



Operation

Caution

The input circuits in the AP034 Active Differential Probe incorporate components that protect the probe from damage resulting from electrostatic discharge (ESD). Keep in mind that this is an active probe, and it should be handled carefully to avoid damage. When using the AP034 Active Differential Probe, you are advised to take precautions against potential instrument damage due to ESD.

CONNECTING THE PROBE TO THE TEST INSTRUMENT

When you are using the AP034 Active Differential Probe with a LeCroy Oscilloscope equipped with ProBus, attach the probe output connector to the oscilloscope input connector. The oscilloscope will recognize the probe, set the oscilloscope input termination to 50 Ω , and activate the probe control functions in the user interface.

To use the AP034 Active Differential Probe with instrumentation not equipped with a ProBus interface, it is necessary to use the ADPPS Power Supply. Attach the ADPPS connector to the probe output connector. The output connector of the ADPPS is a standard male BNC that can be directly connected to another instrument. If necessary, the output of the ADPPS can be interconnected with a 50 Ω coaxial cable. To minimize the effects of skin loss, this cable should be 1 m or less in length. The AP034 Active Differential Probe is designed to drive a 50 Ω load. The gain will be uncalibrated if the output is not correctly terminated. If you are using the probe with an instrument with a high input impedance, place a 50 Ω BNC in-line terminator on the instrument input before attaching the ADPPS.

CONNECTING THE PROBE TO THE TEST CIRCUIT

At the probe tip, two inputs and a ground connection are available for connecting the probe to a circuit under test. For accurate measurements, both the + and – inputs must always be



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connected to the test circuit. The ground connection is optional. Positive voltages applied to the + input relative to the – input will deflect the oscilloscope trace toward the top of the screen.

To maintain the high performance capability of the probe in measurement applications, user care in connecting the probe to the test circuit. Increasing the parasitic capacitance or inductance in the input paths may introduce a “ring,” or slow the rise time of fast signals. To minimize these effects, use the shortest length possible when connecting the probe to the circuit under test. Input leads that form a large loop area (even shielded coaxial cables) will pick up any radiated magnetic field that passes through the loop, and may induce noise in the probe inputs. Because this signal will appear as a differential mode signal, the probe’s common mode rejection will not remove it. You can greatly reduce this effect by using short interconnection leads, and twisting them together to minimize the loop area.

High common mode rejection requires precise matching of the relative gain or attenuation in the + and – input signal paths. Mismatches in additional parasitic capacitance, inductance, delay, and a source impedance difference between the + and – signal paths will lower the common mode rejection ratio. Therefore, it is desirable to use the same length and type of wire and connectors for both input connections. When possible, try to connect the inputs to points in the circuit with approximately the same source impedance.

If AC coupling is desired, install the AC coupling accessory on the probe tip before connecting it to the test circuit. The low-frequency cutoff (–3 dB point) of the AC coupler is approximately 16 Hz.

If the voltage in the test circuit exceeds the probe’s capability, add the external $\div 10$ or $\div 20$ attenuator* to the probe tip. If both the external attenuator and AC coupler are used, install the attenuator on the probe tip first, then install the AC coupler on the attenuator input.

*** Note**

The external attenuators are precisely adjusted during manufacturing to match the

characteristics of the input of the probe with which they were shipped. The input characteristics of the external attenuator itself do not exactly match those of the probe. Therefore, using the ± 10 and ± 20 attenuators at the same time is not recommended. The scale factor encoding system will not operate correctly with both attenuators installed simultaneously.

The input characteristics of the AP034 1 GHz Active Differential Probe are significantly different than those of the AP033 500 MHz Active Differential Probe. The external attenuators are not interchangeable. The external attenuators currently supplied with the probes are labeled with the appropriate model number. The attenuators supplied with model AP033 probes prior to the introduction of the AP034 did not include the model number on the label. When using an external attenuator with the AP034 Active Differential Probe, make sure it is labeled "AP034."

Interchanging non-compatible attenuators will not damage the probes; however, the transient response of the measured signals will be significantly in error.

In addition to being compatible with the included lead set, the probe input connectors will mate with standard 0.025 in. (0.635 mm) square pins in any rotational orientation. To avoid damaging the input connectors, do not attempt to insert connectors or wire larger than 0.036 in. (0.91 mm) in diameter. Avoid rotating square pins after they are inserted into the input connectors.

The included accessories simplify the task of connecting the probe to the test circuit:

- Use the small (0.5 mm) mini clips with the flexible lead set when connecting to fine-pitch surface mount IC leads.

