TYPE OF EXHIBIT:	INSTRUCTION BOOK (PRELIMINARY)
FCC PART:	2.983 (d) (8)
MANUFACTURER:	RITRON, INC. 505 West Carmel Drive Carmel, IN 46032
MODEL:	DTX-454
TYPE OF UNIT:	UHF-FM Transceiver
FCC ID:	AIERIT11-450
DATE:	February 2, 1999

Preliminary Instruction Book follows.

RITRON, INC.

RITRON MODEL DTX-454

PROGRAMMABLE FM TRANSCEIVER MODULE

MAINTENANCE & OPERATING MANUAL

FOR USE ONLY BY AUTHORIZED SERVICE/MAINTENANCE PERSONNEL

DTX454 SPECIFICATIONS

GENERAL

FCC Identifier	AIERIT11-450 (pending)
FCC Rule Parts	22, 74, 90, 95
Frequency Range	400-420 MHz * 420-440 MHz * 430-450 MHz * 450-470 MHz 470-490 MHz * 490-512 MHz *
Number of Channels	8
Transmit/Receive Spacing	20 MHz max.
Mode of Operation	Simplex or Half Duplex
Frequency Control	PLL Synthesizer
Channel Increment (Synthesizer step size)	5/6.25 kHz
Emissions Bandwidth	
Narrow Mode	11 kHz
Wide Mode	16 kHz
Frequency Stability (-30 to +65C)	1.5 ppm
Supply Voltage	
6 watt version	
w/o internal regulator	7.5 VDC
w internal regulator	11-16 VDC
10 watt version	11.5 to 15 VDC
RF Input/Output Connector	BNC
Power/Data Interface	15 pin subminiature D type
Operating Temperature	-30 to +65 C
Maximum Dimensions (L x W x H)	3.6" x 2.3" x 1.0" including connectors
Weight	6 oz.

* Not Available Yet

TRANSMITTER

Operating Bandwidth	20 MHz
RF Output Power	
6 watt version	1 to 6 watts, adjustable
10 watt version	1 to 10 watts, adjustable
Duty Cycle	5 to 100 % depending upon heatsink and power level
RF Load Impedance	50 ohms
Modulation Distortion (per TIA/EIA 603)	5 % max.
Modulation Frequency Response (+1/-3 dB ref 1 kHz)	
At MIC IN (ref pre-emphasis curve)	50 Hz to 2500 Hz
At AUX IN w/o pre-emphasis	50 Hz to 2700 Hz
Transmitter Attack Time:	
To within 2.5 ppm final frequency	10 ms max.
To within 0.5 ppm final frequency	15 ms max.
Spurious and Harmonics	-20 dBm max.
FM Hum and Noise (per TIA/EIA 603)	
12.5 kHz channel operation	40 dB min.
25 kHz channel operation	45 dB min.
Group Delay Variation (Within Frequency Response)	5 us max.
Current Drain	
6 watt version at 7.5 VDC supply	
1 watt	1.0 A max.
6 watts	2.4 A max.
10 watt version at 13.7 VDC supply	
1 watt	0.7 A max.
10 watts	2.4 A max.

RECEIVER

Operating Bandwidth	20 MHz
Sensitivity (12 SINAD w de-emphasis)	0.30 uV (-117.5 dBm)
RF Input Impedance	50 ohms
Adjacent Channel Selectivity	
+/- 12.5 kHz w narrow IF	60 dB min.
+/- 25 kHz w wide IF	70 dB min.
Spurious and Image Rejection	70 dB min.
Intermodulation Rejection	70 dB min.
FM Hum and Noise (per TIA/EIA 603)	
12.5 kHz channel operation	40 dB min.
25 kHz channel operation	45 dB min.
Conducted Spurious	-57 dBm max.
Receive Attack Time	15 ms max.
Audio Distortion (per TIA/EIA 603)	5 % max.
Audio Response at AUX OUT (+1/-3 dB, ref 1 kHz)	
12.5 kHz channel operation	100 Hz to 3.5 kHz
25 kHz channel operation	100 Hz to 5 kHz
Group Delay Variation (Within Frequency Response)	20 us max.
Receive Current Drain	75 mA max.

DTX-154/454 INPUT/OUTPUT CONNECTOR

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.
5	CSN	Channel Select	
6	RAW SUPPLY	Power Supply Input	Positive Supply voltage input.
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	Active high 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.

Pin Number	Description
1	CS0-Least significant bit of the channel select lines. Active high 5 volt TTL/CMOS level.
2	CS1-Mid bit of the channel select lines. Active high 5 volt TTL/CMOS level.
3	CS2-Most significant bit of the channel select lines. Active high 5 volt TTL/CMOS level.

Channel	CS0	CS1	CS2
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

Pin Number	Description
4	MIC IN-Microphone input. This input accepts microphone type input signals for transmit The signal is amplified, passed through the clipper and the clipper filter and then to the RF board. This input can be programmed to be disabled (muted) if desired.
5	CSN-When enabled through programming, this input selects between channels 1 and 2. This input is TTL/CMOS level type input with a logic low required for channel 1 and a logic high required for channel 2.
6	RAW SUPPLY- The positive supply voltage for the unit is supplied through this pin. The actual supply voltage required depends upon model type. Ensure that the correct supply voltage per the given model is used.
7	AUX IN-This is the broadband input for modulation. The gain through this input to the modulator is programmable as is the use of pre-emphasis. 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.
9	PGN IN/OUT-Connect via Ritron RPT-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 active 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 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.
12	AUDIO OUT-This is the output of the audio power amplifier. This output can drive up to ½ watt in to an 8 ohm load. This output can be enabled and its gain controlled by programming.
13	DCD-Carrier Detect Output. This output becomes active when a signal strong enough to exceed the programmed squelch threshold is present. 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.
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.
15	GND-System ground. All signals and voltages are referenced to this input. The negative side of the power supply should connect here.

