



# TEST REPORT SUMMARY

(Short Report)

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**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/153

**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:** 23555EGS



**"INTEGRITY, HONESTY AND KNOWLEDGE"**

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## **SUMMARIZED TEST RESULTS:**

<b><u>Test Item</u></b>	<b><u>Thin</u></b>	<b><u>Thick</u></b>
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/153 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	$\geq 1.05$			



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	$\geq 0.70$			



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	$\geq 0.70$			



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	$\geq 0.55$			





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	$\geq 0.80$			





## Volume and Surface Resistivity

### Reference:

IPC-4101E/153 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
<b>Average</b>		/	1.2E+06	/	1.4E+08
<b>Requirement</b>		/	$\geq 10^4$	/	$\geq 10^4$

**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
<b>Average</b>		/	1.4E+05	/	2.2E+06
<b>Requirement</b>		/	$\geq 10^3$	/	$\geq 10^3$



## Moisture Absorption

### Reference:

IPC-4101E/153 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 <sub>1</sub>	m <sub>2</sub>		
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	
<b>Average</b>			0.20	
<b>Requirement</b>			≤0.80	



## Dielectric Breakdown

### Reference:

IPC-4101E/153 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/153 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
<b>Average</b>		0.206	4.8	0.015
<b>Requirement</b>			≤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
<b>Average</b>		0.622	5.0	0.011
<b>Requirement</b>			≤5.4	≤0.035



## Flexural Strength

### Reference:

IPC-4101E/153 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 <sup>2</sup> )	(N/mm <sup>2</sup> )	(N/mm <sup>2</sup> )
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/153 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/153 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/153 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/153 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 <sub>1</sub> )	(t <sub>2</sub> )	(t <sub>3</sub> )	(t <sub>1</sub> + t <sub>2</sub> )	(t <sub>2</sub> + t <sub>3</sub> )		
<b>Condition A:</b>	23555-18-1	0.379	0	0	0	0	0	No	No
<b>48 Hours</b>	23555-18-2	0.377	0	0	0	0	0	No	No
<b>(23 ± 2)°C</b>	23555-18-3	0.374	0	0	0	0	0	No	No
<b>(50 ± 5)% RH</b>	23555-18-4	0.373	0	0	0	0	0	No	No
	23555-18-5	0.383	0	0	0	0	0	No	No
	<b>Avg:</b>	<b>0.377</b>	<b>Max: 0</b>			<b>Sum: 0</b>	<b>Max: 0</b>	<b>Pass</b>	<b>Pass</b>
<b>Condition B:</b>	23555-18-6	0.381	0	0	0	0	0	No	No
<b>24 Hours</b>	23555-18-7	0.379	0	0	0	0	0	No	No
<b>(125±2)°C</b>	23555-18-8	0.383	0	0	0	0	0	No	No
	23555-18-9	0.382	0	0	0	0	0	No	No
<b>Results</b>	23555-18-10	0.379	0	0	0	0	0	No	No
<b>V-0</b>	<b>Avg:</b>	<b>0.381</b>	<b>Max: 0</b>			<b>Sum: 0</b>	<b>Max: 0</b>	<b>Pass</b>	<b>Pass</b>
<b>Requirement classification: V-0</b>									



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 <sub>1</sub> )
N/A										
Time										
N/A										
<b>Condition A:</b>	23555-53-1	0.753	3	0	0	3	0	No	No	
<b>48 Hours</b>	23555-53-2	0.763	2	2	0	4	2	No	No	
<b>(23 ± 2)°C</b>	23555-53-3	0.758	3	0	0	3	0	No	No	
<b>(50 ± 5)% RH</b>	23555-53-4	0.763	3	0	0	3	0	No	No	
	23555-53-5	0.760	2	0	0	2	0	No	No	
	<b>Avg:</b>	<b>0.759</b>	<b>Max: 3</b>			<b>Sum: 15</b>	<b>Max: 2</b>	<b>Pass</b>	<b>Pass</b>	
<b>Condition B:</b>	23555-53-6	0.760	3	0	0	3	0	No	No	
<b>24 Hours</b>	23555-53-7	0.764	3	2	0	5	2	No	No	
<b>(125±2)°C</b>	23555-53-8	0.765	3	0	0	3	0	No	No	
	23555-53-9	0.762	2	0	0	2	0	No	No	
<b>Results</b>	23555-53-10	0.761	3	0	0	3	0	No	No	
<b>V-0</b>	<b>Avg:</b>	<b>0.762</b>	<b>Max: 3</b>			<b>Sum: 16</b>	<b>Max: 2</b>	<b>Pass</b>	<b>Pass</b>	
<b>Requirement classification: V-0</b>										



## Glass Transition Temperature and Cure Factor

### Reference:

IPC-4101E/153 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**

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



## Decomposition Temperature ( $T_d$ )

### Reference:

IPC-4101E/153 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/153 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( $\mu\text{m}/\text{m}\cdot\text{°C}$ )			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	$\leq 60$	$\leq 300$	/	$\leq 3.5$	$\geq 150$



### Time to Delamination

#### Reference: Results:

IPC-4101E/153 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/153 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/153 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/153 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 <sub>1</sub>	W <sub>2</sub>	W <sub>2</sub> -W <sub>1</sub>	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 <sub>1</sub>	W <sub>2</sub>	W <sub>2</sub> -W <sub>1</sub>	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/153 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/153 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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