

Power Versa-Lock Connector Systems

1. INTRODUCTION

1.1 Purpose

Testing was performed on Power Versa-Lock connectors with sealed 14 - 20 AWG terminals to determine conformance related to the requirements of product specification 108-143081 Rev.14.
 Scope of the test is the validation with Power Versa-Lock sealed 14 - 20 AWG terminals. Not all test according to 108-143081 have been performed. Group 11 group 12 have not been tested per customer's requirement.

1.2 Scope

This report covers the electrical, mechanical, and environmental performance of Power Versa-Lock connectors. Testing was performed at the Shanghai Electrical Components Test Laboratory between Sept. 18th, 2019 and Oct. 17th, 2019. The associated test number is TP-19-02273. Additional testing was performed at the Harrisburg Electrical Components Test Laboratory between November 25, 2019 and December 5, 2019. The associated test numbers from this location are EA20190519T and EA20190541T.

1.3 Conclusion

Based on the combined results from both test locations, all results met the requirement according to applicant's requirement and product specification 108-143081 Rev.14.

1.4 Test Specimens

Specimens with the following part numbers were used for test:

Table 1

P/N	Description	Quantity (pcs)	Note
1-2325350-2	PWR VERSA-LOCK CAP, 1X2 KEY A	120	Natural color
1-2325350-3	PWR VERSA-LOCK CAP, 1X3 KEY A	15	Natural color. Only tested in Test Group 6
1-2332040-2	PWR VERSA-LOCK CAP, 1X2 KEY A	120	Natural color
1-2332040-3	PWR VERSA-LOCK PLUG, 1X3 KEY A	15	Natural color. Only tested in Test Group 6
1-2345728-1	PWR VERSA-LOCK PLUG, 1X1 KEY A	15	Natural color. Only tested in Test Group 6
1-2345729-1	PWR VERSA-LOCK FH CAP, 1X1 KEY A	15	Natural color. Only tested in Test Group 6
2-2325350-2	PWR VERSA-LOCK CAP, 1X2 KEY B	25	Light Gray color
2-2332040-2	PWR VERSA-LOCK PLUG, 1X2 KEY B	25	Light Gray color
2325347-1	PWR VERSA-LOCK INTERFACE SEAL, 1X1	15	/
2325347-2	PWR VERSA-LOCK INTERFACE SEAL, 1X2	35	/
2325347-3	PWR VERSA-LOCK INTERFACE SEAL, 1X3	15	/
2325349-1	PWR VERSA-LOCK REAR SEAL, 1X1, 2.45-3.60	30	/
2325349-2	PWR VERSA-LOCK REAR SEAL, 1X2, 2.45-3.60	70	/
2325349-3	PWR VERSA-LOCK REAR SEAL, 1X3, 2.45-3.60	30	/
2329907-1	PWR VERSA-LOCK SEAL TAB, 14-16 AWG	80	/
2329908-1	PWR VERSA-LOCK SEAL TAB, 18-20 AWG	290	/
2329914-1	PWR VERSA-LOCK SEAL RECPT, 18-20 AWG	290	/

2329916-1	PWR VERSA-LOCK SEAL RECPT, 14-16 AWG	80	/
3-2325350-2	PWR VERSA-LOCK CAP, 1X2 KEY C	25	Brown color
3-2332040-2	PWR VERSA-LOCK PLUG, 1X2 KEY C	25	Brown color
5-2325350-2	PWR VERSA-LOCK CAP, 1X2 KEY E	25	Orange color
5-2332040-2	PWR VERSA-LOCK PLUG, 1X2 KEY E	25	Orange color



Fig.1

1.5 Test Sequence

The specimens listed in Table 1 were subjected to the test sequences listed in Table 2.

Table 2

Test Item	Test Group (a)									
	1	2	3	4	5	6	7	8	9	10
	Test Sequence (b)									
Examination of Product	1,9	1,5	1,9	1,4	1,4	1,4	1,5	1,5	1,5	1,5
Low Level Contact Resistance	3,7	2,4					2,4	2,4	2,4	2,4
Insulation Resistance			2,7							
Dielectric Withstanding Voltage			3,8							
Temperature Rise vs. Current		3								
Sinusoidal Vibration	5									3
Mechanical Shock	6									
Durability	4									
Connector Mating Force	2									
Connector Unmating Force	8									
Housing Panel Retention Force					2					

Housing Lock Strength					3					
Contact Insertion Force				2						
Contact Retention Force				3						
Thermal Shock			4							
Humidity-Temperature Cycling			5				3(c)			
Temperature Life								3		
Water Immersion						2				
Dust Tightness						3				
Resistance to Cold			6							
Salt Spray							3			

Note: a). Test group defined per customer requirement
 b). Numbers indicate sequence in which tests are performed.
 c). Connectors for these tests shall be preconditioned with 5 durability cycles.

