smiths interconnect

Qualification Test Report

CXH SERIES - Outrigger Product Expansion Qualification Test Report

Juan Ayala, Matthew Mazzochette
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1. Introduction

The CXH outrigger Series is a resistive product that is designed to handle more power than the conventional flip chip resistor. The power increase comes from the SINT patented design with added ground bars to the sides of the chip to dissipate more heat as shown in figures 1 and 2.

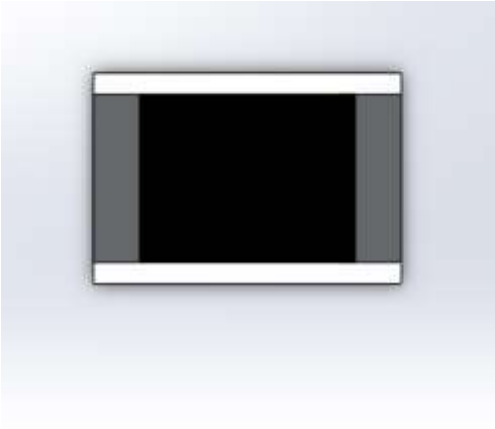

Figure 1 Conventional 0805 Resistor Layout

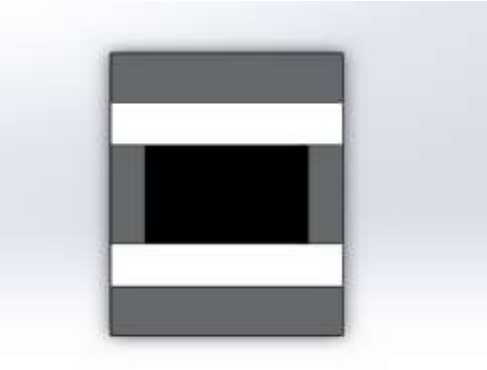

Figure 2: 0805 Dual Outrigger Resistor Layout

The two ground bars in figure 2 create two more thermal paths to ground which allow the resistor to dissipate more power. The 2 outriggers function as heat spreaders that dissipate approximately 50% more power than conventional flip chip resistor.

Figure 3 Single and Dual Outrigger pictures

Currently Smiths Interconnect offers an equivalent 0402 chip and 0603 chip on Alumina for the both the single and dual CRH outrigger series layouts. A single and dual CRH outrigger series product shown in figure 3. The single outrigger will only have one added ground bar instead of two. The goal of this project is to expand on this existing line to create a 0805 and 1206 equivalent CRH outrigger series on

Alumina ceramic and create an ALN ceramic version for increased power handling for all 4 chip sizes (i.e. 0402, 0603,0805, 1206 equivalent). The below report will explain in detail what test were done to qualification these new products.

2. Test Procedure

To release this product line, four-part numbers were selected for qualification the CRH08110505F, CRHA08110505F, CRH12160505F, and CRHA12160505F. These part numbers were subjected to Group A, B and C testing per TP-9277. The test sequences for Group A, B, and C are shown in figure 4.

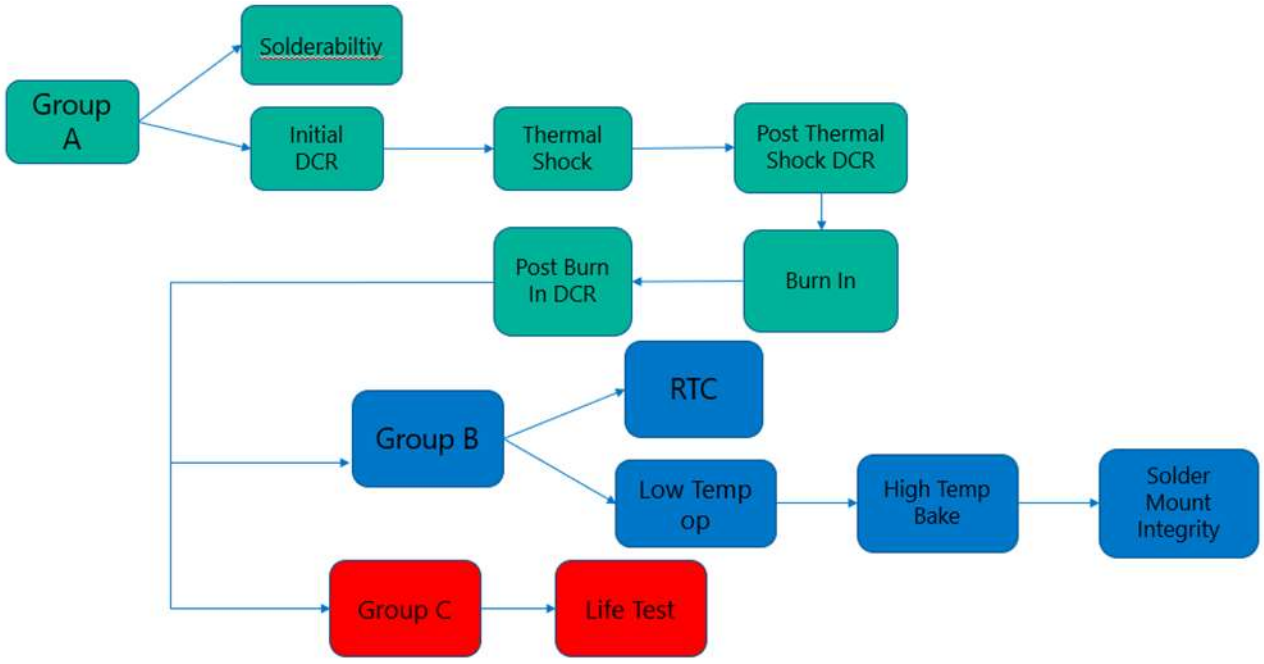

Figure 4: Test Sequences for TP-9277

2.1 Group A Testing

For group A testing, 6 devices of each model were tested from a single manufacturing lot. The devices were split into two subgroups. Subgroup 1 included solderability testing and 1 device of each model was tested. Subgroup 2 included thermal shock and 168hr (1week) burn in and 5 devices of each model were tested.

