

## PTFE/Woven Fiberglass/Ceramic Filled Laminate for Microwave Printed Circuit Boards

AD1000™ high dielectric constant substrate permits circuit miniaturization, compared to traditional low loss materials. It is especially beneficial for power amplifiers, filters, couplers, and other components using low-impedance lines.

AD1000 woven-glass reinforced laminate allows for greater dimensional stability and mechanical robustness than other 10 Dk Products. Its large panel size is also advantageous for “multi-circuits per panel” processing.

AD1000 laminate is considered a “soft substrate” and is relatively insensitive to vibrational stress. This allows miniaturized circuitry without requiring the complicated processing or special handling associated with brittle pure ceramic or ceramic hydrocarbon materials.

AD1000 laminate is compatible with processing used for standard PTFE based printed circuit board substrates. In addition, the low Z-axis thermal expansion provided by the ceramic loading will improve plated through hole reliability, compared to typical PTFE based laminates. The low X-Y thermal expansion provides excellent matching to ceramic chip carriers and other ceramic components.

AD1000 laminate was specifically developed for Miniaturized Circuitry for compact devices (i.e., GPS Receivers), Patch Antennas (where smaller size is required), Satellite Communications Systems, Power Amplifiers (PAs), Low Noise Amplifiers (LNAs), Low Noise Block Down converters (LNBs), Radar Modules and Manifolds, Aircraft Collision Avoidance Systems (TCAS), and Ground Based Radar Systems.

### Features:

- Only Woven Glass Reinforced PTFE/Ceramic with Dk of 10.2 or greater
- Thermal Conductivity is “Best-in-Class”
- High copper peel strength allows for thinner etched line widths
- Lowest Insertion Loss Available
- Larger Panel Sizes Available
- Low Moisture Absorption
- Excellent CTE Values lead to highly reliability ceramic component attachment and PTH reliability

### Benefits:

- Mechanically Robust
- Greater Dimensional Stability than Other 10 Dk Products
- Circuit Miniaturization Leads to Weight Savings
- Heat Dissipation and Management
- Greater Signal Integrity
- Cost-Effective Board Layout and Board Processing
- Low Loss in Humid Environments

### Typical Applications:

- Ideal for X-Band and Below
- Radar Modules and Manifolds
- Aircraft Collision Avoidance Systems (TCAS)
- Ground Based Radar Surveillance Systems
- Miniaturized Circuitry & Patch Antennas
- Power Amplifiers (PAs)
- Low Noise Amplifiers (LNAs)

