

T-2350-1Watt Audio Transmitter

Project 25 Digital & Analog
Users Manual



DTC COMMUNICATIONS INCORPORATED

Draft

How to contact DTC

For operator and troubleshooting information, customers are encouraged to refer to the details in this manual. For additional clarification or instruction, or to order parts, contact DTC.

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Table of Contents

Manual Conventions

 **NOTE** Describes special issues you should be aware of while using a particular function.

 **WARNING** Calls out situations in which equipment could be damaged or a process could be incorrectly implemented, but in which operator safety is not a factor.

 **TIP** Describes application hints.



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Overview



Front of Transmitter



Back of Transmitter

The T-2350 is a synthesized VHF, digital and analog audio transmitter with a software selectable power output of 1 Watt. The T-2350 has an optional removable Mini SD™ Card that can record approximately 1 minute of audio in WAV file format per MB of storage.

The T-2350 has 10 programmable channels. It is designed for body worn personal protection and evidence gathering missions. Its miniature size and rugged design insures safe concealment and long lasting performance. The time to half power with fresh AAA Alkaline batteries is 5 hours. The transmission is programmable for digital P25 clear, digital P25 encrypted, analog narrowband, or analog wideband operation. The T-2350 transmission is either duplexed on the mic/antenna cable (meaning the microphone is the antenna) or transmitted on a stand-alone noodle antenna, in which case the internal microphone or remote microphone must be used.

Concerned with the rapid evolution of digital communication technologies and a need for interoperability, the Association of Public Communications safety Officials (APCO) developed an open architecture, digital standard for public safety and government communications systems. Products compliant with APCO Project 25 standard are interoperable, regardless of the manufacturer. The National Telecommunications and Information Administration (NTIA) has adopted the APCO Project 25 interoperability standard, also known as TIA/EIA-102. The T-2350 is compliant with this standard.

ANTENNA (Female Lemo Connector)

This connector accepts both the mic/antenna and the noodle antenna.

MULTI-PIN CONNECTOR (Male multi-pin connector)

This connector mates with an external microphone and is used in conjunction with the noodle antenna. This connector also mates with the programming cable.

STATUS LED

Once power is applied (after approximately 3 seconds), the Status LED will turn on (green), which indicates a successful self-test. The LED will turn off after a few seconds, and remain off or flash green at 1 second intervals. (See programming section)

ON/OFF SWITCH (Slide Switch: Green dot is ON, Red dot is OFF)

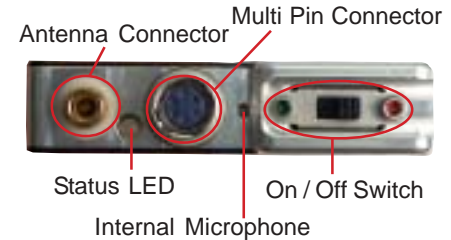
The ON/OFF switch controls the power to the transmitter. The power is supplied through the internal battery compartment, which holds six AAA batteries. Sliding the switch to the green dot turns the power ON. Sliding the switch to the red dot turns the power OFF.

CHANNEL SELECT SWITCH (Rotary Switch)

The channel select switch allows you to change transmit channels and is located on the front of the transmitter. It is a rotary switch which requires the use of the supplied screwdriver to turn the switching mechanism. Select a transmit channel number by turning the rotary switch.

Connections

Top View



✓ **NOTE:** When using the noodle antenna, the unit must be programmed to use the alternate microphone. If no external microphone is connected, the unit will automatically use the internal microphone.

✓ **NOTE:** When Cycling power on the unit, power switch must be left in the off position for at least 2 seconds before turning it back on.

QUICK START Option1

- ✓ **NOTE:** Do not operate the transmitter without an antenna installed.