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- The larger (0.8 mm) mini clips can be used to connect to through-hole leaded components.
- The offset round pins can be used for hand-held probing applications. Reposition the pins by rotating them to obtain the required spacing.

PROBE INPUT LOADING

Attaching any probe to a test circuit will add some loading. In most applications, the high impedance of the AP034 Active Differential Probe inputs imparts an insignificant load to the test circuit. However at very high frequencies, the capacitive reactance of the probe's input capacitance may load the circuit enough to affect measurement accuracy. The equivalent model of the probe input circuits is shown below:

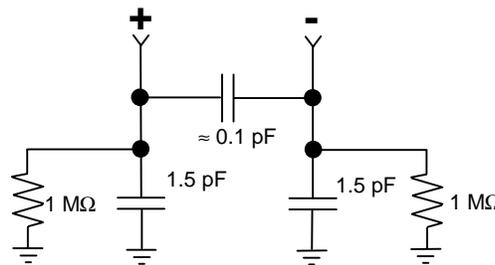


Figure 1. AP034 Equivalent Input Model

GROUNDING THE PROBE

The single lead along with one of the larger (0.8 mm) mini clips can be used to ground the probe to the test circuit. Insert the pin end of the lead into the receptacle marked: 

Note

Do not use the attenuator encoding receptacle (unmarked socket near the – input) to ground the probe. Connecting to the encoding receptacle will not provide adequate grounding, and may result in incorrect scale factor indication.

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In most cases it is not necessary to ground the probe to the circuit under test. However, if the test circuit is isolated from earth ground, it is usually necessary to connect the probe ground to a point in the circuit. Grounding test circuits that are referenced to earth ground may improve the fidelity of high-frequency components in the waveforms. The potential for improvement with grounding will vary depending on the common mode source impedance. However, connecting the probe ground to a circuit that is referenced to earth ground can create a ground loop that may add noise to low-amplitude signals*. Rejection of high-frequency common mode signals is improved when the probe head is ungrounded.

The best recommendation for connecting or not connecting the probe ground is to try both configurations and select the one that performs the best.

Note

The AP034 Active Differential Probe transmits the measured signal differentially through the probe cable. This essentially eliminates signal degradation from ground loop effects within the probe. However, creating a ground loop may introduce signal distortions in the test circuit itself, or in any coaxial cable between the ADPPS power supply and the test instrument.

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SELECTING THE PROPER RANGE

The AP034 Active Differential Probe has a fixed gain of X1 (unity). Use of the $\div 10$ or $\div 20$ external attenuators reduces the amplitude of the input signal when it is necessary to extend the dynamic operating range of the probe. Attenuating the input signal increases both the differential mode range and common mode range of the probe.

Refer to the block diagram below.

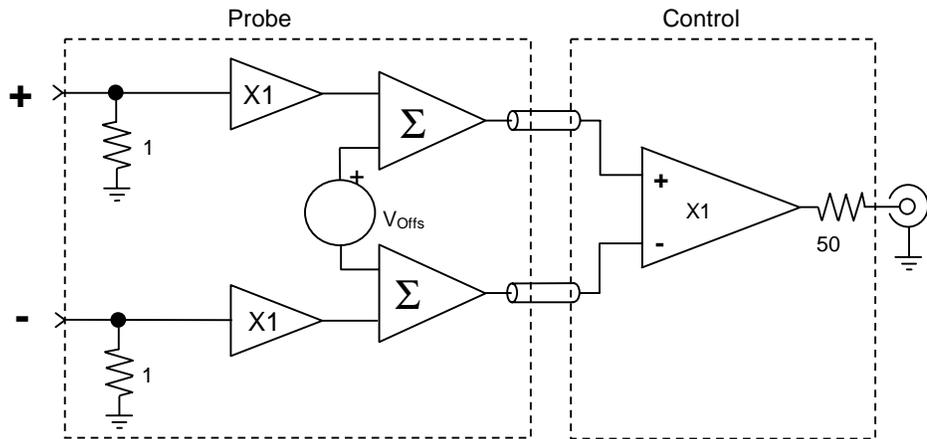


Figure 2. AP034 Block Diagram

By using the plug-on attenuator, you can extend the attenuation range to $\div 20$. Do not use the $\div 10$ and $\div 20$ plug-on attenuators simultaneously. The maximum ranges are given in the following table:

Table 1. AP034 Dynamic ranges and input capacitance at different attenuator settings

	$\div 1$ Attenuation (Probe Only)	$\div 10$ Attenuation	$\div 20$ Attenuation
Common Mode Range	± 16 V	± 42 V	± 42 V
Differential Mode Range *	± 400 mV	± 4 V	± 8 V

*Offset moves the center point of this range.

