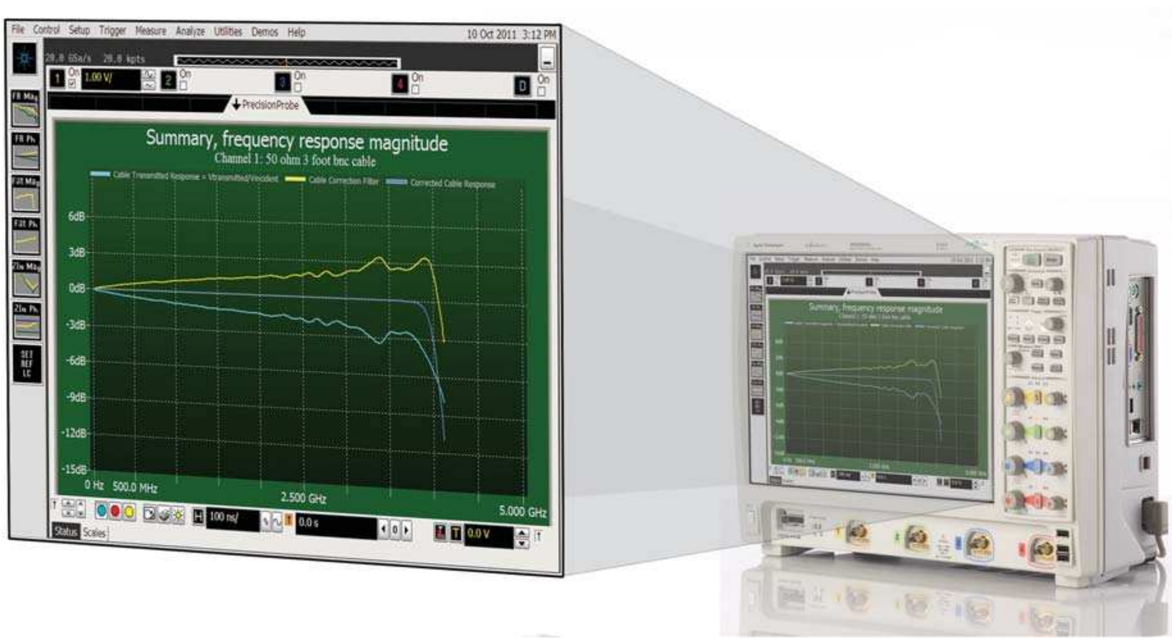
Agilent Technologies N2808A PrecisionProbe for the 9000 Series

Data Sheet



PrecisionProbe solves measurement challenges by allowing you to:

- Characterize the frequency response (both magnitude and phase) of any input to the 9000 Series without the need for extra equipment such as a VNA or TDR
- Quickly and accurately compensate for probe and cable loss, gaining you valuable margins
- Correct probing issues such as phase non-linearity, magnitude non-flatness, and see the effect of probe loading
- Quickly gain insight into the impedance/capacitance that defines your connection

  Increase the bandwidth of your oscilloscope and probe

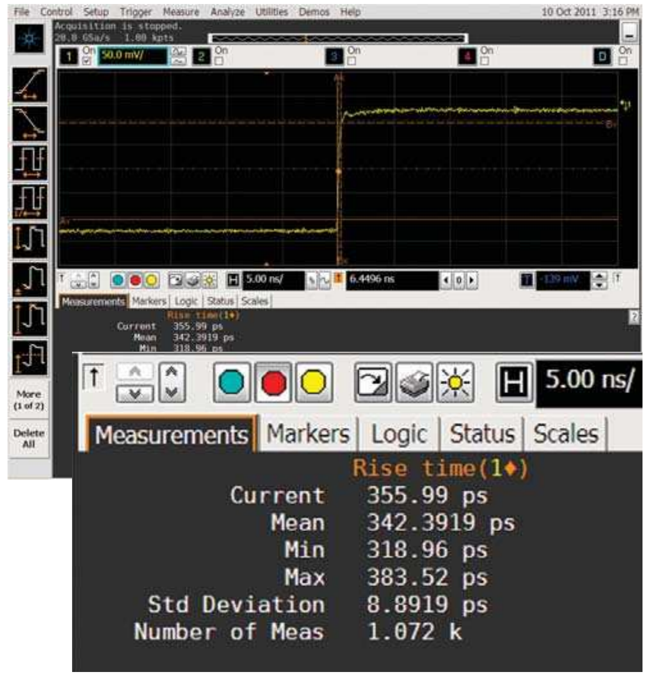
Agilent's PrecisionProbe TDT (N2808A) allows you to characterize and correct your measurement system quickly and accurately, without adding expensive equipment.

