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User and Service Guide

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Agilent Technologies 1141A Differential Probe and 1142A Probe Control and Power Module

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Agilent Technologies 1141A Differential Probe and 1142A Probe Control and Power Module

This manual contains information for use and service of the differential probe system, the 1141A Differential Probe and 1142A Probe Control and Power Module. In this document, the two models will be treated as a system.

Each of the two instrument models that make up the differential probe system has a serial number sticker. The sticker for the 1141A Differential Probe is inside the probe, in the bottom cover. (See chapter 3 for disassembly procedure.)

The 1141A/1142A probe system allows measurement of small differential signals in the presence of much larger common-mode signals. It has the following major features:

- 200 MHz bandwidth
- Variable offset
- dc reject
- ac coupling
- Remote operating capability

The variable offset capability can be used to measure small ac signals in the presence of much larger dc levels. Remote operation of key features allows the use of the probe system in automatic test situations.

The probe can be used with an oscilloscope, spectrum analyzer, or any instrument where differential probing is required and a compatible 50 Ω input is available.

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1

Operating the Probe

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Introduction

This chapter shows you how to connect and operate the 1141A Differential Probe and 1142A Probe Control and Power Module as a differential probe system.

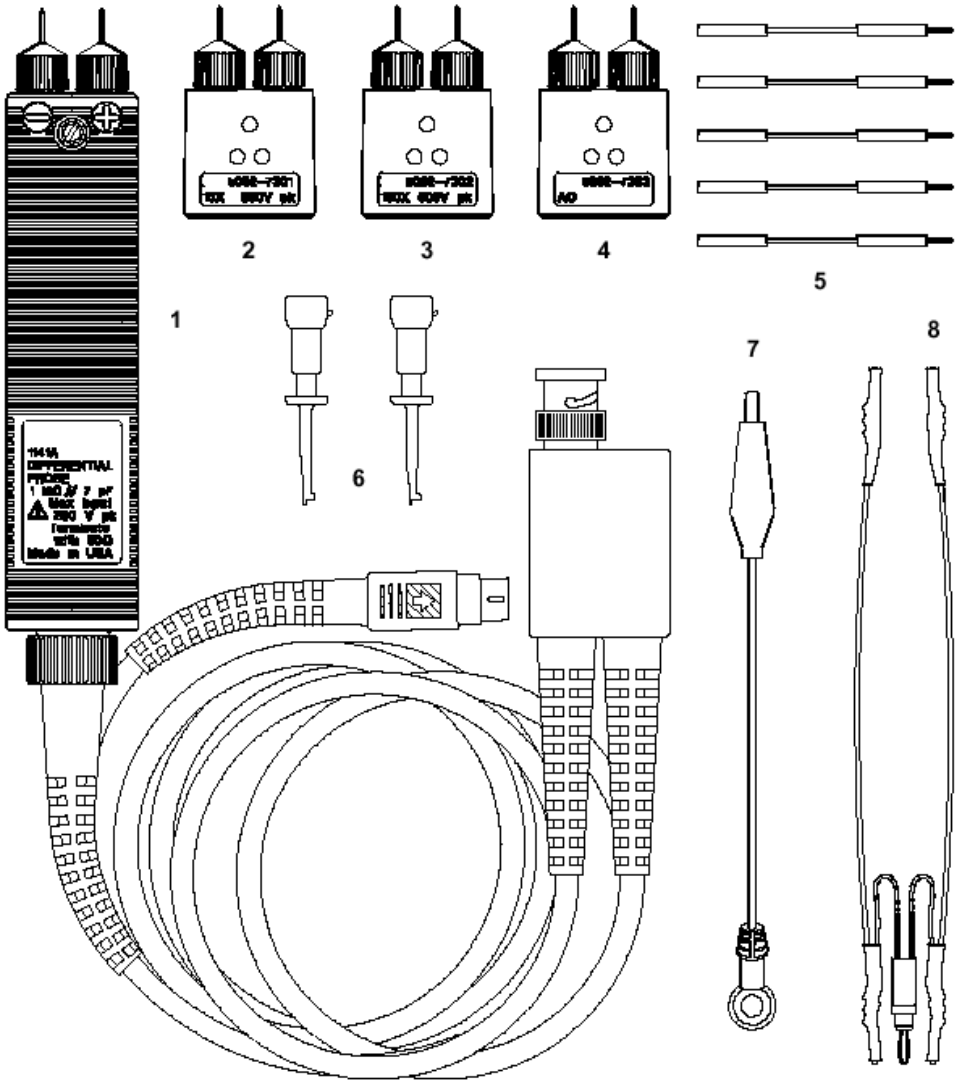
Accessories Supplied

The following items are supplied as part of the 1141A/1142A probe system. Item numbers refer to the numbers in Figure 1-1 on page -7 and Figure 1-2 on page -8. Those without item numbers are supplied but not shown in figures. See the Replaceable Parts List for parts not listed below.

Item	Description	Qty	Part Number
1	Differential Probe	1	
2	10x Attenuator Adapter	1	5063-2144
3	100x Attenuator	1	5063-2145
4	ac Coupling Adapter	1	5063-2146
5	Two-inch Extension Leads (package 5)	1	5959-9334
6	Mini Grabbers	2	1400-1422
7	Five-inch Ground Lead	1	5061-6162
8	Shielded Signal Lead	1	01141-68702
9	Test Board	1	01141-66504
10	Flat-blade Alignment Tool	1	8710-1961
11	Circuit Connection Posts (strip of 20)	1	1251-5943
	Probe Control and Power Module	1	1142A
	Power Cord	1	see parts list
	Carrying case		
	User and Service Manual	1	

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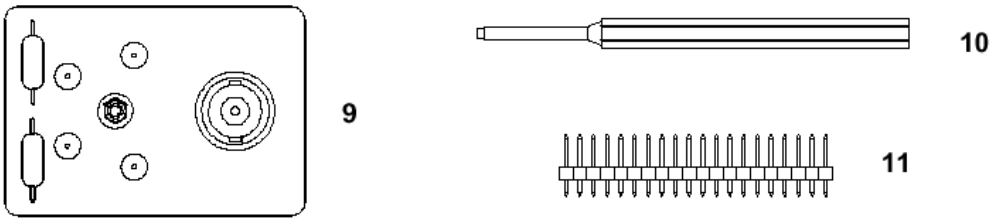
Figure 1-1



1141A Differential Probe and Accessories

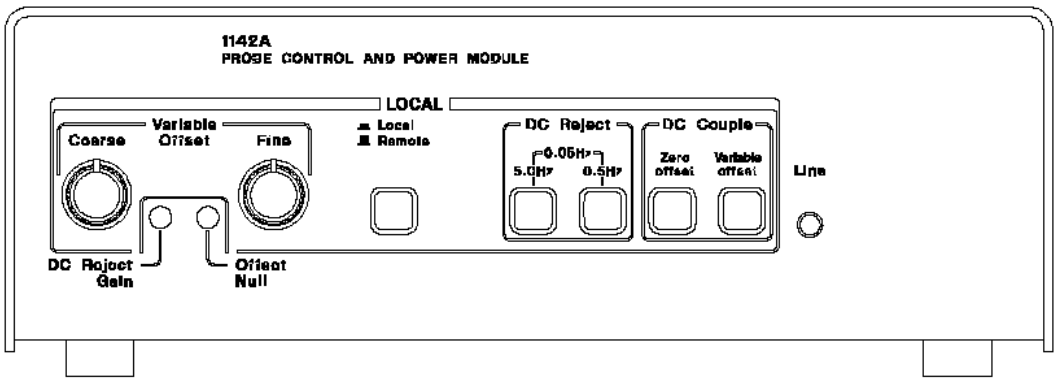
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Figure 1-2



1141A Miscellaneous Accessories

Figure 1-3



1142A Probe Control and Power Module

Accessories Available

The following accessories can be ordered.

- 5959-9335 Long Extension Lead (5.5 inch/14 cm), package of 5
- 5090-4833 Mini grabber for SMT, package of 20

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To inspect the probe

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument had been checked mechanically and electrically. Accessories supplied with the instrument are listed in see “Accessories Supplied” on page 6 of this manual.

If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass calibration tests, notify the nearest Agilent Technologies office. If the shipping container is damaged, or the cushioning materials show sign of stress, notify the carrier as well as the nearest Agilent Technologies office. Keep the shipping materials for the carrier’s inspection. The office will arrange for repair or replacement at Agilent Technologies’ option without waiting for a claim settlement.

Using the probe with other instruments

The 1141A/1142A probe system can be used with other instruments as well as oscilloscopes. You can use it with a spectrum analyzer or frequency counter, or any instrument with an input that can be terminated with 50 Ω.

If you are going to use the probe system with an instrument other than an oscilloscope, you may need to set up the probe with an oscilloscope first. This will allow you to select coupling and reject modes, and set offset, so the output of the probe is compatible with signal requirements of the other instrument.

Recommended Test Equipment

The following table is a list of the test equipment required to test calibration, make adjustments, and troubleshoot this instrument. The table indicates the critical specifications of the test equipment and for which procedure the equipment is necessary. Equipment other than the recommended model may be used if it satisfies the critical specifications listed in the table.

Recommended Test Equipment

Equipment Required	Critical Specifications	Recommended Agilent Model/Part	Use
Signal Generator	1 to 200 MHz, 400 m V_{rms}	8648A	P
Function Generator	2.5 to 500 kHz, 600 m V_{p-p} to 16 V_{p-p}	33120A	A
Oscilloscope	>400 MHz bandwidth, 1 mV/div sensitivity	54830B	P,A
dc source	± 100 mV to 7 Vdc	E3632A	P

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Equipment Required	Critical Specifications	Recommended Agilent Model/Part	Use
Test Board	No substitute (supplied accessory)	01141-66504	A
Load	BNC Feedthrough, 50 Ω	Pasternack Enterprises PE6008-50 or Huber+Suhner 22543742	P
Cables (2)	BNC, 50 Ω 36-inch	10503A	P,A
Cable	BNC, 50 Ω 9-inch	10502A	A
Cable	Type N (m) 24-inch	11500B	P
Adapter	Type N (m) to BNC (f)	1250-0780	A
Adapter	Type N (f) to BNC (m)	1250-0077	P
Adapters (2)	BNC (f) to dual banana (m)	1251-2277	P
Alignment tool	Small flat blade (supplied accessory)	8710-1961/ Sprague-Goodman part number GTT-5G	A

P=Calibration Tests, A=Adjustments

Setting up the probe

The following paragraphs cover system preparation and initial adjustments.

Power Requirements

The 1141A/1142A probe system (specifically the 1142A) requires a power source of either 90 to 132/198 to 264 Vac, 47 to 440 Hz, 25 VA maximum.

CAUTION

Before connecting power to this instrument, be sure the line voltage switch on the rear panel of the instrument is set properly.

Line Voltage Selection

Before applying power, verify the setting of the LINE SELECT switch on the rear panel of the 1142A. The slide switch can be set to either 115 or 230 V.

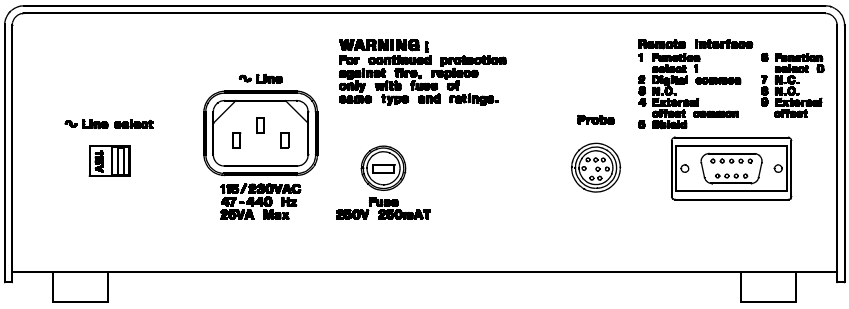
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WARNING

Before connecting this instrument, the protective earth terminal of the instrument must be connected to the protective conductor of the (Mains) power cord. The Mains plug must be inserted in a socket outlet provided with a protective each contact. The protective action must be negated by the use on an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet does not provide an instrument ground.

This instrument is provided with a three-wire power cable. When connected to an appropriate ac power outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with the instrument depends on the country of destination. The 1142A Power Control and Power Module does not have a power switch. A power switch is not required because of the low mains power requirement.

Figure 1-4



1142A Rear Panel

Procedure

1. Use the power cord to connect the 1142A to the ac mains.
2. Connect the 1141A probe cable power connector to the PROBE connector on the rear panel of the 1142A power module.
3. Connect the output of the probe to the input of the oscilloscope.
4. Set the input impedance of the oscilloscope to 50 Ω.
   If the oscilloscope does not have a selectable 50 Ω input impedance, connect a 50 Ω BNC feedthrough termination between the probe output and the input of the oscilloscope.
5. If making an initial equipment setup, continue with the initial adjustment in the following section.

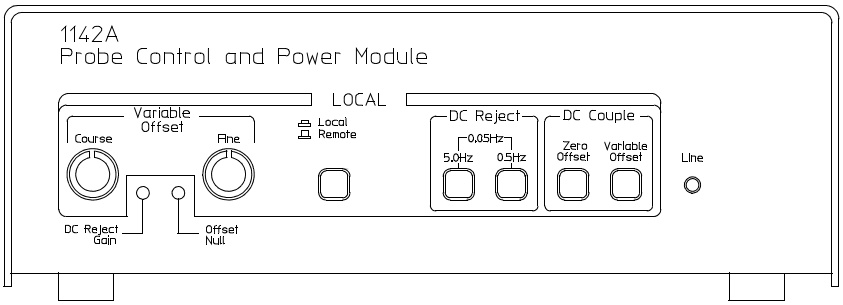
Initial Adjustment

For a given combination of 1141A Differential Probe and 1142A Probe Control and Power Module, you may want to adjust the Offset Null and DC Reject Gain. Typically, you need to make these adjustments only once, before the probe is first used. You can make them any time to optimize the system. These adjustments do not affect the specifications of the probe system.

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- Offset null zeroes the dc level at the output of the probe. The range of adjustment is about ±4 mV.
- DC Reject Gain adjusts the gain of the dc reject circuit to accurately null the dc component of an input signal. The range of adjustment is about ±0.5%.

Figure 1-5



1142A Front Panel

Equipment Needed

The following equipment is necessary for initial adjustment.

- 5 V power supply
- DVM that can measure 25 µV
- 50 Ω BNC feedthrough terminator
- 01141-66504 test board

Equipment Setup

Use the following procedure to setup the differential probe system for initial adjustment.

CAUTION

Do not exceed ±7 V when using the test board for this procedure. If the voltage is too high, it will cause excessive power dissipation in the 50 Ω termination on the test board.

1. Use the probe setup procedure to set up the probe system.
2. Connect a 50 Ω BNC feedthrough terminator to the output of the probe.
3. Disconnect all accessories from the input of the probe.
4. Connect the DVM to measure the dc output of the probe at the 50 Ω load.

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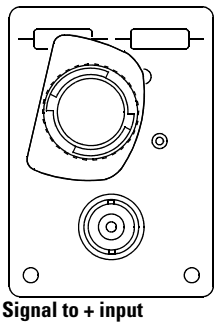
5 Set up the 1142A:
   a Set the Local/Remote push button to Local.
   b Under DC Couple, press Zero offset.
6 Set the power supply output to 5 V.
7 Arrange a connection between the power supply and the test board. The negative terminal of the supply should connect to the shield of the test board BNC.
   If your power supply has standard binding posts, you can connect a banana-to-BNC adapter to the supply and connect a BNC cable between the supply and the test board.

Adjustment

Warm up the 1141A for 30 minutes before making adjustments.

1 With the 1141A probe inputs unconnected, adjust Offset Null on the 1142A for a minimum reading on the DVM.
   The voltage swing of the adjustment is approximately ±4 mV.
2 On the 1142A, under DC Reject, press 5.0 Hz.
3 Read and record the reading on the DVM, _____ mV.
4 Connect the probe to the test board in the position shown below (signal to + input).

