

HITACHI COPPER CLAD LAMINATES

⚠ Special Notice

Thoroughly review SDS or Product Information Sheet before use.

- The contents of this brochure are as of June 2017. Products' specifications or appearance may be changed without previous notice.
- The contents of this brochure are based on the results of experiments conducted by HITACHI CHEMICAL, and do not represent a guarantee of the values for each property. Before using a product, please study its properties, methods for using it, etc., using this catalog as a reference.
- HITACHI CHEMICAL does not take any responsibility for the method of using this product, or for parts or equipment using this product, when these involve the violation of intellectual property rights held by third parties.
- Some products or technologies are subject to regulations in the Foreign Exchange and Foreign Trade Law. When exporting or carrying them to foreign countries, contact the competent authority of the Japanese Government to obtain export permission in advance.

Hitachi Chemical Co., Ltd.

GRANTOKYO SOUTH TOWER, 1-9-2, Marunouchi, Chiyoda-ku, Tokyo, 100-6606, Japan

Laminates & Materials Business Unit Phone: (81) (3) 5533-6680

● AFFILIATES

Hitachi Chemical Co. America, Ltd.

2150 North First Street, Suite 350, San Jose, CA 95131, U.S.A.

Phone: (1) (408) 873-2200

Hitachi Chemical Europe GmbH

Berliner Allee 22, 40212 Düsseldorf, Germany

Phone: (49) (211) 166730

Hitachi Chemical (China) Co., Ltd. Beijing Branch

Room No.1416, Beijing Fortune Building, 5 Dong san Huan Bei-Ju, Chao Yang District, Beijing 100004, China

Phone: (86) (10) 6590-8761

Hitachi Chemical (China) Co., Ltd. Shenzhen Branch

Unit 801 West Block, Coastal Building, Nanshan Commercial and Cultural Center Area, Nanshan District, Shenzhen 518054, China

Phone: (86) (755) 8207-0543

Hitachi Chemical (Shanghai) Co., Ltd.

17F, Jinhang Tower, No.83 Wanhangu Road, Shanghai 200040, China

Phone: (86) (21) 6288-8870

Hitachi Chemical International Co., (Taiwan) Ltd.

Room No.606, Chia Hsin Building, 96, Sec.2, Chung Shan N. Road, Taipei, Taiwan

Phone: (886) (2) 2581-3632

Hitachi Chemical Asia-Pacific Pte.Ltd.

180 Clemenceau Avenue #02-01, Haw Par Centre, Singapore 239922

Phone: (65) (6836) 6988

Hitachi Chemical Asia (Thailand) Co., Ltd. Bangkok Sales Office

No.319 Chamchuri Square Building, 16th Floor, Room No.1609-1610, Phayathai Road, Pathumwan Sub-District, Pathumwan District, Bangkok 10330, Thailand

Phone: (66) (2) 160-5412

URL
<http://www.hitachi-chem.co.jp>

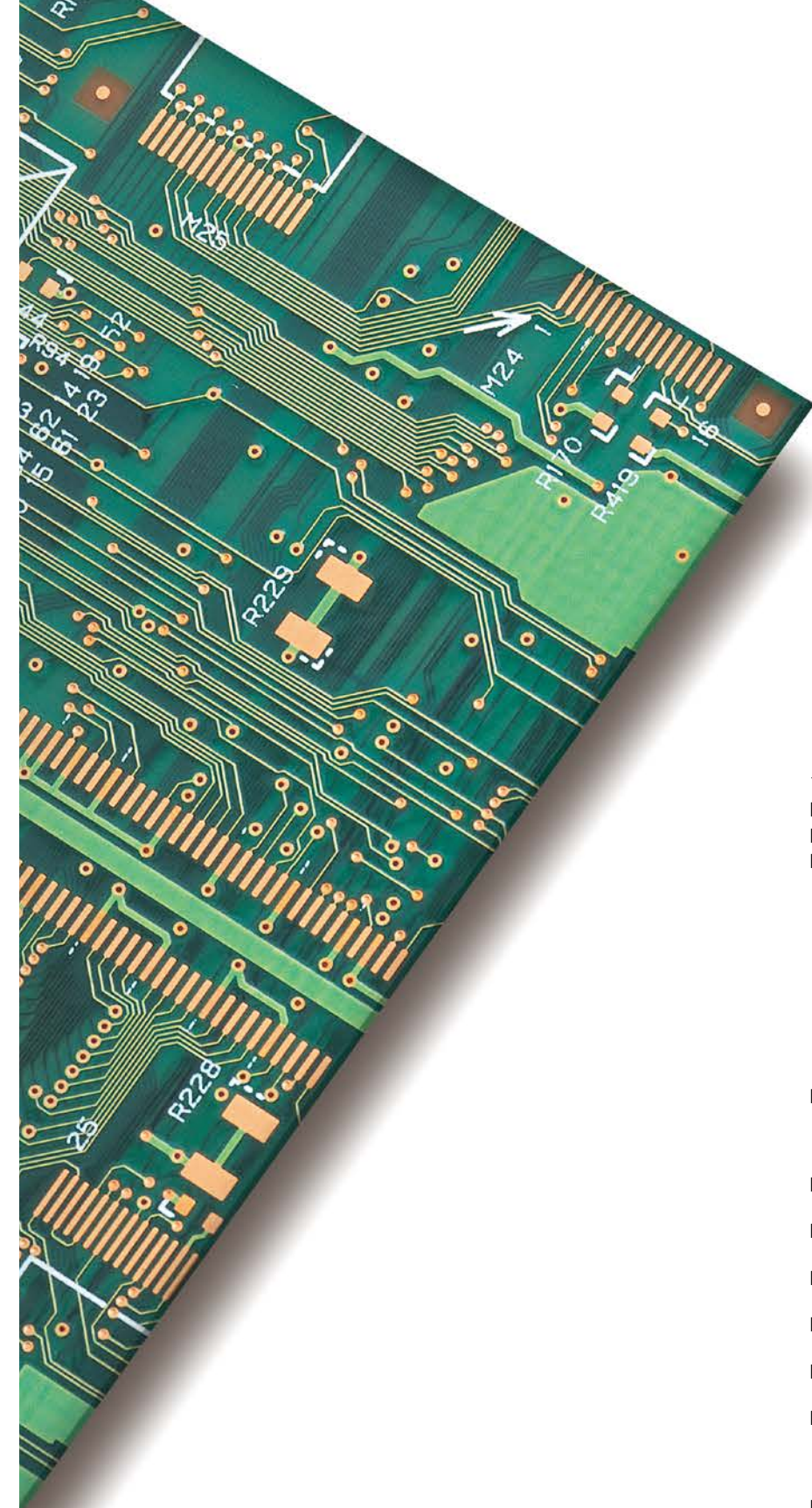
In the world of electronics, especially information systems
and equipment, advancements are occurring
on a daily basis and many new technologies
are rebuting one after the other.

The solution you need is here

Hitachi Chemical Co., Ltd. is engaged
in producing materials from printed wiring boards
to substrates and in processing materials
using "combined technology," a combination of
our existing reliable technologies developed over years
and of leading-edge technologies.

The balanced, reliable, advanced solutions of Hitachi Chemical
and related peripheral technologies are designed
to support the electronics of the future.





CONTENTS

■ Recommended Base Materials by Application	P4
■ Characteristics	P6
■ Glass Epoxy Multilayer Materials	P9
MCL-HS100	P10
MCL-E-770G	P12
MCL-E-705G	P14
MCL-E-700G	P16
MCL-E-679FG	P18
MCL-E-679F Type (R)	P20
MCL-E-78G	P22
TD-002	P24
MCL-E-75G	P26
MCL-E-67	P28
■ Materials for ICT Infrastructure	P31
MCL-E-679 Type (W)	P32
MCL-LW-900G/910G	P34
MCL-HE-679G Type (S)	P36
■ Polyimide Multilayer Material	P39
MCL-I-671	P40
■ Glass Epoxy Double Sided Materials	P43
MCL-E-67	P44
■ CEM-3	P47
E-668T Type (K) (Tracking resistance)	P48
■ Materials for Fine Patterning	P51
PF-EL	P52
■ Epoxy Adhesive Film	P55
AS-2600	P56
■ KOBELITE LAMINATE	P57
KEL-GEF Type (R)	P60
KEL-571 (Only non-woven aramid structure)	P62
KEL-973 (Composite structure of non-woven aramid and polyester)	P62
■ Precautionary Statement	P65
Precautions for Use	P66
Precautions in Process	P67
Precautions in Designing	P68
Precautions for Use of Completed PWB	P69
Recommendation Press Condition for Multilayer Board Lamination	P70
■ Standards	P83
UL Standard	P84
BS Standard-CSA Standard	P85

Recommended Base Materials by Application

Product		MultiLayer Materials									
		MCL-HS100	MCL-E-770G	MCL-E-705G	MCL-E-700G	MCL-E-679FG	MCL-E-679F Type(R)	MCL-E-78G	TD-002	MCL-E-75G	MCL-E-67
Feature		High Tg, Low Dielectric Constant, Low Dissipation Factor, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	High Tg, High Elasticity, Low Thermal Expansion	Low Dielectric Constant, High Elasticity	Low Elastic Modulus	High Tg, High Heat Resistance	Good Dimensional Reliability, and Dielectric Property
Environmentally Friendly	Halogen Free	○	○	○	○	○		○		○	
	Lead Free Application (288°C)	○	○	○	○	○	○	○	○	○	○
Consumer products	Digital Consumer Products									○	○
	Game Instrument									○	○
	Personal Computer							○		○	○
	Mobile Phone						○	○	○	○	○
Infrastructure Products	Router-Server									○	○
	Base Station									○	
	Antenna										
Electronics Devices Products	Package For Semiconductor (BGA-CSP-MCM)	○	○	○	○	○	○				
	Memory Modules	○	○	○	○	○	○	○		○	○
	Semiconductor Testing Devices	○	○	○	○	○	○			○	
	High-frequency Parts	○	○	○				○			
Automotive Products	Electronic Control Unit	○	○	○	○	○	○		○	○	○
	Automotive Electronics	○	○	○	○	○	○		○	○	○
	ITS	○	○	○	○	○	○		○	○	○
UL ANSI		—	—	—	—	FR-4.1	FR-4.0	FR-4.1	—	FR-4.1	FR-4.0
Page		10	12	14	16	18	20	22	24	26	28

Product		Materials For ICT Infrastructure			Polyimide Multilayer Materials	Glass Epoxy Double Side Materials	CEM-3	Materials for Fine Patterning
		MCL-E-679 Type(W)	MCL-LW-900G MCL-LW-910G	MCL-HE-679G Type (S)	MCL-I-671	MCL-E-67	E-668T Type(K)	PF-EL
Feature		High Tg, High insulating Reliability	High Tg High Heat Resistance, Low Dielectric Constant, Low Dissipation Factor	High Heat Resistance, Low Dielectric Constant	High Tg, High Heat Resistance	Dimensional Stability, Low Warpage	High CTI CEM-3	Semi-additive Process Compatible
Environmentally Friendly	Halogen Free		⊙	⊙				⊙
	Lead Free Application (288°C)	⊙	⊙	⊙	⊙	⊙	○	⊙
Consumer products	Digital Consumer Products	○				⊙	⊙	
	Game Instrument	○				⊙	⊙	○
	Personal Computer	○		○			⊙	
	Mobile Phone	⊙			⊙			○
Infrastructure Products	Router·Server	⊙	⊙	⊙	⊙			
	Base Station	⊙	⊙	⊙				
	Antenna		⊙					
Electronics Devices Products	Package For Semiconductor (BGA·CSP·MCM)	⊙						⊙
	Memory Modules	⊙	○	⊙				○
	Semiconductor Testing Devices	○			⊙			○
	High-frequency Parts		○	⊙		⊙		○
Automotive Products	Electronic Control Unit	○				○		
	Automotive Electronics		○			○	○	○
	ITS	○	○			○		
UL ANSI		FR-4.0	—	FR-4.1	GPY	FR-4.0	CEM-3	—
Page		32	34	36	40	44	48	52

General Characteristics

Item	Condition	Unit	Multilayer Materials										
			MCL-HS100 [Halogen Free]	MCL-E-770G [Halogen Free]	MCL-E-705G [Halogen Free]	MCL-E-700G [Halogen Free]	MCL-E-679FG [Halogen Free]	MCL-E-679F Type(R)	MCL-E-78G [Halogen Free]	TD-002	MCL-E-75G [Halogen Free]	MCL-E-67	
			UL ANSI	—	—	—	—	FR-4.1	FR-4.0	FR-4.1	—	FR-4.1	FR-4.0
Tg	TMA	°C	210~230	260~280	250~270	250~270	165~175	160~170	160~170	155~170	155~170	120~130	
	DMA		240~260	320~340	295~305	295~305	200~220	190~200	200~220	—	195~215	150~160	
CTE ^{*1}	X (30~120°C)	ppm/°C	6~8	4~6	5~7	7~9	13~15	12~14	13~15	6~9	12~15	13~16	
			Y	6~8	4~6	5~7	7~9	13~15	12~14	15~17	6~9	14~17	14~17
	Z		(<Tg)	20~30	8~13	10~15	15~25	23~33	20~30	35~45	80~130	30~40	50~70
			(>Tg)	130~180	70~90	70~90	90~120	140~170	130~160	180~230	200~300	180~240	200~300
Solder Heat Resistance(260°C)	A	sec.	>300	>300	>300	>300	>300	>300	>300	>300	>300	>120	
Copper Peel Strength	18μm	A	kN/m	0.8~1.0	0.6~0.8	0.9~1.1	1.0~1.2	0.9~1.1	1.1~1.2	1.0~1.2	0.8~0.9	1.2~1.4	1.4~1.6
	35μm			—	0.8~1.0	—	—	1.1~1.2	1.2~1.3	1.1~1.3	0.9~1.1	1.5~1.8	1.7~2.1
Surface Roughness	A	μm	2~3	2~3	2~3	2~3	2~3	2~3	—	5~13	—	5~13	
Flexural Modulus (Lengthwise)	A	GPa	23~28	30~32	32~34	32~34	23~28	27~33	25~29	5~8	25~29	23~25	
Dielectric Constant	1MHz	C-96/20/65	—	—	4.4~4.6	4.5~4.7	4.8~5.0	5.2~5.4	4.8~5.0	4.2~4.4	—	5.0~5.2	4.7~4.8
	1GHz ^{*2}			3.9~4.1	4.1~4.3	4.2~4.4	4.6~4.8	4.6~4.8	4.5~4.7	3.4~3.6	3.6~3.8	4.4~4.6	4.1~4.2
Dissipation Factor	1MHz	C-96/20/65	—	—	0.0030~0.0050	0.0060~0.0080	0.0080~0.0100	0.0080~0.0100	0.0080~0.0100	0.0070~0.0090	—	0.0090~0.0110	0.0130~0.0170
	1GHz ^{*2}			0.0030~0.0040	0.0040~0.0060	0.0070~0.0090	0.0090~0.0110	0.0160~0.0180	0.0130~0.0150	0.0090~0.0110	0.011~0.013	0.0140~0.0160	0.0180~0.0200
Volume Resistivity	C-96/20/65	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶
Surface Resistance	C-96/20/65	Ω	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹⁴ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶
	C-96/20/65 +D-2/100		1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹⁴ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵
Water Absorption	E-24/50 +D24/23	%	0.2~0.4 ^{*4}	0.2~0.4 ^{*4}	0.4~0.6 ^{*3}	0.4~0.6 ^{*3}	0.4~0.6 ^{*3}	0.4~0.6 ^{*3}	0.3~0.5 ^{*3}	0.1~0.3	0.1~0.3	0.08~0.12	0.12~0.14
Flammability (UL-94)	A	—	V-0	—	—	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
Thermal Conductivity	Xe-flash	W/m·K	0.40~0.50	0.60~0.70	0.60~0.70	0.75~0.85	0.75~0.85	0.40~0.50	0.40~0.50	0.30~0.40	0.60~0.70	0.30~0.40	

*1) Heating Rate: 10°C/min. *2) Measured by Triplate-line Resonator *3) 0.1mm *4) 0.2mm

Item	Condition	Unit	Materials For ICT Infrastructure			Polyimide Multilayer Materials	Glass Epoxy Double Sided Materials	
			MCL-E-679 Type(W)	MCL-LW-900G/910G [Halogen Free]	MCL-HE-679G Type(S) [Halogen Free]	MCL-I-671	MCL-E-67	
		UL ANSI	FR-4.0	—	FR-4.1	GPY	FR-4.0	
Tg	TMA	°C	173~183	190~210	180~190	200~213	120~130	
	DMA		205~215	240~280	260~280	230~245	—	
CTE ⁻¹	X (30~120°C)	ppm/°C	12~15	12~15	12~15	12~15	13~16	
	Y		14~17	12~15	14~17	12~16	14~17	
	Z		(<Tg)	50~60	35~45	30~40	50~80	50~70
			(>Tg)	200~300	240~290	190~230	200~300	200~300
Solder Heat	A	sec.	>300	>300	>300	>300	>120	
Copper Peel Strength	18μm	A	kN/m	1.2~1.4	0.5~0.7 (HVLP)	0.5~0.7 (RT)	1.3~1.5	1.4~1.6
	35μm			1.5~1.7	0.5~0.8 (HVLP)	0.6~0.8 (RT)	1.5~1.7	1.7~2.1
Surface Roughness	A	μm	5~13	—	5~13	5~13	—	
Flexural Modulus (Lengthwise)	A	GPa	24~26	16~21	23~26	24~26	—	
Dielectric Constant	1MHz	C-96/20/65	—	4.7~4.8	3.30~3.80	4.10~4.30	4.2~4.4	4.7~4.8
	1GHz ⁻²			4.2~4.3	3.20~3.70	3.70~3.90	4.1~4.3	—
Dissipation Factor	1MHz	C-96/20/65	—	0.0130~0.0150	0.0005~0.0010	0.0040~0.0060	0.0110~0.0130	0.0130~0.0170
	1GHz ⁻²			0.0210~0.0220	0.0020~0.0035	0.0060~0.0080	0.0130~0.0150	—
Volume Resistivity	C-96/20/65	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁵	1×10 ¹⁵ ~1×10 ¹⁶	1×10 ¹⁵ ~1×10 ¹⁶	
Surface Resistance			Ω	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	1×10 ¹⁴ ~1×10 ¹⁶	
	C-96/20/65 +D-2/100		1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁴	1×10 ¹³ ~1×10 ¹⁵	1×10 ¹³ ~1×10 ¹⁵	
Water Absorption	E-24/50 +D24/23	%	0.15~0.20	0.2~0.4	0.1~0.3	0.10~0.20	0.06~0.08	
Flammability (UL-94)	A	—	V-0	V-0	V-0	V-0	V-0	
Thermal Conductivity	Xe-flash	W/m·K	0.30~0.40	0.40~0.50	0.40~0.50	0.25~0.35	0.30~0.40	

Above properties are typical figures as a laminate.
The figures as PCB may change depending on its material construction.
Above values are Hitachi experimental data and not guaranteed.

General Characteristics

Item	Condition	Unit		CEM-3
		JIS		E-668T Type(K)
		UL ANSI		CGE3F
				CEM-3
T _g	TMA	°C		130~140
	DMA			—
CTE	X	(30~80°C)	ppm/°C	18~22
	Y			19~23
	Z	(<T _g)		40~50 ^{*1}
		(>T _g)		280~300
Solder Heat Resistance(260°C)		A	sec.	>120
Copper Peel Strength	18μm	A	kN/m	1.2~1.6
	35μm			1.8~2.2
Surface Roughness		A	μm	—
Flexural Modulus (Lengthwise)		A	GPa	—
Dielectric Constant	1MHz	C-96/20/65	—	4.4~4.8
	1GHz			— ^{*4}
Dissipation Factor	1MHz	C-96/20/65	—	0.024~0.030
	1GHz			— ^{*4}
Volume Resistivity		C-96/20/65	Ω·cm	5×10 ¹⁵ ~5×10 ¹⁶
Surface Resistance		C-96/20/65	Ω	5×10 ¹⁴ ~5×10 ¹⁵
Insulation Resistance	C-96/20/65		Ω	1×10 ¹⁴ ~1×10 ¹⁵
	C-96/20/65 +D-2/100			1×10 ¹³ ~1×10 ¹⁴
Water Absorption		E-24/50 +D24/23	%	0.04~0.08 (1.6mm)
Thermal Conductivity		Xe-flash	W/m·K	0.6~0.8
Flammability (UL-94)		A	—	V-0

*1)30~80°C. *2)200~250°C.

Glass Epoxy Multilayer Materials

Halogen Free, High Tg, Low Transmission Loss,
Low CTE Multilayer Material

MCL-HS 100

P10

High Elastic Modulus
and Low CTE Multilayer Material

MCL-E-679F Type(R)

P20

Halogen Free, High Tg, High Elastic Modulus,
Ultra Low CTE Multilayer Material

MCL-E-770G

P12

Halogen Free, Low Dielectric Constant,
High Tg and High Heat Resistance Multilayer Material

MCL-E-78G

P22

Halogen Free, High Tg, High Elastic Modulus
and Low CTE Multilayer Material

MCL-E-705G

P14

Reduction of Solder Crack/
Low Elastic Modulus Material

TD-002

P24

Halogen Free, High Tg, High Elastic Modulus
and Low CTE Multilayer Material

MCL-E-700G

P16

Halogen Free, High Tg
and High Heat Resistance Multilayer Material

MCL-E-75G

P26

Halogen Free, High Elastic Modulus
and Low CTE Multilayer Material

MCL-E-679FG

P18

FR-4 Multilayer Material

MCL-E-67

P28

Halogen Free, High Tg, Low Transmission Loss, Low CTE Multilayer Material

MCL-HS100 GH-100 (Prepreg)

Low Dielectric Constant Glass Thermosetting Resin Multilayer Material

Features

- MCL-HS100(E) with Low Dk glass has low Dk/Df values.
- Suitable for package and high frequency application.
- MCL-HS100 has low CTE values and reduces warpage.
- Well-suited for build-up construction.

Applications

- Semiconductor packages.
(FC-CSP, PoP, SiP)
- Core material for HDI.
- Core material for Thinner Module.

Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-HS100	-	3μm 5μm 12μm 18μm 35μm (STD,LP,RT,HVLP)	M0.06	0.06±0.02mm
			0.1	0.10±0.02mm
			M0.11	0.10±0.02mm
			M0.15	0.15±0.02mm
			M0.22	0.21±0.03mm
			0.2	0.20±0.02mm
			0.41	0.40±0.04mm
			0.81	0.80±0.08mm
	(E)	3μm 5μm 12μm 18μm 35μm (LP,RT,HVLP)	M0.06	0.06±0.02mm
			0.1	0.10±0.02mm
			M0.11	0.10±0.02mm
			M0.15	0.15±0.02mm
			M0.22	0.21±0.03mm
			0.2	0.20±0.02mm
			0.41	0.40±0.04mm
			0.81	0.80±0.08mm

Note1) STD:12μm, 18μm, 35μm; LP:3μm, 5μm, 12μm; RT:18μm, 35μm; HVLP:12μm, 18μm, 35μm. Please contact us for details.

Note2) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Characteristics

Thin Laminate

(t0.2mm)

Item	Condition	Unit	Actual Value		Test Method (IPC-TM-650)
			MCL-HS100	MCL-HS100 Type(E)	
Tg	TMA	°C	210~230		2.4.24
	DMA		240~260		-
CTE *1	X Y	ppm/°C	6~8		2.4.24
			Z	6~8	
	(<Tg)			20~30	
			(>Tg)	130~180	
Solder Heat Resistance (260°C)	A	sec.	> 300		-
T-260 (Without copper)	TMA	min.	> 60		2.4.24.1
T-288 (Without copper)			> 60		
Decomposition Temperature(5% weight loss)	TGA	°C	430~450		2.3.40
Copper Peel Strength	A	kN/m	0.7~0.9		2.4.8
			0.8~1.0		
Surface Roughness (Ra)	A	μm	2~3		2.2.17
Flexural Modulus (Lengthwise)	A	GPa	23~28		2.4.4
Dielectric Constant	C-96/20/65	-	3.9~4.1	3.4~3.6	2.5.5.5
			3.9~4.1	3.4~3.6	
Dissipation Factor	C-96/20/65	-	0.0030~0.0040	0.0020~0.0030	
			0.0050~0.0060	0.0030~0.0040	
Volume Resistivity	C-96/20/65+C-96/40/90	Ω·cm	1×10 ¹⁴ ~1×10 ¹⁶		2.5.17
Surface Resistance	C-96/20/65+C-96/40/90	Ω	1×10 ¹³ ~1×10 ¹⁵		
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶		-
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵		-
Water Absorption	E-24/50+D-24/23	%	0.2~0.4		2.6.2.1

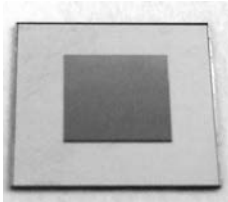
*1) Heating Rate:10°C/min. *2) Measured by Triplate-Line Resonator.
0.4mm thickness core is used depending on test item.

●Prepreg

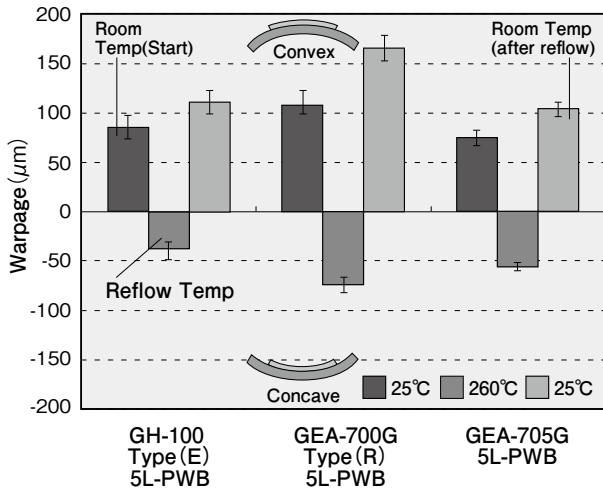
Part Number	Type		Glass Cloth			Properties		
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Dielectric Thickness after Lamination*1 (mm)	
GH-100	-	0.025	(1017N75)	1017	95×95	75±2	≤2.0	0.031
		0.03	(1027N71)	1027	75×75	71±2		0.042
		0.05	(1037N71)	1037	69×72	71±2		0.050
		0.06	(1078N61)	1078	53×53	61±2		0.071
		0.1	(2116N55)	2116	60×58	46±2		0.130
	(E)	0.03	(E1027N73)	1027	75×75	73±2		0.042
		0.05	(E1037N73)	1037	69×72	73±2		0.050
		0.06	(E1078N63)	1078	53×53	63±2		0.072
		0.08	(E2013N60)	2013	69×76	60±2		0.110
		0.1	(E2116N57)	2116	60×58	57±2		0.130
Test Method (IPC-TM-650)						2.3.16	2.3.19	-

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

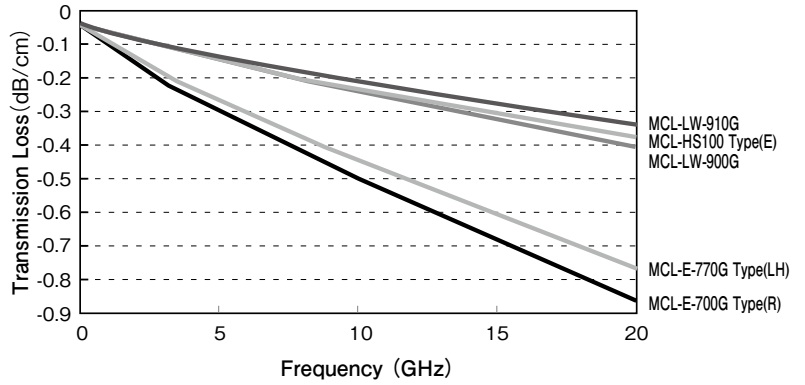
●Warpage of coreless-5layer



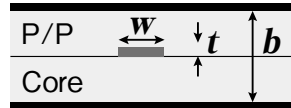
TEG Chip
 *Package size : 14mm×14mm
 *Chip size : 7.3mm×7.3mm
 *Chip thickness : 150μm
 *Underfill thickness : 60μm(CEL-C-3730-4)
 <Sample>
 *L1,5:12μm Cu100%,L2,3,4:No copper,SR:-
 *Prepreg construction
 GH-100 Type(E):(1078,R.C.:63%)×4ply
 GEA-700G Type(R):(1078,R.C.:66%)×4ply
 GEA-705G:(1078,R.C.:65%)×4ply



●Transmission Loss



<Measurement conditions>
 •Evaluation PWB: Strip-line
 •Temperature & Humidity: 25°C/60%RH
 •Characteristic impedance: Approx. 50Ω
 •Proofreading method: TRL(Thru-Reflect-Line)



•Trace width(w): 0.12~0.14mm
 •Dielectric thickness(b): 0.25mm
 •Trace thickness(t): 18μm

Halogen Free, High Tg, High Elastic Modulus, Ultra Low CTE Multilayer Material

MCL-E-770G GEA-770G<Prepreg>

High Tg Glass Epoxy Multilayer Materials

■ Features

- MCL-E-770G has ultra low CTE values in x,y directions and reduces warpage of package substrate significantly.
- MCL-E-770G Type(LH) has ultra low CTE value(less than 2.0ppm/°C).
- GEA-770G is suited for EPS(Embedded Passive Substrate) construction package.