RF BOARD J301 INPUT/OUTPUT

Pin Number	Name	Description
J102-0	PWR_SET	When PC board jumper R185 is installed and R186 omitted (normal with the loader board connected), the voltage on this pin controls the RF output power. When R186 is installed and R185 omitted(normal for stand alone RF board), the RF output power is controlled by R187 on the RF board and this pin has no function. When this pin is used, the voltage should range between about 1 and 4.5 VDC to vary the output power from 1 to 5 watts. The relationship between output power and voltage is non-linear and may vary as a function of operating frequency. The input resistance at this pin is approximately 15 k-ohm.
J101-1	GND	System ground. All voltages are referenced to this point.
J102-2	FB+	Power supply input for the RF PA module. Voltage at this pin depends upon model and should be either +7.2 VDC +/- 10% or 11 to 16 VDC, and filtered . Current drain can be as high as 2.5 amperes at maximum RF output.
J102-3	TX_EN	Active high, 5 volt CMOS logic level input used to enable the transmitter driver stage and PA pin diodes. Timing circuitry exists on the RF board to ramp the PA power up or down to control keying spurious outputs.
J102-4	RX_EN	Active high, 5 volt CMOS logic level input used to enable the receiver stages and to set the VCO to the receive frequency range.
J102-5	XCVR_EN	Active high, 5 volt logic level input used to enable all stages of the board except the PA and PA driver stages. This pin can be used to conserve current consumption in a battery save configuration.
J102-6	MOD_IN	Modulation input for the transmitter. The modulating signal must be superimposed upon a very stable and low noise 2.5 VDC level. Modulation sensitivity is approximately 14 kHz/V. The input resistance is approximately 17 k-ohm. Note: The DC voltage at this pin directly controls the frequency of the unit. Therefore, the DC voltage must be well regulated and controlled over environmental conditions.
J102-7	LOCK_DETECT	Lock detect output of the frequency synthesizer. Output is at 5 volt logic level with a high level indicating lock.
J102-8	SYN_EN	Enable line for loading the synthesizer. Signal is at 5 volt CMOS logic levels.
J102-9	SYN_DATA	Data line for loading the synthesizer. Signal is at 5 volt CMOS logic levels.
J102-10	SYN_CK	Clock line for loading the synthesizer. Signal is at 5 volt CMOS logic levels.
J102-11	+7.2V	+7.2 VDC +/- 10 % input for powering all stages of the radio except RF PA module. Current drain is approximately 45 mA in receive and

		100 mA in transmit.
J102-12	RSSI	Receive signal strength indicator output. This is a high impedance output which is used to indicate the presence of a carrier. When R124 is installed (R125 omitted), the output will vary between approximately 0.5 VDC and 3.0 VDC as the input signal level varies between –130 dBm and –70 dBm. When R125 is installed (R124 omitted), the output will vary between approximately 2.5 VDC at 0 dB SINAD and 0.5 VDC at 20 dB SINAD. The loading on this output must be kept above 100 k-ohm.
J102-13	DISC_OUT	DC coupled discriminator output. The polarity of this output is controlled by R131 and R132. For positive polarity i.e. an increase in carrier frequency causes the DC level to increase, R131 should be installed and R132 omitted. For negative polarity, R132 should be installed and R1431 omitted. The output is low impedance with a modulation sensitivity of approximately 0.5 V/kHz for narrow band units and 0.25 V/kHz for wide band units. The DC level at this pin is typically between 2 and 4 volts.
J102-14	VCO_MOD	When R179 is installed and R178 omitted (normal with loader board attached), a signal at this pin will modulate the VCO. When R178 is installed and R179 omitted (normal for stand alone RF board), theVCO receives its modulation from the MOD_IN pin and this pin has no function. This pin is provided to allow the modulation balance to be controlled through an external board rather than R180 on the RF board. If this pin is to be used, the DC level should be approximately 5 VDC and from a low noise source. The DC voltage at this pin does not affect the transmit frequency. The modulation sensitivity is approximately 20 kHz/V.

DTX-154/454 SYNTHESIZER LOADING

The following information describes the DTX-154/454 synthesizer programming format. This information can be used for designing programming software for the DTX-154/454 RF board synthesizer when the DTX-154/454 Loader board is not used.

> Note: The user must obtain FCC Type Acceptance when the Ritron RF board is not used with the Ritron Loader board in the DTX-154/454 enclosure.

The DTX-154/454 RF board uses a PLL (Phase Locked Loop) frequency synthesizer which compares the phase of the outputs of two digital frequency dividers. One divider divides the VCO (Voltage Controlled Oscillator) frequency and the other divides the reference frequency. If the two divided outputs differ in frequency, an error signal is generated which, after filtering, is used to control the frequency of the VCO. The net result is that the VCO is locked in frequency to an integer multiple of the reference. To control the frequency, the divider values must be determined. These values are converted to binary and become part of four control words which must be loaded to the synthesizer IC for proper operation. The steps for determining the frequency control part of the control words is as follows:

1. The RF R register counter value is first determined. This integer is the reference oscillator frequency (14.4 MHz in this product) divided by desired reference frequency. The reference frequency is 16 times the desired synthesizer step size. Typical step sizes are 5 kHz and 6.25 kHz. For a 6.25 kHz step size and a 14.4 MHz reference oscillator, the R register counter value would be 144 decimal. When converted to binary, this value is substituted for the R in the State column in the RF_R_Register table.

2. The RF N register counter values are then determined. This is accomplished by taking the desired VCO frequency and dividing it by the desired synthesizer step size value used above. The resulting integer is converted to binary. The least significant 4 bits become the value for the FRAC_CNTR. For frequencies below 500 MHz, bit 21 (PRESC_SEL) must be set to 0 with the next 3 significant bits of the integer used to fill in the 3 least significant bits of RF_NA_CNTR (bits 6,7,and 8). The two most significant bits of RF_NA_CNTR (bits 9 and 10) are loaded with 0. The remaining bits of the integer are loaded into RF_NB_CNTR (bits 11 through 20). For frequencies above 500 MHz, bit 21 (PRESC_SEL) must be set to 1 and the 4 bits following the 3 loaded into FRAC_CNTR are used for RF_NA_CNTR with the most significant bit of RF_NA_CNTR (bit 10) set to 0. The remaining bits of the integer are loaded into RF_NB_CNTR.

