Using Current Probes

APPLICATION BRIEF

Some Practical Hints on Effective Current Measurement

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Summary

Teledyne LeCroy offers a series of AC/DC sensitive current probes with maximum continuous current ranges to 500 A and bandwidths to 100 MHz.

Introduction

Based on a combination of Hall effect and transformer technology, Teledyne LeCroy current probes are ideal for making accurate AC, DC, and impulse current measurements. Teledyne LeCroy current probes are available in a variety of models for a wide range of applications. The full range of current probes include models with bandwidths up to 100 MHz, peak currents up to 700 A and sensitivities to 1 mA/div.

Teledyne LeCroy Current Probes

Figure 1 shows the whole family of current probes summarized in the table below.

Figure 1: Teledyne LeCroy Current Probes (clockwise from upper left CP030A, CP030, CP031, CP500, CP150, CP031A)

Note that all the current probes are fully integrated into the scope via the Teledyne LeCroy ProBus interface. They receive power from the scope and produce waveforms in units of Amperes. They are fully controlled, including degaussing and autozero operations, from the input channel menus.

Model	Max Continuous Input Current	Max Peak Current (non-continuous)	Bandwidth	Minimum Sensitivity	Coupling	Max Conductor Size (diameter)	Interface
CP030	30A	50A	50 MHZ	10mA/div	AC, DC, GND	5mm	Probus, 1MΩ only
CP030A	30A	50A	50 MHZ	1mA/div	AC, DC, GND	5mm	Probus, 1MΩ only
CP031	30A	50A	100 MHZ	10mA/div	AC, DC, GND	5mm	Probus, 1MΩ only
CP031A	30A	50A	100 MHZ	1mA/div	AC, DC, GND	5mm	Probus, 1MΩ only
CP150	150A	500A	10 MHZ	100mA/div	AC, DC, GND	20mm	Probus, 1MΩ only
CP500	500A	700A	2 MHZ	100mA/div	AC, DC, GND	20mm	Probus, 1MΩ only

Increasing Probe Sensitivity

While all these current probes have a wide sensitivity range it is sometimes desirable to be able to increase the sensitivity of the probe. For measuring very small currents, the sensitivity of a current probe can be increased by wrapping multiple turns through the primary as shown in Figure 2.

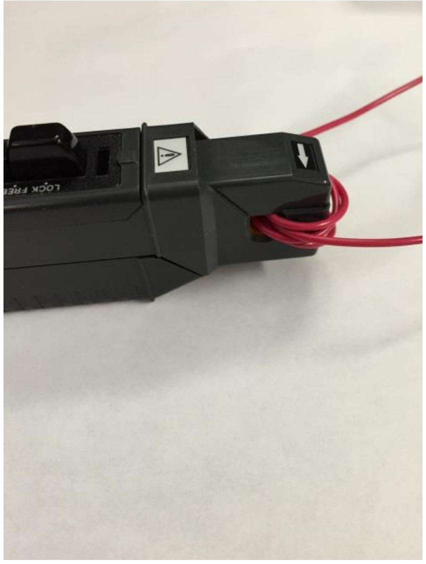

Figure 2: Increasing the sensitivity of the current probe

Since current probes follow the transformer rules, the sensitivity will increase by a factor of the number of turns passing through the primary. Note that the insertion impedance will increase by the square of number of turns. For example, wrapping 10 turns through the jaw opening of a current probe will increase the sensitivity by a factor of 10, and the insertion impedance by a factor of 100. Usually this is not problem since current levels this low will not generate very large voltage potentials across the insertion impedance. When using this technique, be sure to factor the transformer ratio into any on screen scale factors, and math functions.

Current Probe Measurement Techniques

By passing multiple conductors through the primary, as shown in Figure 3, the current probe will only measure the net current sum flowing through all of the conductors.

Figure 3: Setup for measuring the net current in a pair of conductors

Currents of equal magnitude and opposite polarity will cancel. This technique can also be used extend the DC or low-frequency AC current range without exceeding specified limits by subtracting a offset current with a second conductor that has a pure DC component of a known value. You can also cancel low frequency, common components in this manner. The second conductor's current can be increased by winding multiple turns.

When using current probes you should be aware of some common characteristics shared by all such devices. All current probes have some type of shielding to minimize the pickup of electrostatic fields radiating from the test conductor. Optimizing the design of the shield for maximum rejection has some compromises in other probe parameters. Thus, different vendors' probes have differing ability to reject fast dv/dt signals in the test conductor. While the Teledyne LeCroy current probes have among the lowest voltage sensitivity in the industry you should still be aware of it. This means that wherever possible you should probe the circuit under test on the low voltage side of the circuit.   When that is not possible a simple test, shown in Figure 4, can be used to quantify the electric field pick up in the actual circuit. Connect a short piece of wire to the test conductor. Do not terminate the opposite end. Place the jaw opening around the conductor and view the waveform. Because no current is flowing through the un-terminated wire, any signal displayed in the waveform is due to the dv/dt coupling into the probe. Ideally, none of the voltage signal would be visible in the displayed waveform.

Figure 4: A test for dV/dt sensitivity

Inductance and some resistance are added to circuit from the loop added for probe attachment. The smaller jaw configurations of the Teledyne LeCroy probes reduce this impedance because they permit measurement using smaller test loops. A simple trick to reduce the loop inductance further is to twist the loop tightly near the probe as shown in Figure 5.

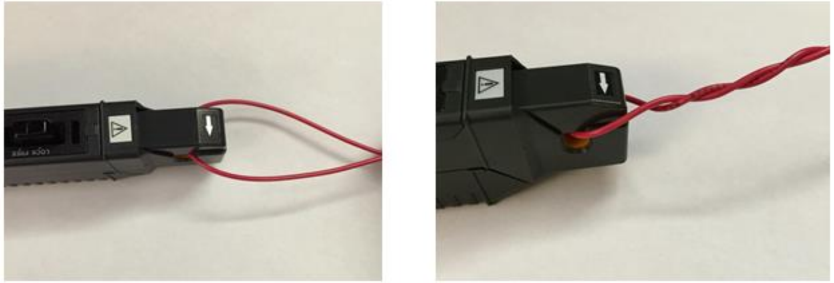

Figure 5: Reducing test loop inductance by twisting the test loop

Conclusion

Whatever your current measurement needs Teledyne LeCroy offers a range of probes from DC to 100 MHz and from mA to 500A measurement capability fully compatible with your Teledyne LeCroy oscilloscope.