N7020A and N7024A Power Rail Probes for
Power Integrity Measurements

D9010POWA Power Integrity Analysis Application

The Right Tools for the Right Job
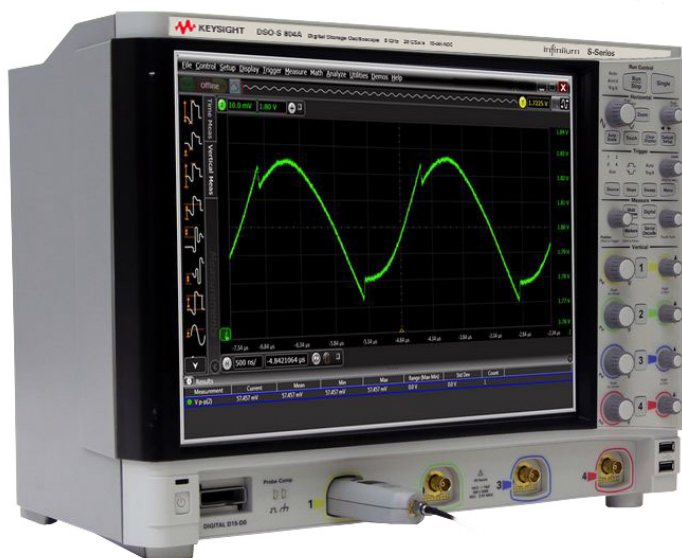

KEYSIGHT
TECHNOLOGIES

Table of Contents

The Need for a Specialized Power Integrity Probe

Would you like to minimize oscilloscope and probe noise when measuring DC power rails? Do you need more offset than is available in your oscilloscope so you can zoom-in to view and analyze small signals on top of DC power supplies? Would you like to have input impedance greater than 50 Ω at DC so your oscilloscope doesn't load your DC power rails? Do you need more bandwidth so you can track down transients on your DC power supplies that can adversely affect your clock and data? If so, the Keysight Technologies, Inc. N7020A and N7024A power rail the right tool for the job.

Developed specifically to help engineers with precise DC power rail testing, the N7020A and N7024A power rail probes were designed to minimize noise and maximize the offset range of the measurement system while providing high bandwidth and low target loading.

The Challenge

The increased functionality, higher density, and higher frequency operation of many modern electronic products has driven the need for lower supply voltages. It is common in many designs today to have 3.3, 1.8, 1.5 and even 1.1 V DC supplies—each of them having tighter tolerances than in previous product generations.

Engineers need to zoom-in on power rails to look for transients, measure ripple, and analyze coupling. An oscilloscope often does not have enough offset to be able to shift the DC power rail to the center of the screen for the required measurements. Even if the oscilloscope being used has enough offset to center the supply on the screen, the oscilloscope will load the supply with 50 ohms to ground and sink 30mA per volt of the supply. This can change the behavior of the supply resulting in inaccurate characterization. Placing a DC blocking capacitor in the signal path eliminates the offset problem but also eliminates relevant DC information such as DC supply compression or low frequency drift.

A low noise measurement solution is of paramount importance so it doesn't confuse the noise of the probe and oscilloscope with the noise and ripple of the DC supply being measured. Using probes (active or passive) that are higher than 1:1 attenuation can help with the offset difficulty but will also decrease the signal-to-noise ratio and negatively affect measurement accuracy. Using the oscilloscope's 50 Ω input with a passive coaxial cable offers a 1:1 attenuation ratio probing method but results in higher-than-desired DC loading of the supply being measured and has the offset limitations mentioned earlier. Ripple, noise, and transients riding on DC supplies are a major source of clock and date jitter in digital systems. Dynamic loading of the DC supply by the processor, memory, or similar items occurs at the clock frequency and can create high speed transients and noise on the DC supply that can easily have content above 1 GHz. Consider the case of a high speed digital designs such as USB3.1 with 10Gbps data rates creating switching transients at 5GHz. Designers need high-bandwidth tools to evaluate and understand high-speed noise and transients on their DC power rails.
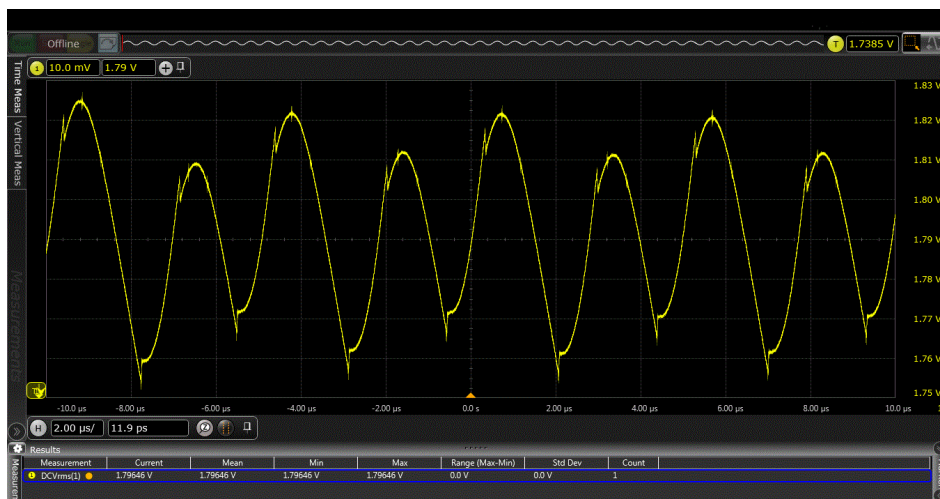
The Challenge (Continued)

Figure 1. Using the N7020A power rail probe, with 2 GHz bandwidth and 50 kΩ DC resistive loading, to see the AC and DC components of a DC power rail.

Power Integrity "What If" Analysis with the D9010POWA PI Analysis Application

Power supply induced jitter (PSIJ) can be one of the largest sources of clock and data jitter in digital systems. Similarly, noise on DC supplies is often caused by switching currents from the transitions of clock and data in these systems. Many designers would like a relatively easy method of determining how much of their systems data jitter is PSIJ and/or how much of the noise on the DC supplies is coming from specific clocks, data lines or other toggling sources.

A common self reflection among power integrity engineers and technicians is wondering if it is worth trying to clean up the supply more--how much margin will it buy back? Or, which of these data lines or toggling signals is causing the noise on the DC supply and how much?

Keysight offers the D9010POWA Power Integrity analysis application for those who are looking for answers to these kinds of questions. The Power Integrity application lets users define a DC supply as either a victim of, or an aggressor to, other periodic transitioning signals and predicts the amount of adverse interaction involved. In this way users can see what their DC supply and/or toggling signals would look like if they were immune to the negative effects of each other. With this insight, users can make informed decisions about what, if any, next steps they would take to clean up the DC supplies.

