Keysight Technologies Connector-based Probes

User's Guide

KEYSIGHT TECHNOLOGIES

Notices

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Contents

1 Probing Options

This chapter contains information to help you select the appropriate probe for your application.

Probing Solutions for Keysight High Speed State Analyzers - At a Glance

The probes in this manual are designed to be used with the existing Keysight 90-pin logic analyzers such as 16753A, 16754A, 16755A, 16756A, 16760A, 16850-series, and U4154A logic analyzers. They will also work with any future analyzers that use a 90-pin connector on the cable where the probe attaches to the logic analyzer. For more information on Keysight logic analyzers, refer to http://www.keysight.com/find/logicanalyzer. For more information on your specific analyzer, refer to the Online help in the product.

E5378A 34 channel single-ended probe

- 34 channels
- State speeds up to 1.5 Gb/s (17 channels)
- 250 mV peak-to-peak sensitivity
- 100-pin Samtec connector
- Requires probing connector kit (see page 68)

E5386A half-channel adapter with E5378A (for use with 16760A)

The E5386A adapter maps the 34 signals from the 100-pin Samtec connector to the 16760A when operating in half-channel state mode.

E5379A 17 channel differential probe

- 17 channels
- State speeds up to 1.5 Gb/s (9 channels)
- 200 mV peak-to-peak sensitivity
- 100-pin Samtec connector
- Requires probing connector kit (see page 68)

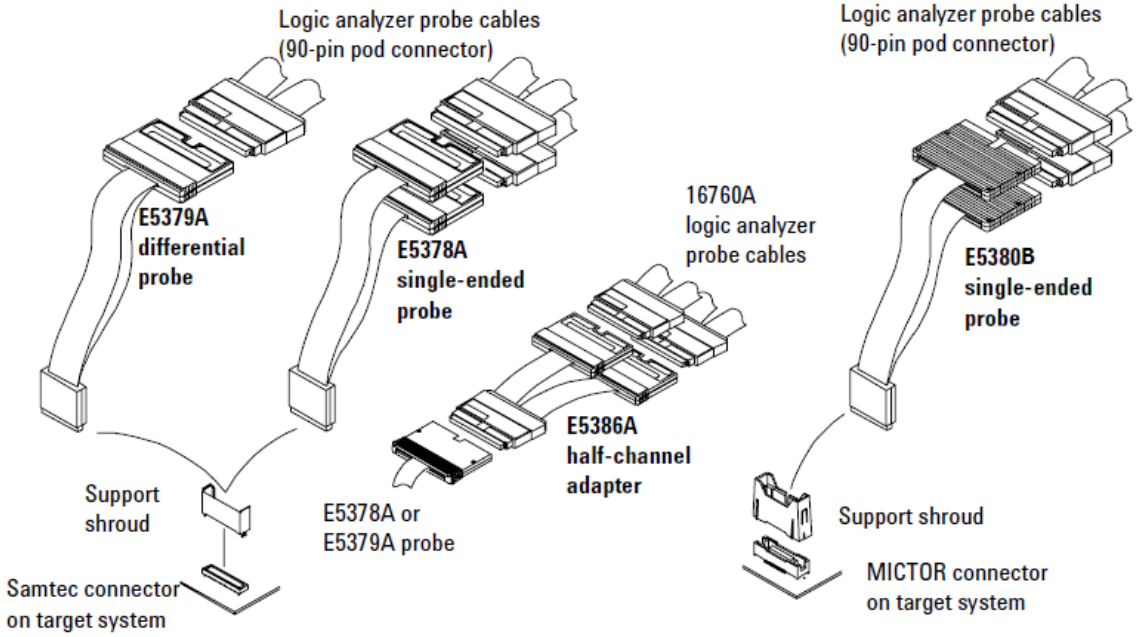
E5386A half-channel adapter with E5379A (for use with 16760A)

The E5386A adapter maps the 17 differential signals from the 100-pin Samtec connector to the 16760A when operating in half-channel state mode. This configuration provides state speeds up to 1.5 Gb/s on all 17 channels.

E5380B 34-channel single-ended probe

- Compatible with boards designed for Keysight E5346A 38-pin probe

- State speeds up to 600 Mb/s
- 300 mV peak-to-peak sensitivity
- 34-channels MICTOR connector
- Requires AMP MICTOR 38 connector and Keysight support shroud (see page 68)



Introduction to Probing Options

This chapter provides information to help you select the appropriate probe for your application. You will find descriptions of the logic analyzer probes and adapters. Tables in this chapter show you the number of probes required and the maximum state speed supported depending on which logic analyzer you have. Another table shows the number of data and clock inputs for the various operating modes of your logic analyzer.

Descriptions of specific probes and adapters

- E5378A 34 channel single-ended probe (page 12)
- E5379A 17 channel differential probe (page 13)
- E5380B 34 channel single-ended probe (page 14)
- E5386A Half-channel adapter (page 16)

NOTE The 100-pin probes (E5378A, E5379A) are recommended over the 38-pin probe (E5380B). The 100-pin probes have much less intrusive loading on the target system, they operate at the 16760A logic analyzers full specified state clock speed of 1.5 Gb/s, and they support smaller-amplitude signals.

Number of probes required

This table shows some examples of how many probes are required to provide connections to all channels of your logic analyzer module.

Table 1 Number of probes required

Probe	Logic Analyzer Module	
	16760A	16753A, 16754A, 16755A, 16756A
E5378A 34 channel single-ended probe	1	2
E5379A 17 channel differential probe	2	4
E5380B 34 channel single-ended probe	1	2

Maximum state speed supported

This table gives some examples of the maximum state speed that is supported by the combination of a probe and your logic analyzer module.

Table 2 Maximum state speed supported

Probe	Logic Analyzer Module		
	16760A	16753A, 16754A, 16755A, 16756A	U4154A
E5378A 34 channel single-ended probe	1.5 Gb/s	600 Mb/s	1.5 Gb/s
E5379A 17 channel differential probe	1.5 Gb/s	600 Mb/s	1.5 Gb/s
E5380B 34 channel single-ended probe	600 Mb/s	600 Mb/s	600 Mb/s

The E5378A 34 Channel Single-ended Probe

The Keysight E5378A is a 34-channel, single-ended, 100-pin probe compatible with the Keysight 90-pin analyzers such as 16753A, 16754A, 16755A, 16756A, 16760A, 16850-series, and U4154A 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 100-pin connector must be installed on the target system board to mate with the E5378A.

The Keysight 16760-68702 or 16760-68703 probing connector kit is required for connecting the E5378A probe to your target system. The kit contains five mating connectors and five support shrouds. The connectors and shrouds may be ordered separately if desired. See the table on page 68 for part numbers.

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

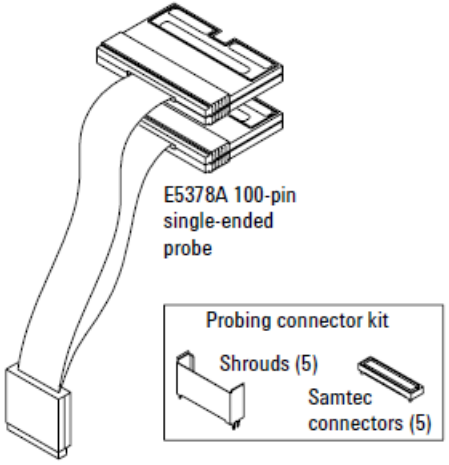


Figure 1 E5378A 34 channel single-ended probe and probing connector kit

The E5379A 17 Channel Differential Probe

The Keysight E5379A is a 17-channel, differential, 100-pin probe compatible with the Keysight 90-pin analyzers such as 16753A, 16754A, 16755A, 16756A, 16760A, 16850-series, and U4154A 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. A 100-pin connector must be installed on the target system board to mate with the E5379A.

The Keysight 16760-68702 or 16760-68703 probing connector kit is required for connecting the E5379A probe to your target system. The kit contains five mating connectors and five support shrouds. The connectors and shrouds may be ordered separately if desired. See the table on page 68 for part numbers.

Differential Input Amplitude Definition

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

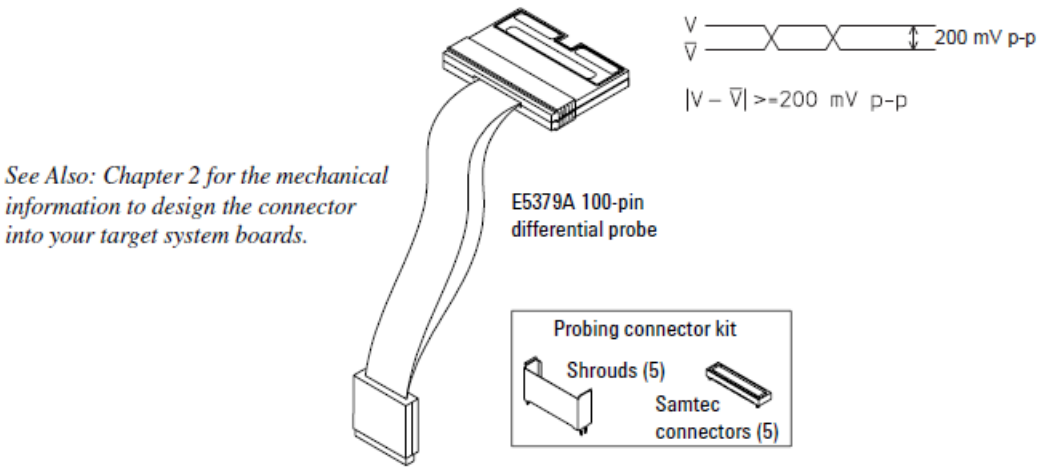


Figure 2 E5379A 17 channel differential probe & probing connector kit

The E5380B 34 Channel Single-ended Probe

The E5380B is a 34-channel, single-ended, 38-pin probe designed to be compatible with the AMP MICTOR 38-pin connector. It is pin-compatible with target systems that were designed for the Keysight E5346A 38-pin probe, thus enabling you to use Keysight's latest logic analyzers with target systems that were designed for older Keysight logic analyzers. The E5380B is compatible with the Keysight 90-pin analyzers such as 16753A, 16754A, 16755A, 16756A, 16760A, 16960A, 16951B, 16950B, U4154A, and 16850-series logic analyzers. It is capable of capturing state (synchronous) data at clock speeds up to 600 MHz, at data rates up to 600 Mb/s, with signal amplitudes as small as 300 mV peak-to-peak. The data valid window into the logic analyzer module must be increased by 500 ps when using the E5380B.

The Keysight E5346-68701 or E5346-68700 probing connector kit is required for connecting the E5380B probe to your target system. The kit contains five mating connectors and five support shrouds. The connectors and shrouds may be ordered separately if desired. See the table on page 68 for part numbers.

See Also: Chapter 2 for the mechanical information to design the connector into your target system boards.

