RITRON, INC.

PRELIMINARY 08-16

RITRON MODELS DTX-X65 SERIES
PROGRAMMABLE
FM TRANSCEIVER MODULES

MAINTENANCE & OPERATING MANUAL

PRELIMINARY!

FOR USE ONLY BY AUTHORIZED SERVICE/MAINTENANCE PERSONNEL

TABLE OF CONTENTS

1 INTRODUCTION

1.1 GENERAL

The RITRON High Power DTX Plus modules are programmable 2-way radios, which operate either in the VHF or UHF professional FM communications bands as well as a number of other bands in the 220 MHz, 350 MHz, and 900 MHz region. Each of eight channels can be programmed to contain a unique set of operating frequencies. The High Power DTX Plus module is made up of two PC boards, an RF board and a control/loader board. These two boards are enclosed in a metal case with two connectors on one end; a 50 ohm BNC connector for connection to an antenna and a DB-15 sub-miniature connector for control input/output and a power input connector on the other end.

In addition, the RF board/heat sink assembly is available as a stand-alone unit for system integrators.

1.2 MODEL IDENTIFICATION

The part number system for the High Power DTX Plus module is as follows:

The module has a part number in the form of "DTX-A65-BCDEF" where:

A is the major frequency band designator:

1=VHF (136-174 MHz bands)
2=216-222 MHz band
3=340-400 MHz bands
4=UHF (400-430 MHz and 450-470 MHz bands)
9=896-901 MHz band

B is the sub-band designator:

G=136-162 for #1 above , 340-360 MHz for #3 above, and 400-430 MHz for #4 above.
A=420-440
B=430-450
O=148-174 for #1 above, 216-222 for #2 above, 360-380 for #3 above, 450-470 for #4 above, and 896-901 for #9 above.
M=380-400 for #3 above.
C=470-490
T=490-512

Note that not all of the sub-bands listed above may be available, and that other sub-bands may become available.

C is the connector designator:

B=BNC connector

D designates the IF bandwidth:

W=wide (25/30 kHz channel bandwidth)
N=narrow (12.5/15 kHz channel bandwidth)
S=very narrow (5/ 6.25/ 7.5 kHz channel bandwidth)

E designates the maximum power level:

30=30 watts

F designates whether the control/loader board has a regulator and if so, at what current level:

I=high current regulator; the unit operates from 10-15 volts at 30 watts max.

Example: A DTX-265-OBN30I would be a VHF module for operation between 216 and 222 MHz with a BNC RF connector, narrow (12.5 kHz channel bandwidth) IF bandwidth, 30 watts maximum output power, and an internal regulator to allow operation from 10 to 15 volts.

The part number system for a stand-alone RF board/Heat Sink assembly is the same as that for a module except that “F” designator (regulator option) does not exist and a “D” is appended at the end.

1.3 FCC REGULATIONS

1.3.1 LICENSING

For those frequency bands governed by FCC rules, the FCC requires that the radio owner obtain a station license for his radio before using the equipment to transmit, but does not require an operating license or permit. The station licensee is responsible for proper operation and maintenance of his radio equipment, and for ensuring that transmitter power, frequency and deviation are within the limits specified by the station license. This includes checking the transmitter frequency and deviation periodically using appropriate methods. Note also, that wideband operation (25/30 kHz channel bandwidth) may not be permitted.

1.3.2 PRODUCT CERTIFICATION

The High Power DTX modules are certified by the FCC for operation in the United States and by Industry Canada for operation in Canada on certain frequency bands and sub-bands for transmission of either voice or data signals when aligned according to the alignment procedure for the proper bandwidth and when operated as a complete unit in the metal case. Operation of the RF board as a stand-alone unit or in combination with any other equipment, in any mode outside the alignment procedure, or with the clipper filter electronically disabled will require the filing of a new type acceptance application with the FCC by the user.

1.3.3 SAFETY STANDARDS-RF EXPOSURE (DTX-165/265, 365/465))

RF ENERGY EXPOSURE AWARENESS AND CONTROL INFORMATION, AND OPERATIONAL INSTRUCTIONS FOR FCC OCCUPATIONAL USE REQUIREMENTS:

BEFORE USING THIS 2-WAY RADIO, READ THIS IMPORTANT RF ENERGY AWARENESS AND CONTROL INFORMATION AND OPERATIONAL INSTRUCTIONS TO ENSURE COMPLIANCE WITH THE FCC’S AND IC’S RF EXPOSURE GUIDELINES.

NOTICE: This radio is intended for use in occupational/controlled conditions, where users have full knowledge of their exposure and can exercise control over their exposure to meet FCC/IC limits. This radio device is NOT authorized for general population, consumer, or any other use.

This 2-way radio uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses radio frequency (RF) energy or radio waves to send and receive calls. RF energy is one form of electromagnetic energy. Other forms include, but are not limited to, electric power, sunlight and x-rays. RF energy, however, should not be confused with these other forms of electromagnetic energy, which when used improperly can cause biological damage. Very high levels of x-rays, for example, can damage tissues and genetic material.

Experts in science, engineering, medicine, health and industry work with organizations to develop standards for exposure to RF energy. These standards provide recommended levels of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection. All 2-way radios marketed in North America are designed, manufactured and tested to ensure they meet government established RF exposure levels. In addition, manufacturers also recommend specific operating instructions to users of 2-way radios. These instructions are important because they inform users about RF energy exposure and provide simple procedures on how to control it. Please refer to the following websites for more information on what RF energy exposure is and how to control your exposure to assure compliance with established RF exposure limits.

http://www.fcc.gov/oet/rfsafety/rf-faqs.html
http://www.osha.gov/SLTC/radiofrequencyradiation/index.html

Federal Communications Commission Regulations:

The FCC rules require manufacturers to comply with the FCC RF energy exposure limits for mobile 2-way radios before they can be marketed in the U.S. When 2-way radios are used as a consequence of employment, the FCC requires users to be fully aware of and able to control their exposure to meet occupational requirements. Exposure awareness can be facilitated by the use of a label directing users to specific user awareness information.

The DTX 2-way radio has an RF exposure product label. Also, this DTX manual includes information and operating instructions required to control your RF exposure and to satisfy compliance requirements.

Compliance with RF Exposure Standards:

The DTX two-way radio is designed and tested to comply with a number of national and international standards and guidelines (listed below) regarding human exposure to radio frequency electromagnetic energy. This radio complies with the IEEE and ICNIRP exposure limits for general population/uncontrolled RF exposure environment at duty factors of up to 50% talk and 50% listen and is authorized by the FCC for occupational use. In terms of measuring RF energy for compliance with the FCC exposure guidelines, your radio antenna radiates measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode. The DTX two-way radio complies with the following RF energy exposure standards and guidelines:

• United States Federal Communications Commission, Code of Federal Regulations; 47 CFR §§ 2 sub-part J.

• American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992.

• Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition.
Copyright Telecommunications Industry Association

To control exposure to yourself and others and ensure compliance with the occupational/controlled environment exposure limits always adhere to the following procedures:

Guidelines:

• User awareness instructions should accompany device when transferred to other users.

• Do not use this device if the operational requirements described herein are not met.

Instructions:

• Transmit no more than the rated duty factor of 50% of the time. To transmit (talk or send data), assert the PTT input pin. To receive calls, un-assert the PTT input. Transmitting 50% of the time, or less, is important because this radio generates measurable RF energy exposure only when transmitting (in terms of
measuring for standards compliance).

• Transmit only when people are at least the recommended minimum lateral distance away, as shown in Table 1, from a properly installed according to installation instructions, externally-mounted antenna.

NOTE - Table 1 lists the recommended minimum lateral distance for bystanders in an uncontrolled environment from transmitting types of antennas (i.e., monopoles over a ground plane, or dipoles) at several different ranges of rated radio power for mobile radios installed on a vehicle. For mobile applications, this transmitter is restricted for use only in a locomotive, and the antenna must be mounted on the metal roof of the locomotive.

