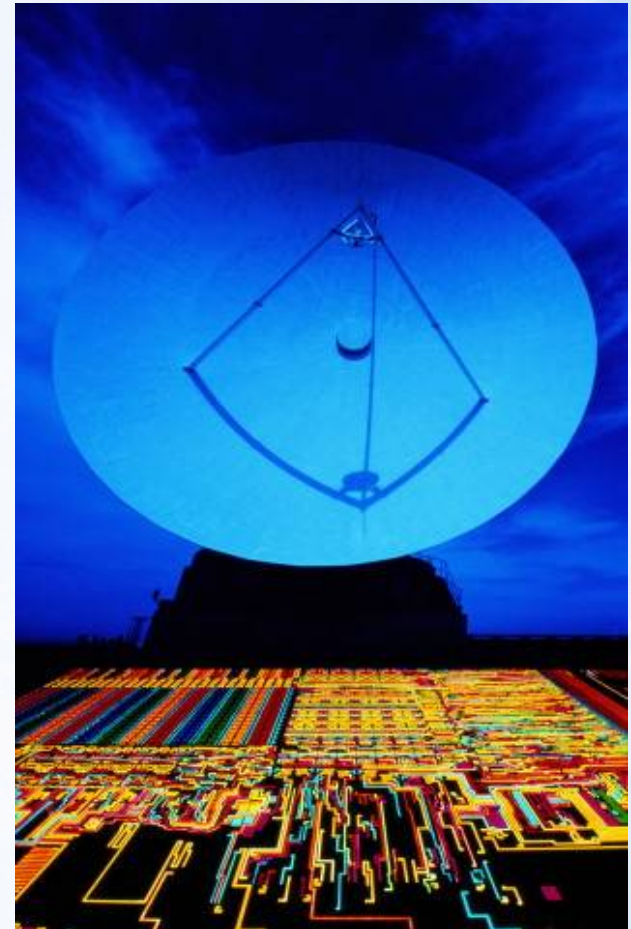
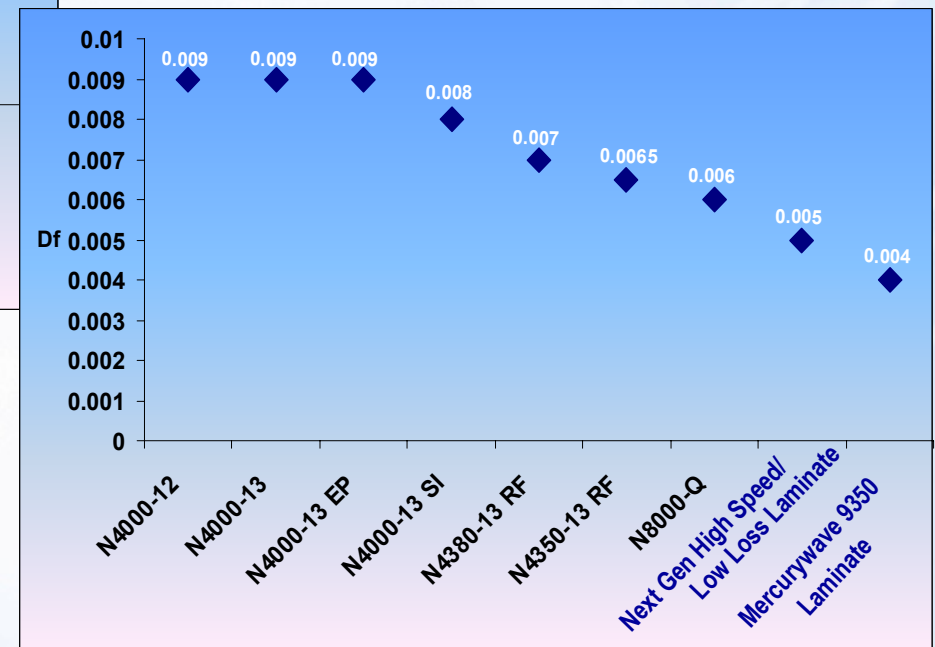
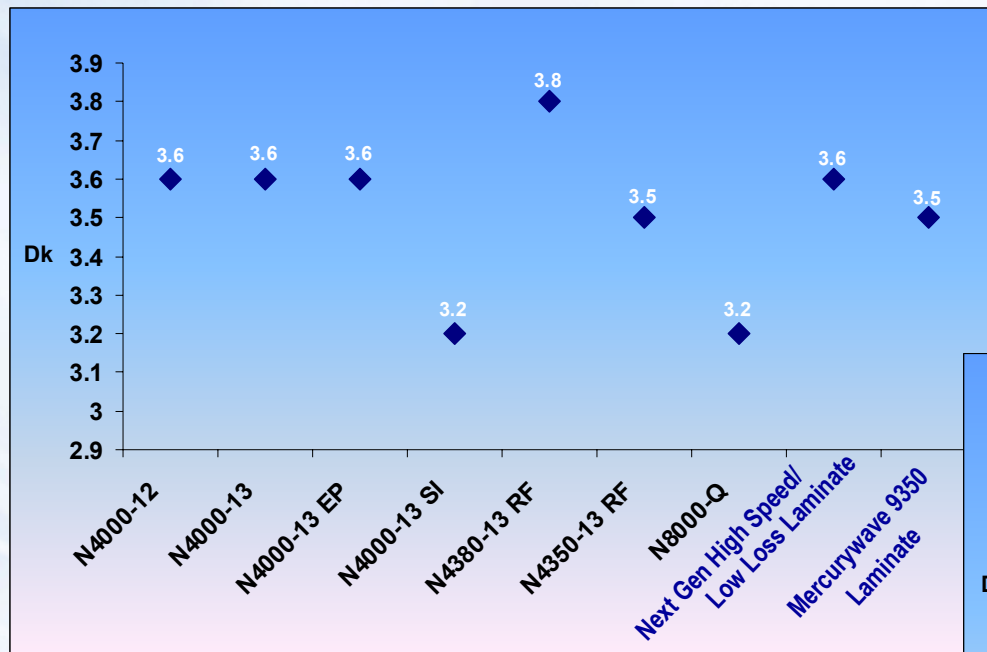


mercurywave™ 9350

Advanced RF & Microwave Material



High Performance RF and Digital Thermoset Electronic Materials



Tested per IPC TM650-2.5.5.5 @ 10 GHz



MercuryWave™ 9350 Benefits

- RF microwave applications
 - Laminate and prepregs have a controlled Dk of 3.5 with a Df of .004 by stripline @ 10 GHz
 - Impedance matching for better electrical performance
- Range of core thicknesses
 - ✓ .003"(.076mm) and up
- Prepregs for multilayer lamination
 - ✓ 106, 1080 & 2116 prepregs available
- Multiple panel size availability
- Global availability
 - ✓ Global manufacturing with standard lead times



mercurywave™ 9350 Benefits

- Enhanced thermal/electrical performance
 - Outstanding thermal performance (thermal conductivity .5W/mK & lead free compatibility)
 - Stable electrical performance:
 - Over frequency (2 GHz – 43 GHz)
 - Elevated temperature (-40°C to 150°C)
 - Humidity (25% to 85% RH)
- High Tg material ($\geq 200^{\circ}\text{C}$ by DMA)
- Low CTE expansion 2.5% (50°C to 260°C)
 - ✓ Alpha 1 = 48 ppm/°C (50°C to Tg)
 - ✓ Alpha 2 = 245 ppm/°C (Tg to 260°C)
- Compatible with lead free processing (multiple 260°C reflows)
- High peel strengths 7lbs/in(1.23 N/mm)
 - ✓ Use RTF as standard copper for adhesion



