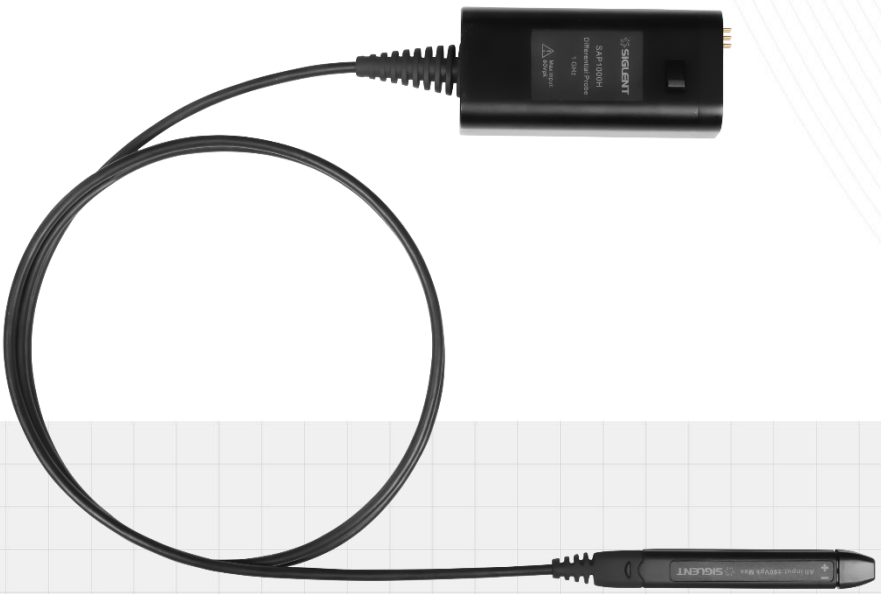
SAP1000H High Voltage Differential Probe

User Manual

EN01B



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1 Introduction

This user manual contains important safety information related to the SAP1000H High Voltage Differential Active Probe, as well as a basic tutorial on the probe's operational use.

2 Safety Instructions

Carefully read the following safety precautions to avoid personal injury and prevent damage to the instrument and any products connected to it. To avoid potential hazards, please use the instrument as specified.

This section contains instructions that must be observed to keep this oscilloscope accessory operating in a correct and safe condition. You are required to follow generally accepted safety procedures in addition to the precautions specified in this section. The overall safety of any system incorporating this accessory is the responsibility of the assembler of the system.

Connect and disconnect properly. Connect the probe to the measurement instrument before connecting the test leads to a circuit/signal being tested.

Use only within the operational environment listed. Do not use in wet or explosive atmospheres.

Ground the product. This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to the earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Use indoors only.

Keep product surfaces clean and dry.

Be careful with sharp tips. The tips may cause bodily injury if not handled properly.

Do not operate with suspected failures. Do not use the probe if any part is damaged. Cease operation immediately and sequester the probe from inadvertent use.

2.1 Symbols

These symbols may appear on the probe body or in this manual to alert you to important safety considerations.

⚠ CAUTION	Potential for damage to probe or instrument it is connected to. Attend to the accompanying information to protect against personal injury or damage. Do not proceed until conditions are fully understood and met

2.2 Operating Environment

The accessory is intended for indoor use and should be operated in a clean, dry environment. Before using this product, ensure that its operating environment is maintained within these parameters:

Temperature: 5℃ to 40℃.

Humidity: The maximum relative humidity is 80 % for temperatures up to 30 ℃ decreasing linearly to 50 % relative humidity at 40 ℃.

Altitude: Up to 10,000 ft (3,048 m).

Notes: It is recommended to use this product in a ventilated environment. It is normal for the probe casing temperature to rise in a closed and windless environment.

⚠ WARNING	Do not operate this product in explosive, dusty or humid air.

⚠ CAUTION	Do not exceed the specified maximum input voltage. See technical data for details.

2.3 Calibration

The recommended calibration interval is one year from the time the probe is put into service.

2.4 Cleaning

The exterior of the probe and cable should be cleaned, using a soft cloth moistened with water. The use of abrasive agents, strong detergents, or other solvents may damage the probe. Always ensure that the input leads are free of debris.

⚠ CAUTION	There are no components inside that can be operated by the personnel. Do not remove the protective cover. Maintenance must be carried out by personnel with the corresponding qualifications.

2.5 Abnormalities

This probe should only be used for the purpose specified by the manufacturer. The probe may be damaged when it exhibits visible damage or is subjected to severe transportation pressure. If you suspect that the probe is damaged, immediately disconnect the probe from the oscilloscope. To use the probe correctly, all instructions and markings should be read carefully.

⚠ WARNING	Using the probe in a manner not specified by the manufacturer may damage the probe. This probe and related accessories should not be directly connected to the human body or used for patient monitoring.

3 First Steps

3.1 Delivery Checklist

First, verify that all items listed on the packing list have been delivered. If you note any omissions or damage, please contact your nearest SIGLENT customer service center or distributor as soon as possible. If you fail to contact us immediately in case of omission or damage, we will not be responsible for replacement.

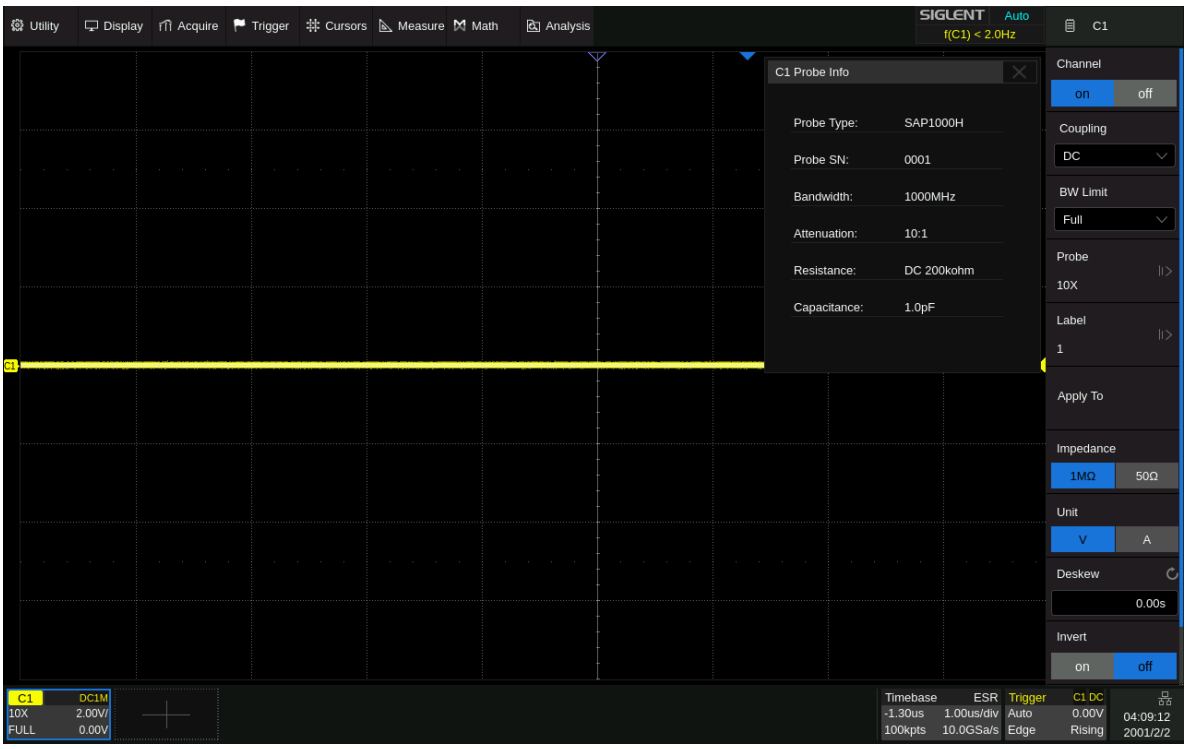


SAP1000H Differential Probe

3.2 Functional Check

The function check needs to use an oscilloscope that supports the SIGLENT SAPBus interface. Please follow the steps below to check the probe function.

1. Power on the oscilloscope and allow it to warm up for 20 minutes.
2. Connect the active probe to Channel 1 of the oscilloscope.
3. Open the parameter panel for Channel 1 and check the probe information, including the probe model, serial number, bandwidth, impedance, capacitance and attenuation ratio.
4. Select the Channel 1. Set the oscilloscope vertical scale to 12 V/div. Set the oscilloscope offset factor to 0 V.
5. Measure the average voltage of channel 1, and the reading range should be within ± (1.5%* full-screen reading +10 mV). If the reading is beyond the range, the check will not pass.
6. Change the vertical scale of channel 1 to 10V/div, 5V/div, 2V/div, 1V/div,500 mV/div, 200 mV/div, 100 mV/div, 50 mV/div, 20 mV/div and repeat Step 5 to check the average voltage reading at each scale.



3.3 Quality Assurance

Probes and accessories have a 1-year warranty from the date of shipment, during normal use and operation. SIGLENT can repair or replace any product that is returned to the authorized service center during the warranty period. We must first examine the product to make sure that the defect is caused by the process or material, not by abuse, negligence, accident, abnormal conditions, or operation.

SIGLENT shall not be responsible for any defect, damage, or failure caused by any of the following:

a) Attempted repairs or installations by personnel other than SIGLENT.

b) Connection to incompatible devices/incorrect connection.

c) For any damage or malfunction caused using non-SIGLENT supplies. Furthermore, SIGLENT shall not be obligated to service a product that has been modified. Spare, replacement parts, and repairs have a 90-day warranty.

3.4 Maintenance Agreement

We provide various services based on maintenance agreements. We offer extended warranties as well as installation, training, enhancement and on-site maintenance, and other services through specialized supplementary support agreements. For details, please consult your local SIGLENT customer service center or distributor.

4 Probe Technical Specifications

SAP1000H is a high-voltage high-bandwidth differential active probe with characteristics such as high input voltage, high bandwidth, low noise, and high input impedance. It is suitable for measuring high-voltage and high-speed signals, such as switch waveform measurement of switching power supplies. Its high input resistance and low input capacitance characteristics ensure that the load introduced by the measurement system is minimized.

With the SAPBus interface, the SAP1000H becomes an integral part of the oscilloscope measurement circuit. The probe can be controlled from the oscilloscope's front panel. The oscilloscope provides power to the probe, so there is no need for a separate power supply or batteries.

Key Benefits

- Bandwidth DC ~ >1 GHz
- 100 kΩ Single-ended Input Resistance
- 200 kΩ Differential Input Resistance
- 10X/50X Attenuation
- 1 pF Differential Input Capacitance
- ±42 Volts Dynamic Range with ±42 Volts Offset Capability
- SAPBus Interface

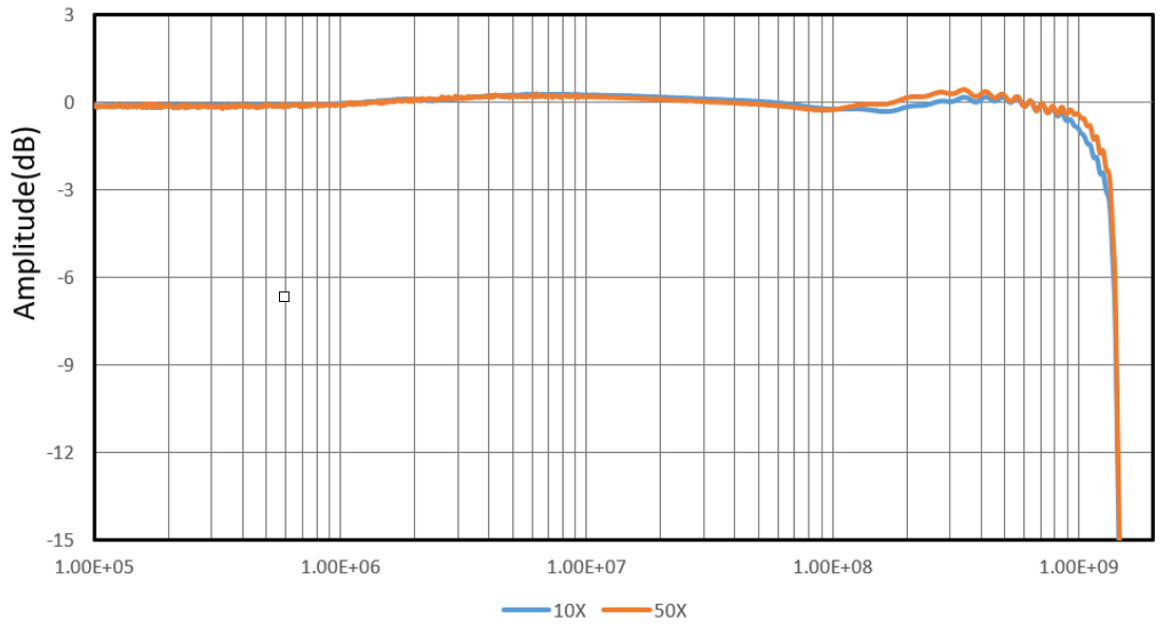
4.1 Model and Specifications

The specifications of the probe need to meet the following conditions:

