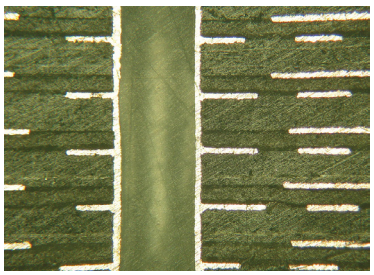
*fast*Rise™ Multilayer Non-Reinforced Prepreg

*fast*Rise™ is designed to eliminate skew in differential transmission lines and eliminate dielectric constant fluctuations caused by fiberglass in filter and coupler applications. This low temperature thermosetting prepreg is based on ceramic, thermoset and PTFE and is ideal for use with Taconic's standard low loss laminates like TSM-DS3 (Df=0.0011), TSM-DS3M (Df= 0.0011) and EZ-IO (Df=0.0012).

For applications that require low loss at high frequencies, *fast*Rise™ prepreg offers design engineers the properties needed for superior performance. The low 0.0017 Df at 40 GHz enables the production of mmWave multilayer PWBs. In addition, the low 420° F lamination temperature enables 5+ sequential laminations to be performed at lower temperatures than those normally used for FEP and PFA in military constructions. Taconic currently has military applications involving four sequential laminations of FR-27.

Due to the material's low Dk, *fast*Rise™ enables thickness reduction of ATE Printed Circuit Boards. The availability of many *fast*Rise™ thicknesses allows flexibility in high layer count PWB design.

Taconic is a world leader in RF laminates and high speed digital materials, offering a wide range of high frequency laminates and prepregs. These advanced materials are used in the fabrication of antennas, multilayer RF and high speed digital boards, interconnections and devices.



Cross section illustrates the very low fiberglass content of FR-27 & multilayers.

Benefits & Applications:

- **Enables 5+ sequential laminations**
- **Low Dk enables reduced thickness of ATE boards**
- **Low temperature alternative to thermoplastic films in military designs**
- **Multilayer prepreg for mmWave applications**
- **Stable Dk over temperature**
- **Fiberglass free prepreg**
- **Laser ablatable**

- **Semiconductor Testing**
- **Military**
- **mmWave Antenna/Automotive**

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*fast*Rise™ Multilayer Non-Reinforced Prepreg

There are many *fast*Rise™ part numbers due to the diverse number of tasks that a prepreg must fulfill. For doing sequential laminations where the intent is to flow and fill copper that has been plated up to 2-3 mils, high resin content and high flow is required from the prepreg. For applications where you do *not* want the prepreg flowing into cavities, a low flow prepreg is desirable. Extremely high flow is needed for filling blind or buried vias or milled out cavities. In some coupler designs, a very thin prepreg is desirable for maximum coupling between the overlay couplers and sufficient flow is only needed to bond artwork with 0.5 oz. copper. Low flow prepregs are best for doing foil laminations. Flow and fill requirements don't exist in a foil lamination so a low flow prepreg is appropriate whereas a high flow prepreg might be more prone to cosmetic defects. Taconic has found that low flow prepregs are most suitable for microvia formation following a foil lamination (the microvia cross sections below are courtesy of Hughes Circuits). Taconic's low flow prepregs have a much better lased hole quality than the high flow prepregs.

In a high layer count PWB, often there are many layers of overlapping edge coupled traces. High layer count PWBs are susceptible to lamination voids due to areas of high and low pressure. For all of these reasons it is best to consult the *fast*Rise™ design guide or talk to a Taconic applications engineer to design with the most suitable prepreg.