Key N7020A and N7024A Power Rail Probe Characteristics

Low noise: The N7020A and N7024A power rail are 1:1 attenuation ratio active probes. This low attenuation ratio provides a superior signal-to-noise ratio compared to other probes, both passive and active. This means users are not giving up margin to measurement system noise and get a clear picture of all the details of their signal.

Large offset range: The N7020A has ± 24 V of probe offset and the N7024A has ± 15 V. This enables users to center the signal on screen and zoom-in to observe and measure signal details.

Low DC loading: Both the N7020A and N7024A power rail probes have a large 50 kΩ DC input impedance, minimizing the probe DC loading of the rails it probes.

High bandwidth: With 2 GHz bandwidth, the N7020A power rail probe can capture fast transients and noise caused by switching currents within the user's system. The N7024A power rail probe offers 6GHz bandwidth for those tasked with testing high speed designs where ultra-fast switching currents are problematic.

Figure 2. The Keysight N7024A (top) and N7020A (bottom) power rail probes for power integrity measurements.

Figure 3. N7024A power rail probe and included accessories, N7021A coaxial "pigtail" probe heads, N7022A main cable, N7023A browser, N7032A 4GHz browser, N7033A 5GHz browser and rotating SMA adapter.

Figure 4. N7024A power rail probe and included accessories, N7021A coaxial "pigtail" probe heads, N7022A main cable, N7023A browser (not shown), N7032A 4GHz browser, N7033A 5GHz browser and rotating SMA adapter.

Key measurements

- **Supply drift:** Because the probe passes through both AC and DC signal components to the oscilloscope, it is possible to accurately measure low frequency DC supply drift or supply compression.
- **PARD (periodic and random disturbances):** The probe's extremely low noise means that it will not contribute significant error to measurements of the DC supplies ripple and noise.
- **Load response:** The large input active voltage range of the N7020A power rail probe makes it possible to analyze large deviations of the DC supply that may result from dynamic loading.
- **High-frequency transient and noise characterization:** With 2 GHz of bandwidth, the probe can help characterize transients and noise on the DC supply that may be offensive to clocks and digital data.
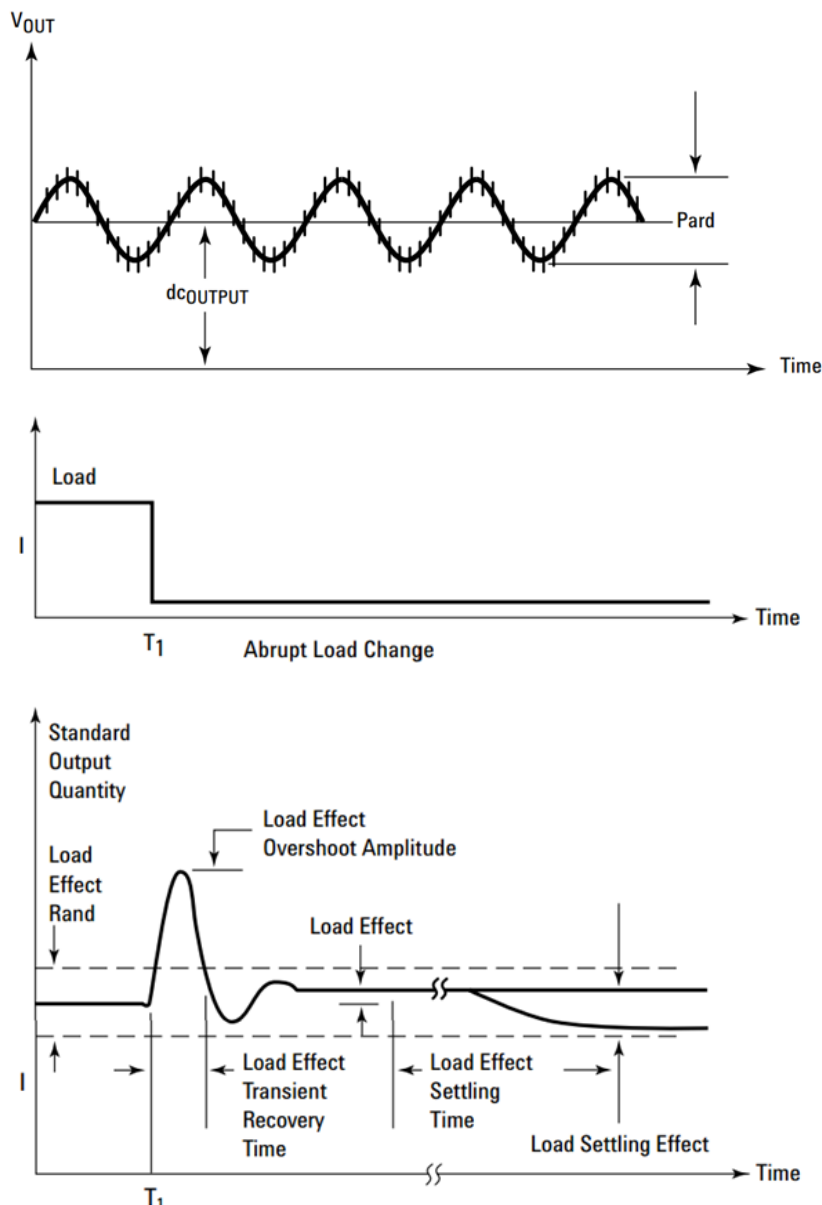

Figure 5. Examples of types of power integrity measurements.

N7020A Probe and Accessory Electrical Characteristics and Specifications

Attribute	Characteristics (based on probe's connection configuration)				
	With N7022A Main Cable	**With N7021A Pigtail Cable & N7022A Main Cable**	**With N7023A Browser**	**With N7032A Browser & N7022A Main Cable**	**With N7033A Browser & N7022A Main Cable**
Probe bandwidth (-3 dB)	2 GHz	2 GHz	350 MHz (using the included ground spring)	2 GHz	2 GHz
Maximum input voltage (non-destructive)			± 30 V peak input		
Attenuation ratio			1.1:1		
Offset range			± 24 V		
Input impedance at DC[1]	50 kΩ ± 2%				
Active signal range			± 850 mV (about offset voltage)		
Probe noise (at 2 GHz)			10% increase in the noise of the connected oscilloscope		
Output termination			50 Ω scope input		
Probe type			Single ended		
Cable length	N7022A main cable: 48"	N7021A coaxial pigtail probe head: 8"	N7023A browser: 45"		
Replacement parts	N7021A Pigtail coax (set of 3)				
	N7022A Main cable				
	N7023A Browser (incl all browser accessories listed below)				
	N4829A probe tip kit				
	N4836A dual-lead adapter				
	N2837A ground lead				
	N4838A ground spring				
	1400-3652 SMD micro grabber				
Compatible accessories not included with the N7020A (orderable separately)	N7032A Browser				
	N7033A Browser				
	1250-4403 rotating adapter				

