AMPLIVAR* 9-Serration Open Barrel Pigtail Splice Terminal

1. INTRODUCTION

1.1 Purpose

Testing was performed on TE Connectivity's (TE) AMPLIVAR 9-Serration Open Barrel Pigtail Splice Terminal to determine its conformance to the requirements of Product Specification 108-32030, Revision A.

1.2 Scope

This report covers the environmental, electrical and mechanical performance of the TE AMPLIVAR 9-Serration Open Barrel Pigtail Splice Terminals that were submitted for testing. Testing was performed at the TE Harrisburg Electrical Components Test Laboratory between February 25, 2013 and May 24, 2013. This documentation is on file and maintained at the TE Harrisburg Electrical Components Test Laboratory under EA20130086T.

1.3 Conclusion

The TE Connectivity AMPLIVAR 9-Serration Open Barrel Pigtail Splice Terminals listed in paragraph 1.5 conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-32030, Revision A.

1.4 Product Description

The AMPLIVAR 9-Serration Open Barrel Pigtail Splice Terminal is designed to splice unstrapped copper or aluminum magnet wires together or along with stranded lead wire within a combined total range of 400 to 22,000 CMA.

1.5 Test Specimens

The test specimens were representative of normal production lots, and the following part numbers were used for test program (refer to Table 1):

Table 1 – Test Specimens

Test Set	Test Group	Qty	Part Number	Description
1.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (1) #22 AWG CU MAGNET WIRE + (1) #20 AWG LEAD WIRE 4923 TOTAL CMA , .110 CW, .081 +/- .002 CH
1.4	1	10	62306-2 Rev P C274	
2.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (1) #22 AWG AL MAGNET WIRE + (1) #20 AWG LEAD WIRE 4923 TOTAL CMA , .110 CW, .081 +/- .002 CH
2.4	1	10	62306-2 Rev P C274	
3.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (1) #17 AWG CU MAGNET WIRE + (1) #16 AWG LEAD WIRE 4923 TOTAL CMA , .110 CW, .081 +/- .002 CH
3.4	1	10	62306-2 Rev P C274	
4.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (1) #17 AWG AL MAGNET WIRE + (1) #16 AWG LEAD WIRE 4923 TOTAL CMA , .110 CW, .081 +/- .002 CH
4.4	1	10	62306-2 Rev P C274	
5.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #23 AWG CU MAGNET WIRES + (1) #20 AWG LEAD WIRE 2240 TOTAL CMA , .110 CW, .067 +/- .002 CH
5.4	1	10	62306-2 Rev P C274	
6.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #23 AWG AL MAGNET WIRES + (1) #20 AWG LEAD WIRE 2240 TOTAL CMA , .110 CW, .067 +/- .002 CH
6.4	1	10	62306-2 Rev P C274	
7.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #20 AWG CU MAGNET WIRES + (1) #16 AWG LEAD WIRE 4994 TOTAL CMA , .110 CW, .081 +/- .002 CH
7.4	1	10	62306-2 Rev P C274	
8.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #20 AWG AL MAGNET WIRES + (1) #16 AWG LEAD WIRE 4994 TOTAL CMA , .110 CW, .081 +/- .002 CH
8.4	1	10	62306-2 Rev P C274	
9.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (3) #25 AWG CU MAGNET WIRES + (1) #20 AWG LEAD WIRE 2200 TOTAL CMA , .110 CW, .067 +/- .002 CH
9.4	1	10	62306-2 Rev P C274	
10.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (3) #25 AWG AL MAGNET WIRES + (1) #20 AWG LEAD WIRE 2200 TOTAL CMA , .110 CW, .067 +/- .002 CH
10.4	1	10	62306-2 Rev P C274	

Table 1 – Test Specimens Cont'

