



Performance Verification

This procedure can be used to verify the warranted characteristics of the AP034 Active Differential Probe.

The recommended calibration interval for the model AP034 Active Differential Probe is one year. The complete performance verification procedure should be performed as the first step of annual calibration. You can record test results on a photocopy of the Test Record provided at the end of this section.

You can do the performance verification without removing the instrument covers, exposing yourself to hazardous voltages. Adjustment should only be attempted if a parameter measured in the Performance Verification Procedure is outside of the specified limits.

Adjustment should only be performed by qualified personnel.

TEST EQUIPMENT REQUIRED

Table 3 lists the test equipment and accessories (or their equivalents) that are required to verify the performance of the AP034 Active Differential Probe.

This procedure is designed to minimize the number of calibrated test instruments required.

Only the parameters listed in **boldface** in the “Minimum Requirements” column must be calibrated to the accuracy indicated.

Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required.



TABLE 3. List of Required Equipment

Description	Minimum Requirements	Test Equipment Examples
Wide Band Oscilloscope ¹	Minimum 1 GHz bandwidth 2 mV to 5 V scale factors ProBus interface equipped 2% vertical accuracy	LeCroy LC584A
Digital Multimeter	DC: 0.1% accuracy AC: 0.2% accuracy to measure 200 mV and 2 V rms @ 1 kHz 5½ digit resolution	Agilent Technologies 34401A Fluke 8842A-09 Keithley 2001
Function Generator	Sine Wave and Square Wave output waveforms 20 V _{p-p} into 1 MΩ 70 Hz to 10 MHz frequency range	Agilent Technologies 33120A Stanford Research Model DS340 Leader LAG-120B
High Frequency Sine Wave Generator	50 to 500 MHz and 50 kHz Output adjustable from 300 mV to 2 V _{p-p}	Agilent Technologies 8648C
Terminator, in-line, BNC	50 Ω ±2% coaxial termination	Pomona 4119-50
Terminator, precision, BNC	50 Ω ±0.2%	LeCroy TERM-CF01
Attenuator, BNC	50 Ω ±2%, ±10 (20 dB)	Pomona 4108-20dB
BNC coaxial cable (2 required)	male-male BNC, 50 Ω, 36 in.	Pomona 5697-36
Calibration Fixture	ProBus Extension Cable	LeCroy PROBUS-CF01
Calibration Fixture	AP033/AP034 Calibration Fixture	LeCroy AP03x-CF01
Banana Plug adapter	BNC female-to-banana plug	Pomona 1269

Notes

¹ If a LeCroy ProBus equipped oscilloscope is not available, you may use an alternate oscilloscope that meets the other minimum specifications listed, and the model ADPPS power supply, to perform the adjustment procedure. The input

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termination of the oscilloscope must be set to 50 Ω , and the offset or position must remain at center screen.

PRELIMINARY PROCEDURE

1. Connect the AP034 Active Differential Probe to the female end of the ProBus Extension Cable. Connect the male end of the ProBus extension cable to Channel 1 of the oscilloscope.
2. Turn the oscilloscope on and allow at least a 30-minute warm-up time for the AP034 and test equipment before performing the Verification Procedure.
3. Turn on the other test equipment and allow these to warm up for the time period recommended by the manufacturer.
4. While the instruments are reaching operating temperature, make a photocopy of the Performance Verification Test Record (located at the end of this section), and fill in the necessary information.

The warranted characteristics of the AP034 Active Differential Probe are valid at any temperature within the Environmental Characteristics listed in the Specifications. However, some of the other test equipment used to verify the performance may have environmental limitations required to meet the accuracy needed for the procedure. Make sure that the ambient conditions meet the requirements of all the test instruments used in this procedure.

