EQUIPMENT INSTALLATION MANUAL

For the

FreeFlight Systems

FDL-978-TX Transmitter (P/N 85595-00)

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FreeFlight Systems
3700 Interstate 35 S.
Waco, TX 76706

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SECTION I GENERAL INFORMATION

1.1 INTRODUCTION

This document contains installation data and specifications about the FreeFlight Systems FDL-978-TX Universal Access Transmitter (UAT) Automatic Dependent Surveillance – Broadcast (ADS-B) Transmitter and associated TC-978 Controller for interfacing to the FDL-978-TX. The FDL-978-TX is a UAT equipment class B1/B1S 978MHz Transmitter that meets TSO-C154c requirements and the minimum operational performance standards in RTCA/DO-282B.

1.2 GENERAL SYSTEM DESCRIPTION

The FDL-978-TX is designed to share aircraft position, velocity, and other flight data with other aircraft and ground station equipment. The FDL-978-TX satisfies the TSO-C154c requirements and the RTCA/DO-282B MOPS for UAT ADS-B class B1/B1S equipment. The FDL-978-TX collects position, velocity, and other aircraft information from an aircraft GPS, pressure altitude sensor, and pilot interface controller and transmits this data out once per second. The GPS data, pressure altitude data, and pilot control inputs are received by the FDL-978-TX through configurable RS-232/422/485 serial, ARINC 429 serial, and/or discrete interfaces. Status information about the FDL-978-TX health and state are output on the configured serial links and/or discrete signals for display to the pilot.

Figure 1 shows a block diagram of a typical FDL-978-TX installation. This installation shows the TC-978 Front Panel Controller, the FDL-978-TX Transmitter, two UAT antennas, a GPS/WAAS sensor, and a GPS antenna. The GPS sensor can be an existing aircraft GPS source if it meets the interface requirements of the FDL-978-TX (ARINC 743A (ARINC 429) or FFS Navigation Interface Protocol (RS-232 or RS-422)).

The TC-978 Controller contains an ETSO-C88a certified pressure altitude encoder and a RS-232 serial output to share the altitude encoder data with other devices such as a transponder. Additionally, an Air Data System or Pressure Altitude Sensor can optionally be interfaced to the FDL-978-TX to provide pressure altitude, altitude rate, and true airspeed if it meets the interface requirements of the FDL-978-TX. If an optional ADS or Altitude Sensor is configured with the FDL-978-TX, the TC-978 Controller will display the optional sensor altitude and output the optional altitude data on its RS-232 serial output. Note that the Transponder and the FDL-978-TX must share the same pressure altitude sensor data.

The installation diagram also shows an optional diplexer installation so that antennas can be shared between a Transponder (1090MHz) and the FDL-978-TX Transmitter. The system can also be installed with a single UAT antenna in installations where the FAA does not require antenna diversity.

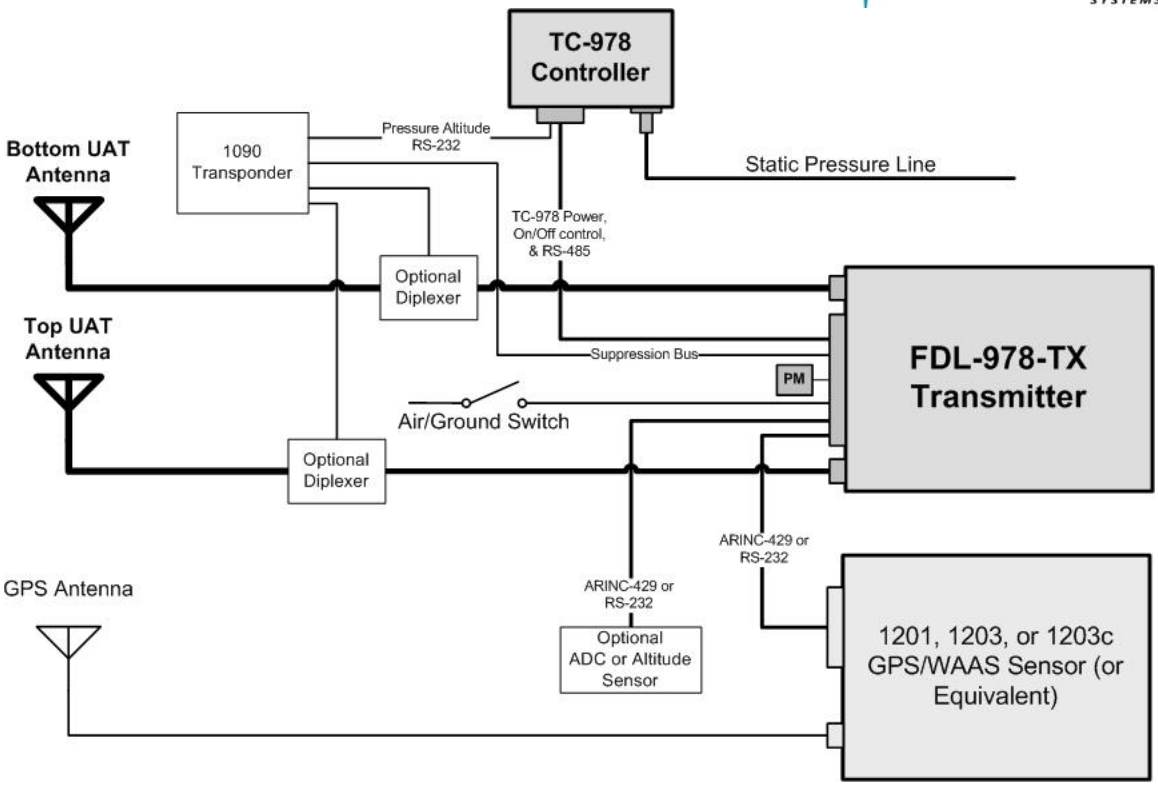


Figure 3. Typical FDL-978-TX Installation

1.2.1 FDL-978-TX Transmitter

Figure 4. FD-978-TX Transmitter

The FDL-978-TX is the main component of the FreeFlight UAT ADS-B Transmitter System. The FDL-978-TX has a DB-44 female connector, a USB micro-AB maintenance connector, and two TNC UAT antenna connectors. The FDL-978-TX contains a UAT Transmitter with top and bottom antenna outputs, four status LEDs, a controller interface, configurable GPS input interface, configurable Air Data/Altitude input interface, configurable Display output interface, Discrete inputs/outputs, Maintenance interface, and a Personality Module interface.

A. UAT Transmitter
The transmitter has top and bottom antenna outputs that can be configured to use the top only, bottom only, or both (diversity).

B. Status LEDs
Four status LEDs (UAT, GPS, UAT TX, and UAT RX(future use)) indicate the operational status of the FDL-978-TX.

C. Controller Interface
The FDL-978-TX has a TC-978 controller interface that provides low voltage power, system on/off discrete control, and a communication interface on serial port 3. The system can be configured through the controller interface.

D. GPS Input
The FDL-978-TX can connect to a FFS navigation protocol GPS (1201) through an RS-232 serial port or ARINC 743A compatible GPS (1203) through an ARINC 429 bus.

E. Altitude/Air Data Input
The FDL-978-TX can connect to an Altitude/Air Data Sensor through an RS-232 serial port or ARINC 429 bus and/or output encoded altitude on a serial output.

F. Display Output
The FDL-978-TX can provide ownship traffic data through a RS-232/RS-422 serial port.

G. Discrete Inputs/Outputs
The FDL-978-TX has six discrete inputs and two discrete outputs.

H. Maintenance Interface
The FDL-978-TX has a USB micro-AB serial port connector that can be used to update system software, check status, test the system, and configure the system.

I. Personality Module Interface
The FDL-978-TX has a personality module interface to retrieve configuration settings if the FDL-978-TX is replaced in the aircraft.

1.2.2 TC-978 Front Panel Controller

Figure 5. TC-978 Controller

The TC-978 Controller is the FDL-978-TX control and status interface. The controller has a DB-9 connector for electrical interface and a static pressure port. The TC-978 contains a LCD display with controls, a built in Altitude Encoder, low voltage input power interface, FDL-978-TX serial interface, remote on/off power control, and serial altitude output.

A. Display and Controls
The controller has an LCD status display, an Ident button, a VFR button, FN (function) button, ENT (enter) button, Mode knob, and Code entry knob.

B. Altitude Encoder
The controller has a built-in altitude encoder to measure pressure altitude.

C. Input Power
The controller receives low-voltage power from the FDL-978-TX.

D. Serial Interface
A two-wire data link is used to connect the TC-978 to the FDL-978-TX.

E. Remote On/Off
System on/off power is controlled with the mode knob.

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

1.2.3 UAT Antenna Requirements

The FDL-978-TX requires a TSO-C66, C74, C112, or C154 UHF antenna. Ensure that the antenna is a 50Ω antenna with a 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 B1 ADS-B equipment (TSO-C154c) installations, antenna diversity (meaning a top and bottom antenna) is required. In Class B1S (single antenna) installations only one antenna (top or bottom) is used.

1.3 TECHNICAL CHARACTERISTICS

1.3.1 FDL-978-TX Transmitter

FDL-978-TX Transmitter (P/N 85995-00)		
ENVIRONMENTAL COMPLIANCE		**See Appendix**
TSO COMPLIANCE		**C154c (B1/B1S)**
FCC IDENTIFICATION		
SOFTWARE		**RTCA/DO-178B Level C**
PHYSICAL DIMENSIONS		
Height		**1.37 in (34.8 mm)**
Width		**5.0 in (127 mm)**
Depth		**5.75 in (146.05 mm)**
WEIGHT		**0.8 lbs (364 g)**
OPERATING TEMPERATURE		**-40°C to +70°C**
STORAGE TEMPERATURE		**-55°C to +85°C**
ALTITUDE		**50,000 feet**
POWER REQUIREMENTS		**10 – 40 Volts DC, Typical 0.1 A @ 28 VDC**
TRANSMITTER FREQUENCY		**978 MHz**
TRANSMITTER POWER		**40 Watts max at antenna after 3dB connector/cable loses**
Avionics Interfaces:		
TYPE	**I/O**	**Description**
Controller	**Input/ Output**	**7 VDC power output, remote on/off discrete input, RS-485 serial interface to the TC-978**
GPS Input	**Input**	**Serial (RS-232, RS-422, or RS-485) or ARINC 429 (ARINC 743A) and PPS (RS-422)**
ADS/Altitude Input	**Input**	**Serial (RS-232, RS-422, or RS-485) or ARINC 429**
Display Output	**Output**	**Serial (RS-232, RS-422, or RS-485)**
Discrete Inputs	**Input**	**6 (Air/Grnd, Anon Mode, CDTI Oper, TCAS RA Active, Traf Test, & Traf Stdby)**
Discrete Outputs	**Output**	**2 (Transmit Suppression and UAT Status)**

1.3.2 TC-978 Front Panel Controller

TC-978 Controller (P/N 86941)		
ENVIRONMENTAL COMPLIANCE		**See Appendix**
TSO COMPLIANCE		**C154c, C88a**
SOFTWARE		**RTCA/DO-178B Level B**
PHYSICAL DIMENSIONS		
Height		**1.8 in (44 mm)**
Width		**2.4 in (63 mm)**
Depth		**2.1 in (54 mm)**
WEIGHT		**.11 lbs (90 g)**
OPERATING TEMPERATURE		**-20°C to +55°C**
ALTITUDE		**35,000 feet**
POWER REQUIREMENTS		**5.5 – 10 Volts DC, 0.3A max @ 6.5VDC, powered by FDL-978-TX**
Interfaces:		
TYPE	**I/O**	**Description**
Controller	**Input/ Output**	**7 VDC power input, remote on/off discrete output, RS-485 serial interface to the FDL-978-TX**
Altitude Output	**Output**	**RS-232 serial altitude encoder**

1.4 PARTS AND EQUIPMENT

1.4.1 FDL-978-TX Transmitter Items

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

Part Number	Qty	Description
85595-XX-XXXX	1	FDL-978-TX Transmitter
85935-00	1	FDL-978-TX Installation Kit

1.4.2 TC-978 Front Panel Controller Items

The TC-978 Controller and optional installation kit part numbers are listed below:

Part Number	Qty	Description
85941	1	TC-978 Controller
86964-00	1	TC-978 Installation Kit

1.4.3 Installation Kits

The items included in the FDL-978-TX Installation Kit (p/n 85935-00) are listed below:

Part Number	Qty	Description
86960	1	FDL-978-TX Installation Manual
85945-00-A	1	Personality Module
86945	1	DB-44 Male Crimp Connector
85942	1	DB-44 Backshell
86967	44	Crimp Pin 24-28 AWG
84192	1	DB-9 Female Crimp Connector
84193	1	DB-9 Backshell
84194	9	Crimp Pin female 9-Dsub
16172	1	Double-sided Adhesive Tape
85937	2	Ball UAT Antenna
0129-0017-00	2	TNC Connector
0123-0012-00	50 ft	RG-142 Coax Cable
86966	2	BNC RG142 Male Crimp Connector

The items included in the TC-978 Installation Kit (p/n 86964-00) are listed below:

Item	Qty	Description
1	1	Mounting Adapter (circular hole adapter)
2	1	Static Tubing, EPDM 5mm ID
3	1	Hose T piece
4	2	Hose Adapter
5	6	Hose clip, small
6	2	Hose clip, large
7	4	Long mounting screws, 4-40

8	**4**	**Short mounting screws, 4-40**

1.5 MATERIALS REQUIRED BUT NOT SUPPLIED

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

- Wire and shielded wire
- Circuit Breaker
- Ground terminals
- A GPS receiver with appropriate serial or ARINC 743 interface such as the FFS 1201, 1203, or 1203C is required for the ADS-B Transmitter

SECTION II INSTALLATION

2.1 GENERAL

This section provides general information for installing the FDL-978-TX and TC-978 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.

