Agilent Technologies Soft Touch Connectorless Probes

User's Guide

Agilent Technologies

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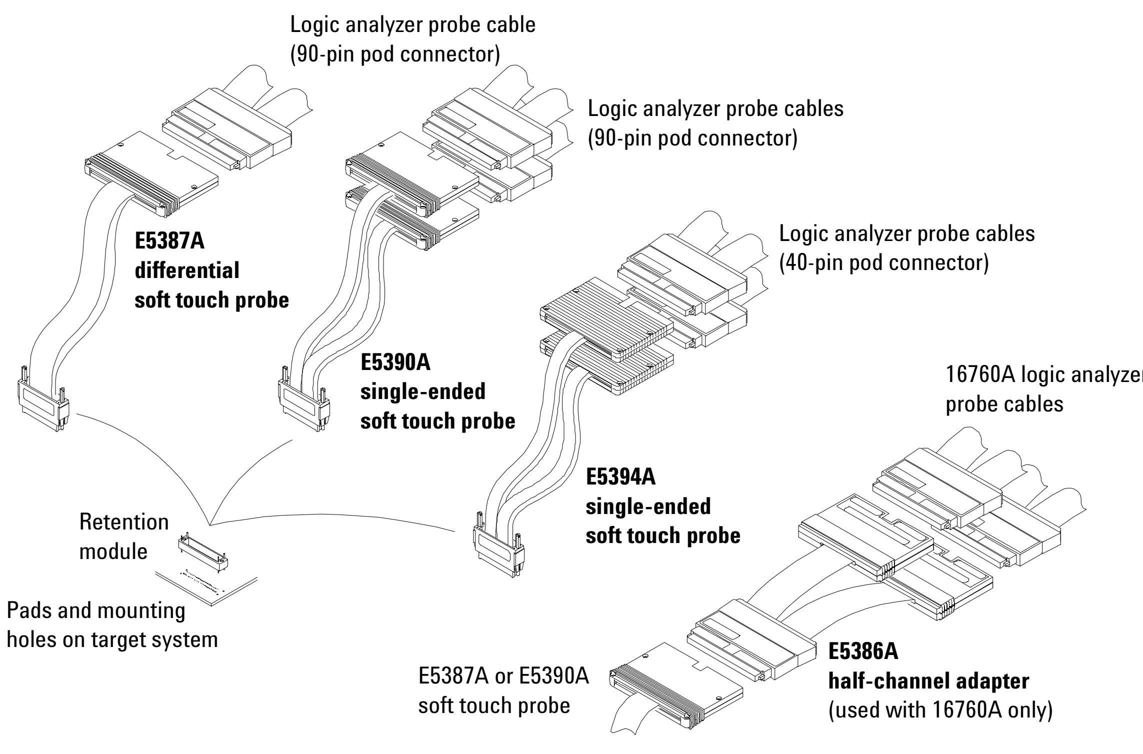
Probing Options

The Soft Touch Probes - At a Glance

The new Agilent soft touch probes are ultra-low-load connector-less probes that work with the Agilent logic analysis modules. The probes attach to the PC board using a retention module which ensures pin-to-pad alignment and holds the probe in place.

- The E5387A is a 17-channel differential connectorless soft touch probe (for analyzers with 90-pin pod connectors).
- The E5390A is a 34-channel single-ended connectorless soft touch probe (for analyzers with 90-pin pod connectors).
- The E5394A is a 34-channel single-ended connectorless soft touch probe (for analyzers with 40-pin pod connectors).
- The E5386A adapter works with the soft touch probes in half-channel state mode on the 16760A logic analyzer.



Introduction to Probing Options

This chapter provides descriptions of the logic analyzer probes and adapters to help you select the appropriate probe for your application. The first table shows how many probes are required to provide connections to all channels of your logic analyzer module. The second table gives you the maximum state speed that is supported by the combination of a probe and your logic analyzer module.

Table 1 Number of Probes Required

	Logic Analyzer Module		
Probe	**16760A**	**16753A, 16754A, 16755A, 16756A**	**1670 Series, 1680/90 Series, 16710/11/12A, 16715/16/17A, 16740/41/42A, 16750/51/52A&B**
E5387A differential soft touch probe	2	4	n/a
E5390A single-ended soft touch probe	1	2	n/a
E5394A single-ended soft touch probe	n/a	n/a	2

Table 2 Maximum State Speed Supported

	Logic Analyzer Module		
Probe	**16760A**	**16753A, 16754A, 16755A, 16756A**	**1670 Series 1680/90 Series, 16710/11/12A, 16715/16/17A, 16740/41/4A, 16750/51/52A&B**
E5387A differential soft touch probe	1.5 Gb/s	600 MHz	n/a
E5390A single-ended soft touch probe	1.5 Gb/s	600 MHz	n/a
E5394A single-ended soft touch probe	n/a	n/a	400 MHz

Retention Modules

A kit of five retention modules are supplied with each probe. Additional kits can by ordered using Agilent part number E5387-68701. If more than 5 retention modules are needed, please contact Precision Interconnect at10025 SW Freeman Court, Wilsonville, OR 97070, http://www.precisionint.com/, 1-503-685-9300. Order part number 600-0118-01.

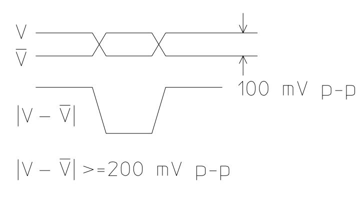
The E5387A Differential Soft Touch Probe

(for analyzers with 90-pin pod connectors)

The Agilent E5387A is a 17-channel, differential, soft touch probe compatible with the Agilent 16753A, 16754A, 16755A, 16756A, and 16760A logic analysis modules. It is capable of capturing data up to the rated maximum state (synchronous) analysis clock rates of all the supported analyzers, with differential signal amplitudes as small as 200 mV peak-to-peak (100 mV peak-to-peak on both positive and negative inputs). A retention module must be installed on the target system board to attach the probe to the board.

A kit of five retention modules are supplied with each E5387A probe. Additional kits can be ordered using Agilent part number E5387-68701.

Differential Input Amplitude Definition For differential signals, the difference voltage $V - \overline{V}$ must be greater than or equal to 200 mV p-p.



See Also: Chapter 2 for the mechanical information to design your target system board.

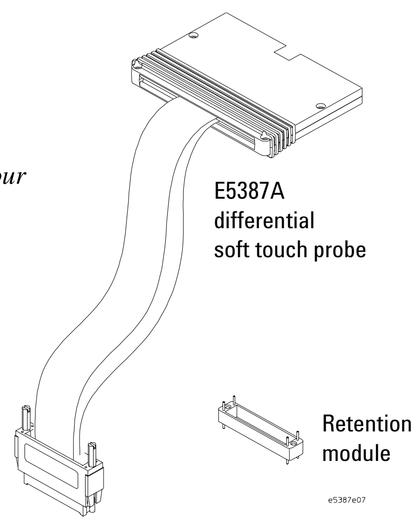


Figure 1 E5387A differential soft touch probe and retention module

The E5390A Single-ended Soft Touch Probe

(for analyzers with 90-pin pod connectors)

The Agilent E5390A is a 34-channel, single-ended, soft touch probe compatible with the Agilent 16753A, 16754A, 16755A, 16756A, and 16760A logic analysis modules. It is capable of capturing data up to the rated maximum state (synchronous) analysis clock rates of all the supported analyzers, with signal amplitudes as small as 250 mV peak-to-peak. A retention module must be installed on the target system board to attach the probe to the board.

A kit of five retention modules are supplied with each E5390A probe. Additional kits can be ordered using Agilent part number E5387-68701.

See Also: Chapter 2 for the mechanical information to design your target system board.

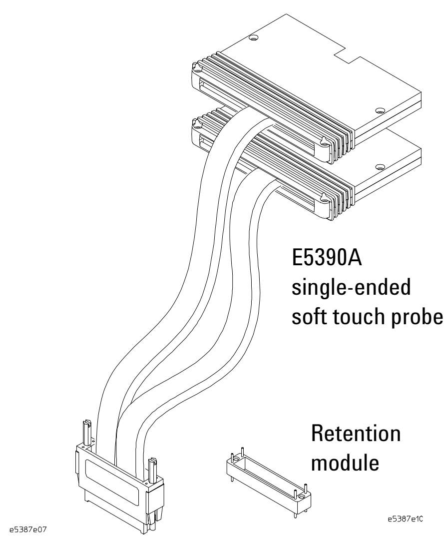


Figure 2 E5390A single-ended soft touch probe and retention module

The E5394A Single-ended Soft Touch Probe

(for analyzers with 40-pin pod connectors)

The Agilent E5394A is a 34-channel, single-ended, soft touch probe compatible with the Agilent 1670 series, 1680/90 series, 16710/11/12A, 16715/16/17A, 16740/41/42A, and 16750/51/52B logic analysis modules. It is capable of capturing data up to the rated maximum state (synchronous) analysis clock rates of all the supported analyzers, with signal amplitudes as small as 500 mV peak-to-peak. A retention module must be installed on the target system board to attach the probe to the board.

A kit of five retention modules are supplied with each E5394A probe. Additional kits can be ordered using Agilent part number E5387-68701.

See Also: Chapter 2 for the mechanical information to design your target system board.

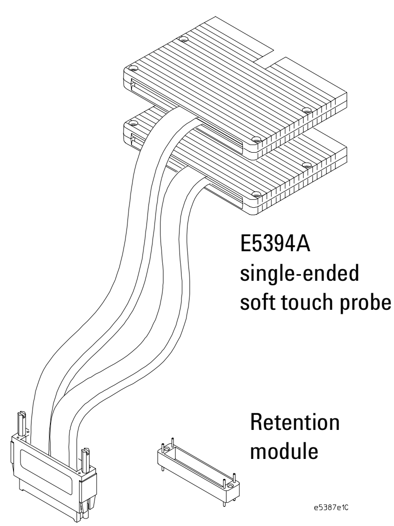
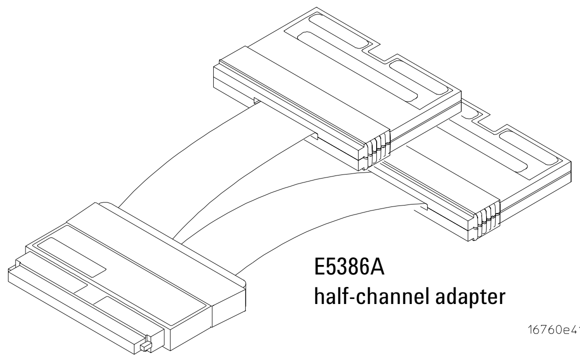


Figure 3 E5390A single-ended soft touch probe and retention module

The E5386A Half-channel Adapter

(for use with the 16760A logic analyzer)

The E5386A Half-channel Adapter is intended to be used with the Agilent 16760A logic analyzer in half-channel state mode. It supports both the E5387A differential soft touch probe and the E5390A single-ended soft touch probe.



The E5386A Half-channel Adapter has its own ID code. When using the adapter, the 16760A logic analyzer recognizes its code rather than that of the probe which is attached to the target. Therefore, the user interface format menu doesn't automatically set thresholds to the right values. You need to go into the threshold menu and select (differential, custom, or standard settings).

When using the adapter in half-channel state mode:

- Clock-bits are not available in half-channel state mode (although JCLK on the master is still used).
- Be sure to connect Master pod 1 of the logic analyzer to the upper bits, 8-15 + clk, on the half-channel adapter. This is necessary to connect the clock in the system under test to the logic analyzer system clock.
- Using the E5386A does not reduce the performance of the 16760A logic analyzer and the soft touch probes.

If the E5386A is used in full-channel state mode, the thresholds on the unused (odd) bits are floating. This could result in spurious activity indicators in the format menu.

2
Mechanical Considerations

Use the following mechanical information to design your target system board.

Characteristics, Dimensions, and Pin Outs

Characteristics

Electrical considerations such as equivalent probe loads, input impedance, and time domain transmission are shown in chapters 3 and 4 of this manual. Other characteristics are dependant on the logic analyzer module you are using.

