When airborne, the control should always be set to either of the two ALT positions unless otherwise directed by ATC. The FDL-978 ADS-B equipment is placed in Transmission Mode with pressure altitude reported in transmitted messages (applies to both ALT positions). The FDL-978 equipment automatically switches between Airborne and Ground Mode. In Airborne Mode **ALT** is displayed below the aircraft image and in Ground Mode **GND** is displayed below the aircraft image. **Airborne Transmission Mode**  **Ground Transmission Mode** 

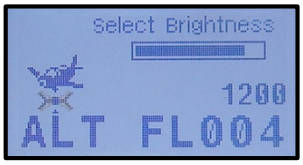
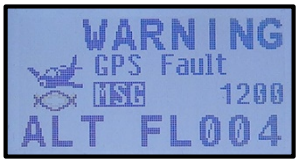
Pos.	Description
ON	The FDL-978 ADS-B equipment is placed in Transmission Mode with ***no*** pressure altitude reported in transmitted messages. The FDL-978 equipment automatically switches between Airborne and Ground Transmission Mode. In Airborne Mode **ON** is displayed below the aircraft image and in Ground Mode **GND** is displayed below the aircraft image. **Airborne Transmission Mode**  **Ground Transmission Mode**  Suppression of pressure altitude reporting is indicated by FL---.

3.1.2.3 Push Buttons

The TC978 control inputs, such as Squawk Codes, Call Sign/Flight ID, and mode control (IDENT, Altitude Inhibit, transmit Standby) are configurable by the TC978 only when external controls are not being used.

Button	Description
IDT	Press the IDT button when ATC instructs you to “Ident” or “Squawk Ident.” 

Button	Description
FN	Pressing the FN button provides access to changing the Call Sign/Flight ID.  You may either directly rotate the CODE knob or press the ENT button and the first character of the Call Sign/Flight ID will be highlighted. Use the rotary CODE knob to select your choice of alpha-numeric characters. Press the ENT button again and the cursor moves to the next character. You must press the ENT button each time, all the way through the eight characters, to save your Call Sign/Flight ID change.   Pressing the FN button again allows the user to view the present Global Positioning System (GPS) position being transmitted. 

Button	Description
FN	Pressing the FN button a third time allows the user to adjust the brightness level of the screen. Turning the CODE knob to the right will make the screen brighter. Turning the CODE knob to the left will decrease the brightness. When the desired brightness is reached, press the FN button to lock the brightness setting.  If there are any errors, the fourth press of the FN button allows user to view the FDL-978 ADS-B equipment WARNINGS.  The next FN button press returns to the main Squawk Code view.
VFR	Pressing the VFR button sets the ADS-B to the pre-programmed Squawk Code or VFR Call Sign/Flight ID. Pressing the VFR button again restores the previous Squawk Code or Call Sign/Flight ID. To toggle the Squawk Code the display must be in the Squawk Code view. To toggle Call Sign/Flight ID the display must be in the Call Sign/Flight ID view. 
ENT	The ENT button enters a digit in the code selector.

3.1.2.4 Code Knob

The CODE knob is used to set Squawk Codes and Call Sign/Flight IDs. The FN button selects which item will be updated. Turning the knob will highlight the first digit on the display, then the digit can be changed as required. Press the ENT button to advance to the next digit. When the ENT button is pressed on the last digit, the new Squawk Code or Call Sign/Flight ID will replace the previous value. If the code entry is not completed within 7 seconds the changes are ignored and the previous code restored.

Code	Description
1200	VFR Code in the USA
7000	VFR Code commonly used in Europe.
7500	Hijack Code
7600	Loss of communications
7700	Emergency Code

The Call Sign/Flight ID should correspond to the aircraft call sign entered on flight plan. If no flight plan is active the aircraft registration should be used as the Call Sign/Flight ID. Use only letters and digits. If the Call Sign/Flight ID is less than eight characters long entering a blank character will end it.

3.1.2.5 Warning Messages

If the FDL-978 Lite Series and FDL-978-XVR detects a malfunction, the MSG icon appears to indicate that warning messages are present. Depending on the nature of the problem the unit may not be transmitting ADS-B messages.

To enter the Warning View mode, press the FN button four times and WARNING will be displayed top center along with a brief description of the fault. In this mode, the Controller continually requests the active warning messages from the FDL-978-XVR and displays them on the Controller. Press the FN button again to exit this mode and return to normal operation.

3.1.2.6 Fault Annunciation

If the transponder detects a catastrophic internal failure the screen will indicate FAULT with a brief statement of the problem. No ADS-B messages will be transmitted when a fault has been detected.

3.2 Preliminary Checkout

Before the unit is installed and tested, verify that all cables are properly secured. With the FDL-978 Series, FDL-978 Lite Series, and TC978 removed, turn on aircraft power, and verify the following:

1. Verify that Aircraft DC bus voltage is present on pins 1 and 16 of P1.
2. Verify that ground is present on pins 17 and 31 of P1.

3. Verify that the two UAT antenna coax center conductors are not shorted to its shield or aircraft ground.

When the above conditions are verified, turn off the master power. Properly attach the external connectors to the FDL-978 Series, FDL-978 Lite Series, and TC978. Mount the FDL-978 Series, FDL-978 Lite Series, and TC978 in their respective mounting locations. Turn on master power and then turn on the TC978, if installed. During initialization the FDL-978 Series and FDL-978 Lite Series unit performs a comprehensive diagnostics test.

A system component failure will be annunciated by a Warning Indication on the TC978, if installed, or the display. Warnings concerning the GPS status may not be displayed until 2.5 minutes after power on in order to give the GPS time to acquire satellites. Consult the Pilot Guide/User Manual for more information concerning warning messages. Detailed system status can be observed using the Maintenance Port Interface as described in Section 3.4.

The FDL-978 Series and FDL-978 Lite Series aircraft installation must be verified to ensure compliant operation and configuration. The FFS FT-9000 Ramp Tester can be used for this purpose (see Section 1.5.2 for more information) and use of the FFS STC data requires the use of the FT-9000 for installation verification.

3.3 Installation Setup and Configuration

System installation is configured using either the:

- MPI on serial port 3 or port 5 (typical) or
- TC978 Controller, if installed, in a special configuration mode.

Sections 3.3 through 3.6 describe the system installation configuration details necessary for configuring the FDL-978 Series and FDL-978 Lite Series installation. Installers should review the information in these sections to ensure proper system configuration. It is important to carefully review Section 3.3.2 to ensure proper system configuration of the serial and ARINC ports, regardless of using the MPI or TC978 for configuration.

3.3.1 FDL-978-XVR Configuration Item Summary

Use the configuration setting lists below to document the system installation.

Table 1. Serial and ARINC Port Configuration Settings

Configuration Item		Default	Setting
Serial Port 1 Configuration:	**IN Function**	GPS-Internal	
	Baud	19200	
Serial Port 2 Configuration:	**IN FUNCTION**	UNUSED	
	OUT Function	UNUSED	
	Baud	9600	
Serial Port 3 Configuration (1):	**IN Function**	TMAP	
	OUT Function	TMAP	
	Baud	38400	
Serial Port 4 Configuration:	**IN Function**	UNUSED	
	Baud	9600	
Serial Port 5 Configuration (2):	**IN Function**	MAINT	
	OUT Function	MAINT	
	Baud	115200	
Serial Port 6 Configuration:	**IN Function**	UNUSED	
	OUT Function	UNUSED	
	Baud	9600	
	Interface	RS-232	
ARINC IN 1 Configuration:	**Function**	UNUSED	
	Speed	Low	
ARINC IN 2 Configuration:	**Function**	UNUSED	
	Speed	Low	
ARINC OUT 1 Configuration:	**Function**	UNUSED	
	Speed	Low	

(1) Serial Port 3 is not configurable on the TC978.

(2) Serial Port 5 is not available on the 87098-00 and 87098-10 Transceivers.

Table 2. ADS-B Transmit Configuration Settings

Configuration Item		Default	Setting
ICAO Address (Mode S)		0	
VFR Call Sign (Flight ID)			
GPS SDA Level		UNKNOWN	
GPS NACv Mode		UNKNOWN	
Receiver Configuration:	**UAT Receiver Installed**	no978	
	ES1090 Receiver Installed	no1090	
Emitter (Aircraft) Category		UNKNOWN	
Squat Mode		none	
Groundspeed Threshold		0 knots	
Vehicle Size:	**Length**	0	
	Width	0	
UAT Antenna:	**Diversity**	bottom	
	DC Ground Check	No DC Gnd Chk	
GPS Antenna Offset:	**Longitudinal**	No Data	
	Lateral	No Data	
Mode A Receive		disable	
Disable Squawk Transmit *(3)*		off	
VFR Squawk Code *(4)*		1200	

(3) Disable Squawk Transmit is not configurable on the TC978.

(4) VFR Squawk Code is only set on the TC978.

Table 3. Display Output Configuration Settings

Configuration Item	Default	Setting
Max Targets Output	max	
Chelton CSA Enable *(4)*	disable	
Traffic Velocity Validation *(5)*	enable	
Display Data Output *(6)*	traffic&fisb	

(4) Chelton CSA Enable is not configurable on the TC978.

(5) Traffic Velocity Validation is not configurable on the TC978.

(6) Display Data Output is not configurable on the TC978.

Refer to Section 3.5.4.13.3 for detailed information on determining the proper display output settings in this table.

3.3.2 FDL-978 Series Serial and ARINC Port Configuration Details

The FDL-978 Series installations require data interfaces to other equipment for complete aircraft installation. The available data interfaces are Control Input (Transceiver Only), GPS Input, Altitude Input, TCAS Input, Display Output, GPS Output, and GPS Predictive RAIM Input. The FDL-978 Series Serial and ARINC ports must be configured to enable these data interfaces and are described in the table below:

Table 4. FDL-978 Series Installation Data Interfaces

Interface	Description
Control Input	Control inputs such as Flight Plan ID (Squawk Code), call sign, and mode control (IDENT, Altitude Inhibit, transmit Standby) are needed by the FDL-978-XVR. The TC978 provides control or the FDL-978-XVR can be configured for other control formats. If a control format is configured and functional with the TC978 installed, the TC978 displays control status but will not accept control inputs. Serial port 2 is typically used for control input. *Control Input is NOT required for receive only systems.*
GPS Input	The FDL-978 Series requires position, velocity, time, and integrity data from a GPS sensor. The internal GPS or an external GPS must be configured to provide this data. *GPS Input is required for all FDL-978 systems.*
Altitude Input	The FDL-978 Series requires external pressure altitude data input from an altitude/air data sensor (ADS). Altitude rate and airspeed will be used if available in the configured protocol. Pressure altitude data output can also be configured to share with a transponder. Serial port 4 is typically used for Altitude Input. *Pressure Altitude Input is required for all FDL-978 systems.*
Heading Input	The FDL-978 Series can optionally receive aircraft true heading data. True heading is sent in UAT transmit messages on the ground and is also used to more accurately correlate TCAS and ADS-B Traffic. Heading input is not required but desirable with TCAS installations.
TCAS Input	TCAS traffic MUST be input to the FDL-978 Series if the aircraft is TCAS equipped so the TCAS traffic can be integrated with ADS-B traffic and a single traffic picture can be presented to the Display Output. The FDL-978 Series accepts TCAS traffic input via ARINC input per the ARINC 735A/B Intruder Labels.

Interface	Description
Display Output	ADS-B traffic and FIS-B data output can be sent to one or more displays simultaneously. A display control can also be configured to provide the *Control Input*. Three different Serial Ports can be configured to simultaneously provide display output: Display on Serial Port 3 Display on Serial Port 5 Display on either Port 2 or 6 ARINC OUT1 can also be configured to output ARINC 735 Intruder Traffic.
GPS Output	FDL-978 Series models with Internal GPS can output GPS position, velocity, time, and integrity data via RS-232 and/or ARINC 429. Internal GPS models will automatically output GPS data in the FFS/Chelton Protocol on port 1. Additionally a serial port (typically port 2) can be configured to output GTX Remote (GPS) protocol data for the GTX 330. Also the ARINC 429 output port can be configured to output ARINC 743B compatible GPS messages.
GPS Predictive RAIM	FDL-978 Series models with Internal GPS can receive and respond to predictive RAIM (PRAIM) requests for a destination or alternate waypoint through RS-232 or ARINC-429. A Flight Management System (FMS) can request the GPS to provide a RAIM prediction on Serial Port 1 input or a PRAIM configured ARINC 429 input and the GPS's PRAIM responses will be sent on Serial Port 1 RS-232 output or the 743B configured ARINC 429 output respectively.

The installer should configure Serial and ARINC ports to specific data functions which provide the necessary data interfaces. All data interface types (except Display Output) from the table above can be configured to *one and only one* Serial or ARINC port.

If multiple Serial/ARINC ports are set to the same data interface type then ***only one*** port is actually configured and other settings of the same data interface type are ignored. The data interface order of precedence is as follows:

1. ARINC 429 ports take precedence over UART Serial ports
2. Lowest port channel number takes precedence over higher channel number

For example, if the FDL-978 Series has an internal GPS and serial in 1 is set to GPS-Internal and ARINC in 1 is set to GPS-743, then the FDL-978 Series *will not* receive GPS data from the internal GPS.

Set *only one* Control Input, *only one* Altitude Input, and *only one* GPS Input. Inadvertently setting more than one of the same input type may result in the correct input data not being received.

Set *only one* Control Input, *only one* Altitude Input, and *only one* GPS Input. Inadvertently setting more than one of the same input type may result in the correct input data not being received.

Only ONE function can typically be set to *either* the input or output of each bi-directional Serial Port (2, 3, 5, or 6). If the serial port input is set to a function then the output should be set to 'UNUSED' and vice versa. If a Serial port's input and output are *both* set *only one* setting is configured and unexpected operation can occur. The exception is if a display output is set on a port output then the port input can be set to display control otherwise the input should be set to 'UNUSED'. (See paragraph 3.3.2.1 and 3.3.2.2 for details).

Control Input is not required for receive only systems.

Using the Android tablet ADS-B MPI application significantly improves system configuration and troubleshooting through use of a graphical user interface (GUI). The ADS-B MPI application includes additional and improved automated status feedback and automatic enforcement of the above configuration rules that is not available when configuring the system with the TC978 or the simple terminal program MPI interface. The ADS-B MPI application requires use of either a Serial-to-Wi-Fi Transceiver, FWF-125 (P/N 86943-00), properly connected to Port 3 or Port 5 or the rechargeable battery powered MPI Module (P/N 87710-00) properly connected to Port 3 or Port 5.

3.3.2.1 Serial Port Input Configuration

The following tables define the serial port input data formats and baud rate settings:

Table 5. Serial Port Input Configuration Settings

Setting (1)	Interface	Description
UNUSED (Not Used)	-	No connection to serial port
ADS (Air Data Sensor)	Altitude Input	Altitude, Airspeed, and Vertical Rate data input. Format for air data sensors using the protocol in Section 6.1.2.
Alt-Encoder (Altitude Encoder)	Altitude Input	Altitude data. Format for air data sensors using the protocol in Section 6.1.1.
Internal-GPS (Internal GPS)	GPS Input	GPS position, velocity, time, and integrity data input and output. Selects use of the internal GPS (models with GPS only). Baud rate must be set to 19200. Internal GPS is only valid for serial port 1. ***The internal GPS data is used by the FDL-978 Series and GPS data is automatically output at 19200 baud on serial output port 1 using the FFS/Chelton Protocol. The output is TSO-C145c Class Beta 1 certified and can be used as an ADS-B position source or navigation source.***
GPS-FFS(6) (GPS-FreeFlight)	GPS Input	GPS position, velocity, time, and integrity data input. Format for the FFS 1201 or other sensors that support the FFS/Chelton Protocol. Typically configured on port 1.
GPS-ADS-B Plus(6) (GPS-GNS ADS-B)	GPS Input	GPS position, velocity, time, and integrity data input. Format for the Garmin Series 400/500 ADS-B Plus GPS Protocol. Typically configured on port 1.
GSL-71 (Control Panel)	Control Input (3)	Squawk Code, IDENT, Call Sign, mode (standby/alt inhibit), and altitude data input. Format for the GSL-71 controller or SL70/R transponder. (2) (7) (8) (9)
GTX-Remote (GTX Remote)	Control Input (3) & GPS Output	Squawk Code, IDENT, Call Sign, and mode (standby/alt inhibit) control input format from GTX 330/33/327/32 transponders. (5) (9) *Internal GPS models will automatically output GTX Remote (GPS) protocol data on the same port. This GPS output is a compliant ADS-B Out position source for the GTX 330/33 with ADS-B Out.*
Disp-Cntrl (TIS/FIS)	Control Input (4)	Squawk Code, IDENT, Call Sign, and mode (standby/alt inhibit). Enables display control from an MX-20, GMX-200, or other displays using the GDL/FDL protocol. The corresponding serial output port must be configured to TIS-FIS or MX-20 at the same baud rate to enable display control input. (3) (9)

(1) MPI setting names are listed first with TC978 configuration menu names in parenthesis ().

(2) Altitude input configuration of the GSL-71/SL70/R can affect the control output baud rate. When passing altitude information from these devices, the baud rate must be set to 9600.

(3) Control Input is not required for receive only systems.

(4) Setting an input port to Disp-Cntrl (TIS/FIS) must correspond to setting the same output port to a display output (e.g. if serial port 6 output is set to Traffic-Alert (TIS/FIS), then serial port 6 input can be set to either a) Disp-Cntrl (TIS/FIS) to enable display control or b) UNUSED (Not Used) to disable display control. ONLY one display port should be set to Disp-Ctrl).

(5) When Port 2 is configured for GTX-Remote Input, it will automatically configure the Port 2 output to provide ADS-B Plus GPS data out to the GTX device.

(6) Refer to Figure 21 and Figure 22 for examples of wiring with one or two pin time mark output.

(7) Do not connect a separate altitude encoder to Port 4 when using the GSL-71 configuration.

(8) The GSL-71 control head must be connected to an altitude encoder with 1ft resolution. Due to the reverse logic of the GSL-71, the UAT status pin (pin 36) must be grounded on the device and a separate ADS-B annunciator or display used to monitor UAT status.

(9) If any port is configured with these settings on a system with a TC978 installed, then the TC978 will not accept inputs and will instead mirror the control inputs coming from the transponder or the display. If control input is lost from another device for 60 seconds, then the TC978 will take over the role as the primary controller.

Table 6. Serial Port Input Baud Rate Settings

Setting	Description
4800, 9600, 19200, 38400, 57600, 115200	These baud rates are typical for RS-232 or RS-422 equipment but the correct rate must be selected to match the interfacing equipment's configured or default baud rate.
230400, 460800	These high baud rates are ***not*** recommended for RS-232 serial ports.

3.3.2.2 Serial Port Output Configuration

The following tables define the serial port output data formats and baud rate:

Table 7. Serial Port Output Configuration Settings

Setting (1)	Interface	Description
UNUSED (Not Used)	-	No connection to serial port
Alt-Encoder (Encoded Altitude)	Altitude Output	Altitude data. Format for sending altitude to a transponder or display using the protocol in Section 6.1.1.
Xpndr-Monitor (XPDR Monitor)	Control Input	Sends requests for Squawk Code and IDENT input data. (Xpndr-Monitor Protocol) This selection requires both serial input and output connections. (2)
Traffic-Alert (TIS/FIS)	Display Output	Ownship data, traffic reports, and FIS-B data. Format for the Aspen, GMX-200, Chelton displays, or other displays using the GDL/FDL protocol. The corresponding serial port input can be configured to Disp-Cntrl to enable display control input. (3)(5) (6)
Pass-Thru (ADS-B Pass Thru)	Display Output	Ownship data, ADS-B traffic data, and FIS-B data. Format for sending unprocessed, uncorrelated, and un-prioritized raw ADS-B messages. Traffic must be processed in another device to meet TSO-C195a ASSAP installation requirements. (3)
MX-20 (MX-20)	Display Output	Ownship data, traffic reports, and FIS-B data. Format for the MX-20. The corresponding serial input port can be configured to Disp Cntrl at the same baud rate to enable display control input. (3) (4)

(1) Maintenance port setting names listed first with TC978 configuration menu setting names in parenthesis ().

(2) Xpndr-Monitor selection requires a serial input and output port for operation. If, I.E., port 2 output is set to Xpndr-Monitor then serial port 2 input is automatically used for Xpndr-Monitor input and serial port 2 input should be set to 'UNUSED'. Only used with FTM-190C at 9600 baud rate. Internal Xpndr-Monitor function is set per Section 3.5.4.13.2.12.

(3) Setting Disp-Cntrl for an input port must correspond to setting a display output on the same output port. (e.g. if serial port 6 output is set to MX-20 or Traffic-Alert then serial port 6 input can be set to Disp-Cntrl to enable control).

(4) For proper traffic and status presentation on legacy displays, review display settings in paragraphs 3.5.4.13.3.2 and 3.5.4.13.3.3 and set accordingly.

(5) When using the FFS Wi-Fi transceiver, ensure port is configured for Traffic Alert.

(6) Configure at baud rate of 38400 when using Chelton FlightLogic display. Ensure CSA bit is set per Section 3.5.4.13.3.2.

Table 8. Serial Port Output Baud Rate Settings

Setting	Description
4800, 9600, 19200, 38400, 57600, 115200	These baud rates are typical for RS-232 or RS-422 equipment but the correct rate must be selected to match the interfacing equipment's configured or default baud rate.
230400, 460800	These high baud rates are not normally recommended for RS-232 serial ports.

3.3.2.3 ARINC 429 Port Input Configuration

The ARINC 429 input data formats and speed configuration settings are described in the following tables:

Table 9. ARINC 429 Port Input Configuration Settings

Setting (1)	Interface	Description
UNUSED (Not Used)	-	No connection to ARINC 429 input port.
ADC (Air Data Computer)	Altitude Input	Altitude, Airspeed, Vertical Rate data input. Format for air data sensors and computers that output the Air Data Computer Labels listed in the table below.
ADC&AHRS (ADC+AHRS)	Altitude & Heading Input	Altitude, Airspeed, Vertical Rate, & True Heading data input. Format for devices that output the Labels listed in the ADC&AHRS table below.
AHRS (AHRS)	Heading Input	True Heading data input. Format for devices that output the True Heading Label 314
Transpndr-Cntrl (Txpdr Control)	Heading Input	Squawk Code, IDENT, and Call Sign. Format for transponders or controllers that output the ARINC Transponder Control Data Labels listed in the table below.
GPS-743 (GPS)	GPS Input	GPS position, velocity, time, and integrity data input. Format for the FFS 1203 and 1203C or other sensors that output the ARINC 743B labels (listed in GPS-743 Labels Table below) and ALSO outputs a Time Mark that is UTC second synchronized.
Traffic (Other 1)	TCAS Input	TCAS Intruder Traffic data input. Format for TCAS that output the Labels listed in the Traffic Input table below.
GPS-PRAIM-743 (Other 2)	GPS Input	Accepts PRAIM input labels from FMS or other ARINC 743 devices.

(1) Maintenance port setting names listed first with TC978 configuration menu setting names in parenthesis ().

Table 10. ARINC Port Input Speed Configuration Settings

Setting	Description
low	Low speed ARINC 429 – 12.5 kBaud
high	High speed ARINC 429 – 100 kBaud

The ARINC 429 Input channels can be configured as the following:

Table 11. GPS-743 Input ARINC Labels

Label	Description
110	Latitude Coarse
120	Latitude Fine
111	Longitude Coarse
121	Longitude Fine
370	Altitude (HAE)
166	North/South Velocity
174	East/West Velocity
112	Groundspeed
103	True Track Angle
165	Vertical Speed
260	Date
150	UTC
130	Horizontal Integrity Limit (HIL)
133	Vertical Integrity Limit (VIL)
247	Horizontal Figure of Merit (HFOM)
136	Vertical Figure of Merit (VFOM)
273	Sensor Status

Table 12. GPS-PRAIM-743 Input ARINC Labels

Label	Description
152	PRAIM Destination ETA
144	PRAIM Destination Latitude
143	PRAIM Destination Longitude

Label	Description
146	PRAIM Satellite Deselect #1
170	PRAIM Satellite Deselect #2

Table 13. Transpnder-Cntrl Input ARINC Labels

Label	Description
016	TCAS/ATC Control (Squawk Code and IDENT only)
031	ATCRBS Control (Squawk Code and IDENT only)
233	Call Sign/Flight ID Characters 1&2
234	Call Sign/Flight ID Characters 3&4
235	Call Sign/Flight ID Characters 5&6
236	Call Sign/Flight ID Characters 7&8

Label 016 or 031 must be present as a minimum.

Labels 016 or 031 control only Squawk Code and IDENT.

Labels 233 – 236, if present, control Call Sign.

Table 14. ADC Format Input ARINC Labels

Label	Description
203	Pressure Altitude
210	Airspeed
212	Altitude Rate

Table 15. AHRS Format Input ARINC Labels

Label	Description
314	True Heading

Table 16. ADC & AHRS Format Input ARINC Labels

Label	Description
203	Pressure Altitude
210	Airspeed
212	Altitude Rate
314	True Heading

Table 17.Traffic Format Input ARINC Labels

Label	Description
274	TCAS Output – Receiver health in System Status
350	Fault Summary – TA only mode set in RI field
314	True Heading
357	RTS and ETX words for Intruder File
130	Intruder Range
131	Intruder Altitude
132	Intruder Bearing

3.3.2.4 ARINC 429 Port Output Configuration

The ARINC 429 output data formats and speed configuration settings are described in the following tables:

Table 18. ARINC 429 Port Output Configuration Settings

Setting (1)	Interface	Description
UNUSED (Not Used)	-	No connection to ARINC 429 output port
Traffic (Traffic)	Display Output	Ownship data and traffic intruder data format for displays that receive the ARINC 735 Traffic Labels listed in the table below (GNS 400/500 series, GNS 480).
GPS-743(2) (GPS)	GPS Output	GPS position, velocity, time, and integrity data output in ARINC 743B labels shown in the table below.

(1) Maintenance port setting names listed first with TC978 configuration menu setting names in parenthesis ().

(2) PRAIM labels output only if the input is configured to accept PRAIM requests.

