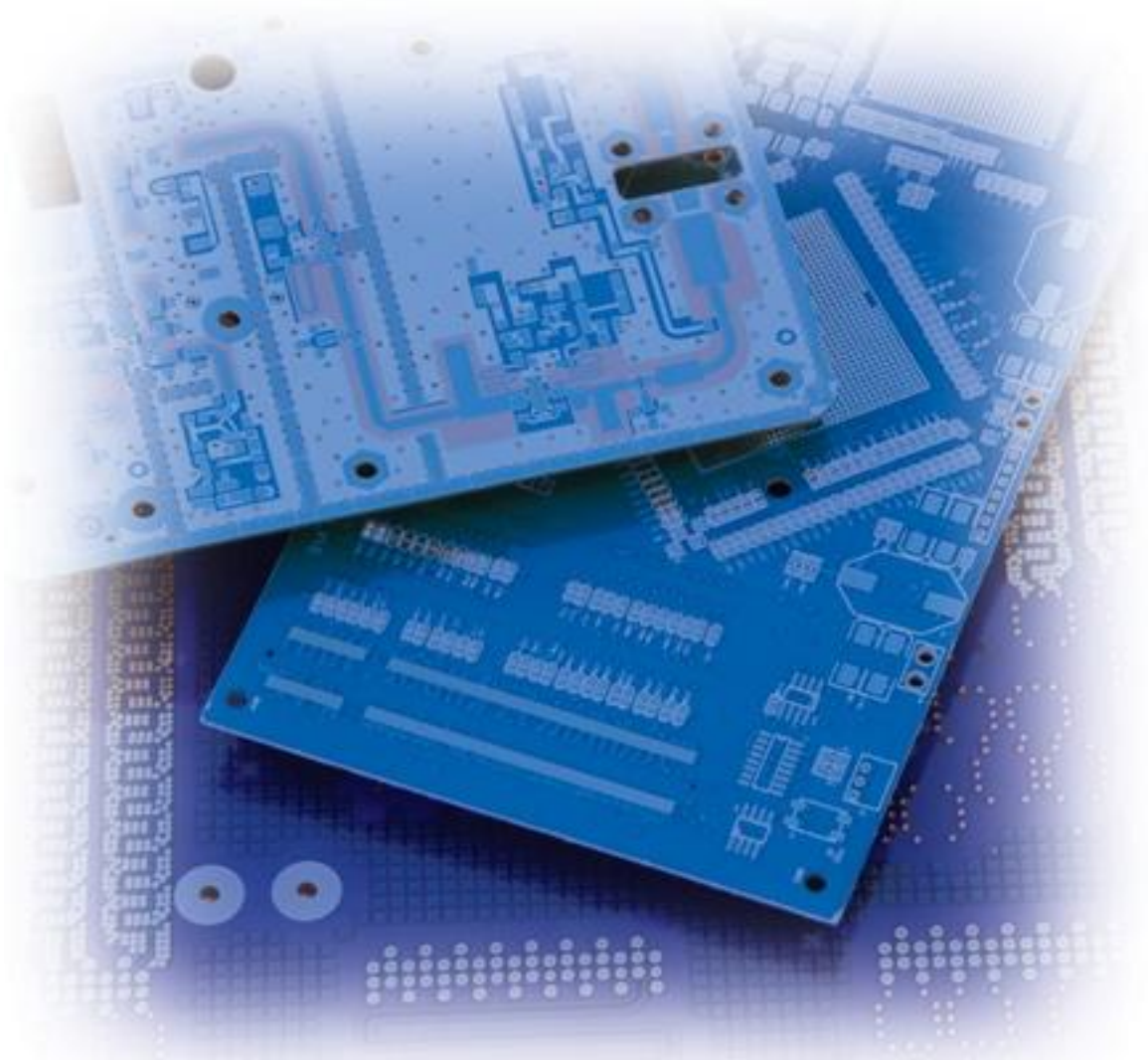


TACONIC

fastRise Multilayers with TSM, TSMDS/DS3,
RF35A2/RF35TC, RF60A, CER10

General Processing Guidelines



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SUMMARY

		High		Filling						
		Striplines	Layer	Between	cavities	Nominal		Adhesive		Microvia
	Speed	with 1.0	Count	subs	blind or	Carrier	Carrier	resin		Formation
	Board C	oz	stripline	with plated	buried	Film	Film	per	Flow	Foil
	part #	copper	PWBS	up copper	vias	(mils)		side	(%)	Lam
FR26-0025-60	2.2 mil	yes	yes	caution	no	1	smooth	Low	17	NP
FR27-0030-25		caution	no	no	no	2.3	rough	Low Flow	4	R
FR27-0035-66	3.4 mil	yes	yes	yes	yes	1	smooth	High	36	NP
FR27-0042-75		yes	yes	yes	yes	1	smooth	Highest	35	NP
FR28-0040-50		yes	yes	caution	no	2.3	rough	High	23	R
FR27-0045-35		yes	caution	caution	no	3	rough	High	13	R
FR27-0050-40		yes	yes	caution	no	3	rough	High	23	R

NR = not preferred but plateable, R = recommended

	Pressed Thickness (500 psi)			Nominal DK (10 GHz)	Typical Flow (%)	Number of Prepreg Plies Copper Weight (oz)		
	(mil)	(mil)	(mil)			(1/2)	(1)	(2 or 3)
FR26-0025-60	2.7	1.3	1.0	2.58	17	1	1	2
FR27-0030-25	3.5	2.1	1.8	2.74	4	1	NR	NR
FR27-0035-66	3.7	2.5	2.1	2.7	36	1	1	2
FR27-0042-75	5.16	4.0	3.5	2.73	35	1	1	1
FR28-0040-50	4.9	3.7	3.5	2.81	23	1	1	2
FR27-0045-35	5.8	4.6	4.2	2.73	13	1	1	2
FR27-0050-40	6.1	5.5	4.9	2.76	23	1	1	2
fastRiseDS	5				4	1	1	NR
fastRise77	5.5				4	1	1	NR

