1159A 1GHz Active Differential Probe
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Inspect the Probe

- Inspect the shipping container for damage.
  
  Keep a damaged shipping container or cushioning material until the contents of the shipment have been checked for completeness and the probe has been checked mechanically and electrically.

- Check the accessories.
  
  Any accessories that were supplied with the probe are listed in “Probe Accessories Supplied” on page 5.
  - If the contents are incomplete or damaged notify your Agilent Sales Office.

- Inspect the instrument.
  
  - If there is mechanical damage or defect, or if the probe does not operate properly or pass calibration, notify your Agilent Sales Office.
  - If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier as well as your Agilent Sales Office. Keep the shipping materials for the carrier's inspection. The Agilent office will arrange for repair or replacement at Agilent’s option without waiting for claim settlement.
1159A Active Differential Probes Introduction

The 1159A is a wide-band differential active probe. The probe features low noise, low input capacitance, high common mode rejection, and Field Effect Transistor (FET) buffered inputs in the probe head. User-selectable offset gives the probe flexibility to measure a large range of signal types. Plug-on attenuators and AC coupling accessories further extend the application range. Included interconnect accessories allow connection to surface mount and through-hole components with minimal signal degradation. The input receptacles in the probe head are compatible with standard 0.025" (0.635 mm) square pins, which provide a convenient low-cost method of creating device characterization test fixtures.

The 1159A is ideal for acquiring high speed differential signals such as those found in disk drive read channels, differential LAN, video, and so on. The high impedance characteristics of both inputs allow you to use the probe as a FET probe to make single-ended measurements in digital systems without introducing a ground loop as a conventional FET probe would.

Differential Amplifiers and CMRR

The 1159A Differential Probe is a high input impedance amplifier. A characteristic of differential amplifiers is the ability to reject signals that are common to the two inputs. The common mode rejection ratio (CMRR) is the measurement of this ability. It is expressed as the ratio between the amplitudes of the common mode and differential signals that produce equal outputs. If the differential gain is known, these measurements can be referred to the probe input. CMRR is usually expressed in dB:

\[
\text{CMRR in dB} = 20 \log \left( \frac{V_{\text{common mode input}} \times \text{Gain}}{V_{\text{common mode output}}} \right)
\]

The ability to reject common mode signals depends on the balance designed into the probe amplifier. As the frequency of the common mode signal increases, it becomes harder to balance the amplifier parasitic parameters. This leads to degradation of the CMRR.

The CMRR of the 1159A Differential probe is specified from the probe tip. This method of specifying the probe CMRR eliminates the effects of source impedance, provided the connections from the probe tip to the signal source are symmetrical.
## Probe Accessories Supplied

The following diagram and table show the accessories supplied with the 1159A Differential Probe.

![Diagram of probe accessories](image)

### Probe Accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Qty.</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AC coupler</td>
<td>1</td>
<td>01154-82101</td>
</tr>
<tr>
<td>2</td>
<td>10:1 Attenuator</td>
<td>1</td>
<td>01159-82104</td>
</tr>
<tr>
<td>3</td>
<td>20:1 Attenuator</td>
<td>1</td>
<td>01159-82105</td>
</tr>
<tr>
<td>4</td>
<td>Header</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>Offset Pin</td>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>0.5 Grabber</td>
<td>2</td>
<td>N/A</td>
</tr>
<tr>
<td>7</td>
<td>0.8 Grabber</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>8</td>
<td>Ground Wire</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>SMT Lead</td>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>10</td>
<td>Wire Lead</td>
<td>1</td>
<td>N/A</td>
</tr>
</tbody>
</table>
To Order Replaceable Parts
To order a replaceable part, in the United States and Canada call our toll-free hotline at 1-877-447-7278, or call your local Agilent Technologies Sales Office.

Replaceable Parts

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Qty.</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AC coupler</td>
<td>1</td>
<td>01154-82101</td>
</tr>
<tr>
<td>2</td>
<td>10:1 Attenuator</td>
<td>1</td>
<td>01159-82104</td>
</tr>
<tr>
<td></td>
<td>(includes an adjustment tool)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20:1 Attenuator</td>
<td>1</td>
<td>01159-82105</td>
</tr>
<tr>
<td></td>
<td>(includes an adjustment tool)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connection Kit</td>
<td>1</td>
<td>01154-60004</td>
</tr>
<tr>
<td>4</td>
<td>Header</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>Offset Pin</td>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>6</td>
<td>0.5 Grabber</td>
<td>2</td>
<td>N/A</td>
</tr>
<tr>
<td>7</td>
<td>0.8 Grabber</td>
<td>3</td>
<td>N/A</td>
</tr>
<tr>
<td>8</td>
<td>Ground Wire</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>SMT Lead</td>
<td>4</td>
<td>N/A</td>
</tr>
<tr>
<td>10</td>
<td>Wire Lead</td>
<td>1</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Trimmer Tool</td>
<td>1</td>
<td>5063-2196</td>
</tr>
</tbody>
</table>

Using the Accessories
The 1159A Differential Probe and accessories provide a variety of ways to connect to circuitry under test. Any method used to connect the probe signal inputs to the circuit under test degrades the performance of the probing solution. Take the following precautions to optimize common mode rejection:

- Maintain tip connection lead length as short as possible and the same length.
- Follow the same path for wires used to connect the inputs of the probe to the circuit under test.
- Probes do not have infinite input impedance and do load the circuit under test. If the impedance of the test points is not identical, unequal loading will occur. This degrades common mode rejection.
- The ground lead length is not usually critical with a differential probe.
- Carefully consider the ground potential relative to the oscilloscope ground potential. The potential difference must be within the common mode range of the probe.
- The DC potential between the AC coupling adapter and the oscilloscope ground must not exceed 42 Vpk.
- Do not cascade the external attenuators.
- Cascade the external AC coupling adapter in the following order: probe, attenuator, and AC coupling adapter.
Other Probe Accessories
The Agilent Wedge was designed to interface directly with the differential probe. These devices simplify connections to surface mount integrated circuits and have output pins compatible with the probe tip and attenuator sockets.