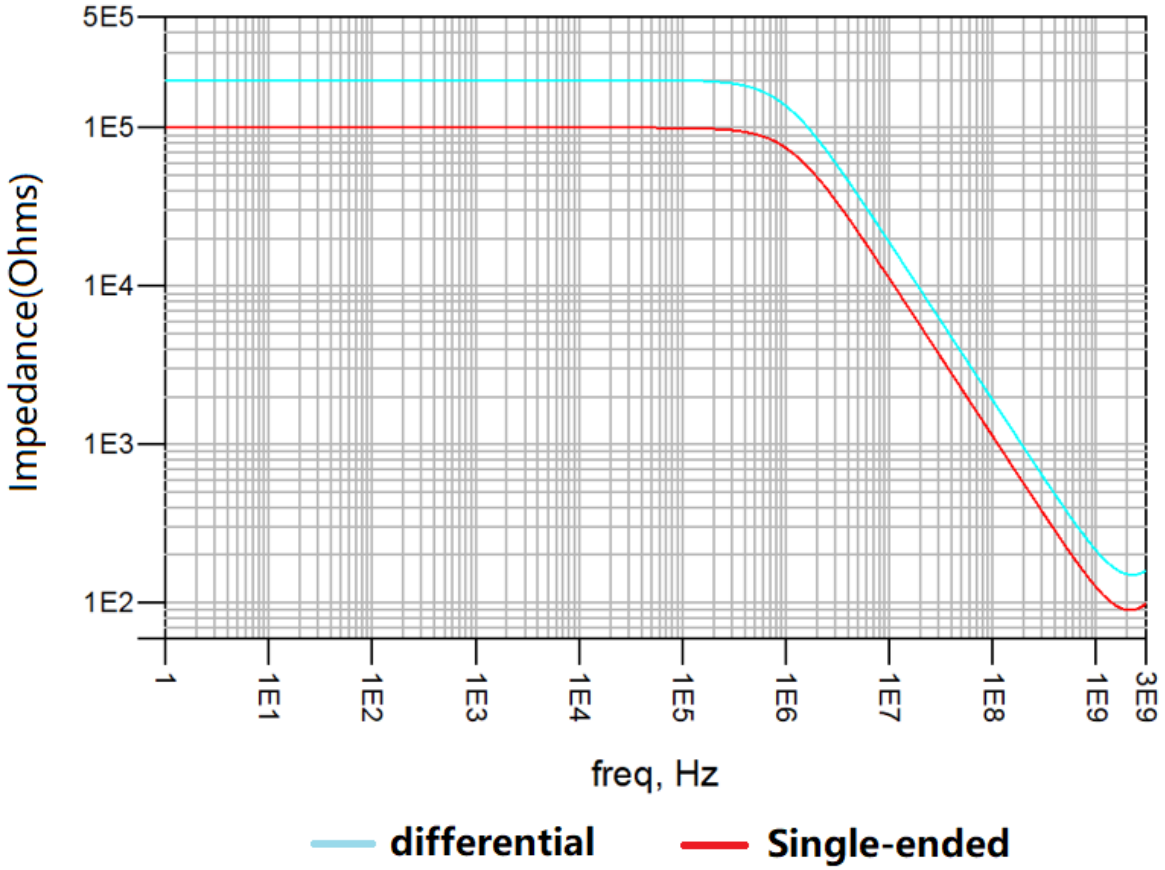
1. The probe is within its valid calibration period.
2. The environmental temperature is within 25°C ± 5°C.
3. The probe is correctly connected to the oscilloscope.
4. The probe and oscilloscope are in a thermally stable environment, and both the probe and oscilloscope have been preheated for at least 20 minutes.

Probe Model and Specification Parameters:

Parameters	SAP1000H	
Bandwidth (Probe only)	1 GHz	
System Bandwidth (Probe + Oscilloscope)	1 GHz（SDS5000X HD）	
Differential Input Capacitance	1 pF	
Rise Time（10%~90%）	<350 ps	
Differential Input Resistance	200 kΩ	
Single-ended Input Resistance	100 kΩ	
Vertical Displacement Range	10X	±8.4 V
	50X	±42 V
Attenuation Ratio (DC)	10X/50X	
Offset Voltage Accuracy	< 3%	
DC Gain Accuracy	< 3%	
Input Dynamic Range	10X	±8.4 V
	50X	±42 V
Common Mode Rejection Ratio	100 kHz	>50dB
	5 MHz	>50dB
	250 MHz	>20dB
Maximum Input Voltage (Reference Ground Socket)	±60 V	
Cable Length	130 cm	



Amplitude Frequency Response



Input Impedance

4.2 Accessories

The SAP1000H high voltage differential probe are provided with numerous features and accessories to make probing and connecting to different test points easier than ever.

Standard Accessory	Part Number	Quantity	Unit
Straight Tip	2.74.70.12.003	5	pcs
Pogo Tip	2.74.70.12.011	5	pcs
Swivel Tip	1.99.20.10.492	2	pcs
Tip Saver	2.74.70.12.027	2	pcs
Y Lead Adapter	2.52.42.11.048	2	pcs
Micro SMD Clip	2.67.10.01.108	1	pcs
Black Chip Clip	2.75.17.10.113	1	pcs
Red Chip Clip	2.75.17.10.114	1	pcs
Pin Header	2.42.08.02.063	2	pcs
Right Angle Pin Lead 5 cm	2.52.42.11.016	1	pcs
Straight Pin Lead 6 cm	2.52.42.11.017	1	pcs
Straight Pin Lead 12 cm	2.52.42.11.019	1	pcs
Spring-loaded Ground (Short)	2.52.42.11.049	2	pcs
Spring-loaded Ground (Long)	2.52.42.11.050	2	pcs
Solder-in Lead	2.52.42.11.051	2	pcs
Channel ID Clips (Set of 4 Colors)	2.75.23.10.007	1	set
Two-legged Positioner PP201	2.78.50.20.027	1	pcs
Short Flex Adapter Square Pin	1.10.40.02.159	1	pcs
Long Flex Adapter Square Pin	1.10.40.02.161	1	pcs
Short Flex Adapter Solder-in	1.10.40.02.160	1	pcs
Long Flex Adapter Solder-in	1.10.40.02.162	1	pcs
Silver Wire	2.52.42.11.037	1	meter

Options Accessory	Part Number	Quantity	Unit
3D Positioner PP301	0.01.80.10.136	1	set
Two-legged Positioner PP201	0.01.80.10.126	1	set
Accessory Kit SAP1H-AB	0.01.80.10.186	1	set
External Attenuator EA0210	0.01.80.10.226	1	set

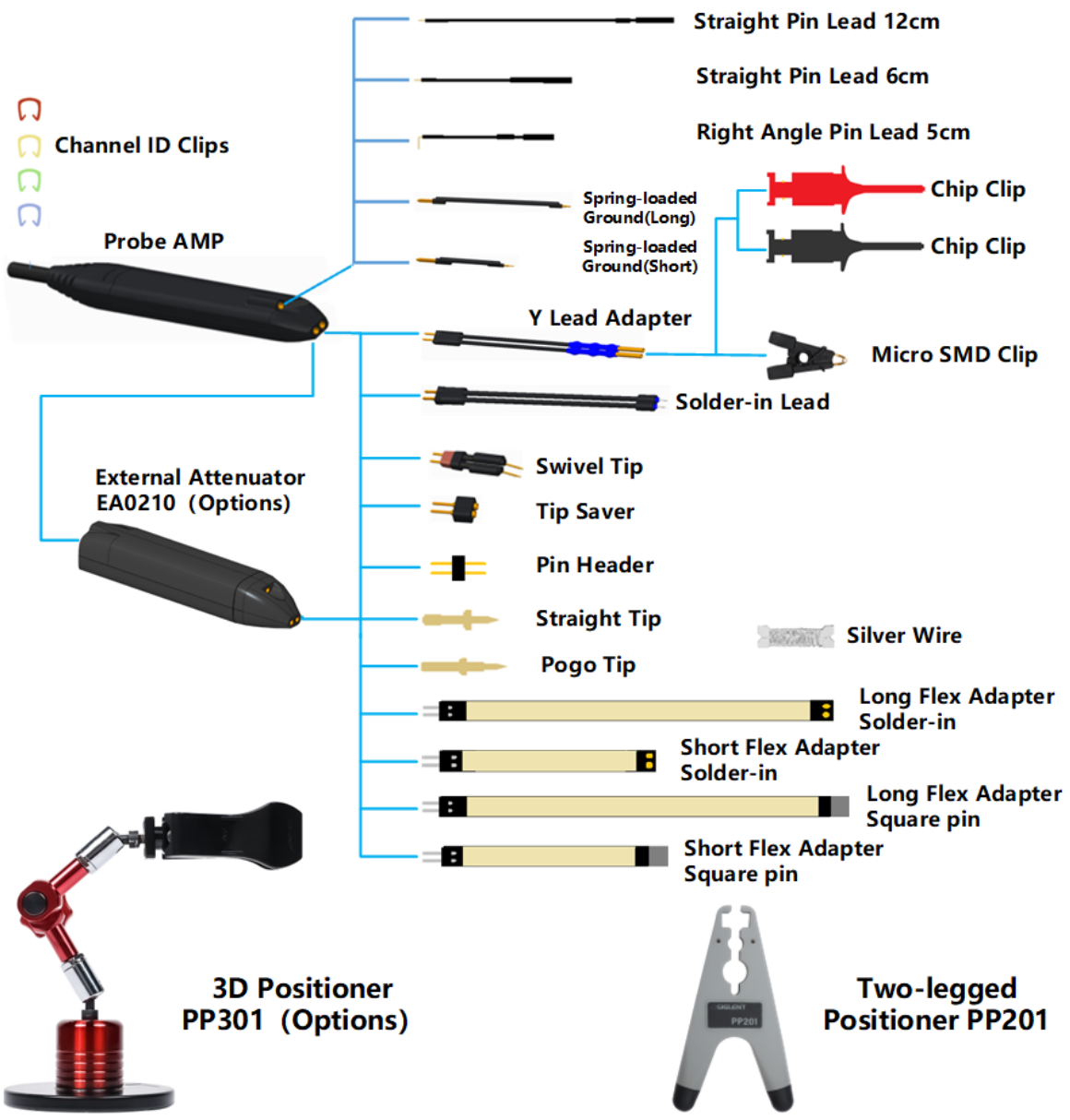


Figure 1 Accessories



Straight Tip (Part Number 2.74.70.12.003): The straight tip is rugged and designed for general probing. Fits in either probe socket.



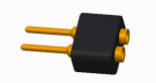
Pogo Tip (Part Number 2.74.70.12.011): The pogo tip provides z axis compliance. The tip can fit into a socket or via and onto an IC leg.



Swivel Tip (Part Number 2.74.70.12.028): The swivel tip adapter features adjustable tip spacing to reach test points. A 20 Ω damping resistor is included to reduce inductive peaking.



Pin Header (Part Number 2.42.08.02.063): For test point connection with female header



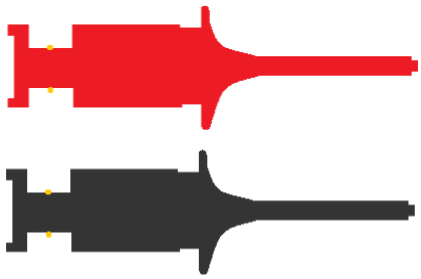
Tip Saver (Part Number 2.74.70.12.027): To prevent wear out on the probe input leads.



Y Lead Adapter (Part Number 2.52.42.11.048): This lead is used for both ground and input lead simultaneously. It has two sockets on one end and two square pins on the other and may be used for general purpose probing.