Using The Antenna/Mic Assembly

- ✓ **NOTE:** The channel being used must be programmed to use the antenna/mic
- 1 Install the antenna/mic into the antenna connector on the transmitter.
- ✓ **NOTE:** This is a push-on, push off locking connector. The connector will rotate 360° in the transmitter without disconnecting. Use extreme caution when connecting or removing the mic/antenna.(See illustration on page 12.)
- 2 Ensure that the power switch on the transmitter is set to OFF. (Red dot is OFF).
 - 3 Slide the battery door to the right and install six, fresh AAA batteries, being careful to observe proper polarity. Slide the battery door to the left to close the battery compartment.
 - 4 Using a small screwdriver, turn the recessed rotary switch located on the front cover, to the desired channel.
 - 5 Turn the unit on by sliding the switch to the ON position. (Green dot is ON.)
- ✓ **NOTE:** Once power is applied (after approximately 3 seconds), the Status LED will turn on (green), which indicates a successful self-test. The LED will turn off after a few seconds.

Using A Separate Microphone with the Noodle Antenna

✓ **NOTE:** The channel being used must be programmed to use the internal mic.

- 1 Install the 36" remote microphone into the auxiliary (multi-pin) connector on the transmitter
- 2 Install the noodle antenna into the antenna connector on the transmitter. Adjust length to center of operating frequencies. (See example on Page 22)

✓ **NOTE:** This is a push-on, push off locking connector. The connector will rotate 360° in the transmitter without disconnecting. Use extreme caution when connecting or removing the noodle antenna.(See illustration on page 12.)

- 3 Ensure that the power switch on the transmitter is set to OFF. (Red dot is OFF).
- 4 Slide the battery door to the right and install six, fresh AAA batteries, being careful to observe proper polarity. Slide the battery door to the left to close the battery compartment.
- 5 Using a small screwdriver, turn the recessed rotary switch located on the front cover to the desired channel.
- 6 Turn the unit on by sliding the switch to the ON position.(Green dot is ON.)

QUICK START Option 2

✓ **NOTE:** Do not operate the transmitter without an antenna installed.



miniSD™ Card



miniSD™ Card

The T-2350 uses an industry-standard miniSD™ card to make audio recordings. A 512 MB card, an SD to miniSD adapter, and an SD card reader are provided with a new T-2350. The audio is recorded in a Windows PCM waveform format (.wav file). Should the need to replace the card arise, they can be purchased at most major retailers in various densities from 32 Mb to 512 Mb. Higher densities may be available in the future. As an example, a 32Mb card will provide approximately 30 minutes of recording time, 64Mb will provide about 60 minutes, etc. The 512 Mb card included with the transmitter will provide well over 8 hours of recording time. Generally speaking, 1 MB of memory will provide about 1 minute of recording.

Every new miniSD™ must be properly formatted before it can be used. Formatting is a simple process that can be done on almost any Microsoft Windows equipped PC, Laptop, Notebook, and some hand-held PCs. Typically, this will only need to be done once on each card.

Installing miniSD™ Card

The miniSD™ card slot is accessed by sliding the side panel down (Figure 2). The Card is inserted with the gold tabs facing the same side as the Channel Switch. When installed, a red LED will be illuminated indicating that the card should not be removed due to file management activity. Wait until the red LED is OFF before removing the card by gently pushing in until it releases.

NOTE: Never insert or remove the card while power is ON.

Formatting Instructions for Desktop, Laptop, and Notebook computers.

1. Double click on 'my computer' to display your list of drives.
2. Insert the miniSD™ card into the miniSD™ to SD adaptor as shown.
3. Insert the adaptor into the SD card reader included with the transmitter.
4. Insert the card reader into an available USB port on your computer. The computer should acknowledge the installation by adding another drive icon in the drive list called 'Removable Disk' and followed by a drive letter.
5. Right click on this new drive, pick Properties, and then Format.



WARNING: Do not perform this function on any drive whose name or type is "LOCAL DRIVE". Doing so could permanently harm your computer.

6. Ensure that the 'Quick Format' and 'Enable Compression' boxes are NOT checked, then click 'Start'.
7. Click OK in the Warning box that appears. When the dialog box that confirms that the format is complete appears, click OK. The format is now complete and the miniSD™ card can be used in the T-2350.