Test Set	Test Group	Qty	Part Number	Description
11.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (3) #22 AWG CU MAGNET WIRES + (1) #16 AWG LEAD WIRE 4901 TOTAL CMA , .110 CW, .080 +/- .002 CH
11.4	1	10	62306-2 Rev P C274	
12.1	1	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (3) #22 AWG AL MAGNET WIRES + (1) #16 AWG LEAD WIRE 4901 TOTAL CMA , .110 CW, .080 +/- .002 CH
12.4	1	10	62306-2 Rev P C274	
13.1	2	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #23AWG CU MAGNET WIRES + (1) #20 AWG LEAD WIRE 2240 TOTAL CMA , .110 CW, .067 +/- .002 CH
13.4	2	10	62306-2 Rev P C274	
14.1	2	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #23AWG AL MAGNET WIRES + (1) #20 AWG LEAD WIRE 2240 TOTAL CMA , .110 CW, .067 +/- .002 CH
14.4	2	10	62306-2 Rev P C274	
15.1	2	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #20AWG CU MAGNET WIRES + (1) #16 AWG LEAD WIRE 4994 TOTAL CMA , .110 CW, .081 +/- .002 CH
15.4	2	10	62306-2 Rev P C274	
16.1	2	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #20AWG AL MAGNET WIRES + (1) #16 AWG LEAD WIRE 4994 TOTAL CMA , .110 CW, .081 +/- .002 CH
16.4	2	10	62306-2 Rev P C274	
17.1	3	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #22 AWG CU MAGNET WIRES 1534 TOTAL CMA , .110 CW, .079 +/- .002 CH
17.4	3	10	62306-2 Rev P C274	
18.1	3	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #22 AWG AL MAGNET WIRES 1534 TOTAL CMA , .110 CW, .079 +/- .002 CH
18.4	3	10	62306-2 Rev P C274	
19.1	3	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #17 AWG CU MAGNET WIRES 4646 TOTAL CMA , .110 CW, .079 +/- .002 CH
19.4	3	10	62306-2 Rev P C274	
20.1	3	10	62306-2 Rev P C260	Splice, AMPLIVAR, 1500-5000 CMA on (2) #17 AWG AL MAGNET WIRES 4646 TOTAL CMA , .110 CW, .079 +/- .002 CH
20.4	3	10	62306-2 Rev P C274	

1.6 Qualification Test Sequence

Table 2-Test Sequence

Test or Examination	Test Sets		
	1-12	13-16	17-20
	Test Group (a)		
	1	2	3
Initial examination of product	1	1	1
Low level contact resistance	2,6,9	2,4	
Temperature rise vs. current	3,10		
Current cycling		3	
Vibration, random	8		
Termination tensile strength			2
Thermal shock	5		
Humidity exposure	7		
Temperature life	4		
Final examination of product	11	5	3

Note: (a) Numbers indicate sequence in which tests are performed

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 Visual Examination – All Test Groups

A Certificate of Conformance stating that all specimens submitted for testing were representative of normal production lots and met the requirements of the applicable product drawing was provided. Where specified, specimens were visually examined, and no evidence of physical damage detrimental to product performance was observed.

2.2 Low Level Contact Resistance – Test Groups 1 and 2

All low level contact resistance measurements recorded were less than the corresponding requirement listed in Table 3 per wire size and material.

Table 3 – Current, Resistance and Crimp Tensile Strength Specifications

Wire Size		Current and Resistance Specifications						Tensile Strength Specs	
		Copper			Aluminum				
AWG	CMA	Current (amps)		Low Level Resistance* (mΩ max)	Current (amps)		Low Level Resistance* (mΩ max)	Copper	Aluminum
		T-Rise	Cycled		T-Rise	Cycled			
32	64	0.5	1.5	36.0	n/a	n/a	n/a	0.7	n/a
31	79	1.0	2.0	26.0	n/a	n/a	n/a	1.0	n/a
30	100	1.5	3.5	23.0	n/a	n/a	n/a	1.4	n/a
29	128	2.0	4.5	18.0	n/a	n/a	n/a	2.1	n/a
28	159	2.5	5.0	14.4	2.0	3.5	28.9	2.8	0.9
27	202	3.0	6.0	10.0	2.5	4.0	20.0	3.5	1.2
26	258	3.5	7.5	9.1	3.0	5.0	18.2	4.2	1.5
25	320	4.0	8.0	7.2	3.3	5.5	15.9	5.6	1.9
24	404	5.0	9.5	5.7	3.8	6.5	11.4	7.0	2.1
23	511	5.5	11.0	4.6	4.5	7.5	9.1	9.1	2.8
22	640	6.5	12.5	4.3	5.0	8.5	8.6	11.2	3.5
21	812	7.0	14.0	3.5	5.5	9.5	7.0	14.7	4.9
20	1024	8.0	16.0	2.7	6.0	11.0	5.5	18.2	5.6
19	1289	9.0	18.0	2.2	7.2	12.0	4.4	23.1	7.7
18	1624	10.0	20.0	2.0	8.0	13.5	4.0	29.4	9.8
17	2052	11.0	22.0	1.8	10.0	15.0	3.6	37.1	11.9
16	2581	14.0	28.0	1.6	12.5	18.7	3.2	46.2	15.4
15	3260	16.0	32.0	1.4	14.5	21.5	2.8	58.8	19.6
14	4109	18.5	37.0	1.2	16.5	24.8	2.4	99.0	24.5

