SFP Double Density Receptacle

1. INTRODUCTION

1.1 Purpose

Qualification testing was performed on TE Connectivity (TE) SFP Double Density (DD) Receptacles to evaluate its conformance to Product Specification 108-130026 Rev A.

1.2 Scope

This report covers the electrical, mechanical and environmental performance of TE SFP DD Receptacles. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL) between 25-March-2020 and 10-July-2020. Detailed test data is stored at HECTL under EA20200087T. Testing was also performed at TE Connectivity Shanghai Electrical Test Laboratory between 2020-09-30 and 2020-12-15. The associated test number is TP-20-02186.

1.3 Conclusion

Specimens met the requirements listed in Product Specification 108-130026 Rev A. Detailed results are located in Section 2.

1.4 Product Description

TE's SFP DD (small form-factor pluggable double density) doubles the density of SFP interconnects with an two-lane electrical interface capable of 28 Gbps NRZ or 56 Gbps PAM-4 to achieve 56 or 112 Gbps aggregate per port. The SFP DD portfolio's backwards compatibility allows existing SFP modules to be plugged into SFP DD ports.

1.5 Test Specimens

The test specimens were representative of normal production lots, and the following part numbers were used:

Table 1 – Test Specimens

Test Set	Qty	Part Number	Description
1,2,3	5	2325864-1	SFP DD 40 Pos Receptacle Connector, SMT
	5	2359845-1	SFP DD 1x1 Cage Assembly w/Generic Heat Sink
	5	N/A	SFP DD Test Cable Assembly w/ Paddlecard 60-1948324-1
	5	60-1948323-1	SFP DD LLCR Test PCB
4	5	2325864-1	SFP DD 40 Pos Receptacle Connector, SMT
	5	60-1948323-1	SFP DD LLCR Test PCB
5,6	5	2325864-1	SFP DD 40 Pos Receptacle Connector, SMT

1.6 Qualification Test Sequence

Specimens identified in Table 1 were subjected to the test sequences listed in Table 2.

Table 2 – Test Sequence

Test or Examination	Test Sets					
	1	2	3	4	5	6
	Test Sequence (a)					
Initial Examination of Product	1	1	1	1	1	1
Low Level Contact Resistance (LLCR)	2,4,8	2,4,6,8	3,6,9			
Insulation Resistance				2,6		
Withstanding Voltage				3,7		
Random Vibration	5					
Mechanical Shock	6					
Durability	3					
Un-mating Force	9					
Connector Solderability					2	
Resistance to Reflow Soldering Heat						2
Thermal Shock				4		
Humidity/Temperature Cycling		7		5(c)		
Temperature Life		3(b)				
Mixed Flowing Gas (MFG)			4			
Thermal Cycling			7			
Re-Seating	7	5	2,5,8			
Final Examination of Product	10	9	10	8	3	3

(a) Numbers indicate the sequence in which tests were performed.
(b) Precondition specimens with 20 durability cycles with latches engaged.
(c) Unmated

1.7 Environmental Conditions

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

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

2. SUMMARY OF TESTING

2.1 Initial Examination of Product

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

2.2 Low Level Contact Resistance

Specimens met the required maximum delta of 20 mohm. Refer to Table 3 to Table 5 for LLCR summary data.

Table 3 – LLCR Summary Data in milliohms, Test Set 1

Reading	Initial Reading (Actual R)	After Durability (ΔR)	After Vibration, Shock and Re-Seating (ΔR)
Minimum	8.89	-4.27	-3.73
Maximum	23.81	1.68	2.95
Average	13.07	-0.19	0.10
Std. Dev.	3.15	0.68	0.78
N =	200	200	200

Table 4 – LLCR Summary Data in milliohms, Test Set 2

Reading	Initial Reading (Actual R)	After Temp Life (ΔR)	After Re-Seating (ΔR)	After Humidity Temperature cycling (ΔR)
Minimum	8.48	-13.26	-12.59	-4.21
Maximum	23.52	16.12	14.93	17.00
Average	13.64	1.32	1.53	3.67
Std. Dev.	3.84	3.80	4.78	3.23
N =	200	200	200	200

Table 5 – LLCR Summary Data in milliohms, Test Set 3

Reading	Initial Reading (Actual R)	After MFG and Minute Disturbance (ΔR)	After Thermal Cycling (ΔR)
Minimum	8.07	-13.89	-13.91
Maximum	26.84	13.23	16.53
Average	13.81	0.60	0.98
Std. Dev.	3.59	6.7	6.98
N =	200	200	200

2.3 Insulation Resistance

All specimens had an insulation resistance greater than 1000 Megaohms, meeting the testing requirements.