Installing the miniSD™ card into the T-2350

1. Power OFF the T-2350.
2. Remove the aluminum cover plate access the miniSD™ slot.
3. Install the miniSD™ card so the gold fingers of the miniSD™ card will face the same side as the Channel Select Rotary switch of the T-2350 transmitter.
4. Replace the aluminum cover plate

Side View of the miniSD™ slot



miniSD™
slot

Figure 2

Recording



Recording to a miniSD™ Card

Each of the ten selected channels on the T-2350 can have the recording feature turned on or off independently from each other. This is accomplished by clicking the 'recording on' or 'recording off' button for each channel in the DTC Universal Programming Software (refer to Figure 3 page 19 for details). To make a recording, the desired channel must have the 'recording on' button checked, and a properly formatted miniSD card with some available space must be installed in the T-2350 miniSD slot. For the purposes of this tutorial, the 'recording messages' radio button should be set to ON via the DTC Universal Programmer.

1. Install a properly formatted miniSD™ card with some available space into the T-2350, gold connectors facing the side with the channel switch, and slide the door closed.
2. Set the channel switch to a channel with recording enabled.
3. Turn on a radio receiver tuned to a matching frequency.
4. Turn on the T-2350. First, a message broadcasting "Media Present With More Than Four Hours Of Recording Time" will be heard on the receiver, then a few seconds later you will hear the message "Recording Start".
5. Speak into whichever microphone is enabled, allowing for the recording to progress for a few moments
6. Set the power switch to the OFF position.
7. Ensure that the red LED in the card slot is NOT on, then push the card in to remove.
8. Insert the card into the miniSD-SD adaptor, then insert the adaptor into the reader.
9. Using Windows Explorer, open the SD card and double click on the newly created .wav file. This should launch the application that plays audio files.
10. Ensure the PC speakers are turned on and at a comfortable listening level. The recording you just made should now be playing.

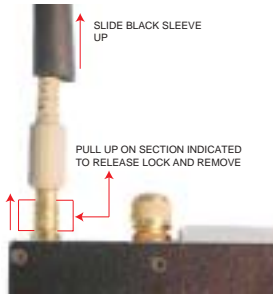
✓ **NOTE:** Pre-recorded messages are broadcast but not recorded.

Trouble Shooting

MESSAGE ERROR	PROBLEM	SOLUTION
"Critical Battery"	There is less than 10 minutes of battery life	Replace batteries
"Low Battery"	There is less than 30 minutes of battery life	Replace batteries
"Media Error"	The T-2300 either cannot recognize or cannot write to the miniSD™ card	Remove the miniSD™ card and reformat on a PC or Replace the miniSD™ card with a new, properly formatted miniSD™ card
"Media Full, No Space Remaining"	The miniSD™ card has no space left for making recordings	Remove the miniSD™ card and save the files to the PC, then clear off the miniSD™ card. Reinstall, or install a new, properly formatted card.
"Media Missing, No Card Present"	There is no miniSD™ card installed	Install miniSD™ card if recording is desired.
"Media Present....." (message not heard)	Channel recording not enabled or messages not enabled	Confirm that the channel being used has the recording capability enabled in the DTC Universal Programmer, and that the unit has the Recording Messages enabled
Recording silent when played back	Speakers/Headphones on PC not connected or turned down. Ensure antenna mic is not connected or defective	Ensure speakers/headphones on PC are turned on or ensure antenna mic is connected and not defective

Tips

Disconnecting the noodle antenna or the mic/antenna assembly.



- NOTE:** This is a push-on, push off locking connector. The connector will rotate 360° in the transmitter without disconnecting. Use extreme caution when connecting or removing the mic/antenna or noodle antenna. To remove slide the black sleeve back, and pull up on the metal base, then pull the mic/antenna or noodle antenna straight out.

Additional Operational Notes:

The T-2350 operates on six AAA batteries in series, which produce 9 VDC. A fresh set of batteries will operate the unit for over five hours when in high power mode. Battery reversal guards are integral to the battery compartment to eliminate the possibility of cell reversal.



NOTE: Always turn the unit off and remove used batteries when not in use. It is imperative to discard partially used batteries, as their remaining life is not predictable. Always start an operation with a fresh set of batteries.