■ Applications

- Semiconductor packages.
(FC-CSP, PoP, SiP)
- Core material for Thinner Module.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-770G	-	2μm	M0.06	0.060±0.020mm
		3μm	0.1	0.105±0.020mm
		5μm	HD0.15	0.155±0.020mm
		12μm	M0.22	0.205±0.030mm
		(STD,LP)	0.2	0.210±0.040mm
		(LH)	LHM0.06	0.060±0.020mm
	(LH)	2μm	LH0.1	0.105±0.020mm
		3μm	LHD0.15	0.155±0.020mm
		5μm	LH0.2	0.210±0.030mm
		12μm	LHY0.25	0.255±0.030mm
		(STD,LP)		

Note1) STD:Standard copper foil, LP:Low profile copper foil.

Note2) STD:12μm,18μm; LP:2μm, 3μm, 5μm, 12μm, 18μm. Please contact us for details.

Note3) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

■ Characteristics

● Thin Laminate

(t0.2mm)

Item	Condition	Unit	Actual Value		Test Method (IPC-TM-650)	
			MCL-E-770G	MCL-E-770G Type(LH)		
Tg	TMA	°C	260~280		2.4.24	
	DMA		300~330		-	
CTE *1	X	ppm/°C	4.0~6.0	1.5~2.0	2.4.24	
			Y	4.0~6.0		1.5~2.0
	Z		(<Tg)	8~13		
			(>Tg)	70~90		
Solder Heat Resistance(260°C)	A	sec.	>300		-	
T260(Without copper)	TMA	min.	>60		2.4.24.1	
T288(Without copper)			>60			
Decomposition Temperature(5% Weight Loss)	TGA	°C	430~450		2.3.40	
Heat Resistance for HDI Process(Semi-Additive)	260°CReflow	cycles	>20		-	
Copper Peel Strength	12μm	A	kN/m	0.5~0.7	2.4.8	
	18μm			0.6~0.8		
Surface Roughness(Ra)	A	μm	2~3		2.2.17	
Flexural Modulus(Lengthwise)	A	GPa	30~32	34~36	2.4.4	
Dielectric Constant	1MHz	C-96/20/65	-	4.4~4.6	4.2~4.4	2.5.5.1
	1GHz*2			4.1~4.3	3.9~4.1	2.5.5.5
Dissipation Factor	1MHz	C-96/20/65	-	0.003~0.005	0.003~0.005	2.5.5.1
	1GHz*2			0.004~0.006	0.004~0.006	2.5.5.5
Volume Resistivity	C-96/20/65+C-96/40/90	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶		2.5.17	
Surface Resistance	C-96/20/65+C-96/40/90	Ω	1×10 ¹³ ~1×10 ¹⁵			
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶		-	
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵		-	
Water Absorption	E-24/50+D-24/23	%	0.2~0.4		2.6.2.1	

*1) Heating Rate:10°C/min. *2) Measured by Triplate-Line Resonator.
t0.4mm thickness core is used depending on test item.

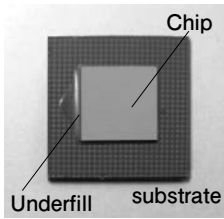
●Prepreg

Part Number	Type		Glass Cloth		Properties				
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination*1 (mm)	
GEA-770G	-	0.025	(1017N72)	1017	95×95	72±2	≤2.0	270±30	0.025
		0.025	(1017N76)	1017	95×95	76±2			0.030
		0.03	(1027N72)	1027	75×75	72±2			0.040
		0.03	(1027N76)	1027	75×75	76±2			0.048
		0.04	(1037N72)	1037	69×72	72±2			0.048
	(L)	0.025	(L1017N72)	1017	95×95	72±2		270±30	0.025
		0.025	(L1017N76)	1017	95×95	76±2			0.030
		0.03	(L1027N72)	1027	75×75	72±2			0.040
		0.03	(L1027N76)	1027	75×75	76±2			0.048
		0.035	(L1024N68)	1024	90×90	68±2			0.041
		0.035	(L1024N73)	1024	90×90	73±2			0.050
		0.04	(L1037N72)	1037	69×72	72±2			0.048
		0.045	(L1030N71)	1030	90×90	71±2			0.058

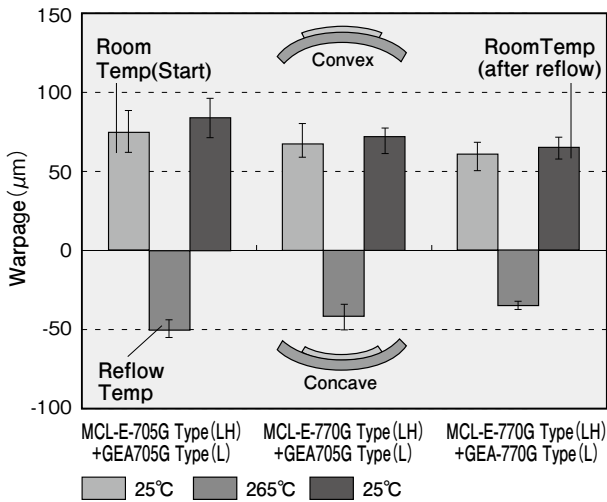
Test Method (IPC-TM-650)	2.3.16	2.3.19	2.3.18	-
--------------------------	--------	--------	--------	---

※1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

●Warpage of FC-CSP



TEG Chip
 *Package size : 14mm×14mm
 *Chip size : 7.3mm×7.3mm
 *Chip thickness : 150μm
 *Underfill thickness : 60μm (CEL-C-3730-4)
 *Solder Resist : 20μm (FZ-2700GA)
 <Sample> Core Thickness 200μm+1024(S-HD) PPG
 MCL-E-705G Type(LH)+GEA-705G Type(L)
 MCL-E-770G Type(LH)+GEA-705G Type(L)
 MCL-E-770G Type(LH)+GEA-770G Type(L)



Halogen Free, High Tg, High Elastic Modulus and Low CTE Multilayer Material

MCL-E-705G GEA-705G (Prepreg)

High Tg Glass Epoxy Multilayer Materials

■ Features

- MCL-E-705G has low CTE values in x,y directions and reduces warpage of package substrate significantly.
- MCL-E-705G Type(L) has ultra low CTE value($\leq 5\text{ppm}/^\circ\text{C}$).
- MCL-E-705G Type(LH) has ultra low CTE value($3\text{ppm}/^\circ\text{C}$).
- Well-suited for build-up construction.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-705G	(-) (L)	2 μm	U0.03	0.03 \pm 0.013mm
		3 μm	U0.04	0.04 \pm 0.013mm
		5 μm	T0.06	0.06 \pm 0.013mm
		12 μm (LP,PF)	M0.06	0.06 \pm 0.02mm
		2 μm	0.1	0.11 \pm 0.02mm
		3 μm	M0.11	0.10 \pm 0.02mm
		5 μm	M0.15	0.15 \pm 0.02mm
		12 μm	M0.22	0.21 \pm 0.03mm
		18 μm	0.2	0.21 \pm 0.03mm
		(STD,LP,PF)	0.31	0.31 \pm 0.03mm
		2 μm	0.41	0.41 \pm 0.04mm
		3 μm	0.51	0.52 \pm 0.05mm
		5 μm	0.61	0.62 \pm 0.06mm
		12 μm	0.71	0.72 \pm 0.07mm
		18 μm	0.81	0.82 \pm 0.08mm
	(STD,LP,PF)	M0.06	0.06 \pm 0.02mm	
	(LH)	2 μm	0.1	0.11 \pm 0.02mm
		3 μm	D0.15	0.15 \pm 0.02mm
		5 μm	0.2	0.21 \pm 0.03mm
		12 μm	0.26	0.26 \pm 0.03mm
		(STD,LP,PF)		

Note1) STD:Standard copper foil, LP:Low profile copper foil, PF:Hitachi profile-free copper foil.

Note2) STD:12 μm ,18 μm ,35 μm ,70 μm ; LP:2 μm ,3 μm ,5 μm ,12 μm ,18 μm ; PF:2 μm ,3 μm ,5 μm ,12 μm . Please contact us for details. Note3) "U" for 1-ply; "T" for 2-ply.

Note4) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note5) The thickness means that of dielectric layer.

■ Characteristics

● Thin Laminate

(t0.1mm)

Item	Condition	Unit	Actual Value			Test Method (IPC-TM-650)	
			MCL-E-705G	MCL-E-705G Type(L)	MCL-E-705G Type(LH)		
Tg	TMA	°C	250~270			2.4.24	
	DMA		295~305			—	
CTE *1	X	ppm/°C	5~7	3~4	2.5~3.5	2.4.24	
			Y	5~7	3~4		2.5~3.5
	Z		(<Tg)	10~15			
			(>Tg)	70~90			
Solder Heat Resistance(260°C)	A	sec.	>300			—	
T260 (Without copper)	TMA	min.	>60			2.4.24.1	
T288 (Without copper)			>60				
Decomposition Temperature(5% Weight Loss)	TGA	°C	430~450			2.3.40	
Heat Resistance for HDI Process(Semi-Additive)	260°CReflow	cycles	>20			—	
Copper Peel Strength	A	kN/m	0.8~1.0			2.4.8	
			0.9~1.1				
Surface Roughness(Ra)	A	μm	2~3			2.2.17	
Flexural Modulus(Lengthwise)	A	GPa	32~34	34~36	37~39	2.4.4	
Dielectric Constant	C-96/20/65	—	4.5~4.7	4.3~4.5	4.3~4.5	2.5.5.1	
			4.2~4.4	4.0~4.2	4.0~4.2	2.5.5.5	
Dissipation Factor	C-96/20/65	—	0.0060~0.0008	0.0060~0.0080	0.0060~0.0080	2.5.5.1	
			0.0070~0.0090	0.0070~0.0090	0.0070~0.0090	2.5.5.5	
Volume Resistivity	C-96/20/65+C-96/40/90	$\Omega \cdot \text{cm}$	$1 \times 10^{15} \sim 1 \times 10^{16}$			2.5.17	
Surface Resistance	C-96/20/65+C-96/40/90	Ω	$1 \times 10^{13} \sim 1 \times 10^{15}$				
Insulation Resistance	C-96/20/65	Ω	$1 \times 10^{14} \sim 1 \times 10^{16}$			—	
	C-96/20/65+D-2/100		$1 \times 10^{13} \sim 1 \times 10^{15}$			—	
Water Absorption	E-24/50+D-24/23	%	0.4~0.6			2.6.2.1	

*1) Heating Rate:10°C/min. *2) Measured by Triplate-Line Resonator.

Thickness core is used depending on test item.

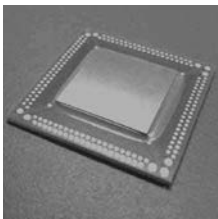
●Prepreg

Part Number	Type		Glass Cloth		Properties				
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination*1 (mm)	
GEA-705G	—	0.025	(1017N73)	1017	95×95	73±2	≤2.0	160±30	0.025
		0.03	(1027N73)	1027	75×75	73±2		180±30	0.040
		0.04	(1037N73)	1037	69×72	73±2		180±30	0.048
		0.06	(1078N65)	1078	53×53	65±2		200±30	0.071
		0.1	(2116N58)	2116	60×58	58±2		200±30	0.126
	(L)	0.025	(L1017N73)	1017	95×95	73±2		160±30	0.025
		0.03	(L1027N73)	1027	75×75	73±2		180±30	0.040
		0.035	(L1024N70)	1024	90×90	70±2			0.042
		0.035	(L1024N75)	1024	90×90	75±2			0.050
		0.04	(L1037N73)	1037	69×72	73±2			0.048
		0.045	(L1030N69)	1030	90×90	69±2			0.050
		0.045	(L1030N73)	1030	90×90	73±2		0.060	
		0.06	(L1078N65)	1078	53×53	65±2		200±30	0.071
		0.1	(L2116N58)	2116	60×58	58±2			0.126

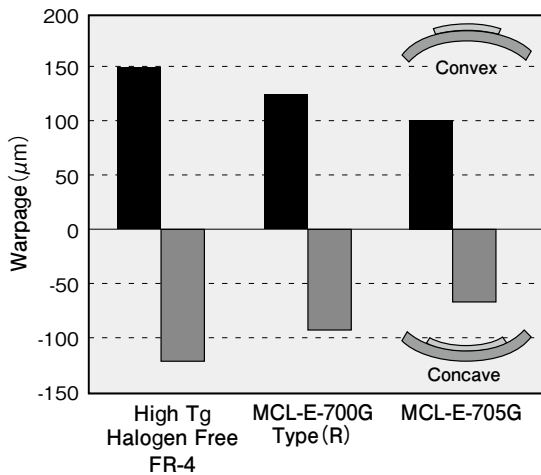
Test Method (IPC-TM-650)	2.3.16.1	2.3.19	2.3.18	—
--------------------------	----------	--------	--------	---

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

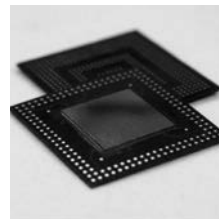
●Warpage of FC-BGA



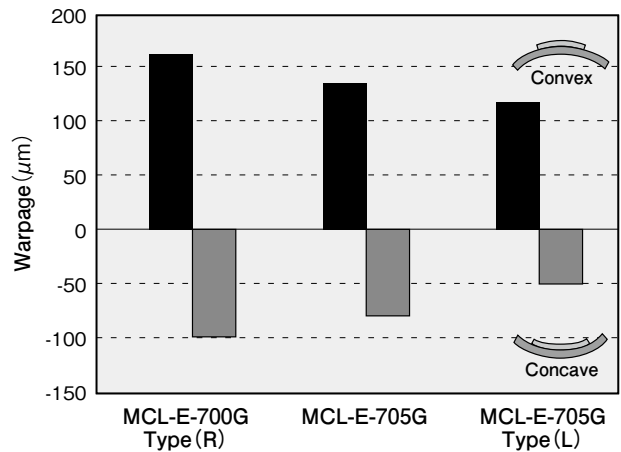
TEG Chip
 *Chip size:20mm×20mm
 *Chip thickness:0.725mm
 *Bump diameter:80μm
 *Bump pitch:200μm
TEG Substrate
 *Sub size:35mm×35mm
 *Core thickness:0.4mm
 *Build up thickness:30μm×2stack
 *SR thickness:20μm



●Warpage Evaluation Results



TEG Substrate spec
 *Size:14mm×14mm
 *Total thickness:250μm
 *SR thickness:20μm
 (SR-7200G:Hitachi Chemical)
 *Prepreg thickness:40μm
 *Core thickness:110μm



Halogen Free, High Tg, High Elastic Modulus and Low CTE Multilayer Material

MCL-E-700G GEA-700G (Prepreg)

High Tg Glass Epoxy Multilayer Materials

■ Features

- Has low CTE values in x,y directions and reduces warpage of package substrate significantly.
- Well-suited for build-up construction.
- Good drill processability : lower process cost.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance	
MCL-E-700G	(R)	2μm	U0.03	0.03±0.013mm	
		3μm	U0.04	0.04±0.013mm	
		5μm	T0.04	0.04±0.013mm	
		12μm	U0.05	0.05±0.013mm	
		(LP,PF)	T0.06	0.06±0.013mm	
		2μm	M0.06	0.06±0.02mm	
	(R)	3μm	0.1	0.11±0.02mm	
		5μm	M0.11	0.10±0.02mm	
		12μm	M0.15	0.15±0.02mm	
		18μm	M0.22	0.20±0.03mm	
		(RL)	(STD,LP,PF)	0.2	0.20±0.03mm
			2μm	0.31	0.30±0.03mm
	3μm		0.41	0.40±0.04mm	
	5μm		0.51	0.50±0.05mm	
	12μm		0.61	0.60±0.06mm	
	18μm		0.71	0.70±0.07mm	
			70μm	0.81	0.80±0.08mm
			(STD,LP,PF)		

Note1) STD:Standard copper foil, LP:Low profile copper foil, PF:Hitachi profile-free copper foil.

Note2) STD:12μm,18μm,35μm,70μm; LP:2μm,3μm,5μm,12μm,18μm; PF:2μm,3μm,5μm,12μm. Please contact us for details. Note3) "U" for 1-ply; "T" for 2-ply.

Note4) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note5) The thickness means that of dielectric layer.

■ Characteristics

● Thin Laminate

(t0.1mm)

Item	Condition	Unit	Actual Value		Test Method (IPC-TM-650)	
			MCL-E-700G Type(R)	MCL-E-700G Type(RL)		
Tg	TMA	°C	250~270		2.4.24	
	DMA		295~305		—	
CTE *1	X	ppm/°C	7~9	5~7	2.4.24	
			Y	7~9		5~7
	Z		(<Tg)	15~25		
			(>Tg)	90~120		
Solder Heat Resistance (260°C)	A	sec.	>300		—	
T-260 (Without Copper)	TMA	min.	>60		2.4.24.1	
T-288 (Without Copper)			>60			
Decomposition Temperature (5% Weight Loss)	TGA	°C	430~450		2.3.40	
Heat Resistance for HDI Process (Semi-Additive)	260°C reflow	cycle	>20		—	
Copper Peel Strength	12μm	A	kN/m	0.9~1.1		2.4.8
	18μm			1.0~1.2		
Surface Roughness (Ra)	A	μm	2~3		2.2.17	
Flexural Modulus (Lengthwise)	A	GPa	32~34	34~36	2.4.4	
Dielectric Constant	1MHz	C-96/20/65	—	4.8~5.0	4.6~4.8	2.5.5.1
	1GHz*2			4.6~4.8	4.2~4.4	2.5.5.5
Dissipation Factor	1MHz	C-96/20/65	—	0.0080~0.0100	0.0080~0.0100	2.5.5.1
	1GHz*2			0.0090~0.0110	0.0100~0.0120	2.5.5.5
Volume Resistivity	C-96/35/90+C-96/40/90	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶		2.5.17	
Surface Resistance			1×10 ¹³ ~1×10 ¹⁵			
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶		—	
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵		—	
Water Absorption	E-24/50+D-24/23	%	0.4~0.6		2.6.2.1	
Flammability (UL-94)	A	—	V-0		2.3.10	

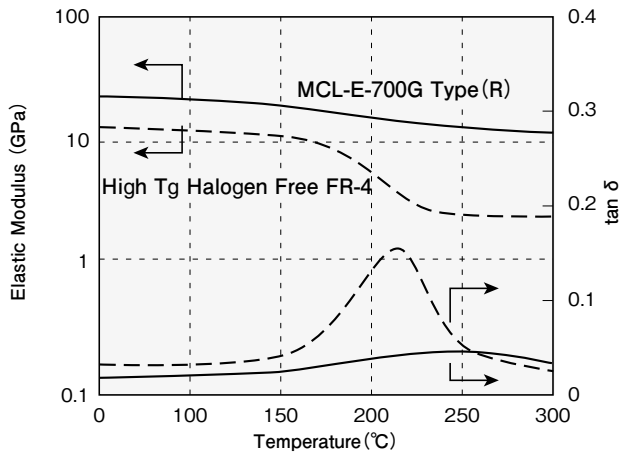
*1) Heating Rate:10°C/min. *2) Measured by Triplate-Line Resonator. 0.4mm thickness core is used depending on test item.

●Prepreg

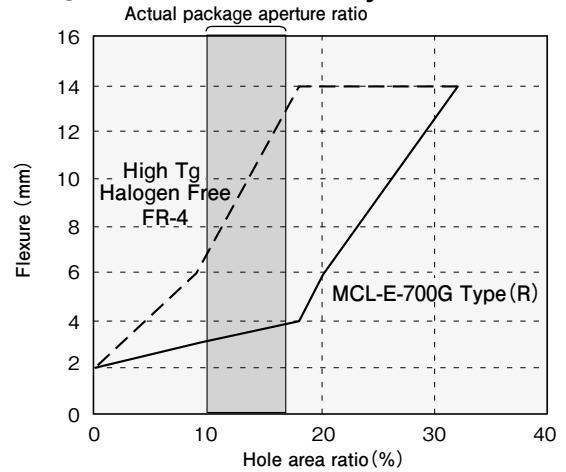
Part Number	Type			Glass Cloth		Properties			
				Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination*1 (mm)
GEA-700G	(-)	0.025	(1017N74)	1017	95×95	74±2	≤2.0	160±30	0.025
		0.03	(1027N74)	1027	75×75	74±2			0.040
		0.04	(1037N74)	1037	69×72	74±2			0.048
		0.06	(1078N66)	1078	53×53	66±2			0.072
	(L)	0.1	(2116N59)	2116	60×58	59±2		130±30	0.127
		0.03	(L1027N74)	1027	75×75	74±2		160±30	0.040
		0.04	(L1037N74)	1037	69×72	74±2		160±30	0.048
		0.06	(L1078N66)	1078	53×53	66±2		130±30	0.072
Test Method(IPC-TM-650)						2.3.16.1	2.3.19	2.3.18	-

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

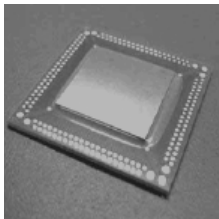
●Elastic Modulus



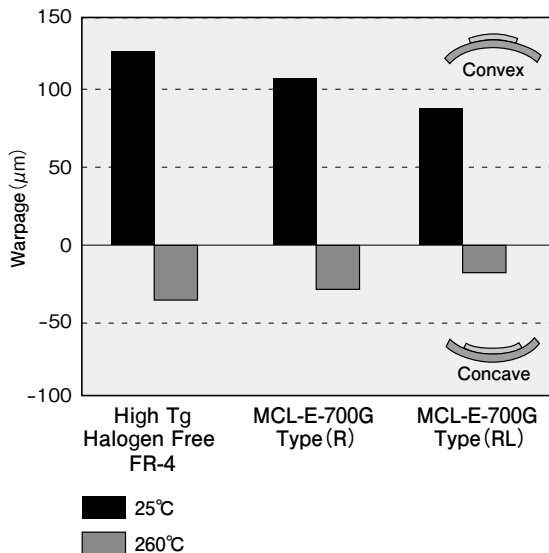
●Amount of deflection by hole area



●FC-BGA Warpage



TEG Chip
 *Chip size : 20mm×20mm
 *Chip thickness : 0.725mm
 *Bump diameter : 80μm
 *Bump pitch : 200μm
 *TEG Substrate
 *Sub size : 35mm×35mm
 *Core thickness : 0.7mm
 *Build up thickness : 30μm×2 stack
 *SR thickness : 20μm



Halogen Free, High Elastic Modulus and Low CTE Multilayer Material

MCL-E-679FG

MCL-E-679FGB (Black Type)
GEA-679FG (Prepreg)

High Tg Glass Epoxy Multilayer Material (FR-4)

Features

- Halogen free material for environmental concerns.
- CTE (Z-direction) is 50% lower than that of our standard FR-4.
- Elastic modulus is 20% higher than that of our standard FR-4. Even thin laminate has less warpage and deflection.
- Superior heat resistance for soldering (suitable for the lead free process).
- Surface roughness is 1/4 of our standard FR-4, and making fine pattern possible.

Applications

- Semiconductor packages. (FC-BGA, BGA, CSP)
- Core material for HDI.

Standard Specifications

Part Number	Type	Copperfoil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-679FG MCL-E-679FGB	(S)	2μm 3μm 5μm 12μm (LP,PF)	U0.03	0.030±0.013mm
			U0.04	0.040±0.013mm
			U0.05	0.050±0.013mm
			T0.04	0.040±0.013mm
			T0.05	0.050±0.013mm
			T0.06	0.060±0.013mm
	(R) (S)	2,3,5,12,18μm (STD,LP,PF)	T0.07	0.070±0.013mm
			M0.06	0.07±0.02mm
			0.1	0.11±0.02mm
			0.15	0.16±0.03mm
			0.2	0.21±0.04mm
			0.3	0.32±0.05mm
			0.41	0.40±0.05mm
			0.61	0.60±0.06mm
0.81	0.80±0.08mm			

Note1) STD:Standard copper foil, LP:Low profile copper foil, PF:Hitachi profile-free copper foil.

Note2) STD:12μm, 18μm, 35μm, 70μm; LP:2μm, 3μm, 5μm, 12μm, 18μm; PF:2μm, 3μm, 5μm, 12μm. Please contact us for details. Note3) "U" for 1-ply; "T" for 2-ply.

Note4) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note5) The thickness means that of dielectric layer.

Characteristics

Thin Laminate

(t0.4mm)

Item	Condition	Unit	Actual Value		Test Method (IPC-TM-650)
			MCL-E-679FG Type (R)	MCL-E-679FG Type (S)	
Tg	TMA	°C	165~175	175~185	2.4.24
	DMA		200~220	210~230	—
CTE *1	(30~120°C)	ppm/°C	13~15	12~14	2.4.24
			13~15	12~14	
			23~33 (<Tg)	20~30	
			140~170 (>Tg)	130~160	
Solder Heat Resistance (260°C)	A	sec.	>300		—
T-260 (Without Copper)	TMA	min.	>60		2.4.24.1
T-288 (Without Copper)			>60		
Decomposition Temperature (5% Weight Loss)	TGA	°C	340~360		2.3.40
Heat Resistance for HDI Process (Semi-Additive)	260°C Reflow	cycles	>10		—
Copper Peel Strength	A	kN/m	0.9~1.1	1.1~1.2	2.4.8
			1.1~1.2	1.2~1.3	
Surface Roughness (Ra)	A	μm	2~3		2.2.17
Flexural Modulus (Lengthwise)	A	GPa	23~28	24~29	2.4.4
Dielectric Constant	C-96/20/65	—	5.2~5.4	5.0~5.2	2.5.5.1
			4.6~4.8		2.5.5.5
Dissipation Factor	C-96/20/65	—	0.0080~0.0100		2.5.5.1
			0.0160~0.0180		2.5.5.5
Volume Resistivity	C-96/35/90	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶		2.5.17
Surface Resistance		Ω	1×10 ¹³ ~1×10 ¹⁵		
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶		—
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵		—
Water Absorption	E-24/50+D-24/23	%	0.4~0.6	0.3~0.5	2.6.2.1
Flammability (UL-94)	A	—	V-0		2.3.10

*1) Heating Rate:10°C/min. *2) Measured by Triplate-Line Resonator.

0.8mm thickness core is used depending on test item.

●Prepreg

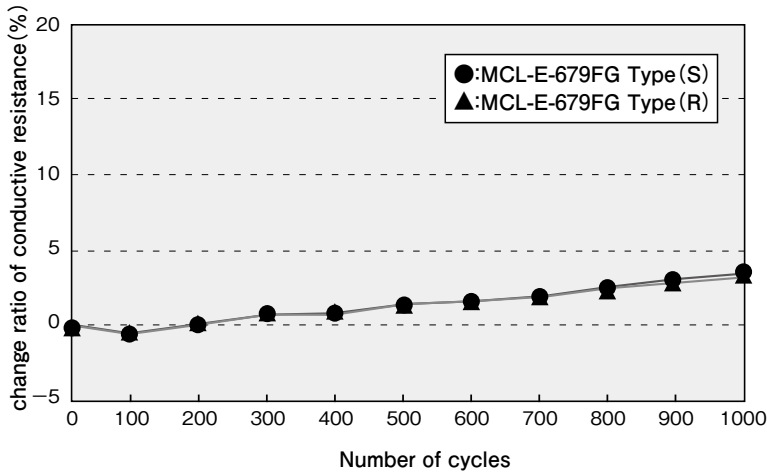
Part Number	Type		Glass Cloth		Properties				
			Style	Yarn Content (warp×fill)	Resin Content (%)	Volation Content (%)	Gelation Time (sec.)	Dielectric Thickness (mm) *1 () After pattern filling	
GEA-679FG	(R)	0.03 (GBPE)	1027	75×75	73±2	≤1.5	175±30	0.040	
		0.04 (GRZPE)	1037	69×72	73±2		165±30	0.048	
		0.06 (GRROE)	1078	53×53	68±2	≤1.0	155±30	0.079	
		0.1 (GRSKE)	2116	60×58	58±2			0.127	
	(S)	0.03 (GSAPE)	1017	95×95	78±2	≤1.5	175±30	0.031	
		0.03 (GSBPE)	1027	75×75	73±2			0.040	
		0.03 (GSBSE)	1027	75×75	78±2			0.050	
		0.04 (GSZPE)	1037	69×72	73±2	≤1.0		0.048	
		0.06 (GSROE)	1078	53×53	68±2			0.079	
		0.1 (GSSKE)	2116	60×58	58±2			165±30	0.127

Test Method(IPC-TM-650)	2.3.16.1	2.3.19	2.3.18	—
-------------------------	----------	--------	--------	---

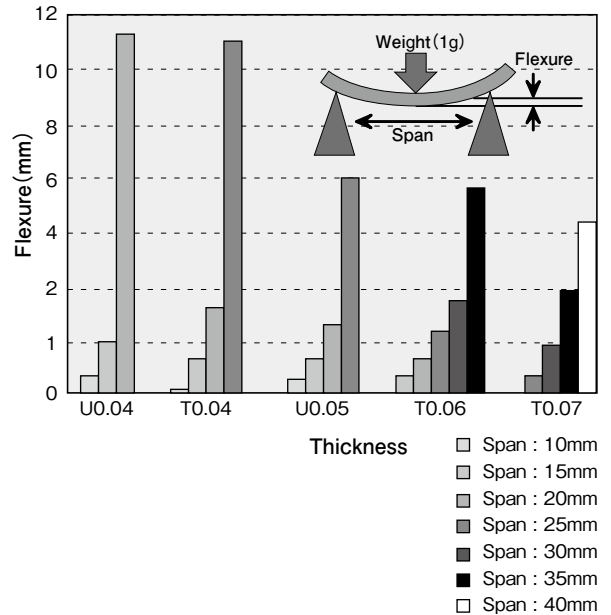
*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%.
This value changes depending on the press condition or inner layer pattern.