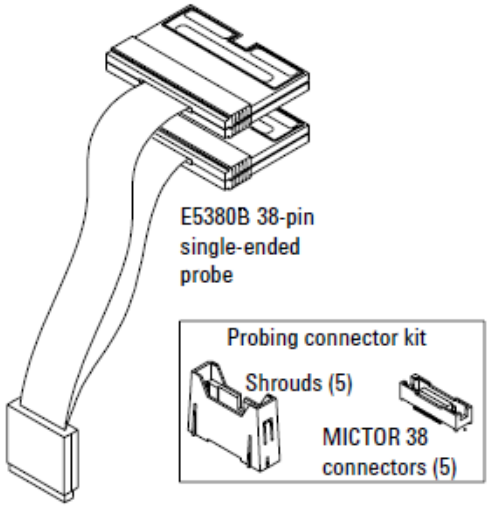
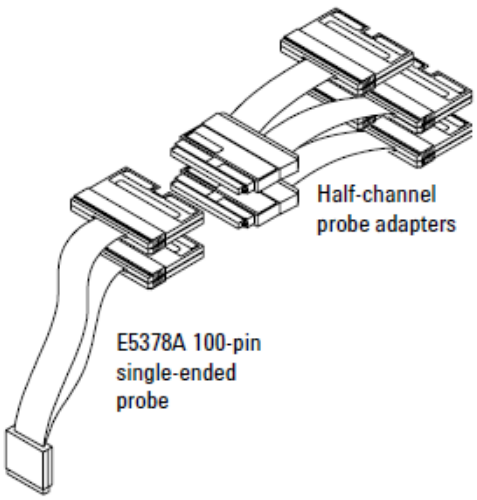


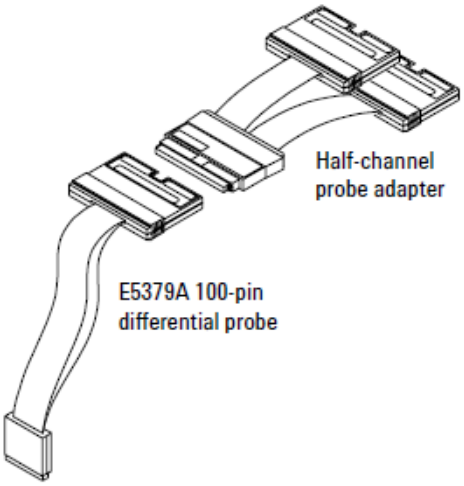
Figure 3 E5380B 34 channel single-ended probe and probing connector kit

The E5386A Half-channel Adapter

The E5386A half-channel adapter is intended to be used with the 16760A logic analyzer in half-channel state mode and works with:

- E5378A 34 channel single-ended probe
- E5379A 17 channel differential probe





The E5386A half-channel adapter has its own ID code. When using the adapter, the 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 proper values. You need to go into the threshold menu and select (differential, custom, or standard settings).

When using the adapter in half-channel state:

- 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 and the E5378A or E5379A system.

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

Once you have decided which probe is required, use the following mechanical information to design the appropriate connector into your target system board.

KEYSIGHT TECHNOLOGIES

E5378A and E5379A 100-pin Single-ended and Differential Probes

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 dependent on the logic analyzer module you are using.

Probe dimensions

The following figures show the dimensions of the 100-pin single-ended and differential probes.

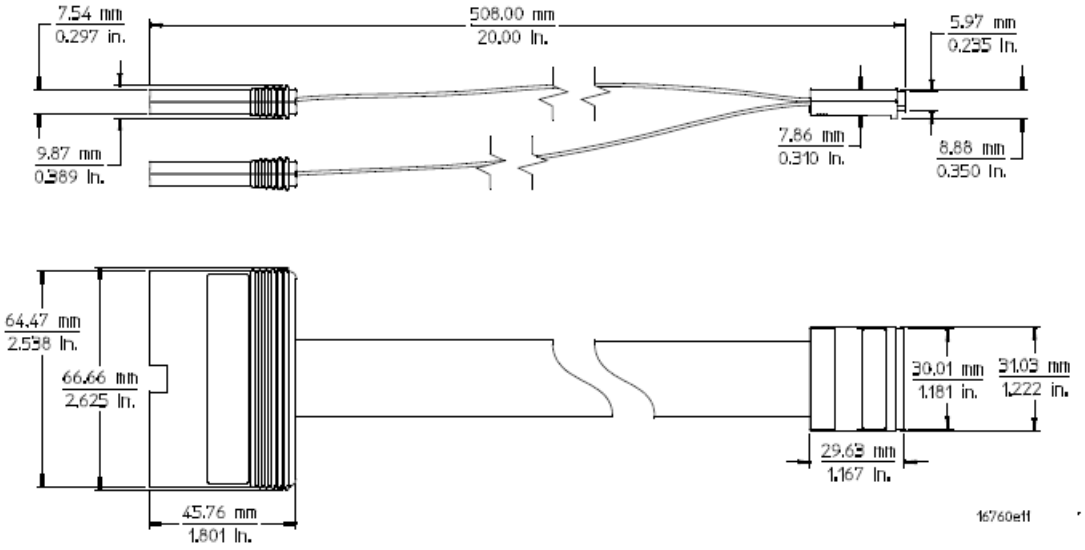


Figure 4 E5378A 100-pin single-ended probe dimensions

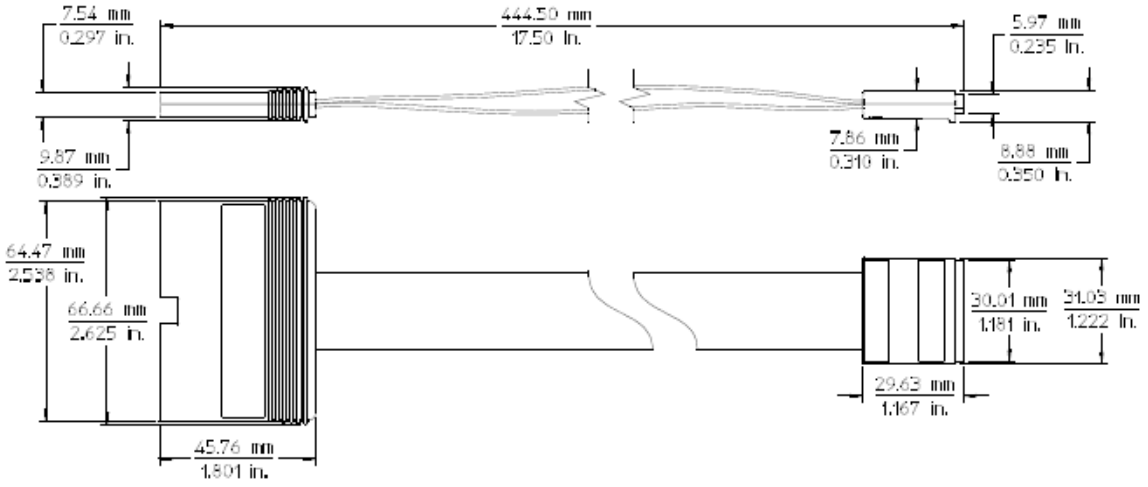


Figure 5 E5379A 100-pin differential probe dimensions

Samtec connector dimensions

The E5378A and E5379A probes require a probe kit that contains 100-pin Samtec connectors. Refer to page 68 for the kit part numbers.

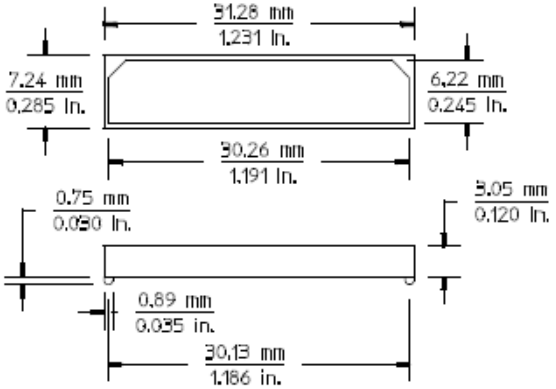


Figure 6 Samtec 100-pin connector dimensions

Support shroud dimensions

Support shrouds are not required but are recommended if pulling forces may be applied to the cables that could cause the connector to be dislodged. Refer to page 68 for the kit part numbers.

CAUTION

The support shrouds are made of conductive metal. Care should be taken to avoid shorting adjacent boards or components with the shrouds. For this reason, it may be advisable not to connect the shrouds to ground.

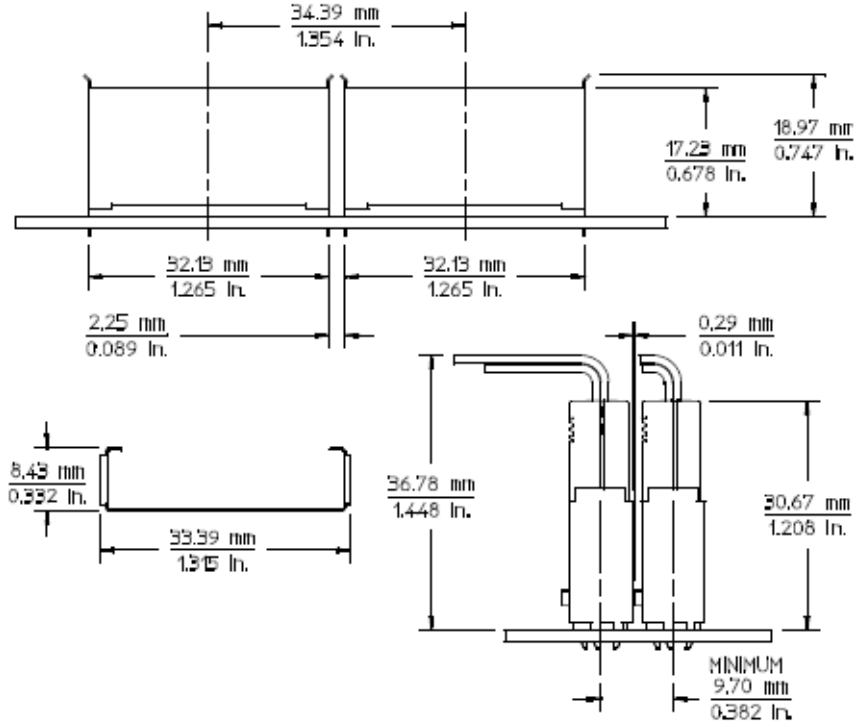


Figure 7 100-pin Samtec support shroud dimensions

Footprint dimensions

Use the following 100-pin Samtec connector footprint and support shroud mounting hole dimensions to design your target system board.

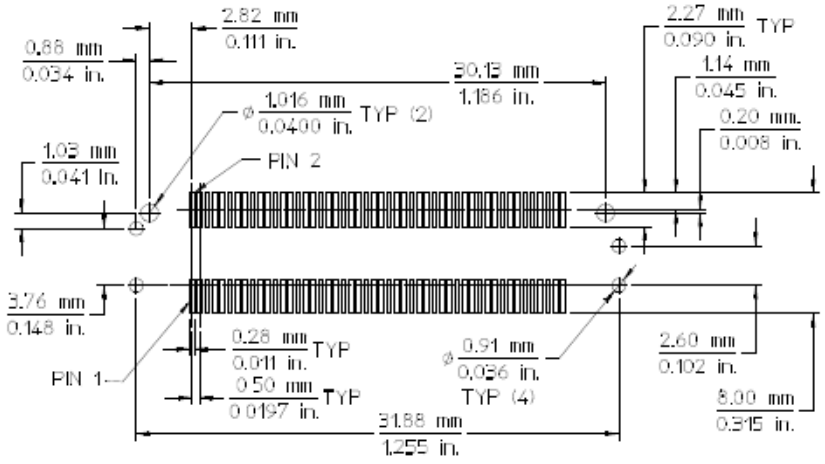


Figure 8 100-pin Samtec connector footprint and support shroud mounting hole dimensions

Pin assignments for the E5378A 34 channel single-ended probe

E5378A Single-ended Probe		Logic Analyzer		
Signal Name	Pin #		Channel	Pod
Ground	1			
Do Not Connect	3			
Ground	5			
D0	7	→	0	Whichever pod is connected to "Odd" on the E5378A probe
Ground	9			
D1	11	→	1	
Ground	13			
D2	15	→	2	
Ground	17			
D3	19	→	3	
Ground	21			
D4	23	→	4	
Ground	25			
D5	27	→	5	
Ground	29			
D6	31	→	6	
Ground	33			
D7	35	→	7	
Ground	37			
D8	39	→	8	

E5378A Single-ended Probe		Logic Analyzer		
Signal Name	Pin #		Channel	Pod
Ground	2			
Do Not Connect	4			
Ground	6			
D0	8	→	0	Whichever pod is connected to "Even" on the E5378A probe
Ground	10			
D1	12	→	1	
Ground	14			
D2	16	→	2	
Ground	18			
D3	20	→	3	
Ground	22			
D4	24	→	4	
Ground	26			
D5	28	→	5	
Ground	30			
D6	32	→	6	
Ground	34			
D7	36	→	7	
Ground	38			
D8	40	→	8	

