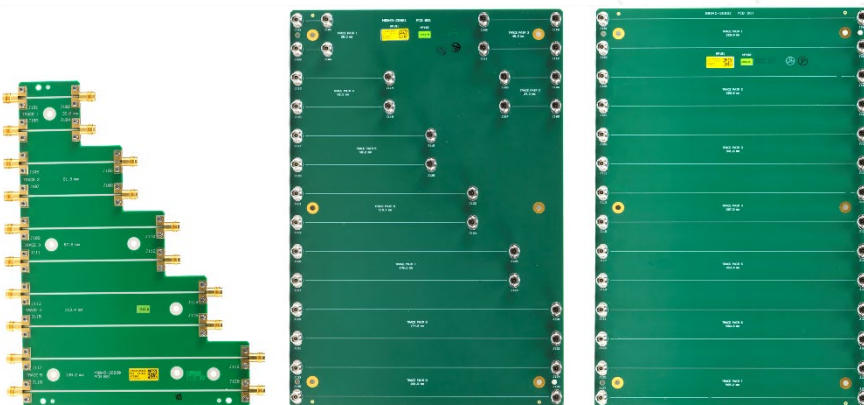


# M8049A ISI Channel Boards

## Master Your Next Designs

### Key Features:

- Emulate a wide range of channel loss with ISI (Inter Symbol Interference) traces with fine resolution
- Three ISI boards with 5 short (1.4" to 5.5"), 9 medium (0.8" to 7.95") and 7 long traces (9.05" to 22.25"), traces can be cascaded
- Rogers 4350B and Megtron 6 PC board material with known S21 parameters
- Differential channels
- Suitable for symbol rates of 32 Gbaud and higher
- Small size



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## Description

The M8049A ISI channel boards can be used to emulate channel loss in receiver test setups. The boards are designed to be used to emulate channel loss for data rates of 32 Gb/s and higher. A choice of 21 PC board traces with different lengths can be inserted into the signal path. The trace lengths range from 0.8 inch (20.3 mm) to 22.3 inch (566.4 mm). By cascading the traces within one board or with another board a wide range of channels can be emulated with very fine resolution of insertion loss steps. With their small size the ISI channel boards can be located closely to the device under test. The cascadable ISI channels are complemented by the Keysight Technologies, Inc. compliance channels for SATA, DisplayPort, PCI Express®.

## Emulate Channel Loss

The channel loss between transmitter and receiver is a critical element for the receiver test 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. Many popular interface standards define the receiver test in a way that must include a certain channel loss in the test setup. M8049A offers a wide range of cascadable channels to emulate certain S21 loss characteristic in a repeatable and accurate way even for electrical interconnects using data rates of 32 Gbaud and higher.

## Emulate frequency-dependent Attenuators

For testing the receivers in medium and long reach electrical interfaces, some standards such as IEEE 802.3cd and OIF-CEI-56G define so-called frequency dependent attenuators. These are used to emulate the channel loss characteristics of a worst-case channel that can occur in a transmission link. The M8049A ISI channel boards can be used to emulate such a frequency dependent attenuator for symbol rates above 10 Gbaud, e.g. you can emulate insertion losses between 1 and 20 dB with a single ISI trace for 16 GHz (corresponds to a 32 Gbaud link).

## Emulate Inter-Symbol Interference

Rogers 4350B and Megtron 6 board material is used in many high-performance backplanes and server interconnects. Electrical cables are also very common (TBT, SAS, 100GBASE-CR4, 400GBASE-CR8) for the highest bandwidth of consumer, server, switch interconnects. With increasing bit rates the signal degradations caused by the channel becomes a critical element for the receiver characterization and compliance test. The so-called inter-symbol interference (ISI) caused by the channel degradation is a data dependent jitter or a bounded deterministic jitter. The ISI jitter added by a PC board trace not only depends on the trace length and the PC board material, but also depends on the data rate and the transmitted bit pattern. The ISI jitter a receiver must tolerate is typically defined in ps or in UI (unit intervals) by each standard for the required bit rate and compliance test pattern.