3. In transmit, the VCO frequency is equal to the operating frequency. In receive, the VCO frequency is 43.650 MHz below the receive frequency. When calculating receive values, ensure that 43.650 MHz is subtracted from the desired frequency before beginning the above calculations.

4. Example:

   For a frequency of 461.750 MHz in transmit with a 6.25 kHz step size, the RF_R value is 144 decimal or 0000 0000 1001 0000 binary. The RF_R register would therefore become 1000 0110 0000 0010 0100 0010 (MSB first). The VCO frequency divided by the step size is 73,880 decimal or 0001 0010 0000 1001 1000 binary. The RF_N register would therefore become 0001 0010 0000 1000 0110 0011 binary. For 461.750 MHz receive, the VCO frequency would be 418.100 MHz, which yields a divider of 66,896 decimal or 0001 0000 0101 0101 0000 binary. The RF_N register would become 0001 0000 0101 0001 0100 0011 binary.

The four registers of the synthesizer, their bit definitions, and required states are shown below:

IF-R Register

Bit	Name	State	Comments
23	OSC	0	External reference oscillator
22	FRAC 16	1	Fraction = 16
21	FoLD	0	RF digital lock detect
20	FoLD	1	RF digital lock detect
19	FoLD	0	RF digital lock detect
18	CP_GAIN_8	X	Don’t care (1=IF charge pump current=8X)
17	IF_PD_POL	X	Don’t care (1=positive polarity on IF charge pump)
16	IF_R_CNTR	X	Don’t care (IF reference divider MSB)
15	IF_R_CNTR	X	Don’t care
14	IF_R_CNTR	X	Don’t care
13	IF_R_CNTR	X	Don’t care
12	IF_R_CNTR	X	Don’t care
11	IF_R_CNTR	X	Don’t care
10	IF_R_CNTR	X	Don’t care
9	IF_R_CNTR	X	Don’t care
8	IF_R_CNTR	X	Don’t care
7	IF_R_CNTR	X	Don’t care
6	IF_R_CNTR	X	Don’t care
5	IF_R_CNTR	X	Don’t care
4	IF_R_CNTR	X	Don’t care
3	IF_R_CNTR	X	Don’t care
2	IF_R_CNTR	X	Don’t care (IF reference divider LSB)
1		0	Identifies register
0		0	Identifies register

Notes:

1. The IF part of the dual synthesizer is not used. Only those bits which affect the RF part of the synthesizer have importance.

IF_N Register

Bit	Name	State	Comments
23	IF_CNT_RS	0	Normal operation
22	PWDN_IF	1	IF powered down
21	PWDN_MODE	0	Asynchronous power down
20	Fastlock	1	Fastlock enabled
19	Test	0	Test bit-should be set to 0
18	OUT_1	X	Don’t care in fastlock mode
17	OUT-0	X	Don’t care in fastlock mode
16	IF_NB_CNTR	X	Don’t care (IF N register B counter MSB)
15	IF_NB_CNTR	X	Don’t care
14	IF_NB_CNTR	X	Don’t care
13	IF_NB_CNTR	X	Don’t care
12	IF_NB_CNTR	X	Don’t care
11	IF_NB_CNTR	X	Don’t care
10	IF_NB_CNTR	X	Don’t care

9	IF_NB_CNTR	X	Don't care
8	IF_NB_CNTR	X	Don't care
7	IF_NB_CNTR	X	Don't care
6	IF_NB_CNTR	X	Don't care
5	IF_NB_CNTR	X	Don't care (IF N register B counter LSB)
4	IF_NA_CNTR	X	Don't care (IF N register A counter MSB)
3	IF_NA_CNTR	X	Don't care
2	IF_NA_CNTR	X	Don't care (IF N register A counter LSB)
1		0	Identifies register
0		1	Identifies register

Note:

1. The IF part of the dual synthesizer is not used. Only those bits which affect the RF portion of the synthesizer and the bits to shut down the IF portion are used.

RF_R Register

Bit	Name	State	Comments
23	DLL_MODE	1	Delay line loop calibration enabled
22	V2_EN	0	Charge pump voltage doubler not enabled
21	CP_8X	0	Charge pump current MSB
20	CP_4X	0	Charge pump current MSB-1
19	CP_2X	0	Charge pump current LSB+1
18	CP_1X	1	Charge pump current LSB
17	PF_PD_PO	1	Charge pump polarity is positive
16	RF_R_CNTR	R	RF R register counter MSB
15	RF_R_CNTR	R	RF R register counter
14	RF_R_CNTR	R	RF R register counter
13	RF_R_CNTR	R	RF R register counter
12	RF_R_CNTR	R	RF R register counter
11	RF_R_CNTR	R	RF R register counter
10	RF_R_CNTR	R	RF R register counter
9	RF_R_CNTR	R	RF R register counter
8	RF_R_CNTR	R	RF R register counter
7	RF_R_CNTR	R	RF R register counter
6	RF_R_CNTR	R	RF R register counter
5	RF_R_CNTR	R	RF R register counter
4	RF_R_CNTR	R	RF R register counter
3	RF_R_CNTR	R	RF R register counter
2	RF_R_CNTR	R	RF R register counter LSB
1		1	Identifies register
0		0	Identifies register

Notes:

1. CP_1X through CP_8X bits determine the magnitude of the charge pump current. The values range from 100 uA for 000b to 1.6 mA for 111b in 100 uA steps. The values shown are for 200 uA. For fast loading algorithms, this current may have to be changed dynamically.

2. The RF_R_CNTR bits are determined by the desired reference frequency which is determined by the synthesizer step size.

