



TEST REPORT SUMMARY

(Short Report)

CLIENT: IPC Greater China HQ
5F B3-1, Block B, International Innovation Park, #1 First Keyuanwei Rd.,
Laoshan District, Qingdao, 266101, PRC
Attention: Ms. Sydney Xiao
Phone: +86 4006218610

TEST ITEM: Peel Strength, Volume Resistivity, Surface Resistivity, Moisture
Absorption, Dielectric Breakdown, Permittivity at 1 MHz, Loss Tangent
at 1 MHz, Flexural Strength, Arc Resistance, Thermal Stress, Electric
Strength, Flammability, Glass Transition Temperature and Cure Factor,
Decomposition Temperature (Td), Glass Transition Temperature and Z-
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: VT-441V

SPECIFICATION: IPC-4101E/128

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

DATE OF REPORT: 20 November 2019

SUMMARY Number: 23556EGS



"INTEGRITY, HONESTY AND KNOWLEDGE"

MICROTEK (CHANGZHOU) PRODUCT SERVICES CO., LTD

NO.19 XINKE ROAD • ELECTRONIC-TECHNOLOGY • CHANGZHOU, JIANGSU, CHINA 213031 •

Tel: 86 519 85487809 • Fax: 86 519 85487810 • WWW.THETESTLAB.CN



SUMMARIZED TEST RESULTS:

<u>Test Item</u>	<u>Thin</u>	<u>Thick</u>
Peel Strength	Pass	Pass
Volume Resistivity	Pass	Pass
Surface Resistivity	Pass	Pass
Moisture Absorption	--	Pass
Dielectric Breakdown	--	Pass
Permittivity at 1 MHz	Pass	Pass
Loss Tangent at 1 MHz	Pass	Pass
Flexural Strength	--	Pass
Arc Resistance	Pass	Pass
Thermal Stress	Pass	Pass
Electric Strength	Pass	--
Flammability	Pass	Pass
Glass Transition Temperature and Cure Factor	--	Pass
Decomposition Temperature (Td)	--	Pass
Glass Transition Temperature and Z-CTE (TMA)	--	Pass
Time to Delamination (T260,T288,T300)	--	Pass
Dimensional Stability	Pass	Pass
Solderability	--	Pass
Chemical Resistance	Report Only	Report Only
Metal Surfaces Cleanability	Report Only	Report Only
Pressure Cooker Test	--	Report Only



Peel Strength

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM-650 Method 2.4.8C Peel Strength of Metal Clad Laminates
 IPC-TM-650 Method 2.4.8.3A Peel Strength of Metal Clad Laminates at Elevated Temperature (Hot Air Method)

Results:

Table 1 Peel Strength(After Thermal Stress) Thin

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-11-05		Ambient	23°C, 48%RH
Sample No.	Peel Strength (N/mm)			
	Top Crosswise	Top Lengthwise	Bottom Crosswise	Bottom Lengthwise
23555-1-1-1	1.10			
23555-1-1-2	1.08			
23555-1-2-1		1.13		
23555-1-2-2		1.15		
23555-1-3-1			1.07	
23555-1-3-2			1.09	
23555-1-4-1				1.17
23555-1-4-2				1.11
Average	1.09	1.14	1.08	1.14
Requirement	≥0.80			



Table2 Peel Strength(After Thermal Stress) Thick

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-11-18		Ambient	22°C, 48%RH
Sample No.	Peel Strength (N/mm)			
	Top Lengthwise	Top Crosswise	Bottom Lengthwise	Bottom Crosswise
23555-34-1-1	1.06			
23555-34-1-2	1.12			
23555-34-2-1		1.09		
23555-34-2-2		1.06		
23555-34-3-1			1.14	
23555-34-3-2			1.13	
23555-34-4-1				1.10
23555-34-4-2				1.12
Average	1.09	1.07	1.14	1.11
Requirement	≥ 1.05			



