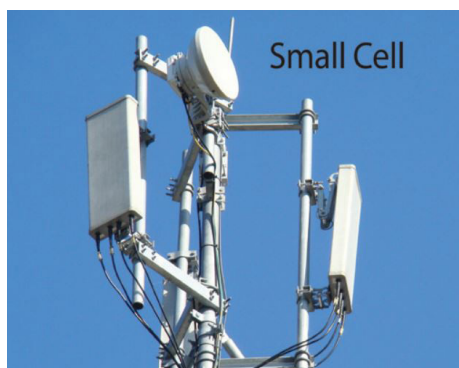


Kappa[®] 438 Laminates

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.



Data Sheet



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

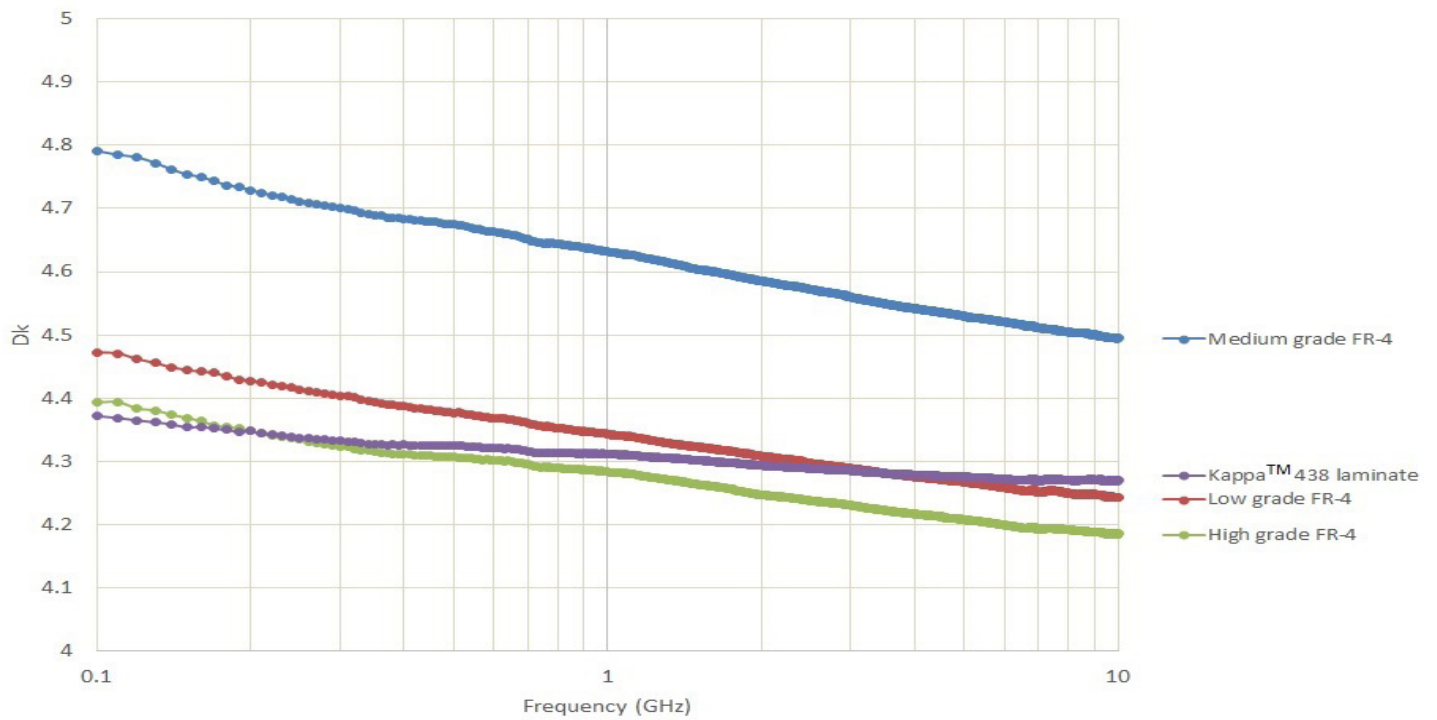
- UL 94 V-0

Typical Applications:

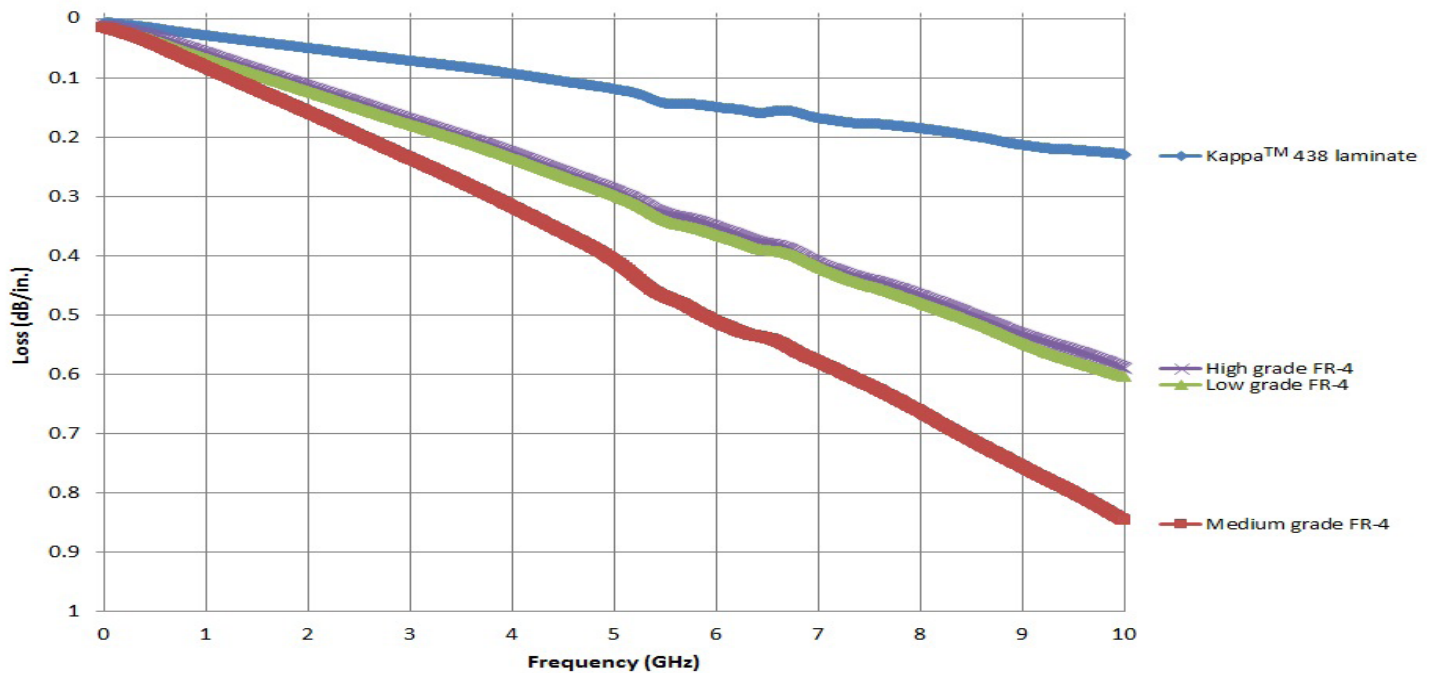
- Carrier Grade WiFi/Licensed Assisted Access (LAA)
- Small Cell and Distributed Antenna Systems (DAS)
- Vehicle to Vehicle/Vehicle to Infrastructure Communications (V2X)
- Internet of Things (IoT) Segments: Smart Home and Wireless Meters



Microstrip differential phase length method, Dk vs. Frequency
using 30mil thick circuit materials



Microstrip Insertion Loss, Differential Length Method
Using 30mil thick circuit materials



Property	Typical Value Kappa Laminate [1]	Direction	Units	Condition	Test Method
^[3] Dielectric Constant, ϵ_r Design	4.38 ^[2]	Z	-	2.5 GHz	Differential Phase Length Method
Dissipation Factor tan, δ	0.005	Z	-	10 GHz/23°C	IPC-TM-650 2.5.5.5
Thermal Coefficient of Dielectric Constant ϵ_r	-21	-	ppm/°C	10 GHz (-50 to 150°C)	Modified IPC-TM-650 2.5.5.5
Volume Resistivity	2.9 x 10 ⁹	-	MΩ-cm	COND A	IPC-TM-650 2.5.17.1
Surface Resistivity	6.2 x 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 12	MD CMD	kpsi	-	ASTM D3039/D3039-14
Flexural Strength	25 19	MD CMD	kpsi	-	IPC-TM-650 2.4.4
Dimensional Stability	-0.48 -0.59	MD 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 2098	MD CMD	kpsi	-	ASTM D3039/D3039-14
Flex Modulus	2337 2123	MD 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/cm ³	-	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 Copper Cladding
0.020" (0.508 mm) 0.030" (0.762 mm) 0.040" (1.016 mm) 0.060" (1.524 mm)	24" X 18" (610 X 457 mm) 24.25" X 18.25" (616 X 464 mm) 48" X 36" (1219 X 915 mm) 48.25" X 36.25" (1226 X 921 mm)	½ oz. (17µm) electrodeposited copper foil (5ED/5ED) 1 oz. (35µm) electrodeposited copper foil (1ED/1ED)

The information in this data sheet is intended to assist you in designing with Rogers' circuit materials. 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 or that the results shown on this data sheet will be achieved by a user for a particular purpose. The user should determine the suitability of Rogers' circuit materials for each application.

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.

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