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When using a differential probe or amplifier, be careful to avoid exceeding the common mode range. Because the common mode signal is rejected by the differential probe, and is not displayed, changes in the amplitude of the common mode component are not apparent to the user. Exceeding the common mode range may introduce distortion into the AP034 output.

Circuitry in the probe detects the presence of either attenuator, and displays the effective gain of the probe on the probe front panel.

OPERATION WITH LECROY OSCILLOSCOPES

When the AP034 probe is connected to a LeCroy oscilloscope equipped with ProBus interface, the displayed scale factor will be adjusted to account for the effective gain of the probe. The channel **OFFSET** knob will control the probe offset, rather than the offset at the oscilloscope input. The probe control menu can be activated by pressing the **COUPLING** button while the channel to which the probe is attached is selected.

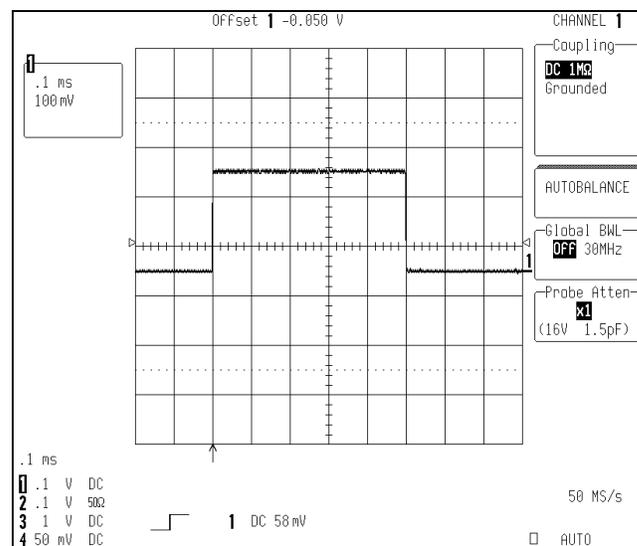


Figure 3. AP034 Probe Control Menu



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When the AP034 Active Differential Probe is first connected to the oscilloscope, the following message will appear: "WARNING: Probe offset buttons are locked." This alerts you that offset control must be made through the oscilloscope, rather than through the buttons located on the probe. It does not indicate a failure in the probe or oscilloscope.

Note:

Correct display of scale factor with the $\div 20$ attenuator installed and correct operation of probe offset require that software version 8.1 or higher be loaded. Refer to the manual section "Oscilloscope Software Compatibility" for additional information.

AP034 USE WITH THE ADPPS POWER SUPPLY

The optional ADPPS Power Supply allows the AP034 Active Differential Probe to be used with instruments that are not equipped with the ProBus interface. When used with the ADPPS, the AP034 must be terminated into $50\ \Omega$. If the test instrument input impedance is not $50\ \Omega$, insert a $50\ \Omega$ in-line terminator between the ADPPS and the instrument input. If a coaxial extension cable is used, the terminator should be located at the instrument end of the cable. Note that the additional parasitic losses of extension cables may reduce the usable bandwidth of the system below the AP034 specification.

To prevent signal distortion, it is necessary to keep the AP034 output less than 400 mV at all times.

With the ProBus interface (see note on following page), the oscilloscope **OFFSET** control actually controls the AP034 offset. Without the ProBus, it is acceptable to use the oscilloscope to position the waveform at high sensitivities, but it is a practice that can lead to erroneous measurements when the probe output exceeds ± 400 mV. Therefore, when the ADPPS is used, it is preferable to use the AP034 offset function to perform all waveform positioning.

The AP034 offset allows you to measure signals up to 2.0 V (1.6 V of offset plus 400 mV of output signal). With accessory plug-on attenuators, the effective offset is increased, and input signals of 20 V ($\div 10$) or 40 V ($\div 20$) may be viewed. The peak

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signal that can be viewed at any equivalent scale factor is the Input Differential Mode Range plus the offset used. See **Adding Offset** on the following page.

When using the AP034 with the ADPPS power supply on oscilloscopes without ProBus interface, use the following table to select the desired effective volts per division and determine the offset available.