| Property                                       | Units             | Value                | Test Method         |
|------------------------------------------------|-------------------|----------------------|---------------------|
| <b>1. Electrical Properties</b>                |                   |                      |                     |
| Dielectric Constant (may vary by thickness)    |                   |                      |                     |
| @1 MHz                                         | -                 |                      | IPC TM-650 2.5.5.3  |
| @ 10 GHz                                       | -                 | 10.20                | IPC TM-650 2.5.5.5  |
| Dissipation Factor                             |                   |                      |                     |
| @ 1 MHz                                        | -                 |                      | IPC TM-650 2.5.5.3  |
| @ 10 GHz                                       | -                 | 0.0023               | IPC TM-650 2.5.5.5  |
| Temperature Coefficient of Dielectric          | -                 |                      |                     |
| TC <sub>εr</sub> @ 10 GHz (-40-150°C)          | ppm/°C            | -380                 | IPC TM-650 2.5.5.5  |
| Volume Resistivity                             |                   |                      |                     |
| C96/35/90                                      | MΩ-cm             | 1.40x10 <sup>9</sup> | IPC TM-650 2.5.17.1 |
| E24/125                                        | MΩ-cm             | 5.36x10 <sup>7</sup> | IPC TM-650 2.5.17.1 |
| Surface Resistivity                            |                   |                      |                     |
| C96/35/90                                      | MΩ                | 1.80x10 <sup>9</sup> | IPC TM-650 2.5.17.1 |
| E24/125                                        | MΩ                | 3.16x10 <sup>8</sup> | IPC TM-650 2.5.17.1 |
| Electrical Strength                            | Volts/mil (kV/mm) | 622 (24.5)           | IPC TM-650 2.5.6.2  |
| Dielectric Breakdown                           | kV                | >45                  | IPC TM-650 2.5.6    |
| Arc Resistance                                 | sec               | >180                 | IPC TM-650 2.5.1    |
| <b>2. Thermal Properties</b>                   |                   |                      |                     |
| Decomposition Temperature (Td)                 |                   |                      |                     |
| Initial                                        | °C                | >500                 | IPC TM-650 2.4.24.6 |
| 5%                                             | °C                | >500                 | IPC TM-650 2.4.24.6 |
| T260                                           | min               | >60                  | IPC TM-650 2.4.24.1 |
| T288                                           | min               | >60                  | IPC TM-650 2.4.24.1 |
| T300                                           | min               | >60                  | IPC TM-650 2.4.24.1 |
| Thermal Expansion, CTE (x,y) 50-150°C          | ppm/°C            | 8, 10                | IPC TM-650 2.4.41   |
| Thermal Expansion, CTE (z) 50-150°C            | ppm/°C            | 20                   | IPC TM-650 2.4.24   |
| % z-axis Expansion (50-260°C)                  | %                 |                      | IPC TM-650 2.4.24   |
| <b>3. Mechanical Properties</b>                |                   |                      |                     |
| Peel Strength to Copper (1 oz/35 micron)       |                   |                      |                     |
| After Thermal Stress                           | lb/in (N/mm)      | >12 (2.1)            | IPC TM-650 2.4.8    |
| At Elevated Temperatures (150°)                | lb/in (N/mm)      | 13.6 (2.4)           | IPC TM-650 2.4.8.2  |
| After Process Solutions                        | lb/in (N/mm)      |                      | IPC TM-650 2.4.8    |
| Young's Modulus                                | kpsi (GPa)        | 200 (1.38)           | IPC TM-650 2.4.18.3 |
| Flexural Strength (Machine/Cross)              | kpsi (MPa)        | 9.9/7.5 (68/52)      | IPC TM-650 2.4.4    |
| Tensile Strength (Machine/Cross)               | kpsi (MPa)        | 5.1/4.3 (35/30)      | IPC TM-650 2.4.18.3 |
| Compressive Modulus                            | kpsi (GPa)        | >425 (>2.93)         | ASTM D-3410         |
| Poisson's Ratio                                | -                 | 0.16                 | ASTM D-3039         |
| <b>4. Physical Properties</b>                  |                   |                      |                     |
| Water Absorption                               | %                 | 0.03                 | IPC TM-650 2.6.2.1  |
| Density, ambient 23°C                          | g/cm <sup>3</sup> | 3.20                 | ASTM D792 Method A  |
| Thermal Conductivity                           | W/mK              | 0.81                 | ASTM E1461          |
| Flammability                                   | class             | Meets V0             | UL-94               |
| NASA Outgassing, 125°C, ≤10 <sup>-6</sup> torr | %                 |                      | NASA SP-R-0022A     |
| Total Mass Loss                                | %                 | 0.01                 | NASA SP-R-0022A     |
| Collected Volatiles                            | %                 | 0.00                 | NASA SP-R-0022A     |
| Water Vapor Recovered                          | %                 | 0.00                 | NASA SP-R-0022A     |

*\*\*Alternative Thickness and Dielectric Constant (Dk) options are available. Tighter tolerances are also available under the AD1001 designation for some thicknesses. Please discuss your needs with Rogers' Applications Engineering Teams.*