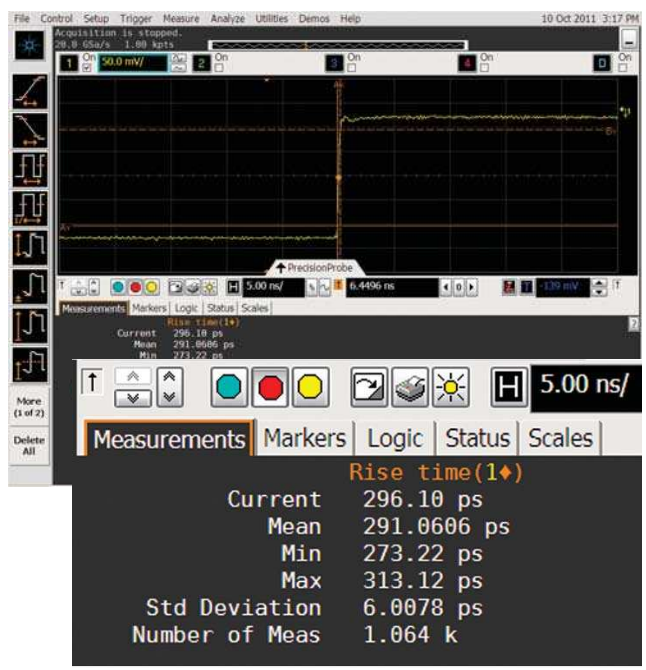
Agilent Technologies

Background – PrecisionProbe (Cable Correction)

A measurement system is only as good as its weakest link. Users spend thousands of dollars on test and measurement equipment, including oscilloscopes, but then ignore the weakest element in their link, the cable. Oscilloscope vendors now provide methods to strengthen the weak link with the use of de-embedding software (Agilent's InfiniiSim N5465A software). However, de-embedding software requires specific characterization of the cable and the creation of an s-parameter file. To get the correct characterization you must characterize the cable using either a TDR or a VNA. Both of these methods provide characterization and s-parameters, but take time and instrument knowledge and more investment on test and measurement equipment.

It is the time, knowledge, and additional equipment that causes us to simply choose to ignore cable loss, and measurements taken by the oscilloscope now may be measuring the weakest link (the cable) and not the device you wish to measure as cable loss can dominate a measurement. At best you may choose to characterize only one or two cables, and use that characterization (s-parameter file) to compensate for of every similar cable you own, causing the magnification of cable-to-cable variability as the cables characteristics vary from the "golden" cable.





Figures 1 and 2: Cable loss degrades rise times and causes measurement non-repeatability. Figure 1 shows the rise time of a signal with a cable that's loss is uncharacterized and not compensated. Figure 2 shows the same measurement with characterization and compensation. Notice the rise time is >15% faster and the measurement is nearly 50% more repeatabile.

Background – PrecisionProbe (Probe Correction)

Probes and cables are inherently lossy and rarely identical in their characteristics. The loss at times can be substantial, or enough from an ideal flat frequency response to cause variation in measurements and the loss of valuable margins. To compensate for the inherent loss, oscilloscope vendors use DSP correction to compensate for loss caused by probes. The vendor uses a "golden" model and base, all compensation/ correction on the single model. While this strategy mitigates the inherent loss of the probe it can't solve probe to probe variation.

If a probe's characteristics have changed/drifted or were not close to the model to begin with, the compensation may cause the probe to make worse measurements. There are also a myriad of probe heads to attach to probe amplifiers, to achieve maximum accuracy every combination must be measured down to the indiviual probe head, tip, and amplifier. Oscilloscope vendors are unable to measure to this level of accuracy and the end result is that you get unwanted inaccuracies and probe to probe variability.

You also use custom probes and probe heads. While this provides great convenience for you it means that the oscilloscope vendor no longer can even provide a "golden" compensation for your probe configuration. As a result, custom probes are uncorrected and inaccurate, but convenient.

You may also want to add something between the probe amplifier (such as Agilent's 3.5 GHz 1131A) probe amplifier and (such as Agilent's 6 GHz E2675A browser) probe head, including a cable to add length or a switch matrix. Adding a new element in the probe system adds inaccuracies as as the probe amplifier and browser head are compensated to the model, but the newly created probe system now has no model. The result is that you must except the inaccuracies that have been added or try to characterize the additional element in the probe link. While accepting both of these trade-offs can be sufficient, it is time consuming to evaluate the element every time and not characterizing the element causes loss of margins (including higher jitter, smaller eyes, and slower rise times). This can also be the cause of differences between numbers measured in simulation and the number actually achieved in actual measurements.

