# MULTIGIG RT* 2-R / RT 3 Connector
# 10k Connector Durability Cycle Performance Validation

## 1. INTRODUCTION

### 1.1 Purpose

Testing was performed on TE Connectivity (TE) MULTIGIG RT2-R Commercial Connectors to determine their durability cycle capability and conformance to select requirements of TE MULTIGIG RT2-R Product Specification 108-2072 Rev. F, and TE MULTIGIG RT3 Product Specification 108-2072-3 Rev. A2.

### 1.2 Scope

This report covers the durability cycle performance of the MULTIGIG RT2-R Commercial Connector, when subjected to the various environmental and mechanical test conditions indicated in this report. Testing of Test Sets 1 and 2 was performed at Contech Research Inc. (CR) between January 7 & February 28, 2020. Testing of Test Sets 5 and 6 was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between January 29 & April 7, 2020.

### 1.3 Conclusion

The MULTIGIG RT2-R Commercial Connectors listed in paragraph 1.4, Table 1, met the specified performance requirements of TE Product Specifications 108-2072 Rev. F, and 108-2072-3 Rev. A2 when tested per the sequences listed in paragraph 1.5, Table 2.

### 1.4 Test Specimens

Test specimens identified with the TE part numbers indicated in Table 1A were used for test:

**Table 1A – Test Specimens**

| TE Test Set ID (b) | CR Test Set ID | Quantity | Part Number | Description (a) |
|---|---|---|---|---|
| 1 | 1 | 2 | 2102771-1, Rev. D | RT2-R Full daughter card Center Module |
| | | 2 | 2102737-1, Rev. D | RT2-R Backplane connector full Right End |
| 2 | 3 | 2 | 2102771-1, Rev. D | RT2-R Full daughter card Center Module |
| | | 2 | 2102737-1, Rev. D | RT2-R Backplane connector full Right End |
| 5 | - | 2 | 2102771-1, Rev. D | RT2-R Full daughter card Center Module |
| | | 2 | 2102737-1, Rev. D | RT2-R Backplane connector full Right End |
| 6 | - | 2 | 2102771-1, Rev. D | RT2-R Full daughter card Center Module |
| | | 2 | 2102737-1, Rev. D | RT2-R Backplane connector full Right End |

NOTE *(a) Specimens mounted on printed circuit boards 60-474650 and 60-474649 for test.*
*(b) See supplemental Table 1B cross reference between TE Test Sets, Control Documents, and Test Objective.*

**Table 1B – Test Set Cross Reference**

| TE Test Set ID | TE Control Document (REF) | Test Group from TE Control Document (REF) (a) | Test Objective |
|---|---|---|---|
| 1 | 108-2072, Rev. F | Test Group 3, Fig. 2D | 10k Durability Cycle Rating |
| 2 | 108-2072, Rev. F | Test Group 5A, Fig. 2D | 10k Durability Cycle Rating |
| 5 | 108-2072, Rev. F | Test Group 2, Fig. 2D | 10k Durability Cycle Rating |
| 6 | 108-2072-3, Rev. A2 | Test Group 3, Table 2 | 10k Durability Cycle Rating |

NOTE *(a) Test sequences for Test Groups indicated in TE Control Documents were modified as shown in Table 2.*

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## 1.5 Test Sequences

**Table 2 – Test Sequences**

| Test or Examination | Test Sets (a) | | | |
|---|---|---|---|---|
| | 1 | 2 | 5 | 6 |
| | Test Sequence (b) | | | |
| Initial Examination of Product | 1 | 1 | 1 | 1 |
| Low Level Contact Resistance, Circuit | 2,4,6,8, 10,12, 14,16 | 3,6,9 | 2,4,6,9 | 2,6 |
| Vibration | | | 7 | |
| Random Vibration | | | | 4 |
| Mechanical Shock | | | 8 | 5 |
| Durability (2,000 cycles) | 3(c),15(c) | | | |
| Durability (4,000 cycles) | | | 3 | |
| Durability (10,000 cycles) | | 5 | | 3 |
| Mating Force | | 2,11 | 11 | 8 |
| Unmating Force | | 4,10 | 10 | 7 |
| Minute Disturbance | 13 | | | |
| Compliant Pin Retention, Connector | | | | 9 |
| Mixed Flowing Gas | 5(d),7(d), 9(e),11(e) | | | |
| Dust Contamination | | | 5 | |
| Thermal Shock | | 7 | | |
| Humidity | | 8 | | |
| Final Examination of Product | 17 | 12 | 12 | 10 |