Attaching External Attenuators to the Probe
The external attenuators plug directly on to the probe tip. They are calibrated at the factory to provide the optimum common mode rejection and should not be swapped between probes.

The 1159A probe’s best performance is achieved when the probe attenuation is set to /10 in the Infiniium’s Probes Setup dialog box.
Specifications and Characteristics

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Configuration</td>
<td>Ground Connector</td>
</tr>
<tr>
<td></td>
<td>True Differential (+ and - inputs), with shield</td>
</tr>
<tr>
<td>Input Coupling</td>
<td>DC AC coupling obtained by installing an AC coupling adapter</td>
</tr>
<tr>
<td>Gain Accuracy at 1 kHz</td>
<td>±2%</td>
</tr>
<tr>
<td>Maximum Input Voltage</td>
<td>&lt; ±42 V</td>
</tr>
<tr>
<td>CMRR at 70 Hz</td>
<td>80 dB</td>
</tr>
<tr>
<td>CMRR at 1 MHz</td>
<td>40 dB</td>
</tr>
<tr>
<td>CMRR at 100 MHz</td>
<td>25 dB</td>
</tr>
<tr>
<td>CMRR at 500 MHz</td>
<td>19 dB</td>
</tr>
<tr>
<td>CMRR at 1 GHz</td>
<td>13 dB</td>
</tr>
</tbody>
</table>

Range

<table>
<thead>
<tr>
<th>Mode</th>
<th>No attenuator</th>
<th>×10 attenuator</th>
<th>×20 attenuator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential</td>
<td>&lt; ±400 mV</td>
<td>&lt; ±4 V</td>
<td>&lt; ±8 V</td>
</tr>
<tr>
<td>Common</td>
<td>&lt; ±16 V</td>
<td>&lt; ±42 V</td>
<td>&lt; ±42 V</td>
</tr>
<tr>
<td>Offset (Common)</td>
<td>&lt; ±1.6 V</td>
<td>&lt; ±16 V</td>
<td>&lt; ±32 V</td>
</tr>
</tbody>
</table>
The following characteristics are valid for the 1159A probe after the probe has reached operating temperature, which is 20 minutes with power applied in a environment with stable ambient temperature. The probe must be operating within the environmental conditions listed in the “Environmental Specifications” section on page 11, and must have been calibrated within the past 12 months in a ambient temperature of 23 ± 5 °C.

### Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Bandwidth (-3 dB)</td>
<td>DC to 1 GHz</td>
</tr>
<tr>
<td>Offset Range</td>
<td>±1.6 V</td>
</tr>
<tr>
<td>Rise Time (Probe only)</td>
<td>&lt;350 ps</td>
</tr>
<tr>
<td>1:1 Attenuation</td>
<td></td>
</tr>
<tr>
<td>Internal switched attenuation only</td>
<td></td>
</tr>
<tr>
<td>Input Resistance (each side to ground)</td>
<td>1 MΩ</td>
</tr>
<tr>
<td>Input Capacitance (between inputs)</td>
<td>&lt;0.85 pF</td>
</tr>
<tr>
<td>1:1 Attenuation</td>
<td></td>
</tr>
<tr>
<td>No external attenuators</td>
<td></td>
</tr>
<tr>
<td>Input Capacitance (each side to ground)</td>
<td>&lt;1.5 pF</td>
</tr>
<tr>
<td>1:1 Attenuation</td>
<td></td>
</tr>
<tr>
<td>No external attenuators</td>
<td></td>
</tr>
</tbody>
</table>
1159A 1GHz Active Differential Probe
Specifications and Characteristics

Typical CMRR versus Frequency (Hz)

Typical Noise
## Specifications and Characteristics

### Environmental Specifications

<table>
<thead>
<tr>
<th></th>
<th>Operating</th>
<th>Non-operating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature</strong></td>
<td>0 to 50°C</td>
<td>-40 to 75°C</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 80% RH at 40°C</td>
<td>Up to 80% RH at 75°C</td>
</tr>
<tr>
<td><strong>Altitude</strong></td>
<td>Up to 4,600 meters (15,000 feet)</td>
<td>Up to 15,000 meters (50,000 feet)</td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td>Random vibration 5 to 500 Hz, 10 minutes per axis, 0.3 g$_{rms}$</td>
<td>Random vibration 5 to 500 Hz, 10 minutes per axis, 2.41 g$_{max}$, Resonant search 5 to 500 Hz swept sine, 1 octave/min. sweep rate, (0.75 g), 5 minutes resonant dwell at 4 resonance’s per axis.</td>
</tr>
</tbody>
</table>

| **Weight**              | Approximately 226 g          |
| **Dimensions**         | Refer to the drawing shown below |

### Dimensions

![Diagram](image-url)
To Connect the Probe to the Circuit under Test

The method you use to connect the probe to the circuit under test is critical for ensuring accurate measurements. The following examples examine the effect of using different lengths of wire at 100MHz to connect the signal source to the probe tip.