Standard *fast*Rise™ Part Numbers

Product	Stripline with 1 oz. Cu	High Layer Count PWBs	Between Plated Up Subassemblies	Fill Blind/ Buried Vias	Resin Content	Microvia Formation/Foil Lamination	Drill Quality
FR-27-0030-25	See below [2]	Yes [1]	No	No	Low	R	Best
FR-27-0040-43F	See below [2]	Yes [1]	See below [3]	No	Medium	Best	Best
FR-27-0045-35	See below [2]	Yes [1]	No	No	High	R	Best
FR-28-0040-50 (S)	Yes	Yes	See below [3]	No	High	R	Best
FR-27-0050-40 (S)	Yes	Yes	See below [3]	No	High	R	Best

Specialty *fast*Rise™ Part Numbers

Product	Stripline with 1 oz. Cu	High Layer Count PWBs	Between Plated Up Subassemblies	Fill Blind/ Buried Vias	Resin Content	Microvia Formation/Foil Lamination	Drill Quality
FR-25-0021-45 (F)	No	No [1]	No	No	Low	No	Susceptible [4]
FR-26-0025-60	Yes	Yes [1]	See below [3]	No	High	No	Susceptible [4]
FR-27-0035-66	Yes	Yes [1]	Yes	Yes	High	No	Susceptible [4]
FR-27-0042-75	Yes	Yes [1]	Yes	Yes	Highest	No	Susceptible [4]

[1] Some layers only

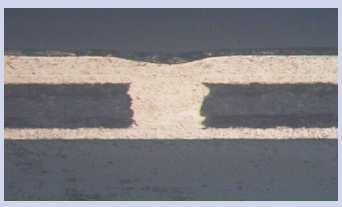
[2] FR-27-0030-25, FR-27-0040-43F and FR-27-0045-35 can be used with 1 oz. copper on low layer count PWBs but should not be used where many layers are bonded together in a single lamination due to the risk of low pressure areas during lamination.

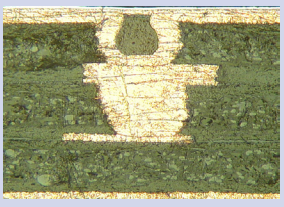
[3] Plated up subassemblies can vary in the ultimate copper thickness. A discussion with a Taconic Applications Engineer is advised.

[4] Susceptible to common PTFE drilling defects

R = Recommended

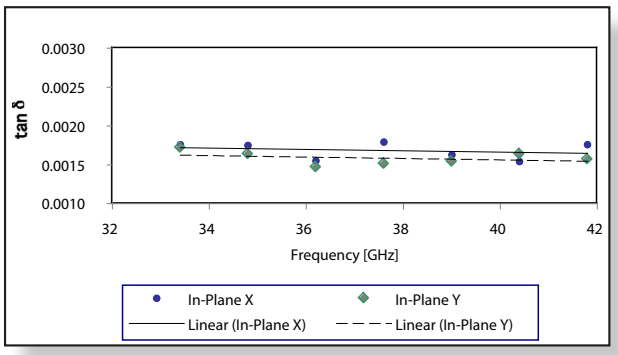
Laser Ablation: **Hughes Circuits** - FR-28-0040-50