1. Warranted specification. All other characteristics are typical.

Attribute	Specification	
	N7021A Pigtail Cables/with N7022A Main Cable	**With N7023A/N7032A/N7033A Browser**
Use	For indoor use only	
Temperature	Operating: -40 °C to +85 °C (main cable/pigtail cable) Non-operating: -30 °C to +70 °C (main cable/pigtail cable) Operating: -10 °C to +55 °C (probe pod) Non-operating: -30 °C to +70 °C (probe pod)	Operating: -10 °C to +55 °C Non-operating: -30 °C to +70 °C
Attitude	Operating: 3,000 m (9,842 feet) Non-operating: 15,300 m (50,196 feet)	Operating: 3,000 m (9,842 feet) Non-operating: 15,300 m (50,196 feet)
Humidity	Operating: 25 - 85% room humidity Non-operating: 25 - 85% room humidity	Operating: 80% room humidity for temperatures up to 31 °C, decreasing linearly to 40% at 50 °C 40% at 50 °C Non-operating: 95% room humidity for temperatures up to 40 °C
Pollution degree	Pollution degree 2	

N7024A Probe and Accessory Electrical characteristics and specifications

	With N7022A Main Cable	With N7021A Pigtail cable & N7022A Main cable	With N7023A Browser	With N7032A Browser & N7022A main cable	With N7033A Browser & N7022A Main Cable
		Characteristis (based on probe's connection configuration)			
Probe bandwidth (-3dB)[1]	6 GHz	5 GHz	350 MHz	4 GHz	5 GHz
Maximum input voltage (non-destructive)	± 15 V peak input				
Attenuation ratio	1.3:1				
Risetime (10 to 90%) calculated as: tr=.435/bandwidth	73 pS	87 pS	1.24 nS	109 pS	87 pS
Risetime (20 to 80%) calculated as: tr=.676[1]10/90tr	49 pS	59 pS	.84 nS	74 pS	59 pS
Offset range	± 15.25 V				
Input impedance at DC[1]	50 kΩ ± 2%				
Active signal range	± 0.6 V (± 1.2 Vpp)				
Probe + oscilloscope noise	1.3 times noise of the connected oscilloscope				
Output termination	50 Ω scope input				
Probe type	Single ended				
Included accessories	N7021 coaxial pigtail probe head 8" (qty=3)				
	N7022A main cable: 48"				
	N7023A browser: 45"				
	N7032A power rail probe browser for 0603 and 0805 packages (inch code) (2012 and 1608 metric code)				
	N7033A power rail probe browser for 0201 and 0402 packages (inch code) (1005 and 0603 metric code)				
	1250-4169 SMA adapter				
	1250-4403 Rotating adapter				
Replacement parts	N7021 Pigtail coax (set of 3)				
	N7022A main cable				
	N7023A browser (incl all browser accessories listed below)				
	N7032A browser				
	N7033A browser				
	N4829A probe tip kit				
	N4836A dual-lead adapter				
	N2837A ground lead				
	N4838A ground springs				
	1250-4169 SMA adapter				
	1250-4403 rotating adapter				
	1400-3652 SMD micro grabber				

1. Warranted specification. All other charecteristics are typical

N7024A Environmental specifications

Attribute	Specification With N7022A Main Cable/N7021A Pigtail Cable	Specification With N7023A/N7032A/N7033A Browser
Use	For indoor use only	
Temperature	Operating: -40 °C to +85 °C	Operating: -10 °C to +55 °C
	Non-operating: -40 °C to +85 °C	Non-operating: -30 °C to +70 °C
Altitude	Operating: 4600 m (15,092 feet)	Operating: 4600 m (15,092 feet)
	Non-operating: 15,300 m (50,196 feet)	Non-operating: 15,300 m (50,196 feet)
Humidity	Operating: 25 - 85% RH at 55 °C	
	Non-operating: <to be filled>	
Pollution degree	Pollution Degree 2	

Compatible Oscilloscopes — N7020A and N7024A Power Rail Probe

Compatible with the Keysight oscilloscopes shown below. Up to four probes can be connected to the oscilloscope at the same time. The table also lists the minimum required firmware version for the oscilloscope.

The N7020A and N7024A probes are designed for oscilloscopes with 50 Ω AutoProbe interface channel inputs. The AutoProbe interface provides power and control to the probe.

Table 1. N7020A compatible oscilloscopes

Infiniium oscilloscopes	Required firmware version
S-Series	≥ 5.20
9000 Series	≥ 5.20
Infiniivision oscilloscope	**Required firmware version**
6000 X-Series	≥ 6.10
4000 X-Series	≥ 4.00
3000T X-Series	≥ 4.00
3000A X-Series	≥ 2.39

Table 2. N7024A compatible oscilloscopes

Infiniium oscilloscopes	Required firmware version	Required interface adapter
S-Series		None
V-Series	≥ 06.20.00803	N5442A Precision BNC Adapter
Z-Series		
Q-series		N5442A for those without BNC input

Figure 6. The N7024A Power Rail probe (R) and the N5442A Precision BNC Adapter (L) for oscilloscopes without a BNC input connector.

Figure 7. The N7024A 6GHz Power Rail probe is compatible with the V–Series and Z–Series (shown) oscilloscopes. Because these oscilloscopes have the AutoProbe II interface they require the N5442A Precision BNC adapter to be able to use the N7024A.

Is your oscilloscope software up-to-date? Keysight periodically releases software updates to support your probe, fix known defects, and incorporate product enhancements. To download the latest firmware, go to **www.keysight.com** and search for the oscilloscope's topic. Click on the "Drivers, Firmware and Software" tab.
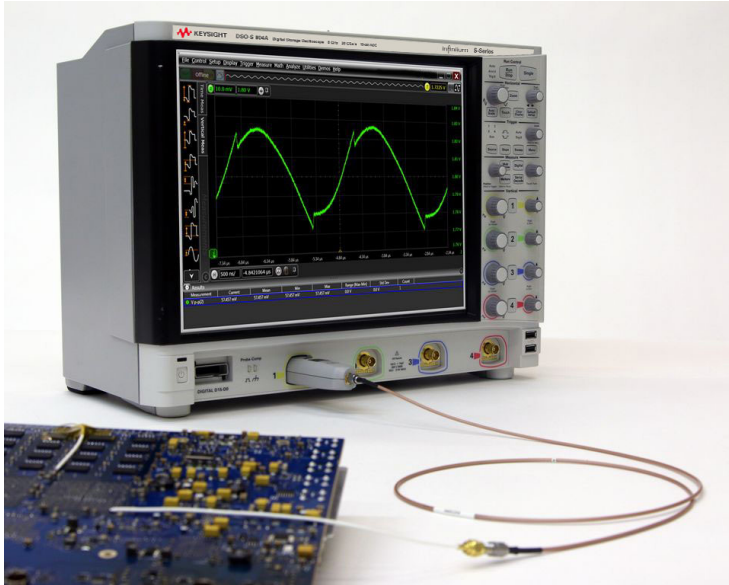

Figure 8. N7020A Power Rail Probe connected to an S-Series Oscilloscope making a power integrity measurement.

