TDFM-136

VHF/FM DIGITAL AIRBORNE TRANSCEIVER

INSTALLATION & OPERATING INSTRUCTIONS

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Technisonic Industries Limited
250 Watline Avenue, Mississauga, Ontario L4Z 1P4 Tel: (905) 890-2113 Fax: (905) 890-5338
3840 E. Robinson road, Suite 214, Amherst, New York 14228 Tel: (716) 691-0669

⚡ ! CAUTION STATIC SENSITIVE ! ⚡

This unit contains static sensitive devices. Wear a grounded wrist strap and/or conductive gloves when handling printed circuit boards.

FCC COMPLIANCE

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: ***This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:***

- ***Re-orient or relocate the receiving antenna***
- ***Increase the separation between the equipment and receiver***
- ***Connect the equipment into an outlet or circuit different from that to which the receiver is connected.***
- ***Consult the dealer or an experienced radio/TV technician for help.***

WARRANTY INFORMATION

The Model TDFM-136, VHF/FM Digital Transceiver is under warranty for one year from date of purchase. Failed units caused by defective parts, or workmanship should be returned to:

Technisonic Industries Limited
250 Watline Avenue
Mississauga,
Ontario L4Z 1P4

Tel: (905) 890-2113
Fax: (905) 890-5338

Technisonic Industries Limited
3840 E. Robinson Road, Suite 214
Amherst,
New York 14228

Tel: (716) 691-0669

DOCUMENT REVISION TABLE: for 99RE255				
REV.	PAGE	DESCRIPTION	DATE	APPR.
A	Section 2 (all pages)	Change Section 2 to reflect operating instructions for R0V20 software.	MARCH 2000	R.R.
B	Section 2 (all pages) page 3-8	Change Section 2 to reflect operating instructions for R0V44 software. Change figure 3-4 to reflect new jumper locations.	JUNE 2000	R.R.
C	Section 2 (all pages)	Change Section 2 to reflect operating instructions for R1V00 software.	SEPTEMBER 2000	R.R.
D	Section 2 (all pages) 3-7, 3-8	Expand descriptions of commands Update Fig 3-4 & 3-5	OCTOBER 2000	A.M.

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SECTION 1

GENERAL DESCRIPTION

1.1 Introduction

This publication provides operating and installation information on the TDFM-136, Digital Transceiver manufactured by Technisonic Industries Limited. The TDFM-136 is Project 25 (P25), Phase 1 compliant. The unit offers digital or conventional analog FM communications over an extended frequency range with selectable channel spacing and is intended for use (in the U.S.) only by government agencies or contractors thereto, who have obtained licensing for operation in the 136-150 MHz portion of the band. If the TDFM-136 transceiver is used in CANADA, operation is restricted to the following sub bands: 138-144, 148-148.99, 149.005-150.005 and 150.05-174 MHz. Furthermore the frequency agile transceiver is restricted to airborne use and must not be operated as a base station in Canada.

1.2 Description

The TDFM-136, Transceiver is a frequency agile, fully synthesized airborne transceiver capable of operating in the 136.000 MHz to 174.000 MHz frequency range in 2.5kHz increments with either 25 kHz analog, 12.5 kHz analog channel spacing and P25, 12.5 KHz digital modulation on a channel by channel basis. The Transceiver can operate without restriction on any split frequency pair in the band and also incorporates a two channel synthesized guard receiver.

The TDFM-136 Transceiver provides 200 operator accessible memory positions. Each of which is capable of storing Scan List membership information, up to nine (9) character alphanumeric identifier, and Operating Mode information. In addition each memory position contains information for both transmit and receive including: frequency, CTCSS tone, DCS (DPL) code, P25 TalkGroup, and P25 Network Access Code (NAC) information.

Channel operating parameters, including frequency and other related data, are presented on a 48 character, two line LED matrix display. Data entry and function control takes place via a 12 button keypad.

1.3 Purpose of Equipment

The TDFM-136, Digital VHF/FM Transceiver is designed to provide secondary airborne communications to facilitate operations which are typically performed in a low altitude environment. The transmitter section of this unit has a minimum of 8 watts and does not exceed 10 watts output power, which may be reduced by a front panel switch to 1 watt, in order to reduce interference to land based systems.

1.4 Model Variation

There are four variations of the Model TDFM-136 Transceiver. All units offer identical features and performance except for the following differences:

TDFM-136, P/N 981087-1	GREEN display and 28 Volt back lighting.
TDFM-136, P/N 981087-1 (5V)	GREEN display and 5 Volt back lighting.
TDFM-136, P/N 981087-2	RED display and 28 Volt back ligting.
TDFM-136, P/N 981087-2 (5V)	RED display and 5 Volt back lighting.

Both P/N's 981087-1 and 981087-2 are always provided with 28 Volt back lighting unless a specific request is made for 5 Volt AC operation.

1.5 Technical Characteristics

The tables below provide the technical characteristics for the Technisonic Industries Ltd. Model TDFM-136.

Table 1-1. TDFM-136 - General Characteristics

Characteristic	Specification
Dimensions (including heat sink)	Approx. 8.0" X 3.0" X 5.75"
Weight	Approx. 3.5 Lbs (1.6 Kg)
Mounting	Panel Mount via DZUS fasteners
Power Requirement: Voltage Current	 28.0 VDC, ± 15% Receive - 0.7 A Max. Transmit Low Power (1W) - 1.3 A Max. Transmit High Power (8-10W) - 2.0 A Max.
Audio Output Power: Headset Speaker Output	 0.5 Watts into 600 ohms 2.5 Watts min. into 4 ohms
Back Lighting	28 Volts (standard) 5 Volts (specify)
Display Colour	Green (standard) Red (specify) NVG (optional)
Temperature Range: Operating Storage	 -45°C to +70°C -55°C to +85°C
Altitude	50,000 feet

Table 1-2. TDFM-136 - Operational Characteristics	
Characteristic	Specification
Frequency Range	136.000 to 174.000 MHz
Operating Modes	conventional Analog: 12.5 / 25 kHz. P25 CAI: 12 KBPS FSK, 9.6 KBPS C4FM
Channel Spacing:	25 kHz. or 12.5 kHz
Programmable Memories: Scan Lists Description Operating Modes Frequency Squelch Modes	200 memories Up to 5 scan lists Up to 9 characters, alpha-numeric Analog Wide, Analog Narrow, P25 Digital Rx/Tx (Simplex/Duplex), 136.0000 – 174.0000 Rx/Tx (Simplex/Duplex), CTCSS Tones, DCS Codes, P25 TalkGroup, P25 NAC
Guard Receiver: Description Operating Modes Frequency Squelch Modes	2 channels programmed with: Up to 9 characters, alpha-numeric Analog Wide, Analog Narrow, Digital Rx/Tx (Simplex/Duplex), 136.0000 – 174.0000 Rx/Tx (Simplex/Duplex), CTCSS Tones, DCS Codes, P25 TalkGroup, P25 NAC
CTCSS Tones	42 CTCSS tones, including all standard tones.
DCS Codes	All standard DCS (DPL*) codes
P25 TalkGroup	0000 to FFFF
P25 Network Access Code (NAC)	000 to FFF

* DPL is a trademark of Motorola Corporation

Table 1-3. TDFM-136 - Receiver Characteristics û Main and Guard	
Characteristic	Specification
Sensitivity at 12 dB SINAD	-116dBm
Adjacent Channel Selectivity	-60dB (25 or 12.5 KHz)
Spurious Attenuation	-70 dB
Third Order Intermodulation	-70 dB
Image Attenuation	-80 dB
FM Acceptance	± 6 KHz
Hum and Noise	Better than 45dB
Audio Distortion	less than 5%
Antenna Conducted Emission	less than -57dBm

Table 1-4. TDFM-136 - Transmitter Characteristics	
Characteristic	Specification
RF Output Power: Low High	 100mW to 1W (internal adjustment). 10 watts.
Output Impedance	50 ohms
Maximum Deviation: Wide (25 kHz) Narrow (12.5 kHz)	 ±5 kHz ±2.5 kHz
Maximum Deviation – Narrow	±2.5 kHz (12.5 kHz mode)
Spurious Attenuation	-90 dB below carrier level
Frequency Stability	± 2.5 ppm
Microphone Circuit	Carbon or equivalent
Side-tone Output	0.5W (max) into 600Ω
Harmonic Attenuation	-65 dB below carrier level
FM Hum And Noise	-40 dB
Audio Input	50 mV at 2.5 into 200Ω input circuit for ±3.5 deviation, adjust.
Audio Distortion	Less than 5%

1.6 Certification Summary

The following table gives a summary of DO-160D Environmental Testing for Technisonic Model TDFM-136, VHF Digital Transceiver.

