Application Notes

Application Note 128

# Choosing the best IP probe for impedance test

**Measuring Impedance**
When measuring impedance with a Polar CITS or any other TDR probe choice is important, this application note sets out to clarify which probe is ideal and clarify some of the misunderstandings that may exist.

**Is there an ideal probe for all impedances?**

The best first choice is the IP50, in fact as you read this application note it should become clearer that the IP50 should be your probe of choice for over 90% of impedance tests.

**Why is the IP50 the ideal choice when my traces are 93 Ohms?**

To understand this it is first necessary to understand the basics of time domain reflectometry:

A TDR sends a fast edge pulse along a transmission line. Changes in impedance will cause the pulse to be reflected back to the TDR. This is a little like RADAR and you could think of a TDR as a "cable RADAR". The TDR makes a simple ratio measurement of the outgoing to the returned voltage. The returned pulse is larger in amplitude if the impedance changes to a higher value and lower if the impedance reduces.

The calculation for impedance is simplest and most accurate when there is only ONE reflection between the TDR and the trace under test.

All TDRs used for impedance measurement have an internal impedance of 50 Ohms as does the internal connection to the front panel and the coaxial cable that leads to the probe.

As the TDR works most accurately when working with a single impedance change between its output and the circuit under test it makes good sense to use the IP 50 (50 Ohm probe) as the preferred choice for impedance testing.

**Variable Pitch probes..**

Some test coupons are designed with different footprints, for small numbers of tests and engineering work its possible to overcome this with a variable pitch probe such as the IP 50-V

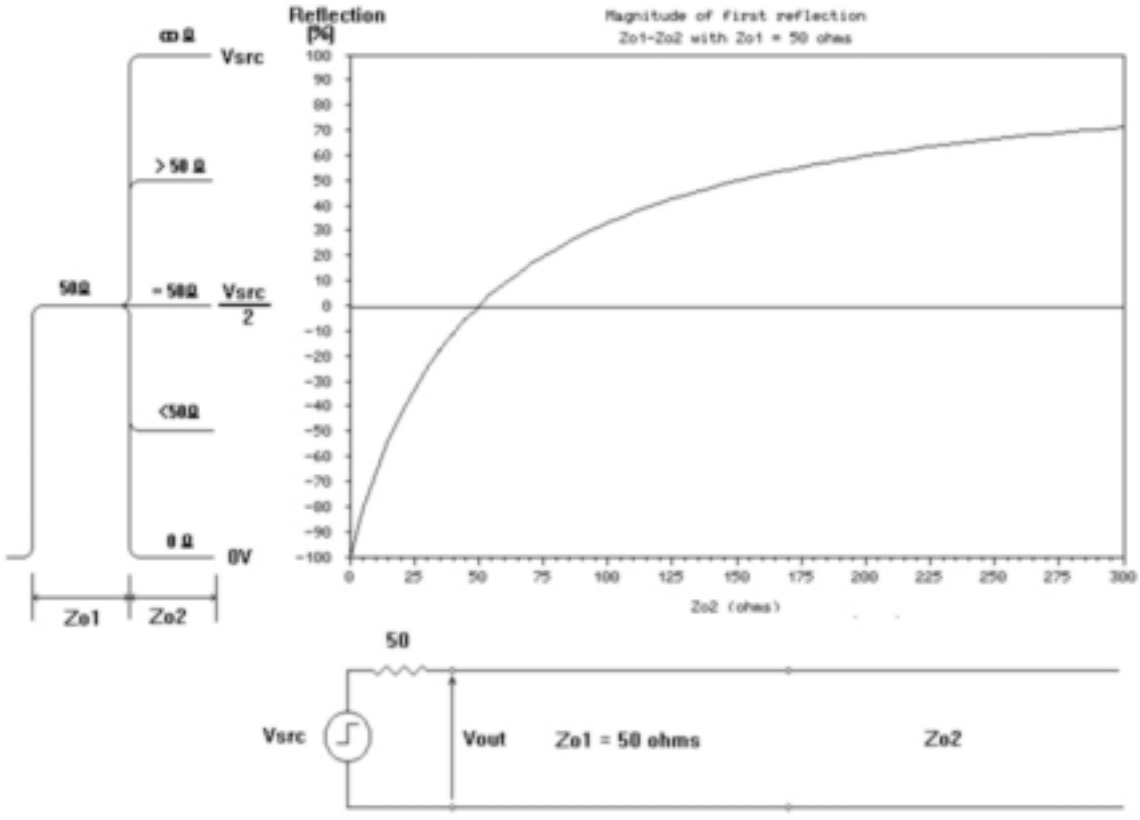
In production use fixed pitch probes are recommended as variable pitch probes are designed for occasional use and are not suitable for continuous operation.

It is recommended that wherever possible you design coupons with a standard pitch to minimise the need for different variations.

Bulk packs of fixed probes are available and these can be ordered with a user specified pitch for no extra cost.

**Why isn't a longer ground wire fitted to the probe?**
Impedance test systems are making Radio Frequency (RF) measurements. The fast pulse sent out by the test system needs to travel in a good quality controlled impedance environment in order to arrive at the test coupon without degradation. Impedance test systems typically have a 50 Ohm internal impedance and use 50 Ohm high quality cables and finally a good quality 50 Ohm probe. The weakest link in the chain is the connection between test probe and the trace under test.