Audio Circuit and Body Mounting Tips:

All body worn transmitters are susceptible to “clothing noise”. Reducing this rubbing effect is accomplished in a variety of ways. Attach the transmitter to the body with a secure mounting method, such as an ace bandage or a custom harness. Then;

- 1 Try to locate the microphone in an area that “pickup” will be best and rubbing noise is least. Avoid the arms, legs, crotch or under the arms or the waist area. Front torso mounting is ideal.
- 2 Always provide a small amount of strain relief on the microphone cable itself. This reduces the noise caused by the microphone cable and element being tugged and prevents cable damage.
- 3 Secure the microphone cable to the body with medical adhesive tape in at least two spots, the final being about an inch below the element. Remember to leave a strain relief loop!
- 4 Completely cover the microphone element (facing outward) with an ordinary Band Aid™. This provides a damped baffle for the microphone and a slick surface for clothing to rub on, and actually does not impact audio pickup level at all.

Specifications

Care should be taken when selecting the proper output power for the T-2350. Higher power will give the greatest range but will shorten the battery life and increase the chance of counter detection. DTC recommends using the lowest possible transmit power that can safely do the job.

The power level must be selected in software. Each channel can be individually set to either high or low power.



ITEM	SPECIFICATION
Power (RF)	500mW 1000mW
Controls and Indicators	<ul style="list-style-type: none"> • 10 position rotary channel/mode switch • Sliding ON/OFF power switch • Bi-color Status LED
Connectors	Mic/antenna, combination external mic/power/programming and multi-pin connector
Frequency Stability	Within +/- 2.5 ppm over -30° C to +65° C
Channel Capacity	10 User programmable with DTC Universal Software
Frequency Range	<ul style="list-style-type: none"> • 150 - 174 MHz (VHF-High) • 138 - 150 MHz (Option VHF-Low)
Minimum Tuning Step	N/A: Transmitter can be programmed to any channel within specified frequency band.
Deviation	5 KHz (wide) or TIA/EIA-102 compliant 2.5 KHz (narrow) , programmed by channel
Microphone	Electret-fet
Spurious and Harmonics	-50 dBc max
Operating Temp Range	-30° C to + 70° C
Power Sources	Six AAA batteries
Battery Life	5 hours min with AAA batteries measured to half-life of transmitter output power
Dimensions	2.275" W x 3.70" L x 0.525" D
Weight	Unit .188 lbs / Unit and Batteries .288 lbs
NTIA Compliant	TIA/EIA-102 - Analog and Digital mode
NOTE	All specifications at 25° C and RF measurements taken into 50 Ohms unless otherwise stated.

Programming

Introduction

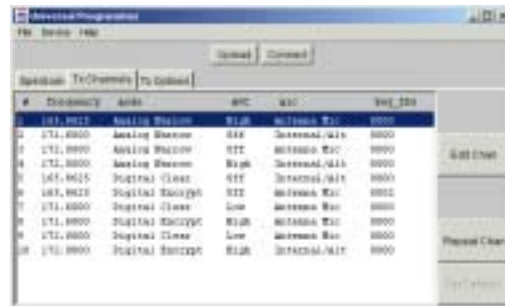
DTC has improved the flexibility in the programming options you have on the T-2350 audio transmitter. You can choose to use some, all, or none of this flexibility.

When you order a T-2350 transmitter, DTC will factory program your frequencies at no additional charge to you. You may want to place a sticker over the rotary switch on the chassis, so users in the field don't attempt to change channels.

DTC will also provide you with free software and a free programming cable, enabling you to change any programmable option. This is ideal if you often work with other agencies, or anticipate the equipment being used by a multi-jurisdictional task force. You can program up to ten channel settings per unit. In general, this allows you to program at the depot for most variations you might encounter in the field.

The configuration of each channel is managed with DTC programming software. The programming software included with your T-2350 allows you to do all of the following:

- Assign frequencies to each channel
- Select the mode of operation for each channel (digital clear, digital encrypted, analog narrow or analog wideband)
- Select the 56-bit DES-OFB encryption key and 16-bit key ID
- Select power level for each channel (High or Low)
- Select which microphone to use (mic/antenna or alternate microphone).
- Select Automatic Gain Control mode (High Gain AGC, Low Gain AGC, No AGC (Digital Clear/Encryption Only))
- Select LED operation (normal operation or disabled)
- Enable/disable recording for each channel
- Turn on/off pre-recorded miniSD™ status and battery status messages
- Set internal clock



TIP: Make sure that you program your transmitter to match the frequencies of your receiver, and test the components as a system prior to going into the field!

