IPC V-TSL-MVIA HATS^{2TM} Single Via & IPC "D" Coupon Test Program

Stated Goals and Executive Summary of Test Program

The scope of the IPC V-TSL-MVIA test program that was submitted for HATS^{2TM} testing:

1) Compare differing stacked microvia structures to see which performs better through a 6 cycle IPC-TM-650 method 2.6.27B 230°C Reflow Simulation followed by subsequent thermal cycle reliability testing.
2) Compare data obtained using IPC-TM-650 method 2.6.27B's 1-second acquisition of data requirement for electrical measurements to a 7-second acquisition of data.
3) Provide a comparison of current accelerated reliability methodologies (HATS^{2TM} & Current Induced Heat Transfer Methods). The IPC committee will publish any comparative data between the methodologies as this report only covers HATS^{2TM} testing results.
    a. This report will cover HATS^{2TM} testing on IPC "D" style coupons submitted for a 6 cycle IPC-TM-650 method 2.6.27B - 230°C Reflow Simulation followed by subsequent thermal cycling of -55°C to 160°C using high speed air-to-sample heat transfer technology. This air-to-sample heat transfer is similar to what would happen in a Dual Chamber thermal cycling test with a significantly increased heat transfer rate to the test samples resulting in 1000 Thermal Cycles completed in a 1 week rather than 6 weeks.
    b. This report will cover HATS^{2TM} testing on IPC "D" style coupons submitted for a 6 cycle IPC-TM-650 method 2.6.27B 230°C Reflow Simulation followed by a subsequent 500x cycles of 25°C to 150°C preconditioning and subsequent 1000x cycles of 25°C to 190°C using high speed air-to-sample heat transfer technology. These cycling temperatures are based on the ECSS-Q-ST-70-60C specifications for IST testing of microvias.
    c. This report will cover HATS^{2TM} testing on HATS^{2TM} single via structures which eliminate daisy-chains and the resistance associated with the circuits connecting the vias allowing focus on monitoring a single via structure without interfering resistances. These results will also be compared to results from IPC "D" style daisy-chain coupons.

The terms reliability and robustness are used herein to define two different philosophies for the accelerated aging of test coupons. Reliability testing is typically done below the glass transition temperature (T_g) of the substrate material, while robustness testing exposes the samples to temperatures well above the T_g of the substrate material. This is done in order to add the addition acceleration factor of z-axis expansion above the PCB material's T_g, which tends to accelerate via failure. The influence on this added acceleration factor is not found in the life experience of products in the field after the component attachment process and while results obtained with robustness testing allow you to compare the relative performance of differing composite systems, it cannot, in general be correlated directly to life in the field without extensive and singular correlation to reliability testing. Two unique composite materials with differing robustness testing results may actually perform quite similarly in life expectancy during normal "in use" operations.

- Testing Services for this test program are provided to the industry courtesy of Microtek Laboratories China and HATS-Tester.com.
- HATS^{2TM} Single Via Coupon Designs are provided under license from HATS-Tester.com to, and courtesy of imec.

Introduction to HATS²™ Testing Technology

The HATS²™ Tester can perform Reflow Simulation & Thermal Shock/Cycling in accordance with IPC-TM-650 methods 2.6.27B & 2.6.7.2C as well as other industry Reflow Simulation or Thermal Shock/Cycling test methodologies. The high-speed air transfer mechanism used by the HATS²™ Tester high provides the fastest possible rate to move heat through the test coupons using "Air" as the heat transfer mechanism. This allows the samples to fully equalize at temperature extremes in 3-6 minutes (depending on thickness and thermal conductivity) rather than the 30 minutes required by Dual Chamber technologies, greatly speeding up the testing process.

Test Coupon nets are electrically tested (real time) in the HATS²™ Chamber using a 4-wire measurement system capable of currents up to 1A in order to make accurate and repeatable measurements of the test nets to determine barrel cracking or interconnection separation. HATS²™ Units can test up to 72 (2-net) IPC-2221B "D" coupons or 36 (4-net) Traditional HATS™ or (7-net) HATS²™ Single Via Coupons* during Reflow Simulation & Thermal Shock/Cycling to detect barrel cracking or interconnection separation in the plated via(s) of the test net.

The HATS²™ Tester most closely replicates the "Air" heat transfer mechanism of a Reflow Oven or Dual Chamber techniques that has been in use since the 1950's. Other High Speed Thermal Shock technologies use different heat transfer fluid mechanisms like Oil, Liquid Nitrogen, Sand or Circuit Conduction to transfer heat to the coupons which results in different heat transfer rates to and from the test coupons than what you would get from air. HATS²™ testers can test up to 252 nets (single via and/or daisy-chain) from a variety of test coupon styles. The HATS²™ tester can emulate any Reflow Profile that can be run in a convection reflow oven and accomplish 1000 thermal shock/cycles of 36 to 72 coupons in about a week.

For more information see www.HATS-Tester.com

* U.S. Patent 10,379,153. German Patent 10 2019 006 553.0. Chinese Patent ZL 201922142627.1. Worldwide Patents Pending.

Introduction to HATS²™ Single Via Coupons*

The HATS²™ Single Via Coupon uses Patented* Technology to allow accurate, high current, micro-ohm precision, 4-wire resistance measurement of 7 Single Vias and/or Daisy-chain test nets in a HATS²™ machine. This allows accelerated testing of 7 net Single Via and/or Daisy-chain test nets to take place in a HATS²™ machine.

Why Test Single Vias instead of Daisy-chains?
Multiple vias daisy-chained together have historically been tested to validate via robustness and reliability. Daisy-chains can be characterized as resistance connected in series, resistance of the circuits connecting the vias and the resistance of the vias themselves. In a daisy-chain, 60-90+% of the measured resistance comes from the circuits connecting the vias together and not from the actual vias themselves.

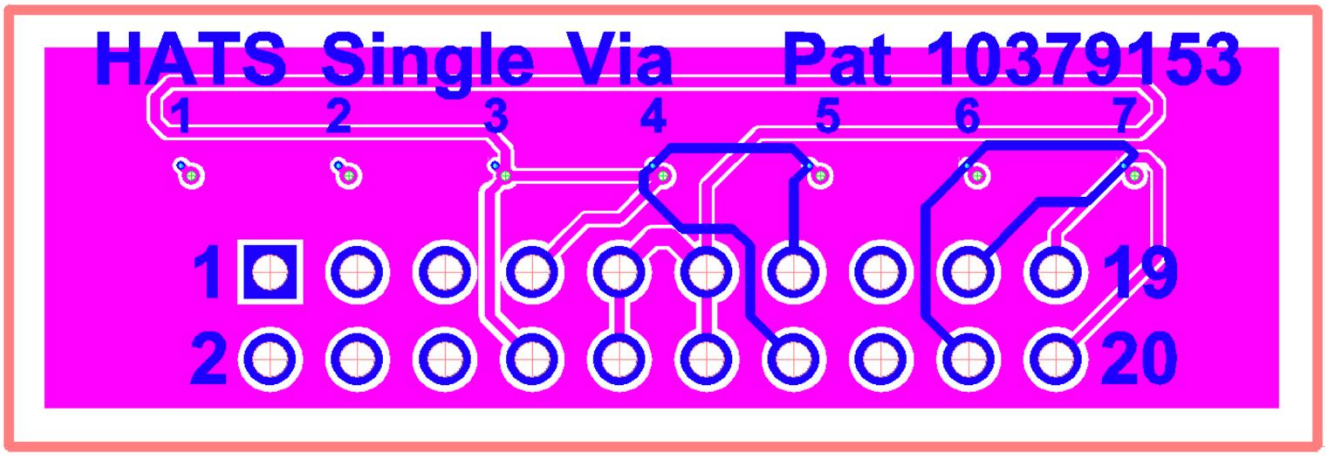
A typical single plated via has a resistance < 0.002 Ohms. In a 0.200 Ohm daisy-chain net, only .020 to .080 Ohms represents actual plated via resistance. The remainder of the resistance is made up of circuits. A 10% crack/separation in ALL of the plated vias at the same time, would only result in a 1 to 4% change in daisy-chain resistance and would not trigger a failure event. A 50% separation of a single via would result in 0.001-0.002 Ohm increase in a .200 Ohm daisy-chain and would register as a .5% change in daisy-chain resistance, a value that would likely be seen as electrical noise or slight shift in temperature of the test chamber.

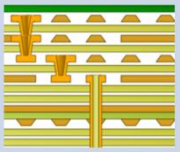
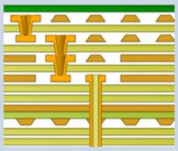
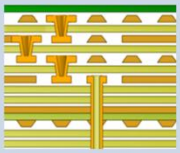
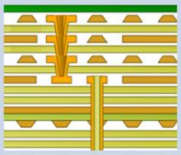
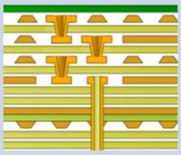
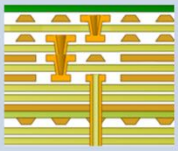
Daisy-chains of plated vias are electrically sensitive to the end of via(s) failure and cannot readily determine when plated vias begin the failure process. Daisy-chains certainly have their place in via reliability & robustness testing as they can determine when a plated via experiences complete failure, but the testing of single plated vias is the way to observe cracks/separations from their initiation through complete failure.

* U.S. Patent 10,379,153. German Patent 10 2019 006 553.0. Chinese Patent ZL 201922142627.1. Worldwide Patents Pending.

Test Samples

HATS²™ Single Via Coupon* Design (Nets 1-7)

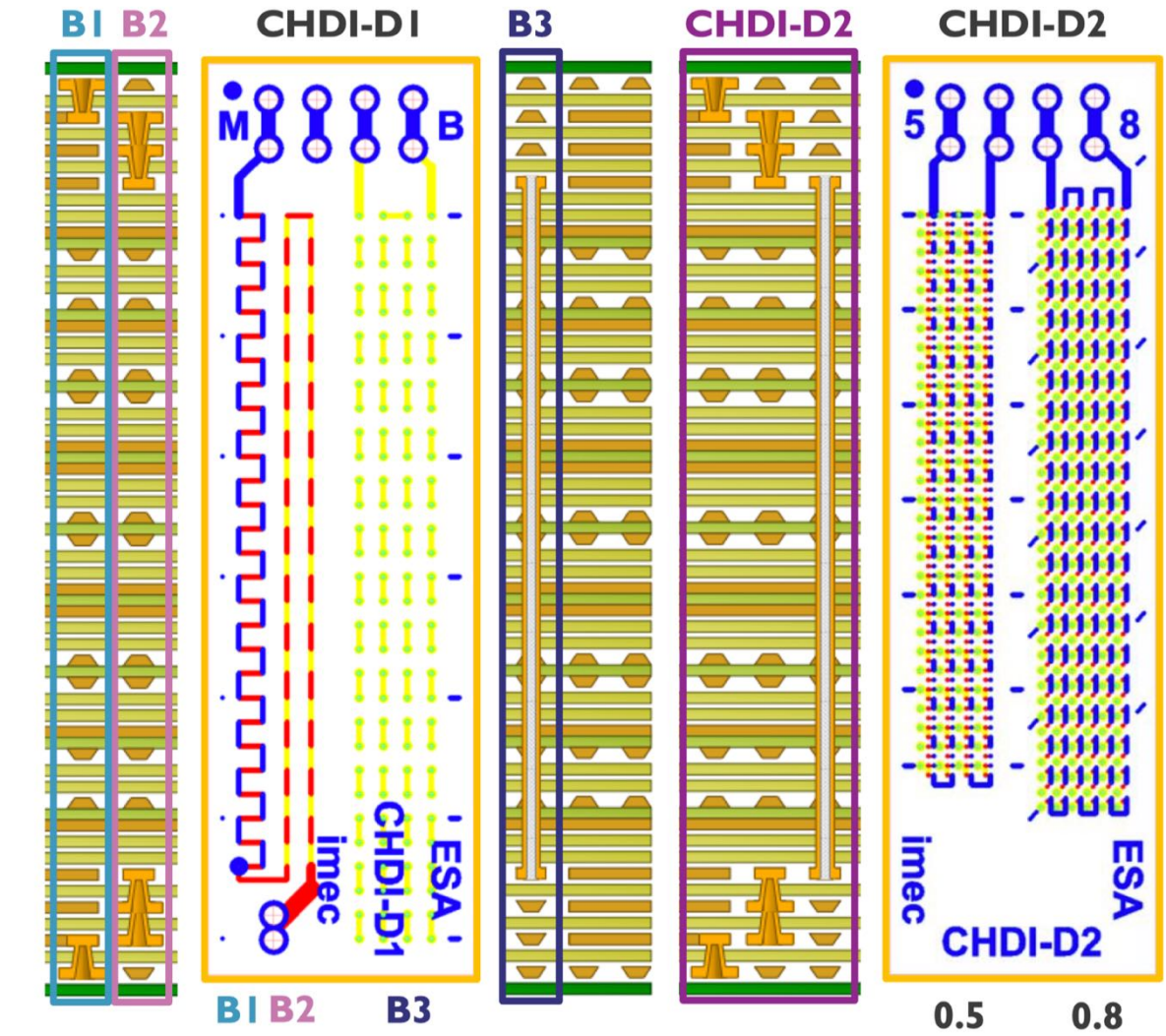


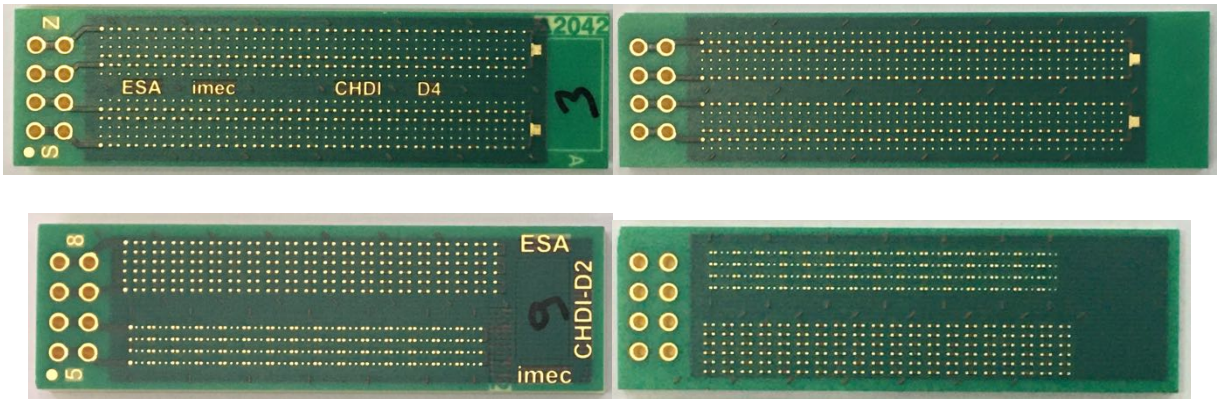
HATS² COUPON A		HATS² COUPON B		HATS² COUPON C	
 SEMI-STACKED OUTSIDE	 SEMI-STACKED INSIDE	 FULL STAGGERED	 FULL STACKED	 STAGGERED ABOVE BV	 SSI ABOVE BV
	1. MVs bottom		1. MVs bottom		1. MVs bottom
2. MVs bottom		2. MVs bottom		2. MVs bottom	
3. Buried via		3. Buried via		3. Buried via	
	4. Microvias top		4. Microvias top		4. Microvias top
	5. MVs+BV+MVs		5. MVs+BV+MVs		5. MVs+BV+MVs
6. MVs+BV+MVs		6. MVs+BV+MVs		6. MVs+BV+MVs	
7. Microvias top		7. Microvias top		7. Microvias top	

Net 1 & 4 are the same design on the Top and Bottom of the Test Coupon
Net 2 & 7 are the same design on the Top and Bottom of Test Coupon
Nets 5 & 6 are the same design and include the entire via structure (microvias top, buried vias microvias bottom)

* HATS²™ single via coupon: U.S. Patent 10,379,153. German Patent 10 2019 006 553.0. Chinese Patent ZL 201922142627.1. Worldwide Patents Pending.
** images courtesy of imec

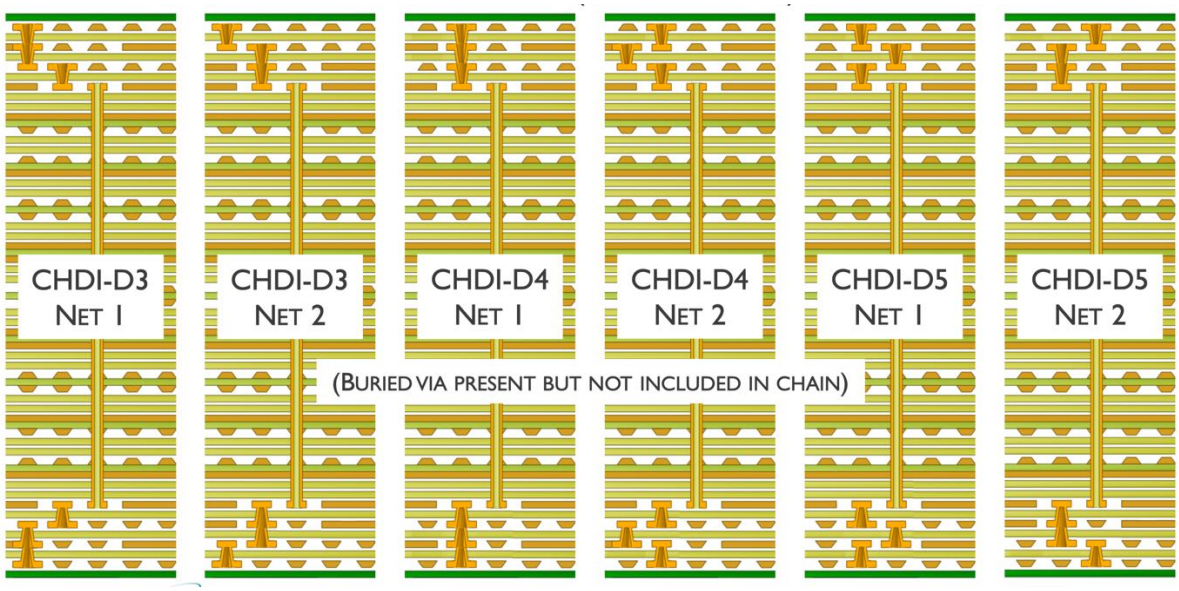
IPC "D" Coupon Designs



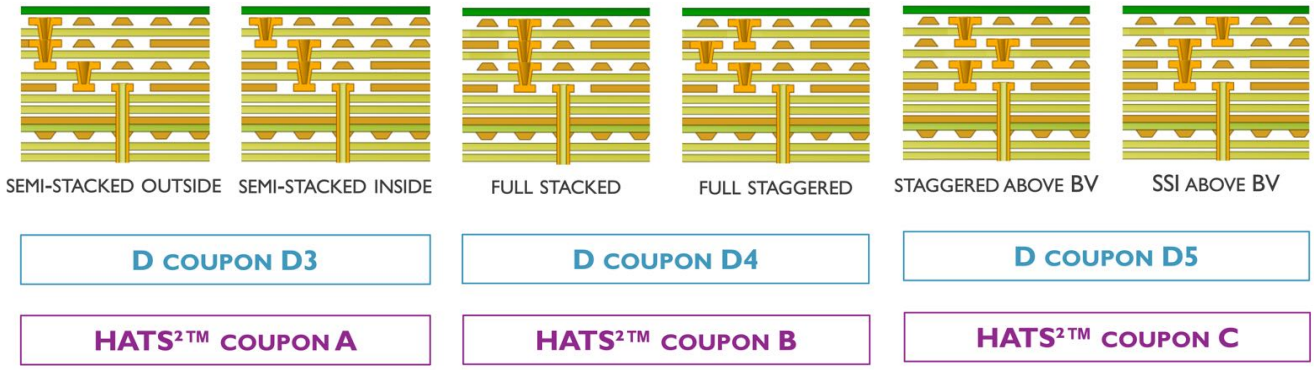


** images courtesy of imec

IPC "D" Coupon Designs

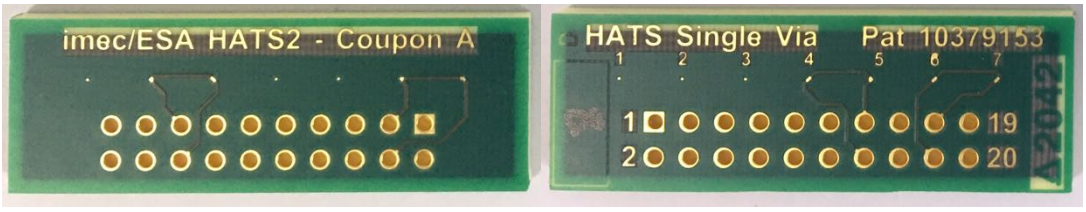


HATS²™ Single Via Coupons vs. IPC "D" Coupons



HATS²™ Single Via Coupon Test Program

Test Coupons from 6 panels, 3 designs per panel, 4 coupons per design condition per panel. The HATS²™ Single Via Coupon Test Program consists of 12 test groupings of samples with different design parameters, test conditions and environmental exposures, each of which is detailed below.



** images courtesy of imec

Test Groups 1A, 1B, 1C; 1 Coupon from each of 6 panels (1, 3, 4, 8, 9, 15) for each of 3 design conditions (A, B & C) from panel location A (for a total of 18 Coupons). Microvia size .125mm, Buried via size .250mm.

1A – 6 Coupons, imecESA HATS^{2TM} - Coupon AA,

1B – 6 Coupons, imecESA HATS^{2TM} - Coupon BA

1C – 6 Coupons, imecESA HATS^{2TM} - Coupon CA

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230 °C.

1. **7s** test measurement interval, 30s above 225°C

b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 1000x cycles from -55°C to 160°C

Test Groups 2A, 2B, 2C; 1 Coupon from each of 3 panels (1, 4, 9) for each of 3 design condition (A, B & C) from panel location B (for a total of 9 Coupons). Microvia size .125mm, Buried via size .250mm.

2A – 3 Coupons, imecESA HATS^{2TM} - Coupon AB

2B – 3 Coupons, imecESA HATS^{2TM} - Coupon BB

2C – 3 Coupons, imecESA HATS^{2TM} - Coupon CB

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.

1. **1s** test measurement interval, 30s above 225°C

b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 1000x cycles from -55°C to 160°C

Test Groups 3A, 3B, 3C; 1 Coupon from each of 6 panels (1, 3, 4, 8, 9, 15) for each of 3 design conditions (A, B & C) from panel locations B & C (for a total of 18 Coupons Total). Microvia size .125mm, Buried via size .250mm.

3A – 3 Coupons, imecESA HATS^{2TM} - Coupon AB; 3 Coupons, imecESA HATS^{2TM} - Coupon AC

3B – 3 Coupons, imecESA HATS^{2TM} - Coupon BB; 3 Coupons, imecESA HATS^{2TM} - Coupon BC

3C – 3 Coupons, imecESA HATS^{2TM} - Coupon CB; 3 Coupons, imecESA HATS^{2TM} - Coupon CC

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.

1. **7s** test measurement interval, 30s above 225°C

b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 500x cycles of "pre-conditioning" from 25°C to 150°C followed by 1000x cycles from 25°C to 190°C. (Based on the ECSS-Q-ST-70-60C specifications for IST testing of microvias.)

Test Group 4A, 4B, 4C; 1 Coupon from each of 3 panels (3, 8, 15) for each of 3 design conditions (A, B & C) from panel location C (for a total of 9 Coupons). Microvia size .125mm, Buried via size .250mm.

4A – 3 Coupons, imecESA HATS^{2TM} - Coupon AC

4B – 3 Coupons, imecESA HATS^{2TM} - Coupon BC

4C – 3 Coupons, imecESA HATS^{2TM} - Coupon CC

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.

1. **1s** test measurement interval, 30s above 225°C

b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 500x cycles of "pre-conditioning" from 25°C to 150°C followed by 1000x cycles from 25°C to 190°C. (Based on the ECSS-Q-ST-70-60C specifications for IST testing of microvias.)

IPC "D" Coupon Test Program

6 panels, 5 designs per panel, 2 coupons per design condition per panel. The IPC "D" Coupon test program consists of 10 test groupings of samples with different design parameters and environmental exposures, each of which is detailed below.

i. Coupons designated D1 & D2 were noted as "procurement" coupons. These will be used to compare 1s and 7s resistance sampling of each net during IPC-TM-650 2.6.27B Reflow exposure.
ii. Coupons Designated D3, D4, D5 are designated for comparison between test methodologies using 7s resistance sampling of each net.
iii. *3x D5 coupons were received damaged and not used in the test plan (panel 8, 9 & 15). 1x D2 coupon from Panel 9 coupon had one net open and is not included in the test plan. The damaged D2 coupon and one damaged D5 coupon from panel 15 were used to create an accurate temperature profile for reflow to IPC-TM-650 2.6.27B - 230°C requirements. The 2 remaining damaged D5 coupons from panels 8 & 9 were used to create precise thermal cycles to assure that the samples reached temperature extremes in accordance with IPC-TM-650 2.6.7.2C.

Test Group A3, A4, A5; 1 Coupon from each of 6 panels (1, 3, 4, 8, 9, 15) for each of 3 design conditions (D3, D4, D5) from panel locations A & C (for a total of 17 Coupons) (* Damaged D5 Coupon from panel 9 cannot be used for test)

A3 – 6 Coupons, imecESA CHDI-D3 A
A4 – 6 Coupons, imecESA CHDI-D4 A
A5 – 3 Coupons, imecESA CHDI-D5 A; 2 Coupons*, imecESA CHDI-D5 C

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.
    1. **7s** test measurement interval, 30s above 225°C
b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 1000x cycles from -55°C to 160°C

Test Group B3, B4, B5; 1 Coupon from each of 6 panels (1, 3, 4, 8, 9, 15) for each of 3 design conditions (D3, D4, D5) from panel location C (for a total of 16 Coupons) (* Damaged D5 Coupons from panel 8 & 15 cannot be used for test)

B3 – 6 Coupons, imecESA CHDI-D3 C
B4 – 6 Coupons, imecESA CHDI-D4 C
B5 – 4 Coupons*, imecESA CHDI-D5 C

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.
    1. **7s** test measurement interval, 30s above 225°C
b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 500x cycles of "pre-conditioning" from 25°C to 150°C followed by 1000x cycles from 25°C to 190°C. (Based on the ECSS-Q-ST-70-60C specifications for IST testing of microvias.)

Test Group C1, C2; 1 Coupon from each of 6 panels (1, 3, 4, 8, 9, 15) for each of 3 design conditions (D1, D2) from panel location A (for a total of 12 Coupons)

C1 – 6 Coupons, imecESA CHDI-D1 A

C2 – 6 Coupons, imecESA CHDI-D2 A

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.

1. **7s** test measurement interval, 30s above 225°C

b. Thermal Cycling: IPC-TM-650 2.6.7.2C: 1000x cycles from -55 °C to 160°C.

Test Group D1, D2; 1 Coupon from each of 6 panels (1, 3, 4, 8, 9, 15) for each of 3 design conditions (D1, D2) from panel location C (for a total of 11 test Coupons) (*Damaged D2 Coupon from Panel 9 cannot be used for test)

D1 – 6 Coupons, imecESA CHDI-D1 C

D2 – 5 Coupons*, imecESA CHDI-D2 C

a. Preconditioning: Bake for 8 hours at 120°C, place in desiccator to cool then run an IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C.

1. **1s** test measurement interval, 30 s above 225°C

b. Cycling: IPC-TM-650 2.6.7.2C: 1000x cycles from -55°C to 160°C.

Thermal Mechanical Analysis (TMA) Testing of PCB Material

IPC-TM-650 2.6.7.2C requires that the upper temperature for thermal shock/cycling be set at (T_g - 10°C). In order to determine the upper temperature for thermal shock/cycling, a sample was removed from the edge of a HATS^{2TM} coupon and the soldermask was subsequently removed by sanding. The remaining sample was then subjected to a double TMA, Degree of cure test per IPC-TM-650 Method 2.4.24C in order to determine T_g.

The T_g from the First TMA run was 165.1 and the T_g from the second run was 171.7°C indicating that some post curing of the resin system was accomplished during the 1st TMA run. This also shows that the apparent T_g of the PCB is near 170°C. Using this number in the calculation we set our IPC-TM-650 2.6.7.2C upper thermal shock/cycling temperature at 160°C (T_g - 10°C).

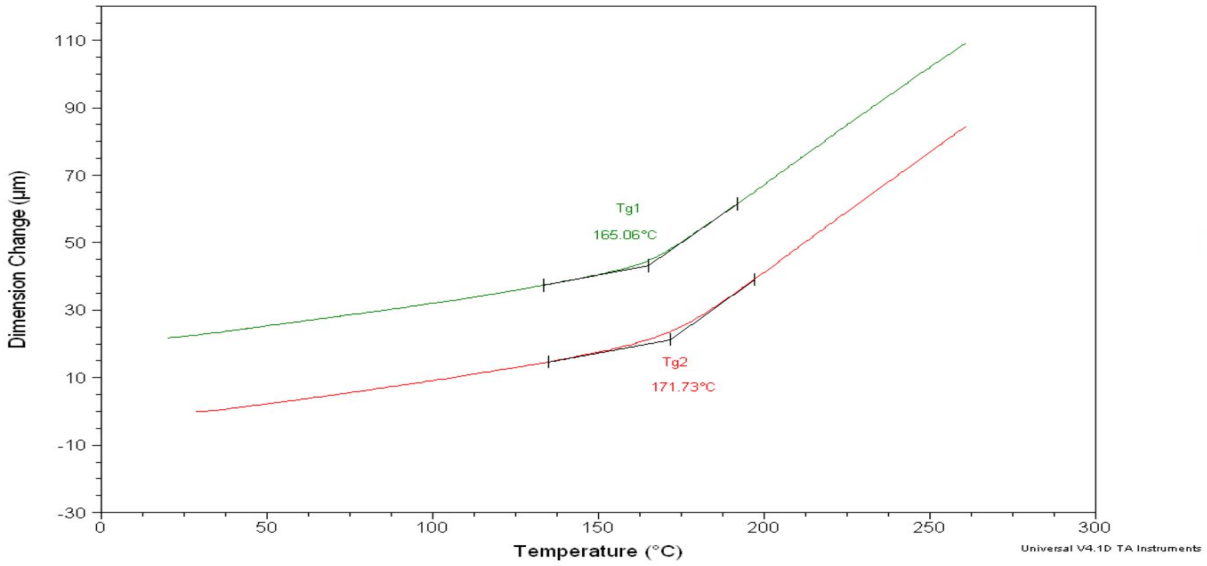
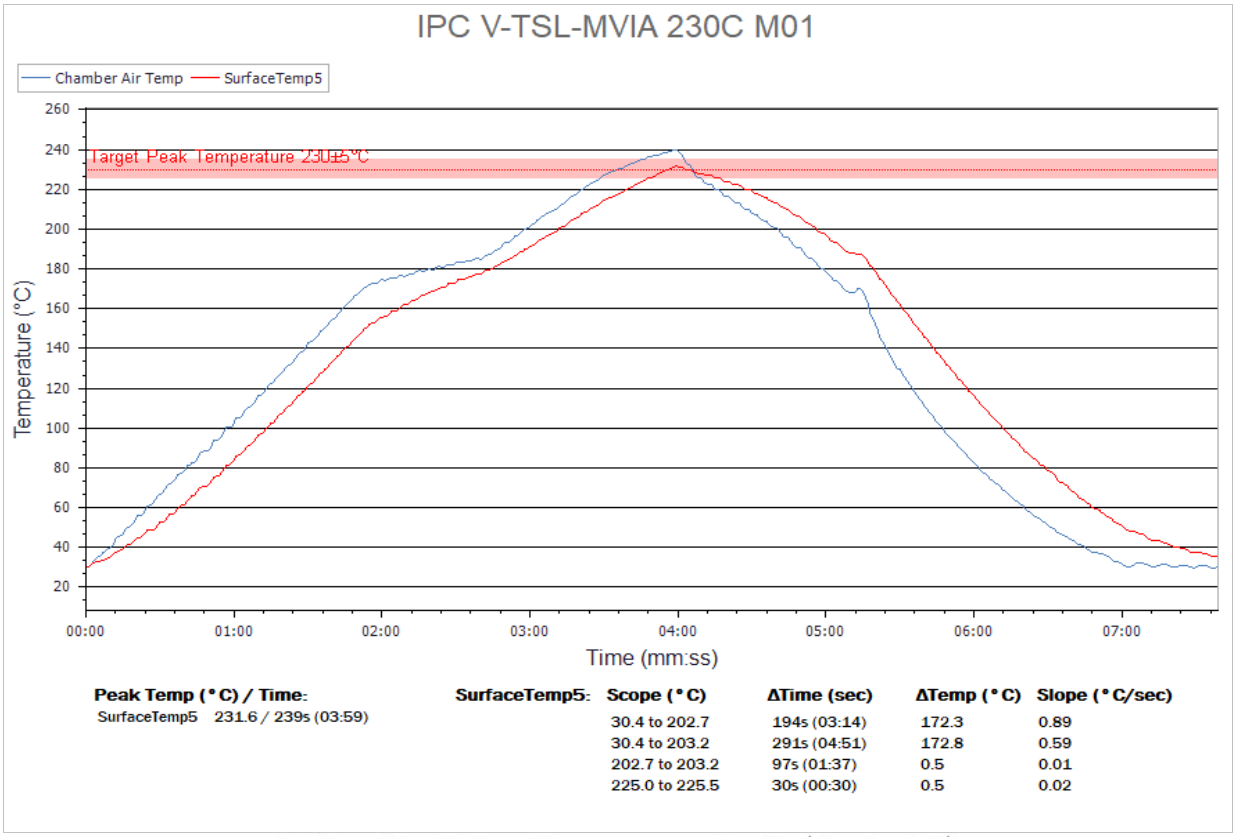


Table 1 Glass Transition Temperature and Z-CTE (TMA)

Sample Designation	HATS2 Coupon		Sample Identification	HATS Panel1 imec/ESA HATS2-Coupon A D	
Test Date	2020-11-20		Ambient	23℃, 49 %RH	
Sample No.		Z-CTE(µm/m·℃) (50～100)℃	Z-CTE(µm/m·℃) (200～260)℃	Tg	△Tg (℃)
28017-1-1	First Scan	50.96	262.8	165.06	6.67
	Second Scan	52.40	270.9	171.73	

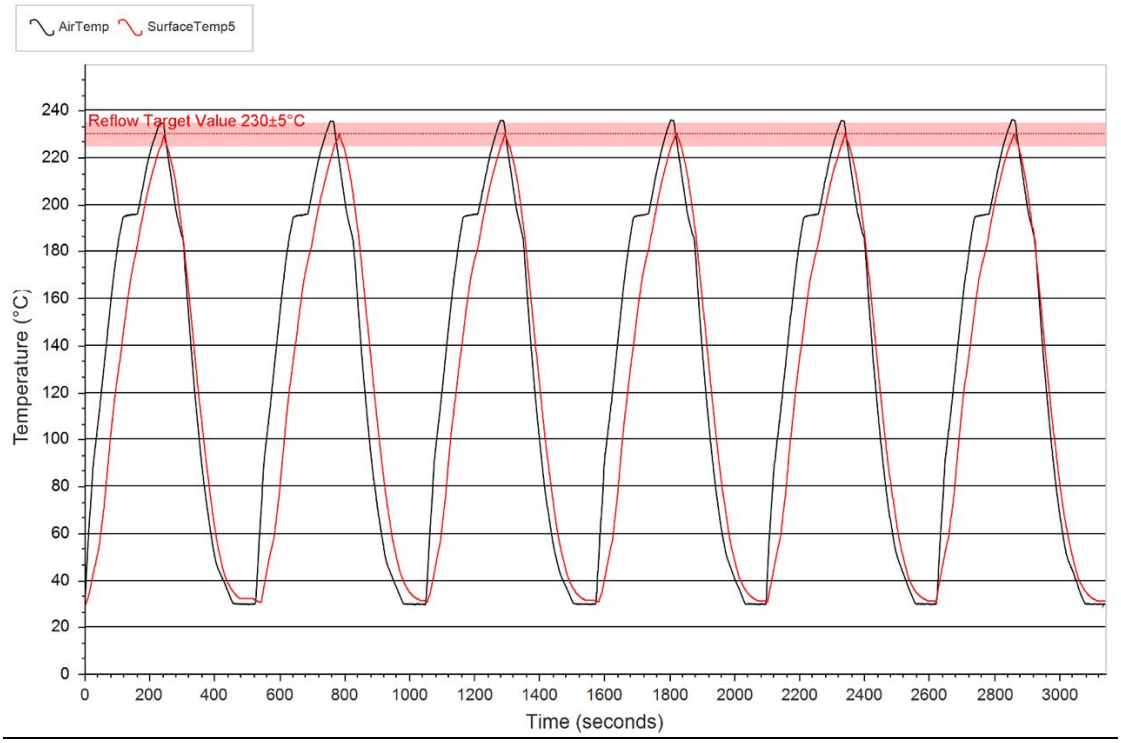
- TMA Test Results Courtesy of Microtek Laboratories China (www.TheTestLab.cn)

IPC 230°C Reflow Profile Performed on Untestable Coupon in HATS²™ Test Chamber



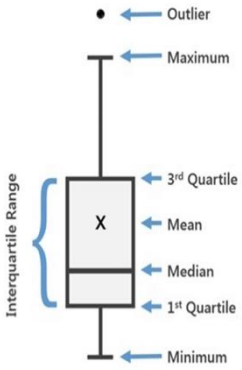
Peak Temp (°C) / Time:					
SurfaceTemp5	231.6 / 239s (03:59)	SurfaceTemp5:	Scope (°C)	ΔTime (sec)	ΔTemp (°C)	Slope (°C/sec)
			30.4 to 202.7	194s (03:14)	172.3	0.89
			30.4 to 203.2	291s (04:51)	172.8	0.59
			202.7 to 203.2	97s (01:37)	0.5	0.01
			225.0 to 225.5	30s (00:30)	0.5	0.02

Reflow Simulation Temperature Profile（Cycle 1-6）



Test Results

Box Plots are used to graphically display the distribution of a data set. The Box (Interquartile Range or IQR) extends from the first quartile (25th percentile of the data set) to the third quartile (75th percentile of the data set) and represents 50% of the population of the data set. The Median value of the data set is a represented by a line and the Mean value by an "X" within the box. A line and whisker extend from the bottom of the box (1st Quartile) to the Minimum value, representing the lower 25% of the population of the data set. A line and whisker extend from the top of the box (3rd Quartile) to the Maximum value, representing the upper 25% of the population of the data set. Statistical Outliers in the data set are represented by a "●" above or below the whiskers and are defined as any data value that is more than 1.5 times the IQR Distance away from the IQR.



IPC-TM-650 2.6.27B Reflow Simulation (Process Survivability Testing)

After running IPC-TM-650 2.6.27B Reflow Simulation six consecutive times to 230°C on all samples, no samples were found to exceed a 3% change and fell well within the 5% failure criteria given by the test method as "acceptable". The samples were then subjected to "Reliability" and "Robustness" testing where the failure criteria was set at a 20% change from that measured during the first cycle. The 20 % criteria was chosen to allow the application of a lower threshold (e.g. 5 % or 10%) retroactively if warranted. Here are summarized the highlights from the test data. The detailed results are below.

IPC "D" Coupons – Groups 1 & 2 – Testing of Daisy-chains with Structures Containing Buried Vias

These daisy-chain coupons were only subjected to reliability testing due to sample constraints. Group 1 contained 61 buried vias daisy-chained together and group 2 contained 240 single-stacked Inside microvia structures with buried vias daisy-chained together. Net 1 microvias were spaced on a 0.5 grid (buried via embedded every other via at 1mm pitch) & Net 2 microvias with buried vias were spaced at 0.8 grid. The results showed all via structures comprised of or containing buried vias failed the 20% criteria. The results did not show a notable difference between the two grid spacings of group 2. The resistance was slightly higher for the 0.8 grid spacing which is likely due to the greater length of the circuits connecting via structures. Increased circuit resistance can cause percentage differences between 2 spacings for similar via resistances despite the fact that both nets had the same quantity of vias.

IPC "D" Coupons – Groups 3, 4 & 5 – Testing of Daisy-chain with Microvias Only (No Buried Vias)

These coupons were subjected to both reliability and robustness testing. They contained 288 daisy-chained microvias connected in parallel on top and bottom of the coupon. This is not a typical design style for IPC D coupons and the parallel nature of the connection between daisy-chains on either side of the coupon reduces the influence of individual vias. Group 3 contained semi-stacked outside & semi-stacked inside via structures. Group 4 coupons contained full stacked & full staggered via structures. Group 5 coupons contained staggered above buried via & semi-stacked inside above buried via structures. None of the results for the structures represented by the daisy-chain nets from groups 3 and 5 showed an indication of failure in either reliability or robustness testing. The results for daisy-chains of full stacked via structures of group 4 in coupons 3 & 6 Showed a small increase of 1.5 & 3.5% respectively after robustness testing that was not seen in reliability testing. These are not a failing values, but maybe an indicator of failure initiation that is not observable in daisy-chains but can be detected using single via testing structures.

HATS²™ Single Via Coupons – Testing of Isolated Via Structures

These microvia structures tested without including the buried via structures showed no resistance changes greater than 2% during reliability testing and showed some slightly larger resistance changes that were no greater than 8% during robustness testing. While 5% may be considered a failing value for daisy-chained vias, 5% of a single via typically does not show any mechanical damage. An 8% value may be an indicator of failure initiation that is not observable in daisy-chains but can be detected using single via testing structures. The semi-stacked outside & semi-stacked inside structures from group 3A & 4A showed increases of resistance between 2% and 4% after robustness testing and the full stacked via structures from groups 3B & 4B showed 4 to 8% increases when compared to the full staggered via structures at 1 to 2% change. These small changes were not seen in the reliability testing that was done.

HATS²™ Single Via Coupons – Testing of Structures Containing Buried Vias

All of the with buried vias or microvia structures that included buried vias in the HATS²™ single via coupon showed failures above 20% for all nets in both reliability and robustness testing. The staggered above buried via structures from Groups 2C (Reliability Test) and 4C (Robustness Test) lasted longer than other microvia structures containing buried vias with the single staggered inside above buried via lasting the longest. This may indicate that the microvia structure placement has a direct effect on buried via reliability. The placement of the microvia structure in relationship to connected buried vias may end up being more important than the reliability of the microvia structure itself. The failures from robustness testing occurred substantially earlier and with a wider cycles to failure distribution and slope of resistance percentage than the reliability test which was very consistent between the samples tested.

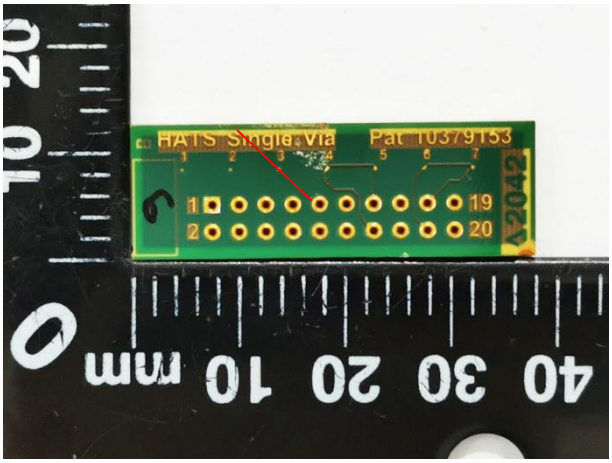
HATS²™ Single Via Coupons – Microsectional Evaluation of Groups 2A, 2B, 2C, 3A, 3B & 3C

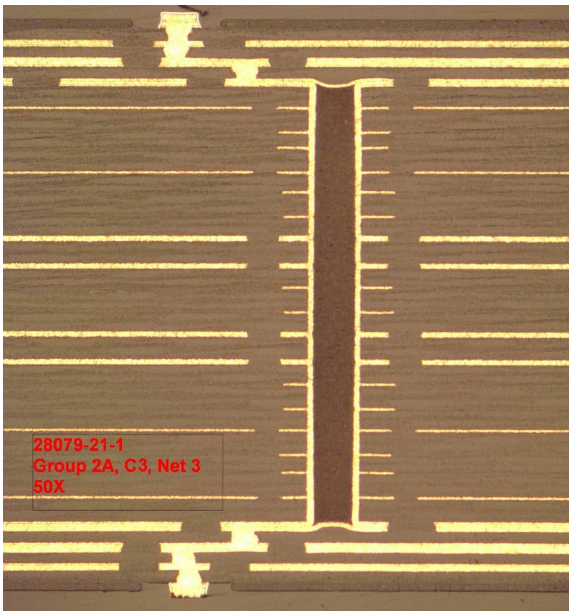
Single Via Structures from Groups 2A, 2B, 2C, 3A, 3B & 3C were microsectioned and evaluated in order to establish correlation between physical failures and the electrical test results. A sampling of nets from these test groups was microsectioned and evaluated for cracks and separations in the cross sectional area of the via structures. A summary chart and detailed photographic results are presented below.

Test Net Information	Buried Via Summary	Micro Via Summary
Group 2A, Coupon 3, Net 3	14 partial & 12 complete cracks found	No cracks or separations found
Group 2A, Coupon 3, Net 5	1 partial crack found	No cracks or separations found
Group 2A, Coupon 3, Net 6	6 partial & 1 complete crack found	No cracks or separations found
Group 2B, Coupon 1, Net 3	13 partial & 13 complete cracks found	No cracks or separations found
Group 2B, Coupon 1, Net 5	26 partial & 23 complete cracks found	No cracks or separations found
Group 2B, Coupon 1, Net 6	8 partial & 12 complete cracks found	No cracks or separations found
Group 2C, Coupon 3, Net 3	5 partial & 5 complete cracks found	1 partial crack at glass fiber
Group 2C, Coupon 3, Net 5	13 partial & 9 complete cracks found	No cracks or separations found
Group 2C, Coupon 3, Net 6	3 partial & 6 complete cracks found	No cracks or separations found
Group 3A, Coupon 4, Net 1	Not in Test Net - Not Evaluated	No cracks or separations found
Group 3A, Coupon 4, Net 7	Not in Test Net - Not Evaluated	No cracks or separations found
Group 3B, Coupon 2, Net 1	Not in Test Net - Not Evaluated	2 partial cracks found
Group 3B, Coupon 2, Net 7	Not in Test Net - Not Evaluated	4 partial cracks found
Group 3C, Coupon 4, Net 1	Not in Test Net - Not Evaluated	No cracks or separations found
Group 3C, Coupon 4, Net 7	Not in Test Net - Not Evaluated	No cracks or separations found

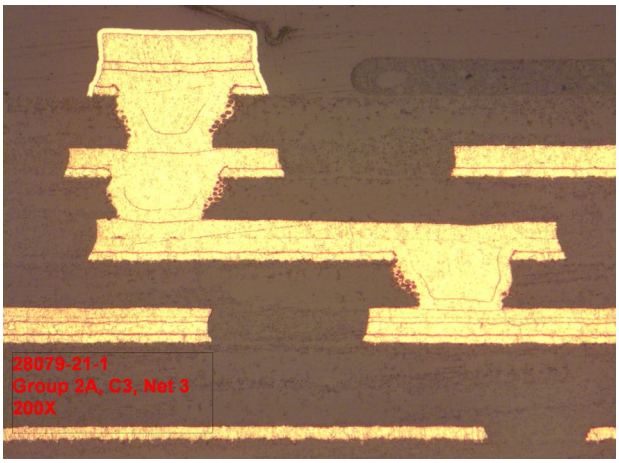
- Microsectional Analysis Courtesy of Microtek Laboratories China (www.TheTestLab.cn)

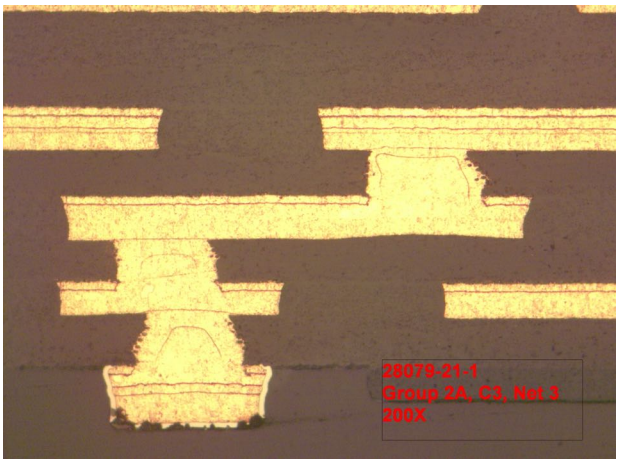
Group 2A, Coupon 3, Net 3





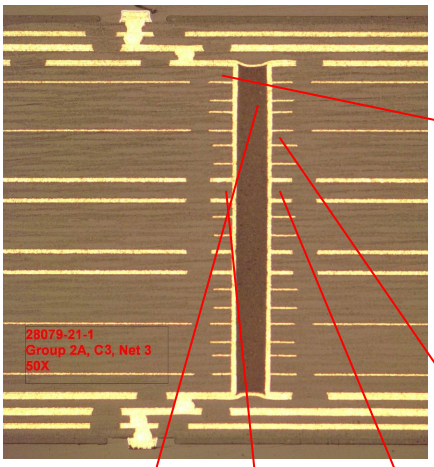
Summary: 14 partial cracks were found in the buried via;
12 complete cracks were found in the buried via

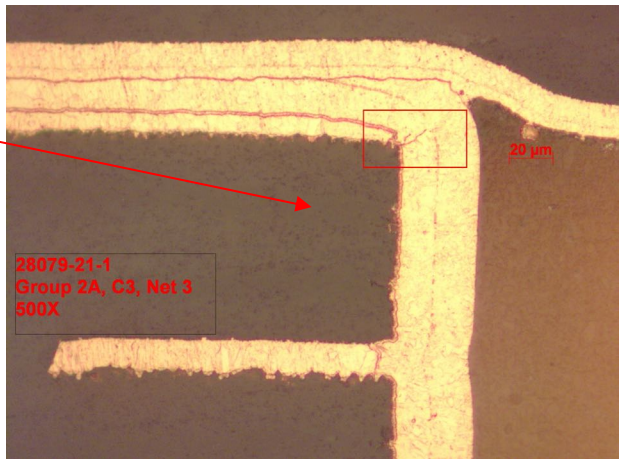




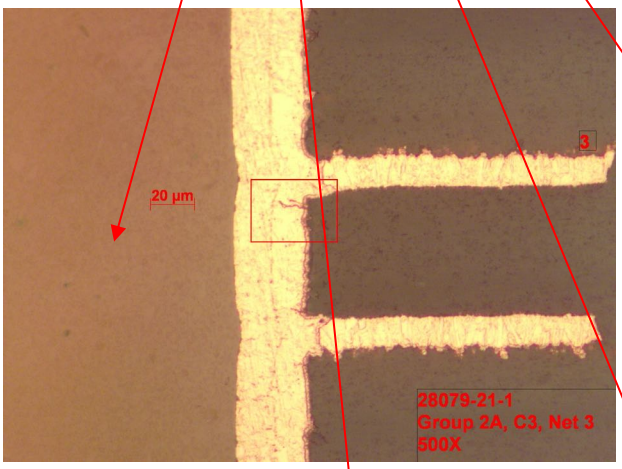
No cracks or separations were found in the micro via structure

Group 2A, Coupon 3, Net 3

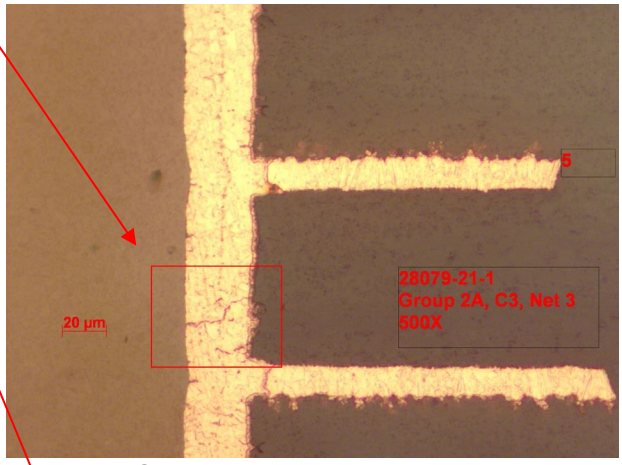




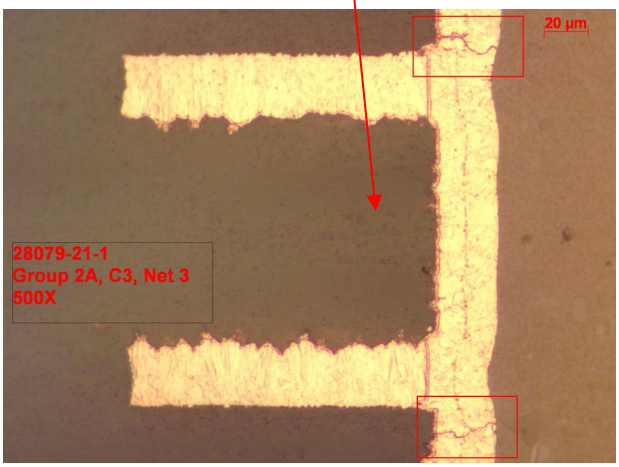
Partial corner crack

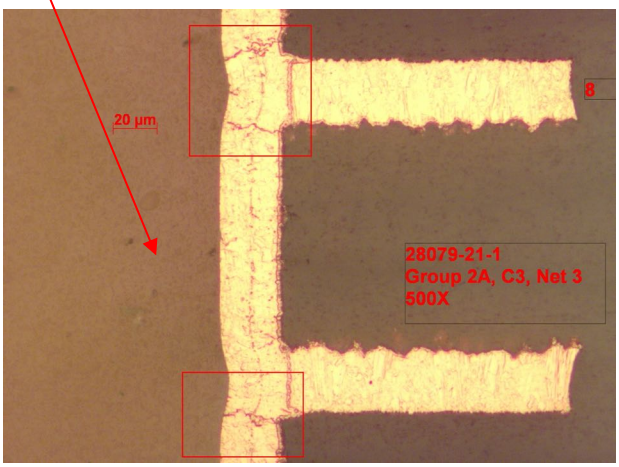


Partial barrel cracks



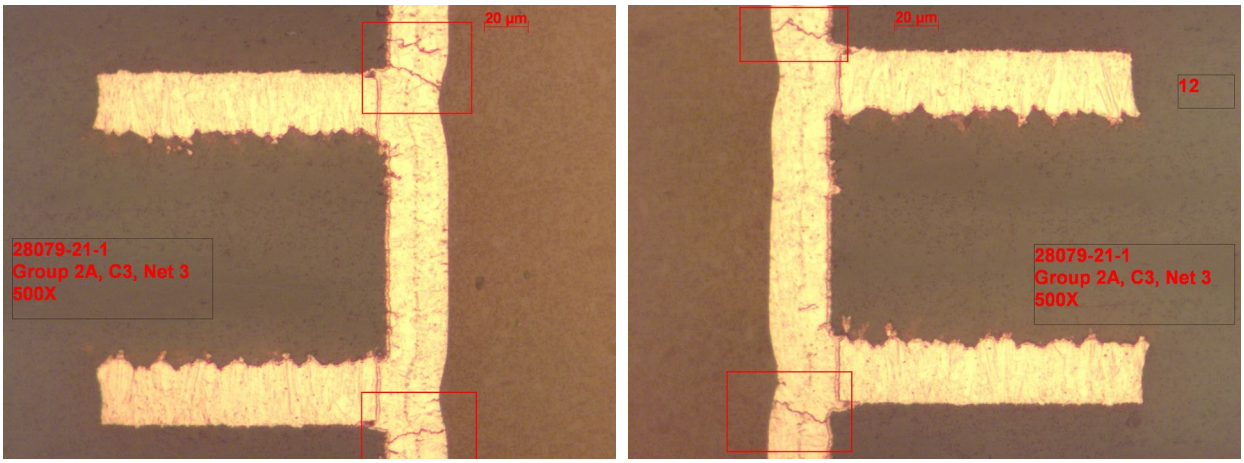
Complete barrel cracks





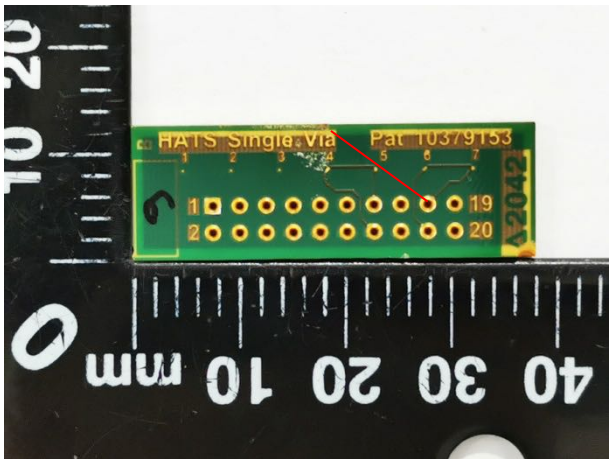
Complete barrel cracks

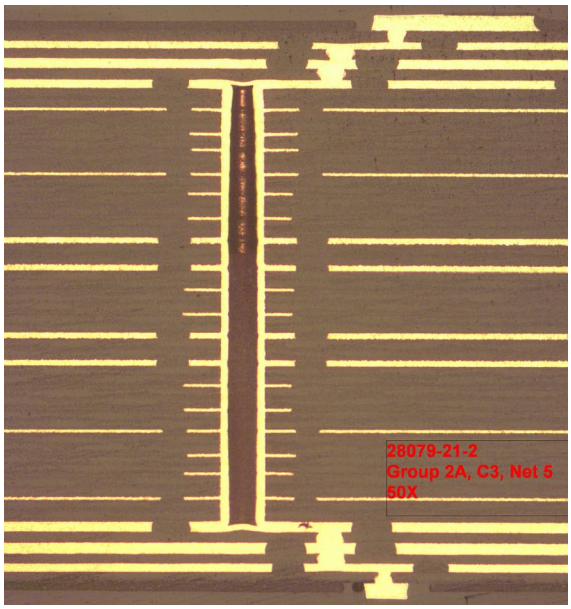
Group 2A, Coupon 3, Net 3



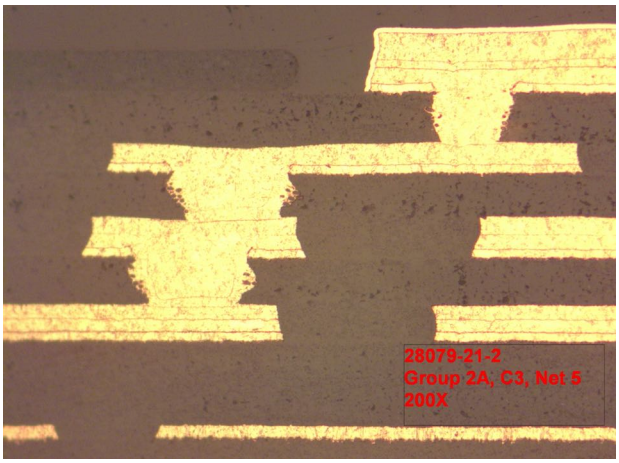
Complete barrel cracks

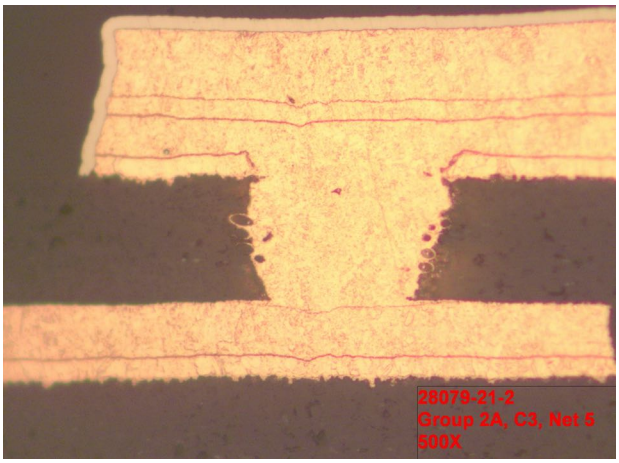
Group 2A, Coupon 3, Net 5





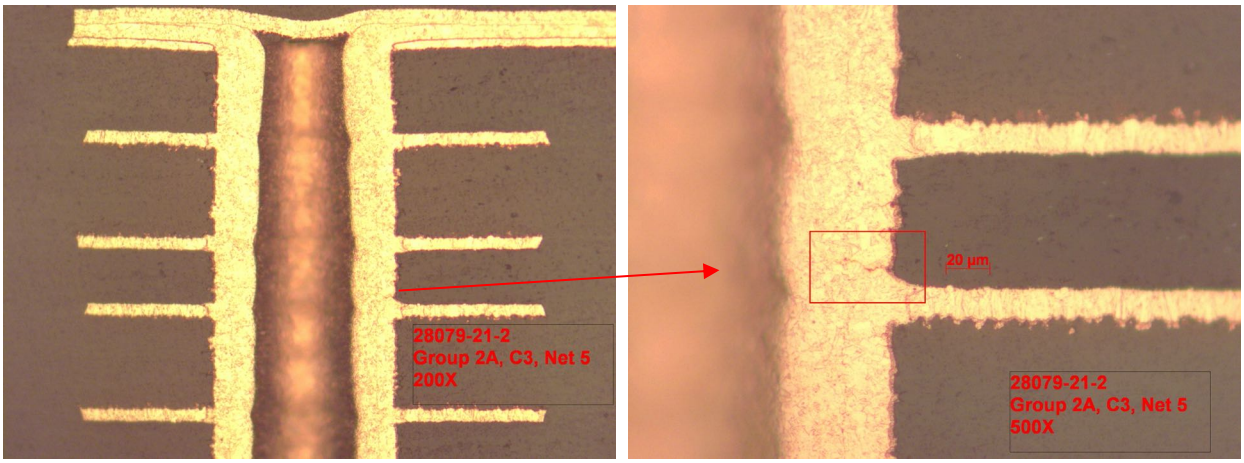
Summary: 1 partial crack was found the buried via



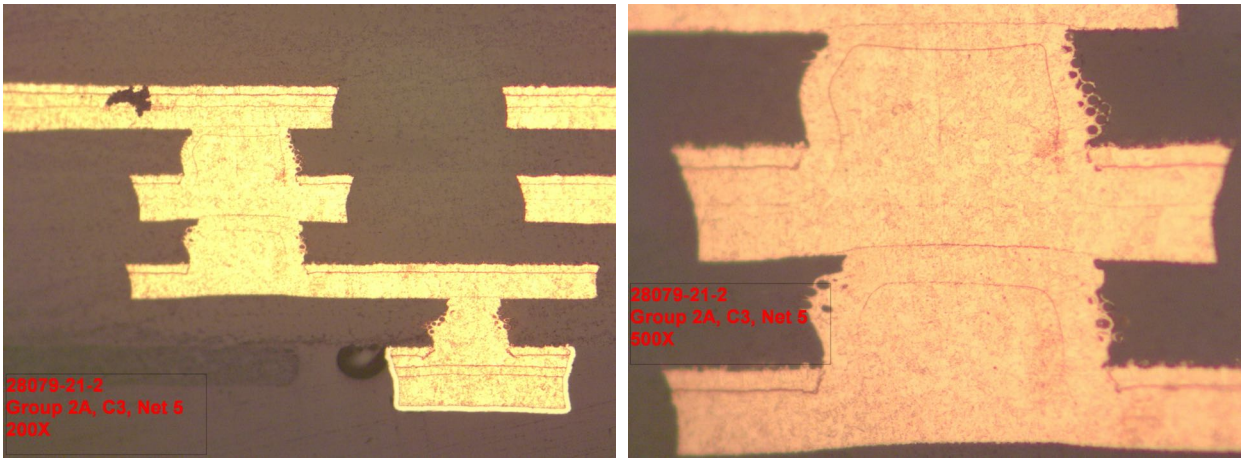


No cracks or separations were found in the micro via structure

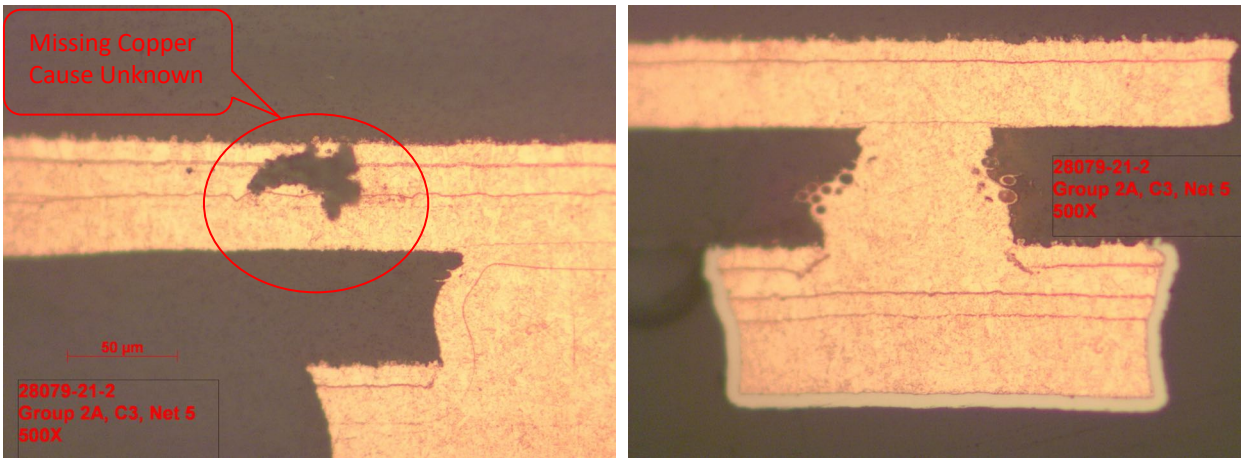
Group 2A, Coupon 3, Net 5



1 Partial crack was found in the buried via

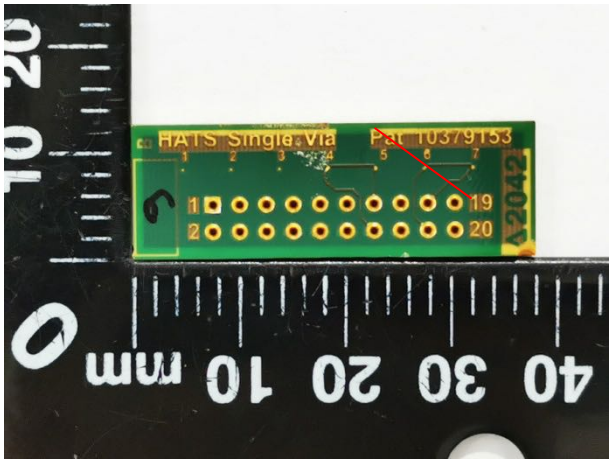


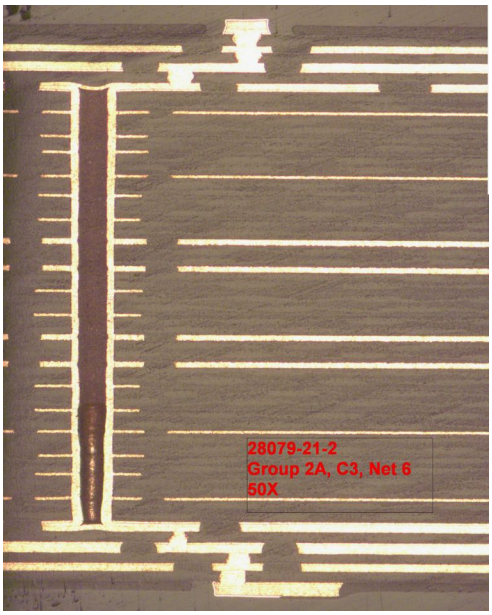
No cracks or separations were found in the micro via structure



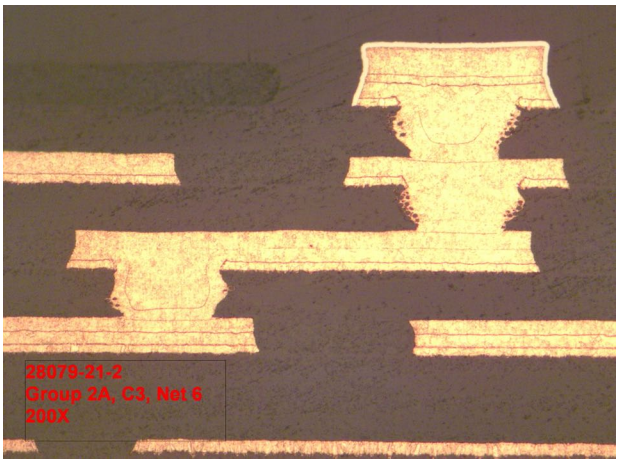
No cracks or separations were found in the micro via structure

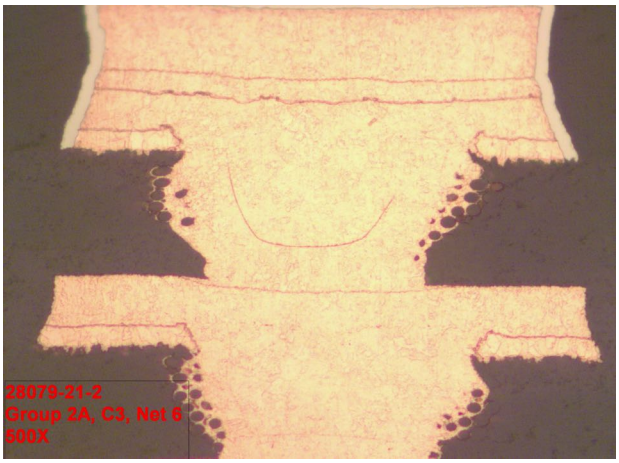
Group 2A, Coupon 3, Net 6





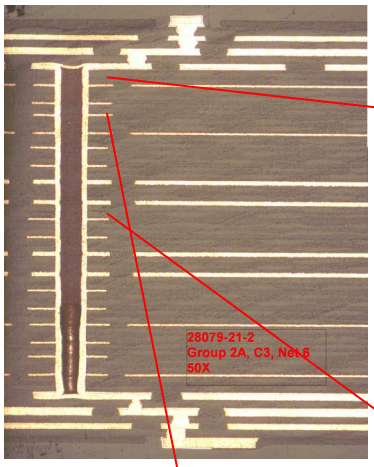
Summary: 6 partial cracks were found in the buried via;
1 complete crack was found in the buried via

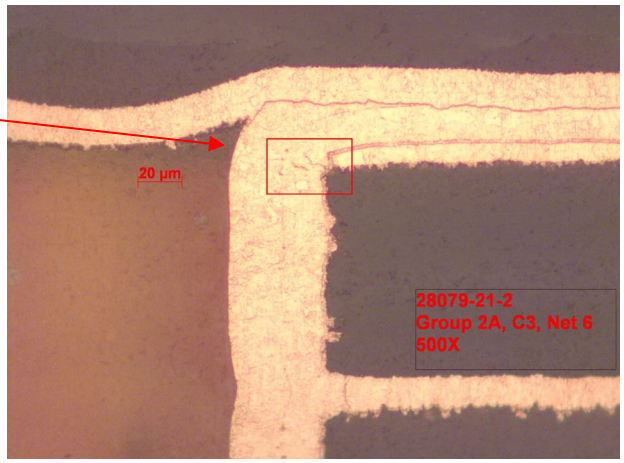




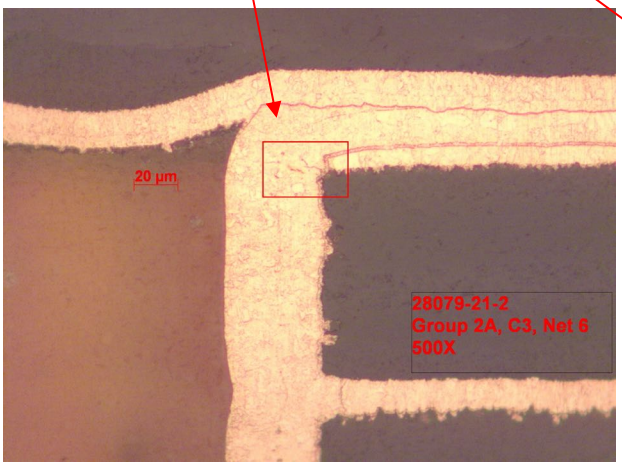
No cracks or separations were found in the micro via structure

Group 2A, Coupon 3, Net 6

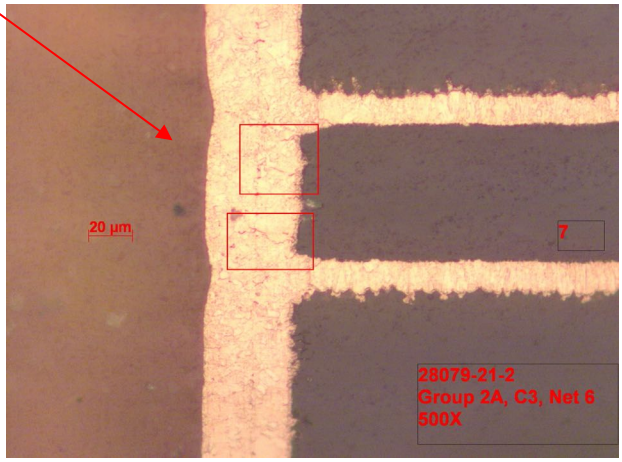




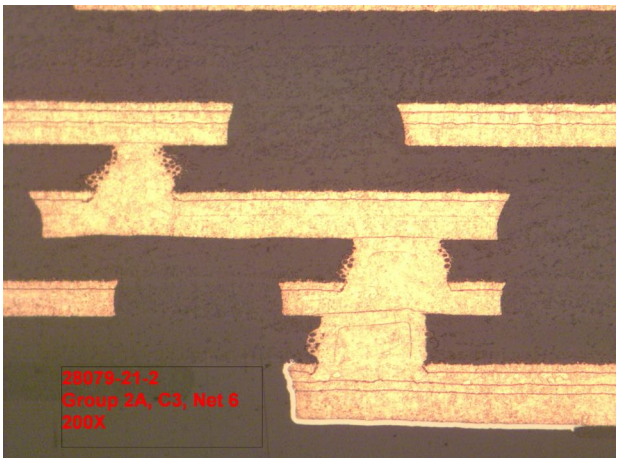
Partial corner crack

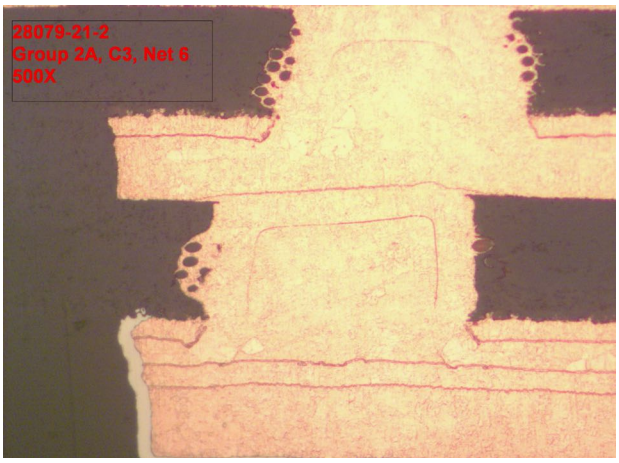


Partial barrel cracks



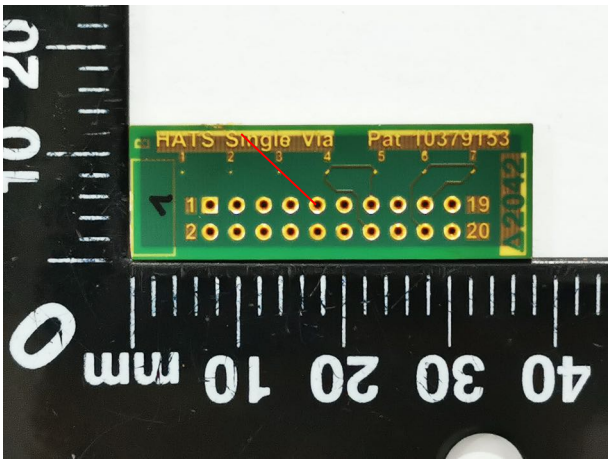
Complete barrel crack

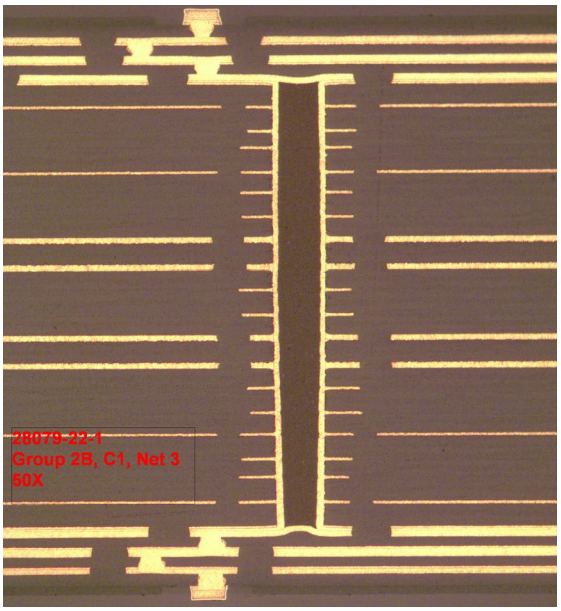




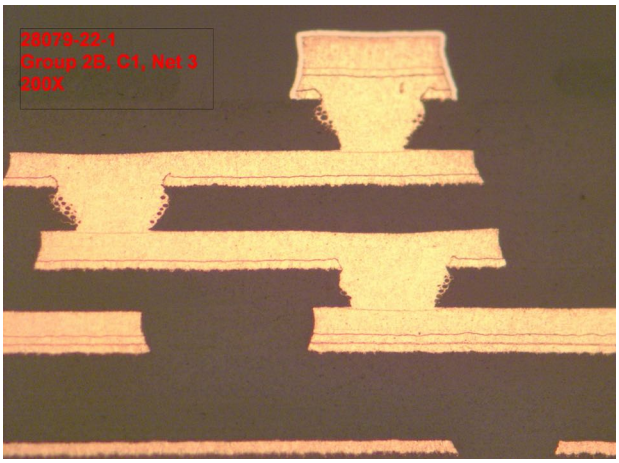
No cracks or separations were found in the micro via structure

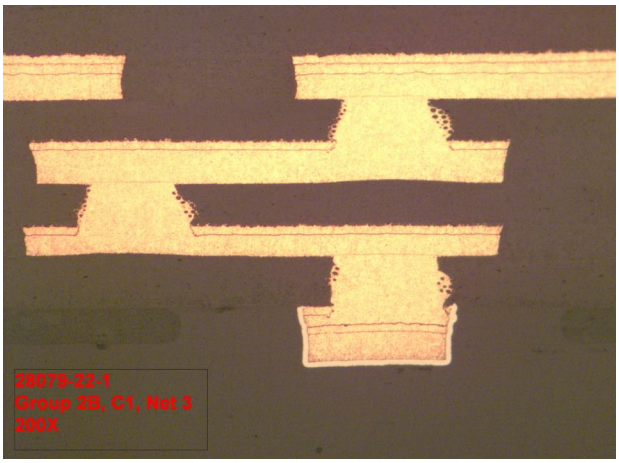
Group 2B, Coupon 1, Net 3





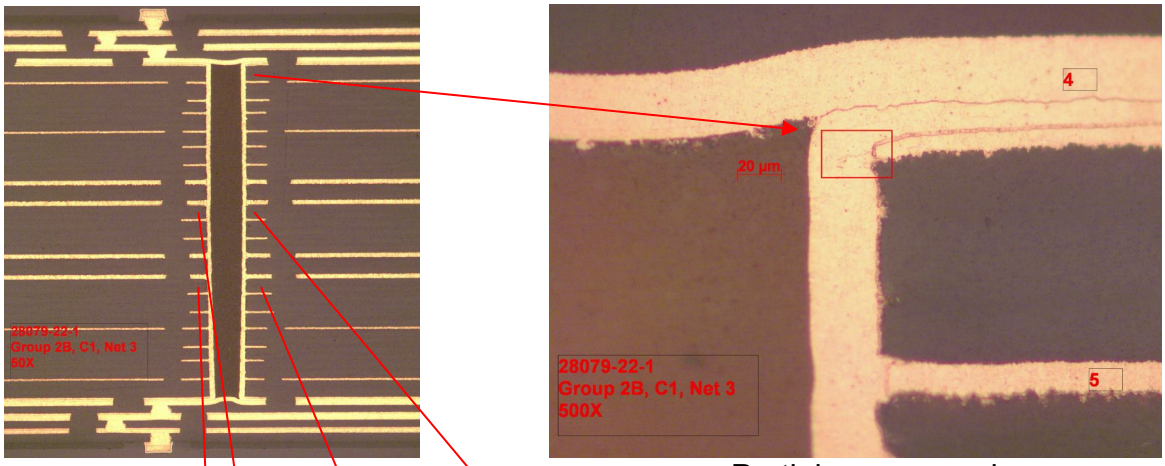
Summary: 13 partial cracks were found in the buried via;
13 complete cracks were found in the buried via



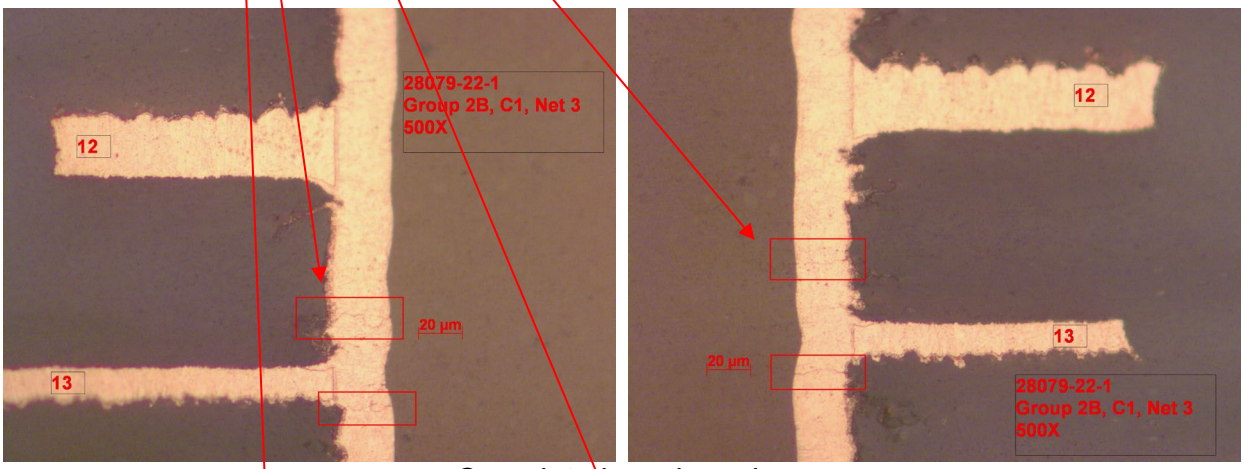


No cracks or separations were found in the micro via structure

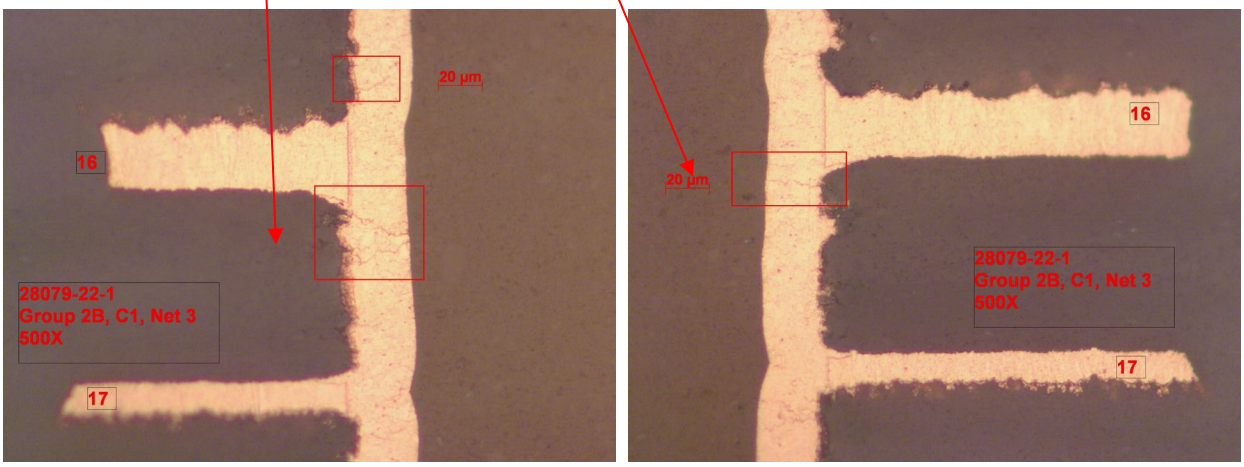
Group 2B, Coupon 1, Net 3



Partial corner crack

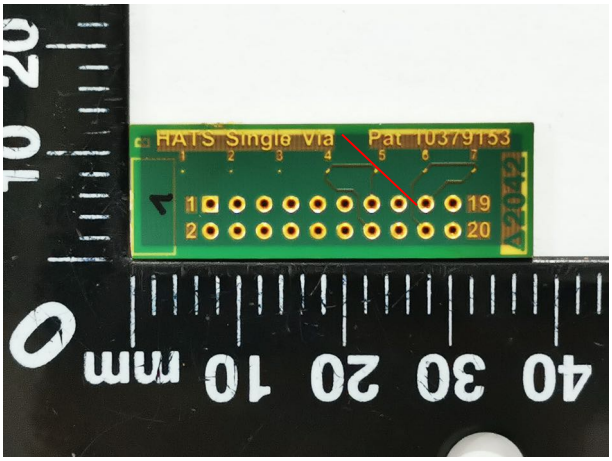


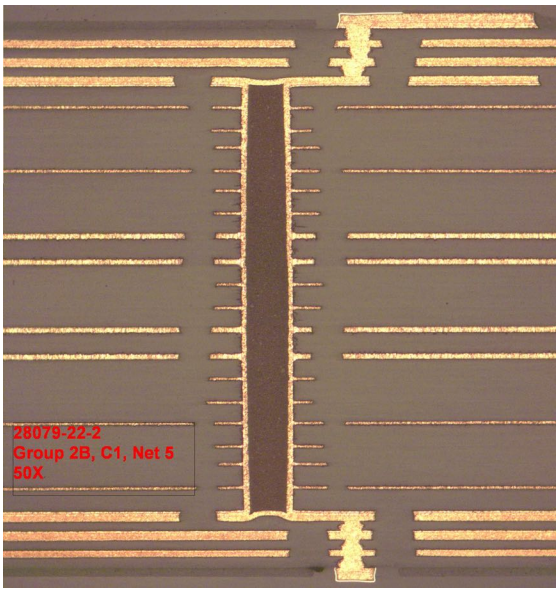
Complete barrel cracks



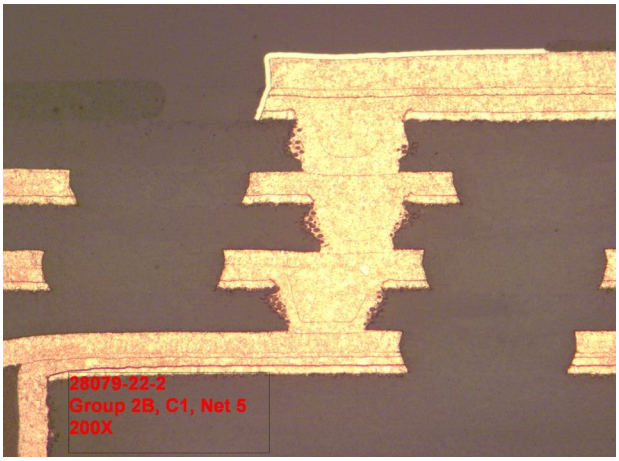
Complete and partial barrel cracks

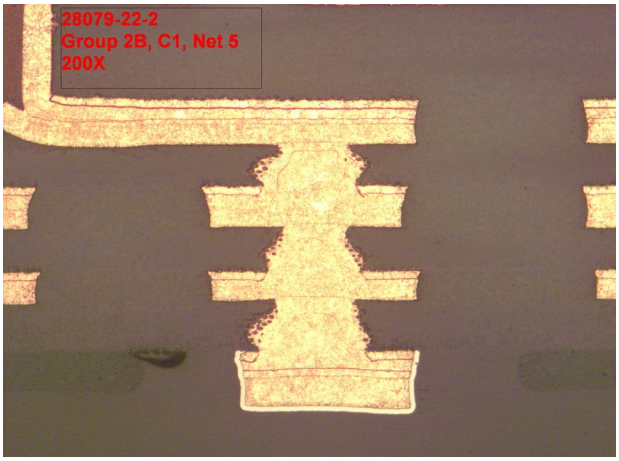
Group 2B, Coupon 1, Net 5





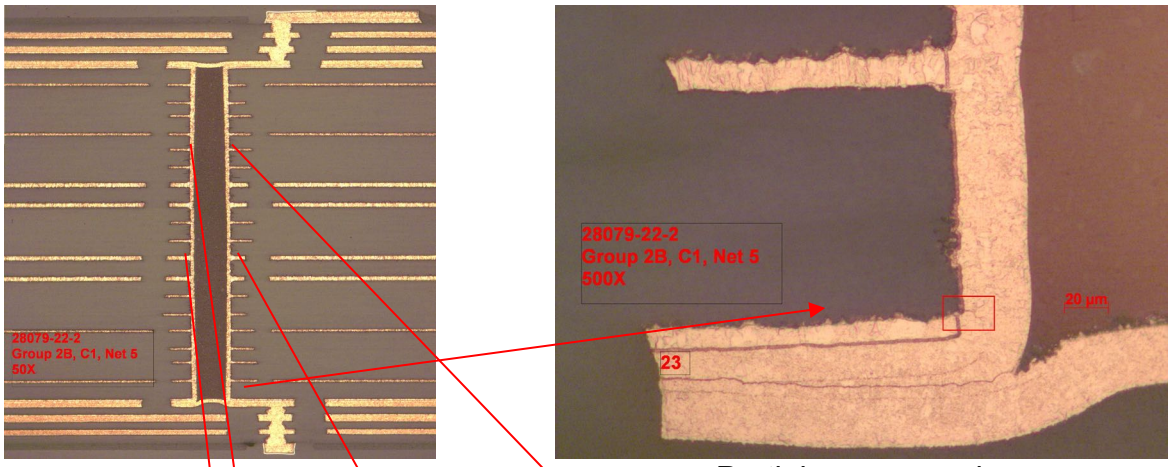
Summary: 26 partial cracks were found in the buried via;
23 complete cracks were found in the buried via



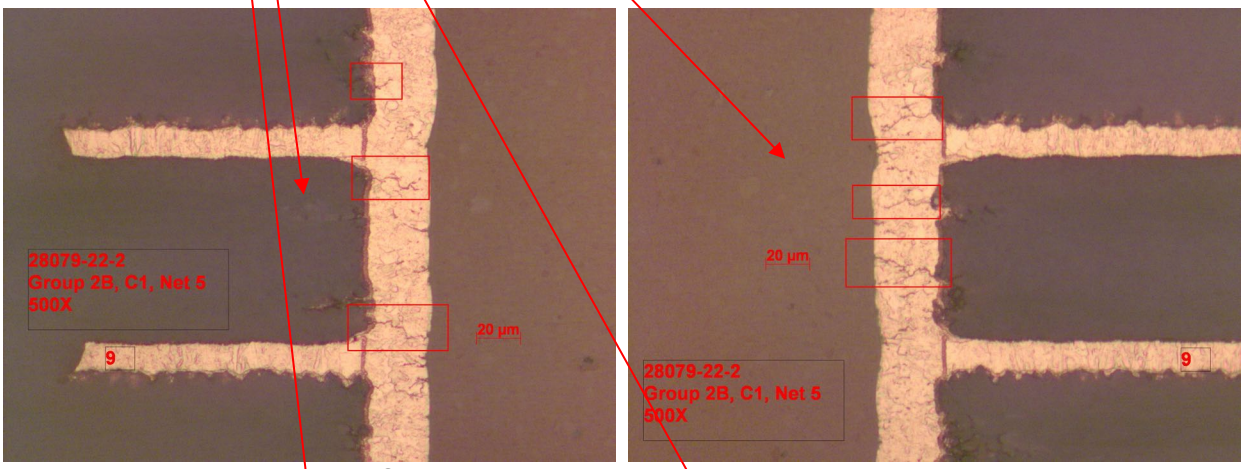


No cracks or separations were found in the micro via structure

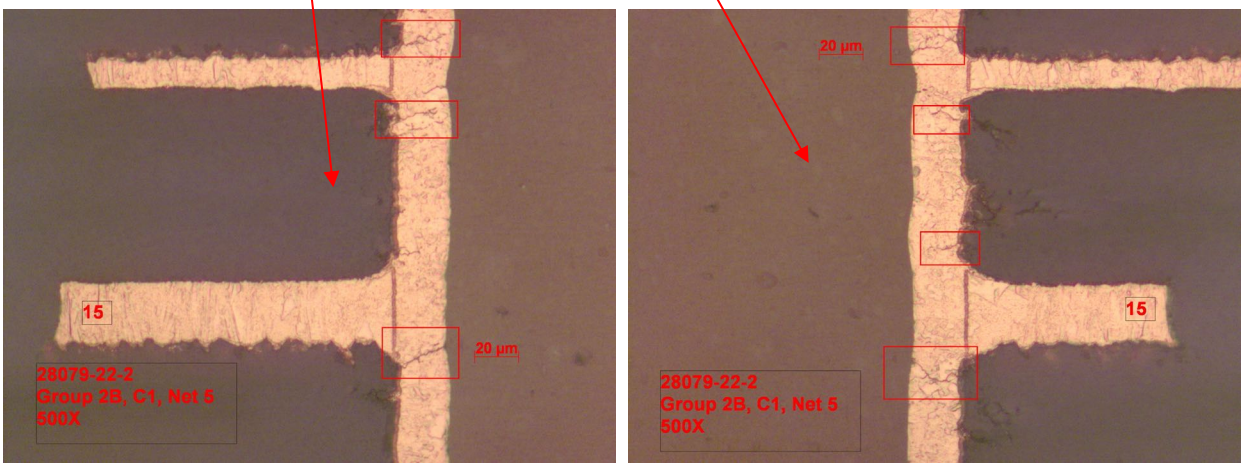
Group 2B, Coupon 1, Net 5



Partial corner crack

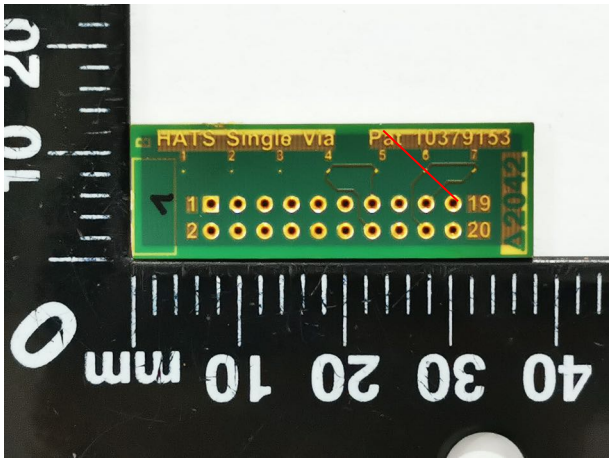


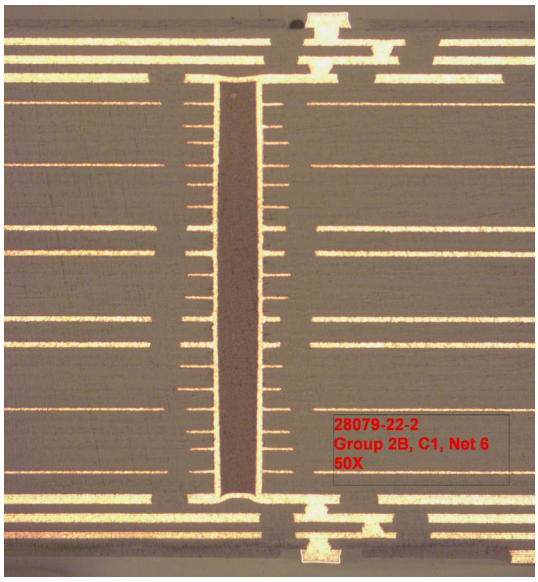
Complete and partial barrel cracks



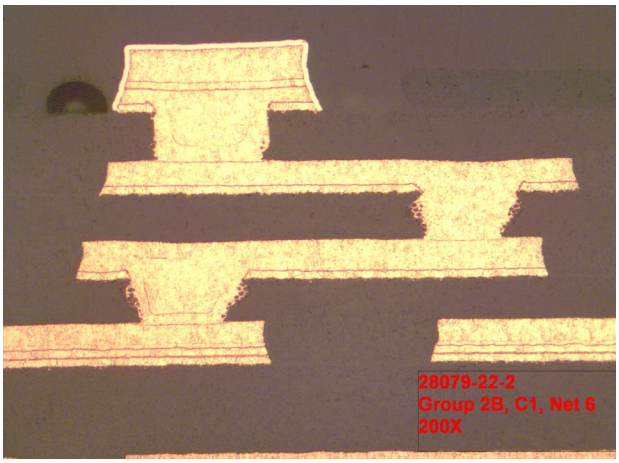
Complete and partial barrel cracks

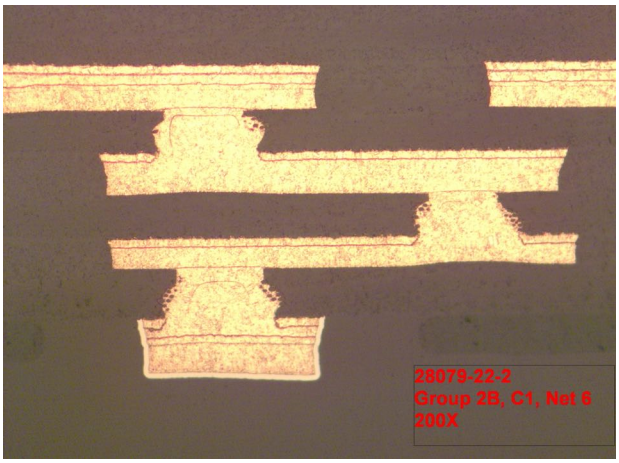
Group 2B, Coupon 1, Net 6





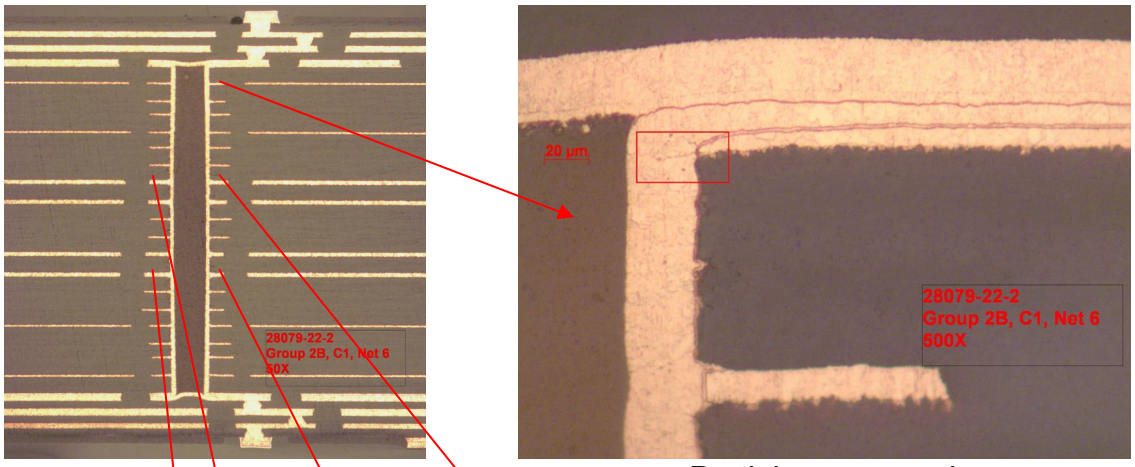
Summary; 8 partial cracks were found in the buried via;
12 complete cracks were found in the buried via



