RETURN LOSS BRIDGE BASICS

Using The

EAGLE

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Return Loss Bridge Basics

1.0 Introduction

Return loss bridges have many useful applications for the two-way radio technician.

These bridges are particularly helpful when used with the tracking generator feature of many service monitors.

A return loss bridge may have a built-in reference termination, or it may require an external reference termination. The reference termination determines the system impedance. If the bridge is used in a 75 ohm system, then the reference termination must be 75 ohms. Similarly, a 50 ohm system would require a 50 ohm reference termination.

Some bridges have a built-in RF detector and provide a dc output from the measurement port. The return loss bridge referenced in this column provides an RF output at the measurement port. Now, let's back up a moment and take a closer look at a typical return loss bridge, as shown in Fig 1.1 below. This bridge is designed for use with 50 ohm systems. It has a built-in 50 ohm reference termination. There are three ports labeled as follows:

SOURCE (or RF input Port).
DUT (device under test or Load Port).
REFLECTED (RF output or measurement Port).

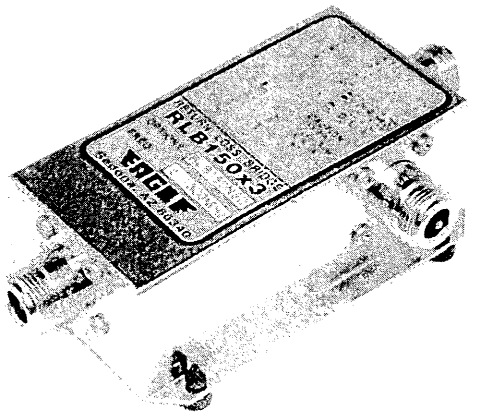
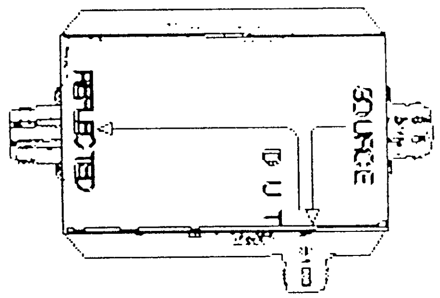


Fig 1.1 picture of a typical return loss bridge

2.0 Theory of Operation

Figure 2.1, at the top of the next column, represents a typical return loss bridge and illustrates the signal paths to the various ports. This bridge contains an internal reference and is designed for 50 ohm systems.

2.0 Theory of Operation-continued



Arrows show direction of signal.

Fig 2.1 Signal PathThru Bridge

Theoretically, the loss from the source port to the DUT port will be 6 dB, and the loss between the DUT and the reflected port will be 6 dB. This assumes that the DUT port is either open or shorted because in these two conditions all of the power that reaches this port is reflected back. If there is a termination at the DUT some of the power will be absorbed by it and therefor the loss from the DUT to reflected port could be much higher. Now, if a 0 dBM signal is applied to the source port with no load connected to the DUT port(this port being open), the signal level at the reflected port will be 12 dB below the level at the source port, or -12 dBM.

Normally, when the return loss bridge is used to make a measurement, the signal at the reflected port is used to calibrate, or to set, the 0 dB reference level on the instrument used to make the return loss measurements. If you are using a spectrum analyzer with the top of the screen set at -10 dBM then you would adjust the generator output to give -10 dBM at the reflected port. This would be about +3 dBM depending on the exact bridge and connecting cable loss.

3.0 Calibration

Refer to Figure 3.1 on page 2, the calibration is done as follows:

With the DUT port left open, the signal level at the source port is adjusted to the desired level on the analyzer screen-this is usually about +3 dBM if you are going to set analyzer for -10 dBM. Normally, the exact signal level at the bridge input is not critical if a usable output is available at the reflected port.

3.0 Calibration-continued

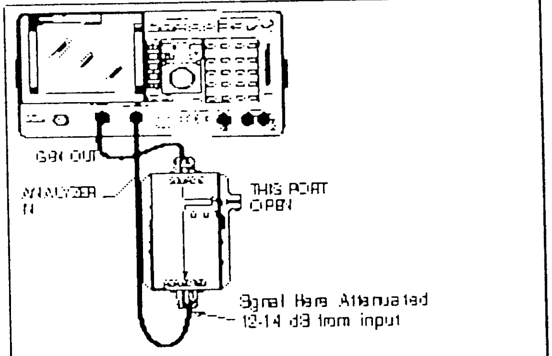


fig 3.1 Bridge setup for calibration

Next, adjust the spectrum analyzer display to -10dB at the top of the screen. This will serve as the reference level. In other words this is 0dB return loss. The reason being that with the DUT port open or shorted all of the power must be reflected to the reflected port.

