

# Kappa® 438 Laminates Circuit Processing Guidelines

These guidelines were developed to provide fabricators basic information on processing double-sided and multi-layered printed wiring boards (PWB's) using Kappa® 438 laminates. Please refer to RO4400™ bondply processing guidelines for additional information on inner-layer preparation and multi-layer bonding.

**Storage:** Fully clad Kappa 438 laminates should be stored at room temperature (between 50-90°F/ 10-32°C). A first-in-first-out inventory system and a method to track material lot numbers through PWB processing and delivery of finished circuits is recommended.

## **INNER LAYER PREPARATION:**

**Tooling:** Kappa 438 laminates are compatible with many pinned and pinless tooling systems. Choosing whether to use round or slotted pins, external or internal pinning, standard or multilayer tooling, and pre vs. post-etch punching would depend on the capabilities and preferences of the circuit facility and final registration requirements. In general, slotted pins, a multilayer tooling format, and post-etch punching will meet most needs.

**Surface Preparation for Photoresist Processing and Copper Etching:** Depending upon Kappa 438 core thickness, copper surfaces can be prepared for photo imaging using chemical or mechanical processes. Thinner cores should be prepared using a chemical process consisting of cleaning, micro-etching, water rinsing, and drying steps. Thicker Kappa 438 cores are compatible with mechanical scrub systems.

Kappa 438 materials are compatible with most liquid and dry film photo-resists and, once patterned, can be processed through develop, etch, and strip (DES) systems typically used to process FR-4 materials.

**Oxide Treatment:** Kappa 438 cores can be processed through any copper oxide or oxide alternative process in preparation for multi-layer bonding. The best treatment choice is typically the one recommended in the guidelines supporting the chosen prepreg or adhesive system.

**Multi-Layer Bonding:** Kappa 438 laminates are compatible with many thermosetting and thermoplastic adhesive systems. Guidelines for the adhesive system should be consulted for bond cycle parameters.

## **DRILLING:**

**Drilling Considerations:** Standard entry (aluminum or thin pressed phenolic) and exit (pressed phenolic or fiber board) materials can be used when drilling Kappa 438 cores or bonded assemblies in one-up or multi-up stacks.

Kappa 438 materials are compatible with a broad range of drilling parameters. However, drilling speeds greater than 500 surface feet per minute (SFM) should be avoided. Chip loads greater than 0.002"/" are recommended for mid-range and large diameter tools while lower chiploads (<0.002"/") are recommended for small (<0.0135") diameter drills. In general, standard geometry drills are preferred over undercut styles as they more effectively evacuate debris from the holes during the drilling process. Hit counts should be based on inspection of plated-through holes (PTH's) and not the appearance of the tools. Drilling Kappa 438 laminates will result in an

accelerated wear rate of drills. But, hole wall quality is determined by the size distribution of the ceramic powder and not by the cutting edge of the drill bit. A hole wall roughness ranging from 8 to 25  $\mu$ m is expected and should remain consistent from the initial hit through several thousand hits.

Offered below are a summary of recommended drill parameters, equations for using surface speed and chip load to calculate spindle speeds and infeed rates, and a ready-reference drill table. A Rogers Technical Service Engineer (TSE) should be contacted for more detailed information.

**Recommended Ranges:**

<b>Surface Speed</b>	300-500 SFM (90 to 150m/min)
<b>Chip Load</b>	0.002"-0.004"/rev. (0.05-0.10mm)
<b>Retract Rate</b>	500 IPM (12.7m/min) for tools less than 0.0135" (0.343mm), 1,000 IPM (25.4 m/min) for all others
<b>Tool Type</b>	Standard carbide
<b>Tool Life</b>	2,000-3,000 hits

**CALCULATING SPINDLE SPEED AND INFEEED:**

Spindle Speed =  $(12 \times \text{Surface Speed (SFM)}) / (\pi \times \text{Tool Diam. (in.)})$   
 Feed Rate (IPM) =  $[\text{Spindle Speed (RPM)}] \times [\text{Chip Load (in/rev.)}]$

**Example:**

Desired Surface Speed: 400 SFM  
 Desired Chip Load: 0.003"(0.08 mm)/rev.  
 Tool Diameter: 0.0295"(0.75 mm)  
 Spindle Speed =  $(12 \times 400) / (3.14 \times 0.0295) = 51800 \text{ RPM}$   
 Infeed Rate =  $51,800 \times 0.003 = 155 \text{ IPM}$

**QUICK REFERENCE TABLE:**

<b>Tool Diameter</b>	<b>Spindle Speed (kRPM)</b>	<b>Infeed Rate (IPM)</b>
0.0100" (0.254mm)	95.5	190
0.0135" (0.343mm)	70.7	141
0.0160" (0.406mm)	95.5	190
0.0197" (0.500mm)	77.6	190
0.0256" (0.650mm)	60.0	180
0.0258" (0.655mm)	60.0	180
0.0295" (0.749mm)	51.8	155
0.0354" (0.899mm)	43.2	130
0.0394" (1.001mm)	38.8	116
0.0453" (1.151mm)	33.7	101
0.0492" (1.257mm)	31.1	93
0.0531" (1.349mm)	28.8	86
0.0625" (1.588mm)	24.5	74
0.0935" (2.350mm)	16.5	50
0.0625" (1.588mm)	24.5	74
0.0925" (2.350mm)	16.5	50
0.1250" (3.175mm)	15.0	45

*\*Conditions stated are tapered from 200 SFM and 0.002" chip load up to 400 SFM and 0.003" chip load.*

**PTH PROCESSING:**

**Surface Preparation:** Thick multi-layer and double-sided constructions can be processed through conveyORIZED de-bur equipment that uses oscillating nylon brushes to abrade the copper surfaces. Thinner layers may require pumice scrubbing by hand, conveyORIZED processing with an abrasive spray, or chemical preparation. In general, the thickness of the material and registration requirements should be considered when choosing the best method of de-bur and surface preparation.

