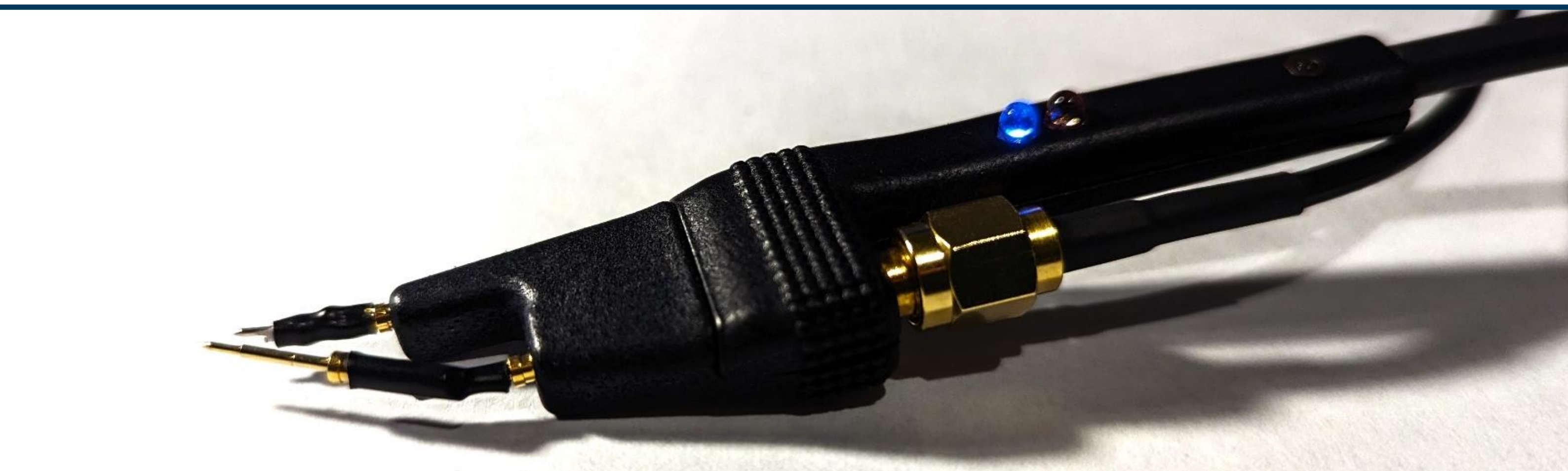
LD-ASP-2.7

SINGLE-ENDED ACTIVE PROBE

FEATURES

- 2.7 GHz bandwidth
- Ultra-low 0.7 pF probe tip capacitance
- 130 ps rise time
- Excellent cost to performance
- DC coupled probes for general purpose use
- Various swappable probe tips included
- Standard BNC output for connection to range of test equipment
- Test report included with every probe.



Parameter	Typical Values*
Bandwidth (-3dB)	DC – 2.7 GHz
Attenuation ratio	20:1
Probe tip capacitance	0.7 pF
DC input impedance	1 MΩ
Rise time	130 ps
Worst effective load resistance < 3.0 GHz	120 Ω
Return loss for probed line	<-15 dB
Response linearity, DC-2GHz	± 1 dB
RMS noise on output	350 µV
RMS noise referred to input (20:1 probe)	7 mV
Output Impedance	50 Ω
Measured input voltage dynamic range	± 14 V
Voltage rating (DC + AC peak) **	± 30 V
Cable length	1 m
Standby battery life	7 hours

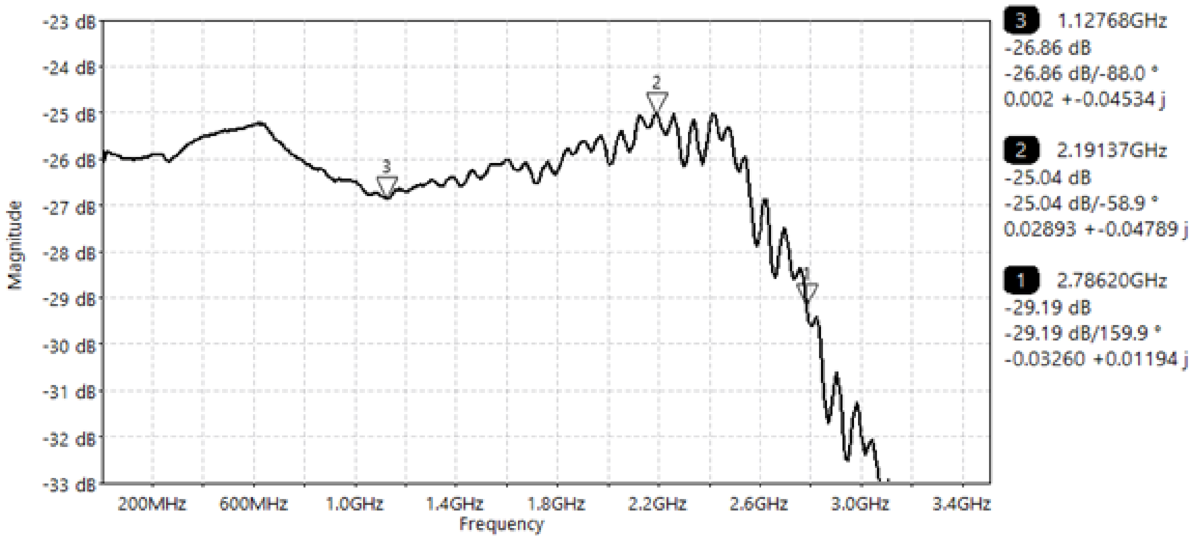
*All parameter values are typical values and are not guaranteed.

