

## High Frequency Circuit Materials

**Rogers Corporation**  
**Microwave Materials Division**  
100 S. Roosevelt Avenue  
Chandler, AZ 85226 U.S.A.  
Tel: 480 961-1382  
Fax: 480 961-4533  
Website: [http://www.rogers-corp.com/mwu/](http://www.rogers-corp.com/mwu/litmwu@rogers-corp.com)  
litmwu@rogers-corp.com

**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 Z-axis CTE 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 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 two styles, which indicate the type of glass reinforcement used.

*Style A* - The original RO4003 product configuration. All plies utilize 1080 glass reinforcement.

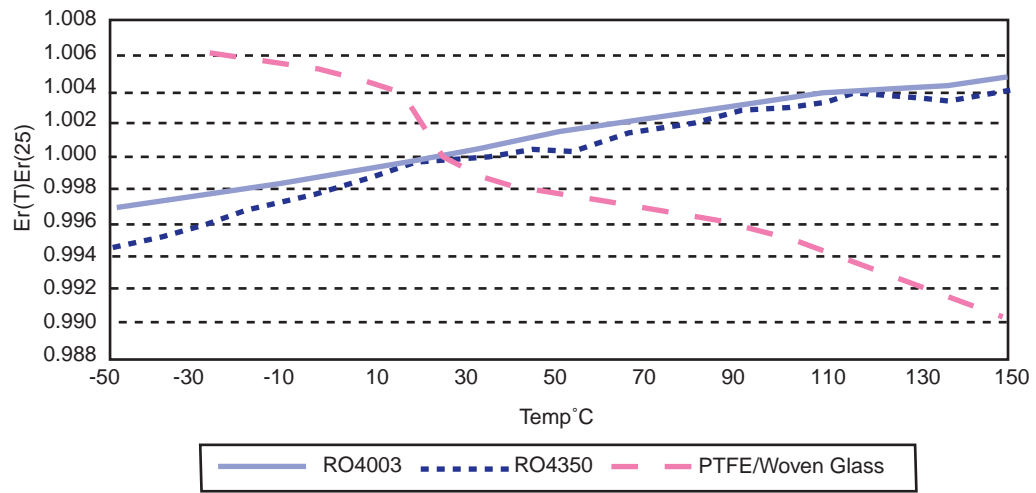
*Style C* - Coarser 1675 glass reinforcement is used for some plies, while 1080 glass is used as required to meet overall thickness requirements. Some dielectric thicknesses may not be available in Style C.

Regardless of the style chosen, all electrical properties are held constant. RO4003 Style C exhibits improved dimensional stability and flatness

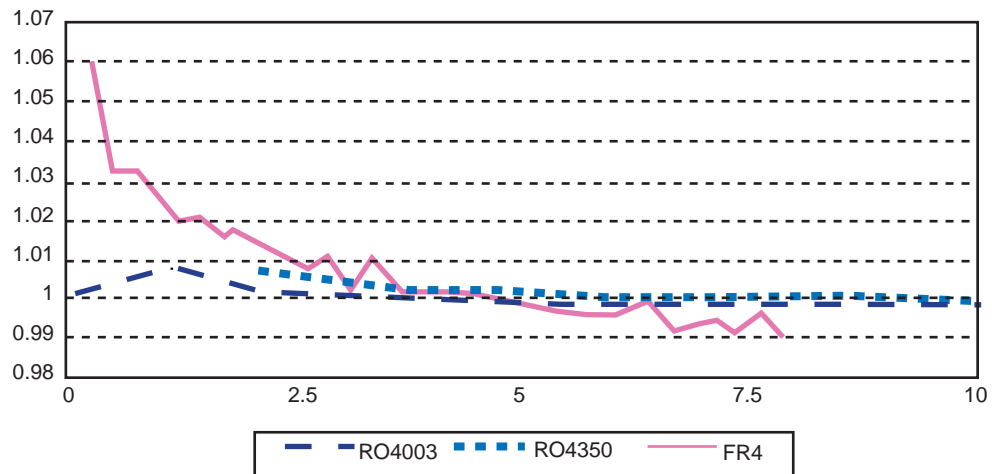
## RO4000® Series Laminate Product Information:

PROPERTY	TYPICAL VALUES		DIRECTION	UNITS	CONDITION	TEST METHOD
	RO4003	RO4350				
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	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 2.24
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	-	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	0.06	0.06	-	%	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	-	-	-	-

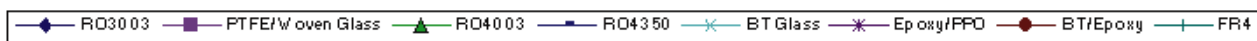
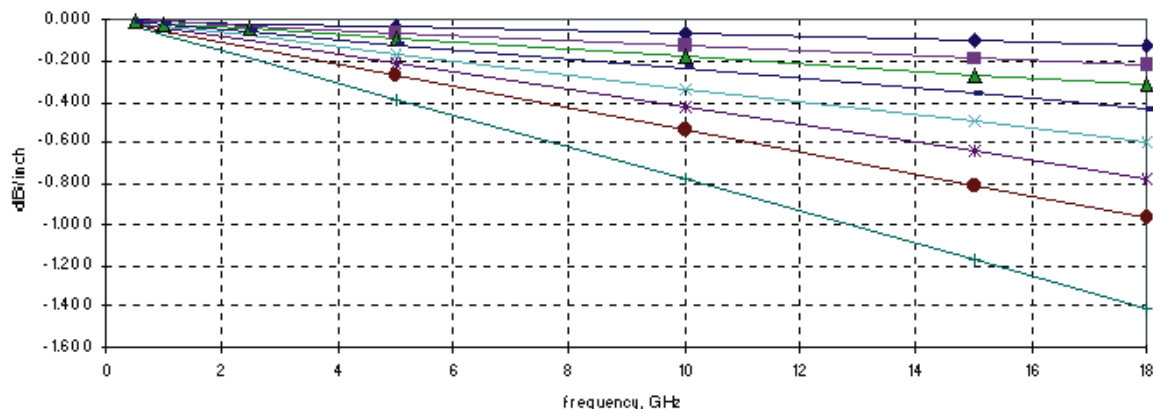
**Chart 1: RO4000 Series Materials  
Dielectric Constant vs. Temperature**



**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:**

0.0100 ± 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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100 S. Roosevelt Avenue  
 Chandler, AZ 85226-3415 U.S.A.  
 Tel: 480 961-1382 Fax: 480 961-4533  
 Toll Free: 877 643-7701  
<http://www.rogers-corp.com/mwu/>

**ISO 9002 CERTIFIED**

**In Japan:**

Rogers Japan Inc., Tokyo 116 Japan  
 Tel: 03-3807-6430 Fax: 03-3807-6319

**In Hong Kong:**

Rogers Southeast Asia, Sheung Wan, Hong Kong  
 Tel: 852-2549-7806 Fax: 852-2549-8615

**In Europe:**

Rogers N.V., Gent, Belgium  
 Tel: 32-9-2353611 Fax: 32-9-2353658

**In Taiwan:**

Rogers Taiwan Inc., Taipei, Taiwan R.O.C.  
 Tel: 886-2-86609056 Fax: 886-2-86609057