TYPE OF EXHIBIT:	TUNE-UP PROCEDURE
FCC PART:	2.1033(C)(9)
MANUFACTURER:	RITRON, Inc. 505 West Carmel Drive Carmel, IN 46032
MODEL:	RLR-460
TYPE OF UNIT:	UHF FM Repeater
FCC ID:	AIERIT15-460
DATE:	November 25, 2002

DUPLEXER

The duplexer allows the Repeater to simultaneously transmit and receive. To accomplish this, in the receive input path, the transmitter signal must be notched or suppressed by 70 dB or more. In addition, on the transmit path, transmitter noise on the receive frequency must be also suppressed by about 70 dB. The duplexer contains four cavities, two for each path to achieve the necessary notch depth. Because the notches are very narrow, the duplexer must be re-tuned if the frequency of operation is changed by more than 50 kHz. Follow the procedure below to tune the duplexer:

1. Connect the antenna to be used to the antenna connector on the Repeater. If possible, the antenna should be positioned in a way that matches the actual configuration as close as possible. If the antenna requires tuning, tune it to the transmit frequency. If an antenna is not available, connect a low VSWR 50-ohm load instead.

2. Unplug the two RF cables connecting the duplexer to the main PCB.

3. A spectrum analyzer with tracking generator or a network analyzer should be used to sweep the duplexer. If one is not available, a spectrum analyzer and an RF signal generator can be used, but the notch frequencies will be difficult to determine. The duplexer should be swept from one RCA plug to the other; it doesn't matter which end goes to the generator or the spectrum analyzer.

4. One should see at least two, and maybe as many as four notches. Carefully loosen the nuts on the two duplexer cavities underneath the transmitter portion of the main PCB. Adjust the two cavity screws for the deepest notch possible at the RECEIVE frequency. Tighten the nuts being careful not to de-tune the notch frequency. Do the same for the two screws on the cavities underneath the receiver portion of the main PCB, but tune for a notch at the TRANSMIT frequency. When finished, one should see two notches, one at the transmit frequency and one at the receive frequency. These two notches are very narrow and special attention should be paid to ensuring that they are at the correct frequencies. The two notches should be about 70 dB deep compared to a straight-through connection.

PRELIMINARY

1. Alignment of the RLR-460 Repeater requires that surface-mount potentiometers be adjusted. These potentiometers do not have end stops so one must pay special attention to the wiper position for maximum clockwise and counterclockwise settings. Also, one should be careful never to set the wiper in the dead band between maximum and minimum.

2. Alignment of the Repeater requires connection to the pins on the front panel modular jack.

3. The frequency deviation numbers shown are for narrow (12.5 kHz channel spacing) operation. Double the values for wide (25 kHz channel spacing) operation.

4. A communications service monitor capable of duplex operation is required to set R328 (REPEAT AUDIO LEVEL). Other alignment steps can use individual pieces of equipment (RF signal generator, RF wattmeter, etc.), although communications service monitors tend to include all the functions necessary to align this product.

5. Ensure that the Repeater is properly programmed for the correct transmit and receive frequencies and the correct QC/DQC tones/codes. Even if a transmit tone is not to be used (unusual), one should program one anyway to get the transmit tone deviation properly set. This parameter is, however, set at the factory.

6. Refer to the RLR-460 ALIGNMENT POINTS diagram for the location of alignment points and adjstments.

RECEIVER

1. Apply power to the Repeater. The green front panel LED should be illuminated, but may be blinking.

2. Connect the MON input (modular jack pin 4) to ground (modular jack pin 1). This will override the squelch operation and also inhibit the transmitter.

Local Oscillator Trim

1. Connect a test probe from a frequency counter or frequency measuring device to test point TP103. The receiver 1st local oscillator signal at approximately –12 dBm is present at this point. The correct frequency at this point is the receive frequency minus the 1st IF frequency of 43.65 MHz ($f_{LO} = f_{RX}$ - 43.65).

2. Using a tuning tool, adjust R134 (RX FREQ TRIM) for the correct frequency +/-100 Hz.

Receive VCO Tuning

1. Connect a high impedance oscilloscope probe to an oscilloscope set for 1 V/div, DC coupled. The sweep speed is not important.

2. Connect the ground lead of the probe to the PCB ground. The mounting legs of the receiver input connector J100 can be used. Touch the probe tip to TP100 and note the voltage on the oscilloscope. This point is very sensitive and the synthesizer may go out of lock. This will be evident by an initial voltage which then decays to zero in about a few seconds. Note the voltage right after the probe is touched to the test point and before it begins decaying.

3. Using an insulated tuning tool, adjust C135 inside the VCO/synthesizer (RX VCO TUNE) shield for 2.5 +/-0.25 volts at TP100. The green front panel LED should be illuminated continuously (not blinking).

Receiver Front-End Tuning

1. Connect a SINAD meter to the AUDIO OUT output (pin 5). Set R330 (SPEAKER AUDIO LEVEL) to mid rotation.

2. Connect an RF signal generator to the antenna connector. The generator frequency should be set to the desired receive frequency modulated with a 1 kHz tone at 1.5 kHz deviation. The RF level should be set to 7 uV (–90 dBm).

3. If the SINAD meter reads greater than 12 dB, reduce the RF signal generator output level until 12 dB SINAD is reached. Adjust L100 through L104 for best SINAD while reducing the RF signal generator output level to keep the SINAD near 12 dB. The RF outptut level for 12 dB SINAD should be 0.25 uV (-119 dBm) or less.

Squelch

1. Set the RF signal generator output level to produce a SINAD where the squelch is desired to unmute, typically 12-14 dB.