Table 1. Rated Power and Recommended Lateral Distance for quarter-wave ground plane antenna:

Rated Power of DTX 2-way Radio	Recommended Minimum Lateral Distance from Transmitting Antenna
DTX-965(896-901 MHz)	
30 Watts or less:	26.5 inches (67.4 cm)

Antennas

• Install antennas taking into account the recommended minimum lateral distances in Table 1. These antenna installation guidelines are limited to antennas with appropriate ground planes. The antenna installation should additionally be in accordance with:

a.) The requirements of the antenna manufacturer/supplier.
b.) Instructions in this manual including minimum antenna cable lengths.
c.) Antennas other than those shown in Table 1 must be tested with the High Power DTX module for RF exposure compliance in the environment in which it is to be used per the FCC's OET Bulletin 65, Edition 97-01 or Industry Canada RSS-102.

Use only a unity gain, quarterwave antenna or equivalent antenna per the frequency range for the device as specified in Table 1. Unauthorized antennas, modifications, or attachments could damage the radio and may violate FCC regulations.

Antennas for this transmitter must not be co-located or operated in conjunction with any other antenna or transmitter. All information herein pertains to the antenna not co-located to other antennas or transmitters.

Approved Accessories

• This radio has been tested and meets the FCC RF exposure guidelines when used with the Ritron accessories supplied or designated for this product. Use of other accessories may not ensure compliance with the FCC's RF exposure guidelines, and may violate FCC regulations.

• For a list of Ritron approved accessories see this user manual, or visit the following website which lists approved accessories: www.ritron,com

Contact Information:

For additional information on exposure requirements or other information, contact Ritron at (317) 846-1201 or at www.ritron.com.

2 SPECIFICATIONS

2.1 GENERAL

FCC/IC Identifier

Model	FCC	IC
DTX-165-0	AIERIT34-1650	1084A-RIT341650
DTX-265-0	AIERIT34-2650	1084A-RIT342650
DTX-365-0	AIERIT34-3650	1084A-RIT343650
DTX-465-0	AIERIT34-4650	1084A-RIT344650
DTX-965-0	AIERIT34-9650	1084A-RIT349650

FCC Rule Parts	90
Industry Canada Rule Parts	RSS-119

Frequency Ranges

DTX-165-0	136-174 MHz
DTX-265-0	216-217MHz, 220-222 MHz
DTX-365-G	340-360 MHz*
DTX-365-0	360-380 MHz*
DTX-365-M	380-400 MHz*
DTX-465-G	400-430 MHz*
DTX-465-A	420-440 MHz*
DTX-465-B	430-450 MHz*
DTX-465-0	450-470 MHz
DTX-465-C	470-490 MHz*
DTX-465-T	490-512 MHz*
DTX-965-0	896-901 MHz, 935-940MHz

* Not Available Yet

Number of Channels	8
Transmit/Receive Spacing	Up to the span of the sub-band
Mode of Operation	Simplex or Half Duplex
Frequency Control	PLL Synthesizer

Channel Increment (Synthesizer step size)

DTX-165/265	2.5 kHz/3.125 kHz
DTX-365/465	6.25 kHz
DTX-965	12.5kHz

Emissions Bandwidth

Very narrow mode	4.0-4.8 kHz depending upon modulation
Narrow Mode	11 kHz
Wide Mode	16 kHz

Frequency Stability

-30 °C to +50 °C	+/-1.0 ppm
-40 °C to +60 °C	+/-1.5 ppm

Supply Voltage	11 to 16 VDC
RF Input/Output Connector	BNC standard

Supply Input Connector	2-Pin Molex
Data Interface	15 pin subminiature D type
Operating Temperature	-30 to +60 °C
Maximum Dimensions (L x W x H)	6.6” x 5.0” x 2.4” including connectors
Weight	35 oz.

2.2 TRANSMITTER(DTX-965)

Operating Bandwidth	Up to the span of the sub-band
RF Output Power (internally adjustable)	5 to 30 watts
Duty Cycle	5 to 100 % depending upon ambient temperature(see chart elsewhere in manual)
RF Load Impedance	50 ohms
Modulation Distortion (per TIA/EIA 603)	5 % max.
Modulation Frequency Response (+1/-3 dB, ref 1 kHz)	
Narrowband wideband versions:	
w pre-emphasis	200 Hz to 2500 Hz
w/o pre-emphasis	50 Hz to 2700 Hz
Transmitter Attack Time:	10 ms max
Spurious and Harmonics	-13 dBm max.
FM Hum and Noise	
Narrowband (12.5/15 kHz) operation	45 dB min.
Group Delay Variation (Within Frequency Response)	5 us max.
Current Drain	Depends upon supply voltage (see chart elsewhere in manual).
AUX IN adjustment range (60% rated dev.)	
w pre-emphasis (@ 1 kHz)	20 to 650 mVrms
w/o pre-emphasis (flat)	20 to 600 mVrms

2.3 RECEIVER (DTX-965)

Operating Bandwidth	Up to span of the sub-band
Sensitivity (12 dB SINAD @ 1 kHz w de-emphasis)	0.25 uV (-119.0 dBm) typical
RF Input Impedance	50 ohms nominal
Adjacent Channel Selectivity	
+/- 12.5 kHz w narrow IF	60 dB min.
Spurious and Image Rejection	
IF/2	100 dB min.
Image & other	70 dB min.
Intermodulation Rejection	80 dB min.
FM Hum and Noise	
Very narrowband (5/6.25/7.5 kHz) operation	40 dB min.
Narrowband (12.5/15 kHz) operation	45 dB min.
Wideband (25/30 kHz) operation	50 dB min.
Conducted Spurious	-70 dBm max.
Receive Attack Time (transmit to receive)	10 ms max.
Carrier Detect Attack Time	5 ms max.
Audio Distortion	5 % max.
Audio Response (+1/-3 dB, ref 1 kHz)	
Narrowband and wideband versions:	
w de-emphasis	400 Hz to 2500 Hz
w/o de-emphasis	100 Hz to 3500 Hz
Very narrowband versions:	
w/o de-emphasis	100 Hz to 1500 Hz
Receive Current Drain	Depends upon supply voltage options (see chart elsewhere in manual).
AUX OUT Adjustment Range (60 % rated dev.)	
w de-emphasis (@ 1 kHz)	20 to 800 mVrms open circuit
w/o de-emphasis (@1 kHz)	35 to 900mVrms open circuit

3 DTX INPUT/OUTPUT CONNECTORS

DB-15 Connector Pinout

Pin Number	Name	Description	Comments
1	CS0	Channel Select low bit	
2	CS1	Channel Select mid bit	
3	CS2	Channel Select high bit	
4	MIC IN	Microphone Input	Input for microphone type signals to be transmitted. Signals at this input are pre-emphasized, limited, and filtered. This input is disabled in very narrowband mode.
5	CSN	High/Low Power or Channel 1/2 (in RNet Mode)	
6	NC	No Connection	
7	AUX IN	Auxiliary Input	Wideband input for data.
8	AUX OUT	Auxiliary Output	Wideband output for data.
9	PGN IN/OUT	Programming I/O	External programmer connects here.
10.	CTS	Clear to Send	Asserted when transmitter can accept modulation.
11.	RX MON	Monitor	Breaks squelch in receive.
12.	AUDIO OUT	Audio PA Output	Output of audio PA.
13.	DCD	Carrier Detect	Carrier detect output.
14.	PTT/RTS	Push to Talk	Activates transmitter.
15.	GND	Ground	Negative supply point and reference for all inputs.

2-Pin Molex Connector

1	+Vsupply	+10-16VDC
2	GND	Ground

Pinout Description

Pin Number	Description
1	CS0-Least significant bit of the channel select lines. Active high 5 volt TTL/CMOS level. Internal 10 kΩ pull-up to +5 volts.
2	CS1-Mid bit of the channel select lines. Active high 5 volt TTL/CMOS level. Internal 10 kΩ pull-up to +5 volts.

