VK5FE's **Shack**

A 3.5 GHZ HIGH PERFORMANCE RETURN LOSS BRIDGE

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Return loss bridges are useful devices to have on our workbenches. As the name implies, they are primarily intended to measure return loss, in other words indirectly measure impedance. It's a scalar measuring device (no phase) and it has been extensively used by radio amateurs to make measurements of the impedance of antennas.

Basically, the higher the return loss, the closer the load is to its characteristic impedance (in our case, 50 Ohm). The devi shown here has four ports: in one of them we connect the reference impedance (Z0), in the others the generator (Gen), the DUT (Device Under Test) and in the last one, the detector. The detector could be a spectrum analyzer or a power met for instance the one shown in other pages of this website (in that case for frequencies below 500 MHz).

Return Loss Bridges are especially interesting when we have a spectrum analyzer with tracking generator, allowing the measurement of the return loss of a DUT, besides the insertion loss.

The quality of a return loss bridge can mainly be expressed by its directivity – the higher the directivity, the better the bridge. Notice that there is a direct relationship between return loss and VSWR and that normally return losses above 20 (VSWR=1.22) are considered satisfactory. Based on this, a directivity of 30 dB can be considered very good, as the bridg in this case could measure a return loss of about 25 dB (VSWR=1.12), but 25 dB of directivity is still very useful.

The basic circuit of a bridge can be seen below. Normally, for frequencies in the UHF region, the transformer is replaced b a balun made with coaxial cable. An interesting couple of articles written by Paul McMahon (VK3DIP), including many details, can be found in the Amateur Radio Magazine, June 2007 and August 2008 – this is a publication of the Wireless Institute of Australia (WIA). Another good source with theoretical details can be seen in the "Manual Return Loss Measurements", paper written by Sam Wetterling (05/Oct/2008) and made available in his website.