Table 1-5. TDFM-136 Environmental Testing Summary		
Conditions	Section	Conducted Test
Temperature and Altitude	4.0	Equipment tested to Categories B2 and D1.
Temperature Variation	5.0	Category B.
Humidity	6.0	Category A.
Operational Shock and Crash Safety	7.0	Category A.
Vibration	8.0	Equipment is tested without shock mounts to categories S and U.
Magnetic Effect	15.0	Equipment is class A.
Power Input	16.0	Category B.
Voltage Spike	17.0	Category B.
Audio Frequency Susceptibility	18.0	Category B.
Induced Signal Susceptibility	19.0	Category A.
Radio Frequency Susceptibility	20.0	Category U.
RF Emission (DO-160D) RF Emission (DO-160C)	21.0 21.0	Category B. Category Z.
Electrostatic Discharge	25.0	Category A.

SECTION 2

OPERATING INSTRUCTIONS

This section provides the user with a reference of the keypad accessible programming features of the Technisonic TDFM-136 VHF FM Digital Transceiver.

2.1 Command Levels

In order to accommodate the necessary commands, the commands have been divided into different levels; the user may move between levels as follows:

0 PROG step **up** through available command levels (see table below).

* ESC step **down** through available command levels (see table below).

Table 2-1. Command Level Table

Command Level	Display Indicator
Operator L1	blank
Operator L2	'**2**'
Operator L3	'**3**'
Maintenance	'**4**'

When stepping through command levels, the indicated level is shown in subscript in the 4th character position on the lower line of the display. Note that this display position is left blank for the default level (level1). Figure 2-1 below shows the front panel display for different Command levels.

Level 4 (Maintenance) commands are to allow maintenance personnel to maintain the radio only. *This command level should NEVER be used in flight.*
In order to restrict access to L4 commands the level must be reached by a special key sequence from power-on or a maintenance jumper must be installed on the MCU board.

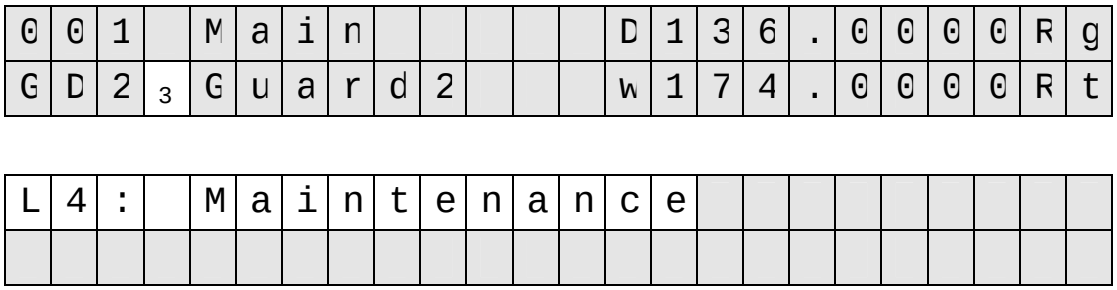


Figure 2-1. Front Panel Display for Operator Level 3 and Maintenance Level.

2.2 Command Types

There are two basic command types: Inherent and Edit. An **Inherent** command is one that requires no additional input from the user, such as the 'memory brightness' or 'scroll memory' commands.

An **Edit** command requires further input from the user. Most, but not all, edit commands can affect either the Main or the Guard Channel. The channel is to be edited depends on the position of the **MN/GD** and the **G1/G2** front panel switches. After selecting the command, the system expects further input from the user. All edit commands may be terminated in the same way:

accept the entry and return.

abandon the command and return.

2.3 Edit Status Indicators

If the user accepts the entry, then the last digit of the memory number - for the channel being edited (main or guard) - is changed to subscript. *This indicates that the data for the channel is in use has changed but is not yet saved to the memory*. The new characteristics will be used by the radio until the radio is turned off or the channel is changed; at any time until then, the user has two choices:

accept the changes and return.

abandon the changes and return.

In either case the pending change character (subscript) will return to full size.

0	0	$_1$		M	a	i	n						D	1	4	4	.	0	0	0	0	R	g
G	D	2		G	u	a	r	d	2				w	1	7	4	.	0	0	0	0	R	t

Figure 2-2. Display Indicating a Pending Change on the Main Channel

In the display example shown above the Main channel memory number indicates that there has been a change made that has not yet been saved to the permanent memory.

2.4 Programming Commands – Overview

The commands are divided into levels: Level 1 is a direct entry level, commands in this level are selected directly by pressing a key. Level 2 commands are programming commands available to the user. Level 3 commands allow personnel to configure various aspects of the radio. Level 4 allows maintenance personnel to maintain the radio.

Table 2-2. TDFM-136 Command Matrix

Key	Operator L1	Operator L2	Operator L3	Maintenance L4
1 CHAN	Select Main Channel	Program New Channel	Select Boot Channel	n/u
2 up	Display – Brighter	Copy Guard to Main	n/u	Data Upload
3 MODE	Edit Mode	Lock Keypad	n/u	n/u
4 back	Scroll Memory Down	Edit NAC	Display Software rev	n/u
5 SCAN	Scan ON/OFF	Edit Scan	n/u	n/u
6 fwd	Scroll Memory Up	Edit Description	Set PTT timer	n/u
7 FREQ	Edit Frequency	n/u	Set Sidetone Audio	n/u
8 down	Display – Dimmer	Copy Main to Guard	n/u	Data Download
9 SQL	Edit Squelch	n/u	Display Squelch Value	Set Noise Squelch
0 PROG	Go to next level	Go to next level	Go to next level	n/u
# ENTER	Save Changes	n/u	n/u	n/u
* ESC	Abandon Changes	Go to Previous level	Go to Previous level	Go to Previous level

NOTE: NEVER fly the radio with level 4 commands enabled. This command level is for maintaining the radio only, the radio may not respond in real time, or as expected when the Maintenance level (level 4) is enabled!

NOTE: n/u indicates command keys that are not currently implemented

2.5 Operator Level 1 Commands

This section lists the commands available to the user in Level 1.

1 CHAN L1 – Select the Operating Memory for the Main Channel

This command allows the user to select the MAIN channel that the radio is operating on. Upon selecting this command the cursor will appear at the first digit in the channel number, select a number from 001 to 200. After entering a number then:

ENTER accept the entry and return

Note: If the cursor remains then this channel number is not valid (ie above 200), if there is no information programmed for the channel, the editor will return to the previously displayed channel.

* ESC abandon the command and return.

NOTE: This command is valid for the *Main channel only*, if the **MN/GD** switch is in the **GD** position, then this command will not be entered.

2 L1 – Increase Display Brightness

Press and hold the up arrow (2) key to increase the brightness of the LED display, it stops at maximum.

3 MODE L1 – Edit Channel Operating Mode

This command will edit the Operating MODE of the selected channel; both MAIN and GUARD channels may be edited. The channel to be edited is determined by the position of the MN/GD switch and the G1/G2 switch.

Upon selecting this command the cursor will appear at the MODE position. Repeatedly pressing the MODE key (3) steps through the available modes - one at a time. See the table below.

Table 2-3. Operating Modes

Channel Operating Mode	Indicator
Analog Wide (25 kHz)	>w=
Analog Narrow (12.5 kHz)	>n=
Digital (12.5 kHz)	>D=

3 MODE step through available Operating Modes.

ENTER accept the entry and return.