**See "Safety information" section. No suitable mechanical or electrical isolation is implemented to protect the operator from voltages deemed hazardous live according to EN 61010-1: 2010. Input voltages between the voltage rating specification and hazardous voltage levels should not cause damage to probe, but have not been qualified in our testing.

PERFORMANCE PLOTS

All measurements shown here were captured with the probe in the recommended handheld configuration, with supplied resistive signal tip, and sprung ground tip with angled ground extension socket. Plots show typical probe performance, actual performance may vary.

See “Measuring High Speed Signals - Probe Tip Loading”, “Frequency Response Measurement and Tuning Methods” and “Time Domain Measurements” sections for a description of the test setup used to capture performance plots.



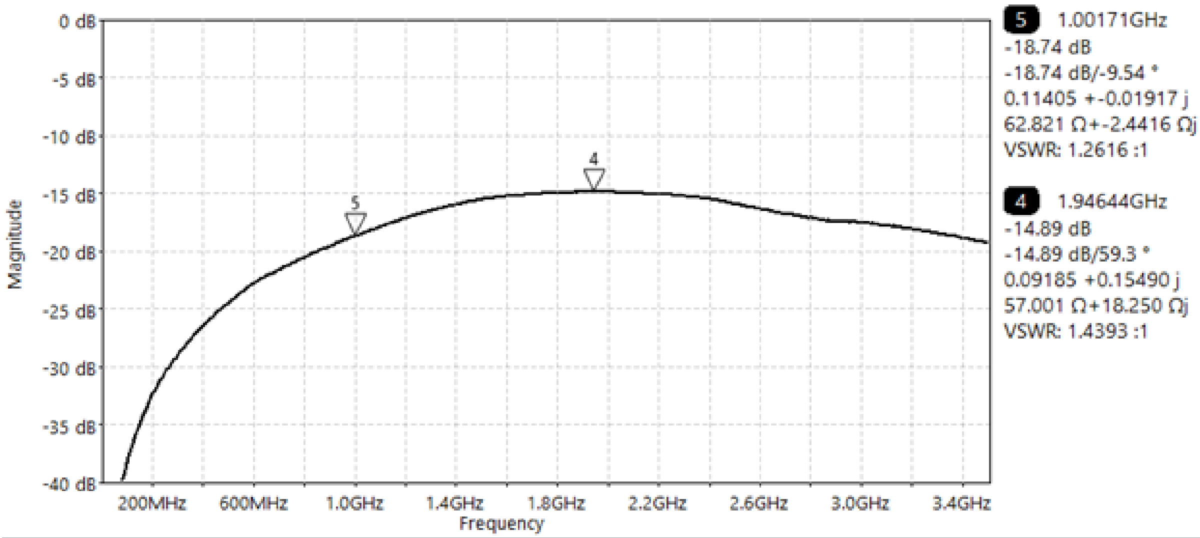


Figure 1. Top: Probe frequency response. Typical attenuation is -26 dB.
Bottom: 50 Ω coplanar waveguide with probe attached return loss.

Marker 1. -3 db point.
Marker 2. Maximum response.
Marker 3. Minimum response in DC - 2 GHz range.
Marker 4. Worst return loss.
Marker 5. Return loss at 1 GHz.

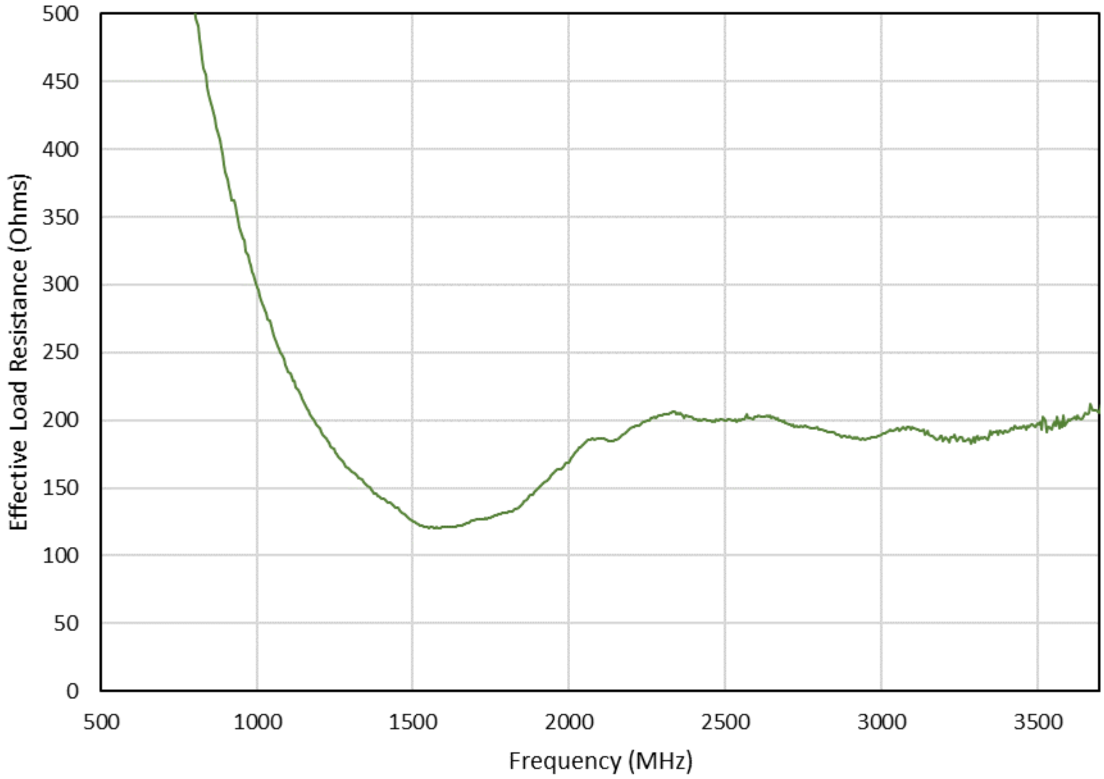


Figure 2. Typical effective load resistance. Measurement achieved by placing probe directly at VNA reference plane. Typical highest load is 120 Ω at 1.6 GHz.

