



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

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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
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
ETX	End of Transmission
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

Item	Definition
hPa	hectopascal
in	inch(es)
lb	pound(s)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MHz	megahertz
M	meter
mm	millimeter
MOPS	Minimum Operational Performance Standards
MPI	Maintenance Port Interface
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
RI	Resolution Instruction
RTS	Request to Send
Rx	Receive
SBAS	Satellite Based Augmentation System
SSI	signal strength indication
STC	Supplemental Type Certificate
TA	Traffic Advisory
TC	Type Certificate
TCAS	Traffic Collision Avoidance System
TIS	Traffic Information Service
TNC	Threaded Neill–Concelman
TSO	Technical Standard Orders
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter

Item	Definition
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 follow the instructions provided may cause serious injury to personnel or damage to equipment if not followed.



Cautions are identified when failure to properly follow the instructions provided may cause serious damage to equipment, or unintended operation, if not followed.



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

1.4 General System Description

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 Minimum Operational Performance Standards (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 87098-00 and 97098-10 models do not include a Port 5.

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:

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



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

The FDL-978-TXL Transmitters are described in SECTION 12.

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.

Installations where the transponder and/or display cannot provide the required control and status, the TC978 Controller (optional for the FDL-978-XVR) 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 block diagram shown in Figure 1 identifies an example installation with a TC978 Controller, FDL-978-XVR Transceiver, GPS Antenna, two UAT antennas, a Personality Module, and a dedicated MPI connection for ease of configuration. The MPI Module is connected during

maintenance activities and allows an Android tablet to communicate with the FDL-978 through the ADS-B Maintenance Port Interface (MPI) Android app. Additionally, connections are shown to an external altitude source (shared with the transponder), the transponder suppression bus, and an air/ground detection, or Squat 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 through an ARINC 429, or serial connection (see Section 1.7 for details).

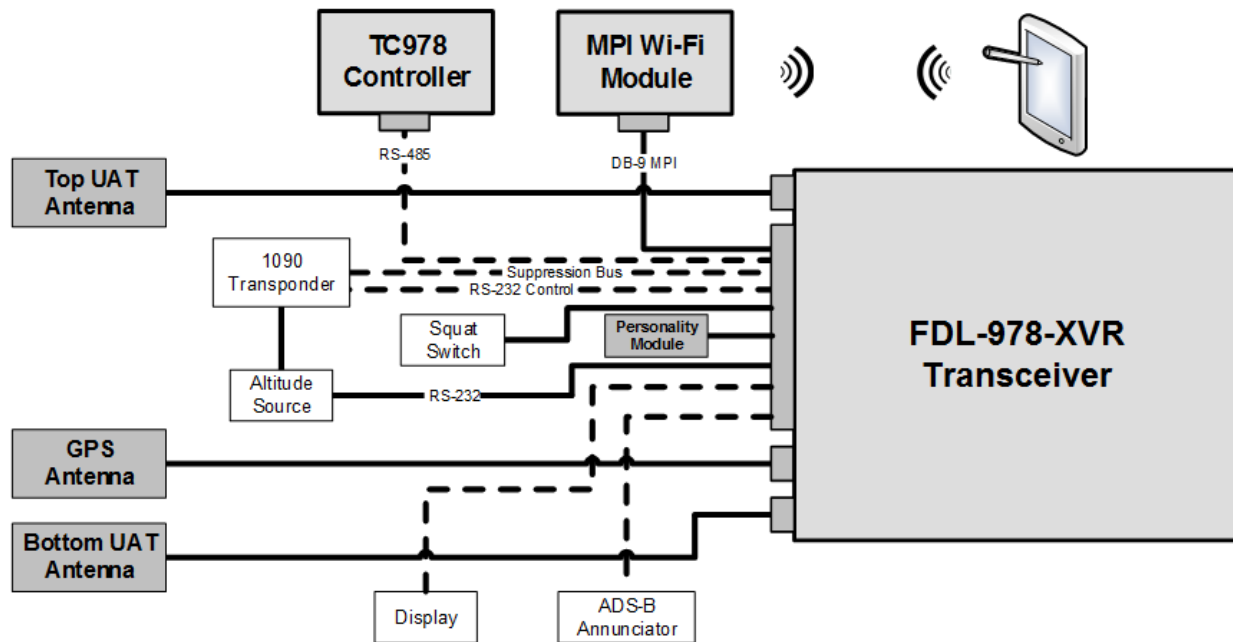


Figure 1. FDL-978-XVR Wi-Fi MPI Block Diagram (Typical)

The block diagram shown in Figure 2 identifies an installation using an aircraft mounted FWF-125 Wi-Fi Transceiver in place of a dedicated MPI Port. This allows traffic and weather data to be shared with a portable electronic device in flight, and can be used to simplify system configuration during maintenance activities.

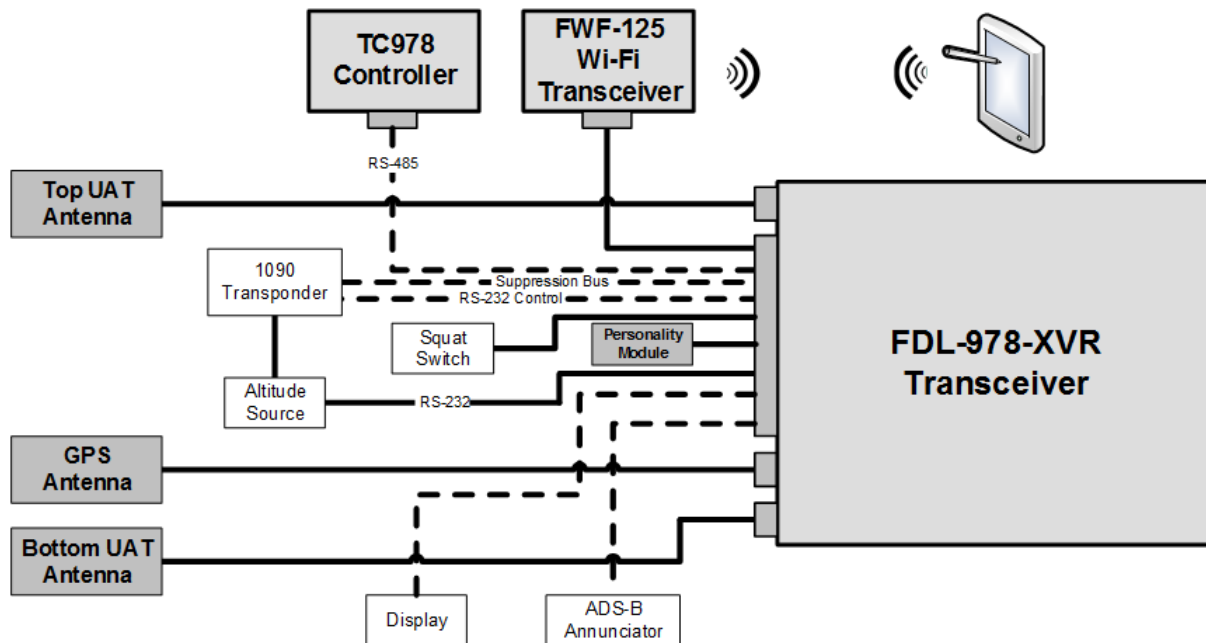


Figure 2. FDL-978-XVR Wi-Fi Transceiver Block Diagram (Typical)



The FDL-978 Series Transmitters and Transceivers (ADS-B Out and ADS-B In/Out) are required to receive altitude data obtained from the same pressure altitude source as the transponder.



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 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 source data are required for receivers as well as transceivers.

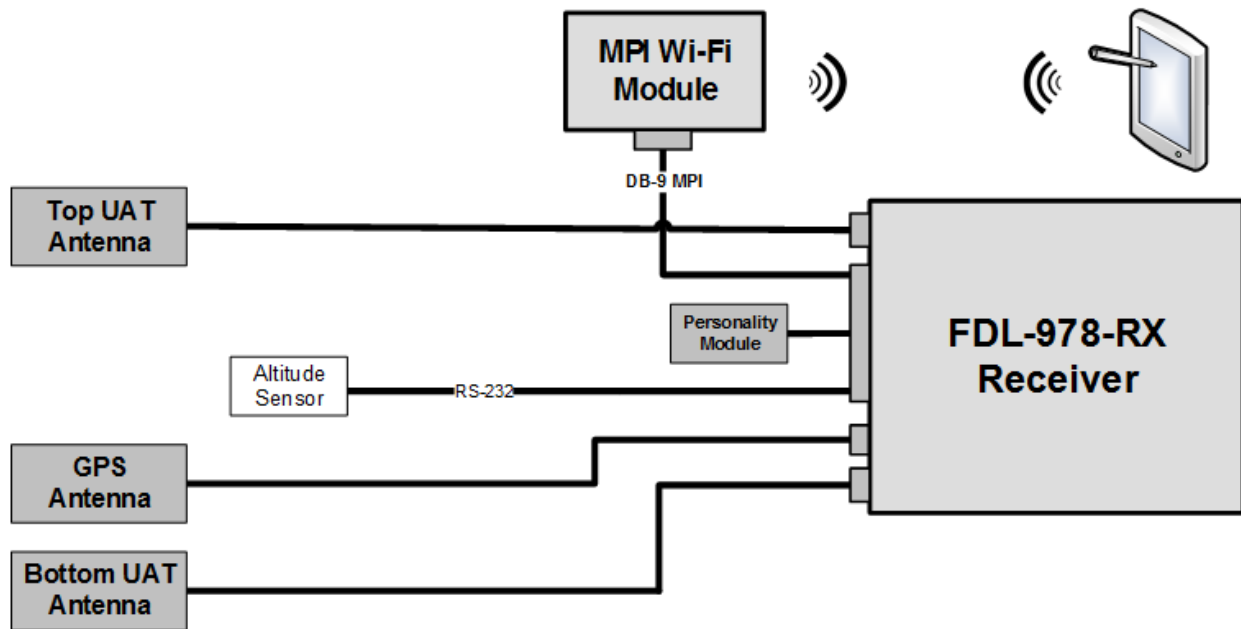


Figure 3. FDL-978-RX Block Diagram (Typical)



The FDL-978 Receivers (ADS-B In only) must receive pressure altitude data; however, it is not required to be from the same pressure altitude source as the transponder.



Figure 4. FDL-978 Series

The main components of the FDL-978 Series System 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. 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).



ARINC 743A/B GPS output labels can also be configured for output on ARINC output port 1. Refer to Section 1.8 for ARINC GPS I/O availability on select FDL-978 models.



ARINC GPS data is output at a 5 Hz rate. Contact FreeFlight Systems customer support integrating with legacy equipment that will not accept 5 Hz input.

External GPS Input

The FDL-978 Series can connect to any FFS navigation protocol compliant GPS (e.g. FFS 1201), Garmin series 400W/500W with GPS ADS-B Plus interface, or Bendix King KSN 765/770 GPS interface through an RS-232 serial port or an ARINC 743A/B compatible GPS interface (e.g. 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.



Refer to Section 1.8 for ARINC I/O availability on select FDL-978 models.

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



Polarized sunglasses may interfere with the display visibility of the TC978.

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

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 50 Ω 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 20-165B) 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 2.11). Use of other antennas or cables may not meet all the performance characteristics required by TSO-C145c.



Not all TSO-C190 and TSO-C144 antennas are compliant with the FDL-978 Series with Internal GPS/SBAS receiver. Please contact FreeFlight Systems for additional information on approved antenna part numbers. Recommended part numbers of antennas are listed in Sections 1.6.2 and 1.7.1.

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
TRANSCIVER FREQUENCY	978 MHz
TRANSMITTER POWER	40 Watts max at antenna after 2dB connector/cable losses
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 743A/B) and PPS (ARINC 743A/B*)
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 429/743* – Internal GPS models only (P/N 87098-00, 87098-00-FX00, and 87098-00-FR00)

* Refer to Section 1.8 for ARINC I/O availability on select FDL-978 models.

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

1.5.3 ADS-B Compliance

The FDL-978 series with internal GPS has been shown to meet the requirements for Airworthiness Approval for use as a valid GNSS position source for Automatic Dependent

Surveillance-Broadcast (ADS-B) Out Systems per AC 20-165B, AC 20-138D and 14 CFR §91.227.

Compliance with the requirements of AC 20-165B Appendix 2 is documented in FreeFlight Systems GPS/SBAS Sensor System Series AC 20-165B ADS-B Compliance Report, P/N 87671. If required, this document may be requested from FreeFlight Systems Technical Customer Support.

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-C144 GPS Type Antenna Installation Kit (optional)
87360-00	1	TSO-C190 GPS Type Antenna Installation Kit (optional)
88110-00	1	FDC-485, RS-232 to RS-485 Converter (optional)
88110-01	1	FDC-422, RS-232 to RS-422 Converter (optional)

1.6.1.1 FDL-978 Upgrade Key Part Numbers

The Table below outlines the current FDL-978 Upgrade Key part numbers.

FFS Part Number	Description
-XVR	FDL-978 XVR Upgrade
-GPS-743O	FDL-978 ARINC 429/743 GPS Output Upgrade Key
-TCAS-735I	FDL-978 ARINC 429/743 TCAS Traffic Input Upgrade Key



Use “info” command or use the ADS-B MPI Android App to identify upgrade keys installed on the FDL-978 system.

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)
9-3154-016-01	1	Heat Shrink Tubing, 1/16", Black

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

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

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

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

A valid GPS receiver with appropriate serial or ARINC 743A/B 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 Series:

- FFS 1201 (P/N 84100-XX-XXXX)
- FFS 1203C (P/N 84327-5X-XXXX)
- Garmin Series 400/500 GPS with ADS-B Plus Interface
- Bendix King KSN 765/770 GPS with GPS PXPRESS Interface



Refer to Section 1.8 for ARINC I/O availability on select FDL-978 models.

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

1.8 Field and Factory Feature Upgrades

With the release of software version 1.12.1.20 and later, owners have the ability to upgrade their existing FDL-978 Series devices and unlock additional capabilities. Software version can be checked using the “info” command in Section 3.5.2.7, or the ADS-B MPI Android App described in Section 3.4.3. Purchasing and installing the upgrades can be performed using the ADS-B MPI App discussed in Section 3.4.3, or by requesting a factory update directly from FreeFlight Systems customer support.

The following chart shows the upgrade path available for the various models in the FDL-978 Series.

FDL-978 MODELS	CONFIGURATION UPGRADE KEYS		
	XVR Upgrade (-XVR)	ARINC 743 GPS Output Option (-GPS-743O)	ARINC 735 TCAS Traffic Input Option (-TCAS-735I)
TXL (87098-00-FT0L)	↑		
RX no GPS (87098-10-FX10)	↑		↑
XVR no GPS (87098-00-FX00)			↑
RX with GPS (87098-00-FR00)	↑	↑	↑
XVR with GPS (87098-00-FX00)		↑	↑



Please allow a minimum of 48 hours for processing requested upgrade keys.

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 20-165B 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 source. Installations must therefore ensure that the transponder and FDL-978-XVR receive altitude data from the same altitude source.



FAA AC 20-165B 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 do not require transponder control data. Receivers do require pressure altitude input, but are not required to obtain the pressure altitude from the same altitude source 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.

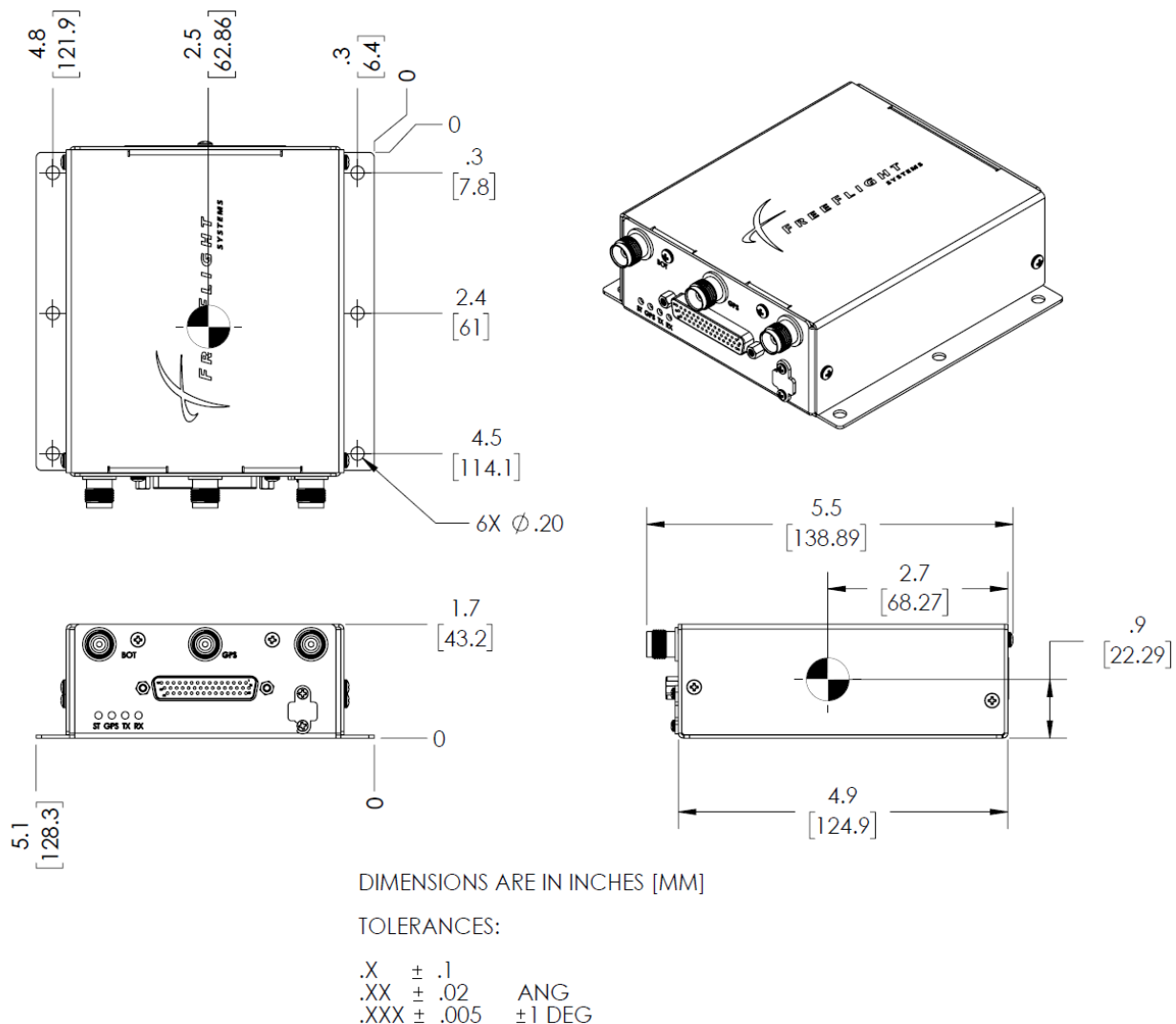


Figure 6. FDL-978 Series Mounting Dimensions

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 shown in Section 8.2.



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.

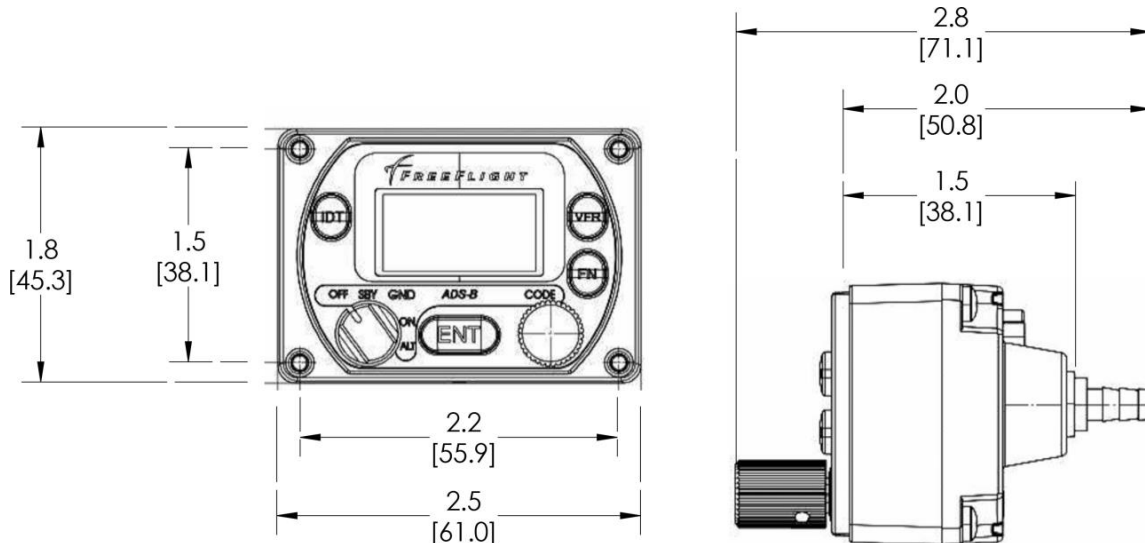


Figure 7. TC978 Dimensions

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, Active High

J1 – Power and I/O Connector (DB-44)				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
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
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 743A/B	I/O	Internal/External GPS Pulse Per Second Out/In+
40	PPS IO-	ARINC 743A/B	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 ² C	O	Personality Module Clock
44	DATA_PM	I ² C	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 ² C	O	Personality Module Clock
J1-44	DATA_PM	I ² C	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.

Name	Description
TX	UAT Transmit (GREEN)
Blink ON	Blinks ON when ADS-B data is transmitted (once per second)
OFF	No UAT transmissions
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-



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.



*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 In
J1-24	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data Out
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
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-

2.5.6.1.1 RS-232 to RS-485/-422 Serial Converters

Some installations may require more RS-485/-422 serial interfaces than are available on the FDL-978 Series. For these installations, serial converters are available that can be installed inline between the devices.

The FreeFlight Data Converters are used to convert an RS-232 port to RS-485 or RS-422. A female DB-9 connects the converter to the FDL-978 wiring harness, while a male DB-9 is connected to the other device.

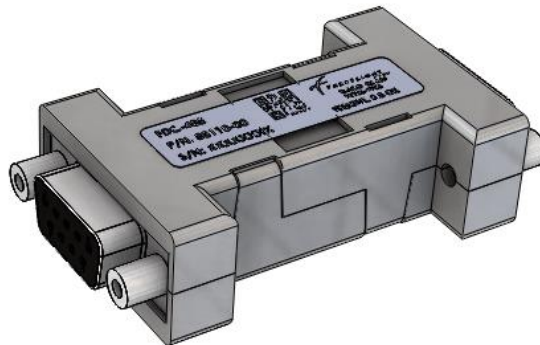


Figure 8. FDC-485/422 Serial Converter

The FDC-485 can be used on the FDL-978 serial port 6 only when configured for RS-232 interface, using pins J1-38 and J1-8. The FDC-422 can be used on any FDL-978 serial port configured for RS-232.

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.



ARINC functionality is available through a separate unit upgrade made available at the time of installation. See Section 1.8 for more information.



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 9 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	I	Anonymous Mode

2.5.7.1 Air/Ground Input

The Air/Ground discrete input connects to an open/ground squat switch or other Air/Ground discrete indication for external input of automatic Air/Ground indication. The Air/Ground input is configurable to be either Not Connected, High when Airborne, or Low (ground) when Airborne. Airborne or On Ground status affects ADS-B message transmission behaviour and is required for Transceiver and Transmitter installations.



