

UNICIRCUIT MANUFACTURING GUIDELINES



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KEY FOR ALL LEVELS IN THIS GUIDELINE:

LEVEL 1	GREEN SIGNIFIES A LOW LEVEL OF DIFFICULTY, AND NO SPECIAL PROCESSING SHOULD BE REQUIRED. YIELDS SHOULD BE GOOD.
LEVEL 2	YELLOW SIGNIFIES A MODERATE LEVEL OF DIFFICULTY, AND SPECIAL PROCESSING TECHNIQUES MAY BE REQUIRED. YIELDS WILL BE AFFECTED.
LEVEL 3	RED SIGNIFIES THAT THERE IS AN EXTREMELY HIGH LEVEL OF DIFFICULTY, AND SPECIAL PROCESSING WILL BE REQUIRED. YIELDS WILL DEFINITELY BE AFFECTED AS A RESULT OF THE LEVEL OF DIFFICULTY.

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COPPER FEATURES - PRINT & ETCH GUIDELINES

GREEN = EASY	YELLOW = PROCEED WITH CARE	RED = APPROVAL REQUIRED
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1/4 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.003"	.003-.0025	<.0025"
MIN SPACE	>.003"	.003-.0025	<.0025"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.005"	.005-.004	<.004"

3/8 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.0035"	.0035" - .0025"	<.0025"
MIN SPACE	>.004	.004" - .003"	<.0030"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0055"	.0055" - .004"	<.004"

1/2 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.004"	.004" - .003"	<.0030"
MIN SPACE	>.0045	.0045" - .0035"	<.0035"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.006"	.006" - .0045"	<.0045"

1 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.005"	.005" - .004"	<.0040"
MIN SPACE	>.0055"	.0055" - .0045"	<.0045"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.007"	.007" - .0055"	<.0055"

2 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.007"	.007" - .006"	<.0060"
MIN SPACE	>.009"	.009" - .008"	<.0080"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.009"	.009" - .0075"	<.0075"

3 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.010"	.010" - .009"	<.0090"
MIN SPACE	>.0135"	.0135" - .0125"	<.0125"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0115"	.0115" - .010"	<.0100"

4 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.012"	.012-.011	<.0110"
MIN SPACE	>.0156"	.0156-.0146	<.0146"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.013"	.013-.012	<.012"

5 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.0155"	.0155-.0145	<.0145"
MIN SPACE	>.019"	.019-.018	<.018"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0165"	.0165-.0155	<.0155"

6 OZ COPPER - PRINT & ETCH (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.0169"	.0169-.0189	<.0189"
MIN SPACE	>.0234"	.0234-.0224	<.0244"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0159"	.0189-.0199	<.0199"

COPPER FEATURES - PRINT & PLATE GUIDELINES

GREEN = EASY	YELLOW = PROCEED WITH CARE	RED = APPROVAL REQUIRED
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1/4 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.003"	.003-.0025	<.0025"
MIN SPACE	>.003"	.003-.0025	<.0025"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.005"	.005-.004	<.004"

3/8 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.0037"	.0037" - .0027"	<.0027"
MIN SPACE	>.0042"	.0042" - .0032"	<.0032"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0057"	.0057" - .0042"	<.0042"

1/2 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.0045	.0045" - .0035"	<.0035"
MIN SPACE	>.005"	.005" - .004"	<.004"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0065"	.0065" - .005"	<.005"

1 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.0055"	.0055" - .0045"	<.0045"
MIN SPACE	>.0065"	.0065" - .0055"	<.0055"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0075"	.0075" - .006"	<.006"

2 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.007"	.007" - .006"	<.006"
MIN SPACE	>.009"	.009" - .008"	<.008"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.009"	.009" - .0075"	<.0075"

3 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN TRACE	>.010"	.010" - .009"	<.009"
MIN SPACE	>.0135"	.0135" - .0125"	<.0125"
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	>.0115"	.0115" - .010"	<.010"

Plated layers clad with copper 4 ounces and greater are all to be considered Level 3

4 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 3	LEVEL 3	LEVEL 3
MIN TRACE	LEVEL 3	LEVEL 3	LEVEL 3
MIN SPACE	LEVEL 3	LEVEL 3	LEVEL 3
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	LEVEL 3	LEVEL 3	LEVEL 3

5 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 3	LEVEL 3	LEVEL 3
MIN TRACE	LEVEL 3	LEVEL 3	LEVEL 3
MIN SPACE	LEVEL 3	LEVEL 3	LEVEL 3
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	LEVEL 3	LEVEL 3	LEVEL 3

6 OZ COPPER - PRINT & PLATE (BEFORE ETCH COMP)			
	LEVEL 3	LEVEL 3	LEVEL 3
MIN TRACE	LEVEL 3	LEVEL 3	LEVEL 3
MIN SPACE	LEVEL 3	LEVEL 3	LEVEL 3
MIN COPPER BETWEEN PLANE RELIEF'S (WEBS)	LEVEL 3	LEVEL 3	LEVEL 3

DRILL GUIDELINES

GREEN = EASY	YELLOW = PROCEED WITH CARE	RED = APPROVAL REQUIRED
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DRILL BIT SIZES (PLATING NOT INCLUDED)				
BOARD THICKNESS	LEVEL 1	LEVEL 2	LEVEL 3	ATE COMMERCIAL
UP TO .031"	>.008"	.008" - .006"	<.006" = NO-QUOTE	N/A
.032" - .062"	>.0091"	.0090" - .0076"	<.0076" = NO-QUOTE	.0059"
.063" - .093"	>.0135"	.0135" - .0080"	<.0080" = NO-QUOTE	.0079"
.094" - .125"	>.0145"	.0145" - .0120"	<.0105" = NO-QUOTE	.009"
.126" - .188"	>.0200"	.0200" - .0180"	<.0160" = NO-QUOTE	.0118"
.188" - .250"	>.0280"	.0280" - .0240"	<.0210" = NO-QUOTE	.0138"
>.250"	CONTRACT REVIEW REQUIRED			
MAX DRILLED HOLE OR DRILLED SLOT = .257				MAX ASPECT RATIO (ATE COMMERCIAL) 20:1
MAX ASPECT RATIO FOR HOLES >.008" IS 12:1 FOR NON-ATE COMMERCIAL PRODUCT MAX ASPECT RATIO FOR .008" HOLE IS 7.75:1 FOR NON-ATE COMMERCIAL PRODUCT FOR ATE COMMERCIAL MARKET PLEASE REFER TO THE "ATE COMMERCIAL" COLUMN				

Non Plated holes can be tented except when:

- Hole is larger than .200"
- Copper is closer than .010" to hole edge
- Panel thickness is less than .030" (Aspect ratio dependant)
- Holes are in a cavity

TOLERANCE GUIDELINES

PLATED HOLE SIZE TOLERANCE		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .003"	+/- .002" - +/- .003"	< +/- .002"

NON PLATED HOLE SIZE TOLERANCE		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .002"	+/- .001" - +/- .002"	< +/- .001"

TRUE POSITIONAL TOLERANCE - WHERE MAXIMUM MATERIAL CONDITION APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
.005	.005	.005
≤ 2" SQUARE AREA	2.1" - 4.0" SQUARE AREA	4.1" AND ABOVE SQUARE AREA
TEFLON MATERIALS ARE EXCLUDED FROM THESE RULES, AND WILL REQUIRE MANAGEMENT APPROVAL		

TRUE POSITIONAL TOLERANCE - WHERE REGARDLESS OF FEATURE SIZE APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
.006	.006	.006
≤ 2" SQUARE AREA	2.1" - 4.0" SQUARE AREA	4.1" AND ABOVE SQUARE AREA
TEFLON MATERIALS ARE EXCLUDED FROM THESE RULES, AND WILL REQUIRE MANAGEMENT APPROVAL		

COUNTER BORE DEPTH TOLERANCE		
LEVEL 1	LEVEL 2	LEVEL 3
> ± .005"	+/- .0031" - +/- .005"	+/- .003"

