Adjustment Procedure

INTRODUCTION

You can use this procedure to adjust the AP034 Active Differential Probe to meet the warranted specifications. This procedure should only be performed if the instrument fails the Performance Verification tests.

If the probe cannot be adjusted to meet the Performance Verification limits, repair may be necessary.

To ensure instrument accuracy, check the calibration of the AP034 Active Differential Probe every year. Before calibration, thoroughly clean and inspect this unit as discussed in the "Cleaning" section.

Completion of each step in the Adjustment Procedure ensures that the differential probe meets specifications. Some of the adjustments interact with other parts of the circuitry. Therefore, it is necessary that all adjustments be performed in the order listed. For best overall instrument performance, make each adjustment to the exact setting, even when adjustment is within the limits stated in the procedure.

Adequate guard bands were designed into the AP034 Active Differential Probe to ensure that it will meet or exceed published specifications over the entire operating temperature range. To continue to meet the environmental specifications, all adjustments must be performed in a controlled environment with an ambient temperature of 25 ±5 ˚C. The AP034 Active Differential Probe must also be at stable operating temperature before performing adjustments.

Caution

The adjustment procedure will require removal of the probe covers. These covers are part of the ESD protection system of the AP034 Active Differential Probe. To protect the probe, you should perform the entire procedure on a static dissipating work surface. Wear an antistatic

grounding wrist strap and follow standard static control procedures.

The probe tip housing provides physical rigidity to the input pins of the probe. When the covers are removed, observe extra caution to avoid breaking the probe tip receptacles when mating the probe to the calibration fixture.

TEST EQUIPMENT REQUIRED

The table on the next page lists the test equipment and accessories, or their equivalents, that are required for complete calibration. Specifications given for the test equipment are the minimum necessary for accurate calibration. All test equipment is assumed to be correctly calibrated and operating within the specifications listed. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the test equipment manual if more information is needed.

If alternate test equipment is substituted, control settings or calibration equipment setups may need to be altered. Alternate models of test equipment may have different connector styles requiring adapters not included in the equipment list.

TABLE 4. Test Equipment and Accessories

Description	Minimum Specifications	Test Equipment Examples
Wide Band Oscilloscope *	500 MHz bandwidth 2 mV to 200 mV vertical scale factors ProBus interface equipped* 2% vertical accuracy	LeCroy LT342 LeCroy LC344A
Digital Multimeter	0.1% DC volts accuracy at 0.4 V 0.2% AC volts accuracy at 2 V and 1 kHz 5½ digit resolution 0.01 mV AC volts resolution	Agilent Technologies 34401A Fluke 8842A-09 Keithley 2001 with test leads
Function Generator	Sine and square wave output 20 V_{p-p} into 1 MΩ 50 Hz to 1 MHz frequency range Sync. or Freq. Reference output	Agilent Technologies 33120A Stanford Research Model DS340 Leader LAG-120B
Fast Rise Pulse Generator	Risetime < 2 ns Amplitude > 400 mV into 50 Ω Over/Undershoot < 6%	Calibrator signal from LeCroy oscilloscope Tegam / Tektronix PG506 with power unit
Sine Wave Generator	Output 250 MHz at 1 V rms	Agilent Technologies 8648C, with male N to female BNC adapter for the output connector Tegam SG504 with TM series mainframe.
DC Voltage Source	0 to 2 VDC regulated output, settable to 1 mV resolution	HP 6633A
Termination, precision	50 Ω ±0.05%	LeCroy TERM-CF01
Termination, BNC	50 Ω through, male-female	Pomona 4119-50
Calibration Fixture	ProBus Extension Cable	LeCroy PROBUS-CF01
Calibration Fixture	AP033/AP034 Calibration Fixture	LeCroy AP03X-CF01

TABLE 4. Test Equipment and Accessories

Description	Minimum Specifications	Test Equipment Examples
BNC coaxial cable (2 required)	male-male BNC, approx. 1 m	Pomona 5697-36
BNC Tee Adapter	female-male-female	Pomona 3285
Banana Plug Adapter (2 required)	BNC female-to-dual male banana plug	Pomona 1269
Shorting Plug	Two 0.025 in. square pins on 0.100 in. centers	Supplied with AP03X-CF01
Adjustment Tool	0.025 in. square tip	Johanson 4192
Low Capacitance Screwdriver		