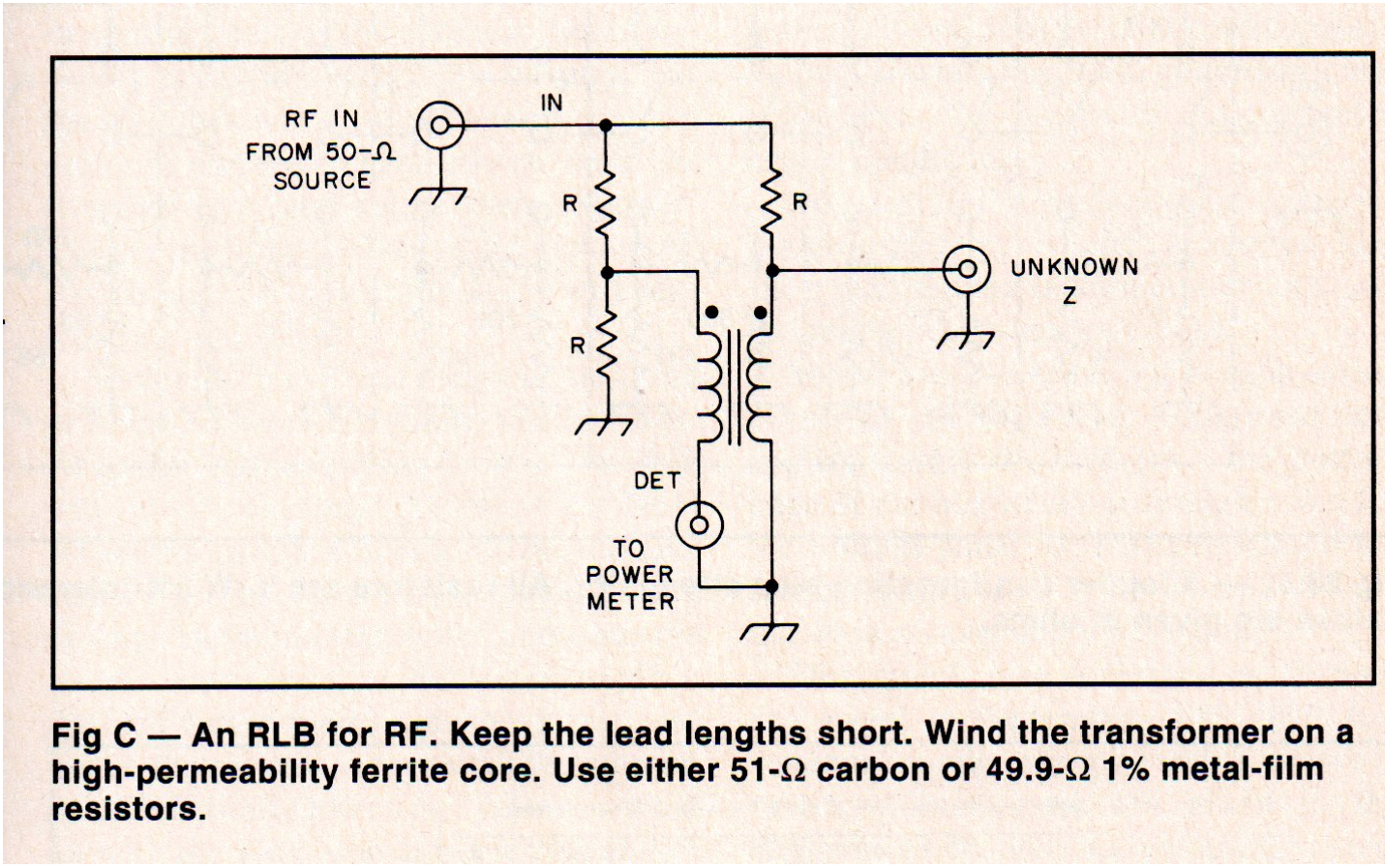
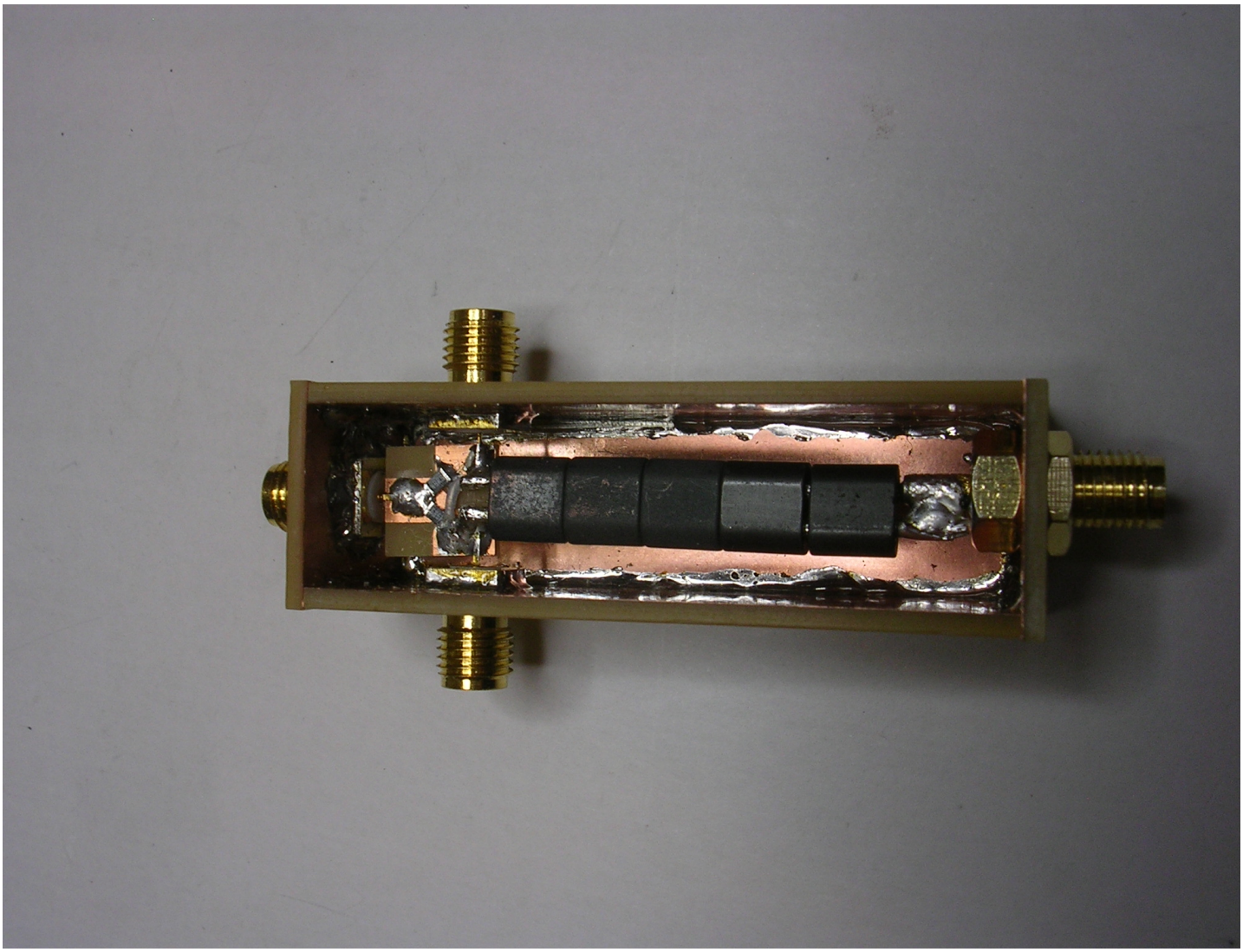


Fig C — An RLB for RF. Keep the lead lengths short. Wind the transformer on a high-permeability ferrite core. Use either 51-Ω carbon or 49.9-Ω 1% metal-film resistors.