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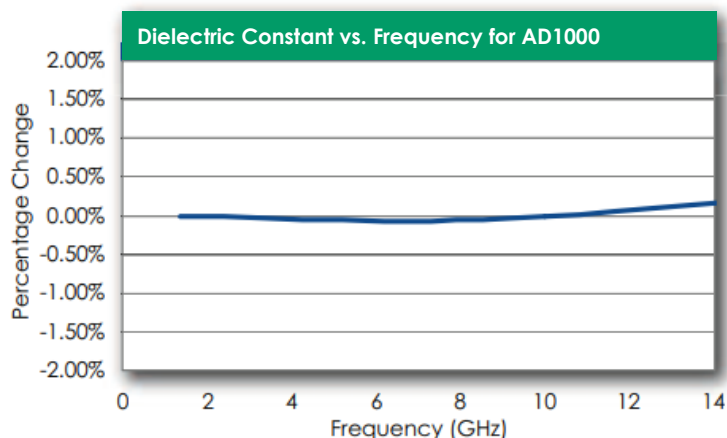
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## Thickness and Dielectric Constant Alternatives

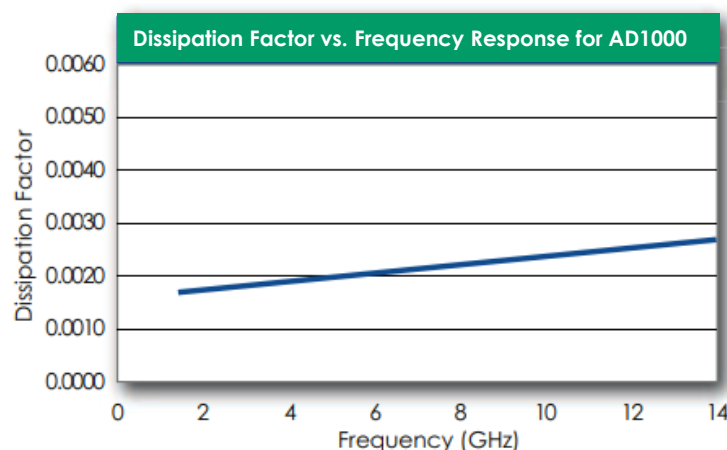
| Thickness<br>(mils) | 0.006<br>±0.0005 | 0.0105<br>±0.0010 | 0.015<br>±0.0015 | 0.020<br>±0.002 | 0.025<br>±0.002 | 0.030<br>±0.002 | 0.050<br>±0.002 | 0.059<br>±0.003 | 0.125<br>±0.003 | 0.127<br>±0.003 |
|---------------------|------------------|-------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Dielectric          | 8.0              | 9.1               | 9.7              | 10              | 10.2            | 10.35           | 10.2 or 10.6    | 10.7            | 10.2            | 10.9            |
| Constant            | ±0.35            | ±0.35             | ±0.35            | ±0.35           | ±0.35           | ±0.35           | ±0.35           | ±0.35           | ±0.35           | ±0.35           |

\* Thicker Options are available. Please Contact Customer Service or your Local Rogers' Representative



**Figure 1**

Demonstrates the Stability of Dielectric Constant across Frequency. This information was correlated from data generated by using a free space and circular resonator cavity. This characteristic demonstrates the inherent robustness of Rogers' laminates across frequency, thus simplifying the final design process when working across EM spectrum. The stability of the Dielectric Constant of AD1000 laminate over frequency ensures easy design transition and scalability of design.



**Figure 2**

Demonstrates the Stability of Dissipation Factor across Frequency. This characteristic demonstrates the inherent robustness of Rogers' laminates across frequency, providing a stable platform for high frequency applications where signal integrity is critical to the overall performance of the application

## Material Availability:

| Standard Thickness                                                                                    | Standard Panel Size                                                                                     | Standard Copper Cladding                                   |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| <b>AD1000L:</b><br>0.025" (0.635 mm)<br>0.050" (1.270 mm)<br><br><b>AD1000X:</b><br>0.050" (1.270 mm) | 18"X 12" (457 X 305 mm)<br>18"x 24" (457 X 610 mm)<br><br>Additional panel sizes available upon request | ½ oz (18µm), 1 oz. (35µm) Electrodeposited Copper (HH, H1) |

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