MercuryWave™ 9350 Benefits

- Compatible with alternative oxide and ENIG/Immersion Tin plating chemistries
- Excellent crack resistance for sequential lamination designs
- Fabrication
 - ✓ No special fabrication techniques required
 - Standard entry material for drill
 - Repoint drill bits permitted (1000 hits/drill)
 - Standard hole wall preparation
 - Does not require sodium etchant or plasma treatment
- No special surface roughness requirement for solder mask adhesion
- Material capable for v-score singulation
- UL approval in process (provisional end of May)
- Meets and exceeds IPC 4103/11 electrical and mechanical requirements



Mercurywave™ 9350 Comparison to 4103/11

	4103 /11	Mercurywave 9350	Units
Peel Strength 1.oz Foil			
Low Profile Foil (sub 1 micron)	N/A	5	Lbs/in
Standard Foil			
After Thermal Stress	3	7	Lbs/in
At 150C	3	7	Lbs/in
After Process Solutions	3	8	Lbs/in
Volume Resistivity			
96/35/90	10 ⁵	10 ⁷	MΩ-cm
24/125	10 ⁴	10 ⁶	MΩ-cm
Surface Resistivity			
96/35/90	10 ³	10 ⁵	MΩ
24/125	10 ²	10 ⁶	MΩ
Moisture Absorption	0.25	0.15	%
Dielectric Breakdown	30	>50	kV
Permittivity 10 GHz	3.48 - 3.60	3.5	
Loss Tangent 10 GHz	0.006	0.004	
Flexural Strength			
Length Direction	310	606	N/mm ²
Cross Direction	228	428	N/mm ²
Thermal Stress 10 s @ 288 C	Pass	Pass	s
Electric Strength	N/A	1500	V/mil
Flammability			
Average Burn Time	50	94-V0	s
Individual Burn Time	10	94-V0	s
CTE			
X/Y Axes	N/A	10-14	ppm/C
Z Axis	N/A		
α1		48	ppm/C
α2		245	ppm/C

A new slash sheet designation has been submitted for Mercurywave™ 9350



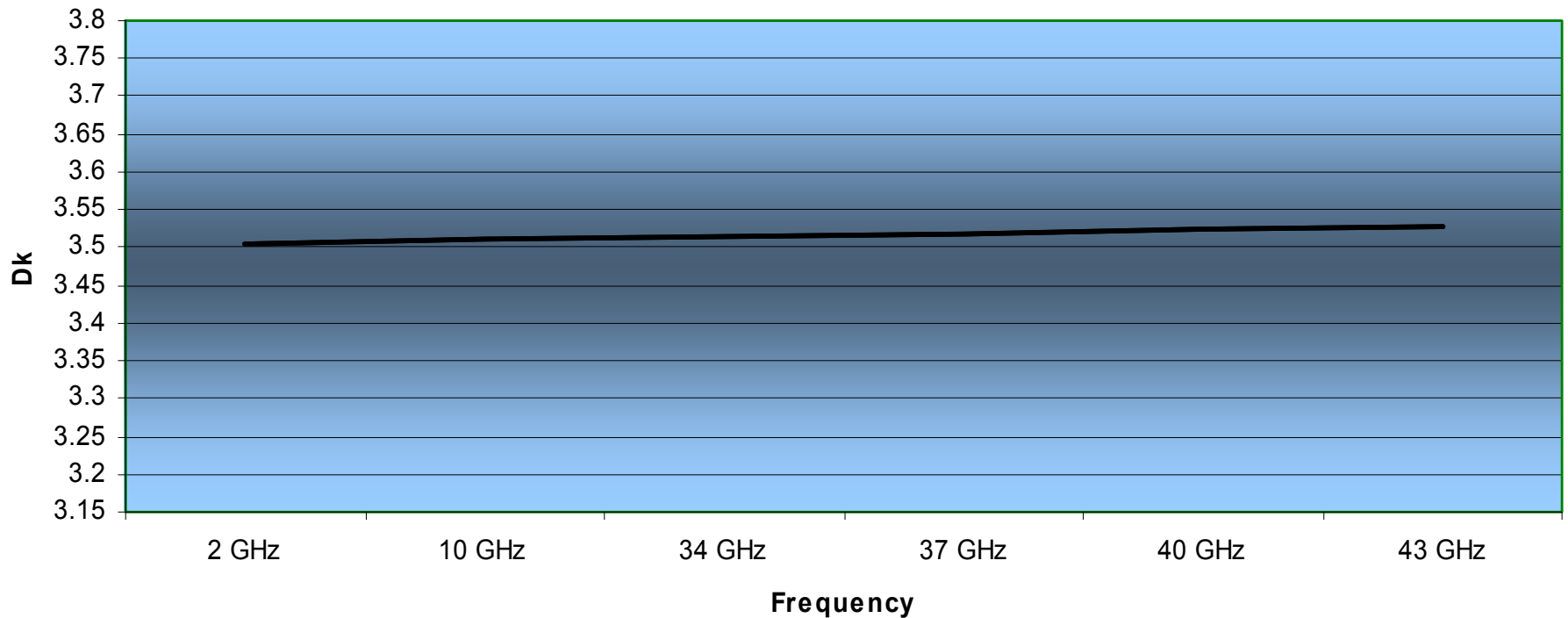
mercurywave™ 9350 Thermal Properties

Property	Mercurywave™ 9350	N4350-13RF	N4000-29
Tg (DSC)	≥200°C*	210°C	185°C
Td (TGA)	360°C	350°C	350°C
T ₂₆₀	200 min.	> 30 min.	> 60 min.
T ₂₈₈	40 min.	>10 min.	15 min.
T ₃₀₀	18 min.	0 min.	3-5 min.
Solder Float (4"x4" Cu Clad 288°C time to failure)	>600 sec.	>470 sec.	>600 sec.
Pressure Cooker (1 hr.)			
Moisture Gain	0.15%	0.10%	0.15%
Solder Dip (288°C)	>600 sec.	>600 sec.	>600 sec.