NOTE *(a) Test Sets 1, 2, and 5 reference 108-2072, Rev F; Test Set 6 references 108-2072-3, Rev A2.*
*(b) Numbers indicate sequence in which tests were performed.*
*(c) Perform 2,000 cycles of durability before, and 2,000 cycles after mixed flowing gas testing.*
*(d) Exposure interval of 5 days with specimens unmated.*
*(e) Exposure interval of 5 days with specimens mated.*

## 1.6 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing at all locations:

Temperature: 15°C to 35°C    Relative Humidity: 20% to 80%

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## 2. SUMMARY OF TEST RESULTS

### 2.1 Test Groups 1 and 2 (Tested at Contech Research Inc)

#### 2.1.1 Initial Examination of Product – Test Sets 1 and 2

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

#### 2.1.2 Low Level Contact Resistance (Termination Resistance) – Test Sets 1 and 2

All low level contact resistance measurements taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 80 milliohms initially, had an increase in resistance (ΔR) of less than 5 milliohms maximum average, and an increase in resistance (ΔR) of less than 10 milliohms maximum individually throughout testing. See Tables 3 and 4 for summary.

**Table 3: Test Set 1, Low Level Contact Resistance (Milliohms)**

| TE Test Set | CR Test Set | Sample ID (b) | Statistics (a) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Initial (c) | Δ R (c) | Δ R (c) | Δ R (c) | Δ R (c) | Δ R (c) | Δ R (c) | Δ R (c) |
| 1 | 1 | 1-1 | **Min** | 29.9 | -2.0 | -2.9 | -2.8 | -2.1 | -1.8 | -1.5 | -2.0 |
| | | | **Max** | 42.6 | -0.3 | 0.0 | 0.3 | 0.5 | 2.0 | 1.5 | 0.4 |
| | | | **Avg** | 35.8 | -1.1 | -0.9 | -0.9 | -0.7 | -0.6 | -0.4 | -0.8 |
| | | | **St. Dev** | 4.4 | 0.4 | 0.6 | 0.7 | 0.6 | 0.7 | 0.7 | 0.6 |
| | | | **N** | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | | 1-2 | **Min** | 29.1 | -1.0 | -0.9 | -1.0 | -0.9 | -0.8 | -0.7 | -1.0 |
| | | | **Max** | 41.6 | 0.0 | 0.1 | 0.9 | 0.5 | 0.7 | 0.4 | 0.3 |
| | | | **Avg** | 34.6 | -0.6 | -0.4 | -0.4 | -0.4 | -0.3 | -0.2 | -0.3 |
| | | | **St. Dev** | 4.4 | 0.3 | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| | | | **N** | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |

NOTE *(a) Ref Contech Research Inc test report TR#219501, Rev.1.0 for measured data.*
*(b) Each sample (specimen) ID represents a mated connector set that remained together throughout testing. See Table 1 above for TE connector Test Set part numbers.*
*(c) Measurements shown (left to right) follow test sequence shown in Table 2 above.*

**Table 4: Test Set 2, Low Level Contact Resistance (Milliohms)**

| TE Test Group | CR Test Set | Sample ID (b) | Statistics (a) | | | |
|---|---|---|---|---|---|---|
| | | | | Initial (c) | Δ R (c) | Δ R (c) |
| 2 | 3 | 3-1 | **Min** | 29.9 | -1.5 | -0.3 |
| | | | **Max** | 41.0 | 0.1 | 1.5 |
| | | | **Avg** | 35.3 | -0.5 | 0.5 |
| | | | **St. Dev** | 4.1 | 0.3 | 0.5 |
| | | | **N** | 30 | 30 | 30 |
| | | 3-2 | **Min** | 30.2 | -1.2 | 0.0 |
| | | | **Max** | 41.7 | 0.0 | 1.6 |
| | | | **Avg** | 35.4 | -0.5 | 0.6 |
| | | | **St. Dev** | 4.3 | 0.3 | 0.5 |
| | | | **N** | 30 | 30 | 30 |

