RITRON, INC.

PRELIMINARY 11-14

RITRON MODEL: DTX-165-RR-SIG

PROGRAMMABLE

FM TRANSCEIVER MODULE

MAINTENANCE & OPERATING

MANUAL

PRELIMINARY!

FOR USE ONLY BY AUTHORIZED SERVICE/MAINTENANCE PERSONNEL

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I DTX-165-RR-SIG MODULES

1 INTRODUCTION

1.1 GENERAL

The RITRON DTX-165-RR-SIG module is a programmable 2-way radios, which operates in the VHF professional FM communications band. Each of eight channels can be programmed to contain a unique set of operating frequencies. The DTX-165-RR-SIG 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.

1.2 MODEL IDENTIFICATION

The part number system for the DTX-165-RR-SIG module is:

The module has a part number in the form of “DTX-A65-RR-SIG” 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)

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 DTX-165-RR-SIG module is 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)

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 general population/uncontrolled conditions.

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-165-RR-SIG two-way radio has an RF exposure product label. Also, this DTX-165-RR-SIG manual includes information and operating instructions required to control your RF exposure and to satisfy compliance requirements.

Compliance with RF Exposure Standards:

The DTX-165-RR-SIG 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.

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

Rated Power of DTX-165-RR-SIG 2-way Radio	Recommended Minimum Lateral Distance from Transmitting Antenna
5 watts or less:	18.7 inches (47.4 cm)
30 to 5 Watts:	36.5 inches (96.2 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 VHF quarterwave antenna or equivalent antenna or other antennas as specified in Table 1. Unauthorized antennas, modifications, or attachments could damage the radio and may violate FCC regulations.

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	FCC: AIERIT42-165 IC: 1084A-RIT42165
FCC Rule Parts	90
Industry Canada Rule Parts	RSS-119
Frequency Range	136-174 MHz
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)	2.5 kHz
Emissions Bandwidth	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

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	400 Hz to 2500 Hz
w/o pre-emphasis	50 Hz to 2700 Hz

Transmitter Attack Time:	10 ms max.
Spurious and Harmonics	-20 dBm max.
FM Hum and Noise (12.5kHz)	45 dB min.
Group Delay Variation (Within Frequency Response)	5 us max.
Current Drain	Depends upon supply voltage (see chart elsewhere in manual).
AUDIO IN adjustment range (60% rated dev.)	
w pre-emphasis (@ 1 kHz)	200 to 1000 mV rms
w/o pre-emphasis (flat)	40 to 300 mV rms

2.3 RECEIVER

Operating Bandwidth	Up to span of the sub-band
Sensitivity (12 dB SINAD @ 1 kHz w de-emphasis)	0.25 uV (-119.0 dBm)
RF Input Impedance	50 ohms nominal
Adjacent Channel Selectivity (12.5 kHz)	60 dB min..
Spurious and Image Rejection	
IF/2	60 dB min.
Image & other	70 dB min.
Intermodulation Rejection	68 dB min.
FM Hum and Noise (12.5kHz)	45 dB min.
Conducted Spurious	-57 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
Receive Current Drain	Depends upon supply voltage options (see chart elsewhere in manual).
AUDIO OUT Adjustment Range (60 % rated dev.)	
w de-emphasis (@ 1 kHz)	50 to 500 mV rms open circuit
w/o de-emphasis (@1 kHz)	250 to 1800 mV rms open circuit

3 DTX-165-RR-SIG INPUT/OUTPUT CONNECTORS

DB-15 Connector Pinout

Pin Number	Name	Description	Comments
1	CS0	Channel Select low bit	Channel 1 – 8 selection.
2	CS1	Channel Select mid bit	Channel 1 – 8 selection.
3	CS2	Channel Select high bit	Channel 1 – 8 selection.
4	AUDIO IN	Microphone Input	Input for microphone type signals to be transmitted. Signals at this input are pre-emphasized, limited, and filtered.
5	HI/LO	RF Power Output	High/Low Power selection.
6	RELAY 1	Relay 1 Contact	N/O Output for Relay1, paired with Pin 7. Can be configured as N/C Output.
7	RELAY 1	Relay 1 Contact	
8	RELAY 2	Relay 2 Contact	N/O Output for Relay 2.
9	PGN IN/OUT	Programming I/O	External PC Programmer connection.
10.	RELAY 2	Relay 2 Contact	N/O Output for Relay 2, paired with Pin 8. Can be configured as N/C Output.
11.	RX MON	Monitor	Breaks squelch in receive.
12.	AUDIO OUT	Audio PA Output	Audio PA output.
13.	DCD	Carrier Detect	Carrier detect output.
14.	PTT	Push to Talk	External PTT input.
15.	GND	Ground	Negative supply point and reference for all inputs.