Figure 1-6



Signal to + input

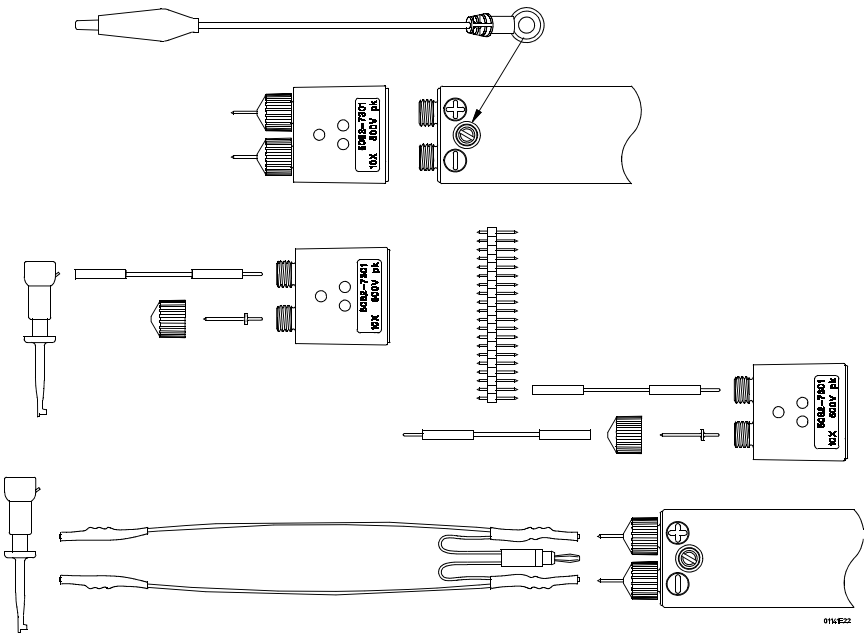
5 After the DVM reading stabilizes, adjust DC Reject Gain to the reading recorded in step 3.
   With a 5 V supply, the voltage swing is approximately ±12.5 mV. With a lower supply, the voltage swings proportionally less.

Using the Accessories

The 1141A Differential Probe and accessories are designed to provide a variety of ways to connect to circuitry and make measurements. In the descriptions, any method used to connect to the probe signal inputs also applied to the adapters. The figure below shows, in a general way, the use of accessories.

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Figure 1-7



Basic Accessory Connections

Probe Tips

Probe tips fit into the receptacles in the probe and are held in place with probe tip caps. If necessary, you can solder the probe tips into a circuit or wires can be soldered to the tips. If you solder to the probe tips, be careful not to melt the plastic probe tip caps.

Note

Because of the close tolerances between the probe tip caps and probe tips, it will be difficult to separate the probe tips and caps once the probe tips have been soldered.

Ground Leads

The circular end of the ground lead fits over the screw on the top side of the probe.

Extension Leads

The extension leads provide a flexible connection between circuitry and the probe.

- To provide a male connection to other circuitry, connect the extension lead over the probe tips.
- To provide a female connection, remove the probe tip caps and probe tips and connect the extension leads to the probe.

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Note Use extension leads and similar connection accessories carefully. Extension leads compromise the high-frequency specifications of the probe. CMRR is particularly sensitive to unbalanced input parameters.

To prevent pickup of stray fields when you use extension lead, either the ones supplied with the 1141A or others, dress them carefully as follows:

- Connect the leads at right angles to the circuitry under test.
- Keep the leads as parallel as possible before they connect to the probe.

Mini-Grabbers

Mini-grabbers can be attached to the probe or adapter through the extension leads.

1. Remove the probe tip caps and tips.
2. Attach the extension leads to the probe or adapter.
3. Attach the mini-grabbers to the extension leads.

Circuit Connector Posts

These 0.025-inch square posts can be used to connect either directly to the probe or to the extension leads.

Solder the posts directly into your circuitry or use them to make extension leads that plug into the inputs of the probe or adapters.

Shielded Signal Leads

The shielded signal leads allow connection to points in a circuit that are up to 10 inches apart. The leads are shielded to within approximately 1/2 inch of the end of the lead so they minimize pick-up due to stray fields from adjacent circuitry.

1. Connect the end with the ground connector to the probe pins and ground of the differential probe or adapter.
2. Connect the free ends of the leads to 0.025-inch square or 0.030-inch round pins in your circuitry or to the mini-grabbers.

Note Each lead has an input capacitance of approximately 15 pF. This capacitance may limit the bandwidth of your measurement (depending on the impedance of the circuit). Also, CMRR may be affected because of slight differences between the input capacitance of the two leads. CMRR is also affected by differences in impedance between the two measurements points.

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Adapters

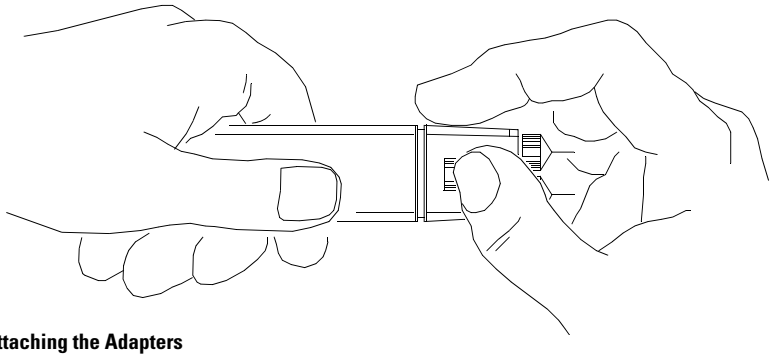
There are three adapters for use with the differential probe. Two adapters are attenuators, a 10x and a100x. The other is an ac adapter for blocking dc from the probe input.

The adapters are installed on the probe after the probe tip caps and probe tips have been removed. The adapter fastens to the probe using a thumb wheel located on the underside of the adapter. the figure below shows a good way to hold the probe while attaching the adapter.

1. Remove the probe tip caps and probe tips, from the probe.
2. Fit the adapter over the end of the probe and rotate the thumb wheel with your finger until the adapter fits snugly.

   A snug fit is important because the ground is maintained through the thumb wheel screw. A loosely attached adapter compromises the mechanical and electrical integrity of the combination.

Figure 1-8



Attaching the Adapters

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Adapter Combinations

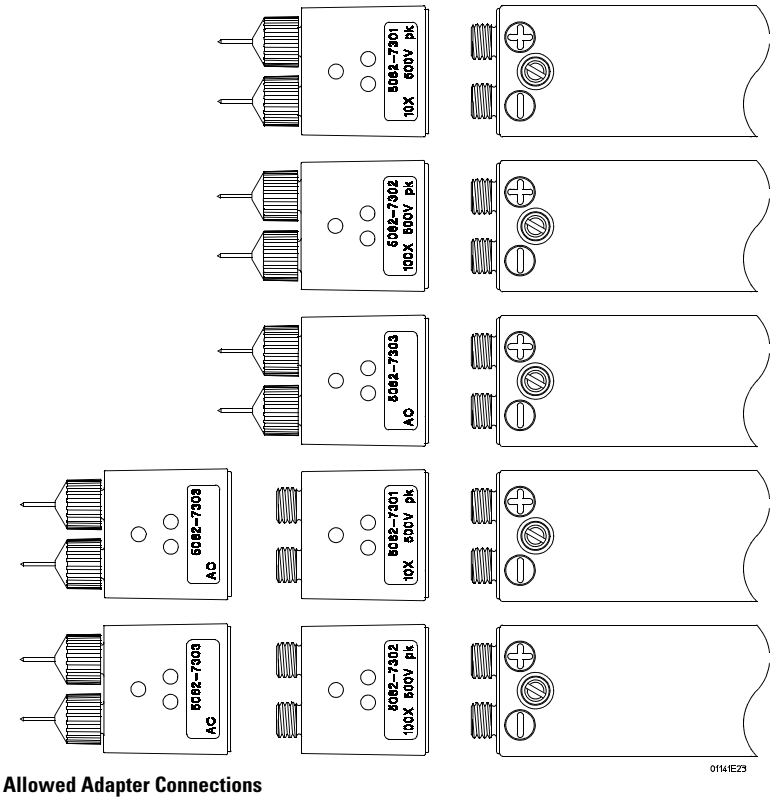
The figure below shows the allowed adapter and probe connections. There are two specific combinations that should not be used.

- Do not attach the ac adapter between an attenuator adapter and the probe.

  An attenuator adapter must be terminated by the input resistance of the probe. The ac adapter isolates the probe input resistance.
- Do not cascade two attenuator adapters.

  The attenuator adapters are designed to be terminated by the 1 MΩ resistance of the probe. The input resistance of the attenuator adapter is 9 MΩ for the 10x adapter and 10 MΩ for the 100x adapter.

Figure 1-9



Allowed Adapter Connections

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Connector Compatibility

The following are general connector characteristics for the probe, adapters, and accessories.

- The female connectors on the probe, adapters, and other accessories are designed to mate with 0.030-inch round or 0.0250-inch square pins.
- The probe, adapter, and extension lead pins are 0.030-inch round.
- The strip of circuit connection posts provided as an accessory has 0.025-inch square pins.
- The mini-grabber has a 0.25-inch square pin.
- The ground connection at the end of the probe and adapters (where the adapters fasten) accepts an M3 metric screw.

Test Board

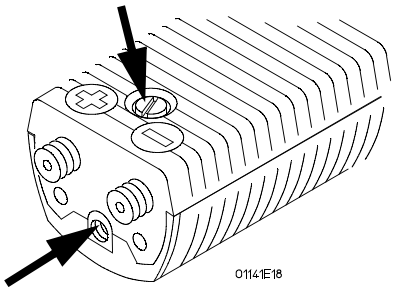
The primary use of the test board is to apply test and calibration signals to the input of the probe or adapters. Specific use of the test board is covered wherever it applies.

Grounding

Grounding is very important when probing circuitry. Improper grounding can increase the common mode signal level. This reduces the effectiveness of the differential probe.

The mechanical connections at the input of the probe are ground for probe signals. The screw where the ground lead attaches (see figure 1-7) fastens to this ground. Also, the attenuator and ac adapter fasten to this ground through the screw connection and the ground is carried through each adapter to its front.

Figure 1-10



Probe Grounds

Coupling Functions

There are three methods for blocking or compensating for the dc component of a signal. Each has specific advantages.

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Probe System Coupling Functions

	dc offset	dc Reject	ac Coupling Adapter
dc Blocked			
Probe alone	± 20 V	± 20 V	± 20 V
Probe with 10x	± 200 V	± 200 V	± 500 V
Probe with 100x	± 500 V	± 500 V	± 500 V
Set-up needed	Adjust offset to put signal on screen	Select DC Reject low-frequency corner	Attach ac Coupling adapter to differential probe
Remote Control?	Yes[1]	Yes[1]	No
CMRR degradation?	No	No	Yes
Low-frequency degradation?	No	Yes	Yes
[1] Isolated external dc reference and control signals are needed			

dc Reject

dc Reject is the best method of eliminating the dc component of a signal when dc is not a factor in the measurement.

The key characteristics are:

- The low-frequency component (from dc to the selected corner frequency) is automatically nulled by the dc reject circuitry.
- Probe CMRR specifications are not compromised as happens when the ac coupling adapter is uses.
- There is a selectable low frequency corner with -3dB points at 0.05 Hz, 0.5 Hz, or 5.0 Hz.
- The voltage reject range is ±20 V with the probe alone, ±200 V with the 10x attenuator, and ±500 V with the 100x attenuator.

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To use dc reject:

1 Remove the ac adapter if it is installed.
2 On the front panel of the 1142A, press Local.
3 Under DC Reject on the front panel, press 5.0 Hz or 0.5 Hz individually, or 5.0 Hz and 0.5 Hz simultaneously to get 0.05 Hz.

Within the frequency and voltage characteristics noted elsewhere in this manual, low frequencies are nulled from the input signal.

Offset

Offset is the best method to use when the low-frequency corners associated with dc reject and the ac adapter interfere with the measurement.

The key characteristics are:

- The user manually null the dc component with the offset adjustment.
- Offset is dc coupled so there is no low frequency roll-off.
- Probe CMRR specifications are not compromised as happens when the ac coupling adapter is used.
- The voltage offset range is ±20 V with the probe alone, ±200 V with the 10x attenuator, and ±500 V with the 100x attenuator. (With the 100x attenuator, the offset range is restricted by the maximum input voltage rating rather than the operating range of the offset).

To use offset:

1 Remove the ac adapter if it is installed.
2 On the front panel of the 1142A, press Local and Variable offset.
3 Adjust the Coarse and Fine Variable Offset until the signal is displayed on the screen of the oscilloscope.

ac Adapter

The ac adapter must be used when the dc component of the signal exceeds the operating range of the dc reject or offset methods. The ac adapter block the dc and low frequency component of the input by forming a high pass filter with the input impedance of the probe or adapter.

The key characteristics are:

- The ac adapter safely blocks ±200 Vdc when attached directly to the probe or ±500 Vdc when attached to a 10x or 100x adapter.
- The probe and adapters have different input impedances, so they have different low frequency corners with the ac adapter. When the ac adapter is directly on the probe the -3dB corner is 15 Hz. When the ac adapter is on an attenuator the corner is 1.5 Hz.
- The low-frequency CMRR when using the ac adapter is not as good as when using the probe alone or the probe with a 10x or 100x adapter.

CAUTION

If you measure a node having a high dc potential, the blocking capacitors in the ac adapter will charge to that potential. After making such measurements, discharge the capacitors by grounding both inputs of the ac adapter. This will prevent damage by a high voltage discharge into sensitive circuitry when the next measurement is made.

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To use ac coupling:

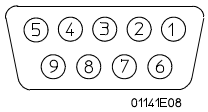
1. Attach the ac coupling adapter to the input of the probe or the input of the attenuator adapter.
2. On the 1142A, press Local and Zero offset.

Remote operation

For automatic test applications, the coupling and offset functions provided by the 1142A Probe Control and Power Module can be remotely controlled through a connector on the rear panel of the module. The connection is through a standard 9-pin female D-subminiature connector. This style is the same as that used on some personal computer monitor cables, which provides an economical way to connect the 1142A to the controller interface on an automatic test system.

The following table gives the connections.

Remote Input Connections

Pin	Function	Pin	Function	Connector
1	Function Select 1 (A1R)	6	Function Select 0 (A0R)	
2	Digital common	7	N.C.	
3	N.C.	8	N.C.	
4	External offset common	9	External offset	
5	Shield			

NOTE

To minimize dc offset errors and potential noise coupling, electrically isolate all connections between the Remote Input connector and the controlling system.

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Function Select

The easiest way to control the function select lines is contact closures between the lines and Digital common (pin 2) of the remote input connector. (TTL compatible control signals can be used; but to avoid problems with ground loops, they must be electrically isolated.) The following truth table shows the functions provided by the function select lines. For the Remote Inputs, "0" represents a closure and "1" represents an open circuit.

Remote Functions Select Truth Table

Remote Input		Function
A1R (Pin 1)	A0R (Pin 6)	
0	0	0.05 Hz Reject
0	1	0.5 Hz Reject
1	0	5 Hz Reject
1	1	DC Couple

Variable Offset

The remote variable offset can be used when the dc couple function is remotely selected. The offset voltage must be referenced to the External offset common (pin 4) of the remote input connector. It must be electrically isolated from the controlling system. The following table shows the offset range and remote offset requirements for probe and adapter combinations.

Remote Offset Input Requirements

	Offset Range	Remote Requirements
Probe alone	± 20 V	± 10 V
Probe with 10x adapter	± 200 V	± 10 V
Probe with 100x adapter	± 500 V	± 2.5 V

Cleaning Requirements

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.

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Differential Amplifiers and CMRR

The 1141A Differential Probe is a high-impedance differential 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 which product equal outputs. For example, if a common mode signal of 1 V and differential signal of 1 mV both produce outputs of 1 mV, the CMRR is 1000:1.

The ability to reject common mode signals is dependent on the balance designed into the differential amplifier. At higher frequencies it becomes harder to balance circuit parasitics and parameters of devices so CMRR degrades as frequency increases. Also, stray coupling increases with frequency and coupling may vary between the two differential paths.

The CMRR of the 1141A Differential Probe is specified at the input of the probe and cannot be affected expect by adjustments in the probe. However, the way the probe is connected into the circuitry being tested can have a big influence in the overall result of the measurement, especially at high frequencies.

The following things can affect the effective CMRR of a test setup:

- The connection to the circuit under test.

  The method used to connect the probe is important because it involves the symmetry of the differential input circuitry. For example, using different lengths of wire to connect the circuit to the two probe inputs unbalances the inductance and capacitance at the inputs. The effective CMRR will be reduced, especially at high frequencies. Additionally, coupling from adjacent circuitry will be less balanced.
- 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 source forms a network with the input impedance of the connections 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 and the unbalance is reflected in a reduced CMRR. Of course, lower source impedances have less effect on the frequency response of the measurement.
- The ground connection.

  A poorly located ground connection allows ground loops to add to the common mode signal.
- Frequency.

  Frequency is the most important factor in CMRR only because all of the factors mentioned above are frequency dependent. The unbalances of capacitance and inductance are more important as frequency increases. Therefore, good high-frequency practice is important when using a high impedance differential probe.

  On the other hand, if the differential probe is ac coupled to the circuit under test (the ac adapter is being used) the CMRR will be degraded below a certain frequency; the lower the frequency the worse the CMRR. This is because unbalance in the series capacitances of the ac coupler becomes more significant the lower the frequency.

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2

Calibration Tests and Adjustment

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Introduction

This chapter is divided into two sections. The first section gives calibration tests and the second adjustment procedures for the 1141A Differential Probe and 1142A Probe Control and Power Module.

Equipment Required

A complete list of equipment required for the calibration tests and adjustments is listed in “Recommended Test Equipment” on page 9. Equipment required for individual procedures is listed at the procedure. Any equipment satisfying the critical specifications listed may be substituted for the recommended model.

