

Keysight Technologies

Extending the Range of Keysight InfiniiMax Probes

Application Note

Introduction

This application note describes how to extend the operating range of Keysight Technologies, Inc. InfiniiMax probes in voltage, temperature, and distance (reach) between probe amplifiers and heads.

Operating at high or low temperatures

You may need to monitor a system in a temperature chamber with an oscilloscope probe to verify performance over a wide range of operating temperature, or to determine the cause of failures at high or low temperatures. Keysight InfiniiMax probe amplifiers (1130 Series and 1160 Series) have a specified operating temperature range from 5° C to 40° C. However, the probe heads can be operated over a much wider range (see Table 1). You can use the Keysight N5450A extension cable set (Figure 1) to physically separate the probe heads from the probe amplifiers. This will allow you to operate the probe heads inside a temperature chamber with the probe amplifier located outside the temperature chamber.

Cycling the probe heads through a wide range of temperatures in a temperature chamber will impact the life of the probe heads. Table 1 shows the expected life of a probe head, expressed in the number of cycles through the range from min to max as shown in the second column. Note: Probe heads may appear discolored after lengthy operation at high temperatures. The color or texture of the cables may also change. This does not indicate degradation of the probe head or cable performance.

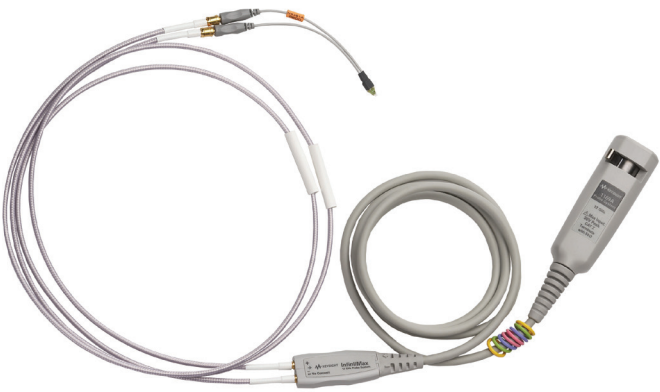


Figure 1 Probe head and extension cables connected to probe amplifier

Measurement challenges

As with any cable, there is some loss due to the 3-ft length of these cables. Figures 2 and 3 show the frequency and time domain responses of the 1169A 13GHz InfiniiMax probe and N5381A solder-in probe head without (red) and with (blue) the extension cables. Figures 4 and 5 show the frequency and time domain responses of the 1134A 8 GHz InfiniiMax probe

and E2677A solder-in probe head without (red) and with (blue) the extension cables. The -3 db frequency does not change noticeably, but there is approximately 1 db of additional in-band loss that will affect the risetime slightly. The addition of the extension cables will also cause the equivalent input noise of the probe to increase by about 40%.

Probe heads	Operating temperature range	Lifetime in number of cycles
N5381A 12 GHz differential solder-in head	-55° C to +150° C	>250
E2677A, E2678A, N5426A, or N5451A	-25° C to +80° C	>1000

Table 1 Probe head operating temperature ranges

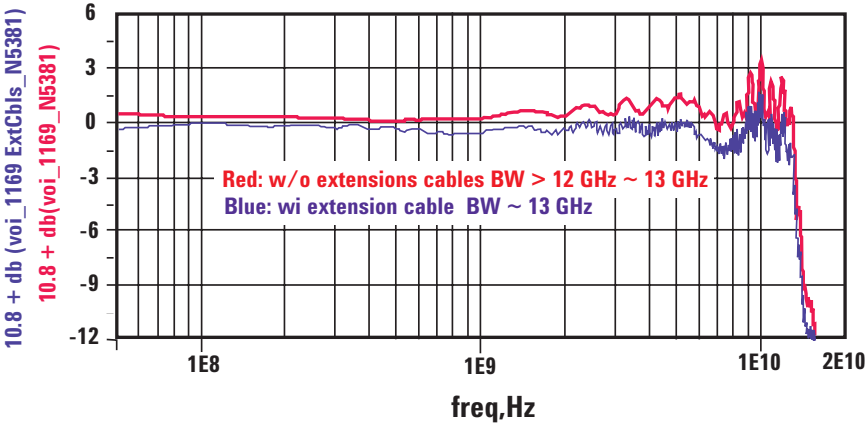


Figure 2 1169A and N5381A frequency response without (red) and with (blue) extension cables

Measurement challenges (continued)

Increasing the voltage dynamic range

The dynamic range of the 1130 series is 5 V p-p; the dynamic range of the 1160 series is 3.3 V p-p. If you need to measure larger signals, the architecture of the InfiniiMax probes allows you to add coaxial RF attenuators between the probe head and the probe amplifier to increase the dynamic range. Attenuators also allow you to increase the offset range of the probe.

