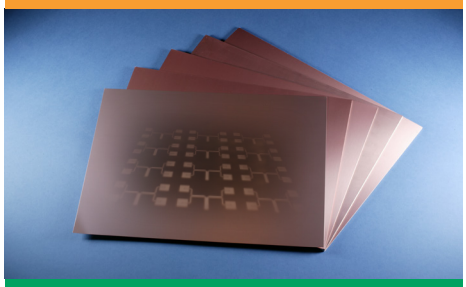
ROGERS CORPORATION

Data Sheet



IM Series™

Antenna Grade Laminates

IM Series™ high frequency laminates are an outstanding Passive InterModulation (PIM) performing version of our AD300D™, AD255C™, and DiClad® 880 antenna grade laminates. These specialty materials from Rogers Corporation are engineered and manufactured to meet the specific demands of today's base station antenna markets. The IM Series materials should be used where very demanding PIM requirements exist.

The IM Series laminates extend the capabilities of the successful AD300D, AD255C, and DiClad 880 product grades. The laminates now include the newly developed IM cladding solution. This includes an ultra-smooth (Rq = 0.5µm by non-contact interferometry method) electrodeposited copper foil cladding option which has excellent adhesion to the substrate materials. Figure 1 below shows a comparison of the new 1 oz. IM cladding option (IM1/IM1) vs the current 1 oz. reverse treated electrodeposited copper option (S1/S1).

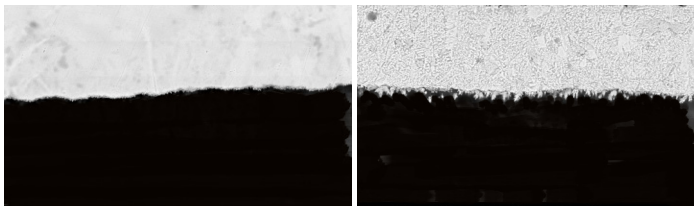


Figure 1. SEM images of IM1 cladding (left, Rq = 0.5µm) and S1 cladding (right, Rq = 1.0µm).

This combination of ultra-low roughness IM foil with the controlled dielectric performance found in the selected laminates results in a family of ultra-low PIM laminate solutions that are unrivaled in PTFE laminates in today's base station antenna market. The PIM performance of all substrates with the IM cladding has typical values of -166 dBc at 0.030" and -165 dBc at 0.060" using the Rogers internal test method of two 43 dBm swept tones at 1900 MHz. The PIM performance has also been evaluated at frequencies as low as 710 MHz with even better results.

Notably, the standard deviation of the PIM values using the IM1/IM1 cladding was found to be significantly improved vs the standard S1/S1 reverse treated electrodeposited copper foil cladding. Figure 2 shows the improvement of the standard deviation and range of the IM cladding vs the S1 cladding. This improvement affords the antenna designer the opportunity to either increase the average PIM performance over current designs or maintain the current PIM levels while improving antenna production yields.

The IM Series laminates are compatible with the processing approaches used for standard PTFE based printed circuit board substrates.

Features and Benefits:

Low PIM (-166 dBc at 0.030")

- Enables the successful production of high performance antenna designs

PTFE resin system

- Controlled Dk, low Df materials enabling high performance designs

Woven glass reinforced materials for excellent dimensional stability

- Greater yield on larger panel sizes

Uniform mechanical properties

- Maintains mechanical form during handling

Some Typical Applications:

- Cellular infrastructure base station antennas
- WiMax antenna networks

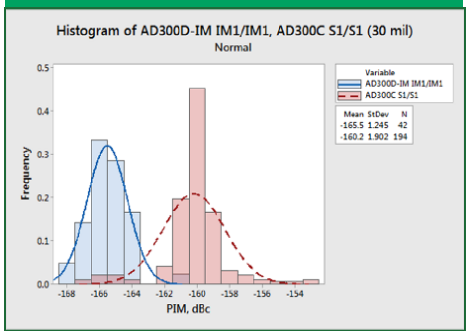


Figure 2. PIM performance of IM1/IM1 vs S1/S1 cladding on AD300 laminate.

