ROGERS CORPORATION

Fabrication Notes

Drilling Guidelines for TMM® Temperature Stable Microwave Laminates

Hole quality with TMM® temperature stable microwave laminates has generally been found to be excellent when proper drilling parameters are used. This application note discusses factors which affect tool wear and hole quality. Guidelines which have been found to yield good results with double-sided TMM boards and bonded assemblies are provided along with a quick reference table.

TMM temperature stable microwave materials consist of a hydrocarbon matrix highly filled with ceramic particles. The ceramic filler provides TMM materials with its low thermal expansion and makes it possible to offer a wide range of dielectric constant grades.

Due to the abrasive nature of the ceramic filler, some precautions are required when drilling TMM materials. High tool surface speed (>500 SFM) and low chip loads (<0.002"/rev.) should be avoided whenever possible since they produce excessive heat and tool wear.

Surface Speed and Chip Load

Surface speed (SFM) is defined as the velocity (ft./min.) of the outer cutting edge of the tool and is used to calculate the spindle speed:

$$\text{Spindle Speed (RPM)} = \frac{12 \times \text{Surface Speed (ft./min.)}}{\pi \times \text{Drill Bit Diameter (in.)}}$$

Chip load is defined as the depth of penetration per revolution and can be calculated using the following equation:

Infeed Rate (in./min.) = Spindle Speed (RPM) x Chip Load (in./rev.)

Effect of Drilling Parameters on Tool Wear

The tool wear resulting from high surface speed varies with TMM grade and chip load. The lower dielectric constant TMM grades contain a larger fraction of highly abrasive filler. With TMM-3 laminates, surface speeds in excess of 500 SFM will significantly reduce useful tool life. For example, the maximum useful tool life may be as low as 10-20 hits if TMM-3 laminate is drilled with surface speeds in excess of 800 SFM. With TMM-10 laminates, useful tool life drops significantly with surface speeds above 650 SFM. The effects of surface speed on tool wear are more pronounced at lower chip loads (<0.002"/rev.).

The minimum spindle speed available on conventional printed wiring board (PWB) drilling machines is usually 15,000 RPM. For tools larger than 0.127", the minimum spindle speed will yield surface speeds in excess of 500 SFM. If only a small number of large holes are required (i.e. tooling holes), conventional drilling equipment can be used with frequent tool replacement. For some applications, useful tool life can be extended by increasing the depth of penetration into backer material to compensate for the decreasing effective flute length. If a significant number of large holes (>0.100") are required, it may be desirable to use NC machining equipment with lower spindle speed capability to minimize tool costs.

Recommended Drilling Conditions

Chip Load:	0.003" - 0.005" per revolution
Surface Speed:	300 - 400 SFM
Retract rate:	500 - 600 in./min.
Entry/Exit:	Phenolic (0.015" entry, 0.100" backer)
Tools:	Carbide

Advanced Connectivity Solutions
100 S. Roosevelt Avenue, Chandler, AZ 85226
Tel: 480-961-1382, Fax: 480-961-4533 www.rogerscorp.com

Calculating the Maximum Recommended Hit Count

The maximum recommended hit count can be calculated by dividing the value shown in the table below by the thickness of the construction (inches). The results are valid for tool sizes between 0.020" and 0.070" with a chip load of 0.003"/rev. and a surface speed of 300 SFM. Tool life may be lower for tool sizes outside this range.

$$\text{Maximum Recommended Hit Count} = \frac{\text{Recommended Tool Life (inches of material)}}{\text{Board thickness (inches)}}$$

Maximum Recommended Tool Life (inches of material)

	TMM-3	TMM-4	TMM-6	TMM-10
Double-Sided Boards	36"	38"	42"	60"
FEP Bonded Assemblies	18"	19"	21"	30"

For example:
The maximum recommended hit count for 0.100" double sided TMM-10 construction would be 600 (60"/0.100" = 600).

Calculating Recommended Spindle Speed and Infeed from Tool Size:

$$\text{Spindle Speed*(RPM)} = \frac{1146}{\text{Tool Diam. (inches)}}$$

$$\text{Infeed* (IPM)} = \frac{3.44}{\text{Tool Diameter (inches)}}$$

A table including recommended spindle speed and infeed for common tool sizes is provided for convenience. If PWB drilling equipment is used to drill larger holes (>0.100"), the minimum spindle speed available should be utilized to minimize surface speed.
Surface speed up to 400 SFM will not generate excessive tool wear. Therefore, use of conventional printed wiring board drilling equipment with tool sizes up to 0.100" will not significantly reduce tool life.

Recommended Spindle Speed and Infeed Table *

Drill Size (#)	Drill Size (in.)	SpindleSpeed (KRPM)	Infeed (in/min)
Parameters for conventional PWB drill equipment (15K-60K spindles)			
76	0.0200″	57.3	172
75	0.0210″	54.6	164
74	0.0255″	50.9	153
73	0.0240″	47.8	143
72	0.0250″	45.8	138
71	0.0260″	44.1	132
70	0.0280″	40.9	123
69	0.0292″	39.2	118
68	0.0310″	37.0	111
67	0.0320″	35.8	107
66	0.0330″	34.7	104
65	0.0350″	32.7	98
64	0.0370″	31.0	93
62	0.0380″	30.1	91
60	0.0400″	28.7	86
59	0.0410″	28.0	84
58	0.0420″	27.3	82
56	0.0465″	24.6	74
54	0.0550″	20.8	63
52	0.0635″	18.0	54
50	0.0700″	16.4	49
48	0.0760″	15.1	45
46	0.0810″	15.0	45
44	0.0860″	15.0	45
42	0.0935″	15.0	45
40	0.0980″	15.0	45
Parameters for NC machining equipment (1K-10K spindles)			
34	0.1110″	10.0	30
32	0.1250″	9.2	28
30	0.1285″	8.9	27
26	0.1470″	7.8	23
24	0.1520″	7.5	23
20	0.1610″	7.1	21
	0.1875″	6.1	18
	0.2500"	4.6	14

* Based on 300 SFM and a 3 mil chip load except for tool #'s 40-48 (3 mil chip, <400 SFM).

Revised 1368 032918, **Publication #92-497**

Advanced Connectivity Solutions
100 S. Roosevelt Avenue, Chandler, AZ 85226
Tel: 480-961-1382, Fax: 480-961-4533 www.rogerscorp.com