Micro SMD Clip (Part Number 2.67.10.01.108): For SMD DUT connection.



Chip Clip (Part Number Red 2.75.17.10.114 / Black 2.75.17.10.113): For quick connection of chip pins.



Straight Pin Leads (Part Number 6 cm 2.52.42.11.017 / 12 cm 2.52.42.11.019): These leads have a socket on one end and a square pin on the other to connect to the input or ground socket of the probe body, and may be used for general purpose probing.



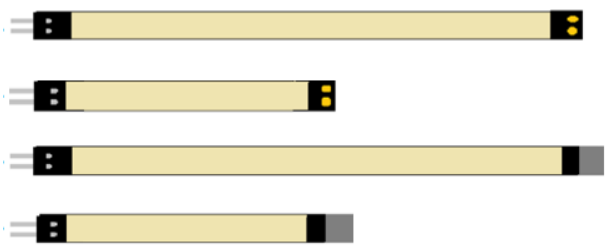
Right Angle Pin Leads (Part Number 2.52.42.11.016): These leads have a socket on one end with a right angle and a square pin on the other to connect to the input or ground socket of the probe body, and may be used for general purpose probing.



Spring-loaded Ground (Part Number Short 2.52.42.11.049 / Long 2.52.42.11.050): Spring-loaded ground leads are bendable. They are designed to be attached to the offset ground socket or be attached to either socket of the probe head.



Solder-in Lead (Part Number 2.52.42.11.057): This lead is designed to be soldered directly to the test points for a secure connection. A damping 56.2 Ω resistor is included to reduce inductive peaking.



Flex Adapter: It is used for connecting the probe amplifier to the circuit under test, and can be soldered or directly connected to 2.54 mm pitch pin headers.



Silver Wire: It is used for connection between the flex adapter solder-in and the DUT.



Channel ID Clips (Part Number 2.75.23.10.007): They are used to distinguish the oscilloscope channel that the probe is connected to.



External Attenuator: After connecting the probe amplifier, the input dynamic range can be expanded to ±60 V.



Two-legged Positioner PP201: For probe fixing.



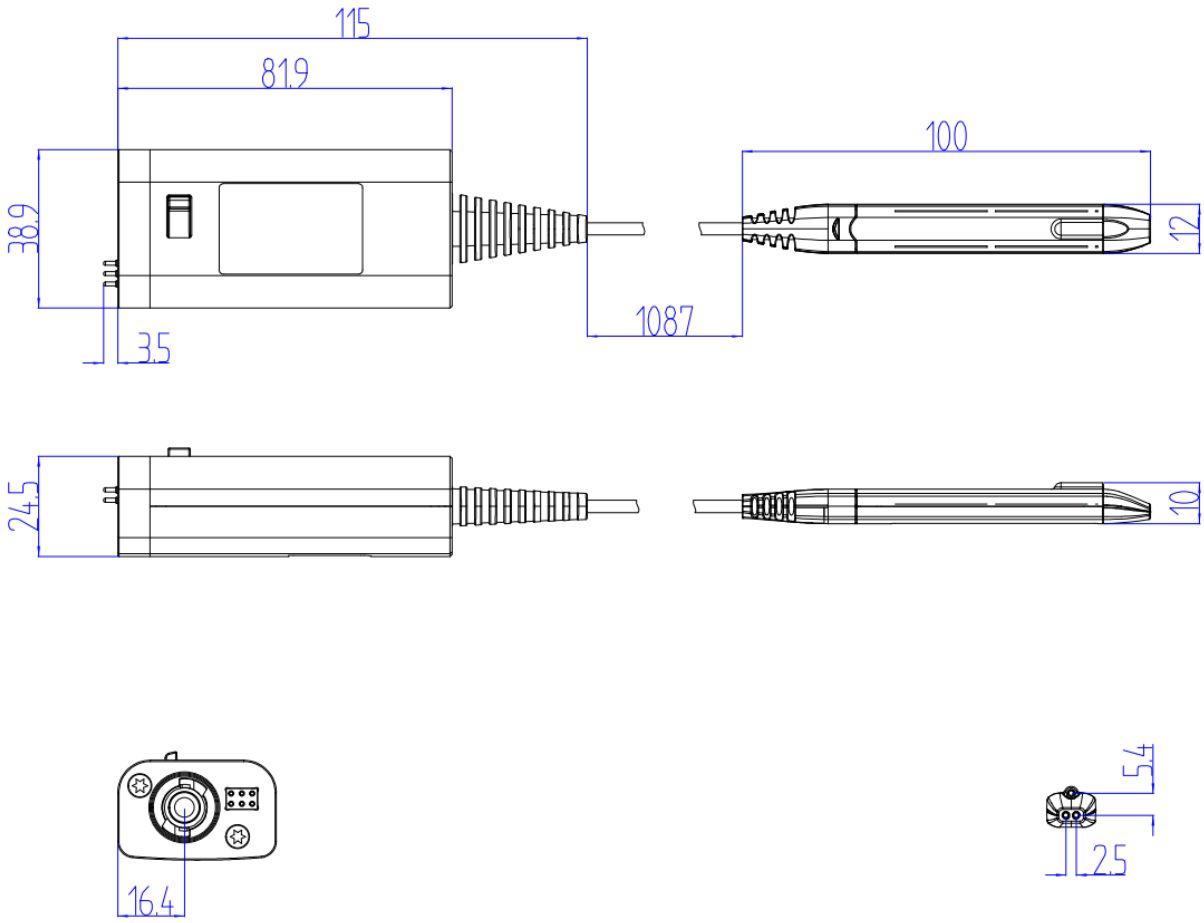
3D Positioner PP301: For probe fixing.

Accessory Kit SAP1H-AB: Includes all standard accessories except PP201.

4.3 Probe Dimensions

Characteristic	Description
SAPBus Interface Box	115.0 mm × 38.9 mm × 24.5 mm
Probe Head	100.0 mm x 12.0 mm x 10.0 mm
Tip Pitch	2.54mm
Cable Length	1.3 m (from the probe head to the compensation box)

Unit: mm



5 Probe Operation

The SAP series probe is a precision test instrument accessory. Exercise care when handling and storing the probe. Always handle the probe by the probe body or compensation box. Avoid putting excessive strain or exposing the probe cable to sharp bends.

	**ESD Sensitive:** The tips of the probes are sensitive to Electrostatic Discharge (ESD). Avoid causing damage to the probe by always following anti-static procedures (wear wrist strap, etc.) when using or handling the probe.

5.1 Connecting the Probe to an Oscilloscope

The SAP1000H high voltage differential active probe have been designed for use with Siglent's SDS5000X HD, SDS6000 Pro, SDS7000A platforms equipped with the SAPBus interface. When you attach the probe output connector to the oscilloscope's input connector, the oscilloscope recognizes the probe and provides proper termination.

5.2 Probe Input

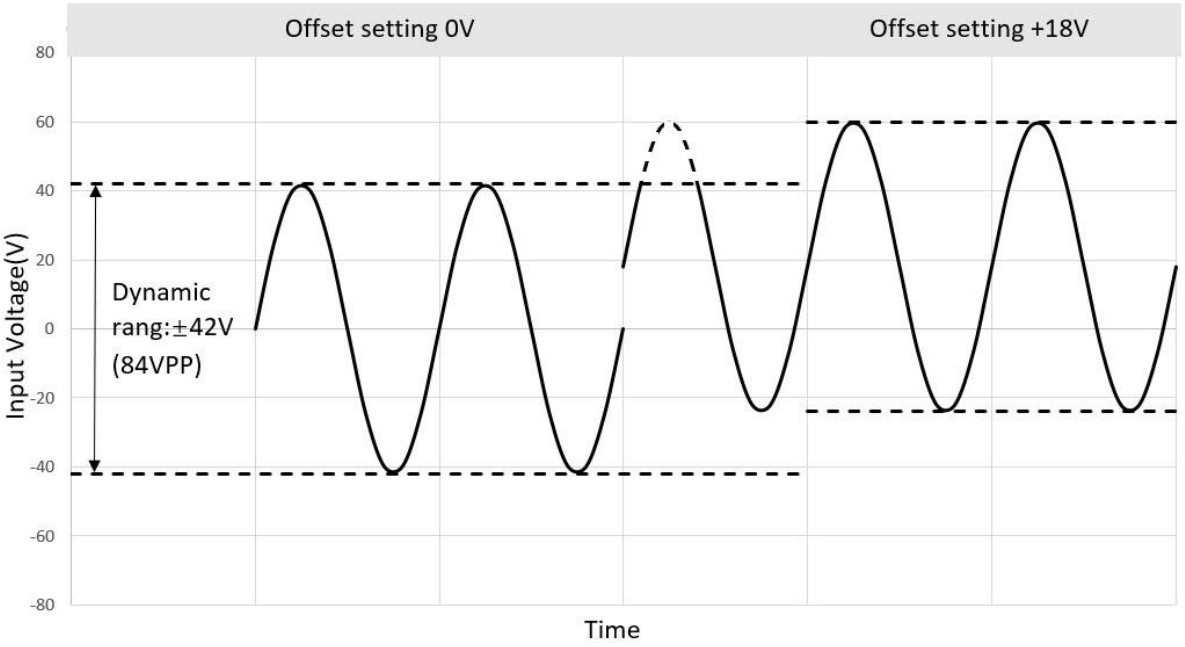
5.2.1 Offset Compensation

The SAP1000H features two offset compensation function: a differential offset compensation and a common-mode offset compensation. Each function compensates a particular DC component of the input signal. The following table shows the input voltage parameters of SAP1000H.

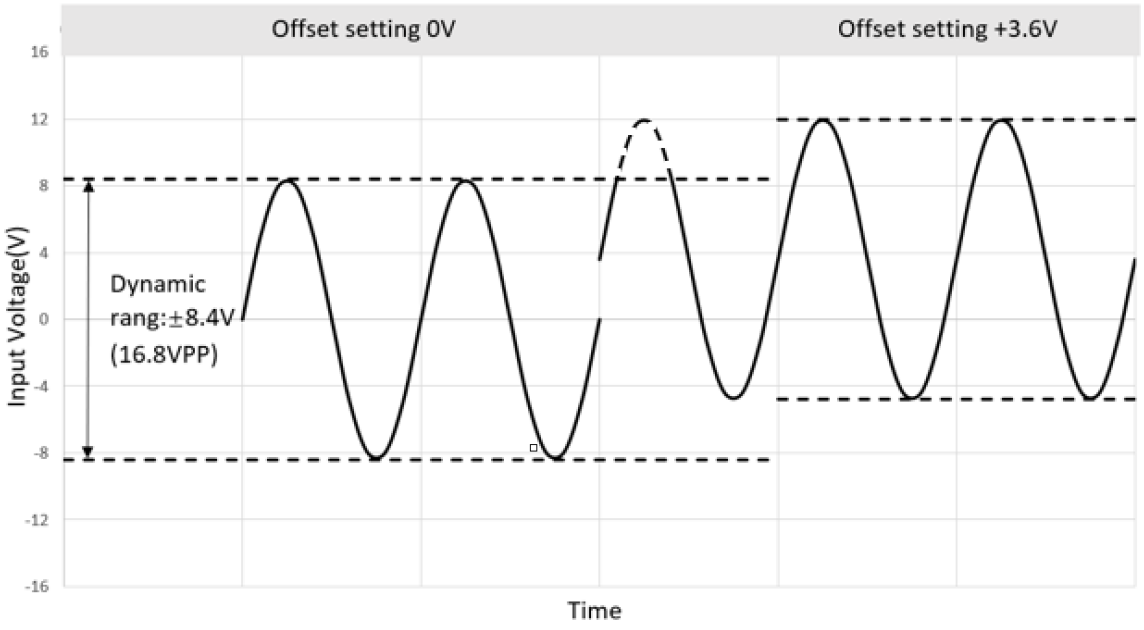
		Explanation
Input Dynamic Range	±42 V 50X ±8.4 V 10X	DC+peak AC
Volts Offset Capability	±42 V 50X ±8.4 V 10X	Reference Ground Socket
Maximum Input Voltage	±60 V 50X ±12 V 10X	DC+peak AC , Reference Ground Socket

Differential offset compensation

The vertical shift function can compensate for the DC voltage applied between the positive and negative input terminals. This function is particularly useful when using a differential probe to measure a small AC single-ended signal with a large DC offset (for example, when the negative input terminal is grounded). Because the SAP1000H measures differential voltage, setting the differential offset compensation allows the voltage offset of the measured waveform to be displayed directly on the oscilloscope screen.