PROCEDURE

Note

*Correct operation of the AP034 controls requires oscilloscope software version 8.1.0 or higher. The use of earlier versions is not recommended. You can verify the software version in the test oscilloscope by pressing the **SHOW STATUS** button, then selecting the **System** menu option. Contact your local LeCroy representative if the software in your oscilloscope requires updating.*



A. Check Gain Accuracy

1. From the oscilloscope display, select the channel that the AP034 is connected to (channel 1), then select the “Coupling” menu. Set the **Coupling** to **DC 1 M Ω** . (If the only choice available is **AC 1 M Ω** , remove the Plug-on AC Coupling adapter from the probe tip.)
2. If necessary, set the probe offset to **0.000 V** by rotating the OFFSET knob in the CHANNEL section of the oscilloscope.
3. Using a BNC female-to-female adapter, connect one end of a BNC cable to the probe end of the ProBus Extension Cable. Connect the Precision 50 Ω Terminator to the other end of the BNC cable.
4. Connect one end of a second BNC cable to the output of the Function Generator. Attach the BNC-to-dual-male banana plug adapter to the free end of the second BNC cable. Connect the banana plugs to the Digital Multimeter (DMM).
5. Set the DMM to measure AC Volts.
6. Set the mode of the Function Generator to Sine Wave; the frequency to approximately 1 kHz; and the output amplitude to approximately 200 mV rms, as measured by the DMM.
7. Record the measured amplitude to 100 μ V resolution in the Test Record.
8. Unplug the output cable from the DMM. Remove the BNC-to-banana plug adapter from the end of the cable.
9. Autobalance the AP034 by pressing the **AUTOBALANCE** menu button located in the “Coupling” menu.
10. Carefully align the four pins that correspond to the **Differential Drive No Termination** portion of the AP03x-CF01 Calibration Fixture with the input receptacles in the AP034 probe head. Press the probe into the fixture to fully engage the pins.
11. Connect the banana plugs of the precision terminator to the digital multimeter (DMM).

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12. Connect the free end of the output cable from the Function Generator to the **Differential Drive No Termination** connector of the AP033/AP034 Calibration Fixture.
13. After the DMM reading has stabilized, record the measured output amplitude to 100 μV resolution in the Test Record.
14. Divide the measured output voltage (recorded in step A-13) by the sine wave generator output voltage (probe input voltage) from step A-7. Subtract 1.0 from the ratio and multiply the result by 100 to get the error in percent.

$$\% \text{ Error} = \left(\frac{\text{Measured Output Voltage}}{\text{Input Voltage}} - 1 \right) \times 100$$

15. Record the answer to two significant places ($\pm x.xx\%$) on line A-15 in the Test Record.
16. Verify that the X1 gain error is less than $\pm 2\%$.
17. Disconnect both BNC cables from the test setup.

B. Check High Frequency Common Mode Rejection Ratio (CMRR)

Note

Common Mode Rejection Ratio (CMRR) is defined as the Differential Mode Gain divided by the Common Mode Gain (normalized inverse of the Common Mode response). At frequencies below approximately 250 MHz, the bandwidth-related attenuation in the AP034 Active Differential Probe is so insignificant that the Differential Mode Gain can be assumed to be unity (1.0).

1. Disconnect the ProBus Extension cable from the AP034 and the oscilloscope. Reconnect the AP034 directly to the Channel 1 input of the oscilloscope.
2. Carefully move the AP034 probe head from the **Differential Drive No Termination** connector of the AP033/AP034 Calibration Fixture to the **Common Mode Drive 50 ohm**



Termination connector. Make sure that the probe is fully engaged in the fixture.

3. Set the oscilloscope to display channel 1. In the oscilloscope Channel 1 “COUPLING” menu, set **Coupling** to **DC 1 M Ω** , and **Global BWL** to **Off**. Autobalance the AP034 by pressing the **AUTOBALANCE** menu button twice. Set the oscilloscope trigger mode to **AUTO**.
4. If necessary, center the trace with the Probe Offset (channel OFFSET knob).
5. Connect a BNC cable from the output of the high frequency sine wave generator to the Channel 2 input of the oscilloscope.
6. Set the oscilloscope as follows:

Display	Channel 2 only
Channel 2 VOLTS/DIV	0.5 V/div
Channel 2 Coupling	DC 50 Ω
Trigger on	2
Trigger coupling 2	HF
TIME/DIV	5 ns/div
Acquisition Mode	NORMAL

7. Set the high-frequency sine wave generator frequency to 100 MHz, and the amplitude to approximately 2 V_{p-p}. Set the RF Output to ON.
8. Adjust the oscilloscope trigger level as needed for a stable display.
9. Adjust the output amplitude of the high frequency sine wave generator for a display of exactly 4 divisions (2 V) peak-to-peak. Turn off the RF Output.
10. Move the high frequency sine wave generator output cable from the oscilloscope channel 2 input to the **Common Mode Drive 50 ohm Termination** connector of the AP033/AP034 Calibration Fixture.
11. Set the high-frequency sine wave generator RF Output to ON.

