Microwave Data Systems Inc.

INSTRUCTION SHEET

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Retuning Procedure for LEDR II Radios

INTRODUCTION

The LEDR II radio is a spectrally efficient radio with 400, 900, and 1400 MHz versions and available data rates from 64 kbps to 8 mbps. As with any high-performance radio, there are some components that are tunable based on the exact transmit and receive frequency settings.

These are the circumstances that require retuning the radio:

- Changing the receive or transmit frequency
- Changing the modem type
- Replacing the duplexer

PREREQUISTES

To perform this procedure, version 2.0.0 or higher of the radio's firmware is required. Furthermore, it is required to log in to the radio as the super user. The super user password defaults to **SUPER** but is configurable by the System Administrator. Before entering any of the commands indicated below, log into the radio. For example:

LEDR> login SUPER

Password: ***** [You typed **SUPER**]

This gives access to the commands needed to complete this procedure. Refer to the radio manual for more details.

RETUNING PROCEDURE

Step 1. Setting the New Transmit and Receive Frequencies

As built, each LEDR II radio contains many components that are specific for a given sub-band for receive and transmit. See Table 1.

Table 1. Receive and Transmit Bands

Family Member	Receive Bands	Transmit Bands
400	330-380	330-380
	380-400	380-400
	400-462	400-462
	462-512	462-512
900	800-860	800-860
	860-900	860-900
	900-960	900-960
1400	1350-1375	1492-1517
	1375-1387.5	1427-1439.5
	1387.5-1400	1439.5-1452
	1427-1449.5	1487.5-1510
	1449.5-1475	1510-1535

It is possible to retune a LEDR II radio, *provided the new transmit and receive frequencies are within the same sub-band as that for which the radio was originally built.*

To set the frequency of the radio, use the following command:

freq XXX.XXX YYY.YYY

where **XXX.XXX** is the transmit frequency and **YYY.YYY** is the receive frequency, both in MHz.

Step 2. Tuning the Transmit Helical Filters (Skip for 1400 MHz Radios)

To perform this procedure, a sensitive power meter or spectrum analyzer must be used. Be sure to use appropriate attenuation so as not to damage your test equipment or the radio. The radio should have a load at the transmit output at all times when powered on.

In order to tune the transmit helical filters, the power output control loop in the radio must be disabled and the power output must be commanded to a fixed level. If this is not done, the power control loop may “fight” the tuning to maintain a constant power output, masking the effect of peaking the helical filters. Another concern is that the power amplifier may saturate during the operation, showing a broad peak in power output which may appear to be a peak in helical tuning.

To turn off the power control loop and fix it to mid-scale, use the following command:

rfout off

rfout tar 128

If the transmitter output is greater than 20 dBm during the procedure that follows, enter a new **rfout tar** command with a lower value until the output is less than 20 dBm. It may be necessary

to reduce the value below 128 even before beginning the procedure. This is to prevent power amplifier saturation.

There are two banks of 3-pole helical filters in the middle shielded area of the radio, FL701 and FL702. These are the transmit helical filters. The center pole on each of these filters has the most impact on tuning.

Using a tuning wand or small flat head screwdriver (non-metallic preferred), tune the two 3-pole filters until maximum power output is obtained as measured with the power meter or spectrum analyzer.

When complete, re-enable the power control loop and set the power output level with the following commands:

rfout on

rfout ZZ

Where **ZZ** is the power output level in dBm, for example **28**.

Step 3. Calibrating Transmitter Output Power

The radio has a set of coefficients that must be set so the radio can accurately control the output power. When the frequency of the radio is changed, these coefficients are invalidated.

To perform this procedure, a power meter is required. It is recommended that a thermal power meter be used, although a service monitor or spectrum analyzer can be used with some loss of accuracy.

This procedure is automated in software. To get into RF output calibration mode, enter the following command:

rfocal 0 0

The radio will report the current gain coefficients and ask for an RF output level and gain estimate pair, for example:

LEDR> rfocal 0 0

Region 0

Index 0, Rfout = 24 dbm, Gain = 80

Index 1, Rfout = 28 dbm, Gain = 142

Index 2, Rfout = 30 dbm, Gain = 185

Index 3, Rfout = 32 dbm, Gain = 240

Enter RF OUT Level (dbm) + Gain (0-255) pair for Frequency Region 0, Index 0

<Rfout (dBm)> <Gain(0-255)> ?

At this point, enter the power level that you wish to calibrate for and an estimate of the gain coefficient, for example:

Enter RF OUT Level (dbm) + Gain (0-255) pair for Frequency Region 0, Index 0

<Rfout (dBm)> <Gain(0-255)> ? 20 40

In this example, the power output to calibrate is 20 dBm and the gain coefficient estimate is 40.

Observe the power output indicated on the power meter, and adjust the coefficient to raise or lower the output to match the desired level. For example, if the power output was slightly low after the above entry, your next entry may appear as follows.