When using a N7020A probe with an Infiniium S-Series oscilloscope, users will achieve precise measurements. Infiniium S-Series oscilloscopes provide support for 10 vertical bits in hardware for vertical sensitivities as small as 16 mV full screen. This means all 10 bits of the ADC are used to produce a resolution of 16.6 µV. S-Series noise at 1 mV/div with 1 GHz bandwidth is 90 uV $_{AC\ rms}$, and lower noise levels can be achieved by averaging or additional bandwidth limiting.

The N7024A Power Rail probe is compatible with the Infiniium S-Series oscilloscope. Additionally the N7024A probe is compatible the Keysight infiniium V-Series and Z-Series high performance oscilloscopes. This enables users who are doing high speed designs to use one oscilloscope for their signal integrity measure (SI) and power integrity measurements (PI).

The N7020A and N7024A power rail probe come with a set of three N7021A pigtail cables and an N7022A main cable.

N7021A Pigtail Cables

The Keysight Technologies N7021A pigtail cables are a replaceable accessory for use with the N7020A oscilloscope power rail probe. These cables are intended to be solder-connected to the power rail of interest and connected to the N7020A power rail probe's main cable. The cables have a small diameter so they occupy less space and are very flexible. They are constructed of high-quality materials, and their solid center conductor can withstand multiple soldering and unsoldering cycles so the cables can be reused.

Small size: Constructed of small-diameter flexible coax to minimize intrusions into target systems.

Durable: Solid center conductor can be soldered and unsoldered multiple times allowing these cables to be reusable.

Convenient: Pre-trimmed—no cable preparation necessary—and come three to a package.

SMA termination: Have SMA terminations for easy, reliable connection to the N7020A power rail probe.
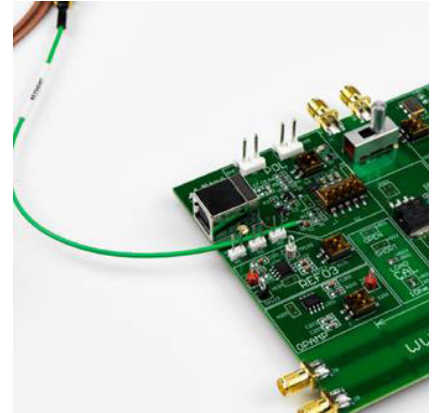

Figure 10. The Keysight N7020A power rail probe and included accessories probing a target with the included coaxial pigtail probe head (N7021A).
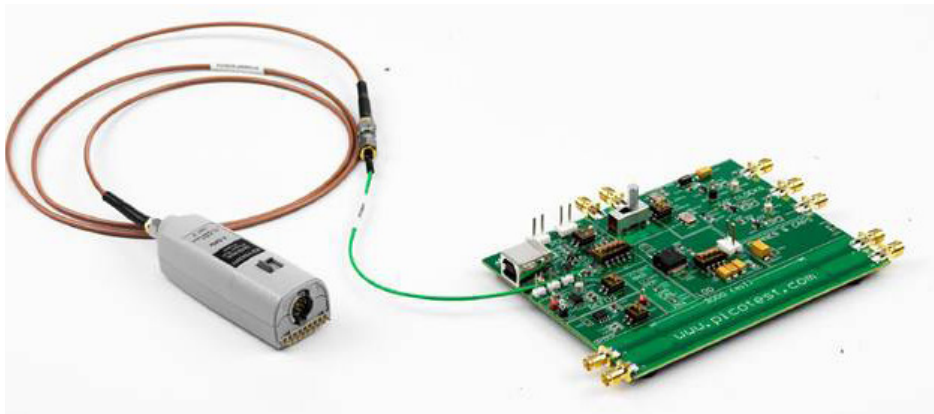

Figure 9. High temperature capable: Can be used to make measurements inside temperature chambers from −40 to 85 °C.

N7022A Main Cable

The N7022A main cable is a replacement cable for the Keysight N7020A and N7024A power rail probes. It is designed to be flexible and durable while still providing high signal fidelity.

Durable: Constructed of high-quality materials to withstand repeated flexing, twisting, and bending.

Convenient: 1.2 m (48") length makes for easy connection to the target without the need to have the oscilloscope nearby.

SMA termination: Has SMA terminations for easy, reliable connection to the N7020A power rail probe.

Included Accessories

Figure 11. N7023A Power Rail Probe browser kit (left). N7023A browser connect to N7020A Power Rail Probe (right).

Keysight N7023A Power Rail Probe browser and included browser accessories

The N7023A power rail probe browser is intended for use with the Keysight N7020A and N7024A power rail probes. The N7023A browser leverages the mechanical components from our popular passive probes to create a convenient browsing style accessory for the power rail probes.

– 350 MHz bandwidth
– 1:1 attenuation ratio
– SMT clip for hands-free probing of capacitors
– Twin lead adapter for connecting to 2-pin headers or other accessories
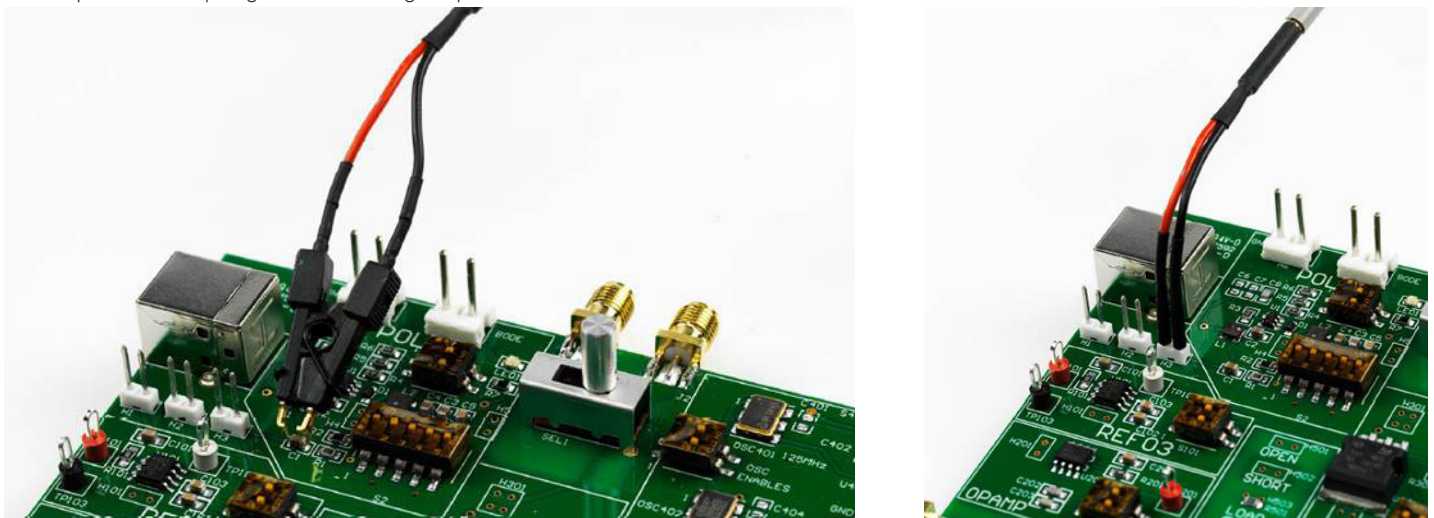– Replacement spring loaded and rigid tips included

