ROGERS CORPORATION

*Data Sheet*

# Kappa® 438 Laminates

Specifically formulated to have FR-4 matched dielectric constant (Dk), design transition to Kappa® 438 laminates will be effortless. These laminates also exhibit low loss, tight Dk and thickness tolerances needed to meet the growing performance needs of the wireless market traditionally served by higher end FR-4 materials. Demand for wireless data is growing exponentially, driving a need for substantially higher levels of mobile network capacity and performance. FR-4 was historically a material choice for many less demanding RF applications, but changes in the wireless infrastructure related to growing performance requirements, especially in small cells and carrier-grade Wi-Fi, has resulted in instances where the properties of FR-4 are lacking, and RF performance and consistency is compromised.

Wireless circuit designers can now realize a true breakthrough with Kappa 438 laminates because they feature the performance of mid-tier circuit materials that extend beyond performance limitations of FR-4, and provide the optimum blend of price, performance, and reliability. Kappa 438 laminates can be fabricated using standard epoxy/glass (FR-4) processes and are compatible with conventional bondplies. These laminates utilize RoHS compliant flame-retardant technology to achieve a UL 94 V-0 flame retardant rating and are lead-free solder process compatible. These materials conform to the requirements of IPC-4103A, slash sheet /250.



**Features and Benefits:**

Glass Reinforced Hydrocarbon Thermoset Platform
- Ease of PCB manufacturing and assembly in line with FR-4

Dk Tailored to FR-4 Industry Standard Norms
- 4.38 Dk for ease of transition when upgraded electrical performance is needed over FR-4

Tighter Dk and Thickness Tolerance than FR-4
- Consistent circuit performance

Low Z Axis CTE and High Tg
- Improved design flexibility, PTH reliability
- Automated assembly compatible

Flame Retardant Laminate
- UL 94 V-0

**Typical Applications:**

- Carrier Grade WiFi/Licensed Assisted Access (LAA)
- Small Cell and Distributed Antenna Systems (DAS)
- Vehicle to Vehicle/Vehicle to Infrastructure Communications (V2X)
- Internet of Things (IoT) Segments: Smart Home and Wireless Meters

