



## TEST REPORT

**CLIENT:** IPC Validation Services  
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Attention: Mr. Randy Cherry  
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**TEST ITEMS:** Peel Strength, Volume Resistivity, Surface Resistivity, Moisture Absorption, Dielectric Breakdown, Permittivity @ 1 MHz, Loss Tangent @ 1 MHz, Flexural Strength, Arc Resistance, Thermal Stress, Electric Strength, Flammability, Glass Transition Temperature, Decomposition Temperature, CTE (TMA), Time to Delamination (T260, T288, T300), Dimensional Stability, Solderability, Chemical Resistance, Metal Surfaces Cleanability, Pressure Cooker Test.

**SAMPLE:** Copper-Clad Laminate

**TEST MATERIAL:** TU-943N

**SPECIFICATION:** IPC-4101E WAM1/102

**TEST RESULTS:** The specimens were tested by the indicated test methods within this report.  
The actual detailed test results are enclosed.

**DATE OF REPORT:** 16 August 2022



**SUMMARIZED TEST RESULTS:**

<b>Test Item</b>	<b>Thin</b>	<b>Thick</b>
Peel Strength	Pass	Pass
Volume Resistivity	Pass	Pass
Surface Resistivity	Pass	Pass
Moisture Absorption	--	Pass
Dielectric Breakdown	--	Pass
Permittivity @ 1MHz	Pass	Pass
Loss Tangent @ 1MHz	Pass	Pass
Flexural Strength	--	Pass
Arc Resistance	Pass	Pass
Surface Resistivity	Pass	Pass
Thermal Stress	Pass	Pass
Electric Strength	Pass	Pass
Flammability	Pass	Pass
Glass Transition Temperature	--	Pass
Decomposition Temperature	--	Pass
Z-Axis CTE	--	Pass
Time to Delamination	--	Pass
Dimensional Stability	Pass	Pass
Solderability	--	Pass
Chemical Resistance	Report Only	Report Only
Metal Surface Cleanability	--	Report Only
Pressure Cooker Test	--	Report Only



## Peel Strength

### Reference:

IPC-TM-650 Method 2.4.8 Peel Strength of Metal Clad Laminates  
IPC-TM-650 Method 3.4.8.3 Peel Strength of Metal Clad Laminates at Elevated Temperature  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 1 Peel Strength After Thermal Strength Thin**

Side A Cross-Wise and Length-Wise Average	0.78	
Side B Cross-Wise and Length-Wise Average	0.77	
Requirement	$\geq 0.70$	Pass

**Table 2 Peel Strength After Thermal Strength Thick**

Side A Cross-Wise and Length-Wise Average	0.79	
Side B Cross-Wise and Length-Wise Average	0.78	
Requirement	$\geq 0.70$	Pass

**Table 3 Peel Strength At Elevated Temperature Thin**

Side A Cross-Wise and Length-Wise Average	0.74	
Side B Cross-Wise and Length-Wise Average	0.73	
Requirement	$\geq 0.70$	Pass

**Table 4 Peel Strength At Elevated Temperature Thick**

Side A Cross-Wise and Length-Wise Average	0.75	
Side B Cross-Wise and Length-Wise Average	0.74	
Requirement	$\geq 0.70$	Pass



**Table 5 Peel Strength After Process Solutions Thin**

Side A Cross-Wise and Length-Wise Average	0.73	
Side B Cross-Wise and Length-Wise Average	0.74	
Requirement	$\geq 0.70$	Pass

**Table 6 Peel Strength After Process Solutions Thick**

Side A Cross-Wise and Length-Wise Average	0.75	
Side B Cross-Wise and Length-Wise Average	0.74	
Requirement	$\geq 0.70$	Pass

**Table 7 Peel Strength As Received Low Profile Copper Thin**

Side A Cross-Wise and Length-Wise Average	0.76	
Side B Cross-Wise and Length-Wise Average	0.77	
Requirement	ABBUS	

**Table 8 Peel Strength As Received Low Profile Copper Thick**

Side A Cross-Wise and Length-Wise Average	0.76	
Side B Cross-Wise and Length-Wise Average	0.76	
Requirement	ABBUS	



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**Volume & Surface Resistivity**

**Reference:**

IPC-TM-650 Method 2.5.17.1 Volume and Surface Resistivity of Dielectric Materials  
 IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer  
 Printed Board

**Results:**

**Table 9 Volume and Surface Resistivity Humidity Conditioning Thin**

Volume Resistivity	Average of three specimens	2.22 E+09	
Requirement C-96/35/90		$\geq 1.00 \text{ E}+06$	Pass
Surface Resistivity	Average of three specimens	4.59 E+08	
Requirement C-96/35/90		$\geq 1.00 \text{ E}+05$	Pass

