



ADS-B FDL-DB Dual Band Series Installation Information

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SECTION 1 GENERAL INFORMATION

1.1 Introduction

This document contains installation data, specifications, and information for the FreeFlight Systems (FFS) Dual Band Automatic Dependent Surveillance – Broadcast (ADS-B) FDL-DB Dual Band series. The FDL-DB Series is the same size with the same mechanical mounting interface as the FDL-978 Single Band (UAT) Series. The FDL-DB Series uses a female 62-pin D-Sub connector that contains all the same electrical connections and interfaces of the FDL-978 Series 44-pin D-Sub connector as well as additional interfaces such as Ethernet, USB, audio output, and optional additional ARINC-429 I/O.

The FDL-DB Series is an ADS-B dual band receiver with an optional UAT ADS-B transmitter. The FDL-DB Series meets the ADS-B UAT equipment class A1H/A1S 978 Megahertz (MHz) (UAT) and 1090 MHz Extended Squitter (1090ES) equipment class A1S/A1 receiver requirements of TSO-C154c, TSO-166b, TSO-C157b, and TSO-C195b. When equipped with the internal class Beta 1 Global Positioning System (GPS), the FDL-DB Series systems also meet the requirements of TSO-C145d.

1.1.1 Equipment Limitations

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

❖ **TSO-C145d**

“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.”

❖ **PRAIM 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-C166b**

“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-C157b**

“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-C195b**

“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)

1.1.2 FCC Warning



RF Exposure Warning – while this device is operating a minimum distance of 4 cm from the antennas should be maintained to all persons nearby.

1.1.3 Non-TSO Functions

The FDL-DB Series does not contain any functions outside the scope of the above TSO certifications

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-DB-XVR (*ADS-B In/Out*) transmits, via UAT datalink, and receives, via a UAT and 1090ES data links, position, velocity, and other flight information to and from other aircraft and ground station equipment. The FDL-DB-RX (*ADS-B In only*) receives position, velocity, and other flight information from other aircraft and ground station equipment via a UAT and 1090ES data links. The FDL-DB Series satisfy the Technical Standard Order (TSO) requirements referenced in Section 1.1 and the associated Minimum Operational Performance Standards (MOPS) RTCA DO-282B for UAT ADS-B class A1H/A1S/B1S transceiver equipment and RTCA DO-260B for 1090ES ADS-B Class A1S/A1 receiver equipment.

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 provide a TSO-C145d Class Beta 1 certified GPS/WAAS data output on serial port 1. FFS/Chelton navigation protocol is output on RS-232 serial output port 1 allowing it to interface with other external equipment. ARINC 743A/B GPS output labels can also be configured as an upgrade option for output on ARINC output port 1 or 2. In addition, the internal GPS models can be configured to output GTX Remote (GPS) protocol data to interface with the GTX 330ES on the output serial port (typically port 2)

External GPS Input

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

Note: external GPS connections are STC specific conforming GSP pairing requirements described in AC 20-165B.

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.

Configurable Serial Interfaces

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

Discrete Inputs/Outputs

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

ADS-B Antennas

There are two (top and bottom) ADS-B 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 1: TC978 Controller



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

The TC978 Controller provides operational functionality, status display, and limited configuration setup for the FDL-DB Series. It is optional for the FDL-DB-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 and built-in Altitude Encoder. TC978 low voltage input power is provided by the connected FDL-DB Series equipment. The TC978 uses serial interface to the FDL-DB Series for control and also provides 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-DB-XVR.

Serial Interface

An RS-485 serial data link is used to connect the TC978 to the FDL-DB-XVR.

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-DB-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 annunciations

1.4.2 UAT Antenna Requirements

The FDL-DB Series requires an Ultra High Frequency (UHF) antenna(s) with at least one of the following: TSO-C66, C74, C112, or C154. Ensure that the antenna has 50Ω impedance with a Voltage Standing Wave Ratio (VSWR) < 1.7:1 at 978 MHz. The Comant CI-101 and RA Miller AV-22 ball antennas and the Comant CI-105 blade antenna meet these requirements.

In Class A1H ADS-B equipment (TSO-C154c) installations, antenna diversity (meaning a top and bottom antenna) is required. In Class A1S (single antenna) installations only one antenna (bottom) is used. For airworthiness approval of ADS-B out systems (AC 20-165B) single bottom mounted antenna (TSO-C154c Class A1S) installations are allowed.

1.4.3 GPS Antenna Requirements

The FDL-DB Series (with internal GPS) require a TSO-C144 (DO-228) antenna. A TSO-C190 (DO-301) compliant GPS antenna may be used for the FDL-DB 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 2.11.2). Use of other antennas or cables may not meet all the performance characteristics required by TSO-C145d & TSO-166b.

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-DB Series

Specification	Characteristics
ENVIRONMENTAL COMPLIANCE	See SECTION 3
TSO COMPLIANCE	C154c (A1H/A1S) C166b (A1S/A1) /Type 1 - Receive Only C157b (Class 1) Incomplete System C195b (Class C1 and C5) C145d (Beta 1) – Internal GPS models only (PNs 87334-00-FX00, 87334-00-FR00)
FCC IDENTIFICATION	T7YFDLDBXXXX
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	0.94 lb [426 g] with no internal GPS 1.05 lb [476 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 Transmit & 978 MHz and 1090 MHz Receive
TRANSMITTER POWER	40 Watts max at antenna after 2dB connector/cable losses
RECEIVER SENSITIVITY	-99 dBm 978 MHz and -80 dbm 1090 MHz

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
Non-Cert Display Output	Output	10/100 Ethernet
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– Internal GPS models only (P/N 87334-00-FX00, and 87334-00-FR00)

1.5.2 TC978 Controller

Specification	Characteristics
ENVIRONMENTAL COMPLIANCE	See SECTION 3
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-DB -XVR
Interfaces:	
Type	I/O
Controller	RS-485 Input/ Output
Altitude Output	RS-232 Output

1.6 Parts and Equipment

1.6.1 FDL-DB Series Items

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

Part Number	Qty	Description
87334-00-FX00	1	FDL-DB-XVR Transceiver with GPS
87334-10-FX10	1	FDL-DB-XVR Transceiver without GPS
87334-00-FR00	1	FDL-DB-RX Receiver with GPS
87334-10-FR10	1	FDL-DB-RX Receiver without GPS
88133-00	1	FDL-DB-XVR/RX Installation Kit (optional)
87349	1	TC978 Controller (optional)
86964	1	TC978 Installation Kit (optional)
87002-20	1	Personality Module Installation Kit – Dualband (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 AERO ANT GPS Type Antenna Installation Kit (optional)
87360-00	1	TSO-C190 SENSOR SYS GPS Type Antenna Installation Kit (optional)
87024-20	1	TSO-C190 RAMI 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)

1.7 Required Materials 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 and Receivers 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-DB Series.

Note: Only previously, STC-approved GPS receivers may be used.

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

1.7.1 List of Other Approved GPS Antennas

The FDL-DB Series 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-DB 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

Contents

- ① Tablet Cable and Adapter
 - USB Cable
 - Power Adapter
- ② FT-9000 Cables and Adapter
 - USB Charging Cable (PN 87616)
 - Power Adapter (PN 87582)
- ③ FT-9000 (PN 87191-00)
- ④ Tablet (PN 87581)
- ⑤ Storage Case (PN 87580)

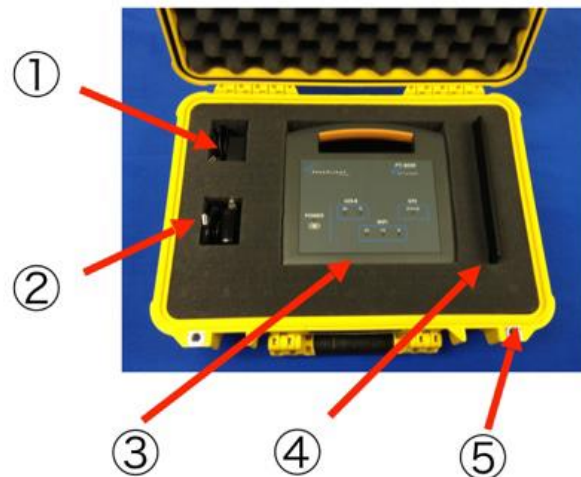


Figure 2. FT-9000 Ramp Tester System

SECTION 2 FDL-DB DUAL BAND SERIES INTERFACES

This section provides general information for installing the FDL-DB 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-DB-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-DB-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-DB-XVR serial port to control Mode A code and IDENT. Mode A/C transponders without serial control out can use the FDL-DB-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-DB-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-DB Series

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



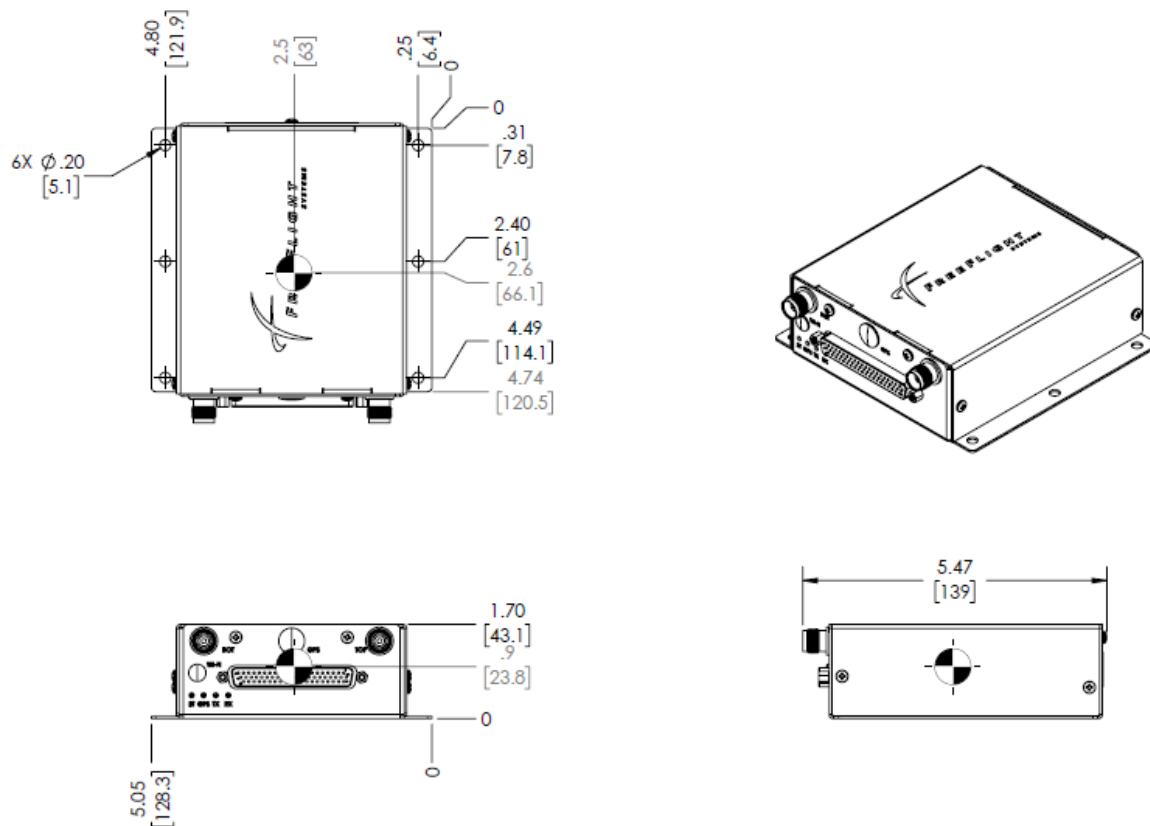
Select a position in the aircraft that is away from any high external heat source. (The FDL-DB Series is not a significant heat source itself).



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



Secure the FDL-DB Series on a flat surface according to the mounting requirements illustrated below in and in the installation drawing in SECTION 7.



87334-10-FR10 SHOWN

Figure 2: FDL-DB 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 7.



Select a position in the panel that is away from 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 the TC978 is to be used as the annunciator for the required failure annunciations (“ADS-B Fail”, “ADS-B GPS Fail”), the TC978 should be placed in the pilot’s primary field of view.

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.

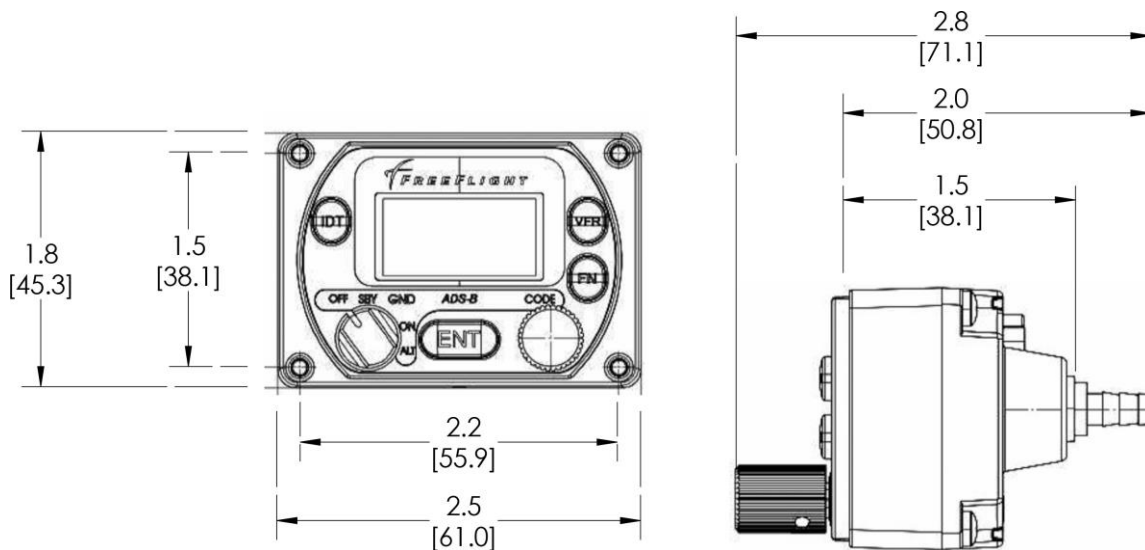


Figure 3: TC978 Dimensions

2.3 Cooling Requirements



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

The FDL-DB 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-62 Pinout



*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-62)				
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	RxD6+	RS-422	O	Serial Port 6 Data In+
8	RxD6-	RS-422/RS-232	O	Serial Port 6 Data IN--
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	USB GND	GND	-	Ground Reference
14	Vpm	3.0 -3.6 VDC	O	Personality Module Power Output
15	TRAF TEST	Open/Ground	I	Traffic Test
16	USB VBUS	+5VDC	Pwr	USB +5VDC
17	429 IN 3A	ARINC 429	I	ARINC 429 Input Channel 3A
18	429 IN 3B	ARINC 429	I	ARINC 429 Input Channel 3B
19	NEMA OUT	RS=232	O	RS-232 NEMA Protocol out
20	Ethernet RX-	Ethernet	I	Ethernet Port Receive -
21	Ethernet RX+	Ethernet	I	Ethernet Port Receive +
22	Vin	10-40 VDC	Pwr	Aircraft Power Input
23	RTRN	Ground	Gnd	Aircraft Power Return
24	Vcp	5.5-10 VDC	O	TC978 Controller Power Output
25	SGND2	Serial Ground	Gnd	Serial Port Ground
26	TRxD3+	RS-485	I/O	Serial Port 3 RS-485 Data+
27	TRxD3-	RS-485	I/O	Serial Port 3 RS-485 Data-
28	GND	Gnd	Gnd	Ground Reference
29	232 RxD3	RS-232	I	Serial Port 3 RS-232 Data In (Not used with TC978)