Installing DTC Universal Programming Software on your PC

- ✓ **NOTE:** Uninstall any previous versions by going to Add/Remove Programs, clicking on DTC Universal Programming, and clicking on uninstall.
- 1 Click on Start, click on run.
 - 2 Click on the Browse button.
 - 3 Click on or find your CD drive
 - 4 Install the JAVA Runtime Environment Application first (CD provided).
 - 5 Follow the install wizard screens.
 - 6 Install the Universal Programming software next (floppy provided).
 - 7 Click on Start, click on run.
 - 8 Click on the Browse Button.
 - 9 Click on your floppy drive.
 - 10 Double click on the setup.
 - 11 Follow the install wizard screens.

Your programming software is installed



Programming

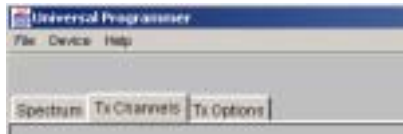
- 1 Connect the antenna to the T-2350 transmitter.
- 2 Install the programming cable into the connector on the T-2350.
- 3 Plug the serial cable of the programming cable into the COM1 or COM2 port of your computer.
- 4 From the Start Menu, Select Programs>DTC Communications>COM1 or COM2 on your computer.



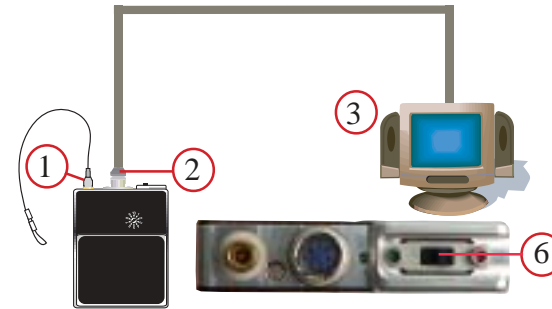
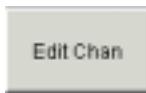
- 5 The cycle power screen displays.
- 6 Slide the power switch to the ON position and click OK. **A message screen displays T-2350 downloading.**



- 7 Click on the TX Channels Tab.



- 8 Click on the channel you need to change and click on the Edit Channel button



- 9 Enter your new settings and click OK. (See Programming Options pages 18-21) You can change the frequencies, mode, key ID, misc source, AGC, and bandwidth **The programming software returns to the TX channels screen with your new settings displayed, and an asterisk (*) beside the channel that has changed.**

- 10 Click on the upload button. **A message screen displays the new settings being uploaded to device. A message screen displays that your settings have been successfully uploaded.**



Your new settings have been installed.

- ✓ **NOTE:** Width refers to channel spacing. 12.5 kHz = Narrowband. 25 kHz = Wideband

Programming Options

Uploads new channel information to the unit. Click this button when all of the necessary configuration changes are complete

Click this button to establish communication between unit and PC. Follow the on-screen instructions.

Individual channel information
See Page 18

Model Number — Device Name: T2300

Firmware Version — Software Bundle Version: 1.0

Denotes band of operation

Global transmit options.
See Page 20

The screenshot shows the 'Universal Programmer' application window. At the top, there are 'File', 'Device', and 'Help' menus. Below the menu bar are two buttons: 'Upload' and 'Connect'. A tabbed interface is visible with three tabs: 'Spectrum', 'Tx Channels', and 'Tx Options'. The 'Tx Options' tab is currently selected, displaying 'Device Name: T2300' and 'Software Bundle Version: 1.0'. Below the text is a frequency spectrum graph labeled 'Tx' with a blue bar indicating a band of operation between 150 and 174. The x-axis of the graph has markers at 130 and 250.

Figure 1

Programming Options

Click on the channel of interest, then click this button to edit individual channel settings. Refer to Page 19.