Refer now to Figure 3.1 below. With a precision termination connected to the DUT port, the signal level at the spectrum analyzer has dropped to -40 dB. This indicates that the bridge and termination are in good agreement with each other. The better the match the lower this number will be. The curve may vary somewhat, usually lower than 40 dB, over the frequency range. This is normal as a very small disturbance will greatly effect the return loss reading at these low levels.

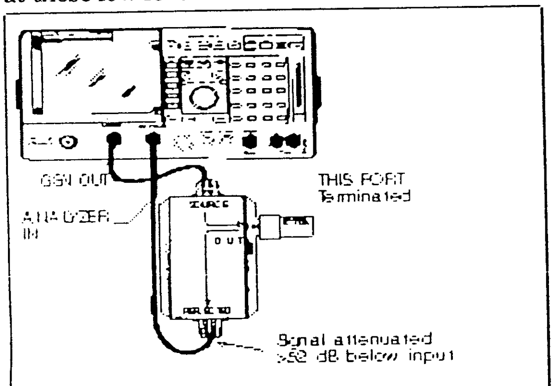


Fig 3.2 Bridge setup for calibration with load

The Analyzer and bridge are now calibrated and ready for use

4.0 Using the Bridge

A major advantage of the return loss bridge method of VSWR is the ability to measure a band of frequencies simultaneously. Figure 4.1 shows the connection.

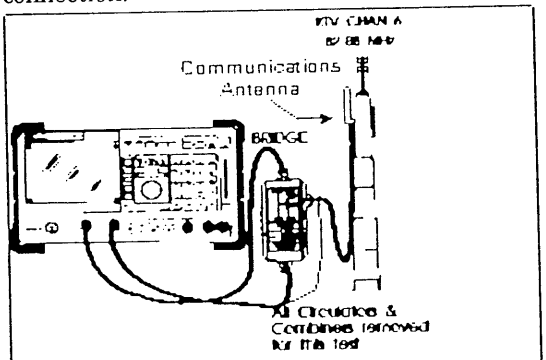


Figure 4.1 Antenna VSWR Measurement Setup

Figure 4.2 is a typical curve of an antenna. As you can see the exact resonant frequency is easily determined as well as the bandwidth of the antenna at a given VSWR (or return loss).

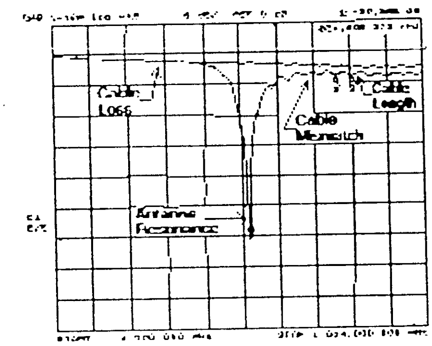


Fig 4.2 Return Loss Curve of Antenna

As shown in the diagram there is other information that is available about the antenna and transmission line. The loss, and line match are also present in this curve.

4.0 Using the Bridge-continued

Most of us are used to dealing with reflected power as VSWR rather than return loss. Figure 4.3 is a chart that can be used for converting between VSWR and return loss

Reflection Conversions

Return Loss dB	VSWR	RHO	Mis Loss dB
0.0	Infinity	1.00	Infinity
1.0	17.40:1	0.89	6.87
2.0	8.72:1	0.79	4.33
3.0	5.85:1	0.71	3.02
5.0	3.57:1	0.56	1.65
6.0	3.01:1	0.50	1.25
9.54	2.00:1	0.33	0.51
10.0	1.93:1	0.32	0.46
14.0	1.50:1	0.20	0.18
15.0	1.43:1	0.18	0.14
20.0	1.22:1	0.10	0.04
25.0	1.12:1	0.06	0.014
30.0	1.06:1	0.03	0.004
40.0	1.02:1	0.01	<0.001

Another point to consider before making measurements is the accuracy of the bridge. The specification for this is directivity. You cannot measure directivity past the limits of the bridge. For example, if the directivity of the bridge is 35dB, then you cannot measure a return loss >35dB. As a matter of fact as the measurement approaches 35 dB, say around 30 or so, the reading becomes ambigious. It could be somewhat better or worse than the indicated reading.

4.0 Using the Bridge-continued

For practical purposes, 35dB is a very good return loss figure. It equates to a VSWR of about 1.04:1. This is much lower than most technicians will ever have to be concerned about.

