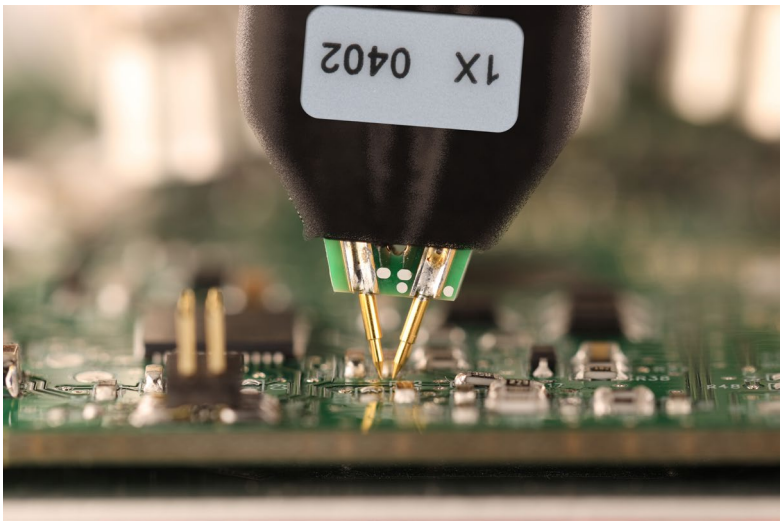
PICOTEST

PDN Probes



Documentation

Version 1.53, January 2022

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Chapter 1 - Overview

Welcome

Thank you for purchasing Picotest's PDN 'Browser' probes.

The Picotest PDN probes are precision passive transmission line 'Browser' probes that support a variety of measurements including impedance (1-Port Reflection and 2-Port Series and Shunt-Through), 3-Port Voltage/Current, Step Load, Ripple, Noise, TDT/TDR, PCB Resonances, Clock Jitter, and the Non-Invasive Stability Measurement ('NISM')[1] [2] [3]. The probes have some significant advantages compared to active probes and other types of passive probes.

The high-bandwidth, fixed-pitch probe tip design enables accurate measurements for a wide variety of component and connector sizes. It eliminates the need for soldering SMA or coax cables to your board and the risk of damaging fine copper pads or pulling up small components. You can get connectivity to circuit boards and devices without connectors.

The probes can be used for 'browser' style measurement. For instance, if you have multiple power rails across your board, the small form factor and easy probe tip placement enables you to quickly browse the regulator outputs, allowing you to decide which rails need further investigation. When coupled with NISM, you have a powerful tool for assessing the stability of multiple power sources no matter the physical configuration.

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[1] https://www.picotest.com/non-invasive-stability-measurement.html
[2] https://www.picotest.com/Power-Integrity-Book.html
[3] https://www.picotest.com/products_J202B.html

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-port impedance is difficult because of the need to connect two 50Ω transmission lines to the output capacitor. To further compound this difficult task, these measurements often need to be made in very small circuits such as cell phones, solid state disk drives, and computer tablets, to name a few examples.

These revolutionary probes alleviate many of these challenges while maintaining the precision 50Ω characteristics required for these types of measurements.

What is a Transmission Line Probe?
Transmission line probes are special types of passive probes that replace the high impedance probe cable found in a traditional passive probe with a precision transmission line, that has a characteristic impedance that matches the oscilloscope's input (50Ω). This greatly reduces the input capacitance to a fraction of a picofarad, minimizing the loading of high frequency signals. The 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 remains nearly constant over their entire frequency range. The probes are useful in applications that produce fast rising, narrow pulses with amplitudes which exceed the dynamic range of active probes. They also tend to have less parasitic effects on frequency response, so they are ideal for measuring impedance. By providing a simple yet elegant and flexible solution to probing high-frequency signals, Picotest's transmission line probes preserve signal fidelity and allow high-bandwidth test equipment to accurately measure circuit characteristics.\

P2104A 1-Port Browser PDN Probe

The P2104A 1-port probe is available in various probe tip spacings (50mil, 60mil, 70mil, and 100mil) allowing good connectivity to various component sizes. It also comes in one of four attenuations (1X, 2X, 5X, or 10X). An AC coupled option providing DC blocking is also available along with the 1X attenuation option. The probes are compatible with all equipment including VNAs, oscilloscopes, and spectrum analyzers. Measurements of greater than 100mohms, approximately, are possible. The range is not dependent on the probe, but inherent in the 1-port reflection methodology.

Figure 1: P2104A 1-port probe

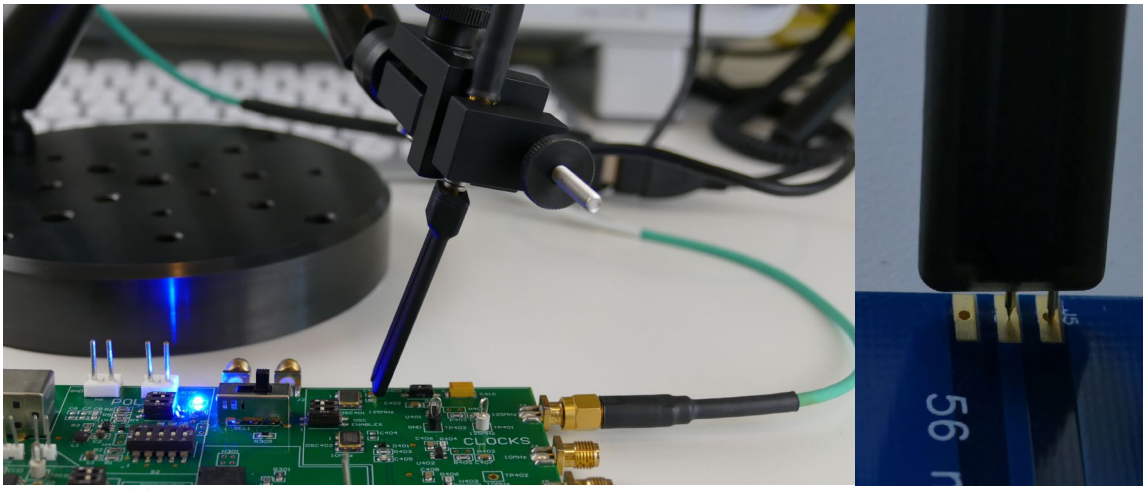


Figure 2: The P2104A 1-port probe comes in fixed pitch widths of 50, 60, 70, and 100mils. A probe holder is a useful accessory.

P2104A 1-Port Probe Feature and Benefit Summary

- High bandwidth - > 6 GHz (uncorrected) Note: USABLE BANDWIDTH FOR VNA WITH CALIBRATION IS HIGHER
- Virtually no capacitive loading (< 1pf, 420fF typical)
- Very flat frequency response (Impedance floor ~ 100mohms for 1-port reflection impedance)

- Supports Browsing Measurement on Multiple Rails
    - Impedance, Ripple, Noise TDT/TDR, 2 port impedance (using two P2104A probes), PCB resonances, Clock Jitter and Non-invasive Stability
- Applications: Power Integrity, Power Electronics, Signal Integrity
- Available in various attenuations and pin pitches: Optimized for sensitivity and SNR
- Integrated series resistor option available for extended measurement range
- Integrated DC Block available for sensitive AC ripple/noise measurements or to reduce DUT loading for impedance measurement.
- Use Two P2104A 1-Port Probes for High Bandwidth 2-Port Measurements
- Bi-directional – send signals to the DUT for signal injection or receive signals from the DUT
- Use as a Browser accessory with Power Rail probes
- 50 ohm impedance compatible with all 50 Ohm instruments
- Rugged, ergonomic design, small form factor gets into tight places
- Slim body with spring tips provides good visibility of the target and reliable connectivity
- Uses PDN Cable ® for optimum performance
- Includes P2100A CAL Calibration Board for SOLT and ISOLATION calibration
- Supports NISM - Non-Invasive Stability Measurement for Phase Margin Testing

P2102A 2-Port Browser PDN Probe

The P2102A 2-port probe comes with four (4) interchangeable, snap on, probe heads sizes (1206, 0805, 0603, and 0402) allowing good connectivity to various component sizes. It also comes in one of four attenuations (1X, 2X, 5X, or 10X). An AC coupled option providing DC blocking is also available along with the 1X attenuation option.

Figure 3: P2102A 2-port probe.

The probes are compatible with all equipment including VNAs, oscilloscopes, and spectrum analyzers.

The P2102A probe is designed to work with the J2102B common mode transformer, or the J2113A ground loop isolator, which eliminates instrument DC ground loops in low impedance measurements.

P2102A 2-Port Probe Feature and Benefit Summary

- Supports Measuring:
  Impedance, Transient Step Load, Ripple, Noise, 2-port impedance, PCB resonances, Clock Jitter, and Non-invasive Stability
- Wide Bandwidth – 300MHz *
- Measures < 1mOhm *, Up to kOhms **
- Four (4) Interchangeable Probe Heads –- Sizes 1206, 0805, 0603, and 0402

- Various Attenuations – 1X for optimum sensitivity and SNR, 2X, 5X, and 10X. Higher attenuation is for higher voltages, impedance, or reduced loading
- True 4-Point Kelvin Measurement
- Browsing capability greatly eases testing of multiple rails and repeat measurements
- Virtually no capacitive loading
- Includes PDN Cables® for ultra-high shield attenuation and ultra-low shield resistance
- Rugged, ergonomic design; small form factor gets into tight places
- Supports Non-Invasive Stability Measurement (NISM)
- Supports the Extended Range 2-Port Shunt-Through measurement

* Calibration dependent
** Using the EXTENDED 2-port setup.