30	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data Out (Not used with TC978)
31	232 RxD4	RS-232	I	Serial Port 4 RS-232 Data In
32	232 RxD5	RS-232	I	Serial Port 5 RS-232 Data In
33	AIR/GND	Open/Ground	I	Air/Ground In (Squat Switch – configurable)
34	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
35	GND	Ground	G	USB Ground
36	GND	Ground	Gnd	Personality Module Power Return
37	USB D+	USB/Serial	I/O	USB Data+ or U5 RX (TTL Serial)
38	USB D-	USB/Serial	I/O	USB Data- or U5 TX (TTL Serial)
39	429 IN 4A	ARINC 429	I	ARINC 429 Input Channel 4A
40	Accord RXS2_232	RS-232	O	Serial Port 2 RS-232 Accord Protocol in
41	Ethernet TX-	Ethernet	O	Ethernet Port Transmit -
42	Ethernet TX+	Ethernet	O	Ethernet Port Transmit +
43	RTRN	Ground	Gnd	Aircraft Power Return
44	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
45	232 TxD2	RS-232	O	Serial Port 2 RS-232 Data Out
46	429 IN 1A	ARINC 429	I	ARINC 429 Input Port 1A
47	429 IN 1B	ARINC 429	I	ARINC 429 Input Port 1B
48	429 IN 2B	ARINC 429	I	ARINC 429 Input Port 2B
49	TxD6+	RS-422	O	Serial Port 6 Data Out+
50	TxD6-*	RS-422/RS-232	I	Serial Port 6 Data Out-
51	PPS IO+	ARINC 743A/B	I/O	Internal/External GPS Pulse Per Second Out/In+
52	PPS IO-	ARINC 743A/B	I/O	Internal/External GPS Pulse Per Second Out/In-
53	UAT STATUS	Open/Ground	O	ADS-B Status
54	232 TxD5	RS-232	O	Serial Port 5 RS Data Out
55	CLK_PM	I ² C	O	Personality Module Clock
56	DATA_PM	I ² C	I/O	Personality Module Data
57	USB ID n Service	Open/Ground	I	USB Connected
58	429 OUT 2A	ARINC 429	O	ARINC 429 Output Channel 2A
59	429 OUT 2B	ARINC 429	O	ARINC 429 Output Channel 2B
60	429 IN 4B	ARINC 429	I	ARINC 429 Input Channel 4B
61	Audio +	Audio	O	Audio + Output
62	Audio -	Audio	O	Audio - Output

2.5 Interface Details

2.5.1 Power Input

Aircraft power is provided to the FDL-DB Dual Band 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
J1-22	Vin	10-40 VDC	Pwr	Aircraft Power Input
J1-23	RTRN	Ground	Gnd	Aircraft Power Return
J1-43	RTRN	Ground	Gnd	Aircraft Power Return
J1-44	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-DB-XVR to power up.

2.5.2 Personality Module



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

The PM eliminates the need to re-configure the FDL-DB 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-DB Series. The installation configuration data in the PM (if present) is copied to the FDL-DB Series at power-up. Both the PM and the FDL-DB-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-DB Dual Band 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-DB-XVR if it is replaced in the installation. However, if the TC978 Controller is replaced in an installation without the PM, the FDL-DB-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
J1-36	GND	Ground	Gnd	Personality Module Power Return
J1-55	CLK_PM	I ² C	O	Personality Module Clock
J1-56	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 (J1-44) **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 (J1-44). 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-DB-XVR interfaces when installed:

- System ON/OFF remote power control, REM ON (J1-44)
- Low voltage +7 VDC power (J1-24 & J1-2)
- Serial Port 3 RS-485 communication (J1-26 & J1-27)

The TC978 uses Serial Port 3 so when it is installed, the Serial Port 3 RS-232 pins (J1-24 & J1-29) 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
J1-24	Vcp	+7 VDC	O	TC978 Controller Power Output
J1-2	GND	Ground	Gnd	TC978 Controller Power Return
J1-44	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
J1-26	TRxD3+	RS-485	I/O	Serial Channel 3 RS-485 Data+
J1-27	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 up to twelve configurable *Serial Interfaces* available on the FDL-DB Dual Band Series. All FDL-DB Dual Band models have six UART style Serial Port Interfaces (Ports 1, 2, 3, 4, 5, and 6) and ARINC capable FDL-DB Dual Band models have four ARINC 429 Input

Interfaces (429 IN1, 429 IN2, 429 IN3, and 429 IN4) and two ARINC 429 Output Interfaces (429 OUT1 and 429 OUT2).



Refer to SECTION 5 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-DB Dual Band 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 6 can be optionally configured for RS-232 serial interface on pins J1-8 and J1-50.

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
J1-45	232 TxD2	RS-232	O	Serial Port 2 RS-232 Data Out
J1-29	232 RxD3	RS-232	I	Serial Port 3 RS-232 Data In
J1-30	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data Out
J1-25	SGND2	Serial Ground	Gnd	Serial Ground
J1-31	232 RxD4	RS-232	I	Serial Port 4 RS-232 Data In
J1-32	232 RxD5	RS-232	I	Serial Port 5 RS-232 Data In
J1-54	232 TxD5	RS-232	O	Serial Port 5 RS-232 Data Out
J1-9	SGND4	Serial Ground	Gnd	Serial Ground
J1-7	RxD6+	RS-422	I	Serial Port 6 Data IN+
J1-8*	RxD6-**	RS-422/RS-232	I	Serial Port 6 Data In-
J1-49	TxD6+	RS-422	I	Serial Port 6 Data out+

Serial Channels				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-50*	TxD6-**	RS-422/RS-232	I	Serial Port 6 Data Out-

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-DB Dual Band 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-DB Series wiring harness, while a male DB-9 is connected to the other device.

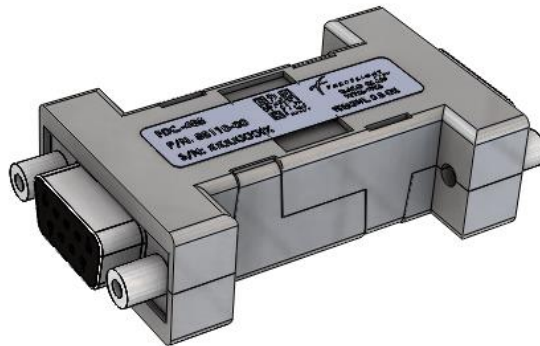


Figure 4: FDC-485/422 Serial Converter

The FDC-485 can be used on the FDL-DB serial port 6 only when configured for RS-232 interface, using pins J1-50 and J1-8. The FDC-422 can be used on any FDL-DB serial port configured for RS-232.

2.5.6.2 ARINC 429 Ports

Four ARINC 429 Input *Serial Interfaces* are available on ARINC capable FDL-DB Dual Band models. The ARINC 429 Input channels are 429 IN 1, 429 IN 2, 429 IN 3, and 429 IN 4. The ARINC capable FDL-DB Dual Band models have two ARINC 429 Outputs which are 429 OUT 1 and 429 OUT 2. The ARINC channels can be software configured for various label interfaces and as either high-speed or low-speed.



Some ARINC functionality is available through a separate unit upgrade made available at the time of installation.



Refer to SECTION 5 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
J1-46	429 IN 1A	ARINC 429	I	ARINC 429 Input Port 1A
J1-47	429 IN 1B	ARINC 429	I	ARINC 429 Input Port 1B
J1-6	429 IN 2A	ARINC 429	I	ARINC 429 Input Port 2A
J1-48	429 IN 2B	ARINC 429	I	ARINC 429 Input Port 2B
J1-17	429 IN 3A	ARINC 429	I	ARINC 429 Input Port 3A
J1-18	429 IN 3B	ARINC 429	I	ARINC 429 Input Port 3B
J1-39	429 IN 4A	ARINC 429	I	ARINC 429 Input Port 4A
J1-60	429 IN 4B	ARINC 429	I	ARINC 429 Input Port 4B
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
J1-58	429 OUT 2A	ARINC 429	O	ARINC 429 Output Port 2A
J1-59	429 OUT 2B	ARINC 429	O	ARINC 429 Output Port 2A

2.5.7 Discrete Inputs



Input pins are pre-configured active low.

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
J1-33	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: If configured to the Light Aircraft (<15500 lbs) Emitter Category, the FDL-DB Dual Band Series will automatically determine the Air/Ground status using aircraft data such as GPS Ground Speed without needing an external Air/Ground input discrete.



Other Aircraft Installations: The FDL-DB Dual Band 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-DB Dual Band 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-DB Dual Band 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-DB-XVR 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-DB Dual Band Series powers on.
- When the squawk code is set to anything other than 1200.

2.5.8 Discrete Output

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
J1-34	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
J1-53	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 control head, such as the TC978, typically provides required failure annunciation. This discrete can be used to drive an annunciator when a display or TC978 is not installed or the MFD is not capable of annunciating 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 (Vin – 1.5 V) only during UAT ADS-B message transmissions and is low otherwise. The TX Suppress output is typically connected to the transponder suppression bus.



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

2.5.9 Time Mark Input/Output

For the FDL-DB Dual Band 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-DB-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.

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

Time Mark Input				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-51	PPS IO+	ARINC 743A/B	I/O	Internal/External GPS Pulse Per Second Out/In+
J1-52	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 the Ethernet Interface via Telnet (and other port applications), the USB interface, or Serial Port 5 on the FDL-DB Dual Band Series DB-62 connector. The preferred MPI connection should be via Wi-Fi using the optional external Wi-Fi module using the ADS-B MPI application. If a Wi-Fi Module is not connected an Ethernet or USB connector should be mounted in the aircraft for convenient wired MPI access.

Use of UART serial port (5) should be avoided since these ports can typically be connected to other aircraft equipment unless installation limitations force the use of a UART port. When a UART port is used, a female DB-9 connector should 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 the UART port is 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-DB Series equipment.

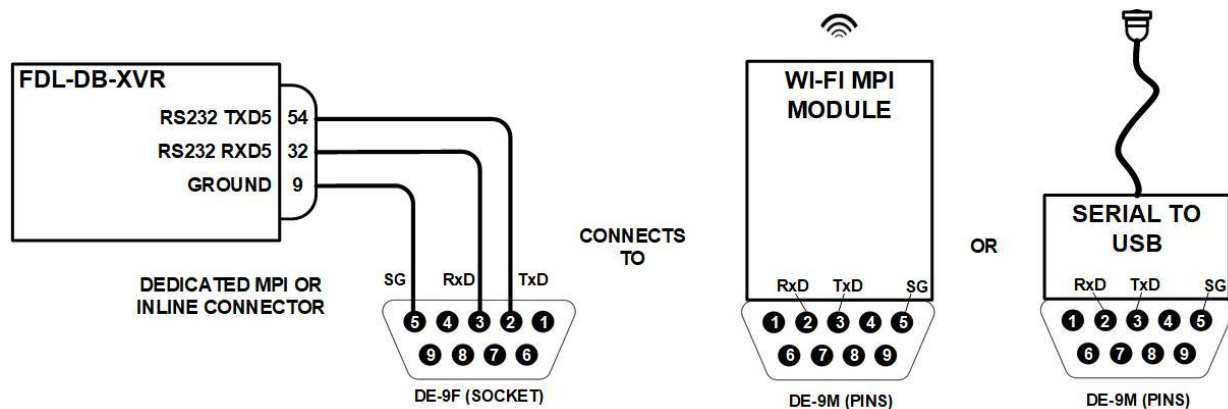


Figure 5: Inline MPI Connector and Compatible MPI Devices

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.

The table below shows the MPI DE-9F connections to Port 5 on the FDL-DB Series.

Table 1. MPI Pinout

MPI Connector		Port 5 (DB-62)	
PIN	SIGNAL	PIN	SIGNAL
2	Tx	J1-54	232 TxD5
3	Rx	J1-32	232 RxD5
5	GND	J1-9	SGND4

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



When Port 5 is configured and interfaced to other equipment (e.g. displays etc.) the connections to the configured device must be temporarily disconnected to use the port for MPI purposes.

2.5.10.1 USB Interface

The standard USB interface that can be used as an MPI **Only** for connection to a computer's USB connection.

USB Interface				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-16	USB VBUS	+5VDC	Pwr	USB +5VDC
J1-38	USB D-	USB/Serial	I/O	USB Data- or U5 TX (TTL Serial)
J1-37	USB D+	USB/Serial	I/O	USB Data+ or U5 RX (TTL Serial)
J1-35	GND	Ground	G	USB Ground

2.5.10.2 Ethernet Interface

The 10/100 Ethernet interface is a standard interface that connect to a computer Ethernet port, Ethernet Switch/Router, Ethernet to Wi-Fi module, non-certified Ethernet compatible display, etc. The Ethernet interface is uncertified and therefore an only connect to *devices supporting non-certified functionality* such as MPI or un-certified traffic and FIS-B information display on portable devices.

Ethernet Interface				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-21	Ethernet RX+	Ethernet	I	Ethernet Port Receive +
J1-20	Ethernet RX-	Ethernet	I	Ethernet Port Receive -
J1-42	Ethernet TX+	Ethernet	O	Ethernet Port Transmit +
J1-41	Ethernet TX-	Ethernet	O	Ethernet Port Transmit -



2.5.11 Audio Interface (*Future Release*)

Future growth to support output of traffic alerting audio functionality.

Audio Output				
PIN	SIGNAL	ELECTRICAL	I/O	DESCRIPTION
J1-61	Audio +	Audio	O	Audio + Output
J1-62	Audio -	Audio	O	Audio - Output

2.6 TC978 Controller Electrical Connections

2.6.1 TC978 Interface – DB-9 Pinout

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

2.7 TC978 Controller Interface Details

2.7.1 Power



Do NOT connect to aircraft input power.

The TC978 uses 5.5 – 10 volts from the FDL-DB-XVR (typically ~7 volts).

2.7.2 Remote ON

The Remote ON output controls the power to the FDL-DB-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-DB-XVR. The TC978 RS-485 lines (TMAPA and TMAPB) are connected to the FDL-DB-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 (Refer to 2.8 for more details). The pressure altitude data output depends on the Altitude input configuration. If an external Altitude/Air Data Input is configured to a FDL-DB-XVR ARINC 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 must feed the aircraft transponder, so they share the same altitude source.

2.7.5 TC978 Connections

DB-62		TC978 (DB-9)	
PIN	SIGNAL	PIN	SIGNAL
J1-24	Vcp	8	POWER
J1-2	GND	1,6,9	GND
J1-44	REM ON	7	REM ON
J1-26	TRxD3+	2	TMAPA
J1-27	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-DB Series and the TC978 to be removed and replaced without having to re-configure the system.

The following install kit parts from the FDL-DB Series PM Install Kit (**P/N 87002-20**) are used to install the personality module in the backshell:

Item	Qty	Description
1	1	Personality Module (P/N 85945-20-B)
2	6	Pin Contact, Crimp 24-28 AWG (P/N 86967)
2	6	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
J1-36	GND	Ground	Gnd	Personality Module Power Return	Black
J1-55	CLK_PM	I ² C	O	Personality Module Clock	Blue
J1-56	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 and the other side should be adhered to one side of the connector backshell as the connector and backshell are assembled together.