Probe dimensions

The following figures show dimensions, footprint, and pin-out information you will need to design your target system board for use with the Agilent soft touch probes

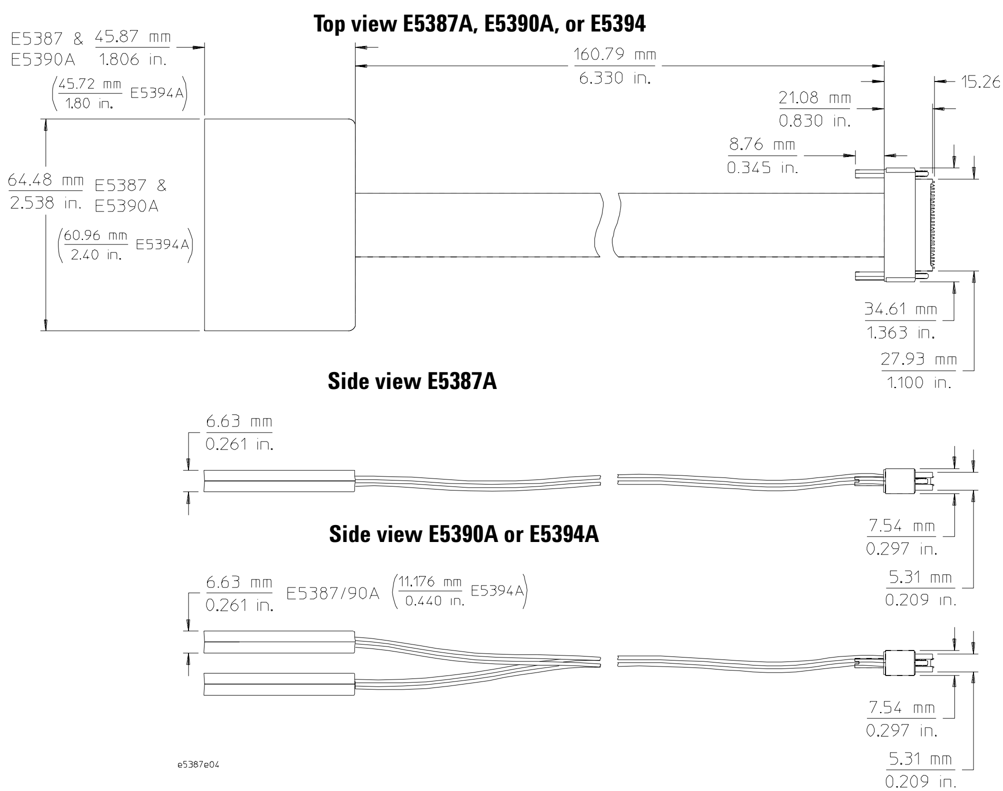


Figure 4 Probe dimensions

Retention module dimensions

The soft touch probes are attached to the PC board using a retention module which ensures pin-to-pad alignment and holds the probe in place. A board thickness of up to 2.54 mm (0.100 in.) is recommended. Insert the retention module into the board, noting the keying pin, and solder the 4 alignment pins to the backside of the board.

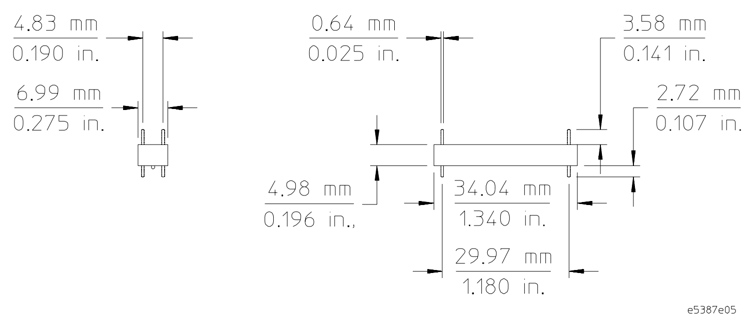


Figure 5 Retention module dimensions

Probe and retention module dimensions

The following dimensions show the soft touch probe attached to the retention module. The retention module is mounted on the PC board.

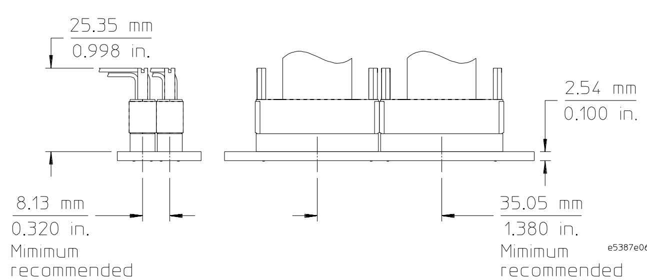
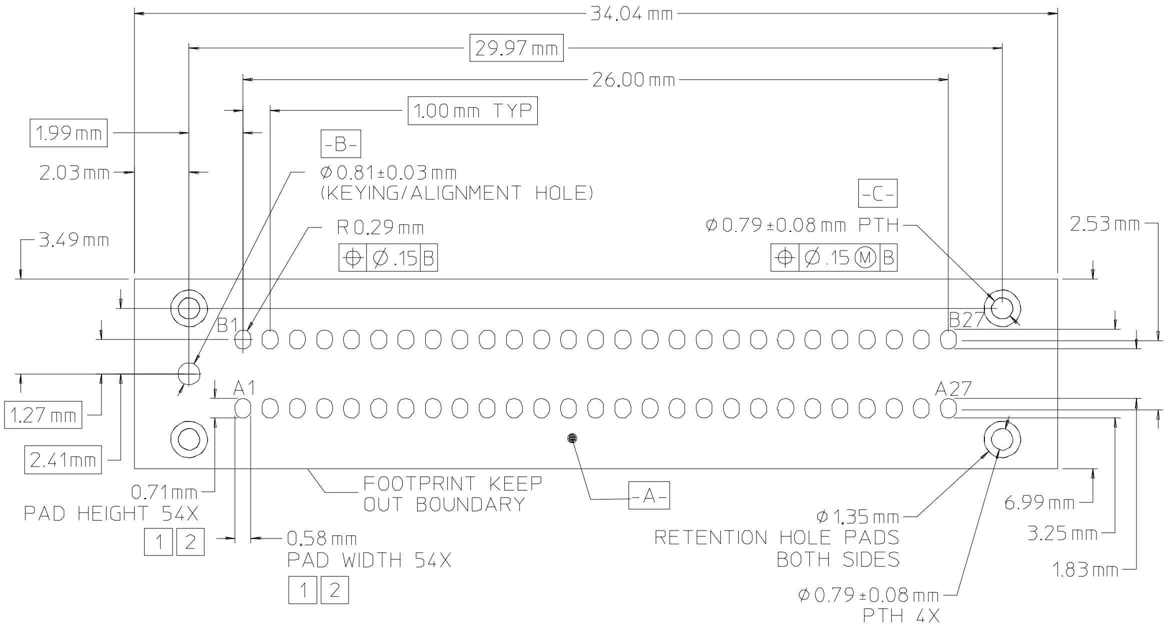


Figure 6 Probe and retention module dimensions

Probe footprint dimensions

Use these probe footprint dimensions for the E5387A, E5390A, and E5394A to layout your PC board pads and holes for attaching the retention module.



NOTES:

1. MUST MAINTAIN A SOLDER MASK WEB BETWEEN PADS WHEN TRACES ARE ROUTED BETWEEN THE PADS ON THE SAME LAYER. SOLDERMASK MAY NOT ENCROACH ONTO THE PADS WITHIN THE PAD DIMENSION SHOWN.
2. VIA IN PAD NOT ALLOWED ON THESE PADS. VIA EDGES MAY BE TANGENT TO PAD EDGES AS LONG AS A SOLDER MASK WEB BETWEEN VIAS AND PADS IS MAINTAINED.
3. PERMISSABLE SURFACE FINISHES ON PADS ARE HASL, IMMERSION SILVER, OR GOLD OVER NICKEL.
4. FOOTPRINT IS COMPATIBLE WITH RETENTION MODULE, AGILENT PART #E5387-68702.
5. RETENTION MODULE DIMENSIONS ARE 34.04 mm x 7.01 mm x 4.98 mm TALL RELATIVE TO THE TOP SURFACE OF THE PDB. RETENTION PINS EXTEND 4.32 mm BEYOND THE BOTTOM SURFACE OF THE RM THROUGH THE PCB.
6. ASSUME NORMAL ARTWORK TOLERANCES FOR PAD SIZE DIMENSIONS

e5387e03

Figure 7 Footprint dimensions for the E5387A, E5390A, and E5394A.

E5386A half-channel adapter dimensions

The E5386A half-channel adapter works with the 16760A logic analyzer and the soft touch probes.

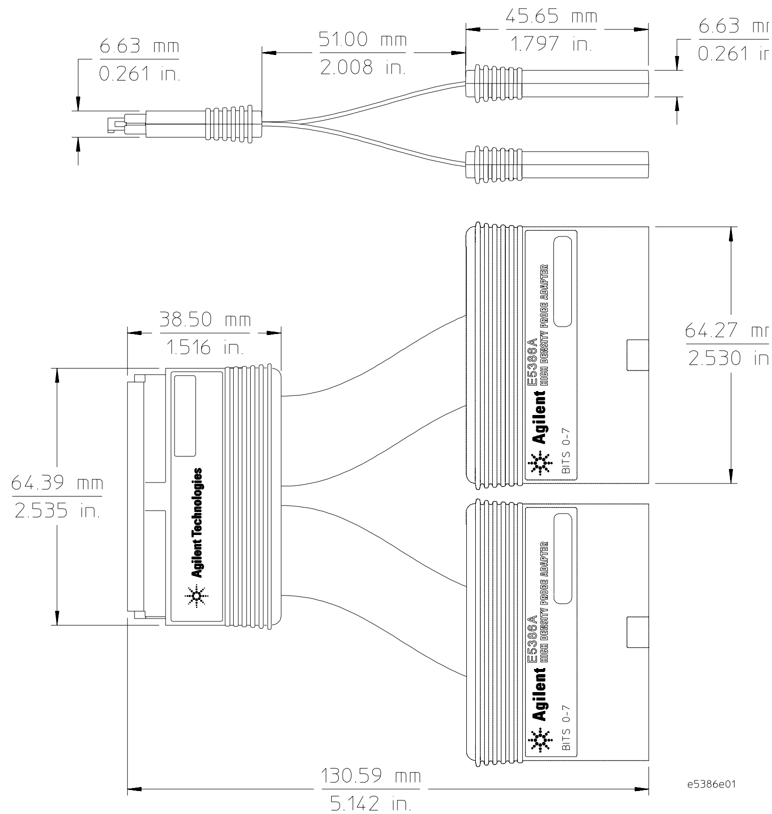


Figure 8 E5386A dimensions

Pin out for the E5387A differential soft touch probe

The following graphic and table show the E5387A differential soft touch probe pad numbers and logic analyzer pod inputs.