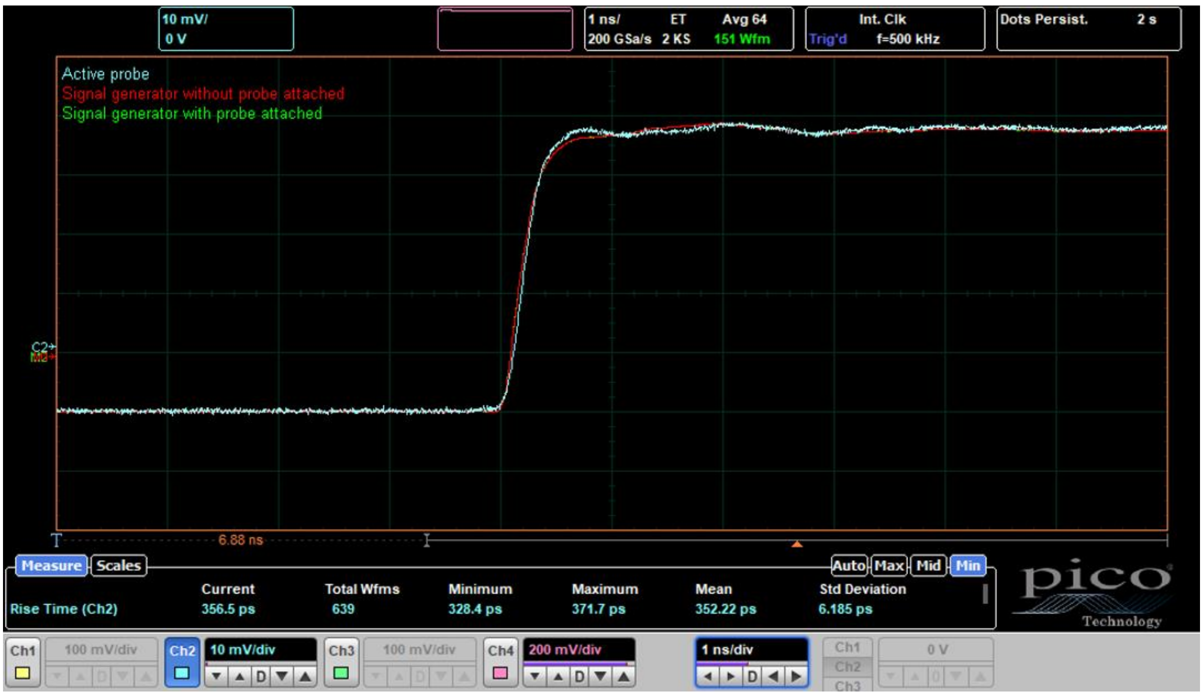


Figure 3. Typical probe step response to 350 ps rising edge. Blue line is output from probe, sensing signal via exposed coplanar waveguide. Red line is signal generator signal measured directly by oscilloscope without probe attached. Green line is signal generator signal measured directly by oscilloscope with probe attached. Good reproduction of original signal displayed, and signal generator signal is entirely unaffected as red trace completely overlaps green trace.