●Through-hole reliability

Test condition: -55°C, 30min. ⇄ 150°C, 30min.
Pattern: Wall to wall distance 0.3mm, Laminate thickness: t0.8mm
Pre-condition: 260°C reflow × 2times ⇒ Solder dipping (260°C 10sec.)

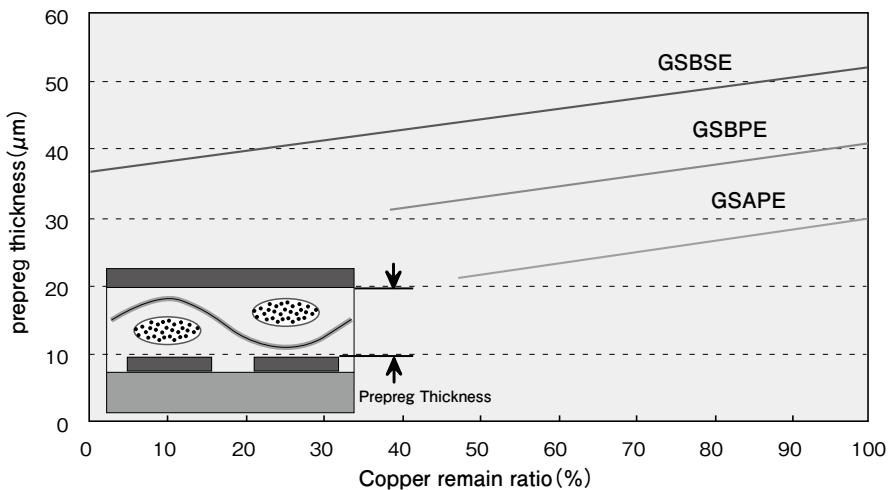


●Stiffness Properties



●Prepreg thickness after pattern filling

(Inner layer copper 15μm)



High Elastic Modulus and Low CTE Multilayer Material MCL-E-679F Type(R) GEA-679F Type(R) (Prepreg)

High Tg Glass Epoxy Multilayer Material(FR-4)

■ Features

- Coefficient of thermal expansion is 20% (in the X- and Y-directions) and 50% (in the Z-direction) lower than that of our standard FR-4.
- Elastic modulus is 30% higher than that of our standard FR-4. Even thin laminate has less warpage and deflection.
- Superior heat resistance at PCT.
- Surface roughness is 1/4 that of our standard FR-4, making fine pattern possible.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-679F	(R)	2,3,5,12,18,35 μ m (STD,LP,PF)	M0.06	0.07 \pm 0.02mm
		2 μ m	0.1	0.11 \pm 0.02mm
		5 μ m	0.15	0.16 \pm 0.03mm
		12 μ m	0.2	0.21 \pm 0.04mm
		18 μ m	0.3	0.32 \pm 0.04mm
		35 μ m	0.41	0.42 \pm 0.05mm
		70 μ m	0.61	0.63 \pm 0.06mm
		(STD,LP,PF)	0.81	0.84 \pm 0.09mm

Note1) STD:Standard copper foil, LP:Low profile copper foil, PF:Hitachi profile-free copper foil.

Note2) STD:12 μ m,18 μ m,35 μ m; LP:2 μ m,3 μ m,5 μ m,12 μ m,18 μ m; PF:2 μ m,3 μ m,5 μ m,12 μ m. Please contact us for details.

Note3) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note4) The thickness means that of dielectric layer.

■ Characteristics

● Thin Laminate

(t0.4mm)

Item	Condition	Unit	Actual Value	Test Method	
			MCL-E-679F Type(R)	(IPC-TM-650)	
Tg	TMA	°C	160~170	2.4.24	
	DMA		190~200	—	
CTE *1	X	(30~120°C)	12~14	2.4.24	
	Y		12~14		
	Z		(<Tg)		20~30
			(>Tg)		130~160
Solder Heat Resistance (260°C)	A	sec.	>300	—	
T-260 (Without Copper)	TMA	min.	>60	2.4.24.1	
T-288 (Without Copper)			>30		
Decomposition Temperature (5% Weight Loss)	TGA	°C	340~360	2.3.40	
Heat Resistance for HDI Process (Semi-Additive)	260°C Reflow	cycles	>10	—	
Copper Peel Strength	18 μ m	A	kN/m	1.1~1.2	2.4.8
	35 μ m			1.2~1.3	
Surface Roughness (Ra)	A	μ m	2~3	2.2.17	
Flexural Modulus (Lengthwise)	A	GPa	27~33	2.4.4	
Dielectric Constant	1MHz	C-96/20/65	—	4.8~5.0	2.5.5.1
	1GHz*2			4.5~4.7	2.5.5.5
Dissipation Factor	1MHz	C-96/20/65	—	0.0080~0.0100	2.5.5.1
	1GHz*2			0.0130~0.0150	2.5.5.5
Volume Resistivity	C-96/35/90	Ω·cm	1 \times 10 ¹⁵ ~1 \times 10 ¹⁶	2.5.17	
Surface Resistance			1 \times 10 ¹³ ~1 \times 10 ¹⁵		
Insulation Resistance	C-96/20/65	Ω	1 \times 10 ¹⁴ ~1 \times 10 ¹⁶	—	
	C-96/20/65+D-2/100		1 \times 10 ¹³ ~1 \times 10 ¹⁵	—	
Water Absorption	E-24/50+D-24/23	%	0.3~0.5	2.6.2.1	
Flammability (UL-94)	A	—	V-0	2.3.10	

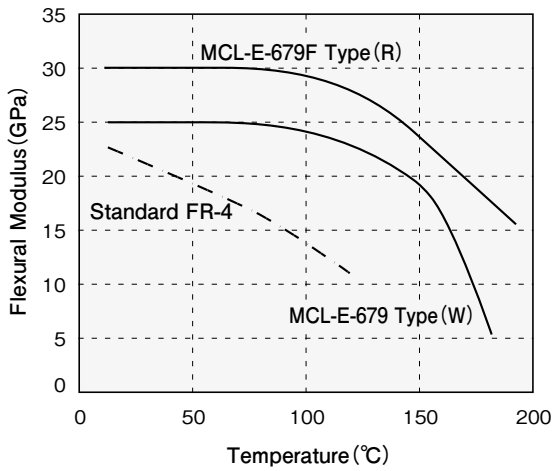
*1) Heating Rate:10°C/min. *2) Measured by Triplate-Line Resonator.
0.8mm thickness core is used depending on test item.

●Prepreg

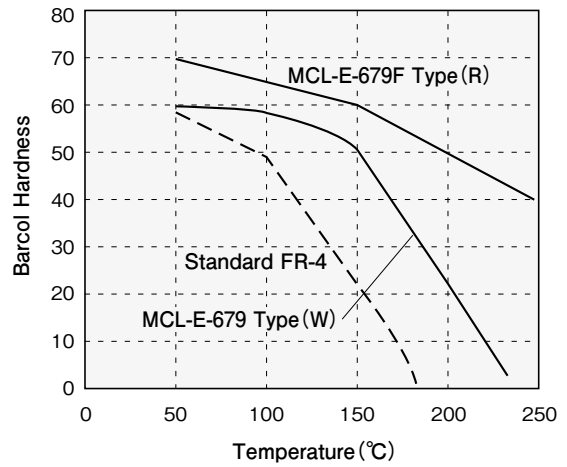
Part Number	Type		Glass Cloth		Properties				
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination *1 (mm)	
GEA-679F	(R)	0.04	(FRZPE)	1037	69×72	73±2	≤1.0	115±25	0.049
		0.06	(FRUOE)	1080	60×48	68±2		110±25	0.081
			(FRROE)	1078	53×53	68±2		0.081	
		0.1	(FRSKE)	2116	60×58	58±2	≤0.75	110±25	0.130
		0.15	(FREGE)	1504	60×50	51±2		0.154	
Test Method(IPC-TM-650)					2.3.16.1	2.3.19	2.3.18	—	

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

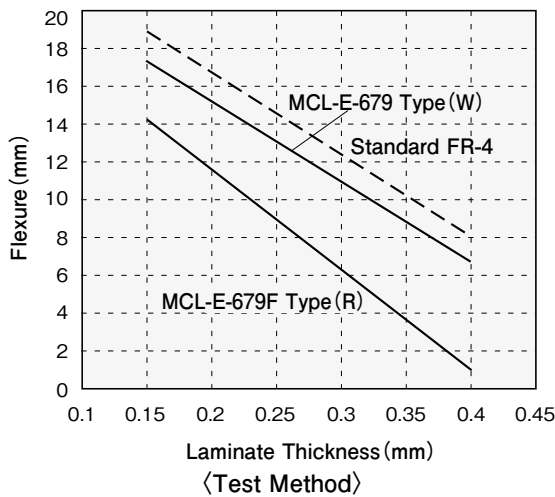
●Flexural Modulus



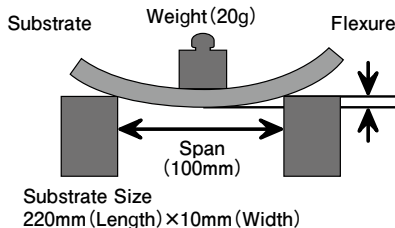
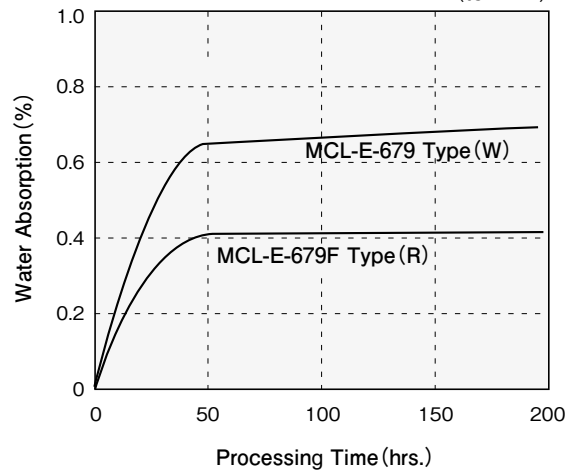
●Barcol Hardness



●Stiffness Properties



●Water Absorption under 85°C 85%RH (t0.4mm)



Halogen Free, Low Dielectric Constant, High Tg and High Heat Resistance Multilayer Material

MCL-E-78G GEA-78G <Prepreg>

Low Dielectric Constant Epoxy Multilayer Material (FR-4)

■ Features

- Halogen-free with low dielectric property.
(Dk 3.5 (@1GHz, Resin cont. = 70%))
- High Tg and elastic modulus is higher than standard FR-4 at high temperature.
- Superior heat resistance. (Suitable for the lead free process)

■ Applications

- Smartphone.
- Tablet PC.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-78G	—	12, 18, 35 μ m	0.04	0.04 \pm 0.02mm
			0.05	0.05 \pm 0.02mm
			0.06	0.06 \pm 0.02mm
		12 μ m 18 μ m 35 μ m 70 μ m	0.07	0.07 \pm 0.02mm
			0.08	0.08 \pm 0.02mm
			0.09	0.09 \pm 0.02mm
			0.1	0.10 \pm 0.02mm
			0.15	0.15 \pm 0.03mm

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

■ Characteristics

● Thin Laminate

(t0.8mm)

Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)
			MCL-E-78G	
Tg	TMA	°C	160~170	2.4.24
	DMA		200~220	—
CTE *1	X Y	(30~120°C)	13~15	2.4.24
			15~17	
	Z	(<Tg)	35~45	
		(>Tg)	180~230	
Solder Heat Resistance (260°C)	A	sec.	>300	—
T-260 (Without Copper)	TMA	min.	>60	2.4.24.1
T-288 (Without Copper)				
Decomposition Temperature (5% Weight Loss)	TGA	°C	380~400	2.3.40
Copper Peel Strength	18 μ m	A	1.0~1.2	2.4.8
	35 μ m		1.1~1.3	
Flexural Modulus (Lengthwise)	A	GPa	25~29	2.4.4
Dielectric Constant (R.C.:70%)	1GHz	C-96/20/65	3.4~3.6	2.5.5.1
	10GHz*2		3.3~3.5	2.5.5.5
Dissipation Factor (R.C.:70%)	1GHz	C-96/20/65	0.009~0.011	2.5.5.1
	10GHz*2		0.012~0.014	2.5.5.5
Volume Resistivity	C-96/20/65+C-96/40/90	$\Omega \cdot \text{cm}$	$1 \times 10^{14} \sim 1 \times 10^{16}$	2.5.17
Surface Resistance	C-96/20/65+C-96/40/90	Ω	$1 \times 10^{13} \sim 1 \times 10^{15}$	
Insulation Resistance	C-96/20/65	Ω	$1 \times 10^{14} \sim 1 \times 10^{16}$	—
	C-96/20/65+D-2/100		$1 \times 10^{13} \sim 1 \times 10^{15}$	—
Water Absorption	E-24/50+D-24/23	%	0.1~0.3	2.6.2.1
Flammability (UL-94)	A	—	V-0	2.3.10

*1) Heating Rate: 10°C/min.

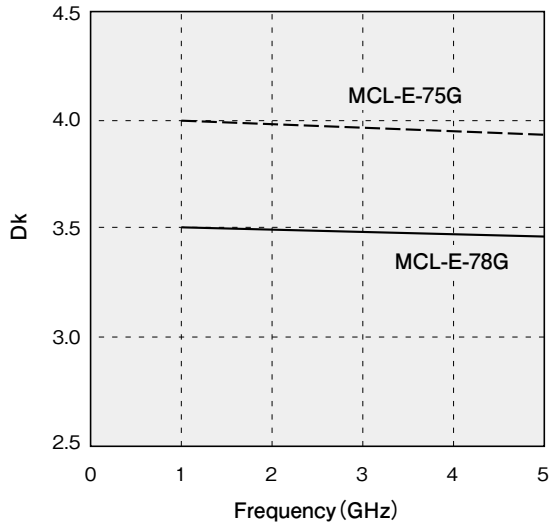
*2) Measured by Triplate-Line Resonator.

●Prepreg

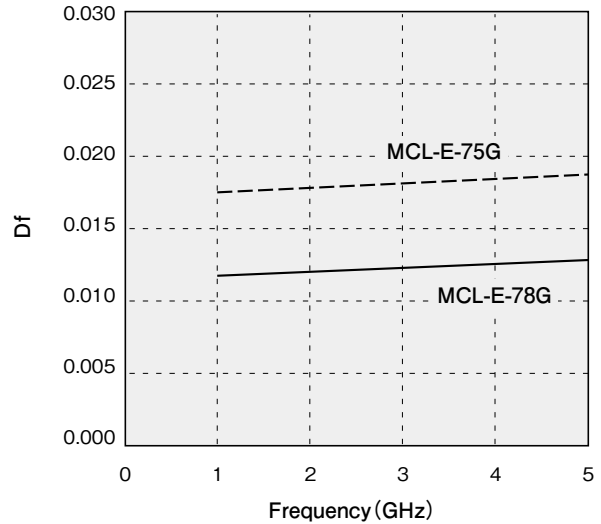
Part Number	Type		Glass Cloth		Properties			
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination*1 (mm)
GEA-78G	0.03	(1027N72)	1027	75×75	72±2	≤3.0	280±40	0.044
	0.04	(106N70)	106	56×56	70±2			0.049
	0.04	(106N72)	106	56×56	72±2			0.052
	0.04	(1037N70)	1037	69×72	70±2			0.049
	0.04	(1037N74)	1037	69×72	74±2			0.057
	0.05	(1067N69)	1067	70×70	69±2			0.060
	0.05	(1067N72)	1067	70×70	72±2			0.068
	0.06	(1080N62)	1080	60×48	62±2			0.073
	0.06	(1078N62)	1078	53×53	62±2		0.073	
Test Method (IPC-TM-650)					2.3.16.1	2.3.19	2.3.18	—

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

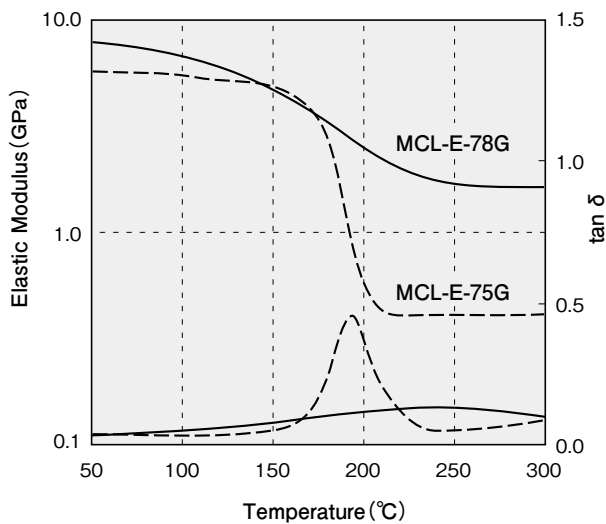
●Correlation between Dielectric Constant and Frequency



●Correlation between Dissipation Factor and Frequency



●Elastic Modulus



Note) Measured by Triplate-line Resonator.

Reduction of Solder Crack/Low Elastic Modulus Material TD-002 [Prepreg]

Low Elastic Modulus Thermosetting Resin Multilayer Material

■ Features

- Applied to PWBs surface of standard material, absorb soldering stress and inhibit solder crack.
- Elastic modulus is 1/4 of that of standard FR-4.
- Enables to reduce solder crack without using high functional material, by combining TD-002 with standard material.

■ Applications

- Electronic equipment for automobiles.
- Engine room set board.
- PCB on component packagings.

■ Standard Specifications [Prepreg]

Part Number	Type		Glass Cloth		Properties		
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Dielectric Thickness after Lamination*1 (mm)
TD-002 [Prepreg]	0.06	(1037N77)	1037	69×72	77±2	≤2.0	0.069
	0.08	(1078N66)	1078	53×53	66±2		0.088
	0.10	(3313N58)	3313	60×62	58±2		0.115
	0.20	(1501N54)	1501	46×45	54±2		0.208

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%.
This value changes depending on the press condition or inner layer pattern.

■ Characteristics

● Thin Laminate

(3313N58, t0.4mm)

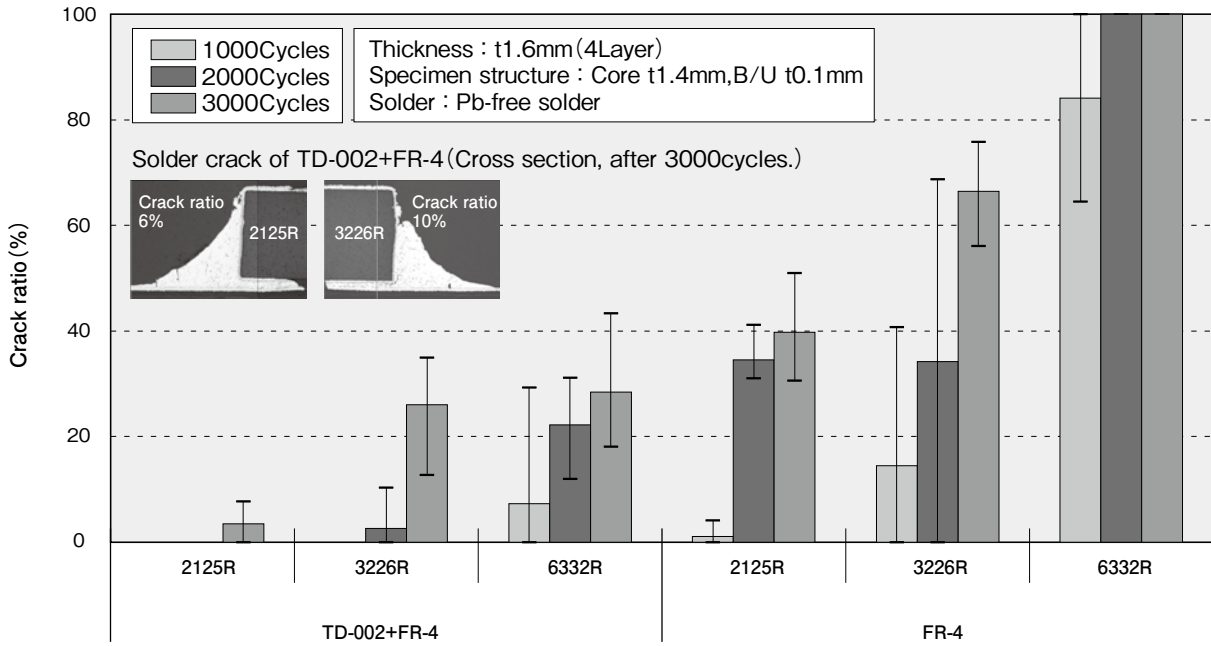
Item	Condition	Unit	Actual Value	Test Method (IPC TM-650)	
			TD-002		
Tg	TMA	°C	155-170	2.4.24	
CTE *1	X	(30~120°C)	6~9	2.4.24	
	Y		6~9		
	Z		(<Tg)		80~130
			(>Tg)		200~300
Solder Heat Resistance(260°C)	A	sec.	>300	—	
T260(Without Copper)	TMA	min.	>50	2.4.24.1	
T288(Without Copper)			>5	2.4.24.1	
Decomposition Temperature(5% Weight Loss)	TGA	°C	345~360	2.3.40	
Copper Peel Strength	18μm	A	0.8~0.9	2.4.8	
	35μm		0.9~1.1		
Flexural Modulus(Lengthwise)	A	GPa	5~8	2.4.4	
Elastic Modulus(Lengthwise) Tensile	A	GPa	7~10	—	
Dielectric Constant *2	1GHz	C-96/20/65	—	3.6~3.8	2.5.5.5
Dissipation Factor *2	1GHz	C-96/20/65	—	0.011~0.013	2.5.5.5
Volume Resistivity	C-96/20/65+C-96/40/90		Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	2.5.17
Surface Resistance	C-96/20/65+C-96/40/90		Ω	1×10 ¹⁴ ~1×10 ¹⁵	
Insulation Resistance	C-96/20/65+D-2/100		Ω	1×10 ¹⁴ ~1×10 ¹⁵	—
Water Absorption	E-24/50+D-24/23		%	0.1~0.3	2.6.2.1
Flammability(UL-94)	A		—	V-0	2.3.10

*1) Heating Rate : 10°C/min.

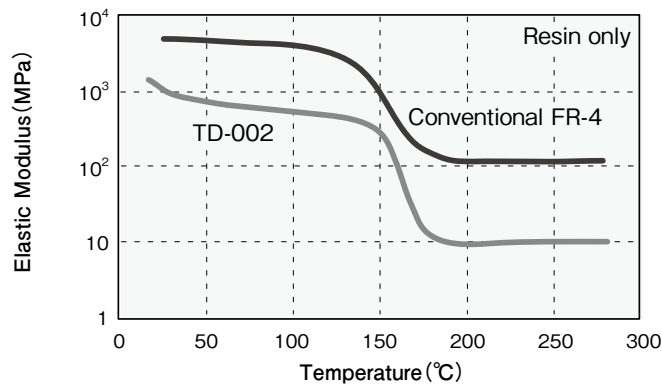
*2) Measured by cavity resonator.

0.1mm thickness core is used depending on test item.

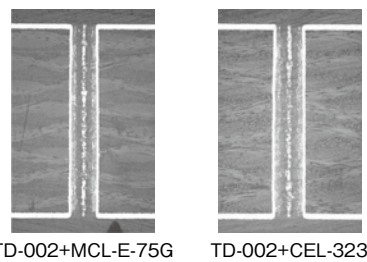
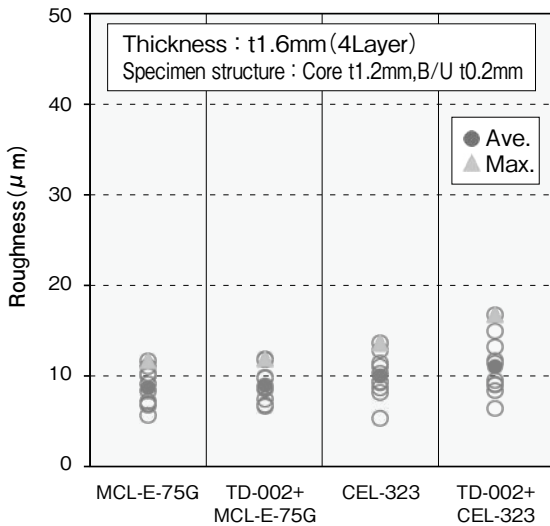
●Connection reliability of Pb-free solder (Thermal condition:-40°C(30min.)⇔125°C(30min.))



●Elastic modulus



●Mechanical drilling processing (After 3000hits)



《Condition of mechanical drilling》
 •Stack-up : 3 panels •E/B : Al t0.15mm
 •Revolution : 120krpm •Feeding Speed : 2.4m/min.
 •Drill bit : φ0.3mm

Halogen Free, High Tg and High Heat Resistance Multilayer Material

MCL-E-75G GEA-75G <Prepreg>

High Tg Glass Epoxy Multilayer Material(FR-4)

■ Features

- Environmentally friendly material. It has achieved the UL 94V-0 level of flammability without using any compound which includes halogen, antimony or red phosphorus.
- Superior heat resistance to that of our standard FR-4, and suitable for the lead free process.
- The coefficient of thermal expansion in Z-direction is 40% lower than that of our standard FR-4. Excellent through-hole reliability.

■ Applications

- Electronics for automobiles.
- Personal computer, high density electronic equipment.
- Electronic branch exchanges, mobile phones, etc.
- Main frame computers.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-75G	—	12μm 18μm 35μm 70μm	0.06	0.06±0.03mm
			0.1	0.10±0.03mm
			0.15	0.15±0.04mm
			V0.2	0.20±0.04mm
			0.3	0.30±0.05mm
			V0.4	0.40±0.06mm
			0.5	0.50±0.07mm
			V0.6	0.60±0.08mm
			0.8	0.80(0.70)±0.09mm
			1.0	1.00(0.90)±0.10mm
			1.2	1.20(1.10)±0.11mm
1.6	1.60(1.50)±0.19mm			

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note 2) The thickness is means that of dielectric layer. Figure in bracket () means thickness of dielectric layer of MCL using 70μm copper foil.

■ Characteristics

● Thin Laminate

(t0.8mm)

Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)
			MCL-E-75G	
Tg	TMA	°C	155~170	2.4.24
	DMA		195~215	
CTE *1	X (30~120°C)	ppm/°C	12~15	2.4.24
	Y (30~120°C)		14~17	
	Z (<Tg)		30~40	
	Z (>Tg)		180~240	
Solder Heat Resistance (260°C)	A	sec.	>300	—
T260	TMA	min.	>60	2.4.24.1
T288	TMA		>60	2.4.24.1
Decomposition Temperature (5% Weight Loss)	TGA	°C	380~390	2.3.40
Copper Peel Strength	18μm	kN/m	1.2~1.4	2.4.8
	35μm		1.5~1.8	
Flexural Modulus (Lengthwise)	A	GPa	25~29	2.4.4
Dielectric Constant	1MHz	C-96/20/65	5.0~5.2	2.5.5.1
	1GHz*2		4.4~4.6	2.5.5.5
Dissipation Factor	1MHz	C-96/20/65	0.009~0.011	2.5.5.1
	1GHz*2		0.014~0.016	2.5.5.5
Volume Resistivity	C-96/20/65+C-96/40/90	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	2.5.17
Surface Resistance	C-96/20/65+C-96/40/90	Ω	1×10 ¹³ ~1×10 ¹⁵	
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶	—
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵	—
Water Absorption	E-24/50+D-24/23	%	0.08~0.12	2.6.2.1
Flammability (UL-94)	A	—	V-0	2.3.10

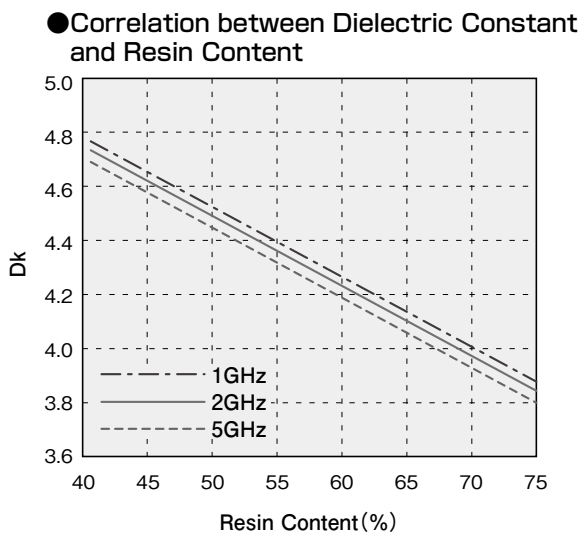
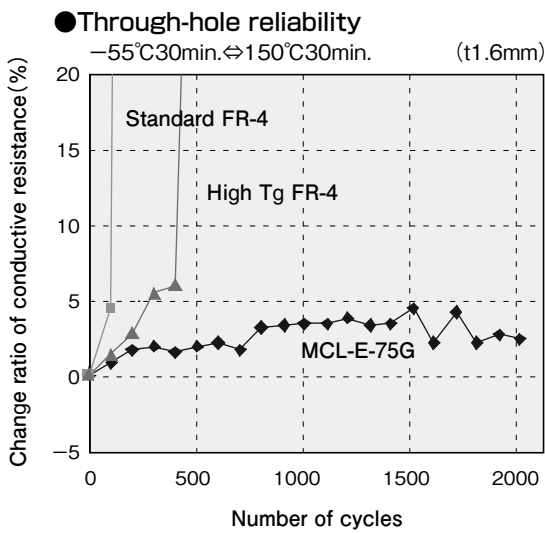
*1) Heating Rate: 10°C/min.