The Test Board

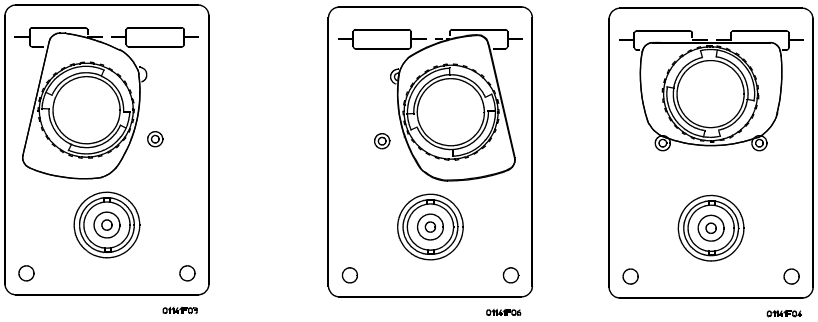
The test board is a supplied accessory for use during calibration tests and adjustments to connect signals to the differential probe (with or without adapters). A BNC connector connects the test board to a cable from the signal generator. The board includes a 50 Ω termination (two 100 Ω resistors).

CAUTION

The power rating of the 50 Ω termination is 1.0 W. Keep the signal input below 7 Vdc or rms to avoid degrading the termination.

Once the probe tip caps and probe tips have been removed, the probe can be connected to the test board in one of three ways, as shown in the figure below. At each position of the probe, probe inputs are connected to a different combination of signal and ground. A separate terminal on the test board connects the ground of the probe to the signal ground.

Figure 2-1



Test Board Showing Probe Positions

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Calibration Tests

These procedures test the probe's electrical performance using applicable specifications given in "Performance Specifications and Characteristics" on page 55 as performance standards. Specifications applicable to individual tests are noted at the test for reference.

Testing Interval

The calibration testing procedures may be performed for incoming inspection of the instrument and should be performed periodically thereafter to ensure and maintain peak performance. The recommended test interval is yearly or every 2,000 hours of operation. Amount of use, environmental conditions, and the user's experience concerning need for testing will contribute to verification requirements.

Calibration Test Record

The results of the calibration tests may be tabulated in the Calibration Test Record provided at the end of the calibration tests. The Calibration Test Record listed the calibration tests and provides an area to mark test results. The results recorded in the Calibration Test Record during initial inspection may be used for later comparisons of the tests during periodic maintenance, troubleshooting, and after repairs or adjustments.

Calibration Test Procedures

Procedures may be done individually or in any order.

NOTE

Allow the instrument to warm up for at least 30 minutes prior to beginning calibration tests.

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dc Gain Accuracy

This test checks the dc gain accuracy of the differential probe and the dc accuracy of the differential probe with attenuator and adapters.

Specification: Probe alone, ±2%; with attenuator adapter, ±4%

Equipment Required

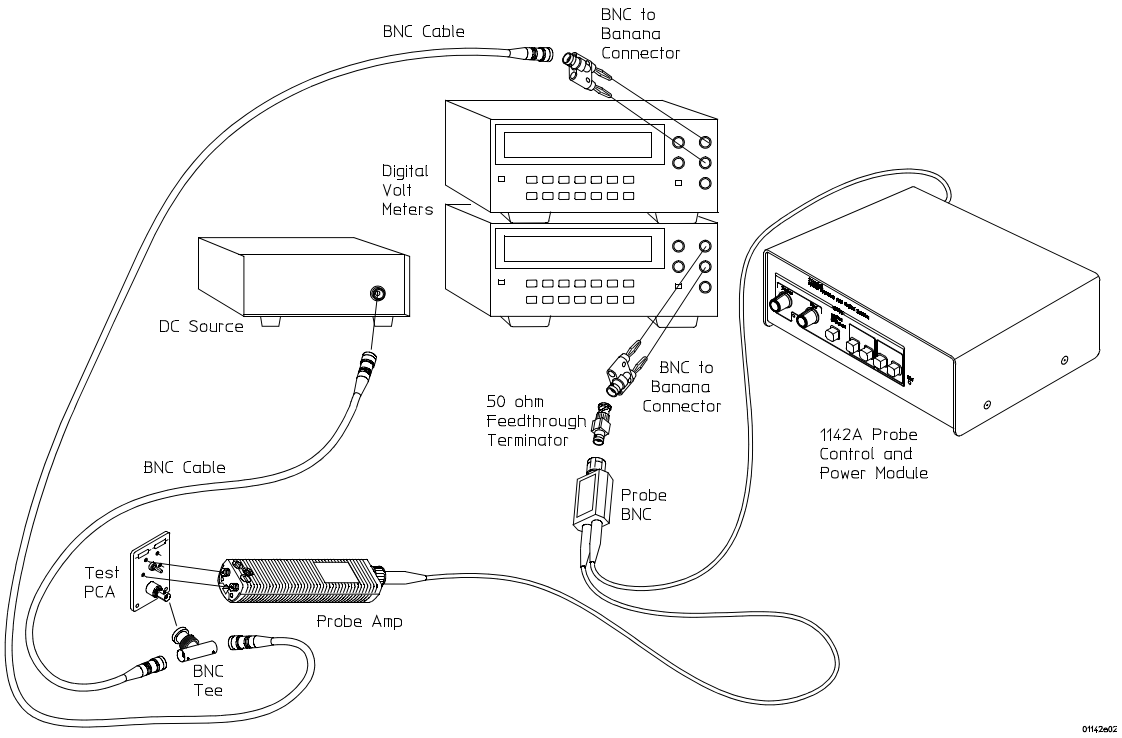
Equipment Required	Critical Specifications	Recommended Agilent Model/Part
ac/dc Calibrator or dc Power Supply	100 mV to 7 V 100 mV to 7 V	E3632A
DVM	0.5% accuracy, 10 µV resolution	3458A or E34401A
Load	BNC Feedthrough, 50 Ω	Pasternack Enterprises PE6008-50 or Huber+Suhner 22543742
Cables (2)	BNC 50 Ω	10503A
Adapters (2)	BNC (f) to dual banana (m)	1251-2277
Test Board	No substitute	01141-66514

Probe Gain Test Procedure

1 Connect the probe and test equipment as shown in figure 2-2.

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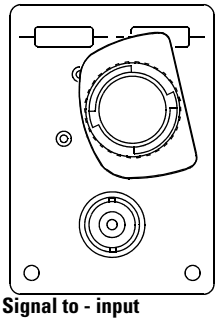
Figure 2-2



2 Set up the 1142A probe control and power module as follows:
   a Set the Local/Remote push button to Local.
   b Under DC Couple, press the Zero offset button.
3 With the 1141A Probe Amp disconnected from the test PCA, adjust the Offset Null control on the 1142A until the DVM reads 0Vdc.
   If the probe output voltage cannot be set to 0V, subtract this voltage from the subsequent measurements in this test.
4 Connect the input of the Probe Amp to the test board in the position shown in Figure 2-4 on page -31.
5 Adjust the DC Source to output 100 mV (nom.)
6 Record the V_{in1} measurement from the top DVM in figure 2-2.
7 Record the V_{out1} measurement from the bottom DVM in figure 2-2.
8 Connect the Probe Amp to measure a negative voltage as shown in figure 2-3.
9 Record the V_{out2} measurement from the bottom DVM in figure 2-2

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Figure 2-3



Signal to - input

10 Calculate probe gain as

$$\frac{\Delta V_{out}}{\Delta V_{in}} = \frac{(V_{out_1} - V_{out_2})}{2 \times V_{in_1}}$$

Record the result of this calculation in the "Calibration Test Record" on page 39.
To pass this test, the probe gain = 0.98 to 1.02

NOTE Failure of the gain accuracy test can be caused by mis-adjustment of the probe. Perform the Probe Adjustment procedure in the Adjustments section later in this chapter and retest.

10x Attenuator Accuracy Test

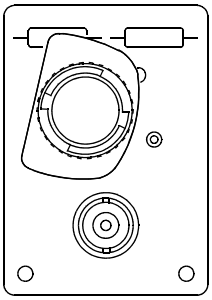
NOTE If the gain test for the probe fails, the 10x Attenuator Accuracy Test will fail or the results will be poor. Do not continue until the probe passes the dc gain test.

1 Disconnect the probe from the test board and connect the 10x attenuator adapter to the probe.

2 Carefully connect the input of the probe/attenuator to the test board in the position shown in the figure below (signal to + input).

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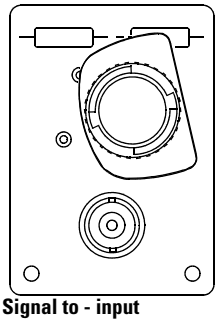
Figure 2-4



Signal to + input

3 Set the dc calibrator output 3 V dc.
4 Record the V_{in1} measurement from the top DVM in figure 2-2.
5 Record the V_{out1} measurement from the bottom DVM in figure 2-2
6 Carefully connect the input of the probe/attenuator to the test board in the position shown in the figure below (signal to - input).

Figure 2-5



Signal to - input

7 Record the V_{out2} measurement from the bottom DVM in figure 2-2.
8 Calculate the 10x attenuator gain as

$$\frac{\Delta V_{out}}{\Delta V_{in}} = \frac{(V_{out_1} - V_{out_2})}{2 \times V_{in_1}}$$

Record the result of this calculation in the “Calibration Test Record” on page 39.

NOTE

Failure of the accuracy test for the 10x attenuator can be caused by mis-adjustment of the low-frequency CMRR (LF CMRR) adjustment. Perform the Attenuator Adapter Adjustment procedure in the Adjustments section later in this chapter then retest the attenuator adapter. If if continues to fail, repair is necessary.

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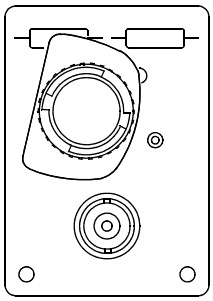
100x Attenuator Accuracy Test

NOTE

If the gain test for the probe fails, it will be reflected in the test for the 100x attenuator adapter. Do not continue until the probe passes the gain test.

1 Disconnect the probe/attenuator from the test board. Remove the 10x attenuator adapter from the probe and connect the 100x attenuator adapter.
2 Carefully connect the input of the probe/attenuator to the test board in the position shown in the figure below (signal to + input).

Figure 2-6



Signal to + input

CAUTION

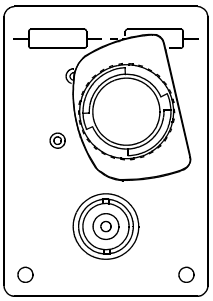
Avoid excessive power dissipation in the termination on the test board. Keep the voltage input at or below ±7 Vdc.

3 Set the dc source output to 7 Vdc.
4 Record the V_{in1} measurement from the top DVM in figure 2-2.
5 Record the V_{out1} measurement from the bottom DVM in figure 2-2

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6 Carefully connect the input of the probe/attenuator to the test board in the position shown in the figure below (signal to - input).

Figure 2-7



Signal to - input

7 Record the V_{out2} measurement from the bottom DVM in figure 2-2.

8 Calculate the 100x attenuator gain as

$$\frac{\Delta V_{out}}{\Delta V_{in}} = \frac{(V_{out_1} - V_{out_2})}{2 \times V_{in_1}}$$

Record the result of this calculation in the "Calibration Test Record" on page 39

NOTE

Failure of the accuracy test for the 100x attenuator can be caused by mis-adjustment of the low-frequency CMRR (LF CMRR) adjustment. Perform the Attenuator Adapter Adjustment procedure in the Adjustments section later in this chapter then retest the attenuator adapter. If if continues to fail, repair is necessary.

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Bandwidth

This test checks the high-frequency response of the 1141A Differential Probe. The bandwidth of the oscilloscope is characterized first so it is not a factor in the measurement.

Specification (-3dB, dc coupled): dc to 200 MHz

Equipment Required

Equipment Required	Critical Specifications	Recommended Model/Part
Oscilloscope	400 MHz bandwidth	54830A
Signal Generator	200 MHz at ≈ 230 mVrms	8648A
Test Board	No substitute	01141-66504
Cable	Type N (m) 24-inch	11500B
Adapter	Type N (f) to BNC (m)	1250-0077

Procedure

This test depends on the accuracy of the termination on the test board and the termination in the oscilloscope. Both should be with 1%.

1. With the N cable and N-to-BNC adapter, connect the signal generator to the oscilloscope channel 1 input.
2. Set the signal generator for 200 MHz at 0 dBm (about 224 mVrms).
3. Set the 1142A front panel switches to Local and Zero offset.
4. On the oscilloscope press AUTOSCALE, then set the following parameters.

Menu	Selection	Setting
TIMEBASE	(time/div)	2 ns/div
CHAN 1	(sensitivity) (input R)	100 mV/div 50 Ω DC
ACQUISITION	Sampling Mode Memory Depth Sample Rate Averaging # of avg	Real Time Automatic Automatic Enabled 32

5. The signal on screen should be about six divisions amplitude.
Measure the peak-to-peak voltage of the channel 1 signal and record the reading.
$V_{p\text{-}p}$ (1) = _____ mV

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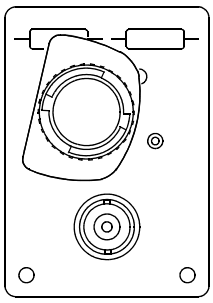
6 Reconfigure the equipment.

a Disconnect the signal generator cable from the oscilloscope input and connect it to the test board.

b Connect the output of the differential probe to the channel 1 input of the oscilloscope.

c Carefully connect the input of the probe to the test board in the position shown in the figure below (signal to + input).

Figure 2-8



Signal to + input

7 Record the $V_{p\text{-}p}$ reading on the oscilloscope.
$V_{p\text{-}p}$ (1) = _____ mV

8 Divide the reading from step 6 by the reading from step 4.

$$\frac{\text{Answer from step 6}}{\text{Answer from step 4}} = _____$$

Record the result in the Calibration Test Record.

The result should be 0.707 or greater, indicating a probe bandwidth of 200 MHz or more.

The bandwidth can be checked at other signal levels. Change the signal generator output level and oscilloscope V/div range proportionally.

NOTE

Failure of the bandwidth test can be caused by mis-adjustment of the probe. Perform the Probe Adjustment procedure in the Adjustments section later in this chapter.

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CMRR Test

This test checks the CMRR at 1 MHz and 100 MHz.

Specification 3000:1 at 1 MHz, 10:1 at 100 MHz

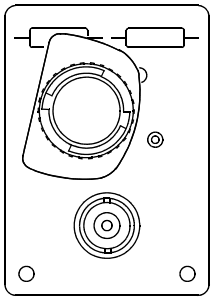
Equipment Required

Equipment Required	Critical Specifications	Recommended Agilent Model/Part
Oscilloscope	400 MHz bandwidth at 1 mV/div	54830B
Signal Generator	1-100 MHz at = 400 mVrms	8648A
Test Board	No substitute	01141-66504
Cable	Type N (m) 24-inch	11500B
Adapter	Type N (f) to BNC (m)	1250-0077

Procedure

1. Connect the probe power connector to the PROBE connection on the rear of the 1142A Probe Control and Power Module.
2. Set the 1142A front panel switches to Local and Zero offset.
3. Connect the probe output to the oscilloscope channel 1 input.
4. Connect the input of the probe to the test board in the position shown in the figure below (signal to + input).

Figure 2-9



Signal to + input

5. Connect the signal generator to the test board.
6. Set the signal generator for 1 MHz at 385 mV_{rms} (1 V_{p-p}).

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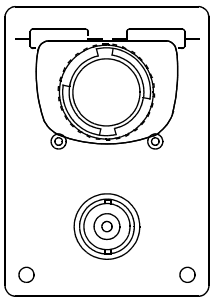
7 On the oscilloscope, press AUTOSCALE and set the following parameters.

Menu	Selection	Setting
TIMEBASE	(time/div)	500 ns/div
CHAN 1	(sensitivity) (input R)	200 mV/div 50 Ω DC
ACQUISITION	Sampling Mode Memory Depth Sample Rate Averaging # of avg	Real Time Automatic Automatic Enabled 32

8 On the oscilloscope, measure the peak-to-peak voltage of the channel 1 signal, then V P-P, then press 1) and record the reading.
$V_{p\text{-}p}$ (1) = _____ mV

9 Connect the input of the probe to the test board in the position shown in the figure below (signal to both inputs).

Figure 2-10



Signal to both input

10 Set the sensitivity to 1 mV/div.

11 After the measurement settles (averaging is complete), record the V P-P reading.
$V_{p\text{-}p}$ (2) = _____ mV

12 Disconnect the probe amp from the test board and measure $V_{noise\ pp}$ on channel 1.

13 Calculate the CMRR result as follows

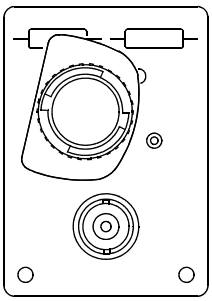
$$\text{CMRR} = \frac{V_{pp_1}}{V_{pp_2} - V_{noisepp}}$$

14 The result in step 12 should be ≥ 3000, representing a CMRR of 3000:1 or more. Record the CMRR in the Calibration Test Record.