2. Rotate R312 (SQUELCH) to the maximum clockwise point. Connect an oscilloscope probe to TP104. The voltage at TP104 should be 5 VDC. Adjust R312 counterclockwise until the TP104 voltage drops to zero. Then, slowly adjust R312 clockwise to the point where the TP104 voltage again goes to 5 volts.

Audio Output Level

1. Increase the RF signal generator output level to 7 uV (-90 dBm). The SINAD reading should be close to 20 dB or so. Connect an oscilloscope to the AUDIO OUT (pin 5) on the modular jack. The SINAD meter is already connected to this point.

2. Adjust R330 (SPEAKER AUDIO LEVEL) for the desired output level.

TRANSMITTER

1. Apply power to the Repeater.

2. Set R115 (TX POWER) to the full counterclockwise position. This is the minimum power point.

3. Connect a 50-ohm RF dummy load capable of handling 5 watts to the Antenna connector. Provisions should be made to couple the RF output signal to a demodulator, a frequency counter, and an RF wattmeter. The demodulated output must be viewable on an oscilloscope.

4. The transmitter will be keyed by taking pin 3 of the modular jack (PTT/MIC) to ground.

5. Ensure that the signal generator output of the service monitor is set to a very low level to prevent the receive squelch from unmuting. This will prevent the transmitter from keying due to receiving a valid carrier. Having a receive QC/DQC tone/code programmed will help greatly in preventing nuisance keying.

Transmit VCO Tuning

1. Connect a high impedance oscilloscope probe to an oscilloscope set for 1 V/div, DC coupled. The sweep speed is not important.

2. Connect the ground lead of the probe to the PCB ground. The mounting legs of the transmitter output connector J101 can be used. Key the transmitter, touch the probe tip to TP101 and note the voltage on the oscilloscope. This point is very sensitive and the synthesizer may go out of lock. This will be evident by an initial voltage which then decays to zero in about a few seconds. Note the voltage right after the probe is touched to the test point and before it begins decaying.

3. Using an insulated tuning tool, adjust C203 inside the VCO/synthesizer shield (TX VCO TUNE) for 2.5 +/-0.25 volts at TP101. The red front panel LED should be illuminated continuously (not blinking). Unkey the transmitter.

Transmitter Output Power

1. Key the transmitter and not the output power. Adjust C180 and C183 for maximum output power. If the output power is too low, adjust R115 (TX POWER) clockwise about 45 ° and readjust C180 and C183. Adjust R115, C180, and C183 until the desired output power is

reached. For 2 watts, R115 would typically be at mid-rotation and for 5 watts, near 80% rotation.

2. Unkey the transmitter.

Modulation Balance and Deviation

1. An audio generator should be connected to the AUDIO IN (pin 2) input of the modular jack. The audio frequency should be 500 Hz and the level should be 10 mV rms or lower.

2. Set R347 (TONE DEVIATION) to the full counterclockwise position.

3. To RF output should be routed to an FM demodulator and the demodulated output made viable on an oscilloscope. The filtering on the demodulator should be 15 kHz or higher on the lowpass filter and below 50 Hz on the highpass filter.

4. While observing the oscilloscope, key the transmitter. Increase the audio generator level until the 500 Hz sinewave becomes viable on the oscilloscope. Increase the generator level until a significant amount of clipping on the top and bottom of the sinewave is evident.

5. Carefully adjust R337 (BALANCE) so that the clipped portion of the observed waveform is flat i.e. not tilted up or down.

6. Adjust R350 (VOICE DEVIATION) for +/- 2.35 kHz deviation.

7. Unkey the transmitter.

Transmitter Frequency Trim

1. Remove the audio generator connection.

2. Key the transmitter and note the frequency of the RF output signal. Adjust R339 (TX FREQ TRIM) for the correct transmit frequency +/- 100 Hz.

3. Unkey the transmitter.

Tone Deviation

1. Key the transmitter and adjust R347 (TONE DEVIATION) for the desired tone/code deviation, typically 350 Hz.

2. Unkey the transmitter.

Repeat Audio Level

1. For this adjustment, the service monitor must be able to generate an RF signal and simultaneously demodulate an incoming RF signal.

2. Set the RF signal generator for the correct receive frequency with 1.5 kHz deviation of a 1 kHz tone and modulated with the correct tone/code, if used. The RF output level should be set for 7 uV (-90 dBm) The demodulator should be set to display deviation.

3. The transmitter should automatically key (red LED illuminated). Adjust R328 (REPEAT AUDIO LEVEL) for +/- 1.5 kHz deviation.

4. Reduce the RF signal generator level to minimum to unkey the transmitter.

INTERNAL REGULATOR OPTIONS

An internal voltage regulator exists in the RLR-460 repeater to regulate the DC input voltage to that required by the transmitter stages. If a regulated power supply is available, this internal regulator may be bypassed. Bypassing the internal regulator allows for a higher RF output power. A more complete description of the regulator options follows:

When the Repeater is used with an unregulated power supply, wide fluctuations in voltage and large AC ripple content are common. Both must be removed for proper operation. This is effected by the internal voltage regulator. The internal regulator does, however, generate heat which limits the maximum current which can be passed through the regulator and to the transmitter power amplifier. This in turn limits the maximum output power to 2 watts even if the power supply is capable of the required current. To use the internal regulator, R378 should be installed. This is the normal configuration of the Repeater as set at the factory and is the configuration for use with the RITRON RPS-1A power supply.

If a regulated power supply is used, the internal regulator may be bypassed to allow higher current operation and thus greater output power to 5 watts. To effect this change, move the resistor in the R378 pad pair to R381 which is next to it. Note that a regulated supply can be used with the Repeater set for internal regulation, but the maximum RF output power is still limited to 2 watts.