TYPE OF EXHIBIT:	USERS MANUAL
FCC PART:	2.1033(c)(3)
MANUFACTURER:	RITRON, INC. 505 West Carmel Drive Carmel, IN 46032
MODEL:	DTX-142
TYPE OF UNIT:	VHF-FM Two Way Radio Transceiver Module
FCC ID:	AIERIT17-142
DATE:	May 21, 2003

DTX-142

PROGRAMABLE VHF FM TRANSCEIVER MODULE
OPERATING AND SERVICE MANUAL

RITRON INC.

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DTX-142 SPECIFICATIONS

GENERAL	
FCC ID:	AIERIT17-142
FCC Rule Parts:	90
Frequency Range:	136-156 MHz or 154-174 MHz
RF Channels:	8 Independent TX/RX frequencies
Synthesizer Step Size:	5 kHz
Frequency Stability:	+/-2.5 PPM (-30 to +50 C)
Tone/Code Signaling:	CTCSS (Quiet Call) and DCS
Maximum Data rate:	9600 bps with 4-level FSK
Power Supply:	8 to 15 VDC
Battery Drain:	
RX Standby:	20 mA at 13.8 VDC
RX Receive:	250 mA
Transmit:	1 Amp @ 5 Watts at 13.5 VDC
Dimensions:	5”H x 3”W x 1.25”D
Weight:	3.8 oz.
Antenna Fitting:	BNC female or SMA female

DTX-142 SPECIFICATIONS

RECEIVER Specifications

	Wide band 25 kHz	Narrow band 12.5 kHz
Sensitivity (12 dB SINAD):	0.25 µV	0.25 µV
Adjacent channel:	-70 dB	-60 dB
Spurious rejection:	-55 dB	-55 dB
Image rejection:	-70 dB	-70 dB
Intermodulation:	-60 dB	-60 dB
FM hum and noise:	-43 dB	-37 dB
Conducted spurious:	-57 dBm	-57 dBm
Receiver attack time:	< 15 ms	< 15 ms
Noise squelch attack time:	< 15 ms	< 15 ms
RSSI squelch attack time:	< 5 ms	< 5 ms
RSSI squelch sensitivity:	Manually adjustable; factory set for –109 dBm	
Noise squelch sensitivity:	Manually adjustable; factory set for 12 dB SINAD @ 3 kHz deviation	
AUX OUT frequency response:	6 - 3000 Hz @ +1 / -3 dB	
Audio Output	>700 mW into 8 Ω, with less than 5 % THD	

TRANSMITTER

RF Power Output:	1.0 Watt minimum @ 13.8 VDC < .4 A 5.0 Watt minimum @ 13.8 VDC < 1 A	
Voice Emission Designator:	16K0F3E	11K2F3E
Data Emissions Designator:		11K2F1D
Deviation:	+/- 5.00 kHz	+/- 2.50 kHz
Transmitter attack time:	15 ms	15 ms
FM Hum and Noise:	-45 dB	-40 dB
Audio Distortion:	< 5 %	< 5 %
Spurious and Harmonics:	-20 dBm max	
Aux In frequency response:	7 Hz to 2700 Hz @ +1 / -3 dB	

DTX-142 SPECIFICATIONS

Sub D 15 Pin Connector

The DTX-142 is equiped with a 15 pin female sub D connector with the following functions:

Pin#	Function
1	least significant channel select bit (CS0)
2	channel select 1 (CS1)
3	Most significant channel select (CS2)
4	Microphone input
5	High/ low power select (pull low to get low power)
6	+ 8 to 15 VDC input
7	auxilary input
8	auxilary ouput
9	PC programing port
10	N/A
11	Auxilary monitor input (pull to ground to open squelch)
12	Speaker output
13	Carrier detect output (pulls to 5 VDC through 390 ohms)
14	PTT (pull to ground to transmit)
15	ground

INTRODUCTION

GENERAL

RITRON's DTX-142 transceiver module is designed to operate in the VHF band. Two band splits are available, 136-156 MHz (low) or 154-174 MHz (high). The unit supports voice through a microphone input and a nominal 1 watt speaker output. It supports up to 9600 bps 4-level FSK through its auxiliary in and auxiliary out ports.

