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MANUFACTURER:	RITRON, Inc. 505 West Carmel Drive Carmel, IN 46032
MODEL:	DTX-254
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RITRON, INC.

PRELIMINARY 12-04

RITRON MODELS DTX-154, 254 & DTX-454

PROGRAMMABLE

FM TRANSCEIVER MODULES

MAINTENANCE & OPERATING

MANUAL

FOR USE ONLY BY AUTHORIZED SERVICE/MAINTENANCE PERSONNEL

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I DTX-154/254/454 MODULES

1 INTRODUCTION

1.1 GENERAL

The RITRON DTX-154/254/454 modules are programmable 2-way radios, which operate either in the VHF, 220 MHz or UHF professional FM communications bands. Each of eight channels can be programmed to contain a unique set of operating frequencies. The DTX-154/254/454 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 power and control input/output.

In addition, the RF board is available as a stand-alone unit for system integrators. The RF board as sold as a stand-alone item has a few more hardware options than when installed and sold as part of a module. See section 11 for details on the hardware options.

1.2 MODEL IDENTIFICATION

The part number system for the DTX-154/254/454 module is as follows:

The module has a part number in the form of "DTX-A54-BCDEF"

Where:

A is the major frequency band designator:

1=VHF
2=220 MHz
4=UHF

B is the sub-band designator:

G=136-162 for VHF and 400-420 for UHF
A=420-440
B=430-450
O=148-174 for VHF, 217-245 MHz for 220 MHz band, and 450-470 for UHF
C=470-490
T=490-512

C is the connector designator:

B=BNC connector

D designates the IF bandwidth:

N=narrow
W=wide

E designates the maximum power level:

3=3 watts
6=6 watts
9=10 watts

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

D=no regulator; the unit must operate at +7.5 VDC and is limited to either 3 or 6 watts max.
L=low current regulator; the power module is not regulated. Used for 10 watt version only.
I=high current regulator; the unit operates from 10-15 volts at either 3 or 6 watts max.

Example: A DTX-454-OBN6I would be a UHF module for operation between 450 and 470 MHz with a BNC RF connector, narrow (12.5 kHz channel spacing) IF bandwidth, 6 watts maximum output power, and an internal regulator to allow operation from 10 to 15 volts.

The part number system for a stand-alone RF board is the same as that for a module except that "F" designator (regulator option) does not exist and a "-DD" is appended at the end.

Note that the RF board inside a module is not exactly the same as the corresponding stand-alone RF board. There are a number of components and jumper options on the stand-alone board that are not necessary when mated to the RITRON DTX control/loader board.

1.3 FCC REGULATIONS

1.3.1 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.

1.3.2 EQUIPMENT AUTHORIZATION

The unit is certified 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

The FCC, with its action in General Docket 79-144, March 13, 1985, adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment.

The DTX-154 has been evaluated for compliance with the maximum exposure limits for RF energy at the maximum power rating of the unit and with the only antenna sold for use with this product by RITRON. To ensure compliance with the General Population/Uncontrolled maximum exposure limits, please observe the following:

When the Ritron RAM-1545 remote magnetic mount antenna is used, mount the antenna in a location that will ensure that all persons will be at least 19 inches (49 cm) away from the antenna.

Antennas other than the Ritron RAM-1545 must be tested with the DTX-154 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.

The DTX-254 has been evaluated for compliance with the maximum exposure limits for RF energy at the maximum power rating of the unit with a common unity gain quarterwave magnetic mount mobile antenna. To ensure compliance with the General Population/Uncontrolled maximum exposure limits, please observe the following:

When the quarterwave remote magnetic mount antenna is used, mount the antenna in a location that will ensure that all persons will be at least 26 inches (67 cm) away from the antenna. Antennas other than a quarterwave magnetic mount antenna must be tested with the DTX-254 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.

The DTX-454 has been evaluated for compliance with the maximum exposure limits for RF energy at the maximum power rating of the unit and with the only antenna sold for use with this product by RITRON. To ensure compliance with the General Population/Uncontrolled maximum exposure limits, please observe the following:

When the Ritron RAM-45 remote magnetic mount antenna is used, mount the antenna in a location that will ensure that all persons will be at least 21 inches (53 cm) away from the antenna. Antennas other than the Ritron RAM-45 must be tested with the DTX-454 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.

2 MODELS DTX-154/254/454 SPECIFICATIONS

2.1 GENERAL

	DTX-154	DTX-254	DTX-454
FCC Identifier	AIERIT12-150	AIERIT20-250	AIERIT11-450
FCC Rule Parts	22, 74, 90	90	22, 74, 90, 95
Industry Canada Identifier	1084A-DTX154	1084A-DTX254	1084A-DTX454
Frequency Range	136-162 MHz 148-174 MHz	217-245MHz	400-420 MHz 420-440 MHz* 430-450 MHz* 450-470 MHz 470-490 MHz* 490-512 MHz*
Number of Channels	8	8	8
Transmit/Receive Spacing	26 MHz max.	28 MHz max.	20 MHz max.
Mode of Operation	Simplex/half Duplex		
Frequency Control	PLL Synthesizer		
Channel Increment (Synthesizer step size)	2.5 kHz	2.5/3.125 kHz	5/6.25 kHz
Emissions Bandwidth			
Narrow Mode	11 kHz	11 kHz	11 kHz
Wide Mode	16 kHz	16 kHz (FCC)	16 kHz
Frequency Stability (-30 to +55 °C)	1.5 ppm	1.0 ppm	1.5 ppm
Supply Voltage			
3 and 6 watt versions			
w/o internal regulator	7.5 VDC	7.5 VDC	7.5 VDC
w internal regulator	11-16 VDC	11-16 VDC	11-16 VDC
10 watt version	N/A	N/A	11-16 VDC
RF Input/Output Connector	BNC standard		
Power/Data Interface	15 pin subminiature D type		
Maximum Dimensions (L x W x H)	3.6” x 2.3” x 1.0” including connectors		
Weight	6 oz.		

* Not Available Yet

2.2 TRANSMITTER

	DTX-154	DTX-254	DTX-454
Operating Bandwidth	26 MHz	28 MHz	20 MHz
RF Output Power (internally adjustable)			
3 watt version	N/A	N/A	1 to 3 watts
6 watt version	1 to 6 watts	1 to 6 watts	1 to 6 watts
10 watt version	N/A	N/A	1 to 10 watts
Duty Cycle	5 to 100 % depending upon voltage and power level		
RF Load Impedance	50 ohms		
Modulation Distortion (per TIA/EIA 603)	5 % max.		
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:	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 (50-2500 Hz)	5 us max.		
Current Drain			
1 watt	1.0 A max.	1.0 A max.	1.0 A max.
3 watts	1.6 A max.	1.6 A max.	1.6 A max.
6 watts	2.4 A max.	2.4 A max.	2.4 A max.
10 watts @ 13.5 V	N/A	N/A	2.4 A max.
AUX IN adjustment range (60% rated dev.)			
w pre-emphasis (@ 1 kHz)	200 to 1000 mV rms		
flat	40 to 300 mV rms		

2.3 RECEIVER

	DTX-154	DTX-254	DTX-454
Operating Bandwidth	26 MHz	28 MHz	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		67 dB min.	
FM Hum and Noise (per TIA/EIA 603)			
12.5 kHz channel operation		35 dB min.	
25 kHz channel operation		40 dB min.	
Conducted Spurious		-57 dBm max.	
Receive Attack Time (transmit to receive)		15 ms max.	
Noise Squelch Attack Time		13 ms max.	
RSSI Squelch Attack Time		5 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 (100-3500 Hz)	20 us max.		
Receive Current Drain	80 mA max.	80 mA max.	75 mA max.
AUX OUT Adjustment Range			
w de-emphasis (@ 1 kHz)	50 to 500 mV rms open circuit		
flat	250 to 1800 mV rms open circuit		
AUDIO OUT Adjustment Range (@ 1 kHz)	400 to 1750 mV rms		

3 DTX-154/254/454 INPUT/OUTPUT CONNECTOR

Connector Pinout

Pin Number	Name	Description	Comments
1	CS0	Channel Select low bit	
2	CS1	Channel Select mid bit	
3	CS2	Channel Select high bit	
4	MIC IN	Microphone Input	Input for microphone type signals to be transmitted. Signals at this input are pre-emphasized, limited, and filtered.
5	CSN	High/Low Power or Channel 1/2	
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.

Pinout Description

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

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

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

0 = Logic low
1 = Logic high

Note: Due to the internal pull-up resistors, the unit defaults to channel 8 if the channel pins are left open (unconnected).

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. Internal 10 kΩ pull-up to +5 volts.
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 the clipper and clipper filter.
8	AUX OUT-This is the broadband output of the receiver. The gain from the receiver to the output is programmable, as is the use of de-emphasis. The choice of AC or DC coupling from the RF board discriminator is also programmable. The coupling at the output of this pin is AC coupled, however. It can be converted to DC coupling with internal hardware modifications.
9	PGN IN/OUT-Connect via RITRON DTXP-PCPK PC Programming Kit to computer for programming the unit.
10	CTS-Clear-To-Send output from the unit which indicates that the unit is transmitting a carrier at the correct frequency and power level and is ready to accept an input signal to be transmitted. This output would normally become true 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. 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 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 true when a signal strong enough to exceed the programmed squelch threshold is present. This output is not affected by the RX MON input. The polarity can be programmed. The output is active low 5 volt logic with an internal 10 kΩ pull-up to +5 volts. It can source up to 10 mA when low.
14	PTT/RTS-Push to Talk/Request to Send. This input commands the unit to transmit. Input levels are TTL/CMOS; polarity may be programmed. Internal 10 kΩ pull-up to +5 volts.
15	GND-System ground. All signals and voltages are referenced to this input. The negative side of the power supply should connect here.

4 ACCESSORIES

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

The Programming Kit for DTX-154/254/454 radios (via compatible computer) is model DTXP-PCKT. It includes:

1) Programming software diskettes, 3.5” (qty 2).