Table 19. ARINC 429 Port Output Speed Configuration Settings

Setting	Description
low	Low speed ARINC 429 – 12.5 kBaud
high	High speed ARINC 429 – 100 kBaud

The ARINC 429 Output channel can be configured as the following:

Table 20. Traffic Format Output ARINC Labels

Label	Description
274	TCAS Output – Receiver health in System Status
350	Fault Summary – TA only mode set in RI field
357	RTS and ETX words for Intruder File
130	Intruder Range
131	Intruder Altitude
132	Intruder Bearing
270	Vertical Resolution Advisory

Table 21. GPS-743 Output Labels Order

Label	Description
076	GNSS Altitude
101	Horizontal Dilution of Precision
102	Vertical Dilution of Precision
103	True Track
110	Latitude
111	Longitude
112	Ground Speed
120	Latitude Fine
121	Longitude Fine
125	UTC
130	Horizontal Integrity
133	Vertical Integrity
136	Vertical Figure of Merit (VFOM)
140	UTC Fine
141	UTC Fine Fractions
142	Vertical Velocity Figure of Merit
145	Horizontal Velocity Figure of Merit
150	UTC
165	Vertical Speed
166	North/South Velocity
174	East/West Velocity
247	Horizontal Figure of Merit (HFOM)
260	Date
261	Date
273	Sensor Status
370	GNSS Altitude (HAE)
371	Equipment ID
377	Equipment ID
162*	PRAIM Response Destination ETA
343*	PRAIM Response Destination HIL

* PRAIM output only sent if an ARINC input is configured to GPS-PRAIM-743.

3.4 MPI Module Overview

The FreeFlight Systems (FFS) Automatic Dependent Surveillance – Broadcast (ADS-B) Maintenance Port Interface (MPI) module is a battery powered device that communicates with the aircraft's ADS-B equipment maintenance port. It provides Wi-Fi connectivity to an Android device loaded with the free ADS-B MPI app.

3.4.1 MPI Module

The MPI module is connected to the aircraft's ADS-B equipment MPI via a DB-9 female connector configured to Serial Port 5 or Port 3. This allows the ADS-B equipment configuration and functionality to be accessed wirelessly using the ADS-B MPI app. *The MPI module USB micro-AB connector can also be connected to the ADS-B equipment USB micro-AB maintenance connector.*

Figure 11. MPI Module

3.4.2 ADS-B MPI App

The ADS-B MPI app allows the user to configure and verify ADS-B equipment settings, access diagnostic information, log, and play back information. The location of the equipment and the traffic received is also displayed on a graphical map.

3.5 MPI Hardware Configuration

3.5.1 Top Components

Three status Light Emitting Diodes (LED) provide continuous MPI module operational status. These LEDs are Associated (AS), Transmit/Receive (Tx/Rx), and Internet Protocol (IP). The table below describes the LED indications.

Figure 12. MPI Module Top View

Condition	Red (AS)	Yellow (Tx/Rx)	Green (IP)
On Solid	N/A	N/A	Connected
Fast Blink	Not Associated	Data transferring	N/A
Slow Blink	N/A	Data transferring	Connected
Off	Associated, Connection OK	N/A	N/A

3.5.2 Front Component

When Serial Port 3 and Port 5 are configured and interfaced to other equipment (TC978 or display) the connections to the configured device must be temporarily disconnected to use the port for MPI purposes.

The front of the MPI module consists of a male DB-9 connector. An MPI can be provided through Serial Port 3 or Port 5 on the ADS-B equipment DB-44 connector. A female DB-9 connector can be mounted in the aircraft for easy MPI access to one of these ports when not connected to other equipment. Standard RS-232 DB-9 connections are shown in the table below:

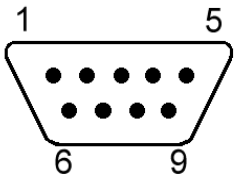


Figure 13. DB-9 Connector

Female DB-9		PORT 5 (DB-44)		PORT 3 (DB-44)	
PIN	**SIGNAL**	**PIN**	**SIGNAL**	**PIN**	**SIGNAL**
2	Tx	J1-42	232 TxD5	J1-24	232 TxD3
3	Rx	J1-26	232 RxD5	J1-23	232 RxD3
5	GND	J1-9	SGND4	J1-18	SGND2

3.5.2.1 Back Components

The back of the MPI module consists of a USB micro-AB plug, battery charge light, and an On/Off switch.

The MPI module includes a rechargeable battery which lasts approximately 8 hours of usage. The battery can be charged through the USB micro-AB socket via a USB micro-A or micro-B to USB B cable connected to a PC USB port or a USB electrical power adapter.

Figure 14. MPI Back View

When connected, the battery recharge light comes on and stays during charging. The light goes off when the module is fully charged. Charge time is typically about 30 minutes.

The MPI module USB micro-AB connector can also be connected to the ADS-B equipment USB micro-AB maintenance connector using a USB micro-B to micro-B cable if a DB-9 connector to Port 5 or 3 is not available.

The On/Off switch turns batter power on and off to the MPI module. The module must be turned on in order to provide a Wi-Fi connection to an Android device running the ADS-B MPI app.

Using the Android tablet ADS-B MPI application significantly improves system configuration and troubleshooting through use of a graphical user interface (GUI), additional and improved automated status feedback, and automatic enforcement of configuration rules not available with the TC978 or the simple terminal program MPI interface when configuring the system. The ADS-B MPI application requires use of either a Serial-to-Wi-Fi Transceiver, FWF-125 (P/N 86943-00), properly connected to Port 3 or Port 5 or the rechargeable battery powered MPI Module (P/N 87710-00) properly connected to Port 3 or Port 5.

3.5.3 Terminal Program Interface

The following 3.5.3 sub-sections describe interfacing directly to the MPI using a terminal interface program on a PC, like “Tera Term,” to enter MPI commands. Any of the four interface devices mentioned above can be used to interface to the PC.

“Tera Term” should be installed on the PC and a MPI connection made via serial port or Wi-Fi depending on the interface device used. Paragraphs 3.5.3.1and 3.5.3.2 detail the serial port and Wi-Fi connection settings.

3.5.3.1 MPI Serial Connection Settings

The typical “Tera Term” serial port settings for a serial connection are:

- BAUD Rate 115200
- Parity – None
- Data bits - 8
- Stop - 1
- Flow Control – None

The default Port 3 settings are Baud Rate: 38400, Parity: odd, Data bits: 8, Stop: 1, and Flow Control: none.

The terminal setup should be set to:

- Local Echo – checked

3.5.3.2 MPI Wi-Fi Connection Settings

A Wi-Fi connection to the Wi-Fi Module SSID must first be made on the PC or Android tablet running the ADS-B MPI app. The typical “Tera Term” TCP settings for the Wi-Fi connection are:

- Host: 192.168.10.1
- TCP Port#: 44000
- Service: Other - 8
- Protocol: UNSPEC

The terminal setup should be set to:

- Local Echo – checked

3.5.3.3 Initial MPI Connection

Once connected to the MPI with a serial or Wi-Fi connection, press the Enter key three times to remove the maintenance lockout. The following prompt should be displayed:

- RANGR-RX> FDL-978-RX
- RANGR-XVR> FDL-978-XVR

3.5.4 Maintenance Commands

The available commands are summarized in the table below:

Command	Description
ads	Display data from the altitude/air data input
bit	Display built-in test status
comm	Display communication ports' status - continuous
control	Display control squawk and mode status
cnfg	Display configuration data
gps	Display data from the GPS input
help or ?	Display command help
info	Display info – S/N, operation hours, versions, etc.
Reset	Reset and restart the unit
rx status	Display receiver status info – continuous
set <item> <value>	Set a configuration item's value
stop	Stop continuous data outputs
cnfg defaults	Reset configuration to defaults
cnfgstatus	Display configuration status

3.5.4.1 "help or ?" Command

This command displays a list of available commands as shown below:

```
help

 AVAILABLE COMMANDS.....
  ads                    Display air data
  bit                    Display POST and PBIT status
  comm                   Display communication ports' status
  control                Display control squawk and mode status
  cnfg                   Display all configuration data
  gps                    Display GPS data
  help or ?              This help
  info                   Display SN, operation hours, versions, etc.
  Reset                  Reset the UAT
  rx status              Display receiver status info
  set <item> <opt>       Set configuration <item> to <opt>
      <item> ---------- ?, addr, emit cat, squat, threshold, nacv, gps,
                        acsize, rx, call sign, gpsant, uatant, max trgs,
                        serial in, serial out, arinc in, arinc out, modeArx
      <opt> ----------- <item> options, enter '?' for usage
  cnfg defaults          Reset configuration to defaults
  cnfgstatus             Display configuration status

RANGR-XVR>
```

3.5.4.2 “ads” Command

This command displays the data from the Altitude/Air Data input interface.

```
RANGR-XVR> ads

 ADS Data from NONE
 Heading Data from NONE
  Altitude:   --- feet, Vert Rate:   --- ft/min, Airspeed: --- knots
  Heading: ---.-°   Altitude above Ground: --- ft
```

3.5.4.3 “bit” Command

This command displays built-in-test information about the FDL-978 Series health. Example output is displayed below:

```
RANGR-XVR> bit
 BIT
 Temperature= 49.75 °C
 External Power= 23.25 V
 Internal Power= 5.05 V
 IC Power= 3.30 V
 RF Tx Pwr= 28.16 V

 POST ==> PASS
  RAM Verify..... P   SDRAM Verify..... P   Temp Sensor ..... P
  UART1 Loopback... P   UART2 Loopback... P   UART3 Loopback... P
  UART4 Loopback... P   UART5 Loopback... P   UART6 Loopback... P
  ARINC1 Loopback.. P   ARINC2 Loopback.. P
  PM/Checksum.... F/F   Cnfg/Checksum.. P/P   Calibration..... P
  Tx Pwr Control... P   Tx Synthesizer... P   Tx Modulator..... P
  FPGA Enabled..... P   FPGA Data Bus.... P   Rx Synthesizer... P

 PBIT ==> FAIL
  Valid Address.... P   Temperature..... P   Input DC Power... P
  GPS Data Good.... F   GPS PPS Good..... F   GPS Comm Good.... P
  ADS Data Good.... F   ADS Comm Good.... F
  Tx Msg Good...... P   Tx PLL Lock..... P   TX PS Good..... P
  UAT Tx Power..... P   BroadcastMonitor. P   Nominal Msg Rate. P
  Rx Own Msg....... P   Rx PLL Lock..... P
  Top Antenna...... P   Bottom Antenna... P
```

3.5.4.4 “comm” Command

This command continually displays serial port communication status information: enabled/disabled status and receive and transmit byte count and errors. The data is updated once per second. Example output is displayed below:

```
Serial Comm:
Port   Status      Baud(Set/Act) P  Rx Count    Tx Count    RxErr    TxErr
-------------------------------------------------------------------------
 1     ENABLED      19200/ 19345 N     553202           2        0        0
 2     DISABLED   115200/116071 N          2           2        0        0
 3     ENABLED      38400/ 38385 O          2           2        0        0
 4     DISABLED   115200/115205 N          2           2        0        0
 5     ENABLED    115200/115205 N         72       69726        0        0
 6     DISABLED   115200/115205 N          2           2        0        0

ARINC Comm:
Port   Status      Speed    Rx Count    Tx Count
-----------------------------------------------
IN1    DISABLED    high              1           0
IN2    DISABLED    high              1           0
OUT1   DISABLED    high              0           1
```

Type the “stop” command to stop updating and return to the prompt.

3.5.4.5 “control” Command

This command displays the control, squawk and mode status including the Squawk Code, IDENT status, altitude control status, call sign, transmit control status and vertical status.

```
RANGR-XVR> control

 Squawk: 1200, IDENT OFF, ALT Transmit, Tx ON, AIRBORNE,
 CallSign: 22222   , Emergency: 0- None
```

3.5.4.6 “gps” Command

This command displays data which is being received from the GPS input.

```
GPS Info

Configuration: Internal GPS - gamma1, 19200
Source: Internal - FFS
SWVer: 1.10

Date:  3/16/2015  UTC Time: 15:26:10 (55570)

 Mode    Latitude   Longitude   Alt NSVel EWVel GSpd  Track    VertV
 SBAS  32.91725°N  96.98651°W   400     0     0    0 111.1°tt      0

   HIL (NIC)    HFOM(NACp)    VFOM(GVA)   VHFOM(NACv)   VVFOM         VIL
0.0231nm( 9)  0.0188nm( 9)   78.63ft(2)    0.17m/s(4)    0.24m/s  209.50ft

Message Counts:
 Msgs:  5300  Nav:  1325  Status:  1325  Aux:  1325  Other:  1325

Status
 Comm:1  Valid:1  Lat:1  Lon:1  FDE:0  SBAS:1  SATu: 0
 Fail:0  NoWAAS:0  neWASS:0  neSAT:0  Ex:0  Ao:1  As:0  SR:0  Osc:0  PL:0
 RTC:0  sbasH:0  ALM:0  RF:0  EEPROM:0  SDRAM:0  Step:0
```

3.5.4.7 “info” Command

This command displays information such as Serial Number, operation time and hardware and software version information about the FDL-978 Series. Example output is displayed below:

```
RANGR-XVR> info

 RANGR-XVR, Internal Gamma1 GPS, No DB-44 Port 5

   Serial Number........ 1305X066
   Operation Time....... 1321.9 hrs
   HW Version........... 4.1
   Boot Version......... 1.0.1.80
   Boot Checksum........ 0xE18AD740
   Boot Build Time...... 07/20/2014 20:11:20
   SW Version........... 1.10.1.95
   SW Checksum.......... 0x541639C6
   SW Build Time........ 05/18/2015 10:07:40
   FPGA Version......... 1.3
   FPGA Build ID........ 0x520F155E
   FPGA Build Time...... 05/04/2015 15:11:40
   GPS Version.......... 1.10
```

3.5.4.8 “Reset” Command

This command causes the FDL-978 Series to reboot.

```
RANGR-XVR> Reset
5
```

3.5.4.9 “rx status” Command

This command displays detailed status and other information about the ADS-B data being received by the FDL-978 Series. Example output is displayed below:

```
UTC Sec:          55056

Msgs Rxd:   Total   LstSec  RSErr:1     2     3     4     5     6    >6   Ovr
UTC Sec:          55060

Msgs Rxd:   Total   LstSec  RSErr:1     2     3     4     5     6    >6   Ovr
-------------------------------------------------------------------------------
 Uplink         0        0        0     0     0     0     0     0     0     0
 Basic        415        0        1     1     1     0     1     1     0     0
 Long         411        2        1     0     1     0     0     1     0     0
 1090ES         0        0        0                                        0

Traffic:   2  Tracks:   2  TCAS:   0  NBAir:  2  Air:  2  Gnd:  0  Other:   0
 #   Addr Typ CallSign   Latitude   Longitude    Alt   Spd G   Msgs  SSI   Range TOs
-------------------------------------------------------------------------------s
OWN      0 ABi XXXXXXXX 32.91716øN  96.98649øW    ---     0 A      0    0     0ft  0s
 1       2 ABi BILL001  32.91716øN  96.98649øW    ---     0 A    409  -89    25ft 24s
 2 ADFBA2 ABi GNDTEST  32.91716øN  96.98651øW    400     0 A    415  -65    49ft 24s
 3
 4
 5
 6
 7
 8
 9
10

Ground Stations:    0  Service Status: 0
 #     Latitude   Longitude Site Slt   Msgs SSI SS   Range TO
-------------------------------------------------------------
 1
 2
 3
 4
 5
 6
 7
 8
 9
10
```

The output displayed contains an initial section with general count information (current UTC second, receiver loop count, and receiver word count). These counts will increment at varying rates when the receiver is operating correctly.

The next rx status output section displays general message count information for ground Uplink, basic, and long message types. The displayed counts include total messages received (Total), messages received in the last second (LstSec) and messages with various counts of corrected Reed-Solomon errors (RSErr:x).

The third rx status section displays detailed traffic information. This information includes total number of traffic targets being tracked and then detailed information about the ownship data being received and the 10 closest traffic targets. The detailed traffic information includes address (Addr), address type (Typ), Call Sign, Latitude, Longitude, altitude in feet (Alt), speed in knots (Spd), air ground status (AG), message count (msgs), signal strength indication in dBm (SSI), and traffic time out in seconds (TO).

Traffic targets will time out being tracked if no ADS-B message is received from the target for more than twenty five seconds.

The fourth rx status section displays detailed ground station information. This information includes total number of ground stations being received and detailed information about the 10 closest ground stations. The detailed ground station information includes Latitude, Longitude, Site ID, time slot of last transmission, message count (Msgs), signal strength indication (SSI) in dbm, and ground station time out in seconds (TO).

Ground stations will time out being tracked if no ADS-B uplink message is received from the ground station for more than forty seconds.

Type the “stop” command to stop updating rx status and return to the prompt.

3.5.4.10 “cnfg” Command

This command displays configurable information such as the serial port settings (protocol and baud rate), the ICAO address, and the VFR Call Sign. Example output is displayed below:

```
RANGR-XVR> cnfg

 ICAO Address.............. FF00
 VFR Call Sign............. FFSSKIES
 GPS Config................ Level C
 NACv Mode................. Auto (from GPS)
 Receiver Config........... no1090, 978
 Emit Category............. LIGHT AIRCRAFT
 Squat Mode................ none
 Groundspeed Threshold..... 0 knots
 Vehicle Size.............. Length=0 meters, Width=0 meters
 UAT Ant................... bottom, No DC Gnd Chk
 GPS Ant Offset............ Long=No Data, Lateral=No Data
 Mode A Rx................. disable
 Disable Squawk Tx......... off
 Max Targets............... max
 Chelton CSA Enable........ disable
 Traffic Vel Validation.... enable
 Display Data Output....... traffic&fisb
 Serial In  1.............. Internal-GPS, 19200
 Serial In  2.............. GTX-Remote, 9600
 Serial Out 2.............. UNUSED, 9600
 Serial In  3.............. TMAP, 38400
 Serial Out 3.............. TMAP, 38400
 Serial In  4.............. UNUSED, 9600
 Serial In  5.............. MAINT, 115200
 Serial Out 5.............. MAINT, 115200
 Serial In  6.............. UNUSED, 9600 (RS-422)
 Serial Out 6.............. UNUSED, 9600 (RS-422)
 ARINC In 1................ UNUSED, low
 ARINC In 2................ UNUSED, low
 ARINC Out 1............... UNUSED, low
```

3.5.4.11 "cnfgstatus" Command

This command displays a summary of the Serial/ARINC port configuration status for various interfaces (GPS, Altitude, Control, Display, etc.). Details are shown on what port is configured and data reception status for each of the functional interfaces.

```
RANGR-RX> cnfgstatus

 ADS:      Alt-Encoder, Serial In 4 (19200), Rx: NO-RX,
 AHRS:     NONE CONFIGURED
 Alt-Out:  NONE CONFIGURED
 GPS:      GPS-FFS, Serial In 1 (19200), Rx: VALID,Internal,Position Acquired
 TCAS:     Traffic, ARINC In 1 (high), Rx: NO-RX,
 TC978:    NONE CONFIGURED
 TCntrl:   NONE CONFIGURED
 ModeARx:  NOT CONFIGURED
 Disp1:    Traffic-Alert, Serial Out 2 (115200), Ctrl Disabled, Rx:
 P3Disp:   MAINT, Serial Out 3 (115200)
 P5Disp:   MAINT, Serial Out 5 (115200)
 A-Traf:   Traffic, ARINC Out 1 (high)

RANGR-RX>
```

3.5.4.12 "cnfg defaults" Command

This command resets all configuration values to default factory settings.

```
RANGR-RX> cnfg defaults
Configuration Reset to defaults
RANGR-RX>
```

3.5.4.13 "set" Command

This command is used to modify configuration settings such as ICAO address, call sign, and serial port function. Help on this command is displayed by entering "set ?". Example "set ?" output is displayed below.

```
RANGR-XVR> set ?

 USAGE: set <item>

  <item>      Configuration item to set. Item options:
    ?                                   This help
    addr [hex]                          ICAO address (6 hex characters)
    emit cat [num]                      Emitter category number
    squat [opt]                         Squat switch option (none, low, or high)
    threshold <num>                     ON GROUND groundspeed threshold
    nacv <num>                          GPS NACv mode
    acsize <len> <width>                Vehicle length and width
    gps <opt>                           GPS configuration data
    rx <opt>                            Installed receiver(s) capability
    call sign <chars>                   VFR default call sign (8 characters)
    gpsant <lat> <lon>                  GPS antenna offset
    uatant <opt> <dcgnd>                UAT antenna mode and DC ground check
    serial in [port] [func] [baud]      Serial in port protocol and baud rate
    serial out <port> <func> <baud>     Serial out port protocol and baud rate
    arinc in <port> <func> <speed>      Arinc in port protocol and speed
    arinc out <port> <func> <speed>     Arinc out port protocol and speed
    max trgs <opt>                      Maximum number of targets received
    modeArx <opt>                       Mode A receive
    disableSquawkTx <opt>               Disable transmit squawk/flight plan id
    cheltonCSA <opt>                    Enable CSA for Chelton
    trafVelVal <opt>                    Disable traffic velocity validation
    displayout <opt>                    Display Output Data
```

3.5.4.13.1 Serial and ARINC Port Settings

This section describes the configuration settings for serial and ARINC port functionality.

3.5.4.13.1.1 "set serial in" Command

This command sets the Serial Port Input configuration options. Help on this command is displayed by entering "set serial in ?". Example "set serial in ?" output is displayed below:

```
RANGR-XVR> set serial in ?

 USAGE: set serial in <port> <func> <baud> <hwtype>

  <port>      Serial port number:  1, 2, 3, 4, 5, 6,

  <func>      Interface function/protocol:
              Port 1:
                 UNUSED, GPS-FFS, GPS-ADSBPlus, Internal-GPS,
              Port 2:
                 UNUSED, GPS-FFS, GPS-ADSBPlus, ADS, Alt-Encoder,
                 GSL-71, GTX-Remote, Disp-Ctrl,
              Port 3:
                 MAINT, TC-Control, TC-Monitor, TC-Out, UNUSED,
                 TMAP, Disp-Ctrl,
              Port 4:
                 UNUSED, GPS-FFS, GPS-ADSBPlus, ADS, Alt-Encoder,
                 GSL-71, GTX-Remote,
              Port 5:
                 MAINT, UNUSED, Disp-Ctrl,
              Port 6:
                 UNUSED, GPS-FFS, GPS-ADSBPlus, ADS, Alt-Encoder,
                 GSL-71, Disp-Ctrl,

  <baud>      4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800,

  <hwtype>    RS-232, RS-422,  (Port 6 ONLY)

RANGR-XVR> set serial in 4 19200 rs-232
 Serial In  4.............. UNUSED, 19200
```

Refer to Section 3.3.2.1 for information on selecting serial input settings.

87098-00 and 87098-10 Transceivers do not allow Serial Port 5 settings.

3.5.4.13.1.2 "set serial out" Command

This command sets the Serial Port Output configuration options. Help on this command is displayed by entering "set serial out ?". Example "set serial out ?" output is displayed below:

```
RANGR-XVR> set serial out ?

 USAGE: set serial out <port> <func> <baud> <hwtype>

  <port>      Serial port number:  2, 3, 5, 6,

  <func>      Interface function/protocol:
              Port 2:
                 UNUSED, Alt-Encoder, Traffic-Alert, Pass-Thru,
                 Xpndr-Monitor, MX-20,
              Port 3:
                 MAINT, TC-Control, TC-Monitor, TC-Out, UNUSED,
                 TMAP, Traffic-Alert, Pass-Thru, MX-20,
              Port 5:
                 MAINT, UNUSED, Traffic-Alert, Pass-Thru, MX-20,
              Port 6:
                 UNUSED, Alt-Encoder, Traffic-Alert, Pass-Thru,
                 Xpndr-Monitor, MX-20,

  <baud>      4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800,

  <hwtype>    RS-232, RS-422,  (Port 6 ONLY)

RANGR-XVR> set serial out 6 Alt-Encoder RS-232
 Serial In  6.............. UNUSED, 19200 (RS-232)
 Serial Out 6.............. Alt-Encoder, 19200 (RS-232)
```

Refer to Section 3.3.2.2 for information on selecting serial output settings.

Serial Port 4 is input ONLY and does not accept output settings.

87098-00 and 87098-10 Transceivers do not allow Serial Port 5 settings

3.5.4.13.1.3 "set arinc in" Command

This command sets the ARINC 429 input configuration for ports 1 and 2.

Refer to Section 3.3.2.3 for information on selecting ARINC input settings.

```
RANGR-XVR> set arinc out ?
 USAGE: set arinc out <port> <func> <speed>
  <port>      ARINC port number:  1,
  <func>      Interface function/protocol:
              Port 1:
                 UNUSED, GPS-743, Traffic,
  <speed>     Speed: low, high
RANGR-XVR> set arinc out 1 GPS-743 high
 ARINC Out 1.............. GPS-743, high
```

3.5.4.13.1.4 "set arinc out" Command

This command sets the ARINC 429 output configuration for port 1. Note that there is only one ARINC 429 output port.

Refer to Section 3.3.2.4 for information on selecting ARINC output settings.

```
RANGR-XVR> set arinc out ?
 USAGE: set arinc out <port> <func> <speed>
  <port>      ARINC port number:  1,
  <func>      Interface function/protocol:
              Port 1:
                 UNUSED, GPS-743, Traffic,
  <speed>     Speed: low, high
RANGR-XVR> set arinc out 1 GPS-743 high
 ARINC Out 1.............. GPS-743, high
```

3.5.4.13.2 ADS-B Transmit Settings

This section describes configuration settings mainly for transmitting ADS-B messages. Some of these settings are relevant for receiver only units as well.