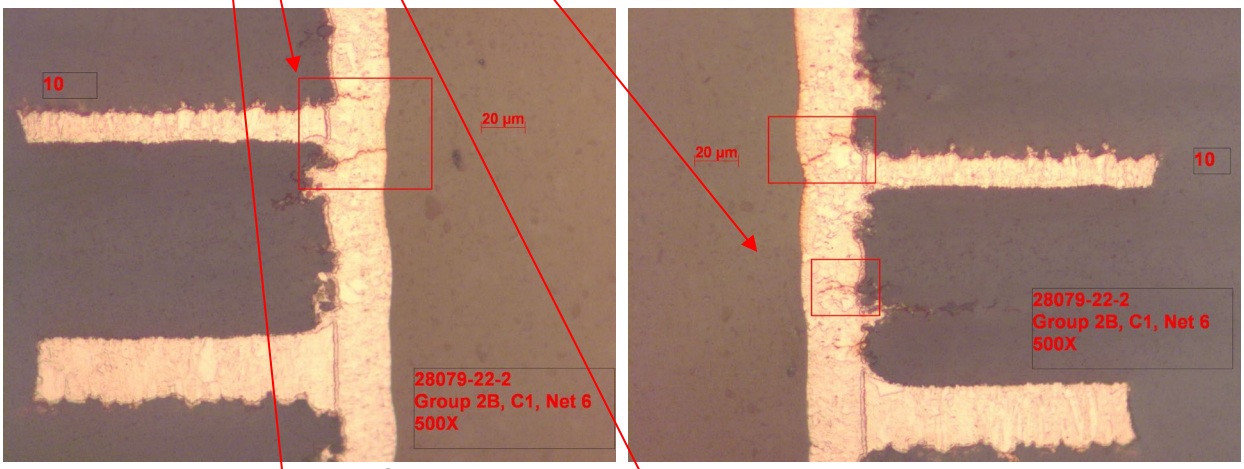


No cracks or separations were found in the micro via structure

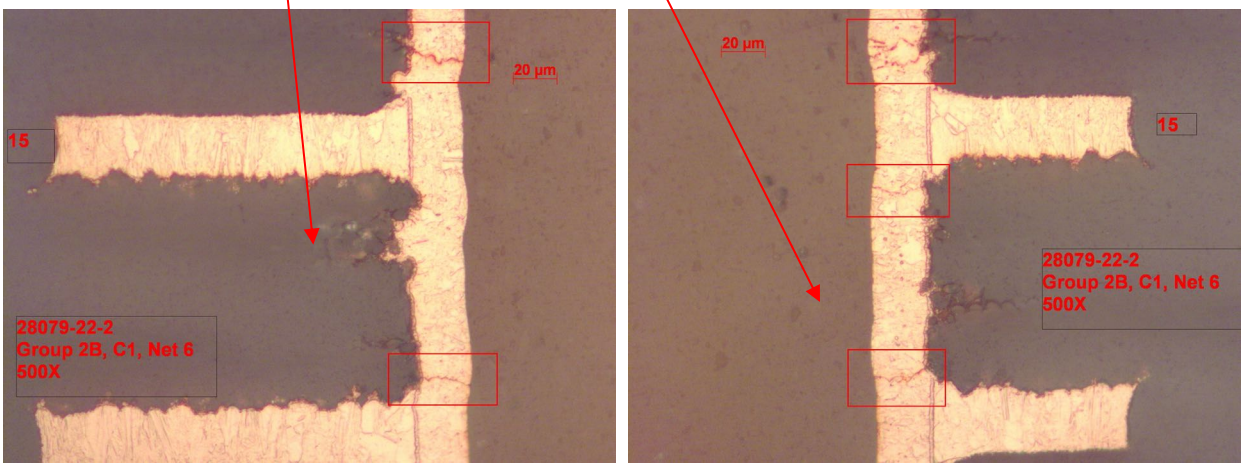
Group 2B, Coupon 1, Net 6



Partial corner crack

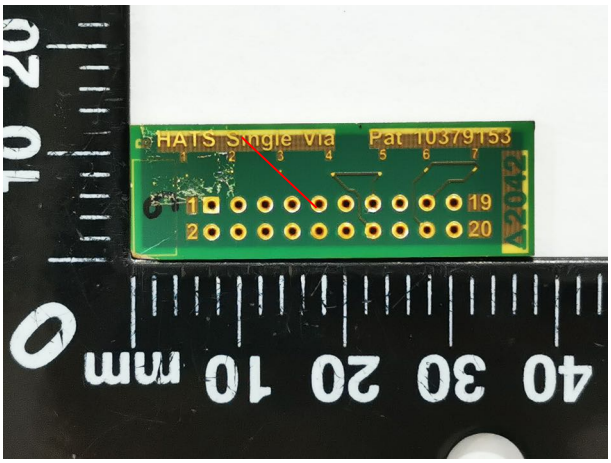


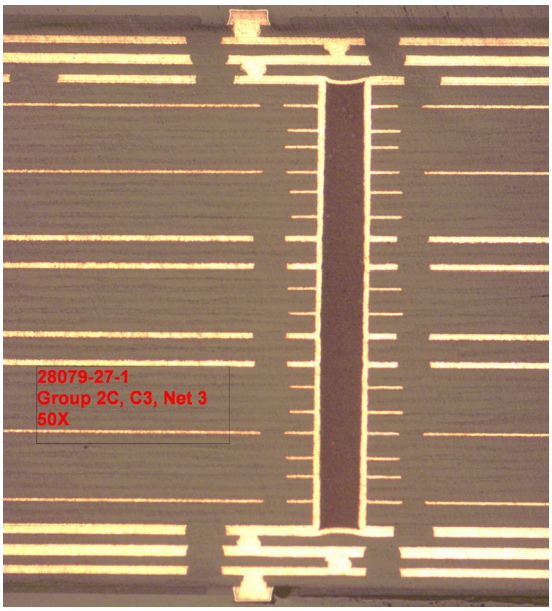
Complete and partial barrel cracks



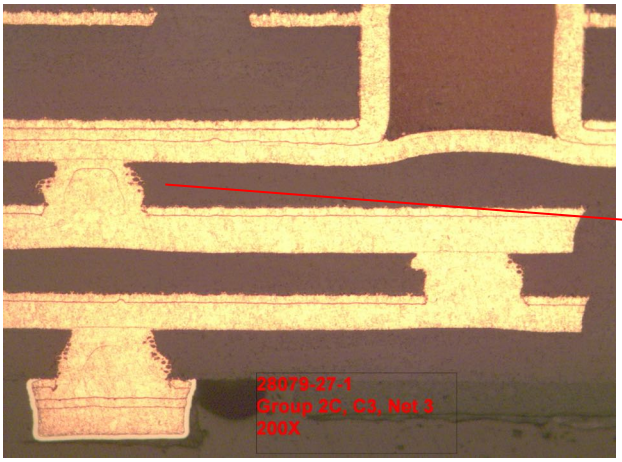
Complete barrel cracks

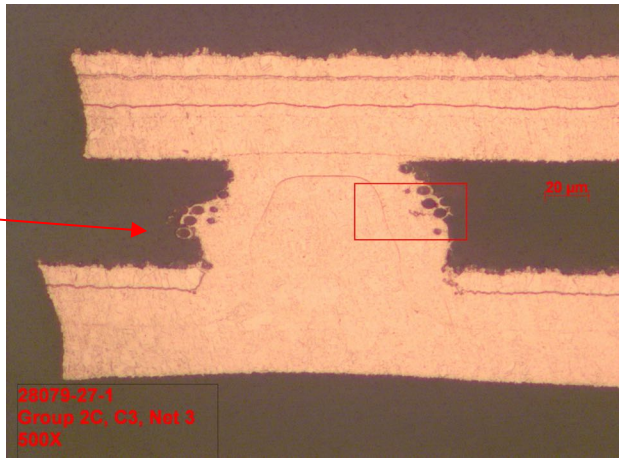
Group 2C, Coupon 3, Net 3





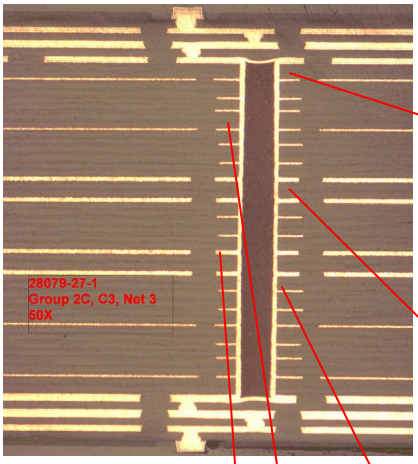
Summary: 5 partial cracks were found in the buried via;
5 complete cracks were found in the buried via;
1 partial crack associated with a glass fiber was found in the micro via structure

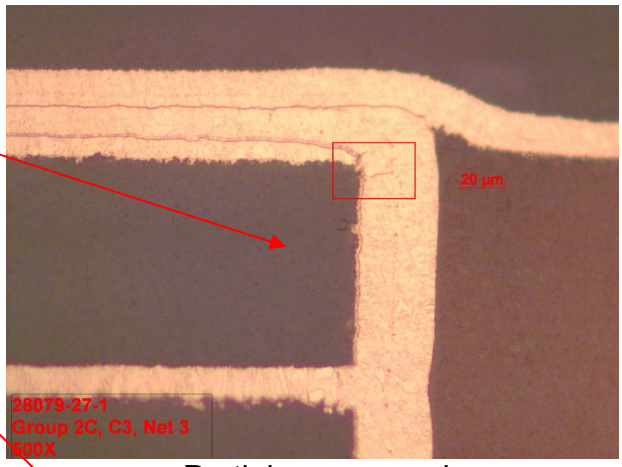




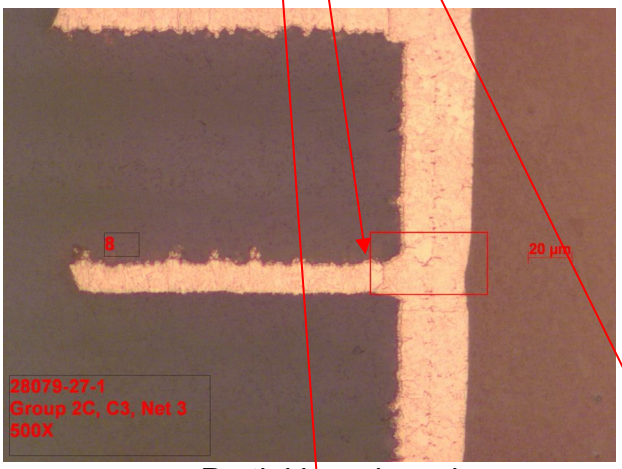
1 partial crack associated with a glass fiber was found in the micro via structure

Group 2C, Coupon 3, Net 3

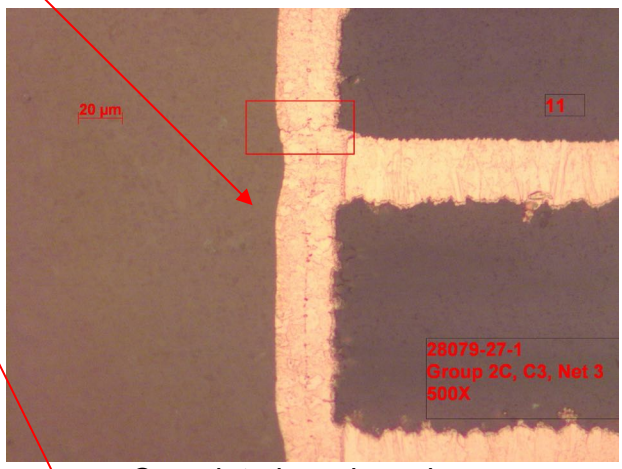




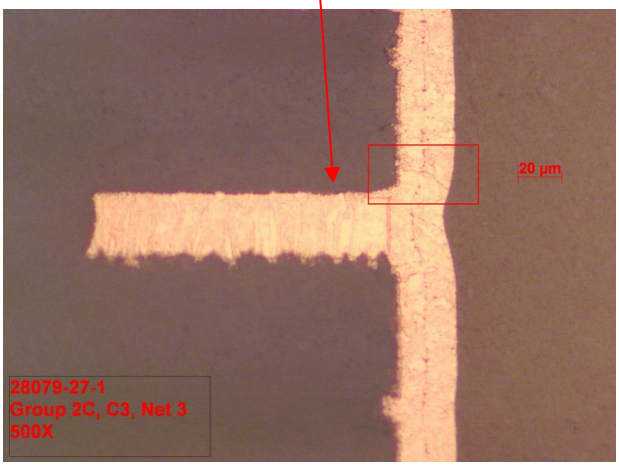
Partial corner crack

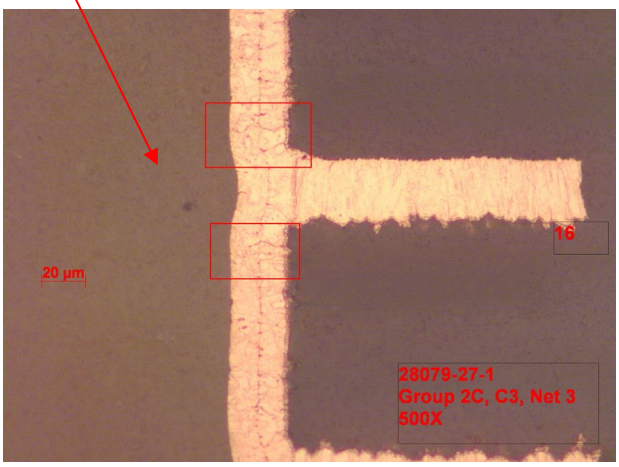


Partial barrel crack



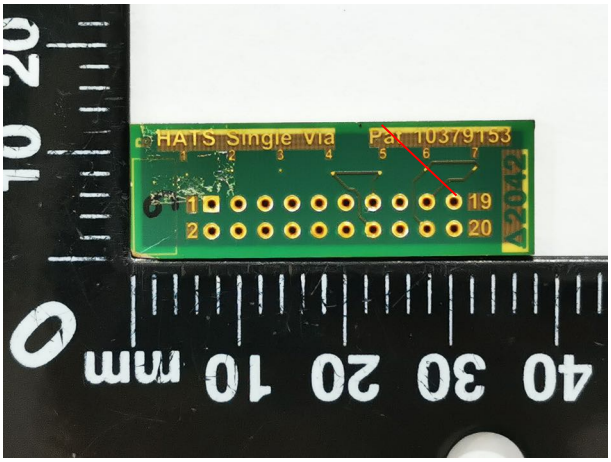
Complete barrel crack

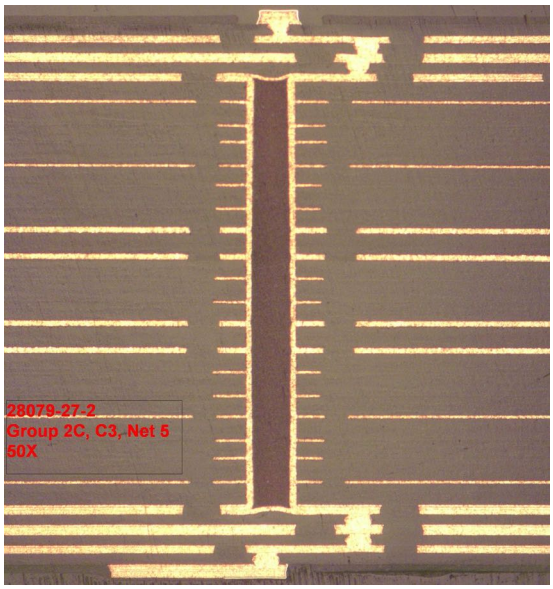




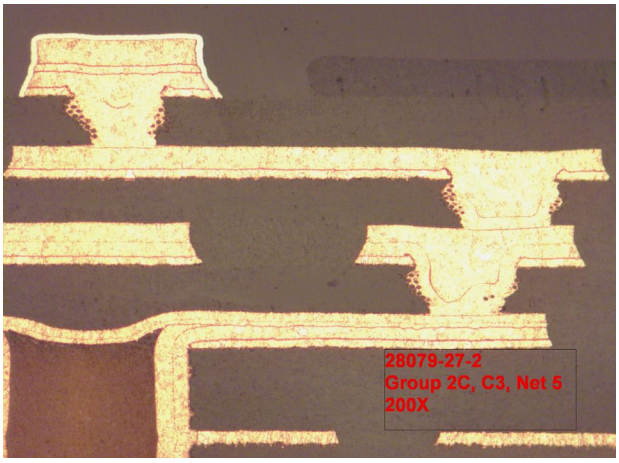
Complete and partial barrel cracks

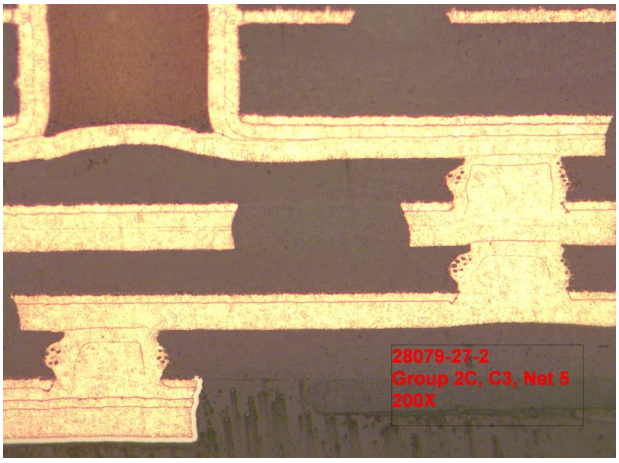
Group 2C, Coupon 3, Net 5





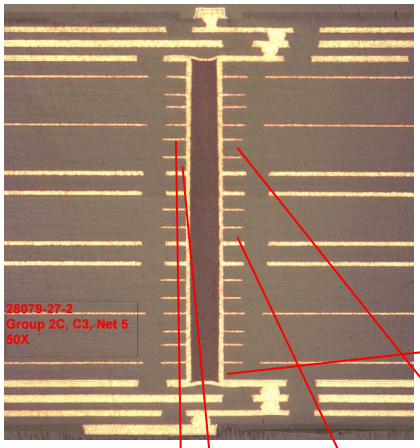
Summary; 13 partial cracks were found in the buried via;
9 complete cracks were found in the buried via

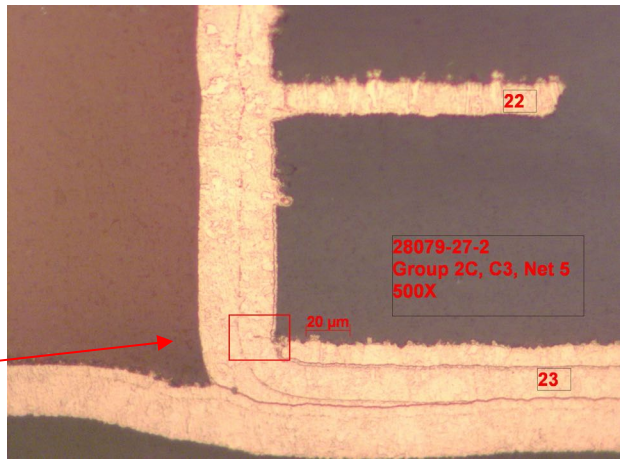




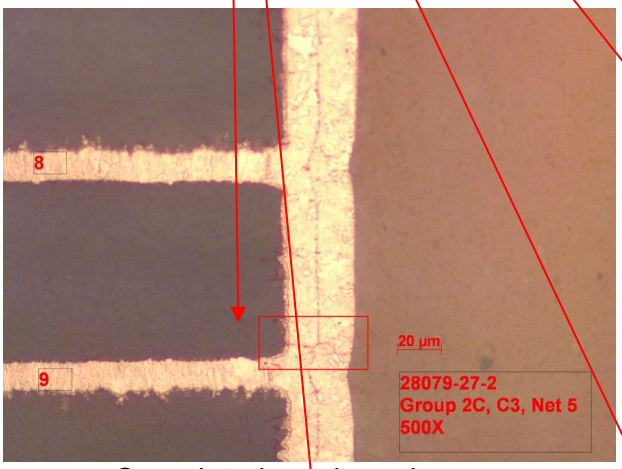
No cracks or separations were found in the micro via structure

Group 2C, Coupon 3, Net 5

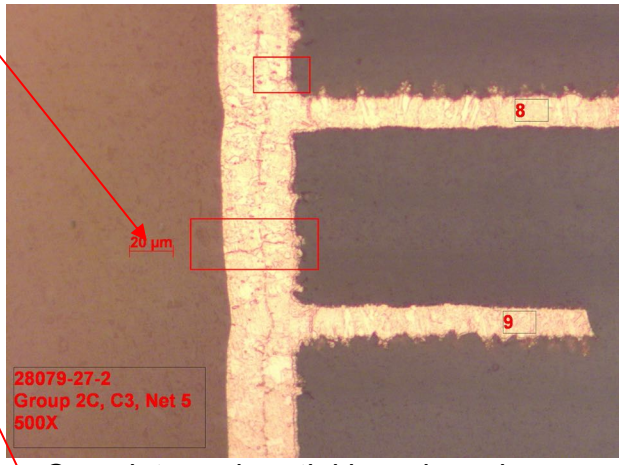




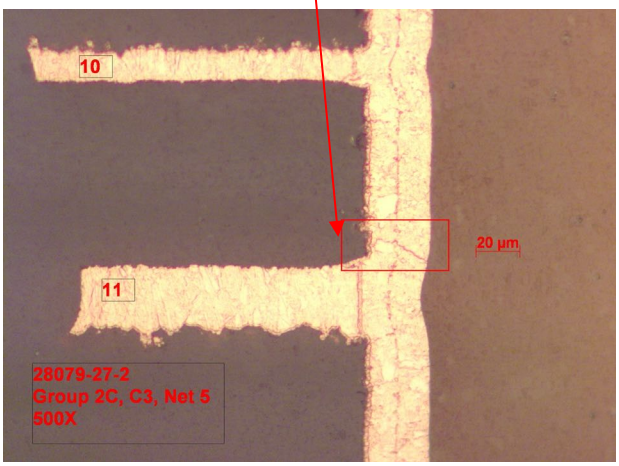
Partial corner crack

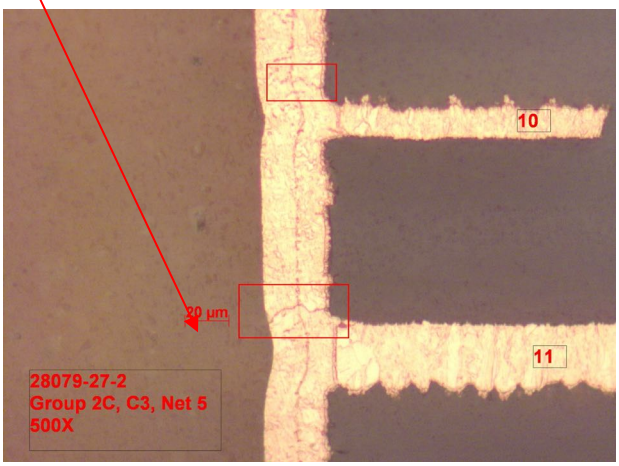


Complete barrel crack



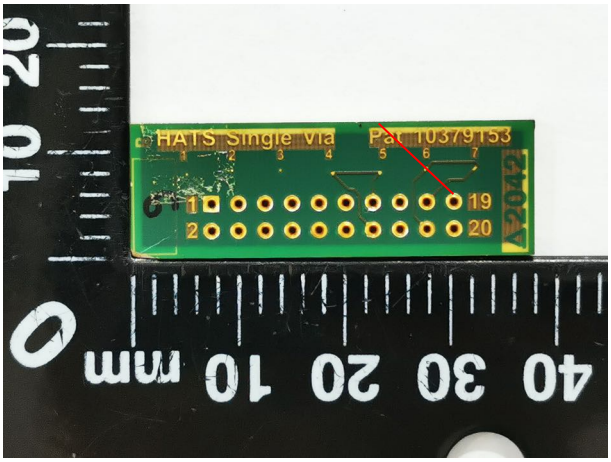
Complete and partial barrel cracks

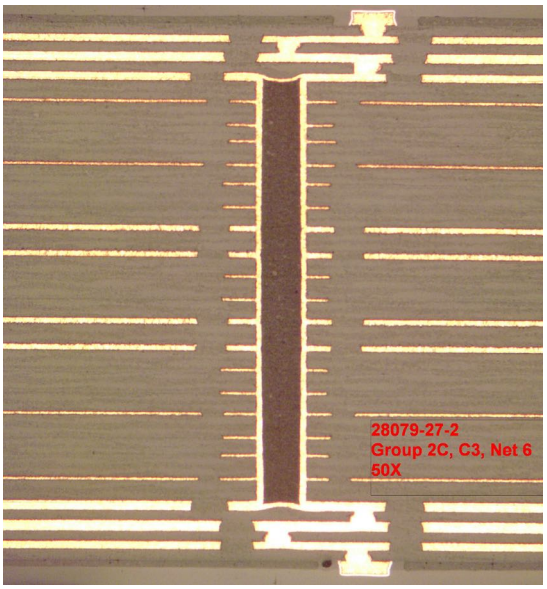




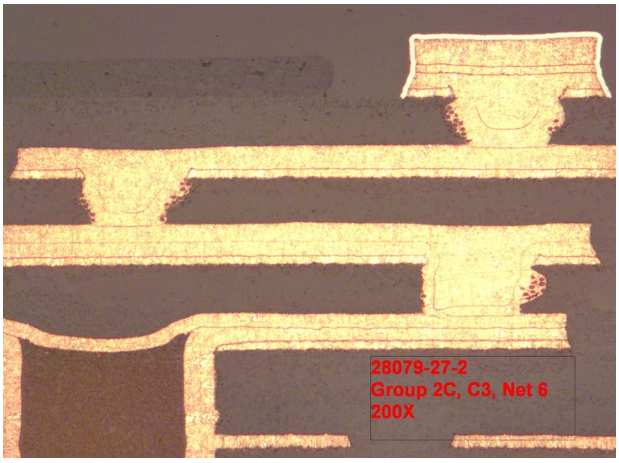
Complete and partial barrel cracks

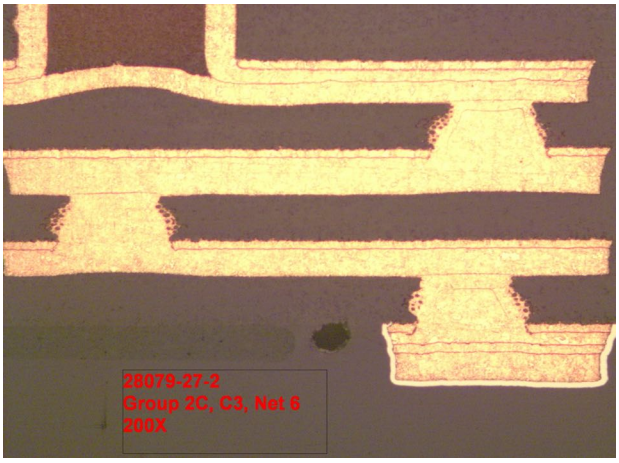
Group 2C, Coupon 3, Net 6





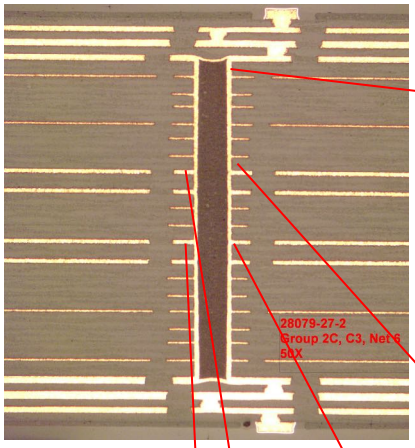
Summary: 3 partial cracks were found in the buried via;
6 complete cracks were found in the buried via

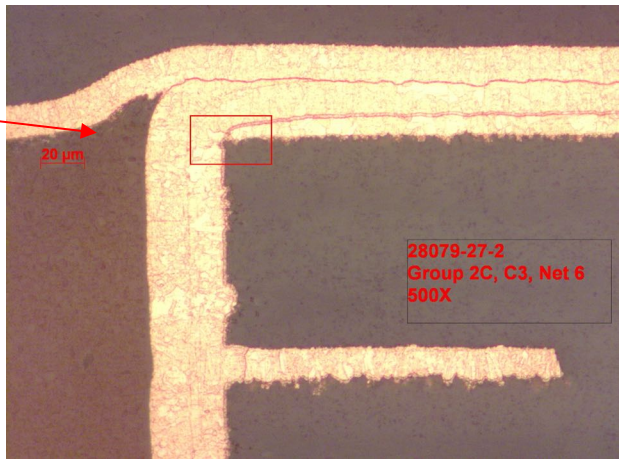




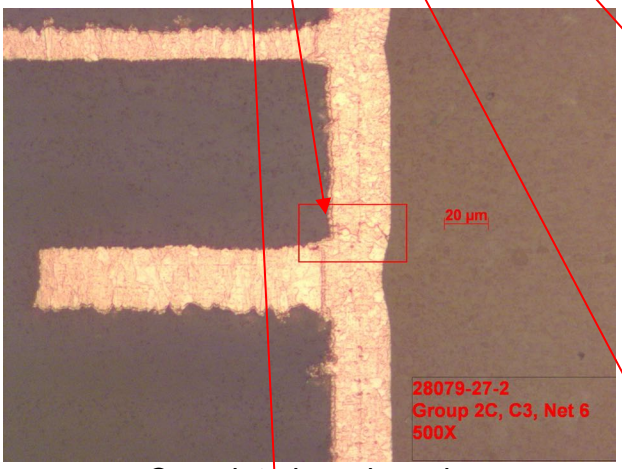
No cracks or separations were found in the micro via structure

Group 2C, Coupon 3, Net 6

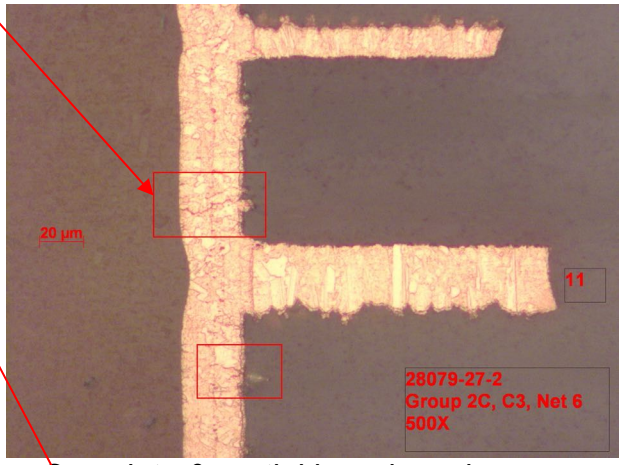




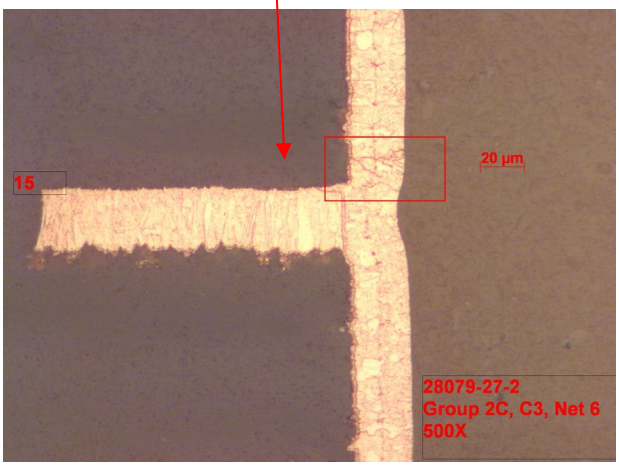
Partial corner crack

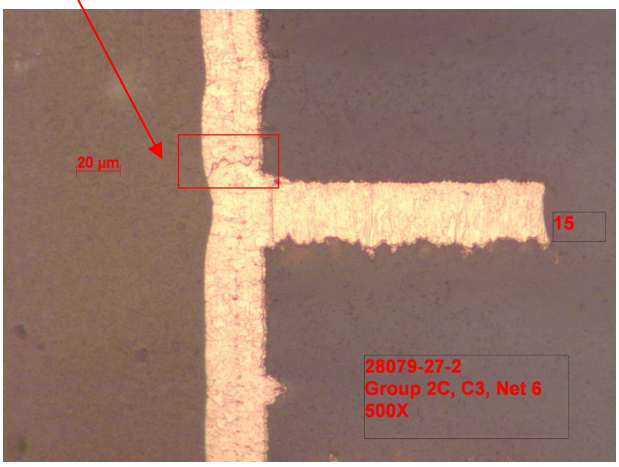


Complete barrel crack



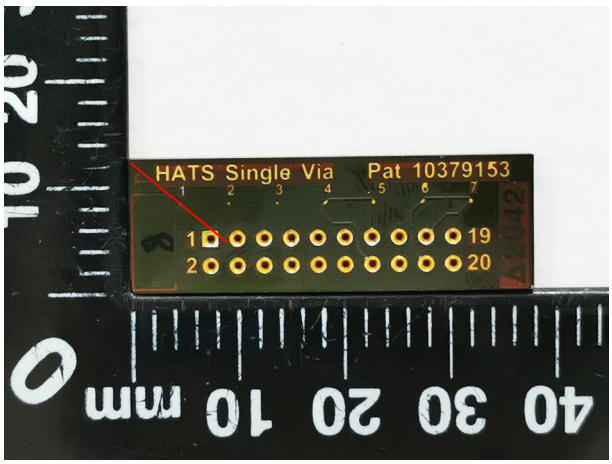
Complete & partial barrel cracks

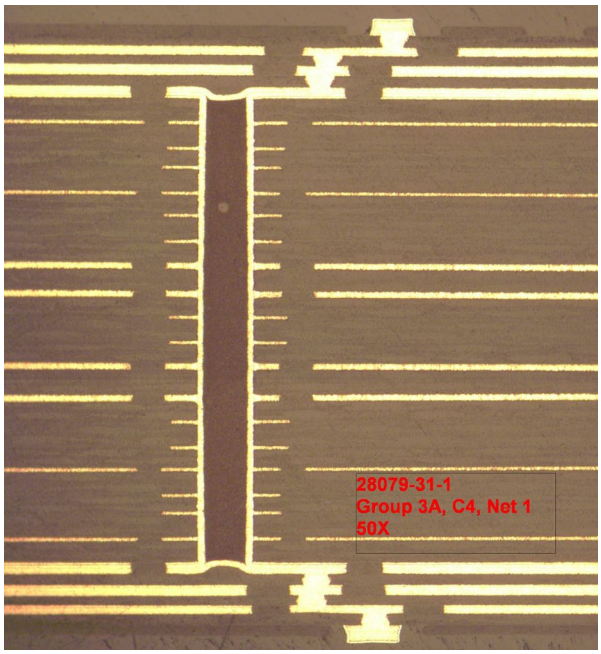




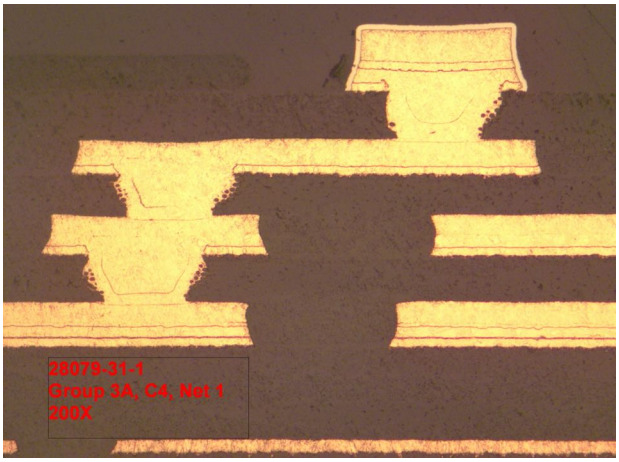
Complete barrel cracks

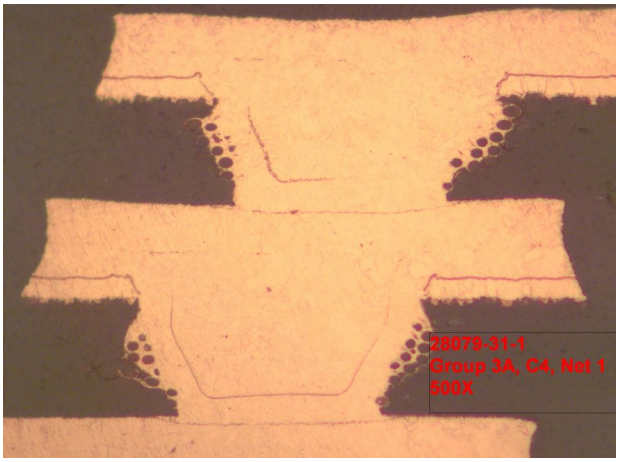
Group 3A, Coupon 4, Net 1





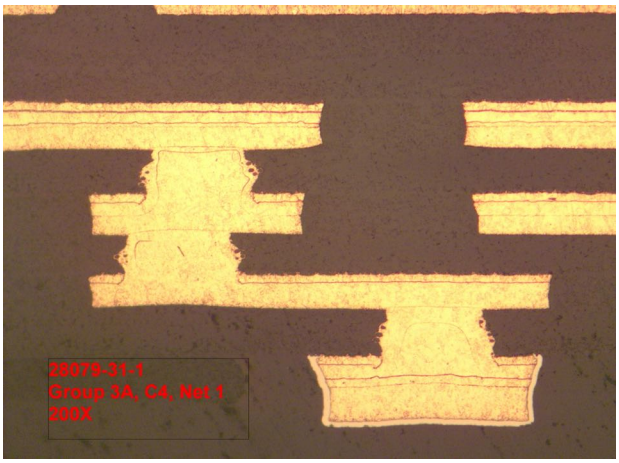
Summary: No cracks or separations were found in the micro via structures;
Buried vias were not evaluated

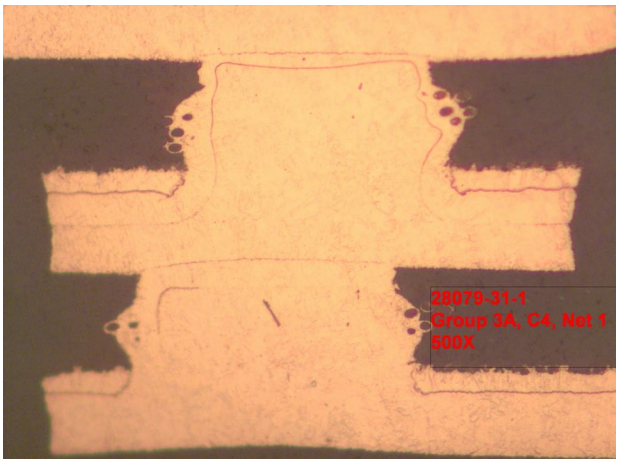


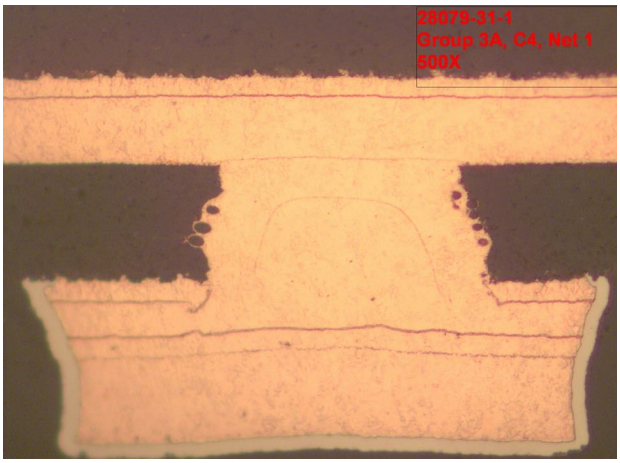


No cracks or separations were found in the micro via structure

Group 3A, Coupon 4, Net 1

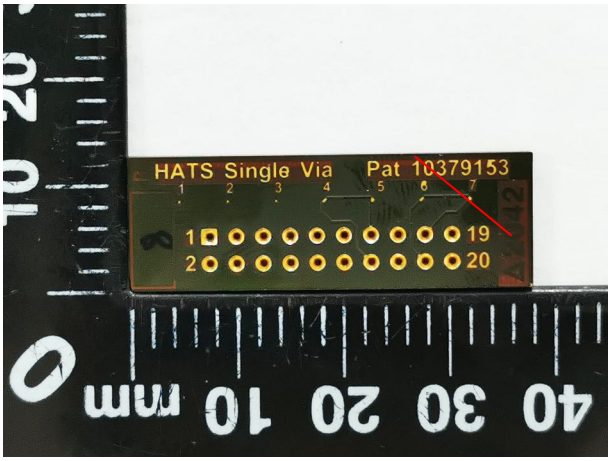


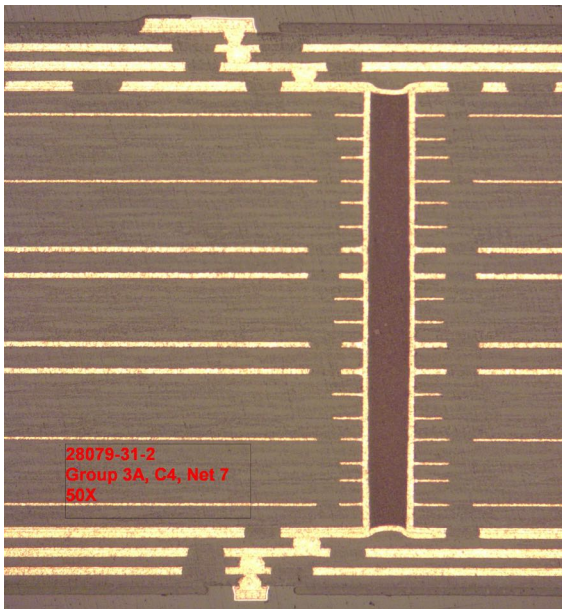




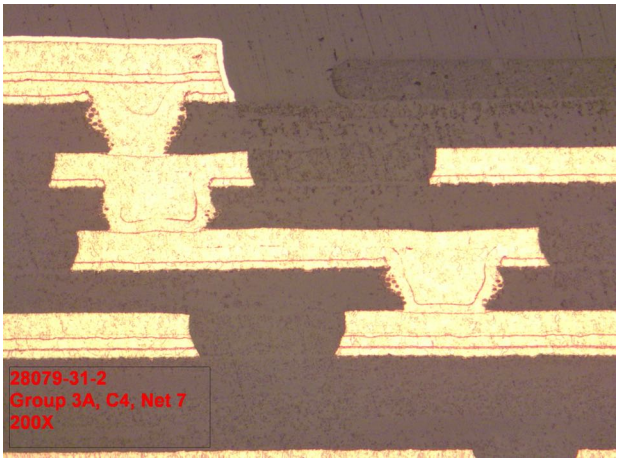
No cracks or separations were found in the micro via structure

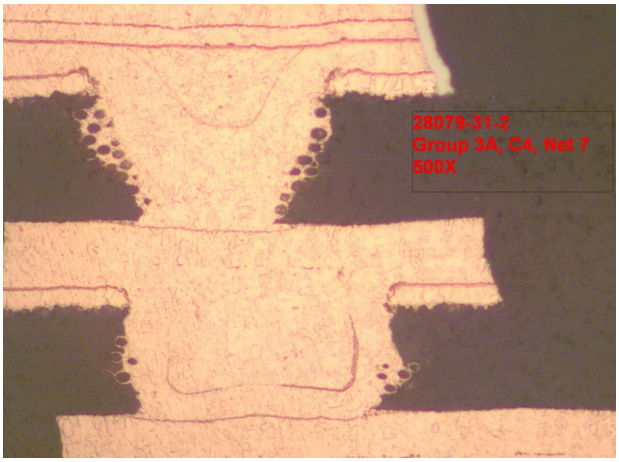
Group 3A, Coupon 4, Net 7





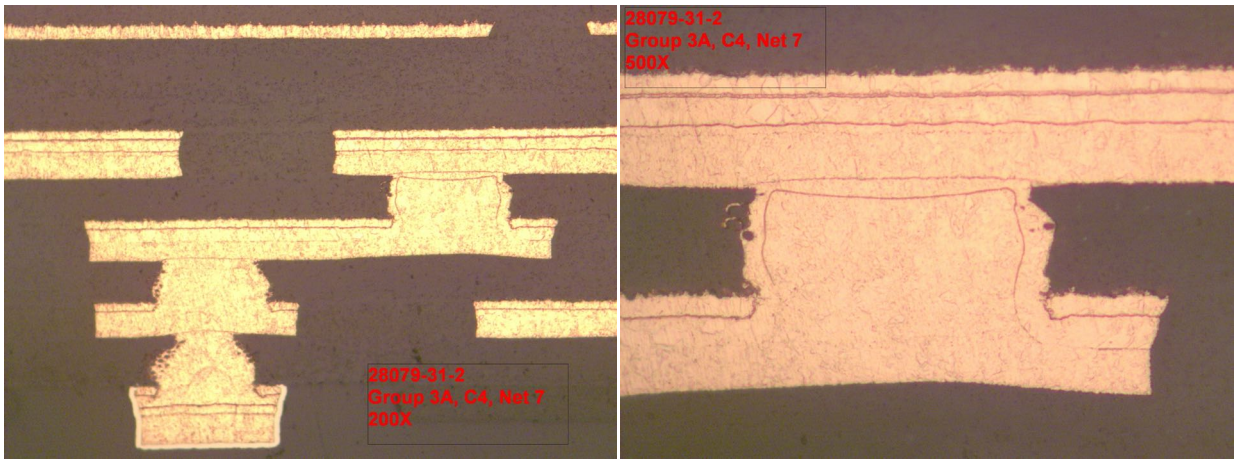
Summary: No cracks or separations were found in the micro via structures;
Buried vias were not evaluated

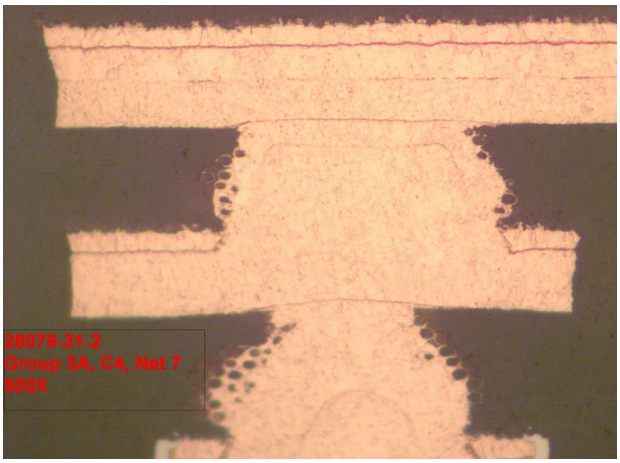




No cracks or separations were found in the micro via structure

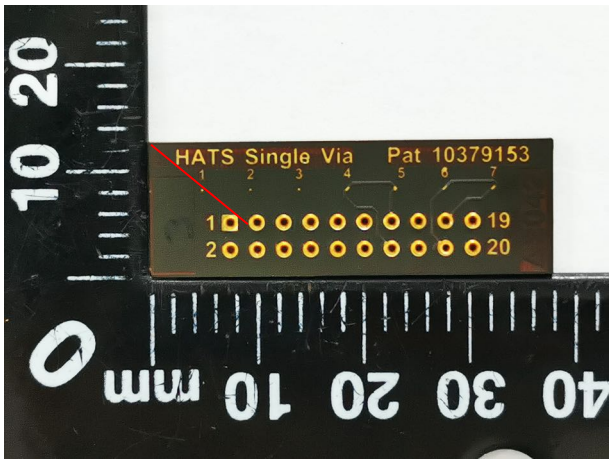
Group 3A, Coupon 4, Net 7

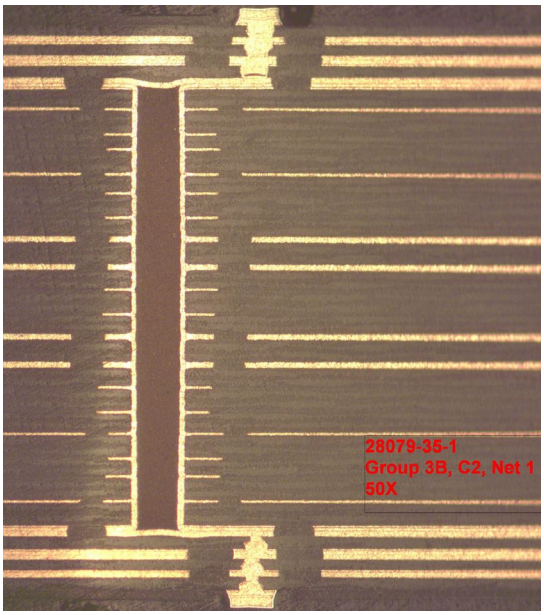




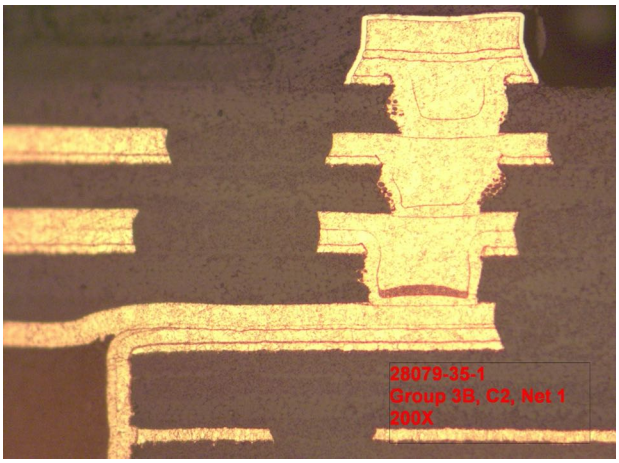
No cracks or separations were found in the micro via structure

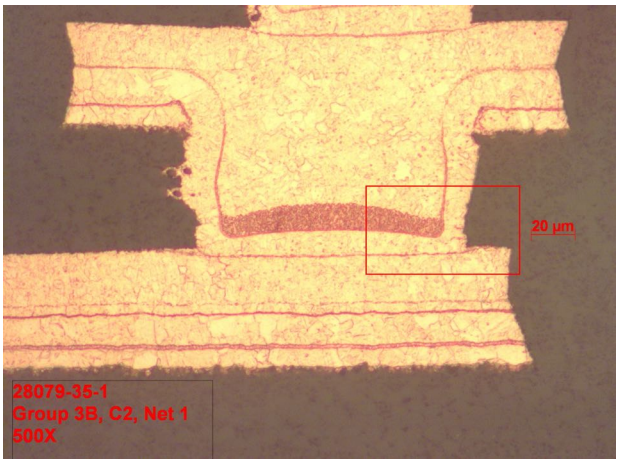
Group 3B, Coupon 2, Net 1





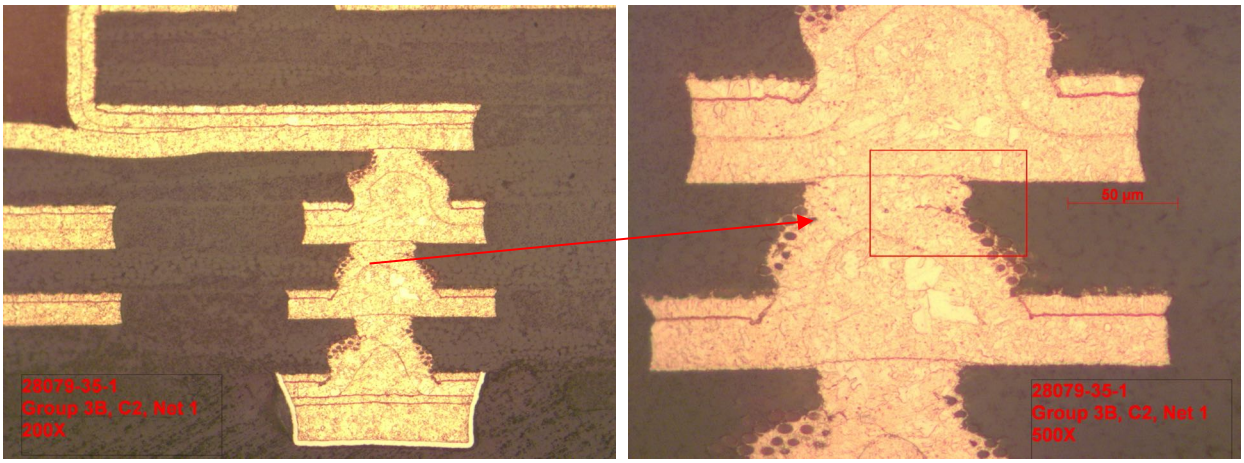
Summary: 2 partial cracks (1 on each side) were found in the micro via structures; Buried vias were not evaluated

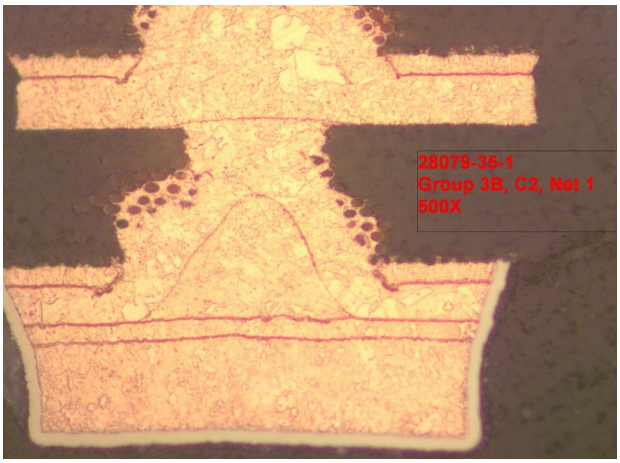




1 partial crack and no separations were found in the micro via structure

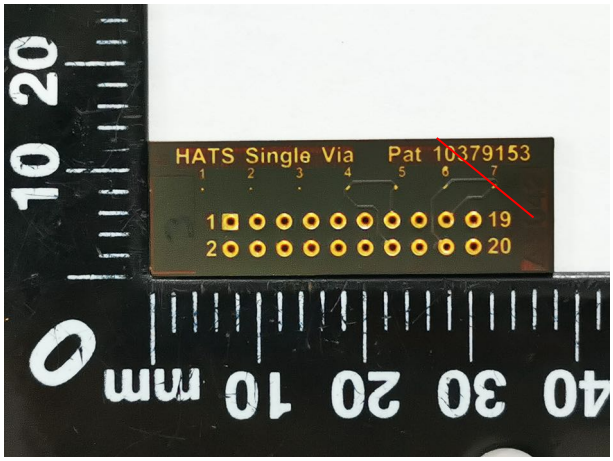
Group 3B, Coupon 2, Net 1

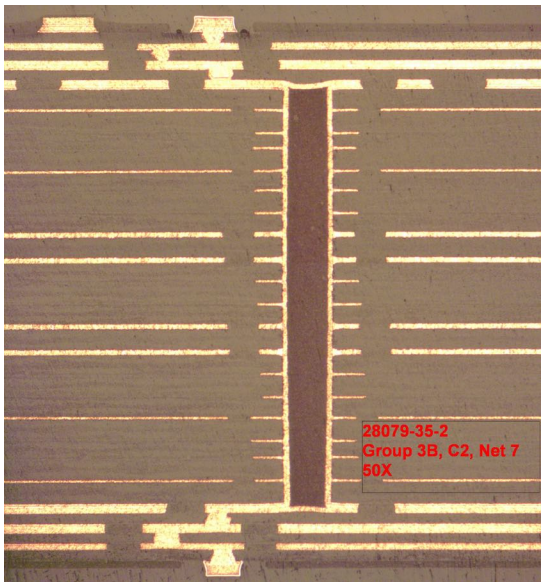




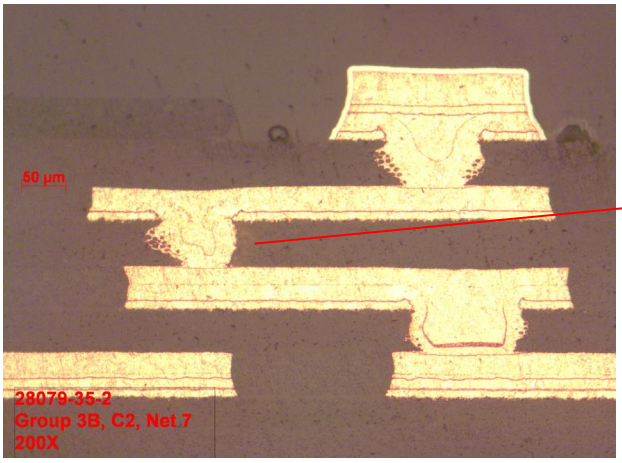
1 partial crack and no separations were found in the micro via structure

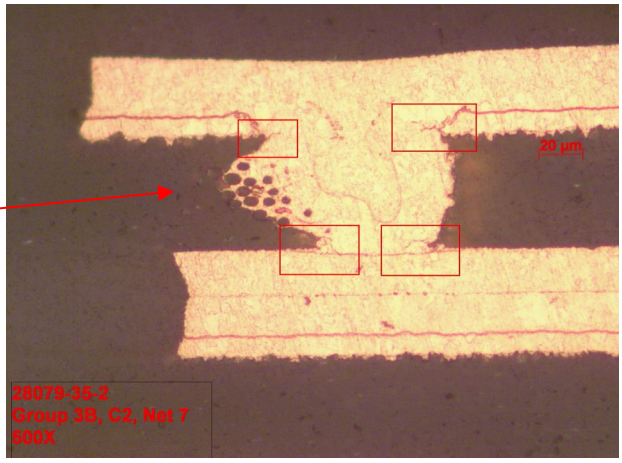
Group 3B, Coupon 2, Net 7





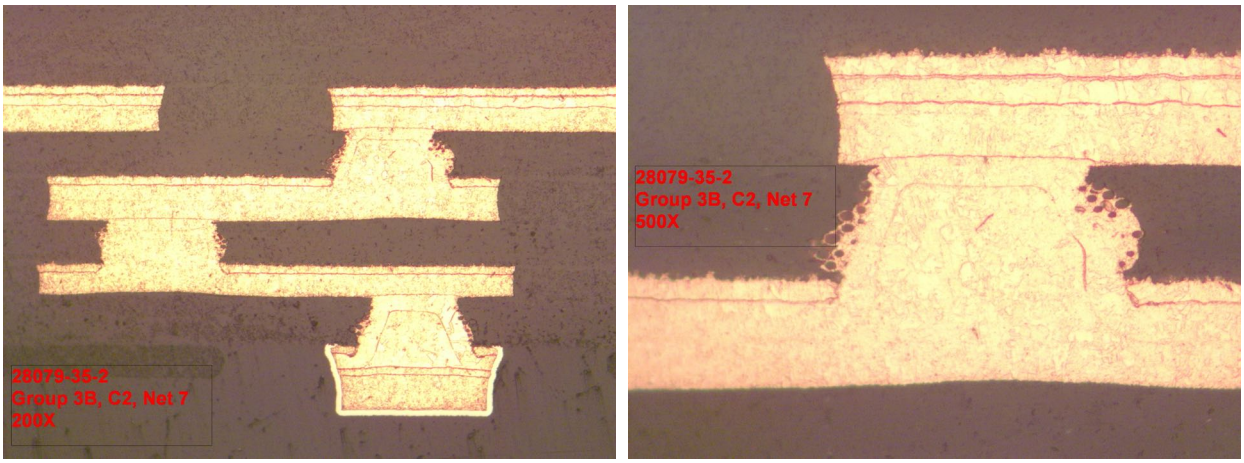
Summary: 4 partial cracks were found in the micro via structure;
Buried via was not evaluated





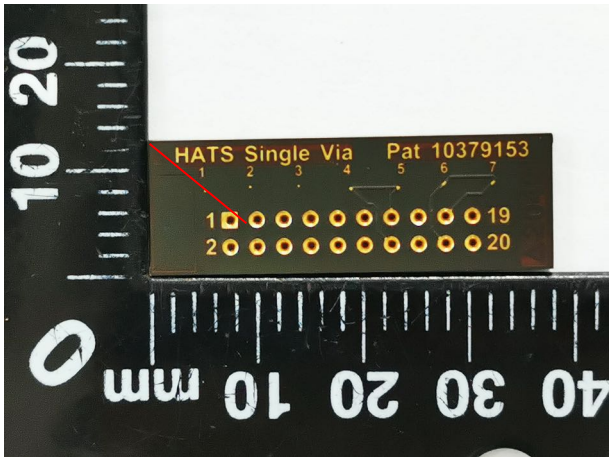
4 partial cracks and no separations were found in micro via structure

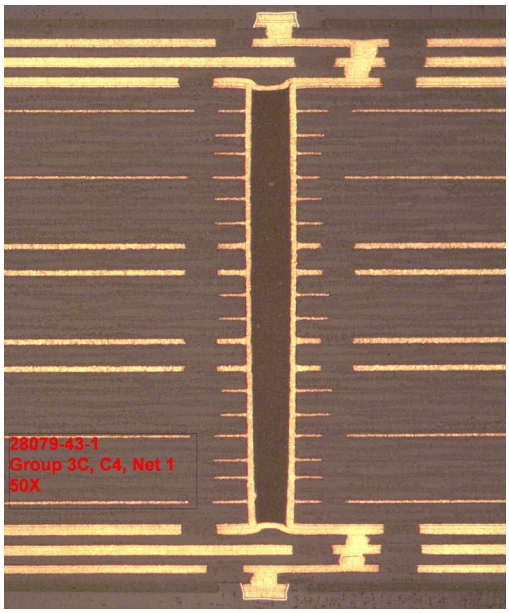
Group 3B, Coupon 2, Net 7



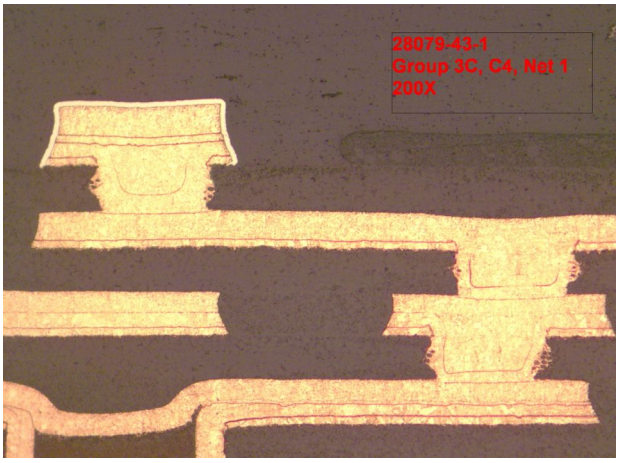
No cracks or separations were found in the micro via structure

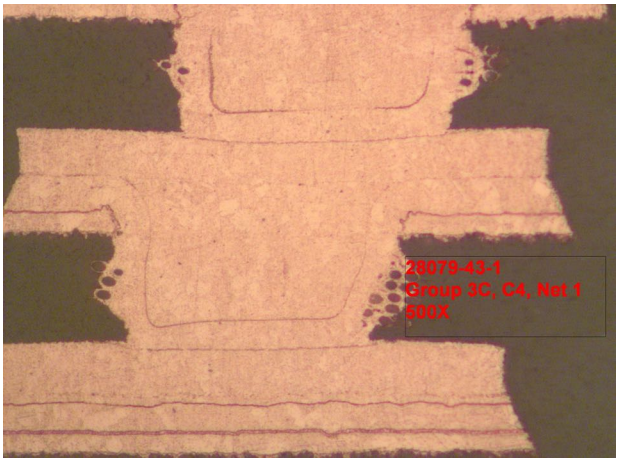
Group 3C, Coupon 4, Net 1





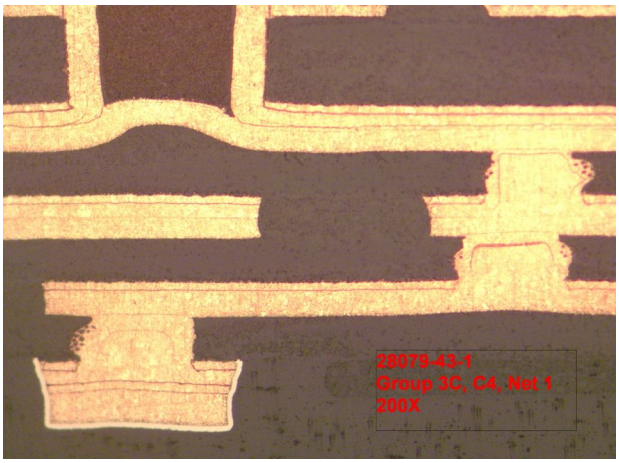
Summary: No cracks or separations were found in the micro via structure;
Buried via was not evaluated

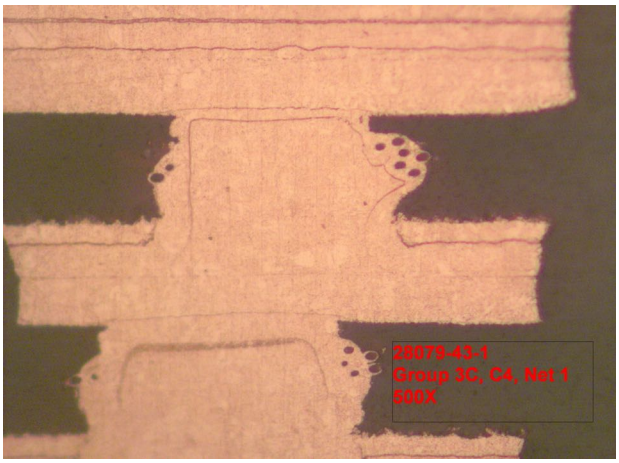


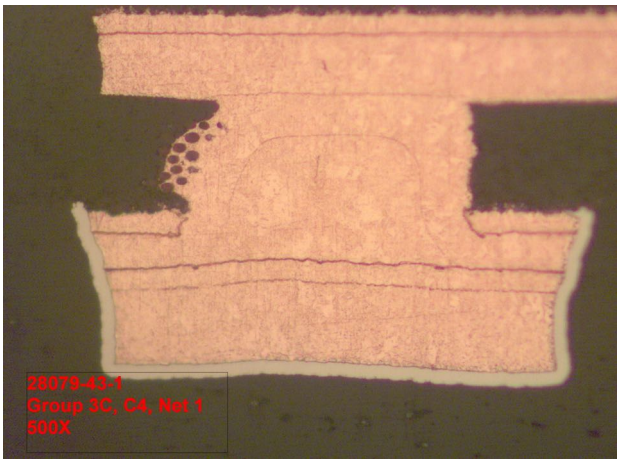


No cracks or separations were found in the micro via structure

Group 3C, Coupon 4, Net 1

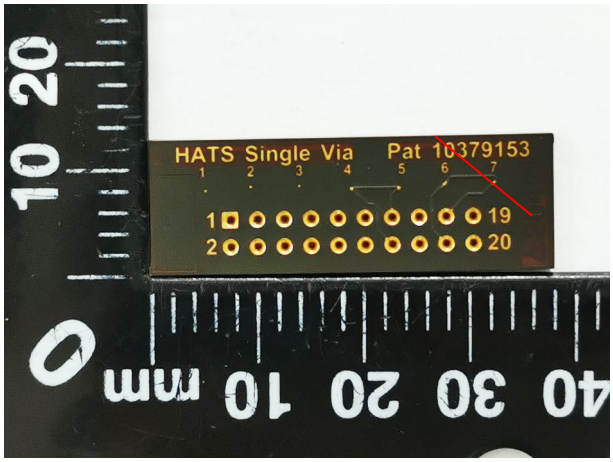


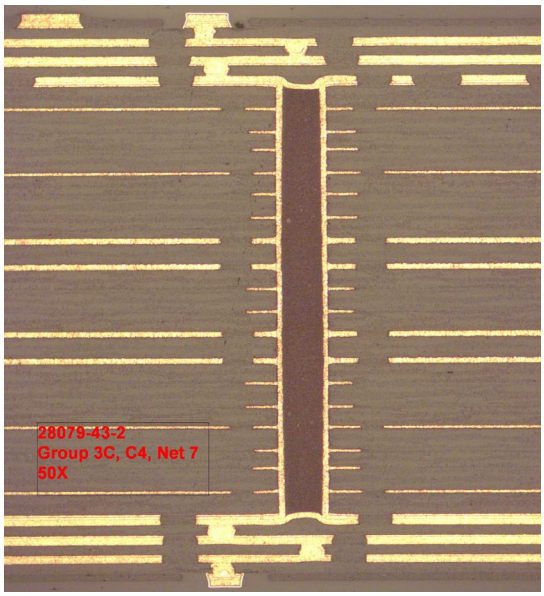




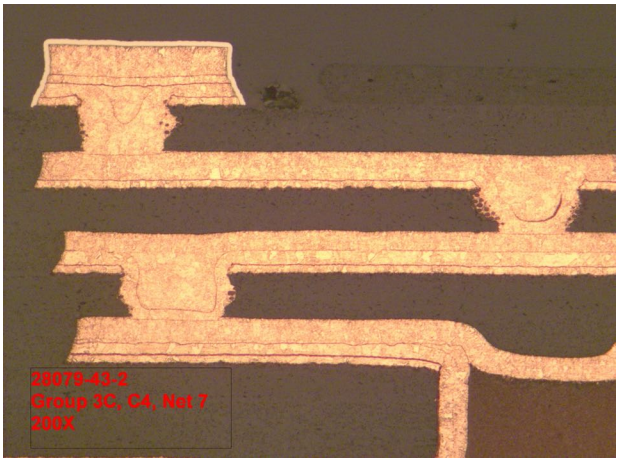
No cracks or separations were found in the micro via structure

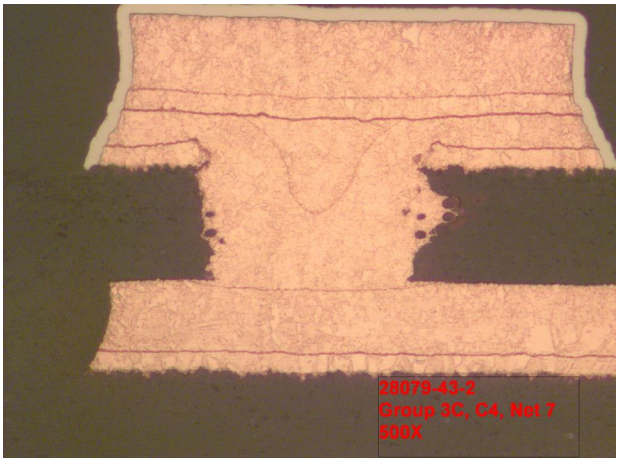
Group 3C, Coupon 4, Net 7





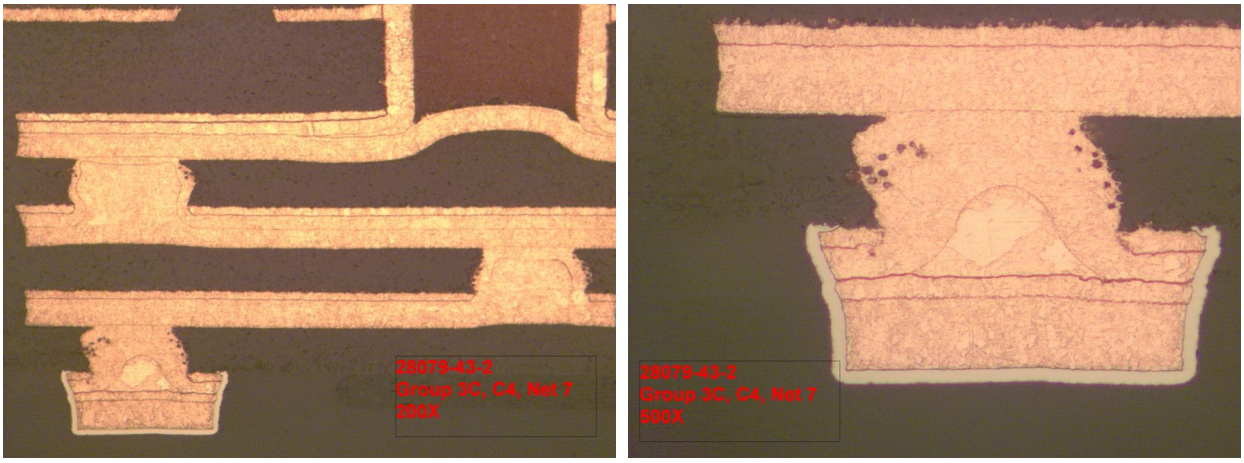
Summary: No cracks or separations were found in the micro via structures;
Buried via was not evaluated





No cracks or separations were found in the micro via structure

Group 3C, Coupon 4, Net 7



No cracks or separations were found in the micro via structure

IPC-TM-650 Method 2.6.27B - 1-second vs. 7-second Data Acquisition Intervals During Reflow Simulation.

The collection of periodic electrical data during reflow simulation is Intended to capture failure events like separation or cracking at or near the peak reflow temperature and subsequently characterize the percentage change of resistance during the entire multiple reflow profile. Via structures experience their highest stress at or near the peak reflow temperature and the possibility exists that a failure due to a separation or crack, at this time, could mechanically reconnect as the sample cools and be undetectable in subsequent testing. This is certainly more likely in daisy-chains than in single via structures as the small resistance differences between a metallurgical (non-failed) and mechanical (failed and reconnected) copper connection would disappear into the noise of daisy-chain measurement while it would be detectable to single via measurement techniques. We obviously want to capture failure events like this, but the question is how often a net should be sampled to ensure that these types of events are captured.

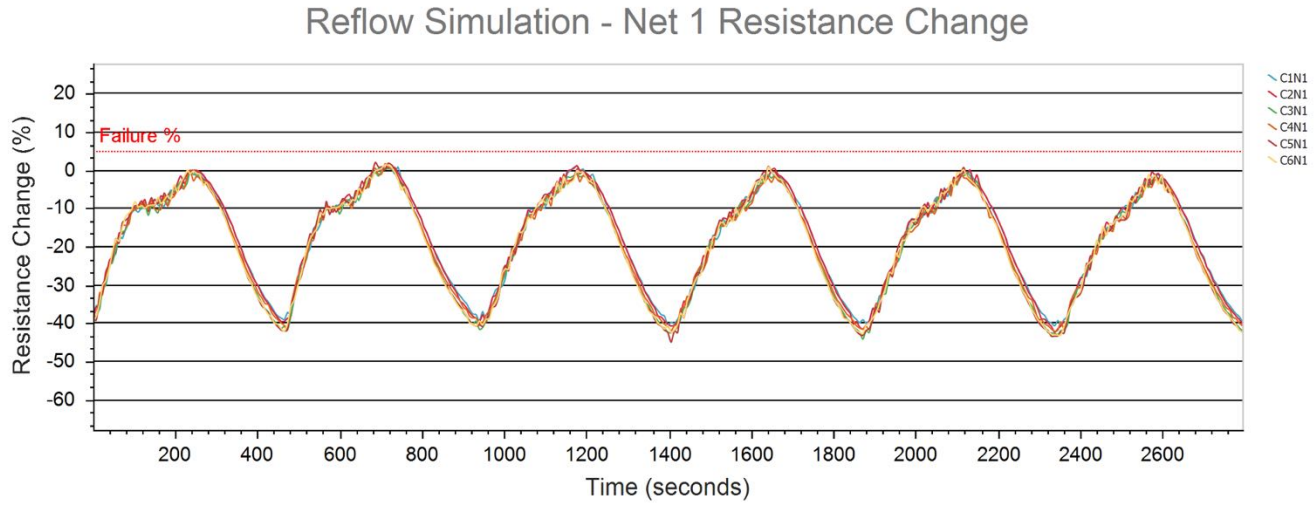
The 1-second data acquisition interval was chosen using data and capability from 1 test system during test method development. The HATS^{2TM} system became available late in the test method's development process and while there was a last-minute opportunity to submit one set of data from the HATS^{2TM} system with 10-second data acquisition interval, the majority of committee members voted to keep the 1-second data acquisition interval as the test method requirement based upon their experience with the originally used test methodology. Further testing on the HATS^{2TM} system has shown that a 7-second data acquisition interval is adequate to capture failures at or near peak reflow temperature. With this resistance acquisition interval, 3-4 data points are captured within 5°C of the peak reflow temperature.

Another issue that should be considered in the decision has to do with the capacity for testing samples. Any significant implementation of this test method will require a great many coupons to be tested, and currently, measuring 24x IPC D coupons simultaneously requires a measurement system capable of greater than 50 Measurements per second. This can only be accomplished in systems that use digital switches which have significant limitations in their measurement capability.

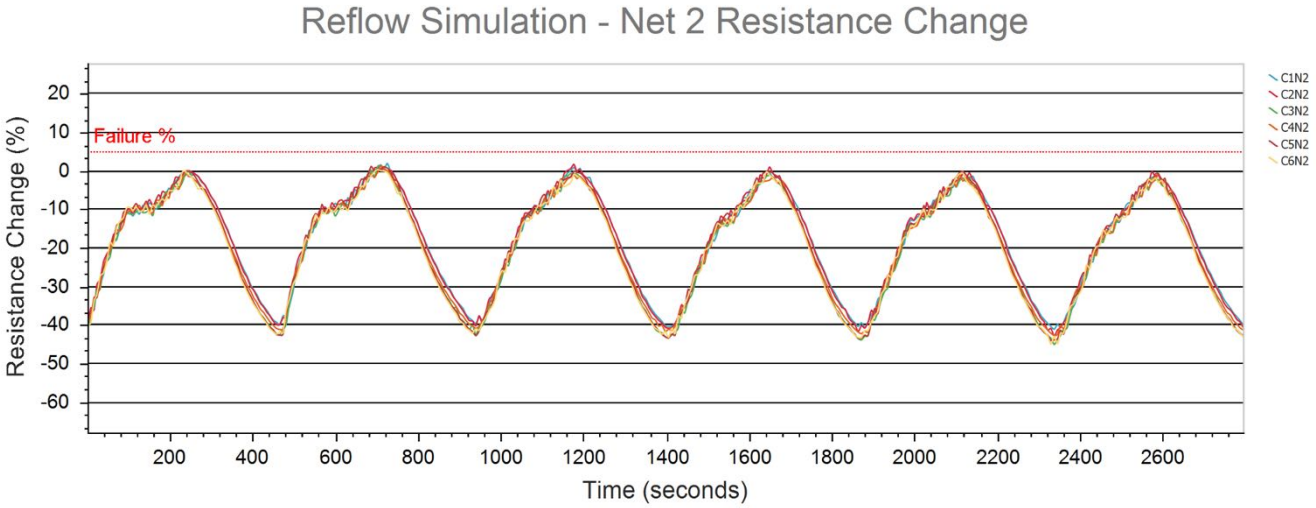
Mechanical switching systems like those is used in the HATS^{2TM} test system is capable of making about 20 accurate and repeatable measurements per second using a 1-second data collection interval. At this interval, only 10x IPC D & 2x HATS^{2TM} single via test coupons can be tested simultaneously. During this test program we tried to push this up to 25 readings per second for our "1-second" data interval results to accommodate testing 3 HATS^{2TM} single via test coupons simultaneously and the data, as seen in further in this report, is not as consistent as it should be. A 7-second data capture interval would allow as many as 65x IPC D and 18x HATS^{2TM} single via test coupons to be tested simultaneously. The benefits of mechanical switching systems also include the ability to measure at currents of up to 1A and gain accuracy and repeatability for measurements below 1 milliohm. Digital switching systems must limit the current of measurement to $\leq$ 10 milliamps. This in turn limits the capability of digital switching-based systems to measuring resistances in the 10s of milliohms and incapable of measuring single via test structures.

Group 1A, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



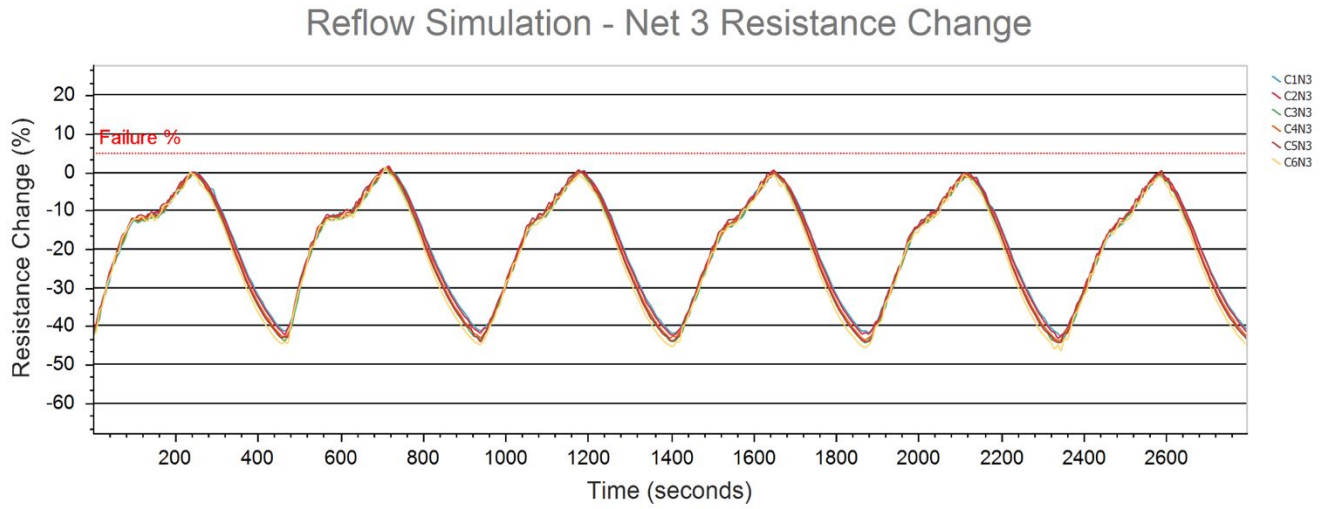
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00171	0.00170	0.00190	0.00158	0.00148	0.00170
Maximum Resistance % Change	1.11	1.24	0.52	1.71	2.10	1.47
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



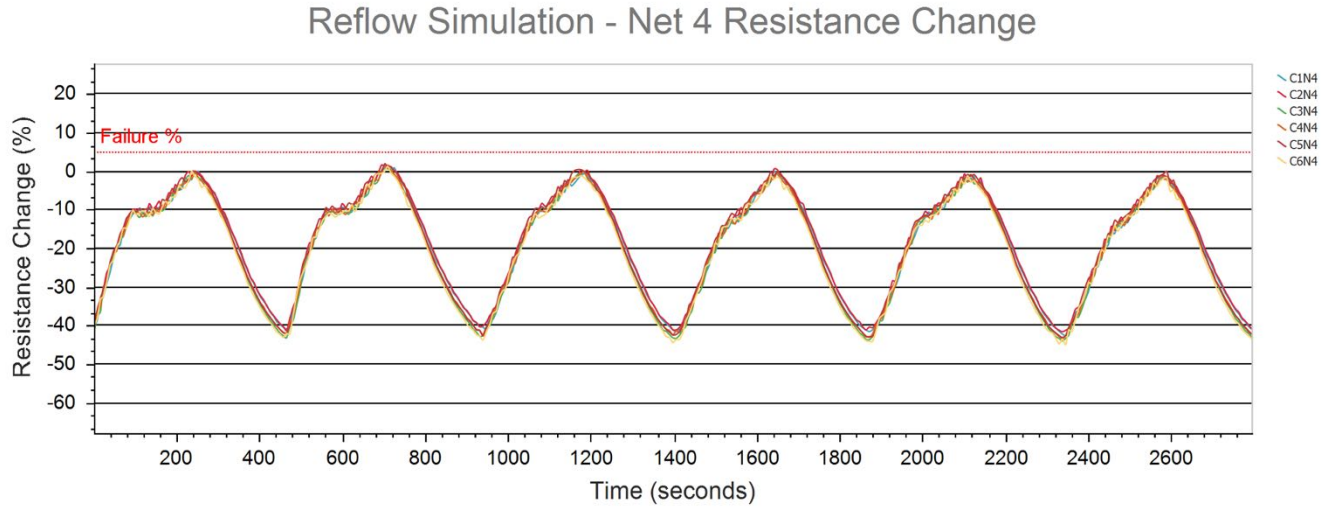
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00204	0.00185	0.00184	0.00190	0.00187	0.00211
Maximum Resistance % Change	1.96	1.73	1.31	1.32	1.17	0.38
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1A, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



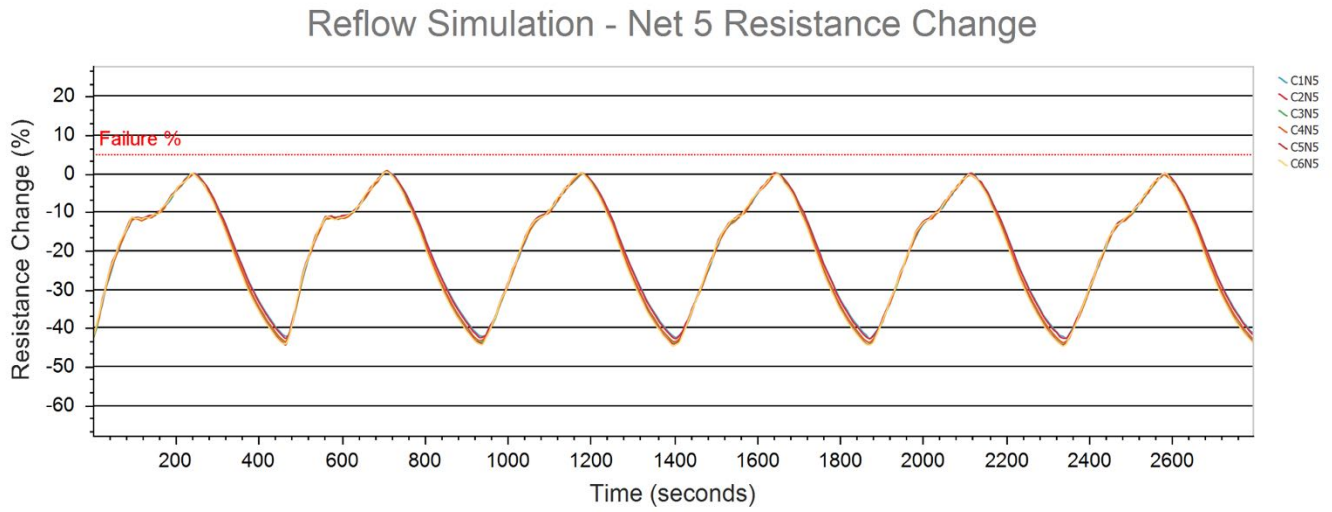
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00337	0.00372	0.00382	0.00356	0.00319	0.00322
Maximum Resistance % Change	1.13	1.61	0.68	1.07	1.04	1.21
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



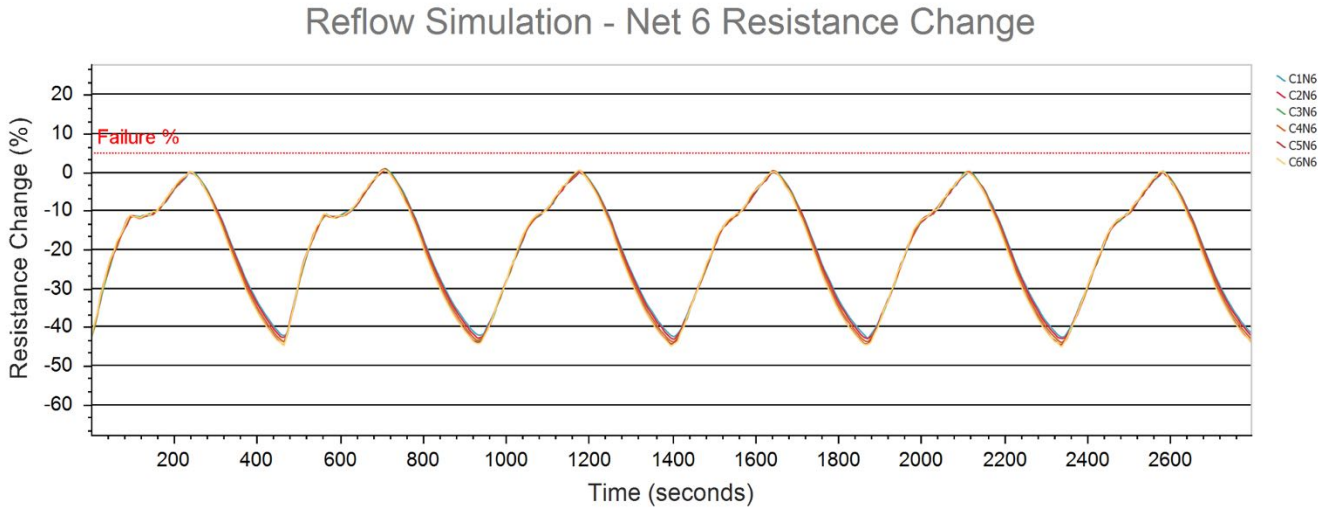
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00226	0.00230	0.00254	0.00233	0.00240	0.00235
Maximum Resistance % Change	1.15	1.61	1.30	1.46	1.96	1.32
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1A, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



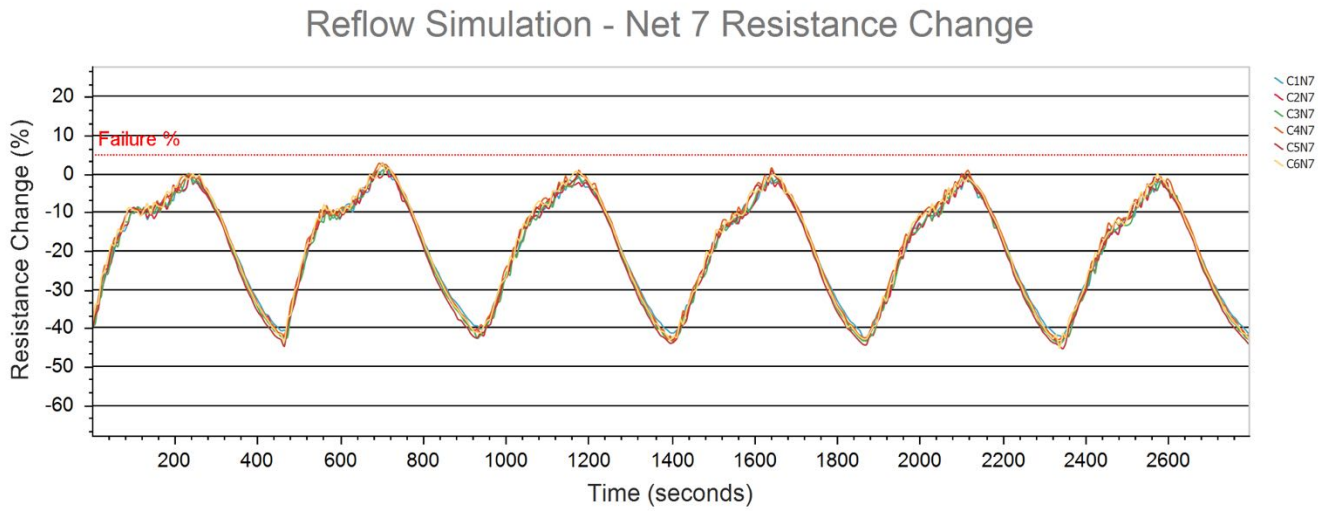
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00839	0.00916	0.00931	0.00869	0.00846	0.00826
Maximum Resistance % Change	0.76	0.81	0.58	0.51	0.74	0.51
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



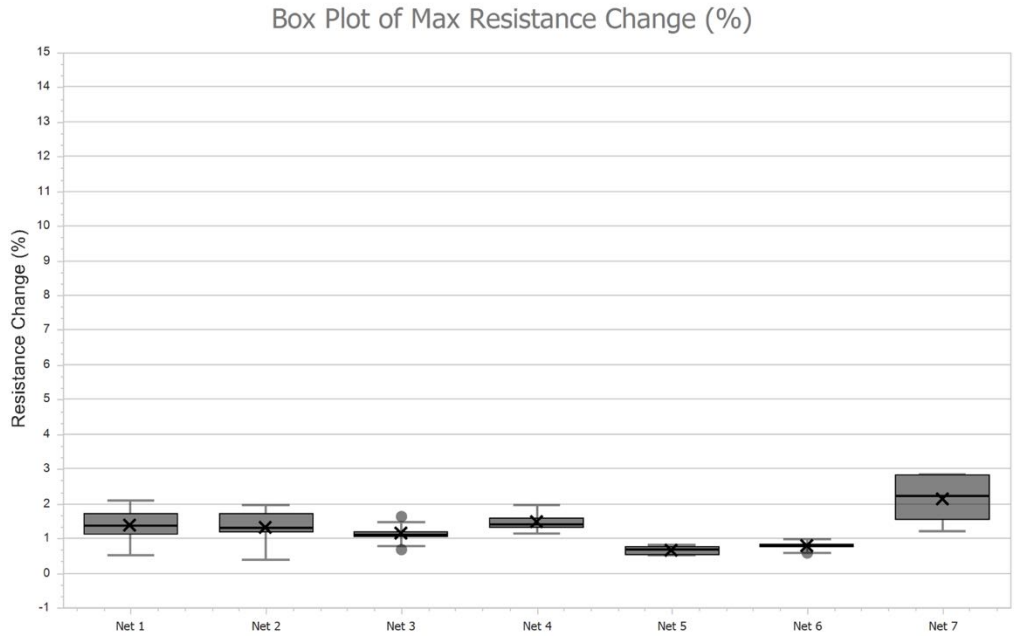
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00842	0.00878	0.00859	0.00837	0.00821	0.00797
Maximum Resistance % Change	0.84	0.77	0.97	0.78	0.74	0.56
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1A, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm

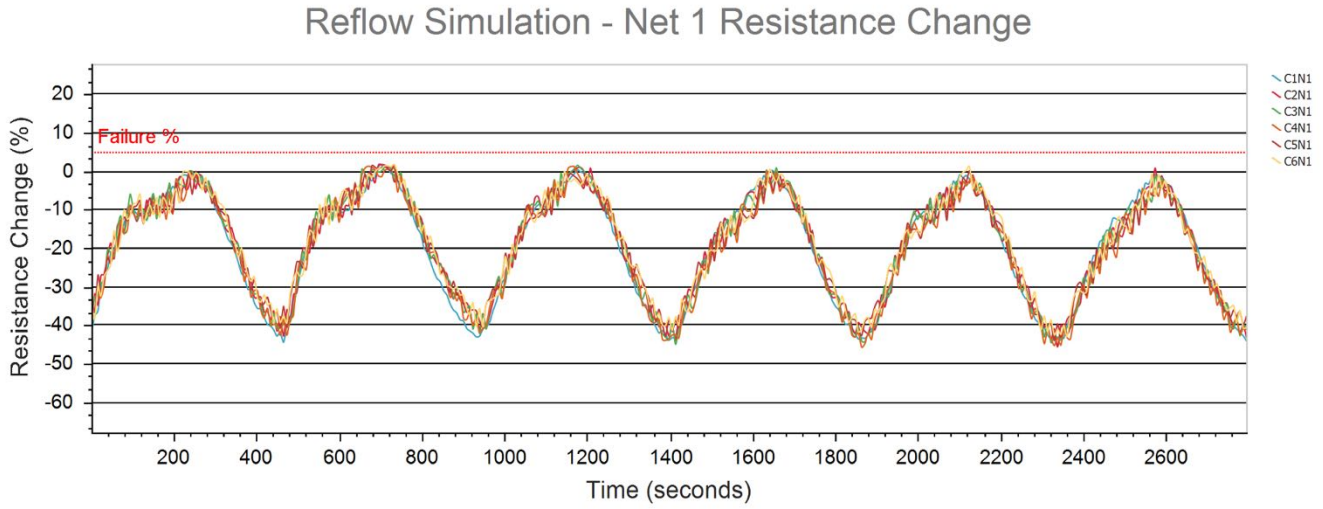


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00176	0.00171	0.00170	0.00177	0.00187	0.00169
Maximum Resistance % Change	1.20	1.52	1.76	2.83	2.83	2.67
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