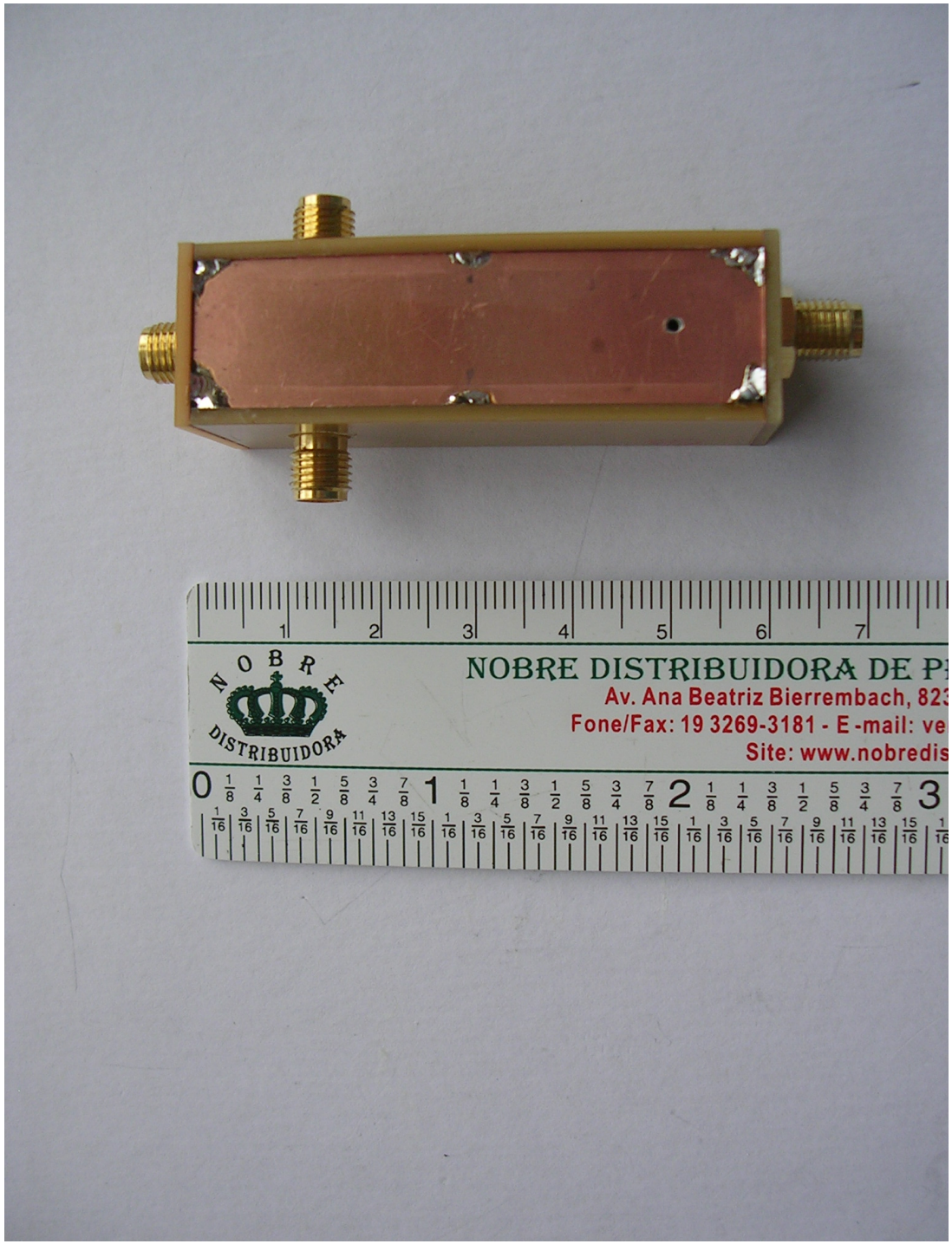
CIRCUIT – EXTRACTED FROM THE ARRL HANDBOOK 1995

In my particular case, I wanted to build a bridge reaching about 3 GHz with good directivity. Based on Paul's article and Sam's text I have built the unit shown below, but optimized for the end of UHF region and beginning of the SHF region. T result, as can be seen, was overwhelmingly good, comparable to very expensive professional counterparts found in the market.