**** Notes***

If a LeCroy ProBus equipped oscilloscope is not available, you may perform the adjustment procedure with an alternate oscilloscope that meets the other Minimum Specifications, and the model ADPPS power supply. The input termination of the oscilloscope must be set to 50 Ω, the offset or position must remain at center screen, and the high-frequency adjustments must be performed with the ADPPS connected directly to the input of the oscilloscope.

PRELIMINARY PROCEDURE

1. Using pliers, carefully remove each of the push buttons from the ProBus interface housing by gently pulling them away from the housing.
2. Remove the two screws that secure the plastic cover on the cable end of the ProBus interface housing. Gently pull on the probe cable to slide the circuit board assembly from the metal housing.
3. Remove the 5/64 in. (2 mm) Allen head cap screw from the small cover on the back of the probe tip. Remove the cover along with the small cover on the opposite side of the probe. Hold the shielded portion of the probe head in one hand and

gently slide the larger cover off by pulling it away from the probe tip end.

4. Connect the AP034 Active Differential Probe output to the female end of the ProBus Extension Cable. Be careful to align the ProBus pins with the corresponding connector correctly. Connect the male end of the ProBus Extension Cable to Channel 1 of the oscilloscope.

Note

The Logic board is connected to the Amplifier board by four small 8-pin connectors. There are no additional mechanical fasteners holding the two boards together. A small foam pad mounted on the circuit board ensures that the connectors remain engaged while the assembly is mounted within the ProBus interface housing. Be sure that the connectors between the boards are firmly engaged before applying power to the probe. Operating the probe without the logic board will not damage it. However, to ensure reliable operation, the logic board should only be mated with the Amplifier board with the power removed, and the ProBus connector disengaged.

5. Apply power to the oscilloscope and to the other test instrumentation. Allow at least 30 minute's warm-up time for the AP034 Active Differential Probe and test equipment before continuing the calibration procedure.

Note

The probe tip cover also serves to thermally stabilize the input circuitry. The differential input stage of the probe utilizes discrete transistors that need to maintain an approximate match of junction temperatures for correct DC balance. With the covers removed, this circuitry is susceptible to drift caused by air currents flowing over the

components. Remove or redirect any fans that may be blowing air currents over the probe tip during adjustment.

Note

Correct operation of the AP034 Active Differential Probe controls requires software version 8.1.0 or higher. You can find out the software version loaded on your LeCroy scope by pressing ***SHOW STATUS****, then selecting the* ***System*** *menu option.*

In version 8.1.0 and higher, the ***OFFSET*** *controls on the front panel of the probe are disabled. Offset is controlled by the OFFSET knob in the oscilloscope CHANNEL section.*

PROCEDURE

A. Adjust Coarse DC Balance (R226)

1. If necessary, set the probe offset to **0.000 V** by rotating the OFFSET knob in the CHANNEL section of the oscilloscope.
2. Insert the two-pin shorting plug into the socket on the Logic Board. Use the two holes closest to the probe cable (Figure 9).

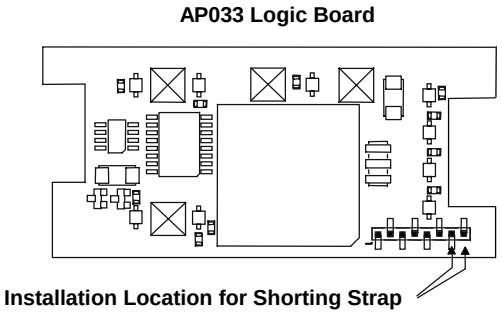

Figure 9.

3. To enter the Cal Mode, push either of the two offset buttons that protrude through holes in the Logic Board.
4. Plug the precision 50 Ω terminator into the DMM input. Set the DMM to measure DC volts.
5. Using a low capacitance screwdriver, adjust **Coarse DC Bal** (R226) on the Amplifier Board for an output voltage of 0 mV ±10 mV (Figure 10).

