



台灣聯合科技股份有限公司

Taiwan Union Technology

## 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 and Loss Tangent, Flexural Strength, Arc Resistance, Thermal Stress, Electric Strength, Vertical Flammability Test, Glass Transition Temperature, Decomposition Temperature, Z-Axis CTE (TMA), Time to Delamination (T260, T288, T300), Glass Transition Temperature (DMA), Dimensional Stability, Solderability, Chemical Resistance, Metal Surfaces Cleanability, Pressure Cooker Test.

**SAMPLE:** Copper-Clad Laminate

**TEST MATERIAL:** TU-883SP

**SPECIFICATION:** IPC-4101E WAM1/134

**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:

Test Item	Thin	Thick
Peel Strength	Pass	Pass
Volume Resistivity	Pass	Pass
Surface Resistivity	Pass	Pass
Moisture Absorption	--	Pass
Dielectric Breakdown	--	Pass
Permittivity	Pass	Pass
Loss Tangent	Pass	Pass
Flexural Strength	--	Pass
Arc Resistance	Pass	Pass
Thermal Stress	Pass	Pass
Electric Strength	Pass	---
Vertical Burning Test	Pass	Pass
Glass Transition Temperature	--	Pass
Decomposition Temperature	--	Pass
Z-Axis CTE (TMA)	--	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 WAM1/134 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	0.71	
Side B Cross-Wise and Length-Wise Average	0.72	
Requirement	$\geq 0.70$	Pass

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

Side A Cross-Wise and Length-Wise Average	0.73	
Side B Cross-Wise and Length-Wise Average	0.72	
Requirement	$\geq 70$	Pass

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

Side A Cross-Wise and Length-Wise Average	0.71	
Side B Cross-Wise and Length-Wise Average	0.72	
Requirement	$\geq 0.70$	Pass

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

Side A Cross-Wise and Length-Wise Average	0.73	
Side B Cross-Wise and Length-Wise Average	0.75	
Requirement	$\geq 0.70$	Pass



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

Side A Cross-Wise and Length-Wise Average	0.72	
Side B Cross-Wise and Length-Wise Average	0.75	
Requirement	$\geq 0.70$	Pass

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

Side A Cross-Wise and Length-Wise Average	0.74	
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	0.72	
Side B Cross-Wise and Length-Wise Average	0.71	
Requirement	No	

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

Side A Cross-Wise and Length-Wise Average	0.70	
Side B Cross-Wise and Length-Wise Average	0.71	
Requirement	No	



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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 WAM1/134 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	1.85 E+08	
Requirement C-96/35/90		$\geq 1.00 \text{ E}+06$	Pass
Surface Resistivity	Average of three specimens	5.84 E+07	
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	4.19 E+08	
Requirement 125°C		$\geq 1.00 \text{ E}+06$	Pass
Surface Resistivity	Average of three specimens	6.81 E+07	
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	1.94 E+07	
Requirement after moisture		1.00 E+05	Pass
Surface Resistivity	Average of three specimens	2.15 E+08	
Requirement after moisture		$\geq 1.00 \text{ E}+06$	Pass

**Table 12 Volume and Surface Resistivity At Elevated Temperature Thick**

Volume Resistivity	Average of three specimens	4.41 E+07	
Requirement 125°C		$\geq 1.00 \text{ E}+06$	Pass



Surface Resistivity	Average of three specimens	1.94 E+07	
Requirement 125°C		$\geq 1.00 \text{ E}+05$	Pass

## Moisture Absorption

### Reference:

IPC-TM-650 Method 2.6.2.1 Water Absorption of Metal Clad Plastic Laminates

IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 13 Moisture Absorption Thick**

Moisture Absorption	Average of three specimens	0.16	
Requirement		$\leq 0.2$	Pass



## Dielectric Breakdown

### Reference:

IPC-TM-650 Method 2.5.6 Dielectric Breakdown

IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

Table 14 Dielectric Breakdown

Dielectric Breakdown	Average of four specimens	44+	
Requirement		$\geq 40$	Pass



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**Permittivity and Loss Tangent**

**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 by SPDR 1 GHz to 20 GHz  
IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Boards

**Results:**

**Table 15 Permittivity and Loss Tangent**

Permittivity @ 1 MHz Requirement Thin	Average of three specimens	3.4 ≤ 4.3	Pass
Loss Tangent @ 1 MHz Requirement Thin	Average of three specimens	0.003 ≤ 0.006	Pass
Permittivity @ 1 MHz Requirement Thick	Average of three specimens	3.90 ≤ 4.3	Pass
Loss Tangent @ 1 MHz Requirement Thick	Average of three specimens	0.003 ≤ 0.006	Pass
Permittivity @ 1 GHz Requirement Thin	Average of three specimens	3.50 ≤ 4.3	Pass
Loss Tangent @ 1 GHz Requirement Thin	Average of three specimens	0.003 ≤ 0.006	Pass
Permittivity @ 1 GHz Requirement Thick	Average of three specimens	3.90 ≤ 4.3	Pass
Loss Tangent @ 1 GHz Requirement Thick	Average of three specimens	0.003 ≤ 0.006	Pass
Permittivity @ 10 GHz Requirement Thin	Average of three specimens	3.29 < 4.2	<b>Pass</b>





