Evaluation of Nickel DIAMOND GRIP* STRATO-THERM* Terminals

1. INTRODUCTION

1.1 Purpose

The purpose of the test was to evaluate the TE Connectivity (TE) Nickel DIAMOND GRIP STRATO-THERM terminals, wire size 22-16 AWG intended for termination to stranded copper, nickel plated, high temperature wire.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of the TE Connectivity Nickel DIAMOND GRIP STRATO-THERM terminals. Testing was performed at the Harrisburg Electrical Components Test Laboratory between 08/29/2013 and 03/25/2014. Detailed test data is on file and maintained at HECTL under EA20130321T.

1.3 Conclusion

The terminal and wire combinations listed in paragraph 1.4 conformed to the electrical, mechanical, and environmental performance requirements specified herein. Part number 321898 meets these requirements based on similarity of design and construction.

1.4 Test Specimens

Table 1 – Test Specimens

Test Group	TE Connectivity Terminal P/N	Wire AWG	Terminal Under Test Quantity	Test Assembly Quantity	Configuration	Approx. Length (in)
1	321897 Rev U	22	10	5	double-ended	36
		16	10	5	double-ended	36
2	321897 Rev U	22	10	5	double-ended	20
		16	10	5	double-ended	20
3	321897 Rev U	22	10	5	double-ended	12
		16	10	5	double-ended	12
4	321897 Rev U	22	10	5	double-ended	12
		16	10	5	double-ended	12
5	321897 Rev U	22	5	5	single-ended	12
		--	5	5	uncrimped	--

NOTE *Production Drawing 321897 Rev U1 corresponds to Customer Drawing 321897 Rev J4 at the time of testing.*

1.5 Test Sequence

Table 2 – Test Sequence

Test or Examination	Test Group				
	1	2	3	4	5
	Test Sequence (a)				
Initial examination of product	1	1	1	1	1
Voltage drop	2,4	2,4	2,4	2,4	
Current cycling	3				
Vibration		3			
Termination tensile strength		6	6		
Axial Load					2
Salt spray			3		
Temperature cycling				3	
Final examination of product	5	5	5	5	3

(a) Numbers indicate sequence in which tests are performed.

1.6 Environmental Conditions

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

Temperature: 20°C to 25°C
Relative Humidity 20% to 80%

2. SUMMARY OF TESTING

2.1 Initial Examination of Product – All Groups

The specimens exhibited no evidence of exposed base metal, cracks, flaking, broken conductor strands, or other gross defects when examined under 10x magnification.

2.2 Voltage Drop – Groups 1, 2, 3, 4

The terminal crimp millivolt drop did not exceed the millivolt drop of an equivalent length of wire by more than the value specified in Table 3.

Table 3 – Maximum Voltage Drop (mV)

Wire Size AWG	Test Current (Amperes)	mV Drop of Equivalent Length of Wire Plus Appropriate Value Below	
		Initial	After Test
22	9	5	8
16	22	5	8

2.3 Current Cycling – Group 1

After current cycling, all voltage drops met the requirements as shown in Table 3.

2.4 Vibration – Group 2

There was no evidence of cracking, breaking, or loosening of parts after vibration testing. Voltage drops met the requirements as shown in Table 3. Tensile strengths were greater than the values specified in Table 4.

2.5 Termination Tensile Strength – Group 2, 3

Terminal lugs did not break or separate from the wire to which it was terminated before the minimum tensile strength requirement was met per Table 4. Failure mode was wire broke outside the crimp or wire broke at the crimp.

Table 4 – Tensile Strength

Test Group	Wire Size (AWG)	Condition	Number of Data Points	Requirement (minimum)
2	22	After Vibration	5	11
	16	After Vibration	5	35
3	22	After Salt Spray	5	11
	16	After Salt Spray	5	35

2.6 Axial Load – Group 5

The metal sleeve on uncrimped lug terminals withstood a minimum axial force of 8 pounds and did not move more than 1/32 inch on the barrel of the lug terminal. The metal sleeve on crimped lug terminals withstood a minimum axial force of 8 pounds.

