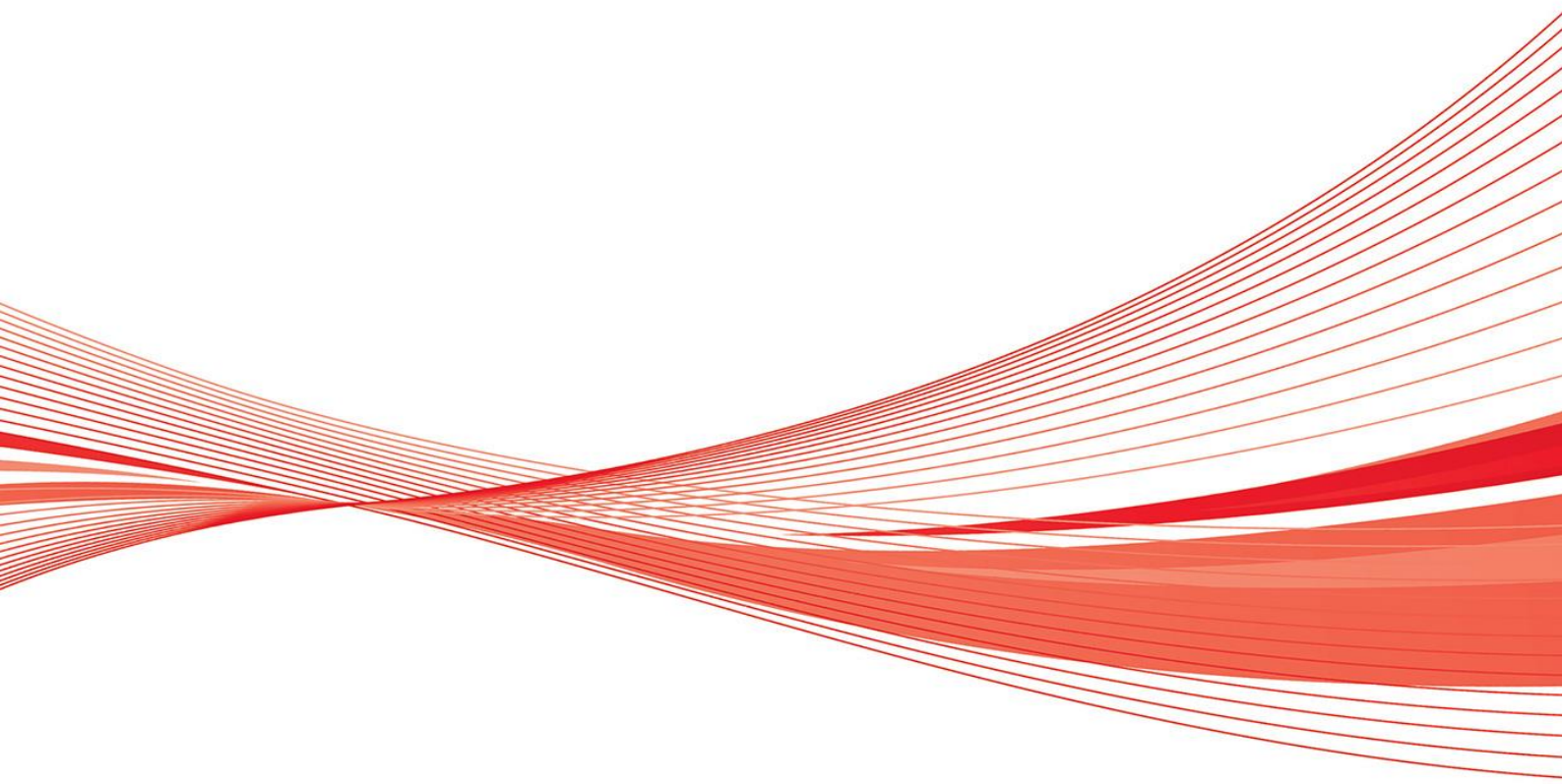
Harwin Test Report Summary

HT07603

Kona

Electrical, Mechanical & Environmental Testing



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1. Introduction

1.1. Description and Purpose

Kona is a high reliability connector range, based on a single row, 8.5mm pitch mating connector pair. These connectors are designed for higher power applications with a rugged or durable requirement. Each contact on both male and female connectors is individually shrouded and recessed (to prevent accidental touch). Polarization and contact 1 identification marks are also incorporated into the housing designs. The following tests were carried out to establish and confirm the operating parameters of the Kona connectors.

1.2. Conclusion

The following data has been summarized from Harwin test reports QA000027, QA000106, QA000108, QA000112, QA000321. The results were used to create Component Specification C052XX for the Kona range. The tests indicate that the Kona range performs as required, suitable for a wide range of applications calling for high power interconnects.

2. Test Method and Requirements

2.1. Specification Parameters

Tests were carried out in general accordance with either EIA-364 standards or BS EN 60068. The list of tests covered in this summary are as follows:

Testing Standard	Description of Test	Section	Page No.
EIA-364-06C: 2006	Contact Resistance	3.1	3
EIA-364-70A: 1998	Power Rating	3.2	3 – 11
EIA-364-09C: 1999	Durability, Insertion & Withdrawal Forces	3.3	12 – 13
EIA-364-20C: 2004	Withstand Voltage	3.4.1	13 – 14
EIA-364-21C: 2000	Insulation Resistance	3.4.2	14
EIA-364-05B: 1998	Contact & Fixing (Insert) Retention	3.5	15
EIA-364-17B: 1999	Temperature Life (without load)	3.6	16
EIA-364-32C: 2000 (BS EN 60068-2-14: 2009)	Thermal Shock (Temperature Cycling)	3.7	16
EIA-364-26B: 1999 (BS EN 60068-2-11: 1999)	Salt Spray	3.8	16 – 17
364-31B: 1999 (BS EN 60068-2-78: 2013)	Humidity	3.9	17
EIA-364-28D: 1999 (BS EN 60068-2-6: 2008)	Vibration	3.10	17
EIA-364-27B: 1996 (BS EN 60068-2-27: 2009)	Mechanical Shock	3.11	18

2.2. List of Connectors/Components

The following components/connectors are used throughout the testing (x = 2, 3 or 4; number of contacts):

- KA1-0400005 – Female Power Solder Cup Cable Contact
- KA1-1410005 – Male Power Solder Cup Cable Contact
- KA1-2010x98F1 – Female Cable Housing, Thumbscrews (standard gender fixing)
- KA1-2010x98F2 – Female Cable Housing, Reverse Fix with panel mount
- KA1-3010x98M1 – Male Cable Housing, Standard Gender fixing with panel mount
- KA1-3010x98M3 – Male Cable Housing, Standard Gender fixing
- KA1-3010x98M5 – Male Cable Housing, Thumbscrews (reverse fix)
- KA1-1100005 – Male Power PCB Throughboard contact (piece part)
- KA1-MV10x05M1 – Male Vertical Throughboard, standard gender fixing
- KA1-MV10x05M2 – Male Vertical Throughboard, reverse fixing
- HM2202-x – Voltage Breakdown & Insulation resistance test PCB
- HM2197-x – Current vs Temperature test PCB
- 8AWG Silicone Rubber Insulated Wire

3. Test Results

3.1. Contact Resistance to EIA-364-06C: 1999

Specification: 2mΩ max. per contact.

Methodology: Power contacts on each connector were measured using a precision milli/micro-ohmmeter for resistance both before and after to any electrical, mechanical, or environmental testing. Mated samples were then submitted to individual environmental conditions and each contact pair was measured for contact resistance.

Results: The maximum, minimum, and average initial values are detailed in the table below. Results after each conditioning test are given in the applicable section.