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15 Connect the input of the probe to the test board in the position shown in the figure below (signal to + input).

Figure 2-11



Signal to + input

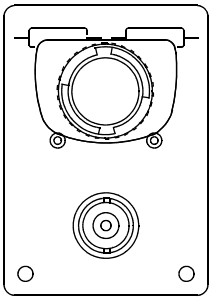
16 Set the signal generator for 100 MHz at 0.0 dBm (about 224 mV_{rms}, 632 mV_{p-p}).

17 Set the oscilloscope to channel 1 and change the horizontal scale to 5 ns/div.

18 After the measurement settles (averaging is complete), note the V P-P reading.
V_{p-p} (1) = _____ mV

19 Connect the input of the probe to the test board in the position shown in the figure below (signal to both inputs).

Figure 2-12



Signal to both input

20 Set the channel 1 sensitivity to 10 mV/div.

21 After the measurement settles (averaging is complete), not the V P-P reading.
V_{p-p} (2) = _____ mV

22 Disconnect the probe amp from the test board and measure $V_{noise\ pp}$ on channel 1.

23 Calculate the CMRR result as follows

$$\text{CMRR} = \frac{V_{pp_1}}{V_{pp_2} - V_{noisepp}}$$

24 The result in step 21 should be ≥ 10, representing a CMRR of 10:1 or more. Record the CMRR in the Calibration Test Record.

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Calibration Test Record

1141A/1142A Differential Probe	Tested by_____
Serial No. _____	Work Order No._____
Recommended Test Interval - 1 Year/2000 hours	Date_____
Recommended next testing_____	Temperature_____

Test	Limits		Results
dc Gain Accuracy	Probe Only	+0.98 mV to +1.02 mV	_____
	10x	+0.096 mV to +0.104 mV	_____
	100x	+0.0096 mV to 0.0104 mV	_____
Bandwidth		>0.707 at 200 MHz	_____
CMRR	1 MHz	≥3000:1	_____
	100 MHz	≥10:1	

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Adjustments

This section provides adjustment procedures for the 1141A Differential Probe and attenuator adapters. There are no service adjustments for the 1142A Probe Control Module.

Adjustment Interval

None of the adjustment procedures that follow should be considered for a routine maintenance plan. The differential probe and attenuator adapters should be adjusted under conditions specified at the beginning of the respective procedures.

NOTE Warm up the instrument for 30 minutes before starting adjustment procedures.

Probe Adjustment

This procedure adjust the high-frequency and low-frequency paths on the 1141A Differential Probe.

NOTE Do not perform this procedure as a part of routine maintenance. Perform the procedure only if the probe does not meet specifications or has been repaired.

CAUTION You are going to remove the covers of the probe, so the assembly inside will be exposed while under power. The PC assembly will be electrically and mechanically vulnerable.

Do these adjustment procedures in an ESD-safe area.

Avoid inadvertent contact between the powered assembly and nearby tools and equipment.

Avoid mechanical damage by carefully handling the exposed assembly and cables.

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The following equipment is required for this procedure. Procedures are based on the model or part number recommended.

Equipment Required

Equipment Required	Critical Specifications	Recommended Agilent Model/Part
Function Generator	2.5 kHz, 1 V_{p-p}	33120A
Oscilloscope	300 MHz at 1 mV/div	54830B
Signal Generator	200 MHz at ≈ 300 mVrms	8648A
Test Board	No substitute	01141-66504
Cables (2)	BNC, 50 Ω	10503A
Adapter	Type N (m) to BNC (f)	1250-0780

Probe Preparation

The probe cover must be removed before adjustment. Drift due to temperature differences with and without covers is negligible.

1 Remove the probe tip caps and probe tips.

2 Loosen the probe clamp ring at the cable end of the probe (1/4 turn counter-clockwise) and slide it down the cable.

3 Remove the bottom cover.

- **a** At the cable end of the probe, separate the covers about centimeter (1/2 inch).
- **b** Slide the bottom cover toward the cable end of the probe until the locator pins at the probe input clear the holes. Then, remove the cover.

NOTE

Note the position of the ground block at the input end of the probe. The ground block is held, through the PC assembly, by the grounding screw on the top of the probe. The ground block must be reinstalled on the PC assembly after the top cover is removed.

Handle the PC assembly by the edges of the PC board.

4 Remove the ground connection screw on the top of the probe.
The ground block will become free.

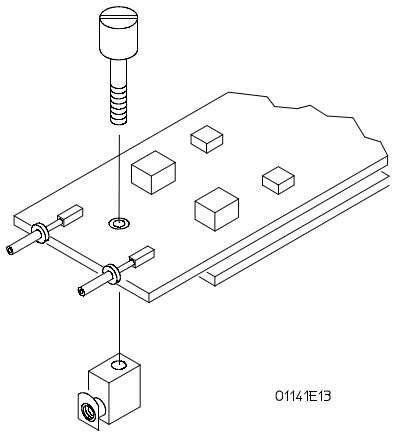
At the cable end, the PC board fits over pins inside the top cover.

5 Lift the board off of the pins in the cover and slide it in the direction of the cable until the input connectors clear the front of the probe.

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6 As shown in the figure below, use the grounding screw to reinstall the ground block on the PC assembly.

Figure 2-13



Attaching Ground Block to Probe PC Assembly

The ground block provides a mechanical and electrical connection when the probe PC assembly is connected to the test board.

7 Connect the probe power connector to the PROBE connection on the rear of the 1142A Probe Control and Power Module.

8 Connect the mains power to the 1142A.

9 Set the 1142A front panel switches to Local and Zero offset.

Adjustment Procedure

Unless specified elsewhere, the procedures must be followed in the order given.

The only adjustment which may be done separately is HF COMP, the high-frequency compensation.

HF Gain and HF CMRR

This adjustment sequence adjusts the HF Gain for unity gain at 500 kHz and the HF CMRR for minimum with a 500 kHz common mode signal.

1 Set up the function generator.
- Sine wave
- 500 kHz
- 600 mV_{p-p}

2 Use BNC cables to connect the function generator to the oscilloscope.
- Generator OUTPUT to oscilloscope channel 1 input
- Generator TRIG OUTPUT to oscilloscope EXT TRIG

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3 On the oscilloscope, then press CLEAR DISPLAY. Press AUTOSCALE, then set up the following parameters.

Menu	Selection	Setting
TIMEBASE	(time/div)	500 ns/div
CHAN 1	(sensitivity) (input R)	100 mV/div 50 Ω DC
TRIG	(mode) source level	trg'd EXT 1.00000 V
ACQUISITION	Sampling Mode Memory Depth Sample Rate Averaging # of avg	Real Time Automatic Automatic Enabled 32

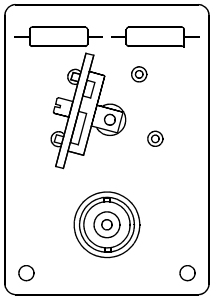
4 On the oscilloscope, measure the peak-to-peak voltage of the channel 1 signal and record the reading.
$V_{p\text{-}p}$ (1) = _____ mV

5 Disconnect the BNC cable from the channel 1 input and connect it to the BNC connector on the test board.

6 Connect the output of the probe to the channel 1 input.

7 Carefully connect the input of the probe to the test board in the position shown in the figure below (signal to + input).

Figure 2-14

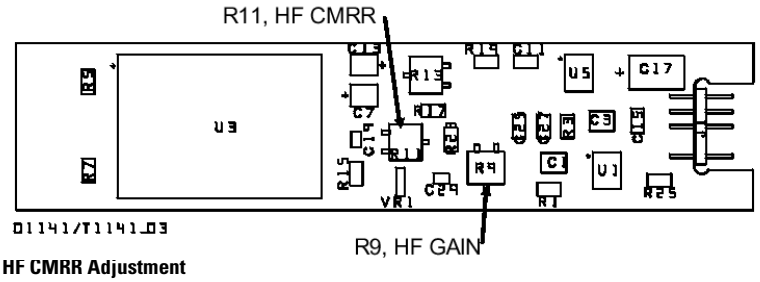


Signal to + input

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8 Center adjustment R11, HF CMRR (see following figure).

Figure 2-15



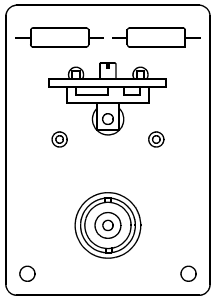
R11, HF CMRR Adjustment

9 Adjust R9, HF GAIN so the V_{p-p} (1) measurement is the same as in step 4, within ±0.5%.

Make the adjustment slowly so the oscilloscope display has time to react to signal averaging. Press CLEAR DISPLAY occasionally to restart averaging, which gives a quicker indication of changes.

10 Carefully connect the probe to the test board in the position shown in the figure below (signal to both inputs).

Figure 2-16



Signal to both inputs

11 Set the function generator output to 1.0 V_{p-p}.

12 On the oscilloscope, set the channel 1 sensitivity to 1.00 mV/div.

13 Adjust R11 for minimum signal amplitude as shown in V_{p-p} reading for channel 1. Adjust R11 slowly and use CLEAR DISPLAY frequently to restart averaging.

Low Frequency Response and CMRR

This adjustment sequence continues from the HF Gain and HF CMRR adjustments. Adjust R14 and C4 for pulse response, and adjust C6 for low-frequency CMRR.

1 Change the function generator settings to:

- Square wave
- 2.5 kHz
- 600 mV_{p-p}

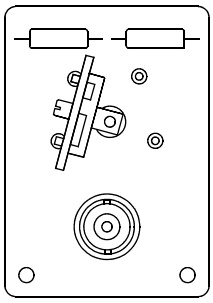
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2 Change the oscilloscope settings to:

Menu	Selection	Setting
TIMEBASE	(time/div)	50 µs/div
CHAN 1	(sensitivity)	100 mV/div

3 Carefully connect the input of the probe to the test board in the position shown in the figure below (signal to + input).

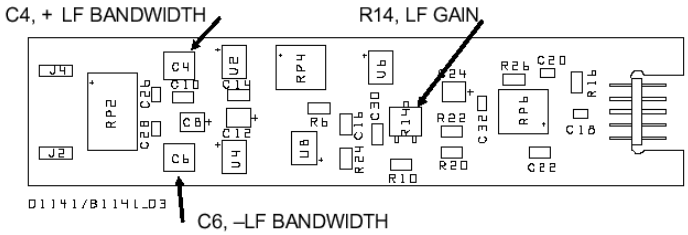
Figure 2-17



Signal to + input

4 Adjust R14 (LF Gain) and C4 (+ LF BANDWIDTH) for the flattest pulse top (see figure below). Again, adjust slowly and press CLEAR DISPLAY frequently to restart averaging.

Figure 2-18

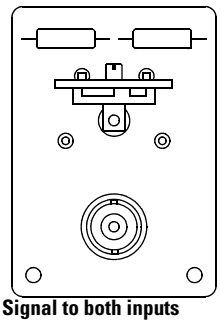


R14 and C4 Adjustment

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5 Carefully connect the probe to the test board in position shown in the figure below (signal to both inputs).

Figure 2-19



Signal to both inputs

6 Change the function generator settings to:
- Sine wave
- 4 kHz
- 1.0 V_{p-p}

7 Change the oscilloscope settings to:

Menu	Selection	Setting
TIMEBASE	(time/div)	50 µs/div
CHAN 1	(sensitivity)	2 mV/div

8 Adjust C6 (-LF BANDWIDTH) for minimum signal amplitude on the oscilloscope. Again, adjust C6 slowly and press CLEAR DISPLAY frequently to restart averaging.

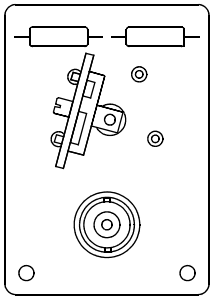
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High Frequency Compensation

This adjustment sequence continues from the Low Frequency Response and CMRR adjustment. However, it can be done separately if the probe meets all specifications except bandwidth. Adjust R13 for unity gain at 200 MHz.

1. Connect the signal generator to the test board and set it for 200 MHz and 300mV$_{p-p}$ (107 mV$_{rms}$).
2. Carefully connect the input of the probe to the test board in the position shown in the figure below (signal to + input).

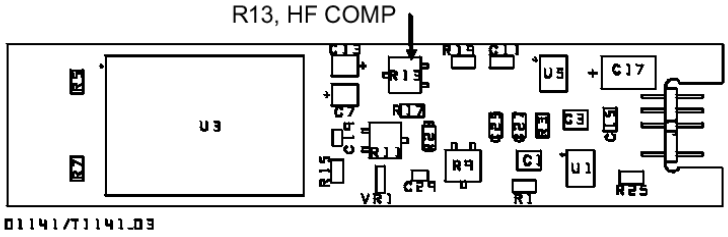
Figure 2-20



Signal to + input

3. Press AUTOSCALE, then measure the peak-to-peak voltage on channel 1 (Press SHIFT (blue), press V P-P, then press 1).
4. Adjust R13 (HF COMP) to make the signal amplitude measurement on the oscilloscope 300 mV$_{p-p}$, or as close to that as possible. Adjust slowly and press CLEAR DISPLAY frequently to restart averaging.

Figure 2-21



R13 Adjustment

The minimum allowable amplitude is 212 mV$_{p-p}$. Typical values will be between 275 and 325 mV$_{p-p}$. the probe needs repair if the minimum cannot be reached.

Probe Reassembly

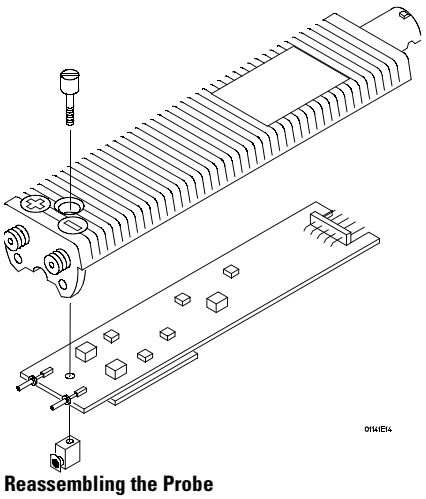
1. Disconnect the probe power cable at the rear panel of the 1142A
2. Remove the probe PC assembly from the test board. Be sure the probe input connectors remain attached to the probe.
3. Remove the grounding screw and ground block from the PC assembly.

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4 Assemble the PC assembly in the top cover.

The side of the PC assembly with the large hybrid is exposed when the assembly is in the top cover. The figure below shows how the top cover, PC board, and ground block fit together.

Figure 2-22



Reassembling the Probe

a Insert the input connectors first, and seat the cable end of the PC assembly over the pins at the rear of the cover.

b Position the ground block at the center-front of the PC assembly.

c Insert the grounding screw through the top cover and PC assembly and screw it into the ground block as shown.

5 Replace the bottom cover.

a Position the cable strain relief and with one hand, hold the cable and top together.

The flange on the strain relief has a notch that fits around a protrusion in the top cover.

CAUTION

Note where the two pins at the rear of the top cover enter the holes in the PC assembly. Position the cable wires away from these two areas. Otherwise, when the bottom cover is closed, part of it will pinch wires that are laying over these areas.

b Insert the pins at the front of the bottom cover into the holes at the front of the top cover.

c Close the two covers together and fasten with the probe clamp ring.

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Attenuator Adapter Adjustment

The following procedure should be used if it is necessary to adjust an attenuator adapter. Attenuator adapters have only characteristics; they do not have any specifications. An adapter will need adjustment only if one or more of the following occurs.

- If an adapter is to be used on a different 1141A probe that it was calibrated with last.
- If an adapter needs to be optimized to requirements for a special measurement.
- If an adapter is suspected of needing adjustment.

NOTE

Attenuator adapters should not be adjusted as part of routine maintenance. The design necessary to give the high CMRR and high impedance of the attenuators makes adjustment delicate.

Additionally, because of broadband noise, a spectrum analyzer should be used to verify adjustment quality.

Each attenuator contains two identical voltage dividers on a ceramic substrate. There are three adjustments. The low-frequency CMRR adjust the low-frequency balance between the two voltage dividers. The two high-frequency adjustments are electrically identical. Each adjusts the high-frequency compensation of one of the voltage dividers. To meet both pulse response and CMRR characteristics they are adjusted differently.

Briefly, the adjustment procedure is:

a Adjust the positive high-frequency response (+ HF RESP) for the best pulse response using a 3.5 kHz square wave.

b Adjust the negative high-frequency response (-HF RESP) and Low-frequency CMRR (LF CMRR) for best CMRR using a 3.5 kHz square wave.

The following equipment is required for this procedure. Procedures are based on the model or part number recommended.