2.2 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 equipment and optional parts supplied.

2.3 EQUIPMENT MOUNTING

2.3.1 TC-978 Mounting

The TC-978 controller must be mounted rigidly in the aircraft panel. The controller can be mounted in the ultra compact mounting hole or in a conventional 57mm (2¼ inch) instrument cut-out.
The following installation procedure should be followed, remembering to allow adequate space for installation of cables and connectors.

- Select a position in the panel that is not too close to any high external heat source. (The TC-978 is not a significant heat source itself).
- Avoid sharp bends and placing the cables too near to the aircraft control cables.

If using a 57mm 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.

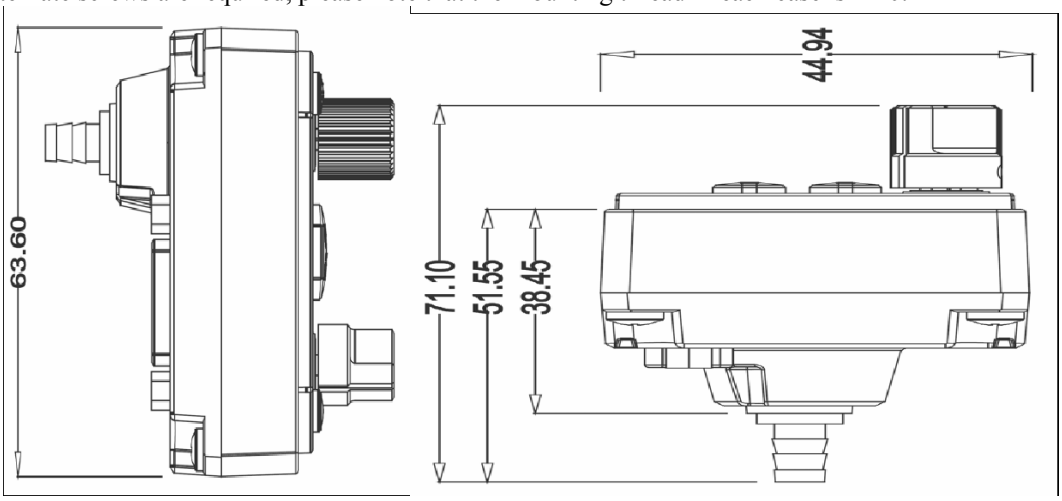


Figure 6. TC-978-TX Dimensions

2.3.2 FDL-978-TX Mounting

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

The following installation procedure should be followed, remembering to allow adequate space for installation of cables and connectors.

- Select a position in the aircraft that is not too close to any high external heat source. (The FDL-978-TX is not a significant heat source itself).
- Avoid sharp bends and placing the cables too near to the aircraft control cables.
- Secure the FDL-978-TX on a flat surface according to the FDL-978-TX mounting requirements illustrated below in Figure 7 and in the installation drawing in Appendix D.

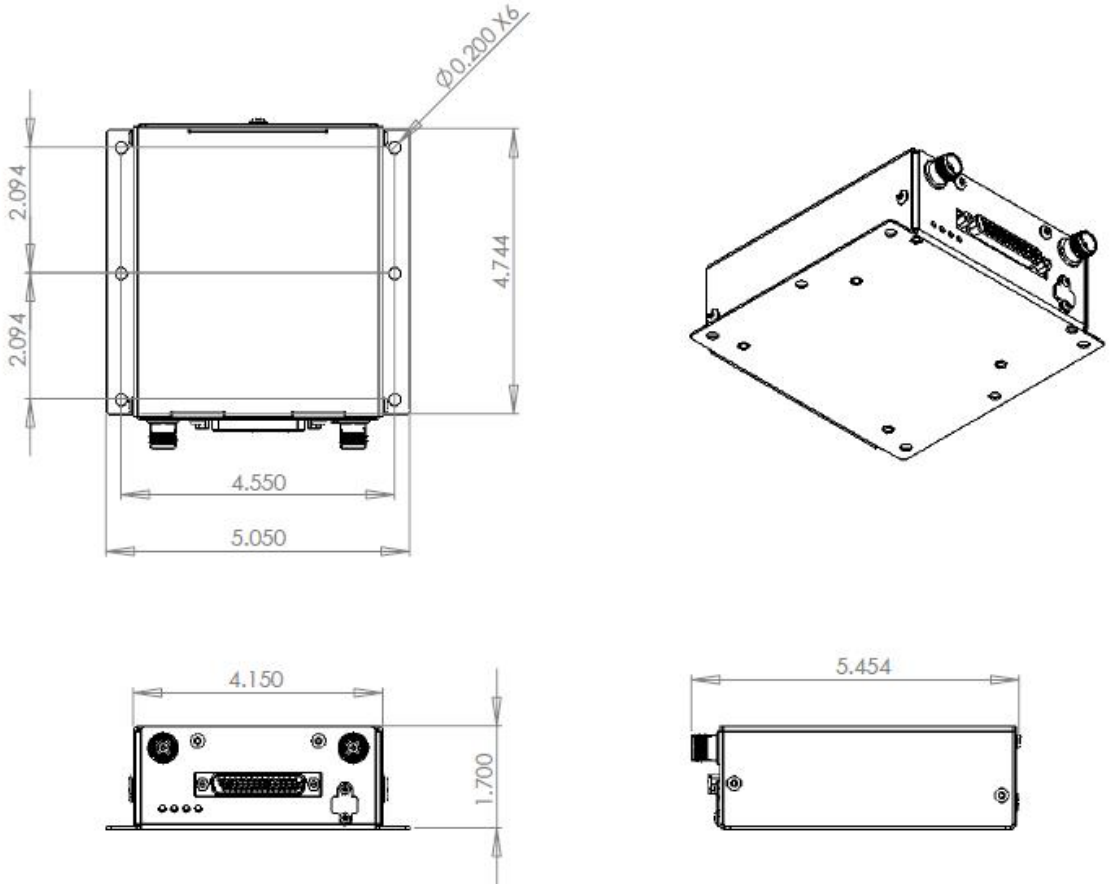


Figure 7. FDL-978-TX Mounting Dimensions

2.4 COOLING REQUIREMENTS

The FDL-978-TX and TC-978 meet all 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. Failure to provide adequate cooling may lead to increased avionics maintenance costs and may void the FreeFlight Systems Warranty.

2.5 FDL-978-TX UAT ELECTRICAL CONNECTIONS

2.5.1 FDL-978-TX Interface – Pinout

J1 - Power and I/O Connector (DB-44)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
1	Vin	10-40 VDC	Pwr	Aircraft Power Input
2	GND	Ground	Gnd	TC-978 Controller Power Return
3	232 RxD2	RS-232	I	Serial Port 2 RS-232 Data In
4	TRxD2+	RS-485	I	Serial Port 2 RS-422/RS-485 Data+
5	TRxD2-	RS-485	I	Serial Port 2 RS-422/RS-485 Data-
6	429 IN 2A	ARINC 429	I	ARINC 429 Input Channel 2A
7	RxD6+	RS-422	I	Serial Port 6 Data In+
8	RxD6-	RS-422	I	Serial Port 6 Data In-
9	SGND4	Serial Ground	Gnd	Serial Port Ground
10	429 OUT 1A	ARINC 429	O	ARINC 429 Output Channel 1A
11	429 OUT 1B	ARINC 429	O	ARINC 429 Output Channel 1B
12	TRAF STDBY	Open/Ground	I	Traffic Standby
13	ANON MODE	Open/Ground	I	Anonymous Mode
14	Vpm	3.0 -3.6 VDC	O	Personality Module Power Output
15	TRAF TEST	Open/Ground	I	Traffic Test
16	Vin	10-40 VDC	Pwr	Aircraft Power Input
17	RTRN	Ground	Gnd	Aircraft Power Return
18	Vcp	5.5-10 VDC	O	TC-978 Controller Power Output
19	SGND2	Serial Ground	Gnd	Serial Port Ground
20	TRxD3+	RS-485	I/O	Serial Port 3 RS-485 Data+
21	TRxD3-	RS-485	I/O	Serial Port 3 RS-485 Data-
22	GND	Gnd	Gnd	Ground Reference
23	232 RxD3	RS-232	I	Serial Port 3 RS-232 Data In (Not used with TC-978)
24	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data Out (Not used with TC-978)
25	232 RxD4	RS-232	I	Serial Port 4 RS-232 Data In
26	TCAS RA ACT	Open/Ground	I	TCAS Resolution Advisory Active In (Active low)
27	AIR/GRND	Open/Ground	I	Air/Ground In (Squat Switch - configurable)
28	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
29	Reserved	-	-	-
30	GND	Ground	Gnd	Personality Module Power Return
31	RTRN	Ground	Gnd	Aircraft Power Return
32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
33	232 TxD2	RS-232	O	Serial Port 2 RS-232 Data Out
34	429 IN 1A	ARINC 429	I	ARINC 429 Input Channel 1A
35	429 IN 1B	ARINC 429	I	ARINC 429 Input Channel 1B
36	429 IN 2B	ARINC 429	I	ARINC 429 Input Channel 2B
37	TxD6+	RS-422	O	Serial Port 6 Data Out+
38	TxD6-	RS-422	O	Serial Port 6 Data Out-
39	PPS IO+	ARINC 743A	I/O	Internal/External GPS Pulse Per Second Out/In+
40	PPS IO-	ARINC 743A	I/O	Internal/External GPS Pulse Per Second Out/In-
41	UAT STATUS	Open/Ground	O	ADS-B Status
42	CDTI OPER	Open/Ground	I	CDTI Operational
43	CLK_PM	I^2C	I	Personality Module Clock
44	DATA_PM	I^2C	I/O	Personality Module Data

2.6 FDL-978-TX UAT INTERFACE DETAILS

2.6.1 Power Input

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

Power Input				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-1	Vin	10-40 VDC	Pwr	Aircraft Power Input
J1-16	Vin	10-40 VDC	Pwr	Aircraft Power Input
J1-17	RTRN	Ground	Gnd	Aircraft Power Return
J1-31	RTRN	Ground	Gnd	Aircraft Power Return

2.6.2 Personality Module

Installation specific configuration information is stored in three separate non-volatile memories in a properly installed system:

- **The Personality Module (PM)**, which is connected to the aircraft connector mated with J1 of the FDL-978-TX, contains the *Master* configuration that is used by the FDL-978-TX to configure the system.
- **The TC-978 Controller** contains a *Back-up* configuration that is used by the FDL-978-TX to configure the system **only** when the Personality Module is not installed.
- **The FDL-978-TX Transmitter** contains a *Local* configuration copy that is used immediately after power-up to start the system and is synchronized with the PM *Master* configuration or the controller *Back-up* configuration if the PM is not installed.