Each radio can be “dealer or factory” programmed to contain a unique set of eight operating frequencies and options. When all three channel select inputs are tied to ground the radio operates on channel 1. The channel selection is done in a binary manner on the CS2, CS1 and CS0 inputs. Separate RX and TX Quiet Call (CTCSS) or Digital Quiet call (DCS) tones can be programmed per channel. Each channel can be programmed to be low power (2 watts) or high power (5 watts). Transmitter wide or narrow deviation can be programmed on a per channel basis.

Model Identification

The DTX-142 model, serial number and FCC Identification are displayed on a label located on the top of the radio VCO shield.

FCC REGULATIONS

Licensing

The FCC requires the radio owner to obtain a station license for his radios before using them to transmit, but does not require an operating license or permit.

The station licensee is responsible for ensuring that transmitter power; frequency and deviation are within the limits specified by the station license. The station licensee is also responsible for proper operation and maintenance of the radio equipment. This includes checking the transmitter frequency and deviation periodically, using appropriate methods.

Exposure to Radio Frequency Energy:

The DTX-142 transceiver consists of a transmitter and a receiver. The transmitter is active when the Push-to-Talk line is connected to ground or when activated electronically and emits radio frequency (RF) energy at a power level up to 5.0 watts.

This product has been evaluated for compliance with the maximum permissible exposure limits for RF energy at the maximum power rating of the unit with the whip antenna available from RITRON. To ensure compliance with the General Population/Uncontrolled Exposure RF exposure maximum limits, all persons must be at least 43 cm (16.9 inches) from the antenna while the unit is transmitting. The installer must site the antenna in such a way that all persons would be at least 43 cm (16.9 inches) or greater away during transmission.

The antenna tested for this product for RF exposure was the RITRON RAM-1545, which has a gain of –2.2 dBd with the included 25 feet of coaxial cable. This is the only antenna available from RITRON for use with this product. Other antennas may require lesser or greater distances to meet the limits depending upon their gains relative to that tested. Higher gain antennas are capable of yielding a higher RF energy density in the strongest part of their field and would, therefore, require a greater separation from the antenna. If other antennas are used, it is incumbent upon the installer to insure that the RF exposure limits for General Population/Uncontrolled Exposure are met. See 47CFR1.1307(b)(1)-(3) and/ or OET Bulletin 55, Edition 97-01 for more information on RF exposure guidelines.

FCC Label:

An FCC label must be visible on the unit as installed in its final configuration. If the unit is to be used as shipped from RITRON, this would be no problem since an FCC label is affixed to the top of the VCO shield. If the DTX-142 is to be installed in an enclosure, the installer must ensure that either the FCC label on the unit is visible through a door, window or other opening, or add a label to the outside of the enclosure. If a label is to be added to the outside of the enclosure, the label must be of a type which is not easily removed or damaged and contain wording: Contains FCC ID: AIERIT17-142.

MAINTENANCE INFORMATION

Surface Mount Repair

RITRON surface mount products require special equipment and servicing techniques. Improper servicing techniques can cause permanent damage to the printed circuit boards and/or components, which is not covered by RITRON's warranty. If you are not completely familiar with surface mounted component repair techniques, RITRON recommends that you defer maintenance to qualified service personnel.

Precautions for Handling CMOS Devices

This radio contains complementary metal-oxide semiconductor (CMOS) devices, which require special handling techniques. CMOS circuits are susceptible to damage by electrostatic or high voltage charges. Damage can be latent, with no failure appearing until weeks or months later. For this reason, take special precautions any time you disassemble the radio. Follow the precautions below, which are even more critical in low humidity environments.

1) Storage/transport - CMOS devices that will be stored or transported must be placed in conductive material so that all exposed leads are shorted together. CMOS devices must not be inserted into conventional plastic "snow" or plastic trays of the type that are used for other semiconductors.
2) Grounding - All CMOS devices must be placed on a grounded bench surface. The technician that will work on the radio/CMOS circuit must be grounded before handling the radio. Normally, the technician wears a conductive wrist strap in series with a 100K Ohm resistor to ground.
3) Clothing - Do not wear nylon clothing while handling CMOS circuits.
4) Power off - Remove power before connecting, removing or soldering a PC board that contains CMOS devices.
5) Power/voltage transients - Do not insert or remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices, making sure that no voltage transients are present.
6) Soldering - Use a grounded soldering iron for soldering CMOS circuitry.
7) Lead-straightening tools - When straightening CMOS leads, provide ground straps for the tool used.