Input voltage range diagram for single-ended measurement (one input is grounded) in the X50 attenuation ratio



Input voltage range diagram for single-ended measurement (one input is grounded) in the X10 attenuation ratio

Common-mode offset compensation

Common-mode offset compensation can compensate for the common-mode DC voltage applied to the two inputs(referenced to the ground socket). This is particularly useful for measuring differential signals with high common-mode levels, such as the voltage across a shunt resistor used to measure the two inputs. The SAP1000H only measures differential signals. Common-mode signals are suppressed by the probe, so the common-mode offset compensation cannot be directly displayed on the oscilloscope screen. The maximum input voltage requirement must be met for each input.

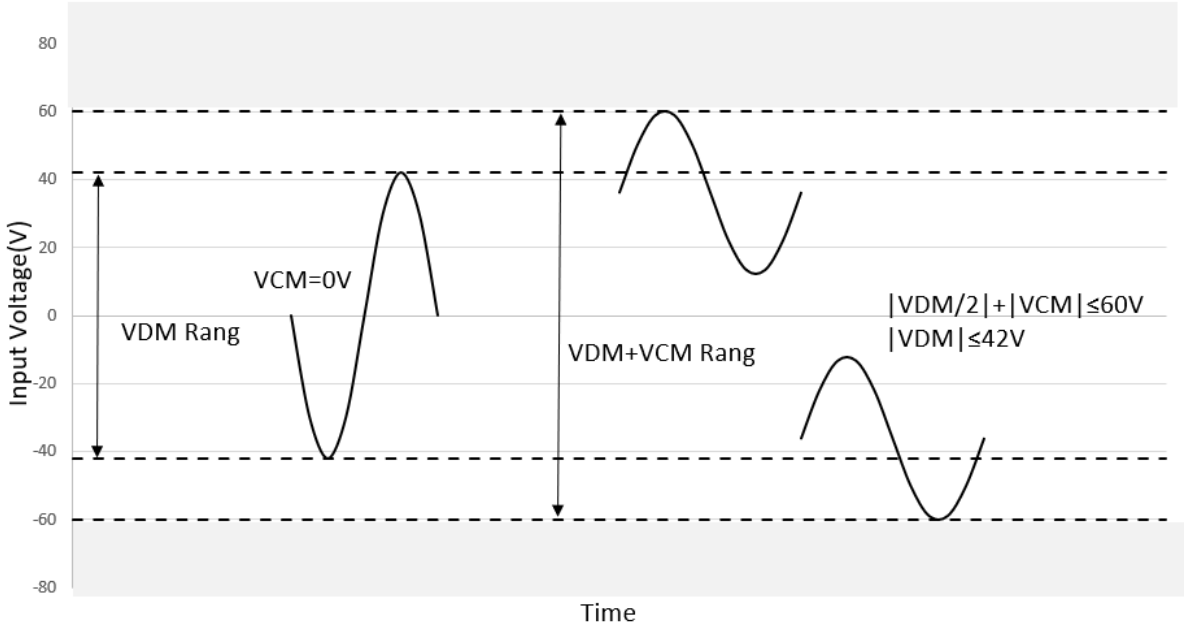


Diagram showing the requirements for common-mode voltage and differential-mode voltage for differential measurementsin the X50 attenuation ratio

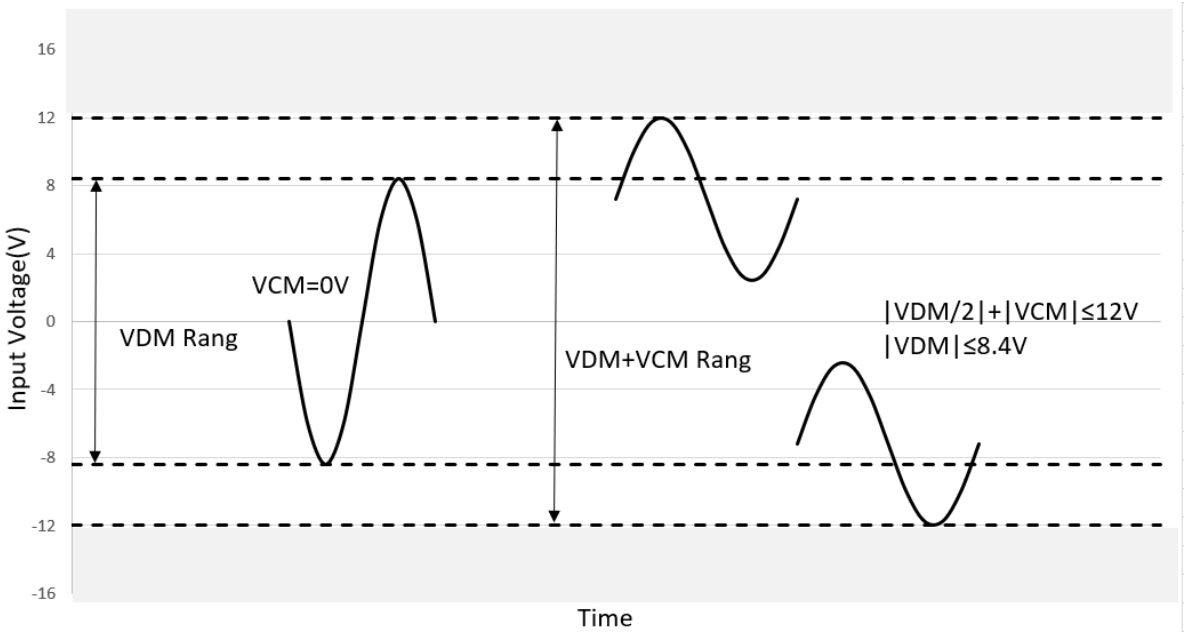
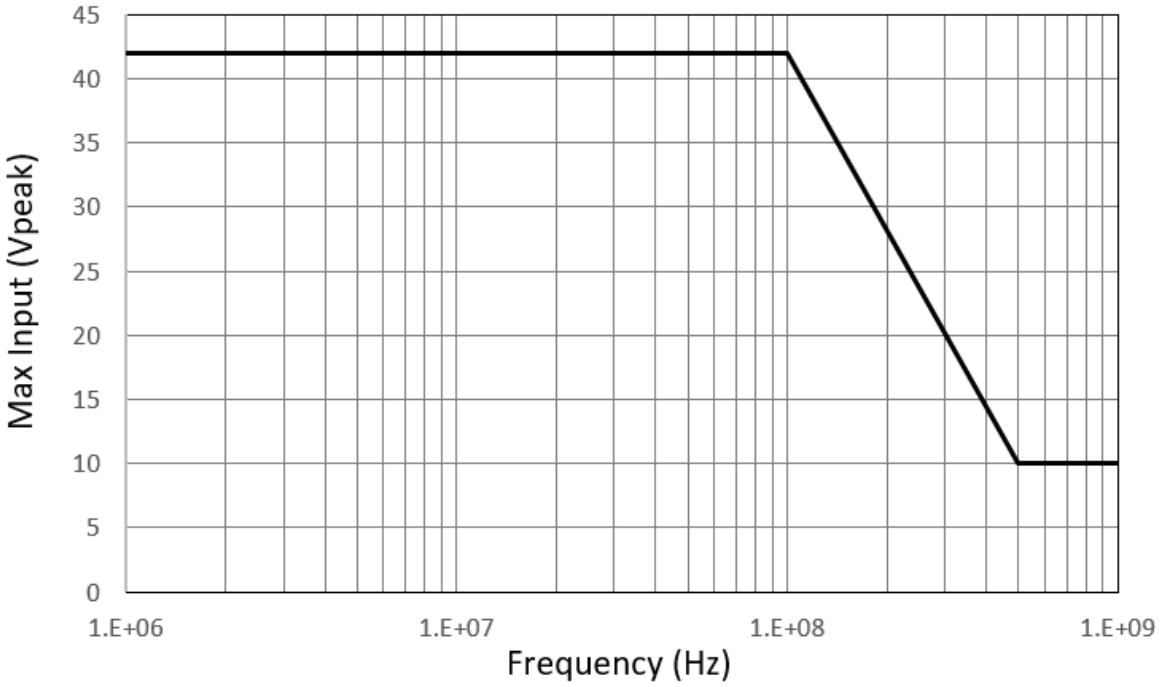


Diagram showing the requirements for common-mode voltage and differential-mode voltage for differential measurementsin the X10 attenuation ratio

5.2.2 Maximum Voltage vs. Frequency Characteristics



5.3 Connecting the Probe to the Test Circuit

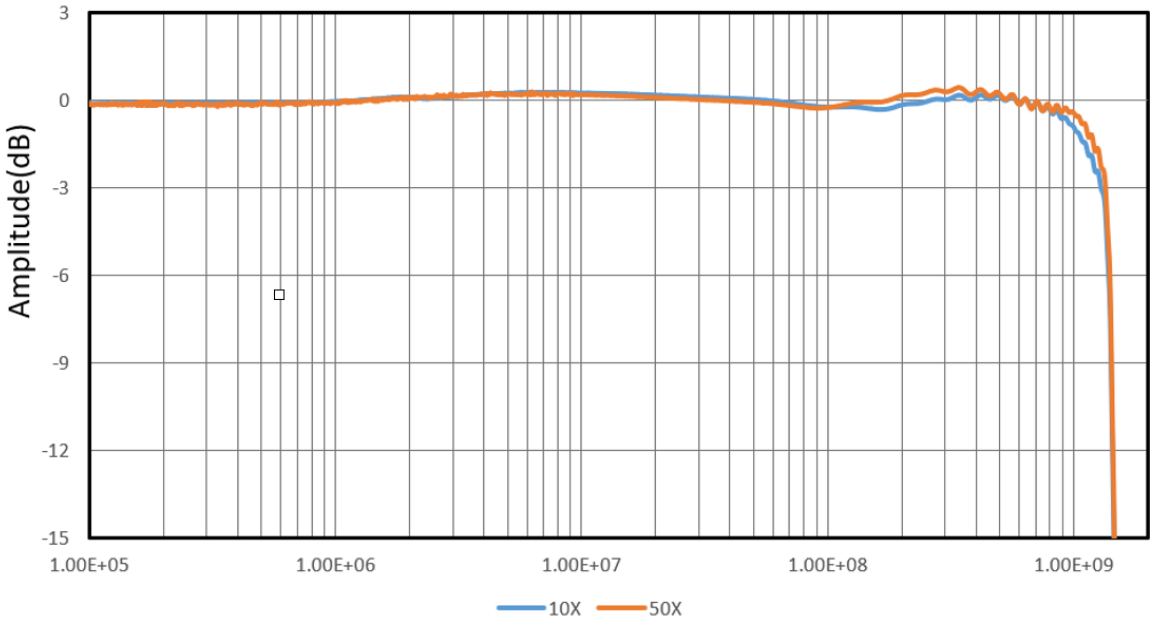
To maintain the high-performance capability of the probe in measurement applications, care must be exercised in connecting the probe to the test circuit. Increasing the parasitic capacitance or inductance in the input paths may introduce a “ring” or slow the rise time of fast signals. Input leads that form a large loop area will pick up any radiated electromagnetic field which passes through the loop and may induce noise into the probe input.

Using one of the available accessories makes the SAP1000H probe with its small profile and low mass head ideally suited for applications in dense circuitry.

The amplifier inside the probe has a limited linear working range. To ensure that the input linearity error is less than 3%, the amplitude of the input signal needs to be limited to ± 42 V. The probe has a DC offset adjustment function, which can adjust the DC offset to eliminate the DC component in the test signal and maximize the performance of the probe. The DC offset adjustment range is ± 42 V.

