Go Beyond Normal Limits...℠

RITRON®

WIRELESS SOLUTIONS

TELEswitch®

WIRELESS SWITCH CONTROL

MAINTENANCE & OPERATING MANUAL

FOR USE ONLY BY AUTHORIZED SERVICE/MAINTENANCE PERSONNEL

TS-142/442

TABLE OF CONTENTS

INTRODUCTION

GENERAL

RITRON's TS-142 VHF TeleSwitch is designed to operate in one of two band splits, 136-156 MHz or 154-174 MHz. RITRON's TS-442 UHF TeleSwitch is designed to operate from 400-420 MHz or 450-470 MHz. The transceiver is a single board unit mounted in a weather tight housing with a DTMF decoder board that provides dual relay outputs. Each relay is independently controlled

The transceiver 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. Transmitter wide or narrow deviation can be programmed on a per channel basis. The unit is set up to transmit 5 watts or about 2 watts low power when operating at 13.8 VDC. The standby current at 13.8 VDC is 20 mA or less.

MODEL IDENTIFICATION

The standard DTX-142/442 is contained in an aluminum case with a BNC and a DB-15 connector. A standalone board version is also available. The DTX model, serial number and FCC Identification are displayed on a label located on the top of the radio VCO shield for board versions or on the non-connector end for cased units. Also, two frequency range sub-bands exist. The following breakdown explains the model number.

The model number form is: " DTX-X42-./IBCD " where:

Xis the band designator: 1
=VHF 4 = UHF

A is the sub-band designator:
G = 136-156 MHz for VHF
G = 400-420 MHz for UHF
0 = 154-174 MHz for VHF
0 = 450-470 MHz for UHF

B is the connector type:
B = BNC
S = SMA
0 = no connector

C designates the IF bandwidth:
N = Narrow W = Wide

D designates the case: D = deletion of case E = enclosed in aluminum extrusion

Examples:
DTX-142-GBNE -136 to 156 MHz with narrowband receiver in case with BNC connector
DTX-142-00WD -154 to 174 MHz wideband receiver with no RF connector and no case
DTX-442-0SWD -450 to 470 MHz wideband receiver with SMA connector and no case

DTX-142/442 units without cases may be delivered with a vertical or right angle female DB15 connector. Contact the RITRON sales department for further details.

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-142/442 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 for the DTX-142 and 20 cm (7.9 in) for the DTX-442 while the unit is transmitting. The installer must site the antenna in such a way that all persons would be at this distance or greater away during transmission.

The antenna tested for this product for RF exposure was the RITRON RAM-1545 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 or case end cap. If the DTX-142/442 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 forthe DTX-142 or Contains FCC ID: AIERIT17-442 for the DTX-442

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. Ifyou 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. Sucking or wicking the solder up around the perimeter can remove the shield. If this should prove difficult a side cutters can cut the top off after which the walls can be removed. A replacement shield will then be needed and is available from RITRON (PN# 25107800).

DTX-142 / 442 SPECIFICATIONS

GENERAL	DTX-142	DTX-442
FCC ID:	AIERIT17-142	AIERIT17-442
Frequency Range:	136-156 MHz or 154-174 MHz	400-420 MHz or 450-470 MHz
Bandwidth:	20 MHz	20 MHz
Synthesizer Step Size:	2.5 kHz	6.25 kHz
FCC Rule Parts:	90	90
RF Channels:	8 Independent TX/RX frequencies	8 Independent TX/RX frequencies
Frequency Stability:	+2.5 PPM (-30° to +60° C)	+2.5 PPM (-30° to +60° C)
Tone/Code Signaling:	CTCSS (Quiet Call) and DCS	CTCSS (Quiet Call) and DCS
Maximum Data rate:	9600 bps with 4-level FSK	9600 bps with 4-level FSK
Power Supply:	8to16.7VDC	8 to 16.7 VDC
Battery Drain:		
RX Standby:	20mA@13.8VDC	20 mA@ 13.8 VDC
RX Receive:	250 mA	250 mA
Transmit:	1 Amp @ 5 Watts at 13.8 VDC	1.2 Amp @ 5 Watts at 13.8 VDC
Dimensions:	5"Hx3"Wx1.25"D	5"Hx3"Wx1.25"D
Weight:	3.8 oz.	3.8 oz.
Antenna Fitting:	BNC female or SMA female	BNC female or SMA female
Transmitter Duty Cycle:	100% up to 30° C (above 25° C degrades linearly to 5% at 60° C)	100% up to 25° C (above 25° C degrades linearly to 5% at 60° C)

RECEIVER

Sensitivity (12 dB SINAD):	0.25 uV	0.25 uV
Adjacent Channel:		
Wide	-70 dB	-70 dB
Narrow	-60 dB	-60 dB
Spurious Rejection:	-65 dB	-60 dB
Image Rejection:	-80 dB	-60 dB
Intermodulation:	-65 dB	-60 dB
FM Hum & Noise:		
Wide	-46 dB Wide	-46 dB Wide
Narrow	-40 dB Narrow	-40 dB Narrow
Conducted Spurious:	-57 dBm	-57 dBm
Receiver Attack Time (TX to **RX):**	< 25 ms	< 25 ms
Noise Squelch Attack Time (12 dB SINAD):	<15ms	< 15 ms
RSSI Squelch Attack Time:	< 5 ms	< 5 ms
RSSI Squelch Sensitivity:	Manually adjustable; factory	set for-106 dBm
Noise Squelch Sensitivity:	Manually adjustable; factory	set for-121 dBm
AUX OUT Frequency Response:	6-3000Hz@+1 / - 3 dB	6-3000Hz@+1 / - 3 dB
Audio Output:	>700 mW into 8 W, with less	than 5 % THD