Standard Thicknesses	Standard Panel Sizes	Standard Cladding
0.030" (0.762 mm) 0.060" (1.524 mm) *Additional non-standard thicknesses available *Contact Customer Service or Sales Engineering to inquire about additional available product configurations	12" X 18" (305 X 457 mm) 24" X 18" (610 X 457 mm) *Additional sizes available.	Interferometry Method Electrodeposited Copper Foil 1 oz. (35 µm) *M1/M1* *Additional cladding weights may be available

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Electrical Properties[1]	DiClad 880-IM	AD255C-IM	AD300D-IM	Units	Test Conditions		Test Method
PIM (30mil/60mil)[2]	-166/-165	-166/-166	-166/-165	dBc	Reflected 43 dBm swept tones at 1900MHz, IM1/IM1		Rogers internal 50 ohm
Dielectric Constant (process)	2.17 2.20	2.55	2.97/3.03 (2.94/3.00)	-	23°C @ 50% RH	10 GHz (1 MHz)	IPC TM-650 2.5.5.5 (IPC TM-650 2.5.5.3)
Dissipation Factor (process)	0.0009	0.0014	0.0021	-	23°C @ 50% RH	10 GHz	IPC TM-650 2.5.5.5
Dielectric Constant (design)	2.20	2.58	2.95/3.01	-	C-24/23/50	10 GHz	Microstrip Differential Phase Length
Thermal Coefficient of Dielectric Constant	-160	-110	-73	ppm/°C	0 to 100°C	10 GHz	IPC TM-650 2.5.5.5
Volume Resistivity	1.4 X 10^9	7.4 X 10^8	1.7 X 10^8	Mohm-cm	C-96/35/90	-	IPC TM-650 2.5.17.1
Surface Resistivity	2.9 X 10^6	3.6 X 10^7	5.1 X 10^7	Mohm	C-96/35/90	-	IPC TM-650 2.5.17.1
Electrical Strength (dielectric strength)	640	910	750	V/mil	-	-	IPC TM-650 2.5.6.2
Dielectric Breakdown	>45	>45	46	kV	D-48/50	X/Y direction	IPC TM-650 2.5.6
Comparative Tracking Index	I (V≥600)	I (V≥600)	II (400 ≤ V <600)	class/ volts	C-40/23/50	-	UL-746A, ASTM D3638
Thermal Properties[1]							
Decomposition Temperature (T_d)	>550	>550	>550	°C	2 hrs @ 105°C	5% Weight Loss	IPC TM-650 2.3.40
Coefficient of Thermal Expansion - x	28	34	24	ppm/°C	-	-55°C to 288°C	IPC TM-650 2.4.41
Coefficient of Thermal Expansion - Y	49	26	23	ppm/°C	-	-55°C to 288°C	IPC TM-650 2.4.41
Coefficient of Thermal Expansion - z	317	196	98	ppm/°C	-	-55°C to 288°C	IPC TM-650 2.4.41
Thermal Conductivity	0.23	0.35	0.37	W/m°K	-	z direction	ASTM D5470
Time to Delamination	> 60	> 60	> 60	minutes	as received	288°C	IPC TM-650 2.4.24.1
Mechanical Properties[1]							
Copper Peel Strength after Thermal Stress	2.5 (14.1)	2.1 (12.1)	2.1 (11.9)	N/mm (lbs/in)	10s @ 288°C	35 µm foil	IPC TM-650 2.4.8
Flexural Strength (MD/CMD)	80.7/62.7 (11.7/9.1)	60.7/44.1 (8.8/6.4)	152.4/127.6 (22.1/18.5)	MPa (ksi)	25°C +/-3°C	-	ASTM D790
Tensile Strength (MD/CMD)	42.7/39.5 (6.2/5.7)	55.8/45.5 (8.1/6.6)	122.0/120.7 (17.7/17.5)	MPa (ksi)	23°C/50RH	-	ASTM D3039/ D3039-14
Flex Modulus (MD/CMD)	5,540/4,740 (805/687)	6,400/5,650 (930/820)	10,400/9,580 (1510/1390)	MPa (ksi)	25°C +/-3°C	-	IPC TM-650 Test Method 2.4.4
Dimensional Stability (MD/CMD)	0.63/0.43	0.03/0.07	-0.08/0.02	mils/inch	after etch + bake	-	IPC TM-650 2.4.39a
Physical Properties[1]							
Flammability	V-0	V-0	V-0	-	-	-	UL 94
Moisture Absorption	0.02	0.03	0.04	%	E1/105 +D48/50	-	IPC TM-650 2.6.2.1
Density	2.23	2.28	2.23	g/cm^3	C-24/23/50	-	ASTM D792
Specific Heat Capacity	0.87	0.81	0.80	J/g°K	2 hours at 105°C	-	ASTM E2716
NASA Outgassing	0.01/0.01	0.01/0.01	0.01/0.01	%	-	TML/CCVM	ASTM E595

(1) Typical values are a representation of an average value for the population of the property using a 0.060" laminate.
(2) PIM Performance is heavily influenced by the copper choice. PIM values provided are typical values based on testing of the IM foil using Rogers' internal test method on 0.030" thick and 0.060" thick laminates. Rogers recommends that the customer evaulate each material and design combination to determine fitness for use over the entire life of the end product.

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