Do Measles Cause CAF?

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Definitions

Measle – A discrete white square below the surface of the base material related to a thermal stress. This internal condition does not propagate when exposed to additional thermal stress.

Delamination – An anomaly with the appearance of a measle that propagates under additional thermal stress. This condition may be a catalyst for CAF growth.

Background

- Measles have been considered an acceptable condition for years for high reliability applications.
  - Improved materials led to reduced occurrence rate
- The increased temperature of lead free assembly is expected to increase the frequency of measling.
  - Raised the issue of acceptability of measles

Study

- The IPC assembly documents J-STD-001 and IPC-A-610 classify measles as defect.
  - The technical reason is measling results in long term internal short formation – CAF
- The Rigid Board Performance Subcommittee was reviewing a comment to classify measles as a defect in IPC-6012 and IPC-A-600.
- This study was designed and performed to determine if measles could be associated with CAF formation.

Do Measles Cause CAF?

Test Objective

Validate measles result in conductive anodic filament (CAF) failures.

Approach

- Build test vehicles with (2) types of laminate material.
  - Isola FR406 (Eutectic Solder material)
  - MEM 1755 (Lead Free material)
- Accelerate failures using the electromigration test methodology.
- Do failure analysis to locate the CAF failure site.
- Classify the failure. Measle or no measle failure.

Do Measles Cause CAF?

- Test Vehicle Design
  - Materials — Isola FR406 / MEM 1755
  - Board Thickness — 0.122”
  - Number of Layers — 28
  - Drill Diameter — 0.0098”
  - Aspect Ratio — 12.4:1
  - Final Finish — OSP

  - Beep Test Pattern — 4 corners of image

Do Measles Cause CAF?

Merix CAF Test Vehicle

Designed to find the following types of CAF.

		Spacing (mils)			
Feature Description	CAF Axis	Minnimum	Maximum	No./Image	Why Test
Hole to Hole Spacing	X-Y	10.2	20	200	glass integrity
Hole to Hole Spacing Staggered	X-Y	11.4	23.7	200	resin integrity
Via PTH to Plane (Plane Clearance Spacing)	X-Y	3	8.5	200	glass integrity
Via NPTH to Plane	X-Y	4.1	8.6	200	resin integrity
Split Plane Clearance	X-Y	5	50	16	glass integrity
Plane to Plane	Z	varies	varies	10	resin integrity
0.8mm BGA IL Trace to Pad	X-Y	3.8	6.3	2000	glass integrity

		Number of Boards		Number of Test Sites	
Hole to Hole Spacing	Material	Measle	No Measle	Measle	No Measle
	FR406	6	5	1200	1000
	MEM1755	6	5	1200	1000
Via PTH to Plane (Plane Clearance Spacing)	FR406	6	5	1200	1000
	MEM1755	6	5	1200	1000

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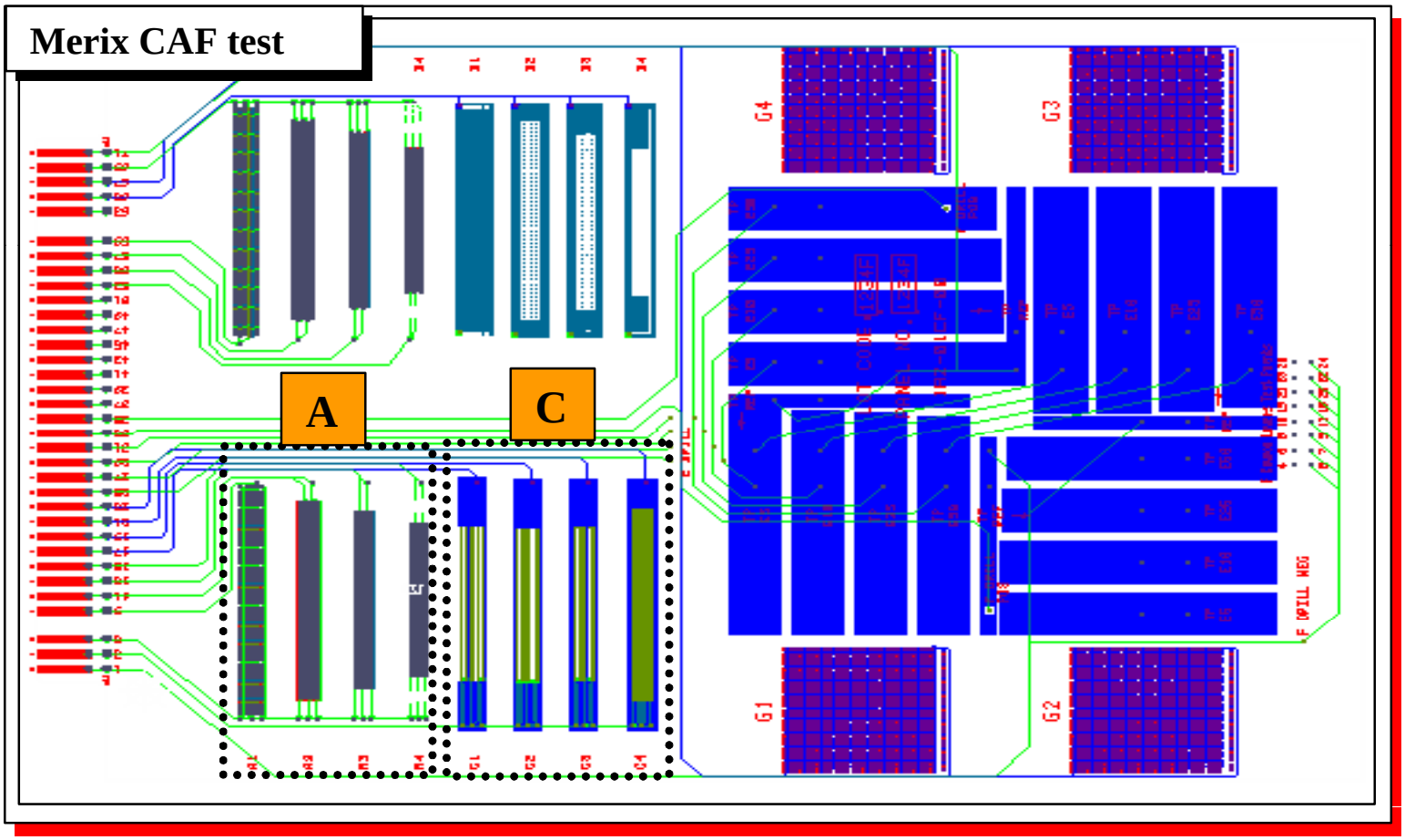

