Evaluation Testing of Tin Plated Ring Terminals

1. INTRODUCTION

1.1. Purpose

Testing was performed to evaluate the impact of reducing the minimum tin plating thickness of ring terminal part number 60772-2 from 80 microinches to 40 microinches.

1.2. Scope

This report covers the performance of ring terminal 60772-2 with reduced tin plating thickness. Testing was performed at the Harrisburg Electrical Components Test Laboratory between 10Oct07 and 08Feb08, the test file number for this testing is CTL1089-046-1. This documentation is on file at and available from the Harrisburg Electrical Components Test Laboratory.

1.3. Test Specimens

Test Group	Quantity	Part Number	Description
1	15	60772-2	Ring terminal with 40 microinch tin plating
2	15	60772-2	Ring terminal with 80 microinch tin plating

Figure 1

1.4. Conclusion

Based on test results, the reduction in plating thickness had no adverse impact on product performance.

1.5. Specimen Preparation

Specimens were measured from the wire side of the crimp to the opposing crimp. This measurement was divided by two to determine the location of the voltage probe used to monitor crimp millivolt drop. Average wire length for all specimens was 6.125 ± .0625 inches. Crimp voltage probe wires (red) were then soldered to the specimens. Thirty gauge T-Type thermocouple wire was used to monitor all temperatures. Thermocouples were attached using a resistance welder, examined to ensure proper placement on the terminal transition, good contact to the connector, and that the thermocouple wire was parallel to the specimen wire. Specimens were attached front to back (both crimps oriented down) using #4 bolts to secure them to the vibration board as shown in Figure 2. All nuts were then tightened to 20 inch-pounds and connected in a series circuit.

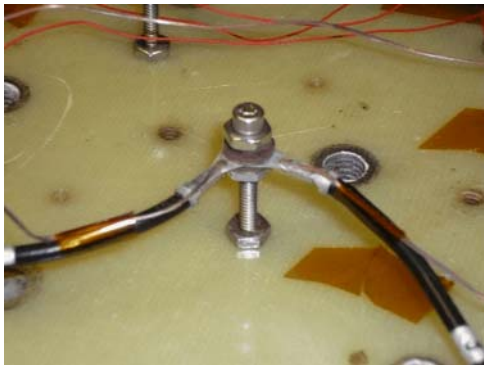

Figure 2

1.6. Test Sequence

Test or Examination	Test Group (a)	
	1	2
	Test Sequence (b)	
Initial examination of product	1	1
Low Level Contact Resistance (LLCR)	2,4,6,8,10,12,14	2,4,6,8,10,12,14
Temperature rise	3,13	3,13
Sinusoidal vibration	11	11
Durability	5	5
Humidity/temperature cycling	7	7
Temperature life	9	9
Final examination of product	15	15

NOTE *(a) See paragraph 1.3.*
(b) Numbers indicate sequence in which tests are performed.

Figure 3

1.7. Environmental Conditions

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

- Temperature: 15 to 35°C
- Relative Humidity: 25 to 75%

2. TEST RESULTS

2.1. Initial Examination of Product

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

2.2. LLCR

All LLCR measurements were taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage. Data summaries are shown in Figure 4.

Crimp LLCR		
Measurement (milliohms)	Test Group	
	1	2
Initial minimum	0.80	0.81
Initial maximum	0.85	0.85
Initial average	0.83	0.83
Initial standard deviation	0.02	0.01
Final minimum	0.85	0.84
Final maximum	1.15	1.10
Final average	0.93	0.93
Final standard deviation	0.10	0.09
Average Delta	0.10	0.10

Interface LLCR		
Measurement (milliohms)	Test Group	
	1	2
Initial minimum	0.22	0.26
Initial maximum	0.43	0.44
Initial average	0.30	0.32
Initial standard deviation	0.09	0.06
Final minimum	0.25	0.30
Final maximum	0.35	0.49
Final average	0.30	0.36
Final standard deviation	0.04	0.06
Average Delta	0.01	0.04

Figure 4

2.3. Temperature Rise

Specimens were tested at the current levels shown in Figure 5.

Test Group 1 Crimp Millivolt Drop										
Current (amperes)	10.00	10.01	15.01	14.99	20.00	20.00	25.00	25.00	30.00	30.01
Measurement (millivolts)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Minimum	8.48	8.71	13.00	13.34	17.81	18.29	22.98	23.67	28.62	29.63
Maximum	8.94	11.95	13.71	18.38	18.77	25.32	24.22	32.98	30.12	41.49
Mean	8.61	9.54	13.21	14.66	18.10	20.16	23.37	26.20	29.17	32.93
Standard Deviation	0.14	1.13	0.20	1.75	0.27	2.43	0.34	3.21	0.41	4.11
Specimen quantity	10	10	10	10	10	10	10	10	10	10

Test Group 1 Interface Millivolt Drop										
Current (amperes)	10.00	10.01	15.01	14.99	20.00	20.00	25.00	25.00	30.00	30.01
Measurement (millivolts)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Minimum	2.19	2.63	3.32	3.99	4.49	5.39	6.56	6.86	6.97	8.42
Maximum	4.17	3.64	6.33	5.53	8.54	7.49	9.41	9.53	13.27	11.70
Mean	3.14	3.14	4.76	4.76	6.43	6.43	7.91	8.19	10.00	10.05
Standard Deviation	0.77	0.39	1.17	0.59	1.57	0.80	1.02	1.02	2.45	1.25
Specimen quantity	6	6	6	6	6	6	6	6	6	6