Table3 Peel Strength(At Elevated Temperature) Thin

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-11-06		Ambient	23°C, 49%RH
Sample No.	Peel Strength (N/mm)			
	Top Lengthwise	Top Crosswise	Bottom Lengthwise	Bottom Crosswise
23555-2-1-1	0.97			
23555-2-1-2	0.97			
23555-2-2-1		0.93		
23555-2-2-2		0.93		
23555-2-3-1			0.93	
23555-2-3-2			0.93	
23555-2-4-1				0.90
23555-2-4-2				0.91
Average	0.97	0.93	0.93	0.90
Requirement	≥ 0.70			



Table4 Peel Strength(At Elevated Temperature) Thick

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-11-06		Ambient	23°C, 49%RH
Sample No.	Peel Strength (N/mm)			
	Top Lengthwise	Top Crosswise	Bottom Lengthwise	Bottom Crosswise
23555-33-1-1	0.93			
23555-33-1-2	0.94			
23555-33-2-1		0.92		
23555-33-2-2		0.91		
23555-33-3-1			0.98	
23555-33-3-2			0.98	
23555-33-4-1				0.91
23555-33-4-2				0.90
Average	0.93	0.91	0.98	0.90
Requirement	≥ 0.70			



Table5 Peel Strength(After Process Solution) Thin

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-11-06		Ambient	23°C, 49%RH
Sample No.	Peel Strength (N/mm)			
	Top Lengthwise	Top Crosswise	Bottom Lengthwise	Bottom Crosswise
23555-1-5-1	1.10			
23555-1-5-2	1.09			
23555-1-6-1		1.07		
23555-1-6-2		1.03		
23555-1-7-1			1.03	
23555-1-7-2			1.05	
23555-1-8-1				1.03
23555-1-8-2				1.03
Average	1.09	1.05	1.04	1.03
Requirement	≥ 0.55			



Table6 Peel Strength(After Process Solution) Thick

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-11-06		Ambient	23°C, 49%RH
Sample No.	Peel Strength (N/mm)			
	Top Crosswise	Top Lengthwise	Bottom Crosswise	Bottom Lengthwise
23555-32-5-1	1.06			
23555-32-5-2	1.06			
23555-32-6-1		1.08		
23555-32-6-2		1.09		
23555-32-7-1			1.13	
23555-32-7-2			1.08	
23555-32-8-1				1.14
23555-32-8-2				1.12
Average	1.06	1.08	1.10	1.13
Requirement	≥ 0.80			



Volume and Surface Resistivity

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 2.5.17.1A Volume and Surface Resistivity of Dielectric Materials

Results:

Table 7 Surface and Volume Resistivity Thin (Humidity Conditioning)

Sample Designation	CCL		Sample Identification	VT-441V	
Test Date	2019-10-23~2019-10-28		Ambient	(23~24)°C, (48~50)%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=R'P/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ·cm)
23555-5-1	0.0212	5.0E+04	1.6E+07	2.5E+05	6.1E+07
23555-5-2	0.0210	7.0E+04	2.3E+07	5.0E+06	1.2E+09
23555-5-3	0.0210	4.0E+04	1.3E+07	3.0E+05	7.4E+07
Average		/	1.7E+07	/	4.5E+08
Requirement		/	$\geq 10^4$	/	$\geq 10^6$

Table 8 Surface and Volume Resistivity Thin (At Elevated Temperature)

Sample Designation	CCL		Sample Identification	VT-441V	
Test Date	2019-11-07~2019-11-08		Ambient	(20~22)°C, (47~50)%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=R'P/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ·cm)
23555-6-1	0.0207	6.5E+03	2.1E+06	7.5E+03	1.9E+06
23555-6-2	0.0208	5.2E+03	1.7E+06	5.8E+03	1.4E+06
23555-6-3	0.0209	5.0E+03	1.6E+06	5.4E+03	1.3E+06
Average		/	1.8E+06	/	1.5E+06
Requirement		/	$\geq 10^3$	/	$\geq 10^3$