* Tg by DMA

mercurywave™ 9350

Dk vs Frequency

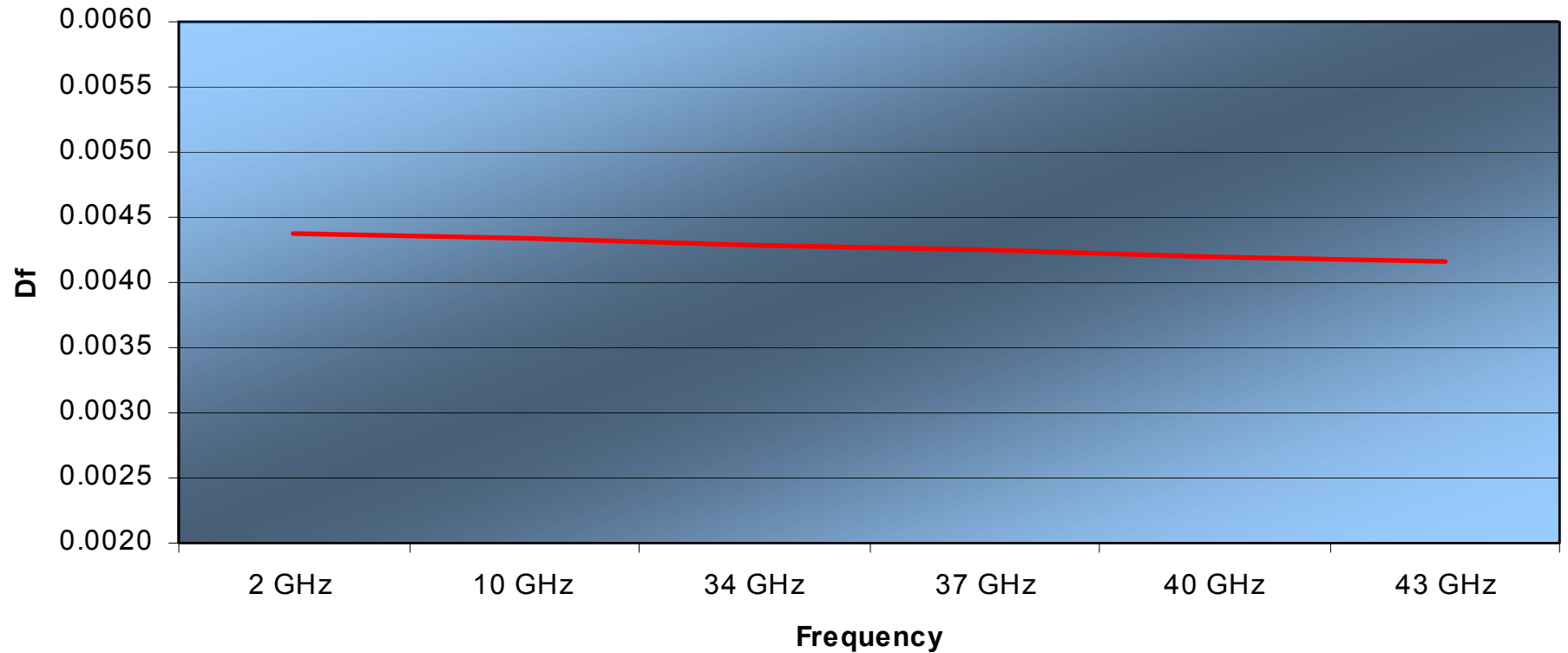


Tested per IPC TM650-2.5.5.5 @ 10 GHz
Tested with Open Circular Cavity above 10 GHz
(Out of Plane Measurement)



mercurywave™ 9350

Df vs Frequency

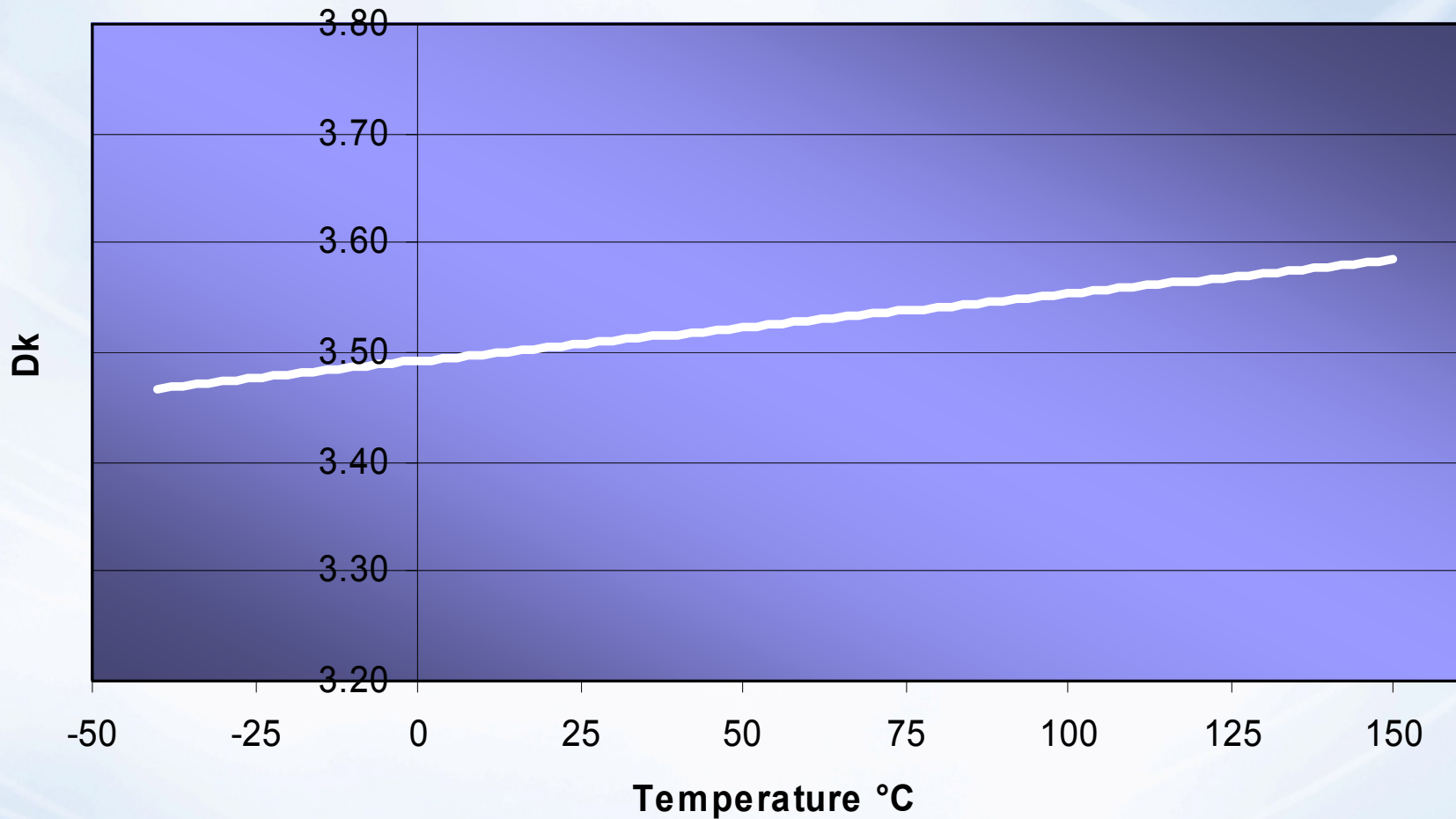


Tested per IPC TM650-2.5.5.5 @ 10 GHz
Tested with Open Circular Cavity above 10 GHz
(Out of Plane Measurement)