The Personality Module (PM) eliminates the need to set-up the installation configuration again if a new FDL-978-TX transmitter or a new TC-978 controller is installed. The *Master* configuration in the PM is extracted by the FDL-978-TX and used to update the TC-978 Controller *Back-up* configuration and FDL-978-TX *Local* configuration if different than the PM *Master* configuration.

The PM should be installed in the aircraft but the system will continue to function correctly if the PM malfunctions. If the PM malfunctions, the TC-978 *Back*-up installation configuration will be transferred to the FDL-978-TX and the FDL-978-TX will update its *Local* configuration if different. If a new TC-978 controller is installed in a system with a malfunctioning PM then the configuration information must be re-configured.

The PM has no lightning protection so the wire length between the PM and the Power and I/O connector must be less than 4". The PM connection is on the following pins:

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

2.6.3 Status LEDs

Four external LEDs on the front of the enclosure indicate 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.
GPS	***GPS Status (GREEN)***	
	Flashing	GPS is acquiring satellites and determining position.
	ON	GPS has acquired satellites and is operating normally.
	OFF	GPS is not communicating or has failed.
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)***	
	OFF	No UAT receptions (UAT transmitter has no receiver so this is the normal condition)

2.6.4 Controller Interface

Low voltage power (+7 Volts DC), a system ON/OFF discrete control, and serial communication (RS-485 or RS-232) on serial port 3 is provided through the J1 Power and I/O connector as the controller interface. Serial port 3 is a single communication port that can be electrically interfaced via RS-232 or RS-485. For the current FDL-978-TX this interface is intended for use with the TC-978 Controller. The TC-978 Controller uses the serial port 3 RS-485 pins (J1-20 & J1-28) and does not use serial port 3 RS-232 pins (J1-23 & J1-24). Future controllers may use the serial port 3 RS-232 pin interface rather than the RS-485 interface.

The controller interface connections are as follows:

Controller Interface				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-18	Vcp	+7 VDC	O	TC-978 Controller Power Output
J1-2	GND	Ground	Gnd	TC-978 Controller Power Return
J1-32	REM ON	Open/Ground	I	Remote Power Control (Ground: ON, Open: OFF)
J1-20	TRxD3+	RS-485	I/O	Serial Port 3 RS-485 Data+
J1-21	TRxD3-	RS-485	I/O	Serial Port 3 RS-485 Data-
J1-23	232 RxD3	RS-232	I	Serial Port 3 RS-232 Data In (Not used with TC-978)
J1-24	232 TxD3	RS-232	O	Serial Port 3 RS-232 Data Out (Not used with TC-978)

2.6.5 Physical Serial Interfaces

There are a total of five *physical serial interfaces* available on the FDL-978-TX: Three UART style Serial Port interfaces and two ARINC 429 Input interfaces. These *physical serial interfaces* are available for connecting to four different *functional interfaces*:

- GPS Input
    - Serial Port: “GPS-FreeFlight” or

- ARINC: “GPS”

- Altitude/Air Data Input
  - Serial Port: “Altitude Encoder” or “ADC”
  - ARINC: “ADC”
- Altitude Encoder Output
  - Serial Port: “Encoded Altitude”
- Display Output
  - Serial Port: “TIS/FIS” or “ADS-B Pass Thru”

Each of the four *functional interfaces* can be configured to one and only one *physical serial interface*. Only one of each of the *functional interfaces* is handled by the FDL-978-TX All *physical serial interfaces* are configured to *functional interfaces* in Configuration Mode. If two or more *physical serial interfaces* are configured to the same *functional interface* only **one** *physical serial interface* is programmed by the FDL-978-TX to use the *functional interface* and all other configurations of the same *functional interface* are ignored. The order of precedence used by the FDL-978-TX for a *functional interface* is as follows:

- ARINC 429 *physical interface* takes precedence over UART *physical interface*
- Lowest port/channel number takes precedence over higher port/channel number

For example, if Serial Port 2 Input is configured to “GPS-FreeFlight” and ARINC 429 Input Channel 1 is configured to “GPS” then the FDL-978-TX uses ARINC 429 Input Channel 1 as the GPS Input *functional interface* and the Serial Port 2 Input configuration is ignored. As another example, if ARINC 429 Input Channel 2 and ARINC 429 Input Channel 1 are both configured to “GPS” then the FDL-978-TX uses ARINC 429 Input Channel 1 for the GPS Input *functional interface* and the ARINC 429 Input Channel 2 configuration is ignored.

Additionally, only one *functional interface* type can be configured for each of the two UART style Serial Port (2 & 6) *physical serial interfaces* that have bi-directional capability. If both the input and the output of Serial Port 2 or 6 are configured then the order of precedence is as follows:

- GPS Input
- Altitude/Air Data Input
- Altitude Encoder Output
- Display Output

For example, if Serial Port 2 Input is configured to ”GPS-FreeFlight” and Serial Port 2 Output is configured to “TIS/FIS” then the FDL-978-TX uses Serial Port 2 as the GPS Input *functional interface* and the Serial Port 2 Output configuration is ignored.

2.6.5.1 Serial Ports - RS-232 / RS-422 / RS-485

Three UART style (Serial Port) *physical serial interfaces* are available on the FDL-978-TX. The three Serial Ports available are described below:

- Serial Port 2 – Bi-directional (transmit and receive) capability and can interface via either RS-232 or RS-485. Typically configured as the GPS Input *functional interface* but can also be configured as a Display Output, Altitude/Air Data Input, Altitude Encoder Output
- Serial Port 4 – RS-232 receive-only capability. Typically configured as the Altitude/Air Data Input *functional interface* but can also be configured as a GPS Input.
- Serial Port 6 – RS-422 bi-directional (transmit and receive) capability. Typically configured as the Display Output *functional interface* but can also be configured as a GPS Input, Altitude/Air Data Input, or Altitude Encoder Output.

The UART style *physical serial interface* pin connections are as follows:

Serial Ports				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-3	232 RxD2	RS-232	I	Serial Port 2 RS-232 Data In
J1-33	232 TxD2	RS-232	O	Serial Port 2 RS-232 Data Out
J1-19	SGND2	Serial Ground	Gnd	Serial Port Ground
J1-4	TRxD2+	RS-485	I	Serial Port 2 RS-422/RS-485 Data+
J1-5	TRxD2-	RS-485	I	Serial Port 2 RS-422/RS-485 Data-
J1-25	232 RxD4	RS-232	I	Serial Port 4 RS-232 Data In
J1-9	SGND4	Serial Ground	Gnd	Serial Port Ground
J1-7	RxD6+	RS-422	I	Serial Port 6 Data In+
J1-8	RxD6-	RS-422	I	Serial Port 6 Data In-
J1-37	TxD6+	RS-422	O	Serial Port 6 Data Out+
J1-38	TxD6-	RS-422	O	Serial Port 6 Data Out-

2.6.5.2 ARINC 429 Channels

Two ARINC 429 Input *physical serial interfaces* are available on the FDL-978-TX. The ARINC 429 Input channels are 429 IN 1 and 429 IN 2. The FDL-978-TX has one ARINC 429 Output that is reserved for future use and is not currently configurable. Both ARINC channels can be configured as either high-speed or low-speed. The ARINC output channel is reserved for future use.

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

- **Air Data Computer Input** – accepts the following ARINC labels:

LABEL	DESCRIPTION
203	Pressure Altitude
210	Airspeed
212	Altitude Rate

- **GPS Input** – accepts the following ARINC 743A labels:

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

The ARINC 429 *physical serial interface* pin connections are as follows:

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

2.6.6 Discrete Inputs

Six discrete inputs are available on the FDL-978-TX for specific purposes (current or future). All six discrete inputs are intended to be connected to open/ground type switches if used. All discrete inputs default to the open condition if not connected. The discrete input pin connections are as follows:

Discrete Inputs				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J1-12	TRAF STDBY	Open/Ground	I	Traffic Standby
J1-13	ANON MODE	Open/Ground	I	Anonymous Mode
J1-15	TRAF TEST	Open/Ground	I	Traffic Test
J1-22	GND	Ground	Gnd	Ground Reference
J1-26	TCAS RA ACT	Open/Ground	I	TCAS Resolution Advisory Active In (Active low)
J1-27	AIR/GRND	Open/Ground	I	Air/Ground In (Squat Switch - configurable)
J1-42	CDTI OPER	Open/Ground	I	CDTI Operational

2.6.6.1 Air/Ground Input

The Air/Ground discrete input can be connected to an open/ground squat switch or other Air/Ground discrete indication. The Air/Ground discrete is configurable to be either Not Connected, High when Airborne, or Low (ground) when Airborne. The FDL-978-TX automatically determines air/ground state based on several factors: Emitter Category type, Airspeed (if available), groundspeed, and Air/Ground discrete input.

2.6.6.2 Anonymous Mode Input

The anonymous mode discrete input determines if the FDL-978-TX is in anonymous address mode. If the anonymous mode input is tied to ground the FDL-78-TX will be in anonymous mode and transmit a randomly generated anonymous address in the ADS-B message in place of the ICAO address. Even if anonymous mode is set, the FDL-978-TX will transmit the configured Mode S (ICAO) address under the following conditions:

- During the first two minutes after initial power-up
- When the squawk code is set to anything other than 1200

2.6.6.3 CDTI Operational Input

The CDTI Operational Input is reserved for future use to indicate the operational status of an on-board TCAS. A ground will indicate the TCAS is installed and operational, while an open will indicate the TCAS is not installed or operational. This discrete should be left open.

2.6.6.4 TCAS Resolution Advisory Active Input

The TCAS Resolution Advisory Active Input is reserved for future use to indicate the status of any resolution advisories from an on-board TCAS. A ground will indicate a TCAS resolution advisory is active, while an open will indicate no TCAS resolution advisories are active. This discrete should be left open.

2.6.6.5 Traffic Standby Input

The Traffic Standby Input is reserved for future use to indicate the traffic standby status of a 429 traffic display. This discrete should be left open.

2.6.6.6 Traffic Test Input

The Traffic Test Input is reserved for future use to indicate the traffic test status of a 429 traffic display. This discrete should be left open.

2.6.7 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**
J1-28	TX SUPPRESS	Vin -1.5V	O	L-Band Suppression Bus
J1-41	UAT STATUS	Open/Ground	O	ADS-B Status

2.6.7.1 UAT Status Output

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 system failure when grounded. Note that UAT system failure includes the loss of valid GPS data from the external GPS.

2.6.8 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.

2.6.9 Time Mark Input (PPS)

The Time Mark Input is an RS-422 differential pair for the one pulse-per-second (PPS) input from a GPS like the FFS 1201 or FFS 1203/1203C. The Time Mark input from a GPS provides the timing synchronization for sending ADS-B messages. The Time Mark input pin connections are as follows:

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

2.6.10 Maintenance Interface

The Maintenance interface is used to communicate with a PC using a special Maintenance Interface Cable (p/n 85595-00-TC) from FreeFlight Systems. This interface can be used to configure the system, provide additional status information, and update system software. The Maintenance interface is reserved for use by qualified FreeFlight Systems personnel. The Maintenance interface pin connections are as follows:

J4 – Maintenance Port (USB Micro-AB)				
PIN	**SIGNAL**	**ELECTRICAL**	**I/O**	**DESCRIPTION**
J4-1	VBUS	+5V DC	O	+5V DC Power Out
J4-2	TTL RxD5	TTL Serial	I	Serial Port 5 TTL (3.3V) Data In
J4-3	TTL TxD5	TTL Serial	O	Serial Port 5 TTL (3.3V) Data Out
J4-4	SERVICE ID	Open/Ground	I	Maintenance Control (Ground: ON, Open: DISABLED)

J4-5	GND	Ground	Gnd	Ground Reference / Power Return

2.7 TC-978 CONTROLLER ELECTRICAL CONNECTIONS

2.7.1 TC-978 Connection – Pinout

TC-978 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	CLK_PM	Ground	Gnd	Controller Power Common

2.8 TC-978 CONTROLLER INTERFACE DETAILS

2.8.1 Power

The TC-978 uses 5.5 – 10 volts from the FDL-978-TX (typically ~7 volts). Do NOT connect to aircraft input power.