E5378A Single-ended Probe		Logic Analyzer		
Signal Name	Pin #		Channel	Pod
Ground	41			
D9	43	→	9	
Ground	45			
D10	47	→	10	
Ground	49			
D11	51	→	11	
Ground	53			
D12	55	→	12	Whichever pod is connected to "Odd" on the E5378A probe
Ground	57			
D13	59	→	13	
Ground	61			
D14	63	→	14	
Ground	65			
D15	67	→	15	
Ground	69			
NC	71			
Ground	73			
NC	75			
Ground	77			
D16p/CLKp	79	→	CLK p	
Ground	81			
D16n/CLKn	83	→	CLK n	

E5378A Single-ended Probe		Logic Analyzer		
Signal Name	Pin #		Channel	Pod
Ground	42			
D9	44	→	9	
Ground	46			
D10	48	→	10	
Ground	50			
D11	52	→	11	
Ground	54			
D12	56	→	12	Whichever pod is connected to "Even" on the E5378A probe
Ground	58			
D13	60	→	13	
Ground	62			
D14	64	→	14	
Ground	66			
D15	68	→	15	
Ground	70			
NC	72			
Ground	74			
NC	76			
Ground	78			
D16p/CLKp	80	→	CLK p	
Ground	82			
D16n/CLKn	84	→	CLK n	

E5378A Single-ended Probe		Logic Analyzer	
Signal Name	Pin #	Channel	Pod
Ground	85		
Ext Ref	87		
Ground	89		
NC	91		
Ground	93		
Ground	95		
Do not connect	97		
Do not connect	99		

E5378A Single-ended Probe		Logic Analyzer	
Signal Name	Pin #	Channel	Pod
Ground	86		
Ext Ref	88		
Ground	90		
NC	92		
Ground	94		
Ground	96		
Do not connect	98		
Do not connect	100		

Ground pins indicated in this table are grounded in the probe. Grounding of specific ground pins on the target board is optional. However, the following guidelines should be observed:

1 Multiple ground returns are desirable to maintain signal integrity. As many probe ground pins as possible should be connected to ground in the target system board.

2 The ground pins located between signal pins are particularly important because they provide improved signal-to-signal isolation. This is particularly important for differential inputs. Excessive coupling between differential inputs causes the apparent input capacitance to increase. Capacitance between the two sides of a differential signal will appear to each side as approximately twice the capacitance to ground, because the capacitance is connected to a signal of opposite polarity. The best practice is to ground as many of these pins on the target board as possible.

Pin assignments for the E5379A 17 channel differential probe

E5379A Differential Probe						
Negative Signals		Positive Signals		Logic Analyzer		
Signal Name	Pin#	Signal Name	Pin#		Channel	Pod
Ground	1	Ground	2			Whichever pod is plugged into the E5379A probe
Do Not Connect	3	Do Not Connect	4			
Ground	5	Ground	6			
D0N	7	D0 p	8	→	0	
Ground	9	Ground	10			
D1 n	11	D1 p	12	→	1	
Ground	13	Ground	14			
D2 n	15	D2 p	16	→	2	
Ground	17	Ground	18			
D3 n	19	D3 p	20	→	3	
Ground	21	Ground	22			
D4 n	23	D4 p	24	→	4	
Ground	25	Ground	26			
D5 n	27	D5 p	28	→	5	
Ground	29	Ground	30			
D6 n	31	D6 p	32	→	6	
Ground	33	Ground	34			
D7 n	35	D7 p	36	→	7	
Ground	37	Ground	38			
D8 n	39	D8 p	40	→	8	

E5379A Differential Probe						
Negative Signals		Positive Signals			Logic Analyzer	
Signal Name	Pin#	Signal Name	Pin#		Channel	Pod
Ground	41	Ground	42			
D9 n	43	D9 p	44	→	9	
Ground	45	Ground	46			
D10 n	47	D10 p	48	→	10	
Ground	49	Ground	50			
D11 n	51	D11 p	52	→	11	
Ground	53	Ground	54			
D12 n	55	D12 p	56	→	12	

E5379A Differential Probe						
Negative Signals		Positive Signals			Logic Analyzer	
Signal Name	Pin#	Signal Name	Pin#		Channel	Pod
Ground	57	Ground	58			Whichever pod is plugged into the E5379A probe
D13 n	59	D13 p	60	→	13	
Ground	61	Ground	62			
D14 n	63	D14 p	64	→	14	
Ground	65	Ground	66			
D15 n	67	D15 p	68	→	15	
Ground	69	Ground	70			
NC	71	NC	72			
Ground	73	Ground	74			
NC	75	NC	76			
Ground	77	Ground	78			
D16/Clk n	79	D16/Clk p	80	→	Clk	
Ground	81	Ground	82			
NC	83	NC	84			
Ground	85	Ground	86			
NC	87	Ground	88			
N/C	89	N/C	90			
NC	91	NC	92			
Ground	93	Ground	94			
Ground	95	Ground	96			
Do not connect	97	Do not connect	98			
Do not connect	99	Do not connect	100			

Ground pins indicated in this table are grounded in the probe. Grounding of specific ground pins on the target board is optional. However, the following guidelines should be observed:

1 Multiple ground returns are desirable to maintain signal integrity. As many probe ground pins as possible should be connected to ground in the target system board.

2 The ground pins located between signal pins are particularly important because they provide improved signal-to-signal isolation. This is particularly important for differential inputs. Excessive coupling between differential inputs causes the apparent input capacitance to increase. Capacitance between the two sides of a differential signal will appear to each side as approximately twice the capacitance to ground, because the capacitance is connected to a signal of opposite polarity. The best practice is to ground as many of these pins on the target board as possible.

E5380B 34 Channel Single-ended Probe

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 dependent on the logic analyzer module you are using.

Probe dimensions

The following figure shows the dimensions of the 34 channel single-ended probe.

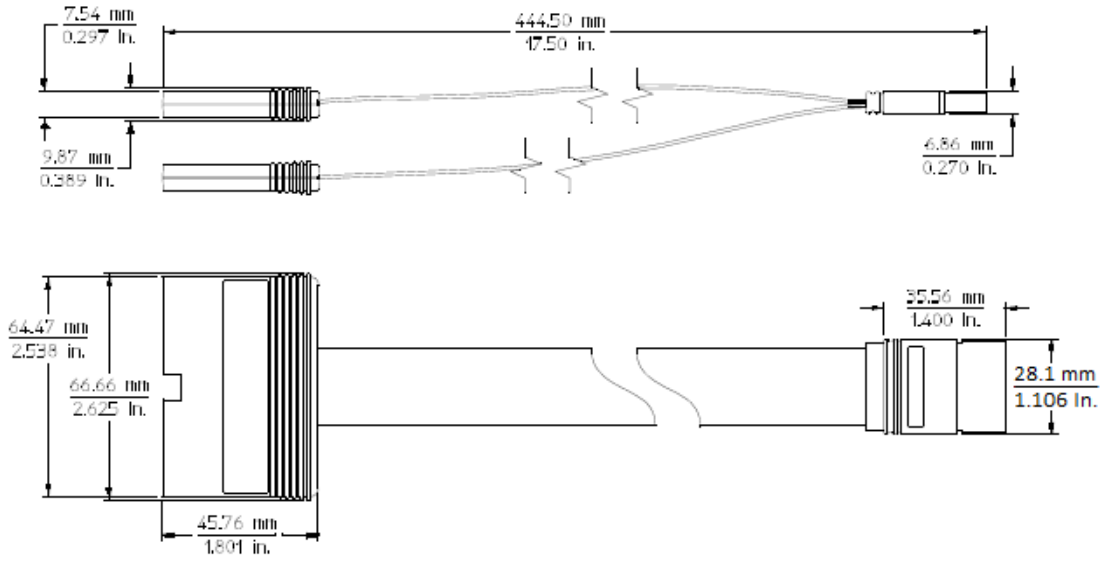


Figure 9 E5380B 34 channel single-ended probe dimensions

MICTOR connector dimensions

The E5380B probe is compatible with target systems designed for the Keysight E5346A 38-pin probe. This probe requires a probe kit that contains MICTOR connectors and shrouds. Refer to page 68 for the kit part numbers.

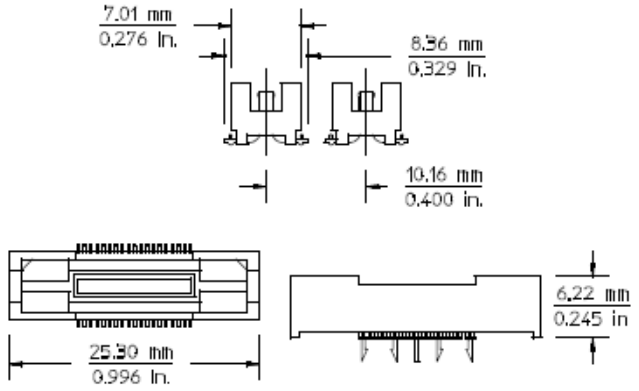


Figure 10 MICTOR 38-pin connector dimensions

Support shroud dimensions

Support shrouds are not required but are recommended if pulling forces may be applied to the cables that could cause the connector to be dislodged. Refer to page 68 for the kit part numbers.

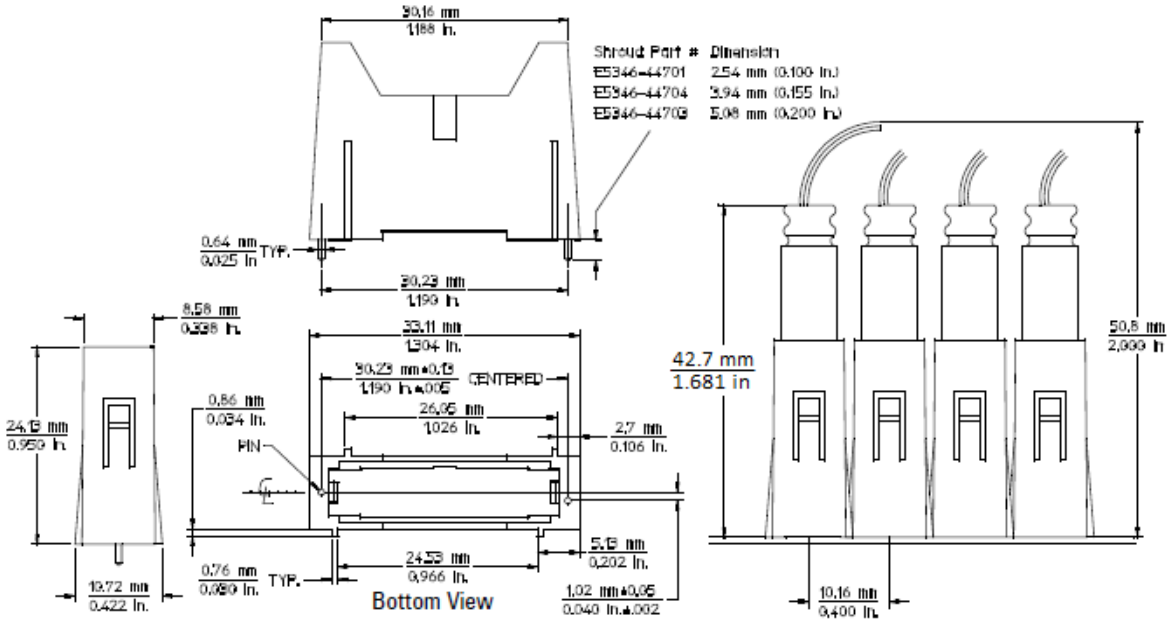


Figure 11 Support shroud dimensions for the MICTOR 38-pin connector

Footprint dimensions

Use the following 38-pin MICTOR connector footprint and support shroud mounting hole dimensions to design your target system board.