2.7 Salt Spray – Group 3

After salt spray exposure, terminals did not show any evidence of exposure of the base metal or blistering of the plated surfaces. The voltage drops and tensile strengths met the requirements as shown in Table 3 and Table 4.

2.8 Temperature Cycling – Group 4

Specimens showed no physical damage after temperature cycling and met the voltage drop requirements shown in Table 3.

2.9 Final Examination of Product – All Groups

The specimens exhibited no evidence of exposed base metal, cracks, flaking, broken conductor strands, or other gross defects when examined under 10x magnification.

3. TEST METHODS

3.1 Initial Examination of Product

The specimens were visually examined at 10x magnification for evidence of exposed base metal, cracks, flaking, broken conductor strands, or other gross defects.

3.2 Voltage Drop

Voltage drop testing was in accordance with SAE AS7928B paragraph 4.7.2. For the purpose of recording terminal crimp voltage drop measurements, the specimens of one wire gauge were bolted together in a series chain. Terminal temperatures were measured for the purpose of monitoring thermal stability. The test current (see Table 3) was applied to the specimens using a direct current (DC) supply until thermal stability was achieved. Thermal stability was defined as three temperature measurements taken at five minute intervals that did not vary by more than 2°C. The terminal crimp millivolt drops were measured from a point on the terminal at the intersection of the terminal tongue and wire barrel to a point on the conductor 1/16 inch from the wire-receiving end of the terminal. Using this same distance, the millivolt drop of a same length of wire was measured at the same current. The measured millivolt drop of the equivalent length of wire was added to the appropriate value in Table 3 to determine the maximum millivolt drop. Test setup is shown in Figure 1.

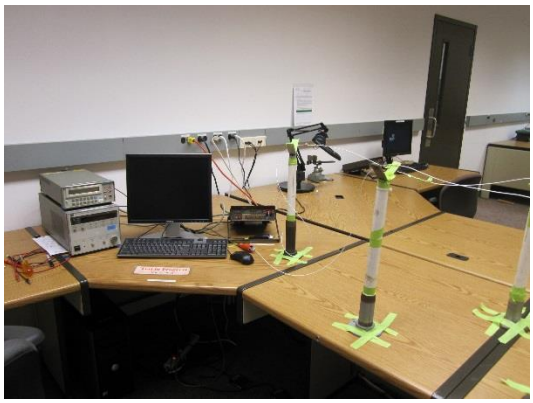

Figure 1 – Voltage Drop Setup

3.3 Current Cycling

Current cycling was done in accordance with SAE AS7928B paragraph 4.7.3. The specimens of one wire gauge were bolted together in a series chain and subjected to 50 current cycles. Each cycle consisted of 30 minutes at 125% of the test current specified in Table 3, followed by 15 minutes at no load. Current cycling parameters are shown in Table 5.

Table 5 – Current Cycling Parameters

Wire Size AWG	Cycle Definition				# Cycles
	Segment 1		Segment 2		
	Current (Amperes)	Time (minutes)	Current (Amperes)	Time (minutes)	
22	11.25	30	No load	15	50
16	27.5	30	No load	15	50

3.4 Vibration

The test specimens were subjected to a sinusoidal vibration test as stated in paragraphs 3.5.6 and 4.7.7 of specification SAE AS7928B, in accordance with specification MIL-STD-202G, Method 201A. See Figure 2 below for vibration setup photograph.

The test specimens were subjected to a simple harmonic motion having an amplitude of 0.06 inch double amplitude (maximum total excursion). The vibration frequency was varied uniformly between the approximate limits of 10 to 55 Hertz (Hz). The entire frequency range of 10 to 55 Hz and return to 10 Hz was traversed in approximately 1 minute. The motion was applied for a period of 18 hours in two of the three mutually perpendicular axes (the axis forcing the wire back upon itself was not run), so the motion was applied for a total period of approximately 36 hours.