3 CS2-Most significant bit of the channel select lines. Active high 5 volt TTL/CMOS level. Internal 10 kΩ pull-up to +5 volts.

Channel		CS2	CS1	CS0
1	0	0	0	
2	0	0	1	
3	0	1	0	
4	0	1	1	
5	1	0	0	
6	1	0	1	
7	1	1	0	
8	1	1	1	

0 = Logic low
1 = Logic high

Note: Due to the internal pull-up resistors, the unit defaults to channel 8 if the channel pins are left open (unconnected). **Channel 8 would be the nominal channel when the Ritron programmer is connected.**

4 MIC IN-Microphone input. This input accepts microphone-type input signals for transmit. This input is a higher gain version of the AUX IN input. This input is not available in very narrow channel mode.

5 CSN-Depending upon how it is programmed, this input selects between channels 1 and 2 or between high and low RF output power. This input is TTL/CMOS level type input with a logic low required for channel 1/low power and a logic high required for channel 2/high power. Internal 10 kΩ pull-up to +5 volts.

6 NO CONNECTION.

7 AUX IN-This is the main audio input for modulation. The gain through this input to the modulator is programmable, as is the use of pre-emphasis, but not independently of the MIC IN. This signal passes through the clipper and clipper filter.

8 AUX OUT-This is the broadband output of the receiver. The gain from the receiver to the output is programmable, as is the use of de-emphasis. The choice of AC or DC coupling from the RF board discriminator is also programmable. The coupling at the output of this pin is AC coupled, however. It can be converted to DC coupling with internal hardware modifications. **Note: The output impedance is approximately 600 ohms. Therefore, it is not recommended that this output drive loads with less than 1000 ohms unless the resultant voltage drop is accounted for.**

9 PGN IN/OUT-Connect via RITRON DTXP-PCPK PC Programming Kit to computer for programming the unit.

10 CTS-Clear-To-Send output from the unit which indicates that the unit is transmitting a carrier at the correct frequency and power level and is ready to accept an input signal to be transmitted. This output would normally become asserted in response to a PTT RTS (see pin 14 description below) activation. The polarity of this output can be programmed. The output is active low 5 volt logic with an internal 10 k ohm pull-up to 5 volts. It can source up to 10 mA when low.

11 RX MON-This input breaks the squelch (unmutes) on the receiver i.e. allows for monitoring the channel even when a signal not strong enough to break squelch is present. Input levels are TTL/CMOS; polarity may be programmed. Internal 10 kΩ pull-up to +5 volts.

12 AUDIO OUT-This is the output of the audio power amplifier. This output can drive up to 100 milliwatts into an 8 ohm load. The output level can be controlled by programming. De-emphasis can be applied to this output, but not independently of the AUX OUT output. Note that this output level varies with the adjustment via the programmer of the AUX OUT level. Thus, the AUX OUT level should be set first before adjusting the AUDIO OUT level.

13 DCD-Carrier detect output. This output becomes asserted when a signal strong enough to exceed the programmed squelch threshold is present. This output is not affected by the RX MON input. The polarity can be programmed. The output is active low 5 volt logic with an internal 10 kΩ pull-up to +5 volts. It can source up to 10 mA when low.

14 PTT/RTS-Push to Talk/Request to Send. This input commands the unit to transmit. Input levels are TTL/CMOS; polarity may be programmed. Internal 10 kΩ pull-up to +5 volts.

15 GND-System ground. All signals and voltages are referenced to this input. The negative side of the power supply should connect here.

4 ACCESSORIES

Note: Programming kits are for use by authorized service/maintenance personnel only.

The Programming Kit for DTX Plus radios (via compatible computer) is model DTXP2-PCPK-HP-1. It includes:

1) Programming Software CD, DTXP2-PCPS-1.

2) 1 25 pin PC to 6 pin modular adapter cable with built-in interface circuitry, 9/RTC-PAS.

3) 1 modular adapter to DB-15 connector cable with power cable, DTXP-PAC.

4) 9-Pin to 25-Pin Adapter, 2147C001.

Factory programming of channels and features is also optional. Contact the factory for details.

5 OPERATION

5.1 CHANNEL SELECTION

The DTX module supports eight channels. The desired channel is chosen via pins 1, 2, and 3 of the 15 pin connector as shown:

Channel	Pin 3 (CS2)	Pin 2 (CS1)	Pin 1(CS0)
1	0	0	0
2	0	0	1
3	0	1	0
4	0	1	1
5	1	0	0
6	1	0	1
7	1	1	0
8	1	1	1

0 = Logic low (0 to 0.3 VDC)
1 = Logic high (3.5 to 5.0 VDC or left unconnected)

A logic low is a voltage level below 1 volt while a logic high is a voltage level above 3.5 volts. These three pins have an internal 10 kΩ pull-up resistor to + 5 volts. Therefore, any pin left unconnected will assume a logic high state. Do NOT apply voltages outside the range of 0 to +5 volts to these pins. Note: When the Ritron programming cable is connected, these pins are not connected and thus, assume a logic high state. Therefore, the radio will be on channel 8 when the Ritron programming cable is connected.

A change in the channel selection in receive will cause the receiver to operate on the new channel. In transmit, however, the channel selection is only checked upon a push-to-talk activation. Changes in channel during transmit will not change the transmit operating channel of the unit until the unit is cycled from transmit to receive and back to transmit.

5.2 POWER SUPPLY VOLTAGE

The 2-pin Molex connector is the supply voltage input to the unit. One should be absolutely sure of the proper voltage and current requirements before applying power.

The DTX-165, DTX-265, DTX-365, and DTX-465 units use 12.5 volt RF Power Modules. The supply voltage can be at any voltage between 11 and 16 volts. Since the module is powered directly from this voltage, the supply should be “clean” and, preferably, regulated. The output power will vary with supply voltage. Switching power supplies can be used, but care must be taken that the output waveform is low noise. Also, the module antenna should never be placed near an unshielded switching power supply.

5.3 CURRENT DRAIN VS SUPPLY VOLTAGE (DTX-965)

The current drain of the module is a function of the supply voltage and the RF output in transmit. Typical current drain values are shown in the table below:

Receive Mode Supply Voltage	Internal Regulator	Current Drain
11.0 V	Yes	150 mA
12.5 V	Yes	150 mA
16.0 V	Yes	150 mA

Transmit Mode – 5 watt output power

Supply Voltage	Internal Regulator	Current Drain
11.0 V	Yes	3.4 A
12.5 V	Yes	3.9 A
16.0 V	Yes	4.8 A

Warning: Although the output power can be set as low as 5 watts, and the module is certified as low as 5 watt, operation below 5 watts output power is not recommended. At low power levels, the output power can vary by 50% or more with variations in ambient temperature.

Transmit Mode – 15 watt output power

Supply Voltage	Internal Regulator	Current Drain
11.0 V	Yes	5.6 A
12.5 V	Yes	5.8 A
16.0 V	Yes	6.0 A

Transmit Mode – 30 watt output power

Supply Voltage	Internal Regulator	Current Drain
11.0 V	Yes	8.8 A
12.5 V	Yes	8.9 A
16.0 V	Yes	9.1 A

5.4 DUTY CYCLE/KEY-DOWN LIMITATIONS (DTX-965)

The major heat generating component within the modules is the RF power amplifier which has a maximum temperature limit that should not be exceeded. In addition, the temperature within the module itself must be kept below the maximum temperature of the reference oscillator to ensure that regulatory frequency stability limits are observed. As a result, depending upon the RF output power, the supply voltage, and the ambient temperature, limits upon the average transmit duty cycle and the maximum continuous transmitter on time exist. These limits are summarized below for operation in still air:

	Ambient Temperature (°C)	Duty Cycle (%)	Key-Down Time (min)
5 watts RF output	25	100	
	50	50	6
15 watts RF output	25	100	
	50	50	6
30 watts RF output	25	75	
	50	25	6

Blowing air across the large finned heat sink can significantly improve the duty cycle/key-down times.