* ESC abandon the command and return.

NOTE: If an Operating Mode is selected that is incompatible with the current Squelch Mode, then the Squelch mode will automatically be changed to >x= This translates to Noise Squelch for analog Operating mode (n or w) and to Digital clear Squelch for digital Operating mode (D).

L1 – Scroll Backwards through Available Memories

This command will scroll the Main Channel BACK, or down, through the programmed memories until reaching the lowest memory programmed, it will then wrap around and restart from the top. Once the user releases the button the displayed characteristics will be programmed. The scroll speed will increase as the button is held.

L1 – Select Scan List and Start/Stop Scan

This command allows the user to select a Scan list to scan, and to start and stop the Scan operation as follows:

select list to scan / stop scan.

accept the entry and start scan.

abandon the command and return / stop scan.

Once scan has started the scan list digit remains to indicate that the unit is in SCAN mode. Also note that all keypad keys are disabled except for:

stop scan and return.

display brightness works normally.

Front panel switch operation is modified as well: operation of **MN/GD** or **G1/G2** *will terminate scan* and restore normal operation of keys and switches. The front panel **Squelch** button is disabled. The **HI/LO** power switch is unaffected.

L1 – Scroll Forward through Available Memories

This command will scroll FORWARD, or up, through the programmed channels, scroll speed will increase as the button is held and the scroll will wrap around and restart from the bottom. Once the user releases the button the displayed characteristics will be programmed.

L1 – Edit Channel Operating Frequency

This command allows the user to edit the **Operating Frequency** of the selected channel; both MAIN and GUARD channels may be edited. The channel to be edited is determined by the position of the **MN/GD** switch and the **G1/G2** switch.

The frequency may be edited in one of three **edit modes**: Simplex (**Sx**), Receive only (**Rx**), or Transmit (**Tx**) only. If simplex is chosen then the selected frequency will be applied to both Rx and Tx operation.

Upon selecting the Edit Frequency Option, the cursor will appear on the prompt line over top of the >S= character, the user selects the **edit mode** as follows:

step through available edit modes (Sx, Rx, Tx).

accept the edit mode and continue the edit session.

abandon the command and return.

Once the **edit mode** has been selected the cursor advances to the second character in the frequency field of the channel to be edited (Main or Guard). The user may now enter the desired operating frequency via the keypad using the digits zero (0) through nine (9). Once done the user may:

accept the entry and return.

abandon the command and return.

The editor will not accept a value outside the limits of 136.0000 MHz. to 174.0000 MHz. In addition, 25 kHz spacing will be enforced when wide band operation has been selected (Operating Mode: w) and 12.5 kHz. spacing will be enforced when narrow band or digital operation has been selected (Operating Modes: n or D).

L1 – Decrease Display Brightness

Press and hold the down arrow (8) key to decrease the brightness of the LED display, it stops at minimum.

L1 – Edit Channel Squelch Mode

This command will edit the **Squelch Mode** of the selected channel; both MAIN and GUARD channels may be edited and the channel to be edited is determined by the position of the **MN/GD** switch and the **G1/G2** switch.

As with the Frequency Edit function above, the Squelch Edit directly supports Simplex, Rx only or Tx only editing.
Upon selecting the Edit Squelch Option, the cursor will appear on the prompt line over top of the >S= character, pressing the **MODE** button (3) allows the user to cycle through the available Squelch Edit Modes as follows: Simplex (Sx), receive only (Rx) or Transmit only (Tx).

step through available edit modes (Sx, Rx, Tx).

accept the edit mode and continue the edit session.

abandon the command and return.

If “ENTER@ is selected then the cursor advances to the Squelch Mode Indicator position on the edit line (top for Main and bottom for Guard). The available options are constrained by the operating mode, that is, different Squelch Modes are available for the analog Operating Modes (wide and narrow) than for the P25 operating mode. See the table below.

step through available Squelch Modes (see table below).

accept the squelch mode and enter relavent value editor.

abandon the command and return.

Table 2-4. Receive and Transmit Squelch Modes

Operating Mode	Squelch Mode	Receive	Transmit
Analog & Digital	noise	Rx	Tx
Analog only	CTCSS Tones	Rt	Tt
Analog only	DCS Codes	Rc	Tc
Digital only	P25 Talkgroup	Rg	Tg

Select CTCSS Tones or DCS Codes (analog modes only)

If either CTCSS tones or DCS codes are chosen, the prompt line will display the current value for that tone or code, the user may select from the available choices (Appendix A lists the available choices), as follows.

scroll **up/down** through available values.

accept the entry and return.

abandon the command and return.

Edit Project 25 Talkgroup (digital mode only)

If the P25 TalkGroup was chosen the, the prompt line will display the current TalkGroup value and the user may edit it as follows:

scroll **up/down** through hex digits (0-9, A-F).

ve cursor forward / backward.

ENTER accept the entry and return.

* ESC abandon the command and return.

0 PROG L1 – Command Level Up

This key selects the next HIGHER Command Level, the Command Level is indicated by a subscript digit in the 4th character position on the lower row of the display. See according to the table:

Table 2-5. Command Level Table

Command Level	Display Indicator
Operator L1	blank
Operator L2	2
Operator L3	3
Maintenance	4

Upon pressing this key, the radio will remain in the new Command Level for 5 seconds, if there is no further user input within this time then the radio will revert to the Direct Command Level. The Direct Command Level (level 1) is the normal operating mode for the radio and is indicated by a blank space.

ENTER L1 – Save Pending changes to Selected Channel

If there have been changes made to the current operating channel, pressing >ENTER= will allow the user to save these changes to the channel memory. The subscript indicator will be replaced by a full size digit to indicate that the changes are no longer pending.

NOTE: The information saved depends on the channel selected as determined by the position of the **MN/GD** and **G1/G2** switches.

* ESC L1 – Abandon Pending changes and Restore previous

Abandon pending changes, if any, to channel as determined by the front panel switches. If there is a pending change to a channel then pressing this button will re-load the original settings from memory. The subscript digit will be replaced by a full sized digit to indicate that the changes are no longer pending. The display will be updated with the previous channel information.

NOTE: The information saved depends on the channel selected as determined by the position of the **MN/GD** and **G1/G2** switches.

2.6 Operator Level 2 Commands

Access the **Operator Level 2 Commands** by pressing the **>PROG=** key from the **Operator Level 1** once. The Menu Level is indicated in the 4th character position on the lower row of the display, this will indicate a subscript **>2=**.

The Operator Command Level 2 maps the keys to provide a new set of functions for the operator as shown below.

L2 – Program Channel Information

This command allows the user to program all the information for an operating channel. If the memory location has already been programmed then the existing data will be loaded, if the location has NOT been previously programmed then the default template data will be loaded. For each step below:

accept the entry and advance to the next parameter.

abandon the command and return.

1. Enter a **Channel** number (001 to 202).
   Enter the number of the memory that you wish to edit, if the number is in the range 000 to 200 then the memory is for the MAIN channel.

   If the number entered is '201' then it is mapped to the Guard1 channel, similarly '202' is mapped to the Guard2 channel.

   Note that in all cases the edit occurs in the TOP row of the display. Upon selecting 'ENTER' to accept this selection the channel number display will change to GD1 or GD2 as appropriate.

2. Select **Scan Lists** for the channel if desired.
   Select member ship in any or all of the five (5) scan lists that are supported. See section **L2 – Edit Scan Lists** below for a full description of the procedure.

3. Enter a **Text Description** for the channel
   Enter the text description for the memory, up to 9 characters. See the section on editing text: **L2 – Edit Channel Text Description** below for a full description of the Text Data editor.

4. Select the Operating Mode.
   Select the Operating mode as described in **L1 – Edit Channel Operating Mode** above.

5. Select a **Frequency** in the range 136.0000 to 174.0000.
   Select the Operating Frequency as described in **L1 – Edit Channel Operating Frequency** above.