Synthesizer Shield

The synthesizer shield should not be removed, unless a component must be replaced. This shield is soldered to the main PC board.

DESCRIPTION OF INPUT/OUTPUT

Antenna
The antenna should ideally be located a least a few feet away from the radio via coaxial cable. The antenna should be installed in such a way that no metal objects other than ground plane metal and no humans are within 43 cm (16.9 in) of the antenna. The installer should confirm there is no RF interference picked up on the analog and digital control lines that run between the transceiver and any other circuitry. Although the DTX-142 inputs are de-coupled and buffered, the external circuitry driving the DTX-142 may be susceptible to RF fields.

Channel Select (pins 3,2,1)
Three lines control the channel selection; CS2, CS1, CS0. The inputs have binary weighting of 4, 2 and 1 respectively. Tying an input to ground gives it a zero weighting. Thus, if no inputs are tied low channel eight is selected.

Microphone (pin 4)
An electret microphone can be connected to the microphone input at pin4. A 22 kohm resistor internal to the DTX-142 supplies power to the microphone.

High/ Low Power Input (pin 5)
Pulling this input to ground will yield a 2 watt transmit power. Unconnected it will transmit 5 watts.

Power Input (pin 6)
A power source of 10 to 15 VDC with 1 Amp capability should be connected here.

Auxiliary Input (pin 7)
This input (pin7) has a frequency response from 5 Hz to 3000 Hz. The input gain is set up to produce +/- 3.0 kHz deviation when a 100 mV peak-peak signal is applied. The gain can be adjusted by an internal potentiometer for other input levels.

Auxiliary Output (pin 8)
An output loading of 600 ohms or greater should be applied to this output. With a 600 ohm load the output exhibits a frequency response of 6 Hz to 3000 Hz. Higher load impedances will lower the low end frequency response. The output is adjustable with an internal potentiometer. It is preset at the factory to give 1 volt peak to peak output when receiving a +/- 3 kHz deviated signal.

Programming Port (pin 9)
This line is a bi-directional programming port to be connected to a RITRON programming cable. The other end of the programming cable connects to the PC's serial port 25 pin D-sub connector. The appropriate DTX-142 programming software must be run for configuring the transceiver.

Auxiliary Output Monitor Input (pin 11)
Bringing this input to ground will switch the auxiliary and speaker outputs on. Normally the AUX_OUT and SPEAKER_ OUT are switched on only when a carrier with required tone is detected.

Speaker (pin 12)
A speaker with 8 ohms or higher should be connected to pin12. A nominal 1 watt of audio power at 10% THD is expected.

Carrier Detect Output (pin 13)
This line will be pulled to 5 volts through a 390 ohm resistor when a carrier is present.

Push-To-Talk (pin 14)
Pulling the /PTT input (pin14) low activates the transmitter, and must be held low while transmitting. Alternately, a microphone with a PTT switch (switched to ground through < 3 k ohm) can be connected to pin4 to activate transmission.

DESCRIPTION OF INPUT/OUTPUT

OPERATION

Turning the Transceiver On
Once power is applied to pin 6 of the radio the microcontroler will start and load the receive frequency of the channel designated by CS2, CS1 and CS0 (pins 3, 2 and 1). The radio will beep out the channel number on the speaker line.

Receive
The radio will monitor the channel until a carrier becomes present. When an on channel carrier appears, the carrier detect line (pin 13) will be pulled high. If the correct CTCSS or DCS tone is present the radio will unsquelch the SPEAKER and AUX_OUT lines.

Speaker Volume
The speaker volume is preset by an internal potentiometer (R350) to yield 2 volts RMS into 8 ohms. If your application requires a different audio level two options exist. One is to open the transceiver unit by removing the 4 corner screws on the connector end of the radio case, pull out the PCB and reset the volume potentiometer (R350). The second is to place a power resistor or potentiometer in series with the output and speaker to reduce or adjust volume.

Monitor
Pulling pin 11 low will cause the SPEAKER and AUX_OUT to unsquelch. This allows the operator to hear any on channel signal.

Transmit
Pulling the /PTT input pin14 low activates the transmitter, and must be held low while transmitting. A microphone with an internal PTT switch, with less than 3 k ohm resistance connected to pin4 will also activate transmission when the microphone PTT is pressed. A programmable time-out-timer will shut down transmission when /PTT is held down too long.