Light Aircraft Installations: The FDL-978 Series automatically determines the Air/Ground status if configured to the Light Aircraft (<15500 lbs) Emitter Category (see Section 3.5.2.13.2.8 and 3.6.2.4 for details) without the use of the external Air/Ground input discrete.



Other Aircraft Installations: The FDL-978 Series validates the Air/Ground status of the external Air/Ground input for all other Emitter Categories including Rotorcraft utilizing available GPS and air (pressure altitude, airspeed, etc.) data.



Rotorcraft Installations: The FDL-978 Series sufficiently validates an Air/Ground input discrete based on collective position or collective position combined with oil pressure, no/low engine RPM, airspeed, etc. to ensure false On Ground indications are not transmitted during auto-rotation training and other unusual conditions.



Automatic air/ground determination is required for Transceiver and Transmitter 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

Anonymous Mode allows the FDL-978 to broadcast a self-assigned random temporary address and no call sign when enabled. A dedicated pilot interface is required to provide this input.



Anonymous Mode cannot be used on:

- Aircraft equipped with a Mode S transponder
- Aircraft with Dual Link 1090ES and UAT ADS-B Out systems operating at the same time



Anonymous Mode is not active:

- During the first 90 seconds after the FDL-978 Series powers on.
- When the squawk code is set to anything other than 1200.

2.5.8 Discrete Output



Refer to SECTION 9 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, Active high
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.

2.5.8.2 TX Suppression Output

The TX Suppress output is for suppressing other L-band equipment during UAT transmissions. TX Suppress outputs a high ($V_{in} - 1.5\text{ V}$) 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.

2.5.9 Time Mark Input/Output

For the FDL-978 Series, the Time Mark Input/Output is an RS-422 differential pair conforming to the ARINC 743A/B specification 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 743A/B	I/O	Internal/External GPS Pulse Per Second Out/In+
J1-40	PPS IO-	ARINC 743A/B	I/O	Internal/External GPS Pulse Per Second Out/In-

2.5.10 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 (preferred) on the FDL-978 Series DB-44 connector. A female DB-9 connector can be mounted in the aircraft for convenient MPI access to a standard RS-232 interface meeting the specifications of TIA/EIA-232-F, *Interface Between DTE and DCE Employing Serial Binary Data Interchange*.

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. An inline connector is recommended to be installed between the devices and used to temporarily disconnect the configured device and permit external MPI access.

The figure below shows an example of Port 5 connecting to a standard female DB-9 (DE-9F) RS-232 connector as an inline connection or dedicated MPI port. This allows any other standard RS-232 device to communicate with the FDL-978.

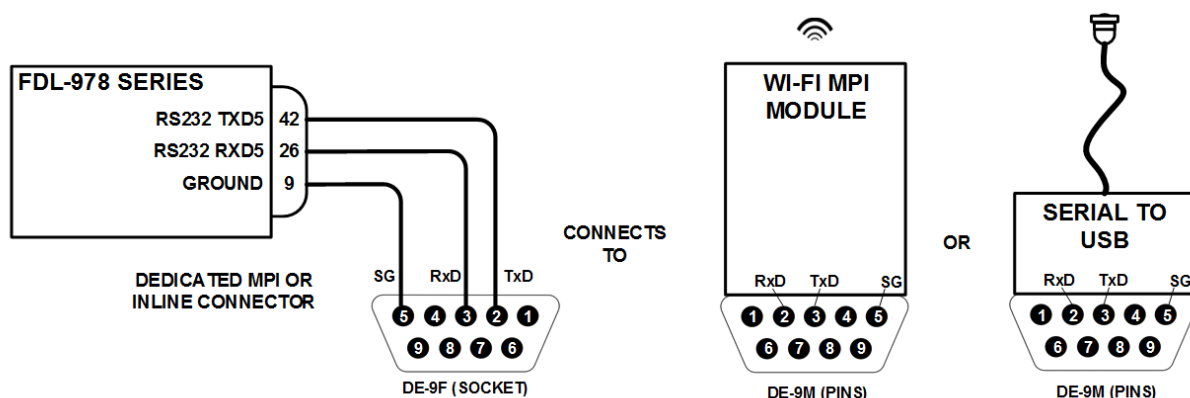


Figure 9. Inline MPI Connector and Compatible MPI Devices

The MPI connector can be mated to an off-the-shelf RS-232 to USB converter or a battery powered Serial-to-Wi-Fi MPI Module (P/N 87710-00) for configuration and troubleshooting. Refer to Sections 3.3.3 and 3.5 for more information on configuring the FDL-978 through the MPI.

The table below shows the MPI DE-9F connections to Port 3 or Port 5 on the FDL-978.

Table 1. MPI Pinout

MPI Connector		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 FDL-978 Series also has a USB micro-AB connector which provides an alternate Serial Port 5 connection but is **not** recommended for use. The MPI Module can also connect to the USB micro-AB port for wireless Wi-Fi connection.

Alternatively, 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. If the TC978 is disconnected, the Remote On pin (J1-32 on the FDL-978) must be grounded to turn on the FDL-978.

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

TC978 Connections (DB-9)				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
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). 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 ² C	O	Personality Module Clock	Blue
J1-44	DATA_PM	I ² C	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 10 and the other side should be adhered to one side of the connector backshell as the connector and backshell are assembled together.

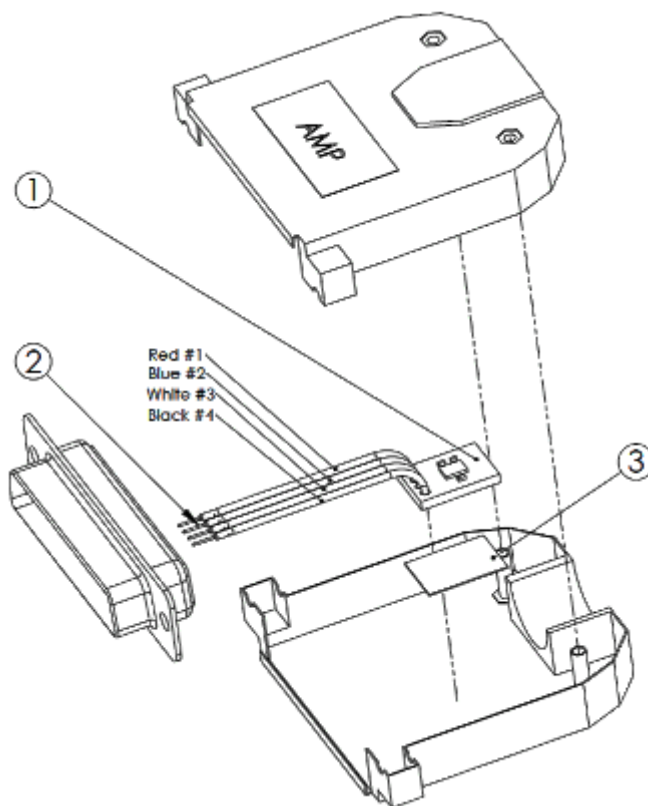


Figure 10. Personality Module Assembly

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. Only transmitter models without digital interfaces need to adhere to the following requirement. Refer to Section 1.4 for receiver only model designations.
 - 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

*Minimum cable lengths apply to transmitter models, not to receiver-only models. Refer to Section 1.4 for receiver only model designations.

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.

- Typically, a GNSS antenna is located forward or aft of the wings on top of the fuselage.

- GNSS antennas must be installed to provide the widest, unobstructed view of GNSS satellites.
- 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.
- 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.
- 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.
- 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 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

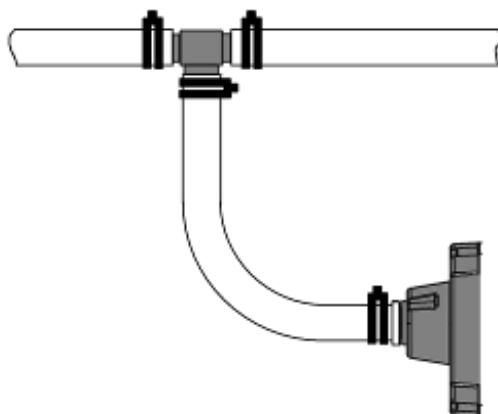
The TC978 Controller includes an altitude encoder which must be connected to the same source of static pressure as the primary altimeter on the aircraft if this sensor is utilized in the installation. The TC978 static pressure port provides a mounting spigot intended for nominal 5 mm or 3/16 in inside 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 1/4 in static lines, two adapters are provided which can convert from 1/4 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**

“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 2.10 for UAT antennas and Section 2.12 for GPS antennas.



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

2.13.1 Non-TSO Functions

The FDL-978 does not contain any functions outside the scope of the above TSO certifications.

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.”

SECTION 3 FDL-978 SERIES CONFIGURATION AND CHECKOUT

3.1 General

This section contains installation configuration, checkout, and basic operating procedures. 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)

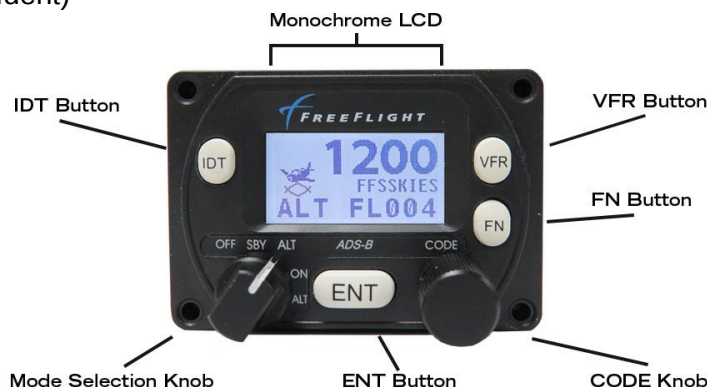


Figure 11. TC978 Controller Knobs and Buttons

For instructions on using the TC978, refer to the FDL-978 ADS-B Equipment Pilot Guide/User Manual, document number 87351.

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 12 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

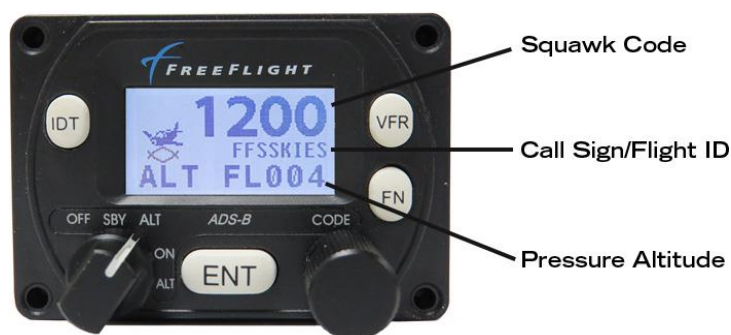


Figure 12. TC978 Controller Display (Typical)

If an external controller is configured and functional with the TC978 installed the TC978 displays status, but locks out user control inputs. Mode control is always provided by the external controller, so the position of the Mode Selection Knob only serves to turn on power to the ADS-B system. When in external control mode the TC978 will display the Squawk Code and/or Call Sign/Flight ID in reverse video, as shown below.



3.1.2.2 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.

3.1.2.3 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 1.7.2 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 2. Serial and ARINC Port Configuration Settings

Configuration Item		Default	Setting
Serial Port 1 Configuration:	IN Function	Internal-GPS	
	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-422	
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 3. 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	978	
	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 4. 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 3.5.2.13.3 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 5. 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. <i>GPS Input is required for all FDL-978 systems.</i>
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. <i>Pressure Altitude Input is required for all FDL-978 systems.</i>
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.

Interface	Description
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.
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 <i>Control Input</i> . 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 735A/B 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 743A/B 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. PRAIM responses will be sent on Serial Port 1 RS-232 output or the 743A/B configured ARINC 429 output respectively.

* Refer to Section 1.8 for ARINC I/O availability on select FDL-978 models.

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.



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 6. Serial Port Input Configuration Settings

Setting ⁽¹⁾	Interface	Description
UNUSED (Not Used)	-	No connection to serial port
ADS (Air Data Computer)	Altitude Input	Altitude, Airspeed, and Vertical Rate data input. Format for air data sensors using the protocol in Section 6.2.
Alt-Encoder (Altitude Encoder)	Altitude Input	Altitude data. Format for air data sensors using the protocol in Section 6.1.
Internal-GPS (GPS Internal)	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. <i>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.</i>
GPS-FFS ⁽⁵⁾ (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 ⁽⁵⁾ (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.
GPS-KSN ⁽⁵⁾ (GPS - Aviation)	GPS Input	GPS position, velocity, time, and integrity data input. Format for the Bendix King KSN 765/770 GPS PXPRESS Protocol. Typically configured on port 4 or 6 (configured for RS-232).
GSL-71 (Control Panel)	Control Input ⁽²⁾	Squawk Code, IDENT, Call Sign, mode (standby/alt inhibit), and altitude data input. Format for the GSL-71 controller or SL70/R transponder. ⁽⁶⁾
GTX-Remote (GTX Remote)	Control Input ⁽²⁾ & GPS Output	Squawk Code, IDENT, and mode (standby/alt inhibit) control input format from GTX 330/33/327/32 transponders. Typically configured on port 2. ^{(4) (6)(7)} 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 ⁽³⁾	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. ^{(2) (6)}

Setting ⁽¹⁾	Interface	Description
TC-Monitor	Control Input	TC-Monitor is a proprietary protocol using RS-485 bi-directional serial bus. It receives data (monitors it) but does not output messages on this port.



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



⁽²⁾ Control Input is not required for receive only systems.



⁽³⁾ 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).



⁽⁴⁾ When the FDL-978 is configured for GTX-Remote Input, it will automatically configure the corresponding serial output to provide ADS-B Plus GPS data out to the GTX device.



⁽⁵⁾ Refer to Figure 26 and Section 9.2 for examples of wiring with one or two pin time mark output.



⁽⁶⁾ 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.



⁽⁷⁾ The GTX-330 outputs its own call sign in a single message at startup. When the FDL-978 is powered on first, it takes the call sign from the GTX-330 and uses that as the default call sign.

Table 7. 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 8. 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.
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⁾
TC-Out (Other 3)	Control Output	TC-Out is a proprietary protocol using RS-485 bi-directional serial bus allowing the FDL-978 series to control FDL-1090 series transponders.



⁽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 3.5.2.13.2.12.



⁽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 3.5.2.13.3.2 and 3.5.2.13.3.3 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 3.5.2.13.3.2.

Table 9. 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:



ARINC functionality is available through a separate unit upgrade made available at the time of installation. See Section 1.8 for more information.

Table 10. 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 1203C or other sensors that output the ARINC 743A/B 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 the FMS or other ARINC 743A/B devices.



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

Table 11. 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 accept the following input labels depending on channel configuration:

Table 12. GPS-743 Input ARINC Labels

Label	Description
273	Sensor Status
110	Latitude
111	Longitude
120	Latitude Fine
121	Longitude Fine
125	UTC
103	Track Angle
112	Ground Speed
130	HIL
133	VIL
165	Vertical Velocity
166	N/S Velocity
174	E/W Velocity
136	VFOM
247	HFOM
260	Date (BCD)
370	Height Above Ellipsoid
142	Velocity Vertical FOM
145	Velocity Horizontal FOM
140	UTC, fine
141	UTC, fine fraction
150	UTC
352	FreeFlight Maintenance



Data content must conform to the navigation data block of ARINC 743A/B.

Table 13. GPS-PRAIM-743 Input ARINC Labels

Label	Description
152	PRAIM Destination ETA
144	PRAIM Destination Latitude
143	PRAIM Destination Longitude
146	PRAIM Satellite Deselect #1
170	PRAIM Satellite Deselect #2

Table 14. Transponder-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 15. ADC Format Input ARINC Labels

Label	Description
203	Pressure Altitude
210	Airspeed
212	Altitude Rate

Table 16. AHRS Format Input ARINC Labels

Label	Description
314	True Heading

Table 17. ADC & AHRS Format Input ARINC Labels

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

Table 18. Traffic Format Input ARINC Labels

Label	Description
274	TCAS Output – Receiver health in System Status
350	Fault Summary – Traffic Advisory (TA) only mode set in Resolution Instruction (RI) field
314	True Heading
357	Request to Send (RTS) and (End of Transmission) 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:



ARINC functionality is available through a separate unit upgrade made available at the time of installation. See Section 1.8 for more information.

Table 19. 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 735A/B 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 743A/B 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 20. 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 outputs the following labels based on the channel configuration:

Table 21. 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 22. GPS-743 Output Labels Order³

Label	Description
273	Sensor Status
076	Altitude (MSL)
110	Latitude
111	Longitude
120	Latitude Fine
121	Longitude Fine
125	UTC
103	Track Angle
112	Ground Speed
130	HIL
133	VIL
165	Vertical Velocity
166	N/S Velocity
174	E/W Velocity
136	VFOM
247	HFOM
261	Date (BNR)
260	Date (BCD)
370	Height Above Ellipsoid
371 ²	Gen Av Equip Ident Code
377	Equipment ID
101	HDOP
102	VDOP
142	Velocity Vertical FOM
145	Velocity Horizontal FOM
140	UTC, fine
141	UTC, fine fraction
150	UTC
162 ¹	PRAIM Response Destination ETA
343 ¹	PRAIM Response Destination HIL



¹ PRAIM output only sent if an ARINC input is configured to GPS-PRAIM-743.

² Label 371, General Aviation Equipment Identification Code, are part of the ARINC 429 General Aviation Subset (published by GAMA) and are not part of the labels defined in ARINC 743.

³ Data content conforms to Attachment 4-2 of ARINC 743A-5

3.3.3 1090ES and 978 UAT (Dual-Band) ADS-B Installations

The FDL-978 Series can be paired with 1090ES ADS-B solutions. Aircraft already equipped with a 1090ES capable transponder may add an FDL-978 Series solution to provide ADS-B In benefits of Traffic Information Service – Broadcast (TIS-B) and Flight Information System – Broadcast (FIS-B). The following paragraphs describe the supported dual-band installations.

The FreeFlight FDL-1090 Series and Trig TT21/TT22 are able to be controlled using a TC978 Control Head through an FDL-978 Series device. Because the FDL-1090 Series and TT21/TT22 require RS-485 control input, a second RS-485 output is required on the FDL-978 Series. The FDC-485 inline serial converter is available to convert the RS-232 output from the FDL-978 to the RS-485 control input required on these transponders. Refer to Section 2.5.6.1.1 for more information on the serial converters.

Transponders such as the Garmin GTX-330ES are capable of interfacing the with FDL-978 Series using the GTX-Remote Protocol as described in Section 3.3.2.1, and sample installation shown in Figure 31.



The FDL-978 Series can also be paired with other 1090ES solutions such as the Bendix King/ L3-ACSS or Becker Avionics transponders. Contact FreeFlight Systems for additional 1090ES transponder compatibility information.



Refer to Section 1.8 for available Field or Factory Upgrade keys.

3.4 Configuration Methods

3.4.1 Installation Adapter

The Installation Adapter (P/N 87988-00) simplifies system installation and configuration by installing between the FDL-978 and existing aircraft wiring. This eliminates temporary wiring during installations and the need for additional disconnects between equipment. The Installation Adapter combines all of the features necessary to configure the system including:

- Remote On Power switch
- RS-232 MPI connector with Port 5 or 3 selector switch
- Password reset switch

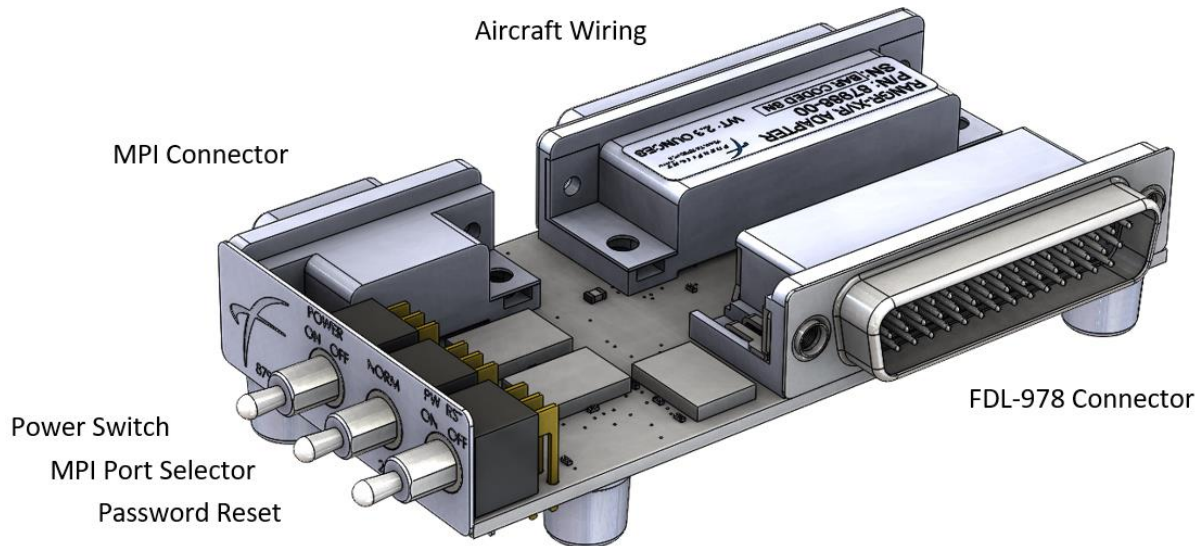


Figure 13. Installation Adapter (P/N 87988-00)

Systems without a dedicated MPI port can use the Installation Adapter to provide an MPI connector for the MPI Module described below.

3.4.2 MPI Module

The FreeFlight Systems (FFS) 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.

The MPI Module (P/N 87710-00) connects to the aircraft's ADS-B equipment MPI (Serial Port 5 or Port 3) via a DB-9 female connector. This allows the ADS-B equipment configuration and status 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 14. MPI Module (P/N 87710-00)



The MPI Module must be configured for the same baud rate as the port to which it is connected. Refer to the MPI Module Help Guide, FreeFlight Document 87837 for more information.

3.4.3 ADS-B MPI App

The app is available for free through the Google Play Store on Android devices. 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 current position of the unit and the traffic received is also displayed on a graphical map.

Software upgrades are made available through the app that allows the FDL-978 to be upgraded to the latest system version, as well as unlock additional functionality.



Additional information on how to use the app is contained within the app help file.

3.4.4 9-Pin D-Sub Serial to USB Converter

The MPI connector can be mated to an off-the-shelf RS-232 to USB converter for configuration and troubleshooting. Refer to Sections 3.3.3 and 3.5 for more information on configuring the FDL-978 through the MPI.

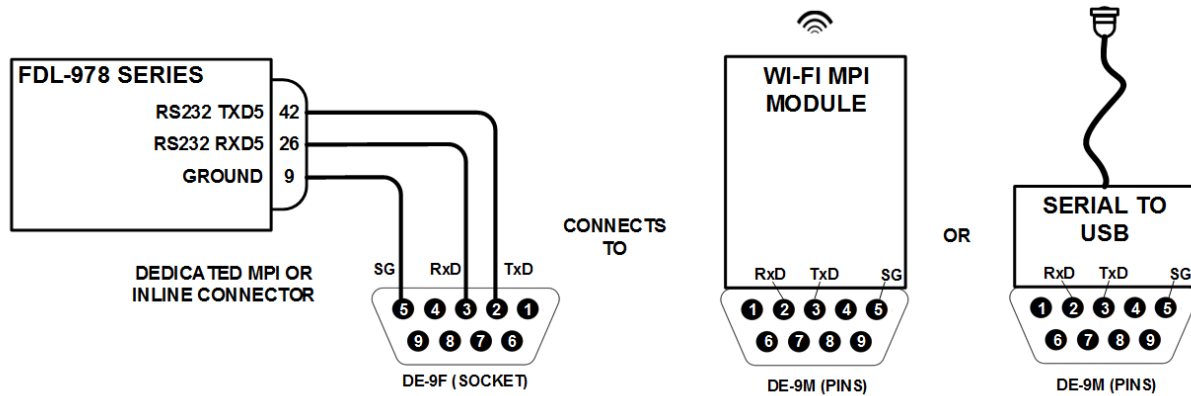


Figure 15. Inline MPI Connector and Compatible MPI Devices

3.5 MPI Configuration Setup

3.5.1 Terminal Program Interface

The following 3.3.3 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 interfaces discussed earlier (Wi-Fi MPI, Serial-to-USB) 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 3.5.1.1 and 3.5.1.2 detail the serial port and Wi-Fi connection settings respectively.