5.5 OPERATING MODES

5.5.1 RECEIVE

Carrier Detect and Squelch Operation

The DTX is a transceiver; i.e. it can receive and transmit, although not at the same time. A carrier detect system exists within the unit to detect the presence of a carrier which controls the logic state of the DCD (data carrier detect) output. The RF levels at which this output changes state are programmable. In addition, the unit may be programmed such that the audio outputs, AUDIO OUT and AUX OUT, are muted (squelched) in conjunction with DCD operation. In units where squelch operation has been enabled, the RX MON input can be used to override a squelched condition. The DCD output is not affected by the RX MON operation.

Receiver Audio Outputs

Two receiver audio outputs are present on the DTX module. The AUX OUT is a general purpose output which can have pre-emphasis enabled or bypassed. Its gain can be controlled and its output is designed to drive 1000 ohm or higher loads. The coupling from the discriminator on the RF board may be set to AC or DC by the programmer. DC coupling allows for internal bandwidth to extend to DC, but if a high gain value is chosen for the AUX OUT, clipping may occur on the waveform due to discriminator voltage offsets. AC coupling removes this issue. The output stage is AC coupled, but can be modified for DC coupling. This requires replacing a coupling capacitor with a zero-ohm resistor. Contact Ritron for details on this modification. The AUDIO OUT is always de-emphasized, but its gain can be programmed. This output can drive 8-ohm speaker-type loads. In the programmer menu, there is provision to set both the AUX OUT levels and the AUDIO OUT levels. However, the AUDIO OUT level is dependent upon the AUX OUT level. Therefore, the AUX OUT level should be set before setting the AUDIO OUT level.

5.5.2 TRANSMIT

PTT Operation

The transmitter is activated by placing the PTT/RTS (Push-To-Talk/Request-To-Send) input in its asserted state. This state is programmable. If the unit is to operate in simplex (transmitter and receiver on the same frequency), one should check for activity on the channel before transmitting. This can be done by checking the state of the DCD output. In addition, the unit can be programmed so that transmit operation is inhibited if the DCD threshold has been exceeded (busy channel lockout option).

CTS Output

The CTS (Clear To Send) output goes to its active state when the unit has powered up the transmitter, it is locked on the correct transmit frequency, and it is ready to accept modulation. This output may be used to signal a modem to start transmitting data. If this output is not used, to avoid losing data, a delay of at least 12 ms is required between PTT/RTS activation and the application of data.

Transmitter Audio Inputs

Two mutually exclusive audio inputs are available on the DTX module. The AUX IN is a general-purpose input with an input impedance greater than 50 k-ohms and is capacitive coupled with a lower roll-off frequency of about 25 Hz. The MIC IN input is a higher gain input designed for connection to a standard electret or dynamic microphone. The choice of the input source is made via the programmer. The selected signal can be set for a pre-emphasized or flat audio response and the gain can also be set. At maximum gain, the AUX IN signal input can achieve 60% rated modulation with about 25 mv rms input signal while the MIC IN signal can achieve the same modulation with 4 mv rms in the low gain position and 0.5 mv in the high gain position.

High/Low Power

If RNet compatibility mode is not programmed into the unit, high and low power levels can be programmed into the unit on a channel by channel basis. High power is selected by placing the CSN input at a logic high state. Placing the CSN input at a logic low state chooses low power. The CSN input has an internal pull-up resistor; it will assume the high state and the module will be set for high power when left unconnected.

Specialized Modem Operation

Modems designed to achieve the highest data rates possible in a radio channel may require a direct DC connection to the modulation path and the removal of the limiter-filter. In order to receive FCC Certification, the DTX module must either be tested and approved with a specific modem connected to the transmitter, or a modulation limiter and limiter-filter must always be present in the transmit modulator audio path with the modulation inputs AC coupled. To allow for the most flexibility for the end user, the unit was certified as a stand-alone unit. It is possible, with hardware modifications and special programming software (not supplied with the unit), to DC couple the AUX IN input and/or defeat the limiter-filter. The modulation limiter would still be in place, but the deviation of the DTX module could be set such that the modulation limit within the DTX module is never reached. The deviation would be set by the modem level and the AUX IN gain setting. The end user/system integrator would then bear the responsibility of obtaining certification or operating in a frequency band where certification is not required. Contact RITRON for details. **Note: Most modems will connect directly to the DTX without requiring any special modifications or programming.**

Antenna Placement

The DTX module is enclosed in a metal housing for RF shielding. However, RF emitting sources located very close (less than 12 inches) to the unit can at times affect its operation. It is not recommended that an antenna be connected directly to the module's BNC connector unless the RF output power is set for less than 5 watts or the module is placed within another RF-tight enclosure.

5.6 RNET COMPATIBILITY MODE

The DTX module can be programmed to mimic some of the behavior of the RNet 450 radio. In the RNet compatibility mode, the CSN input is used as a channel selector line. A logic low selects channel 1 while a logic high selects channel 2. The channel select lines, CS0, CS1, and CS2 have no effect. Also, the DCD output is held in its true state during transmit. It would normally be false in transmit.

5.7 RECEIVER SELF-QUIETING SPUR (BIRDIE) FREQUENCIES

Receiver self-quieting spurious signals (birdies) are internally generated signals that result from the outputs and harmonics of the outputs of the various oscillators that form part of the DTX radio. These usually sound like unmodulated carriers -- signals with "dead air." The DTX has two oscillators that tend to cause birdies, the 14.4 MHz reference oscillator and the 12.288 MHz oscillator on the control/loader board. Of these two, the 14.4 MHz is by far the most significant due to its proximity to the sensitive receiver circuitry. Most of the spur frequencies in the following table have sensitivity degraded by 3 dB or less. Frequencies where the sensitivity is degraded more than 4 dB below specification are in **bold**. Frequencies that are integer multiples of the 14.4 MHz reference oscillator typically cause a reduction in sensitivity of 10 dB or more and are in **bold** and in **red**. Note that a birdie is not the same thing as a receiver spurious response. A spurious response is the receiver hearing a signal on a frequency other than that to which it has been programmed.

Self-Quieting Frequencies(MHz)

6 PROGRAMMING

To program DTX Module, the RITRON PC Programming Kit, DTXP2-PCPK-1, must be used.

6.1 PC PROGRAMMING KIT

The user should install the programming software on the host computer. The RITRON adapter cables connect the radio to a computer's serial communications port. Once the cables are hooked up, the user runs the programmer software. This program transfers data between radio and computer memory.

6.1.1 PROGRAMMING KIT CONTENTS AND REQUIREMENTS

The Programming Kit for DTX Plus radios (via compatible computer) is model DTXP2-PCPK-HP-1. It includes:

1) Programming Software CD, DTXP2-PCPS-1.

2) 1 25 pin PC to 6 pin modular adapter cable with built-in interface circuitry, 9/RTC-PAS.

3) 1 modular adapter to DB-15 connector cable with power cable, DTXP-PAC.

4) 9-Pin to 25-Pin Adapter, 2147C001.

The Programmer Kit requires a PC compatible computer with Windows 95 or later operating system installed. The computer must have an RS-232 serial port available. A hard disk drive is also required.

6.2 LOADING THE PROGRAMMER SOFTWARE

Insert the Software disc which contains the programmer in the CD/DVD/CD ROM drive of the host computer. The program should load automatically. If not, view the contents of the CD ROM and double click on the install.exe file. Follow the instructions as they appear on the screen. At the conclusion of the installation procedure, the programming software will be resident on the user's host computer.

