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# Guidelines for Drilling RT/duroid® 6002 Bonded Assemblies and Multilayer Boards

RT/duroid® 6002 microwave laminate is a PTFE-based composite, highly filled with ceramic particles and reinforced with glass microfiber. High ceramic filler loading results in low thermal expansion and good dimensional stability. However, the ceramic filler is also very abrasive to cutting tools, so special precautions are required to yield high quality plated through-holes.

Use of excessively worn drill bits can significantly degrade hole quality. This is especially true for bonded assemblies since most bonding films can be readily smeared by hot drill bits. The recommendations provided below are developed to yield good hole quality with conventional PCB drilling equipment. Spindle speed capability for common PCB drilling equipment is generally between 15 KRPM and 60 KRPM.

## Guidelines for Bonded Assemblies

Tool life should be established based on hole quality requirements rather than bit breakage. Hole quality aspects typically examined are interconnect reduction (smear), nail-heading and deflection for bonded assemblies. Tools should be replaced after drilling 10-12 inches of dielectric to yield good hole quality. Hit counts should rarely exceed 500 hits even for thin bonded structures. The preferred maximum count is 250 hits since lower hit counts yield better hole quality.

For critical applications, it is best to evaluate drilling conditions for the construction in question since the relationship between tool life and hole quality can vary with construction and bonding material. Fusion bonding or high melt point bonding films like FEP tend to broaden the process window for drilling.

Recommended conditions are presented in Table 1. Equations necessary to calculate input parameters for most drilling machines are provided on page 2. Table 2 provides spindle feed and infeed rate data for common tool sizes with a 0.002”/revolution chip loading.

| | |
|---|---|
| **Chip Load:** | 0.002” - 0.003” per revolution (50-100 mm/rev) |
| **Surface Speed:** | 300 - 600 ft/min (90-180 m/min) |
| **Retract Rate:** | 500 - 600 in/min (13-15 m/min) |
| **Entry/exit:** | Phenolic (0.015” entry, 0.100” backer) (0.38 mm entry, 2.54 mm exit) |
| **Tools:** | Carbide |
| **Tool Life:** | 10 - 12 inches (25.4 - 30.48 cm) of dielectric (maximum) |

**Table 1: Recommended Drilling Conditions**

## Calculating Spindle Speed and Infeed Rate

The spindle speed (RPM) for a particular tool size and surface speed target can be calculated using the following equation:

$$RPM = \frac{12 \times SFM}{\pi \times Diameter}$$

where, RPM = Spindle Speed (rev./min.)
SFM = Surface Speed (ft./min.)
Diam = Bit Diameter (inches)

With a spindle speed range of 15 KRPM to 60 KRPM, it is possible to maintain 300 to 600 SFM for tool sizes ranging friom 0.019" to 0.150".

Infeed can be calculated by multiplying RPM and chip load:

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

Calculating Maximum Hit Count:
Maximum Recommended Hit Count = 12/T
where, T = Board Thickness

| Drill Size (#) | Drill Size (in) | Spindle Speed (KRPM) | Infeed (in/min) |
|---|---|---|---|
| 76 | 0.0200" | 57 | 114 |
| 75 | 0.0210" | 57 | 114 |
| 74 | 0.0225" | 57 | 114 |
| 73 | 0.0240" | 57 | 114 |
| 72 | 0.0250" | 57 | 114 |
| 71 | 0.0260" | 57 | 114 |
| 70 | 0.0280" | 55 | 110 |
| 69 | 0.0292" | 52 | 104 |
| 68 | 0.0310" | 49 | 98 |
| 67 | 0.0320" | 48 | 96 |
| 66 | 0.0330" | 46 | 92 |
| 65 | 0.0350" | 44 | 88 |
| 64 | 0.0360" | 42 | 84 |
| 63 | 0.0370" | 41 | 82 |
| 62 | 0.0380" | 40 | 80 |
| 60 | 0.0400" | 38 | 76 |
| 59 | 0.0410" | 37 | 74 |
| 58 | 0.0420" | 36 | 72 |
| 56 | 0.0465" | 33 | 66 |
| 54 | 0.0550" | 28 | 56 |
| 52 | 0.0635" | 24 | 48 |
| 50 | 0.0700" | 22 | 44 |
| 48 | 0.0760" | 20 | 40 |
| 46 | 0.0810" | 19 | 38 |
| 44 | 0.0860" | 18 | 36 |
| 42 | 0.0935" | 18 | 36 |
| 40 | 0.0980" | 18 | 36 |
| 38 | 0.1015" | 18 | 36 |
| 36 | 0.1065" | 18 | 36 |
| 34 | 0.1110" | 18 | 36 |
| 32 | 0.1160" | 18 | 36 |
| | 0.1250" | 18 | 36 |

**Table 2: Spindle Speed and Infeed**


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