**** Resistance measurement includes crimp + 1.5 inches of wire.***

2.3 Temperature Rise Vs. Current – Test Group 2

All specimens had values of less than 30°C for temperature rise vs. current measurements at their respective current levels, initially and finally. Refer to Table 3 for the listing of T-rise currents per wire size and material.

2.4 Current Cycling – Test Group 2

No evidence of physical damage detrimental to product performance was observed during or after current cycling. Low level contact resistance measurements were taken initially, and after every 5,000 cycles. Refer to Table 3 for the listing of cycled currents per wire size and material.

2.5 Vibration, random – Test Group 1

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

2.6 Termination tensile strength – Test Group 3

All termination tensile strength measurements recorded were greater than the corresponding requirement listed in Table 3 per wire size and material.

2.7 Thermal Shock – Test Group 1

No evidence of physical damage detrimental to product performance was observed.

2.8 Humidity Exposure – Test Group 1

No evidence of physical damage detrimental to product performance was observed.

2.9 Temperature Life – Test Group 1

No evidence of physical damage detrimental to product performance was observed.

2.10 Final Examination of Product – All Test Groups

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 Certificate of Conformance 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

Low level contact resistance measurements were taken at a current level of 100 milliamperes maximum and 20 millivolts maximum open circuit voltage. Measurements were taken from the center of the AMPLIVAR Splice to a point on the magnet wire that was 1.5 inches from the center of the splice. Figure 1 illustrates the measurement points.

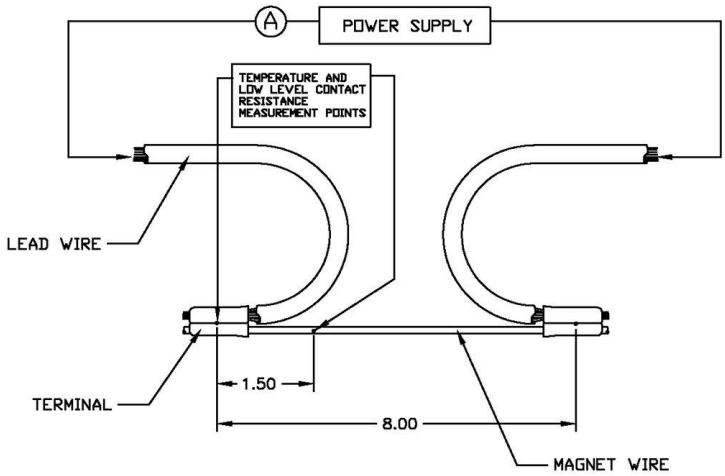

Figure 1 – Low Level Contact Resistance Measurement Points

3.3 Temperature Rise vs. Current

Infrared temperature measurement points were coated with Equate powder, used as an emissivity correction coating. The emissivity correction coating has a known value which is 0.95. Raising and knowing the emittance value allows for accurate temperature measurements. The infrared camera was used with a 34/80 mm close up lens attached to the standard optics (24°) lens to image the test specimens.

ThermaCAM* Researcher 2001 thermal imaging processing system was used for data analysis. The area tool software feature was used to determine maximum temperature of the exposed contacts. The area tool software feature allows a shape, which can be sized, to be placed on an area of interest. The pixels inside the shape are analyzed giving minimum, maximum, average, and standard deviation measurements of temperature. The test specimens were placed a temperature rise enclosure. Refer to Figure 2 for an image of the typical test setup.