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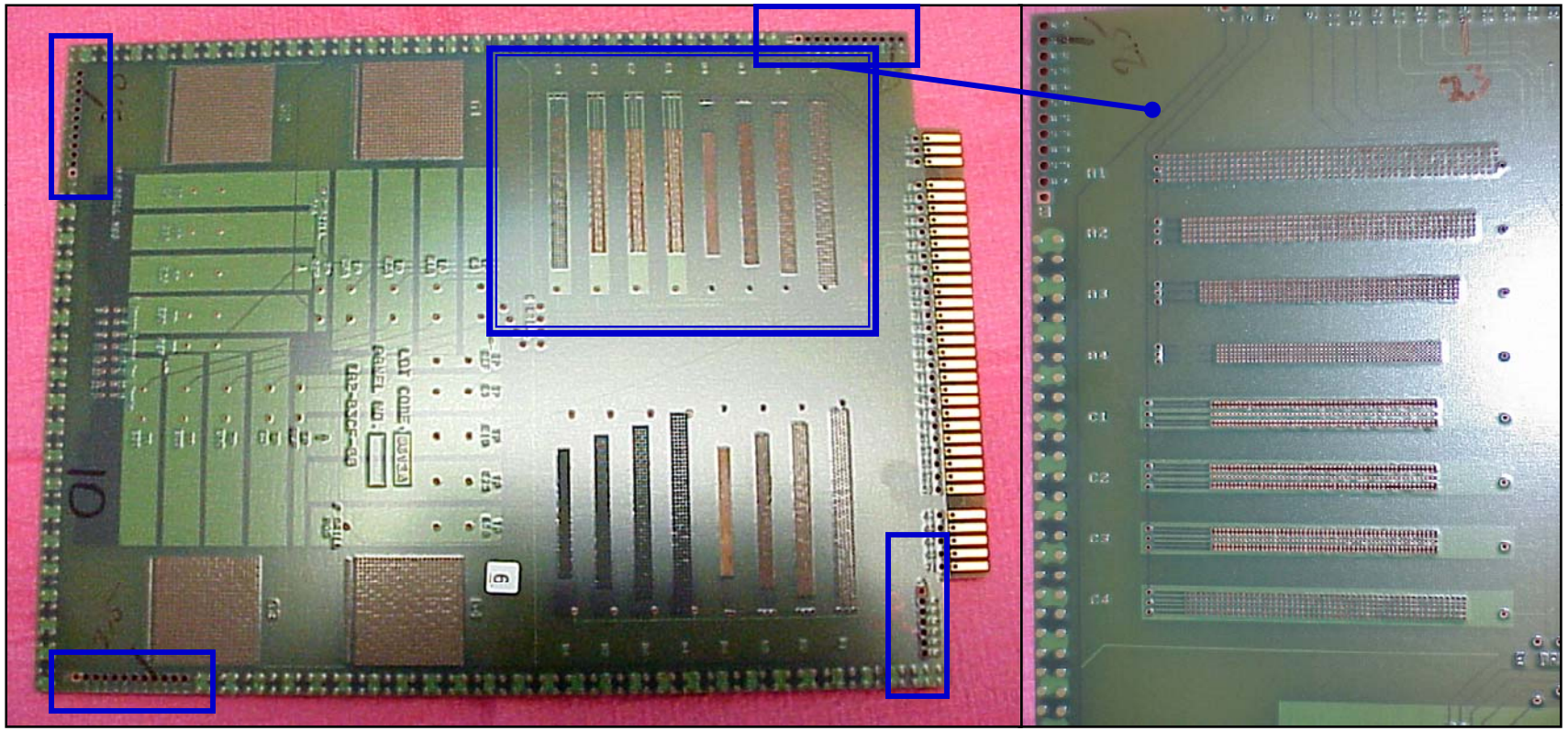

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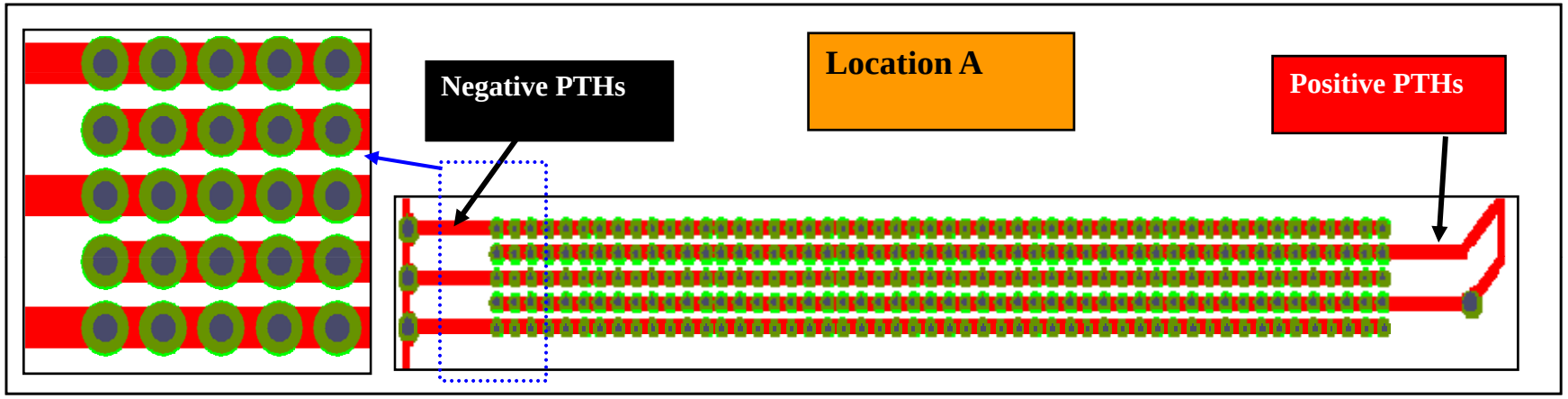
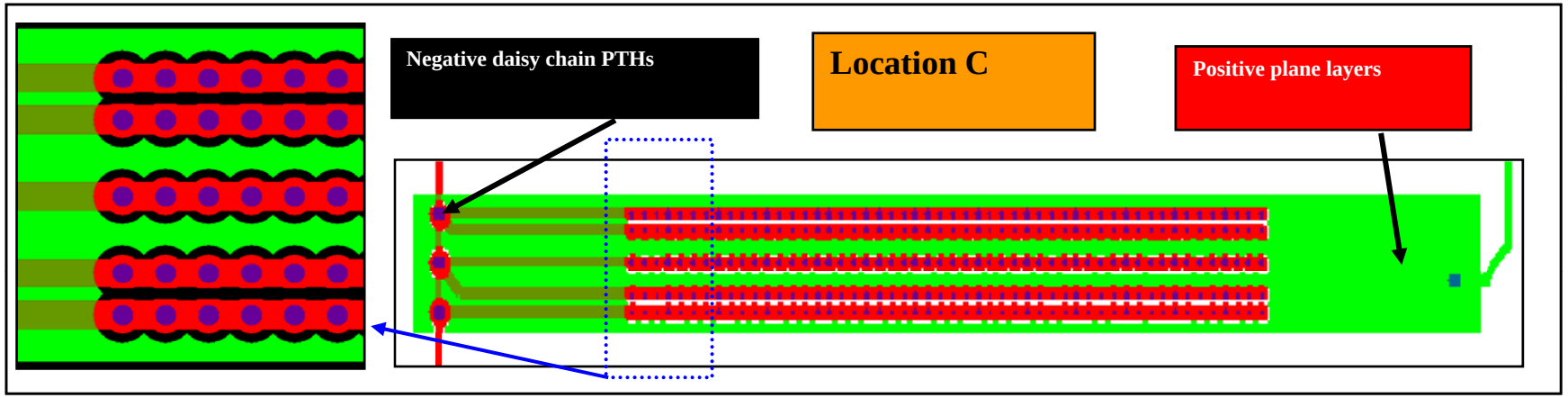


Test Structure A1 to A4 Design Rules and Voltage Gradients

	A1	A2	A3
Outer layer pad size	21	21	19
Inner layer pad size	18	18	18
OL pad to pad spacing	9	5	4
IL pad to pad spacing (shortest distance)	12	8	5
IL Annular Ring	4.1	4.1	4.1
Drilled Hole Size	9.8	9.8	9.8
Pitch	30	26	23
Via edge to via edge	20.2	16.2	13.2

Do Measles Cause CAF?



Test Structure C1 to C4 Design Rules and Voltage Gradients

	C1	C2
Outer layer pad size	21	20
Inner layer pad size	18	18
OL pad to pad spacing	-1	0
IL pad to pad spacing	2	2
IL Annular Ring	4.1	4.1
Drilled Hole Size	9.8	9.8
Pitch	20	20
Antipad Diameter	26.8	22
Via edge to antipad	8.5	6.1
Antipad web	-6.8	-2

For negative antipad web values, copper plane is cleared between holes. This note applies to the plane between rows 1-2 and 4-5

Do Measles Cause CAF?