between ground planes 0.5 oz. Cu, 50% removal 1.0 oz. Cu, 50% removal



fastRise

General Processing Guidelines

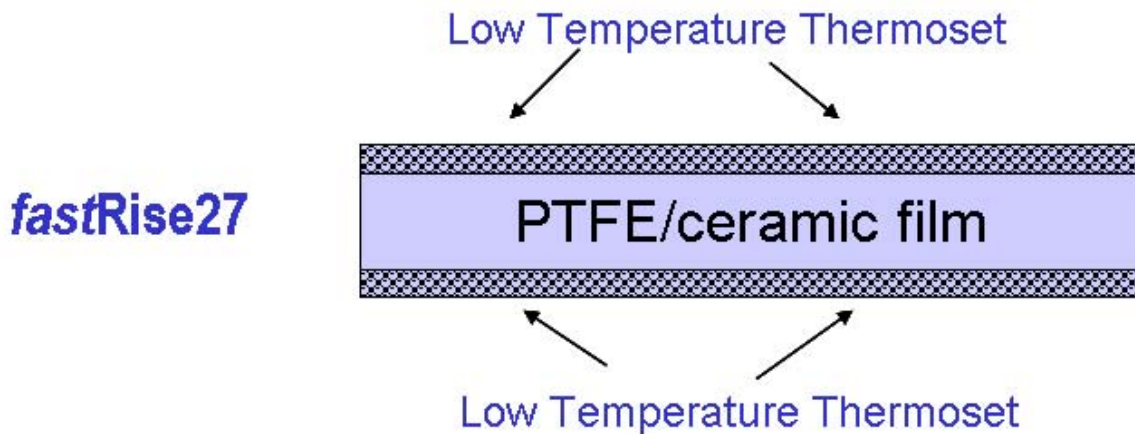
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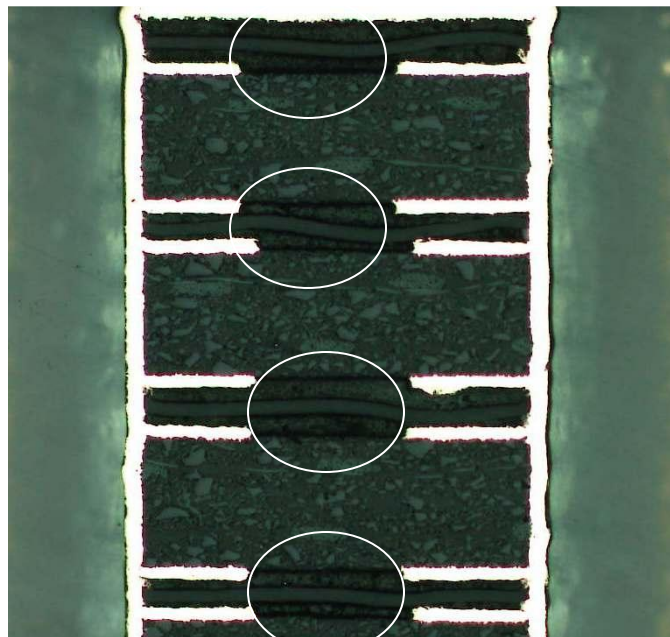
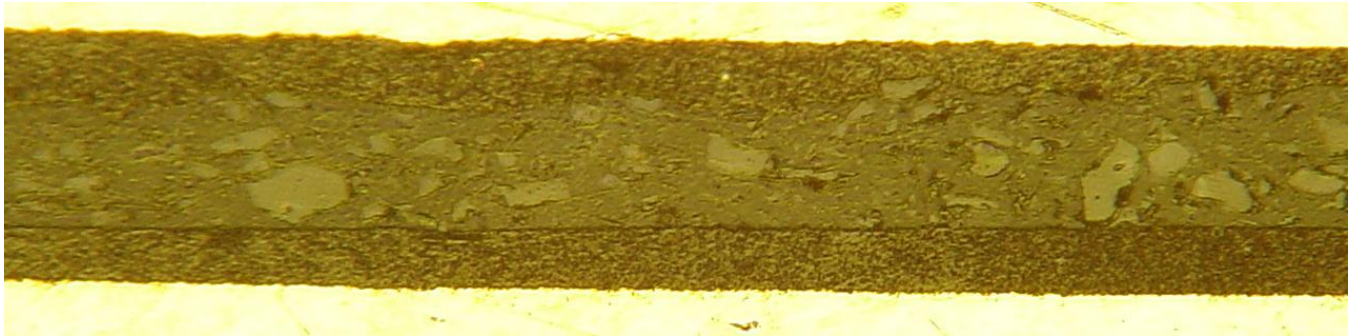
General Information

fastRise prepreg is part of the Taconic product offering designed specifically for High Speed Digital /ATE (DUT) applications, and RF multilayers for mmWave frequencies. Coupled with other Taconic laminate cores, *fastRise* enables the use of low electrical loss stripline structures in high multilayer count boards out to high data rates (43+ gbps) and mmWave frequencies. The thermoset properties of the bonding agent enable multiple laminations and thermal excursions during standard circuit board fabrication without delamination of the multilayer package. 5 sequential laminations is not unusual.

fastRise utilizes a high loading of ceramic for low electrical loss and dimensional stability, a high performance thermoset resin as a bonding agent for the copper foil, and some PTFE. The major component is silica. *fastRise* prepreg can be used to bond together all standard PTFE core materials (TLX etc), ceramic filled PTFE material (TSM30, RO3003, RT/duroid6002, CLTE), rubber products (RO4003/R4350), standard modified epoxy cores (N4000-13SI), and polyimide cores.



fastRise is designed very much like an acrylic based polyimide prepreg. Polyimide prepreps typically contain a polyimide film with a butter coat of a low temperature adhesive. *fastRise* contains a highly ceramic loaded PTFE film with a surface coat of a low temperature adhesive. The adhesive layer is responsible for flowing and filling between the innerlayer artwork. There are two mechanisms for filling the artwork. The thermosetting resin that is coated onto the PTFE/ceramic film will do most of the work in filling the copper artwork as shown in the pictures below. However, in very demanding applications where there is very heavy copper and a very tight pitch, the PTFE-ceramic film will conform and fill around the copper thus increasing the effective mass available to flow and fill the artwork.



DESIGN NOTE: In order to achieve adequate filling around etched features, the number of *fastRise* plies and ply thickness should be determined using the guidelines in Table 2. These guidelines are based on high layer count multilayer designs with stacked traces which create high and low pressure areas during lamination. The recommendations are conservative and other designs may realize satisfactory results using fewer or thinner bond plies. The flow properties are very dependent on the pressure used during lamination and the prepreg used. For low flow or cavity type applications, the prepregs with 4-5% flow should be used and low lamination pressures. For 2-3 oz copper filling, high flowing prepregs are necessary. 2 plies of prepreg may be necessary for 2-3 oz copper.

Table 1 Choosing the Right fastRise Part Number

		High	Filling							
	Speed	Striplines	Layer	Between	cavities	Nominal	Carrier	Carrier	Adhesive	Microvia
	Board C	with 1.0	Count	subs	blind or	Carrier	Film	Film	resin	Flow
	part #	oz	stripline	with plated	buried	Film	(mils)		per	Foil
		copper	PWBS	up copper	vias				side	(%)
										Lam
FR26-0025-60	2.2 mil	yes	yes	caution	no	1	smooth	Low	17	NP
FR27-0030-25		caution	no	no	no	2.3	rough	Low Flow	4	R
FR27-0035-66	3.4 mil	yes	yes	yes	yes	1	smooth	High	36	NP
FR27-0042-75		yes	yes	yes	yes	1	smooth	Highest	35	NP
FR28-0040-50		yes	yes	caution	no	2.3	rough	High	23	R
FR27-0045-35		yes	caution	caution	no	3	rough	High	13	R
FR27-0050-40		yes	yes	caution	no	3	rough	High	23	R