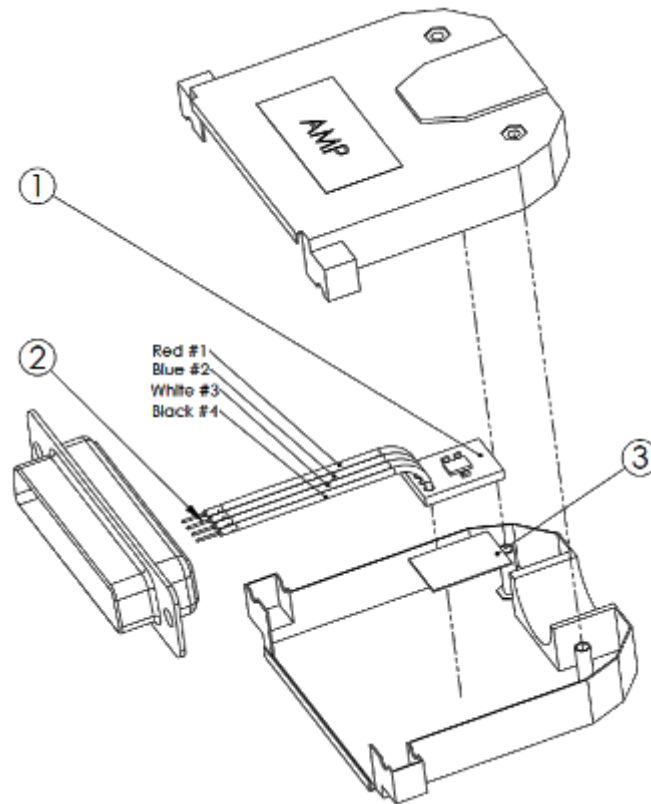


Figure 6: Personality Module Assembly

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-DB-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-DB-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	Milliohm/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-DB Series. Consider the following 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 other 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-DB Series contains a Mode A receiver to receive Mode A/C Transponder control data from the transponder antenna through the UAT antennas. Ensure the transponder antenna is on the bottom of the aircraft (same as the UAT antenna). The transponder antenna should

be at least 6 ft and no further than 12 ft away from the UAT antenna. 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 decrease, but will improve by increasing the ground plane to 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-DB Series are designed to meet Class A1H/A1S requirements with an allowance of 2 maximum 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 maximum of 2dB.

An acceptable cable then has:

- A minimum of 1.5dB loss for the run length, but no greater than 2.0dB 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-DB 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)	Max Length (ft)
-------	------------------------------------	--------------------

RG-174	27.1	7.4
RG-316	25.8	7.76
RG-400	14.5	13.8
RG-142	12.8	15.64
RG-393	7.5	26.7

When routing the cable, ensure the following:

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

2.11 GPS Antenna Installation



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



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

Selecting appropriate GPS antenna locations is critical to the proper performance of the FDL-DB Series. Consider the following 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-DB 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 for GPS

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 1.4.31.7.1, 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-DB 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:

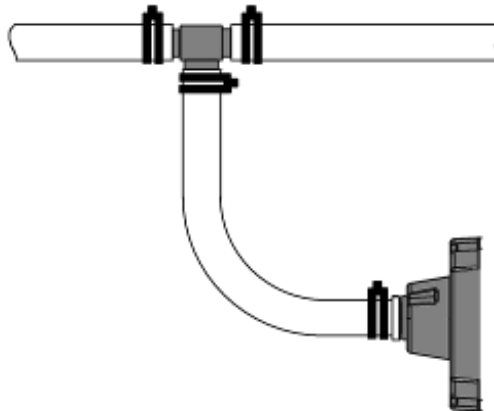


Figure 7: Static Line Connection

For aircraft with $\frac{1}{4}$ in static lines, two adapters are provided which can convert from $\frac{1}{4}$ in inside diameter hoses to $\frac{3}{16}$ ", compatible with the hose in the install kit.

2.13 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-DB Series with GPS 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 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]).

3.1 FDL-DB Series 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	Z (N/A – No cooling required)
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
Operational 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	BXX
Voltage Spike	17	A
Audio Frequency Conducted Susceptibility – Power Inputs	18	Z
Induced Signal Susceptibility	19	ACX
Radio Frequency Susceptibility	20	TT

Conditions	Para	Category (DO-160G)
Emission of Radio Frequency Energy	21	MM
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

SECTION 4 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 5.1.

4.1 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

4.2 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-DB-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 5 FDL-DB DUAL BAND SERIES PORT CONFIGURATION

5.1 General

This section contains installation configuration and descriptions for serial and ARINC data interfaces on the FDL-DB Dual Band Series.

5.1.1 FDL-DB Dual Band Series Serial, ARINC and Network Port Configuration Details

The FDL-DB Dual Band 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-DB Dual Band Series Serial, ARINC and Network ports must be configured to enable these data interfaces and are described in the table below:

Table 2. FDL-DB Dual Band 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-DB-XVR. The TC978 provides control or the FDL-DB-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. Remote network server ports 1 and 2 can also be used for control input. Control Input is NOT required for receive only systems.
GPS Input	The FDL-DB Dual Band 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-DB systems.</i>
Altitude Input	The FDL-DB Dual Band 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-DB systems.</i>
Heading Input	The FDL-DB Dual Band Series can optionally receive aircraft true heading data. True heading is sent in UAT transmit messages on the ground and is also used to more accurately correlate TCAS and ADS-B Traffic. Heading input is not required but desirable with TCAS installations.
TCAS Input *Optional Feature	TCAS traffic MUST be input to the FDL-DB Dual Band 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-DB Dual Band Series accepts TCAS traffic input via ARINC input per the ARINC 735A/B Intruder Labels.

Interface	Description
Display Output	<p>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:</p> <ul style="list-style-type: none"> • Display on Serial Port 3 • Display on Serial Port 5 • Display on either Port 2 or 6 • Display on either Network Server Port 1 or 2 <p>ARINC OUT1 can also be configured to output ARINC 735A/B Intruder Traffic.</p>
GPS Output	<p>FDL-DB Dual Band Series models with Internal GPS can output GPS position, velocity, time, and integrity data via RS-232. Internal GPS models will automatically output GPS data in the FFS/Chelton Protocol on port 1.</p>
GPS Predictive RAIM	<p>FDL-DB Dual Band Series models with Internal GPS can receive and respond to serial predictive RAIM (PRAIM) requests for a destination or alternate waypoint through RS-232. A Flight Management System (FMS) can request the GPS to provide a RAIM prediction on Serial Port 1 input. PRAIM responses will be sent on Serial Port 1 RS-232 output</p>

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-DB Dual Band 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-DB Dual Band 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 5.1.1.1 and 5.1.1.2 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 5 or the rechargeable battery powered MPI Module (P/N 87710-00) properly connected to Port 5.

5.1.1.1 Serial Port Input Configuration

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

Table 3. 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 4.2.
Alt-Encoder (Altitude Encoder)	Altitude Input	Altitude data. Format for air data sensors using the protocol in Section 4.1.
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. The internal GPS data is used by the FDL-DB Dual Band Series and GPS data is automatically output at 19200 baud on serial output port 1 using the FFS/Chelton Protocol. The output is TSO-C145c Class Beta 1 certified and can be used as an ADS-B position source or navigation source.
GPS-FFS ⁽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.
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⁾	Squawk Code, IDENT, and mode (standby/alt inhibit) control input format from GTX 330/33/327/32 transponders. ⁾⁽⁶⁾⁽⁷⁾
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⁾



⁽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-Cntrl).



(5) Refer to Section 2.5.9 and Section 7.1.1 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-DB-XVR is powered on first, it takes the call sign from the GTX-330 and uses that as the default call sign.

Table 4. 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.

5.1.1.2 Serial Port Output Configuration

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

Table 5. 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 4.1.
Traffic-Alert (TIS/FIS)	Display Output	Ownship data, traffic reports, and FIS-B data. Format for the Aspen, GMX-200, Chelton displays, or other displays using the GDL/FDL protocol. The corresponding serial port input can be configured to Disp-Cntrl to enable display control input. ⁽³⁾⁽⁵⁾⁽⁶⁾
Pass-Thru (ADS-B Pass Thru)	Display Output	Ownship data, ADS-B traffic data, and FIS-B data. Format for sending unprocessed, uncorrelated, and un-prioritized raw ADS-B messages. Traffic must be processed in another device to meet TSO-C195a ASSAP installation requirements. ⁽³⁾
MX-20 (MX-20)	Display Output	Ownship data, traffic reports, and FIS-B data. Format for the MX-20. The corresponding serial input port can be configured to Disp Cntrl at the same baud rate to enable display control input. ⁽³⁾⁽⁴⁾



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



⁽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 7.1.2, 0 and 0and 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 5.2.2.12.4.2.

Table 6. 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.

5.1.1.3 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.

Table 7. 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
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.



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

Table 8. 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 9. GPS-743 Input ARINC Labels

Label	Description
273	Sensor Status
110	Latitude

Label	Description
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 10. 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 11. ADC Format Input ARINC Labels

Label	Description
203	Pressure Altitude
210	Airspeed
212	Altitude Rate

Table 12. AHRs Format Input ARINC Labels

Label	Description
314	True Heading

Table 13. ADC & AHRs Format Input ARINC Labels

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

Table 14. 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

5.1.1.4 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.

Table 15. 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).



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



⁽²⁾The FDL-DB-XVR does not support ARINC PRAIM requests.

Table 16. 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 17. 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

5.1.1.5 Network Server Port Connection Configuration Details

defines the network server port IP connection settings. Two network servers are supported, each individually configurable for connection and type of data output.

5.1.1.5.1 UDP Connection

Network servers can send output on UDP in three ways:

- Broadcast
- IP address of a specific client
- IP address of the originator of the most recently received message on the UDP “listener” port. Note there is no output until a message is received to initialize the destination address and port.

5.1.1.5.2 TCP Connection

Network servers can connect and send to up to a maximum of 10 TCP clients from a pool shared between the two network servers (i.e. the sum of the two network server connections cannot exceed the maximum). Each network server can receive from only 1 TCP client. The Server listens on the configured *local_port* and automatically connects until the maximum number of clients is reached.

Only one client is permitted to be the “control” client. The control client is assigned as follows:

1. *Server control client is initialized to “no control client”*
2. *Server wait for an input message from any client*
3. *First client that sends an input message is assigned as “control client” and we ignore input messages from any other client*
4. *If no input message is received from the “control client” within a 5 second period go back to (1)*

Table 18: Network Server Port Connection Settings

Setting	Interface	Description
ip	Network Server	TCP or UDP protocol selection
local_port	Network Server	TCP or UDP Server port.
remote_addr	Network Server UDP	UDP Client IP address remote_addr = 0.0.0.0 Send output to IP address/port of most recently received client remote_addr = 255.255.255.255 Send output to Broadcast IP remote_addr = Other Send output to remote_addr:remote_port
remote_port	Network Server UDP	UDP Client IP port

5.1.1.6 Network Server Port Input Configuration Details

The following table defines the network server port input data formats:

Table 19: Network Server Port Input Configuration Settings

Setting	Interface	Description
cntrl enable	Control Input	Squawk Code, IDENT, Call Sign, and mode (standby/alt inhibit). Enables display control from a GMX-200, or other displays using the GDL/FDL protocol. The corresponding network server output port must be configured to Traffic-Alert to enable display control input. ^{(2) (6)}

5.1.1.7 Network Server Port Functionality Configuration Details

The following table defines the network server port output data formats:

Table 20: Network Server Port Output Configuration Settings

Setting	Interface	Description
Traffic-Alert	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 network port input can be configured to "cntrl enable" to enable display control input.

Setting	Interface	Description
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.



The Network server port functionality can also be set to “MAINT” to enable configuration and maintenance modes for the FDL-DB Series systems. See “set netserver” command information in section 5.2.2.12.3.

5.2 Maintenance Port Interface (MPI) Hardware Configuration

5.2.1 Terminal Program Interface

The following 5.2.1 sub-sections describe interfacing directly to the MPI using a terminal interface program on a PC, like “Tera Term,” to enter MPI commands. The interfaces discussed earlier in sections 2.5.10, 2.5.10.1, 2.5.10.2 (Wi-Fi MPI, Serial-to-USB, Ethernet) 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.

The terminal setup should be set to:

- Local Echo – checked

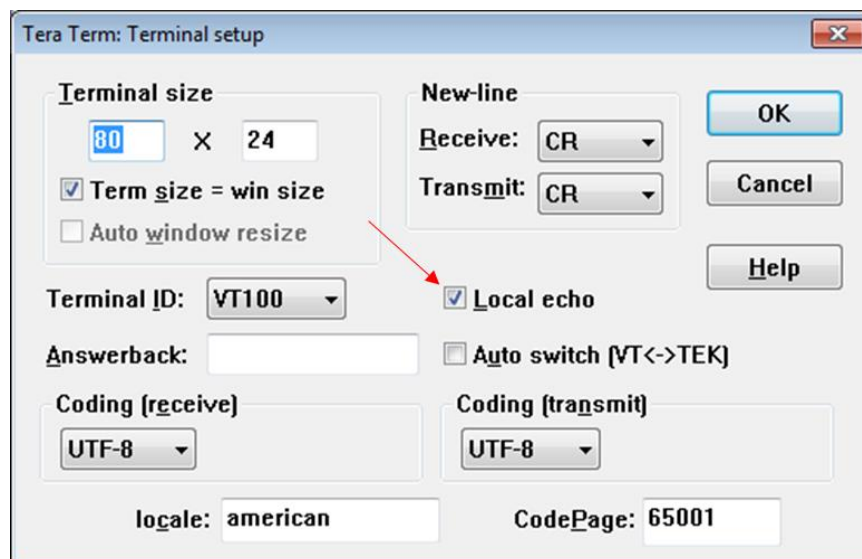


Figure 8: Tera Term Terminal Setup

5.2.1.1 Terminal MPI Network Connection Settings

A Network connection to the FDL-DB series systems can be made on the PC or Android tablet running the ADS-B MPI app. The typical “Tera Term” TCP settings for the Network connections are:

Table 21. Tera Term Network Connection Settings

Setting	Remote Network Server Port 1	Remote Network Server Port 2	TELNET
Host Address	User configurable	User configurable	DHCP (default) OR User defined Static
TCP Port (default) OR UDP	44000 (default) OR User configurable	55000 (Default) OR User configurable	23
Service	Other		Telnet
Protocol	UNSPEC		