TRANSMITTER

RF Power Output:	2.0 Watt® 13.8 VDC < .6 A 5.0 Watt® 13.8 VDC < 1 A	2.0 watts @ 13.8 VDC < .75 A 5.0 watts® 13.8 VDC < 1.2 A
Voice Emission Designator:		
Wide voice:	14K6F3E	15K2F3E
Narrow voice:	10K4F3E	10K6F3E
Data Emissions Designator:	9K20F1D	9K4F1D
Deviation:		
Wide:	+ 5.0 kHz	+ 5.0 kHz
Narrow:	+ 2.5 kHz	+ 2.5 kHz
Transmitter Attack Time:	20 ms	20 ms
FM Hum & Noise:		
Wide:	-45 dB	-45 dB
Narrow:	-40 dB	-40 dB
Audio Distortion:	<5%	<5%
Spurious and Harmonics:	-20 dBm max	-20 dBm max
Aux In Frequency Response:	7 Hz to 2700 Hz @ +1 / -3 dB	

SUB-D 15-PIN CONNECTOR

The DTX-142/442 is equipped with a 15-pin femail sub-D connector with the following functions:

PIN#	FUNCTION
1	Least Significant Channel Select Bit (CSO)
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 15VDCInput
7	Auxilary Input
8	Auxilary Output
9	PC Programing Port
10	Optional 10k Ohm Speaker Volume Potentiometer (DTX-442 only)
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

CHANNEL SELECT (pins 3, 2, and 1) ***IMPORTANT*: Channel 8 is the default channel (no inputs tied low)**

Three lines control the channel selection; CS2, CS1, CSO. 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.** In this case the 111 in binary or 7 in decimal is the eighth channel. 000 would be channel 1.

MICROPHONE (pin 4)

An electret microphone can be connected to the microphone input at pin 4. A 22 k ohm resistor tied to +5 VDC internal to the DTX-442 supplies power to the microphone.

HIGH / LOW POWER INPUT (pin 5)

Pulling this input to ground will yield about a 2 watt transmit power. Unconnected it will transmit up to 5 watts. Actual power output will depend on supply voltage.

POWER INPUT (pin 6)

A power source of 8 to 15 VDC with 1.2 Amp capability should be connected here. Once power is applied to pin 6 of the radio the microcontroller will start and load the receive frequency of the channel designated by CS2, CS1 and CSO (pins 3, 2, and 1).

AUXILIARY INPUT (pin 7)

This input (pin7) has a frequency response from 7 Hz to 3000 Hz with no pre-emphasis. The input gain is factory set to produce ± 3 kHz deviation (1.5 kHz for narrowband) when a 300 mV peak-peak signal is applied. Input signal should not exceed 1.5 v peak-to-peak. The gain can be adjusted by an internal potentiometer R375 for other input levels. No signal should be applied to this input when in receive mode. Signals present here can modulate the frequency reference and cause distortion in the receiver audio output.

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 7 Hz to 3000 Hz with no de-emphasis. Higher load impedances will lower the low end frequency response. The output is adjustable with an internal potentiometer R360. It is preset at the factory to give 1 volt peak to peak output when receiving a + 3 kHz (1.5 kHz for narrowband) deviated signal.

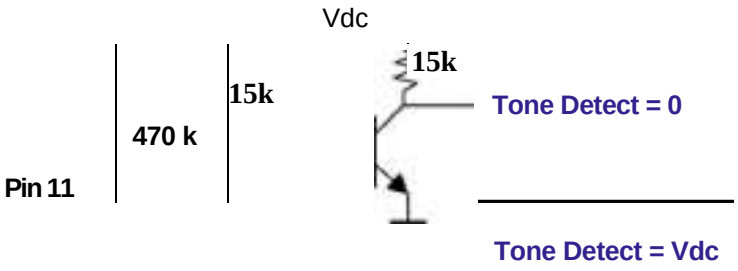
SUB-D 15-PIN CONNECTOR (continued)

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-142/442 programming software must be run for configuring the transceiver.

EXTERNAL VOLUME POTENTIOMETER (pin 10)
Connecting a 10 k pot to ground at this point will allow the speaker volume to be adjusted. For maximum range the internal volume pot R350 should be set to the maximum. (DTX-442 only)

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. Alternately, since pin 11 gets pulled low when a carrier with correct tone is detected, the following external circuitry can be used as a tone detect output. Pin 11 can still be pulled low to monitor channel.

EXTERNAL CIRCUIT TO USE AUX MON INPUT AS TONE DETECT OUTPUT



SPEAKER (pin 12)
A speaker with 8 ohms or higher should be connected to pin 12. As much as 1 watt of audio power is possible. The speaker volume is preset by an internal potentiometer (R350) to maximum gain. 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 fixed or variable resistor from pin 10 to ground to attenuate the audio. This option is available on all the DTX-442 only.

CARRIER DETECT OUTPUT (pin 13)
This line will be pulled to 5 volts through a 390 ohm resistor when a carrier is present. This output is carrier detect only. If a carrier with valid tone detect is needed use pin 11 with the external circuitry as shown above.