Before Testing / Pre-conditioned (mΩ)			
Mating Pair	**Max.**	**Min.**	**Average**
KA1-0400005 (female cable) & KA1-1100005 (male PCB)	0.39	0.34	0.36
KA1-0400005 (female cable) & KA1-1410005 (male cable)	0.63	0.51	0.57

3.2. Power Rating (Current versus Temperature Rise) to EIA-364-70A (Method 2): 1998

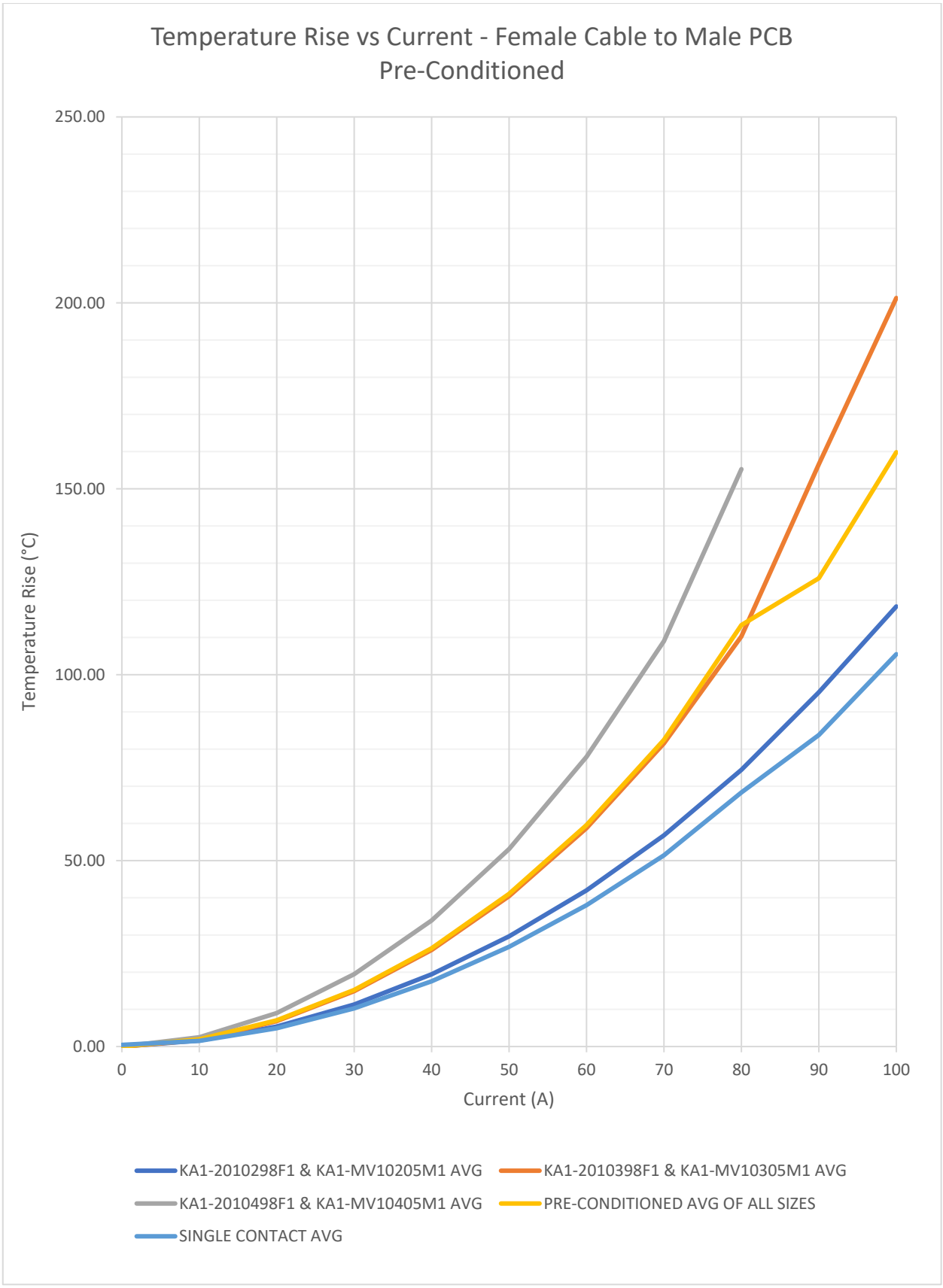
Specification: Current Rating (when all contacts are electrically loaded) = 60.0A.

Methodology: This test demonstrates the current carrying capability of the Kona connector system, both before and after environmental conditioning. The mated connector pairing was wired in a series circuit using 8AWG Silicone Rubber insulated wire and a custom PCB to complete the circuit. Power was supplied using a controlled power source.

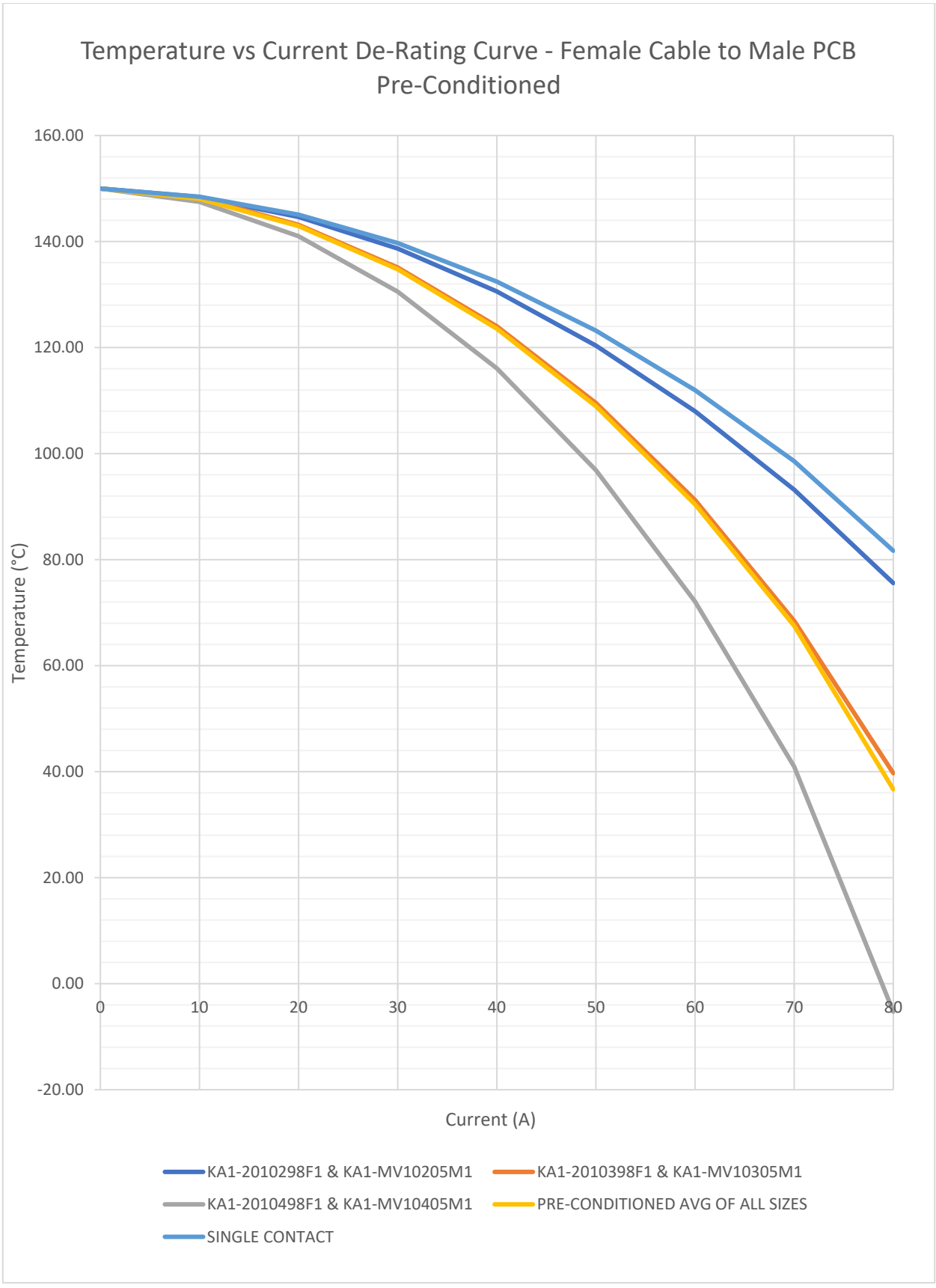
Current was applied in 10A increments to the connector, and the temperature rise above ambient recorded in each case.