mercurywave™ 9350

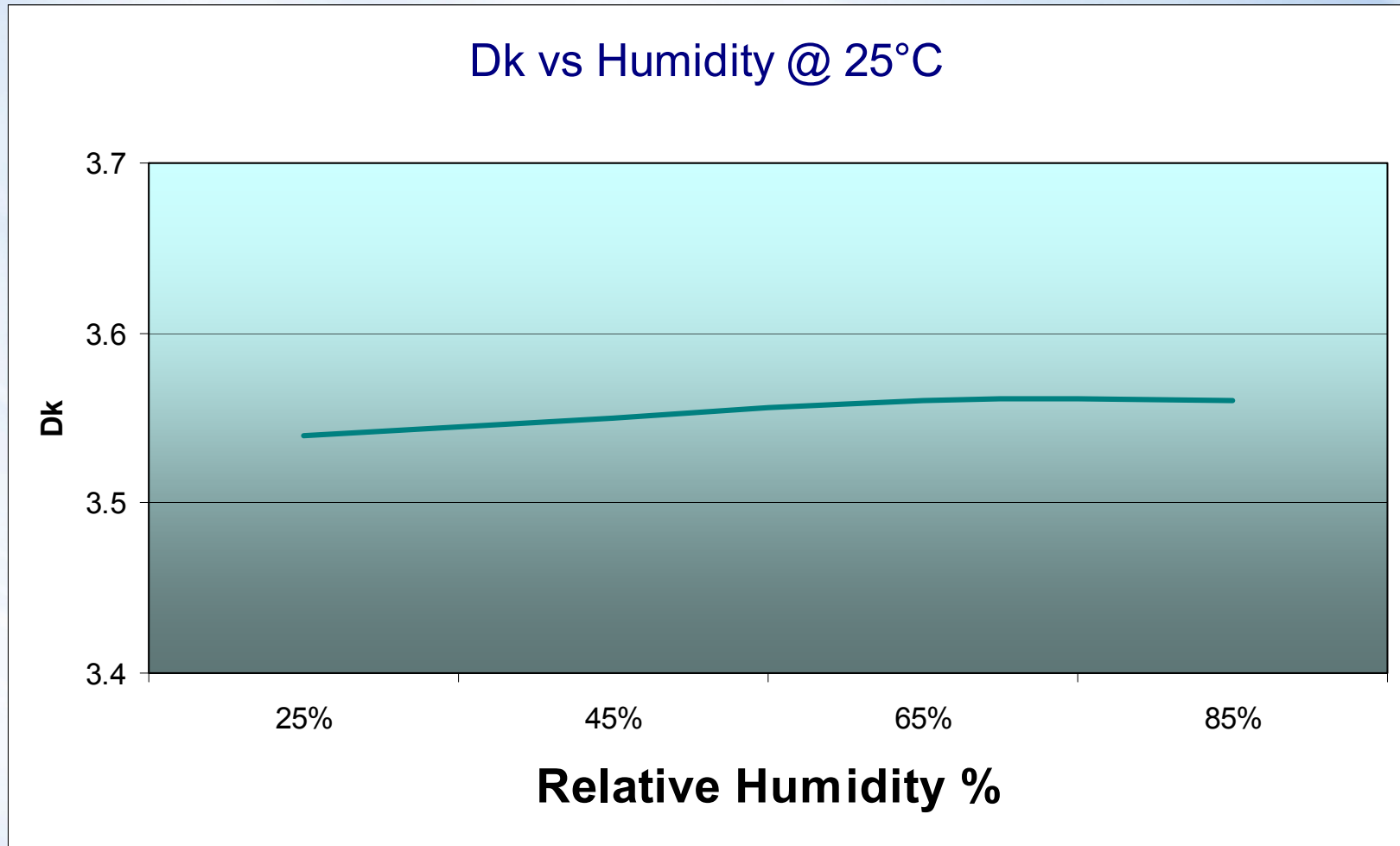
Dk vs Temperature



Tested per IPC TM650-2.5.5.5 @ 10 GHz



mercurywave™ 9350



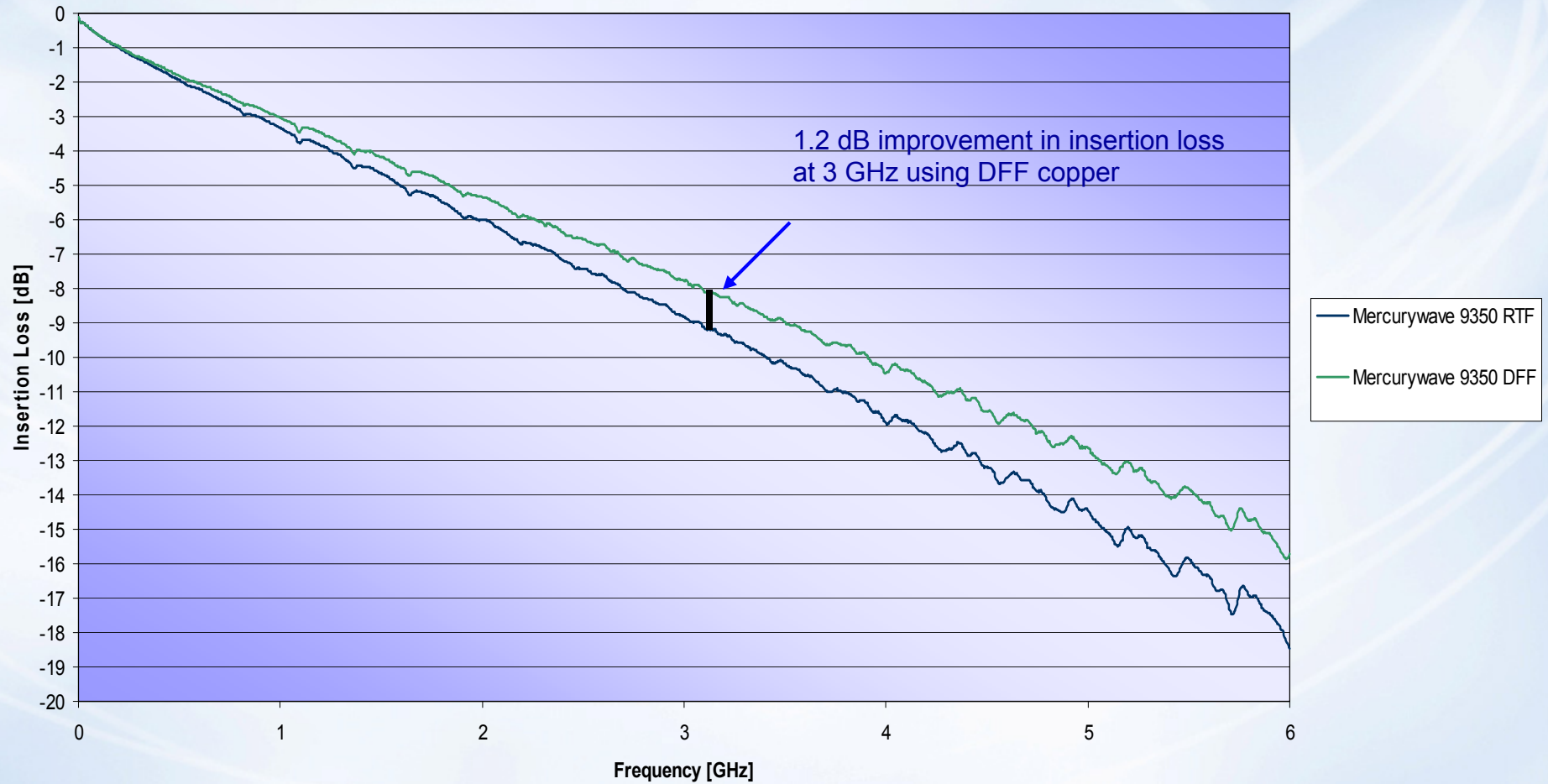
Tested per IPC TM650-2.5.5.5 @ 10 GHz
Samples were equilibrated for 24hrs at each RH% before test