The terminal setup should be set to:

- Local Echo – checked

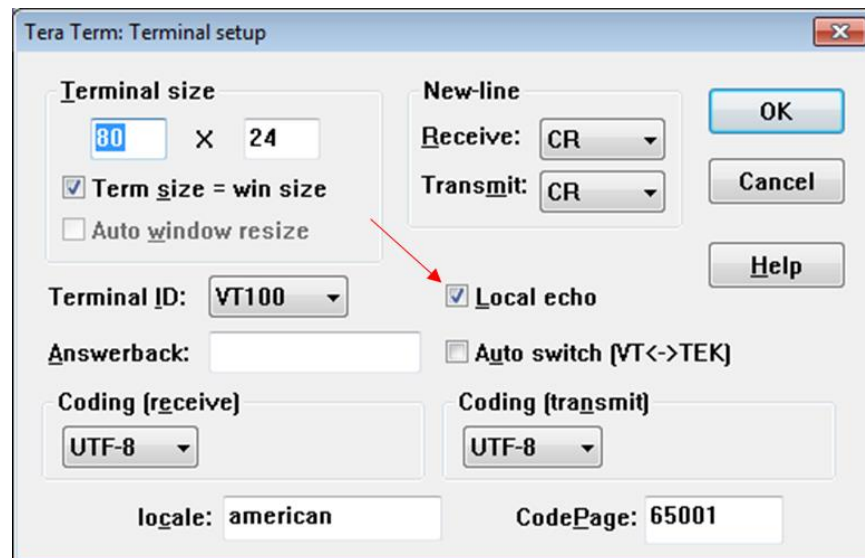


Figure 16. Tera Term Terminal Setup

3.5.1.1 MPI Serial Connection Settings

The default MPI port settings for a serial connection are shown in the table below. These settings applicable to all MPI devices (USB-to-Serial, MPI Module, and Aircraft Wi-Fi Module)

Table 23. Default MPI Port Configuration Settings

MPI Port	Baud	Parity	Data	Stop	Flow Control
3	38400	Odd*	8 bit	1 bit	None
5	115200	None			

*Odd parity is only required if Port 3 is configured to TMAP at 38400 baud. If the port has changed from either of these default settings, Parity should be set to “None”.

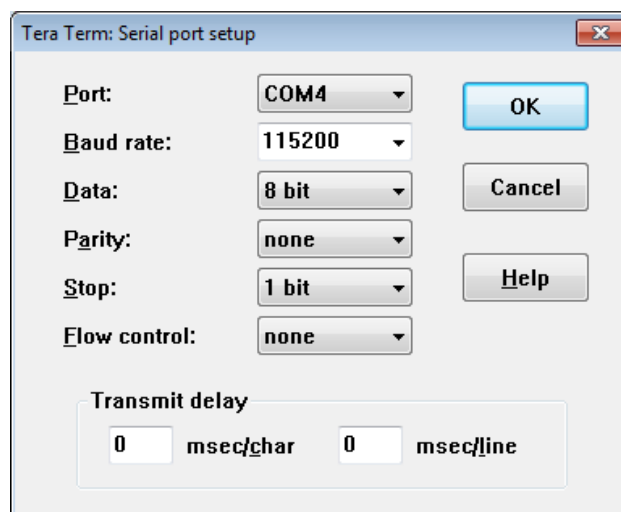


Figure 17 . Tera Term Serial Port Setup

3.5.1.2 Terminal 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 (See Section 3.3.3). The typical “Tera Term” TCP settings for the Wi-Fi connection are:

Table 24. Tera Term Wi-Fi Connection Settings

Setting	MPI Module FFS P/N: 87710-00	FWF-125 (Aircraft Wi-Fi Module) FFS P/N: 86943-00
Host	192.168.10.1	192.168.5.1
TCP Port	44000	4000
Service	Other	
Protocol	UNSPEC	

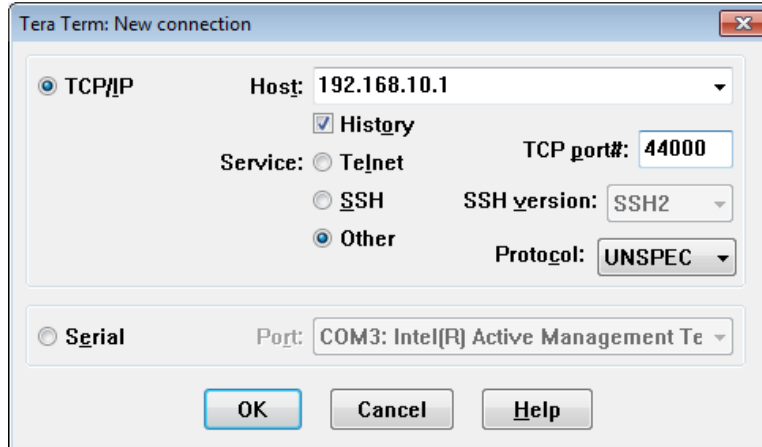


Figure 18. Tera Term Wi-Fi Connection SettingsInitial MPI Connection

3.5.1.3 Initial MPI Connection

Once connected to the MPI with a serial or Wi-Fi connection using Tera Term, 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



If ports 3 or 5 are configured for to something besides MAINT or UNUSED, streams of text will scroll down the terminal window. Type in the command “**maint ascii**” for the prompt to appear.



If Port 3 is configured for TMAP, type in the command “**maint ascii**” for the prompt to appear.

3.5.2 Terminal Maintenance Commands

The available maintenance commands are summarized in the table below:

Command	Description
ads	Display data from the altitude/air data input
bit	Display built-in test status
clear	Clear the terminal screen
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
resetpw	Disable MPI access password (See Section 3.5.3)
rxstatus	Display receiver status info – continuous
set <item> <value>	Set a configuration item's value
setpw	Set MPI access password (See Section 3.5.3)
stop	Stop continuous data outputs
cnfg defaults	Reset configuration to defaults

All screenshots in the following sections are taken from the FDL-978-XVR configuration with no feature upgrade applied. Feature upgrades will introduce new configuration options that will be described underneath each screenshot. FDL-978-RX configurations will have a limited subset of available commands and options shown for the FDL-978-XVR.

3.5.2.1 “help or ?” Command

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

```
RANGR-XVR> help
AVAILABLE COMMANDS.....
?          This help
info       Display SN, operation hours, versions, etc.
bit        view POST and PBIT status
cnfg       Display configuration data
cnfgdefaults Reset configuration to defaults
set        "set <item> to <opt>" or "set ?" for usage
Reset      Reset the UAT
comm       Display communication ports' status
ads        Display air data
gps        Display GPS data
stop       Stop continuous update
clear      Clear the terminal screen
setpw      Set MPI access password
resetpw    Disable MPI access password
control    Display control squawk and mode status
rxstatus   Display receiver status info
```

3.5.2.2 “ads” Command

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

```
RANGR-XVR> ads
ADS Data
Altitude: 302 ft, Vert Rate: 64 ft/min, BaroAlt: 300 ft, Airspeed: 100 knts
Heading Data
True Heading: 125.00 Altitude above Ground: --- ft
```

3.5.2.3 “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= 58.88 °C
External Power= 23.25 V
Internal Power= 5.05 V
IC Power= 3.20 V
RF Tx Pwr= 28.54 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.... W/W   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 ==> PASS
Valid Address.... P   Temperature..... P   Input DC Power... G
GPS Data Good.... P   GPS PPS Good..... G   GPS Comm Good.... P
GPS Ant Open..... W   GPS Ant Short.... G
ADS Data Good.... W   ADS Comm Good.... W
TX Msg Good..... P   TX PLL Lock..... P   TX PS Good..... P
UAT TX Power..... G   BroadcastMonitor. P   Nominal Msg Rate. P
RX Own Msg..... P   RX PLL Lock..... P
Top Antenna..... P   Bottom Antenna... P
```

3.5.2.4 “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 Port	Comm: Status	Baud(Set/Act)	P	Rx Count	Tx Count	RxErr	TxErr
1	ENABLED	19200/ 19345	N	1264804	43	0	0
2	DISABLED	115200/116071	N	2	2	0	0
3	ENABLED	38400/ 38385	O	196104	149566	0	0
4	DISABLED	115200/115205	N	2	2	0	0
5	ENABLED	115200/115205	N	474	397291	0	0
6	DISABLED	115200/115205	N	2	2	0	0

ARINC Port	Comm: Status	Speed	Rx Count	Tx Count
IN1	DISABLED	high	24364	0
IN2	DISABLED	high	0	0
OUT1	DISABLED	high	0	1

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

3.5.2.5 “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: FXVRGA , Emergency: 0- None
```

3.5.2.6 “gps” Command

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

```
GPS Info
Configuration: Internal GPS - gamma1, 19200
Source: Serial - FFS/Chelton
SWVer: 1.11

Date: 4/13/2017 UTC Time: 15:18:14 (55094s)
Mode Latitude Longitude Altft Vkt:NS EW GSpd Track VVelrpm
SBAS 32.9171210N 96.9864330W 493 -0.2 -0.1 0.2 -146.230 17.0

HIL (NIC) HFOM(NACp) VFOM(GVA) VHFOM(NACv) VVFOM VIL
52.2m( 9) 22.0m( 9) 27.80m(2) 0.25m/s(4) 0.33m/s 74.09m

Message Counts:
Msgs: 30174 Nav: 7522 Stat: 7522 Aux: 7522 Ver: 86 Aid: 7522 Oth: 0

Status
Comm:1 Valid:1 Lat:1 Lon:1 FDE:0 SBAS:1 SATu: 0
Fail:0 NoWAAS:0 neWAAS: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
```

3.5.2.7 “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 Beta1 GPS
Serial Number..... 1305x066
Operation Time..... 112.5 hrs
HW Version..... 4.11
Boot Version..... 1.0.1.80
Boot Checksum..... 0xE18AD740
Boot Build Time..... 07/20/2014 20:11:20
SW Version..... 1.11.1.95
SW Checksum..... 0xFD68022D
SW Build Time..... 03/30/2016 17:45:50
FPGA Version..... 1.3
FPGA Build ID..... 0x520F155E
FPGA Build Time..... 05/04/2015 15:11:40
GPS Version..... 1.11
GPS CRC..... 0x65602F3A
```

For systems with feature upgrades installed, the “info” command will display the FDL-978’s part number followed by the upgrade key part numbers.

```
RANGR-XVR> info

RANGR-XVR, Internal Beta1 GPS

Part Number..... 87098-00-FX00
+ -GPS-7430
+ -TCAS-735I

Serial Number..... ABCD1234
Operation Time..... 2.0 hrs
HW Version..... 4.11
Boot Version..... 1.0.1.80
Boot Checksum..... 0xE18AD740
Boot Build Time..... 07/20/2014 20:11:20
SW Version..... 1.16.0.11
SW Checksum..... 0x0CA147C0
SW Build Time..... 11/21/2018 08:54:30
FPGA Version..... 1.3
FPGA Build ID..... 0x520F155E
FPGA Build Time..... 05/04/2015 15:11:40
GPS Version..... 1.11
GPS CRC..... 0x65602F3A
```

3.5.2.8 “Reset” Command

This command causes the FDL-978 Series to reboot.

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

Press the **Enter** key three times to return to the maintenance interface.

3.5.2.9 “rxstatus” 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:		55950									
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	954	1	25	8	8	7	4	9	0	0	
Long	1668	3	25	23	1	7	2	4	5	0	
1090ES	0	0	0							0	
Traffic:	4	Tracks:	4	TCAS:	0	NBAir:	2	Air:	2	Gnd:	0
#	Addr	Typ	CallSign	Latitude	Longitude	Alt	Spd	G	Msgs	SSI	Range TO
OWN	FF00	ABi	FXVRGA	32.917140N	96.986580W	---	0	A	0	0	0ft 0s
1	2456	ABi	BILL1234	32.917140N	96.986580W	450	0	A	454	-21	48ft 24s
2	ADFBA2	ABi	GNDTEST	32.917100N	96.986490W	375	0	A	3	-20	127ft 24s
3	BB2345	ABi	BILL001	31.999870N	96.000170W	---	---	A	523	-20	74.3nm 24s
4	B528c9	ABi	00000000	--.-----0?	--.-----0?	---	---	A	889	-21	---nm 4s
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 rxstatus 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 rxstatus 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 rxstatus 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 rxstatus and return to the prompt.

3.5.2.10 “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

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... FF00
VFR Call Sign..... FXVRGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 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
XVR Mode..... xvr
Serial In 1..... Internal-GPS, 19200
Serial In 2..... UNUSED, 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
```

3.5.2.11 Deleted

3.5.2.12 “cnfg defaults” Command

This command resets all configuration values to default factory settings.

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

3.5.2.13 “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 items:  
?           This help  
addr <hex>   ICAO address (6 hex characters)  
call sign <string> VFR default call sign (8 characters)  
gps <sda>     GPS System Design Assurance  
nacv <val>    GPS NACv mode  
rx <cap>      Receiver capability  
emit cat <num> Emitter category number  
squat <opt>   Squat switch option (none, low, or high)  
threshold <num> ON GROUND groundspeed threshold  
acsize <len> <width> Vehicle length and width  
uatant <opt> <dcgnd> UAT antenna mode and DC ground check  
gpsant <lon> <lat> GPS antenna offset  
modeArx <opt> Mode A receive  
disableSquawkTx <opt> Disable transmit squawk/flight plan id  
max trgs <opt> Maximum number of targets displayed  
cheltonCSA <opt> Enable CSA for Chelton  
trafVelVal <opt> Disable traffic velocity validation  
displayout <opt> Display Output Data  
serial <dir> <port> <func> <baud> Serial port function protocol & baud rate  
arinc <dir> <port> <func> <speed> ARINC port protocol & speed  
xvrMode <opt> XVR Mode (XVR or RX)
```

3.5.2.13.1 Serial and ARINC Port Settings

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

3.5.2.13.1.1 “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-KSN, GPS-ADSBPlus, ADS, Alt-Encoder,
  GSL-71, GTX-Remote,
Port 5:
  MAINT, UNUSED, Disp-Ctrl,
Port 6:
  UNUSED, GPS-FFS, GPS-KSN, GPS-ADSBPlus, ADS, Alt-Encoder,
  GSL-71, TMAP, Disp-Ctrl,

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

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

RANGR-XVR> set serial in 1 Internal-GPS
Serial In 1..... Internal-GPS, 19200
RANGR-XVR>
```



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.

3.5.2.13.1.2 “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 MX-20 38400 RS-422  
Serial In 6..... UNUSED, 38400 (RS-422)  
Serial Out 6..... MX-20, 38400 (RS-422)
```



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



Port 6 can be configured to “TC-Out” even though this configuration option may not be shown in the help menu of certain software versions. This configuration is specifically required when pairing a FDL-978 series unit with an FDL-1090-TX as shown in Section 9.1.10.

3.5.2.13.1.3 “set arinc in” Command

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

```
RANGR-XVR> set arinc in ?

USAGE: set arinc in <port> <func> <speed>

<port>    ARINC port number:  1, 2,

<func>    Interface function/protocol:
Port 1:
          UNUSED, GPS-743, ADC, AHRS, ADC&AHRS, Transpndr-Cntrl,
Port 2:
          UNUSED, GPS-743, ADC, AHRS, ADC&AHRS, Transpndr-Cntrl,

<speed>    Speed: low, high

ARINC In 1..... UNUSED, low
RANGR-XVR> set arinc in 1 GPS-743 low
ARINC In 1..... GPS-743, low
```

With feature upgrade for ARINC TCAS Traffic Input (part number -TCAS-735I) applied, the additional “Traffic” option becomes available.

With feature upgrade for ARINC GPS Output (part number -GPS-743O) applied, the additional “GPS-PRAIM-743” option becomes available.

An example output is below.

```
RANGR-XVR> set arinc in ?

USAGE: set arinc in <port> <func> <speed>

<port>    ARINC port number:  1, 2,

<func>    Interface function/protocol:
Port 1:
          UNUSED, GPS-743, ADC, AHRS, ADC&AHRS, Transpndr-Cntrl,
          Traffic, GPS-PRAIM-743,
Port 2:
          UNUSED, GPS-743, ADC, AHRS, ADC&AHRS, Transpndr-Cntrl,
          Traffic, GPS-PRAIM-743,

<speed>    Speed: low, high

ARINC In 1..... UNUSED, low
RANGR-XVR> set arinc in 1 GPS-PRAIM-743
ARINC In 1..... GPS-PRAIM-743, low
```



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

3.5.2.13.1.4 “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.

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

With feature upgrade for ARINC GPS Output (part number -GPS-743O) applied, the additional “GPS-743” option becomes available. An example output is below.

```
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 low  
ARINC Out 1..... GPS-743, low
```



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

3.5.2.13.2 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.

3.5.2.13.2.1 “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 hexadecimal characters (0-9 & A-F)
RANGR-XVR> set addr 5150BD
ICAO Address..... 5150BD
```

3.5.2.13.2.2 “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)
NOTE:      Applies to XVR, TX
VFR Call Sign..... FXVRGA
RANGR-XVR> set call sign FFSSKIES
VFR Call Sign..... FFSSKIES
```

3.5.2.13.2.3 “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
```



For external position sources, contact the manufacturer to obtain the relevant data.

3.5.2.13.2.4 “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 3  
NACV Mode..... Auto (from GPS)
```



For external position sources, contact the manufacturer to obtain the relevant data.

3.5.2.13.2.5 “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>      ADS-B Receiver Capabilities:  
no1090, 1090, no978, 978,  
  
NOTE:      Applies to XVR, TX  
  
RANGR-XVR> set rx no1090 978  
Receiver Capability..... no1090, 978
```

3.5.2.13.2.6 “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
    9 : GLIDER/SAIL
   10 : LIGHTER THAN AIR
   12 : ULTRALIGHT/HG
   14 : UAV

Emit Category..... NO AIRCRAFT TYPE
RANGR-XVR> set emit cat 1
Emit Category..... LIGHT AIRCRAFT
RANGR-XVR>
```

3.5.2.13.2.7 “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 none
Squat Mode..... none
```

3.5.2.13.2.8 “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. This is applicable for the Light Aircraft (1) Emitter Category, only. A groundspeed of less than the threshold indicates the aircraft is on the ground.

```
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,

NOTES:      1. Groundspeed threshold for (1)LIGHT AIRCRAFT Emit Category only
             2. Applies to XVR, TX

RANGR-XVR> set threshold 30
Groundspeed Threshold..... 30 knots
```

3.5.2.13.2.9 “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 (0-90)

<width>     Aircraft width in meters (0-90)

NOTES:      1. Odd values are rounded down to nearest even meter
             2. Applies to XVR, TX

RANGR-XVR> set acsize 20 50
Vehicle Size..... Length=20 meters, Width=50 meters
```

3.5.2.13.2.10 “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 nochk
UAT Ant..... dual, No DC Gnd chk
```

3.5.2.13.2.11 “set gpsant” Command

This command sets the GPS antenna configuration. This should be set for transceivers but is not necessary for receivers. GPS Reference Position is measured from the GPS antenna location to the lateral distance from centerline and longitudinal distance from the most forward part of the aircraft.

```
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

NOTE:      Applies to XVR, TX

RANGR-XVR> set gpsant 2 4
GPS Ant Offset..... Long=2 meters, Lateral=Center
```

3.5.2.13.2.12 “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 disable
Mode A RX..... disable
```

3.5.2.13.2.13 “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.

```
RANGR-XVR> set disableSquawkTx ?

USAGE: set disableSquawkTx <opt>

<opt>      on, off

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

3.5.2.13.2.14 “set xvrMode” Command

This command allows an FDL-978-XVR to be configured for either a ADS-B In only (RX device), or ADS-B In and Out (XVR).

```
RANGR-XVR> set xvrMode ?  
<opt>      xvr, rx  
  
RANGR-XVR> set xvrMode xvr  
XVR Mode..... xvr
```

3.5.2.13.3 Display Output Settings

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

3.5.2.13.3.1 “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.

```
RANGR-XVR> set max trgs ?  
  
USAGE: set max trgs <num>  
  
<num>      8-30, max  
  
Max Targets..... max  
RANGR-XVR> set max trgs 30  
Max Targets..... 30  
RANGR-XVR>
```

3.5.2.13.3.2 “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 TSO-C195a 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 TSO-C195a 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 TSO-C195a do not currently specify any CSA applications.

```
RANGR-XVR> set cheltonCSA ?  
  
USAGE: set cheltonCSA <opt>  
  
<opt>      enable, disable  
  
RANGR-XVR> set cheltonCSA disable  
Chelton CSA Enable..... disable
```

3.5.2.13.3.3 “set trafVelVal” Command

This command enables/disables the DO-317A/TSO-C195A 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* TSO-C195a compliant and 2) *do not* adequately display non-directional

traffic symbols. Several non-TSO-C195a 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/TSO-C195a 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/TSO-C195a 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 disable  
Traffic Vel Validation... disable
```

3.5.2.13.3.4 “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 traffic&fisb  
Display Data Output..... traffic&fisb
```

3.5.3 Terminal Maintenance Port Interface Security

The FDL-978 series provides additional security features to prevent unauthorized access to the maintenance port interface. Installers now have the option to set a password to restrict access.

In order to use the commands, the installer must have access to the MPI through a terminal interface, either through a PC using Tera Term, or using the ADS-B MPI App with a Wi-Fi connection.

Command	Description
setpw <password>	Sets the password to access the FDL-978 MPI
checkpw <password>	Verifies the password while in the MPI
resetpw	Removes password protection from MPI
maint ascii pw <password>	Command to access the MPI with a set password



MPI security settings are not accessible through the TC978.

3.5.3.1 “setpw” Command

This command allows the installer to set a password in order to access the MPI. The password goes into effect once the unit is reset, and prevents access until the correct password is entered.

Passwords are case sensitive, and any combination of printable ASCII characters, including symbols and spaces, can be used. Passwords are limited to between 1 and 30 characters in length, and cannot start with a space. However, spaces can be used between characters and at the end of passwords. Extended ASCII characters are not supported.



Examples of valid passwords include “FFS <3 ” or “I love FreeFlight Systems”.

After entering a password, the FDL-978 asks for confirmation. Re-enter the password to complete the setpw command.