2) 1 25 pin PC to 6 pin modular adapter cable with built-in interface circuitry.

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

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

5 OPERATION

5.1 CHANNEL SELECTION

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

Channel	Pin 3	Pin 2	Pin 1
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

A logic low is a voltage level below 1 volt while a logic high is a voltage level above 3.5 volts. These three pins have an internal 10 kΩ pull-up resistor to + 5 volts. Therefore, any pin left unconnected will assume a logic high state. Do NOT apply voltages outside the range of 0 to +5 volts to these pins.

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

5.2 POWER SUPPLY VOLTAGE

Pin 6 is the positive supply input to the unit. The type of module determines the actual voltage that should be applied to this pin. One should be absolutely sure of the proper voltage and current requirements before applying power.

Three voltages are used within the unit; +5 volts for the processor and logic circuits along with most of the receiver, +7.5 volts for the transmitter driver stages, and the supply voltage for the RF power module which depends upon which module is used.

The VHF and 220 MHz units and the 3 and 6-watt UHF units use 7.5 volt RF power modules. Two supply voltage options are available for these units depending upon whether the control/loader board has a regulator installed. If a regulator is not installed, the voltage should be 7.5 volts +/-10 %. This voltage should be “clean” and preferably regulated since the RF power module is powered directly from this source. Variations in voltage will cause variations in transmitted output power. Conversely, if the control/loader board has a regulator installed, the supply voltage can be at any voltage between 10 and about 15 volts. Although the use of the regulator allows flexibility in terms of supply voltage, because of the amount of heat generated by the regulator, significant duty cycle/key down limitations may apply (see below).

The RF power module in the 10 watt UHF unit requires at least 12 volts to achieve 10 watts, although voltages as high as 15 may be used. Since the module is powered directly from this voltage, the supply should be "clean" and, preferably, regulated. The output power will vary with supply voltage. The 7.5 volts required for the transmitter driver stages is developed by a regulator, but since the current requirements are limited, the regulator is not a factor in determining the duty cycle/key down limits.

5.3 DUTY CYCLE/KEY-DOWN LIMITATIONS

The major heat generating components within the module such as the RF power amplifier and voltage regulator (if used) have maximum temperature limits that should not be exceeded. In addition, the temperature within the module itself must be kept below the maximum temperature of the reference oscillator. As a result, depending upon power, supply voltage, and 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:

	Temperature (°C)	Duty Cycle (%)	Key-Down Time (s)
w/o internal regulator:			
3 watt RF output	25	100	30
	60	15	5
6 watt RF output	25	80	30
	60	10	5
10 watt RF output @ 13.5 V	25	30	15
	60	5	5
w internal regulator			
3 watt RF output	25	50	20
	60	5	5
6 watt RF output	25	30	15
	60	5	5

Blowing air across the unit and/or adding heat sinks can significantly improve the duty cycle/key-down times, especially in units without the internal regulator.

5.4 OPERATING MODES

5.4.1 RECEIVE

Carrier Detect and Squelch Operation

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

Receiver Audio Outputs

Two receiver audio outputs are present on the DTX module. The AUX OUT is general purpose output which can have pre-emphasis enabled or bypassed. Its gain can be controlled and its output is designed to drive 600 Ω loads. The coupling from the discriminator on the RF board may be set to AC or DC by the programmer. The output stage is AC coupled, but can be modified for DC coupling. See the maintenance section of the manual for details on this modification. The AUDIO OUT is always de-emphasized, but its gain can be programmed. In addition, transmit sidetone can be programmed as an option, if desired. This output can drive 8 Ω speaker-type loads.

5.4.2 TRANSMIT

PTT Operation

The transmitter is activated by placing the PTT/RTS (Push-To-Talk/Request-To-Send) input in its true 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.

CTS Output

The CTS (Clear To Send) output goes to its true state when the unit has powered up the transmitter, is locked on the correct transmit frequency, and is ready to accept modulation. This output may be used to signal a modem to start transmitting data. If this output is not used, to avoid loosing data, a delay of at least 15 ms is required between PTT/RTS activation and the application of data.

Transmitter Audio Inputs

Two audio inputs are available on the DTX module. The AUX IN is a general-purpose input that can have pre-emphasis enabled or bypassed and its gain can be controlled through programming. The input impedance is greater than 50 kΩ and is capacitive coupled with a lower roll-off frequency of about 25 Hz. The MIC IN input is fixed gain input designed for connection to a standard electret or dynamic microphone. About 25 mV rms of input signal at 1 kHz will produce 60 % of maximum deviation. The signal at this input is pre-emphasized. The signals at both inputs pass through the modulation limiter and post-limiter filter.

High/Low Power

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

Specialized Modem Operation

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

Antenna Placement

The DTX module is enclosed in a metal housing for RF shielding. However, RF emitting sources located very close (less than 12 inches) to the unit can at times affect its operation. It is not recommended that an antenna be connected directly to the module's BNC connector unless the RF output power is set for less than 1 watt or the module is placed within another RF tight enclosure.

5.5 RNET COMPATIBILITY MODE

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

6 PROGRAMMING

To program the DTX Module, the RITRON PC Programming Kit, DTXP-PCKT, 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 RITRON Programming Kit includes the following:

1. Programming software that is contained on two diskettes.

2. PC to radio adapter cable, which is terminated at one end with a DB-25F connector and at the other end with a modular plug. The DB-25 connector plugs into the computer's serial port, the modular plug into an adapter.

3. The adapter for use with the DTX Plus series of radios. This adapter mates the modular plug to a DB-15M plug for connection to the radio. The adapter also includes wires for powering the unit. The red wire is for positive voltage, the black for negative. Insure that the correct voltage is applied to the unit.

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 disk one of the two disk set in the floppy disk drive. View the contents of the floppy disk and double click on the install.exe file. Follow the instructions as they appear on the screen including the prompt to insert the second disk. 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

Upon starting the programming software, a screen will appear with three buttons at the top, Program Radio, Programmer Configuration, and Exit. Program radio 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). A few notes about using the programming software:

- Moving from menu item to menu item and from screen to screen may take from 1 to 7 or 8 seconds. Some commands require that the entire contents of the radio's memory be accessed. An hourglass symbol may or may not be present for some or all of that time.

- If the programmer acts as if it is accepting commands, but the radio does not appear to be responding, exit the programmer and start over. A power glitch on the radio during the middle of a programming session can cause a serial communications conflict.

- The adjustments on the alignment menu are somewhat slower than changes in settings on the settings menu. More computations and radio memory communications are required on the alignment items.

6.5 PROGRAMMER MENUS

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

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

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

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

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

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

6.5.1 FREQUENCY SELECTION

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

6.5.2 SETTINGS

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

Microphone Mute-Allows the signal path from the MIC IN (microphone input) to be muted. If the microphone input is not to be used, the "mute" function should be selected. Factory default is for the microphone to be muted.

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

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

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

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

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

Carrier Mode-Allows the programmer to set the radio to match the type of carrier detection used by the RF board. The carrier detect mode may be either RSSI (Receive Signal Strength Indicator), based upon carrier level or Noise, which is based upon the receive signal to noise level. RSSI based is significantly faster than noise based systems and is usually preferred for data applications where fast turn-around times are important. **This selection must match that of the radio hardware. It is preset at the factory to match the RF board and must not be changed unless the RF board is modified.** See the Hardware Options section under Maintenance in this manual for details. The factory default is RSSI mode.

Audio PA TX Sidetone-When enabled, the Audio PA is turned on during transmit and has at its output the signal to be transmitted as a sidetone. The factory default is for this function to be off.

RX Discriminator Coupling-Selects whether the coupling from the discriminator output on the RF board is AC or DC coupled to the control/loader board. Since the audio outputs of the control/loader board are AC coupled, this function is normally set for AC as well. For response to DC, a hardware jumper options can be made for DC coupling at the AUX OUT. (See the Hardware Options section under Maintenance for details on this option.) If this is done, this function should be set for DC. The factory default is AC.

CSN Input-Selects whether RNET Compatibility mode is to be used. See section 5.5 for an explanation of this function. Normal operation is to set this for high/low Power. The factory default is high/low power mode.

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

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

TX Timeout Timer-Allows for limits on the maximum time the transmitter may be continuously keyed. When set, the maximum limit is set in the box. To prevent overheating and possible damage to the unit, this is normally set on with a time of 60 seconds of less. See section 5.3 for limits on maximum key-down times. The factory default is 60 seconds.

6.5.3 ALIGNMENT

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

Aux In (TX) Gain-Set so that without pre-emphasis (flat), 100 mv rms will produce 60 % rated deviation. If pre-emphasis has been set, 500 mv rms at 1 kHz will produce 60 % rated deviation.

Aux Out (RX) Gain-Set so that without de-emphasis (flat), a signal with 60 % rated deviation will product 400 mv rms into an open circuit (half this value into 600 ohms). If de-emphasis has been set, the output level will be about 100 mv rms at 1 kHz into an open circuit.

Carrier Detect On and Carrier Detect Off-For RSSI based systems, factory set for carrier on at about –110 dBm and carrier detect off at about –115 dBm.

TX Frequency Trim and RX Frequency Trim-factory set to be on frequency.

Audio PA Gain-Set such that a signal at 60 % rated deviation at 1 kHz will product 400 mV rms of output level.

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 and loaded by the programmer when a frequency is entered in the frequency menu.

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

6.5.4 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.

