IPC D Coupon Testing for Microvia Reliability

January 2020

- Summit is the second largest PCB company in North America – over $100 million in revenue
- Total of 175,000 sq. ft. of manufacturing space and approximately 670 employees
- Three California based plants: Anaheim, Orange and Santa Clara
- Additional manufacturing through Summit Global provides competitive global pricing
- Focused on advanced technology PCBs for domestic manufacturing
- Expanded technology scope for medium to advanced technology through Summit Global
- Redundant capacity offering for commercial and military customers
- Provides a total PCB solution from prototype & quick-turn to volume production

Summit Facilities

Santa Clara – QTA

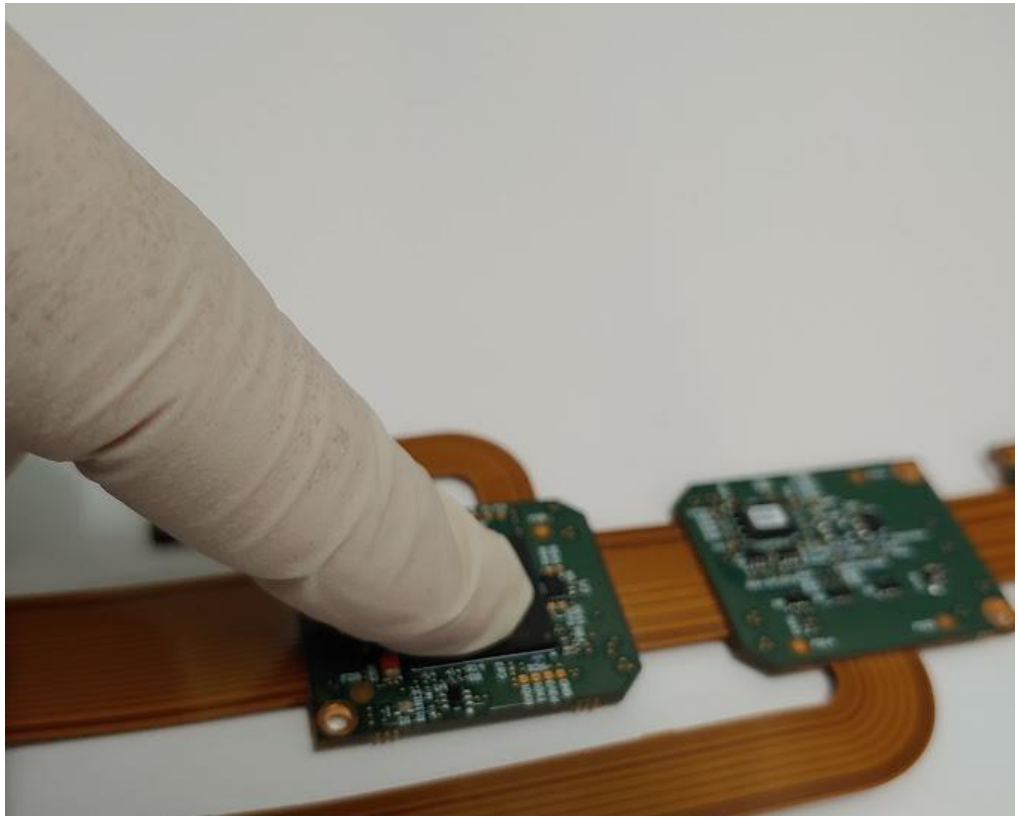
Orange – High Mix / Low Volume

Anaheim - Production

Global – Volume

If you have ever been here…

"It works when I press down on it…"



It might be the reason you are here today

Current State of Micro Vias

IPC Microvia Reliability Warning

" There have been many examples of post fabrication microvia failures over the last several years. Typically, these failures occur during reflow, however they are often undetectable (latent) at room temperature. The further along the assembly process that the failures manifest themselves the more expensive they become. If they remain undetected until after the product is placed into service, they became a much greater cost risk, and more importantly, may pose a safety risk."

Source: IPC Press Release on Microvia Reliability

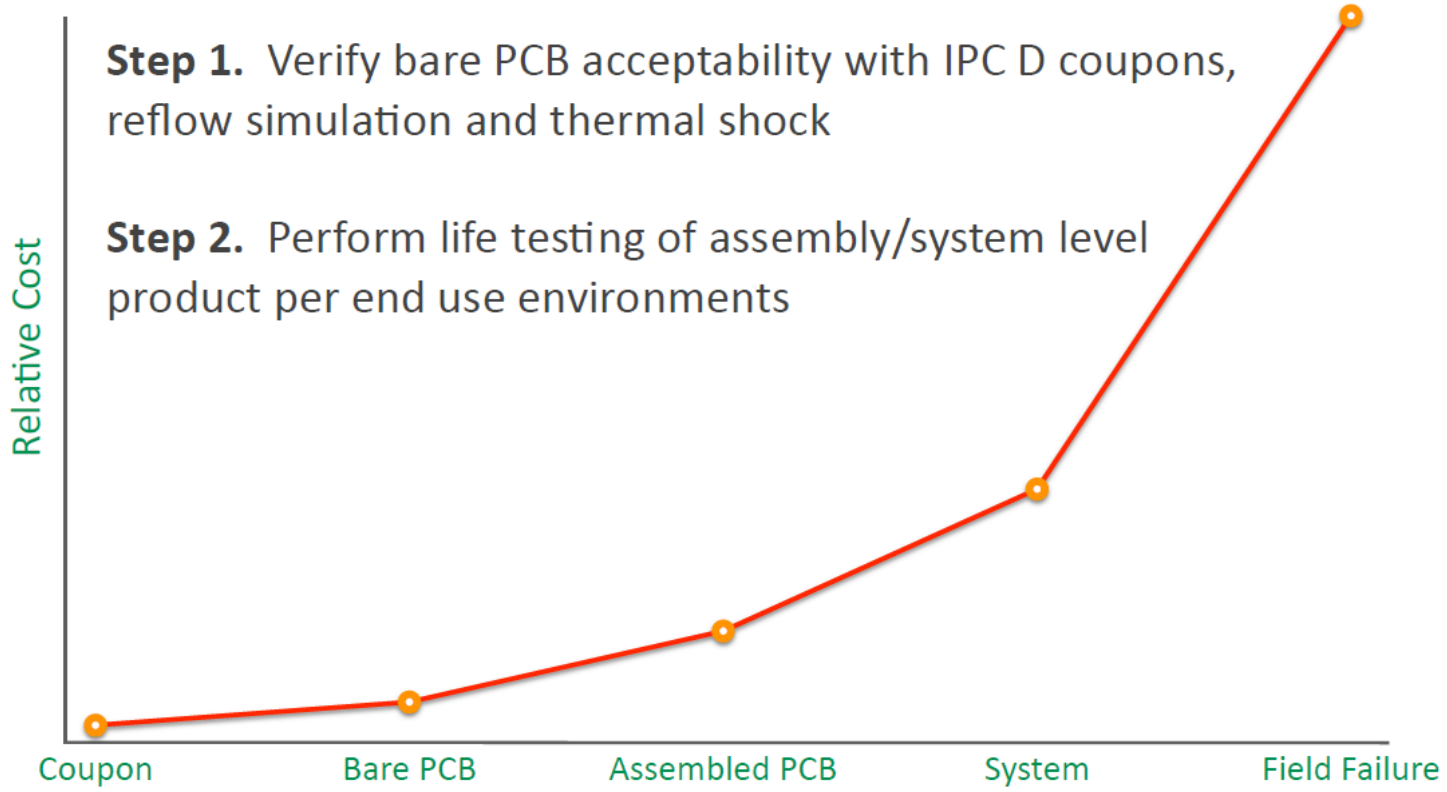
Note: The OM Thermal Stress System was specifically designed to detect these types of failures!

Why are we testing for reliability?

Accelerated Life Testing

Step 1. Verify bare PCB acceptability with IPC D coupons, reflow simulation and thermal shock

Step 2. Perform life testing of assembly/system level product per end use environments



OM testing provides real world validation for today's demanding printed board designs

- Review Current Evaluation Methods
- Temperature Test Methods
- Why methods fail to provide true assessment
- OM Testing and real world evaluation
- Summary

Current Evaluation Methods

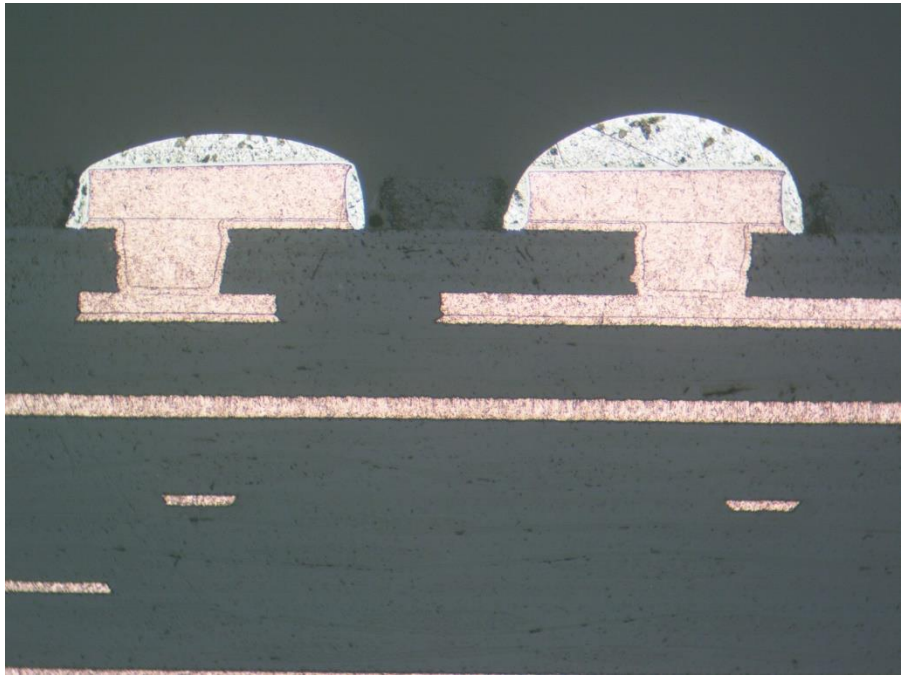
- Thermal Stressed
- Cross section evaluation IPC-TM 2.6.8, or 2.6.27
- Micro etch evaluation IPC-6012 3.6.2
- Monthly Quality Conformance Testing IPC-6012 Table 4-4
- Electrical Testing at room temperature possibly without any thermal excursion (HASL)
- D coupon test only when specified IPC-TM-2.6.27A

