



Your Dreams, Our Challenge

# meteorwave

## 1000, 2000, 3000, 4000 & 8000

### Very Low to Extremely Low Loss Materials

#### Laminate & Prepreg

*The Meteorwave family of materials offer very advanced electrical performance and very high reliability. They are intended for use in next generation core routers, high speed switches, supercomputers and applications where low signal attenuation, high reliability and high data transfer rates are critical. Meteorwave products are designed to facilitate high temperature lead-free assemblies and high layer count printed circuit board designs that require high reliability, CAF resistance and low Z-axis expansion.*

#### Key Features

##### Excellent Electrical Properties

- Low Dk
- Very low loss and ultra low loss Df electrical performance
- Stable electrical properties versus frequency when tested over various environmental conditions

##### Lead-Free Compatibility

- Designed to withstand multiple lead-free assembly reflow cycles at 260°C

##### Highly CAF Resistant

- CAF resistant materials after high temperature reflow

##### Thermal and Mechanical Properties

- Very low Z-axis expansion for high reliability
- Good peel strength
- Excellent IST performance
- Meets NASA outgassing specification

##### High-Tg FR-4 Processing

- Processing similar to other high-Tg materials
- 30 min press at 177°C plus 60 min press at 216°C and 390 psi

##### Available in a variety of constructions

- Available in a wide variety of constructions, copper weights and glass styles, including ultra low profile copper, standard copper and RTFOIL®
- Available as 2 mil core products that meet the specifications of a capacitive laminate
- A rating of UL 94V-0 and 130°C MOT for the entire Meteorwave family of materials
- Meets IPC-4101/102 specification
- All of our PCB materials are RoHS compliant

#### Applications

- 25 - 100 GHz Infrastructure
- Cloud Storage
- Core Routers
- High Speed Switches
- Servers
- Supercomputers
- RF/Microwave Applications
- 5G