6.5.5 SUMMARY

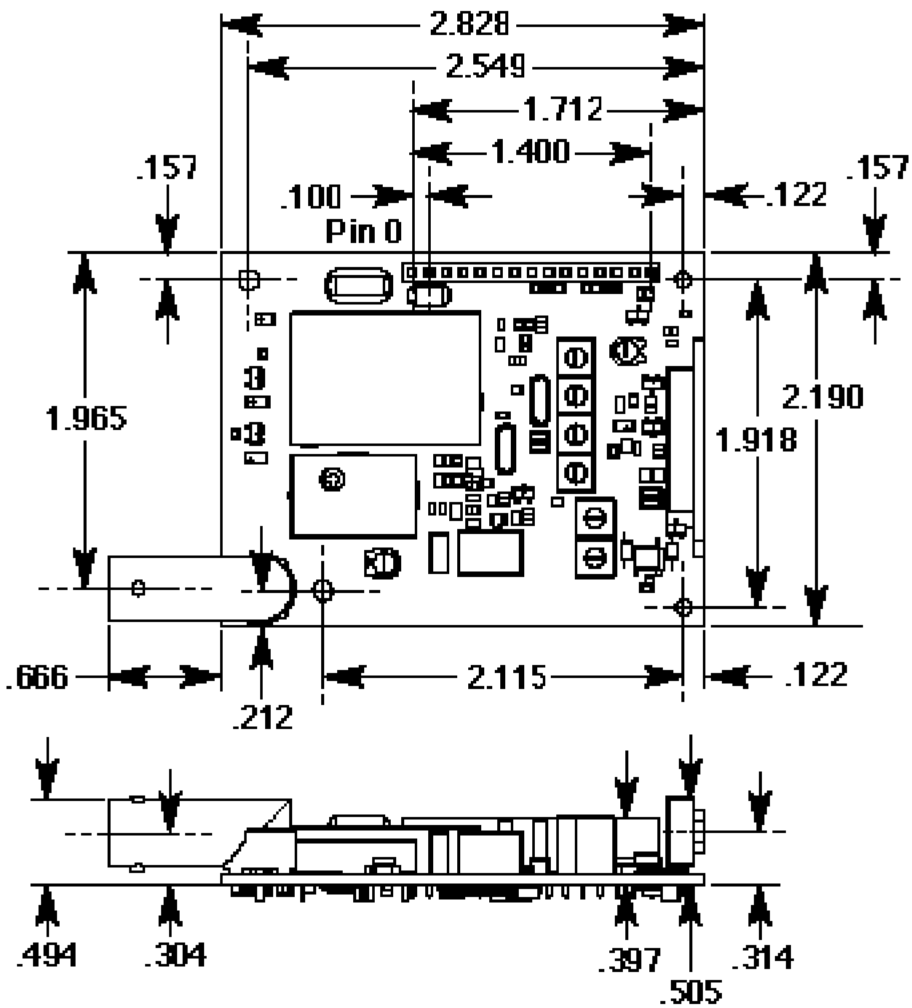
The summary page summarizes the information shown on the other three pages and, in addition, includes the model and serial number of the unit.

6.5.6 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.

II DTX-154/254/454 STAND-ALONE RF BOARD

7 DTX RF BOARD DIMENSIONS



8 RF BOARD J102 INPUT/OUTPUT

Pin Number	Name	Description
J102-0	PWR_SET	When PC board jumper R185 is installed (R186 omitted), the voltage on this pin controls the RF output power. When R186 is installed (R185 omitted), 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.
J101-2	FB+	Power supply input for the RF PA module. Voltage at this pin is filtered. Current drain can be as high as 2.5 amperes at full power.
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 4.5 kHz/V for the VHF versions and approximately 14 kHz/V for the UHF versions. 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 low 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 the 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 analog output, which is used to determine the presence of a carrier. When set for RSSI mode, 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 set for SINAD mode, the output will vary between approximately 2.5 VDC at 0 dB SINAD to 0.5 VDC at 20 dB SINAD. See the Hardware Options section for details on changing the mode. The loading on this output must be kept above 100 k-ohm.
J102-13	DISC_OUT	DC coupled discriminator output. This 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. The polarity can be set via hardware jumpers. See the Hardware Options section for details.
J102-14	VCO_MOD	Depending upon the hardware options, a signal at this pin can modulate the VCO. Otherwise, the VCO gets its signal from an on-board potentiometer from the MOD IN input. This pin is provided to allow the modulation balance to be controlled through an external board rather than 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.

Note: An RF board purchased as a stand-alone board has components installed to support easy interface to external circuitry. This includes, but is not limited to, potentiometers for setting deviation and balance, and various zero ohm jumpers. If the zero ohm jumpers are placed in the correct position, operation with the RITRON control/loader board is possible. An RF board which is part of a DTX module cannot as easily be integrated in a system as a stand-alone board since the parts not required when used with the RITRON control/loader board are not installed.

9 DTX SYNTHESIZER LOADING

The following information describes the DTX-154/254/454 synthesizer programming format. This information can be used for designing programming software for the DTX-154/254/454 RF board when the DTX-154/254/454 control/loader board is not used.

Note: The user must obtain FCC and/or Industry Canada Certification when the RITRON RF board is not used with the RITRON control/loader board in the DTX-154/254/454 enclosure.

The DTX-154/254/454 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 oscillator frequency. If the two divided outputs differ in frequency and/or phase, an error signal is generated which, after filtering, is used to control the frequency of the VCO. The net result is that the VCO frequency is locked to a multiple of the reference frequency (the divided down reference oscillator frequency). To set the desired frequency, the divider values must be determined. These values are converted to binary and become part of four control words, which must be loaded into the synthesizer IC for proper operation. The steps for determining the frequency control part of the 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 2.5 kHz for VHF and either 5 kHz or 6.25 kHz for UHF. 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. Note: The values for the loop filter are based upon a 2.5 kHz step size for VHF and either a 5 kHz or 6.25 kHz step size for UHF.

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 VHF and 220 MHz units have a VCO frequency which is 43.650 MHz above the receive frequency. The VCO in the UHF units operate 43.650 MHz below the desired receive frequency. When calculating receive values, ensure that 43.650 MHz is either added or subtracted (depending upon whether the unit is VHF or UHF) 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 (14.4/0.1) 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 (461.750/0.00625) 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 (461.750 – 43.650), 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. This is consistent with the values of the loop filter used on the RF board. 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. For the loop filter values as supplied, the step size should be 2.5 kHz for VHF units and either 5 kHz or 6.25 kHz for UHF units.

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, and 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.

III MAINTENANCE

10 IMPORTANT MAINTENANCE INFORMATION

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

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

1) Storage/transport-CMOS devices that will be stored or transported must be placed in conductive material so that all exposed leads are shorted together. CMOS devices must not be inserted into conventional plastic "snow" or plastic trays of the type that are being used for other semiconductors. Conductive containers are typically gray or pink in color.

2) Grounding-All CMOS devices must be placed on a grounded bench surface. The technician that will work on the radio/CMOS circuit must be grounded before handling the radio. Normally, the technician wears a conductive wrist strap in series with a 100 kΩ resistor to ground.

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

4) Power Off-Remove power before connecting, removing, or soldering on a PC board that contains CMOS devices.

5) Power/Voltage Transients-Do not insert or remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices, making sure that no voltage transients are present.

6) Soldering-Use a soldering iron with a grounded tip for soldering CMOS circuitry.

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

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

Unit Disassembly and Re-assembly:

1) Case Removal

   a) Remove the two nuts at the rear of the unit. These nuts secure the rear bracket to the case.

b) Remove the three side screws (one on one side, two on the other). These screws secure the front bracket to the case. Removal of these screws requires a TORX T-9 driver.

c) Slide the case off the two-board assembly.

2) Board Separation

Remove the two screws that secure the control/loader board to the rear bracket. The rear bracket stays connected to the RF board. Remove the two screws that secure the RF board to the front bracket. The front bracket stays connected to the control/loader board. These four screws are removed with a TORX T-9 driver. The two boards are held together by their interconnecting header/socket. Gently pry the two boards apart at the header/socket. The RF board is then rotated and tilted so to allow the right angle BNC connector to pass through the hole in the front bracket.

3) Re-assembly is the reverse of assembly with the rear nuts installed before the side screws. DO NOT OVER_TORQUE THE REAR NUTS-DAMAGE TO THE INTENAL PA DEVICE MAY RESULT.

11 THEORY OF OPERATION

11.1 DTX-154 and DTX-254 RF BOARD

11.1.1 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 three pole bandpass filter formed around L102, L103, and L104. This filter is of Cohn type with 1.5 dB insertion loss and a bandwidth of 30 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 three pole Cohn filter formed around L107 through L109. The characteristics of this filter are identical to that of the first. 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 26 to 28 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 L111, L112, C130, and C140. 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 (R123) 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 Q111 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.

11.1.2 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 IC109, 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 higher switching speeds. 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 Hartley oscillator formed around Q107. One of the elements in the resonant circuit is a varactor diode, CR105, 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 above that of the desired receive frequency. In receive, the VCO's oscillating frequency range is shifted upward by about 44 MHz by switching C191, C192, and L122 into the resonant circuit. The VCO has a tuning range of about 40 MHz when its tuning voltage is varied between 1 and 5 volts. To frequency modulate the VCO for transmit, another varactor diode, CR106, is lightly coupled into the resonant circuit.

The output of the VCO is amplified to a level of about 0 dBm by Q106. Q110 with R171 and C196 act as a very low noise power supply filter for the VCO.

11.1.3 TRANSMITTER

PA Driver Stages

The output of the VCO buffer drives Q105 through R152. The signal level at this point is about –10 dBm. Q105 amplifies this signal to about +5 dBm. Q104 further amplifies the signal to +13 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 +13 dBm, the PA module is capable of producing 6 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 L115 and L116 and C169 through C173.

To isolate the PA module from the receiver, an electronic T/R switch is used. The switch is formed around PIN diodes CR103 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 CR103 protects and isolates the receiver input when the radio is in transmit.

11.1.4 MISCELLANEOUS FUNCTIONS

Two on-board regulators are used to provide the 5 volts DC used by most of the circuitry in the radio. IC107 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. IC108 is an identical regulator which supplies power to those circuits which are to be powered-up only in receive. The regulator is enabled through IC106E and IC106F 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 IC106 and Q112 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.

