

PDN Probes

1-Port and 2-Port 50 ohm Passive Probes

power integrity

PDN impedance testing

ripple

PCB resonances

transient step load

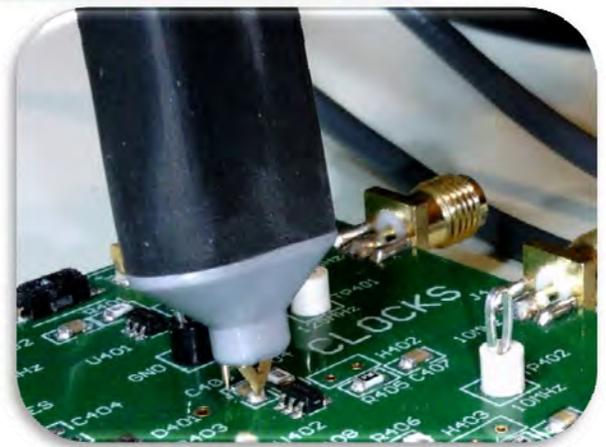
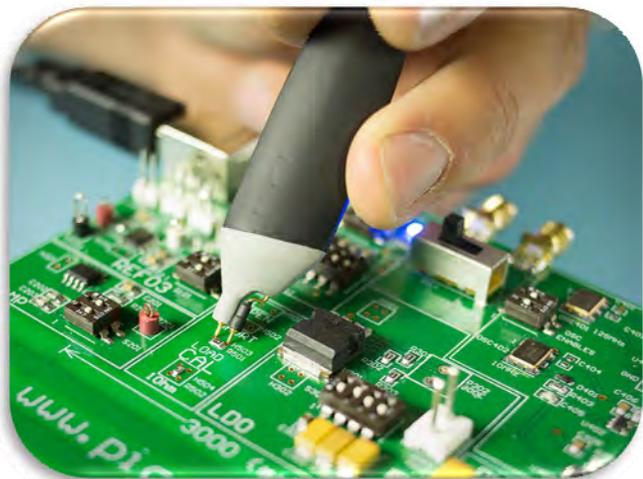
stability and NISM

noise

TDT/TDR

clock jitter

dc blockers



PDN Probes

1-Port and 2-Port Probes

The Picotest PDN probes are 50 ohm passive transmission line probes. These precision, unity (1x) gain, wide bandwidth probes support a variety of measurements including impedance (1-Port Reflection and 2-Port Series and Shunt-thru), step-load, ripple, noise, TDT/TDR, PCB resonance, clock jitter, and non-invasive stability measurement ('NISM').¹

The small and lightweight probe heads are designed for both easy handling and high-performance measurement. The small form factor probe tip and variable pitch ground lead allow you to easily browse different device outputs, component footprints, and test points.

Different accessories for the signal and ground sockets allow the probe head to be connected to a wide range of devices under test ('DUTs').



The probes have some significant advantages over active probes and other types of passive probes.

KEY PROBE CHARACTERISTICS

Transmission line probes are a special class of passive probe that replaces the high impedance probe cable, found in a traditional passive probe, with a precision transmission line. The probe characteristic impedance matches the 50 ohm impedance of your VNA's or oscilloscope's input. This greatly reduces the input capacitance to a fraction of a picofarad, minimizing the loading of high frequency signals sensitive outputs. These probes are referred to as 'PDN' probes, because of their effective use in measuring the low and ultra-low impedances found in Power Distribution Networks.

The input impedance of the Picotest probes remain nearly constant over their entire frequency range. A traditional ± 10 passive probe has a high input impedance at DC, however, this impedance drops rapidly

¹ <https://www.picotest.com/non-invasive-stability-measurement.html>

FEATURES:

- Measure Impedance, Step-Load, Ripple, Noise, TDT/TDR, 2-Port Impedance, PCB Resonances, Clock Jitter and Non-Invasive Stability
- 1x for optimum sensitivity/SNR
- Virtually no capacitive loading < 1 pf
- 50 ohm impedance compatibility
- Single (1 Port) or Dual (2 Ports)
- Wide Bandwidth –1GHz+ *
- Variable pitch ground lead with multiple replaceable tips
- Includes DC Blockers & accessories

HIGHLIGHTS:

- Browser class probes - greatly ease testing multiple power rails
- Eliminates need to solder test cables; reduces the risk of damaging fine copper pads
- Rugged, comfortable, ergonomic design; small form factor gets into tight places

* based on probe to probe S21 measurement. The 2-port shunt impedance measurement capability is dependent on probe de-embedding. A typical probe model is available. The minimum two port impedance measurement is 25mohm, limited by contact resistance.

with frequency, passing below the input impedance of a transmission line probe at <100MHz. Transmission line probes are useful in applications that produce fast rising, narrow pulses with amplitudes that exceed the dynamic range of active probes. They also tend to have less parasitic effects on frequency response and so they are ideal for measuring impedance. By providing a simple, elegant, and flexible solution to probing high-frequency signals, Picotest's 1 and 2-Port probes preserve signal fidelity and allow high-bandwidth test equipment to properly measure circuit characteristics.