Customer Evaluation

Copper Foil Impact on Insertion Loss

130" Meanderline Trace Comparison (Insertion Loss)
WiMax Antenna Application Operating at 3 GHz

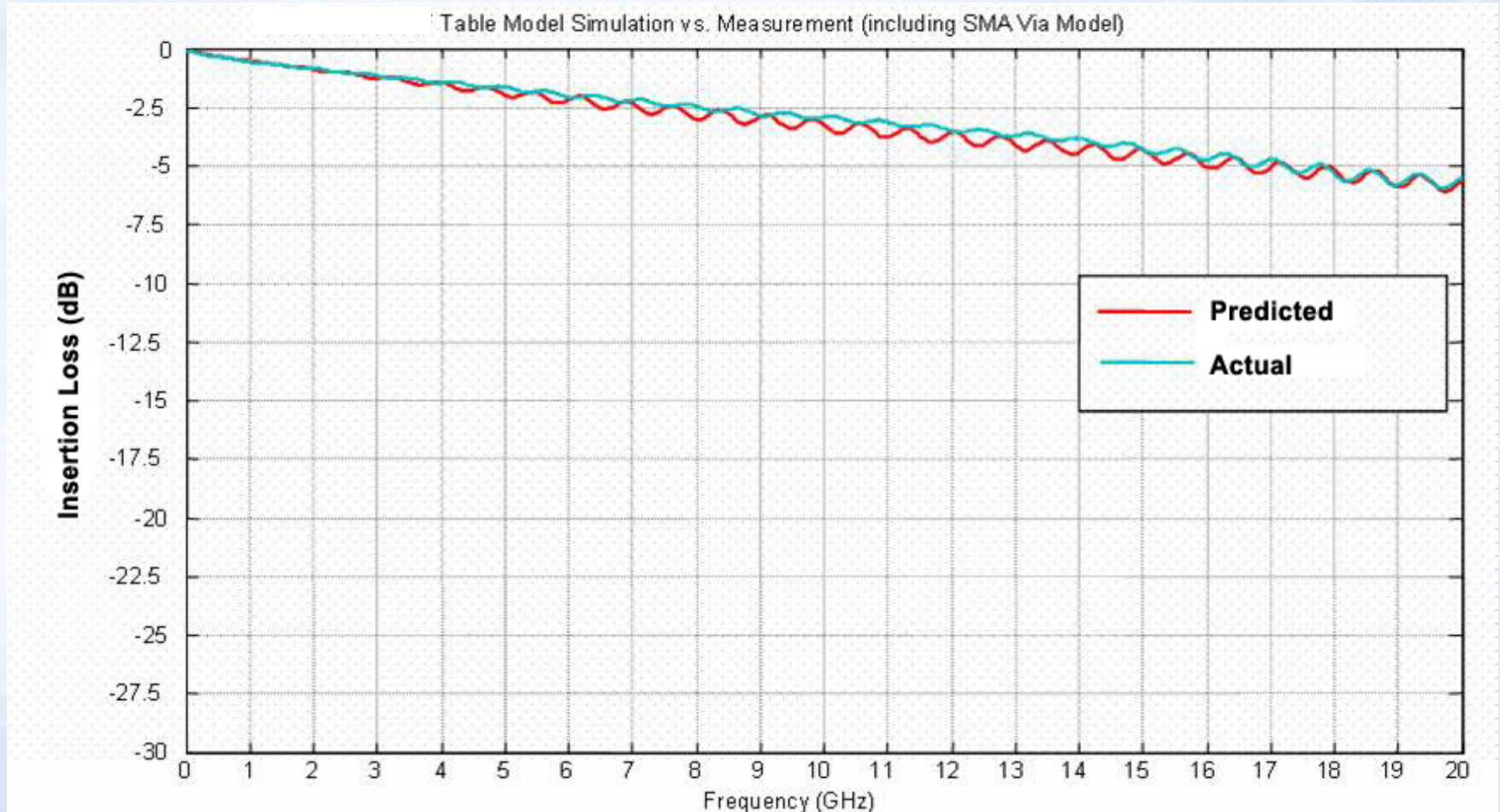


Customer Evaluation

8L .066" Signal Integrity Test Vehicle

Designed to evaluate a 3.5 Dk laminate

Output was looking at simulated vs measured insertion loss over frequency (simulated meet actual)



Customer Evaluation

12L TV .067" - .004" (2116), .006" (1080), .010" (1080) all are ½ oz copper with 1080 prepreg