Traditional Thermal Test Methods

- HATS 2.6.7A (Reflow process without resistance measurement)
- IST IPC-TM-2.6.26 Developed in the 1980’s (Reflow is theoretical no recording of temperature)

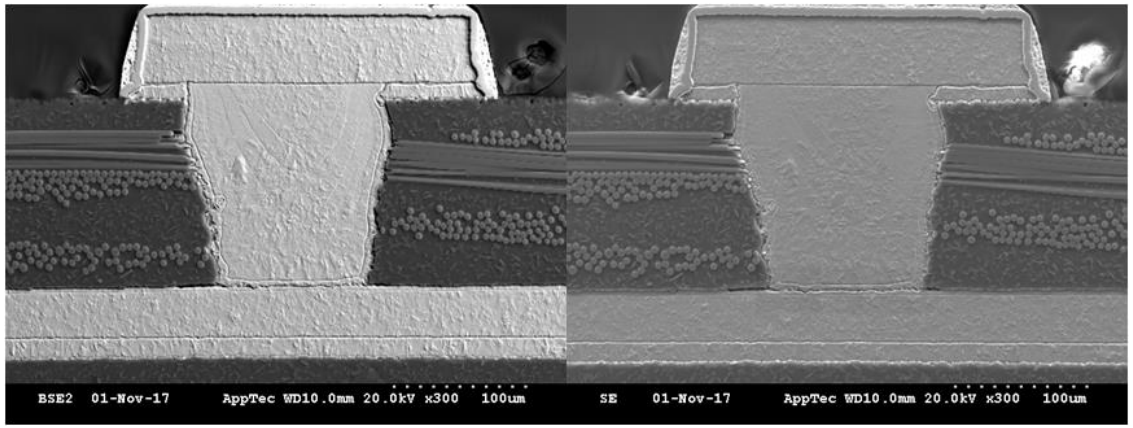
Limitation of older methods.

- Micro Etched cross sections hide small separations found in the as polished condition.

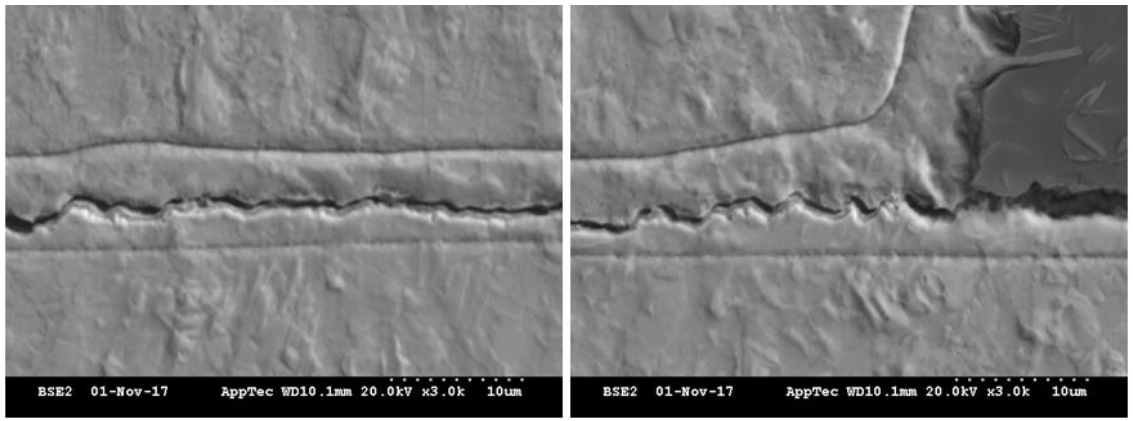


How the older methods fail.

- Examination above IPC-6012 100x and 200X

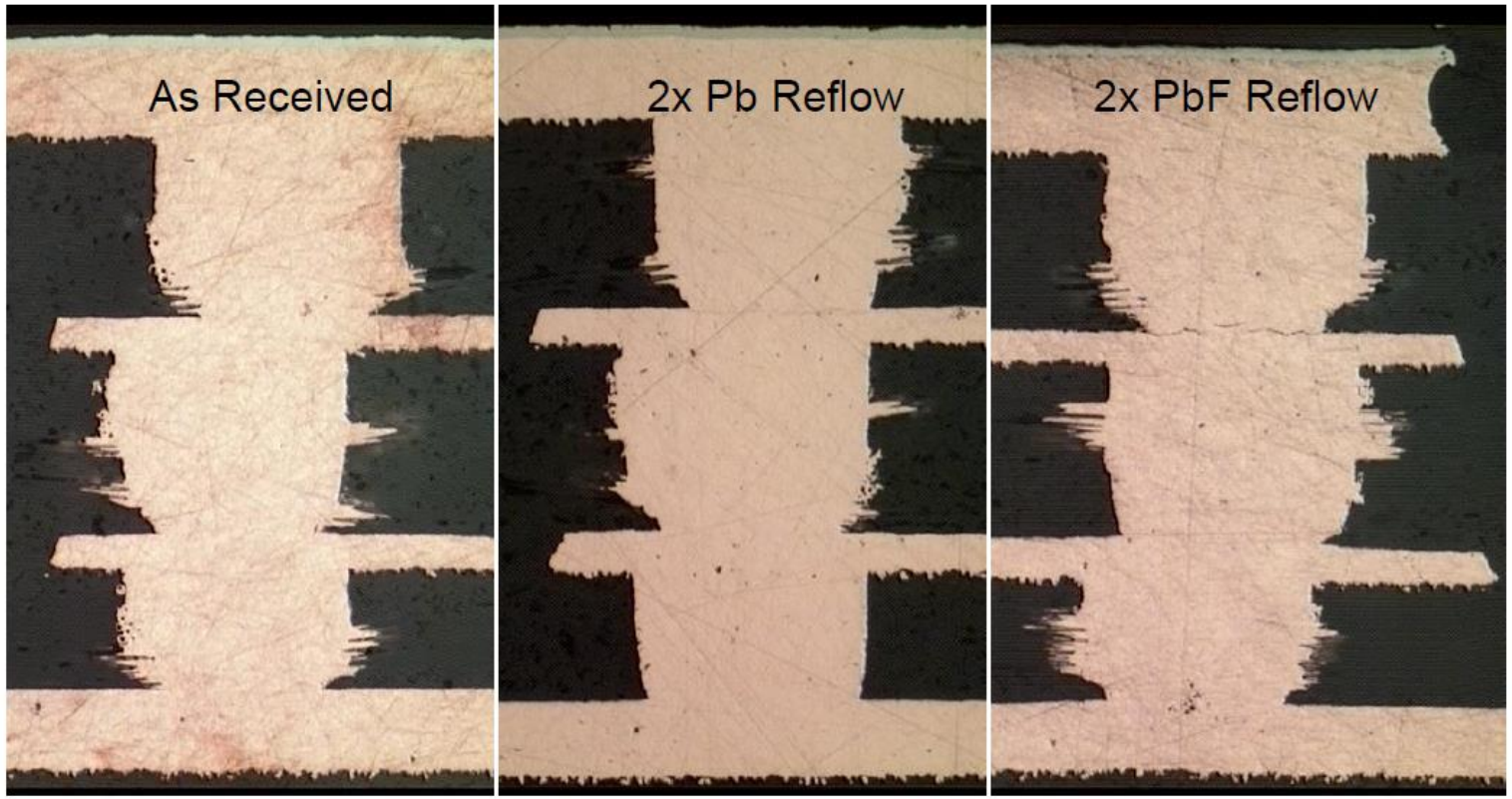


300x



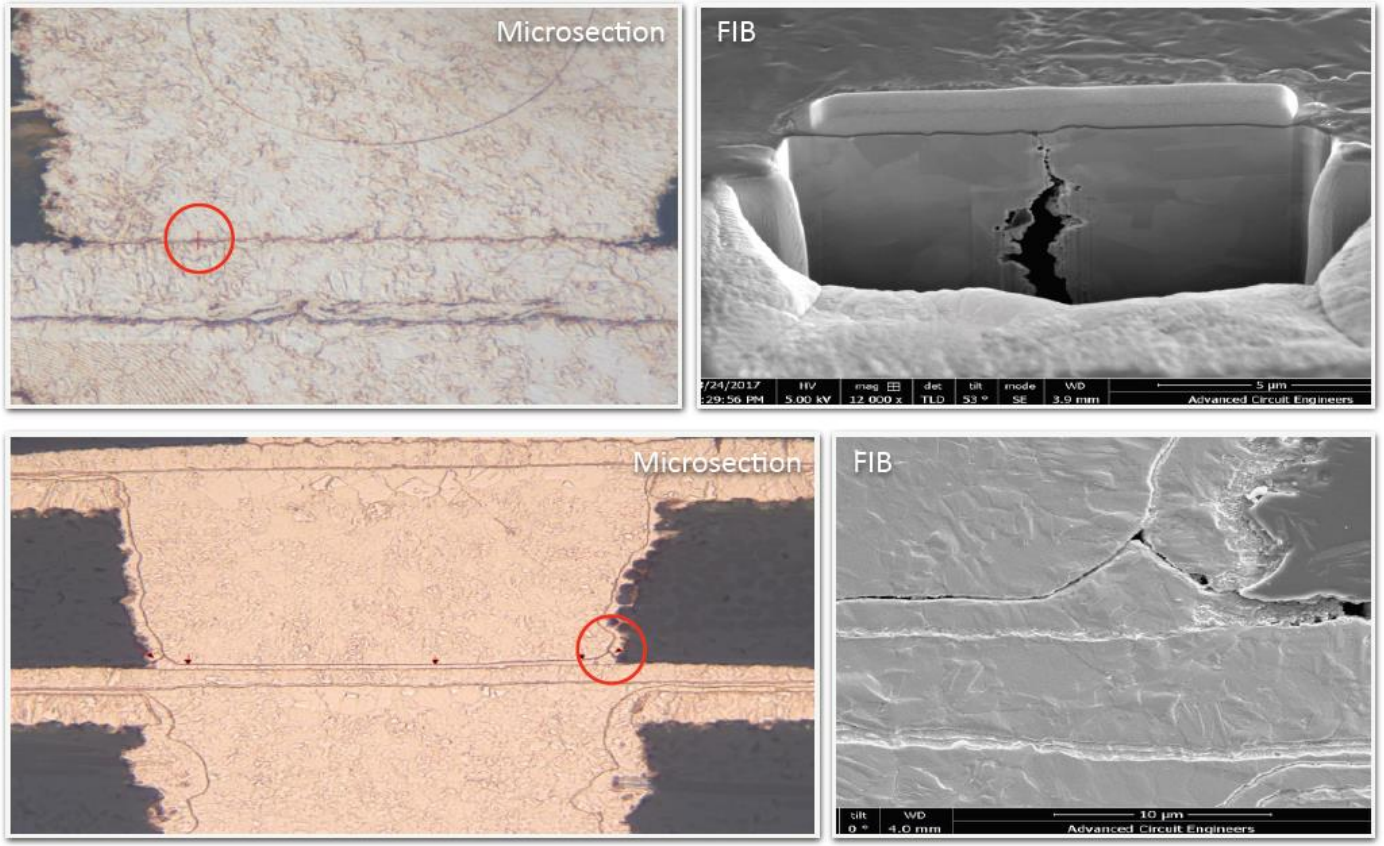
3000x

How the older methods fail.



