



APPLICATION NOTE - 011

Measuring components at high frequency

Introduction:

As frequencies increase over a few MHz, accurately measuring component impedance becomes progressively more difficult because:

- a) Even a few pF of stray capacitance can have a significant conductance.
- b) A small connection can add significant inductance
- c) A length of unterminated coax cable acts as a transmission line instead of a length of cable.

The significance of c) is often underestimated by engineers without much experience of using unterminated cables at MHz frequencies. For example, 1m of RG58 driven from a low impedance source at 25MHz can deliver a voltage 50% higher than the source voltage into a high impedance.

The PSM1735 and IAI can operate up to 35MHz but care must be taken to achieve accurate results. The key factors are:

- a) Minimise the length of connections.
- b) Securely fix any connections so that they cannot move
- c) Perform open circuit compensation first, then short circuit
- d) Use a substantial connection such as a length of earth braid for short circuit compensation.

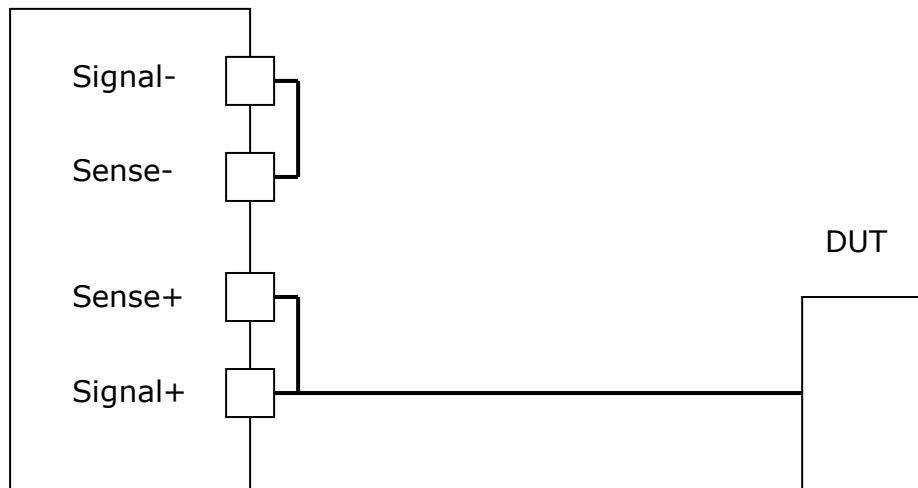
Practical connections

The easiest connection is to use the dedicated component fixture available from Newtons4th Ltd. This device clips onto the front of the IAI and allows components to be inserted between some connection plates. The length of the connections is minimised, and the whole assembly is held securely in place.

In some applications it is not practical to use the test fixture (such as in an automated production test system). In these cases, for optimum results, a single wire connection to the IAI is easiest. Kelvin connection is not appropriate at high frequency because of the characteristics of unterminated RG58 so the alternative arrangement shown below can be used.

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IAI



This arrangement connects the component under test directly across a length of coax. The cable should be:

- a) The minimum length possible.
- b) High quality cable with the lowest capacitance possible
- c) Stripped the minimum possible at the connection end to minimise the inductance

The cables and T-piece used to connect the Sense inputs should be very short and made from high quality cable and connectors.

Compensation

Open, short and reference compensation are essential to adjust for effects within the cable and fixture at high frequencies. If there is 100pF of cable capacitance and just 1uH of inductance within the connection fixture, then there will be a resonant peak at $\sim 16\text{MHz}$ when a short circuit is applied ($\omega^2 = 1/\text{LC}$).

For optimum measurements at a specific frequency:

- a) Perform open circuit compensation first to minimise the effects of the parallel capacitance.
- b) Short out the connections with a piece of earth braid and perform short circuit compensation to remove the effects of the fixture inductance.
- c) Insert a known component of comparable impedance at the specific frequency and perform reference compensation to compensate for the effects of the unterminated coax cable.

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