Shut down
The radio will shut down when the battery voltage drops below a predetermined “dead battery” level. This is around 6 volts.

PROGRAMMING THE RADIO USING A PC COMPUTER

RITRON's programming kit allows programming of the DTX-142 model radios using a PC compatible computer. An adapter cable DTXP-PAC connects the radio to a computer's serial communications port. Once the cable is hooked up, the user inserts the diskette provided into his computer's floppy disk drive and loads a software program. This program transfers data between radio and computer memory, and includes on-screen instructions and help. Radio data may be saved to the computer's hard disk in order to program other radios.

The PC Programming Kit Includes:

1) Ritron Transceiver programming software, which is contained on 3.5" diskettes.
2) Installation instructions and a registration form.
3) Ritron PC to radio adapter cable, which is terminated at one end with a DB-25F connector, at the other end with a modular jack. Another cable with a modular plug (which mates to the previous cable) on one end with a DB-15M on the other end mates to the radio.

The PC Programming Kit Requires: A PC compatible computer with Windows 95 or later. The computer must have an RS-232 serial port available. A hard disk drive is recommended.

Programming the DTX-142 To program the DTX-142 do the following:

1) Start with radio disconnected from power supply.
2) Connect the DTXP-PAC programming cable.
3) Take the /PTT line (pin 14) to ground.
4) Apply 8 to 15 VDC power to pin 6 of the DB15.
5) Run programming software and read or write parameters.
6) Release /PTT from ground when finished.

PC Programmable Features

Channel features can be programmed differently on each channel. One channel can have wide band deviation (+/- 5 kHz) on the transmitter and the next narrow band (+/- 2.5 kHz). Transmit and receive frequencies and QC or DQC tones on a channel can be different. A channel can also be deleted. Up to a 32 character ID string can be entered to allow PC programmers to identify radios.

COMPUTER SOFTWARE COPYRIGHTS

DTX-142 THEORY OF OPERATION

INTRODUCTION

The DTX-142 is an eight-channel synthesized transceiver unit capable of rapid data reception and rapid data transmission at rates up to 9600 bps when using 4-level FSK. The unit maintains under 20 mA current consumption at 13.8 VDC when in the receive standby mode. The current drain goes up as the voltage goes down. The transmitter also exhibits good efficiency. The following table shows typical DTX-142 performance.

Power Supply (VDC)	Transmit Power (watts)	Transmit Current (Amps)	Radio TX Efficiency (%)	Receive standby current (mA)
8	1.75	0.55	39.8	28.5
9	2.35	0.61	42.8	25.5
10	3.05	0.70	43.6	23.3
11	3.75	0.77	44.3	21.7
12	4.52	0.80	47.1	20.0
13	5.00	0.80	48.1	19.0
14	5.00	0.80	44.6	17.9
15	5.00	0.80	41.7	17.0

POWER SUPPLY AND VOLTAGE DISTRIBUTION

The DTX-142 is powered by an 8 to 15 VDC external power supply. F601 is a 3A fuse in series with J301 for short circuit protection. Zener diode D601 prevents over voltage damage by blowing the F601 fuse when over 18 volts is applied. If reverse battery voltage is applied F601 will blow by conducting current through D601.

The DTX-142 is designed to consume low current by using a switching DC/DC converter called a buck converter. Receiver standby current is less than 20 mA at 13.8 volts. The buck converter outputs about 40 mA at 5.4 volts. The conversion efficiency of the buck converter is about 90%. Lowering the supply voltage will cause more current to be drawn from the supply. The buck converter's output of 5.4 volts feeds a 5 volt low drop out regulator U402. A voltage clamp consisting of Q601, 2 and 3 limits the RF final PA and audio PA voltages to +13 volts. This circuitry is enabled by Q604 only when receiving a carrier, when transmitting or when AUX_MON is enabled. A +8 volt regulator consisting of Q201 and Q202 supply power to the pin diode switches CR101 and CR201 and VCO buffer stage Q210 during transmission.