PUSH-TO-TALK (pin 14)
Pulling the PTT input (pin 14) 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 pin 4 to activate transmission. A programmable time-out-timer will shut down transmission when PTT is held down too long.

Inverse Operation - Removing Q316 and shorting the base to collector of Q316 will invert the PTT operation (ie. the unit transmits when taken high rather than to ground). R370 must also be removed since it connects to the microphone circuit which has a 22 kohm pull up to + 5 VDC.

PC PROGRAMMING

RITRON's PC programming kit, DTXL-PCPK-2.0, allows programming of the DTX-142/442 model radios using a compatible computer. An adapter cable 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:
Ritron Transceiver programming software, DTXL-PCPS-2.0, contained on a CD-ROM.
Ritron PC to radio adapter cable, 9/RTC-PAS, which is terminated at one end with a DB-25F connector, at the other end with a 6 pin modular plug.
Another cable, DTXP-PAC, with a modular jack (which mates to the previous cable) on one end with a DB-15M on the other end to mate to the radio. Power leads are also provided. Red is positive.

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 highly recommended.

PC Programming the DTX-142: To program the DTX-142 do the following:
Connect the PC's RS-232 port to 9/RTC-PAS and DTXP-PAC programming cable. Connect DTXP-PAC to DTX-142
Apply 8 to 15 VDC power to pin 6 of the DB15 (Red wire)
Insert disk 1 in floppy disk drive. View the disk contents and double click on **setup.exe.** Follow the instructions on screen. When finished the software will be resident on the PC's hard disk.

USING THE PROGRAMMING SOFTWARE

Upon starting the software, with a radio connected to the programming cable and powered up, the PC will read the radio data. A form then appears identifying the radio and displaying all channel information. If no radio is connected when the software is started a form appears asking the operator to select a model. When a model is selected default parameters for that model are displayed. These parameters could be programmed into a radio or a previously defined file can be recalled and loaded. To program a radio click *radio* on the menu bar and then click *program radio.* To read the radio contents click *radio* on the menu bar and then *read radio.* Allow several seconds for the reading to take place. To change a parameter click a white field or double click the channel field to access it. Files can be saved and read using the *File* menu option.

Channel features can be programmed differently on each channel. One channel can have wide band deviation (+ 5 kHz) on the transmitter and another 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 moved or deleted. A transmit time out timer of up to 254 seconds can be programmed. Entering 0 or 255 will disable the time out timer. An ID string of up to 72 characters can be entered to allow PC programmers to identify radios.

DTX-142/442 THEORY OF OPERATION

INTRODUCTION

The DTX-142/442 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 standby current drain goes up as the voltage goes down. The transmitter also exhibits good efficiency.

The following tables show typical DTX-142 performance when set to 5 watt or 2 watt output levels.

5 WATT DTX-142 PERFORMANCE					2 WATT DTX-142 PERFORMANCE				
Power Suppl (VDC)	Transmit Power (Watts)	Transmit Current (Amps)	Radio TX Efficiency (%)	Standby Current (mA)	Power Supply (VDC)	Transmit Power (Watts)	Transmit Current (Amps)	Radio TX Efficiency (%)	Standby Current (mA)
8	1.73	0.52	41.6	28.5	**8**	1.73	0.52	41.6	28.5
9	2.36	0.60	43.7	25.5	**9**	2.12	0.56	42.1	25.5
10	3.05	0.68	44.9	23.3	**10**	2.20	0.55	40.0	23.3
11	3.84	0.73	47.8	21.7	11	2.28	0.54	38.4	21.7
12	4.65	0.81	47.8	20.0	12	2.30	0.53	36.2	20.0
13	5.00	0.80	48.1	19.0	**13**	2.28	0.52	33.7	19.0
14	5.06	0.79	45.8	17.9	14	2.20	0.52	30.2	17.9
	5.08	0.79	42.9	17.0	15	2.20	0.52	28.2	17.0 ^

The following tables show typical DTX-142 performance when set to 5 watt or 2 watt output levels.

^^ 5 WATT DTX-442 PERFORMANCE					2 WATT DTX-442 PERFORMANCE				
Power Suppl (VDC)	Transmit Power (Watts)	Transmit Current (Amps)	Radio TX Efficiency (%)	Standby Current (mA)	Power Supply (VDC)	Transmit Power (Watts)	Transmit Current (Amps)	Radio TX Efficiency (%)	Standby Current (mA)
8	1.13	0.57	24.8	29.5	8	1.13	0.57	24.8	29.5
9	1.90	0.69	30.6	27.0	9	1.76	0.64	30.6	27.0
10	2.70	0.78	34.6	24.5	10	1.87	0.64	29.2	24.5
11	3.57	0.89	36.5	22.5	11	1.93	0.63	27.8	22.5
12	4.38	0.97	37.6	21.0	12	2.00	0.62	26.9	21.0
13	4.70	0.96	37.7	19.5	13	2.00	0.61	25.2	19.5
14	4.96	0.96	36.9	18.0	14	2.00	0.61	23.4	18.0
s[15]	5.00	0.96	34.7	17.0	15	2.00	0.61	21.9	17.0

DTX-142 THEORY OF OPERATION

DTX-142 POWER SUPPLY & 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. The buck converter outputs about 40 mA at 5.4 volts. The conversion efficiency of the buck converter is about 85%. 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. A voltage regulator consisting of Q601, 2 and 3 limits the RF final PA and audio PA voltages to +13.8 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.