3.5.4.13.2.1 "set addr" Command

This command is used to set the ICAO address of the aircraft. For example, to set the ICAO address to ABCD12, enter "set addr ABCD12." The ICAO address must be entered as a hex value. *The FDL-978 Series requires the ICAO to be set to the aircraft's registered ICAO address.* This should be set for receivers and transceivers.

```
RANGR-XVR> set addr ?
 USAGE: set addr <chars>
  <hex>      ICAO address - up to 6 hexidecimal characters (0-9 & A-F)
RANGR-XVR> set addr 5150BD
 ICAO Address.............. 5150BD
```

3.5.4.13.2.2 "set call sign" Command

This command sets the default call sign of the aircraft and is typically the aircraft tail number. For example, to set the call sign to ABCD1234, enter "set call sign ABCD1234." The default call sign is transmitted by a Transceiver if a call sign setting is not received from a configured transmit controller (transponder, TC978, etc.). In a receiver the default call sign is for informational purposes only.

```
RANGR-XVR> set call sign ?
 USAGE: set call sign <chars>
  <chars>    Default Call Sign - 8 characters (0-9 & A-Z)
RANGR-XVR> set call sign FFSSKIES
 VFR Call Sign............. FFSSKIES
```

3.5.4.13.2.3 "set gps" Command

This command sets the system design assurance level for the GPS input. Internal GPS should be set to Level C. For external GPS units refer to the GPS manufacturer's data for setting system design assurance level. This should be set for both receivers and transceivers.

```
RANGR-XVR> set gps ?
 USAGE: set gps <opt>
  <opt>      GPS SW design assurance level:
              U, D, C, B,
RANGR-XVR> set gps C
 GPS Config................ Level C
```

3.5.4.13.2.4 “set nacv” Command

This command sets the Navigation Accuracy Category for velocity (NACv) for the GPS input. Internal GPS should be set to 3 (auto). For external GPS units refer to the GPS manufacturer’s data for setting NACv. This should be set for both receivers and transceivers.

```
RANGR-XVR> set nacv ?

 USAGE: set nacv <num>

  <num>       NACv mode number for GPS:
               0 : UNKNOWN
               1 : <10 m/s
               2 : <3 m/s
               3 : Auto (from GPS)

RANGR-XVR> set nacv 2
 NACv Mode.................. <3 m/s
RANGR-XVR>
```

3.5.4.13.2.5 Set gps “set rx” Command

This command sets the receiver installed options to be transmitted by a Transceiver. Transceivers should be set to 978 and no1090. It is not necessary to set this for a receiver only.

```
RANGR-XVR> set rx ?

 USAGE: set rx <opt>

  <opt>      Installed receiver Capabilities:
              no1090, 1090, no978, 978,

RANGR-XVR> set rx 1090
 Receiver Config........... 1090, no978
```

3.5.4.13.2.6 "set emit cat" Command

This command sets the emitter category of the aircraft and must be set to something other than the default of 0 (no aircraft type). This should be set for transceivers and receivers.

```
RANGR-XVR> set emit cat ?

 USAGE: set emit cat <num>

  <num>       Vehicle emitter category number:
               0 :  NO AIRCRAFT TYPE
               1 :  LIGHT AIRCRAFT
               2 :  SMALL AIRCRAFT
               3 :  LARGE AIRCRAFT
               4 :  HIGH VORTEX LARGE
               5 :  HEAVY AIRCRAFT
               6 :  HIGH PERFORM AC
               7 :  ROTORCRAFT
               8 :  GLIDER/SAIL
               9 :  undefined
              10 :  LIGHTER THAN AIR
              11 :  PARACHUTIST
              12 :  ULTRALIGHT/HG
              13 :  undefined
              14 :  UAV
              15 :  SPACE VEHICLE
              16 :  undefined
              17 :  EMERGENCY VEHICLE
              18 :  SURFACE VEHICLE
              19 :  POINT OBSTACLE
              20 :  CLUSTER OBSTACLE
              21 :  LINE OBSTACLE

RANGR-XVR> set emit cat 5
 Emit Category.............. HEAVY AIRCRAFT
RANGR-XVR>
```

3.5.4.13.2.7 "set squat" Command

This command sets the active state (low or high) for the Squat Switch of the aircraft or to indicate there is no active Squat Switch. The Squat Switch (or other air/ground determination discrete) is an automatic means to indicate when the aircraft is on the ground or in the air. This should be set for transceivers and receivers.

```
RANGR-XVR> set squat ?

 USAGE: set squat <opt>

  <opt>       squat switch configuration:
              none    No squat switch input
              low     Low input for ON GROUND
              high    High input for ON GROUND

RANGR-XVR> set squat low
 Squat Mode................. low
```

3.5.4.13.2.8 "set threshold" Command

This command sets the groundspeed threshold which is used to determine when the aircraft is on the ground if an automatic means (Squat Switch) is not configured for the Light Aircraft (1) Emitter Category only. A groundspeed of less than the threshold indicates the aircraft is on the ground. Setting this parameter is only required for transceivers.

```
RANGR-XVR> set threshold ?
 USAGE: set threshold <knts>
  <knts>     Groundspeed threshold for Air/Gnd switching:
          0, 30, 40, 50, 60, 70, 80, 90, 100, 120,
  NOTE: Groundspeed threshold for (1)LIGHT AIRCRAFT Emit Category only
RANGR-XVR> set threshold 53
 Groundspeed Threshold..... 50 knots
```

3.5.4.13.2.9 "set acsize" Command

This command sets the aircraft size that is used to set the aircraft size code transmitted by the transceiver. Setting this parameter is only required for transceivers.

```
RANGR-XVR> set acsize ?
 USAGE: set acsize <len> <width>
  <len>      Aircraft length in meters (0-100)
  <width>    Aircraft width in meters (0-100)
  NOTE: Odd values are rounded down to nearest even meter
RANGR-XVR> set acsize 20 50
 Vehicle Size.............. Length=20 meters, Width=50 meters
```

3.5.4.13.2.10 "set uatant" Command

This command sets the UAT antenna configuration. This should be set for transceivers and receivers.

```
RANGR-XVR> set uatant ?
 USAGE: set uatant <opt> <dcgnd>
  <opt>      Antenna configuration:    dual, top, bottom
  <dcgnd>    Antenna DC ground check:  nochk, check
RANGR-XVR> set uatant dual check
 UAT Ant................... dual, DC Gnd Chk
```

3.5.4.13.2.11 "set gpsant" Command

This command sets the GPS antenna configuration. This should be set for transceivers but is not necessary for receivers.

```
RANGR-XVR> set gpsant ?
 USAGE: set gpsant <lon> <lat>

  <lon>       GPS antenna longitudinal offset:
               0 : No Data
               1 : Offset Applied by Sensor
              2-60 : Distance from AC nose in even valued meters

  <lat>       GPS antenna lateral offset:
               0 : No Data
               1 : Left 2 meters
               2 : Left 4 meters
               3 : Left 6+ meters
               4 : Center
               5 : Right 2 meters
               6 : Right 4 meters
               7 : Right 6+ meters
               8 : No Data

RANGR-XVR> set gpsant 5 4
 GPS Ant Offset..... Long=4 meters, Lateral=Center
```

3.5.4.13.2.12 "set modeArx" Command

This command enables/disables Mode A code reception from the on-aircraft Mode A/C transponder. When enabled Flight Plan ID (Squawk Code) and IDENT are received from the on aircraft's Mode A/C transponder via its RF transmissions. The default setting is "disable." This is only used with transceivers and should not be set in receiver only units. This should be set to "enable" if using the external or internal Xpndr-Monitor functions.

```
RANGR-XVR> set modeArx ?

 USAGE: set modeArx <opt>

  <opt>       enable, disable

RANGR-XVR> set modeArx enable
 Mode A Rx.................. enable
```

3.5.4.13.2.13 "set disableSquawkTx" Command

This command disables the Squawk Code transmissions over the UAT datalink when set to "on." This setting should not be set to "on" and left to the default "off" setting. This is only used with transceivers and should not be set in receiver only units.

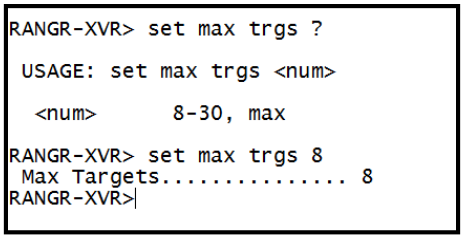
```
set disableSquawkTx ?

 USAGE: set disableSquawkTx <opt>

  <opt>       on, off

RANGR-XVR> set disableSquawkTx on
 Disable Squawk Tx......... on
RANGR-XVR>
```

3.5.4.13.3 Display Output Settings

This section describes configuration settings for controlling traffic display output typically for legacy displays.

3.5.4.13.3.1 "set max trgs" Command

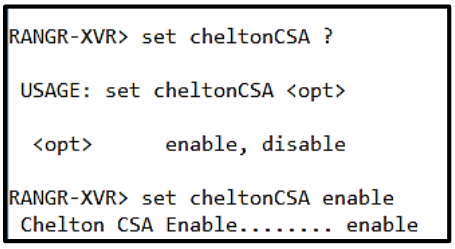
This command sets the maximum number of targets to be sent on any configured serial or ARINC 429 port configured for traffic display output. This is typically used to limit the number of traffic targets for displays that can process a large number of traffic targets.



3.5.4.13.3.2 "set cheltonCSA" Command

This command enables/disables the (Conflict Situational Awareness) CSA bit in the Heartbeat message of the "Traffic-Alert" protocol. This parameter defaults to "disable" and should *ONLY* be set to "enable" when interfacing to a Chelton FlightLogic Display. The Chelton display is not TSOC-195a compliant and requires this Heartbeat message bit to be set or it will generate an ADS-B failure. The FDL-978-XVR does *not* implement a Conflict Situation Awareness (CSA) algorithm since DO-217A and TSOC-195a do not currently specify any CSA applications. For all other displays leave this parameter at the default setting of "disable."

The FDL-978-XVR does not implement a CSA algorithm since DO-217A and TSOC-195a do not currently specify any CSA applications.



3.5.4.13.3.3 "set trafVelVal" Command

This command enables/disables the DO-317A/TSOC-195A Traffic Velocity Validation\Invalidation of legacy ADS-B Transmitters that transmit NACv values of 0. This parameter defaults to "enable" and should *ONLY* be set to "disable" when interfacing to legacy displays that are 1) *not* TSOC-195a compliant and 2) *do not* adequately display non-directional traffic symbols. Several non-TSOC-195a displays adequately display non-directional traffic and do not require velocity validation/invalidation to be disabled.

The FDL-978 Series attempts to validate NACv=0 velocities per DO-317A/TSOC-195a but some traffic states (low-speed ground) will still cause the NACv=0 track velocities to be invalidated and sent to the display as non-directional traffic. Setting this parameter to "disable" turns off all DO-317A/TSOC-195a velocity validation/invalidation and passes the track's velocity

data to the display as directional traffic. This parameter should *only* be set to “disable” for legacy non-TSO-C195a displays without non-directional traffic symbols when occasional display of non-directional traffic is deemed to be unacceptable or misleading. Otherwise leave this parameter at the default setting of “enable.”

The legacy MX-20 Display does not support non-directional traffic symbols and instead displays a directional traffic symbol pointing at approximately 120 degrees from North. For compatibility with the ADS-B system, the traffic velocity validation should be set to “enable” for this display.

```
RANGR-XVR> set trafVelVal ?

 USAGE: set velValDisable <opt>

  <opt>      enable, disable

RANGR-XVR> set trafVelVal enable
 Traffic Vel Validation.... enable
```

3.5.4.13.3.4 “set displayout”

“trafficOnly” will provide traffic information to the display (position, ground track, etc.) but no weather or other flight information.

“fisbOnly” will provide weather and flight information (NOTAMS, TFRs, ATIS, etc.) but no traffic.

“traffic&fisb” will provide traffic, weather, and flight information simultaneously.

This command allows the installer to set the type of data to be sent to the display. The installer can configure the FDL-978-XVR to output traffic only, FISB only, or both. By default, the FDL-978-XVR will output the traffic and FISB data to the display.

```
RANGR-XVR> set displayout ?
 USAGE: set displayout <opt>
  <opt>      traffic&fisb, fisbOnly, trafficOnly,
RANGR-XVR> set displayout fisbOnly
 Display Data Output..... fisbOnly
```

3.6 Configuration and Setup Using TC978

Do not use Configuration Mode during flight.

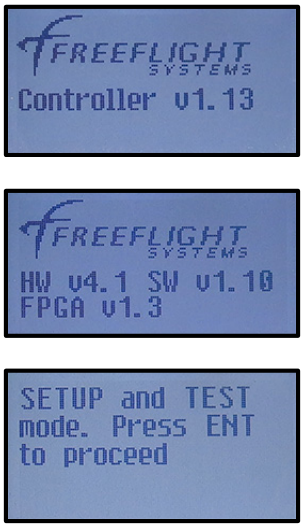
The system should be configured during initial system installation by a qualified technician. The configuration items list in 3.3.1 should be used to document the system installation for future reference. To view or change these settings you must enter TC978 Configuration Mode.

The configuration setup screen is the first thing displayed on startup when a completely new FDL-978 Lite Series and FDL-978-XVR system is installed and powered up for the first time. After a configuration has been programmed, the system will power up in normal operating mode and the configuration will be stored in the FDL-978-XVR or FDL-978 Lite Series.

3.6.1 Entering Configuration Mode

To enter TC978 configuration mode:

- Hold down the FN button while turning the Mode Selection knob from OFF to any operating mode.
- In the configuration mode the TC978 Controller displays the following typical messages in a quick, sequential order:

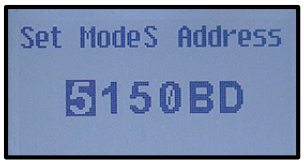


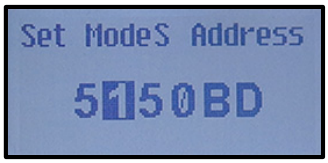
3.6.2 FDL-978-XVR Configuration Mode Operation

The following paragraphs detail the setup modes available for configuring the FDL-978-XVR. Configuration items can be changed using the CODE knob and the ENT button. Pressing the FN button advances to the next configuration item.

3.6.2.1 Aircraft Mode S (or ICAO) Address

The Mode S address is a 24 bit number assigned to the aircraft and is represented in a six character hexadecimal format. The CODE knob is used to change each character as required. Each character of the Mode S address is a number between 0 to 9 or a letter between A to F. When the ENT button is pressed the cursor advances to the next character as shown below.





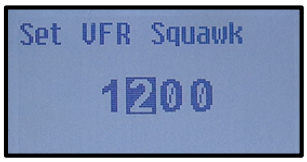
To advance to the next configuration item without changing the ICAO address either scroll through the six characters by pressing the ENT button six times or press the FN button.

3.6.2.2 VFR Squawk Code

VFR Squawk Code is a pre-programmed default code when the pilot is flying VFR and not in contact with ATC. When the pilot presses the VFR button, the VFR Squawk Code will replace the current Squawk Code. In the USA, the VFR Squawk Code is 1200 and in most parts of Europe the VFR Squawk Code is 7000.

The default VFR Squawk Code cannot be changed in-flight and can only be set in the configuration mode.

The VFR Squawk Code is a 12 bit number and is represented as a four character octal number. The CODE knob is used to change each character as required. Each character of the Squawk Code is a number between 0 and 7. When the ENT button is pressed the cursor advances to the next character as shown below.



To advance to the next configuration item without changing the VFR Squawk Code either scroll through the four characters by pressing the ENT button four times or press the FN button.

3.6.2.3 VFR Flight ID

The VFR Flight ID (aka Call Sign) is usually one of the following types:

- Type A – The characters corresponding to the registration marking of the aircraft.
- Type B – The telephony designator of the aircraft operating agency, followed by the last four characters of the registration marking of the aircraft.

- Type C – The telephony designator of the aircraft operating agency, followed by the flight identification.

The VFR Flight ID is an eight character alpha-numeric string. The CODE knob is used to change each character as required. Each character of the Flight ID is a number between 0 to 9 or letter between A to Z. When the ENT button is pressed the cursor advances to the next character as shown below.

To advance to the next configuration item without changing the VFR Flight ID either scroll through the eight characters by pressing the ENT button eight times or press the FN button.

The VFR Flight ID cannot be changed in-flight and can only be set in the configuration mode.

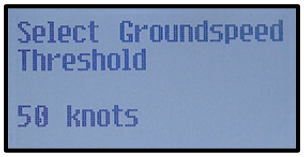
3.6.2.4 Groundspeed Threshold

Groundspeed threshold can be used to help determine and verify the ON GROUND condition for transmitting ON GROUND ADS-B message types for “Light Fixed Wing” aircraft types only. The FDL-978-XVR uses the ground speed threshold configuration to determine a maximum ON GROUND speed. There are 10 options to select groundspeed threshold:

1. Unknown
2. 30 knots
3. 40 knots
4. 50 knots
5. 60 knots
6. 70 knots
7. 80 knots
8. 90 knots
9. 100 knots
10. 120 knots

This only applies to an Emitter Category of Light Aircraft – no other categories use a configurable groundspeed threshold.

The display screen is as shown below with one of the options from the list above.



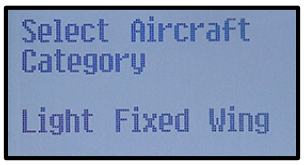
Rotate the CODE knob to display the options above and select the groundspeed threshold. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

3.6.2.5 Aircraft (Emitter) Category

The following options are offered for selecting aircraft (emitter) category:

1. Unknown
2. Light Fixed Wing
3. Medium Fixed Wing
4. Large Fixed Wing
5. High Vortex B757
6. Heavy Fixed Wing
7. High G/ High Speed
8. Rotorcraft
9. Glider/Sailplane
10. Lighter than air
11. Parachutist
12. ULM/Hang/Paraglider
13. UAV

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct aircraft category. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

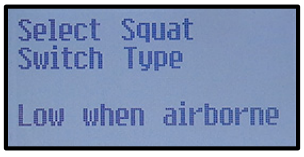
3.6.2.6 Squat Switch Type

Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct Squat Switch type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

The following options are offered for selecting aircraft Squat Switch type:

1. Not Connected
2. Low when ground
3. Low when airborne

The display screen is as shown below with one of the options from the list above.



3.6.2.7 Serial IN Channel X Data Type

(X = channel number) The FDL-978-XVR can receive data via four serial channels. The following options are offered for selecting serial input type for each individual input serial channel of the FDL-978-XVR:

Channel 1

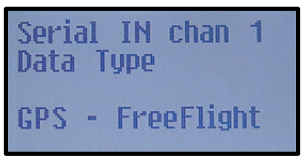
1. Not Used
2. GPS-FreeFlight
3. GPS-GNS ADS-B
4. GPS Internal

Channel 2, 4, or 6

1. Not Used
2. GPS-FreeFlight
3. GPS-GNS ADS-B
4. Air Data Computer
5. Altitude Encoder
6. Control Panel*
7. GTX Remote (not available for Channel 6)
8. TIS/FIS (not available for Channel 4) Refer to Section 3.3.2.1 for details on selecting serial input settings.

*The TC978 will not accept control inputs and will mirror the transponder or primary controller. If communication with the primary controller is lost for 60 seconds, then the TC978 will assume the role of the controller and allow control inputs (squawk, IDENT). If the TC978 is used in this manner, it is strongly recommended to set the squawk code first on the transponder before entering it into the TC978.

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct serial input type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

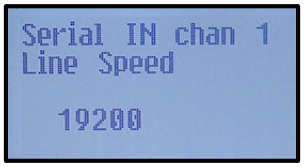
If “Not Used” is selected then the serial input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

3.6.2.8 Serial IN Channel X Line Speed

(X = channel number) The following options are offered for selecting the serial input baud rate for each channel data type:

1. 4800
2. 9600
3. 19200
4. 38400
5. 57600
6. 115200
7. 230400

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct serial input speed. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

3.6.2.9 Serial OUT Channel X Data Type

(X = channel number) The FDL-978-XVR can transmit data via two serial channels. The following options are offered for selecting serial output type for each individual channel of the FDL-978-XVR:

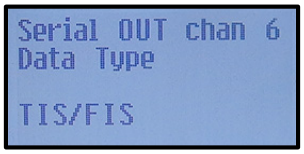
Channel 2 or 6

1. Not Used
2. Encoded Altitude
3. TIS/FIS
4. ADS-B Pass Thru
5. XPDR Monitor*
6. MX-20

* Only used in conjunction with FTM-190C, external Transponder Monitor.

Refer to Section 3.3.2.2 for details on selecting serial output settings.

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct serial output type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

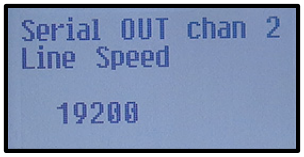
If “Not Used” is selected then the serial output line speed configuration mode is not displayed and the next configuration mode item is displayed.

3.6.2.10 Serial OUT Channel X Line Speed

(X = channel number) The following options are offered for selecting the serial output baud rate for each channel data type:

1. 4800
2. 9600
3. 19200
4. 38400
5. 57600
6. 115200
7. 230400

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options mentioned above and select the correct serial output speed. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

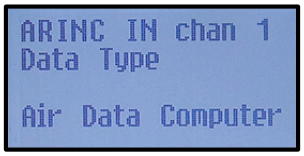
3.6.2.11 ARINC IN Channel X Data Type

(X = channel number) The FDL-978-XVR can receive data via two ARINC 429 input channels. The following options are offered for selecting ARINC 429 input type for each individual channel of the FDL-978-XVR:

1. Not Used	2. GPS
3. Air Data Computer	4. AHRS
5. ADC+AHRS	6. Txpdr Control
7. Other 1	8. Other 2

Refer to Section 3.3.2.3 for information on selecting ARINC input settings.

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct ARINC input type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

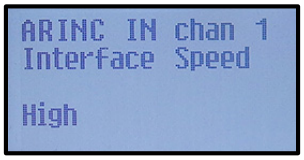
If “Not Used” is selected then the ARINC input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

3.6.2.12 ARINC IN Channel X Interface Speed

(X = channel number) The following options are offered for selecting the ARINC interface speed for each channel data type:

1. Low
2. High

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct ARINC input interface speed. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

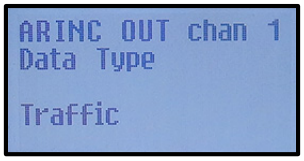
3.6.2.13 ARINC OUT Chan 1 Data Type

The FDL-978-XVR can transmit data via an ARINC 429 output channel. The following options are offered for selecting ARINC 429 output type:

1. Not Used
2. GPS
3. Traffic

Refer to Section 3.3.2.4 for information on selecting ARINC output settings.

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct ARINC output type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

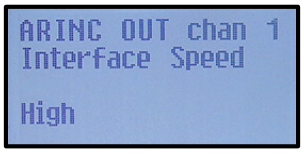
If “Not Used” is selected then the ARINC output line speed configuration mode is not displayed and the next configuration mode item is displayed.

3.6.2.14 ARINC OUT Chan 1 Interface Speed

The following options are offered for selecting the ARINC output interface speed:

1. Low
2. High

The display screen is as shown below with one of the options from the list above.



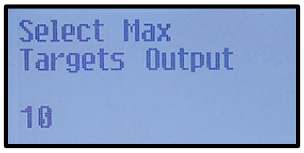
Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct ARINC output interface speed. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

3.6.2.15 Select Max Targets Output

This option controls the maximum number of targets which will be sent out the serial or ARCINC 429 channels when traffic output has been configured. There are 24 total options offered for selecting Max Targets. These include:

1. Integers 8 through 30
2. Max

The display screen is as shown below with one of the options from the list above.



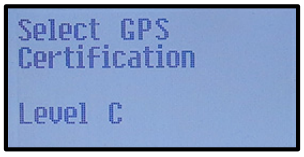
Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct number of targets. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

3.6.2.16 GPS Certification

The FDL-978-XVR needs a valid GPS source so that aircraft position can be transmitted in its ADS-B message. The GPS source is usually certified to a RTCA-DO178B software level as mandated by the governing FAA TSO. The following GPS software certification levels can be selected:

1. Uncertified
2. Level D
3. Level C
4. Level B

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct GPS certification level. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

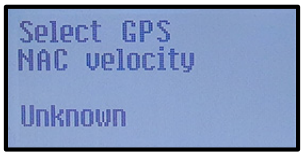
If the FFS Internal GPS, FFS 1201, or the 1203C are installed and used as a valid position source set the certification to Level C. For position sources other than those manufactured by FFS the customer is advised to contact the position manufacturer to obtain the relevant data.

3.6.2.17 GPS NAC Velocity

The GPS source used in the installation should have a navigation accuracy category for velocity (NACv) setting specified by the GPS manufacturer. Use the GPS manufacturer's setting to set this. The following options are available for selection.

1. Unknown
2. 10 meters/ sec
3. 3 meters/ sec
4. GPS Auto

The display screen is as shown below with one of the options from the list above.



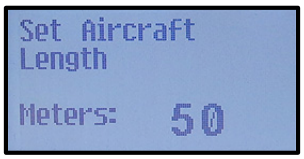
Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct GPS certification level. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

Settings 1, 2, and 3 are hard-coded settings in the software. Setting 4 is automatically set from the velocity FOM (VFOM) data from the GPS unit. The NACv value is hard-coded to be no better than 3 meters/sec even if GPS Auto is selected.

If the FFS Internal GPS or the 1203C is installed and used as a valid position set the NAC velocity to auto. If the FFS 1201 GPS is installed and used as a valid position source set the NAC velocity to 10m/s. For position sources other than those manufactured by FFS the customer is advised to contact the position source manufacturer to obtain the relevant data.

3.6.2.18 Aircraft Length

The aircraft length can be set from 1 meter to 75 meters by rotating the CODE knob either clockwise or counterclockwise to display the correct length. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.



3.6.2.19 Aircraft Width

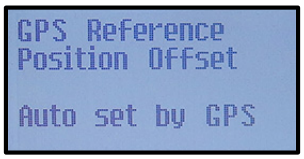
The aircraft width can be set from 1 meter to 80 meters by rotating the CODE knob either clockwise or counterclockwise to display the correct width. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

3.6.2.20 GPS Reference Position Offset

There are three modes by which the GPS reference offset can be set:

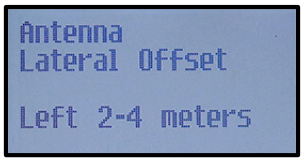
1. Unknown
2. Auto set by GPS
3. Manual set here

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct GPS reference offset. Once selected, press the ENT button to confirm your selection. If “Unknown” or “Auto Set by GPS” is selected the next configuration item in the setup mode will be displayed. If “Manual Set here” is selected then options for manually entering the GPS antenna reference offset are displayed as below:

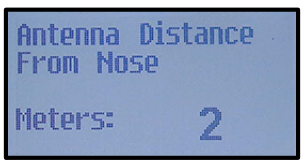
The antenna distance from the nose can be entered anywhere between 2 meters to 60 meters by rotating the CODE knob either clockwise or counterclockwise to display the correct distance. Once selected, press the ENT button to confirm selection and move to the lateral offset configuration item in the setup mode.



The antenna lateral offset has the following options that can be selected:

1. Unknown
2. Left 0-2 meters
3. Left 2-4 meters
4. Left 4+ meters
5. Central
6. Right 0-2 meters
7. Right 2-4 meters
8. Right 4+ meters

The display screen is as shown below with one of the options from the list above.