RF_N Register

Bit	Name	State	Comments
23	RF_CNT_RST	0	Normal operation
22	PWDN_RF	0	Powered up
21	PRESC_SEL	0	Prescaler modulus set for 8/9 for 250-500 MHz operation
20	RF_NB_CNTR	B	RF N register B counter MSB
19	RF_NB_CNTR	B	RF N register B counter
18	RF_NB_CNTR	B	RF N register B counter
17	RF_NB_CNTR	B	RF N register B counter
16	RF_NB_CNTR	B	RF N register B counter
15	RF_NB_CNTR	B	RF N register B counter
14	RF_NB_CNTR	B	RF N register B counter
13	RF_NB_CNTR	B	RF N register B counter
12	RF_NB_CNTR	B	RF N register B counter
11	RF_NB_CNTR	B	RF N register B counter LSB
10	RF_NA_CNTR	A	RF N register A counter MSB
9	RF_NA_CNTR	A	RF N register A counter
8	RF_NA_CNTR	A	RF N register A counter
7	RF_NA_CNTR	A	RF N register A counter
6	RF_NA_CNTR	A	RF N register A counter LSB
5	FRAC_CNTR	F	RF fraction counter MSB
4	FRAC_CNTR	F	RF fraction counter
3	FRAC_CNTR	F	RF fraction counter
2	FRAC_CNTR	F	RF fraction counter LSB
1		1	Identifies register
0		1	Identifies register

Note:

1. The bits for the RF_NB_CNTR, RF_NA_CNTR, and FRAC_CNTR are determined by operating frequency and reference frequency.

2. To conserve power, the synthesizer can be powered down with the PWDN_RF bit.

The four registers are loaded using pins 8, 9, and 10 of J102. Pin 8, SYN_EN is the synthesizer enable line. Pin 9, SYN_DATA is the data line, and pin 10, SYN_CK is the clock line. Data is clocked into the synthesizer most significant bit first and must be valid and stable on the rising edge of the clock. The clock must be high a minimum of 10 ns and must be low a minimum of 50 ns before the next pulse. During loading, the synthesizer enable line must be held low. At the conclusion of loading a register, the enable line must be taken high for a minimum of 50 ns. The user should wait a minimum of 5 ms after board power up before loading the synthesizer. This gives the power supply regulators time to reach stable voltages. More complete information regarding the synthesizer IC may be obtained by referring to the National LMX2352 data sheet.

INTRODUCTION

General

The RITRON DTX-454 is a programmable 2-way radio module which operates in the UHF professional FM communications band. Each of eight channels can be programmed to contain a unique set of operating frequencies and settings.

The DTX-454 module is made up of two PC boards, an RF board and a 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 power and control input/output.

FCC Regulations

Licensing

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.

Type Acceptance

The unit is type accepted 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.

Safety Standards

The FCC (with its action in General Docket 79-144, March 13, 1985) has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment. RITRON follows these safety standards and recommends that you observe them also:

DO NOT operate radio equipment near electrical blasting caps or in an explosive atmosphere.

DO NOT operate any radio transmitter unless all RF connectors are secure and any open connectors are properly terminated.

DO NOT operate the transmitter of a fixed radio (base station, microwave, rural telephone RF equipment) or marine radio when someone is within two feet of the antenna.

Repair of RITRON products should be performed only by RITRON authorized personnel.

ACCESSORIES

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

Description	Item Number
Programming Kit for DTX-154/454 radios (via compatible computer)	RPT-PCKT

Includes:

1) 1 software installation instructions
2) 2 programming software diskettes, 3.5" and 5.25" (1 each)
3) 1 PC/radio adapter cable (DB25F connector to 6 pin modular connector)

Factory programming of channels and features is also optional.

DTX-154/454 PROGRAMMING

CHANNEL FREQUENCIES

Enter the transmit and receive frequencies for the channels (1-8) in the area indicated. The entered frequencies must be divisible by 5 kHz or 6.25 kHz and within the unit's operating range.

ADJUSTMENTS

Name:	TX Frequency Trim
Description:	Used to trim the unit on frequency during transmit.
Value Range:	-31 to +32
Adjustment Range:	Approximately 5 kHz total.
Default Value:	0
Comments:	Sets the reference oscillator frequency during transmit. Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.
Name:	RX Frequency Trim
Description:	Used to trim the unit on frequency during receive.
Value Range:	-31 to +32
Adjustment Range:	Approximately 5 kHz total.
Default Value:	0
Comments:	Should be set equal to TX Frequency Trim. May be fine tuned away from TX Frequency Trim value for better distortion, but should not be necessary. Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.
Name:	Modulation Balance
Description:	Sets the relative levels of the modulation signals going to the reference oscillator and the VCO for transmit audio response flatness.
Value Range:	-31 to +32
Default Value:	0
Comments:	Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	TX Deviation
Description:	Set maximum deviation of transmit modulation.
Value Range:	0 to +63
Default Value:	20
Comments:	Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	AUX IN Audio Gain
Description:	Sets the modulation sensitivity of the AUX IN input.
Value Range:	0 to +63
Default Value:	20
Comments:	Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	AUX OUT Audio Gain
Description:	Sets the output level of the AUX OUT signal.
Value Range:	0 to +63
Default Value:	20
Comments:	Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	AUDIO OUT Gain
Description:	Sets the output level of the AUDIO OUT signal.
Value Range:	0 to +63
Default Value:	20
Comments:	Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	TX Output Power
Description:	Sets the RF Output Power

Value Range:	1 to 15
Default Value:	12
Comments:	Typical values are 5 for 1 watt output, 12 for maximum rated power. Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	Squelch Lower Limit
Description:	Sets the RF level at which the receiver audio is muted.
Value Range:	1 to 255
Default Value:	40
Comments:	Determines operation of Squelch, Busy Channel Lockout function and DCD output. Must be set if any of these three functions are to be used. Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	Squelch Upper Limit
Description:	Sets the RF level at which the receiver is unmuted.
Value Range:	1 to 255
Default Value:	45
Comments:	Determines operation of Squelch, Busy Channel Lockout function and DCD output. Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	TX Timeout Timer
Description:	Sets the maximum length of time the transmitter may be keyed continuously.
Value Range:	0 to 255
Adjustment Range:	1 to 255 seconds or disabled.
Default Value:	60
Comments:	Value in seconds; zero seconds disables function. Changes made to current channel which is highlighted. Value can be transferred to common field for all channels or the value can be programmed on a channel by channel basis.