*2) Measured by Triplate-Line Resonator.

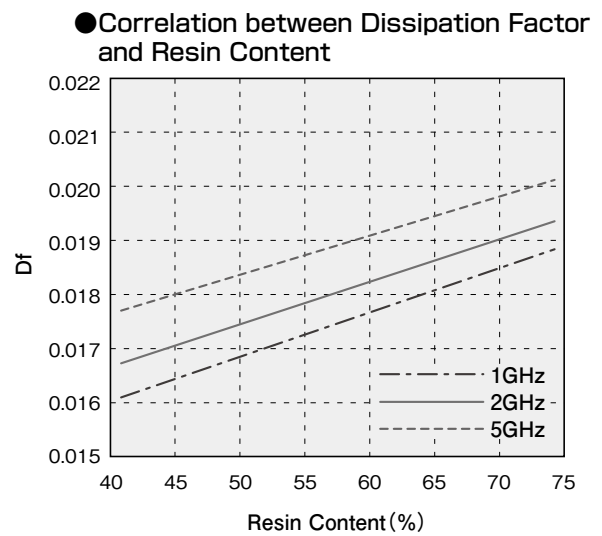
●Prepreg

Part Number	Type		Glass Cloth		Properties			
			Style	Yarn Count (Warp×Fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination*1 (mm)
GEA-75G	0.06	(1080N65)	1080	60×48	65±2	≦1.0	145±30	0.077
	0.06	(1078N65)	1078	53×53	65±2		145±30	0.077
	0.10	(2116N56)	2116	60×58	56±2		145±30	0.128
	0.15	(1501N52)	1501	46×45	52±2		135±30	0.182
	0.20	(7628N51)	7628	44×31	51±2		135±30	0.219
Test Method(IPC-TM-650)					2.3.16	2.3.19	2.3.18	—

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner-layer pattern.



Note) IPC TM-650 2.5.5.5



FR-4 Multilayer Material

MCL-E-67 GEA-67N<Prepreg> [UV Block Type MCL-E-67 Type(W)]

Glass Epoxy Multilayer Material(FR-4)

■ Features

- Superior electrical and mechanical characteristics.
- Laminating time can be reduced depending on prepreg types and conditions.

■ Applications

- Personal computers and high-density electronic equipment.
- Small and midsize computers and their peripheral devices.
- Electronic branch exchanges, portable terminal devices, etc.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-67	—	12μm 18μm 35μm 70μm	0.06	0.06±0.03mm
			0.1	0.10±0.03mm
			0.15	0.15±0.04mm
			V0.2	0.20±0.05mm
			0.3	0.30±0.05mm
	(W)		V0.4	0.40±0.08mm
			0.5	0.50±0.08mm
			V0.6	0.60±0.09mm
			0.8	0.80(0.70)±0.10mm
			1.0	1.00(0.90)±0.12mm
			1.2	1.20(1.10)±0.12mm

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.
 Note 2) The thickness means that of dielectric layer. Figure in bracket () means thickness of dielectric layer of MCL using 70μm copper foil.

■ Characteristics

● Thin Laminate

(t0.8mm)

Item	Condition	Unit	Actual Value	Test Method(IPC-TM-650)	
			MCL-E-67		
Tg	TMA	°C	120~130	2.4.24	
	DMA		150~160	—	
CTE *1	X	(30~120°C)	13~16	2.4.24	
	Y		14~17		
	Z		(<Tg)		50~70
			(>Tg)		200~300
Solder Heat Resistance(260°C)		A	sec.	>120	—
T-260(Without Copper)		TMA	min.	>10	2.4.24.1
T-288(Without Copper)			—		
Decomposition Temperature(5% Weight Loss)		TGA	°C	300~320	2.3.40
Copper Peel Strength	18μm	A	kN/m	1.4~1.6	2.4.8
	35μm			1.7~2.1	
Flexural Modulus(Lengthwise)		A	GPa	23~25	2.4.4
Dielectric Constant	1MHz	C-96/20/65	—	4.7~4.8	2.5.5.1
	1GHz*2			4.1~4.2	2.5.5.5
Dissipation Factor	1MHz	C-96/20/65	—	0.0130~0.0170	2.5.5.1
	1GHz*2			0.0180~0.0200	2.5.5.5
Volume Resistivity	C-96/35/90	—	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	2.5.17.1
Surface Resistance			Ω	1×10 ¹³ ~1×10 ¹⁵	
Insulation Resistance	C-96/20/65	—	Ω	1×10 ¹⁴ ~1×10 ¹⁶	—
	C-96/20/65+D-2/100			1×10 ¹³ ~1×10 ¹⁵	—
Water Absorption		E-24/50+D-24/23	%	0.12~0.14	2.6.2.1
Flammability(UL-94)		A	—	V-0	2.3.10

*1) Heating Rate:10°C/min.

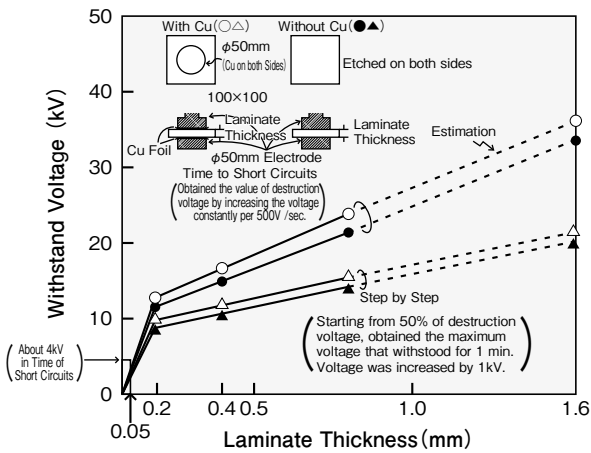
*2) Measured by Triplate-Line Resonator.

●Prepreg

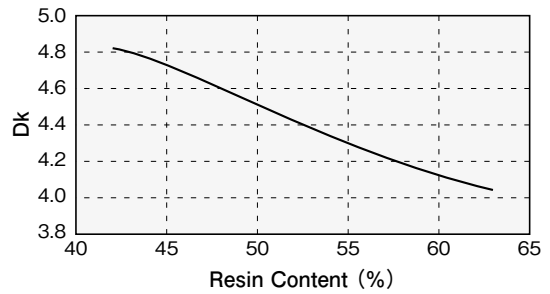
Part Number	Type	Glass Cloth		Properties							
		Natural Color	UV Block	Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile content (%)	Gelation Time (sec.)	Resin Flow (%)	Dielectric Thickness after Lamination*1 (mm)	
GEA-67N	0.06	(KLN)	(WKLN)	1080	60×48	62±2	≤0.5	125±25	42±5	0.076	
		(LPN)	—			68±2			48±5	0.093	
	0.1	(VAGN)	(WAGN)	2116	60×58	52±2			31±5	0.126	
		(VAJN)	—			55±2			37±5	0.136	
	0.15	(VEFP)	—	1504	60×50	48±2			105±25	27±5	0.158
		(VEGJ)	(WEGJ)			51±2			120±25	32±5	0.171
	0.2	(VHDN)	(WHDN)	7629	44×34	45±2		105±25	27±5	0.208	
		(VHGQ)	—			52±2		35±8	0.249		
	Test Method (IPC-TM-650)					2.3.16		2.3.19	2.3.18	2.3.17	—

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

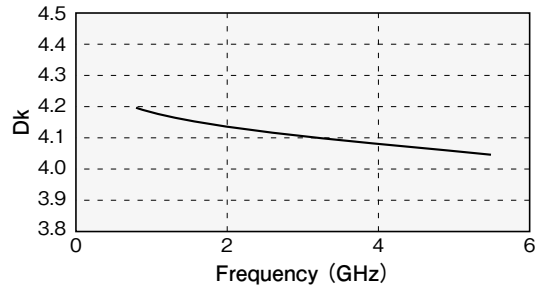
●Result of Withstand Voltage Test



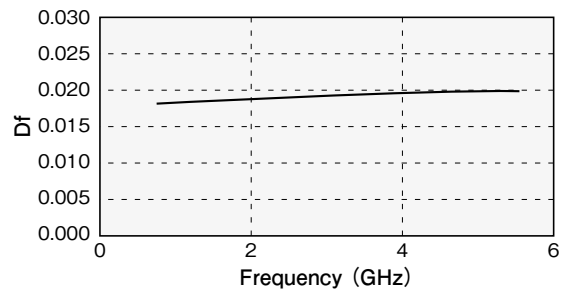
●Dielectric Constant vs Resin Content of Laminate (1MHz)



●Correlation between Dielectric Constant and Frequency



●Correlation between Dissipation Factor and Frequency



Note) Measured by Triplate-line Resonator.

MEMO

A series of horizontal dashed lines for writing.

Materials For ICT Infrastructure

High Tg Multilayer Material
MCL-E-679 Type(W)

P32

Halogen Free, High Tg,
Low Transmission Loss Multilayer Material
MCL-LW-900G/910G

P34

Halogen Free, Low Dielectric Constant
and High Heat Resistance Multilayer Material
MCL-HE-679G Type(S)

P36

High Tg Multilayer Material MCL-E-679 Type (W) GEA-679N<Prepreg>

High Tg Glass Epoxy Multilayer Material (FR-4)

■ Features

- High Tg (>205°C: DMA) and excellent through-hole reliability.
- The thermal decomposition temperature is high and reliability at high temperature is superior. (Thermal decomposition temperature: >340°C)
- Water absorption is low and insulation degradation is small.

■ Applications

- Semiconductor packages .(BGA, CSP and MCM)
- Main frame computers.
- Telephone switchboards.
- Mobile phones.
- Semiconductor testing devices and burn-in boards.
- Electronics for automobiles.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-679	(W)	12,18,35 μ m	0.06	0.07 \pm 0.02mm
			0.1	0.10 \pm 0.03mm
			0.15	0.15 \pm 0.03mm
		12 μ m	0.2	0.20 \pm 0.04mm
		18 μ m	0.3	0.30 \pm 0.05mm
		35 μ m	0.4	0.40 \pm 0.07mm
		70 μ m	0.6	0.60 \pm 0.07mm
		(STD,LP)	0.8	0.80(0.70) \pm 0.09mm
			1.0	1.00(0.90) \pm 0.10mm
			1.2	1.20(1.10) \pm 0.12mm

Note1) STD:12 μ m,18 μ m, 35 μ m, 70 μ m; LP:2 μ m, 3 μ m, 5 μ m, 12 μ m, 18 μ m. Please contact us for details.

Note2) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note3) The thickness means that of dielectric layer.

■ Characteristics

● Thin Laminate

(t0.8mm)

Item	Condition	Unit	Actual Value	Test Method(IPC-TM-650)	
			MCL-E-679 Type (W)		
Tg	TMA	°C	173~183	2.4.24	
	DMA		205~215	—	
CTE *1	X	ppm/°C	12~15	2.4.24	
	Y		14~17		
	Z		50~60		
	(<Tg)		200~300		
	(>Tg)				
Solder Heat Resistance(260°C)	A	sec.	>300	—	
T-260(Without Copper)	TMA	min.	>60	2.4.24.1	
T-288(Without Copper)			>30		
Decomposition Temperature(5% Weight Loss)	TGA	°C	340~360	2.3.40	
Copper Peel Strength	18 μ m	A	kN/m	1.2~1.4	2.4.8
	35 μ m			1.5~1.7	
Surface Roughness(Ra)	A	μ m	5~13	2.2.17	
Flexural Modulus (Lengthwise)	A	GPa	24~26	2.4.4	
Dielectric Constant	1MHz	C-96/20/65	—	4.7~4.8	2.5.5.1
	1GHz*2			4.2~4.3	2.5.5.5
Dissipation Factor	1MHz	C-96/20/65	—	0.0130~0.0150	2.5.5.1
	1GHz*2			0.0210~0.0220	2.5.5.5
Volume Resistivity	C-96/35/90	—	Ω ·cm	1 \times 10 ¹⁵ ~1 \times 10 ¹⁶	2.5.17
Surface Resistance				1 \times 10 ¹³ ~1 \times 10 ¹⁵	
Insulation Resistance	C-96/20/65	—	Ω	1 \times 10 ¹⁴ ~1 \times 10 ¹⁶	—
	C-96/20/65+D-2/100			1 \times 10 ¹³ ~1 \times 10 ¹⁵	—
Water Absorption	E-24/50+D-24/23	%	0.15~0.20	2.6.2.1	
Flammability(UL-94)	A	—	V-0	2.3.10	

*1) Heating Rate:10°C/min.

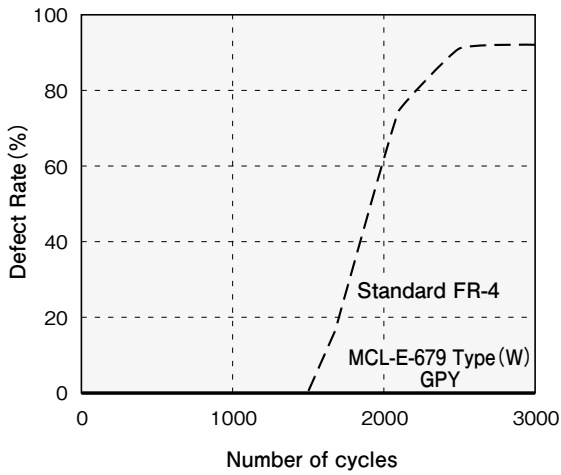
*2) Measured by Triplate-Line Resonator.

●Prepreg

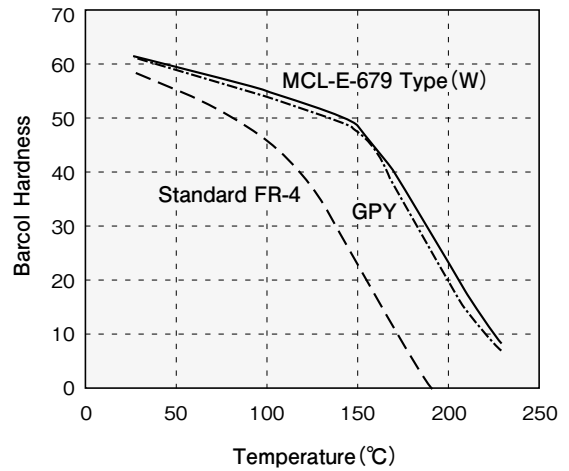
Part Number	Type		Glass Cloth		Properties				
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Resin Flow (%)	Dielectric Thickness after Lamination*1 (mm)
GEA-679N	0.03	(WOPE)	106	56×56	68±2	≤1.0	120±25	-	0.050
		(WULE)	1080	60×48	62±2				0.078
	(WUME)	65±2			0.086				
	0.1	(WSGE)	2116	60×58	52±2	≤0.75		35±5	0.126
		(WCJE)	2117	66×55	56±2			-	0.146
	0.15	(WQEE)	1501	46×45	48±2			33±5	0.174
-							-		
Test Method(IPC-TM-650)					2.3.16	2.3.19	2.3.18	2.3.17	-

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

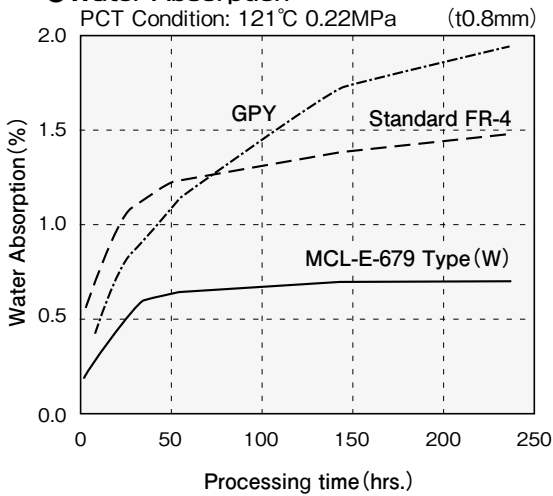
●Thermal Shock Test(MIL-STD-202 Method107E)



●Barcol Hardness



●Water Absorption



Halogen Free, High Tg, Low Transmission Loss Multilayer Material MCL-LW-900G/910G GWA-900G/910G<Prepreg>

Low Dielectric constant Glass Thermosetting Resin Multilayer Material

■ Features

- MCL-LW-910G achieved low dielectric constant (3.3 at 10GHz) and low dissipation factor (0.0028 at 10GHz) using low Dk glass and HVLP copper.
- MCL-LW-910G enables the high-speed transmission/communication of 25Gbps by the low transmission loss.
- MCL-LW-910G has excellent heat resistance, connection reliability.

■ Applications

- High-speed computer, server
- High-speed Router
- High Frequency Devices, Antenna

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-LW-900G (E glass cloth) MCL-LW-910G (Low Dk glass cloth)	—	18μm 35μm 70μm (RT)	M0.05	0.05±0.02mm
			M0.06	0.06±0.02mm
			M0.08	0.08±0.02mm
			0.1	0.10±0.02mm
			M0.11	0.10±0.02mm
		12μm 18μm 35μm (HVLP)	0.13	0.13±0.03mm
			M0.15	0.15±0.03mm
			0.2	0.20±0.03mm
			0.26	0.25±0.04mm

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.
Note 2) Please inquire about the line-up except the above.

■ Characteristics

● Thin Laminate

(t0.8mm)

Item	Condition	Unit	Actual Value		Test Method (IPC-TM-650)	
			MCL-LW-900G	MCL-LW-910G		
Tg	TMA	°C	190~210		2.4.24	
	DMA		240~280		—	
CTE *1	X Y	ppm/°C	12~15		2.4.24	
			Z	12~15		
	(<Tg)			35~45		
			(>Tg)	240~290		
Solder Heat Resistance(260°C)	A	sec.	>300		2.4.24.1	
T-260(Without Copper)	TMA	min.	>60			
T-288(Without Copper)			>60			
Decomposition Temperature(5% Weight Loss)	TGA	°C	370~390		2.3.40	
Copper Peel Strength	18μm RT	A	kN/m	0.6~0.8		2.4.8
	18μm HVLP			0.5~0.7		
Flexural Modulus (Lengthwise)	A	GPa	16~21		2.4.4	
Dielectric Constant	C-96/20/65	—	3.50~3.70	3.20~3.40	2.5.5.1	
			3.40~3.60	3.20~3.40		
Dissipation Factor	C-96/20/65	—	0.0025~0.0035	0.0020~0.0030		
			0.0040~0.0050	0.0025~0.0035		
Volume Resistivity	C-96/20/65+C-96/40/90	Ω·cm	1×10 ¹⁴ ~1×10 ¹⁶		2.5.17	
Surface Resistance	C-96/20/65+C-96/40/90	Ω	1×10 ¹³ ~1×10 ¹⁵			
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶		—	
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵		—	
Water Absorption	E-24/50+D-24/23	%	0.2~0.4		2.6.2.1	
Flammability (UL-94)	A	—	V-0		2.3.10	

*1) Heating Rate: 10°C/min.

*2) Measured by Triplate-line Resonator.

●Prepreg

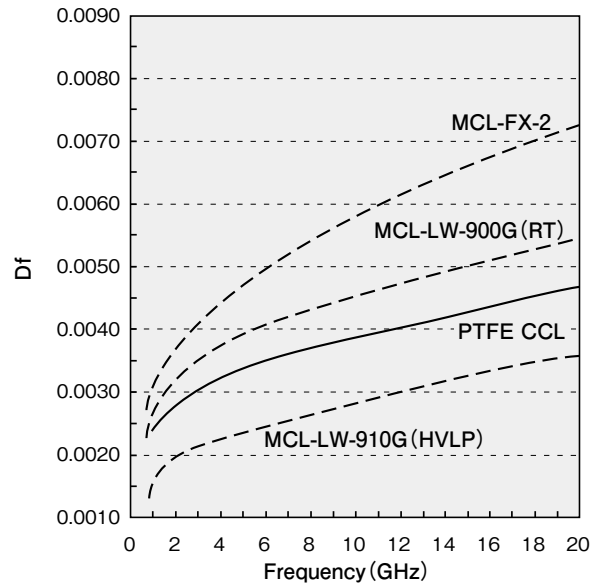
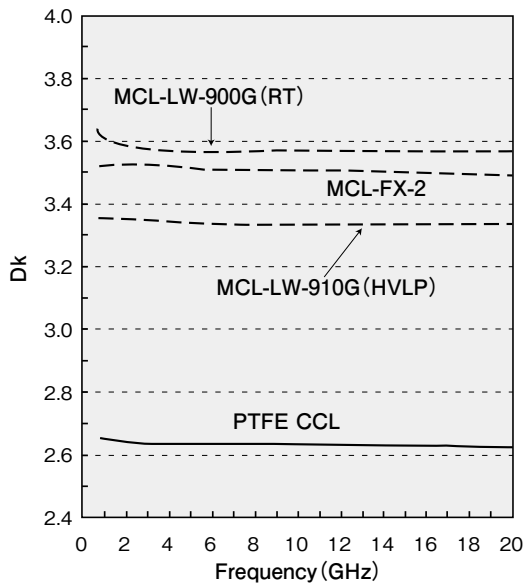
Part Number	Type		Glass Cloth		Properties		
			Style	Yarn Count (warp×fill)	Resin Content (%)	Volatile Content (%)	Dielectric Thickness after Lamination *1 (mm)
GWA-900G	0.05	(1037N72)	1037	69×72	72±2	≤2.0	0.050
	0.06	(1078N65)	1078	53×53	65±2		0.078
	0.08	(3313N57)	3313	60×62	57±2		0.106
	0.1	(2116N55)	2116	60×58	55±2		0.125
GWA-910G	0.05	(1037N74)	1037	69×72	74±2		0.050
	0.06	(1078N67)	1078	53×53	67±2		0.078
	0.08	(2013N59)	2013	69×76	59±2		0.106
	0.1	(2116N57)	2116	60×58	57±2		0.125
Test Method (IPC-TM-650)					2.3.16	2.3.19	—

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%.

This value changes depending on the press condition or inner layer pattern.

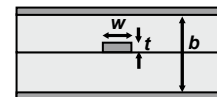
Note) Please inquire about the line-up other than the above.

●Dielectric characterization results

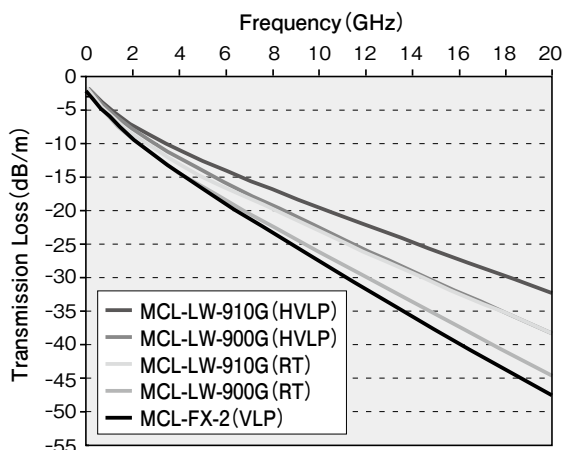


《Measurement Conditions》

- Method : Triplate-Line Resonator (JPCA-TM001)
- Temperature & Humidity : 25°C/60%RH
- Laminate Thickness (b) : 1.6mm (Signal-Ground : 800μm), Copper foil (t) : 18μm (RT, HVLP)
- Signal Conductor Line Width (w) : 1mm (Zo:ca.50Ω)
- Copper Foil (t) : 18mm (RT, HVLP)

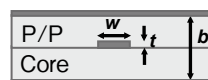


●Transmission Loss



《Measurement conditions》

- Evaluation PWB : Strip-line
- Temperature & Humidity : 25°C/60%RH
- Characteristic impedance : Approx. 50Ω
- Inner layer surface treatment : Black-reduction
- Proofreading method : TRL (Thru-Reflect-Line)



- Trace width (w) : 0.120mm
- Dielectric thickness (b) : 0.25mm
- Trace thickness (t) : 18μm

Halogen Free, Low Dielectric Constant and High Heat Resistance Multilayer Material

MCL-HE-679G Type(S) GHA-679G Type(S) (Prepreg)

Low Dielectric Constant Thermosetting Resin Multilayer Material (FR-4)

■ Features

- Enables lower transmission loss than MCL-HE-679G with lower dissipation factor.
- High Tg and superior heat resistance for soldering. (Suitable for the lead free process)
- The coefficient of thermal expansion in Z-direction is 30% lower than that of our standard FR-4.
- Environmentally friendly material. It achieved the UL 94V-0 level of flammability without using any compound which includes halogen, antimony or red phosphorous.

■ Applications

- Network applications.
- High-frequency parts. (filters, VCOs, etc.)

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-HE-679G	(S)	12μm 18μm 35μm 70μm	0.06	0.06±0.02mm
			0.08	0.08±0.02mm
			0.1	0.10±0.02mm
			0.15	0.15±0.03mm
			0.2	0.20±0.03mm
			0.4	0.40±0.04mm
			0.6	0.60±0.06mm
			0.8	0.80±0.08mm
			1.0	1.00±0.08mm
			1.2	1.20±0.10mm

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.
 Note 2) The thickness means that of dielectric layer.

■ Characteristics

● Thin Laminate

(t0.8mm)

Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)	
			MCL-HE-679G Type(S)		
Tg	TMA	°C	180~190	2.4.24	
	DMA		260~280	—	
CTE *1	X	(30~120°C)	12~15	2.4.24	
	Y		14~17		
	Z		(<Tg)		30~40
			(>Tg)		190~230
Solder Heat Resistance (260°C)		A	sec.	>300	—
T-260 (Without Copper)		TMA	min.	>60	2.4.24.1
T-288 (Without Copper)				>60	
Decomposition Temperature (5% Weight Loss)		TGA	°C	370~390	2.3.40
Copper Peel Strength (RT)	18μm	A	kN/m	0.5~0.7	2.4.8
	35μm			0.6~0.8	
Flexural Modulus (Lengthwise)		A	GPa	23~26	2.4.4
Dielectric Constant	1MHz	C-96/20/65	—	4.10~4.30	2.5.5.1
	1GHz*2			3.70~3.90	2.5.5.5
	1GHz*3			3.90~4.10	2.5.5.9
Dissipation Factor	1MHz	C-96/20/65	—	0.0040~0.0060	2.5.5.1
	1GHz*2			0.0060~0.0080	2.5.5.5
	1GHz*3			0.0050~0.0070	2.5.5.9
Volume Resistivity	C-96/35/90	—	Ω·cm	1×10 ¹⁴ ~1×10 ¹⁶	2.5.17
Surface Resistance			Ω	1×10 ¹³ ~1×10 ¹⁵	
Insulation Resistance	C-96/20/65	—	Ω	1×10 ¹⁴ ~1×10 ¹⁶	—
	C-96/20/65+D-2/100			1×10 ¹³ ~1×10 ¹⁴	—
Water Absorption	E-24/50+D-24/23	—	%	0.1~0.3	2.6.2.1
Flammability (UL-94)	A	—	—	V-0	2.3.10

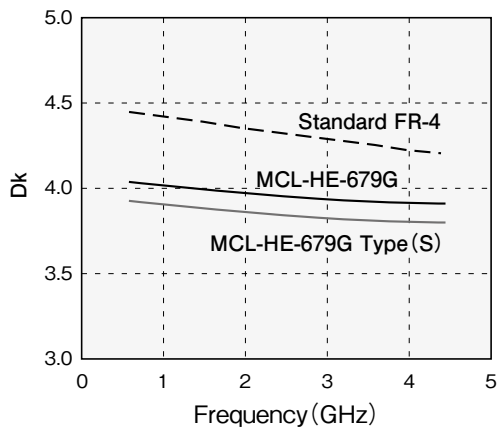
*1) Heating Rate: 10°C/min. *2) Measured by Triplate-line Resonator. *3) Measured by Material Analyzer.