Region 0, Index 0, RF OUT + 20 dbm, Gain 40

Adjust/Modify Gain ? 41

When satisfied with the output power, simply press the ENTER key at the prompt, for example:

Region 0, Index 0, RF OUT + 20 dbm, Gain 41

Adjust/Modify Gain ? [You pressed Enter here]

Region 0

Index 0, Rfout = 20 dbm, Gain = 41

The reply is the contents of the coefficient table so far. Repeat this procedure for the power levels of interest in increasing order. **MDS recommends calibration at 20, 22, 28, 30, and 32 dBm.** When the procedure is complete, press ENTER alone instead of entering an additional power level/gain estimate combination. An output similar to the following will be printed:

Enter RF OUT Level (dbm) + Gain (0-255) pair for Frequency Region 0, Index 5

<Rfout (dBm)> <Gain(0-255)> ? [You pressed Enter here]

End of Calibration

At this point you may wish to check the actual output levels for given commanded levels, for example:

LEDR> rfout 30

Wait for power loop to settle...

rfout {Tx RF Out}: 30.0 dBm

LEDR> rfout 20

Wait for power loop to settle...

rfout {Tx RF Out}: 20.0 dBm

LEDR> rfout 28

Wait for power loop to settle...

rfout {Tx RF Out}: 28.0 dBm

Observe the power level on the power meter and verify that the output power is correct for each commanded level. It is normal for the power output indicated to be off by a tenth of a dB or so, especially at levels other than those calibrated.

Step 4. Tuning the Receive Helical Filters (Skip for 1400 MHz Radios)

To perform this procedure, a signal generator capable of providing –60 dBm at the receive frequency is required. It is *vitally important* to avoid overdriving the receiver as it can be damaged with strong signals. Signals as strong as -20 dBm are safe, but should be avoided over the long term.

To begin this procedure, drive a –60 dBm signal at the receive frequency into the receive connector (J910).

With the radio on, monitor the voltage on H602 (for Rev. 03 PCBs) or U715 pin 8 (for Rev. A or later PCBs).

There are two 3-pole receive helical filters located in the shielded area furthest from the heatsink. They are labeled FL602 and FL603. Tune the helical filters in the same manner as the transmit helical filters to maximize the voltage monitored, however there is no need to adjust the output power of the radio during this step. *Be sure not to adjust any other components in this area.*

Step 5. Calibrating Receive Signal Strength Indication

The LEDR II radio maintains a second set of coefficients that calibrate the Receive Signal Strength Indication (RSSI). These coefficients must be programmed so the radio reports an accurate indication of signal strength.

To perform this step, a signal generator is required that is capable of driving a –110 to –30 dBm unmodulated (CW) signal at the receive frequency.

This procedure is automated in software. To get into RSSI calibration mode, enter the following command:

rssical 0 0

The radio will report the current RSSI calibration coefficients and prompt for an input signal level, for example:

LEDR> rssical 0 0

Region 0

Index 0, RSSI = -110 dbm, Gain = -128

Index 1, RSSI = -90 dbm, Gain = -89

Index 2, RSSI = -70 dbm, Gain = -27

Index 3, RSSI = -50 dbm, Gain = +16

Index 4, RSSI = -30 dbm, Gain = +56

Enter current RSSI Level (dbm) for Frequency Region 0, Index 0, Gain -4

<Rssi (dBm)> ?

At this point, set your signal generator to a signal level of –110 dBm and enter this level at the prompt as follows:

Enter current RSSI Level (dbm) for Frequency Region 0, Index 0, Gain -4

<Rssi (dBm)> ? -110

The radio will respond with the gain setting that it calculates to match this level as follows:

Region 0, Index 0, RSSI -110 dbm, Gain -128

Hit <Enter> to see next gain or '.<Enter>' to move to next CAL point >

At –110 dBm, the gain coefficient is usually at the bottom limit. Proceed to the next calibration point by entering a period (**.**) followed by ENTER.

Region 0, Index 0, RSSI -110 dbm, Gain -128

Hit <Enter> to see next gain or '.<Enter>' to move to next CAL point > .

Region 0

Index 0, RSSI = -110 dbm, Gain = -128

Enter current RSSI Level (dbm) for Frequency Region 0, Index 1, Gain -128

<Rssi (dBm)> ?

Set the generator to the next signal level (–90 dBm) and enter this level at the prompt:

Enter current RSSI Level (dbm) for Frequency Region 0, Index 1, Gain -128

<Rssi (dBm)> ? -90

Repeat this procedure until you have entered all signal level calibration points.

Region 0, Index 4, RSSI -30 dbm, Gain 53

Hit <Enter> to see next gain or '.<Enter>' to move to next CAL point >

Region 0

Index 0, RSSI = -110 dbm, Gain = -128

Index 1, RSSI = -90 dbm, Gain = -95

Index 2, RSSI = -70 dbm, Gain = -33

Index 3, RSSI = -50 dbm, Gain = +13

Index 4, RSSI = -30 dbm, Gain = +53

Enter current RSSI Level (dbm) for Frequency Region 0, Index 5, Gain 52

<Rssi (dBm)> ? [You pressed Enter here]

End of Calibration

At this point, you may wish to check the calibration using the RSSI command, for example:

LEDR> rssi

Rssi: >-30 dBm

LEDR> rssi

Rssi: -41.0 dBm

LEDR> rssi

Rssi: -57.3 dBm

LEDR> rssi

Rssi: -79.3 dBm

LEDR> rssi

Rssi: <-110 dBm

Note that the radio's RSSI indication is not intended to have the accuracy of calibrated test equipment, and may be off by up to 2 dB as compared with a true instrument—especially if the ambient temperature is different than it was when the radio was calibrated.

CONCLUSION

This concludes the steps required to retune a LEDR II radio. It is hoped that this information has been clear and helpful. If you need further assistance with this procedure, please contact our factory in Rochester, NY at +1-716-242-9600.