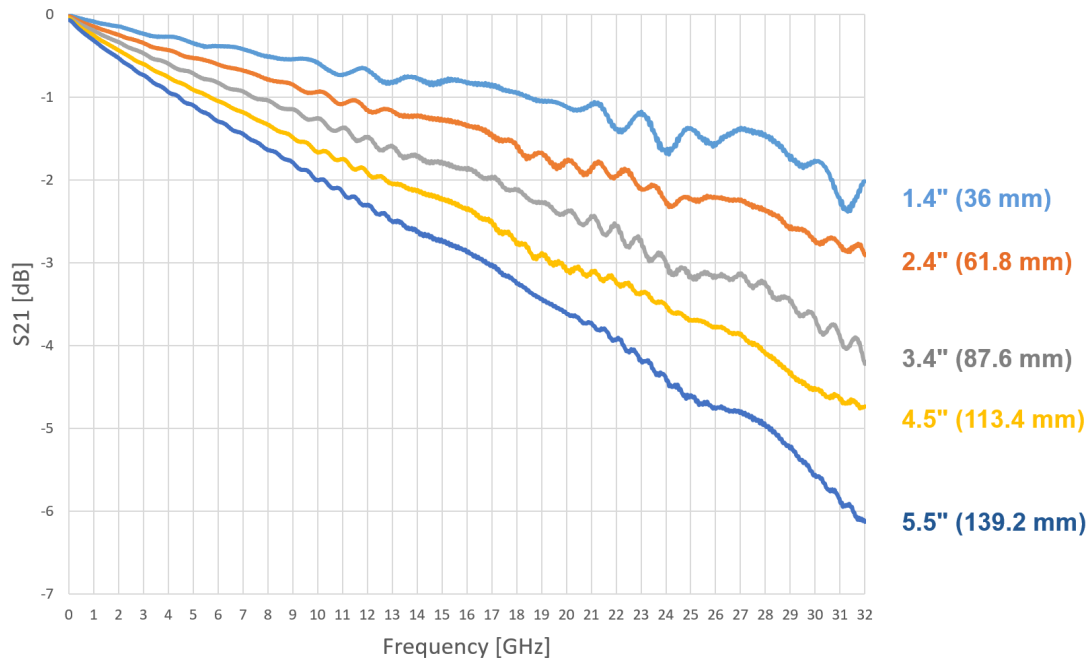


Figure 2. This shows the typical insertion loss (S21) for M8049A-001 ISI channel boards.

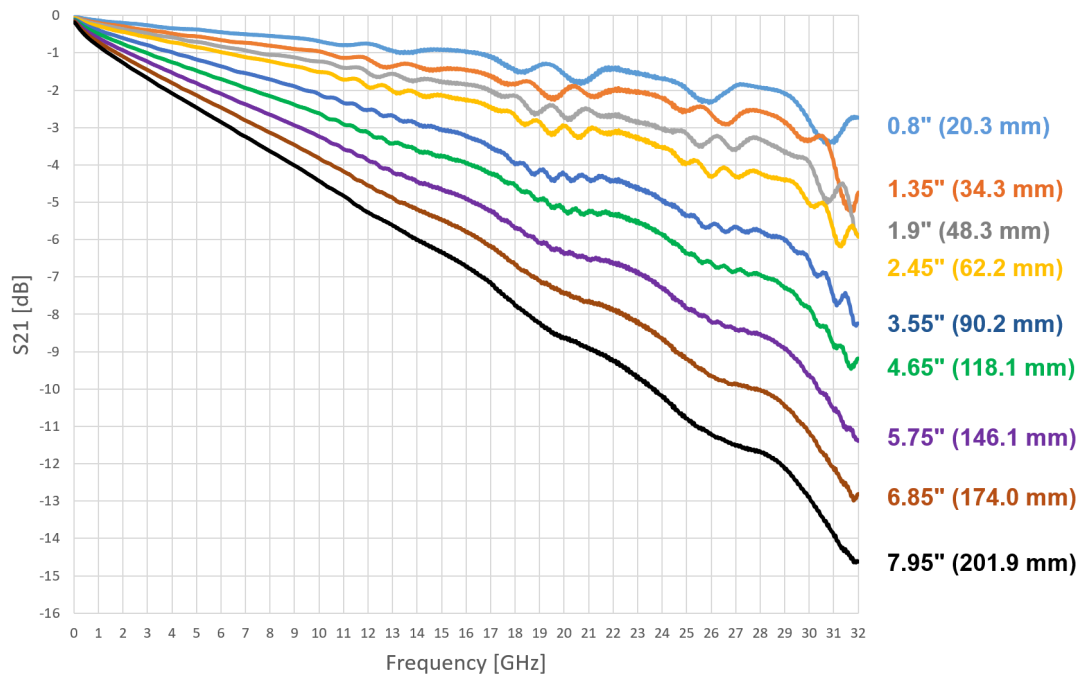


Figure 3. This shows the typical insertion loss (S21) for M8049A-002 ISI channel boards.