**Table 10 Volume and Surface Resistivity At Elevated Temperature Thin**

Volume Resistivity	Average of three specimens	2.31 E+09	
Requirement 125°C		$\geq 1.00 \text{ E}+06$	Pass
Surface Resistivity	Average of three specimens	6.19 E+08	
Requirement 125°C		$\geq 1.00 \text{ E}+05$	Pass

**Table 11 Volume and Surface Resistivity Humidity Conditioning Thick**

Volume Resistivity	Average of three specimens	1.47 E+09	
Requirement after moisture		1.00 E+06	Pass
Surface Resistivity	Average of three specimens	4.05 E+09	
Requirement after moisture		$\geq 1.00 \text{ E}+05$	Pass



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Table 12 Volume and Surface Resistivity At Elevated Temperature Thick

Volume Resistivity Requirement 125°C	Average of three specimens	1.68 E+08 ≥ 1.00 E+06	Pass
Surface Resistivity Requirement 125°C	Average of three specimens	2.27 E+08 ≥ 1.00 E+05	Pass



## Moisture Absorption

### Reference:

IPC-TM-650 Method 2.6.2.1 Water Absorption of Metal Clad Plastic Laminates  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 13 Moisture Absorption Thick**

Moisture Absorption	Average of three specimens	0.08	
Requirement		$\leq 0.5$	Pass

## Dielectric Breakdown

### Reference:

IPC-TM-650 Method 2.5.6 Dielectric Breakdown  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 14 Dielectric Breakdown**

Moisture Absorption	Average of four specimens	44+	
Requirement		$\geq 40$	Pass



### Permittivity and Loss Tangent @ 1 MHz

**Reference:**

IPC-TM-650 Method 2.5.5.9 Permittivity and Loss Tangent, Parallel Plate 1 MHz to 1.5 MHz

IPC-TM-650 Method 2.5.5.15 Permittivity and Loss Tangent, SPDR 1 GHz to 20 GHz

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**Results:**

**Table 15 Permittivity and Loss Tangent**

Permittivity @ 1 MHz	Average of three specimens	3.11	
Requirement Thin		≤ 4.3	Pass
Loss Tangent @ 1 MHz	Average of three specimens	0.002	
Requirement Thin		≤ 0.007	Pass
Permittivity @ 1 MHz	Average of three specimens	3.41	
Requirement Thick		≤ 4.3	Pass
Loss Tangent @ 1 MHz	Average of three specimens	0.001	
Requirement Thick		≤ 0.007	Pass
Permittivity @ 1 GHz	Average of three specimens	3.20	
No Requirement Thin			
Loss Tangent @ 1 GHz	Average of three specimens	0.001	
No Requirement Thin			
Permittivity @ 1 GHz No	Average of three specimens	3.38	
No Requirement Thick			
Loss Tangent @ 1 GHz	Average of three specimens	0.001	
No Requirement Thick			





## Flexural Strength

### Reference:

IPC-TM-650 Method 2.4.4 Flexural Strength of Laminates at Ambient Temperature  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer  
Printed Board

### Results:

**Table 16 Flexural Strength**

Flexural Strength Length Direction Requirement	Average of two specimens	370 ≥ 345	Pass
Flexural Strength Cross Direction Requirement	Average of two specimens	359 ≥ 345	Pass

## Arc Resistance

### Reference:

IPC-TM-650 Method 2.5.1 Arc Resistance of Printed Wiring Material  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 17 Arc Resistance**

Arc Resistance Thin Requirement	Average of three specimens	137 ≥ 60	Pass
Arc Resistance Thick Requirement	Average of three specimens	181 ≥ 60	Pass



## Thermal Stress

### Reference:

IPC-TM-650 Method 2.4.13.1 Thermal Stress of Laminates

IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 18 Thermal Stress**

Thermal Stress Thin Etched A Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thin Etched B Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thick Etched A Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thick Etched B Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thin Un-Etched A Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thin Un-Etched B Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thick Un-Etched A Side	No obvious blister, delamination or damage	Pass
Thermal Stress Thick Un-Etched B Side	No obvious blister, delamination or damage	Pass

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## Electric Strength

### Reference:

IPC-TM-650 Method 2.5.6.2 Electric Strength

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### Results:

**Table 19 Electric Strength**

Electric Strength Thin Requirement	Average of three specimens	86	
		$\geq 30$	Pass

## Flammability Vertical Burning

### Reference:

UL94 Section 8 50W (20mm) Vertical Burning Test; V-0, V-1, V-2

IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

#### Table 20 Vertical Burning Test Thin

The specimens were tested by the methods given above.

The flammability Classification Condition A of specimens is V-0

The flammability Classification Condition A of specimens is V-0

The specimens pass.

#### Table 21 Vertical Burning Test Thick

The specimens were tested by the methods given above.