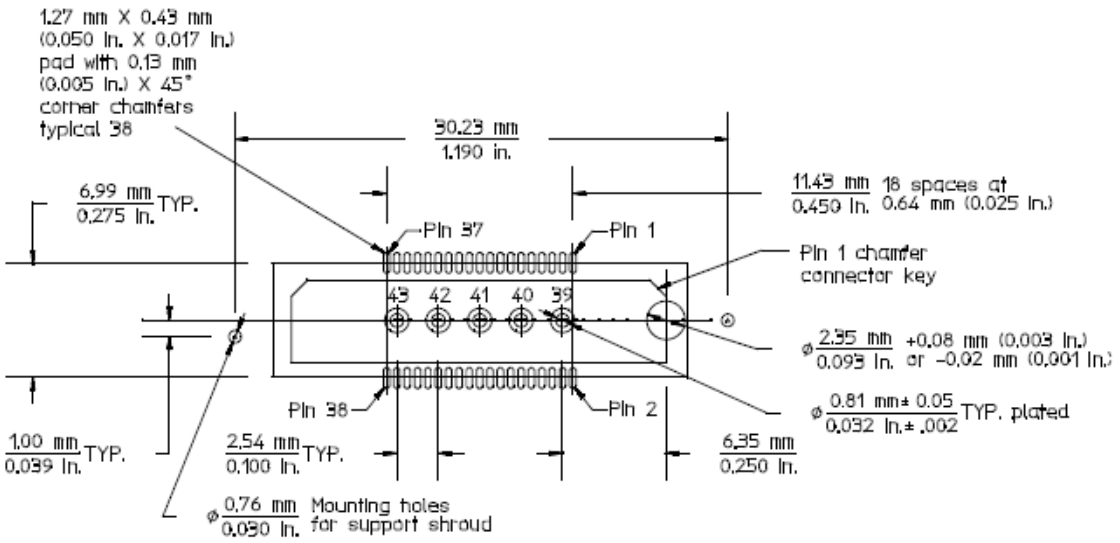


Figure 12 38-pin MICTOR connector footprint and support shroud mounting hole dimensions.

E5380B 34 channel single-ended probe pin out table

E5380B Single-ended Probe			Logic Analyzer	
Signal Name	MICTOR Pin #		Channel	Pod
Clk	5	→	Clk	Whichever pod is connected to "Even" on the E5380B probe
D15	7	→	15	
D14	9	→	14	
D13	11	→	13	
D12	13	→	12	
D11	15	→	11	
D10	17	→	10	
D9	19	→	9	
D8	21	→	8	
D7	23	→	7	
D6	25	→	6	
D5	27	→	5	
D4	29	→	4	
D3	31	→	3	
D2	33	→	2	
D1	35	→	1	
D0	37	→	1	
Ground	39-43			
Do not connect the following pins. These pins are +5 volt supply and DC return for analysis probes.				
+5 V dc	1			

E5380B Single-ended Probe			Logic Analyzer	
Signal Name	MICTOR Pin #		Channel	Pod
Clk	6	→	Clk	Whichever pod is connected to "Odd" on the E5380B probe
D15	8	→	15	
D14	10	→	14	
D13	12	→	13	
D12	14	→	12	
D11	16	→	11	
D10	18	→	10	
D9	20	→	9	
D8	22	→	8	
D7	24	→	7	
D6	26	→	6	
D5	28	→	5	
D4	30	→	4	
D3	32	→	3	
D2	34	→	2	
D1	36	→	1	
D0	38	→	1	
Ground	39-43			
Do not connect the following pins. These pins are +5 volt supply and DC return for analysis probes.				
+5 V dc	1			

E5380B Single-ended Probe		Logic Analyzer	
Signal Name	MICTOR Pin #	Channel	Pod
Ground	3		
Do not connect the following pins. They are used by the Keysight logic analyzer with an emulator or analysis probe to program or read target information.			
SCL	2		
SDA	4		

E5380B Single-ended Probe		Logic Analyzer	
Signal Name	MICTOR Pin #	Channel	Pod
Ground	3		
Do not connect the following pins. They are used by the Keysight logic analyzer with an emulator or analysis probe to program or read target information.			
SCL	2		
SDA	4		

E5386A Half-channel Adapter (16760A only)

Characteristics

The E5386A half-channel adapter works with the 16760A logic analyzer and the E5378A 100-pin Single-ended Probe or the E5379A 100-pin Differential Probe. 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 dependent on the logic 16760A module.

Adapter dimensions

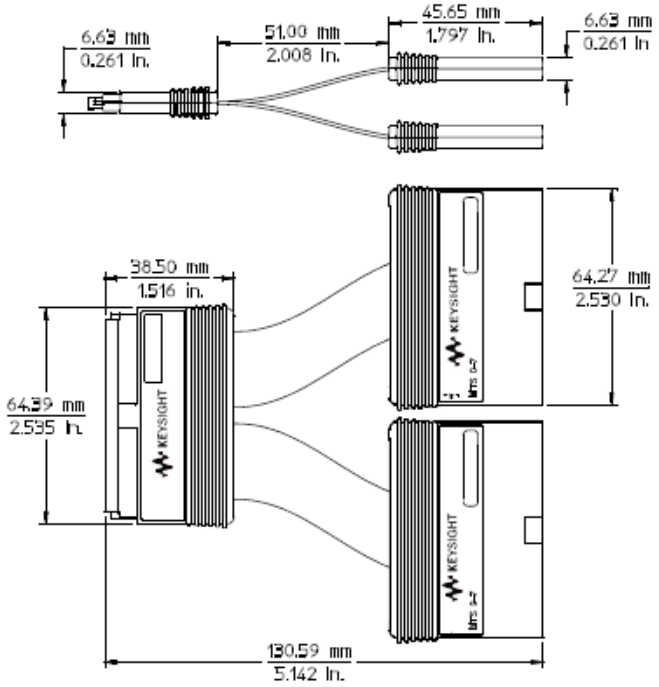


Figure 13 Half-channel adapter dimensions.

Pinout for the half-channel adapter when connected to E5378A

When used with the E5378A 100-pin single-ended 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 E5378A labeled 'odd' becomes the 'odd' E5386A adapter.

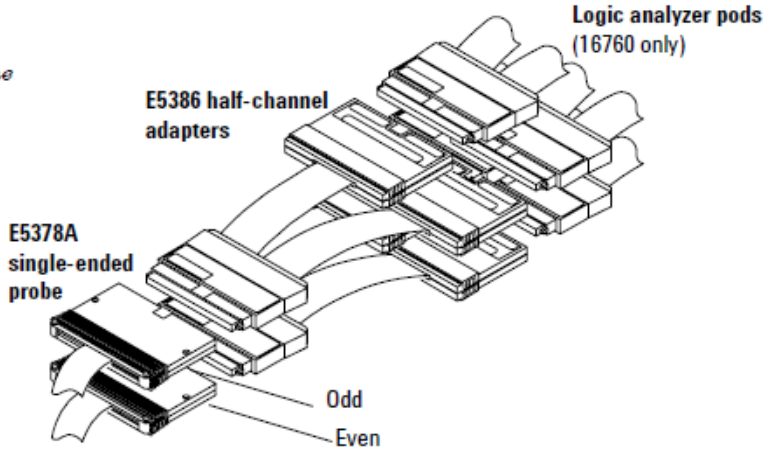


Figure 14 Two half-channel adapters with E5378A

Table 3 Pin-out table for two E5386A half-channel adapters connected to an E5378A

E5386A Adapter Odd				
E5378A Single-ended Probe			Logic Analyzer	
Signal Name	Pin #		Channel	Pod
D0	7	→	0	Whichever pod is connected to bits 0-7 on the odd E5386A
D1	11	→	2	
D2	15	→	4	
D3	19	→	6	
D4	23	→	8	
D5	27	→	10	
D6	31	→	12	
D7	35	→	14	
D8	39	→	0	Whichever pod is connected to bits 8-15 on the odd E5386A
D9	43	→	2	
D10	47	→	4	
D11	51	→	6	
D12	55	→	8	
D13	59	→	10	
D14	63	→	12	
D15	67	→	14	
D16 p/Clk p	79	→	Clk p	
D16 n/Clk p	83	→	Clk n	
Ext Ref	87	→	Ext Ref	

E5386A Adapter Even				
E5378A Single-ended Probe			Logic Analyzer	
Signal Name	Pin #		Channel	Pod
D0	8	→	0	Whichever pod is connected to bits 0-7 on the even E5386A
D1	12	→	2	
D2	16	→	4	
D3	20	→	6	
D4	24	→	8	
D5	28	→	10	
D6	32	→	12	
D7	36	→	14	
D8	40	→	0	Whichever pod is connected to bits 8-15 on the even E5386A
D9	44	→	2	
D10	48	→	4	
D11	52	→	6	
D12	56	→	8	
D13	60	→	10	
D14	64	→	12	
D15	68	→	14	
D16 p/Clk p	80	→	Clk p	
D16 n/Clk n	84	→	Clk n	
Ext Ref	88	→	Ext Ref	

Pinout for the half-channel adapter when connected to E5379A

When used with the E5379A 100-pin differential probe, you need only one half-channel adapter. The table below shows the pin assignments.

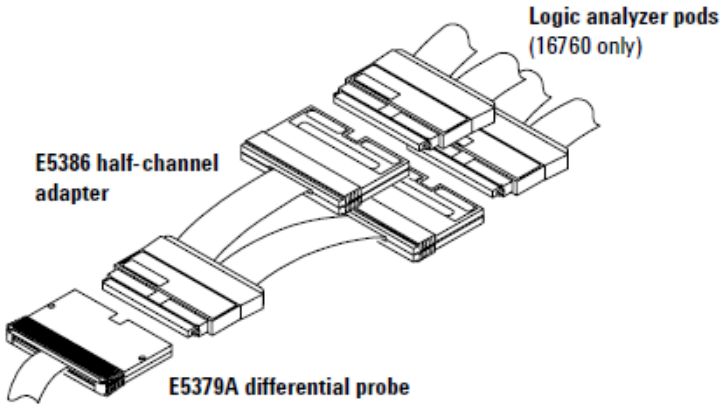


Figure 15 One half-channel adapter when connected to E5379A

Table 4 Pin-out table for one E5386A half-channel adapter connected to an E5379A

E5379A Differential Probe						
Negative Signals		Positive Signals			Logic Analyzer	
Signal Name	Pin#	Signal Name	Pin#		Channel	Pod
D0 n	7	D0 p	8	→	0	Whichever pod is plugged into bits 0-7
D1 n	11	D1 p	12	→	2	
D2 n	15	D2 p	16	→	4	
D3 n	19	D3 p	20	→	6	
D4 n	23	D4 p	24	→	8	
D5 n	27	D5 p	28	→	10	
D6 n	31	D6 p	32	→	12	
D7 n	35	D7 p	36	→	14	
D8 n	39	D8 p	40	→	0	Whichever pod is plugged into bits 8-15
D9 n	43	D9 p	44	→	2	
D10 n	47	D10 p	48	→	4	
D011 n	51	D11 p	52	→	6	
D12 n	55	D12 p	56	→	8	
D13 n	59	D13 p	60	→	10	
D14 n	63	D14 p	64	→	12	
D15 n	67	D15 p	68	→	14	
D16 n/Clk n	79	D16 p/Clk p	80	→	Clk	

3 Operating the Probes

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

Equivalent Probe Loads

The equivalent probe loads for the E5378A, E5379A, and E5380B probes are shown in the figures below. The equivalent loads include the 100-pin Samtec or 38-pin MICTOR connector.

E5378A and E5379A models

The following simple model is accurate up to 1 GHz. Transient analysis with Spice is fastest with this model.