Figure 12. N7023A Browser accessories being used to probe a small capacitor (left) and a 2-pin, 0.1 inch pitch header (right).

Included Browser Accessories

2.5 mm ground spring: The ground spring provides the highest performance connection for the N7023A power rail probe browser. Its flexible construction makes it easy to vary the span between the input and ground to accommodate the device being probed.
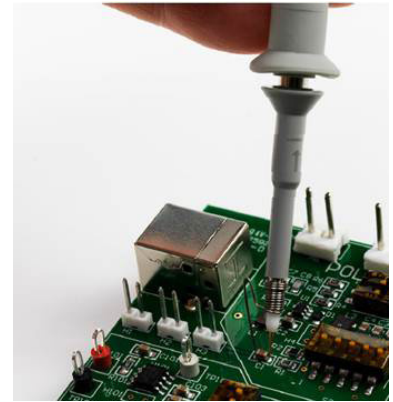

Figure 13. Browser ground spring.

15 cm ground lead: This ground lead can be used to reach grounding locations that are farther away from the probing location than can be reached by the ground spring.

Figure 14. Browser ground lead.

Dual lead adapter: The dual lead adapter allows you to easily connect the N7023A power rail probe browser to popular 0.1" pin headers with 0.025" square pins. This dual lead adapter has no shorting hazards since all external metal surfaces are insulated.

Figure 15. Browser dual lead adapter.

Dual lead adapter with Micro SMD clip: The Micro SMD clips were designed to provide fast and convenient hands-free probing of surface mount capacitors. The Micro SMD clip is used in conjunction with the dual lead adapter.
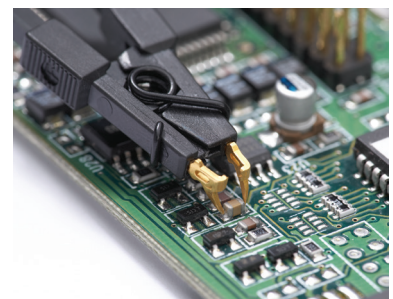

Figure 16. Browser Micro SMD clip.

Keysight N7032A and N7033A Power Rail Probe browsers.

The N7032A and N7033A browsers offer a convenient, high bandwidth means of probing surface mount capacitor packages which are frequently used in power distribution networks.
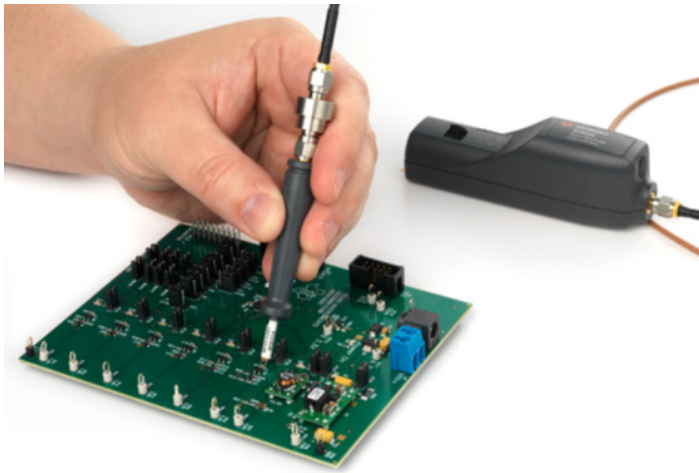

Figure 17. The N7032A 4GHz power rail probe browser in use

Figure 18. Close up view of the N7032a 4GHz power rail probe browser probing a small capacitor package on the power distribution network

These browsers have a spring pin ground connection enabling a variety of probing angles which allows the browsers to probe several different common SMT package sizes.

Figure 19. Detailed view of the N7032A 4GHz and N7033A 5GHz power rail probe browsers

The N7032A browser is for probing 0805 and 0603 packages (inch code—2012 and 1608 metric code) while the N7033A browser is for probing 0402 and 0201 packages (inch code—1005 and 0603 metric code).

Figure 20. Example showing the N7032A or N7033A browsers in use, being held in place by the Keysight N2787A 3D probe positioner

Making Probing Easier

Sometimes, when probing a target, one finds themselves 'fighting' the natural twist of the probe main cable. For example, when using a handheld browser, as one changes orientation of the browser one finds that the main cable connected to the browser resists the rotation. A similar case occurs when using the pigtail coaxial probe heads, as one tightens the connection to the main cable there is a torque applied to pigtail which might damage the solder joint between the pigtail and the target. To eliminate these issues the N7024A Power Rail probe includes a rotating SMA adapter, the 1250-4403. This adapter can rotate 360 degrees continuously and eliminates the torque or "fighting" of the main cable. The adapter is orderable from Keysight and is helpful in many applications.

Figure 21. The N7024A with the included 1250-4403 rotating adapter attached to the main cable. The wrench shown is included with the N7024A and is for the removal of the rotating adapter
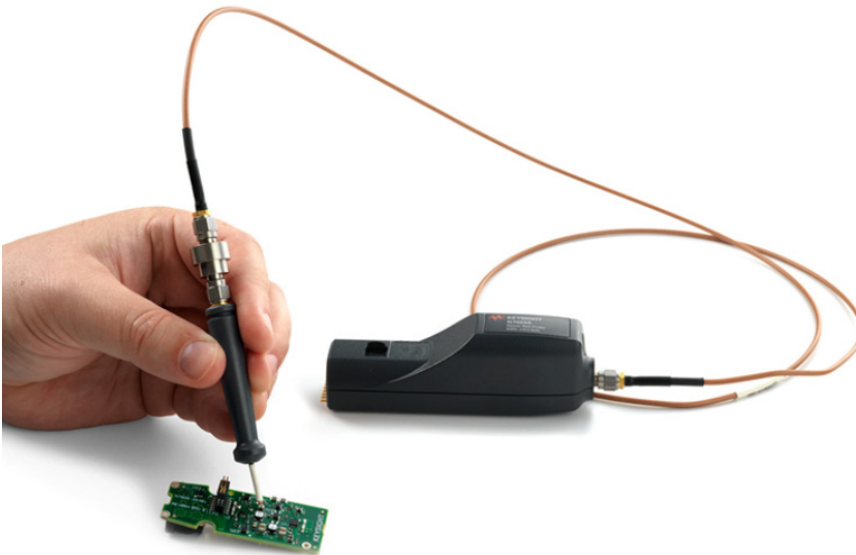

Figure 22. Notice how the rotating adapter isolates the browser from the natural torque or twist of the probe main cable.