DFM GUIDELINES & TOOLS:

ABSOLUTE MINIMUM DRILL BIT SIZE FOR PANEL THICKNESS FOR ATE COMMERCIAL PRODUCT				
Drill Dia.	Des.	Flute length	Max pnl thickness	Max pnl thickness (if flip drilled)
0.0059"	0.15mm	0.097"	0.062"	0.090"
0.0079"	0.20mm	0.136"	0.090"	0.150"
0.0090"	0.23mm	0.150"	0.125"	0.180"
0.0098"	0.25mm	0.175"	0.140"	0.200"
0.0118"	0.30mm	0.234"	0.200"	0.250"
0.0138"	0.35mm	0.300"	0.250"	0.250"
0.0145"	#79	0.250"	0.250"	0.250"
0.0158"	0.40mm	0.331"	0.250"	0.250"
0.0177"	0.45mm	0.330"	0.250"	0.250"
0.0200"	#76	0.300"	0.250"	0.250"
0.0210"	#75	0.300"	0.250"	0.250"
0.0225"	#74	0.300"	0.250"	0.250"
0.0240"	#73	0.300"	0.250"	0.250"
0.0250"	#72	0.300"	0.250"	0.250"
0.0260"	#71	0.300"	0.250"	0.250"

DRILL TO FEATURE GUIDELINES

GREEN = EASY

YELLOW =
PROCEED WITH
CARE

RED =
APPROVAL
REQUIRED

ANNULAR RING REQUIREMENTS FOR CLASS 3 PRODUCT

	LEVEL 1	LEVEL 2	LEVEL 3
EXTERNAL	>.010"	.010" - .007"	<.007"
INTERNAL	>.009"	.009" - .006"	<.006"

THE EMPLOYMENT OF FILLETING OR "TEAR DROPPING" IN CLASS 3 PRODUCT SHALL BE AS AGREED UPON BETWEEN UNICIRCUIT AND THE CUSTOMER.

ANNULAR RING REQUIREMENTS TO MEET TANGENCY REQUIREMENTS

	LEVEL 1	LEVEL 2	LEVEL 3
EXTERNAL	>.008"	.008" - .005"	<.005"
INTERNAL	>.008"	.008" - .005"	<.005"

UNLESS PROHIBITED BY THE CUSTOMER, FILLETING OR "TEAR DROPS" SHALL BE ACCEPTABLE TO CREATE ADDITIONAL LAND AREA AT THE CONDUCTOR JUNCTION FOR CLASS 1 & 2.

THE EMPLOYMENT OF FILLETING OR "TEAR DROPPING" IN CLASS 3 PRODUCT SHALL BE AS AGREED UPON BETWEEN UNICIRCUIT AND THE CUSTOMER.

ANNULAR RING REQUIREMENTS FOR CLASS 2 PRODUCT

	LEVEL 1	LEVEL 2	LEVEL 3
EXTERNAL	>.007"	.007" - .004"	<.004"
INTERNAL	>.007"	.007" - .004"	<.004"

UNLESS PROHIBITED BY THE CUSTOMER, FILLETING OR "TEAR DROPS" SHALL BE ACCEPTABLE TO CREATE ADDITIONAL LAND AREA AT THE CONDUCTOR JUNCTION FOR CLASS 1 & 2.

MINIMUM DISTANCE BETWEEN HOLE AND INNER LAYER FEATURES

3/8 & 1/2 OZ SIGNAL LAYERS			
BOARD THICKNESS	LEVEL 1	LEVEL 2	LEVEL 3
UP TO .062"	>.012"	.012" - .007"	<.007"
.063" - .093"	>.012"	.012" - .007"	<.007"
.094" - .125"	>.012"	.012" - .007"	<.007"
.126" - .188"	>.014"	.013" - .009"	<.009"
.189" -	>.014"	.014" - .010"	<.010"

FOR PLANE LAYERS, ADD AN ADDITIONAL .001"

1 OZ SIGNAL LAYERS			
BOARD THICKNESS	LEVEL 1	LEVEL 2	LEVEL 3
UP TO .062"	>.0125"	.0125" - .0075"	<.0075"
.063" - .093"	>.0125"	.0125" - .0075"	<.0075"
.094" - .125"	>.0125"	.0125" - .0075"	<.0075"
.126" - .188"	>.0135"	.0135" - .0095"	<.0095"
.189" -	>.0145"	.0145" - .0105"	<.0105"

FOR PLANE LAYERS, ADD AN ADDITIONAL .001"

2 OZ SIGNAL LAYERS			
BOARD THICKNESS	LEVEL 1	LEVEL 2	LEVEL 3
UP TO .062"	>.0135"	.0135" - .0085"	<.0085"
.063" - .093"	>.0135"	.0135" - .0085"	<.0085"
.094" - .125"	>.0135"	.0135" - .0085"	<.0085"
.126" - .188"	>.0145"	.0145" - .0105"	<.0105"
.126" - .188"	>.0155"	.0155" - .0115"	<.0115"

FOR PLANE LAYERS, ADD AN ADDITIONAL .001"

ELECTRICAL TEST

GUIDELINES FOR TEST BEFORE ROUT

All boards with thickness under .040" should be set to test before rout.

All boards sizes smaller than 6X6" and / or with testable features within .200" of board edge should be set to test before rout.

All boards with odd shapes (round, triangle, L shape Etc.) should be set to test before rout.

GUIDELINES FOR TEST AFTER ROUT

Multiple parts within arrays, with board thickness equal to or greater than .040" with testable features no closer than .200" of board edges.

Square and rectangle parts 6x6" and greater, with testable features no closer than .200" of board edges should be tested after rout.

TEST CAPABILITIES

Maximum Test Voltage	500 volts
Minimum Ohms Continuity Test	10-5 ohms
Discontinuity Test (M ohms)	2-100 M ohms
Minimum Test Pitch	0.012
Minimum test pad size	.008 x .010
Maximum Test Size	24 x 24
Standard Test Voltage	IPC 40V

ANY REQUIREMENTS THAT EXCEED THESE REQUIREMENTS WILL REQUIRE A WAIVER OR OUTSIDE SERVICE.

HI-POT TEST CAPABILITIES

500 volts DC at 100 volt per second rate of rise time, for a duration of 30 seconds between voltage and ground layers

HOLE FILL GUIDELINES

FILLED HOLE COPPER THICKNESS GUIDELINES (BEFORE FILL AND AFTER SAND)					
PLATE CYCLES	MINIMUM CU THICKNESS BEFORE FILL				
0	(1/4 oz).00035"	(3/8 oz.).00053	(.5 oz).0007"	(1 oz) .0014"	(2 oz.) .0028"
1	.0008-.0012	.0010-.0014	.0012-.0016	.0019-.0023	.0033-.0037
2	.0011-.0015	.0013-.0017	.0015-.0019	.0022-.0026	.0036-.0040
3	.0014-.0018	.0016-.0020	.0018-.0022	.0025-.0029	.0039-.0043
4	.0017-.0021	.0019-.0023	.0021-.0025	.0028-.0032	.0042-.0046
PLATE CYCLES	MINIMUM CU THICKNESS AFTER SAND				
0	(1/4 oz).00035"	(3/8 oz.).00053	(.5 oz).0007"	(1 oz) .0014"	(2 oz.) .0028"
1	.0006-.0010	.0008-.0012	.0010-.0014	.0017-.0021	.0031-.0035
2	.0009-.0013	.0011-.0015	.0013-.0017	.0020-.0024	.0034-.0038
3	.0012-.0016	.0014-.0018	.0016-.0020	.0024-.0026	.0037-.0041
4	.0015-.0019	.0017-.0020	.0019-.0023	.0027-.0028	.0040-.0044

NEVER fill a laser hole with conductive or non-conductive hole fill

CONDUCTIVE HOLE FILL - DUPONT - CB 100

CB hole fill is NOT to be used unless the customer has a requirement documented on the drawing.

