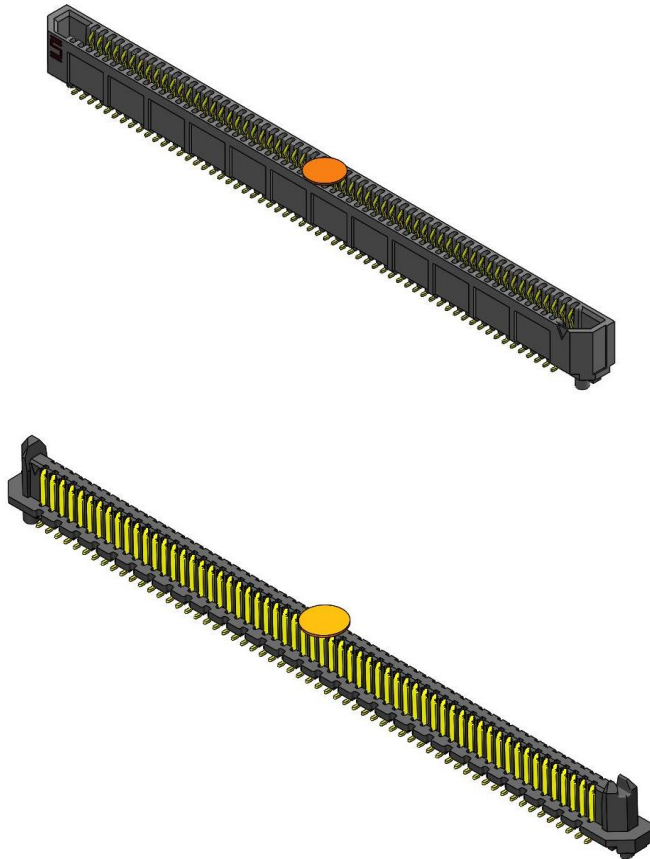




Project Number: Design Qualification Test Report	Tracking Code: 2140935_Report_Rev_1
Requested by: Tyler Lang	Date: 8/31/2020
Part #: ERF6-60-03.5-L-DV-A/ERM6-60-01.5-L-DV-A	
Part description: ERF6/ERM6	Tech: Aaron McKim, Tony Wagoner, and Troy Cook
Test Start: 10/4/2019	Test Completed: 10/31/2019



DESIGN QUALIFICATION TEST REPORT
ERF6/ERM6
ERF6-60-03.5-L-DV-A/ERM6-60-01.5-L-DV-A

Tracking Code: 2140935_Report_Rev_1	Part #: ERF6-60-03.5-L-DV-A/ERM6-60-01.5-L-DV-A
Part description: ERF6/ERM6	

REVISION HISTORY

DATA	REV.NUM.	DESCRIPTION	ENG
8/31/2020	1	Initial Issue	KH

CERTIFICATION

All instruments and measuring equipment were calibrated to National Institute for Standards and Technology (NIST) traceable standards according to ISO 10012-1 and ANSI/NCSL 2540-1, as applicable.

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SCOPE

To perform the following tests: Design Qualification test. Please see test plan.

APPLICABLE DOCUMENTS

Standards: EIA Publication 364

TEST SAMPLES AND PREPARATION

- 1) All materials were manufactured in accordance with the applicable product specification.
- 2) All test samples were identified and encoded to maintain traceability throughout the test sequences.
- 3) After soldering, the parts to be used for LLCR and DWV/IR testing were cleaned according to CO-SC-WI-3029.
- 4) Either an automated cleaning procedure or an ultrasonic cleaning procedure may be used.
- 5) The automated procedure is used with aqueous compatible soldering materials.
- 6) Parts not intended for testing LLCR and DWV/IR are visually inspected and cleaned if necessary.
- 7) Any additional preparation will be noted in the individual test sequences.
- 8) Solder Information: Lead Free
- 9) Samtec Test PCBs used: PCB-108846-TST-XX, PCB-108845-TST-XX, PCB-108844-TST-XX,
PCB-110229-TST-XX

FLOWCHARTS

Gas Tight

Group 1

ERF6-60-03.5-L-2-A

ERM6-60-01.5-L-2-A

8 Assemblies

Step	Description
------	-------------

- | | |
|----|--|
| 1. | LLCR ⁽²⁾ |
| 2. | Gas Tight ⁽¹⁾ |
| 3. | LLCR ⁽²⁾
Max Delta = 15 mOhm |

(1) Gas Tight = EIA-364-36

(2) LLCR = EIA-364-23

Open Circuit Voltage = 20 mV Max

Test Current = 100 mA Max

Normal Force

Group 1

ERF6-60-03.5-L-DV-A

ERM6-60-01.5-L-DV-A

8 Contacts Minimum

Signal Without Thermals

Step	Description
------	-------------

- | | |
|----|--|
| 1. | Contact Gaps |
| 2. | Normal Force ⁽¹⁾
Deflection = 0.009 "
Expected Force at Max Deflection = 50 g |

Group 2

ERF6-60-03.5-L-DV-A

ERM6-60-01.5-L-DV-A

8 Contacts Minimum

Signal With Thermals

Step	Description
------	-------------

- | | |
|----|--|
| 1. | Contact Gaps |
| 2. | Thermal Age ⁽²⁾ |
| 3. | Contact Gaps |
| 4. | Normal Force ⁽¹⁾
Deflection = 0.009 "
Expected Force at Max Deflection = 50 g |

(1) Normal Force = EIA-364-04

(2) Thermal Age = EIA-364-17

Test Condition = 4 (105°C)

Time Condition = B (250 Hours)

FLOWCHARTS Continued**Thermal Aging**Group 1

ERF6-60-03.5-L-DV-A

ERM6-60-01.5-L-DV-A

8 Assemblies

Step	Description
1.	Contact Gaps
2.	Mating/Unmating Force ⁽²⁾
3.	LLCR ⁽¹⁾
4.	Thermal Age ⁽³⁾
5.	LLCR ⁽¹⁾ Max Delta = 15 mOhm
6.	Mating/Unmating Force ⁽²⁾
7.	Contact Gaps

(1) LLCR = EIA-364-23

Open Circuit Voltage = 20 mV Max

Test Current = 100 mA Max

(2) Mating/Unmating Force = EIA-364-13

(3) Thermal Age = EIA-364-17

Test Condition = 4 (105°C)

Time Condition = B (250 Hours)

FLOWCHARTS Continued**Mating/Unmating/Durability**Group 1

ERF6-60-03.5-L-2-A
ERM6-60-01.5-L-2-A
8 Assemblies

Step	Description
1.	Contact Gaps
2.	LLCR ⁽²⁾
3.	Mating/Unmating Force ⁽³⁾
4.	Cycles Quantity = 25 Cycles
5.	Mating/Unmating Force ⁽³⁾
6.	Contact Gaps
7.	LLCR ⁽²⁾ Max Delta = 15 mOhm
8.	Thermal Shock ⁽⁴⁾
9.	LLCR ⁽²⁾ Max Delta = 15 mOhm
10.	Humidity ⁽¹⁾
11.	LLCR ⁽²⁾ Max Delta = 15 mOhm
12.	Mating/Unmating Force ⁽³⁾

Group 1

ERF6-10-03.5-L-DV-A
ERM6-10-01.5-L-DV-A
8 Assemblies
10 Pos.

Step	Description
1.	Contact Gaps
2.	Mating/Unmating Force ⁽¹⁾
3.	Cycles Quantity = 25 Cycles
4.	Mating/Unmating Force ⁽¹⁾

Group 2

ERF6-30-03.5-L-DV-A
ERM6-30-01.5-L-DV-A
8 Assemblies
30 Pos.

Step	Description
1.	Contact Gaps
2.	Mating/Unmating Force ⁽¹⁾
3.	Cycles Quantity = 25 Cycles
4.	Mating/Unmating Force ⁽¹⁾

Group 3

ERF6-60-03.5-L-DV-A
ERM6-60-01.5-L-DV-A
8 Assemblies
60 Pos.

Step	Description
1.	Contact Gaps
2.	Mating/Unmating Force ⁽¹⁾
3.	Cycles Quantity = 25 Cycles
4.	Mating/Unmating Force ⁽¹⁾

(1) Humidity = EIA-364-31

Test Condition = B (240 Hours)

Test Method = III (+25°C to +65°C @ 90% RH to 98% RH)

Test Exceptions: ambient pre-condition and delete steps 7a and 7b

(2) LLCR = EIA-364-23

Open Circuit Voltage = 20 mV Max

Test Current = 100 mA Max

(3) Mating/Unmating Force = EIA-364-13(4) Thermal Shock = EIA-364-32

Exposure Time at Temperature Extremes = 1/2 Hour

Method A, Test Condition = I (-55°C to +85°C)

Test Duration = A-3 (100 Cycles)

FLOWCHARTS Continued

IR/DWV**Pin-to-Pin**

<u>Group 1</u>		<u>Group 2</u>		<u>Group 3</u>		<u>Group 4</u>	
ERF6-60-03.5-L-2-A		ERF6-60-03.5-L-2-A		ERM6-60-01.5-L-2-A		ERF6-60-03.5-L-2-A	
ERM6-60-01.5-L-2-A						ERM6-60-01.5-L-2-A	
2 Assemblies		2 Assemblies		2 Assemblies		2 Assemblies	
Step	Description	Step	Description	Step	Description	Step	Description
1.	DWV Breakdown (2)	1.	DWV Breakdown (2)	1.	DWV Breakdown (2)	1.	IR (4)
						2.	DWV at Test Voltage (1)
						3.	Thermal Shock (5)
						4.	IR (4)
						5.	DWV at Test Voltage (1)
						6.	Humidity (3)
						7.	IR (4)
						8.	DWV at Test Voltage (1)

Row-to-Row

<u>Group 5</u>		<u>Group 6</u>		<u>Group 7</u>		<u>Group 8</u>	
ERF6-60-03.5-L-2-A		ERF6-60-03.5-L-2-A		ERM6-60-01.5-L-2-A		ERF6-60-03.5-L-2-A	
ERM6-60-01.5-L-2-A						ERM6-60-01.5-L-2-A	
2 Assemblies		2 Assemblies		2 Assemblies		2 Assemblies	
Step	Description	Step	Description	Step	Description	Step	Description
1.	DWV Breakdown (2)	1.	DWV Breakdown (2)	1.	DWV Breakdown (2)	1.	IR (4)
						2.	DWV at Test Voltage (1)
						3.	Thermal Shock (5)
						4.	IR (4)
						5.	DWV at Test Voltage (1)
						6.	Humidity (3)
						7.	IR (4)
						8.	DWV at Test Voltage (1)

