*fast*Rise™EZ

and

*fast*Rise™EZpure

Processing Guide

June 2017

Disclaimer:

This process guide is provided to users to assist in gaining an understanding of these materials and to quickly establish processes for PCB fabrication. It is assumed that the users will have a technical understanding and experience in the processes, equipment and standards related to PCB fabrication. The user will likely need to make adjustments to account for specific requirements and their production processes.

The following process recommendations are based on testing and production processes at several circuit board facilities. Each facility will have different product designs, equipment, or methods that will require modifications to these recommendations. For example, drilling parameters, routing parameters, and artwork compensation can vary dependent on circuit board thickness, design, processes, and equipment.

Adjustments should be based on the experience of each facility. Please contact your Taconic representative if assistance is required.

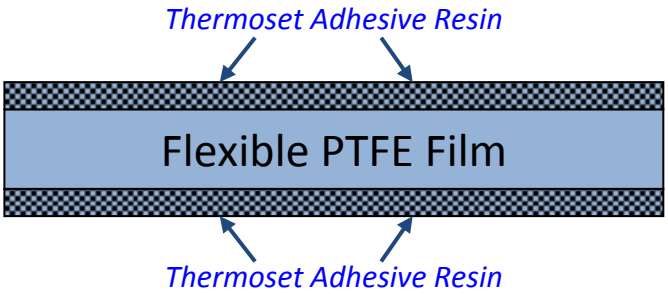
TABLE OF CONTENTS

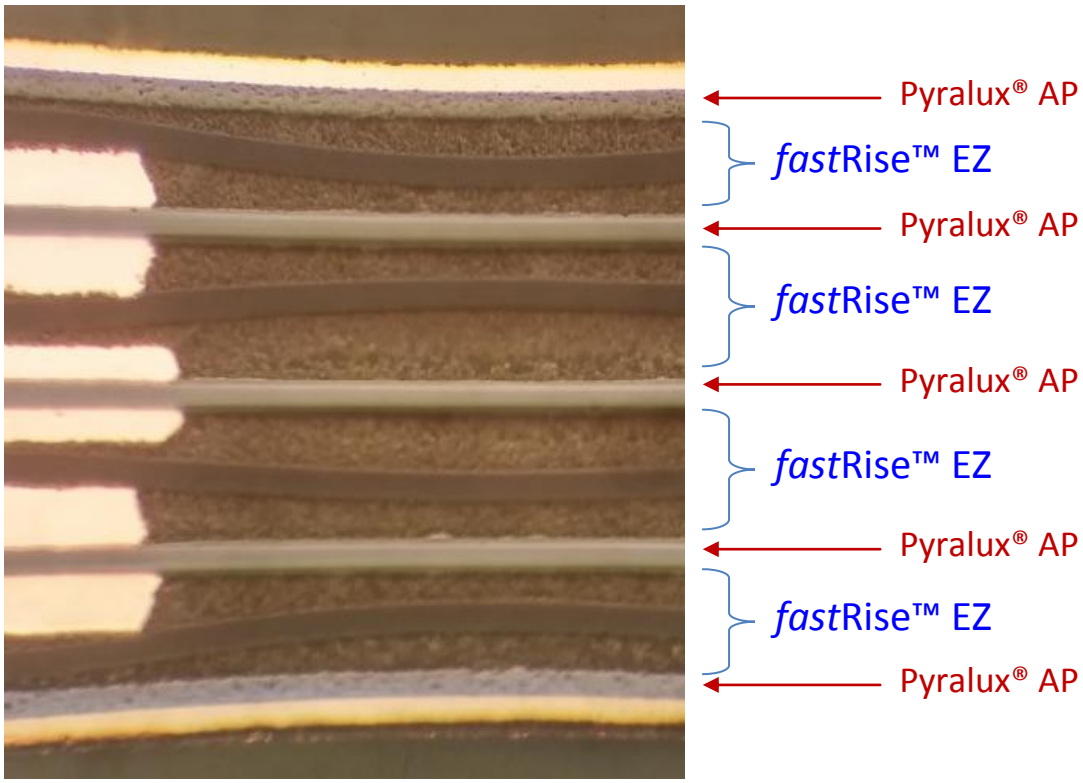
GENERAL INFORMATION

*fast*Rise™ EZ

*fast*Rise™ EZ prepreg (FREZ) is a *fast*Rise™ product that has been engineered for use in flexible printed circuit boards. It is compatible with most materials, especially those that are difficult to bond to including LCP, Polyimides (e.g. DuPont AP), and PTFE laminates (e.g. DuPont TK). *fast*Rise™ EZ provides an ideal solution where flexible circuits with low loss, high operating temperature, and/or improved peel strengths are required. Similar to other parts in the *fast*Rise™ family, *fast*Rise™ EZ utilizes a flexible PTFE film for low electrical loss and a high performance thermoset resin as an adhesive on the top and bottom.