The TV has approximately 15,000 holes split into 4 different pitch sizes

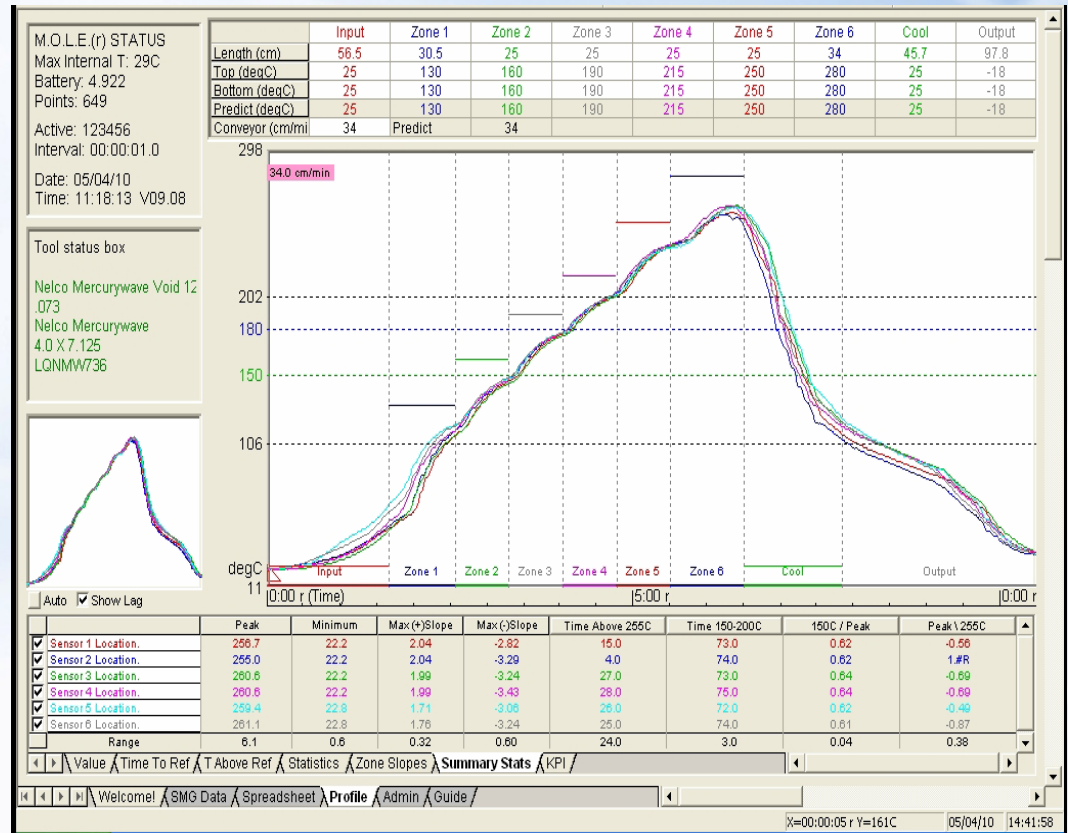
Technology

1 mm BGA, 10 mil holes

1 mm BGA, 12 mil holes

.8 mm BGA, 10 mil, holes

.8 mm BGA 12 mil holes



4 panels were reflowed at 6X, 8X, 10X 260C. All 12 panels were horizontally ground & visually inspected. No delamination was found after visual inspection.



Customer Evaluation

Board is 9.5"X6" Signal Integrity TV
8L .066" 1 & .5 oz copper innerlayers
Laminate & prepreg consisted of all high RC 106
& 1080

Aspect ratio is 3 to 1 (.022" holes)
Test boards were reflowed a total of 15 times
6X260C + 6X270C + 3X300C

No delamination was seen after visual
inspection or after cross section were taken

Thermal data after 15 reflow cycles

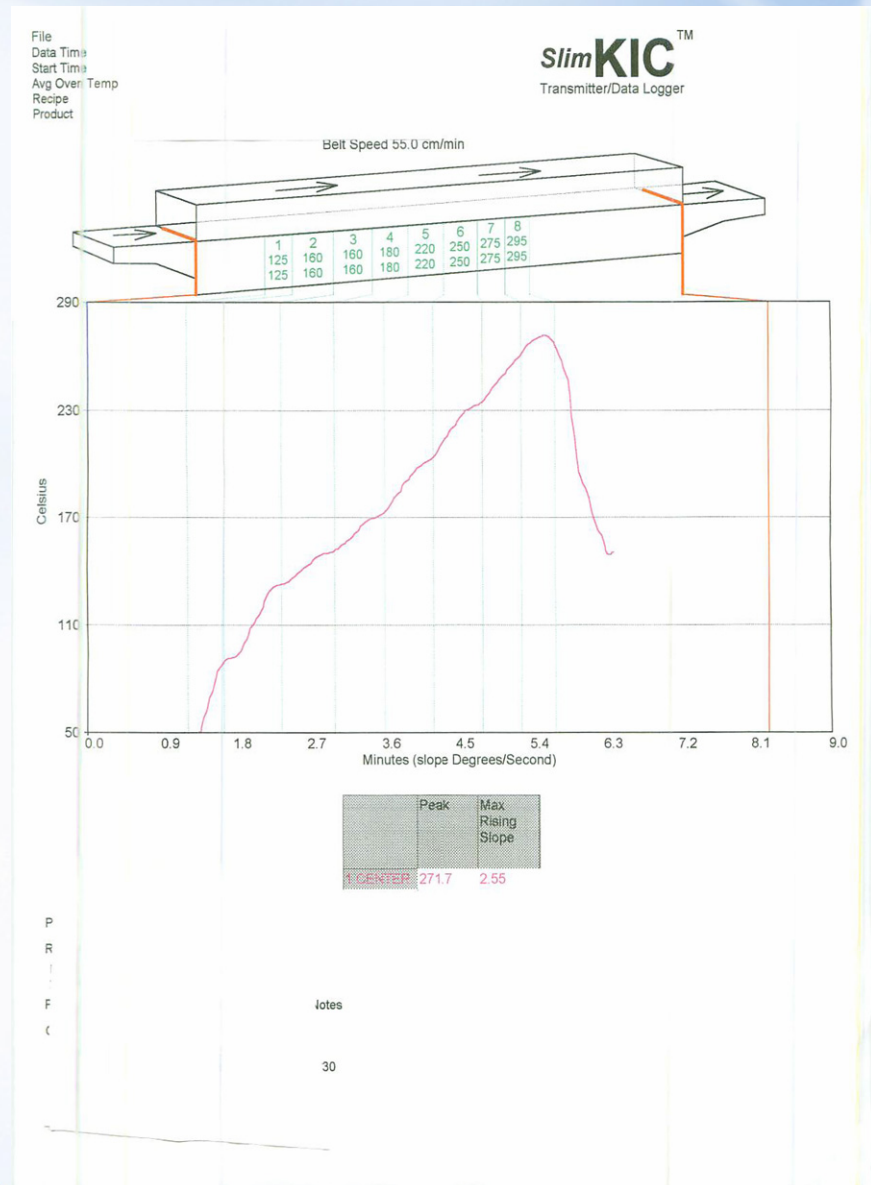
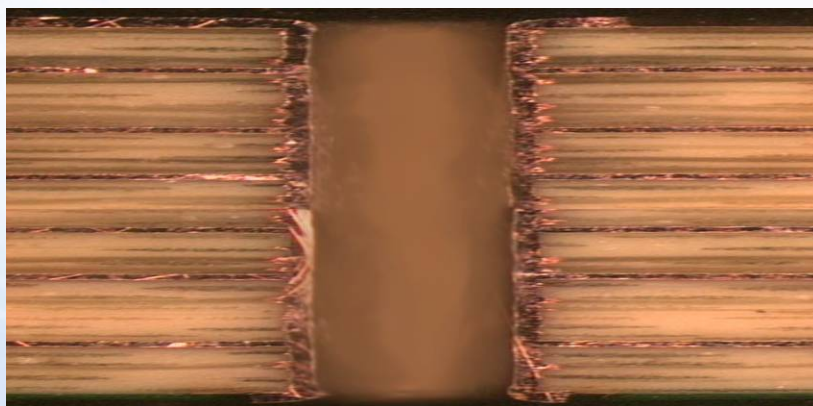
DMA (TgI/TgU) = 221°C/221°C

TGA = 387°C

T260 = >60 min no delamination

T288 = 13 min

T300 = 7 min



Customer Evaluation

Production board 13.5"X5.25" Hybrid Mercurywave™ 9350 /-6FC

3X Sequential lamination design

12L .105" .5 oz copper innerlayers

Laminate & prepreg consisted of all 106 & 1080 glass

1 mm pitch BGA

Aspect ratio is 6.5 to 1 (.016" holes)