DTX-142 REFERENCE OSCILLATOR

Reference oscillator Y301 is a temperature compensated, voltage controlled crystal 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 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.

DTX-142 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. When the receive or transmit mode is switched, a new synthesizer operating frequency is selected. Microcontroller U301 clocks new data into the U401 internal buffer in synchronization with clock pulses. The channel information is stored in the EE memory of U301 and is loaded into RAM when the channel is selected.

Two separate VCOs 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. 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.

DTX-142 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 the 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 1 st 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.

DTX-142 FM RECEIVER SUBSYSTEM

A multi-function integrated circuit, U101 and associated components form the FM-receiver subsystem. The subsystem performs the functions of 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 kHz6-pole ceramic filter YF101 and applied to the input of the limiting IF amplifier at Pin 5. IC101 pin 6 decouples 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 -106 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-121 dBm for a 14 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.

DTX-142 RECEIVER VOICE & TONE CONDITIONING

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. The data path goes through U304a and b which serve as buffer amplifiers. U307a is an adjustable gain buffer stage. This stage is squelched by Q311. 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 the processor, using an internal discrete Fourier transform, looks for the wanted tone. Decode bandwidth is about +/- 2 Hz.

DTX-142 RECEIVER CURRENT CONSUMPTION

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 through a 390 ohm resistor. If the correct CTCSS or DCS tone is present the radio will unsquelch the speaker and auxiliary output lines. In standby mode the radio consumes 20 mA or less. When unsquelched both the internal regulator and the audio PA are turned on. Total current consumption goes up to about 65 mA. If only the auxiliary output and no voice is needed current consumption can be saved by disabling the internal regulator and audio PA when a carrier is present. This is done by removing R606, R617 and R357 and will bring current consumption down to about 33 mA during receive. If no carrier detect is needed and the modem used is able to monitor the auxiliary output continually then AUX_MON can be tied low. By disabling both RSSI and noise squelch (fully counterclockwise) the current can be reduced to 20 mA.

DTX-142 TRANSMITTER

The transmit VCO output feeds pre-driver stage Q210 which feeds the driver Q209 and in turn the RF final Q208. The final is an 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 constant power output if the amplifier efficiency is also level. U201 a is a differential amp monitoring current through the four paralleled 1 ohm shunt resistors. U201 b is a comparator op amp. Potentiometer R222 is used to set the high level power to 5 watts when in the high power mode. When excess current producing power greater than 5 watts goes through the four 1 ohm resistors the output of U201 a drops. This in turn causes U201 b 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 U201 b pin 6 causing a lower power output. R222 is preset in the factory to give 5 watts in high power mode and around 2 watts in low 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.

DTX-142 TRANSMITTER VOICE & TONE

In transmit mode two audio paths and one tone path exist. The microphone input is a 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. On PCB 1750360D op amp 308d is not present.

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 (+/-1.5 kHz narrowband) deviation with 300 mV peak to peak input.

The QC 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 28.8 kHz. A simple RC filter consisting of R319, R373 and C338 suppress higher order frequency components. On PCB 1750360D op amp 308d adds a variable cutoff low pass filter. Normal roll of for QC tones is around 300 Hz. For DQC tones the roll off is around 150 Hz. This additional filtering gets ride of "purring" sounds caused by the DQC. Also for DQC generation the rise times from the PWM output is limited further reducing audio harmonics. The fifth order 3 kHz low pass filter further attenuates the 28.8 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. The reference oscillator's deviation is adjusted by the "balance" pot R304. The balance pot is adjusted to give a minimal tilt on a 50 Hz square data waveform. The transmit loop bandwidth of the synthesizer is about 100 Hz. The QC deviation from 67 to 254 Hz lies between 600 and 900 Hz in wide band mode.

DTX-442 THEORY OF OPERATION

DTX-442 POWER SUPPLY & VOLTAGE DISTRIBUTION

The DTX-442 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-442 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 6.4 volts. The conversion efficiency of the buck converter is about 85%. Lowering the supply voltage will cause more current to be drawn from the supply. The buck converter's output of 6.4 volts feeds a 5 volt low drop out regulator U602 and a 6 volt regulator U402. The 5 volt regulator supplies the logic and audio processing ICs and the 6 volt regulator supplies the frequency synthesizer. A voltage regulator consisting of Q601, 2 and 3 limits the RF final PA and audio PA voltages to +13.8 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.

DTX-442 REFERENCE OSCILLATOR

Reference oscillator Y301 is a temperature compensated, voltage controlled crystal 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 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.

DTX-442 SYNTHESIZER

The DTX-442 radio is built around a PLL synthesizer that consists of a receiver voltage-controlled oscillator (VCO) and transmit VCO. When the receive or transmit mode is switched, a new synthesizer operating frequency is selected. Microcontroller U301 clocks new data into the U401 internal buffer in synchronization with clock pulses. The channel information is stored in the EE memory of U301 and is loaded into RAM when the channel is selected. Two separate VCOs are used in the synthesizer. The transmit VCO operates from 400 to 420 MHz or 450 to 470 MHz. The receive synthesizer works 43.65 MHz lower 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 CR401. 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 varactor CR405 for receiver or 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 1 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.