(1) DWV at Test Voltage = EIA-364-20

Test Condition = 1 (Sea Level)

DWV test voltage is equal to 75% of the lowest breakdown voltage

Test voltage applied for 60 seconds

(2) DWV Breakdown = EIA-364-20

Test Condition = 1 (Sea Level)

DWV test voltage is equal to 75% of the lowest breakdown voltage

Test voltage applied for 60 seconds

(3) Humidity = EIA-364-31

Test Condition = B (240 Hours)

Test Method = III (+25°C to +65°C @ 90% RH to 98% RH)

Test Exceptions: ambient pre-condition and delete steps 7a and 7b

(4) IR = EIA-364-21

Test Condition = 500 Vdc, 2 Minutes Max

(5) Thermal Shock = EIA-364-32

Exposure Time at Temperature Extremes = 1/2 Hour

Method A, Test Condition = I (-55°C to +85°C)

Test Duration = A-3 (100 Cycles)

FLOWCHARTS Continued**Current Carrying Capacity**Group 1

ERF6-60-03.5-L-2-A
ERM6-60-01.5-L-2-A
2 Pins Powered
Signal

Step	Description
1.	CCC ⁽¹⁾ Rows = 2 Number of Positions = 1

Group 2

ERF6-60-03.5-L-2-A
ERM6-60-01.5-L-2-A
4 Pins Powered
Signal

Step	Description
1.	CCC ⁽¹⁾ Rows = 2 Number of Positions = 2

Group 3

ERF6-60-03.5-L-2-A
ERM6-60-01.5-L-2-A
6 Pins Powered
Signal

Step	Description
1.	CCC ⁽¹⁾ Rows = 2 Number of Positions = 3

Group 4

ERF6-60-03.5-L-2-A
ERM6-60-01.5-L-2-A
8 Pins Powered
Signal

Step	Description
1.	CCC ⁽¹⁾ Rows = 2 Number of Positions = 4

Group 5

ERF6-60-03.5-L-2-A
ERM6-60-01.5-L-2-A
120 Pins Powered
Signal

Step	Description
1.	CCC ⁽¹⁾ Rows = 2 Number of Positions = 60

(1) CCC = EIA-364-70

Method 2, Temperature Rise Versus Current Curve

(TIN PLATING) - Tabulate calculated current at RT, 65°C, 75°C and 95°C after derating 20% and based on 105°C

(GOLD PLATING) - Tabulate calculated current at RT, 85°C, 95°C and 115°C after derating 20% and based on 125°C

FLOWCHARTS Continued**Mechanical Shock/Random Vibration/LLCR**Group 1

ERF6-60-03.5-L-2-A

ERM6-60-01.5-L-2-A

8 Assemblies

Step Description

1. LLCR ⁽¹⁾
2. Mechanical Shock ⁽²⁾
3. Random Vibration ⁽³⁾
4. LLCR ⁽¹⁾
Max Delta = 15 mOhm

(1) LLCR = EIA-364-23

Open Circuit Voltage = 20 mV Max

Test Current = 100 mA Max

(2) Mechanical Shock = EIA-364-27

Test Condition = C (100 G Peak, 6 milliseconds, Half Sine)

Number of Shocks = 3 Per Direction, Per Axis, 18 Total

(3) Random Vibration = EIA-364-28

Condition = VB (7.56 gRMS Average, 2 Hours/Axis)

Mechanical Shock/Random Vibration/Event DetectionGroup 1

ERF6-60-03.5-L-2-A

ERM6-60-01.5-L-2-A

60 Points

Step Description

1. Nanosecond Event Detection
(Mechanical Shock) ⁽¹⁾
2. Nanosecond Event Detection
(Random Vibration) ⁽²⁾

(1) Nanosecond Event Detection (Mechanical Shock)

Use EIA-364-87 for Nanosecond Event Detection:

Test Condition = F (50 nanoseconds at 10 ohms)

Use EIA-364-27 for Mechanical Shock:

Test Condition = C (100 G Peak, 6 milliseconds, Half Sine)

Number of Shocks = 3 Per Direction, Per Axis, 18 Total

(2) Nanosecond Event Detection (Random Vibration)

Use EIA-364-87 for Nanosecond Event Detection:

Test Condition = F (50 nanoseconds at 10 ohms)

Use EIA-364-28 for Random Vibration:

Condition = VB (7.56 gRMS Average, 2 Hours/Axis)

ATTRIBUTE DEFINITIONS

The following is a brief, simplified description of attributes.

THERMAL:

- 1) EIA-364-17, *Temperature Life with or without Electrical Load Test Procedure for Electrical Connectors*.
- 2) Test Condition at 105° C.
- 3) Test Time Condition B for 250 hours.
- 4) All test samples are pre-conditioned at ambient.
- 5) All test samples are exposed to environmental stressing in the mated condition.

THERMAL SHOCK:

- 1) EIA-364-32, *Thermal Shock (Temperature Cycling) Test Procedure for Electrical Connectors*.
- 2) Test Condition: -55°C to +85°C
- 3) Test Time: ½ hour dwell at each temperature extreme
- 4) Number of Cycles: 100
- 5) All test samples are pre-conditioned at ambient.
- 6) All test samples are exposed to environmental stressing in the mated condition.

HUMIDITY:

- 1) Reference document: EIA-364-31, *Humidity Test Procedure for Electrical Connectors*.
- 2) Test Condition B, 240 Hours.
- 3) Method III, +25° C to + 65° C, 90% to 98% Relative Humidity excluding sub-cycles 7a and 7b.
- 4) All samples are pre-conditioned at ambient.
- 5) All test samples are exposed to environmental stressing in the mated condition.

MECHANICAL SHOCK (Specified Pulse):

- 1) Reference document: EIA-364-27, *Mechanical Shock Test Procedure for Electrical Connectors*
- 2) Test Condition: C
- 3) Peak Value: 100 G
- 4) Duration: 6 Milliseconds
- 5) Wave Form: Half Sine
- 6) Velocity: 12.3 ft/s
- 7) Number of Shocks: 3 Shocks / Direction, 3 Axis (18 Total)

VIBRATION:

- 1) Reference document: EIA-364-28, *Vibration Test Procedure for Electrical Connectors*
- 2) Test Condition V, Letter B
- 3) Power Spectral Density: 0.04 G² / Hz
- 4) G 'RMS': 7.56
- 5) Frequency: 50 to 2000 Hz
- 6) Duration: 2.0 Hours per axis (3 axis total)

NANOSECOND-EVENT DETECTION:

- 1) Reference document: EIA-364-87, *Nanosecond-Event Detection for Electrical Connectors*
- 2) Prior to test, the samples were characterized to assure the low nanosecond event being monitored will trigger the detector.
- 3) After characterization it was determined the test samples could be monitored for 50 nanosecond events

MATING/UNMATING:

- 1) Reference document: EIA-364-13, *Mating and Unmating Forces Test Procedure for Electrical Connectors*.
- 2) The full insertion position was to within 0.003" to 0.004" of the plug bottoming out in the receptacle to prevent damage to the system under test.
- 3) One of the mating parts is secured to a floating X-Y table to prevent damage during cycling.

ATTRIBUTE DEFINITIONS Continued

The following is a brief, simplified description of attributes

NORMAL FORCE (FOR CONTACTS TESTED IN THE HOUSING):

- 1) Reference document: EIA-364-04, *Normal Force Test Procedure for Electrical Connectors*.
- 2) The contacts shall be tested in the connector housing.
- 3) If necessary, a "window" shall be made in the connector body to allow a probe to engage and deflect the contact at the same attitude and distance (plus 0.05 mm [0.002"]) as would occur in actual use.
- 4) The connector housing shall be placed in a holding fixture that does not interfere with or otherwise influence the contact force or deflection.
- 5) Said holding fixture shall be mounted on a floating, adjustable, X-Y table on the base of the Dillon TC², computer-controlled test stand with a deflection measurement system accuracy of 5.0 μm (0.0002").
- 6) The nominal deflection rate shall be 5 mm (0.2")/minute.
- 7) Unless otherwise noted a minimum of five contacts shall be tested.
- 8) The force/deflection characteristic to load and unload each contact shall be repeated five times.
- 9) The system shall utilize the TC² software in order to acquire and record the test data.
- 10) The permanent set of each contact shall be measured within the TC² software.
- 11) The acquired data shall be graphed with the deflection data on the X-axis and the force data on the Y-axis and a printout will be stored with the Tracking Code paperwork.

TEMPERATURE RISE (Current Carrying Capacity, CCC):

- 1) EIA-364-70, *Temperature Rise versus Current Test Procedure for Electrical Connectors and Sockets*.
- 2) When current passes through a contact, the temperature of the contact increases as a result of I^2R (resistive) heating.
- 3) The number of contacts being investigated plays a significant part in power dissipation and therefore temperature rise.
- 4) The size of the temperature probe can affect the measured temperature.
- 5) Copper traces on PC boards will contribute to temperature rise:
 - a. Self-heating (resistive)
 - b. Reduction in heat sink capacity affecting the heated contacts
- 6) A de-rating curve, usually 20%, is calculated.
- 7) Calculated de-rated currents at four temperature points are reported:
 - a. Ambient
 - b. 85° C
 - c. 95° C
 - d. 115° C
- 8) Typically, neighboring contacts (in close proximity to maximize heat buildup) are energized.
- 9) The thermocouple (or temperature measuring probe) will be positioned at a location to sense the maximum temperature in the vicinity of the heat generation area.
- 10) A computer program, *TR 803.exe*, ensures accurate stability for data acquisition.
- 11) Hook-up wire cross section is larger than the cross section of any connector leads/PC board traces, jumpers, etc.
- 12) Hook-up wire length is longer than the minimum specified in the referencing standard.