Two Power Integrity Tools Working Together — N7020A Power Rail Probe and D9010POWA Power Integrity Analysis Application

The Keysight N7020A Power Rail Probe is a powerful tool for making power integrity measurements with its low noise, large offset range, loading DC loading and high bandwidth. Likewise, the Keysight D9010POWA Power Integrity Analysis application is a powerful tool for analyzing power supply induced jitter or switching current loads on a DC supply due to its ability to analyze adverse interactions and their effects without the need for simulation or complex modeling. Together the products complement each other and provide an even more powerful means of measuring and analyzing power integrity.

Note that the N7020A and D9010POWA are not included together and need to be purchased separately.

The following is a brief example of these two tools working together.

In this example the N7020A Power Rail Probe is used to measure the 1.1 V supply of an FPGA that is transmitting a serial data stream. The 1.1 V supply has about 115 mVpp noise or about ± 5% noise.

Figure 23. FPGA DC supply and the serial data captured by the S-Series oscilloscope.

Two Power Integrity Tools Working Together — N7020A Power Rail Probe and D9010POWA Power Integrity Analysis Application (Continued)

An eye diagram was created of the serial data of the FPGA. It can be seen that the width of the eye is approximately 73 ps.
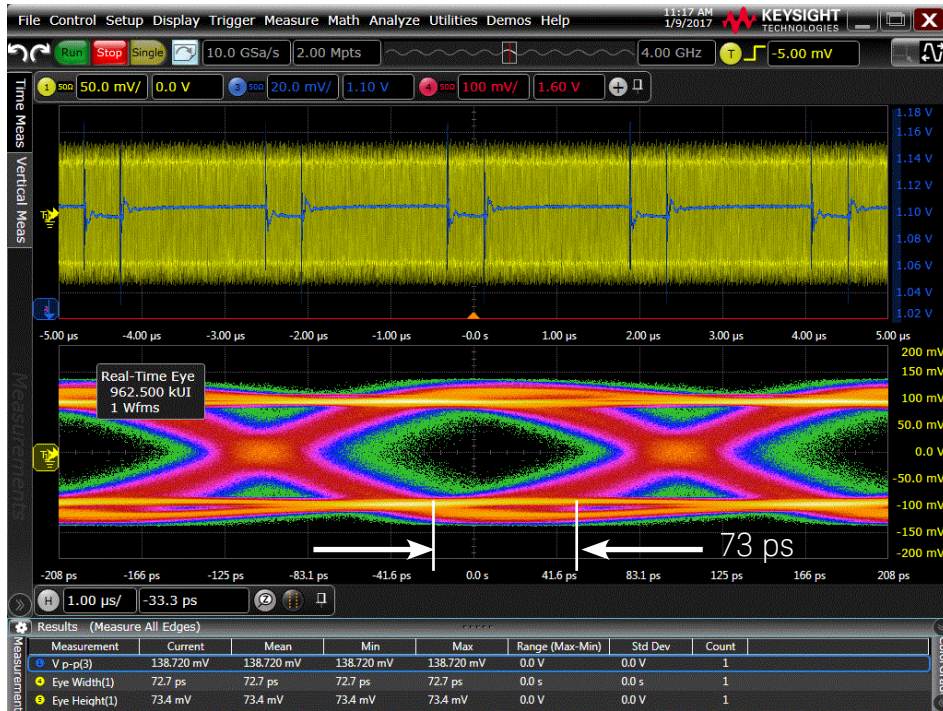

Figure 24. Eye diagram of FPGA serial data effected by DC supply noise.

The next step was to 'clean up' the supply. Modifications where made to the circuit to reduce the noise on the 1.1 V supply as much as possible. This resulted in the 1.1 V supply being nearly noiseless with 3 mVpp noise (< 1%). A new eye diagram of the serial data was created and shows that the width of the eye for serial data is nearly 50% wider than when the DC supply was noisier. The only thing that has changed between these measurements is the noise on the 1.1 V supply. This shows that there was approximately 40 ps of PSIJ of the serial data line.

Figure 25. Eye diagram of FPGA serial data after the DC supply was cleaned-up. Notice the increased width of the eye.

Wouldn't it be convenient if there were a means of knowing how much impact the noise on the 1.1 V supply is causing without having to go through all the work of actually cleaning up the supply? That's what the combination of the N7020A Power Rail Probe and D9010POWA Power Integrity Analysis application can do.

Shown below is original 1.1 V supply with noise on it, the serial data and the eye diagram for the serial data. The lower eye diagram is what the Crosstalk Analysis application is predicting the eye would look like if the adverse effects of the 1.1 V supply were removed from the serial data. The results are the same as when we actually cleaned up the supply.

Figure 26. Results from the D9010POWA PI analysis application showing the eye diagram of the FPGA serial data before and after the effects of the DC supply noise are removed. Notice that the results are nearly identical to the previous results where the supply was physically change to

Shown below is the same data as above, only the time base has been changed so that the some details of the serial data and power supply can be seen. The yellow trace is the original serial data and the red trace is the serial data with the adverse effects of the power supply removed. A slight shift in timing can be observed which contributes to the increased width of the eye diagram. Obtaining these analysis results was quick and simple using the Power Integrity Application setup wizard to tell the application that the serial data line was the victim and the aggressor was the 1.1 V supply.

Figure 27. Expanded timebase view of the FPGA serial data with and without the effects of the DC supply noise.

D9010POWA Power Integrity (PI) Analysis Application

The PI analysis application lets users define a dc supply as either a victim of, or an aggressor to, other periodic transitioning signals and quantifies the amount of adverse interaction involved. In this way, users can see what their dc supply and/or digital signals would look like if they were immune to the negative effects of each other. With this insight, users can make informed decisions about what, if any, next steps they would take to clean up their dc supplies.

The PI Analysis application works optimally with the N7020A Power Rail probe. Although it can work with other probes used to capture power rail data, the best results will be obtained when used with the N7020A due to its low noise and large offset range.