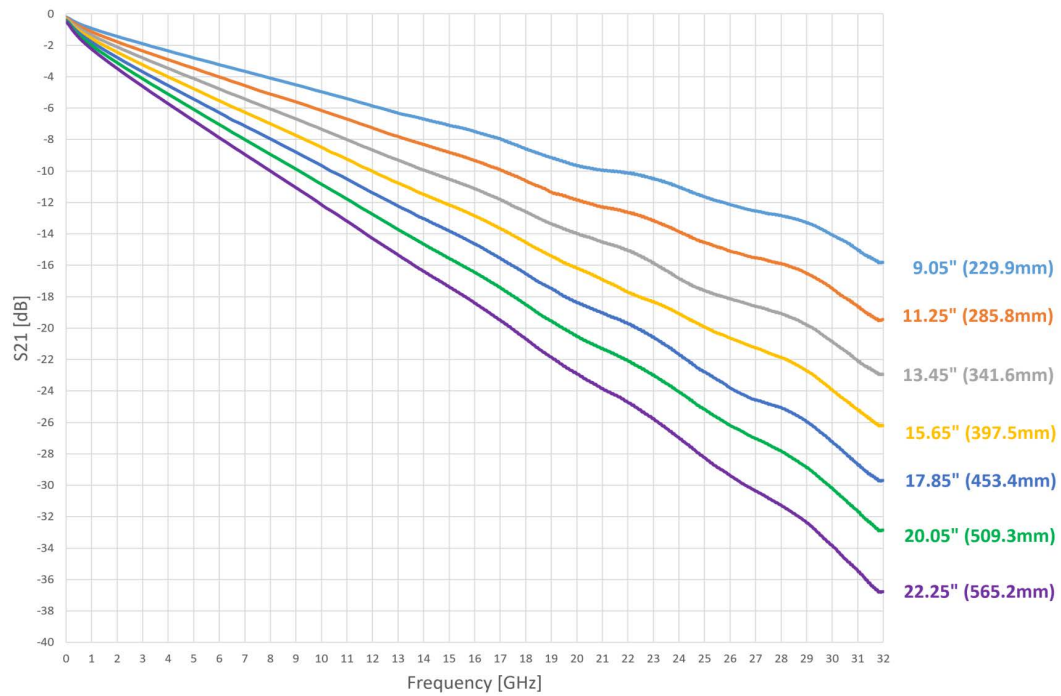


Figure 4. This shows the typical insertion loss (S21) for M8049A-003 ISI channel boards.

### Application Examples

- PCI Express 4.0, 5.0
- OIF CEI-56G MR and LR
- Ethernet backplanes, cable and chip-to-chip, chip-to-module interfaces as defined by IEEE 802.3 cd, bj, by
- Thunderbolt
- Receiver stress testing
- SAS
- Channel operating margin test

# M8049A Specifications

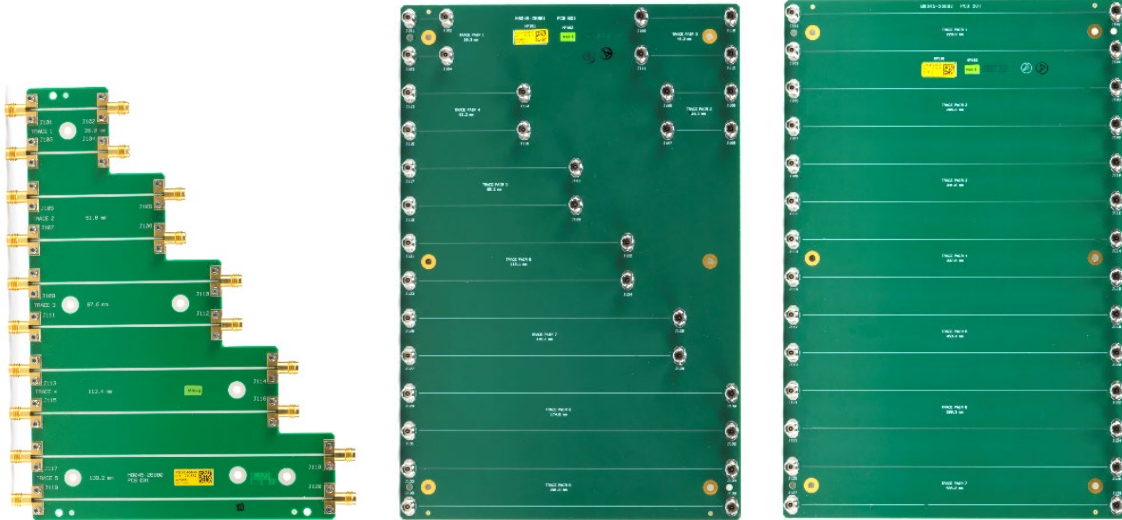


Figure 5: Front view of M8049A option 001, 002, 003 from left to right.

