# M8067A ISI Channel Boards

## Emulate channel loss for accurate and repeatable receiver characterization operating at symbol rates up to 64 GBd and 120 GBd

**Data Sheet – Version 4.0**

## Key Features

- Emulate a wide range of channel loss from 5 to 30 dB with intersymbol interference (ISI) traces for accurate and repeatable receiver characterization
- Six traces with 1.85 mm connectors suitable for symbol rates up to 64 GBd (M8067A-001 and -002, each with three trace pairs per board)
- Six traces with 1.0 mm connectors suitable for symbol rates up to 120 GBd (M8067A-003, -004, and -005, each with two trace pairs per board)
- Small size and mechanical brackets for vertical and horizontal placement on the test bench help minimize electromagnetic susceptibility
- Downloadable individual S-parameter files simplify accurate embedding in the test environment




KEYSIGHT

# Introduction

The M8067A ISI channel boards can be used to emulate a wide range of channel loss for characterizing high-speed digital receivers used in server and data center network interfaces. The so-called inter-symbol interference (ISI) caused by the channel degradation is data-dependent jitter, a form of bounded deterministic jitter. The ISI channel boards are designed to emulate channel loss for symbol rates up to 64 GBd and 120 GBd. A choice of twelve PC board traces with different lengths can be inserted into the signal path. The layout of the trace pairs allows them to be used for single-ended and differential signals.

For symbol rates up to 64 GBd, two boards are available with 1.85 mm connectors and trace lengths from 3.8″ (96.7 mm) to 17.1″ (434 mm).

For symbol rates beyond 64 GBd and up to 120 GBd, three boards are available with 1.0 mm connectors and trace lengths from 1.4″ (35 mm) to 8.8″ (222 mm).

For symbol rates below 32 GBd, consider the M8049A ISI channel boards.

With their small size, the M8067A ISI channel boards can be placed close to the device under test.

The mechanical brackets allow them to be placed vertically or horizontally on the test bench. Individual S-parameter files can be downloaded for each serial number.

## Emulate Channel Loss and Intersymbol Interference (ISI)

The channel loss between transmitter and receiver is a critical element of receiver testing for all electrical multi-gigabit serial interfaces. The channel loss depends primarily on the distance between transmitter and receiver and the electrical medium. The channel loss is typically defined by the S21 parameter in dB for certain frequencies. Most electrical interface standards such as PCI Express define that a receiver must tolerate a certain channel loss in the test setup. The M8067A offers a wide range of channels that emulate specific S21 loss characteristics. They allow repeatable and accurate testing of electrical interconnects at symbol rates up to 64 GBd and 120 GBd.

## Emulate Frequency-Dependent Attenuators

For testing the receivers in medium and long reach electrical interfaces, some standards such as IEEE 802.3ck and the emerging IEEE 802.3dj, OIF-CEI-112G and OIF-CEI-224G define so-called frequency-dependent attenuators. These frequency-dependent attenuators emulate the channel loss characteristics of a worst-case channel that can occur in a transmission link. Use the M8067A ISI channel boards to emulate such a frequency-dependent attenuator for symbol rates up to 120 GBd. For example, you can emulate insertion losses between 4.5 and 27 dB at 53.125 GHz (corresponding to a 106.25 GBd symbol rate).

## Key applications

- PCI Express 6.0 and 7.0 (64 and 128 GT/s)
- OIF CEI-112G electrical interfaces
- OIF-CEI-224G electrical interfaces
- IEEE 802.3ck Ethernet backplanes, cable and chip-to-chip, chip-to-module interfaces
- IEEE 802.3dj Ethernet backplanes, cable and chip-to-chip, chip-to-module interfaces
- Emulate channel loss for receiver tolerance testing
- Emulate frequency-dependent loss
- Channel operating margin test