P2105A 1-Port Browser PDN Probe

The Picotest P2105A probe is 50 ohm 1-port transmission line 'Browser' probe for TDR applications. This precision probe supports a variety of measurements using the 1-port reflection methodology including primarily impedance and TDT/TDR, but also ripple, noise, PCB power rail, VRM (Voltage Regulator Module), and clock jitter. It has significant advantages in comparison to active probes and other types of passive probes.

The P2105A is referred to as a 'browser' probe for its ability to quickly and easily be moved from point-to-point/rail-to-rail simply by reseating the probe points. The probe achieves a very low inductance at the tip to mitigate space constraints on a dense PCB, while eliminating the need to add additional SMA connections or other test points necessary for impedance measurements. It is especially useful when there are multiple rails to assess and there is not time or PCB iterations available to provide test point implementations for each. Repeated measurements are simplified because connection is by simply touching the tip to existing trace. The P2105A is available in four fixed pin pitches (31, 40, 50, 60 mil spacing with 1X attenuation).

The probe is compatible with all 50 ohm instruments, including the J2154A PerfectPulse TDR, vector network analyzers (VNAs), oscilloscopes, and spectrum analyzers. The probe is designed to work with the traditional single ended TDR setup.

The center pin is always signal and provides a reference using the probe tip label side. When used with a TDR, getting it backwards won't normally result in any damage. The P2104A and P2105A can do damage if connected backwards to an active power rail.

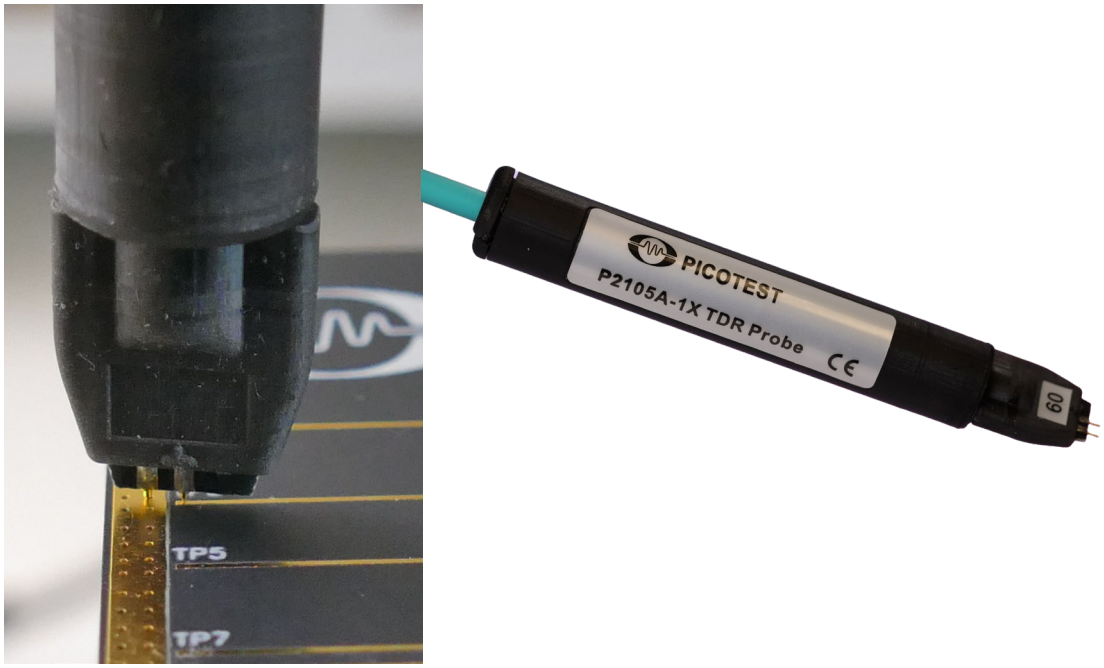


Figure 4: P2105A TDR probe. The P2105A 1-port probe comes in fixed pitch widths of 31, 40, 50, 60, 70, 100mils and GSG SMA. Custom pitches are also available.

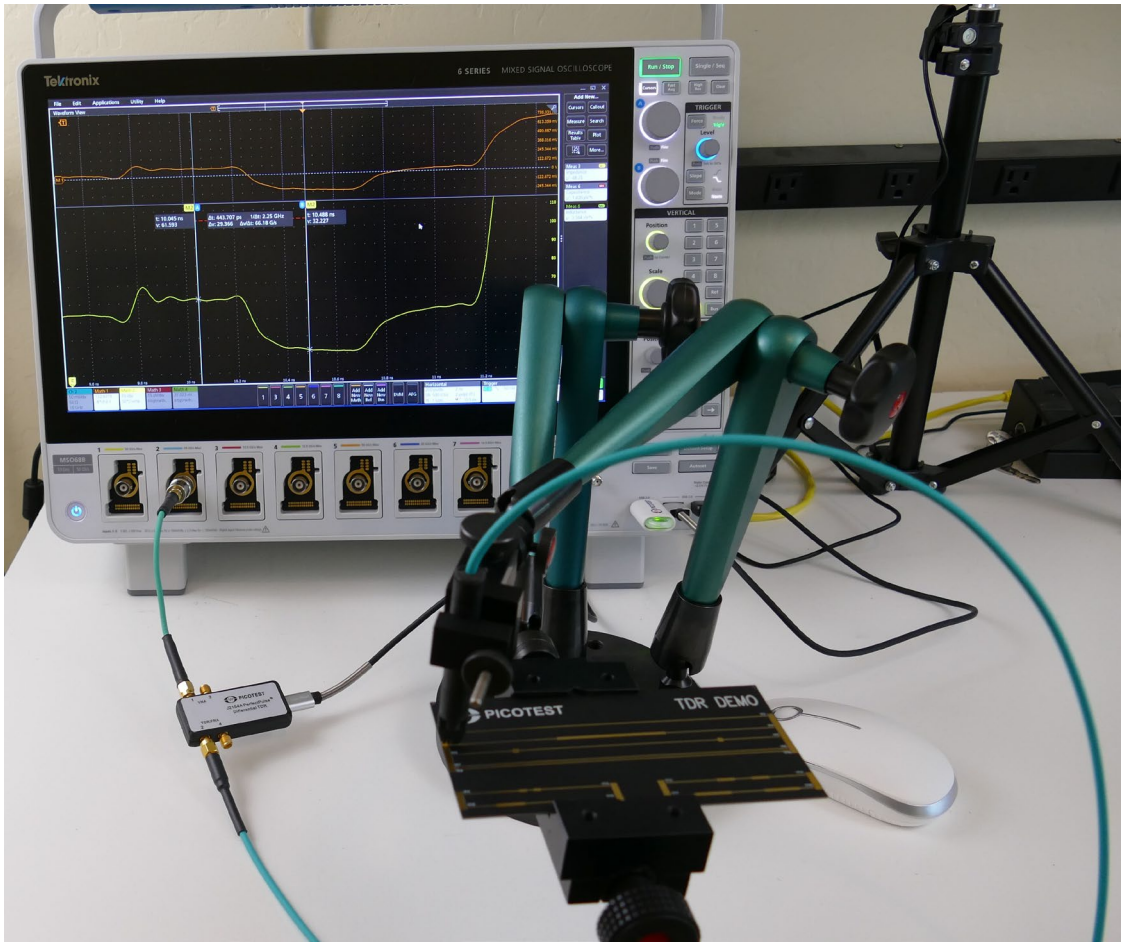


Figure 5: The P2105A TDR probe with the J2154A PerfectPulse TDR. A probe holder is a useful accessory.

P2105A 1-Port Probe Feature and Benefit Summary

- 15GHz Single-Ended Precise High Bandwidth Probe for all Time Domain Reflectometry (TDR) Applications
- Compatible with the Picotest J2154A PerfectPulse TDR
- Fixed pitches available: 31, 40, 50, 60, 70, 100 mils and GSG SMA
- Compatible with all 50 ohm Instruments
- Spring pins for easy landing
- Short pins and integrated, but removable, PDN cable for low coupling and optimum shielding
- Handheld browser style for repeatable and easy probing; Handle design fits most probe holders
- Slim low-profile housing for comfort and visibility

Applications *

- Low-cost PCB coupon tester - Characteristic Impedance PCB traces
- Measure PCB trace length, characteristic impedance, and dielectric constant
- Locate and detect impedance mismatches
- Measure parasitic values of inductance and capacitance such as bond wires, vias, and ESL
- Measure PCB trace path rise/fall time and overshoot/undershoot
- Supports cable and trace loss modeling

* When coupled with the J2154A TDR.

P2106A 1-Port Resistive Divider Probe

The Picotest P2106A probe is a high impedance voltage divider 'Browser' probe, specifically designed to be low bandwidth and resonance free. When paired with the Picotest J2180A low noise amplifier and PDN cable, the low noise measurement can be connected directly to any 50 Ohm instrument, including signal source analyzers, spectrum analyzers, and low-noise oscilloscopes. The P2106A provides one of the lowest noise floor testing solutions allowing measurement of sensitive power supplies for power amplifiers and telecommunications equipment up to 65V.