6.3 COMPUTER SOFTWARE COPYRIGHTS

The RITRON, Inc. products described in this manual include copyrighted RITRON, Inc. computer programs. Laws in the United States and other countries grant to RITRON, Inc. certain exclusive rights in its copyrighted computer programs, including the exclusive right to distribute copies of the programs, make reproductions of the programs, and prepare derivative works based on the programs. Accordingly, any computer programs contained in RITRON, Inc. products may not be copied or reproduced in any manner without the express written permission of RITRON, Inc. The purchase of RITRON, Inc. products does not grant any license or rights under the copyrights or other intellectual property of RITRON, Inc. except for the non-exclusive, royalty fee license to use that arises in the sale of a product, or as addressed in a written agreement between RITRON, Inc. and the purchaser of RITRON, Inc. products.

6.4 USING THE PROGRAMMING SOFTWARE

Note: Power up the radio and connect it, via the programming cable, to the host computer before opening the programmer.

Upon starting the programming software, a screen will appear with two buttons at the upper right, Program Radio and Programmer Configuration. Program radio reads the configuration of the radio and moves the user to the program radio menus which are described below. Programmer configuration is used to select the appropriate serial port and password (if desired).

Note: Changes made to the radio via the programmer will be accepted by the radio, but will not be permanent i.e. if the radio is powered down, the changes will be lost. The pages of the radio menu will have a button, Update Radio, which will make changes permanent.

6.5 PROGRAMMER MENUS

The DTX Programmer has five menus or pages, selectable via tabs at the top of each page, which are always visible. These pages are:

1. Frequency-Used to program the channel frequencies of the radio.

2. Settings-Used to set programmable features/functions of the radio.

3. Alignment-Used to align and set the internal digital potentiometers in the radio. Information on the use of this page is found in the Maintenance section of the manual.

4. Summary-Used to summarize on one page the model, settings, and alignment information.

5. Restore Data-Used to program the unit with a set of previously saved frequency and setting values.

The programmer also has radio buttons on the top right of each page. These are:

1. Receiving-This button is the software equivalent to the hardware PTT input. Clicking on this button forces the radio into transmit mode where the button will change to Transmitting. Clicking it again will put the radio back into receive.

2. Monitor-This button is the software equivalent to the hardware RX MON input. Clicking on this button will override any squelch operation.

3. Clone Radio-This button is used to update the radio with the changes that have been made via the programmer as shown on the programming screens with the exception of the deviation and balance settings. Since the deviation and balance settings are unique to each radio, even though the actual deviation may be the same, this button allows the personality of one radio to be shown on the programming screens and then loaded into another radio. Also, if the programmer is disconnected and then reconnected, this button will still function. If the deviation and balance settings have not been changed which is normal, this button is performs the same as the update radio button below.

4. Update Radio-This button is used to update the radio with all of the changes that have been made via the programmer. Although the radio accepts changes as they are made via the programmer, the changes are volatile i.e. they are lost when the radio is powered off. Clicking on this button makes the changes non-volatile so that they are saved and stored permanently unless changed via the programmer.

5. Read Radio-Forces the programmer to do a read of the radio to update the programmer screens with the current state of the radio. This allows a radio to be connected to the programmer and powered up without closing and then reopening the programmer.

6.5.1 FREQUENCY SELECTION

The Frequency page has fields for the transmit and receive frequencies of each channel. Channel information can be entered by clicking on the appropriate box and entering the desired frequency. The frequency chosen must be within the operating range of the radio and on a frequency for which the synthesizer is capable of channeling i.e. for VHF, divisible by 2.5 kHz and for UHF, divisible by 5 or 6.25 kHz. When the RNET compatibility mode is chosen via the settings menu, only channel one and two are available for programming.

6.5.2 SETTINGS

The Settings page allows for programming various parameters of the radio. These are detailed below:

Audio Input- Allows a choice between the two audio inputs for transmit, the Aux In input and the Microphone input. As a rule, the microphone input has higher gain, but conversely, cannot accept as high an input level. If the Microphone input is selected, the Microphone Gain box to its right will allow a choice of two gain settings; there is no microphone gain setting available on the alignment page. Note that even if signals are applied to both inputs, only the one selected will be transmitted. Factory default is AUX IN.

TX Pre-emphasis- Allows for the signal path from AUX IN and the MIC IN input to be either pre-emphasized or flat. Most applications where the AUX IN input is used work best with a flat response. Factory default is flat response.

RX De-emphasis- Allows for the signal path from the discriminator to the AUX OUT and Audio Out to be either de-emphasized or flat. Most applications where the AUX OUT output is used work best with a flat response. Factory default is for flat response.

Busy Channel Lockout- Prevents the transmitter from activating when the carrier detect output is true. Used to prevent interference on a channel where activity already exists. Not normally enabled in half duplex operation since the transmit and receive channels are not on the same frequency. Factory default is for this function to be off.

Squelch Enable- Allows the receive audio paths to be muted when the carrier detect output is false. It is used to prevent the output of noise from the audio outputs when no signal is present. Due to the finite squelch attack time, some high-speed modems work best with unsquelched audio. The factory default is for this function to be set for never mute.

DCD Output Logic Level- Allows the setting of the polarity of the DCD (Data Carrier Detect) output. Active high means that the true state is a logic high while active low means that the true state is logic low. Normal setting is active high. The factory default is active high.

Microphone Gain- Available when the Audio Input selection is set to Microphone. This box allows the gain of the signal at the Microphone input to be set either low or high. Factory default is for the Microphone input gain to be set to low. Note that if the Audio Input is set to AUX IN above, no signal from the Microphone input will be passed to the transmitter.

Audio PA- Turns the AUDIO OUT output on or off. Turning the AUDIO OUT output off when not needed saves current drain in receive.

RX Discriminator Coupling- Selects whether the coupling from the discriminator output on the RF board is AC or DC coupled to the control/loader board. Since the audio outputs of the control/loader board are AC coupled, this function is normally set for AC as well. Setting this function to DC will extend the low frequency receiver response somewhat, but makes the audio output subject to clipping due to DC offsets on the discriminator output. For true response to DC, a hardware jumper options can be made for DC coupling at the AUX OUT. (See the Hardware Options section under Maintenance for details on this option.) If this is done, this function should be set for DC. For direct-modulated type of data streams such as true FSK, RRCFSK, 4FSK, etc., DC coupling may be indicated, even if the output of the unit is not modified for true DC coupling to the output. AFSK modulation types such as Bell 202, etc. should use AC coupling. The factory default is AC.

CSN Input- Selects whether RNET Compatibility mode is to be used. See section 5.6 for an explanation of this function. Normal operation is to set this for high/low Power. The factory default is high/low power mode.

High Pass Filter- When RX Discriminator Coupling is set to AC, this box is enabled. This box allows a choice of two rolloff frequencies for the lower high-pass rolloff. The 250 Hz selection may attenuate certain types of data signals and cause tilt on square waves, but is the fasted at responding to changes in discriminator DC level caused by frequency errors on either the receiver or the receiving transmitter. For better low-frequency response, 50 Hz may be selected.

CSN Input- Controls the function of the CSN pin. This pin can be used to select one of two transmitter power levels in the High/Low Power position or can be used to select one of two channels in the RNET Channel 1/2 mode. See Section 5.6, RNET COMPATIBILITY MODE for details on this selection.

CTS Output Logic Level- Sets the polarity of the CTS (Clear-To-Send) output. Setting for active high caused the true logic state to be high. Active high is the normal setting. The factory default is active high.

Monitor Polarity- The monitor input is used to override the action of the receiver squelch (mute) when squelch is active. This function sets the polarity, active low or active high, of this input. When active, squelch is disabled, even is enable via the Squelch Enable setting above.

PTT/RTS Input Logic Level- Sets the polarity of the PTT/RTS input. Normally set for active low i.e. transmitter is activated when this input is at the logic low state. **Due to the internal pull-up resistor, setting this to active high will cause activation of the transmitter when the PTT/RTS input is left unconnected.** The factory default is active low.