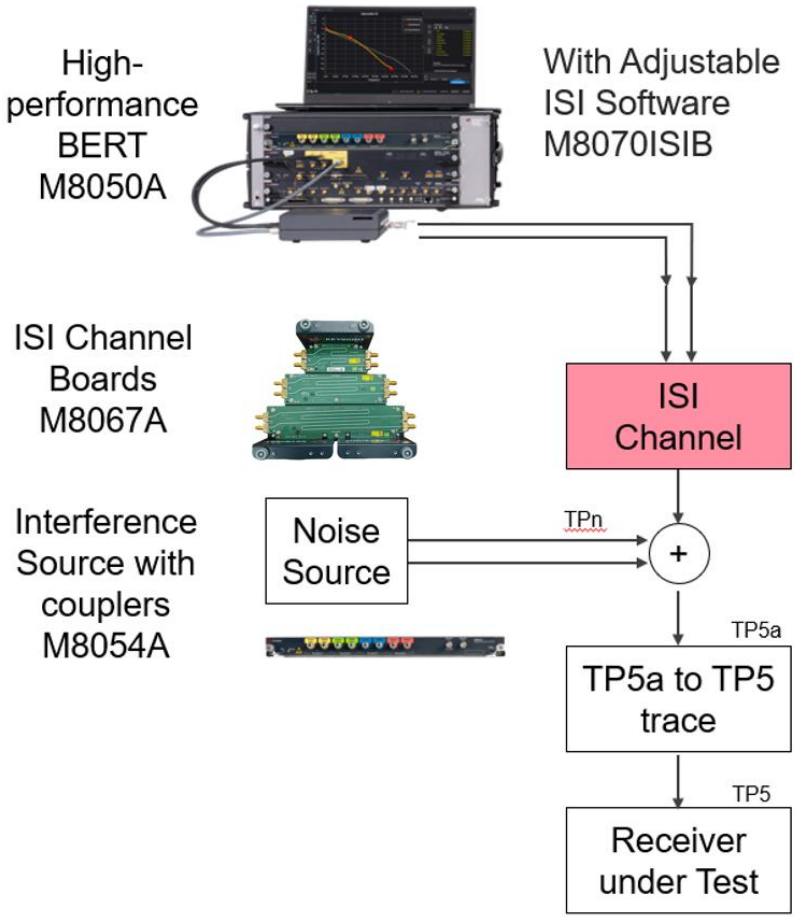



**Figure 1**. Typical receiver test setup with M8050A high-performance BERT, interference source and ISI channels.

# Overview of M8067A Options

| Model | Function | Description |
|---|---|---|
| M8067A-001  | This ISI channel board has 1.85 mm connectors. Suitable for symbol rates up to 64 GBd. Approximate IL of 10, 18 and 26 dB @ 26.125 GHz.<br>• For 800G (112 Gbps)<br>• For PCIe (128 GT/s) | 3 trace pairs with length of<br>• Trace pair 1: 6.2″ (157 mm)<br>• Trace pair 2: 11.6″ (296 mm)<br>• Trace pair 3: 17.1″ (434 mm) |
| M8067A-002  | This ISI channel board has 1.85 mm connectors. Suitable for symbol rates up to 64 GBd. Approximate IL of 6, 13 and 22 dB @ 26.125 GHz.<br>• For 800G (112 Gbps)<br>• For PCIe (128 GT/s) | 3 trace pairs with length of<br>• Trace pair 1: 3.8″ (97 mm)<br>• Trace pair 2: 8.9″ (227 mm)<br>• Trace pair 3: 14.4″ (365 mm) |
| M8067A-003  | This ISI channel board has 1.0 mm connectors. Suitable for symbol rates > 64 GBd and up to 120 GBd.<br>• For 1.6T (224 Gbps) receiver test | 2 trace pairs with length of<br>• Trace pair 1: 1.4″ (35 mm)<br>• Trace pair 2: 4.3″ (110 mm) |
| M8067A-004  | This ISI channel board has 1.0 mm connectors. Suitable for symbol rates > 64 GBd and up to 120 GBd.<br>• For 1.6T (224 Gbps) receiver test | 2 trace pairs with length of<br>• Trace pair 1: 2.9″ (72.5 mm)<br>• Trace pair 2: 5.8″ (148 mm) |
| M8067A-005  | This ISI channel board has 1.0 mm connectors. Suitable for symbol rates > 64 GBd and up to 120 GBd.<br>• For 1.6T (224 Gbps) receiver test especially for medium and long reach | 2 trace pairs with length of<br>• Trace pair 1: 7.3″ (185 mm)<br>• Trace pair 2: 8.8″ (223 mm) |

# Specifications for M8067A




**Figure 2.** Front view of ISI channel boards without brackets. The M8067A-001 and -002 ISI channel boards shown in the top row have 1.85 mm connectors and the M8067A-003, -004 and -005 ISI channel boards shown at the bottom have 1.0 mm connectors.