11.2 DTX-454 RF BOARD

11.2.1 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 2nd local oscillator.

11.2.2 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 higher switching speeds. 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 5 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.

11.2.3 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 6 watts (10 watts in the 10 watt version) 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.

11.2.4 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. 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.

11.3 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.

11.3.1 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 microphones 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.

11.3.2 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 Q301 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 in 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.

11.3.3 MICELLANEOUS FUNCTIONS

The microcontroller, IC302, controls the operation of the control/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.

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 control/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, IC317, is used to power the digital devices. Low noise, stable bias for the operational amplifiers is generated by R361, R362, IC304A, and IC304B.

12 HARDWARE OPTIONS

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

12.1 CONTROL/LOADER BOARD OPTIONS

12.1.1 AUX OUT COUPLING

The AUX OUT output is normally AC coupled through C380. If DC coupling is desired, an 0805 size SMD zero ohm jumper resistor (RITRON P/N 47100000) must be soldered in the location of R383. (In lieu of a zero ohm jumper, a small piece of wire may be carefully soldered between the pads.) The R383 pad pair would normally be open. The AUX OUT DC level then becomes nominally 2.5 volts.

12.1.2 AUX IN COUPLING

The AUX IN input is normally AC coupled through C359. DC coupling is possible, however, the carrier frequency of the unit would then become directly affected by the DC voltage present. If DC coupling is desired, R355 must be removed and installed in the open location of R354**.** The DC voltage should be 2.5 volts nominal and very well regulated. **Note: The FCC Type Acceptance obtained by RITRON is invalid once this modification is made. The user is responsible for obtaining type acceptance in a configuration which includes the device which is connected to the AUX IN input.**

12.2 RF BOARD OPTIONS-STAND-ALONE OR PART OF DTX MODULE

12.2.1 DISCRIMINATOR POLARITY

The polarity of the discriminator output at pin 13 of J102 is configured at the factory such that an increase in RF frequency causes an increase in DC voltage. This is considered “normal” mode. An inverted mode is available where an increase in frequency causes a decrease in voltage. On VHF and 220 MHz models, this is effected by removing R134 and placing it in the open pad pair denoted as R135. On UHF models, this is effected by removing R131 and placing it in the open pad pair denoted as R132.

12.2.2 CARRIER DETECT METHOD

Two methods of carrier detection are available on the DTX, carrier level based referred to as RSSI (Receive Signal Strength Indicator) and signal to noise ratio based, referred to as Noise. The factory configuration is for RSSI based carrier detection. If Noise based carrier detection is desired, On VHF models, R127 should be removed and placed in the open pad pair denoted as R128. On UHF models, R124 should be removed and placed in the open pad pair denoted as R125. **Note that the software programmed selection for carrier detect type on the selection page must match the hardware.**

12.3 RF BOARD OPTIONS-STAND-ALONE ONLY

Some of the functions provided by the control/loader board may not be available in all of the applications which use the RF board in its stand-alone form. To provide maximum flexibility, additional options exist on a stand-alone RF board verses one which is part of a DTX module. These additional options are as follows:

12.3.1 VCO MODULATION SOURCE

When used with the RITRON control/loader board, the VCO receives its modulation signal from pin 14 of J102. The stand-alone version of the RF board is configured such that the VCO modulation is derived from the signal at pin 6 of J102, MOD_IN and the balance adjustment is done through R180. If the user wishes to provide a separate VCO modulation signal, on VHF models, R177 should be removed and placed in the open pad pair denoted as R178. On UHF models, R178 should be removed and placed in the open pad pair denoted as R179.

12.3.2 TRANSMITTER OUTPUT POWER ADJUSTMENT

When used with the RITRON control/loader board, the RF output power is controlled through pin 0 of J102. The stand-alone version of the RF board is configured such that the output power is controlled by R186 on VHF models and R187 on UHF models; pin 0 is not connected. If the user wishes to supply the voltage to set output power, on VHF models, R185 should be removed and placed in the open pad pair denoted as R184. On UHF models, R186 should be removed and placed in the open pad pair denoted as R185.

13 ALIGNMENT

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

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

13.1 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 2.5 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.

13.2 ALIGNMENT PROCEDURE

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

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

13.2.1 RX FREQUENCY TRIM

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

To determine if the receiver is correctly trimmed to frequency, the 1st local oscillator frequency must be measured. When the RX frequency trim box on the alignment screen is highlighted, certain stages in the transmit chain are enabled which cause the local oscillator leakage at the antenna connector to stronger than normal. Even so, the level may be less than 0 dBm. The frequency counter must be connected directly to the antenna connector and be able to operate at this level**. 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.

13.2.2 AUX OUT GAIN

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

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

13.2.3 AUDIO PA GAIN

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

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

13.2.4 CARRIER DETECT ON AND CARRIER DETECT OFF

The Carrier Detect On and Carrier Detect Off settings control the RF level (or Signal-to-noise ratio) at which the DCD output goes true and what level at which it goes false. To prevent chattering on noise, these two settings are not normally the same. 3 to 5 dB of hysteresis is usually provided i.e. if the RF signal level is increased from zero, at some point, the DCD output will go from false to true. The RF level may then have to be decreased by several dB before the

DCD output goes false again. This prevents chattering with signal levels near the carrier detect level. If squelch is enabled, the receive audio muting will follow the DCD output.

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.

Set the RF signal generator output to the level at which the Carrier Detect On should go true. Set the Carrier Detect On value to maximum. If the DCD output is true, increase the Carrier Detect Off value until the DCD output goes false.

Set the Carrier Detect Off value to minimum. Slowly adjust the Carrier Detect On value downward until the DCD output just goes true. Re-adjust the signal generator level to the desired level for the DCD output to go false. Normally, this would be about 3 dB or so lower than the level for DCD to go true. Slowly increase the Carrier Detect Off value until the DCD output goes false.

Confirm the operation of the DCD output by decreasing the signal generator level to that substantially below the Carrier Detect Off point and increasing it beyond the Carrier Detect On point and back while observing the DCD output. If the settings are not satisfactory, they can be modified or the procedure can be repeated.

The numbers entered in the Carrier Detect On and Carrier Detect Off fields of the alignment menu are RSSI values for RSSI based systems (most common for data applications) and signal to noise ratio values for noise based systems. RSSI based is the normal factory shipped configuration. It provides a very fast carrier detect operation. As a guide for radios using RSSI based carrier detect, the chart below gives typical RSSI values vs RF input signal levels:

RF Level (dBm)	RSSI Reading
-120	55
-115	75
-110	100
-105	120
-100	145
-95	170
-90	185
-85	205
-80	225
-75	235

13.2.5 TX LOW POWER AND HIGH POWER

The transmitter output power level can be programmed on a per channel basis via the alignment page of the programmer. If RNet Compatibility has not been programmed on the settings page, both the low and high power levels can be set. If RNet Compatibility has been programmed, only high power can be set. The TX High Power and TX Low Power settings in the TX Power box act to select a common value for all channels. Individual values for each channel can be entered in the per channel boxes at the bottom of the screen. Note that the transmitter does not recognize a change in power setting while transmitting, only while receiving. If the PTT is activated and a change in setting is made, the PTT would have to be released and then re-activated to see the new power setting. The relationship between power and setting is not linear and may vary as a function of channel frequency.

13.2.6 AUX IN GAIN

To set the Aux In gain, an audio oscillator or appropriate signal source (e.g. modem) should be connected to the Aux In input at the desired input level. An FM deviation meter should be connected to the antenna connector through a suitable attenuator or coupler. The unit should be keyed for transmit and the Aux In gain should be adjusted for the desired deviation, typically 60 % of rated deviation. In cases where pre-emphasis is not used, large changes in Aux In gain can cause a slight shift in transmit frequency. If the gain is changed significantly (10 to 15 units or more), the TX Frequency Trim step below is recommended.

13.2.7 TX FREQUENCY TRIM

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

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

13.2.8 DEVIATION AND BALANCE

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

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

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

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

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

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

13.3 RF BOARD INTERNAL ADJUSTMENTS

Note: All internal adjustments have been performed at the factory for optimum performance. These should not be changed unless one is fairly certain that alignment is necessary or if repairs have been made to the appropriate sections of the RF board.

13.3.1 FRONT-END INDUCTORS

The front-end inductors on the DTX-454, L101 through L106 (L102 through L104 and L107 through L109 on the DTX-154/254) are preset at the factory for optimum sensitivity across the band of frequencies for each particular model. These should never need adjustment unless a component in the front-end is replaced. Even then, adjustment should not be necessary. Typically, the RF level to achieve 12 dB SINAD should vary about 1 dB or less across the band. To confirm this, the unit should be programmed for receive frequencies which represent the low, mid, and high ends of the band. The sensitivity should be checked on each frequency. If adjustment is deemed desirable, the normal procedure is to adjust the slugs for maximum sensitivity at the mid frequency channel and then check the band edge frequencies. If the sensitivity is worse by 1 dB or more, each slug should be adjusted slightly to test if any improvement is noted. Only those slugs which improve the sensitivity should be changed and only by an amount necessary to bring the sensitivity within 1 dB of the mid channel. After any change is made, the sensitivity should be re-checked across the band. The adjustments may have to be repeated several times to get satisfactory performance across the entire band.

13.3.2 TCXO FREQUENCY ADJUST

The frequency of the TXCO (Y101) is controlled by the DC voltage on its tuning pin and by adjustment of the trimmer capacitor accessible through a hole in the top of the TCXO itself. The tuning sensitivity through the electronic control pin is much greater than that of the trimmer capacitor. The trimmer capacitor is normally never adjusted, even at the factory. If, however, the TX and RX Frequency Trim values are approaching the limits of their electronic adjustment, adjustment of the trimmer may bring the trim values more toward the center.

14 ACTIVE COMPONENT VOLTAGE CHART

Note: All voltages measured with reference to negative supply input (case ground).