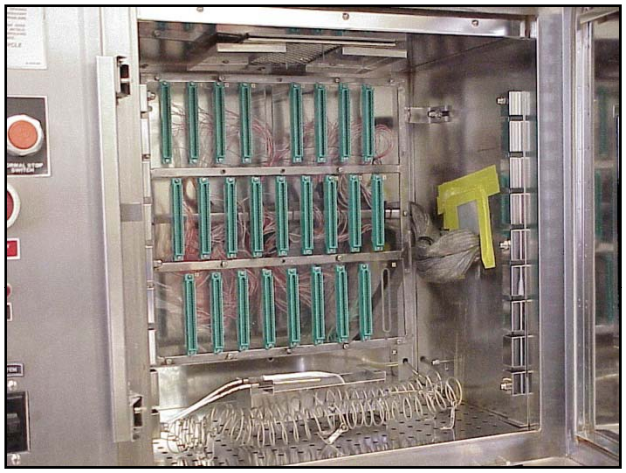
Measle Conditioning

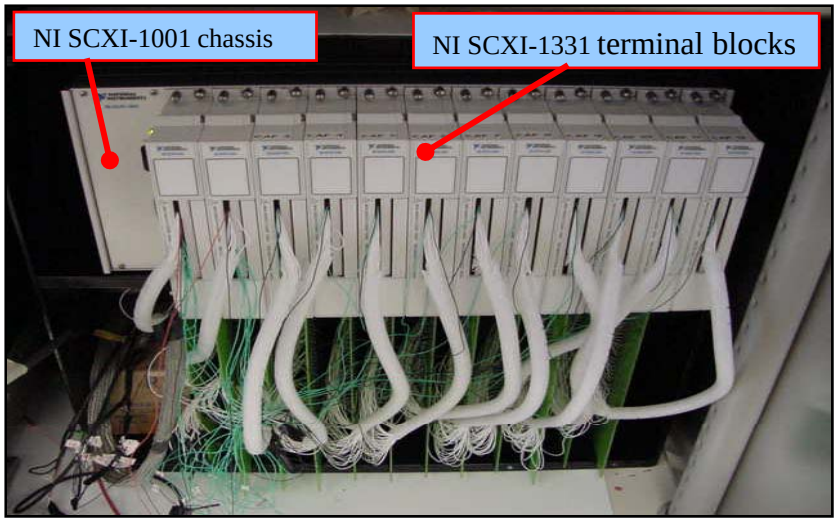
- The conditioning was done by Vicka White (Honeywell)
- Conditioning Parameters
  - Humidity oven (86°C, 85%RH) for 48 hours
  - Rework simulation using eutectic solder
  - Humidity oven (86°C, 85%RH) for 48 hours
  - Heat gun and soldering iron applied at some locations

Do Measles Cause CAF?

- CAF Test Method
  - IPC-TM-650, Method 2.6.25
    - Temperature: 65°C
    - Humidity: 85% RH
    - Bias: 100V
    - Test Duration 500 hours
    - Resistance Measuring Voltage: 100V
    - In Line Resistor: 100K ohm
    - Frequency of Measurement 24 hours

Do Measles Cause CAF?



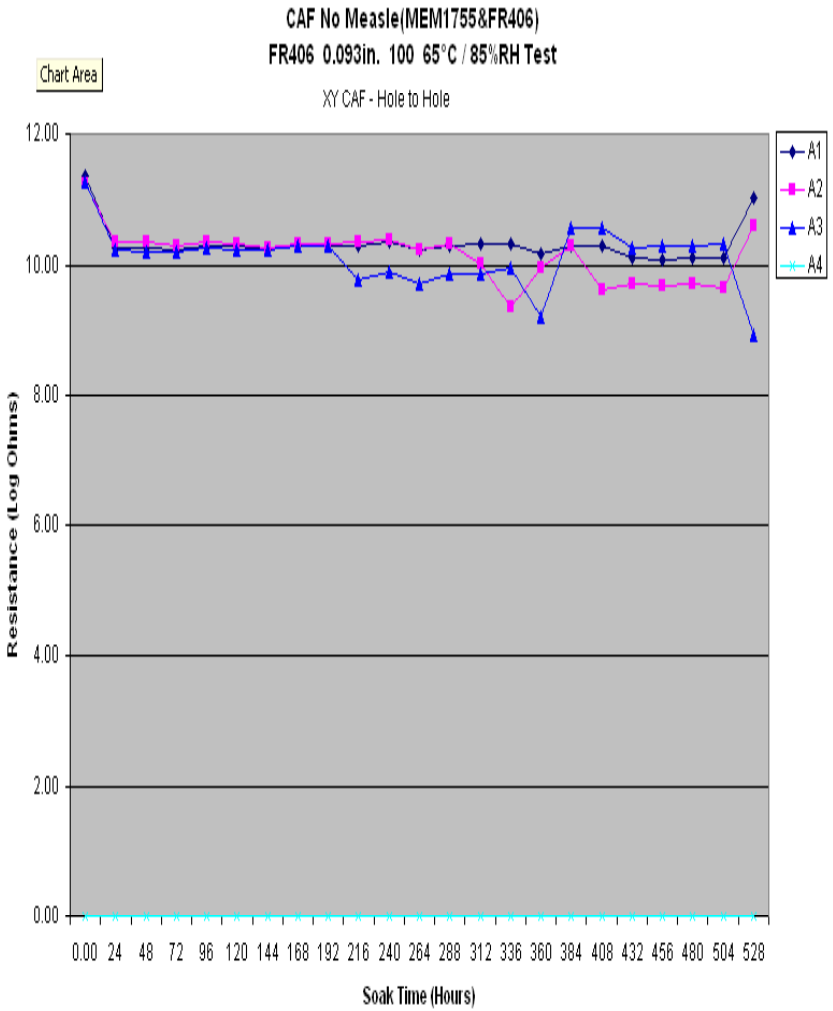


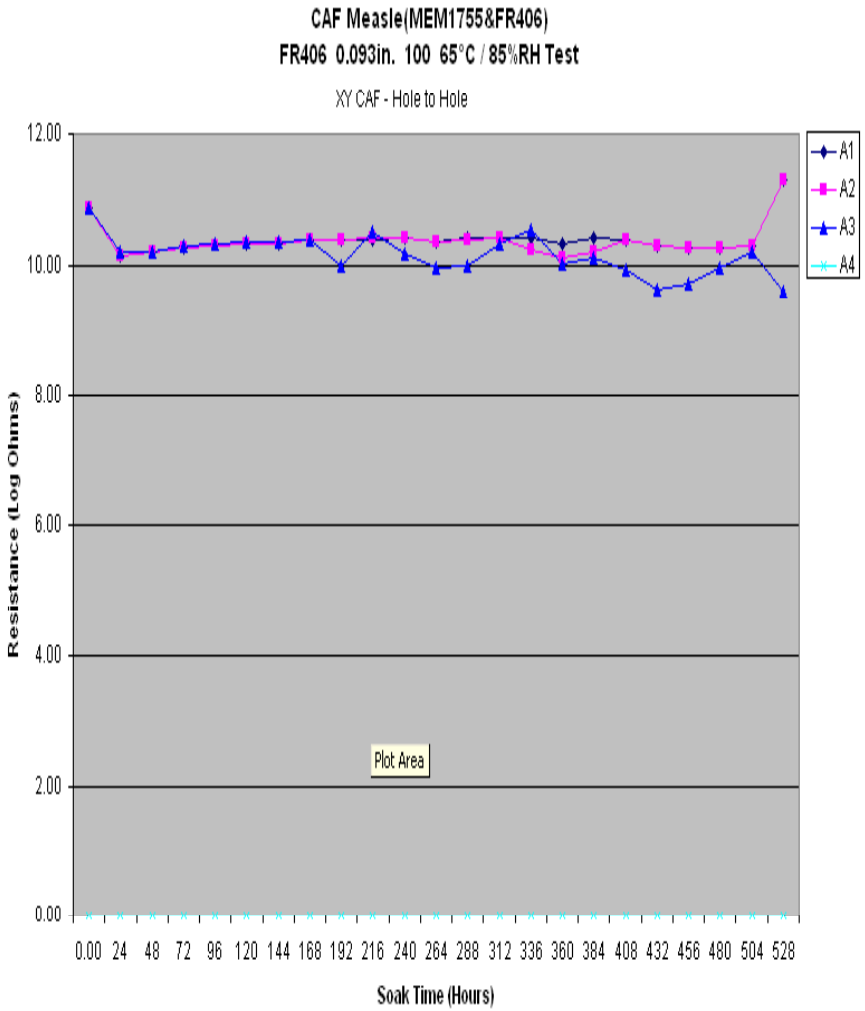
Do Measles Cause CAF?