Table 2. Recommended AP034 and Oscilloscope settings to obtain desired equivalent Volts/Division

Equivalent Scale Factor	Oscilloscope Scale Factor	AP034 Attenuation	Common Mode Range	Input Differential Mode Range	Maximum Offset	Maximum Observable Signal with Offset	Input Noise (nV/ $\sqrt{\text{Hz}}$), Typical
2 mV/Div	2 mV/Div	$\div 1$	$\pm 16\text{V}$	$\pm 8\text{ mV}^2$	$\pm 1.6\text{ V}$	$\pm 1.608\text{ V}$	35
5 mV/Div	5 mV/Div	$\div 1$	$\pm 16\text{ V}$	$\pm 20\text{ mV}^2$	$\pm 1.6\text{ V}$	$\pm 1.620\text{ V}$	35
10 mV/Div	10 mV/Div	$\div 1$	$\pm 16\text{ V}$	$\pm 40\text{ mV}^2$	$\pm 1.6\text{ V}$	$\pm 1.640\text{ V}$	35
20 mV/Div	20 mV/Div	$\div 1$	$\pm 16\text{ V}$	$\pm 80\text{ mV}^2$	$\pm 1.6\text{ V}$	$\pm 1.680\text{ V}$	35
50 mV/Div	50 mV/Div	$\div 1$	$\pm 16\text{ V}$	$\pm 200\text{ mV}^2$	$\pm 1.6\text{ V}$	$\pm 1.800\text{ V}$	35
100 mV/Div	100 mV/Div	$\div 1$	$\pm 16\text{ V}$	$\pm 400\text{ mV}^3$	$\pm 1.6\text{ V}$	$\pm 2.0\text{ V}$	35
200 mV/Div	20 mV/Div	$\div 10^1$	$\pm 42\text{ V}$	$\pm 800\text{ mV}^2$	$\pm 16\text{ V}$	$\pm 16.8\text{ V}$	350
500 mV/Div	50 mV/Div	$\div 10^1$	$\pm 42\text{ V}$	$\pm 2\text{ V}^2$	$\pm 16\text{ V}$	$\pm 18\text{ V}$	350
1 V/Div	100 mV/Div	$\div 10^1$	$\pm 42\text{ V}$	$\pm 4\text{ V}^3$	$\pm 16\text{ V}$	$\pm 20\text{ V}$	350
2 V/Div	100 mV/Div	$\div 20^1$	$\pm 42\text{ V}$	$\pm 8\text{ V}^3$	$\pm 32\text{ V}$	$\pm 40\text{ V}$	700

¹ Attenuation obtained using the external $\div 10$ or $\div 20$ attenuator.

² Input differential mode range displayed is limited by ± 4 divisions of vertical scale on oscilloscope.

³ Limited by probe output and ± 4 divisions of vertical scale on oscilloscope. Oscilloscope OFFSET and POSITION must be set to zero.

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ADDING OFFSET

The AP034 Active Differential Probe has true differential offset capability. This allows you to remove a DC bias voltage from the differential input signal while maintaining DC coupling. By using probe offset rather than the **POSITION** control on the oscilloscope, the full dynamic range of the probe remains centered around the offset level.

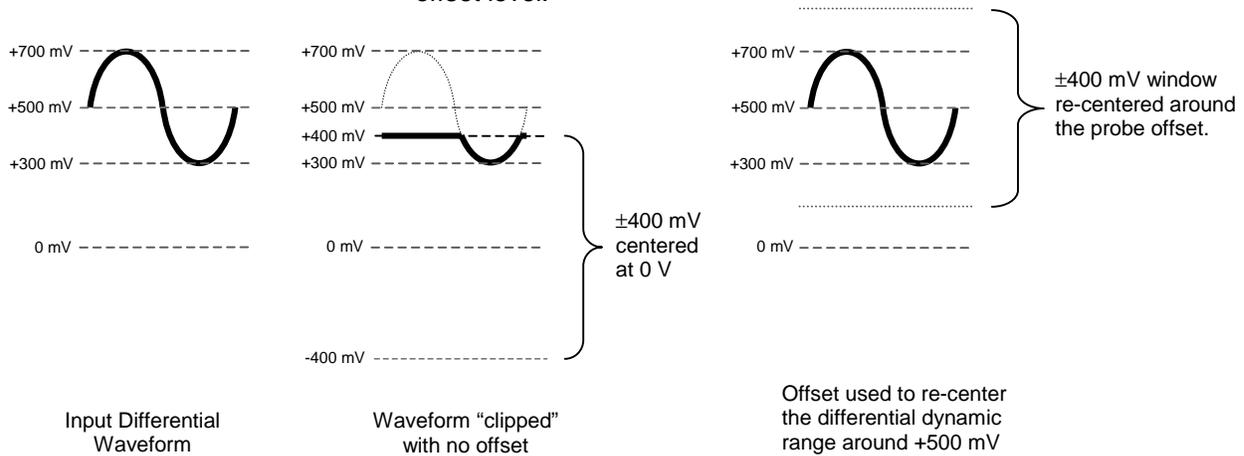


Figure 4. Effect of Differential Offset

When the AP034 Active Differential Probe is used with a LeCroy oscilloscope equipped with ProBus interface, the probe offset can be controlled with the channel **OFFSET** knob.* The buttons on the probe housing will be disabled.