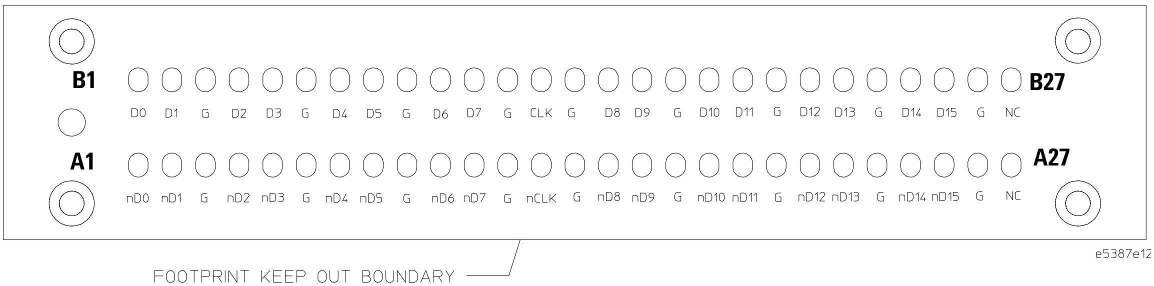


Figure 9 E5387A probe pad numbers

Table 3 E5387A pin-out table

E5387A Differential Probe					Logic Analyzer	
Negative Signals		Positive Signals				
Signal Name	Pad#	Signal Name	Pad#		Channel	Pod
D0 (-)	A1	D0 (+)	B1	→	0	Whichever pod is plugged into the E5387A probe ↓
D1 (-)	A2	D1 (+)	B2	→	1	
Ground	A3	Ground	B3			
D2 (-)	A4	D2 (+)	B4	→	2	
D3 (-)	A5	D3 (+)	B5	→	3	
Ground	A6	Ground	B6			
D4 (-)	A7	D4 (+)	B7	→	4	
D5 (-)	A8	D5 (+)	B8	→	5	
Ground	A9	Ground	B9			
D6 (-)	A10	D6 (+)	B10	→	6	
D7 (-)	A11	D7 (+)	B11	→	7	
Ground	A12	Ground	B12			
Clock (-)	A13	Clock (+)	B13	→	Clock	
Ground	A14	Ground	B14			
D8 (-)	A15	D8 (+)	B15	→	8	

E5387A Differential Probe					Logic Analyzer	
Negative Signals		Positive Signals				
Signal Name	Pad#	Signal Name	Pad#		Channel	Pod
D9 (-)	A16	D9 (+)	B16	→	9	Whichever pod is plugged into the E5387A probe ↓
Ground	A17	Ground	B17			
D10 (-)	A18	D10 (+)	B18	→	10	
D11 (-)	A19	D11 (+)	B19	→	11	
Ground	A20	Ground	B20			
D12 (-)	A21	D12 (+)	B21	→	12	
D13 (-)	A22	D13 (+)	B22	→	13	
Ground	A23	Ground	B23			
D14 (-)	A24	D14 (+)	B24	→	14	
D15 (-)	A25	D15 (+)	B25	→	15	
Ground	A26	Ground	B26			
N/C	A27	N/C	B27			

Pin out for the E5390A single-ended soft touch probe

The following graphic and table show the E5390A single-ended soft touch probe pad numbers and logic analyzer pod input.

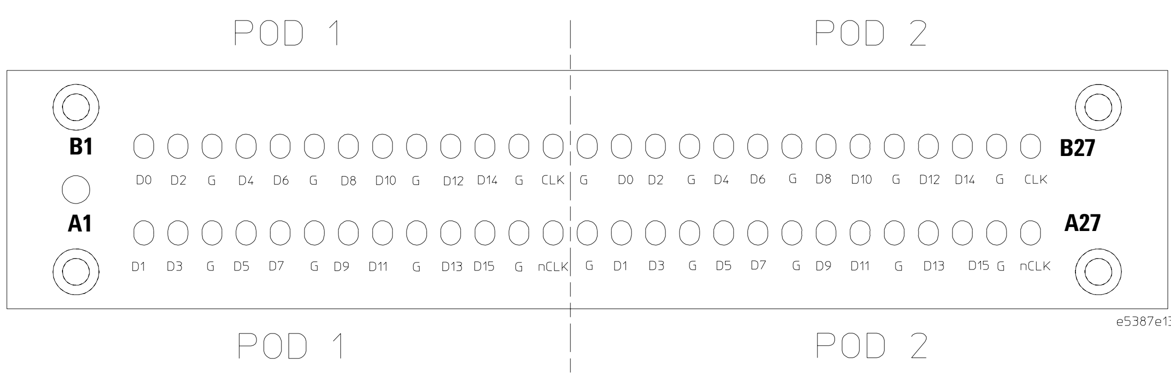


Figure 10 E5390A probe pad numbers

Table 4 E5390A pin-out table

E5390A Single-ended Probe			Logic Analyzer	
Signal Name	**Pad #**		**Channel**	**Pod**
D1	A1	→	1	Whichever pod is connected to "Odd" on the E5390A probe ↓
D3	A2	→	3	
Ground	A3			
D5	A4	→	5	
D7	A5	→	7	
Ground	A6			
D9	A7	→	9	
D11	A8	→	11	
Ground	A9			
D13	A10	→	13	
D15	A11	→	15	
Ground	A12			
Clock (-)	A13	→	Clock	
Ground	A14			Whichever pod is connected to "Even" on the E5390A probe ↓
D1	A15	→	1	
D3	A16	→	3	
Ground	A17			
D5	A18	→	5	
D7	A19	→	7	
Ground	A20			
D9	A21	→	9	
D11	A22	→	11	
Ground	A23			
D13	A24	→	13	
D15	A25	→	15	
Ground	A26			
Clock (-)	A27	→	Clock	

E5390A Single-ended Probe			Logic Analyzer	
Signal Name	**Pad #**		**Channel**	**Pod**
D0	B1	→	0	Whichever pod is connected to "Odd" on the E5390A probe ↓
D2	B2	→	2	
Ground	B3			
D4	B4	→	4	
D6	B5	→	6	
Ground	B6			
D8	B7	→	8	
D10	B8	→	10	
Ground	B9			
D12	B10	→	12	
D14	B11	→	14	
Ground	B12			
Clock(+)	B13	→	Clock	
Ground	B14			Whichever pod is connected to "Even" on the E5390A probe ↓
D0	B15	→	0	
D2	B16	→	2	
Ground	B17			
D4	B18	→	4	
D6	B19	→	6	
Ground	B20			
D8	B21	→	8	
D10	B22	→	10	
Ground	B23			
D12	B24	→	12	
D14	B25	→	14	
Ground	B26			
Clock(+)	B27	→	Clock	

Pin out for the E5394A single-ended soft touch probe

The following graphic and table show the E5394A single-ended soft touch probe pad numbers and logic analyzer pod inputs.

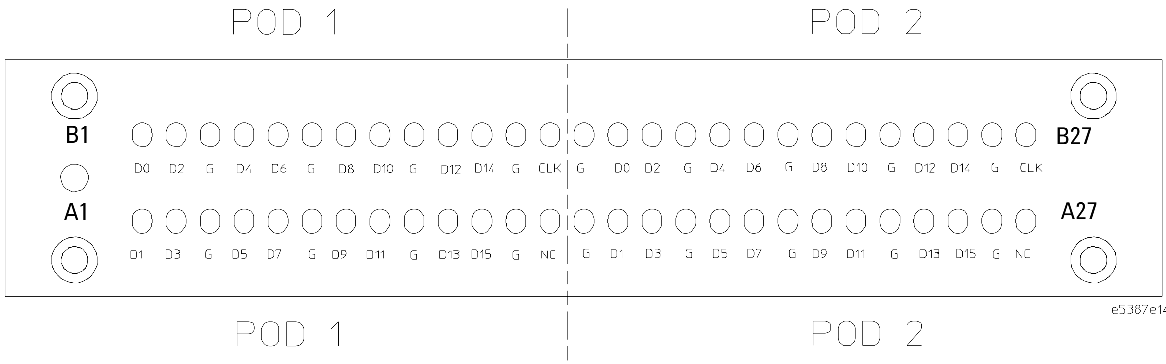


Figure 11 E5394A probe pad numbers

Table 5 E5394A pin-out table

E5394A Single-ended Probe			Logic Analyzer	
Signal Name	**Pad #**		**Channel**	**Pod**
D1	A1	→	1	Whichever pod is connected to "Odd" on the E5394A probe ↓
D3	A2	→	3	
Ground	A3			
D5	A4	→	5	
D7	A5	→	7	
Ground	A6			
D9	A7	→	9	
D11	A8	→	11	
Ground	A9			
D13	A10	→	13	
D15	A11	→	15	
Ground	A12			
NC	A13	→	NC	

E5394A Single-ended Probe			Logic Analyzer	
Signal Name	**Pad #**		**Channel**	**Pod**
D0	B1	→	0	Whichever pod is connected to "Odd" on the E5394A probe ↓
D2	B2	→	2	
Ground	B3			
D4	B4	→	4	
D6	B5	→	6	
Ground	B6			
D8	B7	→	8	
D10	B8	→	10	
Ground	B9			
D12	B10	→	12	
D14	B11	→	14	
Ground	B12			
Clock	B13	→	Clock	

E5394A Single-ended Probe			Logic Analyzer	
Signal Name	Pad #		Channel	Pod
Ground	A14			Whichever pod is connected to "Even" on the E5394A probe
D1	A15	→	1	
D3	A16	→	3	
Ground	A17			
D5	A18	→	5	
D7	A19	→	7	↓
Ground	A20			
D9	A21	→	9	
D11	A22	→	11	
Ground	A23			
D13	A24	→	13	
D15	A25	→	15	
Ground	A26			
NC	A27	→	NC	

E5394A Single-ended Probe			Logic Analyzer	
Signal Name	Pad #		Channel	Pod
Ground	B14			Whichever pod is connected to "Even" on the E5394A probe
D0	B15	→	0	
D2	B16	→	2	
Ground	B17			
D4	B18	→	4	
D6	B19	→	6	↓
Ground	B20			
D8	B21	→	8	
D10	B22	→	10	
Ground	B23			
D12	B24	→	12	
D14	B25	→	14	
Ground	B26			
Clock	B27	→	Clock	

Pin out for the E5386A half-channel adapter when connected to E5387A

When used with the E5387A differential soft touch probe, you need only one half-channel adapter. The table below shows the pin assignments.

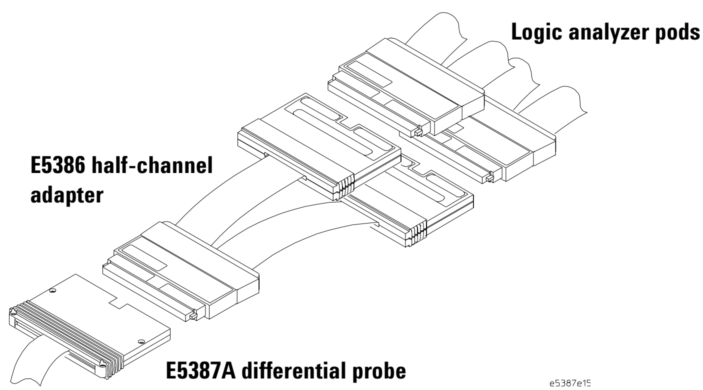


Figure 12 Half-channel adapter with E5387A

Table 6 Pin-out table for E5386A connected to an E5387A

E5387A Differential Probe					Logic Analyzer	
Negative Signals		Positive Signals				
Signal Name	Pin#	Signal Name	Pin#		Channel	Pod
D0(-)	A1	D0(+)	B1	→	0	Whichever pod is plugged into bits 0-7 ↓
D1(-)	A2	D1(+)	B2	→	2	
D2(-)	A4	D2(+)	B4	→	4	
D3(-)	A5	D3(+)	B5	→	6	
D4(-)	A7	D4(+)	B7	→	8	
D5(-)	A8	D5(+)	B8	→	10	
D6(-)	A10	D6(+)	B10	→	12	
D7(-)	A11	D7(+)	B11	→	14	
D8(-)	A15	D8(+)	B15	→	0	Whichever pod is plugged into bits 8-15 ↓
D9(-)	A16	D9(+)	B16	→	2	
D10(-)	A18	D10(+)	B18	→	4	
D011(-)	A19	D11(+)	B19	→	6	
D12(-)	A21	D12(+)	B21	→	8	
D13(-)	A22	D13(+)	B22	→	10	
D14(-)	A24	D14(+)	B24	→	12	
D15(-)	A25	D15(+)	B25	→	14	
D16(-)/Clk(-)	A13	D16(+)/Clk(+)	B13	→	Clock	

Pin out for two E5386A half-channel adapters connected to one E5390A

When used with the E5390A single-ended soft touch probe, you need two half-channel adapters, one adapter for Odd data and one for Even data. The table below shows the pin assignments.

The E5386A that is connected to the end of the E5390A labeled 'odd' becomes the 'odd' E5386A adapter.