Results: The graphs below detail the results up to 80A.

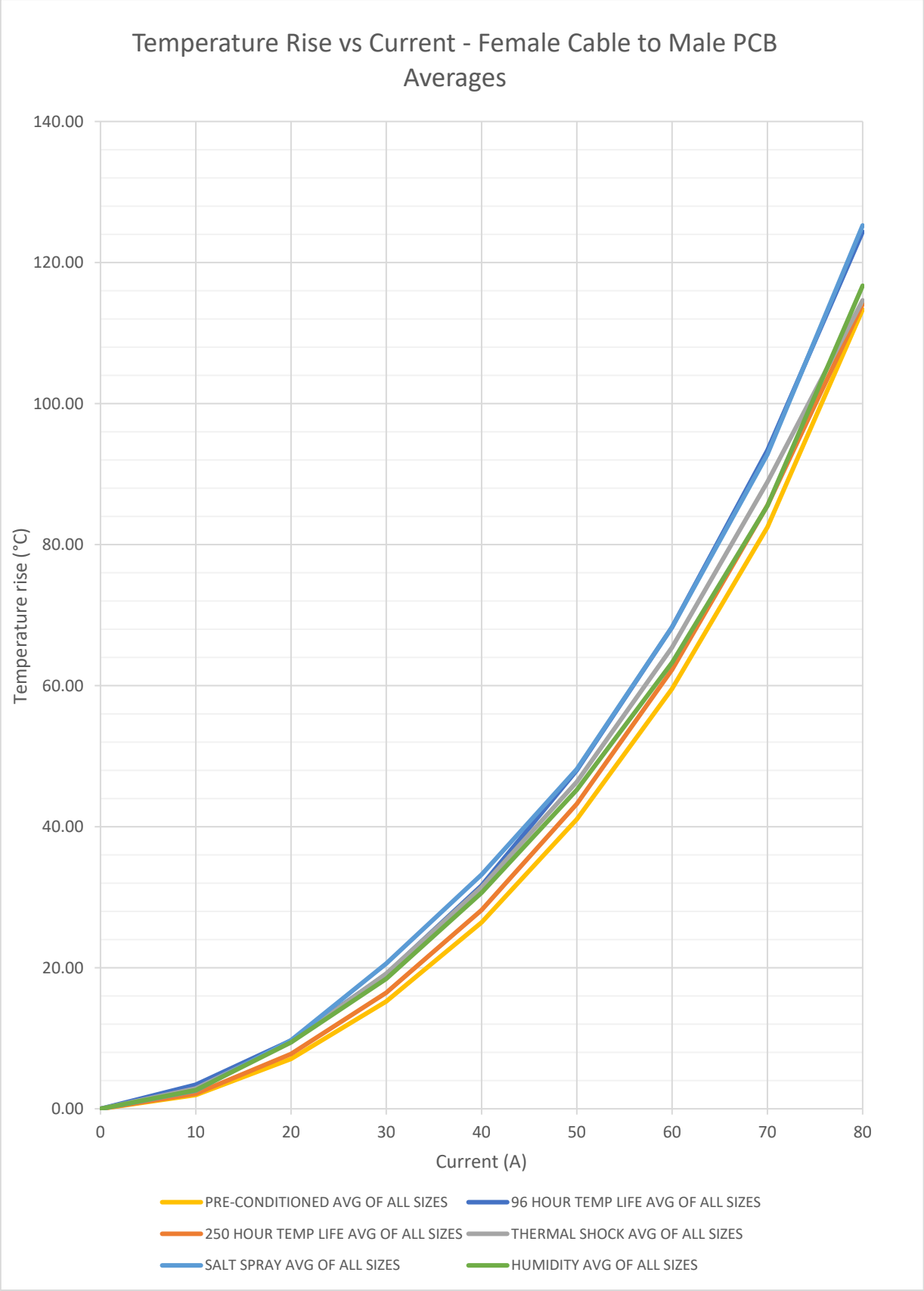
- Graphs 1, 2, 5 and 6 show pre-conditioned results, for mated connectors before any other electrical, mechanical, or environmental testing.
- Graphs 3, 4, 7 and 8 show environmental post-conditioned results, comparing each conditioning test carried out.
- Graphs 1 to 4 are for female cable to male PCB connectors; graphs 5 to 8 are for female cable to male cable connectors.



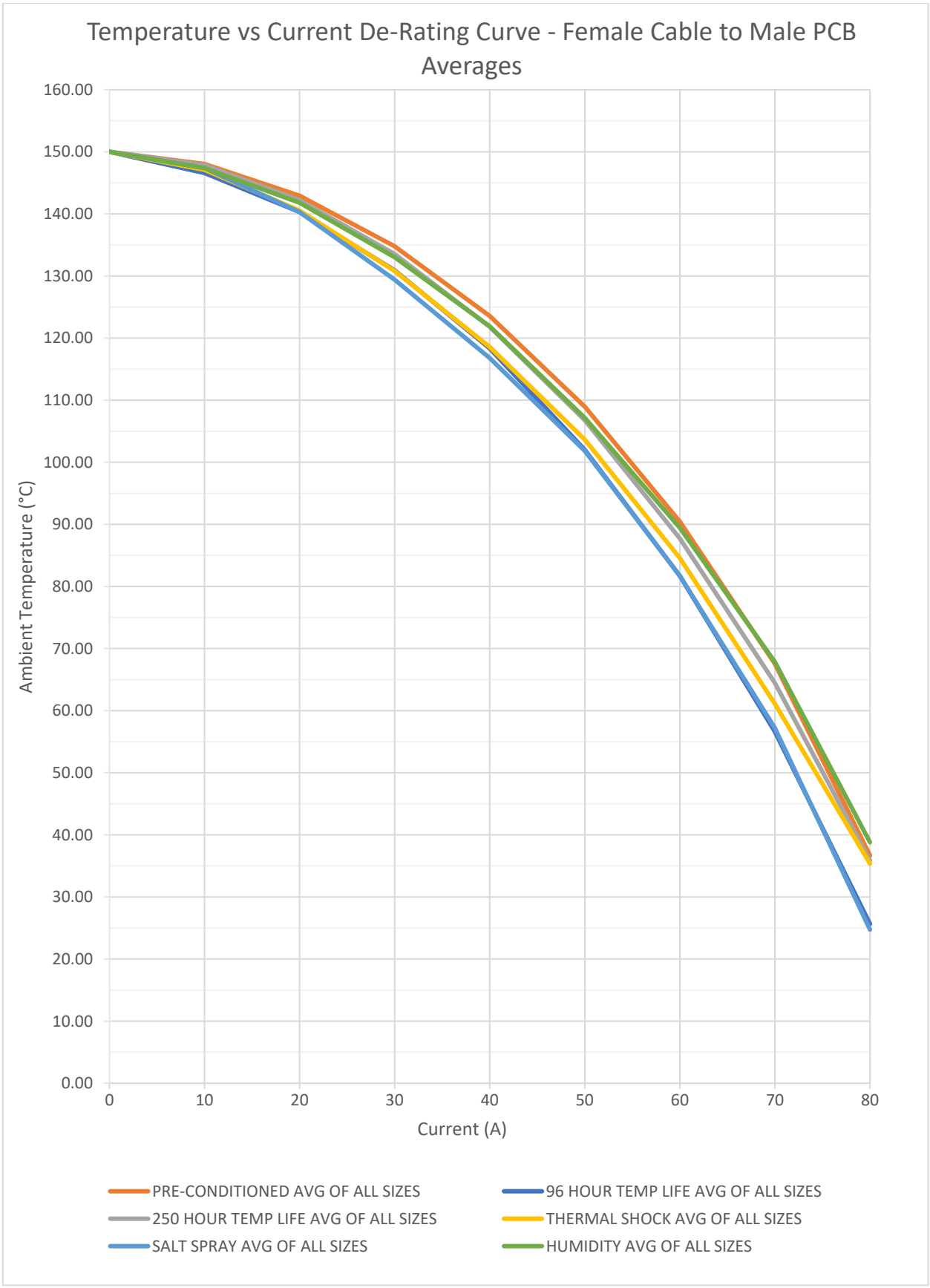
Graph 1: Temperature Rise vs Current for different contact counts – Female Cable to Male PCB