5.3.1 Direct Connection

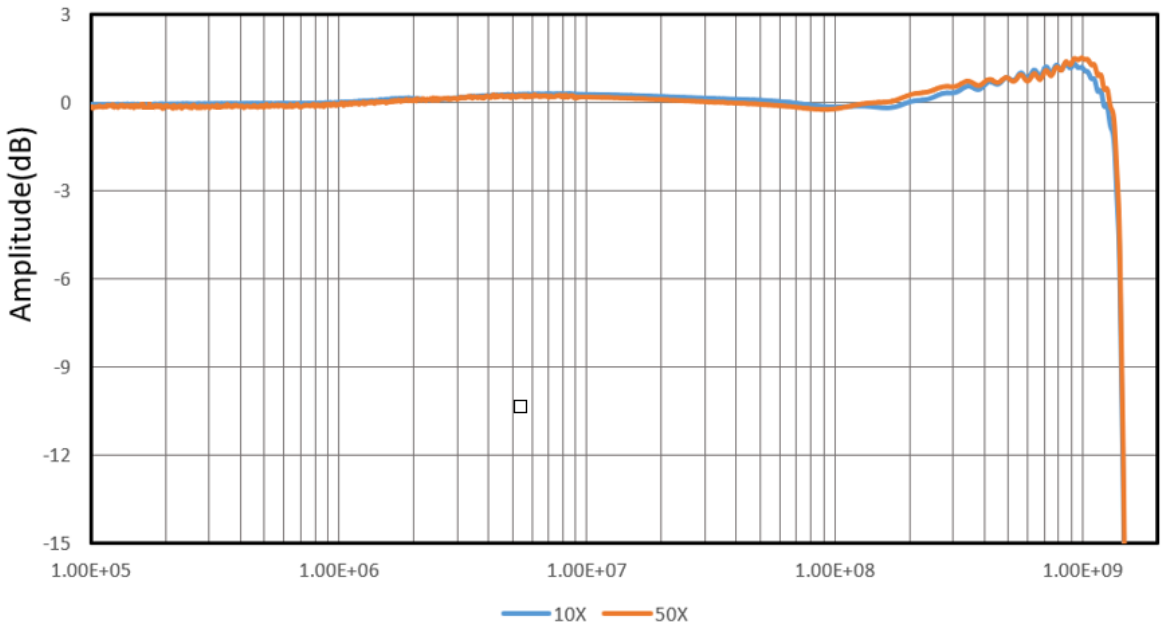
If the measured point is a 2.54 pitch pin header, you can directly use the probe amplifier to access it, which will give you the best performance.



Amplitude Frequency Response

5.3.2 Use Pin Header

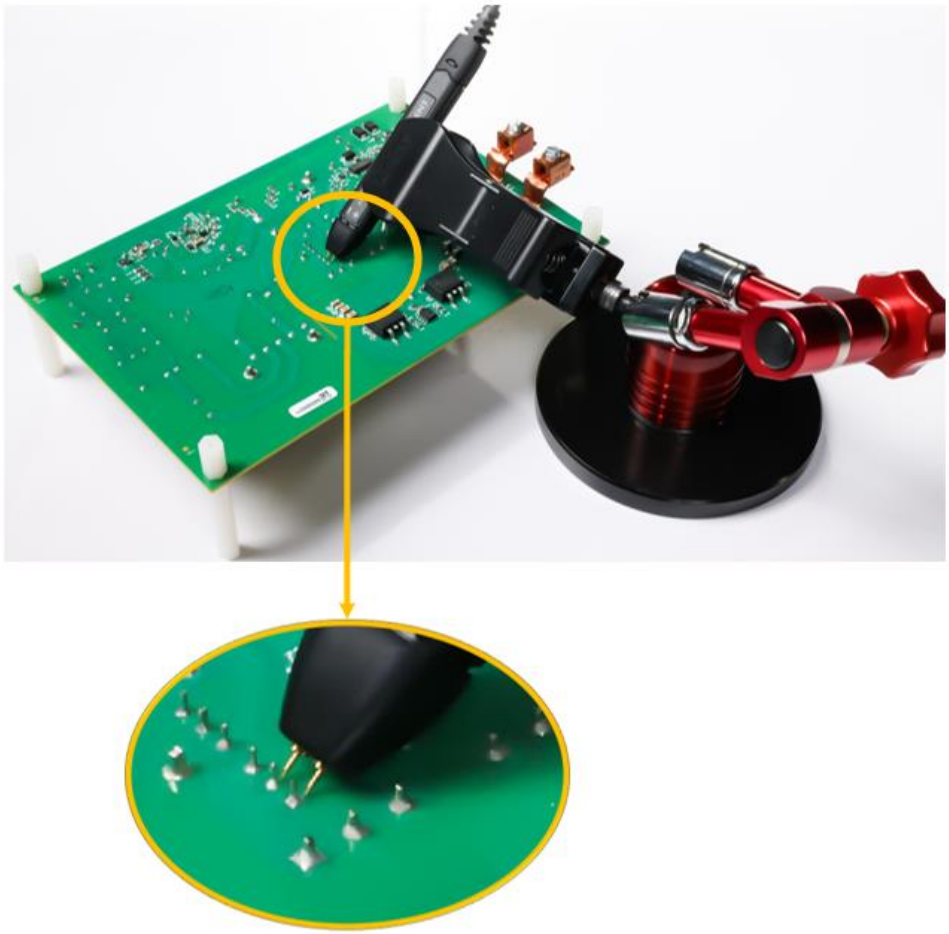
If the measured point is a female header, a pin header can be used to connect the probe amplifier to the measured point, with a measurement bandwidth greater than 1GHz.

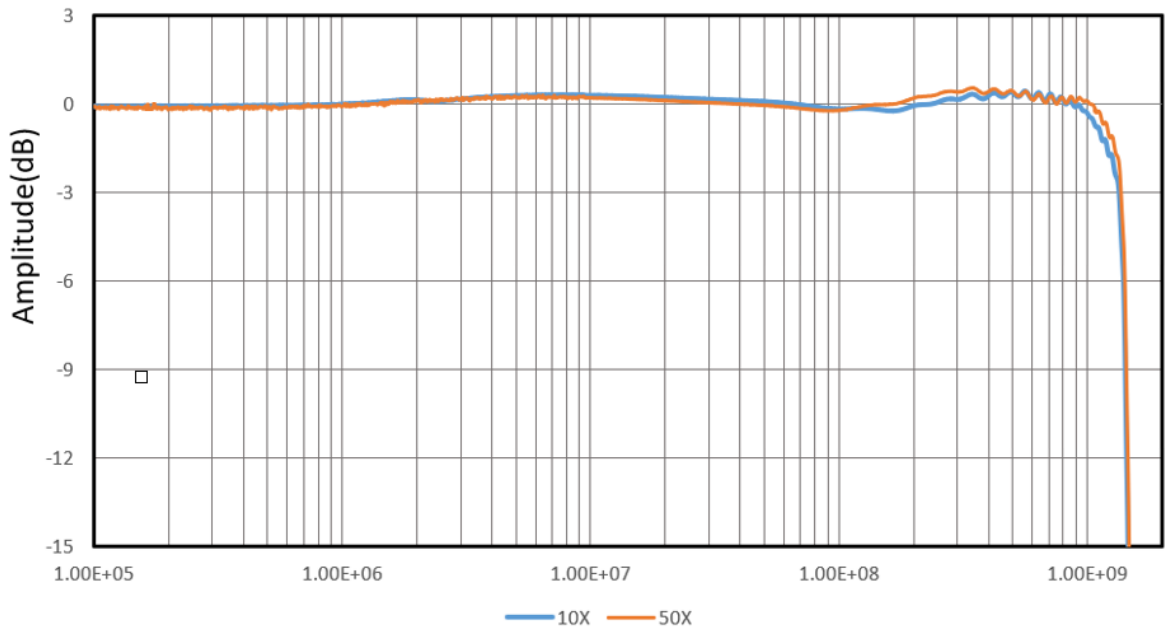


Amplitude Frequency Response

5.3.3 Point Measurement with the Probe Tip

The center distance of the measured points is 2.54mm, and the measurement can be carried out using the pogo tip or straight tip, with a measurement bandwidth greater than 1GHz.

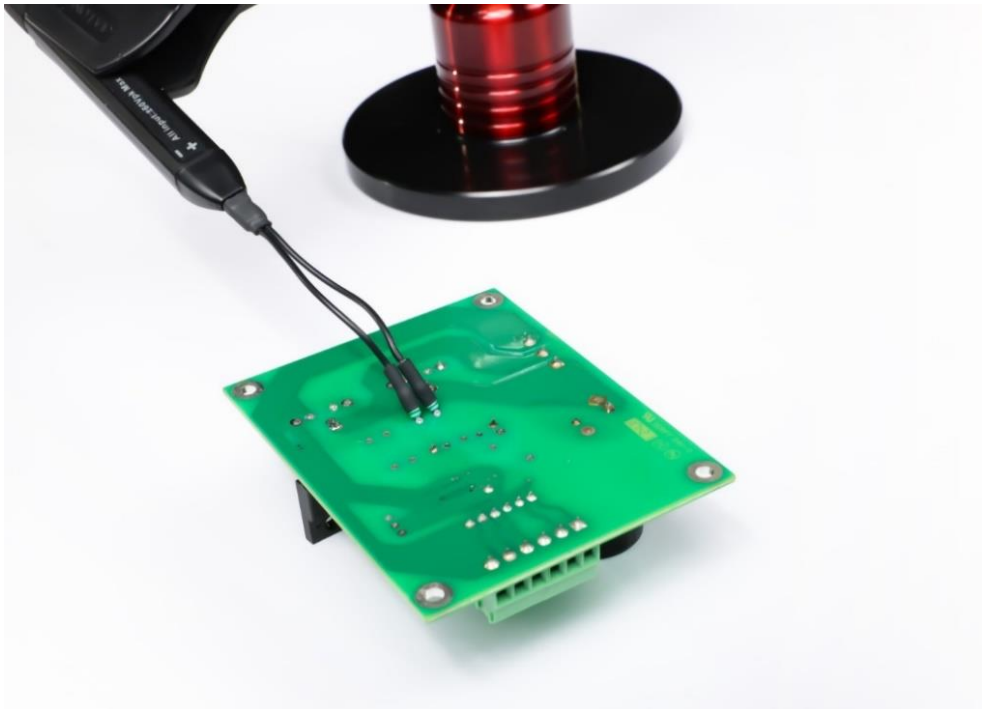


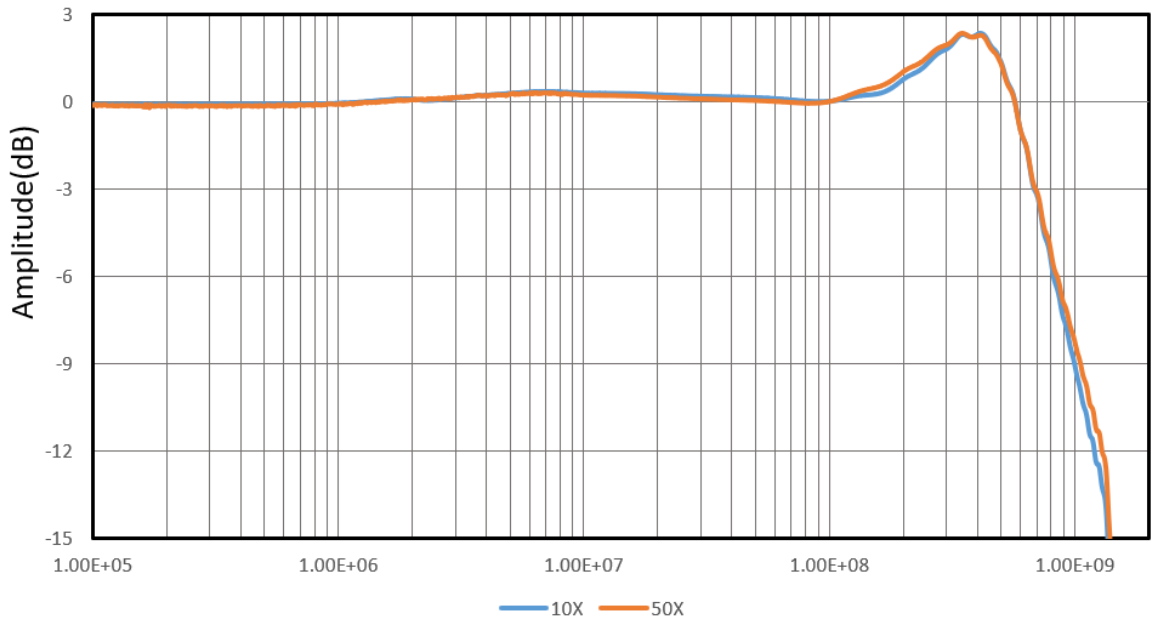


Amplitude Frequency Response

5.3.4 Use Solder-in Lead

Using solder-in leads to connect the test points can provide a reliable and stable connection with a measurement bandwidth of approximately 700MHz. Please refer to 5.5 for soldering precautions.

