Excerpts from some of Sam Wetterlins' Documents

That are relevant to the Series Fixture

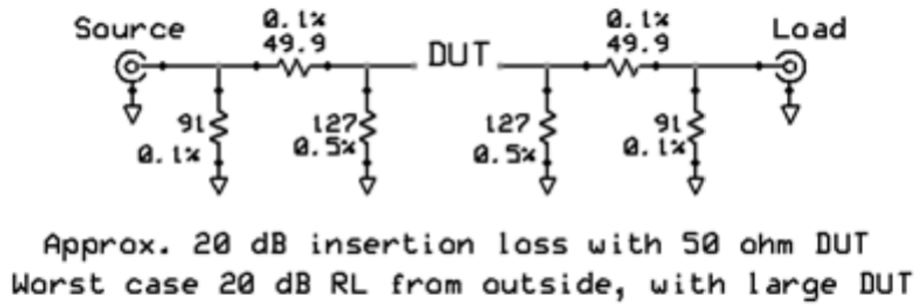
Note - All are available at: https://web.archive.org/web/20181206052548/http://www.wetterlin.org/sam/

VNA Guide.pdf pg 5

Series Fixture Specifics

The section discussing shunt fixtures describes resistor values for homemade attenuators, and discusses the fact that simply attaching standard attenuators to a fixture does not produce optimal results. For example, in the case of the series fixture, if the DUT has a large impedance, each attenuator sees a large load, rather than the 50 ohms that its design assumes. This causes the return loss at the outside of the attenuators to be very low, causing large reflections.

The design in the schematic below solves this problem and achieves a worst-case return loss of 20 dB (with an infinite DUT).



Ref: https://web.archive.org/web/20181206052548/http://www.wetterlin.org/sam/SA/Operation/VNA_Guide.pdf

S21/Shunt Impedance Measurement Appendix A

The attenuators and DUT connection were contained on a single small board. The schematic for the 50 ohm fixture is shown in Figure 12.

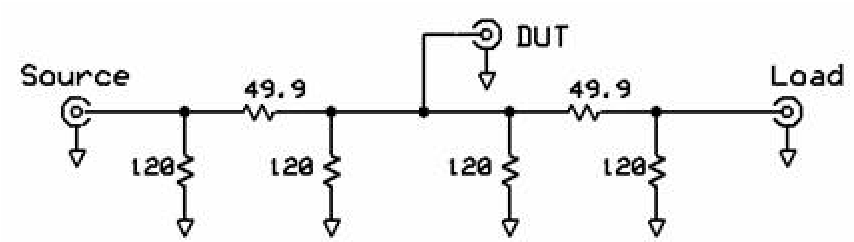


Figure 12—Schematic of 50 Ohm Test Fixture Resistors are 0.1%

The attenuators in Figure 12 are standard 50 ohm 7.7 dB attenuators. But note that such attenuators are intended to connect to 50 ohm sources and loads. In this case, the end of the attenuators attached to the DUT see the impedance of the DUT in parallel with the other attenuator. For any DUT other than an open circuit, each attenuator thus sees an impedance smaller than 50 ohms. This causes its attenuation and return loss to differ from what might be expected. As long as the source and load have good return loss, the degradation of the attenuator return loss (as seen from the outside) is not a problem. However, it is possible to improve the test fixture so low impedance DUTs do not disrupt the return loss as much. Figure 13 shows such a fixture.

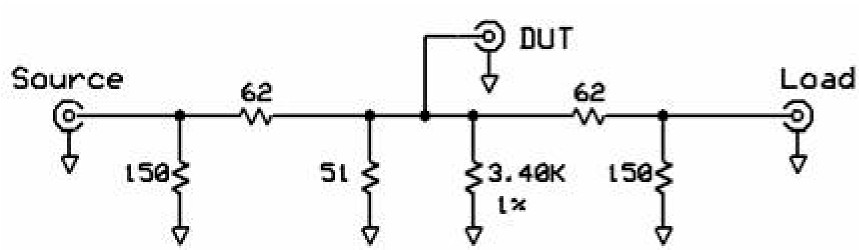


Figure 13—Improved 50 ohm test fixture.