●Prepreg

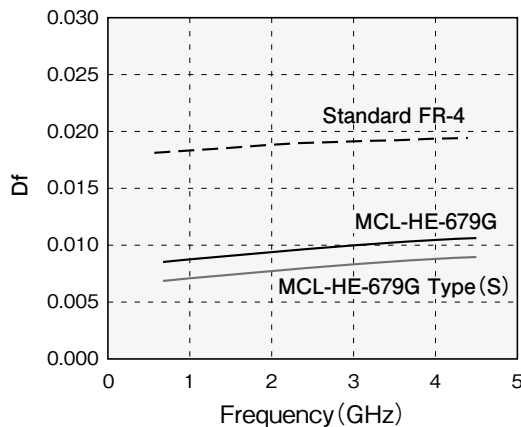
Part Number	Type		Glass Cloth		Properties			
			Style	Yarn Count (Warp×Fill)	Resin Content (%)	Volatile Content (%)	Gelation Time (sec.)	Dielectric Thickness after Lamination*1 (mm)
GHA-679G	0.04	(S1037N72)	1037	69×72	72±2	≤3.0	150±40	0.053
	0.06	(S1080N64)	1080	60×48	64±2			0.080
	0.06	(S1080N69)	1080	60×48	69±2			0.095
	0.06	(S1078N64)	1078	53×53	64±2			0.078
	0.08	(S3313N56)	3313	60×62	56±2			0.105
	0.08	(S3313N62)	3313	60×62	62±2			0.126
	0.1	(S2116N54)	2116	60×58	54±2			0.128
	0.1	(S2116N60)	2116	60×58	60±2			0.152
	0.15	(S1501N49)	1501	46×45	49±2		0.178	
Test Method(IPC-TM-650)					2.3.16	2.3.19	2.3.18	—

*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%.
This value changes depending on the press condition or inner layer pattern.

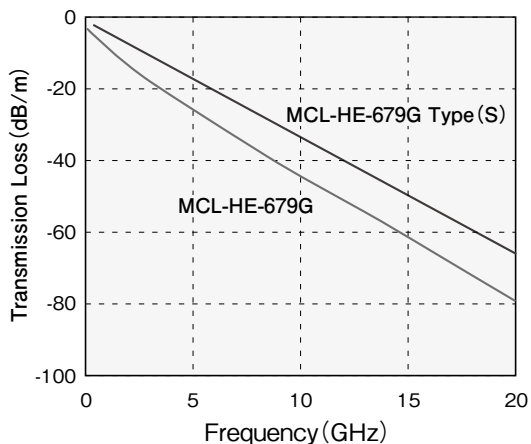
●Correlation between Dielectric Constant and Frequency



●Correlation between Dissipation Factor and Frequency



●Transmission Loss



MEMO

A series of horizontal dashed lines for writing.

Polyimide Multilayer Material

Polyimide Multilayer Material

MCL-I-671

P40

Polyimide Multilayer Material

MCL-I-671 GIA-671N<Prepreg>

Glass Modified Polyimide Multilayer Material(GPY)

■ Features

- High Tg (>230°C : DMA) material for high through-hole reliability.
- Same lamination condition as FR-4 is applicable. (175°C, 90 min.)
- MDA, a general polyimide resin curing agent, is not used. (Non-MDA Resin System)
- Resin flow control technology enables from high to low flow.

■ Applications

- Main frame computers and super computers.
- Semiconductor testing equipment, and burn-in boards.
- Flex-rigid PWBs. (no-flow prepreg)

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-I-671	—	12μm 18μm 35μm 70μm	0.06	0.06±0.02mm
			0.1	0.10±0.02mm
			0.2	0.20±0.04mm
			0.3	0.30±0.04mm
			0.41	0.41±0.05mm
			0.79	0.79±0.10mm

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.
 Note 2) The thickness means that of dielectric layer.

■ Characteristics

(t0.8mm)

Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)
			MCL-I-671	
Tg	TMA	°C	200~213	2.4.24
	DMA		230~245	—
CTE *1	X Y	(30~120°C)	ppm/°C	2.4.24
	Z	(<Tg)	12~16	
		(>Tg)	50~80	
Solder Heat Resistance (260°C)	A	sec.	>300	—
T-260 (Without Copper)	TMA	min.	>60	2.4.24.1
T-288 (Without Copper)			>15	
Decomposition Temperature (5% Weight Loss)	TGA	°C	330~350	2.3.40
Copper Peel Strength (18μm)	20°C	A	kN/m	2.4.8
	180°C			
Flexural Modulus (Lengthwise)	A	GPa	1.0~1.2	2.4.4
Dielectric Constant	1MHz	C-96/20/65	—	24~26
	1GHz*2			4.2~4.4
Dissipation Factor	1MHz	C-96/20/65	—	2.5.5.1
	1GHz*2			4.1~4.3
Volume Resistivity	C-96/35/90	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	2.5.5.1
Surface Resistance				Ω
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶	2.5.5.5
	C-96/20/65+D-2/100			1×10 ¹³ ~1×10 ¹⁵
Water Absorption	E-24/50+D-24/23	%	0.0110~0.0130	2.5.5.5
Flammability (UL-94)	A	—	0.0130~0.0150	2.5.17

*1) Heating Rate: 10°C/min.

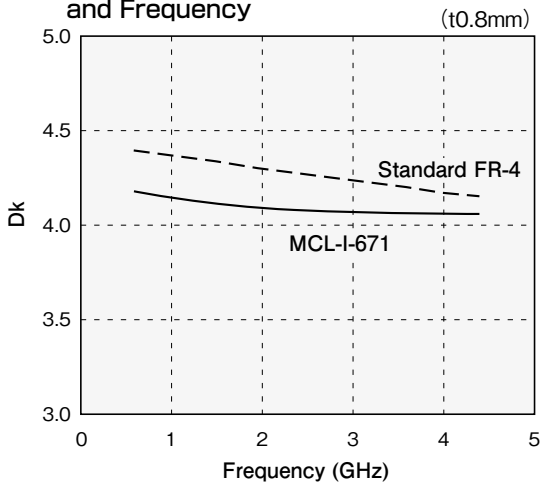
*2) Measured by Triplate-line Resonator.

●Prepreg

Part Number	Type		Glass Cloth		Properties			Application	
			Style	Yarn Count (Warp×Fill)	Resin Content (%)	Volatile Content (%)	Resin Flow (%)		Dielectric Thickness after Lamination*1 (mm)
GIA-671N	(T)	0.03	106	56×56	72±3	≤2.0	50±5	0.059	MLB
		0.05	1080	60×48	65±3		43±5	0.087	
		0.1	2116	60×58	54±3		29±5	0.134	
	(N)	0.03	106	56×56	68±3		4±3	0.047	Flex-rigid PWBs
		0.05	1080	60×48	59±3		54±5	0.072	
	(F)	0.05	1080	60×48	74±3			0.111	Metal core PWBs
Test Method(IPC-TM-650)					2.3.16	2.3.19	2.3.17	—	—

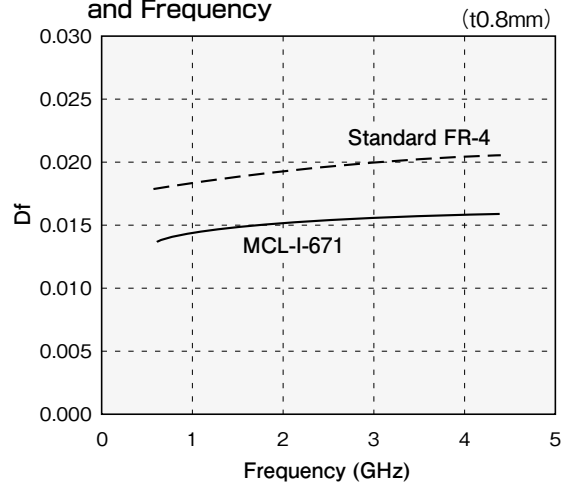
*1) The dielectric thickness after lamination is defined as the thickness of one sheet of prepreg when the resin flow is 0%. This value changes depending on the press condition or inner layer pattern.

●Correlation between Dielectric Constant and Frequency

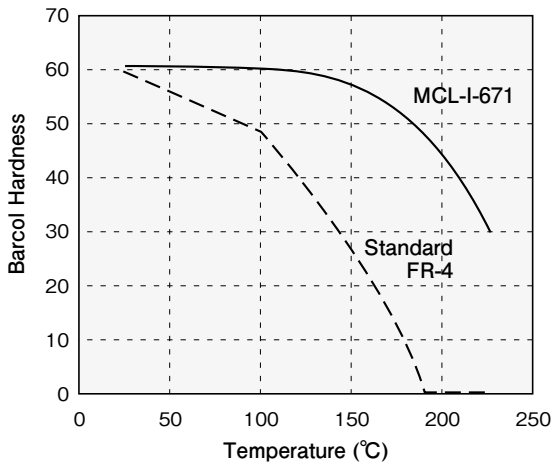


Note) Measured by Triplate-line Resonator.

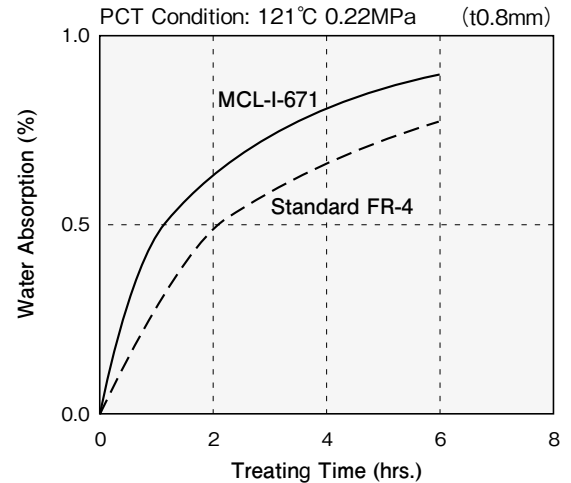
●Correlation between Dissipation Factor and Frequency



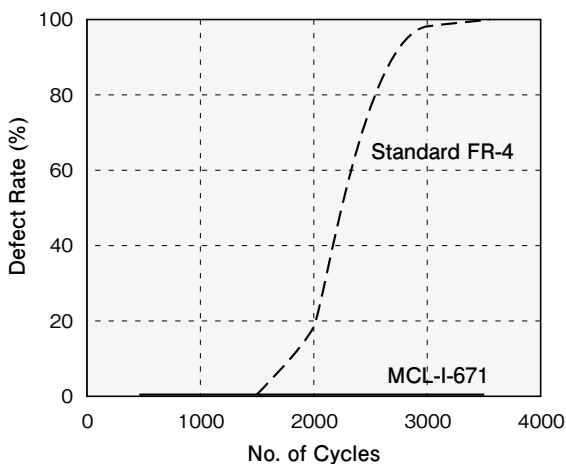
●Barcol Hardness



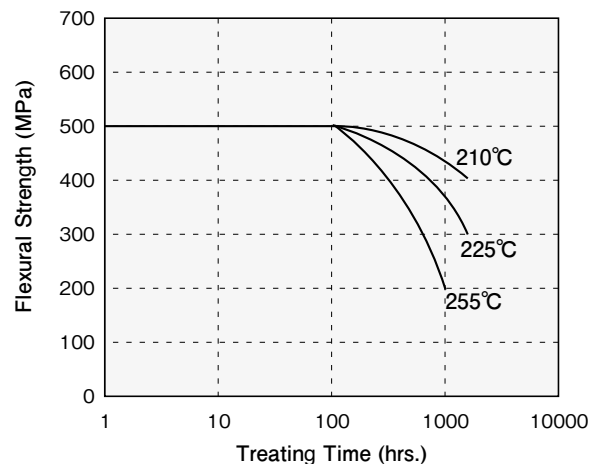
●Water Absorption



●Thermal Shock Test MIL-STD-202 Method 107E



●Flexural Strength



MEMO

A series of horizontal dashed lines for writing.

Glass Epoxy Double Sided Materials

Copper Clad Laminate for Double Sided PWBs (FR-4)

MCL-E-67

P44

Copper Clad Laminate for Double Sided PWBs

MCL-E-67 [UV Block Type MCL-E-67 Type(WK)]

Glass Epoxy Copper Clad Laminate(FR-4)

■ Features

- Superior electrical characteristics, surface smoothness and dimensional stability.
- Superior drilling ability.
- Superior heat resistance, moisture resistance and through-hole reliability.

■ Applications

- Office automation equipment, communication tools and measuring instruments.
- Game machines.
- Electronics for automobiles.

■ Standard Specifications

Part Number	Type	Copper Foil Thickness	Code Name	Actual Thickness and Tolerance
MCL-E-67	—	18μm 35μm 70μm (105μm)	0.3	0.30±0.08mm
			0.4	0.40±0.13mm
			0.5	0.50±0.13mm
			0.6	0.60±0.15mm
	(WK)		0.8	0.80(0.70)±0.17mm
			1.0	1.00(0.90)±0.18mm
			1.2	1.20(1.10)±0.19mm
			1.6	1.60(1.50)±0.19mm

Note 1) In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.

Note 2) The thickness means that of dielectric layer. Figure in bracket () means thickness of dielectric layer of MCL using 70μm copper foil.

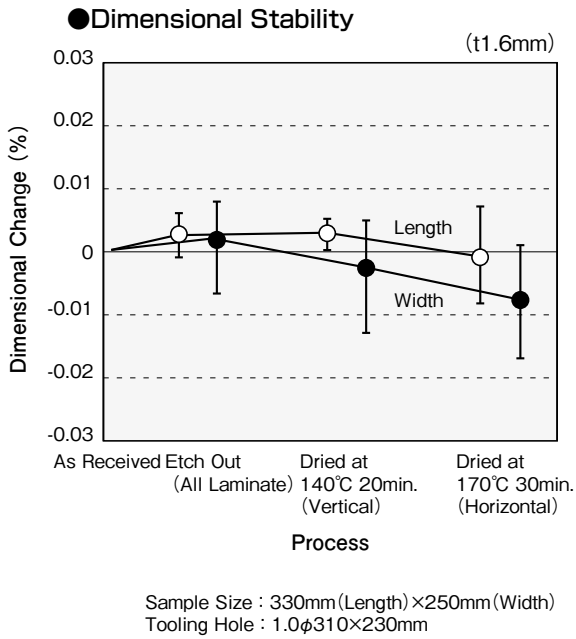
Note 3) Prior confirmation is recommended for 105μm copper foil availability.

■ Characteristics

(t1.6mm)

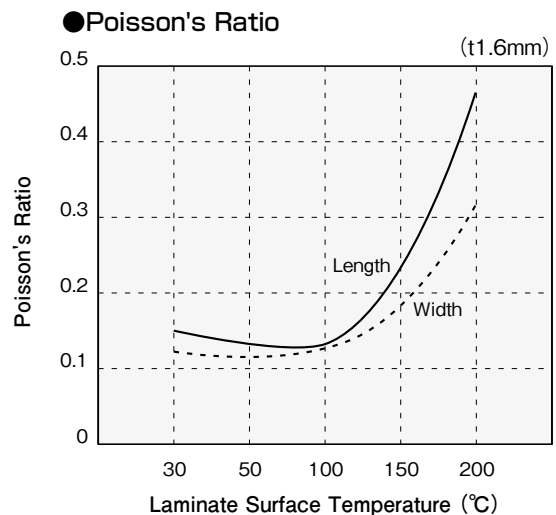
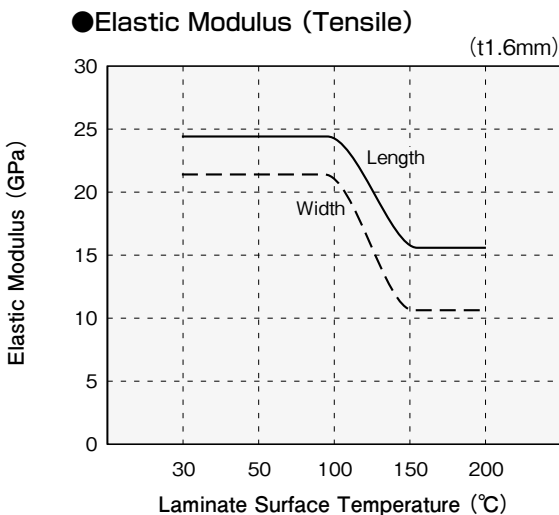
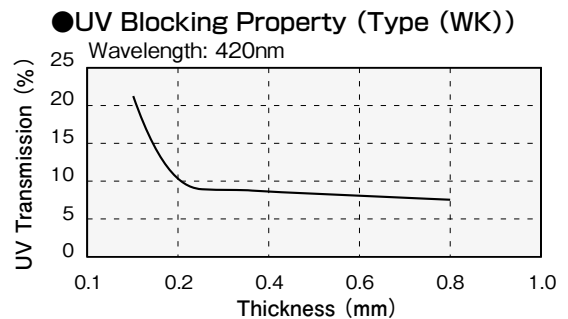
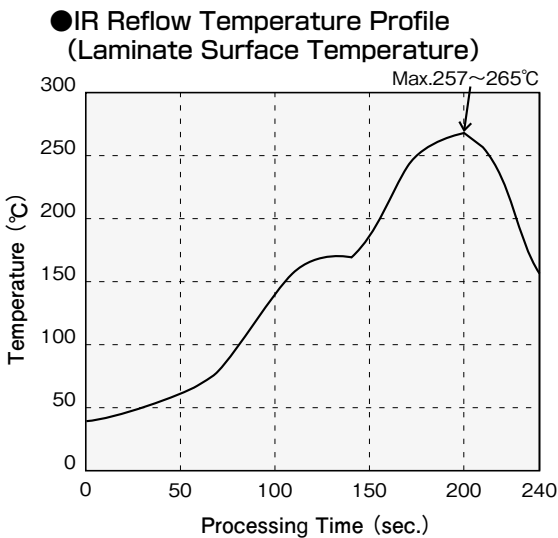
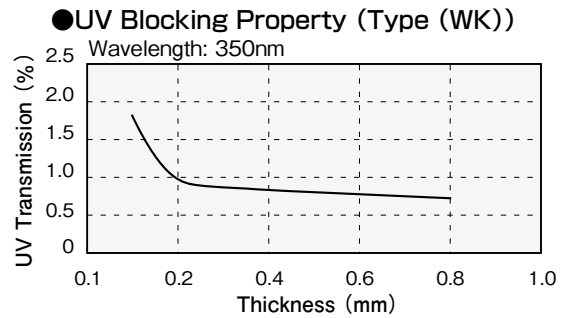
Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)	
			MCL-E-67		
Tg	TMA	°C	120~130	2.4.24	
CTE *1	X	(30~120°C)	13~16	2.4.24	
	Y		14~17		
	Z	(<Tg)	50~70		
		(>Tg)	200~300		
Solder Heat Resistance(260°C)	A	sec.	>120	—	
Heat Resistance	A	—	E-1/200 No Problem	—	
Copper Peel Strength	18μm	A	kN/m	1.4~1.6	2.4.8
Flexural Strength	Length	A	N/mm ²	500~600	2.4.4
	Width			400~500	
Dielectric Constant(1MHz)	C-96/20/65	—	4.7~4.8	2.5.5.1	
Dissipation Factor(1MHz)	C-96/20/65	—	0.0130~0.0170		
Volume Resistivity	C-96/35/90	Ω·cm	1×10 ¹⁵ ~1×10 ¹⁶	2.5.17.1	
Surface Resistance			Ω		1×10 ¹³ ~1×10 ¹⁵
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁶	—	
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁵		
Water Absorption	E-24/50+D-24/23	%	0.06~0.08	2.6.2.1	
Flammability (UL-94)	A	—	V-0	2.3.10	

*1) Heating Rate: 10°C/min.



● Heat Resistance Property [Unit: sec.]

Thickness	Copper	ANSI Grade	Solder Heat Resistance (Float)			Reflow Heat Resistance 260°C/30sec.
			260°C	288°C	300°C	
1.6mm	35μm Double Sided	FR-4	180 OK	180 OK	180 OK	OK



MEMO

Dashed lines for writing.

MEMO

A series of horizontal dashed lines for writing.

CEM-3

Copper clad laminate for Tracking-Resistant composites

E-668T Type(K)

P48

CEM-3

E-668T Type(K)

Copper Clad laminate for tracking-Resistant composites

■ Features

- Good tracking resistance(CTI600)

■ Applications

- Power supply units.
- Displays.
- Air conditioners.
- Washing machines

■ Standard Specifications

Part Number	Type	Master Size(Length×Width)(mm)	Copper Foil Thickness	Actual Thickness(mm)
E-668T (Double-side)	(K)	1030 ⁺⁵ ₋₀ × 1030 ⁺⁵ ₋₀	18μm 35μm 70μm	0.8
				1.0
				1.2
				1.6
E-568T (One-side)	(K)	1230 ⁺⁵ ₋₀ × 1030 ⁺⁵ ₋₀	35μm 70μm	0.8
				1.0
				1.2
				1.6

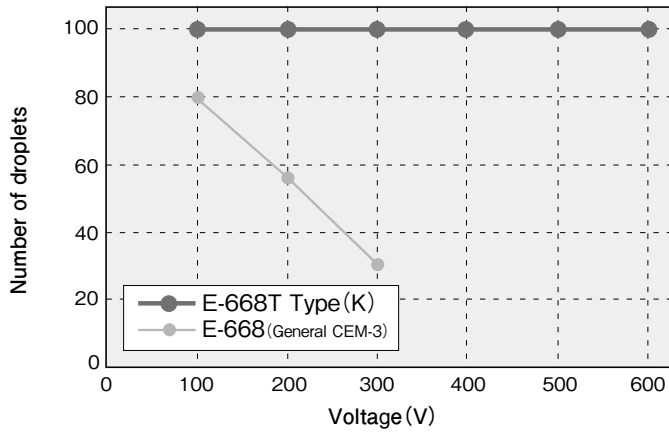
※Please consult in advance for production support.

■ Characteristics

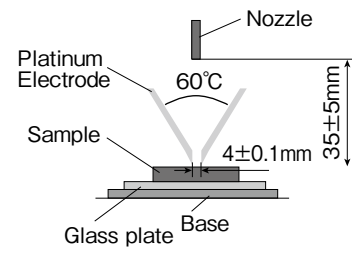
Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)
			E-668T/E-568T	
Tg	TMA	°C	130~140	2.4.24
CTE	X	ppm/°C	18~22	2.4.24
	Y		19~23	
	Z		40~50	
Solder Heat Resistance(260°C)	A	sec.	>120	—
Copper Peel Strength	18μm	A	kN/m	2.4.8
	35μm			
Surface Roughness(Ra)	A	μm	—	—
Flexural Modulus(Lengthwise)	A	GPa	—	2.4.4
Dielectric Constant	1MHz	C-96/20/65	—	4.4~4.8
	1GHz			—
Dissipation Factor	1MHz	C-96/20/65	—	0.024~0.030
	1GHz			—
Volume Resistivity	C-96/20/65	Ω·cm	5×10 ¹⁵ ~5×10 ¹⁶	2.5.17
Surface Resistance	C-96/20/65	Ω	5×10 ¹⁴ ~5×10 ¹⁵	
Insulation Resistance	C-96/20/65	Ω	1×10 ¹⁴ ~5×10 ¹⁵	—
	C-96/20/65+D-2/100		1×10 ¹³ ~1×10 ¹⁴	
Water Absorption	E-24/50+D24/23	%	0.04~0.08(1.6mm)	2.6.2.1
Flammability(UL-94)	A	—	V-0	2.3.10

The contents of this report are based on the results of experiments conducted by HITACHI CHEMICAL and do not represent a guarantee of the values for each property. Before using this product, please study its properties, methods for using it, etc., using this data as a reference.

● Tracking resistance



Method	IEC-60112
Electrolyte	NH ₄ Cl (0.1%)
Voltage	100~600V
Detection	0.5A/2sec.



MEMO

A series of horizontal dashed lines for writing.

Fine Patterning Material

Copper Foil for Fine Patterning

PF-EL

P52

5/5 10/10 15/15 20/20 25/25 30/30 35/35 40/40



Copper Foil for Fine Patterning

PF-EL

Profile-Free Copper Foil is Suitable for Fine line Patterning with the Surface Roughness 1.0~2.0 μm (adhesive side).

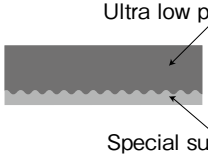
■ Features

- PF-EL is a copper foil that is appropriate for fine line patterning with semi-additive process(SAP) using rough shapes of primer made with the copper profile.
- PF-EL has high peel strength for plating copper.
- High flexural modulus substrates with using prepregs.

■ Applications

- Semiconductor package substrates
- High density multi-layer PWB

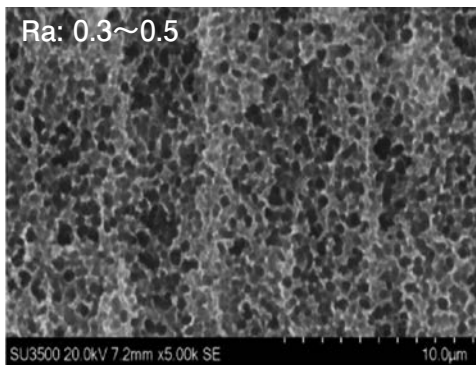
■ Standard Specifications

Part Number	Copper Foil Thickness(μm)	Special Surface Treatment(μm)	Roughness(μm)	Composition	Process
PF-EL-12	12	4	Ra: 0.3~0.4 Rz: 1.5~2.5	 <p>Ultra low profile copper foil</p> <p>Special surface treatment</p>	SAP* ¹
PF-EL-3	3	2, 4	Ra: 0.3~0.5 Rz: 1.5~2.5		SAP* ¹ MSAP* ²
PF-EL-2	2	2, 4	Ra: 0.3~0.5 Rz: 1.5~2.5		
PF-EL-1.5	1.5	2	Ra: 0.3~0.5 Rz: 1.5~2.5		
PF-EL-1.5SP	1.5	2	Ra: 0.2~0.3 Rz: 1.5~2.5		

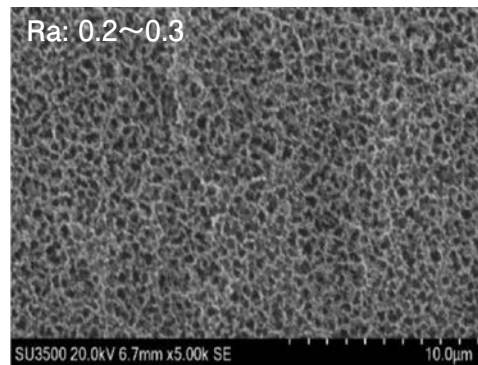
※1:After lamination of the material to the prepreg,the copper foil is etched out,and the special surface treatment with appropriate roughness made by a replica of the copper profile etched out remains on prepreg surface.This process is SAP using this replica.

※2:Semi additive process using thin copper foil as seed layer for having E' less copper +copper on both patterning and via plating purpose.