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12. Set the oscilloscope to display channel 1 only, set the trigger source to channel 1, and set the channel 1 vertical scale factor as needed to measure the amplitude of the displayed waveform. Adjust the trigger level as necessary for a stable display. This is the common mode signal. Turn on Math Channel A. Press **MATH SETUP**, then **REDEFINE A**. Set the **A Math** type to **Average**, **Avg Type** to **Continuous**, with **1:15 weighting**, of channel 1. Turn off the trace 1 display.

Note

*The amplitude of the Common Mode signal should be relatively small. If the output waveform appears to be a 1 Volt square wave, check that the **Common Mode Drive 50 ohm Termination** connector of the AP033/AP034 Calibration Fixture is being used and not the **Differential Drive 50 ohm Termination** connector.*

13. Measure the peak-to-peak output amplitude of the AP034. Record the reading to two-digit resolution (xx mV) as "Common Mode Signal at 100 MHz" in the Test Record.
14. Calculate the Common Mode Rejection Ratio (CMRR) at 100 MHz by dividing 2,000 mV by the measured Common Mode Signal recorded in step B-14 (direct reciprocal of the Common Mode Gain). Record the result to two-digit resolution (xx:1) in the Test Record.
15. Verify that the CMRR at 100 MHz is greater than 18:1 (25 dB).
16. Turn off the high frequency sine wave generator RF output, and disconnect the output cables.



C. Check Low Frequency CMRR

Note

Because greater amplitudes are required to measure the higher CMRR specifications at low frequencies, the Function Generator will be used in place of the high-frequency sine wave generator for the low frequency CMRR test.

1. Carefully move the AP034 probe head from the **Common Mode Drive 50 ohm Termination** connector of the AP033/AP034 Calibration Fixture to the **Common Mode Drive No Termination** connector. Make that sure the probe is fully engaged in the fixture.
2. Set the oscilloscope to display channel 2, the channel 2 input coupling to DC1 M Ω , the channel 2 vertical scale to 5 Volt/div, the horizontal scale to 5 ms/div, and the trigger source to channel 2. Set BW limiting on channels 1 and 2 to 25 MHz.
3. Connect the BNC Tee adapter to the output connector of the Function Generator. Connect a BNC cable from one end of the BNC Tee adapter to channel 2 of the oscilloscope. Connect a second BNC cable from the remaining end of the BNC Tee adapter to the **Common Mode Drive No Termination** input connector of the AP033/AP034 Calibration Fixture.

Caution

*Make sure that the **Common Mode Drive No Termination** connection is used. Prolonged application of the power levels used in the low frequency common mode test may damage the termination resistance in either 50 ohm Termination input of the AP033/AP034 calibration fixture.*