DTX-442 RECEIVER FRONT END

The signal from the antenna passes through the transmitter lowpass filter and then goes to the tunable bandpass filter L101 and L102. Q101 amplifies the signal about 13 dB before going through another bandpass filter and the 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 1 st local oscillator signal from the synthesizer module is buffered and filtered by bandpass 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.

DTX-442 FM RECEIVER SUBSYSTEM

A multi-function integrated circuit, U101 and associated components form the FM-receiver subsystem. The subsystem performs the functions of 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 lowpass 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-442, 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 -108 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 bandpass. 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 -120dBm 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 for fast audio closure R145 can be removed or R144 can be set fully counterclockwise.

DTX-442 RECEIVER VOICE & TONE CONDITIONING

Three post demodulation paths are provided in the DTX-442. 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 highpass filter U304a and U305c. U305d provides an adjustable gain preamplifier. C326, R353 and R351 de-emphasis the audio. The 1 watt audio amp is turned on by Q311 and Q312.

The data path goes through U304b and U307a. U304a buffers the signal. U307a is an adjustable gain inverting buffer stage. This stage is squelched by Q311.

Sub-audible signals go through a third order 250 Hz lowpass filter U304d, R342, and C319. Pin 27 of U301 decodes the CTCSS or DCS signa.l In the case of CTCSS the processor, using an internal discrete Fourier transform, looks for the wanted tone. Decode bandwidth is about *+1-2* Hz.

DTX-442 RECEIVER CURRENT CONSUMPTION

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 through a 390 ohm resistor. If the correct CTCSS or DCS tone is present the radio will unsquelch the speaker and auxiliary output lines. In standby mode the radio consumes 20 mA or less. When unsquelched both the internal regulator and the audio PA are turned on. Total current consumption goes up to about 65 mA. If only the auxiliary output and no voice is needed current consumption can be saved by disabling the internal regulator and audio PA when a carrier is present. This is done by removing R606, R617 and R357 and will bring current consumption down to about 33 mA during receive. If no carrier detect is needed and the modem used is able to monitor the auxiliary output continually then AUX_MON can be tied low. By disabling both RSSI and noise squelch (fully counterclockwise) the current can be reduced to 20 mA.

DTX-442 TRANSMITTER

The transmit VCO feeds pre-driver stage Q210 which feeds the driver Q209 and in turn the RF final Q208. The final is an 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 also level. U201 a is a differential amp monitoring current through the four paralleled 1 ohm shunt resistors. U201 b 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 U201 a drops. This in turn causes U201 b 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 U201 b pin 6 causing a lower power output. R222 is preset in the factory to give 5 watts in high power mode and around 2 watts in low power mode.

A low-pass filter comprised of filter L201, L202, L203, C204, C205 and C235 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-442 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.

DTX-442 TRANSMITTER VOICE & TONE

In transmit mode two audio paths and one tone path exist. The microphone input is a high gain pre-emphasized path. U305b along with C332, C362, C363, R364, R365 and R390 form a 300 Hz high pass filter. This filters out audio voice components that will disturb DQC decoding. 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 U308b and c.

The data path (AUXJN), with a flat frequency response, goes through an inverting amp U309 and 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 (+ 1.5kHz) deviation with 300 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 28.8 kHz. A third order variable cutoff low pass filter consisting of R373, C338 and U308d suppress harmonics higher than 300 Hz for QC tones and 150 Hz for DQC tones. Q306 is turned on for the DQC filter which adds C360 in parallel with C359. The fifth order 3 kHz lowpass filter further attenuates the 28.8 kHz PWM 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. The reference oscillator's deviation is 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 wideband mode

MICROCONTROLLER

The DTX-142/442 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 $VDCV_{CC}$ supply voltage.
5	GROUND
6	+5 $VDCV_{CC}$ 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 in transmit mode.
14	SQUELCH output goes high to apply power to audio amp U306 for speaker and receiver data out.
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	Connects to pin6 of J401. Grounding this defeats synthesizer unlock reloading for diagnosis.
18	AVCC supplies+5VDC.
19	Input could be 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 high for DQC transmission on PCB 1750360D. Always high on others.
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-142/442 ALIGNMENT PROCEDURE

An authorized RF service technician must perform test and alignment of the DTX-142/442. Do not attempt service of the DTX-142/442 if not completely familiar with frequency synthesized radio operation.

RECOMMENDED TEST EQUIPMENT

1. 13.8 VDC, 1A current-limited power supply
2. RF Communications Test with:
    - FM Deviation Meter
    - RF Wattmeter
    - Frequency Counter
    - SINAD Measuring Device
3. Oscilloscope
5. DTXL-PCPK-2.0 Programming Kit
6. Square wave generator around 50 Hz

RADIO PREPARATION

1. Remove the DTX-142/442 from case.
2. Connect the FM communications test set to the antenna connector.
3. Connect RITRON programming cable to radio and PC.
4. Apply 13.8 VDC to the red wire with the black to ground.
5. Run RITRON software and read the radio.
6. Program three channels of your choice for band edge tune up; one to the low side of the operating band, one to the high side and one in the middle (Hint: use a bit of an offset from even frequencies to avoid receiver interference. Agood choice for VHF is 136.1, 146.1 and 156.1 MHz forthe low split or 154.1, 164.1 and 174.1 MHz for the high split. For UHF a good choice is 400.1, 410.1 and 420.1 or 450.1, 460.1 and 470.1. All of these will be wideband mode.)
7. Type in these RX and TX frequencies in all channels.
8. Set the transmitter to wideband deviation.
9. Program the radio with these parameters.