Repeats channel settings from previously set channel

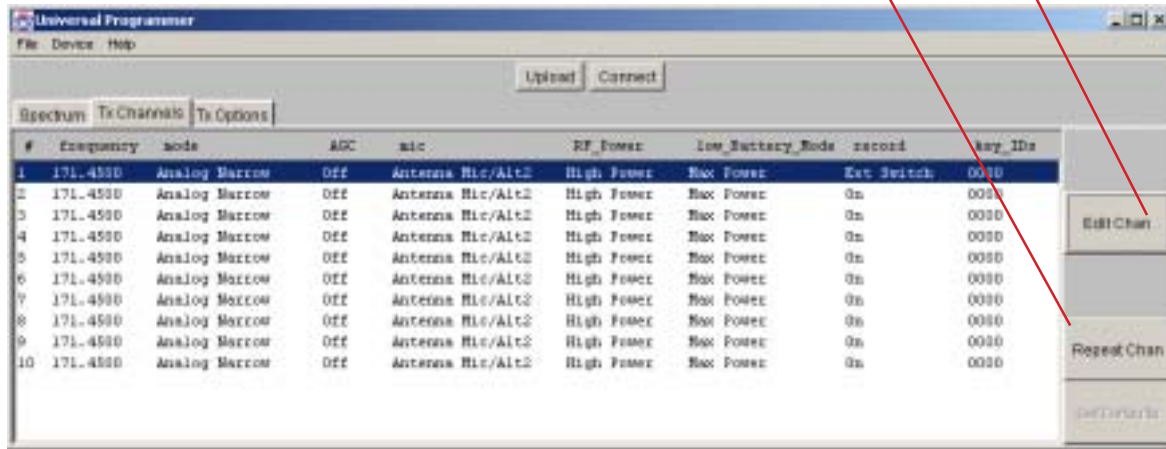


Figure 2

Programming Options

Enter frequency in MHz

Selects Modulations mode

A

B

Select RF Power

C

D

Sets encryption key to be associated with this channel

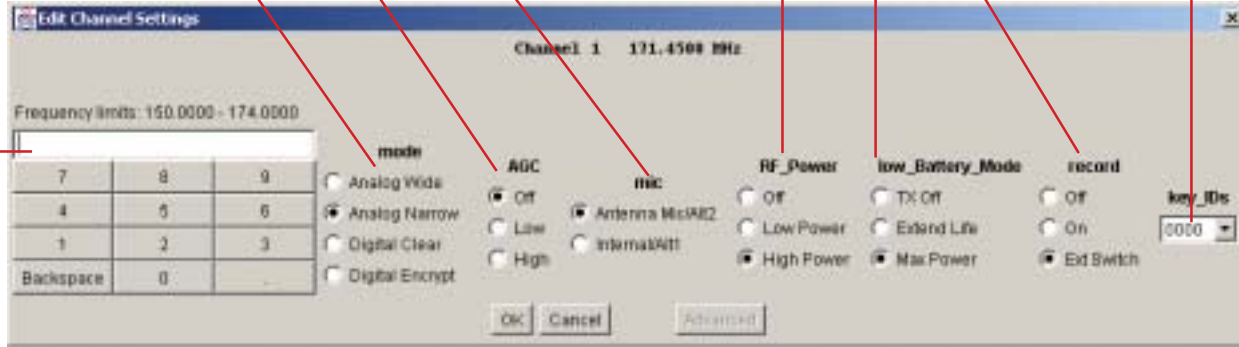


Figure 3

A. Selects AGC mode. In analog transmission modes, AGC Off is not available and will operate as LOW when selected. In digital transmission mode all three settings are available.

B. Selects microphone or auxiliary input. When selecting Internal/ALT1, the internal microphone will be automatically selected unless there is an external source connected to ALT1 on the circular connector. In both settings, an external source will automatically be selected when connected. When selecting Antenna Mic/ALT2, you must have either the Antenna Mic (DTC PN 7011149) or an external input source connected to ALT2 on the circular connector.

C. Selects RF power operation when unit is in a low battery condition. When the internal microprocessor detects that the battery voltage has dropped below 4.1 VDC, the transmit power will be controlled according to these settings. Selecting Low Power or Off will prolong battery life, and will not affect recording settings.