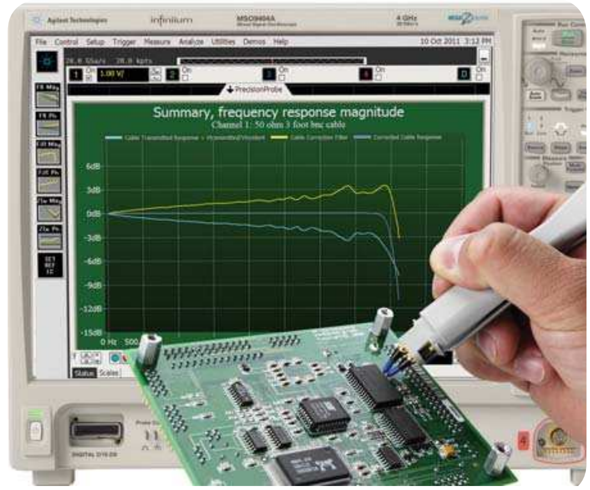


Figure 3: Probe browser with a non-standard pitch

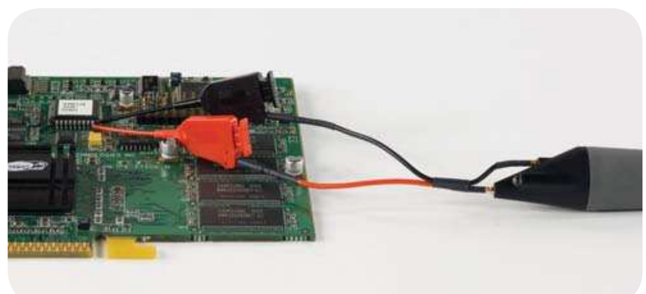


Figure 4: Image of custom probe

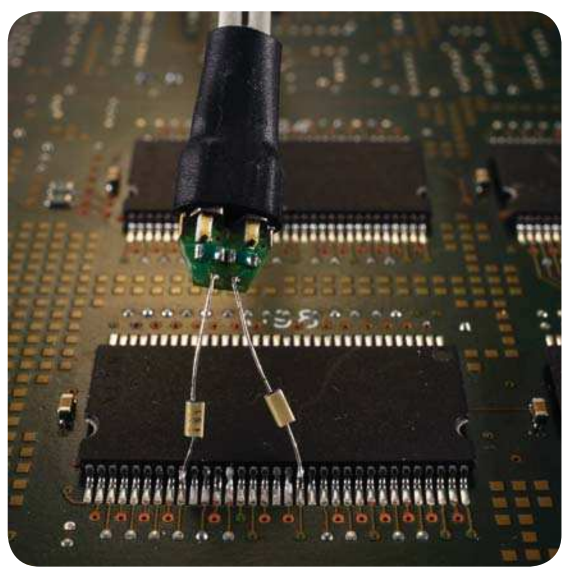


Figure 5: Image using LW ZIF Head

Solution - PrecisionProbe

PrecisionProbe for the 9000 can solve the problems outlined in the background information by allowing quick characterization of your entire probe system (including cables and switches). The award winning, innovative technology takes advantage of the calibration output of the 9000 Series oscilloscopes to properly characterize cables and probes.

The software quickly (less than five minutes in most cases)and accurately characterizes the desired element in the system without the need for additional test and measurement equipment.

PrecisionProbe

- Removes unwanted cable loss
- Characterizes probe input impedance
- Properly Creates Custom Probe Transfer Function = VOut / VIn or VOut/VInc = VOut/VSrc

Now every probe and cable in your system can have the exact same frequency response probe to probe or cable to cable, without the inaccuracies that using one model can produce. Custom probes can now be properly characterized and unwanted responses can be removed. Not only does PrecisionProbe characterize the cables, it allows for immediate use on the same instrument. You can characterize your measuring system and be using it within five minutes without adding more complicated, expensive equipment.

PrecisionProbe saves time and money while increasing accuracy. When combining Infiniimax probes with switches between the amplifier and the probe head, PrecisionProbe allows for full correction and automation of each probes path. Full automation is then available to allow for swapping of the inputs and never leaving the automation.

