Applies to: NAT and NACT MODES

Prerequisites: Tutorials 0, 1, 2 and 3 (or 3T)

This tutorial takes you through the steps to use a Return Loss Bridge (RLB) to measure the return loss and VSWR of a resonating DUT.

The requirements for this tutorial are:

- NAT running firmware Version 3.0 or later.

- Logarithmic RF Power Meter such as the RF Power meter designed by W7ZOI and W7PUA used by the PHSNA.

- PS2 Keyboard

- Return Loss Bridge

- Resonating DUI such as an antenna.

To operate in NAT mode you will also need the following:

- PHSNA Arduino UNO/NANO based controller.

You will also need all interconnecting cables and power sources.

For this tutorial I used my 20 meter vertical antenna as the resonating DUI. My NAT was in NACT mode.
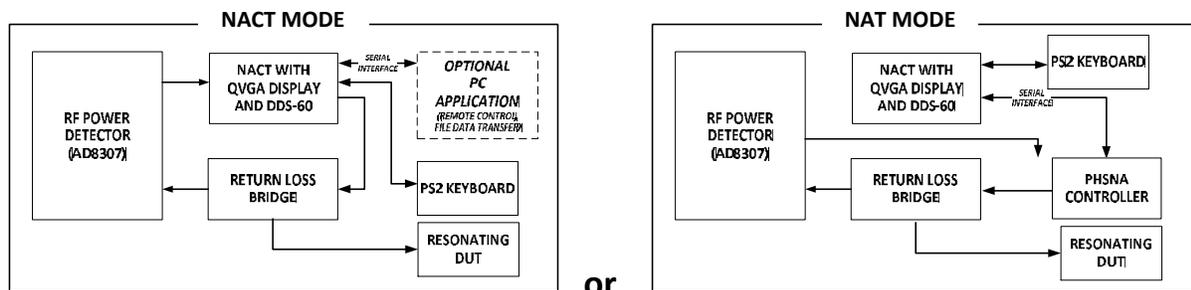
Return Loss Bridge (RLB)

The RLB I used for this tutorial is based on a design from Experimental Methods in RF DESIGN (Figure 7.41). There are certainly many other RLB designs that could be used.
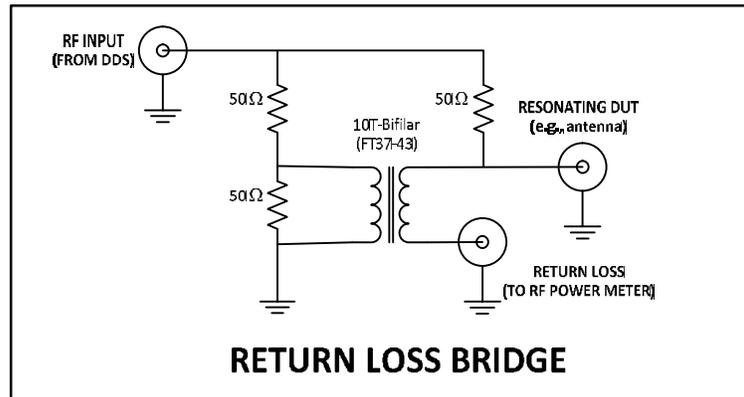
I built my RLB on a small one-sided, perforated board using, what I call, a "Carved Circuit Board" ("CCB" as opposed to "PCB").
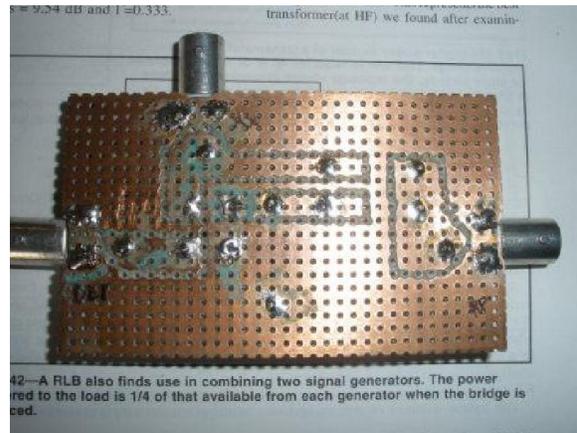
There are three basic parts to this tutorial:

1. RLB calibration
2. Preliminary sweep
3. DUT tuning.

This tutorial presents each of the basic parts as a separate sequence of steps.