Frequency range is another consideration. The bridge is only accurate over its specified frequency range. The frequency range of most bridges is clearly marked on the housing. Be sure to observe it.

The return loss bridge can be used to check the degree of mismatch of filter, antennas, receiver inputs, amplifier inputs and isolators--in short, any 50 ohm device. the EAGLE corporation website has some application notes about using bridges check it out at:

www.eagle-1st.com/notes/note_toc.htm

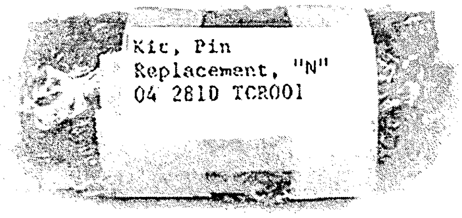
The return loss bridge can be used as a combiner to combine two signal sources into a single port. By putting one of the sources into the source port and the other into the reflected port you will get a combined output at the DUT port. This can be used for measuring adjacent channel rejection and desensitization figure of a receiver. It is also useful for two-tone testing of amplifiers.

5.0 CAUTIONS!

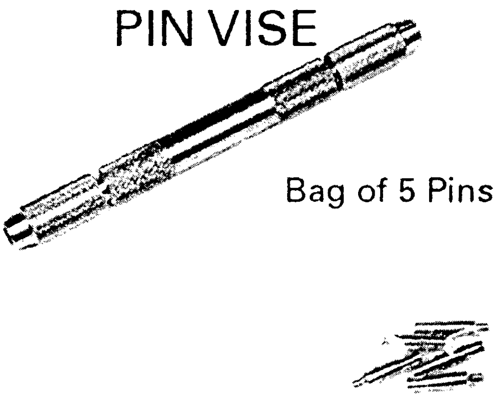
When using a return loss bridge, it is important to be familiar with the specifications and limitations of the particular bridge being used. Be sure to observe the input power limit. Do not apply DC; these are RF devices-- low power RF devices.

1.0 Preface
The **EAGLE** product you have purchased is equipped with replaceable pin connectors. These connectors are type "N" female. The replaceable center pin allows for field replacement of the center pin should it become worn or damaged.

2.0 Replacement
Replacement pins are available by ordering our replacement pin kit. This kit contains a pin vise and five replacement pins. Please see the figure below which shows the kit as it is packed.



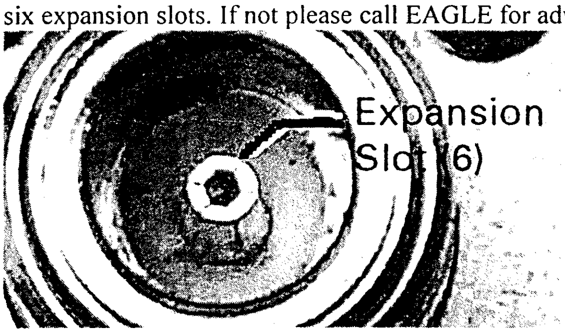
The figure below shows the pin vise and the pins. It is recommended that the pins be stored in a place where they will not become lost.



3.0 Cautions
3.1 Caution: Use proper mating connector.
Insure that the mating connector is an "N" male designed for 50 ohms. The use of other connectors such as a 75 ohm "N" or the "UHF" can cause damage.
3.2 Caution: Missing Center Pins
On receipt of your equipment inspect all connectors. Insure that each center pin is present. If a pin is missing check the packing material and try to locate the pin. When the pin is located it may be installed using a common pin vise or the above kit can be obtained.

3.0 Cautions-continued
3.3 Caution: Loose Center Pins
Loose center pins may cause errors in the operation of the device. The center pins have been loctited and tested for tightness at the factory. It is highly recommended that they be retested in the field. Especially if readings are of an intermittent nature. The pin vice supplied in the replacement kit is suitable for checking the pins for tightness.

4.0 Pin Replacement
4.1 The figure below shows a center pin. There should be six expansion slots. If not please call EAGLE for advice.



4.2 Remove damaged pin as follows: Heat the pin with a heat gun to 90-100 deg C. Then place pin vise over pin and tighten the collet to firmly grab the pin. Remove the pin by rotating the pin vise counter-clockwise.
If pin does not unscrew repeat the heating process and attempt to remove the pin again. If it does not come out after two or three attempts contact factory for assistance.
4.3 Install new pin into the pin vise. Apply a small amount of Loctite #222 to the threads of the pin.
4.4 Carefully insert the pin into the mating threads being careful not to touch the body of the connector. Touching the body may deposit some of the loctite on it which is not good.
4.5 Tighten the pin to where the pin vise starts slipping on the pin.