Equipment Required

Equipment Required	Critical Specifications	Recommended Model/Part
Function Generator	3.5 kHz, 3 V to 16 V_{p-p}	33120A
Oscilloscope	100 MHz at 1 mV/div	54830B
Probe/Power Module	No substitute	1141A/1142A
Test Board	No substitute	01141-66504
Cable	BNC, 50 Ω 9-inch	10502A
Cable	BNC, 50 Ω 36-inch	10503A
Alignment tool	Flat blade (supplied accessory)	8710-1961/ Sprague-Goodman part, GTT-5G

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Adjustment Procedure

NOTE

The attenuator must be adjusted when installed on the 1141A probe with which it will be used. The specifications and characteristics will not be met if the attenuator adapter is adjusted with one differential probe then used with another.

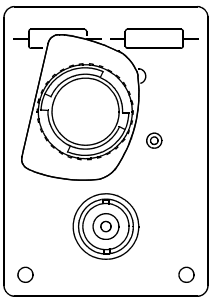
1. Remove the probe pins from the attenuator adapter and differential probe, then attach the adapter to the probe.
2. Set the 1142A front panel switches to Local and Zero offset.
3. Use the 9-inch BNC cable to connect the function generator to the test board. The short cable minimized ground-loop voltages.
4. Set up the function generator.
   - Square wave
   - 3.5 kHz
   - 3.0 Vp-p for 10x adapter and 16 V_{p-p} for a 100x adapter.
5. Use the long BNC cable to connect the Trig Out of the function generator to the EXT TRIG of the oscilloscope.
6. Set up the oscilloscope, then set the following parameters.

Menu	Selection	Setting
TIMEBASE	(time/div)	50 µs/div
CHAN 1	(sensitivity) (input R)	50 mV/div 50 Ω DC
TRIG	(mode) source level	trg'd EXT 1.00000 V
ACQUISITION	Sampling Mode Memory Depth Sample Rate Averaging # of avg	Real Time Automatic Automatic Enabled 32

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7 Connect the adapter/probe combination to the test board in the position shown in the figure below.

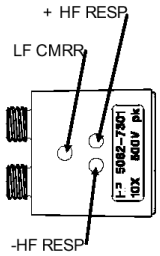
Figure 2-23



Signal to + input

8 Adjust the + HF RESP for best overall pulse response, the flattest pulse top. Use the figure below for adjust locations.

Figure 2-24



Adjustment Locations

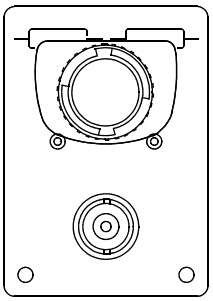
9 Change the function generator to 10 V_{p-p} (10x adapter adjustment only).

10 On the oscilloscope, press CHAN and set the sensitivity to 1 mV/div.

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11 Connect the adapter/probe combination to the test board in the position shown in the figure below (signal to both inputs).

Figure 2-25



Signal to both input

12 Alternately adjust the LF CMRR and then the -HF RESP for a minimum signal on the oscilloscope. Repeat the adjustments until the signal is optimized to a minimum. Each adjustment should be set to minimize the component of the signal it affects most. Some high-frequency components of the signal are not affected by either adjustment.

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3

Service

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Introduction

This section provides troubleshooting, service, and repair information for the 1141A Differential Probe and 1142A Probe Control and Power Module. The troubleshooting information is provided to isolate a faulty assembly. When a faulty assembly has been located, the disassembly/assembly procedures help direct replacement of the assembly.

WARNING

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

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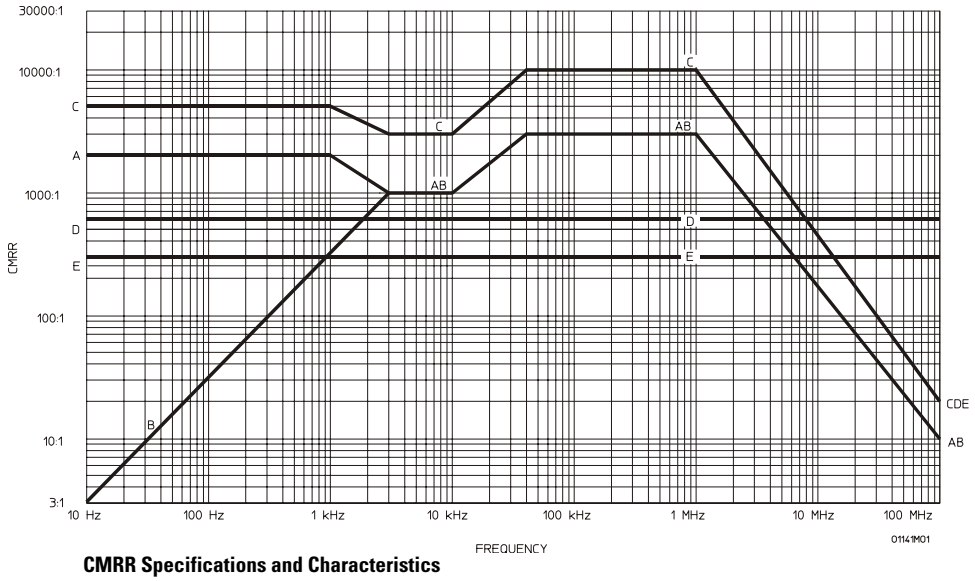
Performance Specifications and Characteristics

The following table gives performance specifications used to test the 1141A and 1142A. It also gives performance characteristics that are typical for the probe system.

Performance Specifications and Characteristics			
Parameter	**Probe alone**	**With 10x attenuator**	**With 100x attenuator**
SPECIFICATIONS			
Bandwidth (-3 dB, dc coupled)	dc to 200 MHz[1]		
Rise Time: (calculated)	1.75 ns		
Gain Accuracy	2.0%	4.0%	
CMRR	See the graphs in figure 3-1		
Maximum Input Voltage (see figure 3-2)	±200 V(dc + peak ac)	±500 V(dc + peak ac)	
Differential Input Range			
DC mode with no offset	± 300 mV peak	±3.0 V peak	±30 V peak
with DC Reject or appropriate offset	±20 Vdc, decreasing to ±300 mV at 30 Hz	±200 Vdc, decreasing to ±3.0 mV at 30 Hz	±500 Vdc, decreasing to ±30 mV at 30 Hz
Common-mode Operating Range			
dc	±20 Vdc	±200 Vdc	±500 Vdc
dc to 30 Hz	linear change	linear change	linear change
30 Hz to 200 MHz	±0.5 V	±5 V	±50 V
dc Offset Range	±20 V	±200 V	±500 V
Input Impedance Resistance	1 MΩ	9 MΩ	10 MΩ
Capacitance	7 pF	3.5 pF	2 pF
ac Low-freq. Response (-3dB)	15 Hz	1.5 Hz	1.5 Hz
dc Reject Response	5 Hz, 0.5 Hz, or 0.05 Hz (selectable irrespective of attenuator)		
Output Impedance	50 Ω		
Thermal drift	≤ 50 µVdc/°C		
Displayed noises	≤ 50 μV_{rms}		
Overload Recovery	< 1 ms from overdrive that is less than the common mode range		
Note: 1. For maximum signal fidelity above 100 MHz, limit the probe input (without attenuators to ≤ 300 mV peak-to-peak.			

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Figure 3-1



CMRR Specifications and Characteristics

Legend

A. CMRR specification for probe with no input adapters.

B. Low-frequency CMRR specification for probe with the ac adapter.

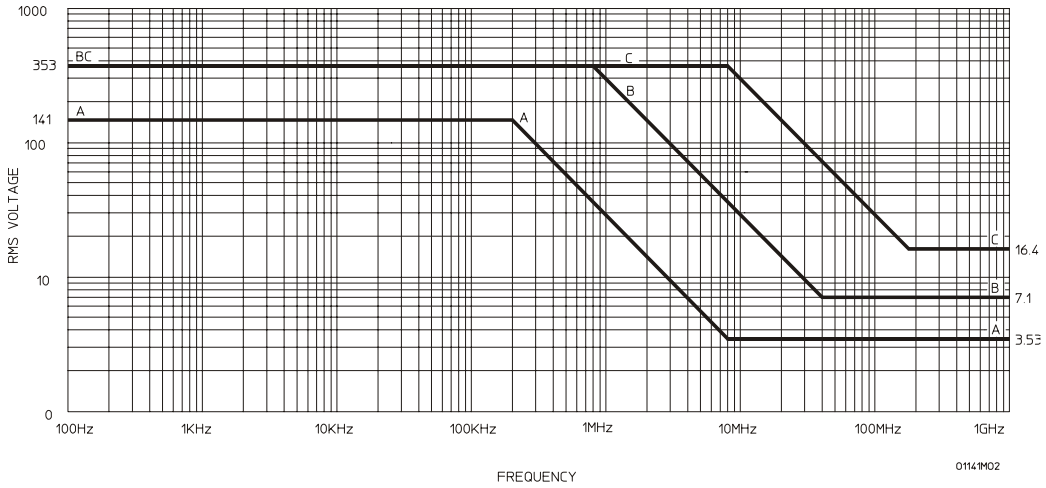
C. Typical CMRR characteristic for differential probe with no input adapters

D. Typical CMRR characteristic for differential probe with 100x attenuator adapter at input.

E. Typical CMRR characteristic for differential probe with 100x attenuator adapter at input.

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Figure 3-2



Maximum Input Voltage vs. Frequency

Legend

A. Input voltage limits for probe alone.

B. Input voltage limits for 10x adapter.

C. Input voltage limits for 100x adapter.

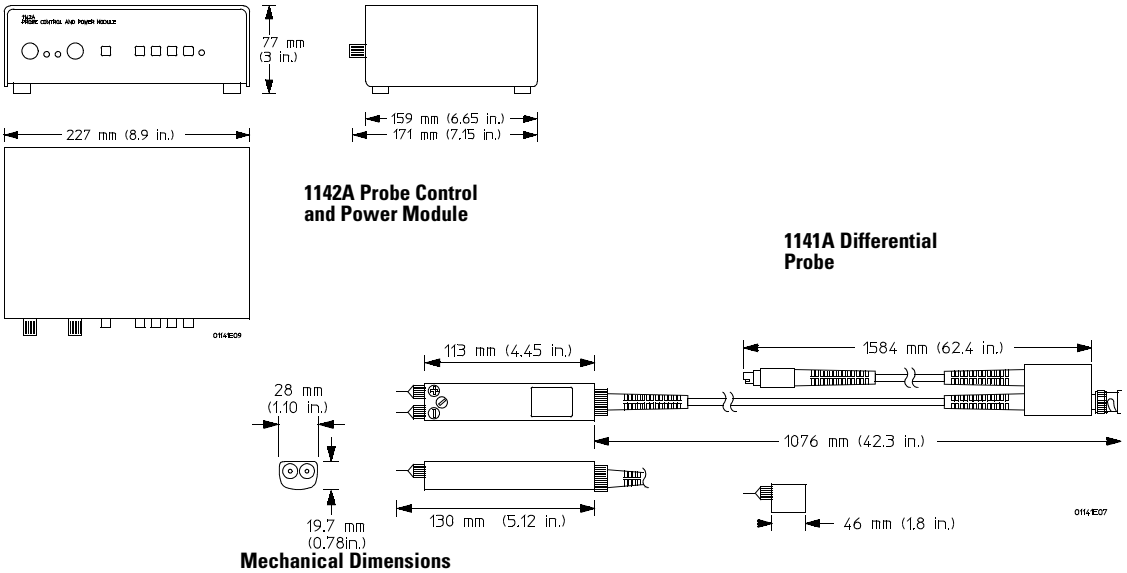
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General Characteristics

The following characteristics apply to the 1141A Differential Probe with the 1142A Probe Control and Power Module.

Environmental Conditions		
	Operating	**Non-operating**
Temperature	0°C to +55 C° (32°F to +131°F)	-40°C to +70°C (-40°F to +158°F)
Humidity	up to 95% relative humidity (non-condensing) at +40°C (+104°F)	up to 90% relative humidity at +65°C (+149°F)
Altitude	up to 4,600 meters (15,000 ft)	up to 15,300 meters (50,000 ft)
Vibration	Random vibration 5 to 500 Hz, 10 minutes per axis, 0.3grms.	Random vibration 5 to 500 Hz, 10 min. per axis, 2.41 grams. Resonant search 5 to 500 Hz swept sine, 1Octave/min. sweep rate, (0.75g), 5 min. resonant dwell at 4 resonances per axis.
Power Requirements	Voltage: 90 to 132/198 to 264 Vac, 47 to 440 Hz Power: 25 VA maximum	
Weight	Net: approximately 1.8 kg (4.0 lb.) Shipping: approximately 2.7 kg (6.0 lb.)	
Dimensions	Refer to the outline drawings below.	

Figure 3-3



Mechanical Dimensions

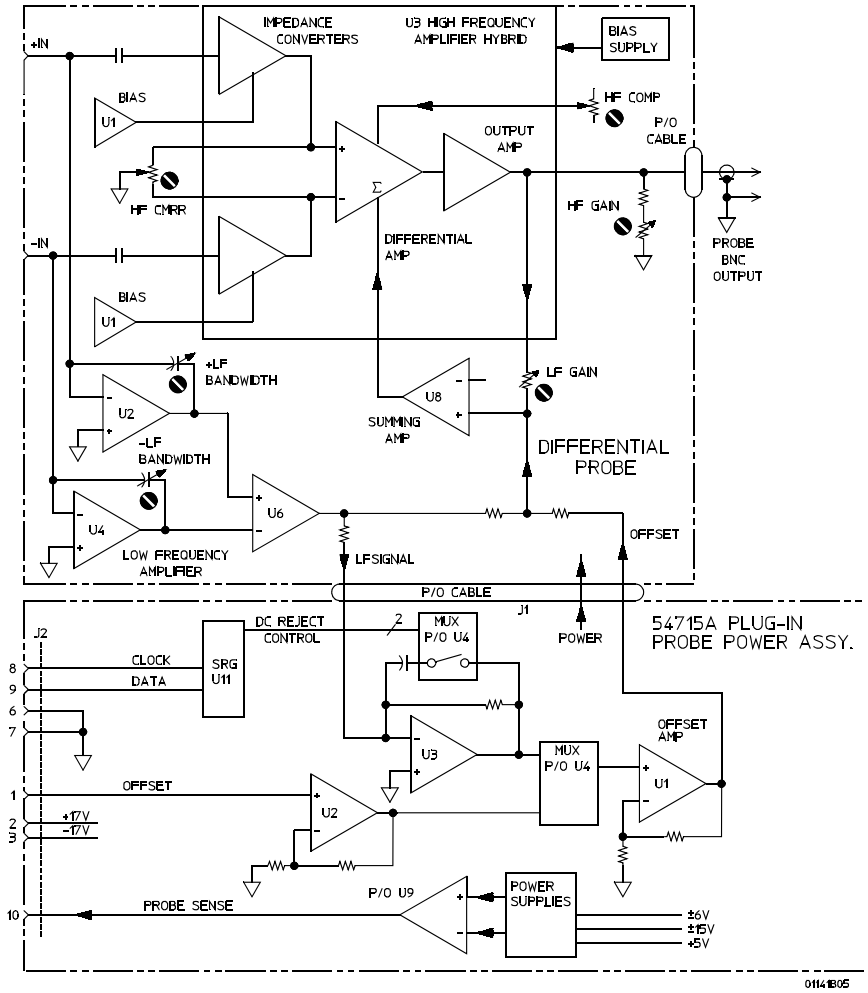
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Theory of Operation

The following discussion covers block-level theory for the 1141A/1142A differential probe system. Refer to the block diagram below.

The differential probe system consists of two units, the 1141A Differential Probe with its accessories and the 1142A Probe Control and Power Module. For purposes of the following discussion, these will be called the probe and the control module respectively.

Figure 3-4



Differential Probe System Block Diagram

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Differential Probe

The probe contains a two-path differential amplifier with unity gain. It is implemented on a double-sided surface-mount PC board with the high-frequency path on one side and the low-frequency path on the other. The two paths are split directly after the differential input connections.

High-Frequency Path

The positive and negative inputs are ac-coupled at 33 Hz into identical impedance converters. The HF CMRR adjustment balances the gain at the outputs of the impedance converters. The impedance feed a semi-custom differential amplifier. An additional negative input to the differential amplifier brings in the sum of the low-frequency and feedback signals. The FREQ COMP adjustment provides variable high-frequency peaking of the differential amp. The output amp provides two signals. A feedback signal is summed with the low-frequency signals and the output signal is the final output of the probe. Overall probe gain is set by the HIGH FREQ GAIN adjustment.

The entire signal portion of the high-frequency path is implemented on a hybrid IC. Support circuitry includes bias for the impedance converters and a bias supply for current sources on the hybrid.

Low-Frequency Path

The bandwidth of the low-frequency path is approximately 75 KHz. The positive and negative inputs are dc coupled into identical inverting op-amps with gain of 0.5. They provide a precision 1 M Ω input impedance for the probe. The LOW FREQ BANDWIDTH adjustments match the gain and phase of the low-frequency path to that of the feedback from the probe output. One of the two adjustments is set to match the properties of the feedback and the other is to match the two low-frequency paths. These adjustments affect the CMRR quality of the probe. The inputs of the inverting op-amps include protection for ESD and over-voltage conditions.