How the older methods fail.

Detecting Microvia Defects



Monthly Quality Conformance Testing

Test is taken from most complex build in a given month for each material type.

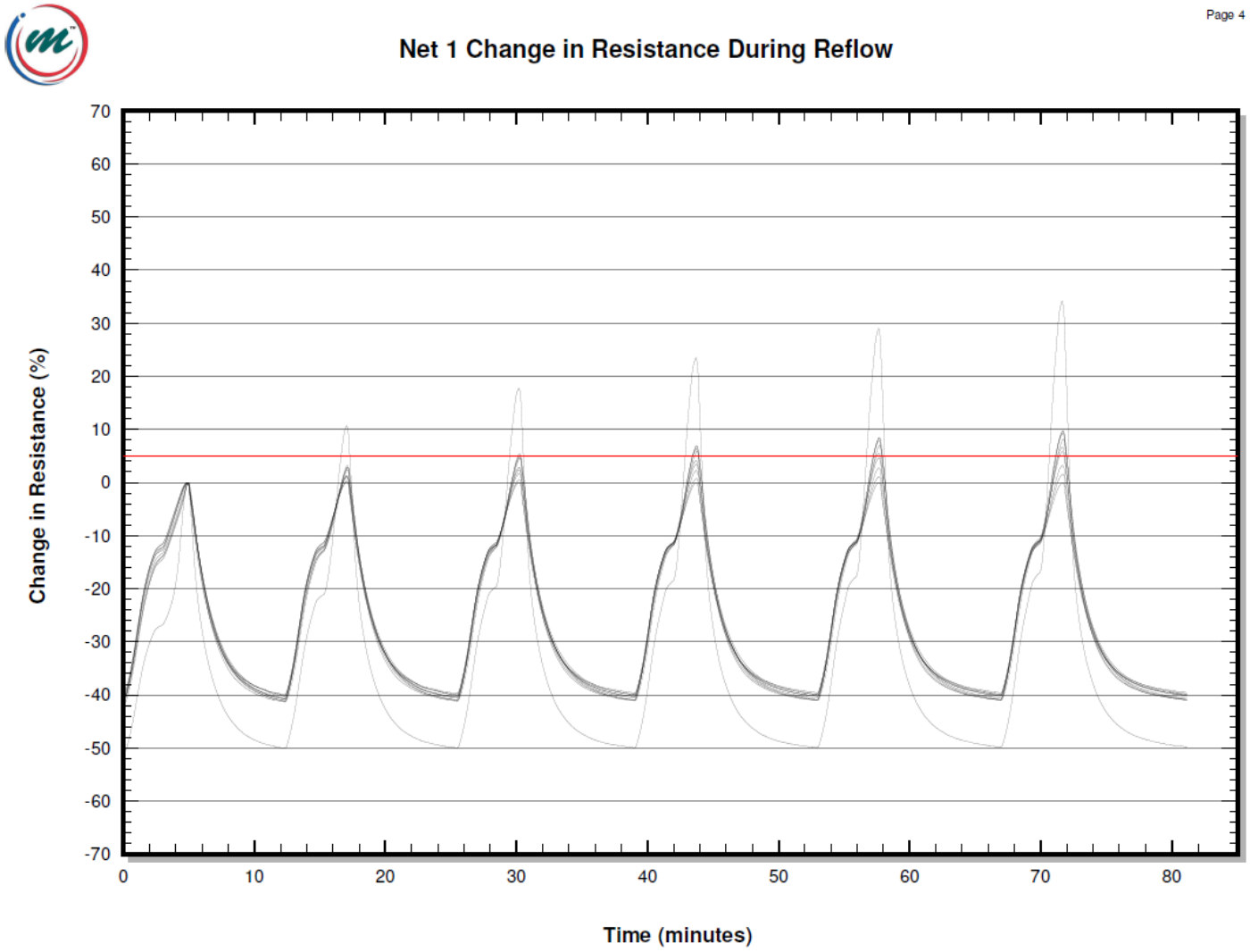
- Rework Simulation (no resistance testing)
- Bond Strength
- Peel Strength
- Dielectric Withstanding Voltage
- Moisture and Insulation

Conclusion, doesn’t identify weak via structures

Electrical Testing

- Electrical testing at ambient room temperature will not find weak micro vias.

Resistance is only open during reflow!



Traditional Thermal Testing HATS

- Highly Accelerated Thermal Shock (HATS™)
- Air-to-air methodology with stationary coupons
- Single chamber, high volume airflow with large heat transfer capacity
- Temperature range: -60 to +160C
- Air transition time: 30 seconds (-60 to +160C)
- Air Stability: ± 2C Data acquisition
- Mode: 4-wire resistance Accuracy: 2% of resistance value
- Precision: 2% resistance CoV
- Speed: 10 readings per second

Example How HATS Will Pass Coupons That Fail Reflow

Thermal Cycling Statistics

Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 175C (ohms)		Cycles to 5% Change		Change after 100 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	1.138	0.717	1.693	1.070	>100	>100	0.3	0.1
2	1.150	0.739	1.738	1.118	>100	>100	0.5	0.7
3	1.163	0.606	1.750	0.913	>100	>100	0.5	0.1
4	1.089	0.657	1.661	0.993	>100	>100	1.5	0.6
5	1.034	0.695	1.568	1.046	>100	>100	4.0	0.6
6	1.045	0.700	1.578	1.048	>100	>100	1.3	0.4
7	1.089	0.622	1.629	0.930	>100	>100	0.5	0.1
8	1.143	0.659	1.736	0.992	>100	>100	1.6	0.4
9	1.019	1.145	1.517	1.698	>100	>100	0.3	0.3
10	1.170	1.207	1.741	1.792	>100	>100	0.1	0.2
11	1.105	1.167	1.645	1.741	>100	>100	0.1	0.3
12	1.122	1.067	1.670	1.585	>100	>100	0.1	0.2
13	1.060	1.154	1.573	1.713	>100	>100	0.3	0.5
14	1.125	1.212	1.683	1.807	>100	>100	0.2	0.1
15	0.135	1.256	0.204	1.876	>100	>100	0.4	0.2
16	1.121	1.100	1.687	1.650	>100	>100	0.4	0.1
17	0.203	0.336	0.311	0.513	>100	>100	-0.2	-0.1
18	0.218	0.281	0.333	0.428	>100	>100	-0.2	-0.3
19	0.208	0.264	0.317	0.402	>100	>100	0.1	0.4
20	0.201	0.300	0.311	0.460	>100	>100	0.1	0.3
21	0.196	0.326	0.300	0.497	>100	>100	-0.2	-0.1
22	0.203	0.280	0.310	0.424	>100	>100	-0.1	0.0
23	0.210	0.304	0.321	0.463	>100	>100	-0.0	0.2
24	0.183	0.273	0.280	0.414	>100	>100	0.1	0.1

Here Is What HATS Missed At Reflow

Reflow Statistics

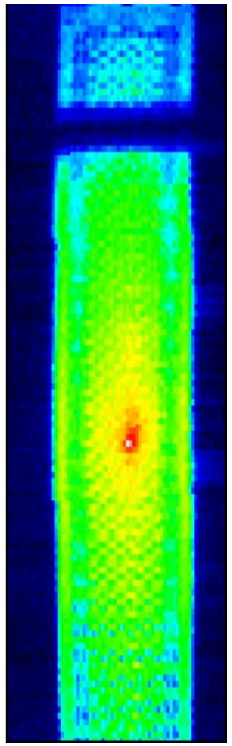
Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 230C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	1.117	0.708	1.905	1.210	>6	>6	0.2	-0.3
2	1.135	0.734	1.979	1.279	>6	>6	0.4	-0.2
3	1.147	0.591	1.990	1.039	>6	>6	1.7	0.3
4	1.063	0.649	1.885	1.136	>6	>6	2.6	0.0
5	1.017	0.689	1.782	1.197	2	>6	Open	0.2
6	1.030	0.693	1.790	1.189	3	>6	Open	0.3
7	1.072	0.615	1.845	1.055	>6	>6	1.1	0.0
8	1.119	0.652	1.969	1.124	5	>6	Open	0.5
9	1.006	1.126	1.700	1.903	>6	>6	0.5	0.5
10	1.157	1.192	1.955	2.011	>6	>6	0.5	0.5
11	1.092	1.150	1.855	1.967	>6	>6	0.2	0.6
12	1.108	1.052	1.880	1.780	>6	>6	0.2	0.2
13	1.044	1.135	1.766	1.950	>6	2	0.3	Open
14	1.106	1.192	1.903	2.038	>6	>6	0.6	0.2
15	0.133	1.237	0.230	2.120	>6	>6	0.4	0.3
16	1.102	1.086	1.915	1.872	>6	>6	0.4	0.0
17	0.202	0.334	0.355	0.585	>6	>6	-0.1	-0.3
18	0.217	0.280	0.377	0.485	>6	>6	-0.2	-0.2
19	0.208	0.263	0.357	0.456	>6	>6	0.2	0.3
20	0.201	0.298	0.354	0.524	>6	>6	0.2	0.5
21	0.195	0.325	0.341	0.563	>6	>6	-0.3	-0.2
22	0.203	0.278	0.352	0.483	>6	>6	0.1	-0.3
23	0.210	0.301	0.363	0.524	>6	>6	0.3	0.6
24	0.183	0.272	0.315	0.464	>6	>6	0.2	0.2