Name:	Microphone Mute

Description:	Enables or disables the MIC IN signal.
Value Range:	Off (unmuted) or On (muted).
Default Value:	Off (unmuted).
Comments:	Common to all channels.

Name:	Clipper Filter Enable
Description:	Allows bypassing the filter which follows the modulation limiter.
Value Range:	Off (filter bypassed) and On (filter in circuit).
Default Value:	On.
Comments:	Ritron's FCC Type Acceptance not valid unless On. Common to all channels.

Name:	RX De-emphasis Enable
Description:	Enables or disables de-emphasis on AUX OUT signal.
Value Range:	Off (no de-emphasis) or On (de-emphasis).
Default Value:	Off.
Comments:	Common to all channels.

Name:	Audio PA RX Enable
Description:	Enables or disables the operation of the Audio PA (AUDIO OUT signal) during receive.
Value Range:	Off (no audio) or On (audio present).
Default Value:	On.
Comments:	Common to all channels.

Name:	Audio PA TX Enable
Description:	Enables or disables the operation of the Audio PA (AUDIO OUT signal) during transmit.
Value Range:	Off (no audio) or On (audio present).
Default Value:	Off.
Comments:	Used for transmit sidetone. Common to all channels.

Name:	RX AC/DC Coupled

Description:	Sets the coupling from the discriminator to the AUX OUT audio processing circuits on the loader board.
Value Range:	AC or DC.
Default Value:	AC
Comments:	Sets the coupling mode into the audio circuitry; AUX OUT output coupling is always DC coupled at 2.5 volts nominal DC value unless the parts are changed on the Loader board. Common to all channels.

Name:	TX Pre-emphasis Enable
Description:	Determines whether the AUX IN signal is pre-emphasized. (MIC IN is always pre-emphasized.)
Value Range:	Off (no pre-emphasis) or On (pre-emphasis).
Default Value:	Off.
Comments:	Common to all channels.

Name:	AUDIO OUT Squelch Enable
Description:	Determines whether the AUDIO OUT signal is ever muted on the basis of receiver signal strength.
Value Range:	Off (never muted) and On (muted on the basis of signal strength).
Default Value:	On.
Comments:	Common to all channels.

Name:	AUX OUT Squelch Enable
Description:	Determines whether the AUX OUT signal is ever muted on the basis of receiver signal strength.
Value Range:	Off (never muted) and On (muted on the basis of signal strength).
Default Value:	On.
Comments:	Common to all channels.

Name:	AUDIO OUT MON Enable
Description:	Determines whether the MON input is active on the AUDIO OUT signal.
Value Range:	Off (not active) or On (active).
Default Value:	On.

Comments:	MON function used to override squelch operation and allow receive audio to be present. Common to all channels.

Name:	AUX OUT MON Enable
Description:	Determines whether the MON input is active on the AUX OUT signal.
Value Range:	Off (not active) or On (active).
Default Value:	On.
Comments:	MON function used to override squelch operation and allow receive audio to be present. Common to all channels.

Name:	Busy Channel Lockout Enable
Description:	Determines whether the transmitter is allowed to transmit when activity is sensed on the channel.
Value Range:	Off (transmit allowed when channel busy) or On (transmit inhibited when channel busy).
Default Value:	On.
Comments:	Carrier detect for this function based upon squelch setting. Common to all channels.

Name:	DCD Polarity
Description:	Determines polarity of DCD output.
Value Range:	Normal (Logic high when carrier present) or Inverted (Logic low when carrier present).
Default Value:	Normal.
Comments:	Output is collector with internal pullup to +5 volts. Common to all channels.

Name:	PTT RTS Polarity
Description:	Determines polarity of PTT RTS input.
Value Range:	Normal (Logic low requests transmit) or Inverted (Logic to transmit).
Default Value:	Normal.
Comments:	Input has internal pullup resistor to +5 volts. If Inverted value is chosen and this input is left unconnected, the unit will go into transmit. Common to all channels.

Name:	MON Polarity
Description:	Determines polarity of MON input.
Value Range:	Normal (Logic low unmutes audio) and Inverted (Logic high unmutes audio).
Default Value:	Normal.
Comments:	Input has internal pullup resistor to +5 volts. If inverted value is chosen and this input is left unconnected, the squelch will not function. Common to all channels.

THEORY OF OPERATION
RF BOARD

RECEIVER

RF amplifier and bandpass filters.

The incoming RF signal from the input connector J101 passes backwards through the transmitter lowpass filter and the electronic T/R switch to a two pole bandpass filter formed around L101 and L102. This filter is of Cohn type with 1.5 dB insertion loss and a bandwidth of 25 MHz. This filter is followed by a low noise amplifier stage formed around Q101. This amplifier has a gain of about 17 dB with a noise figure of 2 dB and serves to amplify the incoming RF signal above the noise of the following stages. Following this stage is a four pole Cohn filter formed around L103 through L106. This filter has an insertion loss of 4 dB and a bandwidth of 25 MHz. The two filter sections are narrow enough to filter out the spurious responses of the first mixer while wide enough to support a performance bandwidth of 20 MHz.

1st mixer, 1st IF filters, and 1st IF amplifier.

IC101 is an active double balanced mixer which converts the incoming RF signal to the first intermediate frequency (IF) of 43.65 MHz. This mixer has a gain of 0 dB and a noise figure of 10 dB. Its differential output is matched to the first IF filter, YF101, by L107, L108, C128, and C137. An IF amplifier based around Q102 is used to provide gain. Its output drives another IF filter section, YF102, which is identical to YF101. These two filters serve the double function filtering out the spurious responses of the second mixer and, with the second IF filter, of removing signals at the adjacent and further removed channels.