NR = not preferred but plateable, R = recommended

Table 2 Pressed Thicknesses and Design Guidance

	Pressed Thickness (500 psi)			Nominal	Typical	Number of Prepreg Plies		
				DK	Flow	Copper Weight (oz)		
	(mil)	(mil)	(mil)	(10 GHz)	(%)	(1/2)	(1)	(2 or 3)
FR26-0025-60	2.7	1.3	1.0	2.58	17	1	1	2
FR27-0030-25	3.5	2.1	1.8	2.74	4	1	NR	NR
FR27-0035-66	3.7	2.5	2.1	2.7	36	1	1	2
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FR27-0045-35	5.8	4.6	4.2	2.73	13	1	1	2
FR27-0050-40	6.1	5.5	4.9	2.76	23	1	1	2
fastRiseDS	5				4	1	1	NR
fastRise77	5.5				4	1	1	NR

fastRise is manufactured to a mass specification and not to a thickness specification. The final pressed thickness will depend on many factors including: (1) the mass of copper etched away

(2) pitch (3) the presence of low pressure zones in the pwb (4) press pressure during multilayer lamination (5) the presence of features such as blind or buried vias that will draw thermoset resin away. fastRise will vary in thickness by no more than 9% when all of the lamination parameters have been established and they are consistent.

Processing [fastRise](#) can be readily accomplished using standard epoxy circuit board processing methods coupled with either plasma or sodium treatment of the PTFE hole walls. The following process recommendations are based on circuit boards produced at several facilities. It should be noted that each board shop may have different equipment and methods that will require modifications to these recommendations. Drill and routing parameters and artwork compensation data are very dependent on circuit board thickness and design and should be adjusted based on the experience of each facility. The treatment of hole walls prior to plating must be done using a plasma or sodium treatment system.

Handling of PTFE Laminate Copper Clad Cores

PTFE is a thermoplastic material which is very stable electrically and chemically when compared with common thermosetting resins such as epoxy, polyphenyleneoxide, polyimide and cyanate ester. PTFE is a relatively soft material. Care must be taken to not dimensionally distort the material. Taconic laminates reinforced with glass fabric are generally fairly dimensionally stable but care should be exercised in their handling. The glass fabric reinforcement of the substrate greatly increases stability in the X and Y axis over non-woven or unreinforced PTFE products. While the glass fabric provides very good dimensional stability and increased stiffness, the relative softness of the PTFE resin requires that the following process and handling precautions should be taken to prevent damage or deformation of the laminate during fabrication.

Do not mechanically scrub PTFE Laminate cores

As with thin core or flexible substrates, mechanically scrubbing will stretch and deform the material. The pinch rollers used to move the panel during scrubbing can also cause dents as particle or brush material are pressed into the surface of the laminate. Chemical cleaning is preferred. Eliminating mechanical cleaning and unnecessary handling will improve the dimensional accuracy of subsequent processes by preventing mechanical distortion of the laminate.

- **Do not pick up a panel horizontally by one end or edge**

By allowing the material to flop over you may stretch the copper and substrate. Lift the panel by two parallel edges; preferably the two closest dimensionally.

- **Prevent contaminant deposits on the material or copper**

The use of clean protective gloves and slip sheets will prevent contamination and staining. You will not need to remove oils, grease or fingerprints if you don't deposit them.

- **Do not stack panels directly on top of each other**

Particles or debris on the surface of the panel can become imprinted into the copper and substrate of adjacent panels. The preferred method of storage is to rack the panels vertically. If panels must be stacked use clean, soft, slip sheet material between each panel and keep stack height to a minimum.

Inner Layer Preparation

Multilayer applications require that two or more laminates be bonded together to form a single circuit board. There are two important considerations when processing the circuit board. The first is registration of the features from one layer to another. The second is the condition of the bond surface prior to lamination.

Registration: Layer to layer registration is often a critical requirement of the finished circuit board and misregistration can cause a variety of issues such as open circuits and poor coupler performance. Therefore, it is important that the material be acclimated to the processing environment and the correct artwork compensation used. Acclimation to the processing environment is simply making sure that the laminate is at ambient temperature prior to processing. It is recommended that if the laminate has seen extreme temperatures during shipment or storage, it should be placed in ambient conditions for 24 hours prior to processing. All laminates experience movement after the copper foil has been etched. Various factors such as laminate thickness, glass style, construction, copper foil thickness, and circuit design all contribute to the characteristic known as dimensional stability. The data is reference only and, again, is dependent on the factors listed above. Most printed circuit board shops determine artwork compensation data by running samples or estimating based on previous experience. Taconic’s TSMDS and TSMDS3 should be used with fastRise when fabricating high layer count pwbs with small drilled holes and pads.

Table 3. Typical Dimensional Change

Material Designation	Dimensional Change in Parts Per Million (PPM)
TLC	200 – 400
TLE	220 – 400
TLT	400 – 600
TLX	400 – 600
TLY	400 - 800
RF-35, 35P	200 – 400
RF60	400 – 600
Cer-10	400 – 600

fastRise

Refrigeration / Storage / Shelf life

fastRise is a non reinforced prepreg that is manufactured between release liners so that individual plies of **fastRise** do not stick together. The adhesive layer on the surface of the PTFE/ceramic film can be tacky especially for freshly manufactured material. It is recommended to refrigerate **fastRise** prior to lamination. Continuous refrigeration is always a good practice for storing prepreps. **fastRise** will stiffen up and will separate from the release liners a lot easier when removed from cold storage. **fastRise** has a shelf life of 9+ months on newly manufactured material. Because Taconic cannot guarantee how long any given part number has been stored in Taconic's inventory, Taconic will never ship any material with less than 3 months shelf life. Aged prepreg can be easily checked by an IPC flow test if a customer has prepreg that is after the recommended use time. Please make contact with your Taconic technical sales person assigned to your territory.

Lamination

Various laminate cores are used in conjunction with **fastRise** prepreg to produce multilayer boards for the RF/digital/ATE multilayer markets. **fastRise** when used in a symmetrical board design, will result in optimum electrical and mechanical performance. Because of the thermoset properties of the bonding agent, multiple bonding cycles can be achieved without worry of delamination. In addition, the recommended press temperature of 420°F [215.5°C] is within reach of most board shops.

The as shipped prepreg cure is not very advanced (cured). For best gap filling it is desirable to achieve the maximum amount of flow prior to the advancement of the resin. The earliest application of pressure will help, certainly below the melt of the thermoset (140°F [60°C]), coupled with a 3°F - 10°F [1.5°C -5.5°C] rate of rise. A cold start of the press is desirable. A hot start of the press will advance the cure of the resin before the best flow is achieved and the optimal amount of flow will not be achieved. For lamination of 2 oz innerlayers a slow heat ramp up rate is suggested. Lagging or padding will help achieve a slower heat rise. Press pressure will affect the degree of flow and any voiding if present. Low pressure will yield less flow, more pressure more flow. A slow cool is necessary to avoid any issues associated with delamination. The hot press should be cooled to somewhere between 170-200°F before opening, although data suggests the press could be opened at 250°F. Transfer to a cold press should not be done until the hot press has reached the recommended temperatures.