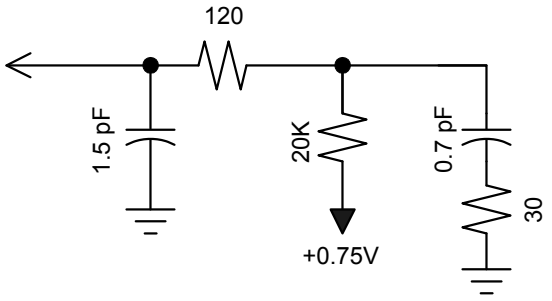


Figure 16 Simple probe load model

The following transmission line model is the most accurate. It is accurate up to 5 GHz. Transient analysis with Spice will be the slowest with this model.

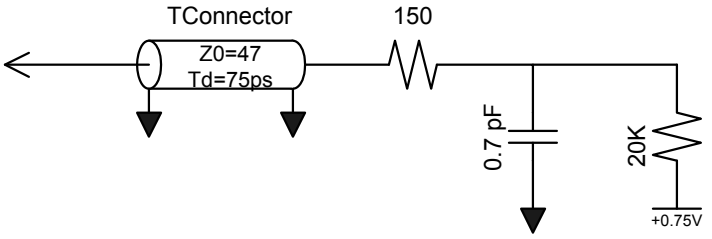


Figure 17 Transmission line model

The following lumped LC transmission line model is identical to the transmission line, but provides faster transient analysis.

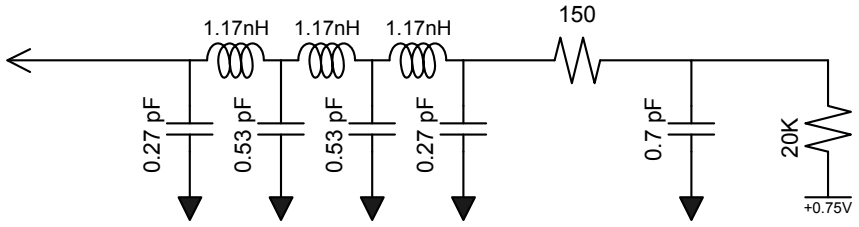


Figure 18 Lumped LC model

E5380B model

The following equivalent probe load for the E5380B includes the target connector. The model is accurate up to 1 GHz.

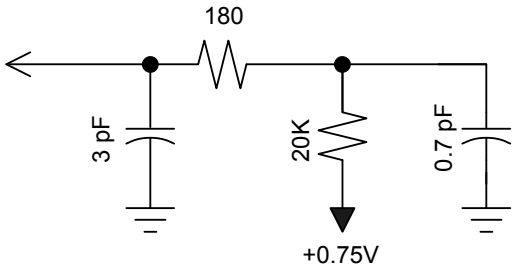
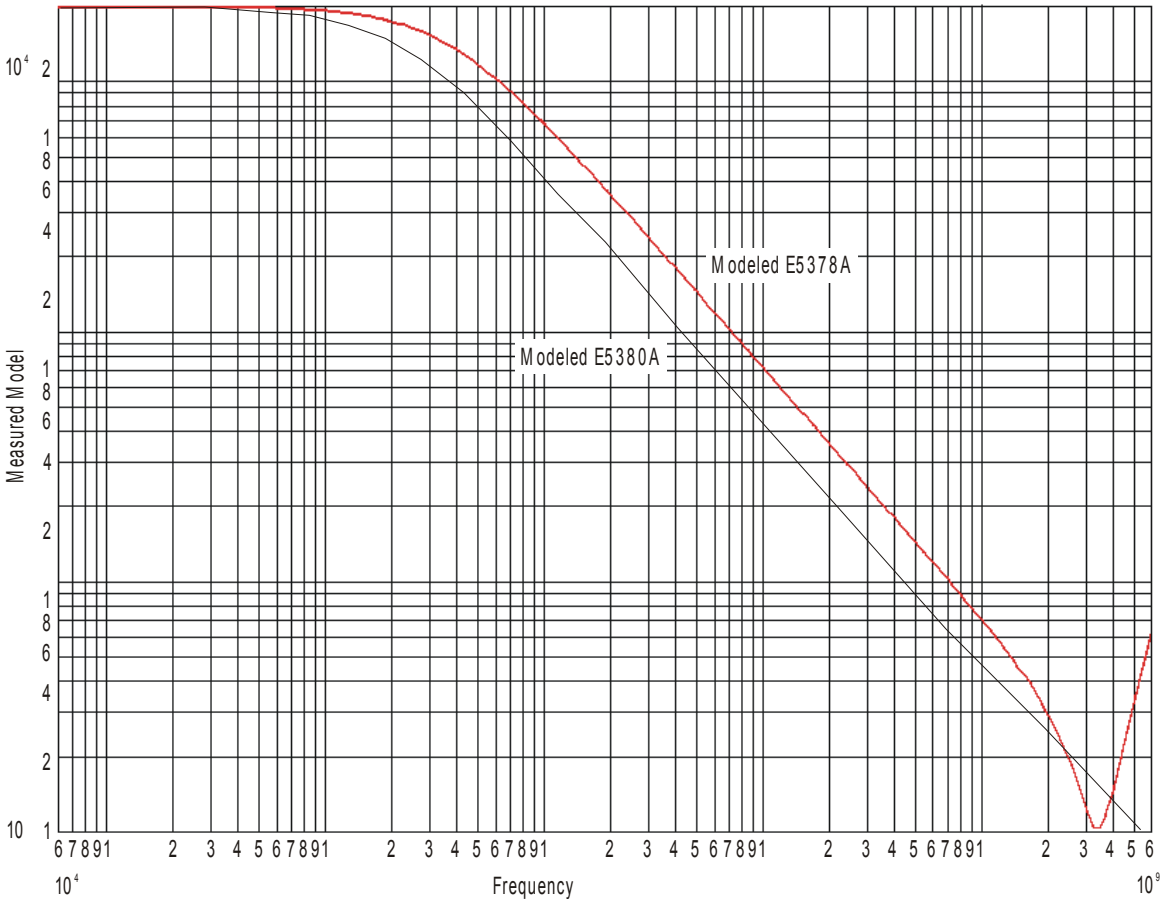


Figure 19 Equivalent load for E5380B

Measured versus modeled input impedance



Time Domain Transmission (TDT) E5378A and E5379A

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 E5378A/E5379A probes affect an ideal step seen by the receiver for various rise times.

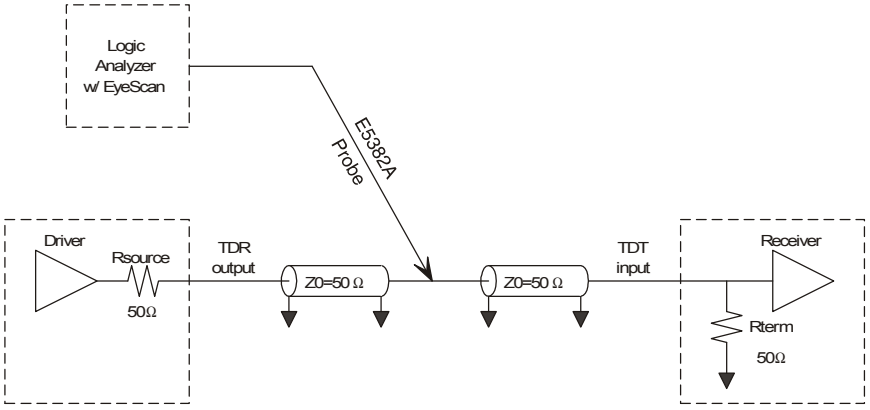


Figure 20 TDT measurement schematic

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

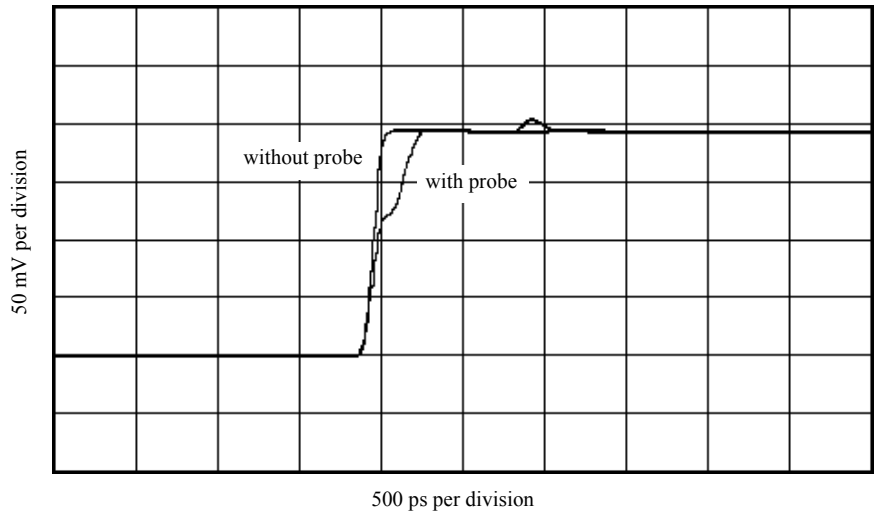


Figure 21 TDT measurement at receiver with and without probe load for 100 ps rise time

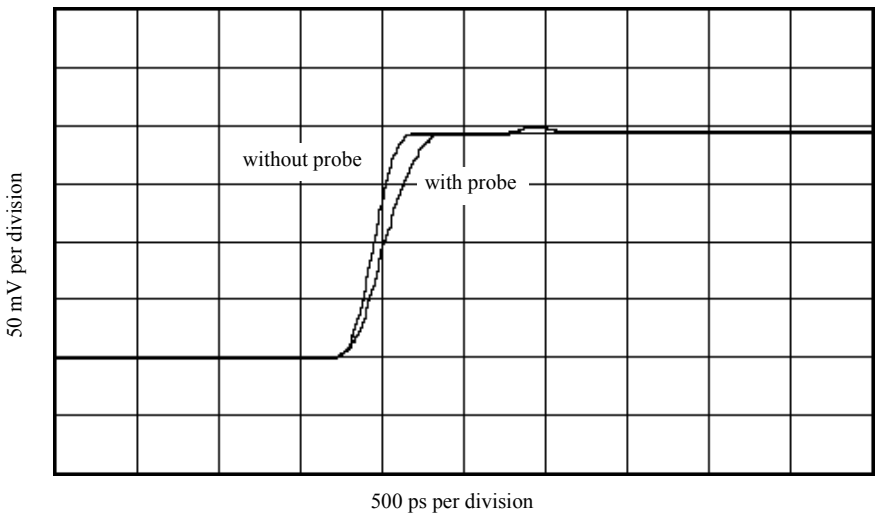


Figure 22 TDT measurement at receiver with and without probe load for 250 ps rise time

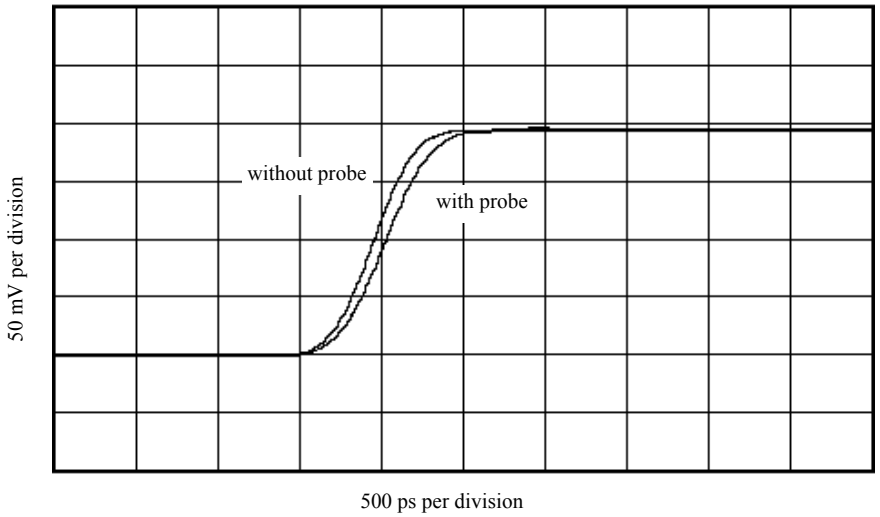


Figure 23 TDT measurement at receiver with and without probe load for 500 ps rise time