PrecisionProbe Correction (Probes)

Two methods exist for correcting probe responses, Vout/Vin and Vout/Vsource

Vout/Vin Correction

Vout/Vin characterizes the output of the probe as a function of the input at the probe tips. Defining the response this way allows you to evaluate the probe's accuracy in reproducing the actual signal present in your system with the probe attached. This correction is known as Vout/Vin, which is what you'd see with a real band limited probe that has finite input impedance. PrecisionProbe corrects the "Vout/Vin" response to be flat with frequency and phase to your defined bandwidth limit. It does not correct the loading effects of the probe. It should be noted that Agilent' s probe frequency response corrections are typically defined using Vout/Vin.

Vout/Vsource Correction

The second way to correct probes is an estimate known as Vout/Vsource, this method corrects the probe as "what would be there if the probe were not present." There are oscilloscope and probe manufacturers that design their probes and DSP correction software to display what the waveform "would have been" in the absence of the probe. One drawback of defining the probe's response in this manner is that if the probe's loading causes your circuit to lose some timing or amplitude margin, you probably want to know that when you make a measurement. Vout/Vsource compensation will hide these effects from you. PrecisionProbe also gives you the freedom to choose this method of correction, which can be effective if probing at the transmitter.

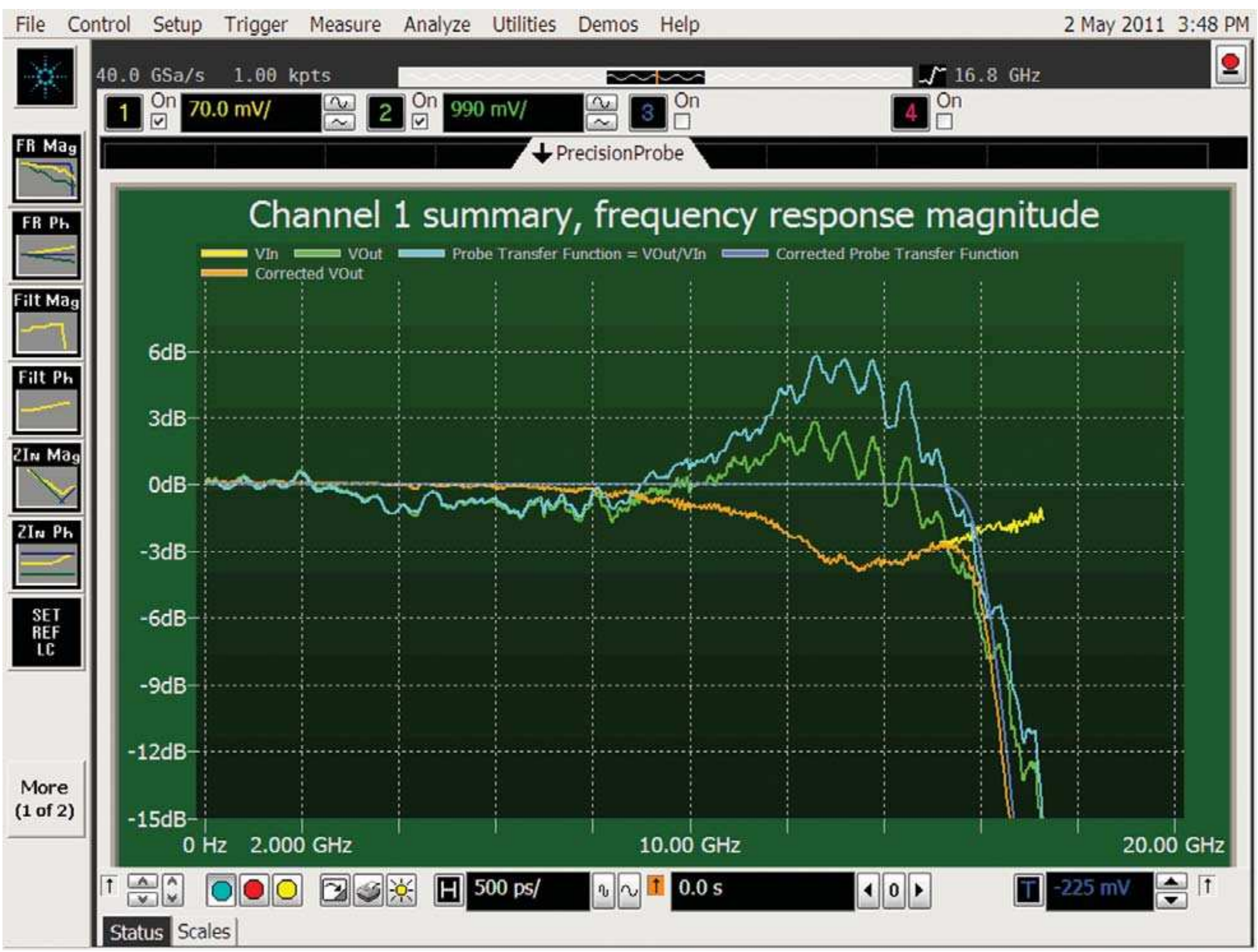


Figure 6: A probe that has perfect transfer function shows an exact copy of a signal at the input. A probe that has a perfect system response shows the signal at the input of probe boosted by the estimate amount of loading due to the probe.

PrecisionProbe Correction (Cables)

S21 Insertion Loss Correction

PrecisionCable can be used to remove insertion loss caused by cables or fixtures. Previously the only way to do this analysis was to characterize the cable using simulation, TDR, or a VNA. All of these methods can be accurate and can yield the desired results. You would then take the newly created s-parameter file to the oscilloscope and use the de-embedding software to remove the insertion loss of the fixture or cable. While this method works, it requires extra equipment and effort. PrecisionCable allows for this characterization to be done inside of the same oscilloscope that the measurements will be taken. Characterizing the cables and fixtures takes less than five minutes in many cases which saves significant time.

Note: This measurement does require access to both ends of the fixture or cable, similar to methods such as VNA and TDR.

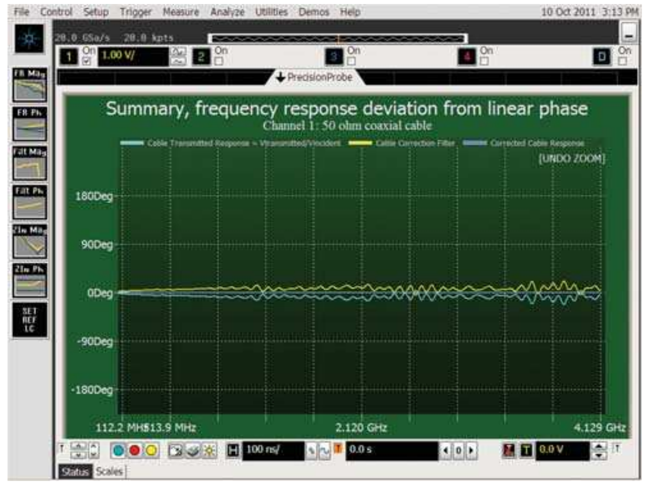


Figure 8: PrecisionProbe corrects phase non-linearities, notice the new flat phase.