- Test Results
  - Measling conditioning has less failures

Material Type	Measle Conditioning	CAF Pattern	Sample Locations	Failure Quantity
FR406	Yes	A	18	2
		C	12	2
	No	A	18	3
		C	12	2
MEM1755	Yes	A	18	0
		C	12	0
	No	A	18	1
		C	12	0

Do Measles Cause CAF?





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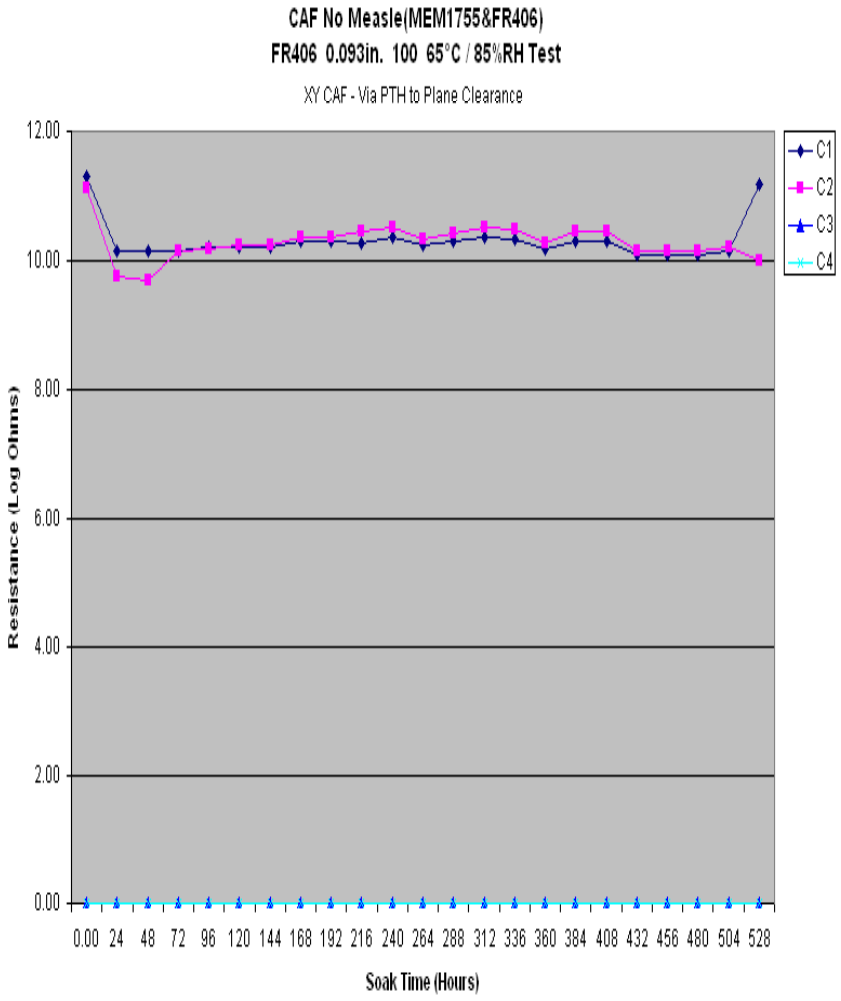
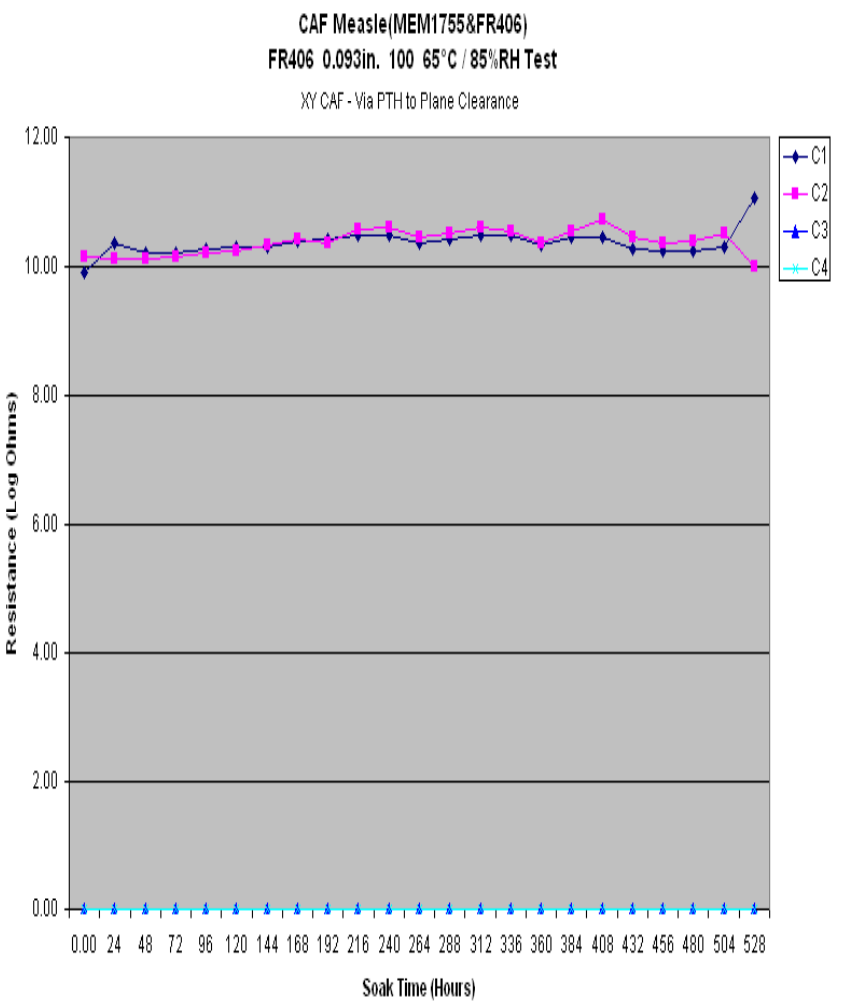