2.4 Withstanding Voltage

No breakdown or flashover occurred between adjacent contacts.

2.5 Random Vibration

No apparent physical damage or discontinuities of one microsecond or greater occurred during random vibration testing.

2.6 Mechanical Shock

No apparent physical damage or discontinuities of one microsecond or greater occurred during mechanical shock testing.

2.7 Durability

No physical damage detrimental to product performance was visible due to durability.

2.8 Unmating Force

Specimens met the 15 Newton minimum unmating force requirement. See Table 6 for detailed results.

Table 6 – Unmating Force Results, Test Set 1

Specimen ID	Unmating Force (N)
1	24.07
2	14.59
3	18.59
4	10.54
5	22.37
Minimum	10.54
Maximum	24.07
Mean	18.03
Std. Dev.	5.56

2.9 Connector Solderability

The specimens under evaluation exhibited a continuous solder coating, free from defects, over the more than 95% of the critical surface areas. See Figure 1 for a representative image of the typical contacts as tested.

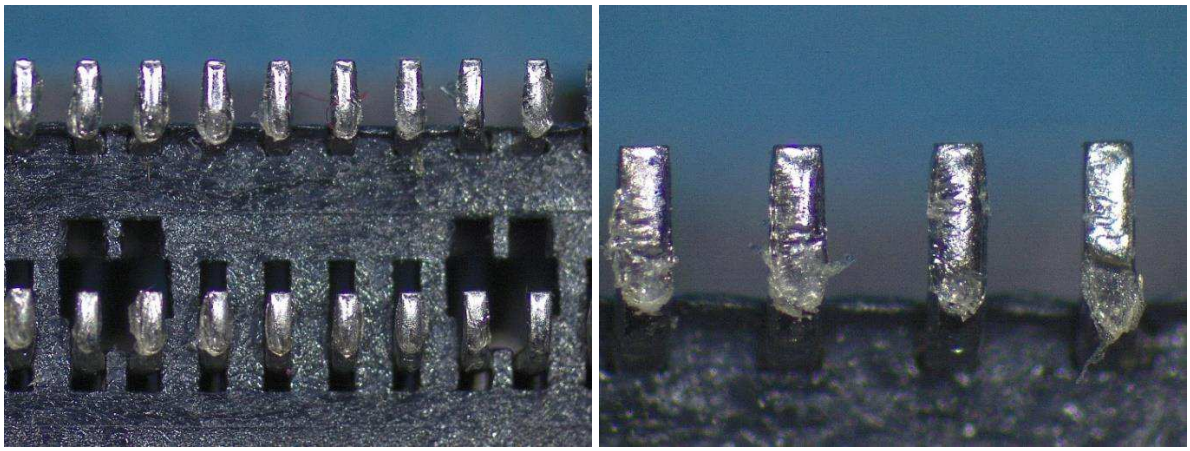

Figure 1 – Connector Solderability Results – Typical Contacts Tested

2.10 Resistance to Reflow Soldering Heat

No defects, damage, or discoloration was observed on any specimen as a result of the moisture soak preconditioning.

No visual evidence of melting, cracking, blistering or other damage was observed on any of the other specimens after the first, second, or third reflow heat exposure.

2.11 Thermal Shock

No physical damage detrimental to product performance was visible due to thermal shock.

2.12 Humidity / Temperature Cycling

No physical damage detrimental to product performance was visible due to humidity/temperature cycling .

2.13 Temperature Life

No physical damage detrimental to product performance was visible due to temperature life.

2.14 Mixed Flowing Gas

No physical damage detrimental to product performance was visible due to mixed flowing gas.

2.15 Thermal Cycling

No physical damage detrimental to product performance was visible due to thermal cycling.