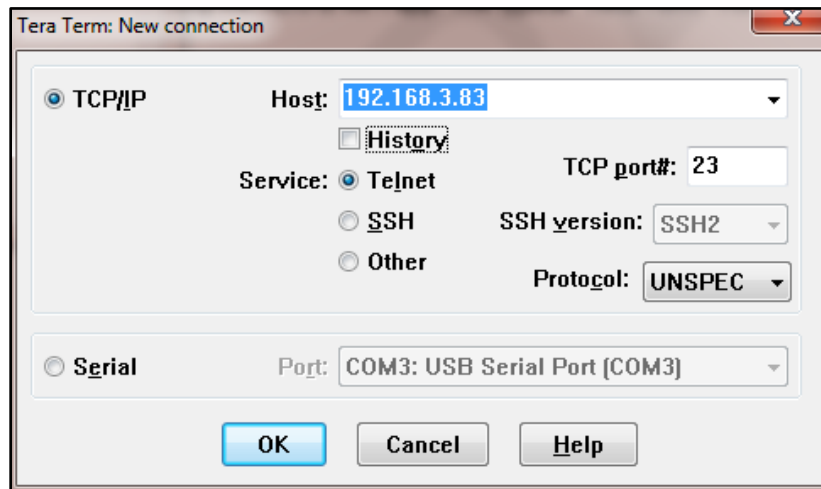


Figure 9: Tera Term Network Connection Settings using Telnet

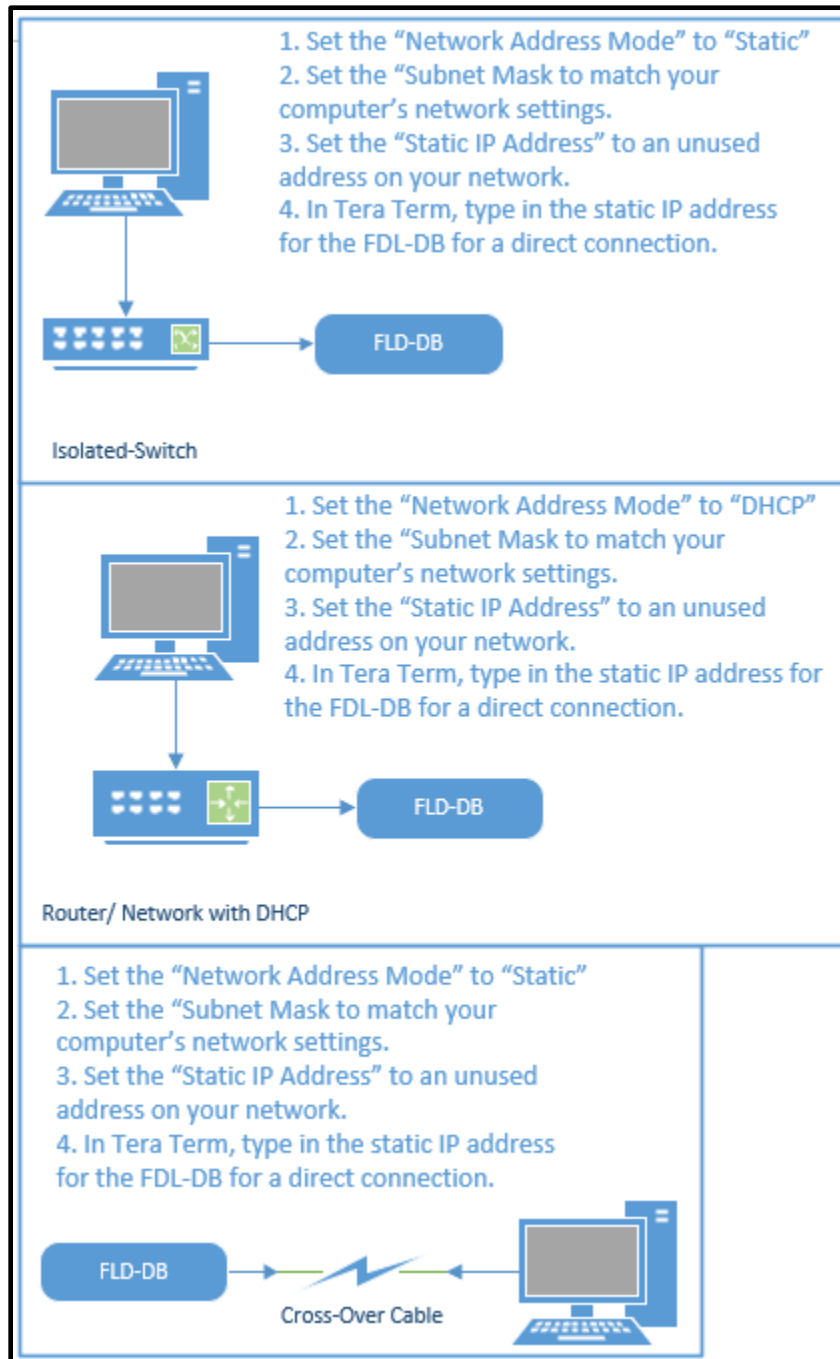


Figure 10: Network Hardware Connections

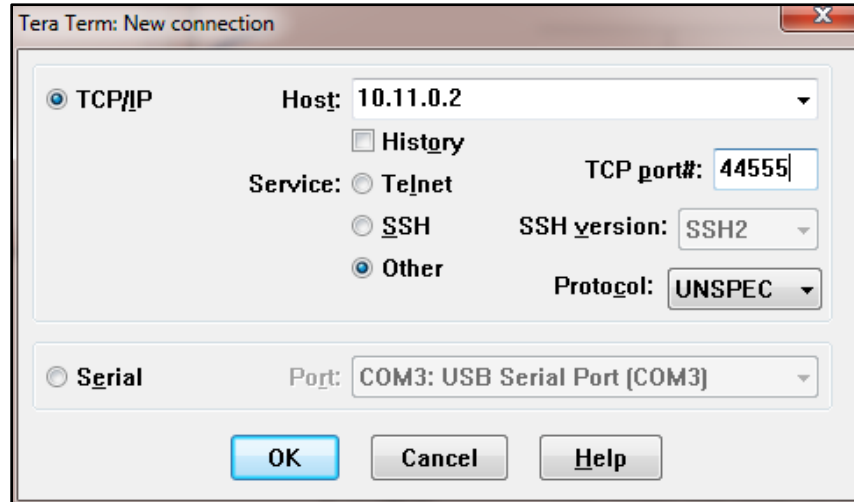


Figure 11: Tera Term Network Connection Settings using a Remote Network Server Port

5.2.1.2 Initial MPI Connection using the Telnet Remote Network Server Port

Once connected to the MPI with a Remote TCP/UDP network connection, press the **Enter** key once to remove the maintenance lockout. The following prompt should be displayed:

- RANGR-RX> FDL-DB-RX
- RANGR-XVR> FDL-DB-XVR

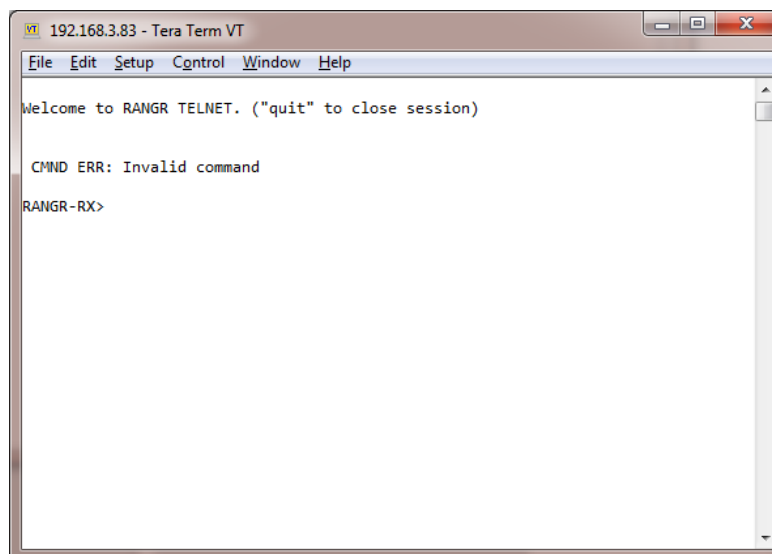


Figure 12: Example Tera Term Network Connection Settings using Telnet

5.2.2 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
rxstatus	Display receiver status info – continuous
set <item> <value>	Set a configuration item's value
stop	Stop continuous data outputs
cnfg defaults	Reset configuration to defaults

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.

5.2.2.1 “help or ?” Command

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


```
RANGR-XVR-DB> help
AVAILABLE COMMANDS.....
?                This help
clear            Clear the terminal screen
info            Display unit info
Reset           Reset the unit
bit             View POST and PBIT status
cnfg            Display configuration data
cnfgdefaults    Reset configuration to defaults
set             "set <item> to <opt>" or "set ?" for usage
comm           Display communication ports' status
stop           Stop continuous update
ads            Display air data
sps            Display GPS data
control        Display control squawk and mode status
rxstatus       Display receiver status info

help
history        <clear> Display/clear reset history
RANGR-XVR-DB> █
```

Figure 13: FDL-DB Series Help Menu

5.2.2.2 “ads” Command

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

```
RANGR-XVR-DB> ads
ADS Data
Altitude: --- ft, Vert Rate: --- ft/min, BaroAlt: --- ft, Airspeed: --- knts
Heading Data
Heading: ---.--- Altitude above Ground: --- ft
RANGR-XVR-DB> █
```

Figure 14: FDL-DB Series ads menu

5.2.2.3 “bit” Command

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

```
RANGR-XVR-DB> bit
BIT
Temperature= 62.13 °C
External Power= 23.25 V
Internal Power= 5.16 V
IC Power= 3.20 V
RF Tx Pwr= 29.46 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
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
Rx Own Msg..... P   Rx PLL Lock..... P
Top Antenna..... P   Bottom Antenna... P
RANGR-XVR-DB> █
```

Figure 15: FDL-DB Series bit menu

5.2.2.4 “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 Comm:							
Port	Status	Baud(Set/Act)	P	Rx Count	Tx Count	RxErr	TxErr
1	ENABLED	19200/ 19345	N	2709102	23	0	0
2	DISABLED	115200/116071	N	2	2	0	0
3	ENABLED	38400/ 38385	O	2	2	0	0
4	DISABLED	115200/115205	N	2	2	0	0
5	ENABLED	115200/115205	N	2	491	0	0
6	ENABLED	115200/115205	N	2	236756	0	0
USB Comm:							
Dev	Status	Speed	Rx Count	Tx Count			
1	ENABLED	Unknown	0	0			
ARINC Comm:							
Port	Status	Speed	Rx Count	Tx Count			
IN1	DISABLED	high	1	0			
IN2	DISABLED	high	1	0			
OUT1	ENABLED	high	0	91901			
Network Comm:							
Dev	Status	IP	LclPrt(Remote IP:Port)	Rx Count	Tx Count		
TEL	CNCTD	TCP 23	(169.254.33.129:54721)	82	125573		
MPI	NoCNCT	TCP 0	(0.0.0.0:0)	0	0		

RANGR-XVR-DB>

Figure 16: FDL-DB Series comm menu

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

5.2.2.5 “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-DB> control

Squawk: 1200, IDENT OFF, ALT Transmit, Tx ON, AIRBORNE,
CallSign: FREEFLT1, Emergency: 0- None

RANGR-XVR-DB> █
```

Figure 17: FDL-DB Series control menu

5.2.2.6 “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 Vknt:NS EW GSpd Track VVelfpm
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 neWASS:0 neSAT:0 Ex:0 Ao:1 As:0 SR:0 Osc:0 PL:0
RTC:0 sbash:0 ALM:0 RF:0 EEPROM:0 SDRAM:0 Step:0
```

Figure 18: FDL-DB Series gps menu

5.2.2.7 “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-DB> info

RANGR-XVR-DB, Internal Beta1 GPS

Part Number..... 87334-00-FX00
+ ADS-B Transceiver [-XVR]

Serial Number..... 0123456789ABCDEF
Operation Time..... 1000.7 hrs
HW Version..... 27.11
Boot S1 Version..... 2.0.1.1
Boot S1 Checksum.... 0xA38B27BA
Boot S1 Build Time... 05/02/2019 12:09:10
Boot S2 Version..... 2.0.2.4
Boot S2 Checksum.... 0x6BA0CE01
Boot S2 Build Time... 06/17/2020 17:09:10
SW Version..... 2.0.2.9
SW Checksum..... 0x56466812
SW Build Time..... 07/20/2020 09:54:10
FPGA Version..... 2.0.5.5
FPGA Build ID..... 0x69930FE2
FPGA Build Time..... 06/19/2019 11:17:40
GPS Version..... 5.4
GPS CRC..... 0xE105DDDF

RANGR-XVR-DB> █
```

Figure 19: FDL-DB Series info menu

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

5.2.2.8 “Reset” Command

This command causes the FDL-DB Series to reboot.

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

Figure 20: FDL-DB Series Reset command

When using the USB maintenance interface, press the **Enter** key three times to return to the maintenance interface. When using the ethernet maintenance interface, it may be necessary to restart Tera Term.

5.2.2.9 “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
-----
Traffic:  4  Tracks:  4  TCAS:  0  NBAir:  2  Air:  2  Gnd:  0  other:  2
#  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  000000000  ---  ---  ---  ---  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
  
```

Figure 21: FDL-DB Series rxstatus command display

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.

5.2.2.10 “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:

```

cnfg
Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... 1
VFR Call Sign..... FREEFLT1
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold..... 0 knots
Vehicle Size..... Length=0 meters, Width=0 meters
UAT Ant..... top, 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..... rx
Serial In 1..... Internal-GPS, 19200
Serial In 2..... UNUSED, 19200
Serial Out 2..... UNUSED, 19200
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, 115200 (RS-232)
Serial Out 6..... Traffic-Alert, 115200 (RS-232)
ARINC In 1..... UNUSED, low
ARINC In 2..... UNUSED, low
ARINC Out 1..... Traffic, high
Network Host Name..... andrew.test.1
Network Address Mode..... Static
Static IP Address ..... 169.254.3.19
Subnet Mask ..... 255.255.0.0
Default Gateway ..... 192.168.3.1
NetServer 1
Function ..... MAINT
Protocol ..... TCP
Local Port ..... 44000
Remote Addr:Port ..... 0.0.0.0:44000 (UDP Only)
NetServer 2
Function ..... MAINT
Protocol ..... TCP
Local Port ..... 55000
Remote Addr:Port ..... 0.0.0.0:55000 (UDP Only)
Syslog status
enabled ..... 0
server ..... 0.0.0.0
severity ..... 0
RANGR-XVR-DB>

```

Figure 22: FDL-DB Series cnfg menu

5.2.2.11 “cnfg defaults” Command

This command resets all configuration values to default factory settings.

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

Figure 23: FDL-DB Series cnfg defaults command

5.2.2.12 “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-RR-DB> set ?
USAGE: set <item>
<item>      Configuration items:
?           This help
addr <hex>  ICAO address <6 hex characters>
gps <sda>   GPS System Design Assurance
nacv <val>  GPS NACv mode
emit cat <num> Emitter category number
squat <opt> Squat switch option (none, low, or high)
acsize <len> <width> Vehicle length and width
uatant <opt> <dcgnd> UAT antenna mode and DC ground check
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
hostname <string> Network Host Name
net <item> <...> Network Configuration
serial <dir> <port> <func> <baud> Serial port function protocol & baud rate
arinc <dir> <port> <func> <speed> ARINC port protocol & speed
netserver <id> <func> <port> <ip> Network Server Configuration
netsyslog <addr> <enable> Network Syslog Configuration
  
```

Figure 24: FDL-DB Series set help menu

5.2.2.12.1 “set hostname” Command

This command sets the Hostname of the FDL-DB Series system by which it can be identified with on the host network. Help on this command is displayed by entering “set hostname ?”. Example “set hostname ?” output is displayed below:

```

RANGR-XVR-DB> set hostname ?
USAGE: set hostname <string>
<string> text string up to 255 characters
RANGR-XVR-DB> █
  
```

Figure 25: FDL-DB Series set hostname help menu

5.2.2.12.2 “set net” Command

This command is used to modify network related configuration settings such as selecting DHCP/Static IP. Help on this command is displayed by entering “set net ?”. Example “set net ?” output is displayed below.

```
RANGR-RX-DB> set net ?  
  
USAGE: set net <item> <...>  
  
<item>:  
  DHCP                               Obtains IP Address automatically  
  
  Static                              Use Static IP Address settings  
  
  addr <ipAddr>                       Set Static IP Address to <ipAddr>:  
  <ipAddr>                             IP Address: xxx.xxx.xxx.xxx  
  
  netmask <ipAddr>                   Set Subnet Mask to <ipAddr>:  
  <ipAddr>                             IP Address: xxx.xxx.xxx.xxx  
  
  gw <ipAddr>                         Set Default Gateway to <ipAddr>:  
  <ipAddr>                             IP Address: xxx.xxx.xxx.xxx  
  
RANGR-RX-DB>
```

Figure 26: FDL-DB Series set net help menu

5.2.2.12.3 “set netserver” Command

This command is used to modify network server related configuration settings such as client ip and network server functionality. Help on this command is displayed by entering “set netserver?”. Example “set netserver?” output is displayed below.

```
RANGR-XVR-DB> set netserver ?

USAGE: set netserver <item> <...>

<item>:
  <id>                NetServer ID: 1, 2

  <parm>              NetServer ID parameter:
    func <value>      Set NetServer <id> function to <value>:
    <value>           MAINT, Traffic-Alert, Pass-Thru

    cntrl <value>     Set NetServer <id> input control to <value>:
    <value>           disable, enable

    ip <value>         Set NetServer <id> Internet Protocol to <value>:
    <value>           UDP, TCP

    local_port <value> Set NetServer <id> Local Port to <value>:
    <value>           0 - 65535
                     UDP connects on port <value>.
                     TCP accepts up to 5 connections on port <value>.

    remote_addr <ipAddr> Set UDP NetServer <id> Remote IP Address to <ipAddr>:
    <ipAddr>          UDP destination IP Address: xxx.xxx.xxx.xxx

    remote_port <value> Set UDP NetServer <id> Remote Port to <value>:
    <value>           UDP destination port: 0 - 65535

RANGR-XVR-DB> █
```

Figure 27: FDL-DB Series set netserver help menu



Refer to Section 5.1.1.5 and 5.1.1.7 for information on selecting network server port control and functionality settings.

5.2.2.12.4 Display Output Settings

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

5.2.2.12.4.1 “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-DB> set max trgs ?

USAGE: set max trgs <num>

  <num>      8-30, max

  Max Targets..... max

RANGR-XVR-DB> █
```

Figure 28: FDL-DB Series set max trgs command

5.2.2.12.4.2 “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. For all other displays leave this parameter at the default setting of “disable.”