The cable is the RG178, but the plastic cover was peeled off to fit in the BN2402 (#61) binoculars holes. The cable braid was lightly soaked with SnPb, behaving like a semi-rigid cable. Eventually, an empirical adjustment may be necessary to improve the end of the frequency range, using tiny pieces of wire or copper sheet, but this will depend on the particular implementation of each bridge. The box of this unit was made using one-sided phenolic boards.

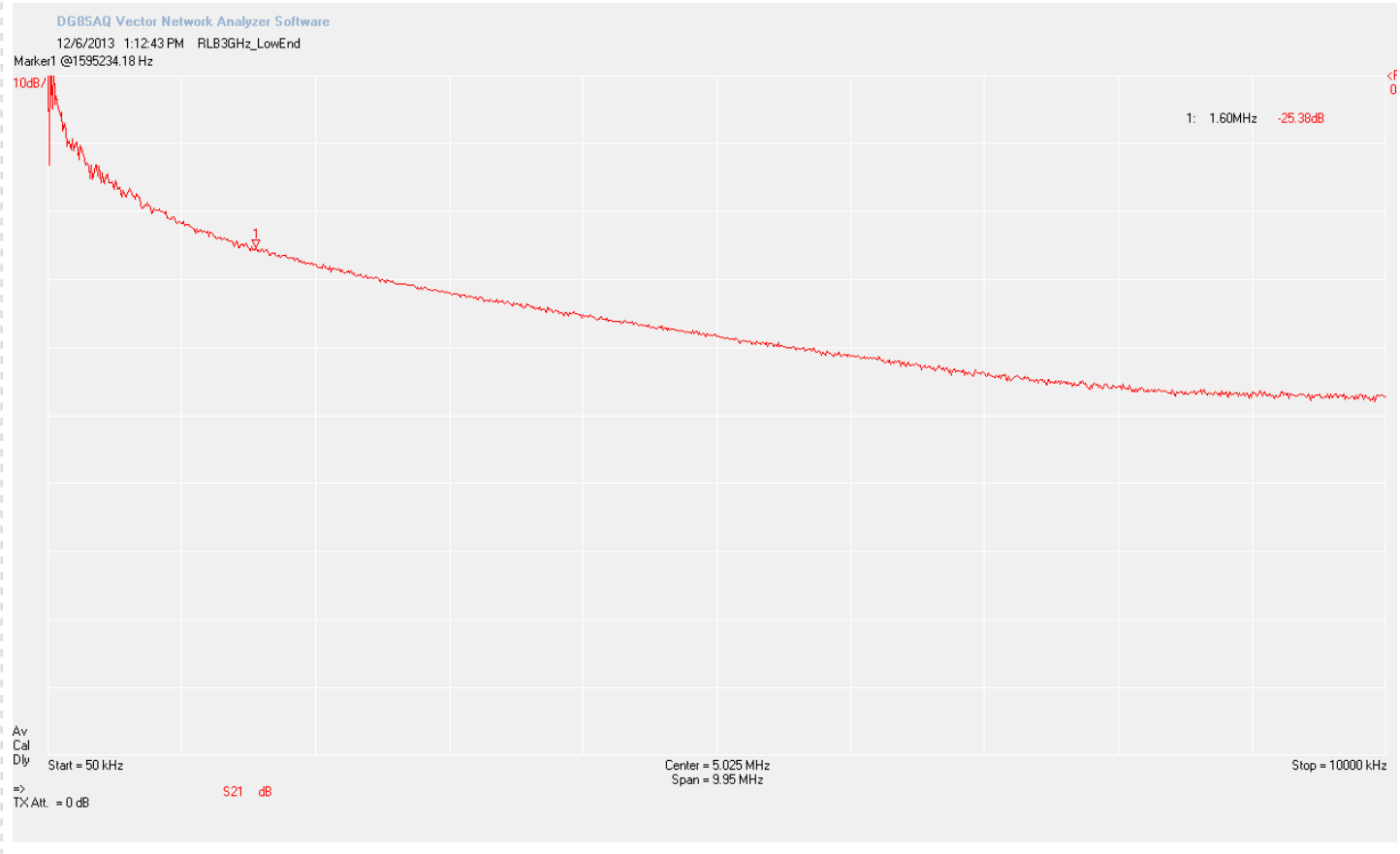


INTERIOR VIEW



EXTERIOR VIEW

DIRECTIVITY – HIGH END



DIRECTIVITY – LOW END

SPECIFICATION:

Directivity: >25 dB (1.8 -3500 MHz) / >30 dB (3.0 – 3300 MHz) / >35 dB (4.5 – 3200 MHz)

Mainline Loss: 6.7 dB @ 2 GHz

Insertion Loss (total): 13 dB @ 2 GHz

Return Loss – Source Port: >10 dB

Return Loss – DUT Port: >10 dB