2.16 Re-Seating

No physical damage detrimental to product performance was visible due to mating and unmating the specimens 1 time.

2.17 Final Examination of Product

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

3. TEST METHODS

3.1. Initial Examination of Product

A C of C was issued stating that all specimens in this test package were produced, inspected, and accepted as conforming to product drawing requirements, and were manufactured using the same core manufacturing processes and technologies as production parts.

3.2 Low Level Contact Resistance

Specimens were subjected to low level contact resistance in accordance with test procedure EIA 364-23C. See Figure 2 for a representative image of the test setup.

Low level contact resistance measurements at low level current were made using a four-terminal measuring technique. The test current was maintained at 100 milliamperes maximum with a 20-millivolt maximum open circuit voltage. Positive voltage and current were applied to the access headers of the PCB and negative voltage and current were applied to wires of the transceiver module.

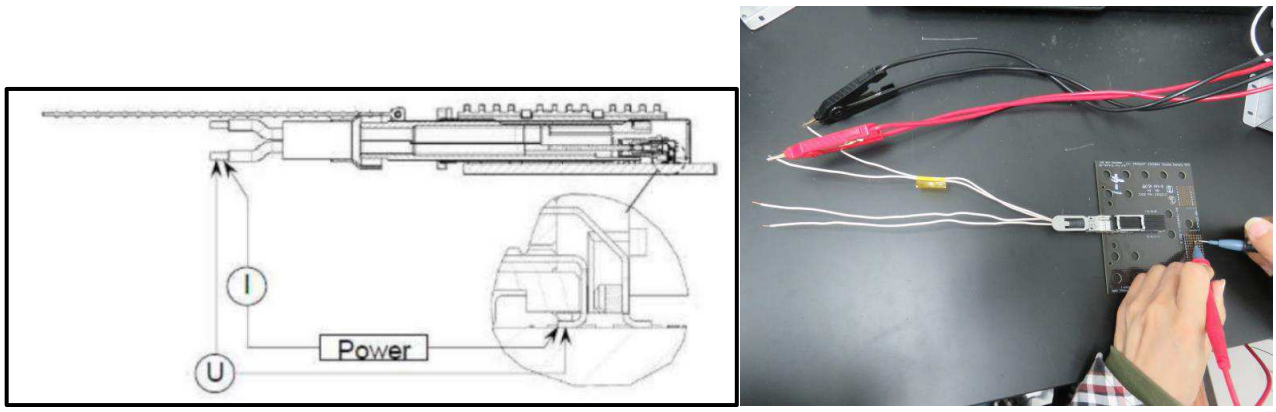

Figure 2 – Low Level Contact Resistance Test Setup

3.3 Insulation Resistance

Insulation resistance was measured between adjacent contacts of unmated specimens. A test voltage of 100 volts DC was applied for one minute before the resistance was measured. Testing was conducted in accordance with EIA-364-21E.

3.4 Withstanding Voltage

A test potential of 300 volts AC was applied between the adjacent contacts of unmated specimens. This potential was applied for one minute and then returned to zero. Testing was conducted in accordance with EIA-364-20F condition I.

3.5 Random Vibration

The test specimens were subjected to a random vibration test in accordance with test procedure EIA 364-28F, test condition VII, test condition letter D. See Figure 3 for a representative image of the test setup.

The parameters of this test condition are specified by a random vibration spectrum with excitation frequency bounds of 20 and 500 Hertz (Hz). The spectrum remains flat at 0.01 G^2/Hz from 20 Hz to the upper bound frequency of 500 Hz. The root-mean square amplitude of the excitation was 3.10 GRMS.