Table 1. Specifications for ISI channel boards

|                                     | M8049A-001   | M8049A-002  | M8049A-003   |
|-------------------------------------|--|---|--|
| Trace lengths                       | 1.4" (36 mm)<br>2.4" (61.8 mm)<br>3.4" (87.6 mm)<br>4.5" (113.4 mm)<br>5.5" (139.2 mm)                           | 0.8" (20.3 mm)<br>1.35" (34.3 mm)<br>1.9" (48.3 mm)<br>2.45" (62.2 mm)<br>3.55" (90.2 mm)<br>4.65" (118.1 mm)<br>5.75" (146.1 mm)<br>6.85" (174.0 mm)<br>7.95" (201.9 mm) | 9.05" (229.9 mm)<br>11.25" (285.8 mm)<br>13.45" (341.6 mm)<br>15.65" (397.5 mm)<br>17.85" (453.4 mm)<br>20.05" (509.3 mm)<br>22.25" (565.2 mm) |
| PC board material                   | Rogers 4350B   | Megtron 6   | Megtron 6  |
| Insertion loss                      | Typical values see figure 2, 3, 4 (excludes cables)  |   |  |
| Insertion loss for M8046A-802 cable | < 2 dB at 16 GHz typical,<br>< 3 dB at 32 GHz typical.   |   |  |
| Return loss                         | Better than -12 dB at up to 16 GHz typical,<br>Better than -10 dB at up to 24 GHz typical.<br>See also figure 6. |   |  |
| Intra-pair skew                     | < 3 ps typical (all three ISI boards)  |   |  |
| Input impedance                     | 100 Ω differential, 50 Ω single ended, ± 10% typical   |   |  |
| Max input voltage levels            | ± 5 V  |   |  |
| Interface                           | Differential or single-ended   |   |  |
| Connectors                          | 2.4 mm, female,<br>soldered  | 2.4 mm, female,<br>removable connectors   | 2.4 mm, female,<br>removable connectors  |
| Torque                              |  |   |  |

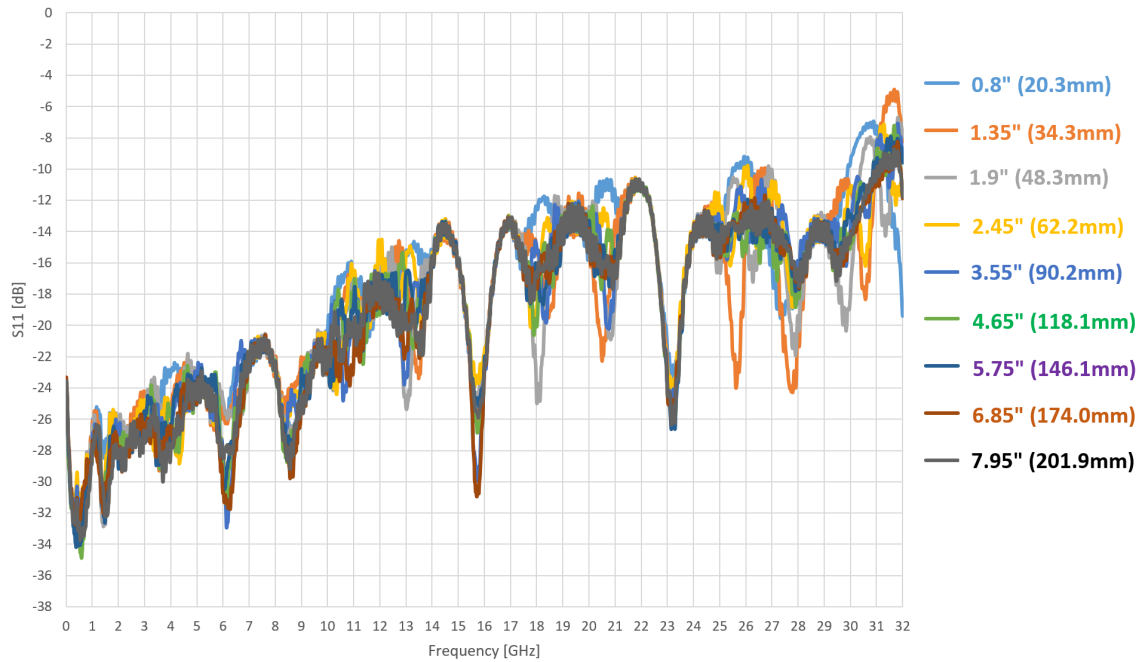


Figure 6: Typical return loss (reflection). The figure shows M8049A-002.