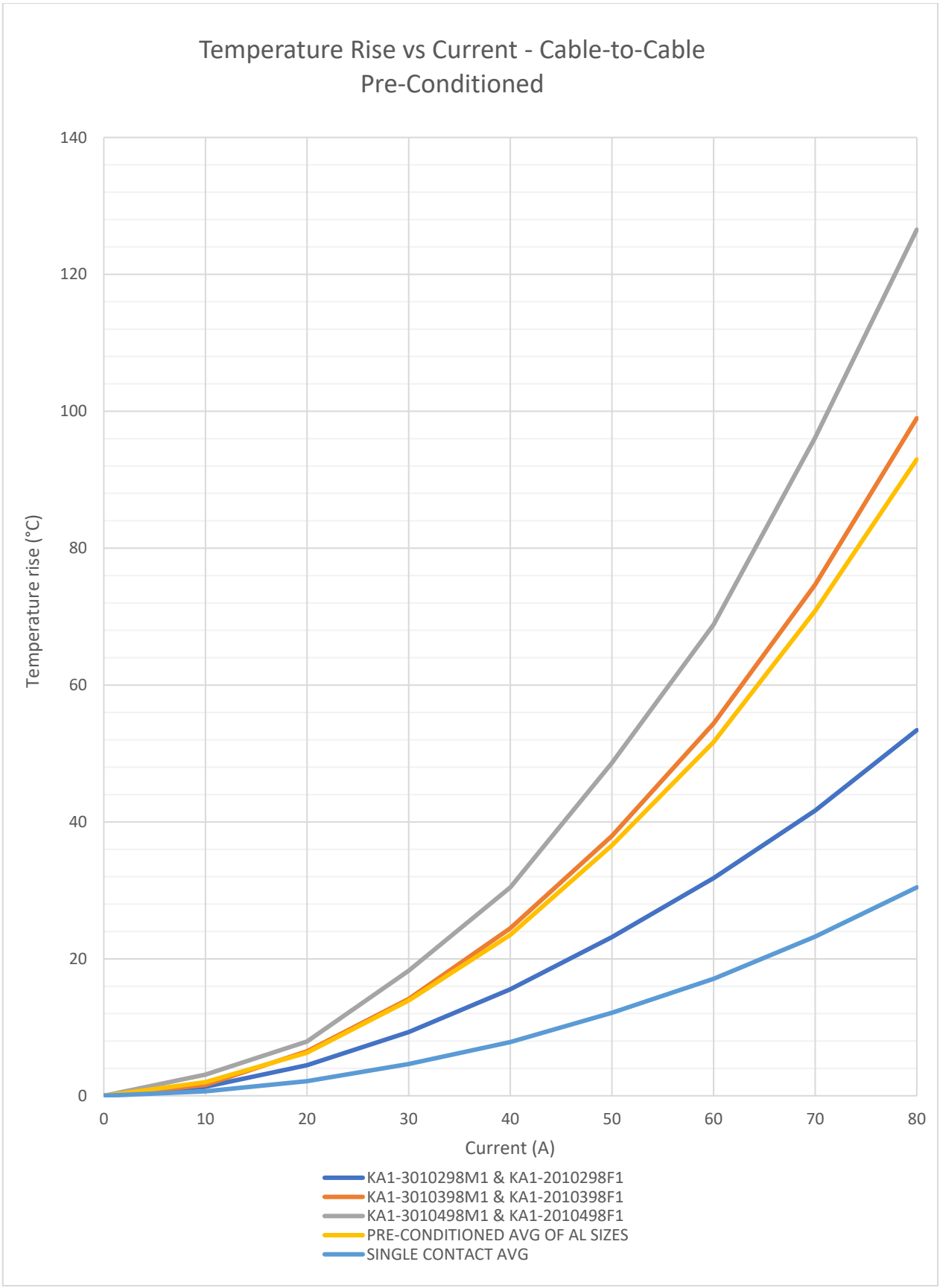
Graph 2: De-rate curve for different contact counts – Female Cable to Male PCB



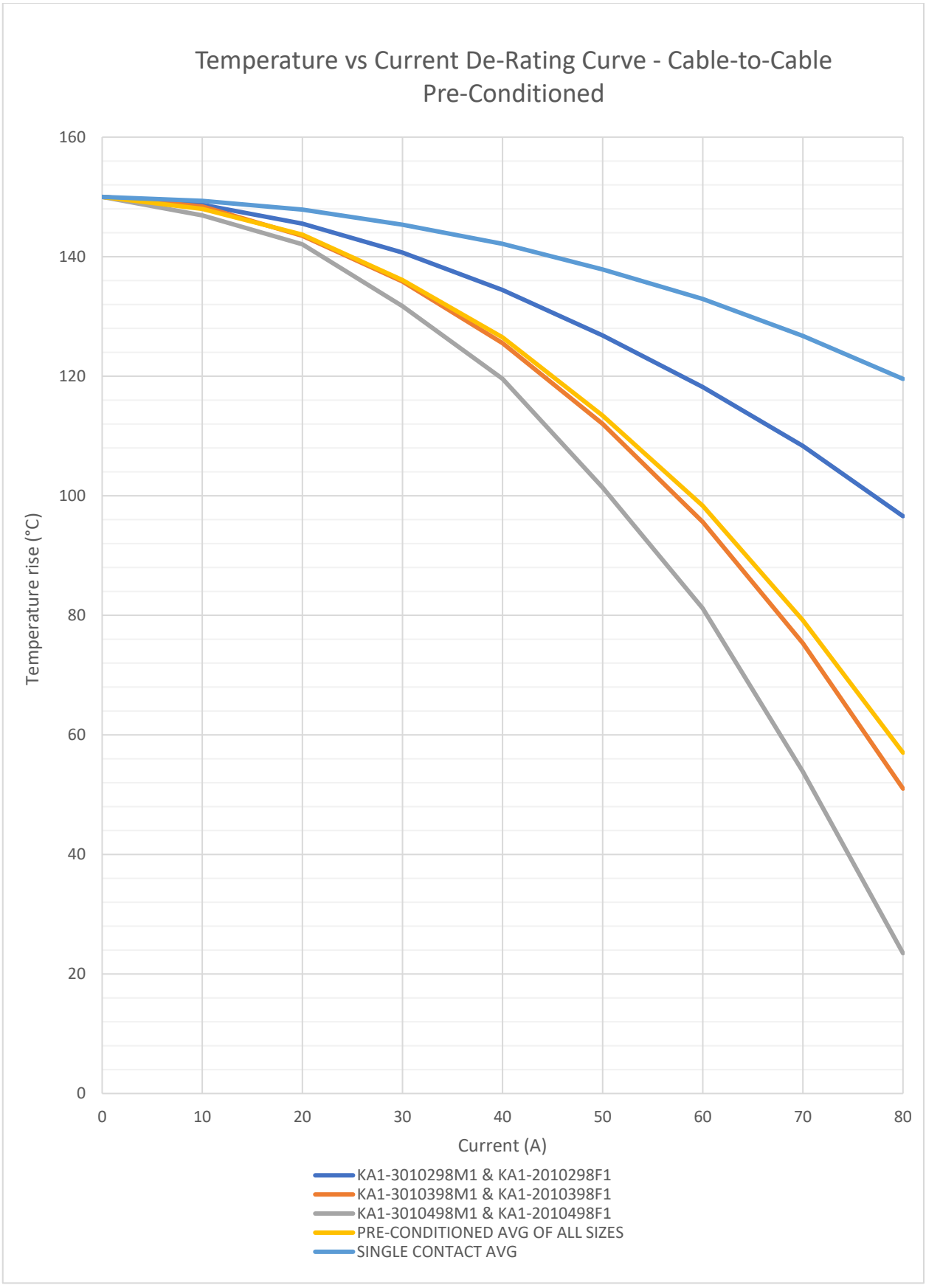
Graph 3: Temperature Rise vs Current for post-conditioned – Female Cable to Male PCB