The bandwidth and rise time of the probe system is not affected when using high quality attenuators. There is, however, a trade-off in noise and in the accuracy of DC offset relative to the input.

The maximum input voltage of the probe heads is +/-30 Vdc, so they should not be used to measure signals that exceed this range. This places a practical limit of 20 dB on the attenuators that are inserted between the probe head and the probe amplifier. Larger attenuation ratios will only degrade the noise performance and gain of the probe system.

Table 2 shows the typical noise, dynamic range, DC attenuation, and offset range for various attenuation values when used with the two families of InfiniiMax probe amplifiers.

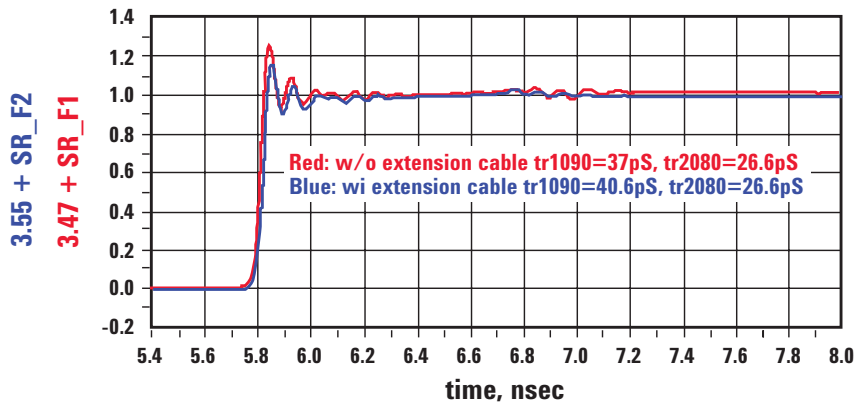


Figure 3A 1169A and N5381A Step response without (red) and with (blue) extension cables

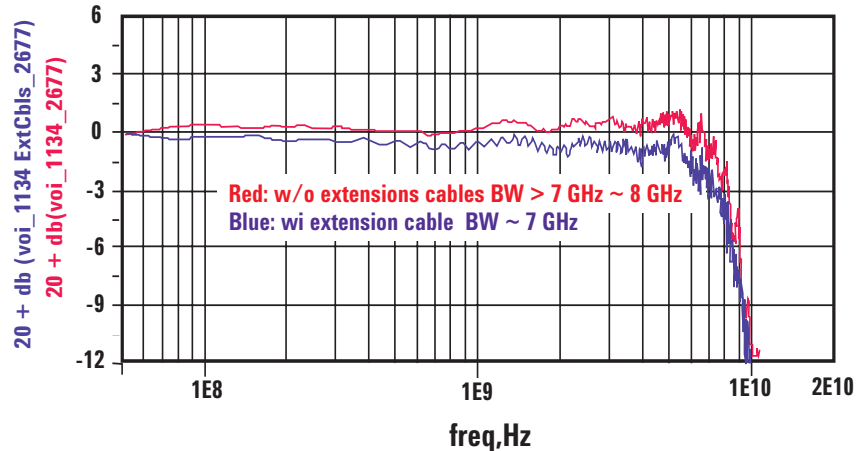


Figure 3B 1134A and E2677A Frequency response without (red) and with (blue) extension cables

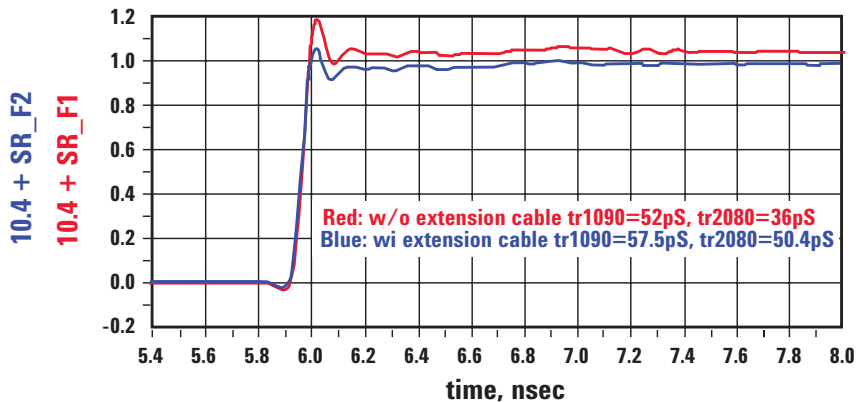


Figure 4 1134A and E2677A Step response without (red) and with (blue) extension cables