NOTE *(a) Ref Contech Research Inc test report TR#219501, Rev.1.0 for measured data.*
*(b) Each sample (specimen) ID represents a mated connector set that remained together throughout testing. See Table 1 above for TE connector Test Set part numbers.*
*(c) Measurements shown (left to right) follow test sequence shown in Table 2 above.*

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### 2.1.3 Durability – Test Sets 1 and 2

No physical damage occurred to the specimens as a result of durability cycle (mate and unmate) testing.

### 2.1.4 Mixed Flowing Gas – Test Set 1

No physical damage occurred to the specimens as a result of mixed flowing gas exposure.

### 2.1.5 Minute Disturbance – Test Set 1

No physical damage occurred to the specimens as a result of a minute disturbance being applied to connectors.

### 2.1.6 Mating Force – Test Set 2

All mating force measurements were less than 0.75N (2.7ozf) maximum average per contact. See Table 5 for summary.

**Table 5: Test Set 2, Mating Force (N)**

| Specimen ID | Average Force per Contact (a) |
|---|---|
| 3-1 | 0.43 |
| 3-2 | 0.43 |

NOTE *(a) Measured when mating daughtercard connector to backplane connector.*

### 2.1.7 Unmating Force – Test Set 2

All unmating force measurements were greater than average 0.15N (0.54ozf) minimum average per contact. See Table 6 for summary.

**Table 6: Test Set 2, Unmating Force (N)**

| Specimen ID | Average Force per Contact (a) |
|---|---|
| 3-1 | 0.28 |
| 3-2 | 0.32 |

NOTE *(a) Measured when unmating daughtercard connector from backplane connector.*

### 2.1.8 Thermal Shock – Test Set 2

No physical damage occurred to the specimens as a result of thermal shock cycle exposure.

### 2.1.9 Humidity – Test Set 2

No physical damage occurred to the specimens as a result of humidity cycle exposure.

### 2.1.10 Final Examination of Product – Test Sets 1 and 2

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

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## 2.2 Test Groups 5 and 6 (Tested at Harrisburg Electronic Components Test Laboratory)

### 2.2.1 Initial Examination of Product – Test Sets 5 and 6

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

### 2.2.2 Low Level Contact Resistance (Termination Resistance) – Test Sets 5 and 6

All low level contact resistance measurements taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 80 milliohms initially, had an increase in resistance (ΔR) of less than 5 milliohms maximum average, and an increase in resistance (ΔR) of less than 10 milliohms maximum individually throughout testing. See Tables 7 and 8 for summary.

**Table 7: Test Set 5, Low Level Contact Resistance (Milliohms)**

| TE Test Group | TE Test Set | Sample ID (a) | Statistics | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Initial (b) | Δ R (b) | Δ R (b) | Δ R (b) |
| 5 | 5 | 501, 502 | Min | 28.66 | -1.05 | -1.02 | -0.83 |
| | | | Max | 38.50 | 1.24 | 1.40 | 0.95 |
| | | | Avg | 33.86 | -0.22 | -0.10 | -0.10 |
| | | | St. Dev | 3.39 | 0.37 | 0.41 | 0.36 |
| | | | N | 40 | 40 | 40 | 40 |

NOTE *(a) Each sample (specimen) ID represents a mated connector set that remained together throughout testing. See Table 1 above for TE connector Test Set part numbers.*
*(b) Measurements shown (left to right) follow test sequence shown in Table 2 above.*

