



**ROGERS**  
CORPORATION

## RO4000® LoPro® Series High Frequency Circuit Materials

RO4000® LoPro® laminates use a proprietary Rogers' technology that allows reverse treated foil to bond to standard RO4000 dielectric. This results in a laminate with low conductor loss for improved insertion loss and signal integrity while maintaining all other desirable attributes of the standard RO4000 laminate system.

RO4000 hydrocarbon ceramic laminates are designed to offer superior high frequency performance and low cost circuit fabrication. The result is a low loss material which can be fabricated using standard epoxy/glass (FR-4) processes offered at competitive prices.

The selection of laminates typically available to designers is significantly reduced once operational frequencies increase to 500 MHz and above. RO4000 material possesses the properties needed by designers of RF microwave circuits and matching networks and controlled impedance transmission lines. Low dielectric loss allows RO4000 series material to be used in many applications where higher operating frequencies limit the use of conventional circuit board laminates. The temperature coefficient of dielectric constant is among the lowest of any circuit board material and the dielectric constant is stable over a broad frequency range. This makes it an ideal substrate for broadband applications.

RO4000 material's thermal coefficient of expansion (CTE) provides several key benefits to the circuit designer. The expansion coefficient of RO4000 material is similar to that of copper which allows the material to exhibit excellent dimensional stability, a property needed for mixed dielectric multilayer boards constructions.

The low Z-axis CTE of RO4000 laminates provides reliable plated through-hole quality, even in severe thermal shock applications. RO4000 series material has a T<sub>g</sub> of >280°C (536°F) so its expansion characteristics remain stable over the entire range of circuit processing temperatures.

RO4000 series laminates can easily be fabricated into printed circuit boards using standard FR-4 circuit board processing techniques. Unlike PTFE based high performance materials, RO4000 series laminates do not require specialized via preparation processes such as sodium etch. This material is a rigid, thermoset laminate that is capable of being processed by automated handling systems and scrubbing equipment used for copper surface preparation.



### Data Sheet



#### FEATURES AND BENEFITS:

RO4000 materials are reinforced hydrocarbon/ceramic laminates with very low profile reverse treated foil.

- Lower insertion loss
- Low PIM
- Increased signal integrity
- High circuit density
- Ease of fabrication

Low Z-axis coefficient of thermal expansion

- MLB capability
- Design flexibility

Lead-free process compatible

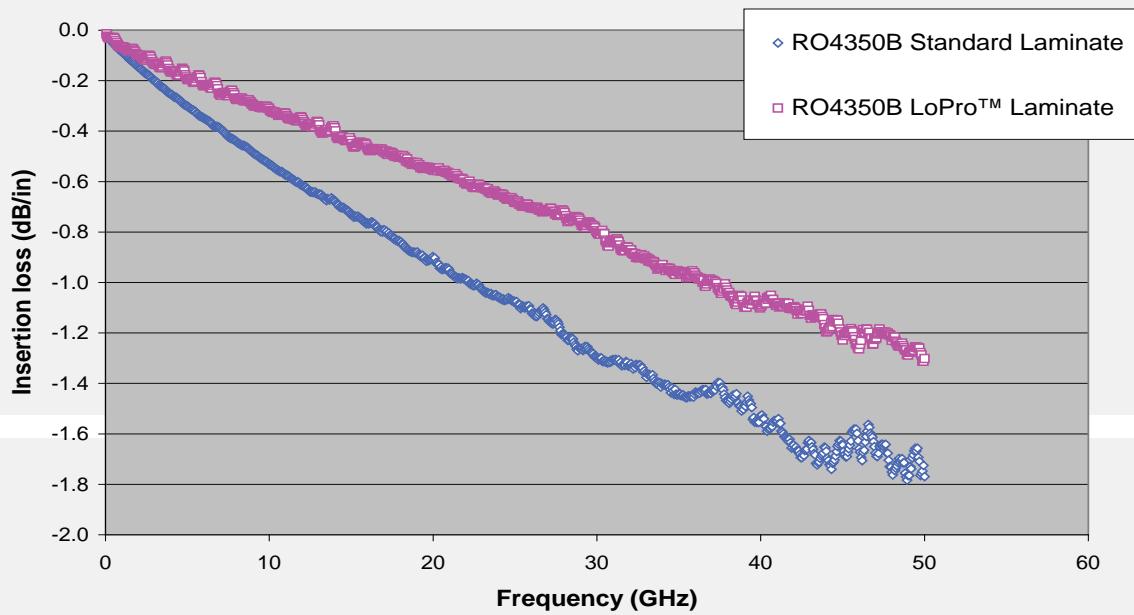
- High temperature processing
- Ease of fabrication
- Meets environmental concerns