2.8.2 Remote ON

The Remote ON output controls the ON/OFF power to the FDL-978-TX. This output is connected directly to the Power/Mode switch on the TC-978 and should be connected to the REM ON input (J1-32) of the FDL-978-TX.

2.8.3 TMAP Bus

TMAP is a proprietary bus using RS-485 serial communication. TMAP is a bi-directional interface between the TC-978 and the FDL-978-TX. The TMAP differential lines (TMAPA & TMAPB) on the TC-978 must be connected to the corresponding differential lines (TRxD3+ and TRxD3-) on the FDL-978-TX.

2.8.4 Altitude Out

The TC-978 outputs pressure altitude data on this RS-232 serial output pin (ALT_OUT) at 9600 baud using the commonly called “Icarus” format. The pressure altitude data that is output depends on the Altitude input configuration. If an Altitude/Air Data *functional interface* is configured on a FDL-978-TX *physical interface,* then the pressure altitude data output will be from the configured interface. If no Altitude/Air Data *functional interface* is configured, then the pressure output defaults to the TC-978 built-in altitude encoder. This output should feed the transponder so they share the same altitude source unless the altitude sensor has multiple outputs to feed both the FDL-978-TX and the transponder.

2.9 PERSONALITY MODULE INSTALLATION

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

The following install kit parts from the FDL-978-TX install kit (p/n 85935-00) are used to install the personality module in the backshell:

Item	Qty	Description

1	**1**	**Personality Module (p/n 85945-00-A)**
2	**4**	**Pin Contact, Crimp (p/n 86967)**
3	**1**	**Double-sided Adhesive Tape (p/n 16172)**

The following table shows the Personality Module (PM) wire color connections to the DB-44 connector:

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

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

1. Strip 1/8” of the insulation from each of the four wires of the Personality Module.
2. Crimp pin contacts onto each of the four wire of the Personality module.
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 Personality Module as shown in Figure 8 and the other side should be adhered to one side of the connector backshell as the connector and backshell are assembled together.

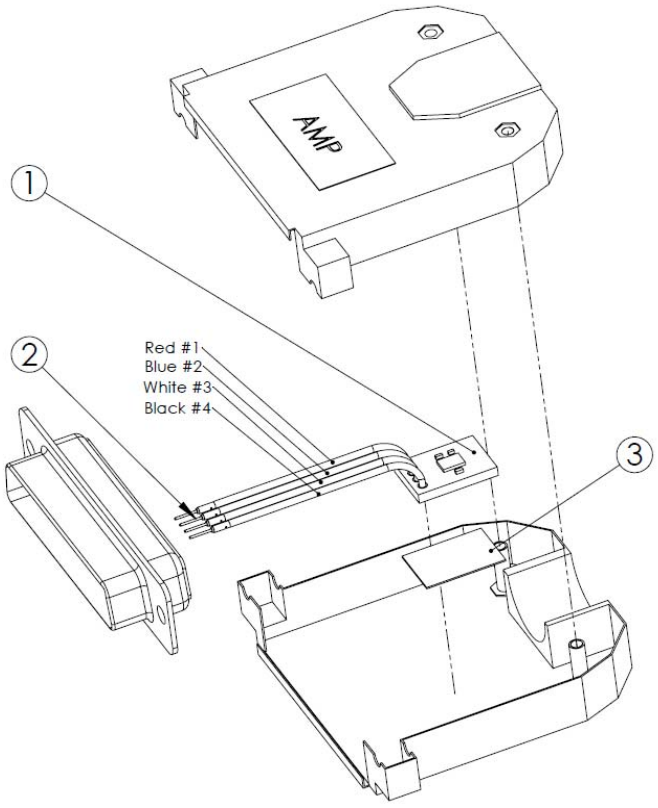


Figure 8. Personality Module Assembly

2.10 WIRING CONSIDERATIONS

The connection from the FDL-978-TX transmitter to the TC-978 controller uses a minimum of six (6) 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 AWG for all wires. Shielded, twisted wiring is recommended for the TMAP pair (and all serial data communication pairs) to improved electromagnetic emissions and susceptibility – one twist per 1 to 2 inches is adequate. Other pairs in the bundle can also be twisted but are not required.

The distance between the FDL-978-TX transmitter and the TC-978 controller is limited by the impedance of the wire between them. The TC-978 is powered from the FDL-978-TX, not from aircraft power, and therefore the acceptable voltage drop in the power line limits the wire length. The TC-978 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. Note that different brands may vary – check your supplier for details.

GAUGE	MILIOHM/FT	LENGTH FOR 0.5 OHM
24 AWG	30.2	33.2 ft

An alternative to a harness built from individual wires, particularly for a long cable run, is to use a multi-core cable. Aviation grade cable with 6 or more cores is often more expensive than the individual wires.

Note that not all data cable is suitable for this application. Cables with solid cores should not be used, and 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.

2.11 UAT ANTENNA INSTALLATION

The antenna should be installed according to the manufacturer's instructions.
Selecting appropriate UAT antenna locations is critical to the proper performance of the FDL-978-TX. The following considerations should be taken into account when selecting the Antenna location.

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

2.11.1 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 ~12in. 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, and small multiples of the wavelength should be avoided, as should circles. Rectangles or squares are much less likely to create a critical dimension that resonates with the transmissions. The smallest practical ground plane is a square around 5.25 in per side; as the size increases the performance may actually get worse, but will be better by the time the ground plane is 30.5 in on each side. Anything much larger than that size is unlikely to show significant further improvement.
The thickness of the material used to construct the ground plane is not critical, providing it is sufficiently conductive. A variety of proprietary mesh and grid solutions are available.

2.11.2 UAT Antenna Cable

The FDL-978-TX is designed to meet Class B1/B1S requirements with an allowance of 2.5 – 6.5 dB for loss in the connectors and cable used to connect it to the antenna. Excessive loss degrades transmitter output power so it is recommended that the installation cable loss be limited to the loss minimum of 2.5dB. Allowing 0.25dB loss for the connector at each end of the antenna cable assembly leaves an allowance of 2.0 – 6.0 dB loss for the cable itself.
An acceptable cable then has:

- A minimum of 2.0dB loss for the run length but no greater than 6.0dB loss
- A characteristic impedance of 50 Ohms
- Double braid screens or has a foil and braid screen

Once the cable run length is determined, a cable type with the proper attenuation (loss) per foot that meets the above requirements can be chosen. Longer runs require lower loss cable. Consider moving the FDL-978-TX closer to the antenna to minimize the losses in the antenna cable subject to the limits identified above.
The following table is a guide to the minimum and maximum usable lengths of some common cable types. Actual cable loss varies between manufacturers and the table is based on typical data. Use the table as a guide only and refer to the manufacturer's data sheet for the specific cable chosen to calculate the minimum and maximum lengths.

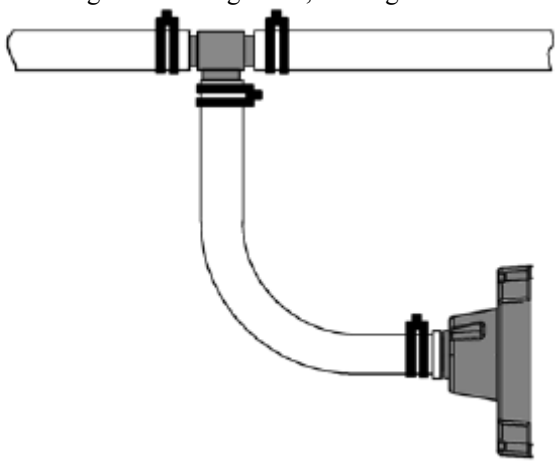
CABLE	ATTENUATION (dB/100 ft @ 1 GHz)	MIN LENGTH (ft)	MAX LENGTH (ft)
RG-174	27.1	7.4	22.1
RG-316	25.8	7.75	23.25
RG-400	14.5	13.8	41.3
RG-142	12.8	15.6	46.9
RG-393	7.5	26.7	80

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 inches (300mm) from an 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.

2.12 STATIC PRESSURE CONNECTION

The TC-978 controller includes an altitude encoder which must be connected to the same source of static pressure as the primary altimeter on the aircraft. The TC-978 static pressure port provides a mounting spigot intended for nominal 5mm or 3/16 inch inside diameter tubing. A length of 5mm 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 TC-978. 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.
The following diagram shows the general arrangement, although other combinations may be used:



For aircraft with ¼ inch static lines, two adapters are provided which can convert from ¼ inch inside diameter hoses to the 5 mm hose in the install kit.
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.

2.13 EQUIPMENT LIMITATIONS

For a compliant installation in accordance with the Technical Standard Order (TSO) and the Federal Aviation Regulations (FAR), the FDL-978-TX installation must meet the following requirements:

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

- The antenna installation must comply with the specifications in Section 2.11.

SECTION III CONFIGURATION AND CHECKOUT

3.1 GENERAL

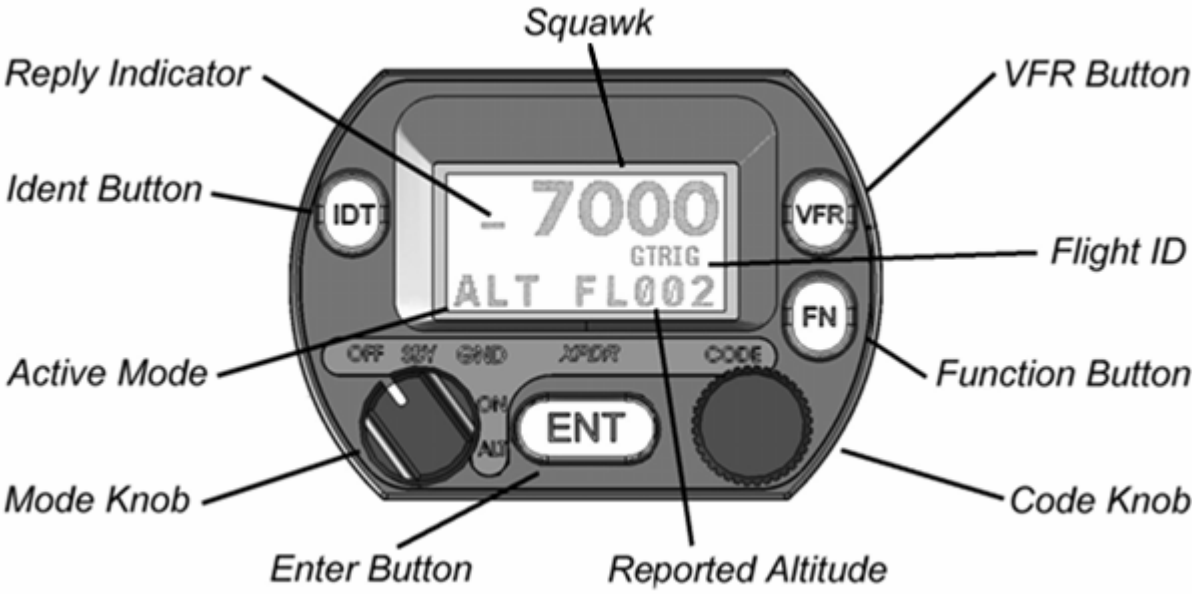
This section contains installation configuration, checkout, and basic operating procedures. More detailed operating procedures are contained in the Pilot Guide.

3.1.1 Continued Airworthiness Requirements

The FreeFlight FDL-978-TX and TC-978 requires no periodic maintenance or calibration. Maintenance is performed on an on-condition basis only. The FreeFlight FDL-978-TX does a power on self test (POST) and is continually tested periodically using a Built-In Test (PBIT) when the system is in operation. This method of testing will notify the operator of a failure. System software updates are accomplished using the Maintenance Interface.

3.1.2 Normal Controller Operation

The FDL-978-TX interfaces to a TC-978 Front Panel Controller used in-flight by the pilot to control output of ADS-B messages. The TC-978 receives its power from the FDL-978-TX and communicates to the FDL-978-TX through a RS-485 serial port. The TC-978 has a monochrome LCD display flanked by a rotary mode selector knob (OFF, SBY, GND, ON, and ALT) and a continuously rotating knob used for code and data entry.



3.1.2.1 Display

The display shows the operating mode of the FDL-978-TX, the reported pressure altitude, and the current squawk code and Flight ID. The reply indicator is active when the FDL-978-TX transmits ADS-B messages.