**The Impedance of the Source**

This is another instance where the symmetry of the differential circuit is important. The impedance of the source forms a network with the input impedance of the connection and the probe. This network determines the frequency response for the measurement. If each side of the differential source has a different impedance, the frequency response of each side will be different. This lack of balance is reflected in reduced CMRR. The higher the impedance of the source, the more critical these parasitic effects.

**The Ground Connection**

A poorly located ground connection allows ground loops to add to the common mode signal. The differential probe measures the potential difference between two locations on a PC board. Usually, it is not necessary to ground the probe. Whether to ground the probe depends on the magnitude and frequency of the voltage difference between the oscilloscope ground and the board ground. It is good practice to maintain a board ground. Without this ground reference, you could easily exceed the common mode range of the probe.

**Probe Offset**

The amplifiers in the 1159A probe limit the Differential Mode Range to 400mV. If the input to the probe is approaching 400mV, there is little offset range available for positioning the trace on screen. There are two solutions to this problem:

- **Attenuate the signal into the probe with the 1/10 or 1/20 attenuator. This mode of operation will induce some small loss in CMRR.**
- **Use Position to position the trace on screen.**

The added feature of position control independent of Offset allows trace positioning without calculating how much probe offset range is available. The trace can be positioned by **dragging** the trace or positioning the trace under the Probe menu.
To Connect the Probe to the Circuit under Test

1159A 1GHz Active Differential Probe

Both inputs derived from a common signal at probe tip.
CMRR = 35.6dB

Both inputs derived from a common signal via 5cm coupling lead.
CMRR = 35dB

Probe coupling leads of different length. Positive input 5.3cm. Negative input 7.5cm.
CMRR = 33dB
1159A 1GHz Active Differential Probe

Recommended Probe Configurations

For best performance, use the following configurations. They are presented in the recommended order from the most desirable to the least.

**Note**

The use of the ground connection is optional for all configurations.

### Direct Connection

**1159A Probe Tip**

**AC Adapter/Attenuator**

Use the attenuator shipped with the probe and marked with the same serial number for accurate measurements. Do not use the attenuators with other probes.

**Test Point Layout**

See the “Test Point Layout” section for more information.
1159A 1GHz Active Differential Probe
Recommended Probe Configurations

**Offset Pins**
You may use offset pins with any of the tip adapters.

**SMT Lead**
You may use SMT leads with any of the tip adapters.
1159A 1GHz Active Differential Probe

**Recommended Probe Configurations**

**Wire Leads**
You may use wire leads with any of the tip adapters.

**Grabbers**
Using grabbers and wire leads results in significant lead length. Expect measurement quality degradation with fast signals.
Safety Considerations

Read the Safety summary in the warranty pages at the back of this guide before servicing the instrument. Before performing any procedure, review the safety information for cautions and warnings.

**WARNING**

Only trained service personnel aware of the hazards involved (for example, fire and electric shock) should perform maintenance on the instrument. When maintenance can be performed without power applied, the power cord must be removed from the instrument.
Service Strategy

For repair and calibration, return the 1154A probe to an Agilent Service Center. If the probe is under warranty, normal warranty service apply. If the probe is not under warranty, repair costs will be applied.

To Return the Probe to Agilent for Service
Call (877) 447-7278 for further details and the location of your nearest Agilent Service Office.

1 Write the following information on a tag and attach it to the probe.
• Name and address of owner.
• Probe model number.
• Probe serial number.
• Description of the service required or failure indications.

2 Return the following accessories with the probe:
• Attenuators
• AC coupling adapter

   Retain all other accessories.

3 Return the probe in its case or pack the probe in foam or other shock absorbing material and place it in a strong shipping container.
   You can use the original shipping materials or order materials from an Agilent Sales Office. If neither are available, place 3 to 4 inches of shock-absorbing material around the instrument and place it in a box that does not allow movement during shipping.

4 Seal the shipping container securely.

5 Mark the shipping container as FRAGILE.

In all correspondence, refer to the instrument by model number and full serial number.
Calibration Testing Procedures

These procedures are used to test the warranted specifications for the 1159A Differential probe. The recommended calibration test interval for the 1159A is once a year. Use the equipment listed in the Test Equipment Required section to complete the Testing Procedures.

1. Perform the steps listed in the “Preliminary Procedure” section on page 19.
2. Perform the steps listed in the “Gain Accuracy Testing Procedure” section on page 25.
3. Perform the steps listed in the “Test Offset” section on page 26.
5. Perform the steps listed in the “CMRR Test Introduction” section on page 27.

Test Equipment Required

<table>
<thead>
<tr>
<th>Description</th>
<th>Minimum Requirements</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infinium Oscilloscope</td>
<td>1.5 GHz</td>
<td>54845A</td>
</tr>
<tr>
<td>Digital AC/DC Voltmeter</td>
<td>DC: 0.1% accuracy, AC: 0.2% accuracy, 200 mV @ 1 kHz, 5 1/2 digit resolution</td>
<td>34401A</td>
</tr>
<tr>
<td>Function Generator</td>
<td>Sine Wave and Square Wave output waveforms</td>
<td>33120A</td>
</tr>
<tr>
<td>Sine Wave Generator</td>
<td>50 MHz to 1 GHz</td>
<td>E9625A</td>
</tr>
<tr>
<td>BNC T</td>
<td></td>
<td>5063-2143</td>
</tr>
<tr>
<td>Probe Tip BNC Adapter</td>
<td></td>
<td>01154-63801</td>
</tr>
<tr>
<td>Calibration Fixture</td>
<td></td>
<td>1163A</td>
</tr>
<tr>
<td>High Frequency 10:1 Resistor Divider Probe</td>
<td>500 Ω</td>
<td>1161A</td>
</tr>
<tr>
<td>10:1 Resistor Divider Probe (provided with the 54845A)</td>
<td>10 MΩ</td>
<td>1161A</td>
</tr>
<tr>
<td>Trimmer Tools (provided with the 54845A)</td>
<td>Flat blade 0.04&quot; (1 mm) wide Square Head 0.025&quot; (0.635 mm)</td>
<td>5063-2196</td>
</tr>
</tbody>
</table>