*fast*Rise™ EZ



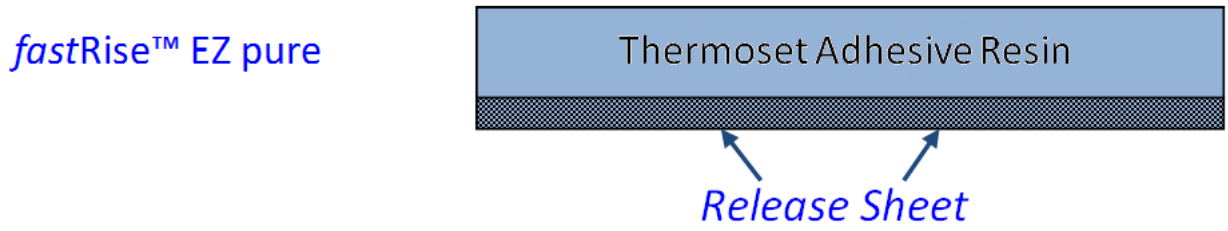


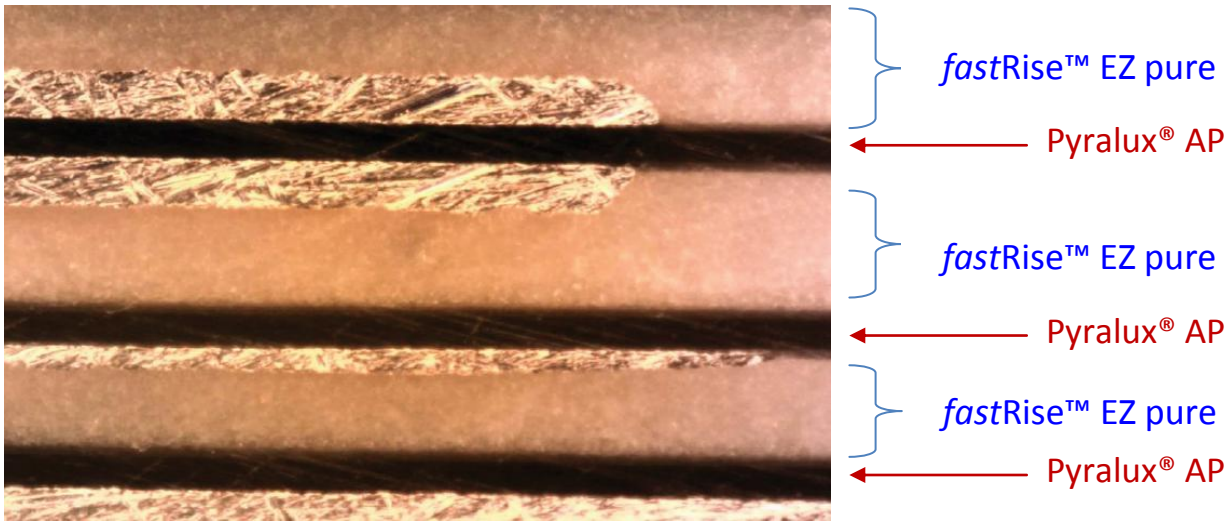
*fast*Rise™ EZpure

*fast*Rise™ EZpure prepreg uses the flexible *fast*Rise™ EZ thermoset resin system without the supporting PTFE film. This allows for thinner dielectric spacing (1.5 mil and 3.0 mil nominal) and eliminates the processing challenges of PTFE. Performance characteristics and material compatibility are similar to *fast*Rise™ EZ.

In this processing guide, references to *fast*Rise™ EZ will also apply to *fast*Rise™ EZpure except where noted.

> ***Design Note:*** *Due to a lack of film reinforcement to restrict flow, careful consideration must be made with regard to designing two adjacent copper layers separated solely by* *fast*Rise™ EZpure*. Z-axis shorts have the potential to occur and Taconic recommends thorough testing before proceeding with such a design.*





STORAGE

Store the material in a cool dry area away from direct sunlight and high humidity, avoiding material contamination. *fast*Rise™ EZ is certified to meet all requirements as agreed upon between the user and supplier for a given shelf life as defined by the storage conditions below.