The inverting op-amps feed a precision differential amplifier with unity gain and a single-ended output. The output is fed to the summing amp and to the control module for use in the dc reject circuit.

Summing Amp

The summing amp combines the feedback signal, the low-frequency signal, and the offset signal. The LOW FREQ GAIN adjustment matches the gain of the low-frequency path to the overall gain.

Control and Power Module

The control and power module provides offset functions, local and remote control, and power to the probe system.

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Offset Functions

There are two offset functions developed in the control module: variable offset and dc reject. A variable offset voltage with coarse and fine adjustments can be selected by the front panel controls. The offset level is buffered by U8 and selected by multiplexer U3 as the input to offset amp U7. The output of the offset amp is summed with the low-frequency signal and feedback which gives dc coupling in the probe. Front panel screwdriver adjustment Offset Null zeros the dc output from the probe when the dc input and offset are zero.

For dc Reject, an output from the low-frequency amplifier in the probe (LFSIG) is used to develop a voltage used to null the dc component of the input signal. LFSIG is an input to U6, an inverting amplifier and low-pass filter. Multiplexer U3 selects one of three capacitors to set a roll-off frequency of 0.05, 0.5, or 5 Hz. The output of U6 is selected, again by U3, as the input to the offset amp. When the output of the offset amp is summed into the low frequency path, the result is cancellation of the dc component of the input signal. Front panel screwdriver adjustment DC Reject Gain adjusts the gain of the dc reject circuit.

Local and Remote Control

The front panel switch controls the dc reject and offset functions. It also selects remote operation, which allows control through the rear panel remote input connector.

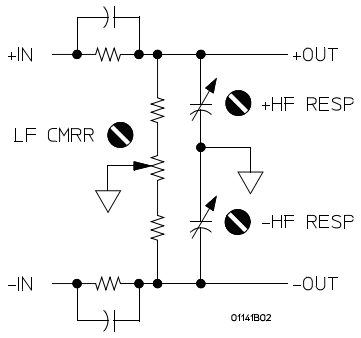
Power Supply

The supply provides ±6 V and ±15 V for the probe and analog control circuitry as well as +5 V for the digital control circuitry.

Attenuator Adapters

The 10x and 100x Attenuator Adapter are similar. A ceramic substrate carries two attenuators, one for each input polarity. A variable resistor adjusts the low-frequency balance (LF CMRR) between the two attenuators. The high-frequency adjustments are the same for each attenuator. Each attenuator is adjusted differently. One attenuator is adjusted for optimum pulse response and the other for best high-frequency CMRR.

Figure 3-5



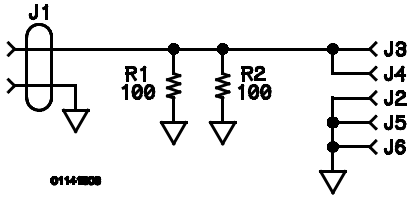
Attenuator Adapter, Simplified Schematic

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Test Board

The test board is a device for conveniently connecting test signals to the differential probe. The probe can be connected to the board with the signal to the positive, negative, or both inputs.

Figure 3-6



Test Board Schematic

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Service Policy

For parts of the 1141A/1142A probe system that are complex, the service policy is for assembly-level repair. For parts of the system with simple circuitry, the service policy is component-level repair.

The service policy for the 1141A Differential Probe is assembly-level repair. Assemblies include the PC assembly and cable. The PC assembly is an “exchange assembly.” A repaired and tested assembly is shipped upon receipt of the defective assembly.

The attenuator and ac coupling adapters are shipped as complete assemblies.

The service policy for the 1142A Probe Control and Power Module is component-level repair.

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Troubleshooting

Use the following paragraphs to assist in troubleshooting problems with the 1141A/1142A Differential Probe.

Probe Troubleshooting

To troubleshoot the probe:

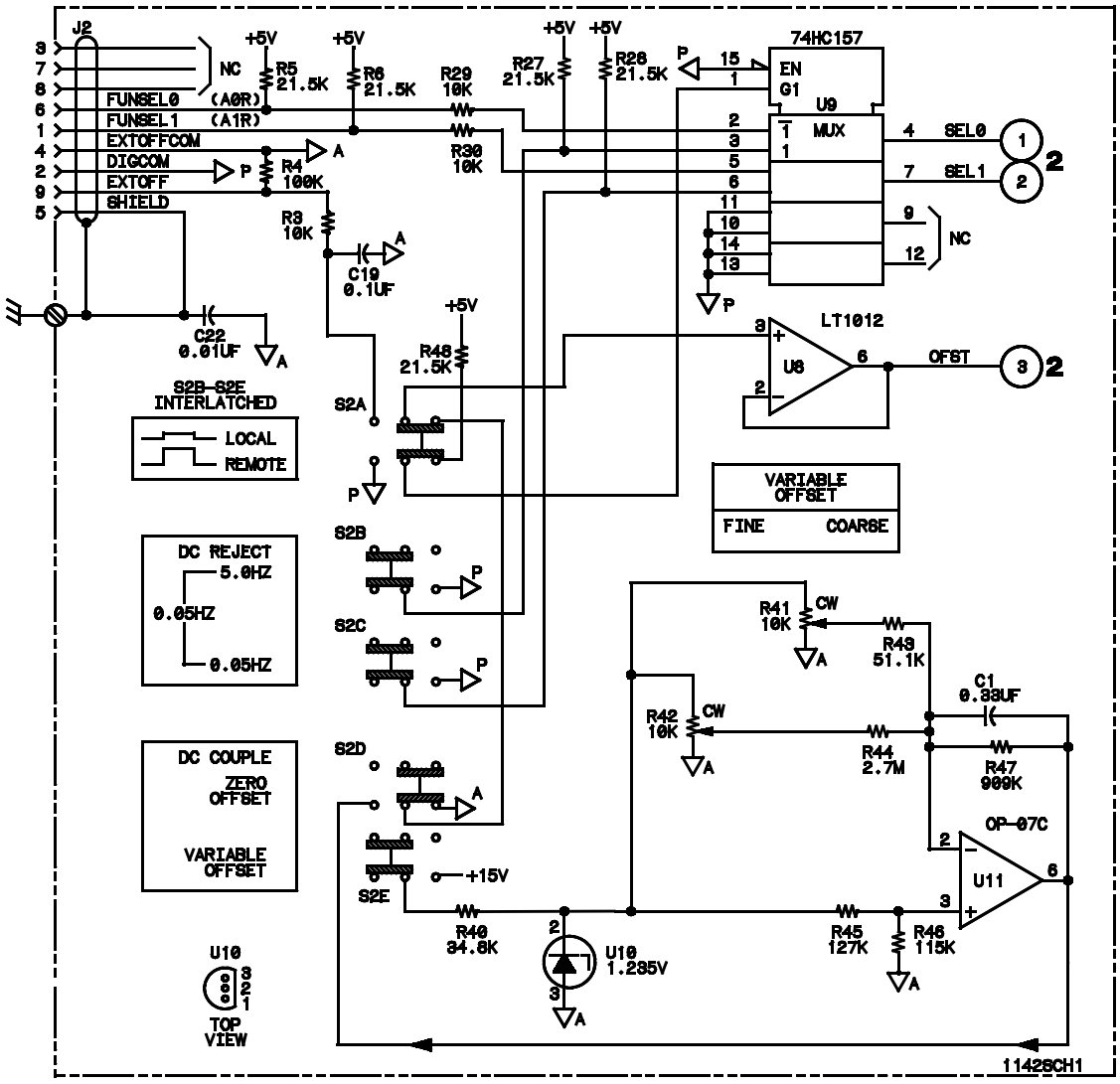
1. Apply a known signal to the input of the probe.
2. Check for an identical output at the output coax to the cable. This connection is the one soldered to the PC board. If the probe output cable is not terminated, or the coax is open, the output signal will be about twice the amplitude of the input signal.
3. If the signal is incorrect, check the power supply voltages from the 1142A Probe Control and Power Module. Use the cable diagram on the next page.
4. Troubleshoot the cable with an ohmmeter. Use the cable diagram on the next page.

Probe Control and Power Module Troubleshooting

The circuitry consists of simple power supplies, operational amplifiers, and TTL. Use conventional troubleshooting techniques. A complete parts list, component locator, and schematics are provided later in this chapter.

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Figure 3-7



1142A Probe Control and Power Module

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Removing and Replacing Assemblies

This section contains procedures for the removal and replacement of major assemblies.

CAUTION Never remove or install any assembly with the instrument power ON. Component damage can occur.

Differential Probe

Use the following procedure to remove and replace the amplifier PC board in the differential probe.

CAUTION ELECTROSTATIC DISCHARGE can damage electronic components. Use grounded wrist straps and mats when servicing the probe.

CAUTION Handle the differential probe carefully once it has been disassembled. If unsupported, the weight of the cable can put strain on the PC board.

Disassemble Probe

1. Remove the probe tip caps and probe tips.
2. Loosen the probe clamp ring at the cable end of the probe (1/4 turn counter-clockwise) and slide it down the cable.
3. Remove the bottom cover.
   a. At the cable end of the probe, separate the covers about one centimeter (1/2 inch).
   b. Slide the bottom cover toward the cable end of the probe until the locator pins at the probe input clear the holes. Then, remove the cover.
   Note the way the cable strain relief is keyed and held at the rear of the top cover.
4. Remove the probe top cover.
   The ground screw passes through the top cover and PC board and screws into the ground block.
   a. Remove the ground screw on the top of the probe.
   At the cable end, the PC board fits over the pins in the top cover.
   b. Lift the board off of the pins and slide it in the direction of the cable until the input connectors clear the front of the probe.
5. Un-solder the two connections where the coaxial output cable connects to the PC board.
6. Disconnect the cable connector from the probe PC board.

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Reassemble Probe

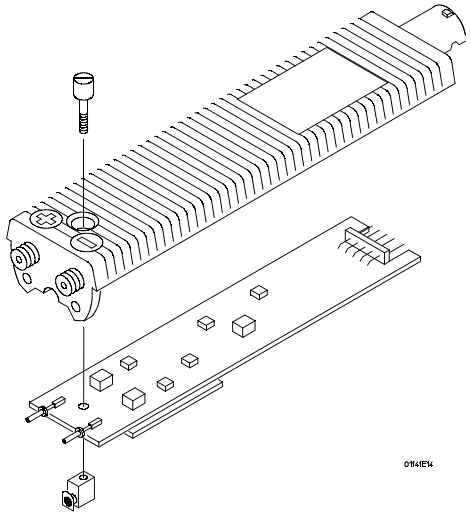
The ground screw passes through the top cover and PC board and screws into the ground block.

1. If replacing the PC board, remove the input connectors from the old board and put them on the new one.
2. If replacing the cable, note the orientation of the probe clamp ring on the old cable, remove the ring and put it on the new cable.
3. Connect the cable connector to the PC board.
4. Solder the two connections of the coaxial cable to the PC board.

   On a new probe cable, the conductors of the coaxial cable are connected by a heavy single wire. Cut the heavy wire so it matches the wire on the cable that was removed.
5. Assemble the PC assembly into the top cover.

   The large hybrid is exposed when the assembly is in the top cover. The figure on the below shows the sequence of the ground screw, top cover, PC board, and ground block.

Figure 3-8



Reassembling the Probe

   a. Insert the input connectors first, and seat the cable end of the PC assembly over the pins at the rear of the cover.
   b. Position the ground block at the front of the PC assembly.
   c. Insert the grounding screw through the top cover and screw it into the ground block as shown in the figure above.
6. Replace the bottom cover.
   a. Position the cable strain relief and with one hand, hold the cable and top cover together.

      The flange on the strain relief has a notch that fits over a protrusion in the top cover.

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CAUTION

Note where the two pins at the rear of the top cover enter the holes in the PC assembly. Position the cable wires away from these two areas. When the bottom cover is closed, part of it will pinch wires that are laying over these areas.

b Insert the pins at the front of the bottom cover into the holes at the front of the top cover.

c Close the covers together and fasten with the probe clamp ring. If the covers do not fit together tightly and easily, check for pinched wires (see caution above).

Probe Adapters

Use the following procedure to disassemble the probe adapters. The adapter housing consists of two plastic parts, one of which slides into the other. The parts are held together by the spring effect of two plastic tabs on the inner part.

Mechanically, the ac adapter is about the same as the 10x and 100x attenuator adapters. The attenuator adapters have an extra ground connector which connects the substrate ground to the thumbwheel screw and plating inside the housing.

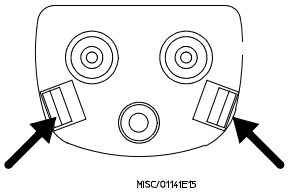
Disassemble Adapter

1 Remove the probe tip caps and probe tips from the adapter input.

2 Hold the adapter in one hand taking care not to block the output end of the adapter (the end which attaches to the probe).

3 Note the view of the input end of the adapter in the figure below. The arrows indicate the holding tabs.

Figure 3-9



Disassembling Adapters

4 With the thumb and forefinger, squeeze the tabs together, as indicated by the arrows. Simultaneously, push the tabs into the outer housing so the inner housing begins to slide out.

5 While holding the outer housing, push back against the thumbwheel until the inner housing can be grasped and removed.

Reassemble Adapter

Reassembling the adapter is slightly harder because you have to align the connector pins and thumbwheel screw, while sliding the inner housing and outer housing together.

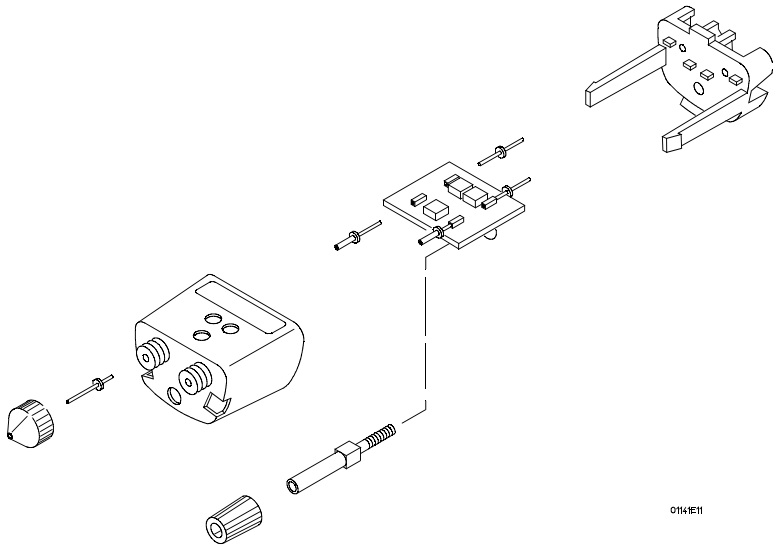
1 Be sure the input connectors and output pins are present and seated on the substrate or PC board.

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2 Combine the thumbwheel screw and thumbwheel and insert them into the hole in the outer housing.

3 Insert the substrate/board into the outer housing. Slip the attenuator ground (attenuator adapters only) over the thumbwheel screw and seat the input connectors in the proper holes in the housing.

Figure 3-10



Reassembling the Adapter

Do not force reassembly of the adapter. The housing halves will slide together with moderate friction.

4 Align the inner housing tabs with the grooves in the side of the outer housing and slide the two partly together.

While seating the thumbwheel screw and pins, it will help to hold the assembly vertically, with the input end of the adapter down. This will allow the assemblies to sit vertically and more easily align with the holes in the inner housing.

5 Seat the thumbwheel screw first, then the output pins, into the appropriate holes in the inner housing.

6 Once the two housings are nearly together, press them together firmly until the tabs click into place.

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Probe Control and Power Module

Use the following procedure to disassemble the probe control and power module.

WARNING Hazardous voltages exist on the power supply. To avoid electrical shock, adhere closely to the following procedures.

1. Remove the power cord.
2. Remove four flathead screws and remove the top cover.

WARNING Be sure to reconnect the safety ground when reassembling the instrument.

3. Unplug the safety ground from the tab on the rear panel of the instrument.
4. Note the orientation of the knobs. Remove the two knobs.
5. On the bottom of the instrument, remove the 5mm screw that fastens the transformer support.
6. Remove the following pan-head screws.
   - Three directly on the PC board.
   - Two on the ac input connector.
   - Two on the heatsink.
7. Remove the PC board. Slide it slightly forward so parts will clear the rear panel, then lift the rear of the board out while sliding it backwards.
8. Remove the two heatsink spacers from the standoffs that were directly under the heatsink.
9. Reverse the procedure to reassemble the control and power supply.

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Replaceable Parts

This section contains information for ordering parts. Service support for the 1141A Differential Probe is to the assembly level. Service support for the adapters is as complete assemblies, except for the probe tip caps and the probe tips. Service support for the 1142A Probe Control and Power Module is to the component level.