■ Surface

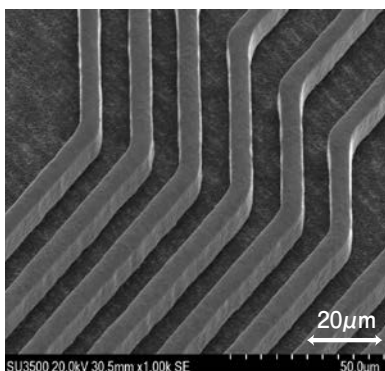


PF-EL

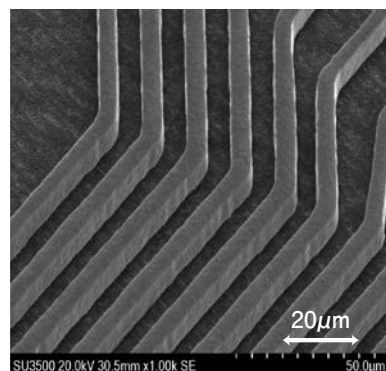


PF-EL SP

■ Fine patterning with SAP



Design
L/S=10/10 μm with PF-EL
(Exposure LDI)

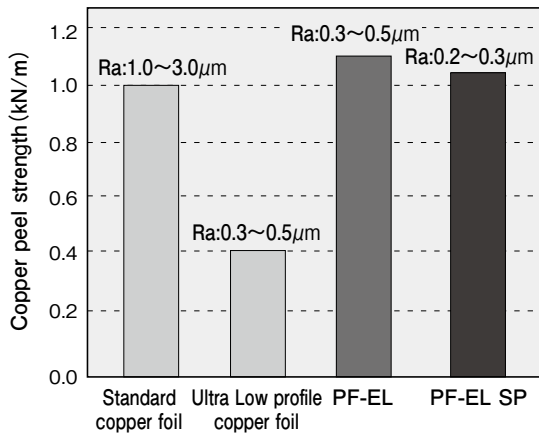


Design
L/S=7/7 μm with PF-EL SP
(Exposure LDI)



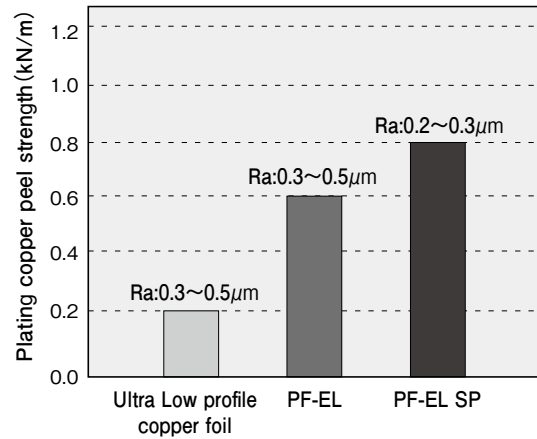
Design
L/S=5/5 μm with PF-EL SP
(Exposure Stepper)

■ Copper peel strength



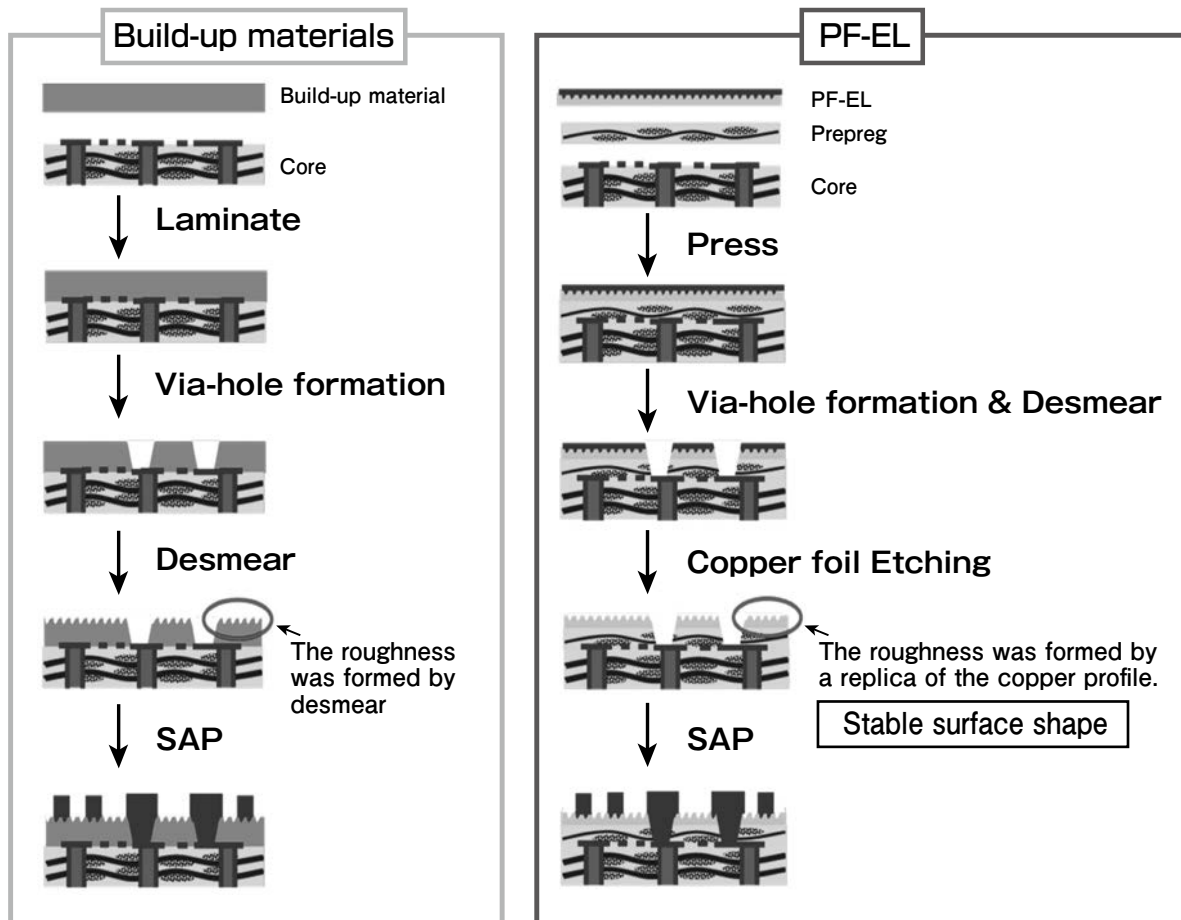
※MCL-E-770G Type(R), Copper foil 1.5µm with plating copper 20µm

■ Plating copper peel strength



※MCL-E-770G Type(R), plating copper thickness 20µm

■ Fine patterning process



MEMO

A series of horizontal dashed lines for writing.

Epoxy Adhesive Film

Low-Elastic Adhesive Film

AS-2600

P56

Low-Elastic Adhesive Film

AS-2600

Epoxy Adhesive Film

■ Features

- Good adhesivity.
- Low elasticity.

■ Applications

- Electric and electronic equipment.
- Ceramic oscillation device.
- Electric high-precision position device.

■ Standard Specifications

Part Number	Type	Actual Thickness	Carrier Film Thickness
AS-2600	—	25 μ m, 50 μ m, 75 μ m	75 μ m (PET)

■ Characteristics (C-Stage)

Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)
			AS-2600	
Storage Modulus	DVE (25°C)	MPa	1000~1200	—
Tg	DVE	°C	50~70, 190~210	—
CTE	(<Tg)	TMA	110~130	2.4.24
	(>Tg)		140~160	
Peel Strength *1	A	kN/m	1.8~2.0	2.4.8
Breakdown Voltage *1	A	kV	7.0~9.0	2.5.6.3
Volume Resistivity *1	A	Ω ·cm	1×10 ¹³ ~1×10 ¹⁵	2.5.17

*1) Board characteristics (Copper foil 35 μ m/AS-2600/AL2mm).

■ Characteristics (B-Stage)

Item	Condition	Unit	Actual Value	Test Method (IPC-TM-650)
Volatile Content	170°C 15min. weight method	wt%	≤3	—

KOBELITE LAMINATE

KEL-GEF

KEL-571

(Only non-woven aramid structure)

KEL-973

**(Composite structure of
non-woven aramid and polyester)**

P58

KOBELITE LAMINATES

Table of article numbers

Part Number		KEL-GEF		KEL-9383NT	KEL-571	KEL-973
Division		—	(R)			
Item	Resin	Epoxy				
	Base material	Glass fabric	Glass fabric, Non-woven glass fabric	Non-woven aramid fabric	Non-woven aramid fabric, Polyester fabric	
	Color	Natural color				
	Grades	JIS	EL-GEF	—	—	—
		ANSI	FR-4.0	CEM-3 Equivalent	—	—
	UL	94V-0	94V-0	—	—	
	Features	Good insulation resistance Good strength High precision thickness	Good insulation resistance Good punching performance	Reduction scratch High precision thickness		
	Applications	Insulation spacer, FPC brace board, Retaining board for polishing	Insulation spacer, FPC brace board	Retaining board for polishing		
	Thickness (mm)	0.1~20.0	0.2~2.5	1.0~1.6	0.2~2.0	0.6~2.0
Size (mm)	1,020×1,020					

Actual thickness and tolerance

Actual thickness	JIS tolerance	KOBELITE tolerance				
		KEL-GEF	KEL-GEF (R)	KEL-9383NT	KEL-571	KEL-973
0.1	—	±0.02	—	—	—	—
0.2	—	±0.02	±0.02	—	±0.03	—
0.3	—	±0.10	±0.03	—	±0.03	—
0.4	—	±0.10	±0.03	—	±0.03	—
0.5	±0.12	±0.10	±0.03	—	±0.03	—
0.6	±0.13	±0.12	±0.03	—	±0.03	±0.03
0.7	±0.15	±0.15	±0.04	—	±0.04	—
0.8	±0.15	±0.15	±0.04	—	±0.04	±0.04
1.0	±0.15	±0.15	±0.05	±0.15	±0.05	±0.05
1.2	±0.20	±0.20	±0.20	±0.20	±0.06	±0.06
1.5	±0.20	±0.20	±0.20	—	±0.08	±0.08
1.6	±0.23	±0.23	±0.20	±0.22	±0.08	±0.08
2.0	±0.25	±0.25	±0.20	—	±0.14	±0.10
2.5	±0.30	±0.30	±0.20	—	—	—

Actual thickness	JIS tolerance	KEL-GEF
3.0	±0.35	±0.35
4.0	±0.40	±0.40
5.0	±0.55	±0.55
6.0	±0.60	±0.60
8.0	±0.70	±0.70
10.0	±0.80	±0.80
12.0	±0.90	±0.90
15.0	±1.10	±1.10
16.0	±1.10	±1.10
20.0	±1.30	±1.30

1. In case laminate thickness lies in between two thickness figures shown above, the tolerance of such laminate would be equal to the tolerance of the thicker one.
2. Thickness guarantee area is 920×920mm, center of 1020×1020mm (Only KEL-GEF (R), KEL-571, KEL-973)

Water absorption (JIS K 6912)

Condition: E-24/50+D-24/23

Unit (%)

Thickness (mm)	Part Number	KEL-GEF
	JIS	EL-GEF
0.5		1.00
0.8		0.80
1.6		0.35
2.0		0.30
2.5		0.25
3.0		0.20
5.0		0.15
6.0		0.13
12.0		0.10
20.0		0.10

Warp & Twist

Unit (%)

Standard Thickness (mm)	The ratio of the warp & twist against 1000mm	
	KOBELITE	JIS
0.8 ≤ 1.6 ≥	3.50 ≥	—
1.6 < 3.0 ≥	2.00 ≥	3.00 ≥
3.0 < 5.0 ≥	1.20 ≥	1.30 ≥
5.0 < 7.0 ≥	1.00 ≥	
7.0 < 10.0 ≥	0.60 ≥	0.65 ≥
10.0 < 15.0 ≥	0.50 ≥	
15.0 < 20.0 ≥	0.40 ≥	

■ Characteristics (t1.0mm)

Item		Condition	Unit	Actual Value			
				KEL-GEF /KEL-GEF(R)	KEL-9383NT	KEL-571	KEL-973
Withstand Voltage Vertical To Layer		C-90/20/65	kV/mm	18~30	18~30	—	—
Insulation Resistance		C-90/20/65	Ω	$1 \times 10^{14} \sim 1 \times 10^{15}$	$1 \times 10^{14} \sim 1 \times 10^{15}$	$1 \times 10^{14} \sim 1 \times 10^{15}$	—
		C-90/20/65 +D-2/100		$1 \times 10^{14} \sim 5 \times 10^{14}$	$5 \times 10^{13} \sim 5 \times 10^{14}$	$5 \times 10^{13} \sim 5 \times 10^{14}$	—
Dielectric Constant	(1MHz)	C-90/20/65	—	4.5~5.0	4.3~4.7	4.0~4.2	—
		C-90/20/65 +D-24/23		4.6~5.1	4.4~4.8	4.1~4.3	—
Dissipation Factor	(1MHz)	C-90/20/65	—	0.016~0.025	0.015~0.022	0.020~0.022	—
		C-90/20/65 +D-24/23		0.020~0.026	0.018~0.023	0.021~0.023	—
Flexural Strength	Length	A	N/mm ²	600~650	350~410	330~400	200~220
	Width			450~500	290~350	300~380	170~190
Flexural Modulus	Length	A	kN/mm ²	22~24	—	8.4~8.6	7.4~7.6
	Width			19~22	—	7.8~8.0	6.6~6.8
Compressive Strength	vertical	A	N/mm ²	400~550	—	—	—
	parallel			250~300	—	—	—
Izod Impact Strength		A	J/cm	5.00~6.50	—	—	—
Cleavage Strength		A	kN	7.84~9.81	—	—	—
Air Flammability		E-2/180	—	No abnormality	No abnormality	No abnormality	No abnormality
Specific Gravity		A	—	1.7~1.9	1.5~1.7	1.4~1.5	1.5~1.6
Chemical Resistance	HCl	(*1)	—	No abnormality	No abnormality	No abnormality	No abnormality
	NaOH			No abnormality	No abnormality	No abnormality	No abnormality
Flammability	(UL-94)	A	—	V-0	V-0	—	—
Aptitude Punching Temperature		A	°C	—	15~16	—	—
CTE *2	X	(30~80°C)	ppm/°C	12~14	20~22	6~8	27~30
	Y			14~16	22~25	8~10	38~40
	Z			50~70	40~50	105~120	—

The contents of this report are based on the results of experiments conducted by HITACHI CHEMICAL and do not represent a guarantee of the values for each property. Before use, please study its properties, methods for using it, etc., using this data as a reference.

*1) Concentration: $3 \pm 0.2\%$, $20 \pm 2^\circ\text{C}$. Appearance checked with naked eyes after soaking for 24hrs.

*2) Heating Rate: $10^\circ\text{C}/\text{min}$.

KOBELITE LAMINATE

KEL-GEF

Glass epoxy laminates

■ Features

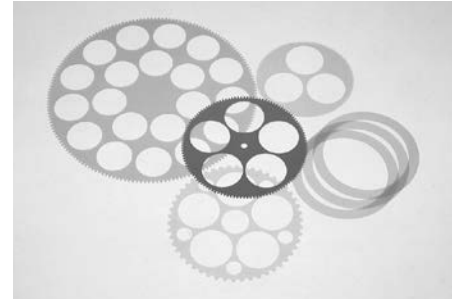
- Precise thickness and low warpage compared to the standard epoxy glass laminates.

■ Applications

- Retaining board for polishing
- DAM substrate

■ Polishing products

- Hard disk



■ Standard Specifications

Part Number	Type	Master Size (Length×Width) (mm)	Actual Thickness (mm)
KEL-GEF	—	$1020^{+5}_{-0} \times 1020^{+5}_{-0}$	0.1
			0.2
			0.3
			0.4
			0.5
			0.6
			0.7
			0.8
			1.0
			1.2
			1.5
			1.6
			2.0
			2.5
			(R)
	0.3		
	0.4		
	0.5		
	0.6		
	0.7		
	0.8		
	1.0		
	1.2		
	1.5		
	1.6		
2.0			
2.5			

※Please consult in advance for production support.

■ Characteristics

Item		Condition	Unit	Actual Value
				KEL-GEF/KEL-GEF (R)
Withstand Voltage Vertical To Layer		C-90/20/65	kV/mm	18~30
Insulation Resistance		C-90/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁵
		C-90/20/65+D-2/100		1×10 ¹⁴ ~5×10 ¹⁴
Dielectric Constant	(1MHz)	C-90/20/65	—	4.5~5.0
		C-90/20/65+D-24/23		4.6~5.1
Dissipation Factor	(1MHz)	C-90/20/65	—	0.016~0.025
		C-90/20/65+D-24/23		0.020~0.026
Flexural Strength	Length	A	N/mm ²	600~650
	Width			450~500
Flexural Modulus	Length	A	kN/mm ²	22~24
	Width			19~22
Compressive Strength	vertical	A	N/mm ²	400~550
	parallel			250~300
Izod impact strength		A	J/cm	5.00~6.50
Cleavage Strength		A	kN	7.84~9.81
Air Flammability		E-2/180	—	No abnormality
Specific Gravity		A	—	1.7~1.9
Chemical Resistance	HCl	(*1)	—	No abnormality
	NaOH			No abnormality
Flammability	(UL-94)	A	—	V-0
Aptitude Punching Temperature		A	°C	—
CTE *2	X	(30~80°C)	ppm/°C	12~14
	Y			14~16
	Z			50~70

The contents of this report are based on the results of experiments conducted by HITACHI CHEMICAL and do not represent a guarantee of the values for each property. Before use, please study its properties, methods for using it, etc., using this data as a reference.

*1) Concentration: 3±0.2%, 20±2°C. Appearance checked with naked eyes after soaking for 24hrs.

*2) Heating Rate: 10°C/min.

KOBELITE LAMINATE

KEL-571 (Only non-woven aramid structure)

KEL-973 (Composite structure of non-woven aramid and polyester)

Non-woven aramid epoxy laminates

■ Features

- Non woven aramid fiber prevents scratch.
- Aramid fiber contributes to long life of polishing machine.
- Prevents crash with high tear strength.

■ Applications

- Retaining board for polishing

■ Polishing products

- Hard disk, wafer, lens, liquid crystal display

■ Standard Specifications

Part Number	Type	Master Size (Length×Width) (mm)	Actual Thickness (mm)
KEL-571	—	$1020^{+5}_{-0} \times 1020^{+5}_{-0}$	0.2
			0.3
			0.4
			0.5
			0.6
			0.7
			0.8
			1.0
			1.2
			1.5
			1.6
KEL-973	—	$1020^{+5}_{-0} \times 1020^{+5}_{-0}$	2.0
			0.6
			0.8
			1.0
			1.2
			1.5
1.6			
2.0			

※Please consult in advance for production support.

■ Characteristics

Item	Condition	Unit	Actual Value		
			KEL-571	KEL-973	
Withstand Voltage Vertical To Layer	C-90/20/65	kV/mm	—	—	
Insulation Resistance	C-90/20/65	Ω	1×10 ¹⁴ ~1×10 ¹⁵	—	
	C-90/20/65+D-2/100		5×10 ¹³ ~5×10 ¹⁴	—	
Dielectric Constant	(1MHz)	C-90/20/65	4.0~4.2	—	
		C-90/20/65+D-24/23	4.1~4.3	—	
Dissipation Factor	(1MHz)	C-90/20/65	0.020~0.022	—	
		C-90/20/65+D-24/23	0.021~0.023	—	
Flexural Strength	Length	A	N/mm ²	330~400	200~220
	Width			300~380	170~190
Flexural Modulus	Length	A	kN/mm ²	8.4~8.6	7.4~7.6
	Width			7.8~8.0	6.6~6.8
Compressive Strength	vertical	A	N/mm ²	—	—
	parallel			—	—
Izod Impact Strength	A	J/cm	—	—	
Cleavage Strength	A	kN	—	—	
Air Flammability	E-2/180	—	No abnormality	No abnormality	
Specific Gravity	A	—	1.4~1.5	1.5~1.6	
Chemical Resistance	HCl	(*1)	—	No abnormality	No abnormality
	NaOH			No abnormality	No abnormality
Flammability	(UL-94)	A	—	—	
Aptitude Punching Temperature	A	°C	—	—	
CTE *2	X	(30~80°C)	ppm/°C	6~8	27~30
	Y			8~10	38~40
	Z			105~120	—

The contents of this report are based on the results of experiments conducted by HITACHI CHEMICAL and do not represent a guarantee of the values for each property. Before use, please study its properties, methods for using it, etc., using this data as a reference.

*1) Concentration:3±0.2%,20±2°C. Appearance checked with naked eyes after soaking for 24hrs.

*2) Heating Rate:10°C/min.

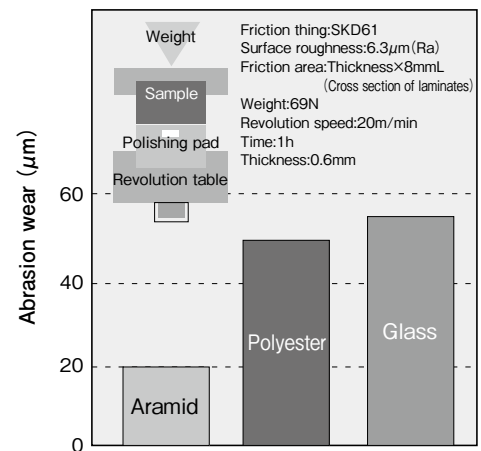
● Table of general characteristics

Item	Part Number	KEL-571	KEL-973	KEL-GEF (R)
		Tear strength(N/mm)	30	38
Tencile strength(N/mm ²)		250	120	320
Flexural strength(N/mm ²)		330	220	600
Flexural modulus(kN/mm ²)		8.5	7.5	22
Chemical Resistance*	Hydrochloric acid 3%	OK		
	Nitric acid 15%	OK		
	Sodium hydroxide 3%	OK		

The above values are measurements taken from samples 1.0mm thickness, but not guaranteed.

(*)Decided concentration, 20±2°C. 24hour dipping.

● Result of wear resistance



The abrasion rate of aramid is less than a half of glass epoxy and polyester laminates.

MEMO

A series of horizontal dashed lines for writing.

Precautionary Statement

Precautions for Use

P66

Precautions in Process

P67

Precautions in Designing

P68

Precautions for Use of Completed PWB

P69

Standard Press Condition for Multilayer Board Lamination

P70

Precautionary Statement

Precautions for Use

● Handling

Take the following measures to avoid contacting and inhaling resin, glass or other dust from material, etc.

- ① Install a local ventilator above the workbench so as to sufficiently exhaust dust.
- ② Wear protection gear to cover hands, mouth nose and eyes.
- ③ Control the room temperature not to sweat and protect skin from dust.

If you come into contact with and/or inhale resin, glass or other dust from material, take the following measures:

- ① If dust has entered into eyes : Wash your eyes with clean running water.
- ② If dust has come in contact with skin : Wash it off with soapy water.
- ③ If you have inhaled dust : If it is in your mouth, rinse out your mouth, and if it is in your nostrils, use tissues to clean.
- ④ If you have ingested dust : Induce vomiting, or if it remains in your mouth, spit it out and then gargle.

Make sure to install a local ventilator since gas is generated in the heating process.

● Storage

Since material characteristics may change depending on the storage conditions, pay attention to the following points:

- ① Protect the materials from direct sunlight; otherwise, discoloration may occur.
- ② Use a ventilator or air conditioner to remove moist air in the storage area and circulate the air.
- ③ Keep the materials horizontally to prevent warpage or deflection and avoid piling materials on pallets. Also, since condensation may collect on the surface of the walls, keep the materials away from walls to prevent them from becoming wet.
- ④ Place dry paper or polyethylene film between materials to prevent them from getting scratched.
- ⑤ Maintain a constant room temperature to prevent from condensation into water on the materials.
- ⑥ As for the prepregs and films which require low-temperature storage, take sufficient time to get them back to ordinary temperature in the packed condition. Before use, confirm there is no waterdrop condensed on the surface. (it takes about 12 hours to bring the temperature of materials stored at 5°C to 22°C).

● Storage Conditions

Classification		Part Number	Temperature	Humidity	Term	Precautions
Double Sided Boards		MCL-E-67	25°C max.	50±15%RH	Double Sided Boards: Within 6 months after delivery	Store in packed state
Multilayer Material	MCL (Core Material)	MCL-E-67 · MCL-HE-679G Type(S) MCL-E-679 Type(W) · MCL-E-75G MCL-E-679F Type(R) · MCL-E-679FG MCL-E-700G Type(R) · MCL-E-679FGB MCL-E-705G · MCL-E-770G MCL-HS100 · MCL-E-78G MCL-I-671 · MCL-LW-910G MCL-LW-900G				
	Prepreg	GEA-67N · GEA-679N · GEA-679F Type(R) GHA-679G Type(S) · GEA-75G · GH-100 GEA-770G · GEA-700G · GEA-705G GIA-671N · GWA-900G · GWA-910G	20±5°C	50±10%RH	Within 3 months after shipment	
			TD-002	5±4%	50±10%RH	
Adhesive Film		AS-2600	10±5°C	—	Within 3 months after shipment	

Precautions in Process

●Etching

For MCL etching, cupric chloride, ferric chloride or ammonium persulfate is generally used. After etching, wash the laminates carefully with clean running water. If the washing is insufficient, residual ions (copper ions, iron ions, etc.) may degrade the electric characteristics, lower the copper foil adhesiveness and discolor the laminates.

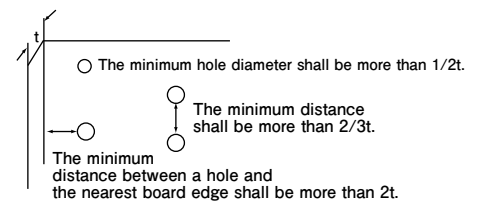
●Removing etching resist

To prevent boards from discoloration or other characteristic change, minimize the processing time. After the processing, wash the materials well with water and then dry them thoroughly.

●Punching

The following three principles are necessary for MCL punching

- ① The minimum hole diameter shall be more than $1/2$ of the board thickness.
- ② The minimum distance between holes shall be more than $2/3$ of the board thickness.
- ③ The minimum distance between a hole and the nearest board edge shall be more than twice the board thickness.



Three Principles of Punching

●Drilling

Pay attention to the total stacked thickness (t) of the MCLs to be drilled and the effective length (l) of the drill: l is 1.5 mm or more longer than (t). A spade type is suitable for glass fabric-based.

Since hole quality varies with the type of drill used, the drilling machine and drilling conditions, examine these conditions carefully when setting or changing them.

●Plating

Carefully control the composition and temperature of the plating solution and plating time when plating MCLs. After taking them out of the plating bath, wash them carefully with running water immediately then dry them sufficiently.

●Use of UV Ink

The surface state of MCL influences adhesion and wettability of the UV ink, so pay attention to the following points:

- ① Polish the MCL surfaces sufficiently.
- ② After polishing, wash them sufficiently with running water.
- ③ Do not store them for a long time.
- ④ If stored for a long time, polish again, wash with water and dry them before use.

●Heating

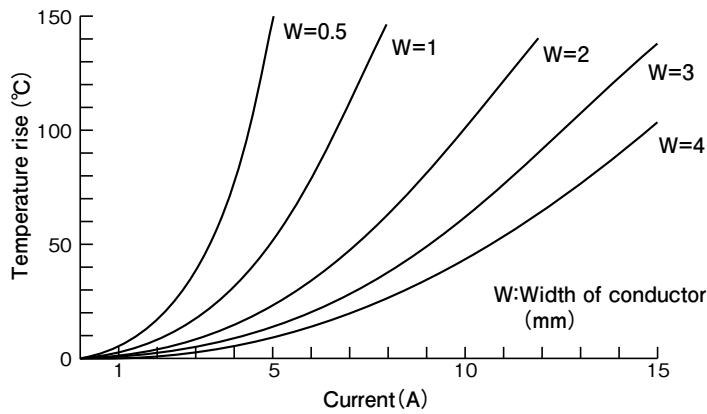
Heat MCL uniformly, not partially, as much as possible. When heating them to temperature higher than the glass-transition temperature, warpage and deflection can be reduced by using a horizontal rack.

When heating them at high temperature for more than 30 minutes, the laminates may become discolored. So, determine the optimum time in advance.

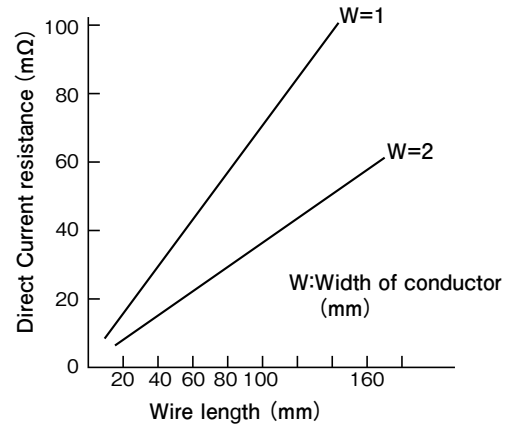
Precautions in Designing

●Circuit designing

When designing circuits, allowable current or copper foil temperature rising by electric current are important factors. Refer to the following figures.



Relationship Between Current and Temperature Rise (Copper foil 35 μ m)



Relationship Between Wire Length and Resistance (Copper foil 35 μ m)

For the relations between inter-conductor creepage distance and voltage, see the IPC-2221 design standard in the tables below:

Without coating
(when used below 3,050m above sea level)

Voltage between conductors (AC, DC) [Peak voltage]	Minimum creepage distance (mm)
0~30	0.1
31~150	0.6
151~300	1.25
301~500	2.5
Over 500	0.005/V

With coating
(Unaffected by atmospheric pressure)

Voltage between conductors (AC, DC) [Peak voltage]	Minimum creepage distance (mm)
0~ 30	0.05
31~100	0.13
101~300	0.4
301~500	0.8
Over 500	0.00305/V

●Directionality of "MCL"

Since MCLs are directional (length and width), be careful with respect to pattern design and lay out.

Precautions for Use of Completed PWB

●Storage

Since printed wiring boards absorb moisture in the environment, pay attention to the following points when storing them:

- ①Keep in a moisture-proof package (polyethylene bag and silica gel) until using them.
- ②Store in an air-conditioned room (below 25°C and below 60%RH).
- ③Do not leave boards in a non-air-conditioned room (humidity: over 60%RH) before mounting.
- ④When using only some of the boards, keep the remaining ones in the same moisture-proof package in which they were delivered.
- ⑤Even when kept in a moisture-proof package, these boards will gradually absorb moisture in the environment during humid seasons. When storing them for more than three months, take care to keep them dry.

●Drying

When boards are assumed to have absorbed moisture because of improper storage conditions or long-term storage of more than three months, be sure to dry them before use.

- ①Recommended drying conditions:

Drying temperature (°C)	Drying time (hrs.)
80	24
100	12
130	2

*In case boards are stacked at drying, extend the drying time by about 20% because temperature of the boards rises slowly.

- ②Hold the boards horizontally during drying.
- ③Too high drying temperature (over 130°C) may cause oxidization of copper foil and discoloration of boards.
- ④In case of devices are mounted on boards, dry the boards at temperature at which the heat resistance of the part is taken into account. This applies to boards with surface protection coating.
- ⑤After drying, component mounting as soon as possible. If the work does not proceed smoothly, protect these boards with a moisture-proof package.

●Heating

- ①Note that excessive force on the board during. Heating may cause bow, twist or measling.
- ②During high temperature heat treatment (such as fusing), rapid heating and cooling may result in interlayer cracks, board swellings, and/or other defects. Such heating or cooling should be done step-by-step. To improve reliability, be sure to dry the materials before heat treatment.

●Soldering

The solder heat resistance of MCL is greatly affected by the temperature of the solder bath. So, use an L-shaped thermometer to control carefully the temperature of the solder bath. When using a soldering iron, note that the actual temperature at the tip varies on its manufacturer and structure even though soldering irons are of the same capacity. You are recommended to measure the temperature with a surface thermometer in advance and to use the soldering iron below 300°C. After soldering, try not to move the substrates while the soldered portions remain hot.