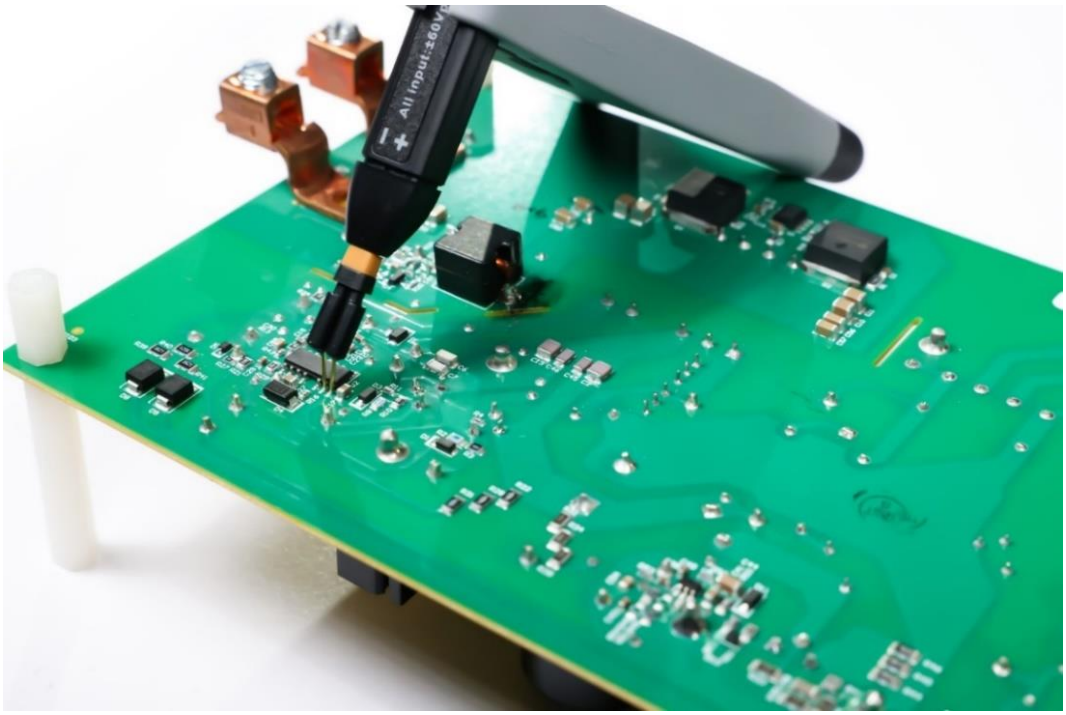


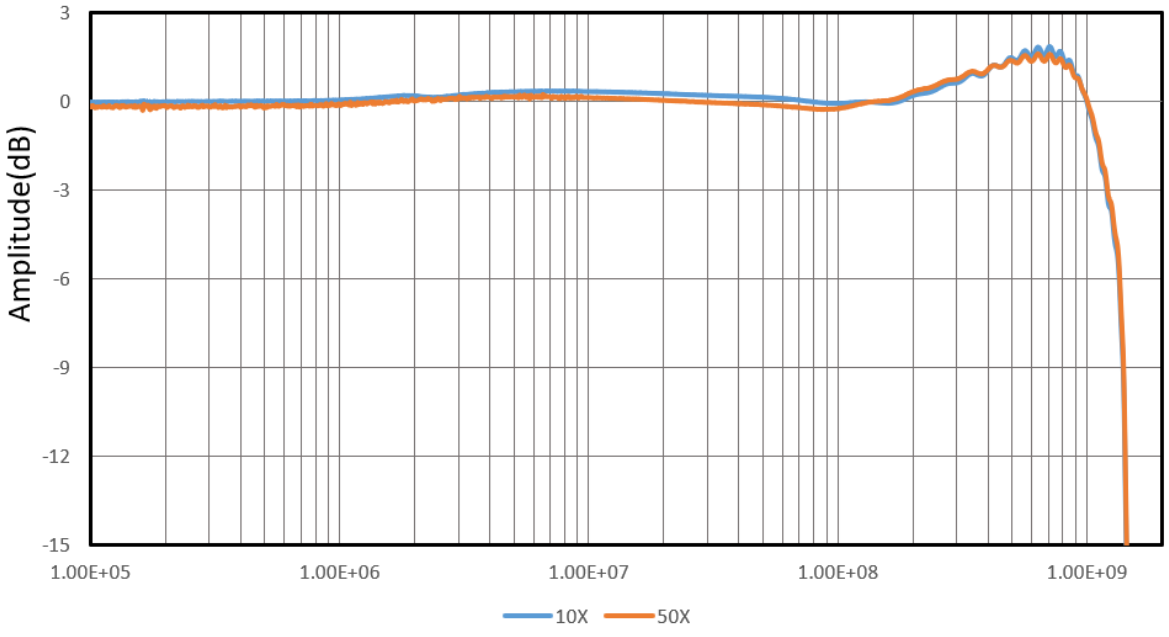


Amplitude Frequency Response

5.3.5 Use Swivel Tip

If you need to test multiple differential test points with different spacing, you can use a swivel tip for testing. The swivel tip can flexibly adjust the spacing of the probes. The measurement bandwidth is greater than 1GHz.

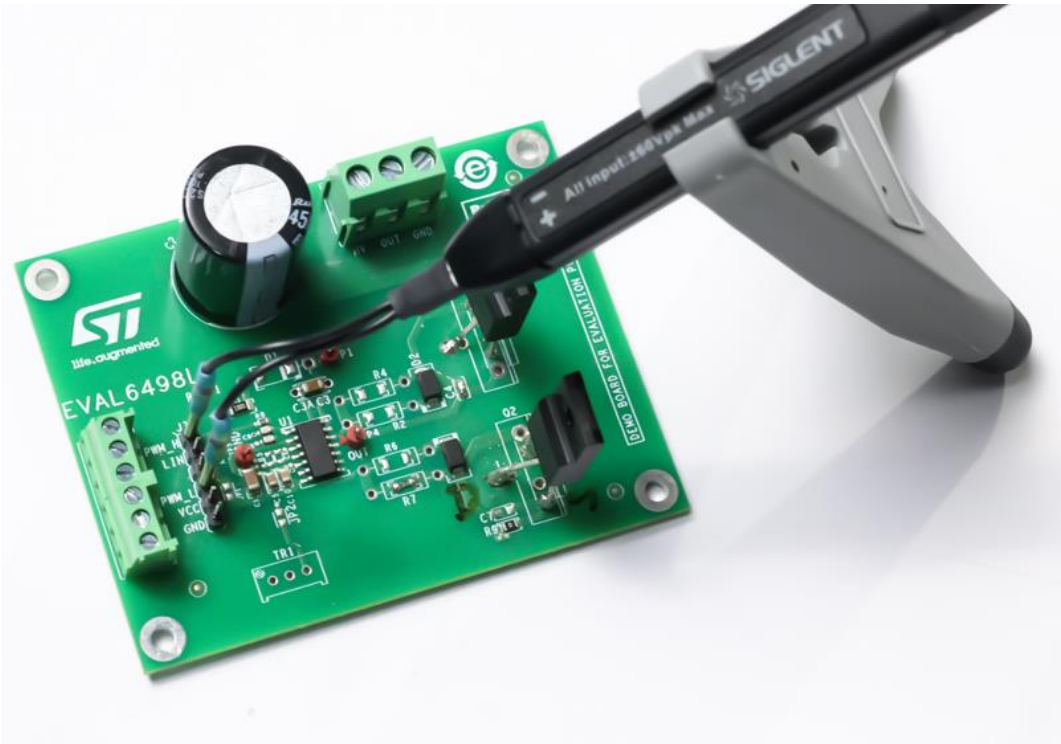


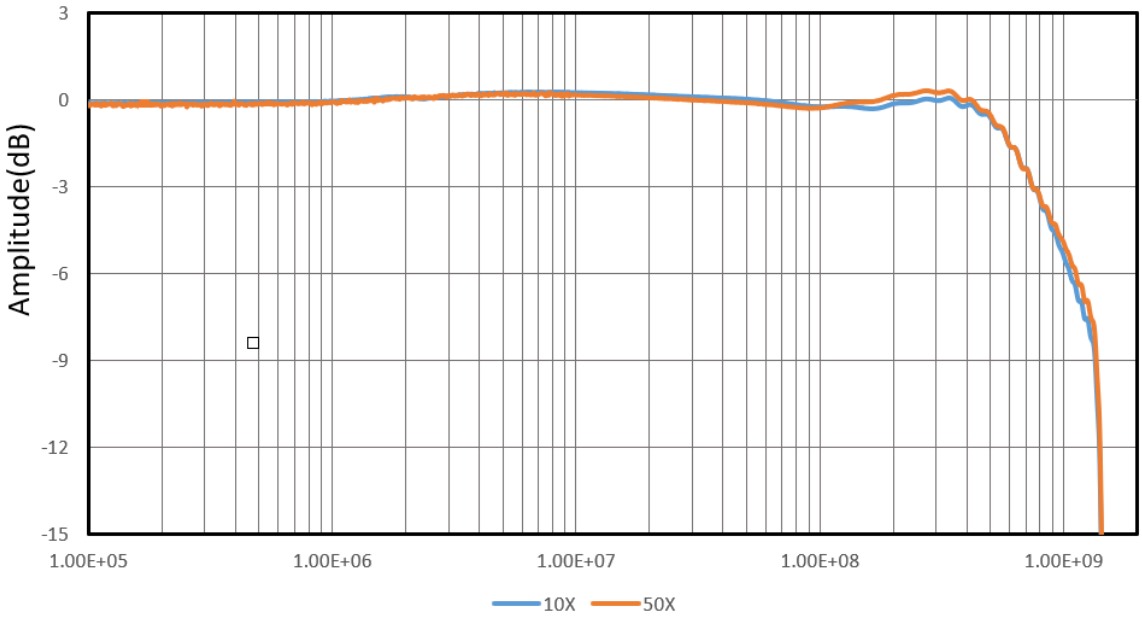


Amplitude Frequency Response

5.3.6 Use Y Lead Adapter

Use Y lead adapter to connect the test point. It is suitable for measuring pin headers with non-2.54 spacing. The measurement bandwidth is about 1GHz.