DTX-142 ALIGNMENT PROCEDURE

DTX-142 FREQUENCY SET & POWER SET

The DTX-142 is preset at the factory for 5 watts in high power and around 2 watts in low power at 13.8 VDC. If it needs to be changed or readjusted do the following:

1. Make sure that the unit is at room temperature and power supply at 13.8 VDC.
2. Set the RF communications test set to the transmit mode.
3. Select high edge channel on channel select inputs CS2, CS1 and CSO.
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 L202 for maximum power.
9. Adjust the power pot R222 to give 5 watts (+ 0.3).
10. Stop transmitting and switch to the low edge frequency and transmit.
11. Adjust L201 to balance the power with the high side. Switch between high and low side to equalize output power. Readjust the power pot R222 if power falls below 4.7 watts. Note that the middle channel will have a higher power output. Keep in mind that the inductors L201 and L202 balance the power across the frequency band and the power pot R222 raises or lowers power on all bands.
12. Stop transmitting and ground pin 5 for low power.
13. Transmit on each channel to check low power setting. R222 can be adjusted to vary power but the high power setting will also be affected. Adjust to get high power 4.9 + 0.2 watts and low power 2 ± 0.5 watts.

DTX-142 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 with audio filtering from <20 Hz to 15 kHz.
2. Set to FM demodulation with +/- peak deviation.
3. Connect oscilloscope to the demodulated output.
4. Select the mid band channel on channel select inputs CS2, CS1 and CSO.
5. Connect sinusoidal 1 kHz audio source to pin 4 microphone input and set to 100 mV rms .
6. Ground PTT (pin 14) to transmit.
7. Adjust deviation pot R388 for peak deviation of 4400 + 100 Hz.
8. Stop transmitting, remove microphone input and inject a 50 Hz + 20 Hz square wave into AUX_IN (pin 7) with a 300 mV peak-peak amplitude. Use the actual data source if it has low frequency content. If, for example, you have a 1200 and 1800 Hz tone for data you will not be able to balance the modulator since the waveform contains no low frequency components. In this case it may not be important. If, however, you use CTCSS or DCS the modulator should be balanced by using the 50 Hz source.
9. Adjust deviation balance pot R304 to give a flat top on the demodulated output square wave.
10. Adjust the auxiliary input gain pot R375 to give a 3.0 ± .1 kHz (± 1.5 kHz narrowband) deviation. If the actual data source is available it should be connected at this point and the gain pot R375 adjusted to give the rated deviation. Input signal should not exceed 1.5 v peak-to-peak.
11. Stop transmitting by releasing the /PTT line on pin 14.

*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 4800 to 5300 Hz. Narrow band tone deviation will be 350 to 500 Hz with overall deviation of 2400 to 2650 Hz.

DTX-142 RECEIVER FRONT END TUNNING

The DTX-142 receiver is factory tuned for a frequency range of 136 to 156 MHz (G-band low split) or 154 to 174 MHz (O-band 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-122 dBm with +/-3 kHz (+/-1.5 kHz for narrowband) deviation. Adjust coil cores L101 and L102 clockwise until SINAD starts to drop. Back off slightly to maintain best SINAD. Set generator to the lowest frequency programmed at -122 dBm. Similar SINAD readings as the high band edge frequency should be obtained. If not, adjust coils slightly. Recheck high end and balance performance.

DTX-142 RECEIVER SQUELCH

The DTX-142 is capable of two squelch operating modes. Also, both can operate simultaneously. See the *FM Receiver Subsystem* section for theory. The units can be configured, as the user requires. When a low level signal appears the noise squelch opens when the SINAD is 14 dB or greater. When the signal appearing is -106dBm or greater the RSSI squelch opens the audio with an even faster attack time. The above levels are factory set levels. Ambient noise will affect the level at which the RSSI should be set. The squelch level ideally should be set 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.

If a very fast receiver decay time (or squelching after signal disappears) is needed the noise squelch should be defeated by turning the R144 pot fully counterclockwise or removing Q110.

To adjust squelch levels for simultaneous use do the following:

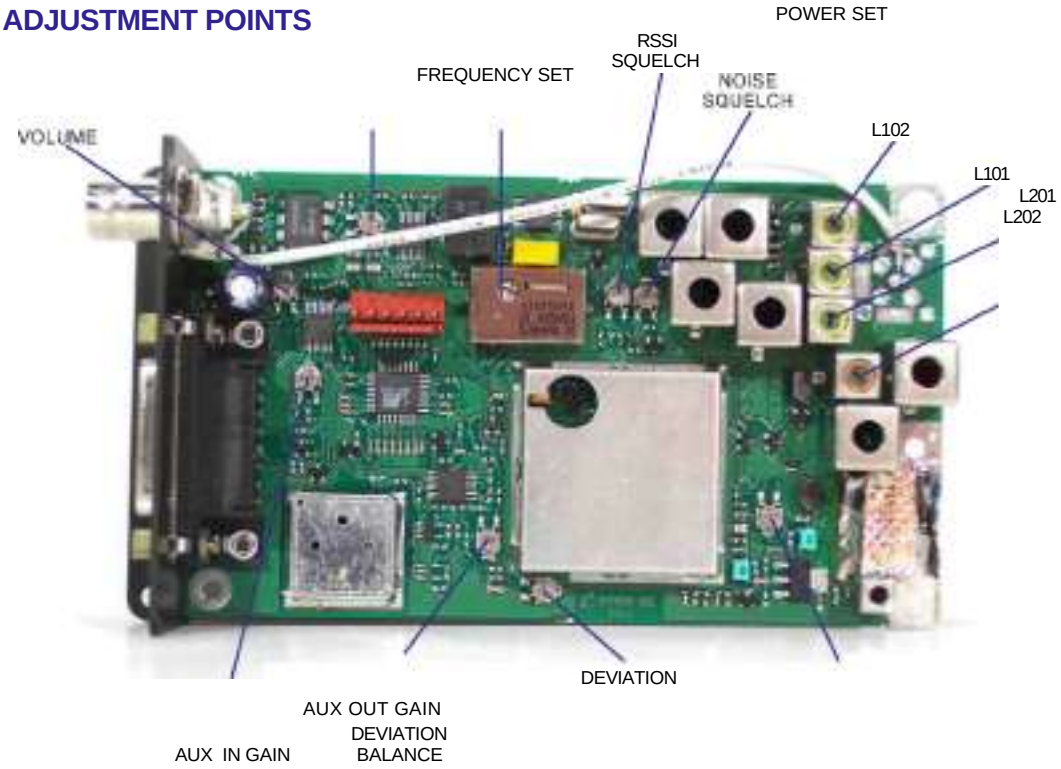
SET RSSI SQUELCH LEVEL FIRST:

1. Select a channel
2. Temporarily defeat noise squelch pot by turning R 144 to counterclockwise minimum setting.
3. Adjust RSSI pot R123 fully counterclockwise to squelch audio. Be sure AUX_MON line is high to allow squelching.
4. Set generator to -106 dBm or the opening level desired with ± 3 kHz (±1.5 for narrowband) deviation and 1 kHz tone. Add any CTCSS or DCS as needed.
5. Turn R123 clockwise until audio opens. Go no further if you want only RSSI squelch operation.

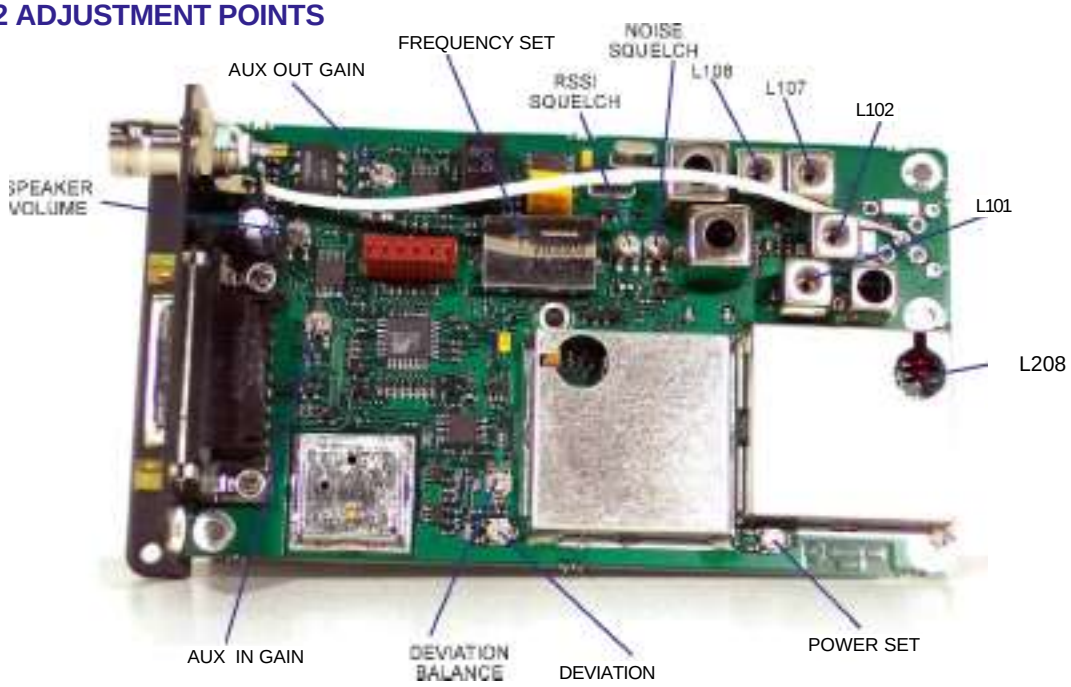
NOW SET NOISE SQUELCH:

1. Select a channel.
2. Bring AUX_MON line low to allow channel monitoring.
3. Adjust squelch pot R144 fully counter clockwise.
4. Adjust the communications test set generator on frequency to obtain a 14 dB SINAD. The deviation should be ± 1.5 kHz (3 kHz for wideband) with a 1 kHz audio signal.
5. Bring AUX_MON line high to enable squelching.
6. Slowly adjust squelch pot R144 clockwise until squelch opens.
7. Reduce generator level until radio squelches.
8. Increase generator level until audio opens. Confirm squelch hysteresis is between 1 and 4 dB.