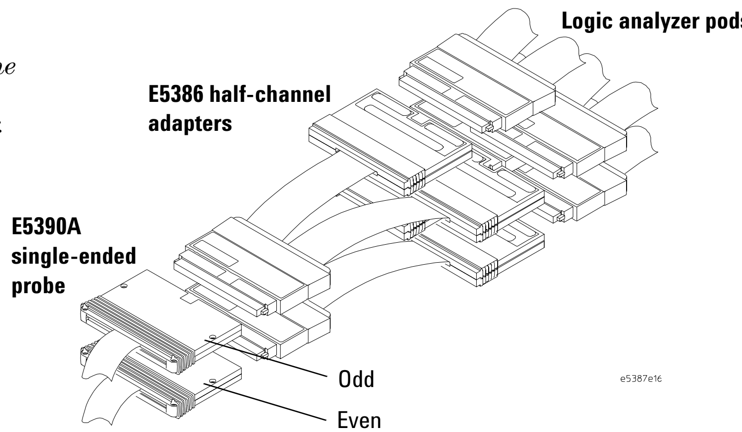


Figure 13 Two half-channel adapters with E5390A

Table 7 Pin-out table for two E5386A adapters connected to an E5390A

E5386A Adapter Odd				
E5390A Single-ended Probe			Logic Analyzer	
Signal Name	Pin #		Channel	Pod
D0	B1	→	0	Whichever pod is connected to bits 0-7 on the odd E5386A ↓
D1	A1	→	2	
D2	B2	→	4	
D3	A2	→	6	
D4	B4	→	8	
D5	A4	→	10	
D6	B5	→	12	
D7	A5	→	14	

E5386A Adapter Even				
E5390A Single-ended Probe			Logic Analyzer	
Signal Name	Pin #		Channel	Pod
D0	B1	→	0	Whichever pod is connected to bits 0-7 on the even E5386A ↓
D1	A1	→	2	
D2	B2	→	4	
D3	A2	→	6	
D4	B4	→	8	
D5	A4	→	10	
D6	B5	→	12	
D7	A5	→	14	

E5386A Adapter Odd				
E5390A Single-ended Probe			Logic Analyzer	
Signal Name	Pin #		Channel	Pod
D8	B7	→	0	Whichever pod is connected to bits 8-15 on the odd E5386A ↓
D9	A7	→	2	
D10	B8	→	4	
D11	A8	→	6	
D12	B10	→	8	
D13	A10	→	10	
D14	B11	→	12	
D15	A11	→	14	
D16n/Clk(+)	B13	→	Clock(+)	
D16n/Clk(-)	A13	→	Clock(-)	

E5386A Adapter Even				
E5390A Single-ended Probe			Logic Analyzer	
Signal Name	Pin #		Channel	Pod
D8	B21	→	0	Whichever pod is connected to bits 8-15 on the even E5386A ↓
D9	A21	→	2	
D10	B22	→	4	
D11	A22	→	6	
D12	B24	→	8	
D13	A24	→	10	
D14	B25	→	12	
D15	A25	→	14	
D16n/Clk(+)	B27	→	Clock(+)	
D16n/Clk(-)	A27	→	Clock(-)	

3
Operating the E5387A and E5390A Probes

Electrical considerations such as equivalent probe loads, input impedance, time domain transmission (TDT), step inputs, and eye opening.

Equivalent Probe Loads

The following probe load models are based on in-circuit measurements made with an Agilent 8753E 6 GHz network analyzer and an Agilent 54750A TDR/TDT using a 50 Ω test fixture. The following schematic accurately models the probe load out to 6 GHz. The figure on the following page shows the agreement between measured impedance and this model. PC board pads are not included.

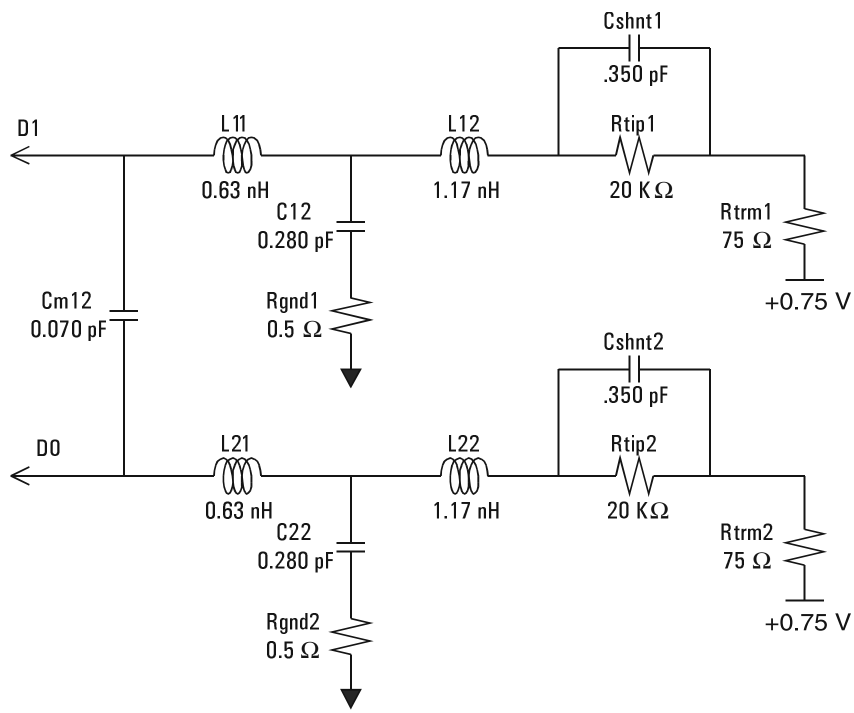


Figure 14 E5387A and E5390A probe load model

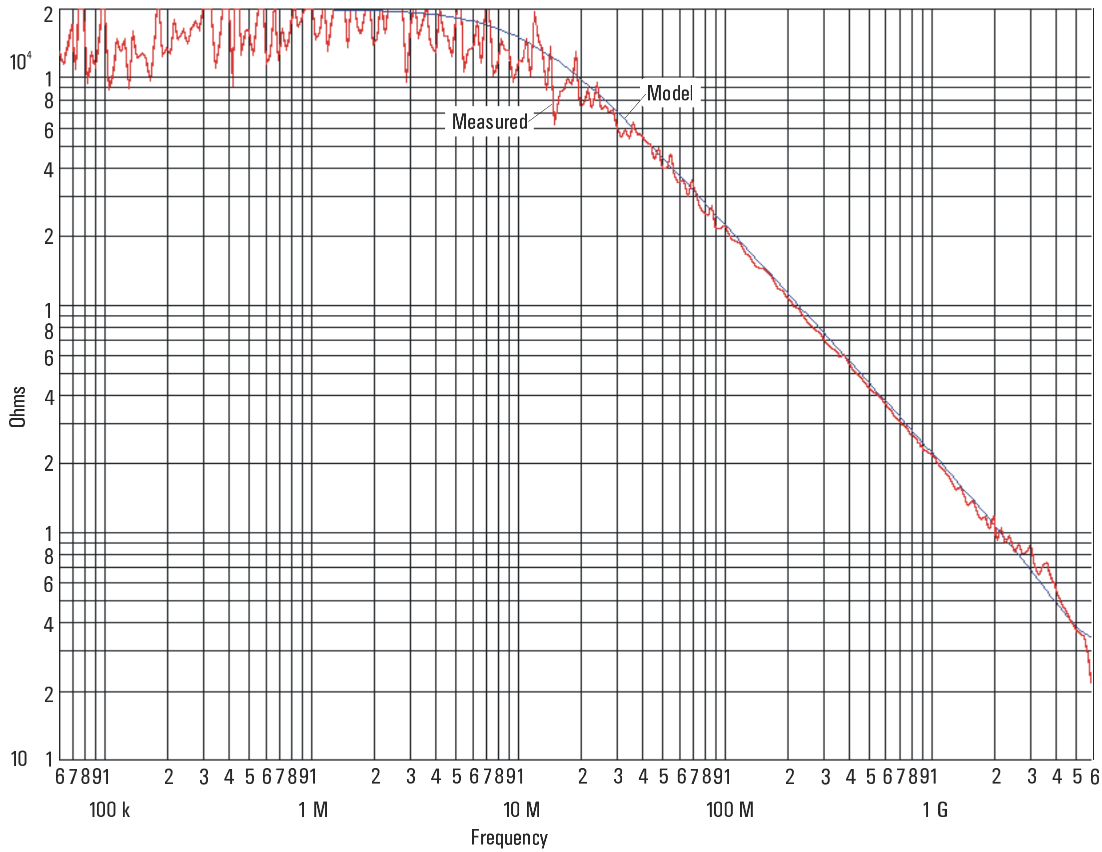


Figure 15 Measured versus modeled input impedance

Time Domain Transmission (TDT)

All probes have a loading effect on the circuit when they come in contact with the circuit. Time domain transmission (TDT) measurements are useful for understanding the probe loading effects as seen at the target receiver. The following TDT measurements were made mid-bus on a 50Ω transmission line load terminated at the receiver. These measurements show how the E5387A and E5390A soft touch probes affect an ideal step seen by the receiver for various rise times.

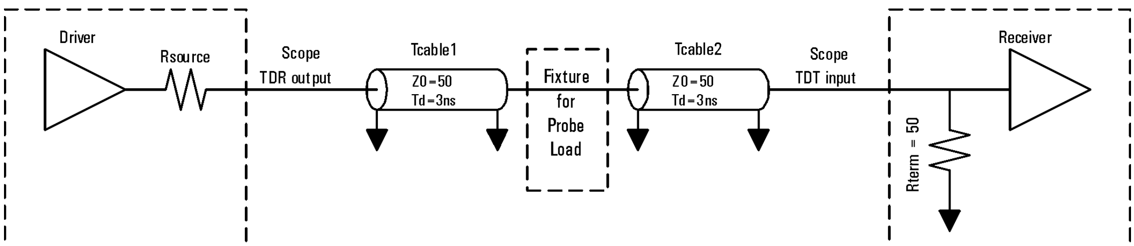


Figure 16 TDT measurement schematic

The following plots were made on an Agilent 54750A oscilloscope using TDT.

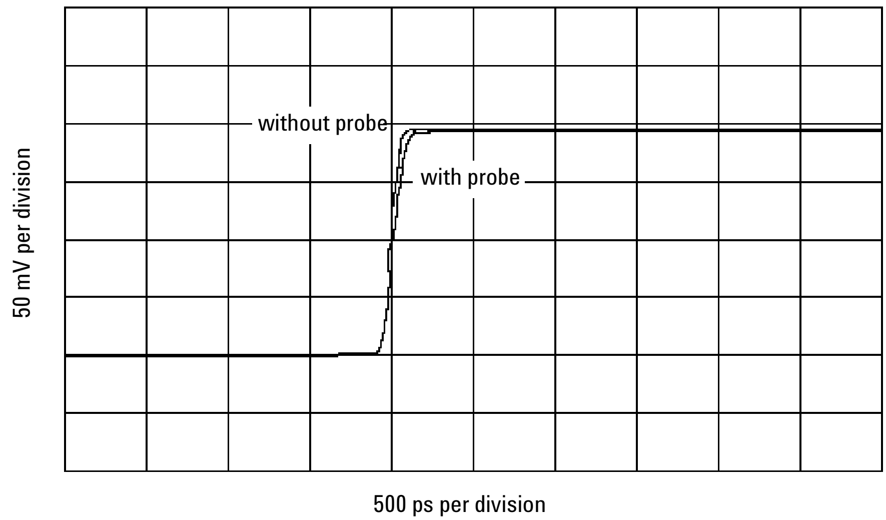


Figure 17 TDT measurement at receiver with and without probe load for 100 ps rise time

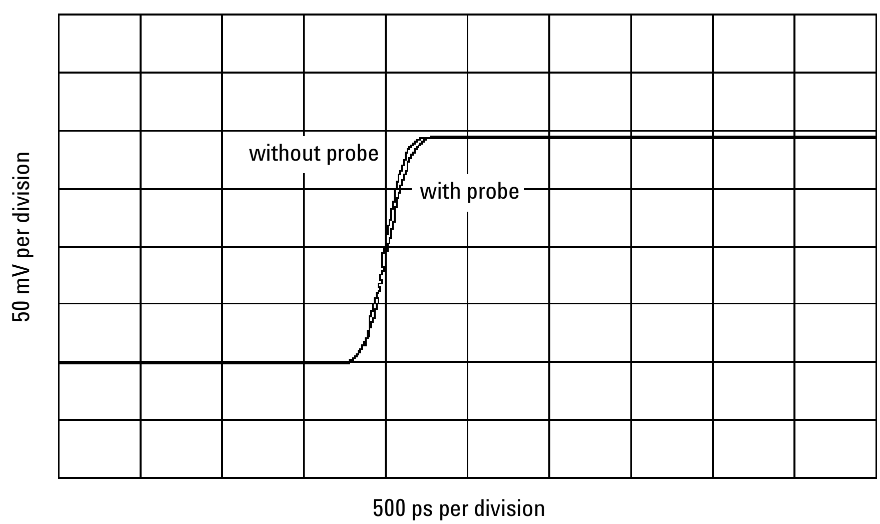


Figure 18 TDT measurement at receiver with and without probe load for 250 ps rise time