Key features of the D9010POWA PI Analysis application

– No crosstalk simulation or modeling is required when using the PI Analysis application.
– Analyze the adverse interactions between power supplies and digital lines. Power supply induced jitter (PSIJ) or voltage-dependent amplitude noise when the power rail is the aggressor. Simultaneous switching noise (SSN) when the power rail is the victim.
– Before-and-after views of the victim waveform are presented for quick and easy visual qualitative assessment.
– Waveforms are automatically labeled for easy recognition—"victim", "aggressor" and "crosstalk removed".
– Quantitative analysis unique to the victim signal type is also presented—before-and-after peak-peak noise measurements and FFT's if the supply is the victim, before-and-after eye diagrams of the digital signal when it is the victim.
– Additional measurements can be performed on either the before or after waveforms at the user's discretion (math functions, waveform measurements, jitter analysis, et cetera).
– Analysis can also be performed on saved waveform data. This allows users to study their data offline or to study previous revisions of data.
– Quick an easy setup wizard guides the user through selections and automatically identifies signals probed by the N7020A Power Rail probe as being power supplies.

Types of Analysis

Power supply aggressor crosstalk

Power supplies can be a significant source of interference on a data line, creating both noise and jitter. This type of interference may simply be referred to as "power supply noise," but its effects are similar to traditional crosstalk, and so it is straightforward to think of a power supply as just another source of crosstalk. Noise and voltage drift in a power supply can affect the timing of the serial data waveforms they are driving. Timing errors can occur through a number of different mechanisms, such as phase changes which are caused by voltage-dependent driver impedances and frequency changes caused by voltage-controlled oscillators. The resulting jitter is called power supply induced jitter (PSIJ). In another case, the power supply may be directly connected to the transmission line when the logic level switches to that value. Noise and bias on the voltage rail can therefore transfer directly to the bit stream. The interference may be present only when the bit stream is at a particular logic level (for Vcc aggressors it might present only when the logic level is high, whereas for GND aggressors it might present only when the logic level is low). It is therefore possible to have the high voltage bits experience a lot of noise while the low bits have little (or vice versa). This is a non-linear (or voltage dependent) type of interference.

Power supply victim crosstalk

The signal integrity of power supply voltages (including ground) can be affected by the circuits they are driving. One common example of this is simultaneous switching noise (SSN), which can produce ground bounce (the Vcc rail can also "bounce" and may be referred to as Vcc sag). SSN can occur as a result of parasitic inductances that lie between the device (chip) ground and the system (board) ground. As the voltage on the output changes state, it draws a current through the switching transistors. As that current flows to ground, it causes a voltage drop across the parasitic inductances. That voltage drop in turn changes the voltage you would measure at the device ground. The voltage measured there may bounce up and down in correlation with data transitions. The effect is amplified when more than one line is switching states at the same time since this will draw more current. In addition depending on the impedance and the various switching delays, the ground bounce may appear to have a ringing effect as well.

Example Analysis — Power Supply As Victim

Previously an example was shown using the PI Analysis application with the power supply as the aggressor and it adverse effects on the timing of the digital signal. Following is an example where the power supply is the victim. This example uses a 3.3 V DC supply output from a POL (point of load) DC/DC converter powering a digital circuit. The supply was measured using the N7020A Power Rail probe connected to a Keysight S-Series High-definition Oscilloscope. The results from this measurement are shown in Figure 20. The supply (top trace) can be seen to have a lot of noise on it. Performing a horizontal zoom (second from the top) it can be seen that there is a low frequency ripple and some high frequency noise on the supply. Evaluating this data in the frequency domain (doing an FFT) we can see that the low frequency ripple happens at about 2.9 MHz which is the frequency of the switching DC/DC converter (third from top). Finally we can also see that the high frequency noise is likely caused by a 125 MHz clocked system (bottom trace). This analysis led to the theory that the 125 MHz digital system was a major cause of noise on the supply—but how much? Is it worth fixing? How much improvement could be gained?
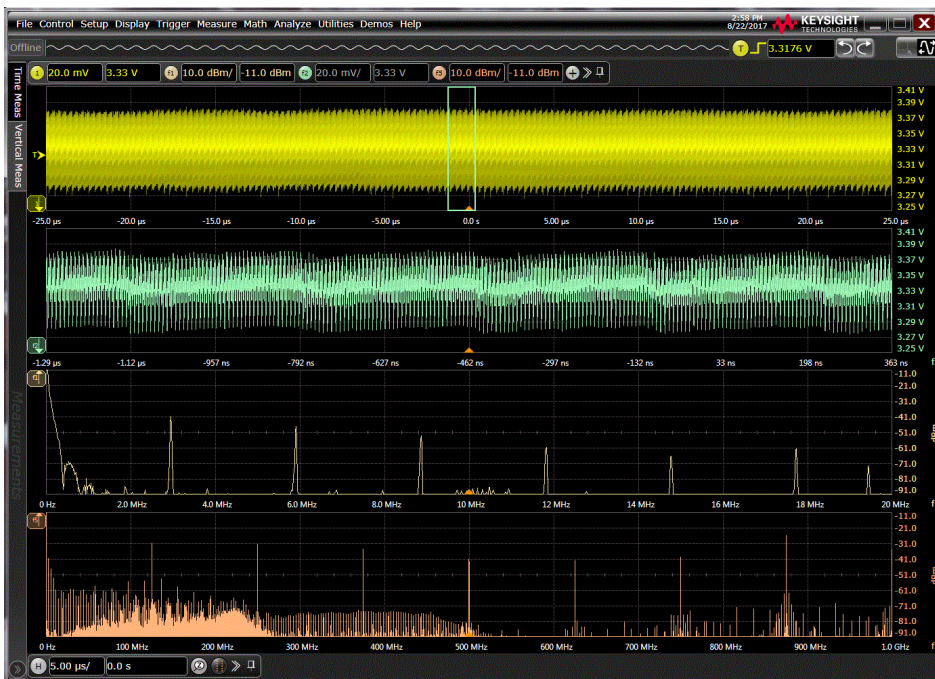

Figure 28. N7020A Power Rail Probe and S-Series High-definition oscilloscope measuring the noise on a 3.3 V supply.