Subgroup 1
Solderability testing

For solderability testing 1 device of each model was tested for a total of 4 devices. Each device was immersed in Kester 186 flux and dipped in a solder pot at 220°C per MIL-STD-202 method 208 for 5 seconds. In order to pass solderability each piece must have at least 95% solder coverage on the input/output pads and the ground bars per J-STD-002

Subgroup 2
Initial DCR

5 devices of each model were selected for Initial DCR for total of 20 devices. To measure the DCR, each device was soldered to Rogers 6035HTC test board and then measured with an ohm meter using 4 wire leads. The Rogers 6035HTC material was used because of its high conductivity which allowed for higher power dissipation during burn in testing. The 4 wire leads were used to account for any losses that may exist in the wires. In order to pass Initial DCR the resistance of each device must be 50Ω±5%.

Thermal Shock

After Initial DCR was complete the 5 devices of each model were subjected to thermal shock. For this test the devices were subjected to 10 cycles of thermal shock from -55°c to 150°c per MIL-STD-202 method 107. The exact conditions for thermal shock are shown in table I.

Table I: Thermal Shock Test Conditions for the CRH Outrigger Series Qualification

STEP	TEMPERATURE (ºC)	TIME (MINUTES)
1	-55 (+0/-3)	15 min.
2	+25 (+10/-5)	5.0 max.
3	+150 (+3/-0)	15 min.
4	+25 (+10/-5)	5.0 max.

In order to pass thermal shock, the % change in DCR of each device must be within ±0.5% of its initial DCR reading per MIL-PRF-55432.

Burn in Testing

After thermal shock was complete, the 5 devices of each model were subjected to 168hr burn in test. To burn in the devices, each device was mounted to the appropriate heat sink as shown in figures 5-8.

Figure 5: CRH08110505F Burn In Setup

Figure 6: CRH12160505F Burn In Setup

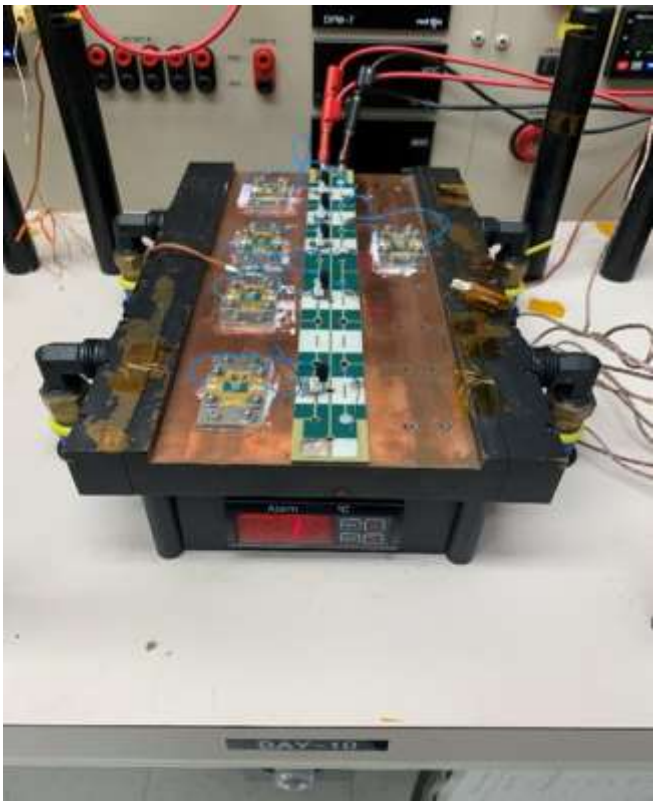

Figure 7: CRHA08110505F Burn In setup

Figure 8: CRHA12160505F Burn In Setup

During mounting a thin layer (i.e. around 1 mil thick) of TECHSPRAY 1978-DP thermal compound was applied between the test board and the heatsink. The thermal compound was applied to fill in any air gaps that may exist between the board and the heat sink. If the thermal compound is not applied the power handling of the device will be significantly reduced because air gaps will add thermal resistance between the device and the heat sink. It is also important not to apply too much thermal compound because it could also reduce the power handling of the device. Although better air, most thermal compounds can add thermal resistance if too much is applied.

After mounting was complete, the devices were ready for burn in. The power levels for each device are shown in table II

Table II: Power level of each device during burn in test

Part number	Power Level (watts)	Test Conditions
CRH08115005F	2.5	@100°C Chip Temperature
CRHA08115005F	8.5	@100°C Chip Temperature
CRH12165005F	4	@100°C Chip Temperature
CRHA12165005F	12	@100°C Chip Temperature

In order to pass burn in the % change in DCR of each device after burn in must be within ±.5% of it is pre-burn in DCR reading per MIL-PRF-55432. For this test, the DCR taken after thermal shock was used for the pre-burn in reading.

2.2 Group B Testing

Subgroup 1

Resistance to Temperature Characteristics (RTC)

After completing group A testing, 1 device of each model was subjected to RTC. For this test, DCR measurements for each device were measured at 25°c, -55°c, and 125°c. The devices were allowed to stabilize at each temperature for 30-45 minutes before taking the DCR measurements. After taking the DCR measurements at each temperature, the hot and cold TCRs were calculated based on the measurements. In order to pass RTC the hot and cold TCRs must be less than ±200ppm/°C.