The pressure altitude is displayed as a Flight Level, which is the pressure altitude in hundreds of feet. When non-standard atmospheric conditions apply this may not match the altimeter indicated altitude but will be correctly reported in the ADS-B message.

3.1.2.2 Mode Selector Knob

The left hand Mode knob controls the power to the FDL-978-TX and the operating mode.

The knob rotates between the different operating modes as defined in the table below:

POS	DESCRIPTION
OFF	Power is removed from the FDL-978-TX.
SBY	The FDL-978-TX is on but will not transmit any ADS-B messages.
GND	The FDL-978-TX is in normal transmission Mode and reports pressure altitude in ADS-B message if available. (Same as ALT setting)
ON	The FDL-978-TX is placed in pressure altitude transmission inhibit Mode. Pressure altitude reporting in ADS-B message is suppressed.
ALT	The FDL-978-TX is in normal transmission Mode and reports pressure altitude in ADS-B message if available. (Same as GND setting)

When airborne the controller should always be set to ALT unless otherwise directed by Air Traffic Control. Aircraft installations should include a ground indication squat switch to automatically transmit ADS-B ground messages upon landing.

3.1.2.3 Push Buttons

BUTTON	DESCRIPTION
IDT 	Press the IDT button when ATC instructs you to “Ident” or “Squawk Ident”.
FN 	Pressing the FN button provides access to changing the Flight ID, displaying warnings, and checking reported GPS position.
VFR 	Pressing the VFR button sets the ADS-B to the pre-programmed conspicuity code. Pressing the button again restores the previous squawk code.
ENT 	The ENT button enters a digit in the code selector.

3.1.2.4 Code Selector Knob

The right hand knob is used to set squawk codes and the Flight ID. The FN button selects which will be updated. Turning the knob will highlight the first digit on the display, and the digit can be changed as required. Press the ENT button to advance to the next digit. When ENT is pressed on the last digit, the new

squawk code or Flight ID will replace the previous value. If the code entry is not completed within 7 seconds the changes are ignored and the previous code restored.

CODE	DESCRIPTION
1200	VFR code in the USA
7000	VFR code commonly used in Europe.
7500	Hijack code
7600	Loss of communications
7700	Emergency code

The Flight ID should correspond to the aircraft call sign entered on flight plan. If no flight plan is active the aircraft registration should be used as the Flight ID. Use only letters and digits. If the Flight ID is less than 8 characters long entering a blank character will end it.

3.1.2.5 Warning Messages

If the FDL-978-TX detects a problem the screen will indicate WARNING with a brief statement of the problem. Depending on the nature of the problem the FDL-978-TX may not be transmitting ADS-B messages. Press ENT to clear the message. If the fault is still present the message will reappear.

3.1.2.6 Fault Annunciation

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

3.2 PRELIMINARY CHECKOUT

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

1. Verify that Aircraft DC bus voltage is present on pins 1 and 16 of P1.
2. Verify that ground is present on pins 17 and 31 of P1.
3. Verify that the two UAT antenna coax center conductors are not shorted to its shield or aircraft ground.

When the above conditions are verified, turn off the master power. Properly attach the external connectors to the FDL-978-TX and TC-978. Mount the TC-978 in there respective mounting locations. Turn on master power and then turn on the TC-978. During initialization the FDL-978-TX unit performs a comprehensive diagnostics test. A failure of a system component will be annunciated by a "Warning Indication" on the TC-978. Warnings concerning the GPS status may not be displayed until 2.5 minutes after power on in order to give the GPS time to acquire satellites. Consult the Pilot Guide for more information concerning WARNING messages.

3.3 INSTALLATION SETUP AND CONFIGURATION

The TC-978 Controller is used in a special configuration mode to program important system installation parameters and is described in the following paragraphs.

3.3.1 Configuration Item Summary

CONFIGURATION ITEM	DEFAULT	SETTING
Mode S Address (ICAO)	0	
VFR Squawk Code	1200	
VFR Flight ID (Call Sign)		
Maximum Airspeed	Unknown	
Aircraft (Emitter) Category		
Squat Switch Type	Not connected	
Serial IN Port 2 Configuration: **Type** **Line Speed**	Not Used 9600	
Serial IN Port 4 Configuration: **Type** **Line Speed**	Not Used 9600	
Serial IN Port 6 Configuration: **Type** **Line Speed**	Not Used 9600	
Serial OUT Port 2 Configuration: **Type** **Line Speed**	Not Used 9600	
Serial OUT Port 6 Configuration: **Type** **Line Speed**	Not Used 9600	
ARINC IN Channel 1 Configuration: **Type** **Speed**	Not Used Low	
ARINC IN Channel 2 Configuration: **Type** **Speed**	Not Used Low	
GPS Certification Level	Uncertified	
GPS NAC Velocity	Unknown	
Aircraft Length	10	
Aircraft Width	10	
GPS Reference Position Offset: **Antenna Distance from Nose** **Antenna Lateral Offset**	Unknown	
1090MHz Receiver Installed	No	
UAT Receiver Installed	No	
UAT Antenna Diversity	Top Only	
Check Ground on UAT Antenna	No	
Source Integrity Level (SIL) Supplement		

3.4 CONFIGURATION MODE

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

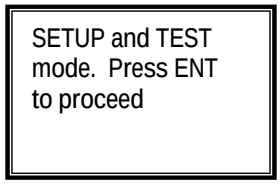
Caution: Do not use Configuration Mode in flight.

The configuration setup screen is the first thing displayed on startup when a completely new FDL-978-TX 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 TC-978, FDL-978-TX and Personality Module.

3.4.1 Entering Configuration Mode

To enter configuration mode on the TC-978:

- Hold down the function button FN while turning the mode knob from off to any operating mode.
- In the configuration mode the front panel controller displays the following messages on the screen



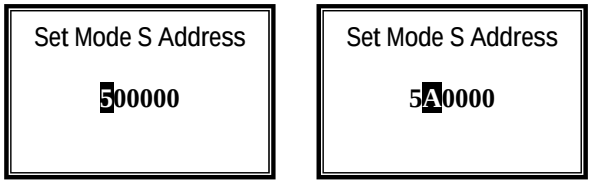
3.5 CONFIGURATION MODE SETUP

Configuration items can be changed using the Code Knob and the ENT button. Pressing FN advances to the next configuration item.

The following paragraphs detail the setup modes available for configuring the FDL-978-TX.

3.5.1 Aircraft Modes S (or ICAO) Address

The Mode S address is a 24 bit number assigned to the aircraft and is represented in a 6 character hexadecimal format. The rotary 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 key is pressed the cursor advances to the next character as shown below.

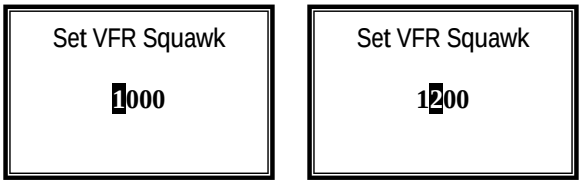


To advance to the next configuration item without changing the ICAO address either scroll through the 6 characters by pressing the ENT key 6 times or press the FN key.

3.5.2 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. *Note: 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 4 character octal number. The rotary 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 key 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 4 characters by pressing the ENT key 4 times or press the FN key.

3.5.3 Call Sign/VFR Flight ID

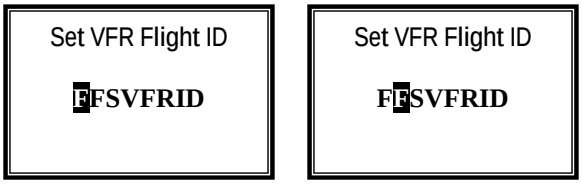
The Call Sign/ VFR flight ID is usually one of the following types:

Type A – the characters corresponding to the registration marking of the aircraft

Type B – the telephony designator of the aircraft operating agency, followed by the last four characters of the registration marking of the aircraft

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

The Call Sign/ VFR Flight ID is an 8 character alpha-numeric string. The rotary code knob is used to change each character as required. Each character of the flight ID is a number between 0 to 9 and letter between A to Z. When the ENT key is pressed the cursor advances to the next character as shown below.



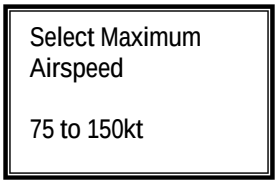
To advance to the next configuration item without changing the VFR Flight ID either scroll through the 8 characters by pressing the ENT key 8 times or press the FN key.
Note: The Call Sign/VFR Flight ID cannot be changed in flight and can only be set in the configuration mode.

3.5.4 Maximum Airspeed

Airspeed can be used to help determine and verify the ON GROUND condition for transmitting ON GROUND ADS-B message types. THE FDL-978-TX uses maximum airspeed configuration to determine a maximum ON GROUND speed. There are 7 options to select maximum aircraft speed:

1. Unknown
2. Up to 75kt
3. 75 to 150kt
4. 150 to 300kt
5. 300 to 600kt
6. 600 to 1200kt
7. Over 1200kt

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



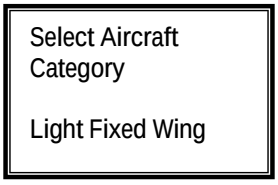
Rotate the code knob either clockwise or counterclockwise to display the options above and select the maximum airspeed. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode.

3.5.5 Aircraft (Emitter) Category

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

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

The display screen is as shown below with one of the options from 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 key to confirm your selection and move to the next configuration item in the setup mode.

3.5.6 Squat Switch Type

The following options are offered for selecting aircraft squat switch type:

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

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

Select Squat Switch Type Low when airborne

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 key to confirm your selection and move to the next configuration item in the setup mode.

3.5.7 Serial IN Channel X Data Type

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

1. Not Used
2. GPS-FreeFlight
3. Air Data Computer
4. Altitude Encoder

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

Serial IN chan 2 Data Type GPS - FreeFlight

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 key to confirm your selection and move to the next configuration item in the setup mode.

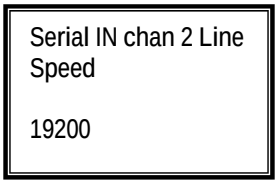
Note: If "Not Used" is selected then the serial input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

3.5.8 Serial IN Channel X Line Speed

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

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

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



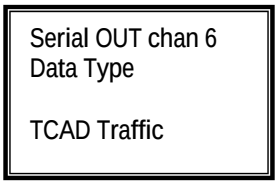
Rotate the code knob either clockwise or counterclockwise to display the options above and select the correct serial input speed. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode.

3.5.9 Serial OUT Channel X Data Type

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

1. Not Used
2. Altitude Encoder
3. TIS/FIS
4. ADS-B Pass Thru

The display screen is as shown below with one of the options from 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 key to confirm your selection and move to the next configuration item in the setup mode.

Note: If "Not Used" is selected then the serial output line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

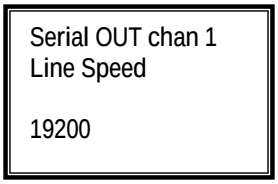
3.5.10 Serial OUT Channel X Line Speed

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

1. 4800
2. 9600
3. 19200
4. 38400
5. 57600

6. 115200
7. 230400

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



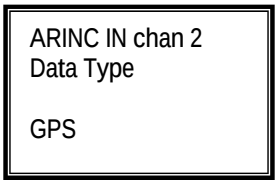
Rotate the code knob either clockwise or counterclockwise to display the options mentioned above and select the correct serial output speed. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode.

3.5.11 ARINC IN Channel X Data Type

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

1. Not Used
2. GPS
3. Air Data Computer

The display screen is as shown below with one of the options from 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 key to confirm your selection and move to the next configuration item in the setup mode.

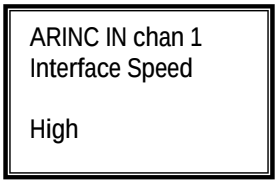
Note: If "Not Used" is selected then the ARINC input line speed configuration mode will not be displayed and the next configuration mode item will be displayed.

3.5.12 ARINC IN Channel X Interface Speed

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

1. Low
2. High

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



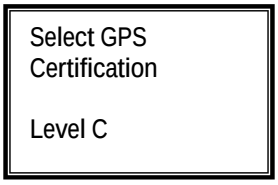
Rotate the code knob either clockwise or counterclockwise to display the options above and select the correct ARINC input interface speed. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode.