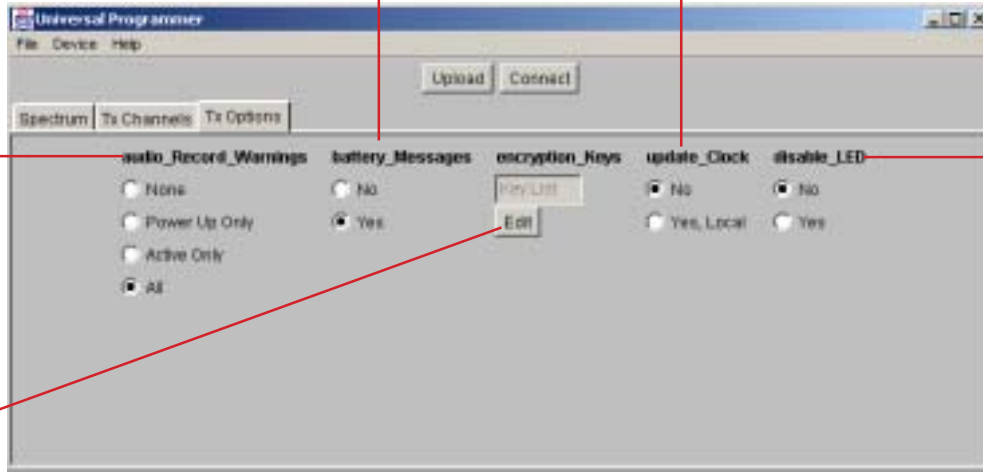
D. Record mode. Disables or enables recording on individual channels. The Switched setting is intended to be used with the optional remote recording switch.

Programming Options

Turns low battery Warnings On/Off

F

E



Turns external status LED On/Off

Edits encryptions codes and keys.
See Page 21

Figure 4

E. Turns audio messages On/Off

None - No recording status or warnings will be broadcast.

Power Up - The status of the card will be broadcast on power up only, not during operation.

Active Only - Record status and warnings will be broadcast during operation, but NOT on power up.

All - Record status and warnings will be broadcast during operation AND on power up.

F. Updates clock

Selecting yes will update the T-2350 internal clock using the time from your computer. The update will be made when the Upload button is clicked.

Encryption

1. To start entering KeyID/Key pairs, select the “Tx Options” tab , and click the Edit button under “Encryption_Keys”.
2. To enter a new pair, click “Add Item”. In the dialog box (see Figure A), enter a four-digit hexadecimal number for the KeyID and click “OK”.
3. The KeyID will be displayed at the top of the dialog box, and the program will then ask to enter the Encryption Key (16 hexadecimal digits). When done entering the Key, click OK, and the KeyID/Key pair will be entered into the available list. If the parity of any of the bytes is not odd, the user will be warned “Wrong parity entered” and the KeyID/Key will have to be re-entered. To protect the Key, it will not be shown or displayed once it is entered.

Digital Encryption

In the “Digital Encrypt” mode of operation, this unit uses a 56-bit DES-OFB Encryption Key per the APCO Project 25 specification. Each Encryption Key is identified/labeled using a shorter Key Identifier (16 bits), known as the KeyID. If the unit uses the Digital Encrypt mode of operation, one or more KeyID/key pairs need to be entered.

Entering Key/KeyID pairs

The KeyID is essentially a label for the DES-OFB Encryption Key. The KeyID is a 16-bit value, represented by four hexadecimal digits, with each hexadecimal digit representing 4-bits (see Table 1 below). The Encryption Key is a 64-bit value (56-bit key + 8 bits parity), represented by eight hexadecimal digits. Per the APCO Project 25 specification, each byte (i.e. pair of hexadecimal digits) in

the Encryption Key must have odd parity. Odd parity means that the number of “one’s” in the binary (0/1) representation of the 8-bit byte must be odd. For example, the following is a valid Encryption Key: 2F AB 08 E3 B5 9D 4C 16 .