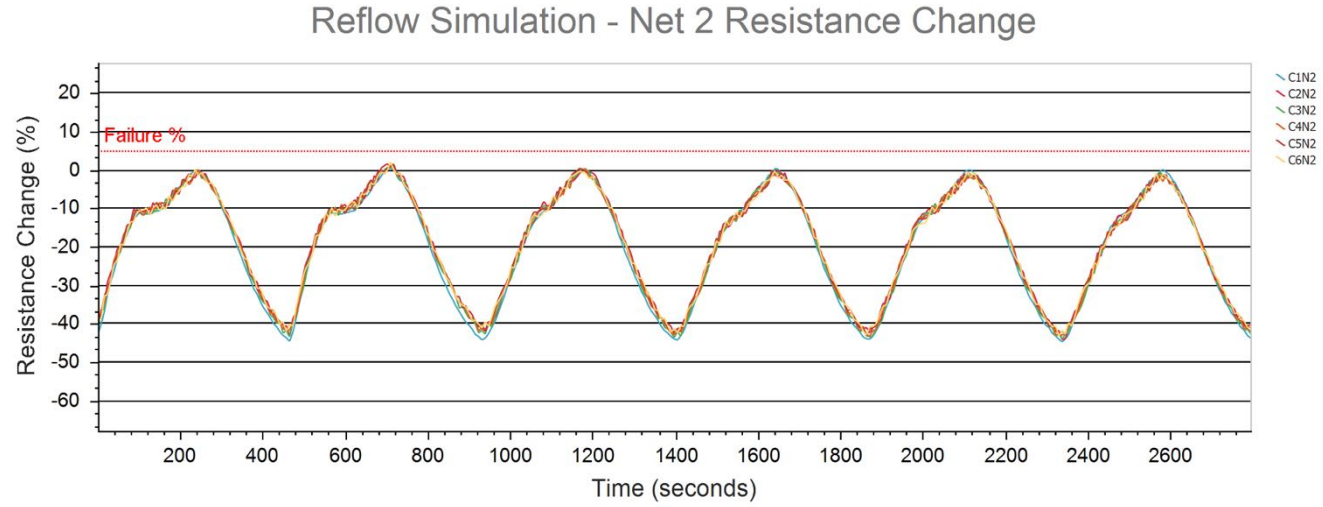


Group 1B, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



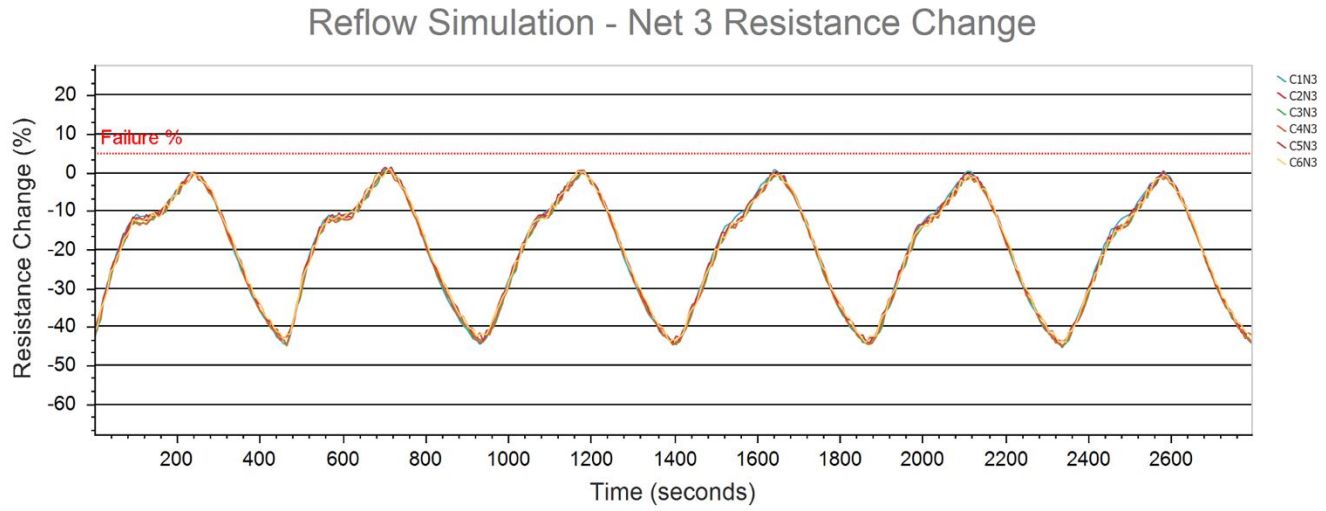
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00267	0.00096	0.00088	0.00081	0.00082	0.00088
Maximum Resistance % Change	1.69	1.78	1.59	1.37	1.71	1.83
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



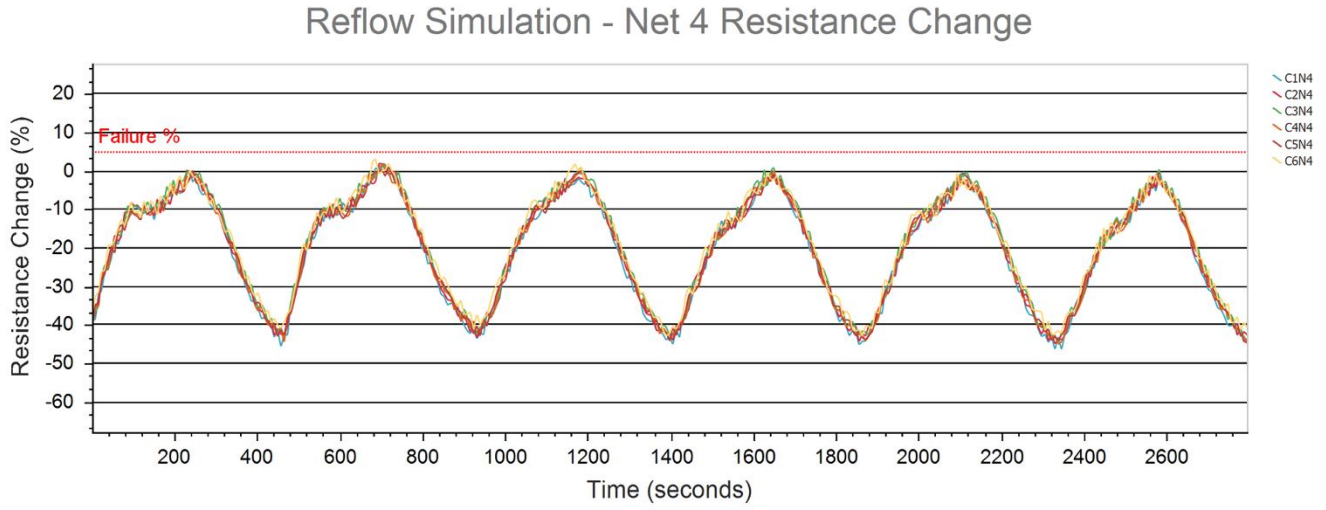
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01027	0.00242	0.00272	0.00245	0.00245	0.00255
Maximum Resistance % Change	0.48	1.61	1.03	1.51	1.39	1.96
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1B, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



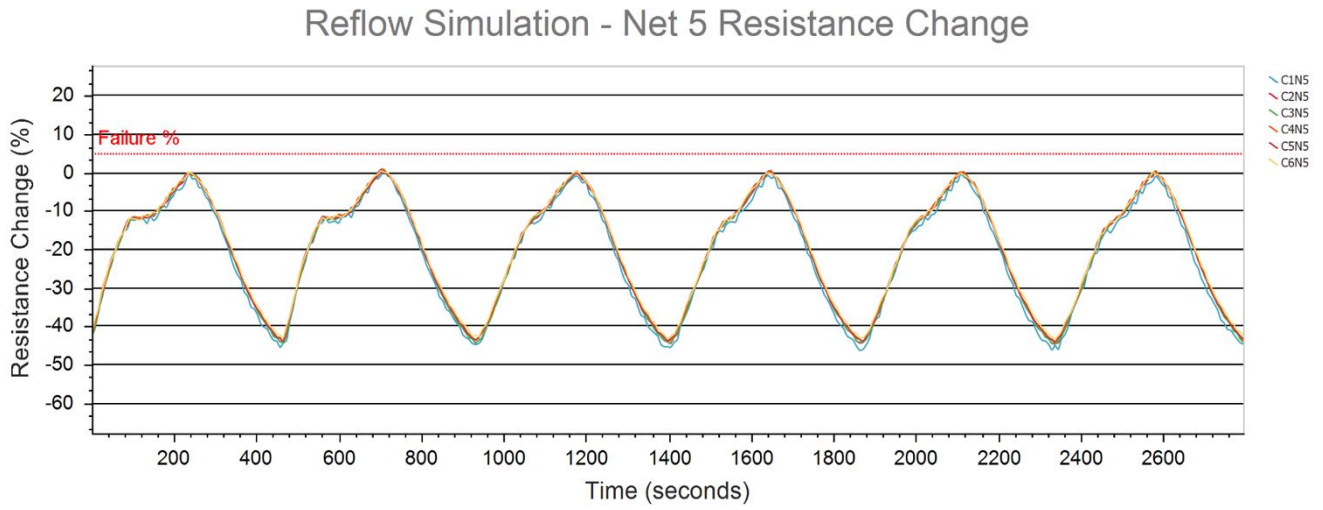
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00673	0.00376	0.00384	0.00357	0.00317	0.00316
Maximum Resistance % Change	0.91	1.28	0.52	0.11	1.36	0.85
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



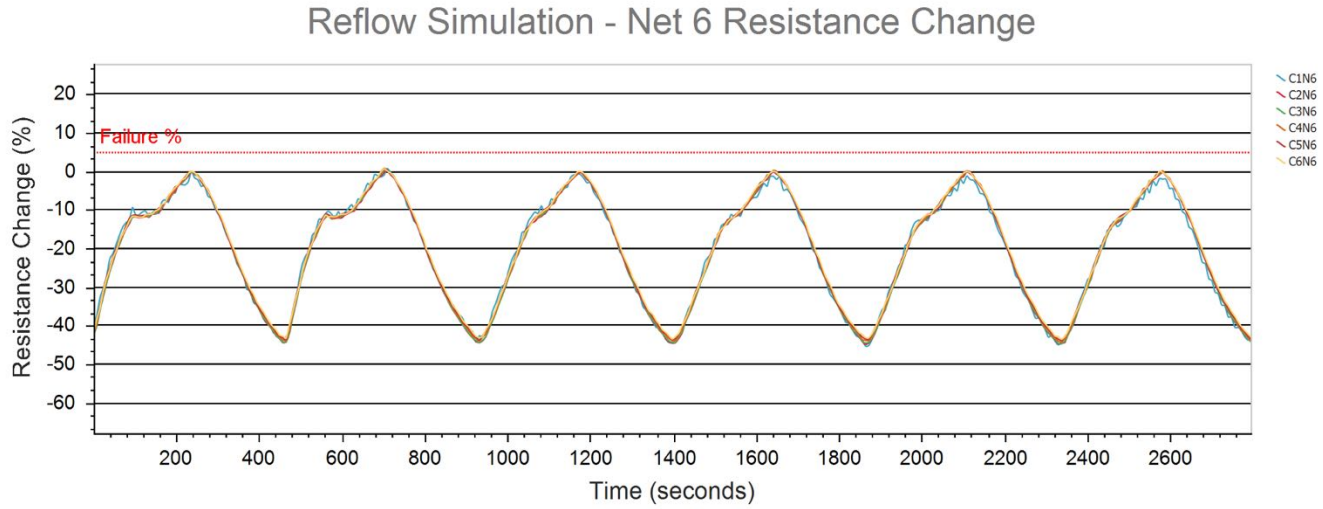
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00156	0.00153	0.00147	0.00160	0.00169	0.00135
Maximum Resistance % Change	1.25	1.82	1.55	1.62	0.95	2.97
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1B, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



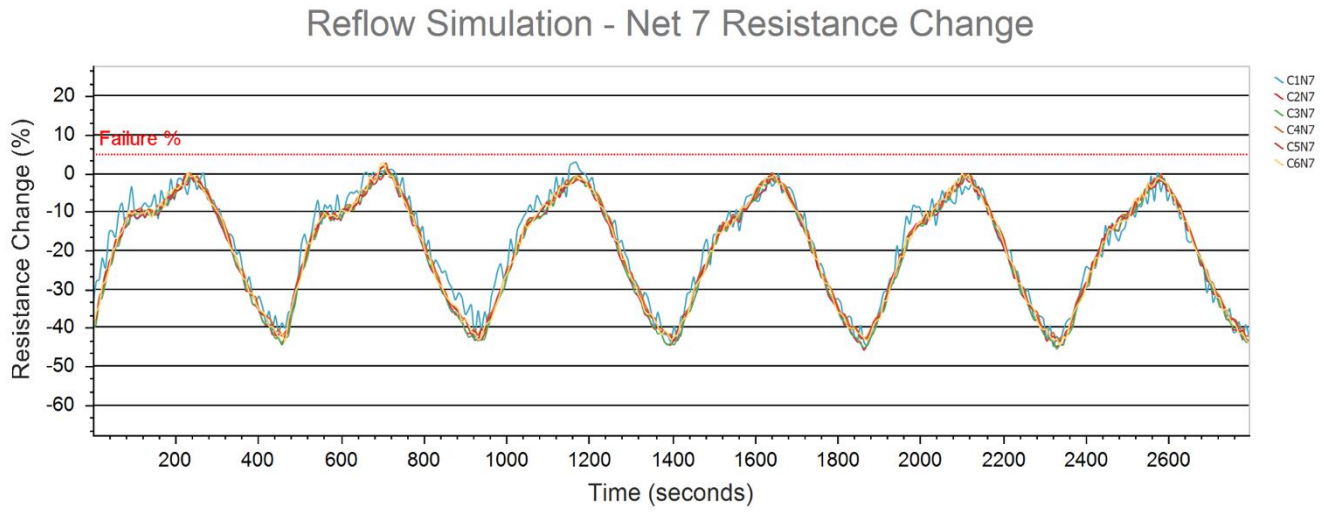
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00347	0.00741	0.00698	0.00699	0.00676	0.00650
Maximum Resistance % Change	0.81	0.69	0.92	0.89	0.74	0.54
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



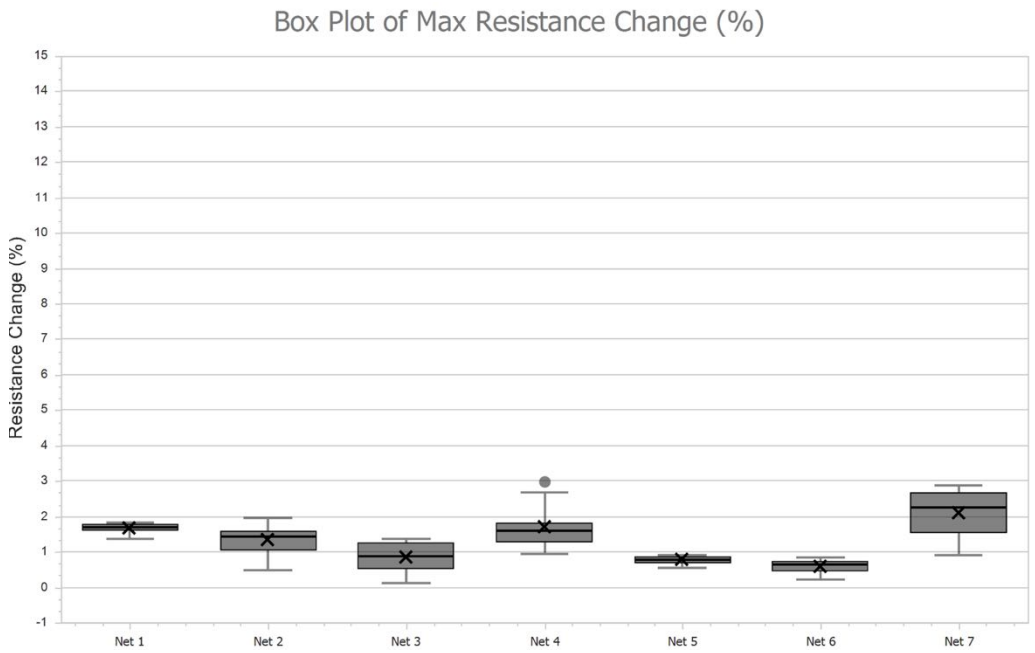
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00266	0.01048	0.01063	0.00978	0.00999	0.00956
Maximum Resistance % Change	0.75	0.23	0.45	0.54	0.83	0.72
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1B, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm

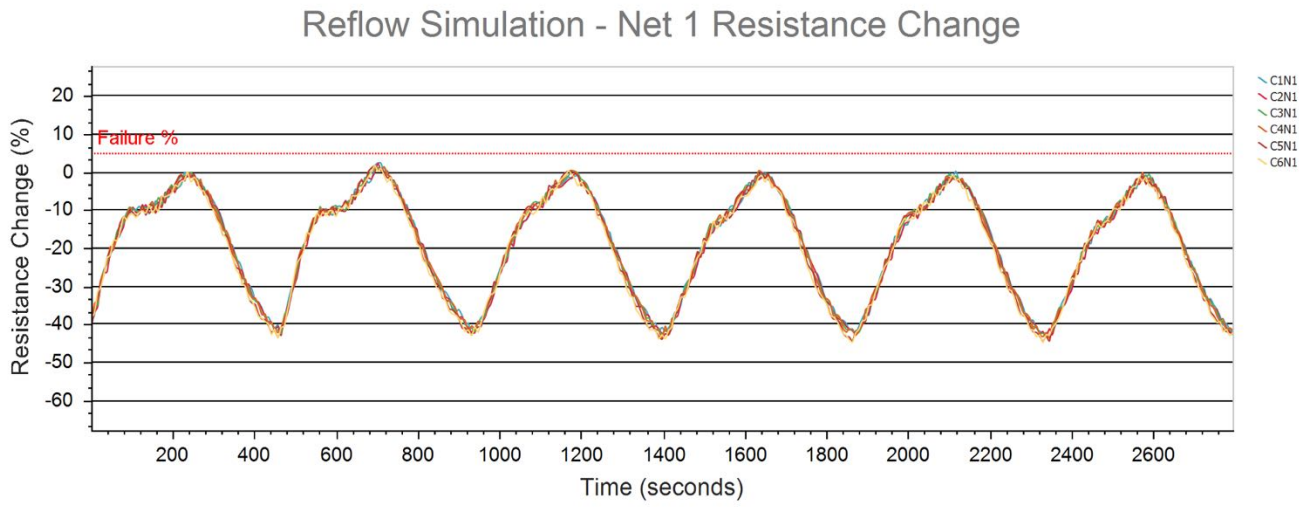


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00080	0.00253	0.00259	0.00237	0.00273	0.00228
Maximum Resistance % Change	2.89	0.91	1.55	2.66	1.83	2.68
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

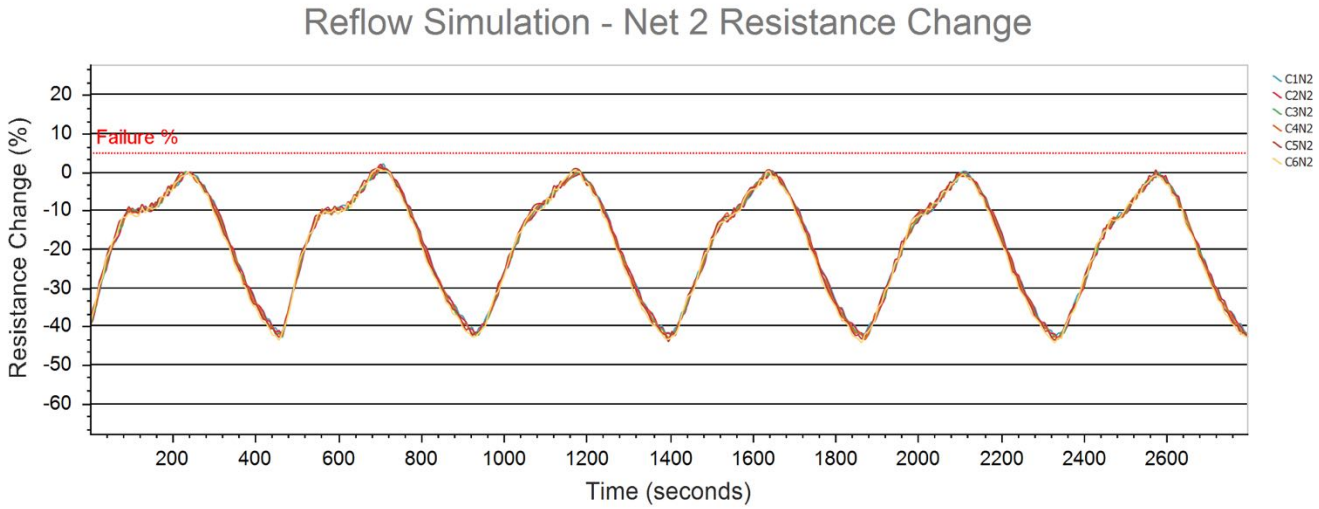


Group 1C, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



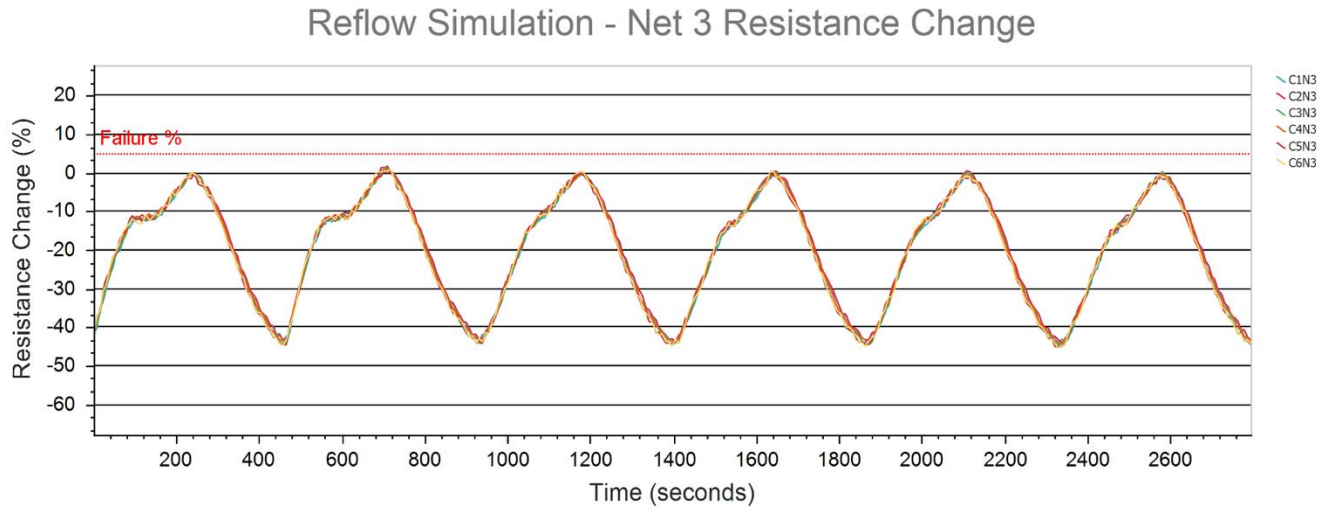
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00226	0.00240	0.00253	0.00203	0.00218	0.00228
Maximum Resistance % Change	2.43	2.29	1.46	1.23	1.70	1.75
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



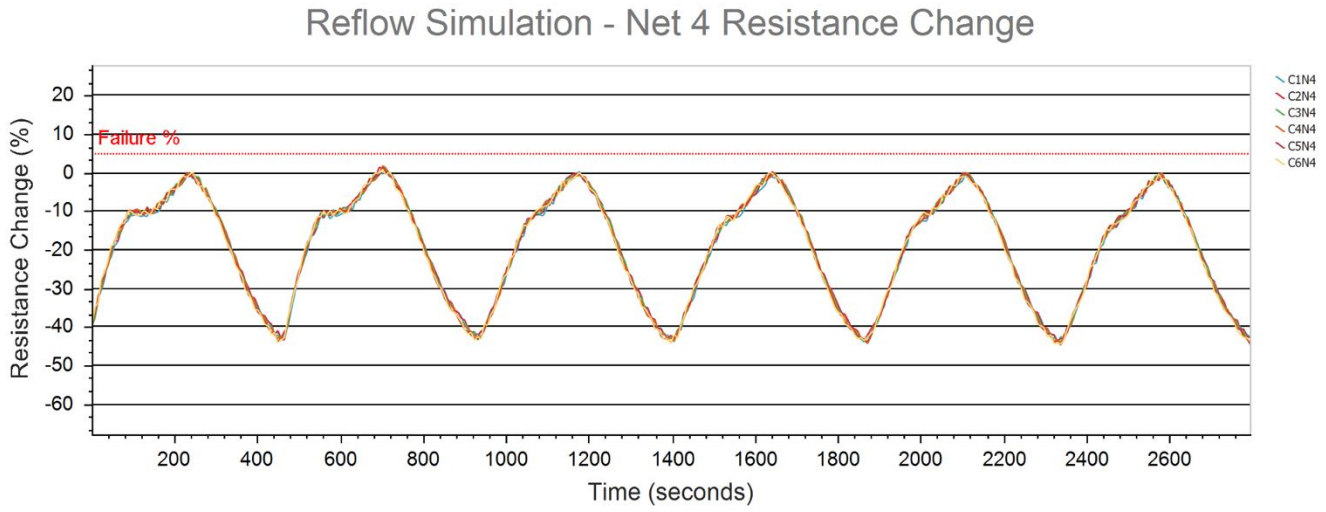
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00352	0.00343	0.00385	0.00336	0.00308	0.00361
Maximum Resistance % Change	2.10	2.01	1.43	1.07	1.20	0.94
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1C, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



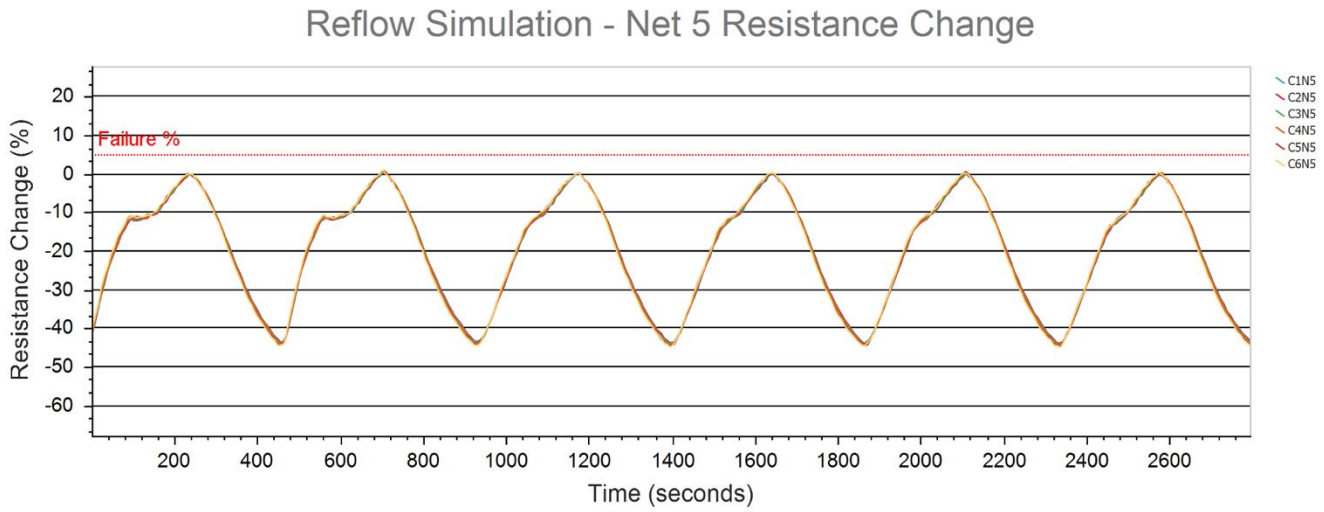
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00340	0.00371	0.00384	0.00352	0.00321	0.00318
Maximum Resistance % Change	1.82	1.59	1.51	1.39	0.59	0.88
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



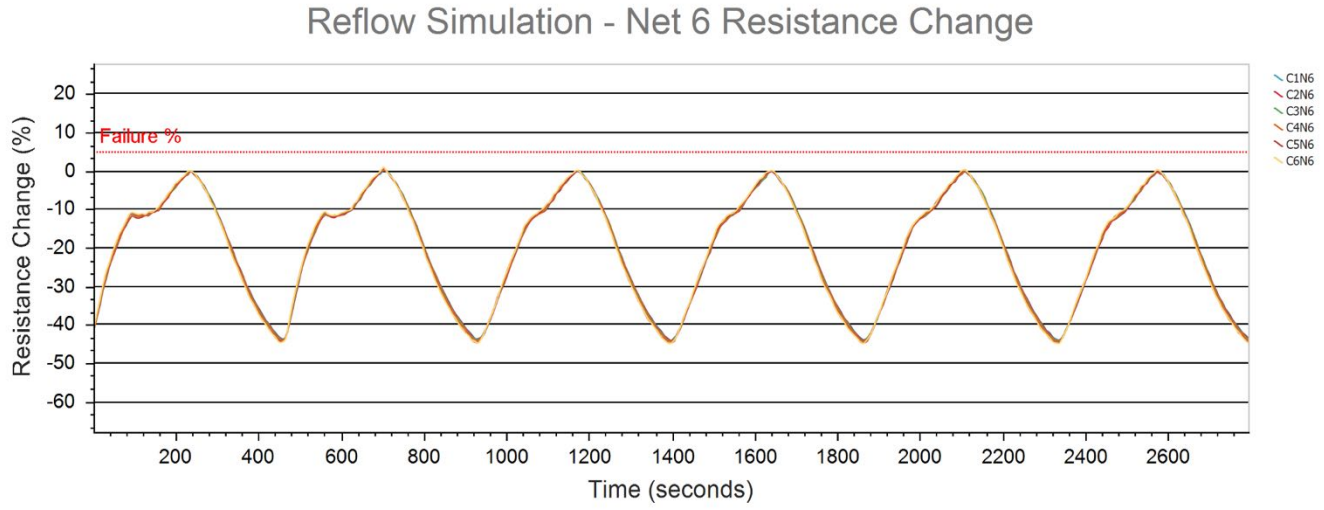
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00330	0.00319	0.00352	0.00309	0.00364	0.00323
Maximum Resistance % Change	0.91	1.41	1.59	1.75	1.35	0.87
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1C, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



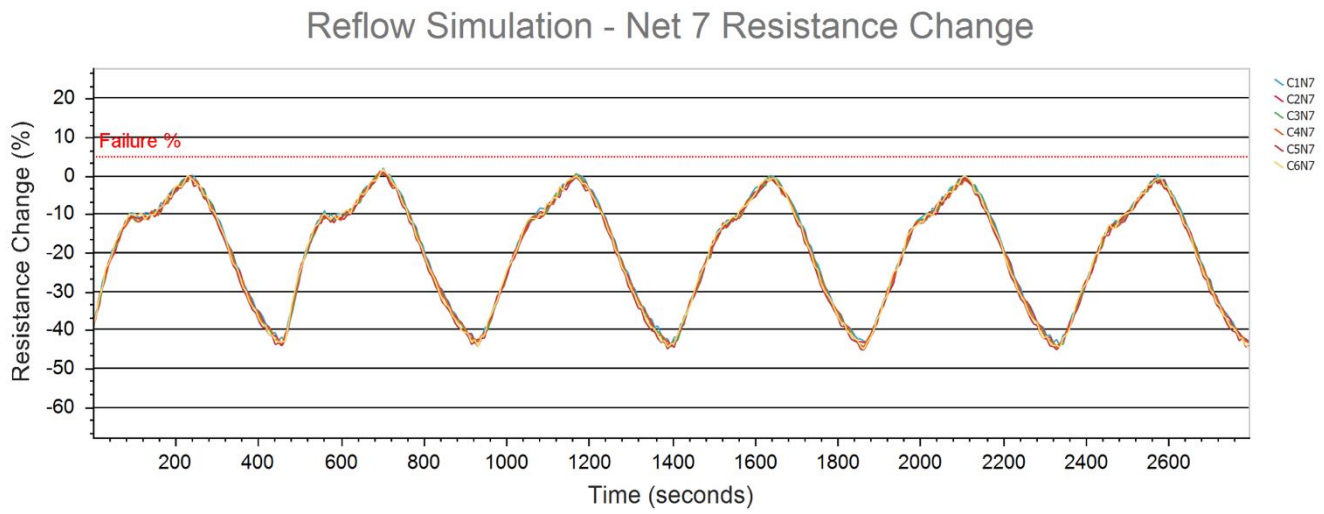
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01007	0.01071	0.01091	0.00986	0.01015	0.00994
Maximum Resistance % Change	0.20	0.21	0.48	0.90	0.94	1.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



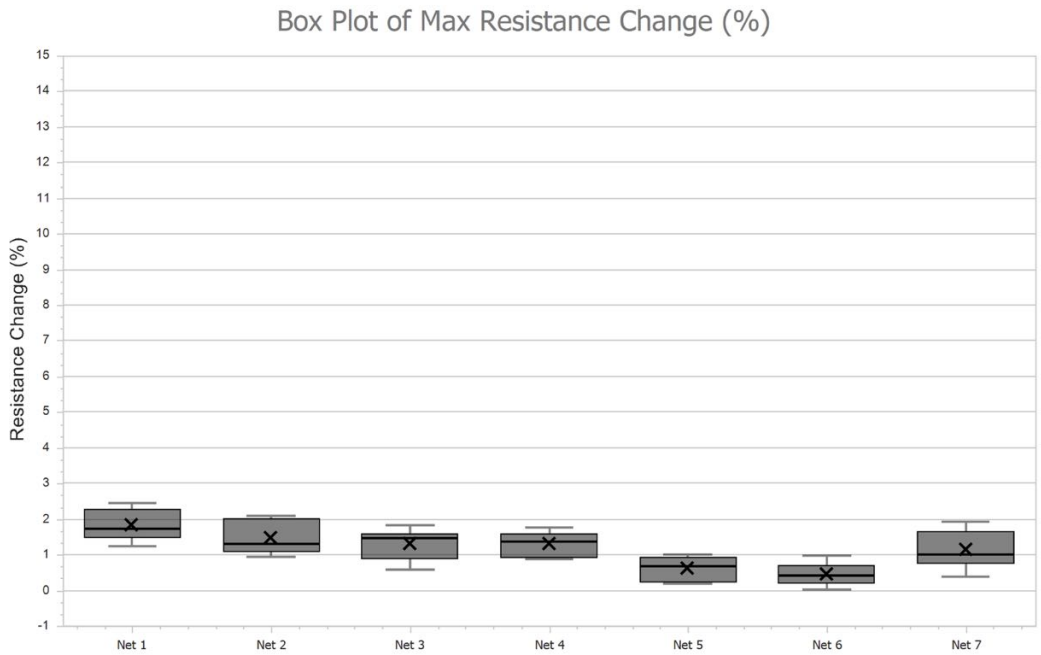
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01234	0.01269	0.01319	0.01213	0.01202	0.01239
Maximum Resistance % Change	0.19	0.02	0.31	0.53	0.72	0.98
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 1C, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm

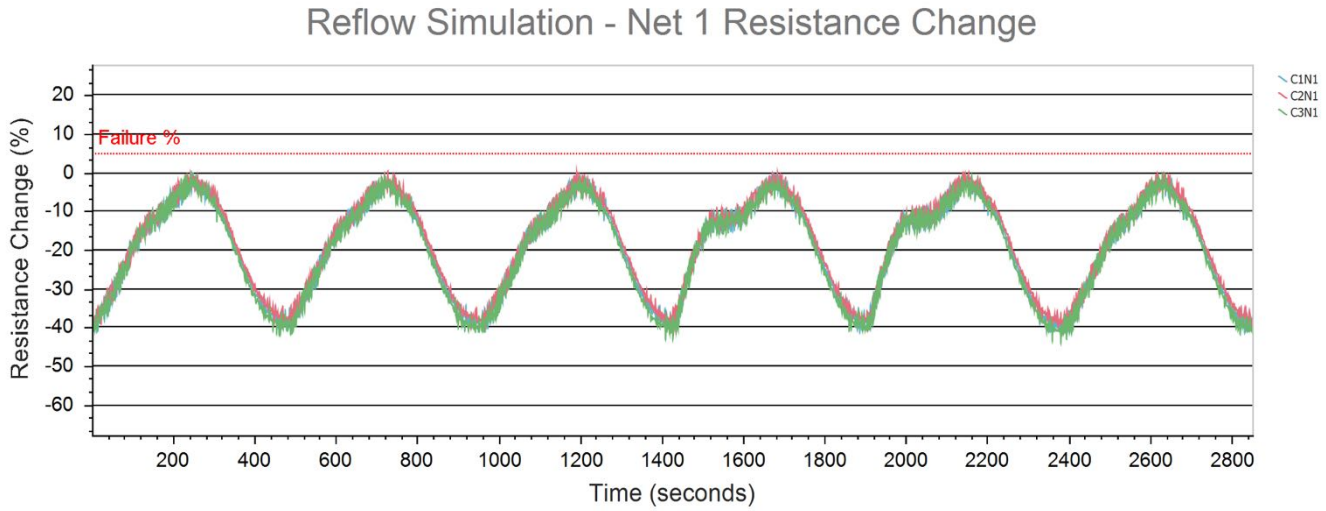


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00347	0.00360	0.00379	0.00328	0.00350	0.00339
Maximum Resistance % Change	1.93	0.39	0.74	1.16	0.86	1.65
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

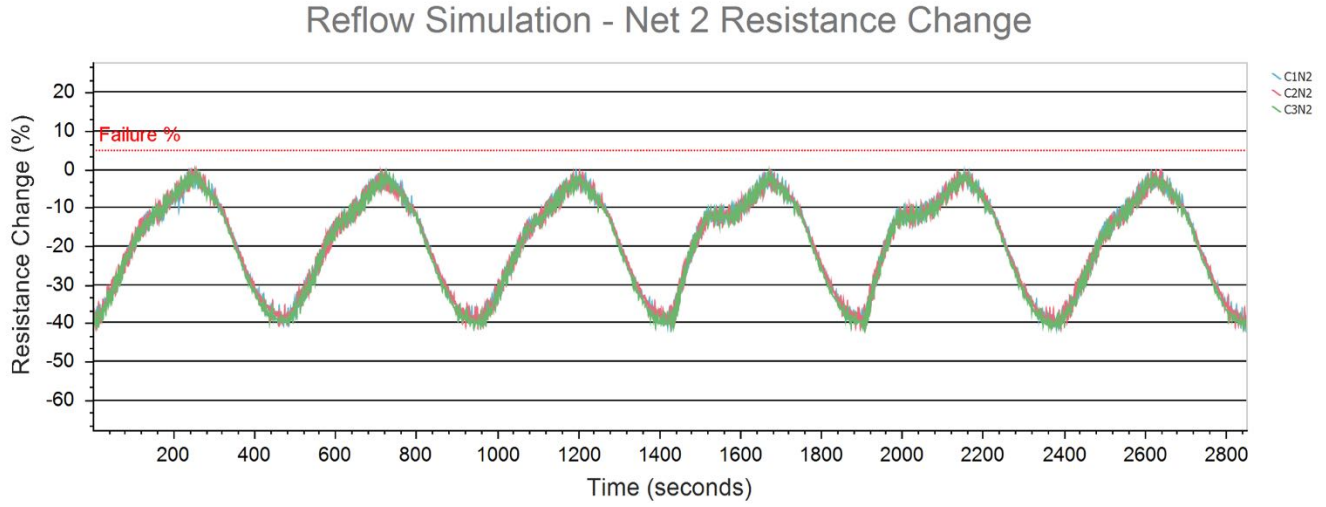


Group 2A, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



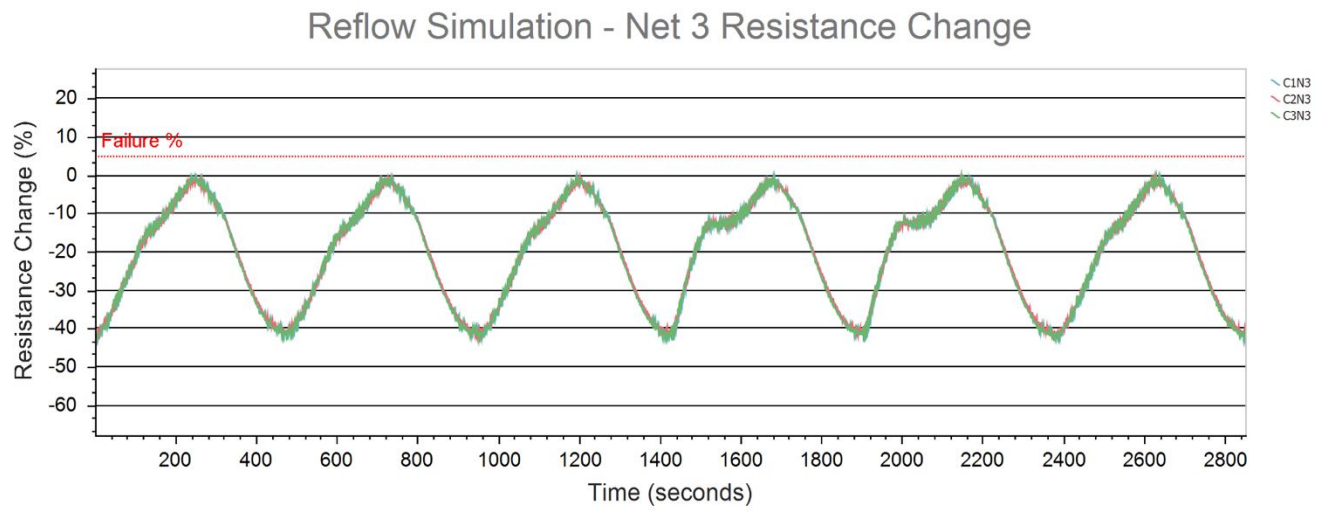
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00184	0.00202	0.00166	-	-	-
Maximum Resistance % Change	0.00	0.44	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



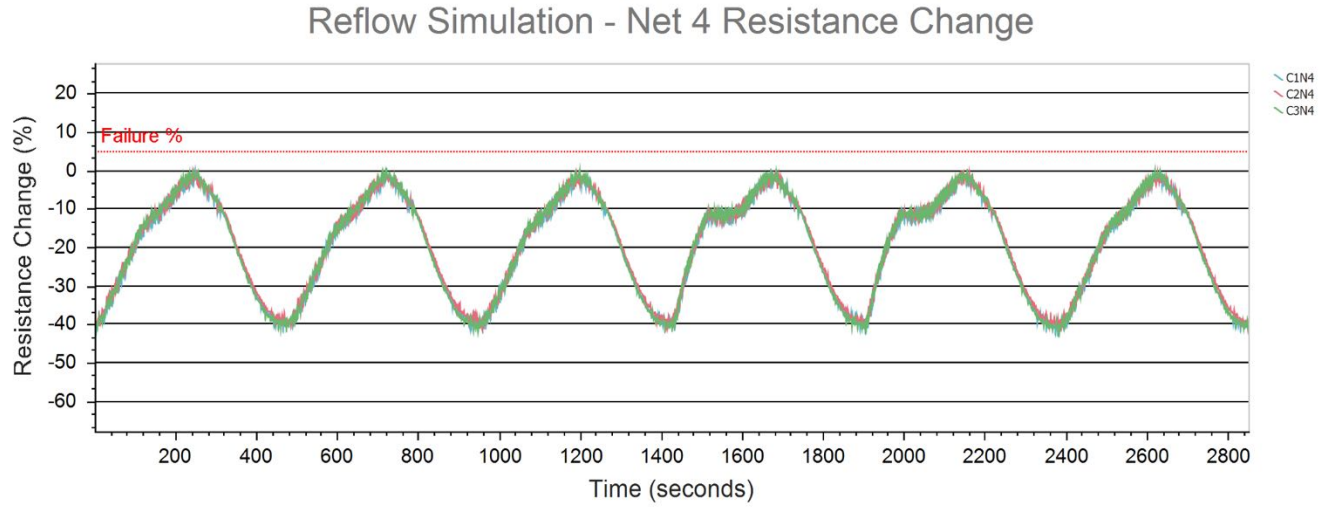
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00212	0.00187	0.00202	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2A, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:** .125 mm	
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:** .125 mm	
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:** .25 mm	
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:** .125 mm	
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:** .125 mm	
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:** .125 mm	
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:** .125 mm	



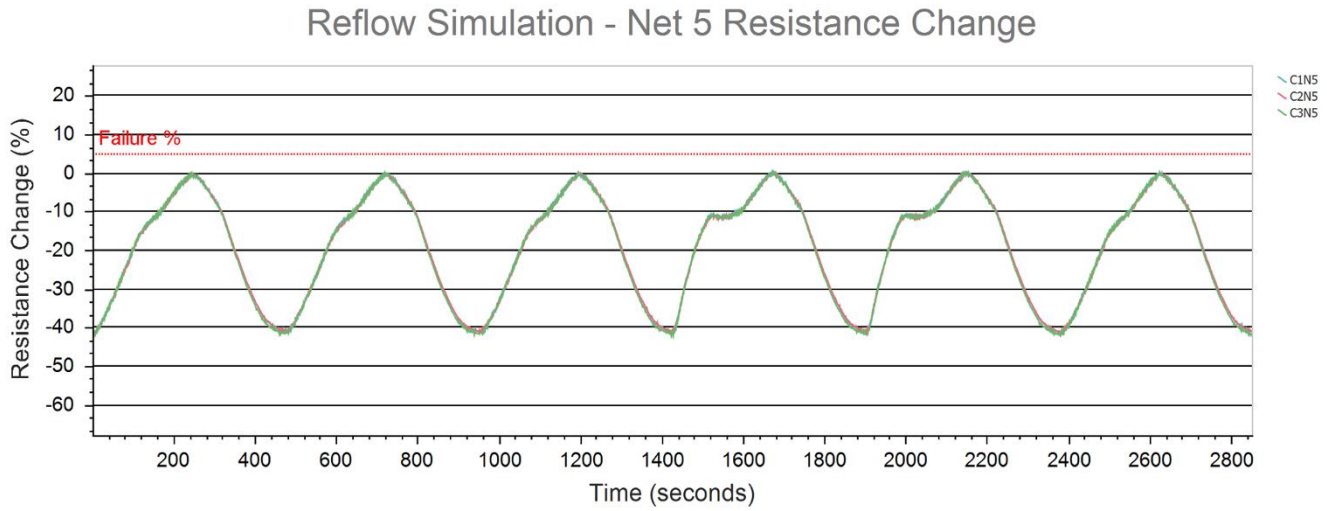
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00372	0.00376	0.00329	-	-	-
Maximum Resistance % Change	0.06	0.00	0.15	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



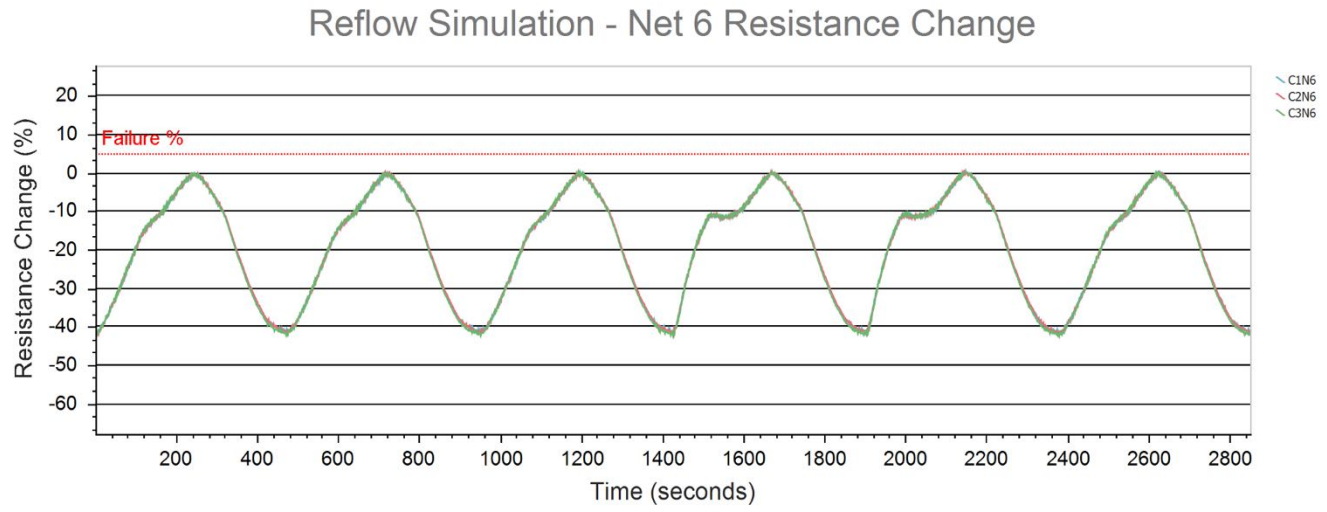
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00243	0.00275	0.00273	-	-	-
Maximum Resistance % Change	0.00	0.00	0.48	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2A, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 18. IPC V TSL 230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



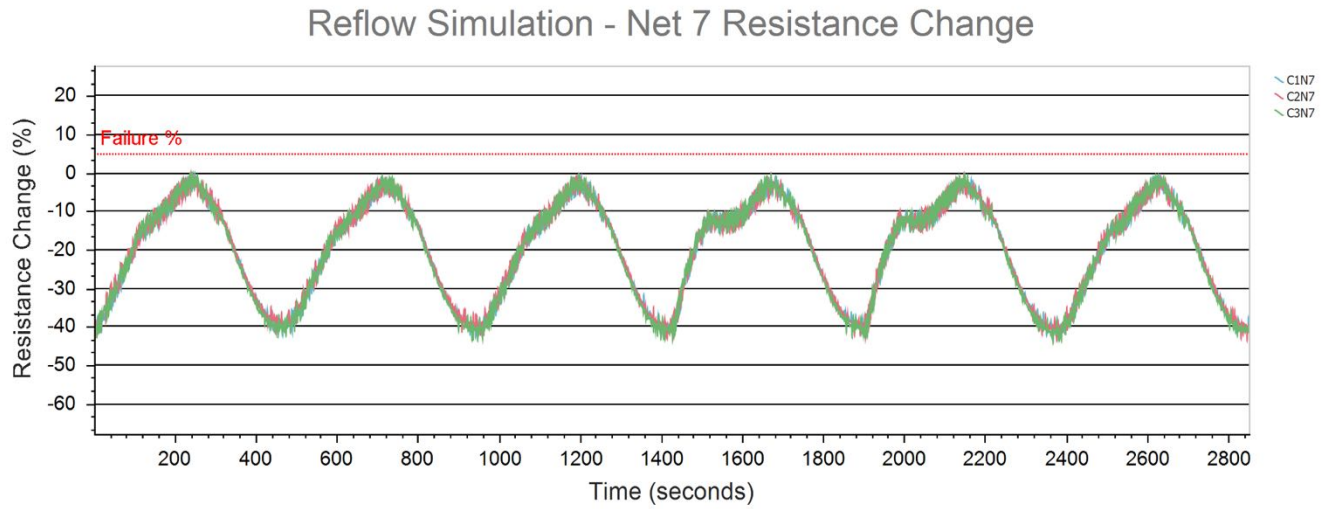
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00856	0.00926	0.00836	-	-	-
Maximum Resistance % Change	0.49	0.27	0.38	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



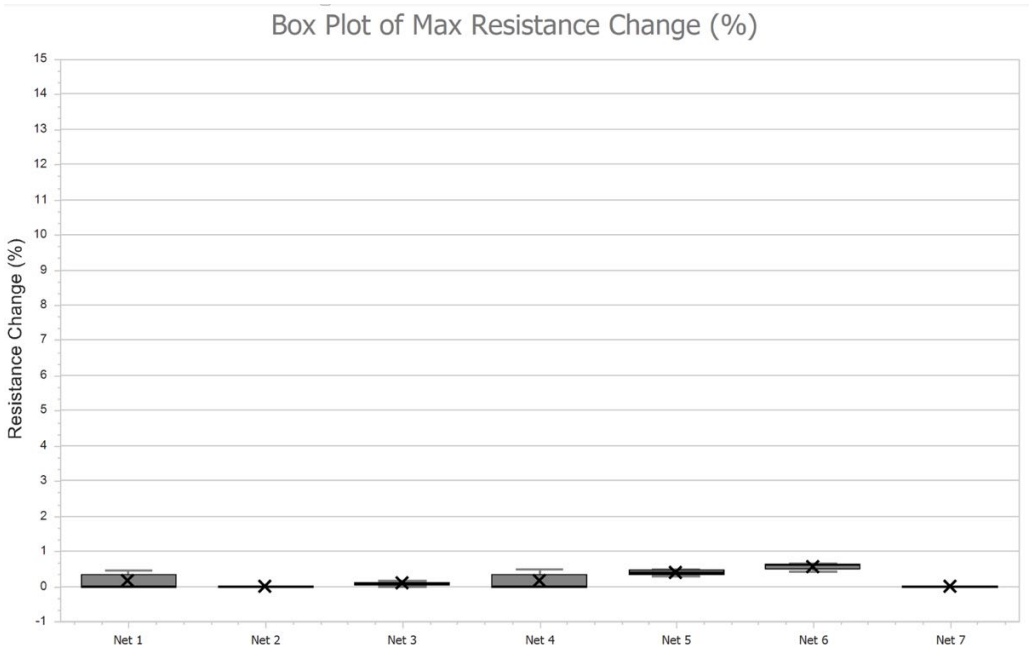
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00836	0.00820	0.00821	-	-	-
Maximum Resistance % Change	0.63	0.61	0.43	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2A, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons: 3		**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:** .125 mm	
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:** .125 mm	
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:** .25 mm	
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:** .125 mm	
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:** .125 mm	
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:** .125 mm	
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:** .125 mm	

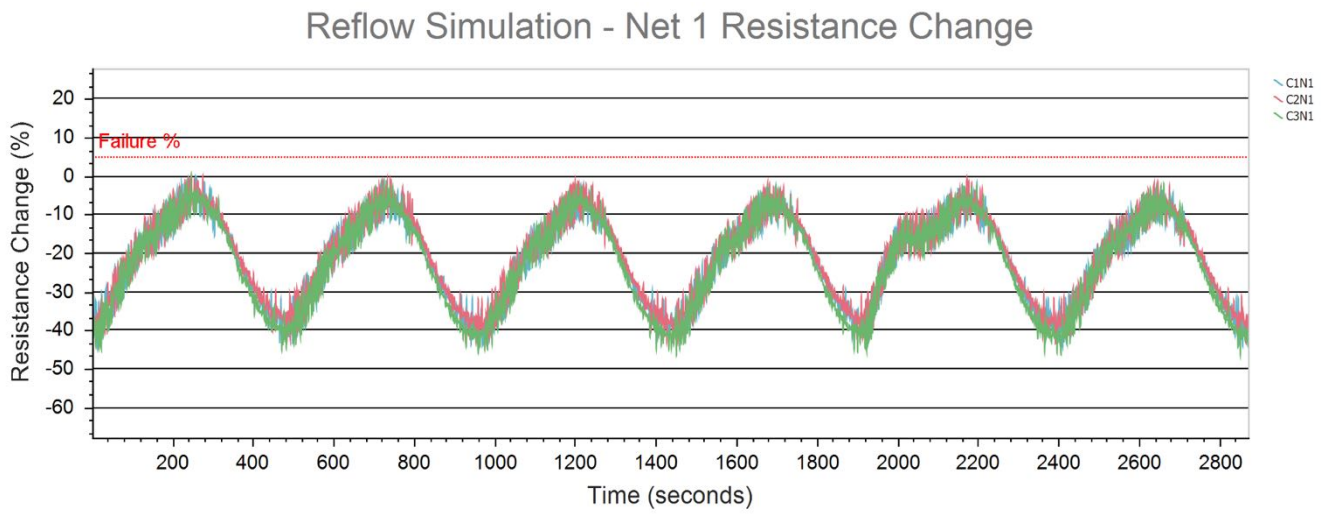


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00195	0.00179	0.00192	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

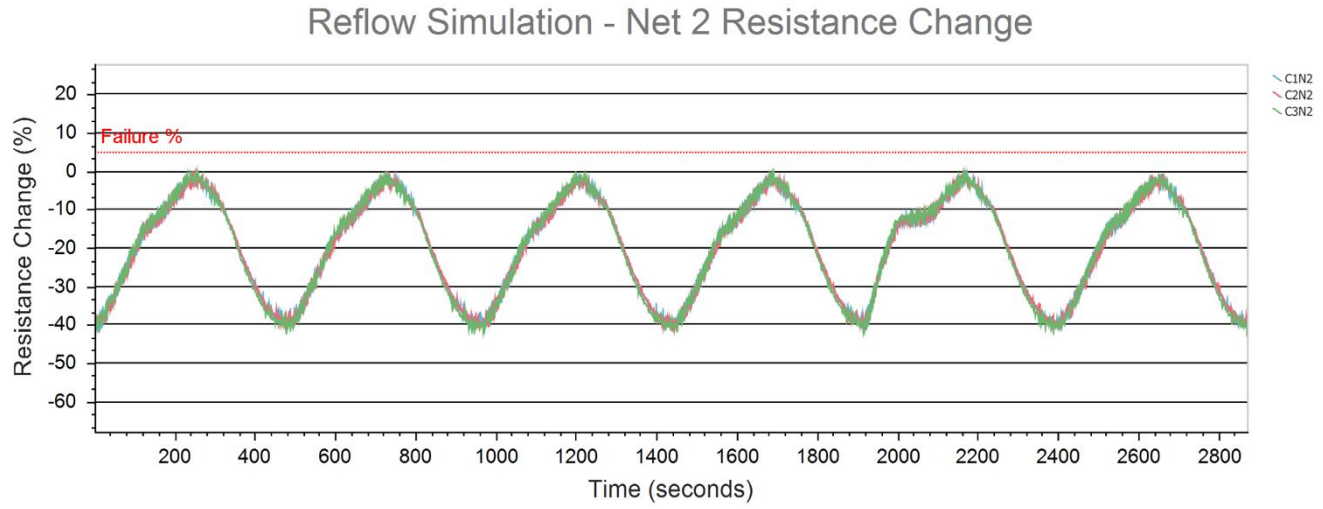


Group 2B, HATS2TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



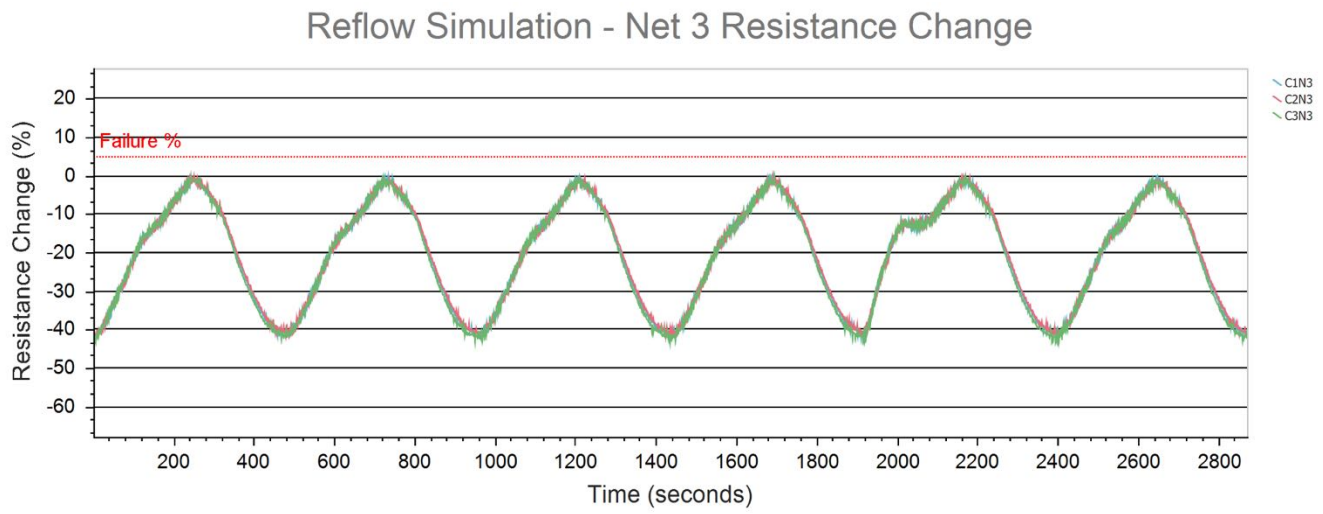
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00095	0.00100	0.00101	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



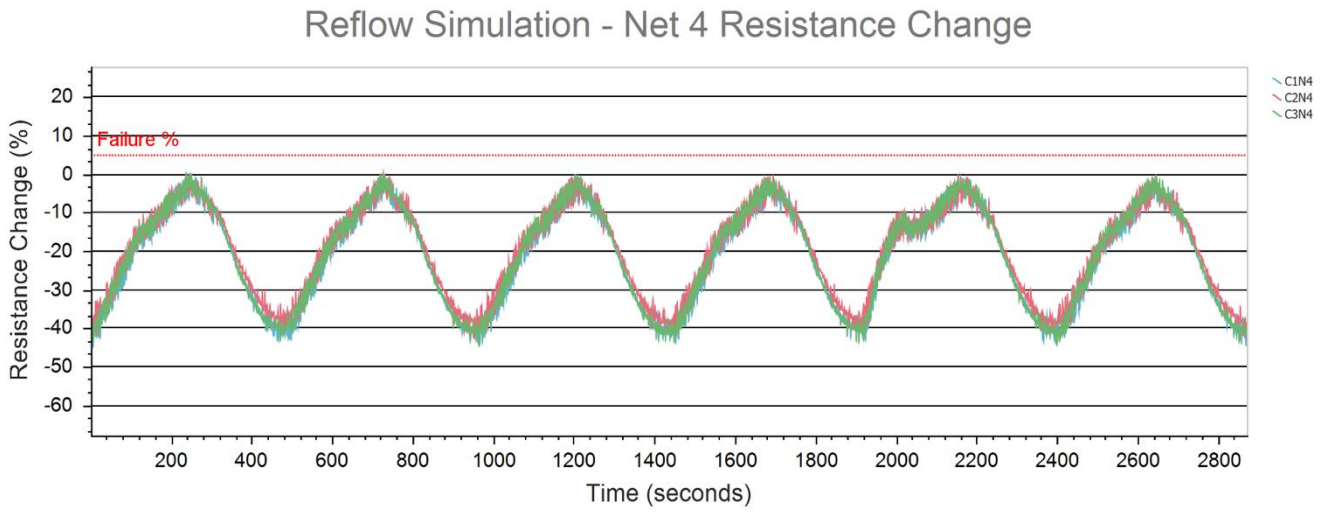
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00249	0.00256	0.00251	-	-	-
Maximum Resistance % Change	0.00	0.00	0.16	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2B, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



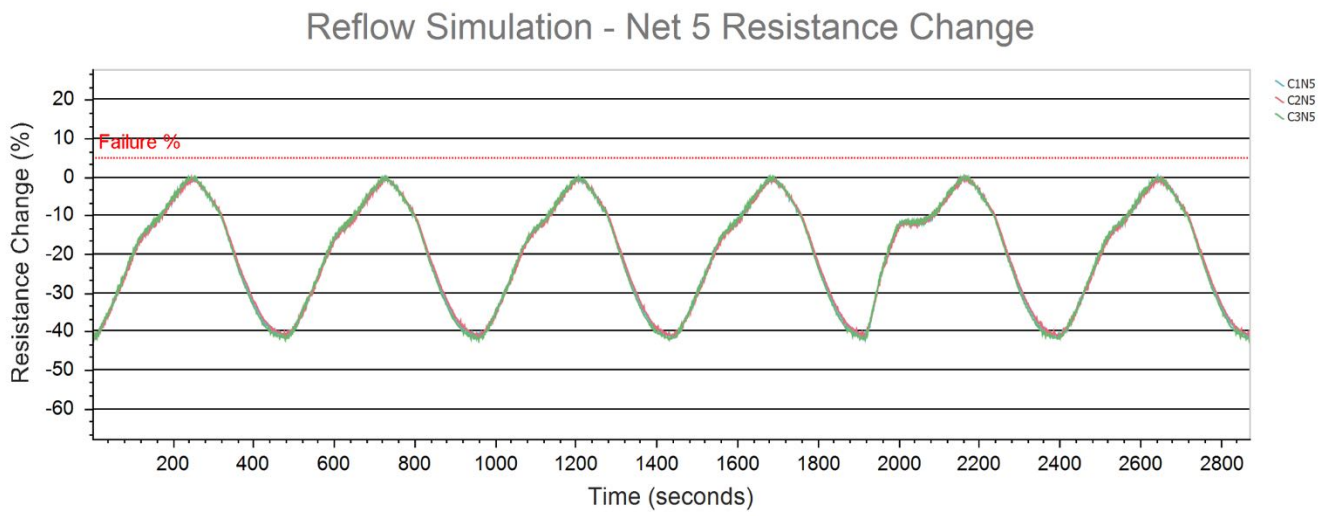
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00347	0.00372	0.00332	-	-	-
Maximum Resistance % Change	0.06	0.13	0.09	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



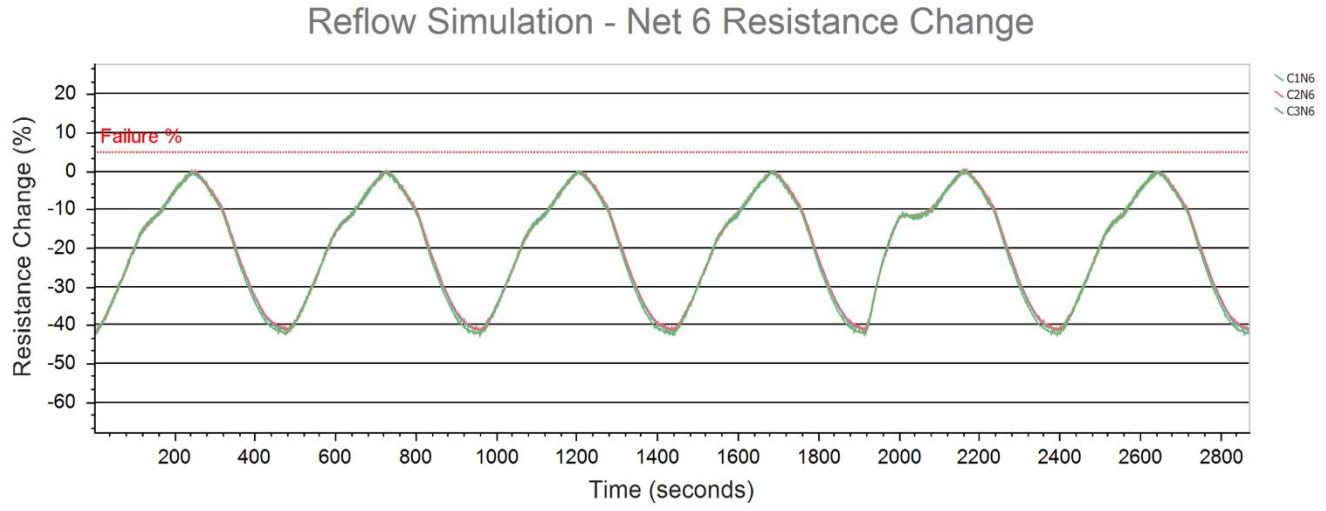
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00155	0.00144	0.00178	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2B, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



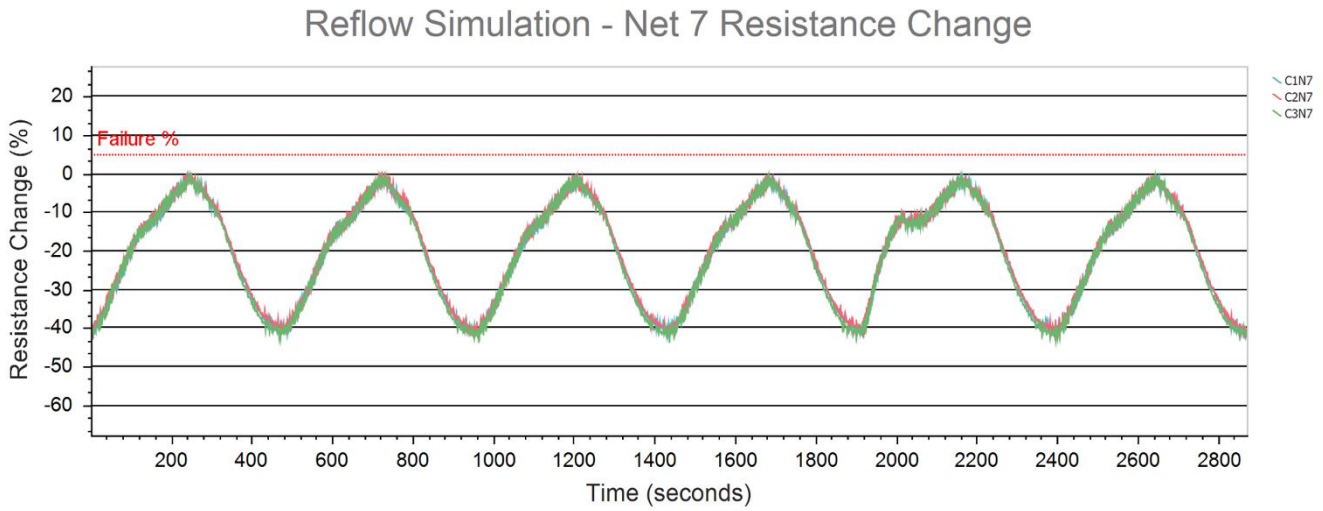
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00685	0.00694	0.00675	-	-	-
Maximum Resistance % Change	0.23	0.09	0.41	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



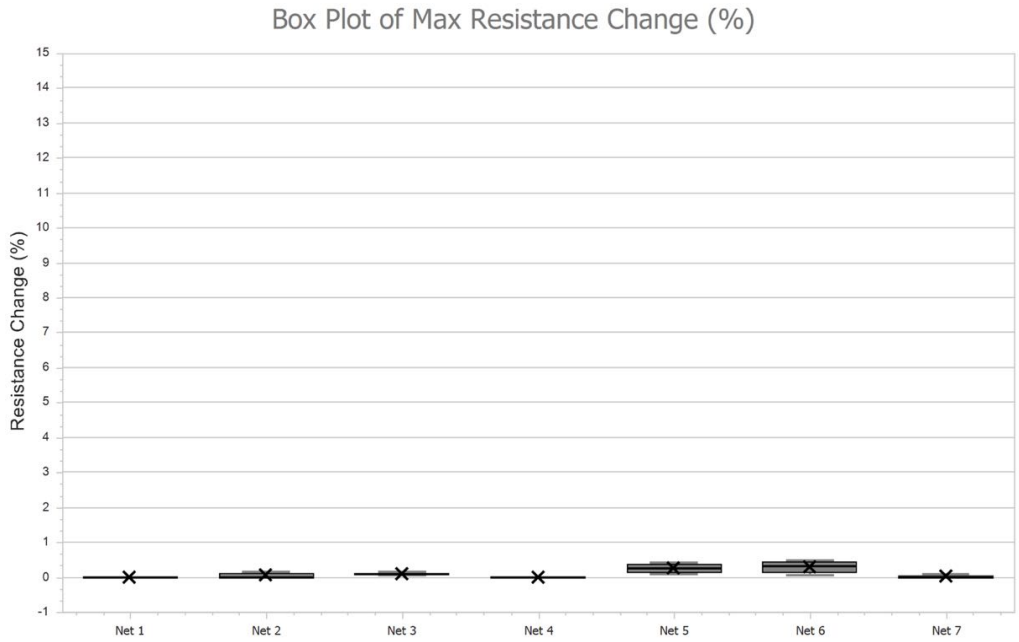
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00993	0.01029	0.01015	-	-	-
Maximum Resistance % Change	0.31	0.48	0.04	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2B, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm

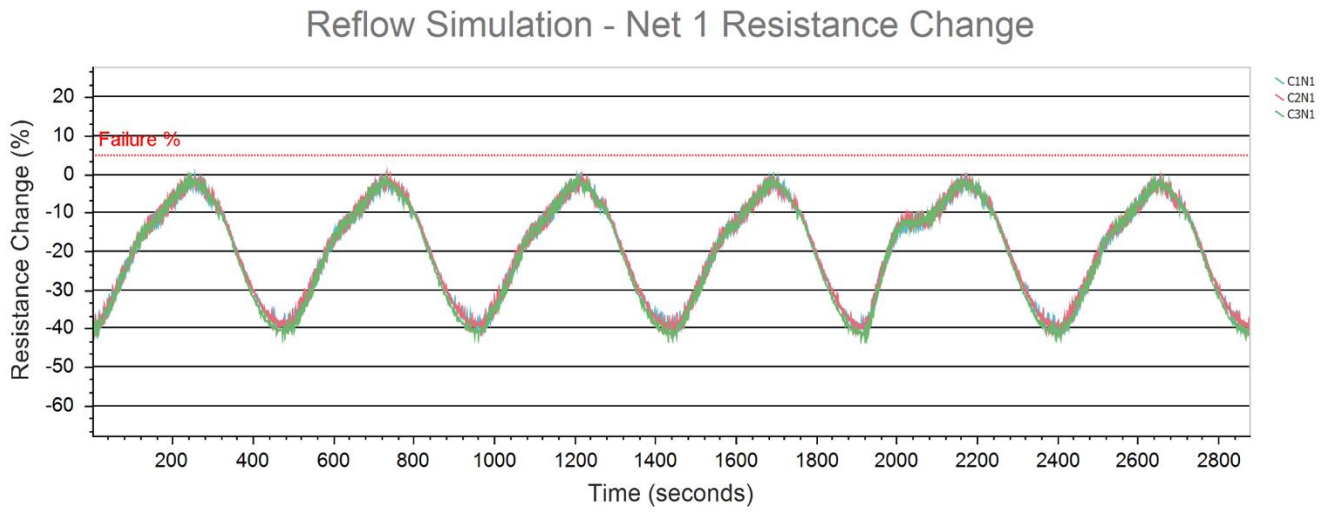


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00276	0.00258	0.00268	-	-	-
Maximum Resistance % Change	0.00	0.08	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

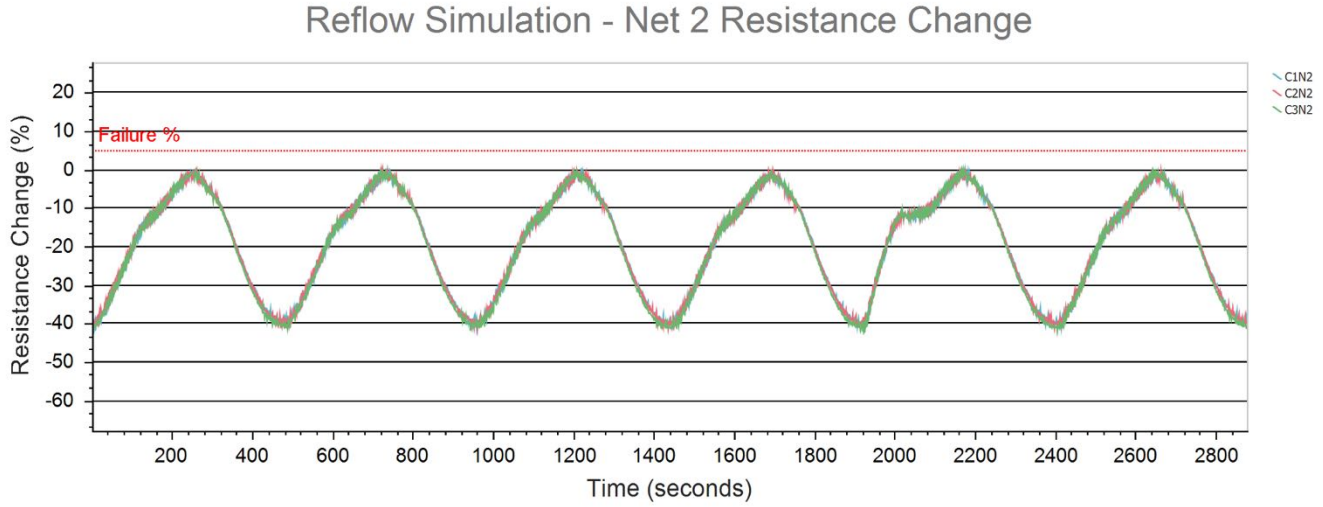


Group 2C, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 18. IPC V TSL 230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



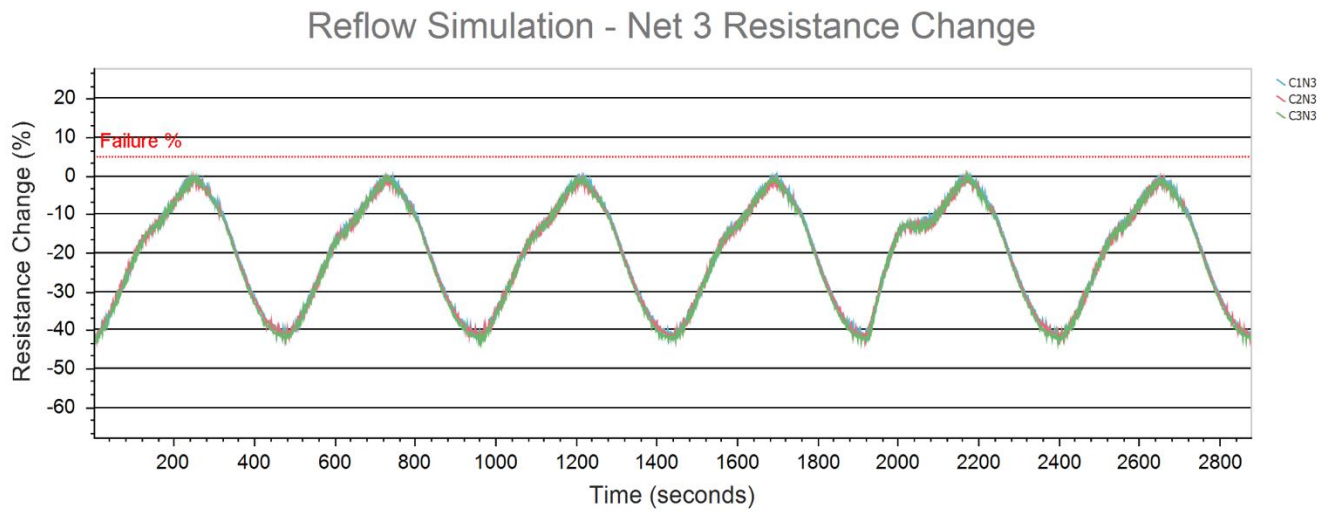
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00223	0.00222	0.00261	-	-	-
Maximum Resistance % Change	0.00	0.36	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



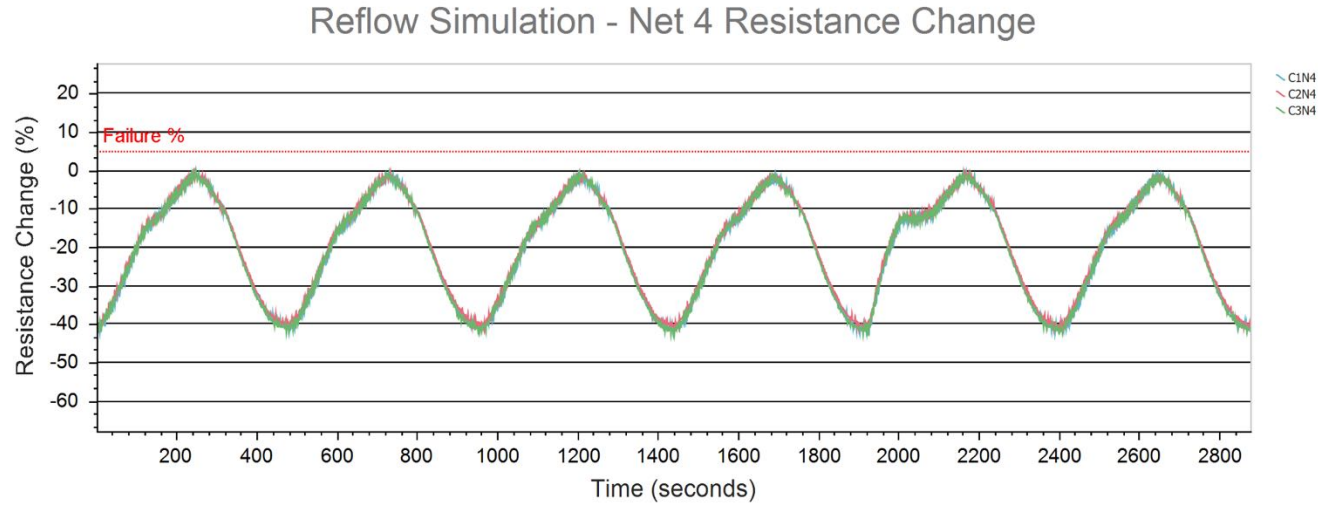
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00332	0.00317	0.00370	-	-	-
Maximum Resistance % Change	0.18	0.22	0.30	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2C, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:** .125 mm	
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:** .125 mm	
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:** .25 mm	
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:** .125 mm	
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:** .125 mm	
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:** .125 mm	
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:** .125 mm	



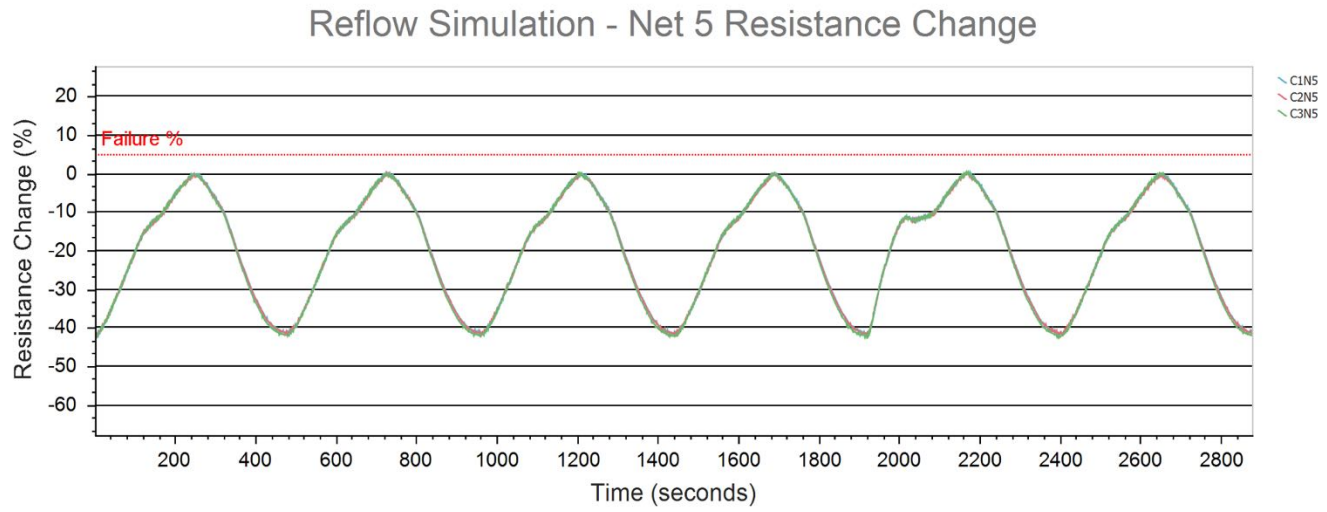
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00354	0.00337	0.00377	-	-	-
Maximum Resistance % Change	0.45	0.12	0.45	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



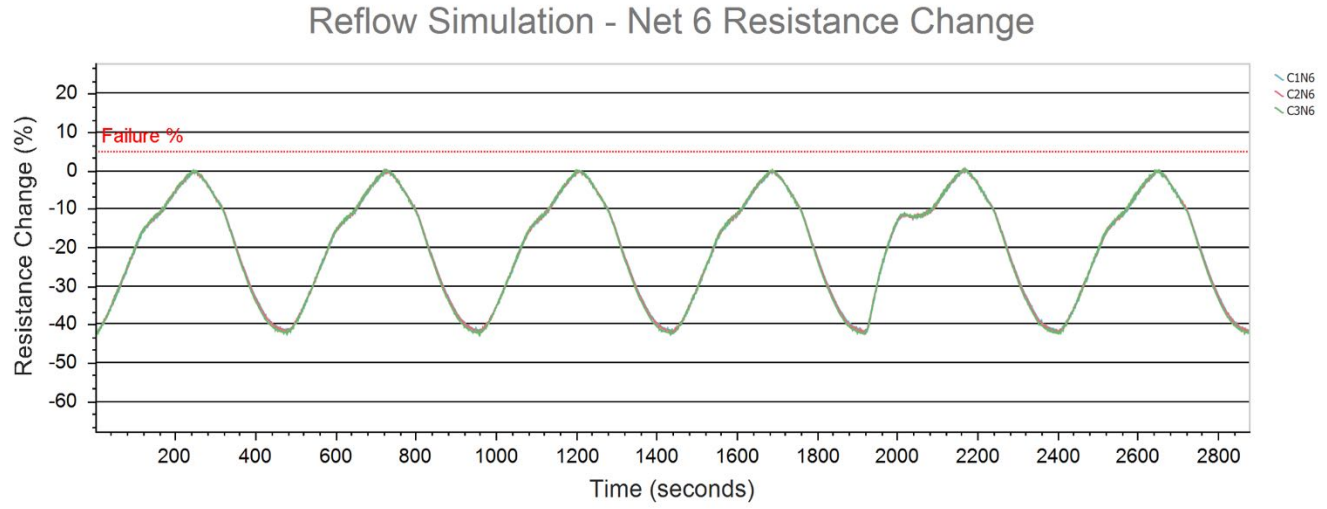
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00318	0.00355	0.00349	-	-	-
Maximum Resistance % Change	0.00	0.03	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2C, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 18. IPC V TSL 230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



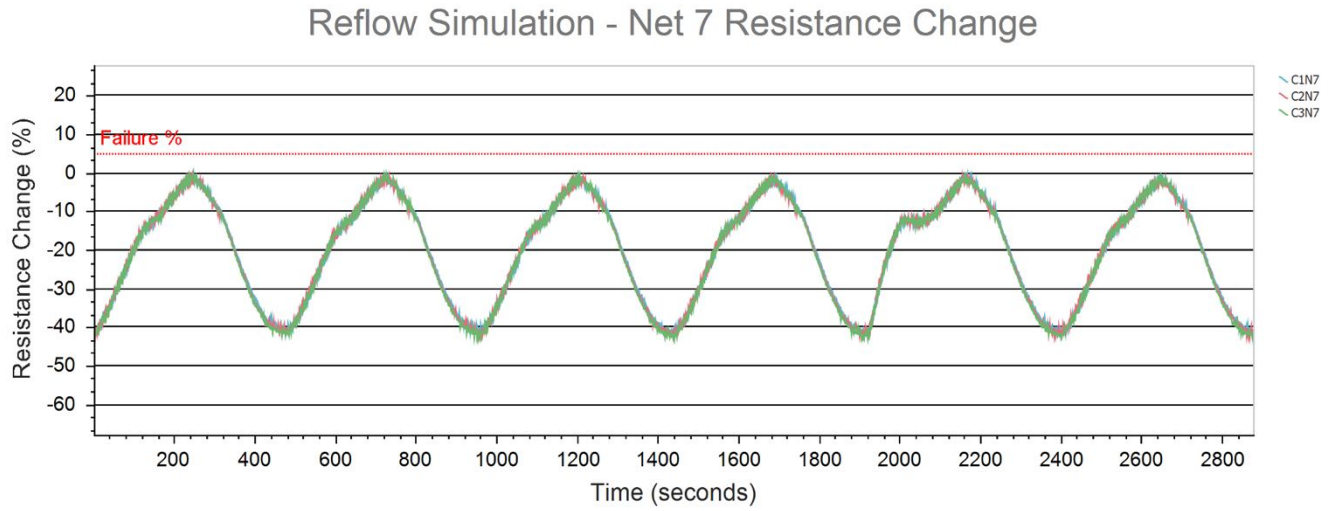
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00998	0.00994	0.01063	-	-	-
Maximum Resistance % Change	0.46	0.30	0.49	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



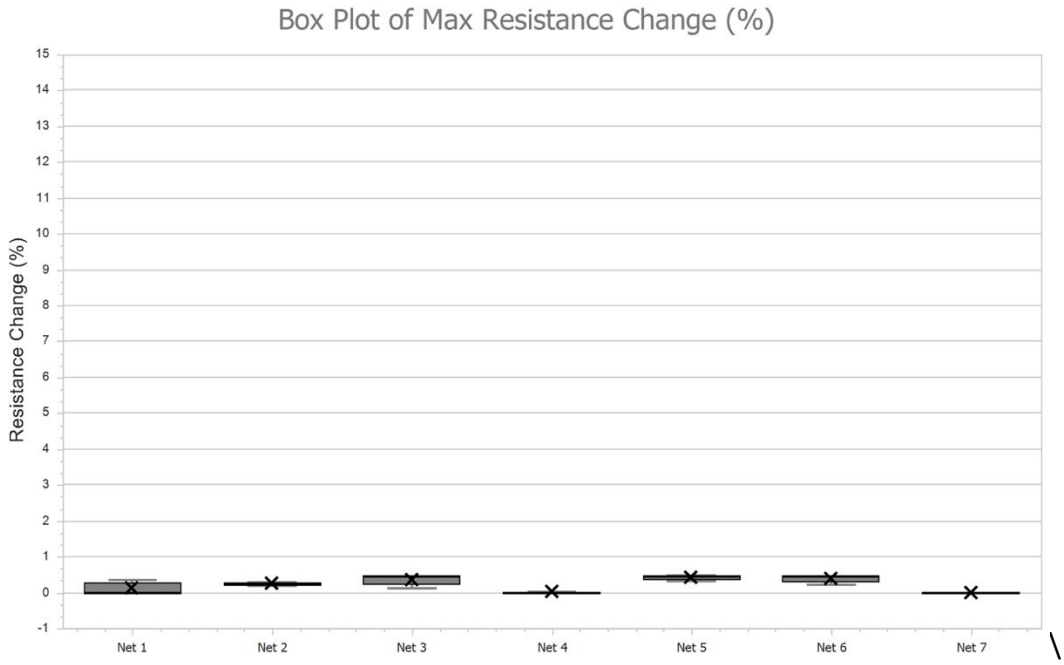
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01202	0.01172	0.01274	-	-	-
Maximum Resistance % Change	0.21	0.46	0.46	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 2C, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm

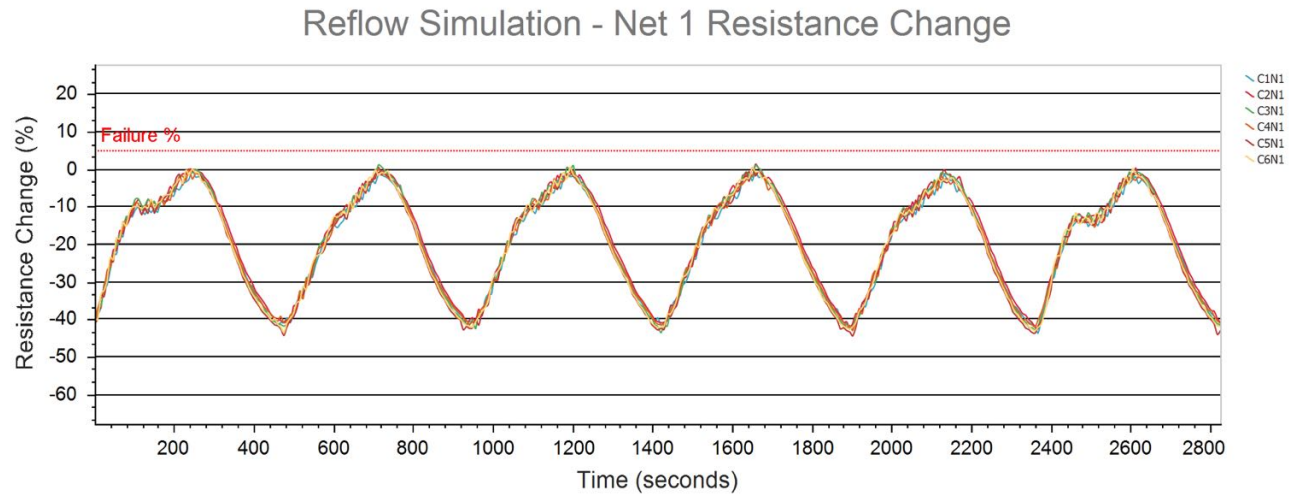


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00332	0.00328	0.00364	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

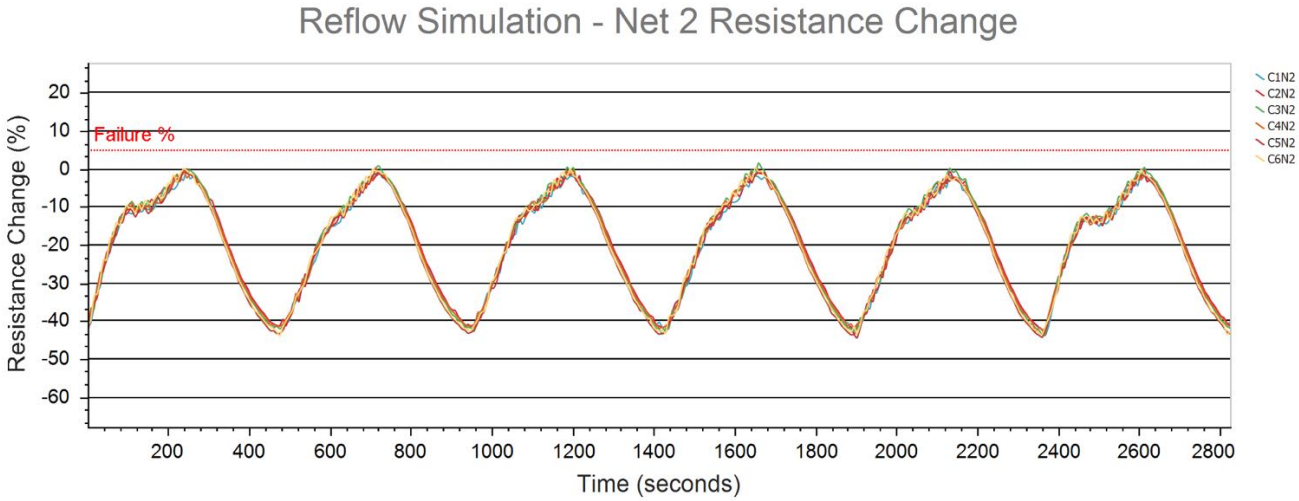


Group 3A, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons: 6		**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



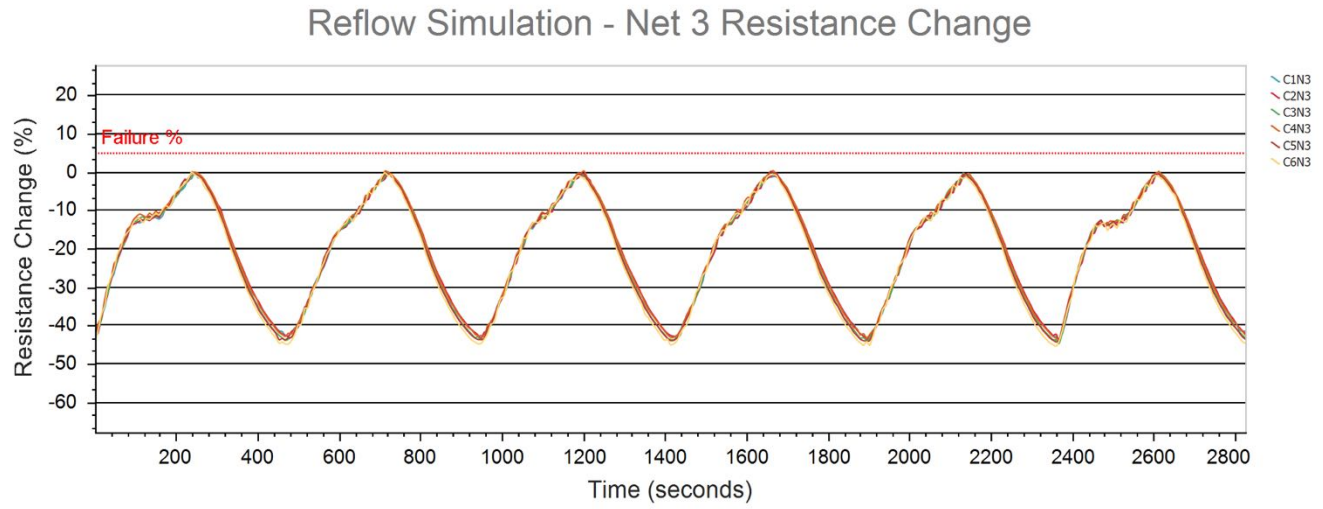
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00178	0.00187	0.00184	0.00162	0.00152	0.00179
Maximum Resistance % Change	0.00	1.34	1.14	0.06	0.46	0.56
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



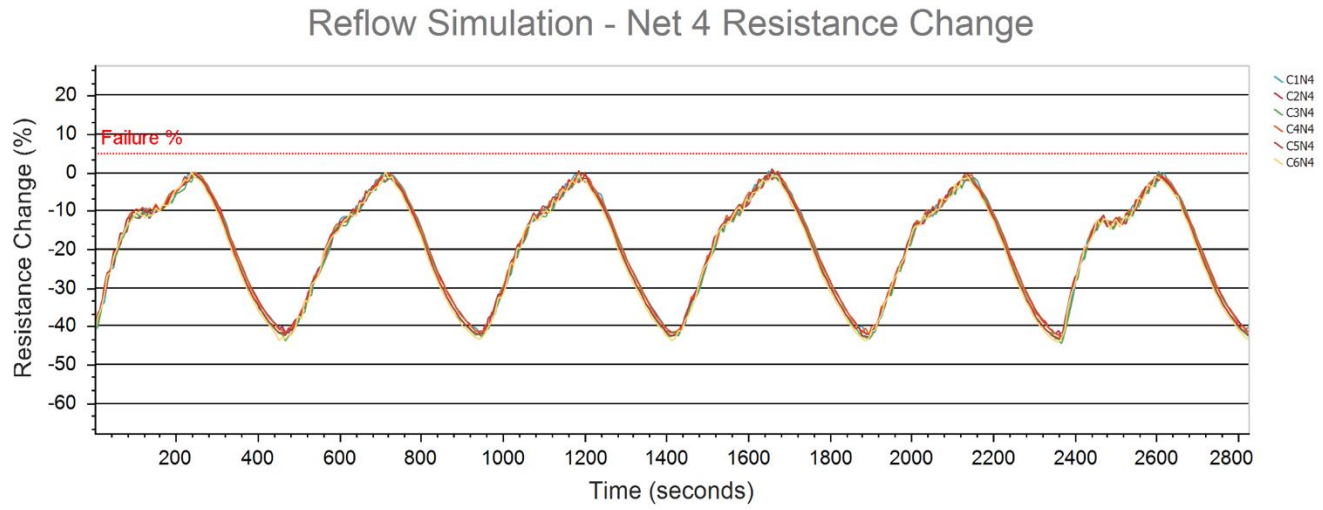
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00201	0.00188	0.00196	0.00192	0.00204	0.00202
Maximum Resistance % Change	0.00	0.00	1.53	0.26	0.00	0.25
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3A, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons: 6		**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