**Figure 3.** The 1.0 mm connectors are soldered, and the connectors have a mechanical hold.

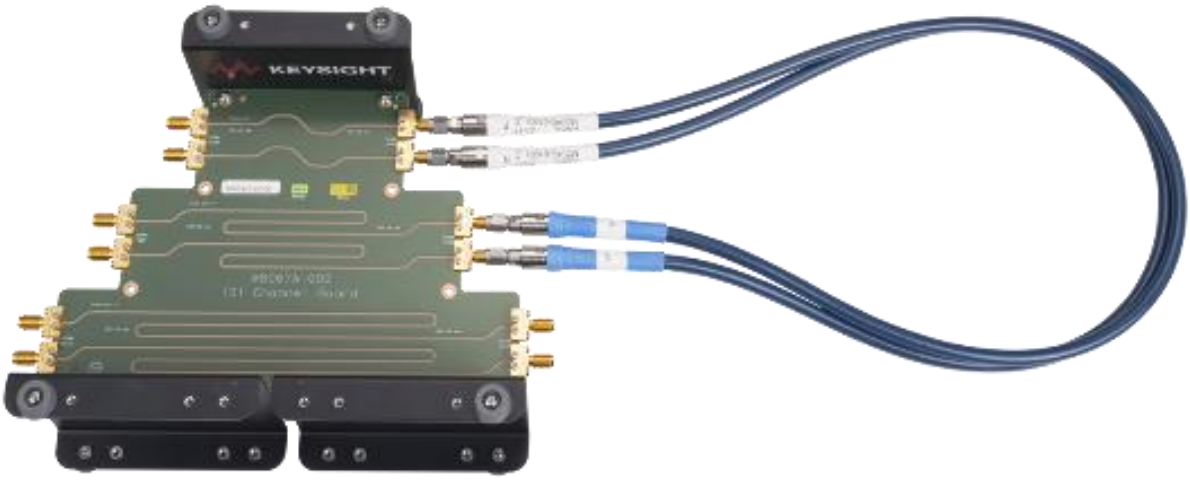



**Figure 4.** To achieve higher insertion loss, you can cascade two ISI channels by connecting them with a cable.

The figures below show typical insertion loss and return loss characteristics of the M8067A ISI channel boards.