Until the unit is reset, the FDL-978 will continue to allow configuration access without requiring the password to be entered.

```
RANGR-XVR> setpw FreeFlight Systems
Confirm Password: FreeFlight Systems
Set!! PW REQUIRED to enter Maintenance Mode!
RANGR-XVR>
```

3.5.3.2 “checkpw” Command

This command is used to verify the password before resetting the system.

```
RANGR-XVR> checkpw Freeflight Systems
Invalid PW!
MAINT LOCKED OUT -
RANGR-XVR> checkpw FreeFlight Systems
Valid PW!
RANGR-XVR>
```

3.5.3.3 “resetpw” Command

This command is used to remove password protection from the MPI.

```
RANGR-XVR> resetpw  
PW RESET and disabled for Maintenance Mode!  
RANGR-XVR>
```

3.5.3.4 “maint ascii pw” Command

Once a password has been set, pressing the **Enter** key three times no longer removes the maintenance lockout. It will instead display a message, “MAINT LOCKED OUT – PW PROTECTION”. This will continue to display until the command “maint ascii pw <password>” is entered correctly into the terminal to gain access to the MPI.

```
MAINT LOCKED OUT - PW PROTECTION  
maint ascii pw 1234  
Invalid Pw!  
  
MAINT LOCKED OUT - PW PROTECTION  
maint ascii pw FreeFlight Systems  
Valid Pw!  
RANGR-XVR>
```

3.5.3.5 Resetting Forgotten Password

In the case where a password is lost or unknown, the following reset procedure must be performed which requires access to the physical unit.

1. Remove power from the FDL-978.
2. Ground pins J1-12 (Anonymous Mode), J1-15 (Traffic Test), J1-27 (Air/Gnd).¹
3. Apply power to the FDL-978, and turn on by grounding J1-32 (Remote On).
4. Enter the command “maint ascii pwreset” into the terminal.



¹ The Installation Adapter (P/N 87988-00) can also be used to perform the above operation.

This will remove the password protection from the MPI and allow normal access.

3.6 Configuration and Setup Using TC978



Do not use Configuration Mode during flight.

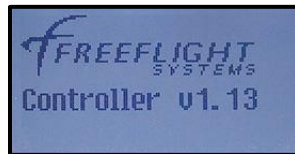
The system should be configured during initial system installation by a qualified technician. The configuration items list in Section 3.3.1 should be used to document the system installation for future reference. To view or change these settings you must enter TC978 Configuration Mode.

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.

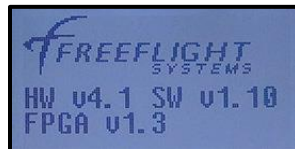
3.6.1 Entering Configuration Mode

To enter TC978 configuration mode:

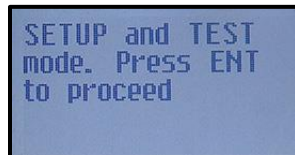
- Hold down the **FN** button while turning the Mode Selection knob from **OFF** to any operating mode.
- In the configuration mode the TC978 Controller displays the following typical messages in a quick, sequential order:



FREEFLIGHT
SYSTEMS
Controller v1.13



FREEFLIGHT
SYSTEMS
HW v4.1 SW v1.10
FPGA v1.3



SETUP and TEST
mode. Press ENT
to proceed

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.

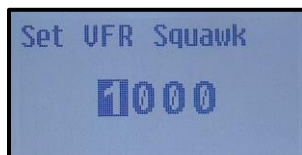
3.6.2.2 VFR Squawk Code

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

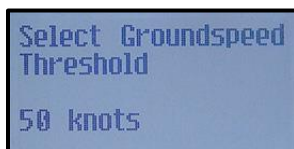
Groundspeed threshold can be used to help determine and verify the ON GROUND condition for transmitting ON GROUND ADS-B message types for “Light Fixed Wing” aircraft types only. The FDL-978-XVR uses the ground speed threshold configuration to determine a maximum ON GROUND speed. There are 10 options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

- | | |
|-------------|-------------|
| • Unknown | • 30 knots |
| • 40 knots | • 50 knots |
| • 60 knots | • 70 knots |
| • 80 knots | • 90 knots |
| • 100 knots | • 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.



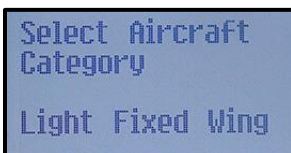
Rotate the **CODE** knob to display the options above and select the groundspeed threshold. Once selected, press the **ENT** button to confirm your selection and move to the next configuration item in the setup mode.

3.6.2.5 Aircraft (Emitter) Category

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

- Unknown
- Medium Fixed Wing
- High Vortex B757
- High G/ High Speed
- Glider/Sailplane
- Parachutist
- UAV
- Light Fixed Wing
- Large Fixed Wing
- Heavy Fixed Wing
- Rotorcraft
- Lighter than air
- ULM/Hang Glider

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.

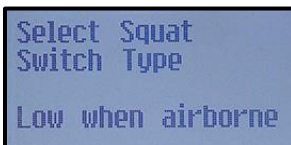
3.6.2.6 Squat Switch Type

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:

- Not Connected
- Low when ground
- 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 five 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

- Not Used
- GPS - FreeFlight
- GPS - GNS ADS-B
- GPS Internal

Channel 2

- Not Used
- GPS - FreeFlight
- GPS - GNS ADS-B
- Air Data Computer
- Altitude Encoder
- Control Panel*
- GTX Remote*
- TIS/FIS

Channel 4

- Not Used
- GPS - FreeFlight
- GPS - Aviation
- GPS - GNS ADS-B
- Air Data Computer
- Altitude Encoder
- Control Panel*
- GTX Remote*

Channel 5

- Not Used
- TIS/FIS

Channel 6

- Not Used
- GPS - FreeFlight
- GPS - Aviation
- GPS - GNS ADS-B
- Air Data Computer
- Altitude Encoder
- Control Panel*
- TMAP Remote**
- TIS/FIS

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

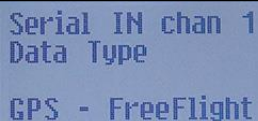


*The TC978 will not accept control inputs and will mirror the transponder or primary controller. If communication with the primary controller is lost for 60 seconds, then the TC978 will assume the role of the controller and allow control inputs (squawk, IDENT). If the TC978 is used in this manner, it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



**When the Port 6 Input is set to TMAP Remote, the corresponding Port 6 Output must be configured for Other 3, as well. The baud rate must be set to 38400 to ensure proper communication with the device.

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.



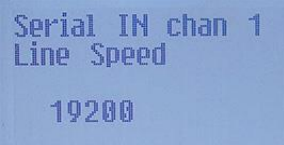
If “Not Used” is selected then the serial input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

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:

- 4800
- 19200
- 57600
- 230400
- 9600
- 38400
- 115200

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

- Not Used
- Encoded Altitude
- TIS/FIS
- ADS-B Pass Thru
- XPDR Monitor*
- MX-20

Channel 5

- Not Used
- TIS/FIS
- ADS-B Pass Thru
- MX-20

Channel 6

- Not Used
- Encoded Altitude
- TIS/FIS
- XPDR Monitor*
- MX-20
- Other 3**

- ADS-B Pass Thru



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

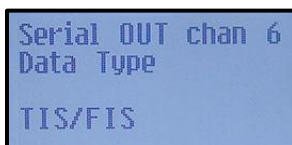


**When the Port 6 Output is set to Other 3, the corresponding Port 6 Input must be configured for TMAP, as well. The baud rate must be set to 38400 to ensure proper communication with the device.



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.



```
Serial OUT chan 6
Data Type
TIS/FIS
```

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.



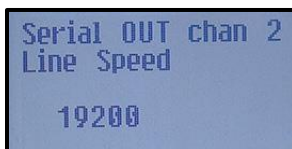
If “Not Used” is selected then the serial output line speed configuration mode is not displayed and the next configuration mode item is displayed.

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:

- 4800
- 19200
- 57600
- 230400
- 9600
- 38400
- 115200

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



```
Serial OUT chan 2
Line Speed
19200
```

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.

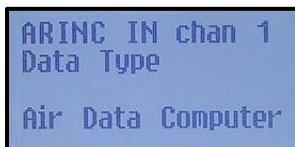
3.6.2.11 ARINC IN Channel X Data Type

(*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:

- Not Used
- Air Data Computer
- ADC+AHRS
- Other 1
- GPS
- AHRS
- Txpdr Control
- 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.



```
ARINC IN chan 1
Data Type
Air Data Computer
```

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:

- Low
- High

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



```
ARINC IN chan 1
Interface Speed
High
```

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

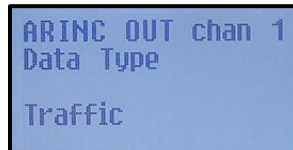
The FDL-978-XVR can transmit data via an ARINC 429 output channel. The following options are offered for selecting ARINC 429 output type:

- Not Used
- GPS
- 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.



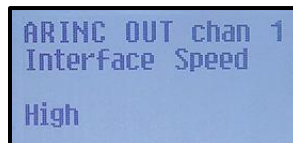
If “Not Used” is selected then the ARINC output line speed configuration mode is not displayed and the next configuration mode item is displayed.

3.6.2.14 ARINC OUT Chan 1 Interface Speed

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

- Low
- High

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



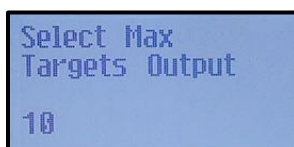
Rotate the **CODE** knob either clockwise or counterclockwise to display the options above and select the correct ARINC output interface speed. Once selected, press the **ENT** button to confirm your selection and move to the next configuration item in the setup mode.

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:

- Integers 8 through 30
- Max

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



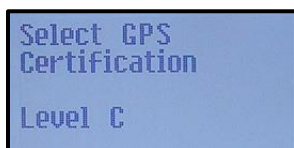
Rotate the **CODE** knob either clockwise or counterclockwise to display the options above and select the correct number of targets. Once selected, press the **ENT** button to confirm your selection and move to the next configuration item in the setup mode.

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:

- Uncertified
- Level D
- Level C
- 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.



For FDL-978 series units with internal GPS, set GPS Certification to Level C.



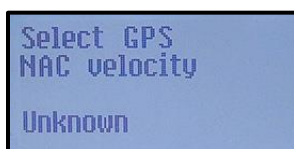
For external position sources, contact the manufacturer to obtain the relevant data.

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.

- Unknown
- 10 meters/sec
- 3 meters/sec
- 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.

Unknown, 10 meters/sec, and 3 meters/sec are permanent set at installation in the software. GPS Auto is automatically set from the velocity FOM (VFOM) data from the GPS unit. The NACv value is hard-coded to broadcast no better than 3 meters/sec, even if GPS Auto is selected.



For FDL-978 series units with internal GPS, set GPS NAC Velocity to GPS Auto.



For external position sources, contact the 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.

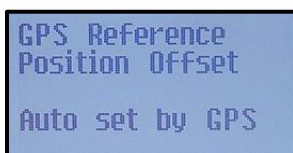


3.6.2.20 GPS Reference Position Offset

There are three modes by which the GPS (GNSS antenna) reference offset can be set:

- Unknown
- Auto set by GPS
- Manual set here

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

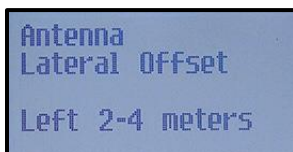


Rotate the **CODE** knob either clockwise or counterclockwise to display the options above and select the correct GPS reference offset. Once selected, press the **ENT** button to confirm your selection. If "Unknown" or "Auto Set by GPS" is selected the next configuration item in the setup mode will be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



It is recommended to use the "Manual Set Here" option to set the GPS (GNSS antenna) reference position for all installations.

GPS Reference Position is measured from the GPS antenna location to the lateral distance from centerline and longitudinal distance from the most forward part of the aircraft. 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.

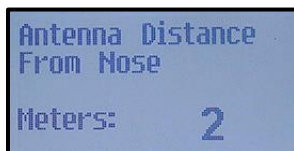


The antenna lateral offset has the following options that can be selected:

- Unknown
- Left 0-2 meters
- Left 2-4 meters
- Left 4+ meters

- Central
- Right 0-2 meters
- Right 2-4 meters
- 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.

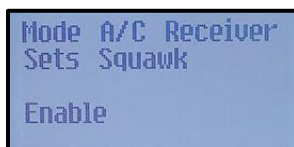
3.6.2.21 Mode A/C Receiver Sets Squawk

This mode has two options:

- Enable
- Disable

Set to “enable” when configuring for use with a Mode A/C 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.



This feature is not compatible with Mode S transponders.

3.6.2.22 1090 MHz Receiver Installed

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



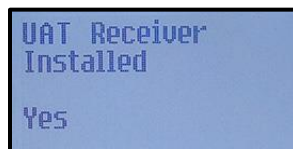
Rotate the **CODE** knob either clockwise or counterclockwise to display either “Yes” or “No” and select the correct option. Once selected, press the **ENT** button to confirm selection and move to the next configuration item in the setup mode.



The FDL-978 series receivers only receive on 978 MHz. Select “Yes” only if a 1090 MHz ADS-B receiver is installed on the aircraft.

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.



All FDL-978 series units, except the -TXL, contain a UAT receiver and should select the “Yes” option.

3.6.2.24 UAT Antenna Diversity



The default value is set at “Bottom Only.”



It is recommended to install dual antennas for maximum coverage.



* Top only installations are not allowed per FAA AC 20-165B, Paragraph 3.8.3.5.

The FDL-978-XVR provides the flexibility for installing either one or two approved UAT antennas. When two antennas are used they are to be installed with one on the top and one on the bottom of the aircraft. Single antenna installations must use Bottom Only to comply with AC 20-165B.

The default value is set at “Bottom Only.” The following options can be selected:

- Top Only*
- Bottom Only
- 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.

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.



This option should be set to “No” when using installation kits provided by FreeFlight Systems.

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). Section 2.7.4 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

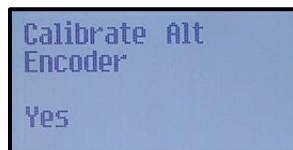
There are two adjustment points on the altitude encoder, a low altitude adjustment point, and a high altitude adjustment point. The low altitude point adjusts the correspondence at sea level, and the high altitude point adjusts the correspondence at the altitude limit of the encoder. Since the

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.

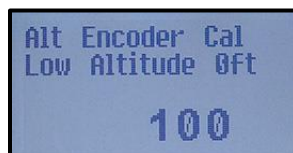


DO NOT EXCEED THE ALTITUDE OR RATE OF CLIMB LIMITS OF THE PITOT-STATIC INSTRUMENTS OF THE AIRCRAFT. The TC978 altitude encoder is a solid state device and will not be affected by excess altitude or rate of climb and descent, but the mechanical instruments in the aircraft can easily be damaged by being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

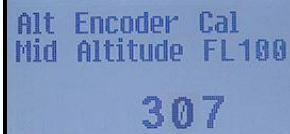
1. Set the primary altimeter subscale setting to 1013.2 hectopascal (hPA), 29.92 in hectogram (hg).
2. Connect the pitot-static test set to the aircraft.
3. You can enter the altitude encoder calibration setup either after following the steps from above in order or you can enter directly by holding the 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.

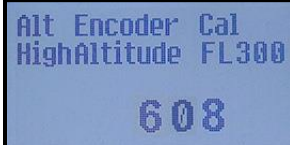


6. On the static test set, drive the altitude to 0 feet.
7. Read the primary altimeter value; rotate the **CODE** knob either clockwise or counterclockwise until the altitude displayed on the TC978 Controller matches the aircraft primary altimeter.
8. Press the **ENT** button and the display will move 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.



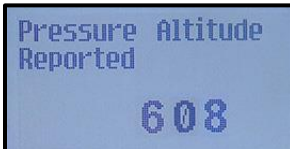
Alt Encoder Cal
Mid Altitude FL100
307

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.



Alt Encoder Cal
HighAltitude FL300
608

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.



Pressure Altitude
Reported
608

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.

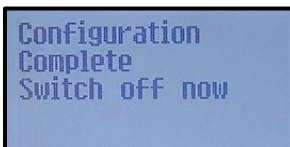
3.7.3 Pressure Altitude Reported

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.



Pressure Altitude
Reported
307

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



Configuration
Complete
Switch off now

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 3 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.

Warning	Potential Cause	Troubleshooting
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.
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.

Warning	Potential Cause	Troubleshooting
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 (-40°F to +158°F [-40°C to +70°C])/D/A
Operating Low Temperature	4.5.2	-40°F [-40°C] (C4)
Operating High Temperature	4.5.4	+158°F [+70°C] (C4)
Short-Time Operating Low Temperature	4.5.1	-40°F [-40°C] (C4)
Short-Time Operating High Temperature	4.5.3	+158°F [+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

Conditions	Para	Category (DO-160G)
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

5.2 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	-4°F [-20°C] (C4)
Short-Time Operating High Temperature	4.5.3	+158°F [+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 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

6.2 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
28	Capability Codes	Installation configuration

#	Input Data Element	Comment (Use within the FDL-978-XVR)
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)	From GPS data
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

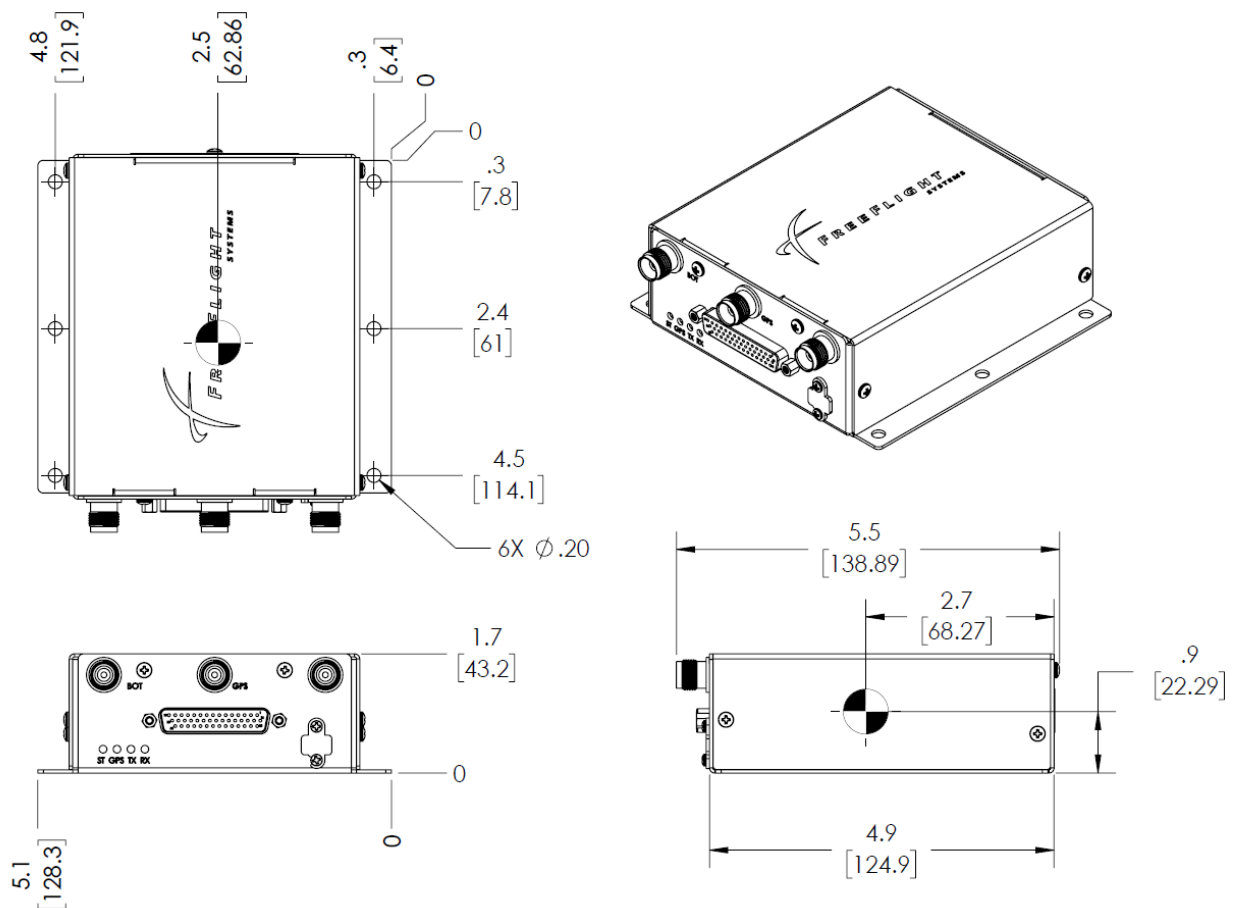
8.1 Dimensions



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.



DIMENSIONS ARE IN INCHES [MM]

TOLERANCES:

.X ± .1
.XX ± .02 ANG
.XXX ± .005 ± 1 DEG

Figure 19. FDL-978 Series and FDL-978 Lite Series Dimensions

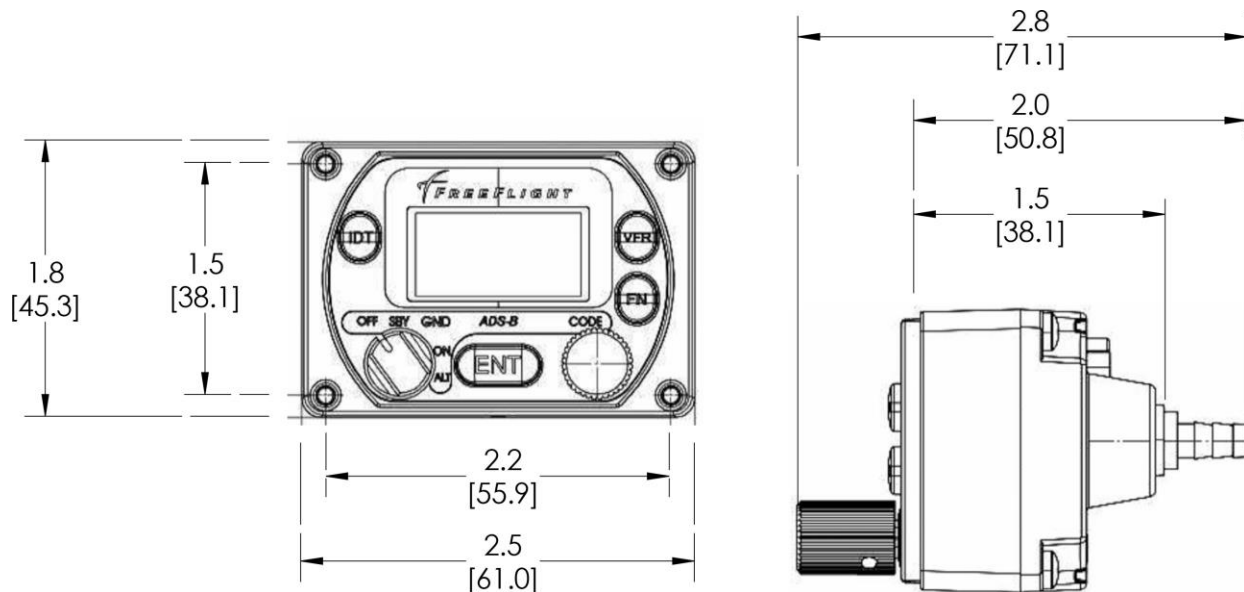


Figure 20. TC978 Controller Dimensions

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.