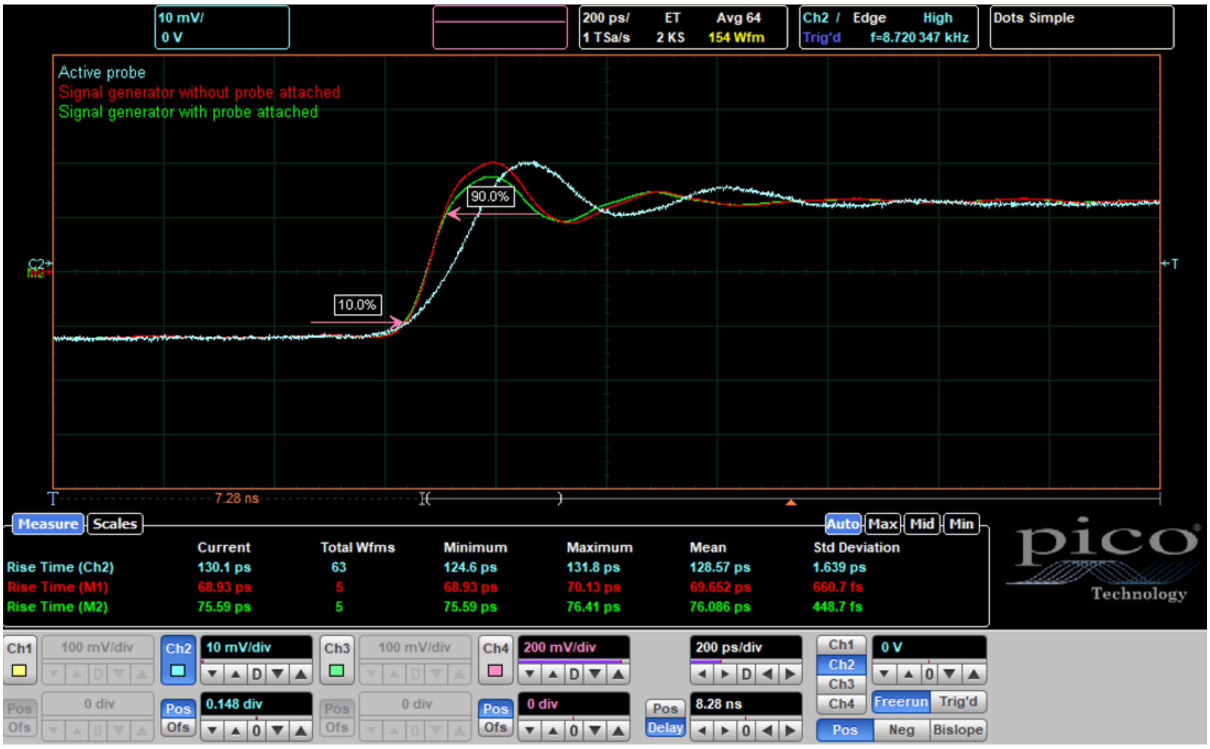


Figure 4. Rise time measurement using fast edge (70 ps) from fast signal generator. Blue line is output from probe, sensing signal via exposed coplanar waveguide. Red line is signal generator signal measured directly by oscilloscope without probe attached. Green line is signal generator signal measured directly by oscilloscope with probe attached. Probe rise time of around 130 ps is measured. Note probe has only a minor loading on this fast signal. The rise time of probed signal is slowed by around 6 ps, and it exhibits some reduction in peaking.

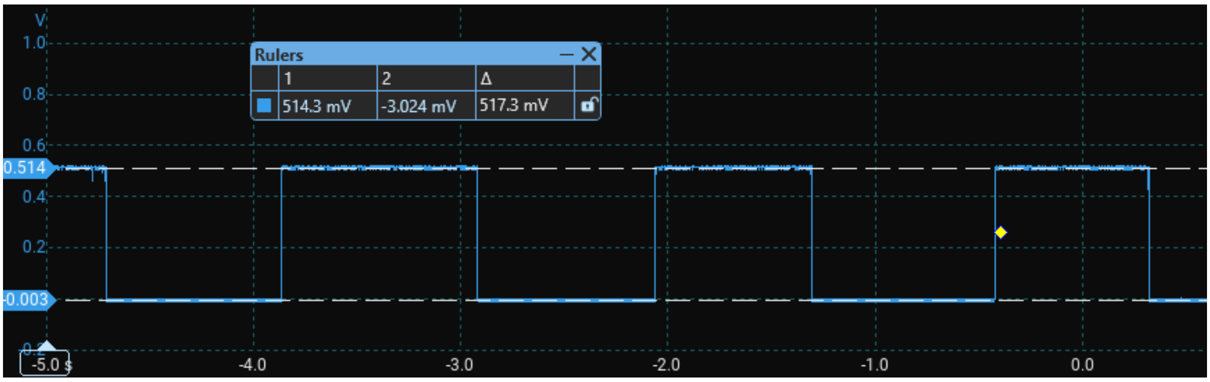


Figure 5. Low frequency and higher voltage performance. Probe response of an 0.5 Hz, 10 V square wave.

SAFETY INFORMATION

Follow all generally accepted safety practices and procedures for working with and near electricity. Symbols used in this document:

Symbol	Description
	Warning. Identifies conditions or practices that could result in injury or death.
	Caution. Identifies conditions or practices that could result in damage to the probe, equipment to which it is connected, or the device under test.

WARNING
To prevent injury or death only qualified personnel should use this product, only as instructed and with only accessories supplied or recommended.

WARNING
To prevent injury or death, DO NOT CONTACT THE PROBE TO HAZARDOUS VOLTAGES: ± 60 V DC, 30 V AC RMS, ± 42 V peak as defined by EN 61010-1. Take all necessary safety precautions when working on equipment where hazardous live voltages may be present. Do not probe near hazardous live or mains circuits in case of accidental contact with these. The LD-ASP-2.7 has no isolation to protect from hazardous live signals, as such it is classified as a Type D probe, according to IEC 61010-031:2023.

WARNING
To prevent personal injury or death, never contact the probe ground input to any electrical potential other than ground, and ensure that both probe and device under test have a common ground. Use a voltmeter to check that there is no significant AC or DC voltage between the probe ground and the ground point to which you intend to connect it. Significant AC or DC differences in the ground potential may cause damage to the probe, the device under test, and any connected equipment.

WARNING
To avoid injury or death, only use supplied 9 V battery box to power the probe. Third party power supplies may cause hazardous voltages to become accessible.

WARNING
To prevent injury or death, do not use near explosive gas or vapor.

CAUTION
Ensure adherence to “PROBE OPERATION GUIDANCE” section when connecting probe to external test equipment to avoid causing damage to the probe, test equipment, or the device under test.

CAUTION
Do not use the product if it appears to be damaged in any way. Stop use immediately if you are concerned by any abnormal behaviour.

CAUTION
The probe inputs and supply connections are protected internally against electrostatic discharges, however, measurement of voltages above the specified absolute maximum input voltage may cause damage.

CAUTION
Applying a voltage to the ground input may cause permanent damage to the probe or other connected equipment.