2nd IF IC

The output of YF102 drives the mixer internal to IC102. IC102 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 IC102 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, YF103. The output of the filter re-enters the IC and drives the high gain limiting amplifier. Because the discriminator inside IC102 is sensitive to both amplitude and frequency modulation components, a limiter must precede it to remove any amplitude modulation. In addition, the noise based carrier detection system available with this product requires that the RF signal at the discriminator stay constant in amplitude as the RF input signal level varies. The output of the limiter amplifier drives the discriminator. The resonator for the discriminator is YF104.

Receiver audio and carrier detection

The recovered audio from pin 9 of IC102 is filtered and DC shifted by IC103A and associated components. IC103B is a simple inverter and is used to provide inverted audio for those applications which may require it.

Two methods of carrier detection are available on this radio. One is based upon the absolute RF signal level at IC102's input and the other is based upon the magnitude of the ultrasonic noise on the recovered audio. IC102 has circuitry which develops a DC current which is proportional to the input RF signal level. Passing this current through a resistor (R115) creates a voltage which varies from about 0.5 volts at no signal input to about 3 volts with –70 dBm at the antenna connector. In addition, a voltage can be developed which is proportional to the amount of noise present on the recovered audio signal. This is effected by filtering the recovered audio such that only frequencies above the normal modulation range remain. This prevents modulation components from being detected as noise. The filter is formed around an op-amp internal to IC102 between pins 10 and 11 and the components connected to these two pins. The filtered output at pin 11 is rectified by Q103B and then filtered. The output varies from about 3 volts for a 0 dB SINAD signal to about 0.5 volts for a 20 dB SINAD signal.

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, Y101. Transistor Q112 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 2^{nd} local oscillator.

VCO and Synthesizer

The 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 synthesizer, almost wholly contained within IC108, 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. The synthesizer IC used in this radio, however, allows the use of non-integer values for the divider which in turn allows the reference frequency to be much higher than normal. This creates a synthesizer whose output has lower noise, lower spurious levels, and a higher switching speed s. 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 VCO itself is a voltage follower Colpitts oscillator formed around Q108. One of the elements in the resonant circuit is a varactor diode, CR106, whose capacitance when reverse biased varies as a function of the applied voltage. Since the oscillator frequency is controlled by the resonant circuit, varying the voltage on the varactor diode effects a change in frequency. To serve as a local oscillator for the first mixer, the VCO operates at a frequency 43.65 MHz below that of the desired receive frequency. In transmit, the VCO's oscillating frequency range is shifted upward by about 44 MHz by switching C190 and L115 into the resonant circuit. The VCO has a tuning range of about 30 MHz when its tuning voltage is varied between 1 and 4 volts. To frequency modulate the VCO for transmit, another varactor diode, CR105, is lightly coupled into the resonant circuit.

The output of the VCO is amplified to a level of about 0 dBm by Q107 and Q106. Q111 with R172 and C196 act as a very low noise power supply filter for the VCO.

TRANSMITTER

PA Driver Stages

The output of the last VCO buffer drives Q105 through R151. The signal level at this point is about –10 dBm. Q105 amplifies this signal to about +5 dBm. Q104 further amplifies the signal to +17 dBm, the level required by the PA module. The supply voltage to these two stages is switched on in transmit by Q113.

PA Module, Lowpass filter, and T/R switch

When driven by +17 dBm, the PA module is capable of producing 5 watts or more of 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 0.5 watts to full power by changing the voltage at this pin.

To reduce carrier frequency harmonics of the PA module output to acceptable levels, a lowpass filter is inserted between the module and the antenna connector. This filter is of elliptic design and formed around a buried stripline transmission line and C164, C165, and C166.

To isolate the PA module from the receiver, an electronic T/R switch is used. The switch is formed around PIN diodes CR101 and CR104 which are turned on in transmit and are off in receive. CR104 switches the PA module into and out of the circuit while CR101 protects and isolates the receiver input when the radio is in transmit.

MISCELLANEOUS FUNCTIONS

Two on-board regulators are used to provide the 5 volts DC used by most of the circuitry in the radio. IC106 is a low noise, low dropout regulator which provides 5 volts to all the portions of the radio which do not get switched on or off as the radio changes from transmit to receive. This regulator is enabled by the XCVR-EN (J102, pin 5) input. When this regulator is not enabled, the radio is essentially powered down. IC107 is an identical regulator which supplies power to those circuits which are to be powered-up only in receive and to the switches in the VCO which shift the VCO frequency range to that needed as the 1st local oscillator. The regulator is enabled through IC105E and IC105F by the RX-EN (J102, pin 4) input.

The transmitter PA module driver stages and the T/R switch are powered by +7.2 volts through Q113. Q113 is enabled by the TX-EN (J102, pin3) input through delay and sequencing circuitry formed around IC105 and Q115 and Q114. The sequencing circuitry delays PA turn-on until the driver stages and T/R switches are on and delays driver stage and T/R switch shutdown until the PA module has ramped down in power. This prevents “keyclicks” from abrupt transmitter turn-on and turn-off.

THEORY OF OPERATION
LOADER BOARD

The 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.

Transmit Audio Chain

Two audio inputs are available to the user. One, MIC IN is, as its name implies, is designed to accept a microphone-like input for modulation of the transmitter. The other, AUX IN, is designed to be more flexible in terms of gain and pre-emphasis.

The signal at the MIC IN input is applied to pin 3 of IC308A after passing through a blocking capacitor, C342. R378 is used as a bias source for those microphone which may require it e.g. electret, carbon, etc. IC308A is configured as a unity gain buffer amplifier. Its output is fed through the pre-emphasis network formed by C344 and R337 to IC308B. IC308B is an amplifier used to boost the level of the input signal. The output at pin 7 is fed to an analog switch, IC309C. This switch is used to mute the signal in those cases when the MIC IN input is not used. The output of the switch is routed to the input of the clipper IC310A.