Preliminary Procedure

1. Turn on the oscilloscope, the 1159A, and the other test equipment. Allow 30 minutes for all test equipment to warm up.
2 Press Default Setup.
3 Perform Probe Tip Cal on the 1161A connected to CH4 of the oscilloscope (54845A).
4 Save the setup files listed in the “Setup Files for testing” section on page 20 to the C drive of the 54845A. These setups can also be saved to drive A and filed for future use.

**Setup Files for testing**

Save the setup information shown below for the various tests to the specified file names on the C drive of the 54845A or to a floppy disk in drive A. Connect the probes to the specified channels before creating and storing the setup files.

**Setup for Differential Mode Range**

**File Name: 1159CAL0**

<table>
<thead>
<tr>
<th>Probe Connected to CH1</th>
<th>1159A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Connected to CH4</td>
<td>1161A</td>
</tr>
<tr>
<td>CH1 and CH4 Sensitivity</td>
<td>200 mV/div</td>
</tr>
<tr>
<td>CH2 and CH3</td>
<td>Off</td>
</tr>
<tr>
<td>Offset and Position CH1, CH2, CH3 and CH4</td>
<td>0 V</td>
</tr>
<tr>
<td>Measurements: CH1 and CH4</td>
<td>V amplitude under Measure Voltage</td>
</tr>
<tr>
<td>Timebase</td>
<td>500 µSec/div</td>
</tr>
<tr>
<td>Timebase Delay</td>
<td>0 Sec</td>
</tr>
<tr>
<td>Setup Acquisition</td>
<td>Equivalent time: 8 averages</td>
</tr>
<tr>
<td>Trigger</td>
<td>CH4; level 0 V +ve edge</td>
</tr>
</tbody>
</table>
**Setup for CMRR at 70 Hz**

**File Name: 1159CAL1**

- Probe Connected to CH1: 1159A
- Probe Connected to CH4: 1161A
- CH1 Sensitivity: 2 mV/div
- CH4 Sensitivity: 5 V/div
- Measure Amplitude: CH1 and CH4
- CH2 and CH3: Off
- Offset and Position CH1, CH2, CH3 and CH4: 0 V
- Timebase: 10 mSec/div
- Timebase Delay: 0 Sec
- Setup Acquisition: Equivalent time: 64 averages
- Trigger: CH4; level 0 V + ve edge

**Setup for CMRR at 1 MHz**

**File Name: 1159CAL2**

- Probe Connected to CH1: 1159A
- Probe Connected to CH4: 1161A
- CH1 Sensitivity: 10 mV/div
- CH4 Sensitivity: 5 V/div
- CH2 and CH3: Off
- Offset and Position CH1, CH2, CH3 and CH4: 0 V
- Measure Amplitude: CH1 and CH4
- Timebase: 500 nSec/div
- Timebase Delay: 0 Sec
- Setup Acquisition: Equivalent time: 64 averages
- Trigger: CH4; level 0 V + ve edge
### Setup for CMRR at 100 MHz

**File Name: 1159CAL3a**

<table>
<thead>
<tr>
<th>Setup</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Connected to CH1</td>
<td>None</td>
</tr>
<tr>
<td>Probe Connected to CH4</td>
<td>1163A</td>
</tr>
<tr>
<td>CH1 Sensitivity</td>
<td>200 mV/div; 50 Ω</td>
</tr>
<tr>
<td>CH4 Sensitivity</td>
<td>200 mV/div; 50 Ω</td>
</tr>
<tr>
<td>CH2, CH3, and CH4</td>
<td>Off</td>
</tr>
<tr>
<td>Offset and Position CH1, CH2, CH3 and CH4</td>
<td>0 V</td>
</tr>
<tr>
<td>Measure Amplitude</td>
<td>CH1</td>
</tr>
<tr>
<td>Timebase</td>
<td>5 nSec/div</td>
</tr>
<tr>
<td>Timebase Delay</td>
<td>0 Sec</td>
</tr>
<tr>
<td>Setup Acquisition</td>
<td>Equivalent time: 64 averages</td>
</tr>
<tr>
<td>Trigger</td>
<td>CH4; 0 V + ve edge</td>
</tr>
</tbody>
</table>

### Setup for CMRR at 100 MHz

**File Name: 1159CAL3b**

<table>
<thead>
<tr>
<th>Setup</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Connected to CH1</td>
<td>1159A</td>
</tr>
<tr>
<td>Probe Connected to CH4</td>
<td>1163A</td>
</tr>
<tr>
<td>CH1 Sensitivity</td>
<td>5 mV/div</td>
</tr>
<tr>
<td>CH4 Sensitivity</td>
<td>200 mV</td>
</tr>
<tr>
<td>CH2, CH3, and CH4</td>
<td>Off</td>
</tr>
<tr>
<td>Offset and Position CH1, CH2, CH3 and CH4</td>
<td>0 V</td>
</tr>
<tr>
<td>Measure Amplitude</td>
<td>CH1</td>
</tr>
<tr>
<td>Timebase</td>
<td>5 nSec/div</td>
</tr>
<tr>
<td>Timebase Delay</td>
<td>0 Sec</td>
</tr>
<tr>
<td>Setup Acquisition</td>
<td>Equivalent time: 64 averages</td>
</tr>
<tr>
<td>Trigger</td>
<td>CH4; 0 V+ ve edge</td>
</tr>
</tbody>
</table>
### Setup for CMRR at 500 MHz