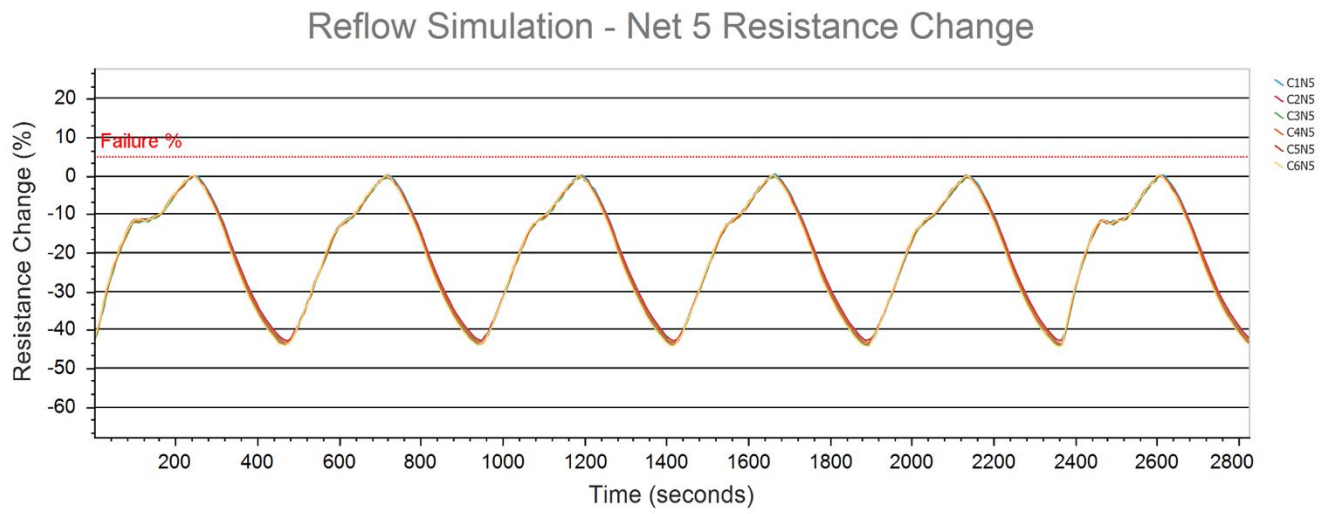
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00369	0.00366	0.00384	0.00345	0.00368	0.00319
Maximum Resistance % Change	0.00	0.00	0.23	0.35	0.16	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



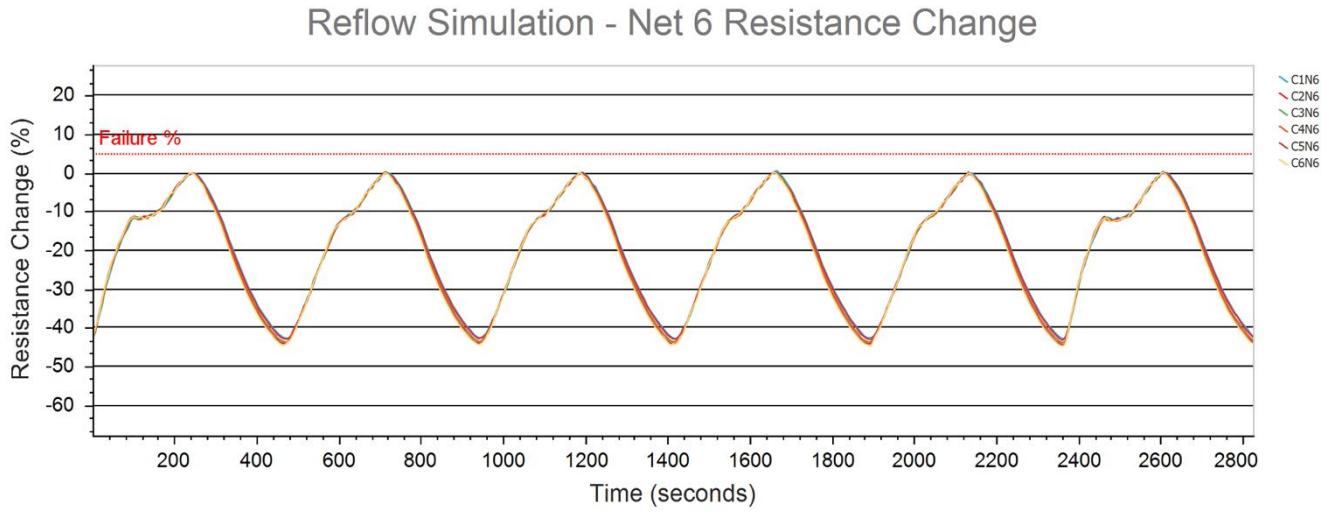
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00231	0.00247	0.00241	0.00227	0.00224	0.00252
Maximum Resistance % Change	0.30	0.00	0.00	0.22	0.85	0.08
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3A, HATS2TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons: 6		**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



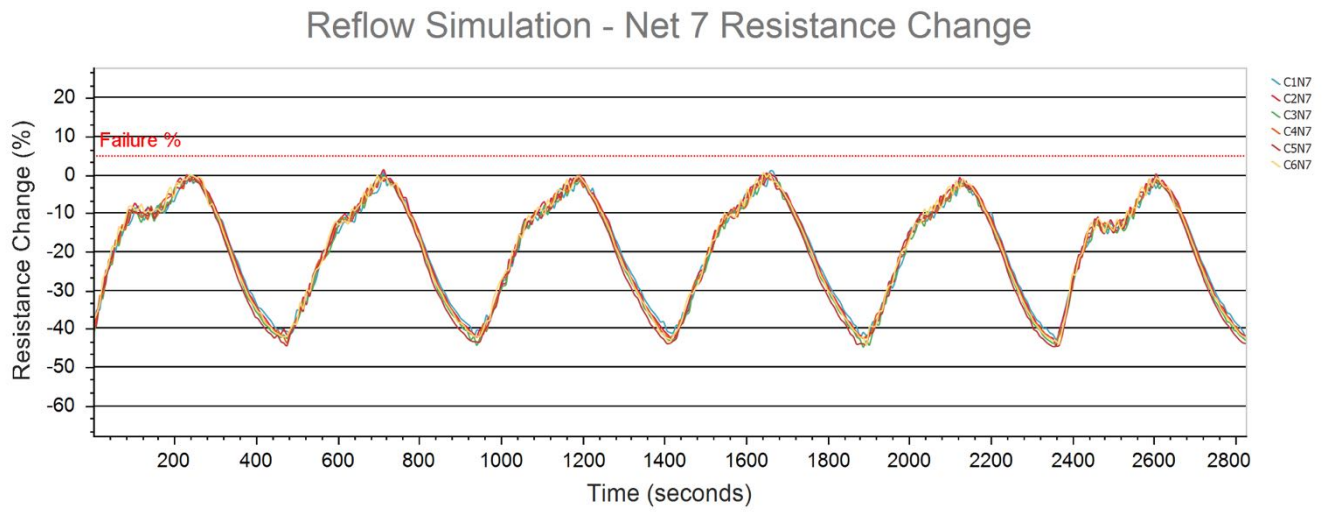
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00848	0.00918	0.00884	0.00835	0.00870	0.00865
Maximum Resistance % Change	0.51	0.10	0.00	0.11	0.23	0.29
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



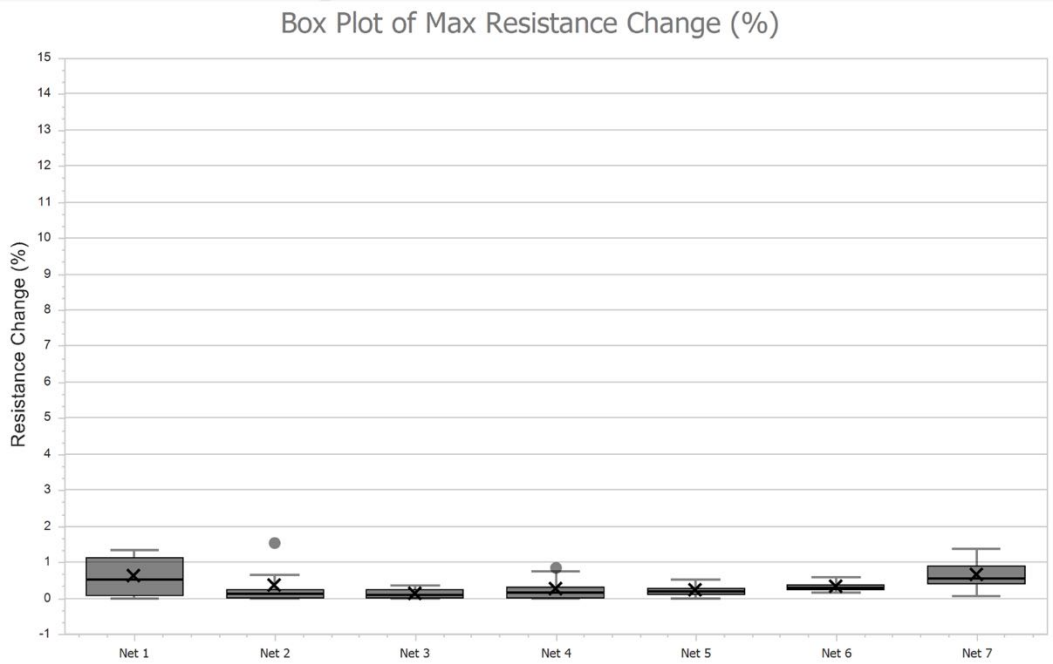
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00818	0.00835	0.00859	0.00811	0.00870	0.00810
Maximum Resistance % Change	0.59	0.29	0.38	0.15	0.29	0.22
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3A, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons: 6		**Number of Nets:** 7		**Coupon Thickness:** 2.75 mm	
Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:** .125 mm	
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:** .125 mm	
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:** .25 mm	
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:** .125 mm	
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:** .125 mm	
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:** .125 mm	
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:** .125 mm	

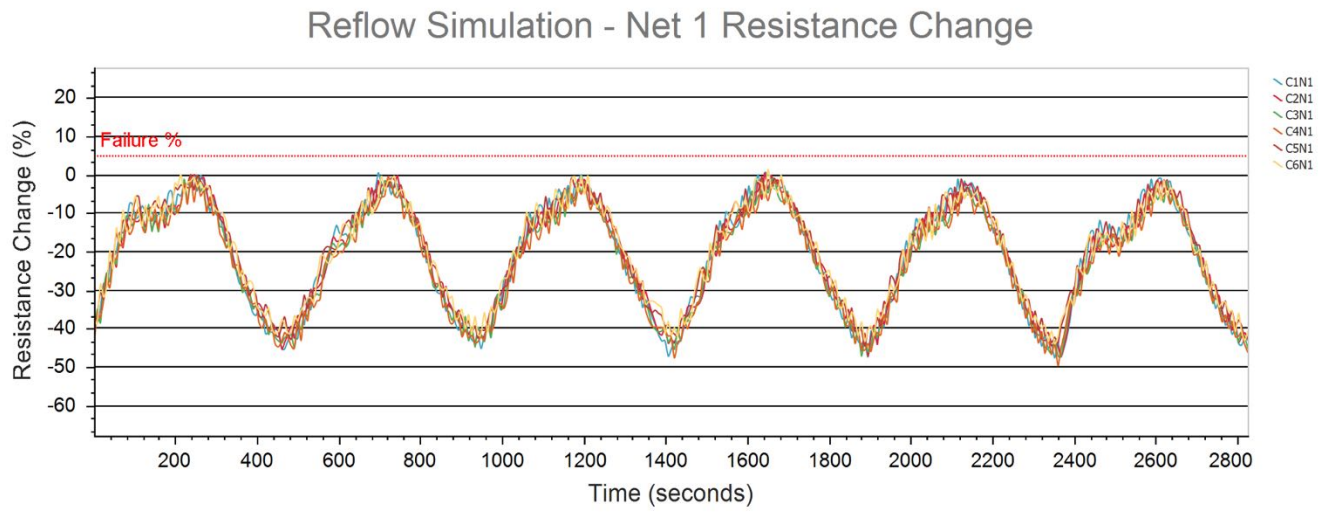


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00153	0.00168	0.00156	0.00179	0.00185	0.00159
Maximum Resistance % Change	0.91	1.37	0.06	0.50	0.38	0.57
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

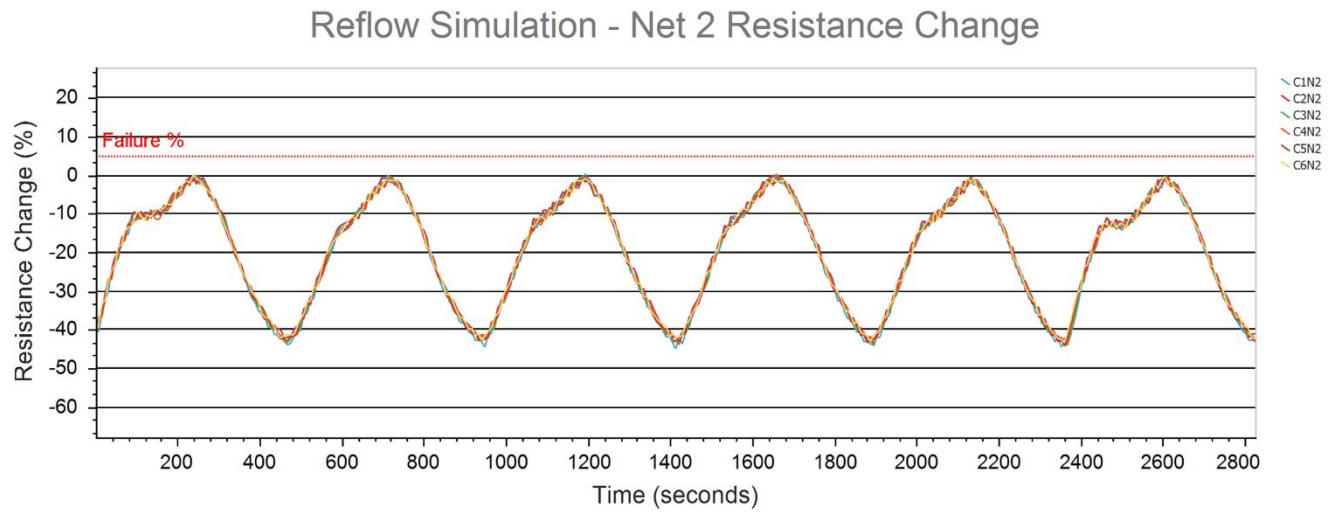


Group 3B, HATS2TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



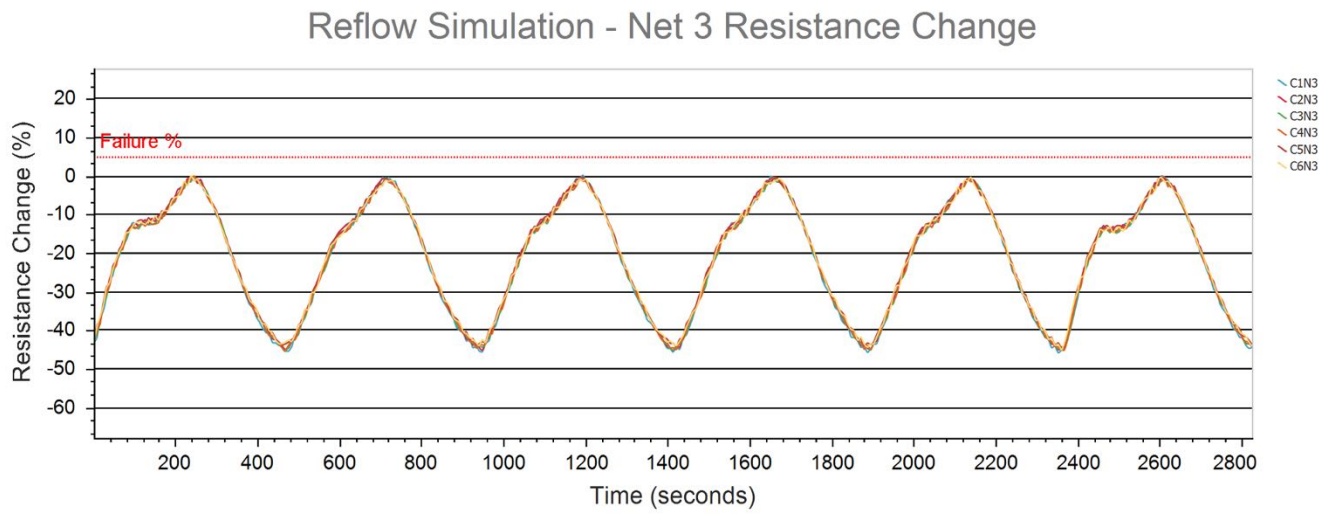
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00096	0.00100	0.00092	0.00090	0.00096	0.00080
Maximum Resistance % Change	0.52	0.50	0.00	0.00	0.00	1.38
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



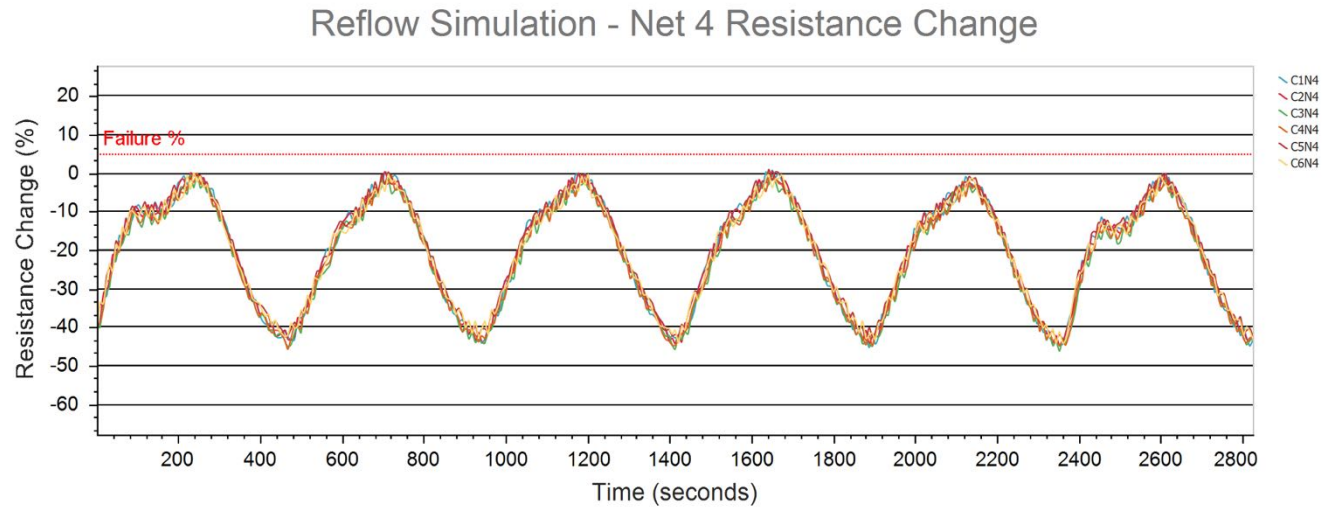
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00263	0.00256	0.00265	0.00236	0.00247	0.00257
Maximum Resistance % Change	0.34	0.12	0.26	0.00	0.00	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3B, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



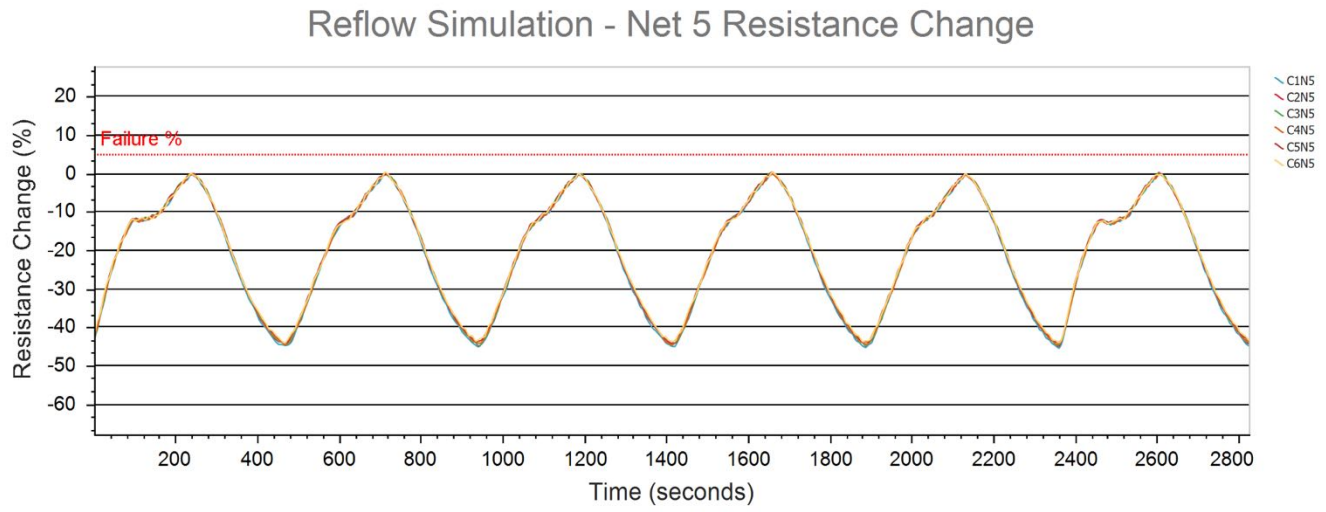
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00374	0.00370	0.00382	0.00352	0.00362	0.00317
Maximum Resistance % Change	0.27	0.00	0.00	0.00	0.00	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



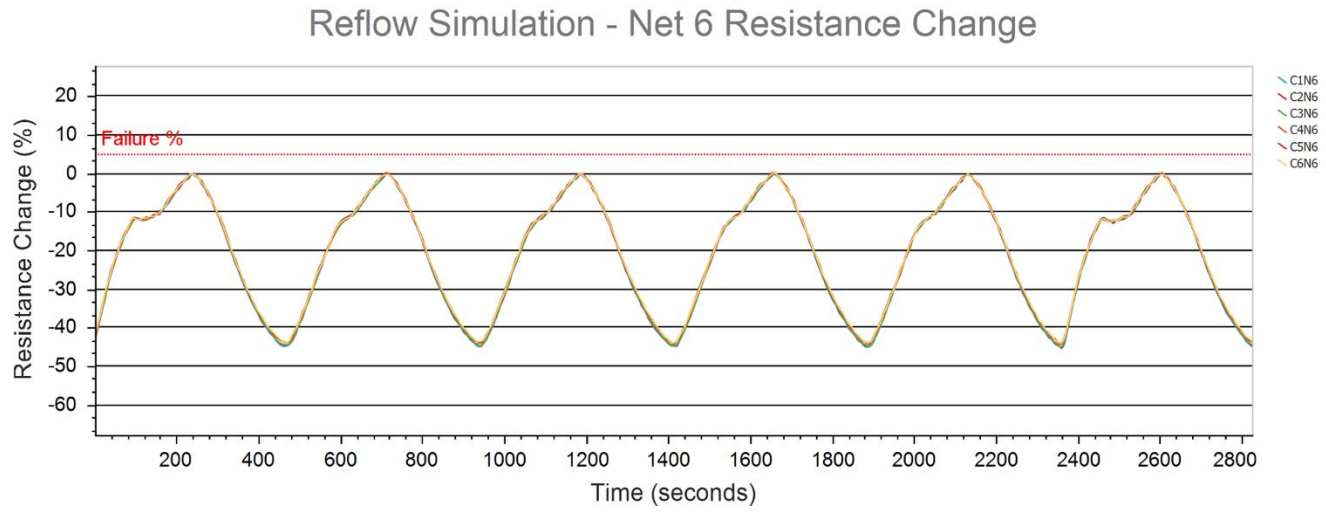
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00145	0.00157	0.00146	0.00148	0.00152	0.00139
Maximum Resistance % Change	0.76	0.45	0.00	0.00	0.98	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3B, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



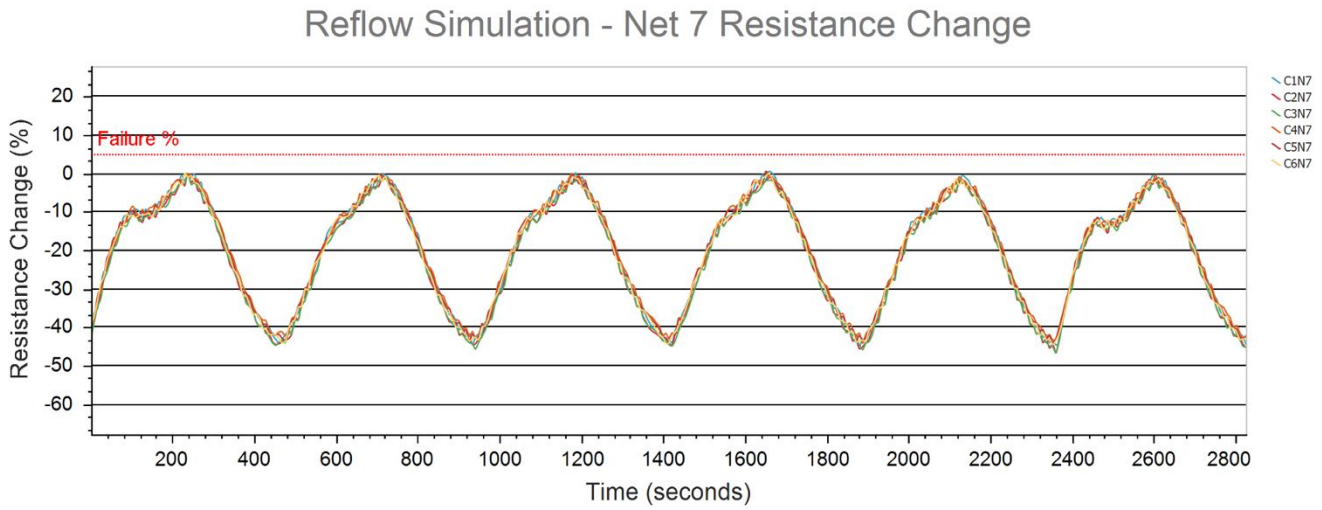
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00682	0.00719	0.00702	0.00675	0.00734	0.00633
Maximum Resistance % Change	0.03	0.29	0.14	0.03	0.44	0.40
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



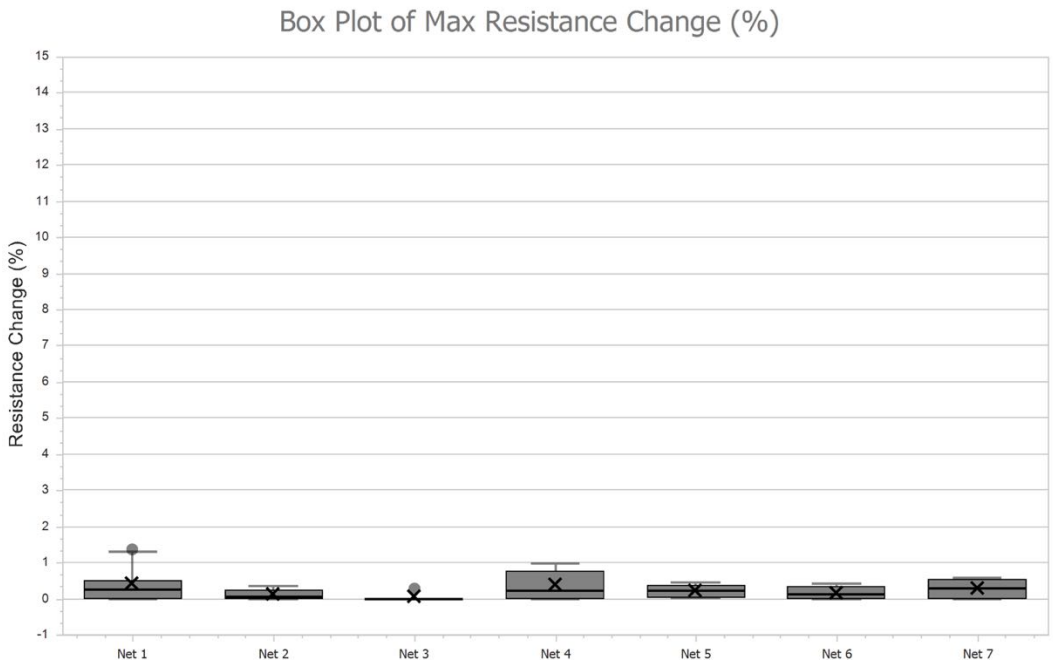
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01018	0.01024	0.01035	0.00948	0.01037	0.00960
Maximum Resistance % Change	0.00	0.00	0.06	0.16	0.41	0.33
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3B, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm

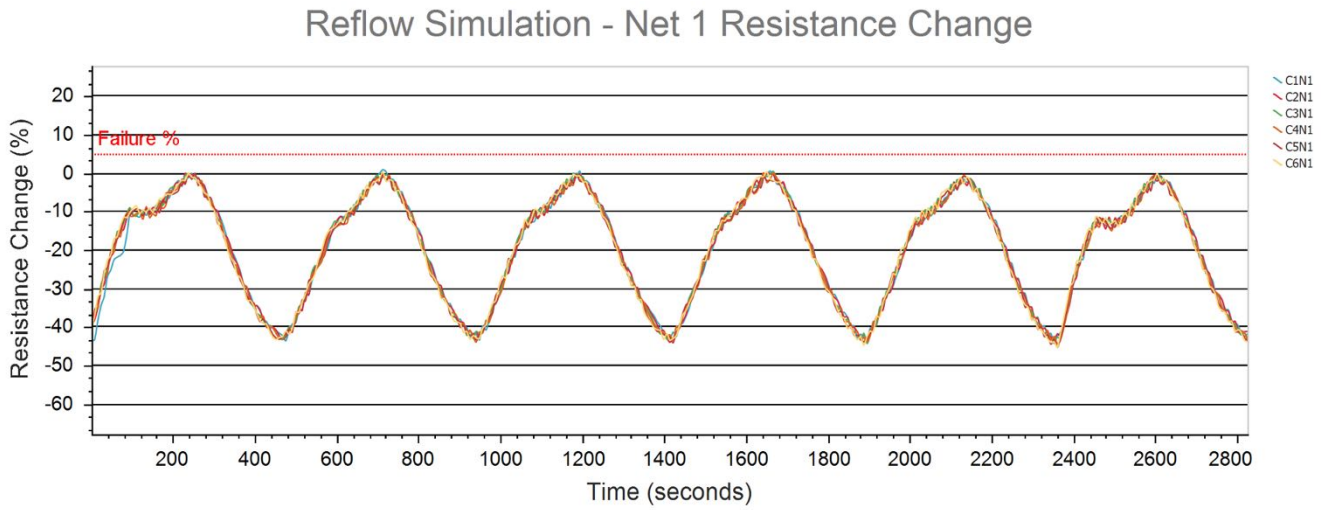


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00241	0.00243	0.00253	0.00229	0.00252	0.00252
Maximum Resistance % Change	0.58	0.00	0.00	0.53	0.56	0.04
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

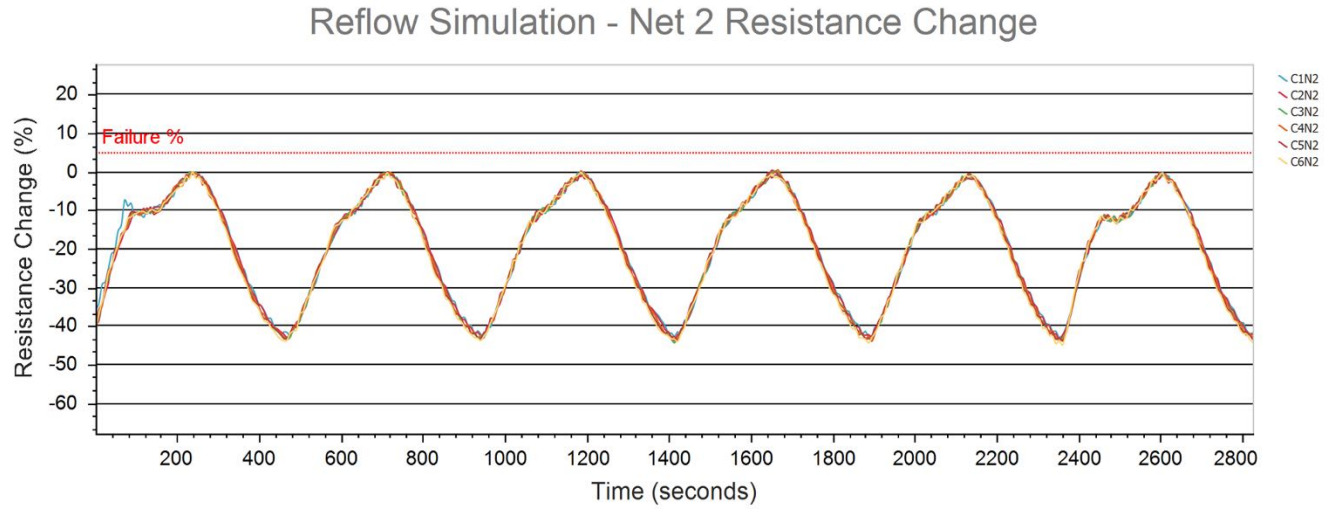


Group 3C, HATS²TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



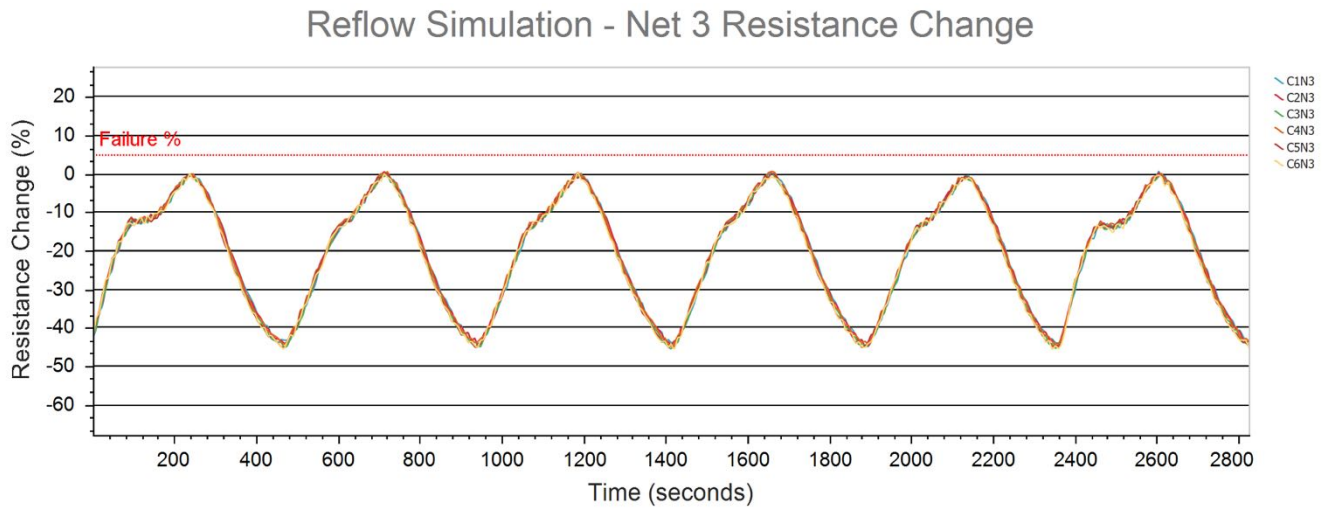
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00241	0.00238	0.00233	0.00211	0.00211	0.00221
Maximum Resistance % Change	0.99	0.04	0.52	0.14	0.00	0.41
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



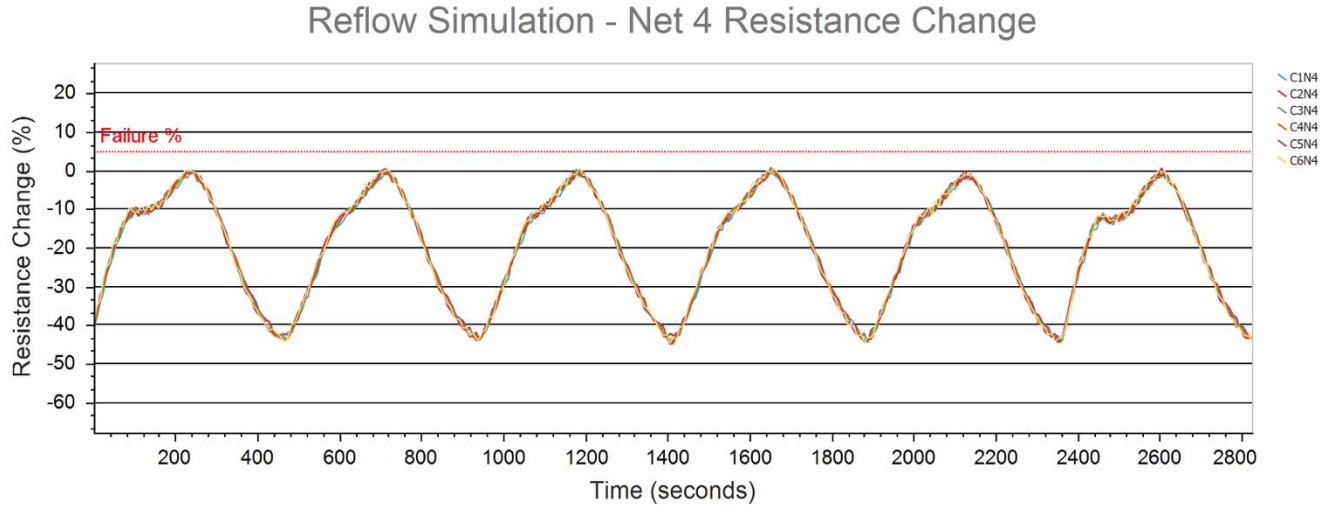
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00336	0.00369	0.00342	0.00343	0.00302	0.00348
Maximum Resistance % Change	0.06	0.38	0.20	0.52	0.23	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3C, HATS2TM Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	6	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



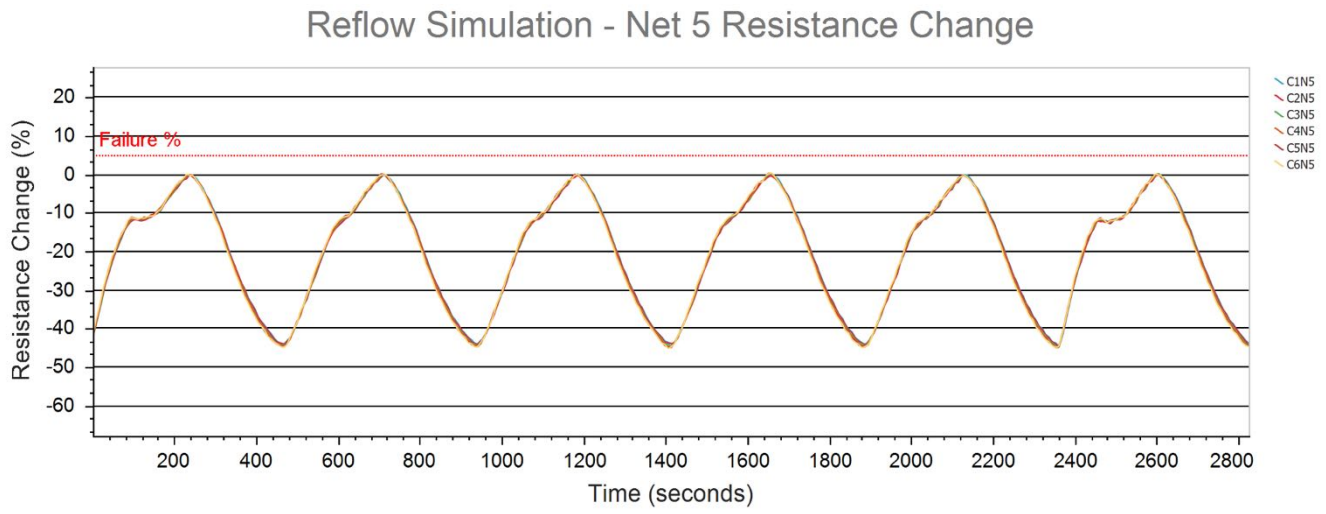
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00372	0.00373	0.00384	0.00348	0.00372	0.00322
Maximum Resistance % Change	0.67	0.59	0.23	0.66	0.22	0.28
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



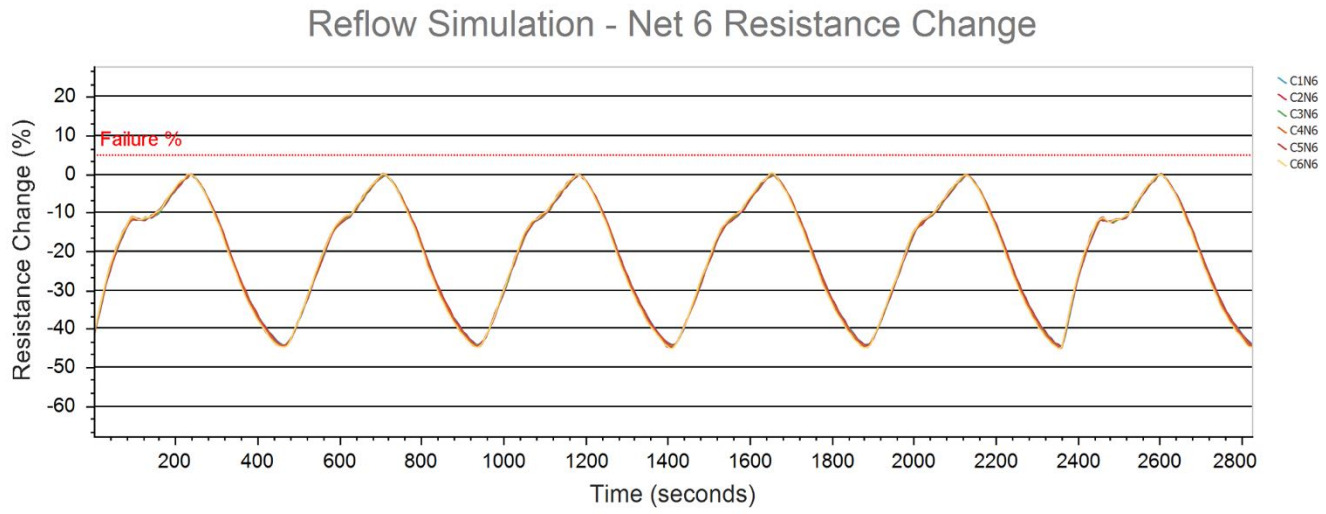
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00319	0.00305	0.00312	0.00315	0.00325	0.00315
Maximum Resistance % Change	0.00	0.62	0.67	0.25	0.43	0.51
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3C, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons:	6	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



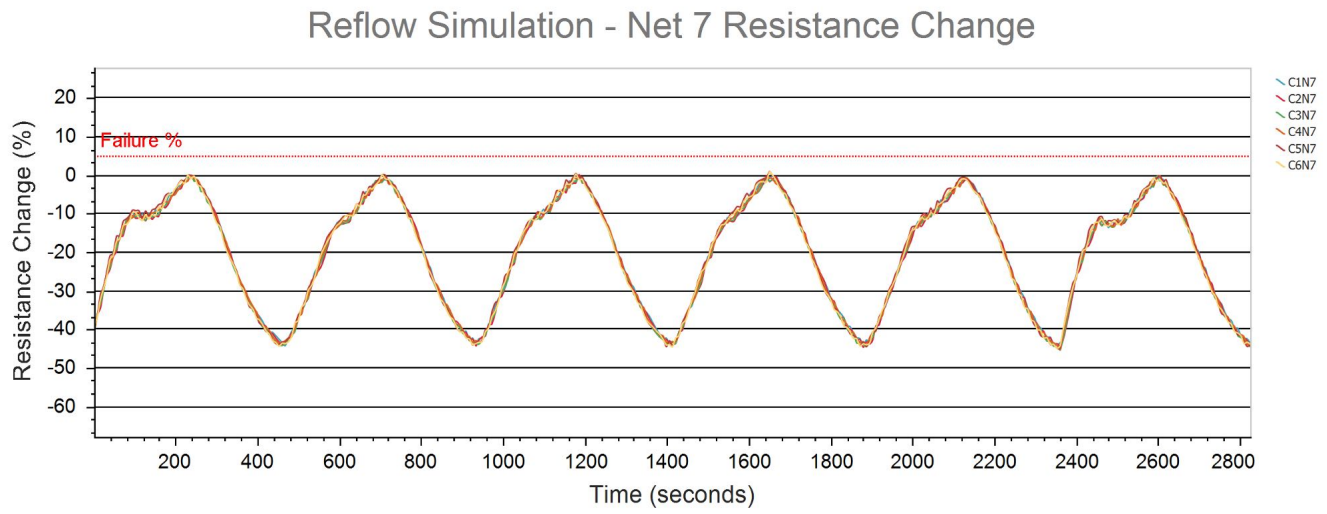
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01015	0.01047	0.01030	0.00981	0.01020	0.00964
Maximum Resistance % Change	0.21	0.03	0.18	0.30	0.34	0.38
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



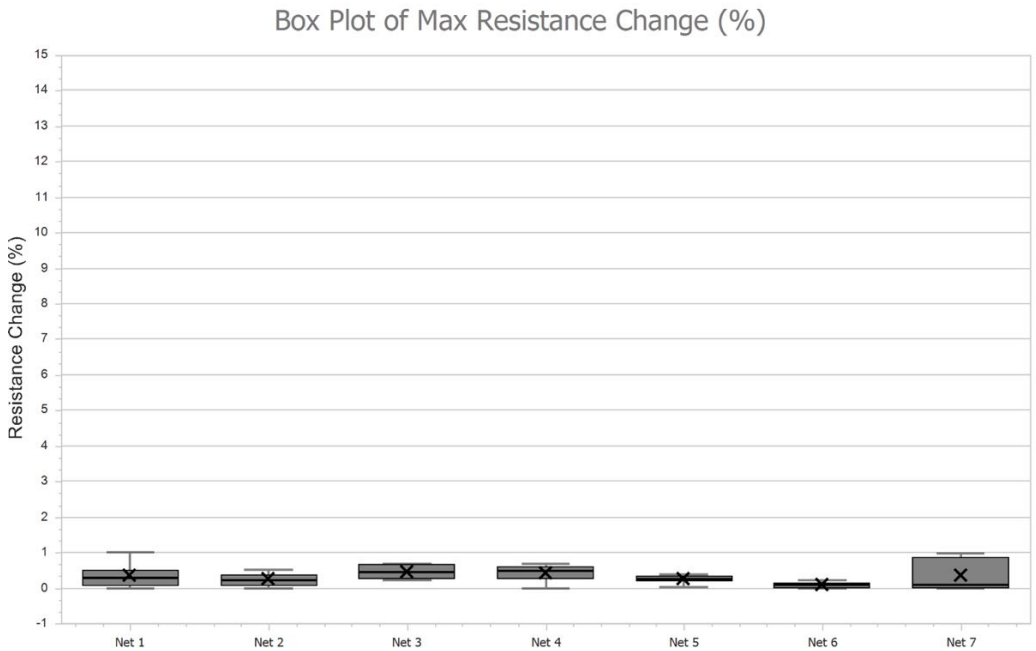
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01223	0.01285	0.01240	0.01186	0.01208	0.01201
Maximum Resistance % Change	0.00	0.00	0.06	0.09	0.15	0.21
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group 3C, HATS²™ Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons:	6	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm

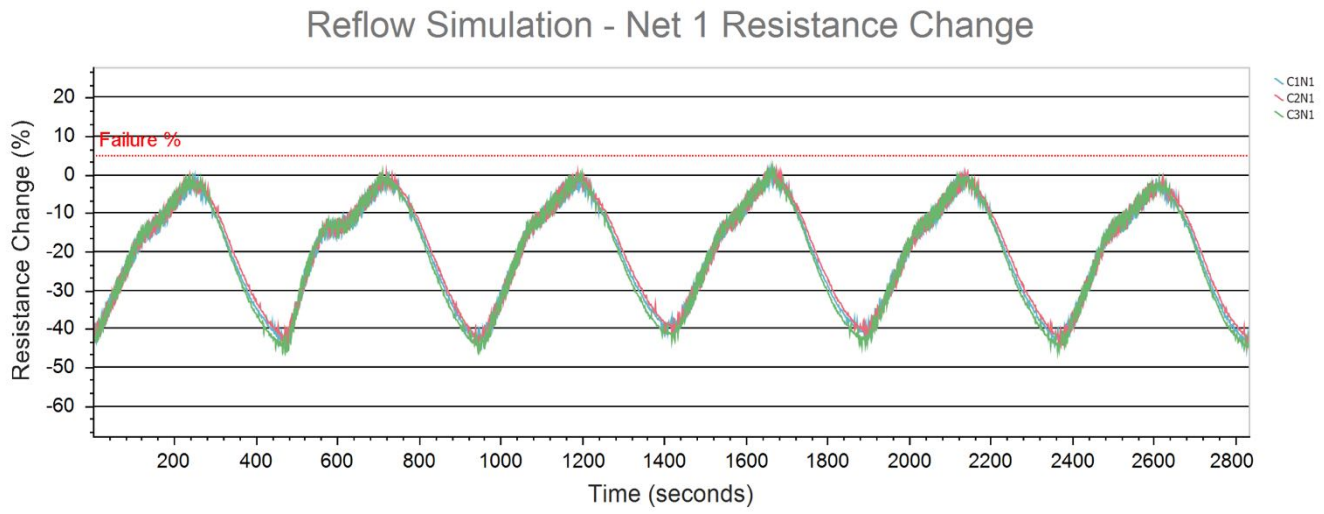


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00335	0.00326	0.00335	0.00320	0.00305	0.00349
Maximum Resistance % Change	0.00	0.15	0.00	0.00	0.98	0.86
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

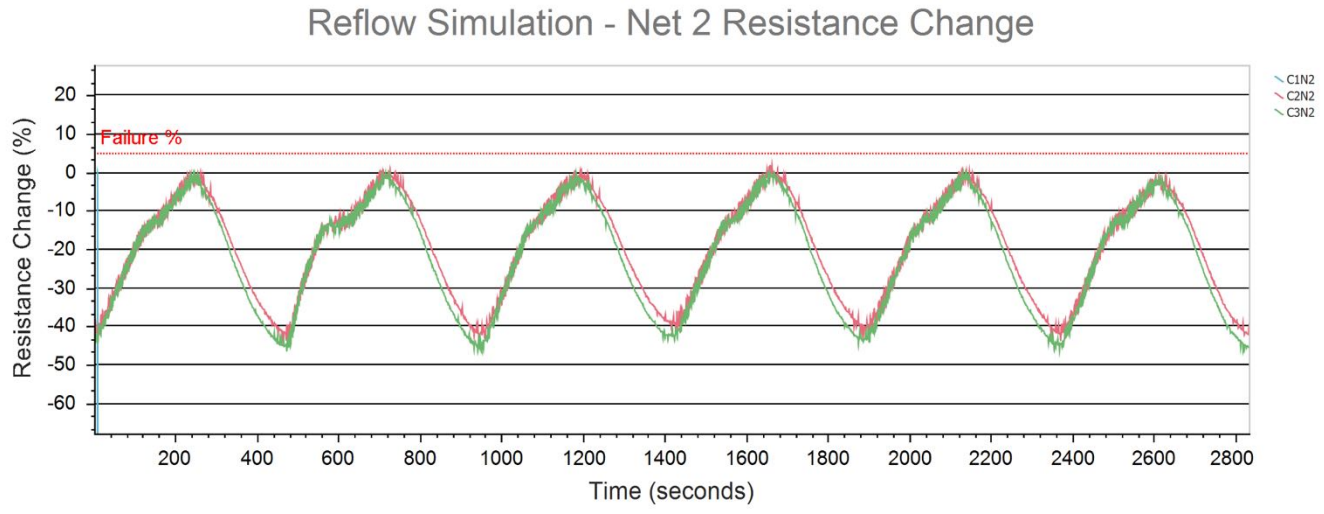


Group 4A, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



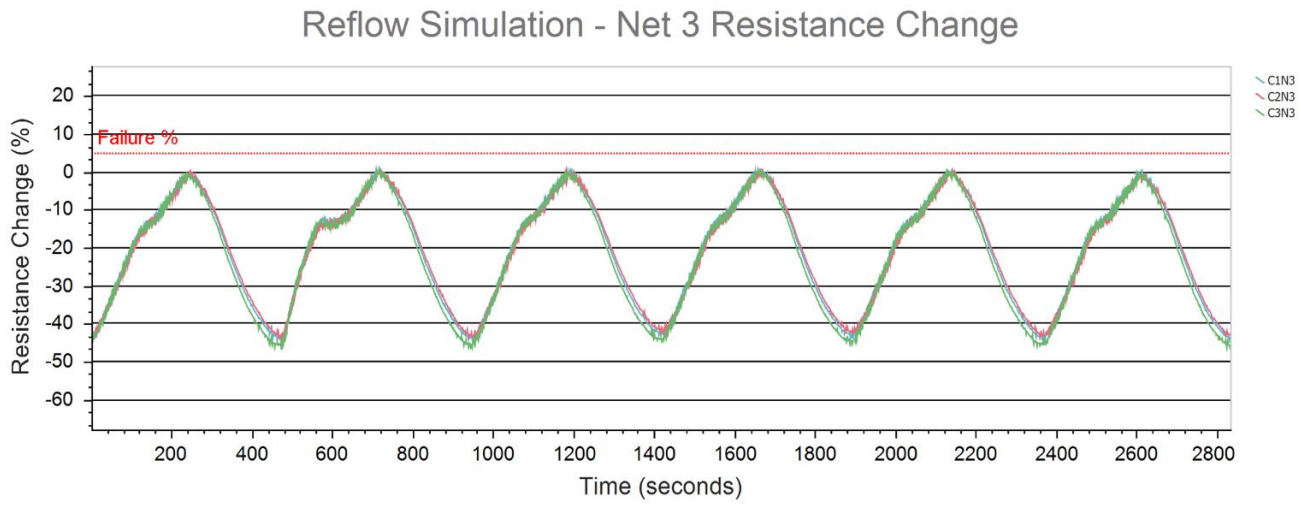
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00154	0.00174	0.00173	-	-	-
Maximum Resistance % Change	1.56	1.84	2.09	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



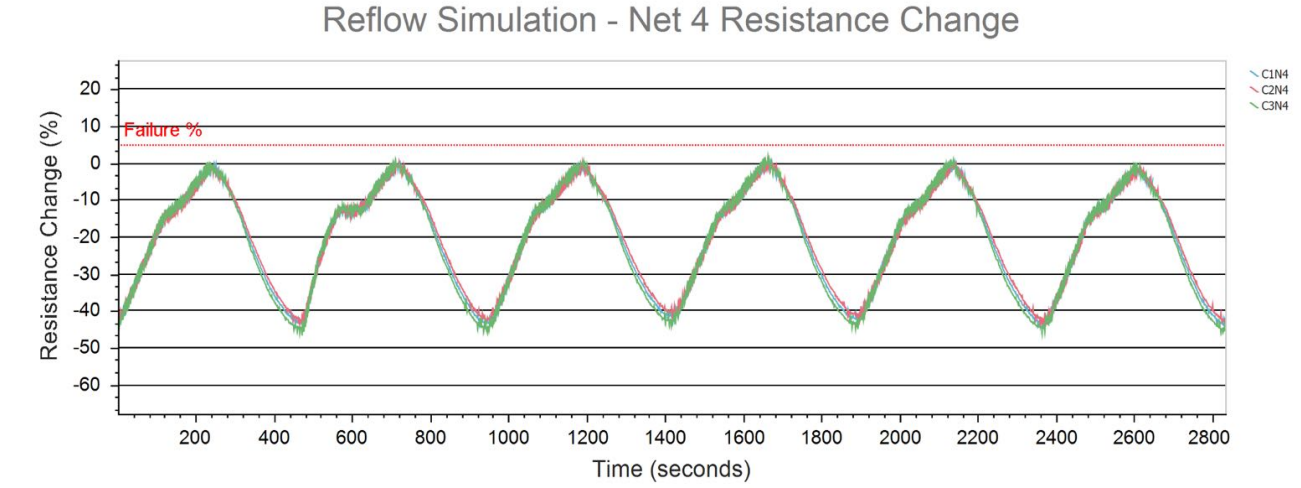
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.14643	0.00184	0.00201	-	-	-
Maximum Resistance % Change	0.00	2.07	0.20	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4A, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



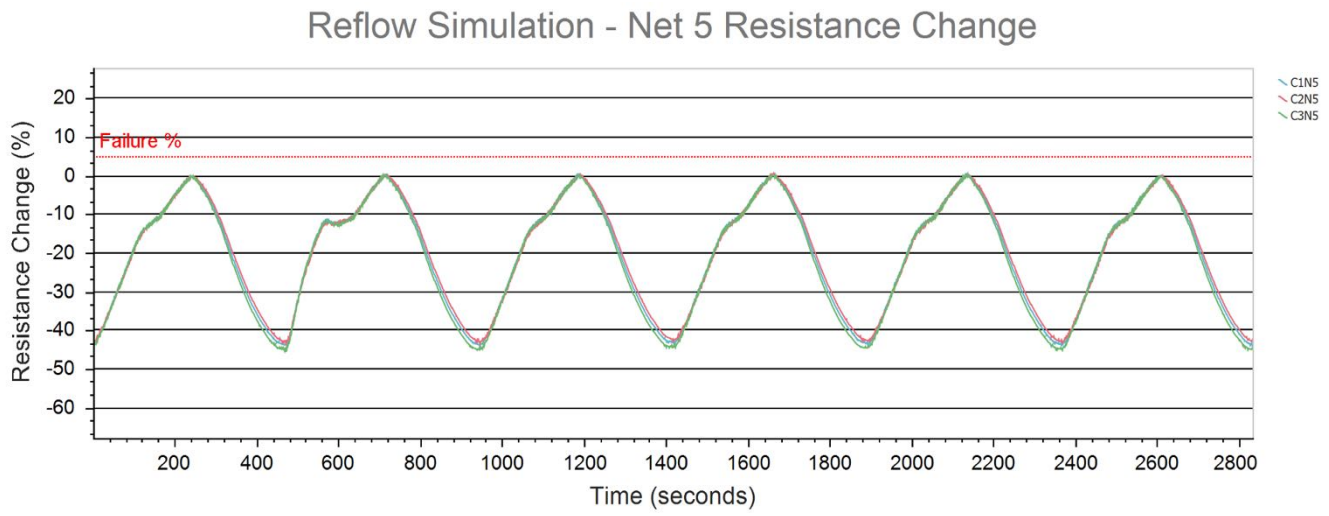
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00378	0.00353	0.00334	-	-	-
Maximum Resistance % Change	0.87	0.71	0.78	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



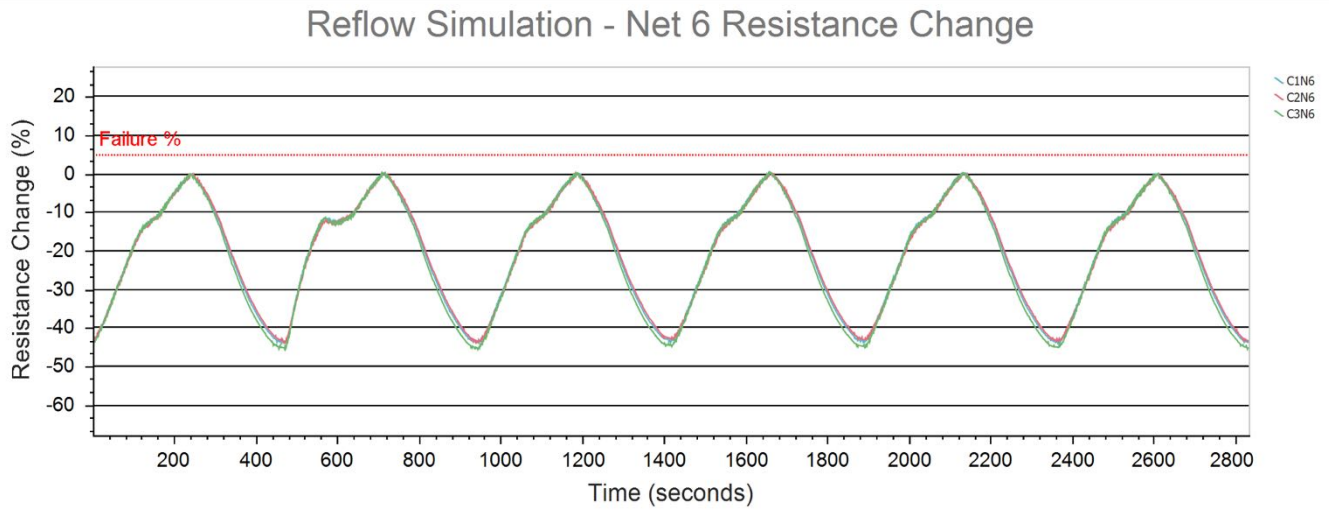
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00246	0.00238	0.00241	-	-	-
Maximum Resistance % Change	1.06	0.96	1.95	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4A, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



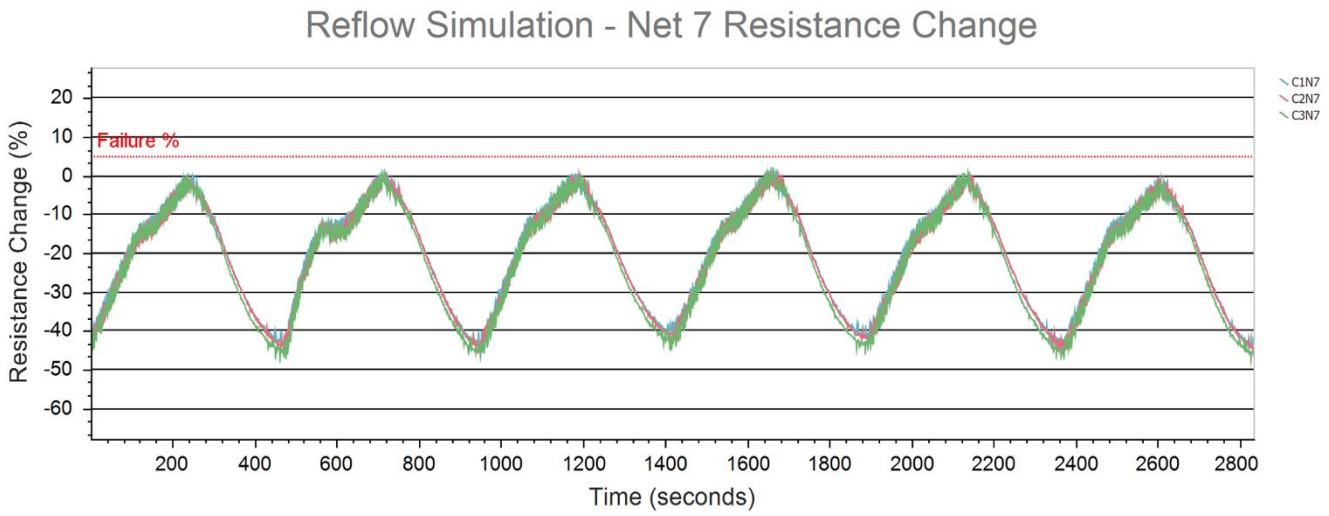
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00903	0.00840	0.00837	-	-	-
Maximum Resistance % Change	0.66	0.73	0.31	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



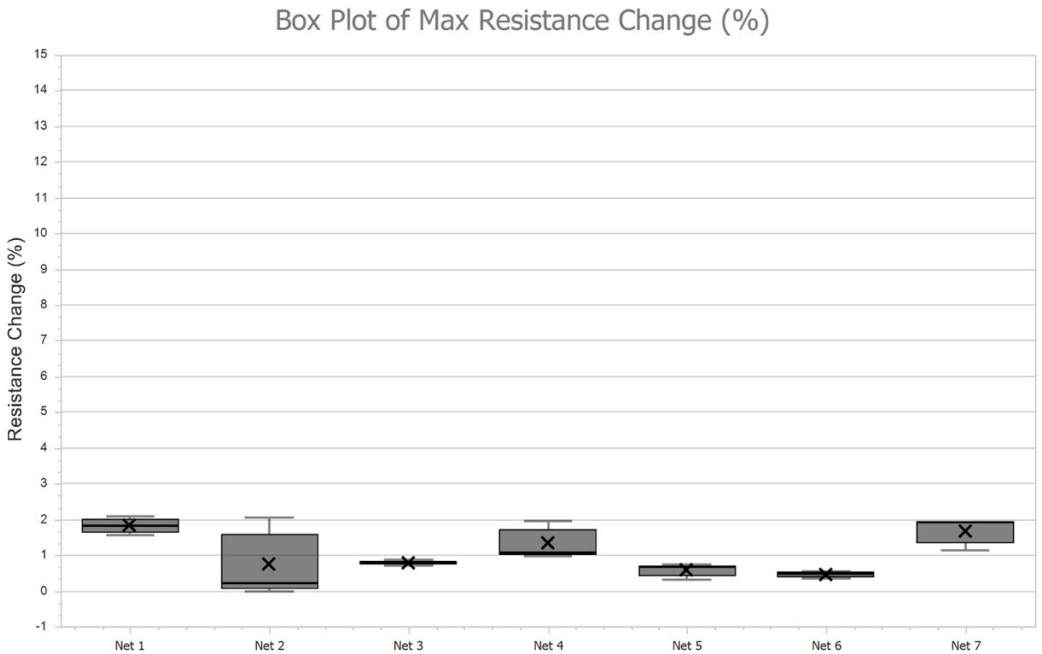
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00884	0.00789	0.00802	-	-	-
Maximum Resistance % Change	0.47	0.35	0.55	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4A, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm

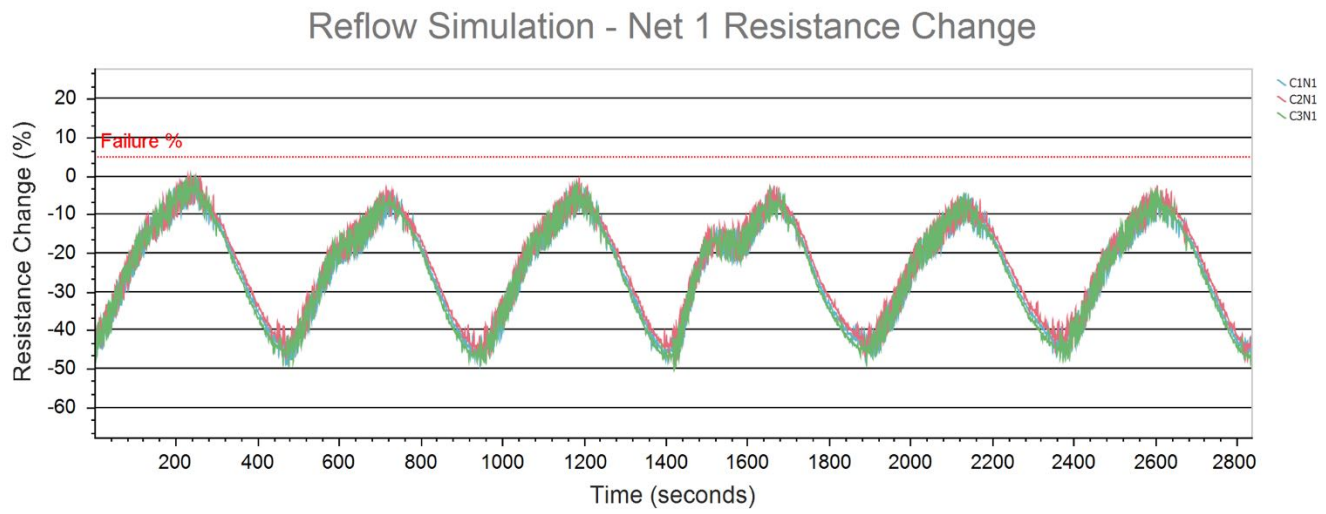


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00167	0.00169	0.00162	-	-	-
Maximum Resistance % Change	1.92	1.13	1.92	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

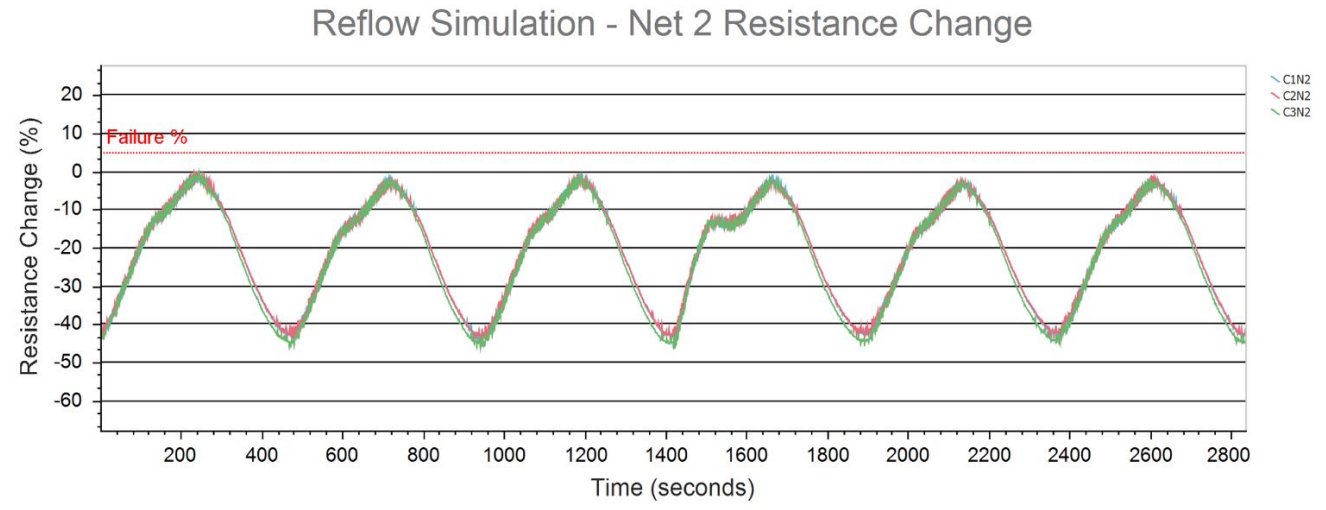


Group 4B, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 10.V-TSL-MVIA_230C	**Quality of Profiles:** 6	**Failure Percentage (%):** 5
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: Full Stacked MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Full Staggered MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



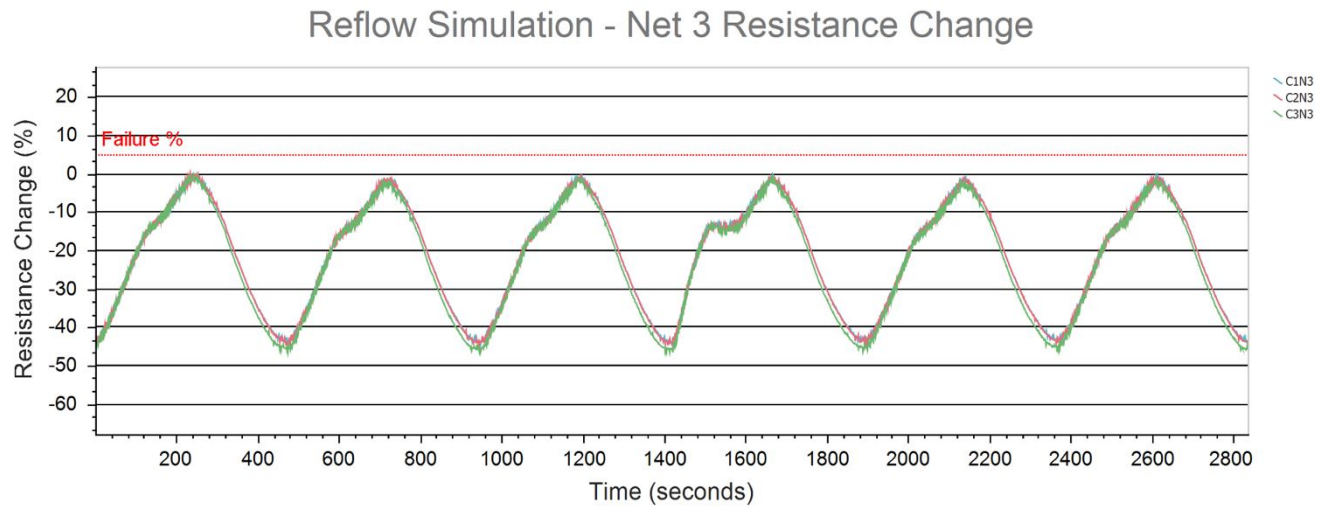
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00096	0.00098	0.00103	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



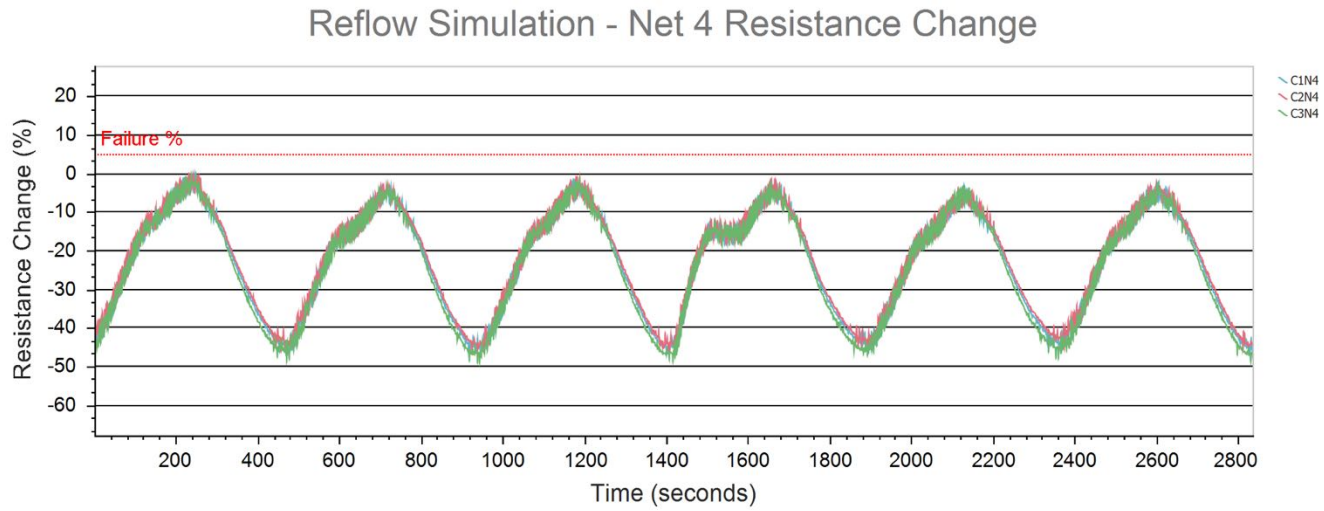
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00269	0.00226	0.00262	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4B, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



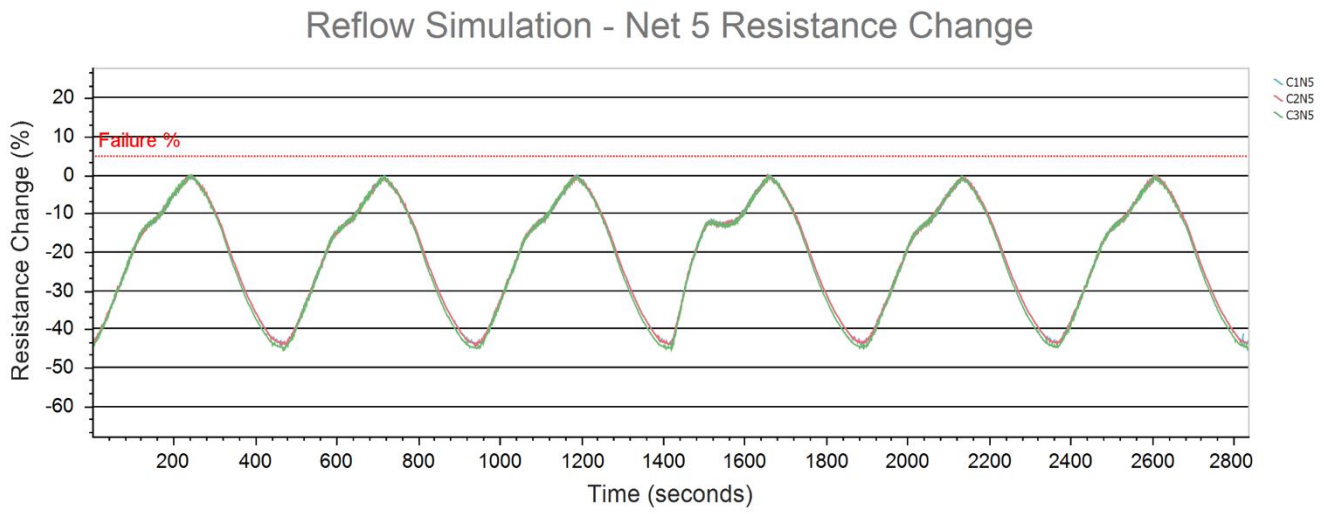
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00380	0.00352	0.00331	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



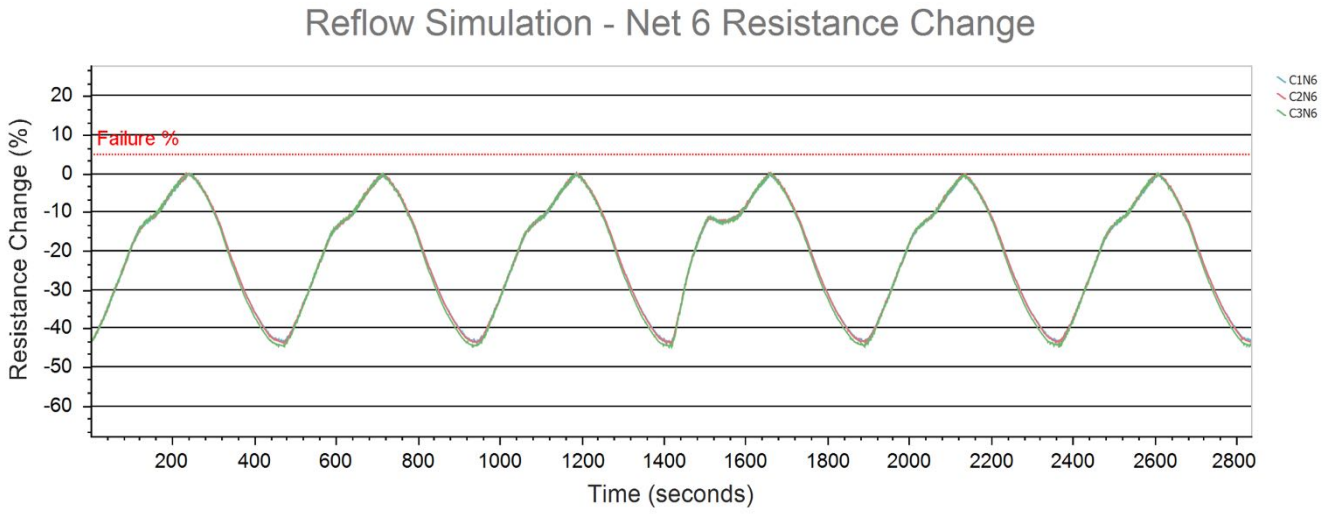
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00147	0.00140	0.00158	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4B, HATS2TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm



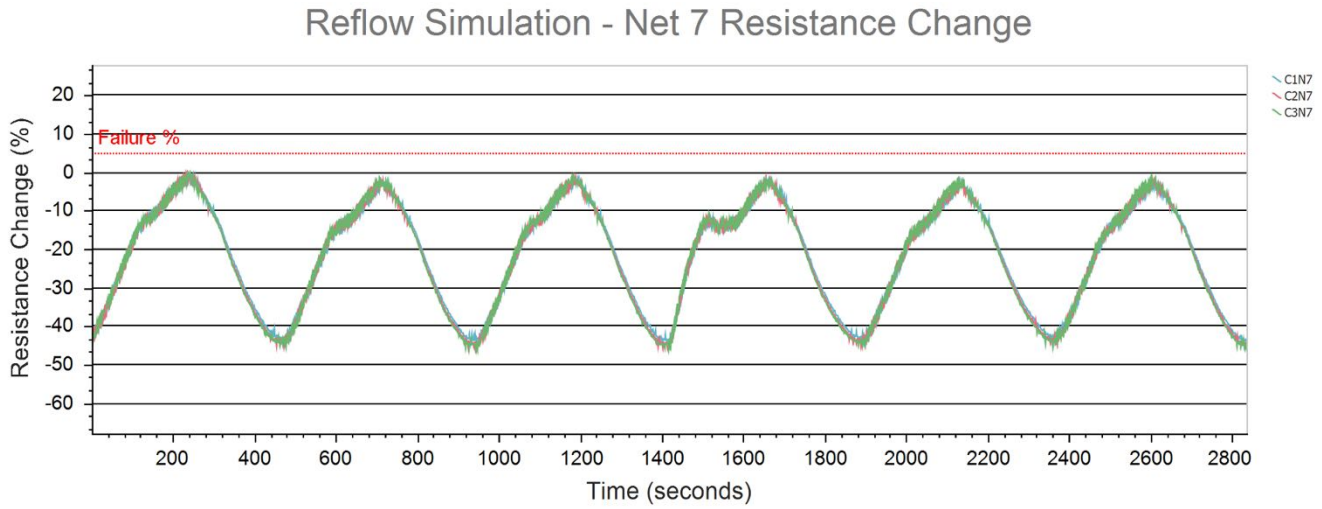
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00724	0.00663	0.00661	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



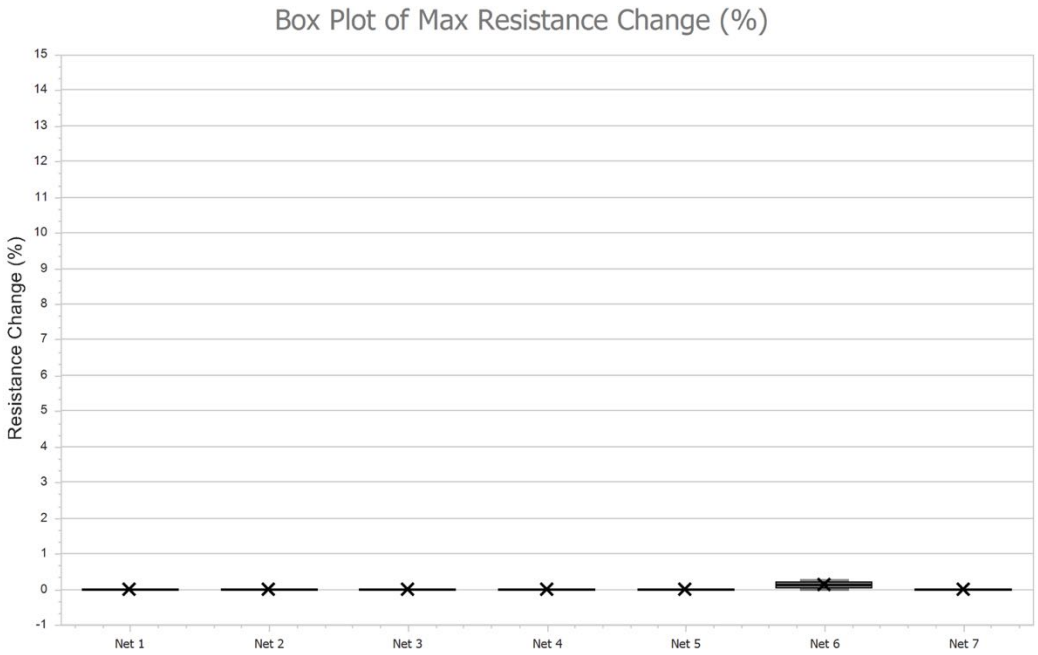
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01007	0.00944	0.00953	-	-	-
Maximum Resistance % Change	0.00	0.23	0.10	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4B, HATS2TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	10.V-TSL-MVIA_230C	**Quality of Profiles:** 6		**Failure Percentage (%):** 5	
Quantity of Coupons:	3	**Number of Nets:** 7		**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1		**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1		**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1		**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1		**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1		**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1		**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1		**Net 7 Hole Size:**	.125 mm

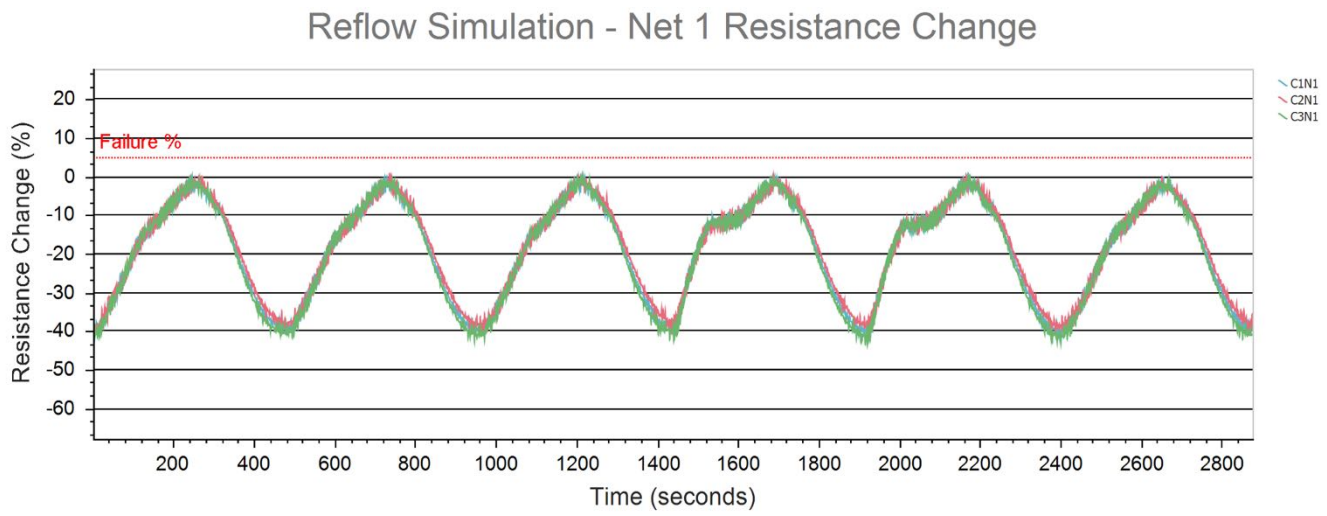


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00233	0.00241	0.00226	-	-	-
Maximum Resistance % Change	0.00	0.00	0.00	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

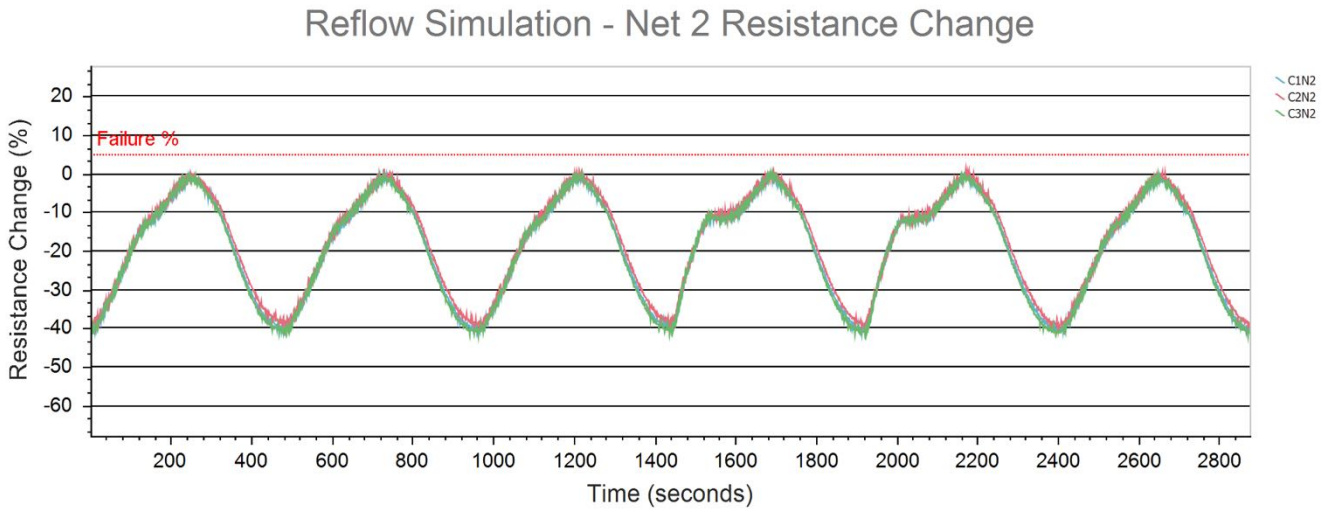


Group 4C, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	3	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



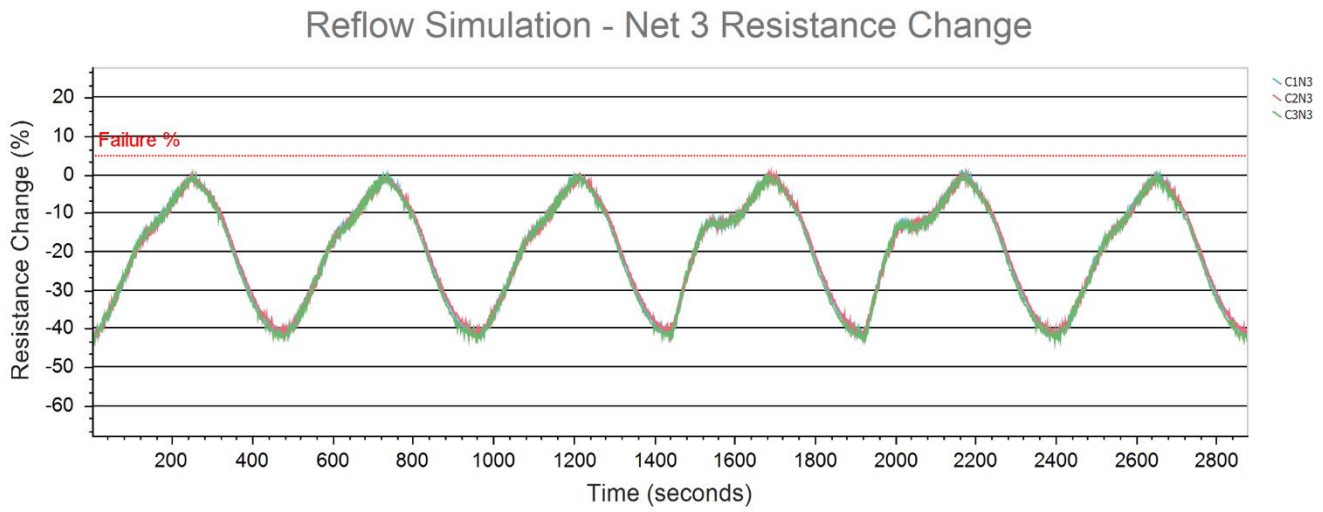
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00238	0.00221	0.00242	-	-	-
Maximum Resistance % Change	0.46	0.77	0.58	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



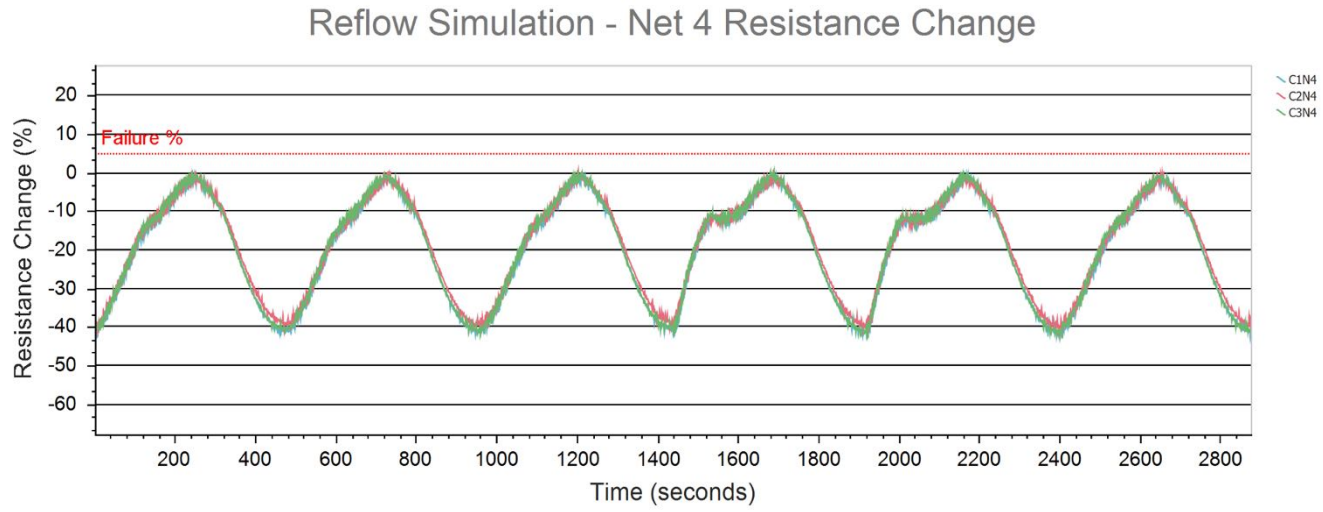
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00364	0.00321	0.00346	-	-	-
Maximum Resistance % Change	0.25	1.31	0.55	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4C, HATS²TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	3	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



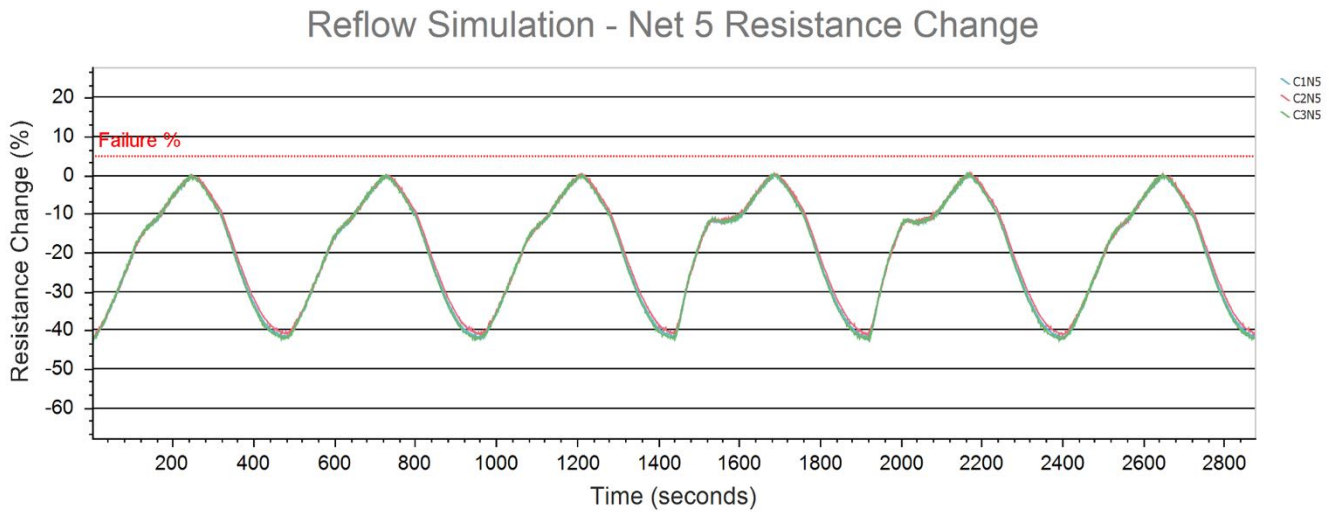
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00381	0.00355	0.00334	-	-	-
Maximum Resistance % Change	0.79	0.59	0.09	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



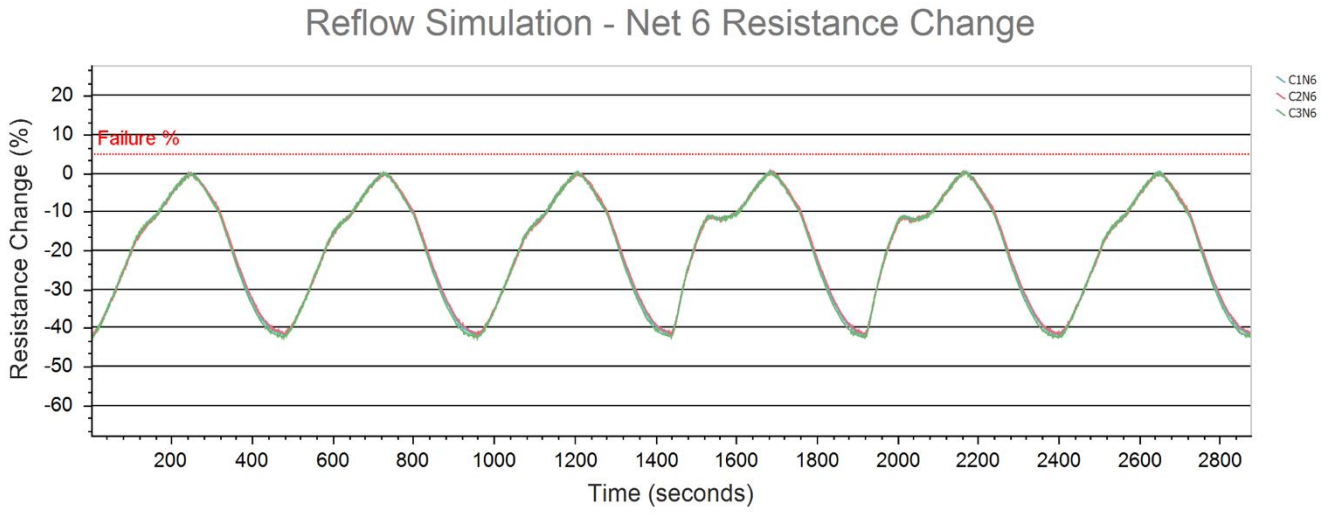
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00316	0.00288	0.00322	-	-	-
Maximum Resistance % Change	0.00	0.63	0.56	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4C, HATS²™ Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	3	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