Subgroup 2

Low Temperature Operation

After completing group A testing 2 devices of each model were selected for low temperature operation. For low temp operation the temperature of each device was lowered to -55°c. Once at -55°c the devices were allowed to stabilize at that temperature for 1hr where they were subject to the same power levels as group A burn in for 45 minutes. After subjecting the devices to power, they were brought back to 25°c where there DCR was measured and recorded. In order to pass low temp operation, the %change in DCR of each device must be within ±0.25% of it is pre-test measurement.

High Temperature Exposure

After completing low temperature operation, the 2 devices of each model were subjected to high temperature exposure. For high temperature exposure the devices were subject to 150°c bake for 100hrs (approximately 4 days). The DCR of each device was measure before and after the 150°c bake. In order to pass high temperature exposure, the post bake DCR of each device must be within ±0.5% of its pre-bake measurement.

Die Shear Test (Solder Mount Integrity)

After high temperature exposure was complete, the 2 devices of each model were subjected die shear testing. For die shear testing a 2kg shearing force was subjected to the edge of each device for 30 seconds. Each device was still mounted to the test board in which it was soldered to during group A testing. In order to pass die shear testing, each device must show no signs of mechanical damage after subjecting it to a 2kg shearing force.

2.3 Group C

Life Test

3 devices of each model were subjected to life test. 2 of the 3 devices came from the left-over group A devices that didn't go through group B testing. The 3rd device of each model came from the one that passed RTC. For this test each piece was mounted to the appropriate heat sink the same way they were mounted for group A burn in. Each device was also mounted to the same heat sink used for group A burn in. After mounting was complete each device was subjected to same power level as group A burn in for 1000hrs. DCR measurements were taken after 250, 500, and 1000hrs. In order to pass life test, the % change in DCR of each device must be within ±0.5% of its previous measurement. For example, the post 250hr measurement must be within ±0.5% of its initial value, the post 500hr

measurement must be within ±0.5% of its post 250hr measurement, and its post 1000hr measurement must be within ±0.5% of its post 500hr measurement.

3. Test Results

3.1 Group A

Initial DCR

For initial DCR testing, 5 devices of each model were tested. Each device was soldered to a different test board (board material: Rogers 6035HTC) using sn63 solder. The soldered parts were then DCR tested using 4 wire leads. The results for this test are shown in Figure 7.

Outrigger Resistor Series per Test Plan TP-9277

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Test Group	A	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	A3	Description	Outrigger Resisitor, SMT
Test Step	Initial Electrical (DC Resistance) Inspection	Revision	B
Quantity	20	Test Plan	TP-9277
Date In	12/12/2019	Factory Order	18979, 223974
Date Out	12/13/2019	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50 Ω	Summary Sheet
Upper Limit DCR	52.5 Ω	Test Conditions
Lower Limit DCR	47.5 Ω	

	Initial Measurements		
Serial Number	DC Resistance (Ω)	Model	Test Date
1.1	50.34	CRH08115005F	1/8/2020
2.1	50.21	CRH08115005F	1/8/2020
3.1	50.31	CRH08115005F	1/8/2020
4.1	49.76	CRH08115005F	1/8/2020
5.1	50.21	CRH08115005F	1/8/2020
6.1	50.02	CRHA08115005F	1/7/2020
7.1	50.16	CRHA08115005F	1/7/2020
8.1	49.95	CRHA08115005F	1/7/2020
9.1	50.03	CRHA08115005F	1/7/2020
10.1	50.05	CRHA08115005F	1/7/2020
11	49.88	CRH12165005F	12/13/2019
12	49.89	CRH12165005F	12/13/2019
13	49.92	CRH12165005F	12/13/2019
14	49.90	CRH12165005F	12/13/2019
15	49.91	CRH12165005F	12/13/2019
16	49.67	CRHA12165005F	12/13/2019
17	49.93	CRHA12165005F	12/13/2019
18	49.81	CRHA12165005F	12/13/2019
19	49.75	CRHA12165005F	12/13/2019
20	49.85	CRHA12165005F	12/13/2019

Figure 9: Initial DCR Test Results

Figure 9 shows that all 20 pieces passed initial DCR. The data shows that all 20 pieces are all within ±0.5Ω (±1%) of 50Ω which is well within the spec of 50Ω±5%.

Thermal Shock

After initial DCR was complete the 5 devices of each model were subject to thermal shock. The parts were thermal shocked per the requirements listed in section 2.1. After thermal shock was complete the DCR of each part was measured again. The results are shown in Figure 9.

Outrigger Resistor Series per Test Plan TP-9277 — smiths interconnect bringing technology to life

Test Group	A	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	A5	Description	Outrigger Resistor, SMT
Test Step	Post Thermal Shock Electrical (DC Resistance) Inspection	Revision	B
Quantity	20	Test Plan	TP-9277
Date In	12/17/2019	Factory Order	18979, 223974
Date Out	12/17/2019	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50 Ω
Upper Limit DCR	52.5 Ω
Lower Limit DCR	47.5 Ω
Delta DCR	0.50 % (±)

	After Thermal Shock		Initial		
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model	Test Date
1.1	50.36	0.04	50.34	CRH08115005F	1/9/2020
2.1	50.23	0.04	50.21	CRH08115005F	1/9/2020
3.1	50.35	0.07	50.31	CRH08115005F	1/9/2020
4.1	49.87	0.23	49.76	CRH08115005F	1/9/2020
5.1	50.24	0.05	50.21	CRH08115005F	1/9/2020
6.1	50.05	0.00	50.02	CRHA08115005F	1/8/2020
7.1	50.16	0.00	50.16	CRHA08115005F	1/8/2020
8.1	49.96	0.02	49.95	CRHA08115005F	1/8/2020
9.1	50.04	0.02	50.05	CRHA08115005F	1/8/2020
10.1	50.05	0.00	50.05	CRHA08115005F	1/8/2020
11	49.90	0.05	49.88	CRH12165005F	12/17/2019
12	49.90	0.02	49.89	CRH12165005F	12/17/2019
13	49.93	0.01	49.92	CRH12165005F	12/17/2019
14	49.91	0.02	49.90	CRH12165005F	12/17/2019
15	49.92	0.01	49.91	CRH12165005F	12/17/2019
16	49.68	0.01	49.67	CRHA12165005F	12/17/2019
17	49.92	-0.01	49.93	CRHA12165005F	12/17/2019
18	49.81	0.01	49.81	CRHA12165005F	12/17/2019
19	49.76	0.00	49.75	CRHA12165005F	12/17/2019
20	49.85	0.01	49.85	CRHA12165005F	12/17/2019