The FDL-978-XVR does not implement a CSA algorithm.

```
RANGR-XVR-DB> set cheltonCSA ?  
USAGE: set cheltonCSA <opt>  
  
<opt>    enable, disable  
RANGR-XVR-DB> █
```

Figure 29: FDL-DB Series set cheltonCSA command

5.2.2.12.4.3 “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-DB> set trafVelVal ?  
USAGE: set velValDisable <opt>  
  
<opt>    enable, disable  
RANGR-XVR-DB> █
```

Figure 30: FDL-DB Series set traffVelVal command

5.2.2.12.4.4 “set displayout”

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

```
RANGR-XVR-DB> set displayout ?
USAGE: set displayout <opt>
<opt>    traffic&fisb, fisbOnly, trafficOnly, ssi on/off, repinfo on/off,
RANGR-XVR-DB> □
```

Figure 31: FDL-DB set displayout command



“*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.



“*repinfo*” will provide identification information on whether the traffic target received is on the 1090ES (“e”) frequency band or the UAT (“u”) band.



“*ssi on/off*” will turn on or off the received radio signal frequency strength by the FDL-DB dual band systems.

5.3 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 **Error! Reference source not found.** 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-DB-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-DB-XVR.



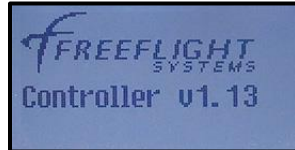
Anytime “**Configuration Mode**” is **entered** using the TC978, the user must re-enter **ALL** configuration items, including serial and ARINC port settings.

5.3.1 Entering Configuration Mode

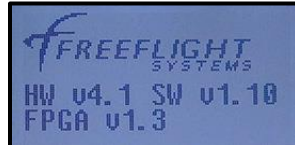
To enter TC978 configuration mode:

- Hold down the **FN** button while turning the Mode Selection knob from **OFF** to any operating mode.

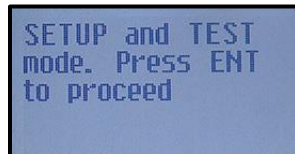
- In the configuration mode the TC978 Controller displays the following typical messages in a quick, sequential order:



```
FREEFLIGHT  
SYSTEMS  
Controller v1.13
```



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



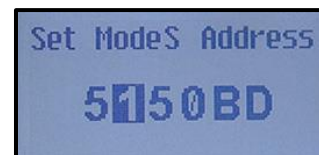
```
SETUP and TEST  
mode. Press ENT  
to proceed
```

5.3.2 FDL-DB-XVR Configuration Mode Operation

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

5.3.2.1 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.

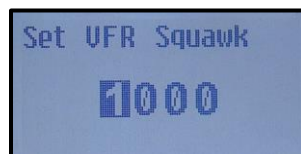
5.3.2.2 VFR Squawk Code

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.

5.3.2.3 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.

5.3.2.4 Groundspeed Threshold

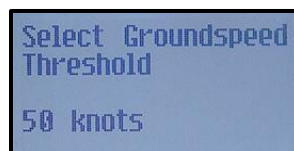
Groundspeed threshold can be used to help determine and verify the ON GROUND condition for transmitting ON GROUND ADS-B message types for “Light Fixed Wing” aircraft types only. The FDL-DB-XVR uses the ground speed threshold configuration to determine a maximum ON GROUND speed. There are 10 options to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

5.3.2.5 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.

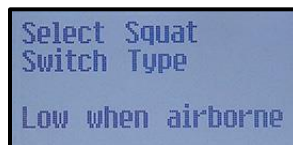
5.3.2.6 Squat Switch Type

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.



5.3.2.7 Serial IN Channel X Data Type

(*X = channel number*) The FDL-DB-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-DB-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 - 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 - GNS ADS-B
- Air Data Computer
- Altitude Encoder
- Control Panel*
- TMAP Remote**
- TIS/FIS

Refer to Section 5.1.1.1 for details on selecting serial input settings.

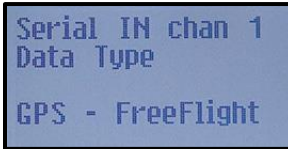


*The TC978 will not accept control inputs and will mirror the transponder or primary controller. If communication with the primary controller is lost for 60 seconds, then the TC978 will assume the role of the controller and allow control inputs (squawk, IDENT). If the TC978 is used in this manner, it 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.



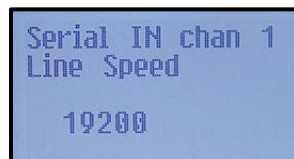
If “Not Used” is selected then the serial input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

5.3.2.8 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.

5.3.2.9 Serial OUT Channel X Data Type

(*X = channel number*) The FDL-DB-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-DB-XVR:

Channel 2

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

Channel 5

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

Channel 6

- Not Used
- Encoded Altitude
- TIS/FIS
- MX-20

- ADS-B Pass Thru



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

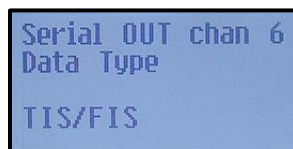


**When the Port 6 Output is set to Other 3, the corresponding Port 6 Input must be configured for TMAP, as well. The baud rate must be set to 38400 to ensure proper communication with the device.



Refer to Section 5.1.1.2 for details on selecting serial output settings.

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



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



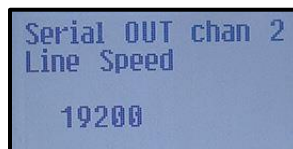
If “Not Used” is selected then the serial output line speed configuration mode is not displayed and the next configuration mode item is displayed.

5.3.2.10 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.



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.

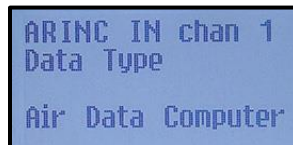
5.3.2.11 ARINC IN Channel X Data Type

(*X = channel number*) The FDL-DB-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-DB-XVR:

- Not Used
- Air Data Computer
- ADC+AHRS
- GPS
- AHRS



Refer to Section 5.1.1.3 for information on selecting ARINC input settings. The display screen is as shown below with one of the options from the list above.



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



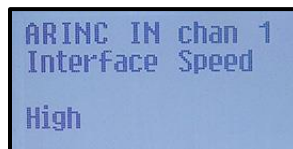
If “Not Used” is selected then the ARINC input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

5.3.2.12 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.



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.

5.3.2.13 ARINC OUT Chan 1 Data Type

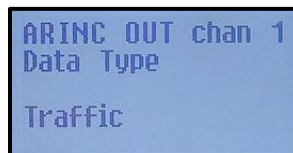
The FDL-DB-XVR can transmit data via an ARINC 429 output channel. The following options are offered for selecting ARINC 429 output type:

- Not Used
- GPS
- Traffic



Refer to Section **Error! Reference source not found.** 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.



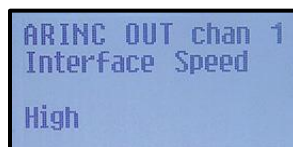
If “Not Used” is selected then the ARINC output line speed configuration mode is not displayed and the next configuration mode item is displayed.

5.3.2.14 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.

5.3.2.15 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.



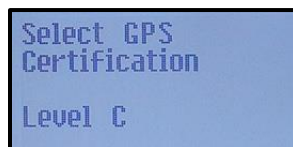
Rotate the **CODE** knob either clockwise or counterclockwise to display the options above and select the correct number of targets. Once selected, press the **ENT** button to confirm your selection and move to the next configuration item in the setup mode.

5.3.2.16 GPS Certification

The FDL-DB-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 DO-178B 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-DB series units with internal GPS, set GPS Certification to Level C.



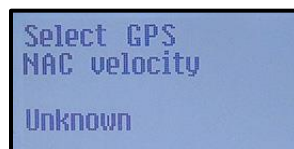
For external position sources, contact the manufacturer to obtain the relevant data.

5.3.2.17 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.

5.3.2.18 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.



5.3.2.19 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.

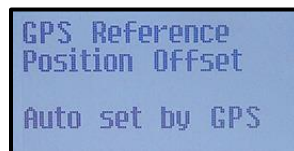


5.3.2.20 GPS Reference Position Offset

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.

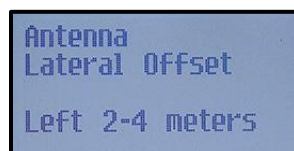


Rotate the **CODE** knob either clockwise or counterclockwise to display the options above and select the correct GPS reference offset. Once selected, press the **ENT** button to confirm your selection. If “Unknown” or “Auto Set by GPS” is selected the next configuration item in the setup mode will be 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.

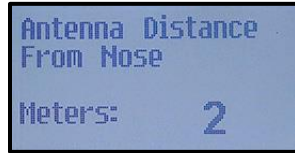


The antenna lateral offset has the following options that can be selected:

- | | |
|-------------------|--------------------|
| • 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.

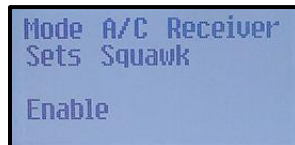
5.3.2.21 Mode A/C Receiver Sets Squawk

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.

5.3.2.22 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.

5.3.2.23 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.

5.3.2.24 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-DB-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.

5.3.2.25 UAT Antenna Check Ground

Confirm if the UAT antenna(s) used have a ground connection that allows the FDL-DB-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.

5.4 TC978 Test and Calibration

5.4.1 Local Voltage Supply Test

The TC978 Controller of the FDL-DB-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.

5.4.2 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 4.1). 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-DB-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.

5.4.2.1 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.

5.4.2.2 Calibration Procedure

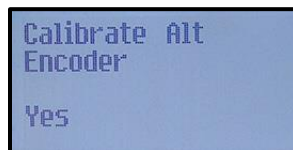
There are two adjustment points on the altitude encoder, a low altitude adjustment point, and a high altitude adjustment point. The low altitude point adjusts the correspondence at sea level, and the high altitude point adjusts the correspondence at the altitude limit of the encoder. Since the

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.



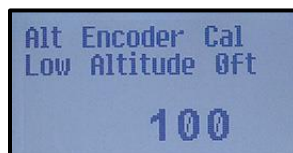
DO NOT EXCEED THE ALTITUDE OR RATE OF CLIMB LIMITS OF THE PITOT-STATIC INSTRUMENTS OF THE AIRCRAFT. The TC978 altitude encoder is a solid state device and will not be affected by excess altitude or rate of climb and descent, but the mechanical instruments in the aircraft can easily be damaged by being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



Calibrate Alt
Encoder
Yes

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.



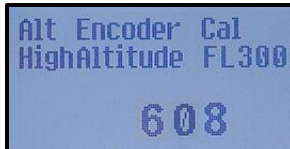
Alt Encoder Cal
Low Altitude 0ft
100

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.

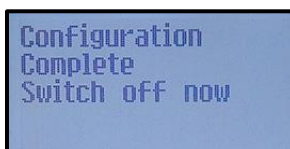
5.4.3 Pressure Altitude Reported

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 6 TROUBLESHOOTING

6.1 General

This section provides information for troubleshooting problems that occur after FDL-DB-XVR installations. This section contains information on how to use the units LEDs and TC978 Controller to troubleshoot installation problems. Refer to SECTION 5 to set up and configure the system.

6.2 FDL-DB Series LED Troubleshooting Procedure

The following is a quick reference troubleshooting guide using the FDL-DB-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

6.2.1 UAT Status LED/Discrete Fault Indications

The status LED/discrete is an indicator of a warning or fault reported by the FDL-DB-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-DB-XVR)	POST
General Processing/Interface Hardware Failure	POST
Transceiver Hardware Check Failure	POST

6.3 Warning Messages

If the FDL-DB-XVR detects a malfunction, the **MSG** icon appears to indicate that warning messages are present. Depending on the nature of the malfunction, the FDL-DB-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-DB-XVR 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-DB Series 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

6.3.1 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-DB-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-DB-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-DB-XVR. Return for maintenance if problem persists.
Tx PSU Low	Transmitter power supply voltage too low.	Cycle power on the FDL-DB-XVR. Return for maintenance if problem persists.
Squitter Fail	Transmitter modulation fault.	Cycle power on the FDL-DB-XVR. Return for maintenance if problem persists.
Remote Hot	FDL-978-XVR internal temperature too high.	Cycle power on the FDL-DB-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-DB-XVR. Return for maintenance if problem persists.
ADC Fault	Air Data Computer or Altitude encoder fault or not responding.	Verify ADC is functioning. Verify ADC Port Configuration and speed. Verify ADC Cable connection.

SECTION 7 TYPICAL INTERCONNECT DIAGRAMS

7.1 Typical System Configurations

This section contains general wiring diagrams examples for popular configurations.

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-DB Series. 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.

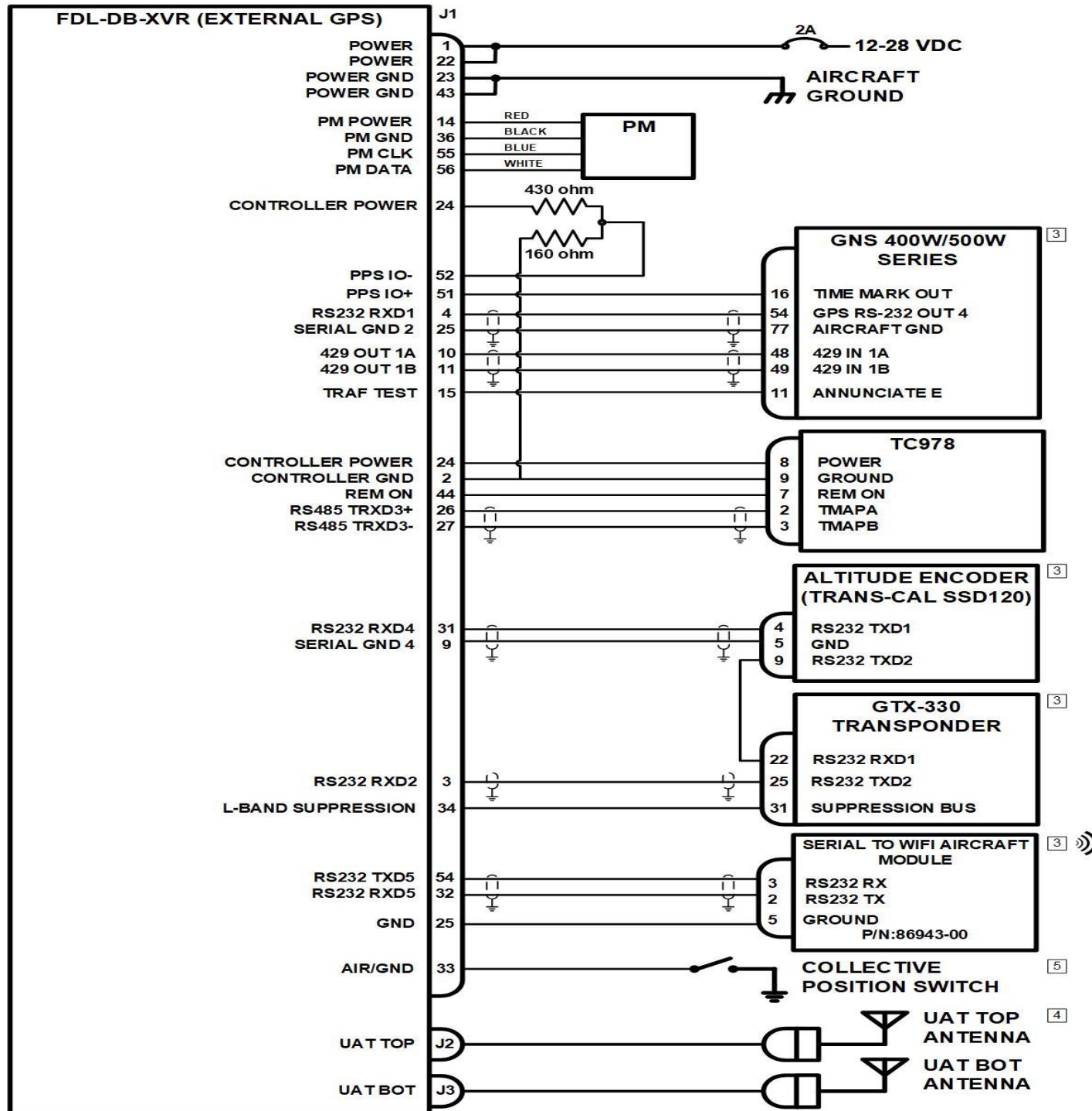


The FDL-DB Series requires an approved STC before installation



Contact FreeFlight Systems for additional information and STC validation

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



NOTES:

- ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
- 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.
- REFER TO INDIVIDUAL EQUIPMENT INSTALLATION MANUAL FOR EXTERNAL EQUIPMENT INTERCONNECTS. SEE END OF SECTION 9 FOR APPLICABLE MINIMUM SOFTWARE VERSIONS.
- FOR SINGLE ANTENNA INSTALLATIONS (CLASS A1S) INSTALL BOTTOM ANTENNA ONLY.
- REFER TO SECTION 2.5.7.1 AIR/GROUND INPUT FOR DETAILS ON ROTORCRAFT INSTALLATIONS.
- 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.

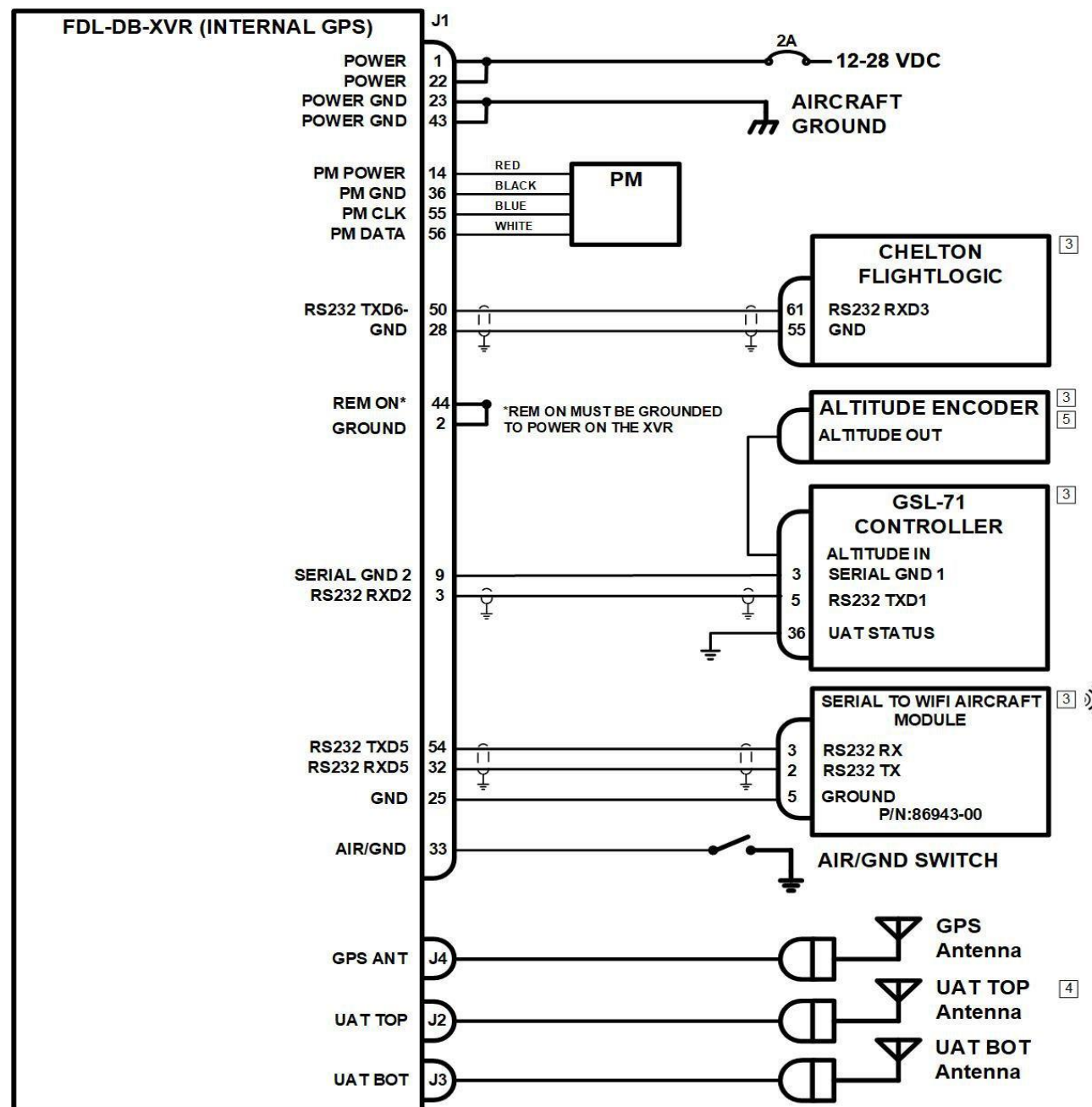
Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):