14.1 DTX-154/254 RF BOARD

DEVICE	PIN	VOLTAGE Transmit	VOLTAGE Receive	COMMENTS
Q101		Receiver RF Preamplifier		
	E	0	0	
	B	0	0.7	
	C	0	2.5	
Q102		Receiver 1st IF Amplifier		
	E	0	0	
	B	0	0.7	
	C	0	3.5	
Q103-A		Noise Squelch Voltage Reference		
	E (1)	0	0.5 to 1.5	Receive voltage varies with signal level.
	B (2)	0	1.1	
	C (6)	0	5.0	
Q103-B		Noise Squelch Amplifier		
	E (4)	0	0.5 to 1.5	Receive voltage varies with signal level.
	B (5)	0	0 to 1.5	Receive voltage varies with signal level.
	C (3)	0	0 to 1.5	Receive voltage varies with signal level.
Q104		Transmitter Driver Amplifier		
	E	0	0	
	B	0.7	0	
	C	2.5 to 3.5	0	
Q105		Transmitter Pre-driver Amplifier		
	E	0	0	
	B	0.7	0	
	C	2.5 to 3.5	0	
Q106		VCO Amplifier		
	E	0	0	
	B	0.7	0.7	
	C	2.2 to 3.0	2.2 to 3.0	
Q107		VCO Oscillator		
	E	1.5	1.5	
	B	2.2	2.2	
	C	4.4	4.4	
Q108		VCO RX/TX Switching Transistor		
	E	0	0	
	B	4.1	0	
	C	0.2	4.3	

Q109		VCO RX/TX Switching Transistor		
	E	4.3	4.3	
	B	0	5	
	C	4.1	0	
Q110		VCO Active Power Supply Filter		
	E	4.3	4.3	
	B	4.9	4.9	
	C	4.9	4.9	
Q111		Reference Oscillator Tripler		
	E	0.4	0.4	
	B	0.7	0.7	
	C	4.7	4.7	
Q112		TX Switching Transistor		
	E	0	0	
	B	5	0	
	C	0.2	7.3	
Q113		TX Switching Transistor		
	E	7.3	7.3	
	B	6.4	7.3	
	C	7.1	0	
Q114		Transmit Enable Switching Transistor		
	E	5	5	
	B	0	5	
	C	4.8	0.2	
Q115		PLL RF Buffer Transistor		
	E	0.4	0.4	
	B	1.1	1.1	
	C	3.0	3.0	
Q116		PLL Charge Pump Voltage Regulator		
	E	6.1	6.1	
	B	6.7	6.7	
	C	7.3	7.3	
Q117		PLL Lock Detect Driver Transistor		
	E	5	5	
	B	5	5	0 volts when unlocked.
	C	0	0	4.9 volts when unlocked.
IC101		Receiver 1st Mixer		
	1	0	1.6	
	2	0	5	
	3	0	5	
	4	0	5	
	5	0	5	
	6	0	5	
	7	0	5	
	8	0	0.8	
IC102		Receiver 2nd Mixer, IF, Detector		

	1	0	4.4	
	2	0	3.8	
	3	0	3.7	
	4	0	4.6	
	5	0	3.6	
	6	0	3.6	
	7	0	3.6	
	8	0	4.6	
	9	0	2.1	
	10	0	0.6	
	11	0	3.5	
	12	--	--	No connect.
	13	0	0 to 3	Receive voltage varies with signal level.
	14	0	0	
	15	0	0	
	16	0	1.8	
IC103		Receiver Detector Buffer Amplifier		
	1	0	2.4	
	2	0	2.3	
	3	0	2.3	
	4	0	0	
	5	0	2.5	
	6	0	2.5	
	7	0	2.7	
	8	7.3	7.3	
IC104		RF PA Module		
	1	2.5 to 3.5	0	
	2	0 to 4	0	Transmit voltage varies with RF power.
	3	7.5	7.5	
	4	--	--	Don’t Measure!
IC106		RX/TX Logic		
	1	5	0	
	2	0	5	
	3	0	5	
	4	5	0	
	5	5	0	
	6	0	5	
	7	0	0	
	8	5	0	
	9	0	5	
	10	0	5	
	11	5	0	
	12	5	0	
	13	0	5	
	14	5	5	
IC107		5 Volt Regulator		
	1	7.3	7.3	
	2	0	0	
	3	5	5	
	4	--	--	No Connect.
	5	7.3	7.3	

IC108		Receiver 5 Volt Regulator		
	1	7.3	7.3	
	2	0	0	
	3	0	5	
	4	--	--	No Connect.
	5	7.3	7.3	
IC109		PLL Synthesizer IC		
	1	0	0	
	2	4.9	4.9	
	3	6.1	6.1	
	4	1 to 5	1 to 5	Tuning Voltage-depends upon frequency.
	5	0	0	
	6	1.6	1.6	
	7	1.6	1.6	
	8	0	0	
	9	2.4	2.4	
	10	--	--	No connect.
	11	5	5	Lock Detect-0 when unlocked.
	12	5	5	
	13	0	0	
	14	0 and 5	0 and 5	Pulsing continuously is normal.
	15	0 and 5	0 and 5	Pulsing continuously is normal.
	16	0	0	Pulses to 5 volts to load synthesizer.
	17	0	0	
	18	--	--	No connect.
	19	--	--	No connect.
	20	0	0	
	21	--	--	No connect.
	22	5	5	
	23	5	5	
	24	--	--	No connect.

14.2 DTX-454 RF BOARD

DEVICE	PIN	VOLTAGE Transmit	Receive	COMMENTS
Q101		Receiver RF Preamplifier		
	E	0	0	
	B	0	0.7	
	C	0	2.5	
Q102		Receiver 1st IF Amplifier		
	E	0	0	
	B	0	0.7	
	C	0	3.5	
Q103-A		Noise Squelch Voltage Reference		
	E (1)	0	0.5 to 1.5	Receive voltage varies with signal level.
	B (2)	0	1.1	
	C (6)	0	5.0	
Q103-B		Noise Squelch Amplifier		
	E (4)	0	0.5 to 1.5	Receive voltage varies with signal level.
	B (5)	0	0 to 1.5	Receive voltage varies with signal level.
	C (3)	0	0 to 1.5	Receive voltage varies with signal level.
Q104		Transmitter Driver Amplifier		
	E	0	0	
	B	0.7	0	
	C	2.5 to 3.5	0	
Q105		Transmitter Pre-driver Amplifier		
	E	0	0	
	B	0.7	0	
	C	2.5 to 3.5	0	
Q106		VCO Amplifier		
	E	0	0	
	B	0.7	0.7	
	C	2.2 to 3.0	2.2 to 3.0	
Q107		VCO Buffer Amplifier		
	E	0	0	
	B	0.7	0.7	
	C	2.2 to 3.0	2.2 to 3.0	
Q108		VCO Oscillator		
	E	1.5	1.5	
	B	2.2	2.2	
	C	4.4	4.4	
Q109		VCO RX/TX Switching Transistor		
	E	0	0	
	B	4.1	0	
	C	0.2	4.3	
Q110		VCO RX/TX Switching Transistor		

	E	4.3	4.3	
	B	0	5	
	C	4.1	0	
Q111		VCO Active Power Supply Filter		
	E	4.3	4.3	
	B	4.9	4.9	
	C	4.9	4.9	
Q112		Reference Oscillator Tripler		
	E	0.4	0.4	
	B	0.7	0.7	
	C	4.7	4.7	
Q113		TX Switching Transistor		
	E	7.3	7.3	
	B	6.4	7.3	
	C	7.1	0	
Q114		TX Switching Transistor		
	E	0	0	
	B	5	0	
	C	0.2	7.3	
Q115		Transmit Enable Switching Transistor		
	E	5	5	
	B	0	5	
	C	4.8	0.2	
Q116		PLL Lock Detect Driver Transistor		
	E	5	5	
	B	5	5	0 volts when unlocked.
	C	0	0	4.9 volts when unlocked.
Q117		PLL Charge Pump Voltage Regulator		
	E	6.1	6.1	
	B	6.7	6.7	
	C	7.3	7.3	
IC101		Receiver 1st Mixer		
	1	0	1.6	
	2	0	5	
	3	0	5	
	4	0	5	
	5	0	5	
	6	0	5	
	7	0	5	
	8	0	0.8	
IC102		Receiver 2nd Mixer, IF, Detector		
	1	0	4.4	
	2	0	3.8	
	3	0	3.7	
	4	0	4.6	
	5	0	3.6	
	6	0	3.6	

	7	0	3.6	
	8	0	4.6	
	9	0	2.1	
	10	0	0.6	
	11	0	3.5	
	12	--	--	No connect.
	13	0	0 to 3	Receive voltage varies with signal level.
	14	0	0	
	15	0	0	
	16	0	1.8	
IC103		Receiver Detector Buffer Amplifier		
	1	0	2.4	
	2	0	2.3	
	3	0	2.3	
	4	0	0	
	5	0	2.5	
	6	0	2.5	
	7	0	2.7	
	8	7.3	7.3	
IC104		RF PA Module		
	1	2.5 to 3.5	0	
	2	0 to 4	0	Transmit voltage varies with RF power.
	3	7.5/11 to 16	7.5/11 to 16	Depends upon type of PA module.
	4	--	--	Don’t Measure!
IC105		RX/TX Logic		
	1	5	0	
	2	0	5	
	3	0	5	
	4	5	0	
	5	5	0	
	6	0	5	
	7	0	0	
	8	5	0	
	9	0	5	
	10	0	5	
	11	5	0	
	12	5	0	
	13	0	5	
	14	5	5	
IC106		5 Volt Regulator		
	1	7.3	7.3	
	2	0	0	
	3	5	5	
	4	--	--	No connect.
	5	7.3	7.3	
IC107		Receiver 5 Volt Regulator		
	1	7.3	7.3	
	2	0	0	
	3	0	5	
	4	--	--	No connect.
	5	7.3	7.3	

IC108		PLL Synthesizer IC		
	1	0	0	
	2	4.9	4.9	
	3	6.1	6.1	
	4	1 to 5	1 to 5	Tuning Voltage-depends upon frequency.
	5	0	0	
	6	1.6	1.6	
	7	1.6	1.6	
	8	0	0	
	9	2.4	2.4	
	10	--	--	No connect.
	11	5	5	Lock Detect-0 when unlocked.
	12	5	5	
	13	0	0	
	14	0	0	Data Input-Pulses high while being loaded.
	15	0	0	Data Input-Pulses high while being loaded.
	16	0	0	Data Input-Pulses high while being loaded.
	17	0	0	
	18	--	--	No connect.
	19	--	--	No connect.
	20	0	0	
	21	--	--	No connect.
	22	5	5	
	23	5	5	
	24	--	--	No connect.