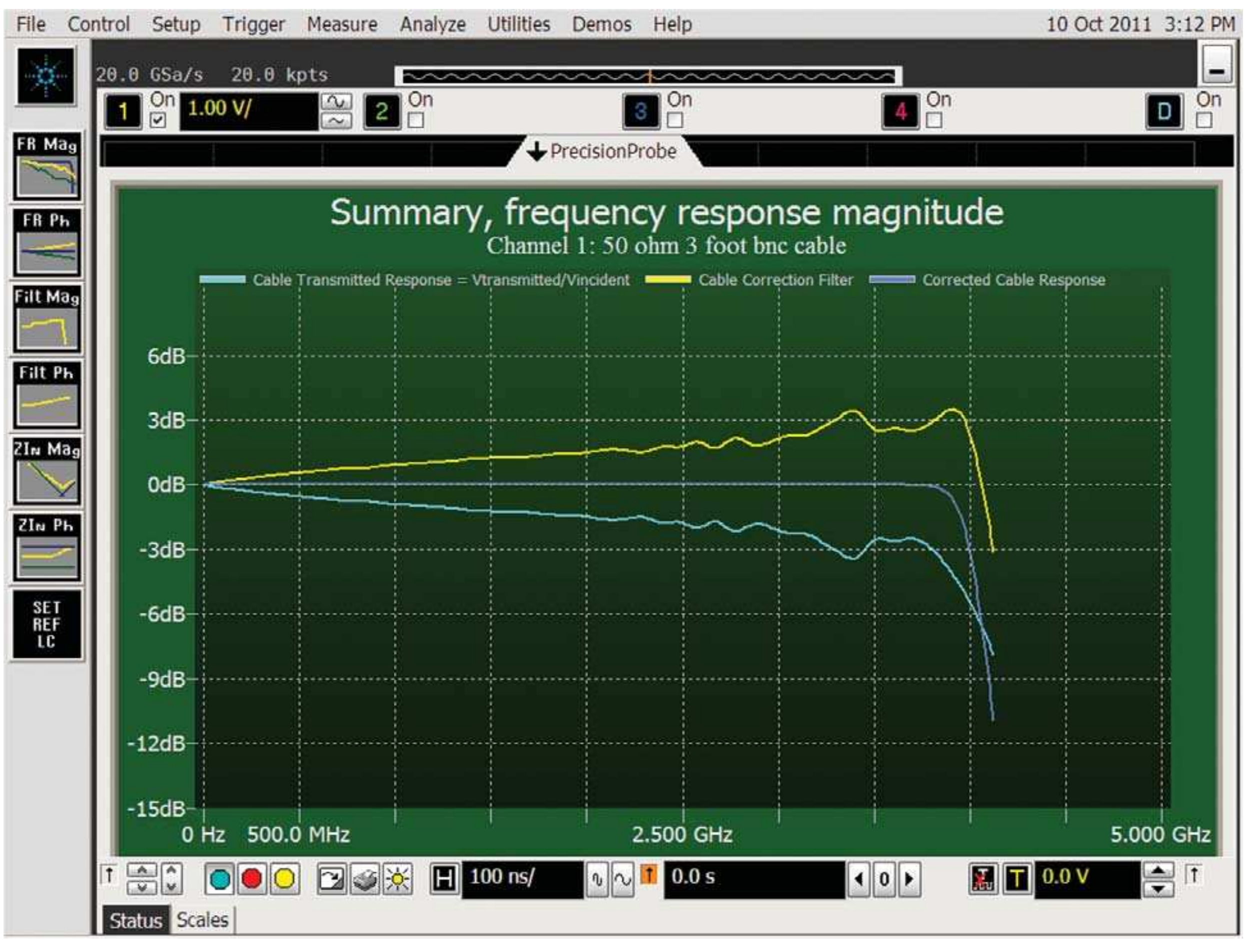


Figure 7: Example of frequency response correction of a cable. The 3 dB down point moved from 2.5 GHz to 4 GHz.

Analysis Tools

PrecisionProbe provides many tools to allow you to know exactly what has been characterized and what parameters have been improved by the innovative software.

PrecisionProbe Wizard

PrecisionProbe provides an easy to follow guide with its wizard. The wizard takes you step by step through the set up of the software and ensures that your measurements are taken with the highest signal integrity.

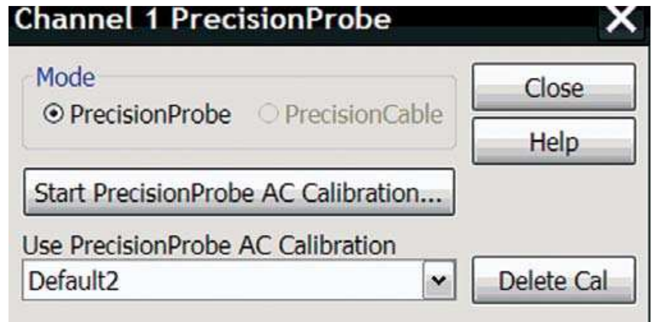


Figure 9: Starting the PrecisionProbe wizard

Probe correction

To maximize margins it is important to correct each probe identically and to ensure the correction method is the same. The Probe Correction menu allows you to change between Vout/Vin and Vout/Vsource. PrecisionProbe also allows for the source impedance via s-parameter file or an estimate. This is important when measuring Vout/Vsource to ensure a high level of accuracy as assuming an ideal 50 ohm environment can cause unwanted errors.

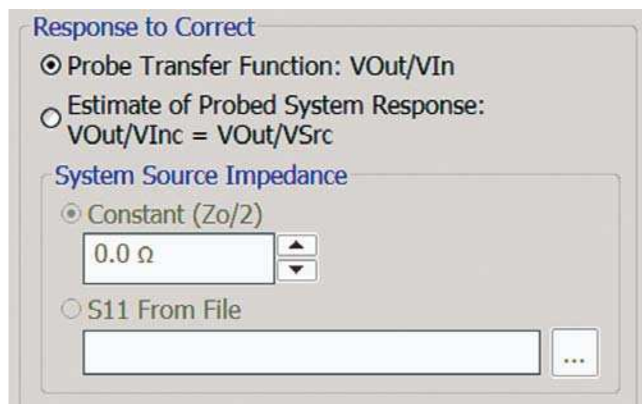


Figure 10: Choosing the probe correction that you need

Bandwidth Control

Software such as PrecisionProbe can amplify high frequency noise when correcting for the loss of a probe or cable. The high frequency noise can then cause unwanted noise and inaccuracies. Bandwidth control allows you to remove unwanted high frequency noise by providing a filter.