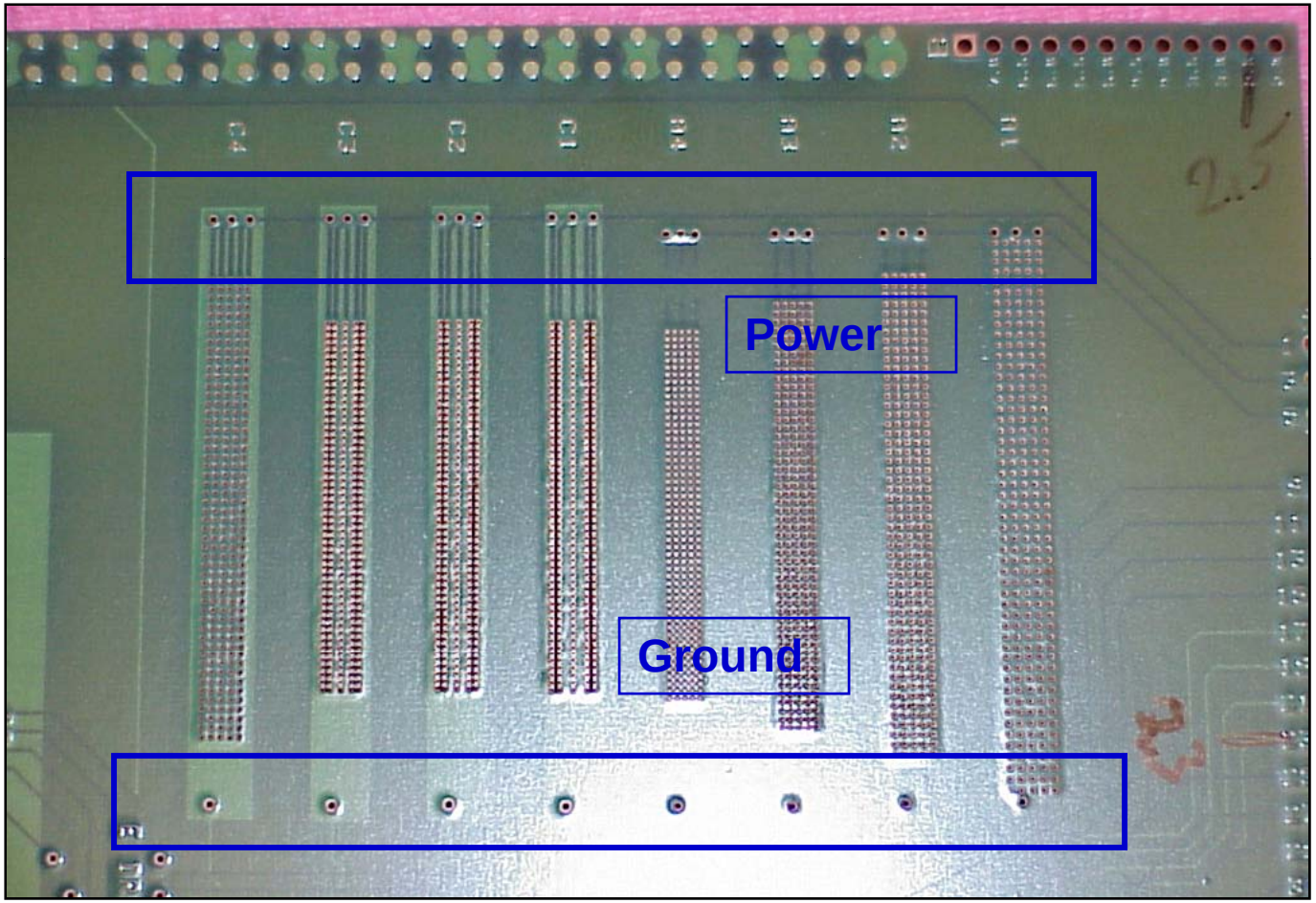


Do Measles Cause CAF?

- Failure Analysis
  - Designed to find the resistance failure
    - Drill out location
      - Isolate the test pattern
      - Isolate the chain and the affected hole or spacing
  - Debug protocols developed
    - Microsection techniques
    - Microscope filters
    - Digital multimeter (CAF resistance typically K ohm range)
    - Knowledge: CAF artifacts versus anomalies
    - SEM for verification of CAF paths

Do Measles Cause CAF?

- Drill Out Locations

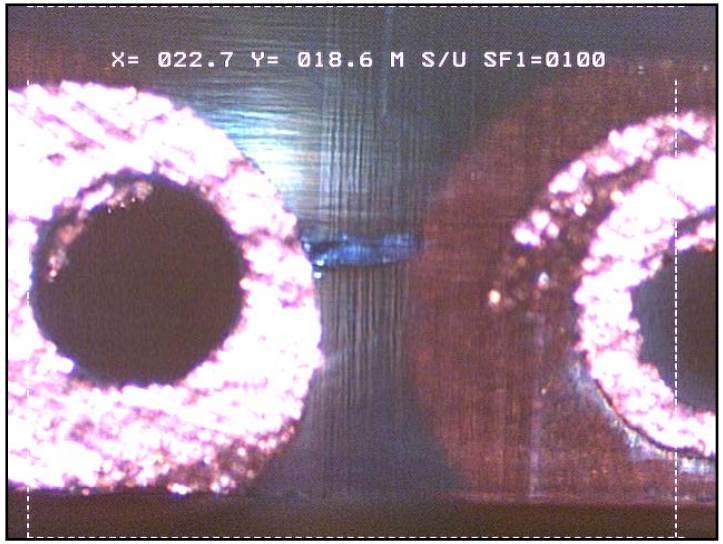


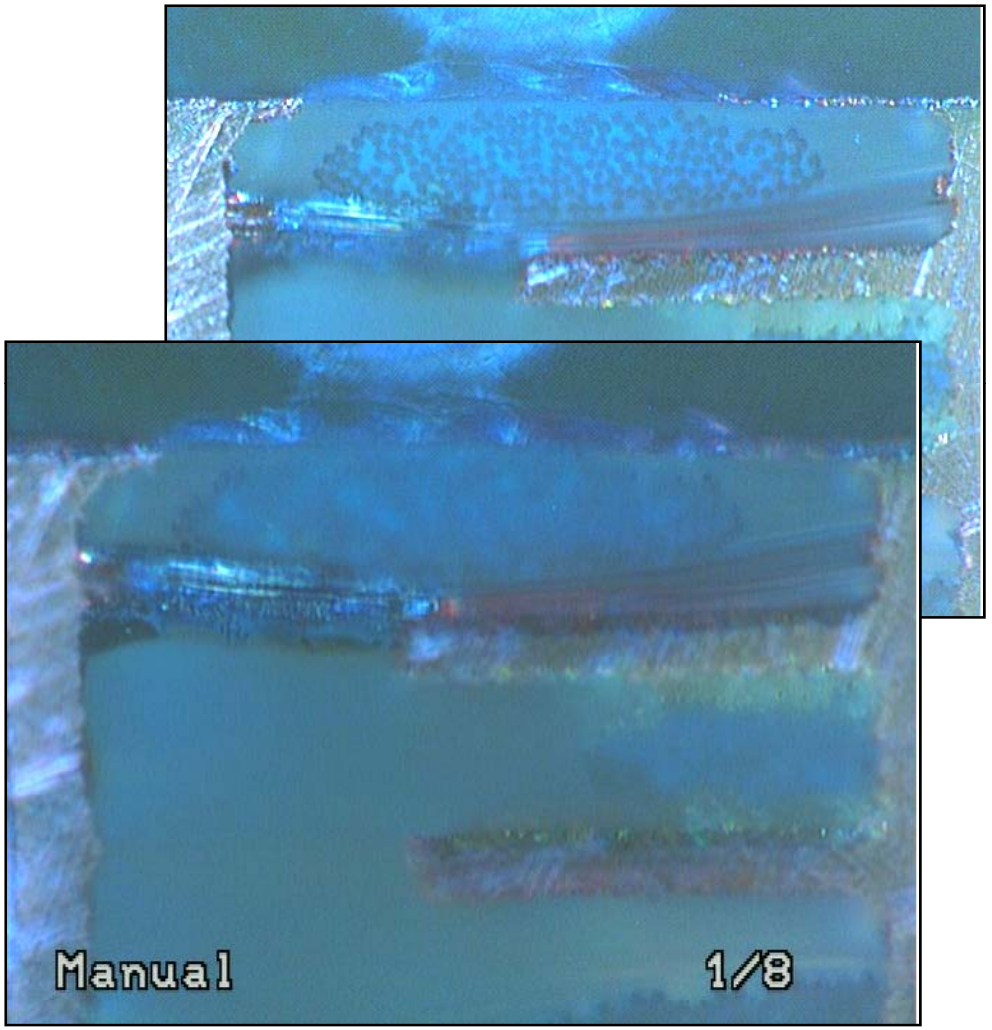
Do Measles Cause CAF?