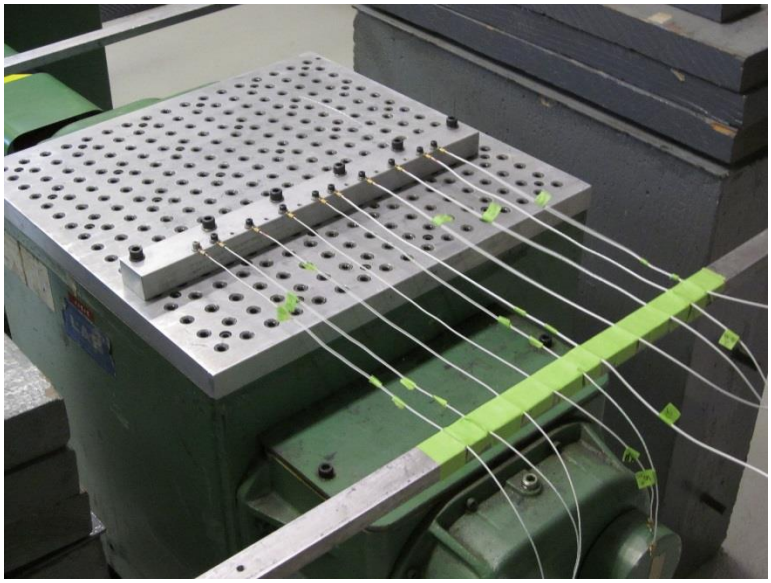

Figure 2 – Vibration Setup

3.5 Termination Tensile Strength

Terminal tensile strength testing was done in accordance with SAE AS7928B paragraph 4.7.8. The double-ended specimens under test were mounted on an INSTRON 1122 test system by securing the terminal tongue in a clamping fixture attached to the base of the tensile system. The terminal tongue at the opposing end of the assembly was then clamped to the moveable crosshead of the tensile test system. The specimens were pulled along the conductor longitudinal axis at a rate of 1.0 ± 0.25 inch per minute until failure. The tensile data was recorded and the specimen examined. It was noted whether the wire pulled out of the crimp, the wire broke at the crimp, the wire broke outside of the crimp, or the terminal broke. See Figure 3 for test setup.

Figure 3 – Tensile Test Setup

3.6 Axial Load

Axial load testing was in accordance with SAE AS7928B paragraph 4.7.6.1 and 4.7.6.2. Five uncrimped specimens had 0.022 inch diameter holes drilled through the insulating sleeve and a piano wire of 0.020 inch diameter shall be inserted through the drilled holes. The specimens were then fastened in a tensile testing machine and 8 pounds of axial force was exerted on the piano wire. Test setup is shown in Figure 4 and Figure 5.