14.3 DTX-154/454 CONTROL/LOADER BOARD

DEVICE	PIN	VOLTAGE Transmit	VOLTAGE Receive	COMMENTS
Q301		Audio PA Enable Switching Transistor		
	E	7.3	7.3	
	B	6.5	6.5	
	C	7.1	7.1	
Q302		Audio PA Enable Driver Switching Transistor		
	E	4.3	4.3	
	B	5	5	
	C	6.5	6.5	
Q303		Microprocessor Reset Transistor		
	E	5.7	5.7	
	B	5	5	
	C	5.6	5.6	
Q304		Programmer Interface Transistor		
	E	0	0	
	B	0	0	Pulses to 5 volts when sending data.
	C	5	5	5 volts drops to 2.5 when programmer is connected. Pulses to 0.2 volts to send data.
Q305		CTS Interface Transistor		
	E	0	0	
	B	0 or 5	0 or 5	Depends upon programming and mode.
	C	0.2 or 5	0.2 or 5	Depends upon programming and mode.
Q306		DCD Interface Transistor		
	E	0	0	
	B	0 or 5	0 or 5	Depends upon programming and mode.
	C	0.2 or 5	0.2 or 5	Depends upon programming and mode.
IC301		Audio PA		
	1	1.3	1.3	
	2	0	0	
	3	0	0	
	4	0	0	
	5	3.6	3.6	
	6	7.3	7.3	
	7	--	--	No connect.
	8	1.3	1.3	
IC302		Microprocessor		
	1	5	5	Reset Input (Resets at 0 volts).
	2	5	5	External Interrupt (Tied to 5 volts).
	3	0	0	Lock Detect Input, 5 volts when unlocked.
	4	0 or 5	0 or 5	Channel Select LSB input.
	5	0 or 5	0 or 5	Channel Select mid bit input.
	6	0 or 5	0 or 5	Channel Select MSB input.
	7	0 or 5	0 or 5	CSN input.
	8	0 or 5	0 or 5	RX MON input.

	9	0 or 5	0 or 5	RTS input.
	10	5	5	Drops to 2.5 volts when programmer is connected. Drops to 0 when sending data.
	11	0 and 5	0 and 5	Pulsing continuously is normal.
	12	0	0	
	13	0 and 5	0 and 5	Pulsing continuously is normal.
	14	0	0	
	15	5	5	
	16	0 or 5	0 to 5	Power set LSB in transmit, RSSI input in receive.
	17	0 or 5	0	Power set bit in transmit.
	18	0 or 5	0	Power set bit in transmit.
	19	0 or 5	0	Power set MSB in transmit.
	20	0 and 5	0 and 5	Pulsing continuously is normal.
	21	0 and 5	0 and 5	Pulsing continuously is normal.
	22	0	0	Pulses to 5 volts to load synthesizer.
	23	0	0	Pulses to 5 volts to send data.
	24	0	0	
	25	2.5 or 5	2.5 or 5	2.5 volts when programmer connected. Drops to 0.2 volts during data transfer.
	26	2.5	2.5	
	27	2.5	2.5	
	28	5	5	
IC303		Analog Switch		
	1	2.5	2.5	
	2	2.5	2.5	
	3	0	0 to 5	Depends upon RF input level.
	4	0 or 5	0 to 5	TX power set in TX, RSSI in RX.
	5	0 or 5	0	TX power set LSB.
	6	0	0	
	7	0	0	
	8	0	0	
	9	0	5	
	10	5	0	
	11	0	0	
	12	2.5	2.5	
	13	2.5	2.5	
	14	2.5	2.5	
	15	2.5	2.5	
	16	5	5	
IC304		Operational Amplifier		
	1	2.5	2.5	
	2	2.5	2.5	
	3	2.5	2.5	
	4	5	5	
	5	2.5	2.5	
	6	2.5	2.5	
	7	2.5	2.5	
	8	0	0 to 5	RX value depends upon RF input level.
	9	0	0 to 3	RX value depends upon RF input level.
	10	0	0 to 3	RX value depends upon RF input level.
	11	0	0	

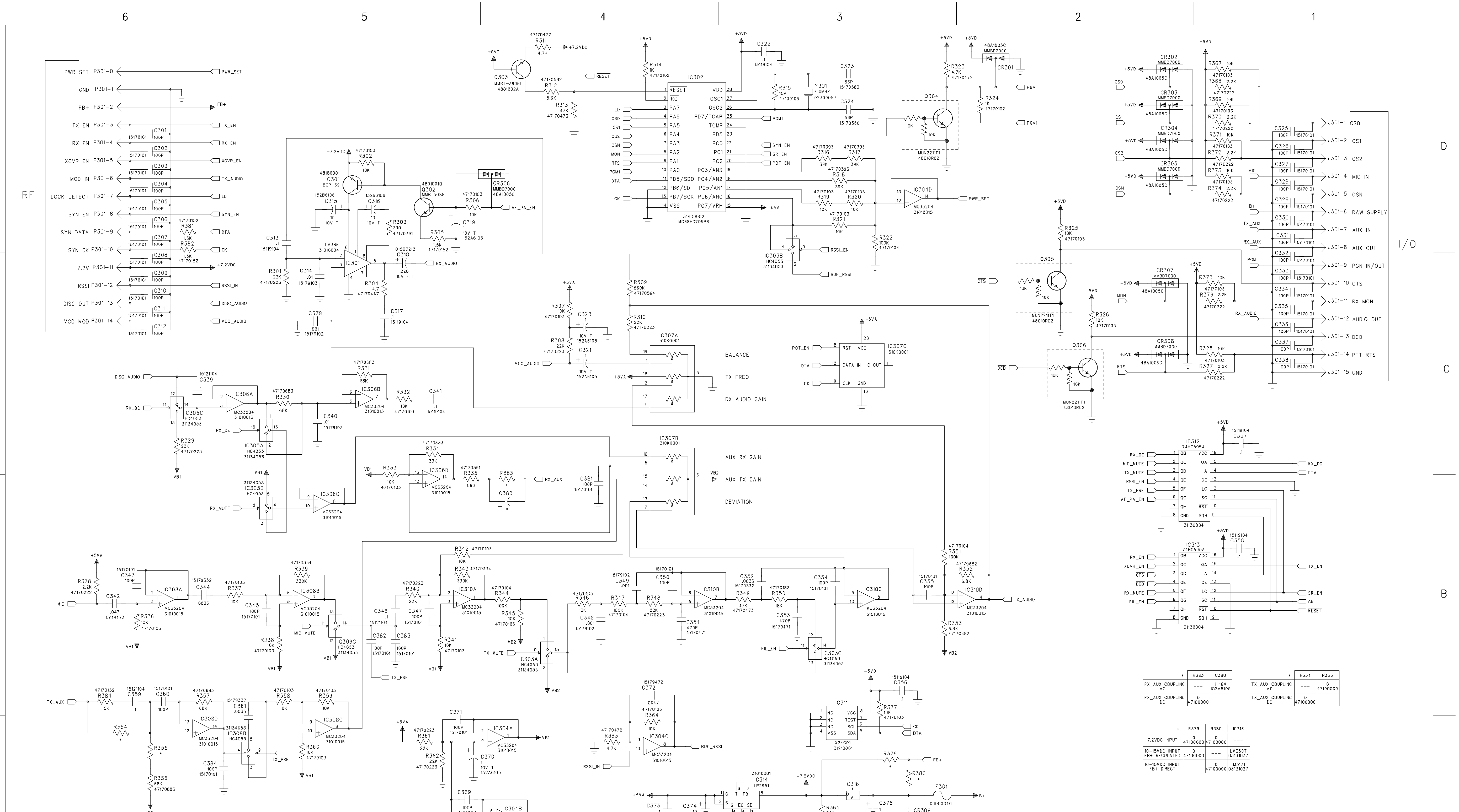
	12	0 to 4.5	0	TX value depends upon RF output level.
	13	0 to 4.5	0	TX value depends upon RF output level.
	14	0 to 4.5	0	TX value depends upon RF output level.
IC305		Analog Switch		
	1	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	2	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	3	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	4	2.5	2 to 3	Varies with disc. coupling and DC value.
	5	2.5	2.5	
	6	0	0	
	7	0	0	
	8	0	0	
	9	0	0 or 5	0 volts mutes receive audio chain.
	10	5	0 or 5	0 volts for flat AUX OUT.
	11	5	0 or 5	0 volts for DC coupled RX audio.
	12	0	2 to 3	Discriminator audio.
	13	2.5	2.5	
	14	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	15	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	16	5	5	
IC306		Operational Amplifier		
	1	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	2	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	3	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	4	5	5	
	5	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	6	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	7	0 or 2.5	2 to 3	Varies with disc. coupling and DC value.
	8	2.5	2 to 3	Varies with disc. coupling and DC value.
	9	2.5	2 to 3	Varies with disc. coupling and DC value.
	10	2.5	2 to 3	Varies with disc. coupling and DC value.
	11	0	0	
	12	2.5	2 to 3	Varies with disc. coupling and DC value.
	13	2.5	2 to 3	Varies with disc. coupling and DC value.
	14	2.5	2 to 3	Varies with disc. coupling and DC value.
IC307		Digital Potentiometer		
	1	0 to 0.8	0	TX value depends upon pot setting.
	2	0 to 5	0 to 5	Values depend upon frequency trim settings.
	3	0	0	
	4	0	0	
	5	2.5	2.5	
	6	2.5	2.5	
	7	2.5	2.5	
	8	0 and 5	0 and 5	Pulsing continuously is normal.
	9	0 and 5	0 and 5	Pulsing continuously is normal.
	10	0	0	
	11	--	--	No connect.
	12	0 and 5	0 and 5	Pulsing continuously is normal.
	13	2.5	2.5	
	14	2.5	2.5	
	15	2.5	2.5	
	16	2.5	2.5	