Desmear is typically not required of drilled holes in double-sided boards as the high glass transition temperature of the resin system (>280°C/ >536°F) minimizes the occurrence of smear. Multi-layer boards may require desmear depending upon the needs of the bondply or prepreg layers. If desmear is required, a single or double pass through alkaline permanganate or a CF<sub>4</sub>/O<sub>2</sub> plasma process may be used. Plasma desmear is preferred over chemical desmear when processing CAF sensitive designs.

We recommend against etchback of the Kappa 438 laminate layers as this might result in aggressive etchback of resin near copper layers and loosening of filler particles on the hole wall.

**Metal Deposition:**

Kappa 438 materials do not require special treatments prior to metallization and are compatible with electroless copper processing and direct deposition of ionic and colloidal conductive layers. A copper flash plate (0.00025") prior to imaging might be considered for boards with high aspect ratio holes.

**COPPER PLATING & OUTER-LAYER PROCESSING:**

Kappa 438 laminates are compatible with panel and pattern processing using standard acid copper and electrolytic tin or tin/lead plating. Once plated, Kappa 438 laminates can be processed through any standard strip/etch/strip (SES) process.

The post-etch surface of Kappa 438 laminates should be preserved as this surface will bond very well with direct screened and photo-imageable solder masks.

**Final Metal Finishes:**

Kappa 438 laminates are compatible with organic solderability preservatives (OSP's), hot air solder levelling (HASL), and most chemically deposited or electroplated finishes.

**FINAL CIRCUITIZATION:**

Circuits made using Kappa 438 laminates can be "individualized" by dicing, sawing, shearing, routing or punching. V-scoring and breakaway tabs can be used to facilitate individualization of circuits after automated assembly.

Recommendations for routing are provided below:

**ROUTING:**

Kappa 438 laminates are routed using carbide tools and conditions that are typical to processing traditional epoxy/glass materials. Copper should be etched away from the routing path to prevent burring.

**MAXIMUM STACK HEIGHT:**

The maximum stack height should be based on 70% of the actual flute length to allow for debris removal.

**Example:**

Flute Length:	$0.300" \times 0.70 = 0.210"(5.33 \text{ mm})$
Backer Penetration:	$- 0.030"(0.762\text{mm})$
Max. Stack Height:	$0.180"(4.572\text{mm})$

**TOOL TYPE:**

Carbide multi-fluted spiral chip breakers or diamond cut router bits.

**ROUTING CONDITIONS:**

Surface speeds below 500 SFM should be used whenever possible to maximize tool life. Tool life is generally greater than 30 linear feet when routing the maximum allowable stack height.

Chip Load: 0.0010-0.0015"(0.0254-0.0381mm)/rev  
 Surface Speed: 300 – SFM

**QUICK REFERENCE TABLE:**

Tool Diameter	Spindle Speed	Lateral Feed Rate
1/32	40k RPM	50 IPM
1/16	25k RPM	31 IPM
3/32	20k RPM	25 IPM
1/8	15k	25 IPM

**SHELF LIFE:**

Rogers' High Frequency laminates can be stored for extended durations under ambient room temperatures (55-85°F, 13-30°C) and humidity levels. At room temperature, the dielectric materials are inert to high humidity. However, metal claddings such as copper can be oxidized during exposure to high humidity. (Oxidation on the copper surface can easily be removed in a standard micro-etch process.) In addition, over an extended period (>5 years) the exposed dielectric along edges of the panel may experience detectable levels of oxidation. Accounting for standard tooling hole and trim loss, such trace levels of oxidation would not be expected to extend into the utilized portion of the laminate. Please note however, that as each application is different, Rogers cannot warrant that its products are fit for any particular end use, and, as always, Rogers recommends that the circuit designer and/or the end user test the properties and performance of these materials in each proposed application to determine their fitness for use over the entire product life.

Prolonged exposure in an oxidative environment may cause changes to the dielectric properties of hydrocarbon based materials. The rate of change increases at higher temperatures and is highly dependent on the circuit design. Although Rogers' high frequency materials have been used successfully in innumerable applications and reports of oxidation resulting in performance problems are extremely rare, Rogers recommends that the customer evaluate each material and design combination to determine fitness for use over the entire life of the end product.

**The information in this data sheet is intended to assist you in designing with Rogers' circuit materials. It is not intended to and does not create any warranties express or implied, including any warranty of merchantability or fitness for a particular purpose or that the results shown on this data sheet will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers' circuit materials for each application.**

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 Revised 1536 101921 **Publication #92-541**