The return loss seen from the source or load is never worse than 24 dB, no matter what the DUT impedance.

The two middle resistors in Figure 13 may seem odd, but they are the equivalent of two parallel resistors of 100.5 ohms each. Such resistors would normally be at the inside end of each attenuator, but that is a non-standard 0.1% value.

[Note: A web program called “Resistor Finder”, Finds a combination of two series or parallel connected resistors for a custom value. And returns a list of the best values found. For a desired result of 50.25 Ohms it finds the two values of 61.9 Ohms and 267 Ohms to have greater precision . This also means that the 61.9 ohm resistors can also be used for the 62 Ohm parts too. Dick K9IVB 9/3/2024]
http://mustcalculate.com/electronics/resistorfinder.php?r=50.25&es=E96]

The most important thing in either test fixture is that the DUT itself see a 50 ohm impedance from each attenuator (meaning it actually sees a net 25 ohms). With these fixtures, if the source and load have return loss of at least 30 dB, the impedance seen by the DUT will be good. The buffer amplifiers in Figure 11 show extremely good return loss, so the main issue is the cabling connecting the amplifiers to the test fixture. We could actually use fairly long quality cables for the connection without any problem.

Ref: https://web.archive.org/web/20181206052548/http://www.wetterlin.org/sam/SA/S21ImpedHTML/ImpedMeasS21.htm

For some of the theory look at:

RLC Analysis with the MSA

https://web.archive.org/web/20181206052548/http://www.wetterlin.org/sam/SA/Operation/RLC_Analysis.pdf

and

Fixture_LoZ.pdf

https://web.archive.org/web/20170119045259if_/http://www.wetterlin.org/sam/SA/Operation/Fixture_LoZ.pdf

Of some interest may also be the Fixture_DipMeter.pdf

https://web.archive.org/web/20170119050250if_/http://www.wetterlin.org/sam/SA/Operation/Fixture_DipMeter.pdf

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The above information should not be considered a restrictive reading list, as Sam Wetterlin’s web page has many other relevant files that should be of interest. These files include theory and other circuits and techniques to obtain better test data and understanding of the circuits and measurements.

Also note the Shunt circuits can be built on the same PCB as the series circuits if a short is placed across the two outside pins of the terminal block.

The following is an abbreviated BOM for the resistor values discussed above.

Resistor Designators refer to *my series fixture schematic*.

Basic Hi Z Fixture [Series]

Ref Des	Description	Mouser Part #
R1, R6	Thin Film Resistors - SMD 0805 1/8W 91ohms 0.1% 25ppm	667-ERA-6AEB910V
R2, R5	Thin Film Resistors - SMD 0805 1/8W 49.9ohm 0.1% 25ppm	667-ERA-6AEB49R9V
R3, R4	Thin Film Resistors - SMD 0805 1/8W 127ohm 0.1% 25ppm	667-ERA-6AEB1270V

Figure 13—Improved 50 ohm test fixture [Shunt]

Ref Des	Description	Mouser Part #
R1, R6	Thin Film Resistors - SMD 0805 1/8W 150ohms 0.1% 25ppm	667-ERA-6AEB151V
R2, R3, R5	Thin Film Resistors - SMD 0805 1/8W 61.9ohm 0.1% 25ppm	667-ERA-6AEB61R9V
R4	Thin Film Resistors - SMD 0805 1/8W 267ohm 0.1% 25ppm	667-ERA-6AEB2670V

Fixture_LoZ..pdf & Fixture_DipMeter.pdf Ref Des from document

Ref Des	Description	Mouser Part #
R1, R3	Thin Film Resistors - SMD 0805 1/8W 49.9ohm 0.1% 25ppm	667-ERA-6AEB49R9V
R2	Thin Film Resistors - SMD CPF 0805 1/8W 10R 0.1% 25ppm	279-CPF0805B10RE
No ref	Thin Film Resistors - SMD 0805 1/8W 100ohms 0.1% 25ppm	667-ERA-6AEB101V

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