**File Name: 1159CAL4a**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Connected to CH4</td>
<td>1163A</td>
</tr>
<tr>
<td>CH1 Sensitivity</td>
<td>200 mV/div; 50 Ω</td>
</tr>
<tr>
<td>CH4 Sensitivity</td>
<td>200 mV/div; 50 Ω</td>
</tr>
<tr>
<td>Offset and Position CH1, CH2, CH3 and CH4</td>
<td>0 V</td>
</tr>
<tr>
<td>Measure Amplitude</td>
<td>CH1</td>
</tr>
<tr>
<td>Timebase</td>
<td>1 nSec/div</td>
</tr>
<tr>
<td>Timebase Delay</td>
<td>0 Sec</td>
</tr>
<tr>
<td>Setup Acquisition</td>
<td>Equivalent time: 64 averages</td>
</tr>
<tr>
<td>Trigger</td>
<td>CH4; 0 V</td>
</tr>
</tbody>
</table>

### Setup for CMRR at 500 MHz

**File Name: 1159CAL4b**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe Connected to CH1</td>
<td>1159A</td>
</tr>
<tr>
<td>Probe Connected to CH4</td>
<td>1163A</td>
</tr>
<tr>
<td>CH1 Sensitivity</td>
<td>20 mV/div</td>
</tr>
<tr>
<td>CH4 Sensitivity</td>
<td>200 mV/div; 50 Ω</td>
</tr>
<tr>
<td>Offset and Position CH1, CH2, CH3 and CH4</td>
<td>0 V offset</td>
</tr>
<tr>
<td>Measure Amplitude</td>
<td>CH1</td>
</tr>
<tr>
<td>Timebase</td>
<td>1 nSec/div</td>
</tr>
<tr>
<td>Timebase Delay</td>
<td>0 Sec</td>
</tr>
<tr>
<td>Setup Acquisition</td>
<td>Equivalent time: 16 averages</td>
</tr>
<tr>
<td>Trigger</td>
<td>CH4; 0 V</td>
</tr>
</tbody>
</table>
Setup for CMRR at 1 GHz
File Name: 1159CAL5a

Probe Connected to CH1: None
Probe Connected to CH4: 1163A
CH1 Sensitivity: 200 mV/div; 50 Ω
CH4 Sensitivity: 200 mV/div; 50 Ω
CH2, CH3, and CH4: Off
Offset and Position CH1, CH2, CH3 and CH4: 0 V
Measure Amplitude: CH1
Timebase: 500 pSec/div
Timebase Delay: 0 Sec
Setup Acquisition: Equivalent time: 16 averages
Trigger: CH4; 0 V

Setup for CMRR at 1 GHz
File Name: 1159CAL5b

Probe Connected to CH1: 1159A
Probe Connected to CH4: 1163A
CH1 Sensitivity: 50 mV/div
CH4 Sensitivity: 200 mV/div; 50 Ω
CH2, CH3, and CH4: Off
Offset and Position CH1, CH2, CH3 and CH4: 0 V
Measure Amplitude: CH1
Timebase: 500 pSec/div
Timebase Delay: 0 Sec
Setup Acquisition: Equivalent time: 16 averages
Trigger: CH4; 0 V
Gain Accuracy Testing Procedure

This test should be performed by qualified Agilent Service Center personnel.

1. Connect a BNC tee connector to the function generator, P/N 33120A.
2. Connect a 50-Ω cable from the BNC tee to the channel on the Infiniium oscilloscope.
3. Set the termination on channel 1 to 50-Ω.
4. Connect the digital voltmeter (DVM) to the other side of the BNC tee.
5. Set the frequency on the function generator to 1 kHz and the amplitude to 200 mvrms as read on the voltmeter.
6. Set the oscilloscope trigger source to channel 1.
7. Set the horizontal scale to 200 μsec/div and the vertical scale to 100 mV/div.
8. Set the oscilloscope to equivalent time sampling mode and enable averaging with 16 averages.
9. Measure and record Vamptd _______________.
   Vamptd should be -566 mV which is 2.828 x 200 mvrms.
10. Disconnect the 50-Ω cable from the oscilloscope and connect it to the middle BNC source of the calibration test fixture, P/N 01154-63801.
11. Connect the probe under test to channel 1 on the oscilloscope and the other end of the probe to the probe input on the middle source of the calibration test fixture.
12. Adjust the function generator until the Vamptd reading is the same as in step 9.
13. Record VRMS reading the digital multimeter _______________.
    The reading will be slightly different from the original 200 mvrms setting if the probe gain is not exactly 1:1.
14. Calculate the actual gain of the probe by:
    \[
    \text{Gain} = \frac{\text{VRMS reading}}{200\,\text{mvrms}}
    \]
15. The percentage error of gain is:
    \[
    \text{Gain Error (\%)} = (\text{Gain} - 1) \times 100
    \]

Note: A remaining source of error is the 50-Ω termination resistor in the oscilloscope. That error is minimized by using the same channel on the oscilloscope for all measurements. That same error exists in the current method of measurement since the probe is not being terminated in an exact 50-Ω. Agilent oscilloscopes have 1% 50-Ω termination resistors.
1159A 1GHz Active Differential Probe
Calibration Testing Procedures

**Test Offset**
This is an important step in testing the probe. It should be performed, even though no data is recorded in the Performance Test Record.