Storage Conditions

Condition 1 (i.e. refrigeration): <4.5°C (40°F)

Condition 2 (i.e. room temp): <23°C (73°F), Relative Humidity <50%

When removing *fast*Rise™ EZ prepreg from refrigeration, it should be allowed to acclimate to room temperature in the sealed bag. This will reduce the chance of moisture condensation on the prepreg and will also provide a more consistent start temperature for the lamination process. Bags should be resealed when not in use.

Shelf Life

If material is stored under Condition 1 above, a shelf life of 180 days after receipt of shipment will apply. If material is stored under Condition 2 above, a shelf life of 90 days after receipt of shipment will apply. Taconic will not ship *fast*Rise™ EZ material with less than 90 days of remaining shelf life. Packaging will default to indicate shelf life based on storage Condition 2 unless we are notified that Condition 1 applies. In the event that prepreg expires, please contact with your Taconic technical sales person for assistance to coordinate re-testing the expired prepreg.

HANDLING

*fast*Rise™ EZ

*fast*Rise™ EZ prepreg is supplied between two release sheets. The surface of *fast*Rise™ EZ may be tacky, especially for freshly manufactured material. Although it is recommended to allow refrigerated *fast*Rise™ EZ prepregs to acclimate prior to opening a sealed bag, in some cases it may be advantageous to use the prepreg while it is cool* which will reduce the tackiness of the material and make handling easier.

**do not allow condensation to form on the prepreg*

*fast*Rise™ EZpure

*fast*Rise™ EZpure resin is cast onto a release sheet and packaged with a slip sheet between each piece. The release sheet should remain attached until just prior to layup. To avoid damaging the resin during removal, best practice is to attach a piece of tape to both the release sheet and the resin, then pull apart. The resin can withstand some flexing and folding without cracking, though to minimize any potential cracking it is advised to handle by at least 2 edges at all times.

INNER LAYER PREPARATION

Laminate Preparation

*fast*Rise™ EZ will bond well to most other materials. Inner-layers should be clean and dry before bonding. Oxide treatments of copper surfaces are recommended. As long as the uncured prepreg hasn't been exposed to moisture or high humidity, vacuum desiccating of the material is not required.

Flow Patterns / Thieving

Solid copper borders with small alternating "star burst" vent lines are ideal. Interlocking thieving patterns, offset diamonds, honeycombs, or other patterns which inhibit resin flow channels are also acceptable. Interlocking "star burst" flow patterns or other patterns which may promote resin flow channel formation should be avoided.

BAKING

As a general recommendation, *fast*Rise™ EZ should be baked after exposure to moisture for 3 hours at 80°C (175°F). This can be substituted with a 1 hour bake at 120°C (250°F). For simplicity in this processing guide, all bake steps will refer to the 80°C process even though they are both acceptable.

Taconic has seen negative outcomes when baking *fast*Rise™ EZ at temperatures of 180°C (350°F) for as little as 30 minutes. It is up to each user to establish proper bake times and temperatures that are compatible with their equipment and the materials being used. Contact your Taconic technical service representative if these recommendations are incompatible with other established processes.

LAMINATION

Excessive resin flow should be avoided as it can cause flow channels or other undesirable conditions.

Quick Start

	***fast*Rise EZ**	***fast*Rise EZ Low Temp**	***fast*Rise EZpure**
Cure Temp / Time (measured at bondline)	60 minutes at 215°C (420°F)	150 minutes at 200°C (390°F)	Use *fast*Rise EZ or *fast*Rise EZ Low Temp
Pressure	100 (preferred) – 200 psi	100 (preferred) – 200 psi	Contact – 50 psi
Heating Rate	2 – 4°C/min (3 – 8°F/min)		
Critical Range	80°C – 150°C (175°F – 300°F)		
Cooling Rate	Less than 3°C/min (6°F/min)		
Breakdown	Breakdown or transfer to cold press when bondline is below 90°C (200°F)		
Vacuum	Full vacuum is recommended through entire cycle		
Vacuum Delay	Hold vacuum 10-20 minutes before applying heat or pressure		

Padding and Conformance Materials

Typical padding and conformance materials used for flexible circuit manufacturing can be used (pending temperature ratings of the materials).

Press padding (outside separator plates) is recommended. Use of conformance materials such as Taconic TacPad, PTFE skive film, clutch lamination, or others are often helpful to balance pressure variations induced from circuits.