Table 2. Typical ISI jitter values p-p for all M8049A traces at PRBS 21<sup>5</sup>-1 and selected symbol rates

|                   | Data rate                        | 10 Gb/s |       | 16 Gb/s |        | 26.5625 Gb/s |       | 32 Gb/s  |       | 53.125 Gb/s |       |
|-------------------|----------------------------------|---------|-------|---------|--------|--------------|-------|----------|-------|-------------|-------|
|                   | Corresponding UI (unit interval) | 100 ps  |       | 62.5 ps |        | 37.647 ps    |       | 31.25 ps |       | 18.824 ps   |       |
|                   | Trace length                     | ps      | UI    | ps      | UI     | ps           | UI    | ps       | UI    | ps          | UI    |
| M8049A-001        | 1.4" (36 mm)                     | < 0.05  |       | 1.43    | 0.023  | 1.7          | 0.045 | 3.3      | 0.107 | 3.4         | 0.182 |
|                   | 2.4" (61.8 mm)                   |         |       | 2.13    | 0.034  | 3.7          | 0.098 | 4.3      | 0.139 | 4.5         | 0.237 |
|                   | 3.4" (87.6 mm)                   |         |       | 2.68    | 0.043  | 5.4          | 0.142 | 5.4      | 0.174 | 6           | 0.321 |
|                   | 4.5" (113.4 mm)                  |         |       | 3.4     | 0.054  | 6.3          | 0.167 | 5.9      | 0.189 | 8.3         | 0.442 |
|                   | 5.5" (139.2 mm)                  |         |       | 3.68    | 0.059  | 6.7          | 0.177 | 6.2      | 0.199 | 10.7        | 0.568 |
| M8049A-002        | 0.8" (20.3 mm)                   | < 0.05  |       |         | < 0.05 | 3.9          | 0.103 | 4.2      | 0.136 | 4.6         | 0.246 |
|                   | 1.35" (34.3 mm)                  |         |       |         |        | 4.1          | 0.109 | 4.3      | 0.138 | 4.8         | 0.258 |
|                   | 1.9" (48.3 mm)                   |         |       |         |        | 4.3          | 0.115 | 4.6      | 0.146 | 5.2         | 0.276 |
|                   | 2.45" (62.2 mm)                  |         |       |         |        | 4.8          | 0.128 | 5.0      | 0.160 | 5.3         | 0.279 |
|                   | 3.55" (90.2 mm)                  |         |       | 3.4     | 0.054  | 5.3          | 0.140 | 5.5      | 0.177 | 6.1         | 0.322 |
|                   | 4.65" (118.1 mm)                 |         |       | 4.4     | 0.065  | 6.0          | 0.160 | 6.7      | 0.214 | 7.2         | 0.381 |
|                   | 5.75" (146.1 mm)                 |         |       | 4.9     | 0.078  | 7.2          | 0.191 | 8.1      | 0.259 |             |       |
|                   | 6.85" (174.0 mm)                 |         |       | 5.5     | 0.089  | 8.3          | 0.220 | 9.4      | 0.301 |             |       |
| 7.95" (201.9 mm)  | 6.7                              | 0.107   | 9.9   | 0.263   | 11.4   | 0.364        |       |          |       |             |       |
| M8049A-003        | Trace length                     | ps      | UI    | ps      | UI     | ps           | UI    | ps       | UI    | ps          | UI    |
|                   | 9.05" (229.9 mm)                 | 6.2     | 0.062 | 8.0     | 0.128  | 11.1         | 0.294 | 13.7     | 0.438 |             |       |
|                   | 11.25" (285.8 mm)                | 8.4     | 0.084 | 10.4    | 0.166  | 15.0         | 0.399 |          |       |             |       |
|                   | 13.45" (341.6 mm)                | 11.2    | 0.112 | 13.8    | 0.221  | 18.9         | 0.503 |          |       |             |       |
|                   | 15.65" (397.5 mm)                | 14.4    | 0.144 | 18.1    | 0.289  |              |       |          |       |             |       |
|                   | 17.85" (453.4 mm)                | 18.2    | 0.182 | 22.5    | 0.359  |              |       |          |       |             |       |
|                   | 20.05" (509.3 mm)                | 22.3    | 0.223 | 28.2    | 0.451  |              |       |          |       |             |       |
| 22.25" (565.2 mm) | 26.4                             | 0.264   | 34.2  | 0.547   |        |              |       |          |       |             |       |

Table 3. General characteristics

|   |  |  |
|---|--|--|
| 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<br>(W x H x D)<br>with connectors | M8049A-001   | 142 x 10 x 203 mm (5.6 x 0.4 x 8.0 inch)           |
|   | M8049A-002   | 183 x 25 x 279 mm (7.25 x 1.0 x 11.0 inch)         |
|   | M8049A-003   | 183 x 25 x 279 mm (7.25 x 1.0 x 11.0 inch)         |
| Warranty  | 1 year   |  |
| Weight net / shipping                                 | M8049A-001   | net: 0.2 kg (0.44 lb)/ shipping: 1.33 kg (2.93 lb) |
|   | M8049A-002   | net: 0.3 kg (0.66 lb)/ shipping: 1.43 kg (3.15 lb) |
|   | M8049A-003   | net: 0.3 kg (0.66 lb)/ shipping: 1.43 kg (3.15 lb) |
| EMC   | IEC 61326-1  |  |
| Safety  | IEC 61010-1  |  |
| Quality management                                    | ISO 14001, ISO 9001                                    |  |

## Specification Assumptions

The specifications in this document describe the instruments performance. All specifications if not otherwise stated are valid using the recommended cable set M8046A-802 (2.4 mm, matched pair).