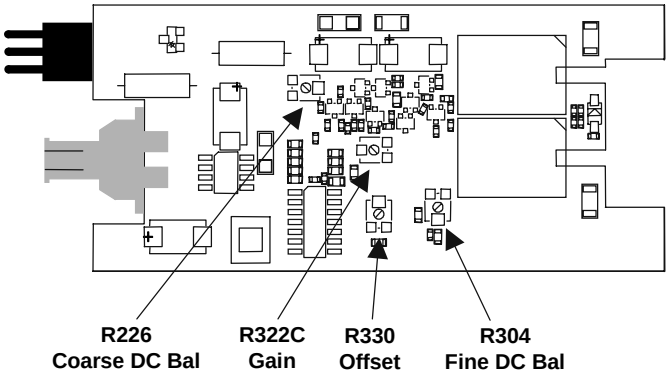

Figure 10. Amplifier Board Adjustment Locations

B. Adjust Fine DC Balance (R304)

1. Remove the shorting plug from the Logic Board.
2. Reinsert the shorting plug into the two holes near the end of the Logic Board. (Figure 9.)
3. Reenter Cal Mode by pushing either of the two buttons that protrude through holes in the Logic Board.
4. Remove the BNC cable from the precision 50 Ω terminator connected to the DMM.
5. Short the output BNC connector by reconnecting the cable to the **SHORT** connector on the AP033/AP034 Calibration Fixture. The **SHORT** connector is the only BNC connector on the AP033/AP034 Calibration Fixture that does not have corresponding input pins for the probe tip. It is located on the end of the board beyond the Common Mode Terminated connector.
6. In Cal Mode, the **EFFECTIVE GAIN** indicators serve as an adjustment indicator. The **EFFECTIVE GAIN** indicators are located on the Logic Board (Figure 11). It may be necessary to hold the boards in your hands to see the indicators while making the adjustment.

7. Using a low capacitance screwdriver, adjust **Fine DC Balance** (R304) until the ÷**10 EFFECTIVE GAIN** indicator lights (Figure 11).

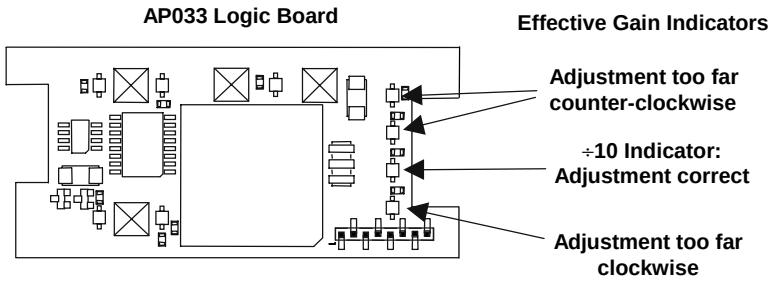

Figure 11. ÷11 Effective Gain Indicator

8. Disconnect the BNC cable from the short connector. Remove the shorting plug from the logic board.

C. Adjust Low Frequency CMRR (R7)

1. Leave the BNC cable connected to the probe end of the ProBus extension cable. Connect a 50 Ω BNC Through Terminator on the other end of the BNC cable. Connect the male end of the 50 Ω terminator to channel 3 on the scope. The scope end of the ProBus extension cable should remain connected to channel 1 of the scope, although there is no signal cable connected.
2. Connect a BNC cable from the output of the Function Generator to the Channel 2 input of the oscilloscope.
3. Connect a second BNC cable from the Function Generator **SYNC OUT** to the external trigger input of the oscilloscope.
4. Set the Function Generator waveform to **Sine** and the frequency to **70 Hz**.