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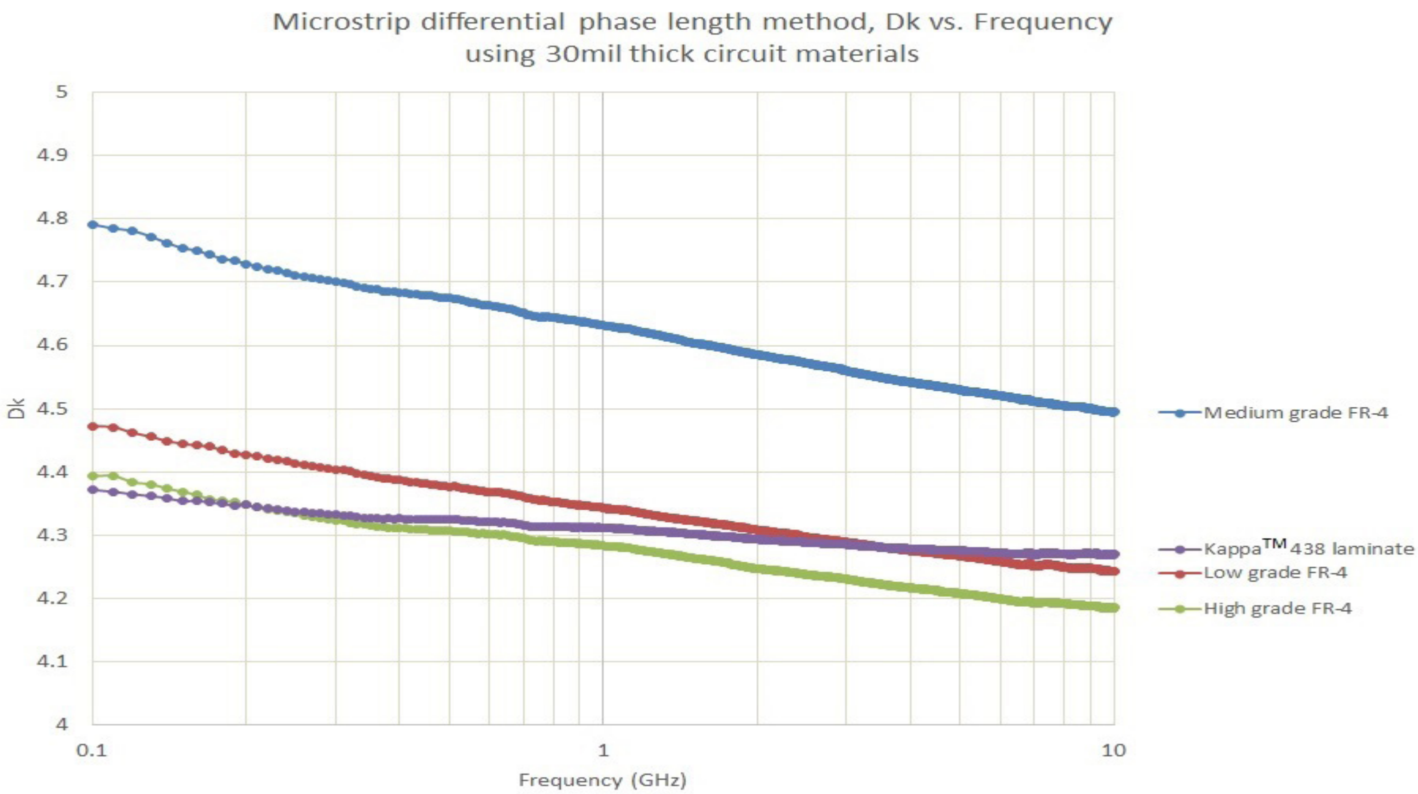
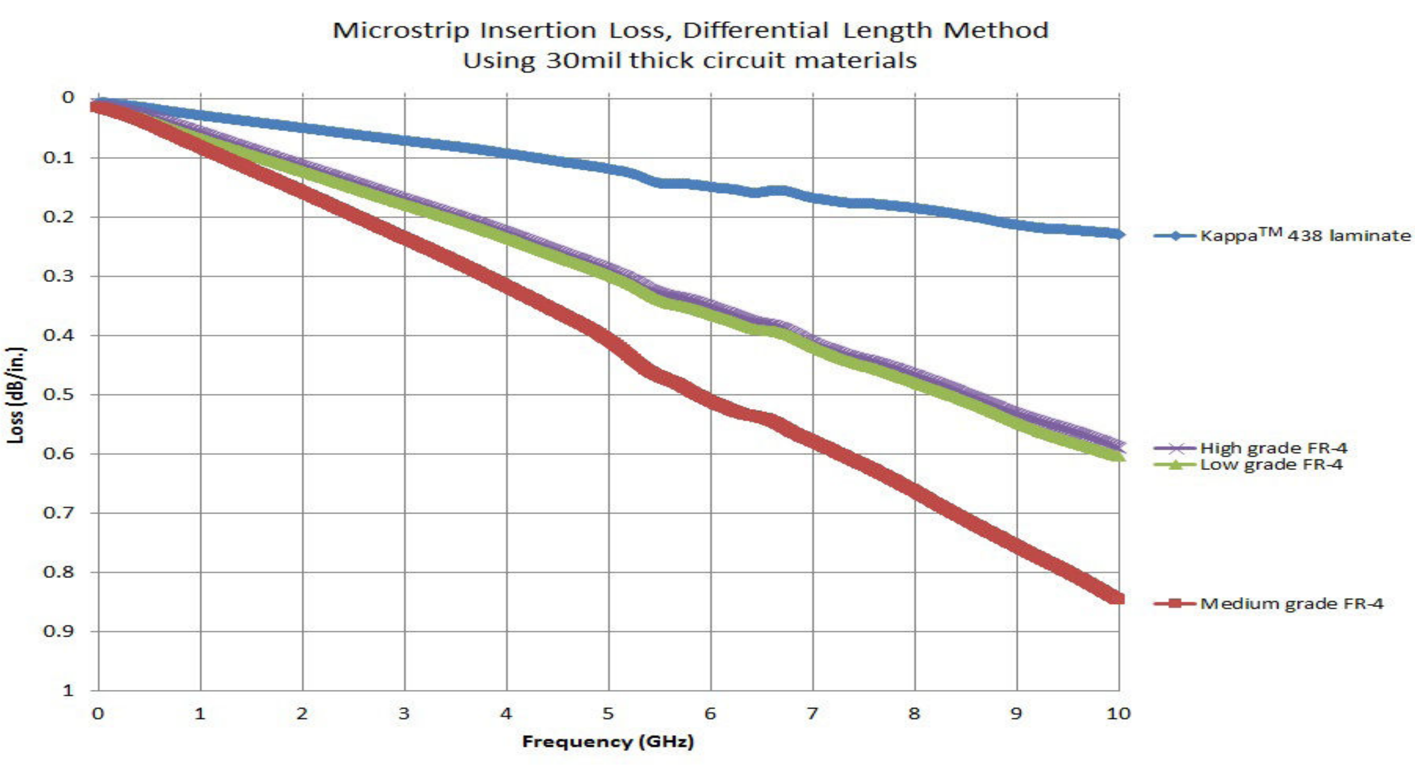