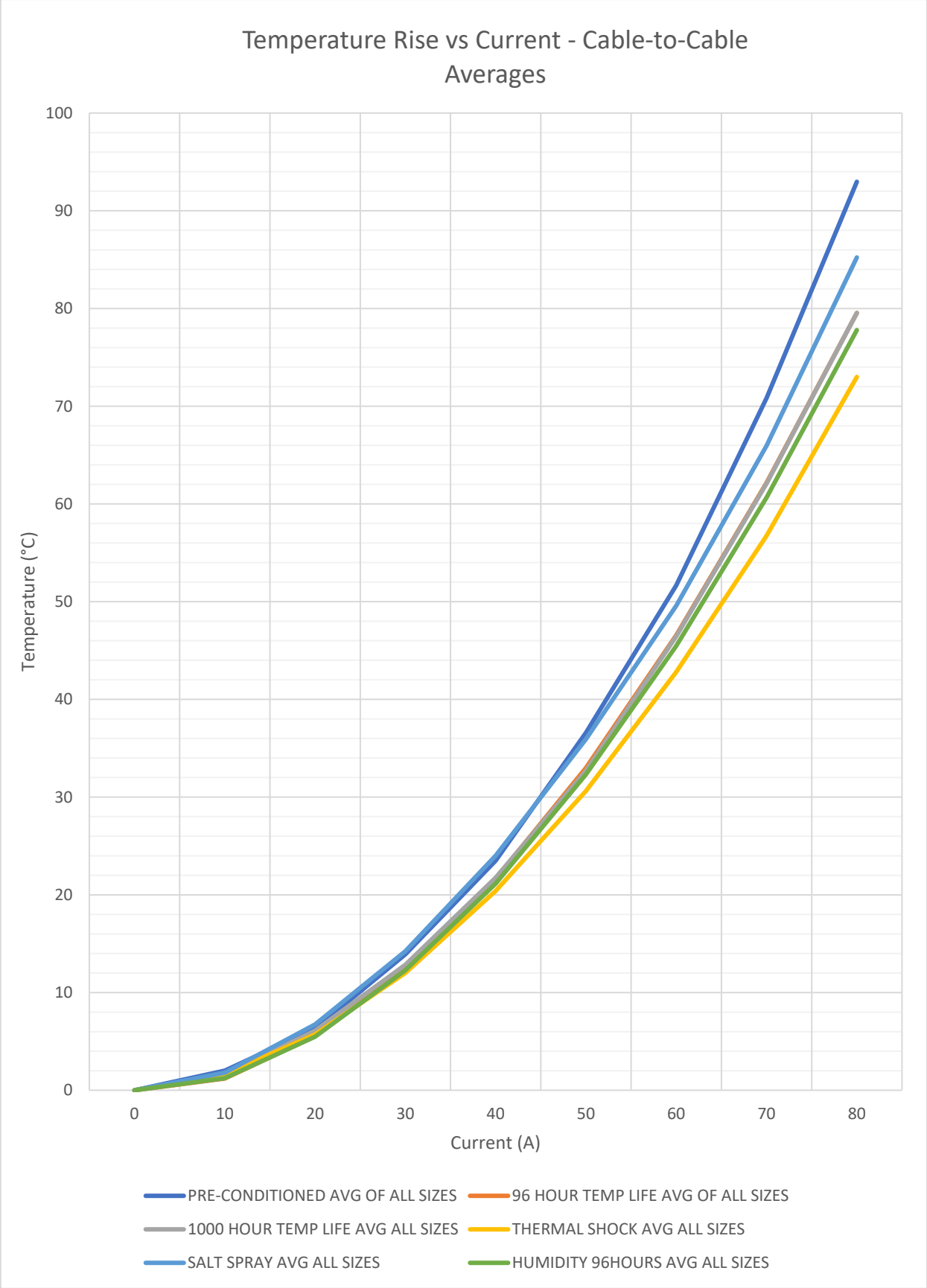
Graph 4 De-Rate curve for post-conditioned – Female Cable to Male PCB



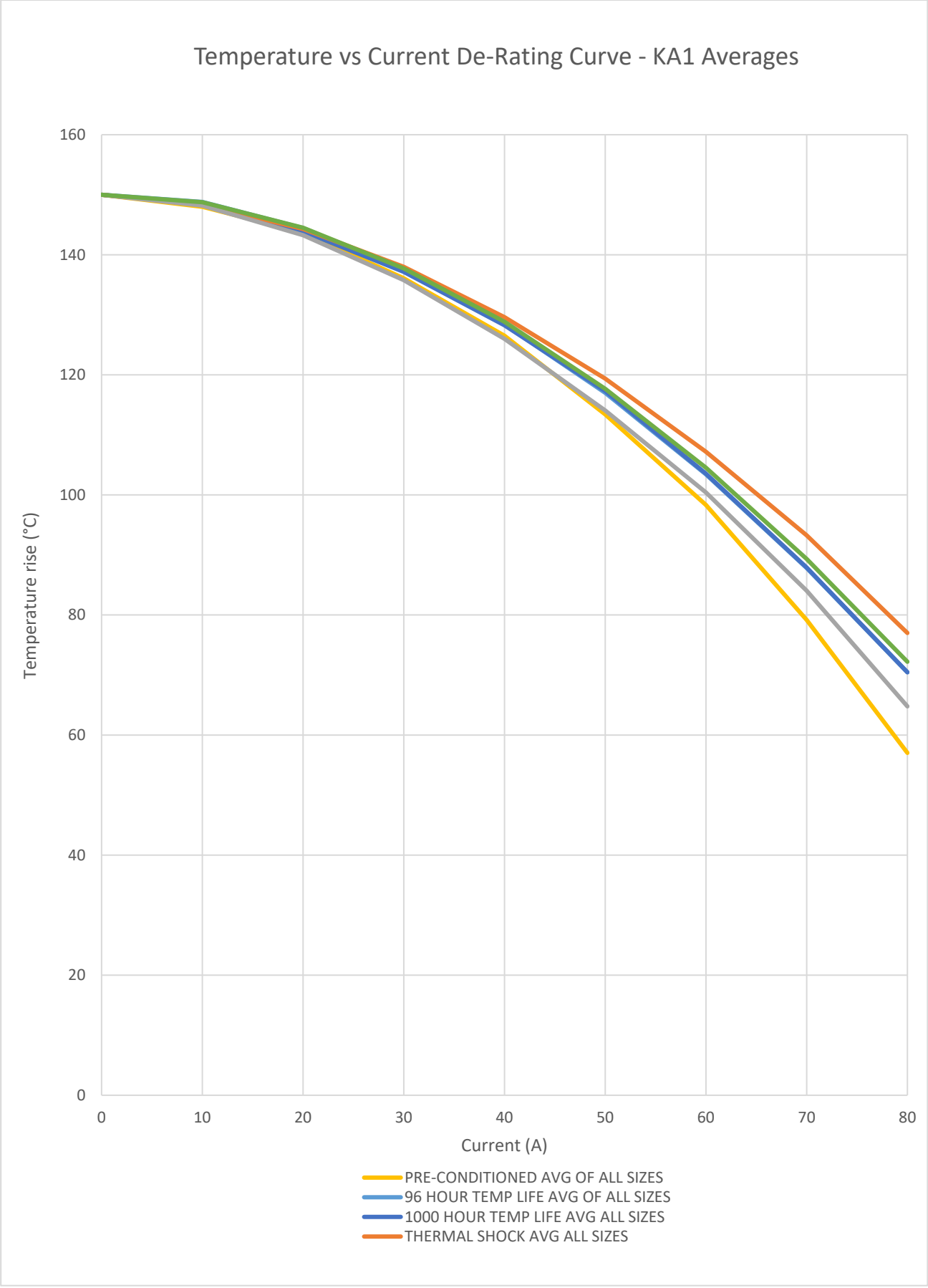
Graph 5: Temperature Rise vs Current for different contact counts – Cable-to-Cable