RLB Calibration

1. Connect the RLB RF INPUT connector to the DDS output and the RETURN LOSS connector to the RF Power Meter input. Do not attach anything to the RESONATING DUT connector for this part.
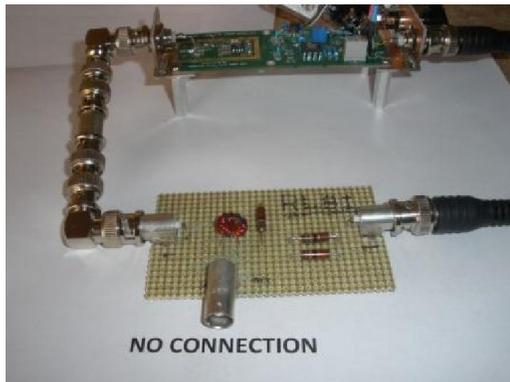
2. Power on all components.
3. Create a PLX data sheet as follows:

    a. Press Scroll Lock to enter Command mode.

    b. Press F4 to display the data entry form

    c.   Set up the F4 PLX data sheet to cover the frequency range of interest (the 20 Meter amateur band in my case). Enter the following on the form:

page one:

TITLE – RLB
FILE NAME – RLB.CAL
FREQ LO – 14000
FREQ HI – 14350
FREQ ST – leave blank
ROWS - 481
Leave the rest of page one blank and press Page Down to have the firmware calculate FREQ ST, save page one in EEPROM, and display the form for page two

page two:

OP MODES – NACT mode: CV
                    NAT mode: V

4.   Press Enter to save the data sheet to EEPROM.
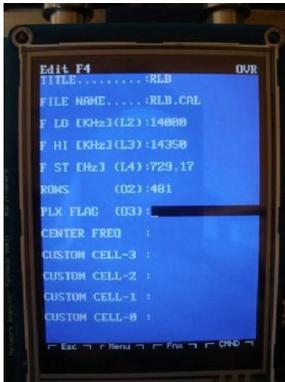
5. Press F4 to activate the data sheet.

6. Press the Space bar to start the frequency scan and spool the results in the file named RLB.CAL. After the scan, the results will be plotted. This relatively straight line illustrates the RLB insertion loss. Ignore the VSWR (green trace) for now.
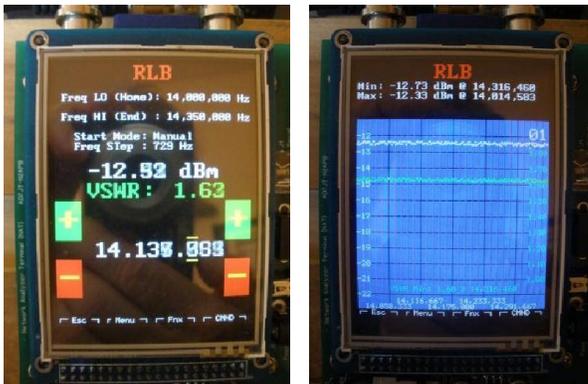
7. Press Escape twice to close the spool file and return to Terminal mode.

8. Press Ctrl-C to capture the calibration data in the calibration buffer and EEPROM. The calibrated data will then be plotted as a straight line at 0.00 dBm.

9. Press Escape twice and F4 to restart the PLX data sheet. Note that this time you will get a file overwrite error since the RLV.CAL file already exists. That is expected; ignore the error.

