Amphenol Spectra-Strip
720 Sherman Avenue, Hamden CT 06514 (203) 281-3200

A Wide-Band Balun Test Fixture

Suitable for SCSI Measurements

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Described is a test fixture that Amphenol Spectra-Strip has found suitable for measurements from 1 to 1000 MHz. Measurements may be performed to 1500 MHz with modestly reduced confidence.

Any balun, as purchased, is optimized for a particular impedance. Frequently, we must examine products having other impedances, such as 122 Ω used for SCSI. Matching pads may be used to provide the required impedance 'transformation'. Included are design equations for matching pads, and the particular resistances required to match the selected balun to either 100 Ω or 122 Ω.

The described fixture is almost always used in conjunction with a network analyzer. The combined setup, usually comprised of a network analyzer and two described fixtures, must be calibrated using a method suitable for the particular measurement.
A simple production measurement of gain ("attenuation") might require only a simple 'thru' calibration. More exacting impedance or gain measurements require full 2-port calibration. Crosstalk measurement often requires special consideration during calibration and measurement in order to achieve a sufficiently low 'noise floor' (e.g.: setting analyzer to a higher than default power level, and averaging during both calibration and sample measurement).

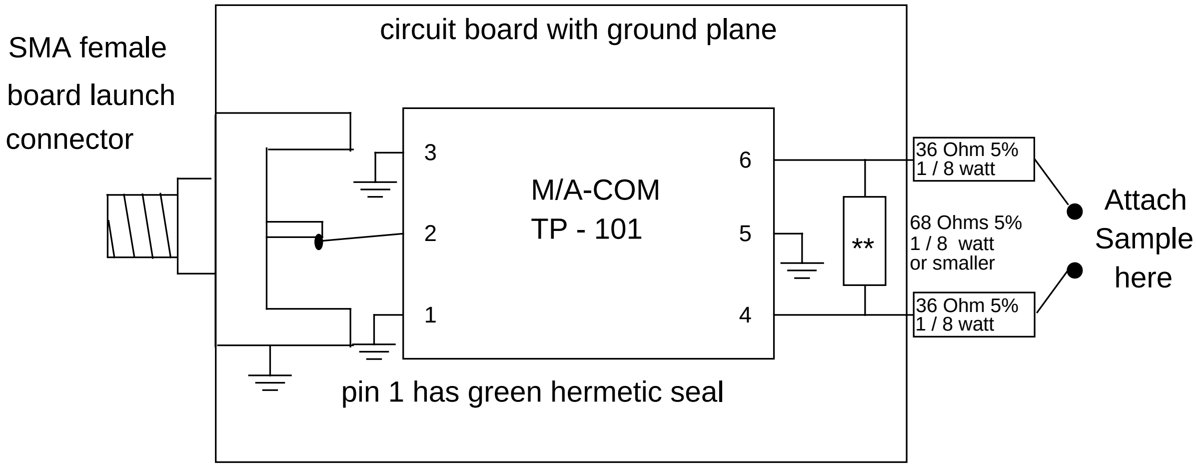
Usually, when calibrating a network analyzer, one uses 50 Ω standards that have exquisite performance (such as precision shorts, opens, and loads). When using the described fixture, particularly at unconventional impedances, suitable calibration standards are not readily available.

Amphenol has achieved sufficient, though not outstanding, calibration by using small high-frequency chip resistors (1% tolerance preferred) for 'load' standards. A calibration 'short' is achieved by connecting the fixture output resistors using solder. A calibration 'open' is achieved by positioning the output resistors as they will be during actual measurement. Using this approach, measurements may be performed that match physics quite nicely.

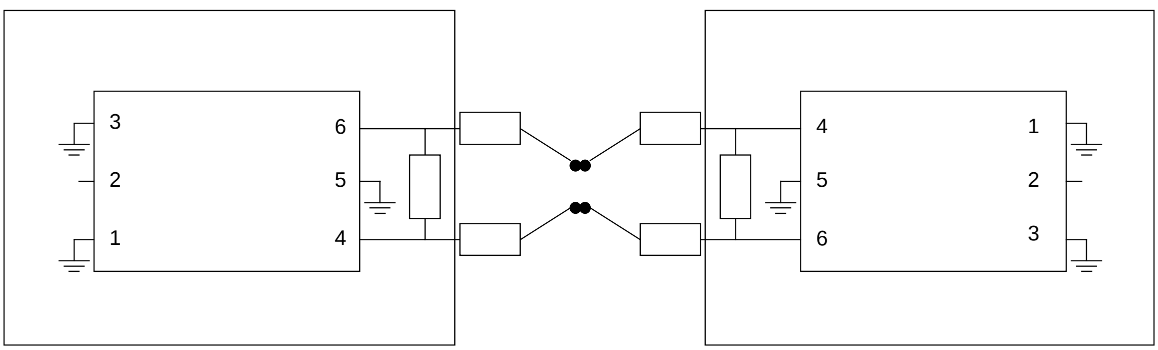
Acknowledgement, with deep gratitude, is owed Charles J. Intrieri of FCI Electronics. His prior advice and seeming patience were essential.

100 Ω Balun Test Fixture
Use balun to transform 50 Ω unbalanced to 50 Ω balanced (two signals @ 180° phase, each 25 Ω to virtual ground). Use balanced L-pad to convert pin 6 from 25 Ω to 50 Ω and pin 4 from 25 Ω to 50 Ω (the two opposite phase 50 Ω lines "equal" 100 Ω differential).

Keep all lead lengths DESPERATELY short!



To measure attenuation (simple method, not quite as good as next method):
Take two balun fixtures, solder them together:



Using a network analyzer, measure the insertion loss (S_{21}) of the joined test fixtures. Store this measurement into network analyzer memory. Detach to fixtures from each other, install sample. Set the network analyzer to display {S_{21} ÷ Memory}, which is the insertion loss of the cable with the fixture contribution removed. Set IF BW to ≤ 100 Hz to eliminate spurious data.

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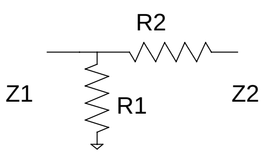
To measure attenuation (better method) and crosstalk:
Using a network analyzer, perform a full 2-port calibration. For calibration load, a high frequency chip resistor having appropriate value (e.g. 100 Ω) is recommended. The two resistors of each fixture are shorted together for the calibration short. The calibration open has the two resistors open circuited in approximately the position where they will be used for measurements.

Matching Resistors for Impedances other than 100 Ω:
Matching network shown in fixture drawing is for single ended 25 Ω to 50 Ω match (or differential 50 Ω to 100 Ω).

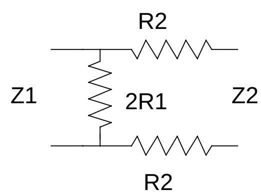
Frequently, other impedances are required. The general equations for unbalanced (single ended) match are provided below. (derived from Reference Data for Radio Engineers, Sixth Edition, pages 11-4 to 11-5)

$Z_2 > Z_1$



$$R_1 = Z_1 \sqrt{\frac{Z_2}{Z_2 - Z_1}} \qquad R_2 = \sqrt{Z_2 (Z_2 - Z_1)}$$

Differential Circuit:



Remember that this TP-101 balun has two 25 Ω unbalanced outputs!

Matching Resistors for 122 Ohm Differential (e.g. SCSI):