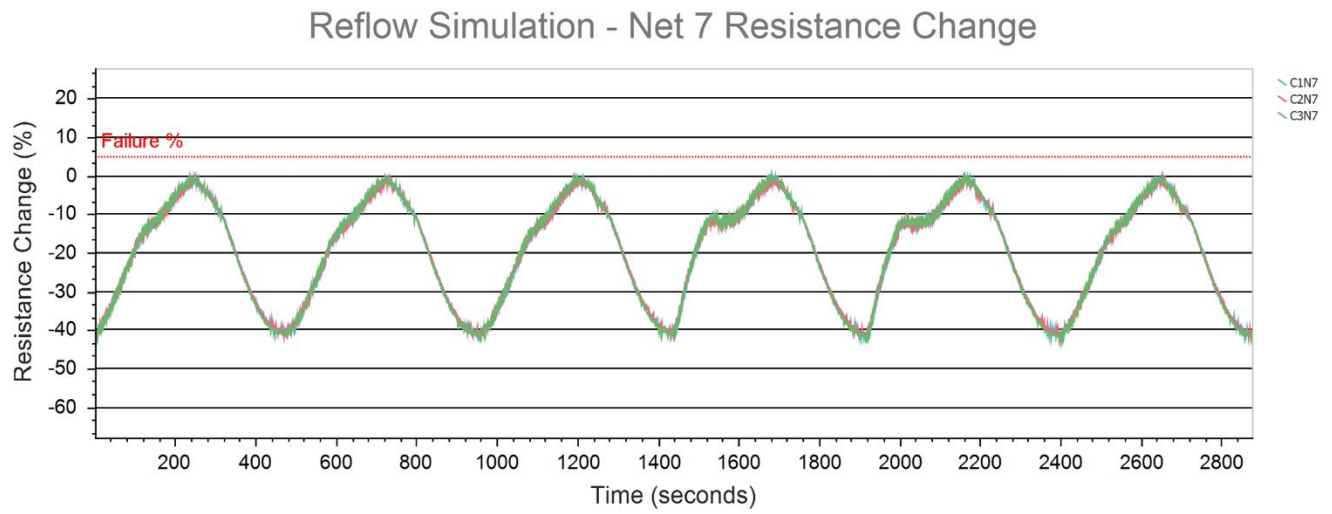
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01011	0.00938	0.00962	-	-	-
Maximum Resistance % Change	0.32	0.67	0.50	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-



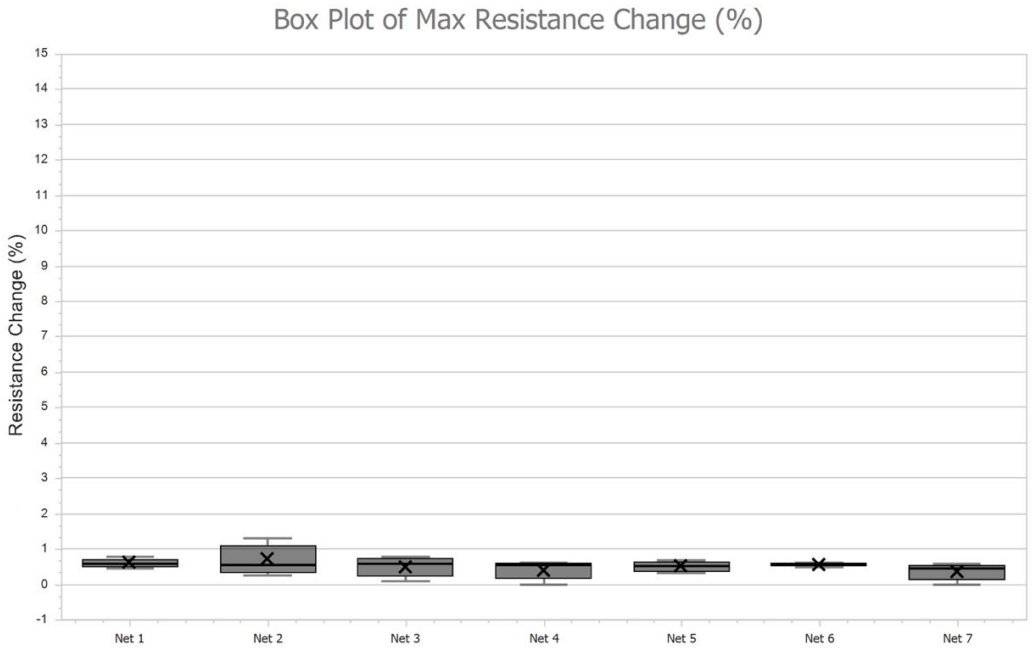
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01250	0.01166	0.01185	-	-	-
Maximum Resistance % Change	0.62	0.54	0.49	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

Group 4C, HATS2TM Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile:	18. IPC V TSL 230C	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	3	**Number of Nets:**	7	**Coupon Thickness:**	2.75 mm
Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm

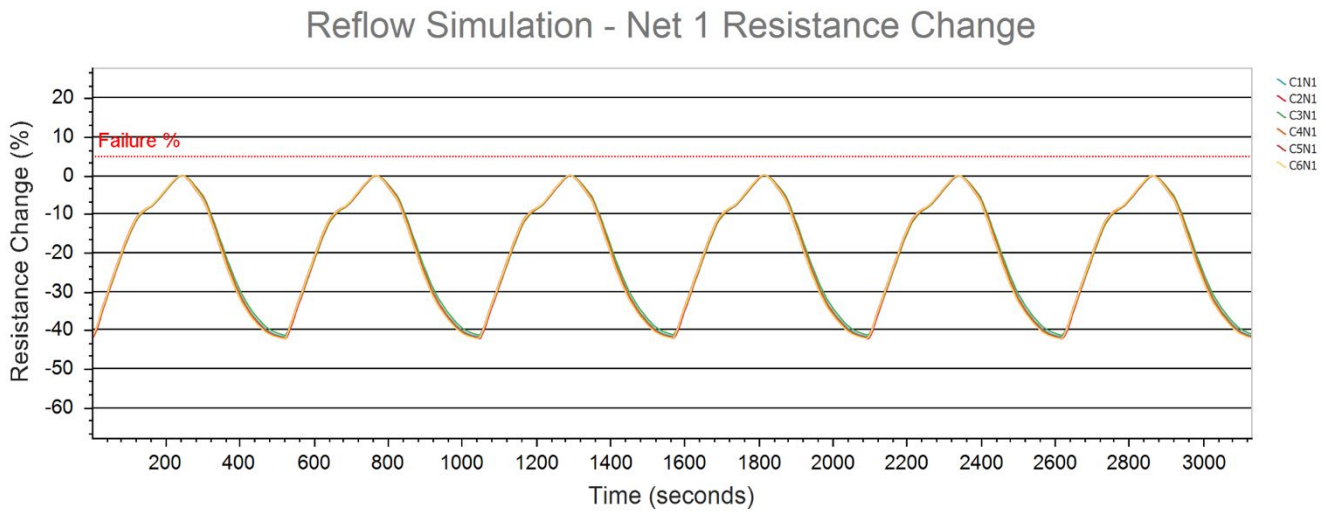


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00338	0.00340	0.00339	-	-	-
Maximum Resistance % Change	0.44	0.00	0.59	-	-	-
Cycle Failed 5% Limit	>6	>6	>6	-	-	-

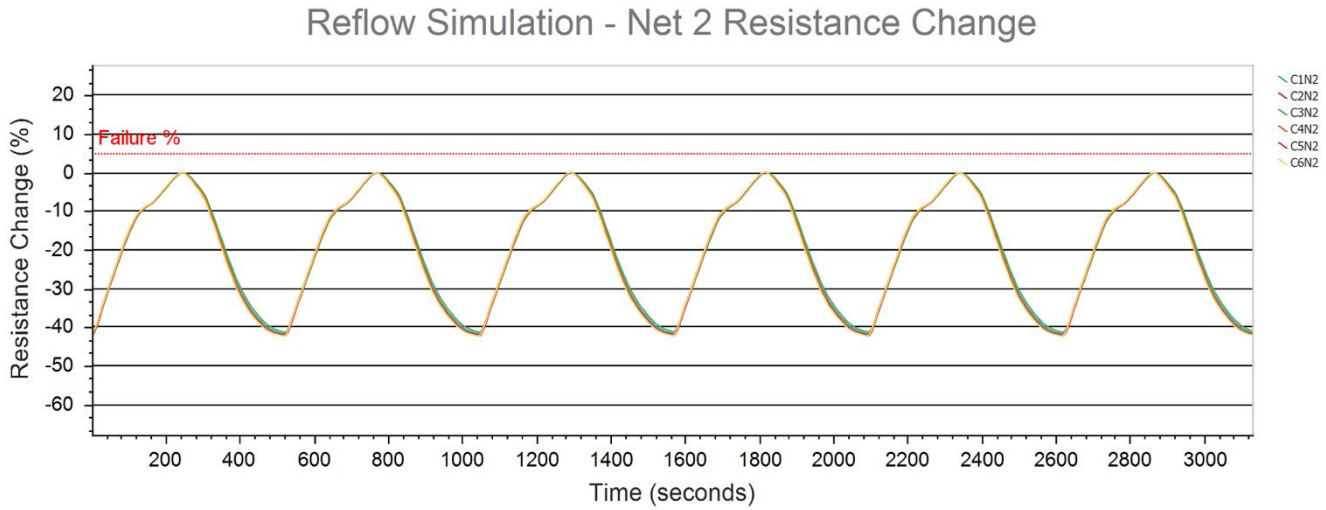


Group A3, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile:	18.IPC-V-TSL_230	**Quality of Profiles:**	6	**Failure Percentage (%):**	5
Quantity of Coupons:	6	**Number of Nets:**	2	**Coupon Thickness:**	2.8 mm
Net 1 Via Type:	SS Outside (Parallel)	**Net 1 Quantity of Holes:**	288	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Inside (Parallel)	**Net 2 Quantity of Holes:**	288	**Net 2 Hole Size:**	.125 mm



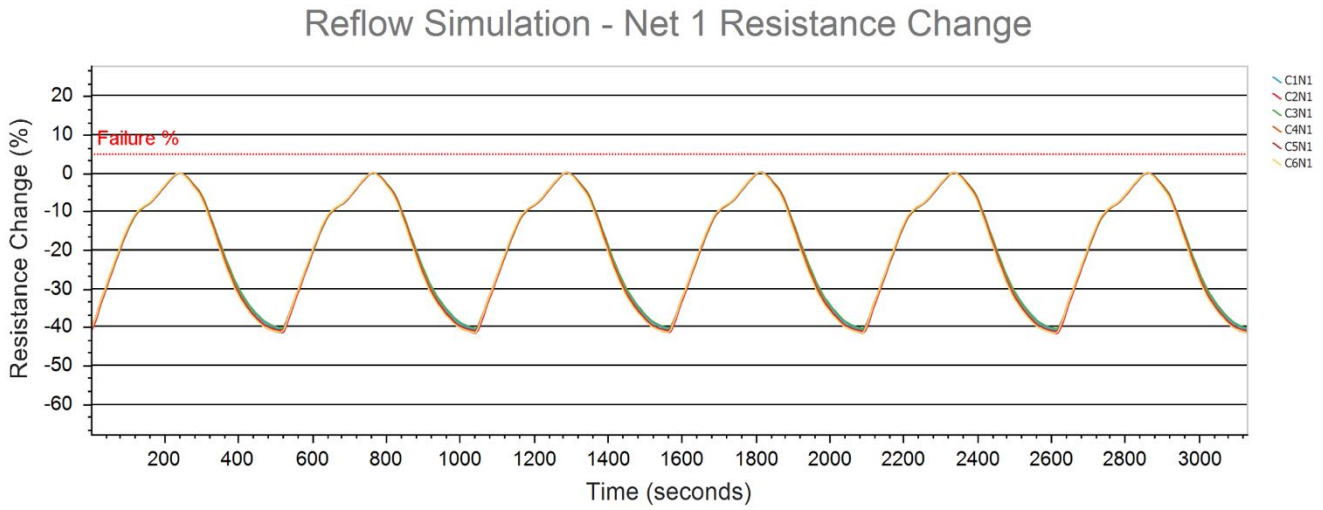
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.22330	0.21674	0.21662	0.22312	0.22949	0.21579
Maximum Resistance % Change	0.02	0.06	0.06	0.04	0.14	0.15
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



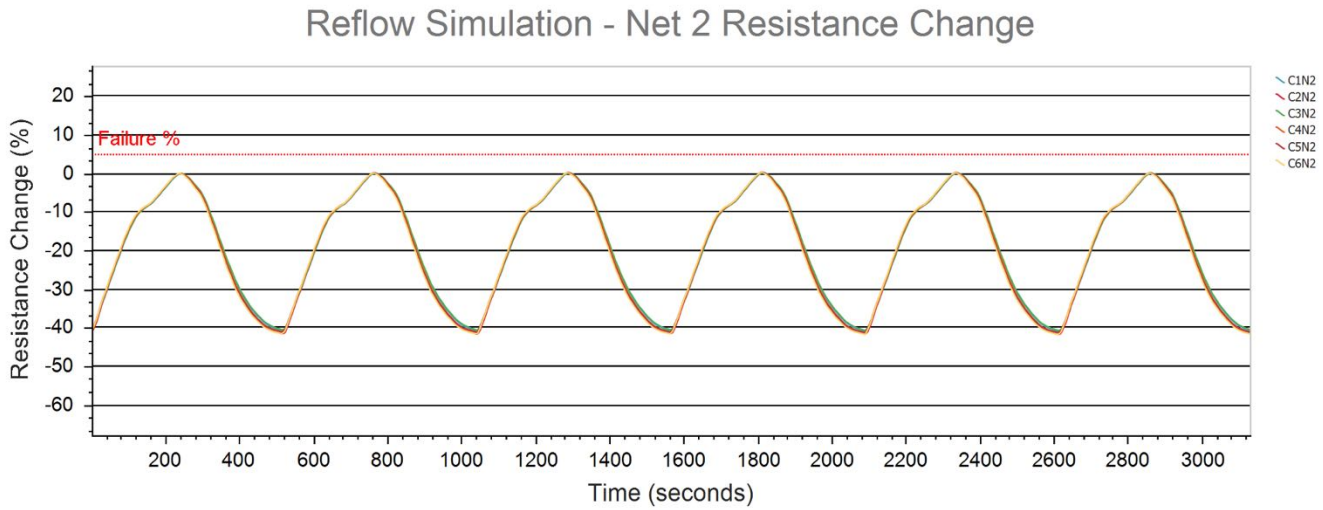
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.23664	0.23306	0.24285	0.23964	0.23754	0.23030
Maximum Resistance % Change	0.07	0.05	0.10	0.03	0.12	0.13
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group A4, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Full Stacked (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: Full Staggered (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



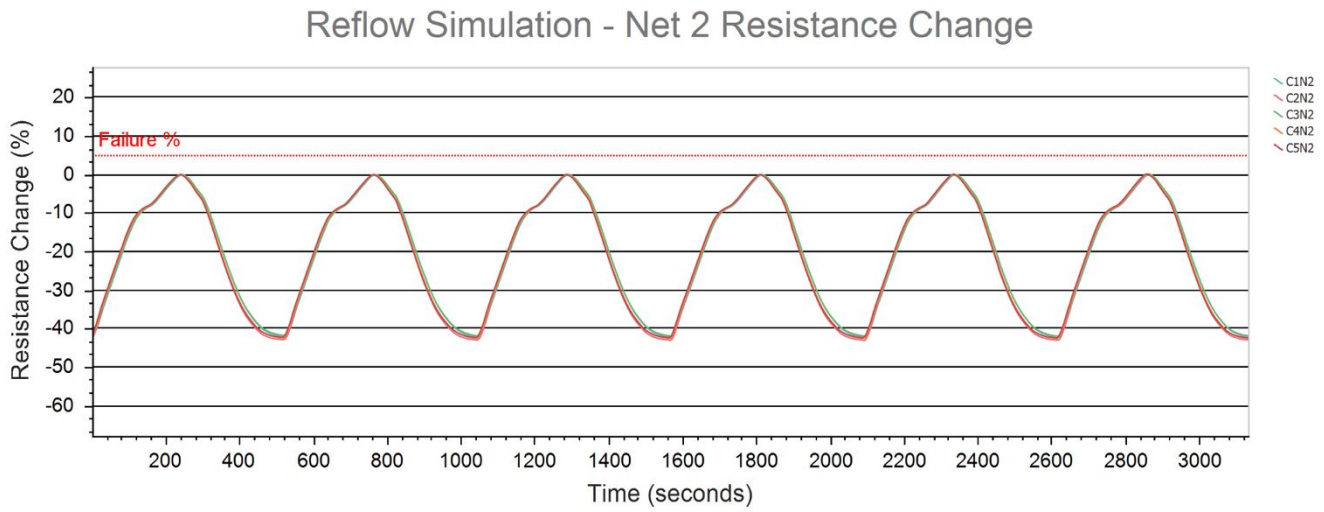
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.16685	0.16092	0.16155	0.17019	0.17574	0.16003
Maximum Resistance % Change	0.28	0.25	0.30	0.29	0.27	0.26
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



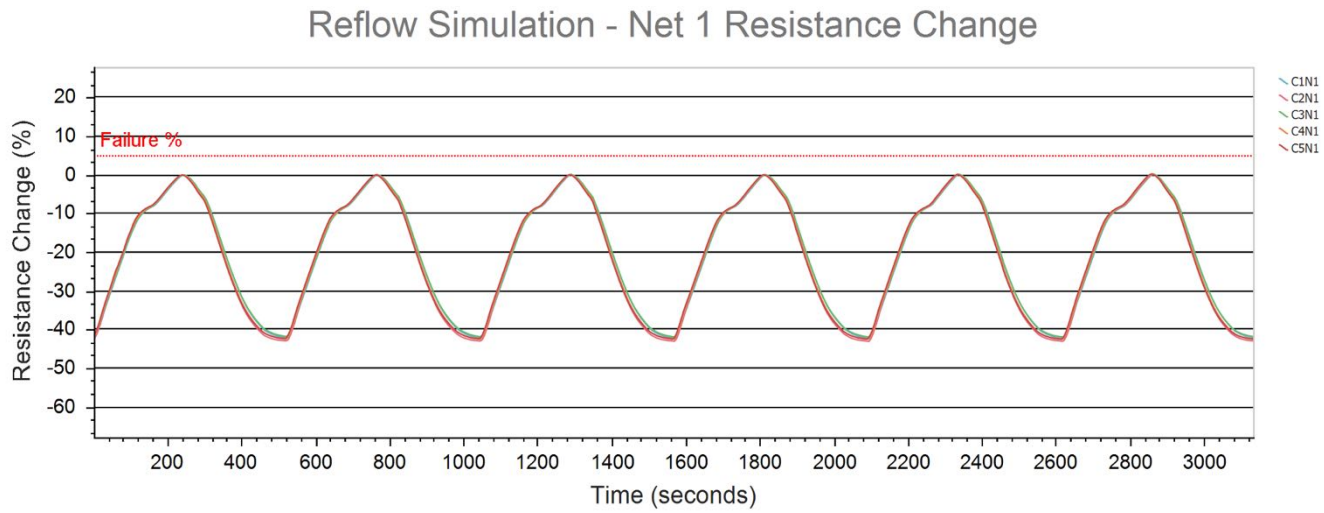
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.27517	0.26975	0.28668	0.27280	0.28409	0.27270
Maximum Resistance % Change	0.23	0.26	0.26	0.29	0.31	0.20
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group A5, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 5
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Staggered Above BV (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: SSI Above BV (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



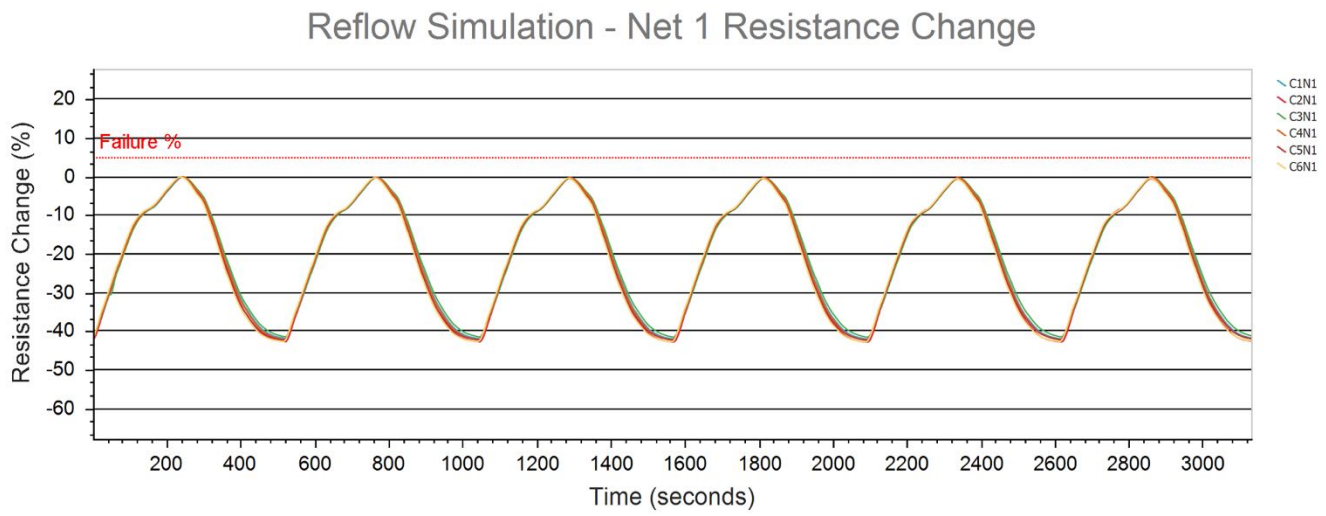
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.26535	0.26290	0.28735	0.26264	0.27607	-
Maximum Resistance % Change	0.03	0.06	0.17	0.06	0.17	-
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	-



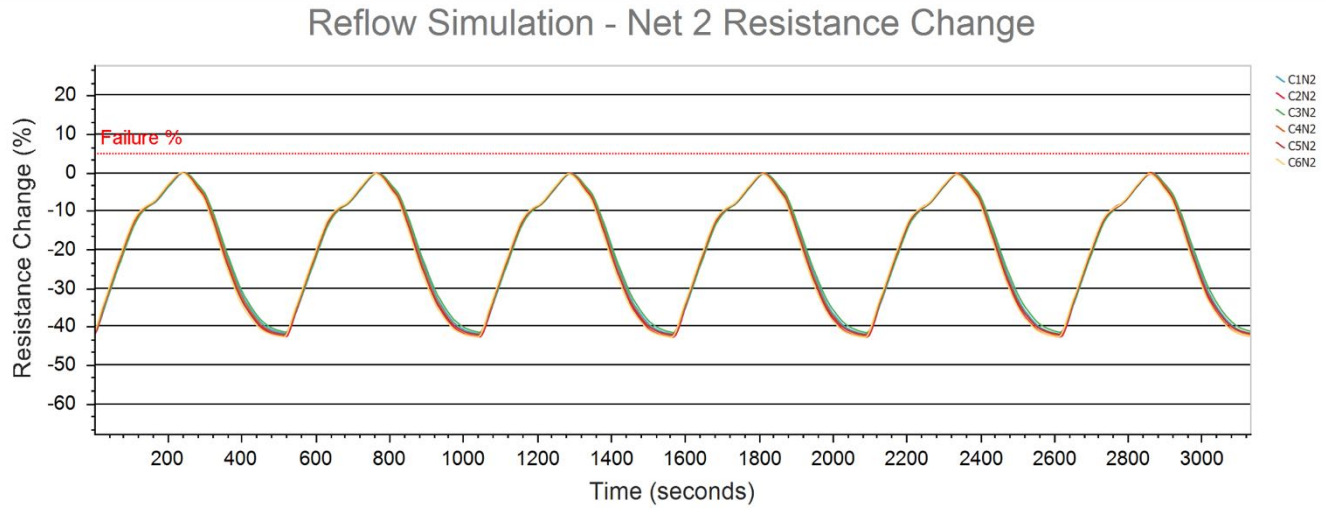
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.36302	0.34756	0.37441	0.33345	0.35226	-
Maximum Resistance % Change	0.08	0.13	0.24	0.13	0.24	-
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	-

Group B3, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: SS Outside (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: SS Inside (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



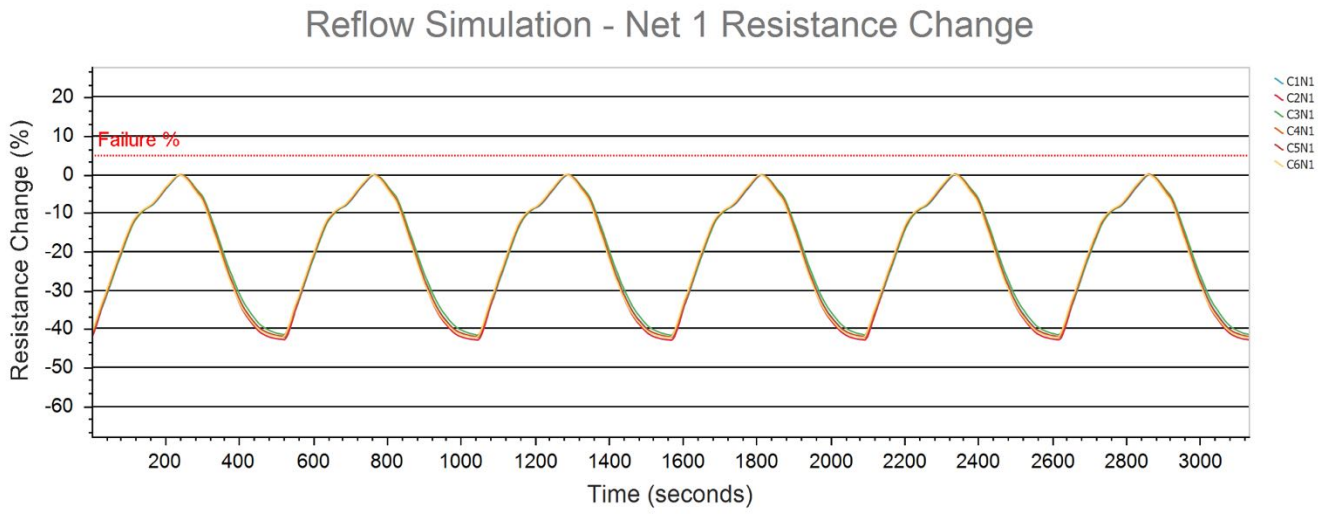
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.22484	0.22088	0.22414	0.21835	0.24104	0.21910
Maximum Resistance % Change	0.00	0.00	0.00	0.00	0.00	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



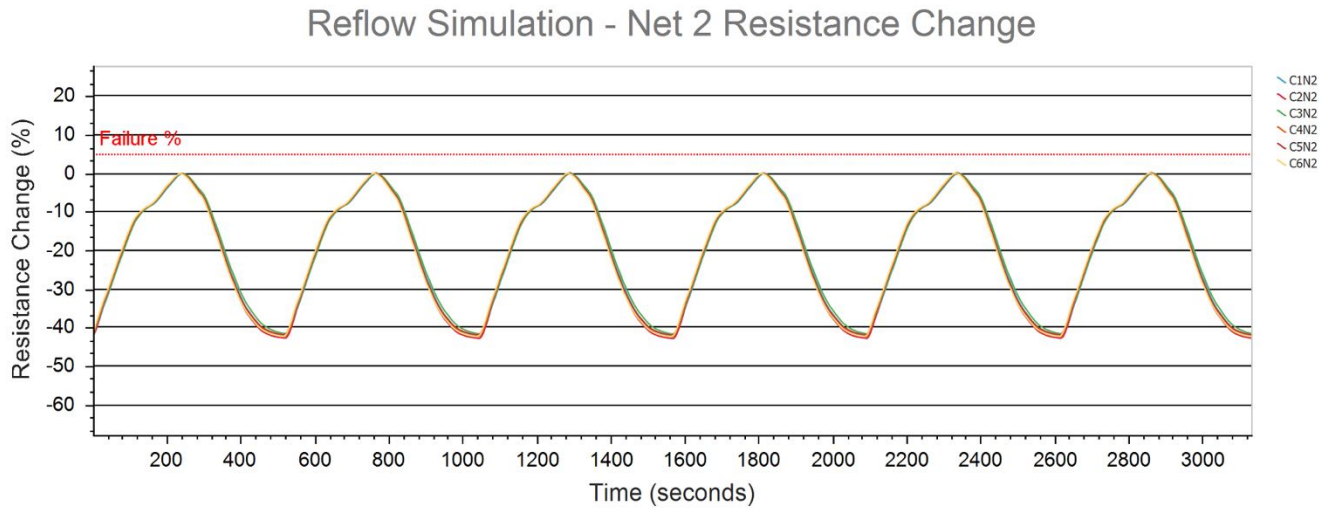
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.24264	0.23552	0.23217	0.21973	0.24564	0.23679
Maximum Resistance % Change	0.00	0.00	0.00	0.00	0.00	0.00
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group B4, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Full Stacked (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: Full Staggered (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



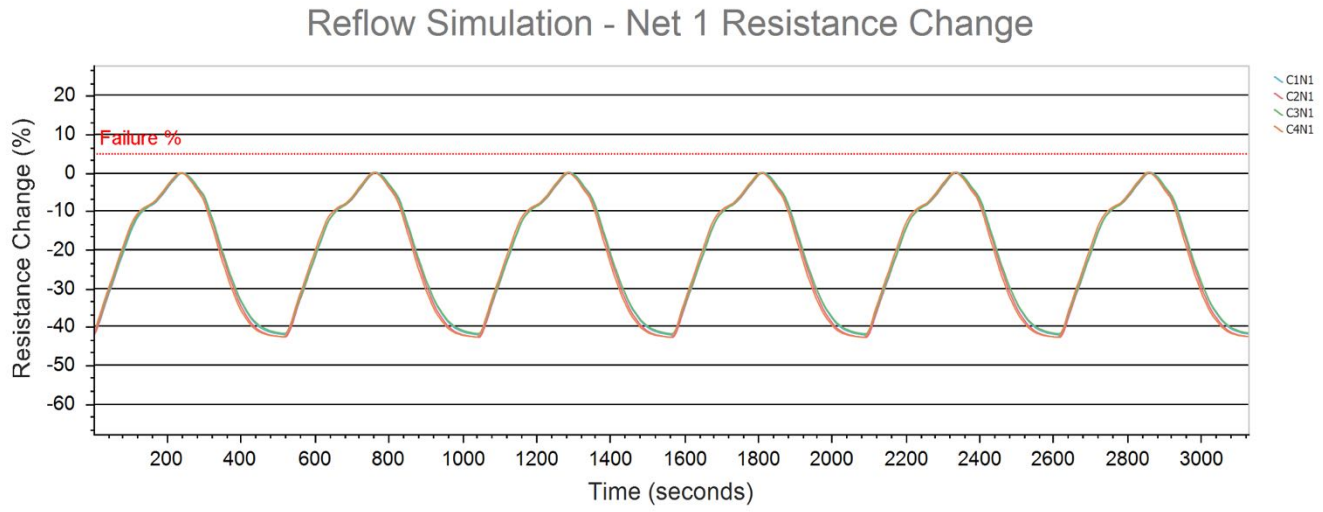
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.17619	0.16842	0.17506	0.16792	0.16998	0.17331
Maximum Resistance % Change	0.00	0.12	0.15	0.16	0.06	0.05
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



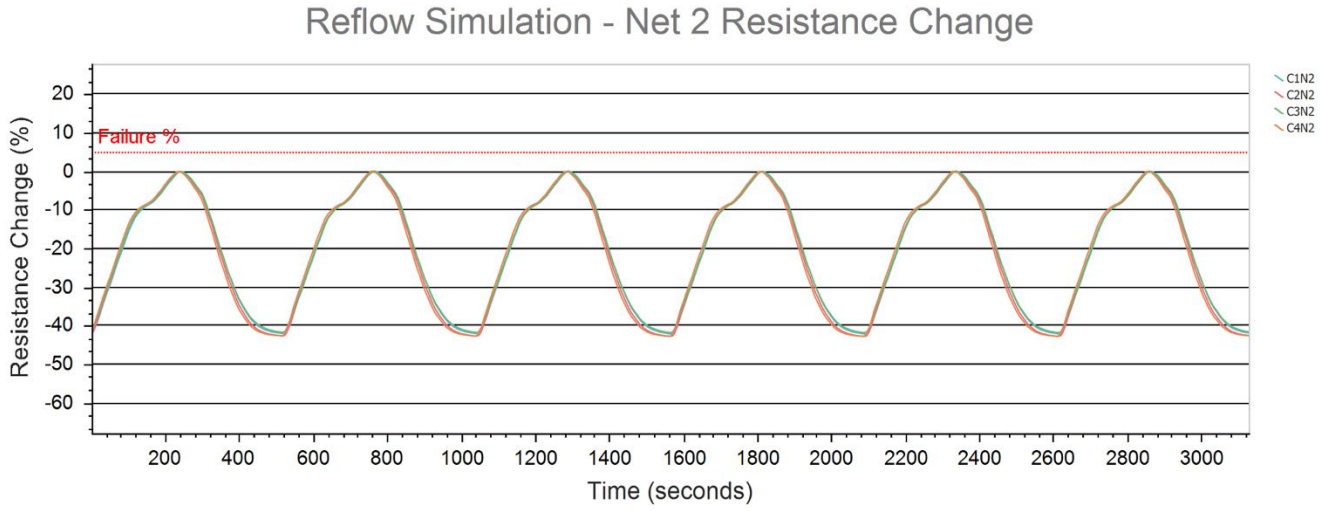
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.28210	0.27892	0.27812	0.27019	0.27326	0.27905
Maximum Resistance % Change	0.06	0.15	0.13	0.14	0.14	0.06
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group B5, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 4
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Staggered Above BV (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: SSI Above BV (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



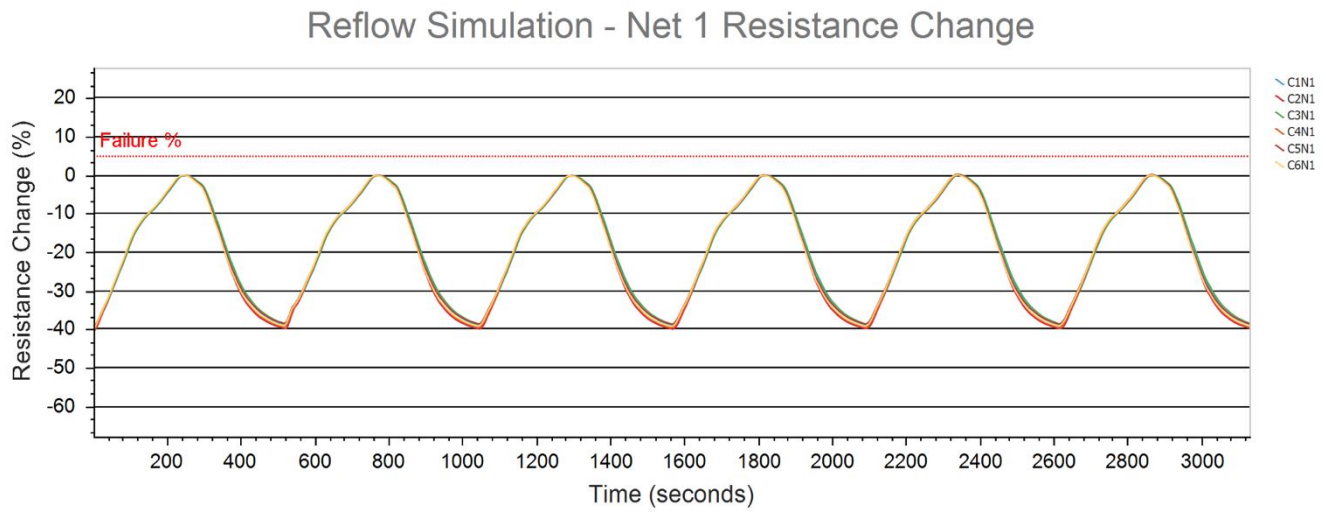
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.35123	0.34838	0.34958	0.35297	-	-
Maximum Resistance % Change	0.16	0.01	0.08	0.11	-	-
Cycle Failed 5% Limit	>6	>6	>6	>6	-	-



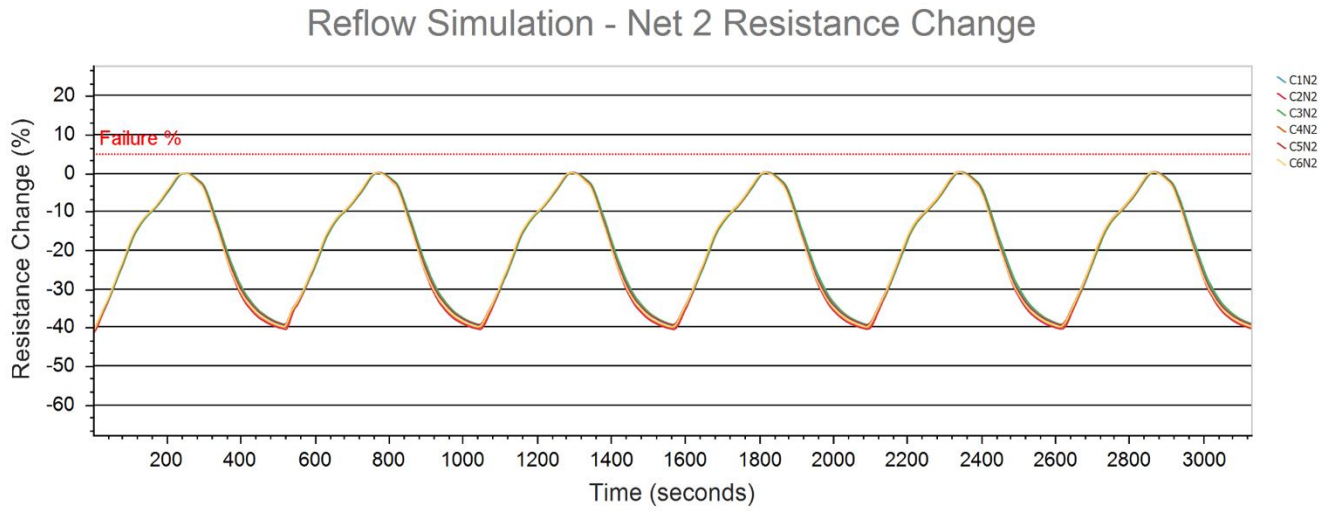
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.27401	0.26530	0.26858	0.27760	-	-
Maximum Resistance % Change	0.11	0.01	0.04	0.06	-	-
Cycle Failed 5% Limit	>6	>6	>6	>6	-	-

Group C1, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Single & Stacked Microvia (Parallel)
Net 1 Quantity of Holes: 61
Net 1 Hole Size: .125 mm
Net 2 Via Type: Buried Via
Net 2 Quantity of Holes: 61
Net 2 Hole Size: .25 mm



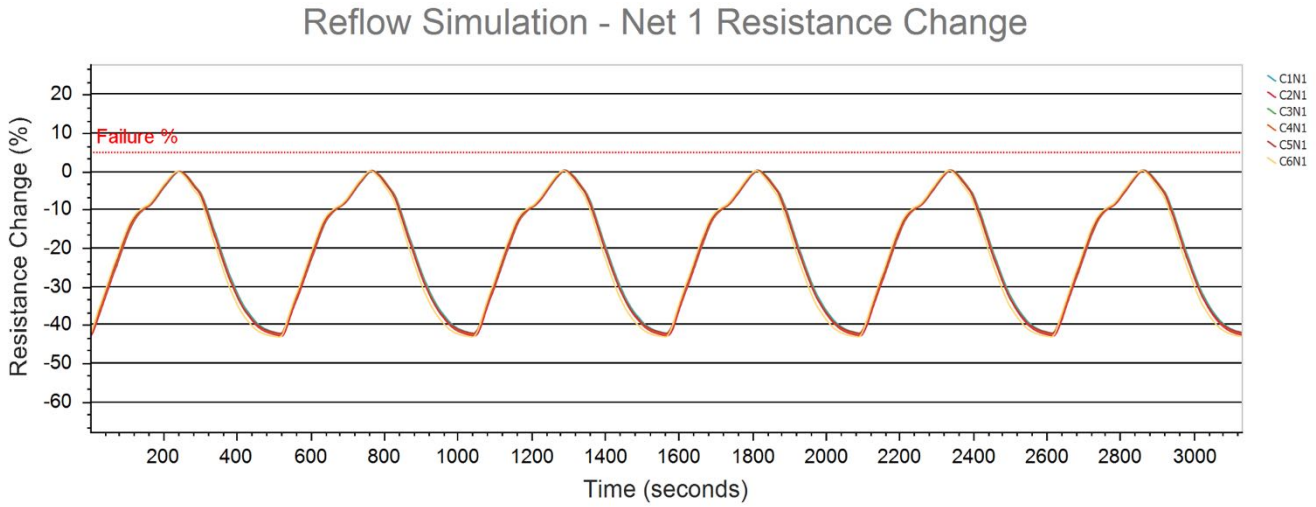
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.24124	0.24260	0.27108	0.24459	0.23265	0.23811
Maximum Resistance % Change	0.12	0.12	0.04	0.06	0.22	0.06
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



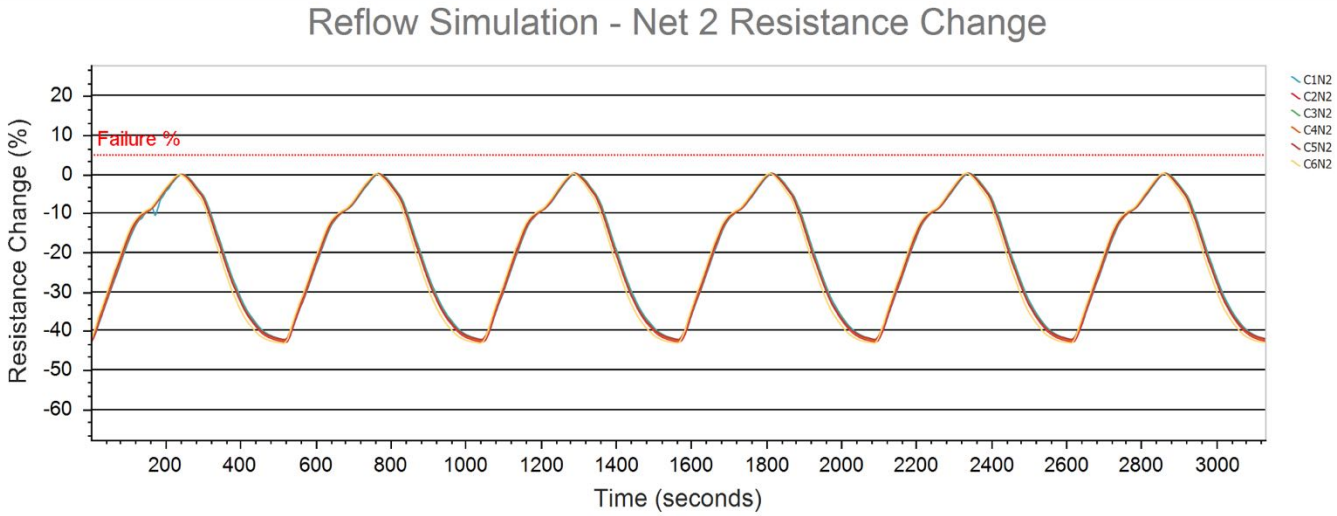
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.79048	0.85744	0.85054	0.82779	0.85925	0.77237
Maximum Resistance % Change	0.28	0.23	0.20	0.25	0.34	0.22
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group C2, IPC "D" Coupons - Reflow Simulation Test Results (7s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Buried & SS Inside 0.5 grid
Net 1 Quantity of Holes: 240
Net 1 Hole Size: .125 mm
Net 2 Via Type: Buried & SS Inside 0.8 grid
Net 2 Quantity of Holes: 240
Net 2 Hole Size: .125 mm



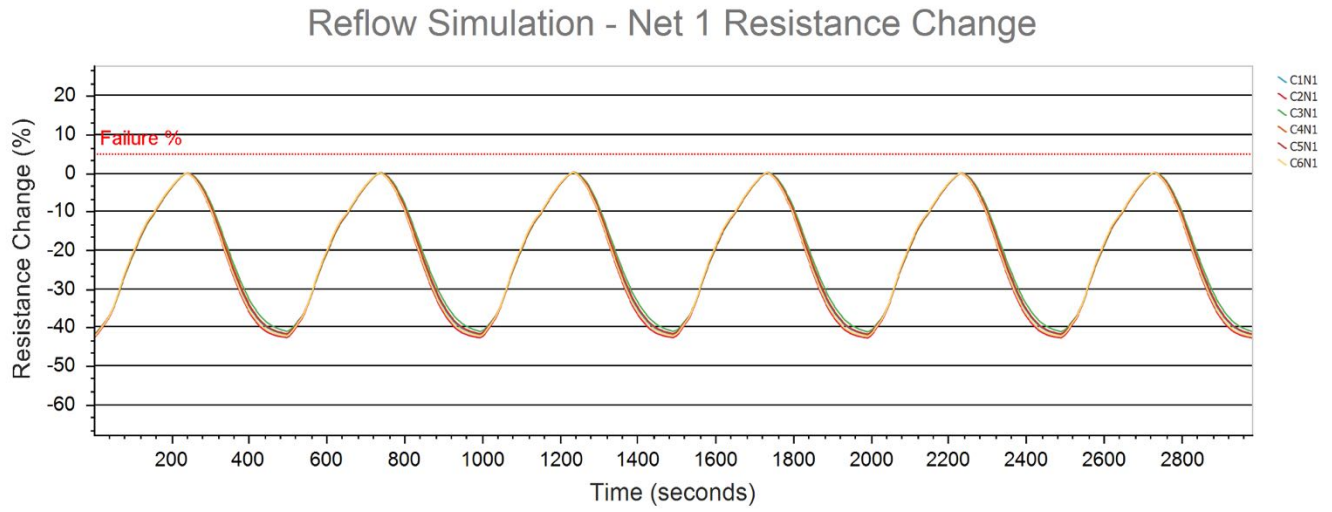
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	1.36220	1.40479	1.51014	1.38568	1.38601	1.35057
Maximum Resistance % Change	0.29	0.27	0.35	0.29	0.35	0.27
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



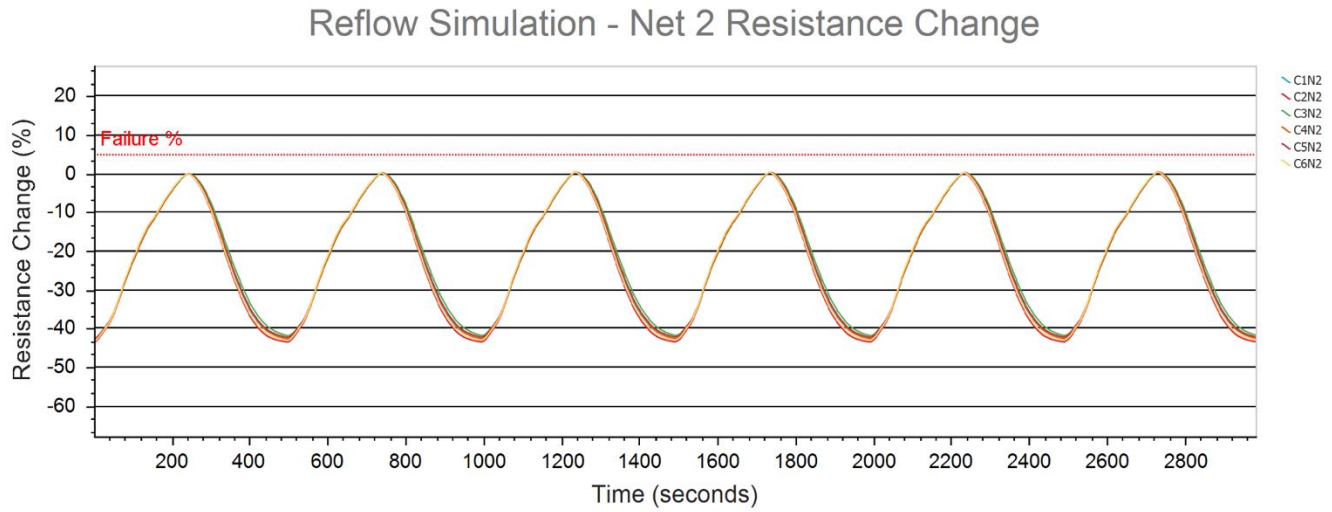
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	2.73294	2.80072	3.01238	2.76869	2.78527	2.68040
Maximum Resistance % Change	0.26	0.31	0.33	0.28	0.31	0.29
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group D1, IPC "D" Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Single & Stacked Microvia (Parallel)
Net 1 Quantity of Holes: 61
Net 1 Hole Size: .125 mm
Net 2 Via Type: Buried Via
Net 2 Quantity of Holes: 61
Net 2 Hole Size: .25 mm



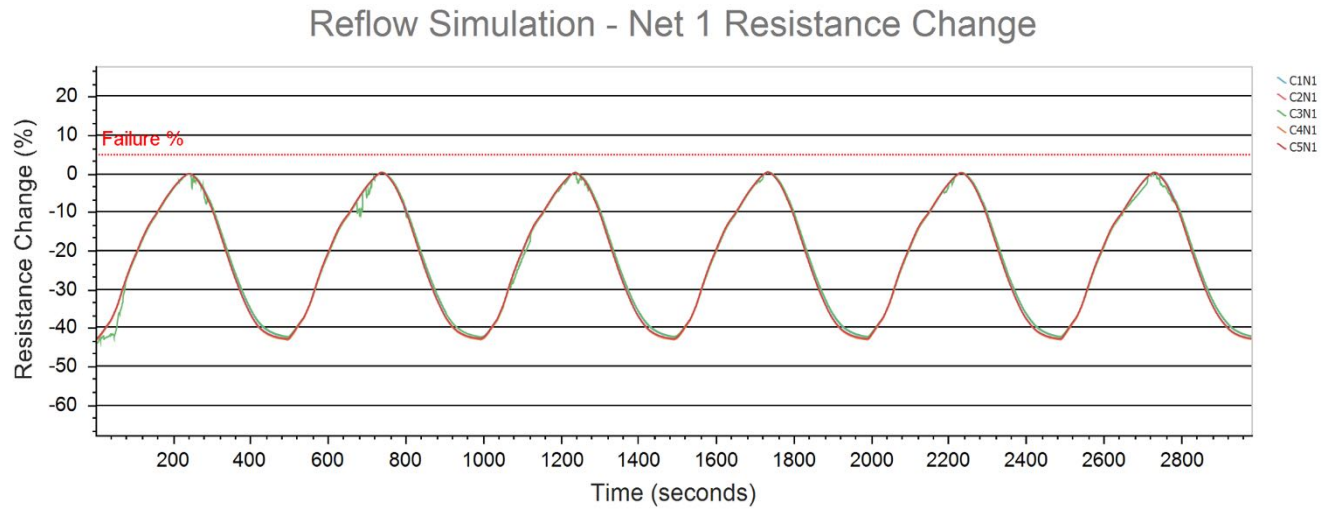
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.24991	0.24259	0.23995	0.22123	0.24740	0.24548
Maximum Resistance % Change	0.22	0.21	0.26	0.20	0.21	0.22
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6



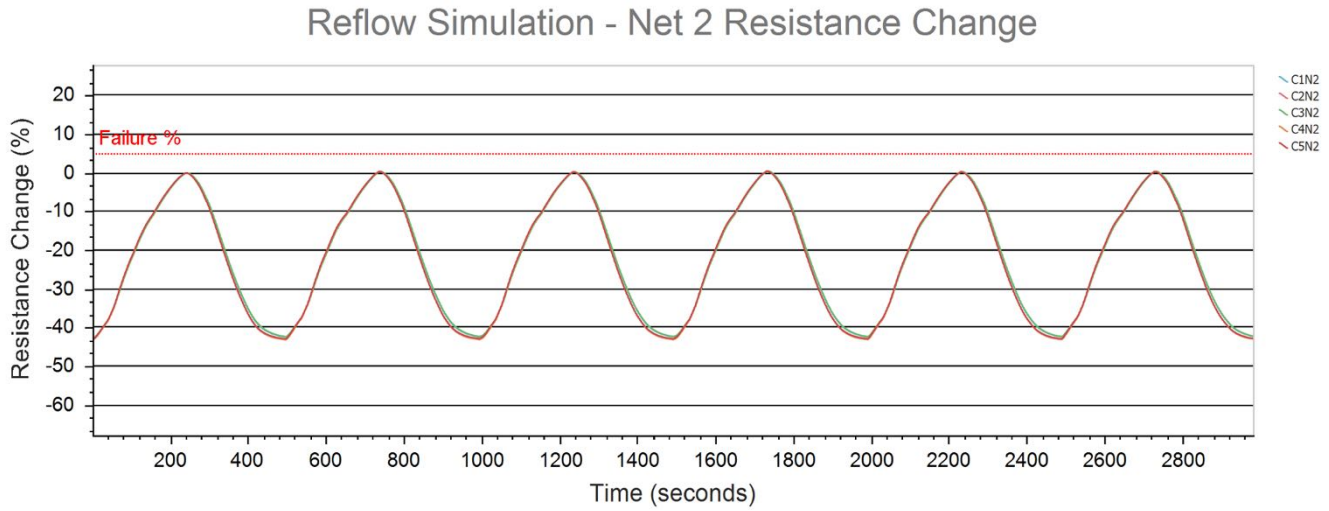
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.88913	0.88755	0.85623	0.79932	0.96044	0.80339
Maximum Resistance % Change	0.43	0.38	0.46	0.50	0.46	0.48
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	>6

Group D2, IPC "D" Coupons - Reflow Simulation Test Results (1s between measurements)

Reflow Profile: 18.IPC-V-TSL_230
Quality of Profiles: 6
Failure Percentage (%): 5
Quantity of Coupons: 5
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Buried & SS Inside 0.5 grid
Net 1 Quantity of Holes: 240
Net 1 Hole Size: .125 mm
Net 2 Via Type: Buried & SS Inside 0.8 grid
Net 2 Quantity of Holes: 240
Net 2 Hole Size: .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	1.45650	1.42950	1.54211	1.33209	1.36144	-
Maximum Resistance % Change	0.46	0.47	0.45	0.46	0.45	-
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	-



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	2.91402	2.77481	3.07158	2.69129	2.74616	-
Maximum Resistance % Change	0.46	0.49	0.47	0.50	0.47	-
Cycle Failed 5% Limit	>6	>6	>6	>6	>6	-

Thermal Cycling/Shock in a HATS²™ Test System

IPC "D" Coupon Test Program

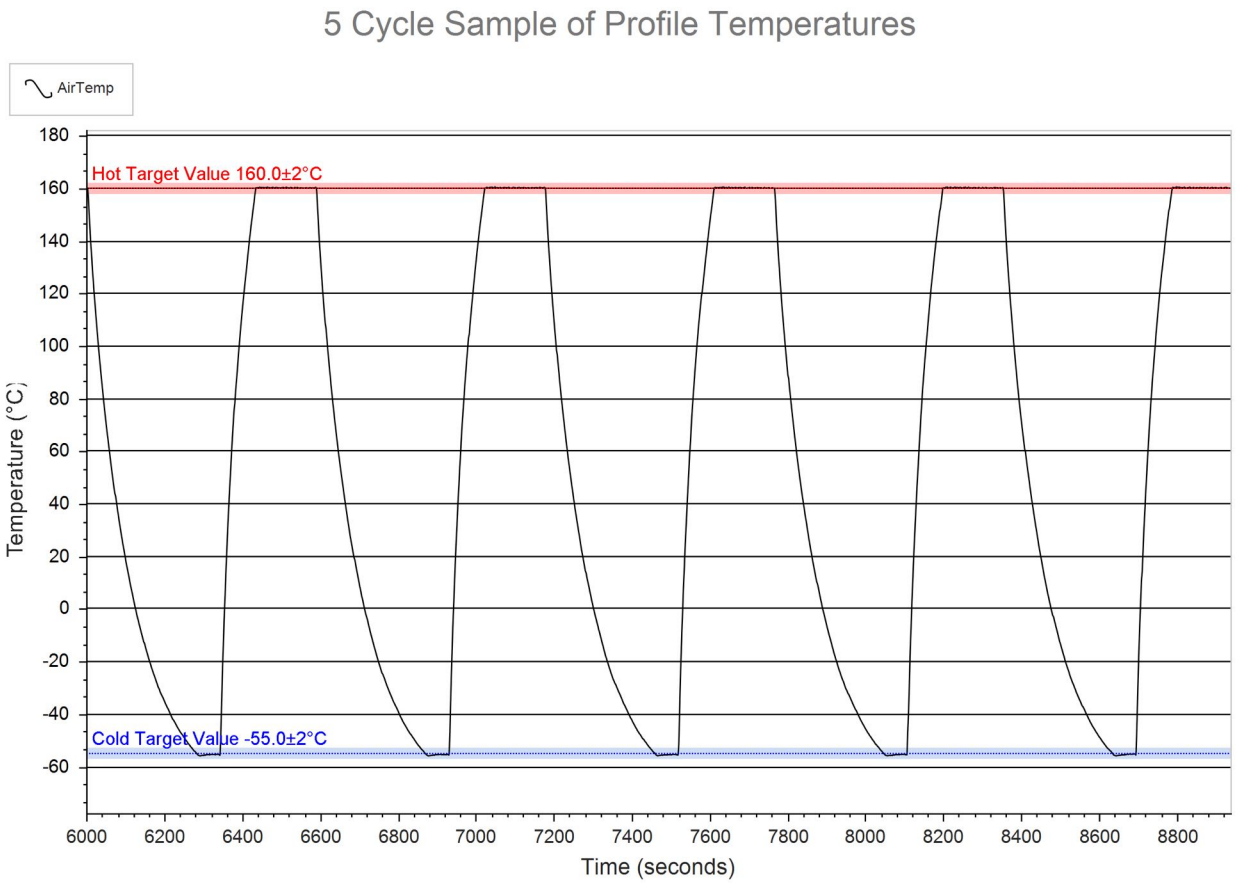
Microtek Laboratories China received samples from the IPC office:
6 panels, 5 designs per panel, 2 coupons per design condition per panel

iv. Coupons designated D1 & D2 were noted as "procurement" coupons. These will be used to compare 1-second and 7-second resistance sampling of each net during IPC-TM-650 2.6.27B Reflow exposure.

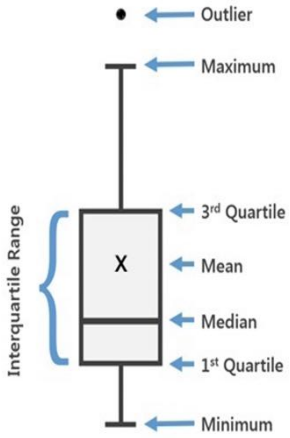
v. Coupons Designated D3, D4, D5 are designated for comparison between test methodologies using 7s resistance sampling of each net.

vi. *3x D5 coupons were received damaged and not used in the test plan (panel 8, 9 & 15). 1x D2 coupon from Panel 9 coupon had one net open and is not included in the test plan. The damaged D2 coupon and one damaged D5 coupon from panel 15 were used to create an accurate temperature profile for reflow to IPC-TM-650 2.6.27B - 230°C requirements. The 2 remaining damaged D5 coupons from panels 8 & 9 were used to create precise thermal cycles to assure that the samples reached temperature extremes in accordance with IPC-TM-650 2.6.7.2C.

The below results are from the -55°C to 160°C Cycling performed on IPC "D" coupon test samples A3, A4, A5, C1, C2, D1, D2. Below is a 5 Cycles sample of the air temperatures from the HATS²™ chamber test used to test these samples.



Box Plots are used to graphically display the distribution of a data set. The Box (Interquartile Range or IQR) extends from the first quartile (25th percentile of the data set) to the third quartile (75th percentile of the data set) and represents 50% of the population of the data set. The Median value of the data set is a represented by a line and the Mean value by an "X" within the box. A line and whisker extend from the bottom of the box (1st Quartile) to the Minimum value, representing the lower 25% of the population of the data set. A line and whisker extend from the top of the box (3rd Quartile) to the Maximum value, representing the upper 25% of the population of the data set. Statistical Outliers in the data set are represented by a "□" above or below the whiskers and are defined as any data value that is more than 1.5 times the IQR Distance away from the IQR.



- Box Plots are not included where final results are less than 1% variance from 1st Cycle.

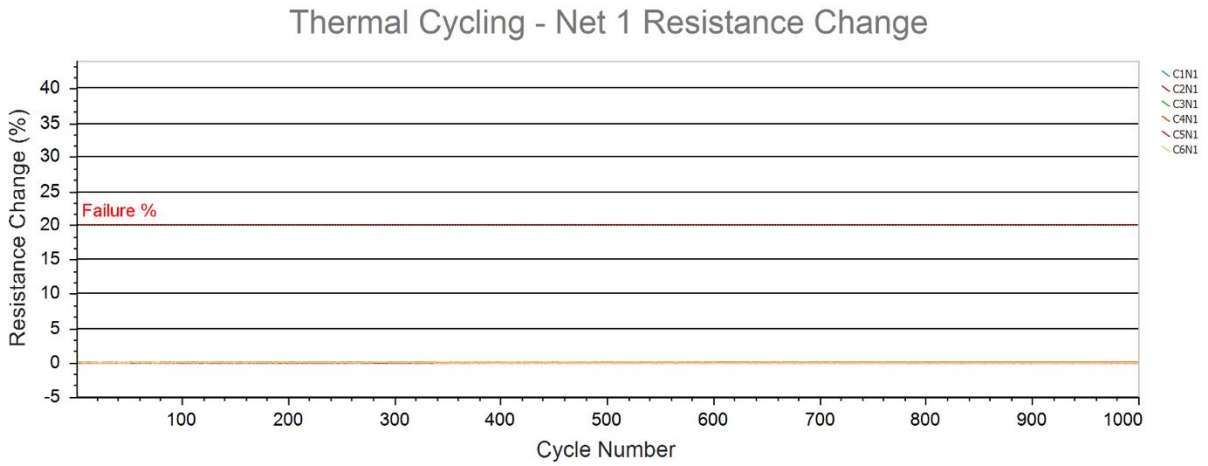
Group A3, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

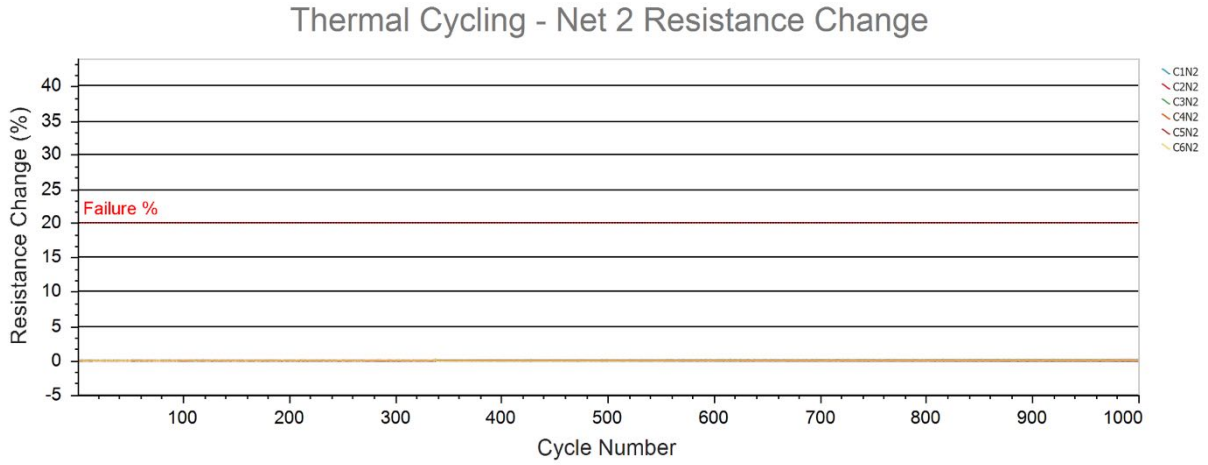
Quantity of Coupons: 6 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: SS Outside (Parallel) **Net 1 Quantity of Holes:** 288 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: SS Inside (Parallel) **Net 2 Quantity of Holes:** 288 **Net 2 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.19090	0.18538	0.18567	0.19076	0.19565	0.18399
Maximum Resistance % Change	0.05	0.00	0.08	0.09	0.04	0.06
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.20247	0.19928	0.20819	0.20482	0.20256	0.19624
Maximum Resistance % Change	0.06	0.00	0.15	0.10	0.15	0.10
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

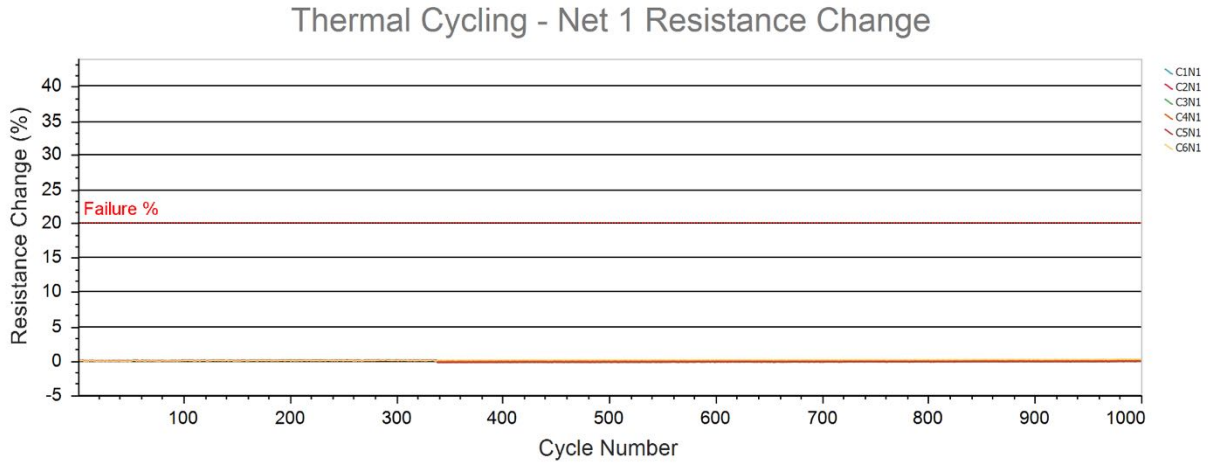
Group A4, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

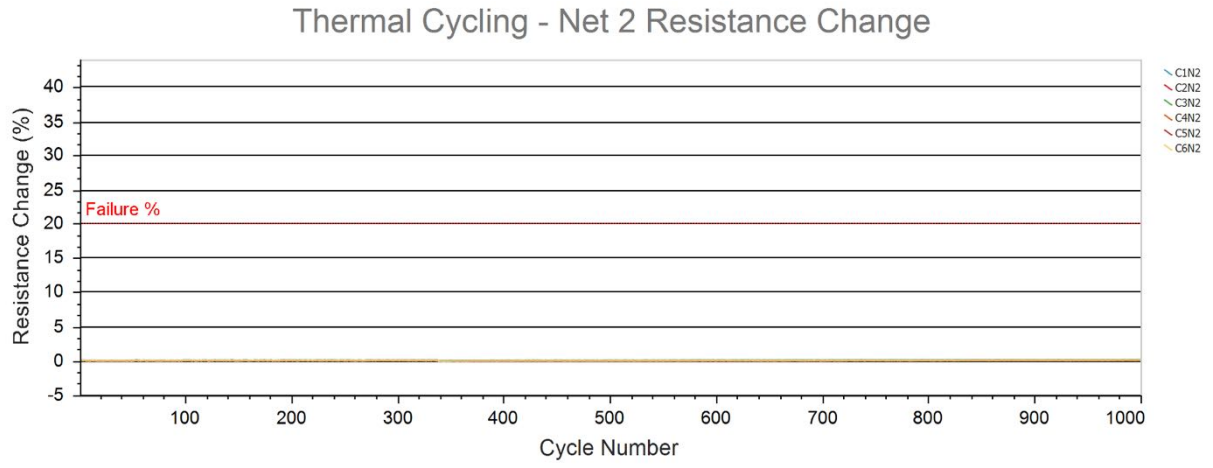
Quantity of Coupons: 6 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Full Stacked (Parallel) **Net 1 Quantity of Holes:** 288 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: Full Staggered (Parallel) **Net 2 Quantity of Holes:** 288 **Net 2 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.14318	0.13763	0.13921	0.14599	0.15049	0.13701
Maximum Resistance % Change	0.20	0.12	0.14	0.10	0.11	0.23
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.23611	0.23052	0.24609	0.23341	0.24334	0.23276
Maximum Resistance % Change	0.07	0.06	0.16	0.09	0.12	0.08
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

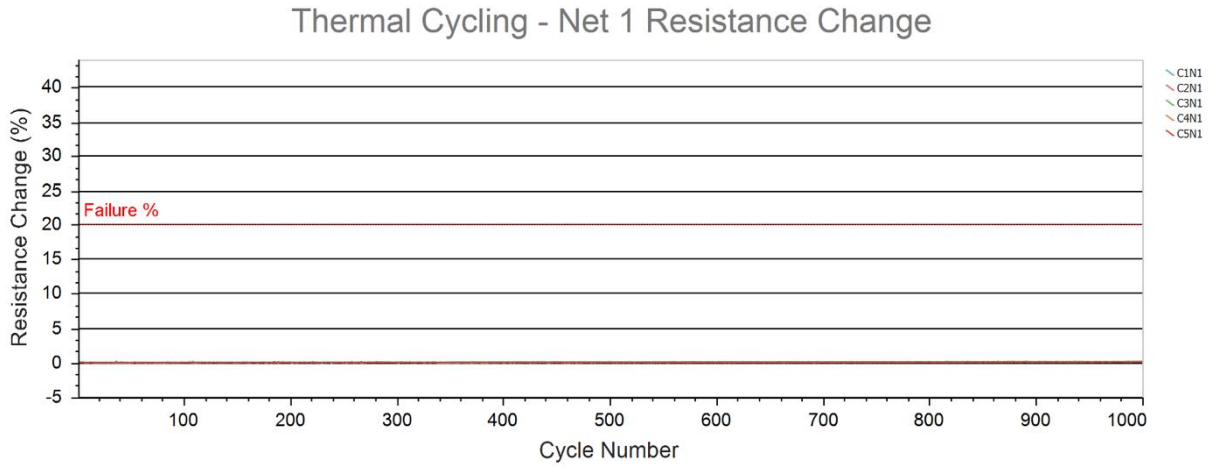
Group A5, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

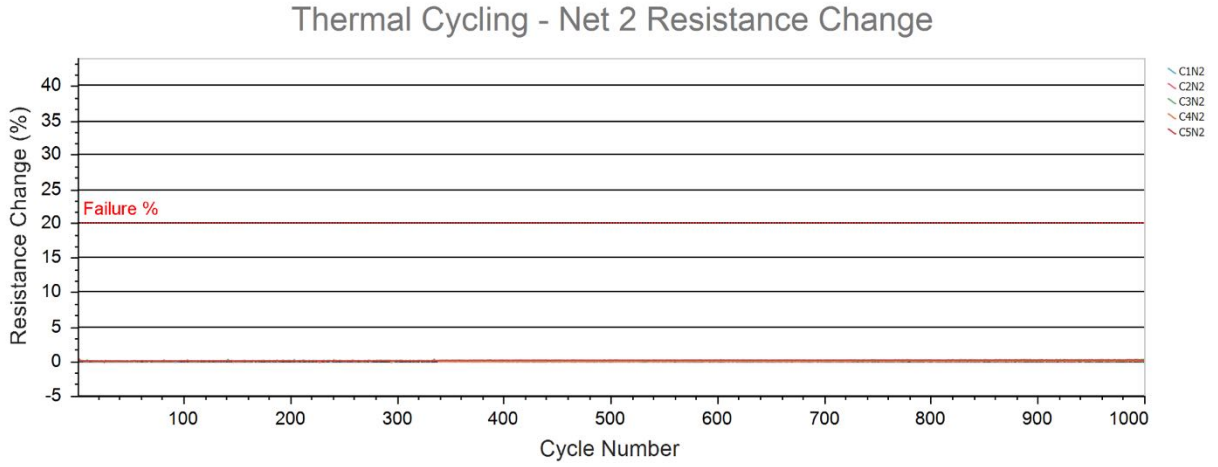
Quantity of Coupons: 5 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Staggered Above BV (Parallel) **Net 1 Quantity of Holes:** 288 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: SSI Above BV (Parallel) **Net 2 Quantity of Holes:** 288 **Net 2 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.30725	0.29244	0.31761	0.28179	0.29851	-
Maximum Resistance % Change	0.12	0.16	0.21	0.22	0.18	-
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	-



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.22445	0.22128	0.24369	0.22203	0.23390	-
Maximum Resistance % Change	0.20	0.26	0.24	0.19	0.21	-
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	-

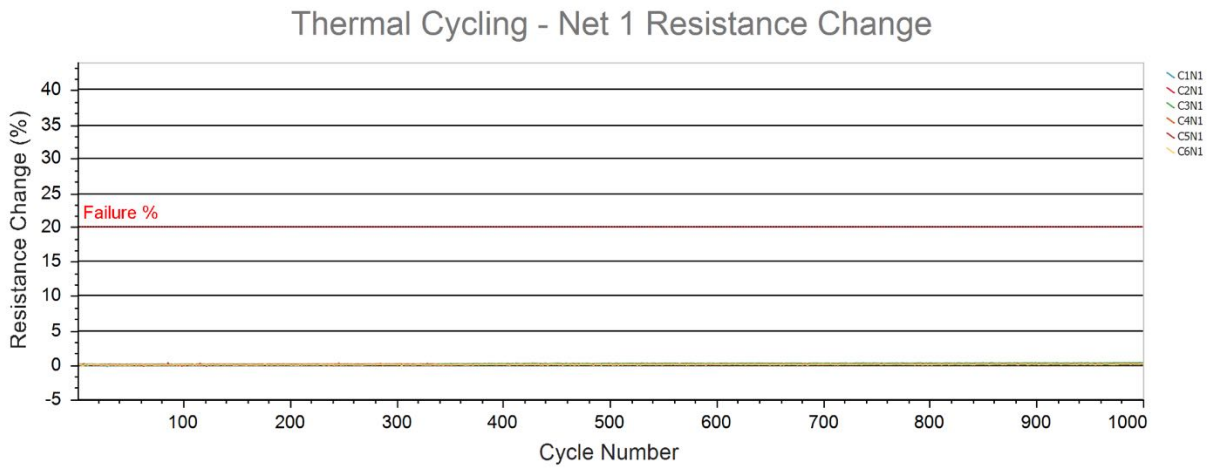
Group C1, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

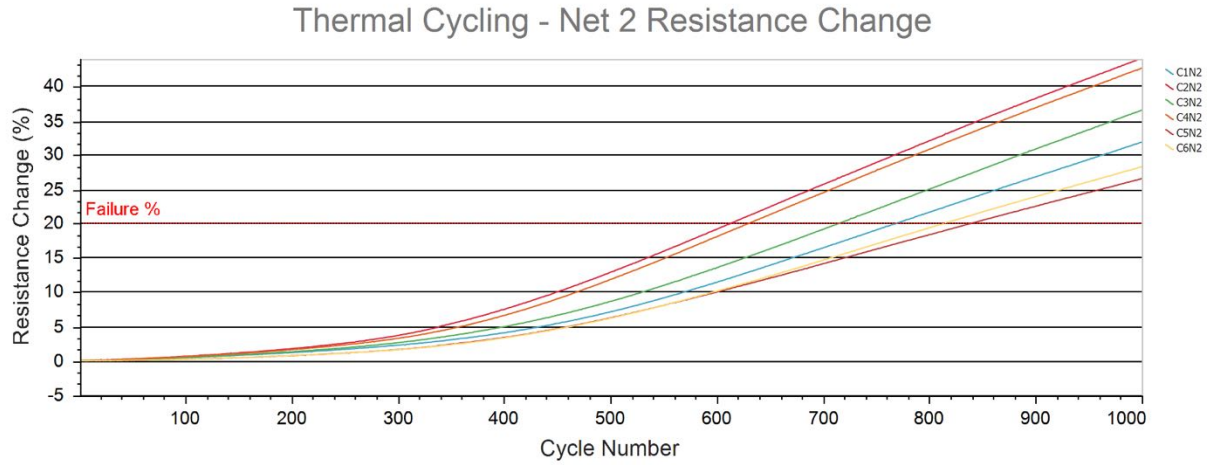
Quantity of Coupons: 6 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Single & Stacked Microvia (Parallel) **Net 1 Quantity of Holes:** 61 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: Buried Via **Net 2 Quantity of Holes:** 61 **Net 2 Hole Size:** .25 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.21037	0.21058	0.23637	0.21259	0.20403	0.20774
Maximum Resistance % Change	0.22	0.21	0.19	0.24	0.26	0.19
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.68399	0.73840	0.73630	0.71445	0.74662	0.66880
Maximum Resistance % Change	31.96	44.22	36.63	42.77	26.63	28.37
Cycle Failed 20% Limit	768	613	714	629	837	812

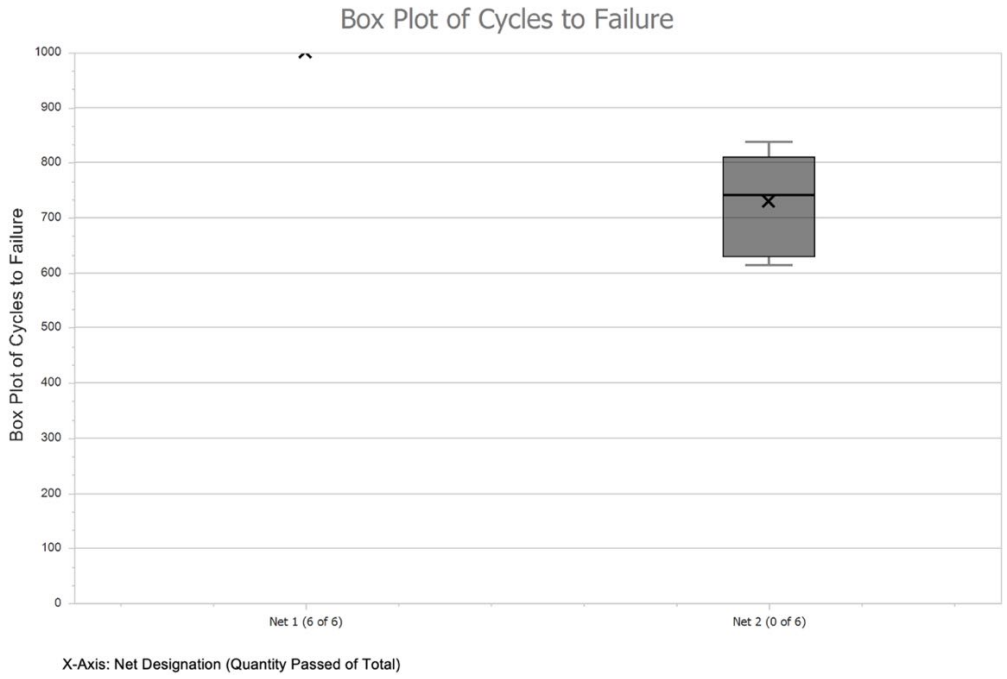
Group C1, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

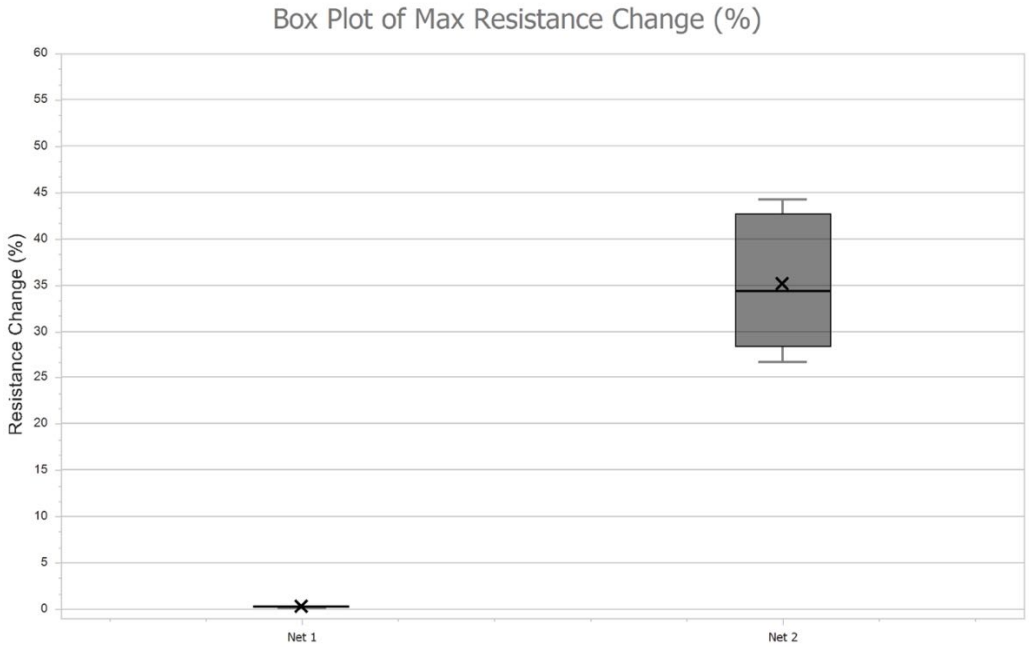
Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Single & Stacked Microvia (Parallel) **Net 1 Quantity of Holes:** 61 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: Buried Via **Net 2 Quantity of Holes:** 61 **Net 2 Hole Size:** .25 mm

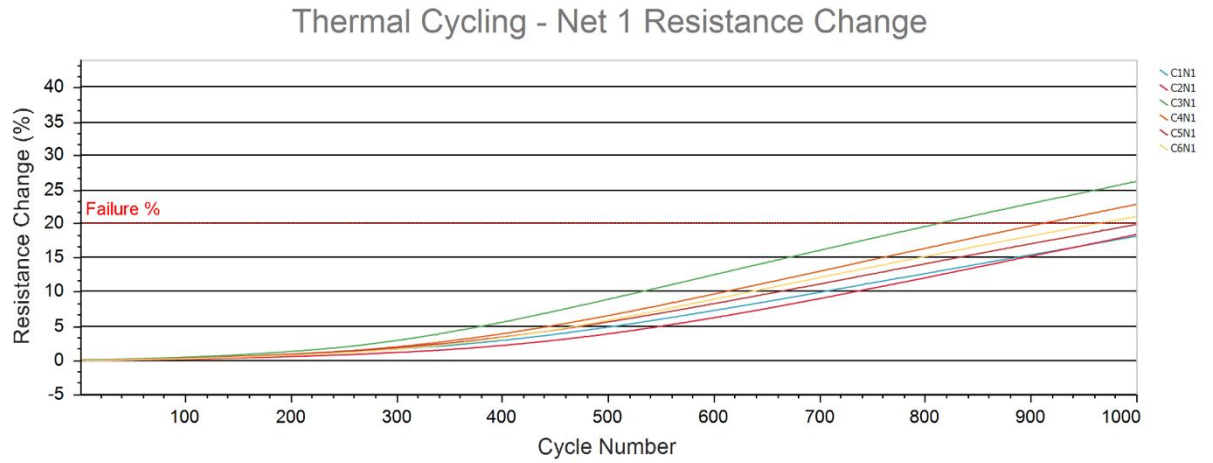




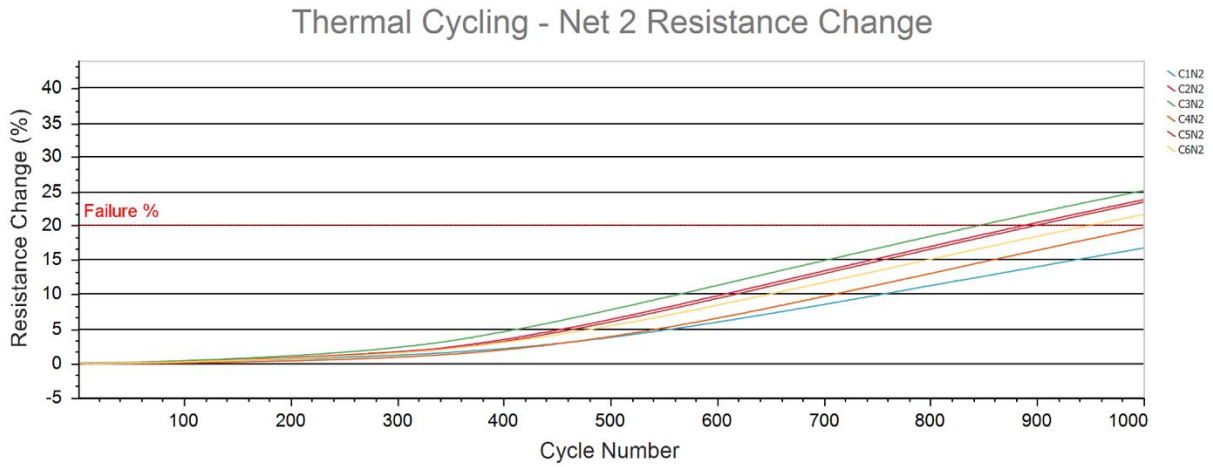
IPC V-TSL-MVIA HATS^{2TM} Single Via & IPC "D" Coupon Test Program

Group C2, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C):	-55 to 160	**Quality of Cycles:**	1000	**Failure Percentage (%):**	20
Quantity of Coupons:	6	**Number of Nets:**	2	**Coupon Thickness:**	2.8 mm
Net 1 Via Type:	Buried & SS Inside 0.5 grid	**Net 1 Quantity of Holes:**	240	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Buried & SS Inside 0.8 grid	**Net 2 Quantity of Holes:**	240	**Net 2 Hole Size:**	.125 mm



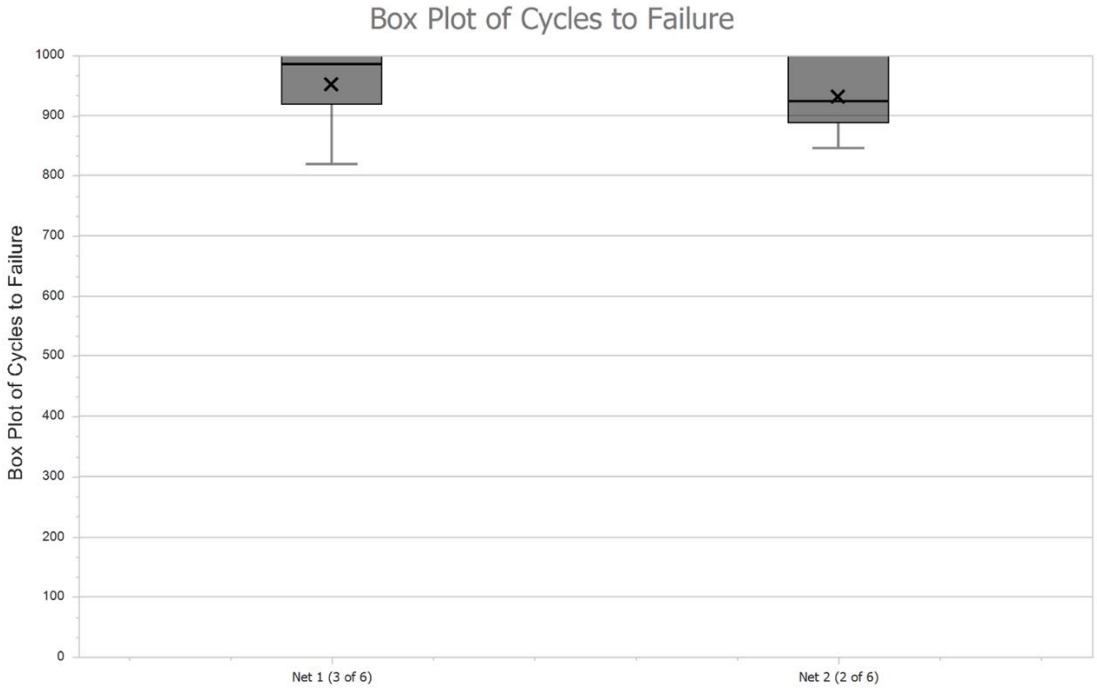
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	1.15055	1.18245	1.28054	1.17457	1.17617	1.13900
Maximum Resistance % Change	17.94	18.21	26.02	22.62	19.68	20.85
Cycle Failed 20% Limit	>1000	>1000	819	917	>1000	970



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	2.30759	2.35826	2.55362	2.34339	2.36316	2.25997
Maximum Resistance % Change	16.77	23.79	25.12	19.75	23.44	21.64
Cycle Failed 20% Limit	>1000	887	845	>1000	898	948

Group C2, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C):	-55 to 160	**Quality of Cycles:**	1000	**Failure Percentage (%):**	20
Quantity of Coupons:	6	**Number of Nets:**	2	**Coupon Thickness:**	2.8 mm
Net 1 Via Type:	Buried & SS Inside 0.5 grid	**Net 1 Quantity of Holes:**	240	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Buried & SS Inside 0.8 grid	**Net 2 Quantity of Holes:**	240	**Net 2 Hole Size:**	.125 mm



X-Axis: Net Designation (Quantity Passed of Total)

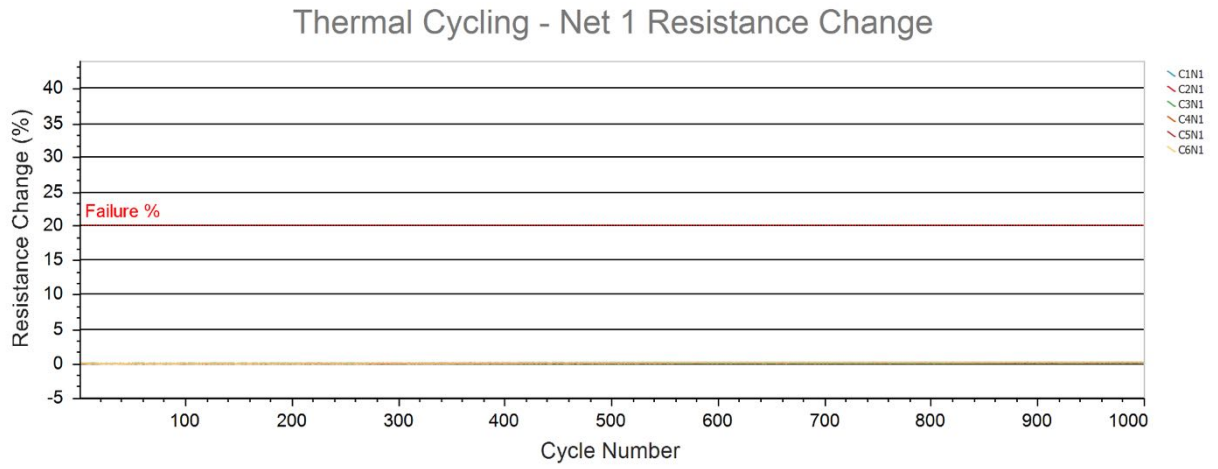
Group D1, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

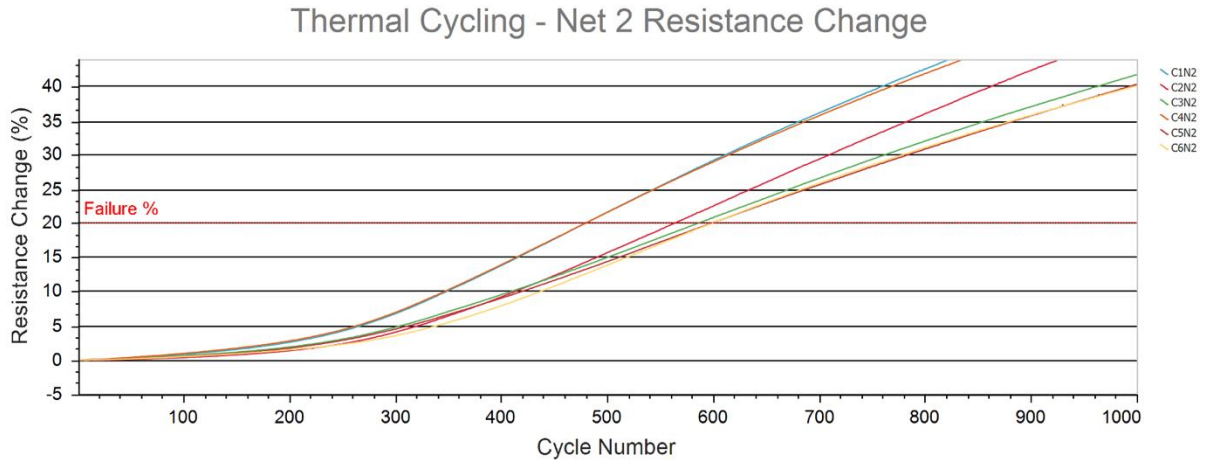
Quantity of Coupons: 6 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Single & Stacked Microvia (Parallel) **Net 1 Quantity of Holes:** 61 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: Buried Via **Net 2 Quantity of Holes:** 61 **Net 2 Hole Size:** .25 mm



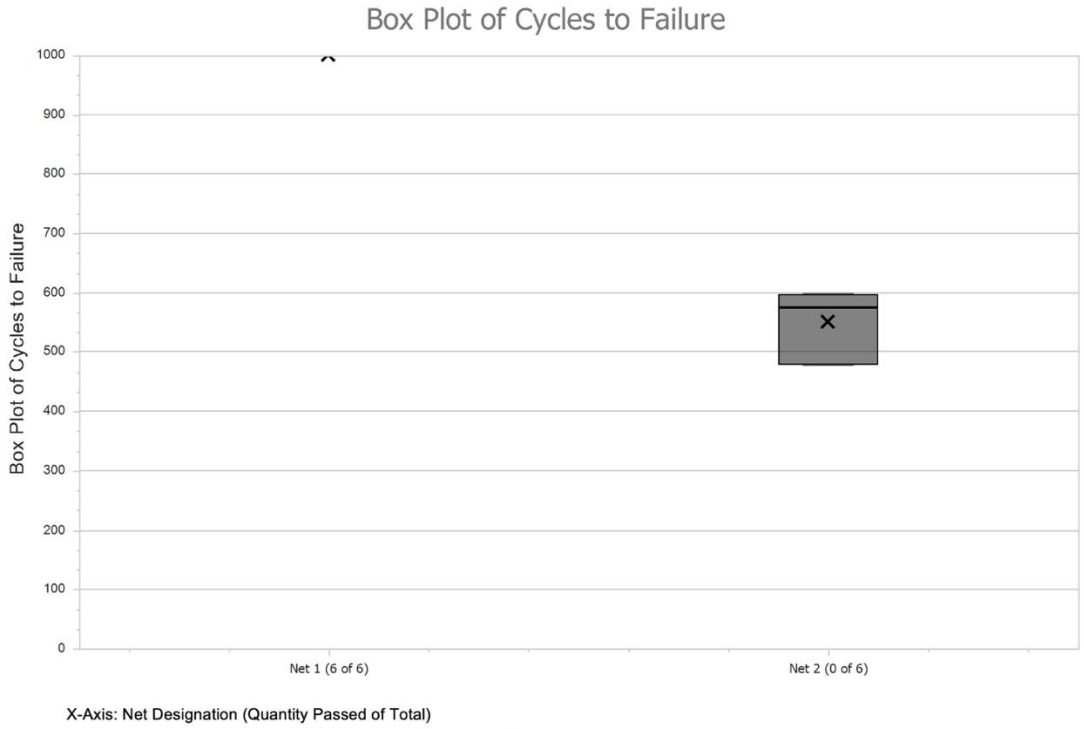
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.21280	0.20588	0.20566	0.18920	0.21126	0.20912
Maximum Resistance % Change	0.11	0.11	0.15	0.07	0.11	0.08
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000



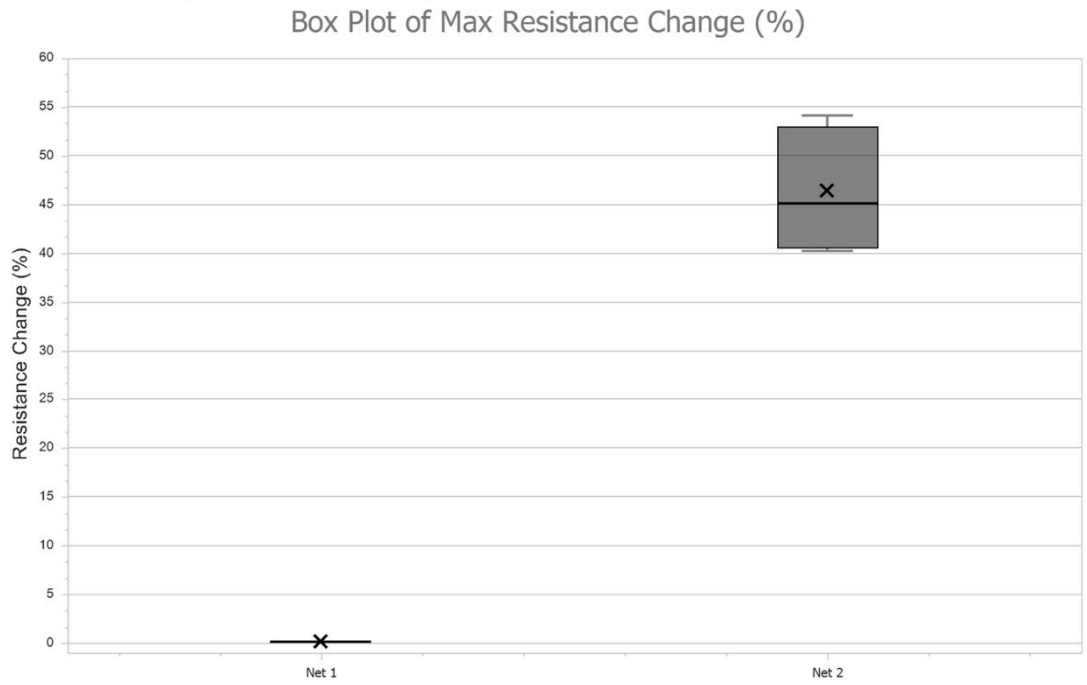
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.74950	0.74410	0.72627	0.67587	0.81358	0.67729
Maximum Resistance % Change	54.14	48.47	41.84	52.95	40.41	40.21
Cycle Failed 20% Limit	479	563	585	479	598	598

Group D1, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C):	-55 to 160	**Quality of Cycles:**	1000	**Failure Percentage (%):**	20
Quantity of Coupons:	6	**Number of Nets:**	2	**Coupon Thickness:**	2.8 mm
Net 1 Via Type:	Single & Stacked Microvia (Parallel)	**Net 1 Quantity of Holes:**	61	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Buried Via	**Net 2 Quantity of Holes:**	61	**Net 2 Hole Size:**	.25 mm

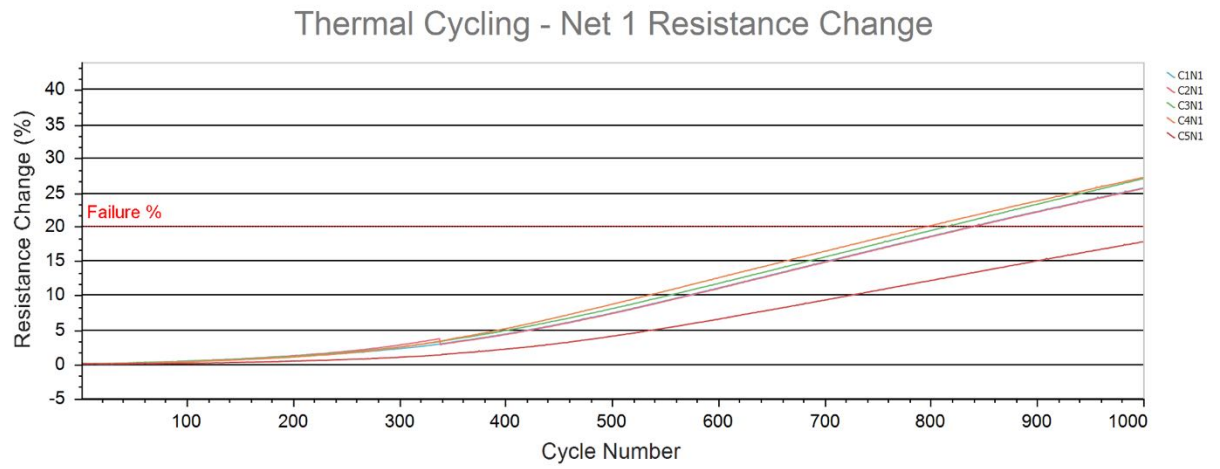


X-Axis: Net Designation (Quantity Passed of Total)

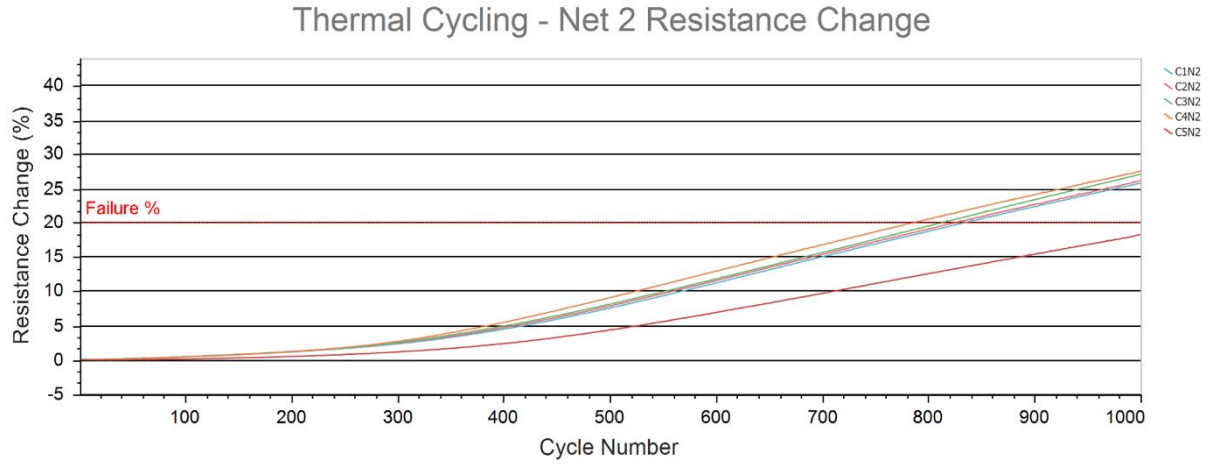


Group D2, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C):	-55 to 160	**Quality of Cycles:**	1000	**Failure Percentage (%):**	20
Quantity of Coupons:	5	**Number of Nets:**	2	**Coupon Thickness:**	2.8 mm
Net 1 Via Type:	Buried & SS Inside 0.5 grid	**Net 1 Quantity of Holes:**	240	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Buried & SS Inside 0.8 grid	**Net 2 Quantity of Holes:**	240	**Net 2 Hole Size:**	.125 mm



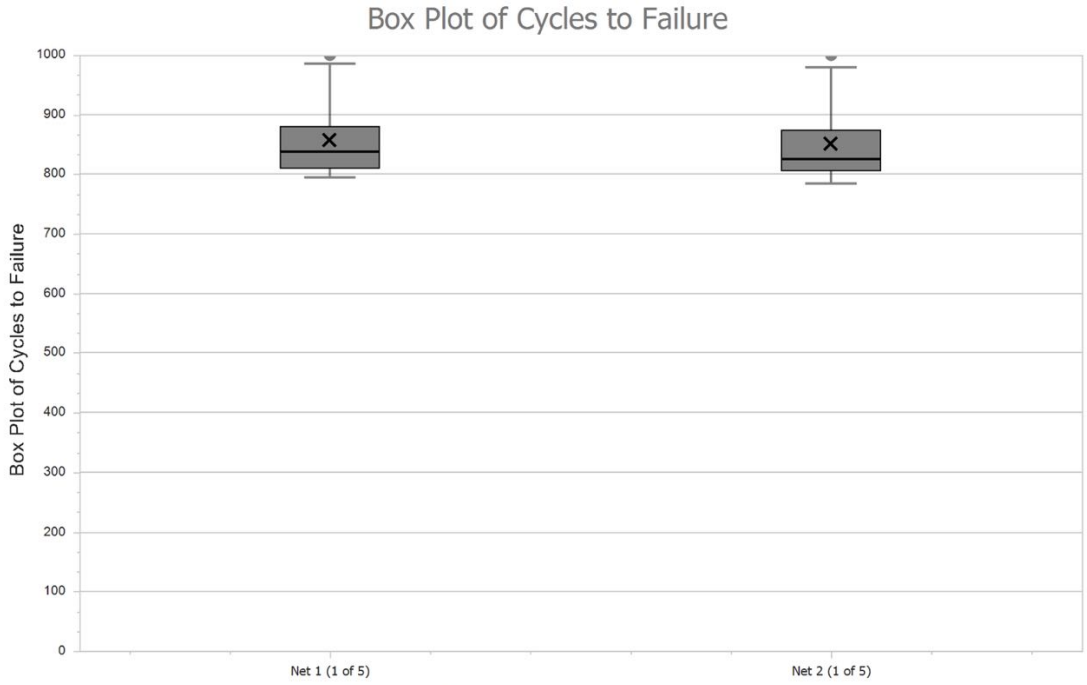
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	1.23159	1.20632	1.30677	1.12505	1.15405	-
Maximum Resistance % Change	25.72	25.64	27.09	27.23	17.85	-
Cycle Failed 20% Limit	837	840	814	795	>1000	-

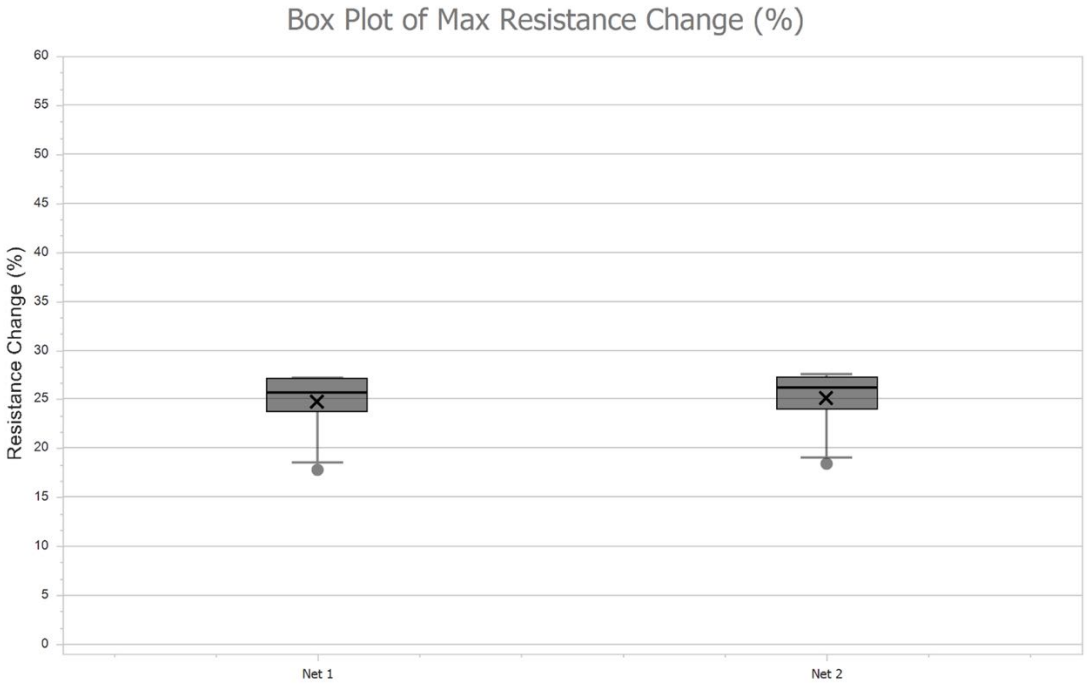


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	2.46408	2.34123	2.60184	2.27342	2.32678	-
Maximum Resistance % Change	25.83	26.23	27.17	27.58	18.36	-
Cycle Failed 20% Limit	833	825	812	785	>1000	-

Group D2, IPC "D" Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C):	-55 to 160	**Quality of Cycles:**	1000	**Failure Percentage (%):**	20
Quantity of Coupons:	5	**Number of Nets:**	2	**Coupon Thickness:**	2.8 mm
Net 1 Via Type:	Buried & SS Inside 0.5 grid	**Net 1 Quantity of Holes:**	240	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Buried & SS Inside 0.8 grid	**Net 2 Quantity of Holes:**	240	**Net 2 Hole Size:**	.125 mm

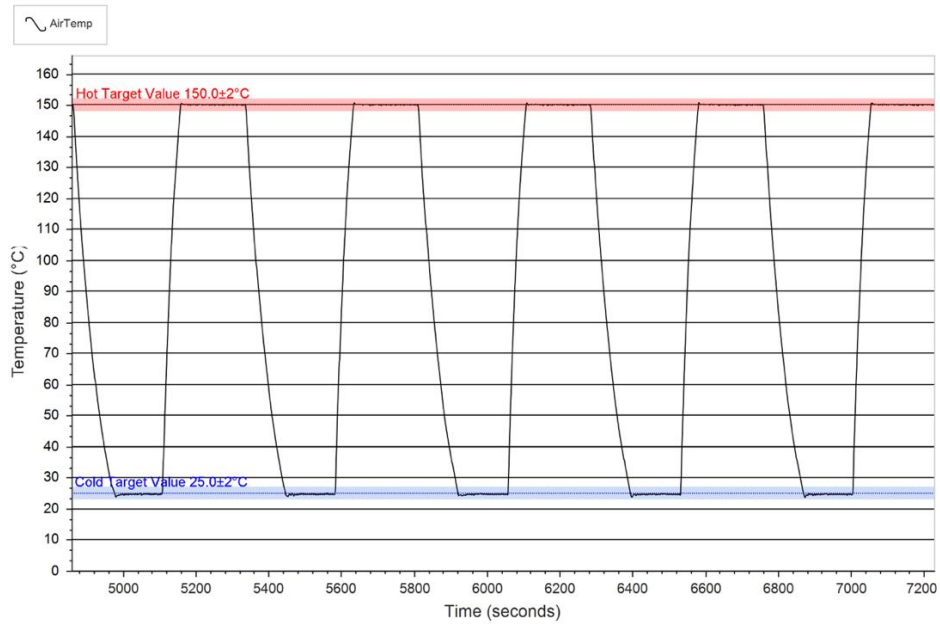




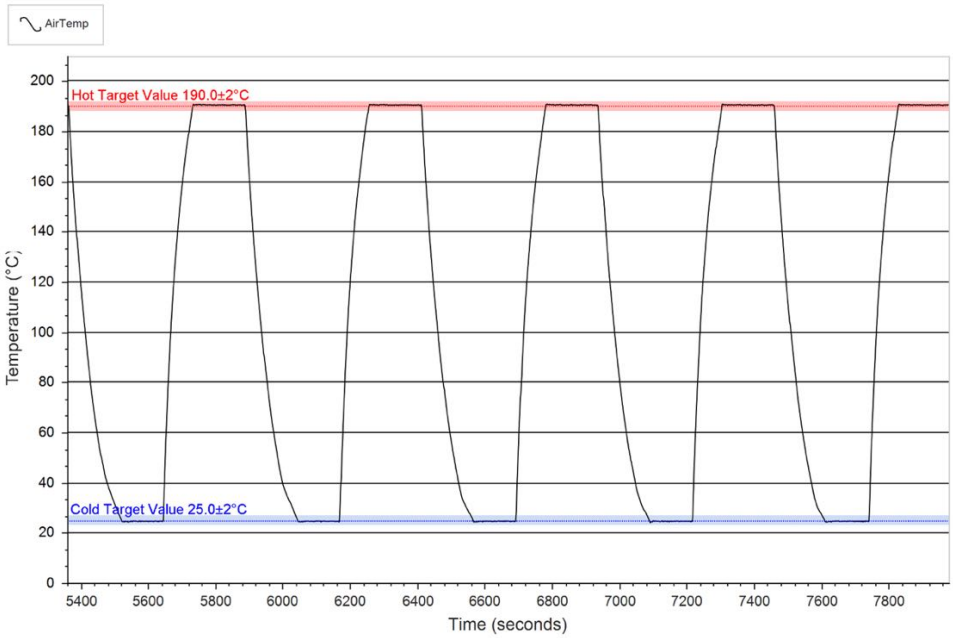
The below results are performed on IPC "D" coupon test samples B3, B4, B5 using 500x Cycles of a 25°C to 150°C Cycling "Preconditioning", subsequently followed by 1000x Cycles of 25°C to 190°C Cycling.