**Table 8: Test Set 6, Low Level Contact Resistance (Milliohms)**

| TE Test Group | TE Test Set | Specimen ID (a) | Statistics | | |
|---|---|---|---|---|---|
| | | | | Initial (b) | Δ R (b) |
| 6 | 6 | 601, 602 | Min | 29.38 | -0.64 |
| | | | Max | 39.24 | 1.10 |
| | | | Avg | 33.90 | 0.20 |
| | | | St. Dev | 3.33 | 0.47 |
| | | | N | 40 | 40 |

NOTE *(a) Each sample (specimen) ID represents a mated connector set that remained together throughout testing. See Table 1 above for TE connector Test Set part numbers.*
*(b) Measurements shown (left to right) follow test sequence shown in Table 2 above.*

### 2.2.3 Durability – Test Sets 5 and 6

No physical damage occurred to the specimens as a result of durability cycle (mate and unmate) testing.

### 2.2.4 Dust Contamination – Test Set 5

No physical damage occurred to the specimens as a result of dust exposure.

### 2.2.5 Sinusoidal Vibration – Test Set 5

No physical damage occurred to the specimens as a result of vibration testing. No discontinuities exceeded 1 microsecond.

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### 2.2.6 Random Vibration – Test Set 6

No physical damage occurred to the specimens as a result of random vibration testing. No discontinuities exceeded 1 microsecond.

### 2.2.7 Mechanical Shock – Test Sets 5 and 6

No physical damage occurred to the specimens as a result of mechanical shock testing. No discontinuities exceeded 1 microsecond.

### 2.2.8 Mating Force – Test Sets 5 and 6

All mating force measurements were less than 0.75N (2.7ozf) maximum average per contact. See Table 9 for summary.

**Table 9: Test Sets 5 and 6, Mating Force (N)**

| Specimen ID | Average Force per Contact (a) |
|---|---|
| 501 | 0.65 |
| 502 | 0.69 |
| 601 | 0.40 |
| 602 | 0.36 |

NOTE (a) *Measured when mating daughtercard connector to backplane connector.*

### 2.2.9 Unmating Force – Test Sets 5 and 6

All unmating force measurements were greater than average 0.15N (0.54ozf) minimum average per contact. See Table 10 for summary.

**Table 10: Test Sets 5 and 6, Unmating Force (lbf)**

| Specimen ID | Average Force per Contact (a) |
|---|---|
| 501 | 0.49 |
| 502 | 0.53 |
| 601 | 0.29 |
| 602 | 0.31 |

NOTE (a) *Measured when unmating daughtercard connector from backplane connector.*

### 2.2.10 Compliant Pin Retention, Connector – Test Set 6

All compliant pin retention forces exceeded 1.78N (0.4lbf) minimum average per pin. See Table 11 for summary.

**Table 11: Test Sets 6 & 8, Compliant Pin Retention (lbf)**

| Specimen ID | PCB Type | Average Retention Force per Pin |
|---|---|---|
| 601 | Daughtercard | 0.81 |
| 602 | Daughtercard | 0.76 |
| 601 | Backplane | 1.53 |
| 602 | Backplane | 1.41 |

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#### 2.2.11 Final Examination of Product – All Test Sets

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

## 3. TEST METHODS

### 3.1 Test Sets 1 and 2 (Tested at Contech Research Inc)

#### 3.1.1 Initial Examination of Product – Test Sets 1 and 2

Specimens were visually examined under a microscope for any signs of damage per EIA-364-18 (referenced revision level not provided).

#### 3.1.2 Low Level Contact Resistance (Termination Resistance) – Test Sets 1 and 2

Low level contact resistance testing was conducted in accordance with EIA-364-23 (referenced revision level not provided). Measurements were made using a four-terminal configuration on the signal circuits (Figure 1). Test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage in accordance TE 108-2072 Rev F.