2-Pin Molex Connector

1	+Vsupply	DC Supply Input	External +10–16VDC Input.
2	GND	Ground	Negative supply point and reference for all inputs.

DB-15 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 Pins 1, 2, and 3 are left open (unconnected).

4	AUDIO IN- Microphone input. This input accepts microphone-type input signals for transmit.
5	HI/LO- This input selects between high and low RF output power. This input is TTL/CMOS level type input with a logic low required for low power and a logic high required for high power. Internal 10 kΩ pull-up to +5 volts.
6,7	RELAY 1- Normally open contacts of Relay 1. Contacts are rated for 5A @ 6VDC. The output can be configured for Normally Closed.
8,10	RELAY 2- Normally open contacts of Relay 2. Contacts are rated for 5A @ 6VDC. The output can be configured for Normally Closed.
9	PGN IN/OUT- Connect via RITRON DTXT-PCPK PC Programming Kit to computer for programming the unit.
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. Note that this output level varies with the adjustment via the programmer of the AUD 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- Push to Talk. 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 the DTX-165-RR-SIG radios (via compatible computer) is model DTXT-PCPK. It includes:

1) Programming Software CD, DTXT-PCPS.

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-165-RR-SIG module supports eight channels. The desired channel is chosen via pins 1, 2, and 3 of the 15 pin connector as shown:

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(0 to 0.3VDC)
1 = Logic high(3.5 to 5.0VDC)

A logic low is a voltage level below 0.3 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 transmitter 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-RR-SIG unit uses 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 slightly 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

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	Current Drain
11.0 V	193 mA
12.5 V	193 mA
16.0 V	193 mA

Transmit Mode (5 watt)

Supply Voltage	Current Drain
11.0 V	2.2 A
12.5 V	2.3 A
16.0 V	2.3 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)

Supply Voltage	Current Drain
11.0 V	3.9 A
12.5 V	4.0 A
16.0 V	4.1 A

Transmit Mode (30 watt)

Supply Voltage	Current Drain
11.0 V	5.5 A
12.5 V	5.8 A
16.0 V	5.9 A

5.4 DUTY CYCLE/KEY-DOWN LIMITATIONS

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:

Power (W)	Ambient Temp (°C)	Duty Cycle (%)	Key-Down Time (min)
5	25	100	
	50	50	6
15	25	100	
	50	50	6
30	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-165-RR-SIG 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 output, AUDIO OUT, is 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 Output

The AUDIO OUT is programmable as de-emphasized or a flat frequency response. Its gain is also programmable. This output can drive 8-ohm speaker-type loads.

5.5.2 TRANSMIT

PTT Operation

The transmitter is activated by placing the PTT (Push-To-Talk) 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).

Transmitter Audio Input

The AUDIO 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 MIC IN signal can achieve 60% modulation with 4 mv rms in the low gain position and 0.5 mv in the high gain position.

High/Low Power

High and low power levels can be programmed into the unit on a channel by channel basis. High power is selected by placing the HI/LO input at a logic high state. Placing the HI/LO input at a logic low state chooses low power. The HI/LO 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**.**

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 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.

6 PROGRAMMING

To program the DTX-165-RR-SIG Module, the RITRON PC Programming Kit, DTXT-PCPK, 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 the DTX-165-RR-SIG (via compatible computer) is model DTXT-PCPK. It includes:

1) Programming Software CD, DTXT-PCPS.

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 DTXT-PCPS Programmer has six 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 1-Used to set programmable features/functions of the radio.

3. Settings 2-Used to set adjustable settings of the radio.

4. 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.

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

6. 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 “Receiving”.

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.

6.5.2 SETTINGS 1 and 2

The Settings 1 page allows for programming various parameters of the radio. These are detailed below:

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

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

RX De-emphasis- Allows for the signal path from the discriminator to the AUDIO OUT to be either de-emphasized or flat. Most applications the AUX OUT output is used work best with a de-emphasized response. Factory default is for a de-emphasized 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 path to be muted when the carrier detect output is false. It is used to prevent the output of noise from the audio output 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.

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 Input Logic Level- Sets the polarity of the PTT 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 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 or less. See section 5.4 for limits on maximum key-down times. The factory default is 60 seconds.