Pressure

Excessive pressure should be avoided; it can distort circuit patterns, induce resin/filler separation, create flow channels, and impact phase shift in signals.

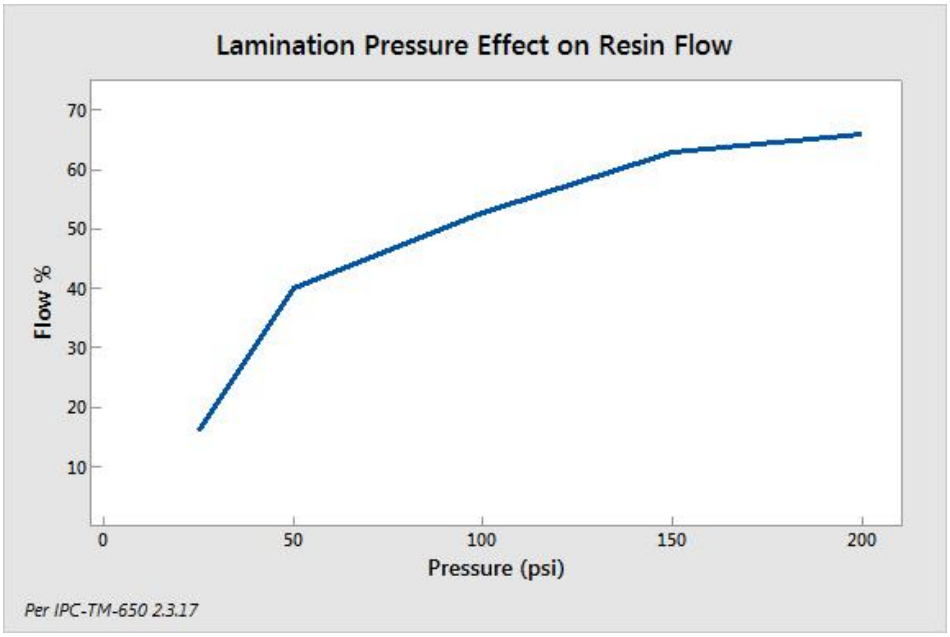
Full pressure should be achieved before the *fast*Rise™ EZ reaches 80°C (175°F). *fast*Rise™ resin flow has been shown to be directly proportional to lamination pressure and higher pressures can increase resin flow when required.

*fast*Rise™ EZ

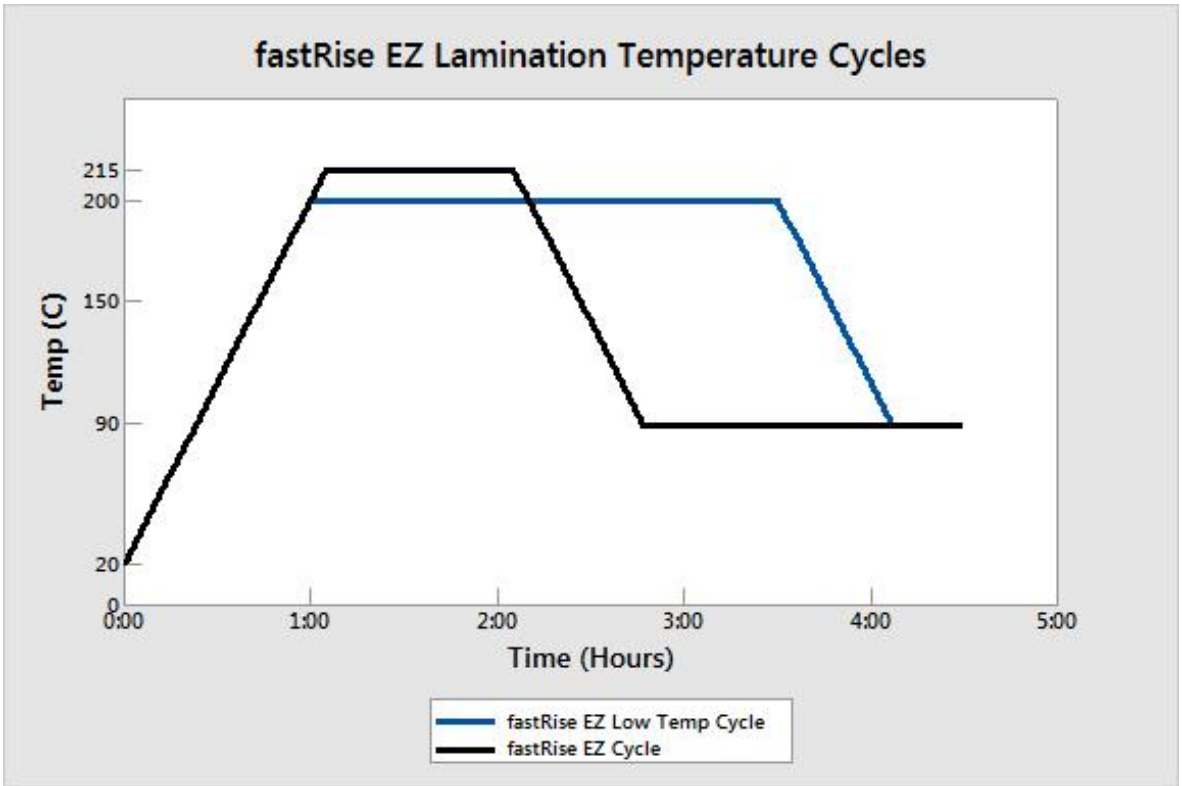
Lower pressures are believed to aid the center film in laying flat which may reduce phase shift in the circuitry at elevated frequencies. Past data has also shown that lower lamination pressures are linked to decreased scale variation between panels.