This temperature range is intended to approximate the temperature ranges typically used by Current Induced Test Methods. Below is a 5 Cycles sample of the air temperatures from the HATS^{2TM} chamber run for both the 500x Cycle Preconditioning and 1000x Thermal Cycling used to test these samples.

500x Cycles of a 25°C to 150°C



1000x Cycles of 25°C to 190°C



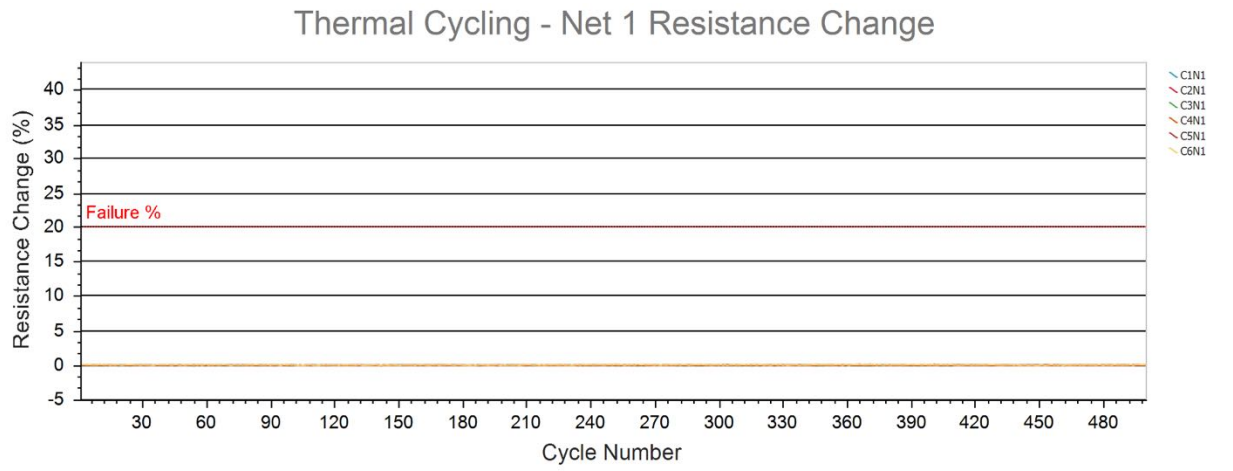
- Box Plots of failures are not included where final results are less than 1% variance from 1st Cycle as they provide no additional information.

Group B3, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

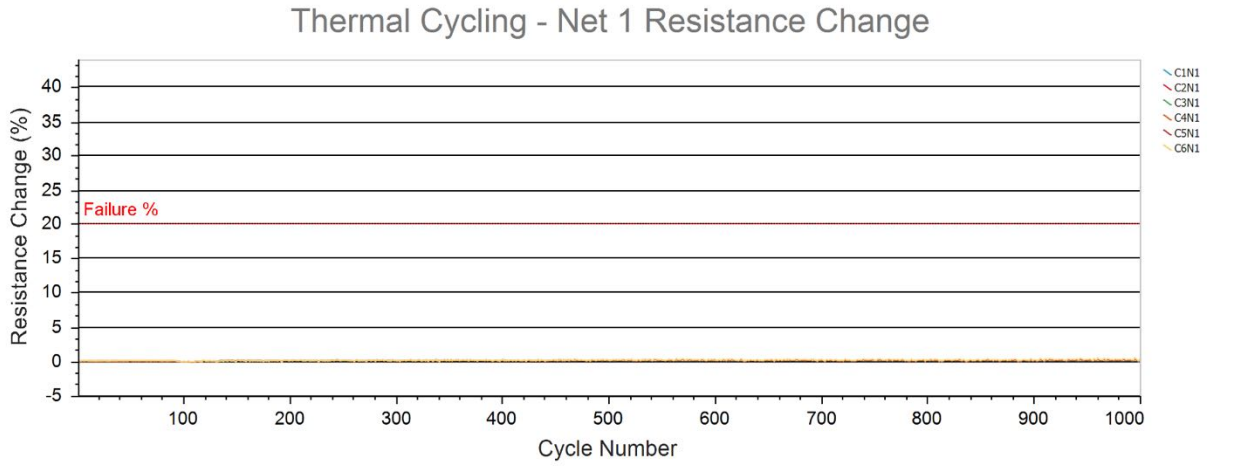
Cycle Range (°C): 25 to 150 / 25 - 190
Quantity of Coupons: 6
Net 1 Via Type: SS Outside (Parallel)
Net 2 Via Type: SS Inside (Parallel)

Quality of Cycles: 500/1000
Number of Nets: 2
Net 1 Quantity of Holes: 288
Net 2 Quantity of Holes: 288

Failure Percentage (%): 20
Coupon Thickness: 2.8 mm
Net 1 Hole Size: .125 mm
Net 2 Hole Size: .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.18711	0.18324	0.18716	0.18177	0.19980	0.18124
Maximum Resistance % Change	0.05	0.00	0.06	0.00	0.07	0.08
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



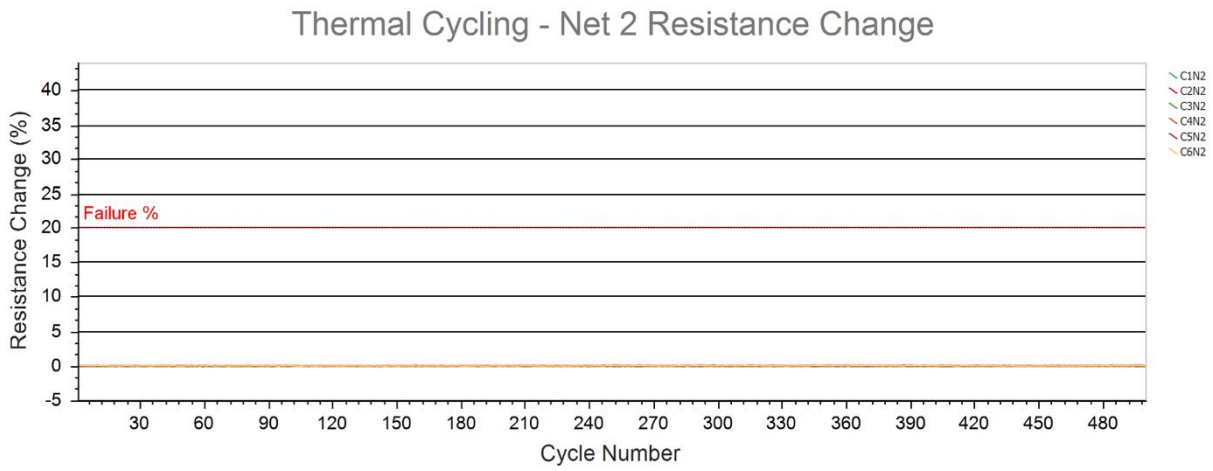
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.20657	0.20240	0.20658	0.20071	0.22041	0.20006
Maximum Resistance % Change	0.33	0.41	0.42	0.37	0.37	0.49
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group B3, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

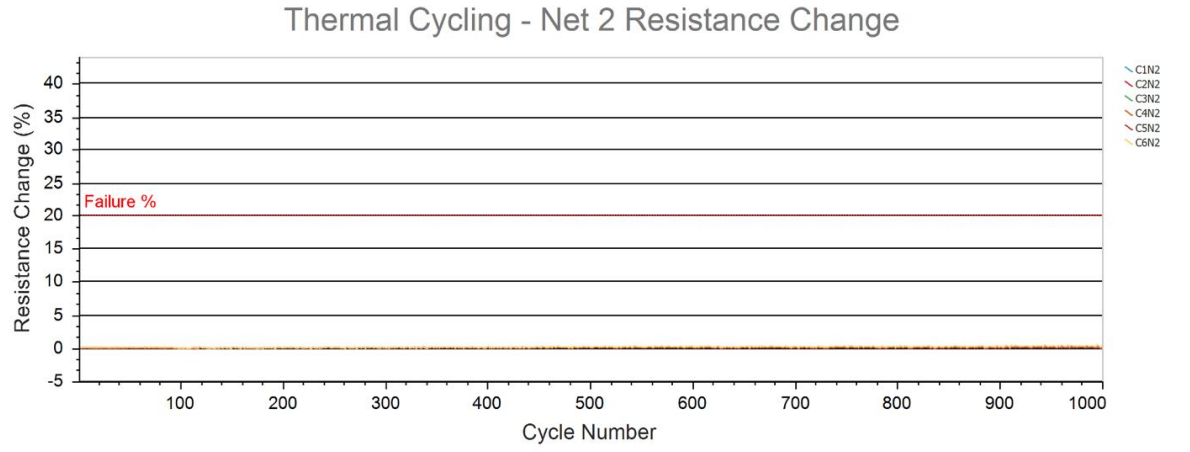
Cycle Range (°C): 25 to 150 / 25 - 190
Quantity of Coupons: 6
Net 1 Via Type: SS Outside (Parallel)
Net 2 Via Type: SS Inside (Parallel)

Quality of Cycles: 500/1000
Number of Nets: 2
Net 1 Quantity of Holes: 288
Net 2 Quantity of Holes: 288

Failure Percentage (%): 20
Coupon Thickness: 2.8 mm
Net 1 Hole Size: .125 mm
Net 2 Hole Size: .125 mm



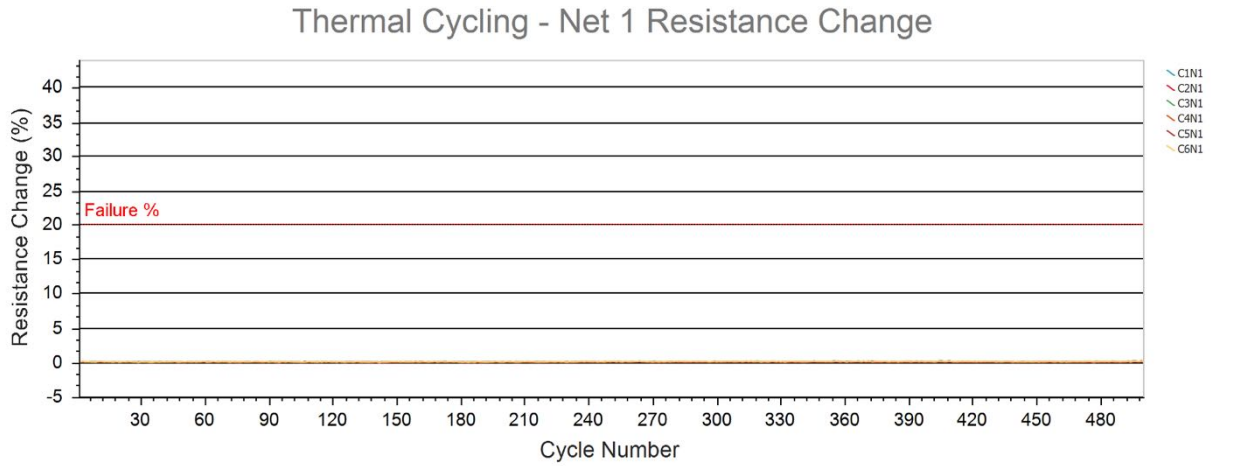
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.20199	0.19543	0.19385	0.18280	0.20378	0.19582
Maximum Resistance % Change	0.03	0.00	0.02	0.00	0.09	0.04
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



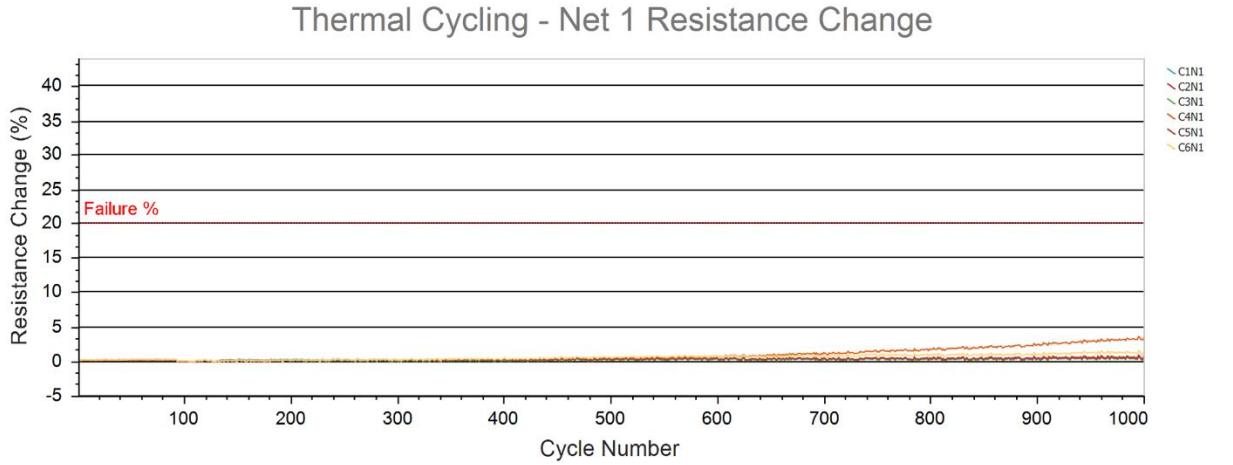
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.22301	0.21586	0.21395	0.20186	0.22484	0.21615
Maximum Resistance % Change	0.34	0.31	0.41	0.43	0.45	0.50
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group B4, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 to 150 / 25 to 190
Quality of Cycles: 500/1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Full Stacked (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: Full Staggered (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



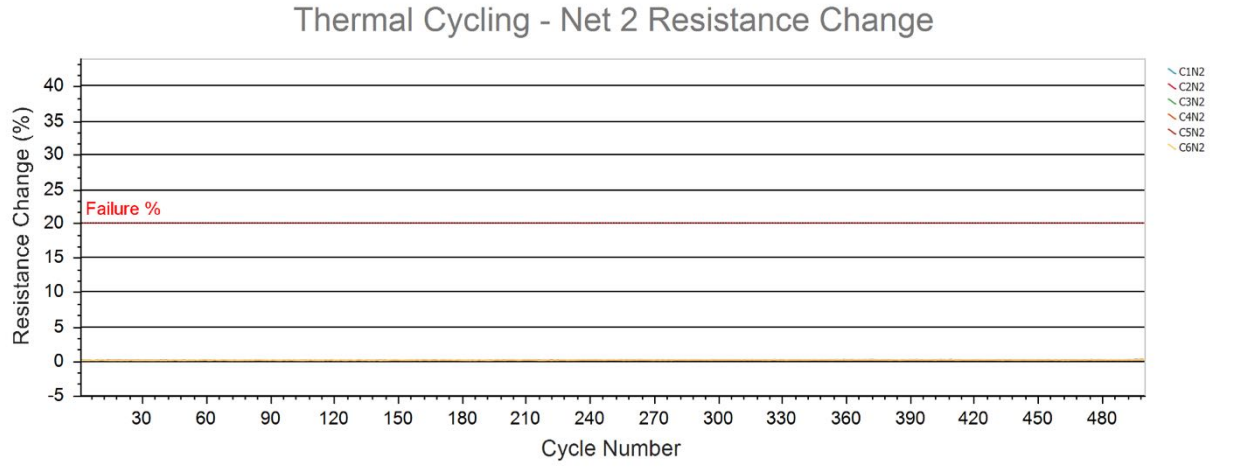
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.14532	0.13878	0.14535	0.13911	0.14031	0.14340
Maximum Resistance % Change	0.19	0.09	0.21	0.15	0.19	0.17
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



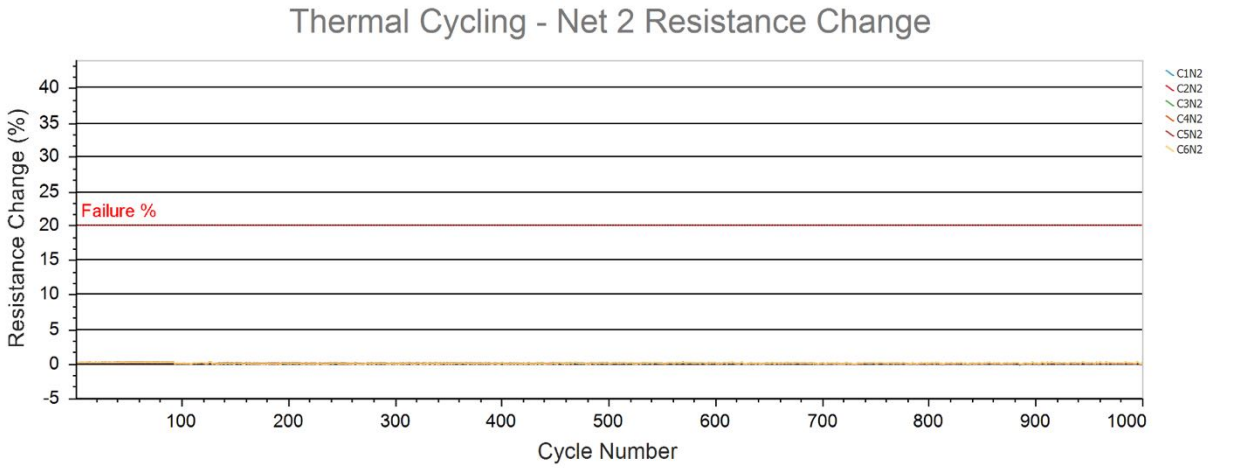
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.16012	0.15301	0.16015	0.15333	0.15450	0.15806
Maximum Resistance % Change	0.71	0.83	0.60	3.55	0.73	1.49
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group B4, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 to 150 / 25 to 190
Quality of Cycles: 500/1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 2
Coupon Thickness: 2.8 mm
Net 1 Via Type: Full Stacked (Parallel)
Net 1 Quantity of Holes: 288
Net 1 Hole Size: .125 mm
Net 2 Via Type: Full Staggered (Parallel)
Net 2 Quantity of Holes: 288
Net 2 Hole Size: .125 mm



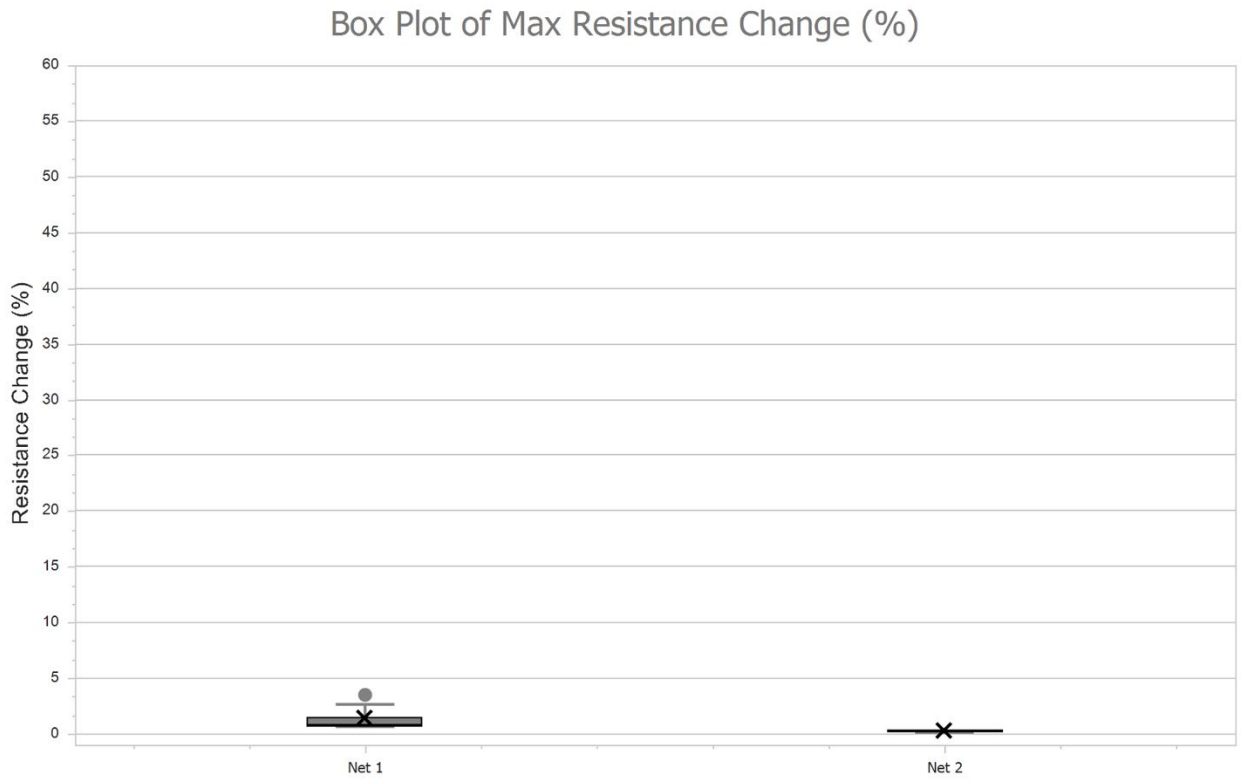
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.23270	0.22976	0.23065	0.22306	0.22628	0.23045
Maximum Resistance % Change	0.18	0.12	0.17	0.17	0.17	0.15
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.25653	0.25341	0.25410	0.24600	0.24935	0.25403
Maximum Resistance % Change	0.18	0.21	0.23	0.21	0.22	0.24
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group B4, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 to 150 / 25 to 190
Quantity of Coupons: 6
Net 1 Via Type: Full Stacked (Parallel)
Net 2 Via Type: Full Staggered (Parallel)
Quality of Cycles: 500/1000
Number of Nets: 2
Net 1 Quantity of Holes: 288
Net 2 Quantity of Holes: 288
Failure Percentage (%): 20
Coupon Thickness: 2.8 mm
Net 1 Hole Size: .125 mm
Net 2 Hole Size: .125 mm



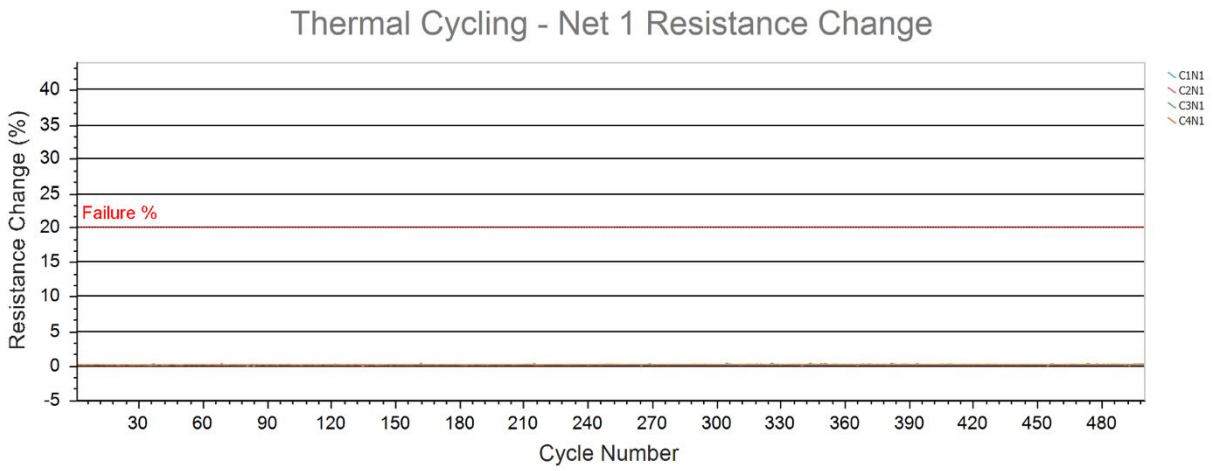
Group B5, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

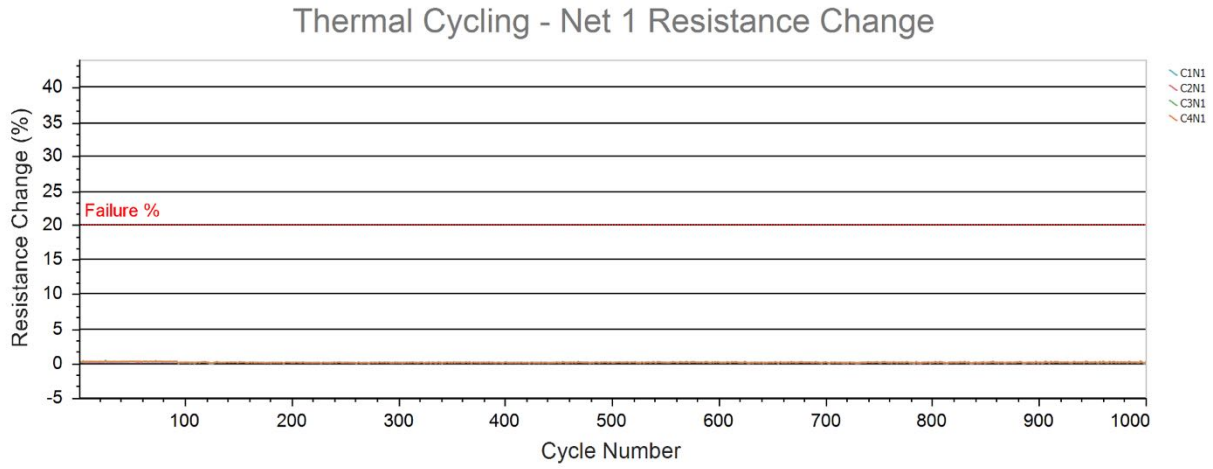
Quantity of Coupons: 4 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Staggered Above BV (Parallel) **Net 1 Quantity of Holes:** 288 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: SSI Above BV (Parallel) **Net 2 Quantity of Holes:** 288 **Net 2 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.29015	0.28662	0.28935	0.29086	-	-
Maximum Resistance % Change	0.33	0.27	0.31	0.28	-	-
Cycle Failed 20% Limit	>500	>500	>500	>500	-	-



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.31983	0.31599	0.31880	0.32045	-	-
Maximum Resistance % Change	0.29	0.20	0.40	0.30	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	-	-

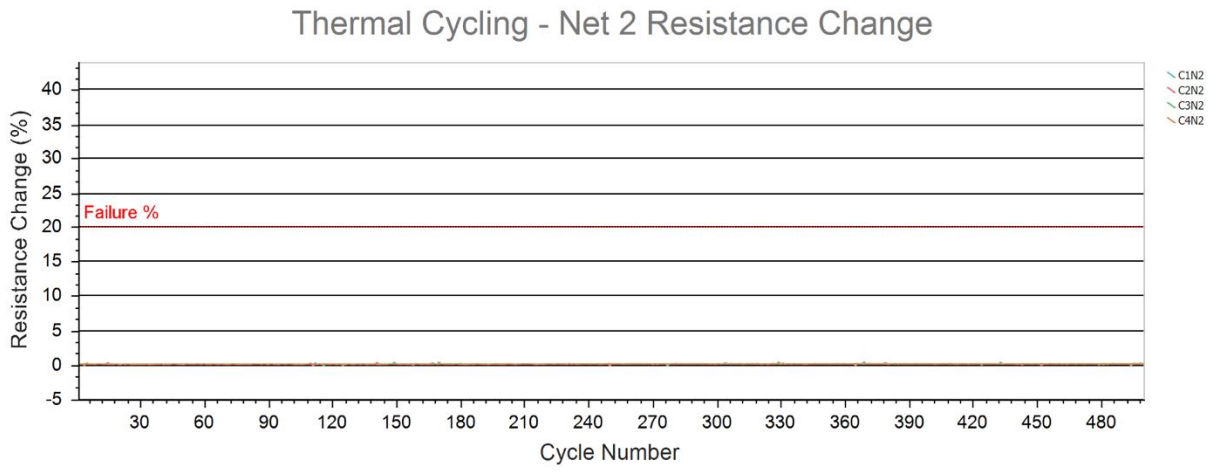
Group B5, IPC "D" Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles) Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

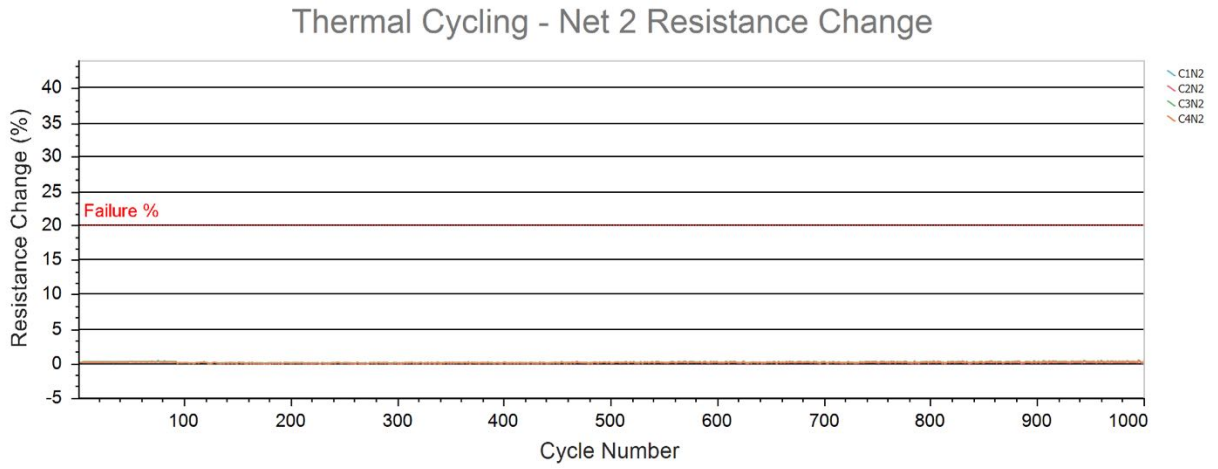
Quantity of Coupons: 4 **Number of Nets:** 2 **Coupon Thickness:** 2.8 mm

Net 1 Via Type: Staggered Above BV (Parallel) **Net 1 Quantity of Holes:** 288 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: SSI Above BV (Parallel) **Net 2 Quantity of Holes:** 288 **Net 2 Hole Size:** .125 mm

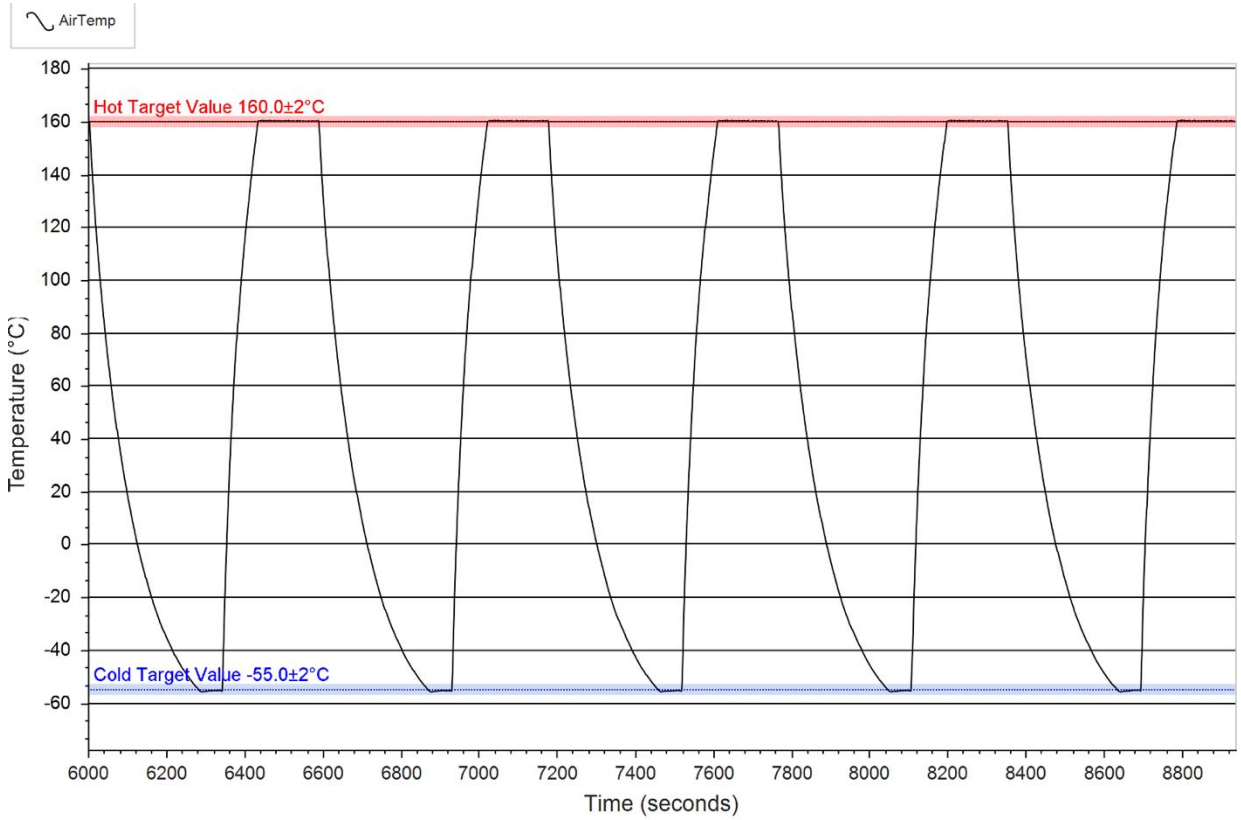


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.22629	0.21841	0.22235	0.22871	-	-
Maximum Resistance % Change	0.38	0.29	0.37	0.23	-	-
Cycle Failed 20% Limit	>500	>500	>500	>500	-	-

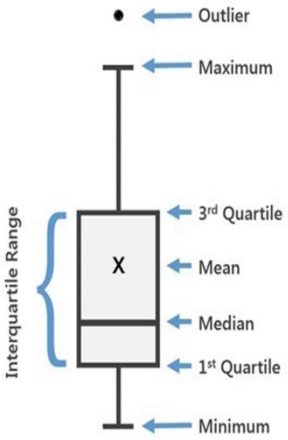


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.24929	0.24075	0.24493	0.25220	-	-
Maximum Resistance % Change	0.41	0.32	0.46	0.40	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	-	-

The below results are from the -55°C to 160°C reliability cycling performed on HATS²™ single via coupon test samples 1A, 1B, 1C, 2A, 2B & 2C. Below is a 5 cycles sample of the air temperatures from the HATS²™ chamber test used to perform reliability testing for these samples.



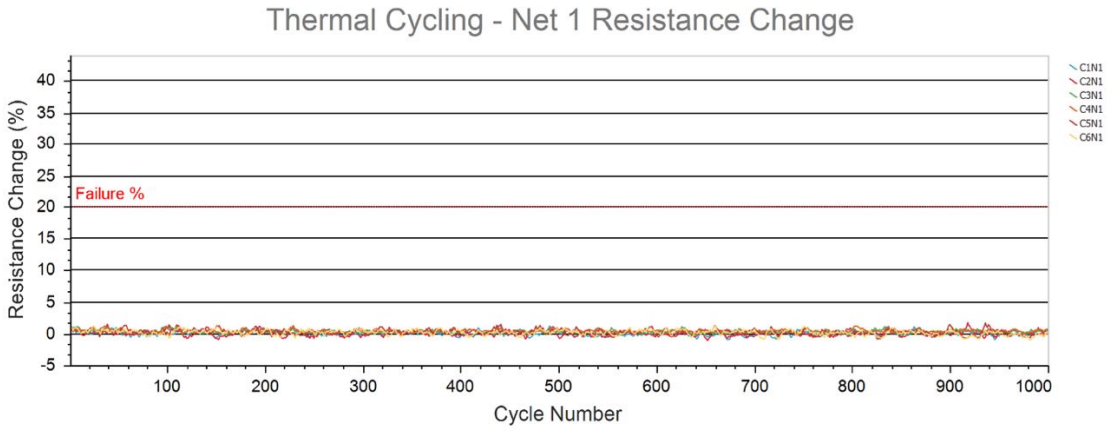
Box Plots are used to graphically display the distribution of a data set. The Box (Interquartile Range or IQR) extends from the first quartile (25th percentile of the data set) to the third quartile (75th percentile of the data set) and represents 50% of the population of the data set. The Median value of the data set is a represented by a line and the Mean value by an "X" within the box. A line and whisker extend from the bottom of the box (1st Quartile) to the Minimum value, representing the lower 25% of the population of the data set. A line and whisker extend from the top of the box (3rd Quartile) to the Maximum value, representing the upper 25% of the population of the data set. Statistical Outliers in the data set are represented by a "□" above or below the whiskers and are defined as any data value that is more than 1.5 times the IQR Distance away from the IQR.



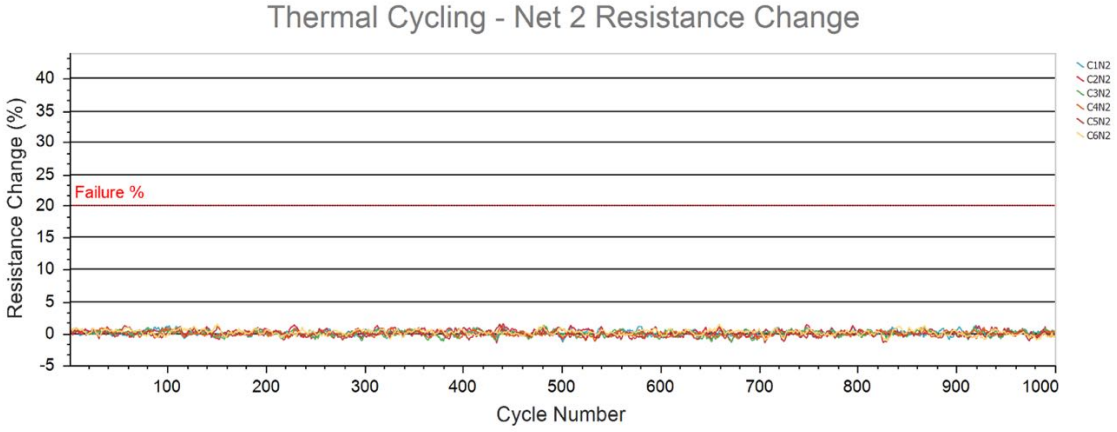
- Box Plots are not included where final results are less than 1% variance from 1st Cycle.

Group 1A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm
Net 1 Via Type: SS Inside MV Bottom
Net 1 Quantity of Holes: 1
Net 1 Hole Size: .125 mm
Net 2 Via Type: SS Outside MV Bottom
Net 2 Quantity of Holes: 1
Net 2 Hole Size: .125 mm
Net 3 Via Type: Buried
Net 3 Quantity of Holes: 1
Net 3 Hole Size: .25 mm
Net 4 Via Type: SS Inside MV Top
Net 4 Quantity of Holes: 1
Net 4 Hole Size: .125 mm
Net 5 Via Type: SS Inside MV+BV+MV
Net 5 Quantity of Holes: 1
Net 5 Hole Size: .125 mm
Net 6 Via Type: SS Outside MV+BV+MV
Net 6 Quantity of Holes: 1
Net 6 Hole Size: .125 mm
Net 7 Via Type: SS Outside MV Top
Net 7 Quantity of Holes: 1
Net 7 Hole Size: .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00156	0.00152	0.00172	0.00146	0.00133	0.00153
Maximum Resistance % Change	1.17	1.69	1.15	1.20	1.66	1.17
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

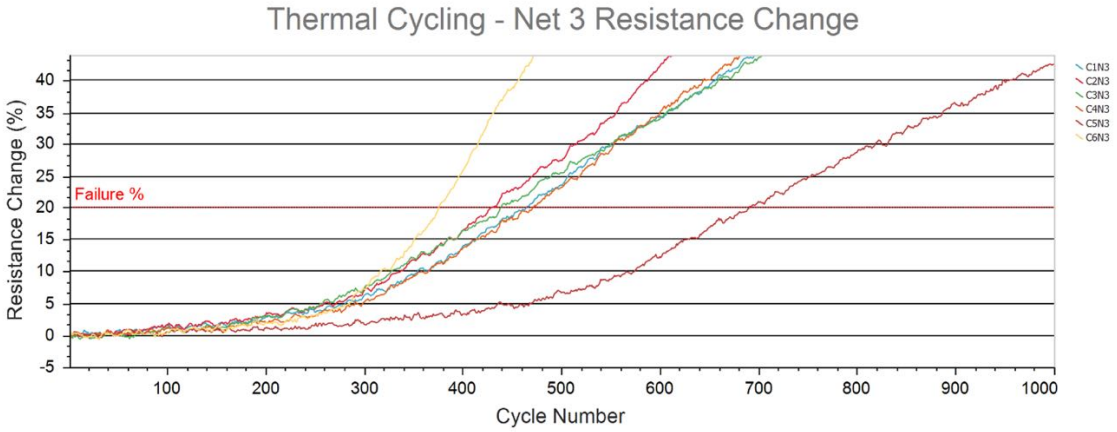


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00181	0.00163	0.00159	0.00170	0.00165	0.00185
Maximum Resistance % Change	1.23	1.45	1.22	1.25	1.40	1.40
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

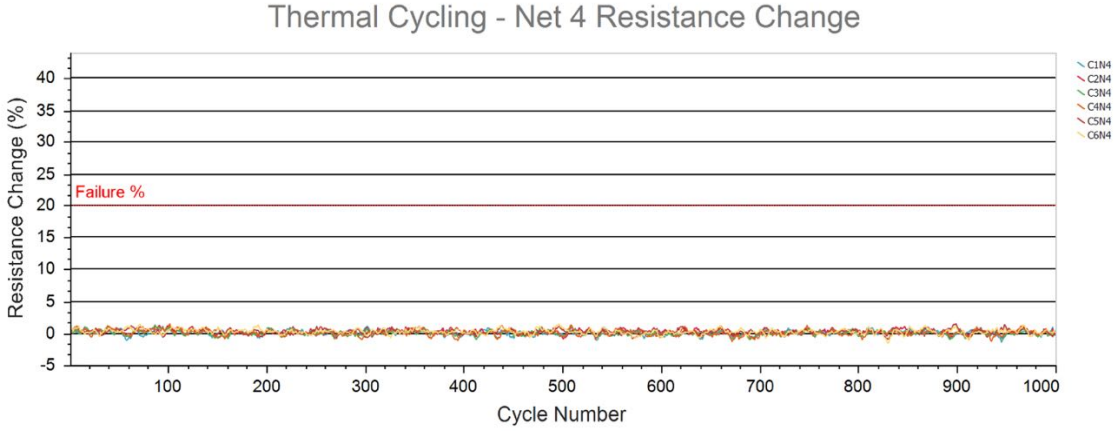
Group 1A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00292	0.00317	0.00322	0.00303	0.00275	0.00273
Maximum Resistance % Change	69.91	89.76	70.60	69.25	42.63	170.84
Cycle Failed 20% Limit	465	429	439	475	691	376

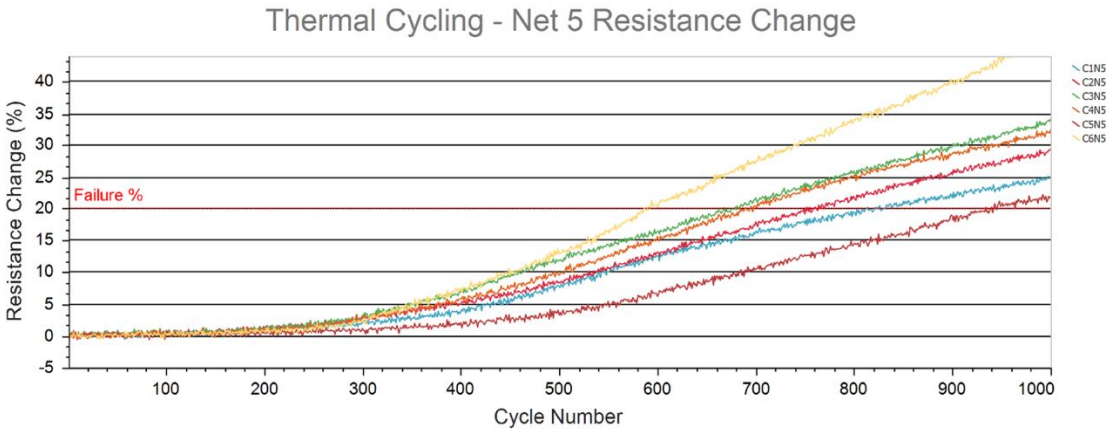


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00202	0.00201	0.00217	0.00204	0.00213	0.00209
Maximum Resistance % Change	1.06	1.06	1.06	1.06	1.06	1.06
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

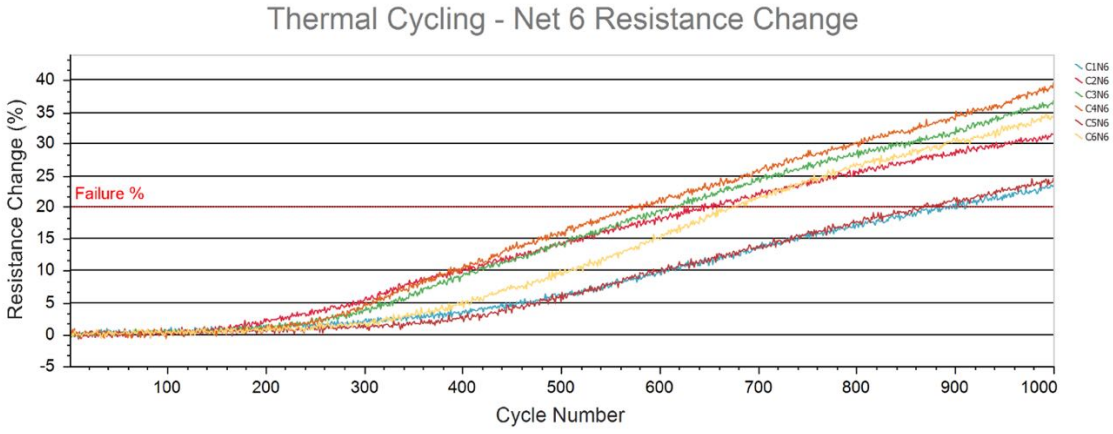
Group 1A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00713	0.00777	0.00783	0.00734	0.00713	0.00700
Maximum Resistance % Change	25.08	29.38	34.28	32.53	22.23	47.16
Cycle Failed 20% Limit	812	751	668	685	934	587

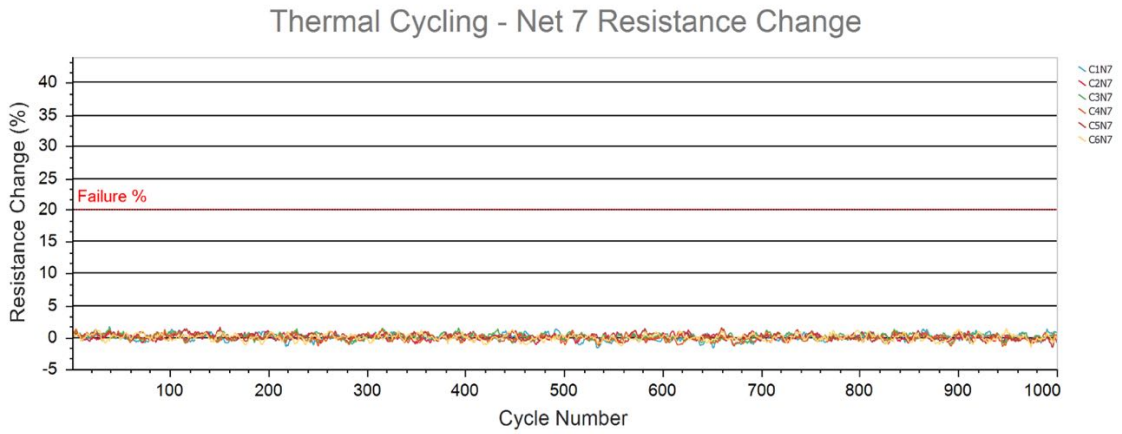


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00716	0.00747	0.00727	0.00708	0.00692	0.00672
Maximum Resistance % Change	23.50	31.59	36.87	39.69	24.63	34.73
Cycle Failed 20% Limit	893	643	611	570	869	675

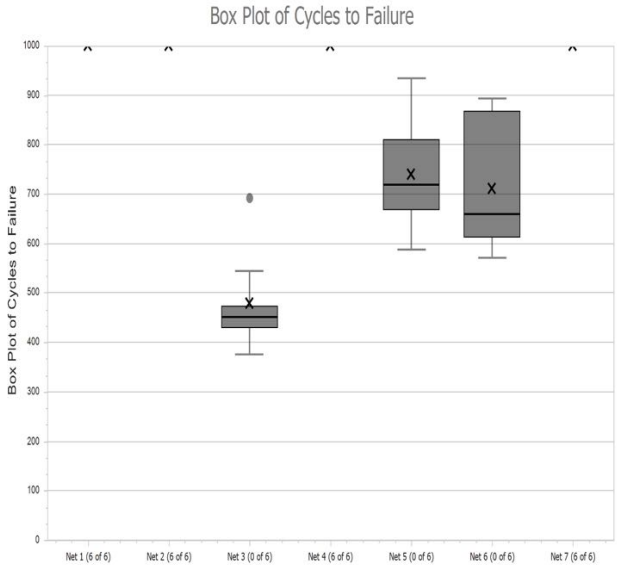
Group 1A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

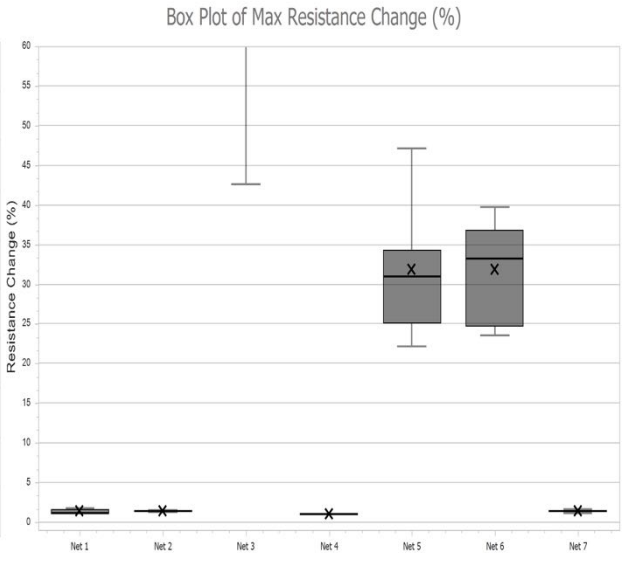
Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00157	0.00154	0.00154	0.00161	0.00166	0.00154
Maximum Resistance % Change	1.62	1.11	1.40	1.25	1.52	1.32
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

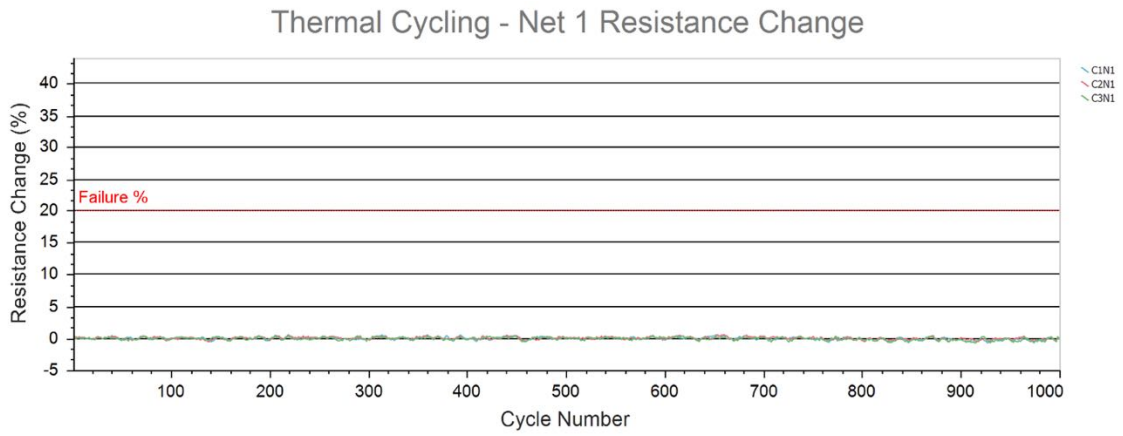




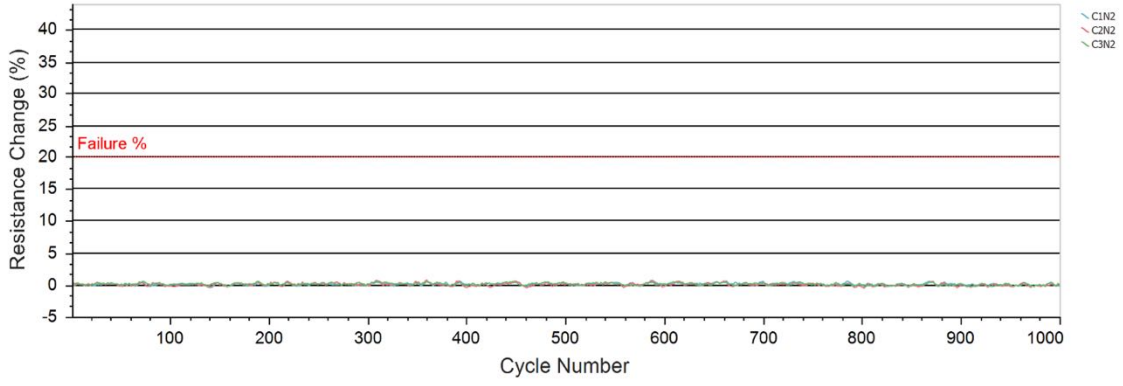
Group 2A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00161	0.00179	0.00143	-	-	-
Maximum Resistance % Change	0.51	0.54	0.38	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

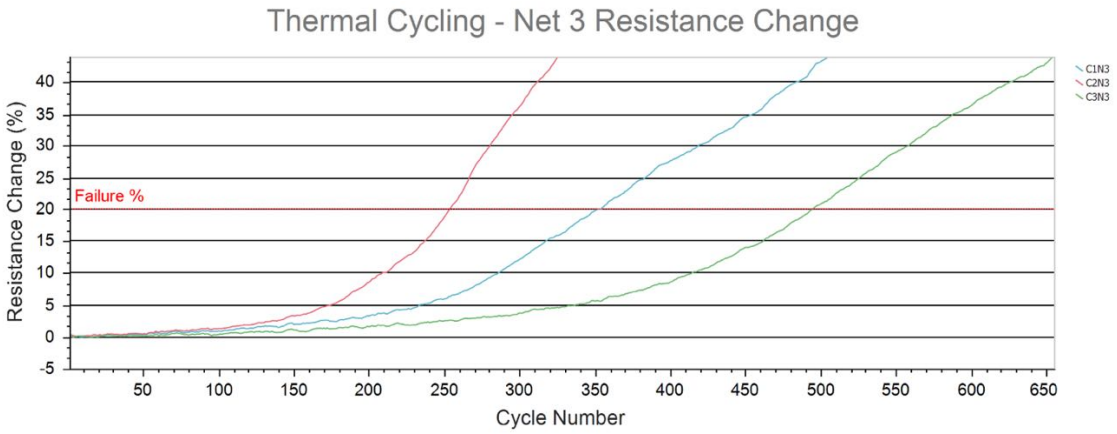


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00186	0.00164	0.00174	-	-	-
Maximum Resistance % Change	0.65	0.69	0.54	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

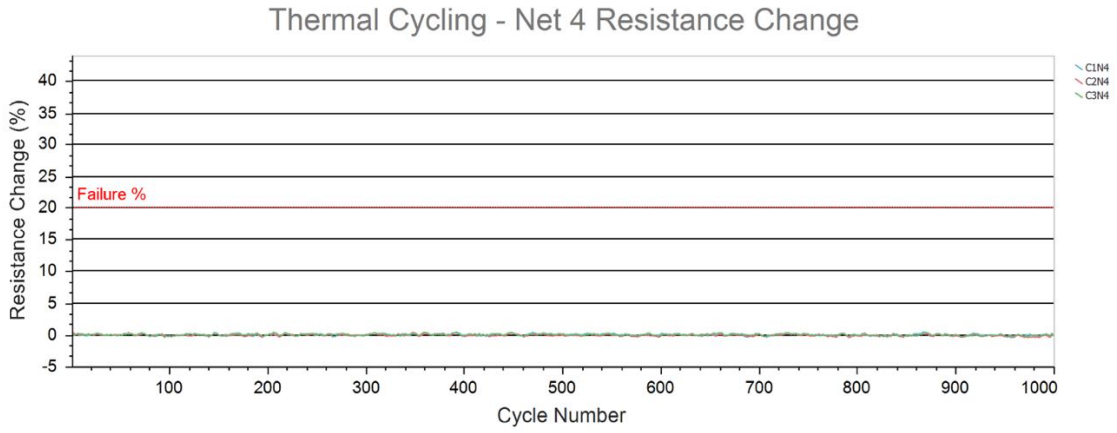
Group 2A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00292	0.00323	0.00281	-	-	-
Maximum Resistance % Change	104.91	215.63	85.84	-	-	-
Cycle Failed 20% Limit	352	254	495	-	-	-

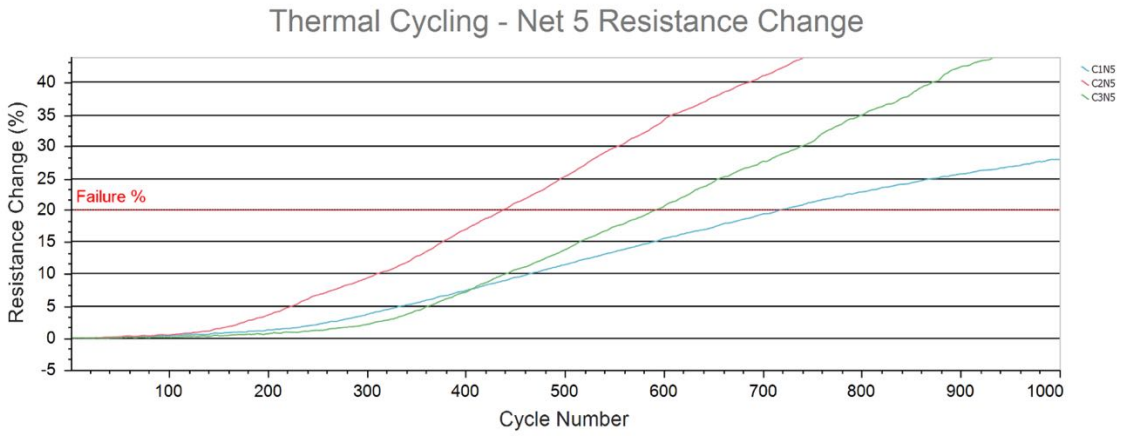


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00210	0.00242	0.00237	-	-	-
Maximum Resistance % Change	0.42	0.33	0.36	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

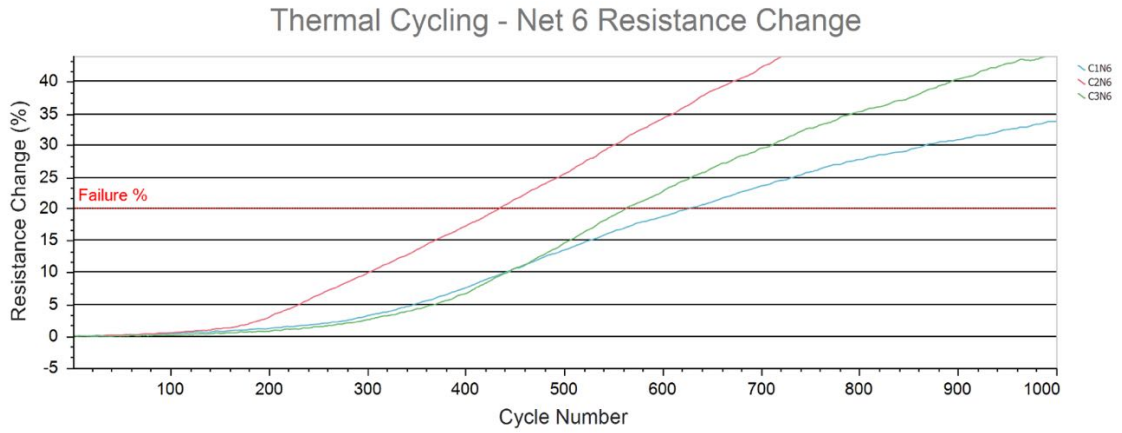
Group 2A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00739	0.00803	0.00721	-	-	-
Maximum Resistance % Change	27.99	58.14	47.64	-	-	-
Cycle Failed 20% Limit	717	438	591	-	-	-

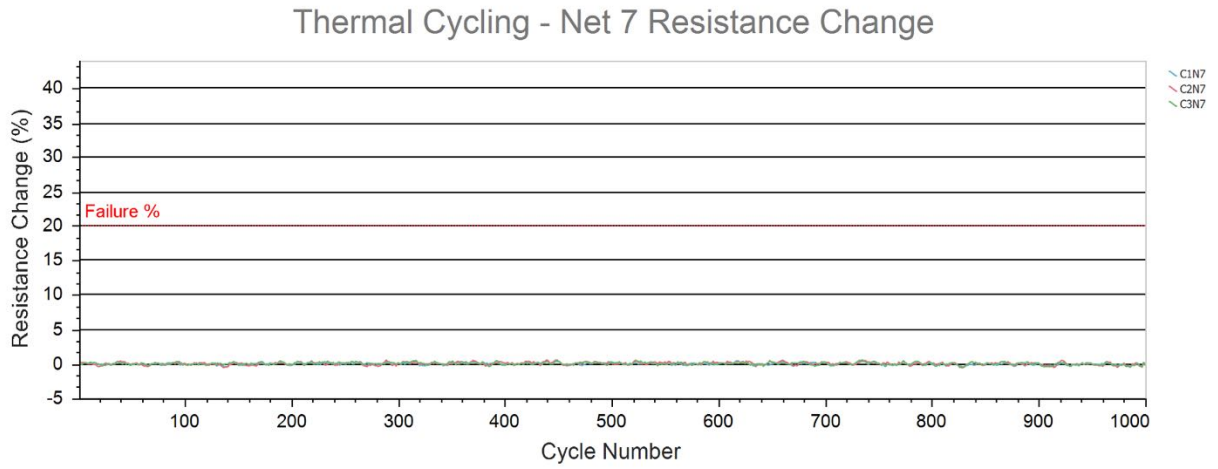


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00718	0.00709	0.00709	-	-	-
Maximum Resistance % Change	33.87	60.83	44.27	-	-	-
Cycle Failed 20% Limit	626	434	567	-	-	-

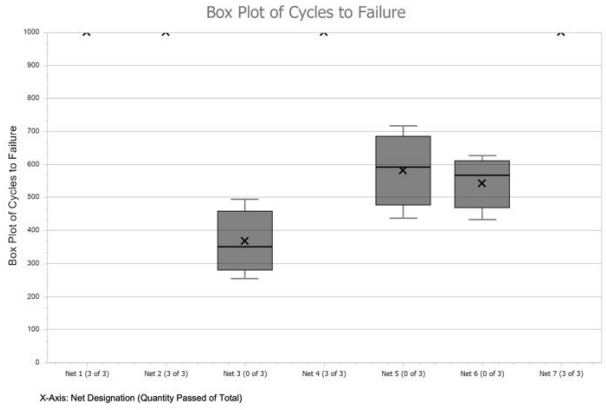
Group 2A, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

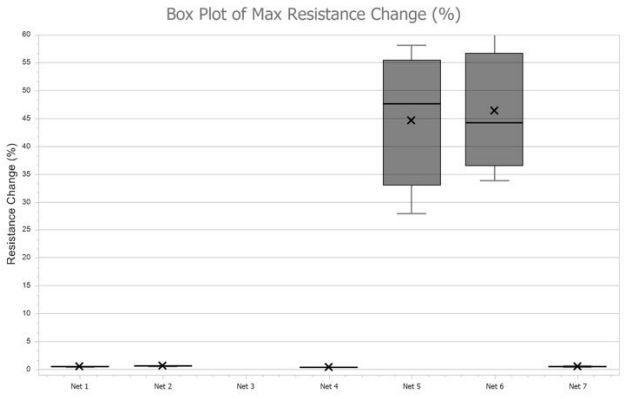
Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00167	0.00153	0.00166	-	-	-
Maximum Resistance % Change	0.42	0.56	0.57	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-



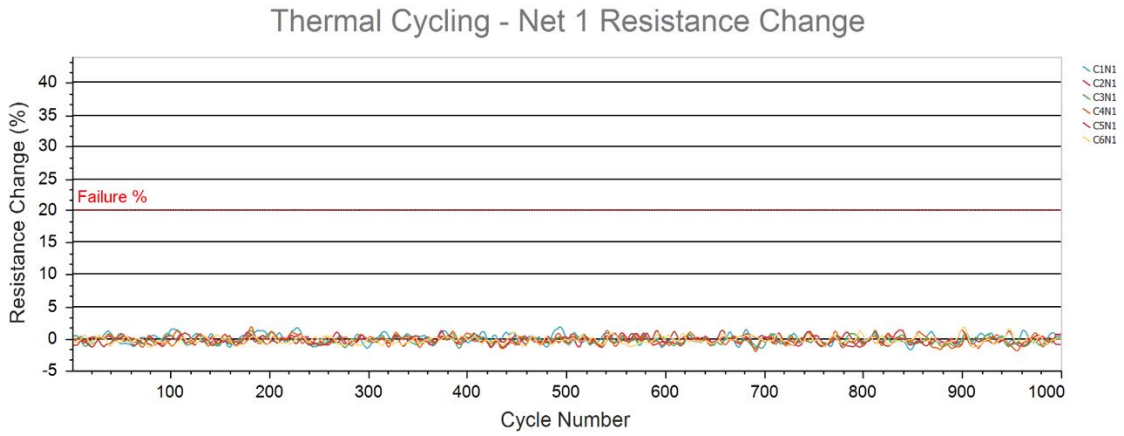


Group 1B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

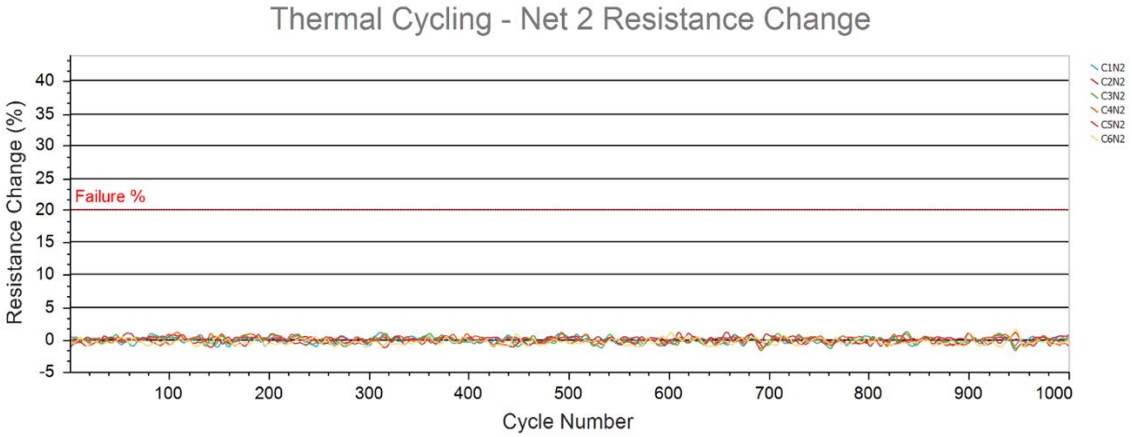
Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00080	0.00094	0.00088	0.00075	0.00080	0.00081
Maximum Resistance % Change	1.73	1.29	1.22	1.80	1.25	1.76
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000



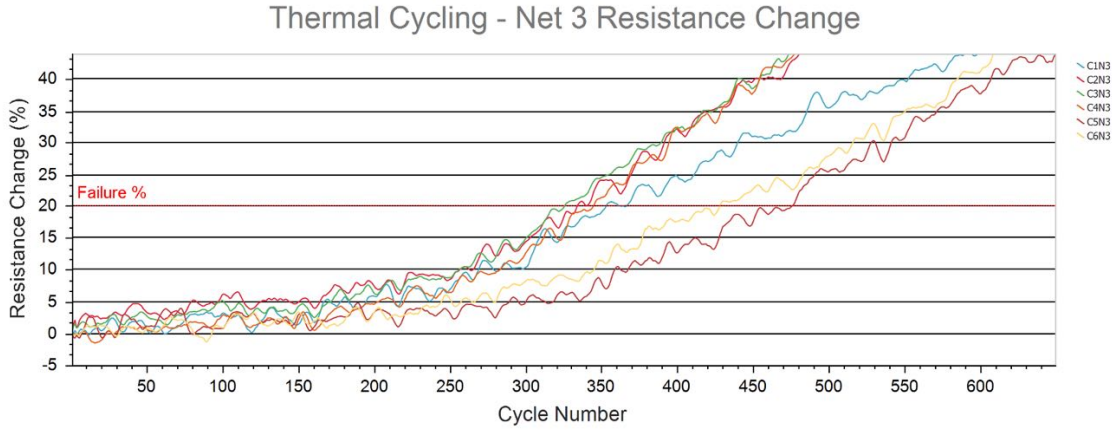
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00231	0.00203	0.00237	0.00217	0.00217	0.00224
Maximum Resistance % Change	1.43	0.73	1.27	1.45	1.37	1.68
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 1B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

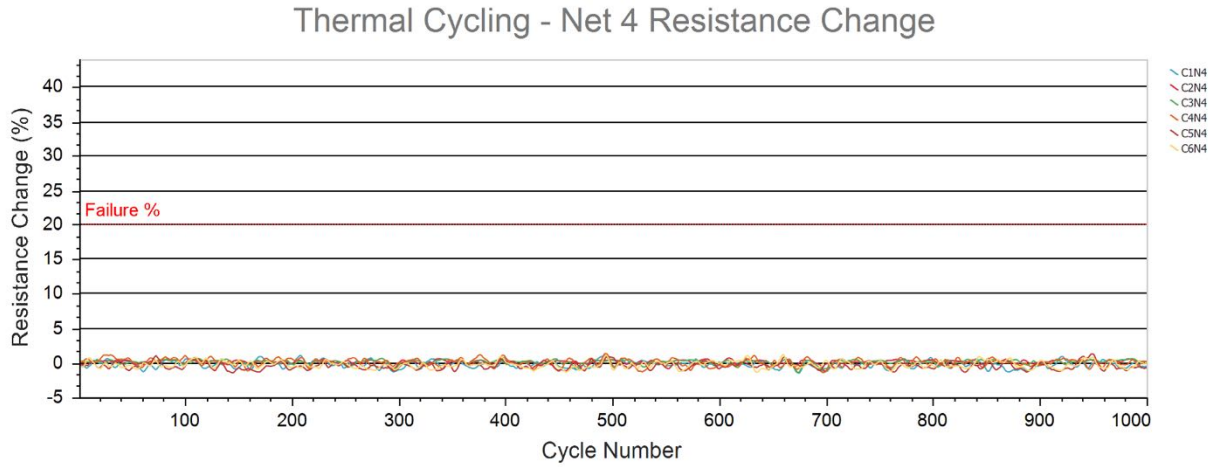
Cycle Range (°C): -55 to 160 | **Quality of Cycles:** 1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00294	0.00311	0.00317	0.00307	0.00273	0.00273
Maximum Resistance % Change	75.81	105.32	101.07	108.44	80.17	91.76
Cycle Failed 20% Limit	354	334	326	345	476	428

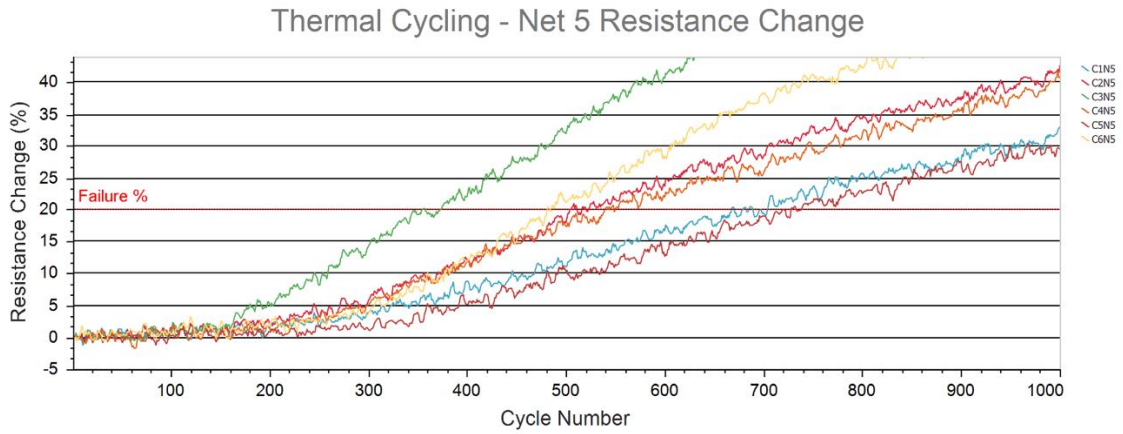


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00138	0.00126	0.00119	0.00143	0.00151	0.00126
Maximum Resistance % Change	1.04	0.67	0.60	1.31	1.27	1.16
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

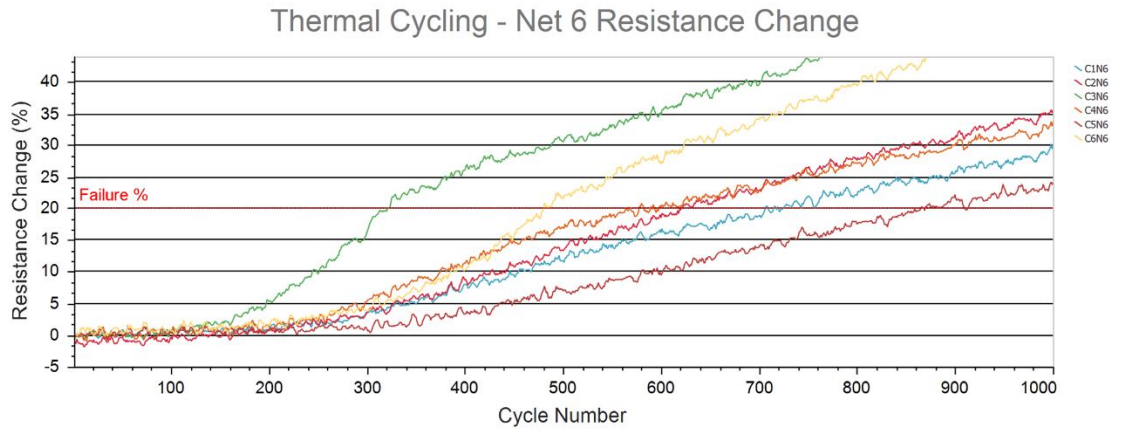
Group 1B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



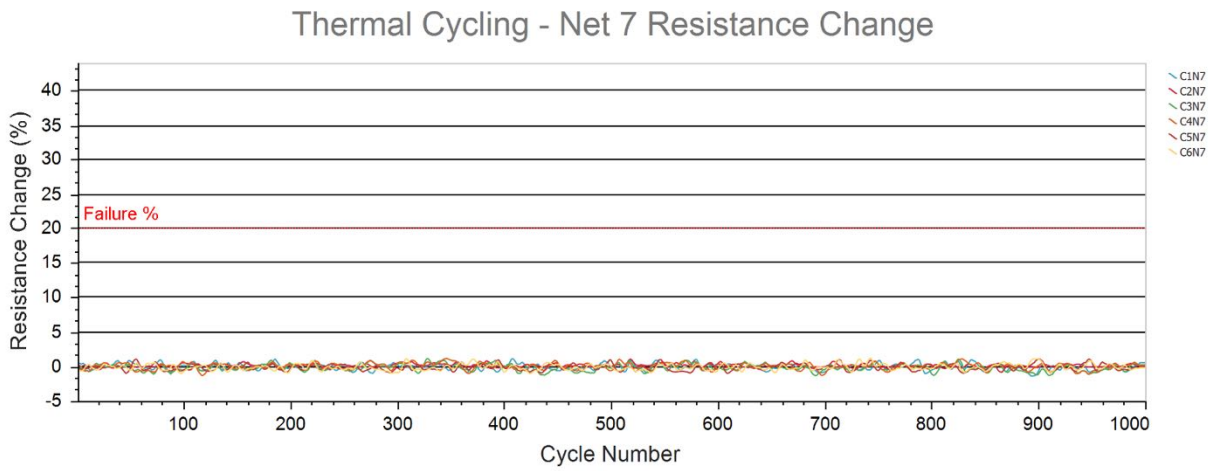
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00570	0.00622	0.00585	0.00595	0.00573	0.00560
Maximum Resistance % Change	33.00	42.76	65.53	41.78	30.42	51.40
Cycle Failed 20% Limit	668	504	373	540	722	481



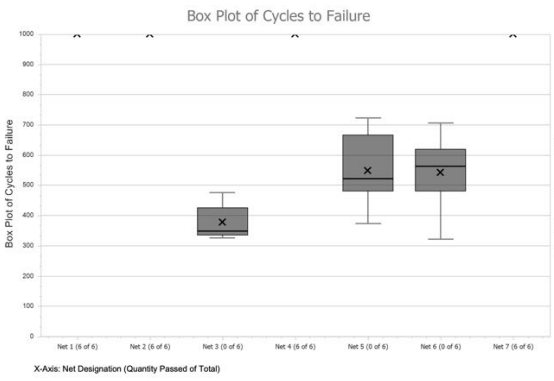
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00871	0.00894	0.00898	0.00829	0.00848	0.00817
Maximum Resistance % Change	30.13	35.60	54.70	33.72	24.15	50.24
Cycle Failed 20% Limit	707	621	322	568	559	481

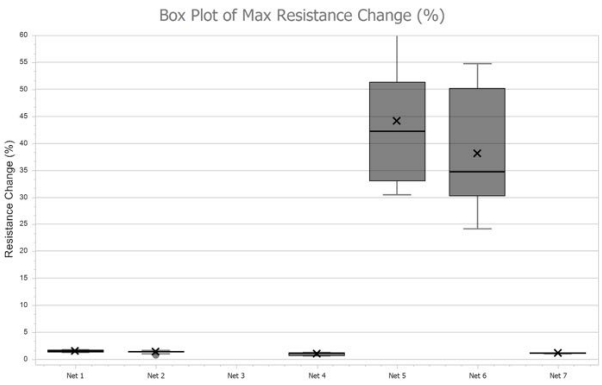
Group 1B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm
Net 1 Via Type: SS Inside MV Bottom
Net 1 Quantity of Holes: 1
Net 1 Hole Size: .125 mm
Net 2 Via Type: SS Outside MV Bottom
Net 2 Quantity of Holes: 1
Net 2 Hole Size: .125 mm
Net 3 Via Type: Buried
Net 3 Quantity of Holes: 1
Net 3 Hole Size: .25 mm
Net 4 Via Type: SS Inside MV Top
Net 4 Quantity of Holes: 1
Net 4 Hole Size: .125 mm
Net 5 Via Type: SS Inside MV+BV+MV
Net 5 Quantity of Holes: 1
Net 5 Hole Size: .125 mm
Net 6 Via Type: SS Outside MV+BV+MV
Net 6 Quantity of Holes: 1
Net 6 Hole Size: .125 mm
Net 7 Via Type: SS Outside MV Top
Net 7 Quantity of Holes: 1
Net 7 Hole Size: .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00234	0.00233	0.00223	0.00211	0.00240	0.00203
Maximum Resistance % Change	1.09	1.03	1.11	1.15	1.04	1.15
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000



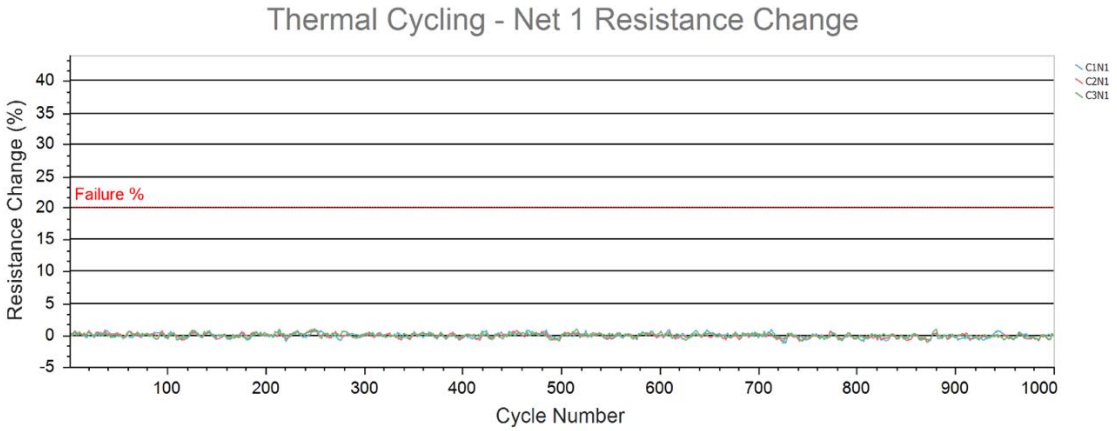


Group 2B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

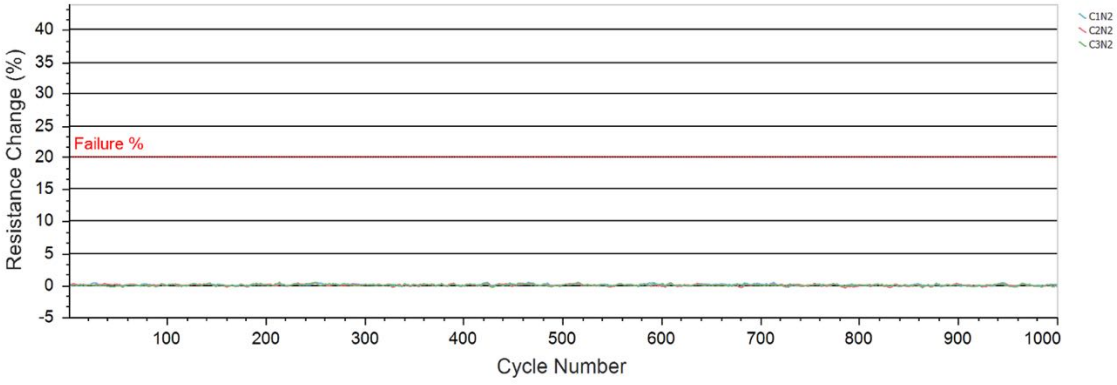
Cycle Range (°C): -55 to 160 | **Quality of Cycles:** 1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00082	0.00089	0.00085	-	-	-
Maximum Resistance % Change	0.84	0.72	0.95	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00216	0.00224	0.00214	-	-	-
Maximum Resistance % Change	0.42	0.34	0.42	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 2B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160 **Quality of Cycles:** 1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type: Full Stacked MV Bottom **Net 1 Quantity of Holes:** 1 **Net 1 Hole Size:** .125 mm

Net 2 Via Type: Full Staggered MV Bottom **Net 2 Quantity of Holes:** 1 **Net 2 Hole Size:** .125 mm

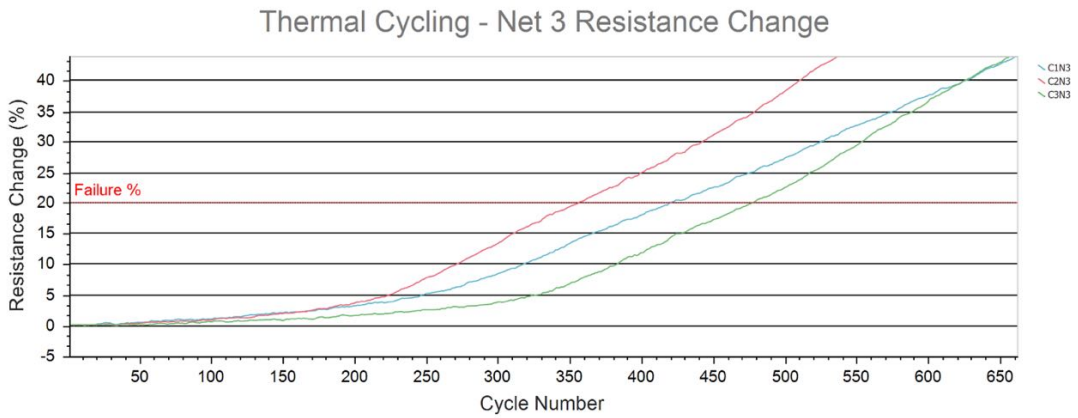
Net 3 Via Type: Buried **Net 3 Quantity of Holes:** 1 **Net 3 Hole Size:** .25 mm

Net 4 Via Type: Full Stacked MV Top **Net 4 Quantity of Holes:** 1 **Net 4 Hole Size:** .125 mm