Green LED- Sets the operation of the green LED on the front of the radio. The choices are:

a. Off-The green LED is never on.
b. Power ON-The green LED is on whenever the radio is powered up.'
c. Carrier Detect-The green LED is on whenever a carrier is detected that is above the programmed carrier detect on threshold.
d. RX Synthesizer Lock-The green LED is on whenever the frequency synthesizer is locked while in receive mode. This is the factory default setting.

Red LED- Sets the operation of the red LED on the front of the radio. The choices are:

a. Off-The red LED is never on.
b. RX-The red LED is on whenever the radio is actually transmitting. This is the factory default setting.

TX Timeout Timer- Allows for limits on the maximum time the transmitter may be continuously keyed. When set, the maximum limit is set in the box. To prevent overheating and possible damage to the unit, this is normally set on with a time of 60 seconds of less. See section 5.4 for limits on maximum key-down times. The factory default is 60 seconds.

6.5.3 ALIGNMENT

The alignment page is used for setting the values of the digital gain settings which are used for aligning the unit and setting the gains of the audio paths. The unit leaves the factory already aligned, but the user may wish to change the values of some of the input and output gain settings. Different systems or modems may require different input and output levels.

Audio Input (TX) Gain- This input allows adjustment of the signal level to be applied to the modulation limiter and filter circuits from either the AUX IN or MIC IN inputs. At the maximum gain setting, the AUX IN signal input can achieve 60% rated modulation with about 25 mv rms input signal while the MIC IN signal can achieve the same modulation with 4 mv rms in the low gain position and 0.5 mv in the high gain position. The setting can vary from 0 for muted input to 32 for maximum gain.

Aux Out (RX) Gain- Sets the audio level of the AUX OUT output and **also affects the level of the AUDIO OUTPUT, even though the AUDIO OUTPUT has its own level control (see Audio PA Gain below).**

Carrier Detect On and Carrier Detect Off- Sets the carrier detect on and off values in dBm. For proper operation, always set the carrier detect on value to a higher level than the carrier detect off value. Typical values might be -100 dBm for carrier detect on and -114 dBm for carrier detect off. The difference between the two values represents the squelch hysteresis and is used to prevent squelch chatter when the receive signal is near the squelch setting values. Typical hysteresis would be between 2 and 4 dB.

TX Frequency Trim and RX Frequency Trim- These values allow the transmitter and receiver to be trimmed on frequency. A typical adjustment range is about +/-2 kHz. This adjustment is set at the factory and should not be changed except by trained service technicians with the proper equipment.

Audio PA Gain- Sets the audio level of the AUDIO OUT output. Note that the AUDIO OUT level is also affected by the Aux Out(RX) Gain setting. Therefore, the Aux Out(RX) Gain should be set before setting the Audio PA Gain, even if the AUX OUT output is not being used. If the AUX OUT output is not being used, the Audio PA Gain should be set to 0.

Deviation and Balance- Set such that the maximum deviation will fall within the regulatory requirements and the transmit audio response has the correct characteristics. Deviation and Balance do not need to be adjusted after a change in programmed frequency. New values are calculated by the radio when a frequency is entered in the frequency menu. The values are shown in the box at the bottom of the page on a per-channel basis. Note that even though the values may differ by channel, unless the values in the boxes have been edited, the deviation and balance of the radio will be the same on all channels, just the values to achieve equal balance and deviation may differ. One can actually modify the calculated deviation and balance values per channel by entering values in the boxes, but this requires the services of a very qualified technician and the proper test equipment. The radio has been properly aligned at the factory and should not need to be adjusted. Details on how to perform these adjustments are found in the Alignment section.

TX Low Power and TX High Power- Sets the global power level for the transmitter in watts for the two positions of the CSN input. A logic high on the CSN input would cause the radio to use the TX High Power setting while a logic low on the CSN would cause the radio to use the TX Low Power setting. Note that the names Low and High Power are purely arbitrary and that the Low Power value can actually be set to be higher than the High Power value if desired. If it is desired that the power levels be set different values for different channels, the desired power levels can be inserted into the box at the bottom of the page. Note, however, if a change is made in the TX Low Power and/or TX High Power values in the slide bar area, it will affect all channels equally.

Instructions for using the alignment page can be found in section 13 of this manual.

6.5.4 SUMMARY

The summary page summarizes the information shown on the other three pages and, in addition, includes the model and serial number of the unit.

6.5.5 RESTORE EEPROM

This selection is used to load a previously saved radio configuration file to the radio connected to the programmer. This is of benefit when a number of radios are to set to the same frequencies and with the same switch settings. There are three options for this page, but none will copy the deviation and balance settings since these are unique to each radio, even if the actual deviation of a set of radios is identical. The top selection allows all settable parameters, including power levels and squelch settings to be read. The second selection does not read in the power levels and squelch in case these have already been set in the recipient radio. The last selection is for someone who has a configuration file from a series DTX-X54 and want to load it into the series DTX-X60. Older radio parameters are converted and presented such that the audio levels should be the same. Note that the RF power levels and squelch levels cannot be converted and must be set on the new radio by hand.

6.5.6 SAVING A CONFIGURATION

Upon exiting the programmer via the exit button, the user will be presented with a box which allows the saving of the current configuration. This is useful if a number of other radios are to be programmed with the same frequencies and settings. If one does not wish to save the current configuration, the cancel icon should be selected. Also, if changes to the radio have been made via the programmer and the radio has not been updated, the user will be prompted to update the radio.

II MAINTENANCE

10 IMPORTANT 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 board and/or components, which is not covered by RITRON's warranty. If you are not completely familiar with surface mount component repair techniques, RITRON recommends that you defer maintenance to qualified service personnel.

Precautions Handling CMOS Devices: The DTX transceiver module 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 module. 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 being used for other semiconductors. Conductive containers are typically gray or pink in color.

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 100 kΩ resistor to ground.

3) Clothing-Do not wear nylon clothing while handling CMOS circuits.

4) Power Off-Remove power before connecting, removing, or soldering on 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 soldering iron with a grounded tip for soldering CMOS circuitry.

7) Lead-Straightening Tools-When straightening CMOS leads, provide ground straps for the tool used.

VCO Shield: The VCO shield is virtually impossible to remove without damaging either the PC board or nearby components. The parts within the shield are low failure items; repair or replacement should not be required unless the RF board is mishandled. If failure of a part within the shield is deemed to have occurred, the RF board should be returned to RITRON for service or replacement.

Unit Disassembly and Re-assembly:

1) Case Removal
   a) Remove the (4) screws at the ends of each of the sides of the unit. These screws secure the Bottom Panel to the case. Removal of these screws requires a medium Phillips driver.
   b) Remove the Bottom Panel.

2) Board Separation

   Remove the (4) screws that secure the Control/Loader board to the RF Board. Remove the two Hex Spacers next to the DB-15 Connector that secure the Control/Loader Board to the front panel. Gently pull the two boards apart at the header/socket.

3) Re-assembly is the reverse of assembly with the rear screws installed before the side screws.

8 THEORY OF OPERATION

8.1 DTX-965 RF BOARD

8.1.1 RECEIVER

RF amplifier and Bandpass Filters

The incoming RF signal from the antenna connector passes backwards through the transmitter harmonic filter and to a diode switch. The diode switch, CR101, CR201, and CR202 route the RF signal to a SAW Filter FL101 and then an amplifier Q101. The amplifier is followed by another SAW Filter. The SAW Filters are designed to pass all signals within the 935-940 MHz band without much attenuation, but to attenuate out-of-band signals.

1st Mixer, 1st IF filters, and 1st IF Amplifier

The output of the front-end stage is passed to the first mixer U101. This device converts the RF signal to the first IF frequency of 43.65 MHz. L102, R105, and C107 match the mixer output to the 1st IF filter Y101.
The first IF filter, Y101, is at the first IF frequency of 43.65 MHz and has a passband of +/-6 kHz. This is followed by an identical filter, Y102. The output of the 1st IF filters is amplified by Q105 and then routed to the IF IC U102.