Parts List

The replaceable parts lists include all parts relevant to the applicable service levels. The information given for each part consists of the following:

- Reference designator
- Part number
- Total quantity (Qty) in instrument or on assembly. The total quantity is given once and at the first appearance of the part number in the list.
- Description of part
- Typical manufacturer of part in a five-digit code.

Ordering Information

To order a part in the material part list, quote the part number, indicate the quantity desired, and address the order to the nearest Agilent Technologies Sales Office.

To order a part not listed in the material list, include the instrument part number, instrument serial number, a description of the part (including its function), and the number of parts required. Address the order to the nearest Agilent Technologies Sales Office.

Direct Mail Order System

Within the USA, Agilent Technologies can supply parts through a direct mail order system. There are several advantages to this system:

- Direct ordering and shipment from the Agilent Technologies parts center in California, USA.
- No maximum or minimum on any mail order (there is a minimum amount for parts ordered through a local Agilent Technologies Sale Office when the orders require billing and invoicing).
- Prepaid transportation (there is a small handling charge for each order).
- No invoices.

In order for Agilent Technologies to provide these advantages, a check or money order must accompany each order.

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Mail order forms and specific ordering information are available through your local Agilent Technologies Sales Office. Addresses and telephone numbers are located in a separate document shipped with the manuals.

Manufacturers' Codes

A list of manufacturers' codes is given the table below. The codes are given for parts in the parts lists. The table gives the manufacturer and address for each code.

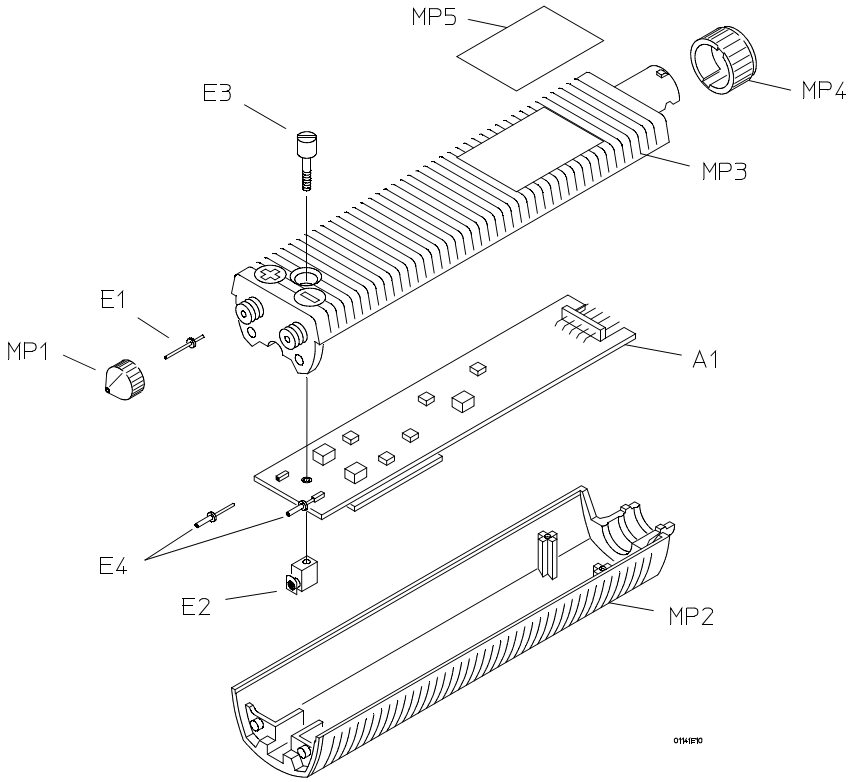
Manufacturers' Code List

Mfr. No.	Name	Address
00000	Any satisfactory supplier	
06665	Precision Monolithics Inc.	Santa Clara, CA 95050
24546	Corning Glass Works (Bradford)	Bradford, PA 16701
27014	National Semiconductor Corp	Palo Alto, CA 94304
28480	Agilent Technologies Corporate Hq	Palo Alto, CA 94304
32997	Bourns Inc.	Riverside, CA 92507

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Exploded View

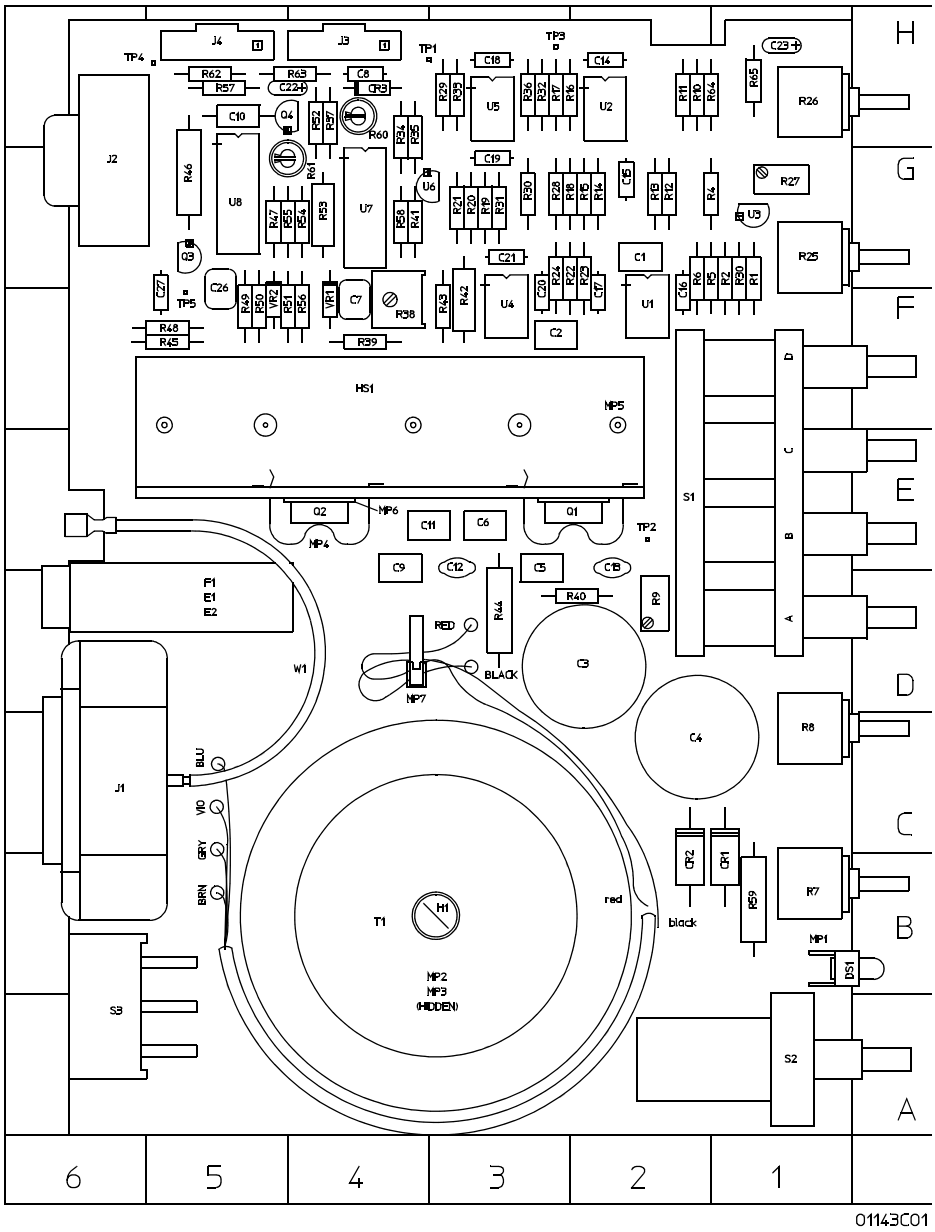
Figure 3-11



1141A Differential Probe Parts

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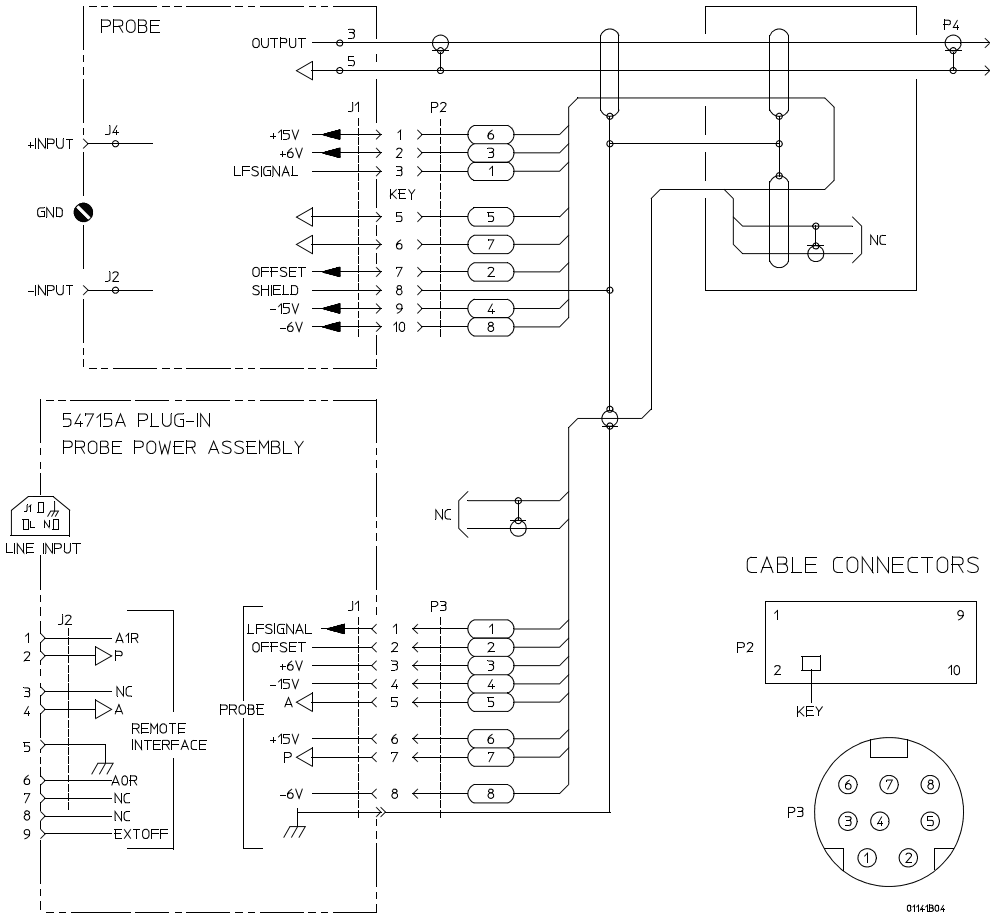
Figure 3-12



Power and Control Board Component Locator

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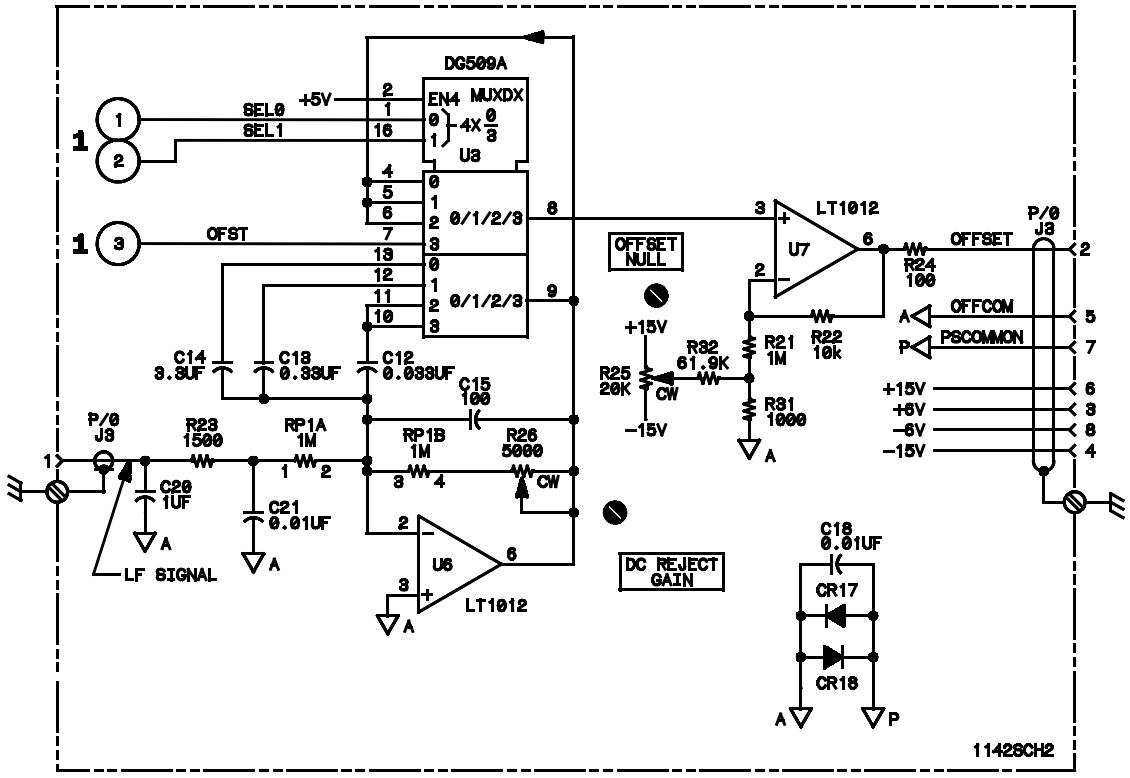
Figure 3-13



Cabling Diagram

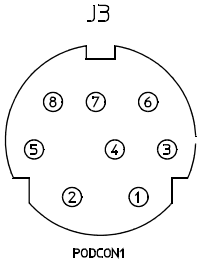
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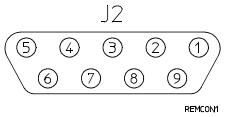
Figure 3-14



IC Connectors not Shown

Supply	Pin No.	IC Group
+15	14	U3
-15	3	
GND	15	
+15	7	U6-8, 11
-15	4	
NC	1, 5, 8	
+5	16	U9
GND	8	

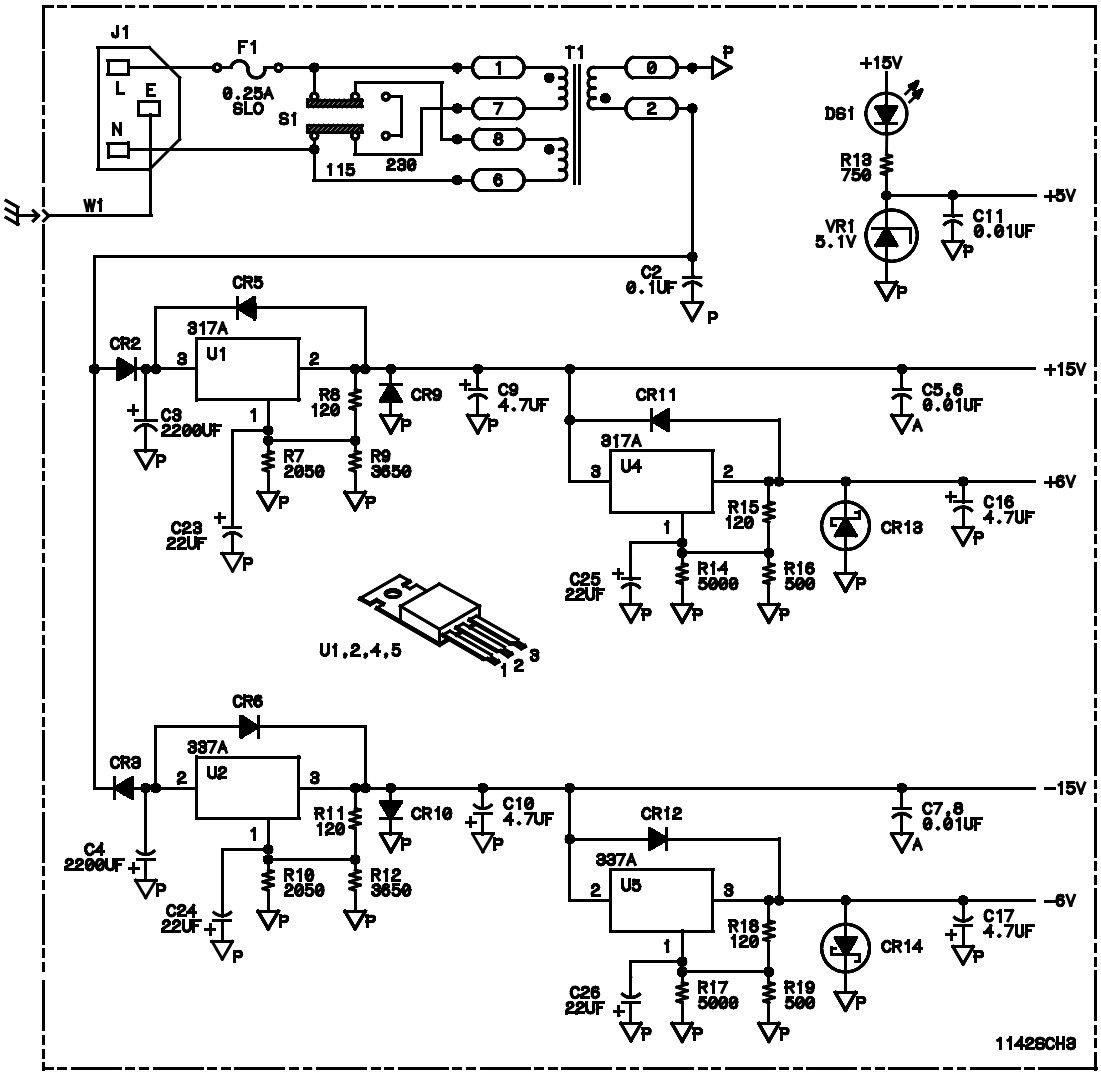




1142A Probe Control and Power Module

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Figure 3-15



1142A Probe Control and Power Module

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1141A and 1142A Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
			1141A Differential Probe		
A1	01141-66503	1	PC ASSEMBLY-DIFFERENTIAL PROBE	28480	01141-66501
E1	01141-26102	2	PROBING PIN	28480	01141-26102
E2	01141-22301	1	GROUND BLACK	28480	01141-22301
E3	01141-22401	1	GROUND SCREW	28480	01141-22401
MP1	01141-24102	2	CAP-PROBING PIN	28480	01141-24101
MP2	01141-44702	1	PROBE BOTTOM COVER	28480	01141-44701
MP3	01141-44102	1	PROBE TOP COVER	28480	01141-44101
MP4	01141-22502	1	PROBE POS CLAMP RING	28480	01141-22501
MP5	01141-94307	1	DIFFERENTIAL PROBE LABEL	28480	01141-94301
W1	01141-61603	1	PROBE CABLE ASSEMBLY	28480	01141-61601
			10X Attenuator Adapter		
	01141-26102	2	PROBING PIN	28480	01141-26102
	01141-24102	2	CAP-PROBING PIN	28480	01141-24101
			100X Attenuator Adapter		
	01141-26102	2	PROBING PIN	28480	01141-26102
	01141-24102	2	CAP-PROBING PIN	28480	01141-24101
			AC Adapter		
	01141-26102	2	PROBING PIN	28480	01141-26102
	01141-24102	2	CAP-PROBING PIN	28480	01141-24101