**Table 9 Surface and Volume Resistivity Thick (Humidity Conditioning)**

Sample Designation	CCL		Sample Identification	VT-441V	
Test Date	2019-10-23~2019-10-30		Ambient	(23~24)°C, 48%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=R'P/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ·cm)
23555-36-1	0.0625	2.6E+04	7.3E+05	4.0E+05	1.6E+08
23555-36-2	0.0628	3.0E+04	8.5E+05	2.9E+05	1.2E+08
23555-36-3	0.0629	7.0E+04	2.0E+06	3.6E+05	1.5E+08
Average		/	1.2E+06	/	1.4E+08
Requirement		/	$\geq 10^4$	/	$\geq 10^4$

Table 10 Surface and Volume Resistivity Thick (At Elevated Temperature)

Sample Designation	CCL		Sample Identification	VT-441V	
Test Date	2019-11-07~2019-11-08		Ambient	(20~22)°C, (47~50)%RH	
Sample No.	Average Thickness T	Surface Resistance R'	Surface Resistivity $r'=R'P/D_4$	Volume Resistance R	Volume Resistivity $r=RA/T$
	(cm)	(MΩ)	(MΩ)	(MΩ)	(MΩ·cm)
23555-37-1	0.0620	5.2E+03	1.5E+05	6.5E+03	2.7E+06
23555-37-2	0.0619	5.6E+03	1.6E+05	3.8E+03	1.6E+06
23555-37-3	0.0622	4.4E+03	1.2E+05	5.8E+03	2.4E+06
Average		/	1.4E+05	/	2.2E+06
Requirement		/	$\geq 10^3$	/	$\geq 10^3$



Moisture Absorption

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.6.2.1 Water Absorption, Metal Clad Plastic Laminates

Results:

Table11 Moisture Absorption Thick

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-10-17~2019-10-18		Ambient	23°C,49%RH
Sample No.	mass(g)		increasing weight percent of mass(%)	
	m ₁	m ₂		
23555-39-1	3.0200	3.0256	0.19	
23555-39-2	3.1552	3.1618	0.21	
23555-39-3	3.0683	3.0742	0.19	
Average			0.20	
Requirement			≤0.80	



Dielectric Breakdown

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.5.6B Dielectric Breakdown

Results:

Table 12 Dielectric Breakdown Thick

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-23~2019-10-25	Ambient	24°C, 50%RH
Sample No.	Thickness	Voltage	
	(mm)	(kV)	
23555-41-1 (Length Direction)	0.632	46.7+N.B.	
23555-41-2 (Length Direction)	0.629	45.8+N.B.	
23555-41-3 (Cross Direction)	0.631	47.6+N.B.	
23555-41-4 (Cross Direction)	0.635	46.3+N.B.	
Minimum Voltage		46+N.B.	
Requirement		≥40	



Permittivity and Loss Tangent (1MHz)

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM-650 Method 2.5.5.9 Permittivity and Loss Tangent, Parallel Plate, 1MHz to 1.5 GHz

Results:

Table13 Permittivity and Loss Tangent

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-10-17~2019-10-18		Ambient	23°C,49%RH
Sample No.	test frequency	thickness(mm)	permittivity	loss tangent
23555-8-1	1MHz	0.208	4.7	0.015
23555-8-2		0.207	4.8	0.015
23555-8-3		0.203	4.8	0.015
Average		0.206	4.8	0.015
Requirement			≤5.4	≤0.035
23555-39-4	1MHz	0.624	5.0	0.011
23555-39-5		0.625	5.0	0.011
23555-39-6		0.616	5.0	0.011
Average		0.622	5.0	0.011
Requirement			≤5.4	≤0.035



Flexural Strength

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 2.4.4B Flexural Strength of Laminates (at Ambient Temperature)

Results:

Table 14 Flexural Strength Test Thick (At Ambient Temperature)