Figure 10: Post Thermal Shock DCR Results

Figure 10 shows that all 20 pieces passed thermal shock. In order to pass thermal shock, the % change in DCR of each part must be within ±0.5% of it is initial DCR measurement. Figure 10 clearly shows that all 20 parts tested pass the spec of ±0.5%. The max changed observed was serial number 4.1 (PN CHR08110505F) which was 0.23%. The remaining 19 pieces changed less than 0.10%.

Burn In

After thermal shock was complete the 5 devices of each model were subjected to 168hr burn in. The devices were burned in per the requirements laid out in section 2.1. After burn in testing was complete the DCR of each part was measured. The results are shown in figure 11.

Outrigger Resistor Series per Test Plan TP-9277 — smiths interconnect bringing technology to life

Test Group	A	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F,
Test Sequence	A7	Description	Outrigger Resistor, SMT
Test Step	Post Burn In Electrical (DC Resistance) Inspection	Revision	B
Quantity	20	Test Plan	TP-9277
Date In	12/18/2019	Factory Order	18979, 223974
Date Out	1/8/2020	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50 Ω
Upper Limit DCR	52.5 Ω
Lower Limit DCR	47.5 Ω
Delta DCR	0.50 % (±)
Power Handling	2.5, 3.5, 4, 12.5 W, respectively

	After Burn-in		Before Burn-in *	
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model
1.1	50.38	0.03	50.36	CRH08115005F
2.1	50.27	0.09	50.23	CRH08115005F
3.1	50.38	0.08	50.35	CRH08115005F
4.1	50.06	0.38	49.87	CRH08115005F
5.1	50.26	0.04	50.24	CRH08115005F
6.1	50.10	0.15	50.05	CRHA08115005F
7.1	50.21	0.11	50.16	CRHA08115005F
8.1	50.01	0.10	49.96	CRHA08115005F
9.1	50.14	0.20	50.04	CRHA08115005F
10.1	50.12	0.14	50.05	CRHA08115005F
11	50.01	0.22	49.90	CRH12165005F
12	49.98	0.16	49.90	CRH12165005F
13	49.99	0.13	49.93	CRH12165005F
14	49.99	0.16	49.91	CRH12165005F
15	50.00	0.16	49.92	CRH12165005F
16	49.75	0.15	49.675	CRHA12165005F
17	49.96	0.07	49.921	CRHA12165005F
18	49.83	0.04	49.814	CRHA12165005F
19	49.83	0.16	49.756	CRHA12165005F
20	49.94	0.18	49.849	CRHA12165005F

Figure 11: Post Burn in DCR Results

Figure 11 shows that the 20 devices passed their individual power handling requirements. In order to pass burn in, the % change in DCR of each device must be within ±0.5% of its post thermal shock measurement. 19 of the 20 devices changed less than 0.25% as shown in figure 9. Serial number 4.1 changed 0.38% (largest changed observed), but still meets the requirement of ±0.5%

3.2 Group B

Subgroup 1

Resistance to Temperature Characteristics (RTC)

After passing group A, 1 device of each model was subjected to RTC. The testing requirements for RTC are laid out in section 2.2. In order to pass RTC the hot and cold TCRs of each device must be less than ±200ppm/°c. The Results are shown in Figure 10.

Outrigger Resistor Series per Test Plan TP-9277 — smiths interconnect bringing technology to life

Test Group	B	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	B1-1	Description	Outrigger Resisitor, SMT
Test Step	Resistance to Temperature Characteristics	Revision	B
Quantity	2	Test Plan	TP-9277
Date In	11/14/2020	Factory Order	18979, 223974
Date Out	11/15/2020	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50	Ω
Upper Limit DCR	52.5	Ω
Lower Limit DCR	47.5	Ω
Delta DCR	200	ppm/°C (±)

	25C	-55C	RTC Cold	
Serial Number	DC Resistance (Ω)	DC Resistance (Ω)	Δ DC Resistance (ppm)	Model
10.1	50.136	50.046	22.44	CRHA08115005F
15	50.002	50.110	-27.00	CRH12165005F
20	49.970	49.791	44.78	CRHA12165005F

	25C	+125C	RTC Hot	
Serial Number	DC Resistance (Ω)	DC Resistance (Ω)	Δ DC Resistance (ppm)	Model
10.1	50.250	50.621	73.83	CRHA08115005F
11	50.020	50.170	29.99	CRH12165005F
20	50.012	50.569	111.37	CRHA12165005F

Figure 12: RTC Test Results

Figure 12 shows that all 3 devices passed RTC testing. The maximum TCR observed was the hot TCR for serial number 20 which was 111.37ppm/°C (less 200ppm/°C). All other devices had TCRs of less than 100ppm/°C.

Subgroup 2

Low Temp Operation

After Group A testing was complete 2 devices of each model were subjected to Low Temp Operation. The test requirements for low temperature operation are laid out in section 2.2. In order to pass low temp operation, the %change in DCR must be within ±0.25% of is pre low temp operation value. The results of this test are shown in Figure 13.