DTMF- The DTMF decoder codes for Relay1 and Relay2 are programmable to a maximum of 12 characters. The options are:

a. Close Relay1- DTMF code to cause the contacts of Relay1 to close.
b. Open Relay1- DTMF code to cause the contacts of Relay1 to open.
c. Momentary Relay1- DTMF code to cause the contacts of Relay1 to momentarily close for the programmed Rly1 Duration.
d. Close Relay2- DTMF code to cause the contacts of Relay2 to close.
e. Open Relay2- DTMF code to cause the contacts of Relay2 to open.
f. Momentary Relay2- DTMF code to cause the contacts of Relay2 to momentarily close for the programmed Rly2 Duration.

The Settings 2 page allows for programming various adjustments of the radio. These are detailed below:

Audio Input (TX) Gain- This input allows adjustment of the signal level to be applied to the modulation limiter and filter circuits from the AUDIO IN input. At the maximum gain setting the AUDIO IN signal can achieve 60% 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.

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.

TX Low Power and TX High Power- Sets the global power level for the transmitter in watts for the two positions of the HI/LO input. A logic high on the HI/LO input would cause the radio to use the TX High Power setting while a logic low on the HI/LO 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.

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. The unit leaves the factory already aligned, but the user may wish to change the values of some of the settings.

Deviation and Balance- Set such that the maximum deviation will fall within the regulatory requirements and that 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.

Power Table- Sets the global power level for the transmitter in watts. Separate power levels for a given frequency can be calibrated. These calibrated power levels can then be used in the High/Low Power selection on the Settings 2 page.

Carrier Detect Calibration- 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.

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 DTX-165-RR-SIG and want to load it into another. 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

7 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 For Handling CMOS Devices: The DTX-165-RR-SIG 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 (2) #6 Phillips-Head screws on each side of the unit. Remove the bottom plate.
   b) Remove the (4) #4 Phillips-Head screws and washers securing the two pcb assemblies together.
   c) Remove the large hex nut securing the BNC connector to the enclosure frame.
   d) Remove the (2) small hex nuts securing the DB-15 connector to the enclosure frame.

2) Board Separation

   Carefully lift the Control/Loader Board assembly away from the RF Board assembly.

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

8 THEORY OF OPERATION

8.1 DTX-165 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, CR103, and CR201 route the RF signal to a lumped-element bandpass filter and then an amplifier Q101. The amplifier is followed by another lumped-element filter. The lumped element filters are designed to pass all signals within the 136-174 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. L107, R108, and C132 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 second IF filter, FL101(12.5kHz) or FL102(6.25kHz). 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 and CR601 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 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 Q201 and Q202.

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 less than 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 CR101 and CR201 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 DB-15 Connector, J301.

Audio Chain

The audio processing, both transmit and receive, is handled by the audio processing IC, U302 and the 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 input is routed to the Audio Processor IC pins 32 and 33. This IC has internal gain adjustments for levels, filtering, and limiting. The output signal at Pin 35 is then routed to U309 and U304 for deviation set and modulation balance. The output of balance control U304B routes the audio to the RF board for FM modulation. The TX frequency adjustment is made by U304C.

In receive, the raw discriminator audio from the RF board is routed to the audio processor IC at Pins 28 and 29. The audio signal is processed by the audio processor IC for level and frequency response. The audio output of the audio processor IC, Pin 38, is buffered then routed to audio amplifier U307.

In receive, the discriminator audio is also sent to the DTMF decoder input, Pins 30 and 31, of the audio processor IC. If a valid decode signal is detected, Microcontroller U301 will enable relay control Q303 or Q304.

Other Analog Functions

To supply the proper voltages for the two boards, various voltage regulators are used. U311 is used to produce +7.5 VDC for the RF board. U310, U312 and U313 are used to supply +5 VDC and +3.3 VDC for the control/loader board.

9 HARDWARE OPTIONS

The DTX-165-RR-SIG 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 RELAY1 AND RELAY2 POLARITY

The default polarity for Relay1 and Relay2 is Normally Open.
To change the polarity of Relay1 to Normally Closed, remove R339 and place a 0ohm resistor for MR340.
To change the polarity of Relay2 to Normally Closed, remove R343 and place a 0ohm resistor for MR344.

9.2 RF BOARD OPTIONS

9.2.1 DISCRIMINATOR POLARITY

The polarity of the discriminator output at pin 9 of U102 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 R125 and placing it in the open pad pair denoted as MR130.

10 ALIGNMENT

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

The DTX-165-RR-SIG 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. 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 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 AUDIO PA GAIN

To set the Audio PA gain, an RF signal generator must be connected to the DTX-165-RR-SIG 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.

10.2.3 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.

10.2.4 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.

10.2.5 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 AUDIO 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.

10.2.6 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 AUDIO IN input. The output waveform should be sine, the level at zero, and at a frequency of 500 Hz. Confirm that the Audio 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 Audio 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 2.3 kHz. 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.