CAUTION
Take care to avoid mechanical stress or tight bends on the coaxial cable and power cable. Mishandling

could cause damage to cables, and degrade performance and measurement accuracy. Avoid applying excess pressure whilst probing with tips to avoid damaging the tips, sockets, or probe enclosure.

CAUTION

The probe enclosure is not sealed to liquids, only clean with damp cloth. Do not allow liquids to enter the probe or damage will occur. Ensure probe is dry before use.

CAUTION

Only operate the probe in the following environmental conditions:

1. Indoor use; Pollution degree 2;
2. Altitude up to 2000 m;
3. Ambient temperature 5 °C to 40 °C;
4. Dry location;
5. Maximum relative humidity of 80% for temperatures up to 31 °C, decreasing linearly to 50 % relative humidity at 40 °C.

PROBE OPERATION GUIDANCE

HOLDING THE PROBE

For best results, use of the probe should predominantly be handheld at the bump grips, according to the below photographs. The frequency response of the probe has been tuned considering handheld operation. The frequency response when clamped (not handheld) will have reduced linearity.

Due to the ultra-low 0.7 pF tip capacitance, care should be taken to only hold the probe at or behind the bump grips. Parasitic capacitance from a misplaced finger will modify the probe response and increase tip loading on the circuit being measured.

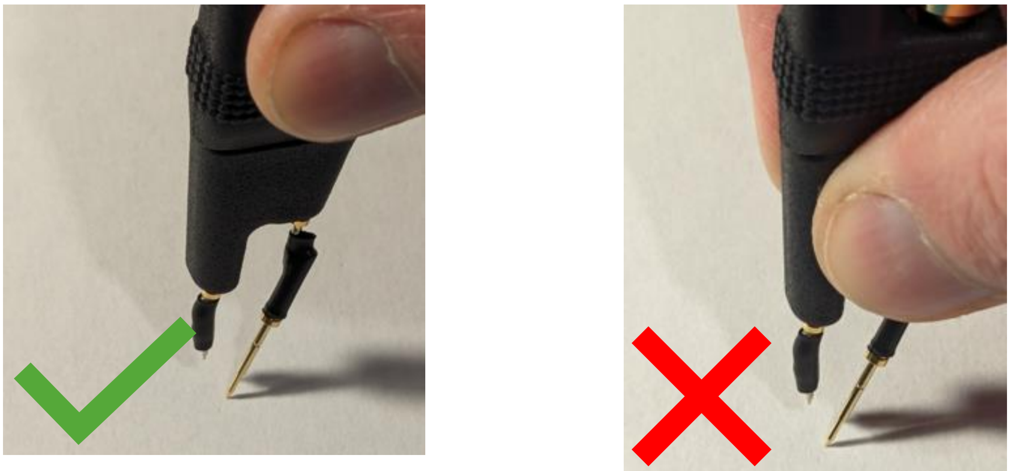


Figure 6. How to hold the probe. How not to hold the probe.

PROBE GENERAL OPERATION

Power to the probe is enabled by a slide switch on the 9 V battery box. A 9 V battery (not supplied) should be fitted in the battery box. A blue LED on the probe indicates it is powered. A red LED will light to indicate a low battery voltage condition. The device may still be used under this low voltage condition, but the measurement range and performance of the probe will be reduced.

When probing circuits, ensure that the probe is held or supported vertically and without applying excessive forces to the tips which can cause damage. Additionally, ensure that forces are generally applied axially to the tips and sockets. Excessive lateral forces on the tips can cause damage to the tips and sockets. Remove tips from probe sockets before storing probe in the provided hard carry-case.

TEST EQUIPMENT CONNECTION

When in good working order, the probe will output a maximum ± 1.6 V into a high impedance load, which due to its 50 Ω termination, will be observed as ± 0.8 V at a 50 Ω terminated device. DO NOT CONNECT ANY TEST EQUIPMENT WHOSE INPUT VOLTAGE RATING IS EXCEEDED BY THE MAXIMUM OUTPUT VOLTAGE SPECIFICATION OF THE PROBE. Additionally, if test equipment can be damaged by a voltage higher than the supply voltage to the probe (ie. 9 V from battery), the operator should confirm before connecting the probe that no electrical fault within the probe is present that is causing the output to drive outside the stated ranges. An oscilloscope with an appropriate voltage rating, or an in-line RF attenuator could be used here.

The probe BNC output has a 50 Ω impedance. Any interfacing equipment should be 50 Ω terminated. If interfacing equipment does not have a 50 Ω termination (such as a 1 MΩ oscilloscope input), a 50 Ω through terminator, or 50 Ω load on a BNC T-piece, can be used instead. However, these will likely distort the probe frequency response at higher frequencies.

Ensure that the probe BNC connector is connected to the test equipment at all times whilst probing a circuit.

The SMA–BNC cable may be replaced with a 1-meter RG174 SMA –SMA cable for interfacing with test equipment requiring an SMA input. Repeated connections and disconnections of the SMA connector will begin to degrade its performance. SMA connectors should be tightened with an SMA torque wrench to 1 Nm. The included BNC output coaxial cable is a part of the probe system. The attenuation induced by the cable has been considered when tuning the frequency response of the probe. As such, replacing the cable with a shorter or longer version will increase peaking and bandwidth, or reduce peaking and bandwidth of the probe as a whole.