Measling and blistering of the glass fabric epoxy MCLs are apt to occur on wet printed wiring boards. So dry them (at 130°C for 1 to 2 hours) before soldering. Excessively hot solder may result in shorter heat-resistance time, leading to swellings in circuits and boards. Make sure to maintain the appropriate temperature.

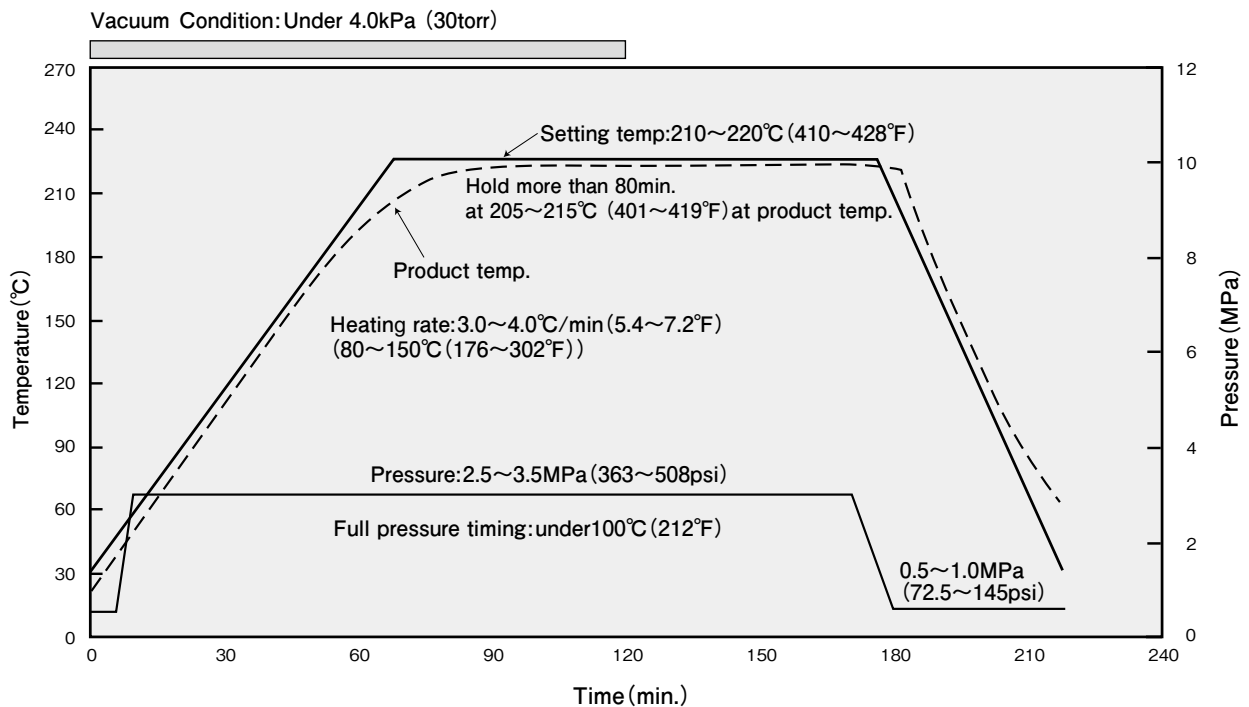
Recommendation Press Condition for Multilayer Board Lamination

GH-100

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product should be about 3.0~4.0°C/min. within the melting temperature range of the prepreg resin (80~150°C). Hold the product temperature 205~215°C for more than 80 min.
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ The degree of vacuum shall be below 4.0kPa(30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.5~3.5 MPa.)
- ⑤ We recommend that pressure on material is the low pressure of 0.5MPa for resin of prepreg at the initial stage and material temperature preaurize it before 80°C. The starting pressure is 0.5MPa, and set the full-pressure, before product temperature become 100°C.
- ⑥ Inner pattern filling capability of prepreg may change according to inner pattern and thickness design.
- ⑦ By out gas from an inner substrate, the curing property of prepregs may be affected. Please use MCL-HS100 as an inner substrate.
- ⑧ When you will use FR-4 laminates as dummy products, it is possible that FR-4 laminates will decompose because of high lamination temp. Please use MCL-HS100 or GH-100 for dummy laminates, too.

■ Recommendation Press Conditions



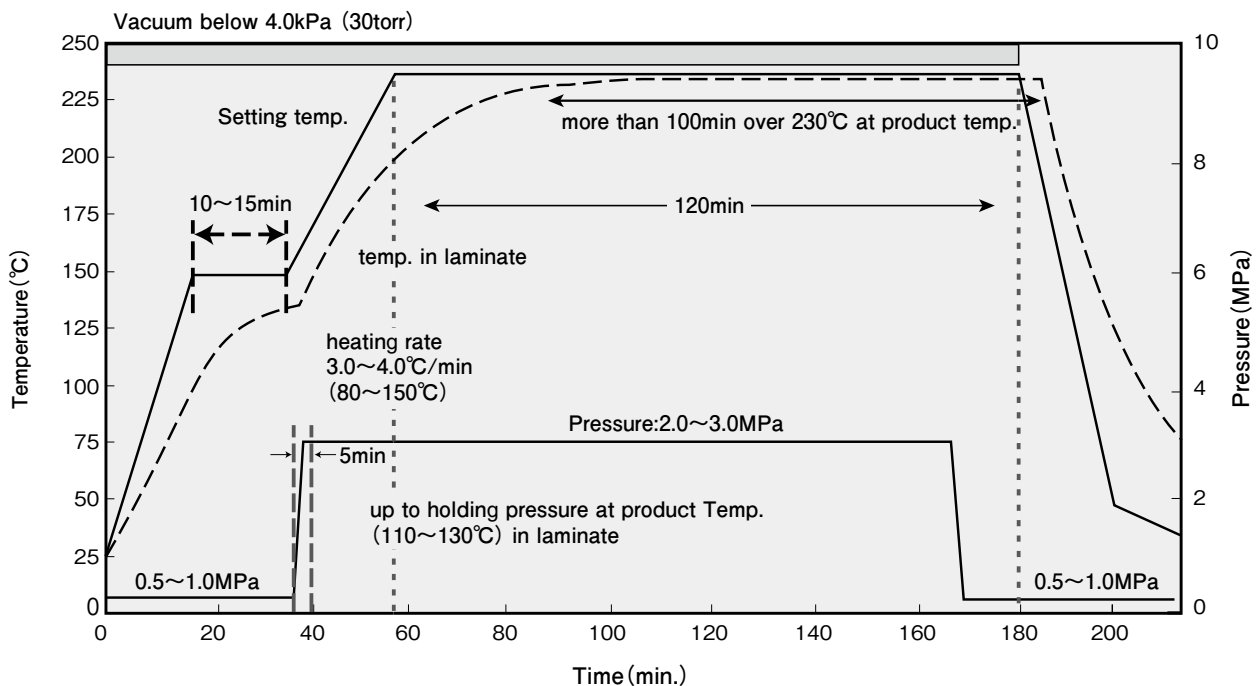
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-770G

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product should be about 3.0~4.0°C/min. within the melting temperature range of the prepreg resin (80~150°C). Hold the product temperature above 230°C for more than 100 min.
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ The degree of vacuum shall be below 4.0kPa(30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.0~3.0 MPa.)
- ⑤ In order to reduce the pressure shock to each part of the laminate, low pressure shall be applied to the material at the initial stage and increase it at the material temperature 110~130°C, when the resin becomes soft.
- ⑥ Inner pattern filling capability of prepreg may change according to inner pattern and thickness design.
- ⑦ By out gas from an inner substrate, the curing property of prepreps may be affected. Please use MCL-E-770G as an inner substrate.
- ⑧ When you will use FR-4 laminates as dummy products, it is possible that FR-4 laminates will decompose because of high lamination temp. Please use MCL-E-770G or GEA-770G for dummy laminates, too.

■ Recommendation Press Conditions



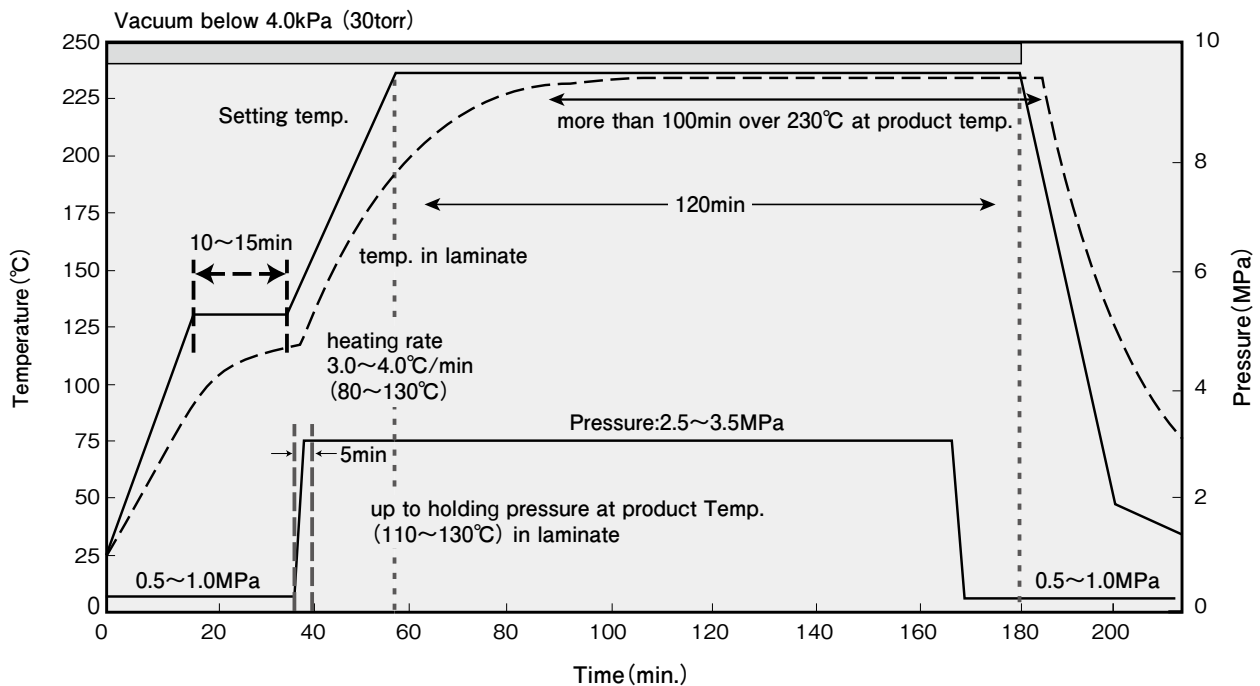
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-705G

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product should be about 3.0~4.0°C/min. within the melting temperature range of the prepreg resin (80~130°C). Hold the product temperature above 230°C for more than 100 min.
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ The degree of vacuum shall be below 4.0kPa(30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.5~3.5 MPa.)
- ⑤ In order to reduce the pressure shock to each part of the laminate, low pressure shall be applied to the material at the initial stage and increase it at the material temperature 110~130°C, when the resin becomes soft.
- ⑥ Inner pattern filling capability of prepreg may change according to inner pattern and thickness design.
- ⑦ By out gas from an inner substrate, the curing property of prepreps may be affected. Please use MCL-E-705G as an inner substrate.
- ⑧ When you will use FR-4 laminates as dummy products, it is possible that FR-4 laminates will decompose because of high lamination temp. Please use MCL-E-705G or GEA-705G for dummy laminates, too.

■ Recommendation Press Conditions



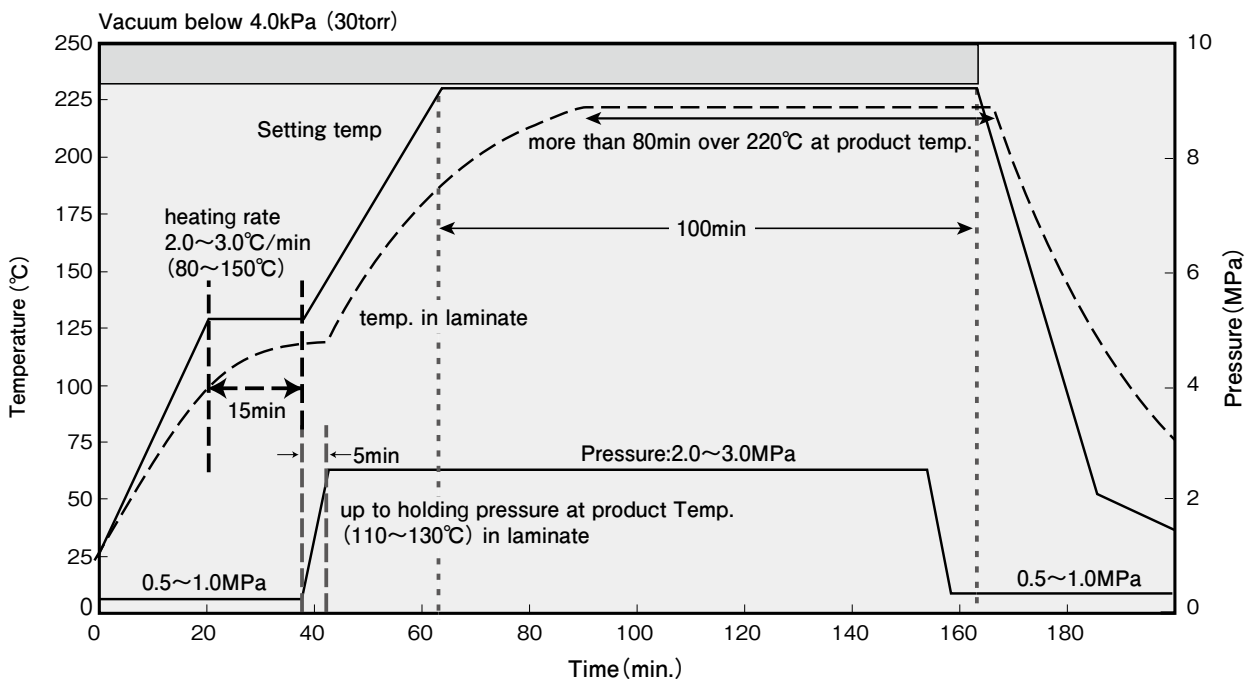
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-700G

■Precautions for Lamination of Multilayer Board

- ① Heating rate of the product should be about 2.0~3.0°C/min. within the melting temperature range of the prepreg resin (80~150°C). Hold the product temperature above 220°C for more than 80 min.
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ The degree of vacuum shall be below 4.0kPa(30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.0~3.0 MPa.)
- ⑤ In order to reduce the pressure shock to each part of the laminate, low pressure shall be applied to the material at the initial stage and increase it at the material temperature 110~130°C, when the resin becomes soft.
- ⑥ Inner pattern filling capability of prepreg may change according to inner pattern and thickness design.
- ⑦ By out gas from an inner substrate, the curing property of prepreps may be affected. Please use MCL-E-700G Type(R) as an inner substrate.
- ⑧ When you will use FR-4 laminates as dummy products, it is possible that FR-4 laminates will decompose because of high lamination temp. Please use MCL-E-700G Type(R) or GEA-700G for dummy laminates, too.

■Recommendation Press Conditions



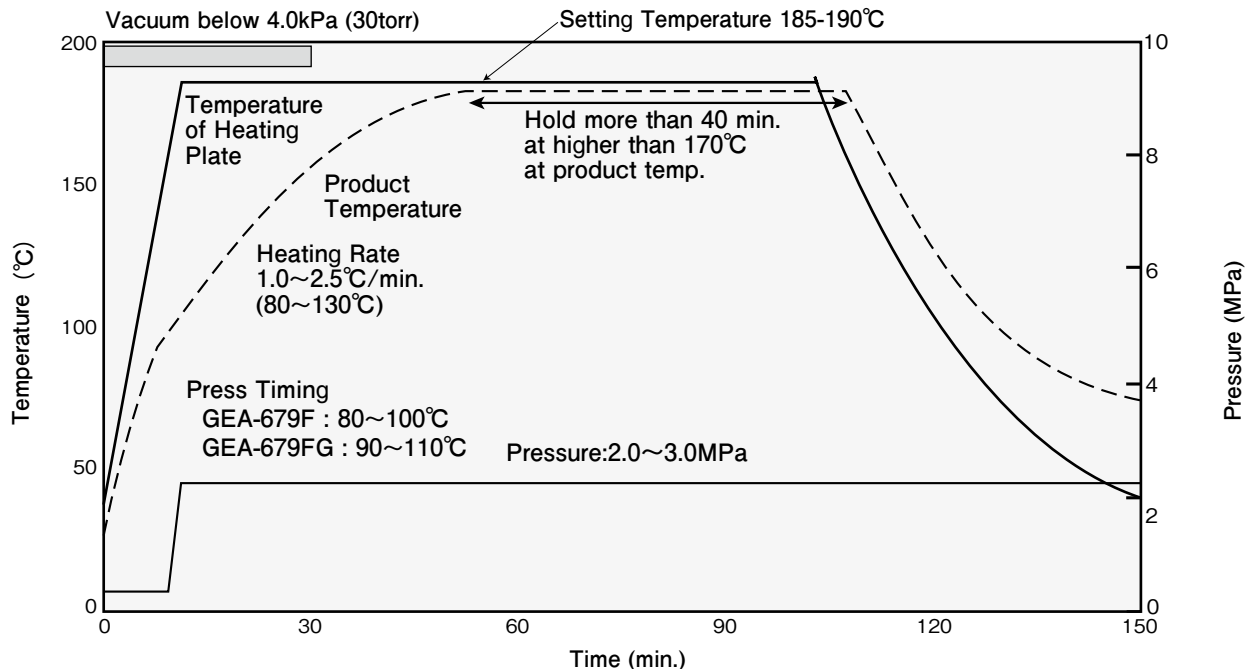
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-679F Type(R)/GEA-679FG

■Precautions for Lamination of Multilayer Board

- ①Heating rate of the product should be 1.0~2.5°C/min. within the melting temperature range of the prepreg resin (80~130°C). Hold the product temperature above 170°C for more than 40 min.
- ②The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③The degree of vacuum shall be below 4.0 kPa (30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④The time for vacuuming shall not be longer than the end of molding process (When resin flow stops). If the vacuuming is continued until the end of the lamination process, flowed resin becomes fragile due to bubble remain. Fragments of it may become a cause of dent. Also small bubbles (blur) may occur in the edge of the product.
- ⑤The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.0~3.0 MPa.)
- ⑥Inner pattern filling capability of prepreg may change according to inner pattern and thickness design.
- ⑦In order to reduce the pressure shock to the product, it is recommended to set initial pressure low, 0.5 MPa with 80~110°C (GEA-679F Type(R): 80~100°C, GEA-679FG:90~110°C) product temperature at the initial stage.

■Recommendation Press Conditions



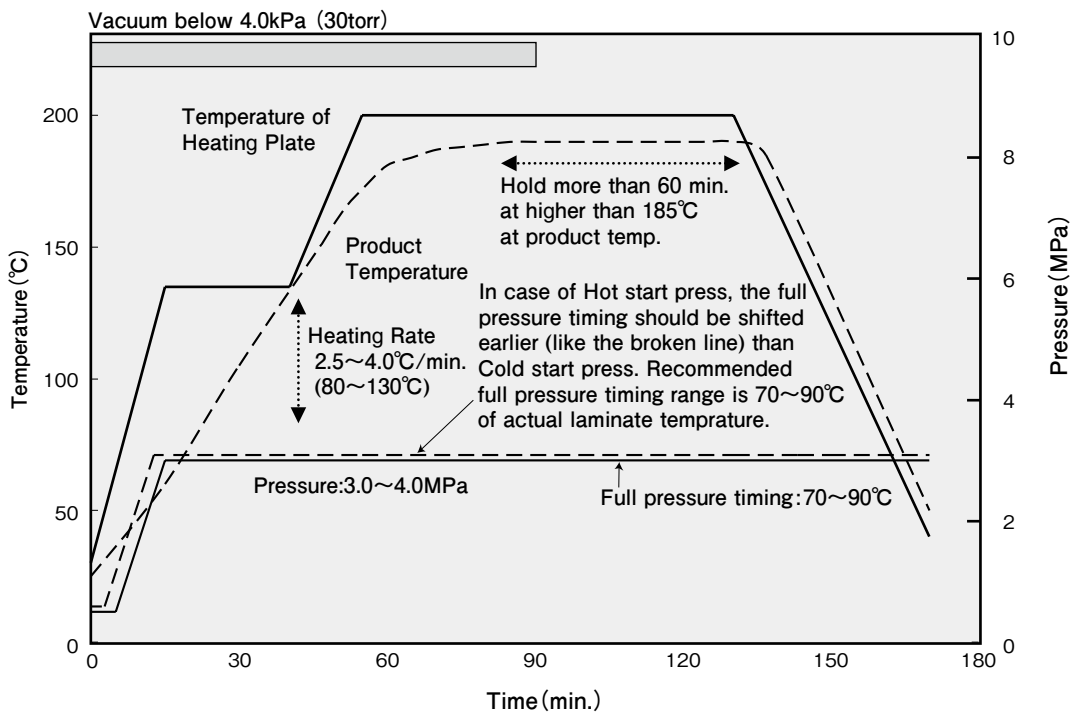
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-78G

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product measured from 80~130°C should be between 2.5 and 4.0°C/minutes. The heating time when the product temperature is 185°C or higher should be 60minutes or longer.
- ② Setting temperature of heating plates differs depending on the heating rate of the product and the type of cushions used, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ Vacuuming should be started before heating and pressing the product and degree of vacuum should be below 4.0kPa(30torr).
- ④ Vacuuming should not be continued until the end of molding process. If the vacuuming is continued until the end of the lamination process, bubbles might remain in the flowed prepreg resin. As a result, the flowed resin might become fragile and break into fragments. The fragments of resin scattezed on the product might cause dents or defaults on the surface of the product. Also fine bubbles and blur might occur at the edge of the product, if the vacuuming is continued till the end.
- ⑤ Lamination pressure should be thoroughly examined, because it might influence the thickness of the product and the rate of dimensional change of the product.
(Standard pressure for vacuum pressing is 3.0~4.0MPa.)
- ⑥ To lessen the pressure shock of the product, two-stage press is recommended. The lamination pressure at the first stage recommended is 0.5MPa.
- ⑦ In case of Hot start press, the full pressure timing should be shifted earlier (like the broken line) than Cold start press. Recommended full pressure timing range is 70~90°C of actual laminate temperature.

■ Recommendation Press Conditions



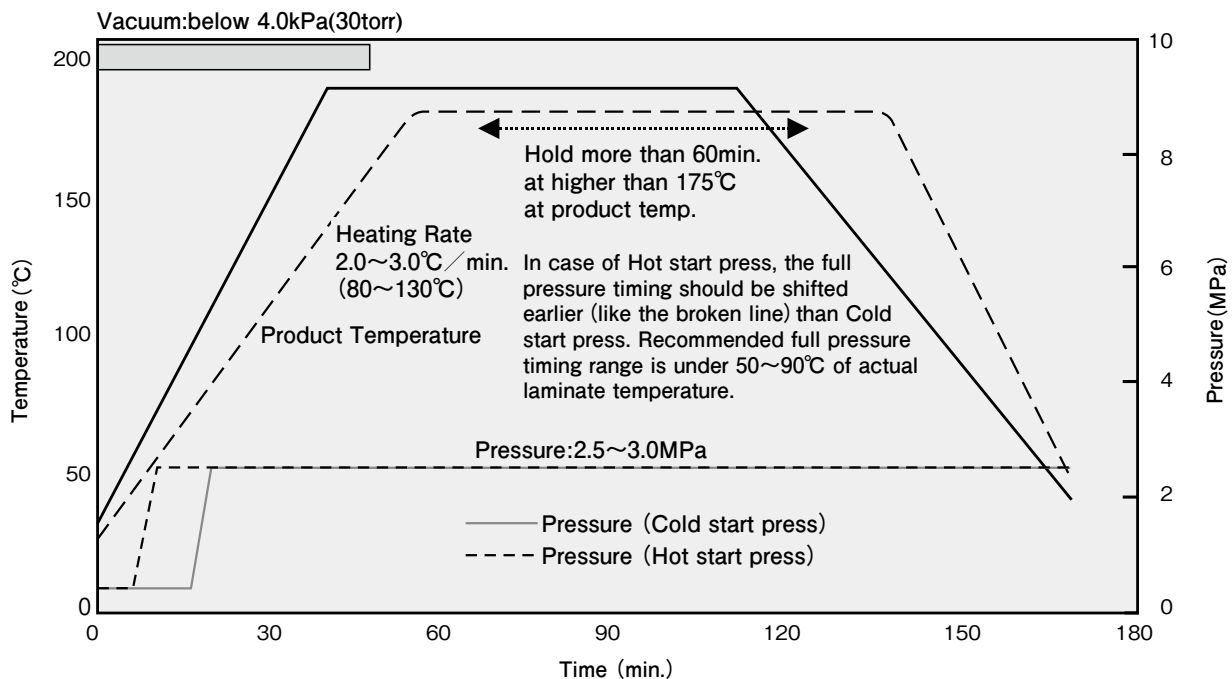
*The standard heating profile is for general reference only. Conditions may change according to metal plate thickness, number of cushion layers, number of MLB lay-ups, etc.

TD-002

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product measured from 80~130°C should be between 2.0~3.0°C/minutes.
The heating time when the product temperature is 175°C or higher should be 60 minutes or longer.
- ② Setting temperature of heating plates differs depending on the heating rate of the product and the type of cushions used, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ Vacuuming should be started before heating and pressing the product and degree of vacuum should be below 4.0kPa(30torr).
- ④ Vacuuming should not be continued until the end of molding process. If the vacuuming is continued until the end of the lamination process, bubbles might remain in the flowed prepreg resin. As a result, the flowed resin might become fragile and break into fragments. The fragments of resin scattered on the product might cause dents or defaults on the surface of the product.
Also fine bubbles and blur might occur at the edge of the product, if the vacuuming is continued till the end.
- ⑤ Lamination pressure should be thoroughly examined, because it might influence the thickness of the product and the rate of dimensional change of the product. (Standard pressure for vacuum pressing is 2.5~3.0MPa.)
- ⑥ To lessen the pressure shock of the product, two-stage press is recommended. The lamination pressure at the first stage recommended is 0.5MPa.
- ⑦ In case of Hot start press, the full pressure timing should be shifted earlier (like the broken line) than Cold start press. Recommended full pressure timing range is under 50~90°C of actual laminate temperature.

■ Recommendation Press Conditions



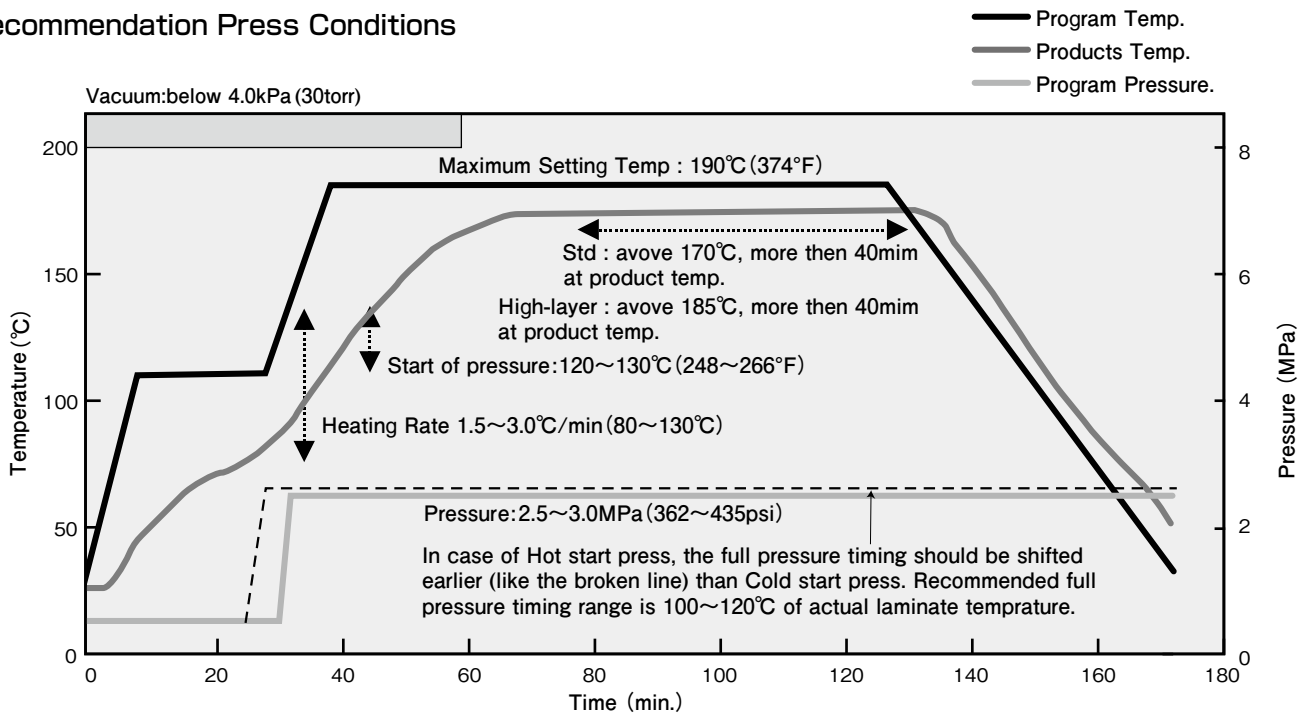
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-75G

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product should be about 1.5~3.0°C/min. within the melting temperature range of the prepreg resin (80~130°C).
- ② Hold the product temperature above 170°C for more than 40 min.
- ③ For high layer MLBs requiring the high Tg and higher through hole reliability, please set the product temperature higher than the standard temperature (above 185°C for more than 40min).
- ④ Vacuuming should be started before heating and pressing the product and degree of vacuum shall be below 30torr(0.58psi). The time for vacuuming is continued until the end of molding process(when resin flow stops).
- ⑤ The initial pressure is 0.5MPa, and step up pressure to 2.5~3.0MPa before minimum melt viscosity(100~120°C).
- ⑥ In case of Hot start press, the full pressure timing should be shifted earlier (like the broken line) than Cold start press. Recommended full pressure timing range is 100~120°C of actual laminate temperature.