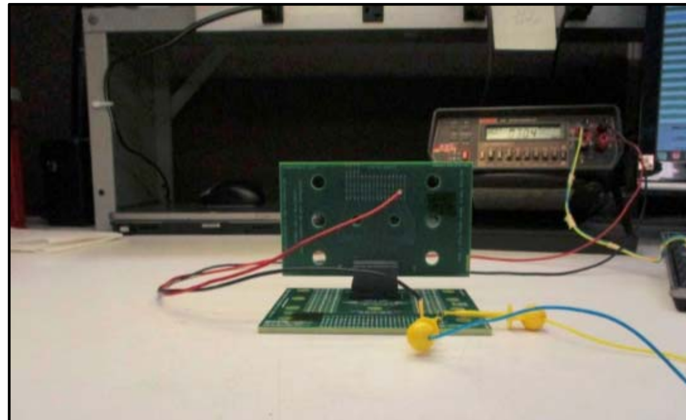

**Figure 1 – Typical Low Level Contact Resistance Test Setup**

#### 3.1.3 Durability – Test Sets 1 and 2

Durability testing was conducted in accordance with EIA 364-09 (referenced revision level not provided), and 108-2072 Rev. F. Specimens were mated and unmated, per the number of cycles indicated in Table 1, at a maximum rate of 500 cycles per hour (Figure 2).

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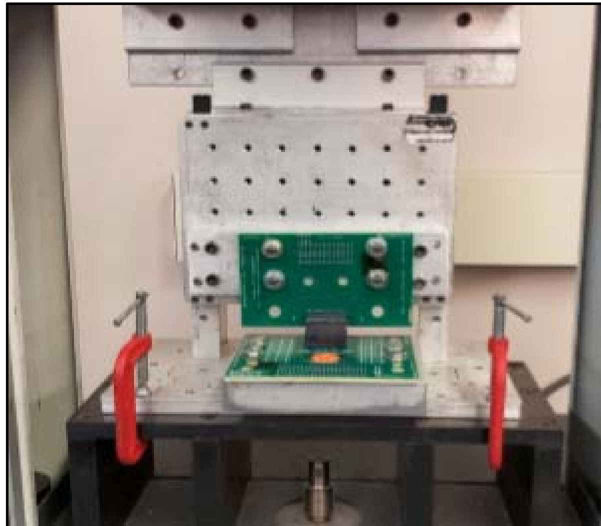

Figure 2 – Typical Durability Test Setup

### 3.1.4 Mixed Flowing Gas – Test Set 1

Mixed flowing gas (MFG) testing was conducted in accordance with EIA-364-65 (referenced revision level not provided), Class IIA (4 gas) exposure per TE 108-2072 Rev F (Figure 3). Specimens were unmated on days 1-5 & 6-10, and mated on days 11-15 & 16-20. During the exposure, low level contact resistance measurements were taken at specified intervals per Table 1.

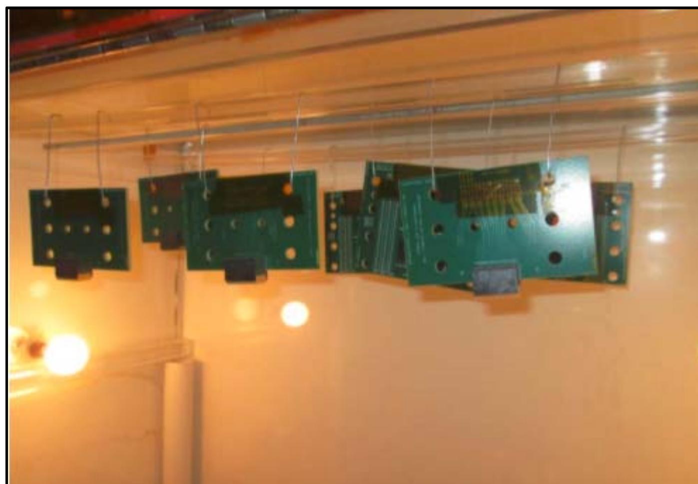

Figure 3 – Typical Mixed Flowing Gas Test Setup

### 3.1.5 Minute Disturbance – Test Set 1

Minute disturbance was conducted in accordance with TE 108-2072 Rev. F, by unmating specimens a distance of approximately 1mm, followed by fully mating the specimens.