REFERENCE OSCILLATOR

Reference oscillator Y301 is a temperature controlled, voltage controlled oscillator (TCVCXO) operating at 14.4 MHz. The Pin 4 output of the TCVCXO provides a reference for the frequency synthesizer U401 at Pin 8. The reference oscillator also feed pin 7 of the U301 microcontroller through a buffer amplifier Q310 and a Schmit inverter U303 to obtain a14.4 MHz clock. The Y301 pin 4 output is also multiplied (tripled) up to 43.2 MHz by Q104 and its associated circuitry to provide a receiver second local oscillator signal.

SYNTHESIZER

The DTX-142 radio is built around a PLL synthesizer that consists of a receive voltage-controlled oscillator (VCO) and transmit VCO. U401 contains both a prescaler and synthesizer controller. The prescaler squares and divides the VCO output present at pin 5 by either 8 or 9, determined by a synthesizer controller logic signal. The prescaler changes once every reference cycle at the appropriate time to yield the right frequency. U401 contains a digital phase detector that works as follows. When the receive/transmit mode is switched, a new synthesizer operating frequency is selected. Microcontroller U301 clocks new data into U401 internal buffer in synchronization with clock pulses. The channel information is stored in EE memory of U301 and is loaded into RAM when the channel is selected.

Two separate VCO are used in the synthesizer. The transmit VCO operates from 136 to 156 MHz for low split or 154 to 174 MHz for high split. The receive synthesizer works 43.65 MHz higher than the transmit band. The transmit VCO is turned on by Q405 and the receive VCO by Q408. The transmit VCO has a modulation varactor diode CR404 and a modulation leveling diode CR403 to maintain equal deviation across its operating band. The loop filter C403, C404,C405, R407 and R408 transform the pin 2 output signal to a DC voltage for application to the VCO tuning varactors CR405 and CR406 for receiver or CR401 and CR402 for transmitter. The synthesizer system is "locked" when the phase and frequency of both the reference and the divided VCO signal are the same. Output pin 1 of U401 is brought low for about 3 milliseconds after the frequency is loaded to speed up lock time. Internally the charged pump phase detector current is increased to momentarily widen the loop bandwidth thereby reducing settling time. When the synthesizer is locked pin 14 goes high. If the loop becomes unlocked pin 14 goes low.

RECEIVER

Receiver Front End

The signal from the antenna passes through the transmitter low pass filter and then goes to the tunable bandpass filter L101 and L102. Q101 amplifies the signal about 15 dB before going through another band pass filter and mixer matching stage. The receiver is turned on by Q107 and Q108 supplying RX_5v when RXEN of U301 goes high.

The amplified received input signal is applied to the base of mixer Q102. The 1st local oscillator signal from the synthesizer module is buffered and filtered by band pass amplifier Q106 and then applied to the source of Q102. L195, C114, C115 and C135 tune the drain output of Q102 to 43.65 MHz and apply it to Y101 and Y103, a 43.65 MHz four-pole crystal filter. Q103 and associated components amplify the 43.65 MHz IF signal and apply it to the input of the 2nd mixer at Pin 16 of U101.

FM Receiver Subsystem

A multi-function integrated circuit, U101 and associated components form the FM-receiver subsystem. The subsystem performs the following functions as a 2nd mixer, IF amplifier and FM detector. The second local oscillator at 43.2 MHz is applied to the 2nd local oscillator input at Pin 1 of U101. The 43.65 MHz signal at Pin 16 and the 2nd local oscillator are mixed, with the resulting 450 KHz output signal appearing at Pin 3. This signal is filtered by a 450 kHz 6-pole ceramic filter YF101 and applied to the input of the limiting IF amplifier at Pin 5. IC101 pin 6 de-couples the IF amplifier. An internal quadrature detector, whose center frequency is determined by the 450 kHz quadrature resonator Y102, detects the FM IF signal. One input of the quadrature detector is connected internally to the IF signal from pin11 while the other input is the phase-shifted signal from Y102 at Pin 10. Demodulated audio appears at Pin 9, where a low-pass filter R323 and C309 removes spurious second IF output prior to application to the voice, tone or squelch conditioning audio circuitry.