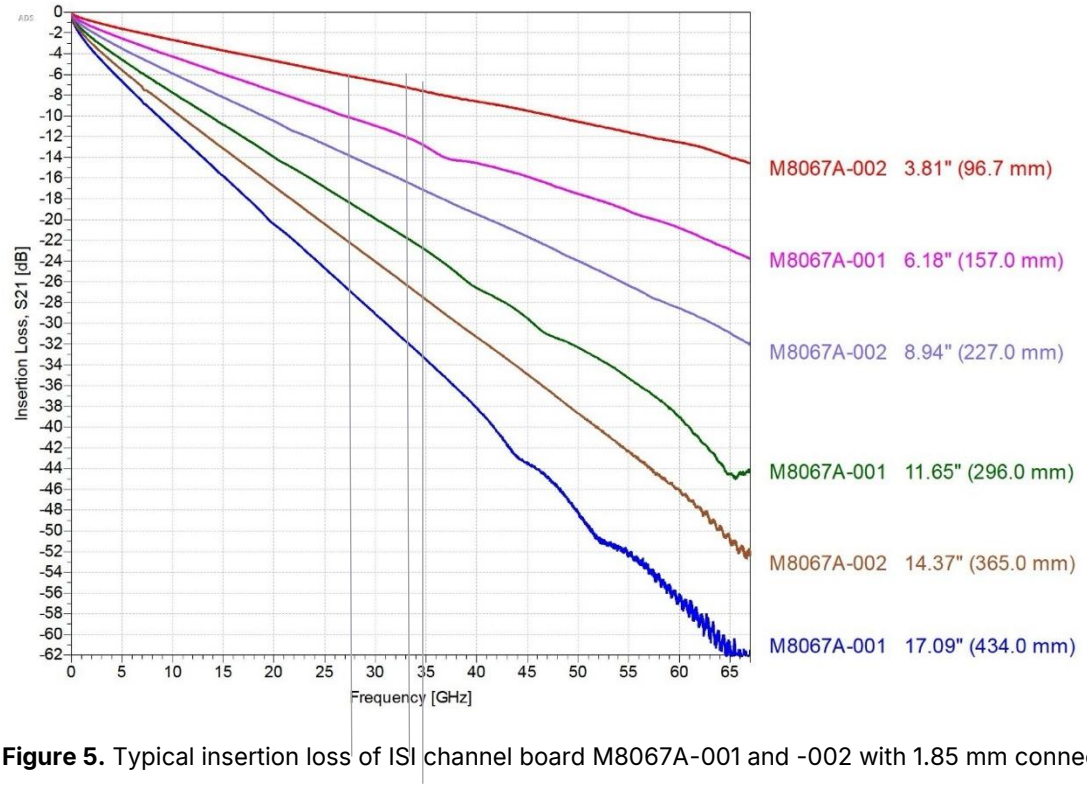



**Figure 5.** Typical insertion loss of ISI channel board M8067A-001 and -002 with 1.85 mm connectors.

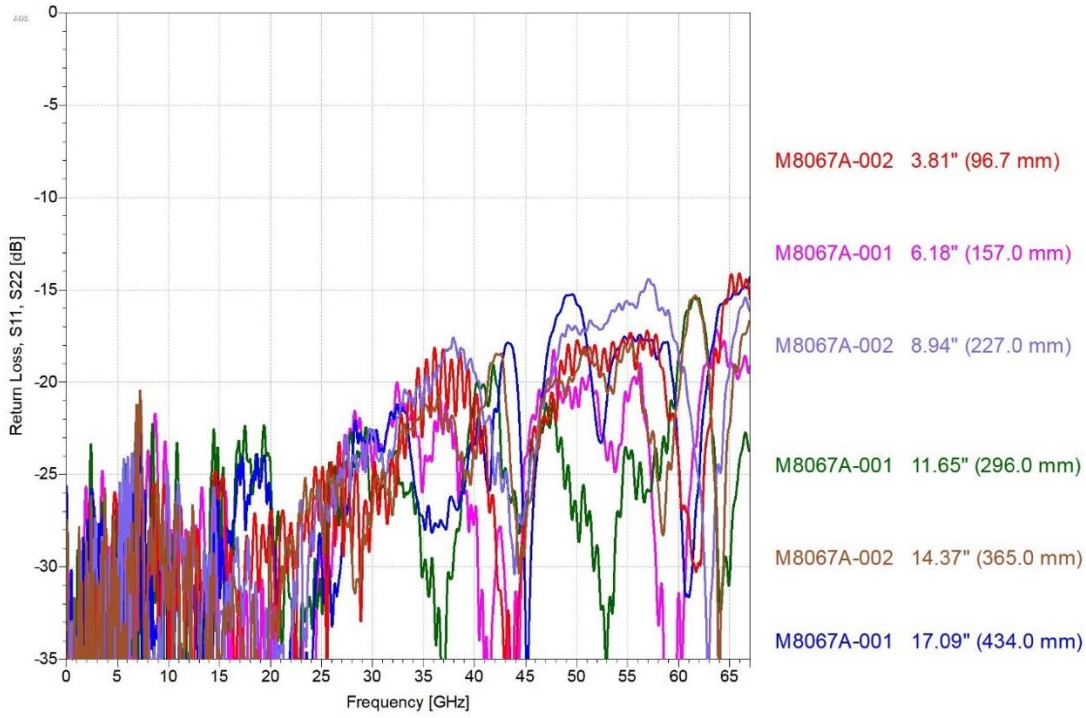



**Figure 6.** Typical return loss of ISI channel board M8067A-001 and -002 with 1.85 mm connectors.

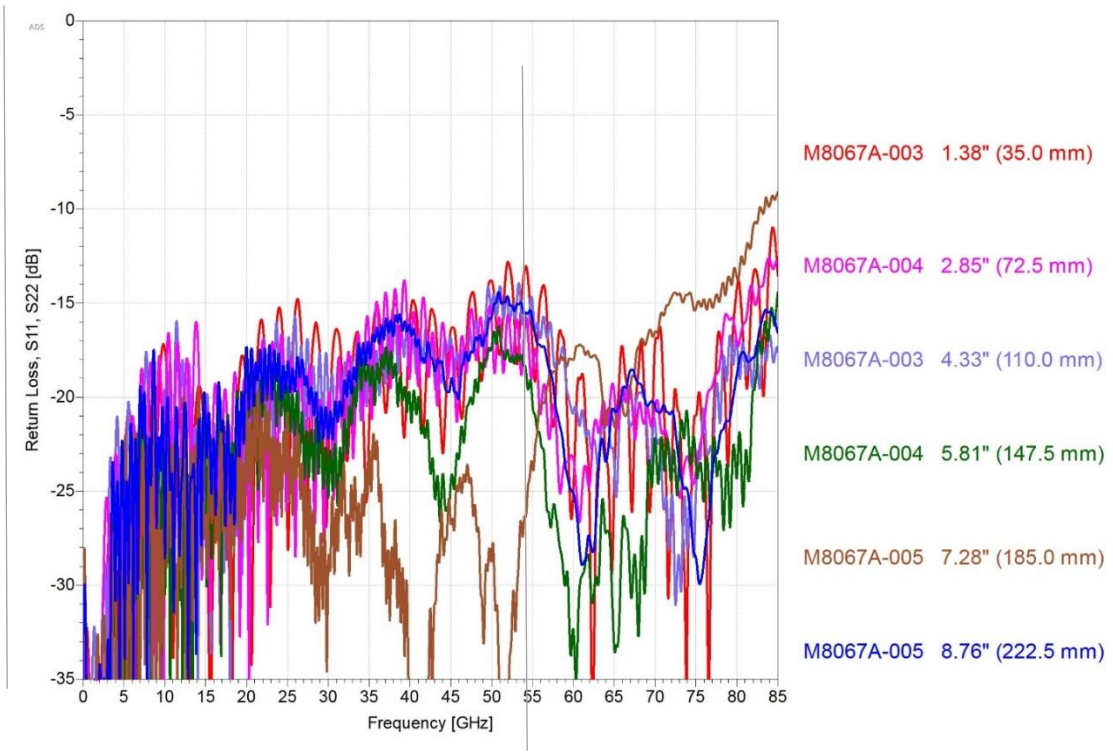



**Figure 7.** Typical insertion loss of ISI channel board M8067A-003, -004, and -005 with 1.0 mm connectors.

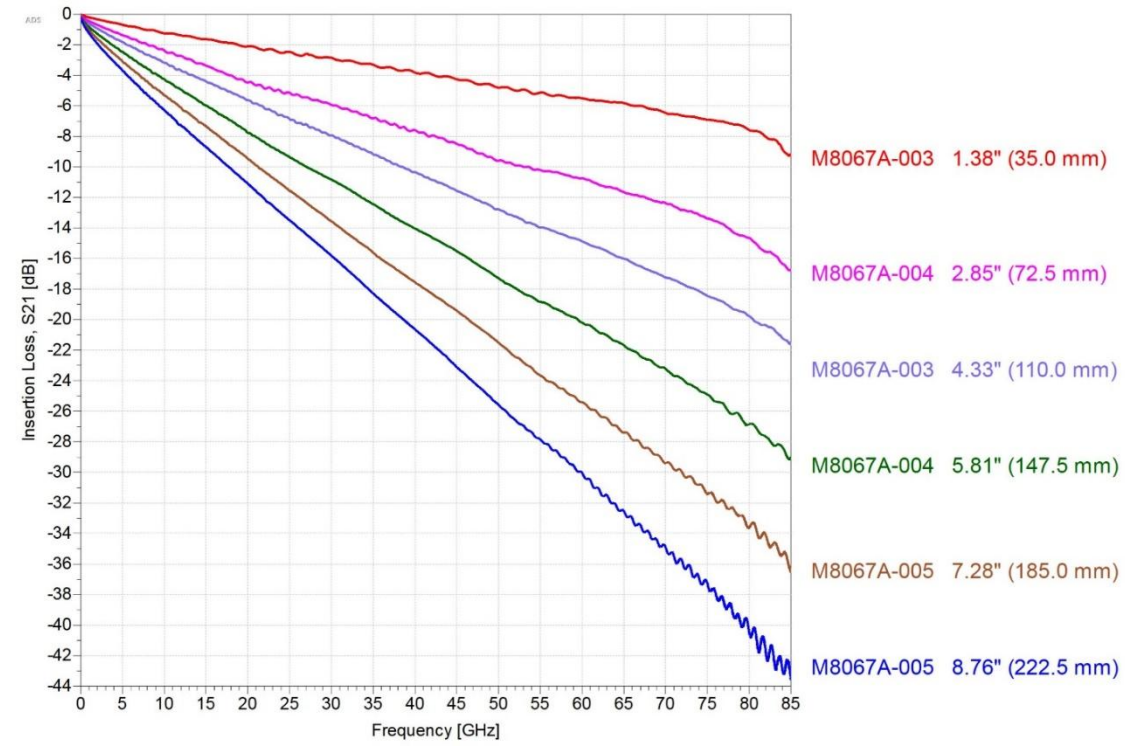



**Figure 8.** Typical return loss of ISI channel board M8067A-003, -004, and -005 with 1.0 mm connectors.

**Table 1. Specifications for M8067A ISI channel boards.**

| Parameter | M8067A-001 | M8067A-002 | M8067A-003 | M8067A-004 | M8067A-005 |
|---|---|---|---|---|---|
| Trace lengths | 6.2″ (157 mm)<br>11.6″ (296 mm)<br>17.1″ (434 mm) | 3.8″ (97 mm)<br>8.9″ (227 mm)<br>14.4″ (365 mm) | 1.4″ (35 mm)<br>4.3″ (110 mm) | 2.9″ (72.5 mm)<br>5.8″ (148 mm) | 7.3″ (185 mm)<br>8.8″ (223 mm) |
| PC board material | Astra MT77 | | | | |
| Insertion loss | Typical values, see Figure 5 (excluding cables) | | Typical values, see Figure 7 (excluding cables) | | |
| Insertion loss per inch | ~ 1.45 dB/ inch at 26.5 GHz typical<br>~ 1.7 dB/inch at 32 GHz typical<br>~ 3.1 dB/ inch at 53 GHz typical | | | | |
| Insertion loss for M8059A-801 cable | | | < 3.4 dB (0.5 to 110 GHz) typical | | |
| Insertion loss for M8058A-801 cable | < 1.5 dB (DC to 50 GHz) typical<br>< 2.0 dB (50 to 65 GHz) typical | | | | |
| Return loss | Better than -17 dB up to 25 GHz typical,<br>Better than -12 dB up to 50 GHz typical,<br>Better than -10 dB up to 67 GHz typical,<br>See also Figure 6 | | Better than -10 dB up to 85 GHz typical<br>See also Figure 8 | | |
| Individual S-parameters | Downloadable s2p files from Keysight Infoline at:<br>https://wcosisqlk.cos.is.keysight.com/archivews/ | | | | |