6. Select a **Squelch Mode**, choose TONES, CODES etc as required.
   Select the Squelch Mode as described in **L1 – Edit Channel Squelch Mode** above.

7. Set the Network Access Code (NAC)
   Select the NAC for the channel as described in **L2 – Edit Network Access Code** below.

Once the user is finished and selects ‘ENTER’ then the newly edited channel parameters are selected and displayed for the appropriate channel.

L2 – Copy Guard to Main

Copy the currently displayed Guard information UP to the Main channel. This information is used until the Main Channel is changed (via direct entry or scroll) or until the unit is turned off. The user may save the new data by pressing ‘ENTER’ or return to the previous data by pressing ‘ESC’.

L2 Lock Keypad

This command locks the keypad to prevent accidental change to parameters of the radio unbeknownst to the operator. This will disable all keyboard functions (except keyboard unlock and display luminance). To unlock the keyboard, press and hold the >**ESC=** key for two seconds.

Lock the keypad, displays æLockedÆ until key released.

Unlock the keypad (after 2 seconds), displays æUnLockedÆ until key released.

L2 Edit Network Access Code (NAC)

This command allows the user to edit the Network Access Code (NAC) used in Project 25 operation. The NAC is a three (3) digit hexadecimal code (digits 0 – 9 plus A, B, C, D, E, F). The editor operates as follows:

scroll **up** through hex digits (0-9, A-F).

move cursor forward / backward.

accept the entry and return.

abandon the command and return.

L2 Edit Scan Lists

This command is available only when the unit is in ‘Main’ mode (**MN/GD = MN**).

This command allows the user to select which of the **SCAN LISTs** - if any - that the selected channel is included in. The channel may be a member of any, or all, of the five (5) scan lists that are supported.

Upon selecting 'Edit Scan Lists' a character will appear at the 4th position on the upper line of the display, a full size digit indicates that that scan list is active for the memory being edited, if the channel is not active then the indicator digit is subscript.

5 SCAN Step through the available Scan Lists (1 to 5, 0 for none)

0 PROG Select/Deselect displayed list for this memory. This toggles the displayed digit between normal (selected) and subscript (not selected).

ENTER accept this entry and return.

* ESC abandon the command and return.

0	0	1	2	M	a	i	n					D	1	4	4	.	0	0	0	0	R	g
G	D	2		G	u	a	r	d	2			w	1	7	4	.	0	0	0	0	R	t

Figure 2-3. The Indicated Channel is NOT a Member of Scan List

0	0	1	2	M	a	i	n					D	1	4	4	.	0	0	0	0	R	g
G	D	2		G	u	a	r	d	2			w	1	7	4	.	0	0	0	0	R	t

Figure 2-4. The Indicated Channel IS a Member of Scan List

6 L2 – Edit Channel Description

This command allows the user to edit the text description for the selected channel. There are four groups of characters that may be used; upper case (A-Z), lower case (a-z), numbers (0-9), and a selection of special characters (blank space, '!', ' " ', '#', '$', '%', '&'). The user can change character groups *at any time* and as many times as desired during a description edit session. The editor operates as follows:

3 MODE step through available edit groups (A, a, 0, <space>)

8 ↓ 12 ↑ scroll **up/down** through hex digits (0-9, A-F).

 move cursor forward / backward.

 accept the entry and return.

 abandon the command and return.

L2 Copy Main to Guard

Copy the currently displayed Main information Down to the displayed Guard channel. This information is used until the Guard Channel is changed (via G1/G2 switch) or until the unit is turned off. The user may save the new data by pressing 'ENTER' or return to the previous data by pressing 'ESC'.

L2 – Command Level Up

This key selects the next HIGHER Command Level, the Command Level is indicated by a subscript digit in the 4th character position on the lower row of the display. See section 2.1 above.

L2 – Command Level Down

This key selects the next LOWER Command Level, the command Level is indicated by a subscript digit in the 4th character position on the lower row of the display. See section 2.1 above.

Unused Level 2 Command Keys

The following Level 2 command keys are currently un-implemented:

2.7 Operator Level 3 Commands

The Level 3 commands to allow the operator access to less often used commands and features of the radio.

L3 Select Boot Channel

This command steps through the available power-on channel defaults. This allows selection of which channel will be selected when the unit is turned on. The available choices are: the *last used channel* or the *last programmed channel* or set a particular channel.
The default is: *last used channel.*

1 CHAN — Step through the available Boot Channel Options (Last Used, Last Programmed)

ENTER — Accept this entry and return.

* ESC — Abandon the command and return.

L3 Display Software Release and Version Information

The current software release and version number is displayed on the bottom line of the display *as long as the key is held*. Upon release of the key the user is returned to Level 1.

L3 Configure the PTT Timer

The PTT timer duration may be set using this command: scroll through the available selections: OFF, 30 seconds, 60 seconds and 90 seconds. The active keys for this edit are:

2 8 — Scroll up/down through the available timer duration settings.

ENTER — Accept this entry and return.

* ESC — Abandon the command and return.

L3 Guard/Sidetone Audio Adjust

This command toggles the operation of the 'GUARD' volume control on the front panel, between Guard Receive Audio Level adjust and Sidetone Audio Level adjust. When in sidetone adjust mode, the 'GUARD' volume control is used to adjust the sidetone level. See section 3.8 below for the setup of the Sidetone adjust.

Note: After adjusting Sidetone audio be sure to return the control back to Guard!

9 SQL L3 Display Channel Squelch Parameters

Display the Squelch parameters for the channel as long as the user HOLDS the 'SQL' key. The data are displayed as follows:

't' CTCSS Tone, 'c' DCS Code, 'G' P25 Talkgroup, 'N' P25 NAC.

R	x	t		6	7	.	0		c	1	3	1		G	F	F	F	F		N	F	7	F
T	x	t	1	1	0	.	9		c	1	3	1		G	2	E	3	F		N	3	A	7

Figure 2-5. The Channel Parameters Display

The data displayed on the TOP line are for RECEIVE and the data displayed on the BOTTOM line are for TRANSMIT.

0 PROG L3 – Command Level Up

This key selects the next HIGHER Command Level, the Command Level is indicated by a subscript digit in the 4th character position on the lower row of the display. See section 2.1 above.

* ESC L3 – Command Level Down

This key selects the next LOWER Command Level, the command Level is indicated by a subscript digit in the 4th character position on the lower row of the display. See section 2.1 above.

Unused Level 3 Command Keys

The following Level 3 command keys are currently un-implemented:

2.8 Maintenance Commands (Level 4)

The Maintenance Command Level is available to allow configuration of the radio.
This command level does not preserve the Normal Operating display characteristics, that is: the Main and Guard displays are replaced by suitable command prompt information. As a result access to this level is restricted to two methods as follows:

1. Install a shunt on jumper J4 (pins 3 & 4) on the MCU board.

NOTE: jumper access to this command level must be DISABLED when the radio is used in flight.

2. Temporary in-airframe access is available by holding **BOTH**:

keys simultaneously and then turning the transceiver ON, remain holding the keys until the 'Software Revision' is displayed.

The user then has 10 seconds to access the desired command or the unit will return to Operator Command Level 1. After time-out the user may not scroll back into this level using the 'PROG' key.

The commands available in this command level are:

L4 Data Upload

Upload TDFM-136 Record files from the transceiver to a PC. The unit must be connected to a PC running Windows 95, 98, or NT 4.0 and the TiL Transceiver Data Programmer software package. To upload data to the PC, be sure that the software running on the PC is waiting to receive data from the TDFM-136 before pressing this key. The radio will indicate which memory is being uploaded and when the upload is complete.

L4 Data Download

Download TDFM-136 Record files from a PC to the transceiver. The unit must be connected to a PC running Windows 95, 98 or NT 4.0 and the TiL Radio Communications Software package. To download record data the Transceiver must be set to receive data BEFORE the PC software is told to send the data. The transceiver will wait for 25 seconds to receiver a valid record before timing out. The radio will indicate which memory is being downloaded, and when the download is complete.