Taconic recommends the following press cycle for fastRise27 for most laminations:

- Vacuum Lamination Recommended
- Heat rise 3°F - 10°F / minute [1.5°C – 5.5°C] to 420°F [215.5°C] *
 - Flow window is 130°F [80°C] – 302°F [150°C]
- Maintain pressure at 73 psi [5 bar] until package reaches 100°F [37°C] then apply full pressure of 500 psi [31 bar]
- Hold (cure) for 1 hour
- Cool package under full pressure at < 6°F [3°C] / minute

Alternate press cycle for hybrids:

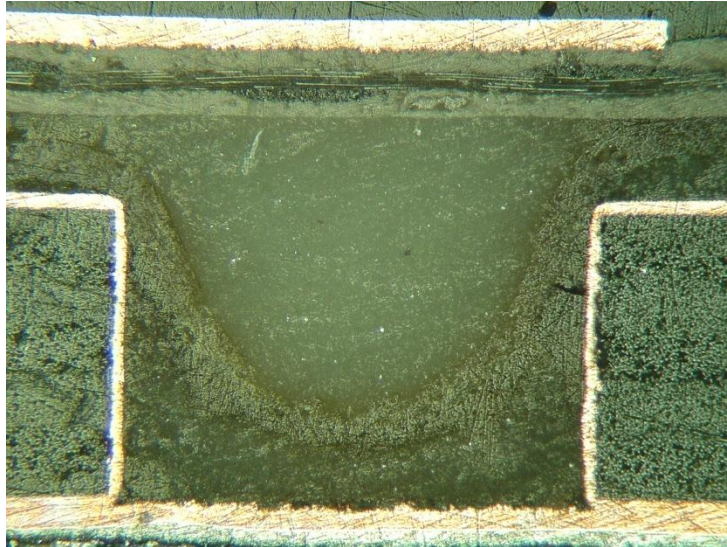
- Press at 395F for 3 hours, otherwise same as above
- CAUTION: lower temperature lamination will yield lower interlayer adhesion between cores and runs a risk of incomplete resin cure. Delamination could result. Some customers are laminating at 395F but caution is advised.**

For low flowing fastRise part numbers (FR27-0030-25, FR27-0040-25), fastRiseDS, fastRise77P, and very difficult flow and fill multilayers with fastRise27, Taconic recommends the following press cycle:

- Vacuum Lamination Recommended
- Heat rise 3°F - 10°F / minute [1.5°C – 2.0°C] to 225 °F [121°C]
- Maintain pressure at 73 psi [5 bar] until package reaches 100°F [37°C] then apply full pressure of 500 psi [31 bar]
- HOLD AT 225 °F for 60 minutes
- Increase temperature from 225°F [121 °C] to 420°F [215.5°C] at 1.5 – 3.0 °C / minute - Flow window is 130°F [80°C] – 302°F [150°C]
- Hold (cure) for 1 hour
- Cool package under full pressure at < 6°F [3°C] / minute

*For high layer count boards, best flow and fill has been seen at low heat-up rates. For low layer count multilayers, a low heat-up rate is less critical.

fastRise27 begins to flow and achieves a low viscosity at 215°F. *fastRise27* will not cure at this temperature however. The longer the board is held at 215°F, the greater the likelihood that *fastRise27* will fill and flow into the worst of cavities. For filling difficult blind or buried vias, or for filling cavities, it is recommended that the multilayer be held for 1 hr at 215°F.



The PTFE film can wiggle in and around circuitry and help fill the artwork. The PTFE based film can have an elongation from 30-300% depending on the *fastRise27* part number. The adhesive resin will flow from areas of high pressure to areas of low pressure. Although the PTFE carrier film is not porous, the entire structure will flow and fill into a cavity to help gap filling. For structures that have a potential for lamination voids, Taconic recommends that during heat up the multilayer stack be held at 217°F for one hour to allow the resin and fill to completely fill any artwork.

Foil Lamination

For successful foil lamination with *fastRise27* the outer layer foil should have sufficient tooth structure to yield acceptable adhesion. If delamination occurs during foil lamination, the adhesion of a good section should be checked. If the adhesion is poor, a copper foil should be chosen with sufficient dendritic structure (TWS or TW foils from Circuit Foils Luxembourg +352-95-75-51-301). Another option is Gould copper: CTDR2002602C10H, AC .007 Al 3/8 HP GLD CU 20x26, distributed by Insulectro.

Flow in a foil lamination is very dependent on pressure. 400 psi on the high flow *fastRise27* part numbers will give incredible flow and may result in the appearance of flow channels. The lower flowing *fastRise27* part numbers are less prone to the appearance of any cosmetic issues related to excessive flow. Reducing the pressure during lamination will reduce excessive flow. Customers should not be afraid to use 100-200 psi lamination pressures to yield the optimal cosmetic quality of a foil lamination. The pressure of lamination has a marginal impact on bond strength if any. The bond strength is more related to the

420°F/215°C cure temperature. fastRise27 part numbers **FR27-0030-25** and **FR27-0045-35** are more likely to yield a flatter surface during foil lamination. The higher flowing fastRise flow excessively (FR27-0035-66 and FR27-0042-75) and a careful control of pressure is necessary to yield good surface cosmetic results.

FR27-0035-66

FR27-0045-35



If the adhesion is good the delamination likely is the result of thermal stresses. Cooling should never be done by transferring the laminates from a hot press to a cold press. Cooling should be conducted in the multilayer lamination press at the slowest rate possible. The stress is transferred from caul plates. An aluminum sheet between the copper and the caul plate will help reduce stress. Pacopadding will help stress relief, the thicker the better. Stress relief can also be accomplished by inserting a layer of flowing FR4 prepreg between the copper foil and the padding. The prepreg should be separated by some type of release film such that no contamination of the multilayer occurs. The construction should be press plate, release film, prepreg, release film, and then multilayer foil lamination. The prepreg will flow and offset thermal stresses. The prepreg can be FR4 or acrylic based polyimide prepreg. The goal is that the thermoset flow and offset thermal stresses. The release layer could be PTFE film, PVDF film, silicone coated paper etc.

Drilling Multilayers Containing *fastRise*

The typical material combination for RF / Microwave and digital multilayers are [fastRise27/TSMDS/DS3](#) [fastRiseDS/TSMDS/DS3](#), [fastRise77P/RF60A](#), [fastRise27/TLE95](#). [fastRise](#) can also be combined with other laminate cores from other manufacturers including: polyimide, modified epoxy, rubber based materials (RO4000 series), or polyesters known as liquid crystalline polymers (LCPs). Tight process control and optimized parameters are essential to achieve required hole wall quality for thick multilayer (> 0.100") and back planes.