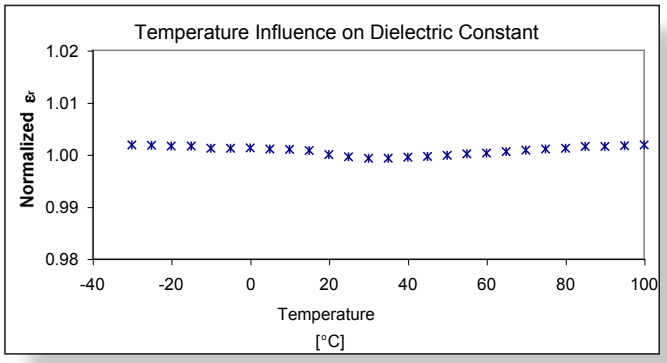




Foil Lamination Surface Smoothness
FR-27-0045-35

*fast*Rise™ (FR-27-0045-35)Typical Values					
Property	Test Method	Unit	Value	Unit	Value
Dk @ 10 GHz	IPC-650 2.5.5.5.1 (modified)		2.74		2.74
Dk @ 40 GHz	Damaskos Open Resonator		2.70		2.70
Dk Tolerance			+/- 0.04		+/- 0.04
Df @ 10 GHz	IPC-650 2.5.5.5.1 (modified)		0.0014		0.0014
Df @ 40 GHz	Damaskos Open Resonator		0.0017		0.0017
Moisture Absorption	IPC-650 2.6.2.1	%	0.08	%	0.08
Dielectric Breakdown	IPC-650 2.5.6 (parallel to lamination)	Kv	49	Kv	49
Dielectric Strength	ASTM D 149	V/mil	1090	Kv/mm	42.9
Volume Resistivity	IPC-650 2.5.17.1 (after elevated temp.)	Mohms/cm	8.00×10^8	Mohms/cm	8.00×10^8
Volume Resistivity	IPC-650 2.5.17.1 (after humidity)	Mohms/cm	1.71×10^8	Mohms/cm	1.71×10^8
Surface Resistivity	IPC-650 2.5.17.1 (after elevated temp.)	Mohms	3.48×10^8	Mohms	3.48×10^8
Surface Resistivity	IPC-650 2.5.17.1 (after humidity)	Mohms	1.16×10^8	Mohms	1.16×10^8
T_g	ASTM E 1640 (DMA)	°C	188	°C	188
Tensile Strength (x)	ASTM D 882	psi	1,690	N/mm^2	12
Tensile Strength (y)	ASTM D 882	psi	1,480	N/mm^2	10
Tensile Modulus (x)	ASTM D 882	kpsi	304	N/mm^2	2,100
Tensile Modulus (y)	ASTM D 882	kpsi	295	N/mm^2	2,030
Elongation at Break (x)	ASTM D 882	%	0.82	%	0.82
Elongation at Break (y)	ASTM D 882	%	0.73	%	0.73
Density (Specific Gravity)	ASTM D 792 Method A	g/cm^3	1.82	g/cm^3	1.82
T_d (2% Wt. Loss)	IPC-650 2.4.24.6/TGA	°F	709	°C	376
T_d (5% Wt. Loss)	IPC-650 2.4.24.6/TGA	°F	790	°C	421
Peel Strength (HH)	IPC-650 2.4.8	lbs./inch	5	N/mm	0.88
Peel Strength (H1)	IPC-650 2.4.8	lbs./inch	7	N/mm	1.23
Thermal Conductivity	ASTM F433	W/M*K	0.25	W/M*K	0.25
T_cK (-30 to 100 °C)	IPC-650 2.5.5.5.1 (modified)	ppm/°C	0.06	ppm/°C	0.06
CTE (X axis) (-55 to 125 °C)	IPC-650 2.4.41/TMA	ppm/°C	59	ppm/°C	59
CTE (Y axis) (-55 to 125 °C)	IPC-650 2.4.41/TMA	ppm/°C	70	ppm/°C	70
CTE (Z axis) (-55 to 125 °C)	IPC-650 2.4.41/TMA	ppm/°C	72	ppm/°C	72
Hardness	ASTM D 2240	Shore D	68	Shore D	68

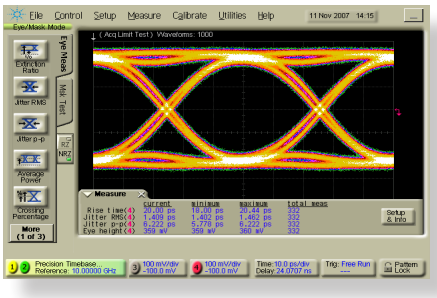




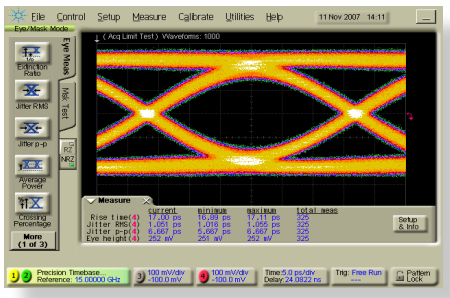
***fast*Rise™ Dielectric Loss at mmWave Frequency**

All reported values are typical and should not be used for specification purposes. In all instances, the user shall determine suitability in any given application.