Probe amplifier	Added attenuation	Dynamic range	Offset range	Typical noise referred to	Nominal DC attenuator of probe system
1130 Series	None	5 V p-p	+/-12V	3 mV RMS	10:1
1130 Series	6 dB	10 V p-p	+/-24V	7.8 mV RMS	20:1
1130 Series	12 dB	20 V p-p	+/-48V*	16.7 mV RMS	40:1
1130 Series	20 dB	50 V p-p	+/-120V*	41.7 mV RMS	100:1
1160 Series	None	3.3 V p-p	+/-16V	2.2 mV RMS	3.45:1
1160 Series	6 dB	6.6 V p-p	+/-32V*	6.3 mV RMS	6.9:1
1160 Series	12 dB	13.2 V p-p	+/-64V*	13.2 mV RMS	13.8:1
1168A/69A Series	20 dB	33.3 V p-p	+/-160V*	33.4 mV RMS	34.5:1

*: Usable range of DC voltage at the probe input is limited to +/-30 Vdc
Note: The figures shown above do not apply to the N5380A dual-SMA probe head. Due to the maximum input voltage specification of 2.28 VRMS of the N5380A, it is not suitable for measuring signals large enough to require an added attenuator.

Setting up the scope for the proper probe attenuation ratio

The software in the Infiniium oscilloscope will detect the probe when connected and by default will assume that no additional attenuation is installed. If you want the scale factor readings and settings on the oscilloscope to be correct with the attenuator installed, go to the Setup menu and select the channel to which the probe is connected.

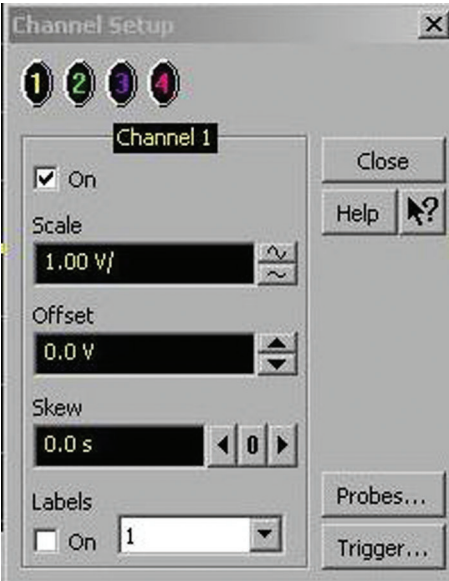


Figure 5 Channel menu

In the Channel Setup menu, click on “probes.”

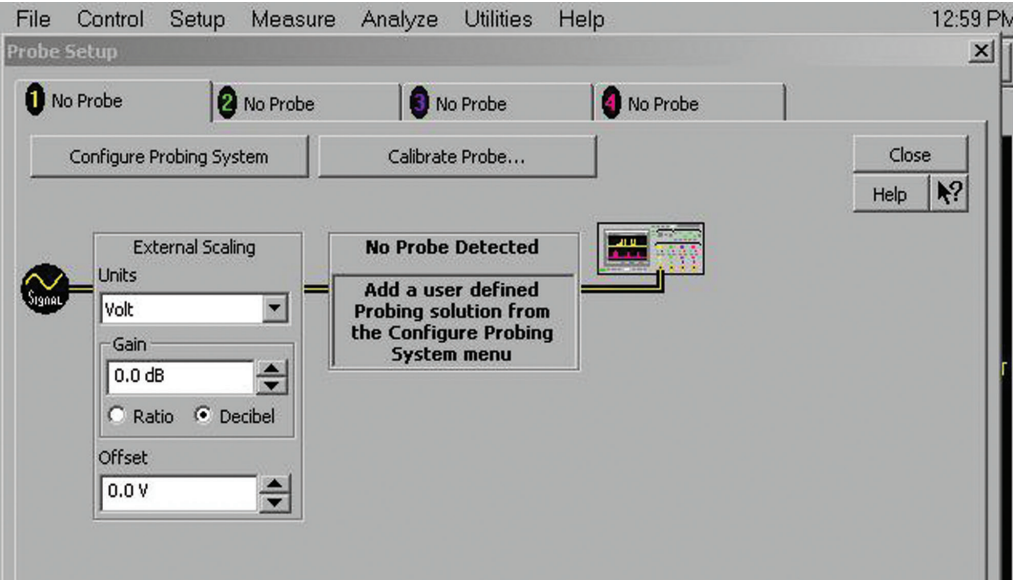


Figure 6 Probe menu

In the next screen, click on “Configure probing system.”