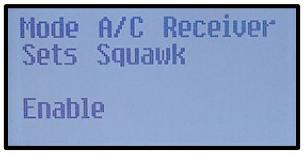
Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct antenna offset. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

3.6.2.21 Mode A/C Receiver Sets Squawk

This mode has two options:

1. Enable
2. Disable

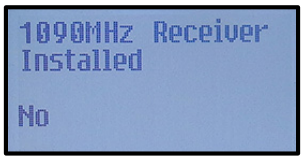
Set to “enable” when configuring for use with a transponder that does not have digital control output. This allows the internal or external transponder monitor sniffer antenna to detect the squawk code being broadcast from the airplane and use this same one in the ADS-B Out messages.
Set to “disable” when using a transponder with digital control output. The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select either enable or disable. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

3.6.2.22 1090 MHz Receiver Installed

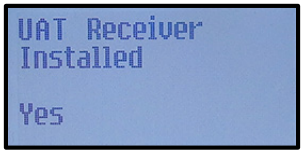
The display screen is as shown below with either Yes or No options.



Rotate the CODE knob either clockwise or counterclockwise to display either “Yes” or “No” and select the correct option. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

3.6.2.23 UAT Receiver Installed

The display screen is as shown below with either Yes or No options.



Rotate the CODE knob either clockwise or counterclockwise to display either “Yes” or “No” and select the correct option. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

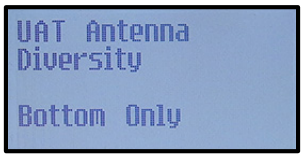
3.6.2.24 UAT Antenna Diversity

The default value is set at “Bottom Only.”

* Top only installations are not allowed at this time.

The FDL-978-XVR provides the flexibility for installing either one or two approved UAT antennas. A single antenna can either be installed on the top of the aircraft fuselage or on the bottom of the aircraft. When two antennas are installed they are installed on the top and bottom of the aircraft. The default value is set at “Bottom Only.” The following options can be selected:

1. Top Only*
2. Bottom Only
3. Dual

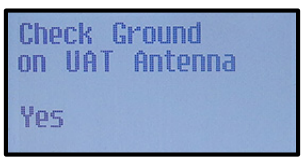


Rotate the CODE knob either clockwise or counterclockwise to display the correct antenna diversity option. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

It is recommended to install dual antennas for maximum coverage.

3.6.2.25 UAT Antenna Check Ground

Confirm if the UAT antenna(s) used have a ground connection that allows the FDL-978-XVR to check if the antenna is installed by selecting the YES or No options. Rotate the CODE knob either clockwise or counterclockwise to display either Yes or No and select the correct option. The display is as shown below:

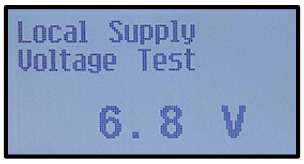


Once selected, press the ENT button to confirm selection and complete the configuration setup.

3.7 TC978 Test and Calibration

3.7.1 Local Voltage Supply Test

The TC978 Controller of the FDL-978-XVR utilizes a DC supply voltage of 5.5V to 8V. The display typically shows the supply voltage between 6.5V to 7.1V as shown below.



There is no option or configuration to be entered or selected in this step. Press the ENT button or the FN button and move to the next configuration item in the setup mode.

3.7.2 TC978 Altitude Encoder Calibration

The TC978 includes a built-in altitude encoder. The TC978 Controller reports pressure altitude on pin 4 of the DB-9 male connector on the back of the TC978 as RS-232 serial data, at 9600 bps, using the format commonly called “Icarus” format (See Section 6.1.1). The installation manual provides further details of interfacing the altitude encoder with the primary static pressure of the aircraft altimeter. The calibrate altitude encoder setup allows the recalibration of the altitude encoder. This ensures that the altitude seen on the pilot’s primary altimeter is the same as what is transmitted out of the FDL-978-XVR. The maximum allowed difference between the primary altimeter and the altitude encoder is 125 feet in European Technical Standard Order (ETSO) C88a and TSO C88b. The altitude encoder in the TC978 Controller is accurately calibrated in the factory to be within 50 feet of the applied pressure altitude at all altitudes, whereas the allowed error in the primary altimeter increases with altitude, and above 18,000 feet the altimeter error alone may exceed 125 feet. It is therefore possible that the combination of the allowed errors in the encoder and the primary altimeter may exceed 125 feet, in which case the altitude encoder must be adjusted to correspond to the primary altimeter.

The purpose of calibrating the encoder is to make the output correspond to the primary altimeter. The encoder calibration procedure must therefore only be undertaken after the primary altimeter has been tested and found to comply with the relevant standards.

3.7.2.1 Calibration Equipment

To calibrate the encoder the TC978 must be powered up and you will need a pitot-static test set with the appropriate adapters to connect to the static port on the aircraft. The pitot-static test set should be able to drive the altitude down to sea level, and above the service ceiling of the aircraft.

No test set is required – the calibration procedure displays all the information you need on the screen of the TC978 Controller.

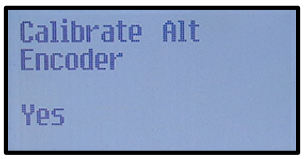
3.7.2.2 Calibration Procedure

There are two adjustment points on the altitude encoder, a low altitude adjustment point, and a high altitude adjustment point. The low altitude point adjusts the correspondence at sea level,

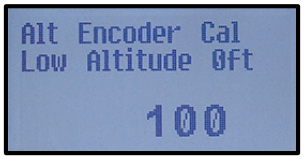
and the high altitude point adjusts the correspondence at the altitude limit of the encoder. Since the altitude limit of the encoder is likely to be higher than the service ceiling of the aircraft, it is sufficient to set the upper adjustment at the service ceiling of the aircraft.

DO NOT EXCEED THE ALTITUDE OR RATE OF CLIMB LIMITS OF THE PITOT-STATIC INSTRUMENTS OF THE AIRCRAFT. The TC978 altitude encoder is a solid state device and will not be affected by excess altitude or rate of climb and descent, but the mechanical instruments in the aircraft can easily be damaged by being driven beyond their intended range.

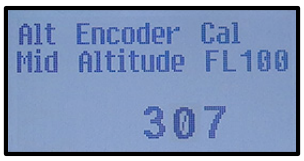
1. Set the primary altimeter subscale setting to 1013.2 hectopascal (hPA), 29.92 in hectogram (hg).
2. Connect the pitot-static test set to the aircraft.
3. You can enter the altitude encoder calibration setup either after following the steps from above in order or you can enter directly by holding the FN button down on the controller on power up to enter setup mode. And skipping over the configuration modes until reaching the calibrate altitude encoder section. When you are in the calibrate altitude encoder setup mode the display shows the following information:



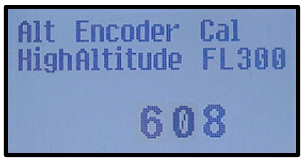
4. Rotate the CODE knob either clockwise or counterclockwise to display either Yes or No and select the correct option. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode. If No is selected then the next configuration item in the setup mode will be displayed. If Yes is selected then options for calibrating the altitude encoder is as shown below.
5. On selecting Yes the low altitude set point will now be active, and an altitude will be displayed as below.



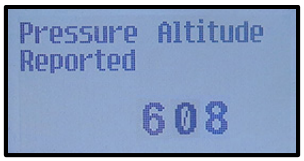
6. On the static test set, drive the altitude to 0 feet.
7. Read the primary altimeter value; rotate the CODE knob either clockwise or counterclockwise until the altitude displayed on the TC978 Controller matches the aircraft primary altimeter.
8. Press the ENT button and the display will move to the mid altitude set point and an altitude will be displayed as shown below. On the static test set, drive the altitude to the middle range ceiling of the aircraft.



9. Read the primary altimeter value; rotate the CODE knob either clockwise or counterclockwise until the altitude displayed on the TC978 Controller matches the aircraft primary altimeter. Press the ENT button and the display will move to the high altitude set point and an altitude will be displayed as shown below. On the static test set, drive the altitude to the service ceiling of the aircraft.



10. Read the primary altimeter value; rotate the CODE knob either clockwise or counterclockwise until the altitude displayed on the TC978 Controller matches the aircraft primary altimeter. Press the ENT button and the display will move to the test altitude screen which is the next configuration item in the setup mode.

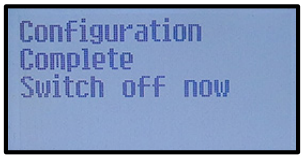


To complete the testing you should leave the front controller screen displaying the encoder altitude, and exercise the altitude on the static test set across the altitude range of the aircraft. The display will be as shown above for pressure reported. Use at least 10 test points, and verify that in each case the altitude displayed on the primary altimeter and the altitude displayed on the TC978 Controller correspond within the 125 foot tolerance. Lightly tap the altimeter at each test point to eliminate friction effects.

3.7.3 Pressure Altitude Reported

Pressure altitude is displayed after the altitude calibration setup has been completed. The display shows the reported pressure altitude and should match the altitude reported by the primary altimeter.

Press ENT button and the display will instruct completion of setup and power off the system.



SECTION 4 TROUBLESHOOTING

4.1 General

This section provides information for troubleshooting problems that occur after FDL-978 Lite Series and FDL-978-XVR installations. This section contains information on how to use the units LEDs and TC978 Controller to troubleshoot installation problems. Refer to SECTION III to set up and configure the system.

4.2 FDL-978-XVR LED Troubleshooting Procedure

The following is a quick reference troubleshooting guide using the FDL-978-XVR LEDs:

Problem	Potential Cause	Troubleshooting
No LED Activity	No power	Verify power is turned on, Check power connections to unit.
TX LED not active	Unit is not transmitting ADS-B messages	Check antenna connections, Check Controller Warning messages
RX LED not active	Unit is not receiving ADS-B messages	Check antenna connections, Check Controller Warning messages
ST LED is on	A fault with the unit	Check Controller Warning messages
ST LED is flashing quickly	GPS fault has occurred	Check GPS connection/configuration, Check Controller Warning messages
GPS LED is flashing slowly	GPS is acquiring satellites	Allow 2-3 minutes for GPS tracking, Check GPS antenna, Check GPS for problems
GPS LED is off	GPS not communicating	Check GPS connection, Check installation configuration
GPS LED is flashing quickly	GPS is reporting a fault	Check GPS for fault

4.2.1 UAT Status LED/Discrete Fault Indications

The status LED/discrete is an indicator of a warning or fault reported by the FDL-978 Lite Series and FDL-978-XVR. The status LED is visible on the units or the discrete may be connected to a cockpit annunciator. Potential faults that cause the UAT ST LED to turn on and the Status Discrete to be active (ground) are listed below:

Problem Reported	Reported by
RF Transmission Failure	PBIT
Bottom Antenna Not Connected (If DC ground check configured)	PBIT
Top Antenna Not Connected (If DC ground check configured)	PBIT
RF Transmission Power Too Low	PBIT
GWSS not communicating or reporting fault	PBIT
RF Transmit Power Supply Low	PBIT
Internal Temperature Too High	PBIT
RF Transmit Reverse Power Too High	PBIT
Nominal Message Rate not once per second	PBIT
Broadcast monitor failure – All message types not transmitted	PBIT
Nominal Message Rate not once per second	PBIT
Internal Power Supply Failure	PBIT
UART Serial Channel Loopback Test Failure	POST
ARINC 429 Channel Loopback Test Failure (FDL-978-XVR)	POST
General Processing/Interface Hardware Failure	POST
Transceiver Hardware Check Failure	POST

4.3 Warning Messages

If the FDL-978-XVR detects a malfunction, the MSG icon appears to indicate that warning messages are present. Depending on the nature of the malfunction, the FDL-978-XVR may not transmit ADS-B messages.

To enter the Warning View mode, press the FN button four times and WARNING will be displayed top center along with a brief description of the fault. In this mode, the Controller continually requests the active warning messages from the FDL-978-XVR and FDL-978 Lite Series and displays them on the Controller. Press the FN button again to exit this mode and return to normal operation.

TC978 Warning Messages	
Warning MSG	**Description**
Synth Unlock	Transceiver Diagnostic – Timing Fault
Tx Fault	UAT Transceiver fault
Tx Power Low	UAT Transceiver power low during transmit
Tx PSU High	UAT Transceiver power supply output too high
Tx PSU Low	UAT Transceiver power supply output too low
Squitter Fail	System Diagnostic
Remote Hot	FDL-978 Lite Series and FDL-978-XVR internal temperature too high
No ADS-B Pos	The unit is not receiving digital serial communication from the GPS.
GPS Fault	GPS has reported unavailable position or a fault.
Top Ant Fault	Top antenna disconnected
Bot Ant Fault	Bottom antenna disconnected
PSU Fail	Internal DC power supply failure
ADC Fault	ADC or Altitude sensor fault or not responding

4.3.1 TC978 Warning Message Troubleshooting

The following is a quick reference troubleshooting guide using the TC978 Warnings:

Warning	Potential Cause	Troubleshooting
Synth Unlock	Transmitter can't lock to carrier frequency	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Return for maintenance if problem persists.
TX Fault	Generic Transmitter Fault – POST, transmit, address, broadcast, or nominal rate failure.	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Check for valid ICAO address config.

Warning	Potential Cause	Troubleshooting
Tx Power Low	Transmitter power too low.	Check antennas and cabling. Return for maintenance if problem persists.
Tx PSU High	Transmitter power supply voltage too high.	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Return for maintenance if problem persists.
Tx PSU Low	Transmitter power supply voltage too low.	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Return for maintenance if problem persists.
Squitter Fail	Transmitter modulation fault.	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Return for maintenance if problem persists.
Remote Hot	FDL-978-XVR internal temperature too high.	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Turn power off for several minutes, then back on. Return for maintenance if problem persists.
No ADS-B Pos	The unit is not receiving digital serial communication from the GPS.	Verify GPS is functioning. Verify GPS Port Configuration and speed. Verify GPS communication connection.
GPS Fault	GPS has reported no available position or a fault.	Verify GPS is functioning. Verify GPS Antenna Cable connection. Verify GPS Antenna installation/operation.
Top Ant Fault	Top antenna disconnected	Check UAT antenna connection. Ensure antenna is DC grounded. Disable DC Gnd Check in config if antennas are not DC grounded.
Bottom Ant Fault	Bottom antenna disconnected	Check UAT antenna connection. Ensure antenna is DC grounded. Disable DC Gnd Check in config if antennas are not DC grounded.
PSU Fail	Internal DC Power Supply failure	Cycle power on the FDL-978 Lite Series and FDL-978-XVR. Return for maintenance if problem persists.
ADC Fault	Air Data Computer or Altitude encoder fault or not responding.	Verify ADC is functioning. Verify ADC Port Configuration and speed. Verify ADC Cable connection.

SECTION 5 RTCA/DO-160 Environmental Qualifications

U.S. standard units of measure are the primary means of identifying dimensions, weights, etc. The equivalent metric values may also be shown in brackets (e.g. 1.9 in [48 mm]).

5.1 FDL-978 Equipment and UAT DO-160 Qualification

Conditions	Para	Category (DO-160G)
Temperature and Altitude	4	C4 (-40ºF to +158ºF [-40ºC to +70ºC])/D/A
Operating Low Temperature	4.5.2	-40ºF [-40°C] (C4)
Operating High Temperature	4.5.4	+158ºF [+70°C] (C4)
Short-Time Operating Low Temperature	4.5.1	-40ºF [-40°C] (C4)
Short-Time Operating High Temperature	4.5.3	+158ºF [+70°C] (C4)
Ground Survival Low Temperature	4.5.1	-67°F [-55°C] (C4)
Ground Survival High Temperature	4.5.3	+185°F [+85°C] (C4)
Loss of Cooling	4.5.5	N/A
Altitude	4.6	+50,000ft (D)
Decompression	4.6.2	+50,000ft (A)
Overpressure	4.6.3	-15,000ft (A)
Temperature Variation	5	B
Humidity	6	A
Shock/Crash Safety	7	B
Vibration	8	S (Zone 1, Curve C) & U2
Explosive Atmosphere	9	N/A
Waterproofness	10	N/A
Fluids Susceptibility	11	N/A
Sand and Dust	12	N/A
Fungus Resistance	13	N/A
Salt Fog	14	S
Magnetic Effect	15	Z
Power Input	16	BB
Voltage Spike	17	A
Audio Frequency Conducted Susceptibility – Power Inputs	18	Z
Induced Signal Susceptibility	19	AC
Radio Frequency Susceptibility	20	TT
Emission of Radio Frequency Energy	21	B
Lightning, Induced Transient Susceptibility	22	A2J3L3 (shielded) A2H3L3 (unshielded)
Lightning Direct Effects	23	N/A
Icing	24	N/A
Electrostatic Discharge	25	A
Fire, Flammability	26	C

5.3 TC978 Controller DO-160 Qualification

Condition	Para	Category (DO-160F)
Temperature and Altitude	4	C4/C4/A4
Ground Survival Low Temperature	4.5.1	-67°F [-55°C] (C4)
Short-Time Operating Low Temperature	4.5.1	-13°F [-25°C] (C4)
Operating Low Temperature	4.5.2	-40ºF [-40°C] (C4)
Short-Time Operating High Temperature	4.5.3	+158ºF [+70°C] (C4)
Ground Survival High Temperature	4.5.3	+185°F [+85°C] (C4)
Operating High Temperature	4.5.4	+131°F [+55°C] (C4)
Loss of Cooling	4.5.5	N/A
Altitude	4.6	+35,000ft (D)
Decompression	4.6.2	+50,000ft (A)
Overpressure	4.6.3	-15,000ft (A)
Temperature Variation	5	A
Humidity	6	A
Shock/Crash Safety	7	B
Vibration	8	U (Curve G)
Explosive Atmosphere	9	N/A
Waterproofness	10	W (front face only)
Fluids Susceptibility	11	N/A
Sand and Dust	12	N/A
Fungus Resistance	13	N/A
Salt Fog	14	N/A
Magnetic Effect	15	Z
Power Input	16	N/A
Voltage Spike	17	N/A
Audio Frequency Conducted Susceptibility – Power Inputs	18	N/A
Induced Signal Susceptibility	19	BC
Radio Frequency Susceptibility	20	TT
Emission of Radio Frequency Energy	21	M
Lightning, Induced Transient Susceptibility	22	XXJ3L3 (shielded) XXH3L3 (unshielded)
Lightning Direct Effects	23	N/A
Icing	24	N/A
Electrostatic Discharge	25	N/A
Fire, Flammability	26	C

SECTION 6 SERIAL INTERFACE SPECIFICATIONS

Two data formats may be selected to accept input from external Altitude sensors:

- **Encoder Altitude** – Gray-code to serial altitude converters, etc.
- **Air Data Computer** – To select a data format, refer to Section 3.3.2.

6.1.1 Altitude Encoder Format

The Altitude Encoder (aka “Icarus”) data format accepts messages with the following parameters:

Baud: 9600
Parity: None
Start Bit: 1
Data Bits: 8
Stop Bit: 1
Update Rate: 1 msg/sec

Compatible devices include Rosetta Encoders and Serializers (ARS 50 and ARS 100). The compatible format for altitude information is the following 10 byte ASCII message:

Byte	0	1	2	3	4	5	6	7	8	9
Contents	A	L	T		1	2	3	4	5	c/r

Some examples include:

'ALT 00000'	0 feet
'ALT -1200'	-1200 feet
'ALT 62505'	62,505 feet
'ALT 05604'	5,604 feet

6.1.2 Air Data Computer/Sensor Format

The ADC format accepts messages with the following parameters:

Baud: 9600 (default minimum)
Parity: None
Start Bit: 1
Data Bits: 8
Stop Bit: 1
Update Rate: 1 msg/sec

Air Data messages are accepted when the serial port is set to "ENCODER.” A packet consists of a set of ASCII message strings. The first character of each packet is an ASCII Start-of-Text (STX = 02H). The last character of each packet will be an ASCII End-of-Text (ETX = 03H). Each message string begins with one ASCII character to identify it as an Air Data message ("Z"). The second character identifies which message it is. The rest of the string consists of one or more

alphanumeric ASCII fields. Each message field ends with a carriage return, line feed (CR = 0D0AH). All numeric fields are ASCII decimal, right justified and zero filled. If the ADC cannot supply data in a particular field, the field is filled with dashes ("-" = 2DH). The table below lists the message items used by the FDL-978-XVR. Additional items may be in the message, but they are not used by the units.

Item Format	Contents	Description
ZBddd	True Air Speed	ddd = knots (40 to 600)
ZDsdddd	Pressure Altitude	s = sign, dddd = tens of feet (-100 to +5999)
ZKsddd	Vertical Speed	s = sign, ddd = tens of feet/minute (-600 to +600)
ZRddd	Packet Checksum	ddd = number (0 to 255)

SECTION 7 ADS-B COMPLIANCE

ADS-B Parameters Supported:

#	Input Data Element	Comment (Use within the FDL-978-XVR)
1	ICAO 24-bit Address	Installation configuration
2	Address Selection (ICAO vs Temporary)	Anonymous discrete input
3	Latitude	From GPS data
4	Longitude	From GPS data
5	Altitude Type Selection (Barometric vs Geometric)	Baro unless invalid or inhibited
6	Barometric Pressure Altitude	From altitude/air data sensor
7	Geometric Altitude	From GPS data
8	NIC	From GPS data
9	Automatic AIRBORNE/ON-GROUND Indication	Air/Ground discrete input
10	North Velocity	From GPS data
11	East Velocity	From GPS data
12	Ground Speed	From GPS data
13	Track Angle	From GPS data
14	Heading	From configured heading input
15	Barometric Vertical Rate	From altitude/air data sensor
16	Geometric Vertical Rate	From GPS data
17	A/V Length and Width, and POA	Installation configuration
18	UTC 1 PPS Timing	From GPS Data
19	Emitter Category	Installation configuration
20	Call Sign	From controller interface
21	Emergency/Priority Status Selection	From controller interface
22	SIL	GPS with HIL or HPL only
23	System Design Assurance (SDA)	Installation configuration
24	SIL Supplement	GPS with HIL or HPL only
25	NAC_P	From GPS data
26	NAC_V	From GPS data
27	NIC_{BARO}	Non-Gilham altitude sensors only

#	Input Data Element	Comment (Use within the FDL-978-XVR)
28	Capability Codes	Installation configuration
29	TCAS Installed and Operational	Installation configuration
30	TCAS/ACAS resolution advisory flag	TCAS RA serial data input
31	IDENT Switch Active	From controller interface
32	Call Sign Identification	From controller interface
33	Geometric Vertical Accuracy (GVA)	Installation configuration
34	Single Antenna Flag	Installation configuration
35	NIC Supplement Flag	From GPS data
36	Selected Altitude Type	Not supported in current software
37	Selected Altitude Setting	Not supported in current software
38	Barometric Pressure Setting	Not supported in current software
39	Selected Heading	Not supported in current software
40	Status of MCP/FCU Mode	Not supported in current software
41	Mode Indicators: Autopilot Engaged	Not supported in current software
42	Mode Indicators: VNAV Engaged	Not supported in current software
43	Mode Indicators: Altitude Hold Mode	Not supported in current software
44	Mode Indicators: Approach Mode	Not supported in current software
45	Mode Indicators: LNAV Engaged	Not supported in current software
46	Radio Height	Not supported in current software
47	Pressure Altitude Disable	From controller interface
48	Airspeed	From altitude/air data sensor
49	Flight Plan ID	From controller interface

SECTION 8 INSTALLATION DRAWINGS

8.1 Dimensions

U.S. standard units of measure are the primary means of identifying dimensions, weights, etc. The equivalent metric values may also be shown in brackets (e.g. 1.9 in [48 mm]).

The physical dimensions are identical between the FDL-978 Series and FDL-978 Lite Series. The only external difference is the FDL-978 Lite Series do not have a TOP UAT antenna connector.