The flammability Classification Condition A of specimens is V-0

The flammability Classification Condition B of specimens is V-0

The specimens pass.



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## Glass Transition Temperature

### Reference:

IPC-TM-650 Method 2.4.25 Glass Transition Temperature and Cure Factor by DSC  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer  
Printed Boards

### Results:

**Table 22 Glass Transition Temperature**

Glass Transition Temperature	196°C	
Requirement	$\geq 185$	Pass

## Decomposition Temperature

### Reference:

IPC-TM-650 Method 2.4.24.6 Decomposition Temperature of Laminate Material Using TGA  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed  
Board

### Results:

**Table 23 Decomposition Temperature**

Glass Transition Temperature 5% Weight Loss	420°C	
Requirement	$\geq 340$	Pass



Z-Axis CTE (TMA)

Reference:

IPC-TM-650 Method 2.4.24.6 Decomposition Temperature of Laminate Material Using TGA  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed  
Board

Results:

Table 24 Z-Axis CTE (TMA)

Z-Axis CTE Alpha 1	Average of two specimens	39		
		$\leq 60$	Pass	
Z-Axis CTE Alpha 2	Average of two specimens	215		
		$\leq 300$	Pass	
Z-Axis CTE 50-260	Average of two specimens	2.6		
		$\leq 3.0$	Pass	



## Time to Delamination

### Reference:

IPC-TM-650 Method 2.4.24.1 Time to Delamination (TMA Method)

IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 25 Time to Delamination (TMA)**

Delamination T260	Average of two specimens	> 60	
	Requirement	$\geq 30$	Pass
Delamination T288	Average of two specimens	> 45	
	Requirement	$\geq 15$	Pass
Delamination T300	Average of two specimens	> 4	
	Requirement	$\geq 2$	Pass



## Dimensional Stability

### Reference:

IPC-TM-650 Method 2.4.39 Dimensional Stability, Glass Reinforced Thin Laminates  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 26 Dimensional Stability Thin**

Dimensional Stability Bake	Average of three specimens			
	Machine direction	-0.02		
	Cross direction	-0.03		
	Requirement	-0.3 to +0.3		Pass
Dimensional Stability Stress	Average of three specimens			
	Machine direction	-0.02		
	Cross direction	-0.05		
	Requirement	-0.3 to +0.3		Pass

**Table 27 Dimensional Stability Thick**

Dimensional Stability Bake	Average of three specimens			
	Machine direction	-0.03		
	Cross direction	-0.04		
	Requirement	-0.3 to +0.3		Pass
Dimensional Stability Stress	Average of three specimens			
	Machine direction	-0.05		
	Cross direction	-0.02		
	Requirement	-0.3 to +0.3		Pass



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**Solderability (Edge Dip Test)**

**Reference:**

IPC-J-STD-003C; Method 4.2.1 Edge Dip Test

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**Results:**

**Table 28 Solderability (TMA)**

Solderability Thin	Sample surface exhibited good wetting	Pass
Solderability Thick	Sample surface exhibited good wetting	Pass





Chemical Resistance

Reference:

IPC-TM-650 Method 2.3.4.2 Chemical Resistance of Laminates, Prepreg and Coated Foil Products by Solvent Exposure.

IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

Results:

Table 29 Chemical Resistance

Chemical Resistance Thin Requirement	Three specimens		
	Appearance after bake	No change	Pass Requirement
	Appearance after solvent	No change	Pass
Chemical Resistance Thick Requirement	Three specimens		
	Appearance after bake	No change	Pass Requirement
	Appearance after solvent	No change	Pass

Metal Surface Cleanability

Reference:

IPC-TM-650 Method 2.3.1.1 Chemical Cleaning of Metal-Clad Laminate

IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

Results:

Table 30 Metal Surface Cleanability

Metal Surface Cleanability Requirement	Three specimens	
	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the surface does not bead or form puddles.	Pass



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## Pressure Cooker Test

### Reference:

IPC-TM-650 Method 2.6.16 Pressure Vessel Method for Glass Epoxy Laminate Integrity  
IPC-4101E WAM1/102 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 31 Pressure Cooker Test**

Pressure Cooker Test Requirement	Five specimens The samples shall have no measles, blisters or surface erosion	Pass
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## CERTIFICATE OF CONFORMANCE

The TAWIAN UNION TECHNOLOGY CORPORATION (TUC) certifies that the test equipment used complies with the requirements of correlation criterion and that data contained in this report is accurate within the tolerance limitation of the equipment.

The report is invalid without the signature of the reviewer and the approver.

Reviewed by:

Approved by:

Weiting Shen

QA Engineer

16 August 2022

Money Wang

QA Manager

16 August 2022

For IPC

16 August 2022