Six boards were reflowed at 6X245C

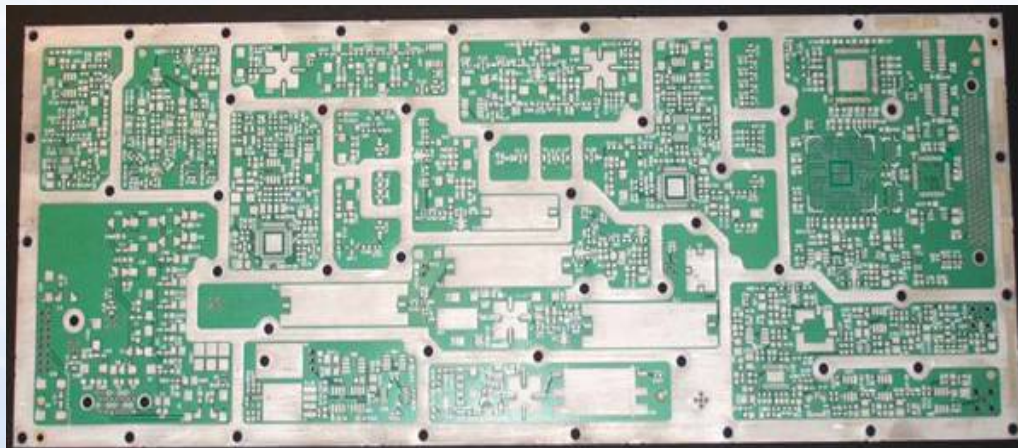
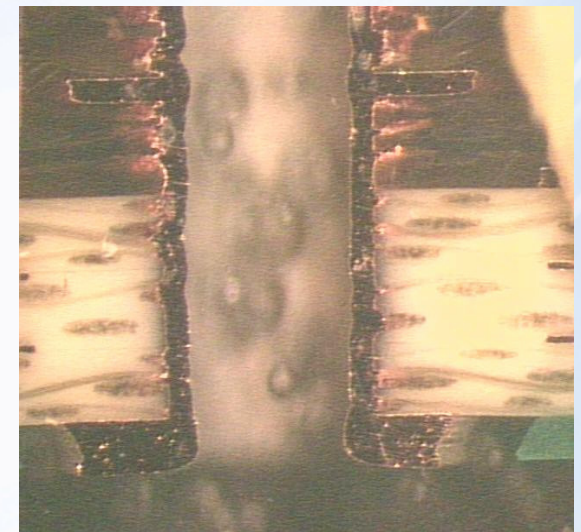
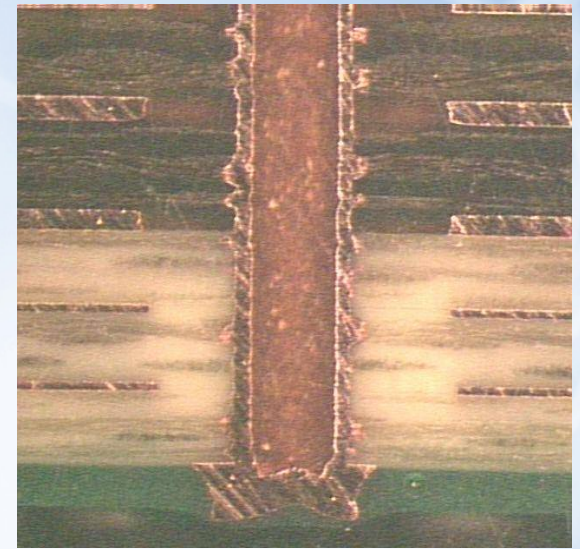
No delamination was seen after visual inspection or after cross sections were taken