| Intra-pair skew | < 2.0 ps typical | | < 1.5 ps typical | | |
| Input impedance | 50 Ω single ended, ±10% typical | | | | |
| Max input voltage levels | ±5 V | | | | |
| Interface | Differential or single-ended | | | | |
| Connectors | 1.85 mm, female, soldered | 1.85 mm, female, soldered | 1.0 mm, female, soldered | 1.0 mm, female, soldered | 1.0 mm, female, soldered |
| Torque | Use the recommended torque wrench. For details, see:<br>https://www.keysight.com/main/editorial.jspx?ckey=2516881&id=2516881&lc=ger&cc=DE | | | | |

| | Symbol rate | 26.5625 GBd | | 32.0 GBd | | 53.125 GBd | | 58.0 GBd | | 64.0 GBd | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Corresponding UI (Unit interval) | 37.647 ps | | 31.25 ps | | 18.824 ps | | 17.241 ps | | 15.625 ps | |
| | Pattern | PRBS13Q | | PRBS23 | | PRBS13Q | | PRBS13Q | | PRBS23 | |
| | Line coding | PAM4 | | PAM4 | | PAM4 | | PAM4 | | PAM4 | |
| | Trace length | ps | mUI | ps | mUI | ps | mUI | ps | mUI | ps | mUI |
| M8067A-001 | 6.2″ (157 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 11.6″ (296 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 17.1″ (434 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| M8067A-002 | 3.8″ (97 mm) | 20.7 | 549.3 | 20.9 | 667.5 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 8.9″ (227 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 14.4″ (365 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

**Figure 9.** Measured ISI peak-peak jitter generated by the ISI channels for PAM4 signals at 26.5625, 32.0, 53.125, 58.0, and 64.0 GBd for M8067A-001 and -002. n.a. means that the value was not measurable.

| | Symbol rate | 26.5625 GBd | | 32.0 GBd | | 53.125 GBd | | 58.0 GBd | | 64.0 GBd | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Corresponding UI (Unit interval) | 37.647 ps | | 31.25 ps | | 18.824 ps | | 17.241 ps | | 15.625 ps | |