The bottom resistor is typically 1K and the tip resistor sets the attenuation. The P2106A-20K-20X has approximately a 19K tip resistor and 1K bottom resistor. This ~1kOhm Thevenin impedance forms a low pass filter with the coaxial cable (30pF/ft) and the J2180A low noise preamplifier input capacitance (~36pF) (Fbw=1/(2*PI*1k*125pF)=1.2MHz. There is essentially zero capacitance at the probe tip. The general application is to connect a relatively High Z, uncompensated probe to the J2180A amplifier for the purpose of getting a low noise, low bandwidth signal to a 50 Ohm instrument.

The P2106A is available in fixed pin pitches of 50, 60, or 100mils. The P2106A probe can be purchased in almost any desired attenuation (1:1, 20:1 and User-Defined Attenuations Variable Resistance including 20kOhm). Using an uncompensated voltage divider results in near zero capacitance and is assured to be resonance free for accurate measurement with minimal loading. The uncompensated divider results in a low bandwidth measurement, set primarily by the coaxial cable and J2180A preamplifier capacitance.

P2106A 1-Port Probe Feature and Benefit Summary

- Available in custom attenuations and resistance levels
- Bandwidth – Typically 1-2 MHz
- Low loading, uncompensated assures no peaking
- Supports low noise measurement
- Couples to J2180A preamplifier to reduce noise, convert to 50 Ohm instrument

compatibility

- Available in various attenuations and pin pitches: Optimized for SNR
- Virtually no capacitive loading (< 1pf, 420fF typical)
- Rugged, ergonomic design, small form factor gets into tight places
- Slim body with spring tips provides good visibility of the target and reliable connectivity
- Uses PDN Cable ® for optimum performance

What's Included with Your Probe

Your Picotest Probe kit (P2104A) includes the following:

- 1-Port Probe with PDN Cables
- P2100A-CAL probe calibrator board
- Probe Case

Your Picotest Probe kit (P2102A) includes the following:

- 2-Port Probe with PDN Cables
- P2100A-CAL probe calibrator board
- Probe Case

Your Picotest Probe kit (P2105A) includes the following:

- TDR Probe with PDN Cables
- TDR Demo Board
- Probe Case

Your Picotest Probe kit (P2106A) includes the following:

- 1-Port Probe with PDN Cable
- P2100A-CAL probe calibrator board
- Probe Case

Documentation and Support

This documentation details the use of various probes. Specifications for the individual probes are also included. The support section of Picotest's web site, https://www.picotest.com/support.html, contains additional documentation and various publications on testing power supplies, regulators, and other equipment using the Picotest probes.

Warranty

Every Picotest product you buy from Picotest.com is backed by a 1-year manufacturer's warranty. For warranty service or repair this product must be returned to a service facility designated by PICOTEST. Please contact your local service representative for further assistance.

Chapter 2 –PDN Probes Usage

Introduction

The PDN probes have a wide dynamic range and can measure up to various voltage levels without distortion (see specifications table for the voltage ranges for different attenuations). The low inherent noise enables the measurement of small input signals. The P2104A and the P2102A may be used with any 50 Ohm instrument. Both are bi-directional and can be used like a traditional probe to record signals, as well as to inject stimulus (load step currents or EMI). The probes are especially useful for VRM/stability measurements.

Usage notes:

- Variable pin compression means variable inductance and coupling. It is recommended that the same pressure/pin depression be used for calibration and actual testing. There may be an uncertainty of 100-200 pH.

- The resistors on the calibrator board are all 49.9 Ohms. Very small resistors are used to stay out of the way of the pins and to present minimum parasitic inductance.

- The 2-port SOLT fixture removal calibration works well for low impedance testing. Consult your VNA's or oscilloscope's user manual for details on performing probe calibration.

- Full 2-port calibration with isolation is important if you want measure inductance values below a few nH.

- Typical cable markers are placed on the cables/probe head for identifying the ports and the probe head has an indent in the housing for the tip side while the ground side is flat and smooth.

- It is recommended that the pads used for testing be oversized by 20% if possible, to make it easier to land the probe. For instance, the calibrator pads are about 20% oversized.

- Two 1-port P2104A probes are generally better than one 2-port P2102A probe for coupling and pin length, but harder to use and generally require probe holders to fix the relative angle.

- Excessive pressure on the pins can damage the pin springs leaving the pin stuck in a depressed state. The pins can be replaced at the factory, but it is recommended that you avoid excessive pressure on the probe tips.

Connecting Your PDN Browser Probe to the Instrument and Making a Measurement

To connect your PDN Browser probe, connect the SMA connector of the probe to the SMA connector on the instrument. If the instrument has a BNC connector, then a SMA to BNC adapter is required.

For measurements on most instruments, configure the settings as follows:

- Input impedance of the channel = 50 Ω
- Unit = V
- Attenuation = 1:1 (for the 1x probe)

Note: Not all instruments will handle this the same way. Instruments that accept the extended range just want to know the tip resistor. Other instruments might want the attenuation.

You can now place the signal and ground pins on the target measurement points in your circuit.

The probe consists of the probe head for connection to the DUT, the probe cable, and SMA connector(s). The 2-port probe has two SMA connectors, one for each port with a common ground.

The probes have standard SMA connectors on each port.

For the P2102A, the positive pins/signals are on the side with the label.
For the P2104A and the P2105A, the positive pin/signal is the pin in the center.

Figure 6: A 2-port measurement using the P2102A probe. Pressure is needed to seat the four pins firmly in place. The probe head should match or be larger than the capacitor you are measuring across. Two pins go on each side of the capacitor.

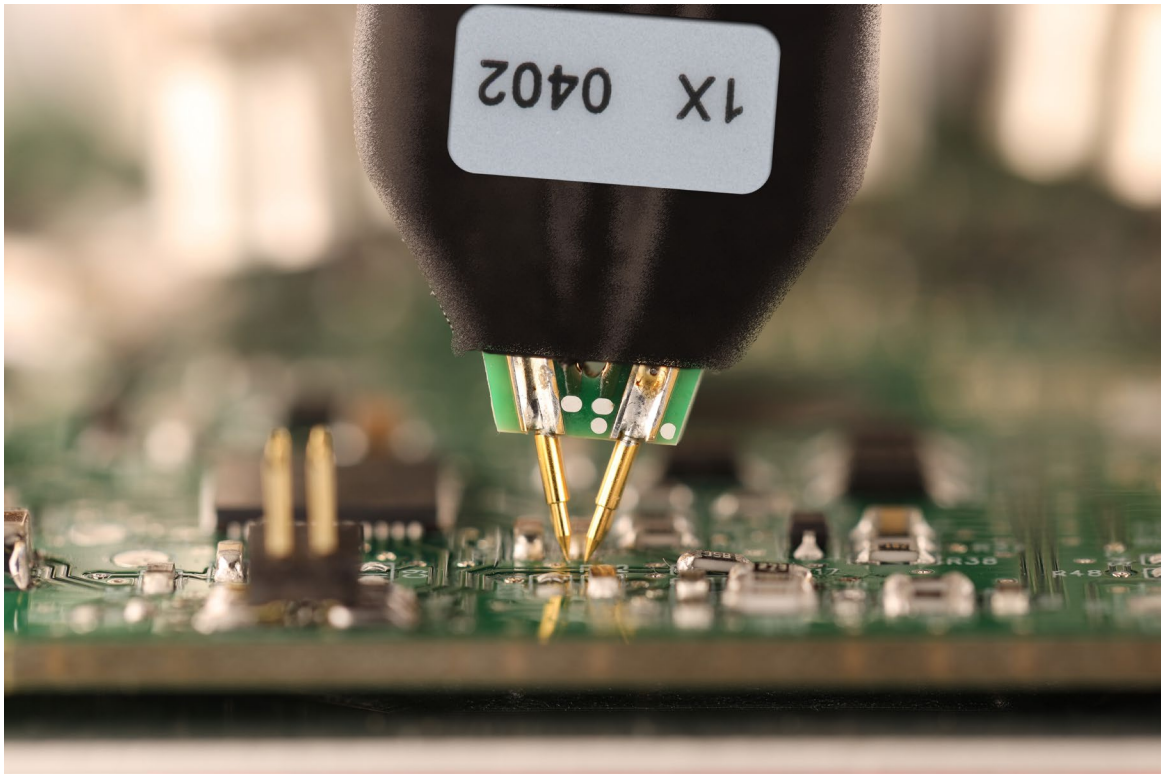


Figure 7: Two signal lines go on the positive side of the capacitor and two ground lines go on the ground side of the capacitor. The positive probe side is the side with the label.