Outrigger Resistor Series per Test Plan TP-9277

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Test Group	B	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	B2-2	Description	Outrigger Resisitor, SMT
Test Step	Low Temperature Operation	Revision	B
Quantity	8	Test Plan	TP-9277
Date In	1/22/2020	Factory Order	18979, 223974
Date Out		Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50	Ω
Upper Limit DCR	52.5	Ω
Lower Limit DCR	47.5	Ω
Delta DCR	0.50	% (±)
Power Handling	2.5, 8.5, 4, 12.5	W

	After Low Temp Op		Initial		
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model	B/I Date
1.1	50.38	0.01	50.38	CRH08115005F	1/22/2020
2.1	50.29	0.04	50.27	CRH08115005F	1/22/2020
6.1	50.12	0.03	50.10	CRHA08115005F	1/23/2020
7.1	50.26	0.01	50.26	CRHA08115005F	1/23/2020
11	50.00	0.00	50.00	CRH12165005F	1/22/2020
12	49.97	0.00	49.97	CRH12165005F	1/22/2020
16	49.76	0.01	49.75	CRHA12165005F	1/23/2020
17	49.96	0.00	49.96	CRHA12165005F	1/23/2020

Figure 13: Low Temperature Operation Test Results.

Figure 13 shows that all 8 pieces passed low temp operation. As figure 13 shows, there was virtually no change in DCR for any of the parts. The maximum change observed was 0.04% (serial number 2.1) which is essentially measurement error.

High Temperature Exposure

After low temperature was completed, the 2 devices of each model were subjected to high temperature exposure. The requirements for high temperature exposure are laid out in section 2.2. In order to pass high temperature exposure, the % change in DCR of each device must be within ±0.5% of its pre-test value. The results for high temperature exposure are shown in figure 14.

Outrigger Resistor Series per Test Plan TP-9277

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Test Group	B	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	B2-4	Description	Outrigger Resisitor, SMT
Test Step	High Temperature Exposure	Revision	B
Quantity	8	Test Plan	TP-9277
Date In	1/24/2020	Factory Order	18979, 223974
Date Out	1/29/2020	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50	Ω
Upper Limit DCR	52.5	Ω
Lower Limit DCR	47.5	Ω
Delta DCR	0.50	% (±)
VSWR Limit	0.75 / 2.0	kg.

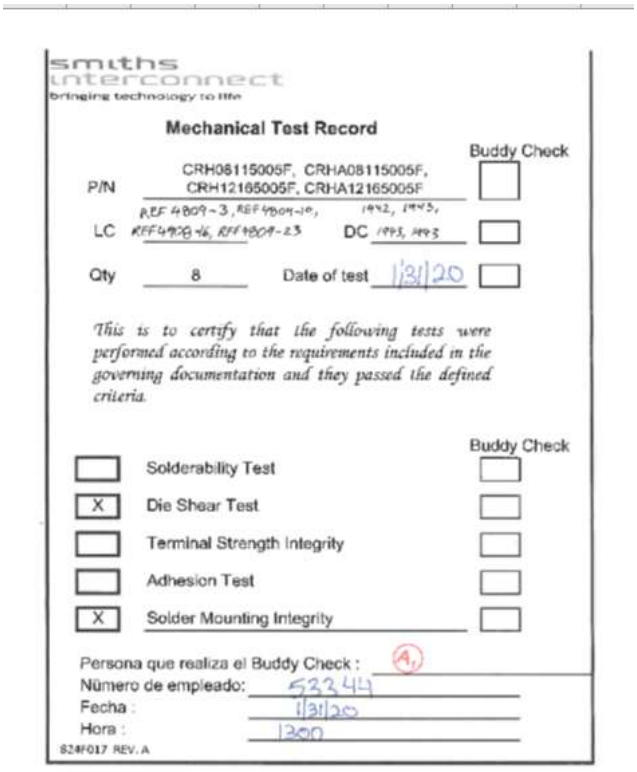
	After High Temperature Exposure		Initial (APC)	
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model
1.1	50.36	-0.03	50.38	CRH08115005F
1.2	50.26	-0.07	50.29	CRH08115005F
6.1	50.14	0.05	50.12	CRHA08115005F
7.1	50.29	0.07	50.26	CRHA08115005F
11	50.00	0.00	50.00	CRH12165005F
12	49.98	0.01	49.97	CRH12165005F
16	49.76	0.01	49.76	CRHA12165005F
17	49.98	0.03	49.96	CRHA12165005F

Figure 14: High Temperature Exposure DCR test results

Figure 14 shows that the 8 pieced passed high temperature exposure. As figure 14 shows, there was very little to no change in DCR after subjecting the devices to high temperature exposure. The maximum changed observed was -.07% for serial number 1.2 (PN CRH08110505F) which is essentially measurement error.

Solder Mount Integrity

After high temperature was completed, the 8 devices of each model were subjected to solder mount integrity. The test requirements for solder mount integrity are laid out section 2.2. In order to pass solder mount integrity, the devices must pass visual inspection from quality. The results for solder mount integrity are shown in figure 15.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Mechanical Test Record

Buddy Check

P/N CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F

REF 4809-3, REF 4809-10, 1992, 1995,

LC REF 4809-16, REF 4809-23 DC 1995, 1993

Qty 8 Date of test 1/31/20

This is to certify that the following tests were performed according to the requirements included in the governing documentation and they passed the defined criteria.

Buddy Check

- [ ] Solderability Test
- [X] Die Shear Test
- [ ] Terminal Strength Integrity
- [ ] Adhesion Test
- [X] Solder Mounting Integrity

Persona que realiza el Buddy Check : A.