| | Pattern | PRBS13 | | PRBS13 | | PRBS13 | | PRBS13 | | PRBS13 | |
| | Line coding | NRZ | | NRZ | | NRZ | | NRZ | | NRZ | |
| | Trace length | ps | mUI | ps | mUI | ps | mUI | ps | mUI | ps | mUI |
| M8067A-001 | 6.2″ (157 mm) | 6.5 | 172.4 | 7.1 | 226.6 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 11.6″ (296 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 17.1″ (434 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| M8067A-002 | 3.8″ (97 mm) | 2.2 | 57.4 | 2.7 | 85.8 | 3.7 | 198.2 | 3.7 | 216.9 | 4.0 | 254.7 |
| | 8.9″ (227 mm) | 11.6 | 308.1 | 12.8 | 409.9 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| | 14.4″ (365 mm) | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

**Figure 10.** Measured ISI peak-peak jitter generated by the ISI channels for NRZ signals at 26.5625, 32.0, 53.125, 58.0, and 64.0 Gb/s for M8067A-001 and -002. n.a. means that the value was not measurable.

| | Symbol rate | 106.25 GBd | | 112.0 GBd | |
|---|---|---|---|---|---|
| | Corresponding UI (Unit interval) | 9.412 ps | | 8.929 ps | |
| | Pattern | PRBS13Q | | PRBS13Q | |
| | Line coding | PAM4 | | PAM4 | |
| | Trace length | ps | mUI | ps | mUI |
| M8067A-003 | 1.4″ (35 mm) | 3.49 | 370.8 | 3.9 | 443.5 |
| | 4.3″ (110 mm) | 9.4 | 1000.9 | 8.9 | 1000.1 |
| M8067A-004 | 2.9″ (72.5 mm) | 6.2 | 660 | 7.05 | 789.1 |
| | 5.8″ (147.5 mm) | n.a. | n.a. | n.a. | n.a. |
| M8067A-005 | 7.3″ (185 mm) | n.a. | n.a. | n.a. | n.a. |
| | 8.8″ (223 mm) | n.a. | n.a. | n.a. | n.a. |

**Figure 11.** Typical ISI peak-peak jitter generated by the ISI channels at 106.25 and 112 GBd for PRBS13Q for M8067A-003, -004 and -005. n.a. means that the value was not measurable.