The transceiver may have to swap memory space during the download, if this happens the activity will be displayed on the front panel and the download will be completed after a SWAP and ERASE cycle is finished.

L4 Edit Noise Squelch

Edit the Noise Squelch level. This is a global function that is general to both Main and Guard channels. The level is adjustable through the range: 00 to 10 in HEX (the factory default setting is 0A), 00 is lowest level, 10 is highest level. At the lowest setting squelch is easily broken, and it becomes increasingly difficult to break squelch as the level is increased.

Scroll up/down through the available timer duration settings.

Accept this entry and return.

Abandon the command and return.

L4 Command Level Down

Return to the next lower Command Level (Operator Level 3).

Unused Level 4 Command Keys

The following Level 4 command keys are currently un-implemented:

SECTION 3

INSTALLATION INSTRUCTIONS

3.1 General

This section contains information and instructions for the correct installation of the TDFM-136, VHF/FM Digital Transceiver.

Make certain that the correct frequencies are pre-programmed in accordance with the equipment user's valid FCC operator's license, prior to installation.

3.2 Equipment Packing Log

Unpack the equipment and check for any damage that may have occurred during transit. Save the original shipping container for returns due to damage or warranty claims. Check that each item on the packing slip has been shipped in the container. Verify that the equipment display and back-lighting configuration are the same as those ordered.

3.3 Transceiver Installation

The TDFM-136 Transceivers are designed to be Dzus mounted and should be installed in conjunction with a IN-150 installation kit. See Figure 3-1 for an outline drawing of the unit with dimensions to facilitate the installation.

3.4 Installation Kit – Contents

The IN-150 installation kit consists of:

1. One 15 pin Cannon D mating connector (female) complete with crimp pins and hood.

2. One BNC antenna mating RF connector (male) and hood.

3.5 Antenna Installation

Antenna, P/N ATM-150 may be obtained from Technisonic Industries Limited or a suitable equivalent 0dB gain antenna may be utilized with the TDFM-136 transceivers. The antenna should be mounted on the bottom of the aircraft whenever possible and must be located at least 20cm (8 inches) from any occupant in the airframe. Consult with instructions provided with the antenna. Connect RF cable from antenna to the back of the TDFM-136 unit by utilizing the BNC mating connector provided in the installation kit.

3.6 Installation – Pin Locations and Connections

A single 15 pin DSUB connector, mounted on the rear of the unit, provides the means to connect all power, control and audio signals between the TDFM-136 and the airframe. The pin numbers and locations for the 15 pin DSUB connector are shown in figure 3-1 below. The view shown is of the connector mounted in the unit, select mating connector appropriately.

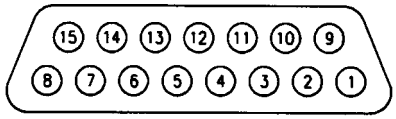


Figure 3-1. Transceiver mounted view of 15 pin connector

The description of the pin connections for the transceiver are in provided in TABLE 3-1.

Table 3-1. TDFM-136 - Rear Connector û Pin Assignments

Pin #	Description	Notes
1	Audio - Headset	**output – 600 Σ**
2	Serial Data Out	**output – RS232**
3	Power - Panel Lighting	**28VDC standard, 5VDC option**
4	Signal - Memory Up	**input – active low**
5	Signal - Memory Down	**input – active low**
6	Audio - Microphone	**input**
7, 14	Power - Main +28VDC	**power**
8, 15	Power - Main Ground	**power**
9	Audio - Speaker	**output – 4Σ**
10	Signal Ground	
11	Serial Data In	**input – RS232**
13	Signal – PTT	**input – active low**

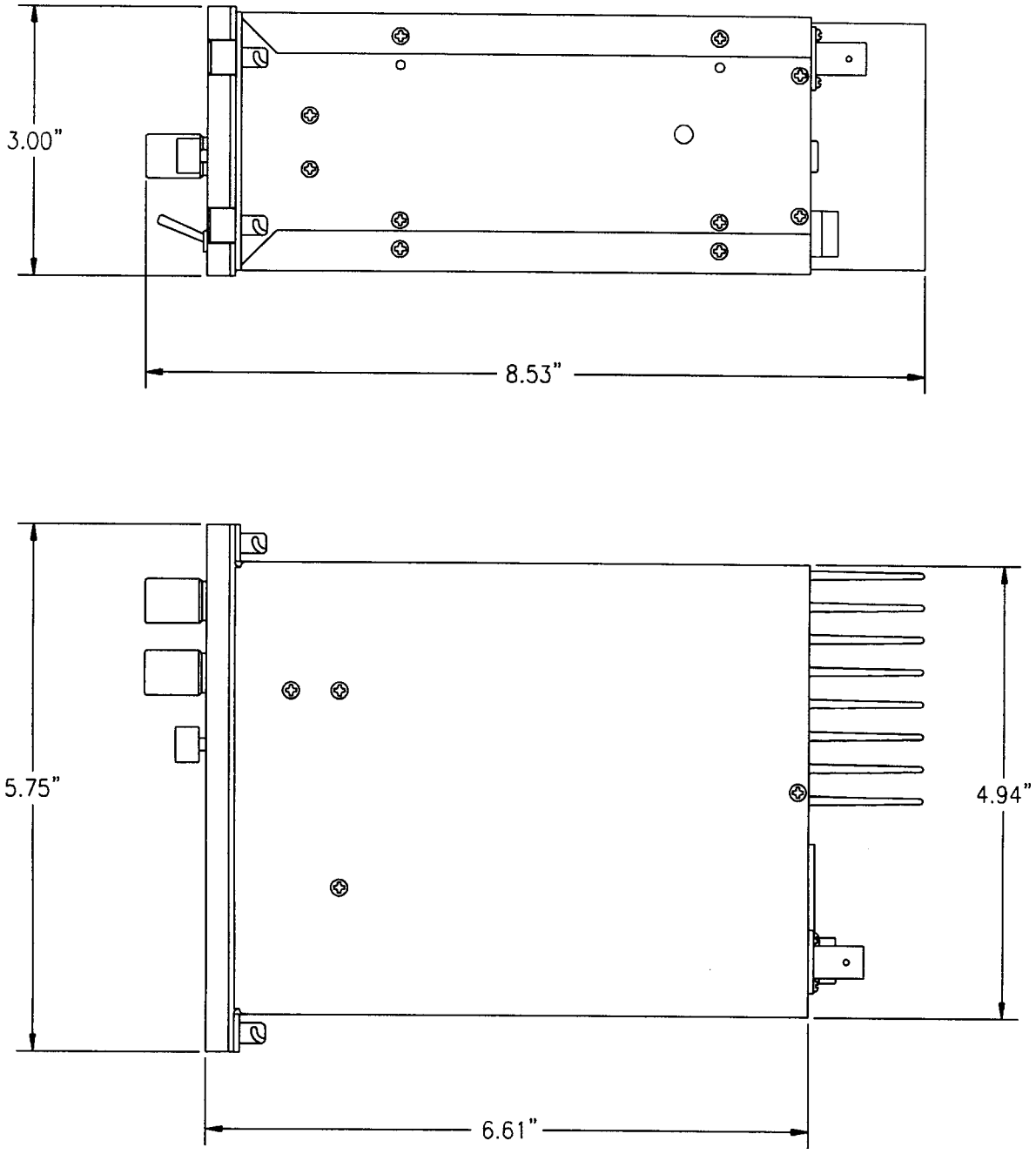


FIGURE 3-2. Outline drawing for TDFM_136 Transceiver

3.7 Wiring Instructions

Figure 3-3 shows all required connections and recommended wire sizes for the TDFM-136 Transceiver operation in the airframe.

3.7.1 Main Power +28VDC

The main power +28VDC (±15%) is connected to pins 7 and 14 of the transceiver. Both pins should be connected.

3.7.2 Main Ground

Ground connections for the transceiver are made on pins 8 and 15. Both pins should be connected

3.7.3 PTT (Ground Keying)

The PTT line is connected to pin 13 and should be floating when the transceiver is in receive mode, and grounded during transmit mode.