Signals at the AUX IN input are routed to IC308D. Provisions exist to either allow this input to be DC coupled or AC coupled by installing R354 or R355. IC308D is a unity gain buffer amplifier. Its output is fed to analog switch IC309B. This switch allows C361 to be inserted into the path from IC308D to IC308C to work with R358 as a pre-emphasis network. IC308C is a unity gain inverting amplifier. Its purpose is to insure that there is an even number of inversions between the AUX IN input and the modulation input on the RF board. The output at pin 8 drives the AUX TX GAIN section of digital potentiometer IC307A. The signal at the wiper of the digital potentiometer is routed to the input of the clipper, IC310A.

The clipper limits the amplitude of all signals at its input by virtue of the fact that the signal at its output can not swing above the positive supply voltage or below ground. To prevent clipping in the following stages, the signal level at the clipper output is reduced by R344 and R345. Following the clipper is an analog switch, IC303 which is used as a mute gate. The output of the mute gate drives a fifth order pseudo-raised cosine lowpass filter formed around IC310B and IC310C which removes harmonics created in the clipping process. For those systems where the AUX IN signal is already limited in amplitude and frequency, the clipper filter can be bypassed by enabling IC303C. The clipped and filtered signal at pin 8 of IC310C is fed through the DEVIATION section of the digital potentiometer, IC307B. The signal is then routed to IC310D where it is summed with a DC voltage from the TX FREQ section of the digital potentiometer and also inverted. The output at pin 14 is fed to the modulation input of the RF board.

To produce the signal for the VCO modulation input on the RF board, the output at pin 14 of IC310D is also fed through the BALANCE section of the digital potentiometer, through a blocking capacitor and to the VCO modulation input of the RF board. This allows the reference oscillator and the VCO on the RF board to be fed with modulation signals whose amplitude can be independently controlled. This is necessary to achieve a flat transmit audio frequency response on the RF board.

Receive Audio Chain

Two receive audio paths are available to the user. One is similar to that found on voice two-way radios in that it can drive a low impedance speaker. The other has an output which is designed for line level at 600 ohms.

Discriminator audio from the RF board is passed to analog switch IC305C which determines whether the signal is to be AC or DC coupled to the buffer amplifier IC306A. The output at pin 1 drives the two receive audio paths. For the path which can drive a speaker, the output of IC306A is passed through a de-emphasis network R330/C340 and then to a buffer amplifier IC306B. The output of IC306B is routed through R332 and C341 to the RX AUDIO GAIN section of the digital potentiometer. The output of the digital potentiometer feeds the input to the audio power amplifier, IC301. The output of the audio power amplifier at pin 5 passes through blocking capacitor C318 and on to pin 12 of J301. The audio power amplifier is enabled and disabled by controlling its power supply voltage through Q310 and Q302. Transmit audio sidetone is provided by passing the transmit audio signal through R309 to the audio power amplifier.

The other receive audio path passes from pin 1 of IC306A through two analog switch sections is tandem. The first, IC305A switches in or out a de-emphasis network formed with R330 and C340. The second section, IC305B is used as a mute gate. The output of the mute gate passes through a unity gain buffer, IC306C and to the AUX RX GAIN section of the digital potentiometer. From the digital potentiometer, the signal passes through a gain of 4.3 amplifier, IC306D and on to pin 8 of J301.

MISCELLANEOUS FUNCTIONS

The microcontroller, IC302, controls the operation of the loader board as well as communicating with the user interface software and the RF board. Because the processor IC itself doesn’t have enough I/O to support all of the functions required, two shift registers, IC312 and IC313 are used as output port expanders. IC311 is used to store frequencies and operating parameters such as the settings of the digital potentiometer. This memory device is non-volatile, meaning that the memory contents are not lost when power is removed from the device.

The RSSI signal from the RF board used for carrier detection is amplified by IC304C and then applied to one of the analog to digital converter inputs of the microcontroller. The PWR SET voltage for setting the RF power output level on the RF board is developed by digital to analog converter using four output pins of the microcontroller and a weighted resistor network, R316 through R321 and IC304D. Because one of the pins is shared with the carrier detect function, analog switch IC303B is used to switch the pin to the appropriate circuitry.

Except for the audio PA IC, IC301, all of the active devices are powered from 5 volts. Two regulators are used to provide this voltage. One, IC314, is a low noise, high stability device which is used to power the audio stages of the board. Its high stability is required because the loader board develops the DC bias for the reference oscillator on the RF board. Any drift in DC voltage causes a corresponding drift in operating frequency. The other regulator, IC315, is used to power the digital devices. Low noise, stable bias for the operational amplifiers is generated by R361, R362, IC304A, and IC304B.

ALIGNMENT INSTRUCTIONS

ALL ADJUSTMENTS REQUIRED FOR ALIGNMENT ARE EFFECTED ELECTRONICALLY THROUGH COMPUTER INTERFACE USING RPT-PCPK SOFTWARE. THE DTX-154/454 COVER DOES NOT HAVE TO BE REMOVED FROM THE UNIT FOR ALIGNMENT.

RECOMMENDED EQUIPMENT

1. Power Supply-0 to 15 volts, 3 ampere current capability.
2. FM Service Monitor (500 MHz RF capability).
3. Oscilloscope (100 kHz min.)
4. FM Deviation Meter.
5. RF Wattmeter, 10 watts full scale.
6. Frequency Counter (500 MHz min.)
7. SINAD measuring device.
8. VTVM or DMM.
9. 30 dB RF Power Attenuator.
10. Audio Generator, 300 to 300 Hz, 0 to 1V RMS output.
11. RITRON model RTX-SRVBD adapter
12. RSM-3X
13. PC computer and RITRON PC programmer kit.

Note: The FM Service Monitor may contain include many of the other instruments required.