Sample Designation	CCL		Sample Identification		VT-441V		
Test Date	2019-10-16		Ambient		23°C, 47%RH		
Sample No.	Span	Width	Thickness	Load	Flexural Strength $S=3PL/2bd^2$	Average	Requirement
	L	b	d	P			
	(mm)	(mm)	(mm)	(N)	(N/mm ²)	(N/mm ²)	(N/mm ²)
23555-46-1 (Length Direction)	15.90	25.24	0.597	279.171	740	744	≥415
23555-46-2 (Length Direction)		25.77	0.602	293.073	748		
23555-46-3 (Cross Direction)		25.98	0.598	247.084	634	628	≥345
23555-46-4 (Cross Direction)		25.11	0.600	235.439	621		



Arc Resistance

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.5.1B Arc Resistance of Printed Wiring Material

Results:

Table 15 Arc Resistance Thin

Sample Designation	CCL	Sample Identification	VT-441V	
Test Date	2019-10-23~2019-10-25	Ambient	24°C, 49%RH	
Sample No.	Thickness (mm)	Times (s)	Average (s)	Requirement (s)
23555-11-1	0.209	181	182	≥60
23555-11-2	0.208	183		
23555-11-3	0.207	182		

Table 16 Arc Resistance Thick

Sample Designation	CCL	Sample Identification	VT-441V	
Test Date	2019-10-23~2019-10-25	Ambient	24°C, 49%RH	
Sample No.	Thickness (mm)	Times (s)	Average (s)	Requirement (s)
23555-48-1	0.622	184	184	≥60
23555-48-2	0.623	183		
23555-48-3	0.619	184		



Thermal Stress

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.4.13.1 Thermal Stress of Laminates

Results:

Table17 Thermal Stress Etched

Sample Designation	CCL		Sample Identification	VT-441V
Test Date	2019-10-23		Ambient	24°C, 49%RH
Sample No.			Test result	
23555-13-1	Etched	Top	Thin	No evidence of blistering, delamination, wrinkling or cracking
23555-13-2				No evidence of blistering, delamination, wrinkling or cracking
23555-13-3				No evidence of blistering, delamination, wrinkling or cracking
23555-13-4		Bottom		No evidence of blistering, delamination, wrinkling or cracking
23555-13-5				No evidence of blistering, delamination, wrinkling or cracking
23555-13-6				No evidence of blistering, delamination, wrinkling or cracking
23555-50-1	Etched	Top	Thick	No evidence of blistering, delamination, wrinkling or cracking
23555-50-2				No evidence of blistering, delamination, wrinkling or cracking
23555-50-3				No evidence of blistering, delamination, wrinkling or cracking
23555-50-4		Bottom		No evidence of blistering, delamination, wrinkling or cracking
23555-50-5				No evidence of blistering, delamination, wrinkling or cracking
23555-50-6				No evidence of blistering, delamination, wrinkling or cracking



Table18 Thermal Stress Unetched

Sample Designation	CCL			Sample Identification	VT-441V
Test Date	2019-10-23			Ambient	24°C, 49%RH
Sample No.				Test result	
23555-14-1	Unetched	Top	Thin	No evidence of blistering, delamination, wrinkling or cracking	
23555-14-2				No evidence of blistering, delamination, wrinkling or cracking	
23555-14-3				No evidence of blistering, delamination, wrinkling or cracking	
23555-14-4		Bottom		No evidence of blistering, delamination, wrinkling or cracking	
23555-14-5				No evidence of blistering, delamination, wrinkling or cracking	
23555-14-6				No evidence of blistering, delamination, wrinkling or cracking	
23555-51-1	Unetched	Top	Thick	No evidence of blistering, delamination, wrinkling or cracking	
23555-51-2				No evidence of blistering, delamination, wrinkling or cracking	
23555-51-3				No evidence of blistering, delamination, wrinkling or cracking	
23555-51-4		Bottom		No evidence of blistering, delamination, wrinkling or cracking	
23555-51-5				No evidence of blistering, delamination, wrinkling or cracking	
23555-51-6				No evidence of blistering, delamination, wrinkling or cracking	