2nd IF IC

U102 is an integrated FM IF IC which contains a mixer, high gain limiting IF amplifier, FM discriminator (detector), and other support circuitry. The mixer in U102 converts the RF signal at the first IF to the second IF of 450 kHz. The output of the mixer exits the IC and is filtered by the either Narrowband IF filter, FL103, or Very NarrowBand IF Filter, FL104. The output of the filter re-enters the IC and drives the high gain limiting amplifier. Because the discriminator inside U102 is sensitive to both amplitude and frequency modulation components, a limiter must precede it to remove any amplitude modulation. The output of the limiter amplifier drives the discriminator. The resonator for the discriminator is Y103.

2nd Local Oscillator

The two mixers in this radio act to produce an output signal whose frequency is equal to the difference between the frequency present at the RF input port and the frequency at the local oscillator port. To convert signals at the first IF frequency of 43.65 MHz to that of the second IF at a frequency of 450 kHz, a local oscillator signal at a frequency of 43.2 MHz (43.65 – 0.45) is used. This signal is created by tripling the output of the radio's 14.4 MHz master reference oscillator, Y401. Transistor Q106 acts as a frequency tripler. Its associated components are used to bias the transistor at an harmonic rich bias point and to filter the output such that only the third harmonic remains for use as the 2nd local oscillator.

VCO and Synthesizer

The frequency synthesizer is responsible for generating the carrier in transmit and the first local oscillator in receive. A voltage-controlled oscillator (VCO) is an oscillator whose frequency can be controlled by an external signal. The receiver synthesizer, almost wholly contained within U401, divides the VCO frequency by digital dividers and compares the result with an accurate reference. An error signal, proportional to the frequency error is created which is routed to the frequency control input of the VCO. This action locks the VCO to a frequency which is equal to the reference frequency multiplied by the divider number. To set the VCO frequency, different divider numbers can be programmed into the synthesizer. In most synthesizer designs, the divider must be an integer, which forces the reference frequency to be equal to the synthesizer step size. This synthesizer, however, uses a fractional-N technique to generate smaller step sizes. The reference frequency is derived by digitally dividing the frequency of the 14.4 MHz master oscillator. When locked, the VCO attains the same relative frequency stability as that of the master oscillator.

The output of the VCO is amplified to a level of about 0 dBm by Q401 and Q402. Q603 with R602, R603, CR601, C603 and C604 act as a very low noise power supply filter for the VCO.

8.1.2 TRANSMITTER

PA Driver Stages

The output of the VCO buffer drives Q204 and Q203 to provide a drive level to the RF PA device of about +17 dBm. The supply voltage to this stage is switched on in transmit by Q202 and Q201.

PA Module, Lowpass Filter, and T/R Switch

When driven by +17 dBm, the PA module, U201, is capable of producing full rated power at the antenna connector. Pin 2 of the module is used for power control. The output power level can be varied from 5 watts to full power by changing the voltage at this pin.

To reduce carrier frequency harmonics of the PA module output to acceptable levels, lowpass filters are inserted between the module and the antenna connector. To isolate the PA module from the receiver, an electronic T/R switch is used. The switch is formed around PIN diodes CR201 and CR202 which are turned on in transmit and are off in receive.

8.2 CONTROL/LOADER BOARD

The control/loader board is responsible for controlling the operation of the RF board and for processing the audio input and output signals to and from the RF board and to and from the outside.

Audio Chain

The audio processing, both transmit and receive, is handled by the audio Codec IC, U302 and the DSP microcontroller U301. These devices handle pre-emphasis, modulation limiting, and lowpass filtering on transmit as well as de-emphasis and filtering on receive.

In transmit, the audio inputs are routed to the Codec IC. This IC has internal analog to digital converters which convert the analog input to a digital data stream. This data stream is sent to the DSP processor where the signal is adjusted in level, filtered, limited, and filtered again. The output digital signal is sent back to the Codec IC where digital to analog converters convert the signal back to analog for routing to the RF board for FM modulation.

In receive, the raw discriminator audio from the RF board is passed to the Codec and is converted to a digital signal. The digital signal is processed by the DSP processor for level and frequency response and sent back to the Codec. The Codec converts the signal back to analog where it is sent to the I/O connector.

Other Analog Functions

To supply the proper voltages for the two boards, various voltage regulators are used. U310 is used to produce +7.5 VDC for the RF board. U308 and U309 are used to supply +5 VDC and +3.3 VDC for the control/loader board.

9 HARDWARE OPTIONS

The DTX is setup at the factory in a configuration that should be acceptable for most users. The most common changes required are effected through the programmer without removing the cover from the unit. There are, however, a number of component jumper changes which can be made which may result in more satisfactory integration in a data system. These changes require the soldering and unsoldering of SMD components and should be undertaken only by qualified service personnel. Refer to the PCB component locator and schematic diagrams as needed.

9.1 CONTROL/LOADER BOARD OPTIONS

9.1.1 AUX OUT COUPLING

The AUX OUT output is normally AC coupled through C372. If DC coupling is desired, an 0805 size SMD zero ohm jumper resistor (RITRON P/N 47100000) must be soldered in the location of C372. (In lieu of a zero ohm jumper, a small piece of wire may be carefully soldered between the pads.) The AUX OUT DC level then becomes nominally 1.67 volts.

9.1.2 AUX IN COUPLING

The AUX IN input is normally AC coupled through C352. DC coupling is possible, however, the carrier frequency of the unit would then become directly affected by the DC voltage present. If DC coupling is desired, C352 must be removed and an 0805 size SMD zero ohm jumper resistor (RITRON P/N 47100000) must be soldered in the C352 location**.** The DC voltage should be 2.5 volts nominal and very well regulated. **Note: The FCC Type Acceptance obtained by RITRON is invalid once this modification is made. The user is responsible for obtaining type acceptance in a configuration which includes the device which is connected to the AUX IN input.**

9.2 RF BOARD OPTIONS

9.2.1 DISCRIMINATOR POLARITY

The polarity of the discriminator output at pin 14 of J102 is configured at the factory such that an increase in RF frequency causes an increase in DC voltage. This is considered “normal” mode. An inverted mode is available where an increase in frequency causes a decrease in voltage. This is effected by removing R130 and placing it in the open pad pair denoted as R125.

10 ALIGNMENT

Warning: Alignment must only be performed by qualified and trained service personnel.

The DTX module is aligned at the factory before shipment and should need no further adjustment. It is possible that the gain settings for the audio input and output signal paths may need optimized. The frequency trim, deviation, and balance should not need adjustment. The procedure for performing all of the alignment steps is detailed below. The unit should not be opened for alignment; all adjustments are electronic and effected through the programmer software.

10.1 REQUIRED TEST EQUIPMENT

Depending upon which alignment steps are to be performed, some or all of the following pieces of test equipment may be required:

DC Power Supply - capable of operating at the correct voltage for the module and capable of 7 Ampere minimum current.

RF Signal Generator- capable of operating at the carrier frequency of the module with an output level adjustment and able to be frequency modulated.

FM Demodulator/Deviation Meter- capable of operating at the carrier frequency of the module.

RF Frequency Counter- must operate at the RF frequency of the unit with a resolution of 10 Hz or better and an accuracy of +/-1 ppm (+/-150 Hz at VHF, +/-450 Hz at UHF) or better.

Audio Oscillator- must have sinewave output allow for output frequency and amplitude adjustment.

Oscilloscope

RF Power Attenuator or Dummy Load with coupled output- must be 50 ohms impedance at the operating frequency and rated for the output power of the module and have an output which can drive the FM demodulator at the correct level and the frequency counter.

RF Power Meter- capable of accurately indicating the RF output power of the module.

Note: Except for the power supply, a two-way radio test set may include most, if not all, of the required equipment.

10.2 ALIGNMENT PROCEDURE

It is not absolutely necessary to perform all of the alignment steps detailed below. However, some adjustments interact somewhat with others e.g. balance affects deviation, deviation affects AUX IN gain, and the output power AUX IN gain has a slight affect on TX frequency trim. It may be prudent to spot check all of the adjustments which interact. These will be indicated in the particular alignment step.