1.6 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:
 Temperature: 15°C to 35°C
 Relative Humidity: 25% to 75%

2. TEST PROCEDURES

2.1 Visual Examination of Product

There shall be no corrosive influence on the performance and no physical damage that would impair product performance.
 Test Method: EIA-364-18.

2.2. Low Level Contact Resistance

Subject contacts assembled in a housing to 20mV (max.) open circuit at 10 mA. Subtract the resistance of the wire from the measurement. Connection per Figure 2.
 Requirement: Initial: 10 mΩ (milliohm) maximum
 Final: 20 mΩ (milliohm) maximum
 Test Method: EIA-364-23.

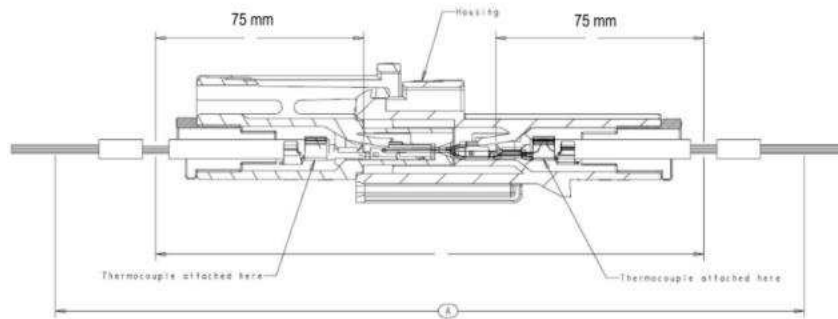


Fig.2

- 2.3. **Insulation Resistance**
 Apply 500 VDC and hold for 2 minutes. Test between contacts in adjacent circuits and between housing and contacts in a mated connector.
 Requirement: Initial: 1000 MΩ minimum
 Final: 500 MΩ minimum
 Test Method: EIA-364-21.

- 2.4. **Dielectric Withstanding Voltage**
 Hold at 2.2 kV AC at sea level for 1 minute. Test between contacts in adjacent circuits and between housing and all contacts in a mated connector.
 Requirement: 1 minute hold without a creep discharge or flashover.
 Current Leakage: 5 mA (maximum)
 Test Method: EIA-364-20, Method A, Condition 1.

- 2.5. **Temperature Rise vs. Current**
 Measure the temperature rise above ambient created by the energizing current. Measurement must be taken at a place where there is no influence from air convection. Contacts to be assembled in housing with all circuits connected. The thermocouple is to be attached to the contact in the center circuit. Stabilize at a single current level until 3 readings at 5 minute intervals are within 1°C.
 Requirement: 30°C maximum when subjected to rated current
 Test Method: EIA-364-70, Method 1

- 2.6. **Sinusoidal Vibration**
 Subject mated connector to 10-55-10 Hz traversed in 1 minute at 1.52 mm amplitude. Apply 2 hours in each of 3 mutually perpendicular planes. 100 mA applied.
 Requirement: No electrical discontinuity greater than 1 μs shall occur.
 No physical damage that would impair product performance.
 Test Method: EIA-364-28, Condition 1.

- 2.7. **Mechanical Shock**
 Subject mated connector to 50G's half -sine shock pulse of 11 ms duration. 3 drops each to normal and reversed directions of X, Y and Z axis. Total of 18 drops.
 Requirement: No electrical discontinuity greater than 1 μs shall occur.
 No physical damage that would impair product performance.
 Test Method: EIA-364-27, Condition A.

- 2.8. **Durability**
 Manually mate and unmate connectors for 25 cycles.
 Requirement: No physical damage that would impair product performance.
 Test Method: EIA-364-09.

- 2.9. **Connector Mating Force**



Measure the force required to mate connectors with locking latches. Operation Speed: 25.4 mm/min.
Requirement: Unsealed: (6.67 x # of Positions) N (maximum)
 Sealed: (18 x # of Positions) N (maximum)
Test Method: EIA-364-13, Method A.

2.10. Connector Unmating Force

Measure the force required to unmate connectors without locking latches. Operation Speed: 25.4 mm/min.
Requirement: (1.25 x # of Positions) N (minimum)
Test Method: EIA-364-13, Method A.

2.11. Housing Locking Strength

Ensure that locking latches are fully engaged. Operation Speed: 13 mm/min.
Requirement: 66.7 N minimum
Test Method: EIA-364-98.

2.12. Contact Insertion Force

Measure the force required to insert contact into housing.
Requirement: 13.3N maximum
Test Method: EIA-364-05.