High speed digital application have tight specifications to ensure that press fit connectors are not damaged

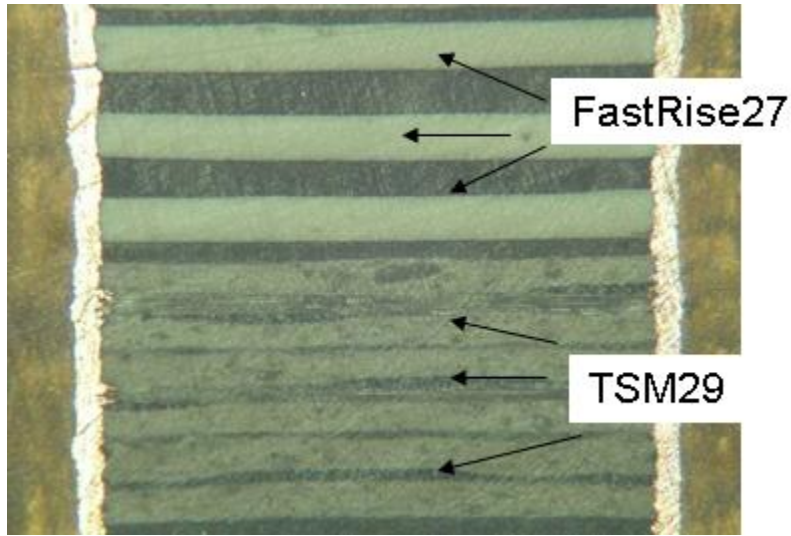


Figure 4 – Multilayer board made with TSM-29 and *fastRise27*

Drill setup conditions

- (1) Drill bits: Use only new straight shank bits. For example:
 - a. Diameter < 15mil Tycom/Kyocera 560 series straight shank. A comparison of drill bit vendors yielded the following results for a 10 mil tool when drilling a 115 mil fastRise27/TSM multilayer stackup:

Vendor	Model	Helix Angle	Style	Nodules/hole
Union	NEU L026, 0.25x4.5	40	UC	0.54
Union	MD35 A3815, 0.25x5/#8	35	Straight	0.72
Kemmer	SH381010021021R	38	Straight	0.67
Kemmer	E34000250-C45040	38	UC	0.72
Kyocera/Tycom	460.0098.177	38	UC	0.98
Kyocera/Tycom	560.0098.177	38	Straight	0.12
HPTec	8 212 0250	40	UC	0.48
HPTec	212, 157mil flute	45	UC	0.25

Parameters: 10 mil Tycom 560 series straight shank, 7 mil aluminum entry, 16.5 mil phenolic entry, 16.5 mil phenolic exit, 120K speed, infeed 55, 0.25 second dwell between hits, 1st peck to the depth of phenolic + aluminum + 2 mils into material (28 mil), 1 peck/30 mils thereafter.

(2) Maximum hit counts: 200 hits/bit

(3) Drill Stackup Illustration (for 250 mil thick pwbs, thick phenolic entry should be used):

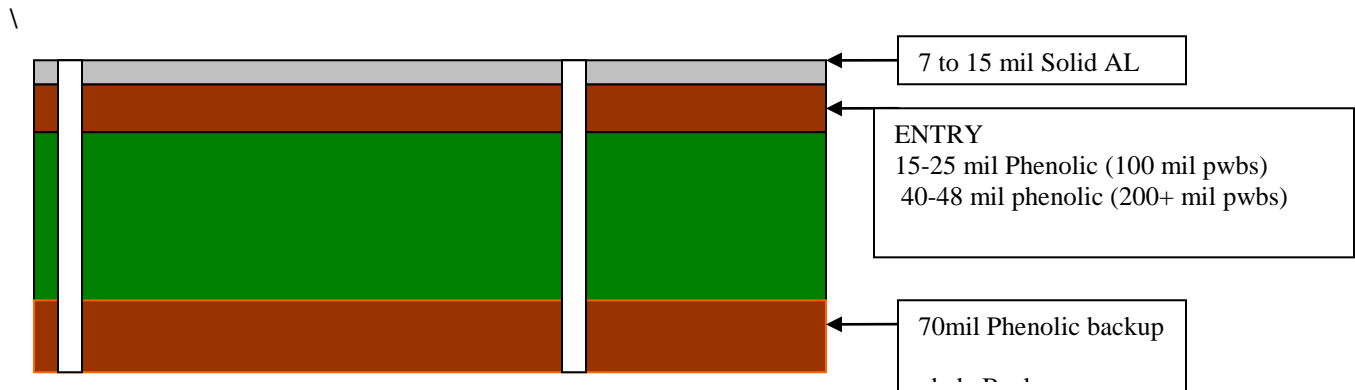


Figure 5 – Stackup of Multilayer Drilling

(4) Vacuum: Maximum capacity

(5) Drill foot pressure: > 40 psi

(6) Dwell between hits: 1 second (250 millisecond may work)

(7) Peck drilling through the phenolic entry material.

Table 4. Drilling Parameters for Thick Multilayers

Drill Size (inch)	Chipload (mil)	Spindle speed (Krpm)	Feed rate (ipm)	Retract Rate (in/min)
0.010	0.4 -0.6	80-125	55-60	1000
0.012	0.4 -0.6	80-125	55-60	1000
0.0200 ¹	0.64	70	45	1000
(0.020) ²	(0.33)	(45)	(15)	(1000)
0.0280	1.0	32	32	1000
0.0380	1.3	24	31	1000
0.0400	1.8	22	40	1000
0.0420	1.8	21	38	1000
0.0440	1.8	20	37	1000
0.0460	1.8	19	35	1000
0.0480	1.8	19	34	1000
0.0500	2.0	18	36	1000

(¹) 50 hits per bit with peck drilling, (²) 150 hits per bit, no pecking

Drill Bit Hit Count

There are two sources of defects in PTFE based multilayers. Large nodules that are attached to the hole wall are usually related to large chunks of debris that accumulate on the drill bit and the scrape off onto the side wall. The nodule size will reflect the size of a large chunk of debris that was clinging to the drillbit. Usually thick phenolic as an entry will scrape the drill bit clean of debris. The second defect is smear at an interconnect. Fabricators with a lot of experience drilling PTFE based multilayers may use anywhere from 25 hits per bit to 200. 30 hits per bit is not unusual for a critical military pwb. Most military pwbs are drilled with 100 hits per bit. Fabricators building for commercial accounts may push the hit rate to 150-200 hits/bit. It is critical that the drill trip be sharp. If the drill bit is not sharp, instead of cutting it will push or pull resulting in smear. In case of unacceptable drill quality, the first two key strategies to improve hole wall quality is to reduce the hits/bit and reduce the chip load.

Entry/Exit Materials

Phenolic entry and exit material is critical for drilling PTFE based circuit boards. 16-25 mil phenolic is recommended for 100 mil pwbs. 30-50 mil phenolic entry is recommended for 250 mil thick pwbs. PTFE gets hot and likes to accumulate on the surfaces of the bit. Phenolic entry and exit material will essentially “clean” the surface of a bit. Debris builds up on the bit which includes anything the bit comes into contact with: entry material, copper, fiberglass, silica, PTFE, metal from the bit itself, phenolic, Aluminum etc. It is necessary to use a hard thick phenolic entry material to essentially break the debris off the bit and smear the debris onto the phenolic before the bit arrives clean at the surface of the pcb and drills. Following these drill parameters should allow the user to arrive at fairly good hole wall quality on very thick telecom type boards (200-300 mil). Fabricators may worry about the thick phenolic causing excessive drill wear. First the fabricator has to reach a level of acceptable debris in the whole, usually none, and that is achieved by using thick phenolic to scrape debris off the drill tool between hits. Drilling Teflon is limited by debris filling and fusing to the drill bits. Drill bits are exchanged due to debris build up on the bits before wear becomes an issue. Typically 70 mil phenolic is used as backup but the phenolic only needs to be 15 mils or the depth of the drill. If the drill only penetrates 20 mils at the bottom the phenolic need only be 20 mil. Phenolic backup can be stacked with spectrumboard. Phenolic can also be combined. A 25 mil piece of phenolic can be combined with a 15 mil piece of phenolic to yield a 40 mil piece of phenolic.