1142A PROBE CONTROL AND POWER MODULE

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1141A and 1142A Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
A1	01142-66501	1	PC ASSEMBLY-POWER AND CONTROL	28480	01142-66501
H1	0515-0374	7	SCREW-MACHINE M3 10mm-LG	00000	ORDER BY DESP.
H2	0515-1031	4	SCREW-MACHINE M3 6mm-LG 90-DEG-FLH-HD	00000	ORDER BY DESP.
H3	0515-1579	1	SCREW-MACHINE M5 18mm-LG	00000	ORDER BY DESP.
MP1	01142-47702	1	BOTTOM CHASSIS	28480	01142-47701
MP2	01142-44101	1	TOP CHASSIS	28480	01142-44101
MP3	01142-24701	2	SPACER-HEAT SINK	28480	01142-24701
MP4	0370-1097	2	KNOB-POINTER	28480	0340-1097
MP5	0403-1012	4	FOOT	28480	0403-0727
MP6	5041-0234	5	KEYCAP	28480	5041-0234
W1	8120-1521	1	POWER CORD 18-AWG 3-COND 90-IN-LG (US/ Canada only)	28480	8120-1521

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Power Supply Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
			Prefix the reference designators with A1		
C1	0160-6190	2	CAPACITOR-FXD 0.33UF ±10% 50VDC	28480	0160-6190
C2	0160-5474	1	CAPACITOR-FXD 0.1UF ±5% 100VDC MET-POLY	28480	0160-5474
C3	0180-3298	2	CAPACITOR-FXD 2200UF+30-10% 50VDC AL	28480	0180-3298
C4	0180-3298		CAPACITOR-FXD 2200UF+30-10% 50VDC AL	28480	0180-3298
C5	0160-6500	4	CAPACITOR-FXD 0.01UF ±10% 100VDC CER	28480	0160-6500
C6	0160-6500		CAPACITOR-FXD 0.01UF ±10% 100VDC CER	28480	0160-6500
C7	0160-6500		CAPACITOR-FXD 0.01UF ±10% 100VDC CER	28480	0160-6500
C8	0160-6500		CAPACITOR-FXD 0.01UF ±10% 100VDC CER	28480	0160-6500
C9	0180-3845	4	CAPACITOR-FXD 4.7UF ±10% 35VDC TA	28480	0180-3845
C10	0180-3845		CAPACITOR-FXD 4.7UF ±10% 35VDC TA	28480	0180-3845
C11			NOT ASSIGNED		
C12	0160-5581	1	CAPACITOR-FXD 0.033UF ±10% 63VDC	28480	0160-5581
C13	0160-6190		CAPACITOR-FXD 0.33UF ±10% 50VDC	28480	0160-6190
C14	0160-7060	1	CAPACITOR-FXD 3.3UF ±10% 63VDC	28480	0160-7060
C15	0160-4801	1	CAPACITOR-FXD 100PF ±5% 100VDC CER	28480	0160-4801
C16	0180-3845		CAPACITOR-FXD 4.7UF ±10% 35VDC TA	28480	0180-3845
C17	0180-3845		CAPACITOR-FXD 3.3UF ±10% 63VDC	28480	0180-3845
C18			NOT ASSIGNED		
C19	0160-5471	1	CAPACITOR-FXD 0.1UF ±5% 50VDC MET-POLY	28480	0160-5471
C20	0160-5469	1	CAPACITOR-FXD 1UF ±10% 50VDC MET-POLY	28480	0160-5469
C21-22			NOT ASSIGNED		
C23	0180-3784	4	CAPACITOR-FXD 22UF ±20% 25VDC TA	28480	0180-3784
C24	0180-3784		CAPACITOR-FXD 22UF ±20% 25VDC TA	28480	0180-3784
C25	0180-3784		CAPACITOR-FXD 22UF ±20% 25VDC TA	28480	0180-3784
C26	0180-3784		CAPACITOR-FXD 22UF ±20% 25VDC TA	28480	0180-3784

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Power Supply Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
CR1			NOT ASSIGNED		
CR2	1901-1087	2	DIODE-PWR RECT 100V 3A	04713	MR501
CR3	1901-1087		DIODE-PWR RECT 100V 3A	04713	MR501
CR4			NOT ASSIGNED		
CR5	1901-0731	8	DIODE-PWR RECT 400V 1A	28480	1901-0731
CR6	1901-0731	8	DIODE-PWR RECT 400V 1A	28480	1901-0731
CR7-8			NOT ASSIGNED		
CR9	1901-0731	8	DIODE-PWR RECT 400V 1A	28480	1901-0731
CR10	1901-0731	8	DIODE-PWR RECT 400V 1A	28480	1901-0731
CR11	1901-0731	8	DIODE-PWR RECT 400V 1A	28480	1901-0731
CR12	1901-0731	8	DIODE-PWR RECT 400V 1A	28480	1901-0731
CR13	1901-0734	2	DIODE-PWR RECT 1N5818 30V 1A	04713	IN5818
CR14	1901-0734	2	DIODE-PWR RECT 1N5818 30V 1A	04713	IN5818
CR15-16			NOT ASSIGNED		
CR17	1901-0731		DIODE-PWR RECT 400V 1A	28480	1901-0731
CR18	1901-0731		DIODE-PWR RECT 400V 1A	28480	1901-0731
DS1	1990-0521	1	LED-LAMP LUM-INT=2.2MCD IF=50MA-MAX	24840	5082-4955
E1	2110-0642	1	FUSEHOLDER 6.3A 250A	28480	2110-0642
E2	2110-0565	1	FUSEHOLDER CAP	28480	2110-0565
F1	2110-0201	1	FUSE 0.25A 250V TD	28480	2110-0201
H1	0515-1579	1	SCREW-MACHINE M5 18mm-LG	28480	0515-1579
HS1	01142-21101	1	HEAT SINK	28480	01142-21101

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Power Supply Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
J1	1252-4731	1	CONNECTOR-AC PWR	28480	1251-4743
J2	1252-1487	1	CONN-RECT D-SUBMIN 9-CKT (remote)	28480	1252-1487
J3	1252-3935	1	CONNECTOR-ROUND 8-CKT (probe)	28480	1252-3134
MP1	1400-1604	1	LED MOUNT	28480	1400-1604
MP2	1205-0732	4	SPRING CLIP	28480	1205-0732
MP3	0361-0685	3	RIVET-BLIND DR-PIN RNDH 0.125DIA	28480	0361-0685
MP4	0340-1211	3	INSULATOR-THERMAL	28480	0340-1211
MP5-6			NOT ASSIGNED		
MP7	1400-0249	1	CABLE TIE 0.062-0.625-DIA 0.091-WD NYL	16956	08-465/GRY
MP8	01142-24702	1	TRANSFORMER SUPPORT	28480	01142-24702
MP9	01142-28801	1	WASHER-TRANSFORMER SUPPORT	28480	01142-28801
R1-2			NOT ASSIGNED		
R3	0757-0442	4	RESISTOR 10K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1002-F
R4	0757-0465	1	RESISTOR 100K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1003-F
R5	0757-0199	5	RESISTOR 21.5K 1% 0.125W TC=0±100	24546	CT4-1/8-TO-2152-F
R6	0757-0199		RESISTOR 21.5K 1% 0.125W TC=0±100	24546	CT4-1/8-TO-2152-F
R7	0698-4431	2	RESISTOR 2.05K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-2052-F
R8	0699-1203	4	RESISTOR 120.0 1% 0.125W TF TC=0±25	28480	0699-1203
R9	0757-0434	2	RESISTOR 3.65K 1% 0.125W TF TC=±100	24546	CT4-1/8-TO-3651-F
R10	0698-4431		RESISTOR 2.05K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-2052-F
R11	0699-1203		RESISTOR 120.0 1% 0.125W TF TC=0±25	28480	0699-1203
R12	0757-0434		RESISTOR 3.65K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-3651-F
R13	0757-0420	1	RESISTOR 750 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-751-F
R14	0698-4002	2	RESISTOR 5K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-5001-F
R15	0699-1203		RESISTOR 120.0 1% 0.125W TF TC=0±25	28480	0699-1203

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Power Supply Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
R16	0698-6317	2	RESISTOR 500 0.1% 0.125W TF TC=0±25	28480	0698-6317
R17	0698-4002		RESISTOR 5K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-5001-F
R18	0699-1203		RESISTOR 120.0 1% 0.125W TF TC=0±25	28480	0699-1203
R19	0698-6317		RESISTOR 500 0.1% 0.125W TF TC=0±25	28480	0698-6317
R20			NOT ASSIGNED		
R21	0698-8827	1	RESISTOR 1M 1% 0.125W TF TC=0±100	28480	0698-8827
R22	0757-0442		RESISTOR 10K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1002-F
R23	0757-0427	1	RESISTOR 1.5K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1501-F
R24	0757-0401	1	RESISTOR 100 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-101-F
R25	2100-3161	1	RESISTOR-TRMR 20K 10% TKF SIDE-ADJ	32997	3006P-1-203
R26	2100-3056	1	RESISTOR-TRMR 5K 10% TKF SIDE-ADJ 17-TRN	32997	3006P-1-502
R27	0757-0199		RESISTOR 21.5K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-2152-F
R28	0757-0199		RESISTOR 21.5K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-2152-F
R29	0757-0442		RESISTOR 10K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1002-F
R30	0757-0442		RESISTOR 10K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1002-F
R30	0757-0280	1	RESISTOR 1K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1001-F
R32	0757-0460	1	RESISTOR 61.9K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-6192-F
R33-39			NOT ASSIGNED		
R40	0757-0123	1	RESISTOR 34.8K 1% 0.125W TF TC=0±100	28480	0757-0123
R41	2100-4250	2	RESISTOR-VAR 10K 20%	28480	2100-4250
R42	2100-4250		RESISTOR-VAR 10K 20%	28480	2100-4250
R43	0757-0458	1	RESISTOR 51.1K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-5112-F
R44	0683-2755	1	RESISTOR 2.7M 1% 0.25W TF TC=0±100	28480	0683-2755
R45	0698-4517	1	RESISTOR 127K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1273-F
R46	0698-3271	1	RESISTOR 115K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-1153-F
R47	0698-8961	1	RESISTOR 909K 1% 0.125W TF TC=0±100	28480	0698-8961
R48	0757-0199		RESISTOR 21.5K 1% 0.125W TF TC=0±100	24546	CT4-1/8-TO-2152-F

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Power Supply Replaceable Parts					
Ref. Des.	**Part Number**	**Qty**	**Description**	**Mfr. Code**	**Mfr. Part Number**
RP1	1810-1242	1	RESISTOR NETWORK	28480	1810-1242
S1	3101-2609	1	SWITCH-SL DPST STD 5A 250VAC PC	28480	3101-2609
S2	3101-3007	1	SWITCH-6 STATION ASSEMBLY	28480	3101-3007
T1	9100-4750	1	TRANSFORMER-POWER (with mtg. hardware)	28480	9100-4750
U1	1826-1403	2	IC V RGLTER-ADJ-POS 3/40V	00000	LT317AT
U2	1826-1670	2	IC V RGLTR-ADJ-NEG -37/1.2V TO-220 PKG	00000	LT337AT
U3	5081-9233	1	ANALOG MULTIPLEXER 4 CHNL 16 -DIP-P	28480	1820-2182
U4	1826-1403		IC V RGLTR ADJ-POS 3/40V	00000	LT317AT
U5	1826-1670		IC V RGLTR-ADJ-NEG -37/1.2V TO-220 PKG	00000	LT337AT
U6	1826-1381	3	IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG	00000	LT1012CN8
U7	1826-1381		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG	00000	LT1012CN8
U8	1826-1381		IC OP AMP LOW-BIAS-H-IMPD 8-DIP-P PKG	00000	LT1012CN8
U9	1820-3177	1	IC MUXR/DATA-SEL CMOS/74HC 2-TO-1-LINE	04713	MC74HC157N
U10	1826-0774	1	IC V RGLTR-V-REF-FXD 1.22/1.24V TO-92	27014	LM385BZ-1.2
U1	1826-0635	1	IC OP AMP LOW-OFS 8-DIP-P PKG	06665	OP-07CP
VR1	1902-0951	1	DIODE-ZNR 5.1V 5% D0-35 PD=.4W TC±.035%	28480	1902-0951
W1	01141-61602	1	CABLE ASSEMBLY, SAFETY GROUND	28480	01141-61602

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Locator Table for Control and Power Supply

Ref. Des.	Grid Loc	Ref Des	Grid Loc	Ref Des	Grid Loc	Ref Des	Grid Loc	Ref Des	Grid Loc	Ref Des	Grid Loc	Ref Des	Grid Loc	Ref Des	Grid Loc
C1	C-2	C17	C-6	CR10	C-5	J1	G-7	R5	B-6	R22	B-3	R45	C-3	U5	D-6
C2	F-3	C18	B-5	CR11	C-3	J2	B-7	R6	B-6	R23	B-5	R46	C-3	U6	B-3
C3	H-2	C19	B-6	CR12	C-6	J3	C-7	R7	C-4	R24	B-5	R47	C-2	U7	C-3
C4	J-3	C20	B-5	CR13	C-3			R8	C-5	R25	B-2	R48	D-3	U8	B-3
C5	C-3	C21	B-5	CR14	C-6	MP1	H-1	R9	C-4	R26	B-2			U9	A-5
C6	C-5	C22	B-6	CR17	B-5	MP2	E-3	R10	C-5	R27	A-5	RP1	B-3	U10	C-2
C7	B-3	C23	B-4	CR18	B-6	MP3	D-3	R11	C-5	R28	A-5			U11	C-3
C8	C-5	C24	B-6			MP4	E-5	R12	C-5	R29	B-6	S1	H-7		
C9	C-5	C25	B-4	DS1	G-2	MP7	E-4	R13	E-3	R30	B-6	S2	E-2	VR1	E-3
C10	C-5	C26	G-6			MP8	G-4	R14	C-4	R31	B-3				
C11	E-3			E1	F-6	MP9	G-4	R15	C-4	R32	B-2	T1	H-5		
C12	A-3	CR2	F-3	E2	E-6			R16	C-4	R40	C-2				
C13	A-3	CR3	F-3			P1	E-7	R17	A-2	R41	A-2	U1	D-4		
C14	B-4	CR5	C-3	F1	E-6			R18	C-6	R42	C-2	U2	D-5		
C15	A-3	CR6	C-5			R3	A-6	R19	C-6	R43	C-2	U3	A-2		
C16	C-4	CR9	C-3	HS1	D-5	R4	A-6	R21	B-3	R44	C-3	U4	D-3		

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Agilent Technologies, Inc.
1900 Garden of the Gods Road
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Product 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 fuseholders. 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.

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