Electric Strength

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.5.6.2A Electric Strength

Results:

Table 19 Electric Strength Thin

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-23~2019-10-25	Ambient	24°C, 50%RH
Sample No.	Average Thickness (mm)	Voltage (kV)	Electric Strength (kV/mm)
23555-16-1	0.207	11.7	56.52
23555-16-2	0.209	11.6	55.50
23555-16-3	0.205	11.6	56.59
Average			56
Requirement			≥30



Vertical Burning Test; V-0, V-1 or V-2

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
UL94, Section 8 50W (20 mm) Vertical Burning Test; V-0, V-1, or V-2

Results:

Table 20 Vertical Burning Test Thin

Sample Designation		CCL		Sample Identification			VT-441V		
Test Date		2019-10-21~2019-10-29		Ambient			21°C, 48%RH		
Solder Limits	Sample No.	Sample Thk: (mm)	Afterflames (s)		Afterglow (s)	Sum of after flames (s)	Sum of afterflame and afterglow (s)	Did samples burn to the clamp?	Did the cotton ignite?
Temperature									
N/A									
Time									
N/A									
			(t ₁)	(t ₂)	(t ₃)	(t ₁ + t ₂)	(t ₂ + t ₃)		
Condition A:	23555-18-1	0.379	0	0	0	0	0	No	No
48 Hours	23555-18-2	0.377	0	0	0	0	0	No	No
(23 ± 2)°C	23555-18-3	0.374	0	0	0	0	0	No	No
(50 ± 5)% RH	23555-18-4	0.373	0	0	0	0	0	No	No
	23555-18-5	0.383	0	0	0	0	0	No	No
	Avg:	0.377	Max: 0			Sum: 0	Max: 0	Pass	Pass
Condition B:	23555-18-6	0.381	0	0	0	0	0	No	No
24 Hours	23555-18-7	0.379	0	0	0	0	0	No	No
(125±2)°C	23555-18-8	0.383	0	0	0	0	0	No	No
	23555-18-9	0.382	0	0	0	0	0	No	No
Results	23555-18-10	0.379	0	0	0	0	0	No	No
V-0	Avg:	0.381	Max: 0			Sum: 0	Max: 0	Pass	Pass
Requirement classification: V-0									



Table 21 Vertical Burning Test Thick

Sample Designation		CCL			Sample Identification		VT-441V			
Test Date		2019-10-21~2019-10-29			Ambient		21°C, 48%RH			
Solder Limits	Sample No.	Sample Thk: (mm)	Afterflames (s)		Afterglow (s)	Sum of after flames (s)	Sum of afterflame and afterglow (s)	Did samples burn to the clamp?	Did the cotton ignite?	
Temperature										(t ₁)
N/A										
Time										
N/A										
Condition A:	23555-53-1	0.753	3	0	0	3	0	No	No	
48 Hours	23555-53-2	0.763	2	2	0	4	2	No	No	
(23 ± 2)°C	23555-53-3	0.758	3	0	0	3	0	No	No	
(50 ± 5)% RH	23555-53-4	0.763	3	0	0	3	0	No	No	
	23555-53-5	0.760	2	0	0	2	0	No	No	
	Avg:	0.759	Max: 3			Sum: 15	Max: 2	Pass	Pass	
Condition B:	23555-53-6	0.760	3	0	0	3	0	No	No	
24 Hours	23555-53-7	0.764	3	2	0	5	2	No	No	
(125±2)°C	23555-53-8	0.765	3	0	0	3	0	No	No	
	23555-53-9	0.762	2	0	0	2	0	No	No	
Results	23555-53-10	0.761	3	0	0	3	0	No	No	
V-0	Avg:	0.762	Max: 3			Sum: 16	Max: 2	Pass	Pass	
Requirement classification: V-0										



Glass Transition Temperature and Cure Factor

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM-650 Method 2.4.25D Glass Transition Temperature and Cure Factor by DSC