3.5.13 GPS Certification

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

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

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



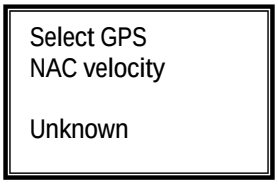
Rotate the code knob either clockwise or counterclockwise to display the options above and select the correct GPS certification level. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode.

3.5.14 GPS NAC Velocity

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

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

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

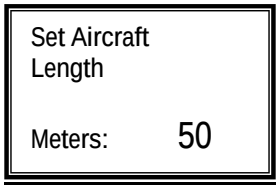


Rotate the code knob either clockwise or counterclockwise to display the options above and select the correct GPS certification level. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode.

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

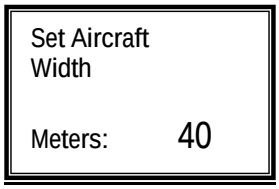
3.5.15 Aircraft Length

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 key to confirm selection and move to the next configuration item in the setup mode.



3.5.16 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 key to confirm selection and move to the next configuration item in the setup mode.



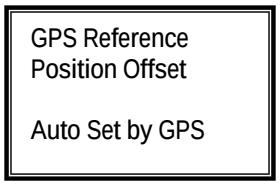
3.5.17 GPS Reference Position Offset

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

1. Unknown

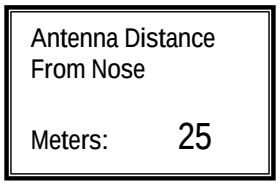
2. Auto set by GPS
3. Manual set here

The display screen is as shown below with one of the options from 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 key to confirm your selection. If “Unknown” or “Auto Set by GPS” is selected the next configuration item in the setup mode will be displayed. If “Manual Set here” is selected then options for manually entering the GPS antenna reference offset are displayed as below:

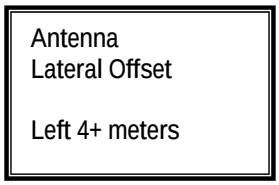
The antenna distance from the nose can be entered anywhere between 2 meters to 60 meters by rotating the code knob either clockwise or counterclockwise to display the correct distance. Once selected, press the ENT key to confirm selection and move to the lateral offset configuration item in the setup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



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

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

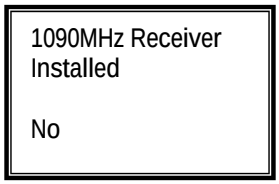
The display screen ia as shown below with one of the options from above:



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

3.5.18 1090 MHz Receiver Installed

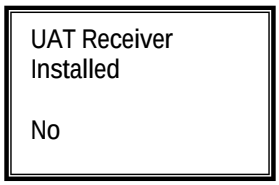
The display screen is as shown below with either Yes or No options.



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

3.5.19 UAT Receiver Installed

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



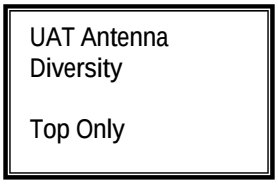
Rotate the code knob either clockwise or counterclockwise to display either “Yes” or “No” and select the correct option. Once selected, press the ENT key to confirm selection and move to the next configuration item in the setup mode.

3.5.20 UAT Antenna Diversity

The FDL-978-TX provides the flexibility for installing either one or two approved UAT antennas. A single antenna can either be installed on the top of the aircraft fuselage or on the belly of the aircraft. When two antennas are installed they are installed on the top and bottom of the aircraft. The following options can be selected:

1. Top Only
2. Bottom Only

3. Dual

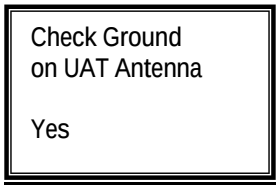


Rotate the code knob either clockwise or counterclockwise to display the correct antenna diversity option. Once selected, press the ENT key to confirm selection and move to the next configuration item in the setup mode.

Note: It is recommended to install dual antennas for maximum coverage.

3.5.21 Check Ground on UAT Antenna

Confirm if the UAT antenna(s) used have a ground connection that allows the FDL-978-TX 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:

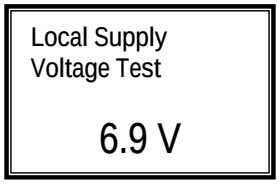


Once selected, press the ENT key to confirm selection and complete the configuration setup.

3.6 TEST AND CALIBRATION

3.6.1 Local Voltage Supply Test

The front panel controller of the FDL-978-TX utilizes a D.C 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 key or the FN key and move to the next configuration item in the setup mode.

3.6.2 Calibrate Altitude Encoder

The TC-978 includes a built-in altitude encoder. The front panel reports pressure altitude on pin 4 of the DB-9 male connector on the back of the TC-978 as RS-232 serial data, at 9600 bps, using the format commonly called “Icarus” format. The installation manual provides further details of interfacing the altitude encoder with the primary static pressure of the aircraft altimeter. The calibrate altitude encoder setup allows the recalibration of the altitude encoder. This ensures that the altitude seen on the pilot’s primary altimeter is the same as what is transmitted out of the FDL-978-TX. The maximum allowed difference between the primary altimeter and the altitude encoder is 125 feet in ETSO C88a and TSO C88b. The altitude encoder in the Front Panel 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.

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

3.6.2.1 Calibration Equipment

To calibrate the encoder the TC-978 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 Front Panel Controller

3.6.2.2 Calibration Procedure

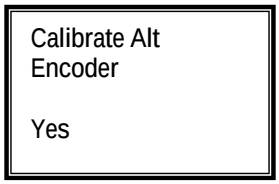
There are two adjustment points on the altitude encoder, a low altitude adjustment point, and a high altitude adjustment point. The low altitude point adjusts the correspondence at sea level, and the high altitude point adjusts the correspondence at the altitude limit of the encoder. Since the altitude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

Note: DO NOT EXCEED THE ALTITUDE OR RATE OF CLIMB LIMITS OF THE PITOT-STATIC INSTRUMENTS OF THE AIRCRAFT. The TC-978 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 hPa, 29.92 in hg.

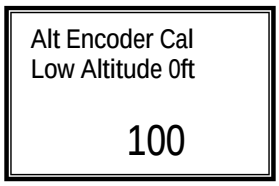
2. Connect the pitot-static test set to the aircraft.

3. You can enter the altitude encoder calibration setup either after following the steps from above in order or you can enter directly by holding the FN button down on the controller on power up to enter setup mode. And skipping over the configuration modes until reaching the calibrate altitude encoder section. When you are in the calibrate altitude encoder setup mode the display shows the following information;



4. Rotate the code knob either clockwise or anticlockwise to display either "Yes" or "No" and select the correct option. Once selected, press the ENT key to confirm your selection and move to the next configuration item in the setup mode. If "No" is selected then the next configuration item in the setup mode will be displayed. If "Yes" is selected then options for calibrating the altitude encoder is as shown below.

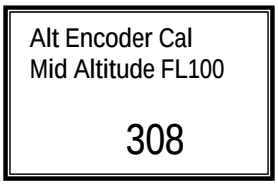
5. On selecting "Yes" the low altitude set point will now be active, and an altitude will be displayed as below.



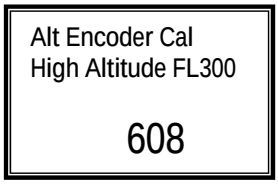
6. On the static test set, drive the altitude to 0 feet.

7. Read the primary altimeter value; rotate the code knob either clockwise or anticlockwise until the altitude displayed on the front panel matches the aircraft primary altimeter.

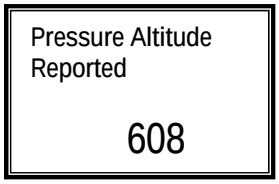
8. Press ENT and the display will move to the mid altitude set point and an altitude will be displayed as shown below. On the static test set, drive the altitude to the middle range ceiling of the aircraft.



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



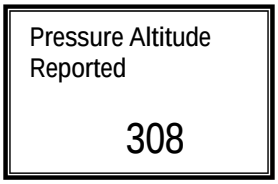
10. Read the primary altimeter value; rotate the code knob either clockwise or anticlockwise until the altitude displayed on the front panel matches the aircraft primary altimeter. Press ENT and the display will move to the test altitude screen which is the next configuration item in the setup mode.



11. 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 front panel correspond within the 125 foot tolerance. Lightly tap the altimeter at each test point to eliminate friction effects. When the correspondence test is complete, press ENT again on the front panel, and power off the system.

3.6.3 Pressure Altitude Reported

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



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

SECTION IV TROUBLESHOOTING

4.1 GENERAL

This section provides information for troubleshooting problems that occur after FDL-978-TX installation. This section contains information on how to use the FDL-978-TX LEDs and TC-978 Controller display to troubleshoot installation problems. Refer to SECTION III to setup and configure the system.

4.2 FDL-978-TX LED TROUBLSHOOTING PROCEDURE

The following is a quick reference troubleshooting guide using the FDL-978-TX 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 TC-978 Warning messages
Rx LED not active	Normal operation for transmitter	
Status LED is on	A fault with the unit or the attached GPS exists	Check TC-978 Warning messages Check GPS connection/configuration
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 or has a fault	Check GPS connection/configuration Check GPS for fault

4.2.1 UAT Status LED/Discrete Fault Indications

The status LED/discrete is an indicator of a warning or fault reported by the FDL-978-TX. The status LED is visible on the FDL-978-TX or the discrete may be connected to a cockpit annuciator. Potential faults that cause the UAT Status 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 Port Loopback Test Failure	POST
ARINC 429 Channel Loopback Test Failure	POST
General Processing/Interface Hardware Failure	POST
Transmitter Hardware Check Failure	POST

4.3 WARNING MESSAGES

If the FDL-978-TX detects a problem the TC-978 display will indicate WARNING with a brief statement of the problem. Depending on the nature of the problem the FDL-978-TX may not be transmitting ADS-B messages.

Press ENT to return the Control Head to normal operation. The LCD will display an icon in the upper left-hand corner to indicate that warnings are still present. To enter the Warning View mode, press FN four times. In this mode, the control head continually requests the active warning messages from the FDL-978-TX and displays them on the Control Head. Press FN again to exit this mode and return to normal operation.

TC-978 WARNING MESSAGES

WARNING MSG	DESCRIPTION
Synth Unlock	Transmitter carrier frequency lock fault
Tx Fault	UAT transmitter fault
Tx Power Low	UAT transmitter power low during transmit
Tx PSU High	UAT transmitter power supply output too high
Tx PSU Low	UAT transmitter power supply output too low
Squitter Fail	Transmitter message modulation fault
Remote Hot	FDL-978-TX internal temperature too high
No ADS-B Pos	GPS position not acquired, satellite tracking lost, or GPS not communicating
GPS Fault	GPS indicates a fault or not responding or no time mark pulse detected
Top ant Fault	Top antenna disconnected
Bot ant Fault	Bottom antenna disconnected
PSU Fail	Internal DC power supply failure
ADC Fault	ADC or Altitude sensor fault or not responding

4.3.1 TC-978 Warning Message Troubleshooting

The following is a quick reference troubleshooting guide using the TC-978 Warnings:

WARNING	POTENTIAL CAUSE	TROUBLESHOOTING
Synth Unlock	Transmitter can't lock to carrier frequency	Cycle Power on the FDL-978-TX Return for maintenance if problem persists
TX Fault	Generic Transmitter Fault – POST, transmit, address, broadcast, or nominal rate failure.	Cycle Power on the FDL-978-TX Check for valid ICAO address config
Tx Power Low	Transmitter power too low	Check antennas and cabling Return for maintenance if problem persists
Tx PSU High	Transmitter power supply voltage too high.	Cycle Power on the FDL-978-TX. Return for maintenance if problem persists.
Tx PSU Low	Transmitter power supply voltage too low.	Cycle Power on the FDL-978-TX. Return for maintenance if problem persists.
Squitter Fail	Transmitter modulation fault	Cycle Power on the FDL-978-TX. Return for maintenance if problem persists.
Remote Hot	FDL-978-TX internal temperature too high.	Cycle Power on the FDL-978-TX. Turn power off for several minutes then back