### 3.1.6 Mating Force – Test Set 2

Mating force was conducted in accordance with EIA 364-13 (referenced revision level not provided), and TE 108-2072 Rev. F. Specimens were mated at a rate of 0.5 inches per minute (Figure 4). Maximum force prior to connector bottoming was recorded. Average force per contact was calculated.

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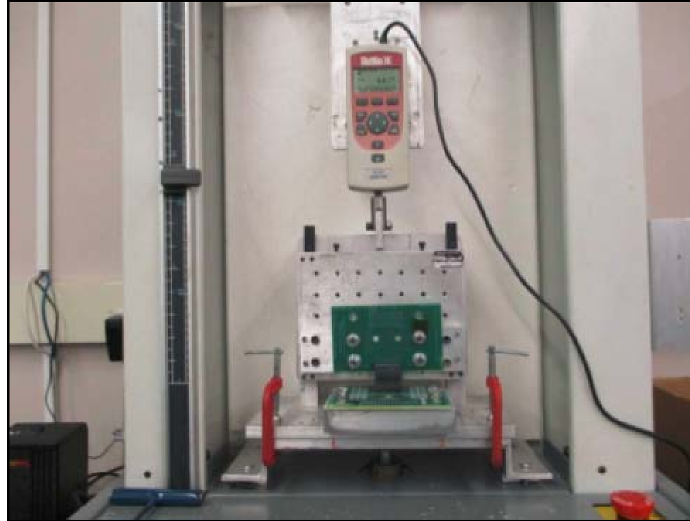
Figure 4 – Typical Mate/Unmate Test Setup

### 3.1.7 Unmating Force – Test Set 2

Unmating force was conducted in accordance with EIA 364-13 (referenced revision level not provided), and TE 108-2072 Rev. F. Specimens were mated at a rate of 0.5 inches per minute (Figure 4). Average force per contact was calculated.

### 3.1.8 Thermal Shock – Test Set 2

Thermal shock was conducted in accordance with EIA-364-32 (referenced revision level not provided), Test Condition VII, except specimens were subjected to 100 cycles between -55 and 105°C per TE 108-2072 Rev. F (Figure 5).

Figure 5 – Typical Thermal Shock Test Setup

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### 3.1.9 Humidity – Test Set 2

Humidity exposure was conducted in accordance with EIA-364-31 (referenced revision level not provided), Method III. Specimens were subjected to 10 cycles between 25 and 65°C at 80% relative humidity per TE 108-2072 Rev. F (Figure 6).

**Figure 6 – Typical Humidity Test Setup**

### 3.1.10 Final Examination of Product – Test Sets 1 and 2

Specimens were visually examined under a microscope for any signs of damage per EIA-364-18 (referenced revision level not provided).

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## 3.2 Test Sets 5 and 6 (Tested at Harrisburg Electronic Components Test Laboratory)

### 3.2.1 Initial Examination of Product – Test Sets 5 and 6

Specimens were visually examined under a microscope for any signs of damage per EIA-364-18B.

### 3.2.2 Low Level Contact Resistance (Termination Resistance) – Test Sets 5 and 6

Low level contact resistance testing was conducted in accordance with EIA-364-23C. Measurements were made using a four-terminal configuration on the signal circuits (Figure 7). Test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage in accordance TE 108-2072 Rev. F and 108-2072-3 Rev. A2.