Results:

Table22 Glass Transition Temperature And Cure Factor Thick

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-11-01	Ambient	24°C, 49 %RH
Sample No.	23555-57-1		
Element	Measurement (°C)		Requirement
Tg1	151.94		≥ 150
Tg2	152.06		
Cure Factor ΔT_g	0.12		/



Decomposition Temperature (T_d)

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM-650 method 2.4.24.6 Decomposition Temperature (T_d) of Laminate Material Using
 TGA

Results:

Table 23 Decomposition Temperature Test Thick

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-28~2019-10-29	Ambient	23°C, 49%RH
Sample No.	Decomposition temperature (°C)		
	mass loss at 2%	mass loss at 5%	
23555-56-1	360.90	398.84	
Requirement	/	≥325	



Glass Transition Temperature and Z-CTE (TMA)

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM-650 Method 2.4.24 Glass Transition Temperature and Z-Axis Thermal Expansion
 by TMA

Results:

Table 24 Glass Transition Temperature and Z-CTE (TMA) Thick

Sample Designation	CCL		Sample Identification	VT-441V	
Test Date	2019-11-08		Ambient	23°C, 50%RH	
Sample No.	Z-CTE($\mu\text{m}/\text{m}\cdot^\circ\text{C}$)			PTE (%)	Tg($^\circ\text{C}$)
	(50~100) $^\circ\text{C}$	(220~260) $^\circ\text{C}$	(50~260) $^\circ\text{C}$	(50~260) $^\circ\text{C}$	
23555-56-2	45.61	223.5	131.3	2.76	150.75
23555-56-3	44.25	225.5	131.7	2.76	151.10
Requirement	≤ 60	≤ 300	/	≤ 3.5	≥ 150



Time to Delamination

Reference: Results:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.4.24.1 Time to Delamination (TMA Method)

Results:

Table 25 Time to Delamination Thick

Sample Designation	CCL	Sample Identification	VT-441V	
Test Date	2019-11-01~2019-11-04	Ambient	(24~25)°C, 49%RH	
Sample No.	Test Item	Time of Reversible Event (min)	Time of Delaminate (min)	Requirement
23555-57-2	T260	/	>60	≥60
23555-57-3		/	>60	
23555-57-4	T288	/	>60	≥60
23555-57-5		/	>60	
23555-57-6	T300	/	>30	≥30
23555-57-7		/	>30	



Dimensional Stability

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.4.39A Dimensional Stability, Glass Reinforced Thin Laminates

Results:

Table 26 Dimensional Stability Thin

Sample Designation	CCL				Sample Identification	VT-441V			
Test Date	2019-10-30~ 2019-11-05				Ambient	23°C, (48~50)%RH			
Sample No.	After Bake Process (mm/m)				After Thermal Stress Process (mm/m)				
	MD		TD		MD		TD		
23555-22	202	174	-63	12	149	161	-150	-87	
23555-23	-149	-53	-24	-43	-205	-178	-130	-95	
23555-24	-64	-44	-146	-106	-149	-52	-273	-150	
Requirement	-300~300								

Table 27 Dimensional Stability Thick

Sample Designation	CCL				Sample Identification	VT-441V			
Test Date	2019-10-30~ 2019-11-05				Ambient	23°C, (48~50)%RH			
Sample No.	After Bake Process (mm/m)				After Thermal Stress Process (mm/m)				
	MD		TD		MD		TD		
23555-60	134	24	-154	-106	16	-85	-248	-158	
23555-61	-28	-202	-32	-79	-162	-198	-229	-185	
23555-62	-64	-45	-79	-47	-201	-142	-173	-158	
Requirement	-300~300								



Solderability (Edge Dip Test)

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC J-STD-003C; 4.2.1 Edge Dip Test

Results:
Table 28 Solderability (Edge Dip Test) Thick

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-23	Ambient	24℃, 49%RH
Sample No.	Test result		
23555-64-1	Sample surface exhibit good wetting		
23555-64-2	Sample surface exhibit good wetting		
23555-64-3	Sample surface exhibit good wetting		