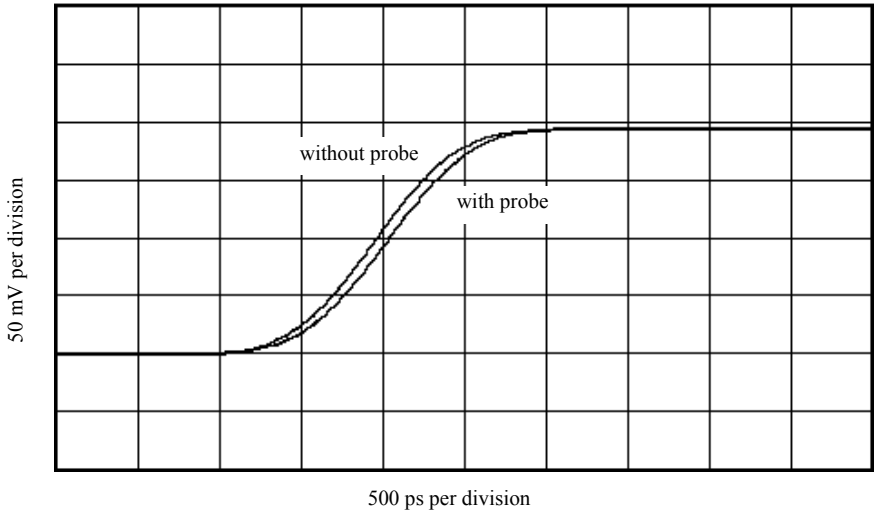


Figure 24 TDT measurement at receiver with and without probe load for 1 ns rise time

Step Inputs E5378A and E5379A

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 E5378/79 probes.

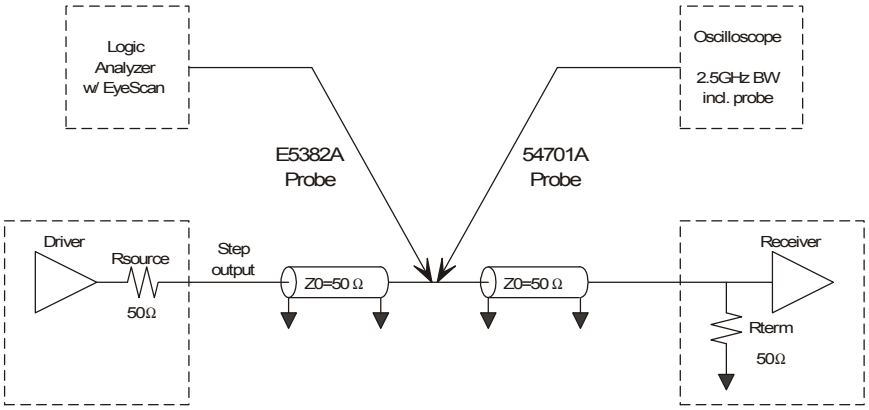


Figure 25 Step input measurement schematic

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

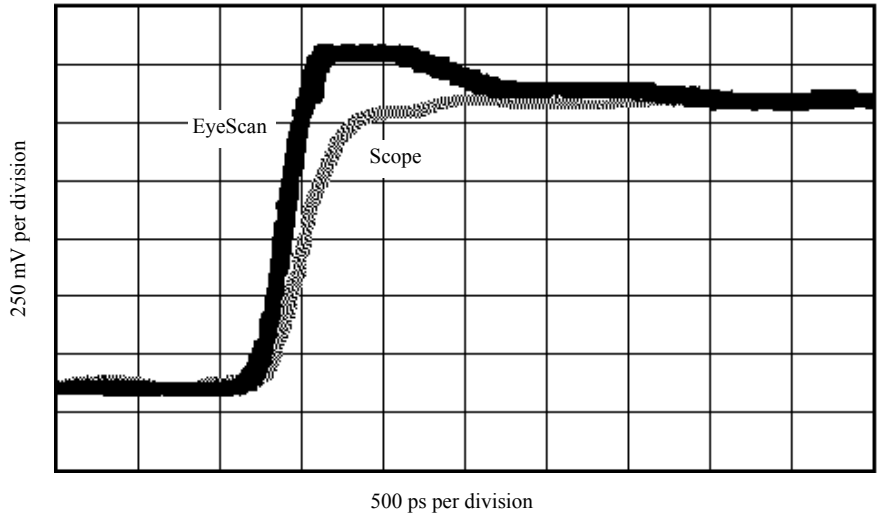


Figure 26 Logic analyzer's response to 250 ps rise time

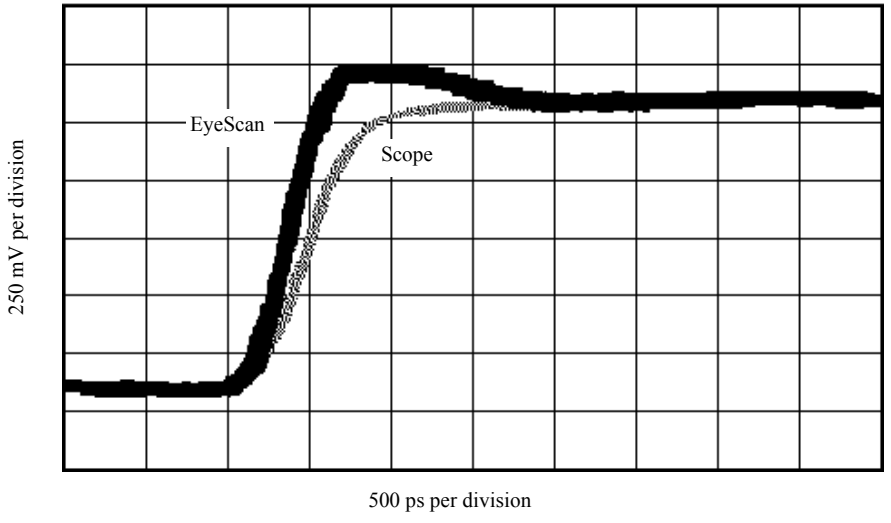


Figure 27 Logic analyzer's response to 500 ps rise time

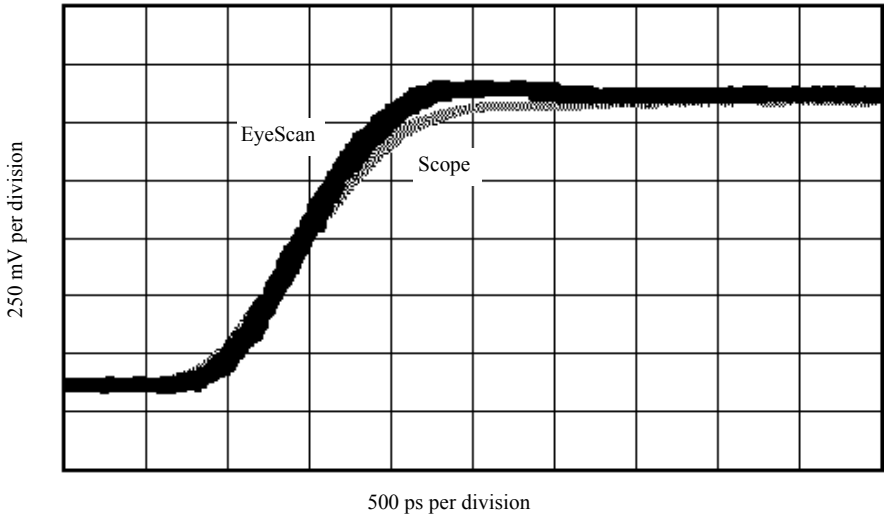


Figure 28 Logic analyzer's response to 1 ns rise time

Eye Opening E5378A and E5379A

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 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).

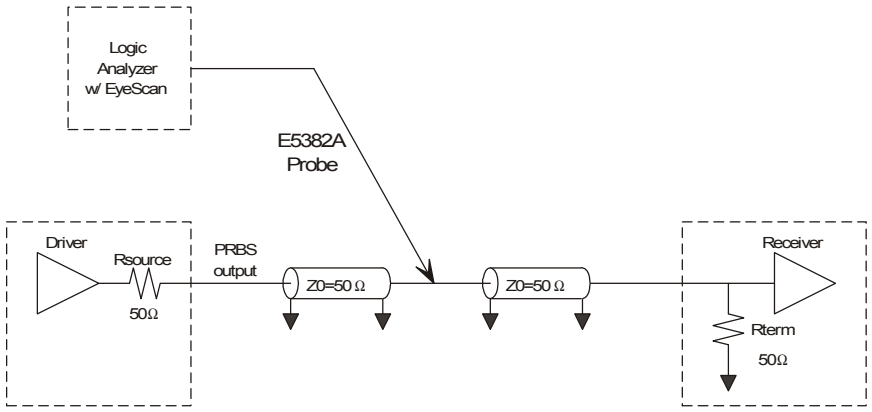


Figure 29 Eye opening measurement schematic

The following plots were made on an Keysight 16760A logic analyzer using an Keysight 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.

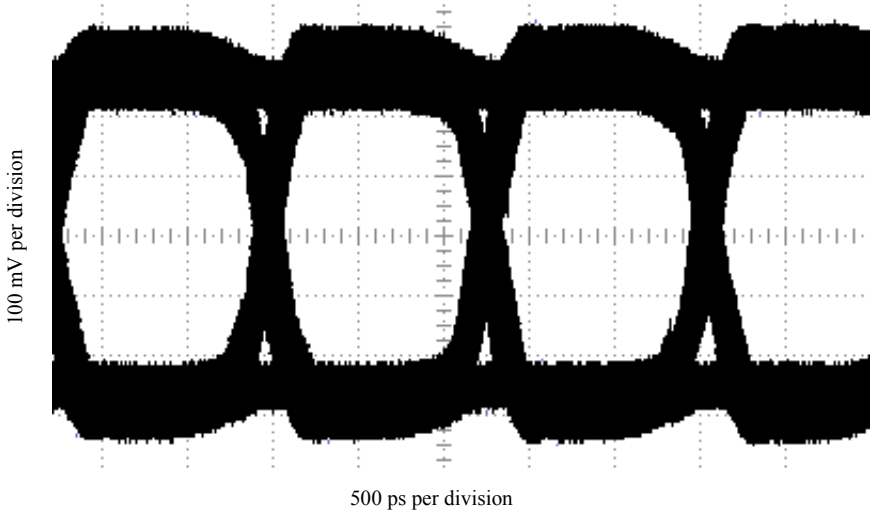


Figure 30 Logic analyzer eye opening for a PRBS signal of 500 mV p-p, 800 Mb/s data rate

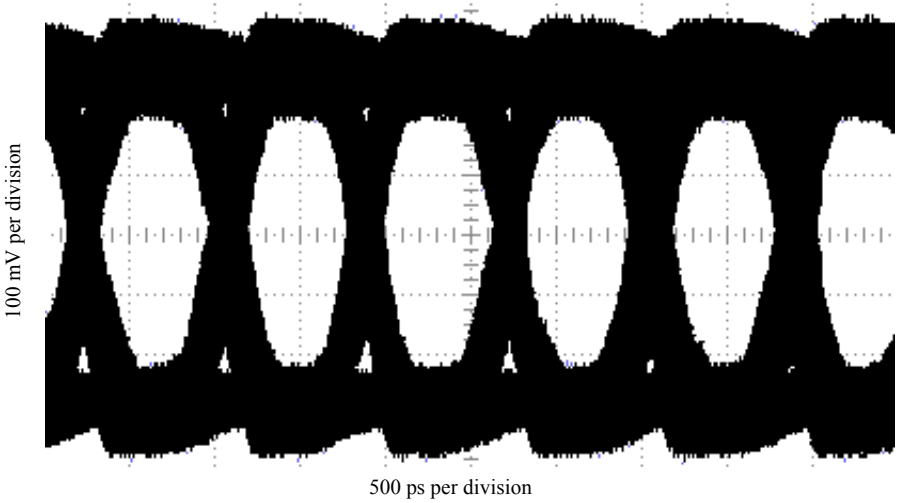


Figure 31 Logic analyzer eye opening for a PRBS signal of 500 mV p-p, 1250 Mb/s data rate