WARNING	POTENTIAL CAUSE	TROUBLESHOOTING
		on. Return for maintenance if problem persists.
No ADS-B Pos	GPS position not acquired, satellite tracking lost, or GPS not communicating	Verify GPS is functioning. Verify GPS Port Configuration and speed. Verify GPS Cable connection.
GPS Fault		Verify GPS is functioning. Verify Incoming GPS Port Configuration and speed. Verify GPS Cable connection.
Top ant Fault	Top antenna disconnected.	Check antenna connection. Ensure antenna is DC grounded. Disable DC Grnd Check in config if antennas are not DC grounded.
Bot ant Fault	Bottom antenna disconnected.	Check antenna connection. Ensure antenna is DC grounded. Disable DC Grnd Check in config if antennas are not DC grounded.
PSU Fail	Internal DC Power Supply failure.	Cycle Power on the FDL-978-TX. 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 V RTCA/DO-160 ENVIRONMENTAL QUALIFICATION FORMS

5.1 FDL-978-TX UAT DO-160 QUALIFICATION

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

5.2 TC-978 CONTROLLER DO-160 QUALIFICATION

CONDITIONS	PARA	CATEGORY (DO-160E)
Temperature and Altitude	4	C4 (-20ºC to +55ºC)
Temperature Variation	5	A
Humidity	6	A
Shock/Crash Safety	7	B
Vibration	8	U (Curve G)
Explosive Atmosphere	9	n/a
Waterproofness	10	W (front face only)
Fluids Susceptibility	11	n/a
Sand and Dust	12	n/a
Fungus Resistance	13	n/a
Salt Fog	14	n/a
Magnetic Effect	15	Z
Power Input	16	n/a
Voltage Spike	17	n/a
Audio Frequency Conducted Susceptibility – Power Inputs	18	n/a
Induced Signal Susceptibility	19	AC
Radio Frequency Susceptibility	20	TT
Emission of Radio Frequency Energy	21	M
Lightning, Induced Transient Susceptibility	22	n/a
Lightning Direct Effects	23	n/a
Icing	24	n/a
Electrostatic Discharge	25	n/a
Fire, Flammability	26	n/a

SECTION VI 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 B.4. The baud rate of each of these formats is automatically set; ENCODER is 9600 baud and RMI is 1200 baud.

6.1 ALTITUDE ENCODER FORMAT

The Altitude Encoder data format accepts messages with the following parameters:

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

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

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

Some examples include:
'ALT 00000' 0 feet
'ALT -1200' -1200 feet
'ALT 62505' 62,505 feet
'ALT 05604' 5,604 feet

6.2 AIR DATA COMPUTER FORMAT

The Air Data computer format accepts messages withthe following parameters:

Baud: 9600
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 Air Data Computer cannot supply data in a particular field, the field is filled with dashes ("-" = 2DH). The table below lists the message items used by the FDL-978-TX. Additional items may be in the message but they are not used by the FDL-978-TX.

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)

ITEM FORMAT	CONTENTS	DESCRIPTION
ZKsddd	Vertical Speed	s = sign, ddd = tens of feet/minute (-600 to +600)
ZRddd	Packet Checksum	ddd = number (0 to 255)

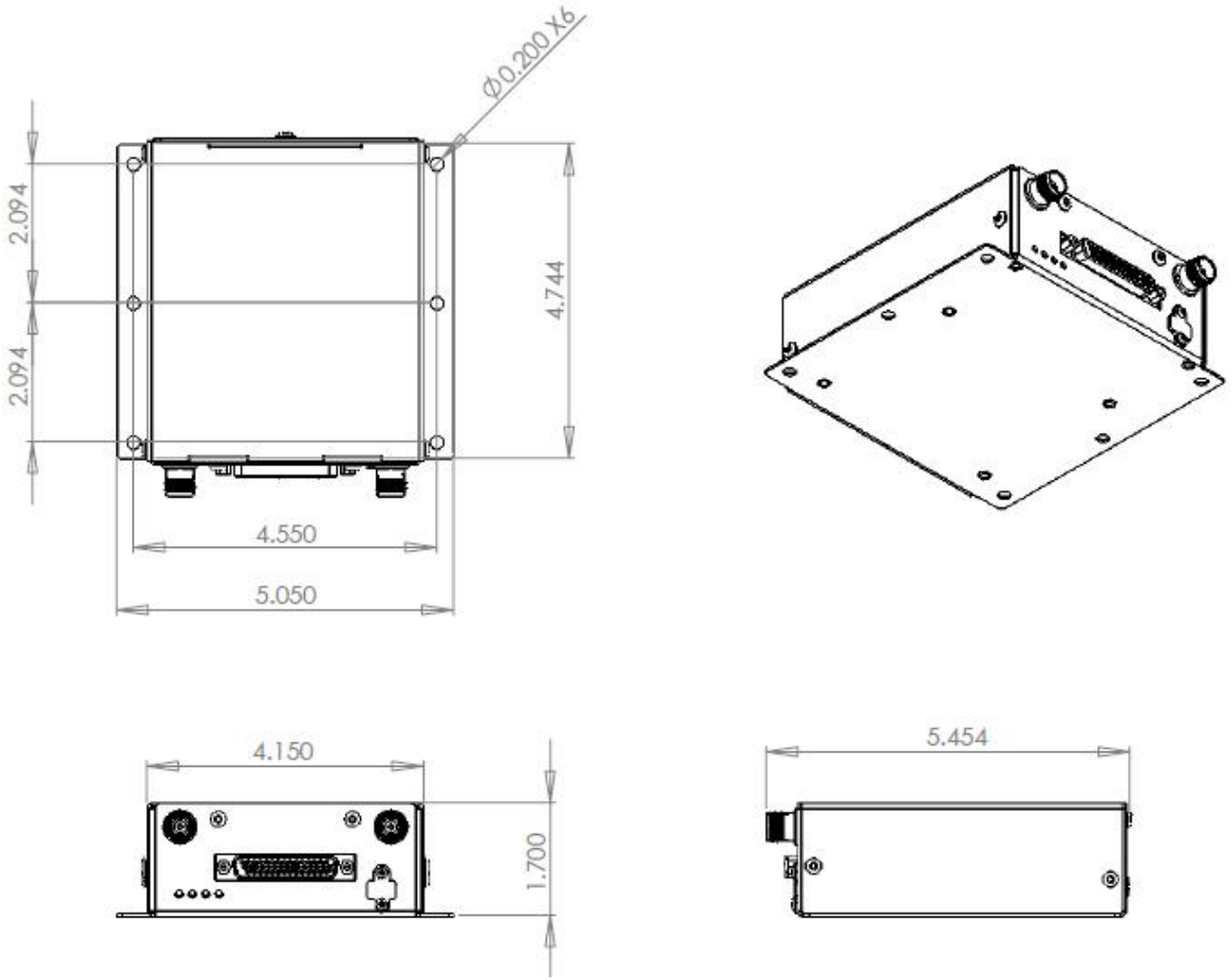
SECTION VII ADS-B COMPLIANCE

ADS-B PARAMETERS SUPPORTED

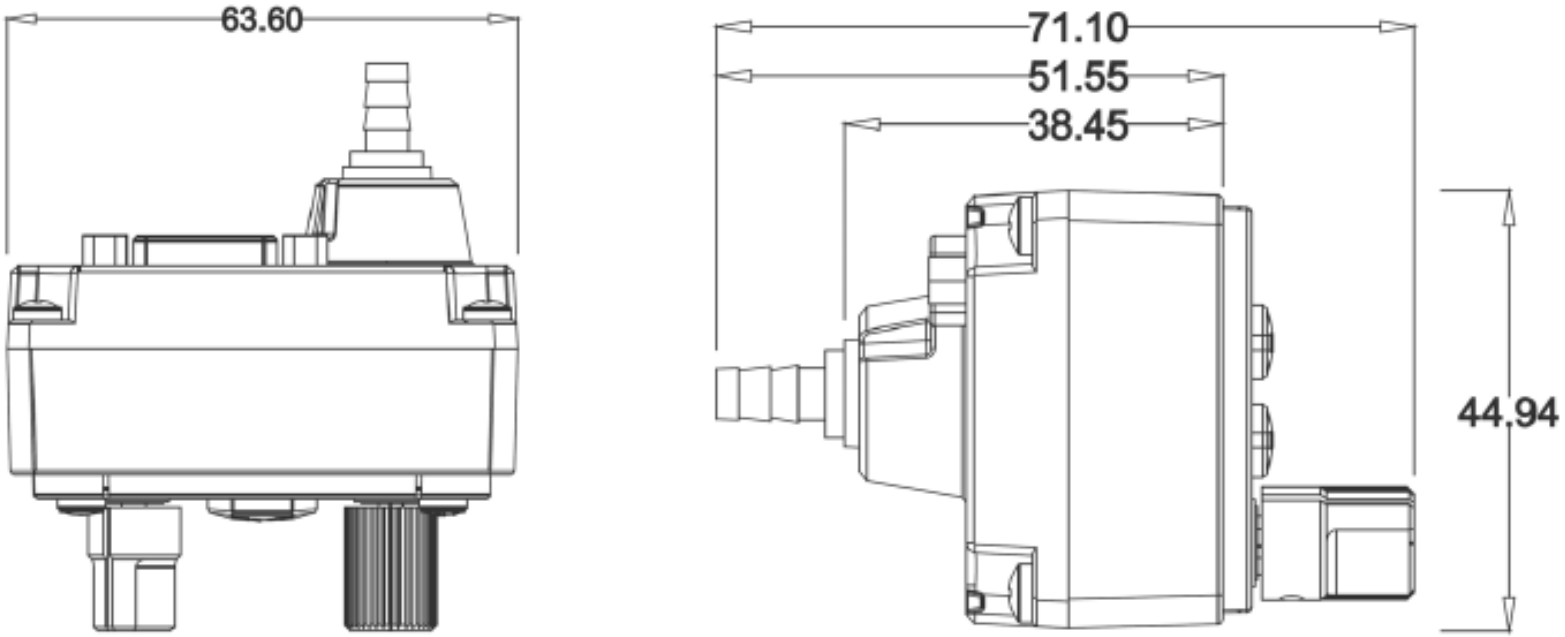
#	Input Data Element	Comment (Use within the FDL-978-TX)
1	ICAO 24-bit Address	Installation configuration
2	Address Selection (ICAO vs Temporary)	Anonymous discrete input
3	Latitude	From GPS data
4	Longitude	From GPS data
5	Altitude Type Selection (Barometric vs Geometric)	Baro unless invalid or inhibited
6	Barometric Pressure Altitude	From altitude/air data sensor
7	Geometric Altitude	From GPS data
8	NIC	From GPS data
9	Automatic AIRBORNE/ON-GROUND Indication	Air/Ground discrete input
10	North Velocity	From GPS data
11	East Velocity	From GPS data
12	Ground Speed	From GPS data
13	Track Angle	From GPS data
14	Heading	From GPS data
15	Barometric Vertical Rate	From altitude/air data sensor
16	Geometric Vertical Rate	From GPS data
17	A/V Length and Width, and POA	Installation configuration
18	UTC 1 PPS Timing	From GPS Data
19	Emitter Category	Installation configuration
20	Call Sign	From controller interface (TC-978)
21	Emergency/Priority Status Selection	From controller interface (TC-978)
22	SIL	GPS with HIL or HPL only
23	System Design Assurance (SDA)	Installation configuration
24	SIL Supplement	GPS with HIL or HPL only
25	NAC_P	From GPS data
26	NAC_V	From GPS data
27	NIC_{BARO}	Non-Gilham altitude sensors only
28	Capability Codes	Installation configuration
29	TCAS Installed and Operational	Installation configuration
30	TCAS/ACAS resolution advisory flag	TCAS RA discrete input
31	IDENT Switch Active	From controller interface (TC-978)
32	Call Sign Identification	From controller interface (TC-978)
33	Geometric Vertical Accuracy (GVA)	Installation configuration
34	Single Antenna Flag	Installation configuration
35	NIC Supplement Flag	From GPS data
36	Selected Altitude Type	Not supported in current software
37	Selected Altitude Setting	Not supported in current software
38	Barometric Pressure Setting	Not supported in current software
39	Selected Heading	Not supported in current software
40	Status of MCP/FCU Mode	Not supported in current software
41	Mode Indicators: Autopilot Engaged	Not supported in current software
42	Mode Indicators: VNAV Engaged	Not supported in current software
43	Mode Indicators: Altitude Hold Mode	Not supported in current software
44	Mode Indicators: Approach Mode	Not supported in current software
45	Mode Indicators: LNAV Engaged	Not supported in current software
46	Radio Height	Not supported in current software
47	Pressure Altitude Disable	From controller interface (TC-978)
48	Airspeed	From altitude/air data sensor
49	Flight Plan ID	From controller interface (TC-978)