	Dk	Df	Tg	CTE (ppm)
DUPONT - CB 100			115° C	35

15:1

Minimum finished hole sizes for CB fill				
Board Thickness	Level 1	Level 2	Level 3	ATE
Up to 0.031	>.0145	.0080 - .0145	<.0080	0.0080
.032 - 0.062	>.0145	.0080 - .0145	<.0080	0.0080
.063 - 0.093	>.0155	.0100 - .0155	<.0100	0.0080
.094 - 0.125	>.0208	.0125 - .0208	<.0125	0.0083
.126 - 0.157	>.0261	.0157 - .0261	<.0157	0.0105
.158 - 0.188	>.0313	.0235 - .0313	<.0235	0.0125
.189 - 0.220	>.0366	.0275 - .0366	<.0275	0.0145
.221 - 0.250	>.0416	.0313 - .0416	<.0313	0.0166
.251 - UP	.045 MAX	.0350 - .0450	<.0350	15:1 A/R

Aspect Ratio = 8 :1

NON CONDUCTIVE HOLE FILL - PETERS - PP 2795 SD, PETERS - PP 2361 SD & SAN-EI KAGAKU (PHP900)

	Dk	Df	Tg	CTE (ppm)
PETERS - PP 2795 SD			140° C	<40
	Dk	Df	Tg	CTE (ppm)
PETERS - PP 2361 SD			86° C	632 / 1472
	Dk	Df	Tg	CTE (ppm)
SAN-EI KAGAKU PHP-900	5.51 @ 1MHz	.0162 @ 1MHz	160° C	42 / 113

20:1

Minimum finished hole sizes for Lackwerke Peters & San-Ei Kagaku Fill				
Board Thickness	Level 1	Level 2	Level 3	ATE
Up to 0.031	>.0145	.006 - .0145	<.006	0.0060
.032 - 0.062	>.0145	.006 - .0145	<.006	0.0060
.063 - 0.093	>.0145	.006 - .0145	<.006	0.0060
.094 - 0.125	>.0145	.0085 - .0145	<.0085	0.0063
.126 - 0.157	>.0174	.0111 - .0174	<.0111	0.0079
.158 - 0.188	>.0208	.0137 - .0208	<.0137	0.0094
.189 - 0.220	>.0244	.0164 - .0244	<.0164	0.0110
.221 - 0.250	>.0277	.0189 - .0277	<.0189	0.0125

Aspect Ratio 12 :1

Maximum finished hole sizes for Lackwerke Peters fill			
Board Thickness	Level 1	Level 2	Level 3
Up to .250	<.040	.040 - .050	>.050

FILLET MATERIAL (RIGID FLEX)

FILLET MATERIAL (RIGID FLEX) - EMERSON & CUMMINGS - ECCOBOND

NOTES:
CLEAR, BLACK, WHITE
CATALYST CLEAR

FILLET MATERIAL (RIGID FLEX) - 3M - SCOTCHWELD 2216 B/A TRANSLUCENT

NOTES:

IMPEDANCE GUIDELINES

MIXED DIELECTRIC CALCULATOR

PREPREG LOSS CALCULATOR

50 OHM SINGLE ENDED PRINT & ETCH			
	Level 1 Tolerance	Level 2 Tolerance	Level 3 Tolerance
Dielectric To Reference Plane $\geq .004$	10%	5% - 10%	<5%
Dielectric To Reference Plane $< .004$	10%	7% - 10%	<7%
Trace Width $\geq .004$	10%	5% - 10%	<5%
Trace Width $< .004$	10%	7% - 10%	<7%
Trace Width $< .004$ & Dielectric To Reference Plane $< .004$	15%	10% - 15%	<10%
REQUIREMENTS THAT FALL OUTSIDE OF THE LISTED CAPABILITIES MUST BE MODELED PRIOR TO ACCEPTANCE.			

50 OHM SINGLE ENDED PRINT & PLATE INNER LAYER			
	Level 1 Tolerance	Level 2 Tolerance	Level 3 Tolerance
Dielectric To Reference Plane $\geq .004$	10%	7% - 10%	<7%
Dielectric To Reference Plane $< .004$	15%	10% - 15%	<10%
Trace Width $\geq .004$	10%	7% - 10%	<7%
Trace Width $< .004$	15%	10% - 15%	<10%
Trace Width $< .004$ & Dielectric To Reference Plane $< .004$	20%	15% - 20%	<15%
REQUIREMENTS THAT FALL OUTSIDE OF THE LISTED CAPABILITIES MUST BE MODELED PRIOR TO ACCEPTANCE.			

50 OHM SINGLE ENDED PRINT & PLATE OUTER LAYER			
	Level 1 Tolerance	Level 2 Tolerance	Level 3 Tolerance
Dielectric To Reference Plane $\geq .004$	10%	5% - 10%	<5%
Dielectric To Reference Plane $< .004$	10%	7% - 10%	<7%
Trace Width $\geq .004$	10%	5% - 10%	<5%
Trace Width $< .004$	30%	25% - 30%	<25%
Trace Width $< .004$ & Dielectric To Reference Plane $< .004$	25%	20% - 25%	<20%
REQUIREMENTS THAT FALL OUTSIDE OF THE LISTED CAPABILITIES MUST BE MODELED PRIOR TO ACCEPTANCE.			

51-75 OHM SINGLE ENDED PRINT & ETCH			
	Level 1 Tolerance	Level 2 Tolerance	Level 3 Tolerance
Dielectric To Reference Plane $\geq .004$	10%	7% - 10%	<7%
Dielectric To Reference Plane $< .004$	45%	35% - 45%	<35%
Trace Width $\geq .004$	10%	7% - 10%	<7%
Trace Width $< .004$	15%	10% - 15%	<10%
Trace Width $< .004$ & Dielectric To Reference Plane $< .004$	50%	40% - 50%	<40%
REQUIREMENTS THAT FALL OUTSIDE OF THE LISTED CAPABILITIES MUST BE MODELED PRIOR TO ACCEPTANCE.			

51-75 OHM SINGLE ENDED PRINT & PLATE INNER LAYER			
	Level 1 Tolerance	Level 2 Tolerance	Level 3 Tolerance
Dielectric To Reference Plane $\geq .004$	15%	10% - 15%	<10%
Dielectric To Reference Plane $< .004$	50%	40% - 50%	<40%
Trace Width $\geq .004$	15%	10% - 15%	<10%
Trace Width $< .004$	15%	10% - 15%	<10%
Trace Width $< .004$ & Dielectric To Reference Plane $< .004$	50%	40% - 50%	<40%
REQUIREMENTS THAT FALL OUTSIDE OF THE LISTED CAPABILITIES MUST BE MODELED PRIOR TO ACCEPTANCE.			

51-75 OHM SINGLE ENDED PRINT & PLATE OUTER LAYER			
	Level 1 Tolerance	Level 2 Tolerance	Level 3 Tolerance
Dielectric To Reference Plane $\geq .004$	10%	5% - 10%	<5%
Dielectric To Reference Plane $< .004$	25%	20% - 25%	<20%
Trace Width $\geq .004$	10%	5% - 10%	<5%
Trace Width $< .004$	10%	7% - 10%	<7%
Trace Width $< .004$ & Dielectric To Reference Plane $< .004$	25%	20% - 25%	<20%
REQUIREMENTS THAT FALL OUTSIDE OF THE LISTED CAPABILITIES MUST BE MODELED PRIOR TO ACCEPTANCE.			

100 OHM DIFFERENTIAL PRINT & ETCH
REQUIREMENTS FOR TOLERANCES LESS THAN 10% MUST BE MODELED PRIOR TO ACCEPTANCE.

100 OHM DIFFERENTIAL PRINT & PLATE INNER LAYER
REQUIREMENTS FOR TOLERANCES LESS THAN 10% MUST BE MODELED PRIOR TO ACCEPTANCE.

100 OHM DIFFERENTIAL PRINT & PLATE OUTER LAYER
REQUIREMENTS FOR TOLERANCES LESS THAN 10% MUST BE MODELED PRIOR TO ACCEPTANCE.