CAF resistant

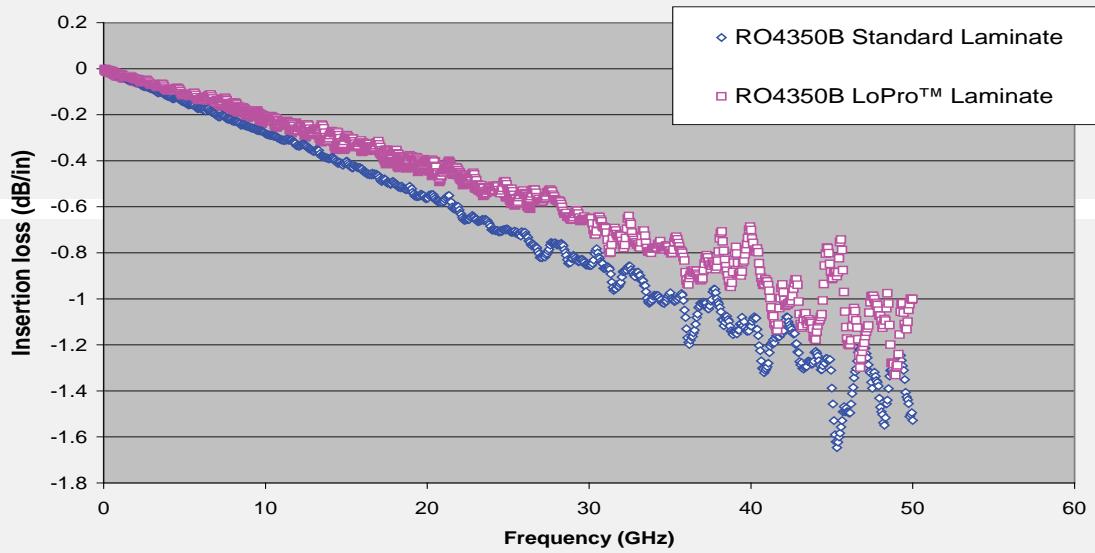
#### SOME TYPICAL APPLICATIONS:

- Digital applications such as servers, routers, and high speed back planes
- Cellular base station antennas and power amplifiers
- LNB's for direct broadcast satellites
- RF Identification Tags

RO4350B Insertion Loss with Different Copper Foil Types  
0.0073" Laminates



RO4350B Insertion Loss with Different Copper Foil Types  
0.0173" Laminates



Property	Typical Value			Direction	Units	Condition	Test Method
	RO4003C LoPro	RO4350B LoPro	RO4835 LoPro				
Dielectric Constant, $\epsilon_r$ Process	3.38 $\pm$ 0.05	[1] 3.48 $\pm$ 0.05	3.48 $\pm$ 0.05	Z	--	10 GHz/23°C	IPC-TM-650 2.5.5.5 [1]Clamped Stripline
[2] Dielectric Constant, $\epsilon_r$ Design	3.50	3.55	3.55	Z	--	8 to 40 GHz	Differential Phase Length Method
Dissipation Factor tan, $\delta$	0.0027 0.0021	0.0037 0.0031	0.0037 0.0031	Z	--	10 GHz/23°C 2.5 GHz/23°C	IPC-TM-650 2.5.5.5
Thermal Coefficient of $\epsilon_r$	+40	+50	+50	Z	ppm/°C	-50°C to 150°C	IPC-TM-650 2.5.5.5
Volume Resistivity	1.7 X 10 <sup>10</sup>	1.2 X 10 <sup>10</sup>	1.0 X 10 <sup>10</sup>		MΩ•cm	COND A	IPC-TM-650 2.5.17.1
Surface Resistivity	4.2 X 10 <sup>9</sup>	5.7 X 10 <sup>9</sup>	1.0 X 10 <sup>9</sup>		MΩ	COND A	IPC-TM-650 2.5.17.1
Electrical Strength	31.2 (780)	31.2 (780)	30.2 (755)	Z	KV/mm (V/mil)	0.51mm (0.020")	IPC-TM-650 2.5.6.2
Tensile Modulus	26,889 (3900)	11,473 (1664)	17,781 (2579)	Y	MPa (kpsi)	RT	ASTM D638
Tensile Strength	141 (20.4)	175 (25.4)	133 (19.3)	Y	MPa (kpsi)	RT	ASTM D638
Flexural Strength	276 (40)	255 (37)	186 (27)		MPa (kpsi)		IPC-TM-650 2.4.4
Dimensional Stability	<0.3	<0.5	<0.5	X,Y	mm/m (mils/inch)	after etch +E2/150°C	IPC-TM-650 2.4.39A
Coefficient of Thermal Expansion	11 1.4 46	14 16 35	11 14 24	X Y Z	ppm/°C	-55 to 288°C	IPC-TM-650 2.1.41
Tg	>280	>280	>280		°C TMA	A	IPC-TM-650 2.4.24.3
Td	425	390	390		°C TGA		ASTM D3850
Thermal Conductivity	0.64	0.62	0.73		W/m/°K	80°C	ASTM C518
Moisture Absorption	0.06	0.06	0.05		%	48 hrs immersion 0.060" sample Temperature 50°C	ASTM D570
Density	1.79	1.86	1.92		gm/cm <sup>3</sup>	23°C	ASTM D792
Copper Peel Strength	1.05 (6.0)	0.88 (5.0)	0.88 (5.0)		N/mm (pli)	after solder float 1 oz. TC Foil	IPC-TM-650 2.4.8
Flammability	N/A	[3] V-0	V-0				UL 94
Lead-Free Process Compatible	Yes	Yes	Yes				