2.13. Contact Retention Force

Measure the axial force required to remove contact from the housing with and without a TPA accessory. Operation Speed: 25.4 mm/min.
Requirement: 66.7N minimum with TPA; 53.4N minimum without TPA.
Test Method: EIA-364-29.

2.14. Thermal Shock

Subject mated specimens to 25 cycles between - 55°C and 85°C with 30 minute dwell time at temperature extremes and 5 minute transition (maximum) between temperatures.
Requirement: No physical damage that would impair product performance.
Test Method: EIA-364-32, Method A, Test Condition I.

2.15. Humidity-Temperature Cycling

Subject mated specimen to 10 cycles between 25°C and 65°C at 80-100% RH. Measurements to be recorded after specimens are held for 3 hours at ambient temperature and humidity. 1 cycle is 24 hours.
Requirement: No physical damage that would impair product performance.
Test Method: EIA-364-31, Method IV.

2.16. Temperature Life

Subject mated connector to 105°C for a duration of 8 hours. Measurements to be recorded after specimens are held for 3 hours at ambient temperature and humidity.
Requirement: No physical damage that would impair product performance.
Test Method: EIA-364-17.

2.17. Water Immersion

Immerse mated samples in water for 30 minutes with the lowest point of the sample 1 meter below the surface. Tank must be 8 inches (minimum) in diameter.
Requirement: No ingress of water or physical damage that would impair product performance.
Test Method: IEC 60529, Test Conditions per IP67

2.18. Dust Tightness

Subject mated connector to 8 hours of circulating talcum powder dust. 2 kg of powder per cubic meter of test chamber shall be used.
Requirement: No ingress of dust or physical damage that would impair product performance.

Test Method: IEC 60529, Test Conditions per IP67

2. 19. Resistance to Cold

Subject mated connector to $-30^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 96 hours.
 Requirement: No physical damage that would impair product performance.
 Test Method: IEC 60512-11-10.

2. 20. Salt Spray

Subject mated connectors to $5 \pm 1\%$ salt concentration for 48 hours.
 Requirement: No physical damage that would impair product performance.
 Test Method: EIA-364-26, Condition B.

3. SUMMARY OF TESTING

3.1 Visual Examination

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

3.2. Low Level Contact Resistance

Test result are shown in Table 3.

Table 3

Unit: mΩ

Group	Quantity	Condition	Low Level Contact Resistance			Requirement	Judgment
			Max.	Min.	Ave.		
1	10	Initial	2.88	2.17	2.44	10mΩ Max.	Meet spec.
	10	After Durability, Vibration and Mechanical Shock	10.23	3.24	6.05	20mΩ Max.	Meet spec.
2	20	Initial	2.98	1.25	1.90	10mΩ Max.	Meet spec.
	20	After Temperature Rise	2.88	1.49	1.96	20mΩ Max.	Meet spec.
7	10	Initial	2.17	1.68	1.82	10mΩ Max.	Meet spec.
	10	After Salt Spray	2.98	1.98	2.39	20mΩ Max.	Meet spec.
8	10	Initial	2.89	2.44	2.67	10mΩ Max.	Meet spec.
	10	After Humidity and Temperature Cycling	4.21	2.75	3.23	20mΩ Max.	Meet spec.
9	10	Initial	2.29	1.92	2.08	10mΩ Max.	Meet spec.
	10	After Temperature Life	3.34	2.29	2.71	20mΩ Max.	Meet spec.
10	10	Initial	2.98	2.55	2.78	10mΩ Max.	Meet spec.
	10	After Vibration	3.15	2.74	2.97	20mΩ Max.	Meet spec.

3.3. Insulation Resistance

Test result are shown in Table 4.

Table 4

Unit: $10^{10}\Omega$

Group	Quantity	Condition	Insulation Resistance			Requirement	Judgment
			Max.	Min.	Ave.		
3	10	Initial	82.49	10.08	35.37	1000MΩ min.	Meet spec.
	10	After Thermal Shock Humidity and Temperature Cycling	47.22	0.66	11.97	500MΩ min.	Meet spec.

3.4. Dielectric Withstanding Voltage

Test result are shown in Table 5.

Table 5

Group	Quantity	Condition	Dielectric Withstanding Voltage			Requirement	Judgment
			Max.	Min.	Ave.		
3	10	Initial	No breakdown, no flashover.			No breakdown or flashover.	Meet spec.
	10	After Thermal Shock Humidity and Temperature Cycling	No breakdown, no flashover.				Meet spec.

- 3.5. Temperature Rise vs. Current
Test result are shown in Table 6.