If the requirements are such that even higher hole wall quality is needed there is another solution:

Tip: Strategies to remove plating nodules: for very demanding hole wall specifications it might be necessary to drill the holes, pass the pcb through an electroless treatment or flash plating treatment to essentially make the debris in the hole rigid, then redrill to snap the debris from the side of the hole wall. Another strategy for critical hole wall quality is to slightly under drill (using undersized diameter drill bit?)the hole, thereby remove most of the PTFE-ceramic from the hole, flash plate the hole, and then redrill it with the proper size bit. If undersized drilling is used, flash plating between drill sizes may not be necessary.

Dwell Times

Studies have shown that the best hole wall quality is obtained when the drill bit has a chance to cool. This makes intuitive sense because a cooler bit will be less likely to cause the PTFE to become soft and stretchy. We have found that a 1 second (1,000 ms) dwell time between hits is sufficient. Longer dwell times will not improve hole wall quality.

Peck Drilling

We have also found that it is beneficial to “clean” the bit by pecking to a depth that corresponds to the thickness of the entry material. Pecking through the distance of the phenolic will abrade debris off the bit in the phenolic and allow the debris from the phenolic to be removed before the bit reenters the hole and starts drilling the multilayer based on **fastRise**. Therefore the first peck should be the depth of the entry material. This is necessary to remove the phenolic debris before “cleaned” drill bit starts drilling into the PTFE based pcb. Past studies have shown that peck drilling inside of PTFE pcb is necessary for micro diameters (12mil and 14mil) to remove the debris in order to prevent tool breakage. However, for 28mil holes, peck drilling inside 200 mil PTFE based pcb is still not clear. Some drill studies suggest that peck drilling will leave a small circular ring where the drill bits stop in the hole. However, it may be necessary to peck drill to remove drill debris. Peck drilling has the benefit of allowing the bit to cool a bit and it improves debris removal. However, we have found in a very complex 250 mil pwb that the peck drilling puts a lot more wear on the drill bit. You need a sharp cutting tool to cut the Teflon smoothly otherwise it does smear. Some drill bit vendors claim that pecks increase drill wear proportional to the # of pecks. If there is no concern for drill bit breakage, the best approach seems to be a single peck to the depth of the phenolic, then a through hole drill the rest of the way with a very low chipload, keeping the hit count on the bit low.

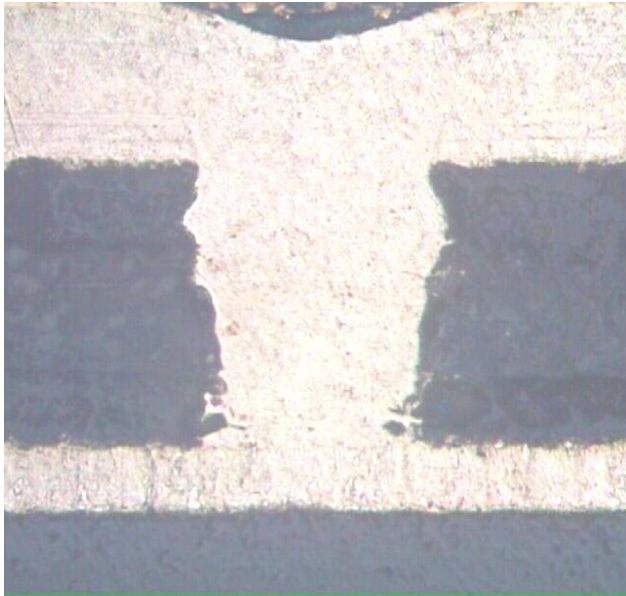
No pecking and low 50 hits per bit has the best chance of eliminating smear because the drill bit will stay very sharp. To drill a thick pwb with no pecking however, you have to operate at very low chiploads. Table 4 shows two different successful drill parameters for drilling a 20 mil hole, with and without peck drilling.

Laser Drilling MicroVia Formation

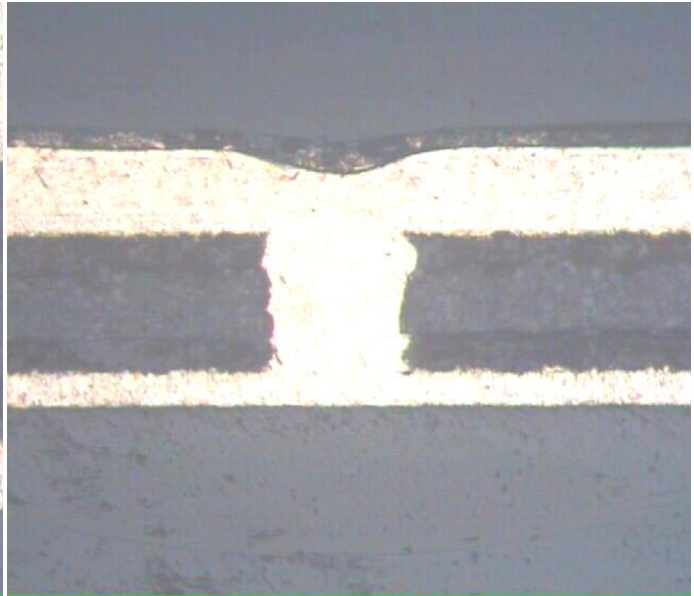
The lasing of the fastRise part numbers will vary with the fastRise part numbers. Please see the summary chart on the recommended part numbers for foil lamination and laser drilling microvia formation. Laser ablations yields the smoothest sidewalls using FR27-0030-25, FR27-0040-50, FR27-0045-35, and FR27-0050-40. Please see the following photomicrographs of microvias fabricated by **Hughes Circuits**. The copper filled microvias were formed with the goal of showing good quality lasing using FR27-0040-50. The microvias with the thin copper plating were formed with the goal of comparing two different fastRise part

numbers. Laser ablation was not optimized, nor was the intent to fill the via with plating. The only goal was to check relative via hole quality of the two fastRise part numbers.