The test specimens were subjected to this test for 15 minutes in each of the three mutually perpendicular axes, for a total test time of 45 minutes per test specimen. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

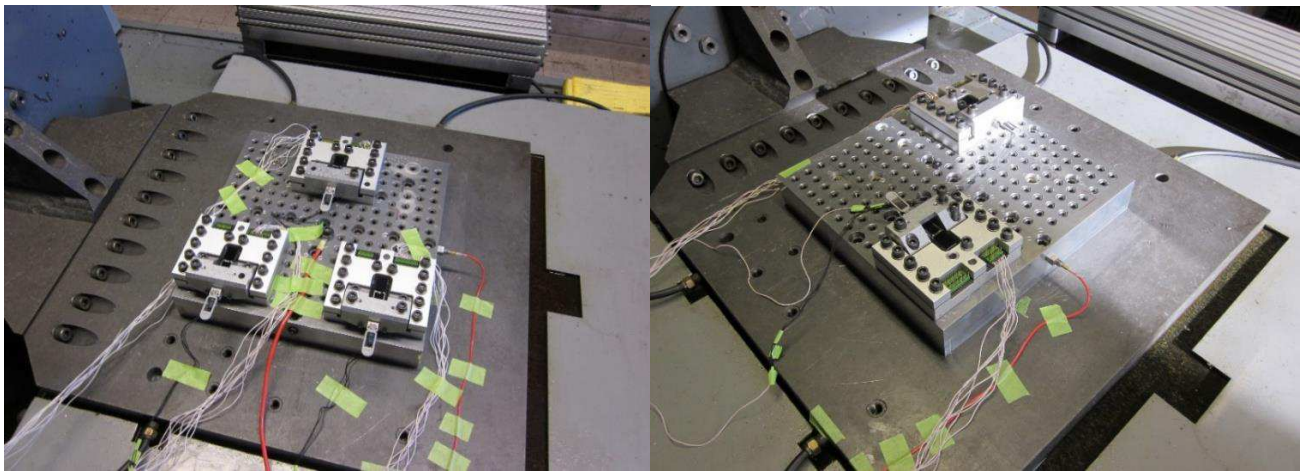

Figure 3 – Random Vibration Test Setup

3.6 Mechanical Shock

The test specimens were subjected to a mechanical shock test in accordance with test procedure EIA 364-27C, test condition H. See Figure 4 for a representative image of the test setup.

The parameters of this test condition are a half-sine waveform with an acceleration amplitude of 30 gravity units (g's peak) and a duration of 11 milliseconds. Three shocks in each direction were applied along the three mutually perpendicular axes of the test specimens, for a total of eighteen shocks.

The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes. See Figure 10 through 12 for mechanical shock test setups.

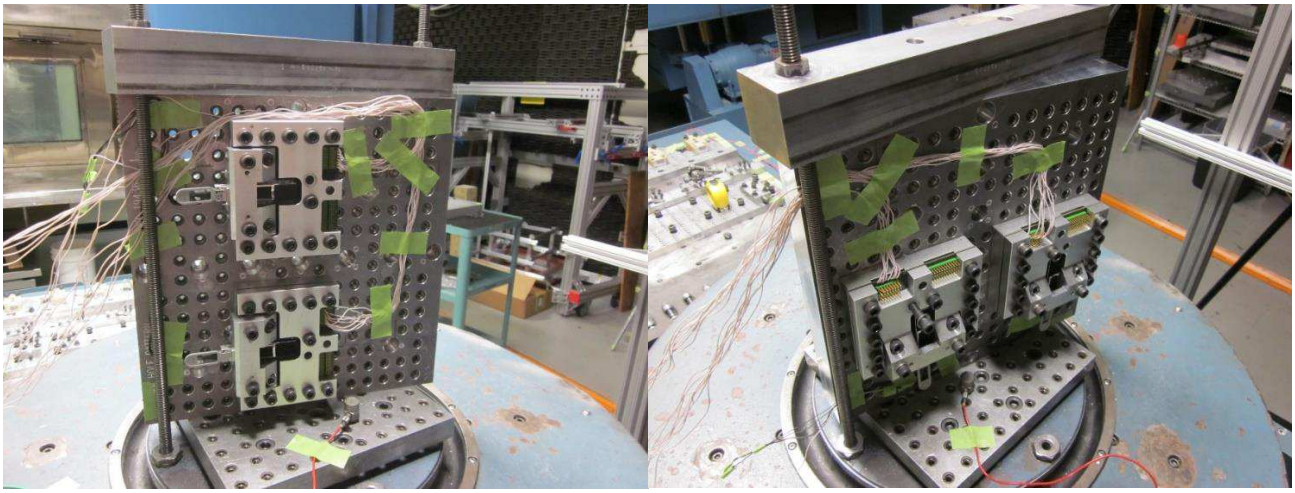

Figure 4 – Mechanical Shock Test Setup

3.7 Durability

The specimens were cycled 100 times by hand. A new module was used for durability and was replaced every 50 cycles. Testing was conducted in accordance with EIA-364-9D.