Figure 5 (continued)

Test Group 1 Temperature Rise Above Ambient										
Current (amperes)	10.00	10.01	15.01	14.99	20.00	20.00	25.00	25.00	30.00	30.01
Measurement (°C)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Minimum	5.10	4.10	11.10	10.50	18.60	18.60	27.80	29.60	39.30	43.00
Maximum	6.00	5.10	12.60	12.40	20.60	22.40	30.80	34.50	43.40	49.90
Mean	5.53	4.59	11.60	11.38	19.24	20.38	28.69	31.86	40.81	46.03
Standard Deviation	0.31	0.37	0.50	0.70	0.72	1.34	1.03	1.78	1.44	2.63
Specimen quantity	10	10	10	10	10	10	10	10	10	10
Test Group 2 Crimp Millivolt Drop										
Current (amperes)	10.00	10.01	15.01	14.99	20.00	20.00	25.00	25.00	30.00	30.01
Measurement (millivolts)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Minimum	8.31	8.58	12.77	13.18	17.53	18.13	22.67	23.49	28.34	29.49
Maximum	8.65	10.83	13.29	16.65	18.25	22.91	23.62	29.93	29.58	37.84
Mean	8.54	9.25	13.11	14.20	17.99	19.53	23.24	25.37	29.07	31.88
Standard Deviation	0.11	0.77	0.16	1.19	0.22	1.66	0.28	2.24	0.35	2.95
Specimen quantity	10	10	10	10	10	10	10	10	10	10
Test Group 2 Interface Millivolt Drop										
Current (amperes)	10.00	10.01	15.01	14.99	20.00	20.00	25.00	25.00	30.00	30.01
Measurement (millivolts)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Minimum	2.87	2.99	4.35	4.53	5.88	6.12	7.49	7.79	9.19	9.57
Maximum	4.74	5.03	7.19	7.63	9.71	10.32	12.35	13.12	15.13	16.09
Mean	3.55	3.80	5.39	5.77	7.29	7.80	9.26	9.93	11.35	12.18
Standard Deviation	0.73	0.69	1.10	1.05	1.49	1.42	1.90	1.81	2.32	2.22
Specimen quantity	6	6	6	6	6	6	6	6	6	6
Test Group 2 Temperature Rise Above Ambient										
Current (amperes)	10.00	10.01	15.01	14.99	20.00	20.00	25.00	25.00	30.00	30.01
Measurement (°C)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Minimum	5.60	4.00	11.20	10.20	18.90	18.30	28.20	28.50	40.20	40.90
Maximum	6.20	5.00	12.40	12.40	20.80	22.00	31.40	34.60	44.50	49.30
Mean	5.78	4.44	11.73	11.20	19.78	20.07	29.58	31.04	42.18	44.81
Standard Deviation	0.18	0.32	0.48	0.73	0.70	1.20	1.23	1.99	1.50	2.80
Specimen quantity	10	10	10	10	10	10	10	10	10	10

Figure 5 (end)

2.4. Sinusoidal Vibration

No discontinuities were detected during vibration testing. Following vibration testing, no cracks, breaks, or loose parts on the specimens were visible.

2.5. Durability

No physical damage occurred as a result of loosening and retightening the nuts used to secure the specimens 6 times.

2.6. Humidity/temperature Cycling

No evidence of physical damage was visible as a result of humidity/temperature cycling.

2.7. Temperature Life

No evidence of physical damage was visible as a result of temperature life testing.

2.8. 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

Specimens were visually examined for evidence of physical damage detrimental to product performance.

3.2. LLCR - EIA 364-23

All LLCR measurements were recorded using a 4 terminal measurement technique at 100 milliamperes test current and 20 millivolt maximum open circuit voltage. Crimp resistance was measured using the red voltage probe wire and the copper strand from the thermocouple probe. All LLCR measurements include 3.0625 ± .0625 inches of wire resistance. Interface resistance was measured using the copper strand from the thermocouple probes on adjacent specimens. To maintain data sheet consistency throughout the test groups (10 readings per group), LLCR measurements 2 through 9 were taken twice at the same resistance reading.

3.3. Temperature Rise

All specimens were connected to form a series circuit in numerical order. Temperature, crimp millivolt drop and interface millivolt drop probes were connected to a data acquisition system. All specimens were subject to 10 through 30 amperes in 5 ampere increments until all specimen temperatures stabilized, after which measurements were recorded.

3.4. Sinusoidal Vibration - EIA 364-28, Test Condition II

Specimens were subjected to sinusoidal vibration, having a simple harmonic motion with an amplitude of 0.06 inch peak-to-peak, or 10 G peak. The vibration frequency was varied uniformly between the limits of 10 and 500 Hz and returned to 10 Hz in approximately 15 minutes. This cycle was performed for 3 hours in each of 3 mutually perpendicular planes. Specimens were monitored for discontinuities of 1 microsecond or greater using a current of 100 milliamperes DC.

3.5. Durability

The nuts securing the specimens were loosened and retightened 6 times to 20 inch-pounds.

3.6. Humidity/temperature Cycling - EIA 364-31, Method III

Specimens were exposed to 10 humidity/temperature cycles. Each cycle lasted 24 hours and consisted of cycling the temperature between 25 and 65°C twice while maintaining high humidity.

3.7. Temperature Life - EIA 364-17

Specimens were exposed to a temperature of 105°C for 10 days.

3.8. Final Examination of Product

Specimens were visually examined for evidence of physical damage detrimental to product performance.