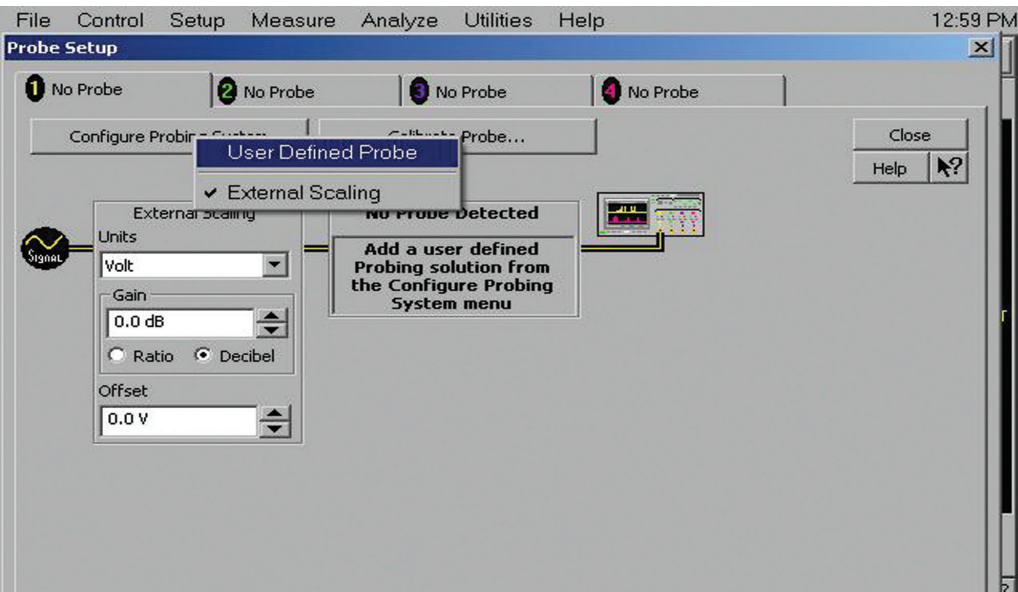


Figure 7 Probe menu

Then select “User defined probe.”

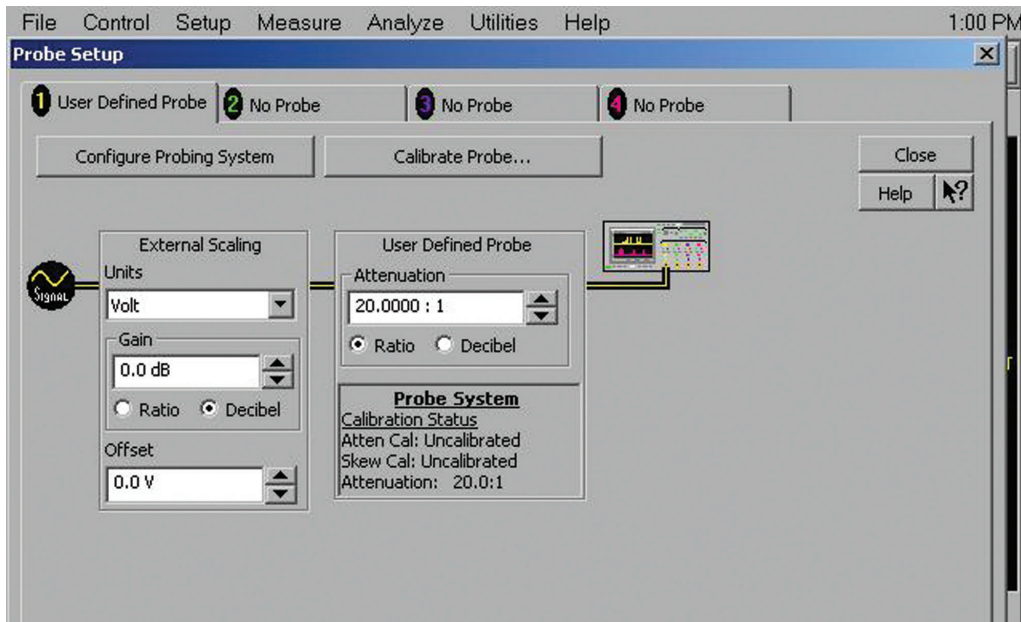


Figure 8 Probe menu

Then enter the nominal attenuation value from the table above.