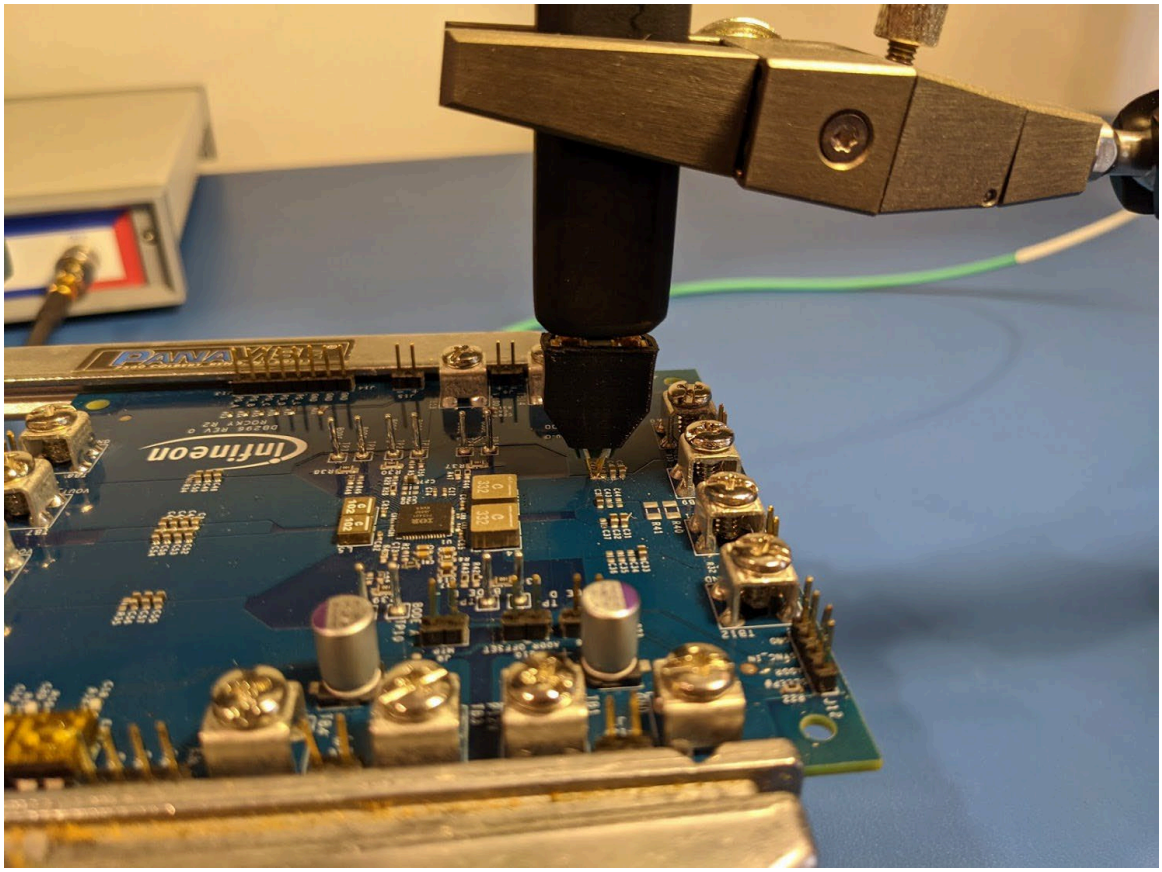


Figure 8: A 2-port measurement using a probe holder which can help supply even pressure for the four pins.

Figure 9: The center pin is the positive pin on the P2104 q-port probe.

Connecting Your P2105A TDR Probe to the J2154A TDR

For more information on connecting and using your P2105A TDR probe, please see the J2154A Differential TDR manual.

Calibration

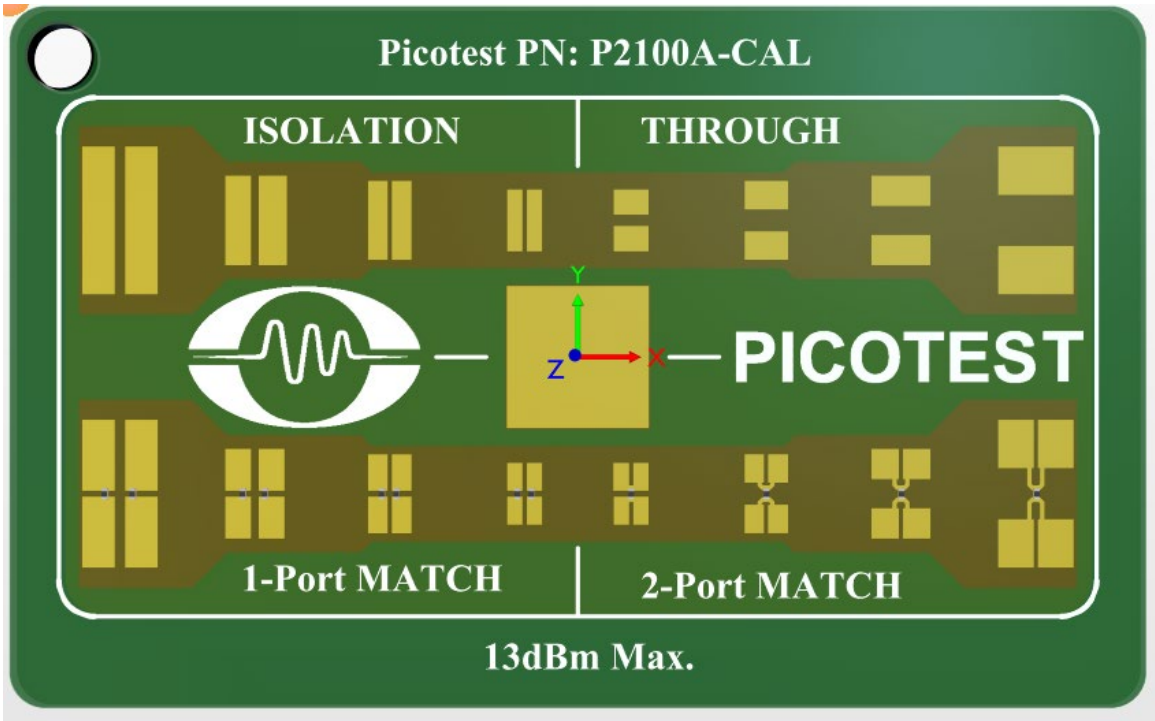


Figure 10: P2100A -CAL probe calibrator board.

See your instrument's user guide for calibration instructions. The calibration process can be measurement (setup) dependent.

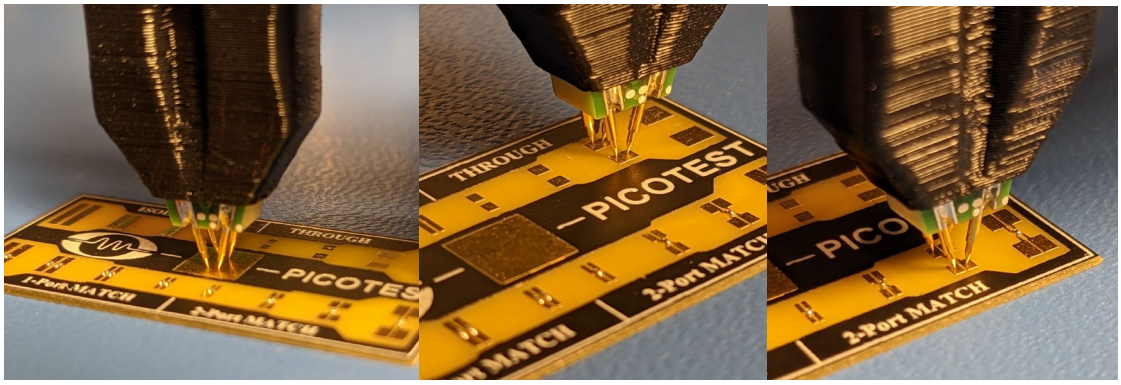


Figure 11: Performing an SOL calibration: Short (left), Open (center), and load (50 ohm, right) calibration.

DC Blockers: When and Why to Use Them

A coaxial DC Block (or Blocker) is used when DC isolation is required to protect sensitive test equipment or RF circuitry. Since the probe impedance of 50 ohms would load low impedance sources, it is often necessary to block any DC current. Either the J2130A DC bias Injector or the P2130A DC Blocker can be used for this purpose. The P2130A has male and female SMA connectors that allow it to be easily connected to the 1-Port and 2-Port probes.

An SMA to SMA cable, or an SMA to BNC cable can then be used to connect the probe to the instrument.

Figure 12: The P2130A DC blocker, available separately.

The P2130A DC Blocker lets through frequencies between 500 Hz and 8 GHz while simultaneously providing low insertion loss and excellent VSWR. Its maximum differential (input – output) voltage is 50V.

Blocks can still damage RF equipment if voltages are exceeded at the instrument. The blocking cap is VERY large to get to low frequency (4uF) so it can transfer a lot of energy. That is one reason for the attenuating probes rather than the blocks.

NISM Stability Measurement (VRTS3 Board)

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 case, the output impedance of a Voltage Reference is measured. The VNA, in this

case the Bode 100, 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.