■ Recommendation Press Conditions



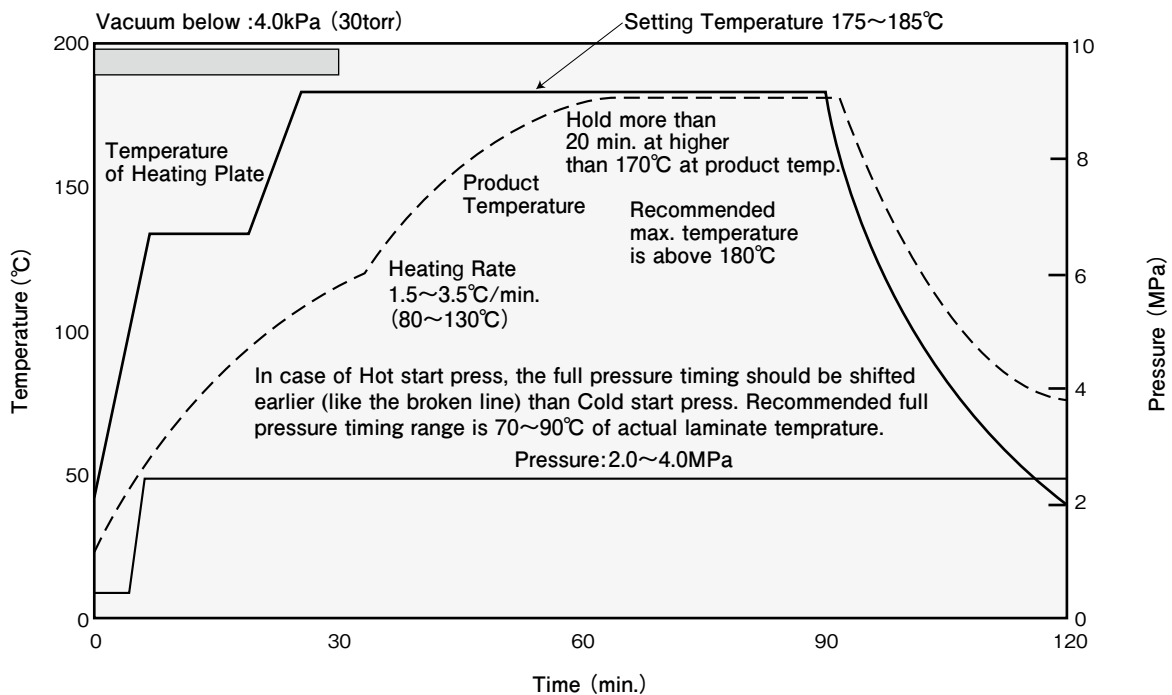
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GEA-67N

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product shall be about 1.5~3.5°C/min. within the melting temperature range of the prepreg resin (80~130°C). Hold the product temperature above 170°C for more than 20 min. (Above 180°C as maximum temperature is recommended.)
- ② Two-steps heating enables to minimize the temperature deviation of each layer and position in laminate, by keeping the temperature at 120~130°C for about 10 to 20 min.
 ※Once the resin flow stops after molding, please set the temperature to be second level
- ③ The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above conditions ① and ②.
- ④ The degree of vacuum shall be below 4.0 kPa (30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ⑤ The time for vacuuming shall not be longer than the end of molding process (when resin flow stops). If the vacuuming is continued until the end of the lamination process, flowed resin becomes fragile due to bubble remain. Fragments of it may become a cause of dent. Also small bubbles (blur) may occur in the edge of the product.
- ⑥ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.0 to 4.0 MPa at Vacuum press.)
- ⑦ In order to reduce pressure shock to the product, it is recommended to set initial pressure low, 0.5 MPa for 5 to 10 min, although one-step pressure is basically no problem.
- ⑧ In case of Hot start press, the full pressure timing should be shifted earlier (like the broken line) than Cold start press. Recommended full pressure timing range is 70~90°C of actual laminate temperature.

■ Recommendation Press Conditions



※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

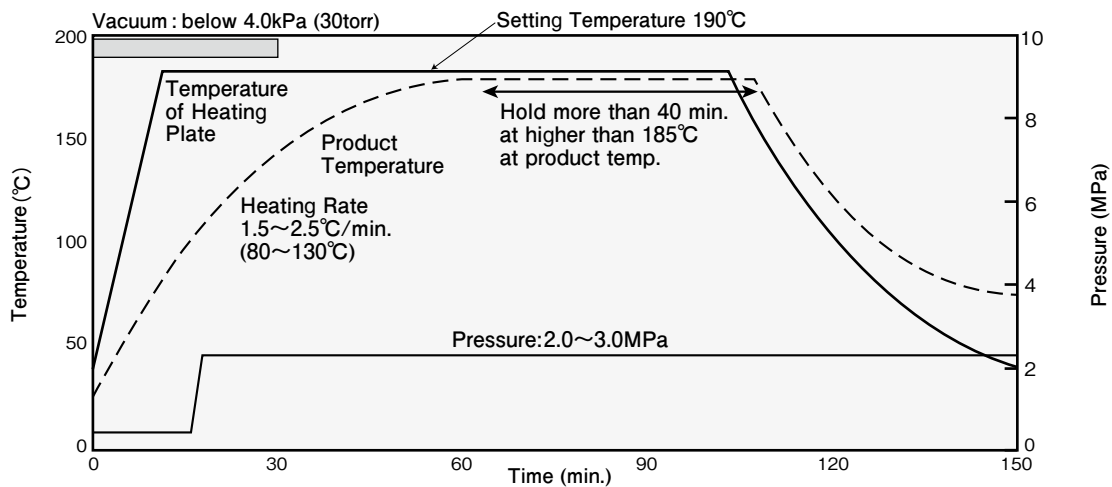
GEA-679N

■Precautions for Lamination of Multilayer Board

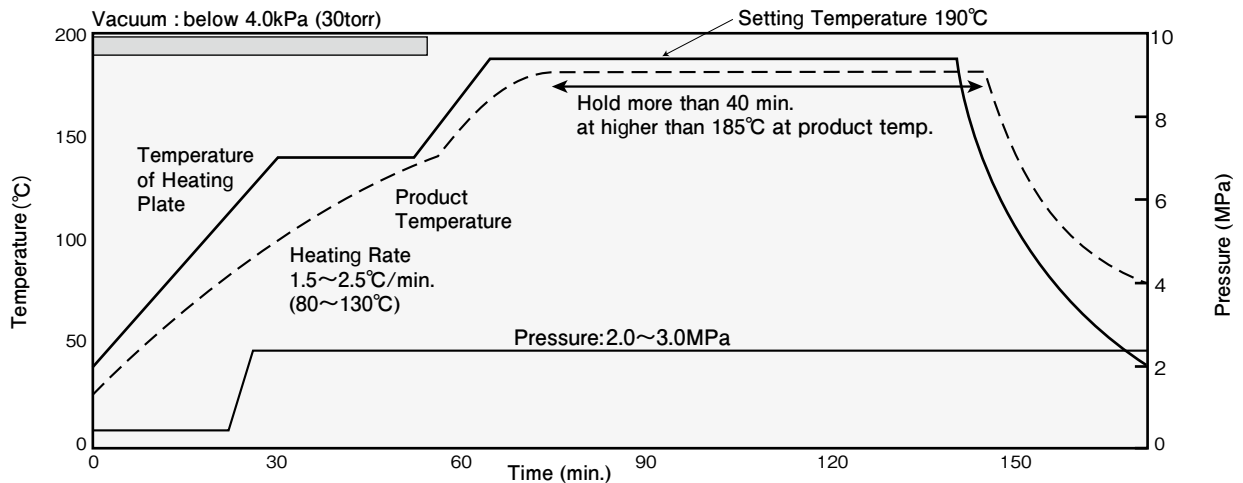
- ① Heating rate of the product should be about 1.5~2.5°C/min. within the melting temperature range of the prepreg resin (80~130°C). Hold the product temperature above 185°C for more than 40 min.
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ For semiconductor packaging application, it is necessary to maintain the properties of the product (such as wire bonding) at high temperature. Therefore, please set the temperature of the heating plates higher than the standard temperature.
- ④ The degree of vacuum shall be below 4.0 kPa (30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ⑤ The time for vacuuming shall not be longer than the end of molding process (When resin flow stops). If the vacuuming is continued until the end of the lamination process, flowed resin becomes fragile due to bubble remain. Fragments of it may become a cause of dent. Also small bubbles (blur) may occur in the edge of the product.
- ⑥ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (standard pressure is 2.0 to 3.0 MPa.)
- ⑦ In order to reduce pressure shock to the product, it is recommended to set initial pressure low, 0.5 MPa for 5 to 20 min., although one-step pressure is basically no problem.
- ⑧ Inner pattern filling capability of prepreg may change according to inner pattern and thickness design.

■Recommendation Press Conditions

●For Standard Multilayer Application



●For Semiconductor Packaging Application



※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GWA-900G/GWA-910G

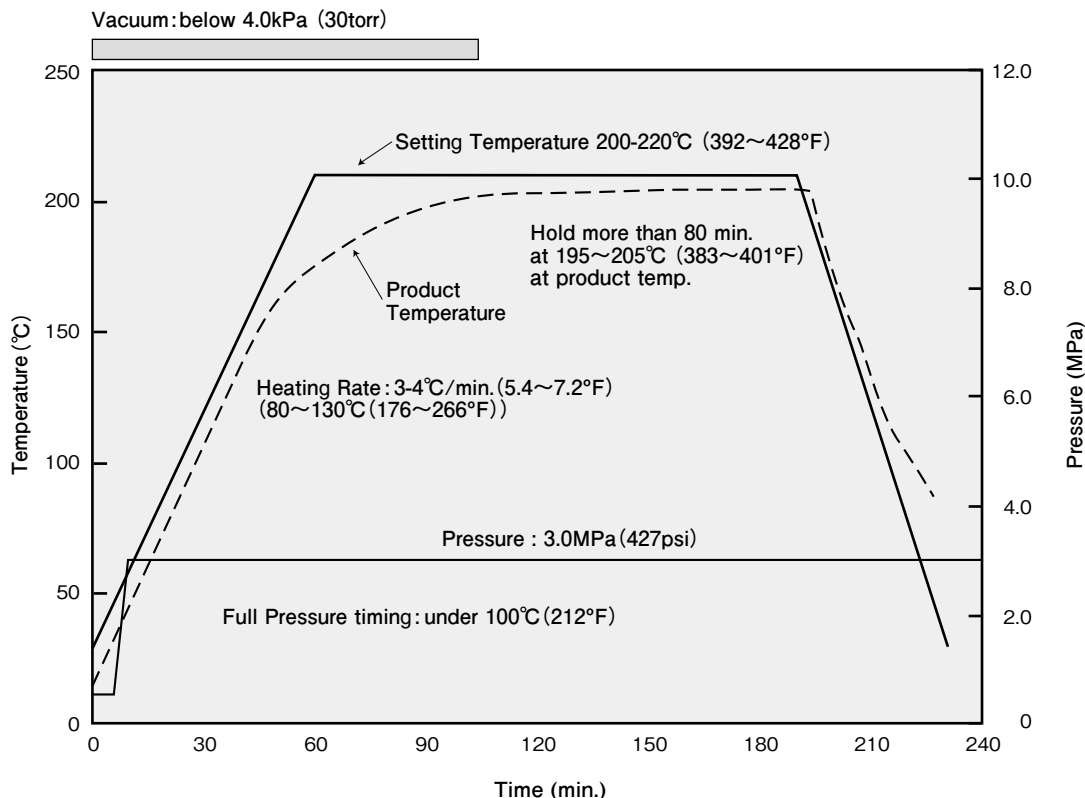
■Precautions for Outer-layer Copper Foil

There is the case that Outer-layer peel strength lowers by a kind of the copper foil. Copperfoil should be examined enough.

■Precautions for Lamination of Multilayer Board

- ①Heating rate of the product should be about 3~4°C/min. within the melting temperature range of the prepreg resin (80°C~).
- ②The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temprature in order to satisfy the above condition ①.
- ③The degree of vacuum shall be below 4.0 kPa (30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④The time for vacuuming shall not be longer than the end of molding process. If the vacuuming is continued until the end of the lamination process, flowed resin becomes fragile due to bubble remain. Fragments of it may become a cause of dent. Also small bubbles (blur) may occur in the edge of the product.
- ⑤The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.5~4.0 MPa at vacuum pressing.)
- ⑥We recommend that pressure on material is the low pressure of 0.5 MPa for resin of prepreg at the initial stage and material temperature pressurizes it befor 80°C. The starting pressure is 0.5MPa, and set the full-pressure, before product temperature become 100°C.

■Recommendation Press Conditions



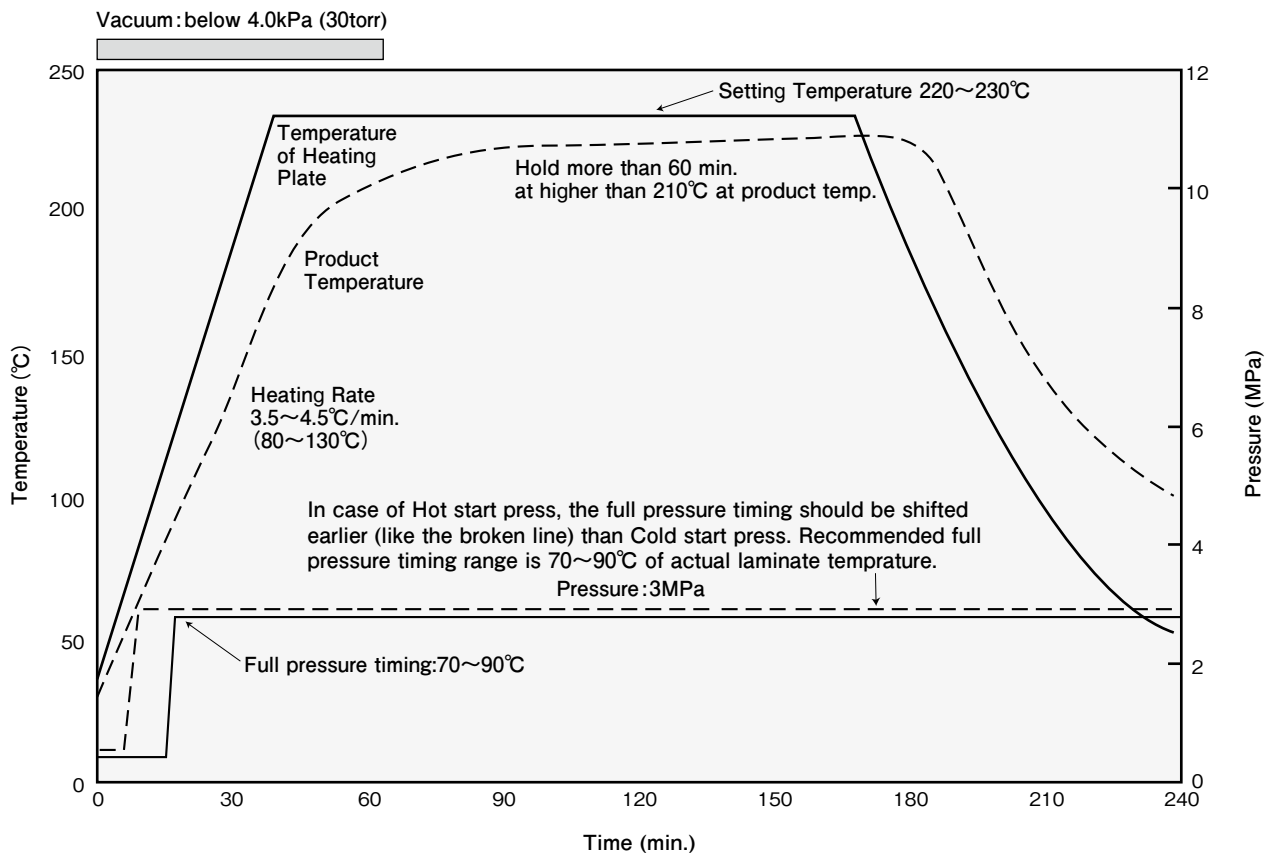
※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

GHA-679G Type(S)

■ Precautions for Lamination of Multilayer Board

- ① Heating rate of the product should be about 3.5~4.5°C/min. within the melting temperature range of the prepreg resin. Hold the product temperature above 210°C for more than 60 min
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ The degree of vacuum shall be below 4.0 kPa (30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ④ The time for vacuuming shall not be longer than the end of molding process. If the vacuuming is continued until the end of the lamination process, flowed resin becomes fragile due to bubble remain. Fragments of it may become a cause of dent. Also small bubbles (blur) may occur in the edge of the product.
- ⑤ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (Standard pressure is 2.5~3.5 MPa at vacuum pressing.)
- ⑥ In order to reduce pressure shock to the product, it is recommended to set initial pressure low, 0.5 MPa, although one-step pressure is basically no problem.
- ⑦ In case of Hot start press, the full pressure timing should be shifted earlier (like the broken line) than Cold start press. Recommended full pressure timing range is 70~90°C of actual laminate temperature.

■ Recommendation Press Conditions



※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

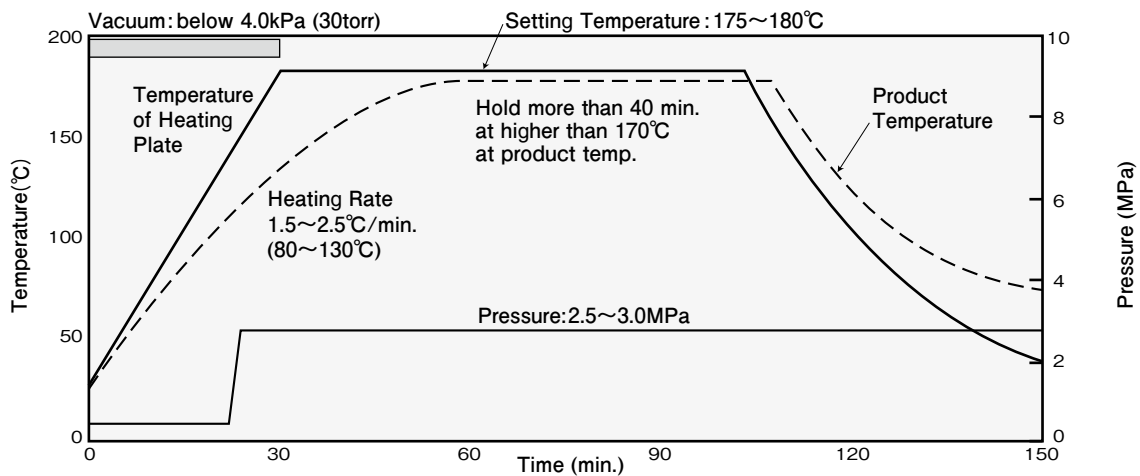
GIA-671N

■Precautions for Lamination of Multilayer Board

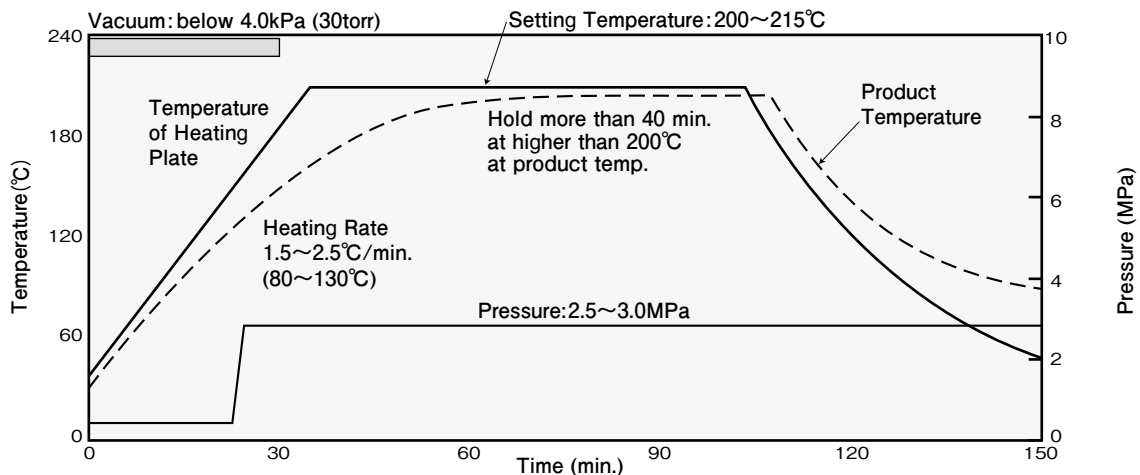
- ① Heating rate of the product should be about 1.5~2.5°C/min. within the melting temperature range of the prepreg resin (80~130°C). Hold the product temperature above 170°C for more than 40 min.
- ② The setting temperature of the heating plates differs, depending on the heating rate or cushions, so it is necessary to adjust the temperature in order to satisfy the above condition ①.
- ③ For high Tg (over 200°C) MLB, please set the temperature of the heating plates higher than the standard temperature.
- ④ The degree of vacuum shall be below 4.0 kPa (30torr). Please start the vacuuming before adding heat and pressure for lamination.
- ⑤ The time for vacuuming shall not be longer than the end of molding process. If the vacuuming is continued until the end of the lamination process, flowed resin becomes fragile due to bubble remain. Fragments of it may become a cause of dent. Also small bubbles (blur) may occur in the edge of the product.
- ⑥ The pressure of the product may influence molding property, thickness between layers or dimensional change, so it is necessary to examine sufficiently to decide the condition. (standard pressure is 2.5~3.0 MPa.)
- ⑦ In order to reduce pressure shock to the product, it is recommended to set initial pressure low, 0.5 MPa for 20~30 min., although one-step pressure is basically no problem.

■Recommendation Press Conditions

●For Standard Multilayer Application



●For Multilayer Application Requiring Tg of More than 200°C



※The standard heating profile is for general reference only. Conditions may change depending on metal plate thickness, number of cushion layers, number of MLB lay-up, etc.

Standards

UL Standard

P84

BS Standard • CSA Standard

P85

Standards

UL Standard

●Base Material Recognition File No. E80148

Part Number	ANSI	Min. Thickness (mm)	UL 94 Flame Class	TI *		PLC				DSR
				Elec	Mech	HWI*	HAI*	HVTR*	CTI	
MCL-E-67	FR-4.0	0.03	V-0	130	140	0	2	4	3	YES
MCL-E-679	FR-4.0	0.03	V-0	130	140	0	2	3	3	YES
MCL-E-679F	FR-4.0	0.03	V-0	130	140	0	1	0	1	YES
MCL-E-75G	FR-4.1	0.03	V-0,VTM-0	130	140	0	1	-	3	YES
MCL-E-679FG	FR-4.1	0.03	V-0,VTM-0	130	140	0	2	0	0	YES
MCL-HE-679G	FR-4.1	0.03	V-0,VTM-0	130	140	0	0	-	2	YES
MCL-E-78G	FR-4.1	0.03	V-0,VTM-0	130	140	0	0	-	2	YES
MCL-I-671	GPY	0.03	V-0	170	180	0	0	3	4	YES
MCL-E-700G	-	0.02	V-0,VTM-0	180	180	3	0	-	0	YES
MCL-E-770G	-	0.02	V-0,VTM-0	50	50	0	0	-	1	YES
MCL-LW-900G MCL-LW-910G	-	0.05	V-0,VTM-0	160	140	0	1	-	1	YES
MCL-HS100	-	0.05	V-0,VTM-0	160	140	0	1	-	1	YES
TD-002	-	0.04	V-0,VTM-0	50	50	0	1	-	3	YES
E-668T	CEM-3	0.38	V-0	130	140	1	0	-	0	YES
KEL-GEF	FR-4.0	0.10	V-0	130	140	0	1	0	3	YES

* The data above are based on unclad laminates, and the properties may vary depending on the board thickness.

TI : Temperature Index(°C)
HWI : Hot Wire Ignition(PLC)

HAI : High Ampare Arc Ignition(PLC)
HVTR : High-voltage-arc Tracking Rate(PLC)

CTI : Comparative Tracking Index(PLC)

Hot Wire Ignition Performance Level Categories

Range - Mean Ignition Time (Sec.)	Assigned PLC
120 \leq IT	0
60 \leq IT < 120	1
30 \leq IT < 60	2
15 \leq IT < 30	3
7 \leq IT < 15	4
0 \leq IT < 7	5

High Ampare Arc Ignition Performance Level Categories

Range - Mean Number of Arc to Cause Ignition (NA)	Assigned PLC
120 \leq NA	0
60 \leq NA < 120	1
30 \leq NA < 60	2
15 \leq NA < 30	3
0 \leq NA < 15	4

High-voltage Arc-tracking-rate Performance Level Categories

Range - Tracking Rate (mm/min.)	Assigned PLC
0 < TR \leq 10	0
10 < TR \leq 25.4	1
25.4 < TR \leq 80	2
80 < TR \leq 150	3
150 < TR	4

Comparative Tracking Performance Level Categories

Range - Tracking Index (Voltage)	Assigned PLC
600 \leq TI	0
400 \leq TI < 600	1
250 \leq TI < 400	2
175 \leq TI < 250	3
100 \leq TI < 175	4
0 \leq TI < 100	5

●MCIL Recognition

File No. E80148

Part Number	ANSI	Min. Thickness (mm)	UL Flame Class	Clad Conductive Thickness(μm)		Max. Area Diameter (mm)	Solder Limit		Max. Operating Temperature (°C)
				Min.	Max.		Temperature(°C)	Time (Sec.)	
MCL-E-67	FR-4.0	0.09	V-0	5	70	50.8	*1		125
		0.20	V-0	5	105	50.8	*1		130
MCL-E-679	FR-4.0	0.12	V-0	5	105	50.8	*1		130
		0.20	V-0	5	105	50.8	*2		130
MCL-E-679F	FR-4.0	0.12	V-0	14.3	35	50.8	*1		110
		0.38	V-0	5	70	50.8	*1		130
MCL-E-679FG	FR-4.1	0.06(*)	V-0	5	105	50.8	*1		110
		0.12	V-0	3	35	50.8	*1		110
		0.20	V-0	5	70	50.8	*1		125
		0.38	V-0	5	70	50.8	*1		130
MCL-E-75G	FR-4.1	0.12	V-0	3	35	50.8	*3		120
		0.20	V-0	3	35	50.8	*3		130
		0.38	V-0	3	70	50.8	*3		130
		0.63	V-0	3	105	50.8	*3		130
MCL-HE-679G	FR-4.1	0.17	V-0	3	35	50.8	*3		120
		0.20	V-0	3	35	50.8	*3		130
		0.38	V-0	3	70	50.8	*3		130
MCL-E-78G	FR-4.1	0.17	V-0	3	35	50.8	*3		120
		0.20	V-0	3	35	50.8	*3		130
		0.38	V-0	3	70	50.8	*3		130
MCL-I-671	GPY	0.20	V-0	5	105	50.8	*2		130
E-668T E-568T	CEM-3	0.38(*)	V-0	12	102	50.8	*6		130

Certified condition may vary depending on the board thickness.

(*)Double sided.

*1: 230°C/40Min. + 250°C/40Sec. + 260°C/20Sec.
 *2: 230°C/60Min. + 260°C/2Min. + 260°C/20Sec.
 *3: 230°C/40Min. + 250°C/2Min. + 288°C/30Sec.

*4: 260°C/20Sec.
 *5: 200°C/30Min. + 250°C/40Sec. + 260°C/40Sec. or 200°C/20Min. + 230°C/2Min. + 260°C/1Min.
 *6: 260°C/3Min.

BS Standard

Certificate No.	Part Number	Flammability category	Min. Thickness(mm)
5499	MCL-E-67	V-0	0.10
VC643584	MCL-E-679	V-0	0.10
VC643585	MCL-I-671	V-0	0.10
VC660376	MCL-E-679F	V-0	0.06
VC656656	MCL-E-679FG	V-0	0.06
9013	MCL-E-75G	V-0	0.07

CSA Standard

Part Number	ANSI	Min. Thickness(mm)	Flammability
MCL-E-67	FR-4	0.21	V-0

MEMO

A series of horizontal dashed lines for writing.