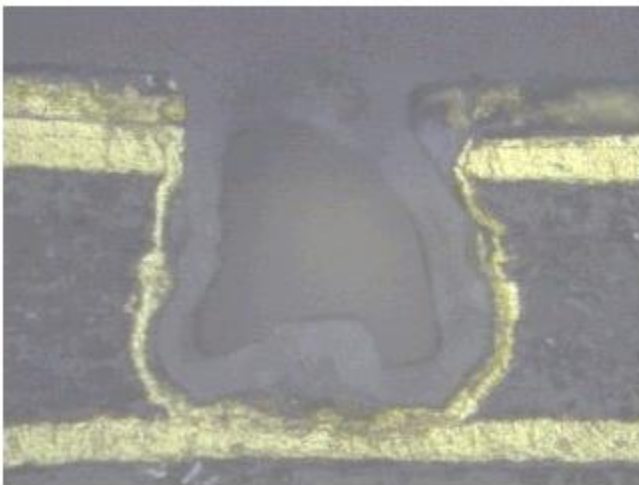
FR28-0040-50 (Hughes Circuits)



FR28-0040-50 (Hughes Circuits)



FR27-0045-35 (Hughes Circuits)



FR27-0045-35 (Hughes Circuits)



FR27-0035-66 (Hughes Circuits)



FR27-0035-66 (Hughes Circuits)



Hole Wall Preparation

PTFE based laminates require that drilled holes be subjected to a process that will prepare the PTFE resin system for subsequent plating. Since *fastRise* contains some PTFE resin; it requires treatment prior to plating. There are two hole wall treatment processes that have been shown capable of providing void-free copper plating. One process is chemical in nature and involves a sodium-based solution that strips the fluorine atoms from the PTFE molecules. This process has been used for many years in the industry with great success. The advantages of sodium etching include long shelf life of the hole wall treatment, fast treatment time, and complete coverage. The primary disadvantage of sodium etchant is the volatility of the chemical. Various manufacturers and etchant services are available.

Another method of preparing the holes for plating is plasma etching. If the proper gases and cycles are used, plasma will allow plating to the PTFE resin. Experience has shown that the best gases to use are a mixture of hydrogen and nitrogen. Helium can also be used in many cases. The advantage of plasma etching is that it is a relatively safe procedure. Disadvantages include relatively long cycle times (35 to 60 minutes) and short shelf life of the effect (4 – 24 hours).

fastRise also contains a thermoset resin as the bonding agent. This requires a desmear process in addition to the PTFE treatment. There are two common methods of desmearing thermoset resin systems. One of the desmear processes involves dipping the boards in a permanganate chemical which dissolves the resin. The second method is plasma. Generally speaking, the gases used to desmear the thermoset resin do not affect the PTFE resin, nor do the gases used for treating the PTFE resin desmear the thermoset resin very well if at all.

Also, the sodium solution commonly used to treat the PTFE resin will not affect the thermoset resins system.

Permanganate desmear IS NOT RECOMMENDED and has been shown to be very aggressive, due to the relatively thin layer of thermosetting resin and due to the fact that the thermosetting layer contains a silica filler., and can cause excessive etchback. Permanganate will not affect the PTFE. Desmearing of the **fastRise** can be more closely controlled with a plasma desmear cycle. In addition, hole wall treatment of the PTFE can also be done successfully with plasma and it is possible to have back-to-back desmear and hole treatment without removing the product from the plasma machine. Basically desmear and PTFE activation should occur in a two cycle plasma cycle.

Taconic recommends the following hole wall treatment:

- Thoroughly clean holes prior to treatment. If water cleaning is used, bake the boards at 220°F (105°C) for 1 hour
- Plasma treat the epoxy component using a standard epoxy desmear gases and power and a 15 minute cycle time to reduce overetching of the epoxy
- Continue plasma cycle with a PTFE cycle shown below

Plasma Etching: If desmearing or etchback of the thermoset used to bond **fastRise** is necessary, the prepreg should first be exposed to a standard FR4 plasma desmear (10-15 minutes, 185°F/85°C, O₂, N₂ CF₄ gas mixture. If too much etchback or pencil tipping of the interconnect occurs at the post then the dwell time in the FR4 plasma desmear cycle needs to be reduced. The treatment of the PTFE requires a different gas mixture. Plasma treatment of the PTFE resin using a 30-70% Hydrogen, 70-30% Nitrogen gas mixture has been shown to be very effective. If Hydrogen is not available, a 100% Helium should also suffice. Power setting for the RF-signal generator should be 60-75% of full rated power for 30-60 minutes depending on the hole diameter, number of holes, and thickness of the board. Boards with relatively higher aspect ratios will require longer plasma cycle times. Industry experience has shown that gases such as helium and CF₄ are not as effective as hydrogen as evidenced by sporadic plating voids and higher contact angles.

Note: Regardless of which method of hole wall treatment is used, desmearing of the thermoset resin should be done prior to treatment of the PTFE resin.

Sodium Treatment: A sodium-based chemical treatment process does an excellent job of preparing the PTFE through-hole surface prior to the plated through hole process. Follow the manufacturer's recommended treatment process. Bake for 1 hour at 250° F [120°C] prior to plating to remove moisture that may have been absorbed during the sodium treatment process. NOTE: Do not subject the treated holes to heavily concentrated chlorine-based chemical processes prior to electroless copper plating or direct metallization. Chlorine can

have adverse effects on the sodium treatment and result in plating voids. Etchants can be obtained from Acton Associates in Pittston, PA for information on their Fluoroetch.

Plating

After the hole wall has been properly prepared, *fastRise* will accept either electroless copper or direct metallization plating. The electrolytic plating process is the same for PTFE or epoxy based materials. Typical plating consists of 1 – 1.5 mils [25µm - 35µm] of copper plate in the holes and/or on the surface.

Image, Develop, Etch, Strip

Prepare the copper surface, apply dry film, and image and develop using a standard process. The copper surface preparation should consist of microetching the copper. Scrubbing is not recommended for thin core PTFE-based materials or multilayer inner layers due to possible registration issues.

The etching process is the same as for a standard printed circuit board. Machine settings should be appropriate for the copper thickness of the multilayer inner layers. Strip the photoresist using a standard process.

Solder Mask

fastRise and other Taconic laminate cores readily accepts LPI solder mask and requires no special treatment.

Solder Reflow

Hot air solder leveling is a common method of protecting exposed copper circuitry. Two basic types of hot air level machines are used in the industry, horizontal and vertical. By far the more popular of the two is the vertical machine. It is less expensive and easier to maintain than the horizontal type. However, the vertical machine subjects the printed circuit board to a more severe level of thermal shock than the horizontal. Once the board is clamped in the vertical machine, the only preheat the board sees is the few seconds above the solder pot prior to immersion. Typical immersion times are 5 – 6 seconds from entry into the solder pot to complete withdrawal. This minimal preheat time can be particularly harsh on PTFE based laminates due to their z axis expansion characteristics. When using hot air solder leveling on PTFE laminates, Taconic recommends a bake cycle of 2 – 3 hours at 300° F [150°C] just prior to the HASL process. The solder pot temperature should be maintained at 460° – 480° F [238°C – 250°C] for optimal performance.