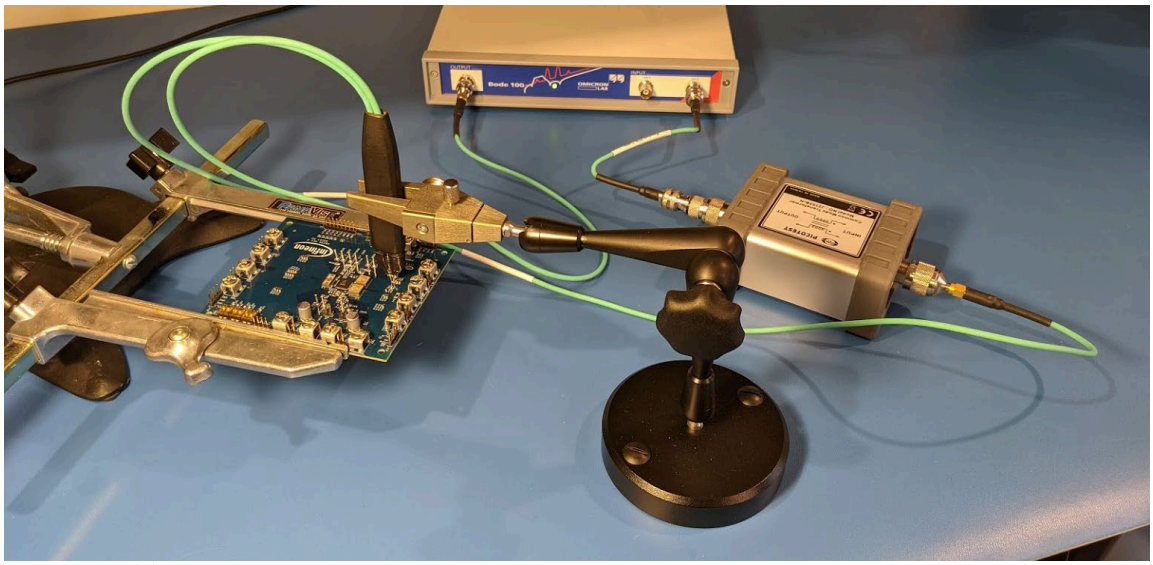
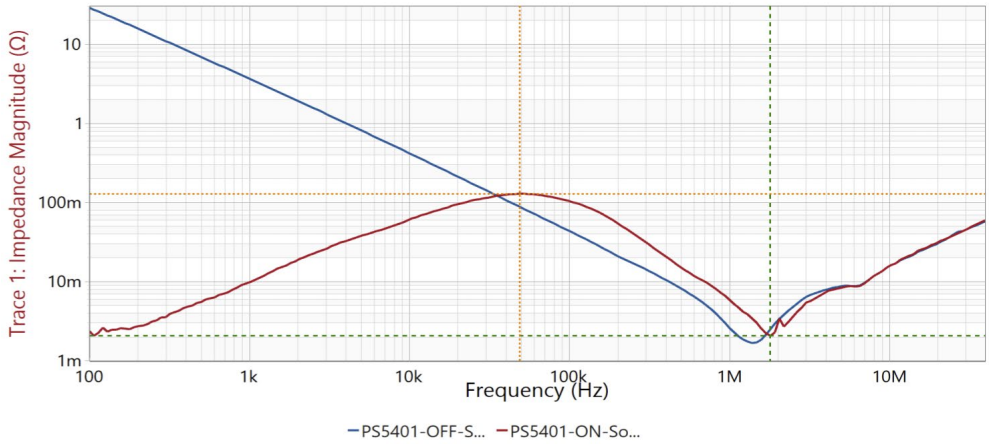
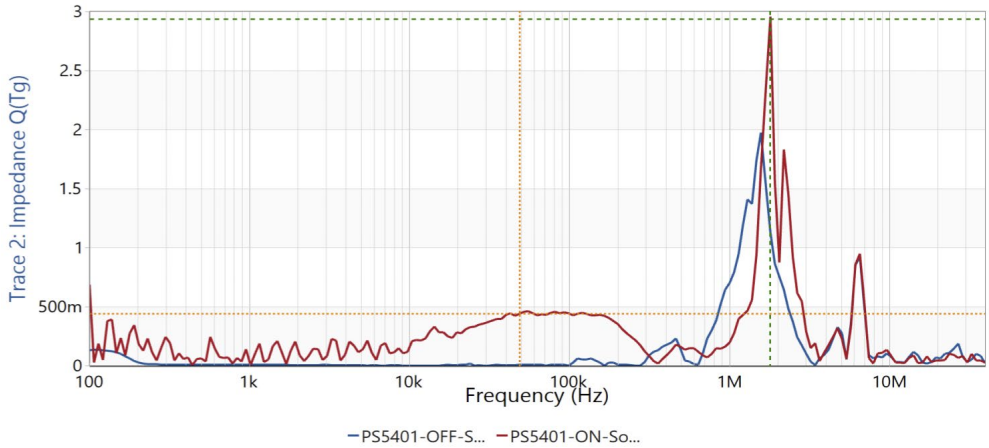


Figure 13: The P2102A 2-port probe in the 2-port shunt-through test setup is used to measure the output impedance at the output capacitor of a power supply. This same test can be performed on any power supply control loop including POLs, switchers, and linear regulators. The software converts the output impedance to phase margin.





	Cursor 1	Cursor 2	
Frequency	1.805 MHz	48.874 kHz	
Trace 1	**Magnitude**	**Magnitude**	
PS5401-ON-So...	2.058 mΩ	127.677 mΩ	
Trace 2	**Q(Tg)**	**Q(Tg)**	
PS5401-ON-So...	2.935	438.715 m	

Phase margin Cursor 1-Cursor 2: >71° of PS5401-ON-So...

Figure 14: Stability of the Infineon PS5401 at C42 is measured using NISM. Top graph is the on and off state impedance. The bottom graph is the QTg waveform. The measurement reveals the phase margin of the voltage reference to better than 71 degrees.

1-Port Probe Applications

The P2104A is a versatile 1-port probe that can be used to support many different tests. Here are few examples.

Signal Injection – Jitter Testing using the J2150A (VRTS3 Board)

The P2104A probe is bi-directional. It can both receive (traditional usage) a signal and transmit a signal.

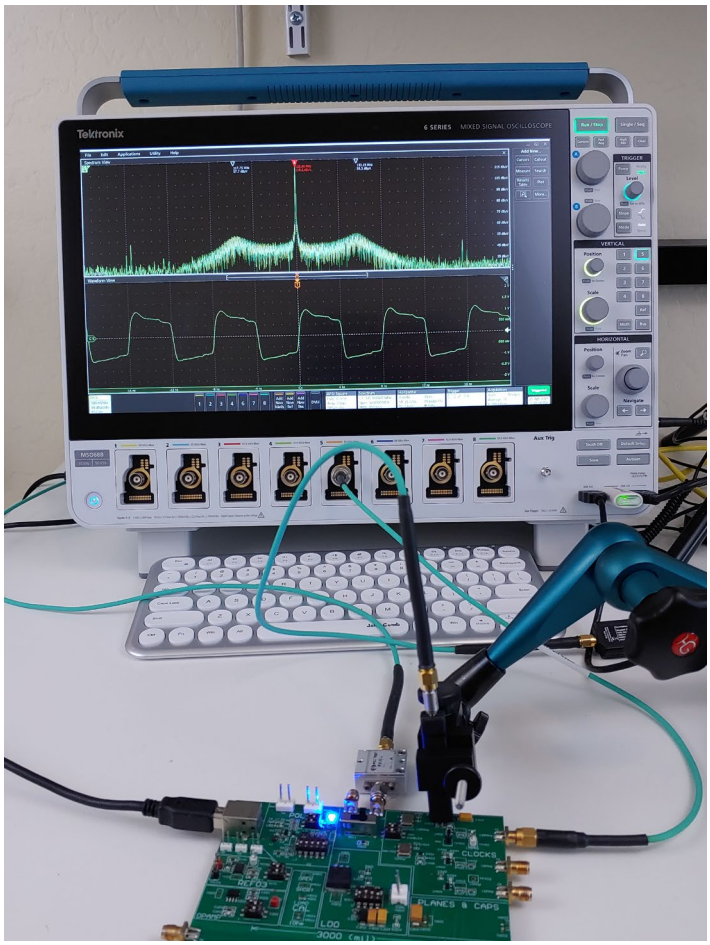


Figure 15: The spectrum domain response is obtained by connecting the output of the J2150A harmonic comb to the P2104A probe and injecting the signal into the circuit to see the impact of noise on the signal jitter.

Testing PCB Traces and Small values of Capacitance and Inductance

The P2104A probe can be paired with the J2154 Differential TDR to measure PCB traces and parasitic inductance and capacitance.

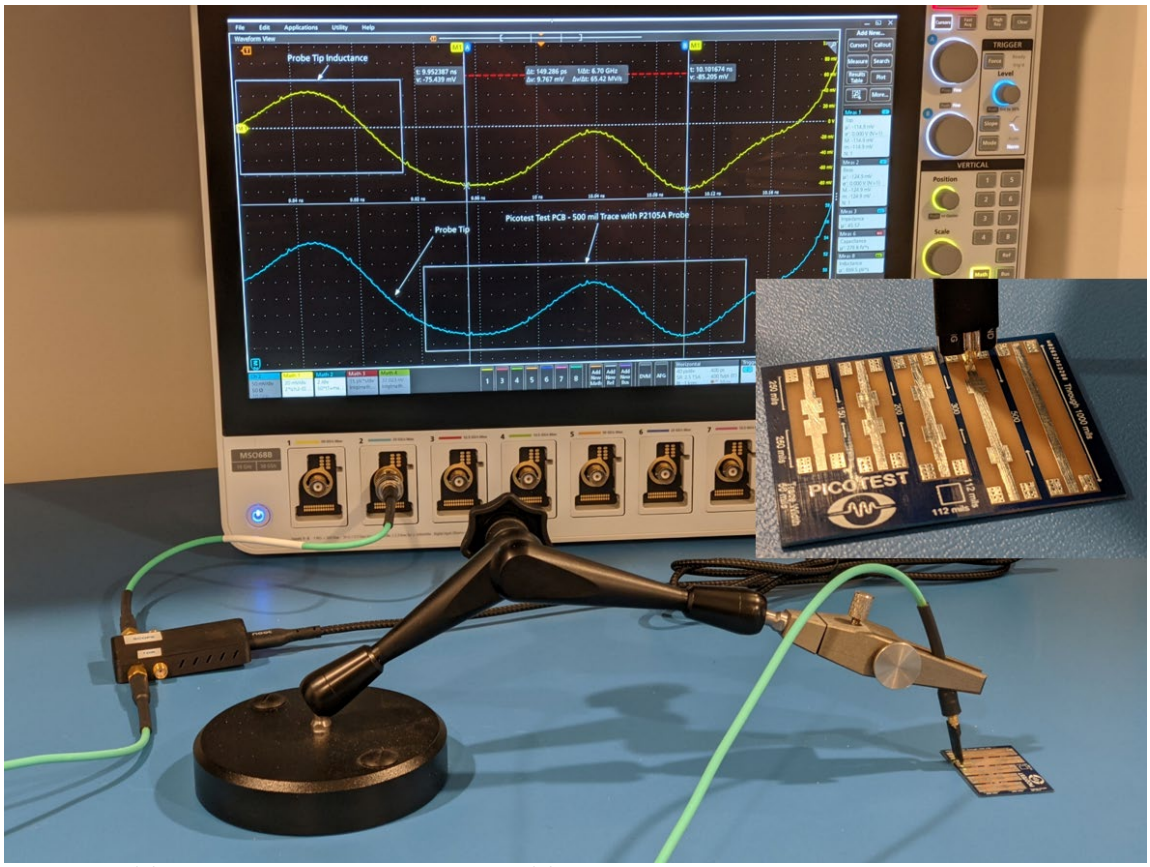


Figure 16: The Picotest J2154A differential TDR (left) can be used with the 1-port probe to test PCB traces for impedance and continuity and for capacitance and inductance elements.