5. Set the oscilloscope as follows:

Display:	Channel 2
Channel 1 VOLTS/DIV:	2 mV/div
Channel 2 VOLTS/DIV:	5 V/div
Channel 2 Coupling:	DC1MΩ
Channel 3 VOLTS/DIV:	2 mV/div
Channel 3 Coupling:	AC 1MΩ
Trigger on:	EXT10
cplg EXT10:	DC
TIME/DIV:	10 ms/div
Acquisition Mode:	NORMAL

6. Adjust the trigger level for a stable display.
7. Set the Function Generator output voltage to 20 V_{p-p} as displayed on the oscilloscope.
8. Disconnect the output cable of the function generator from the channel 2 input of the oscilloscope and reconnect it to the **Common Mode Drive No Termination** connector of the AP033/AP034 Calibration Fixture.
9. Carefully align the four pins that correspond to the **Common Mode Drive No Termination** portion of the AP033/AP034 Calibration Fixture with the input receptacles in the AP034 probe head. Press the probe into the fixture to fully engage the pins.
10. Set the oscilloscope to display channel **3**. The waveform is the common mode signal. Turn the offset as necessary to keep the trace on screen. 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 **3**. Turn off the trace 3 display. Use the Math Zoom and Position controls as necessary to view the waveform.
11. Adjust **LF CMRR** (R7) for minimum amplitude. (See Figure 12 for location.)

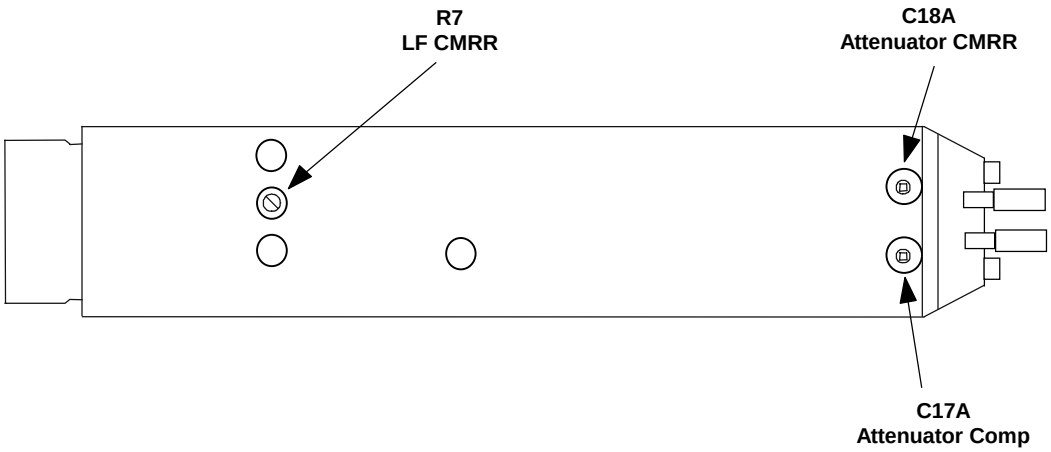

Figure 12. Probe Tip Adjustment Locations

12. Remove the BNC cable from the output of the Function Generator and the calibration fixture. Leave the BNC cable from the SYNC output to the oscilloscope external trigger input in place.

D. Adjust OFFSET (R330)

1. Reconnect the BNC cable to both ends of the ProBus extension cable. The oscilloscope end of the extension cable should still be connected to channel 1.
2. Set the oscilloscope channel 1 scale factor to **10 mV/div**, and the acquisition mode to **Auto**. Set the BWL to **20** or **25 MHz**. Adjust the OFFSET to **0.0 mV**
3. Carefully move the AP034 probe tip from the **Common Mode Drive No Termination** position of the AP033/AP034 Calibration Fixture to the **Differential Drive No Termination** position. Press the probe into the fixture to fully engage the pins.
4. Connect female BNC-to-dual male banana plug adapters to each end of the BNC cable. Plug one end into the output of the DC voltage source, making sure the plug corresponding to the BNC shield (marked “Ground”) is connected to the voltage source **–Output** (or **common** for dual supplies) connector, and the other pin on the **+Output** connector.