Board Number	7
Pattern Location	A3
CAF Pattern	PTH to PTH
Spacing	4.4 mils
Material	FR406

Measle Conditioning	Yes
Measle Evident at Failure Location	NO

Failed Layer	Prepreg Layer 3-4
Glass Style	1080



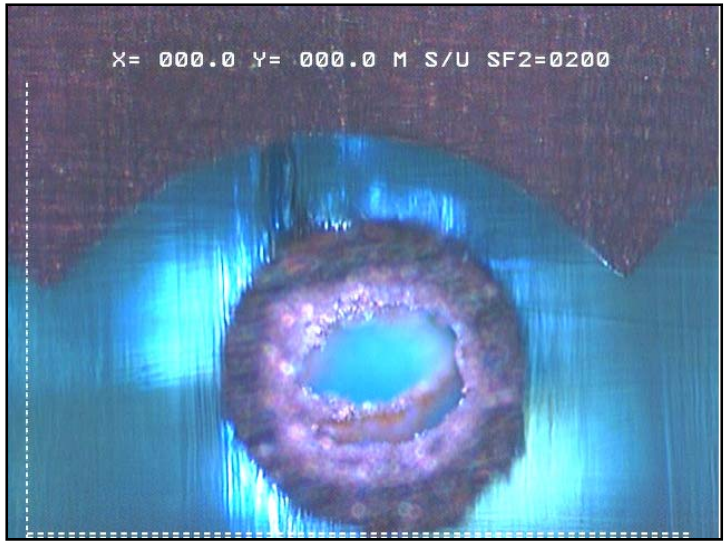


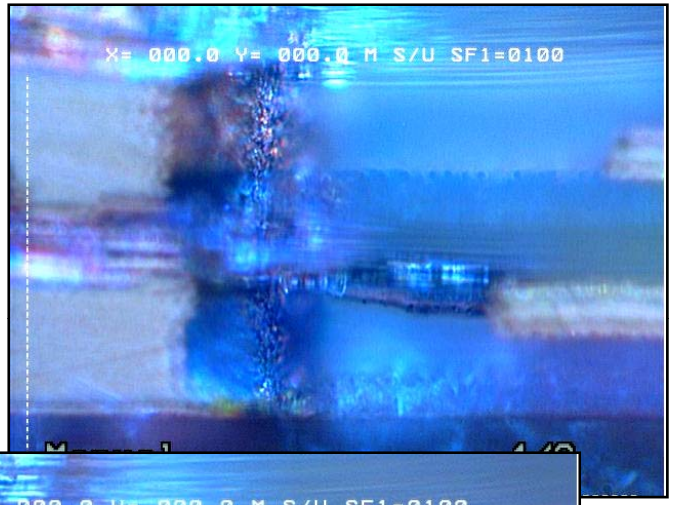
Do Measles Cause CAF?

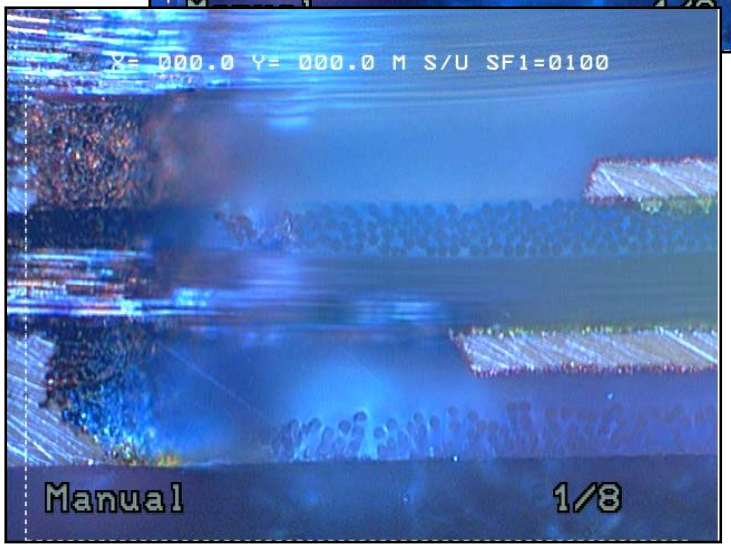
Board Number	11
Pattern Location	C2
CAF Pattern	PTH to Plane
Spacing	3.3 mils
Material	FR406

Measle Conditioning	Yes
Measle Evident at Failure Location	NO

Failed Layer	Prepreg Layer 24-25
Glass Style	1080





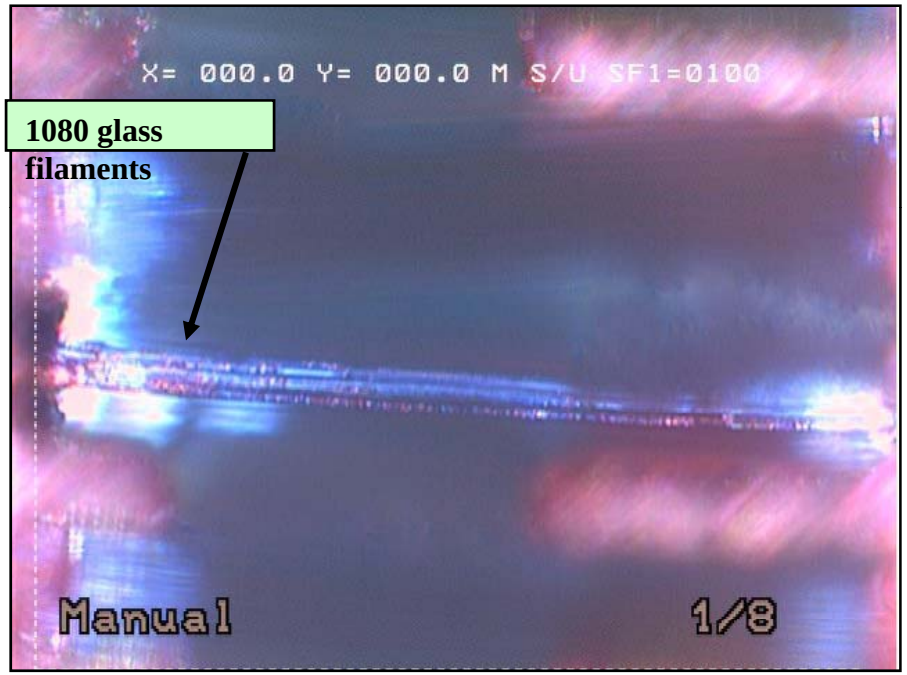


Do Measles Cause CAF?