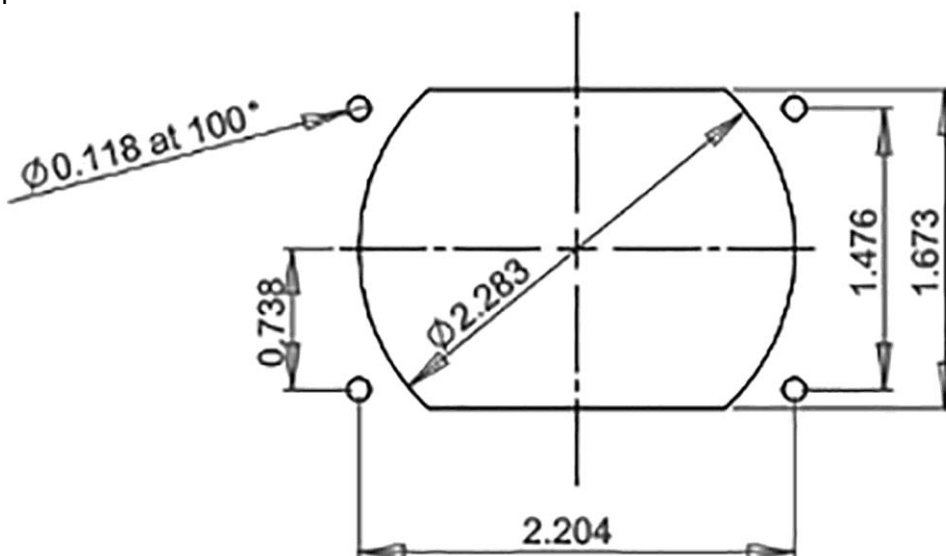


Figure 21. TC978 Fitted Cut-out

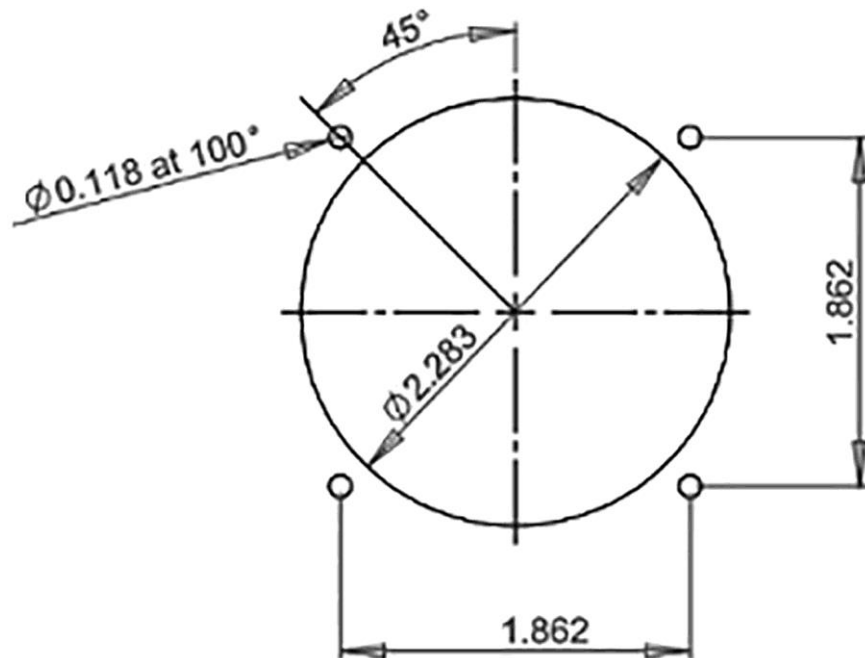


Figure 22. TC978 Conventional Cut-out

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SECTION 9 TYPICAL INTERCONNECT DIAGRAMS

9.1 Typical System Configurations

This section contains general wiring diagrams examples for popular configurations. After each figure, a table of appropriate FDL-978 settings are listed for reference.

Air/Ground input will vary on each aircraft depending on the equipment installed. Refer to the aircraft manual to determine the appropriate input signal to the FDL-978. Light Aircraft can refer to Section 2.5.7.1 for additional notes on Air/Ground determination.

All ports (except MPI) not connected to equipment should be set to UNUSED.



The following sections show system configuration from the Terminal MPI. For corresponding TC978 or MPI App settings, refer to Sections 3.3.3 and 3.6.

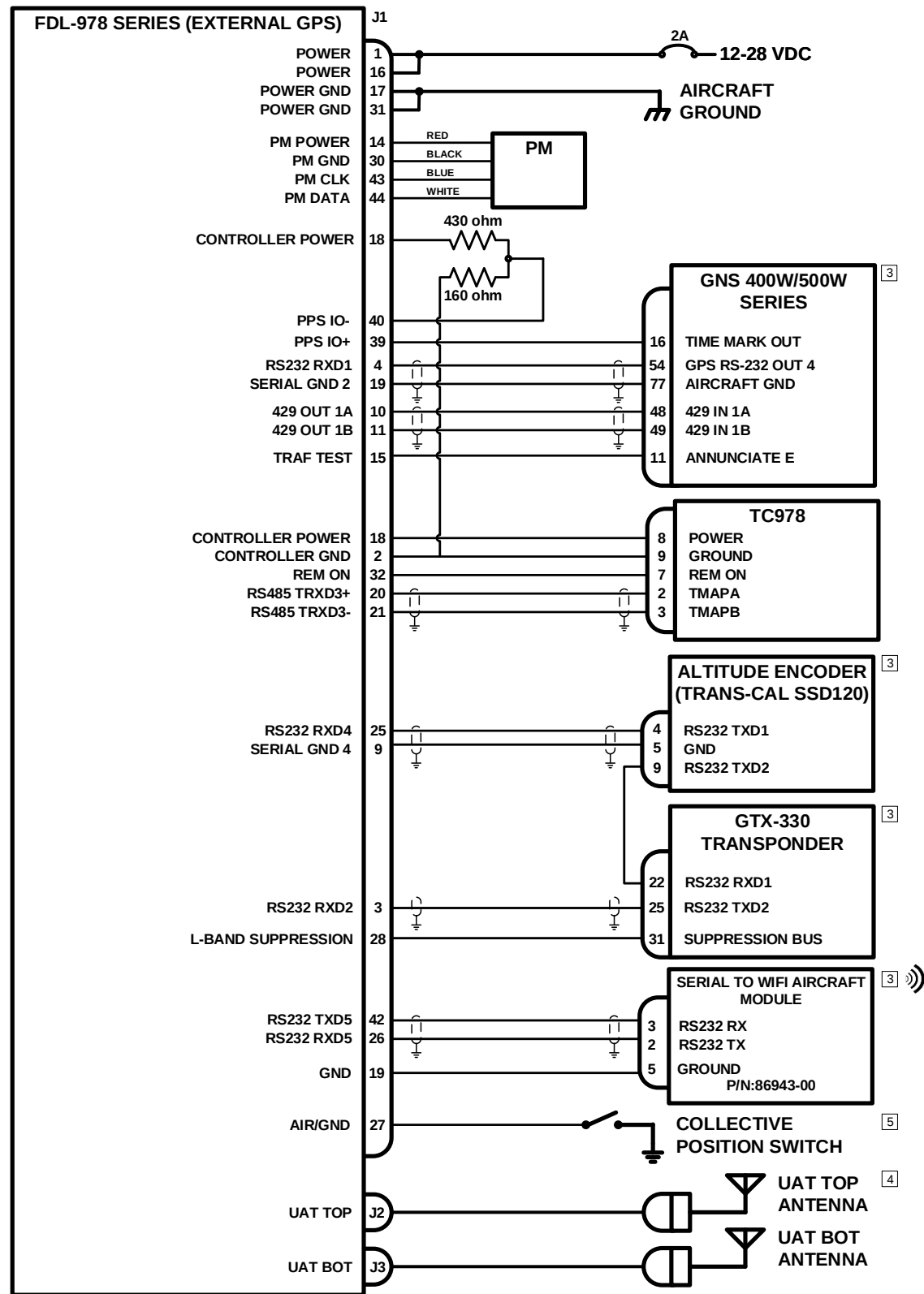


Highlighted configuration options represent those that are unique to each aircraft. Ensure that these configuration options are configured appropriately per Sections 3.5.2 and 3.6.



Contact FreeFlight Systems for additional information and STC validation

9.1.1 Garmin GNS 430W/530W Display and GPS, GTX-330 Transponder



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. REFER TO SECTION 2.5.7.1 AIR/GROUND INPUT FOR DETAILS ON ROTORCRAFT INSTALLATIONS.
6. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, AND MODE CONTROL ARE PROVIDED BY GTX-330 WITH TC978 AS BACKUP.
FAULT ANNUNCIATION IS PROVIDED BY TC978.
TRAFFIC DISPLAY ON GNS 400W/500W AND PERSONAL ELECTRONIC DEVICE.

Table 25. Garmin System Configuration Settings

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	ROTORCRAFT
Squat Mode.....	low
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	GPS-ADSBPlus, 9600
Serial In 2.....	GTX-Remote, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 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.....	Traffic, high

Figure 23. Garmin GNS 430W/530W Display and GPS, GTX-330 Transponder

9.1.2 Chelton FlightLogic Display, GSL-71 Controller, No Transponder

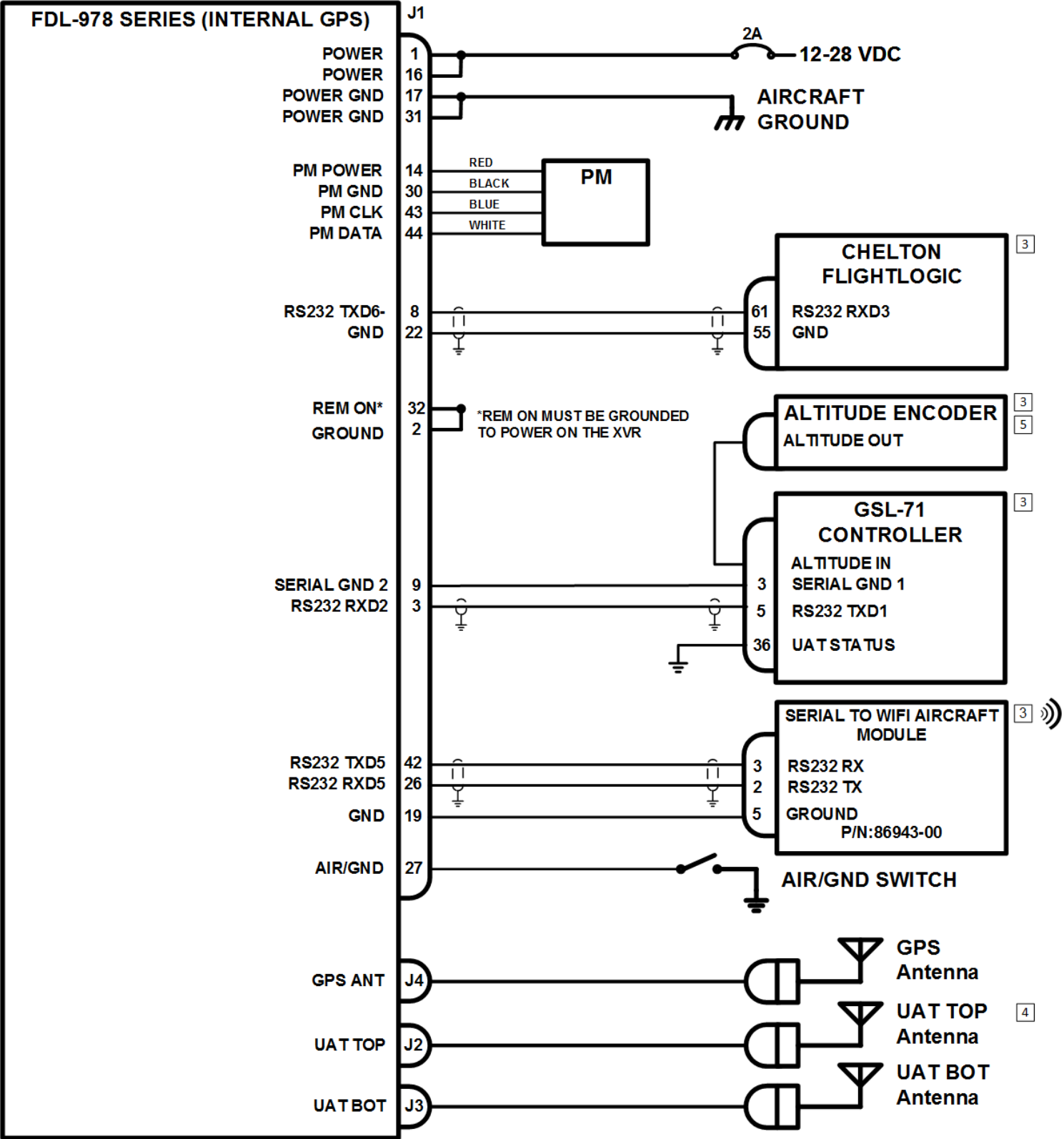


Figure 24. Chelton FlightLogic Display, GSL-71 Controller

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH A SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. ALTITUDE SOURCE MUST PROVIDE DATA TO GSL-71 AT 9600 BAUD AND MINIMUM RESOLUTION OF 10 FEET.
6. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, MODE CONTROL ARE PROVIDED BY GSL-71.
FAULT ANNUNCIATION PROVIDED BY CHELTON FLIGHTLOGIC
TRAFFIC DISPLAY ON CHELTON FLIGHTLOGIC AND PERSONAL ELECTRONIC DEVICE.

Table 26. Chelton FlightLogic Display, GSL-71 Controller Settings

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	SMALL AIRCRAFT
Squat Mode.....	low
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	enable
Traffic Vel Validation....	enable
Display Data Output.....	traffic&fisb
Serial In 1.....	Internal-GPS, 19200
Serial In 2.....	GSL-71, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	UNUSED, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	UNUSED, 38400 (RS-232)
Serial Out 6.....	Traffic-Alert, 38400 (RS-232)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	UNUSED, low

9.1.3 Aspen Display and Control, GTX 327 Transponder

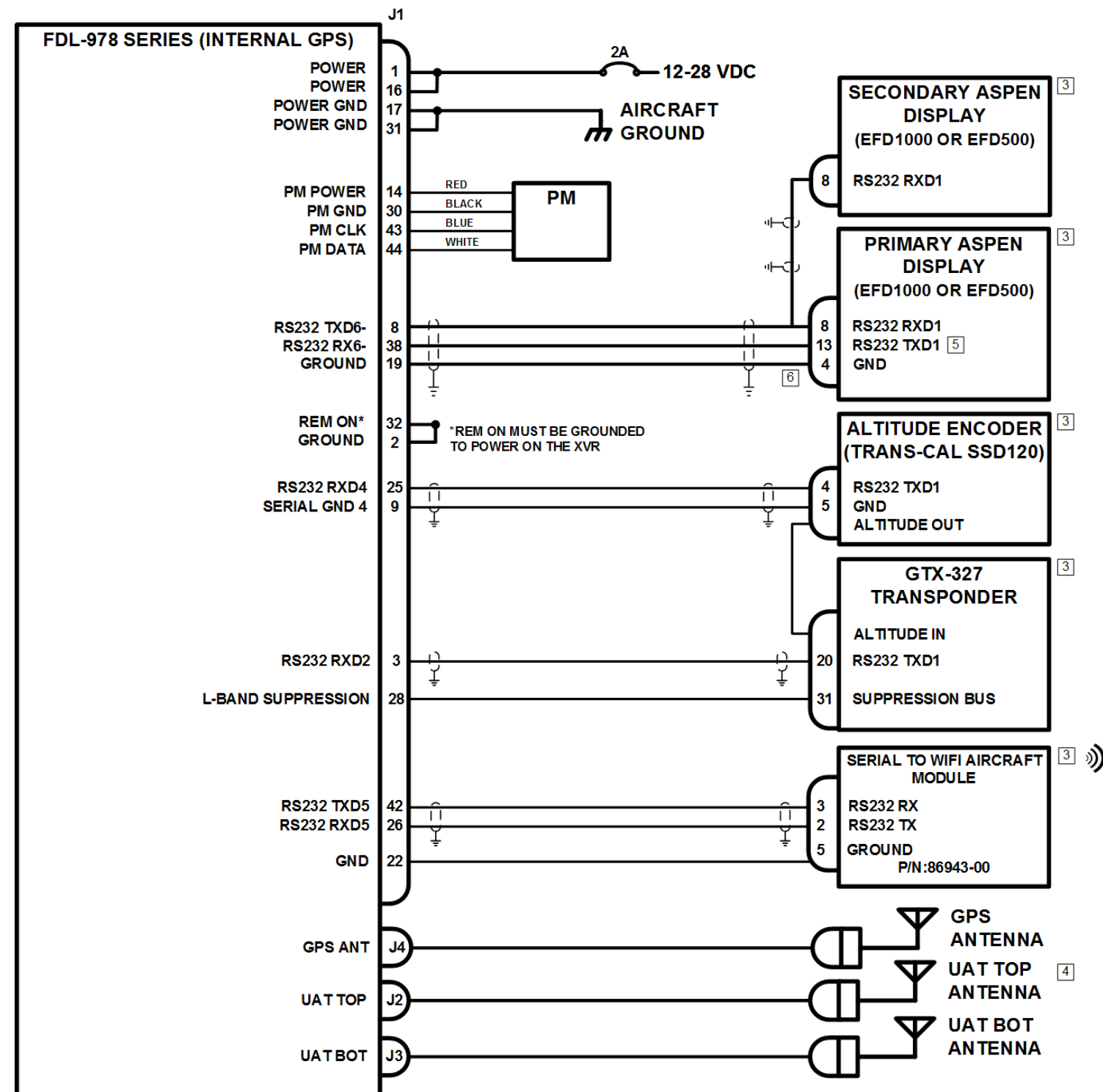


Figure 25. Aspen Display and Control, GTX 327 Transponder

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. ONLY THE PRIMARY FLIGHT DISPLAY PIN 13 MAY BE CONNECTED TO THE FDL-978. USE ONLY WHEN SEPARATE TRANSPONDER IS NOT INSTALLED.
6. GROUND CONNECTION SHOULD BE MADE TO EITHER THE ASPEN POWER GROUND PIN OR CASE GROUND.
7. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, MODE CONTROL ARE PROVIDED BY GTX-327 (ASPEN PFD, OPTIONAL)
FAULT ANNUNCIATION PROVIDED BY A SPEN PFD.
TRAFFIC DISPLAY ON PED AND ASPEN EFD.

Table 27. Aspen Display and Control, GTX 327 Transponder

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	Disp-Ctrl, 115200 (RS-232)
Serial Out 6.....	Traffic-Alert, 115200 (RS-232)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	UNUSED, low

9.1.4 Bendix King KSN 765/770 Display and GPS, GTX-327 Transponder

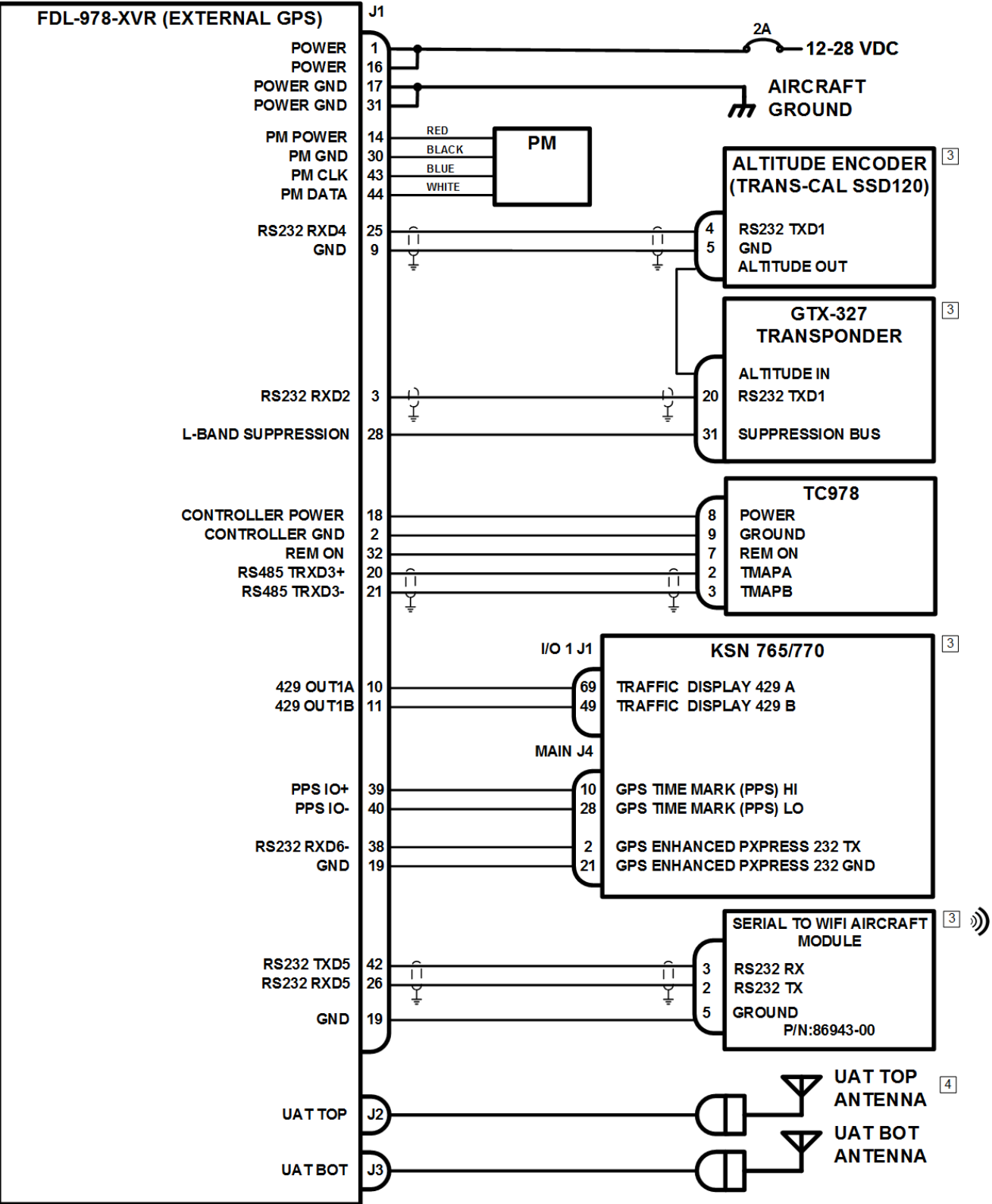


Figure 26. Bendix King KSN 765/770 Display and GPS, GTX-327 Transponder

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, MODE CONTROL ARE PROVIDED BY GTX-327.
FAULT ANNUNCIATION PROVIDED BY TC978.
TRAFFIC DISPLAY ON BENDIX KING KSN 765/770 AND PERSONAL ELECTRONIC DEVICE.