Chemical Resistance

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM-650 Method 2.3.4.2 Chemical Resistance of Laminates, Prepreg, and Coated Foil
 Products, by Solvent Exposure

Results:

Table 29 Chemical Resistance (Thin)

Sample Designation	CCL			Sample Identification	VT-441V	
Test Date	2019-10-30			Ambient	23°C, 49%RH	
Sample No.	Thickness (mm)	Weight (mg)		Increase Weight (mg)	Appearance Inspection	
		W ₁	W ₂	W ₂ -W ₁	After Bake	After Immerse in the Solvent
23555-8-7	0.208	1034.6	1035.9	1.3	no any change	no any change
23555-8-8	0.206	1004.1	1005.1	1.0	no any change	no any change
23555-8-9	0.202	1035.2	1036.4	1.2	no any change	no any change
Average				1.2	/	

Table 30 Chemical Resistance (Thick)

Sample Designation	CCL			Sample Identification	VT-441V	
Test Date	2019-10-30			Ambient	23°C, 49%RH	
Sample No.	Thickness (mm)	Weight (mg)		Increase Weight (mg)	Appearance Inspection	
		W ₁	W ₂	W ₂ -W ₁	After Bake	After Immerse in the Solvent
23555-39-7	0.625	3033.8	3034.8	1.0	no any change	no any change
23555-39-8	0.625	3112.6	3113.7	1.1	no any change	no any change
23555-39-9	0.625	3055.7	3056.4	0.7	no any change	no any change
Average				0.9	/	



Metal Surface Cleanability

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
IPC-TM-650 Method 2.3.1.1 Chemical Cleaning of Metal-Clad Laminate

Results:

Table 31 Metal Surface Cleanability Thin

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-29	Ambient	23°C, 49%RH
Sample Number	Test Result		
23555-29-1	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		
23555-29-2	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		
23555-29-3	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		

Table 32 Metal Surface Cleanability Thick

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-29	Ambient	23°C, 49%RH
Sample Number	Test Result		
23555-72-1	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		
23555-72-2	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		
23555-72-3	The metal cladding on the test specimen shall be cleaned to a uniform matte finish. Deionized or distilled water poured on the metal surface does not bead or form puddles.		



Pressure Cooker Test

Reference:

IPC-4101E/128 Specification for Base Materials for Rigid and Multilayer Printed Boards
 IPC-TM 650 2.6.16 Pressure Vessel Method for Glass Epoxy Laminate Integrity

Results:
Table 33 Pressure Cooker Test Thick

Sample Designation	CCL	Sample Identification	VT-441V
Test Date	2019-10-23	Ambient	24°C, 49%RH
Sample No.	Test result		
23555-69-1	Grade5:The sample have no measles, blisters, or surface erosion.		
23555-69-2	Grade5:The sample have no measles, blisters, or surface erosion.		
23555-69-3	Grade5:The sample have no measles, blisters, or surface erosion.		
23555-69-4	Grade5:The sample have no measles, blisters, or surface erosion.		
23555-69-5	Grade5:The sample have no measles, blisters, or surface erosion.		

**CERTIFICATE OF CONFORMANCE**

Microtek (Changzhou) Laboratories certifies that the test equipment used complies with the calibration requirements of correlation criterion and that the data contained in this report is accurate within the tolerance limitation of this equipment.

The report is invalid without signature of approver and “Special seal for test report”, and the test results of this report are only responsible for tested samples.

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Thank you for selecting Microtek (Changzhou) Laboratories for your testing requirements.

Edited by:

Sheadon Xu

Sheadon Xu
Project Engineer
Date: 2019-11-20

Reviewed by:

Liu Dengping

Liu Dengping
Project Manager
Date: 2019-11-20

Approved by:

Susan Le

Susan Le
Laboratory Manager
Date: 2019-11-20