1. Disconnect the probe tip from the calibration fixture.
2. Select Auto Zero under the probe menu.
3. Measure the probe output with DVM DC mode.

**Test Differential Mode Range**
Use setup file 1159CAL0 for this test. Set up the test equipment as shown in the following diagram.

1. Connect the 1159A to CH1 of the oscilloscope.
2. Load 1159CAL0.
3. Connect the 1161A to the output of the function generator and CH4 of the oscilloscope.
4. Setup the test equipment as shown in the following table. Connect the 1161A probe to CH4 of the oscilloscope. Measure the amplitude on CH4.

<table>
<thead>
<tr>
<th><strong>Test Equipment</strong></th>
<th><strong>Setting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1161A</td>
<td>Offset: 0</td>
</tr>
<tr>
<td>Function Generator</td>
<td>Frequency: 1 kHz</td>
</tr>
<tr>
<td></td>
<td>Output Amplitude: 800 mV&lt;sub&gt;pp&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

5. Select Auto Zero under the probe menu.
   Do not connect the probe tip to the fixture when Auto Zero is performed.
6 Connect a coaxial cable from the function generator to BNC A on the calibration fixture.
7 Connect the 1159A probe to the output of the calibration fixture CH A.
8 Record “Pass” in the “Differential Mode Range” section of the Calibration Test Record on page 36 if no clipping occurs. Record “Fail” if visible clipping occurs.

CMRR Test Introduction
You will use setup files 1159CAL1 through 1159CAL5b to perform the CMRR tests.
1 Set the output of the function generator to 20 Vpp.
2 Connect the 1161A probe to the output of the function generator using BNC T.
The instrument setup is shown in the following diagram.

3 Follow the steps in the “Test CMRR at 70 Hz” section on page 28.
4 Follow the steps in the “Test CMRR at 1 MHz” section on page 28.
5 Follow the steps in the “Test CMRR at 100 MHz” section on page 29.
6 Follow the steps in the “Test CMRR at 500 MHz” section on page 30.
7 Follow the steps in the “Test CMRR at 1 GHz” section on page 31.
1159A 1GHz Active Differential Probe

Calibration Testing Procedures

**Test CMRR at 70 Hz**  
Use setup file 1159CAL1 in this test. If only a short time has elapsed from the last AUTO-ZERO calibration this step may be omitted.

1 Set the function generator as shown in the following table.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Level</td>
<td>20 V&lt;sub&gt;pp&lt;/sub&gt;</td>
</tr>
<tr>
<td>Frequency</td>
<td>70 Hz</td>
</tr>
</tbody>
</table>

2 Connect the 1161A to the function generator output and CH4 of the oscilloscope.
3 Connect the 1159A probe to the CH C probe input of the calibration fixture.
4 Load setup file 1159CAL1.
5 Select Auto Zero under the probe menu.  
   Do not connect the probe tip to the fixture during Auto Zeroing.
6 Connect the function generator to Channel C BNC of the calibration fixture.
7 Measure the amplitude of the function generator output (CH4).  
   Record V1:__________
8 Measure the maximum value of CH1.  
   Record V2:__________
9 Calculate CMRR.
   \[
   \text{CMRR in dB} = 20\log\left(\frac{V_2 \text{ amplitude}}{V_1 \text{ amplitude}}\right)
   \]
10 Record CMRR in the “CMRR at 70 Hz” section of the Calibration Test Record on page 36.

*Note* CMRR must 80dB or greater.

**Test CMRR at 1 MHz**  
Use setup file 1159CAL2 in this test.

1 Set the function generator as shown in the following table.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Level</td>
<td>20 V&lt;sub&gt;pp&lt;/sub&gt;</td>
</tr>
<tr>
<td>Frequency</td>
<td>1 MHz</td>
</tr>
</tbody>
</table>

2 Disconnect the function generator from the BNC calibration fixture.
3 Load setup file 1159CAL2.
4 Perform Auto Zero under the probe menu.  
   Do not connect the probe tip to the calibration fixture during Auto Zeroing.
5 Connect the function generator to CHANNEL C BNC on the calibration fixture.
6 Measure the amplitude of the function generator output (CH4).
   Record V1:_____________
7 Measure the maximum value of CH1.
   Record V2:_____________
8 Calculate CMRR.
   \[ \text{CMRR in dB} = 20 \log \left( \frac{V2 \text{ amplitude}}{V1 \text{ amplitude}} \right) \]
9 Record CMRR in the “CMRR at 1 MHz” section of the Calibration Test Record on page 36.

**Note**  
CMRR must 40dB or greater.

**Test CMRR at 100 MHz**  
Use setup files 1159CAL3a and 1159CAL3b in this test.

1 Set the signal generator as shown in the following table.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Level</td>
<td>5 dBm</td>
</tr>
<tr>
<td>Frequency</td>
<td>100 MHz</td>
</tr>
</tbody>
</table>

2 Disconnect the 1159A probe from CH1 and connect it to CH2 to maintain a constant temperature.
3 Load setup file 1159CAL3a.
4 Connect the signal generator to CH1 on the oscilloscope.
5 Measure the amplitude of the signal generator output.
   Record V1:_____________
6 Remove the signal generator from CH1.
7 Remove the 1159A probe from CH2 and connect it to CH1.
8 Select Auto Zero under the probe menu.
   Do not connect the probe tip to the calibration fixture during Auto Zeroing.
9 Connect the signal generator to BNC D of the calibration fixture.
10 Load setup file 1159CAL3b.
11 Connect the 1159A probe to D on the calibration fixture.
12 Measure the maximum value of CH1.
   Record V2:_____________
13 Calculate CMRR.

\[
CMRR \text{ in } \text{dB} = 20 \log \left( \frac{V_2 \text{ amplitude}}{V_1 \text{ amplitude}} \right)
\]

14 Record CMRR in the “CMRR at 100 MHz” section of the Calibration Test Record on page 36.

**Note**
CMRR must 25dB or greater.

**Test CMRR at 500 MHz**

Use setup files 1159CAL4a and 1159CAL4b in this test.