Testing Ripple

The P2104A probe can be used to measure power supply output ripple voltages.

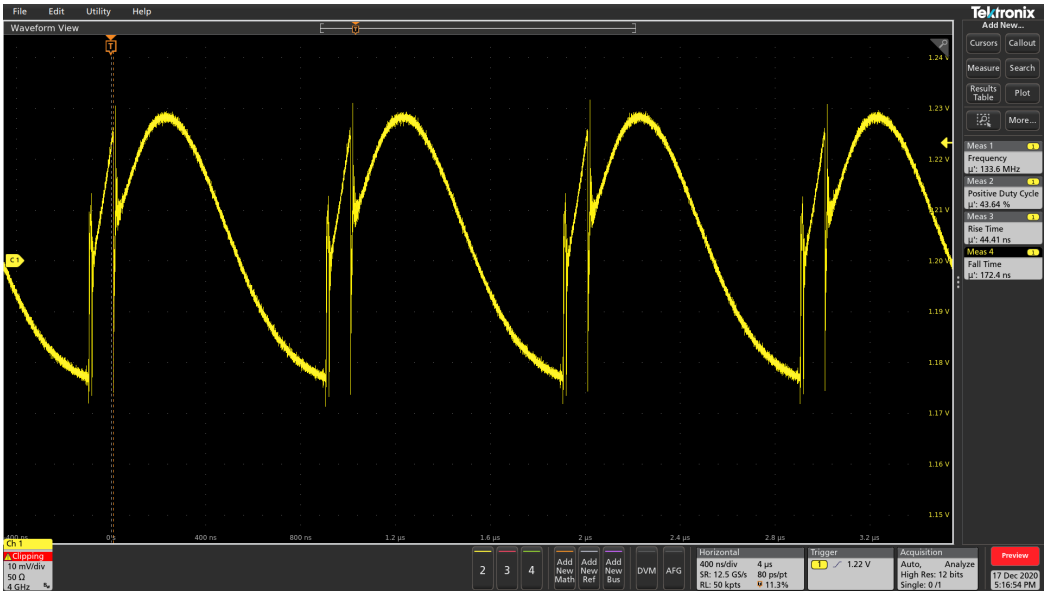


Figure 17: The output ripple of a power supply can be tested simply by connecting the P2104A to the output and ground (across an output capacitor) of a switching power supply.

2-Port Probe Applications

Regulator Load Step Testing (VRTS3 Board)

The 2-port probe can be used to transmit a load current step through one port, while measuring the response from 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.

In this example of a linear regulator load step test, the J2150A Harmonic comb is used as a simple and portable square wave generator (one of its modes of operation). It drives the Picotest J2111A current injector. This modulates the load current at the output of the regulator when the probe is applied. The P2130A DC blocker may be needed so that the scope does not load the output of the regulator.

The impedance and step load are measured in the same way. Load step testing does not get any easier.

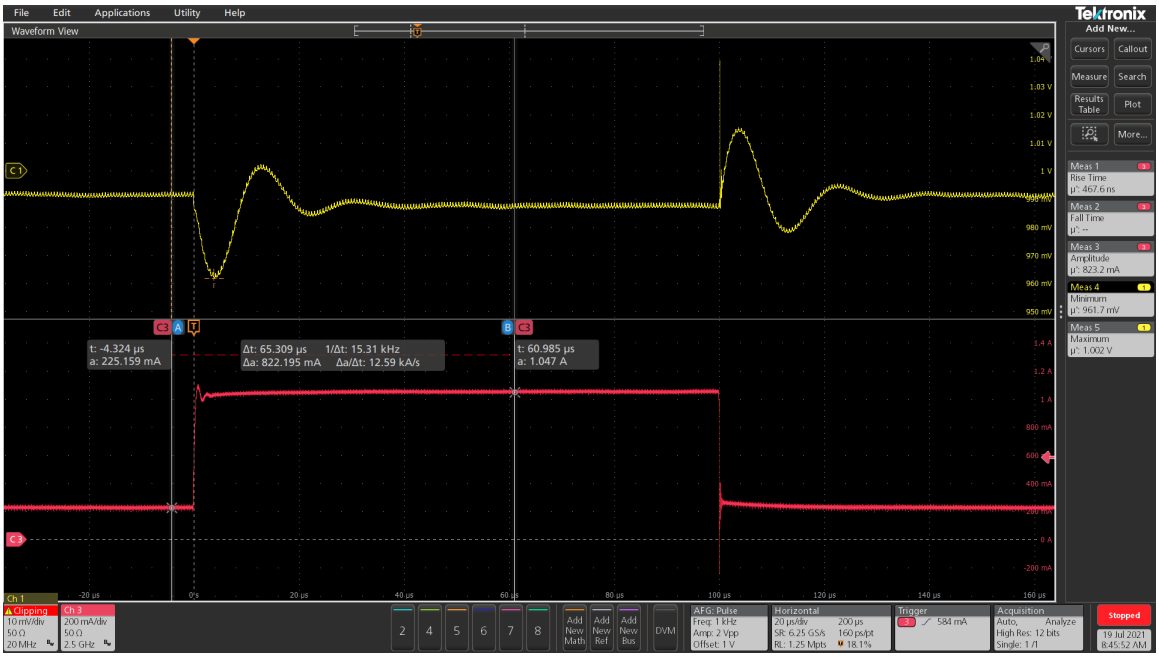


Figure 18: The step load response is shown on CH1 and the applied load step is shown on CH3. The amount of ringing is related to the stability of the system.

Low Impedance PDN Power Integrity Testing (VRTS3 Board)

This sample test measures the output impedance and stability of an LDO using a 2-port probe and a common mode transformer.

The J2102B common mode transformer is essential here, as there is an instrument ground loop which would otherwise distort the low frequency data. Therefore, it is generally required for VNA 2-port measurements.

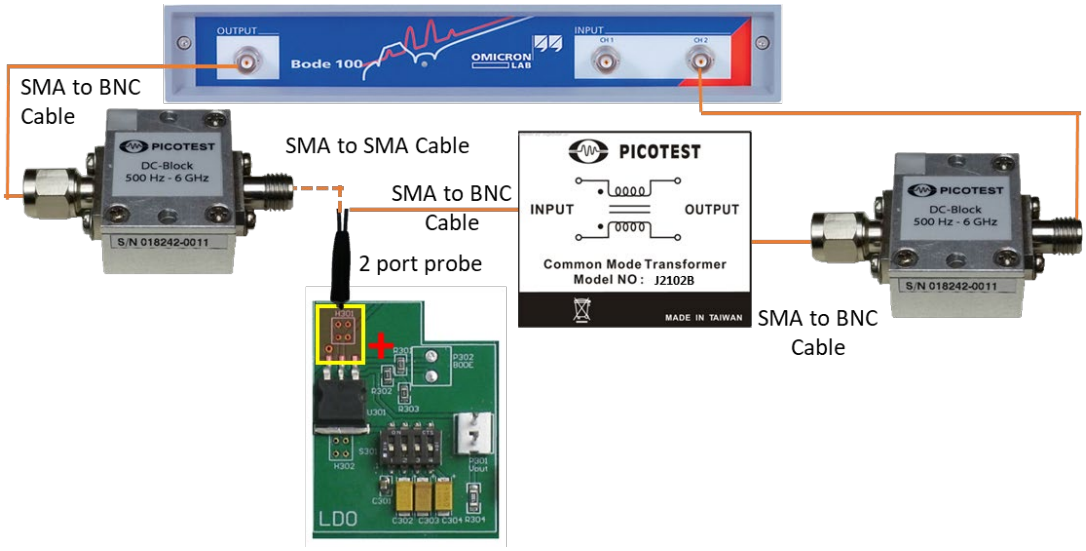
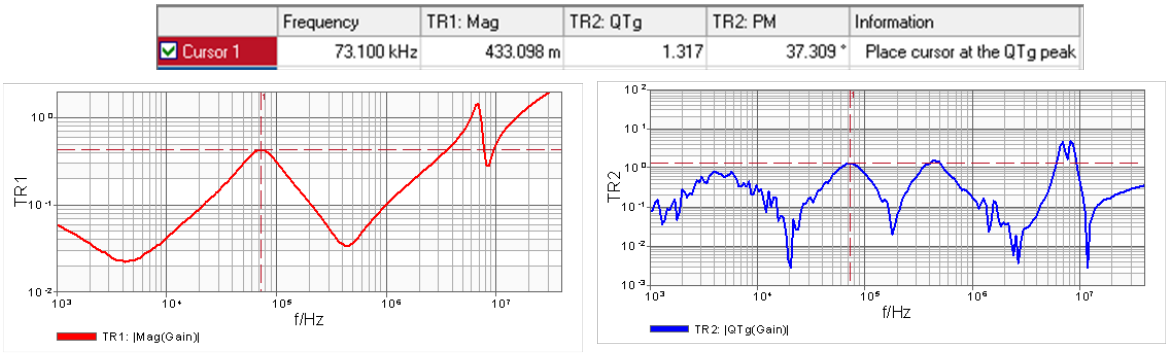


Figure 19: The 2-port probe setup for a 2-port impedance/stability measurement of an LDO. In this case, NISM software is also used to convert the impedance measurement to phase margin (stability). The J2102B common mode transformer is used to break the instrument ground loop that impacts low frequency data.