*fast*Rise™ EZpure

Due to the absence of PTFE film in *fast*Rise™ EZpure, this product is especially prone to excessive squeeze out at higher pressures. Taconic recommends as low a pressure as can possibly be achieved (i.e. contact pressure) up to a maximum of 100 psi, depending on the application. Approximate flow vs. pressure for *fast*Rise™ EZpure is charted below.



Temperature



Resin Flow Window / Critical Range

*fast*Rise™ resins gel and flow between 80°C - 150°C (175°F – 300°F) and reaches their lowest viscosity between 100°C – 125°C (212°F – 260°F).

Heating Rate

A cold start of the press is desirable. Typical *fast*Rise™ heating rates are 2°C/min – 4°C/min (3°F/min – 8°F/min). In difficult to fill applications such as heavy copper or high layer count boards, a slow heating rate should be used. It is also recommended that low heating rates be used if the process is to accommodate tight registration requirements or high layer counts. Past studies have shown that lower heating rates (i.e. 2°C/min) can provide substantial improvements in registration repeatability.

Curing

*fast*Rise™ EZ resins cure at a lower temperature than other *fast*Rise™ part numbers. A standard *fast*Rise™ heating profile can usually be used where the bondline is held at 215°C (420°F) for a minimum of 1 hour. However, *fast*Rise™ EZ can also be cured where the bondline is held at 200°C (390°F) for 2.5 hours. The lower cure temperature can provide some advantages in what release/padding/conformance

materials can be used as well as enabling the use of traditional lamination presses designed for FR4. This also increases compatibility with other low-temperature flexible materials.

Cooling

A slow cool is necessary to avoid any issues associated with delamination. The hot press should be cooled below 90°C (200°F) before transferring to a cold press. In situations where mismatched CTE's may induce delamination or where warping may be an issue, slower cooling rates may provide better results.

Additional Notes

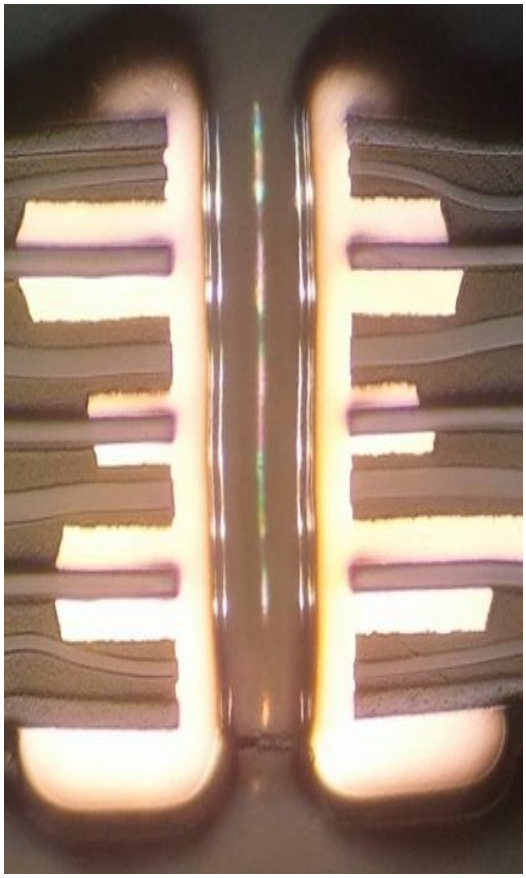
Multiple Ply Constructions

Resin flow can increase when multiple plies of *fast*Rise™ EZ are used against each other. If higher-flow is not desired, pressure should be reduced to prevent excess resin flow, resin separation, rippling of the center film, or formation of flow channels.