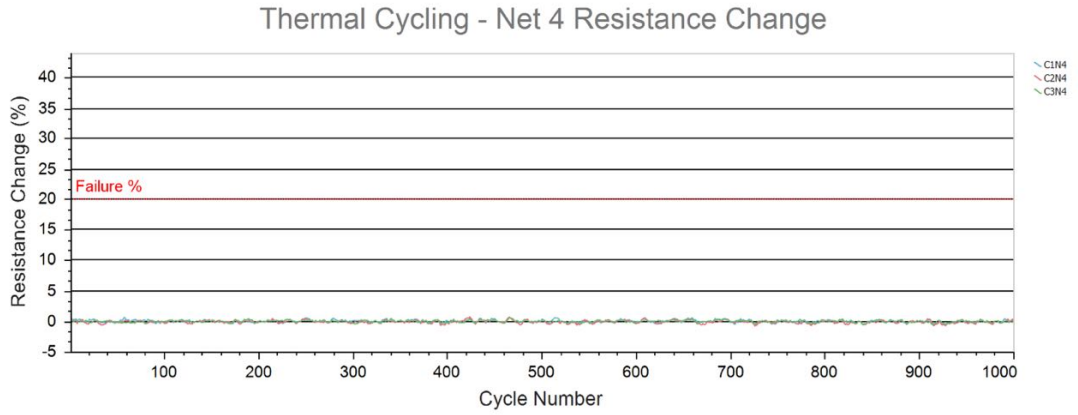
Net 5 Via Type: Full Stacked MV+BV+MV **Net 5 Quantity of Holes:** 1 **Net 5 Hole Size:** .125 mm

Net 6 Via Type: Full Staggered MV+BV+MV **Net 6 Quantity of Holes:** 1 **Net 6 Hole Size:** .125 mm

Net 7 Via Type: Full Staggered MV Top **Net 7 Quantity of Holes:** 1 **Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00294	0.00319	0.00279	-	-	-
Maximum Resistance % Change	70.23	93.26	83.30	-	-	-
Cycle Failed 20% Limit	420	356	479	-	-	-



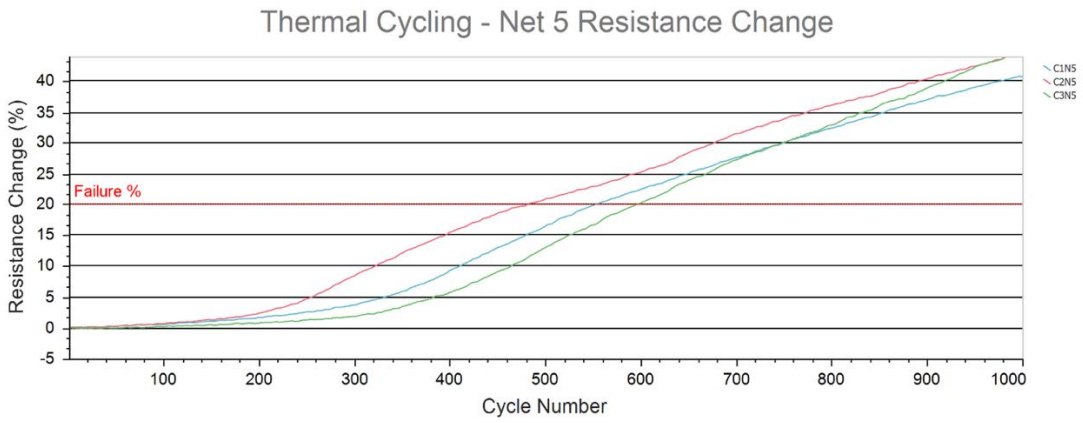
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00130	0.00125	0.00151	-	-	-
Maximum Resistance % Change	0.63	0.68	0.54	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-
Coupon Number	7	8	9	10	11	12
Reference Resistance (Ohms)	-	-	-	-	-	-
Maximum Resistance % Change	-	-	-	-	-	-
Cycle Failed 20% Limit	-	-	-	-	-	-

Group 2B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

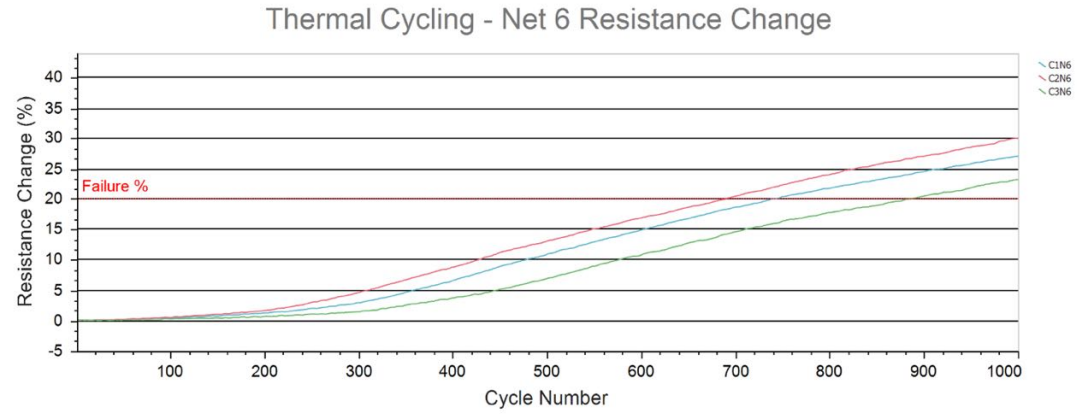
Cycle Range (°C): -55 to 160 | **Quality of Cycles:** 1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



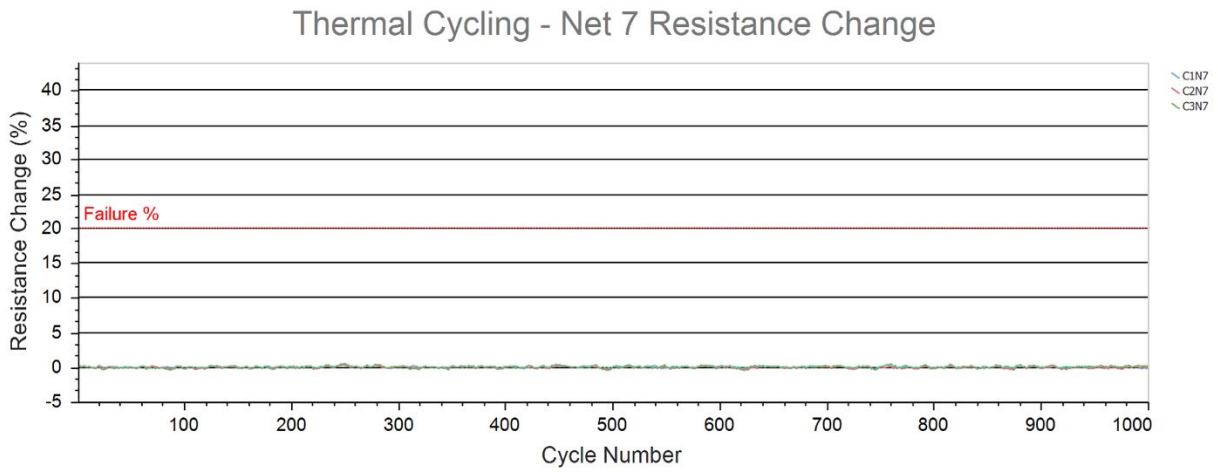
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00588	0.00594	0.00576	-	-	-
Maximum Resistance % Change	40.94	44.75	44.85	-	-	-
Cycle Failed 20% Limit	553	481	596	-	-	-
Coupon Number	**7**	**8**	**9**	**10**	**11**	**12**
Reference Resistance (Ohms)	-	-	-	-	-	-
Maximum Resistance % Change	-	-	-	-	-	-
Cycle Failed 20% Limit	-	-	-	-	-	-



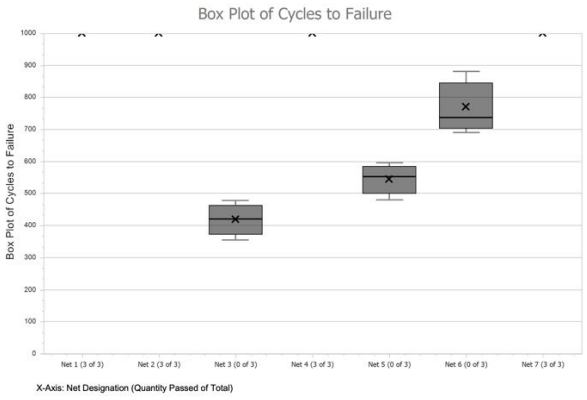
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00852	0.00884	0.00861	-	-	-
Maximum Resistance % Change	27.19	30.09	23.30	-	-	-
Cycle Failed 20% Limit	738	689	881	-	-	-

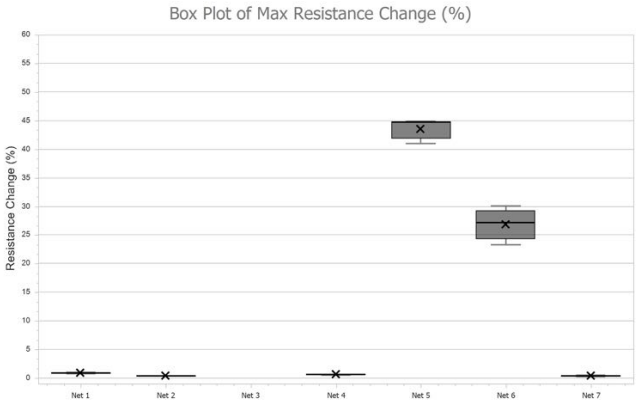
Group 2B, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160	**Quality of Cycles:** 1000	**Failure Percentage (%):** 20
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: Full Stacked MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Full Staggered MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00237	0.00224	0.00228	-	-	-
Maximum Resistance % Change	0.30	0.34	0.52	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

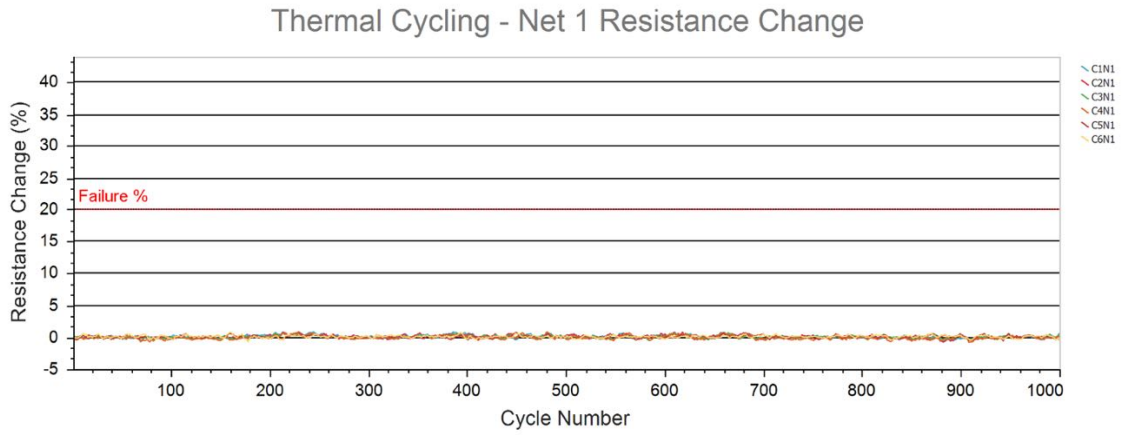




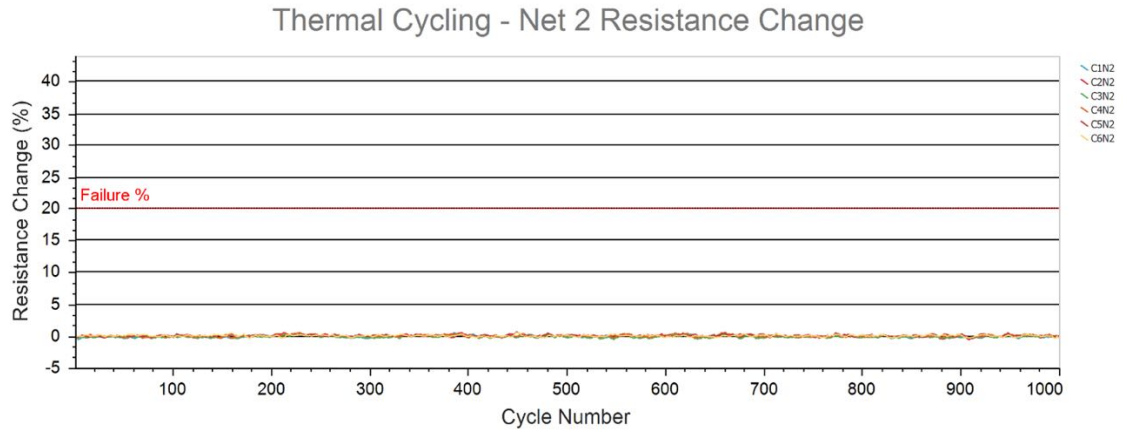
Group 1C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00201	0.00212	0.00226	0.00183	0.00193	0.00201
Maximum Resistance % Change	0.83	0.81	0.67	0.82	0.73	0.76
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

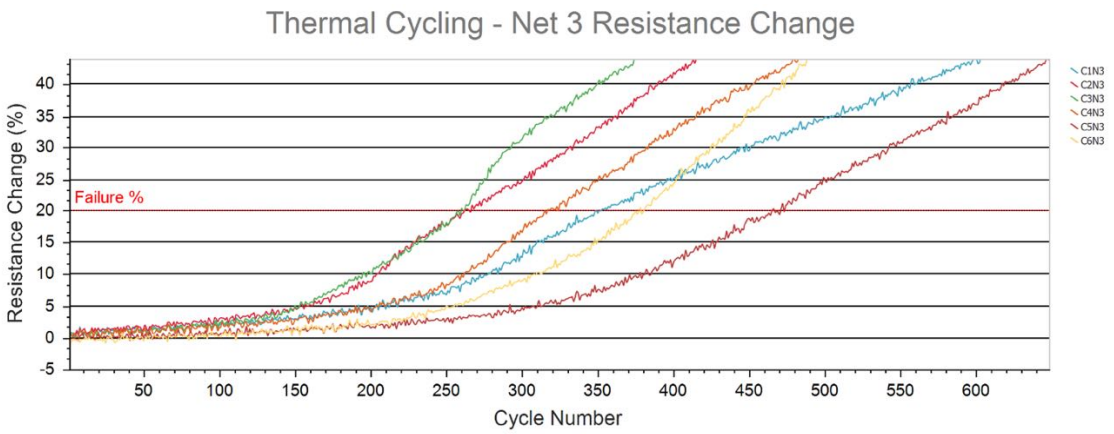


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00308	0.00300	0.00337	0.00294	0.00272	0.00314
Maximum Resistance % Change	0.51	0.57	0.27	0.56	0.64	0.53
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

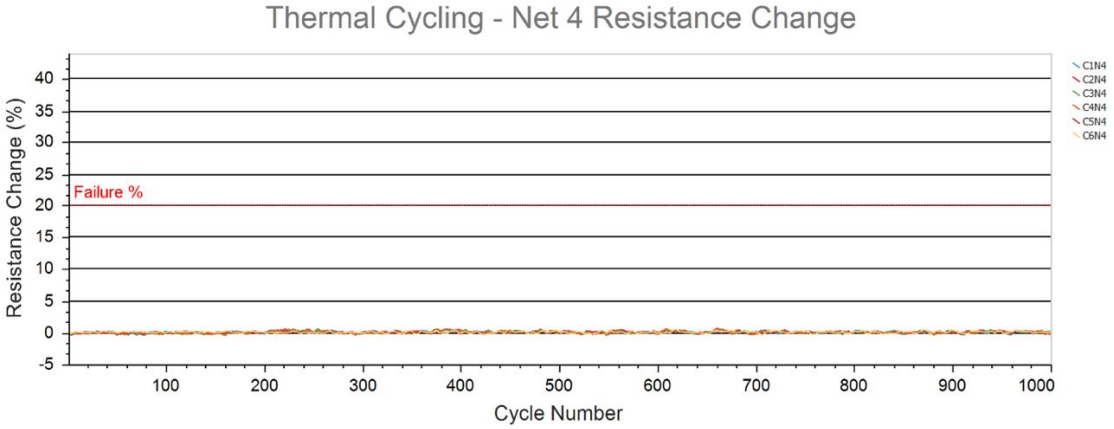
Group 1C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00291	0.00322	0.00328	0.00305	0.00276	0.00275
Maximum Resistance % Change	74.25	105.99	123.26	99.82	85.10	116.27
Cycle Failed 20% Limit	349	262	258	315	465	378



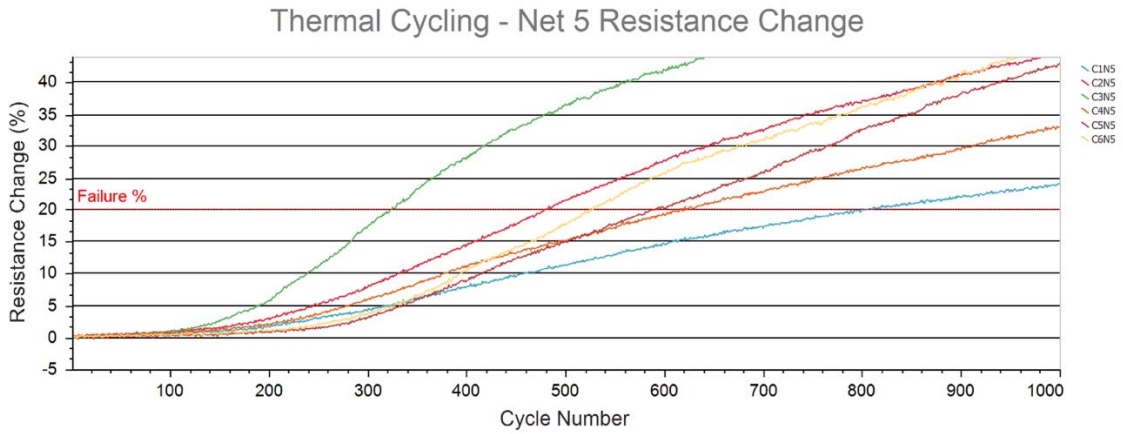
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00287	0.00280	0.00308	0.00271	0.00317	0.00282
Maximum Resistance % Change	0.53	0.70	0.56	0.58	0.40	0.53
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 1C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

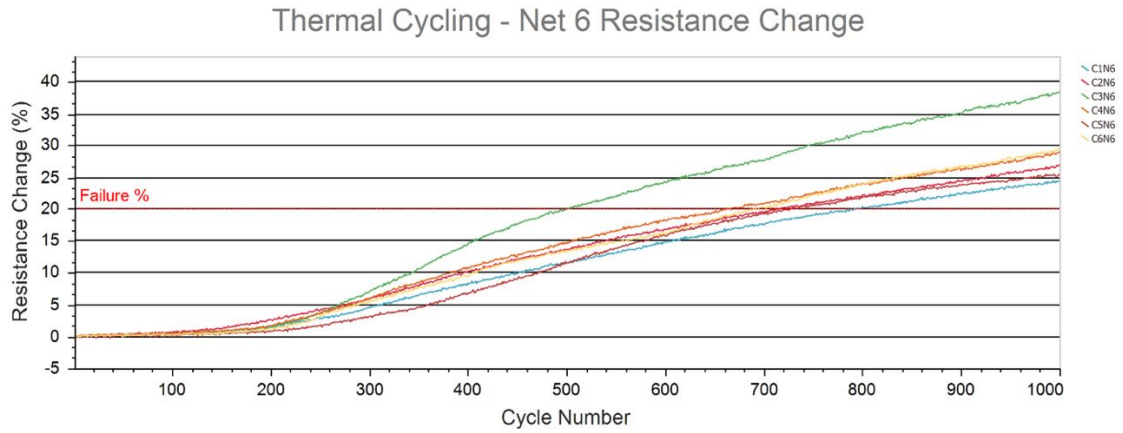
Cycle Range (°C): -55 to 160 | **Quality of Cycles:** 1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00854	0.00910	0.00928	0.00836	0.00860	0.00844
Maximum Resistance % Change	24.26	44.92	61.06	33.10	43.10	46.19
Cycle Failed 20% Limit	794	479	323	616	591	525

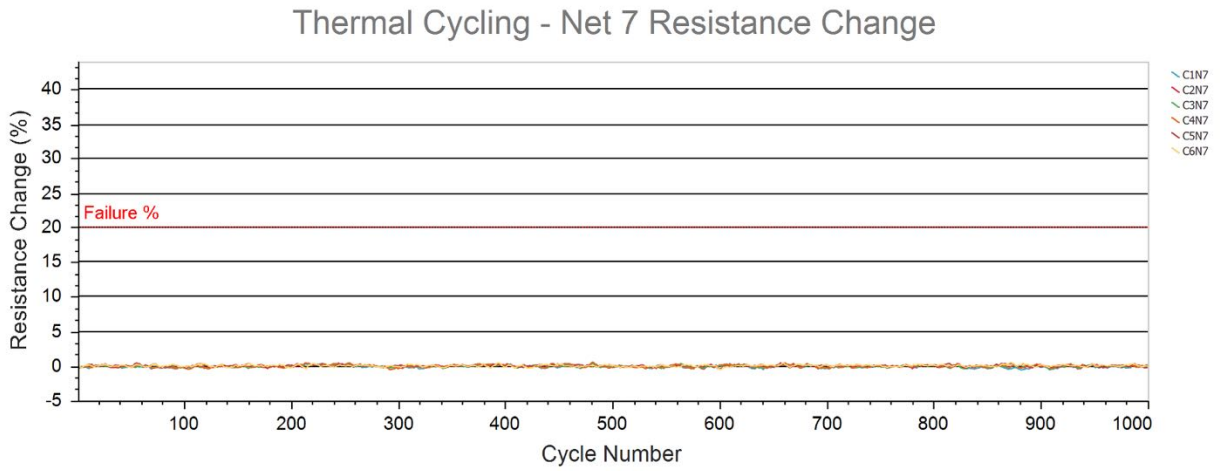


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01045	0.01075	0.01118	0.01028	0.01014	0.01047
Maximum Resistance % Change	24.51	27.06	38.53	29.20	25.49	29.53
Cycle Failed 20% Limit	788	713	500	660	727	689

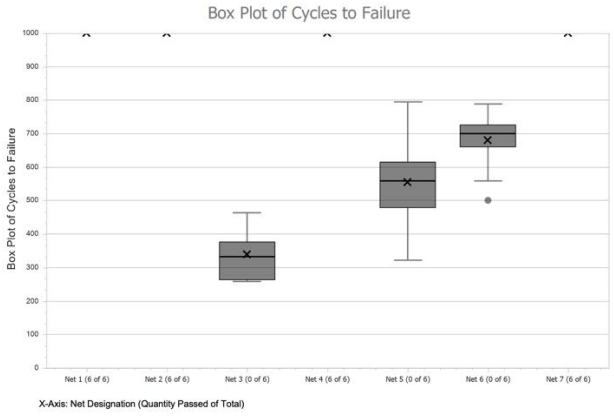
Group 1C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

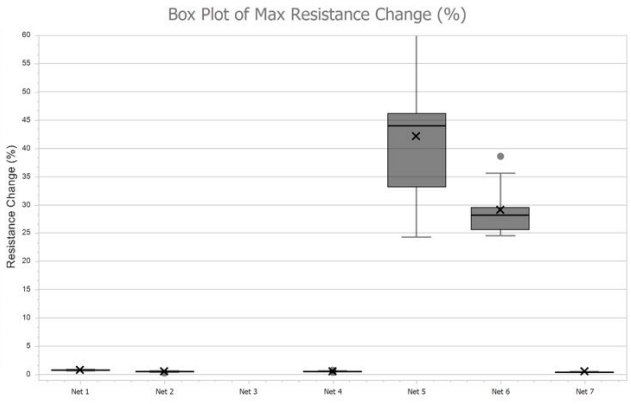
Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 6
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type: SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00304	0.00315	0.00328	0.00287	0.00303	0.00295
Maximum Resistance % Change	0.36	0.44	0.39	0.52	0.42	0.52
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

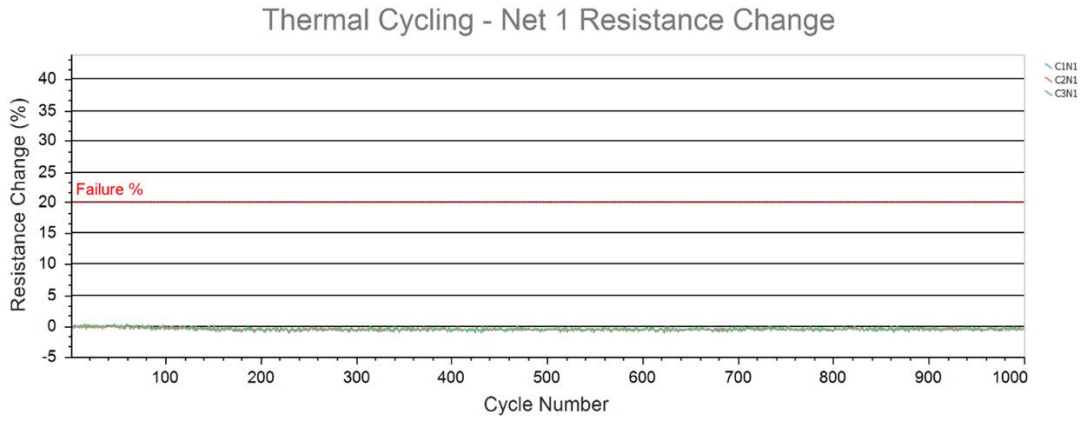




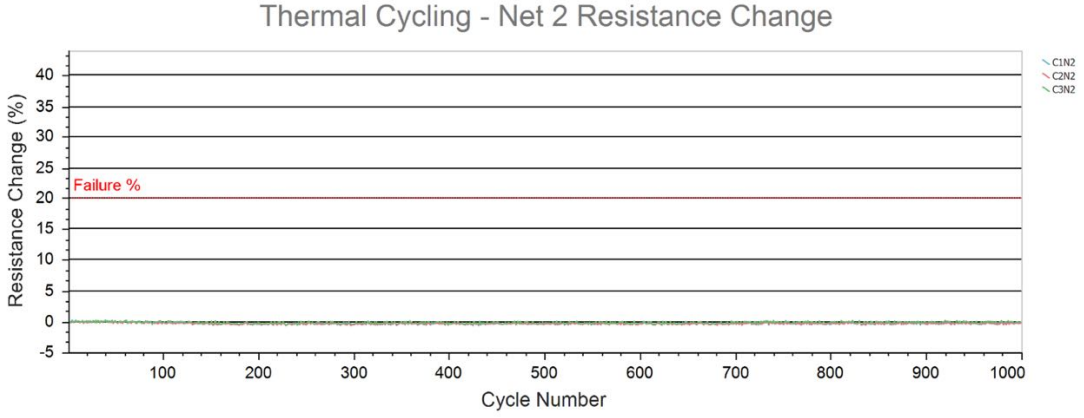
Group 2C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00193	0.00221	0.00194	-	-	-
Maximum Resistance % Change	0.23	0.10	0.29	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

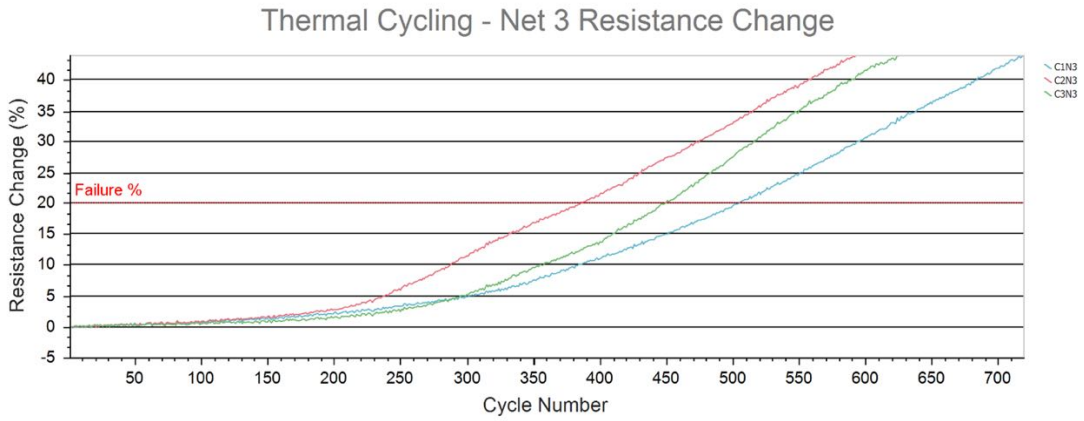


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00286	0.00315	0.00273	-	-	-
Maximum Resistance % Change	0.21	0.09	0.18	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

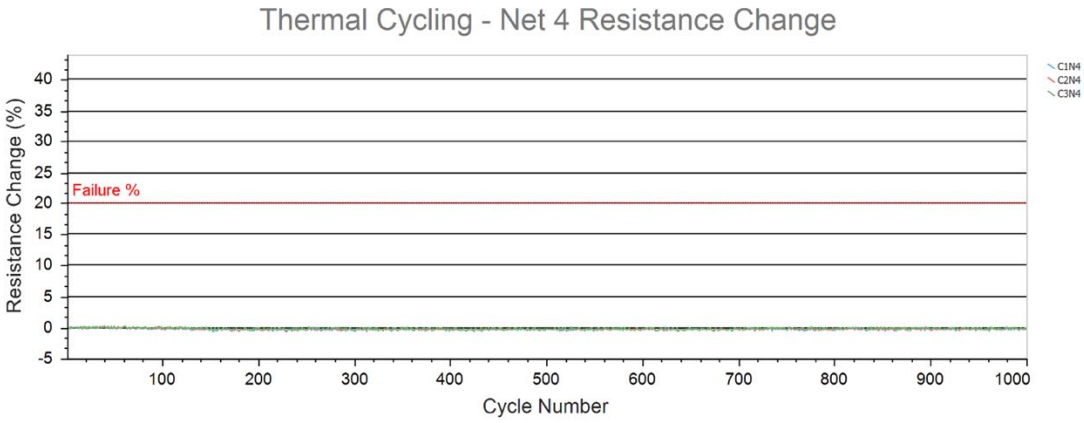
Group 2C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

Cycle Range (°C): -55 to 160
Quality of Cycles: 1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00300	0.00318	0.00285	-	-	-
Maximum Resistance % Change	67.94	89.44	86.91	-	-	-
Cycle Failed 20% Limit	505	386	450	-	-	-



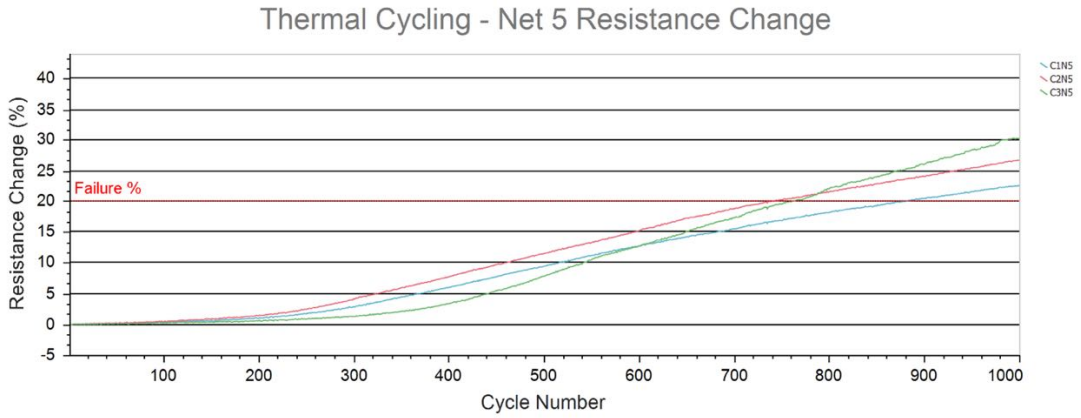
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00269	0.00297	0.00307	-	-	-
Maximum Resistance % Change	0.19	0.23	0.19	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 2C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

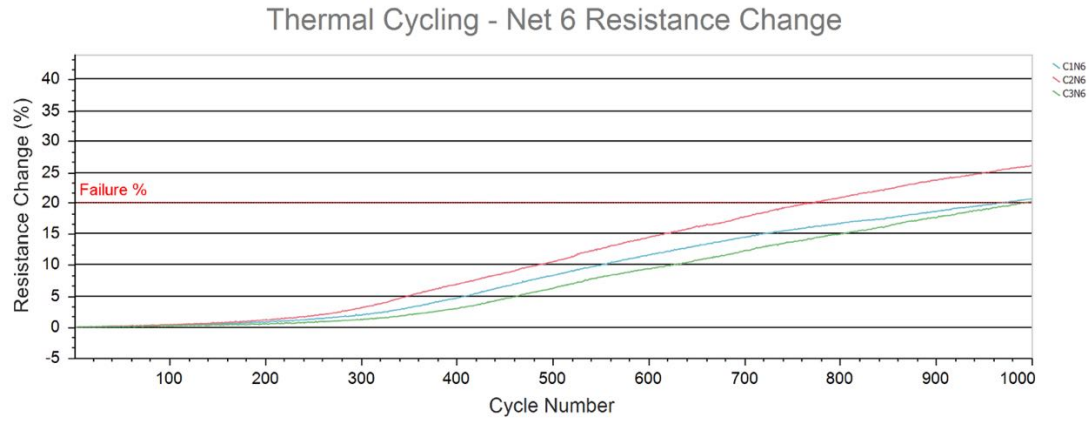
Cycle Range (°C): -55 to 160 | **Quality of Cycles:** 1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00846	0.00901	0.00845	-	-	-
Maximum Resistance % Change	22.63	26.74	30.32	-	-	-
Cycle Failed 20% Limit	878	740	762	-	-	-



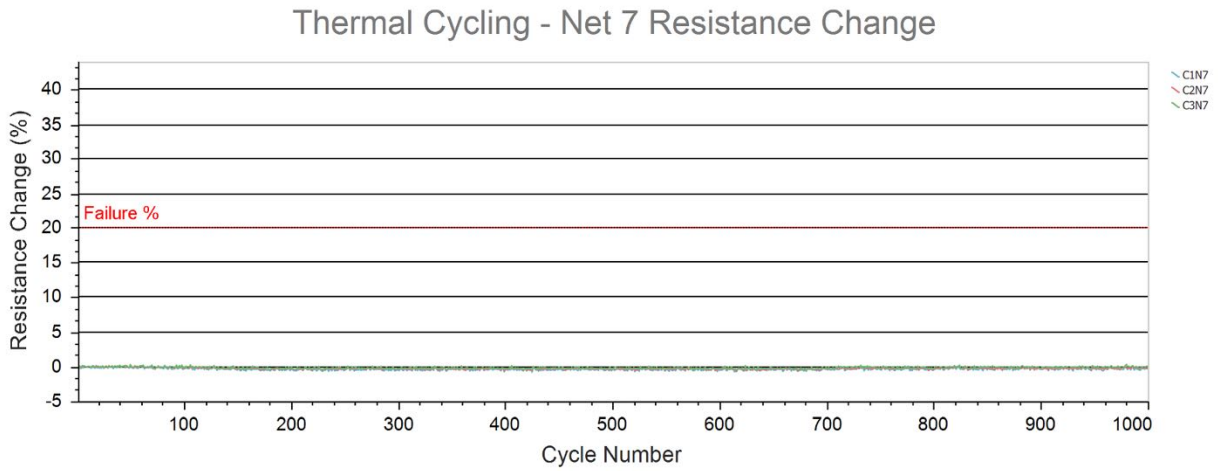
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01016	0.01076	0.00994	-	-	-
Maximum Resistance % Change	20.74	26.08	20.27	-	-	-
Cycle Failed 20% Limit	965	766	989	-	-	-

Group 2C, HATS²™ Single Via Coupons – Thermal Cycling -55°C to 160°C (1000x Cycles)

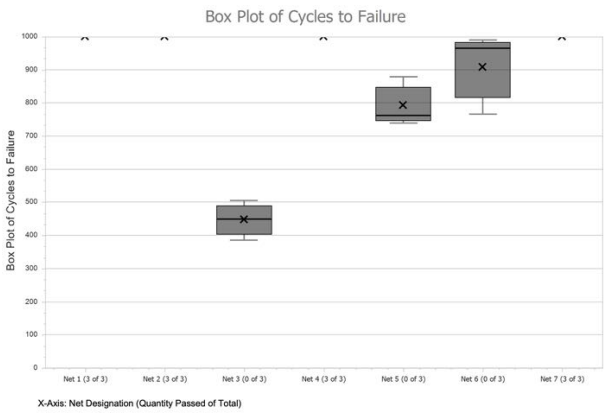
Cycle Range (°C): -55 to 160 | **Quality of Cycles:** 1000 | **Failure Percentage (%):** 20

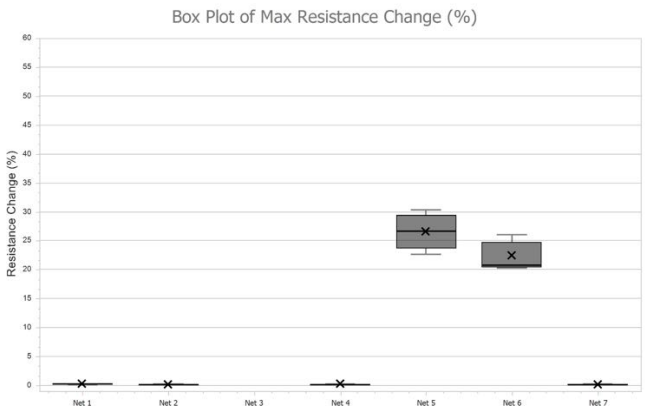
Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



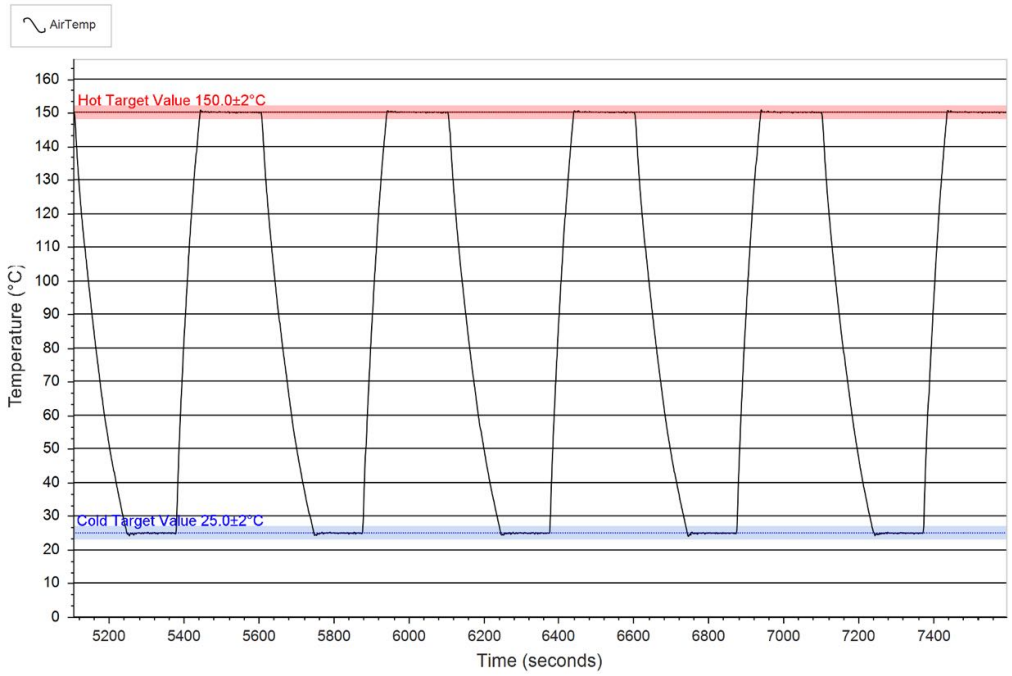
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00283	0.00309	0.00280	-	-	-
Maximum Resistance % Change	0.10	0.16	0.26	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-



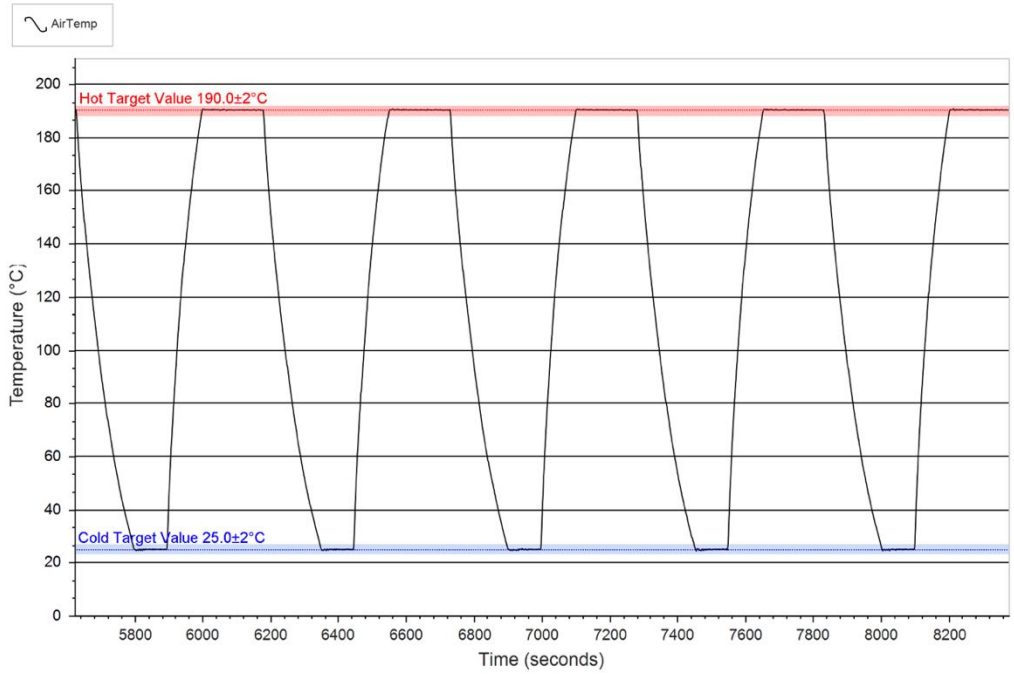


The below results are performed on HATS²™ single via coupon test samples 3A, 3B, 3C, 4A, 4B & 4C using a 500x Cycles of a 25°C to 150°C Cycling "Preconditioning" subsequently followed by 1000x Cycles of 25°C to 190°C Cycling. These cycling temperatures are based on the ECSS-Q-ST-70-60C specifications for IST testing of microvias. Below is a 5 Cycles sample of the air temperatures from the HATS²™ chamber test used to perform robustness exposure to these samples.

500X Cycle "Preconditioning"



1000x Cycle Thermal Cycling



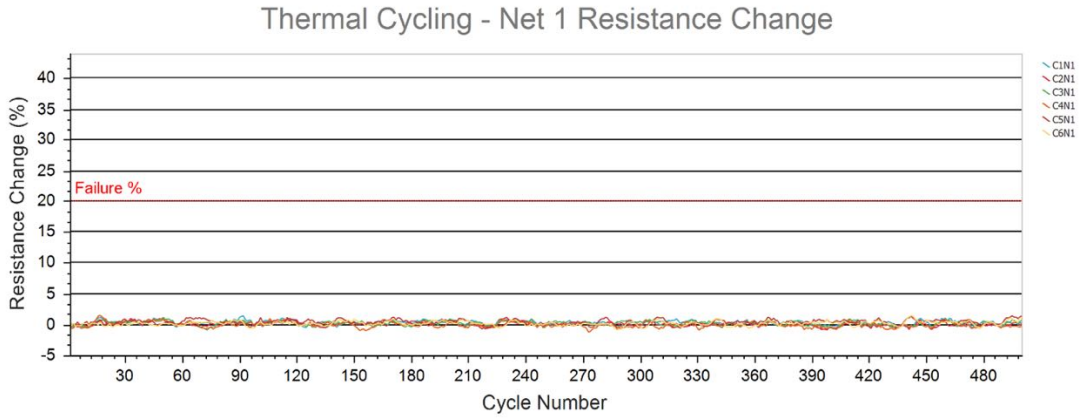
- Box Plots are not included where final results are less than 1% variance from 1st Cycle.

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

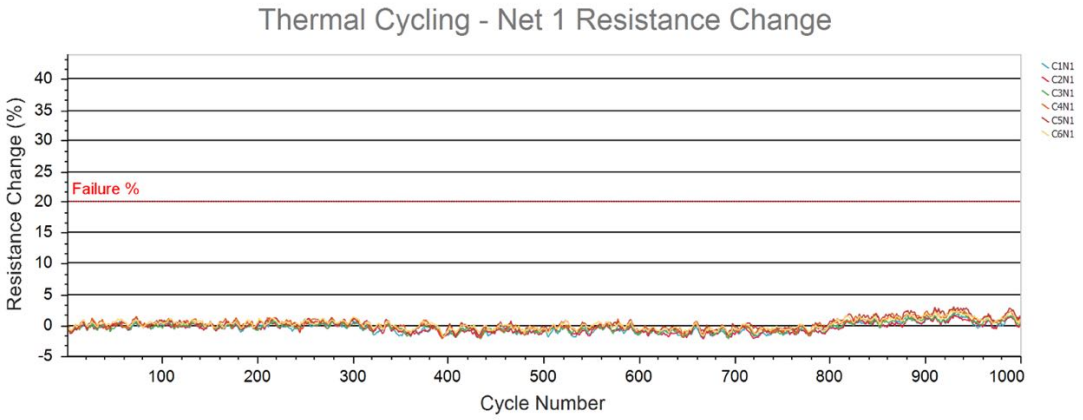
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00158	0.00167	0.00164	0.00146	0.00138	0.00159
Maximum Resistance % Change	1.35	1.10	1.09	1.40	1.36	1.38
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



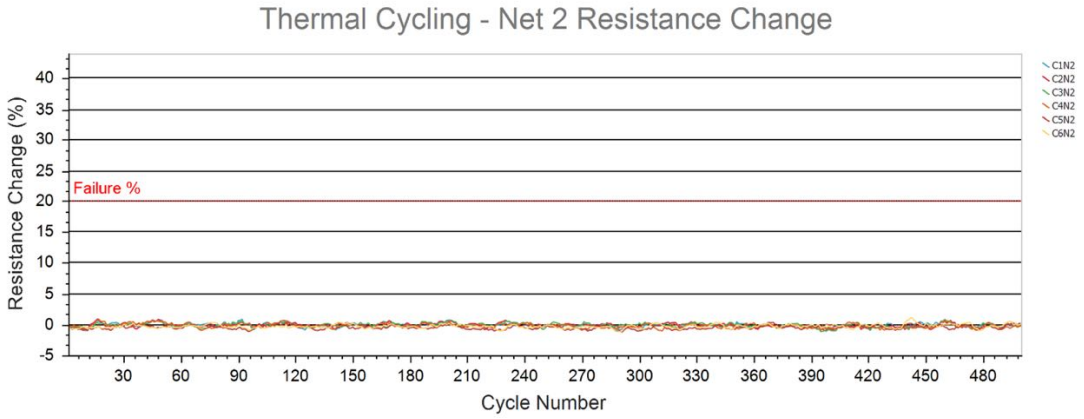
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00171	0.00180	0.00176	0.00155	0.00145	0.00169
Maximum Resistance % Change	1.86	1.59	2.22	2.58	2.91	2.27
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

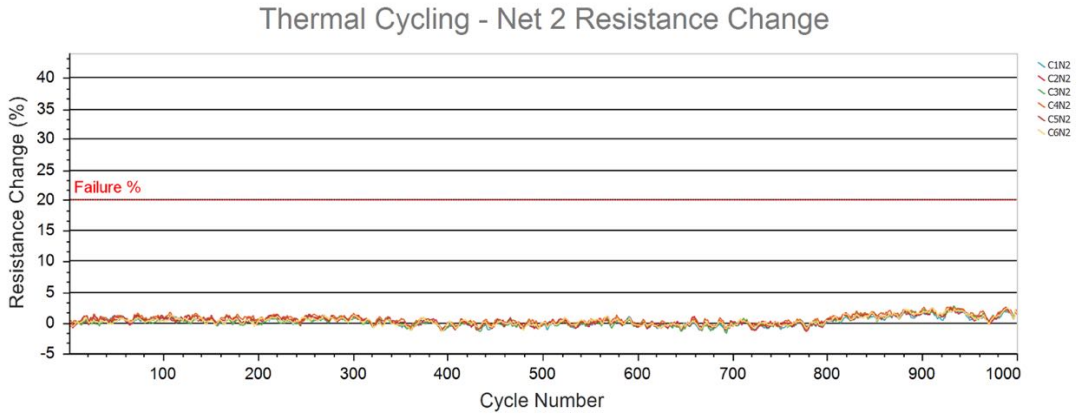
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00176	0.00167	0.00174	0.00173	0.00179	0.00178
Maximum Resistance % Change	0.81	0.82	0.79	0.70	0.35	1.03
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



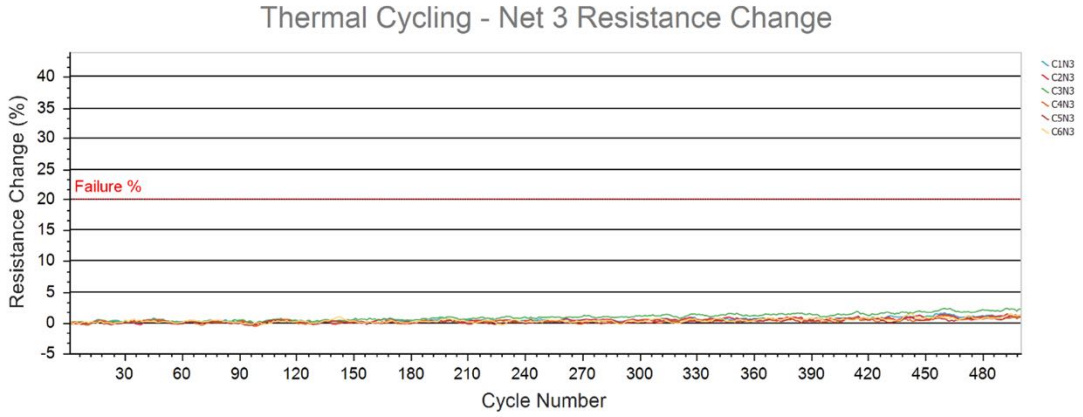
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00191	0.00181	0.00187	0.00183	0.00193	0.00190
Maximum Resistance % Change	2.14	2.39	2.68	2.57	2.53	2.40
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

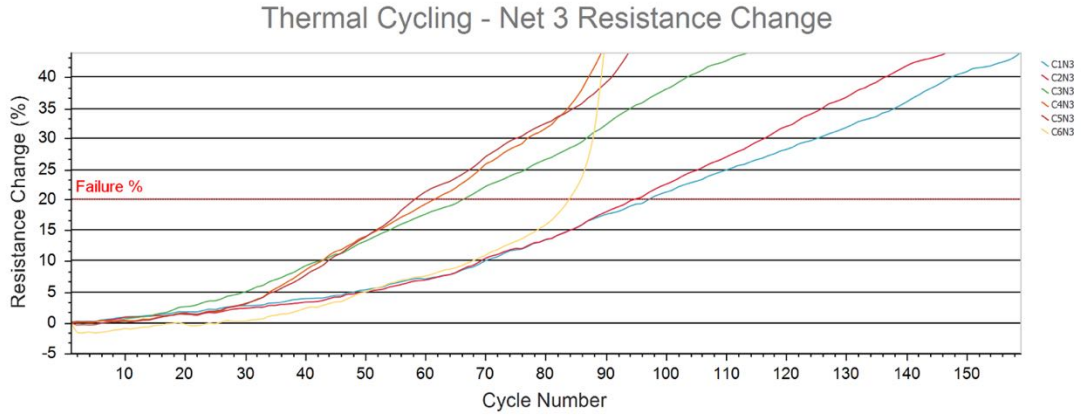
Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00311	0.00310	0.00323	0.00296	0.00310	0.00269
Maximum Resistance % Change	1.55	1.37	2.30	1.18	1.03	1.42
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



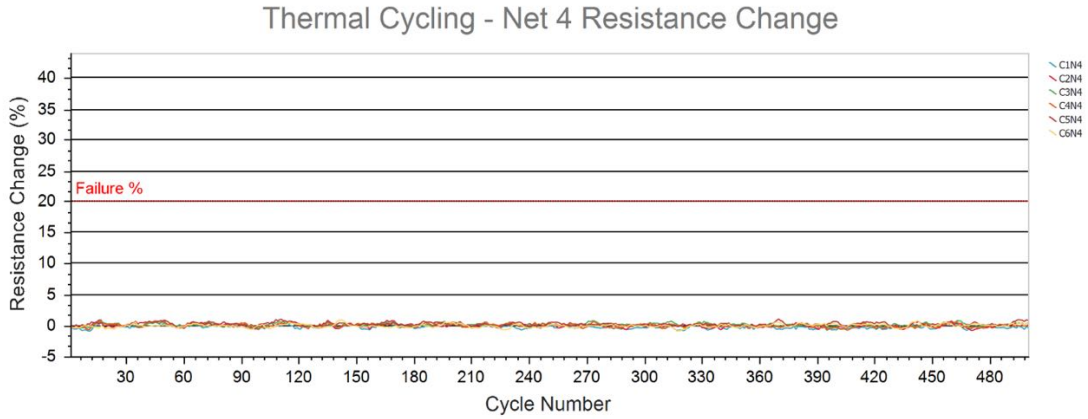
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00346	0.00344	0.00363	0.00325	0.00344	0.00297
Maximum Resistance % Change	183.45	199.38	206.75	338.91	282.93	1031.07
Cycle Failed 20% Limit	98	85	67	62	59	84

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

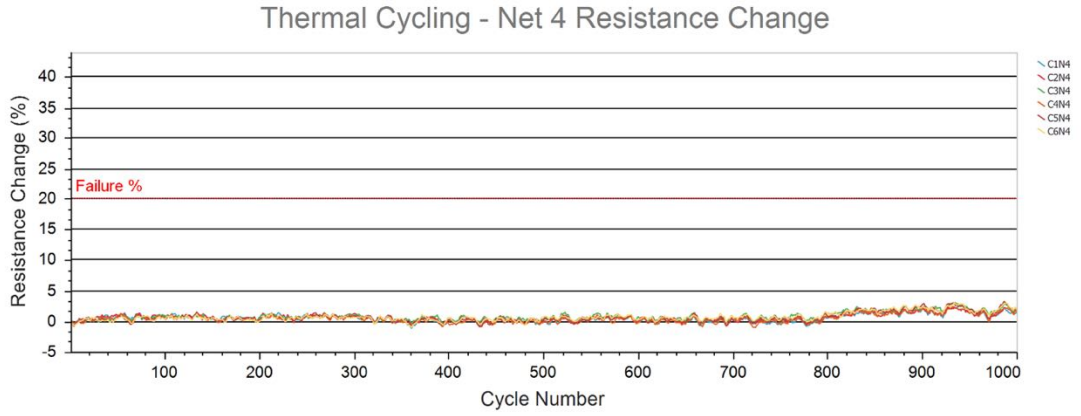
Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00203	0.00215	0.00208	0.00200	0.00194	0.00218
Maximum Resistance % Change	0.60	0.84	0.76	0.71	0.98	0.83
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



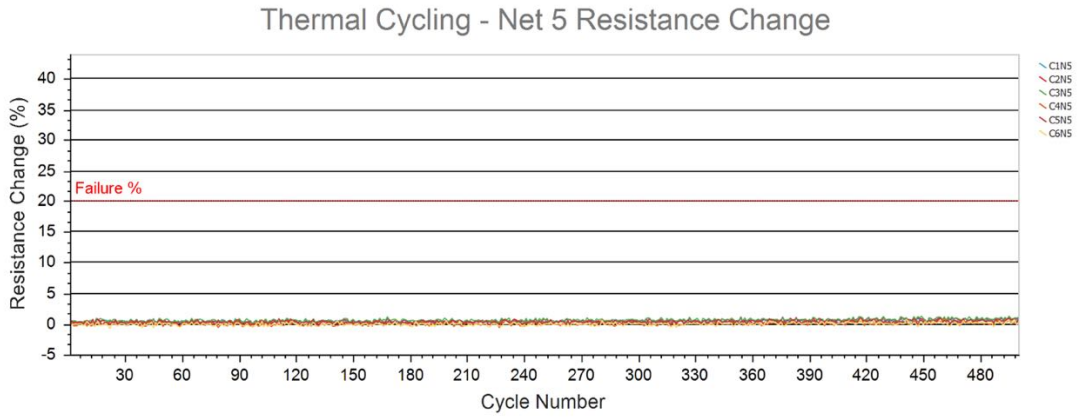
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00218	0.00232	0.00225	0.00216	0.00211	0.00237
Maximum Resistance % Change	2.34	2.30	3.05	2.37	3.19	3.04
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

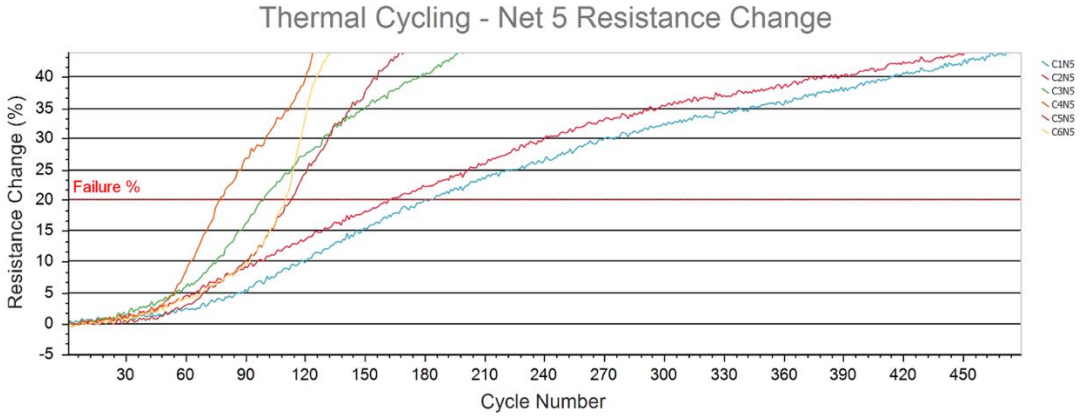
Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00710	0.00768	0.00734	0.00700	0.00723	0.00722
Maximum Resistance % Change	1.07	1.09	1.21	0.79	0.92	0.69
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



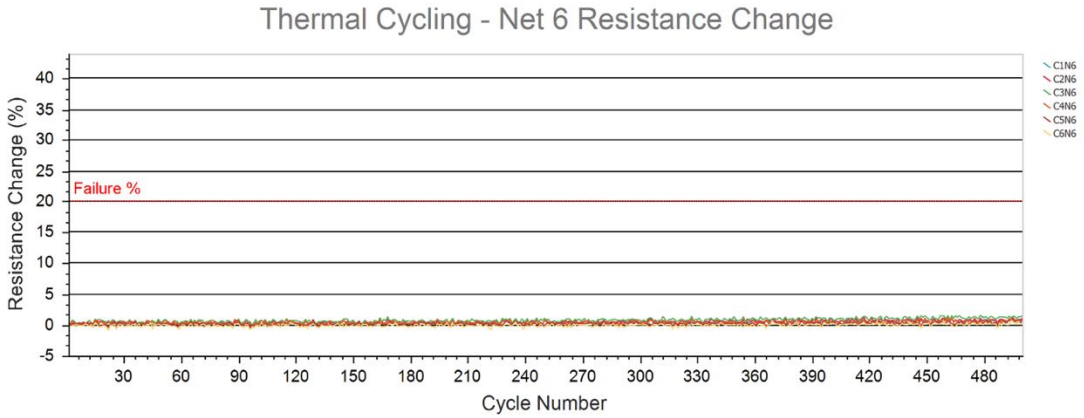
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00782	0.00851	0.00815	0.00772	0.00802	0.00800
Maximum Resistance % Change	63.99	75.78	118.54	161.26	163.16	195.20
Cycle Failed 20% Limit	180	162	100	78	113	110

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

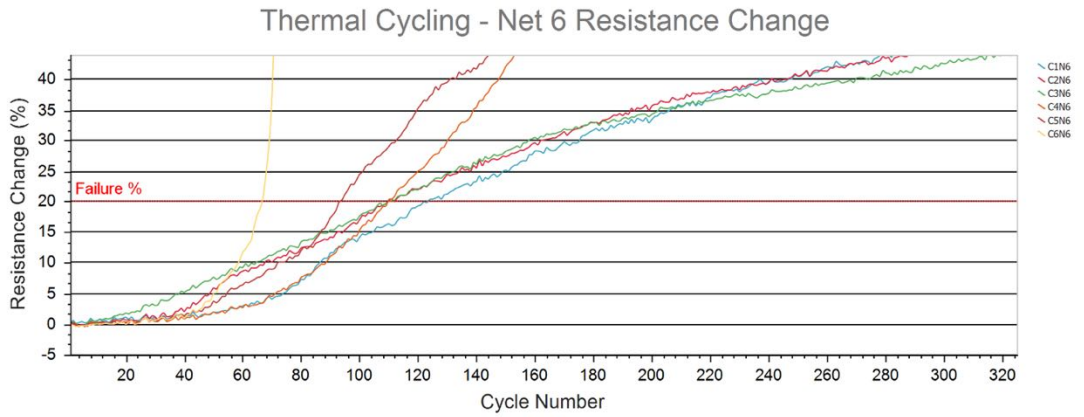
Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00686	0.00700	0.00714	0.00677	0.00723	0.00675
Maximum Resistance % Change	1.13	1.28	1.51	1.18	0.92	0.65
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



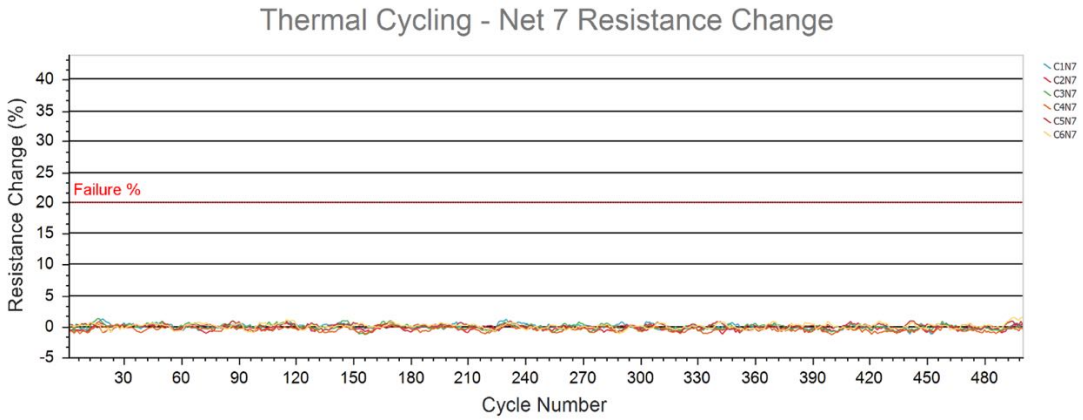
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00756	0.00776	0.00797	0.00749	0.00800	0.00747
Maximum Resistance % Change	100.52	90.30	93.94	165.40	155.80	476.23
Cycle Failed 20% Limit	122	110	110	110	94	67

Group 3A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

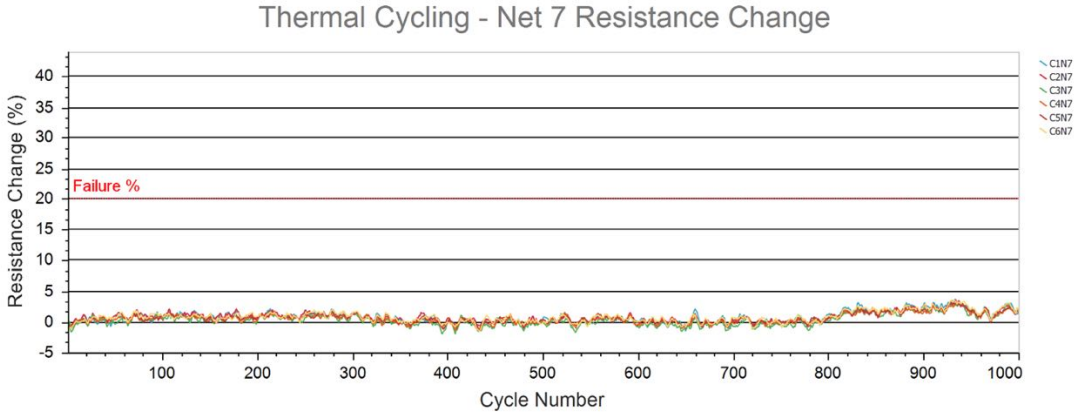
Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00138	0.00151	0.00138	0.00160	0.00162	0.00143
Maximum Resistance % Change	1.15	0.79	1.22	0.40	0.85	1.37
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



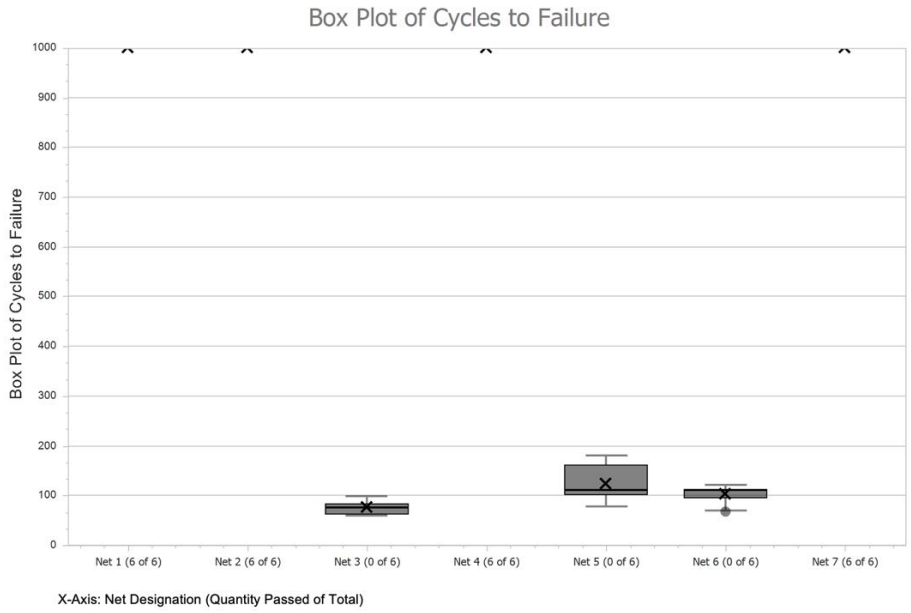
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00146	0.00161	0.00148	0.00170	0.00173	0.00153
Maximum Resistance % Change	3.64	3.49	3.08	3.24	3.00	3.46
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

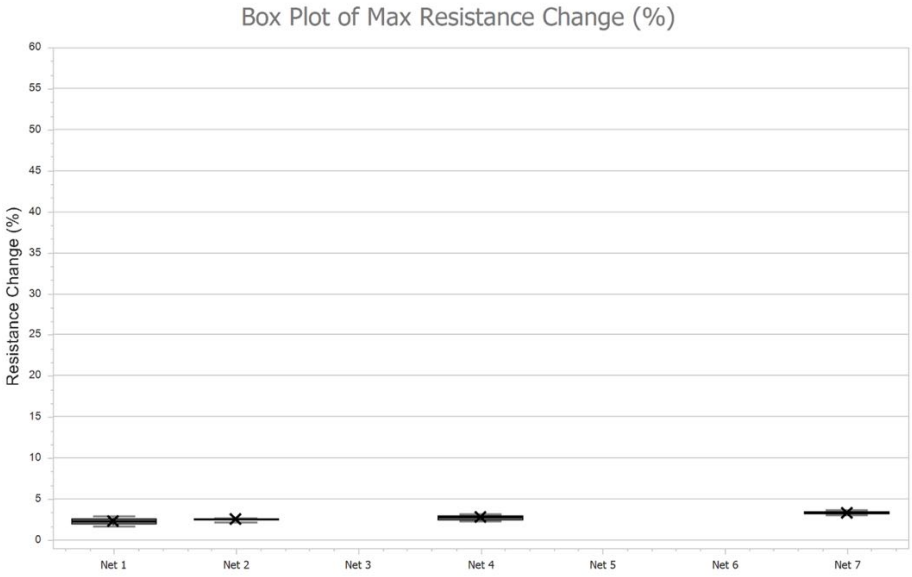
Group 3A, HATS^{2TM} Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles); Box Plots for 1000x Cycle Test

Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 6 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



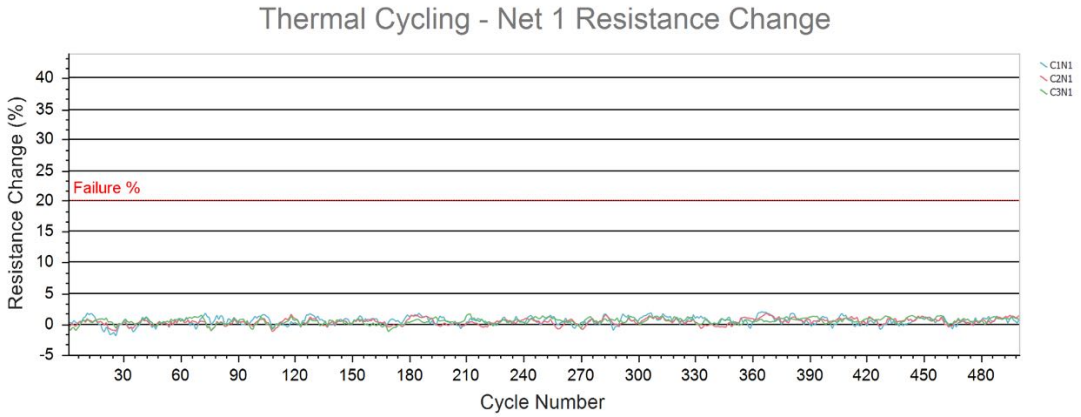


Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

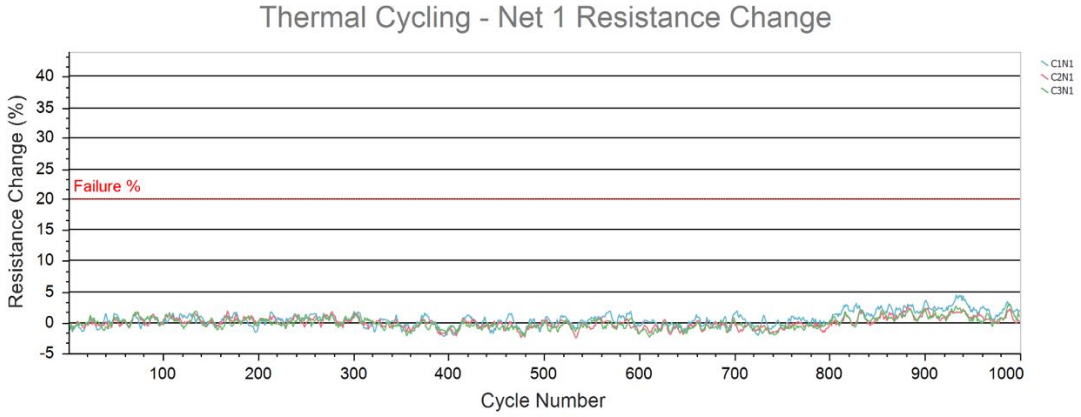
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00138	0.00152	0.00151	-	-	-
Maximum Resistance % Change	1.94	1.66	1.56	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



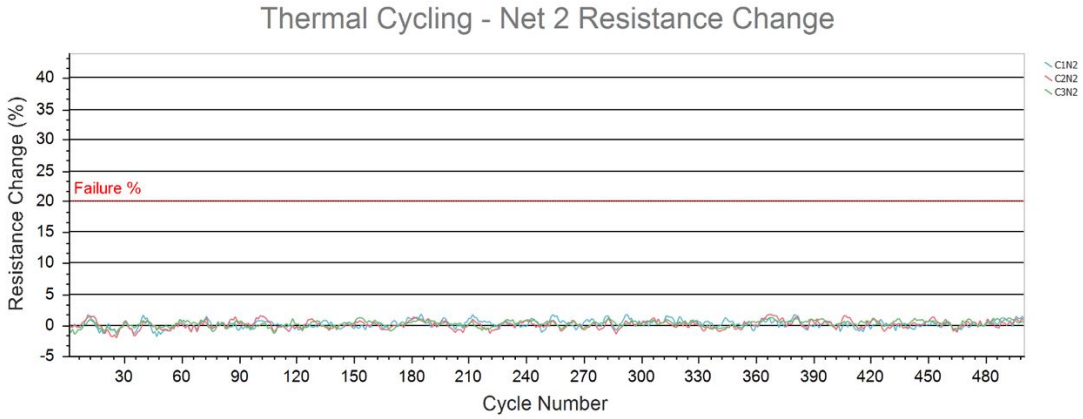
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00147	0.00166	0.00167	-	-	-
Maximum Resistance % Change	4.41	2.61	3.03	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

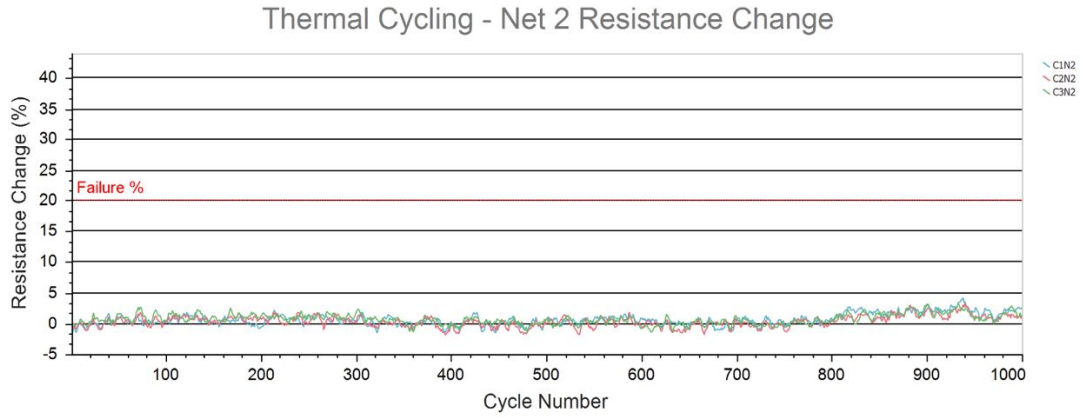
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00170	0.00162	0.00170	-	-	-
Maximum Resistance % Change	1.71	1.67	1.19	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-

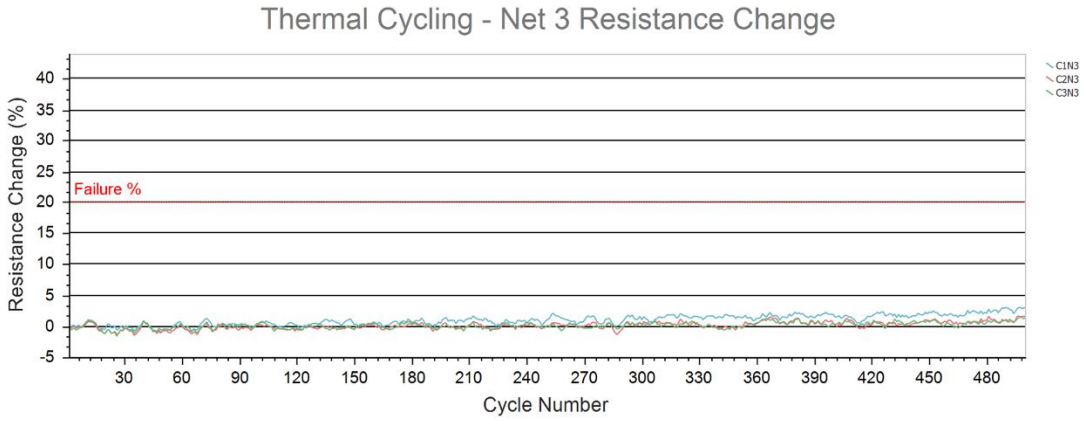


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00180	0.00173	0.00184	-	-	-
Maximum Resistance % Change	4.15	3.20	3.21	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

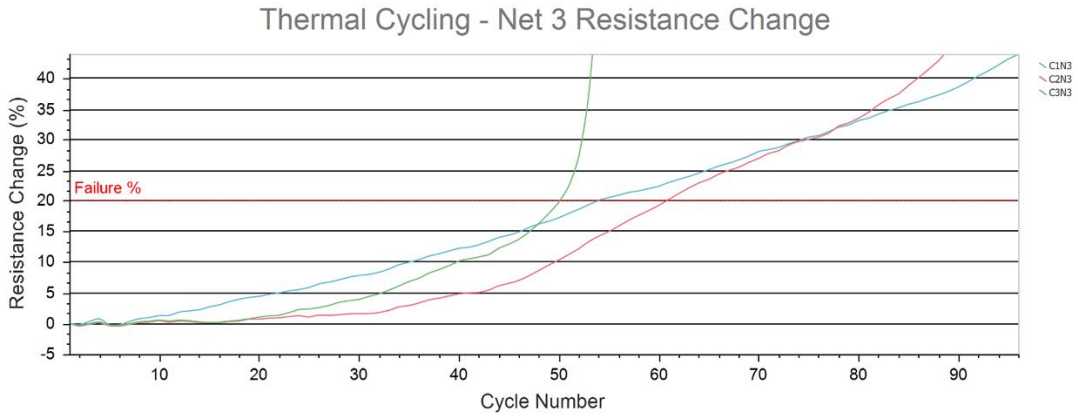
Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 to 150 / 25 to 190
Quality of Cycles: 500/1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00324	0.00303	0.00281	-	-	-
Maximum Resistance % Change	3.03	1.57	1.46	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



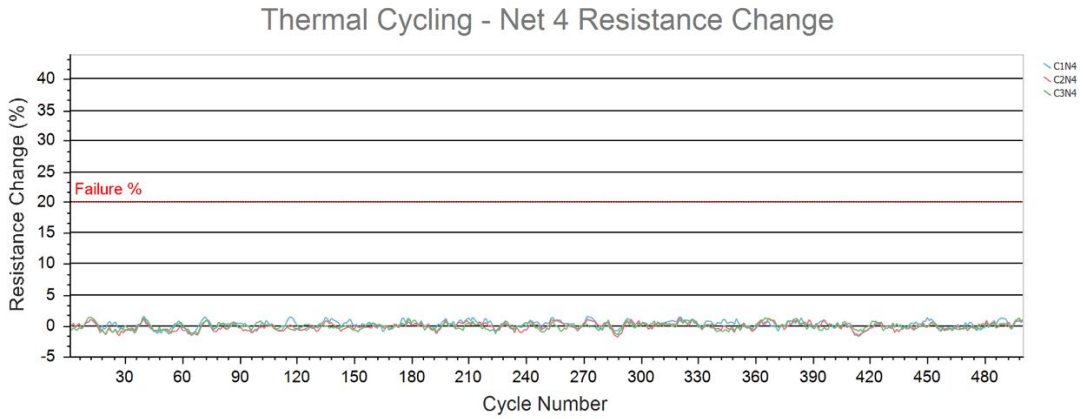
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00361	0.00333	0.00309	-	-	-
Maximum Resistance % Change	282.50	463.57	64582.45	-	-	-
Cycle Failed 20% Limit	54	61	51	-	-	-

Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

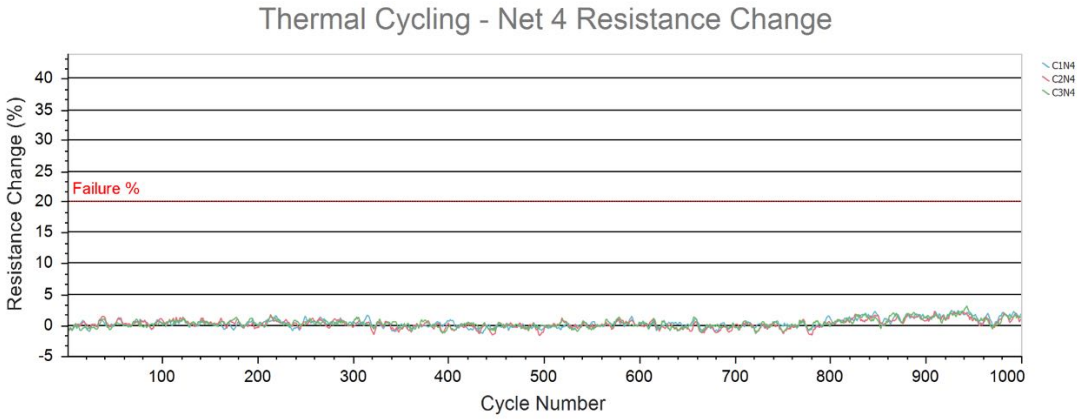
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00216	0.00210	0.00212	-	-	-
Maximum Resistance % Change	1.46	1.13	1.31	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



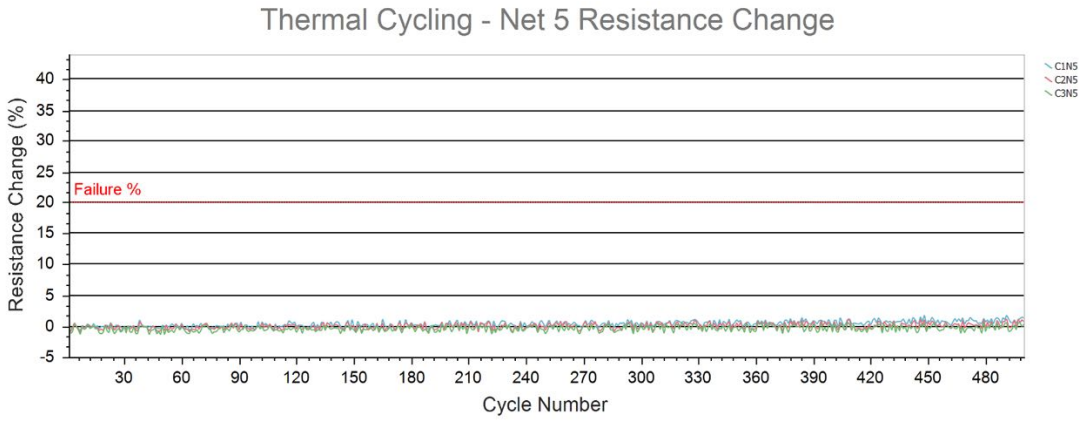
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00231	0.00221	0.00224	-	-	-
Maximum Resistance % Change	2.35	2.35	2.35	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

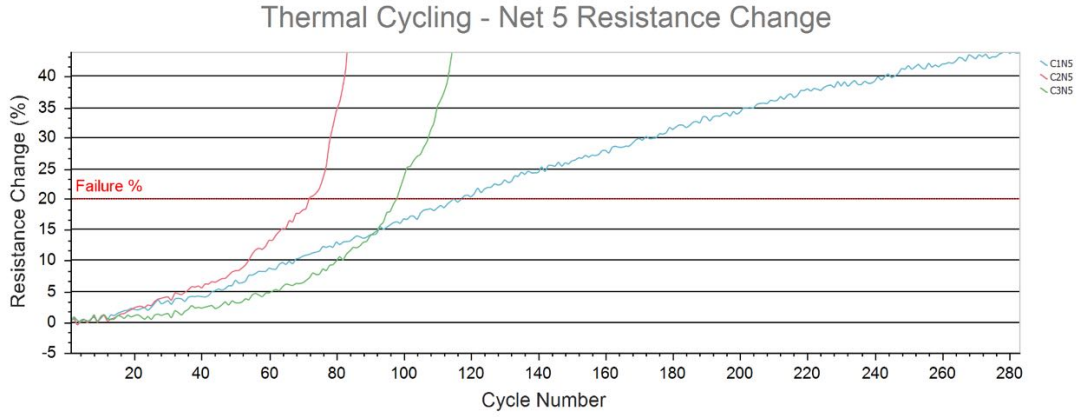
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00756	0.00707	0.00699	-	-	-
Maximum Resistance % Change	1.24	0.83	0.14	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



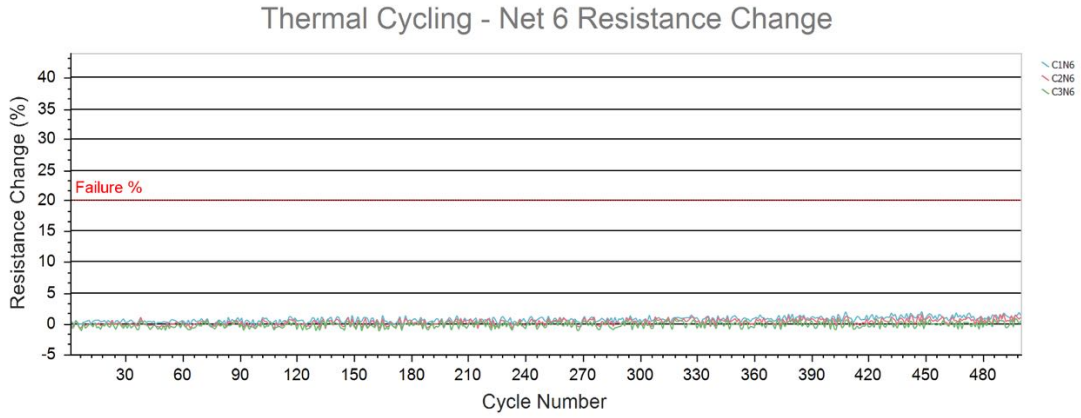
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00843	0.00781	0.00765	-	-	-
Maximum Resistance % Change	140.93	353.31	300.43	-	-	-
Cycle Failed 20% Limit	115	72	98	-	-	-

Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

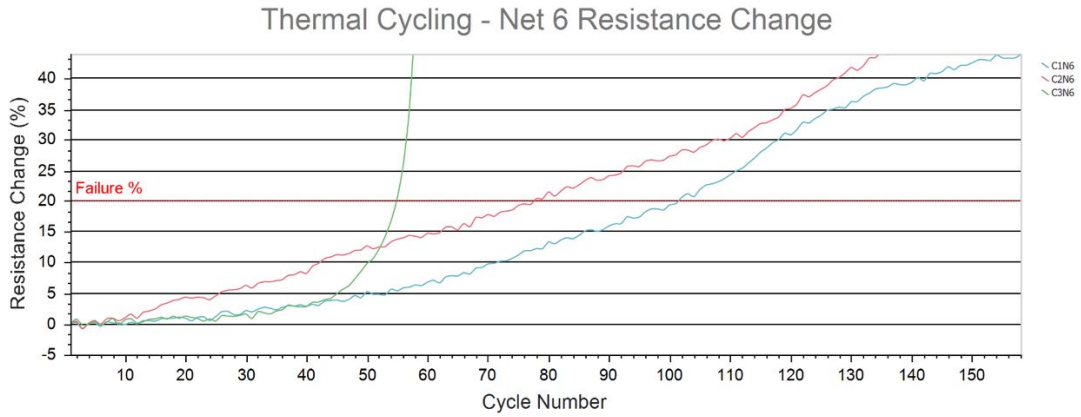
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00738	0.00662	0.00666	-	-	-
Maximum Resistance % Change	1.56	0.99	0.42	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



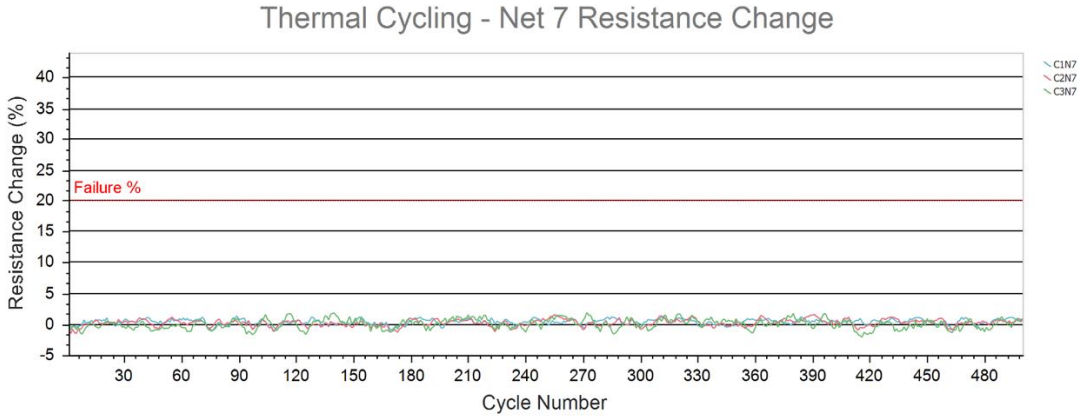
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00827	0.00738	0.00733	-	-	-
Maximum Resistance % Change	194.03	404.70	624.23	-	-	-
Cycle Failed 20% Limit	102	78	55	-	-	-

Group 4A, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

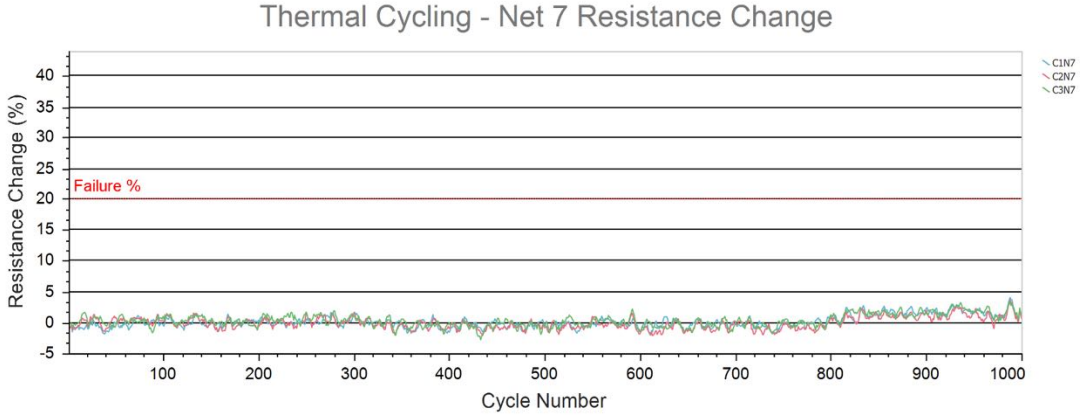
Cycle Range (°C): 25 to 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SS Inside MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	SS Outside MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SS Inside MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SS Inside MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	SS Outside MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	SS Outside MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



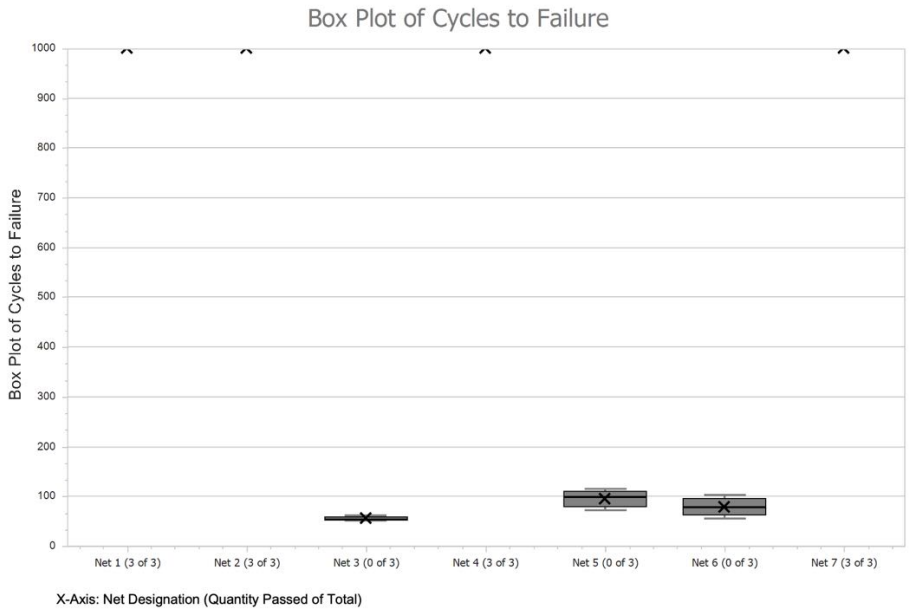
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00147	0.00146	0.00143	-	-	-
Maximum Resistance % Change	1.25	1.53	1.81	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-

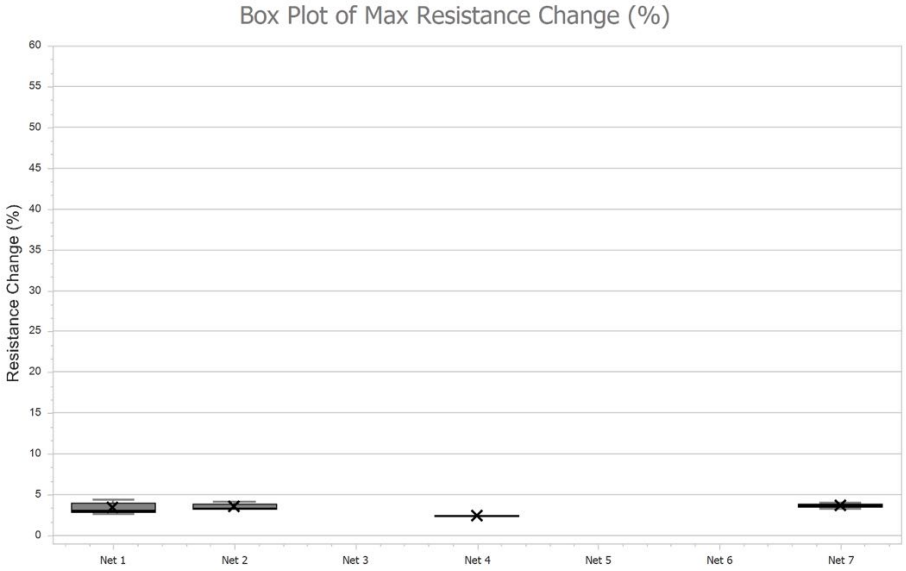


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00161	0.00161	0.00153	-	-	-
Maximum Resistance % Change	4.00	3.59	3.30	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4A, HATS^{2TM} Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles); Box Plots for 1000x Cycle Test

Cycle Range (°C): 25 to 150 / 25 to 190	**Quality of Cycles:** 500/1000	**Failure Percentage (%):** 20
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SS Inside MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: SS Outside MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SS Inside MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SS Inside MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: SS Outside MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: SS Outside MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



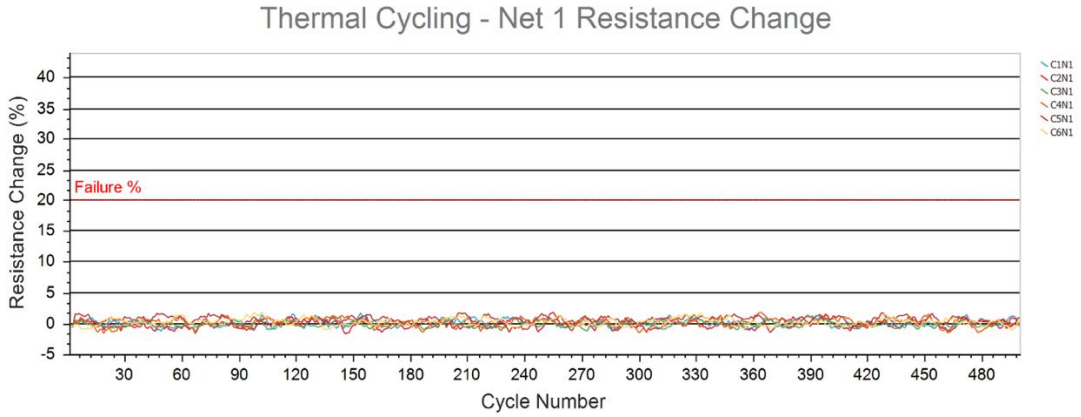


Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

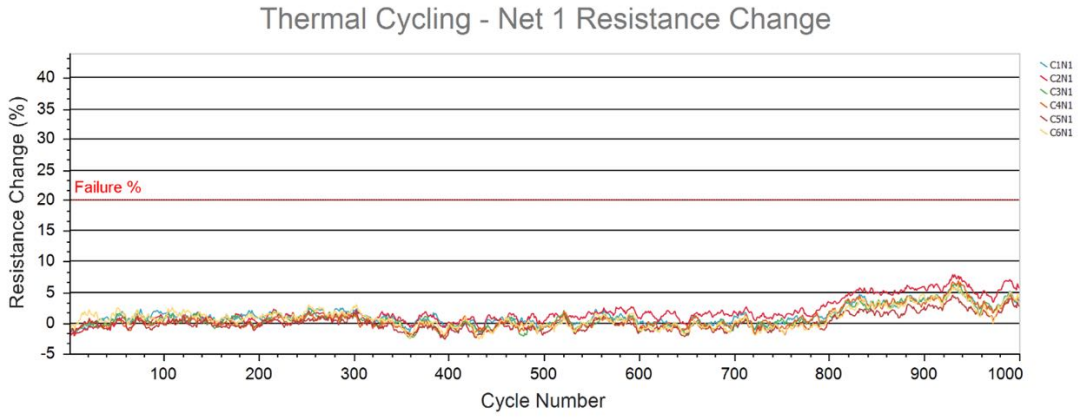
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00090	0.00090	0.00086	0.00081	0.00088	0.00077
Maximum Resistance % Change	1.61	1.77	1.37	1.77	1.69	1.81
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



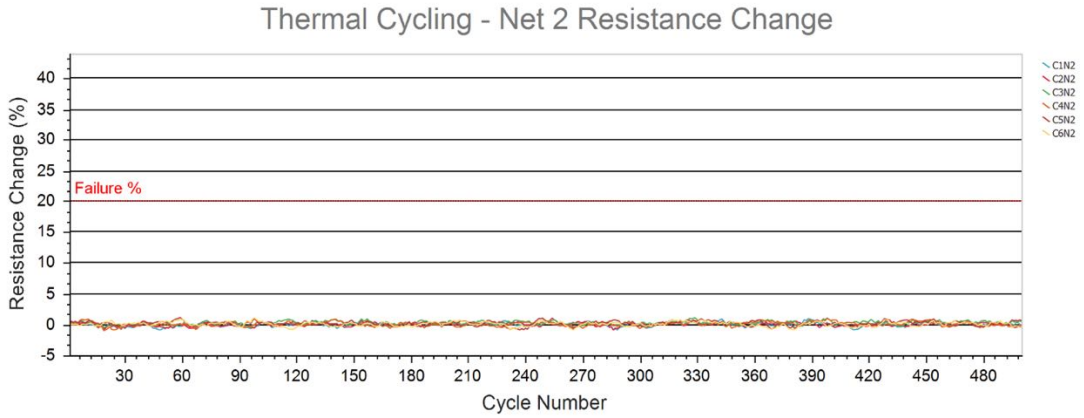
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00095	0.00096	0.00091	0.00088	0.00096	0.00080
Maximum Resistance % Change	6.04	7.84	6.59	6.82	4.50	5.83
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