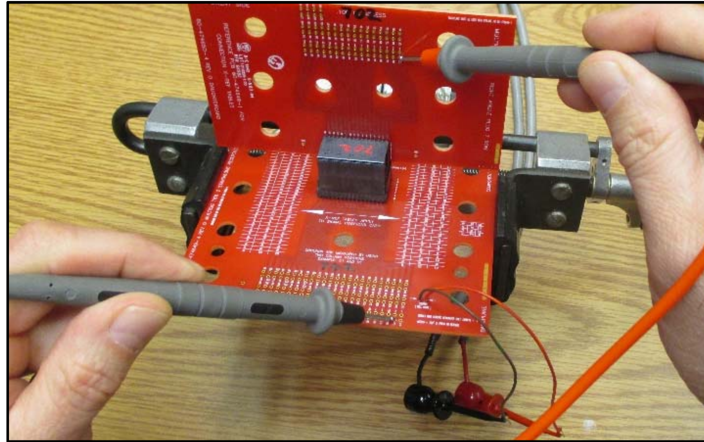

**Figure 7 – Typical Low Level Contact Resistance Test Setup**

### 3.2.3 Durability – Test Sets 5 and 6

Durability testing was conducted in accordance with EIA 364-09D, 108-2072 Rev. F, and 108-2072-3 Rev. A2. Specimens were mated and unmated, per the number of cycles indicated in Table 1, at a maximum rate of 500 cycles per hour (Figure 8).

**Figure 8 – Typical Durability Test Setup**

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### 3.2.4 Dust Contamination – Test Set 5

Dust contamination was conducted in accordance with EIA-364-91B and 108-2072 Rev. F, for 1 hour (Figure 9). Following the exposure, the specimens remained in the chamber with fans turned off for an additional hour so that the dust could settle. Each specimen was tapped 5 times for removal of excess dust.

**Figure 9 – Dust Contamination Setup**

### 3.2.5 Vibration – Test Set 5

Sinusoidal vibration was conducted in accordance with EIA-364-28F, Test Condition II, except two hours per axis of testing was conducted per TE 108-2072, Rev. F. The entire frequency range of 10 to 500 Hz and return to 10 Hz was traversed in 15 minutes. This testing was performed with specimens mounted in each of the three mutually perpendicular axes (Figure 10).

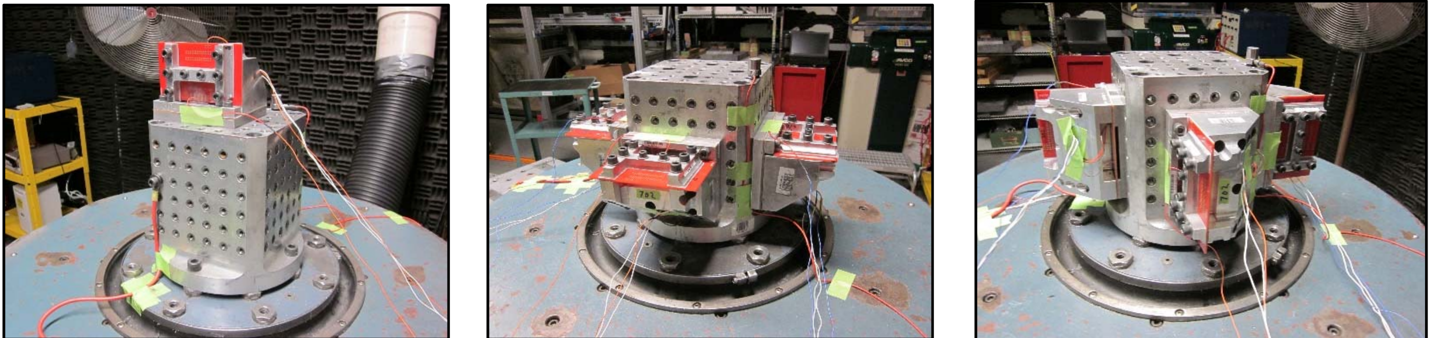

**Figure 10 – Typical Vibration & Shock Test Setup**

### 3.2.6 Random Vibration – Test Set 6

Random vibration was conducted in accordance with EIA-364-28F, Test Condition V, Condition Letter E per TE 108-2072-3, Rev. A2. The amplitude of the excitation was 16.91 GRMS. The entire frequency range of 50 and 2000 Hertz (Hz) was traversed in 8 hours. This testing was performed with specimens mounted in each of the three mutually perpendicular axes (Figure 10).

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#### 3.2.7 Mechanical Shock – Test Set 5

Mechanical shock was conducted in accordance with EIA-364-27C, Test Condition H per TE 108-2072 Rev. F. The test used a half-sine waveform with an acceleration amplitude of 30G and a duration of 11 milliseconds. Three shocks were performed with specimens mounted in each of the three mutually perpendicular axes, for a total of eighteen shocks (Figure 10).