The PDN probes have a wide dynamic range and can measure levels up to 5 V (RMS) without distortion. The low inherent noise enables the measurement of small signals. The comprehensive accessory set allows these probes to be connected to a wide variety of DUTs without impairing their very high bandwidth, though the length of the ground lead should be kept as short as possible.

Impedance Measurement Demands New Probe Capabilities

High speed applications put pressure on the measurement of power supply busses to unprecedented frequencies. As an example, the measurement of PDN impedance for FPGAs, ASICs, and high-speed digital devices generally requires the measurement of impedance levels in the milliohm scale at frequencies exceeding 1GHz. Measuring the high speed step load response in power systems using 2-ports is difficult because of the need to connect two 50 ohm transmission lines to the output capacitor. Compounding this difficult task is that these measurements often need to be made on very small circuits such as cell phones, solid state disk drives, and computer tablets; to name just a few examples.

Bi-Directional - Monitor OR Inject

Both probes are bi-directional. They can be used like a traditional probe to record signals or used to inject stimulus. For example, by connecting the 1-port probe to the J2150A Harmonic Comb Injector you can inject wide-band signal into your power rails in order to look for power plane resonances or troubleshoot EMI problems². The 2-port probe can be used to transmit a stepped load current pulse through one port, while measuring the voltage response from the other port, simultaneously.

These revolutionary probes alleviate many physical testing challenges associated with traditional probes while maintaining the precision 50 ohm characteristics required for a wide variety of measurements.

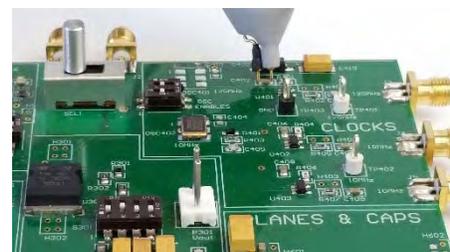
- Slim body with extended tips provides good visibility of the target; gets into tight places



- PDN probes are bi-directional

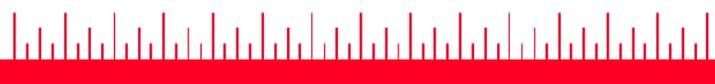


- The 2-Port probe can measure low impedances and supports transient load step browsing



- The 1-Port probe supports a wide variety of key measurements

² https://www.picotest.com/products_J2150A.html



KEY PROBE APPLICATIONS

1-PORT PROBE APPLICATIONS

Shown below are some sample applications using the Picotest 1-Port probe. The 1-Port probe is extremely versatile. It can be used to make both time and frequency domain measurements. The following examples depict ripple and stability measurements.

RIPPLE AND NOISE

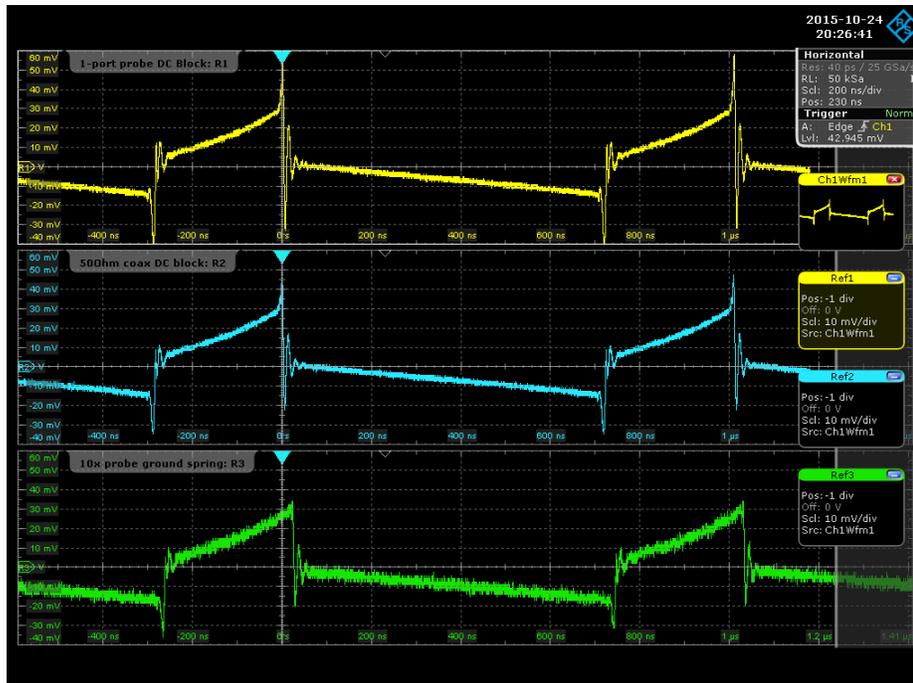
The LM20143 Flat Impedance Demonstration Evaluation Board, available from Picotest, is the shown in the figure below. This board is used to illustrate and teach good VRM design practices.