Associating a Key/KeyID pair with a Channel

For each channel with the “Digital Encrypt” mode selected, a Key/KeyID pair must be selected. Under the “Tx Channels” tab, select the channel and click “Edit Chan”. The Key/KeyID pair is selected under “key_IDs”. Note that you only see the KeyID, not the Key itself. Note that multiple channels may use the same KeyID/Key pair if desired. If the mode is not “Digital Encrypt”, the key_ID setting is ignored and has no effect.

Encryption

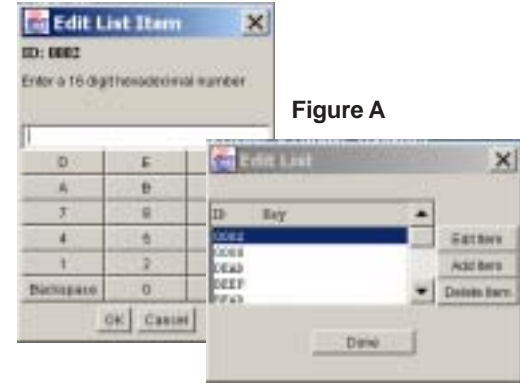


Figure A

Hexa decimal	Binary
1	0000
2	0001
3	0010
4	0011
5	0100
6	0101
7	0110
8	0111
9	1000
A	1001
B	1010
C	1011
D	1100
E	1101
F	1110

(Table 1)

Accessories Antennas



NOODLE ANTENNA

DTC part number

7011151 138 - 225 MHz
(adjustable)



MICROPHONE/ANTENNA

DTC part number Frequency Range

7011149 150 - 174 MHz

7001073 140 - 150 MHz

7001077 210 - 225 MHz

The “noodle” antenna may be adjusted over the frequency range of 138 MHz to 225 MHz by adjusting the amount of wire that is folded back along side the end of the antenna.

The total length may be calculated by the following formula.

$$\text{Length (inches)} = 2950 / (\text{Freq MHz})$$

Example:

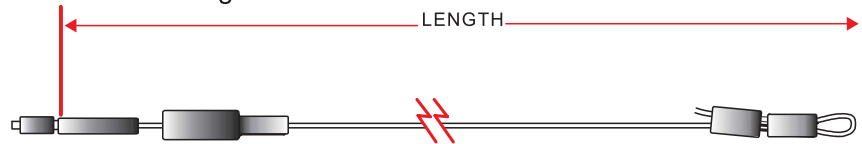
CH1: 150.000

CH2: 151.000 ← Center of operating frequency

CH3: 152.000

Length (inches) = $2950/151$

Total length = 19.5"



TWO YEAR WARRANTY

DTC Communications, Inc. (DTC) warrants its RF transmitting and receiving products to be free from defects in workmanship or material for a period of two (2) years from the date of shipment unless otherwise stated.

The liability of DTC, Inc. under this warranty is limited to replacing, repairing, or issuing credit, at option, for any products, which are returned by the purchaser during such warranty period, provided: DTC is notified and a Repair Authorization Number is issued by DTC Customer Service within 30 days after discovery of such defects by Customer.

The defective units are returned to DTC with transportation charged Prepaid by the Customer. Product damaged in shipment must be reported to and claim forms filed with the Carrier by the Customer. In shipments to the factory, notice and claim procedures will be initiated by DTC.

DTC's examination of such products shall disclose to its satisfaction that such defects exist and have not been caused by misuse, misapplication, neglect, improper installation, improper storage, alteration, physical damage or accidents.

The warranty shall not apply to microphones, batteries, antennas, crystals or material ordinarily susceptible to field damage or any accessories of a disposable nature. The warranty shall not apply to Engineering Prototypes or Customer requested modifications to electronic circuits.

This warranty does not apply to and DTC does not independently warrant items or systems sold by DTC which are produced by other manufacturers. With respect to such items, the Customer shall look to the warranty of the original manufacturer and DTC disclaims all warranty, expressed or implied.

Nothing in this warranty, or any statement, brochure, bulletin, or advertisement is to be interpreted as establishing the suitability of any product for particular application or use. Applications of the product and the determination of suitability for any application, is the sole responsibility of the Customer.



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