Graph 6: De-rate curve for different contact counts – Cable-to-Cable



Graph 7: Temperature Rise vs Current for post-conditioned – Cable-to-Cable



Graph 8: De-Rate curve for post-conditioned – Cable-to-Cable

3.3. Durability, Insertion & Withdrawal Forces to EIA-364-09C: 1999

Specification:

- Durability = 250 mating cycles (operation) minimum
- Insertion Force = 50N max. per contact (using mating contact); initial and during 250 mating cycles
- Insertion Force = 70N max. per contact (using mating contact), after conditioning tests
- Withdrawal Force = 5N min. per contact (using mating contact)

Methodology: For this test, both individual power contacts and fully-assembled connector pairs were mated at a speed of 25mm/min for 250 cycles, in general accordance with EIA-364-09C. Readings were taken on the first insertion and withdrawal (initial), and then during the 250 cycles. Contact resistance was also measured after the 250 cycles.

Post-conditioned environmental samples were also cycled on the force gauge to compare the effects of additional conditions on insertion and withdrawal forces over 250 cycles.

Results: Average forces are taken from multiple samples in each test set-up. Inspection of the plating in the contact area was performed post-cycling, and little contact wear was observed.

Insertion Forces (N):

Connector Pair	Conditioning	Initial (Average)		Over 250 cycles (Max.)	
		Connector	Contact	Connector	Contact
Single contact female cable to male PCB	No conditioning	-	16.01	-	37.22
2-contact female cable to male PCB	No conditioning	44.03	22.01	79.76	39.88
3-contact female cable to male PCB	No conditioning	56.53	18.84	118.11	39.37
4-contact female cable to male PCB	No conditioning	63.12	15.78	135.93	33.98
Female cable contact to male PCB contact *(average per contact)*	No conditioning	18.16		37.61	
	Temp. Life: 96h	27.77		34.27	
	Temp. Life: 250h	23.57		44.22	
	Temp. Life: 1,000h	23.84		46.72	
	Thermal Shock	26.32		47.78	
	Salt Spray	37.96		53.16	
	Humidity	23.29		69.23	
Single contact cable to cable	No conditioning	-	17.42	-	28.92
2-contact cable to cable	No conditioning	39.23	19.61	70.55	35.28
3-contact cable to cable	No conditioning	57.21	19.07	97.02	32.34
4-contact cable to cable	No conditioning	74.40	18.60	108.66	27.17
Cable contact to cable contact *(average per contact)*	No conditioning	18.68		30.93	
	Temp. Life: 96h	8.58		22.22	
	Temp. Life: 1,000h	6.31		16.83	
	Thermal Shock	13.14		32.22	
	Salt Spray	16.83		30.03	
	Humidity	14.26		29.58	

Withdrawal Forces (N):

Connector Pair	Conditioning	Initial (Average)		Over 250 cycles (Min.)		Over 250 cycles (Max.)	
		Connector	Contact	Connector	Contact	Connector	Contact
Single contact female cable to male PCB	No conditioning	-	13.60	-	10.08	-	26.43
2-contact female cable to male PCB	No conditioning	23.50	11.75	24.30	12.15	50.21	25.11
3-contact female cable to male PCB	No conditioning	33.75	11.25	30.24	10.08	69.67	23.22
4-contact female cable to male PCB	No conditioning	46.56	11.64	44.12	11.03	85.42	21.36
Female cable contact to male PCB contact *(average per contact)*	No conditioning	12.06		10.84		24.03	
	Temp. Life: 96h	5.58		5.02		19.12	
	Temp. Life: 250h	6.10		5.17		17.77	
	Temp. Life: 1,000h	5.56		9.11		13.84	
	Thermal Shock	10.85		10.21		24.39	
	Salt Spray	12.47		11.33		26.79	
	Humidity	10.91		8.74		29.24	
Single contact cable to cable	No conditioning	-	11.58	-	10.78	-	21.60
2-contact cable to cable	No conditioning	30.60	15.30	28.00	14.00	41.74	20.87
3-contact cable to cable	No conditioning	46.60	15.53	41.46	13.82	60.14	20.05
4-contact cable to cable	No conditioning	57.52	14.38	53.24	13.31	73.76	18.44
Cable contact to cable contact *(average per contact)*	No conditioning	14.20		12.98		20.24	
	Temp. Life: 96h	8.16		6.10		14.90	
	Temp. Life: 1,000h	5.92		4.08		12.05	
	Thermal Shock	12.35		9.78		21.17	
	Salt Spray	15.68		10.79		21.47	
	Humidity	13.32		10.58		19.75	

Contact Resistance:

Mating Pair	Condition	Max. (mΩ)	Min. (mΩ)	Average (mΩ)
KA1-0400005 (female cable) & KA1-1100005 (male PCB)	Before Test	0.39	0.34	0.36
	After 250 cycles	0.55	0.33	0.46
KA1-0400005 (female cable) & KA1-1410005 (male cable)	Before Test	0.63	0.51	0.57
	After 250 cycles	0.70	0.55	0.62

3.4. Withstand Voltage to EIA-364-20C: 2004 & Insulation Resistance to EIA-364-21C: 2000

Samples: The following connector pairs are used throughout this test sequence. Multiple samples were tested for each combination:

- Set A = KA1-MV10205M1 (male PCB) mated to KA1-2010298F1 (female cable)
- Set B = KA1-MV10305M2 (male PCB) mated to KA1-2010398F2 (female cable)
- Set C = KA1-MV10405M1 (male PCB) mated to KA1-2010498F1 (female cable)
- Set D = KA1-3010298M1 (male cable) mated to KA1-2010298F1 (female cable)
- Set E = KA1-3010398M3 (male cable) mated to KA1-2010398F1 (female cable)
- Set F = KA1-3010498M5 (male cable) mated to KA1-2010498F2 (female cable)

3.4.1. Withstand Voltage

Specification:

- Voltage Proof (sea level): 3,000V DC/AC for 60 seconds
- Voltage Proof (70,000 feet): 500V DC/AC for 60 seconds
- Current leakage: 5mA max.

Methodology: 3,000V or 3,500V was applied to connector pairs wired in two series circuits for 60 seconds to determine whether breakdown or flashover occurred.