DTX-142 ADJUSTMENT POINTS



DTX-442 ADJUSTMENT POINTS



DTX-442 ALIGNMENT PROCEDURE

DTX-442 FREQUENCY SET & POWER SET

The DTX-442 is preset at the factory for 5 watts in high power and around 2 watts in low power at 13.8 VDC. If it needs to be changed or readjusted do the following:

1. Make sure that the unit is at room temperature and power supply at 13.8 VDC.
2. Set the RF communications test set to the transmit mode.
3. Select low edge channel on channel select inputs CS2, CS1 and CSO.
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 +/-200 Hz (assuming your equipment is calibrated)
7. Adjust the trimmer cap on the rectangular reference frequency oscillator Y301 if not within specs.
8. Adjust the power pot R222 to give 4.8 watts (+/- 0.2)
9. Confirm the upper edge frequency produces the same results.
10. If upper edge power is too low spread the turns of L208 to reduce inductance and increase high side power. To access L208 remove the copper tape over the access hole on the transmitter shield. The 2 turn inductor L208 will appear beneath this opening. If the high side power is too high squeeze the 2 turn windings closer together to increase the inductance. Disconnect power while adjusting L208 to avoid shorting to ground.
11. Check low edge power again. Readjust L208 to balance band edge powers. Replace copper tape over hole.

DTX-442 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 with audio filtering from <20 Hz to 15 kHz.
2. Set to FM demodulation with + peak deviation.
3. Connect oscilloscope to the demodulated output.
4. Select the mid band channel on channel select inputs CS2, CS1 and CSO.
5. Connect sinusoidal 1 kHz audio source to pin 4 microphone input and set to 100 mV rms.
6. Ground PTT (pin 14) to transmit.
7. Adjust deviation pot R388 for peak deviation of 4400 + 100 Hz.
8. Stop transmitting, remove microphone input and inject a 50 Hz ± 20 Hz square wave into AUXJN (pin 7) with a 300 mV peak-peak amplitude. Use the actual data source if it has low frequency content. If, for example, you have a 1200 and 1800 Hz tone for data you will not be able to balance the modulator since the waveform contains no low frequency components. In this case it may not be important. If, however, you use CTCSS or DCS the modulator should be balanced by using the 50 Hz source.
9. Adjust the balance pot R304 to give a flat top on the demodulated output oscilloscope square wave.
10. Adjust the auxiliary input gain pot R375 to give a 3.0 ±0 .1 kHz (+ 1.5 kHz narrowband) deviation. If the actual data source is available it should be connected at this point and the gain pot R375 adjusted to give the rated deviation. Input signal should not exceed 1.5 v peak-to-peak.
11. Stop transmitting by releasing the /PTT line on pin 14.

*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 4800 to 5300 Hz. Narrow band tone deviation will be 350 to 500 Hz with overall deviation of 2400 to 2650 Hz.

DTX-442 RECEIVER FRONT END TUNNING

If the DTX-442 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 lower band edge frequency programmed at-122 dBm with + 3 kHz (± 1.5 kHz for narrowband) deviation. Adjust coil core L101 clockwise until SINAD starts to drop. Turn counterclockwise slightly to maintain best SINAD. In turn, do the same for coils L102, L107 and L108. Now, set generator to the highest frequency programmed at-122 dBm. Similar SINAD readings as the low band edge frequency should be obtained. If not, adjust coils slightly. Recheck low edge and balance performance.

DTX-442 RECEIVER SQUELCH

The DTX-442 is capable of two squelch operating modes. Both can operate simultaneously. See the *FM Receiver Subsystem* section for theory. The units can be configured as the user requires. When a low level signal appears the noise squelch opens when the SINAD is 14 dB or greater. When the signal appearing is-106dBm or greater the RSSI squelch opens the audio with an even faster attack time. The above levels are factory set levels. Ambient noise will affect the level at which the RSSI should be set. The squelch level ideally should be set 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.

If a very fast receiver decay time (or squelching after signal disappears) is needed the noise squelch should be defeated by turning the R144 pot fully counterclockwise.

To adjust squelch levels for simultaneous use do the following:

SET RSSI SQUELCH LEVEL FIRST:

1. Select a channel
2. Temporarily defeat noise squelch pot by turning R 144 to counterclockwise minimum setting.
3. Adjust RSSI pot R123 fully counterclockwise to squelch audio. Be sure AUX_MON line is high to allow squelching.
4. Set generator to -106 dBm or the opening level desired with ± 3 kHz (±1.5 for narrowband) deviation and 1 kHz tone. Add any CTCSS or DCS as needed.
5. Turn R123 clockwise until audio opens. Go no further if you want only RSSI squelch operation.

NOW SET NOISE SQUELCH:

1. Bring AUX_MON line low to allow channel monitoring.
2. Adjust squelch pot R144 fully counter clockwise.
3. Adjust the communications test set generator on frequency to obtain a 14 dB SINAD. The deviation should be ±1.5 kHz (3 kHz for wideband) with a 1 kHz audio signal.
4. Bring AUX_MON high to enable squelch.
5. Slowly adjust squelch pot R144 clockwise until squelch opens.
6. Reduce generator level until radio squelches.
7. Increase generator level until audio opens. Confirm squelch hysteresis is between 1 and 4 dB.

PROGRAMMING THE DUAL RELAY DTMF DECODER BOARD

Please refer to the following figure and the insert located on the inside front cover of the TeleSwitch for programming details relative to the dual relay DTMF activated decoder board.