Microstrip differential phase length method, Dk vs. Frequency
using 30mil thick circuit materials
Dk
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
0.1
1
10
Frequency (GHz)
Medium grade FR-4
Kappa™ 438 laminate
Low grade FR-4
High grade FR-4


Microstrip Insertion Loss, Differential Length Method
Using 30mil thick circuit materials
Loss (dB/in.)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
1
2
3
4
5
6
7
8
9
10
Frequency (GHz)
Kappa™ 438 laminate
High grade FR-4
Low grade FR-4
Medium grade FR-4

| Property | Typical Value Kappa Laminate [1] | Direction | Units | Condition | Test Method |
|---|---|---|---|---|---|
| [3] **Dielectric Constant, $\varepsilon_r$ Design** | 4.38[2] | Z | - | 2.5 GHz | Differential Phase Length Method |
| **Dissipation Factor tan, $\delta$** | 0.005 | Z | - | 10 GHz/23°C | IPC-TM-650 2.5.5.5 |
| **Thermal Coefficient of Dielectric Constant $\varepsilon_r$** | -21 | - | ppm/°C | 10 GHz (-50 to 150°C) | Modified IPC-TM-650 2.5.5.5 |
| **Volume Resistivity** | $2.9 \times 10^9$ | - | MΩ•cm | COND A | IPC-TM-650 2.5.17.1 |
| **Surface Resistivity** | $6.2 \times 10^7$ | - | MΩ | COND A | IPC-TM-650 2.5.17.1 |
| **Electrical Strength** | 675 | Z | V/mil | - | IPC-TM-650 2.5.6.2 |
| **Tensile Strength** | 16<br>12 | MD<br>CMD | kpsi | - | ASTM D3039/D3039-14 |
| **Flexural Strength** | 25<br>19 | MD<br>CMD | kpsi | - | IPC-TM-650 2.4.4 |
| **Dimensional Stability** | -0.48<br>-0.59 | MD<br>CMD | mm/m | - | IPC-TM-650 2.4.39a |
| **Coefficient of Thermal Expansion** | 13 | X | ppm/°C | -55 to 288°C | IPC-TM-650 2.4.41 |
| | 16 | Y | | | |
| | 42 | Z | | | |
| **Thermal Conductivity** | 0.64 | Z | W/(m·K) | 80°C | ASTM D5470 |
| **Time to Delamination (T288)** | >60 | - | minutes | 288°C | IPC-TM-650 2.4.24.1 |
| **Tg** | >280 | - | °C TMA | - | IPC-TM-650 2.4.24.3 |
| **Td** | 414 | - | °C | - | IPC-TM-650 2.3.40 |
| **Moisture Absorption** | 0.07 | - | % | 24/23 | IPC-TM-650 2.6.2.1 |
| **Young's Modulus** | 2264<br>2098 | MD<br>CMD | kpsi | - | ASTM D3039/D3039-14 |
| **Flex Modulus** | 2337<br>2123 | MD<br>CMD | kpsi | - | IPC-TM-650 2.4.4 |
| **Bow** | 0.03 | - | % | - | IPC-TM-650 2.4.22C |
| **Twist** | 0.08 | - | % | - | IPC-TM-650 2.4.22C |
| **Copper Peel Strength After Thermal Stress** | 5.8 | - | lbs/in | 1 oz (35 μm) foil | IPC-TM-650 2.4.8 |
| **Flammability** | V-0 | - | - | - | UL 94 |
| **Specific Gravity** | 1.99 | - | g/cm³ | - | ASTM D792 |
| **Lead-Free Process Compatible** | Yes | - | - | - | |

NOTES:
[1] Typical values are a representation of an average value for the population of the property. For specification values contact Rogers Corporation.
[2] Dielectric Constant using stripline method IPC TM-650 2.5.5.5 at 10 GHz is 4.10 +/- 0.08 for Rogers' internal Q.A. testing
[3] 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.

| Standard Thicknesses | Standard Panel Sizes: | Standard Cladding |
|---|---|---|
| 0.010" (0.254 mm) +/- 0.001"<br>0.020" (0.508 mm) +/- 0.0015"<br>0.030" (0.762 mm) +/- 0.002"<br>0.040" (1.016 mm) +/- 0.003"<br>0.060" (1.524 mm) +/- 0.004"<br><br>*Additional non-standard thicknesses of 0.090" and 0.120" available | 24" X 18" (610 X 457 mm)<br>24.25" X 18.25" (616 X 464 mm)<br>48" X 36" (1219 X 915 mm)<br>48.25" X 36.25" (1226 X 921 mm)<br><br>*Additional panel sizes available | Electrodeposited Copper Foil<br>½ oz. (18μm) *HH/HH*<br>1 oz. (35μm) *H1/H1* |

*Contact Customer Service or Sales Engineering to inquire about additional available product configurations

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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.



RoHS Compliant

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