1 Set the signal generator as shown in the following table.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Level</td>
<td>5 dBm</td>
</tr>
<tr>
<td>Frequency</td>
<td>500 MHz</td>
</tr>
</tbody>
</table>

2 Disconnect the 1159A probe from the CH1 and connect it to CH2 to maintain a constant temperature.

3 Load setup file 1159CAL4a.

4 Connect the signal generator to CH1 on the oscilloscope.

5 Measure the amplitude of the signal generator output.

   Record V1:_____________

6 Remove the signal generator from CH1.

7 Remove the 1159A probe from CH2 and connect it to CH1.

8 Select Auto Zero under the probe menu.

   Do not connect the probe tip to the calibration fixture during Auto Zeroing.

9 Connect the signal generator to BNC C of the calibration fixture.

10 Load setup file 1159CAL4b.

11 Connect the 1159A probe to D of the calibration fixture.

12 Measure the maximum value of CH1.

   Record V2:_____________

13 Calculate CMRR.

\[
CMRR \text{ in } \text{dB} = 20 \log \left( \frac{V_2 \text{ amplitude}}{V_1 \text{ amplitude}} \right)
\]

14 Record CMRR in the “CMRR at 500 MHz” section of the Calibration Test Record on page 36.

**Note**
CMRR must 19dB or greater.
**Test CMRR at 1 GHz**  Use setup files 1159CAL5a and 1159CAL5b in this test.

1. Set the signal generator as shown in the following table.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Level</td>
<td>5 dBm</td>
</tr>
<tr>
<td>Frequency</td>
<td>1 GHz</td>
</tr>
</tbody>
</table>

2. Disconnect the 1159A probe from the CH1 and connect it to CH2 to maintain a constant temperature.
3. Load setup file 1159CAL5a.
4. Connect the signal generator to CH1 on the oscilloscope.
5. Measure the amplitude of the signal generator output.
   
   Record V1: __________
6. Remove the signal generator from CH1.
7. Remove the 1159A probe from CH2 and connect it to CH1.
8. Select Auto Zero under the probe menu.
   
   Do not connect the probe tip to the calibration fixture during Auto Zeroing.
9. Connect the signal generator to BNC C of the calibration fixture.
10. Load setup file 1159CAL5b.
11. Measure the maximum value of CH1.
   
   Record V2: __________
12. Calculate CMRR.

   \[
   \text{CMRR in dB} = 20 \log\left(\frac{V2 \text{ amplitude}}{V1 \text{ amplitude}}\right)
   \]
13. Record CMRR in the “CMRR at 1 GHz” section of the Calibration Test Record on page 36.

**Note**

CMRR must be 13dB or greater.
1159A 1GHz Active Differential Probe
Adjustment of 10:1 and 20:1 Attenuators

Adjustment of 10:1 and 20:1 Attenuators

10:1 and 20:1 attenuators are supplied with the 1159A probe. This attenuator is matched to the probe and should require no further adjustment. Each attenuator is labeled with a serial number that matches the last four digits of the probe serial number. Identify matching probes and attenuators using this number. If you purchase new attenuators for the probe, you must adjust them to match the probe.

Optimizing CMRR for an Attenuator

For optimum CMRR when the attenuator is connected to the probe, the DC and HF attenuation should be the same for both active inputs of the probe. Three trimmers are provided in the attenuator to match the two active inputs. The adjustments are located under the serial number label. Apply a new label after calibration and mark this label with the last four digits of the probe’s serial number. Only adjust an attenuator if it is not the original attenuator shipped with the probe.
The attenuator’s plastic covers may be removed. You must take care not to damage the probe attenuator pins.

10:1 and 20:1 Attenuator Adjustment Procedure
Use the following steps to adjust the 10:1 or 20:1 attenuators.

1 Connect the function generator, probe and oscilloscope as shown.
   Connect the + active probe input to the function generator output for these tests.
   Connect the D active input to ground with the probe ground socket.

2 Connect the 1159A Probe to CH1 of the oscilloscope.

3 Turn on the test equipment.
   Allow 30 minutes for the probe to warm up.
4 Place the 10:1 or 20:1 attenuator on the 1159A probe. Do not connect a signal to the probe at this time.

5 Set the function generator as shown in the following table. Use a function with a flat top for this test.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square Wave Output Amplitude</td>
<td>1 V</td>
</tr>
<tr>
<td>Frequency</td>
<td>5 kHz</td>
</tr>
<tr>
<td>Offset</td>
<td>0</td>
</tr>
</tbody>
</table>

6 Select Auto Zero on the probe menu.

7 Connect the 1159A probe as shown. Use the clips to make these connections. The frequency being considered has a fundamental of 5 kHz. Connect the + input of the probe to the signal source. Connect the D input to ground.