3.8 Un-mating Force

Specimens were subjected to unmating force in accordance with test procedure EIA 364-13E. See Figure 5 for a representative image of the test setup.

The test PCB was held vertically in a vice mounted to a floating XY rotational table. The PCB was supported with clamps and the vibration fixture. The plug unmating tab was held in a pneumatic jaw assembly which was attached to the moveable crosshead of the tensile compression device. The crosshead was actuated in an upward direction at 12.7 mm/min while pulling the end of the plug assembly until the connector was fully unmated.

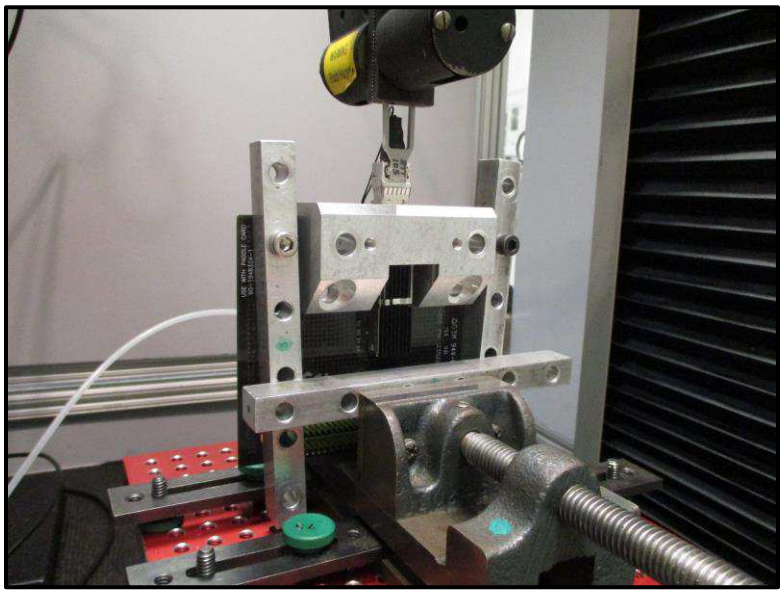

Figure 5 – Unmating Force Test Setup

3.9 Connector Solderability

Specimens were subjected to connector solderability in accordance with test procedure IPC/ECA J-STD-002. See Figure 6 for the reflow profile. See Figures 7 and 8 for representative images of the test setup.

Prior to testing, specimens were prepared by removing the locating studs as well as the connector standoff feature. This was done to enable the specimens to sit flush on the ceramic substrate.

A solder paste with a composition of Sn96.5, Ag3.0, Cu0.5 with flux in the paste having an activation of L0 was then placed onto a stencil, with pad geometry, opening, and thickness that was appropriate for the specimens being tested. The solder paste was printed onto a ceramic substrate (see Figure 7). The screen was removed, and a specimen was placed onto the solder paste print under appropriate magnification. Care was taken to ensure that the specimens were not contaminated in any way and were tested in the "as received" condition.

The specimen and ceramic substrate were placed on a conveyor belt through a convection oven (see Figure 8). The specimen was exposed for 60-120 seconds between the temperatures of 150°C and 180°C and for 30-60 seconds between the temperatures of 230°C and 260°C. The pre-heat and soak parameters were as specified in J-STD-002. The temperature on the ceramic substrate, at a point on a SMT contact was monitored to enable temperature profiling and the recorded temperature profile is shown in Figure 6.

All specimens were examined using a microscope for solder wetting. The specimens were examined at 10X for solder wetting of the critical area of solderability.