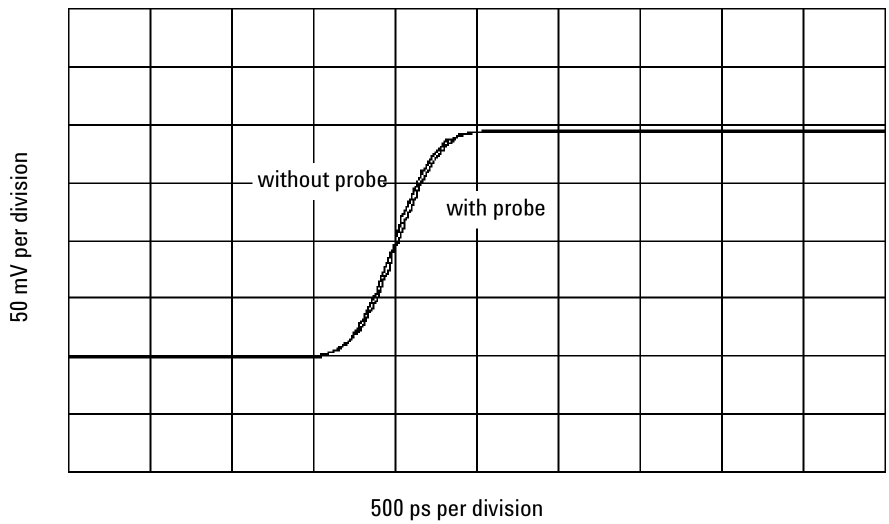


Figure 19 TDT measurement at receiver with and without probe load for 500 ps rise time

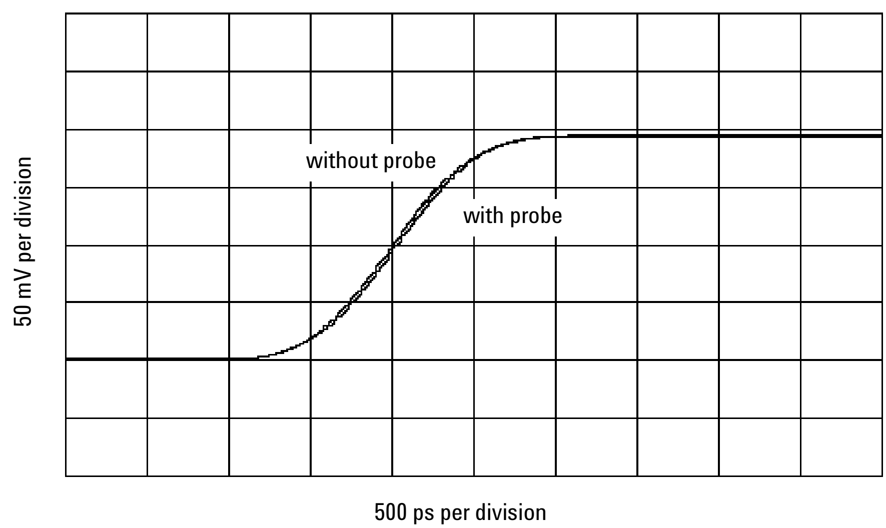


Figure 20 TDT measurement at receiver with and without probe load for 1000 ps rise time

Step Inputs

Maintaining signal fidelity to the logic analyzer is critical if the analyzer is to accurately capture data. One measure of a system's signal fidelity is to compare V_{in} to V_{out} for various step inputs. For the following graphs, V_{in} is the signal at the logic analyzer probe tip. Eye Scan was used to measure V_{out}, the signal seen by the logic analyzer. The measurements were made on a mid-bus connection to a 50Ω transmission line load terminated at the receiver. These measurements show the logic analyzer's response while using the E5387A and E5390A soft touch probes.

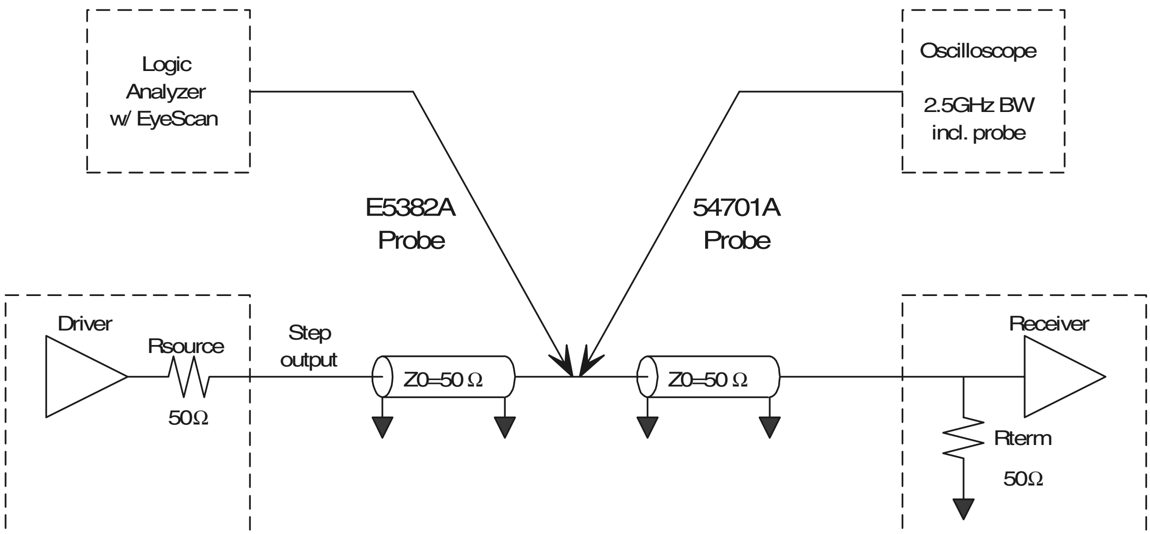


Figure 21 Step input measurement schematic

The following plots were made on an Agilent 54750A oscilloscope and an Agilent 16760A logic analyzer using an Agilent 8133A pulse generator with various rise time converters.

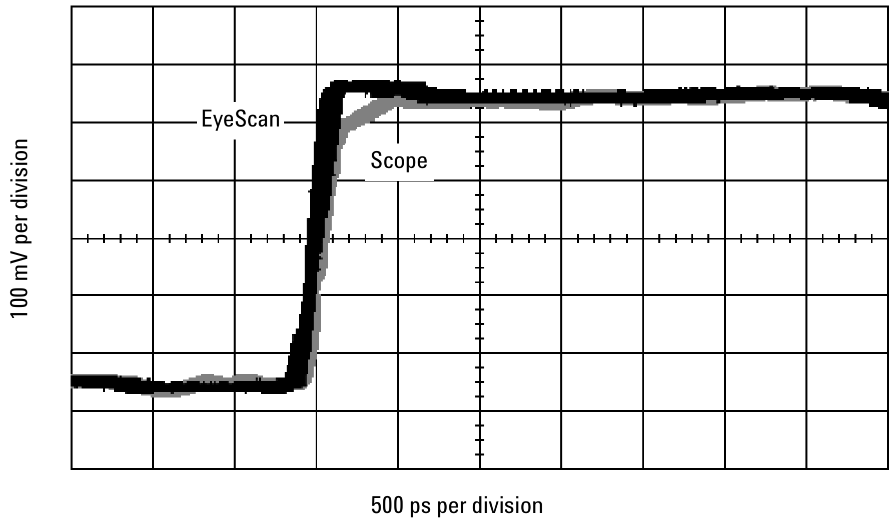


Figure 22 Logic analyzer's response to 150 ps rise time

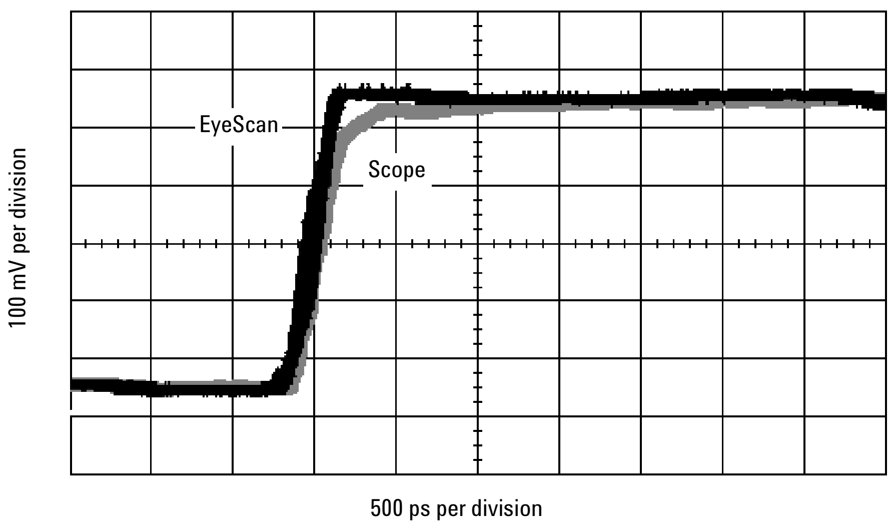


Figure 23 Logic analyzer's response to 250 ps rise time

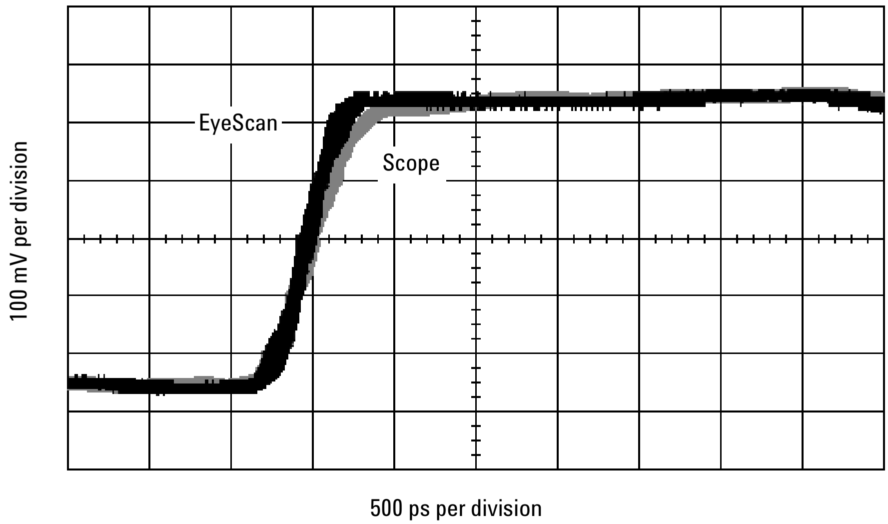


Figure 24 Logic analyzer's response to 500 ps rise time

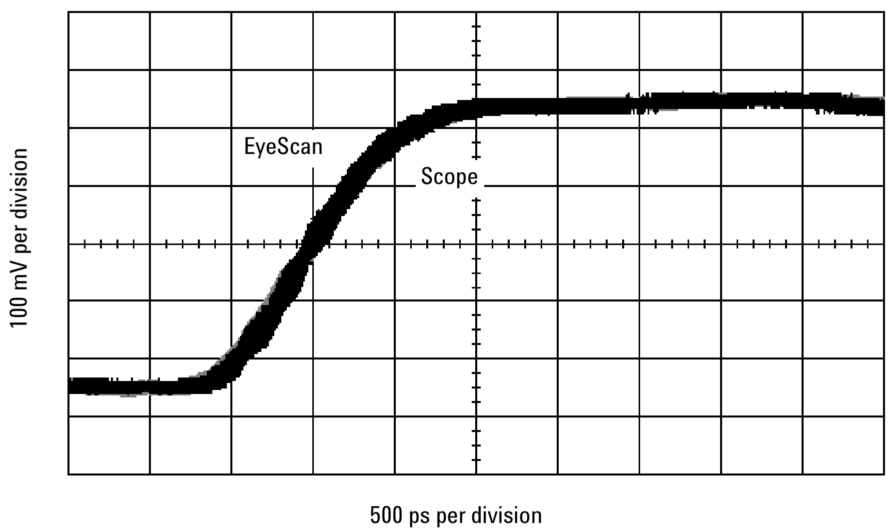


Figure 25 Logic analyzer's response to 1000 ps rise time

Eye Opening

The eye opening at the logic analyzer is the truest measure of an analyzer's ability to accurately capture data. Seeing the eye opening at the logic analyzer is possible with Eye Scan. The eye opening viewed with Eye Scan helps the user know how much margin the logic analyzer has, where to sample and at what threshold. Any probe response that exhibits overshoot, ringing, probe non-flatness, noise, and other issues all deteriorate the eye opening seen by the logic analyzer. The following eye diagrams were measured using E5387A and E5390A soft touch probes and Eye Scan while probed mid-bus on a 50Ω transmission line load terminated at the receiver. The data patterns were generated using a 2^{23}-1 pseudo random bit sequence (PRBS).