Foil Lamination

Due to relatively high flow rates, *fast*Rise™ EZ is not recommended for foil laminations. Contact a Taconic Technical Representative for process and design considerations that must be taken into account before using *fast*Rise™ EZ in a foil lamination construction.

DRILLING



In many cases, the laminate cores will dictate drilling parameters. The following information is provided as a general suggested starting point where fastRise is the primary material.

Quick Start

	Imperial units	SI units
Entry Material	Phenolic (0.010" – 0.024")	Phenolic (0.25mm - 0.6mm)
Backer Material	Rigid Phenolic, Slickback, or comparable	
Cutting Speed (surface speed)	100 SFM	30.5 MPM
Chip Load	0.0010 in.	25.4 µm
Dwell	0-1000 ms (increase dwell time as speed and chip load deviate from above recommendations)	

Drill Bits

Sharp drill bits are critical to any PTFE drilling; new drill bits should always be used. Undercut drill bits are recommended, but past studies have shown that some drill bit brands may obtain better results using their standard drill bits.

Chip Load

A chip load of 1.0 mil (25.4 µm) is common with *fast*Rise™. Increasing the chip load to 1.25 mils (31.8 µm) may provide acceptable hole quality and improved productivity.

Cutting Speed

Drill speeds of 100 SFM (30.5 m/min) or less will usually eliminate drill smear if it is present. The slower speeds allow generated heat to dissipate before smearing PTFE. Drill speed can be increased due to equipment limitations, but added dwell times may become more important.

Dwell Time

If smear is present and ideal cutting speeds cannot be obtained, a 250ms dwell is recommended for initial process setup in order to cool the drill bit between holes. Past Taconic studies have shown that hole-wall quality in PTFE materials may improve as dwell times are increased to as much as 1000ms.

Peck Drilling

Peck drilling should be avoided where possible; it has been shown to increase drill bit wear as well as increase process time. Peck drilling may be required in some situations (e.g. bird nesting, hole plugging, chip extraction on thick panels, breaking thin drill bits, etc.).

If traditional peck drilling is not used, hole-wall quality in PTFE laminates may be improved with the use of a “clean” peck where the peck depth is set to equal that of the phenolic entry. In this, the entry material will effectively clean the drill bit, retract to clear phenolic debris and cool, and then reenter to drill the hole.

Hit Count

Hit counts can vary widely and are usually determined by the laminates used, panel thickness, and hole size. Hit counts of 100-300 hits per bit are typical for ceramic/PTFE constructions. When paired with unreinforced and ceramic free laminates, little drill wear will take place and hit counts of 700-1000 are not unreasonable. When developing the process, the drill point edges should be periodically inspected to assess the level of drill wear and hit count should be adjusted accordingly.

Entry / Backer Materials

Rigid entry and exit material is usually beneficial in order to remove any debris or deposits from the drill bit. 10-25 mil phenolic entry is acceptable for most applications and 30-50 mil phenolic entry can be used if pressure foot clearance is substantial.

Like the entry, rigid backer is usually necessary to prevent burring and aid in obtaining hole-wall quality. Thick phenolic is typical and lubricated rigid backers such as SlickBack® from L.C.O.A.® have also been successful.

Coolant Assisted Drilling

Some drilling equipment is now equipped to apply coolant/lubricant to the drill bit during the drilling process. This process has been shown to provide substantial benefit to the drilling process and should be used if available. If available, expect increased chip loads, cutting speed, and improved hit counts.

HOLE WALL PREPARATION

*fast*Rise™EZ requires a PTFE activation cycle for the PTFE film. The thermoset adhesive resins can be desmeared / etched back prior to the PTFE activation as directed below.

*fast*Rise™ EZpure does not contain PTFE film and therefore does not require an activation step prior to plating. The thermoset adhesive resins can be desmeared / etched back as directed below.