If the probe tips are too long, or worse a wire with clip is added to the probe ripples (ringing / aberrations) will appear in the area under test, these will degrade both the measurement accuracy and repeatability.

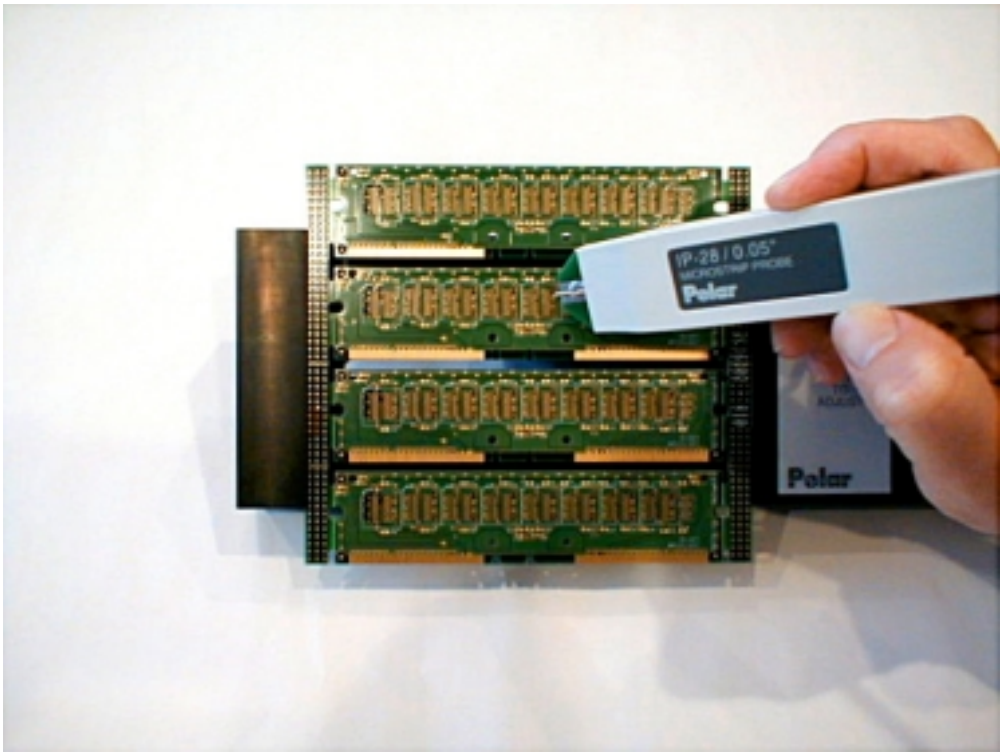



**Why do you offer different probe Impedance values?**
Probe values other than 50 Ohms should only be used for measuring short traces. Ideally you should aim to design coupons and test traces 4" to 6" (100 to 150mm). If you can do this then the IP50 should be your chosen probe.

Perhaps this is the most confusing aspect of probe choice. Imagine probes other than IP50 as "Short trace probes"

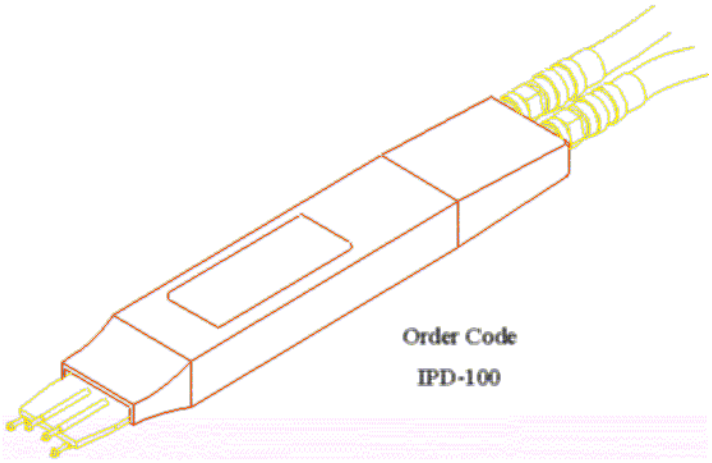
Because impedance measurements are based on the first reflection returning to the TDR it follows that when measuring short traces the probe impedance should match that of the trace under test. e.g. An IP75 should only be used for 75 Ohm traces.

It is an **incorrect** assumption that it is better to measure a 65 Ohm trace with an IP75 "Because it is closer to the trace impedance under test"




**Differential measurements**
You can use a pair of single ended probes, but the ideal solution is to use the IPD 100. The main consideration here is footprint as there are a range of differential test trace footprints in use. Again you should try to standardise the footprints you use to reduce the number of probe variants required.

Internally the IPD 100 is comprised of two uncoupled 50 Ohms lines so it works as a pair of IP 50s, with careful coupon design you can mix single ended and differential tests by selecting the appropriate test method and test channel on the CITS. This will enhance test throughput where you have a range of mixed single ended and differential tests on one coupon.




**For more information?**
Further information on measuring PCB controlled impedances is available by email from martyn.gaudion@polar.co.uk.

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