# General Characteristics for M8067A

**Table 2. General characteristics for M8067A.**

| Parameter | M8067A-001, -002, -003, -004, -005 |
|---|---|
| Operating temperature | 5 °C to 40 °C (41 °F to + 104 °F) |
| Storage temperature | -40 °C to +70 °C (-40 °F to + 158 °F) |
| Operating humidity | 15% to 95% relative humidity at 40 °C (non-condensing) |
| Storage humidity | 24% to 90% relative humidity at 65 °C (non-condensing) |
| Physical dimensions (W x H x D) with connectors and mechanical brackets | M8067A-001: 250.3 x 112 x 195 mm (9.9 x 4.4 x 7.7 inch)<br>M8067A-002: 250.3 x 112 x 195 mm (9.9 x 4.4 x 7.7 inch)<br>M8067A-003: 110 x 112 x 195 mm (4.3 x 4.4 x 7.7 inch)<br>M8067A-004: 110 x 112 x 195 mm (4.3 x 4.4 x 7.7 inch)<br>M8067A-005: 110 x 112 x 195 mm (4.3 x 4.4 x 7.7 inch) |
| Tool to remove mechanical brackets | Screwdriver Torx-T10 (part number 8710-2853) |
| Warranty | 1 year |
| Weight net / shipping | M8067A-001: net: 0.74 kg (1.63 lbs)/ shipping: 4.29 kg (9.45 lbs)<br>M8067A-002: net: 0.74 kg (1.63 lbs)/ shipping: 4.29 kg (9.45 lbs)<br>M8067A-003: net: 0.5 kg (1.1 lbs)/ shipping: 2.54 kg (5.60 lbs)<br>M8067A-004: net: 0.5 kg (1.1 lbs)/ shipping: 2.54 kg (5.60 lbs)<br>M8067A-005: net: 0.56 kg (1.23 lbs)/ shipping: 2.60 kg (5.74 lbs) |
| EMC | IEC 61326-1 |
| Safety | IEC 61010-1 |
| Quality management | ISO 14001, ISO 9001 |

# M8070ISIB Adjustable ISI

In addition to the M8067A ISI channel boards, you can use the M8070ISIB adjustable ISI software package to adjust the amount of insertion loss when using the Keysight M8040A and M8050A BERTs.

The adjustable ISI software package M8070ISIB simplifies receiver testing by offering a flexible way of emulating channel loss for symbol rates up to 120 GBd. Up to a frequency of symbol rate/2, a channel response can be emulated or de-embedded by the pattern generator by specifying a certain insertion loss at specific frequency points.

You can combine the integrated channel emulation with actual physical ISI trace boards such as the M8067A to create a target test channel.