Samples were then put into a vacuum chamber at a reduced air pressure of 44mb to simulate 70,000ft, and 500V was applied to connector pairs wired in two series to determine whether breakdown or flashover occurred.

Current leakage was measured during the test as the indicator for breakdown or flashover occurrence. Pass values were applied for all values below 5mA.

Results: Samples were visually inspected following the test, with no obvious changes to the connectors occuring.

Set	Altitude	Initial	Temperature Life		Thermal Shock	Salt Spray	Humidity 96 hours
			96 hours	250 hours			
A (all)	Sea level	Pass	Pass	Pass	Pass	Pass	Pass
	70,000ft	Pass	Pass	Pass	Pass	Pass	Pass
B (all)	Sea level	Pass	Pass	Pass	Pass	Pass	Pass
	70,000ft	Pass	Pass	Pass	Pass	Pass	Pass
C (all)	Sea level	Pass	Pass	Pass	Pass	Pass	Pass
	70,000ft	Pass	Pass	Pass	Pass	Pass	Pass
D (all)	Sea level	Pass	Pass	-	Pass	Pass	Pass
	70,000ft	Pass	Pass	-	Pass	Pass	Pass
E (all)	Sea level	Pass	Pass	-	Pass	Pass	Pass
	70,000ft	Pass	Pass	-	Pass	Pass	Pass
F (all)	Sea level	Pass	Pass	-	Pass	Pass	Pass
	70,000ft	Pass	Pass	-	Pass	Pass	Pass

3.4.2. Insulation Resistance

Specification: 10GΩ min. pre- and post-conditioning (excluding salt mist conditioning) at 1,000V.

Methodology: 1,000V was applied to connector pairs wired in two series for 2 minutes to determine whether the resistance satisfies the required specification values of 10GΩ minimum.

Results: Samples were visually inspected following the test, with no obvious changes to the connectors occuring.

Set	Altitude	Initial	Temperature Life		Thermal Shock	Salt Spray	Humidity 96 hours
			96 hours	250 hours			
A1	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	4,833MΩ	>9,999MΩ
A (others)	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ
B (all)	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ
C (all)	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ
D (all)	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ
E (all)	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ
F (all)	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ	>9,999MΩ

3.5. Contact & Fixing (Insert) Retention to EIA-364-05B: 1998

3.5.1. Contact Retention in Housing

Specification: Contact Retention in Housing = 75N min.

Methodology: Test to EIA-364-05B for both pre-conditioned and post-conditioned samples. All power contacts were removed from each assembly, measuring the force required to do so an auto force gauge.

Results – Initial Retention, pre-conditioned (all values in N):

Part No.	Max.	Min.	Average
KA1-2010298xx (Female Cable)	166.86	102.22	130.18
KA1-2010398xx (Female Cable)	169.91	136.67	148.39
KA1-2010498xx (Female Cable)	171.18	140.62	161.50
KA1-MV10298xx (Male PCB)	174.91	149.71	160.40
KA1-MV10398xx (Male PCB)	172.97	136.00	153.20
KA1-MV10498xx (Male PCB)	155.83	105.43	132.50
KA1-3010298xx (Male Cable)	188.38	158.27	171.19
KA1-3010398xx (Male Cable)	189.93	129.55	160.72
KA1-3010498xx (Male Cable)	194.72	141.22	170.92

Results – Post-conditioned (all values in N):

Part No.	Female Cable			Male PCB			Male Cable		
	Max.	Min.	Average	Max.	Min.	Average	Max.	Min.	Average
Temp. Life: 96 hours	210.02	95.89	153.66	124.07	90.37	105.83	197.89	127.48	174.22
Temp. Life: 250 hours	192.28	107.67	154.49	109.68	79.93	92.99	-	-	-
Temp. Life: 1,000 hours	199.06	81.73	146.45	136.07	93.95	115.27	184.60	115.00	164.53
Thermal Shock	203.83	88.21	156.22	109.23	76.73	92.08	192.10	125.30	165.29
Salt Spray	203.09	98.93	159.09	151.65	91.19	114.03	297.20	106.50	171.44
Humidity: 96 hours	200.85	84.99	142.84	150.98	83.21	107.81	198.10	114.10	159.08

3.5.2. Fixing (Insert) Retention in Housing

Specification: Fixing (insert) retention = 30N.

Methodology: Fixing (insert) retention was tested to EIA-364-35C for both pre and post conditioned samples. Samples were loaded into the auto force gauge where an axial load of 30N and 50N was applied at a rate of 69kPa, held for 10 seconds. Samples were then visually inspected and given a pass or fail.

Results – Initial Retention (pre-conditioned):

All results are Pass – the value shows whether the pass was at 50N or 30N axial load.

Part No.	Initial	Temperature Life			Thermal Shock	Salt Spray	Humidity	
		96h	250h	1,000h			96h	56 days
KA1-201xx98F1	50N	50N	50N	50N	50N	50N	50N	50N
KA1-201xx98F2	50N	50N	50N	50N	50N	50N	50N	50N
KA1-MV1xx98M1	50N	50N	50N	50N	50N	50N	50N	50N
KA1-MV1xx98M2	50N	50N	50N	50N	50N	50N	50N	50N
KA1-301xx98M1	50N	50N	-	50N	50N	50N	50N	50N
KA1-301xx98M3	50N	50N	-	50N	50N	50N	50N	50N
KA1-301xx98M5	30N	30N	-	30N	30N	30N	30N	30N

3.6. Temperature Life (without load) to EIA-364-17B: 1999

Specification: Operating temperature = -65°C to +150°C.

Methodology: The test was carried out to EIA-364-17B, condition 10, method A; connectors were subjected to 96 hours and 1,000 hours at 150±5°C. Readings were also taken at 250 hours for the Female cable / Male PCB combination.

Results: There were no obvious visual changes.

Contact Resistance results in table below. See also sections 3.2 (Current vs Temperature), 3.3 (Durability), 3.4 (Withstand Voltage & Insulation Resistance) and 3.5 (Contact/Fixing Retention).

Mating Pair	Condition	Max. (mΩ)	Min. (mΩ)	Average (mΩ)
KA1-0400005 (female cable) & KA1-1100005 (male PCB)	Before Test	0.39	0.34	0.36
	After 96 hours	0.55	0.37	0.42
	After 250 hours	0.55	0.39	0.46
	After 1,000 hours	0.55	0.41	0.48
KA1-0400005 (female cable) & KA1-1410005 (male cable)	Before Test	0.63	0.51	0.57
	After 96 hours	0.68	0.45	0.52
	After 1,000 hours	0.84	0.50	0.61

3.7. Thermal Shock (Temperature Cycling) to EIA-364-32C: 2000 & BS EN 60068-2-14: 2009

Specification: Operating temperature = -65°C to +150°C.

Methodology: Test in general accordance with BS EN 60068-2-14: 2009 and EIA-364-32C: 2000 Test Condition 4. This test was conducted using automated transfer every 30 minutes between climatic chambers at the two temperature extremes (-65°C to +150°C). The connectors were measured for contact resistance, current, voltage breakdown, insulation resistance and durability, as well as visual inspection after testing.

Results: There were no obvious visual changes.

Contact Resistance results in table below. See also sections 3.2 (Current vs Temperature), 3.3 (Durability), 3.4 (Withstand Voltage & Insulation Resistance) and 3.5 (Contact/Fixing Retention).