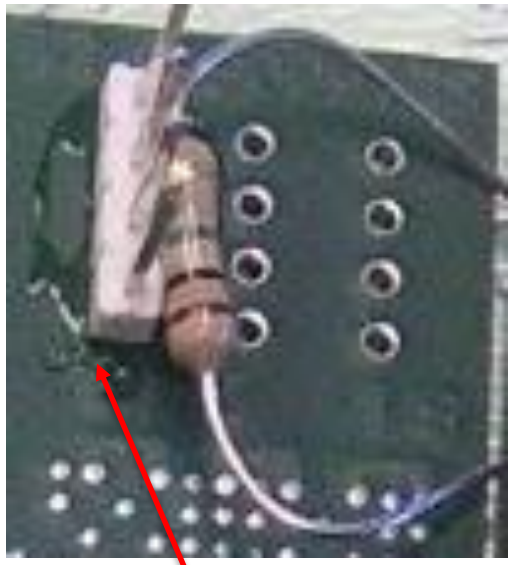
Traditional Thermal Testing IST

- Measure Bulk Resistance
- Determine Resistivity
- Calculate Hot Resistance
- Supply/Apply DC Current
- Monitor Interconnections
- Achieve required temperature
- Cycle test and monitor

IST Greatest Heat in the Center of the Coupon

- IST Coupons are not thermally cycled at actual reflow temperature. The connector is soldered to the coupon and therefore cannot be reflowed.
- IST Coupon is a heating coil with five amps of current through a micro via daisy chain, and the temperature is theoretical, not measured. The greatest heat is at the center of the coupon. OM coupons use the actual recorded temperature readings. Here is a thermal image showing the coupon thermal profile:





Flux from soldering operation.

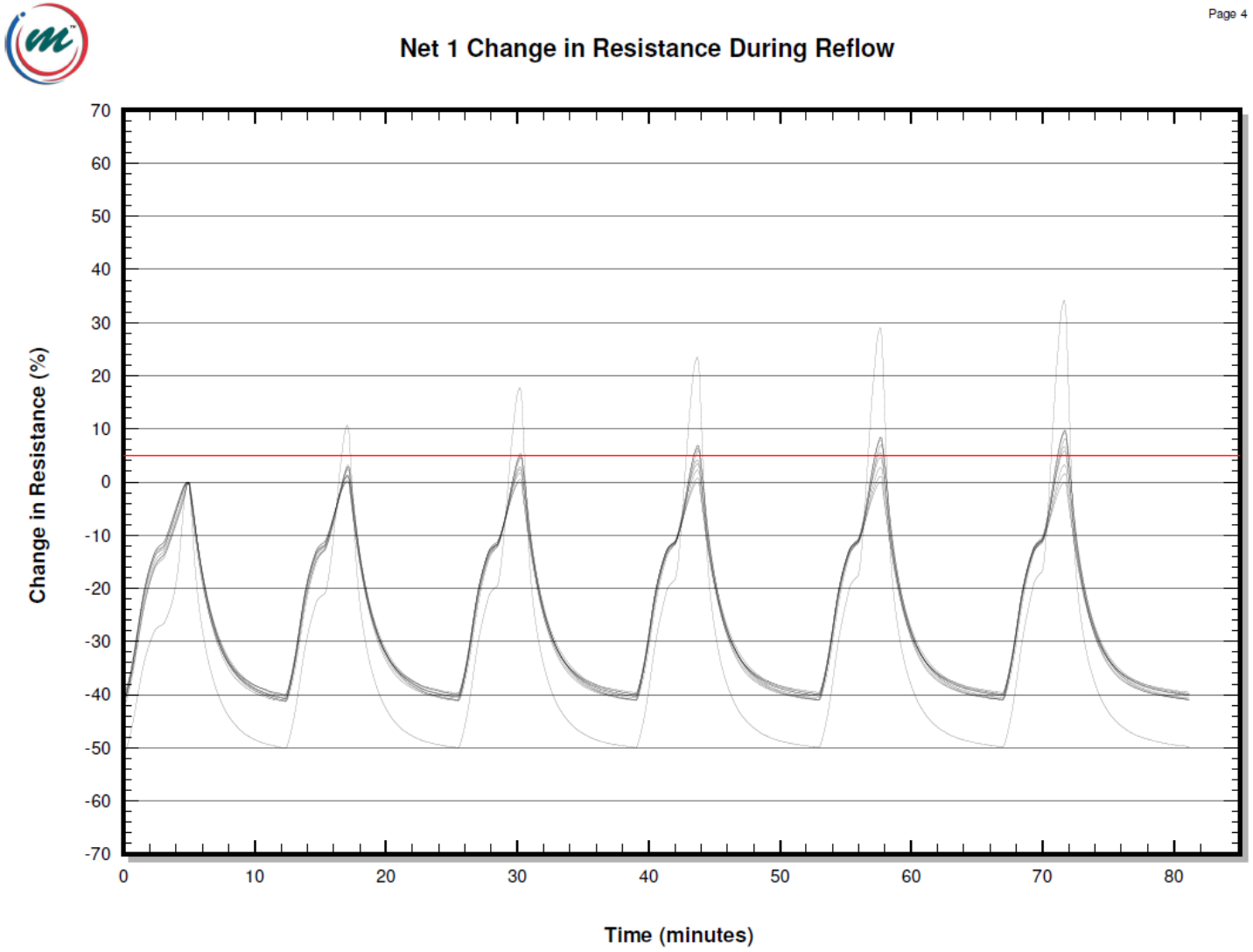
IPC-TM-650 2.6.27A to the rescue

- D-Coupon testing is the only coupon approved by IPC D-32 committee.
- D-Coupon matches the same structure as the PCB. IST Coupons may not match the PCB design.
- IST can require two testing cycles. The first is for through holes and the second is for micro vias.

Coupon Configuration To Be tested

Coupon Number	Designation	Coupon Type	Coupon Design	Thickness (mils)	First Net
1	1	IPC-D	171228-006 1-2 21-22	105	LEFT
2	2	IPC-D	180522-008 1-2 23-24	105	LEFT
3	3	IPC-D	180522-008 1-2 23-24	105	LEFT
4	4	IPC-D	180522-008 1-2 23-24	105	LEFT
5	5	IPC-D	180522-008 1-2 23-24	105	LEFT
6	6	IPC-D	180522-008 1-2 23-24	105	LEFT
7	7	IPC-D	180522-008 1-2 23-24	105	LEFT
8	8	IPC-D	180522-008 1-2 23-24	105	LEFT
9	9	IPC-D	171228-006 1-2 21-22	105	LEFT
10	10	IPC-D	171228-006 1-2 21-22	105	LEFT

Example of Test Results



Real OM test results

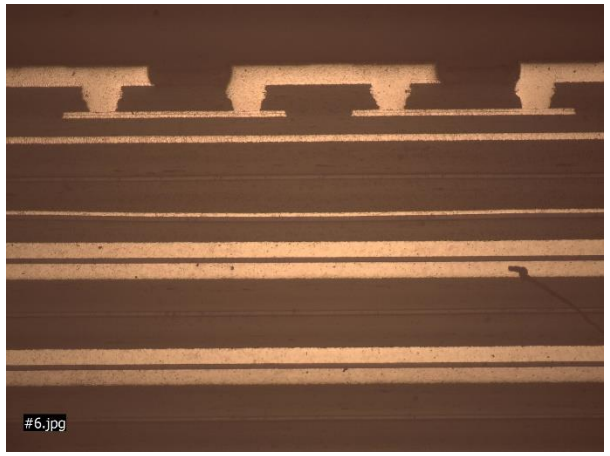
Reflow Statistics

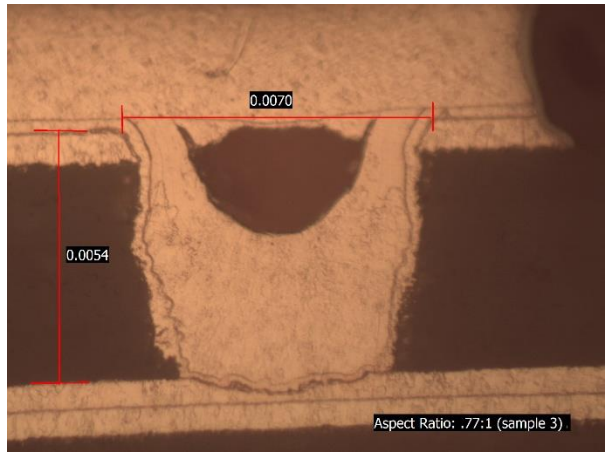
Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 230C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	0.695	0.683	1.201	1.148	4	>6	8.2	0.1
2	0.674	0.671	1.146	1.127	5	>6	6.7	-0.1
3	0.725	0.731	1.235	1.222	6	>6	5.8	1.3
4	0.691	0.669	1.169	1.098	3	>6	9.8	0.2
5	0.715	0.737	1.205	1.204	4	>6	9.2	0.1
6	0.694	0.687	1.179	1.121	3	>6	9.6	0.2
7	0.674	0.698	1.123	1.160	>6	>6	1.6	0.0
8	0.710	0.714	1.180	1.184	>6	>6	-0.1	-0.0
9	0.692	0.700	1.167	1.166	>6	>6	3.2	0.0
10	0.659	0.647	1.351	1.093	2	>6	34.2	2.9

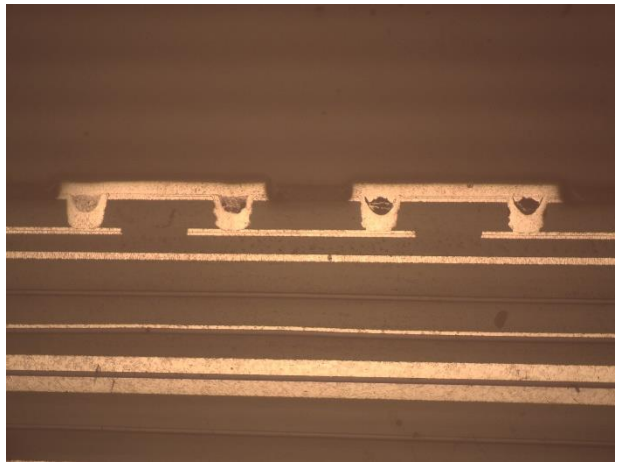
Notes:

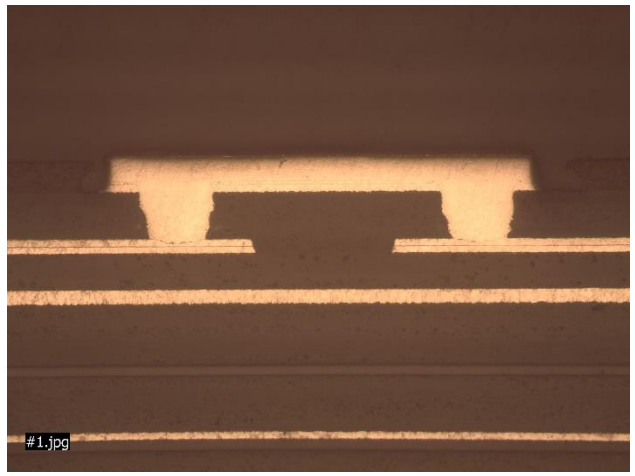
1. Resistances greater than 15 ohms are "open".
2. Reference resistances greater than 3 times their initial room temperature resistance are "open".
3. Reference resistances are based on cycle 1 at high temperature.
4. Cells highlighted in red indicate failures.
5. Cells highlighted in blue indicate suspensions.