Desmear

Plasma

If panels have been exposed to moisture, bake the boards at 80°C (175°F) for 3 hours to drive out moisture. Standard FR4/epoxy desmear processes should then be used. **The desmear plasma time is typically half that of standard FR4/epoxy times because *fast*Rise™ EZ resin systems tends to etch back quickly.**

Permanganate

A standard permanganate desmear process IS NOT RECOMMENDED and has been shown to be very aggressive on *fast*Rise™ EZ thermoset resins resulting in excessive etchback. If permanganate baths must be used for desmear or activation of other materials used in conjunction with *fast*Rise™ EZ, consult with your Taconic technical service representative for specific process recommendations.

PTFE Activation

Plasma

If panels have been exposed to moisture, pre-bake the boards at 80°C (175°F) for 3 hours. Plasma treat the PTFE resin using 70%/30% Hydrogen/Nitrogen gas mixture. 100% Helium may also suffice. Power settings for the RF-signal generator are typically 60-75% of full rated power for 30-60 minutes, but results may vary. Thick panels or high-aspect ratio holes may require extended plasma cycle times.

Sodium Etch

Sodium Etches (e.g. Fluoroetch) for PTFE activation works well with *fast*Rise™ EZ. Follow the manufacturer's recommended treatment process. Subsequently, bake for 3 hours at 80°C (175°F) prior to plating to remove moisture that may have been absorbed during the sodium treatment process.

> Chlorine can have adverse effects on the sodium treatment. Do not subject exposed sodium etch treated holes to heavily concentrated chlorine-based chemical processes.

PLATING

A robust hole wall preparation process is necessary for a successful deposition plating process due to the PTFE content in the *fast*Rise™ EZ . Following hole wall preparation, *fast*Rise™ EZ will accept standard electroless copper or direct metallization plating.

IMAGE, DEVELOP, ETCH, STRIP

When copper surface preparation is required, chemical cleaning processes are preferred (e.g. microetch); mechanical scrubbing (e.g. pumice scrub) should be avoided due to possible mechanical damage. Although *fast*Rise™ EZ should be resistant to this damage, low loss materials typically used in conjunction with *fast*Rise™ may not be. Otherwise, standard processing should be used.

SOLDER MASK

Panels should be clean and dry. No other special treatment is required.

SOLDER REFLOW

A pre-bake cycle of 2 – 3 hours at 120^{o}C [250^{o}F] is recommended prior to thermal stressing. Longer pre-heat times and minimal cycle times may be advantageous depending on design and processes.

ROUTING / MILLING

*fast*Rise™ EZ can be successfully machined using standard router bits or end mills. Rigid phenolic entry and a rigid backer should be used. In some cases, adding paper (white paper or craft paper) between the phenolic and the part allows better conformance to surface topography (e.g. circuits, soldermask, etc.) and may reduce burring. For tight tolerances or superior edge quality, a “rough cut” placed 0.005 in. - 0.010 in. off the part edge may be run prior to the “finish” cut at the nominal part edge.

APPENDIX

Drill Charts

Size		Spindle Speed	Infeed	
(inches)	(mm)	(krpm)	(in/min)	(m/min)
.0040	0.10	95.5	96	2.44
.0050	0.13	76.4	76	1.93
.0059	0.15	64.7	65	1.65
.0063	0.16	60.6	61	1.55
.0067	0.17	57.0	57	1.45
.0071	0.18	53.8	54	1.37
.0075	0.19	50.9	51	1.30
.0079	0.20	48.4	48	1.22
.0083	0.21	46.0	46	1.17
.0087	0.22	43.9	44	1.12
.0091	0.23	42.0	42	1.07
.0095	0.24	40.2	40	1.02
.0098	0.25	39.0	39	0.99
.0100	0.25	38.2	38	0.97
.0105	0.27	36.4	36	0.91
.0110	0.28	34.7	35	0.89
.0115	0.29	33.2	33	0.84
.0118	0.30	32.4	32	0.81
.0120	0.30	31.8	32	0.81
.0125	0.32	30.6	31	0.79
.0130	0.33	29.4	29	0.74
.0135	0.34	28.3	28	0.71
.0138	0.35	27.7	28	0.71
.0145	0.37	26.3	26	0.66
.0156	0.40	24.5	25	0.64
.0158	0.40	24.2	24	0.61
.0160	0.41	23.9	24	0.61
.0177	0.45	21.6	22	0.56
.0180	0.46	21.2	21	0.53