RADIO PREPARATION

Connect the programming adapter to pin 9 of the radio’s DB-15 connector. Install the programming software and open the program. Select the DTX-154/454 radio from the radio menu. If the unit has never been programmed before, the settings should be at their default settings as shipped. If any changes have been made, however, for alignment, the settings should be placed at the default value as shown below:

Function	Value
TX Frequency Trim	0
RX Frequency Trim	0
Modulation Balance	0
TX Deviation `	20

AUX IN Audio Gain	20
AUX OUT Audio Gain	20
AUDIO OUT Gain	20
TX Output Power	12
Squelch Lower Limit	40
Squelch Upper Limit	45
TX Timeout Timer	60
Clipper Filter Enable	On
RX De-emphasis Enable	Off
Audio PA RX Enable	On
RX AC/DC Coupled	AC
TX Pre-emphasis Enable	Off
AUDIO OUT Squelch Enable	On
AUX OUT Squelch Enable	On
AUDIO MON Enable	On
AUX OUT MON Enable	On
Busy Channel Lockout Enable	On
DCD Polarity	Normal
PTT RTS Polarity	Normal
MON Polarity	Normal

SETUP

Using the VTVM (or DMM), set the Power Supply to the correct supply voltage. Connect the positive lead of the supply to pin 6 of the radio's DB-15 connector. Connect the negative lead to pin 15. Connect the FM Service Monitor to the BNC RF connector on the unit.

Program the desired operating frequencies into the unit for both transmit and receive.

TRANSMITTER

Output Power

In the programming program, advance to the TX Output Power section. The current channel will be highlighted. Key the unit via the program and adjust the TX POWER value until the correct power is noted. Repeat for all channels. The unit must be un-keyed before a channel can be changed.

Frequency

Note: The unit must be at an ambient temperature of 22 +/- 1 C (71.6 +/- 1.8 F) for proper setting of frequency.

Move to the TX Frequency Trim section of the programming software. Choose a channel whose frequency is near the middle of the group of programmed channels. Set the Service Monitor to display transmit frequency or connect a Frequency Counter to the unit through a Power Attenuator. Key the unit via the program and adjust the value for the correct frequency. If the unit has been programmed correctly, this value should be satisfactory for all channels and can be made common to all channels in the program. If desired, however, the frequency for each channel may be set individually.

Deviation and Balance

An audio generator set to 500 Hz should be connected to pin 7 (AUX IN) of the DB-15 connector. The output level should be set for 500 mv RMS. The RF output of the unit should be connected to the FM Service Monitor. The Service should be set up to display the demodulated output signal on an oscilloscope. Minimal filtering of the demodulated signal, especially on the low frequency end, should be used. De-emphasis should not be used.

Move to the Modulation Balance section of the program. Select a channel near the middle of the programmed frequency range. Key the unit and confirm that a sinewave or clipped sinewave is visible on the oscilloscope. Increase the audio generator level until clipping is clearly visible. Adjust the value until the clipped portion is as flat as possible. There may be some initial overshoot at the clipping point, but the region after should be flat. This adjustment must be repeated for all channels if the frequencies differ by 2 MHz or more.

Move to the TX Deviation section of the program. Set the FM Service Monitor to measure transmitter modulation deviation or connect an FM Deviation meter to the unit through the RF Power Attenuator. With the audio generator still connected and set at the same level as above, adjust the frequency of the generator until the greatest deviation is noted. Set the deviation value to product the correct maximum deviation, i.e. 2.5 kHz for 12.5 kHz operation and 5 kHz for 25 kHz operation. This adjustment must be repeated for all channels if the frequencies differ by 2 MHz or more.

Other Functions

The other features/functions of the unit should be set via the programming software for transmit operation as desired or returned to the previous settings.

RECEIVER

The AUDIO OUT pin (pin 12 on the DB-15 connector) on the unit should be connected an oscilloscope. Connect the RX MON pin (pin 11 on the DB-15 connector) to ground. Noise should be visible on the oscilloscope.

Front-End

The front-end filters have been tuned at the factory for optimum performance across the entire frequency band of operation. Unless the factory settings have been altered, no adjustment is necessary or advisable. Aligning the front-end requires programming the unit for receive frequencies at the center and each end of the band and noting the sensitivity at these three frequencies. With a SINAD meter attached to the AUDIO OUT pin, the sensitivity should be at or below specification at all receive frequencies. If it is not, the slugs in L101 through L106 should be made flush with the top of their cans and then turned clockwise 1 turn so that the slug is slightly recessed into the can.

The sensitivity should be checked and compared at the center and band edges. If the sensitivity is significantly worse (3 dB or more change required at the RF generator), at one frequency, each slug should be varied in position slightly and the one(s) having the most effect should be adjusted slightly for improved sensitivity. The other channels should be checked to insure that sensitivity has not degraded. This process may need to be repeated a number of times at different channels to insure satisfactory sensitivity across the band. Typically, the sensitivity is slightly better (about 1 dB on the RF generator) at the center channel.

Frequency

Because the transmitter and receiver use the same reference oscillator, TX Frequency Trim values can be used for receive also. If a common value was used for transmit, this value is also already stored as the correct value for receive. If different values are used per channel on transmit, the default value or possibly, the average of the values used in transmit, should be used. For some critical applications it may be possible to optimize the receive frequency trim values by connecting a distortion meter (a SINAD meter may be used if the 1 kHz tone on the generator is adjusted in frequency for highest SINAD) to the AUX OUT pin and adjusting for lowest distortion on a noise quieted RF signal at the correct frequency.

Squelch Setting

The squelch is set by moving to the Squelch Lower Limit section of the program and setting the RF generator output level to the point below which the receiver will be muted (squelched). This point may be determined either by a SINAD reading or by RF level. The choice should be determined by how resistors R124 and R125 are set (the default setting is for SINAD based squelch). When the proper level is reached, the proper command is set in the program and the RSSI value from the RF board at that instant is stored as the lower limit squelch setting.

The upper squelch limit is set by moving to the Squelch Upper Limit section of the program. The RF generator level should be set to the point above which the receiver will always be unmuted. Typically, this setting is a few dB's higher in RF level that the lower squelch limit. The difference between the two values is the squelch hysteresis and prevents squelch chattering.

Other Functions

The other features/functions of the unit should be set via the programming software for receive operation as desired or returned to the previous settings.