Example of failures caught by OM testing

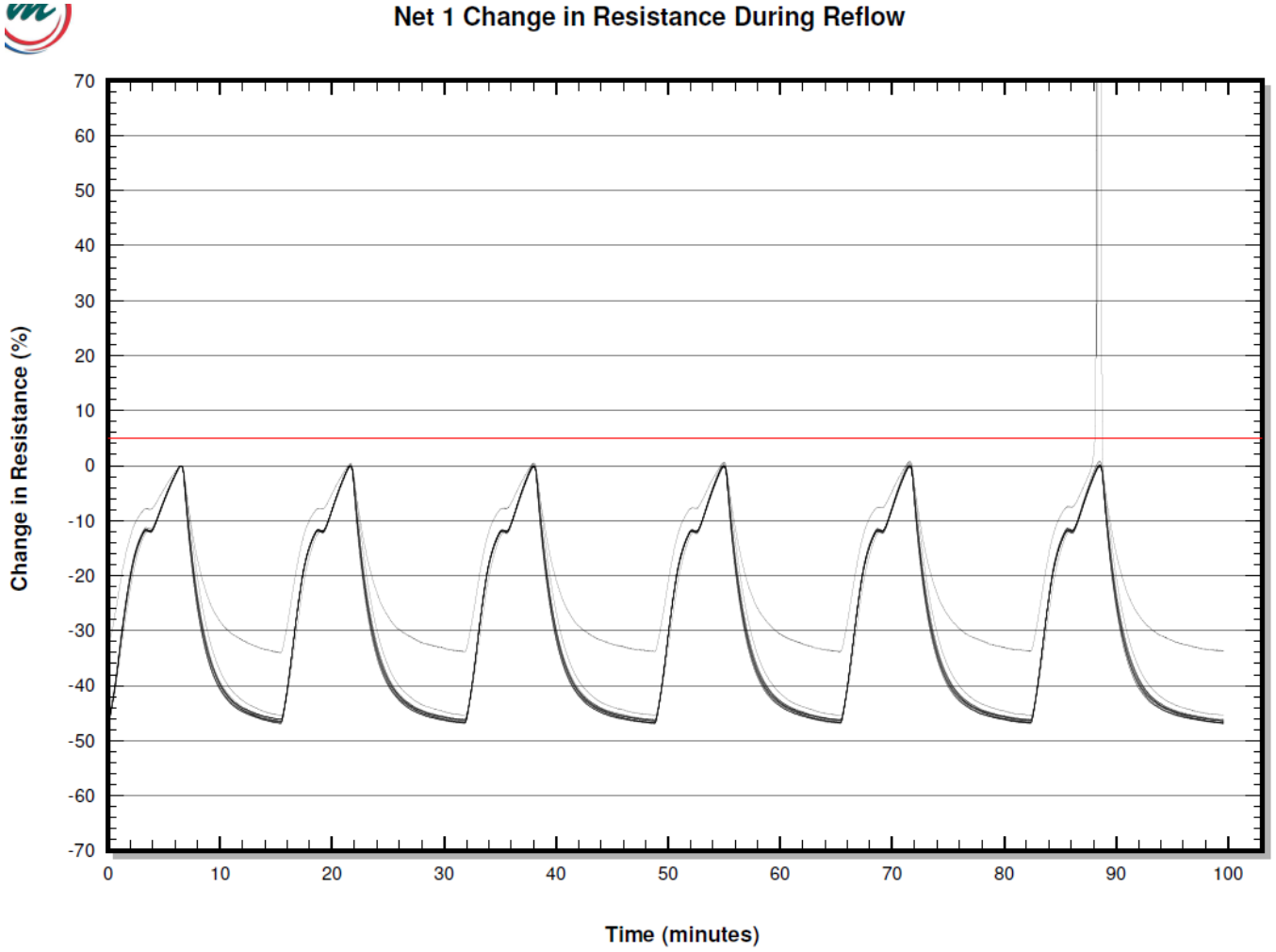








Example of failure at 6th reflow cycle



OM Test Examples

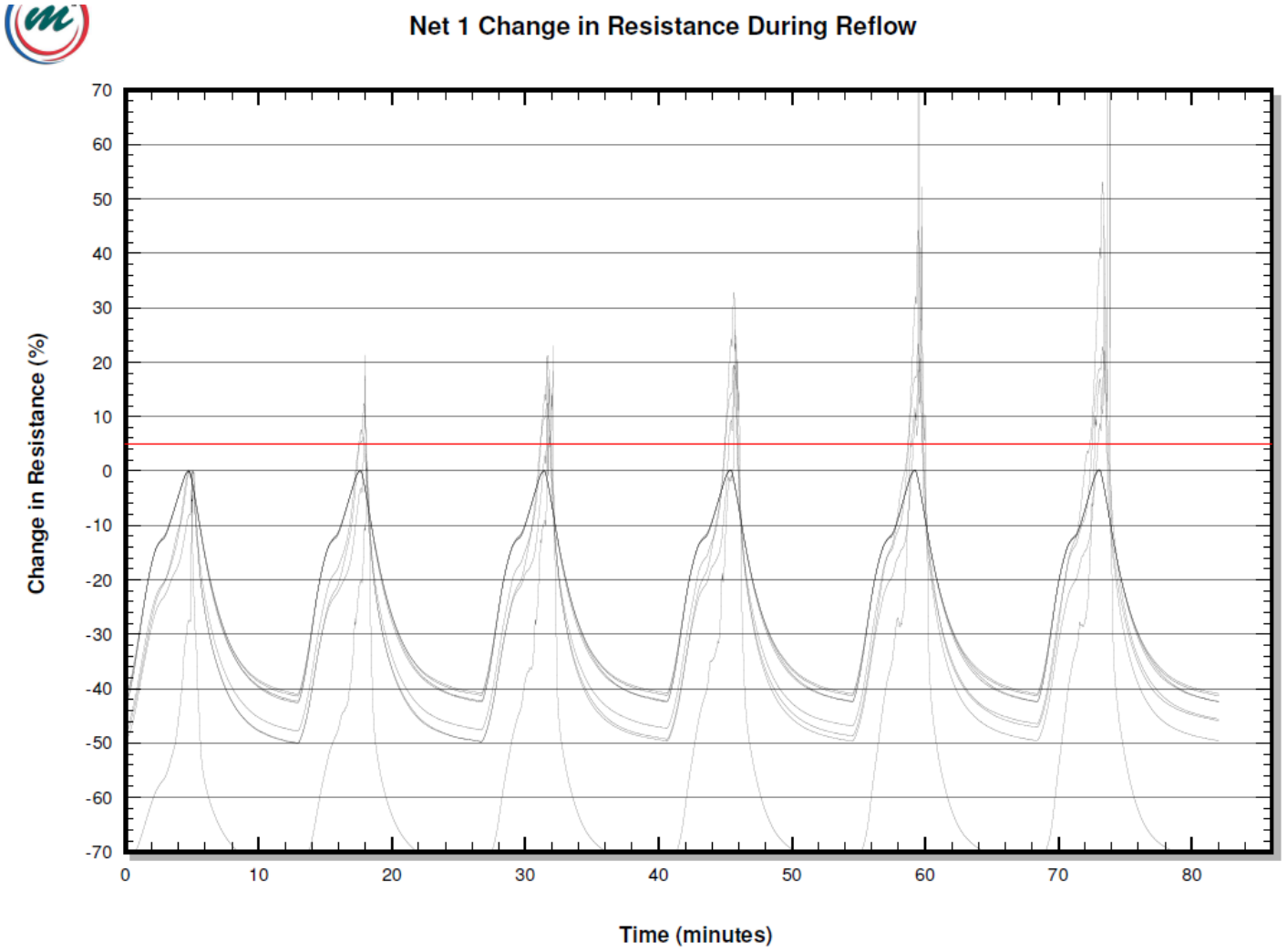
Reflow Statistics

Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 260C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
49	0.371	0.264	0.686	0.488	>6	>6	0.0	-0.4
50	0.266	0.273	0.396	0.514	6	>6	119.1	-0.3
51	0.371	0.275	0.700	0.514	>6	>6	0.2	-0.3
52	0.416	0.281	0.785	0.528	>6	>6	-0.1	-0.3
53	0.452	0.288	0.847	0.539	>6	>6	-0.2	-0.3
54	0.388	0.262	0.729	0.487	>6	>6	0.1	-0.3
55	0.408	0.275	0.762	0.510	>6	>6	-0.0	-0.4
56	0.376	0.277	0.708	0.515	>6	>6	0.1	-0.4
57	0.271	0.280	0.502	0.520	>6	>6	-0.2	-0.5
58	0.372	0.272	0.697	0.505	>6	>6	0.0	-0.4
59	0.378	0.281	0.706	0.521	>6	>6	0.2	-0.1
61	0.385	0.270	0.716	0.500	>6	>6	-0.0	-0.2
62	0.403	0.281	0.754	0.522	>6	>6	-0.0	-0.3
63	0.414	0.271	0.771	0.502	>6	>6	0.1	-0.2
64	0.367	0.265	0.689	0.495	>6	>6	0.7	-0.2
65	0.384	0.278	0.720	0.518	>6	>6	0.8	0.1
66	0.363	0.272	0.676	0.503	>6	>6	0.1	-0.1

Notes:

1. "N/A" is due to nominal resistances less than 0.025 ohms or an issue with the 4-wire connections on the coupon.
2. Resistances greater than 15 ohms are "open".
3. Reference resistances greater than 3 times their nominal room temperature resistance are "open".
4. Reference resistances are based on cycle 1 at high temperature.
5. Cells highlighted in red indicate failures.
6. Cells highlighted in blue indicate suspensions.