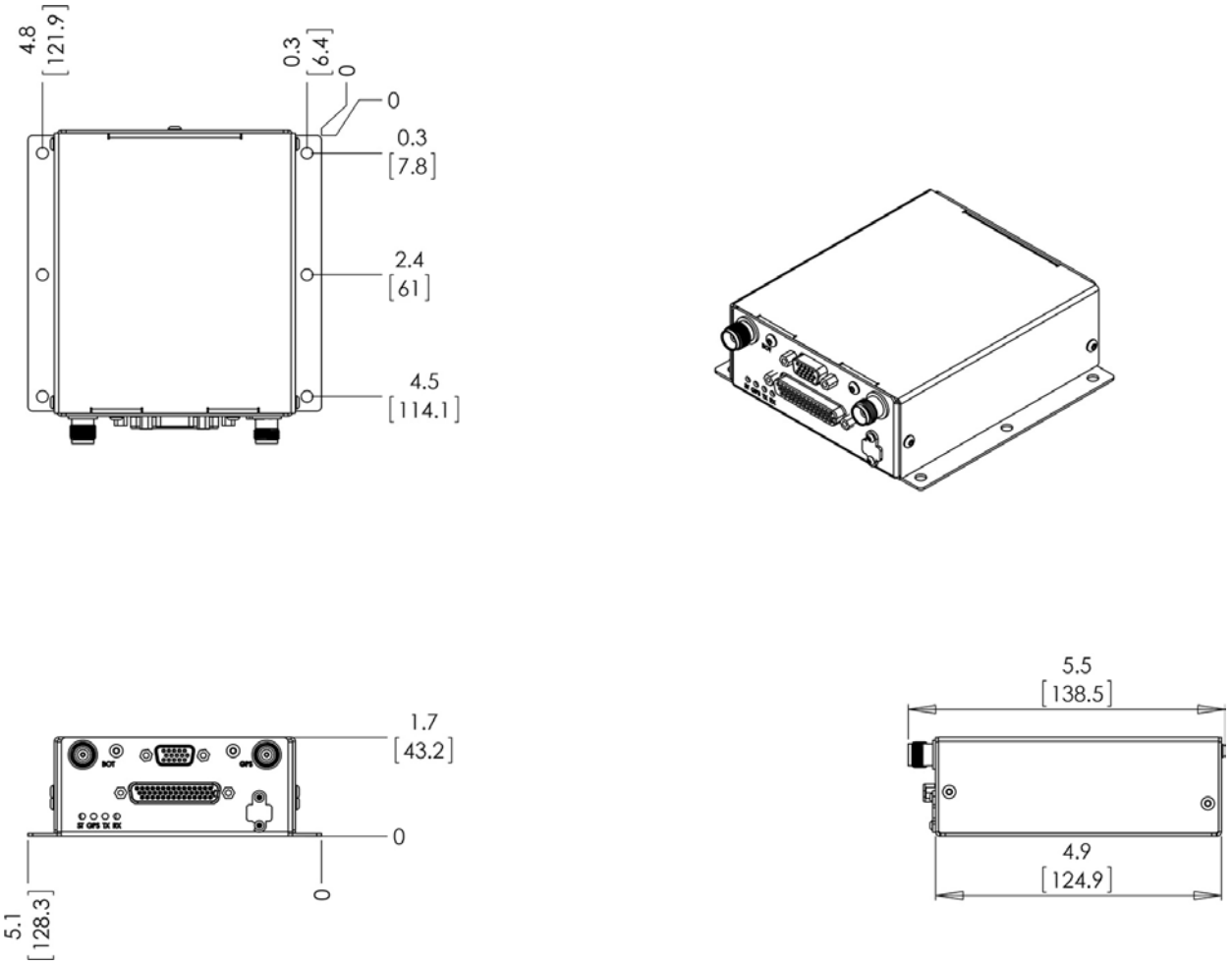


Figure 15. FDL-978 Series and FDL-978 Lite Series Dimensions

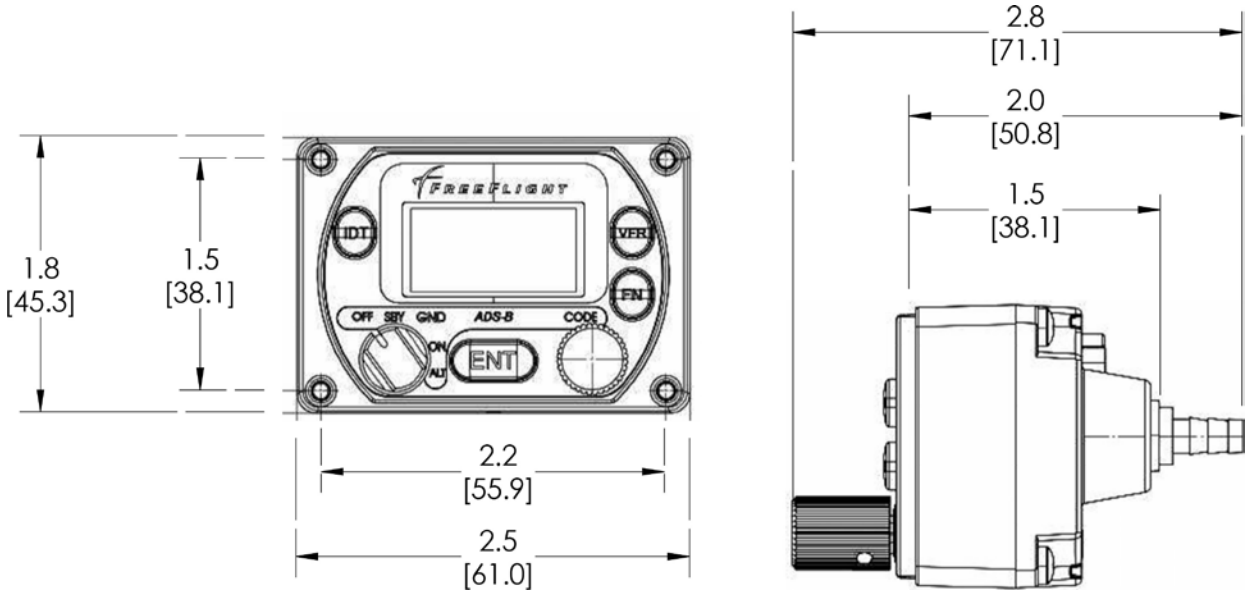


Figure 16. TC978 Controller Dimensions

8.2 TC978 Controller Cut-out Options

The TC978 Controller can be fitted to either the compact mounting hole or a conventional 2.25 in (57mm) instrument cut-out. The compact mounting is a truncated 58 mm opening.

The following diagrams are intended to be to scale; however, variations in the printing process means that you MUST check all dimensions before using it as a template.

The mounting screws are NOT in the same location for the two different cut-out options.

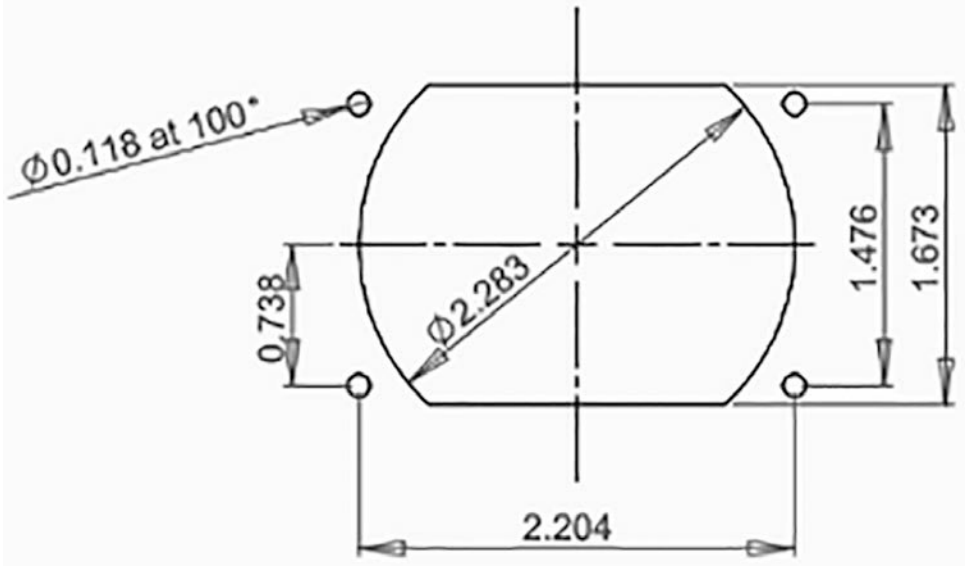


Figure 17. TC978 Fitted Cut-out

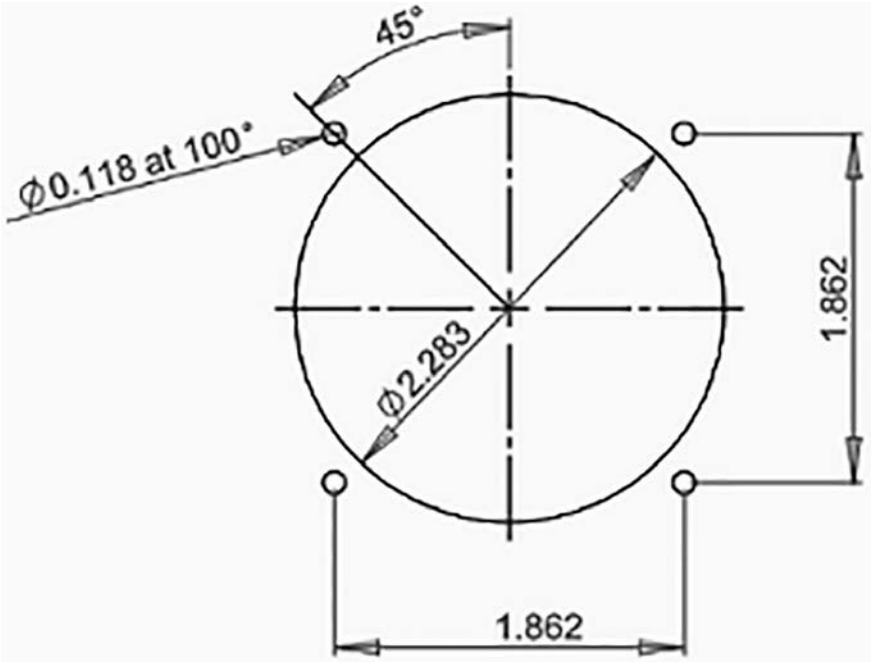


Figure 18. TC978 Conventional Cut-out

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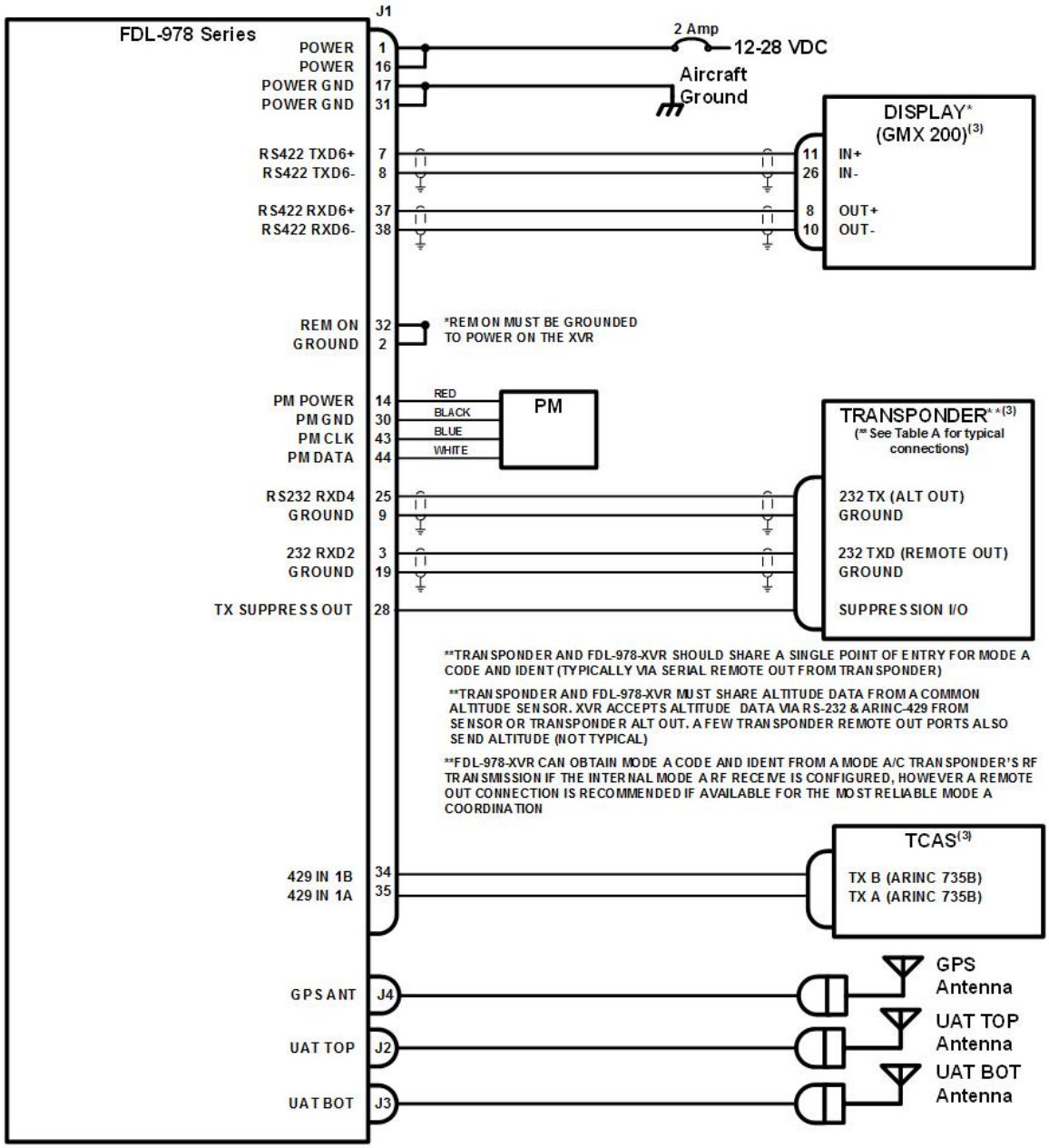
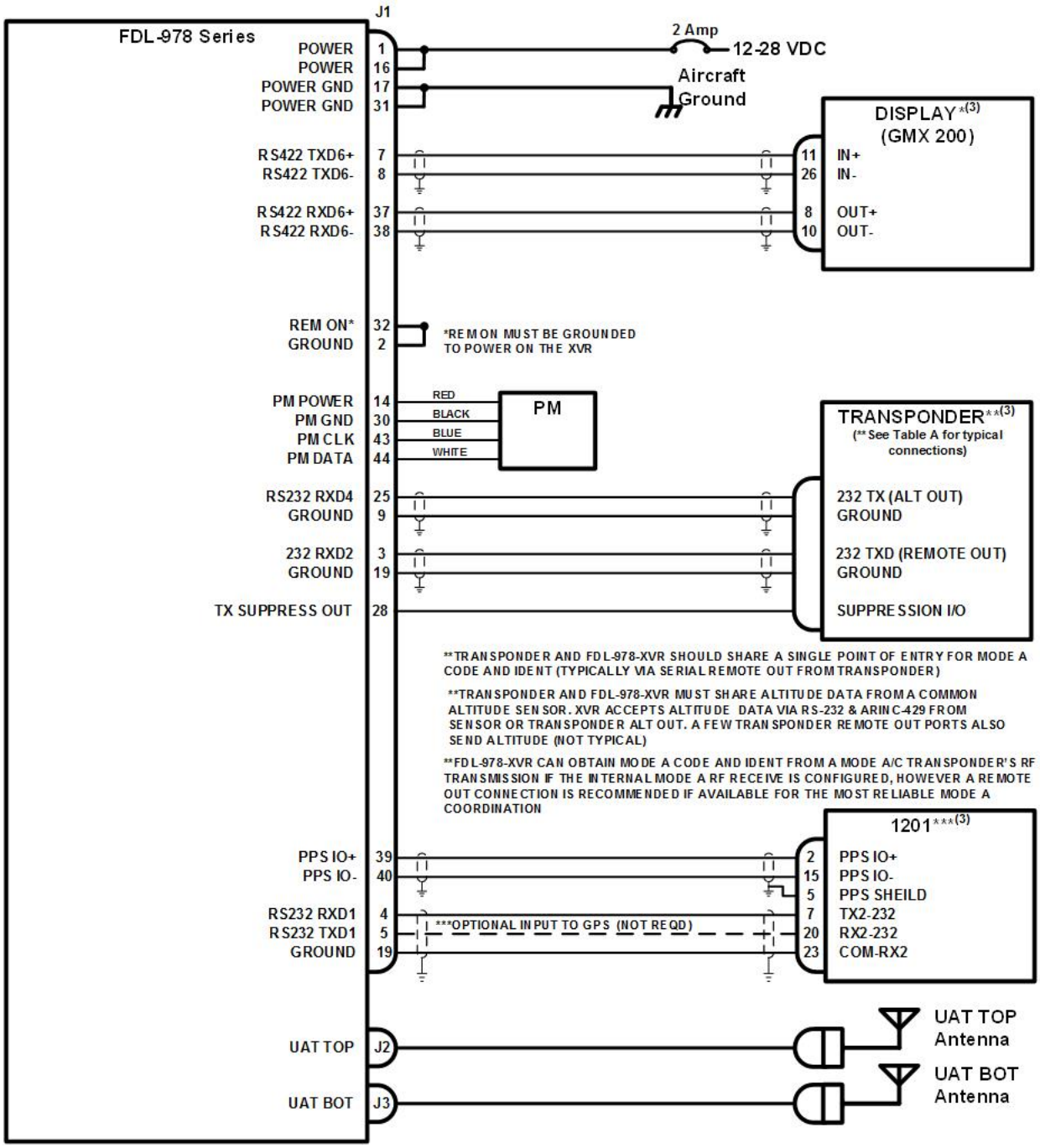
SECTION 9 TYPICAL INTERCONNECT DIAGRAMS



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY

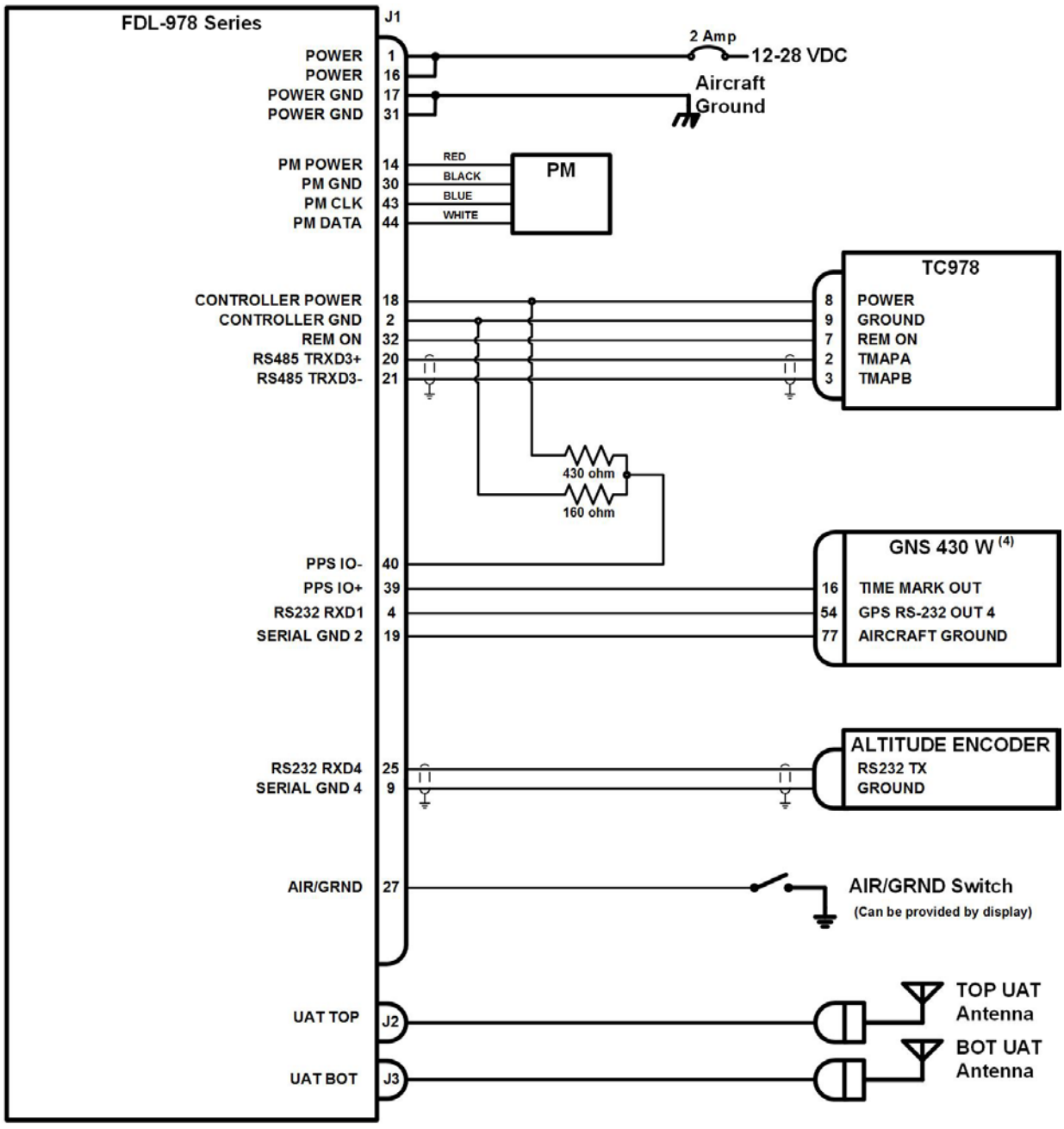
Figure 19. Internal GPS and Transponder



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY

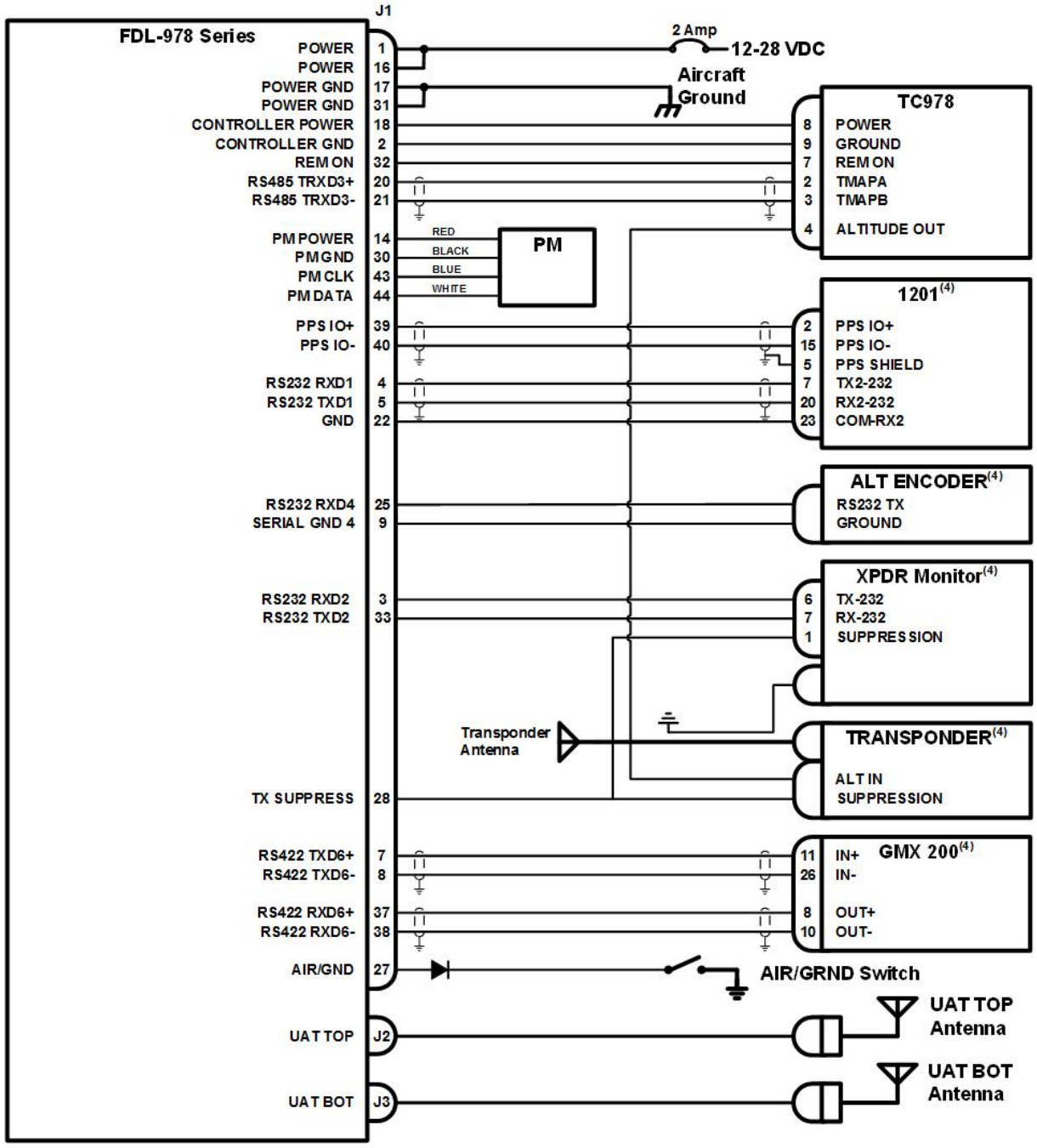
Figure 20. External GPS and Transponder



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. FOR SINGLE ANTENNA INSTALLATIONS (CLASS B1S) INSTALL BOTTOM ANTENNA ONLY
4. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.

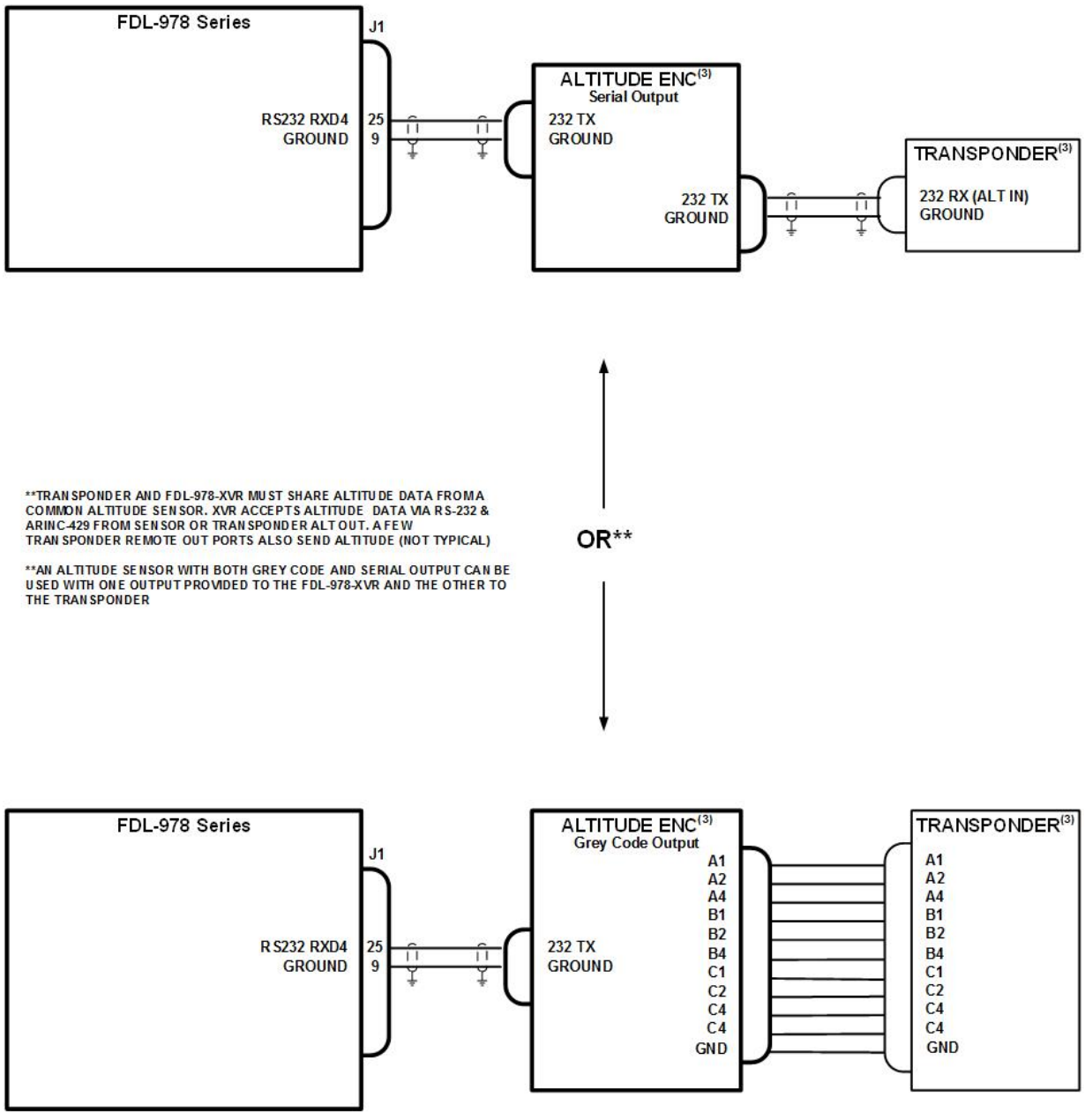
Figure 21. GPS 430W/530W Configuration



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. FOR SINGLE ANTENNA INSTALLATIONS (CLASS B1S) INSTALL BOTTOM ANTENNA ONLY
4. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT.