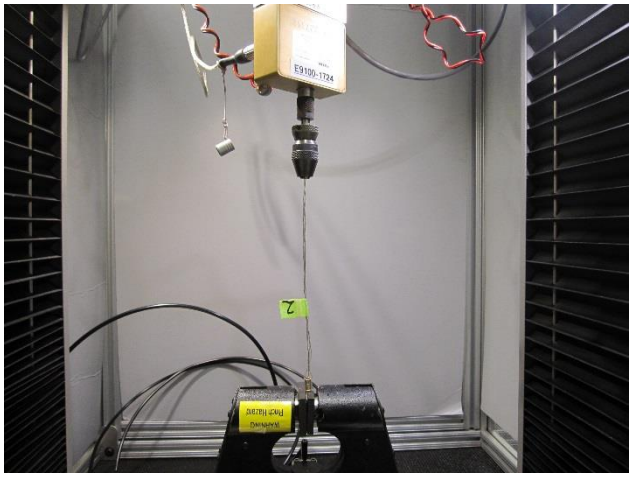

Figure 4 – Axial Load Test Setup, Uncrimped

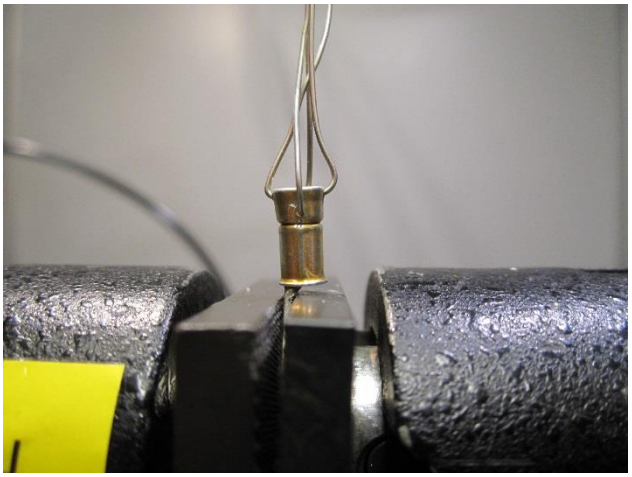

Figure 5 – Axial Load Test Setup, Uncrimped

Five new specimens crimped to 22 AWG wire were tested by applying 8 pounds of axial force at a maximum rate of 1 inch per minute between the crimped conductor and a suitable jig positioned under the metal sleeve. The free end of the crimped conductor and the test jig was fastened to the tensile machine as shown in Figure 6 and Figure 7.

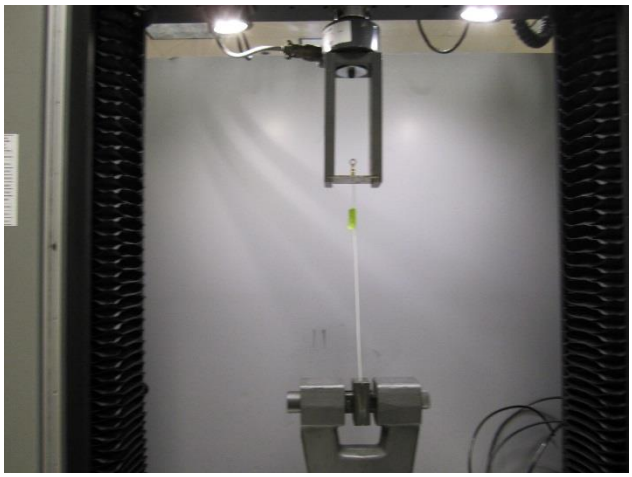

Figure 6 – Axial Load Test Setup, Crimped

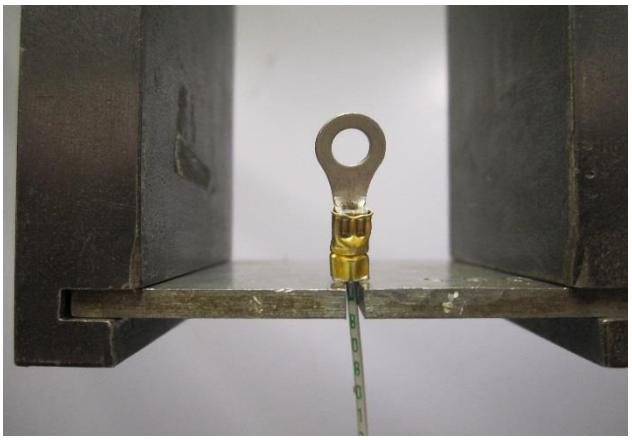

Figure 7 – Axial Load Test Setup, Crimped

3.7 Salt Spray

The specimens were subjected to a salt fog test environment in accordance with SAE AS7928B, paragraph 4.7.5 and method 101, MIL-STD 202G. Mated specimens were subjected to a 5% salt spray environment for 48 hours. The temperature of the box was maintained at 35 +1/-2°C, and the pH of the salt solution was between 6.5 and 7.2. After completion of exposure the specimens were removed from the salt spray chamber, washed with distilled water, air dried for a minimum of 1 hour.

3.8 Temperature Cycling

Temperature cycling was in accordance with IEC 60512-11-4, First Edition, and IEC 60068-2-14, Edition 6.0. Specimens were subjected to 50 cycles of:
30 minutes at -55ºC
30 minutes at room temperature
30 minutes at 200ºC
30 minutes at room temperature.

3.9 Final Examination of Product

The specimens were visually examined at 10x magnification for evidence of exposed base metal, cracks, flaking, broken conductor strands, or other gross defects.

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