Keysight Technologies

# Considerations in Making Small Signal Measurements

Application Brief

The ever-increasing demand for battery-powered mobile devices and more energy efficient green product development has triggered a rising demand for oscilloscope measurement solution that can accurately test and measure the small signals with higher accuracy.

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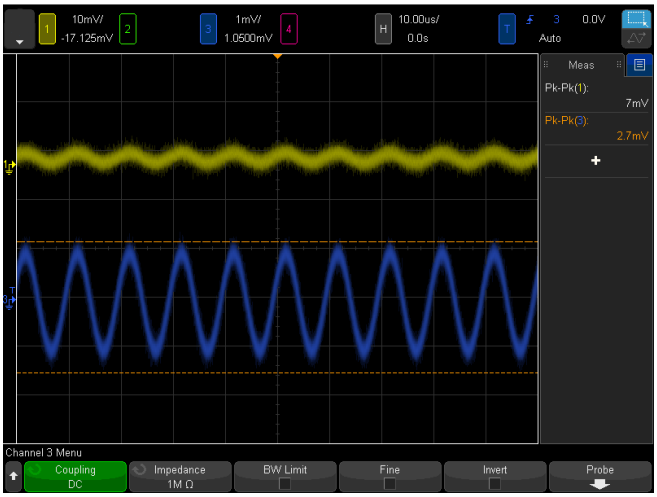
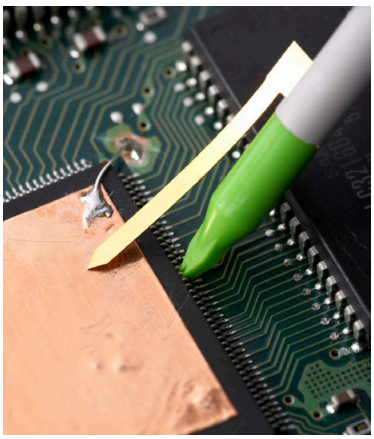
## Probing considerations

If you are measuring the small amplitude of ripple and noise on your power rail or devices, you may need to use an oscilloscope at or near its more sensitive V/div setting.
First, try using a probe with a lower attenuation ratio such as 1:1 probe, rather than using the standard passive probe with 10:1 attenuation ratio that shipped with your instrument. With a 10:1 probe, not only is the oscilloscope's base-line noise floor increased by a factor of 10, but the minimum V/div setting of scope is also ten times higher than with a 1:1 probe.

Another very important tip in probing small signal is to minimize the amount of residual noise picked up by the probe. A 15-cm long ground lead and a hook tip that typically come standard with a general purpose passive probe could pick up noise generated by the target signal or other devices nearby. Use a smaller probe tip and a shorter ground connection such as a BNC adapter on the board or a bayonet type of ground lead reducing noise picked up by minimizing the loop of the connections and also reducing inductive loading.




N2873A 10:1 probe on channel 1 (yellow) and N2870A 1:1 probe on channel 3 (blue) measuring 2mVpp 100kHz sine wave.



Use a smaller probe tip and a shorter ground connection for reduced noise pickup and inductive loading.

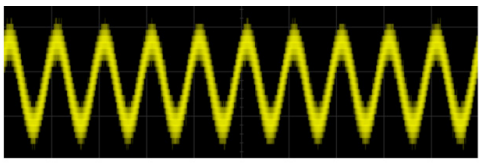
## Higher resolution and lower noise acquisition

When measuring small signals with a large dynamic range, you need a measurement resolution that is higher than the 8 bits provided by conventional digitizing oscilloscopes. Rather than resorting to a high-resolution digitizer or other measuring instrument, you can use the built-in high-resolution mode or averaging mode on your oscilloscope to measure a parameter with a resolution higher than 8 bits and lower noise. Each acquisition mode has pros and cons, but

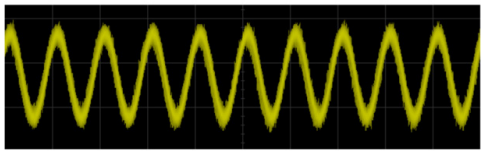
Use averaging acquisition mode when:
- The maximum oscilloscope bandwidth is required
- The signal is repetitive
- Large memory depth is not required
- Control of the number of averages is desired

Use high-resolution acquisition when:
- The maximum oscilloscope bandwidth is not required, or the oscilloscope has excess sample rate relative to its bandwidth
- The signal must be captured from a single trigger
- Deep memory to capture long time ranges is required

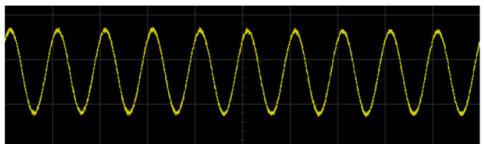
Normal mode



High resolution mode



Averaging mode (8x)



## Helpful scope setups

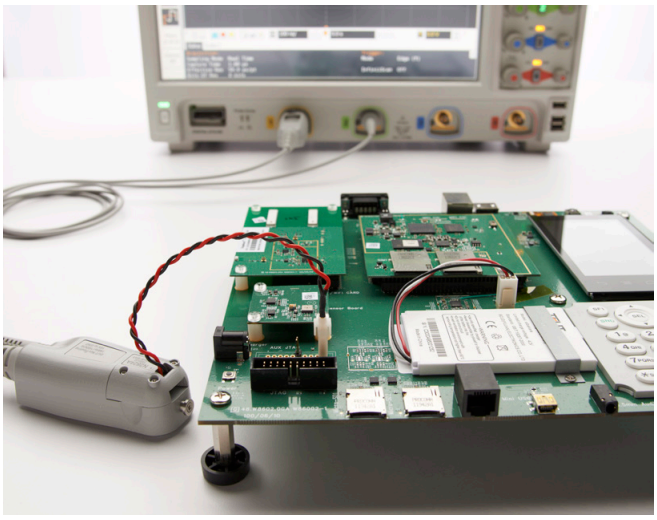
If you're interested in measuring only the AC component of the input signal, you may want to set the scope to an AC coupled mode that removes the DC offset from the input waveform. If the signal output has small AC riding on top of large DC offset (such as 5 V or 12V), you may leave the scope to a DC coupled mode and let the probe provide the offset. Some active probes such as the Keysight Technologies, Inc. InfiniiMax probe or the N2750A InfiniiMode probe provide a wide range of offsets to cancel out the DC offset of the input signal and make more effective use of the probe's dynamic range.

Don't forget to utilize the scope's built-in bandwidth limit or low pass filtering function. Most scopes have a built-in 20 MHz LPF circuit that limits the bandwidth of the scope. By limiting the bandwidth, you can effectively block unwanted high frequency noise from input signals.

# For small current measurements

Keysight offers a unique solution to address the need for high-sensitivity current measurements with a wide dynamic range. The N2820A/21A AC/DC current probes offer the industry's highest sensitivity among oscilloscope current probes, going all the way down to 50 uA with a maximum current range of 5 A.

The N2820A 2-channel high sensitivity current probe comes with two parallel differential amplifiers inside the probe with different gain settings. The low gain side allows you to see the entire waveform or the "zoom out" view of the waveform and the high gain amplifier provides a "zoom in" view to observe extremely small current fluctuations, such as a mobile phone's idle state. The N2820A/21A current probes are optimized for measuring the current flow within the DUT to characterize sub-circuits, allowing the user to see both large signals and details on fast and wide-dynamic current waveforms. The N2820A/21A current probes are compatible with InfiniiVision 3000X, 4000X and Infiniium 9000 Series scopes.



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