Table 28. Bendix King KSN 765/770 Display and GPS, GTX-327 Transponder

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	UNUSED, 9600
Serial In 2.....	GTX-Remote, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	GPS-KSN, 115200 (RS-232)
Serial Out 6.....	UNUSED, 115200 (RS-232)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	Traffic, high

9.1.5 Mode A/C Transponder, TC978 Controller

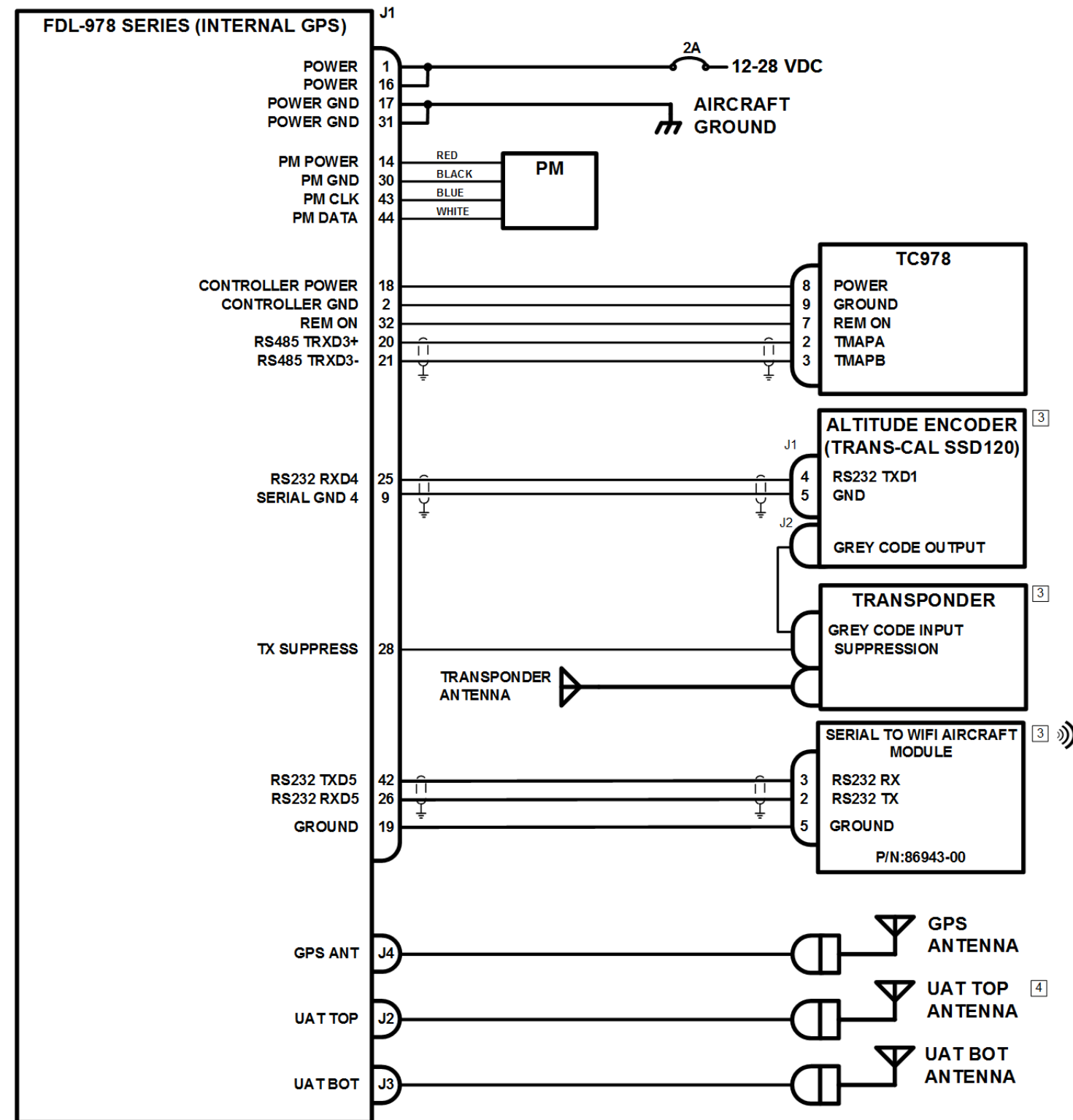


Figure 27. Mode A/C Transponder, TC978 Controller

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. SYSTEM DESCRIPTION:
SQUAWK CODE AND IDENT ARE PROVIDED BY TRANSPONDER.
MODE CONTROL IS PROVIDED BY TC978.
FAULT ANNUNCIATION PROVIDED BY TC978.
TRAFFIC DISPLAY ON PERSONAL ELECTRONIC DEVICE.

Table 29. Mode A/C Transponder, TC978

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, No DC Gnd Chk
GPS Ant Offset.....	Long=No Data, Lateral=No Data
Mode A Rx.....	enable
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.....	UNUSED, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 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



When a separate transponder is present, 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.

9.1.6 Garmin GNS 480, SL-70 Transponder, TCAS

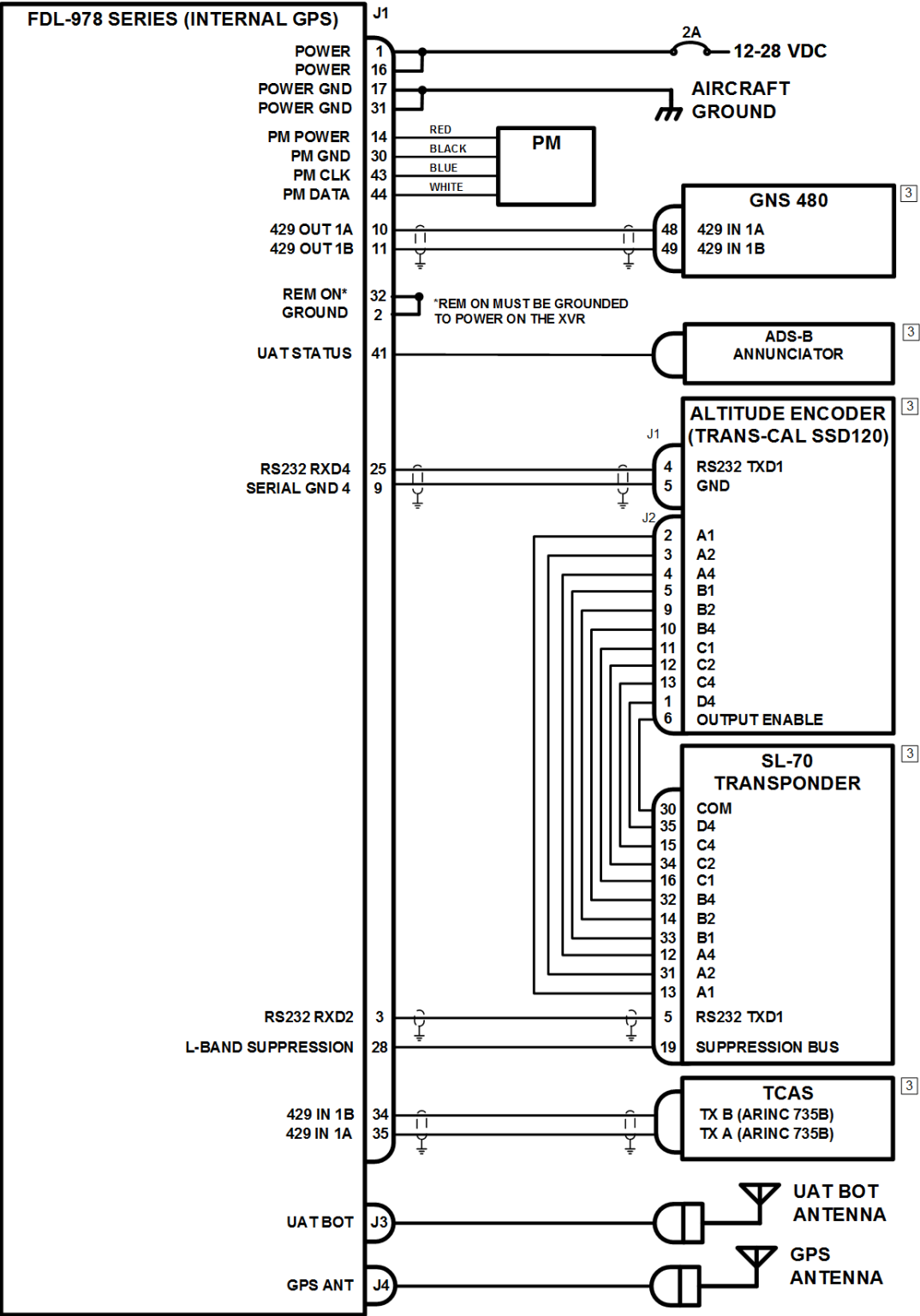


Figure 28. Garmin GNS 480, SL-70 Transponder, TCAS

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, AND MODE CONTROL ARE PROVIDED BY SL-70.
FAULT ANNUNCIATION PROVIDED BY DEDICATED ANNUNCIATOR.
TRAFFIC DISPLAY ON GNS 480.

Table 30. Garmin GNS 480, SL-70 Transponder, TCAS

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	low
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&fish
Serial In 1.....	Internal-GPS, 19200
Serial In 2.....	GSL-71, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	Alt-Encoder, 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.....	Traffic, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	Traffic, low

Refer to Section 1.8 for ARINC GPS and TCAS I/O availability on select FDL-978 models.

9.1.7 Garmin MX-20 Display and Control, No Transponder

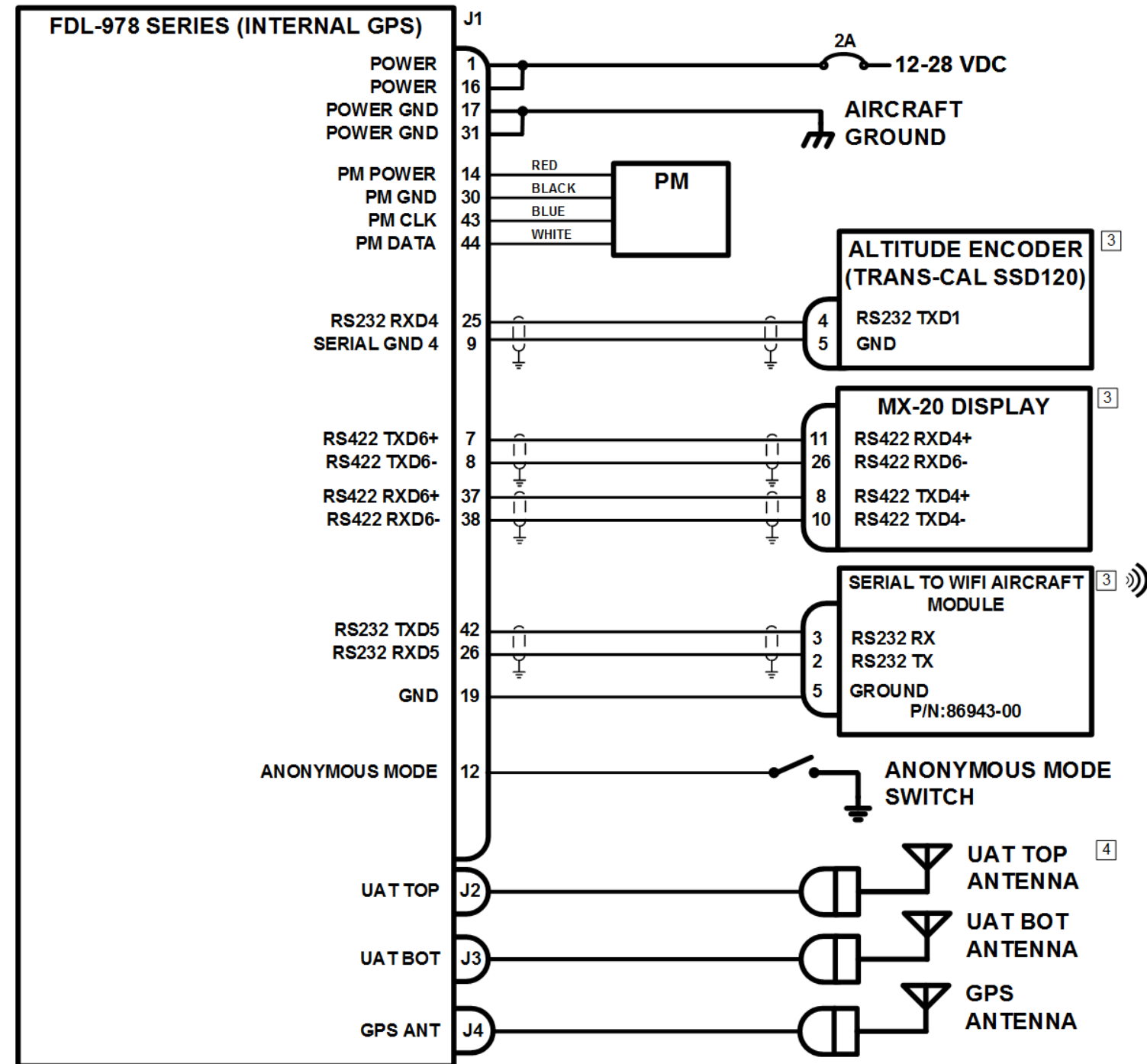


Figure 29. Garmin MX-20 Display and Control, No Transponder

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. SYSTEMS DESCRIPTION:
SQUAWK CODE, IDENT, AND MODE CONTROL ARE PROVIDED BY MX-20.
FAULT ANNUNCIATION PROVIDED BY MX-20.
TRAFFIC DISPLAY ON MX-20.

Table 31. Garmin MX-20 Display and Control

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	UNUSED, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	Disp-Ctrl, 38400 (RS-422)
Serial Out 6.....	MX-20, 38400 (RS-422)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	UNUSED, low

9.1.8 Garmin GMX-200 Display, GTX-330 Transponder

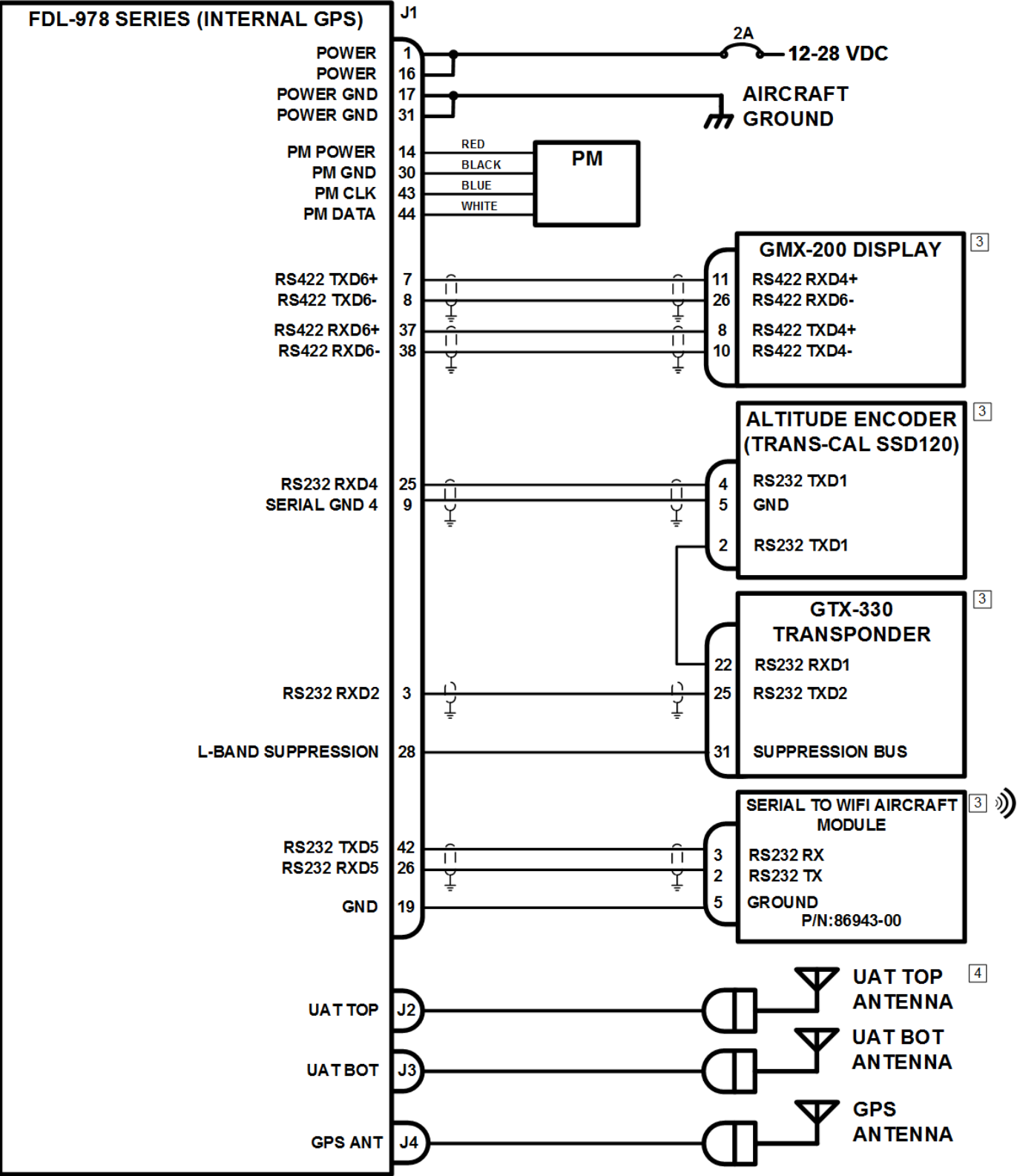


Figure 30. Garmin GMX-200 Display, GTX-330 Transponder

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE  SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. SYSTEM DESCRIPTION:
 - SQUAWK CODE, IDENT, AND MODE CONTROL ARE PROVIDED BY GTX-330.
 - FAULT ANNUNCIATION PROVIDED BY GMX-200.
 - TRAFFIC DISPLAY ON GMX-200 AND PERSONAL ELECTRONIC DEVICE.

Table 32. Garmin GMX-200 Display, GTX-330 Transponder

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 9600
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	UNUSED, 38400 (RS-422)
Serial Out 6.....	Traffic-Alert, 38400 (RS-422)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	UNUSED, low

9.1.9 Garmin GTX-330ES Transponder with FDL-978 GPS Source

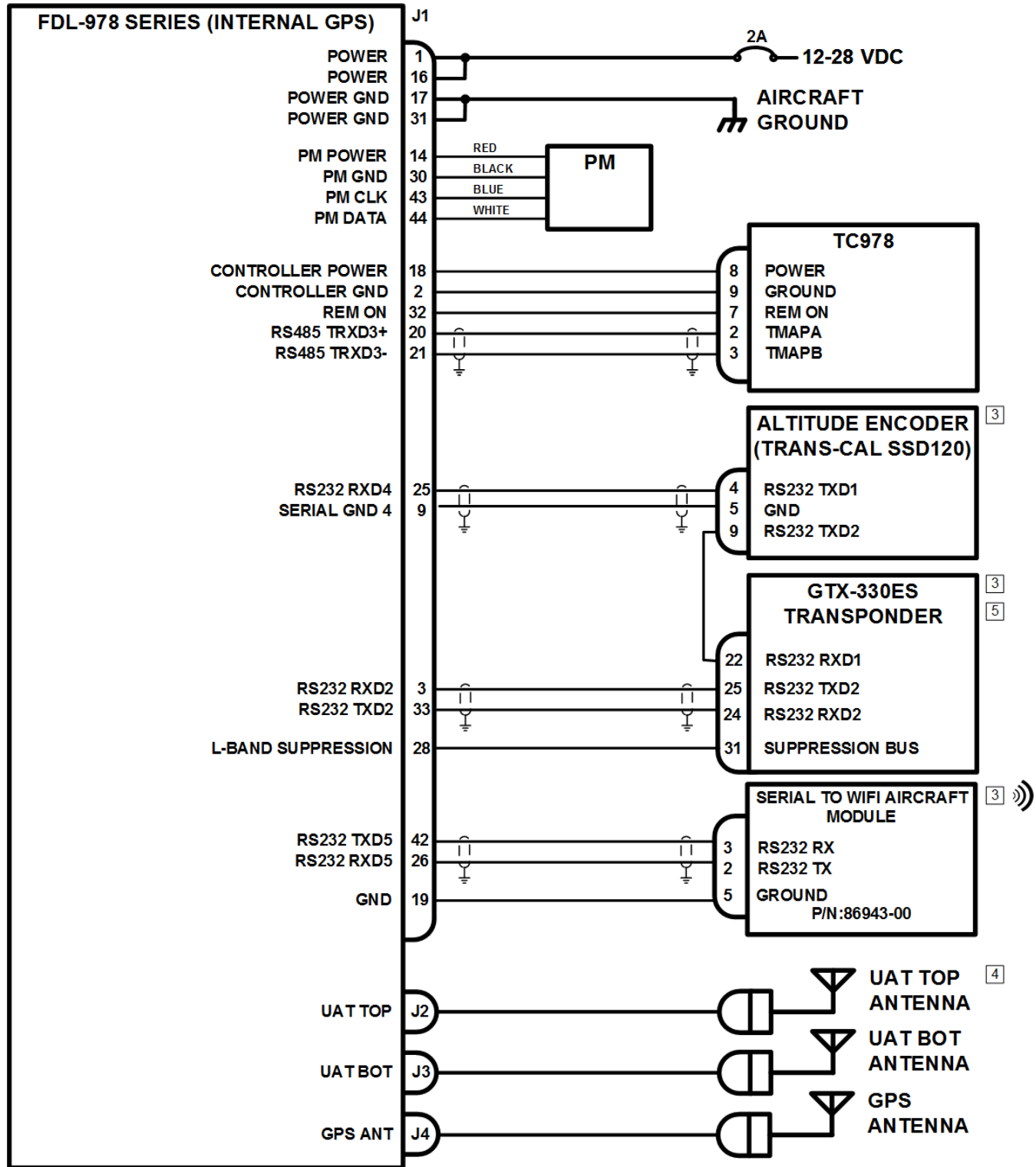


Figure 31. GTX-330ES Transponder with FDL-978 GPS Source

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. REMOTE IN MAY BE USED AS A GPS SOURCE FROM THE XVR FOR THE GTX 330ES.
6. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, AND MODE CONTROL ARE PROVIDED BY GTX-330ES WITH TC978 AS BACKUP.
FAULT ANNUNCIATION IS PROVIDED BY TC978.
TRAFFIC DISPLAY ON PERSONAL ELECTRONIC DEVICE.

Table 33. GTX-330ES Transponder with FDL-978 GPS Source

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 9600
Serial Out 5.....	Traffic-Alert, 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

9.1.10 FDL-1090-TX/TT-22 Transponder and FDL-978-XVR GPS Source

NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL -W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS.SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. SYSTEM DESCRIPTION:
SQUAWK CODE, IDENT, MODE CONTROL ARE PROVIDED BY FDL-978.
FAULT ANNUNCIATION PROVIDED BY TC978.
TRAFFIC DISPLAYED ON PERSONAL ELECTRONIC DEVICE.