Número de empleado: 53344

Fecha : 1/31/20

Hora : 1300

824F017 REV. A

Figure 15: Solder mount integrity Mechanical record

3.3 Group C

Life Test

Three devices of each model were subjected to life test. Two of three devices were the left-over pieces from group A that didn't go through group B testing. The third device came from RTC testing. For this test, the devices were mounted to the heat sinks the same way they were mounted for group A burn in. The devices were also burned in at the same power levels described in section 2.1. DCR measurements were taken for each device after 250hrs, 500hrs, and 1000hrs. In order to pass life test, the % change in DCR must be within ±0.5% of its previous measurement. The results for the life test are shown in figures 16-18.

Outrigger Resistor Series per Test Plan TP-9277

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Test Group	C	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	C2	Description	Outrigger Resisitor, SMT
Test Step	Life Test	Revision	B
Quantity	12	Test Plan	TP-9277
Date In	1/20/2019	Factory Order	18979, 223974
Date Out	3/3/2020	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50	Ω
Upper Limit DCR	52.5	Ω
Lower Limit DCR	47.5	Ω
Delta DCR	0.50	% (±)
Power Handling	2.5, 8.5, 4, 12.5	W

1/31/2020	After 250 Hours		Initial		Lid Temp
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model	(C)
3.1	50.41	0.07	50.38	CRH08115005F	76
4.1	50.14	0.18	50.05	CRH08115005F	78
5.1	50.27	0.03	50.26	CRH08115005F	76
8.1	50.04	0.03	50.03	CRHA08115005F	75
9.1	50.11	-0.05	50.13	CRHA08115005F	79
10.1	50.12	-0.06	50.15	CRHA08115005F	76
13	50.01	0.03	50.00	CRH12165005F	102
14	50.00	0.05	49.97	CRH12165005F	98
15	50.01	0.05	49.99	CRH12165005F	96
18	49.83	0.01	49.82	CRHA12165005F	93
19	49.82	-0.02	49.83	CRHA12165005F	97
20	50.01	-0.05	50.03	CRHA12165005F	99

Figure 16: Post 250hr Burn in DCR Test Results

2/11/2020	After 500 Hours		250 Hours		Lid Temp
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model	(C)
3.1	50.43	0.04	50.41	CRH08115005F	74
4.1	50.15	0.03	50.14	CRH08115005F	73
5.1	50.29	0.04	50.27	CRH08115005F	75
8.1	50.04	-0.01	50.04	CRHA08115005F	76
9.1	50.10	-0.01	50.11	CRHA08115005F	78
10.1	50.12	0.00	50.12	CRHA08115005F	77
13	50.03	0.04	50.01	CRH12165005F	93
14	50.02	0.05	50.00	CRH12165005F	98
15	50.03	0.03	50.01	CRH12165005F	95
18	49.81	-0.03	49.83	CRHA12165005F	93
19	49.81	-0.01	49.82	CRHA12165005F	95
20	49.98	-0.05	50.01	CRHA12165005F	94

Figure 17: Post 500hrs Burn in DCR Test Results

3/3/2020	After 1000 Hours		500 Hours		Lid Temp
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model	(C)
3.1	50.47	0.07	50.43	CRH08115005F	74
4.1	50.20	0.10	50.15	CRH08115005F	73
5.1	50.32	0.05	50.29	CRH08115005F	75
8.1	50.05	0.01	50.04	CRHA08115005F	75
9.1	50.10	-0.01	50.10	CRHA08115005F	76
10.1	50.10	-0.03	50.12	CRHA08115005F	77
13	50.05	0.04	50.03	CRH12165005F	99
14	50.05	0.06	50.02	CRH12165005F	98
15	50.05	0.05	50.03	CRH12165005F	94
18	49.82	0.01	49.81	CRHA12165005F	94
19	49.81	0.00	49.81	CRHA12165005F	96
20	49.99	0.02	49.98	CRHA12165005F	100

Figure 18: Post 1000hr burn in DCR Test Results

Figures 16-18 show that all 12 pieces pass life test. The maximum changed observed was the post 250hr measurement for serial 4.1 (PN CRH08110505F) which was 0.18%. All other changes observed

were less than ±0.10% well within the spec of ±0.5%. The post 1000hr measurements were also compared to the initial measurements to see how much change occurred during the duration of the life test. Those results are shown if figure 17.

Outrigger Resistor Series per Test Plan TP-9277 — smiths interconnect bringing technology to life

Test Group	C	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	C4	Description	Outrigger Resisitor, SMT
Test Step	Group A Initial to Post Life Electrical (DC Resistance) Inspection	Revision	B
Quantity	12	Test Plan	TP-9277
Date In	3/3/2020	Factory Order	18979, 223974
Date Out	3/3/2020	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50	Ω
Upper Limit DCR	52.5	Ω
Lower Limit DCR	47.5	Ω
Delta DCR	0.50	% (±)

	After 1000 Hours		Initial (0 Hours)	
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model
3.1	50.48	0.19	50.38	CRH12165005F
4.1	50.19	0.28	50.05	CRH12165005F
5.1	50.31	0.10	50.26	CRH12165005F
8.1	50.07	0.09	50.03	CRHA12165005F
9.1	50.12	-0.02	50.13	CRHA12165005F
10.1	50.13	-0.03	50.15	CRHA12165005F
13	50.05	0.11	50.00	CRH08115005F
14	50.05	0.16	49.97	CRH08115005F
15	50.05	0.13	49.99	CRH08115005F
18	49.85	0.05	49.82	CRHA08115005F
19	49.83	0.01	49.83	CRHA08115005F
20	50.02	-0.03	50.03	CRHA08115005F

Figure 19: Post 1000hr DCR test results compared to its initial values

Figure 17 shows how much each devise changed during the duration of the life test. According to figure 17 the maximum change observed was 0.28% for serial number 4.1 which is well within the spec of ±0.5%. All the other devices had a %change of less than 0.2%. Not only did each device move less than 0.5% after each individual measurement (i.e. after 250, 500, and 1000hrs), they didn't move more than 0.5% throughout the duration of the life test.