LEGEND & SOLDERMASK

GREEN = EASY	YELLOW = PROCEED WITH CARE	RED = APPROVAL REQUIRED
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LPI SOLDERMASK - TAIYO - PSR4000 BN (HV)

PREFERRED LPI MASK WHEN ALLOWABLE

MEETS NASA OUTGASSING LIMITS

GREEN, BLUE, RED, BLACK, WHITE, CLEAR

ATTRIBUTES: Good for small hole clearing, fine dam resolution, and withstands Enig & Immersion Tin

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .0025"	<.0025"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0055"	.0055" - .0035"	<.0035"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

LPI SOLDERMASK - TAIYO - PSR4000 HFX

GREEN, BLUE, RED, BLACK, WHITE, CLEAR

ATTRIBUTES: Halogen free, fast photospeed, fine dam resolution, and good resistance to Enig & Immersion Tin

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .0025"	<.0025"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0055"	.0055" - .0035"	<.0035"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

LPI SOLDERMASK - TAIYO - PSR4000 MP

MEETS NASA OUTGASSING LIMITS

GREEN

ATTRIBUTES: Solderball resistance, fast photospeed, fine dam resolution, hard surface finish, and good resistance to Enig & Immersion Tin

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .0025"	<.0025"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0055"	.0055" - .004"	<.004"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

LPI SOLDERMASK - ENTHONE - ENPLATE DSR-3241A

MEETS NASA OUTGASSING LIMITS

GREEN

ATTRIBUTES: Solderball resistance, short process time, withstands rigorous post-assembly cleaning solutions.

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .0025"	<.0025"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0055"	.0055" - .0035"	<.0035"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

DRY FILM SOLDERMASK - SHIPLEY- DYNAMASK 5030

FOR 1 OUNCE COPPER CLAD MATERIAL WE MUST USE 8140 MASK

DO NOT USE WHEN THE FINISH IS ENIG, FST, OR IMMERSION SILVER, UNLESS THE MASK IS APPLIED AFTER FINAL FINISH, OR WHEN MATERIAL IS CLAD WITH 2 OUNCE OR GREATER COPPER.

GREEN

THICKNESS = 3 MIL / ROLL WIDTH = 18"

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .002"	<.002"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0085"	.0085" - .0065"	<.0065"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

DRY FILM SOLDERMASK - SHIPLEY- DYNAMASK 5040

FOR 1 OUNCE COPPER CLAD MATERIAL WE MUST USE 8140 MASK

DO NOT USE WHEN THE FINISH IS ENIG, FST, OR IMMERSION SILVER, UNLESS THE MASK IS APPLIED AFTER FINAL FINISH, OR WHEN MATERIAL IS CLAD WITH 2 OUNCE OR GREATER COPPER.

GREEN

THICKNESS = 4 MIL / ROLL WIDTH = 18"

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .002"	<.002"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0085"	.0085" - .0065"	<.0065"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

DRY FILM SOLDERMASK - DUPONT - VACREL 8120

FOR 1 OUNCE COPPER CLAD MATERIAL WE MUST USE 8140 MASK

DO NOT USE WHEN THE FINISH IS ENIG, FST, OR IMMERSION SILVER, UNLESS THE MASK IS APPLIED AFTER FINAL FINISH, OR WHEN MATERIAL IS CLAD WITH 2 OUNCE OR GREATER COPPER.

GREEN

THICKNESS = 2 MIL / ROLL WIDTH = 18"

ATTRIBUTES: Meets Class III IPC-SM-840B, Superior tenting capability, fast cycle time.

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .002"	<.002"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0085"	.0085" - .0065"	<.0065"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

DRY FILM SOLDERMASK - DUPONT - VACREL 8140

DO NOT USE WHEN THE FINISH IS ENIG, FST, OR IMMERSION SILVER, UNLESS THE MASK IS APPLIED AFTER FINAL FINISH, OR WHEN MATERIAL IS CLAD WITH 2 OUNCE OR GREATER COPPER.

Passed ASTM E595 (outgassing in vacuum for spacecraft application)

GREEN

THICKNESS = 4 MIL / ROLL WIDTH = 18"

ATTRIBUTES: Meets Class III IPC-SM-840B, Superior tenting capability, fast cycle time.

	LEVEL 1	LEVEL 2	LEVEL 3
MIN ANNULAR RING	>.003"	.003" - .002"	<.002"
MIN COVERAGE	>.003"	.003" - .002"	<.002"
MIN MASK DAM	>.0085"	.0085" - .0065"	<.0065"

CAM - LEVEL 1 IS ALWAYS TO BE THE GOAL (WHERE POSSIBLE)

LEGEND

PRINTR LEGEND INK MK3.1			
THIS IS THE DEFAULT INK UNLESS OTHER INKS ARE REQUIRED BASED UPON CUSTOMER/SPEC. REQUIREMENTS			
MEETS ALL INDUSTRY SPECIFICATIONS TYPICAL WITH LEGEND INK			
WHITE -			
	LEVEL 1 *	LEVEL 2	LEVEL 3
MIN LINE WIDTH	5 MIL	2 - 4 MIL	<2 MIL
MIN CHAR. HEIGHT / WIDTH	40H 35W	30H 25W	<25H <25W
*Level 1 parameters apply as minimum requirements to parts with MP Mask			

SCREEN PRINTED LEGEND - HAVEN			
NOT APPROVED WHEN LOW OUTGASSING IS REQUIRED			
WHITE -			
YELLOW -			
RED -			
BLACK -			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN LINE WIDTH	7 MIL	6 MIL	<6 MIL
MIN CHAR. HEIGHT / WIDTH	50H 40W	35H 30W	<35H <30W

SCREEN PRINTED LEGEND - ENTHONE - 50-XXXX(see below)			
WHITE - 50-100R	CATALYST 5		
YELLOW - 50-202BR	CATALYST 9		
RED - 50-508R	CATALYST A20		
BLACK - 50-771R			
	LEVEL 1	LEVEL 2	LEVEL 3
MIN LINE WIDTH	7 MIL	6 MIL	<6 MIL
MIN CHAR. HEIGHT / WIDTH	50H 40W	35H 30W	<35H <30W

NON-CONDUCTIVE HOLE PLUG

NON CONDUCTIVE HOLE PLUG - TAIYO PSR400BN			
NOTES:			

Minimum finished hole sizes for Taiyo LPI Hole Plug			
Board Thickness	Level 1	Level 2	Level 3
Up to .031	0.010	.0101 - .0180	>.018
.032 - .062	0.010	.0101 - .0180	>.018
.063 - .093	0.013	.0126 - .0180	>.018
.094 - .125	0.014	.0146 - .0180	>.018
.126 - .157	0.017	.0165 - .0180	>.018
.158 - .188	0.018	0.018	>.018
.189 - .220	0.018	0.018	>.018
.221 - .250	0.018	0.018	>.018
.251 - UP	0.018	0.018	>.018

CAN BE USED WHEN HOLE SIZE RANGE IS .010" - .018"

IF DISTANCE FROM OUTER DIAMETER OF PLUG TO NEAREST SOLDERABLE FEATURE IS <.015, IT MUST BE PHOTO DEFINED.

IF DISTANCE FROM OUTER DIAMETER OF PLUG TO NEAREST SOLDERABLE FEATURE IS >.015, IT DOES NOT HAVE TO BE PHOTO DEFINED.

NON CONDUCTIVE HOLE PLUG - ENTHONE UVP-100			
NOTES:			

Minimum finished hole sizes for Enthone UVP-100 Plug			
Board Thickness	Level 1	Level 2	Level 3
Up to .031	0.008	.0081 - .0180	>.018
.032 - .062	0.010	.0101 - .0180	>.018
.063 - .093	0.013	.0126 - .0180	>.018
.094 - .125	0.014	.0146 - .0180	>.018
.126 - .157	0.017	.0165 - .0180	>.018
.158 - .188	0.018	0.018	>.018
.189 - .220	0.018	0.018	>.018
.221 - .250	0.018	0.018	>.018
.251 - UP	0.018	0.018	>.018

CAN BE USED WHEN HOLE SIZE RANGE IS .010" - .018"

UVP CAN ONLY BE USED WHEN THE DISTANCE FROM THE OUTER DIAMETER OF PLUG TO THE NEAREST SOLDERABLE FEATURE IS >.008.