The probe is placed at the output of the LM20143 voltage regulator. While the 1-Port probe can measure impedances larger than about 0.5 ohms in the frequency domain, here the probe is used to measure time domain noise and ripple. In this case, the oscilloscope image below shows three different ways of measuring the output ripple; directly via an SMA cable connection, with a 10x 500MHz scope probe, and lastly, with the Picotest 1-Port probe.



The 1-port probe is terminated into a P2130A DC Blocker and a 50 ohm scope input.



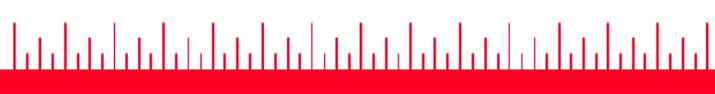


Comparison of the ripple measurement using the three different methods. Note that the 1-Port probe (top) has about the same fidelity as the direct connection (middle) while the 10x scope probe is noisier (bottom).

NISM STABILITY MEASUREMENT

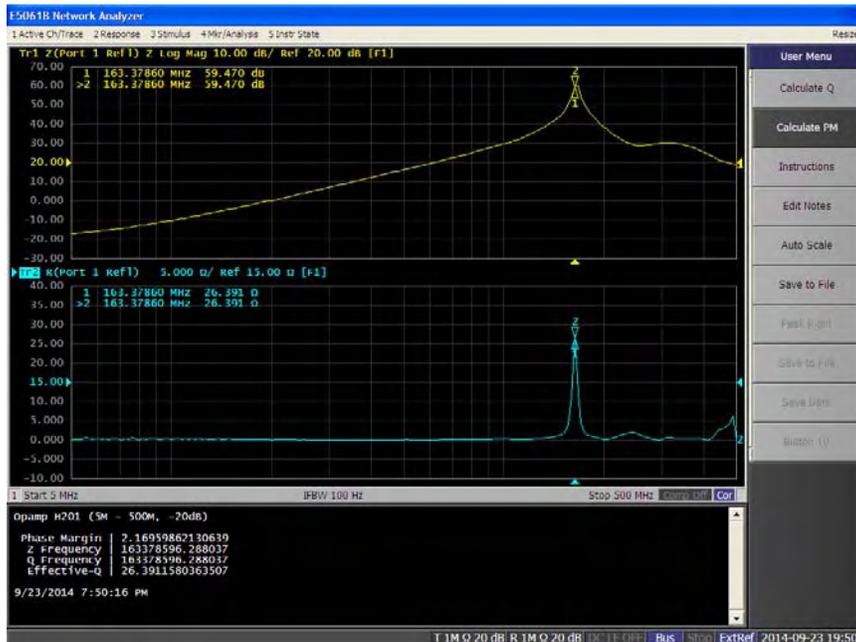
Non-Invasive Stability Measurement, or NISM, is a powerful technique for measuring the stability of control loops. The NISM software, embedded in commonly used VNAs, converts output impedance to phase margin. This is extremely useful considering that many of today’s power ICs do not have their control loops exposed, and in fact, in those cases, NISM is the only way to make an accurate stability measurement.

In this example, the output impedance of a voltage reference is measured. The VNA, in this case the Keysight E5061B VNA, is used to measure the impedance at the output of the reference. The impedance is then converted to phase margin using a simple cursor measurement as shown below.