8 Set the oscilloscope time base to 500 nS/div.

9 Press Auto Scale. The 54845A triggers off CH 4.

10 Use the square head trimmer tool to adjust the + LF comp to achieve the best square corner and flat top of the displayed waveform. Adjust the compensation to achieve the best waveform characteristics when you remove the tool.

11 Connect the + and D probe inputs to the function generator output while the probe ground is connected. You can use the calibration fixture BNC to make these connections.

12 Set the function generator to 50Hz and the output to 10V amplitude. The 1161A CH 4 will show this amplitude.

13 Set the oscilloscope time base to 5 mS/div.

14 Set CH1 sensitivity to maximum.

15 Adjust DC Att. Balance for the minimum square wave amplitude. The phase of the signal will change by 180° as you adjust the balance control through zero.

16 Set the function generator to 5 kHz and amplitude to 1 V<sub>pp</sub>. Connect the D Probe input to function generator’s output and the + input to the ground. You can use BNC A on the calibration fixture. Maintain the probe ground.

17 Press Auto Scale.
19 Use the square head trimmer tool to set the + LF compensation for a minimum of overshoot and undershoot at the leading edge of the waveform.
   Adjust the compensation to achieve the best waveform characteristics when you remove the tool.
20 Set the oscilloscope time base to 500 nS/div
21 Connect the probe + and D inputs to the function generator output.
   You can use BNC C on the calibration fixture. Connect the probe ground to the function generator ground.
22 Set the amplitude of the function generator to 10 V and the frequency to 5 kHz.
23 Set the oscilloscope sensitivity to maximum.
24 Use the square head trimmer tool to adjust the DLF compensation for minimum signal amplitude.
   It is not possible to make the trace completely flat.
### 1159A 1GHz Active Differential Probe

**Calibration Test Record**

**Agilent Technologies**

<table>
<thead>
<tr>
<th>Test</th>
<th>Limit Minimum</th>
<th>Results</th>
<th>Limit Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy at 1 kHz into 50 Ω input of 54845 A</td>
<td>Min Gain 98%</td>
<td>Pass</td>
<td>Max Gain 102%</td>
</tr>
<tr>
<td>Differential Mode Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Att 1; Gain 1</td>
<td>No Clipping</td>
<td>Fail</td>
<td>N/A</td>
</tr>
<tr>
<td>Att 10; Gain 10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMRR at 70 Hz</td>
<td>80 dB</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>CMRR at 1 MHz</td>
<td>40 dB</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>CMRR at 100 MHz</td>
<td>25 dB</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>CMRR at 500 MHz</td>
<td>19 dB</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>CMRR at 1 GHz</td>
<td>13 dB</td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>
DECLARATION OF CONFORMITY
According to ISO/IEC Guide 22 and CEN/CENELEC 45014

Manufacturer's Name: Agilent Technologies
Manufacturer's Address: Colorado Springs Division
1900 Garden of the Gods Road
Colorado Springs, CO 80907, U.S.A.

Declarations, that the product

Product Name: Oscilloscope Differential Probe
Model Number(s): 1159A
Product Option(s): This declaration covers all options of the above product(s).

Conforms with the following product standards

EMC: CISPR 11:1990 / EN 55011:1991 Group 1, Class A
IEC 801-2:1991 / EN 50082-1:1992 4 kV CD, 8 kV AD
IEC 801-3:1984 / EN 50082-1:1992 3 V/m, (1kHz 80% AM, 27-1000 MHz)
IEC 801-4:1988 / EN 50082-1:1992 0.5 kV Sig. Lines, 1 kV Power Lines


Conformity/Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC), and carries the CE-marking accordingly (European Union).

This product was tested in a typical configuration with Agilent test systems.

Colorado Springs, 06/28/2000

Ken Wyatt, Quality Manager

European Contact: Your local Agilent Technologies Sales and Service Office
## Product Regulations

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC</td>
<td>Performance Criteria</td>
</tr>
<tr>
<td></td>
<td>IEC 801-2:1991 / EN 50082-1:1992</td>
</tr>
<tr>
<td></td>
<td>IEC 801-3:1984 / EN 50082-1:1992</td>
</tr>
<tr>
<td></td>
<td>IEC 801-4:1988 / EN 50082-1:1992</td>
</tr>
</tbody>
</table>

### Additional Information:


### Performance Criteria:

- **A** Pass - Normal operation, no effect.
- **B** Pass - Temporary degradation, self recoverable.
- **C** Pass - Temporary degradation, operator intervention required.
- **D** Fail - Not recoverable, component damage.

### Sound Pressure Level

| N/A |

### Regulatory Information for Canada

**ICES/NMB-001**

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

### Regulatory Information for Australia/New Zealand

This ISM device complies with Australian/New Zealand AS/NZS 2064.1

**N10149**
Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under “Safety Symbols.”

Warnings

- Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.

- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuse-holders. To do so could cause a shock or fire hazard.

- If you energize this instrument by an auto transformer (for voltage reduction or mains isolation), the common terminal must be connected to the earth terminal of the power source.

- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.

- Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

- Do not install substitute parts or perform any unauthorized modification to the instrument.

- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.

- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- Do not use the instrument in a manner not specified by the manufacturer.

To clean the instrument

If the instrument requires cleaning: (1) Remove power from the instrument. (2) Clean the external surfaces of the instrument with a soft cloth dampened with a mixture of mild detergent and water. (3) Make sure that the instrument is completely dry before reconnecting it to a power source.

Safety Symbols

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.

Hazardous voltage symbol.

Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.
Notices

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Agilent Technologies, Inc.
1900 Garden of the Gods Road
Colorado Springs, CO 80907
USA

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A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION
A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.