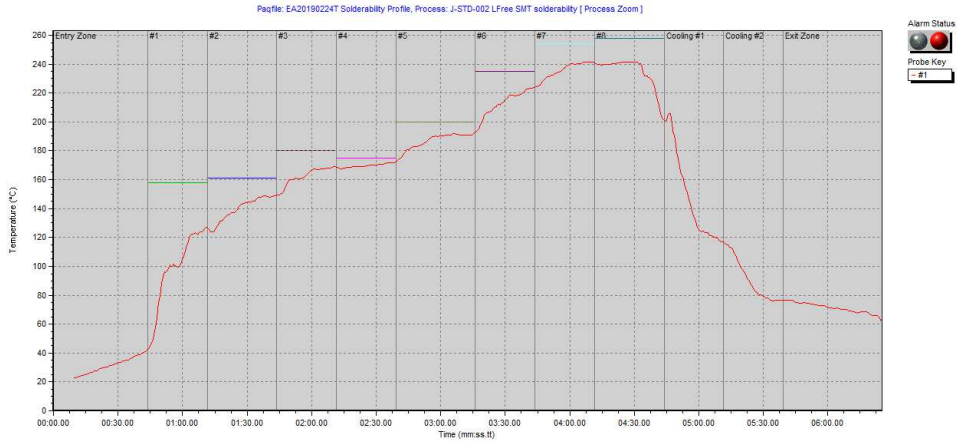

Figure 6 – Solderability Test Setup - Reflow Profile

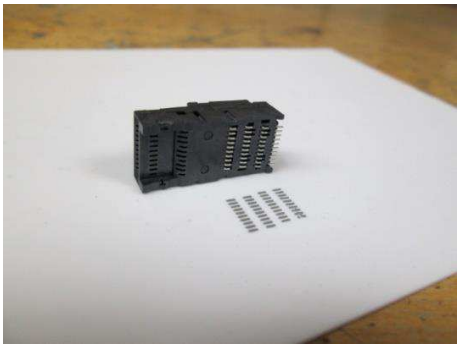

Figure 7 – Solderability Test Setup – Test Specimen and Solder Paste

Figure 8 – Solderability Test Setup – Test Specimen on Oven Conveyor

3.10 Resistance to Reflow Soldering Heat

Specimens were subjected to resistance to reflow soldering heat in accordance with test specification TEC-109-201, Method A, Condition B, Revision E. See Figure 9 for the reflow profile and Figure 10 for the reflow results.

Moisture Soak

Specimens were placed in a clean, dry, shallow container in such a manner that they did not overlap or touch and were exposed to 85°C at 85% relative humidity for 168 hours. Not sooner than 15 minutes, and within 4 hours after removal from the moisture soak, the specimens were subjected to the heat exposure described below.

Component Heat Resistance to Lead Free Reflow Soldering Testing

The specimens were placed on 4 X 6 X 0.0395 inch ceramic substrates and placed on a conveyor belt through a convection air oven. The specimens were exposed to temperatures between 150°C and 200°C for 60 to 180 seconds and between the temperatures of 255°C and 260°C for 20 to 40 seconds, and above liquidus (217°C) for 60 to 150 seconds. The temperature on top of the specimen was monitored to enable temperature profiling. The specimens and substrates were allowed to cool to ambient temperatures, were visually examined, and then run back through the oven a total of 3 times.