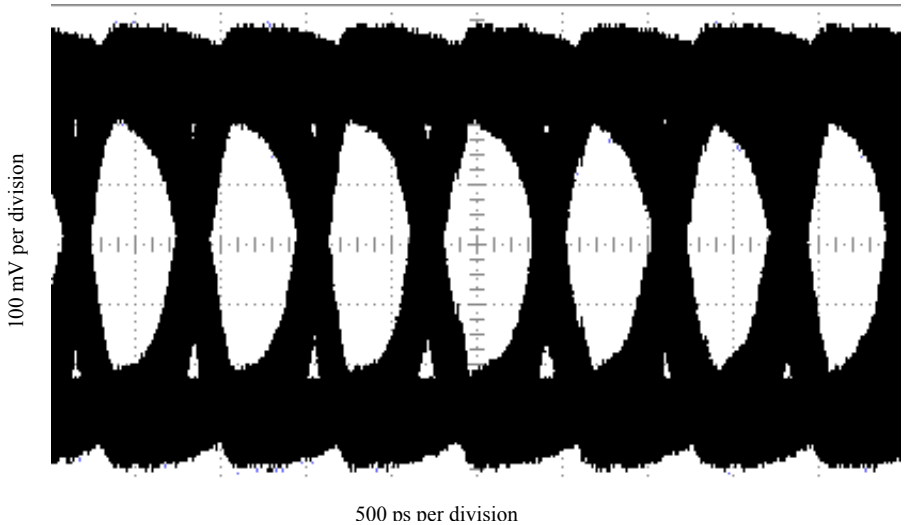


Figure 32 Logic analyzer eye opening for a PRBS signal of 500 mV p-p, 1500 Mb/s data rate

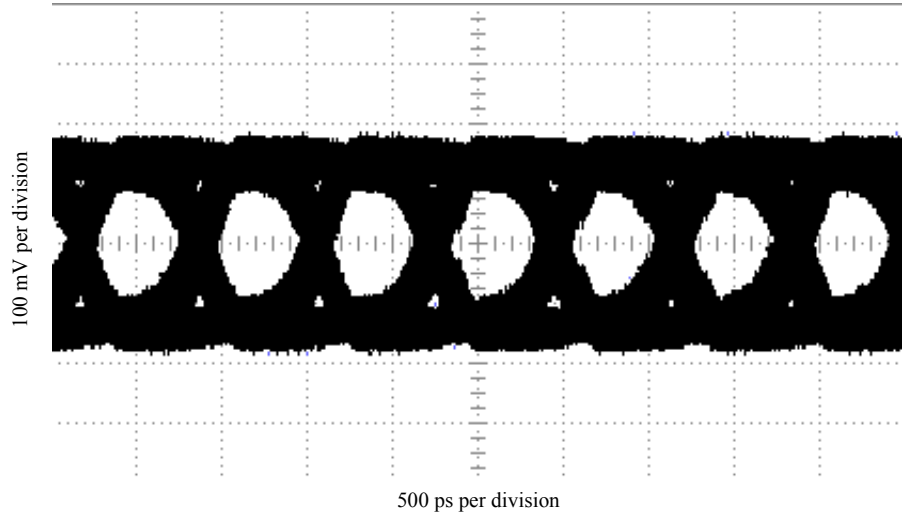


Figure 33 Logic analyzer eye opening for a PRBS signal of 200 mV p-p, 1500 Mb/s data rate

4 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 (microstrip). 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 ohms, 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

The probe load models provided in the previous chapter do not include the vias and short stubs shown in this drawing. The additional load on the target due to this rating is very topology dependant. You need to consider these effects in addition to the published probe load.

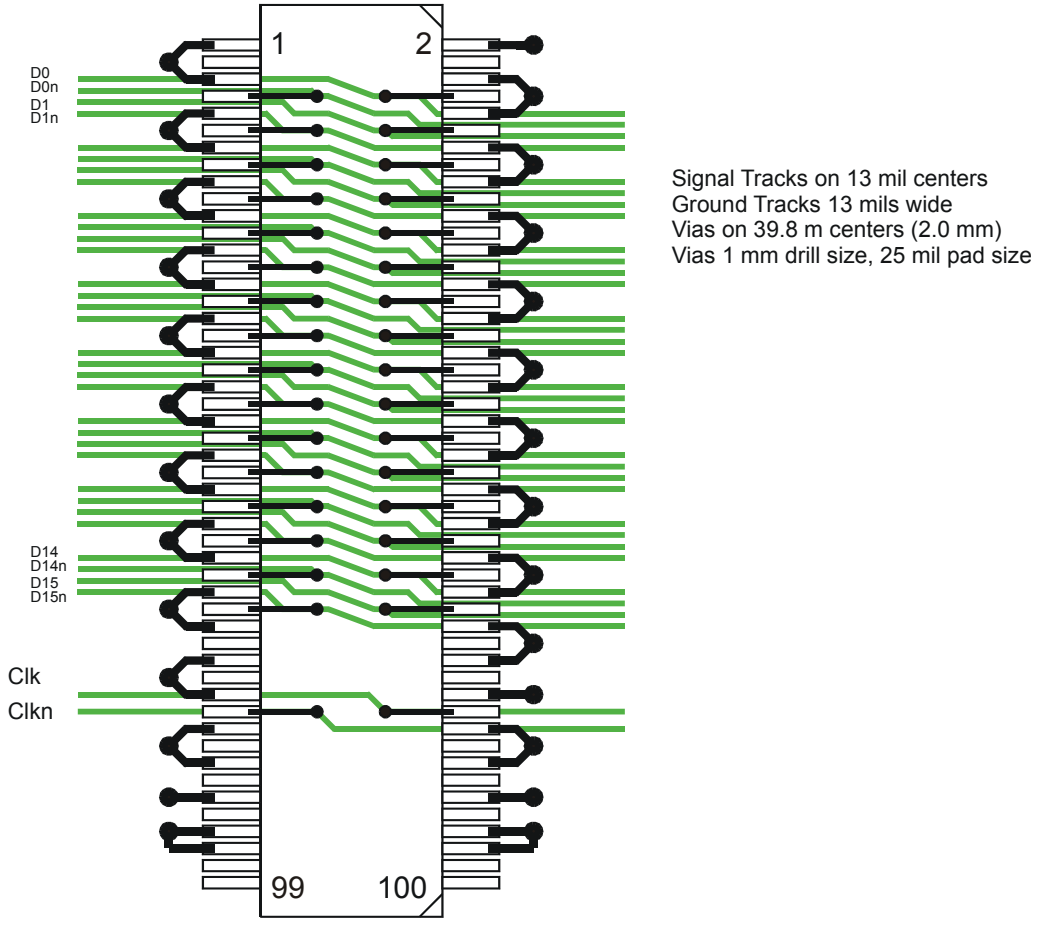


Figure 34 16-bit differential flow-through routing

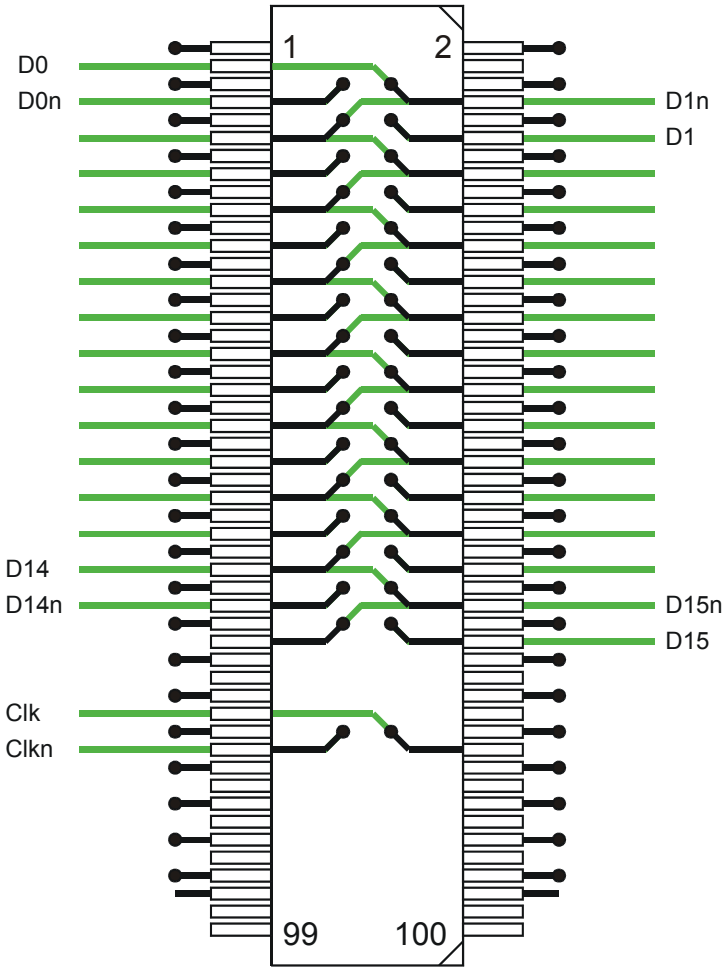


Figure 35 16-bit differential signal pairs broken out to alternate sides

16760A 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 16760A logic analyzer.

Table 5 Data clock inputs per operating mode

16760A Operating Mode	E5378A	E5378A with half-channel adapter E5386A	E5379A	E5379A with half-channel adapter E5386A	E5380B
Synchronous (state) analysis 200 Mb/s, 400 Mb/s, 800 Mb/s	32 data plus 2 clock inputs (see note 1)	N/A	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 1)
Synchronous (state) analysis 1250 Mb/s 1500 Mb/s	16 data plus 1 clock input (see note 2)	32 data plus 2 clock inputs (see note 2)	8 data plus 1 clock input (see note 2)	16 data plus 2 clock inputs (see note 2)	N/A
Eye scan mode 800 Mb/s	32 data plus 2 clock inputs (see note 1)	N/A	16 data plus 1 clock input (see note 1)	N/A	32 data plus 2 clock inputs (see note 1)
Eye scan mode 1500 Mb/s	16 data plus 1 clock input (see note 2)	32 data plus 2 clock inputs (see note 2)	8 data plus 1 clock input (see note 2)	16 data plus 2 clock inputs (see note 2)	N/A
Timing mode	32 data plus 2 clock inputs (see note 3)	N/A	16 data plus 1 clock input (see note 3)	N/A	32 data plus 2 clock inputs (see note 3)

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 Keysight 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 pad 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.

Thresholds

E5378A 34 channel single-ended probe

Data inputs

The E5378A 34 channel single-ended probe has two inputs for a user-supplied threshold voltage for the data inputs, one for the even pod and one for the odd pod. The threshold inputs (pins 87 and 88) may be grounded, left open, or connected to a dc power supply. For each group of data inputs, you may either:

- Supply a threshold voltage between -3V dc and +5V dc to the threshold input. The logic analyzer will use this threshold to determine when the signal is high or low.

Or

- Adjust the logic threshold in the user interface to between -3V dc and +5V dc.

The advantages of supplying a threshold voltage via the threshold input on the probe are:

- A threshold supplied from the source will typically track changes in supply voltage, temperature, etc.
- A threshold supplied from the target is typically the same threshold that the target system's logic uses to evaluate the signals. Therefore the data captured by the logic analyzer will be congruent with the data as interpreted by the target system.