5. Connect the other end of the cable to the DMM input, making sure that the plug corresponding to the BNC shield (marked “Ground”) is connected to the **LO** or **COM** input.
6. Set the DC Voltage Source to read as close as possible to **+1.600 V** on the DMM.
7. Autobalance the AP034 by pressing the **AUTOBALANCE** menu button located in the “COUPLING” menu twice, or by pressing and holding both probe offset buttons for at least two seconds.
8. Disconnect the BNC cable from the female BNC-to-dual male banana plug adapter on the DMM.
9. Reconnect the BNC cable from the DC Voltage Source to the **Differential Drive No Termination** connector on the AP033/AP034 Calibration Fixture.
10. Set the probe offset to **–1.600 V** by rotating the **OFFSET** knob in the channel section of the oscilloscope.
11. Allow 10 seconds for the AP034 to stabilize.
12. Using a low capacitance screwdriver, adjust **Offset** (R330) to bring the trace back to exactly center screen. (See Figure 10 for adjustment location.)
13. Remove the dual banana plug adapter from the output of the DC voltage source and reconnect it, with the pins reversed. (The plug corresponding to the BNC shield (marked “Ground”) should now be connected to the **+Output** connector.)
14. In the CHANNEL menu of the oscilloscope, set the probe offset to **+1.600 V** by rotating the OFFSET knob.
15. Allow 10 seconds for the AP034 to stabilize.
16. Note the amplitude of the trace from center screen.
17. Adjust **Offset Cal** (R330) to position the trace to approximately ½ the amplitude from center screen noted in the previous step. This amplitude should be within ±10 mV of center screen. Note this value.

18. Again, remove the dual banana plug adapter from the output of the DC voltage source and reconnect it, with the pins reversed. The plug corresponding to the BNC shield (marked “Ground”) should now be connected to the **–** or **Common** Output connector.
19. In the CHANNEL menu of the oscilloscope, set the probe offset to **–1.600 V** by rotating the OFFSET knob.
20. Allow 10 seconds for the AP034 to stabilize.
21. The trace should be offset from the center line by the same amplitude but opposite polarity of the value noted in step E-16.
22. Repeat steps E-13 through E-21 as necessary until the errors at +1.6 V and at –1.6 V are approximately equal, and both are within 10 mV of the center scale. Reverse the polarity of the dual banana plug adapter at the output of the DC voltage source, and the corresponding probe offset value with each repetition.
23. Disconnect the cable from the DC Voltage Source. Keep the AP033/AP034 Calibration Fixture connected to the AP034 for the next step.

E. Adjust GAIN (R322C)

1. Set the AP034 offset to **0.000 V** by rotating the OFFSET knob in the CHANNEL section of the oscilloscope.
2. Disconnect the BNC cable from the oscilloscope end of the ProBus extension cable. Reconnect this end of the cable to the precision 50 Ω termination.
3. Connect one end of a second BNC cable to the output of the Function Generator. Connect the BNC-to-dual male banana plug adapter to free the end of the BNC cable. Insert the banana plugs of the adapter into the input terminals of the Digital Multimeter (DMM).
4. Set the DMM to measure AC volts.
5. Set the mode of the Function Generator to Sine Wave, the frequency to approximately 1 kHz and the output amplitude to read approximately 190 mV on the DMM.

6. Record the DMM reading. Be careful not to alter the output amplitude of the generator after the measured value has been recorded
7. Remove the banana plug adapter and connect the free end of the cable to the **Differential Drive no Termination** connector on the calibration fixture.
8. Connect the AP034 Output cable with 50 Ω Precision termination to the DMM.
9. Using a low capacitance screwdriver, adjust **GAIN** (R322C) so that the DMM reading is within ±1 mV (0.5%) of the reading recorded in step E-6. (See Figure 10 for adjustment location.)
10. Disconnect the Function Generator, DMM, calibration fixture, and precision 50 Ω terminator.

F. Adjust Final Attenuator Compensation (C17)

Note

The calibrator signal from a LeCroy oscilloscope is the recommended signal source for this adjustment. If another oscilloscope is being used for this procedure, make sure that the square wave source has adequate flatness (minimum overshoot and undershoot.)