10. Press the Space bar to calibrate and replot the data. Note that the variation from a straight line at 0.00 dBm is due to noise in our test setup and should be much less than one dBm. This variation will not significantly affect our measurements.

11. Press Escape twice to clear the plot and switch to Terminal mode.

Preliminary Scan

1. Connect the resonant DUT to the RLB's RESONATING DUT connector.

2. Press Escape to return to Terminal mode and press Scroll Lock and edit the PLX data sheet.
   On page one change the file name to "RLB.CSV". Page two of the PLX data sheet remains the same as set in the calibration process (step 3c).
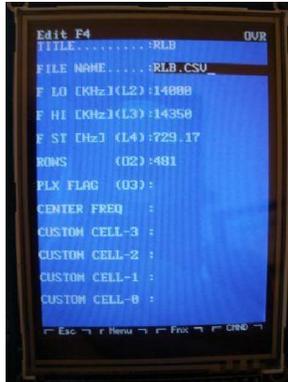
3. Press Enter to save the changes.

4. Press F4 to activate the PLX data sheet and the Space bar to run a scan.
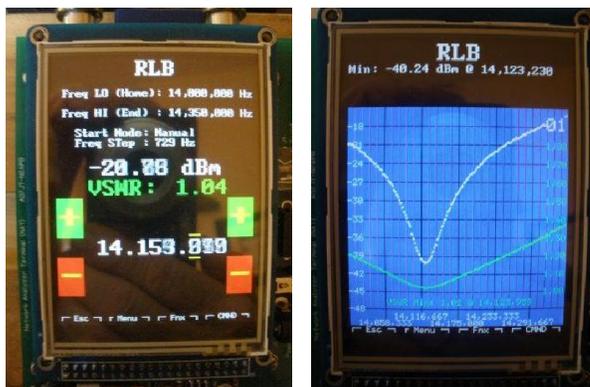
The plot shows the return loss of the DUT over the frequency scan range as a white trace plotted against the scale on the left of the plot area. The green trace is the computed VSWR plotted against the scale on the right of the plot area. The lowest calculated VSWR and the associated frequency are rendered in green at the bottom of the plot area (1.02 @ 14,233,959 in this case).

5. Press Escape twice to close the spool file, clear the plot area, and return to Terminal mode.

6. Press Scroll Lock and Escape to enter DOS mode.

7. Key the DOS command PLOTV RLB.CSV to plot the RLB data from the SD card file.

8. Press Escape twice to clear the plot and return to Terminal mode.

Resonant DUT Tuning

Now, suppose we are not satisfied with the results of our preliminary scan of our resonant DUT and we want to do some tuning. To monitor the effect of our tuning, we will set up the NAT to repeatedly generate VSWR plots. In this case, we will re-initialize the plot area for each plot.

1. Edit the PLX data sheet to delete the file name on page one and add Automatic start (A) and Reinitialize each plot (R) to the OP MODES on page two

2. Press F4 to activate the PLX data sheet. The scan will start immediately and, after the initial scan, will repeat continuously. The time for each scan will depend on the number of frequency steps (FREQ ST) in the scan. In my case, with 481 frequency steps, each scan and plot takes about 0.8 seconds.

3. Here we would tune the resonating DUT until we were satisfied with the RLB readings. The following steps illustrate an alternative to using the Automatic start op mode.

4. Press M to temporarily disable the Automatic start (A) op mode. The repeating scan and plot sequence will stop at the end of the current scan and plot.

5. Press the Space bar to initiate a single scan and plot sequence. In this case, a BEEP will announce the end of the sequence.

6. Press the Space bar several times rapidly. The keyboard input is buffered in a FIFO buffer and processed one character at a time. Each space code read from the FIFO will start another scan and plot sequence. The next character in the FIFO will not be processed until the current scan and plot sequence has completed.

7. Press A to re-enable Automatic start op mode and press the Space bar to start the first scan.

8. Press Escape twice to stop the scanning, clear the plot screen, return to Terminal mode, and end this tutorial.