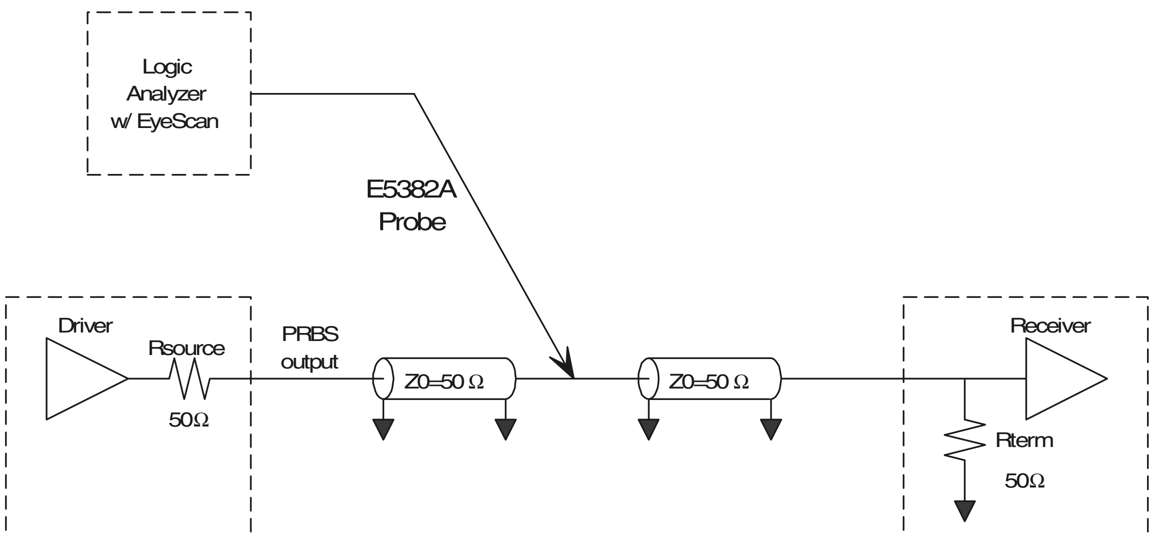


Figure 26 Eye opening measurement schematic

The following plots were made on an Agilent 16760A logic analyzer using an Agilent 8133A pulse generator with a 250 ps rise time converter. The following measurements use Eye Scan to show the margin at 800, 1250, and 1500MT/s. The amplitudes are indicated in the captions.

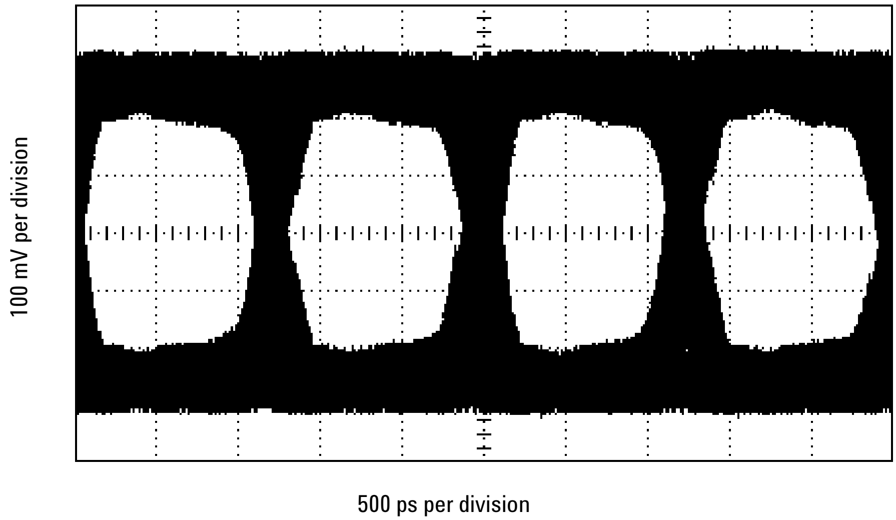


Figure 27 Logic analyzer eye opening for a PRBS signal of 500 mV p-p, 800 MT/s data rate

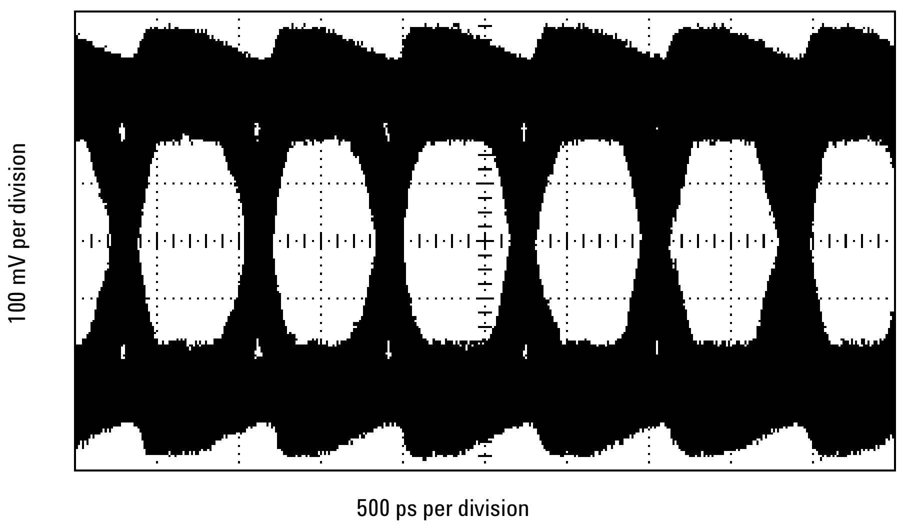


Figure 28 Logic analyzer eye opening for a PRBS signal of 500 mV p-p, 1250 MT/s data rate

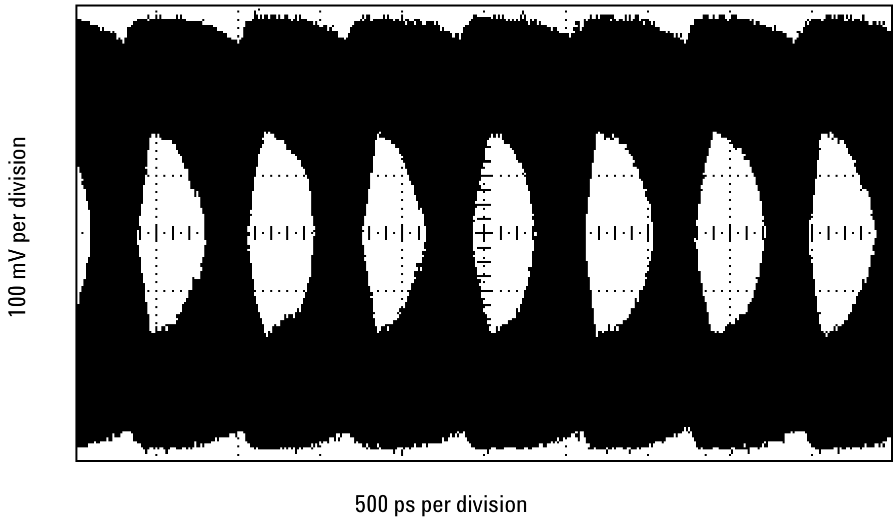


Figure 29 Logic analyzer eye opening for a PRBS signal of 500 mV p-p, 1500 MT/s data rate

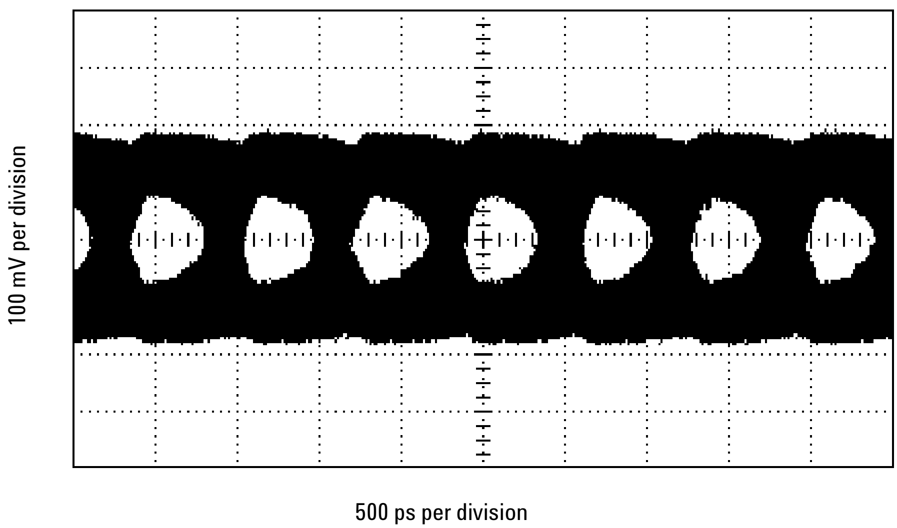


Figure 30 Logic analyzer eye opening for a PRBS signal of 200 mV p-p, 1500 MT/s data rate

4
Operating the E5394A Probe

Electrical considerations such as equivalent probe loads, input impedance, and time domain transmission (TDT).

Equivalent Probe Loads

The following probe load models are based on in-circuit measurements made with an Agilent 8753E 6 GHz network analyzer and an Agilent 54750A TDR/TDT using a 50 Ω test fixture. The following schematic accurately models the probe load out to 6 GHz. The figure on the following page shows the agreement between measured impedance and this model.