Clock input

The clock input to the E5378A 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.

Or

- Supply a threshold reference voltage between -3V dc and +5V dc to the $\overline{\text{clock}}$ input. In this case, the clock threshold in the user interface should be set to zero.

If your circuit uses a resistive divider to provide a threshold reference, be sure to consider the equivalent circuit consisting of the 20k Ω resistor connected to +0.75V as shown on page 42 and 43.

The threshold for the clock input has a separate adjustment in the user interface, independent of the data inputs.

E5379A 17 channel differential probe

Data inputs

If you are using the E5379A 17 channel differential 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 data inputs.

You may also use the E5379A 17 channel differential probe to acquire single-ended signals. If you are using the E5379A probe to acquire single-ended signals, you should either ground the data inputs or connect them to a DC power supply. You may:

- Ground the data inputs and adjust the threshold in the user interface.

Or

- Supply a threshold reference voltage to the 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, be sure to consider the equivalent circuit consisting of the 20k Ω resistor connected to +0.75V as shown on page 42 and 43.

Clock input

The same choices exist for the clock input on the E5379A 100-pin differential probe as outlined above for the data inputs. The clock input has a separate, independent threshold adjustment.

E5380B 34 channel single-ended probe

All inputs on the E5380B 34 channel probe are single-ended. The E5380B probe does not have a threshold reference input. When you use the E5380B, you adjust the logic threshold in the user interface.

The clock input on the E5380B is single-ended. The clock threshold may be adjusted independent of the data.

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 Keysight 16760A” (Keysight 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 Keysight 16760A” (Keysight publication number 5988-2994EN) for more details.

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

In the half-channel 1.5 Gb/s mode, the 16760A analyzer accesses only the even channels (0,2,4, etc.). Note that in the 1.5 Gb/s half-channel mode, the clock inputs cannot be assigned as bits in a label.

The E5386A can be used with the E5378A 100-pin Single-ended Probe or the E5379A 100-pin Differential Probe to map the signals from the 100-pin Samtec connector to the 16760A when operating in half-channel state mode.

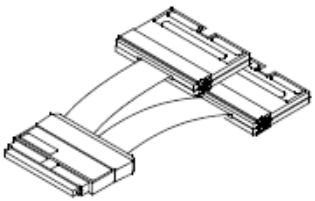


Figure 36 E5386A half-channel adapter

5 Recommended Reading

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

For More Information

For more information on Keysight logic analyzers, refer to http://www.keysight.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” Keysight Technologies application note publication number 5988-2989EN.

6 Connectors and Shrouds

A table of part numbers for ordering connectors, shrouds, and kits.

KEYSIGHT TECHNOLOGIES

Ordering Probing Connectors and Shrouds

Connectors and shrouds may be ordered in kits or ordered separately. Select a support shroud appropriate for the thickness of your PC board. The following table lists the Keysight part numbers for each.

CAUTION

The support shrouds marked with an asterisk in the following table are made of conductive metal. Care should be taken to avoid shorting adjacent boards or components with the shrouds. For this reason it may be advisable not to connect the shrouds to ground.

For Probe Model #	Keysight Part Number	Consists of	For Target PC Board Thickness
E5378A & E5379A	16760-68702	5 Mating Connectors & 5 Support Shrouds*	up to 1.57 mm (0.062 in.)
	16760-68703		up to 3.05 mm (0.120 in.)
	1253-3620 (or Samtec #ASP-65067-01)	1 100-pin Mating Connector	n/a
	16760-02302	1 Support Shroud*	up to 1.57 mm (0.062 in.)
	16760-02303	1 Support Shroud*	up to 3.05 mm (0.120 in.)
68E5380B	E5346-68701	5 MICTOR Connectors & 5 Support Shrouds	up to 1.57 mm (0.062 in.)
	E5346-68700	5 MICTOR Connectors & 5 Support Shrouds	1.575 to 3.175 mm (0.062 to 0.125 in.)
	1252-7431	1 MICTOR Connector	n/a
	AMP part #2-767004-2	1 MICTOR Connector	n/a
	E5346-44701	1 Support Shroud	up to 1.57 mm (0.062")
	E5346-44704	1 Support Shroud	1.575 to 3.175 mm (0.062 to 0.125 in.)
	E5346-44703	1 Support Shroud	3.175 to 4.318 mm (0.125 to 0.70 in.)

Safety Information

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings or operating instructions in the product manuals violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements. Product manuals are provided with your instrument on CD-ROM and/or in printed form. Printed manuals are an option for many products. Manuals may also be available on the Web. Go to www.keysight.com and type in your product number in the Search field at the top of the page.

General

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the unit before applying power. Note the instrument's external markings described in “Safety Symbols”.

Ground the Instrument

If your product is provided with a grounding type power plug, the instrument chassis and cover must be connected to an electrical ground to minimize shock hazard. The ground pin must be firmly connected to an electrical ground (safety ground) terminal at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Fuses

See the user's guide or operator's manual for information about line-fuse replacement. Some instruments contain an internal fuse, which is not user accessible.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Cleaning

Clean the outside of the instrument with a soft, lint-free, slightly dampened cloth. Do not use detergent or chemical solvents.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Keysight Sales and Service Office for service and repair to ensure that safety features are maintained.

In Case of Damage

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

CAUTION

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

WARNING

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

Safety Symbols

Table 6 Description of Safety related symbols that may appear on a product

Symbol	Description
	Direct current
	Alternating current
	Both direct and alternating current
	Three phase alternating current
	Earth ground terminal

Symbol	Description
	Protective earth ground terminal
	Frame or chassis ground terminal
	Terminal is at earth potential
	Equipotentiality
N	Neutral conductor on permanently installed equipment
L	Line conductor on permanently installed equipment
	On (mains supply)
	Off (mains supply)
	Standby (mains supply). The instrument is not completely disconnected from the mains supply when the power switch is in the standby position
	In position of a bi-stable push switch
	Out position of a bi-stable push switch
	Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION
	Caution, refer to accompanying documentation

Symbol	Description
	Caution, risk of electric shock
	Do not apply around or remove from HAZARDOUS LIVE conductors
	Application around and removal from HAZARDOUS LIVE conductors is permitted
	Caution, hot surface
	Ionizing radiation
CAT I	IEC Measurement Category I
CAT II	Measurement Category II
CAT III	Measurement Category III
CAT IV	Measurement Category IV

Informations relatives à la sécurité

Les consignes de sécurité générales présentées dans cette section doivent être appliquées au cours des différentes phases d'utilisation de cet appareil. Le non-respect de ces précautions ou des avertissements et consignes d'utilisation spécifiques mentionnés dans les manuels des produits constitue une violation des normes de sécurité relatives à la conception, à la fabrication et à l'usage normal de l'instrument. Keysight Technologies ne saurait être tenu responsable du non-respect de ces consignes. Les manuels des produits sont fournis avec votre instrument sur CD-ROM et/ou en version papier. Les versions papier des manuels sont en option pour de nombreux produits. Certains manuels sont également disponibles en ligne. Pour y accéder, allez sur le site www.keysight.com et saisissez la référence de votre produit dans le champ Rechercher qui se trouve en haut de la page.

Généralités

Utilisez ce produit uniquement dans le cadre prévu par le fabricant. Si vous ne respectez pas les instructions d'utilisation, les fonctions de sécurité du produit risquent d'être inhibées.

Avant la mise sous tension

Vérifiez que vous avez bien respecté toutes les consignes de sécurité. Faites tous les branchements au niveau de l'appareil avant de mettre ce dernier sous tension. Tenez compte des marquages externes à l'instrument décrits à la section «Symboles de sécurité».

Mise à la terre de l'instrument

Si une prise de mise à la terre est fournie avec le produit, le châssis et le capot de l'instrument doivent être reliés à la terre afin de limiter les risques d'électrocution. Le contact à la terre doit être solidement connecté à une borne de terre (de sécurité) au niveau de la prise de courant . Toute interruption du conducteur de protection (mise à la terre) ou tout débranchement de la borne de terre de protection donne lieu à un risque d'électrocution pouvant entraîner des blessures graves.

Fusibles

Pour obtenir des instructions sur le changement des fusibles de ligne, consultez le guide de l'utilisateur ou le manuel d'instructions. Certains instruments comportent un fusible interne inaccessible à l'utilisateur.

Ne pas utiliser en atmosphère explosive

N'utilisez pas l'instrument en présence de gaz ou de vapeurs inflammables.

Ne pas démonter le capot de l'instrument	Seules des personnes qualifiées, formées à la maintenance et conscientes des risques d'électrocution encourus sont autorisées à démonter les capots de l'instrument. Débranchez toujours le cordon d'alimentation secteur et tous les circuits externes avant de démonter le capot de l'instrument.
Nettoyage	Nettoyez la partie externe de l'instrument à l'aide d'un chiffon doux et non pelucheux, légèrement humidifié. N'utilisez pas de détergents ou de solvants chimiques.
Ne pas modifier l'instrument	N'installez pas de composants de remplacement et n'apportez aucune modification non autorisée à l'appareil. Pour toute opération de maintenance ou de réparation, renvoyez l'appareil à un bureau de vente et de service après-vente Keysight, afin d'être certain que les fonctions de sécurité seront maintenues.
En cas de dommages	Les instruments endommagés ou défectueux doivent être désactivés et protégés contre toute utilisation involontaire jusqu'à ce qu'ils aient été réparés par une personne qualifiée.

ATTENTION La mention ATTENTION indique un risque. Si la manoeuvre ou le procédé correspondant n'est pas exécuté correctement, il peut y avoir un risque de dommages à l'appareil ou de perte de données importantes. En présence de la mention ATTENTION, il convient de s'interrompre tant que les conditions indiquées n'ont pas été parfaitement comprises et respectées.

AVERTISSEMENT La mention AVERTISSEMENT signale un danger pour la sécurité de l'opérateur. Si la manœuvre ou le procédé correspondant n'est pas exécuté correctement, il peut y avoir un risque pour la santé des personnes. En présence d'une mention AVERTISSEMENT, il convient de s'interrompre tant que les conditions indiquées n'ont pas été parfaitement comprises et respectées.

Symboles de sécurité:

Table 7 Description des Symboles de Sécurité qui pourraient apparaître sur le produit.

Symboles	Description
	Courant continu.
	Courant alternatif.
	Courant continu et alternatif.
	Courant alternative triphasé.
	Borne de terre (masse).
	Borne de terre de protection.
	Borne de terre reliée au cadre ou au châssis.
	Borne au potentiel de la terre.
	Equipotentialité
N	Conducteur neutre sur un équipement installé à demeure
L	Conducteur de phase sur un équipement installé à demeure.
	Alimentation en marche.

Symboles	Description
	Alimentation à l'arrêt.
	Alimentation en mode veille. Lorsque l'interrupteur est en mode veille, l'unité n'est pas complètement déconnectée de l'alimentation secteur.
	Position Marche d'un interrupteur par bouton poussoir bi-stable.
	Position Arrêt d'un interrupteur par bouton poussoir bi-stable.
	Appareil entièrement protégé par DOUBLE ISOLATION ou ISOLATION RENFORCÉE
	Attention. Consultez la documentation fournie.
	Attention, danger d'électrocution.
	Ne pas appliquer ou enlever sur des conducteurs SOUS TENSION DANGEREUSE
	Application ou retrait autorisés sur les conducteurs SOUS TENSION DANGEREUSE
	Attention, surface chaude
	Rayonnement ionisant
CAT I	Appareil de mesure de catégorie I selon la norme CEI applicable

Symboles	Description
CAT II	Appareil de mesure de catégorie II selon la norme CEI applicable
CAT III	Appareil de mesure de catégorie III selon la norme CEI applicable
CAT IV	Appareil de mesure de catégorie IV selon la norme CEI applicable

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