3.4 Combined Group A and C Results

After the life test was complete, the post 1000hr DCR measurements were also compared to each individual device's initial group A measurement to see how much change occurred throughout both group A and C testing. Those results are shown in figure 18.

Outrigger Resistor Series per Test Plan TP-9277 smiths interconnect bringing technology to life

Test Group	C	Part Number	CRH08115005F, CRHA08115005F, CRH12165005F, CRHA12165005F
Test Sequence	C4	Description	Outrigger Resisitor, SMT
Test Step	Group A Initial to Post Life Electrical (DC Resistance) Inspection	Revision	B
Quantity	12	Test Plan	TP-9277
Date In	3/3/2020	Factory Order	18979, 223974
Date Out	3/3/2020	Lot Code	REF 4908-3, -19, -16, -23
Operator	JA	Results	Pass

Nominal Resistance Value	50	Ω
Upper Limit DCR	52.5	Ω
Lower Limit DCR	47.5	Ω
Delta DCR	1.00	% (±)

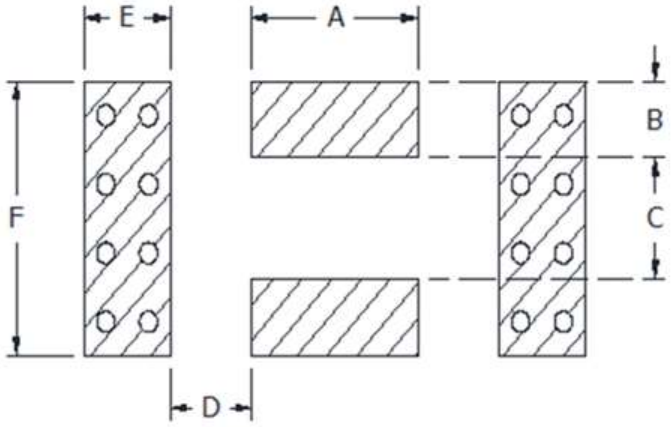
	After 1000 Hours		Initial Grp A	
Serial Number	DC Resistance (Ω)	Δ DC Resistance (%)	DC Resistance (Ω)	Model
3.1	50.48	0.32%	50.31	CRH08115005F
4.1	50.19	0.86%	49.76	CRH08115005F
5.1	50.31	0.19%	50.21	CRH08115005F
8.1	50.07	0.25%	49.95	CRHA12165005F
9.1	50.12	0.19%	50.03	CRHA12165005F
10.1	50.13	0.17%	50.05	CRHA12165005F
13	50.05	0.26%	49.92	CRH12165005F
14	50.05	0.30%	49.90	CRH12165005F
15	50.05	0.29%	49.91	CRH12165005F
18	49.85	0.07%	49.81	CRHA08115005F
19	49.83	0.15%	49.75	CRHA08115005F
20	50.02	0.35%	49.85	CRHA08115005F

Figure 20: Total %change in DCR throughout Group A and C Testing

Figure 20 shows the total changed observed throughout both Group A and C testing. According to figure 20, the maximum change observed was 0.86% for serial number 4.1 (PN CRH08110505F). Serial number 4.1 still passes the qualification because it passed each individual test per MIL-PRF-55432 including life test. All other devices moved less than 0.5% according to figure 18. Giving that 0.86% was the maximum changed observed thought out the duration of the qualification, it is safe to conclude that part numbers CRH0811XXXXF, CRHA1216XXXXF, CRH1216XXXXF, and CHRA0811XXXXF can be rate at 2.5, 12.5, 4, and 8.5 watts respectively.

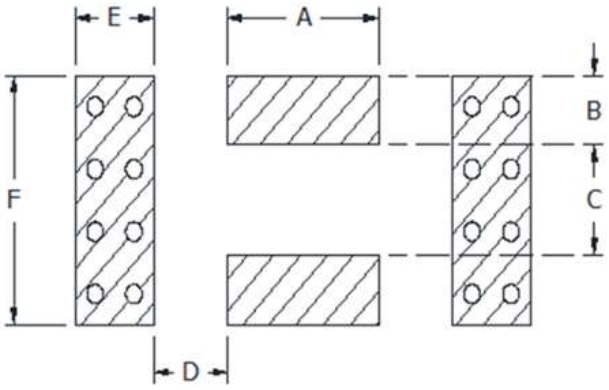
4. Mounting Instructions

The first step in mounting these devices is to design the appropriate test board. The CRH outrigger series is designed to be mounted on a co-planer wave guide 50ohm line. In the case of part numbers CRH1216XXXXF, CRH0811XXXXF, CRHA1216XXXXF, CRHA0811XXXXF the layout of chips was designed to be mounted to a co-planer waveguide 50ohm line for Rogers 6035HTC. For part numbers CRH1216XXXXF and CRHA1216XXXXF, the thickness of the Rogers material was 0.030" and for part numbers CRH0811XXXXF and CRHA0811XXXXF, the thickness of the Rogers material was 0.020". Rogers 6035HTC was used because of its high thermal conductivity (1.44W/m/K). If a more conventional material like Rogers 3003 or RO4350B is used, the power handling numbers shown in this report will go down. Smith's Interconnect recommends the following land patterns for the above part numbers.



