

## High Frequency Circuit Materials

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**DATA**  
RO 1.4000

# RO4000<sup>®</sup> Series High Frequency Circuit Materials

RO4000<sup>®</sup> Series High Frequency Circuit Materials are glass reinforced hydrocarbon/ceramic laminates (**Not PTFE**) designed for performance sensitive, high volume commercial applications.

**RO4000 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 (FR4) 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. Stable electrical properties over environmental conditions allow for repeatable design of filters, 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 (Chart 1), making it ideal for temperature sensitive applications. RO4000 materials exhibit a stable dielectric constant over a broad frequency range (Chart 2). 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 board 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 FR4 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 laminate that is capable of being processed by automated handling systems and scrubbing equipment used for copper surface preparation.

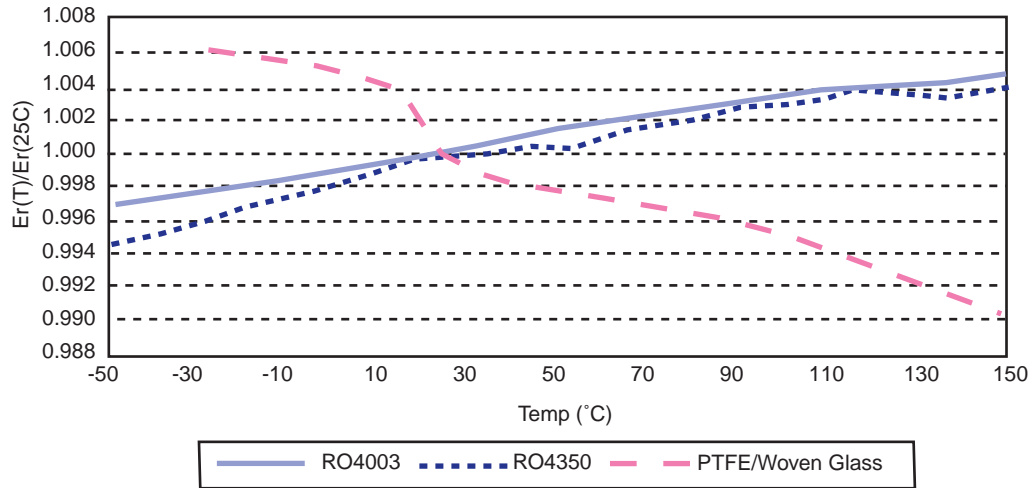
RO4003 laminates are currently offered in various configurations utilizing both 1080 and 1674 glass fabric styles, with all configurations meeting the same laminate performance specification. Responding to the need for higher Relative Thermal Index (RTI) values than 105°C, we have developed RO4350B, which exhibits RTI values as high as 150°C. Specifically designed as a drop-in replacement for RO4350, RO4350B is the standard flame retardant product in the RO4000 product line.

## RO4000® Series Laminate Product Information:

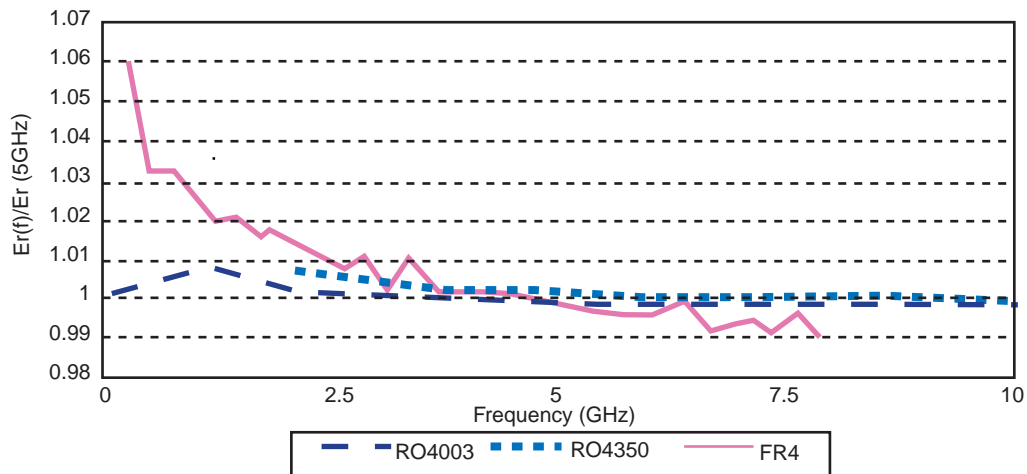
PROPERTY	TYPICAL VALUES		DIRECTION	UNITS	CONDITION	TEST METHOD
	<b>RO4003 <sup>(1)</sup></b>	<b>RO4350B <sup>(1)</sup></b>				
Dielectric Constant $\epsilon_r$	3.38 ± 0.05	3.48 ± 0.05	Z	-	10 GHz/23°C	IPC-TM-650 2.5.5.5
Dissipation Factor, tan (d)	0.0027	0.0040	Z	-	10 GHz/23°C	IPC-TM-650 2.5.5.5
Thermal Coefficient of $\epsilon_r$	+40	+50	Z	ppm/°C	-100°C to 250°C	IPC-TM-650 2.5.5.5
Volume Resistivity	1.7 x 10 <sup>10</sup>	1.2 x 10 <sup>10</sup>	-	MΩ	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>	-	MΩ	COND A	IPC-TM-650 2.5.17.1
Electrical Strength	25.6 (650)	31.5 (800)	Z	KV/mm (V/mil)	0.51mm (0.020")	IPC-TM-650 2.5.6.2
Tensile Modulus	26,889 (3900)	11,473 (1664)	Y	MPa (kpsi)	RT	ASTM D638
Tensile Strength	141 (20.4)	175 (25.4)	Y	MPa (kpsi)	RT	ASTM D638
Flexural Strength	276 (40)	255 (37)	-	MPa (kpsi)	-	IPC-TM-650 2.4.4.
Dimensional Stability	<0.3	<0.5	X,Y	mm/m (mils/inch)	After etch +E2/150	IPC-TM-650 2.2.4
Coefficient of Thermal Expansion	11 14 46	14 16 50	X Y Z	ppm/°C	-55 to 288°C	IPC-TM-650 2.1.4.1
Tg	>280	>280	-	°C	2.4.24	TMA
Thermal Conductivity	0.64	0.62	-	W/m/°K	100°C	ASTM F433
Specific Gravity	1.79	1.86	-	-	23°C	ASTM D792
Water Absorption	0.04	0.02	-	%	48 hrs. immersion 0.060" sample Temperature 50°C	ASTM D570
Copper Peel Strength	1.05 (6.0)	0.88 (5.0)	-	N/mm (pli)	after solder float	IPC-TM-650 2.48
Flammability	N/A	UL 94V-O	-	-	-	