1. Press the UTILITIES button, then select the **CAL BNC Setup** menu. Set the **mode** to **CAL signal**, **Shape** to **Square**, Amplitude to **1 V** into 1 MΩ, and **Frequency** to **1 kHz**.
2. Reconnect the free end of the ProBus Extender BNC cable to the oscilloscope end of the extender located on channel 1.
3. Connect a BNC cable from the CAL output BNC connector to the **Differential Drive 50 ohm Termination** connector on the AP033/AP034 Calibration Fixture.
4. Carefully connect the **Differential Drive 50 ohm Termination** portion of the AP033/AP034 Calibration

Fixture to the probe tip. Press the probe into the fixture to fully engage the pins.

5. Set the oscilloscope display to channel **1**, vertical scale factor to **50 mV/div** and the horizontal scale to **1 μs/div**. Set the trigger source to channel **1**, and Slope to **Positive**. Adjust the oscilloscope trigger level as necessary for a stable display.
6. Using the OFFSET control, move the trace down until the top portion of the waveform is centered.
7. Using the 0.25 in. square adjustment tool, adjust **Attenuator Comp** (C17A) for a flat top waveform. (See Figure 12 for adjustment location.)
8. Remove the cable from the CAL output connector on the scope.

G. Adjust Final Attenuator CMRR (C18A)

1. Carefully move the AP033 probe head from the **Differential Drive 50 ohm Termination** portion of the AP033/AP034 Calibration Fixture to the **Common Mode Drive 50 ohm Termination** portion.
2. Remove the BNC cable from the **Differential Drive 50 ohm Termination** connector of the AP033/AP034 Calibration Fixture. Connect one end of the BNC cable to the **Common Mode Drive 50 ohm Termination** connector of the AP033/AP034 Calibration fixture. Connect the other end of the cable to the female end of a BNC Tee adapter. Plug the male connector of the BNC Tee adapter into the channel 4 input of the oscilloscope. Connect a second BNC cable to the remaining female connector of the BNC Tee adapter. Connect the other end of the second BNC cable to the CAL output BNC connector.
3. Set the oscilloscope display to channel **4**, coupling to **DC1MΩ**, vertical scale factor to **200 mV/div**, and the trigger source to channel **4**. Adjust the oscilloscope trigger level as necessary for a stable display.
4. Set the oscilloscope to display channel **1**, and vertical scale factor to **10 mV/div**. Set the **OFFSET** to **0.0 mV**

5. Adjust **Attenuator CMRR** (capacitor C18A) for minimum amplitude shift of the displayed waveform at the trigger point in time. See Figure 10 for adjustment location.
6. Leave the setup connected for the next step.

H. Assemble Probe and Amplifier

1. Carefully slide the large probe tip cover over the probe tip, being careful to engage the input pins.
2. Snap the small probe cover with the threaded brass insert onto the bottom of the probe. Engage the probe cable strain relief into the mating area of the cover. Carefully dress the wires entering the cable to clear the area above the brass insert.
3. Place the lip on the large end of the remaining cover under the mating surface near the probe tip. Gently press the cover into place. If the cover appears not to close completely, remove it and again check for adequate clearance between the brass insert and the cable wires.
4. Replace the $^{5}/_{64}$ in. Allen cap screw and tighten.
5. Hold the Logic Board/Amplifier Board assembly in one hand with the Logic board facing up. Hold the ProBus Interface housing in the other hand with the control side (side with holes for the buttons) facing up.
6. Align the edges of the Amplifier Board with the slots in the center of the inside of the housing. (The amplifier board is the thicker circuit board and has the BNC connector soldered to it.) Slide the boards into the housing, being careful to align the screw holes in the end cover with the corresponding channels in the corners of the housing.
7. Insert and tighten the two screws that secure the end panel to the ProBus interface housing. Avoid overtightening the screws because the cover may warp.
8. Replace the four push button caps, pressing each fully to seat the cap on the button shaft.

I. Attenuator Matching and Final Check

1. Repeat the Performance Verification procedure to ensure compliance with the warranted specifications.
2. Perform the Attenuator Matching Procedure listed on page 5-8. Apply calibration seals in accordance with your quality procedures.

This concludes the Adjustment Procedure. Repeat the Performance Verification procedure to complete the calibration of the AP034.

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