Two types of squelch circuits exist on the DTX-142, an RSSI squelch and a noise squelch. Both types can be used simultaneously or one or the other can be used. The RSSI (receive signal strength indicator) squelch, which is typically set around –110 dBm, must be set to open at a higher level than the noise squelch. This is necessary since the RSSI measures total power in the receiver IF band pass. All background noise, which at VHF can be high, is seen as signal. The advantage of the RSSI squelch is that it opens and closes the audio paths very quickly. The noise squelch has the advantage that it can be set at a much lower level, typically –122 dBm for a 12 dB SINAD. It takes longer to open and close the squelch. If both are used simultaneously, since they are wired ORed together at U301 pin 32, the squelch will open quickly and close slowly for strong signals. If only RSSI is desired R145 can be removed.

Voice and Tone Conditioning in Receiver

Three post demodulation paths are provided in the DTX-142. U304c provides DC level translation to bias succeeding op amp stages at about 2.5 volts.

The audio path goes through a fourth order 300 Hz high pass filter U305c and d. C326, R353 and R351 de-emphasis the audio. The 1 watt audio amp is turned on by Q311 and Q312. Error tones from come through C325 from pin 13 of U301.

The data path goes through U304a and b. U305b is a second order 3000 Hz low pass filter. U304a produces phase shift around 3000 Hz to equalize time delay. R337 and C316 provide another low pass filter pole. U307a is an adjustable gain buffer stage. This stage is squelched by Q314.

Sub-audible signals go through a third order 250 Hz low pass filter U304d, R342, and C316. Pin 27 of U301 decodes the CTCSS or DCS signal. In the case of CTCSS an internal discrete Fourier transform looks for the wanted tone. Decode bandwidth is about +/-2 Hz.

TRANSMITTER

The transmit VCO feeds buffer stage Q210 which feeds the pre driver Q209 and in turn the RF final Q208. The final is a FET device. The power supply to the driver and the final FET biasing is controlled by a feedback power controller. The power control circuitry maintains a constant current supply to the final Q208 transistor. A constant current across the frequency band will yield a level power output if the amplifier efficiency is similar. U201a is a differential amp monitoring current through the four paralleled 1 ohm shunt resistors. U201b is a comparator op amp. Potentiometer R222 is used to set the high level power to 5 watts. When excess current producing power greater than 5 watt goes through the four 1 ohm resistors the output of U201a drops. This in turn causes U201b pin 7 output to drop forcing the voltage on the collector of Q205 to drop thereby reducing power. In the low power mode Q309 gets turned off when U301 pin 9 goes low. This cause less current to flow through the power control pot R222 and raises the voltage on U201b pin 6 causing in a lower power output. R222 is preset in the factory to give 2 watts in low power mode and 5 watts in high power mode.

A low-pass filter comprised of filter L201, L202, C201, C027, C203 and C204 removes harmonics from the transmitter output before applying the RF signal to the antenna. Two PIN diodes CR101 and CR201 along with associated components form the antenna switching circuit. When transmitting both pin diodes are turned on. CR101 shunts transmitting power to ground at the receiver input to prevent receiver overload. With the DTX-142 in receive mode no voltage is applied to the PIN diodes and they do not conduct. This opens CR201 to prevent the transmitter amplifier from affecting the receiver tuning. Incoming signals from the antenna pass through L203 to the receiver front end.

Voice and Tone in Transmitter

In transmit mode two audio paths and one tone path exist. The microphone input is high gain pre-emphasized path. R366 and C354 form the pre-emphasis network. Signal limiting occurs in U308a. “Splattered” higher frequency components are later filtered out by the fifth order 3000 Hz low pass filter consisting of U308a, c and d.

The data path (AUX_IN) with a flat frequency response goes through an adjustable gain amplifier U305a. The gain should be adjusted so the required deviation is transmitted. Deviation limiting occurs in U305a. It is preset in the factory to give +/- 3 kHz deviation with 100 mV peak to peak input.

The CTCSS and DCS sub-audible tone are generated by the U301 pin 13. These tones are generated by the pulse width modulated (PWM) output at pin 13 of the microcontroller. The 8 bit PWM output operates at 14.4 kHz. A simple RC filter consisting of R319, R373 and C338 suppress higher order frequency components. The fifth order 3 kHz low pass filter further attenuates the 14.4 kHz components.

Both the VCO and the reference oscillator are modulated by all signals resulting in a flat frequency response from DC to 2500 Hz. The FM deviation of the VCO is set by the “deviation” potentiometer R388. adjusted by the “balance” pot R304. The balance pot is adjusted to give a minimal tilt on a DCS generated waveform. The transmit loop bandwidth of the synthesizer is about 100 Hz. The CTCSS deviation from 67 to 254 Hz lies between 600 and 900 Hz in wide band mode.