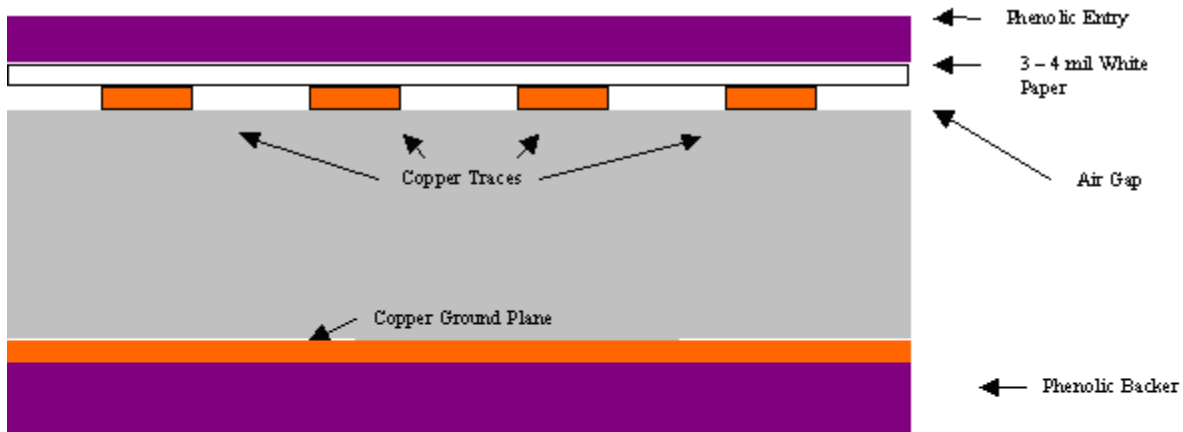
Cycle time should be 5 – 6 seconds from the time of entry to the complete withdrawal of the board. Dwell time in the solder pot should not exceed 2 seconds.

Machining

Machining of PTFE is typically more difficult than epoxy-based substrates due to the softness of the PTFE resin system. The style of fiberglass used in the substrate also affects the quality of routing with respect to burrs and fibers. With multilayers containing fiberglass reinforced core material, the heavier the fiberglass weave, the more difficult it is to cut.

fastRise can be successfully machined using standard router bits or end mills when the recommended methods and router parameters are used. In addition to the router parameters, an equally important factor in successful routing is having intimate contact throughout the routed package. The following illustration shows a typical router stackup with phenolic entry and backer material on either side of the circuit board. Notice that the entry material rides on top of the copper traces leaving an air gap between the entry material and the PTFE substrate. Many circuit board applications also have soldermask on top of the copper traces which increases the gap further. The solution to a cleaner cut is to introduce a material between the copper traces and the phenolic entry material that will conform at the edge and will help fill in the air gap. As the router pressure foot applies pressure, the edge of the phenolic entry and the paper will conform and help fill the air gap, allowing for a cleaner cut of the substrate edge. One type of paper that has been shown to work well is the paper found between artwork film. It is thick and will conform enough to help fill in the normal air gap and cuts without generating as much debris as other paper such as Kraft paper.

Figure 5 Typical Routing Stackup



The following routing parameters in Tables 5 and 6 have been proven to work well on PTFE double-sided boards and are good starting points for multilayer boards with thicknesses of 0.060" [1.58mm] or less. For thicker multilayers, a single flute, 3/32" [2.38mm] carbide bit or a diamond burr tool has been shown to work well at an infeed rate of 24" [0.6m] per minute and a speed of 45,000 rpm

Table 5 – Recommended routing parameters for all Taconic materials

Successful strategies for routing ptfе materials sometimes benefit from a dual pass routing technique. Stringers can be eliminated by first routing the pcb leaving a few mils of additional material left on the pwb. The pwb should then be routed from the opposite direction to yield a much cleaner edge.

Table 5 – Recommended routing parameters for all Taconic materials

Recommended Routing Parameters for All Taconic Materials							
Tool Diameter (mils)	Chipload (mils/rev)	Spindle Type				Z – Feed Rate	
		60,000 max		80,000 max		Without predrilling (in/min)	With predrilling (in/min)
		Spindle Speed (rpm)	Feed Rate (in/min)	Spindle Speed (rpm)	Feed Rate (in/min)		
31.5	0.24	50000	11.8	50000	11.8	0.0	20
35.4	0.26	45000	11.8	45000	11.8	0.0	20
39.4	0.30	40000	11.8	40000	11.8	0.0	79
43.3	0.32	37000	11.8	37000	11.8	0.0	79
47.2	0.35	34000	11.8	34000	11.8	0.0	79
51.2	0.51	31000	15.8	31000	15.8	0.0	79
55.1	0.54	29000	15.8	29000	15.8	0.0	79
59.1	0.59	27000	15.8	27000	15.8	0.0	79
63	0.79	25000	19.7	25000	19.7	0.0	197
66.9	0.82	24000	19.7	24000	19.7	0.0	197
70.8	1.03	23000	23.6	23000	23.6	0.0	197
74.8	1.12	21000	23.6	21000	23.6	0.0	197
78.7	1.38	20000	27.6	20000	27.6	0.0	197
82.7	1.58	20000	31.5	20000	31.5	0.0	197
86.6	1.58	20000	31.5	20000	31.5	0.0	197
90.6	1.58	20000	31.5	20000	31.5	0.0	197
94.5	1.77	20000	35.4	20000	35.4	0.0	197
98.4	1.77	20000	35.4	20000	35.4	0.0	197
118.1	2.17	20000	43.3	20000	43.3	0.0	197
125	2.17	20000	43.3	20000	43.3	0.0	197

Table 6 – Recommended routing parameters for all Taconic materials (metric)

Suggested Routing Parameters for All Taconic Materials (metric)							
Tool Diameter (mm)	Chipload (µm/rev)	Spindle Type				Z – Feed Rate	
		60,000 max		80,000 max		Without predrilling (m/min)	With predrilling (m/min)
		Spindle Speed (rpm)	Feed Rate (m/min)	Spindle Speed (rpm)	Feed Rate (m/min)		
0.80	5	50000	0.25	50000	0.25	0	0.50
0.90	6	45000	0.27	45000	0.27	0	0.50
1.00	8	40000	0.32	40000	0.32	0	2.00
1.10	9	37000	0.33	37000	0.33	0	2.00
1.20	10	34000	0.34	34000	0.34	0	2.00
1.30	12	31000	0.37	31000	0.37	0	2.00
1.40	14	29000	0.41	29000	0.41	0	2.00
1.50	16	27000	0.43	27000	0.43	0	2.00
1.60	18	25000	0.45	25000	0.45	0	5.00
1.70	22	24000	0.53	24000	0.53	0	5.00
1.80	26	23000	0.60	23000	0.60	0	5.00
1.90	30	21000	0.63	21000	0.63	0	5.00
2.00	34	20000	0.68	20000	0.68	0	5.00
2.10	38	20000	0.76	20000	0.76	0	5.00
2.20	40	20000	0.80	20000	0.80	0	5.00
2.30	42	20000	0.84	20000	0.84	0	5.00
2.40	44	20000	0.88	20000	0.88	0	5.00
2.50	46	20000	0.92	20000	0.92	0	5.00
3.00	53	20000	1.06	20000	1.06	0	5.00
3.18	55	20000	1.10	20000	1.10	0	5.00