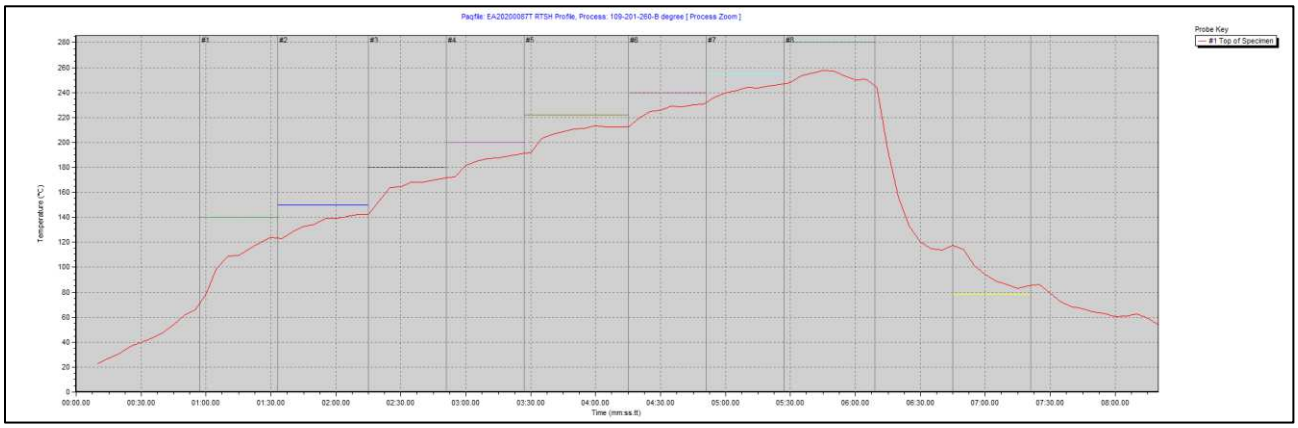

Figure 9 – Resistance to Reflow Soldering Heat – Reflow Profile

Reflow Results

Probe	Positive Slope (°C/sec)	Positive Slope Time (mm:ss.tt)	Rise Time (150.0 - 200.0°C) (mm:ss.tt)	Rise Time 50.0°C to Peak (mm:ss.tt)	Mean Slope to Peak (°C/sec)	Time Above Liquidus (217.0°C) (mm:ss.tt)	Peak Temperature (°C)	Time Above Peak minus 5.0°C (mm:ss.tt)
#1 (°C) Top of Specimen	3.38	01:00.00	01:15.00	05:00.00	0.67	01:55.00	257.6	00:25.00

Figure 10 – Resistance to Reflow Soldering Heat – Reflow Results

3.11 Thermal Shock

Specimens were subjected to thermal shock testing in accordance with test procedure EIA 364-32G, Method A, Test Condition VII.

Unmated specimens were subjected to 5 cycles between -55°C and 105°C with 30-minute dwells at temperature extremes and 1-minute transitions between temperatures.

3.12 Humidity / Temperature Cycling

Specimens were subjected to humidity / temperature cycling in accordance with test procedure EIA 364-31F, Method IV.

Specimens were subjected to 10 cycles (24-hours per cycle) between 25°C and 65°C at 80 to 100%RH. Specimens from Test Set 2 were mated and specimens from Test Set 4 were unmated for the environmental exposure.

3.13 Temperature Life

Specimens were subjected to temperature life in accordance with test procedure EIA 364-17C, Method A.

Mated specimens were exposed to a temperature of 105°C for 1000 hours. Specimens were preconditioned with 20 cycles of durability with the latches disengaged.

3.14 Mixed Flowing Gas

Specimens were subjected to mixed flowing gas in accordance with test procedure EIA 364-65B, Class IIA. See Table 7 for the mixed flowing gas test parameters.

The test specimens were subjected to a 4-gas environment for 14 days. Three specimens were exposed in the unmated condition for the first 7 days with the plugs not exposed and in the mated condition for the final 7 days. The other two specimens were exposed mated for the 14-day exposure. LLCR measurements were taken after 7 days on all specimens.

Table 7 – Mixed Flowing Gas Test Parameters

Environment	Class IIA
Temperature (^{0}C)	30 ± 1
Relative Humidity (%)	70 ± 2
Chlorine (Cl2) Concentration (ppb)	10 ± 3
Hydrogen Sulfide (H2S) Concentration (ppb)	10 ± 5
Nitrogen Dioxide (NO2) Concentration (ppb)	200 ± 50
Sulfur Dioxide (SO2) Concentration (ppb)	100 ± 20
Exposure Period [actual]	14 Days
Chamber Volume Exchange Rate [3-10 per Hour]	8.8 per Hour

3.15 Thermal Cycling

Specimens were subjected to thermal cycling in accordance with test procedure EIA 364-110, Test Condition A, Test Duration A.

Mated specimens were subjected to 10 cycles between 15±3° and 85±3° with 30 minute dwell times at each temperature extreme and ramp times greater than 2°C per minute.

3.16 Re-Seating

Specimens were manually unmated and mated one time by hand.

3.17 Final Examination of Product

The specimens were visually examined in accordance with test procedure EIA-364-18B for evidence of physical damage that would be detrimental to the operation of the parts.