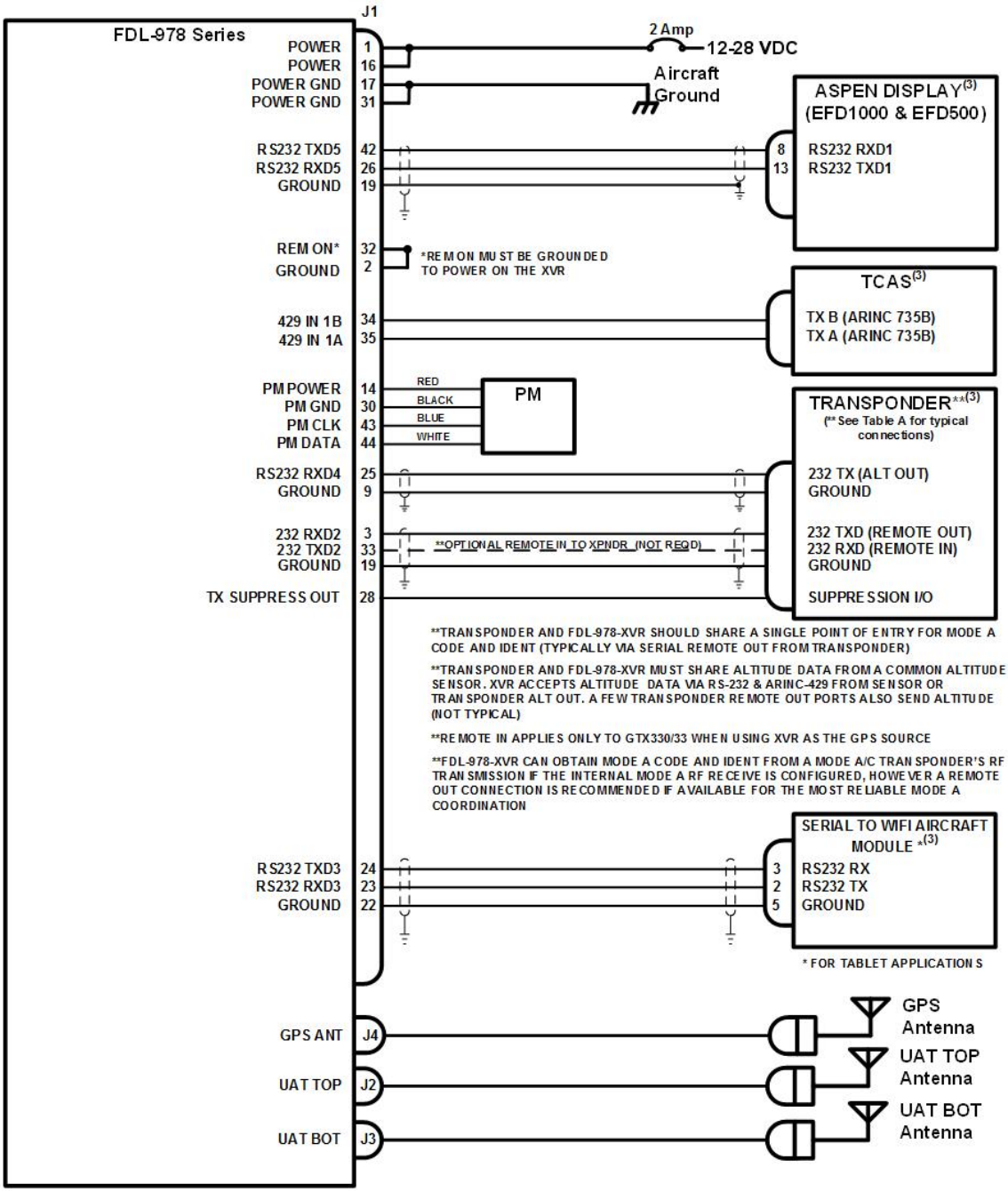
Figure 22. XPDR Monitor



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PIN S OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.

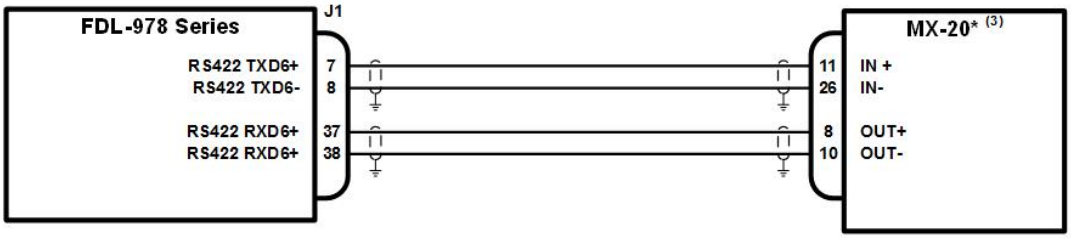
Figure 23. Altitude Encoder



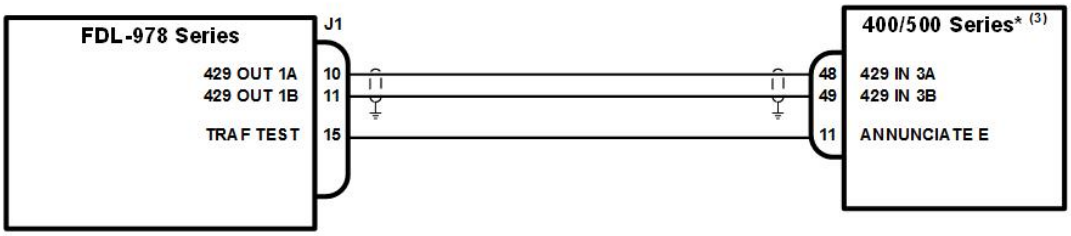
NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE O EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY

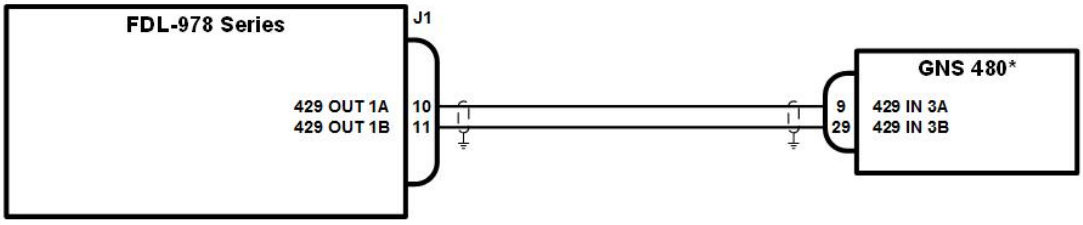
Figure 24. Aspen Avionics Display



*DISPLAY INTERFACE TO XVR VIA PORT 6 CAN ALSO CONTROL FDL-978-XVR



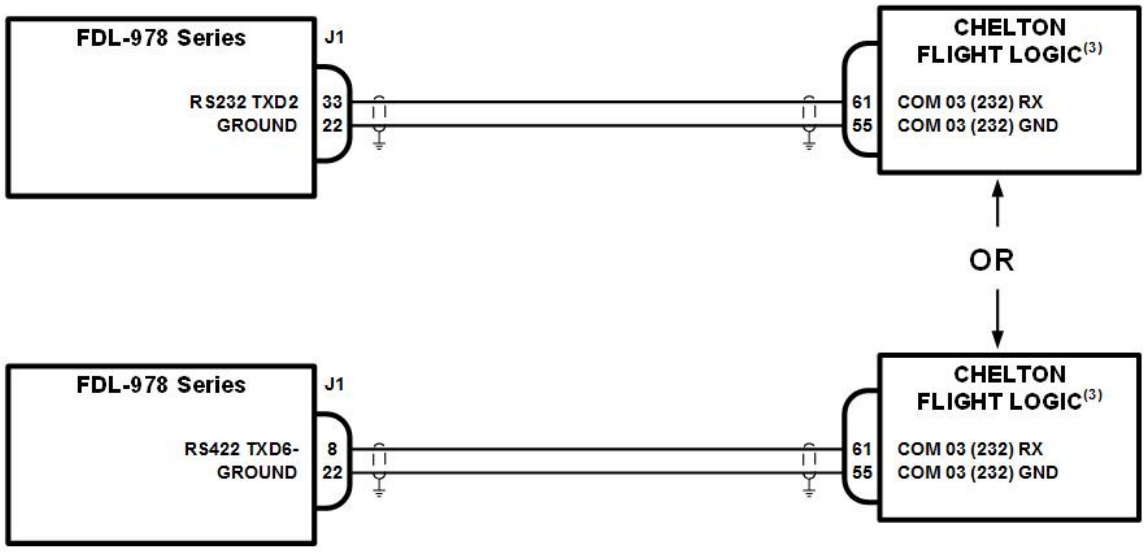
*IF ARINC INPUT PORT SHOWN IS ALREADY USED FOR ANOTHER PURPOSE,
OTHER ARINC PORT INPUTS CAN BE CONFIGURED AND USED.



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.

Figure 25. Alternate Displays



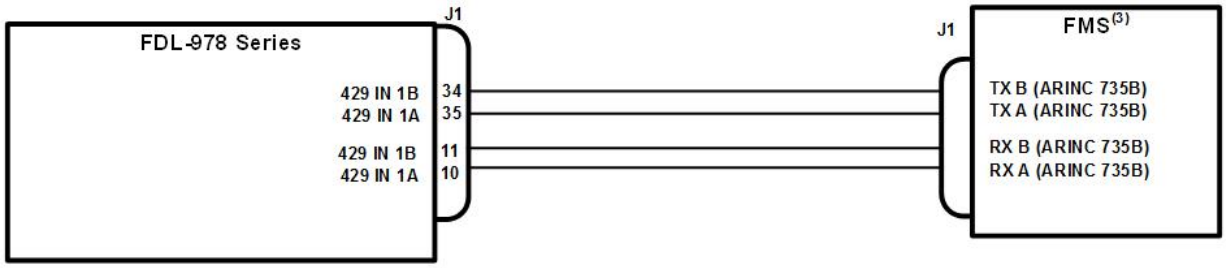
*IF ARINC INPUT PORT SHOWN IS ALREADY USED FOR ANOTHER PURPOSE, OTHER ARINC PORT INPUTS CAN BE CONFIGURED AND USED.

*THESE ARE FOR REFERENCE ONLY. REFER TO 400/500 SERIES OR GNS480 DOCUMENTATION FOR COMPLETE INTERCONNECT INFORMATION

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.

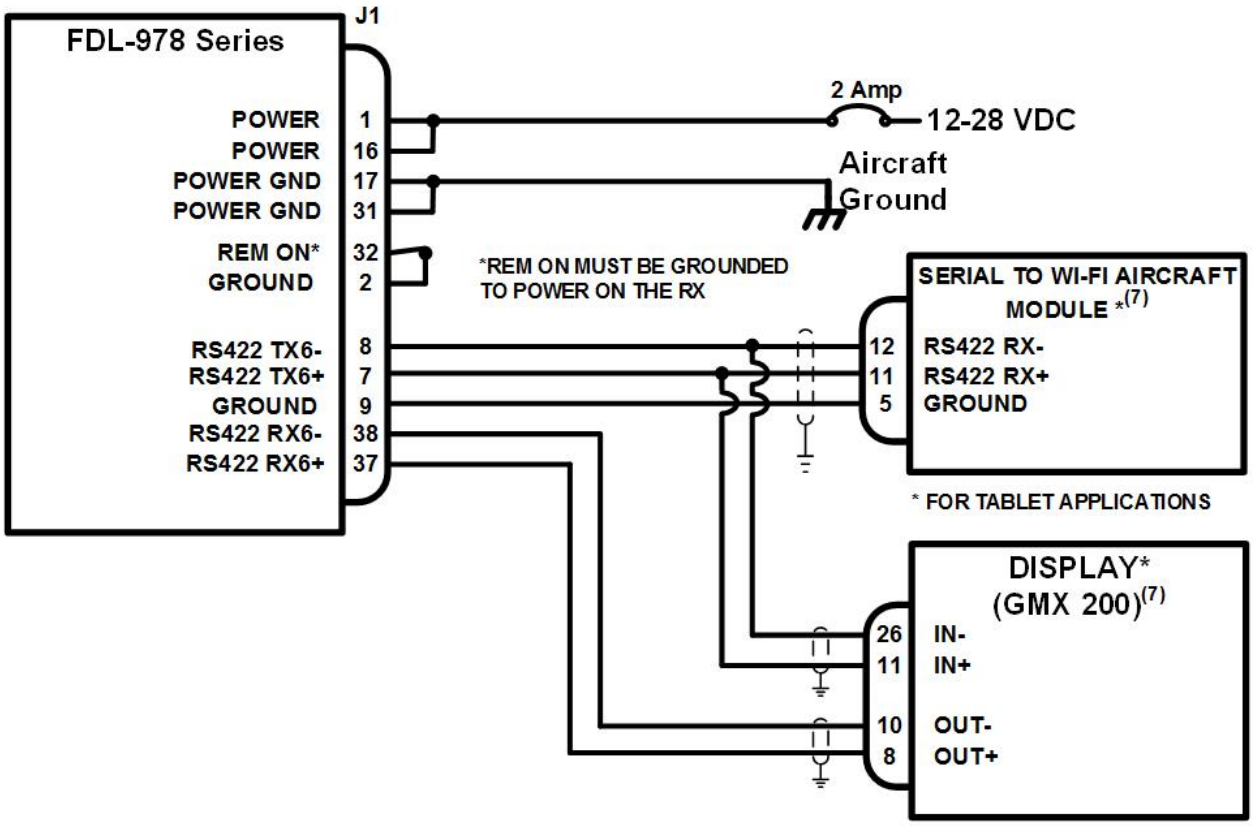
Figure 26. Alternate Displays (Cont'd)



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.

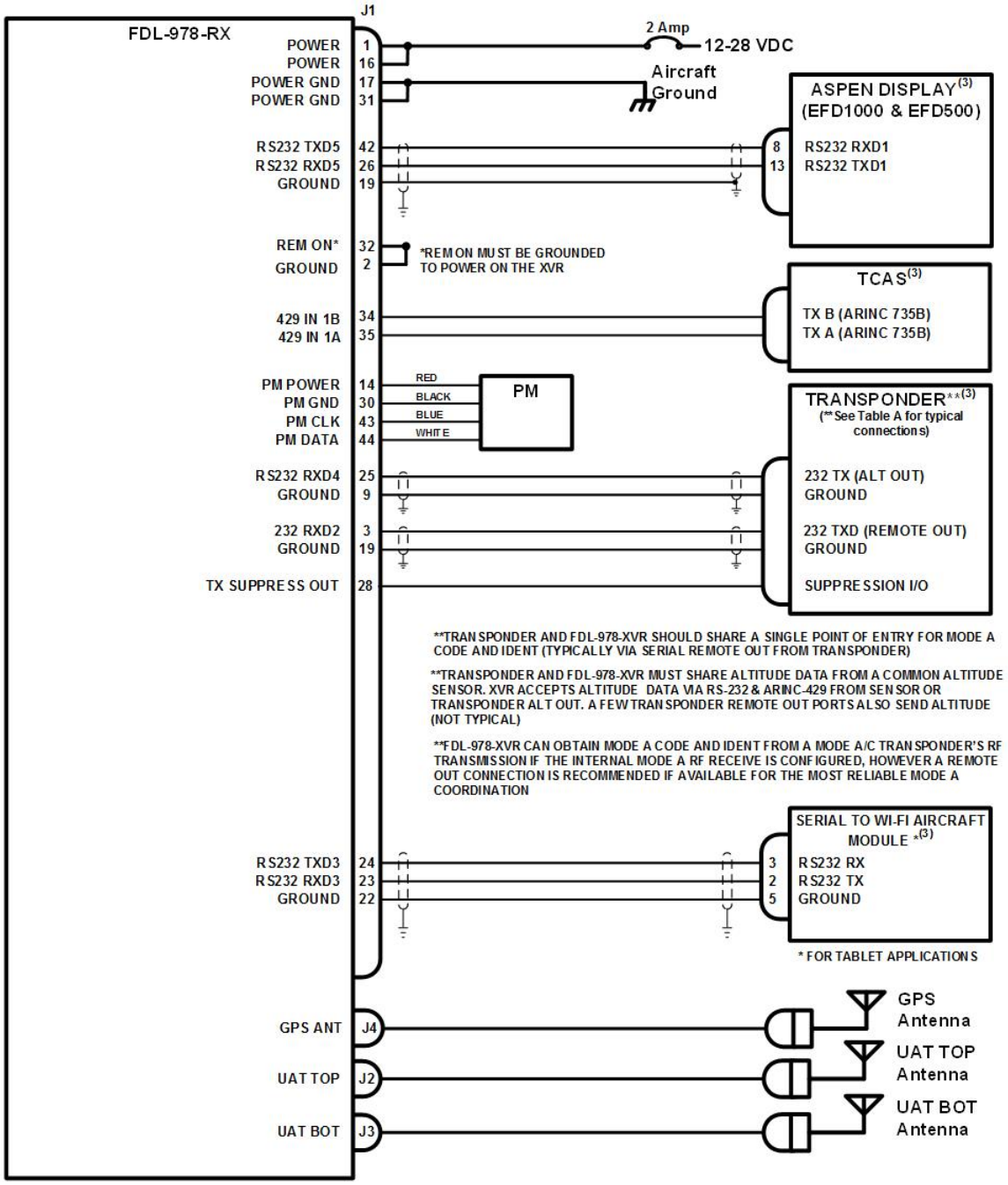
Figure 27. GPS ARINC-743 PRAIM



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED.
2. USE APPROPRIATE CRIMPING TOOL FOR WIRING SOCKET CRIMPS
3. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
4. THE DEFAULT SERIAL TO WIFI AIRCRAFT MODULE BAUD RATE IS 115200. WHEN USING THE SERIAL TO WI-FI AIRCRAFT MODULE IN CONJUNCTION WITH THE GMX200 DISPLAY THE AIRCRAFT WIFI MODULE BAUD RATE MUST BE RECONFIGURED TO 38400. CONTACT FREEFLIGHT FOR UPDATING THE WIFI MODULE BAUD RATE.
5. CONFIGURE THE FDL-978-XVR TO PORT 6 SERIAL OUTPUT AT 38400 BAUD INTERFACE TYPE TIS/FIS TO TRANSMIT DATA OVER THE WI-FI MODULE. SERIAL IN 6 SHOULD NOT BE CONFIGURED TO NOT USED.
6. THE WIFI MODULE DOES NOT TRANMSIT DATA CONTROL PACKETS TO THE FDL-978-XVR. WIRING OF THE RS-422 OR RS-232 TX SIGNALS FROM THE WI-FI MODULE TO THE XVR RS-422 OR RS-232 RX PINS IS NOT REQUIRED.

Figure 28. Serial Aircraft Wi-Fi Module with Display



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY

Figure 29. FDL-978-RX Receiver with Internal GPS

SECTION 10 MAINTENANCE INTERFACE DIAGRAMS

Section 12.12.1 describes the various FDL-978 Lite Series configuration and setup options via the MPI. The diagrams below provide a pictorial representation of these available options for accessing the maintenance port of the FDL-978 Lite Series and FDL-978-XVR.

