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| **TYPE OF EXHIBIT**: | TUNE-UP PROCEDURE |
| **FCC PART**: | 2.983 (d) (9) |
| **MANUFACTURER**: | RITRON, INC.<br>505 West Carmel Drive<br>Carmel, IN 46032 |
| **MODEL**: | DTX-154 |
| **TYPE OF UNIT**: | VHF-FM Transceiver |
| **FCC ID:** | AIERIT12-150 |
| **DATE:** | September 15, 1999 |

Tune-up procedure follows:

**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.

## 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 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: A two-way radio test set may include most, if not all, of the required equipment, except for the power supply.

## 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 has a slight affect on TX frequency trim. It may be prudent to spot check all of the adjustments which interact. These will be indicated in the particular alignment step.

The programmer must be connected to the unit via the programming interface cable and the alignment screen selected. During alignment, the channel may be selected via the channeling control lines on the module or through the programmer. A channel pull-down menu allows for the selection. Also, the unit can be keyed through the programmer, if desired.

**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.

To determine if the receiver is correctly trimmed to frequency, the 1$^{st}$ 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.

**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 of so, a resistor of a value equal to the load impedance should be connected when making the adjustment.

**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 AUX OUT output, the AUX OUT Gain setting should be set to value which produces the desired output level.

**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. A few 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. If squelch is enable, 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.

**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.

**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 if the transmitter power is changed significantly, corrections may be required. Note: Any adjustments must be made at a unit temperature of 25 +/- 2 °C (77 +/- 1.8 °F).

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. 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.

**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 will 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. The demodulator filters should be set for no de-emphasis, as low a highpass cutoff as possible (<50 Hz, preferably down to DC), lowpass cutoff 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 oscillator output level. 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 2.4 kHz for a 12.5 kHz channel or 4.8 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.

**TYPE OF EXHIBIT**: SEMICONDUCTOR FUNCTION LIST

**FCC PART**: 2.983 (d) (6)

**MANUFACTURER**: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

RF Board

| Ref. Des. | Device | Function |
|---|---|---|
| Q101 | MMBR901 | Receiver front-end RF amplifier. |
| Q102 | MMBTH10 | Receiver IF amplifier. |
| Q103 | UMZ1 | Receiver squelch. |
| Q104 | MMBR901 | Transmitter PA driver amplifier. |
| Q105 | MMBR901 | Transmitter PA pre-driver amplifier. |
| Q106 | MMBR901 | VCO buffer amplifier. |
| Q107 | MMBR901 | VCO oscillator. |
| Q108 | MUN2211 | NPN switching transistor for VCO T/R frequency shift. |
| Q109 | MUN2114 | PNP switching transistor for VCO T/R frequency shift. |
| Q110 | MMBT5088 | VCO power supply filter pass transistor. |
| Q111 | MMBTH10 | Reference oscillator multiplier. |
| Q112 | MUN2211 | Transmitter PA driver stage NPN switching transistor. |
| Q113 | MMBT3906 | Transmitter PA driver stage PNP switching transistor. |
| Q114 | MUN2114 | Transmitter enable PNP switching transistor. |
| Q116 | MMBT5088 | Synthesizer power supply filter pass transistor. |
| Q117 | MUN2114 | Synthesizer lock detect transistor. |
| IC101 | MC13143 | Receiver 1st mixer. |

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| IC102 | MC3371 | Receiver FM IF IC. |
| IC103 | LM2904 | Op-amp for receiver discriminator buffer amplifier. |
| IC104 | M68776 | Transmitter power amplifier module. |
| IC106 | 74HC14 | Logic IC for sequencing/control. |
| IC107 | LP2980AIM-5.0 | Monolithic 5 volt regulator. |
| IC108 | LP2980AIM-5.0 | Monolithic 5 volt regulator. |
| IC109 | LMX2352 | Synthesizer IC. |
| Y101 | | Integrated reference oscillator. |

Loader Board

| Ref. Des. | Device | Function |
|---|---|---|
| Q301 | BCP69 | PNP switching transistor for audio PA. |
| Q302 | MMBT5088 | NPN switching transistor for audio PA. |
| Q303 | MMBT3906 | Microprocessor reset. |
| Q304 | MUN2211 | NPN microprocessor interface. |
| Q305 | MUN2211 | NPN microprocessor interface. |
| Q306 | MUN2211 | NPN microprocessor interface. |
| IC301 | LM386 | Audio PA. |
| IC302 | MC68HC705P6 | Microprocessor. |
| IC303 | 74HC4053 | Analog switch for transmitter audio. |
| IC304 | MC33204 | Op-amp bias voltage generator. |
| IC305 | 74HC4053 | Analog switch for receiver audio. |
| IC306 | MC33204 | Op-amp for receiver audio. |
| IC307 | 1806E-010 | Digital potentiomenter. |
| IC308 | MC33204 | Op-amp for transmitter audio. |
| IC309 | 74HC4053 | Analog switch for transmitter audio. |
| IC310 | MC33204 | Op-amp for transmitter audio. |
| IC311 | X24C01 | EEPROM memory. |
| IC312 | 74HC595 | Microprocessor port expander. |

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| IC313 | 74HC595 | Microprocessor port expander. |
| IC314 | LP2951 | Precision 5 volt regulator. |
| IC315 | LM2931 | 5 volt regulator. |
| IC316 | LM350T | High current 7.5 volt regulator. |