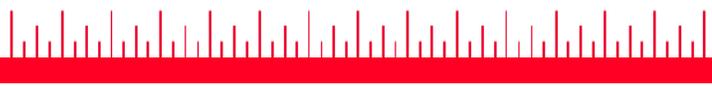




The 1-Port probe is used to make an output impedance measurement of a voltage reference.



The NISM software (add-on software package) for the E5061B converts impedance into phase margin (2.1 degrees) in order to assess stability.



2-PORT PROBE APPLICATIONS

The 2-Port probe can be used to transmit a load current step through one of its ports, while measuring the voltage response via the other port, simultaneously. This is a great advantage when browsing your board's power rails, looking for problems and poor stability. All you have to do is setup the load step range and then simply move the probe to the capacitor at the output of each regulator IC in order to view the transient response.

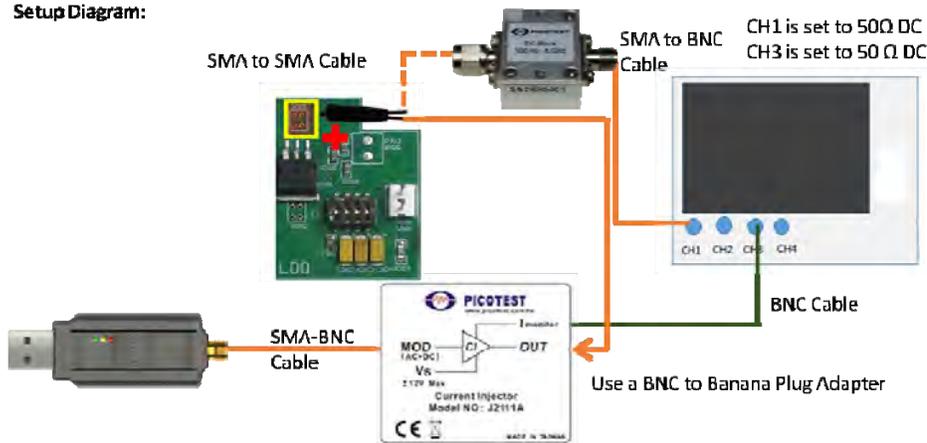
The probe is also essential for performing 2-Port impedance measurements. When the impedance you need to measure is low (less than an ohm), the 1-Port reflection measurement is not acceptable as it can't measure impedance in that range. In low impedance cases, the 2-Port probe, with its near zero capacitance and 50 ohm compatibility, is the perfect option.

REGULATOR LOAD STEP TESTING

In this example of a linear regulator load step test, the J2150A Harmonic comb is used as a simple and portable square wave generator. The harmonic comb drives the Picotest J2111A Current Injector as a high speed electronic load. This setup modulates the load current at the output of the regulator via the J2111A when the probe is applied. The second port of the probe reads the voltage regulator's output excursion response. The P2130A DC blocker is inserted so that the scope and comb port impedances do not load the output of the regulator.

Load step testing doesn't get any easier.

Setup Diagram:



Voltage regulator transient step load setup.





The transient step load response of the voltage regulator using the browsing capability of the 2-Port probe.

COMPATIBILITY

The probes can be used with ANY 50 ohm instrument. The probes have a standard SMA connector on each port for connection to the instrument. The 2-Port probe has two SMA connectors, one for each port with a common ground. For BNC input terminals, a BNC to SMA adapter, such as the one included in the PCK01 High Performance Cable and Connector Kit, is required.

ADDITIONAL ACCESSORIES

The probes are supported by a wide range of separately available signal injectors and accessories, such as preamplifiers, and high speed current injectors.

The PCK01 High Performance Cable and Connector Kit contains a variety of connectors and cables and is highly recommended complement to the either or both probes.

INCLUDED ACCESSORIES

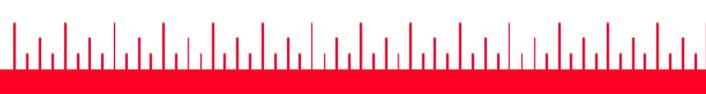
The probes come with a complete set of tips and ground leads (shown below), as well as the P2130A DC blocker (500Hz – 8GHz). One (1) blocker is included for the 1-Port probe, two (2) blockers for the 2-Port probe, and two (2) blockers when both probes are purchased in a bundle (P21B01).