Board Number	1
Pattern Location	A3
CAF Pattern	PTH to PTH
Spacing	5 mils
Material	FR406

Measle Conditioning	None
Measle Evident at Failure Location	NO

Failed Layer	Prepreg Layer 13 to 14
Glass Style	1080

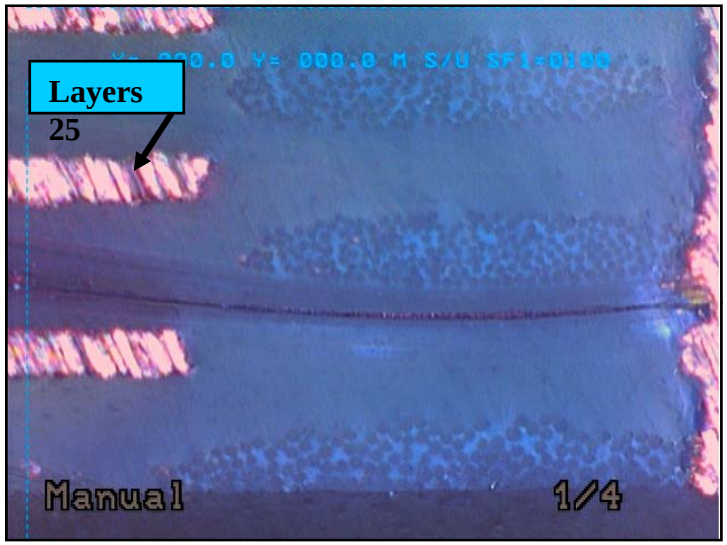


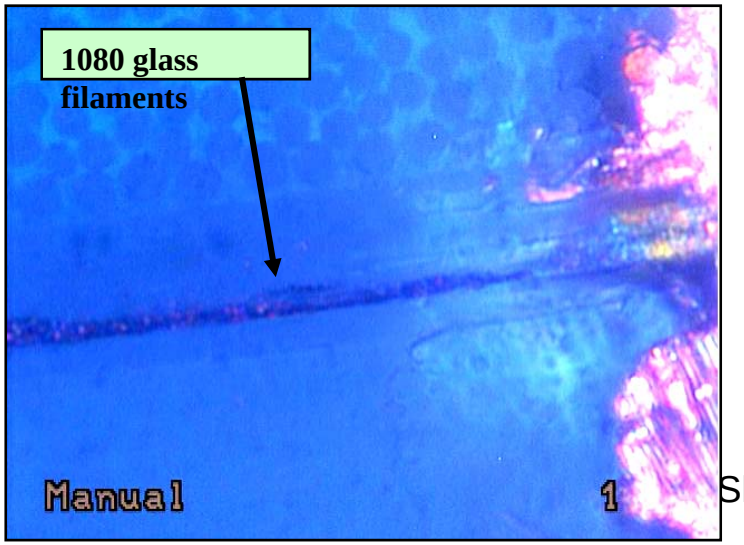
Do Measles Cause CAF?

Board Number	4
Pattern Location	A2
CAF Pattern	PTH to PTH
Spacing	14 mils
Material	FR406

Measle Conditioning	None
Measle Evident at Failure Location	NO

Failed Layer	Prepreg Layer 25 to 26
Glass Style	1080





Do Measles Cause CAF?

Review

1. Conductive anodic filament (CAF) failures are evident on boards with no measle and measle conditioning.
2. The failure rates show there is no statistical increase of CAF on boards with measle conditioning.
3. Measle conditioning did not cause a CAF failure on a lead free material.
4. All CAF failures were within the glass filament.
5. No measles (separation of glass yarn knuckles) were evident at the CAF failure sites.

Do Measles Cause CAF?

Conclusion

- This study did not find measles at any of the CAF failure locations.
- Further testing and failure analysis investigations are required to substantiate that measles result in CAF failures.
- There is no technical evidence to justify the classification of a measle as a defect in IPC-6012.
- The assembly and rigid board performance subcommittees update the acceptance criteria.
  - Measles that do not propagate under thermal stress is an acceptable condition.

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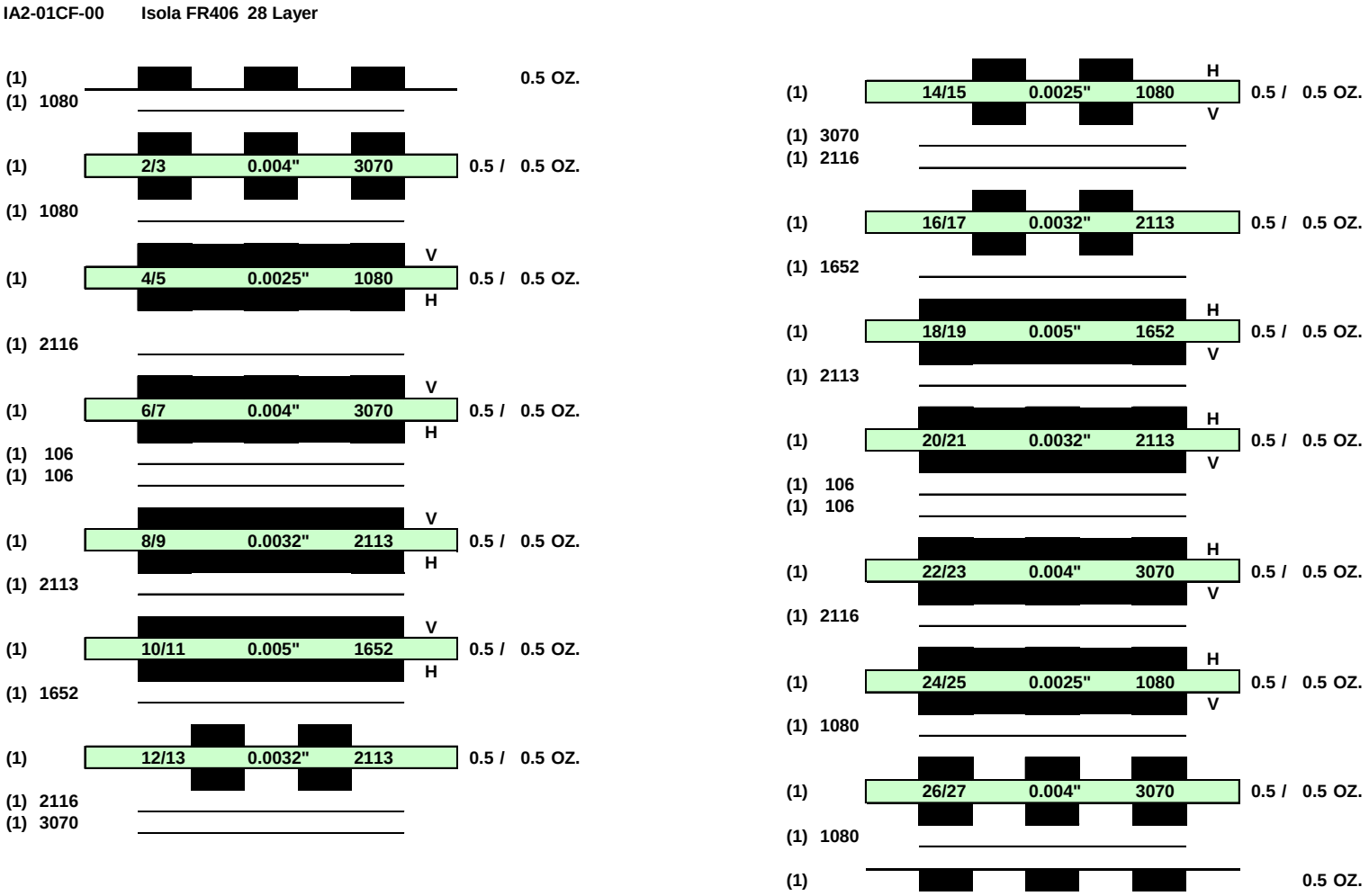