Another example of Non-Conformance found on OM testing



Another example of Non-Conformance found on OM testing

Reflow Statistics

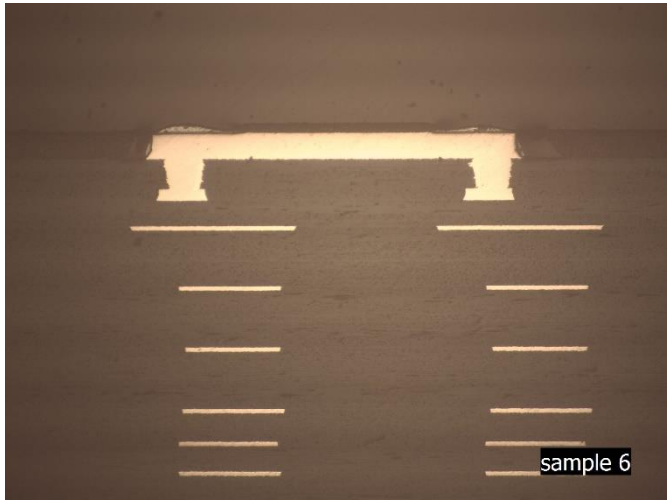
Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 230C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	0.720	0.169	2.656	0.291	3	>6	Open	0.0
2	0.769	0.200	Open	0.359	1	>6	Open	0.3
3	0.643	0.165	1.121	0.293	>6	>6	0.3	0.1
4	0.687	0.169	1.324	0.293	2	>6	53.1	0.1
5	0.774	0.176	1.316	0.304	>6	>6	0.2	0.2
6	0.663	0.177	1.132	0.305	>6	>6	0.1	-0.0
7	0.732	0.158	1.449	0.273	2	>6	22.0	0.2
8	0.908	0.199	Open	0.349	1	>6	Open	0.2
9	0.963	0.181	Open	0.320	1	>6	Open	0.1
10	0.781	0.181	1.485	0.317	2	>6	22.8	0.6
11	0.667	0.176	Open	0.316	1	>6	Open	0.0
12	0.700	0.171	1.226	0.306	>6	>6	0.2	0.3

Thermal Cycling Statistics

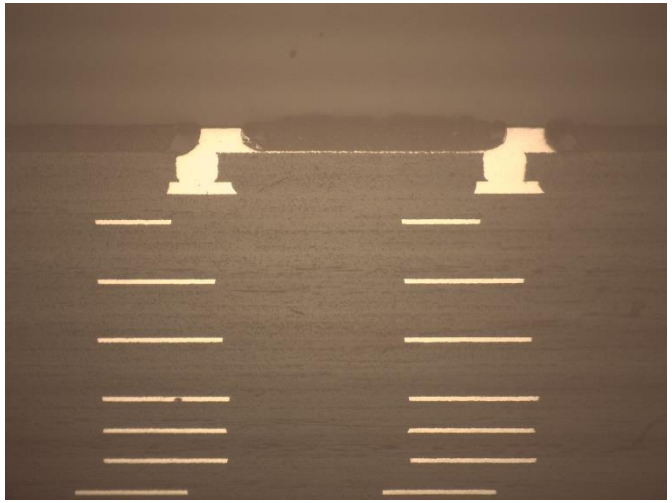
Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 125C (ohms)		Cycles to 10% Change		Change after 25 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	0.751	0.171	1.204	0.227	>25	>25	-4.5	-0.1
2	0.768	0.203	1.125	0.274	>25	>25	3.5	-0.0
3	0.649	0.168	0.870	0.225	>25	>25	-0.0	-0.0
4	0.724	0.171	0.976	0.228	>25	>25	-0.4	0.0
5	0.781	0.177	1.032	0.236	>25	>25	-0.0	-0.0
6	0.668	0.178	0.885	0.237	>25	>25	-0.0	0.0
7	0.735	0.160	0.989	0.213	>25	>25	-0.1	-0.1
8	0.966	0.202	1.439	0.269	3	>25	289.8	0.1
9	0.856	0.183	1.889	0.246	14	>25	-2.5	-0.1
10	0.807	0.185	1.085	0.246	>25	>25	5.2	0.0
11	0.678	0.179	0.911	0.242	>25	>25	-0.1	-0.1
12	0.710	0.174	0.949	0.235	>25	>25	-0.0	-0.1