Table 6

Unit: ° C

Group	Quantity	Specimen Description	Current	Temperature Rise			Requirement	Judgment
				Max.	Min.	Ave.		
2	5	14 AWG Wire	15.0A	26.10	22.98	24.55	30°C maximum	Meet spec.
	5	16 AWG Wire	12.0A	21.81	20.08	20.78		Meet spec.
	5	18 AWG Wire	8.0A	18.45	12.68	15.19		Meet spec.
	5	20 AWG Wire	7.0A	17.54	14.91	16.12		Meet spec.

- 3.6. Sinusoidal Vibration
Both test group 1 and group 10: No physical damage and no electrical discontinuity greater than 1 µs were found during and after test.
- 3.7. Mechanical Shock
No physical damage and no electrical discontinuity greater than 1 µs were found during and after test.
- 3.8. Durability
No physical damage.
- 3.9. Connector Mating Force
Test result are shown in Table 7.

Table 7

Unit: N

Group	Quantity	Condition	Connector Mating Force			Requirement	Judgment
			Max.	Min.	Ave.		
1	10	Initial	10.17	6.76	8.03	36N Max.	Meet spec.

- 3.10. Connector Unmating Force
Test result are shown in Table 8.

Table 8

Unit: N

Group	Quantity	Condition	Connector Unmating Force			Requirement	Judgment
			Max.	Min.	Ave.		
1	10	After Durability, Vibration and Mechanical Shock	12.75	6.41	8.78	2.5N Min.	Meet spec.

- 3.11. Housing Locking Strength
Test result are shown in Table 11.

Table 11

Unit: N

Group	Color	Quantity	Condition	Housing Locking Strength			Requirement	Judgment
				Max.	Min.	Ave.		
5	Orange	10	Initial	92.43	85.85	89.47	66.7N Min.	Meet spec.
	Light Gray	10	Initial	95.52	87.17	90.37	66.7N Min.	Meet spec.
	Brown	10	Initial	85.97	74.86	80.76	66.7N Min.	Meet spec.
	*Natural	15	Initial	108.28	98.23	103.28	66.7N Min.	Meet spec.

*1x3 Tested under report EA20190541T.

3.12. Contact Insertion Force

Test result are shown in Table 12.

Table 12

Unit: N

Group	Quantity	Specimen Description	Contact Insertion Force			Requirement	Judgment
			Max.	Min.	Ave.		
4	15	Orang Cap	5.64	3.54	4.60	13.3N Max.	Meet spec.
	15	Orang Pug	10.62	7.49	8.97		Meet spec.
	15	Light Gray Cap	5.67	3.45	4.53		Meet spec.
	15	Light Gray Pug	10.38	7.81	9.63		Meet spec.
	15	Brown Cap	6.92	4.24	5.48		Meet spec.
	15	Brown Pug	10.85	7.28	9.27		Meet spec.
	15	Natural Cap	5.68	3.99	4.59		Meet spec.
	15	Natural Pug	8.47	5.51	6.53		Meet spec.

3.13. Contact Retention Force

Test without TPA. Test result are shown in Table 13.

Table 13

Unit: N

Group	Quantity	Specimen Description	Contact Retention Force (Without TPA)			Requirement	Judgment
			Max.	Min.	Ave.		
4	15	Orang Cap	94.14	81.36	88.86	53.4N Min.	Meet spec.
	15	Orang Pug	72.63	66.81	70.29		Meet spec.
	15	Light Gray Cap	94.81	84.70	90.58		Meet spec.
	15	Light Gray Pug	73.42	68.47	70.53		Meet spec.
	15	Brown Cap	108.51	81.41	88.19		Meet spec.
	15	Brown Pug	69.93	65.08	67.43		Meet spec.
	15	Natural Cap	105.49	62.50	87.15		Meet spec.
	15	Natural Pug	66.03	59.41	62.68		Meet spec.

3.14. Thermal Shock

No physical damage was found after test.

3.15. Humidity-Temperature Cycling

No physical damage was found after test.

3.16. Temperature Life

No physical damage was found after test.



3.17. Water Immersion

1x1 and 1X2 connectors: No ingress of water nor physical damage.

1X3 connectors: No ingress of water nor physical damage under report EA20190519T.

3. 18. Dust Tightness

1x1 and 1X2 connectors: No ingress of dust nor physical damage.

1X3 connectors: No ingress of dust nor physical damage under report EA20190519T.

3. 19. Resistance to Cold

No physical damage was found after test.

3. 20. Salt Spray

No corrosion was found after test.

4. CALIBRATION

4.1 Calibration Statement

All equipment containing a calibration number is calibrated and traceable through TE Connectivity (TE).