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4. Set the sine wave generator frequency to 70 Hz, and the output amplitude to $20 V_{p-p}$, (4 divisions on the oscilloscope). If necessary, adjust the trigger level for a stable display.
5. Set the oscilloscope to display channel 1, but leave the trigger source set to channel 2. Set the vertical scale of channel 1 to 2 mV/div. Create a math waveform on channel A defined as the Average of channel 1. Set the average factor as necessary to reduce noise. Increase the zoom to a factor of four (0.5 mV/division). Turn off the waveform display of all channels except the **A Math** waveform.
6. Increase the zoom of the **A Math** waveform as needed to measure the peak-to-peak amplitude. This is the common mode signal.
7. Record the displayed “Common Mode Signal at 70 Hz” to two-digit resolution (x.xx mV) in the Test Record.
8. Calculate the Common Mode Rejection Ratio (CMRR) at 70 Hz by dividing 20 000 mV by the measured Common Mode Signal recorded in step C-7 (direct reciprocal of the Common Mode Gain). Record the result to two-digit resolution (xx 000:1) in the Test Record.
9. Verify that the “Common Mode Rejection Ratio at 70 Hz” is greater than 10000:1 (80 dB).
10. Change the output amplitude of the Function Generator to approximately $8.0 V_{p-p}$, and the frequency to 1 MHz.
11. Set the oscilloscope to display channel 2 only. Change the horizontal scale factor to $0.5 \mu\text{s}/\text{div}$, and the channel 2 vertical scale to 2 V/div. Turn the BWL on channels 1 and 2 to 200 MHz.
12. Adjust oscilloscope trigger level as necessary for a stable display. Adjust the Function Generator amplitude as needed to maintain $8.0 V_{p-p}$ as measured on channel 2.
13. Turn off the oscilloscope channel 2 display, turn on the display of channel 1 and the **A Math** waveform (averaged channel 1). Adjust the scale factor of channel 1 and the Zoom of the **A Math** waveform as necessary to accurately measure the amplitude of the averaged signal.



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14. Record the displayed “Common Mode Signal at 1 MHz” to two-digit resolution in the Test Record.
15. Calculate the “Common Mode Rejection Ratio (CMRR) at 1 MHz” by dividing 8000 mV by the measured Common Mode Signal recorded in step C-14. Record the result in the Test Record.
16. Verify that the Common Mode Rejection Ratio at 1 MHz is greater than 100:1 (40 dB).
17. Remove all cables and test fixtures from the AP034 probe.

This completes the Performance Verification of the AP034. Complete and file the results recorded in the AP034 Performance Verification Test Record, as required by your quality procedures. Apply a suitable calibration label to the AP034 housing as required.

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AP034 Performance Verification Test Record

This record can be used to record the results of measurements made during the performance verification of the AP034 Active Differential Probe.

Photocopy this page and record the results on the copy. File the completed record as required by applicable internal quality procedures.

The section in the test record corresponds to the parameters tested in the performance verification procedure. The numbers preceding the individual data records correspond to the steps in the procedure that require the recording of data. Results to be recorded in the column labeled "Test Result" are the actual specification limit check. The test limits are included in all of these steps. Other measurements and the results of intermediate calculations that support the limit check are to be recorded in the column labeled "Intermediate Results."

Permission is granted to reproduce these pages for the purpose of recording test results.

Model: _____ AP034 _____

Serial Number: _____

Asset or Tracking Number: _____

Date: _____

Technician: _____

EQUIPMENT USED:

	MODEL	SERIAL NUMBER	CALIBRATION DUE DATE
OSCILLOSCOPE			
DIGITAL MULTIMETER			
HF SINE WAVE GENERATOR			
FUNCTION GENERATOR ¹			N/A

¹ The function generator provides stimulus for making relative measurements. The output amplitude of the generator is measured with the DMM or oscilloscope in the procedure. Thus, the generator is not required to be calibrated.



AP034 PERFORMANCE VERIFICATION TEST RECORD

Step	Description	Intermediate Data	Test Result
Gain Accuracy			
A-7	Sine Wave Generator Output Voltage	_____ mV	
A-13	Probe Output Voltage	_____ mV	
A-15	Gain Error (Test Limit $\leq \pm 2\%$)		_____ %
High Frequency Common Mode Rejection Ratio (CMRR)			
B-13	Common Mode Signal at 100 MHz	_____ mV	
B-15	CMRR at 100 MHz (Test Limit $\geq 18:1$)		_____ :1
Low Frequency Common Mode Rejection Ratio			
C-7	Common Mode Signal at 70 Hz	_____ mV	
C-8	CMRR at 70 Hz (Test Limit $\geq 10\,000:1$)		_____ :1
C-14	Common Mode Signal at 1 MHz	_____ mV	
C-15	CMRR at 1 MHz (Test Limit $\geq 100:1$)		_____ :1

Notes: _____