NON CONDUCTIVE HOLE PLUG - SR-1000			
NOTES:			

Minimum finished hole sizes for SR-1000 Plug			
Board Thickness	Level 1	Level 2	Level 3
Up to .031	0.008	.0081 - .0180	>.018
.032 - .062	0.010	.0101 - .0180	>.018
.063 - .093	0.013	.0126 - .0180	>.018
.094 - .125	0.014	.0146 - .0180	>.018
.126 - .157	0.017	.0165 - .0180	>.018
.158 - .188	0.018	0.018	>.018
.189 - .220	0.018	0.018	>.018
.221 - .250	0.018	0.018	>.018
.251 - UP	0.018	0.018	>.018

CAN BE USED WHEN HOLE SIZE RANGE IS .010" - .018"

SR-1000 CAN ONLY BE USED WHEN THE DISTANCE FROM THE OUTER DIAMETER OF PLUG TO THE NEAREST SOLDERABLE FEATURE IS >.008.

MATERIALS

LOW Dk (Dielectric Constant) MATERIALS

ARLON	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
CuClad® 217 Woven Fiberglass Reinforced PTFE - Crossplied	2.17, 2.20 ±.02	0.0009		05
DiClad® 880 Woven Fiberglass Reinforced PTFE - Unidirectional	2.17, 2.20 ±.02	0.0009		05
IsoClad® 917 Nonwoven Fiberglass Reinforced PTFE	2.17, 2.20 ±.04	0.0013		04
CuClad® 233LX Woven Fiberglass Reinforced PTFE - Crossplied	2.33 ±.02	0.0013		05
DiClad® 870 Woven Fiberglass Reinforced PTFE - Unidirectional	2.33 ±.02	0.0013		05
IsoClad® 933 Nonwoven Fiberglass Reinforced PTFE	2.33 ±.04	0.0016		04
CuClad® 250GT Woven Fiberglass Reinforced PTFE - Crossplied	2.40 - 2.60 ±.05	0.0022		01
CuClad® 250GX Woven Fiberglass Reinforced PTFE - Crossplied	2.40 - 2.60 ±.04	0.0022		02
DiClad® 522 Woven Fiberglass Reinforced PTFE - Unidirectional	2.40 - 2.65 ±.05	0.0022		01
DiClad® 527 Woven Fiberglass Reinforced PTFE - Unidirectional	2.40 - 2.65 ±.04	0.0022		02
CLTE™ Ceramic Filled PTFE	2.98	0.0025		06
CLTE-XT™ Ceramic Filled PTFE	2.94	0.0012		06
CLTE-LC™ Ceramic Filled PTFE	2.94	0.0025		06
DUPONT	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4103 SLASH SHEET
FEP Fluoropolymer Resin Bonding Film	2.00	0.0005	260° C	
GORE ELECTRONICS	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4101 SLASH SHEET
Speedboard™ C High Performance Prepreg	2.6	0.0040	220° C	
ROGERS CORPORATION ADVANCED CIRCUIT MATERIALS	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
RT/duroid® 5880 Glass Microfiber Reinforced PTFE	2.20 ±.02	0.0009		04
RT/duroid® 5870 Glass Microfiber Reinforced PTFE	2.33 ±.02	0.0012		04
ULTRALAM® 2000 Woven Glass Reinforced Microwave Laminate	2.40 - 2.60	0.0022		02
RT/duroid® 6002 PTFE Ceramic	2.94 ±.04	0.0012		06
RT/duroid® 6202 PTFE Ceramic Woven Glass	2.94 ±.04	0.0015		-
RO3003® Ceramic-Filled PTFE	3.00 ±.04	0.0013		06
RO3203® Ceramic-Filled Woven Fiberglass Reinforced	3.02 ±.04	0.0016		06
TACONIC ADVANCED DIELECTRIC DIVISION	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
TLY 5A Woven Glass PTFE	2.17 ±.02	0.0009		05
TLY 5 Woven Glass PTFE	2.20 ±.02	0.0009		05
TLY 3 Woven Glass PTFE	2.33 ±.02	0.0009		05
TLX 0 Woven Glass PTFE	2.45 ±.04	0.0019		02
TLX 9 Woven Glass PTFE	2.50 ±.04	0.0019		02
TLX 8 Woven Glass PTFE	2.55 ±.04	0.0019		02
TLX 7 Woven Glass PTFE	2.60 ±.04	0.0019		02
TLX 6 Woven Glass PTFE	2.65 ±.04	0.0019		02
TLC 27 Woven Glass PTFE	2.75 ±.05	0.0030		09
TLE 95 Woven Glass PTFE	2.95-3.00 ±.05	0.0028		02
TLC 30 Woven Glass PTFE	3.00 ±.05	0.0030		09
TLC 32 Woven Glass PTFE	3.20 ±.05	0.0030		09

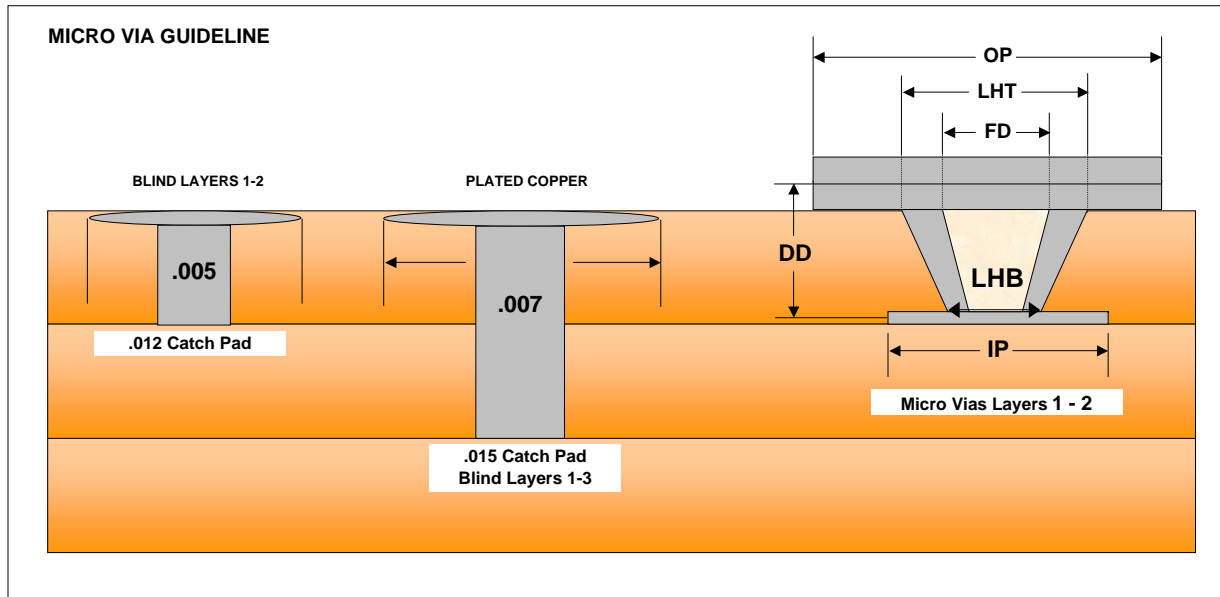
HIGH Dk (Dielectric Constant) MATERIALS

ARLON	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
AR 1000™ Ceramic Filled PTFE	10.0 Nominal	0.003		08
ROGERS CORPORATION ADVANCED CIRCUIT MATERIALS	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
TMM® 10 Temperature Stable Microwave Laminate	9.20 ±.23	0.0022		
TMM® 10i Temperature Stable Microwave Laminate	9.80 ±.245	0.0020		
RT/duriod® 6010LM PTFE	10.2 - 10.8 ±.25	0.0023		08
STABLCOR	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
ST10-EP387 Epoxy Laminate	13.3	N/A	170° C	
ST325-EP387 Epoxy Laminate	13.3	N/A	170° C	
ST325-LC909 Polyimide Laminate	13.3	N/A	240° C	