3.7.4 Front Panel Back Lighting

Front panel back lighting connection should be made on pin 3 of the transceiver. The opposite end of this lead should be connected to the panel lighting system of the aircraft. Before connecting, verify the required panel lighting voltage (28 VDC or 5VAC) on the transceiver configuration control label.

3.7.5 Audio Outputs (600 ohms and 4 0hms)

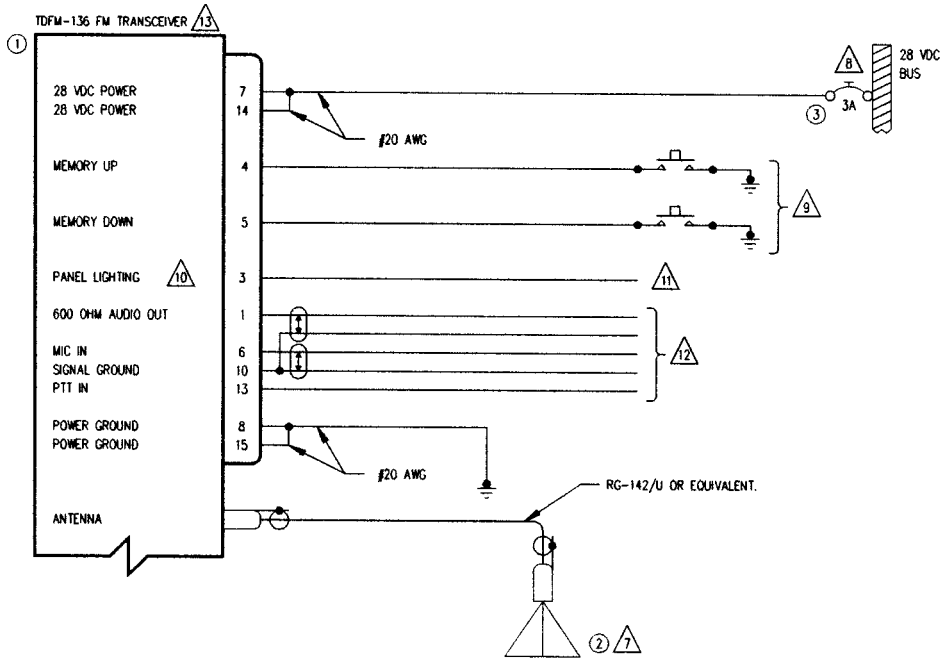
The audio output from pin 9 can be used to drive a 4 ohm speaker up to 2.5 watts. Audio output from pin 1 is 600 ohms, 0.5 watts maximum.

3.7.6 Audio Output Ground

Pin 10 is the ground for both the 4ohm and 600 ohm audio output signals on pins 9 and 1.

3.7.7 Mic Signal Input

The microphone input signal is to be provided on pin 6, utilising shielded wire with the shield grounded to pin 10.



QTY	ITEM	PART NUMBER	DESCRIPTION	SPEC	MATERIAL
1	1	TDFM-136	VHF/FM COMMUNICATIONS TRANSCEIVER.	TECHNISONIC INDUSTRIES LIMITED	
1	2	AT-150	ANTENNA	TECHNISONIC INDUSTRIES LIMITED	
1	3	7274-11-3	CIRCUIT BREAKER, 3 AMPS	KLIXON	

NOTES:

1) ALL WIRE IAW MIL-W-22759 UNLESS OTHERWISE SPECIFIED.
2) ALL CABLE IAW MIL-C-27500 UNLESS OTHERWISE SPECIFIED.
3) COAXIAL CABLE IAW MIL-C-17 UNLESS OTHERWISE SPECIFIED. DO NOT USE COAX WITH PVC INSULATION.
4) FABRICATION & INSTALLATION OF WIRING HARNESS IAW AC 43.13-1A CHAPTER 11, SECTION 3, PARA 445 TO 462 AND SECTION 7.
5) GROUNDING AND BONDING IAW AC 43.13-1A CHAPTER 11, SECTION 3, PARA 452.
6) ALL SINGLE WIRE TO BE #22 AWG MINIMUM AND ALL SHIELDED WIRE TO BE #24 AWG MINIMUM, UNLESS OTHERWISE SPECIFIED.

7 INSTALLATION OF ANTENNA IAW AC 43.13-1A CHAPTER 2, SECTION 3, CHAPTERS 5 & 6, AND AC 43.13-2A CHAPTER 3. IF POSSIBLE, THE ANTENNA SHOULD BE LOCATED A MINIMUM OF 12 FT FROM AIRCRAFT NAVIGATION RECEIVER ANTENNAS AND A MINIMUM OF 4 FEET FROM AIRCRAFT COMMUNICATIONS AND ELT ANTENNAS. BE CAREFUL NOT TO CHOSE SEPARATIONS THAT CLOSELY APROXIMATE 1/4 OR 1/2 OR WHOLE NUMBER MULTIPLES OF THE NAVIGATION OR COMMUNICATIONS SYSTEM WAVELENGTH.

8 AN EQUIVALENT CIRCUIT BREAKER OR FUSE MAY BE USED.

9 THE MEMORY UP/DOWN PUSH BUTTONS ARE OPTIONAL.

10 THE TDFM-136 IS AVAILABLE WITH 28V OR 5V PANEL LIGHTING. CHECK THE CONFIGURATION CONTROL LABEL FOR THE CORRECT VOLTAGE.

11 CONNECT TO THE APPROPRIATE AIRCRAFT DIMMING BUSS.

12 CONNECT TO THE AIRCRAFT AUDIO SYSTEM OR STAND-ALONE HEADSET JACKS.

13 INSTALLATION OF TRANSCEIVER IAW AC 43.13-1A CHAPTER 2, SECTION 3 AND AC 43.13-2A, CHAPTER 2. PR 3 1/2 DZUS RAIL OR EQUIVALENT MAY BE USED.

14) TEST THE SYSTEM IN ACCORDANCE WITH THE POST-INSTALLATION TEST PROCEDURE IN THE INSTALLATION AND OPERATING INSTRUCTIONS MANUAL.

15) REFER TO THE AIRCRAFT STRUCTURAL REPAIR MANUAL AND THE MAINTENANCE MANUAL FOR INSTRUCTIONS AND INFORMATION PERTINENT TO THIS INSTALLATION.

16) THE USE OF RED DISPLAYS SHOULD BE MINIMIZED OR AVOIDED SO AS NOT TO DETRACT FROM THE ATTENTION GETTING CHARACTERISTICS NEEDED IN WARNING AND CAUTION ANNUNCIATORS. RED SHOULD BE USED TO ANNUNCIATE EMERGENCY CONDITIONS REQUIRING IMMEDIATE RESPONSE BY THE FLIGHT CREW. UNITS WITH RED DISPLAYS SHOULD NOT BE LOCATED IN CLOSE PROXIMITY TO WARNING AND CAUTION ANNUNCIATORS. THE INSTALLATION OF UNITS WITH RED DISPLAYS MUST BE EVALUATED ON A CASE BY CASE BASIS TO ENSURE THAT THE EFFECTIVENESS OF THE WARNING AND CAUTION ANNUNCIATORS IS NOT ADVERSELY AFFECTED.

Figure 3-3. Wiring Connections for TDFM-136 Transceiver

3.7.8 Memory Up/Memory Down

Remote scrolling through the 25 memory positions can be achieved by providing a ground to pins 4 (up) and 5 (down) through a momentary contact cyclic switch.

3.7.9 Data Input/Output

Channel data may be transferred to and from the unit using RS-232 communications protocol via pins 2 and 11.

3.8 Transmitter Side Tone Level Adjustment

The sidetone level is set at the factory; however, this level can be altered to suit local conditions as follows:

1. Set the transceiver operating frequency to 155.000 MHz and connect an appropriate test receiver to the RF output connector. Ensure that the output of the transceiver is terminated into a proper dummy load.

