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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.

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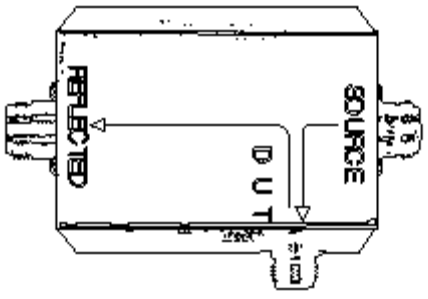
2.0 Theory of Operation-continued



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.

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3.0 Calibration-continued

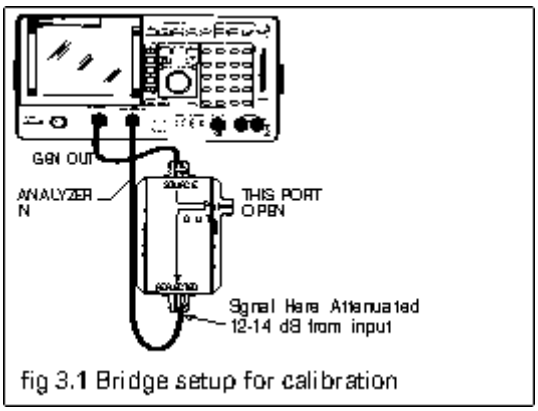

fig 3.1 Bridge setup for calibration

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.

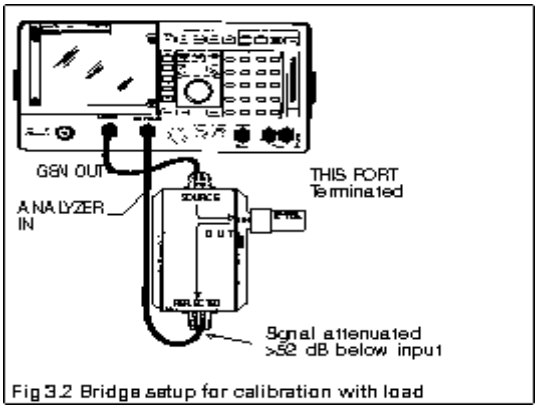

Fig 3.2 Bridge setup for calibration with load

The Analyzer and bridge are now calibrated and ready for use

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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.

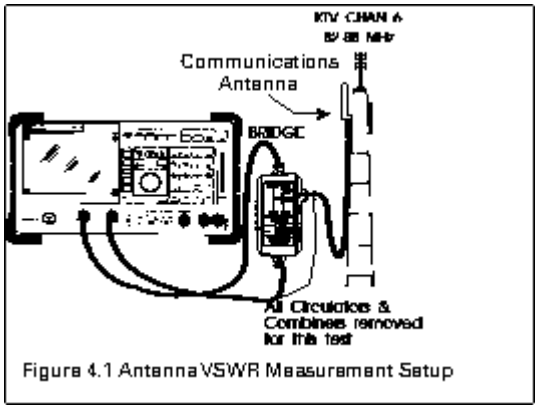

Figure 4.1 Antenna VSWR Measurement Setup

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).

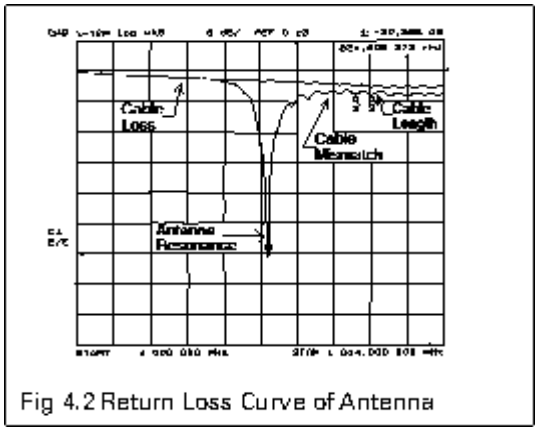

Fig 4.2 Return Loss Curve of Antenna

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.

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Return Loss Bridge Basics

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.

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.B150x5-Product Data Sheet

FEATURES:

- Coverage: 5 Mhz to 3000 MHz
- Five Watt Power Rating
- Covers all Cell and PCS bands
- Directivity >40 dB
- RF reflected port
- Internal 50 ohm Reference
- Rugged case and connectors
- Great for Antenna Work

Applications

Return loss bridges are useful in measuring VSWR, or return loss of filters, mixers, antennas and amplifiers. With directivity ratings of better then 40 dB, EAGLE bridges yield excellent results. The bridges may also be used for coupling two generators for intermodulation testing or power splitting for leveling systems.
All EAGLE bridges have a true RF output they can be connected directly to vector or spectrum analyzers. Even spectrum analyzers contained in communications service monitors can be used. With the high degree of accuracy found in EAGLE bridges error correction is not absolutely necessary.

Description

The RLB150X5 return loss bridge has been designed for lasting service in either laboratory or field service applications. Within its operational range, the bridge yields laboratory performance in directivity and open/short ratio.
Covering a range of 5 to 3000 Mhz, this bridge will provide an excellent means of measuring VSWR in the VHF, UHF, Cellular, and PCS. The bridge is also useful for measuring STLs and other microwave equipment up to 3.0 GHz.

These bridges have three ports SOURCE, LOAD and REFLECTED. The REFLECTED port on all EAGLE bridges is an RF port. The bridge may be connected directly to a network or spectrum analyzer.

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Description-continued

Some bridges have a fourth port called the REFERENCE port. The reference (a precision 50 ohm load) is built into EAGLE bridges so this port is not required. This elimates the problem of lost terminations.

To insure ruggedness this bridge is constructed in a brass case with nickel plating. The connectors are heavy-duty with a field replaceable center pin. This allows replacement should wear or damage degrade the performance of the return loss bridge.

Power rating is a maximum of five watts up to two minutes or one watt continuous.

Quality

To insure that high quality is maintained each unit is thoroughly inspected both mechanically and electrically. Critical components are 100% inspected and tested before assembly into the units. All parameters are tested using the latest in advanced ATE. The unit is then subjected to shock, vibration and temperature extremes after which it is retested to insure compliance.

Directivity is measured twice with a different precision load. The bridge must meet or exceed the applicable specification with both loads.

Availability

These bridges are normally stock items: 1 week delivery. Special orders or large quantities usually require 2-4 weeks.

Specifications & Ordering

Please see the next page for detailed specifications, performance graphs and ordering information.

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SPECIFICATIONS

Electrical:

Insertion Loss:
<7.0 dB SOURCE TO LOAD port
<8.0 dB LOAD TO REFLECTED port

Power Rating:
1.5 Watt Continuous
CAUTION: Do NOT apply DC to any port

Port Match:
Source: >20 dB RL
DUT: >25 dB RL
Reflected: >10 dB RL

Directivity
5 to 50 Mhz >25 dB
50 to 3000 Mhz >40 dB

Open/Short Ratio
<±1.0 dB

Environmental:

Temperature:
10° to 50° C full specification
-10° to +85° C reduced specification
-55°; to +125° C storage

Humidity:
10% to 80% RH, Non-cond

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SPECIFICATIONS-cont

Mechanical:

Case Size:
2.6"Wx4.5"Lx1.4"H

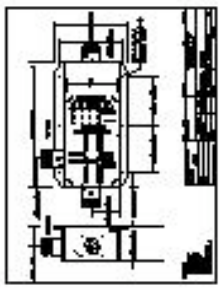
Weight:
<16 Oz

Options:

Connectors:
"N" N female Standard
"M" SMA female

Test:
"TD" test data plot
"COC" Cert of Conformance

Outline Drawing:



click on drawing for enlarged view.