PrecisionProbe also provides the ability to control the amount of gain that is applied to the signal. You can increase the amount of boosting which improves risetimes but also increases noise, or you can decrease the amount of boosting which decreases noise but degrades rise times.

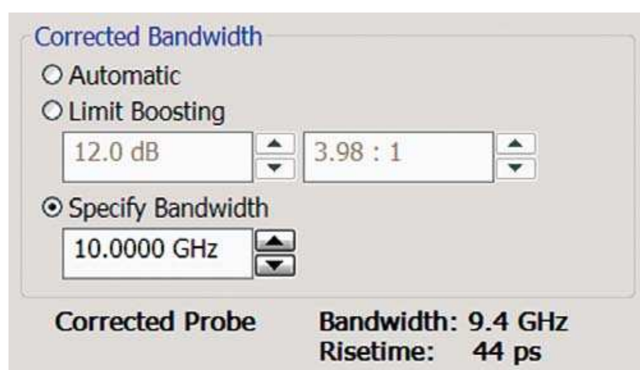


Figure 11: Use bandwidth control to maximize margins

Understanding the Analysis Charts

PrecisionProbe comes with many analysis charts that make understanding the characterization and correction very easy and provide insight that is unique to Agilent oscilloscopes.

The Summary Chart

The summary chart shows the frequency response of the corrected probe or Vout (notice how flat the response is). The chart also shows the transfer function (TF) that is applied to the signal.

Figure 12: The summary chart

Probe Input Impedance

Knowing the impedance profile of the probe allows you to estimate the loading of the probe system. PrecisionProbe allows for you to characterize the impedance profile, along with quickly determining the capacitance, impedance and inductance. Markers allow for easy viewing of the capacitance and inductance at each frequency

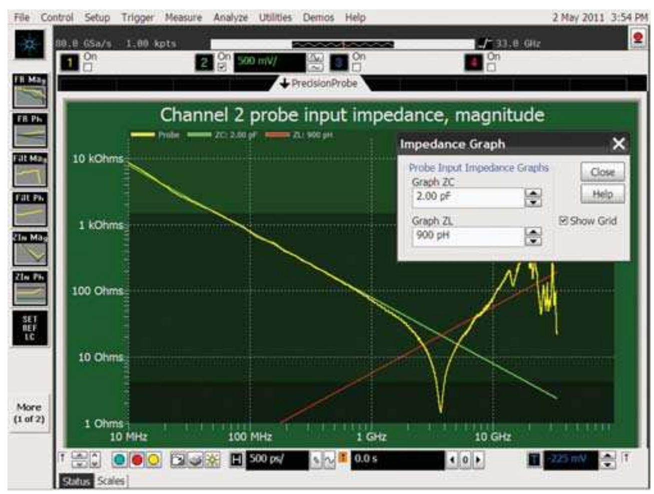


Figure 13: PrecisionProbe properly characterizes a 2 pF capacitor

Probe Correction Filter

The probe correction filter simply shows the filter that is being applied to adjust for the probe. This filter is designed to ensure the signal stays perfectly flat.

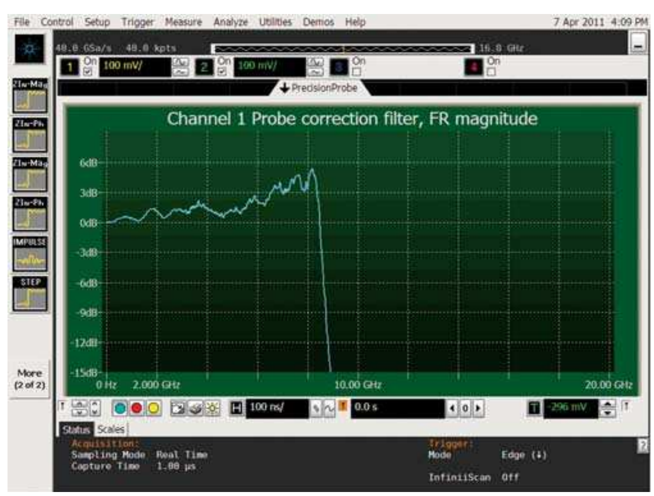


Figure 14: Probe correction summary

Conclusion

Using PrecisionProbe provides the highest level of accuracy without requiring additional equipment. PrecisionProbe will help with accuracy by doing the following:

- Removing insertion loss caused by cables
- Characterizing the impedance of your probe
- Removing probe to probe variation
- Correcting for loss and non-linearities in custom probes
- Correcting for solutions such as switch matrices

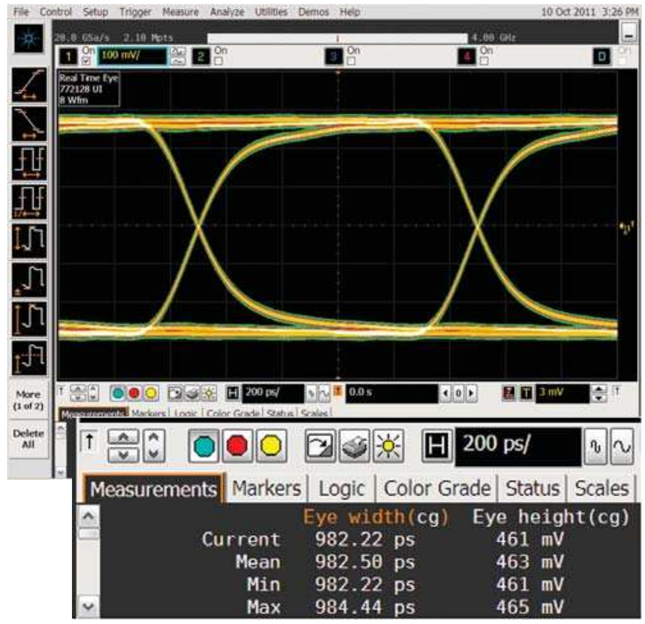


Figure 15: Real time eye with uncorrected cable loss

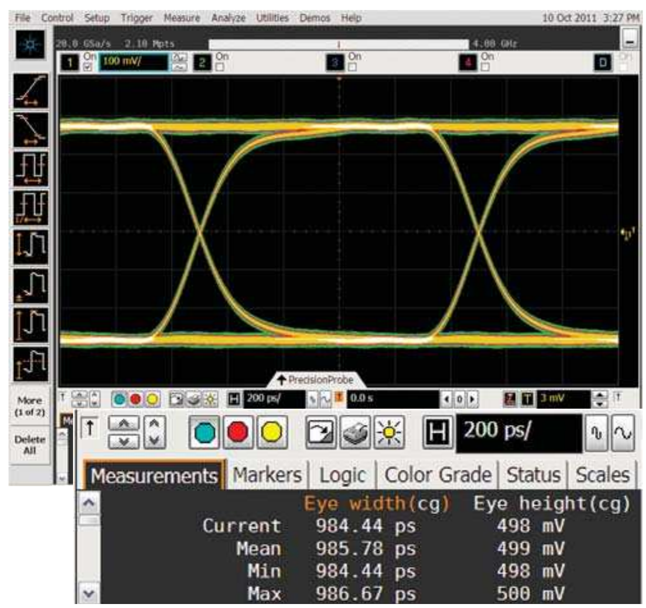


Figure 16: Real time eye with corrected cable using PrecisionProbe, notice that by correcting for cable loss there is a gain of 37mV in the eye height measurement!

Ordering Information

	Option	Standalone
DSO 90000 X-Series	DSOX90000-001	N2809A-001
DSO90000A	DSO90000-001	N2809A-002
DSO9000A	DSO9000A-022	N2808A

Included Accessoried

N2809A-001 or DSOX90000-001	Quantity	N2809A-002 or DSO90000-001	Quantity	Description
N2812A cables	3	N2812A cables	3	High Performance Input Cable – 3.5MM – 1m
5061-5311	2	5061-5311	2	Connector Assembly - 3.5 mm Female to Female
		11636B-FG	1	DC TO 26.5 GHz Power Divider

N2808A	Quantity	Description
N2813A	3	3.5 mm 3m cable
5061-5311	2	Connector assembly - 3.5 mm f to f
11636B-FG	1	DC to 26.5 GHz power divider
	3	BNC to 3.5 mm connector

Recommeded Equipment

N2809A-001 or DSOX90000-001	Quantity	N2809A-002 or DSO90000 -001	Quantity	Description
N5443A	1	E2655B	1	Performance Verification and Deskew Fixture
N2787A	1	N2787A	1	3-D Probe Positioner
		54855-67604	2	Precision BNC adaptor

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