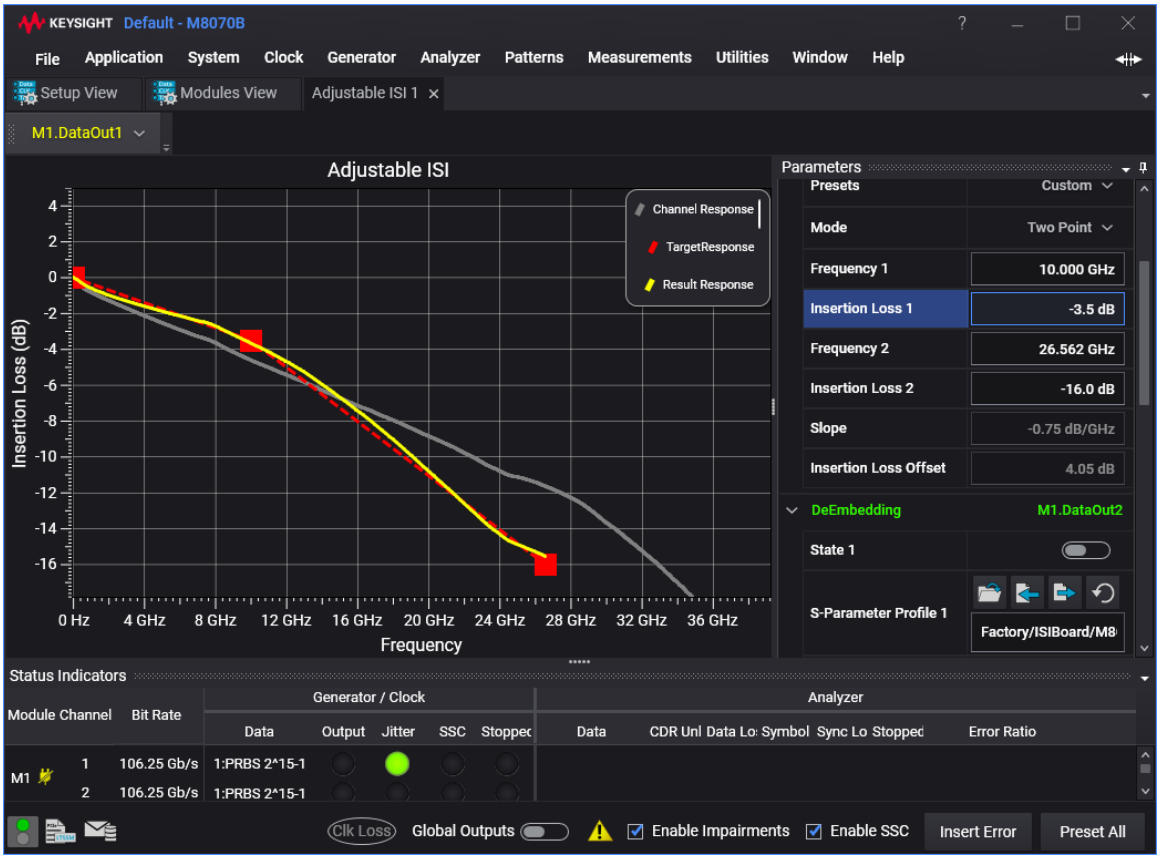



**Figure 12.** The M8070ISIB adjustable ISI software package emulates ISI internally with the M8042A pattern generator module. The example shows the insertion loss of an external ISI channel as channel response (gray). You can add or remove insertion loss (red for target response) at 2 frequency points.

# Specification Definitions

The warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 5 to 40 °C and after a 60-minute warm-up period.

### Typical

The characteristic performance, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement uncertainty, and is valid only at room temperature (approximately 23 °C).

### Nominal

The mean or average characteristic performance, or the value of an attribute that is determined by design such as a connector type, physical dimension, or operating speed.

# Ordering Instructions

Each M8067A option includes the following by default: functional test certificate and certificate of conformance. Mechanical brackets are pre-mounted.

| Description | Option |
|---|---|
| ISI Channel Board Three Traces 6.2, 11.6, and 17.1 inches, 1.85 mm Connectors | M8067A-001 |
| ISI Channel Board Three Traces 3.8, 8.9, and 14.4 inches, 1.85 mm Connectors | M8067A-002 |
| ISI Channel Board Two Traces 1.4 and 4.3 inches, 1.0 mm Connectors | M8067A-003 |
| ISI Channel Board Two Traces 2.9 and 5.8 inches, 1.0 mm Connectors | M8067A-004 |
| ISI Channel Board Two Traces 7.3 and 8.8 inches, 1.0 mm Connectors | M8067A-005 |
| M8070ISIB Adjustable ISI software package for M8040A and M8050A | M8070ISIB |
| KeysightCare: extended 3/5-year warranty, return-to-Keysight | R1280 |

# Recommended Accessories

| Description | Option |
|---|---|
| Matched cable pair 1.0 mm (m), 0.15 m for connecting to the M8050A | M8059A-801 |
| Matched cable pair 1.85 mm (m), 0.15 m for connecting to the M8040A and M8050A | M8058A-801 |
| Matched coupler pair for external interference source, DC to 40 GHz, 12 dB, 2.4 mm | M8045A-803 |
| Matched coupler pair for external interference source, 1 to 50 GHz, 13 dB, 2.4 mm | M8045A-802 |
| Microwave pick-off tee, matched pair, 1.0 mm through path | N1027A-2P1 |
| Screwdriver Torx-T10 to remove brackets | 8710-2853 |

# Related Keysight Literature

| Description | Publication Number |
|---|---|
| XE8-class M8050A High-Performance BERT 120 GBd – Data Sheet | 3122-1338.EN |
| XE8-class M8050A High-Performance BERT 120 GBd – Configuration Guide | 3122-1285.EN |
| XE8-class M8050A High-Performance BERT 120 GBd – Technical Overview | Coming Soon |
| XE7-class M8040A High-Performance BERT 64 GBd – Data Sheet | 5992-1525EN |
| XE7-class M8040A High-Performance BERT 64 GBd – Configuration Guide | Coming Soon |
| M8053A Interference Source 64 GHz – Data Sheet | 3124-1184.EN |
| M8054A Interference Source 32 GHz – Data Sheet | 5992-3917EN |
| M8049A ISI Channel Boards – Data Sheet | 5992-3617EN |

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