ATTRIBUTE DEFINITIONS Continued

The following is a brief, simplified description of attributes

LLCR:

- 1) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 2) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 3) The following guidelines are used to categorize the changes in LLCR as a result from stressing
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms: -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure

GAS TIGHT:

To provide method for evaluating the ability of the contacting surfaces in preventing penetration of harsh vapors which might lead to oxide formation that may degrade the electrical performance of the contact system.

- 1) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 2) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 3) The following guidelines are used to categorize the changes in LLCR as a result from stressing
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms: -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure
- 4) Procedure:
 - a. Reference document: EIA-364-36, *Test Procedure for Determination of Gas-Tight Characteristics for Electrical Connectors, Sockets and/or Contact Systems*.
 - b. Test Conditions:
 - i. Class II--- Mated pairs of contacts assembled to their plastic housings.
 - ii. Reagent grade Nitric Acid shall be used of sufficient volume to saturate the test chamber
 - iii. The ratio of the volume of the test chamber to the surface area of the acid shall be 10:1.
 - iv. The chamber shall be saturated with the vapor for at least 15 minutes before samples are added.
 - v. Exposure time, 55 to 65 minutes.
 - vi. The samples shall be no closer to the chamber walls than 1 inch and no closer to the surface of the acid than 3 inches.
 - vii. The samples shall be dried after exposure for a minimum of 1 hour.
 - viii. Drying temperature 50° C
 - ix. The final LLCR shall be conducted within 1 hour after drying.

ATTRIBUTE DEFINITIONS Continued

The following is a brief, simplified description of attributes

INSULATION RESISTANCE (IR):

To determine the resistance of insulation materials to leakage of current through or on the surface of these materials when a DC potential is applied.

- 1) PROCEDURE:
 - a. Reference document: EIA-364-21, *Insulation Resistance Test Procedure for Electrical Connectors*.
 - b. Test Conditions:
 - i. Between Adjacent Contacts or Signal-to-Ground
 - ii. Electrification Time 2.0 minutes
 - iii. Test Voltage (500 VDC) corresponds to calibration settings for measuring resistances.
- 2) MEASUREMENTS:
- 3) When the specified test voltage is applied (VDC), the insulation resistance shall not be less than 5000 megohms.

DIELECTRIC WITHSTANDING VOLTAGE (DWV):

To determine if the sockets can operate at its rated voltage and withstand momentary over potentials due to switching, surges, and other similar phenomenon. Separate samples are used to evaluate the effect of environmental stresses so not to influence the readings from arcing that occurs during the measurement process.

- 1) PROCEDURE:
 - a. Reference document: EIA-364-20, *Withstanding Voltage Test Procedure for Electrical Connectors*.
 - b. Test Conditions:
 - i. Between Adjacent Contacts or Signal-to-Ground
 - ii. Barometric Test Condition 1
 - iii. Rate of Application 500 V/Sec
 - iv. Test Voltage (VAC) until breakdown occurs
- 2) MEASUREMENTS/CALCULATIONS
 - a. The breakdown voltage shall be measured and recorded.
 - b. The dielectric withstanding voltage shall be recorded as 75% of the minimum breakdown voltage.
 - c. The working voltage shall be recorded as one-third (1/3) of the dielectric withstanding voltage (one-fourth of the breakdown voltage).

RESULTS

Temperature Rise, CCC at a 20% de-rating

- CCC for a 30°C Temperature Rise-----1.40 A per contact with 2 contacts (2x1) powered.
- CCC for a 30°C Temperature Rise-----1.04 A per contact with 4 contacts (2x2) powered.
- CCC for a 30°C Temperature Rise-----1.00 A per contact with 6 contacts (2x3) powered.
- CCC for a 30°C Temperature Rise-----0.79 A per contact with 8 contacts (2x4) powered.
- CCC for a 30°C Temperature Rise-----0.38 A per contact with 120 contacts (2x60) powered.

Mating – Unmating Forces

Thermal Aging Group

- Initial
 - Mating
 - Min ----- 5.26 lbs
 - Max ----- 6.08 lbs
 - Unmating
 - Min ----- 2.49 lbs
 - Max ----- 2.84 lbs
- After Thermal
 - Mating
 - Min ----- 2.30 lbs
 - Max ----- 3.22 lbs
 - Unmating
 - Min ----- 1.38 lbs
 - Max ----- 2.55 lbs

RESULTS Continued**Mating/Unmating Durability Group****ERF6-60-03.5-L-DV-A/ERM6-60-01.5-L-DV-A**

- **Initial**
 - **Mating**
 - **Min** ----- 4.98 lbs
 - **Max** ----- 6.62 lbs
 - **Unmating**
 - **Min** ----- 3.04 lbs
 - **Max** ----- 4.29 lbs
- **After 25 Cycles**
 - **Mating**
 - **Min** ----- 5.80 lbs
 - **Max** ----- 8.70 lbs
 - **Unmating**
 - **Min** ----- 3.89 lbs
 - **Max** ----- 4.97 lbs

ERF6-30-03.5-L-DV-A/ERM6-30-01.5-L-DV-A

- **Initial**
 - **Mating**
 - **Min** ----- 2.75 lbs
 - **Max** ----- 4.47 lbs
 - **Unmating**
 - **Min** ----- 1.36 lbs
 - **Max** ----- 3.65 lbs
- **After 25 Cycles**
 - **Mating**
 - **Min** ----- 2.94 lbs
 - **Max** ----- 4.72 lbs
 - **Unmating**
 - **Min** ----- 1.73 lbs
 - **Max** ----- 4.03 lbs

ERF6-10-03.5-L-DV-A/ERM6-10-01.5-L-DV-A

- **Initial**
 - **Mating**
 - **Min** ----- 0.57 lbs
 - **Max** ----- 0.94 lbs
 - **Unmating**
 - **Min** ----- 0.32 lbs
 - **Max** ----- 0.99 lbs
- **After 25 Cycles**
 - **Mating**
 - **Min** ----- 0.46 lbs
 - **Max** ----- 1.04 lbs
 - **Unmating**
 - **Min** ----- 0.36 lbs
 - **Max** ----- 1.04 lbs

RESULTS Continued**Normal Force at 0.0098 inches deflection**

- **Initial**
 - Min-----44.30 g Set ---- 0.0004 inches
 - Max -----53.50 g Set ---- 0.0008 inches
- **Thermal**
 - Min-----31.20 g Set-----0.0023 inches
 - Max -----38.50 g Set-----0.0030 inches

Insulation Resistance minimums, IR**Pin to Pin**

- **Initial**
 - Mated-----45000 Meg Ω ----- Passed
 - Unmated -----45000 Meg Ω ----- Passed
- **Thermal Shock**
 - Mated-----45000 Meg Ω ----- Passed
 - Unmated -----45000 Meg Ω ----- Passed
- **Humidity**
 - Mated-----45000 Meg Ω ----- Passed
 - Unmated -----45000 Meg Ω ----- Passed

Row to Row

- **Initial**
 - Mated-----45000 Meg Ω ----- Passed
 - Unmated -----45000 Meg Ω ----- Passed
- **Thermal Shock**
 - Mated-----45000 Meg Ω ----- Passed
 - Unmated -----45000 Meg Ω ----- Passed
- **Humidity**
 - Mated-----45000 Meg Ω ----- Passed
 - Unmated -----45000 Meg Ω ----- Passed

Dielectric Withstanding Voltage minimums, DWV

- **Minimums**
 - Breakdown Voltage-----596 VAC
 - Test Voltage-----447 VAC
 - Working Voltage-----149 VAC

Pin to Pin

- Initial DWV -----Passed
- Thermal DWV-----Passed
- Humidity DWV-----Passed

Row to Row

- Initial DWV -----Passed
- Thermal DWV-----Passed
- Humidity DWV-----Passed

RESULTS Continued**LLCR Gas Tight (192 LLCR test points)**

- **Initial** ----- 29.42 mOhms Max
- **Gas-Tight**
 - ≤ +5.0 mOhms ----- 192 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 0 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure

LLCR Thermal Aging (192 LLCR test points)

- **Initial** ----- 24.89 mOhms Max
- **Thermal Aging**
 - ≤ +5.0 mOhms ----- 190 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 2 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure

LLCR Durability (192 LLCR test points)

- **Initial** ----- 27.78 mOhms Max
- **Durability, 25 Cycles**
 - ≤ +5.0 mOhms ----- 192 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 0 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure
- **Thermal**
 - ≤ +5.0 mOhms ----- 192 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 0 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure
- **Humidity**
 - ≤ +5.0 mOhms ----- 192 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 0 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure

RESULTS Continued**LLCR Shock & Vibration (192 LLCR test points)**

- **Initial** ----- 25.19 mOhms Max
- **Shock & Vibration**
 - **<= +5.0 mOhms**----- 192 Points ----- Stable
 - **+5.1 to +10.0 mOhms**----- 0 Points ----- Minor
 - **+10.1 to +15.0 mOhms** ----- 0 Points ----- Acceptable
 - **+15.1 to +50.0 mOhms** ----- 0 Points ----- Marginal
 - **+50.1 to +1000 mOhms**----- 0 Points ----- Unstable
 - **>+1000 mOhms**----- 0 Points ----- Open Failure

Mechanical Shock & Random Vibration:

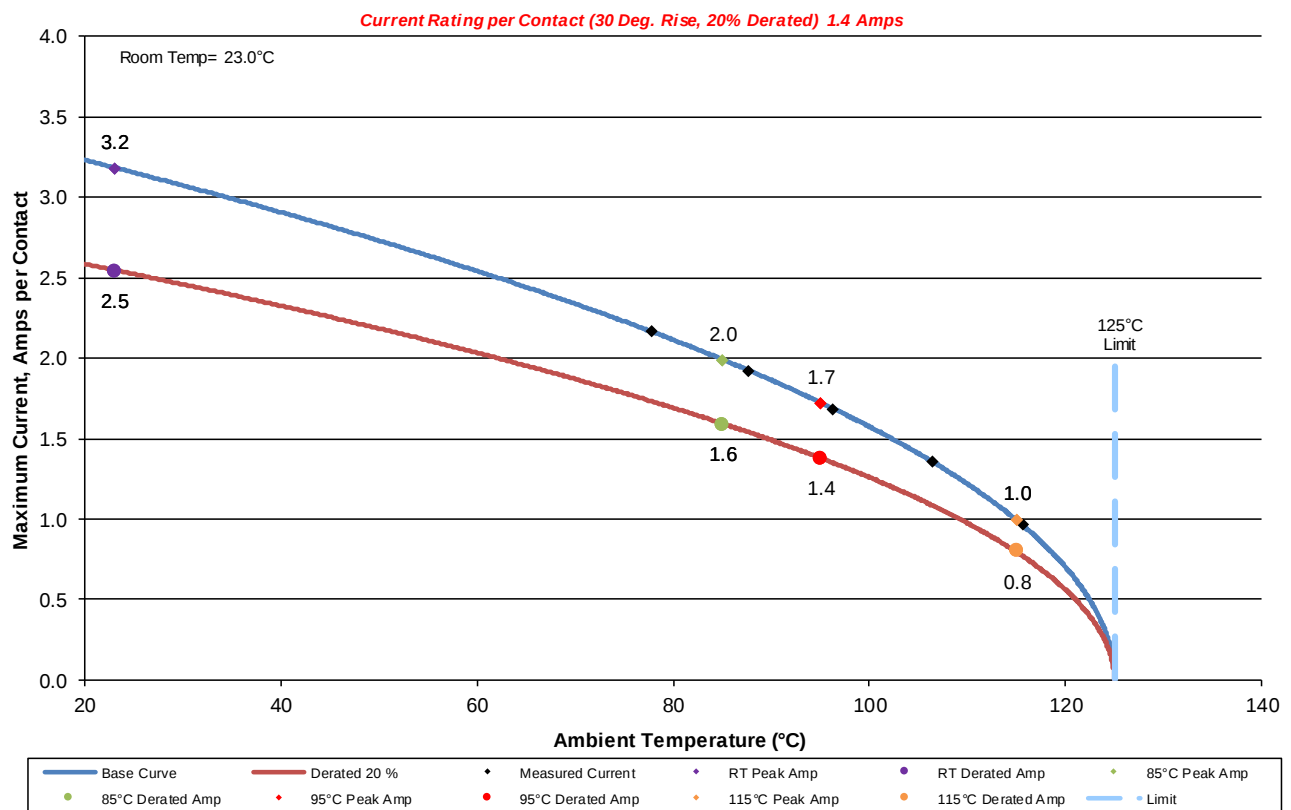
- **Shock**
 - **No Damage**----- Pass
 - **50 Nanoseconds** ----- Pass
- **Vibration**
 - **No Damage**----- Pass
 - **50 Nanoseconds** ----- Pass

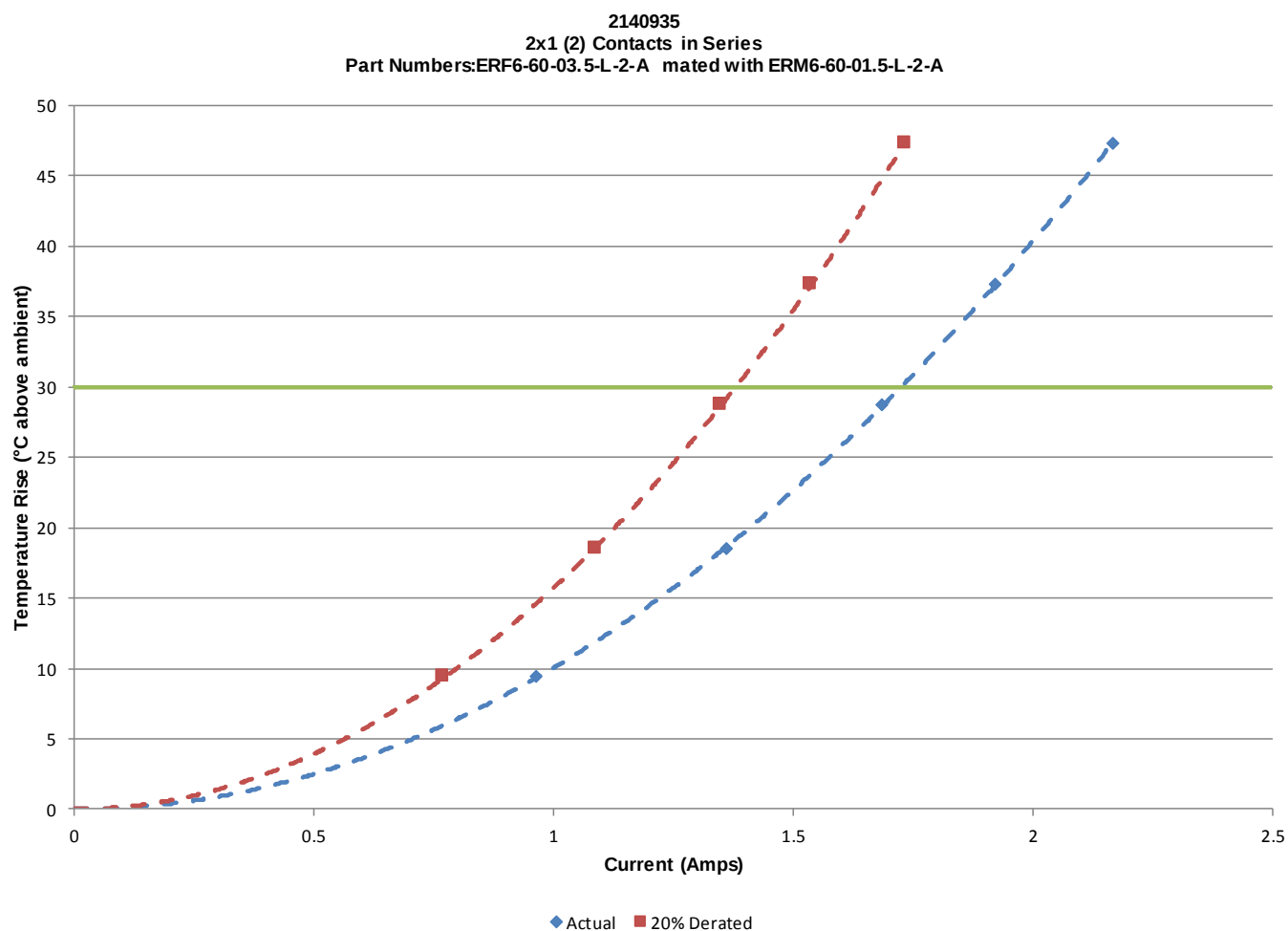
DATA SUMMARIES

TEMPERATURE RISE (Current Carrying Capacity, CCC):

- 1) High quality thermocouples whose temperature slopes track one another were used for temperature monitoring.
- 2) The thermocouples were placed at a location to sense the maximum temperature generated during testing.
- 3) Temperature readings recorded are those for which three successive readings, 15 minutes apart, differ less than 1° C (computer-controlled data acquisition).
- 4) Adjacent contacts were powered:
 - a. Linear configuration with 2 adjacent conductors/contacts powered

2140935
2x1 (2) Contacts in Series
Part Numbers:ERF6-60-03.5-L-2-A mated with ERM6-60-01.5-L-2-A



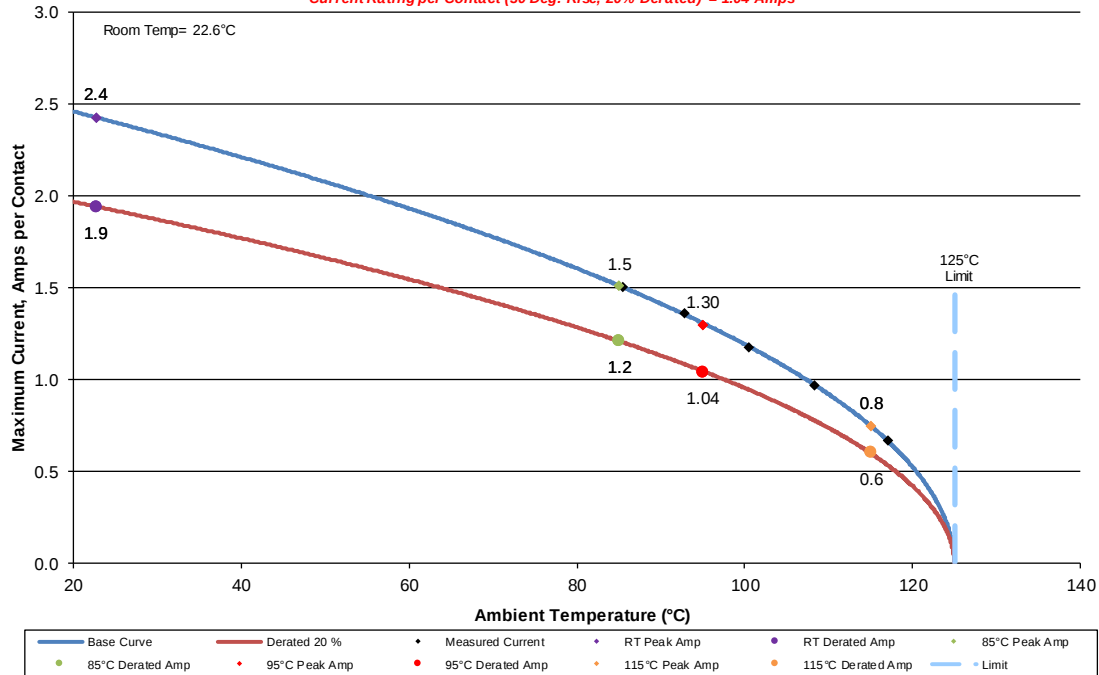


DATA SUMMARIES Continued**b. Linear configuration with 4 adjacent conductors/contacts powered**