Loss Tangent @ 10 GHz Requirement Thin	Average of three specimens	0.00308 < 0.006	Pass
Permittivity @ 10 GHz Requirement Thick	Average of three specimens	3.91 ≤ 4.2	Pass
Loss Tangent @ 10 GHz Requirement Thick	Average of three specimens	0.0041 ≤ 0.006	Pass
Permittivity @ 20 GHz Requirement Thin	Average of three specimens	3.40 ≤ 4.2	Pass
Loss Tangent @ 20 GHz Requirement Thin	Average of three specimens	0.0030 ≤ 0.006	Pass
Permittivity @ 20 GHz Requirement Thick	Average of three specimens	3.88 ≤ 4.2	Pass
Loss Tangent @ 20 GHz Requirement Thick	Average of three specimens	0.0045 ≤ 0.006	Pass



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Flexural Strength**

**Reference:**

IPC-TM-650 Method 2.4.4 Flexural Strength of Laminates at Ambient Temperature  
IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer  
Printed Board

**Results:**

**Table 16 Flexural Strength**

Flexural Strength Length Direction Requirement	Average of two specimens	353 ≥ 345	Pass
Flexural Strength Cross Direction Requirement	Average of two specimens	362 ≥ 345	Pass

**Arc Resistance**

**Reference:**

IPC-TM-650 Method 2.5.1 Arc Resistance of Printed Wiring Material  
IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 17 Arc Resistance**

Arc Resistance Thin Requirement	Average of three specimens	181 ≥ 60	Pass
Arc Resistance Thick Requirement	Average of three specimens	183 ≥ 60	Pass



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**Thermal Stress**

**Reference:**

IPC-TM-650 Method 2.4.13.1 Thermal Stress of Laminates

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**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

## Electric Strength

**Reference:**

IPC-TM-650 Method 2.5.6.2 Electric Strength

IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 19 Electric Strength**

Electric Strength Thin Requirement	Average of three specimens	91	
		$\geq 30$	Pass



## Flammability Vertical Burning

### Reference:

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

IPC-4101E WAM1/134 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.

## Glass Transition Temperature

### Reference:

IPC-TM-650 Method 2.4.25 Glass Transition Temperature and Cure Factor by DSC

IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer

Printed Boards

### Results:

#### Table 22 Glass Transition Temperature

Glass Transition Temperature  
Requirement

No Requirement / DMA only  
Test by DMA Only



## Decomposition Temperature

### Reference:

IPC-TM-650 Method 2.4.24.6 Decomposition Temperature of Laminate Material Using TGA  
IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

### Results:

**Table 23 Decomposition Temperature**

Glass Transition Temperature 5% Weight Loss	411°C	
Requirement	≥ 400	Pass

## Z-Axis CTE (TMA)

### Reference:

IPC-TM-650 Method 2.4.24.6 Decomposition Temperature of Laminate Material Using TGA  
IPC-4101E WAM1/134 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	29	
Requirement	≤ 50	Pass
Z-Axis CTE Alpha 2 Average of two specimens	196	
Requirement	≤ 275	Pass
Z-Axis CTE 50-260 Average of two specimens	1.8	
Requirement	≤ 2.8	Pass

## Time to Delamination

**Reference:**

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

IPC-4101E WAM1/134 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	≥ 60	Pass
Delamination T288	Average of two specimens	> 60	
	Requirement	≥ 60	Pass
Delamination T300	Average of two specimens	> 30	
	Requirement	≥ 30	Pass

## Glass Transition Temperature (DMA)

**Reference:**

IPC-TM-650 Method 2.4.24.4 Glass Transition Temperature by DMA

IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 26 Glass Transition Temperature (DMA)**

Glass Transition Temperature	233°C	
Requirement	≥ 170	Pass



**Reference:**

IPC-TM-650 Method 2.4.39 Dimensional Stability, Glass Reinforced Thin Laminates

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**Results:**

**Table 27 Dimensional Stability Thin**

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

**Table 28 Dimensional Stability Thick**

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	-0.05	
	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  
 IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 29 Solderability**

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 WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 30 Chemical Resistance**

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





**Reference:**

IPC-TM-650 Method 2.3.1.1 Chemical Cleaning of Metal-Clad Laminate  
PC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 31 Metal Surface Cleanability**

Metal Surface Cleanability	Three specimens	
Requirement	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

### Pressure Cooker Test

**Reference:**

IPC-TM-650 Method 2.6.16 Pressure Vessel Method for Glass Epoxy Laminate Integrity  
IPC-4101E WAM1/134 Specification for Base Materials for Rigid and Multilayer Printed Board

**Results:**

**Table 32 Pressure Cooker Test**

Pressure Cooker Test	Five specimens	
Requirement	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