```

ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... ROTORCRAFT
Squat Mode..... none
Groundspeed Threshold..... 0 knots
Vehicle Size..... Length=0 meters, Width=0 meters
UAT Ant..... top, 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..... 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..... MAINT, 115200
Serial Out 5..... Traffic-Alert, 115200
Serial In 6..... UNUSED, 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
    
```

Figure 32: Garmin GNS 430W/530W Display and GPS, GTX-330 Transponder

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



NOTES:

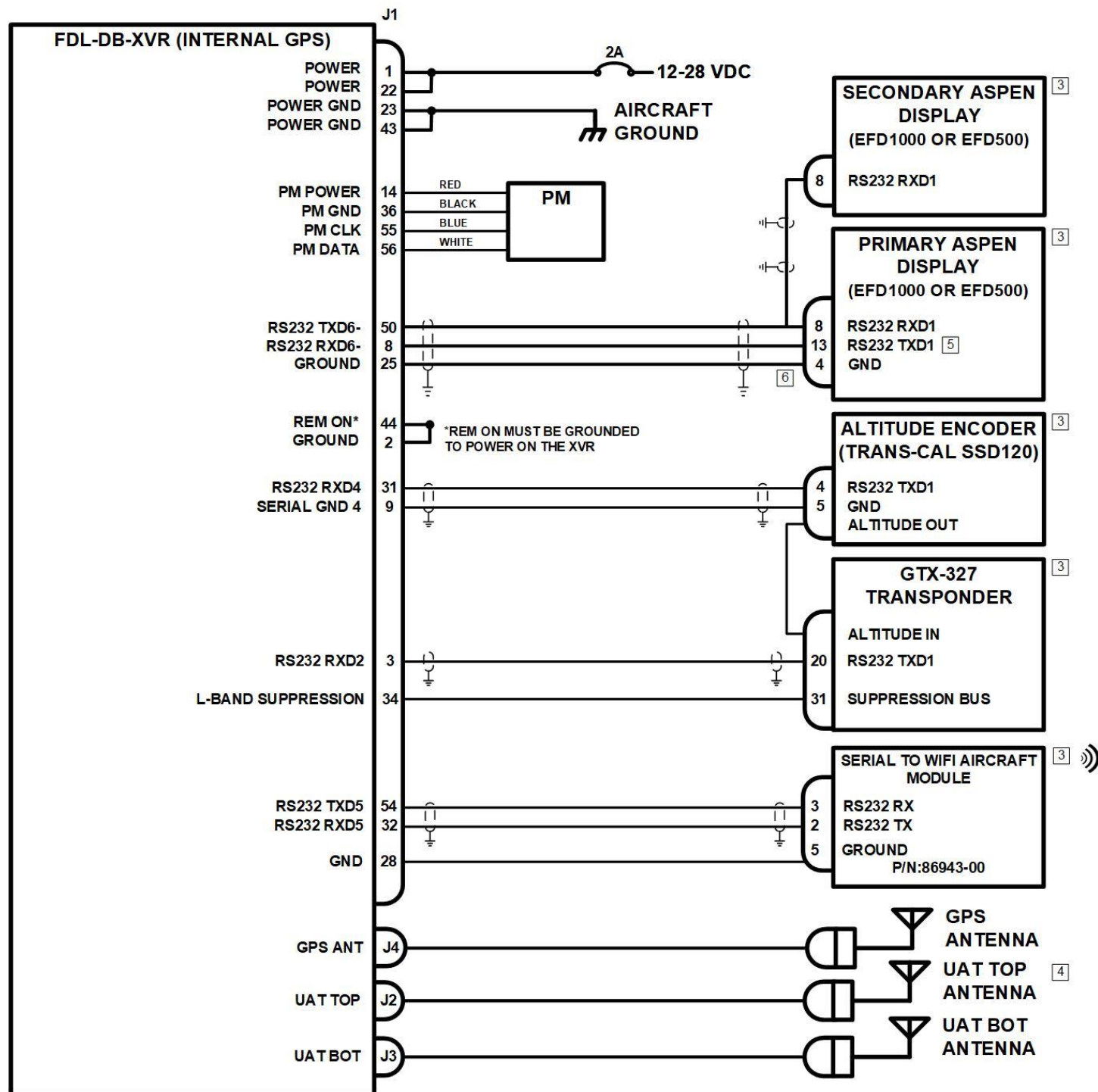
1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON GROUND.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

```

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold..... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... top, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
Mode A Rx..... disable
Disable Squawk Tx..... off
Max Targets..... max
Chelton CSA Enable..... enable
Traffic Vel Validation.... enable
Display Data Output..... traffic&fisb
XVR Mode..... xvr
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..... MAINT, 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
  
```

Figure 33: Chelton FlightLogic Display, GSL-71 Controller

7.1.3 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 ASPEN PFD.
TRAFFIC DISPLAY ON PED AND ASPEN EFD.

```

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold..... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... top, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
Mode A Rx..... disable
Disable Squawk Tx..... off
Max Targets..... max
Chelton CSA Enable..... disable
Traffic Vel Validation... enable
Display Data Output..... traffic&fish
XVR Mode..... xvr
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..... MAINT, 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
    
```

Figure 34: Aspen Display and Control, GTX 327 Transponder

7.1.4 Mode A/C Transponder, TC978 Controller

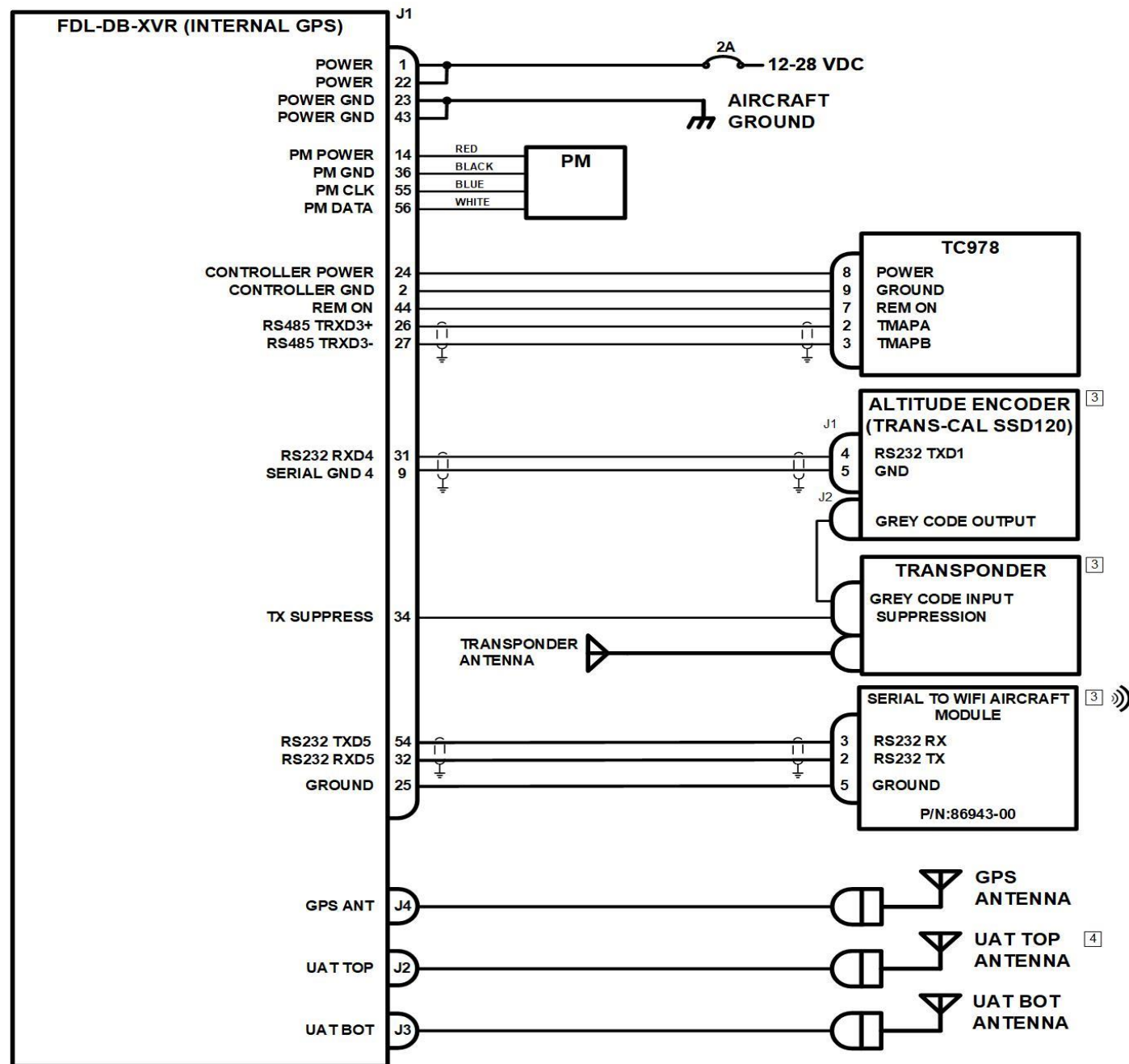


Figure 35: Mode A/C Transponder, TC978 Controller

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.

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):

```

ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold..... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... top, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
Mode A Rx..... enable
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..... Alt-Encoder, 9600
Serial In 5..... MAINT, 115200
Serial Out 5..... Traffic-Alert, 115200
Serial In 6..... UNUSED, 115200 (RS-232)
Serial Out 6..... UNUSED, 115200 (RS-232)
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.