Size		Spindle Speed	Infeed	
(inches)	(mm)	(krpm)	(in/min)	(m/min)
.0197	0.50	19.4	19	0.48
.0200	0.51	19.1	19	0.48
.0210	0.53	18.2	18	0.46
.0217	0.55	17.6	18	0.46
.0225	0.57	17.0	17	0.43
.0236	0.60	16.2	16	0.41
.0240	0.61	15.9	16	0.41
.0250	0.64	15.3	15	0.38
.0256	0.65	14.9	15	0.38
.0260	0.66	14.7	15	0.38
.0276	0.70	13.8	14	0.36
.0280	0.71	13.6	14	0.36
.0292	0.74	13.1	13	0.33
.0295	0.75	12.9	13	0.33
.0310	0.79	12.3	12	0.30
.0312	0.79	12.2	12	0.30
.0315	0.80	12.1	12	0.30
.0320	0.81	11.9	12	0.30
.0330	0.84	11.6	12	0.30
.0335	0.85	11.4	11	0.28
.0350	0.89	10.9	11	0.28
.0354	0.90	10.8	11	0.28
.0360	0.91	10.6	11	0.28
.0370	0.94	10.3	10	0.25
.0374	0.95	10.2	10	0.25
.0380	0.97	10.1	10	0.25
.0390	0.99	9.8	10	0.25
.0394	1.00	9.7	10	0.25
.0400	1.02	9.5	10	0.25

Size		Spindle Speed	Infeed	
(inches)	(mm)	(krpm)	(in/min)	(m/min)
.0410	1.04	9.3	9	0.23
.0413	1.05	9.2	9	0.23
.0420	1.07	9.1	9	0.23
.0430	1.09	8.9	9	0.23
.0433	1.10	8.8	9	0.23
.0453	1.15	8.4	8	0.20
.0465	1.18	8.2	8	0.20
.0469	1.19	8.1	8	0.20
.0472	1.20	8.1	8	0.20
.0492	1.25	7.8	8	0.20
.0512	1.30	7.5	8	0.20
.0520	1.32	7.3	7	0.18
.0531	1.35	7.2	7	0.18
.0550	1.40	6.9	7	0.18
.0551	1.40	6.9	7	0.18
.0571	1.45	6.7	7	0.18
.0591	1.50	6.5	7	0.18
.0595	1.51	6.4	6	0.15
.0610	1.55	6.3	6	0.15
.0625	1.59	6.1	6	0.15
.0630	1.60	6.1	6	0.15
.0635	1.61	6.0	6	0.15
.0650	1.65	5.9	6	0.15
.0669	1.70	5.7	6	0.15
.0670	1.70	5.7	6	0.15
.0689	1.75	5.5	6	0.15
.0700	1.78	5.5	6	0.15
.0709	1.80	5.4	5	0.13
.0728	1.85	5.2	5	0.13
.0730	1.85	5.2	5	0.13
.0748	1.90	5.1	5	0.13
.0760	1.93	5.0	5	0.13
.0768	1.95	5.0	5	0.13
.0781	1.98	4.9	5	0.13
.0785	1.99	4.9	5	0.13

Size		Spindle Speed	Infeed	
(inches)	(mm)	(krpm)	(in/min)	(m/min)
.0787	2.00	4.9	5	0.13
.0807	2.05	4.7	5	0.13
.0810	2.06	4.7	5	0.13
.0820	2.08	4.7	5	0.13
.0827	2.10	4.6	5	0.13
.0846	2.15	4.5	5	0.13
.0860	2.18	4.4	4	0.10
.0866	2.20	4.4	4	0.10
.0886	2.25	4.3	4	0.10
.0890	2.26	4.3	4	0.10
.0906	2.30	4.2	4	0.10
.0925	2.35	4.1	4	0.10
.0935	2.37	4.1	4	0.10
.0938	2.38	4.1	4	0.10
.0945	2.40	4.0	4	0.10
.0960	2.44	4.0	4	0.10
.0965	2.45	4.0	4	0.10
.0980	2.49	3.9	4	0.10
.0984	2.50	3.9	4	0.10
.0995	2.53	3.8	4	0.10
.1004	2.55	3.8	4	0.10
.1015	2.58	3.8	4	0.10
.1024	2.60	3.7	4	0.10
.1040	2.64	3.7	4	0.10
.1043	2.65	3.7	4	0.10
.1063	2.70	3.6	4	0.10
.1065	2.71	3.6	4	0.10
.1083	2.75	3.5	4	0.10
.1094	2.78	3.5	4	0.10
.1100	2.79	3.5	4	0.10
.1102	2.80	3.5	4	0.10
.1110	2.82	3.4	3	0.08
.1122	2.85	3.4	3	0.08
.1130	2.87	3.4	3	0.08
.1142	2.90	3.3	3	0.08