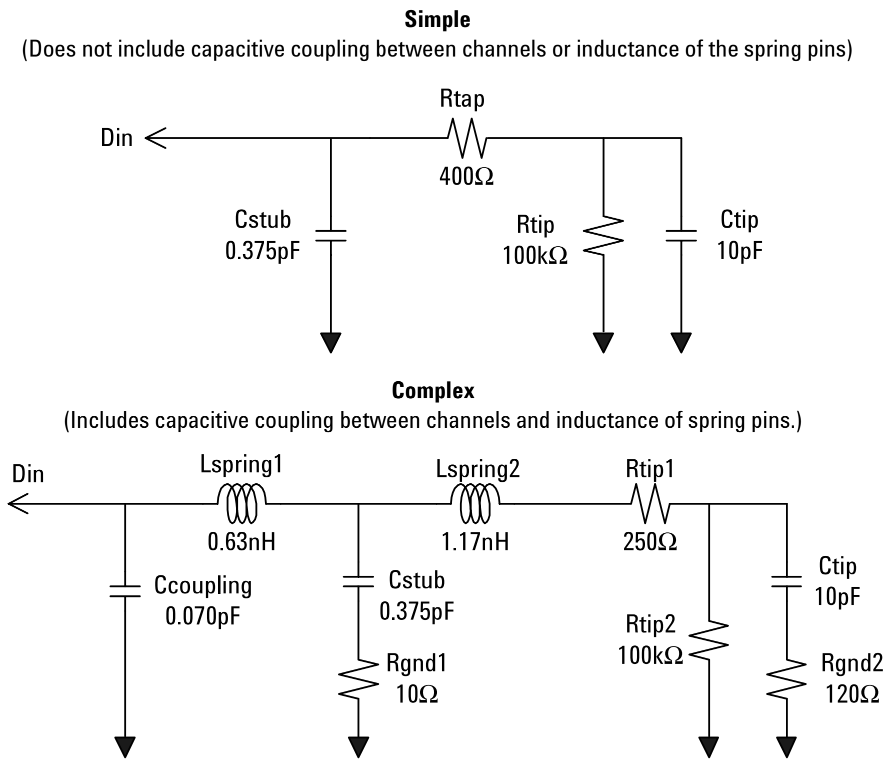


Figure 31 E5394A probe load models

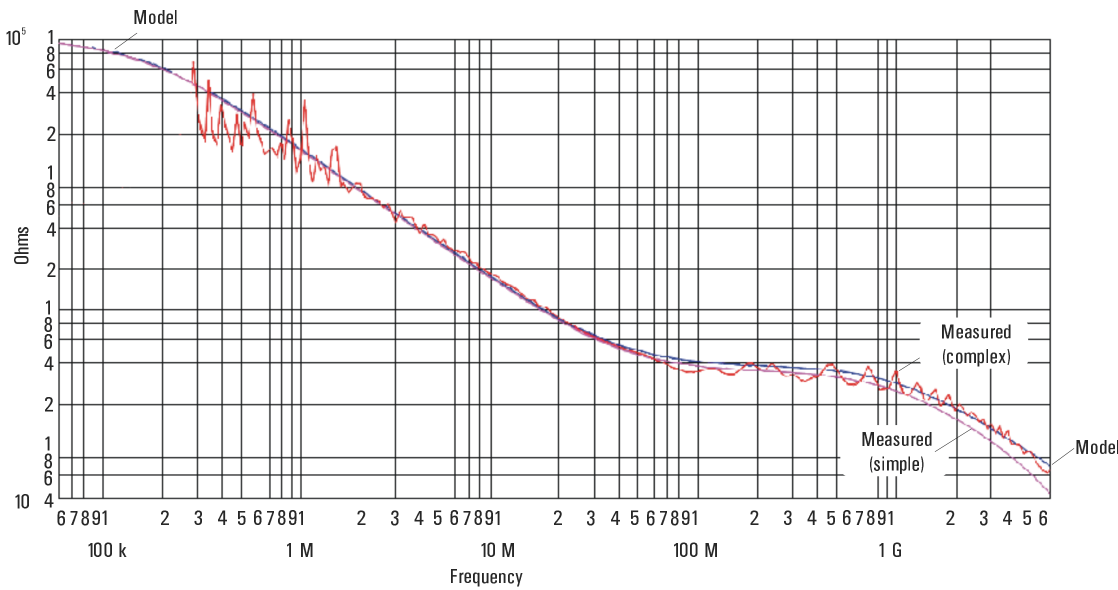


Figure 32 Measured versus modeled input impedance

Time Domain Transmission (TDT)

All probes have a loading effect on the circuit when they come in contact with the circuit. Time domain transmission (TDT) measurements are useful for understanding the probe loading effects as seen at the target receiver. The following TDT measurements were made mid-bus on a 50Ω transmission line load terminated at the receiver. These measurements show how the E5394A soft touch probes affect an ideal step seen by the receiver for various rise times.

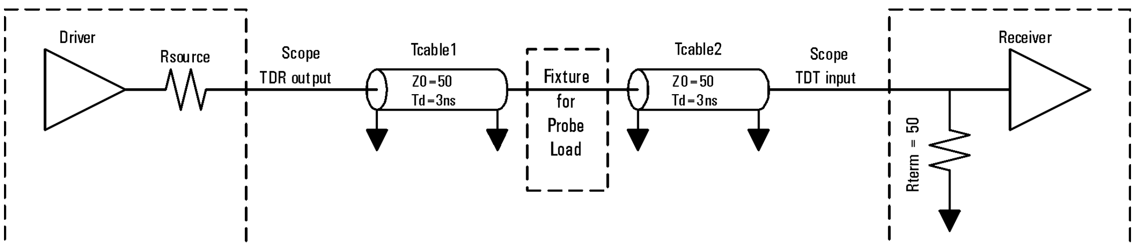


Figure 33 TDT measurement schematic

The following plots were made on an Agilent 54750A oscilloscope using TDT.

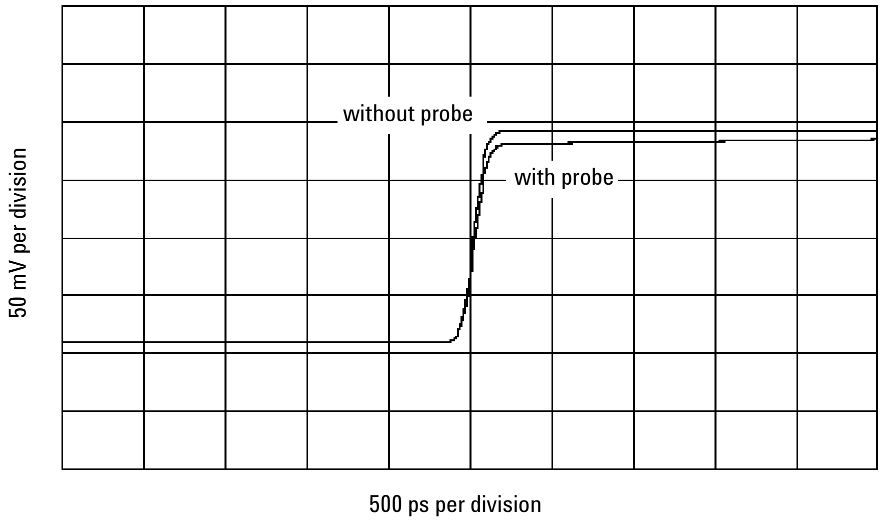


Figure 34 TDT measurement at receiver with and without probe load for 150 ps rise time

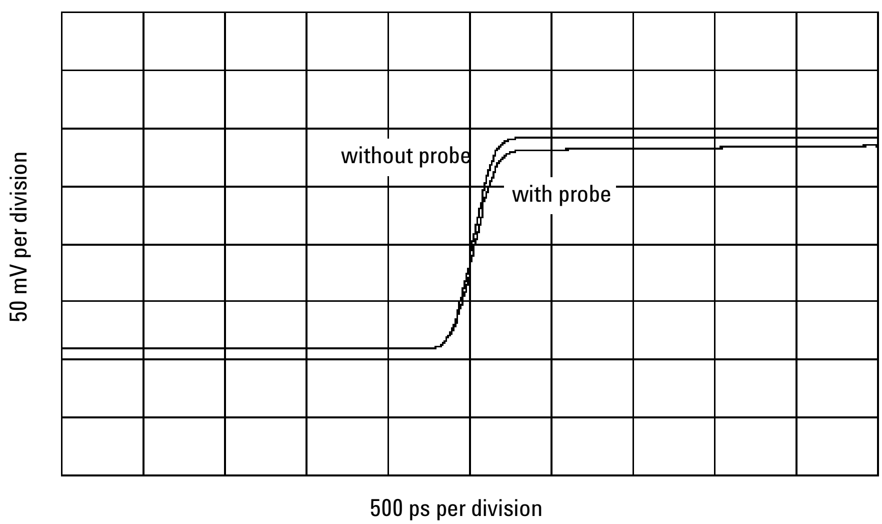


Figure 35 TDT measurement at receiver with and without probe load for 250 ps rise time

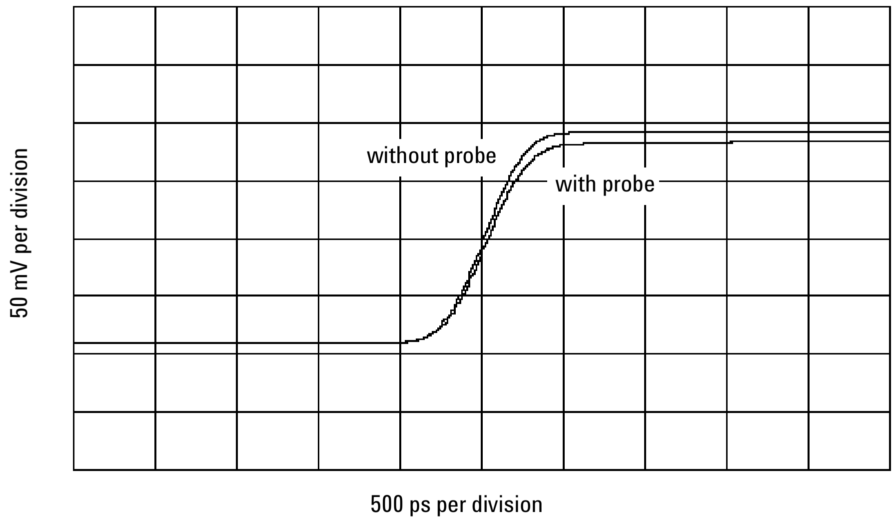


Figure 36 TDT measurement at receiver with and without probe load for 500 ps rise time

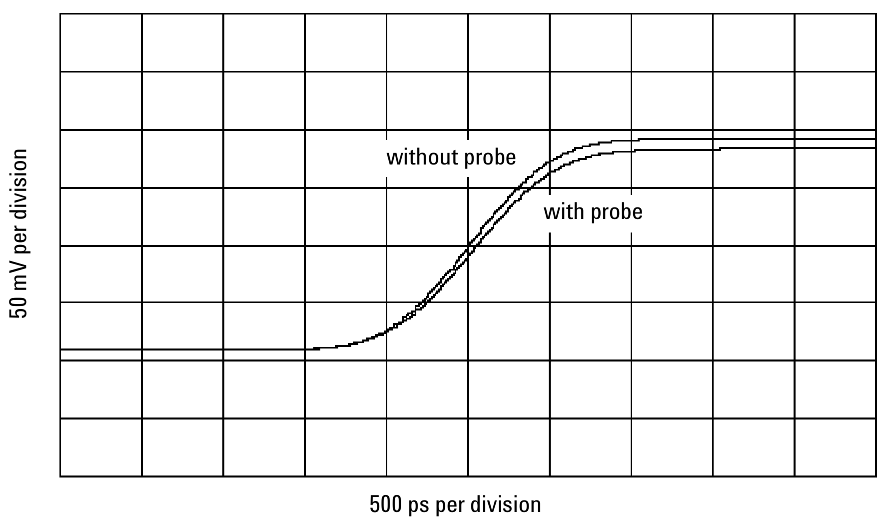


Figure 37 TDT measurement at receiver with and without probe load for 1000 ps rise time

5
Circuit Board Design

Design considerations when you layout your circuit board.

Transmission Line Considerations

Stubs connecting signal transmission lines to the connector should be as short as feasible. Longer stubs will cause more loading and reflections on a transmission line. If the electrical length of a stub is less than 1/5 of the signal rise time, it can be modeled as a lumped capacitance. Longer stubs must be treated as transmission lines.

Example: Assume you are using FR-4 PC board material with a dielectric constant of~4.3 for inner-layer traces (stripline). For example, A 0.28 cm long stub in an inner layer has a propagation delay of ~20 ps. Therefore, for a signal with a rise time of 100 ps or greater, a 0.28 cm stub will behave like a capacitor.

The trace capacitance per unit length will depend on the trace width and the spacing to ground or power planes. If the trace is laid out to have a characteristic impedance of 50 Ω it turns out that the capacitance per unit length is ~ 1.2 pF/cm. Therefore the 0.28 cm stub in the previous example would have an effective capacitance equal to ~0.34 pF.

This trace capacitance is in addition to the probe load model.

Recommended Routing

Two rows of compliant contacts in the probe make contact with pads laid down on the surface of the PC board. These contacts provide an extremely low probe load (<0.70 pF per channel), and make a good electrical connection with a small amount of compression force on a choice of standard PCB platings. Additionally, the pin contact points are free from the contamination effects that plague other connector-less probing technologies.