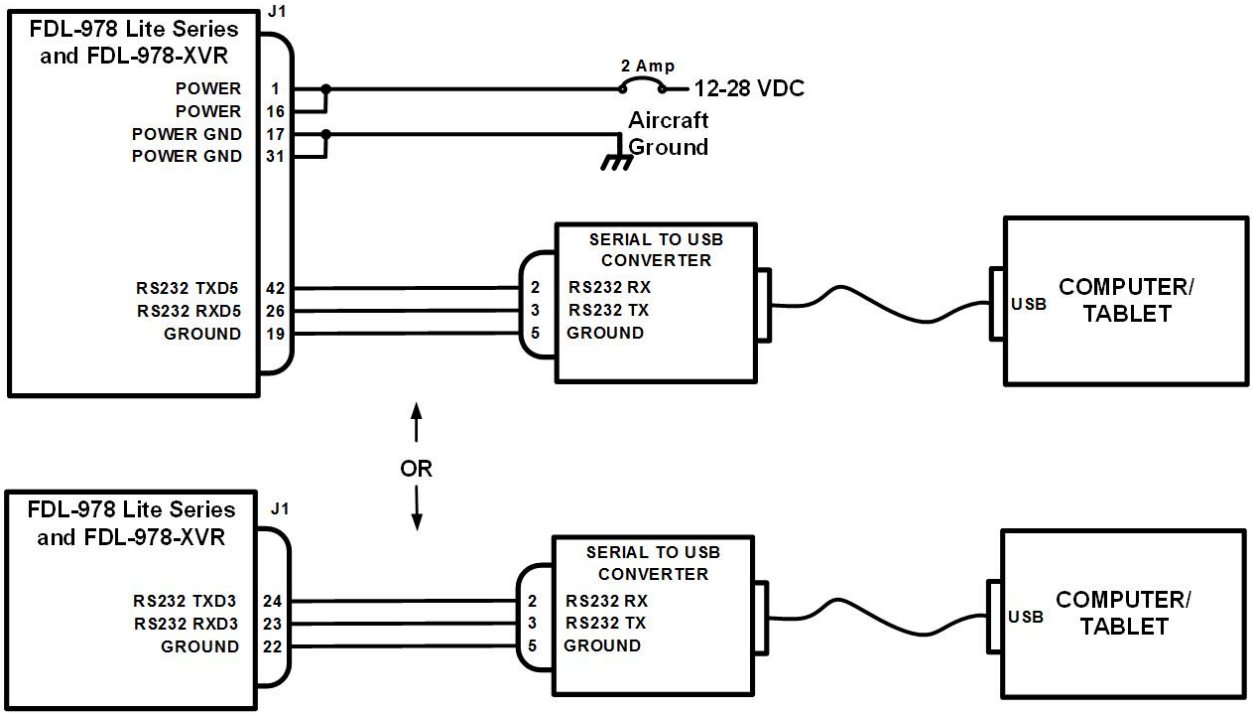


Figure 30. Off-the-Shelf RS-232 to USB Converter

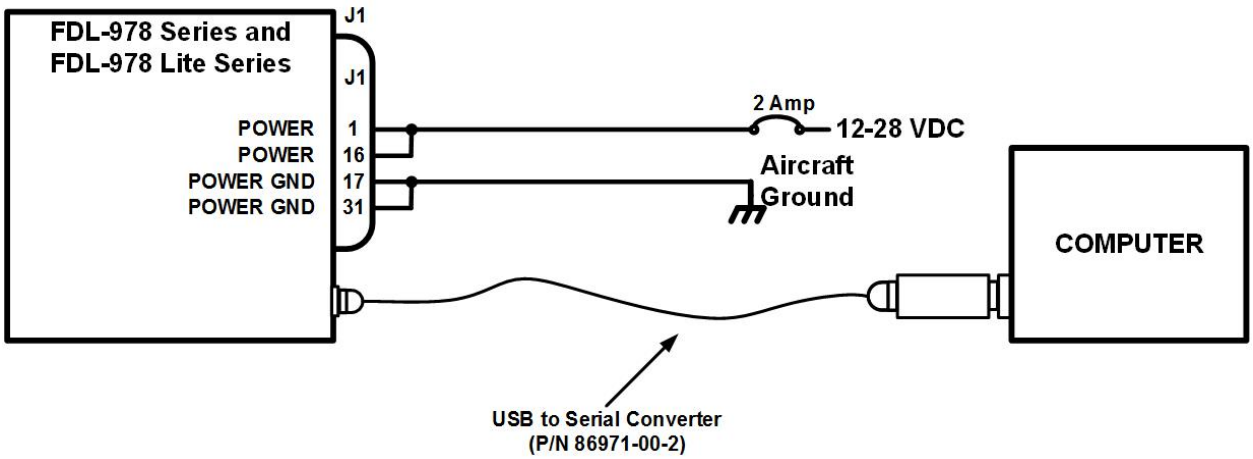


Figure 31. Serial-to-USB MPI Cable and USB-MPI

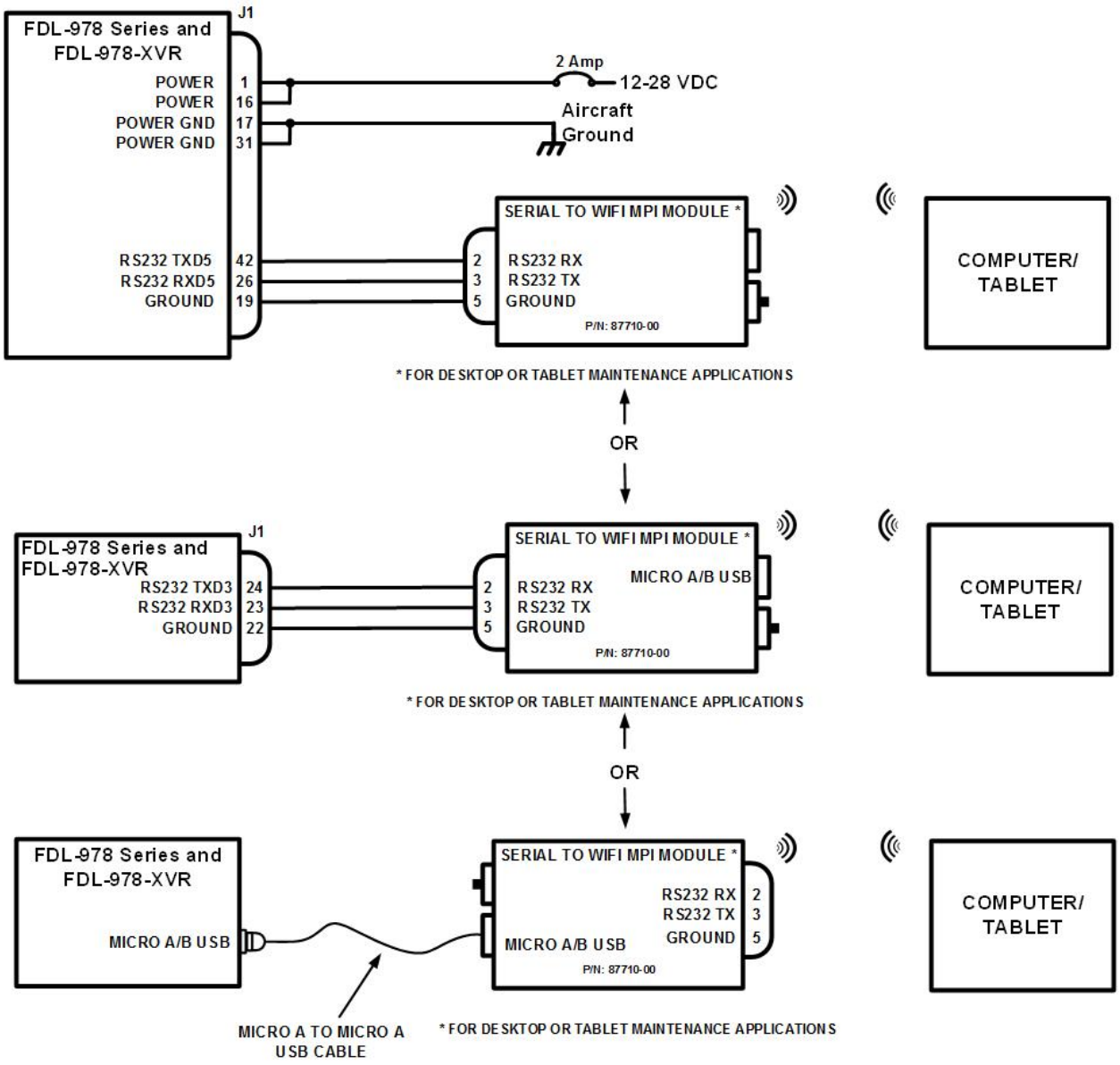


Figure 32. Serial-to-Wi-Fi MPI

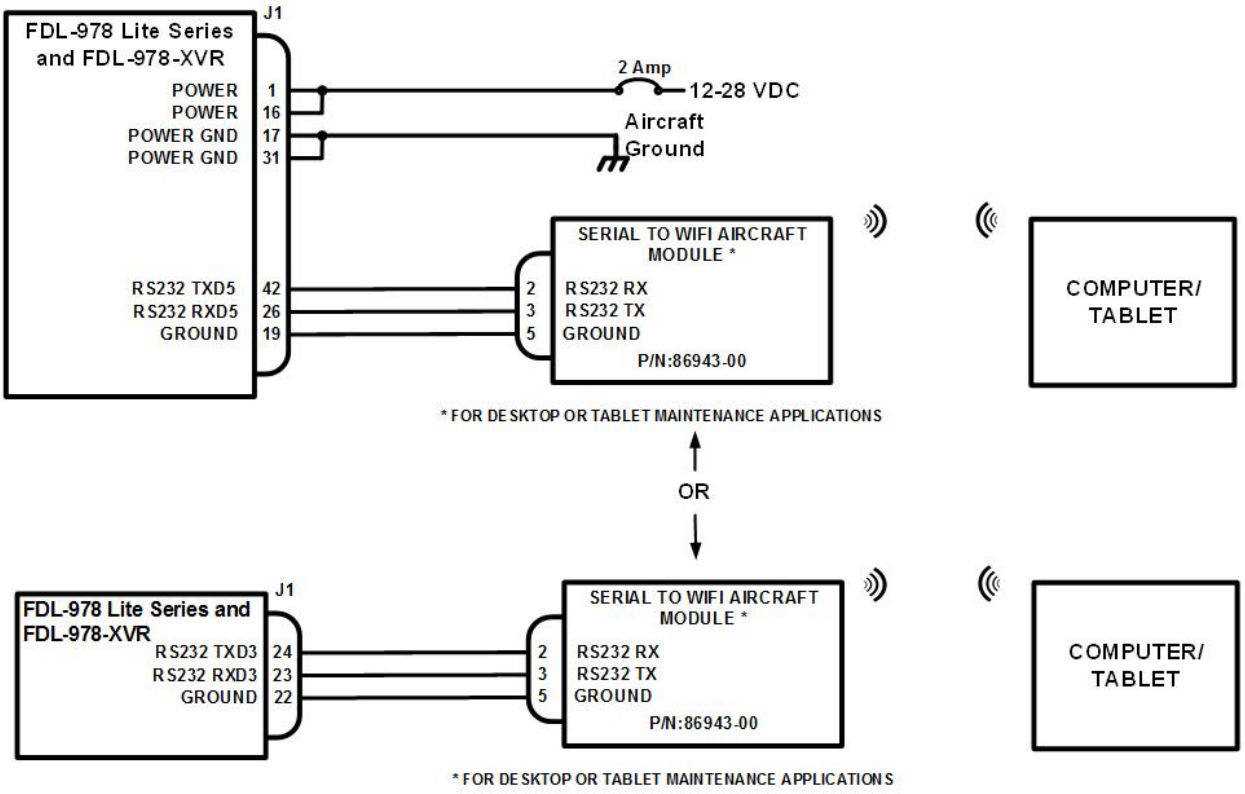
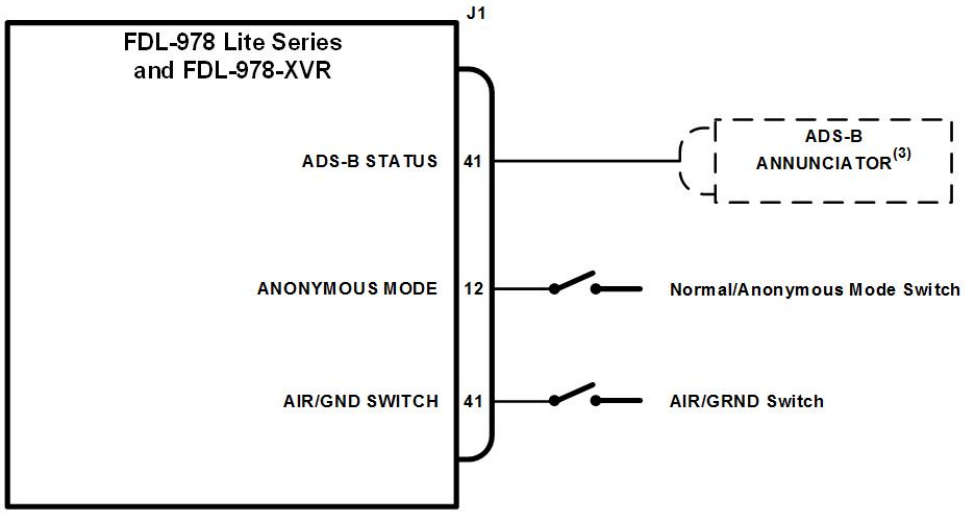


Figure 33. Serial-to-Wi-Fi Aircraft Module



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE OR EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
3. CONNECT TO EXISTING AIRCRAFT AIR/GROUND (SQUAT) SWITCH.

Figure 34. Optional Discrete Inputs/Outputs

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SECTION 11 WARNING DISCLAIMER

The FDL-978 Series provides FIS-B information that can be used as an aid for situational awareness only. FIS-B information provided must be used for advisory use only and should not be used for flight safety critical information and operation. The user is advised to exercise caution and let common sense prevail when confronted with severe weather conditions.

The FDL-978 Series provides traffic information that can be used as an aid for situational awareness only. Pilots must rely on ATC guidance or visual rules for visual acquiring traffic and maneuvering their aircraft in traffic.

The FDL-978 Series provides weather information that can be used as an aid for situational awareness only. Weather information provided must be used for advisory use only and should not be used for flight safety critical information and operation. The user is advised to exercise caution and let common sense prevail when confronted with severe weather conditions.

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SECTION 12 FDL-978 LITE SERIES

12.1 General System Description

The FDL-978 Lite Series includes the FDL-978-XVRL Transceiver *(ADS-B Out & In)* with FWF-125 Wi-Fi Module and the FDL-978-TXL Transmitter (*ADS-B Out only*). The FDL-978-XVRL transmits ownship position, velocity, and flight data (*ADS-B Out)* and receives position, velocity, and flight data from other aircraft and ground station equipment (*ADS-B In)* via a UAT data link. The FDL-978-XVRL satisfies the TSO requirements referenced in Section 1.1 and the associated MOPS for UAT ADS-B class A1S equipment. The FDL-978-TXL has transmit capability only and satisfies the TSO requirements for UAT ADS-B class B1S equipment.

Figure 35. FDL-978 Lite Series

The FDL-978 Lite Series contain an integrated GPS to provide all necessary position and velocity data, allowing it to be used in aircraft that are not equipped with a GPS. Existing Garmin GTX transponders can be used to input squawk codes, IDENT, and mode. A compatible serialized altitude encoder can be used to provide pressure altitude. The FDL-978-XVRL also can provide TIS/FIS data to the cockpit on the pilots PED (e.g. iPad or Android device) through a Wi-Fi connection.

If the aircraft does not have a transponder or altitude encoder, the FDL-978 Lite Series products come with the TC978 control head. The TC978 provides all control input for squawk, IDENT, call sign, mode, and altitude inputs required for ADS-B compliance.

The FDL-978-XVRL Transceiver provides both UAT transmit and receive (*ADS-B In/Out*) and GPS capabilities. The transceiver part number covered by this installation manual is:

- **87098-00-FX0L** FDL-978-XVRL Transceiver with GPS

The FDL-978-TXL Transmitter provides UAT transmit (*ADS-B Out*) and GPS capabilities. The Transmitter part number covered by this installation manual is:

- **87098-00-FT0L** FDL-978-TXL Transmitter with GPS

These units include four status LEDs, serial interfaces (controller input, altitude encoder input, and Wi-Fi Module interface), and discrete inputs/outputs.

The following is a short summary of the features:

Internal GPS
Models have an internal GPS/WAAS sensor and a single antenna input with a TNC connector.

Status LEDs
Four status LEDs (ST – UAT Status, GPS – GPS Status, TX – UAT TX, and RX – UAT RX) indicate the operational status during installation. The RX LED is inoperable on the FDL-978-TXL.

TC978 Controller Interface
A TC978 Controller interface provides low voltage power, system on/off discrete control, and a serial communication interface.

GTX Transponder Control Interface
The GTX Control interface provides connection to Garmin Series transponders (GTX-330/327/32/33) to control FDL-978 Lite Series through a digital serial connection. Other Mode A/C transponders are supported by the FDL-978 Mode A receive feature.

Altitude Encoder Interface
The Altitude Encoder input interface provides connection to an external altitude encoder which outputs the Altitude Encoder format @9600 baud defined in Section 6.1.1.

Wi-Fi Module/MPI Interface
The WiFi Module/MPI interface provides connection to a FWF-125 Wi-Fi Transceiver (FDL-978-XVRL) or a MPI connector (DB-9) (FDL-978-TXRL).

Discrete Inputs/Outputs
Two discrete inputs (Air/Ground Switch and Anonymous Mode) and two discrete outputs (Transmit Suppression and UAT Status) provide optional control and status feedback.

UAT Antennas
There is one (bottom) UAT antenna connector.

FWF-125 Wi-Fi Transceiver (FDL-978-XVRL Only)
The FWF-125 provides a method of transmitting and receiving ADS-B data wirelessly through the use of a laptop or tablet.

The block diagram shown in Figure 36 identifies a TC978 Controller, an FDL-978-TXL, MPI Module, bottom UAT antenna, and a GPS antenna. Additionally, connections are shown to an external altitude sensor (shared with the transponder), the transponder suppression bus, and an air/ground detection switch.

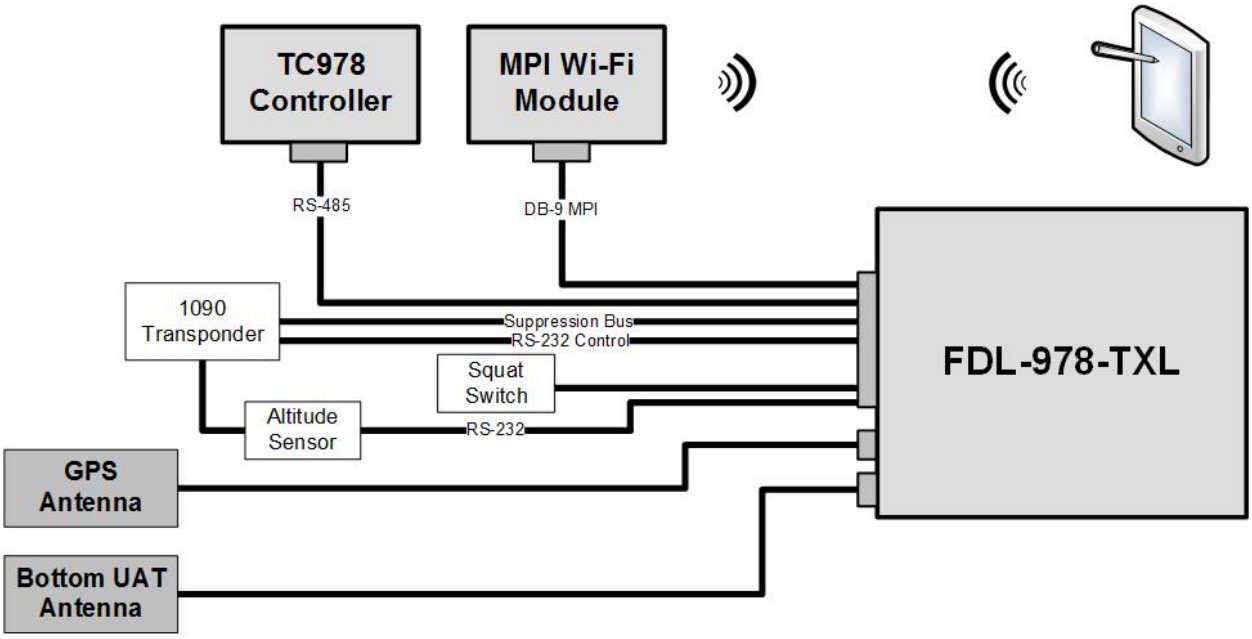


Figure 36. FDL-978-TXL Wi-Fi MPI Block Diagram (Typical)

The block diagram shown in Figure 37 identifies a TC978 Controller, an FDL-978-XVRL, FWF-125 Wi-Fi Transceiver, bottom UAT antenna, and a GPS antenna. Additionally, connections are shown to an external altitude sensor (shared with the transponder), the transponder suppression bus, and an air/ground detection switch.

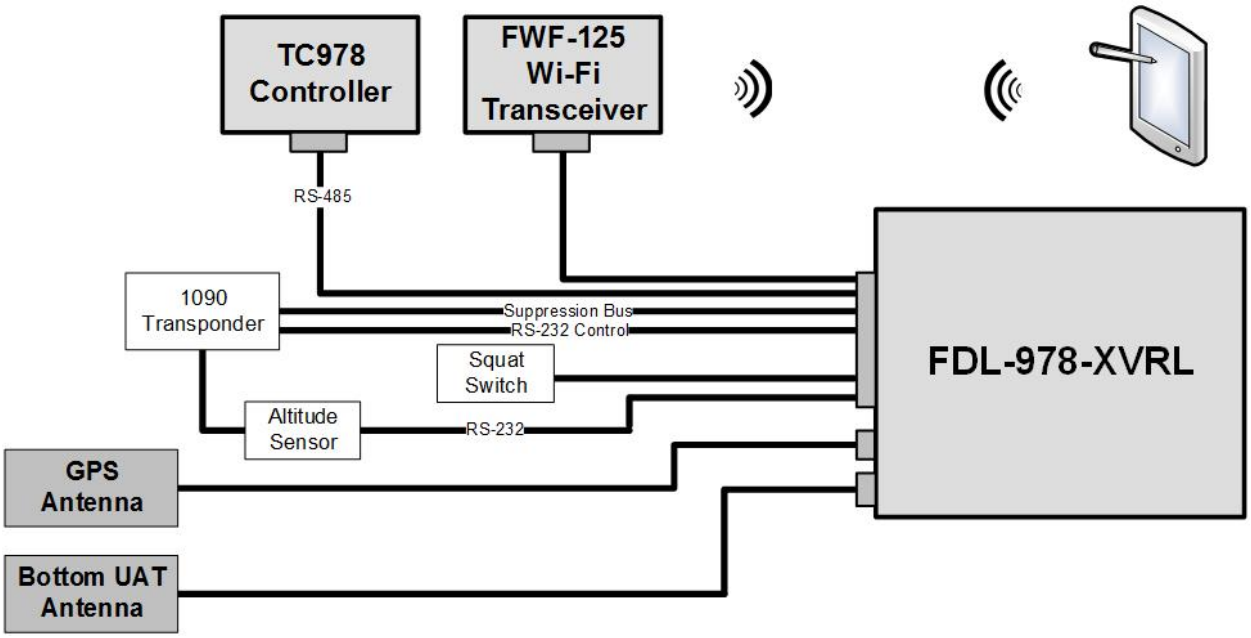


Figure 37. FDL-978-XVRL Wi-Fi Transceiver Block Diagram (Typical)

12.2 Technical Characteristics

U.S. standard units of measure are the primary means of identifying dimensions, weights, etc. The equivalent metric values may also be shown in brackets (e.g. 1.9 in [48 mm]).

Transmitter (P/N 87098-00-FT0L) and Transceiver (87098-00-FX0L) Characteristics

Specification	Characteristics
ENVIRONMENTAL COMPLIANCE	See Section 5.1
TSO COMPLIANCE	C154c (A1S –FX0L B1S –FT0L) C157a (Class 1) Incomplete System C195a (Class C1) C145c (Beta 1)
FCC IDENTIFICATION	T7YFDL978XXXX
SOFTWARE	RTCA/DO-178B Level C
HARDWARE	RTCA/DO-254 Level C
PHYSICAL DIMENSIONS	
Height	1.7 in [43.18 mm]
Width	5.0 in [127 mm]
Depth	5.5 in [139.7 mm]
WEIGHT	0.98 lb [454 g]
OPERATING TEMPERATURE	-40°F to +158°F [-40°C to +70°C]
STORAGE TEMPERATURE	-67°F to +185°F [-55°C to +85°C]
ALTITUDE	50,000 feet
POWER REQUIREMENTS	10 – 40 Volts DC, Typical 0.34 A @ 28 VDC, Peak 0.84 A @ 28 VDC
TRANSCEIVER FREQUENCY	978 MHz
TRANSMITTER POWER	40 Watts max at antenna after 2dB connector/cable loses
RECEIVER SENSITIVITY	-99 dBm (FX0L only)

Avionics Interface		
Type	**I/O**	**Description**
Controller	Input/ Output	7 VDC power output, remote on/off discrete input, RS-485 serial interface to the TC978
Altitude Input	Input	Serial (RS-232)
Discrete Inputs	Input	2 (Air/Ground, Anonymous Mode)
Discrete Outputs	Output	2 (Transmit Suppression and UAT Status)

12.3 Parts and Equipment

12.3.1 FDL-978 Lite Series Items

The items included in the FDL-978-XVRL Ship Kit **(P/N 87098-00-FX0L-KIT)** are listed below:

Part Number	Qty	Description
87098-00-FX0L	1	FDL-978-XVRL Transceiver
87349	1	TC978 Controller
86943-00	1	FWF-125 Wi-Fi Transceiver
87875-00	1	Kit, Installation, XVR Lite

The items included in the XVR Lite Installation Kit **(P/N 87875-00)** are listed below:

Part Number	Qty	Description
85937	1	Antenna UAT Ball & Stick TSO-C74c
86966	1	BNC Connector Male RG-142 Crimp
81194	1	Antenna GPS WAAS DO-228 TSO-C144
0129-0017-00	3	TNC Connector Male RG-142 Crimp
86945	1	DB-44 Connector Male Crimp
85942	1	DB-44 Connector Backshell
83145	30	Pin Male 24-28 AWG Crimp
87093	1	DB-15 Connector Female Crimp
87094	1	DB-15 Connector Backshell
84141	15	Socket Female 24-28 AWG Crimp
84192	1	Connector, DB9F Crimp
84193	1	Hood; 9 Pin Dsub
87872	4	Screw 4-40 1.5 in MS Brass
87873	4	Screw 4-40 0.625 in MS Brass
87866	2	Bracket, Adapter, TC978, TC20

The items included in the FDL-978-TXL Ship Kit **(P/N 87098-00-FT0L-KIT)** are listed below:

Part Number	Qty	Description
87098-00-FT0L	1	FDL-978-TXL Transmitter
87349	1	TC978 Controller
87874-00	1	Kit, Installation, TX Lite

The items included in the TX Lite Installation Kit **(P/N 87874-00)** are listed below:

Part Number	Qty	Description
85937	1	Antenna UAT Ball & Stick TSO-C74c
86966	1	BNC Connector Male RG-142 Crimp
81194	1	Antenna GPS WAAS DO-228 TSO-C144
0129-0017-00	3	TNC Connector Male RG-142 Crimp
86945	1	DB-44 Connector Male Crimp
85942	1	DB-44 Connector Backshell
83145	30	Pin Male 24-28 AWG Crimp
84141	9	Socket Female 24-28 AWG Crimp
84192	1	Connector, DB9F Crimp
84193	1	Hood; 9 Pin Dsub
87872	4	Screw 4-40 1.5 in MS Brass
87873	4	Screw 4-40 0.625 in MS Brass
87866	2	Bracket, Adapter, TC978, TC20

12.4 Installation

This section provides general information for installing the FDL-978 Lite Series into an aircraft. This section contains mounting dimensions, pin outs, and interface details pertaining to installation. Adherence to these installation procedures and information will assure satisfactory system performance. Note that several sections below refer to paragraphs in Section 2 that are common with the FDL-978 Series.

FAA AC 20-165A requires certified installations with ADS-B Out Transmitters (FDL-978 Lites Series) and any transponder on the aircraft to transmit pressure altitude data obtained from the same altitude sensor source. Installations must therefore ensure that the transponder and FDL-978 Lites Series receive altitude data from the same altitude sensor.

FAA AC 20-165A HIGHLY recommends that the ADS-B transmitter and transponder share a single point of entry for Mode A (Squawk Code) and IDENT. Dual entry installations are allowed but discouraged and must ensure that the transponder and UAT transmit the same Mode A and IDENT without increased pilot workload. Garmin Series transponders (GTX-330/327/32/33) must be connected to the GTX-REMOTE Input port on the FDL-978 Lites Series to control Mode A code and IDENT. Mode A/C transponders will automatically use the FDL-978 Lites Series internal Mode A receiver to monitor the on-board transponder transmissions to set Mode A code and IDENT. Mode A receive is *not* compatible with Mode S transponders.

12.5 Unpacking and Inspecting Equipment

Refer to Section 2.1 - Unpacking and Inspecting Equipment.

12.5.1 Equipment Mounting

Refer to Section 2.2- Equipment Mounting.

12.6 Cooling Requirements

Refer to Section 2.3 - Cooling Requirements.

12.7 Electrical Connections

12.7.1 Interface – DB-44 Pinout

J1 - Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
1	Vin	10-40 VDC	Pwr	Aircraft Power Input
2	GND	Ground	Gnd	TC978 Controller Power Return
3	Control Data In	RS-232	I	Control Data RS-232 Data In
4	Reserved	N/A	-	N/A
5	Reserved	N/A	-	N/A
6	Reserved	N/A	-	N/A
7	Reserved	N/A	-	N/A
8	Reserved	N/A	-	N/A
9	Altitude Input Gnd	Serial Ground	Gnd	Altitude Input Ground
10	Reserved	N/A	-	N/A
11	Reserved	N/A	-	N/A
12	Anonymous Mode	Open/Ground	I	Anonymous Mode, Active Low
13	Reserved	N/A	-	N/A
14	Reserved	N/A	-	N/A
15	Reserved	N/A	-	N/A
16	Vin	10-40 VDC	Pwr	Aircraft Power Input
17	RTRN	Ground	Gnd	Aircraft Power Return
18	Vcp	5.5-10 VDC	O	TC978 Controller Power Output
19	Wi-Fi Data Gnd	Serial Ground	Gnd	Wi-Fi Data Ground
20	TC978 Data +	RS-485	I/O	TC978 RS-485 Data+
21	TC978 Data -	RS-485	I/O	TC978 RS-485 Data-
22	GND	Gnd	Gnd	Ground Reference
23	Reserved	N/A	-	N/A
24	Reserved	N/A	-	N/A
25	Altitude Input Data	RS-232	I	Altitude Input RS-232 Data In
26	Wi-Fi Module Input	RS-232	I	Wi-Fi Module or MPI RS-232 Data In
27	AIR/GRND	Open/Ground	I	Air/Ground In (Squat Switch - configurable)
28	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
29	Reserved	N/A	-	N/A
30	Reserved	N/A	-	N/A
31	RTRN	Ground	Gnd	Aircraft Power Return

J1 - Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
33	Control Data Out	RS-232	O	Control Data RS-232 Data Out
34	Reserved	N/A	-	N/A
35	Reserved	N/A	-	N/A
36	Reserved	N/A	-	N/A
37	Reserved	N/A	-	N/A
38	Reserved	N/A	-	N/A
39	Reserved	N/A	-	N/A
40	Reserved	N/A	-	N/A
41	UAT STATUS	Open/Ground	O	ADS-B Status
42	Wi-Fi Module Output	RS-232	O	Wi-Fi Module or MPI RS-232 Data Out
43	Reserved	N/A	-	N/A
44	Reserved	N/A	-	N/A

12.7.2 Interface Details

Refer to Section 2.5 - Interface Details.

12.7.3 Power Input

Refer to Section 2.5.1 - Power Input.

12.7.4 Status LEDs

Refer to Section 2.5.3 - Status LEDs.

12.7.5 Remote Power Control

Refer to Section 2.5.4 - Remote Power Control.

12.7.6 TC978 Controller Interface

Refer to Section 2.5.5 - TC978 Controller Interface.

12.7.7 Control Data Interface

The control data interface is used to connect to a GTX Series (330/33/327/32) transponder for controlling Squawk Code, IDENT, and mode (standby/alt inhibit) to the FDL-978 Lite Series UAT. If no transponder is connected to this interface than the FDL-978 Lite Series will monitor any on-aircraft mode A/C transmissions to control Squawk Code and IDENT. The TC978 is used to control the UAT if no transponder is present on the aircraft. The control data interface pins are as follows:

J1 - Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
3	Control Data In	RS-232	I	Control Data RS-232 Data In
33	Control Data Out	RS-232	O	Control Data RS-232 Data Out
19	Serial Data Gnd	Serial Ground	Gnd	Serial Data Ground (Shared with Wi-Fi)

12.7.8 Altitude Input Data Interface

The altitude input data interface is used to connect to an altitude encoder that outputs the Altitude Encoder format @9600 baud defined in Section 6.1.1. If the Altitude Encoder interface is not configured the altitude data from the TC-978 sensor will be used for altitude data. The altitude input data interface pins are as follows:

J1 - Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
25	Altitude Input Data	RS-232	I	Altitude Input RS-232 Data In
9	Altitude Input Gnd	Serial Ground	Gnd	Altitude Input Ground

12.7.9 Discrete Inputs

Input pins are pre-configured active low. See Section 12.20 for a wiring diagram reference.