2. Key the transmitter and input a 1kHz audio signal @ -10 dBm (0.25 VRMS) into the microphone input.

3. Select the side-tone adjust command and then adjust the side-tone level using the guard volume control to produce a +3.0 dBm (1.0 VRMS) 600 ohm audio output.

3.9 Main and Guard Noise Squelch Adjustment

The squelch on both the main and guard receivers is factory set to open at approximately 0.5 microvolts. This adjustment can be altered to suit local conditions as follows:

1. Set the main receiver of the transceiver to 155.000 MHz. Connect a signal generator to the antenna input of the transceiver.

2. Set the signal generator to produce a ±3 deviation with a 1kHz tone on 156.000 MHz. Increase the signal generator RF level from 0.1 uV until the squelch indicator LED is on. Verify the receiver SINAD ratio is between 12 and 14 dB.

3. If not, re-adjust main receiver squelch via the main receiver squelch software command.

4. Repeat the above procedure to adjust the guard receiver squelch setting using guard receiver squelch adjustment software command.

3.10 Reference Layouts

Reference layouts are given in figure 3-4 and figure 3-5 below. These show the position of control points for both the Main RF Interface, and the MCU boards.

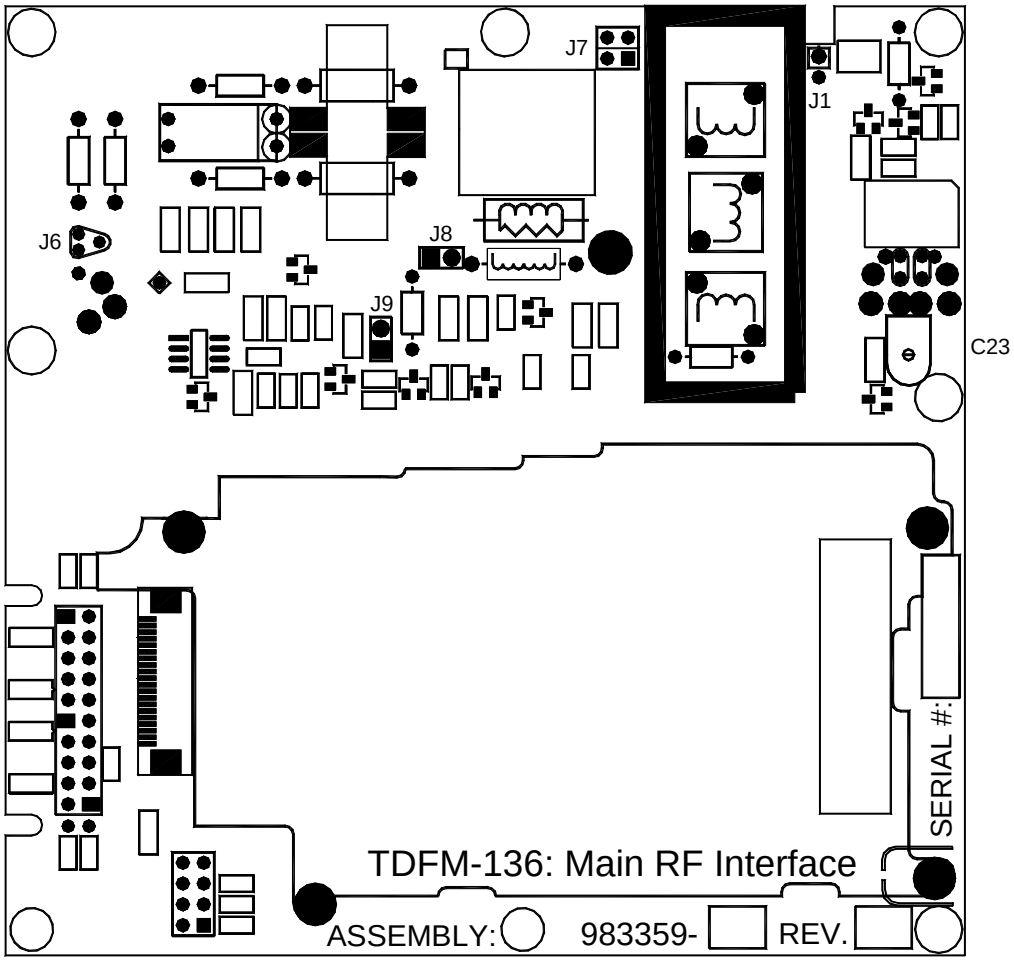


Figure 3-4. Control points for Main RF board.

JP1: RF output stage to Antenna filter jumper - factory installed
JP3: RF feedback circuit power supply, factory set
J1: Antenna connector

R8: RF Power Transistor DC bias - factory set
C15: RF Power bandwidth compensation - factory set

TP1: RF Power Transistor DC bias monitoring point.

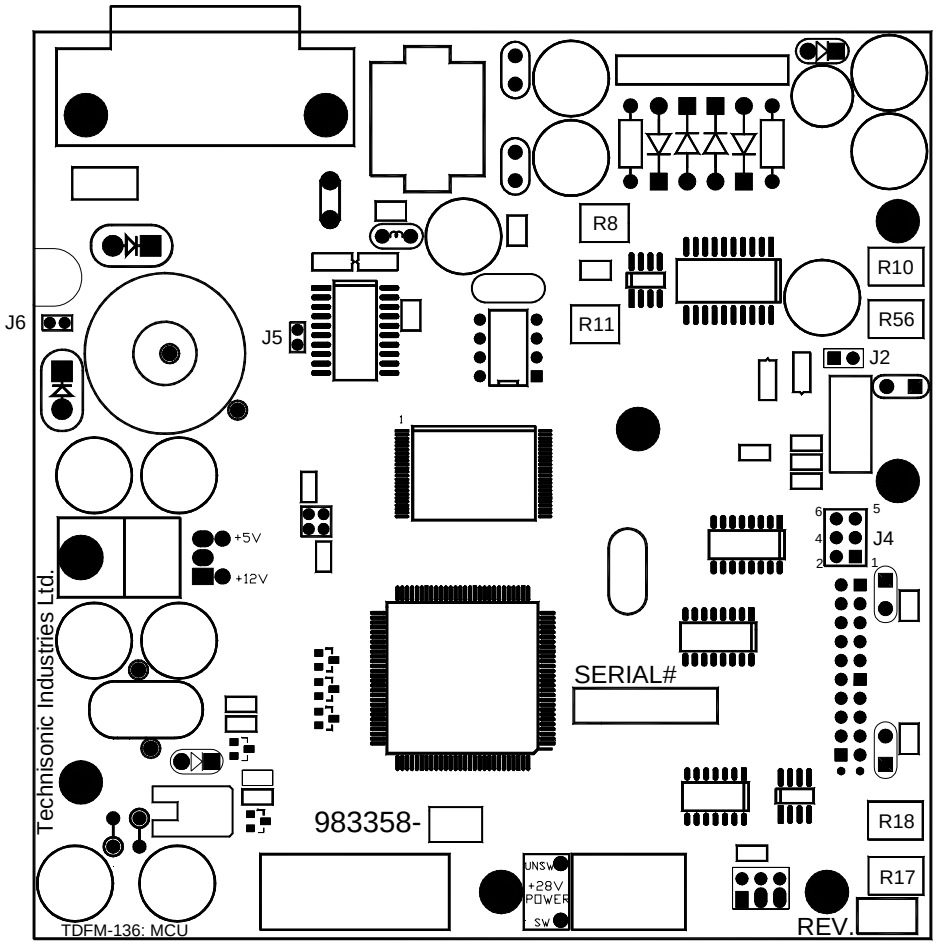


Figure 3-5. Control points for MCU board.