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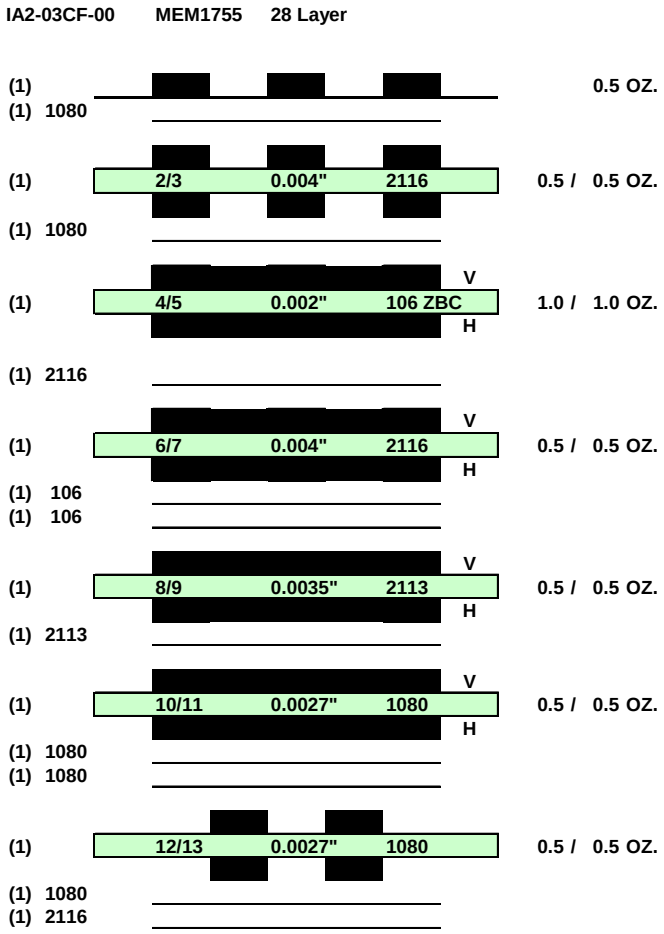
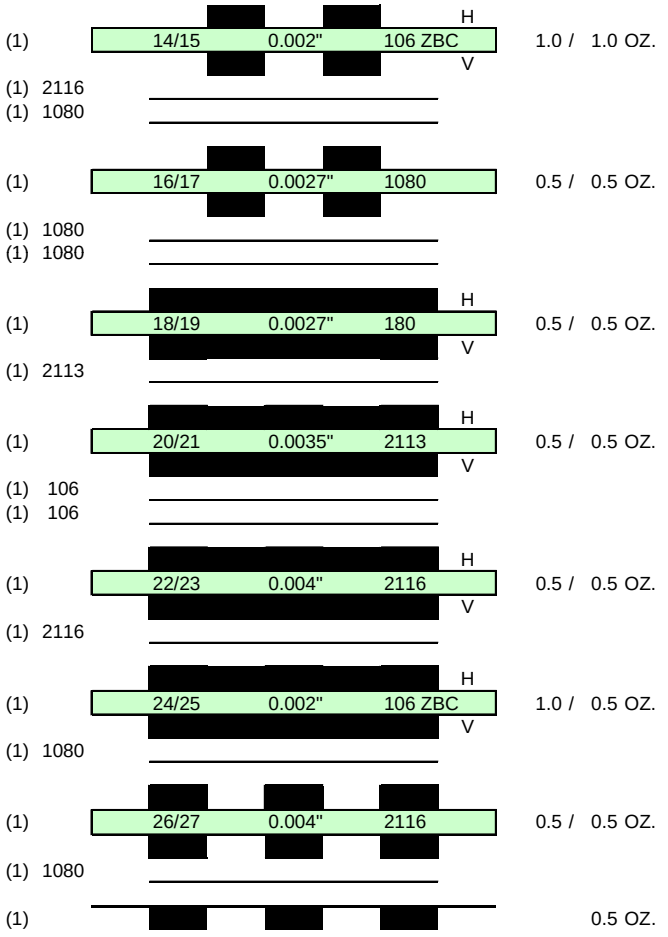
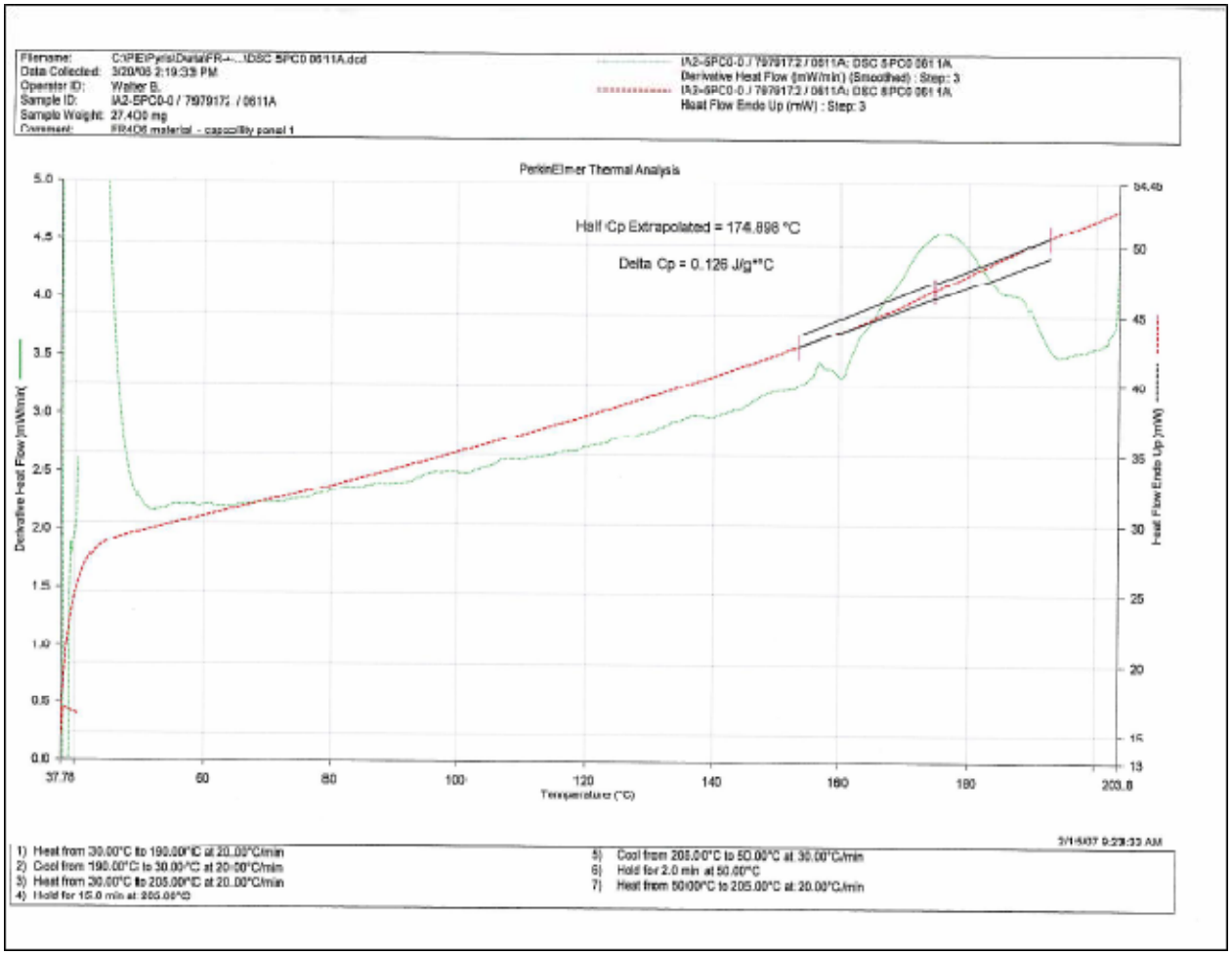




Do Measles Cause CAF?

Isola FR406 Laminate



Do Measles Cause CAF?

MEM 1755
Laminate