Cross Section Pass Versus Fail

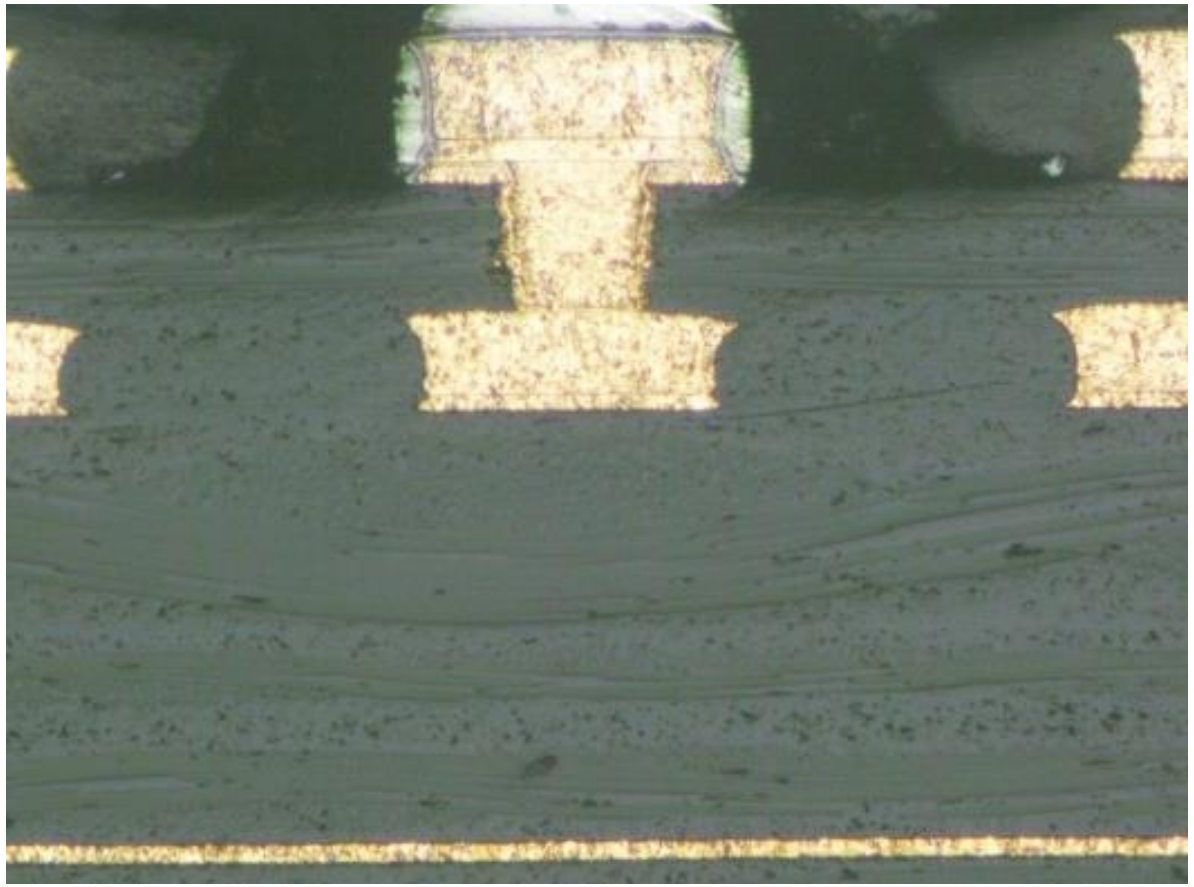
Pass



Fail

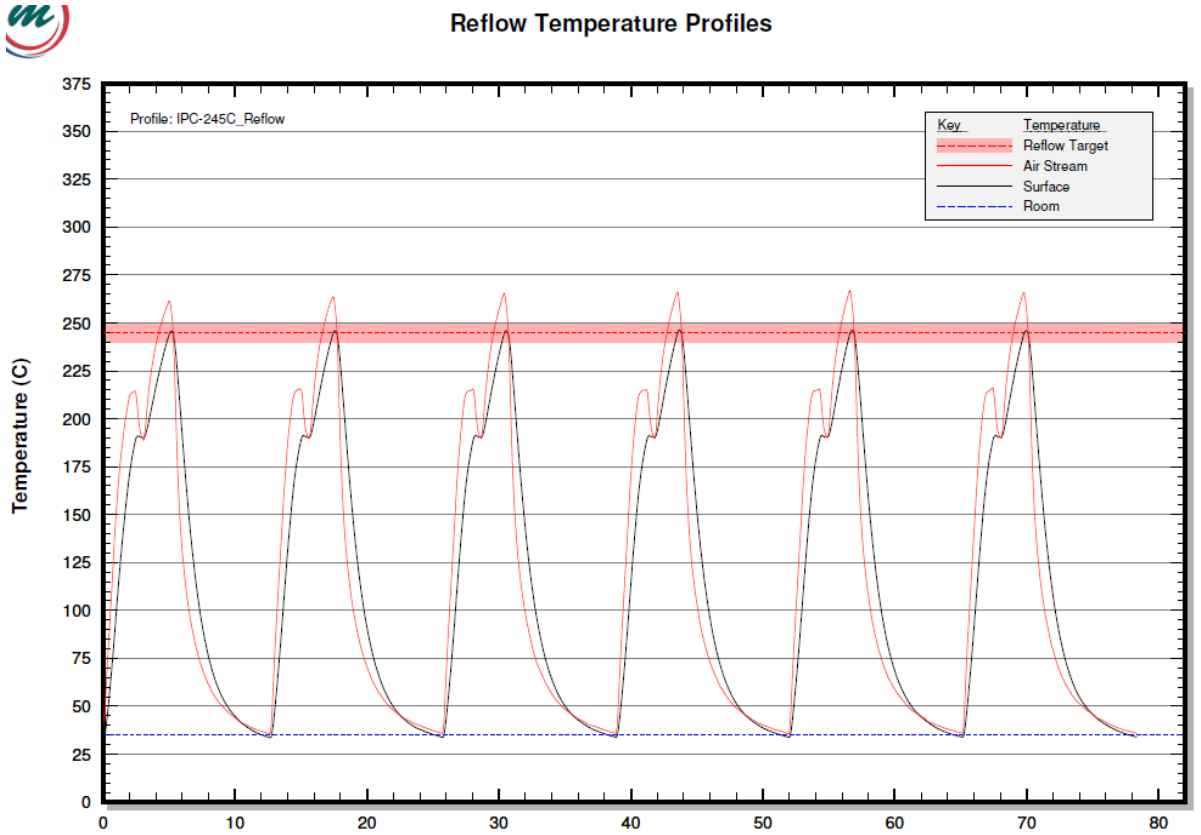


Example of a Compliant Micro Via that Fails Reflow

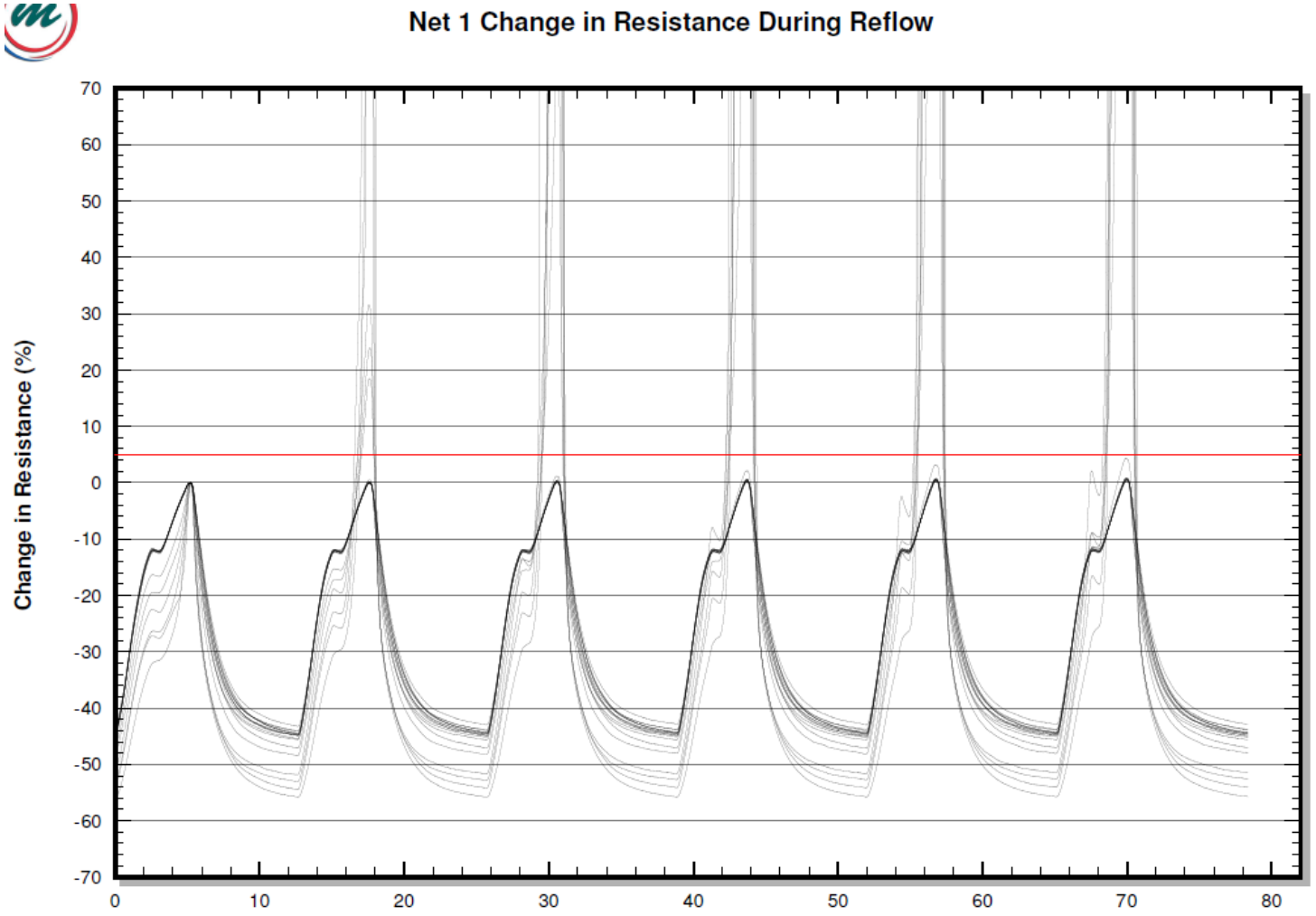


- Micro via .005”
- Aspect ratio 1:1
- Dielectric Target .0045”

OM Test Test Profile on Actual D-Coupons



Notice that all coupons pass first cycle.



Coupon Drill Configuration

Coupon Information

Coupon Number	Designation	Coupon Type	Coupon Design	Thickness (mils)	First Net
1	1 10	IPC-D	190923-003 1-2 7-8	70	LEFT
2	1 06	IPC-D	190923-007 2-7 1-8	70	LEFT
3	2 04	IPC-D	190923-003 1-2 7-8	70	LEFT
4	2 13	IPC-D	190923-007 2-7 1-8	70	LEFT
5	3 10	IPC-D	190923-003 1-2 7-8	70	LEFT
6	3 13	IPC-D	190923-007 2-7 1-8	70	LEFT
7	4 04	IPC-D	190923-003 1-2 7-8	70	LEFT
8	4 06	IPC-D	190923-007 2-7 1-8	70	LEFT
9	5 04	IPC-D	190923-003 1-2 7-8	70	LEFT
10	5 13	IPC-D	190923-007 2-7 1-8	70	LEFT
11	6 10	IPC-D	190923-003 1-2 7-8	70	LEFT
12	6 06	IPC-D	190923-007 2-7 1-8	70	LEFT
13	7 06	IPC-D	190923-007 2-7 1-8	70	LEFT
14	7 13	IPC-D	190923-007 2-7 1-8	70	LEFT
15	8 04	IPC-D	190923-003 1-2 7-8	70	LEFT
16	8 06	IPC-D	190923-007 2-7 1-8	70	LEFT
17	9 10	IPC-D	190923-003 1-2 7-8	70	LEFT
18	9 06	IPC-D	190923-007 2-7 1-8	70	LEFT
19	10 10	IPC-D	190923-003 1-2 7-8	70	LEFT
20	10 13	IPC-D	190923-007 2-7 1-8	70	LEFT

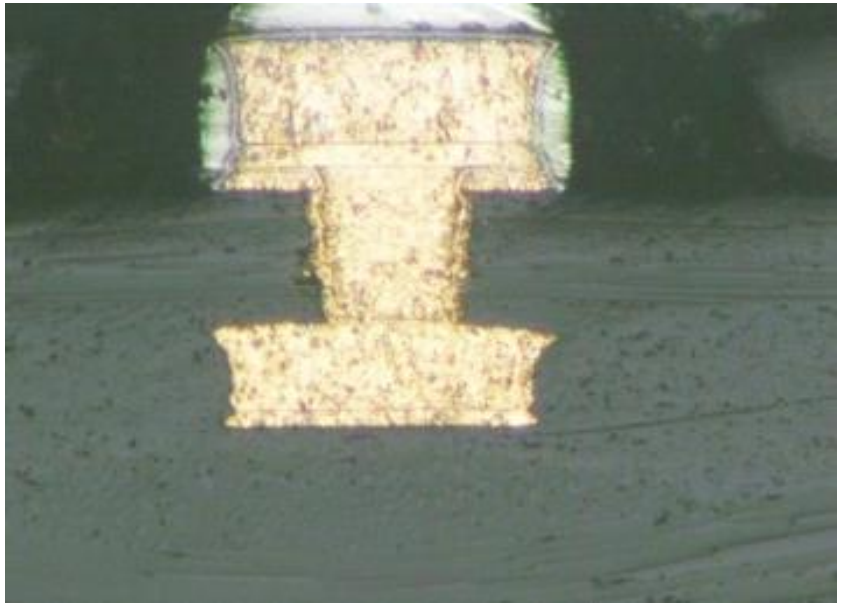
Failures By Net

Reflow Statistics

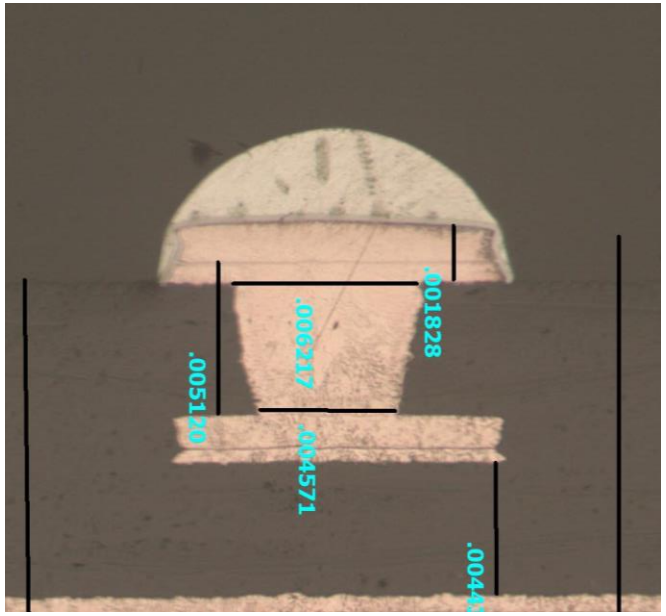
Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 245C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	0.435	0.514	0.995	0.913	2	>6	Open	0.3
2	0.477	0.551	0.868	Open	>6	1	0.5	Open
3	0.473	0.493	0.891	0.879	2	2	Open	Open
4	0.452	0.525	0.817	0.946	>6	4	0.9	11.6
5	0.486	0.584	Open	1.047	1	>6	Open	0.3
6	0.471	0.558	0.842	1.018	>6	2	0.6	53.2
7	0.478	0.488	0.922	0.855	2	>6	Open	0.4
8	0.465	0.526	0.818	0.932	>6	2	0.4	Open
9	0.503	0.540	1.071	0.962	2	5	Open	Open
10	0.577	0.602	1.045	1.095	>6	>6	0.3	3.9
11	0.466	0.531	0.826	0.936	>6	>6	4.4	0.5
12	0.452	0.520	0.810	0.943	>6	2	0.7	Open
13	0.480	0.530	0.860	Open	>6	1	0.8	Open
14	0.475	0.623	0.857	Open	>6	1	0.8	Open
15	0.433	0.472	0.937	0.837	2	>6	Open	0.4
16	0.437	0.492	0.783	0.893	>6	2	0.6	Open
17	0.479	0.535	Open	Open	1	1	Open	Open
18	0.419	0.460	0.749	0.820	>6	3	0.5	Open
19	0.470	0.594	0.964	1.062	2	>6	Open	0.8
20	0.510	0.560	0.920	Open	>6	1	0.6	Open