Two discrete inputs are available (and a spare for future use) to provide control inputs to the UAT. The discrete input connection pins are as follows:

Discrete Inputs				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-27	AIR/GND	Open/Ground	I	Air/Ground In (Squat Switch – configurable)
J1-12	Anonymous Mode	Open/Ground	I	Anonymous Mode

12.7.9.1 Air/Ground Input

Refer to Section 2.5.7.1 - Air/Ground Input.

12.7.9.2 Anonymous Mode Input

Refer to Section 2.5.7.3 - Anonymous Mode Input.

12.7.10 Discrete Output

Refer to Section 2.5.9 - TX Suppression Output.

12.7.11 Wi-Fi Module or Maintenance Port Interface

The Wi-Fi Module interface is used to connect to the FWF-125 Wi-Fi Module (FDL-978-XVRL only) for receiving ADS-B TIS/FIS data wirelessly on the pilots PED (e.g. iPad or Android device) through a Wi-Fi connection. An Android tablet ADS-B MPI application can also be used to configure the system and check system installation status through the Wi-Fi module. The Wi-Fi module interface pins are as follows:

J1 - Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
26	Wi-Fi Module Input	RS-232	I	Wi-Fi Module or MPI RS-232 Data In
42	Wi-Fi Module Output	RS-232	O	Wi-Fi Module or MPI RS-232 Data Out
19	Wi-Fi Data Gnd	Serial Ground	Gnd	Wi-Fi Data Ground

When installing the FDL-978-TXL Transmitter, which does not include a Wi-Fi module, a female DB-9 connector should be mounted in the aircraft for easy Maintenance Port Interface (MPI) access. The MPI can be used to configure the system, provide installation status information, and update system software/firmware. The DB-9 connector allows connection to a battery powered Serial-to-Wi-Fi MPI Module. The Wi-Fi MPI Module (P/N 87710-00) allows Wi-Fi connection to the Android tablet ADS-B MPI application for configuration and installation status/troubleshooting. The standard RS-232 DB-9 connections are shown in the table below:

Female DB-9	**DB-44**		
PIN	**SIGNAL**	**PIN**	**SIGNAL**
2	Tx	J1-42	Wi-Fi Module Output
3	Rx	J1-26	Wi-Fi Module Input
5	GND	J1-19	Wi-Fi Data Gnd

12.8 TC978 Controller Electrical Connections

Refer to Section 2.6 - TC978 Controller Electrical Connections.

12.9 Wiring Considerations

Refer to Section 2.9 - Wiring Considerations.

12.10 UAT Antenna Installation

Refer to Section 2.10 - UAT Antenna Installation.

12.11 Configuration and Checkout

Refer to Section 3.1 - General and Section 3.2 - Preliminary Checkout.

12.12 Installation Setup and Configuration

12.12.1 FDL-978 Lite Series Configuration Item Summary

Table 22. Serial Port Configuration Settings

Configuration Item		Default	Setting
Altitude Encoder (Port 4)	**IN Function**	UNUSED	
Configuration:	**Baud**	9600	

Table 23. ADS-B Transmit Configuration Settings

Configuration Item		Default	Setting
ICAO Address (Mode S)		0	
Call Sign/Flight ID			
Emitter (Aircraft) Category		UNKNOWN	
Squat Mode		None	
Groundspeed Threshold		0 knots	
Aircraft Size:	**Length**	0	
	Width	0	
GPS Antenna Offset:	**Longitudinal**	No Data	
	Lateral	No Data	
VFR Squawk Code (1)		1200	

(1) VFR Squawk Code is only set on the TC978.

12.12.2 FDL-978 Lite Series Interface Configuration Details

12.12.2.1 Control Data Interface

FAA AC 20-165A HIGHLY recommends that the ADS-B transmitter and transponder share a single point of entry for Mode A (Squawk Code) and IDENT. Dual entry installations are allowed but discouraged and must ensure that the transponder and UAT transmit the same Mode A and IDENT without increased pilot workload. Garmin Series transponders (GTX-330/327/32/33) must be connected to the GTX-REMOTE Input port on the FDL-978 Lite Series to control Mode A code and IDENT. Mode A/C transponders will automatically use the FDL-978 Lite Series internal Mode A receiver to monitor the on-board transponder transmissions to set Mode A code and IDENT. Mode A receive is *not* compatible with Mode S transponders.

Control inputs such as Flight Plan ID (Squawk Code), Call Sign, and mode control (IDENT, Altitude Inhibit, transmit Standby) are required by the FDL-978 Lite Series. The FDL-978 Lite Series provides the following three modes to receive control inputs:

1. A Garmin GTX Series transponder can be connected to the GTX-REMOTE Input port interface on the FDL-978 Lite Series. The FDL-978 Lite Series accepts the control (Squawk Code and mode) inputs from the transponder. The TC978 displays control status but Squawk and mode control from the TC978 are locked out. The Call Sign can be controlled by the TC978 in this mode.
2. When NO GTX transponder is connected to the GTX-REMOTE Input port, the FDL-978-TX listens for Mode A messages transmitted by an on-aircraft Mode A/C transponder and sets the squawk code and IDENT to the same code/IDENT being transmitted by the transponder. The TC978 displays control status, but Squawk and IDENT from the TC978 are locked out. The Call Sign and mode control (Altitude Inhibit and Transmit Standby) can be controlled by the TC978 in this mode.
3. When the aircraft has no transponder, the TC978 provides all control inputs and status feedback.

12.12.2.2 Altitude Input Interface

FAA AC 20-165A requires certified installations with ADS-B Out Transmitters (FDL-978 Lite Series) and any transponder on the aircraft to transmit pressure altitude data obtained from the same altitude sensor source. Installations must; therefore, ensure that the transponder and FDL-978 Lite Series receive altitude data from the same altitude sensor.

The FDL-978 Lite Series requires pressure altitude data input from an altitude encoder. The FDL-978 Lite Series provides the following two modes to receive altitude data input:

1. An altitude encoder which outputs altitude data per the Altitude Encoder format @9600 baud defined in Section 6.1.1 can provide altitude data to the FDL-978 Lite Series. The Altitude Data input port (port 4) must be configured to Altitude Encoder input @9600 baud to use this mode.
2. The TC978 internal altitude encoder can provide altitude data to the FDL-978 Lite Series. The Altitude Data input port (port 4) must be configured to UNUSED to use this mode.

12.12.2.3 Wi-Fi Module or Maintenance Port Interface

FDL-978-XVRL Transceiver

ADS-B traffic and FIS-B data is output (FDL-978-XVRL only) on the Wi-Fi Module/MPI Port. The FreeFlight Systems Wi-Fi Module (FWF-125) connects to this port and is used to connect to various tablet applications (e.g. ADS-B MPI and FFS ADS-B View apps) and display traffic and weather data. System configuration/status can also be set/viewed through the Wi-Fi Module using the FFS ADS-B MPI Android Application.

FDL-978-TXL Transmitter

A female DB-9 connector should be mounted in the aircraft to this port for easy Maintenance Port Interface (MPI) access. The DB-9 connector allows connection of a battery powered Serial-to-Wi-Fi MPI Module (P/N 87710-00) during installation and maintenance checks which can be used to configure the system, provide installation status information, and update system software/firmware using the FFS ADS-B MPI Android Application.

12.13 Configuration and Setup Using TC978

Do not use Configuration Mode during flight.

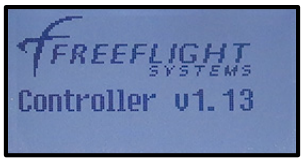
The system should be configured during initial system installation by a qualified technician. The configuration items list in Section 12.3.1 should be used to document the system installation for future reference. To view or change these settings you must enter TC978 Configuration Mode.

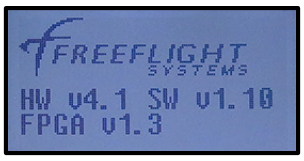
The configuration setup screen is the first thing displayed on startup when a completely new FDL-978 Lite Series is installed and powered up for the first time. After a configuration has been programmed, the system will power up in normal operating mode and the configuration will be stored in the FDL-978 Lite Series and TC978.

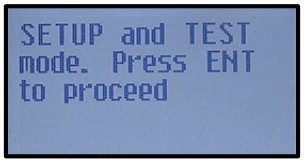
12.13.1 Entering Configuration Mode

To enter TC978 configuration mode:

- Hold down the FN button while turning the Mode Selection knob from OFF to any operating mode.
- In the configuration mode the TC978 Controller displays the following typical messages in a quick, sequential order:







12.13.2 Configuration Mode Operation

*Port 4 (Altitude Encoder) is the only serial port that can be configured by the installer. Input settings can either be left at UNUSED, or configured for use with an Altitude Encoder. Refer to Section 0 for details on configuring this port.

All other options during the TC978 Configuration Mode are ignored and reset and returned to the factory settings.

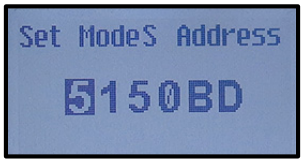
The FDL-978 Lite Series is preconfigured to simplify the installation and configuration process. The following list shows the limited configuration options that can be set by the installer:

- Mode S Address (ICAO Address)
- VFR Squawk
- VFR Flight ID
- Groundspeed Threshold
- Squat Switch Type
- Serial IN Channel 4*
- Aircraft Size – length and width
- GPS Antenna Offset – lateral and longitudinal offset

The following paragraphs detail the setup modes available for configuring the FDL-978 Lite Series. Configuration items can be changed using the CODE knob and the ENT button. Pressing the FN button advances to the next configuration item.

12.13.2.1 Aircraft Mode S (or ICAO) Address

The Mode S address is a 24 bit number assigned to the aircraft and is represented in a six character hexadecimal format. The CODE knob is used to change each character as required. Each character of the Mode S address is a number between 0 to 9 or a letter between A to F. When the ENT button is pressed the cursor advances to the next character as shown below.



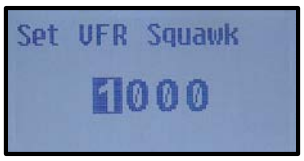
To advance to the next configuration item without changing the ICAO address either scroll through the six characters by pressing the ENT button six times or press the FN button.

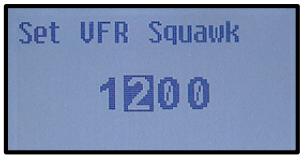
12.13.2.2 VFR Squawk Code

VFR Squawk Code is a pre-programmed default code when the pilot is flying VFR and not in contact with ATC. When the pilot presses the VFR button, the VFR Squawk Code will replace the current Squawk Code. In the USA, the VFR Squawk Code is 1200 and in most parts of Europe the VFR Squawk Code is 7000.

The default VFR Squawk Code cannot be changed in-flight and can only be set in the configuration mode.

The VFR Squawk Code is a 12 bit number and is represented as a four character octal number. The CODE knob is used to change each character as required. Each character of the Squawk Code is a number between 0 and 7. When the ENT button is pressed the cursor advances to the next character as shown below.





To advance to the next configuration item without changing the VFR Squawk Code either scroll through the four characters by pressing the ENT button four times or press the FN button.

12.13.2.3 VFR Flight ID

The VFR Flight ID is usually one of the following types:

- Type A – The characters corresponding to the registration marking of the aircraft.
- Type B – The telephony designator of the aircraft operating agency, followed by the last four characters of the registration marking of the aircraft.
- Type C – The telephony designator of the aircraft operating agency, followed by the flight identification.

The VFR Flight ID is an eight character alpha-numeric string. The CODE knob is used to change each character as required. Each character of the Flight ID is a number between 0 to 9 or letter between A to Z. When the ENT button is pressed the cursor advances to the next character as shown below.

To advance to the next configuration item without changing the VFR Flight ID either scroll through the eight characters by pressing the ENT button eight times or press the FN button.

The VFR Flight ID cannot be changed in-flight and can only be set in the configuration mode.

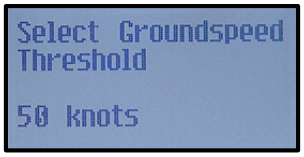
12.13.2.4 Groundspeed Threshold

Groundspeed threshold can be used to help determine and verify the ON GROUND condition for transmitting ON GROUND ADS-B message types for “Light Fixed Wing” aircraft types only. The FDL-978 Lite Series uses the ground speed threshold configuration to determine a maximum ON GROUND speed. There are 10 options to select groundspeed threshold:

1. Unknown
2. 30 knots
3. 40 knots
4. 50 knots
5. 60 knots
6. 70 knots
7. 80 knots
8. 90 knots
9. 100 knots
10. 120 knots

This only applies to an Emitter Category of Light Aircraft – no other categories use a configurable groundspeed threshold.

The display screen is as shown below with one of the options from the list above.



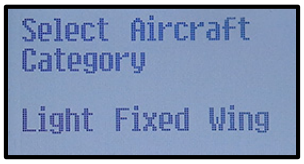
Rotate the CODE knob to display the options above and select the groundspeed threshold. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

12.13.2.5 Aircraft (Emitter) Category

The following options are offered for selecting aircraft (emitter) category:

1. Unknown
2. Light Fixed Wing
3. Medium Fixed Wing
4. Large Fixed Wing
5. High Vortex B757
6. Heavy Fixed Wing
7. High G/ High Speed
8. Rotorcraft
9. Glider/Sailplane
10. Lighter than air
11. Parachutist
12. ULM/Hang/Paraglider
13. UAV

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct aircraft category. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

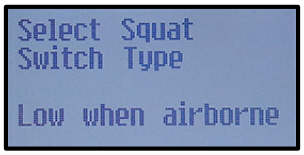
12.13.2.6 Squat Switch Type

Rotate the CODE knob either clockwise or counterclockwise to display the options below and select the correct Squat Switch type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

The following options are offered for selecting aircraft Squat Switch type:

1. Not Connected
2. Low when ground
3. Low when airborne

The display screen is as shown below with one of the options from the list above.



12.13.2.7 Serial IN Channel 4 Data Type

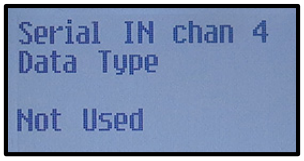
(X = channel number) The FDL-978 Lite Series can receive data on serial channel 4 only. The following options are offered for selecting serial input type of the FDL-978 Lite Series:

Channel 4

1. Not Used
2. Altitude Encoder

Refer to Section 3.3.2.1 for details on selecting serial input settings.

The display screen is as shown below with one of the options from the list above.

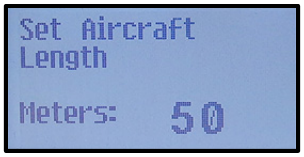


Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct serial input type. Once selected, press the ENT button to confirm your selection and move to the next configuration item in the setup mode.

If “Not Used” is selected then the serial input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

12.13.2.8 Aircraft Length

The aircraft length can be set from 1 meter to 75 meters by rotating the CODE knob either clockwise or counterclockwise to display the correct length. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.



12.13.2.9 Aircraft Width

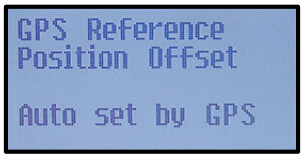
The aircraft width can be set from 1 meter to 80 meters by rotating the CODE knob either clockwise or counterclockwise to display the correct width. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

12.13.2.10 GPS Reference Position Offset

There are three modes by which the GPS reference offset can be set:

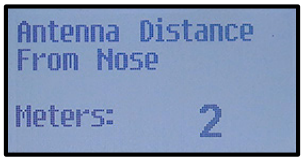
1. Unknown
2. Auto set by GPS
3. Manual set here

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct GPS reference offset. Once selected, press the ENT button to confirm your selection. If “Unknown” or “Auto Set by GPS” is selected the next configuration item in the setup mode will be displayed. If “Manual Set here” is selected, then options for manually entering the GPS antenna reference offset are displayed as below:

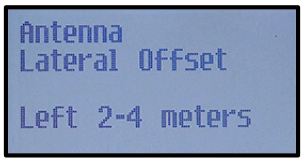
The antenna distance from the nose can be entered anywhere between 2 meters to 60 meters by rotating the CODE knob either clockwise or counterclockwise to display the correct distance. Once selected, press the ENT button to confirm selection and move to the lateral offset configuration item in the setup mode.



The antenna lateral offset has the following options that can be selected:

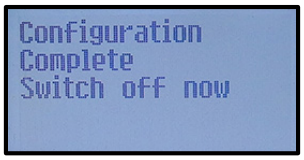
1. Unknown
2. Left 0-2 meters
3. Left 2-4 meters
4. Left 4+ meters
5. Central
6. Right 0-2 meters
7. Right 2-4 meters
8. Right 4+ meters

The display screen is as shown below with one of the options from the list above.



Rotate the CODE knob either clockwise or counterclockwise to display the options above and select the correct antenna offset. Once selected, press the ENT button to confirm selection and move to the next configuration item in the setup mode.

Press ENT button and the display will instruct completion of setup and power off the system.



12.14 TC978 Test and Calibration

Refer to Section 3.7 - TC978 Test and Calibration.

12.15 Troubleshooting

Refer to SECTION 4 - Troubleshooting.

12.16 RTCA/DO-160 Environmental Qualifications

Refer to SECTION 5 - RTCA/DO-160 Environmental Qualifications.

12.17 Serial Interface Specifications

Refer to SECTION 6 - Serial Interface Specifications.

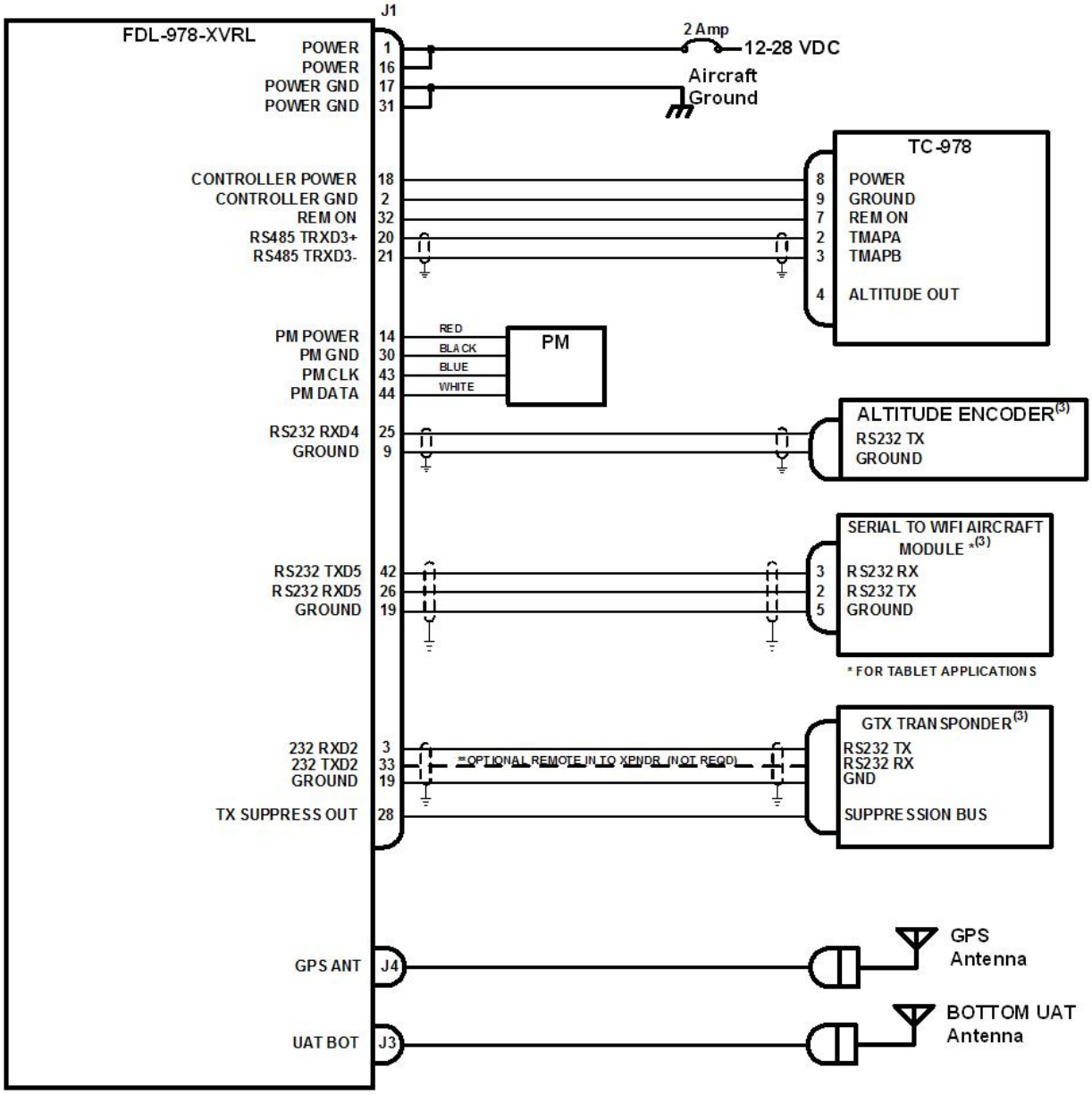
12.18 ADS-B Compliance

Refer to SECTION 7 - ADS-B Compliance.

12.19 Installation Drawings

Refer to SECTION 8 - Installation Drawings.

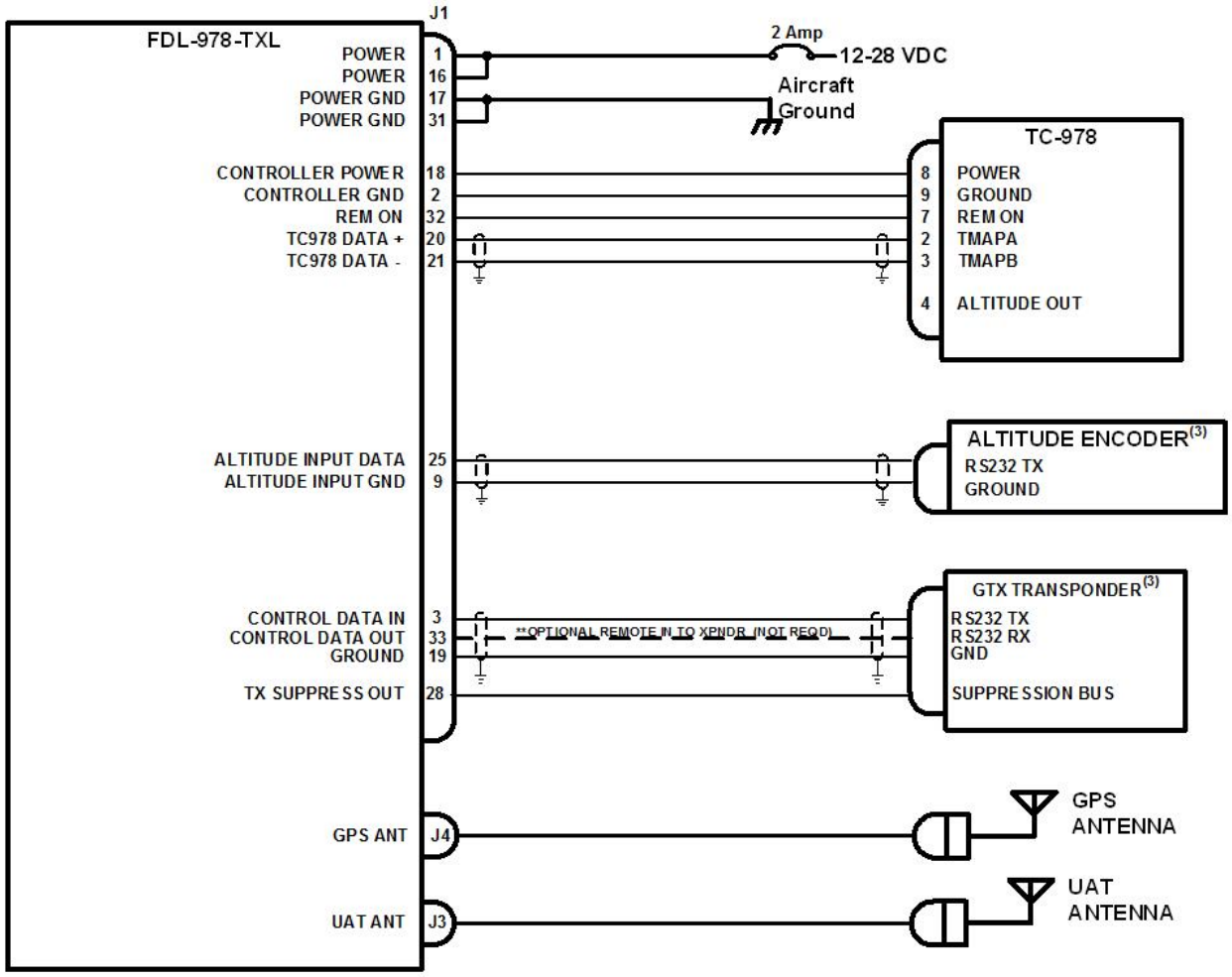
12.20 Typical Interconnect Diagrams



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE O EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY

Figure 38. FDL-978-XVRL (Typical)



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 WIRE O EQUIVALENT IN CERTIFIED INSTALLATIONS.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY

Figure 39. FDL-978-TXL (Typical)

Table 24. Typical Transponder Connections (1)

TRANSPONDER	ALT OUT	REMOTE OUT	REMOTE IN	SUPPRESSION	NOTE
GTX-327/32	N/A	TxD1 pin 20	N/A	Suppress IO pin	Software version 2.10 or later
GTX-330/33	TxD1 pin 23	TxD2 pin 25	RxD1-22 (2) RxD2-24 (2)	Suppress IO pin	Software version 3.06 or later

(1) These connections are typical. If serial ports shown are being used then other ports may be available to configure and use or an alternate interface to get common altitude data may be necessary. Refer to transponder documentation for complete interconnect information.

(2) REMOTE IN may be used as a GPS source from the XVR for the GTX 330/33.

12.21 Maintenance Interface Diagrams

Refer to SECTION 10 - Maintenance Interface Diagrams.

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SECTION 13 LIMITED WARRANTY

I. HARDWARE

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(B) THE WARRANTY CARD SUPPLIED WITH THE PRODUCT MUST BE COMPLETED AND RETURNED TO FREEFLIGHT WITHIN 15 DAYS OF INSTALLATION OF THE PRODUCT IN ORDER FOR THIS WARRANTY TO BECOME EFFECTIVE.

(C) THE PRODUCT IS SOLD AND INSTALLED BY AN AUTHORIZED DEALER. A LIST OF ALL AUTHORIZED FREEFLIGHT DEALERS MAY BE OBTAINED FROM FREEFLIGHT. .

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