UL file number: E36295

# meteorwave 1000 Very Low Loss

# meteorwave 2000 Ultra Low Loss

## Laminate and Prepreg

	Meteorwave 1000	Meteorwave 2000	U.S. Units	Meteorwave 1000	Meteorwave 2000	Metric Units	Test Method
<b>Mechanical Properties</b>							
Peel Strength - 1 oz. (35 micron) Cu After Solder Float	6.6	6.6	lb / inch	1.16	1.16	N / mm	IPC-TM-650.2.4.8
At Elevated Temperature	5.6	5.6	lb / inch	0.98	0.98	N / mm	IPC-TM-650.2.4.8.2a
After Exposure to Process Solutions	5.3	5.3	lb / inch	0.93	0.93	N / mm	IPC-TM-650.2.4.8
X / Y CTE [-40°C to +125°C]	10-14	10-14	ppm / °C	10-14	10-14	ppm / °C	IPC-TM-650.2.4.41
Z Axis CTE Alpha 1 [50°C to Tg] 55% RC	55	55	ppm / °C	55	55	ppm / °C	IPC-TM-650.2.4.24
Z Axis CTE Alpha 2 [Tg to 260°C] 55% RC	260	260	ppm / °C	260	260	ppm / °C	IPC-TM-650.2.4.24
Z Axis Expansion [50°C to 260°C] 43% RC	1.5	1.5	%	1.5	1.5	%	IPC-TM-650.2.4.24
Z Axis Expansion [50°C to 260°C] 55% RC	1.9	1.9	%	1.9	1.9	%	IPC-TM-650.2.4.24
Young's Modulus (X / Y)	3.6 / 3.2	2.7 / 2.5	psi x 10 <sup>6</sup>	24.4 / 21.7	18.3 / 17.0	GN / m <sup>2</sup>	ASTM D3039
Poisson's Ratios (X / Y)	0.148 / 0.132	0.166 / 0.169		0.148 / 0.132	0.166 / 0.169		ASTM D3039
Thermal Conductivity	0.46	0.43	W / mK	0.46	0.43	W / mK	ASTM E1461
Specific Heat	0.92	0.97	J / gK	0.92	0.97	J / gK	ASTM E1461
<b>Electrical Properties</b>							
Dielectric Constant (Typical 65% RC)							
@ 2 GHz (Stripline)	3.5	3.3		3.5	3.3		IPC-TM-650.2.5.5.5
@ 10 GHz (Stripline)	3.4	3.2		3.4	3.2		IPC-TM-650.2.5.5.5
Dissipation Factor (Typical 65% RC)							
@ 2 GHz (Split Post Cavity)	0.0038	0.0027		0.0038	0.0027		
@ 10 GHz (Split Post Cavity)	0.0047	0.0034		0.0047	0.0034		
Volume Resistivity							
C - 96 / 35 / 90	1.93x10 <sup>8</sup>	3.60x10 <sup>7</sup>	MΩ - cm	1.93x10 <sup>8</sup>	3.60x10 <sup>7</sup>	MΩ - cm	IPC-TM-650.2.5.17.1
E - 24 / 125	3.22x10 <sup>8</sup>	2.60x10 <sup>8</sup>	MΩ - cm	3.22x10 <sup>8</sup>	2.60x10 <sup>8</sup>	MΩ - cm	IPC-TM-650.2.5.17.1
Surface Resistivity							
C - 96 / 35 / 90	6.12x10 <sup>7</sup>	2.10x10 <sup>6</sup>	MΩ	6.12x10 <sup>7</sup>	2.10x10 <sup>6</sup>	MΩ	IPC-TM-650.2.5.17.1
E - 24 / 125	9.34x10 <sup>7</sup>	1.10x10 <sup>8</sup>	MΩ	9.34x10 <sup>7</sup>	1.10x10 <sup>8</sup>	MΩ	IPC-TM-650.2.5.17.1
Electric Strength	1667	1800	V / mil	4.2x10 <sup>4</sup>	4.6x10 <sup>4</sup>	V / mm	IPC-TM-650.2.5.6.2
Dielectric Breakdown	>50	>50	kV	>50	>50	kV	IPC-TM-650.2.5.6
Arc Resistance	157	157	seconds	157	157	seconds	IPC-TM-650.2.5.1
<b>Thermal Properties</b>							
*Glass Transition Temperature (Tg)							
TMA (°C)	215	215	°C	215	215	°C	IPC-TM-650.2.4.24c
DMA (°C) (Tan d Peak)	240	240	°C	240	240	°C	IPC-TM-650.2.4.24.3
Degradation Temp (TGA) (5% wt. loss)	390	390	°C	390	390	°C	IPC-TM-650.2.3.40
Pressure Cooker-60 min then solder dip @288°C until failure (max 10 min.)	pass	pass		pass	pass		IPC-TM-650.2.6.16 (modified)
Time to Delamination T300	>120	>120	minutes	>120	>120	minutes	IPC-TM-650.2.4.24.1
<b>Chemical / Physical Properties</b>							
Moisture Absorption	0.12	0.12	wt. %	0.12	0.12	wt. %	IPC-TM-650.2.6.2.1
Methylene Chloride Resistance	0.27	0.27	% wt. chg.	0.27	0.27	% wt. chg.	IPC-TM-650.2.3.4.3
Density [50% resin content]	1.83	1.76	g / cm <sup>3</sup>	1.83	1.76	g / cm <sup>3</sup>	

All test data provided are typical values and not intended to be specification values. For review of critical specification tolerances, please contact a company representative directly.

\*DMA is the preferred method for measuring Tg - other methods may be less accurate.