HIGH Tg (Glass Transition Temperature) MATERIALS				
ARLON				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4101 SLASH SHEET
33N Polyimide E-Glass Laminate & Prepreg	4.00	0.0100	>250° C	40/41
55NT Multifunctional Epoxy/Thermount®	3.85	0.0150	170° C	55
85NT Multifunctional Epoxy/Thermount®	3.80	0.0150	240° C	53
DUPONT				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4103 SLASH SHEET
FEP Fluoropolymer Resin Bonding Film	2.00	0.0005	260° C	
GORE ELECTRONICS				
	Dk @ 10GHZ	Df @ 10GHZ	T _g	IPC 4101 SLASH SHEET
Speedboard™ C High Performance Prepreg	2.60	0.0040	220° C	
HITACHI CHEMICAL COMPANY				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4101 SLASH SHEET
GIA-671N 1080 Type F (High flow with filler) Polyimide	4.20 - 4.40	.011 - .013	220-240° C	
ISOLA				
	Dk @ 2 GHZ	Df @ 2 GHZ	T _g	IPC 4101 SLASH SHEET
ISOLA 410 Epoxy Laminate & Prepreg	3.76	0.0210	180° C	21/24/26/28/ 121/124/129
ISOLA 620 Partially Polymerized Resin Laminate & Prepreg	3.61	0.0080	225° C	30
PARK ELECTROCHEMICAL CORP.				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4101 SLASH SHEET
N4000-6 High Tg Multifunctional Epoxy Laminate & Prepreg	4.30	0.0230	175° C	24/26
N4000-11 High Tg Multifunctional Epoxy Laminate & Prepreg	4.30	0.0120	175° C	26/28/83/98/ 99
N4000-29 Lead-Free Multifunctional Epoxy Laminate & Prepreg	4.50	0.0160	180° C	26/28/83/98/ 99/126
N5000 BT Epoxy Laminate & Prepreg	4.10	0.0130	185° C	30
N4000-12 Enhanced Epoxy Resin Laminate & Prepreg	3.6 @ 10 Ghz	.008 @ 10 Ghz	190° C	29
N5000-30 High-Performance, Chip Packaging BT Epoxy Prepreg	4.40	0.0090	205° C	30
N5000-32 High-Performance, Chip Packaging BT Epoxy Laminate	4.40	0.0090	205° C	30
N4000-13 High Speed Multifunctional Epoxy Laminate & Prepreg	3.90	0.0090	210° C	29
N4000-13 Sl® High Speed Multifunctional Epoxy Laminate & Prepreg	3.60	0.0080	210° C	29
N4000-13EP Lead-Free Enhanced Epoxy Resin Laminate & Prepreg	3.6 @ 10 Ghz	.008 @ 10 Ghz	210° C	29
N8000-F Cyanate Ester Laminate & Prepreg	3.80	0.0080	250° C	71
N8000-S Cyanate Ester Laminate & Prepreg	3.80	0.0080	250° C	70
N7000-2VO Polyimide Laminate & Prepreg	4.00	0.0090	250° C	40/41
N7000-1 Polyimide Laminate & Prepreg	4.30	0.0130	260° C	40/41
N7000-2HT Polyimide Laminate	4.40	0.0140	260° C	40/41
N7000-3 Polyimide Prepreg	4.40	0.0140	260° C	40/41
POLYCLAD LAMINATES, INC.				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4101 SLASH SHEET
PCL-FR-370 High Tg FR-4 Laminate & Prepreg	4.70 ±1.0	.0145 - .015	175° C	24/26/98
PCL-FR-370 TURBO™ High Tg FR-4 Laminate & Prepreg (Greenline)	4.70 ±1.0	0.0150	175° C	21/24/26
ROGERS CORPORATION ADVANCED CIRCUIT MATERIALS				
	Dk @ 10 MHZ	Df @ 10GHZ	T _g	IPC 4103 SLASH SHEET
RT/duroid® 5870 Glass Microfiber Reinforced PTFE	2.33 ±.02	0.0012		04
RT/duroid® 5880 Glass Microfiber Reinforced PTFE	2.20 ±.02	0.0009		04
RO4003® Ceramic-Filled Woven Fiberglass Reinforced	3.38 ±.05	0.0027	>280° C	10
RO4350® Ceramic-Filled Woven Fiberglass Reinforced	3.48 ±.05	0.0037	>280° C	11
STABLCOR				
	Dk @ 10 GHZ	Df @ 10 GHZ	T _g	IPC 4103 SLASH SHEET
ST10-EP387 Epoxy Laminate	13.3	N/A	170° C	
ST325-EP387 Epoxy Laminate	13.3	N/A	170° C	
ST325-LC909 Polyimide Laminate	13.3	N/A	240° C	
TECHNICA				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4101 SLASH SHEET
GETEK® Epoxy/Polyphenylene Oxide Resin	3.90 ±2.0	0.0090	175° - 185° C	25

LOW LOSS (Dissipation Factor) MATERIALS				
ARLON				
	Dk @ 10GHZ	Df @ 10GHZ	T _g	IPC 4103 SLASH SHEET
CuClad® 217 Woven Fiberglass Reinforced PTFE - Crossplied	2.17, 2.20 ±.02	0.0009		05
DiClad® 880 Woven Fiberglass Reinforced PTFE - Unidirectional	2.17, 2.20 ±.02	0.0009		05
CuClad® 233LX Woven Fiberglass Reinforced PTFE - Crossplied	2.33 ±.02	0.0013		05
DiClad® 870 Woven Fiberglass Reinforced PTFE - Unidirectional	2.33 ±.02	0.0013		05
IsoClad® 917 Nonwoven Fiberglass Reinforced PTFE	2.17, 2.20 ±.04	0.0013		04
IsoClad® 933 Nonwoven Fiberglass Reinforced PTFE	2.33 ±.04	0.0016		04
CuClad® 250GT Woven Fiberglass Reinforced PTFE - Crossplied	2.40 - 2.60 ±.05	0.0022		01
CuClad® 250GX Woven Fiberglass Reinforced PTFE - Crossplied	2.40 - 2.60 ±.04	0.0022		02
DiClad® 527 Woven Fiberglass Reinforced PTFE - Unidirectional	2.40 - 2.65 ±.04	0.0022		02
25N Non-PTFE Resin System, E, Stable Over Temperature	3.38	0.0025		IPC 4101/10
CLTE™ Ceramic Filled PTFE	2.98	0.0025		06
CLTE-XT™ Ceramic Filled PTFE	2.94	0.0012		06
CLTE-LC™ Ceramic Filled PTFE	2.94	0.0025		06
25FR Non-PTFE Resin System, E, Stable Over Temperature	3.58	0.0035		IPC 4101/11
AR1000™ Ceramic Filled PTFE	10.00	0.0030		08
DUPONT				
	Dk @ 1 MHZ	Df @ 1 MHZ	T _g	IPC 4103 SLASH SHEET
FEP Fluoropolymer Resin Bonding Film	2.00	0.0005	260° C	
GORE ELECTRONICS				
	Dk @ 10GHZ	Df @ 10GHZ	T _g	IPC 4101 SLASH SHEET
Speedboard™ C High Performance Prepreg	2.6	0.004	220° C	
ROGERS CORPORATION ADVANCED CIRCUIT MATERIALS				
	Dk @ 10GHZ	Df @ 10GHZ	T _g	IPC 4103 SLASH SHEET
RT/duroid® 5880 Glass Microfiber Reinforced PTFE	2.20±.02	0.0009		04
RT/duroid® 5870 Glass Microfiber Reinforced PTFE	2.33 ±.02	0.0012		04
RT/duroid® 6002 PTFE Ceramic	2.94 ±.04	0.0012		06
RT/duroid® 6202 PTFE Ceramic Woven Glass	2.94 ±.04	0.0015		-
RO3003® Ceramic-Filled PTFE	3.00 ±.04	0.0013		06
RO3203® Ceramic-Filled Woven Fiberglass Reinforced	3.02 ±.04	0.0016		06
RO3006® Ceramic-Filled PTFE	6.15 ±.15	0.0020		07
TMM® 3 Temperature Stable Microwave Laminate	3.27 ±.032	0.0020		N/A
TMM® 4 Temperature Stable Microwave Laminate	4.50 ±.045	0.0020		N/A
TMM® 10i Temperature Stable Microwave Laminate	9.80 ±.245	0.0020		N/A
TMM® 10 Temperature Stable Microwave Laminate	9.20 ±.23	0.0022		N/A
ULTRALAM® 2000 Woven Glass Reinforced Microwave Laminate	2.5 ±.10	0.0022		02
RT/duriod® 6010LM PTFE	10.20-10.80 ±.25	0.0023		08
TMM® 6 Temperature Stable Microwave Laminate	6.0 ±.08	0.0023		N/A
RO4003® Ceramic-Filled Woven Fiberglass Reinforced	3.38 ±.05	0.0027	>280° C	10
RT/duriod® 6006 PTFE	6.15 ±.15	0.0027		07
RO4350® Ceramic-Filled Woven Fiberglass Reinforced	3.48 ±.05	0.0037	>280° C	11
TACONIC ADVANCED DIELECTRIC DIVISION				
	Dk @ 10GHZ	Df @ 10GHZ	T _g	IPC 4103 SLASH SHEET
TLY 3 Woven Glass PTFE	2.33 ±.02	0.0009		05
TLY 5 Woven Glass PTFE	2.20 ±.02	0.0009		05
TLY 5A Woven Glass PTFE	2.17 ±.02	0.0009		05
TLX 0 Woven Glass PTFE	2.45 ±.04	0.0019		02
TLX 6 Woven Glass PTFE	2.65 ±.04	0.0019		02
TLX 7 Woven Glass PTFE	2.60 ±.04	0.0019		02
TLX 8 Woven Glass PTFE	2.55 ±.04	0.0019		02
TLX 9 Woven Glass PTFE	2.50 ±.04	0.0019		02
RF-60 Organic Ceramic Laminate	6.15 ±.25	0.0028		07
TLE 95 Woven Glass PTFE	2.95-3.00 ±.05	0.0028		02
TLC 27 Woven Glass PTFE	2.75 ±.05	0.0030		09
TLC 30 Woven Glass PTFE	3.00 ±.05	0.0030		09
TLC 32 Woven Glass PTFE	3.20 ±.05	0.0030		09