5.0 Pin Wear
Even with the proper mating connectors some wear is inevitable. The expected connector life is at least 500 cycles. At the end of this life the connector should still be making its specification. As long as the connector is physically intact and the product into which it is installed is making its specification it can be assumed that the center pin is OK. Should the product not be making its specification with regard to return loss a new connector pin should be installed and the product re-tested.

EAGLE RLB150 Family: Calibration Procedure

1.0 Preface

The **EAGLE** Your RLB150 return loss bridge is a well constructed unit that should give years of trouble free service. The periodic calibration check verifies that the unit is operating within its specifications.

2.0 Calibration Cycle

The calibration cycle is as follows:

1. Bridges in storage for more than one year require calibration before they are used for the first time. There is no need to run calibration on bridges in long term storage.

2. Bridges in use require calibration at no later than one year from date of previous calibration.

3. If any of the following circumstances exist immediate recalibration is required:

The center pin was damaged and has been replaced.

The bridge was known to be subjected to reverse power in excess of its specified rating.

The results are questionable.

The open loss thru the bridge exceeds specification.

The bridge has been subjected to mechanical forces in excess of specification i.e. dropped.

3.0 Calibration Procedure

3.1 Caution: Missing Center Pins

On receipt of your equipment inspect all connectors. Insure that each center pin is present. If a pin is missing check the packing material and try to locate the pin. When the pin is located it may be installed using a common pin vice or with a kit can be ordered from EAGLE.

The three calibration parameters are:

1. The open loss of the bridge
2. The open/short ratio
3. The directivity of the bridge.

3.2 Open Loss Test

This test requires either a network analyzer or spectrum analyzer capable of spanning the rated frequency of your bridge.

Connect the generator to the receiver of your test instrument with the cables you will be using to connect to the bridge. Use a double "N" female adaptor to connect the cables.

Adjust sweep frequency to at least the specified limits of bridge.

Adjust the instrument according to the manufacturers specifications and make sure that the trace indicates 0 dB. Slight errors, say .02 dB or less are allowable.

3.2 Open Loss-continued

Remove the adapter

Connect generator to Source Port.

Connect receiver(input to screen) to Reflected Port.

Leave the DUT Port open or connect an Open.

Note the loss on the analyzer. It should be less than the specified loss. Note: In some bridge specifications the overall loss is not specified if that is the case add the Source to DUT and DUT to Reflected together. This information is contained on the data sheet on this web-site.

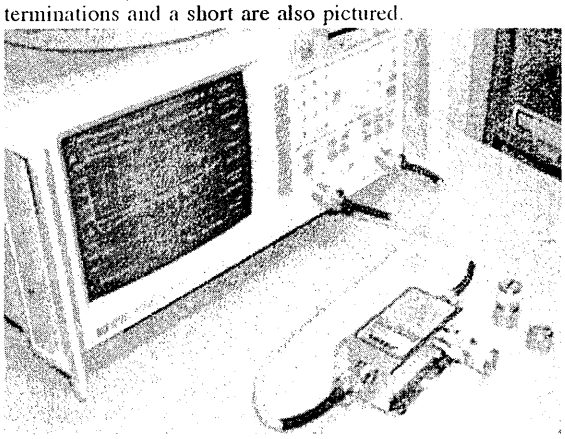
3.3 Open/Short Ratio Test

With everything set as in test above use the trace memory option for your analyzer to yield a trace of 0 dB. This is sometimes referred to as a trace math.

Connect a short to the DUT Port of bridge. Then observe the trace on the analyzer. It will be different, sometimes higher and sometimes lower than with the port open. Check data sheet to see the acceptable level.

3.4 Directivity

Following picture shows return loss bridge connected to network analyzer for the directivity test. Two EAGLE terminations and a short are also pictured.



Remove the short from the DUT Port of bridge.

Connect a precision load, rated at directivity of 50 dB or more

Observe level of the trace. It should be as good or lower than the specification in the data sheet (usually 45 dB).

It is advisable to test the bridge with two precision terminations as terminations are often out of calibration themselves. It is unlikely that two terminations and a bridge with errors would agree to 45 dB directivity. Also, in many cases a bridge reading out of spec is really due to a termination that is not good enough.

EAGLE does have a calibration service for bridges that you may want to consider.