2140935

2x2 (4) Contacts in Series

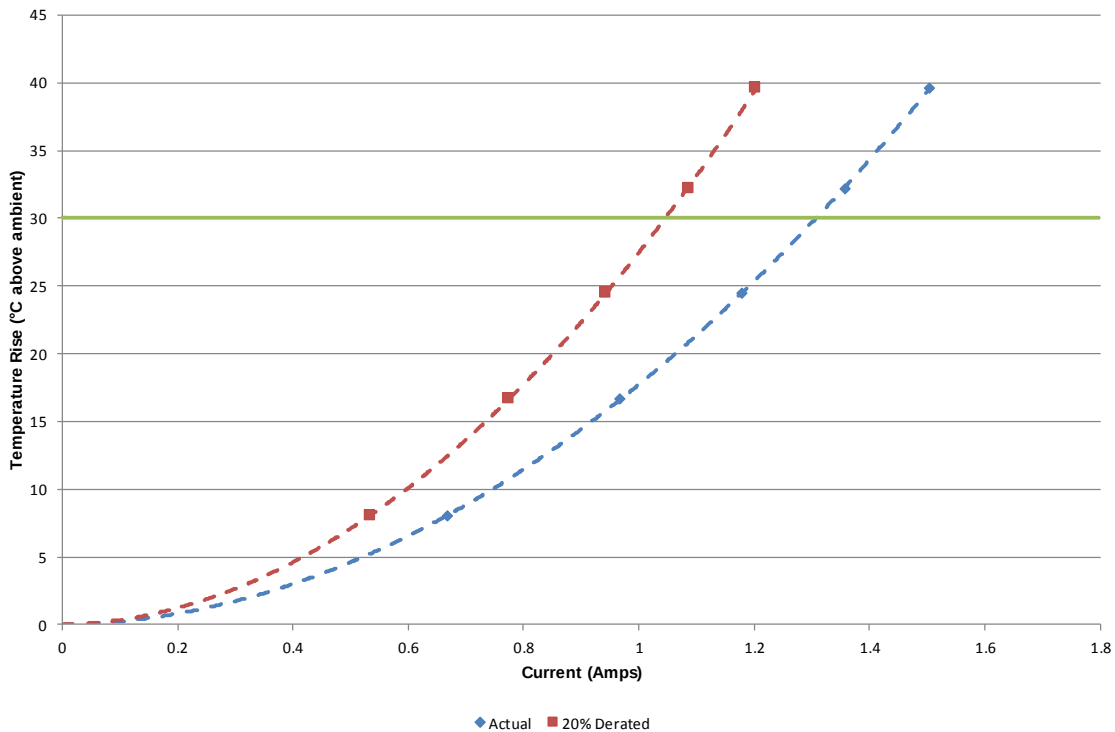
Part Numbers:ERF6-60-03.5-L-2-A mated with ERM6-60-01.5-L-2-A

Current Rating per Contact (30 Deg. Rise, 20% Derated) = 1.04 Amps

2140935

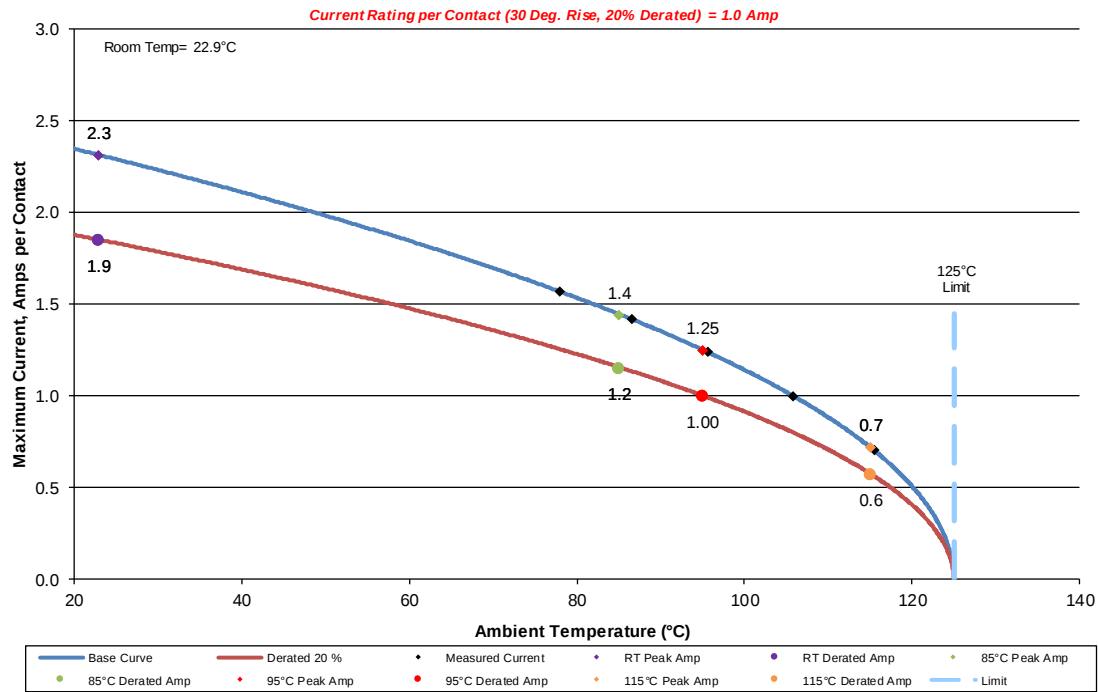
2x2 (4) Contacts in Series

Part Numbers:ERF6-60-03.5-L-2-A mated with ERM6-60-01.5-L-2-A

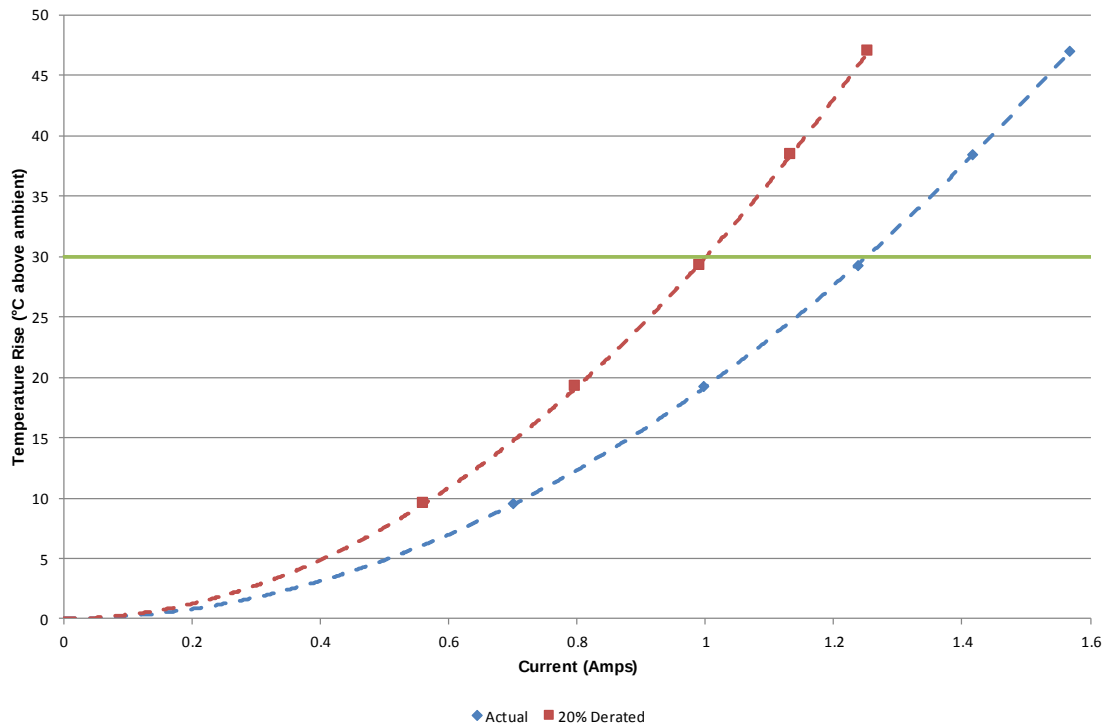


DATA SUMMARIES Continued**c. Linear configuration with 6 adjacent conductors/contacts powered**

2140935
2x3 (6) Contacts in Series
Part Numbers:ERF6-60-03.5-L-2-A mated with ERM6-60-01.5-L-2-A



2140935
2x3 (6) Contacts in Series
Part Numbers:ERF6-60-03.5-L-2-A mated with ERM6-60-01.5-L-2-A