SECTION VIII INSTALLATION DRAWINGS

8.1 FDL-978-TX TRANSMITTER DIMENSIONS



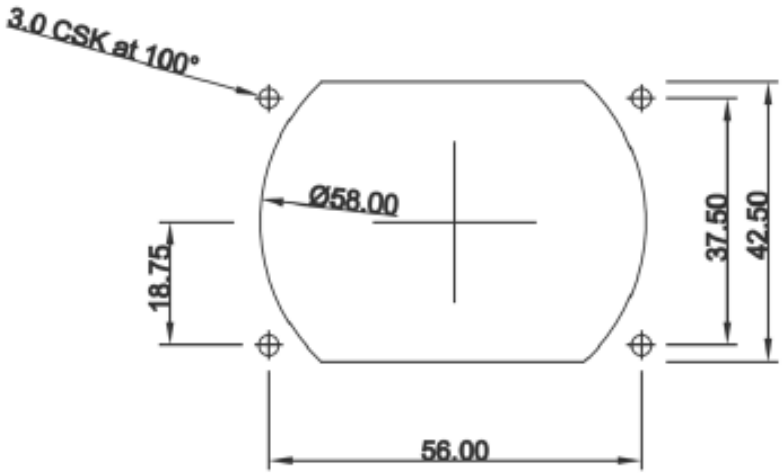
8.2 TC-978 CONTROLLER DIMENSIONS

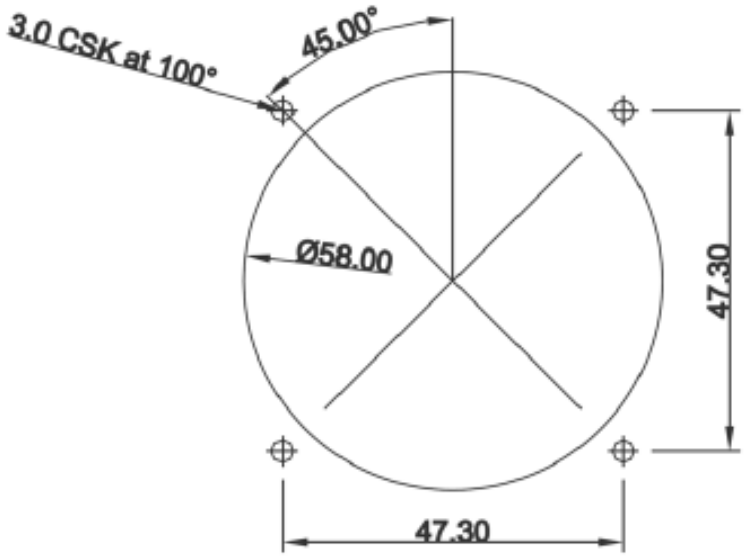


All dimensions in millimeters.

8.3 FRONT PANEL CUT-OUT OPTIONS

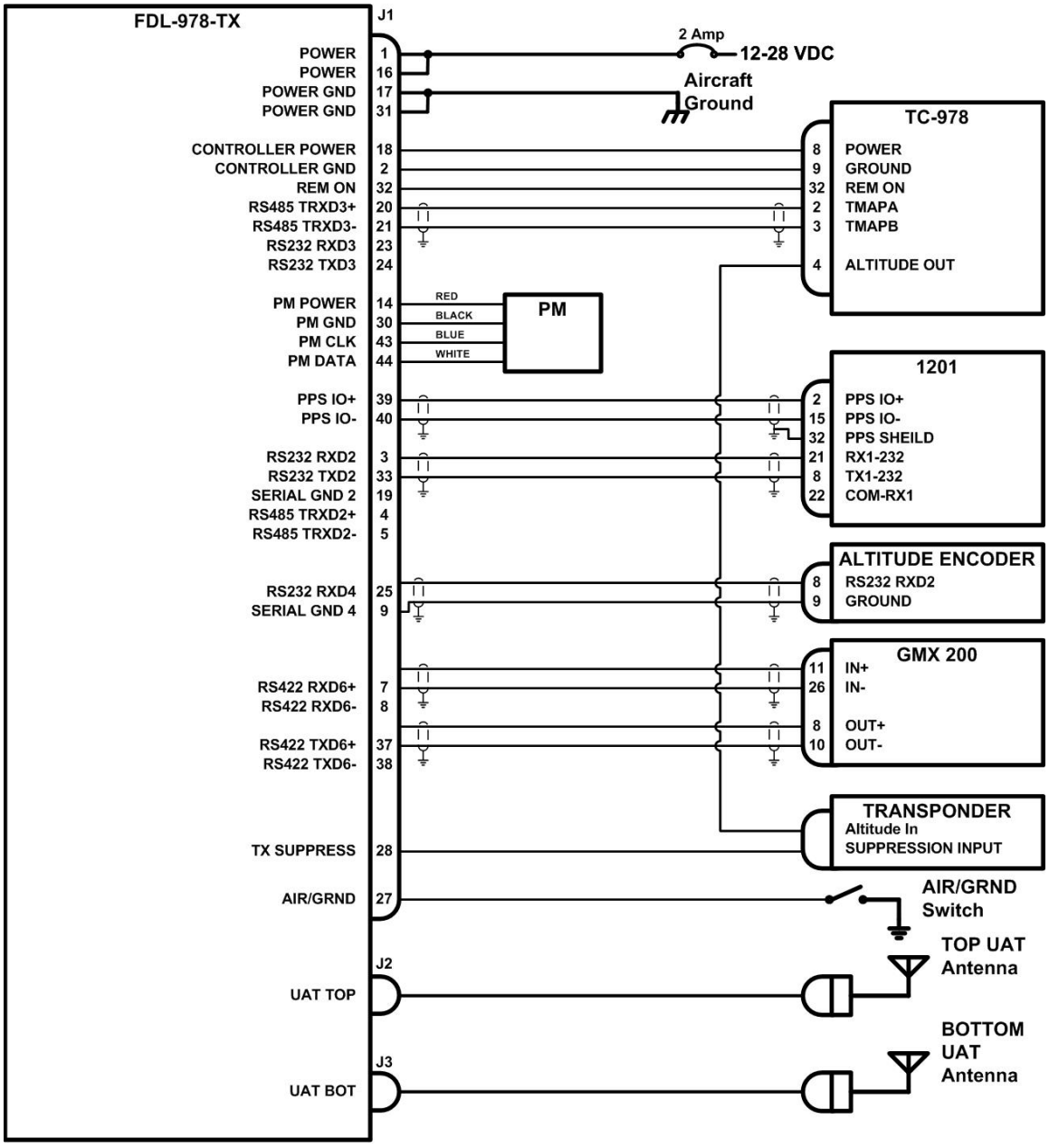
The TC-978 front panel controller can be fitted to either the compact mounting hole or a conventional 2¼ inch (57mm) instrument cut-out. The compact mounting is a truncated 58 mm opening. Note that the mounting screws are NOT in the same location for the two options.


3.0 CSK at 100°
Ø58.00
18.75
37.50
42.50
56.00


3.0 CSK at 100°
45.00°
Ø58.00
47.30
47.30

SECTION IX INTERCONNECT DIAGRAMS

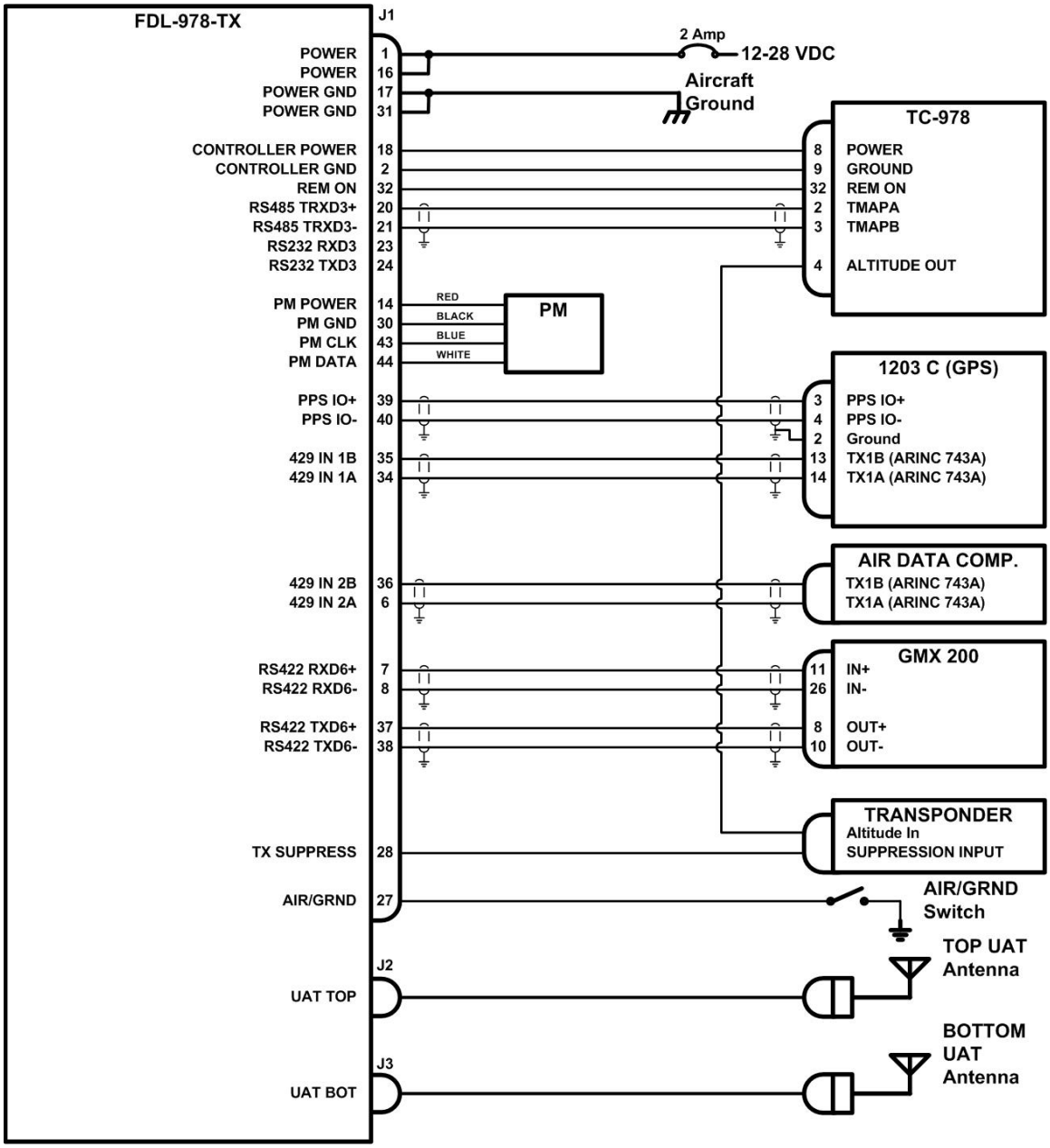
9.1 FDL-978-TX INTERCONNECT DIAGRAM WITH 1201 GPS/SBAS SENSOR



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.

9.2 FDL-978-TX INTERCONNECT DIAGRAM WITH 1203/1203C GPS/SBAS SENSOR



NOTES:

1. ALL WIRES ARE 24 AWG MINIMUM UNLESS OTHERWISE NOTED.
2. CONNECT TWISTED-PAIR SHIELDED WIRE GROUNDS TO SERIAL GROUND PINS OR AIRCRAFT GROUND WITH AS SHORT OF A CONDUCTOR AS POSSIBLE.

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(D) The company must have received a copy of a completed FAA Form 337 covering installation of the product in the purchaser's aircraft or equivalent documentation showing installation of the product by the authorized FREEFLIGHT dealer.

(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.

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Waco, TX 76706
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1 (800) 487-4662
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