Calibrating the probe system (optional)

If you wish to calibrate the probe and attenuator system for the best attainable accuracy, you can use the calibrated dc outputs from the oscilloscope's Aux Out. Go to the Utilities menu and select “Calibration.” Select “dc” from the dropdown menu under “Aux.”

With no input to the probe, measure the average voltage using the “Vavg” automatic measurement. Then probe a known dc output voltage from the Aux Out, using the Probe Cal Fixture E2655B. Measure the average voltage again using the “Vavg” automatic measurement. Calculate the correct attenuation ratio of the probing system based on the ratio of the difference between the two readings to the known output from the calibrator. Enter this correct attenuation value into the user-defined probe menu (see Figure 8).

How to purchase attenuators

For the applications that need to measure larger signals with fast edges, the N2880A in-line coaxial attenuator kit allows you to increase the dynamic range of the probe system up to 50 Vpp and the offset range up to +/-30 V, without affecting the bandwidth or rise time characteristics of the probe system. The N2880A comes with one pair of 6 dB, 12 dB and 20 dB attenuators in a kit. The N2881A DC blocking capacitors can be used in series with the in-line attenuator to block out unwanted DC components of the input signal up to 30 V.

All InfiniiMax probe amplifiers and heads are compatible with the N2880A in-line attenuators and N2881A DC blocking capacitors. However, due to limited max input voltage of N5380A dual SMA probe head, the N5380A is not suitable for measuring signals large enough to require an added attenuator.

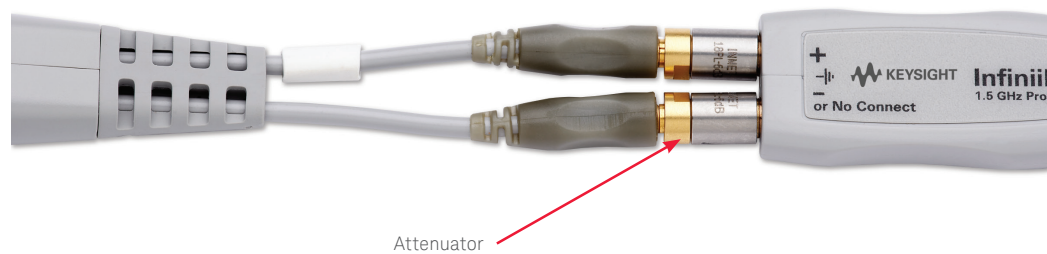


Figure 9. N2880A InfiniiMax in-line attenuator connected to an InfiniiMax probe amplifier and a probe head accessory

Increasing the separation between the probe amplifier and the probe head

In some cases, it may be desirable to increase the distance between the probe amplifier and the probe head. For example, in a densely packed system with large plug-in cards, there may not be enough space between cards for the probe amplifier and the probe head leads may not be long enough to reach the probing points. The probe head extension cables N5450A can be useful in this situation.

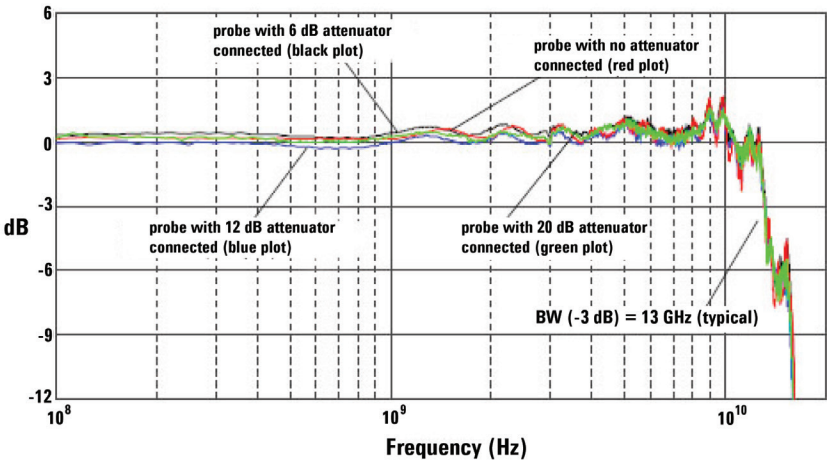


Figure 10. Frequency response plots for four setups -- the probe without any attenuators, the probe with 6 dB attenuator, the probe with 12 dB attenuator, and the probe with 20 dB attenuator

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