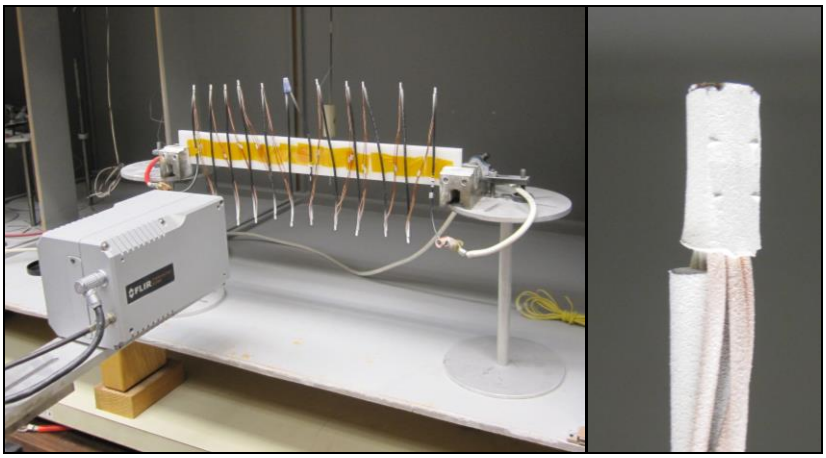

Figure 2 – Typical Test Setup

3.4 Current Cycling

Testing consisted of 10,000 cycles of current cycling, with each cycle having current on for 3 minutes and current off for 3 minutes. The test current was 16 amperes, 11 amperes, 22 amperes, and 15 amperes for test sets 13, 14, 15, and 16 respectively. Low level contact resistance measurements were taken after 5000 cycles and at the completion of the 10,000 cycles.

3.5 Vibration, random

The test specimens were subjected to a random vibration test. 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 0.02 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 3 hours in each of the three mutually perpendicular axes, for a total test time of 9 hours per test specimen. The test specimens were monitored for discontinuities of 1 microsecond or greater using an energizing current of 100 milliamperes.

3.6 Termination Tensile Strength

A floating XY table was secured to the base of the tensile machine. A slotted plate fixture was fastened to the XY table. A mandrel was attached to the crosshead of the tensile machine. The magnet wire of the test specimen was wrapped around the mandrel and the crimp was held in the slotted plate for test sets 17 and 18. A clamp fixture was attached to the crosshead of the tensile machine for test sets 19 and 20 due to the higher forces. The magnet wire of each test specimen was placed in the clamp and the crimp was held in the slotted plate. The crosshead was then raised at a speed of 1 inch per minute until failure. A photo of the test setup for test sets 19 and 20 is shown in Figure 3 below. A photo of the test setup for test sets 19 and 20 is shown in Figure 4 below.

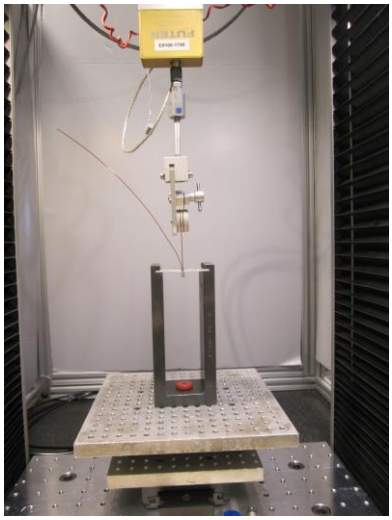

Figure 3 – Crimp Tensile Setup

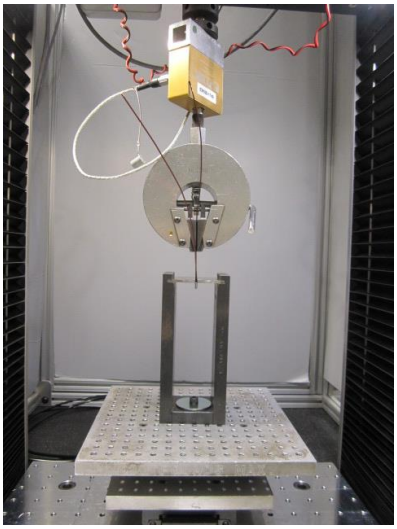

Figure 4 – Crimp Tensile Setup

3.7 Thermal Shock

Test specimens were subjected to fifty cycles of thermal shock testing from -65°C to 150°C with 30 minute dwells at each extreme.

3.8 Humidity Exposure

Specimens were subjected to 40°C at 90-95% relative humidity for 96 hours in an environmental chamber.

3.9 Temperature Life

Specimens were subjected to 150°C for 96 hours in an air circulating oven.

3.10 Final Examination of Product

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