Mating Pair	Condition	Max. (mΩ)	Min. (mΩ)	Average (mΩ)
KA1-0400005 (female cable) & KA1-1100005 (male PCB)	Before Test	0.39	0.34	0.36
	After Test	0.44	0.38	0.42
KA1-0400005 (female cable) & KA1-1410005 (male cable)	Before Test	0.63	0.51	0.57
	After Test	0.65	0.49	0.55

3.8. Salt Spray to EIA-364-26B: 1999 & BS EN 60068-2-11: 1999

Specification:

- Duration: 48 hours continuous
- Water/Salt Mix: 5% NaCl
- Chamber Temperature: +35°C
- pH Level: 6.5-7.2

Methodology: Test in general accordance with BS EN 60068-2-11: 1999 Test Ka and EIA-364-26B Test Condition B. The samples were placed into the salt mist chamber for 48 hours and measured for contact resistance, current, voltage breakdown, insulation resistance and durability, as well as visual inspection post-testing.

Results: Insulation resistance on one sample was affected (see section 3.4), no other issues were noted. Visual changes were noted on the majority of samples.

Contact Resistance results in table below. See also sections 3.2 (Current vs Temperature), 3.3 (Durability), 3.4 (Withstand Voltage & Insulation Resistance) and 3.5 (Contact/Fixing Retention).

Mating Pair	Condition	Max. (mΩ)	Min. (mΩ)	Average (mΩ)
KA1-0400005 (female cable) & KA1-1100005 (male PCB)	Before Test	0.39	0.34	0.36
	After Test	0.50	0.38	0.44
KA1-0400005 (female cable) & KA1-1410005 (male cable)	Before Test	0.63	0.51	0.57
	After Test	0.65	0.44	0.53

3.9. Humidity to EIA-364-31B: 1999 & BS EN 60068-2-78: 2013

Specification: 90-95% Relative humidity at +40°C for 96 hours duration

Methodology: Test in general accordance with BS EN 60068-2-78: 2013 Test Cab and EIA-364-31B: 2000 Method 2 Test Condition A. The samples were pre-conditioned for 24 hours at 50°C then suspended in a humidity chamber for 96 hours at 40°C with 90-95% relative humidity. The connectors were measured for contact resistance, current, voltage breakdown, insulation resistance and durability, as well as visual inspection post-testing.

Results: There were no obvious visual changes.

Contact Resistance results in table below. See also sections 3.2 (Current vs Temperature), 3.3 (Durability), 3.4 (Withstand Voltage & Insulation Resistance) and 3.5 (Contact/Fixing Retention).

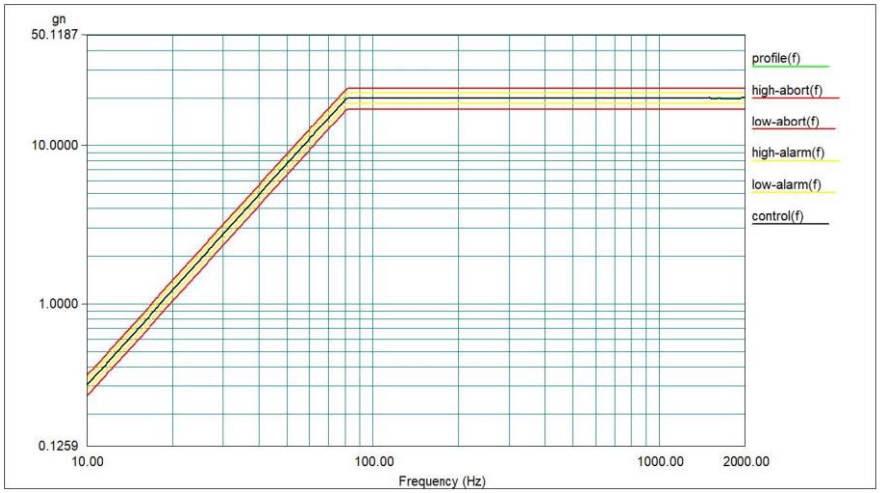
Mating Pair	Condition	Max. (mΩ)	Min. (mΩ)	Average (mΩ)
KA1-0400005 (female cable) & KA1-1100005 (male PCB)	Before Test	0.39	0.34	0.36
	After Test	0.48	0.36	0.42
KA1-0400005 (female cable) & KA1-1410005 (male cable)	Before Test	0.63	0.51	0.57
	After Test	0.75	0.47	0.52

3.10. Vibration to EIA-364-28D: 1999 & BS EN 60068-2-6: 2008

Specification:

- 10Hz to 2kHz
- 1.52mm peak-to-peak displacement or 198m/s² (20G) peak (whichever is less) – see graph 9
- 12 cycles per axis (X / Y / Z), 20 minutes per cycle
- Cables restrained above 200mm from connectors

Methodology: Samples were tested in general accordance with BS EN 60068-2-6: 2008 Test Fc and EIA-364-28D Test Condition 4. The samples were subjected to a Swept Sine Test, with continuous monitoring for discontinuities of 1 microsecond or longer.



Graph 9: Test parameters for vibration frequency

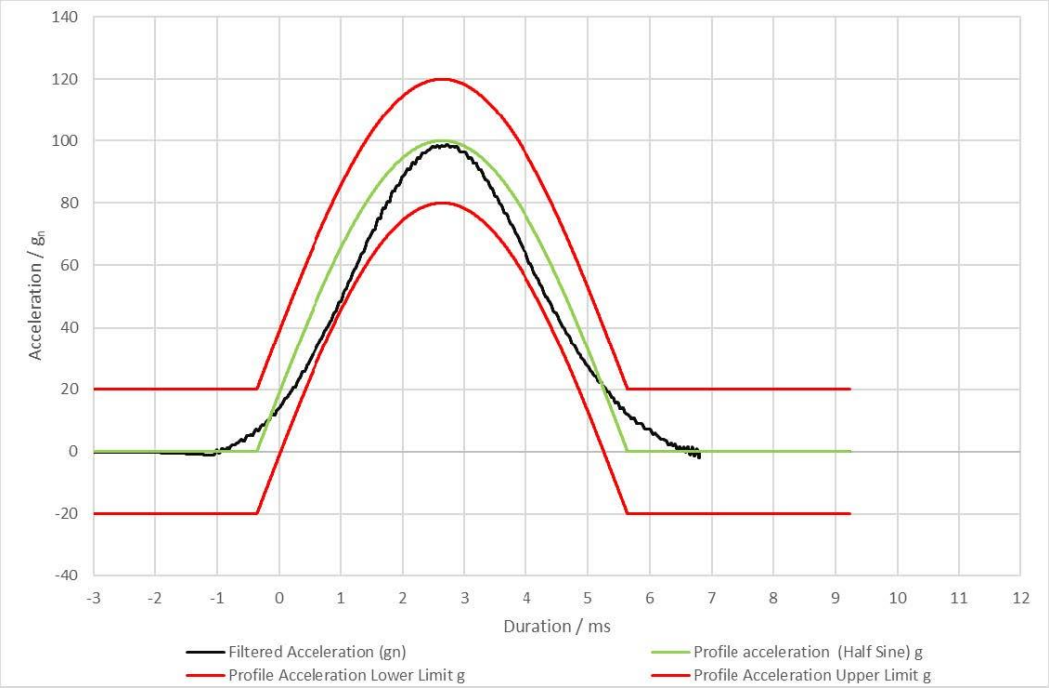
Results: No triggers were noted on any sample during the test process. Upon completion of testing the samples were visually inspected; no obvious changes to the samples were noted.

3.11. Mechanical Shock to EIA-364-27B: 1996 & BS EN 60068-2-27: 2009

Specification:

- Acceleration: 100g
- Shock Duration: 6ms
- Shock Shape: Half Sine Pulse, 3 shocks in each axis

Methodology: Shock Test Sequence was carried out on all samples. During the test, the samples were monitored continuously for discontinuities of 1 microsecond or longer.



Graph 10: Typical plot generated during Mechanical Shock test

Results: No triggers were noted on any sample during the test process. Upon completion of testing the samples were visually inspected; no obvious changes to the samples were noted.