MICROCONTROLLER

The DTX-142 handheld transceiver is electronically controlled by U301, an 8-bit flash programmable microcontroller. U301 has A/D inputs and PWM outputs for processing analog signals. Radio characteristics are stored in internal EE memory. Its RS232 port is used in programming the radio's personal characteristics such as frequencies and tones.

PIN	DESCRIPTION
1	Input is pulled LOW when the PTT input is grounded to initiate transmitter operation.
2	Input is pulled high when high/low power input is grounded. This produces a low RF output power.
3	GROUND
4	+5 VDC V_{CC} supply voltage.
5	GROUND
6	+5 VDC V_{CC} supply voltage
7	XTAL1 is 14.4 MHz reference input from Y301.
8	Input is normally high when PLL is locked and low when unlocked.
9	Output goes high to produce high power RF output.
10	Output drops low momentarily to produce synthesizer latch enable (LE) pulses.
11	Output goes high to enable receiver (RXEN).
12	Output goes high to enable transmitter (TXEN).
13	TONE OUT generates the QC (CTCSS) or DQC (DCS) waveforms via an 8 bit PWM prior to modulating the VCO in transmit mode. Also generates alert tones heard on the speaker.
14	SQUELCH output goes high to apply power to audio amp U306 for receiver speaker audio or radio alert tones.
15	DATA output sends serial data to frequency synthesizer U401 to program frequency information. Also used for flash programming (MOSI)
16	CLK output sends serial data clock pulses to frequency synthesizer. Also used in flash programming (MISO).
17	output is set permanently low to allow CS0 to be a channel select input bit.
18	AVCC supplies +5VDC.
19	Input is used to measure receiver RSSI.
20	AREF supplies the reference level for the A/D and is connected to the regulated +5 VDC.
21	AGND supplies A/D ground.
22	Not used
23	Input is pulled low when the CS2 frequency bit input is tied to ground.
24	Input is pulled high when CS0 channel select bit is pulled low.
25	Output is set permanently low to allow CS1 to be a channel select input bit.
26	Input is pulled high when CS1 channel select bit is pulled low.
27	CTCSS IN is an A/D input sampling the CTCSS or DCS waveform.
28	Not used
29	RESET is held low to start the radio in a known state on power up.
30, 31	SERIAL DATA PORT links the microcontroller to communications from an external data terminal via programming port pin 9 of J301. This allows programming of the DTX-142 EE memory used to store channel frequency and configuration information.
32	CARDET gets pulled low when a RF carrier is detected by the U101.

DTX-142 ALIGNMENT PROCEDURE

An authorized RF service technician must perform test and alignment of the DTX-142. Do not attempt service of the DTX-142 if not completely familiar with frequency synthesized radio operation.

RECOMMENDED TEST EQUIPMENT

1) 0 to +15 VDC, 1A current-limited power supply
2) RF Communications Test with:
   - FM Deviation Meter
   - RF Wattmeter
   - Frequency Counter
   - SINAD Measuring Device
3) Oscilloscope
4) VTVM or DMM
5) RITRON PC Programming Kit

RADIO PREPARATION

1) Remove the DTX-142 from case.
2) Connect the FM communications test set to the antenna connector.
3) Connect RITRON programming cable to radio and PC.
4) Apply 12.5 VDC to the red wire with the black to ground.
5) Run RITRON software and read the radio.
6) Program any two channels of your choice for band edge tune up; one to the low side of the operating band and one to the high side (Hint: use a bit of an offset from even frequencies to avoid receiver interference. A good choice is 136.1 and 156.1 MHz for the low split or 154.1 and 174.1 MHz for the high split.)
7) Type in these RX and TX frequencies in both channels.
8) Select a DCS tone of 071 for TX on both channels. This will be used to set the “balance” pot R304.
9) Set the transmitter to wideband deviation.
10) Program the radio with these parameters.