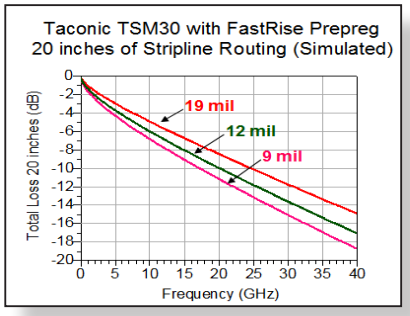
*fast*Rise™27 with TSM Laminate Core (10 inches of trace length, 19 mil wide trace)

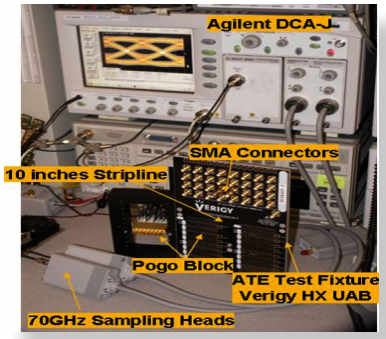


20 Gbps PRBS31 500 MV Input (Verigy)



30 Gbps PRBS31 500 MV Input (Verigy)





*fast*Rise™ Prepreg

Product	Nominal Dk (10 GHz)	DK Tolerance + / -	Pressed Thickness† (mil)	Pressed Thickness† (mil) 0.5 oz. Cu	Pressed Thickness† (mil) 1 oz. Cu	Typical Flow %
FR-25-0021-45	2.43	0.04	2.1 +/- 0.10	1.9	1.5	10 (7.5 - 12.5)
FR-25-0021-45F	2.45	0.04	2.1 +/- 0.15	1.9	1.5	2 (1 - 4)
FR-26-0025-60	2.52	0.04	2.77 +/- 0.10	2.5	2.1	11 (8 - 14)
FR-27-0030-25	2.70	0.04	3.6 +/- 0.20	3.2	2.8	3.6 (2 - 5)
FR-27-0035-66	2.62	0.04	3.98 +/- 0.15	3.6	3.2	15 (12 - 18)
FR-27-0040-43F	2.77	0.04	4.1 +/- 0.25	3.8	3.5	3 (1.5 - 4.5)
FR-27-0042-75	2.68	0.04	5.0 +/- 0.35	4.7	4.3	(20 - 40)*
FR-27-0045-35	2.74	0.04	5.6 +/- 0.40	5.2	4.8	7 (5 - 10)
FR-28-0040-50 (S)	2.74 (2.76)	0.04	4.7 +/- 0.35	4.1	3.7	10 (7.5 - 12.5)
FR-27-0050-40 (S)	2.74 (2.70)	0.04	6.0 +/- 0.40	5.6	5.2	11 (7 - 15)
				0.5 oz. Cu, 50% removal	1 oz. Cu, 50% removal	

* Insufficient data

*fast*Rise™ is shipped at a very low degree of cure. The best flow conditions are achieved when the prepreg spends the maximum amount of time possible at a temperature of 225 °F (107 °C) using the highest possible pressure. For difficult flow and fill designs or when using Taconic's low flow prepregs, the lamination press should ramp up to 225 °F (107 °C) and hold for 30-60 minutes at maximum pressure, followed by a slow 2.0-4.0 °C/min. ramp rate to 420 °F (216 °C).

Because of the large number of possible applications for the *fast*Rise™ prepreg series and the complexity of many multilayer printed circuit designs, Taconic does not warranty or guarantee the performance of *fast*Rise™ when combined with any supplier's core materials. It is the responsibility of the end user to determine the suitability of *fast*Rise™ for any application.