PROBE TIPS GUIDANCE

Various probes tips are supplied for operation with the active probe:

Tip type	Quantity supplied	Parts used
Resistive signal pin	2	3340-1-00-15-00-00-03-0 P75-B1 spear tip RNF18FTD100R Structural epoxy Semi-rigid heat shrink
Angled ground socket extension pin	1	3340-1-00-15-00-00-03-0 7405-0-18-15-18-27-10-0 Semi-rigid heat shrink
Sprung ground pin	4	PA75-B1 (alternative P75-B1)
Solderable pin	2	3340-1-00-15-00-00-03-0
90° solderable pin	2	3740-0-14-15-00-00-03-0

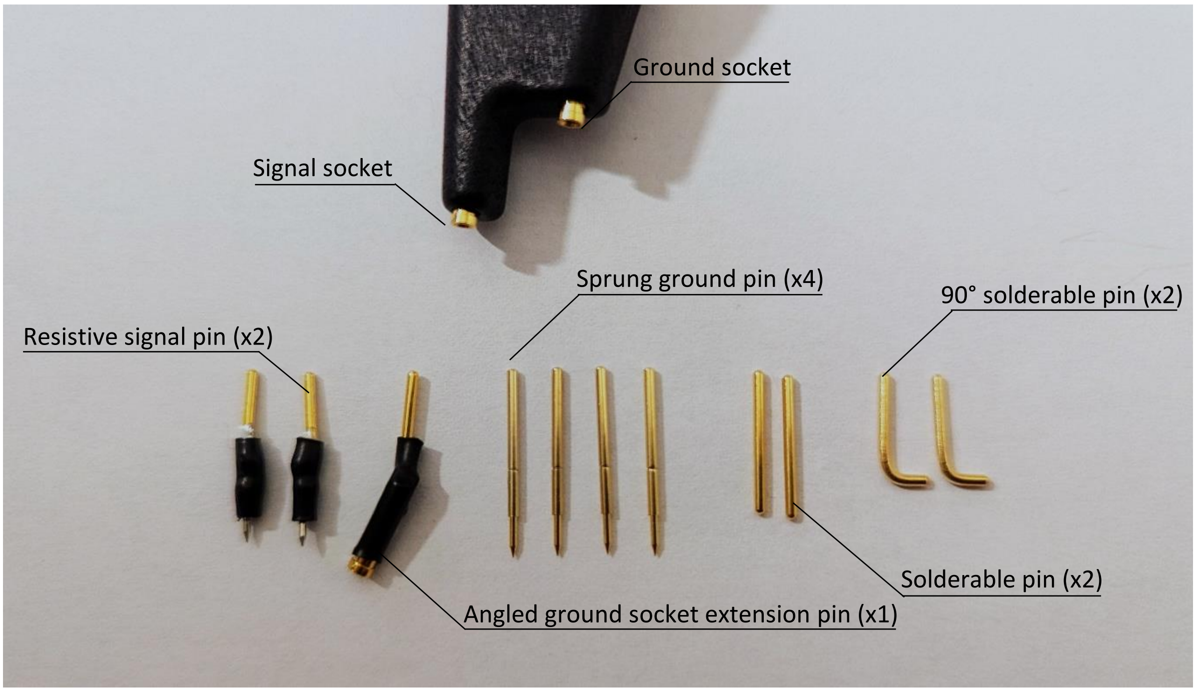


Figure 7. Supplied pins with probe.

When loading tips into sockets, be careful not to stab yourself in the finger with the tip. It is sharp.

The probe contains two sockets for signal and ground, as indicated in Figure 7. The probe is typically used with the included resistive signal pin, the angled ground socket extension pin with a sprung ground pin. The frequency response of the probe is tuned under this configuration.

The signal socket must be used with a resistive tip, or a solderable pin with a 100 Ω resistor soldered in series, as the probe's frequency response is tuned using the resistive signal pin. For solder-in applications, a low inductance resistor type must be used, such as a metal film resistor. Utilising a higher value resistor will reduce the bandwidth and distort the frequency response, but also reduce the loading effect of the probe on the circuit under test.

The angled ground socket extension should be used if handling the probe by hand. Here a sprung ground pin is loaded into the angled socket, this allows achieving a good connection of both pins much easier. Additionally, as the ground pin can pivot, the angled sprung ground pin is able to reach a reasonable distance to a nearby ground reference. Note that improved signal integrity is achieved by keeping the ground connection length reasonably short. Measurements with no tip ground connection are also possible, by relying on a ground connection through the test equipment. This results in a distorted probe frequency response, however the probe tip loading is further reduced.

Solderable straight and 90 degree pins are included if a solder connection to the circuit under test is required.

MEASURING HIGH SPEED SIGNALS – PROBE TIP LOADING

The primary benefit of an active probe is to enable accurate measurements of high-speed signals, while applying negligible load. A series 1 MΩ resistor enables the probe to be used generally with higher impedance or lower speed signals. At higher frequencies, the probe tip capacitance imposes a reactive load on the measured circuit. Careful design of the probe input circuitry is necessary to reduce the tip capacitance. For this probe, the tip's 0.7pF capacitance is stated as measured at 1 GHz.

In many active probes, applied frequencies above 1 GHz begin to set up resonances within the tips, leading to significant unwanted rises in tip loading. This is reduced in this probe via careful design, and the use of a short resistive signal pin. Therefore, to attain an understanding of the probe's actual effect on the circuit, it is essential to plot the effective load resistance across the full bandwidth of the probe. This is plotted in Figures 1 and 2.

Quoted tip impedance measurements in Figure 2 are measured using a vector network analyser (VNA), where the probe tips are connected directly at the reference plane. The loading effect of the probe placed 25 mm from the termination of a 50 Ω coplanar waveguide is shown in Figure 1.