# Mechanical Drawings

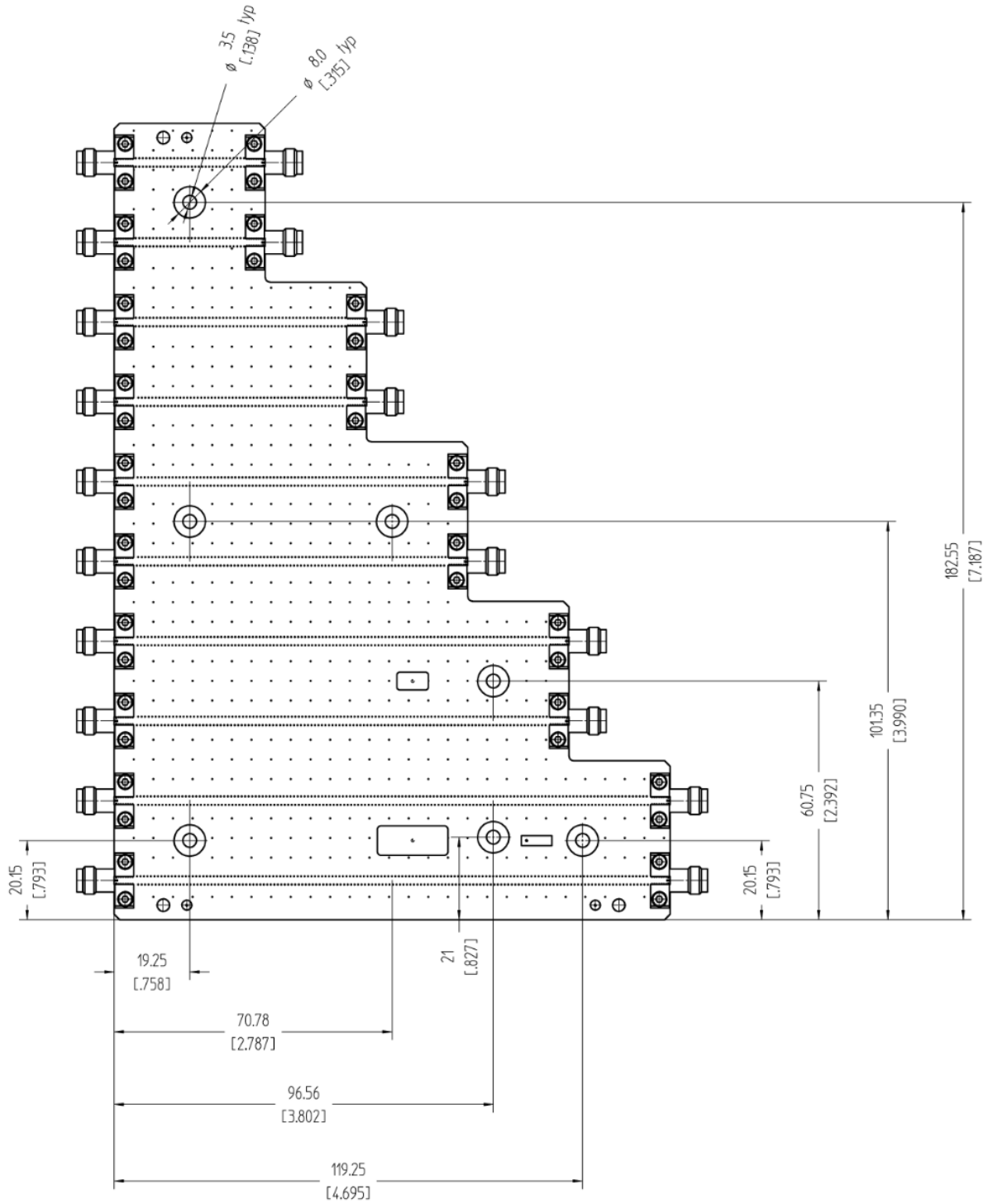


Figure 7: Mechanical drawing of M8049A-001 ISI channel boards with position of fastening holes.