TR1 is the output impedance of the LDO.

TR2 is the group delay.

Figure 20: The impedance data is shown to the left. The group delay is shown on the right and is converted to phase margin (stability) via a simple cursor measurement and the built-in NISM software.

Chapter 3 – Accessories and Specifications

Specifications

P2102A Specifications

Probe Voltage and Impedance for Different Attenuations	Impedance: Maximum Tip voltage 50 ohms: 5 Vrms (1X Attenuation) 100 ohms: 8.9 Vrms (2X Attenuation) 250 ohms: 11 Vrms (5X Attenuation) 500 ohms: 14Vrms (10X Attenuation)	VNA Port Voltage * 5Vrms 4.45Vrms 2.2Vrms 1.4Vrms

Characteristic	Rating
Bandwidth	DC-300MHz **
Input C:	TBD
Maximum thru Current any Port	1Amp
Probe Connectors	SMA-Mini SMP - 1 meter length, BNC available as an option
Interchangeable Probe Tip Size	Four (4) Included: 0402, 0603, 0805, and 1206
Insulation Resistance	20Mohms
Port to Port Isolation	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, 2X, 5X, or 10X – Selected when purchased, NOT Changeable
Probe Pitch	Fixed
Calibrator Board Resistor Rating	30mW (Supports 13dBm)
Maximum Relative Humidity	80% at 31° C max
Usage	Indoor
Altitude	3000 m (9850 feet)
Absolute Maximum Voltage	< 50VAC and 75VDC

Note: The specifications are subject to change without notice.

* The Maximum Port Voltage shown based on the specified maximum tip voltage. Consult your VNA's manual to verify the VNA port voltage is below the ratings of your instrument.
** The actual bandwidth and minimum measurable impedance obtained are dependent on calibration and your test setup.

P2104A Specifications

Probe Voltage and Impedance for Different Attenuations	**Impedance: Maximum Tip voltage** 50 ohms: 5 Vrms (1X Attenuation) 100 ohms: 8.9 Vrms (2X Attenuation) 250 ohms: 11 Vrms (5X Attenuation) 500 ohms: 14Vrms (10X Attenuation)	**VNA Port Voltage *** 5Vrms 4.45Vrms 2.2Vrms 1.4Vrms

Characteristic	Rating
Bandwidth	**DC-6GHz-8GHz ** 50, 60, 70, and 100 mil pitches 1X Attenuation**
Impedance Range	**Typical 1-port impedance reflection floor -ceiling limits (~100mohms – ~k ohms). Not probe dependent. See your instrument's manual**
Input C:	**<1pF TBD**
Maximum thru Current any Port	**1Amp**
Probe Connections	**MINI_SMP**
Probe Tip Size/ Probe Pitch	**Available in various pitches 50 mil 60 mil and 100mil Probe Pitch is Fixed**
Insulation Resistance	**20Mohms**
Rise Time (1X)	**58ps (100 mil), 50ps (70/60 mil), and 44ps (50 mil)**
Operating Temperature	**0 to 45° C (32° F to 104° F) at 80% Relative Humidity**
Nominal Cable Length	**1 meter**
Attenuation	**Available in various attenuations 1X, 2X, 5X, 10X, DC Block. Selected when purchased, NOT changeable by user**
Maximum Relative Humidity	**80% at 31° C max**
Usage	**Indoor**
Pin Resistance	**Typical: 15m Ohms, Maximum 30m Ohms ****
Altitude	**3000 m (9850 feet)**
Absolute Maximum Voltage	**< 50VAC and 75VDC**

Note: The specifications are subject to change without notice.

* The Maximum Port Voltage shown based on the specified maximum tip voltage. Consult your VNA's manual to verify the VNA port voltage is below the ratings of your instrument.
** The actual bandwidth and minimum measurable impedance obtained are dependent on calibration and your test setup.

P2105A Specifications

Probe Voltage and Impedance	Impedance: Maximum Tip voltage 50 ohms: 5 Vrms (1X Attenuation)	VNA Port Voltage * 5Vrms

Characteristic	Rating
Bandwidth	DC-15GHz **
Probe Tip Size/ Probe Pitch	31mil - 0.7874mm 40mil - 1.016mm 50mil - 1.27mm 60 mils - 1.54mm 70 mils – 1.78mm 100 mils – 2.54mm GSG SMA Custom pitches available
Impedance Range	Typical 1-port impedance reflection floor -ceiling limits (~100mohms – ~k ohms). Not probe dependent. See your instrument's manual
Input C:	<1pF TBD
Attenuation	1:1
Maximum thru Current any Port	1Amp
Probe Connections	SMA
Probe Loading Input	50 ohms
Rise Time (1X)	58ps (100 mil), 50ps (60 mil), and 44ps (50 mil)
Operating Temperature	0 to 45° C (32° F to 104° F) at 80% Relative Humidity
Nominal Cable Length	1 meter
Maximum Relative Humidity	80% at 31° C max
Usage	Indoor
Pin Resistance	Typical: 15m Ohms, Maximum 30m Ohms
Altitude	3000 m (9850 feet)
Absolute Maximum Voltage	< 50VAC and 75VDC

Note: The specifications are subject to change without notice.

* The Maximum Port Voltage shown based on the specified maximum tip voltage. Consult your VNA's manual to verify the VNA port voltage is below the ratings of your instrument.

** The actual bandwidth and minimum measurable impedance obtained are dependent on pin pitch and calibration of your test setup.

P2106A Specifications

P2106A-20X-20K **P2106A-1X-__ (User defined resistance)** **P2106A-__X-__ (User defined attenuation and resistance)**	1-Port Transmission Line PDN Probe Sizes 50, 60, and 100 mil Pitches Available in 1:1, 20:1 and User-Defined Attenuations Variable Resistance including 20kOhm Includes Calibration board and PDN Cable® (1m, SMA-Mini SMP) Delivery time is 4-5 weeks ARO for custom attenuation and connectors.	**P2106A-20X-20K** **P2106A-1X-__ (User defined resistance)** **P2106A-__X-__ (User defined attenuation and resistance)**

Probe Voltage and Impedance	**Impedance: Maximum Tip Voltage** 20 kOhms: 65 Vrms (20X Attenuation)	**SMPM Voltage** 3.25V

Characteristic	Rating
Bandwidth	DC-1MHz * Attenuation can be customized
Attenuation	Available in almost any user defined attenuation Selected when purchased, NOT changeable by user
Probe Tip Size/ Probe Pitch	Available in 50 mil 60 mil and 100mil Fixed Pitches
Input C:	<1pF
Probe Connection	MINI_SMP
Rise Time (1X)	175ns - 350ns
Pin Resistance	Typical: 15m Ohms, Maximum 30m Ohms
Nominal Cable Length	1m
Operating Temperature	0 to 45° C (32° F to 104° F) at 80% Relative Humidity
Maximum Relative Humidity	80% at 31° C max
Usage	Indoor
Altitude	3000 m (9850 feet)
Absolute Maximum Voltage	< 50VAC and 75VDC

Note: The specifications are subject to change without notice.

* The Maximum Port Voltage shown based on the specified maximum tip voltage. Consult your VNA's manual to verify the VNA port voltage is below the ratings of your instrument.

** The actual bandwidth and minimum measurable impedance obtained are dependent on pin pitch and calibration of your test setup.

Safety Information

To avoid personal injury and to prevent fire or damage to this product or products connected to it, review and comply with the following safety precautions. Be aware that if you use this probe assembly in a manner not specified, the protection this product provides may be impaired. Only qualified personnel should use this probe assembly. Do not connect the probe to any voltage that exceeds the maximum permissible input voltage specified in the data sheet. Non-compliance with this instruction carries the risk of an electric shock. Make sure not to cause any short circuits when performing measurements on sources with high output currents. Short circuits may cause injuries or burns.

Risk of injury caused by pointed object
The pins of the probe are extremely pointed and can easily penetrate clothes and skin. Therefore, handle the probe pins with great care. When transporting the probe, e.g. when carrying it in a pocket or tool bag, always use the supplied case. To exchange a probe pin, use tweezers or pliers to avoid injuries.

Use only grounded instruments
Do not connect the probe ground lead to a potential other than earth ground. Always make sure the probe and the measurement instrument are grounded properly.