#### 3.2.8 Mechanical Shock – Test Set 6

Mechanical shock was conducted in accordance with EIA-364-27C, Test Condition G per TE 108-2072-3 Rev. A2. The test used a saw-tooth waveform with an acceleration amplitude of 100G and a duration of 6 milliseconds. Three shocks were performed with specimens mounted in each of the three mutually perpendicular axes (Figure 10), for a total of eighteen shocks.

#### 3.2.9 Mating Force – Test Sets 5 and 6

Mating force was conducted in accordance with EIA 364-13E and TE 108-2072 Rev. F. Specimens were mated at a rate of 0.5 inches per minute (Figure 4). Maximum force prior to connector bottoming was recorded. Average force per contact was calculated.

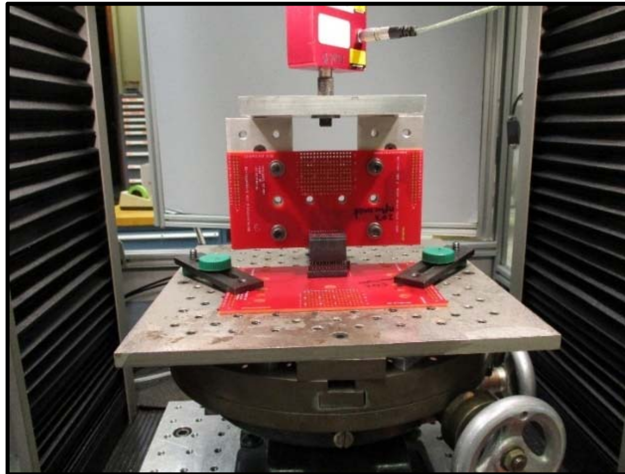

**Figure 11 – Typical Mating and Unmating Force Test Setup**

#### 3.2.10 Unmating Force – Test Sets 5 and 6

Unmating force was conducted in accordance with EIA 364-13E, and TE 108-2072 Rev. F, and 108-2072-3 Rev. A2. Specimens were mated at a rate of 0.5 inches per minute (Figure 11). Average force per contact was calculated.

#### 3.2.11 Compliant Pin Retention, Connector – Test Set 6

Connector compliant pin retention was conducted in accordance with EIA-364-05B, and TE 108-2072-3 Rev. A2. Connectors were removed from daughter card or backplane PCB's at a rate of 12.7mm (0.5 in) per minute maximum (Figures 12A & 12B).

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Figure 12A – Daughtercard Removal Setup

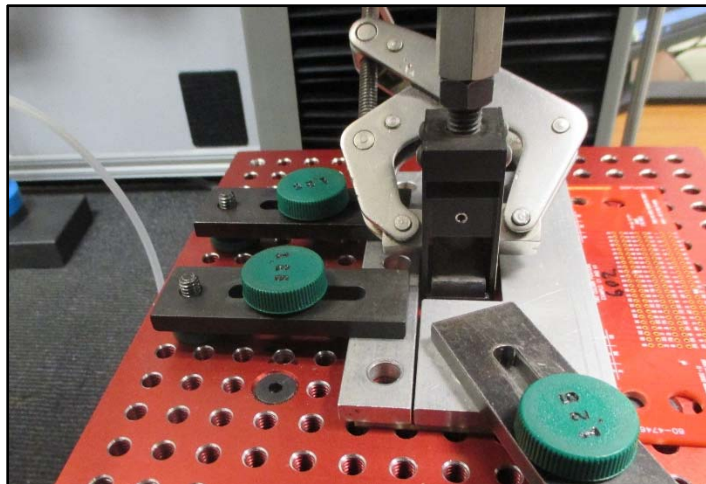

Figure 12B – Backplane Removal Setup

### 3.2.12 Final Examination of Product – Test Sets 5 and 6

Specimens were visually examined under a microscope for any signs of damage per EIA-364-18B.

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