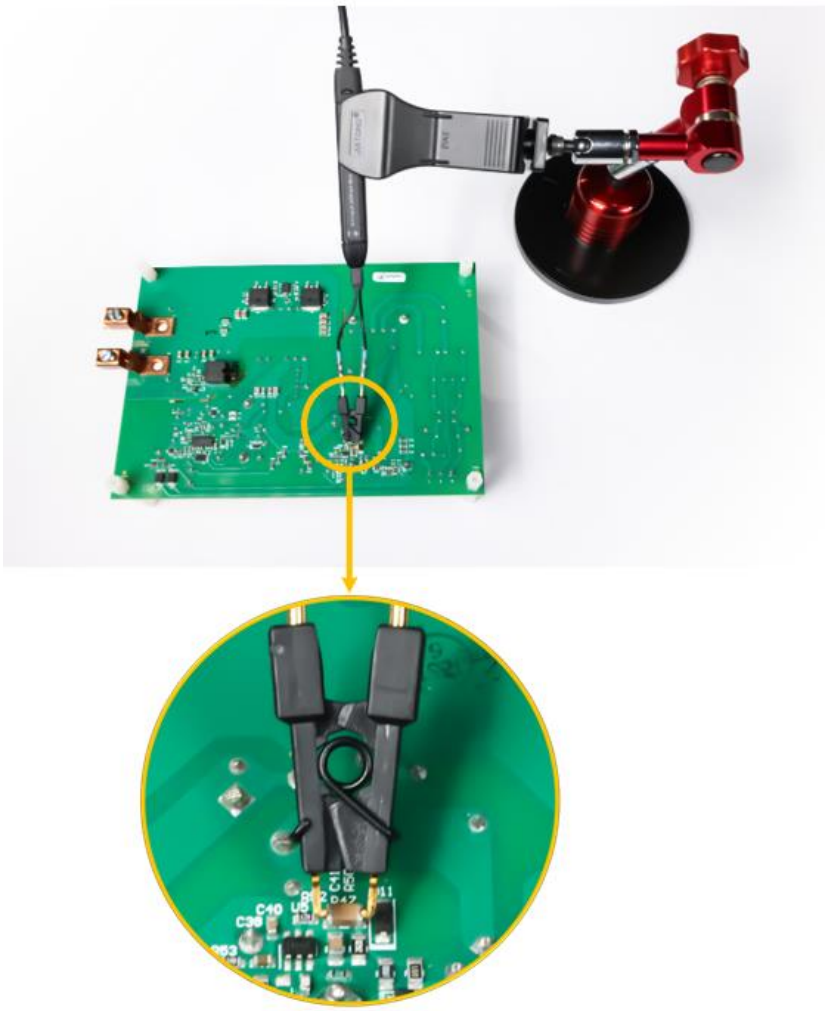


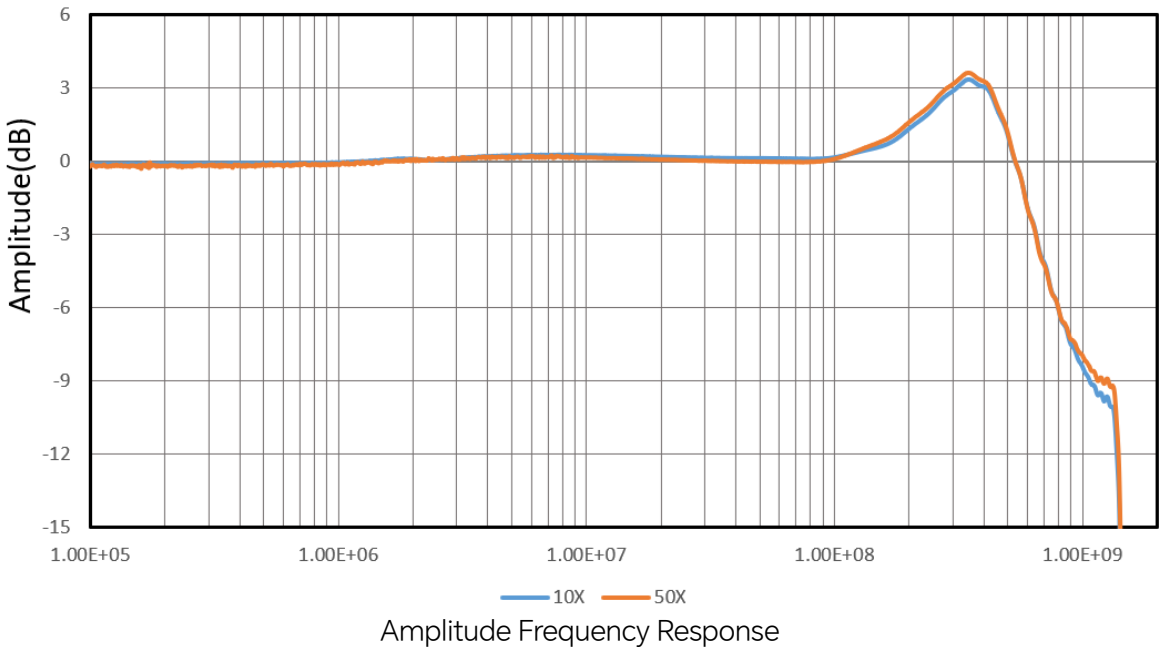


Amplitude Frequency Response

5.3.7 Use Micro SMD Clip

The micro SMD clip is suitable for testing SMD devices, with a measurement bandwidth of about 700MHz.

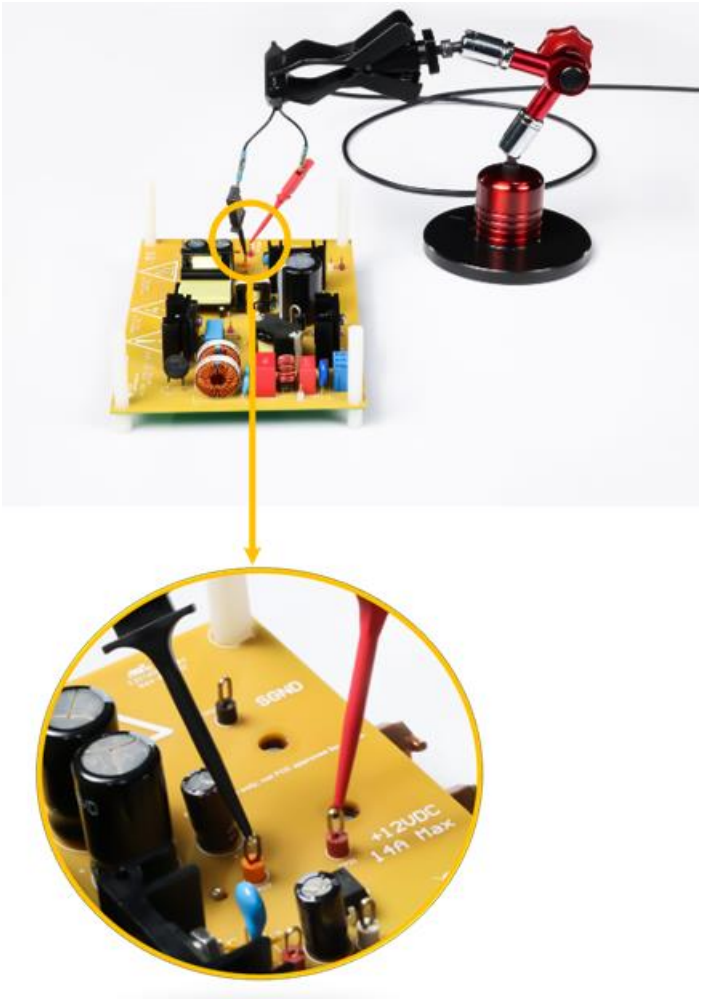


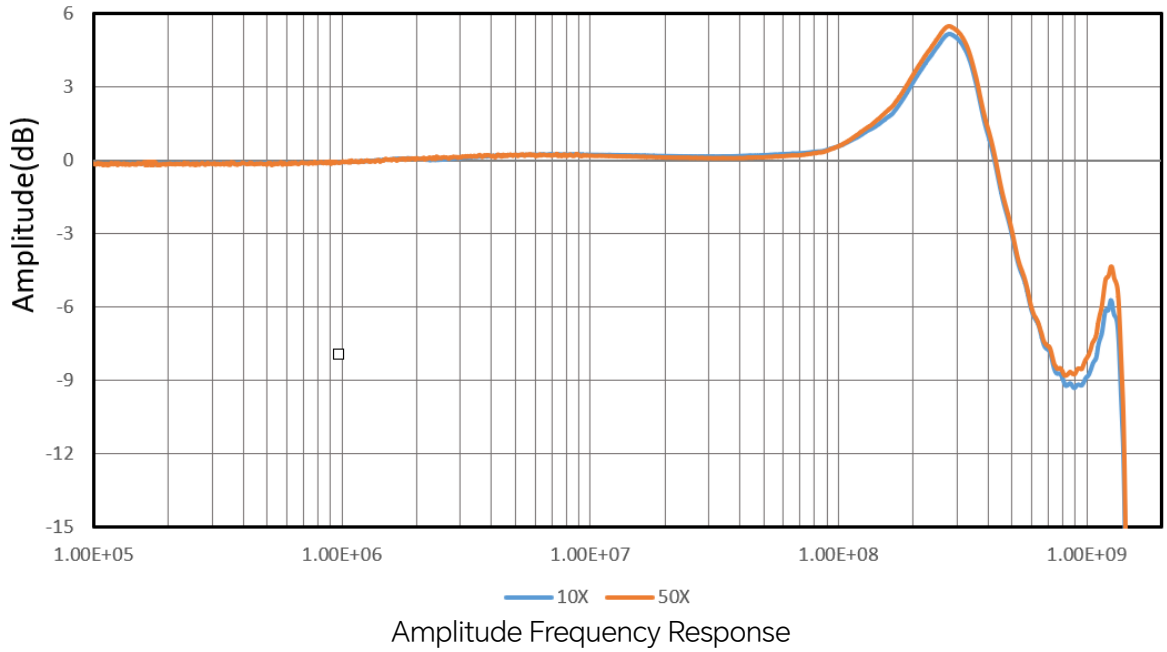


Amplitude Frequency Response

5.3.8 Use Chip Clip

The chip clip can be used to connect the pins of the test socket or the direct-insert chip, which is suitable for measuring signals with a bandwidth below 200MHz.





Amplitude Frequency Response

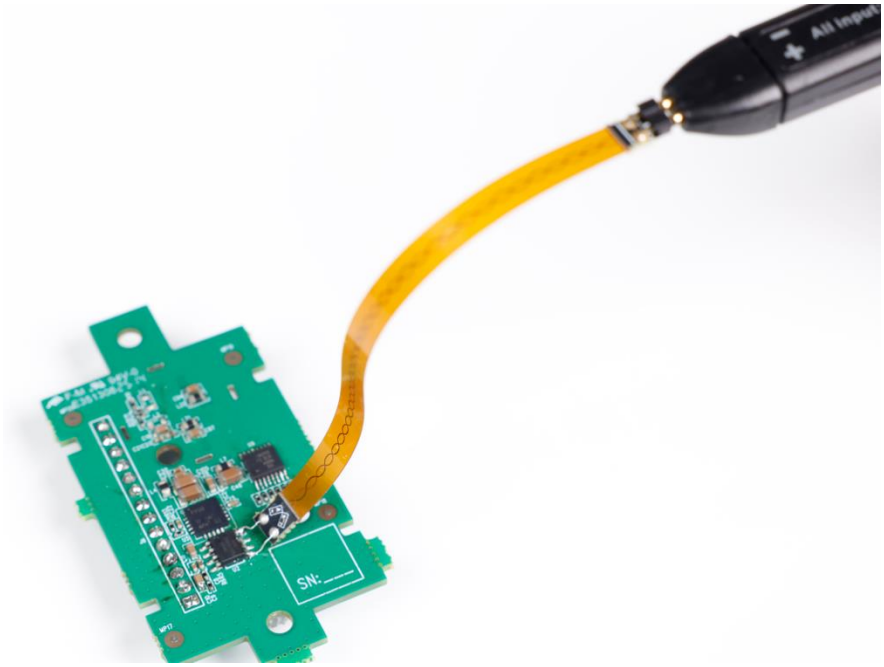
5.3.9 Use the Ground Wire

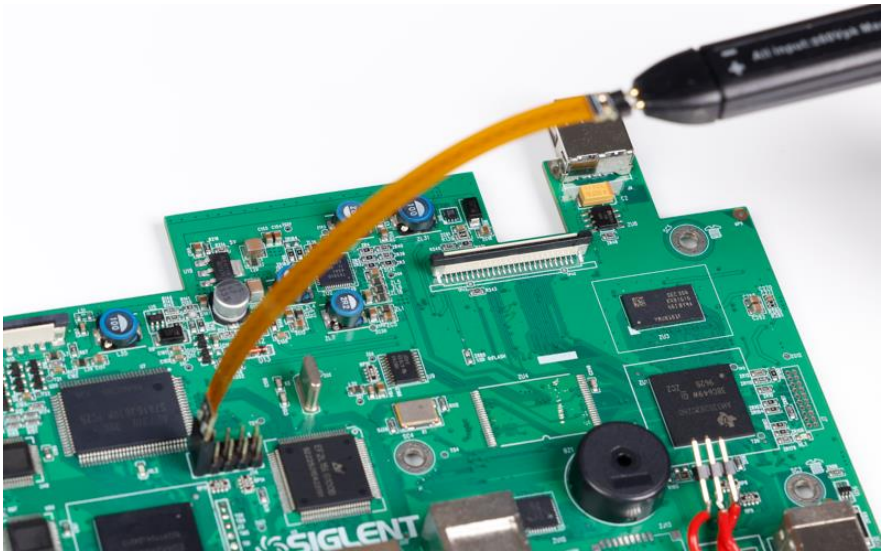
The SAP1000H amplifier has a dedicated grounding hole and is equipped with a variety of grounding wires. Try to use short grounding wires to connect the ground of the circuit under test and the measurement system together.