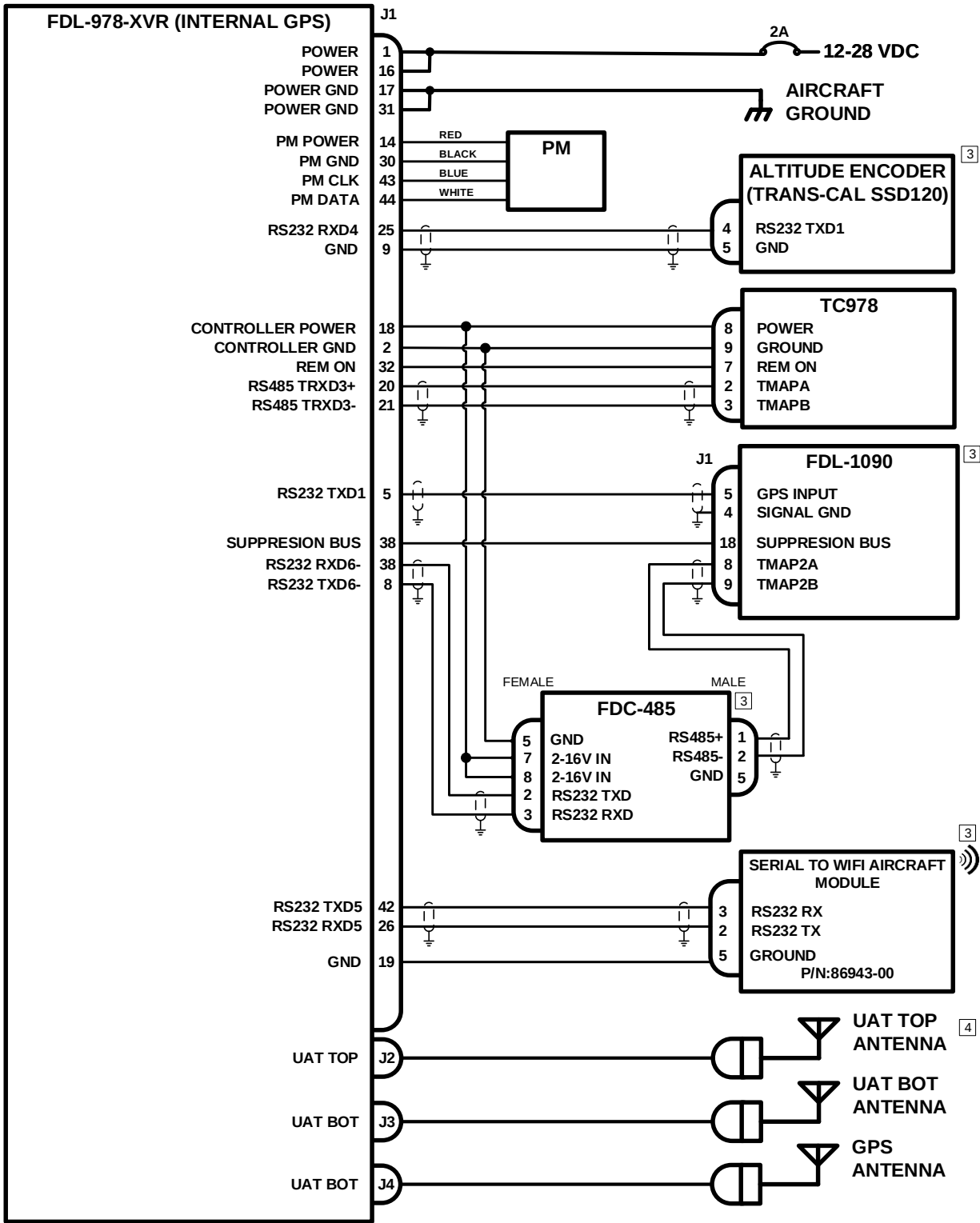


Table 34. FDL-1090-TX/TT-22 Transponder and FDL-978-XVR GPS Source

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	UNUSED, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	TMAP, 38400
Serial Out 3.....	TMAP, 38400
Serial In 4.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 9600
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	TMAP, 38400 (RS-232)
Serial Out 6.....	TC-Out, 38400 (RS-232)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	UNUSED, low

Figure 32. FDL-1090-TX/TT-22 Transponder and FDL-978-XVR GPS Source

9.1.11 Avidyne Display and Control

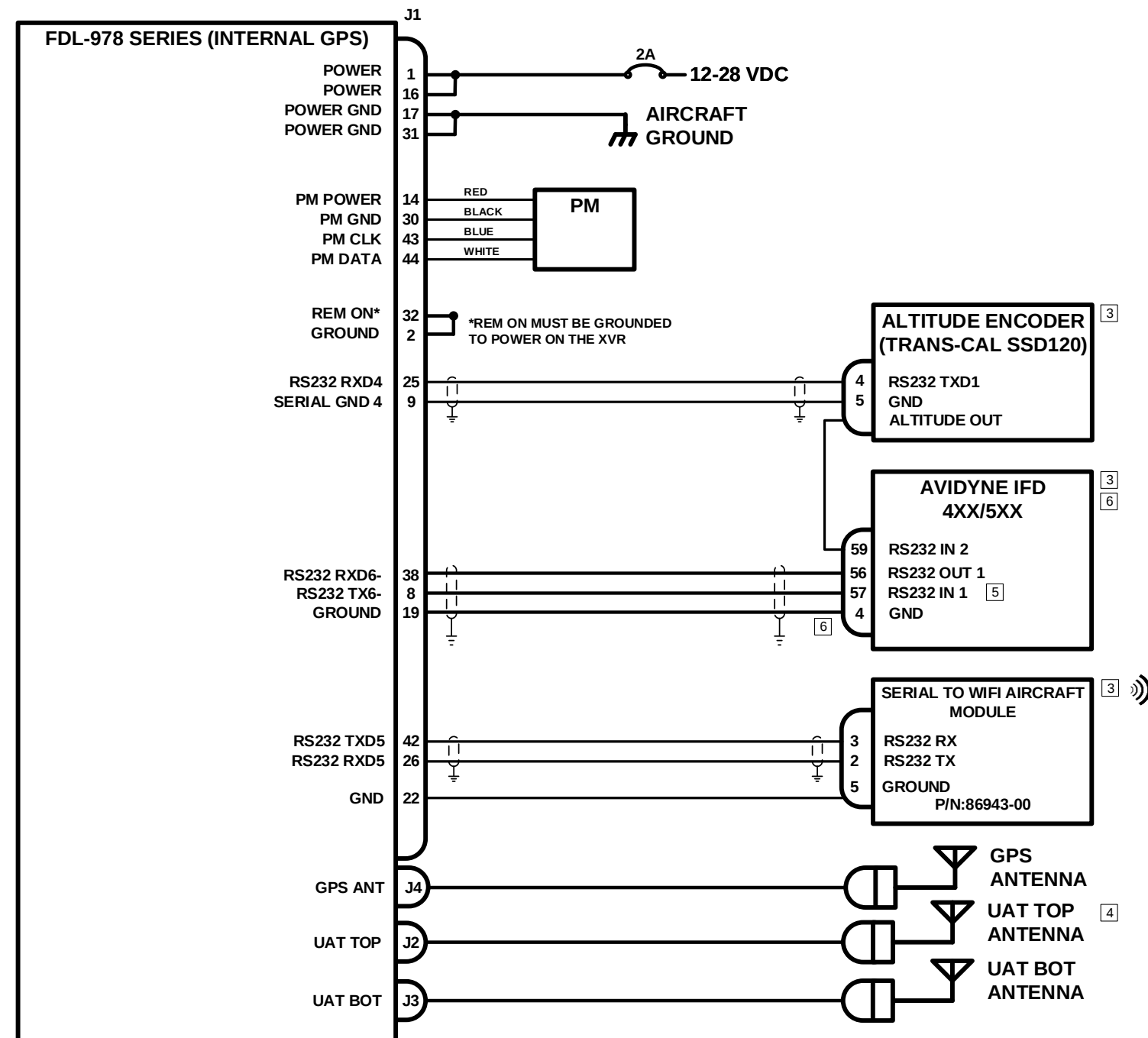


Figure 33. Avidyne Display and Control

NOTES:

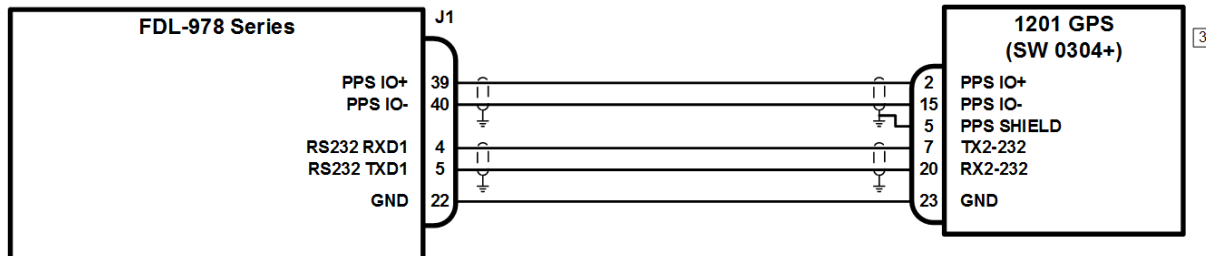
1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
4. FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
5. SYSTEM DESCRIPTION:
 - SQUAWK CODE, IDENT, MODE CONTROL ARE PROVIDED BY AVIDYNE IFD 4XX/5XX.
 - FAULT ANNUNCIATION PROVIDED BY AVIDYNE IFD 4XX/5XX.
 - TRAFFIC DISPLAY ON PED AND AVIDYNE IFD 4XX/5XX.
6. ENSURE PORT 1 IS CONFIGURED TO FREEFLIGHT IN AND OUT.

Table 35. Avidyne Display and Control

ICAO Address.....	FF00
VFR Call Sign.....	FXVRGA
GPS Config.....	Level C
NACv Mode.....	Auto (from GPS)
Receiver Capability.....	no1090, 978
Emit Category.....	LIGHT AIRCRAFT
Squat Mode.....	none
Groundspeed Threshold.....	0 knots
Vehicle Size.....	Length=0 meters, Width=0 meters
UAT Ant.....	dual, 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.....	UNUSED, 9600
Serial Out 2.....	UNUSED, 9600
Serial In 3.....	UNUSED, 9600
Serial Out 3.....	UNUSED, 9600
Serial In 4.....	Alt-Encoder, 9600
Serial In 5.....	UNUSED, 115200
Serial Out 5.....	Traffic-Alert, 115200
Serial In 6.....	Disp-Ctrl, 115200 (RS-232)
Serial Out 6.....	Traffic-Alert, 115200 (RS-232)
ARINC In 1.....	UNUSED, low
ARINC In 2.....	UNUSED, low
ARINC Out 1.....	UNUSED, low

9.2 Equipment Specific Installations

9.2.1 FreeFlight Systems 1201 GPS

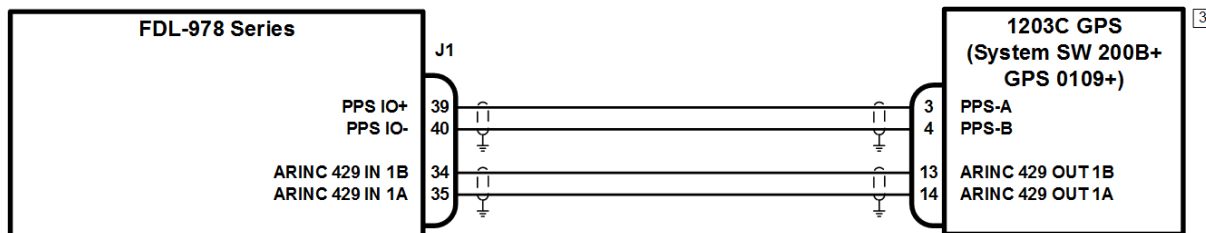


NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. MINIMUM SOFTWARE (SW) VERSIONS MAY BE APPLICABLE.

Figure 34. 1201 Wiring Diagram

9.2.2 Freeflight Systems 1203C GPS



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. MINIMUM SOFTWARE (SW) VERSIONS MAY BE APPLICABLE.

Figure 35. 1203C Wiring Diagram

9.3 Equipment Compatibility and Functions

The table below summarizes the ADS-B transmit control function capabilities of various potential FDL-978 Series controllers. Per AC20-165B the Squawk and IDENT should be controlled for the Transponder and ADS-B Out Transmitter through a single point of entry. There should also be an ADS-B Fault annunciation for both ADS-B GPS loss/fault and ADS-B failure.

Table 36. ADS-B Transmit Control Functions for Various FDL-978 Controllers

Device Type	Device Model	Squawk Code/ IDENT	Call Sign	TX Standby	Altitude Inhibit	ADS-B Fault Annunciation
Transponder	Apollo SL-70/R	X	X	X	X	-
	Garmin GTX 330/33	X	- ¹	X	X	-
	Garmin GTX 327/32	X	-	X	X	-
	Mode A/C Receiver	X	-	-	-	-
	ARINC Transponder Controller	X	X	X		X
Display Controller	Aspen EFD 500/1000	X	-	-	-	X
	Garmin MX-20	X	X	X	X	X
	Garmin GMX-200	X	X	X	X	X
	Chelton Flight Logic	-	-	-	-	X
	Avidyne IFD 4XX/5XX	X	X	X	X	X
ADS-B Controller	FreeFlight TC978	X	X	X	X	X
	Garmin GSL 71	X	X	X	X	-

¹The GTX-330 only outputs the call sign in a single message when it is powered on. The FDL-978 must be powered on first in order to receive this message. If the call sign is received from the GTX-330, it is only set as the default call sign, and can be changed using the TC978.

The table below contains the minimum compatible software versions as tested with the FDL-978 Series.

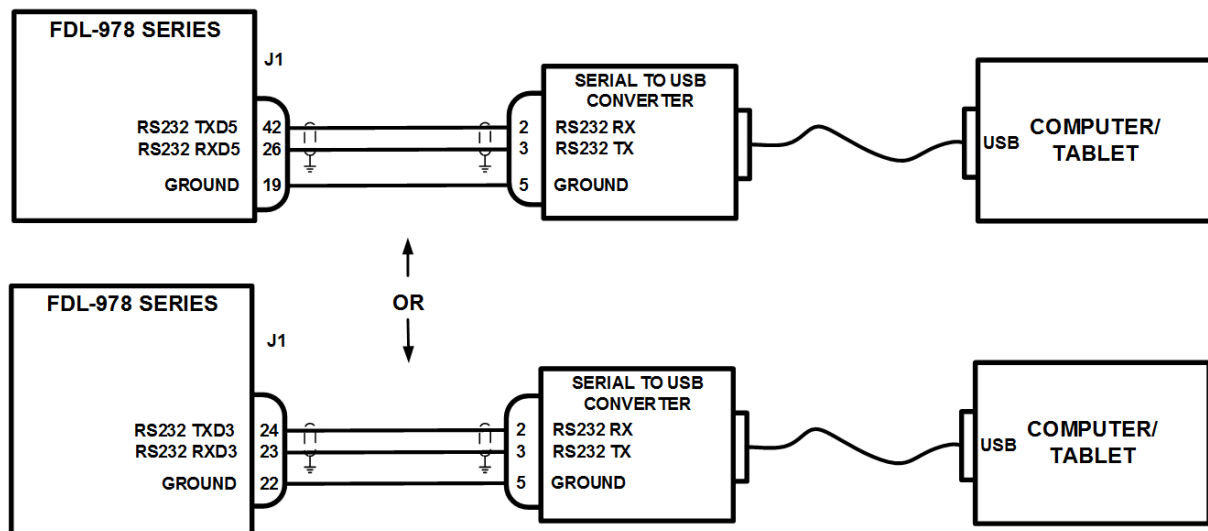
Table 37. Compatible Software Versions

Device	Permitted Software Version
TC-978 UAT Controller	Software Version 1.13 or later FAA-approved version
Aspen EFD1000 PFD Aspen EFD1000 MFD Aspen EFD500 MFD	MAP 2.7.2 or later FAA-approved version IOP 2.0.5 or later FAA-approved version
MX20 MFD	Software Version 5.7
GMX 200 MFD	Software Version 2.12 or later FAA approved version

Garmin GSL 71 UAT Control Panel	No Software Version is Identified
Chelton FlightLogic EFIS	Software Version 6.0B
Wi-Fi Module	All software versions
Model 1201 GPS as a Position Source	Software Version 0306 or later FAA-approved version
Model 1203C GPS	Software Version 200B or later FAA-approved version
Garmin 400W/500W Series as a Position Source and/or ADS-B IN traffic source.	Main Software Version 5.03 or later GPS Software Version 5.00 or later

SECTION 10 MAINTENANCE INTERFACE DIAGRAMS

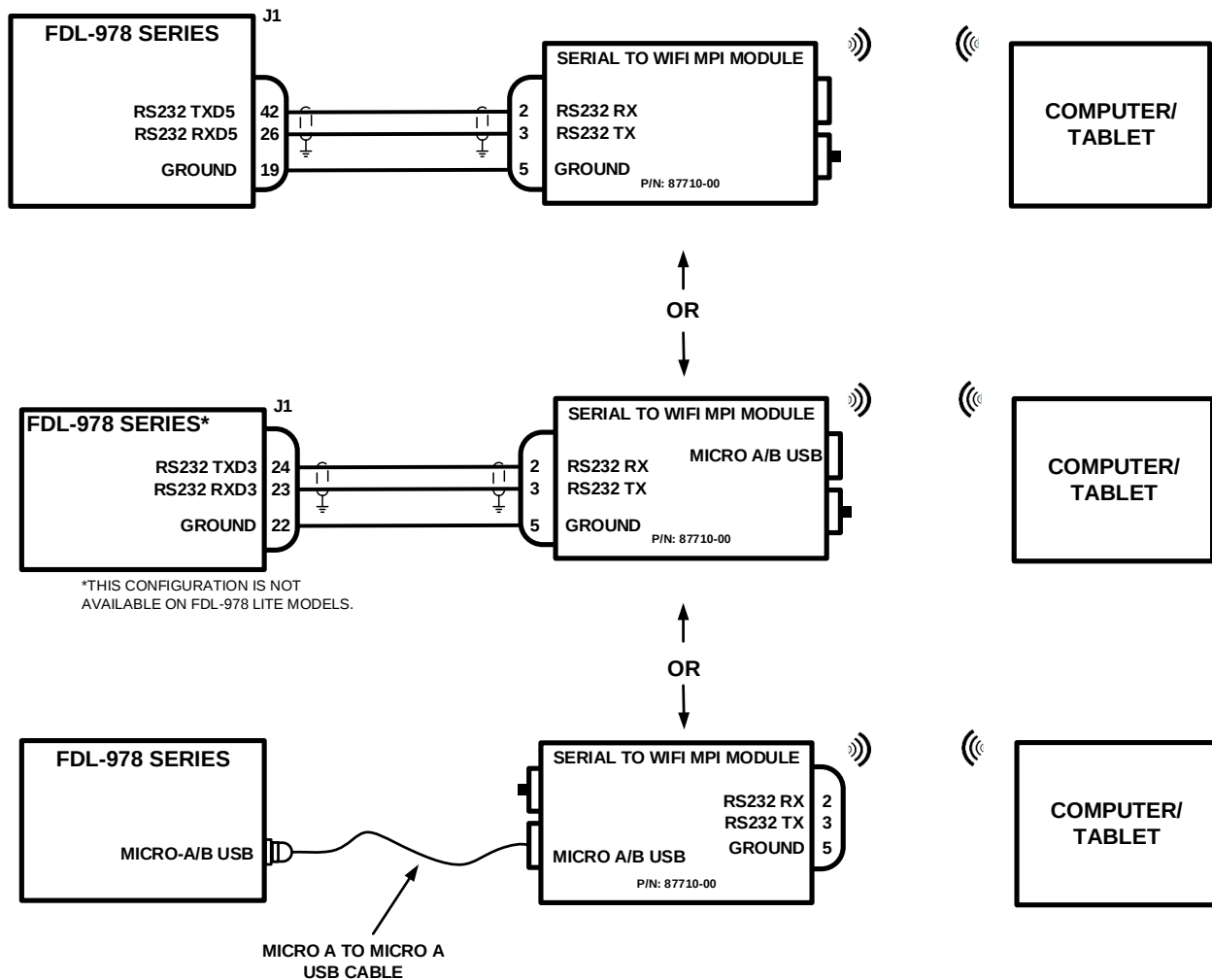
Section 12.12.1 describes the various FDL-978 Lite Series configuration and setup options via the MPI. The diagrams below provide a pictorial representation of these available options for accessing the maintenance port of the FDL-978 Lite Series and FDL-978-XVR.



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3.  REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.

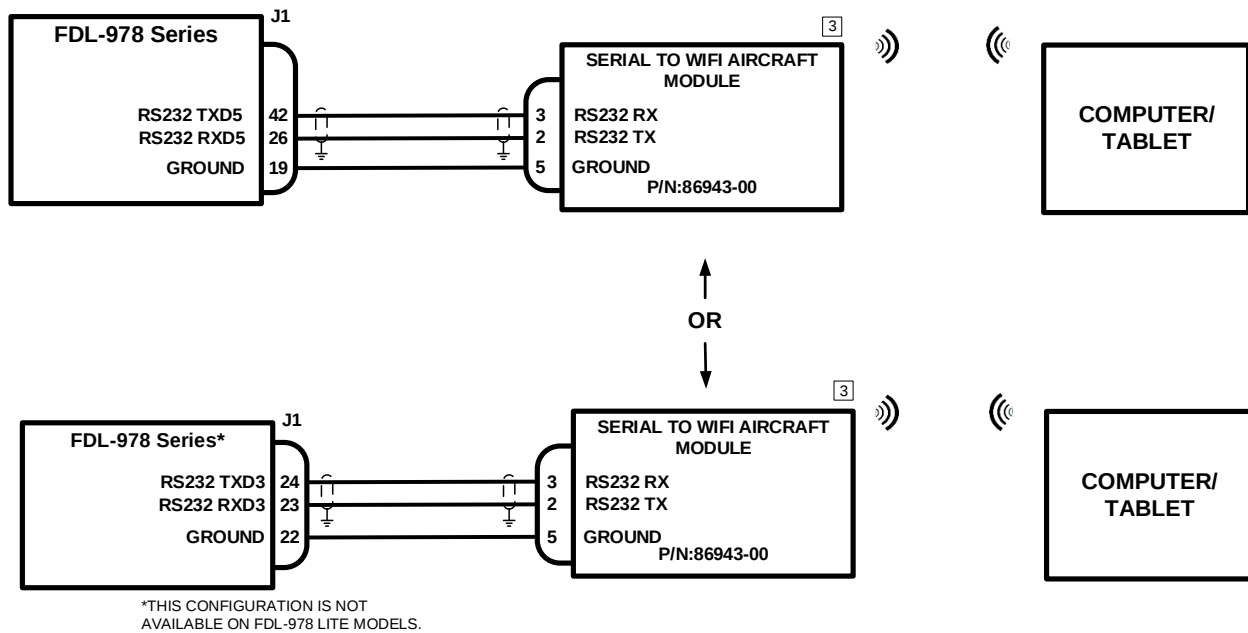
Figure 36. Off-the-Shelf RS-232 to USB Converter



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.

Figure 37. Serial-to-Wi-Fi MPI



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.
3. REFER TO INDIVIDUAL INSTALLATION MANUALS FOR EXTERNAL EQUIPMENT INTERCONNECTS.

Figure 38. Serial-to-Wi-Fi Aircraft Module

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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 39. 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 Source Interface

The Altitude Source input interface provides connection to an external altitude source which outputs the Altitude Encoder format at 9600 baud defined in Section 6.1.

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 40 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 source (shared with the transponder), the transponder suppression bus, and an air/ground detection switch.