FREQUENCY REPSONSE MEASUREMENT AND TUNING METHODS

The LD-ASP-2.7 probe frequency response is tuned in such a way that the output represents the original unloaded signal, rather than the signal as loaded by the probe. This follows how most other probe manufacturers tune their active probes, see Tektronix's "Probe Bandwidth Calculations" technical brief. This tuning strategy is employed because we also believe the user will be more interested in the form of the original unloaded signal. This contrasts with viewing the loaded signal, and then having to perform a back calculation that incorporates the frequency dependent probe loading, to attempt a reconstruction of the original signal.

The probe calibration is completed by arranging the probe to measure a realistic signal in the form of a coplanar waveguide, fitted to the port 1 of a VNA, with the reference plane at the coplanar waveguide termination. The VNA S21 has been calibrated with a normal 'through' measurement from the reference plane. The BNC output of the probe is then connected to the VNA's port 2 reference plane, and the probe tips placed on the coplanar waveguide, 25 mm from the waveguide termination, representing a realistic usage scenario of the probe. The frequency response of the probe is then tuned so that the original signal (but attenuated 20x [-26 db]) is recovered, and the VNA S21 measurement displays a flat response, despite the probe loading the VNA's port 1 output.

PERFORMANCE INSIGHTS

An important point to consider with this widely used tuning system is that the probe response is tuned to be flat when measuring a circuit node with a 50 Ω source impedance, and 50 Ω termination. If the probe is used on other circuits with other impedances, there will be distortions in the frequency response at higher frequencies. For example, considering an LVDS 100 Ω transmission line, the frequency response at high frequencies will be somewhat attenuated as compared to the original unloaded signal. In general, however, due to the ultra-low tip capacitance, these distortions will be minimal as the signal would not be loaded significantly in the first place.

Another important point is that even in a 50 Ω system, the probe frequency response is dependent on the probe loading, which is dependent on where along the transmission line the probe is placed, and other specifics of the measured transmission line. Because of this, it is difficult to get consistent measurements of the probe frequency response across test setups and fixtures.

Due to limitations in the probe output slew rate, combined very-high amplitude and high-speed input voltage swings will lead to distortions in the output signal. The maximum output slew rate a 50 Ω terminated oscilloscope would measure, is 1 V per nanosecond. For example, given the 20x probe attenuation and a measured rising edge with a 10 V swing on the input, the probe will start to become slew-rate limited if the rising edge time is faster than 500 ps.

When driving the input of the probe over around ± 10 V continuously, the probe will start to warm up and there will be a drift in the frequency response. The probe warms up as the amplifier output is drives additional current through its amplifier feedback network at higher voltages.

The probe is sensitive to ambient RF noise, which can be picked up by the probe input circuitry. This will appear as noise on the probe output. If low noise measurements are required, consider shielding the body of the probe.

TIME DOMAIN MEASUREMENTS

Oscilloscope time domain measurements shown in Figures 3 and 4 were captures with the following setup. A signal generator with a fast rising-edge is measured by a sampling oscilloscope (Picoscope 9404-16), via an intermediate coplanar waveguide board (into channel 4). The active probe measures the signal on the coplanar waveguide, and the probe output is measured by the oscilloscope (channel 2). In Figures 3 and 4, the source signal generator trace has been saved and delayed, to allow it to be overlaid with the probe signal trace, due to the phase delay induced by the probe.

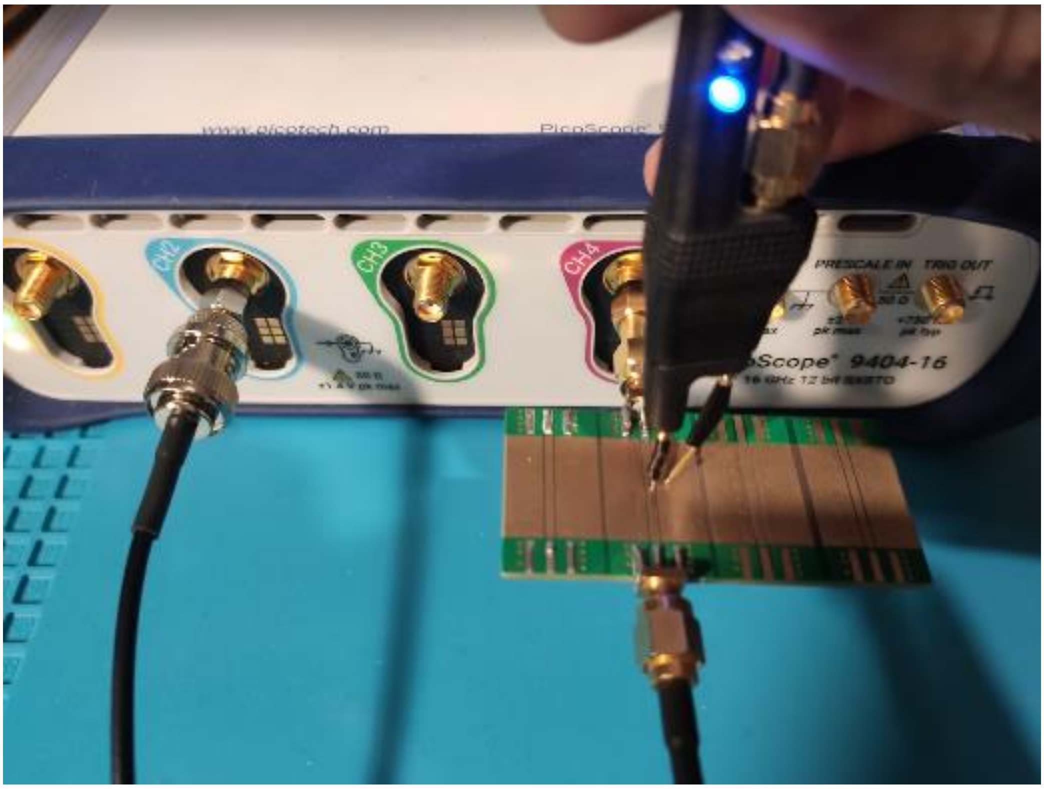


Figure 8. Time domain measurement setup.