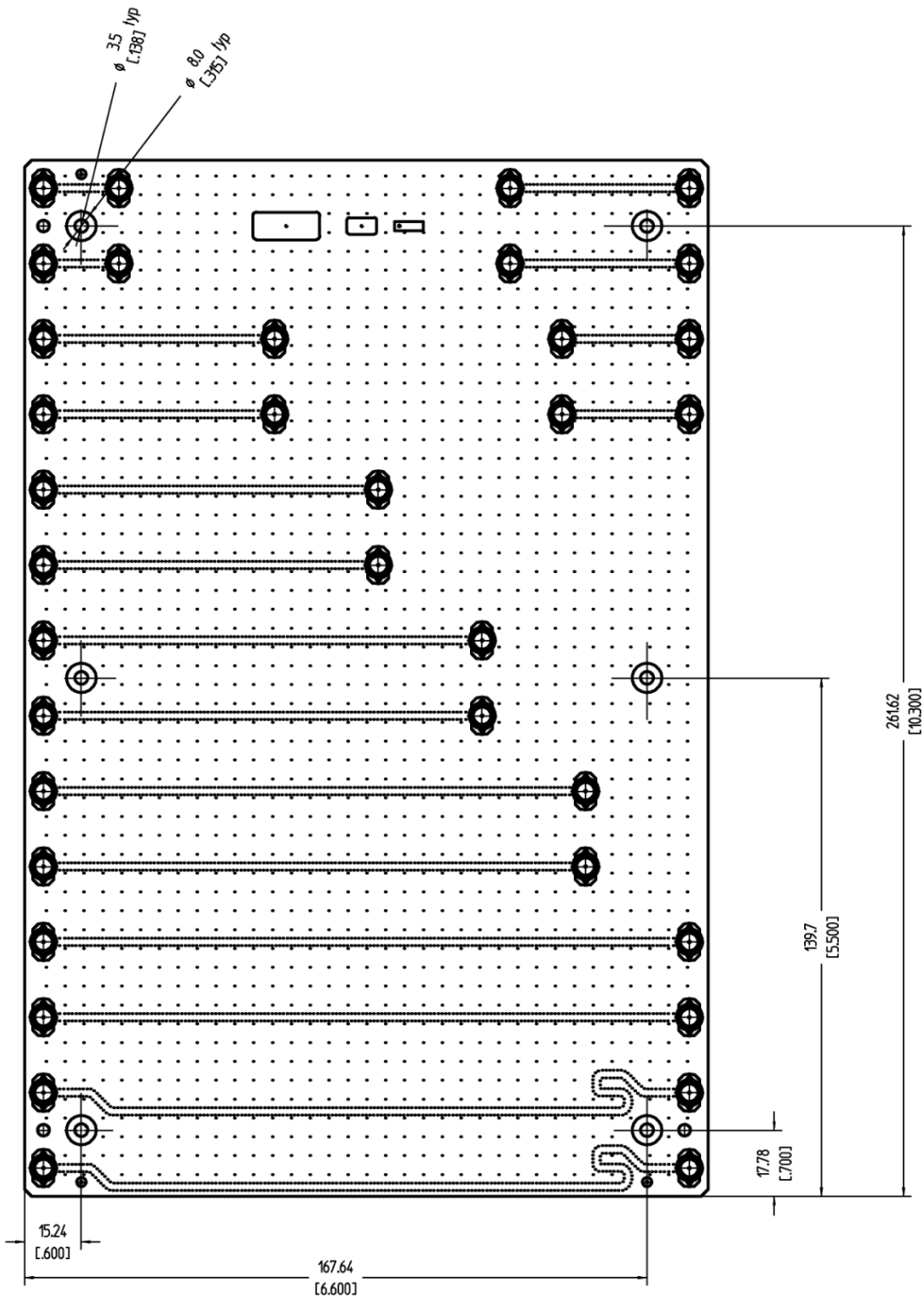


Figure 8: Mechanical drawing of M8049A-002 ISI channel boards with position of fastening holes.