Remake with Correct Via and Dielectric

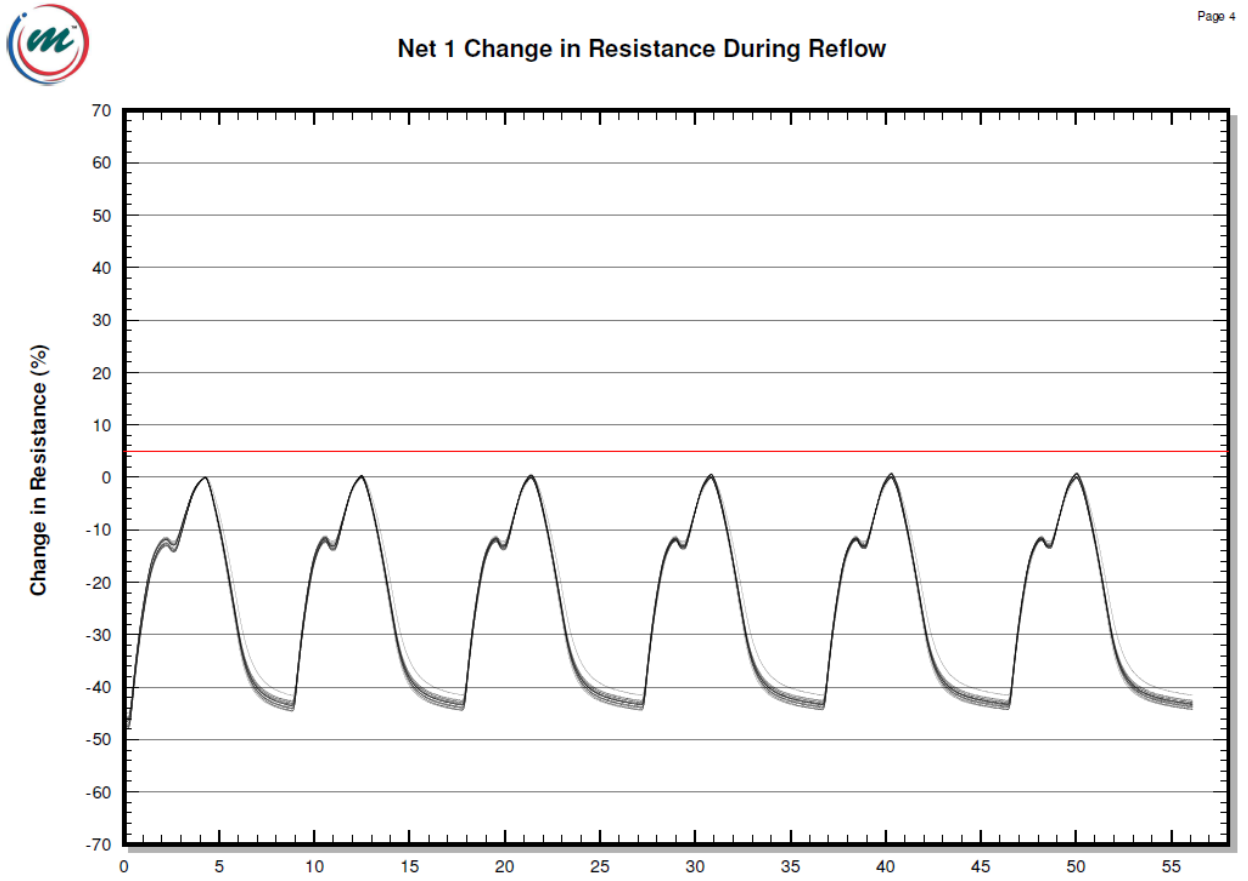
Failed .005” micro via
1:1 aspect ratio



Pass .006” micro via
.82:1 aspect ratio



100% Pass with Correct Via and Aspect Ratio



100% Pass with Correct Via and Aspect Ratio

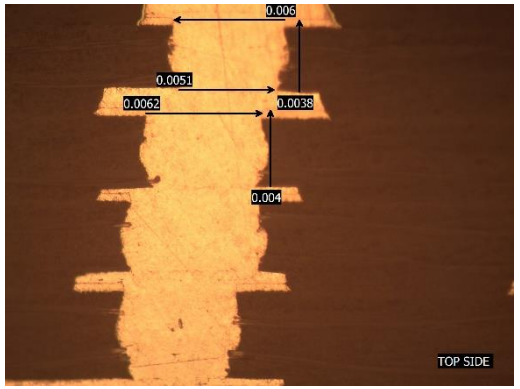
Reflow Statistics

Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 245C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	0.572	0.500	1.040	0.903	>6	>6	-0.1	-0.0
2	0.591	0.629	1.115	1.173	>6	>6	0.8	0.5
3	0.489	0.541	0.905	0.999	>6	>6	0.1	0.2
4	0.478	0.551	0.910	1.032	>6	>6	0.8	0.3
5	0.467	0.487	0.868	0.901	>6	>6	0.1	0.1
6	0.475	0.521	0.907	0.981	>6	>6	0.7	0.4
7	0.503	0.477	0.938	0.886	>6	>6	0.1	0.1
8	0.480	0.575	0.921	1.088	>6	>6	0.6	0.3
9	0.487	0.444	0.914	0.826	>6	>6	-0.1	0.0
10	0.485	0.556	0.931	1.052	>6	>6	0.7	0.3
11	0.531	0.522	0.993	0.974	>6	>6	-0.0	-0.0
12	0.557	0.600	1.063	1.129	>6	>6	0.7	0.5
13	0.530	0.516	0.977	0.948	>6	>6	0.1	0.1
14	0.515	0.570	0.973	1.062	>6	>6	0.8	0.5
15	0.552	0.526	1.022	0.974	>6	>6	0.0	0.1
16	0.544	0.606	1.031	1.139	>6	>6	0.9	0.6
17	0.494	0.554	0.921	1.030	>6	>6	0.0	0.2
18	0.553	0.604	1.061	1.146	>6	>6	0.8	0.5

Stacked Microvia Examples

Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 260C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	1.396	0.208	2.608	0.372	5	>6	9.1	0.1
2	1.354	0.202	2.608	0.365	4	>6	10.0	0.1
3	1.117	0.192	2.110	0.349	>6	>6	1.4	0.1
4	1.161	0.193	2.178	0.351	>6	>6	2.1	0.2
5	1.162	0.201	2.185	0.367	>6	>6	0.8	0.3
6	1.242	0.200	2.345	0.368	>6	>6	3.4	0.0
7	3.029	1.358	Open	2.538	1	>6	Open	0.5
8	3.948	1.295	9.193	2.430	2	>6	Open	0.2
9	2.748	1.214	6.327	2.281	2	>6	Open	0.2
10	3.622	1.306	8.000	2.460	2	>6	84.8	0.2
11	2.270	1.294	4.370	2.427	3	>6	24.7	0.1
12	2.614	1.209	5.047	2.261	3	>6	38.5	0.1
13	2.873	0.210	7.592	0.378	2	>6	Open	0.1
14	2.751	0.189	7.093	0.344	2	>6	Open	0.6
15	2.398	0.188	5.140	0.343	2	>6	Open	0.3
16	2.281	0.203	5.687	0.371	2	>6	Open	0.2
17	2.385	0.207	4.545	0.377	4	>6	12.4	0.0
18	2.153	0.210	4.095	0.383	>6	>6	4.2	-0.2
19	4.702	0.191	Open	0.345	1	>6	Open	0.0
20	Open	0.211	-	0.383	-	>6	-	-0.1
21	2.648	0.192	Open	0.343	1	>6	Open	0.3
22	2.971	0.198	Open	0.353	1	>6	Open	0.2
23	2.250	0.191	Open	0.340	1	>6	Open	0.1
24	2.163	0.190	Open	0.337	1	>6	Open	0.2

Stacked Microvia 5 MV /10 Land



Coupon Number	Nominal Resistance at Room Temperature (ohms)		Reference Resistance at 230C (ohms)		Cycles to 5% Change		Change after 6 Cycles (%)	
	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2	Net 1	Net 2
1	1.040	0.713	1.783	1.210	>6	>6	0.6	-0.1
2	1.138	0.759	1.991	1.311	>6	>6	1.6	0.0
3	1.070	0.695	1.865	1.197	6	>6	Open	0.1
4	1.139	0.671	2.022	1.157	3	>6	Open	0.3
5	1.028	0.661	1.795	1.137	>6	>6	1.0	3.3

Types of D-Coupon Requirements

1. Addition of IPC-2221 D-Coupons Only no testing required.
   - 30 minutes of additional tooling time to create data at Conductor Analysis Technology and to input Gerber files into an existing job.
   - Parts are delivered with D Coupons. There is no delay in delivery.
   - Coupons are to be used if D Coupon testing is desired at a future time.
2. D Coupons are added and Testing is used for data collection only.
   - 30 minutes of additional tooling time to create data at Conductor Analysis Technology and to input Gerber files into an existing job.
   - When parts are completed they are typically shipped while D Coupons are processed for D coupon testing.
   - Test report is sent to the customer after completion of the test, no parts are returned for failures. Cost must be added to the order to perform test.
3. Acceptance based on Pass of D coupons
   - 30 minutes of additional tooling time to create data at Conductor Analysis Technology and to input Gerber files into an existing job.
   - After depanelization Coupons are tested on OM Tester. Serial numbers that pass are shipped.
   - Additional cost must be added to quote.

Summary

OM test validation will prove that there material has structural reliability for today's challenging printed board requirements

- OM testing is a good process indicator that the actual boards will be reliable at 6X reflow
- Validated at actual reflow conditions.
- Detects failures at reflow that heals at room temperature.
- Test records actual temperature on coupon and resistance value.
- Validates propagated via construction that matches the Printed Board’s design.
- Om Failures and root cause evaluation are consistent to IPC-60XX requirements
- Data Collection allows for better design practices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