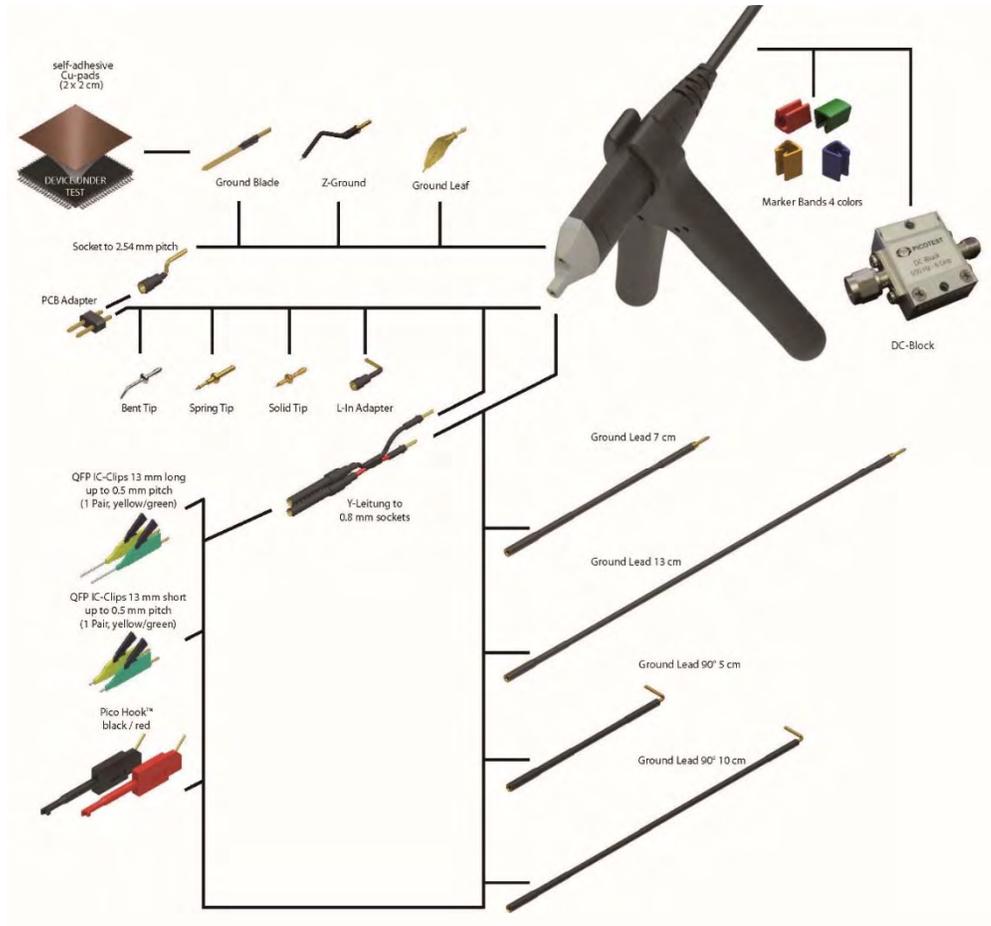


PCK01 High Performance Cable and Connector Kit



Each Probe comes with the P2130A DC Blocker 500Hz – 8GHz.