Thermal data after 6 passes through reflow

DMA (TgI/TgU) = 193°C/193°C

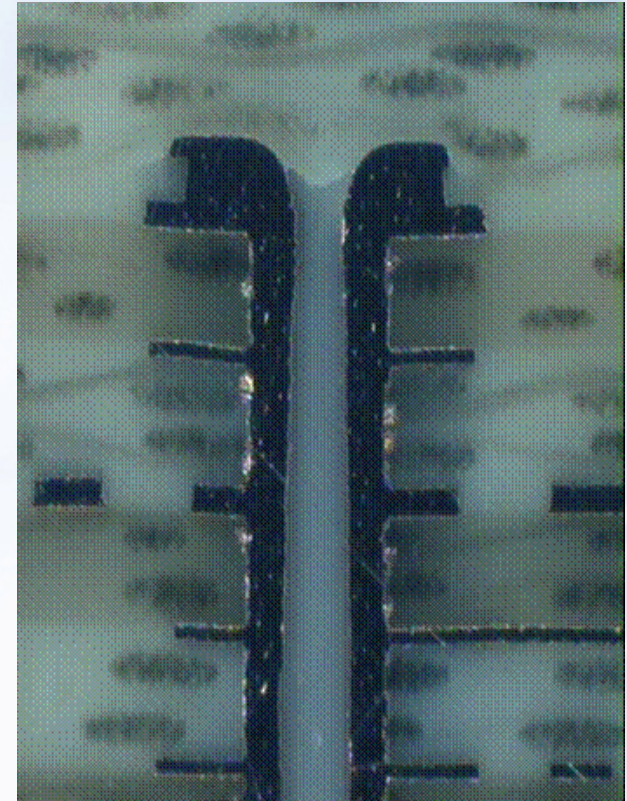
TGA = 375°C

T260 = 2.2 min



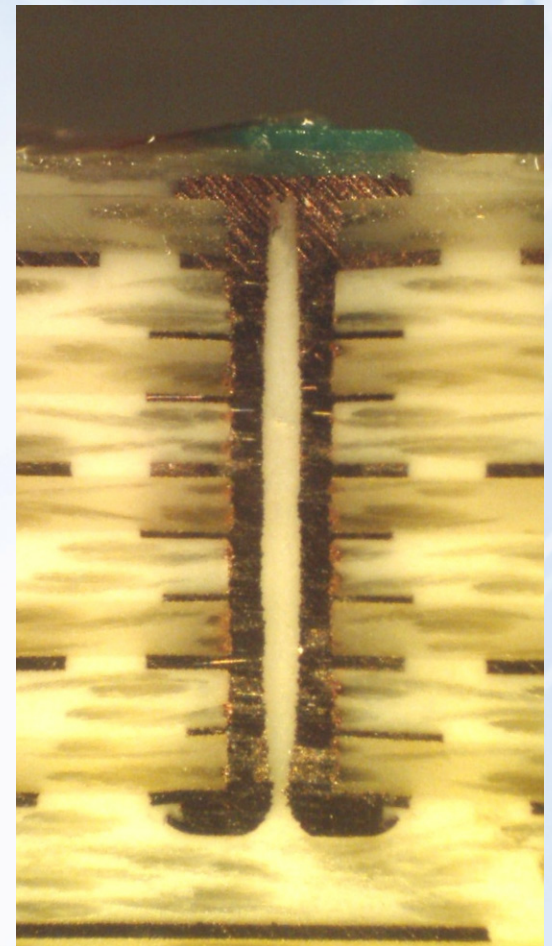
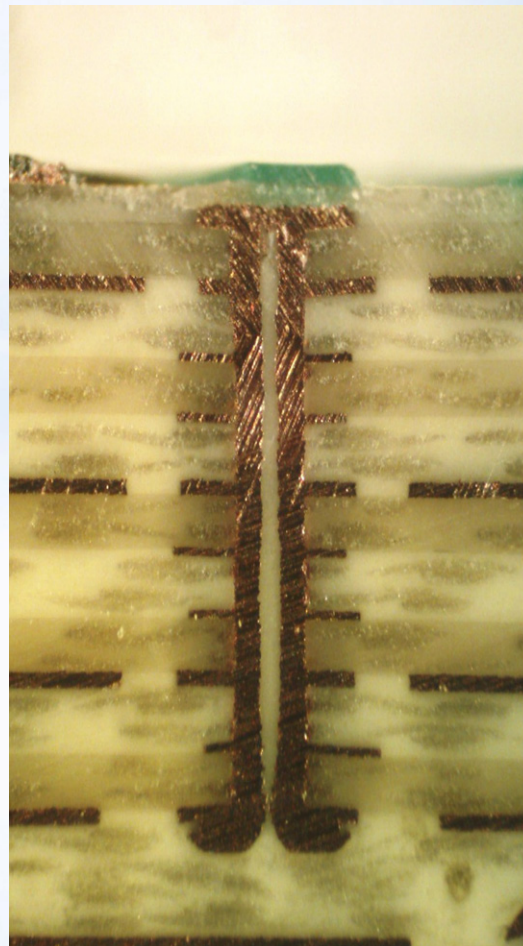
Lead Free PWB Conditioning

- PCBs need to function in a variety of environmental conditions (temperature & humidity)
- Different assembly house conditions in North America, Europe & Asia
- Some OEMs require conditioning of laminate materials as part of the qualification process
 - ✓ 65%RH/ 35°C conditioning for 2 weeks followed by a 9x260°C reflow
- Application test
 - ✓ 22L, .125" 3x sequential lamination with blind and buried laser vias
 - ✓ 65%RH/35°C conditioning for 2 weeks followed by a 9x260°C reflow
 - ✓ No delamination was found after inspection, even after an additional 6x300°C reflow



Via Fill Capability

- Mercurywave™ 9350 has excellent flow and fill characteristics
- Can be used for both laser via and sub lamination designs
- 22L, .125" with .060" with .010" drilled holes
 - ✓ Filled with 2X106 prepreg

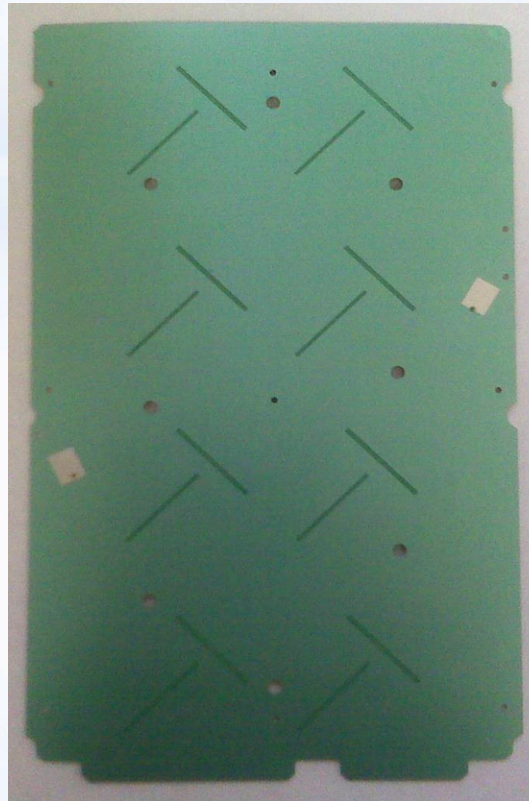
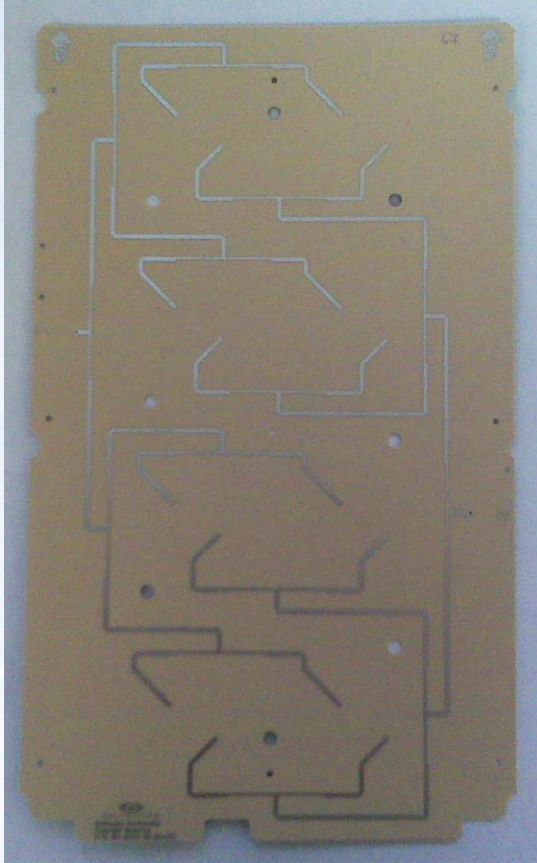


Current Product Application

WiMax Antenna

**.030" double sided tested on
N4350-13RF & Mercurywave™ 9350**

Tri-band antenna deployed in Asia



mercurywave™ 9350 Potential Applications

➤ Base Station Equipment

- ✓ Power Amplifiers
- ✓ Tower Mounted PA's
- ✓ Filters, Combiners and Components

➤ Automotive

- ✓ Radar
- ✓ Communications
- ✓ Road Tolling

➤ Satellite Communications

- ✓ LNB's/LNA's
- ✓ GPS

➤ Military

- ✓ Communication
- ✓ Guidance Systems
- ✓ Radar

➤ Broadband Antennas

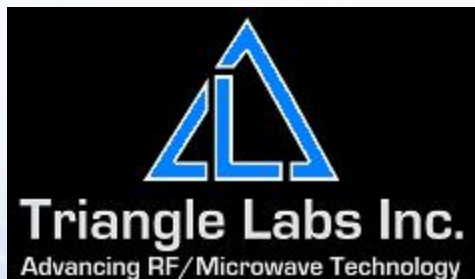
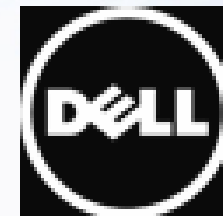
- ✓ WiFi/WiMax
- ✓ RFID Tags
- ✓ LAN's

➤ RF Applications

- ✓ Directional Couplers
- ✓ TXRX (Transmit/receive Boards)
- ✓ Up/Down Converters



OEM & Fabricator Testing of Mercurywave™ 9350



mercurywave™ 9350

Thank You