When used with the ADPPS Power Supply on instruments that lack ProBus support, offset can be controlled with the buttons on the probe's front panel. The offset can be returned to zero at any time by briefly pressing both the **↑** and **↓** **OFFSET** buttons at the same time. Pressing both the **↑** and **↓** **OFFSET** buttons for more than 2 seconds will initiate an Autobalance cycle.

*Note

*Probe offset is controlled with the channel **OFFSET** knob in oscilloscope software versions 8.1.0 or higher. The current offset value is*

*displayed above the graticule for a few seconds after a change is made by turning the knob (refer to Figure 3). In prior software versions, the channel **OFFSET** knob adjusted the offset of the oscilloscope input rather than the probe offset. When the AP034 Active Differential Probe is used with LeCroy oscilloscopes with older software versions, it is important that the channel offset (controlled by the channel **OFFSET** knob) remain set to 0.0000 V. Moving the displayed waveform with the channel offset rather than probe offset will not re-center the dynamic operating range of the probe. Offsetting the trace with the oscilloscope channel offset introduces the possibility of erroneous waveforms that result from overloading the probe.*

AUTOBALANCE

The AP034 Active Differential Probe incorporates an Autobalance function to remove the DC offset from the output. Autobalance must be invoked by you. When power is first applied, the probe will return to the internal values resulting from the last Autobalance cycle. For Autobalance to function properly, all signals must be removed from the input.

After several minutes of warmup, or when the probe is exposed to a large shift in ambient temperature, some DC offset drift may occur from thermal effects in the amplifier circuitry. To initiate an Autobalance cycle, remove the probe from the test circuit and select the **AUTOBALANCE** menu selection in the oscilloscope "COUPLING" menu for the channel the probe is connected to. If the probe is being used with the ADPPS power supply, remove the input signal, then push and hold both **OFFSET** buttons for two seconds. The AP034 must be terminated into 50 Ω for successful Autobalance.

Upon successful completion of the Autobalance cycle, all three of the **EFFECTIVE GAIN** indicators will be briefly illuminated. If an input signal is present during auto balance and the routine fails, the **EFFECTIVE GAIN** indicators will not illuminate. The probe will then revert to the offset values resulting from the last

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successful completion of the Autobalance cycle. In many situations, this will be adequate to make routine measurements.

DESIGNING TEST FIXTURES FOR THE AP034 PROBE

Often it is desirable to connect the probe directly to user-fabricated test fixtures, such as those used for semiconductor characterization. To facilitate use with custom test fixtures, the input receptacles used in the AP034 probe are compatible with commercially available 0.025 in. (0.635 mm) square pins. The receptacles do not require a specific rotational orientation for the square pin. The dimensions listed below can be used as a layout guide for a test fixture circuit board. The recommended insertion depth of the pins is 0.100 in. (2.5 mm) to 0.200 in. (5.0 mm).

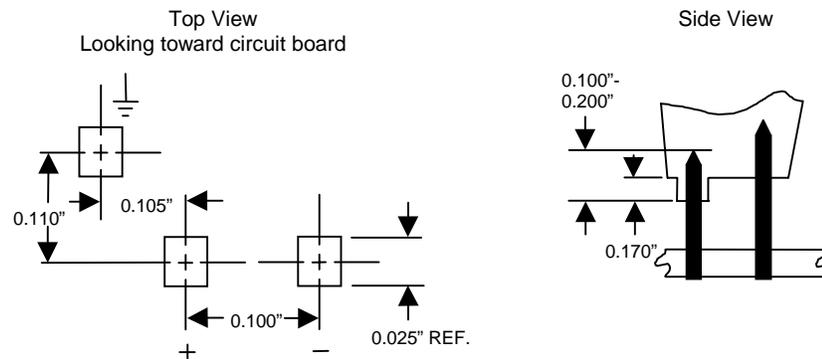


Figure 5. Layout dimensions for test fixtures

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