Typical values are a representation of an average value for the population of the property. RO4000 LoPro laminates use a modified version of the RO4000 resin system to bond reverse treated foil. Values shown above are for RO4000 laminates without the addition of the LoPro resin. For double-sided boards, the LoPro foil results in a thickness increase of approximately 0.0007" (0.000018mm) and the Dk is approximately 2.4. Therefore, design Dk is highly dependent on core thickness. For specification values contact Rogers Corporation or visit the Rogers

- [1] The IPC clamped stripline method can potentially lower the actual dielectric constant due to presence of airgaps between the laminates under test and the resonator card. Dielectric constant in practice may be higher than the values listed.
- [2] The design Dk is an average number from several different tested lots of material and on the most common thickness/s. If more detailed information is required please contact Rogers Corporation. Refer to the Design DK technical articles and presentations available at <http://www.rogerscorp.com>, the Rogers Technology Support Hub.
- [3] \*\* Note on 94V-0 \*\* RO4350B LoPro laminates do not share the same UL designation as standard RO4350B laminates. A separate UL qualification may be necessary

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.

Standard Thickness	Standard Panel Size	Standard Copper Cladding
RO4003C LoPro: 0.0087" (0.221mm), 0.0127 (0.323mm), 0.0167" (0.424mm), 0.0207" (0.526mm) 0.0327" (0.831mm), 0.0607" (1.542mm)	12" X 18" (305 X 457 mm) 24" X 18" (610 X 457 mm) 24" X 36" (610 X 915 mm) 48" X 36" (1.224 m X 915 mm)	½ oz (17µm) LoPro Reverse Treated EDC Foil (.5TC/.5TC) on both sides
RO4350B LoPro: 0.0040" (0.102 mm)*, 0.0073" (0.185mm), 0.0107" (0.272mm), 0.014" (0.356mm), 0.0173" (0.439mm), 0.0207" (0.526mm), 0.0307" (0.780mm), 0.0607" (1.542mm)	*0.004" (0.101mm) material is not available in panel sizes larger than 24"x18" (610 X 457mm)	1 oz (35 µm) LoPro Reverse Treated EDC Foil (1TC/1TC) on both sides
RO4835 LoPro: 0.0040" (0.102 mm)*, 0.0073" (0.185mm), 0.0107" (0.272mm), 0.014" (0.356mm), 0.0173" (0.439mm), 0.0207" (0.526mm), 0.0307" (0.780mm), 0.0607" (1.542mm)		Note: LoPro EDC foil adds .00035" to the panel thickness per side.

**\*SPECIAL NOTES FOR 0.004" (0.102mm) THICKNESS:**

- 1) As with all Rogers Laminate Materials, it is recommended fabricators run a first article to establish relevant scaling factors before beginning production of commercial quantities.
- 2) Bow and Twist: The outgoing inspection criteria for flatness of this construction is <6% Bow and <6% Twist.
- 3) Electrical Strength: This construction (4 mil dielectric thickness) can be expected to withstand 1,500 volts without experiencing dielectric breakdown.
- 4) Dimensional Stability: The material shows a negative Dim Stab nominal value of approximately -.5 in both MD and CMD directions, but the variation tends to express slightly more in the negative direction, with the minimum expected value being >-.7 mm/m.
- 5) Dielectric Constant: The LoPro resin layer is a significant volumetric portion of the overall dielectric, as a result, this material's design dielectric constant will be different than thicker constructions.

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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