	17	0	0	
	18	5	5	
	19	0.8	0.8	
	20	5	5	
IC308		Operational Amplifier		
	1	2.5	2.5	
	2	2.5	2.5	
	3	2.5	2.5	
	4	5	5	
	5	2.5	2.5	
	6	2.5	2.5	
	7	2.5	2.5	
	8	2.5	2.5	
	9	2.5	2.5	
	10	2.5	2.5	
	11	0	0	
	12	2.5	2.5	
	13	2.5	2.5	
	14	2.5	2.5	
IC309		Analog Switch		
	1	0	0	
	2	0	0	
	3	2.5	2.5	
	4	2.5	2.5	
	5	2.5	2.5	
	6	0	0	
	7	0	0	
	8	0	0	
	9	0 or 5	0 or 5	5 volts for TX pre-emphasis.
	10	0	0	
	11	0 or 5	0	0 volts for muted microphone input.
	12	2.5	2.5	
	13	2.5	2.5	
	14	2.5	2.5	
	15	0	0	
	16	5	5	
IC310		Operational Amplifier		
	1	2.5	2.5	
	2	2.5	2.5	
	3	2.5	2.5	
	4	5	5	
	5	2.5	2.5	
	6	2.5	2.5	
	7	2.5	2.5	
	8	2.5	2.5	
	9	2.5	2.5	
	10	2.5	2.5	
	11	0	0	
	12	2 to 3	2 to 3	Values depend upon frequency trim settings.
	13	2 to 3	2 to 3	Values depend upon frequency trim settings.
	14	2 to 3	2 to 3	Values depend upon frequency trim settings.

IC311		EEPROM Memory IC		
	1	0	0	
	2	0	0	
	3	0	0	
	4	0	0	
	5	0 and 5	0 and 5	Pulsing continuously is normal.
	6	0 and 5	0 and 5	Pulsing continuously is normal.
	7	--	--	No connect.
	8	5	5	
IC312		Shift Register Port Expander		
	1	5	0 or 5	0 volts for flat AUX OUT
	2	0 or 5	0	0 volts mutes microphone input.
	3	5	0	
	4	0	5	
	5	0 or 5	0 or 5	5 volts for TX pre-emphasis.
	6	5	5	
	7	--	--	No connect.
	8	0	0	
	9	0 and 5	0 and 5	Pulsing continuously is normal.
	10	5	5	
	11	0 and 5	0 and 5	Pulsing continuously is normal.
	12	0 and 5	0 and 5	Pulsing continuously is normal.
	13	0	0	
	14	0 and 5	0 and 5	Pulsing continuously is normal.
	15	5	0 or 5	0 volts for DC coupled receive audio.
	16	5	5	
IC313		Shift Register Port Expander		
	1	0	5	
	2	5	5	
	3	0 or 5	0 or 5	Depends upon programmed settings.
	4	0 or 5	0 or 5	Depends upon programmed settings.
	5	0	0 or 5	0 volts mutes receive audio.
	6	0	0	
	7	--	--	No connect.
	8	0	0	
	9	--	--	No connect.
	10	5	5	
	11	0 and 5	0 and 5	Pulsing continuously is normal.
	12	0 and 5	0 and 5	Pulsing continuously is normal.
	13	0	0	
	14	0 and 5	0 and 5	Pulsing continuously is normal.
	15	5	0	
	16	5	5	
IC314		Precision 5 Volt Regulator		
	1	5	5	
	2	5	5	
	3	--	--	No connect.
	4	0	0	
	5	--	--	No connect.
	6	1.2	1.2	
	7	1.2	1.2	
	8	7.3	7.3	

IC316		7.5 Volt Regulator		
	I	11 to 16	11 to 16	B+ input.
	A	6.0	6.0	
	O	7.3	7.3	
IC317		5 Volt Regulator		
	1	0	0	
	2	7.3	7.3	
	3	5	5	
	4	--	--	No connect
	5	--	--	No connect.

15 SCHEMATIC DIAGRAMS



*	R383	C380
RX_AUX COUPLING AC	---	1 16V 152A8105
RX_AUX COUPLING DC	0 47100000	---

*	R354	R355
TX_AUX COUPLING AC	---	0 47100000
TX_AUX COUPLING DC	0 47100000	---

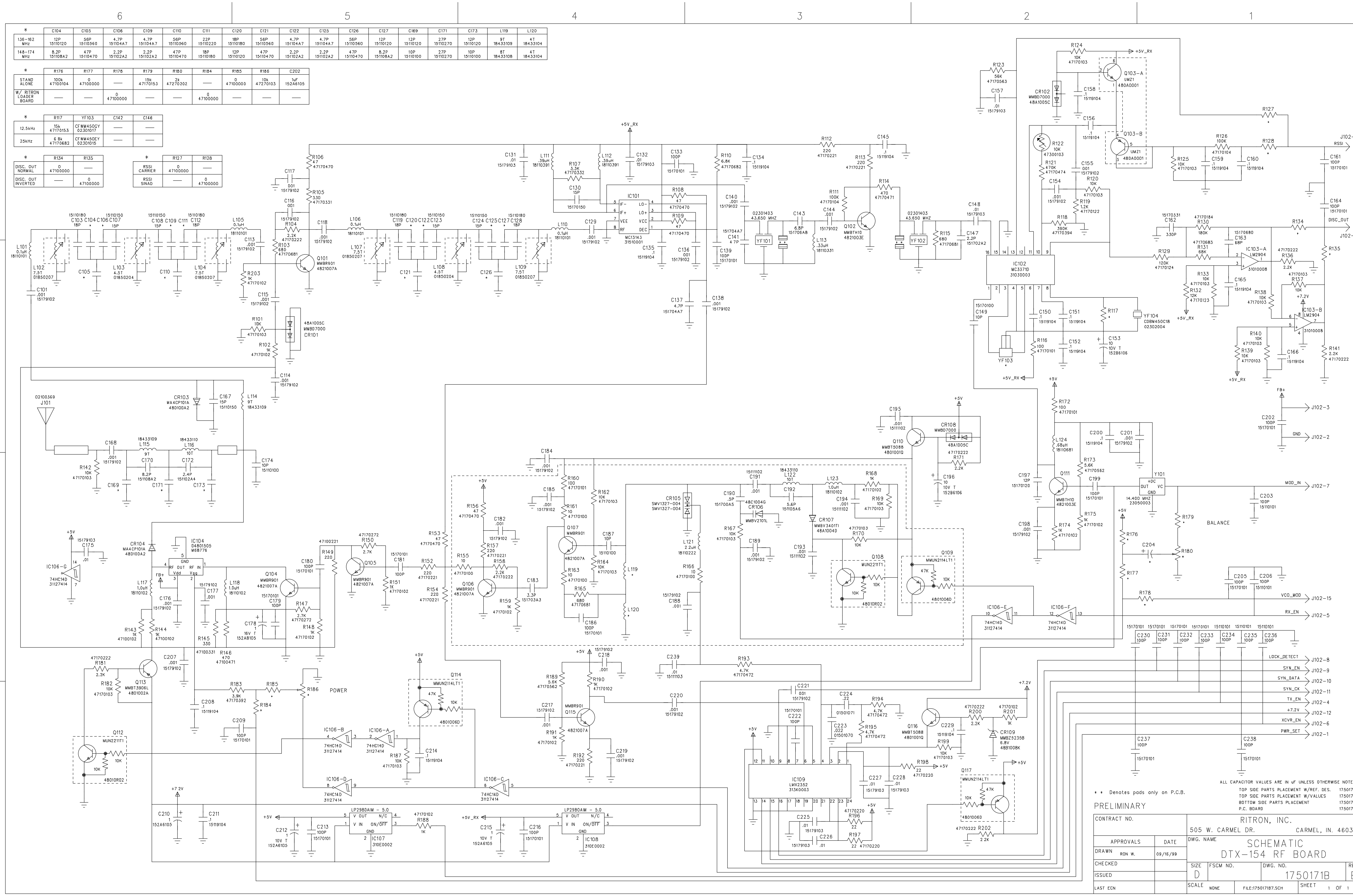
*	R379	R380	IC316
7.2VDC INPUT	0 47100000	0 47100000	---
10-15VDC INPUT FB+ REGULATED	0 47100000	---	LM350T 03131037
10-15VDC INPUT FB+ DIRECT	---	0 47100000	LM317T 03131027

LAST ECN

ALL CAPACITOR VALUES ARE IN uF UNLESS OTHERWISE NOTED.
ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE NOTED.