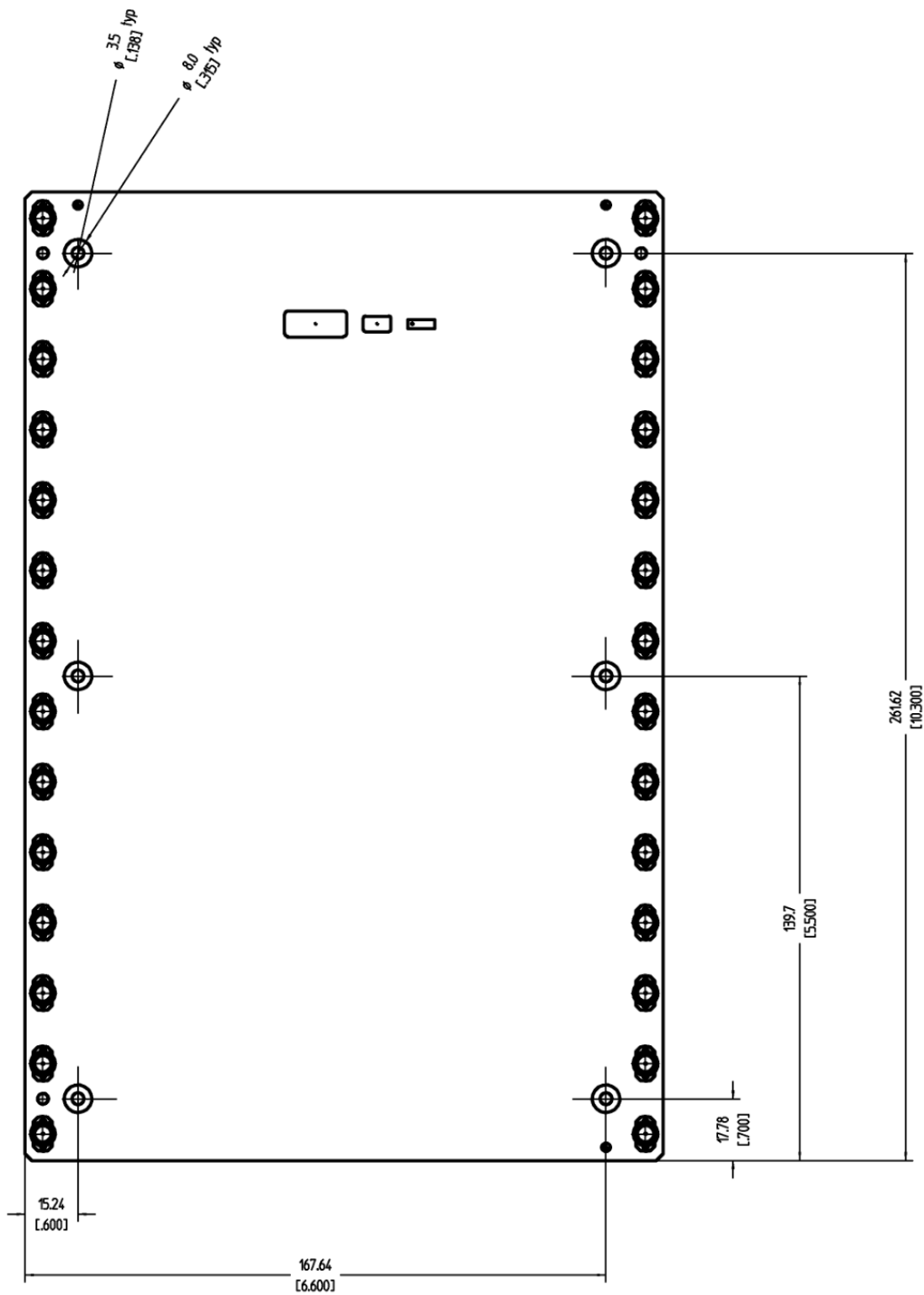


Figure 9: Mechanical drawing of M8049A-003 ISI channel boards with position of fastening holes.

## Related Keysight Literature

|   |             |
|---|-------------|
| M8040A High-Performance BERT Data Sheet         | 5992-1525EN |
| M8054A Interference Source Data Sheet           | TBD         |
| J-BERT M8020A High-Performance BERT Data Sheet  | 5990-3217EN |
| N4915A-014 PCIe Compliance Channels Data Sheet  | 5990-7659EN |
| N4915A-005 DisplayPort ISI Generator Data Sheet | 5990-8688EN |
| N4915-60001 SATA ISI Channel Data Sheet         | N/A         |

## Ordering Instructions

Each M8049A option includes the following by default: functional test certificate, and certificate of conformance.

|  |            |
|--|------------|
| ISI channel board, 5 short traces (1.4" to 5.5")         | M8049A-001 |
| ISI channel board, 9 medium distance traces (0.8" to 8") | M8049A-002 |
| ISI channel board, 7 long traces (9" to 22.2")           | M8049A-003 |
| Extended 3/5 -year warranty Return-to-Keysight           | R1280      |

## Recommended Accessories

|  |            |
|--|------------|
| Matched cable pair 2.4 mm (m), 0.85 m for connecting with M8045A                 | M8046A-802 |
| Directional coupler pair for external interference source, 50 GHz, 13 dB, 2.4 mm | M8045A-802 |
| Matched coupler pair for external interference source, 40 GHz, 12 dB, 2.4 mm     | M8045A-803 |
| Interference source 32 GHz, AXIe module, 1-slot                                  | M8054A     |



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