DC SUPPLY REPLACEMENT AND PROBE MAINTINANCE

If the battery box is to be replaced with a different DC voltage source, the new voltage source must be floating relative to ground. The negative rail of the probe is tied directly to the negative terminal of the power supply, with a virtual ground created 2.5 V above this. This virtual ground is connected to the test equipment ground through the BNC cable. If a ground-referenced supply is connected, the probe will not function correctly and damage is likely to occur. The input voltage range for any supply is 5.3–15.0 V. A lower voltage 5.0 V floating supply can be used, although the dynamic range of the probe will be slightly reduced, and the low battery LED will be lit permanently. Any selection and application of a 3rd party power supply must be completed by a qualified and competent individual, and Lasmux Devices accept no liability for any injuries or damages caused by 3rd party PSU selection.

Do not disassemble the device as input and amplifier circuits have very precisely tuned capacitances. Skin oils or other contamination will negatively affect these and modify the frequency response of the probe. If the probe is disassembled, ensure the circuit board is thoroughly cleaned of any contaminants.

Periodically inspect the coaxial and power cable for any wear.

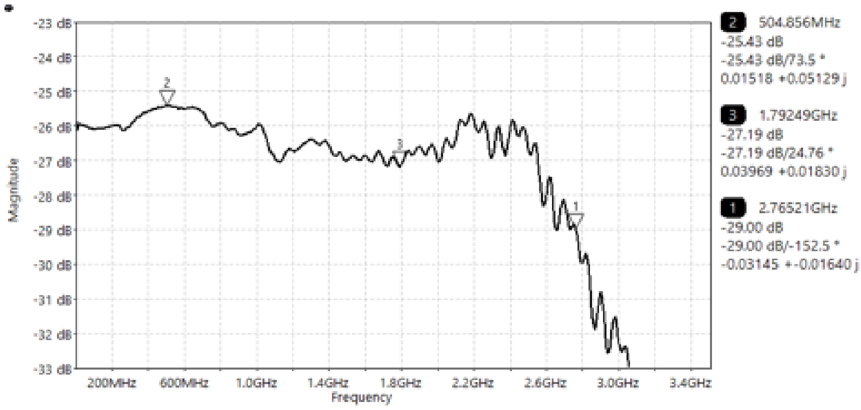
EXAMPLE LD-ASP-2.7 TEST SHEET

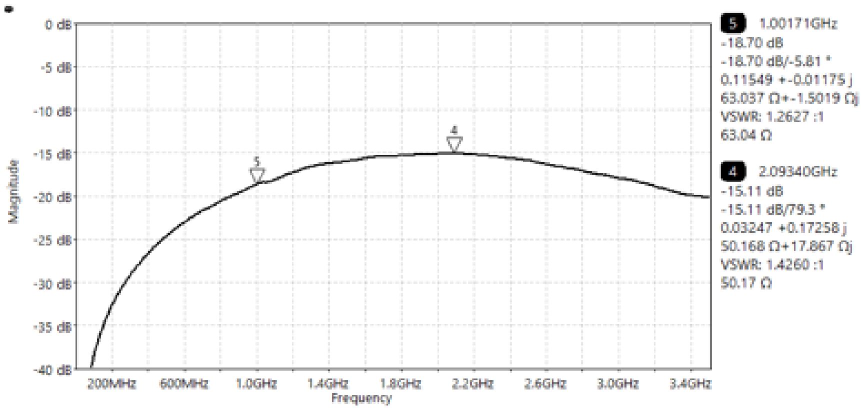
Serial number: ASP002
Test date: 2024/02/15

Test data is only indicative of device performance. All test data is strongly dependent on specific test fixture setup and probe configuration. As such user observed probe characteristics will likely be different. For details on test processes, refer to datasheet.

Test	Measured	Unit
Bandwidth (-3db)	2.77	GHz
Input capacitance at 1GHz	0.71	pF

Probe frequency response (above), and 50Ω coplanar waveguide S11 (below) with probe attached.





Marker 1. -3db point

Marker 2. Maximum response.

Marker 3. Minimum response in DC-2GHz range.

Marker 4. S11 reflection maximum

Marker 5. S11 reflection at 1GHz

WARRANTY

Lasmux Devices warrants this device for normal use and operation within specifications for a period of one year from date of shipment, and will repair or replace any defective product which was not damaged by negligence, misuse, improper installation, accident or unauthorized repair or modification by the buyer. This warranty is applicable only to defects due to material or workmanship, and does not cover normal wear and tear to parts such as cables and probe tips. Lasmux Devices disclaims any other implied warranties of merchantability or fitness for a particular purpose.

MANUFACTURER

Dr Jeremy Leaf
41 Townsend Lane
Rugby
Warwickshire
CV23 9DG
UK

SALES & SUPPORT

Lasmux Devices
41 Townsend Lane
Rugby
Warwickshire
CV23 9DG
UK
support@lasmux.com