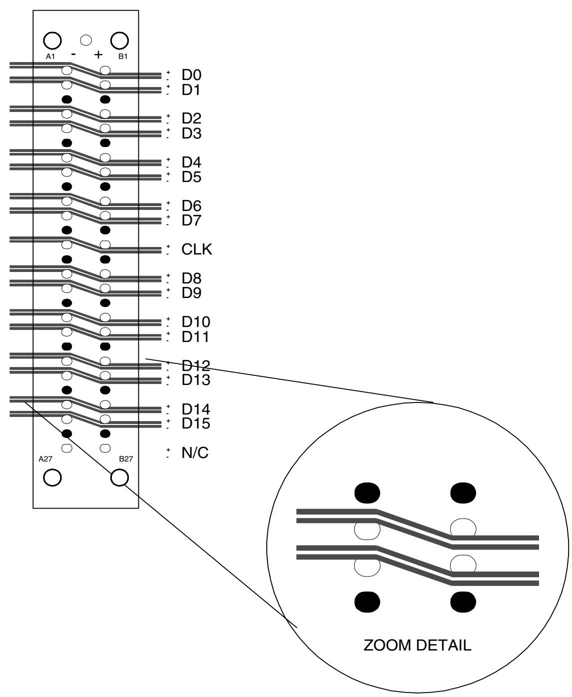


Figure 38 E5387A 17-bit routing

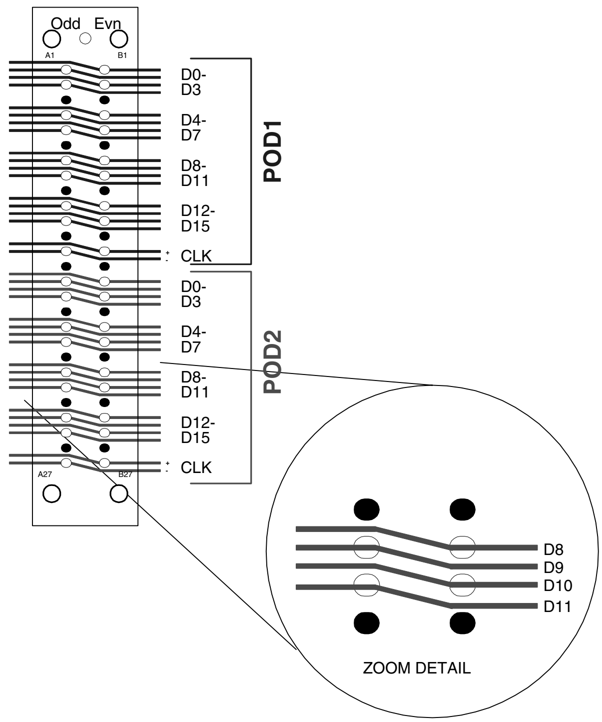


Figure 39 5390A 34-bit routing

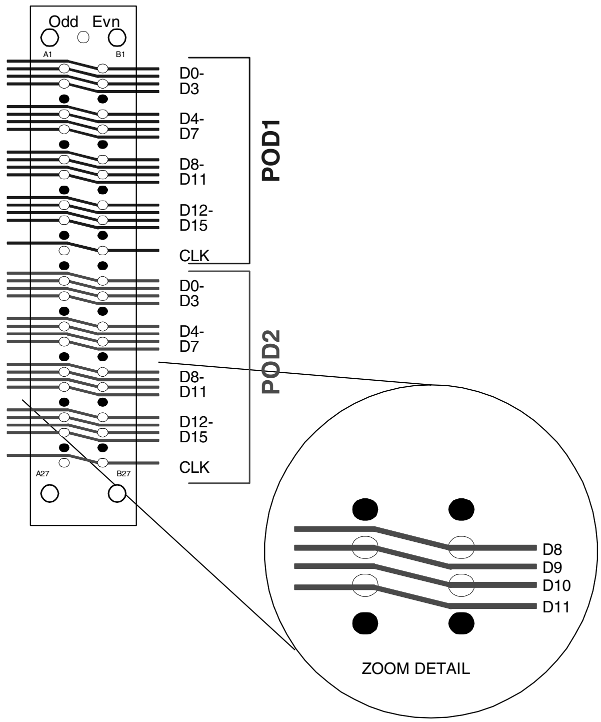


Figure 40 E5394A 34-bit routing

Data and Clock Inputs per Operating Mode

The following table shows the number of data and clock inputs for each connector on your target system for the various operating modes of your logic analyzer.

Table 8 16760A logic analyzer

Operating Mode	E5387A differential soft touch	E5387A with half-channel adapter E5386A	E5390A single-ended soft touch	E5390A with half-channel adapter E5386A
Synchronous (state) analysis 200 Mb/s, 400 Mb/s, 800 Mb/s	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 1)	N/A
Synchronous (state) analysis 1250 Mb/s 1500 Mb/s	8 data plus 1 clock input (see note 2)	16 data plus 1 clock input (see note 2)	16 data plus 1 clock input (see note 2)	32 data plus 1 clock input (see note 2)
Eye scan mode 800 Mb/s	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 1)	N/A
Eye scan mode 1500 Mb/s	8 data plus 1 clock input (see note 2)	16 data plus 1 clock input (see note 2)	16 data plus 1 clock input (see note 2)	32 data plus 1 clock input (see note 2)
Timing mode	16 data plus 1 clock input (see note 3)	N/A	32 data plus 2 clock inputs (see note 3)	N/A

Note 1: In the 200 Mb/s, 400 Mb/s, and 800 Mb/s synchronous (state) analysis modes, and the 800 Mb/s eye scan mode, there is one clock input which must be routed to the clock input on pod 1 (of the master module, in a multi-card set). The clock inputs on other pods can be assigned to labels and acquired as data inputs.

Note 2: In the 1250 Mb/s and 1500 Mb/s synchronous (state) analysis modes, and in the 1500 Mb/s eye scan mode, the clock inputs on other pods cannot be assigned to labels and acquired as data inputs.

Note 3: In asynchronous (timing) analysis, all inputs including clocks can be acquired and assigned to labels.

- To realize 17 data inputs (in full-channel mode) while using time tags in addition to a clock input on a single 16760A module or on the master module in a multi-card set, you must route the data signals to pod 2 and the clock to pod 1. A convenient way to avoid laying out a second connector to connect only the clock signal is to use the Agilent E5382A flying-lead set to make the connection to the clock.

- To use the qualifier input for eye scan, the qualifier signal must be routed to the clock input on pod 2 (K clock), and the clock must be routed to the clock input on pod 1 (J clock), each on the master module in case of a multi-card set.

- In a multiple-card set, the clock used for synchronous (state) analysis must be routed to the clock input on pod 1 of the master module. On a single card, the clock must be routed to the clock input on pod 1.

Table 9 16753/54/55/56A logic analyzers

Operating Mode	E5387A differential soft touch	E5387A with half-channel adapter E5386A	E5390A single-ended soft touch	E5390A with half-channel adapter E5386A
Synchronous (state) analysis 300 Mb/s, 600 Mb/s,	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 1)	N/A
Eye scan mode 300 Mb/s 600 Mb/s	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 1)	N/A
Timing mode	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 3)	N/A

Note 1: In 600 Mb/s mode, there is one clock input which must be routed to the clock input on pod 1 of the master module in a multi-card set. The clock inputs on the other pods can be assigned to labels and acquired as data inputs.

Table 10 1670 Series, 1680/90 Series, 16710/11/12A, 16715/16/17A, 16740/41/4A, 16750/51/52B logic analyzers

Operating Mode	E5394A single-ended soft touch
Synchronous (state) analysis 200 Mb/s, 400 Mb/s,	32 data plus 2 clock inputs (see note 1)
Timing mode	32 data plus 2 clock inputs (see note 1)

Note 1: In 400 Mb/s mode, there is one clock input which must be routed to the clock input on pod 1 of the master module in a multi-card set. The clock inputs on the other pods can be assigned to labels and acquired as data inputs.

Thresholds

E5387A differential soft touch probe

Data inputs

If you are using the E5387A differential soft touch probe to acquire differential signals, you would normally allow the logic analyzer to discriminate between high and low states based on the crossover of the data and $\overline{\text{data}}$ inputs.

You may also use the E5387A differential probe to acquire single-ended signals. If you are using the E5387A probe to acquire single-ended signals, you should either ground the $\overline{\text{data}}$ inputs or connect them to a dc power supply. You may:

- Ground the $\overline{\text{data}}$ inputs and adjust the threshold in the user interface.

Or

- Supply a threshold reference voltage to the $\overline{\text{data}}$ inputs. In this case, the threshold in the user interface should be set to zero.

If your circuit uses a resistive divider to provide a threshold reference, make sure the thevinen equivalent resistance is around 50 Ω.

NOTE The threshold can only be changed on a per pod basis.

Clock input

The same choices exist for the clock input on the E5387A differential probe as outlined above for the data inputs. The clock input has a separate, independent threshold adjustment.

E5390A single-ended soft touch probe

Clock input

The clock input to the E5390A probe is differential. If you supply a differential clock, you should select the "differential" option in the clock threshold user interface.

If your system uses a single-ended clock signal, the $\overline{\text{clock}}$ input should be either grounded or connected to a dc power supply. You may:

- Ground the $\overline{\text{clock}}$ input and adjust the clock threshold from the user interface to between -3V dc and +5V dc.

E5394A single-ended soft touch probe

Data inputs

The threshold can be changed on a “per pod” basis (16 data + 1 clock). This is accomplished using the “user defined threshold” window in the logic analyzer software..

Signal Access

Labels split across probes

If a label is split across more than one pod, this leads to restrictions in triggering. Refer to "Triggering with the Agilent 1675x and 1676x" (Agilent publication number 5988-2994EN) for more details.

Reordered bits

If bits need to be reordered within a label, this leads to additional restrictions in triggering. Specifically, equalities can be used to evaluate the value of a label with reordered bits, but inequalities cannot be used. You may be able to avoid the need to reorder bits in a label by routing signals to appropriate pins on the probe connector. Refer to "Triggering with the Agilent 1675x and 1676x" (Agilent publication number 5988-2994EN) for more details.

Half-channel 1.25 and 1.5 Gb/s modes (16760A only)

In the half-channel 1.25 and 1.5 Gb/s modes, the 16760A analyzer accesses only the even channels (0,2,4, etc.). In the Format user interface, the connections within a pod (16-signal group) are mapped as follows:

Table 11 Half-channel pod mapping

Connector pins	Connection name in this document (pages 24- 26)	Reference in format window
7,8	D0	Bit0
15,16	D2	Bit1
23,24	D4	Bit2
31,32	D6	Bit3
39,40	D8	Bit4

Connector pins	Connection name in this document (pages 24- 26)	Reference in format window
47,48	D10	Bit5
55,56	D12	Bit6
63,64	D14	Bit7

Note that in the 1.25 and 1.5 Gb/s half-channel mode, the clock inputs cannot be assigned as bits in a label.

E5386A Half-channel Adapter The E5386A can be used with the E5387A differential soft touch probe or the E5390A single-ended probe to map the signals from the PC board pads to the 16760A when operating in half-channel state mode.

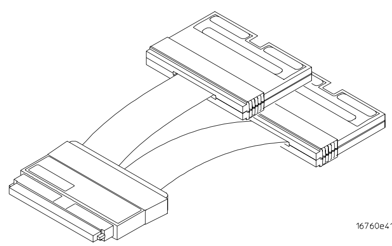


Figure 41 E5386A Half-channed adapter

6
Recommended Reading

A list of recommended reading for more information about systems and high-speed digital design.

For More Information

For more information on Agilent logic analyzers, refer to http://www.agilent.com/find/logicanalyzer. For more information on your specific analyzer, refer to the online help in the product.

MECL System Design Handbook

Blood, William R. Jr., "MECL System Design Handbook," 4th edition, 1988, published by Motorola. This handbook can be obtained from ON Semiconductor on the web. Go to <http://onsemi.com>. Click on "On-line ordering" under "Documentation." Click on the link "General search." Type in "HB205" in the "Document number" field. Click "Submit." To view the document online, click on "PDF" in the right-hand column titled "PDF MFAX." Or order a hardcopy of the handbook on-line.

High-speed Digital Design

Johnson, Howard W., and Martin Graham, "High-speed Digital Design," Prentice-Hall, 1993, ISBN 0-13-395724-1

Designing High-speed Target Systems for Logic Analyzer Probing

“Designing High-speed Target Systems for Logic Analyzer Probing” Agilent Technologies application note publication number 5988-2989EN.

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.

Index

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