TOP SIDE PARTS PLACEMENT W/REF. DES.	1730282C
TOP SIDE PARTS PLACEMENT W/VALUES	1730283C
BOTTOM SIDE PARTS PLACEMENT	1730284C
P.C. BOARD	1730280C

CONTRACT NO.	RITRON, INC. 505 W. CARMEL DR. CARMEL, IN. 46032
APPROVALS / DATE	DWG NAME: SCHEMATIC DTX-154/454 LOADER BD
DRAWN S. CUNNINGHAM 12-MAY-1998	SIZE D; FSCM NO.; DWG. NO. 1730281C; REV. C (10)
CHECKED	
ISSUED S. CUNNINGHAM 04-FEB-1999	SCALE NONE; FILE:1730281C.SCH; SHEET 1 OF 1



*	C104	C105	C106	C109	C110	C111	C120	C121	C122	C125	C126	C127	C169	C171	C173	L119	L120
136–162 MHz	12P 15110120	56P 15110560	4.7P 151104A7	4.7P 151104A7	56P 15110560	22P 15110220	18P 15110180	56P 15110560	4.7P 151104A7	4.7P 151104A7	56P 15110560	12P 15110120	12P 15110120	27P 15110270	12P 15110120	9T 18433109	4T 18433104
148–174 MHz	8.2P 151108A2	47P 15110470	2.2P 151102A2	2.2P 151102A2	47P 15110470	18P 15110180	12P 15110120	47P 15110470	2.2P 151102A2	2.2P 151102A2	47P 15110470	8.2P 151108A2	10P 15110100	27P 15110270	10P 15110100	8T 18433108	4T 18433104

*	R176	R177	R178	R179	R180	R184	R185	R186	C202
STAND ALONE	100k 47100104	0 47100000	—	15k 47170153	2k 47270202	—	0 47100000	10k 47270103	1uF 152A6105
W/ RITRON LOADER BOARD	—	—	0 47100000	—	—	0 47100000	—	—	—

*	R117	YF103	C142	C146
12.5kHz	15k 47170153	CFWM450GY 02301017	—	—
25kHz	6.8k 47170682	CFWM450EY 02301015	—	—

*	R134	R135
DISC. OUT NORMAL	0 47100000	—
DISC. OUT INVERTED	—	0 47100000

*	R127	R128
RSSI CARRIER	0 47100000	—
RSSI SINAD	—	0 47100000

ALL CAPACITOR VALUES ARE IN uF UNLESS OTHERWISE NOTED.

* * Denotes pads only on P.C.B.

TOP SIDE PARTS PLACEMENT W/REF. DES.	1750172B
TOP SIDE PARTS PLACEMENT W/VALUES	1750173B
BOTTOM SIDE PARTS PLACEMENT	1750174B
P.C. BOARD	1750170B

PRELIMINARY

CONTRACT NO.

RITRON, INC.
505 W. CARMEL DR. CARMEL, IN. 46032

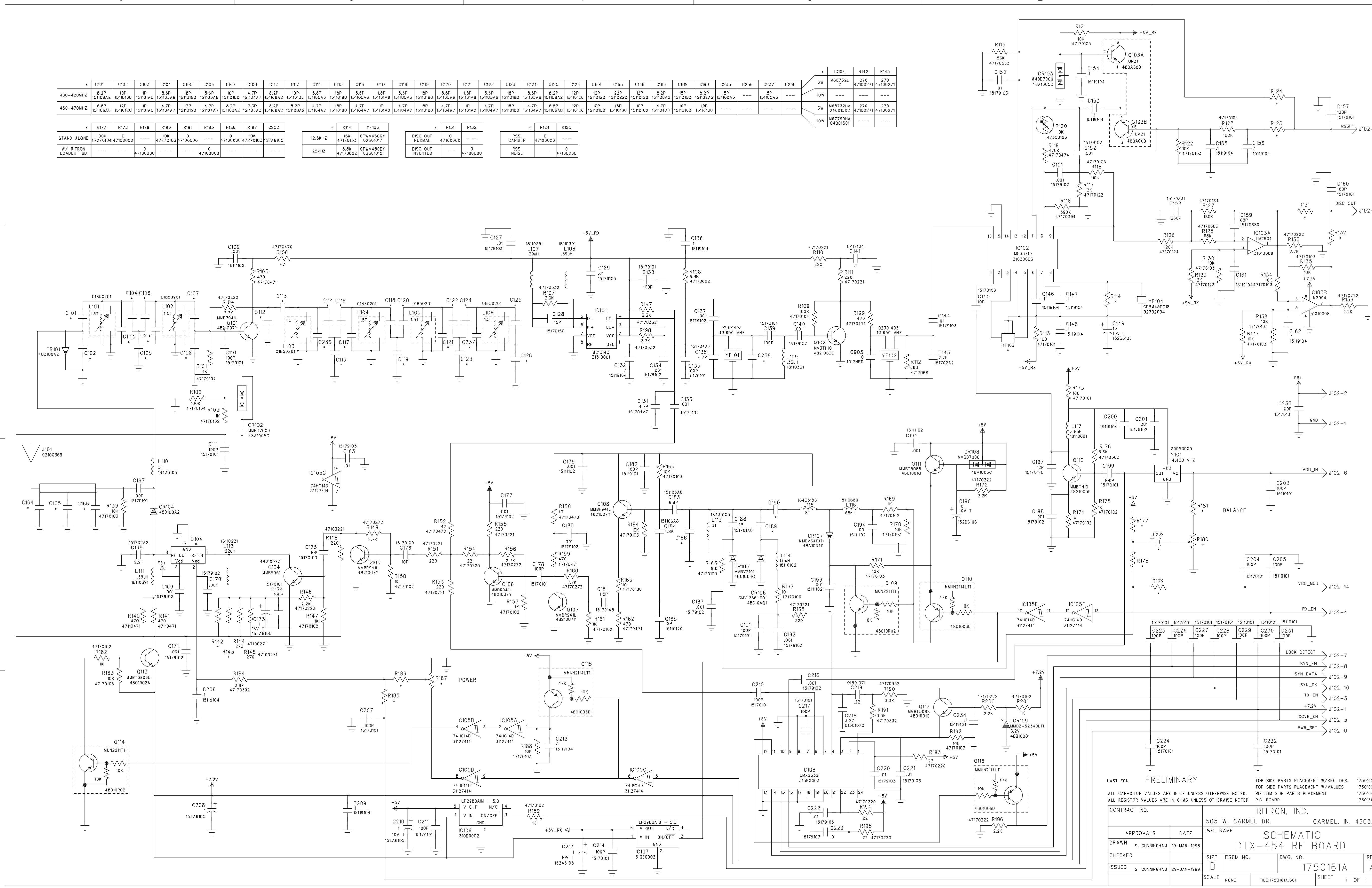
APPROVALS	DATE
DRAWN RON W.	09/16/99
CHECKED	
ISSUED	
LAST ECN	

DWG. NAME: SCHEMATIC DTX-154 RF BOARD

SIZE: D | FSCM NO.: | DWG. NO.: 1750171B | REV.: B

SCALE: NONE | FILE:1750171B7.SCH | SHEET 1 OF 1

(7)



*	C101	C102	C103	C104	C105	C106	C107	C108	C112	C113	C114	C115	C116	C117	C118	C119
400-420MHZ	8.2P 151108A2	10P 15110100	1P 151101A0	5.6P 151105A6	18P 15110180	5.6P 151105A6	10P 15110100	4.7P 151104A7	8.2P 151108A2	10P 15110100	5.6P 151105A6	18P 15110180	5.6P 151105A6	1.8P 151101A8	5.6P 151105A6	18P 15110180
450-470MHZ	6.8P 151106A8	12P 15110120	1P 151101A0	4.7P 151104A7	12P 15110120	4.7P 151104A7	8.2P 151108A2	3.3P 151103A3	8.2P 151108A2	8.2P 151108A2	4.7P 151104A7	18P 15110180	4.7P 151104A7	1P 151101A0	4.7P 151104A7	18P 15110180

*	C120	C121	C122	C123	C124	C125	C126	C164	C165	C166	C186	C189	C190	C235	C236	C237	C238
400-420MHZ	5.6P 151105A6	1.8P 151101A8	5.6P 151105A6	18P 15110180	5.6P 151105A6	8.2P 151108A2	12P 15110120	12P 15110120	22P 15110220	12P 15110120	8.2P 151108A2	15P 15110150	8.2P 151108A2	.5P 151100A5	---	.5P 151100A5	---
450-470MHZ	4.7P 151104A7	1P 151101A0	4.7P 151104A7	18P 15110180	4.7P 151104A7	6.8P 151106A8	12P 15110120	10P 15110100	18P 15110180	10P 15110100	4.7P 151104A7	10P 15110100	10P 15110100	---	---	---	---

*		IC104	R142	R143
400-420MHZ	6W	M68732L ?	270 47100271	270 47100271
400-420MHZ	10W	---	---	---
450-470MHZ	6W	M68732HA 04801502	270 47100271	270 47100271
450-470MHZ	10W	M67799HA 04801501	---	---

*	R177	R178	R179	R180	R181	R185	R186	R187	C202
STAND ALONE	100K 47270104	0 47100000	---	10K 47270103	0 47100000	---	0 47100000	10K 47270103	1 152A6105
W/ RITRON LOADER BD	---	---	0 47100000	---	---	0 47100000	---	---	---

*	R114	YF103
12.5KHZ	15K 47170153	CFWM450GY 02301017
25KHZ	6.8K 47170682	CFWM450EY 02301015

*	R131	R132
DISC OUT NORMAL	0 47100000	---
DISC OUT INVERTED	---	0 47100000

*	R124	R125
RSSI CARRIER	0 47100000	---
RSSI NOISE	---	0 47100000

LAST ECN PRELIMINARY

ALL CAPACITOR VALUES ARE IN uF UNLESS OTHERWISE NOTED.
ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE NOTED.

TOP SIDE PARTS PLACEMENT W/REF. DES. 1750162A
TOP SIDE PARTS PLACEMENT W/VALUES 1750163A
BOTTOM SIDE PARTS PLACEMENT 1750164A
P C BOARD 1750160A

CONTRACT NO.

RITRON, INC.
505 W. CARMEL DR. CARMEL, IN. 46032

APPROVALS		DATE
DRAWN	S. CUNNINGHAM	19-MAR-1998
CHECKED		
ISSUED	S CUNNINGHAM	29-JAN-1999

DWG. NAME SCHEMATIC DTX-454 RF BOARD

SIZE D | FSCM NO. | DWG. NO. 1750161A | REV. A (9)

SCALE NONE | FILE:1750161A.SCH | SHEET 1 OF 1