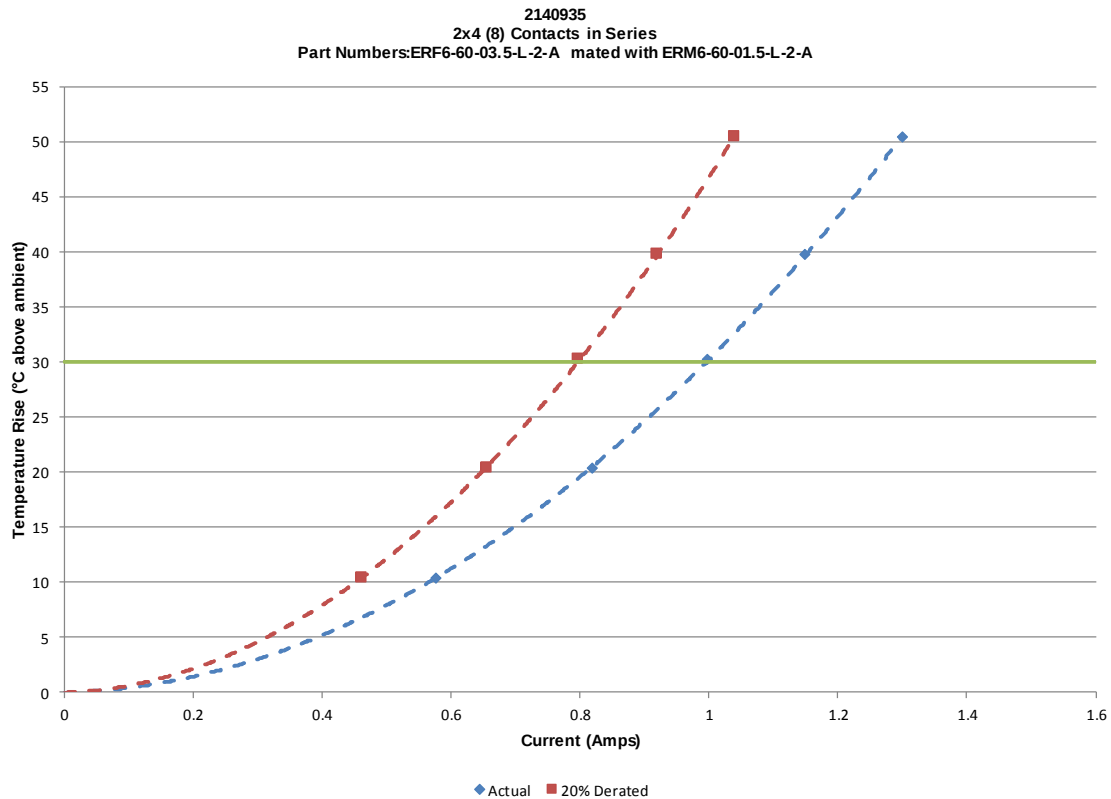
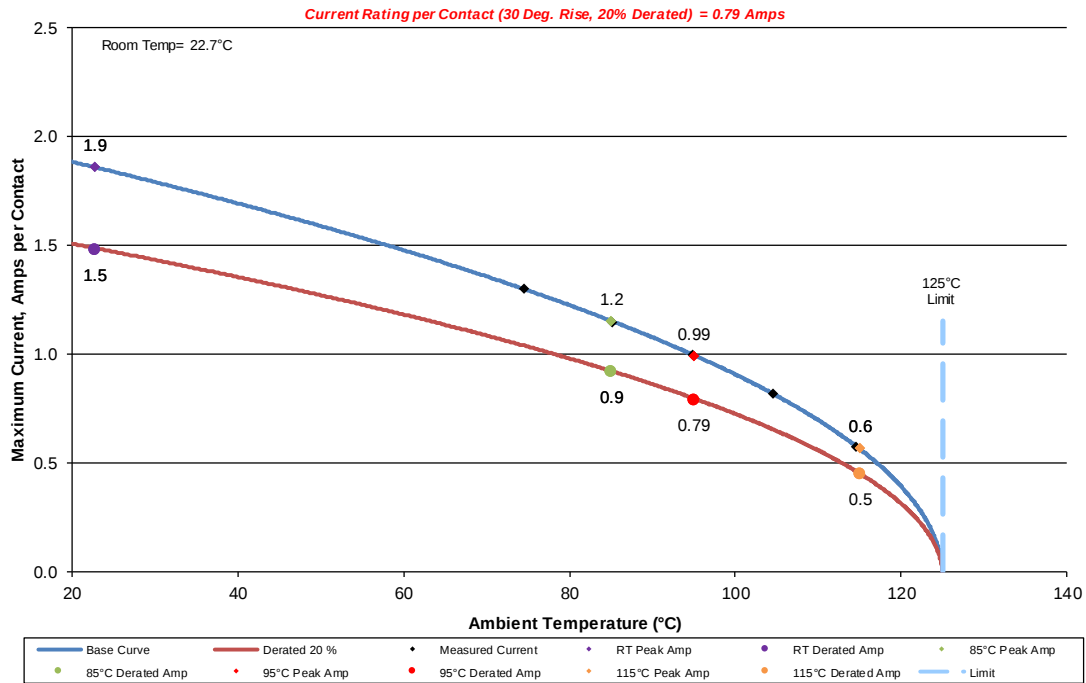


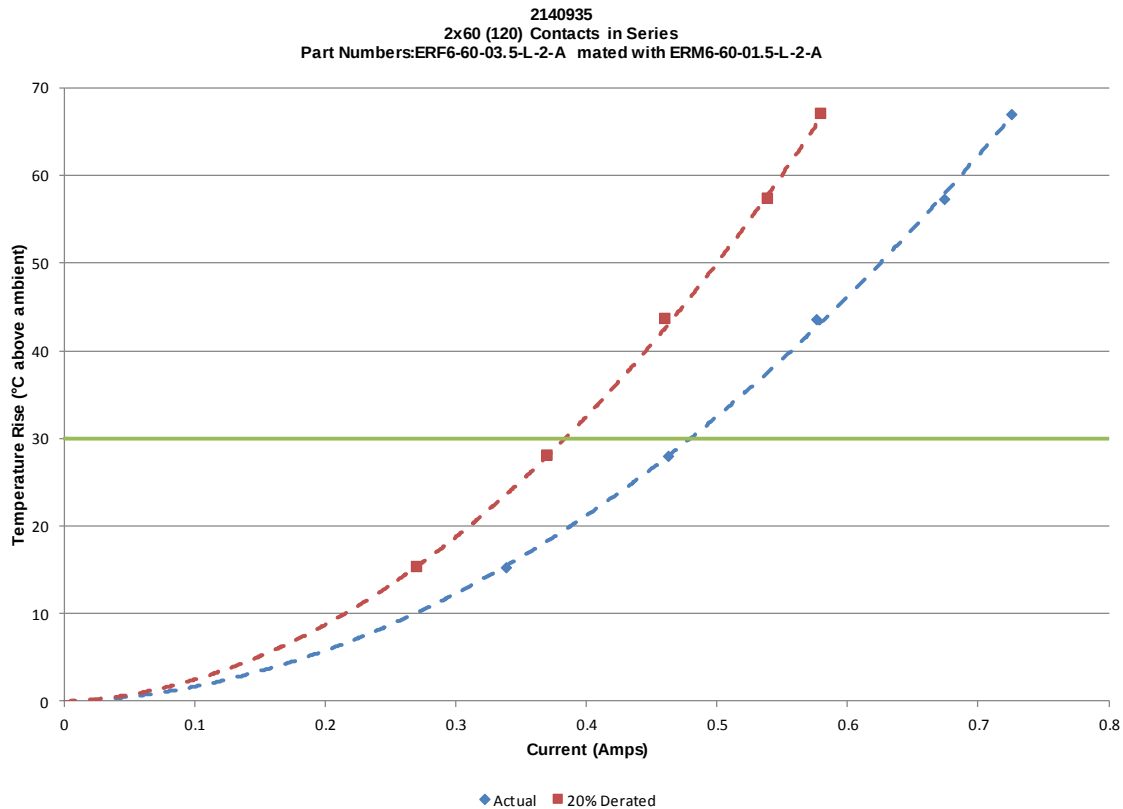
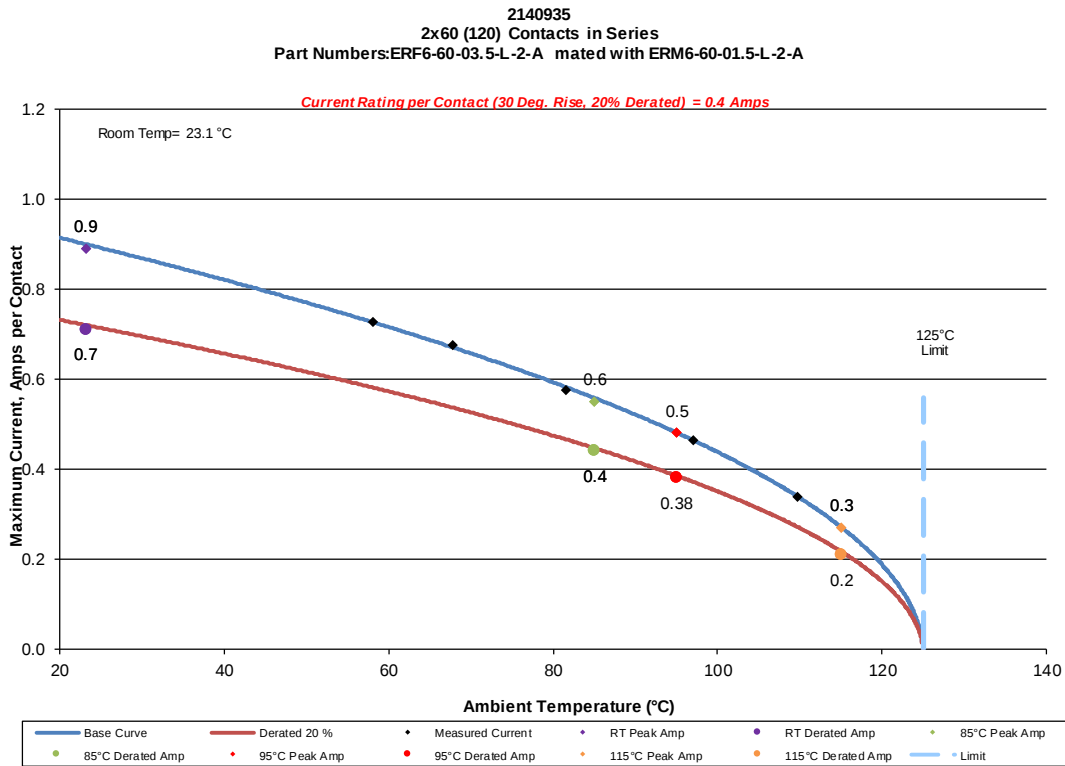
DATA SUMMARIES Continued**d. Linear configuration with 8 adjacent conductors/contacts powered**

2140935

2x4 (8) Contacts in Series

Part Numbers:ERF6-60-03.5-L-2-A mated with ERM6-60-01.5-L-2-A



DATA SUMMARIES Continued**e. Linear configuration with 120 adjacent conductors/contacts powered**

DATA SUMMARIES Continued**MATING/UNMATING:
Thermal Aging Group**

	Initial				After Thermals			
	Mating		Unmating		Mating		Unmating	
	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)
Minimum	23.40	5.26	11.08	2.49	10.22	2.30	6.12	1.38
Maximum	27.04	6.08	12.63	2.84	14.30	3.22	11.34	2.55
Average	25.30	5.69	11.75	2.64	12.72	2.86	8.00	1.80
St Dev	1.24	0.28	0.57	0.13	1.29	0.29	1.72	0.39
Count	8	8	8	8	8	8	8	8