1-Port Probe Accessory Kit

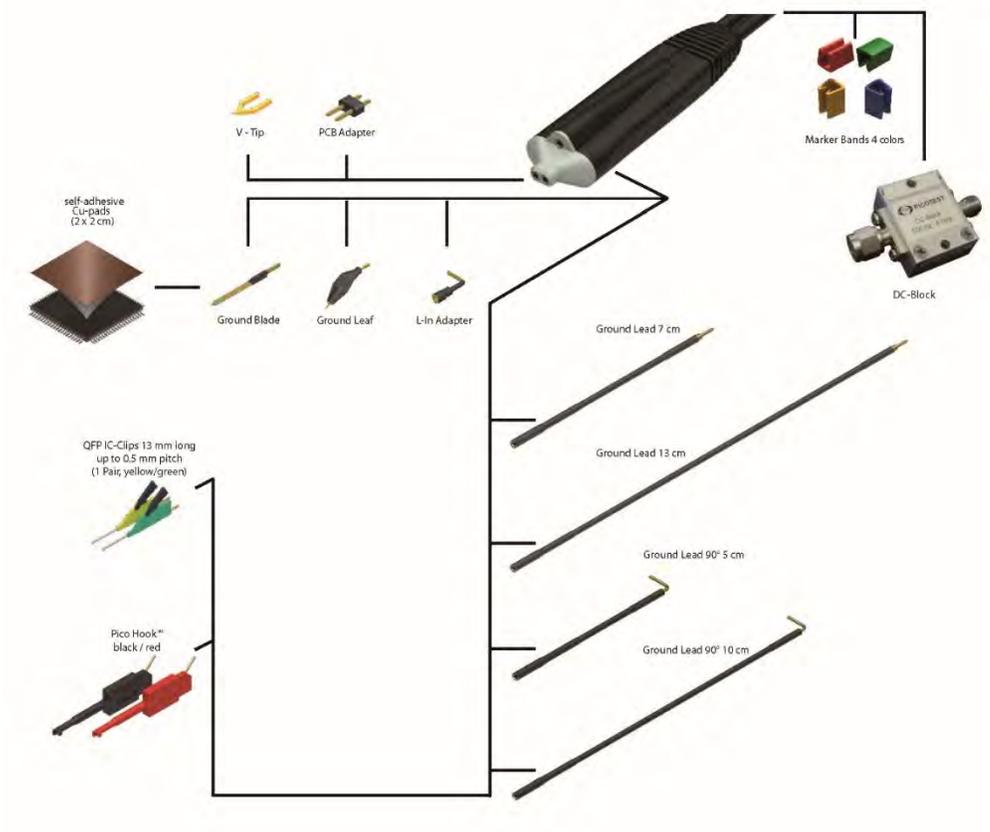


1-Port Probe

ACCESSORY KIT CONTENTS

Item	Qty.
2 Footer Positioner	1
Coding Rings (set) 3x4 Colors	1
Ground Blade 2.5	1
Ground Lead 15 cm	1
Ground Spring 2.5	1
IC-Cap 2.5 0.5 mm pitch; green	1
IC-Cap 2.5 0.65 mm pitch; blue	1
IC-Cap 2.5 0.8 mm pitch; grey	1
IC-Cap 2.5 1.0 mm pitch; brown	1
IC-Cap 2.5 1.27 mm pitch; black	1
Instruction Manual	1
Insulating Cap 2.5	1
PCB Adapter Kit 2.5	1
Probe	1
Protection Cap 2.5	1
Self-adhesive Cu Pad (2 x 2 cm)	2
Solid Tip CuBe 0.5 mm	1
Spring Tip gold plated 0.5 mm	1
Sprung Hook 2.5	1

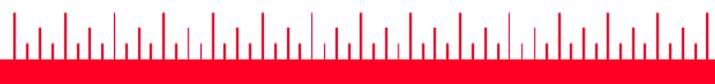




2-Port Probe Accessory Kit



2-Port Probe



SPECIFICATIONS

1-Port Probe	
Characteristic	Rating
Bandwidth	DC-1GHz
Input C:	<1pF, 420fF Typical
Ground Inductance	3.7nH Typical
Input R:	50 ohms
Maximum voltage	5 VRMS
Maximum thru current any port	1Amp
Probe connections	SMA
Probe tip size	0603-1206
Probe impedance	50 Ohm
Port to port isolation	N/A
Rise time	350 ps
Operating temperature	0 to 45° C (32° F to 104° F) at 80% relative humidity
Nominal length with cable	1 meter
Attenuation	1x
Probe-only bandwidth	1Ghz
Probe connection	SMA male
Maximum relative humidity	80% at 31° C max
Usage	Indoor
Altitude	3000 m (9850 feet)
Absolute Maximum Voltage	< 50VAC and 75VDC

2-Port Probe	
Characteristic	Rating
Bandwidth	DC-1GHz
Input C:	<1pF
Input R:	50 ohms
Maximum voltage	5 VRMS
Maximum thru current any port	1Amp
Probe connections	SMA
Probe tip size	0603-1206
Probe impedance	50 ohm
Port to port isolation	TBD
Probe-only Propagation Delay	TBD
Rise time	350 ps
Operating temperature	0 to 45° C (32° F to 104° F) at 80% relative humidity
Nominal length with cable	1 meter
Attenuation	1x
Probe-only bandwidth	1Ghz
Probe connection	SMA male
Maximum relative humidity	80% at 31° C max
Usage	Indoor
Altitude	3000 m (9850 feet)
Absolute Maximum Voltage	< 50VAC and 75VDC

For more information on Picotest products, applications, or services, please contact Picotest.

This information is subject to change without notice.

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Published in USA, 12/15
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Caution: To avoid equipment damage and/or severe injuries death or death do not use this probe close to voltages higher than 50 VAC or 75 VDC. The maximum differential (input to output) voltage for the P2130A DC blocker is 50V (DC+AC).