Observe probe ratings
Do not apply any electrical potential to the probe input which exceeds the maximum ratings of the probe, or the accessories connected to it. In a combination always the lower rating / measurement category applies to both probe and accessories connected to it.

Do not operate with suspected failures
Refer to qualified service personnel.

Indoor use only
Do not operate in wet/damp environment. Keep product surfaces dry and clean. Do not operate the product in an explosive atmosphere.

Handling Information

Handle with care especially when fitted with the extra thin and sharp spring contact tip to avoid any injury. Note that the probe cable is a sensitive part of the probe. Do not damage through excessive bending or pulling. Avoid mechanical shock to this product in general to guarantee accurate performance and protection.

Caution: To avoid equipment damage and/or severe injuries or death ensure that the absolute maximum ratings defined in this manual are observed at all times and never exceeded.

Cleaning

To clean the exterior of the probe, use a soft cloth moistened with either distillated water or isopropyl alcohol. Before use allow the probe to dry completely.

Electrical Specifications

Specifications that are not defined to be guaranteed are typical and are published as general information to the user. To achieve these results, the instrument should have warmed-up for at least 20 minutes and the environmental conditions should not exceed the probe's specified limits.

DC Blockers Electrical Specifications

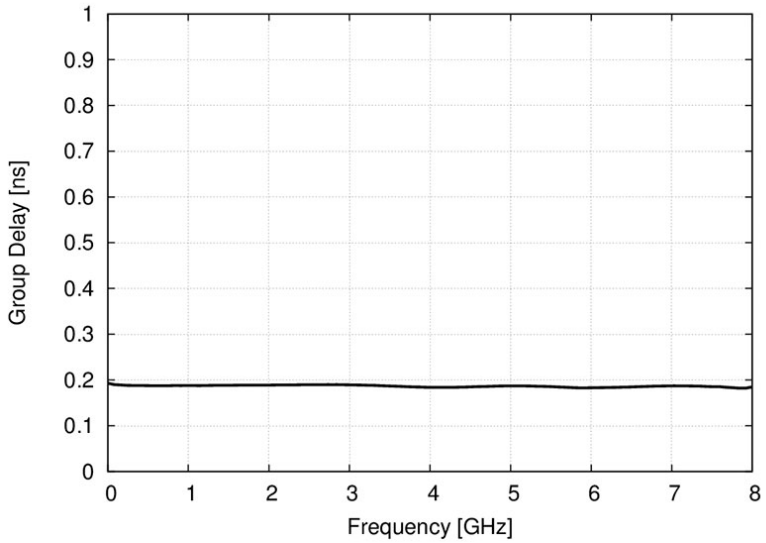
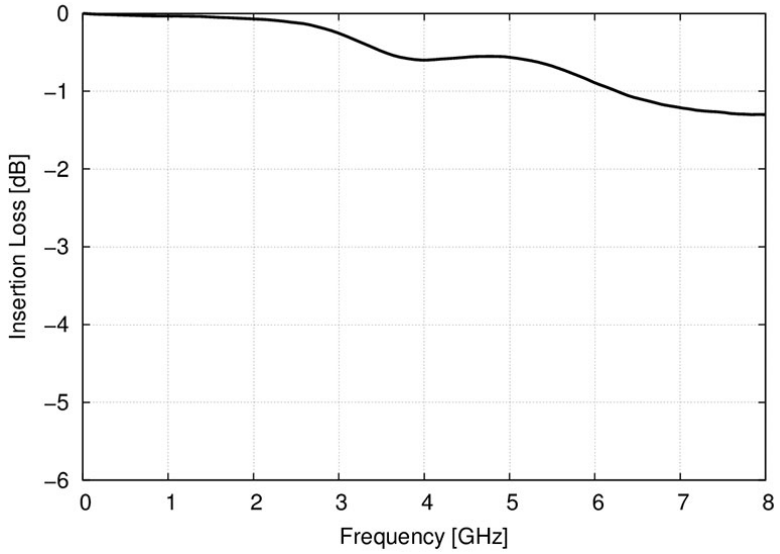
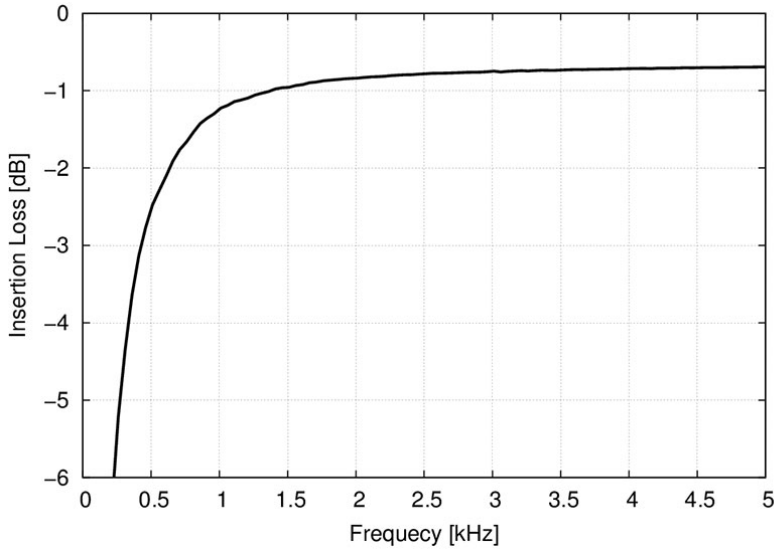


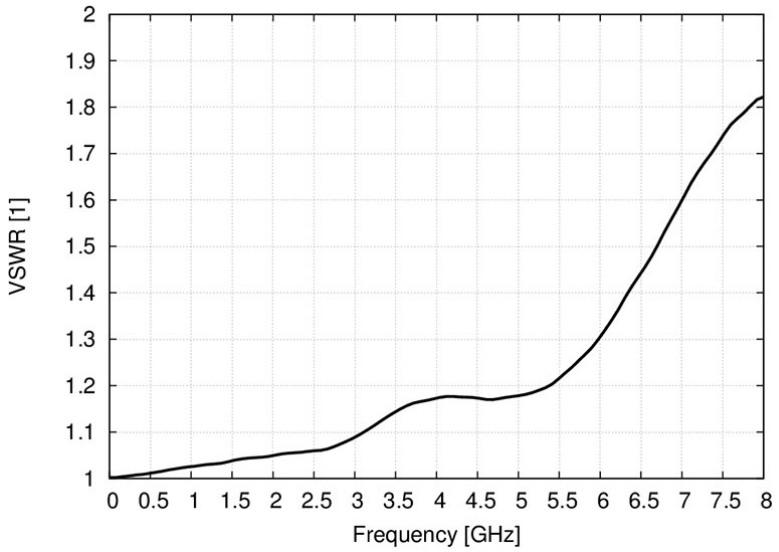
Figure 21: DC Blocker characteristics, DC Block 8GHz Group Delay.



DC Block 8GHz Insertion Loss.



DC Block 8GHz Near DC Insertion Loss.



DC Block 8GHz VSWRs.

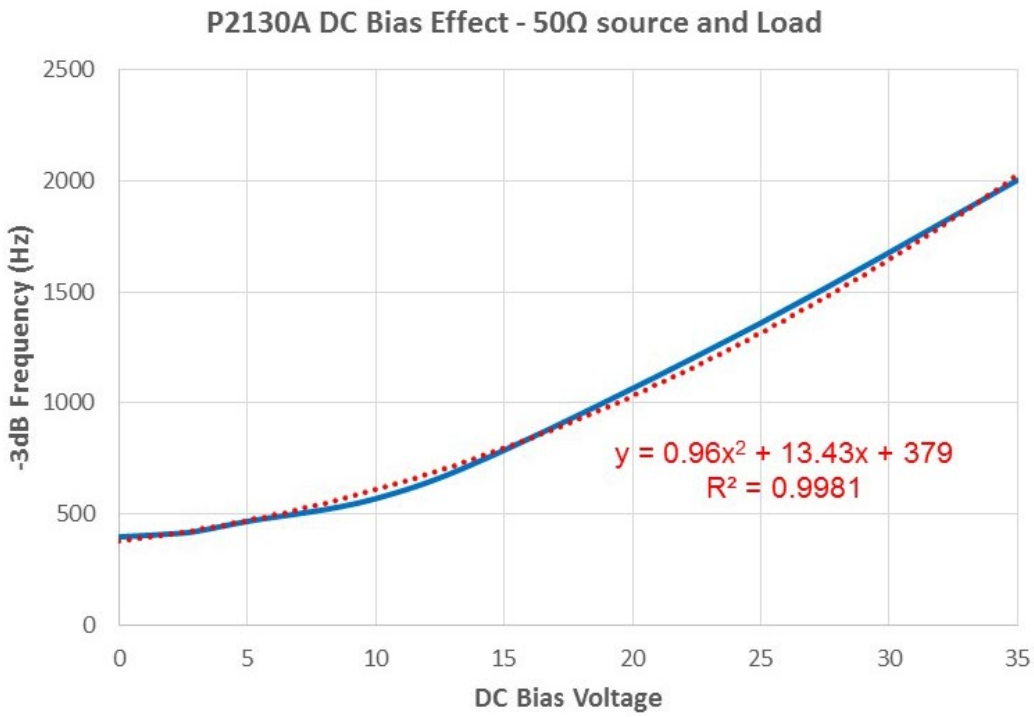


Figure 22: The effect of DC bias on the P2130A DC blocker frequency performance which shifts the - 3dB frequency.