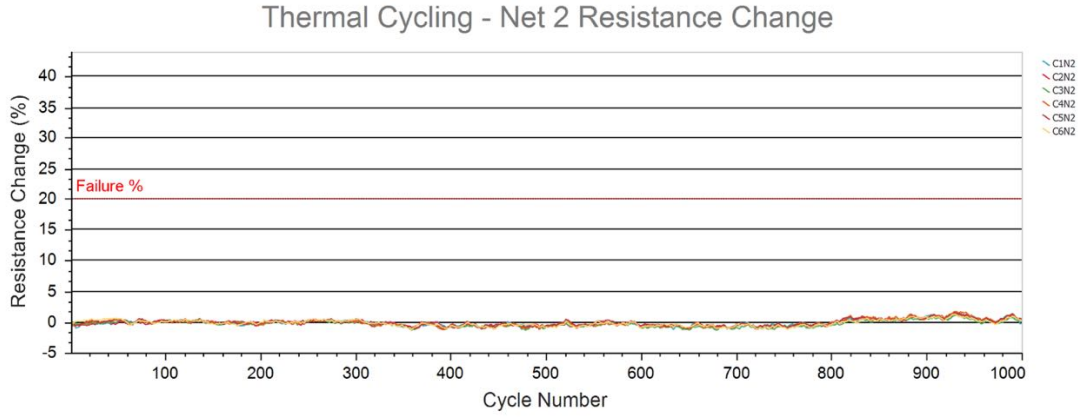
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00228	0.00225	0.00230	0.00205	0.00212	0.00224
Maximum Resistance % Change	0.89	0.98	1.01	0.94	1.10	1.01
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



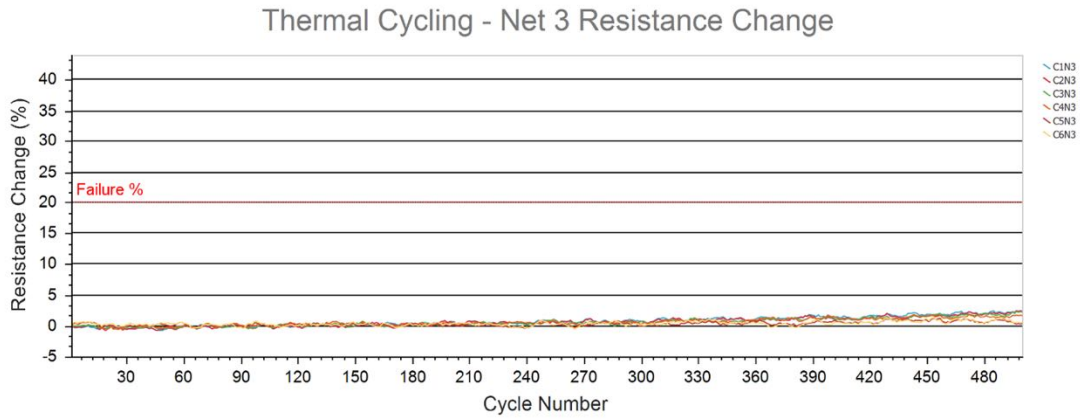
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00244	0.00242	0.00251	0.00224	0.00233	0.00245
Maximum Resistance % Change	1.40	1.35	1.13	1.70	1.54	1.26
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

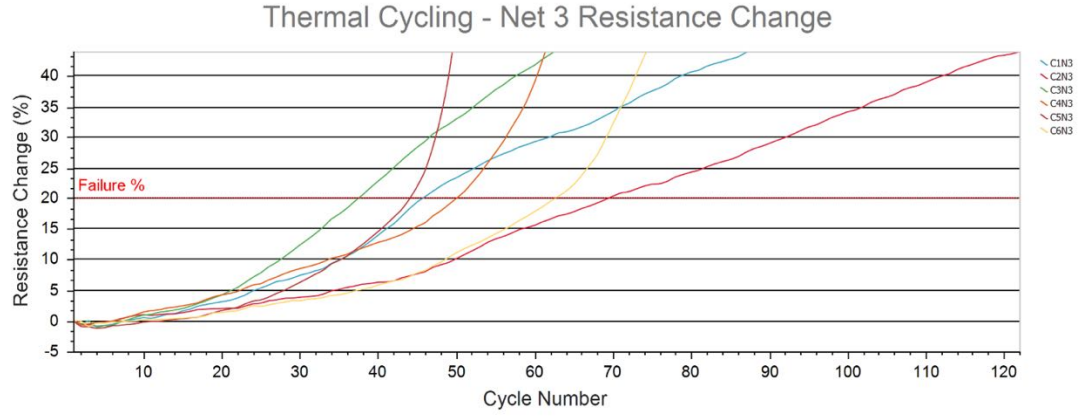
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00315	0.00313	0.00321	0.00297	0.00305	0.00268
Maximum Resistance % Change	2.36	2.39	2.26	1.79	1.16	1.30
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



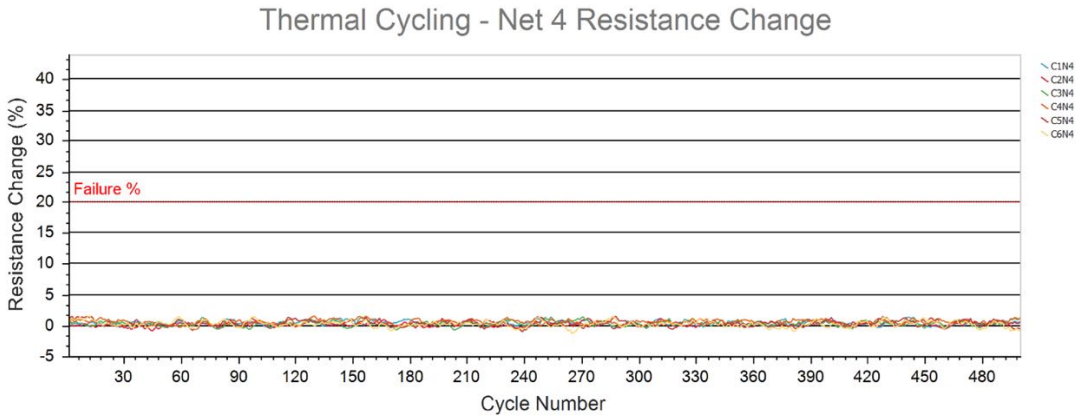
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00354	0.00351	0.00361	0.00332	0.00339	0.00297
Maximum Resistance % Change	222.85	216.19	438.31	393.61	1503.30	67194.45
Cycle Failed 20% Limit	46	70	38	50	45	63

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

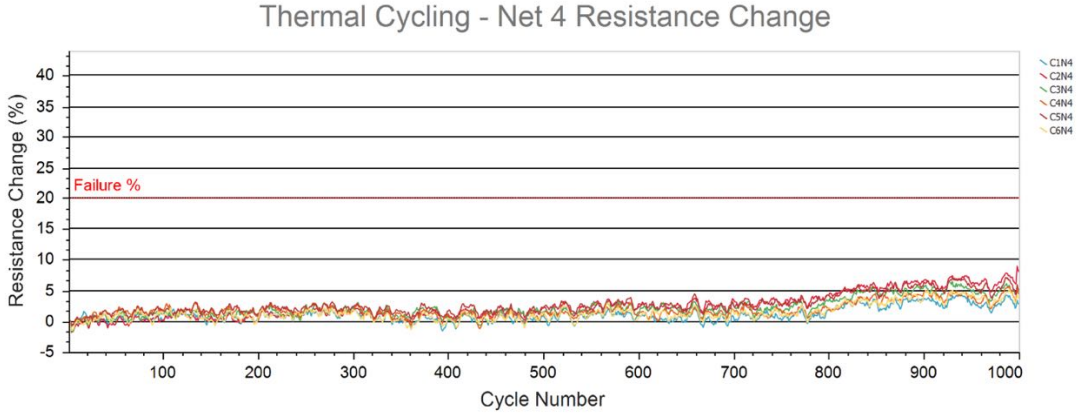
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00132	0.00141	0.00130	0.00133	0.00138	0.00125
Maximum Resistance % Change	1.27	1.11	1.32	1.51	1.43	1.46
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



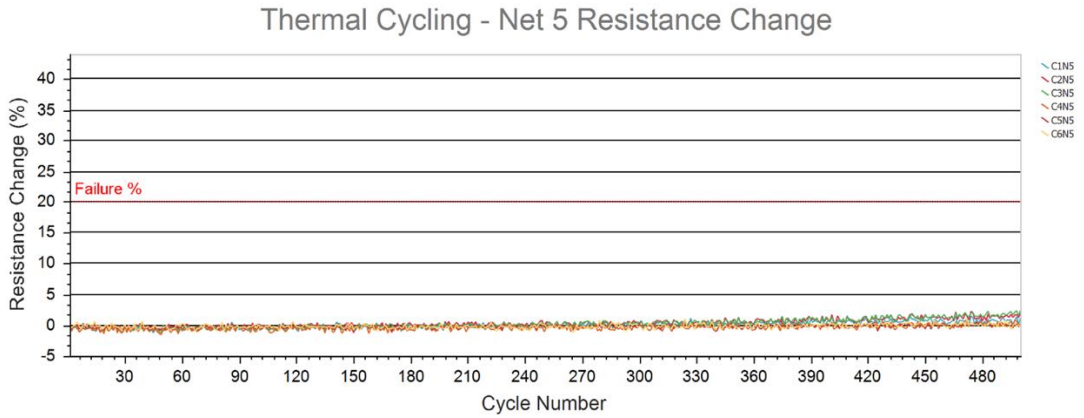
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00138	0.00149	0.00138	0.00139	0.00146	0.00134
Maximum Resistance % Change	4.31	8.85	6.43	5.58	7.13	5.15
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

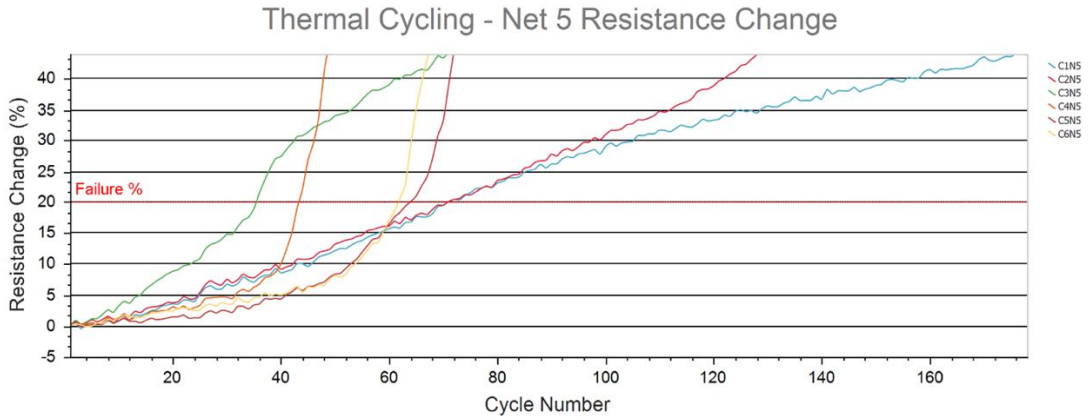
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00568	0.00600	0.00588	0.00567	0.00614	0.00530
Maximum Resistance % Change	1.25	1.98	2.34	0.58	0.39	0.73
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



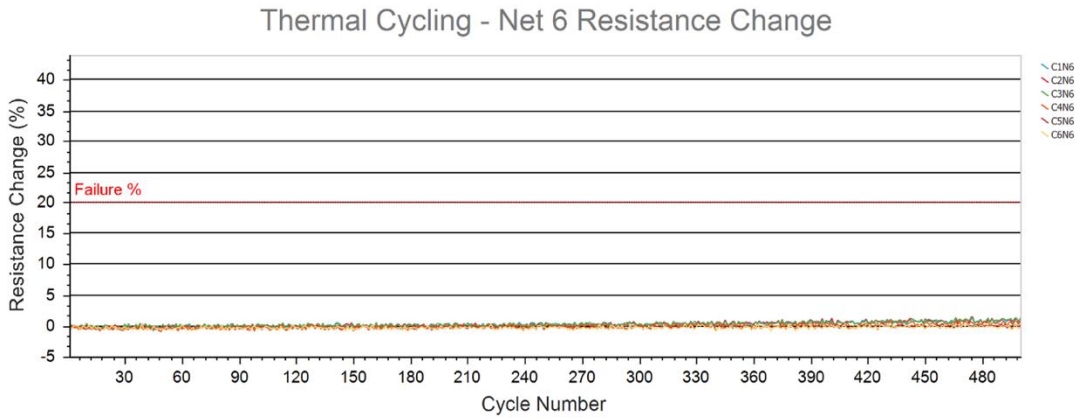
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00635	0.00678	0.00669	0.00627	0.00676	0.00586
Maximum Resistance % Change	181.19	241.66	201.82	1548.20	300.22	34012.23
Cycle Failed 20% Limit	71	71	36	44	64	62

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

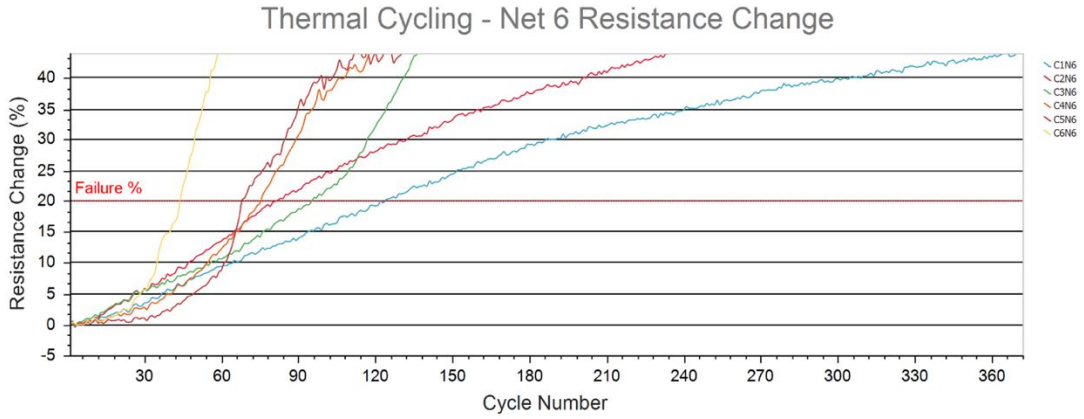
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00843	0.00849	0.00858	0.00793	0.00864	0.00802
Maximum Resistance % Change	1.20	1.16	1.27	0.78	0.18	0.14
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



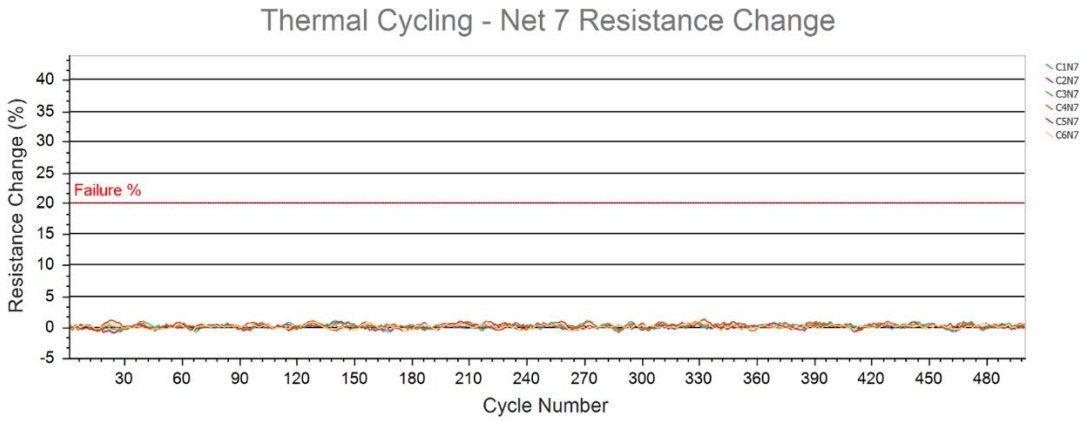
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00943	0.00950	0.00963	0.00880	0.00952	0.00883
Maximum Resistance % Change	81.35	121.89	169.81	129.66	179.67	1032.53
Cycle Failed 20% Limit	122	81	96	76	68	44

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

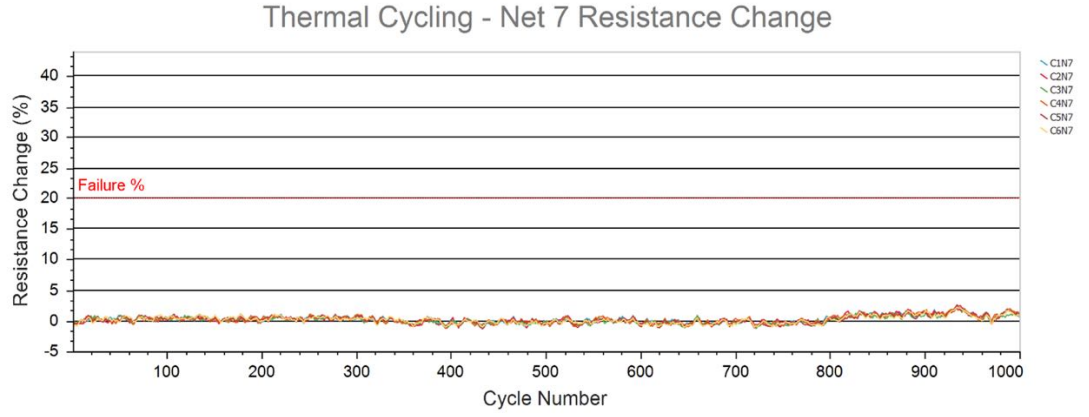
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



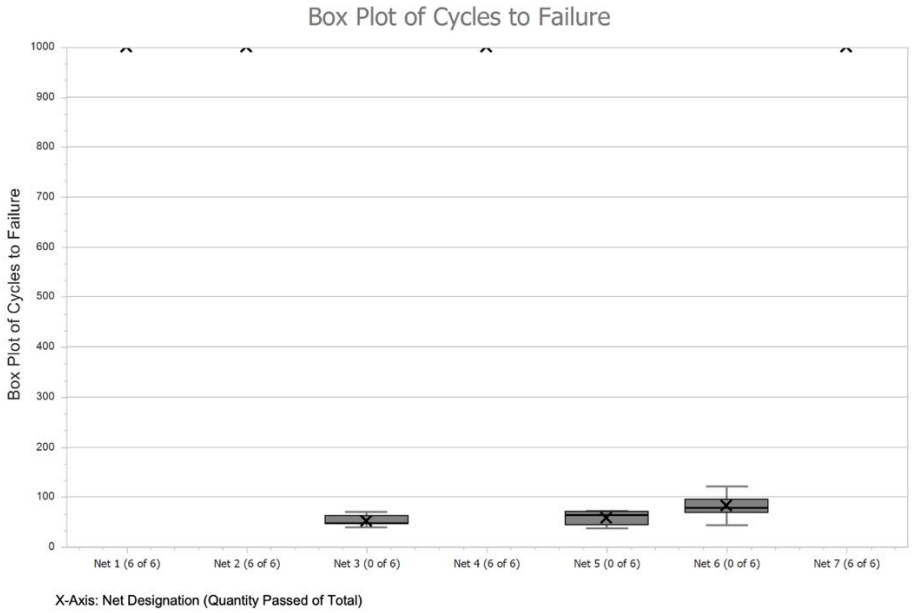
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00209	0.00209	0.00215	0.00201	0.00220	0.00220
Maximum Resistance % Change	0.99	0.91	0.98	0.95	1.20	0.94
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500

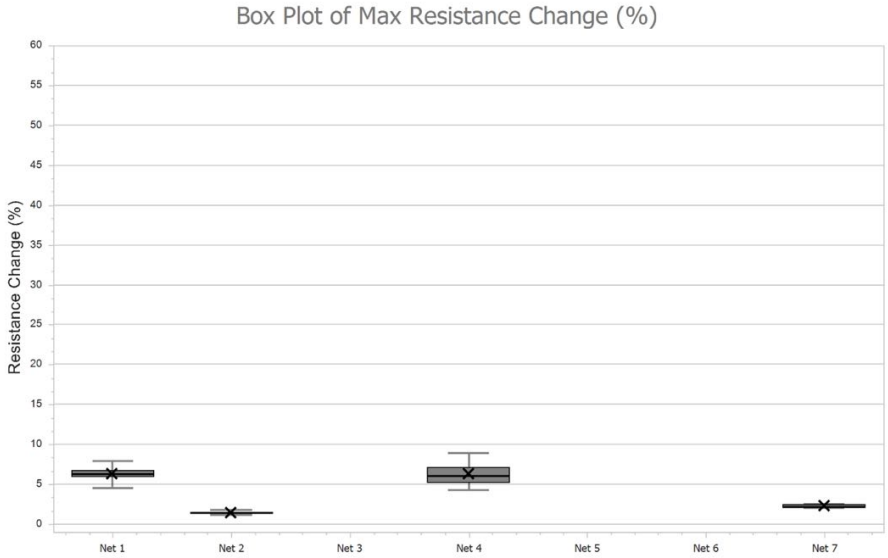


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00229	0.00228	0.00236	0.00218	0.00236	0.00235
Maximum Resistance % Change	2.48	2.57	1.96	2.04	2.19	2.19
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles); Box Plots for 1000x Cycle Test

Cycle Range (°C): 25 to 150 / 25 to 190	**Quality of Cycles:** 500/1000	**Failure Percentage (%):** 20
Quantity of Coupons: 6	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: Full Stacked MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Full Staggered MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



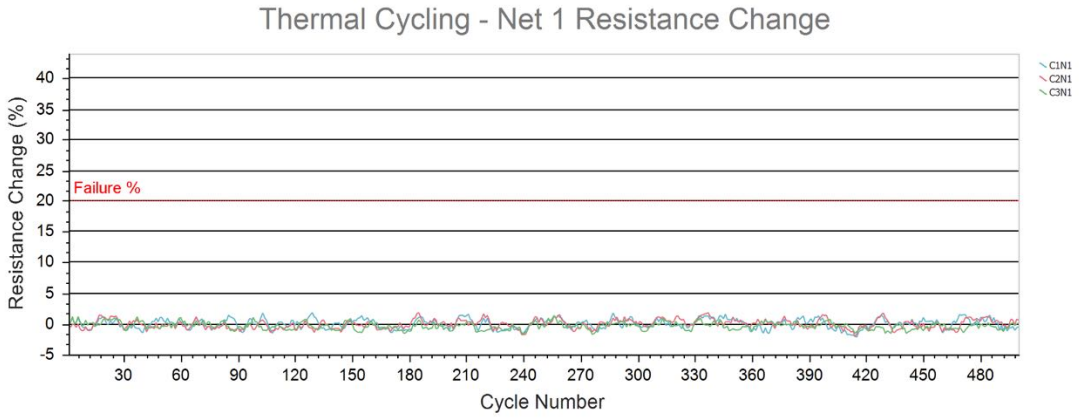


Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

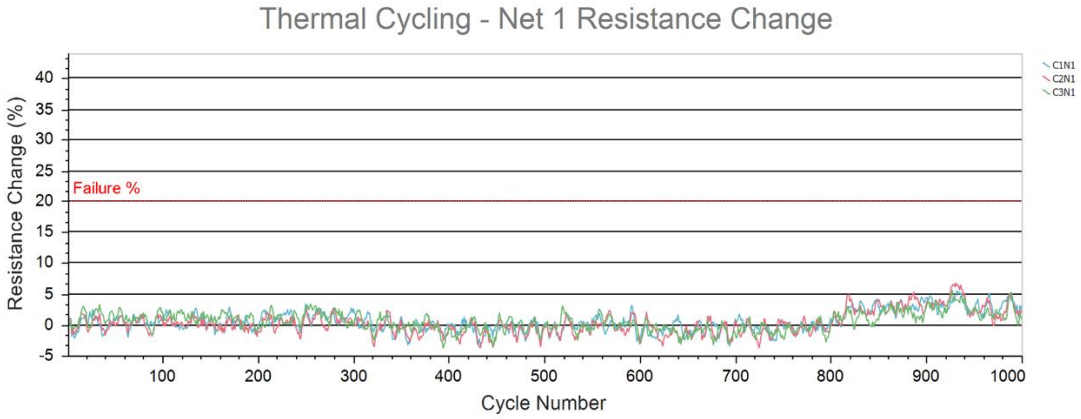
Cycle Range (°C): 25 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00084	0.00086	0.00089	-	-	-
Maximum Resistance % Change	1.76	1.77	1.29	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



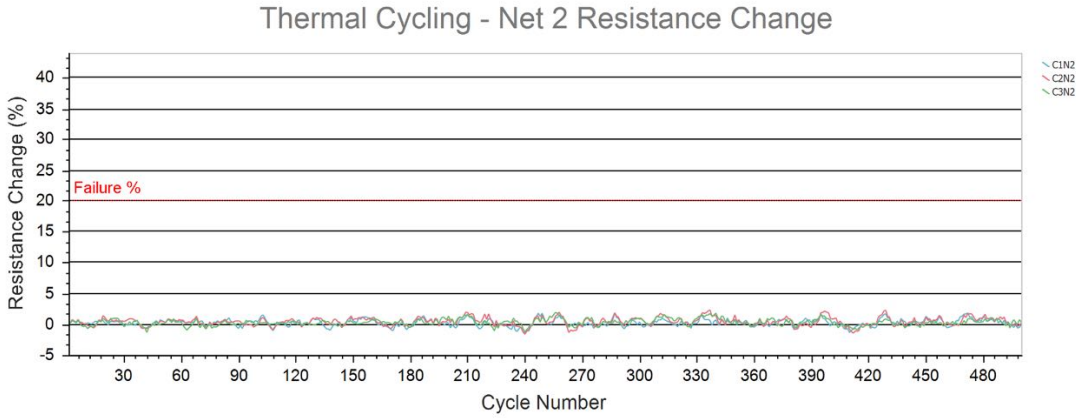
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00092	0.00093	0.00094	-	-	-
Maximum Resistance % Change	5.47	6.70	5.59	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

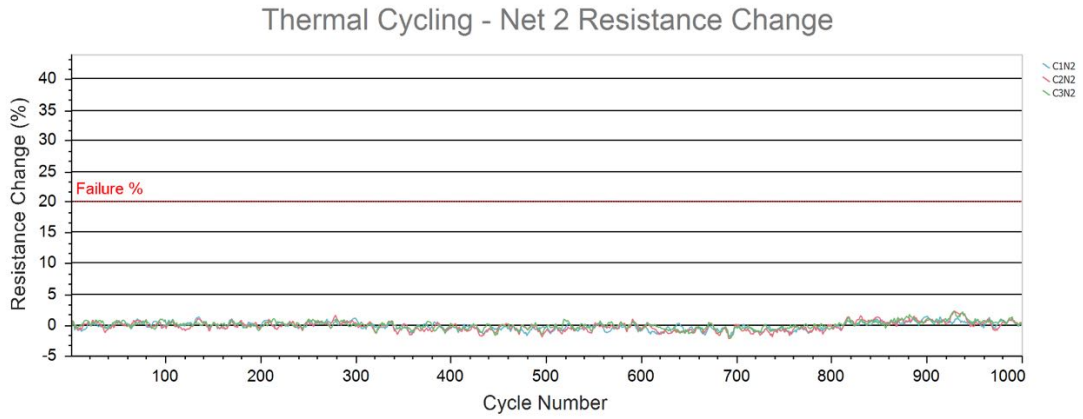
Cycle Range (°C): 25 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00225	0.00194	0.00216	-	-	-
Maximum Resistance % Change	1.73	2.23	1.86	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



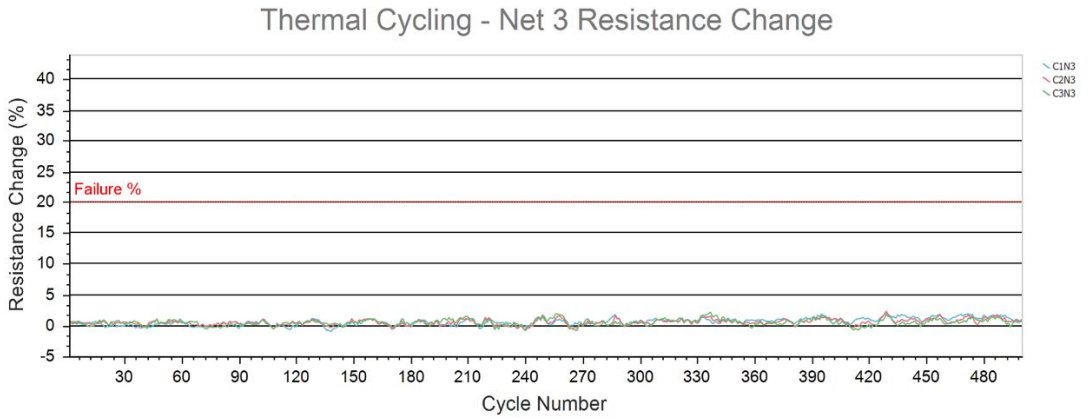
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00249	0.00212	0.00237	-	-	-
Maximum Resistance % Change	1.32	2.23	2.08	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

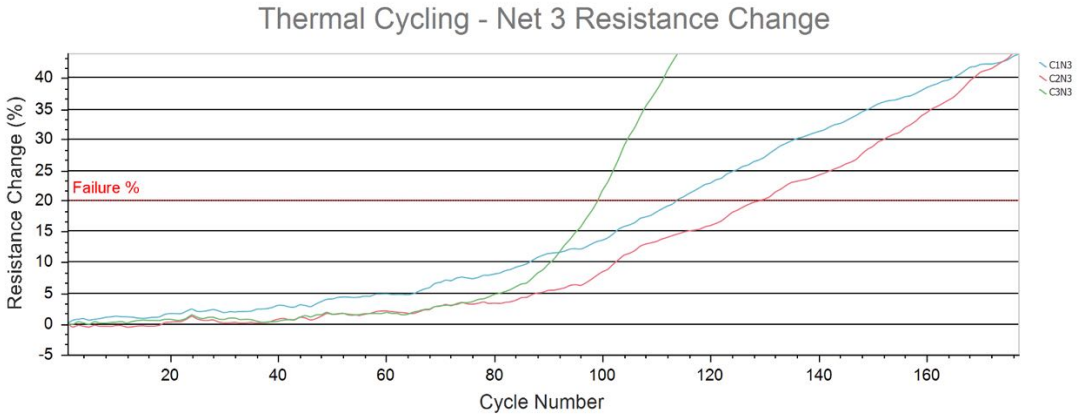
Cycle Range (°C): 25 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00319	0.00294	0.00273	-	-	-
Maximum Resistance % Change	1.93	2.26	2.09	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-

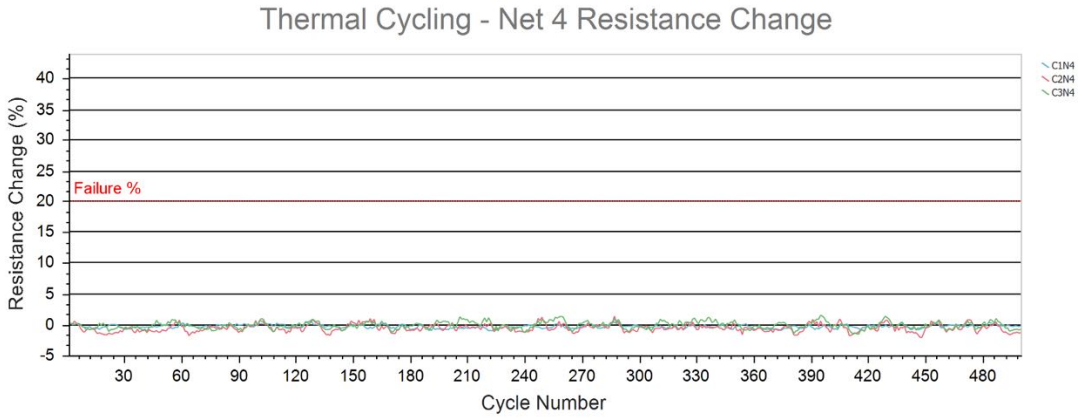


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00353	0.00326	0.00303	-	-	-
Maximum Resistance % Change	183.46	252.24	509.28	-	-	-
Cycle Failed 20% Limit	114	129	100	-	-	-

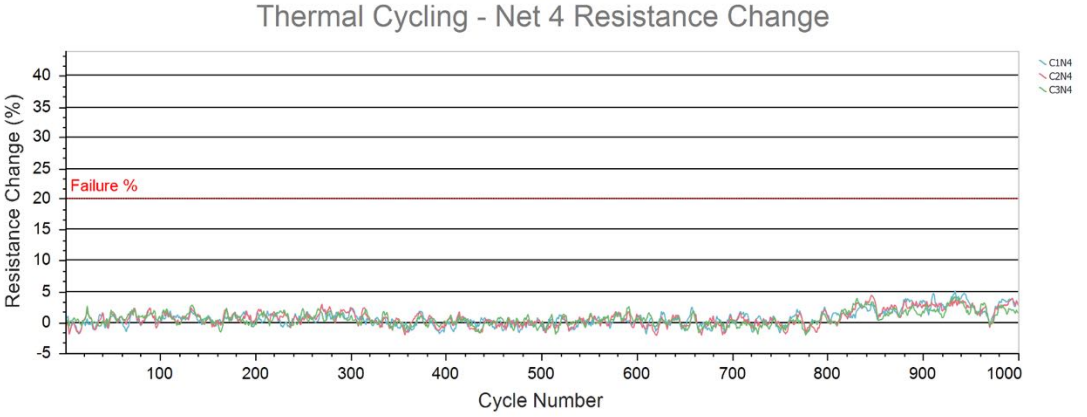
Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

Cycle Range (°C): 25 150 / 25 to 190
Quality of Cycles: 500/1000
Failure Percentage (%): 20
Quantity of Coupons: 3
Number of Nets: 7
Coupon Thickness: 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00130	0.00123	0.00133	-	-	-
Maximum Resistance % Change	0.61	1.28	1.48	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



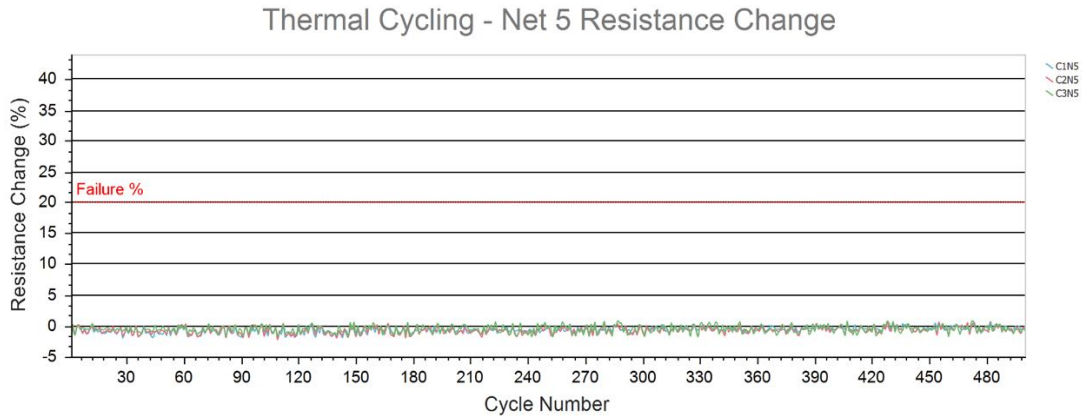
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00132	0.00130	0.00144	-	-	-
Maximum Resistance % Change	5.03	4.32	4.09	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

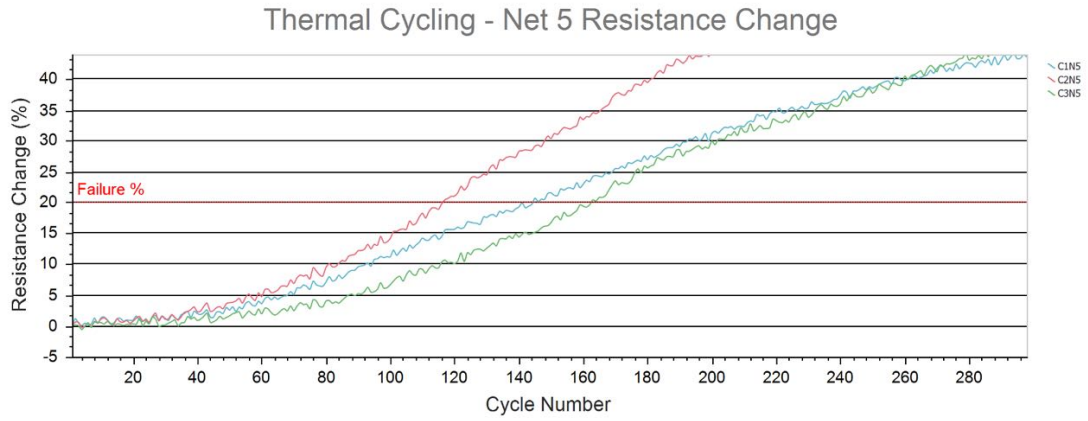
Cycle Range (°C): 25 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00600	0.00553	0.00543	-	-	-
Maximum Resistance % Change	0.65	0.91	0.70	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



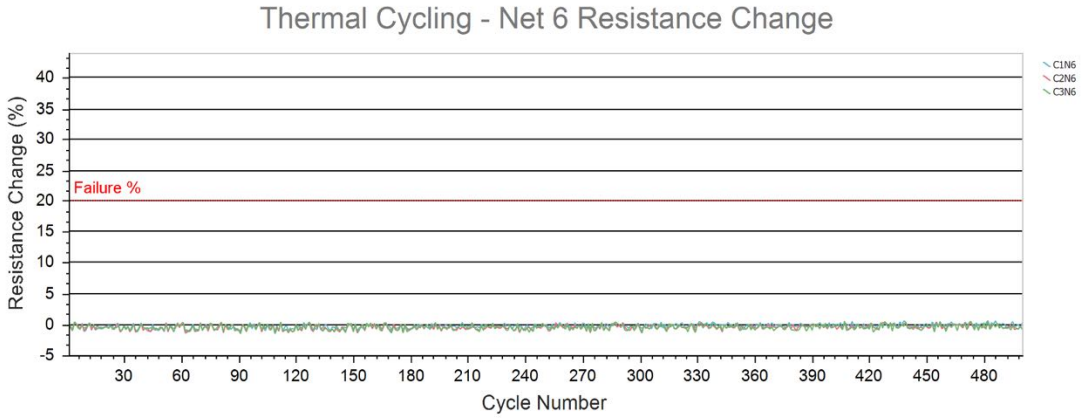
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00658	0.00606	0.00595	-	-	-
Maximum Resistance % Change	88.14	146.12	139.51	-	-	-
Cycle Failed 20% Limit	145	117	163	-	-	-

Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

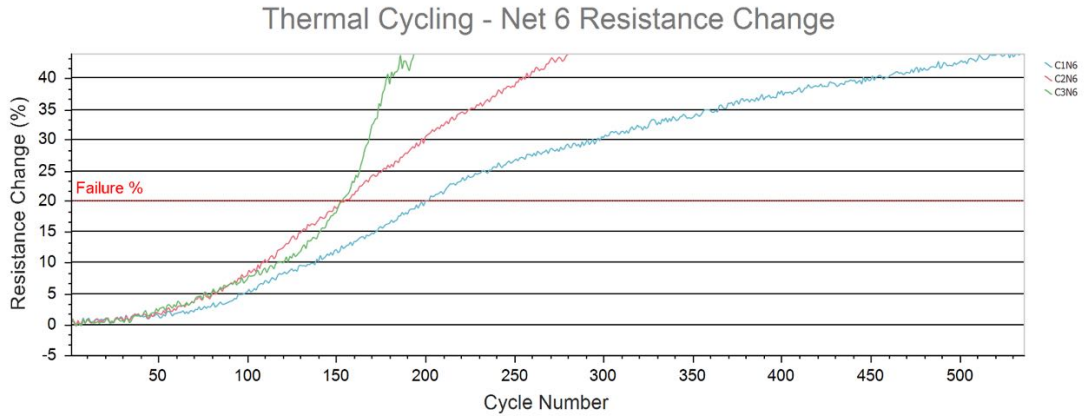
Cycle Range (°C): 25 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00836	0.00784	0.00786	-	-	-
Maximum Resistance % Change	0.62	0.48	0.41	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



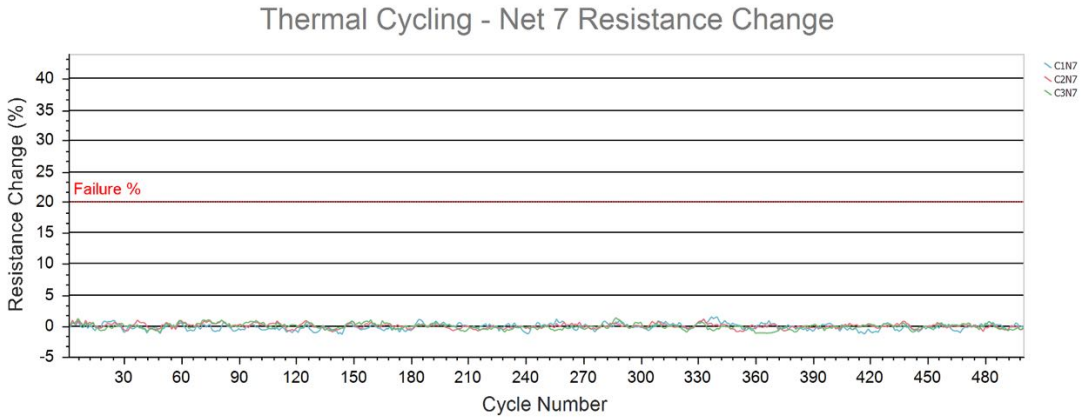
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00920	0.00861	0.00862	-	-	-
Maximum Resistance % Change	58.80	101.71	229.77	-	-	-
Cycle Failed 20% Limit	201	153	154	-	-	-

Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

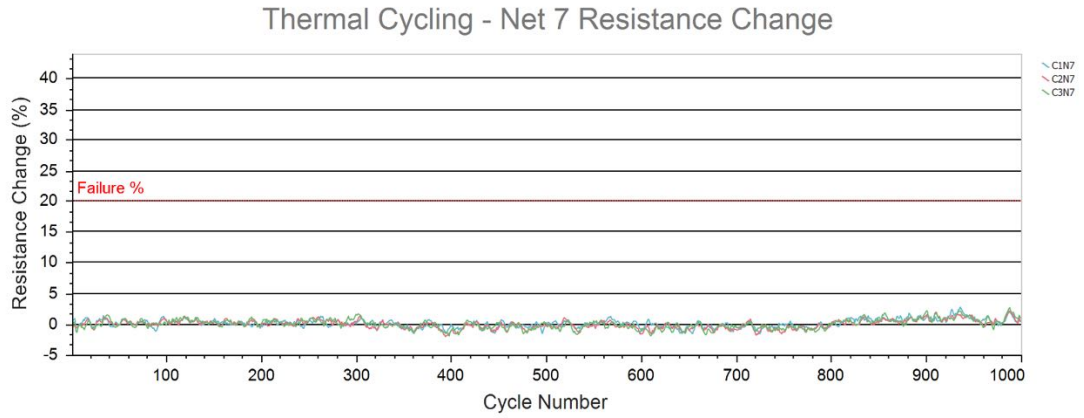
Cycle Range (°C): 25 150 / 25 to 190 **Quality of Cycles:** 500/1000 **Failure Percentage (%):** 20

Quantity of Coupons: 3 **Number of Nets:** 7 **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	Full Stacked MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Full Staggered MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	Full Stacked MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Full Staggered MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



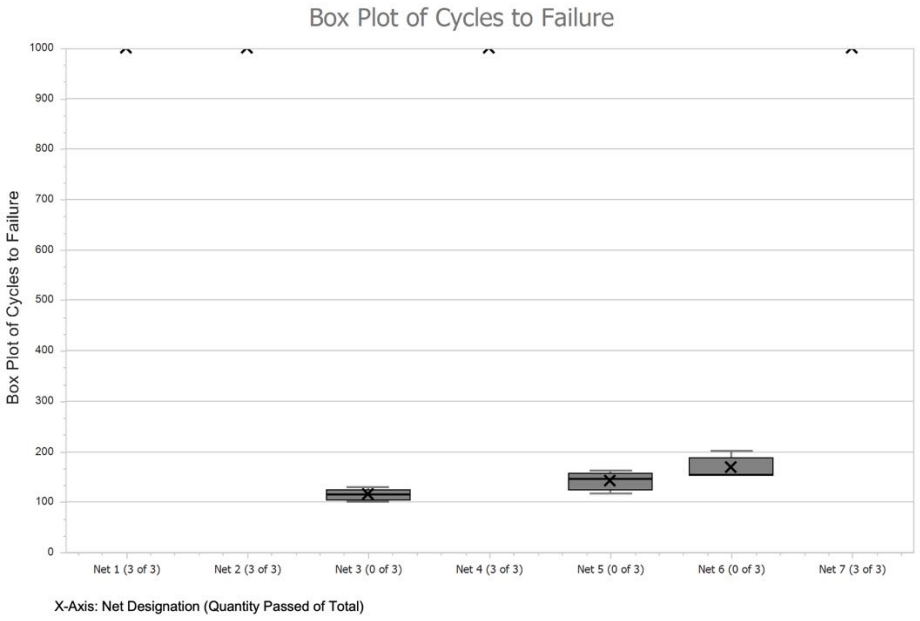
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00202	0.00207	0.00195	-	-	-
Maximum Resistance % Change	1.39	1.04	1.25	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-

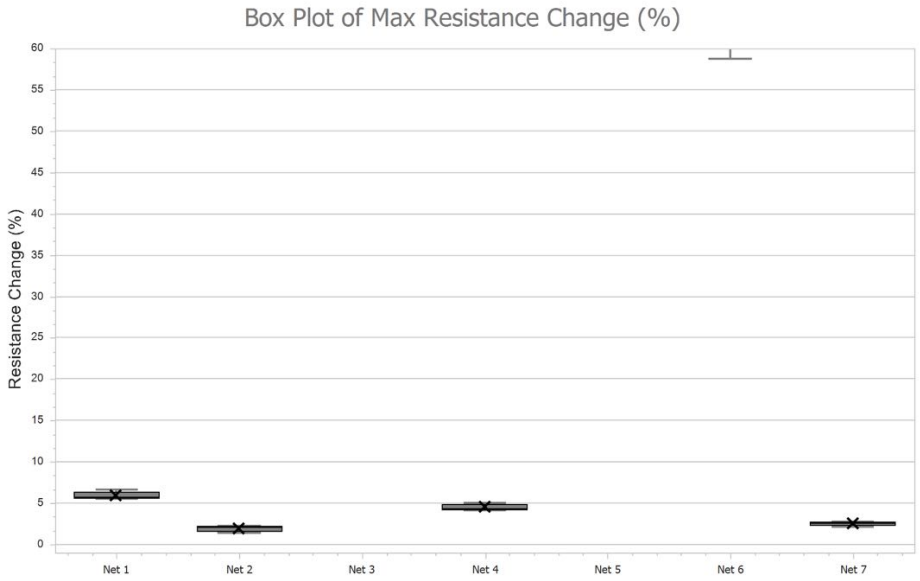


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00216	0.00221	0.00207	-	-	-
Maximum Resistance % Change	2.72	2.09	2.62	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4B, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles); Box Plots for 1000x Cycle Test

Cycle Range (°C): 25 150 / 25 to 190	**Quality of Cycles:** 500/1000	**Failure Percentage (%):** 20
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: Full Stacked MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Full Staggered MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: Full Stacked MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: Full Stacked MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Full Staggered MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Full Staggered MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



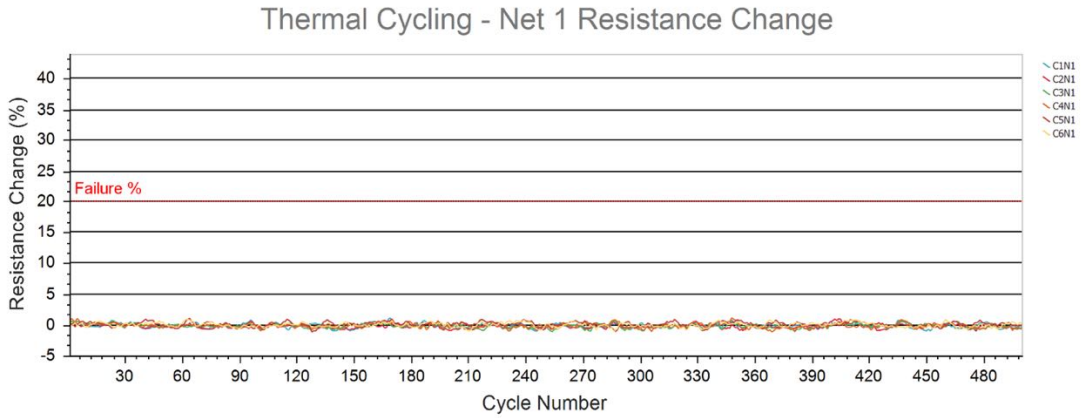


Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

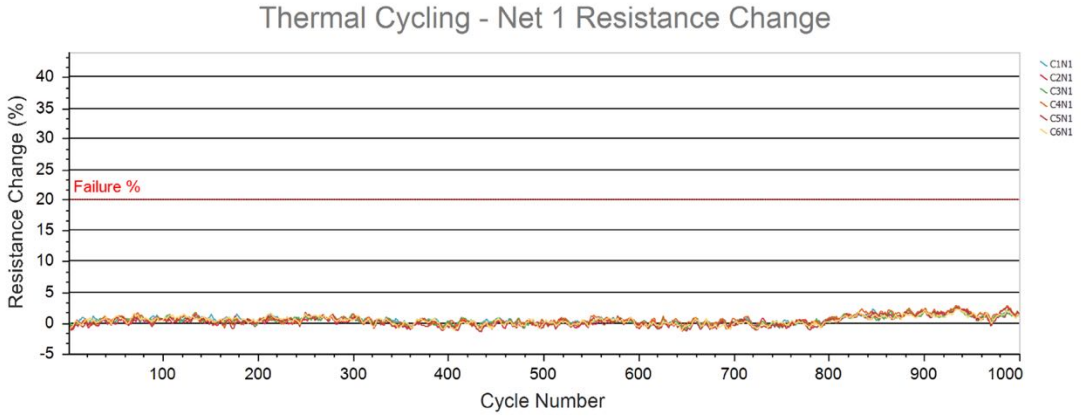
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00213	0.00209	0.00207	0.00188	0.00185	0.00194
Maximum Resistance % Change	1.07	0.93	0.64	1.08	0.99	0.83
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



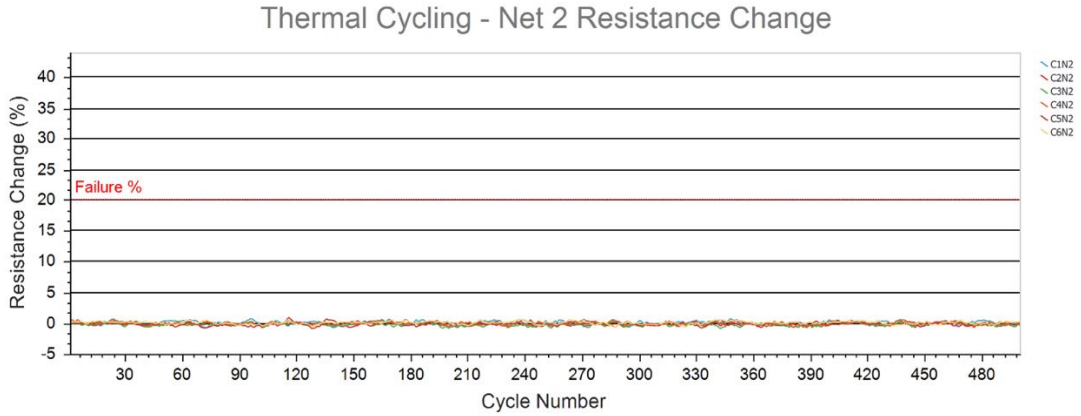
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00227	0.00223	0.00218	0.00197	0.00198	0.00210
Maximum Resistance % Change	2.77	2.54	2.46	2.76	2.52	2.19
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

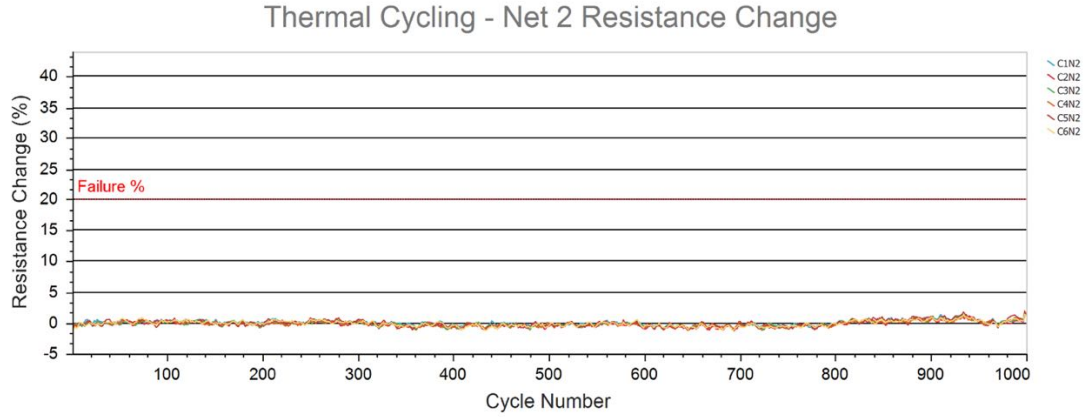
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00291	0.00318	0.00296	0.00298	0.00261	0.00299
Maximum Resistance % Change	0.71	0.44	0.35	0.64	0.88	0.54
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



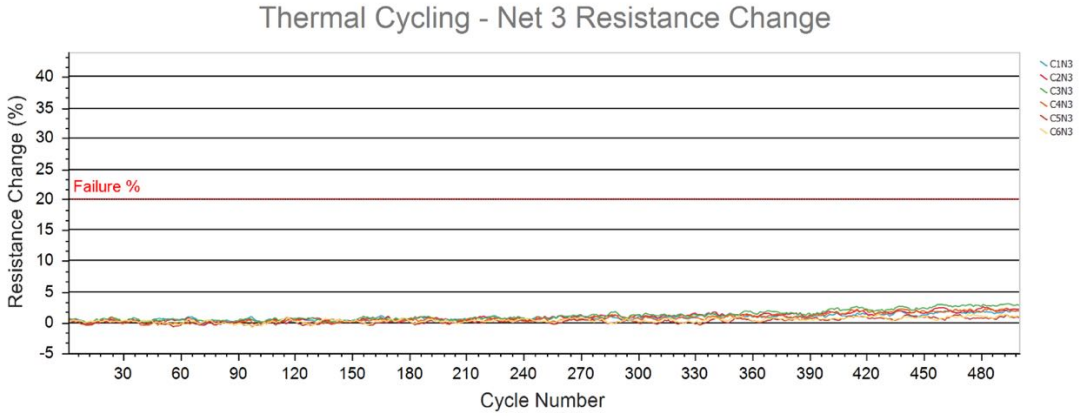
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00315	0.00345	0.00319	0.00319	0.00280	0.00324
Maximum Resistance % Change	1.68	1.36	1.25	1.91	1.74	1.34
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

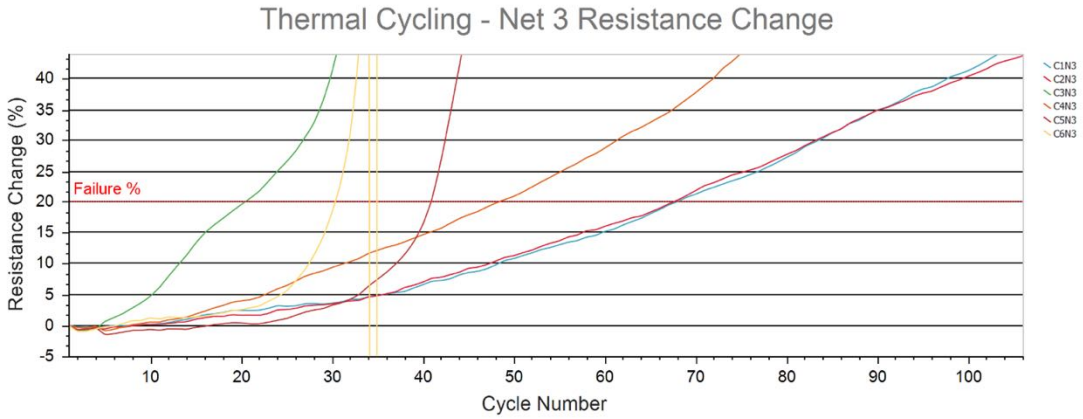
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00314	0.00316	0.00322	0.00297	0.00313	0.00273
Maximum Resistance % Change	1.93	2.52	3.03	2.28	1.27	1.31
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



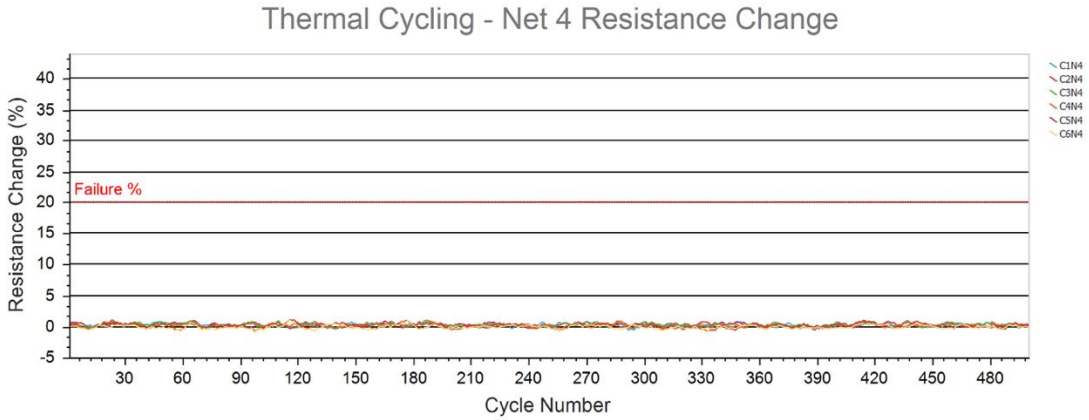
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00352	0.00356	0.00368	0.00333	0.00346	0.00300
Maximum Resistance % Change	1374.13	246.30	590.93	331.59	944.40	66632.80
Cycle Failed 20% Limit	68	68	21	47	42	32

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

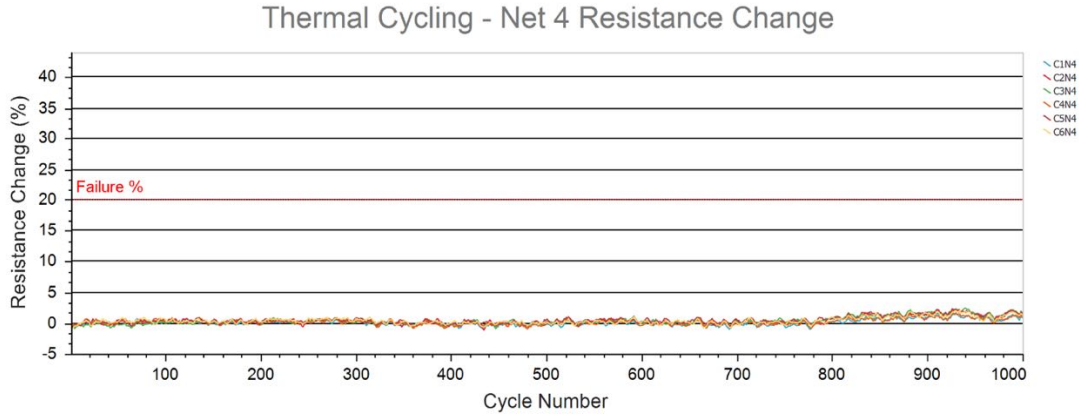
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00275	0.00263	0.00268	0.00271	0.00279	0.00272
Maximum Resistance % Change	0.95	0.94	0.97	1.01	1.08	0.98
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



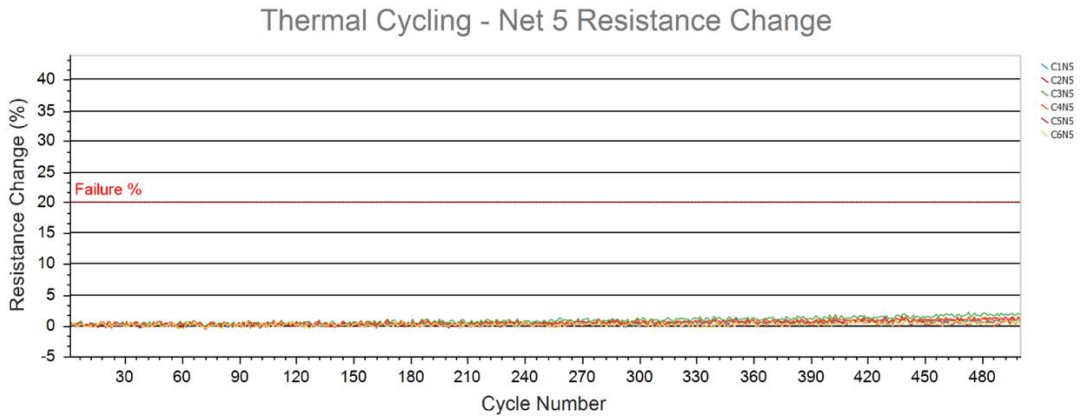
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00299	0.00288	0.00294	0.00296	0.00302	0.00294
Maximum Resistance % Change	1.56	2.16	2.41	1.63	2.28	2.06
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

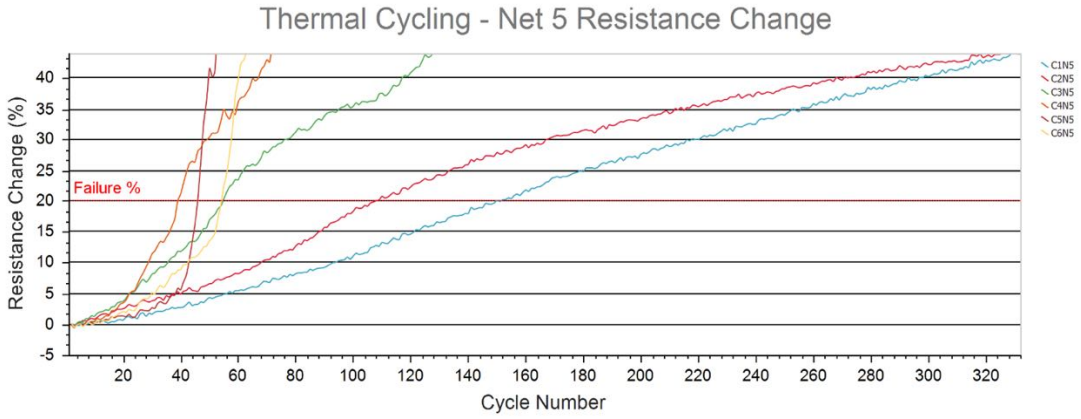
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00844	0.00871	0.00854	0.00815	0.00847	0.00803
Maximum Resistance % Change	1.02	1.27	1.86	1.18	0.51	0.63
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



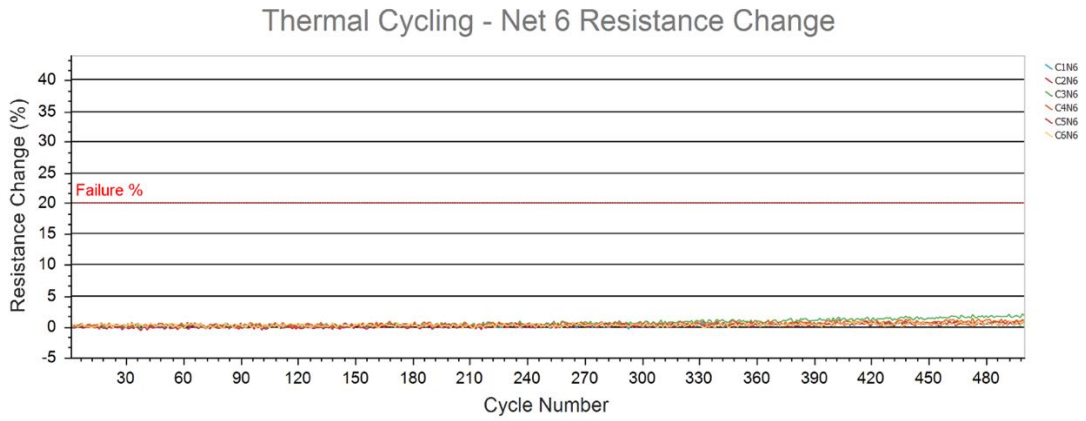
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00939	0.00976	0.00967	0.00913	0.00940	0.00891
Maximum Resistance % Change	92.39	93.21	172.00	639.40	463.64	634.15
Cycle Failed 20% Limit	150	108	55	39	46	55

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

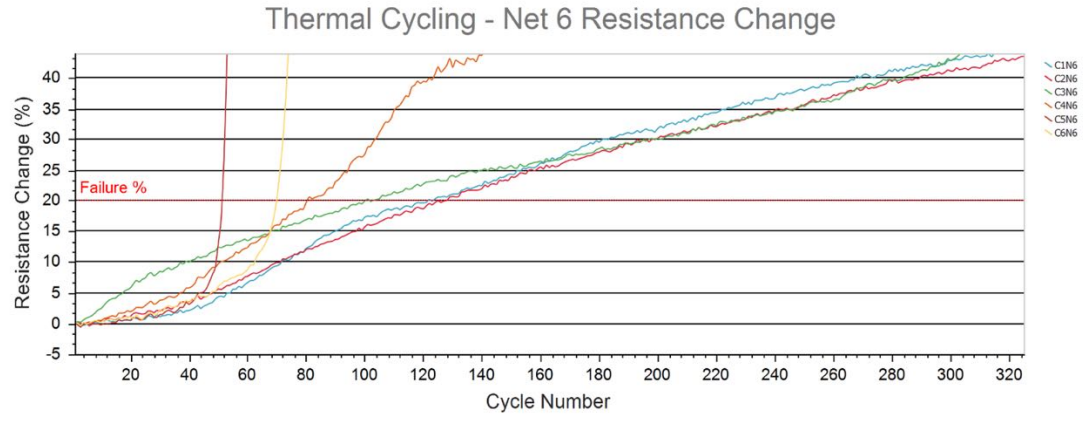
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type: SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01013	0.01067	0.01027	0.00982	0.00999	0.00994
Maximum Resistance % Change	0.77	0.83	1.87	0.96	0.42	0.60
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500



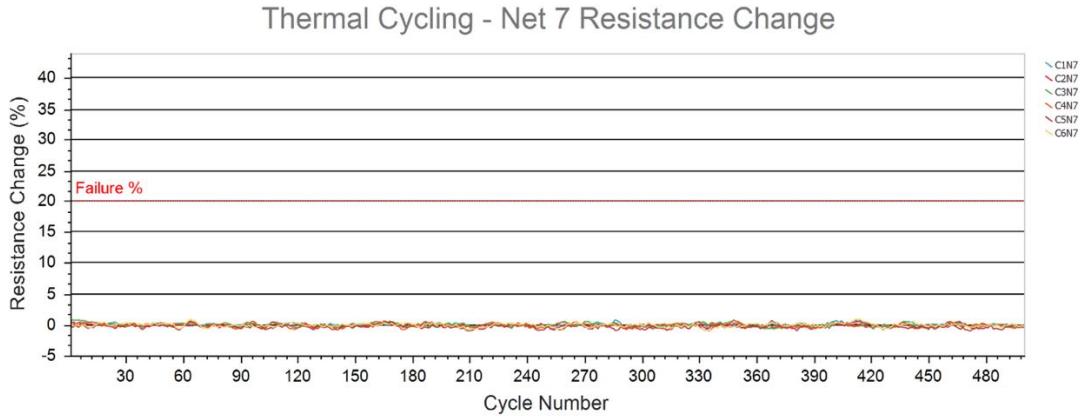
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01126	0.01188	0.01162	0.01099	0.01110	0.01105
Maximum Resistance % Change	146.92	1742.08	95.64	157.59	573.71	17996.26
Cycle Failed 20% Limit	122	125	101	81	52	70

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

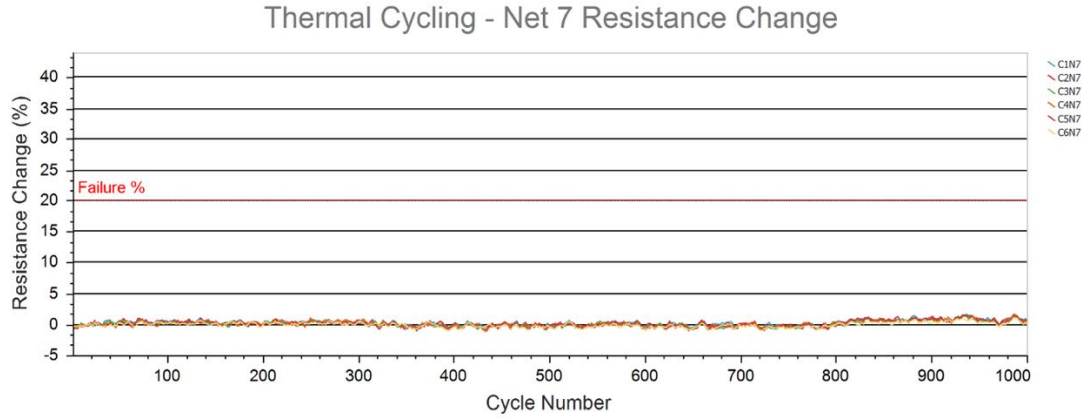
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 6 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



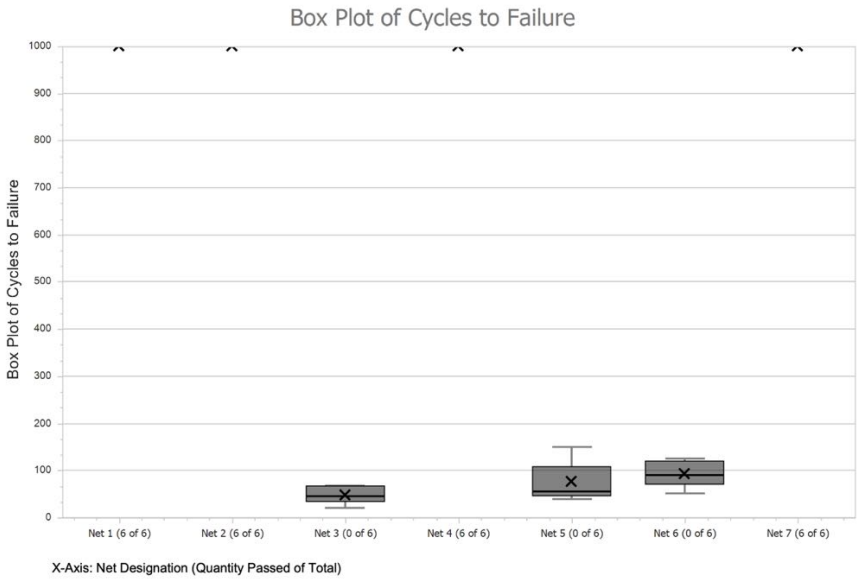
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00289	0.00282	0.00287	0.00273	0.00264	0.00297
Maximum Resistance % Change	0.75	0.49	0.75	0.70	0.62	0.92
Cycle Failed 20% Limit	>500	>500	>500	>500	>500	>500

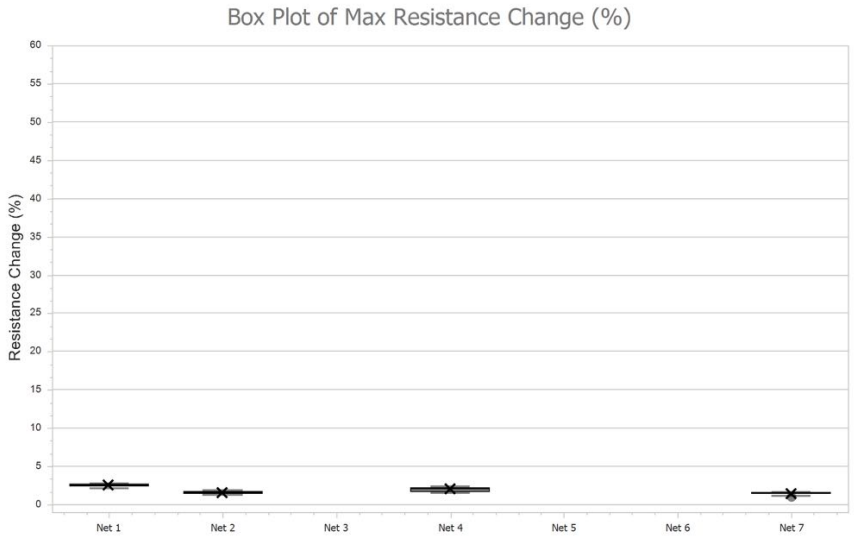


Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00311	0.00303	0.00310	0.00298	0.00287	0.00327
Maximum Resistance % Change	1.60	1.46	1.43	1.60	1.45	1.05
Cycle Failed 20% Limit	>1000	>1000	>1000	>1000	>1000	>1000

Group 3C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles); Box Plots for 1000x Cycle Test

Cycle Range (°C): 25 to 150 / 25 to 190	**Quality of Cycles:** 500/1000	**Failure Percentage (%):** 20
Quantity of Coupons: 6	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm



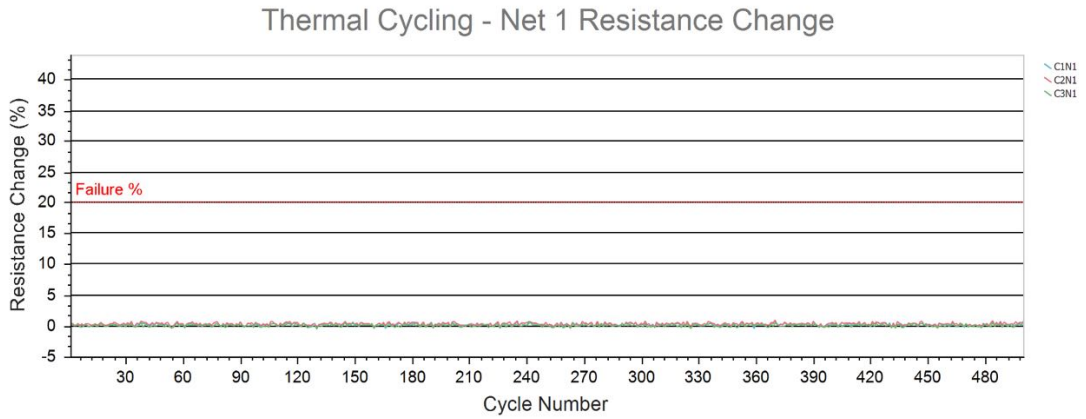


Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

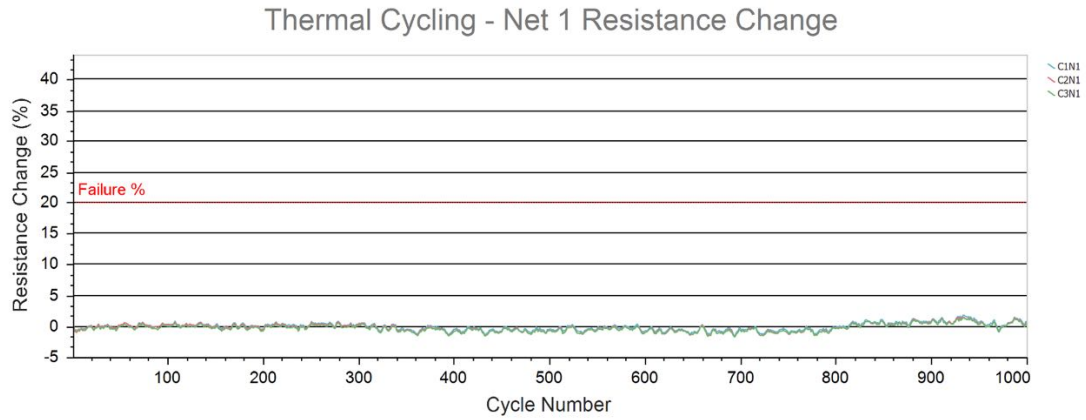
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00199	0.00190	0.00203	-	-	-
Maximum Resistance % Change	1.53	1.91	1.41	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



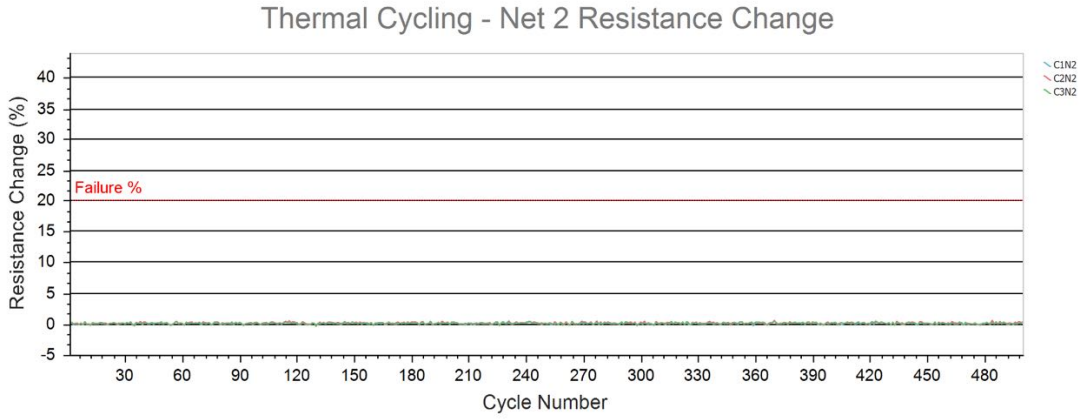
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00214	0.00204	0.00218	-	-	-
Maximum Resistance % Change	1.79	1.46	1.37	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

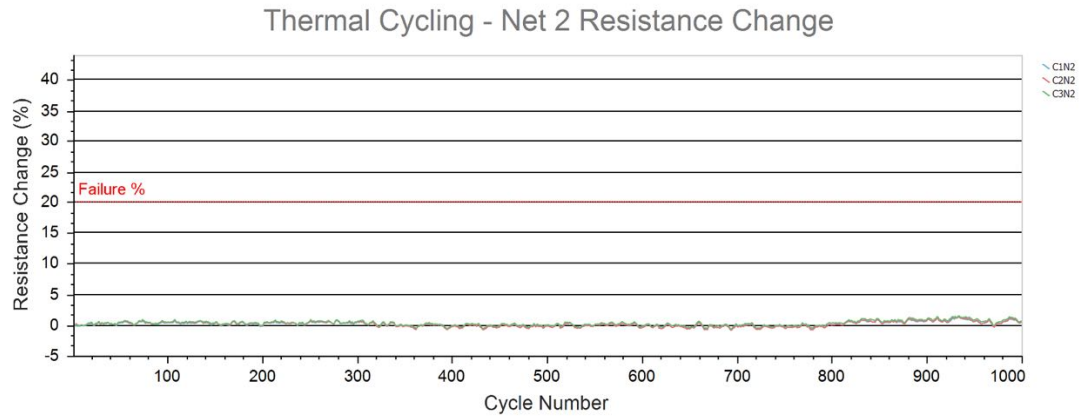
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00304	0.00275	0.00290	-	-	-
Maximum Resistance % Change	1.08	1.29	1.16	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



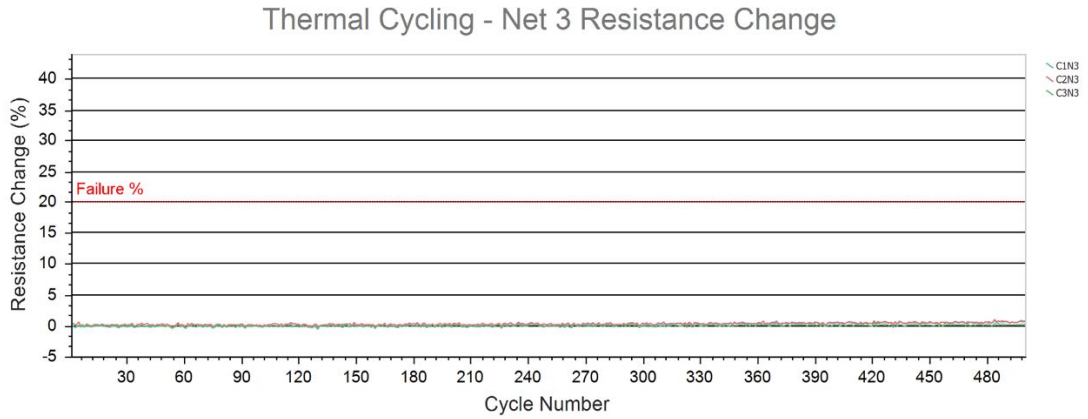
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00329	0.00299	0.00314	-	-	-
Maximum Resistance % Change	1.25	1.32	1.49	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

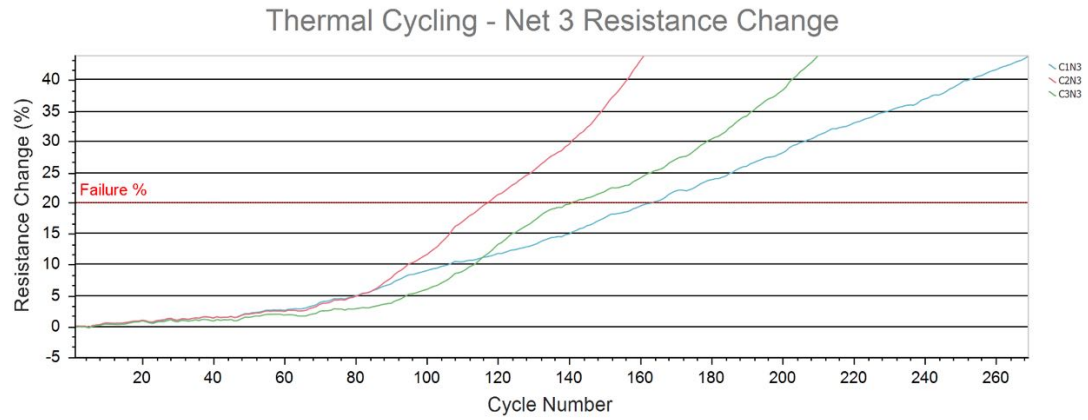
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00315	0.00295	0.00276	-	-	-
Maximum Resistance % Change	1.19	1.34	1.04	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



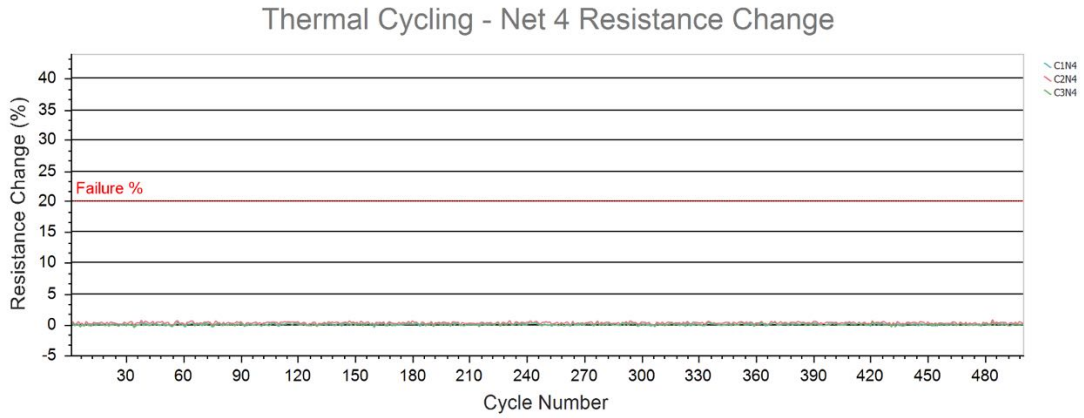
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00346	0.00324	0.00301	-	-	-
Maximum Resistance % Change	131.72	418.53	287.45	-	-	-
Cycle Failed 20% Limit	162	117	141	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

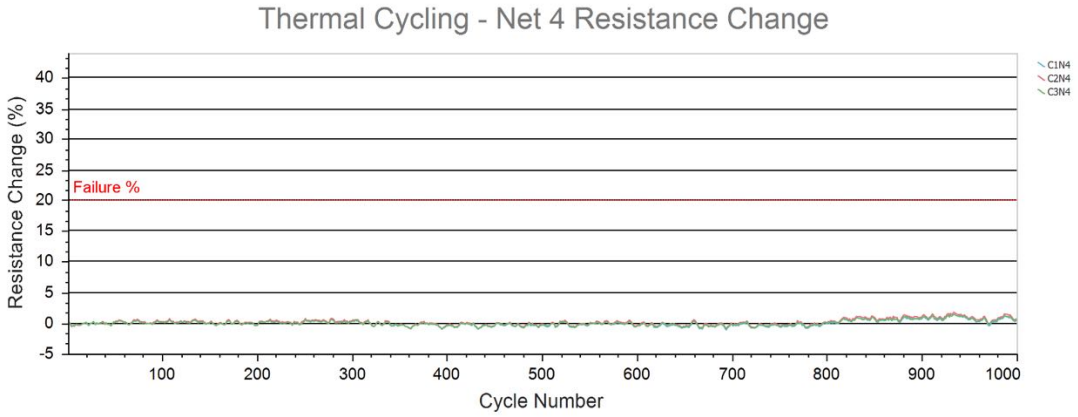
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00262	0.00245	0.00272	-	-	-
Maximum Resistance % Change	1.17	1.53	0.98	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



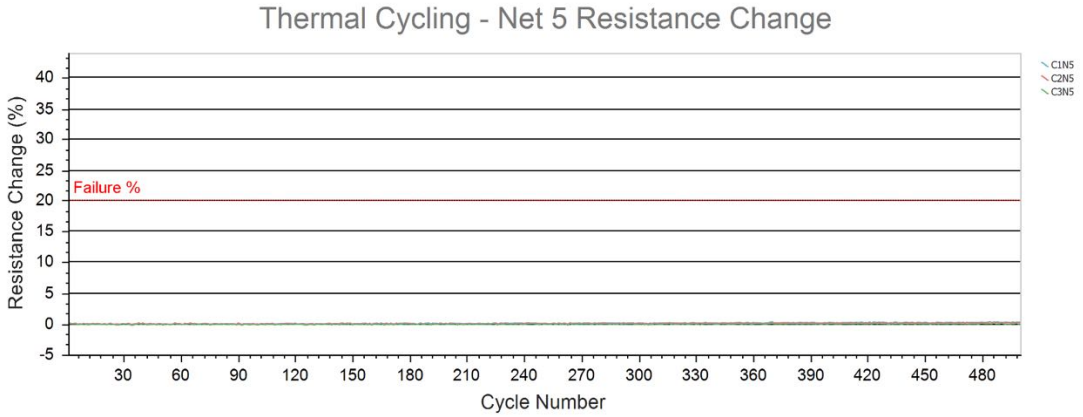
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00284	0.00264	0.00294	-	-	-
Maximum Resistance % Change	1.41	1.73	1.42	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

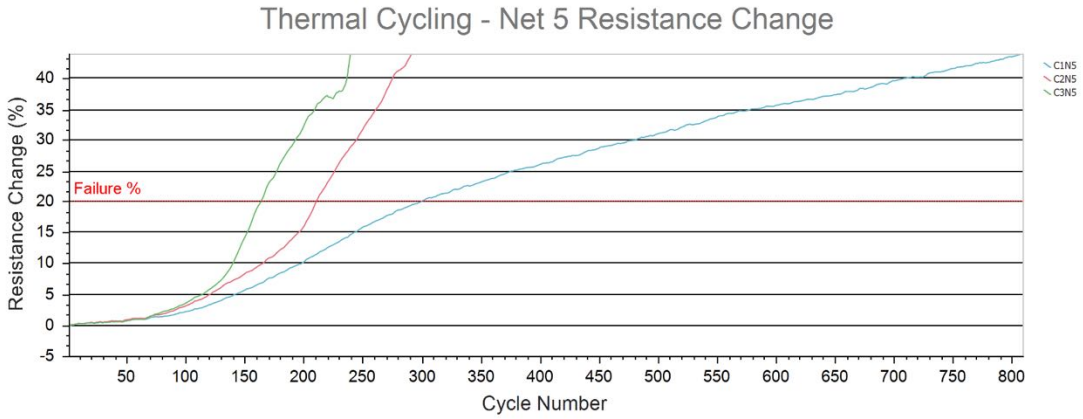
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00832	0.00782	0.00798	-	-	-
Maximum Resistance % Change	0.55	0.48	0.35	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



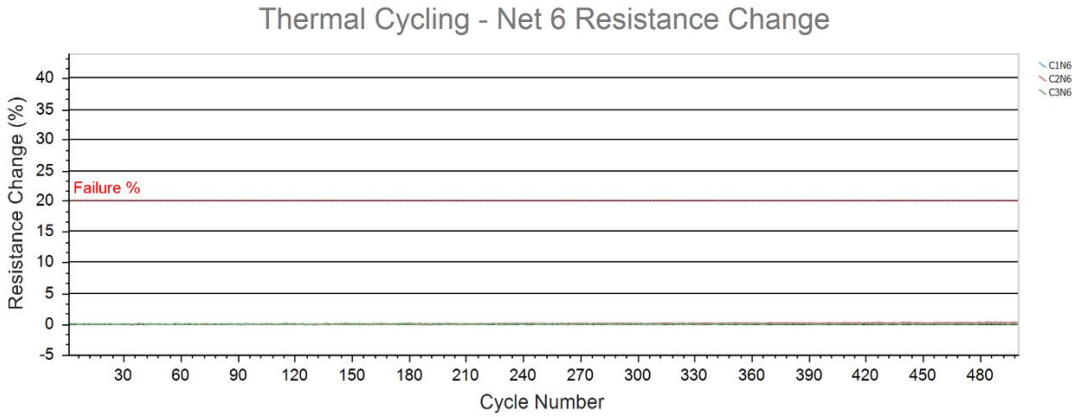
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00916	0.00861	0.00879	-	-	-
Maximum Resistance % Change	50.29	119.15	90.69	-	-	-
Cycle Failed 20% Limit	300	211	164	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

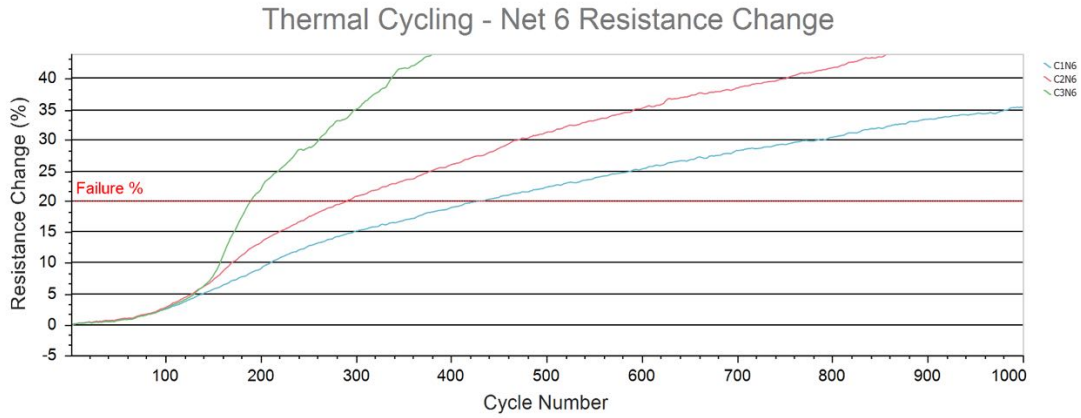
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01031	0.00967	0.00982	-	-	-
Maximum Resistance % Change	0.46	0.49	0.29	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



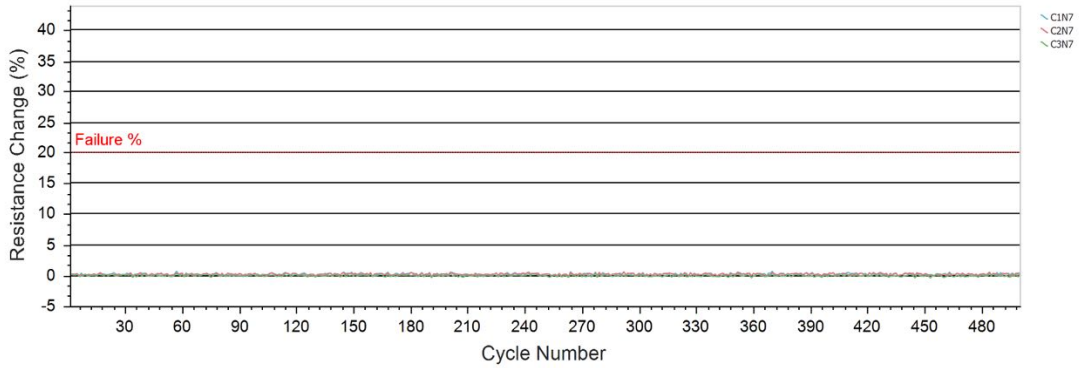
Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.01137	0.01067	0.01081	-	-	-
Maximum Resistance % Change	35.41	50.03	72.03	-	-	-
Cycle Failed 20% Limit	427	290	190	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles)

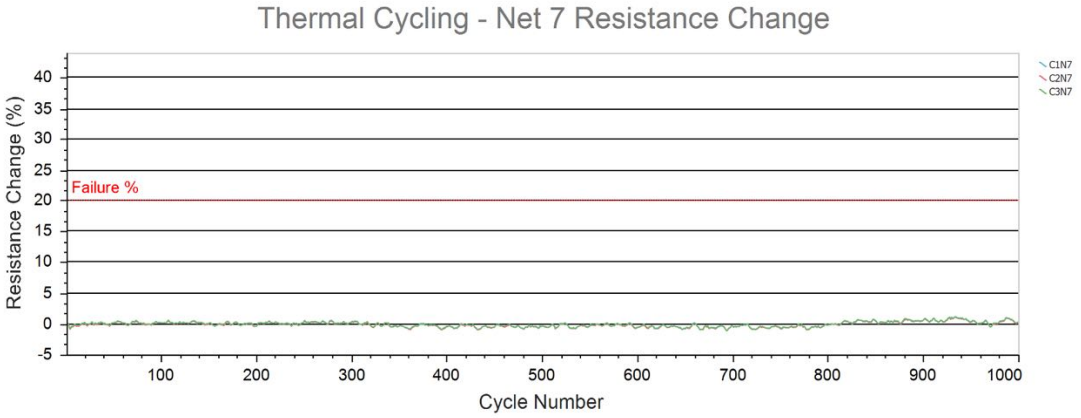
Cycle Range (°C): 25 to 150 / 25 to 190 | **Quality of Cycles:** 500/1000 | **Failure Percentage (%):** 20

Quantity of Coupons: 3 | **Number of Nets:** 7 | **Coupon Thickness:** 2.75 mm

Net 1 Via Type:	SSI Above BV MV Bottom	**Net 1 Quantity of Holes:**	1	**Net 1 Hole Size:**	.125 mm
Net 2 Via Type:	Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:**	1	**Net 2 Hole Size:**	.125 mm
Net 3 Via Type:	Buried	**Net 3 Quantity of Holes:**	1	**Net 3 Hole Size:**	.25 mm
Net 4 Via Type:	SSI Above BV MV Top	**Net 4 Quantity of Holes:**	1	**Net 4 Hole Size:**	.125 mm
Net 5 Via Type:	SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:**	1	**Net 5 Hole Size:**	.125 mm
Net 6 Via Type:	Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:**	1	**Net 6 Hole Size:**	.125 mm
Net 7 Via Type:	Staggered Above BV MV Top	**Net 7 Quantity of Holes:**	1	**Net 7 Hole Size:**	.125 mm



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00282	0.00283	0.00283	-	-	-
Maximum Resistance % Change	1.23	1.15	0.94	-	-	-
Cycle Failed 20% Limit	>500	>500	>500	-	-	-



Coupon Number	1	2	3	4	5	6
Reference Resistance (Ohms)	0.00306	0.00307	0.00307	-	-	-
Maximum Resistance % Change	1.08	1.03	1.12	-	-	-
Cycle Failed 20% Limit	>1000	>1000	>1000	-	-	-

Group 4C, HATS²™ Single Via Coupons – Thermal Cycling Preconditioning, 25°C to 150°C (500x Cycles); Followed by Thermal Cycling 25°C to 190°C (1000x Cycles); Box Plots for 1000x Cycle Test

Cycle Range (°C): 25 to 150 / 25 to 190	**Quality of Cycles:** 500/1000	**Failure Percentage (%):** 20
Quantity of Coupons: 3	**Number of Nets:** 7	**Coupon Thickness:** 2.75 mm
Net 1 Via Type: SSI Above BV MV Bottom	**Net 1 Quantity of Holes:** 1	**Net 1 Hole Size:** .125 mm
Net 2 Via Type: Staggered Above BV MV Bottom	**Net 2 Quantity of Holes:** 1	**Net 2 Hole Size:** .125 mm
Net 3 Via Type: Buried	**Net 3 Quantity of Holes:** 1	**Net 3 Hole Size:** .25 mm
Net 4 Via Type: SSI Above BV MV Top	**Net 4 Quantity of Holes:** 1	**Net 4 Hole Size:** .125 mm
Net 5 Via Type: SSI Above BV MV+BV+MV	**Net 5 Quantity of Holes:** 1	**Net 5 Hole Size:** .125 mm
Net 6 Via Type: Staggered Above BV MV+BV+MV	**Net 6 Quantity of Holes:** 1	**Net 6 Hole Size:** .125 mm
Net 7 Via Type: Staggered Above BV MV Top	**Net 7 Quantity of Holes:** 1	**Net 7 Hole Size:** .125 mm