REFERENCE FREQUENCY AND TX POWER

The DTX-142 is preset at the factory for 5 watts in high power and 2 watts in low power. If you need to change or readjust do the following:

1) Make sure that the unit is at room temperature (approximately +25° C)
2) Set the RF communications test set to the transmit mode.
3) Select low edge channel on channel select inputs CS2, CS1 and CS0.
4) Make sure the Hi/low power pin 5 is ungrounded. This selects high power.
5) Ground /PTT pin 14 of J301 to transmit.
6) Transmitter frequency error should be less than +/- 100 Hz.
7) Adjust the trimmer cap on the rectangular reference frequency oscillator Y301 if not within specs.
8) Adjust the power pot R222 to give 5 watts (+/- 0.3)
9) Confirm the upper edge frequency produces the same results.
10) If upper edge power is too high turn L201 clockwise to reduce and counter clockwise to increase.
11) Check low edge power again. Readjust L201 to balance band edge powers.

DTX-142 ALIGNMENT PROCEDURE

TRANSMITTER VOICE & DATA DEVIATION

If the transmitter voice deviation needs adjustment perform the following.

1) Set the RF communications test set to the transmit mode.
2) Set audio filtering from <20 Hz to 15 kHz.
3) Set to FM demodulation with +/- peak deviation.
4) Connect oscilloscope to the demodulated output.
5) Select low edge channel on channel select inputs CS2, CS1 and CS0.
6) Connect sinusoidal 400 Hz audio source to pin 4 microphone input and set to 1 kHz and 100 mV peak-peak .
7) Ground /PTT (pin 14) to transmit.
8) Adjust deviation pot R388 for peak deviation of 4250 +/- 50 Hz.*
9) Adjust the balance pot R304 to give a flat sloop on the demodulated output oscilloscope waveform.
10) Readjust R388 as needed to maintain 4250 Hz deviation.
11) Stop transmitting by releasing the /PTT line on pin 14.
12) Check the upper channel to confirm similar performance.
13) Readjust both channel band edges as needed for the best compromised performance.

*NOTE: Sub audible tone deviation is automatically set to be within 600 to 900 Hz after this adjustment on wide band tone channels. Maximum voice and tone deviation on wide band channels will then be 4850 to 5150 Hz. Narrow band tone deviation will be 350 to 500 Hz with overall deviation of 2450 to 2600 Hz.

Having set up voice deviation, connect a data source to pin 7 of J301. Adjust R375 to obtain needed data deviation. Typically this will be +/- 3 kHz for a wideband channel and +/- 1.5 kHz for a narrowband channel.

RECEIVER FRONT END TUNNING

The DTX-142 receiver is factory tuned for a frequency range of 136 to 156 MHz (low split) or 154 to 174 MHz (high split). If receiver appears to be less sensitive on one of the band edges the front end tuning coils may need readjustment. Connect a SINAD meter to the SPEAKER output (pin 12). Unsquelch the audio amp by grounding pin 11. Set the generator to the upper band edge frequency programmed at –121 dBm with +/- 2.5 kHz deviation. Adjust coil cores L101 and L102 in until SINAD starts to drop. Back off slightly to maintain best SINAD. Now, set generator to the lowest frequency programmed at –121 dBm. Similar SINAD readings as the high band edge frequency should be obtained. If not, adjust coils slightly. Recheck high end and balance performance.

RECEIVER SQUELCH

The DTX-142 is capable of two squelch operating modes. Also, both can operate simultaneously. See the theory above. The units can be configured as the user requires. When the noise squelch is used the radio unsquelches when the carrier SINAD exceeds 12 db. If this is not happening or the squelch opening level needs to be changed perform the following.

1) Select a channel.
2) Adjust squelch pot R144 fully counter clockwise.
3) Ground the MONITOR pin 11 to unsquelch the radio.
4) Adjust the communications test set generator on frequency with an output level to yield a 12 dB SINAD. The deviation should be +/- 1.5 kHz for narrow or 3 kHz for wide with a 1 kHz tone.
5) Release pin 11 from ground to allow squelch to operate.
6) Slowly adjust squelch pot R123 clockwise until squelch opens.
7) Reduce generator level until radio squelches.
8) Increase generator level until audio opens. Confirm squelch hysteresis is between 0.5 and 4 dB.

Set up for the RSSI squelch is similar except a fixed level, typically –110 dBm, is set on the generator and the RSSI squelch pot R123 is rotated clockwise until it opens. Ambient noise will affect the level at which the RSSI should be set. The squelch level ideally should be done on the desired frequency, in the actual location the radio will be used and connected to the desired antenna. The level should be set high enough to reject most false signals.