Micro Via Guidelines



CANNOT LASER THROUGH FEP - (IT'S NOT CONDUCTIVE TO LASER DRILL OPERATIONS).

KEY	PARAMETER	LEVEL 1 & 2	LEVEL 3
	I/L Copper Foil	≥ ½ ounce	< ½ ounce
	O/L Copper Foil	≥ ½ ounce	< ½ ounce
	Surface Copper Plating	> .0006	≤ .0006
AR	Max. Aspect Ratio = DD/FD	.7:1- 1:1 (not plated shut)	> .75:1 – and plated shut
LHT	Laser Hole Diameter at Top Surface	> .006	≤ .006
DD	Drill Depth	AR Dependent	AR Dependent
	I/L Annular Ring Required	< .001	> .001
IP	Min. I/L Pad Diameter	≥ .012	< .012
	O/L Annular Ring Required	< .002	> .002
OP	Min. O/L Pad Diameter	LHT + .006 and higher	LHT + < .006
LHB	Min. Laser Hole at Bottom	> .004	< .004 = CRB Required (< .004 is a reliability issue)
LHT	Top of Laser Hole at Surface	LHB + .002"	
FD	FD = Finished Hole Diameter		

UNLESS OTHERWISE SPECIFIED ON CUSTOMER PROCUREMENT DOCUMENTATION, THE MINIMUM ANNULAR RING AT THE CAPTURE PAD MUST HAVE TANGENCY AT A MINIMUM, AND NO BREAK-OUT IS ALLOWED (PER IPC-6016).

IPC-6016 ANNULAR RING REQUIREMENTS FOR PLATED HOLES

	CLASS 1	CLASS 2	CLASS 3
EXTERNAL	TANGENCY AT A MINIMUM	TANGENCY AT A MINIMUM	TANGENCY AT A MINIMUM
INTERNAL	TANGENCY AT A MINIMUM	TANGENCY AT A MINIMUM	TANGENCY AT A MINIMUM

RESISTOR GUIDELINES

10 OHM MATERIAL

REQUIRED VALUE	MIN TOLERANCE	MIN WIDTH	MIN LENGTH
15 OHM RESISTOR	30%	10 MILS	> 10 MILS
25 OHM RESISTOR	20%	10 MILS	> 10 MILS
50 OHM RESISTOR	15%	10 MILS	> 10 MILS
75 OHM RESISTOR	15%	10 MILS	> 10 MILS
100 OHM RESISTOR	15%	10 MILS	> 10 MILS

IF 3 OR MORE RESISTOR VALUES ARE REQUIRED ON A SINGLE CORE, THE MINIMUM ASSOCIATED TOLERANCE MUST BE 20% FOR EACH VALUE.

25 OHM MATERIAL

REQUIRED VALUE	MIN TOLERANCE	MIN WIDTH	MIN LENGTH
15 OHM RESISTOR	30%	10 MILS	> 10 MILS
25 OHM RESISTOR	20%	10 MILS	> 10 MILS
50 OHM RESISTOR	15%	10 MILS	> 10 MILS
75 OHM RESISTOR	15%	10 MILS	> 10 MILS
100 OHM RESISTOR	15%	10 MILS	> 10 MILS

IF 3 OR MORE RESISTOR VALUES ARE REQUIRED ON A SINGLE CORE, THE MINIMUM ASSOCIATED TOLERANCE MUST BE 20% FOR EACH VALUE.

50 OHM MATERIAL

REQUIRED VALUE	MIN TOLERANCE	MIN WIDTH	MIN LENGTH
15 OHM RESISTOR	30%	10 MILS	> 10 MILS
25 OHM RESISTOR	20%	10 MILS	> 10 MILS
50 OHM RESISTOR	15%	10 MILS	> 10 MILS
75 OHM RESISTOR	15%	10 MILS	> 10 MILS
100 OHM RESISTOR	15%	10 MILS	> 10 MILS

IF 3 OR MORE RESISTOR VALUES ARE REQUIRED ON A SINGLE CORE, THE MINIMUM ASSOCIATED TOLERANCE MUST BE 20% FOR EACH VALUE.

100 OHM MATERIAL

REQUIRED VALUE	MIN TOLERANCE	MIN WIDTH	MIN LENGTH
50 OHM RESISTOR	15%	10 MILS	> 10 MILS
75 OHM RESISTOR	15%	10 MILS	> 10 MILS
100 OHM RESISTOR	15%	10 MILS	> 10 MILS

IF 3 OR MORE RESISTOR VALUES ARE REQUIRED ON A SINGLE CORE, THE MINIMUM ASSOCIATED TOLERANCE MUST BE 20% FOR EACH VALUE.