<sup>(1)</sup> Dielectric constant and loss tangent are reported based on IPC-TM-2.5.5.5 @ 10 GHz (stripline resonator). Departure from this test method or frequency may yield different values. It has been reported that in some microstrip applications, a Delta (D) of +0.2 in dielectric constant has been observed for both RO4003 and RO4350B based on actual circuit measurement and circuit modeling comparisons. It is up to the user to determine which value best fits the application and modeling software used during the design process while Rogers ensures the repeatability of the product received.

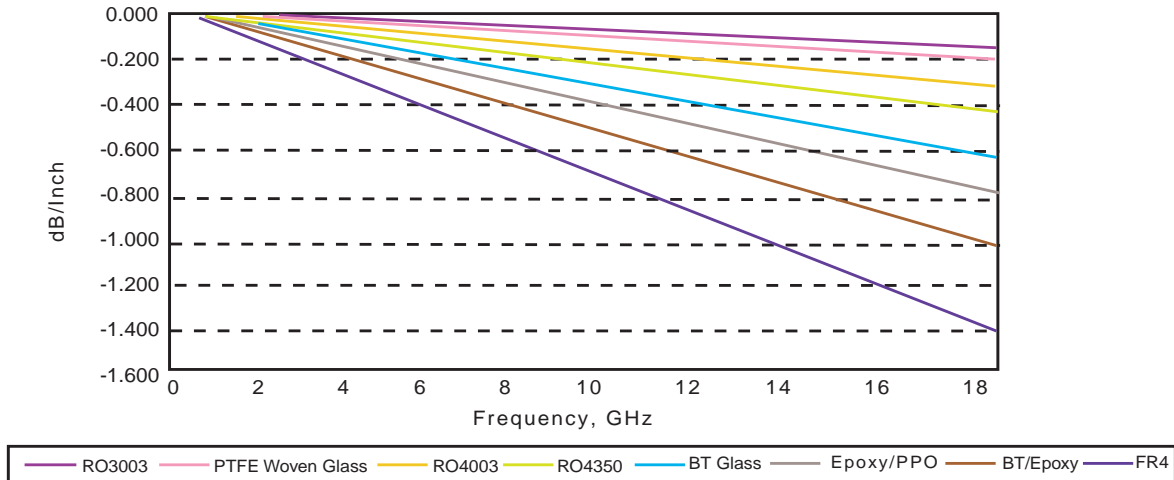
**Chart 1: RO4000 Series Materials  
Dielectric Constant vs. Temperature**



**Chart 2: RO4000 Series Materials  
Dielectric Constant vs. Frequency**



**Chart 3: Microstrip Insertion Loss  
(0.030" Dielectric Thickness)**



**Ordering Information:**

**Standard Thicknesses and Tolerances:**

**RO4003 Materials:**

0.0080 ± 0.0010 (0.20 ± 0.03 mm)  
 0.0200 ± 0.0015 (0.51 ± 0.04 mm)  
 0.0320 ± 0.0020 (0.81 ± 0.05 mm)  
 0.0600 ± 0.0040 (1.52 ± 0.10 mm)

**RO4350 Materials:**

0.0066 ± 0.0007 (0.17 ± 0.07 mm)  
 0.0100 ± 0.0010 (0.25 ± 0.03 mm)  
 0.0200 ± 0.0015 (0.51 ± 0.04 mm)  
 0.0300 ± 0.0020 (0.76 ± 0.05 mm)  
 0.0600 ± 0.0040 (1.52 ± 0.10 mm)

**Standard Claddings:**

½ ounce (17 µm) electrodeposited copper.  
 1 ounce (35 µm) electrodeposited copper.

**Standard Panels Sizes:**

The standard panel sizes are 24" x 18" (610 x 457 mm) and 12" x 18" (305 x 457 mm).

*Information on other thicknesses, claddings and panels sizes available call your Customer Service Representative at Tel: 480 961-1382 or Fax: 480 961-4533.*

RO4003 and RO4350 are licensed trademarks of Rogers Corporation for its microwave laminate.

The above data represents typical values, not statistical minimums. 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. The relative merits of materials for a specific application should be determined by your evaluation.



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