# meteorwave 3000 Very Low Loss meteorwave 4000 Ultra Low Loss Laminate and Prepreg

	Meteorwave 3000	Meteorwave 4000	U.S. Units	Meteorwave 3000	Meteorwave 4000	Metric Units	Test Method
<b>Mechanical Properties</b>							
Peel Strength - 1 oz. (35 micron) Cu							
After Solder Float	5.5	5.5	lb / inch	1.00	1.00	N / mm	IPC-TM-650.2.4.8
At Elevated Temperature	4.4	4.4	lb / inch	0.77	0.77	N / mm	IPC-TM-650.2.4.8.2
After Exposure to Process Solutions	5.0	5.0	lb / inch	0.88	0.88	N / mm	IPC-TM-650.2.4.8.2
X / Y CTE [-40°C to +125°C]	10-14	10-14	ppm / °C	10-14	10-14	ppm / °C	IPC-TM-650.2.4.41
Z Axis CTE Alpha 1 [50°C to Tg] 55% RC	55	55	ppm / °C	55	55	ppm / °C	IPC-TM-650.2.4.24
Z Axis CTE Alpha 2 [Tg to 260°C] 55% RC	260	260	ppm / °C	260	260	ppm / °C	IPC-TM-650.2.4.24
Z Axis Expansion [50°C to 260°C] 43% RC	2.1	2.1	%	2.1	2.1	%	IPC-TM-650.2.4.24
Z Axis Expansion [50°C to 260°C] 55% RC	2.6	2.6	%	2.6	2.6	%	IPC-TM-650.2.4.24
Young's Modulus (X / Y)	3.9 / 3.5	2.7 / 2.6	psi x 10 <sup>6</sup>	26.9 / 24.1	18.6 / 17.9	GN / m <sup>2</sup>	ASTM D3039
Poisson's Ratios (X / Y)	0.163 / 0.146	0.170 / 0.163		0.163 / 0.146	0.170 / 0.163		ASTM D3039
Thermal Conductivity	0.47	0.45	W / mK	0.47	0.45	W / mK	ASTM E1461
Specific Heat	0.82	0.84	J / gK	0.82	0.84	J / gK	ASTM E1461
<b>Flexural Strength</b>							
@125°C (W/F)	56.3 / 47.0	51.7 / 47.6	psi x 10 <sup>6</sup>	388 / 214	356 / 328	GN / m <sup>2</sup>	IPC-TM-650.2.4.4.1
@150°F (W/F)	51.8 / 44.5	50.2 / 44.3	psi x 10 <sup>6</sup>	357 / 307	346 / 305	GN / m <sup>2</sup>	IPC-TM-650.2.4.4.1
<b>Electrical Properties</b>							
<b>Dielectric Constant (Typical 65% RC)</b>							
@ 2 GHz (Stripline)	3.6	3.4		3.6	3.4		IPC-TM-650.2.5.5.5
@ 10 GHz (Stripline)	3.4	3.3		3.4	3.3		IPC-TM-650.2.5.5.5
<b>Dissipation Factor (Typical 65% RC)</b>							
@ 2 GHz (Split Post Cavity)	0.0031	0.0019		0.0031	0.0019		
@ 10 GHz (Split Post Cavity)	0.0039	0.0024		0.0039	0.0024		
<b>Volume Resistivity</b>							
C - 96 / 35 / 90	3.00x10 <sup>7</sup>	4.70x10 <sup>6</sup>	MΩ- cm	3.00x10 <sup>7</sup>	4.70x10 <sup>6</sup>	MΩ- cm	IPC-TM-650.2.5.17.1
E - 24 / 125	5.20x10 <sup>8</sup>	5.20x10 <sup>8</sup>	MΩ- cm	5.20x10 <sup>8</sup>	5.20x10 <sup>8</sup>	MΩ- cm	IPC-TM-650.2.5.17.1
<b>Surface Resistivity</b>							
C - 96 / 35 / 90	7.60x10 <sup>6</sup>	1.30x10 <sup>6</sup>	MΩ	7.60x10 <sup>6</sup>	1.30x10 <sup>6</sup>	MΩ	IPC-TM-650.2.5.17.1
E - 24 / 125	1.20x10 <sup>8</sup>	7.40x10 <sup>7</sup>	MΩ	1.20x10 <sup>8</sup>	7.40x10 <sup>7</sup>	MΩ	IPC-TM-650.2.5.17.1
Electric Strength	1300	1800	V / mil	3.3x10 <sup>4</sup>	4.6x10 <sup>4</sup>	V / mm	IPC-TM-650.2.5.6.2
Dielectric Breakdown	>50	>50	kV	>50	>50	kV	IPC-TM-650.2.5.6
Arc Resistance	210	210	seconds	210	210	seconds	IPC-TM-650.2.5.1
<b>Thermal Properties</b>							
<b>*Glass Transition Temperature (Tg)</b>							
TMA (°C)	170	170	°C	170	170	°C	IPC-TM-650.2.4.24c
DMA (°C) (Tan d Peak)	200	200	°C	200	200	°C	IPC-TM-650.2.4.24.3
Degradation Temp (TGA) (5% wt. loss)	390	390	°C	390	390	°C	IPC-TM-650.2.3.40
Pressure Cooker-60 min then solder dip @288°C until failure (max 10 min.)	pass	pass		pass	pass		IPC-TM-650.2.6.16 (modified)
Time to Delamination T300	>120	>120	minutes	>120	>120	minutes	IPC-TM-650.2.4.24.1
<b>Chemical / Physical Properties</b>							
Moisture Absorption	0.12	0.12	wt. %	0.12	0.12	wt. %	IPC-TM-650.2.6.2.1
Methylene Chloride Resistance	0.27	0.27	% wt. chg.	0.27	0.27	% wt. chg.	IPC-TM-650.2.3.4.3
Density [50% resin content]	2.08	1.95	g / cm <sup>3</sup>	2.08	1.95	g / cm <sup>3</sup>	Internal Method

All test data provided are typical values and not intended to be specification values. For review of critical specification tolerances, please contact a company representative directly.