The programmer must be connected to the unit via the programming interface cable and the alignment screen selected. During alignment, the channel may be selected via the channeling control lines on the module or through the programmer. A channel pull-down menu allows for the selection. Also, the unit can be keyed through the programmer, if desired. Note: Interrupting the power supply to the unit while the programmer software is open will require exiting the software and re-opening it.

10.2.1 RX FREQUENCY TRIM

The RX Frequency Trim trims the unit on frequency during receive. This setting, if incorrect, may degrade receive sensitivity, distortion, and possible recovered audio level, which in turn affects AUX OUT (RX) Gain and Audio PA Gain. The receive frequency trim is not affected by any other alignment step.

To determine if the receiver is correctly trimmed to frequency, the 1st local oscillator frequency must be measured. **DO NOT KEY THE UNIT DURING THIS PROCEDURE AS SERIOUS DAMAGE TO THE COUNTER MAY RESULT!**

A channel with a receive frequency programmed into it should be selected. The correct local oscillator will be displayed on the programmer channel box. The frequency on the counter should be observed and the RX Frequency Trim value adjusted for least error. Because of the very low local oscillator level at the antenna terminals, the frequency counter may not be able to read the frequency. If so, perform the TX Frequency Trim adjustment detailed later and set the RX Frequency Trim value to match that of the proper TX Frequency Trim value.

10.2.2 AUX OUT GAIN

To set the AUX OUT gain, an RF signal generator must be connected to the DTX module. Its frequency should be set to that of a programmed channel. The generator should be modulated at the desired deviation, typically 60 % of maximum, with a 1 kHz tone. The RF output level is not critical, but should be above any squelch threshold which may have been set. –70 dBm should be sufficient. If not, squelch can be disabled via the settings menu of the programmer for this procedure.

With an oscilloscope connected to the AUX OUT output, the AUX OUT Gain setting should be set to value which produces the desired output level. Note that the output impedance of the AUX OUT is about 600 ohms. If the load impedance of the load that will be connected to this output is less than 10 kΩ or so, a resistor of a value equal to the load impedance should be connected to the AUX OUT output when making the adjustment.

10.2.3 AUDIO PA GAIN

To set the Audio PA gain, an RF signal generator must be connected to the DTX module. Its frequency should be set to that of a programmed channel. The generator should be modulated at the desired deviation, typically 60 % of maximum, with a 1 kHz tone. The RF output level is not critical, but should be above any squelch threshold which may have been set. A –70 dBm level should be sufficient. If not, squelch operation can be disabled via the settings menu of the programmer.

With an oscilloscope connected to the AUDIO OUT output, the AUDIO OUT Gain setting should be set to value which produces the desired output level.

10.2.4 CARRIER DETECT ON AND CARRIER DETECT OFF

The Carrier Detect On and Carrier Detect Off settings control the RF level (or Signal-to-noise ratio) at which the DCD output goes true and what level at which it goes false. To prevent chattering on noise, these two settings are not normally the same. 3 to 5 dB of hysteresis is usually provided i.e. if the RF signal level is increased from zero, at some point, the DCD output will go from false to true. The RF level may then have to be decreased by several dB before the DCD output goes false again. This prevents chattering with signal levels near the carrier detect level. If squelch is enabled, the receive audio muting will follow the DCD output. The desired carrier detect levels can be directly entered via the alignment screen in dBm and then fine tuned with a high quality signal generator, if necessary.

To determine the state of the DCD output, connect a DC coupled oscilloscope or DVM to the DCD output. It may help to disable the squelch via the Monitor input or Monitor button on the programmer so that the receive audio signal can be continuously observed i.e. not squelched when DCD is false.

10.2.5 TX LOW POWER AND HIGH POWER

The transmitter output power level can be programmed on a per channel basis via the alignment page of the programmer. If RNet Compatibility has not been programmed on the settings page, both the low and high power levels can be set. If RNet Compatibility has been programmed, only high power can be set. The TX High Power and TX Low Power settings in the TX Power box act to select a common value for all channels. Individual values for each channel can be entered in the per channel boxes at the bottom of the screen. Power is set in watts with a resolution of 0.1 watt. The power level can be confirmed and fine tuned, if desired, by connecting the radio to an accurate wattmeter.

10.2.6 AUX IN GAIN

To set the Aux In gain, an audio oscillator or appropriate signal source (e.g. modem) should be connected to the Aux In input at the desired input level. An FM deviation meter should be connected to the antenna connector through a suitable attenuator or coupler. The unit should be keyed for transmit and the Aux In gain should be adjusted for the desired deviation, typically 60 % of rated deviation.

10.2.7 TX FREQUENCY TRIM

This setting is used to trim the transmitter to frequency. This value should not normally need adjustment. However, as the unit ages and/or if the transmitter power or the Aux In gain is changed significantly, slight corrections may be prudent. Note: Any adjustments must be made at a unit temperature of 25 +/- 2 °C (77 +/- 1.8 °F). Due to internal heating, this adjustment must not be made after the unit has been transmitting unless it has been allowed to cool to the correct temperature. Likewise, the adjustment itself should be made as quickly as possible.

The unit should be set to a channel which is at an output power which is close to what will be used the majority of the time. The RF output of the unit should be coupled to a frequency counter through a suitable attenuator or coupler. Ensure that no modulation source is connected to the MIC IN or AUX IN. The PTT should be activated and the TX Frequency Trim value adjusted for the correct frequency. The value can be changed while the unit is transmitting.

10.2.8 DEVIATION AND BALANCE

The deviation adjustments are used to set the maximum limiting deviation of the transmitter. This must be set properly to ensure that the unit will meet the regulatory spurious emissions requirements, in particular, occupied bandwidth. The balance adjustment is used to ensure a proper relationship between the modulating signal to the reference and to the VCO. If the ratio i.e. balance is not correct, the transmit audio frequency response will not be correct which could result in a distorted data waveform.

The optimum values for deviation and balance vary in a predictable manner as a function of carrier frequency. In order to relieve the user of having to adjust deviation and balance each time a transmit frequency is entered or changed, the radio calculates the required values based upon the correct values for two special alignment frequencies. These required values have already been determined at the factory and are stored in the unit. As transmit frequencies are entered or changed, new calculated values will appear in the per channel boxes at the bottom of the screen. These values can be changed on a channel by channel basis, if desired.

The procedure detailed here is for setting the deviation and balance at the special alignment frequencies so that the deviation and balance will be correct at any programmed frequency. This same procedure can be used to set any given channel values in the per channel boxes.

An FM demodulator should be connected to the RF output of the module through a suitable power attenuator or coupler. The demodulator filters should be set for no de-emphasis, as low a highpass cutoff as possible (<50 Hz, preferably down to DC), and a lowpass cutoff of approximately 15 kHz. The demodulator output should be connected to an oscilloscope so that it can be observed.

An audio oscillator should be connected to the AUX IN input. The output waveform should be sine, the level at zero, and at a frequency of 500 Hz. Confirm that the Aux In Gain value is at least 10.

On the channel drop-down menu, select lower band edge. Activate the PTT, and while observing the demodulated waveform on the oscilloscope, begin increasing the audio oscillator's output level or the Aux In setting. The waveform should begin as a sinewave and at some point show clipping. The clipped portion may not necessarily be flat. The audio oscillator level should be set so that a substantial portion of the waveform is clipped, at least 50 %. Adjust the balance value so that the clipped portion is flat i.e. horizontal rather than tilted. Although the programmer can change values while transmitting, it is better to unkey between value entries. After the balance is set, the deviation should be set to a value of 1.2 kHz for a very narrow channel, 2.3 kHz for a 12.5 kHz channel or 4.6 kHz for a 25/30 kHz channel. Select the upper band edge on the channel menu and repeat. As a result of this procedure, the per channel balance and deviation values may have changed.