Mating/Unmating Durability Group**ERF6-60-03.5-L-DV-A/ERM6-60-01.5-L-DV-A**

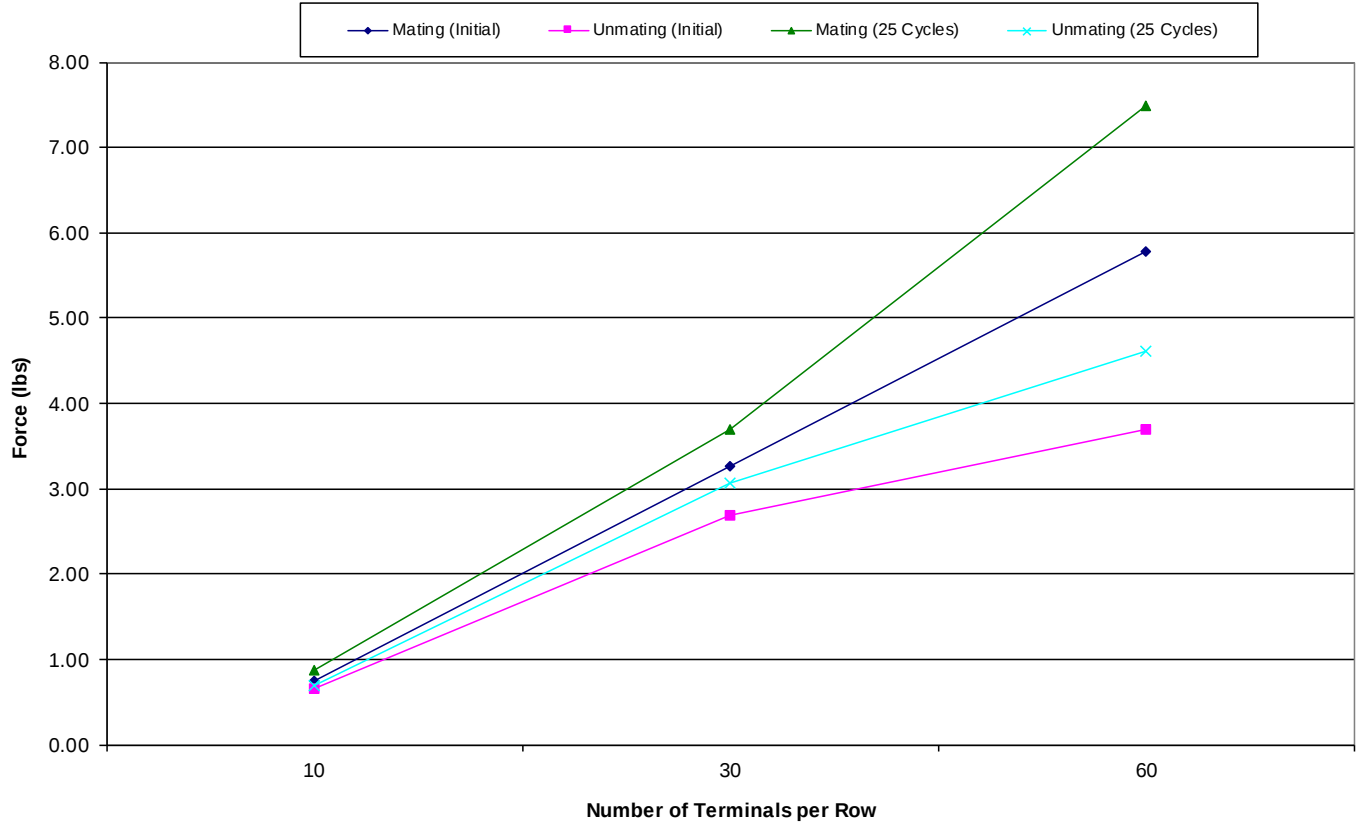
	Initial				25 Cycles			
	Mating		Unmating		Mating		Unmating	
	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)
Minimum	22.15	4.98	13.52	3.04	25.80	5.80	17.30	3.89
Maximum	29.45	6.62	19.08	4.29	38.70	8.70	22.11	4.97
Average	25.69	5.78	16.39	3.69	33.30	7.49	20.53	4.62
St Dev	2.35	0.53	1.81	0.41	5.00	1.12	1.50	0.34
Count	8	8	8	8	8	8	8	8

ERF6-30-03.5-L-DV-A/ERM6-30-01.5-L-DV-A

	Initial				25 Cycles			
	Mating		Unmating		Mating		Unmating	
	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)
Minimum	12.23	2.75	6.05	1.36	13.08	2.94	7.70	1.73
Maximum	19.88	4.47	16.24	3.65	20.99	4.72	17.93	4.03
Average	14.48	3.26	11.97	2.69	16.40	3.69	13.64	3.07
St Dev	2.51	0.56	3.52	0.79	2.52	0.57	3.37	0.76
Count	8	8	8	8	8	8	8	8

ERF6-10-03.5-L-DV-A/ERM6-10-01.5-L-DV-A

	Initial				25 Cycles			
	Mating		Unmating		Mating		Unmating	
	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)
Minimum	2.54	0.57	1.42	0.32	2.05	0.46	1.60	0.36
Maximum	4.18	0.94	4.40	0.99	4.63	1.04	4.63	1.04
Average	3.32	0.75	2.91	0.66	3.88	0.87	3.09	0.70
St Dev	0.62	0.14	1.20	0.27	0.82	0.18	1.19	0.27
Count	8	8	8	8	8	8	8	8

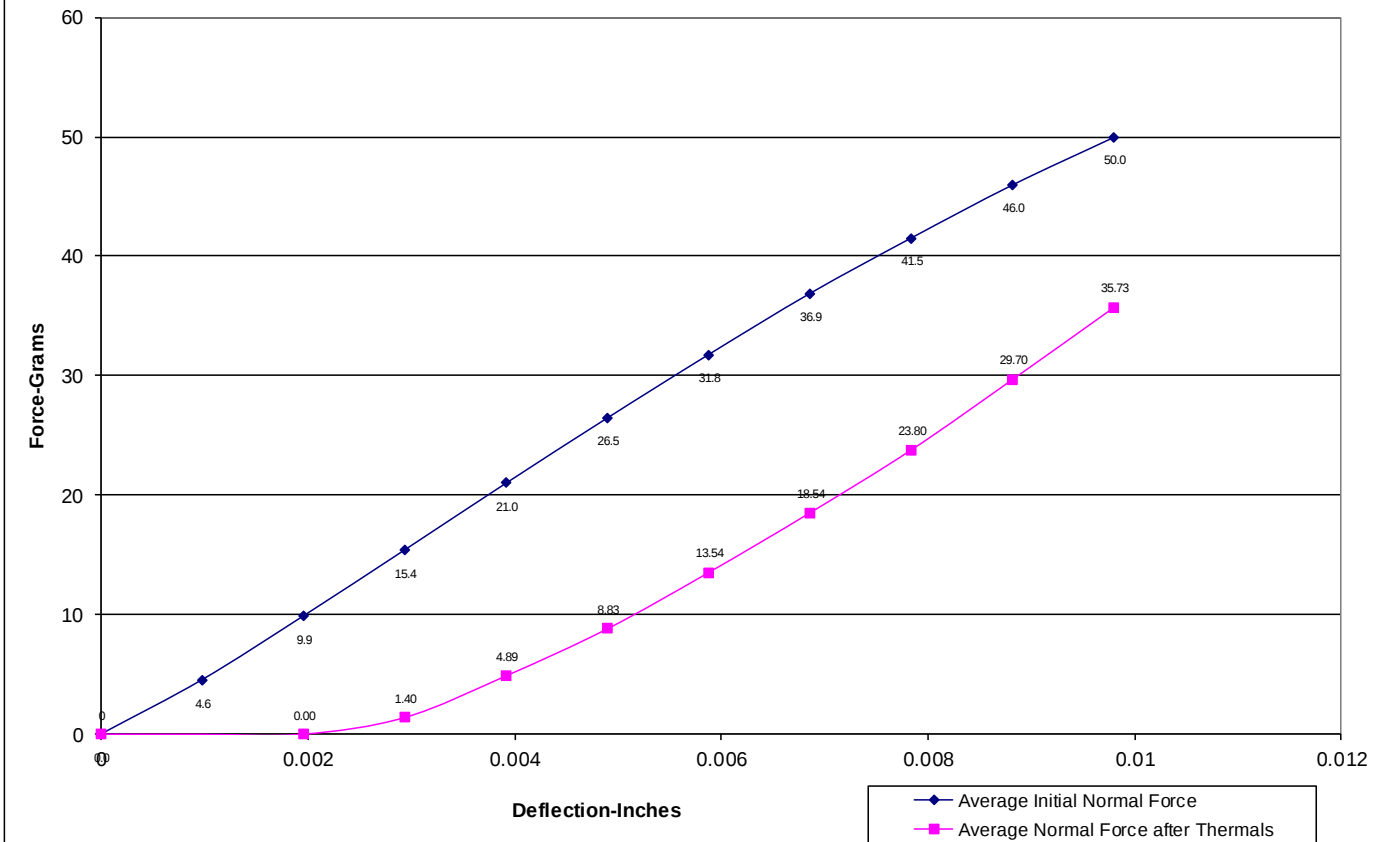
DATA SUMMARIES Continued**Mating\Unmating Force Comparison****Mating/Unmating Data for 10, 30 and 60 Position ERF6/ERM6**

DATA SUMMARIES Continued**NORMAL FORCE (FOR CONTACTS TESTED IN THE HOUSING):**

- 1) Calibrated force gauges are used along with computer-controlled positioning equipment.
- 2) For Normal force 8-10 measurements are taken and the averages reported.