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# meteorwave 8000

## High Speed / Extremely Low Loss Laminate and Prepreg

Mechanical Properties	Meteorwave® 8000	U.S. Units	Meteorwave® 8000	Metric	Test Method
Peel Strength - 1 oz. (35 micron) Cu	3.0	lb / inch	0.52	N / mm	IPC-TM-650.2.4.8
After Solder Float	3.1	lb / inch	0.54	N / mm	IPC-TM-650.2.4.8
At Elevated Temperature	3.3	lb / inch	0.58	N / mm	IPC-TM-650.2.4.8.2a
After Exposure to Process Solutions	3.5	lb / inch	0.61	N / mm	IPC-TM-650.2.4.8
X / Y CTE [-40°C to +125°C]	14 / 16	ppm / °C	14 / 16	ppm / °C	IPC-TM-650.2.4.41
Z Axis CTE Alpha 1 [50°C to Tg] 55% RC	35	ppm / °C	35	ppm / °C	IPC-TM-650.2.4.24
Z Axis CTE Alpha 2 [Tg to 260°C] 55% RC	185	ppm / °C	185	ppm / °C	IPC-TM-650.2.4.24
Z Axis Expansion [50°C to 260°C] 55% RC	2.5	%	2.5	%	IPC-TM-650.2.4.24
Young's Modulus (X / Y)	2.9 / 2.7	psi x 10 <sup>6</sup>	19.9 / 18.6	GN / m <sup>2</sup>	ASTM D3039
Poisson's Ratios (X / Y)	0.177 / 0.163		0.177 / 0.163		ASTM D3039
Flexural Strength (X / Y)	44,989 / 55,199	psi	0.31 / 0.381	GN / m <sup>2</sup>	ASTM D3039
Flexural Strength @ 150°C (X / Y)	34,000 / 22,000	psi	0.234 / 0.151	GN / m <sup>2</sup>	ASTM D3039
Thermal Conductivity	0.51	W / mK	0.51	W / mK	ASTM E1461
Specific Heat	0.943	.J / gK	0.943	J / gK	ASTM E1461
<b>Electrical Properties</b>					
Dielectric Constant (75% RC)					
@ 2 GHz (Stripline)	3.29		3.29		IPC-TM-650.2.5.5.5
@ 10 GHz (Stripline)	3.28		3.28		IPC-TM-650.2.5.5.5
Dissipation Factor (75% RC)					
@ 2 GHz (Split Post Cavity)	0.0012		0.0012		
@ 10 GHz (Split Post Cavity)	0.0016		0.0016		
Volume Resistivity					
C - 96 / 35 / 90	4.2x10 <sup>6</sup>	MΩ - cm	4.2x10 <sup>6</sup>	MΩ - cm	IPC-TM-650.2.5.17.1
E - 24 / 125	8.8x10 <sup>7</sup>	MΩ - cm	8.8x10 <sup>7</sup>	MΩ - cm	IPC-TM-650.2.5.17.1
Surface Resistivity					
C - 96 / 35 / 90	3.1x10 <sup>5</sup>	MΩ	3.1x10 <sup>5</sup>	MΩ	IPC-TM-650.2.5.17.1
E - 24 / 125	3.6x10 <sup>7</sup>	MΩ	3.6x10 <sup>7</sup>	MΩ	IPC-TM-650.2.5.17.1
Electric Strength	1500	V / mil	5.9x10 <sup>4</sup>	V / mm	IPC-TM-650.2.5.6.2
Dielectric Breakdown	>50	kV	>50	kV	IPC-TM-650.2.5.6
Arc Resistance	184	seconds	184	seconds	IPC-TM-650.2.5
<b>Thermal Properties</b>					
*Glass Transition Temperature (Tg)					
TMA (°C)	165	°C	165	°C	IPC-TM-650.2.4.24c
DMA (°C) (Tan d Peak)	185	°C	185	°C	IPC-TM-650.2.4.24.3
Degradation Temp (TGA) (5% wt. loss)	376	°C	376	°C	IPC-TM-650.2.3.40
Pressure Cooker-60 min then solder dip @288°C until failure (max 10 min.)	pass		pass		IPC-TM-650.2.6.16 (modified)
Time to Delamination					
T288	>120	minutes	>120	minutes	IPC-TM-650.2.4.24.1
T300	40	minutes	40	minutes	IPC-TM-650.2.4.24.1
<b>Chemical / Physical Properties</b>					
Moisture Absorption	0.05	wt. %	0.05	wt. %	IPC-TM-650.2.6.2.1
Methylene Chloride Resistance	0.21	% wt. chg.	0.21	% wt. chg.	IPC-TM-650.2.3.4.3
Density [50% resin content]	1.85	g / cm <sup>3</sup>	1.85	g / cm <sup>3</sup>	

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