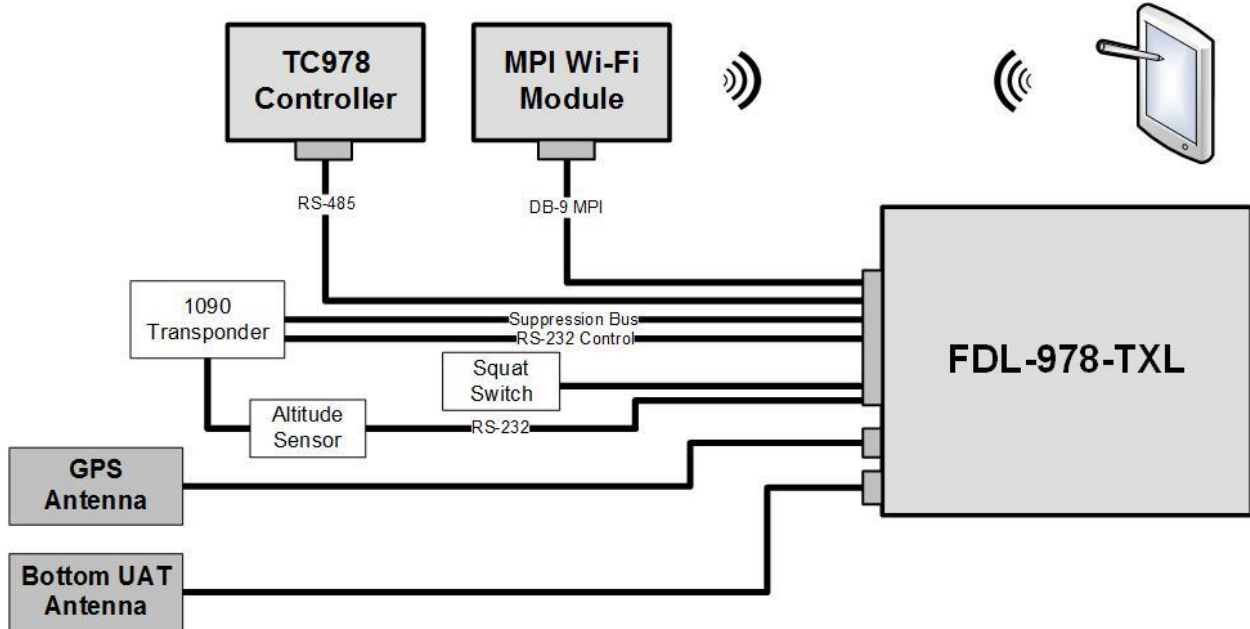


Figure 40. FDL-978-TXL Wi-Fi MPI Block Diagram (Typical)

The block diagram shown in Figure 41 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 source (shared with the transponder), the transponder suppression bus, and an air/ground detection switch.

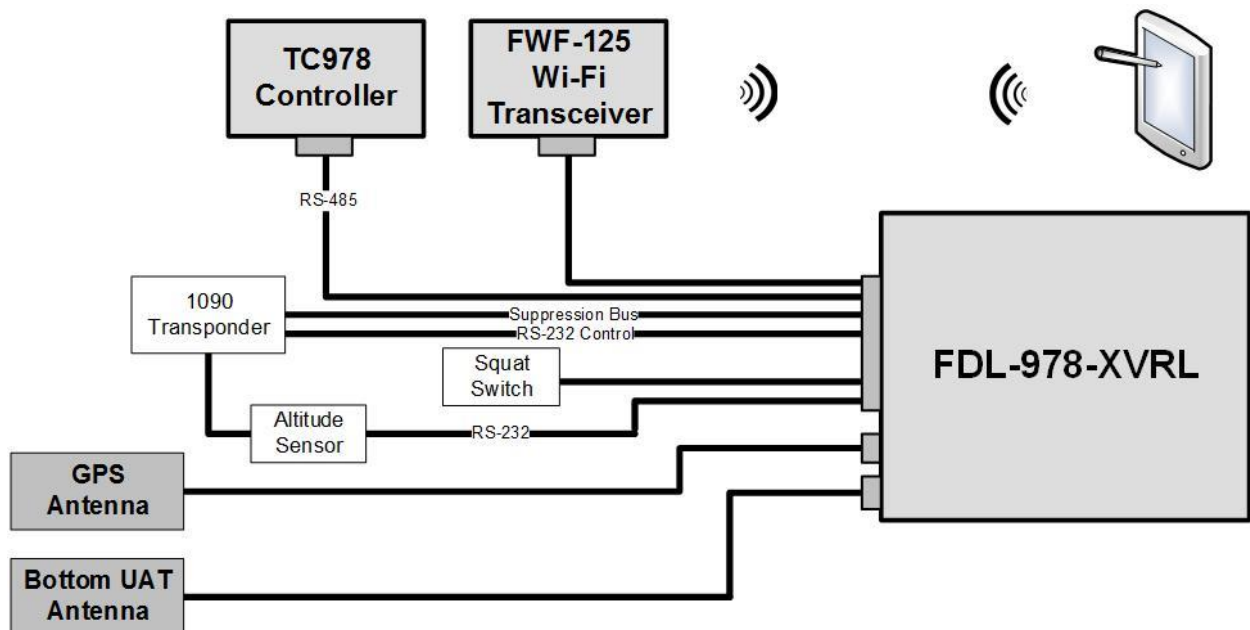


Figure 41. FDL-978-XVRL Wi-Fi Transceiver Block Diagram (Typical)

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
TRANSCIVER FREQUENCY		978 MHz
TRANSMITTER POWER		40 Watts max at antenna after 2dB connector/cable losses
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
88046	1	Antenna RAMI GPS/SBAS TSO-C190
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

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 20-165B 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 source. Installations must therefore ensure that the transponder and FDL-978 Lites Series receive altitude data from the same altitude source.



FAA AC 20-165B 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, Active high
29	Reserved	N/A	-	N/A
30	Reserved	N/A	-	N/A
31	RTRN	Ground	Gnd	Aircraft Power Return
32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)

J1 - Power and I/O Connector (DB-44)				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
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 source that outputs the Altitude Encoder format at 9600 baud defined in Section 6.1. 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 2.5.8.2 - 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.

Refer to Section 2.5.10 for further details on the MPI connector.

12.7.11.1 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-XVRL> FDL-978-XVRL
- RANGR-TXL> FDL-978-TXL

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 38. Serial Port Configuration Settings

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

Table 39. ADS-B Transmit Configuration Settings

Configuration Item		Default	Setting
ICAO Address (Mode S)		0	
Call Sign/Flight ID			
Receiver Configuration:	UAT Receiver Installed	978	
	ES1090 Receiver Installed	no1090	
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 20-165B 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.
 - a. The GTX-330 outputs its own call sign in a single message at startup. When the FDL-978 is powered on first, it takes the call sign from the GTX-330 and uses that as the default call sign.
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 20-165B 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 source. Installations must; therefore, ensure that the transponder and FDL-978 Lite Series receive altitude data from the same altitude source.

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 source which outputs altitude data per the Altitude Encoder format at 9600 baud defined in Section 6.1 can provide altitude data to the FDL-978 Lite Series. The Altitude Data input port (port 4) must be configured to Altitude Encoder input at 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.

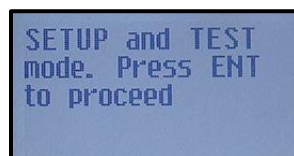
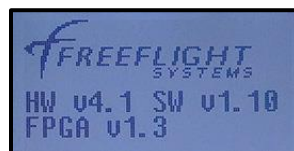
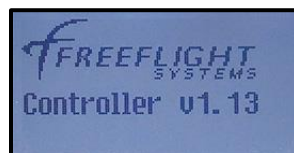
The system should be configured during initial system installation by a qualified technician. The configuration items list in Section 12.3.1 should be used to document the system installation for future reference. To view or change these settings you must enter TC978 Configuration Mode.

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 12.13.2.7 for details on configuring this port.



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

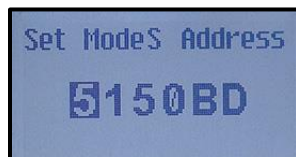
The FDL-978 Lite Series is preconfigured to simplify the installation and configuration process. The following list shows the limited configuration options that can be set by the installer:

- Mode S Address (ICAO Address)
- VFR Squawk
- VFR Flight ID
- Groundspeed Threshold
- Aircraft (Emitter) Category
- Squat Switch Type
- Serial IN Channel 4*
- Aircraft Size – length and width
- GPS Antenna Offset – lateral and longitudinal offset
- 1090Mhz Receiver Installed
- UAT Receiver Installed

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.

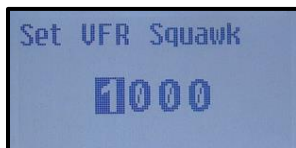
12.13.2.2 VFR Squawk Code

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

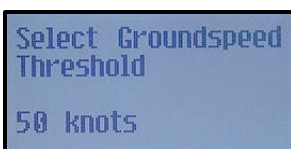
Groundspeed threshold can be used to help determine and verify the ON GROUND condition for transmitting ON GROUND ADS-B message types for “Light Fixed Wing” aircraft types only. The FDL-978 Lite Series uses the ground speed threshold configuration to determine a maximum ON GROUND speed. There are 10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

- Unknown
- 40 knots
- 60 knots
- 80 knots
- 100 knots
- 30 knots
- 50 knots
- 70 knots
- 90 knots
- 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.



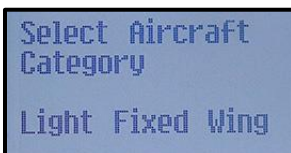
Rotate the **CODE** knob to display the options above and select the groundspeed threshold. Once selected, press the **ENT** button to confirm your selection and move to the next configuration item in the setup mode.

12.13.2.5 Aircraft (Emitter) Category

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

- Unknown
- Medium Fixed Wing
- High Vortex B757
- High G/ High Speed
- Glider/Sailplane
- Parachutist
- UAV
- Light Fixed Wing
- Large Fixed Wing
- Heavy Fixed Wing
- Rotorcraft
- Lighter than air
- ULM/Hang/Paraglider

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.

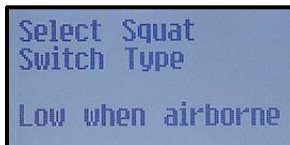
12.13.2.6 Squat Switch Type

Rotate the **CODE** knob either clockwise or counterclockwise to display the options 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:

- Not Connected
- Low when ground
- 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:

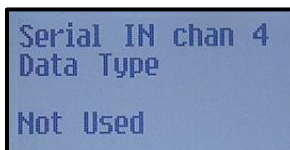
Channel 4

- Not Used
- 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.



Set Aircraft
Length
Meters: 50

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.



Set Aircraft
Width
Meters: 40

12.13.2.10 GPS Reference Position Offset

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

- Unknown
- Auto set by GPS
- Manual set here

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



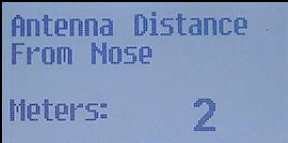
GPS Reference
Position Offset
Auto set by GPS

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:



It is recommended to use the "Manual Set Here" option to set the GPS reference position for all installations.

GPS Reference Position is measured from the GPS antenna location to the lateral distance from centerline and longitudinal distance from the most forward part of the aircraft. 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.

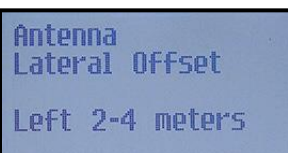


Antenna Distance
From Nose
Meters: 2

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

- Unknown
- Left 0-2 meters
- Left 2-4 meters
- Left 4+ meters
- Central
- Right 0-2 meters
- Right 2-4 meters
- Right 4+ meters

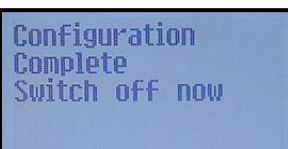
The display screen is as shown below with one of the options from the list above.



Antenna
Lateral Offset
Left 2-4 meters

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.



Configuration
Complete
Switch off now

12.13.2.11 1090 MHz Receiver Installed

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



1090MHz Receiver
Installed
No

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.



The FDL-978 series receivers only receive on 978 MHz. Select “Yes” only if a 1090 MHz ADS-B receiver is installed on the aircraft.

12.13.2.12 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.



All FDL-978 series units, except the -TXL, contain a UAT receiver and should select the "Yes" option. FDL-978-TXL Models should select "No".

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.

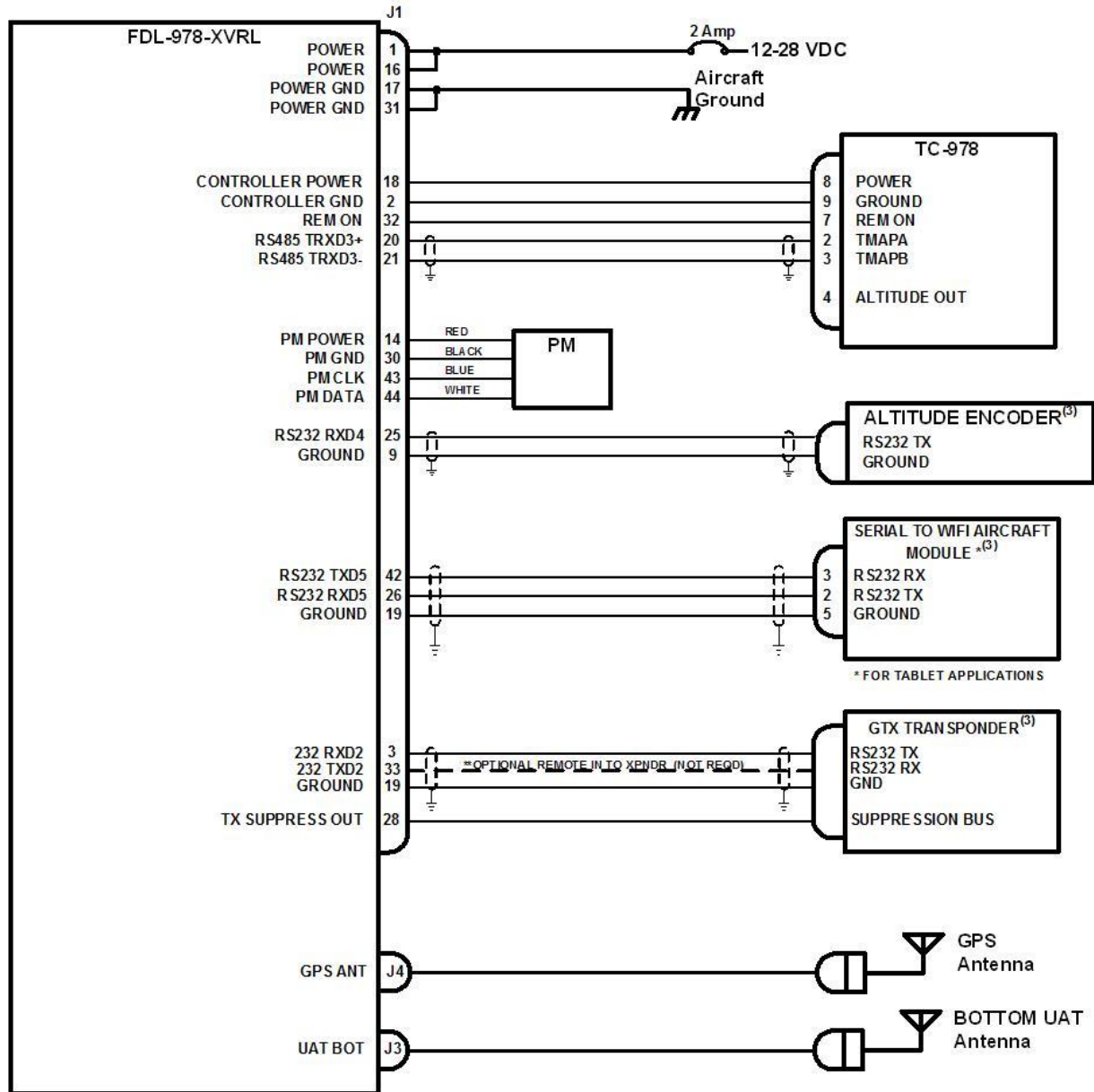
12.18 ADS-B Compliance

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 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 42. FDL-978-XVRL (GTX Transponder)

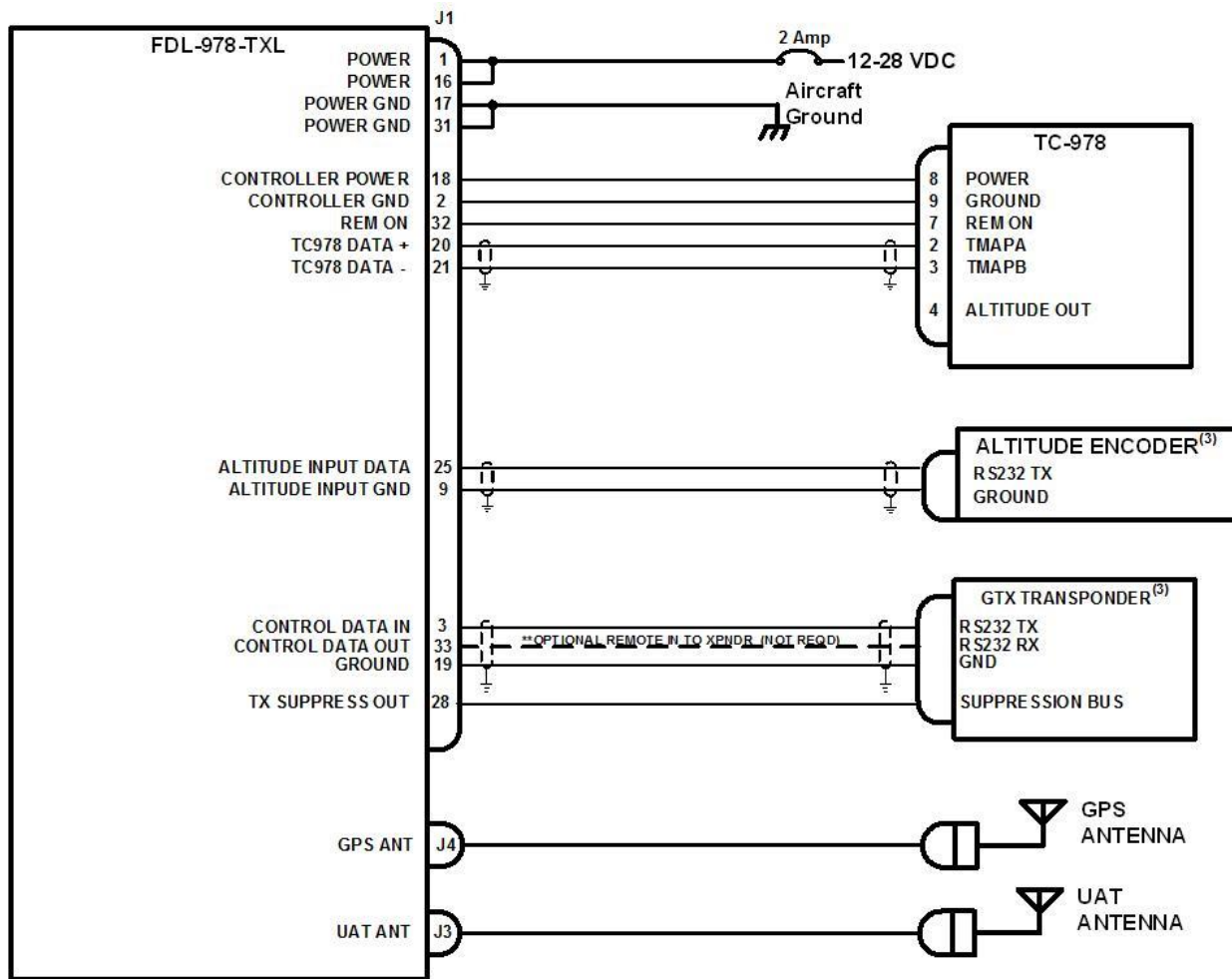
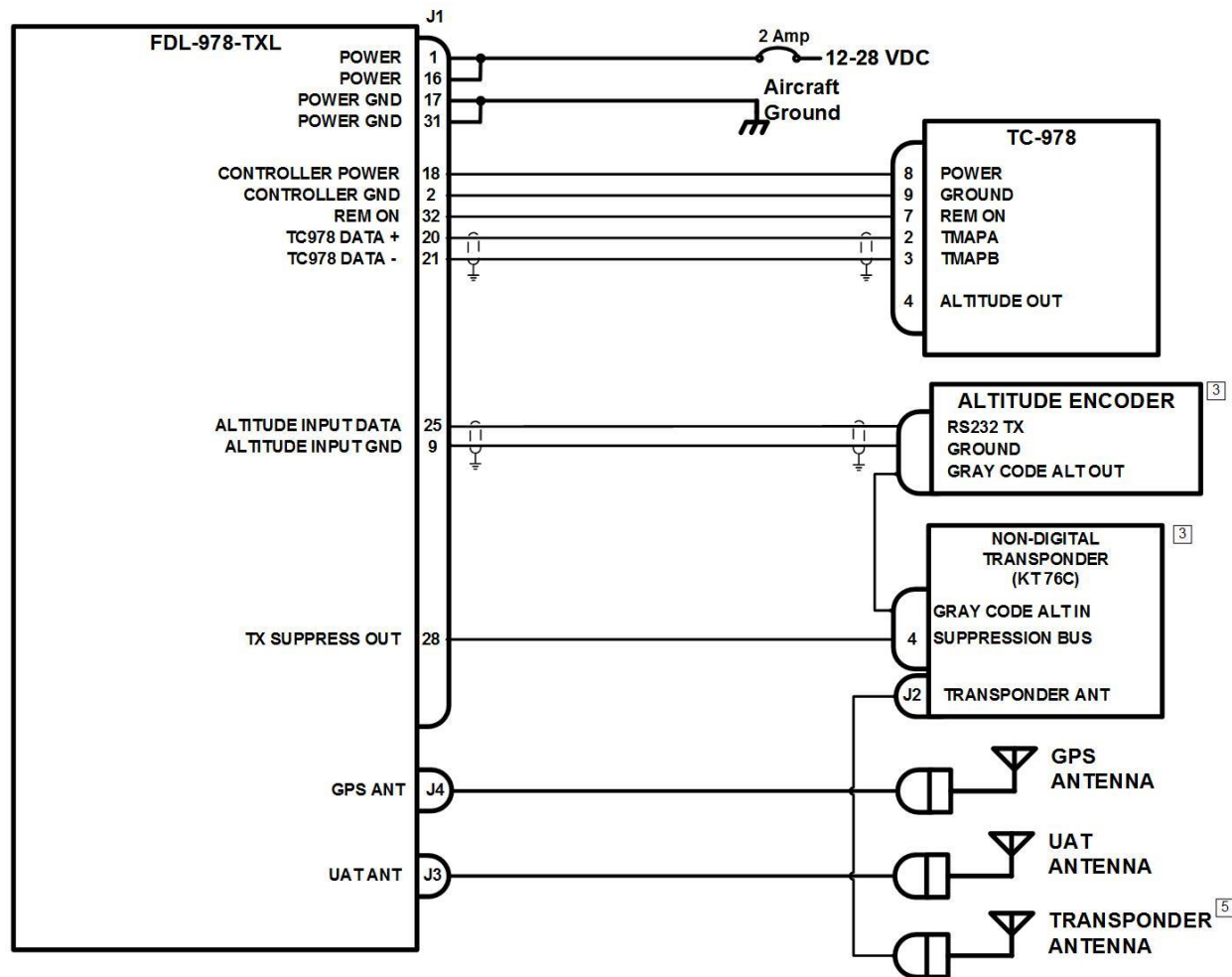


Figure 43. FDL-978-TXL (GTX Transponder)



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
5. INSTALL UAT ANTENNA 6-12 FEET AWAY FROM TRANSPONDER ANTENNA, WITH CLEAR LINE OF SIGHT BETWEEN ANTENNAS.

Figure 44. FDL-978-TXL (Non-Digital Mode A/C Transponder e.g. KT 76C)

Table 40. Typical Transponder Connections ⁽¹⁾

TRANSPONDER	NOTE
GTX-327/32 ⁽²⁾	Software version 2.10 or later
GTX-330/33 ⁽²⁾	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⁾ When the FDL-978 is configured for GTX-Remote Input, it will automatically configure the corresponding serial output to provide ADS-B Plus GPS data out to the GTX device.



Contact FreeFlight Systems for additional information and STC validation

12.21 Maintenance Interface Diagrams

Refer to SECTION 10 - Maintenance Interface Diagrams.

SECTION 13 LIMITED WARRANTY

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