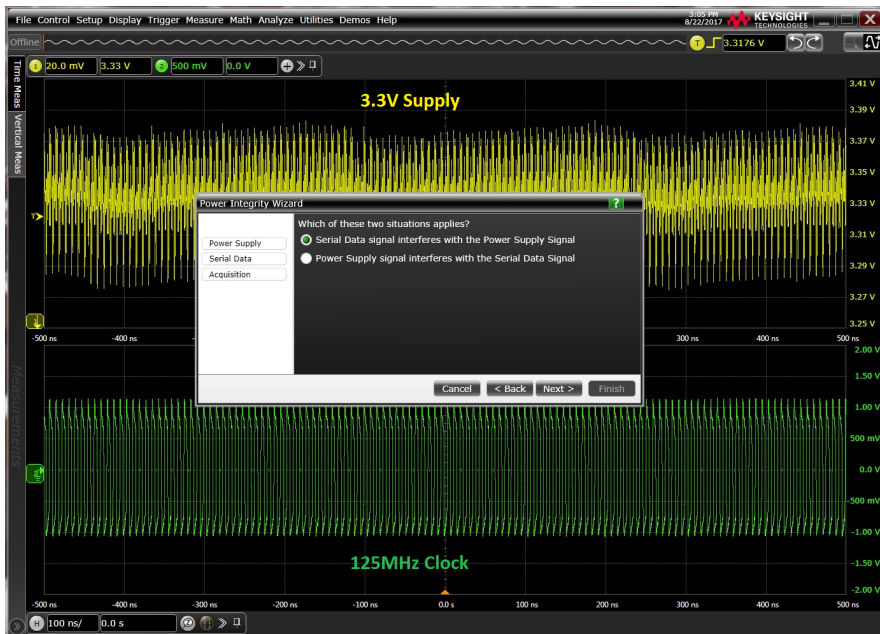# Example Analysis — Power Supply As Victim (Continued)

Figure 29. The clock of the digital was probed and is being analyzed as the aggressor to the power rail as shown in the PI setup wizard dialogue (next page).

Results from the PI Analysis application are shown below. The red trace in the upper grid is what the power rail would look like if it were not being affected by the 125 MHz digital signal (crosstalk removed). The lower two grids are frequency domain views (FFT) of the power rail before and after the crosstalk was removed respectively. The reduction of spikes based on the 125 MHz clock are clear in the bottom FFT. The analysis also reports that the peak-peak noise on the power rail dropped from 117 mVpp to 54 mVpp or approximately a 54% reduction in peak-peak noise. Based on this quick and simple analysis, the engineer or technician responsible for this design could decide if the improvement is worth the effort of making changes to the design.
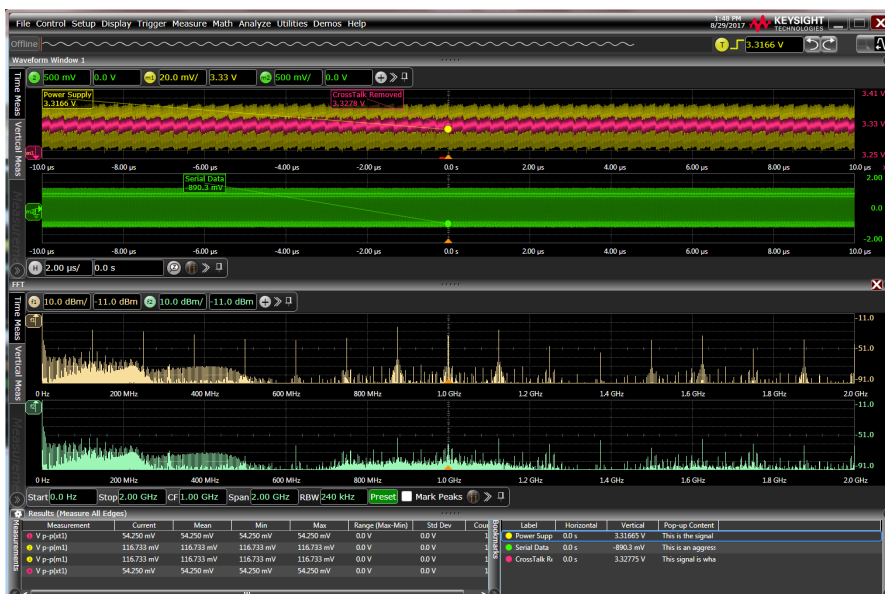

Figure 30. Output from the D9010POWA PI application showing a reduction in the noise on the 3.3 V supply after the affects of the switching loads were removed.

Compatible Oscilloscopes — D9010POWA Power Integrity Analysis Application

The D9010POWA Power Integrity Analysis application is compatible with the oscilloscopes and firmware revisions shown in table 6. The application can also run offline using waveform memories as inputs.

Infiniium oscilloscopes	Required firmware version
S-Series	≥ 6.30
9000 Series	≥ 6.30

Ordering information and related literature

This option is offered as perpetual or time-based (subscription) license, as described in the tables and examples below. A valid support contract is included in the pricing for the term of any time-based licenses. For perpetual license holders, a separate support contract is required to access Keysight technical support and receive software updates.

Types	Description	Pricing Formula
Node-Locked	Allows you to use the license on one specified instrument/ computer	
Transportable	Allows you to use the license on one instrument or computer at a time. This license may be transferred to another instrument or computer using Keysight's online tool.	130% of node-locked
USB Portable	Allows you to move the license from one instrument/computer to another by end-user only with a certified USB dongle, which is purchased separately.	130% of node-locked
Floating	Allows you to access the license on networked instruments / computers from a server, one at a time. For concurrent access, multiple licenses may be purchased.	140% of node-locked
Perpetual	Software license can be used in perpetuity.	
Time-Based	Software license is time limited to a defined period, such as 12 months.	38% of a perpetual for a 12-month license
Support contract (for perpetual licenses)	Allows license holder access to Keysight technical support and all software upgrades.	15% of perpetual for 12 months of support

Software license and support subscription contract model number format:

R-B	‹Term / Service›	P -	‹License Type› -	‹License / Support Contract Term›
	4 = Time Based License		001 = Node-Locked	A = Fixed
	5 = Perpetual		002 = Floating	B = Floating (Single Site)
	6 = Subscription		004 = Transportable	D = Floating (Transportable Perpetual)
			005 = USB Portable	E = USB
				F = 6 Month Term
				L = 12 Month Term
				X = 24 Month Term
				Y = 36 Month Term
				Z = 60 Month Term

Examples

Software License and Support Configuration Examples	Model Number	Perpetual License	Support Contract
Node-locked perpetual license and 12-month renewable support contract (most common) for an Infiniium S-Series	D9010POWA	R-B5P-001-A	R-B6P-001-L
Floating 24-month license subscription for an Infiniium Z-Series	D9020POWA	N/A	R-6BP-002-X

Benefits of flexible license types (transportable, floating, USB portable)

– Maximize the flexibility of your test assets by sharing measurement applications between your Infiniium oscilloscopes
– Save money and increase your return on test asset investments as project needs change by purchasing fewer applications per instrument
– Save time by transporting the licenses to the test bench nearest you, instead of physically moving the test equipment or DUT
– Use the same application in different time zones, departments, and/or test benches
– Keep up with your changing project needs by transporting measurement application licenses; use a simple Keysight server connection with an instrument or a PC to check-in/out licenses

Related Literature

Publication title	Publication number
Making Your Best Power Integrity Measurements - Application Note	5992-0493EN
Infiniium S-Series High-Definition Oscilloscopes - Data Sheet	5991-3904EN
Infiniium 9000 Series Oscilloscopes - Data Sheet	5990-3746EN

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