7.1.5 Garmin GNS 480, SL-70 Transponder, TCAS

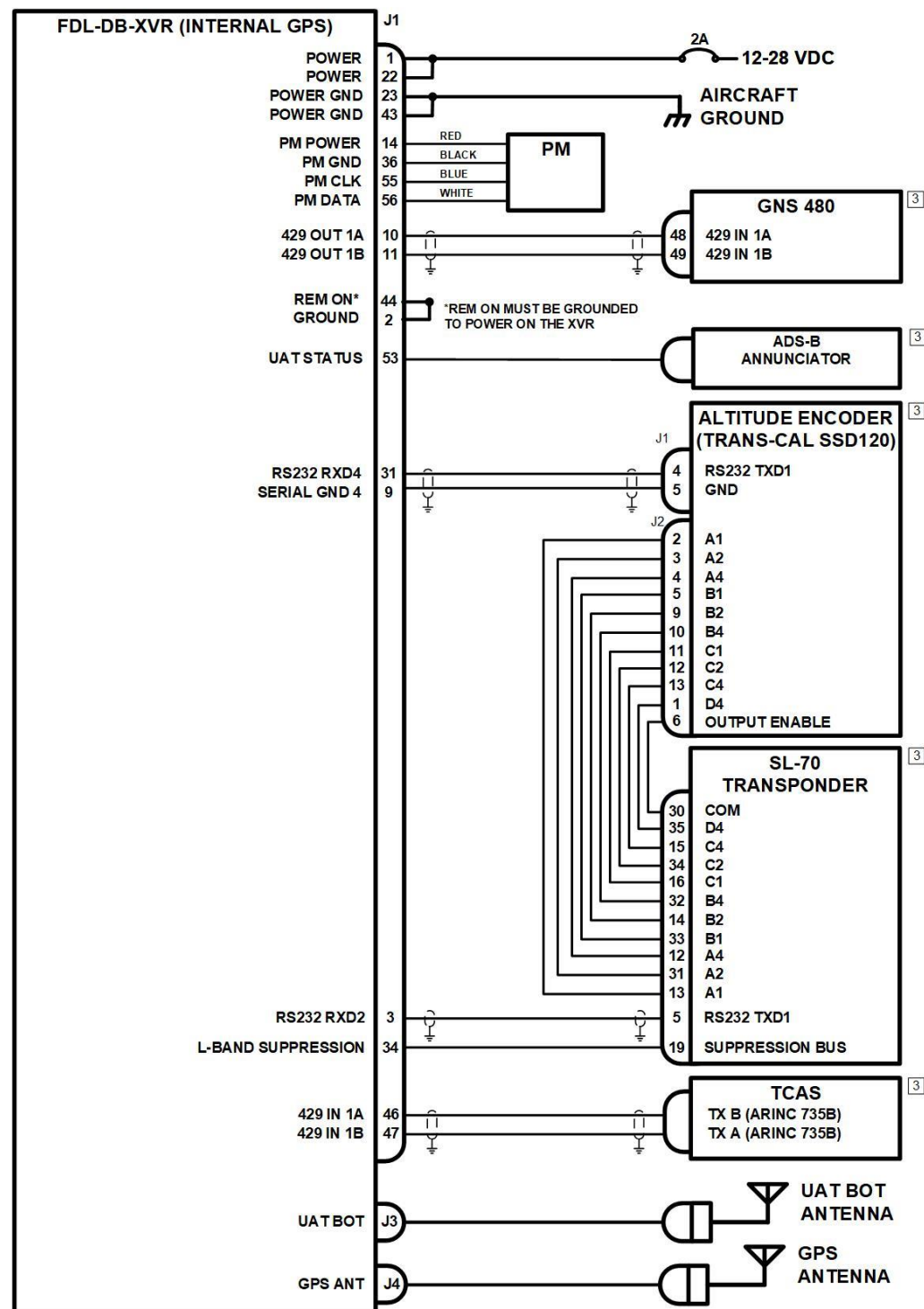
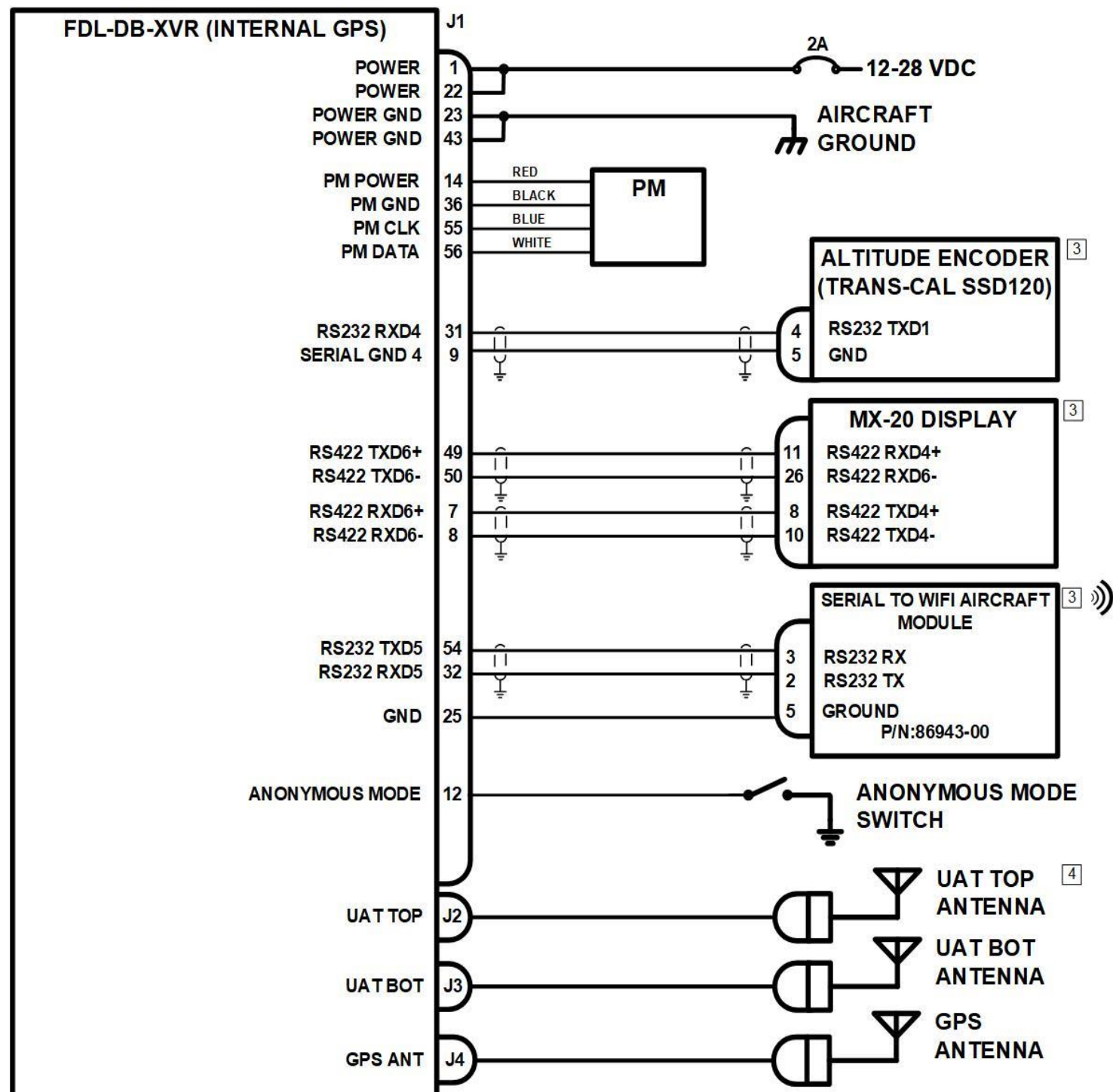


Figure 36: Garmin GNS 480, SL-70 Transponder, TCAS

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.

```
Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold.... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... bottom, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
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..... 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 Out 5..... MAINT, 115200
Serial In 5..... MAINT, 115200
Serial Out 6..... UNUSED, 115200 (RS-232)
Serial In 6..... UNUSED, 115200 (RS-232)
ARINC In 1..... Traffic, low
ARINC In 2..... UNUSED, low
ARINC Out 1..... Traffic, low
```



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.

```

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold.... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... dual, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
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..... Alt-Encoder, 9600
Serial In 5..... MAINT, 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
    
```

Figure 37: Garmin MX-20 Display and Control, No Transponder

7.1.6 Garmin GMX-200 Display, GTX-330 Transponder

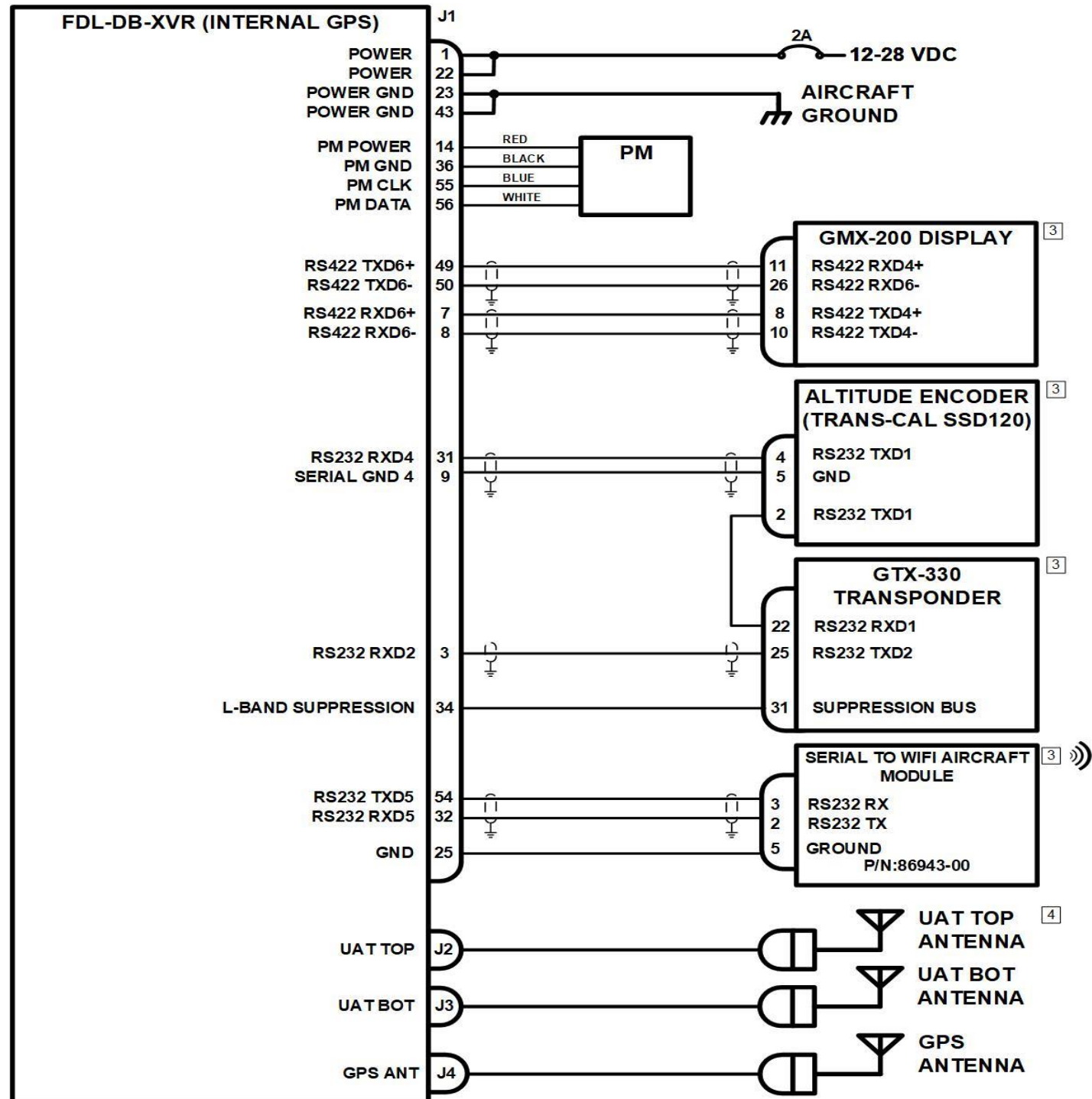




Figure 38: Garmin GMX-200 Display, GTX-330 Transponder

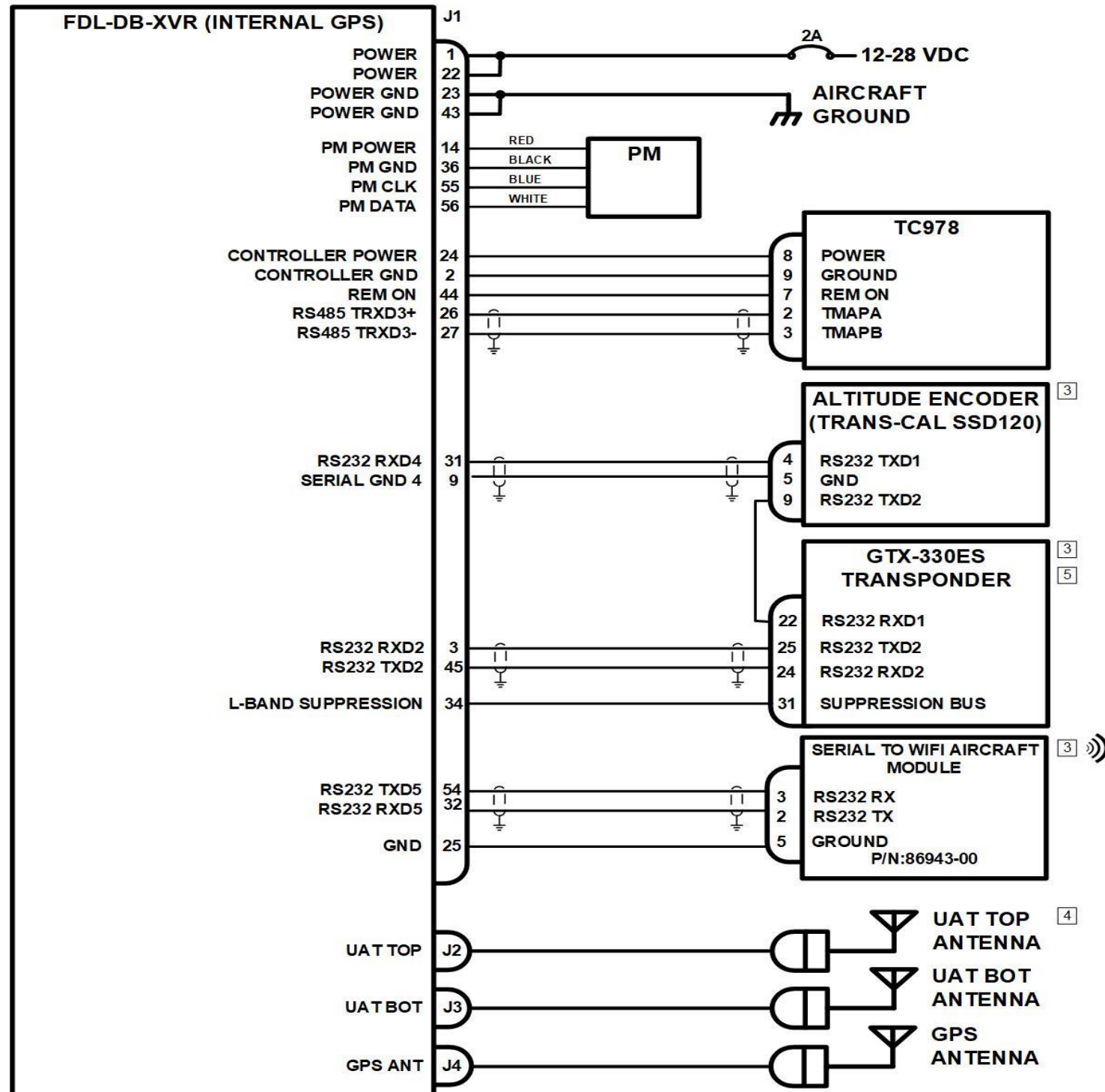
NOTES:

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.

```

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):
ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold.... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... top, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
Mode A Rx..... disable
Disable Squawk Tx..... off
Max Targets..... max
Chelton CSA Enable..... disable
Traffic Vel Validation.... enable
Display Data Output..... traffic&fish
XVR Mode..... xvr
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..... MAINT, 115200
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
    
```

7.1.7 Garmin GTX-330ES Transponder with FDL-DB-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. 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.