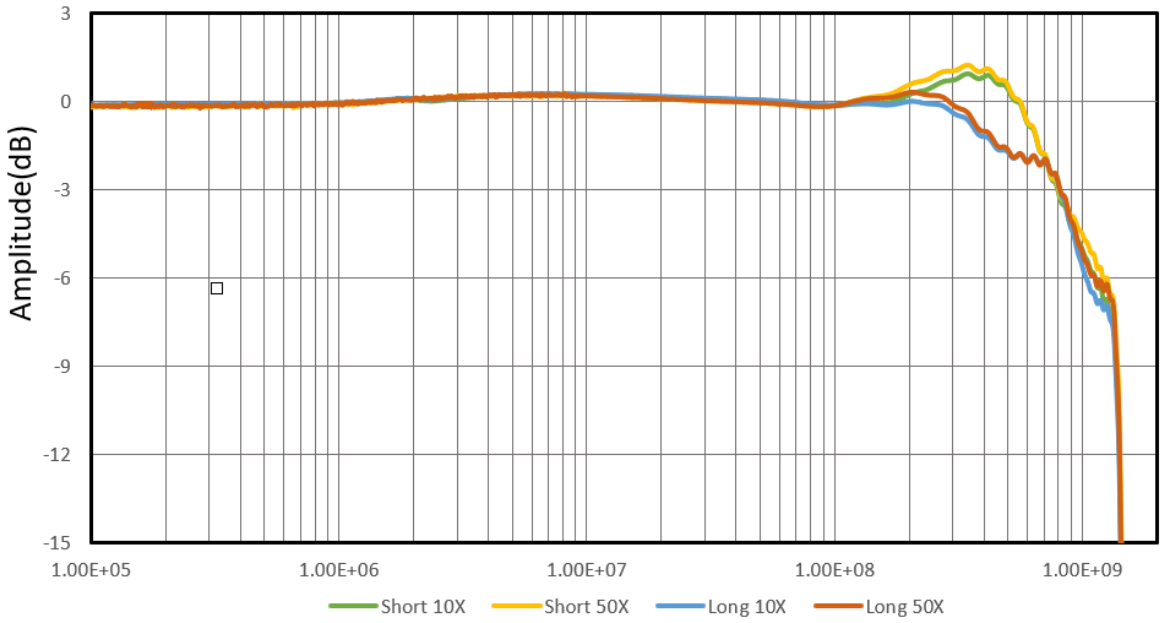


5.3.10 Use the Flex Adapter

The flex adapter has better stability and anti-interference performance, and is suitable for connection with 2.54mm pitch pin headers, or for soldering connection with the silver wire to tiny test points. For the flex adapter solder-in and square pin, we offer two lengths. The short flex adapter has a better measurement bandwidth.







Amplitude Frequency Response

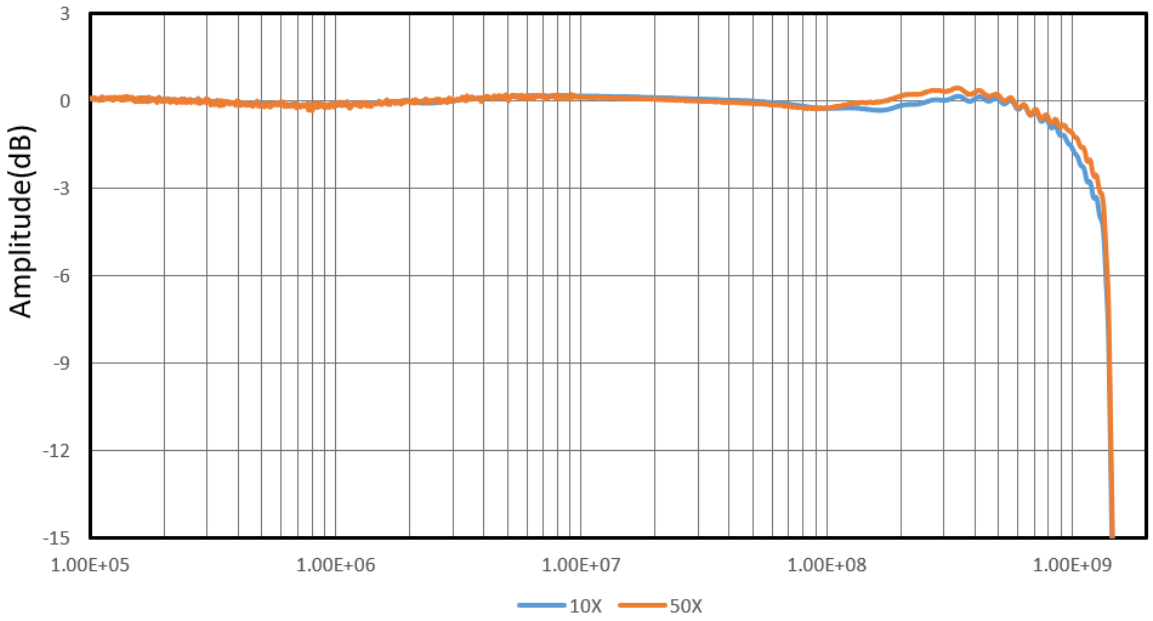
⚠	To ensure the accuracy of the amplitude of the high-frequency signal, the length of the silver wire after soldering should be less than 3mm.

5.4 External Attenuator

5.4.1 Specifications

Using an external attenuator on the SAP1000H can increase the input dynamic range of the probe. Currently, the EA0210 with an attenuation factor of 2X is supported. Here are the main parameters.

Parameters	SAP1000H	SAP1000H + EA0210
Bandwidth	1 GHz	1 GHz
Input Dynamic Range	±42 V	±60 V
Attenuation	10X/50X	20X/100X
Vertical Displacement Range	10X：±8.4 V 50X：±42 V	20X：±16.8 V 100X：±60 V
Maximum Input Voltage (Reference Ground Socket)	±60 V	±90 V
Differential Input Resistance	200 kΩ	400 kΩ
Differential Input Capacitance	1 pF	1.8 pF



The amplitude frequency response
after the external attenuator is connected to the probe

5.4.2 Connect Probe

If you need to connect the external attenuator to the probe, please follow the steps below.

1. Remove all accessories of the probe.

2. Install the pogo tip in the grounding hole of the probe amplifier.

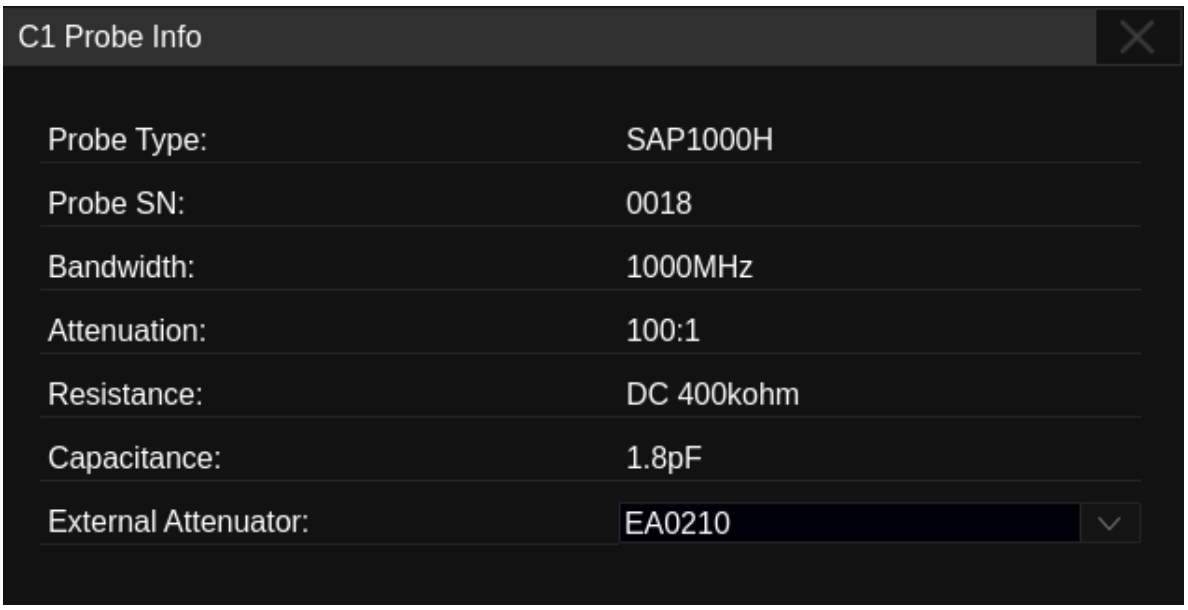


3. Connect the external attenuator to the probe amplifier in the following way. Ensure that the "+" and "–" of both are connected in the corresponding directions.



5.4.3 Oscilloscope Setting

When an external attenuator is connected to an active probe, the oscilloscope will not auto-detect it. The user needs to select the corresponding external attenuation model in the "External Attenuator" section of the active probe's information menu, such as "EA0210". After removing the external attenuator, the user needs to select "NC" in the "External Attenuator" section of the active probe's information menu.



5.5 Pigtail Cable Soldering

Before using the pigtail cable, please read the following instructions carefully, otherwise the cable and the circuit board under test may be damaged.

Soldering method:

1. First add a small amount of solder to the device under test.
2. Adjust the soldering iron to a suitable temperature (the contact point has a small heat dissipation area, and the soldering temperature cannot be too high, otherwise it is easy to damage the cable).
3. First solder the tip of the cable to the power network, and then solder the outer braid of the cable to the ground network.
4. When using the flex adapter solder-in, after soldering the silver wire, the recommended cutting length of the silver wire should be less than 3mm.

⚠	To avoid overheating and damaging the circuit board, do not allow the soldering iron to contact the solder point for longer than necessary.

5.6 Probe Fixing Method

When using the probe, the probe can be fixed using the corresponding probe positioner, which can free your hands and make the connection between the probe and the measured point more stable.

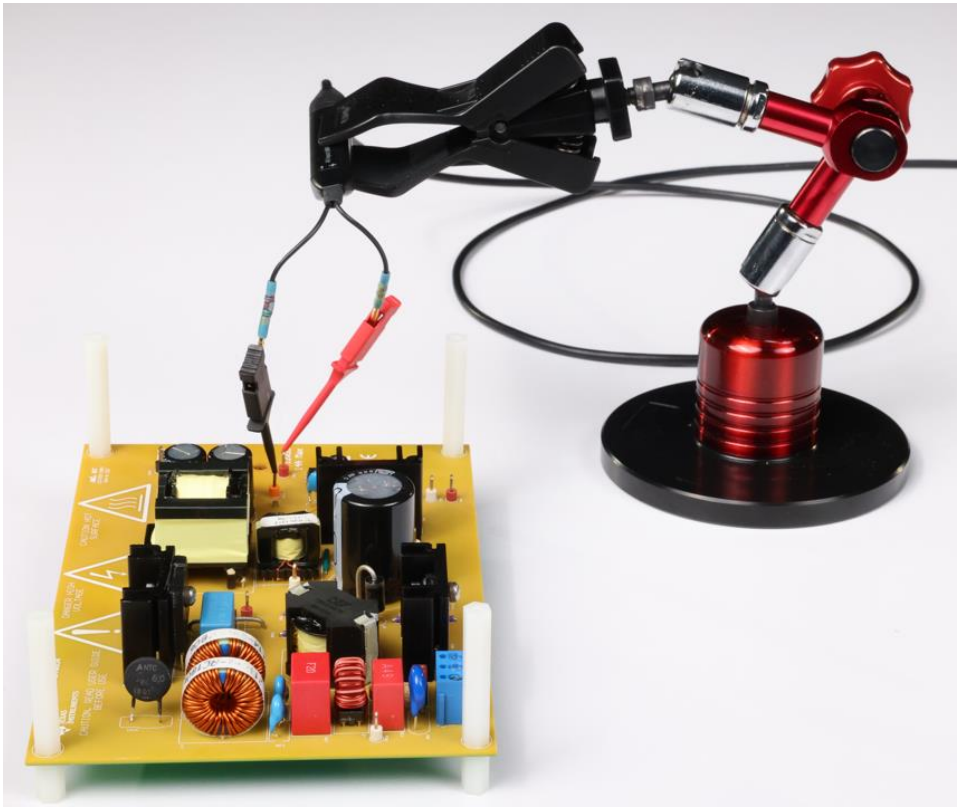
5.6.1 Fixing the Probe Using the Two-Legged Positioner PP201

PP201 is a standard accessory.



5.6.2 Fixing the Probe Using the 3D Positioner PP301

Adjusting the knob of the 3D positioner can adjust the resistance of the three force arms. Turning the knob clockwise increases the resistance and fixes it directly, while turning the knob counterclockwise decreases the resistance.



⚠	Do not turn the knob too far counterclockwise, just enough to allow the lever arm to move. Otherwise, the knob may become inoperable and require reassembly.

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