	Inches						mm					
Part Number	A	B	C	D	E	F	A	B	C	D	E	F
CRH1216XXX5F	0.065	0.017	0.090	0.030	0.025	0.125	1.651	0.43	2.29	0.76	0.64	3.18

Figure 21: Recommended land pattern for PN CRH1216XXXXF and CRHA1216XXXXF



	Inches						mm					
Part Number	A	B	C	D	E	F	A	B	C	D	E	F
CRHA0811XXX5F	0.045	0.014	0.056	0.018	0.025	0.085	1.143	0.36	1.42	0.44	0.64	2.16

Figure 22: Recommended land pattern for PN CRH0811XXXF and CRHA0811XXXF

The land patterns shown in Figures 21 and 22 can also be used for the single CRH outrigger series. The only difference is one ground bar will be used for mounting for a single outrigger. As mentioned above the land patterns were designed for the devices to be mounted on Rogers 6035HTC. If a different material is used, adjustments will need to be made to land pattern in order to keep a 50ohm line.

To mount these parts, the devices need to be soldered your board as shown in figure 21.

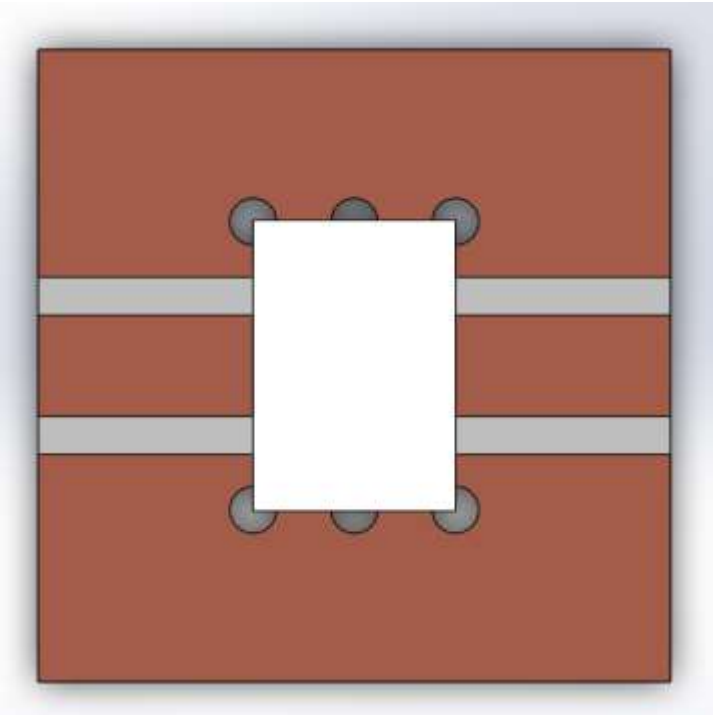


Figure 23: Dual CHR outrigger series mounted to its appropriate test board

The device can be mounted to the test board using either Sn96 or Sn63 depending on your application. During mounting, all solder profiles should be compliant with j-std-020. If the Sn96 is used, the peak body temperature should be 260°C, and if Sn63 is being used, the peak body temperature should be 220°c. The number of reflows should be no more than 3. It is also recommended that via holes be plugged with solder during the soldering process. If the via holes are plugged with solder, you will get more power out of the part. In the case of the parts tested in the above report, the devices were solder using Sn63. After solder the part to the board, a thin layer of thermal compound needs to be applied to the back side of the test board as shown in figure 24.

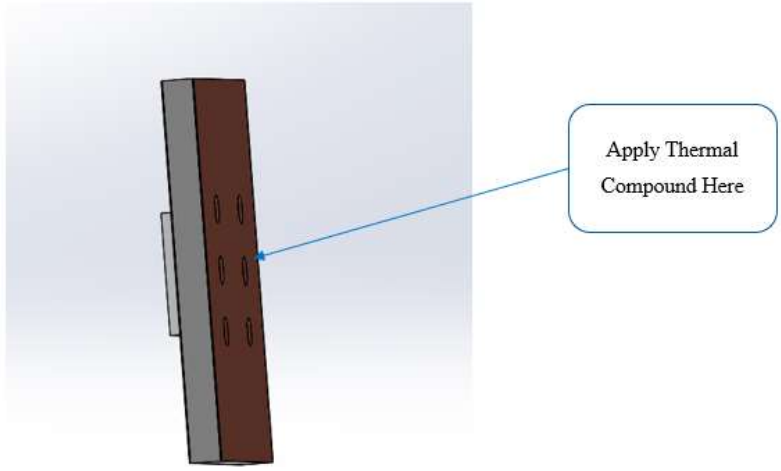


Figure 24: CRH0811XXX5F model showing were to apply the thermal compound

The thermal compound is applied to back of the test board to fill in any air gaps that may exist between the test board and your heat sink. It is very important that the layer of thermal compound be thin (i.e. around 1 mil thick). A 1 mil thick layer of thermal compound will ensure max power handling. If you go much thicker than 1 mil the power handling of the part will be reduced because the thermal compound can add thermal resistance if too much is applied. An easy way to get a 1 mil thick layer of thermal compound is to use a straight edge like a razor to remove any excess material. Once the thermal compound is applied, the device is ready to be mounted to your heat sin.

5. Analysis and Conclusion

The data in this report shows that each device passes the qualification test based on MIL-PRF-55432. Each device passed both the group A and C power handling requirements. According to MIL-PRF-55432 the % change in DCR for both the power handling and life test must be less than ±0.5%. The data confirms that no part moved more the 0.5% during both group A and C. The maximum changed observed was 0.28% for serial 4.1 (PN:

CRH08110505F) and that was total change observed from start to finish of the life test. All the other devices changed less than 0.5% though out the duration of the qualification testing. Proven through the data for Group A and C testing, we conclude that part numbers CRH0811XXXXF, CRHA1216XXXXF, CRH1216XXXXF, and CRHA0811XXXXF can be rated at 2.5 watts, 12.5 watts, 4 watts, and 8.5 watts respectively for resistive power CW applications. Furthermore, the products have passed all screening requirements based on MIL-PRF-55342 and are recommended for all RF application within the specification limits for each product series.