Configuration Settings (Lcl:YES/VALID, PM:NO/INVALID):

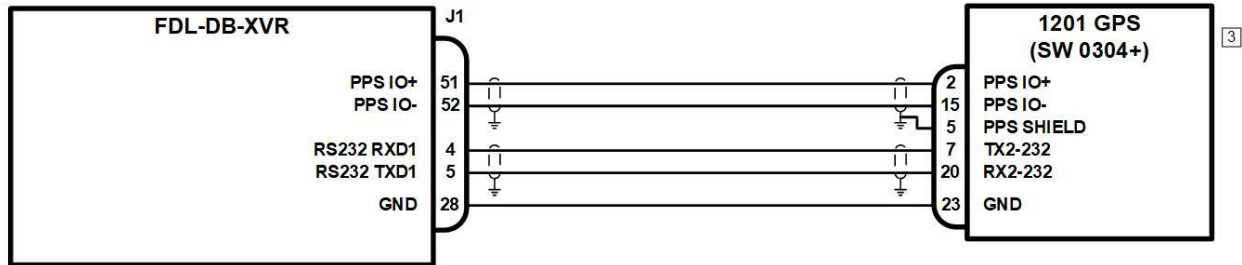
```

ICAO Address..... FF00
VFR Call Sign..... FDBGA
GPS Config..... Level C
NACv Mode..... Auto (from GPS)
Receiver Capability..... 1090, 978
Emit Category..... LIGHT AIRCRAFT
Squat Mode..... none
Groundspeed Threshold.... 30 knots
Vehicle Size..... Length=8 meters, Width=6 meters
UAT Ant..... top, No DC Gnd Chk
GPS Ant Offset..... Long=2 meters, Lateral=Center
Mode A Rx..... disable
Disable Squawk Tx..... off
Max Targets..... max
Chelton CSA Enable..... disable
Traffic Vel Validation.... enable
Display Data Output..... traffic&fish
XVR Mode..... xvr
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..... MAINT, 115200
Serial Out 5..... Traffic-Alert, 115200
Serial In 6..... UNUSED, 115200 (RS-232)
Serial Out 6..... UNUSED, 115200 (RS-232)
ARINC In 1..... UNUSED, low
ARINC In 2..... UNUSED, low
ARINC Out 1..... UNUSED, low
  
```

Figure 39: GTX-330ES Transponder with FDL-DB-XVR GPS Source

7.2 Equipment Specific Installations

7.2.1 FreeFlight Systems 1201 GPS



NOTES:


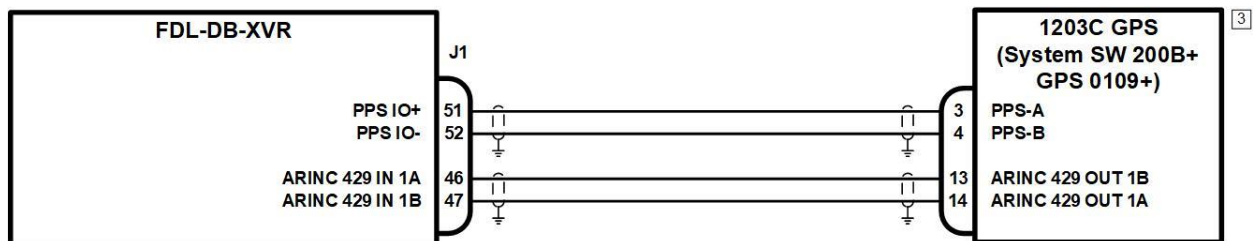
1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON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

Figure 40: 1201 Wiring Diagram

7.2.2 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 41: Figure1203C Wiring Diagram

7.3 Equipment Compatibility and Functions

The table below summarizes the ADS-B transmit control function capabilities of various potential FDL-DB 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 22. ADS-B Transmit Control Functions for Various FDL-DB Series 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	-
	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
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-DB Series 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-DB Series.

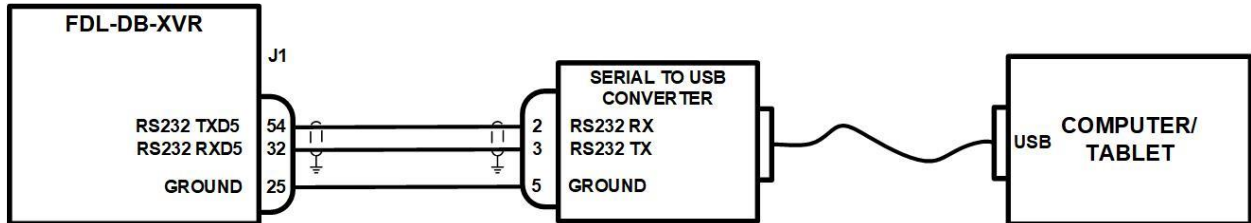
Table 23. Compatible Software Versions

Device	Permitted Software Version
TC978 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 8 MAINTENANCE INTERFACE DIAGRAMS

The diagrams below provide a pictorial representation of these available options for accessing the maintenance port of the FDL-DB-XVR series



NOTES:



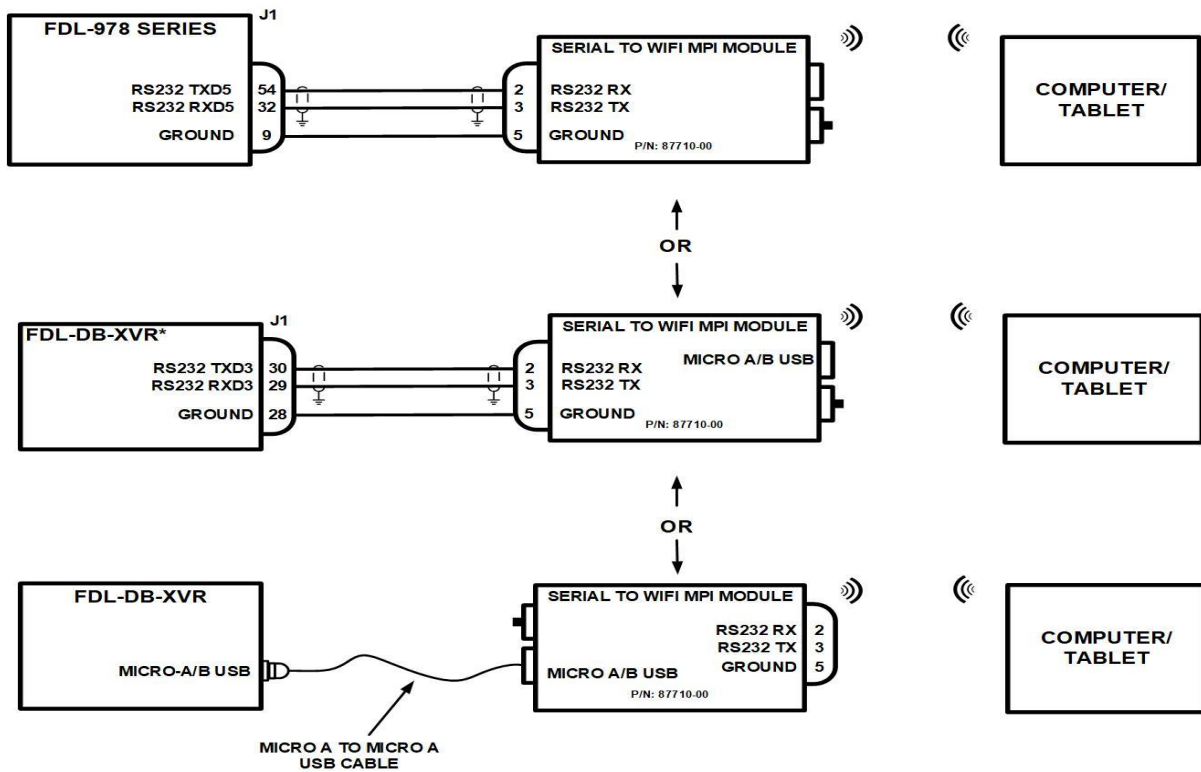
1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED AND MUST BE MIL-W-16878E/4 OR EQUIVALENT.
2.  CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE. GROUND ONLY ONE END EXCEPT WHEN THE SHIELD IS ACTING AS THE SERIAL COMMON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

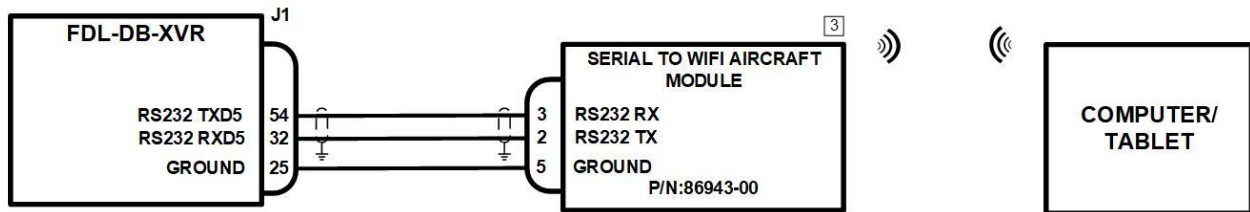
Figure 42: Off-the-Shelf RS-232 to USB Converter



NOTES:



Figure 43: 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 44: Serial-to-Wi-Fi Aircraft Module

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SECTION 9 WARNING DISCLAIMER



The FDL-DB 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-DB 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-DB 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.

SECTION 10 LIMITED WARRANTY

I. HARDWARE

FREEFLIGHT SYSTEMS, LTD. ("FREEFLIGHT"), 3700 INTERSTATE 35 S, WACO, TX 76706, HEREBY WARRANTS TO THE FIRST RETAIL PURCHASER ONLY, THAT HARDWARE PURCHASED HEREUNDER WILL BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF TWO (2) YEARS FROM THE DATE OF INSTALLATION, NOT TO EXCEED THIRTY (30) MONTHS FROM THE DATE OF SHIPMENT FROM FREEFLIGHT'S FACTORY. SHOULD DEFECTS BE FOUND, FREEFLIGHT AT ITS OPTION, WILL REPAIR OR REPLACE THE PRODUCT IN WHICH PHYSICAL DEFECTS IN MATERIALS OR WORKMANSHIP OCCUR. THE FOREGOING STATES THE SOLE LIABILITY AND OBLIGATION OF FREEFLIGHT ARISING OUT OF THIS WARRANTY, AND SUCH WARRANTY IS SUBJECT TO THE FOLLOWING CONDITIONS AND LIMITATIONS.

(A) THE DEFECT SHALL OCCUR UNDER NORMAL USE AND SERVICE FOR WHICH THIS PRODUCT WAS INTENDED. FREEFLIGHT SHALL NOT BE OBLIGATED OR LIABLE UNDER THIS WARRANTY FOR DEFECTS WHICH FREEFLIGHT'S EXAMINATION DISCLOSES ARE DUE TO: (1) TAMPERING, (2) MISUSE, (3) ABUSE, (4) NEGLIGENCE, (5) IMPROPER STORAGE OR MAINTENANCE, (6) USE IN A MANNER BEYOND WHICH SUCH EQUIPMENT IS NORMALLY INTENDED TO BE USED, (7) IMPROPER REPAIR OR POOR WORKMANSHIP BY THOSE WHO ARE NOT AUTHORIZED BY FREEFLIGHT TO REPAIR THE PRODUCTS OR USE OF DEFECTIVE MATERIAL BY SUCH UNAUTHORIZED PERSONS, AND (8) ANY OTHER CAUSE EXCEPT FOR DEFECTS IN MATERIAL OR WORKMANSHIP CAUSED BY FREEFLIGHT.

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

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

(D) FREEFLIGHT SHALL HAVE NO LIABILITY TO CUSTOMER, TO THE EXTENT THAT ANY CLAIM OF INFRINGEMENT ARISING FROM ANY MODIFICATION, SERVICING OR ADDITION MADE TO THE ITEMS BY ANYONE OTHER THAN FREEFLIGHT OR ITS AUTHORIZED REPRESENTATIVE.

(E) THE PRODUCT SHALL BE RETURNED TO FREEFLIGHT VIA THE DEALER WITH TRANSPORTATION CHARGES PREPAID. AFTER CORRECTION OF THE DEFECTS, THE PRODUCTS WILL BE RETURNED TO THE PURCHASER, TRANSPORTATION CHARGES PREPAID, EXCEPT FOR RETURNS TO PURCHASERS IN FOREIGN COUNTRIES, WHICH PURCHASERS SHALL BE RESPONSIBLE FOR PAYMENT OF SUCH CHARGES FROM THE AMERICAN PORT OF EXIT TO PURCHASER'S PLACE OF BUSINESS. THE RISK OF LOSS OR DAMAGE TO ALL PRODUCTS IN TRANSIT SHALL BE ASSUMED BY THE PARTY INITIATING THE TRANSPORTATION OF SUCH PRODUCTS.

II. ITEMS NOT COVERED BY WARRANTY

EXCEPT FOR THE EXPRESS WARRANTIES GRANTED IN SECTIONS I ABOVE, FREEFLIGHT MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, WITH RESPECT TO ITS PRODUCT AND DISCLAIMS THE SAME. FREEFLIGHT MAKES NO EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE DESIGN, ADEQUACY, ACCURACY, RELIABILITY, SAFETY OR CONFORMANCE WITH GOVERNMENT STANDARDS OR REGULATION OF ANY FLIGHT PROCEDURE PRESCRIBED BY A GOVERNMENT AUTHORITY, INCLUDING, BUT NOT LIMITED TO, ANY EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. FURTHER, FREEFLIGHT MAKES NO WARRANTY, EXPRESS, OR IMPLIED, WITH RESPECT TO THE ADEQUACY, ACCURACY, RELIABILITY, SAFETY, OR CONFORMANCE WITH GOVERNMENT STANDARDS OR REGULATIONS, OF ANY INFORMATION CONTAINED IN THE PRODUCT WHICH IS PUBLISHED BY OTHERS OR WHICH FREEFLIGHT OBTAINED FROM OTHERS. FURTHER, FREEFLIGHT MAKES NO EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE COMPLETENESS OF ANY DATA, FLIGHT INFORMATION, OR FLIGHT PROCEDURE CONTAINED IN ITS PRODUCT. FREEFLIGHT DOES NOT INCLUDE ALL AVAILABLE DATA IN ITS PRODUCT.

III. LIMITATIONS ON WARRANTY

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IF ANY, AND SAID IMPLIED WARRANTIES ARE HEREBY EXPRESSLY EXCLUDED AND DISCLAIMED. WHERE THE PRODUCT IS USED OR PURCHASED PRIMARILY FOR THE PURCHASER'S PERSONAL OR FAMILY USE, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IF ANY, ARE HEREBY EXPRESSLY LIMITED TO TWO (2) YEARS FROM THE DATE OF PURCHASE OF THE PRODUCT. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF AN IMPLIED WARRANTY, OR OF INCIDENTAL OR CONSEQUENTIAL DAMAGES; THEREFORE, THE ABOVE LIMITATIONS CONCERNING THE EXCLUSION OF IMPLIED WARRANTIES AND LIMITATIONS OF DAMAGES MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

IV. LIMITATION OF LIABILITY

FREEFLIGHT'S LIABILITY ARISING OUT OF THIS AGREEMENT SHALL NOT EXCEED THE AMOUNTS PAID BY YOU TO OBTAIN THE PRODUCT. FREEFLIGHT SHALL NOT BE LIABLE FOR SPECIAL, CONSEQUENTIAL, INCIDENTAL, OR OTHER TYPES OF DAMAGES, INCLUDING WITHOUT LIMITATION, LOSS OF USE, LOST PROFITS, AND PERSONAL INJURY. FREEFLIGHT EXPRESSLY EXCLUDES AND DISCLAIMS SUCH DAMAGES RESULTING FROM OR CAUSED BY, THE USE, OPERATION, FAILURE, MALFUNCTION OR DEFECT OF ANY FREEFLIGHT PRODUCT, WHETHER OR NOT LIABILITY FOR SUCH DAMAGES IS DUE TO TORT (INCLUDING NEGLIGENCE), CONTRACT, WARRANTY, OR STRICT LIABILITY. THESE LIMITATIONS WILL APPLY EVEN IF FREEFLIGHT OR AN AUTHORIZED DEALER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE, AND NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY. YOU ACKNOWLEDGE THAT THE AMOUNT PAID FOR THE PRODUCT REFLECTS THIS ALLOCATION OF RISK. SOME STATES DO NOT ALLOW THE LIMITATION OR EXCLUSION OF LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU. TO OBTAIN SERVICE UNDER THIS WARRANTY CONTACT: FREEFLIGHT SYSTEMS AT (254) 662-0000.

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**For additional product information and specifications,
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