Initial	Deflections in inches Forces in Grams										
	<u>0.0010</u>	<u>0.0020</u>	<u>0.0029</u>	<u>0.0039</u>	<u>0.0049</u>	<u>0.0059</u>	<u>0.0069</u>	<u>0.0078</u>	<u>0.0088</u>	<u>0.0098</u>	<u>SET</u>
Averages	4.56	9.90	15.43	21.01	26.47	31.78	36.89	41.53	45.98	49.96	0.0006
Min	3.60	8.30	13.30	18.00	22.60	27.40	32.00	36.30	40.40	44.30	0.0004
Max	5.20	10.70	17.00	22.80	28.80	34.30	39.60	44.80	49.30	53.50	0.0008
St. Dev	0.543	0.792	1.113	1.420	1.810	2.056	2.288	2.447	2.547	2.635	0.0001
Count	12	12	12	12	12	12	12	12	12	12	12

After Thermals	Deflections in inches Forces in Grams										
	<u>0.0010</u>	<u>0.0020</u>	<u>0.0029</u>	<u>0.0039</u>	<u>0.0049</u>	<u>0.0059</u>	<u>0.0069</u>	<u>0.0078</u>	<u>0.0088</u>	<u>0.0098</u>	<u>SET</u>
Averages	-0.01	0.00	1.40	4.89	8.83	13.54	18.54	23.80	29.70	35.73	0.0026
Min	-0.10	0.00	0.00	2.90	6.10	10.60	15.30	20.10	25.40	31.20	0.0023
Max	0.00	0.00	2.30	6.20	10.70	15.50	20.70	26.20	31.70	38.50	0.0030
St. Dev	0.035	0.000	0.689	1.099	1.508	1.604	1.606	1.760	2.028	2.226	0.0002
Count	8	8	8	8	8	8	8	8	8	8	8

Normal Force - Average Initial vs Average Thermal

DATA SUMMARIES Continued**INSULATION RESISTANCE (IR):**

Pin to Pin			
	Mated	Unmated	Unmated
Minimum	ERF6/ERM6	ERF6	ERM6
Initial	45000	45000	45000
Thermal	45000	45000	45000
Humidity	45000	45000	45000

Row to Row			
	Mated	Unmated	Unmated
Minimum	ERF6/ERM6	ERF6	ERM6
Initial	45000	45000	45000
Thermal	45000	45000	45000
Humidity	45000	45000	45000

DIELECTRIC WITHSTANDING VOLTAGE (DWV):

Voltage Rating Summary	
Minimum	ERF6/ERM6
Break Down Voltage	596
Test Voltage	447
Working Voltage	149

Pin to Pin	
Initial Test Voltage	Passed
After Thermal Test Voltage	Passed
After Humidity Test Voltage	Passed

Row to Row	
Initial Test Voltage	Passed
After Thermal Test Voltage	Passed
After Humidity Test Voltage	Passed

DATA SUMMARIES Continued**LLCR Durability:**

- 1) A total of 192 points were measured.
- 2) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 3) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 4) The following guidelines are used to categorize the changes in LLCR as a result from stressing.
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms: -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure

LLCR Measurement Summaries by Pin Type				
	10/4/2019	10/11/2019	10/21/2019	10/31/2019
Date	10/4/2019	10/11/2019	10/21/2019	10/31/2019
Room Temp (Deg C)	22	22	23	22
Rel Humidity (%)	45	50	46	47
Technician	Troy Cook	Troy Cook	Tony Wagoner	Troy Cook
mOhm values	Actual	Delta	Delta	Delta
	Initial	25 Cycles	Therm Shck	Humidity
Pin Type 1: Signal				
Average	23.66	1.02	1.27	1.31
St. Dev.	1.03	0.84	0.92	0.98
Min	21.53	0.01	0.00	0.01
Max	27.78	4.29	4.68	4.47
Summary Count	192	192	192	192
Total Count	192	192	192	192

LLCR Delta Count by Category						
	Stable	Minor	Acceptable	Marginal	Unstable	Open
mOhms	≤ 5	$>5 \text{ \& } \leq 10$	$>10 \text{ \& } \leq 15$	$>15 \text{ \& } \leq 50$	$>50 \text{ \& } \leq 1000$	>1000
25 Cycles	192	0	0	0	0	0
Therm Shck	192	0	0	0	0	0
Humidity	192	0	0	0	0	0

DATA SUMMARIES Continued**LLCR Thermal Aging:**

- 1) A total of 192 points were measured.
- 2) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 3) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 4) The following guidelines are used to categorize the changes in LLCR as a result from stressing.
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms:-----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms -----Unstable
 - f. $>+1000$ mOhms:-----Open Failure

LLCR Measurement Summaries by Pin Type				
Date	6/9/2020	6/29/2020		
Room Temp (Deg C)	22	22		
Rel Humidity (%)	54	56		
Technician	Aaron McKim	Aaron McKim		
mOhm values	Actual Initial	Delta Thermal	Delta	Delta
Pin Type 1: Signal				
Average	22.73	1.21		
St. Dev.	0.68	1.11		
Min	21.29	0.01		
Max	24.89	9.61		
Summary Count	192	192		
Total Count	192	192		

LLCR Delta Count by Category						
	Stable	Minor	Acceptable	Marginal	Unstable	Open
mOhms	≤ 5	$>5 \text{ \& } \leq 10$	$>10 \text{ \& } \leq 15$	$>15 \text{ \& } \leq 50$	$>50 \text{ \& } \leq 1000$	>1000
Thermal	190	2	0	0	0	0

DATA SUMMARIES Continued**LLCR Gas Tight:**

- 1) A total of 192 points were measured.
- 2) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 3) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 4) The following guidelines are used to categorize the changes in LLCR as a result from stressing.
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms: -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure

LLCR Measurement Summaries by Pin Type				
Date	10/2/2019	10/2/2019		
Room Temp (Deg C)	22	22		
Rel Humidity (%)	51	50		
Technician	Troy Cook	Troy Cook		
mOhm values	Actual	Delta	Delta	Delta
	Initial	Acid Vapor		
Pin Type 1: Signal				
Average	23.66	0.21		
St. Dev.	1.41	0.24		
Min	19.65	0.00		
Max	29.42	1.77		
Summary Count	192	192		
Total Count	192	192		

LLCR Delta Count by Category						
	Stable	Minor	Acceptable	Marginal	Unstable	Open
mOhms	≤ 5	$>5 \text{ \& } \leq 10$	$>10 \text{ \& } \leq 15$	$>15 \text{ \& } \leq 50$	$>50 \text{ \& } \leq 1000$	>1000
Acid Vapor	192	0	0	0	0	0

DATA SUMMARIES Continued**LLCR Shock &Vibration Group:**

- 1). A total of 192 points were measured.
- 2). EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 3). The following guidelines are used to categorize the changes in LLCR as a result from stressing.
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure

LLCR Measurement Summaries by Pin Type				
Date	10/31/2019	12/13/2019		
Room Temp (Deg C)	22	22		
Rel Humidity (%)	48	36		
Technician	Troy Cook	Troy Cook		
mOhm values	Actual	Delta	Delta	Delta
	Initial	Shock-Vib		
Pin Type 1: Signal				
Average	22.51	0.43		
St. Dev.	0.89	0.39		
Min	20.20	0.00		
Max	25.19	1.98		
Summary Count	192	192		
Total Count	192	192		

LLCR Delta Count by Category						
	Stable	Minor	Acceptable	Marginal	Unstable	Open
mOhms	≤ 5	$>5 \text{ \& } \leq 10$	$>10 \text{ \& } \leq 15$	$>15 \text{ \& } \leq 50$	$>50 \text{ \& } \leq 1000$	>1000
Shock-Vib	192	0	0	0	0	0

Nanosecond Event Detection:

Shock and Vibration Event Detection Summary	
Contacts tested	60
Test Condition	C, 100g's, 6ms, Half-Sine
Shock Events	0
Test Condition	V-B, 7.56 rms g
Vibration Events	0
Total Events	0

EQUIPMENT AND CALIBRATION SCHEDULES**Equipment #:** TCT-04**Description:** Dillon Quantrol TC21 25-1000 mm/min series test stand**Manufacturer:** Dillon Quantrol**Model:** TC2 I series test stand**Serial #:** 04-1041-04**Accuracy:** Speed Accuracy: +/- 5% of indicated speed; Speed Accuracy: +/- 5% of indicated speed;
... Last Cal: 05/29/2020, Next Cal: 05/29/2021**Equipment #:** MO-11**Description:** Switch/Multimeter**Manufacturer:** Keithley**Model:** 3706**Serial #:** 120169**Accuracy:** See Manual

... Last Cal: 09/11/2019, Next Cal: 09/11/2020

Equipment #: THC-05**Description:** Temperature/Humidity Chamber (Chamber Room)**Manufacturer:** Thermotron**Model:** SM-8-3800**Serial #:** 05 23 00 02**Accuracy:** See Manual

... Last Cal: 11/14/2019, Next Cal: 11/14/2020

Equipment #: TSC-01**Description:** Vertical Thermal Shock Chamber**Manufacturer:** Cincinnati Sub Zero**Model:** VTS-3-6-6-SC/AC**Serial #:** 10-VT14993**Accuracy:** See Manual

... Last Cal: 06/30/2020, Next Cal: 06/30/2021

Equipment #: HPT-01**Description:** Hipot Safety Tester**Manufacturer:** Vitrek**Model:** V73**Serial #:** 019808**Accuracy:**

... Last Cal: 05/15/2020, Next Cal: 05/15/2021

Equipment #: OV-05**Description:** Forced Air Oven, 5 Cu. Ft., 120 V (Chamber Room)**Manufacturer:** Sheldon Mfg.**Model:** CE5F**Serial #:** 02008008**Accuracy:** +/- 5 deg. C

... Last Cal: 02/05/2020, Next Cal: 02/05/2021

EQUIPMENT AND CALIBRATION SCHEDULES**Equipment #:** MO-04**Description:** Multimeter /Data Acquisition System**Manufacturer:** Keithley**Model:** 2700**Serial #:** 0798688**Accuracy:** See Manual

... Last Cal: 09/11/2019, Next Cal: 09/11/2020

Equipment #: PS-02**Description:** Power Supply**Manufacturer:** Hewlett-Packer**Model:** 6033A**Serial #:** N/A**Accuracy:** See Manual

... Last Cal: NOT CALIBRATED

Equipment #: SVC-01**Description:** Shock & Vibration Table**Manufacturer:** Data Physics**Model:** LE-DSA-10-20K**Serial #:** 10037**Accuracy:** See Manual

... Last Cal: 04/22/2020, Next Cal: 04/22/2021

Equipment #: ACLM-01**Description:** Accelerometer**Manufacturer:** PCB Piezotronics**Model:** 352C03**Serial #:** 115819**Accuracy:** See Manual

... Last Cal: 07/18/2020, Next Cal: 07/18/2021

Equipment #: ED-03**Description:** Event Detector**Manufacturer:** Analysis Tech**Model:** 32EHD**Serial #:** 1100604**Accuracy:** See Manual

... Last Cal: 10/31/2019, Next Cal: 10/31/2020