ROUT GUIDELINES

MINIMUM SPACE BETWEEN BOARDS

ROUTER BIT DIA.	PART SPACING		
	LEVEL 1	LEVEL 2	LEVEL 3
.020"	>.100"	.100"	<.100
.031"	>.100"	.100"	<.100
.047"	>.100"	.100"	<.100
.062"	>.100"	.100"	<.100
.093"	>.100"	.100"	<.100
.125"	>.100"	.100"	<.100

PLATED EDGE TECHNOLOGY DICTATES .250" BETWEEN BOARDS

MINIMUM ROUTER BIT SIZE FOR PANEL THICKNESS

PANEL THICKNESS	ROUTER BIT SIZE					
	.020"	.031"	.047"	.062"	.093"	.125"
UP TO .031"						
.032" - .049"						
.050" - .062"						
.063" - .093"						
.094" - .125"						
.126" - .188"						
.189" - .250"				CLEAN UP		
OVER - .250"						

MINIMUM INTERNAL RADIUS

LEVEL 1	>.0235"
LEVEL 2	.0234" - .010"

TOLERANCE GUIDELINES

ROUTED DIMENSIONS		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

POSITIONAL TOLERANCE ROUT TO DRILLED HOLE - WHERE MAXIMUM MATERIAL CONDITION APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
>.010"	.0051" - .010"	.005"

POSITIONAL TOLERANCE ROUT TO DRILLED HOLE - WHERE REGARDLESS OF FEATURE SIZE APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .010"	.0061" - .010"	.006"

CONTROLLED DEPTH MILL		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

COUNTER SINK SIZE		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

COUNTER BORE SIZE		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

V-SCORE DEPTH		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

EDGE BEVEL ANGLE		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- 10°	+/- 6° - +/- 10°	+/- 5°

EDGE BEVEL DEPTH CONTROL		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

FABRICATION DEPARTMENT - GENERAL INFO.

COUNTER SINK ANGLES	60°	82°	90°	100°

V-SCORE ANGLES	30°	45°	60°	90°

EDGE/INTERNAL EDGE BEVEL	20°	30°	45°
UNLESS SPECIFIED BY CUSTOMER, WE DEFAULT TO 30°			

SURFACE FINISHES

HOT AIR SOLDER LEVELED TIN/LEAD - VERTICAL	
NOTES: In house Thickness: 40 - 700 Micro Inches	NOTES: IF BOARDS THICKNESS IS GREATER THAN .150", WE NEED TO REQUEST A WAIVER TO REFLOW RATHER THAN HASL.

HOT AIR SOLDER LEVELED TIN/LEAD - HORIZONTAL
NOTES: OUTSIDE SERVICE REQUIRED OUTSIDE SERVICE - MaskTech Thickness: 100 - 500 Micro Inches

REFLOWED TIN/LEAD	
NOTES: In house Thickness: 700 Micro Inches +/- 500	NOTES: MAXIMUM SIZE FOR REFLOW PRODUCT IS 16.5" X 22.5".

UNFUSED TIN/LEAD
NOTES: In house Minimum Thickness: 315 Micro Inches (UNLESS OTHERWISE SPECIFIED)

ELECTROLESS NICKEL / IMMERSION GOLD (ENIG)	
NOTES: In-house service Supplier: Uyemura UIC KAT PROCESS Ni Thickness Min 100 Micro Inches - Max 240 Micro Inches Less than 100 Microinches requires a sign-off Au Thickness Min 3 Micro Inches - Max 8 Micro Inches	NOTES: ENIG FINISH SHOULD NOT BE COMBINED WITH ANY OTHER FINISH.

MULTIPLE-FINISHES CAPABILITIES CHART

PRIMARY FINISH	SECONDARY (SELECTIVE) FINISH								
	HASL	Reflowed Tin/Lead	ENIG	Silver	OSP	Hard Ni/Au	Soft Ni/Au	FST	Sel. Ni
HASL									
Reflowed Tin/Lead									
ENIG									
Silver									
FST									
OSP									
Hard Ni/Au									
Soft Ni/Au									

Immersion finish must be able to be taped off, and the space between finishes must be greater than .150" all around.

SILVER

NOTES: In-house service

Supplier: Uyemura
STERLING SILVER

Thickness
Min 5 Micro Inches - Max 32 Micro Inches

NOTES:
SILVER FINISH SHOULD NOT BE
COMBINED WITH ANY OTHER FINISH.

OSP

Outside service
Contractor: Added Value Technology

Supplier: Enthone
Bath: Entek

Thickness
Min 5 Micro Inches - Max 25 Micro Inches

Hard Ni/Au

MUST USE A MINIMUM OF 100 MICROINCHES NICKEL

NOTES: In-house service

Supplier: Uyemura
Auruna 530-Gold Degussa MPS Sulfamate Nickel

Ni Thickness
Min 100 Micro Inches - Max 400 Micro Inches

Au Thickness
Min 10 Micro Inches - Max 150 Micro Inches

Soft Ni/Au

MUST USE A MINIMUM OF 100 MICROINCHES NICKEL

NOTES: In-house service

Supplier: Uyemura
Auruna 551-Gold Degussa MPS Sulfamate Nickel

Ni Thickness
Min 100 Micro Inches - Max 400 Micro Inches

Au Thickness
Min 10 Micro Inches - Max 150 Micro Inches

Au thickness of >150 Micro inches is possible, but requires engineering and pricing review.

Immersion Tin

NOTES: In-house service

Supplier: MacDermid
MacStan HSR Immersion Tin

Thickness
Min 5 Micro Inches - Max 50 Micro Inches

TOLERANCES

GREEN = EASY

YELLOW = PROCEED WITH CARE

RED = APPROVAL REQUIRED

BOW & TWIST ALLOWANCE IF SMT DESIGN

LEVEL 1	LEVEL 2	LEVEL 3
1.0% MAX	.50% - .99%	<.50%

BOW & TWIST ALLOWANCE NO SMT'S

LEVEL 1	LEVEL 2	LEVEL 3
1.0% MAX	.50% - .99%	<.50%

CONTROLLED DEPTH MILL

LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

COUNTER BORE DEPTH TOLERANCE

LEVEL 1	LEVEL 2	LEVEL 3
> ±.005"	+/- .0031" - +/- .005"	+/- .003"

COUNTER BORE SIZE

LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

COUNTER SINK SIZE

LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

EDGE BEVEL ANGLE

LEVEL 1	LEVEL 2	LEVEL 3
> +/- 10°	+/- 6° - +/- 10°	+/- 5°

EDGE BEVEL DEPTH CONTROL

LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

NON PLATED HOLE SIZE TOLERANCE

LEVEL 1	LEVEL 2	LEVEL 3
> +/- .002"	+/- .001" - +/- .002"	< +/- .001"

PLATED HOLE SIZE TOLERANCE

LEVEL 1	LEVEL 2	LEVEL 3
> +/- .003"	+/- .002" - +/- .003"	< +/- .002"

POSITIONAL TOLERANCE ROUT TO DRILLED HOLE - WHERE MAXIMUM MATERIAL CONDITION APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
>.010"	.0051" - .010"	.005"

POSITIONAL TOLERANCE ROUT TO DRILLED HOLE - WHERE REGARDLESS OF FEATURE SIZE APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
>.010"	.0061" - .010"	.006"

PROFILE TOLERANCE		
LEVEL 1	LEVEL 2	LEVEL 3
+/- .015"	+/- .010" - +/- .0149"	< +/- .010"

ROUTED DIMENSIONS		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"

THICKNESS TOLERANCE (OVERALL)		
LEVEL 1	LEVEL 2	LEVEL 3
$\geq \pm 10\%$	$\pm 7\% - \pm 9.99\%$	< +/- 7%

TRUE POSITIONAL TOLERANCE - WHERE MAXIMUM MATERIAL CONDITION APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
.005	.005	.005
< 2" SQUARE AREA	2.1" - 4.0" SQUARE AREA	4.1" AND ABOVE SQUARE AREA
TEFLON MATERIALS ARE EXCLUDED FROM THESE RULES, AND WILL REQUIRE MANAGEMENT APPROVAL		

TRUE POSITIONAL TOLERANCE - WHERE REGARDLESS OF FEATURE SIZE APPLIES		
LEVEL 1	LEVEL 2	LEVEL 3
.006	.006	.006
< 2" SQUARE AREA	2.1" - 4.0" SQUARE AREA	4.1" AND ABOVE SQUARE AREA
TEFLON MATERIALS ARE EXCLUDED FROM THESE RULES, AND WILL REQUIRE MANAGEMENT APPROVAL		

V-SCORE DEPTH		
LEVEL 1	LEVEL 2	LEVEL 3
> +/- .005"	+/- .0031" - +/- .005"	+/- .003"