



# *The Future of EMC Engineering*

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## *Why FR-4 is Obsolete for Tomorrow's Technology*

A discussion topic between designers, namely those who *only* do circuit design and have no interest in the field of EMC, and compliance engineers attempting to meet regulatory compliance requirements, is the use of FR-4 as the core material for printed circuit board construction. Fiberglass Resin (FR) is low cost and has been used in almost every electrical product for decades, with exceptions such as military and satellite applications, harsh environmental conditions, and other unique uses. The disagreement lies with the extent that we can use FR-4 in high frequency applications and should we be concerned more with electrical performance or manufacturing and assembly.

There are six variations of weave structures available during core construction. Fiberglass strands are first woven in an x- and y- axis and then held together by a resin. Depending on the ratio of fiberglass to resin, the assembly will perform differently under specific operational conditions. A primary parametric concern for electrical performance is dielectric loss. Most FR-4 weave constructions have a high dielectric loss that minimizes signal propagation generally from 2 GHz and above. Also, depending on the weave structure, the quality of ensuring an optimal RF return path is another concern.

The reason why FR-4 is becoming obsolete for today's products deals not with dielectric loss or weave structure, but the RoHS Directive in Europe, China, and soon North America. The Restriction of Hazardous Substance Directive makes the use of lead illegal regardless of application. Typical solder consists of PbSn (tin-lead). Since use of PbSn solder is now illegal, an alternative solder material composition

is required. The metallurgy of this alternate material leads to microscopic problems known as Tin Whiskers. What occurs over time is small metallic whiskers will grow from a soldered joint and may bridge circuits causing system failure. NASA has much documentation on tin whisker growth as well as the Raytheon Corporation. Perform an Internet search on tin whiskers to learn more about this topic.

Another concern why FR-4 is becoming obsolete for technologies of the future is that in order to use the new solder, higher processing temperatures are required to ensure melting during reflow. With higher process temperatures, the resin used to hold the fiberglass strands together will start to evaporate and delamination of the copper from the core occurs. This is now a reliability concern. So should we worry more about electrical performance or manufacturing capabilities for high technology products using FR-4?

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