J2: Boot Program Enable - factory set ***DO NOT INSTALL***
J4: Option Jumpers:
1-2 Maintenance Mode Enable - ***DO NOT INSTALL IN AIRFRAME, BENCH ONLY***
3-4 **Factory Use Only – DO NOT INSTALL**
5-6 n/u reserved

R8: Main Rx Audio adjust - factory set
R10: Tx Mic Audio Level Adjust
R11: Guard Rx Audio adjust - factory set
R17: RF Low power adjust
R18: RF High power adjust
R56: DTMF Level Adjust

APPENDIX A

CTCSS TONE TABLES and DCS CODE TABLES

Available CTCSS Tones
Tone
67
69.3
71.9
74.4
77
79.7
82.5
85.4
88.5
91.5
94.8
97.4
100
103.5
107.2
110.9
114.8
118.8
123
127.3
131.8
136.5
141.3
146.2
151.4
156.7
162.2
167.9
173.8
179.9
186.2
192.8
203.5
206.5
210.7
218.1
225.7
229.1
233.6
241.8
250.3
254.8

Available DCS Codes	
Code	**Code**
23	315
25	331
26	343
31	346
32	351
43	364
47	365
51	371
54	411
65	412
71	413
72	423
73	431
74	432
114	445
115	464
116	465
125	466
131	503
132	506
134	516
143	532
152	546
155	565
156	606
162	612
165	624
172	627
174	631
205	632
223	654
226	662
243	664
244	703
245	712
251	723
261	731
263	732
265	734
271	743
306	754
311	

APPENDIX B

POST INSTALLATION EMI TEST INSTRUCTIONS

PURPOSE

The purpose of these tests is to identify any interference that the TDFM-136 may cause with existing aircraft systems.

TEST CONDITIONS

The TDFM-136 transceiver should be installed and function tested. The antenna VSWR should be checked. A forward/reverse power check with an in-line wattmeter should show no more than 10% reflected power. For the following tests, insure that the power switch is in the high position.

METHODOLOGY

Most of the EMI tests can be accomplished on the ground. In some cases flight testing is required or is easier. If the aircraft is approved for IFR operations, then it is mandatory that interference between the TDFM-136 Airborne FM and the approach aids be checked in flight.

The GPS should be operational and navigating with at least the minimum compliment of satellites. The VHF comm should be set to the frequencies indicated with the squelch open. VOR/DME receivers should be set to the frequencies indicated and selected for display. If possible, set up a DME ramp test set on the frequencies indicated and adjust the output until the flags are out of view. The transponder and encoder should be monitored with ramp test equipment. Set the output of the transponder test set to 3db above the output necessary to achieve 90% reply. If possible set the ADF to a nearby navigation station.

Modulate the TDFM-136 transmitter on the indicated frequencies for at least 20 seconds.

Observe the GPS for any degradation in satellite status or availability or flags. Listen for any noise or detected audio signals on the VHF comm(s). Listen for any noise or detected audio signals on the VOR/LOC receiver audio; look for any ?moment? of flags or needles on the VOR/LOC/GS navigation display(s). Observe the transponder for any loss of reply or spurious reply.

List the power plant, fuel and other electric instruments in the chart provided and note any anomalies that occur while transmitting. Assess the results.

If the aircraft is equipped with an auto-pilot or a stability augmentation system, then test fly the aircraft and verify that operation of the TDFM-136 transceiver does not have adverse effects on these systems. After checking for gross effects at a safe altitude, fly an approach with each of the different navigation systems coupled to the auto-pilot (ILS,GPS etc.) and look for any anomalies.

RESULTS

If the installed system passes all of the applicable EMI tests, then no further action is required. If interference is observed, then the interference must be assessed against the appropriate standards of airworthiness for the system in question. For example, it is permissible for a VFR certified GPS to lose navigation capability while the TDFM-136 is transmitting providing that it recovers properly and promptly, but is not permissible for an IFR approach certified GPS to be affected in the same way. A complete discussion of all the standards of airworthiness to be applied in assessing EMI effects is beyond the scope of this document.

PROCEDURE

A. Operate the TDFM-136 transmitter on the following frequency for at least 20 seconds. Observe the GPS for any degradation in satellite status or availability or flags.

FREQUENCIES	GPS #1		GPS #2	
	PASS	FAIL	PASS	FAIL
143.1800 MHz				
143.1825 MHz				
157.5000 MHz				
157.5425 MHz				

NOTES:

B. Determine if the image frequency for the VHF Comm falls within the range of the TDFM-136. If so, select a set of frequencies that will cause the TDFM-136 to be set as close as possible to the image frequency. Any one of the many possible sets will suffice. Record those values in the spaces provided in the following chart. Modulate the TDFM-136 transmitter on the following frequencies for at least 20 seconds. Listen for any noise or detected audio signals on the VHF Comm.

Example – Bendix/King KY 196A;

The first IF frequency is 11.4 MHz. The L.O. is above the receive frequency (high side injection), therefore the image frequency is 22.8 MHz above the selected frequency. Set the KY 196A to 120.000 MHz and the TDFM-136 to 142.8000 MHz.

FREQUENCIES		RESULTS	
VHF #1	TDFM-136	PASS	FAIL
135.975 MHz	138.0000 MHz		
121.150 MHz	157.5000 MHz		
131.250 MHz	157.5000 MHz		
Image			

FREQUENCIES		RESULTS	
VHF #2	TDFM-136	PASS	FAIL
135.975 MHz	138.0000 MHz		
121.150 MHz	157.5000 MHz		
131.250 MHz	157.5000 MHz		
Image			

NOTES:

C. Determine if the image frequency for the VOR/ILS Nav falls within the range of the TDFM-136. If so, select two sets of frequencies that will cause the TDFM-136 to be set a close as possible to the image frequency. Chose one set in the localizer frequency range. and one in the VOR frequency range. Record those values in the spaces provided in the following chart. Modulate the TDFM-136 transmitter on the following frequencies for at least 20 seconds. Listen for any noise or detected audio signals on the receiver audio; look for any moment of flags or needles on the navigation display.

FREQUENCIES		RESULTS	
VOR/ILS #1	TDFM-136	PASS	FAIL
108.000 MHz	162.0000 MHz		
108.100 MHz	162.1500 MHz		
Image			
Image			

FREQUENCIES		RESULTS	
VOR/ILS #2	TDFM-136	PASS	FAIL
108.000 MHz	162.0000 MHz		
108.100 MHz	161.1500 MHz		
Image			
Image			

NOTES:

D. Modulate the TDFM-136 transmitter on the following frequencies for at least 20 seconds. Observe the Glide Slope displays. Look for any movement of flags or needles on the Navigation display.

FREQUENCIES		RESULTS	
GLIDESLOPE #1	TDFM-136	PASS	FAIL
334.7 (108.1)	167.3500 MHz		

FREQUENCIES		RESULTS	
GLIDESLOPE #2	TDFM-136	PASS	FAIL
334.7 (108.1)	167.3500 MHz		

NOTES:

For the following tests (E & F), select a frequency at the top, middle and bottom of the band of the TDFM-136 Transceiver.

VHF Band (138 to 174 MHz)	
Frequency No. 1	
Frequency No. 2	
Frequency No. 3	

E. At a safe altitude engage the autopilot or stability augmentation system. Modulate the TDFM-136 on the above frequencies for at least 20 seconds. Observe any effect on the autopilot or stability augmentation system.

Observations:

F. Perform a coupled ILS approach to the aircraft's certified limits. Modulate the TDFM-136 transmitter on the above frequencies for at least 20 seconds. Observe any effect on the autopilot. Repeat for second flight director/autopilot if so equipped.

Observations:

G. List the power plant, fuel and other electric instruments in the chart provided and note any anomalies that occur while transmitting. Assess the results.

STEP	SYSTEM	PASS	FAIL	NOTES
1	Comm 1 and Comm 2			
2	Transponder and Encoder			
3	ADF 1 and 2			
4	Vertical Gyro			
5	Glideslope 1 and 2			
6	VOR/LOC 1 and 2			
7	Directional Gyro			
8	Compass			
9	Fuel Pressure			
10	Oil Temperature			
11	Ammeter			
12	Bus Voltage			
13	Fuel			
14	Nt			
15	TOT			
16	% Torque			
17	Digital Clock			
18	Oil Pressure			

19	Annunciators			

STEP	SYSTEM	PASS	FAIL	NOTES
20				
21				
22				
23				
24				
25				
26				
27				

NOTES: