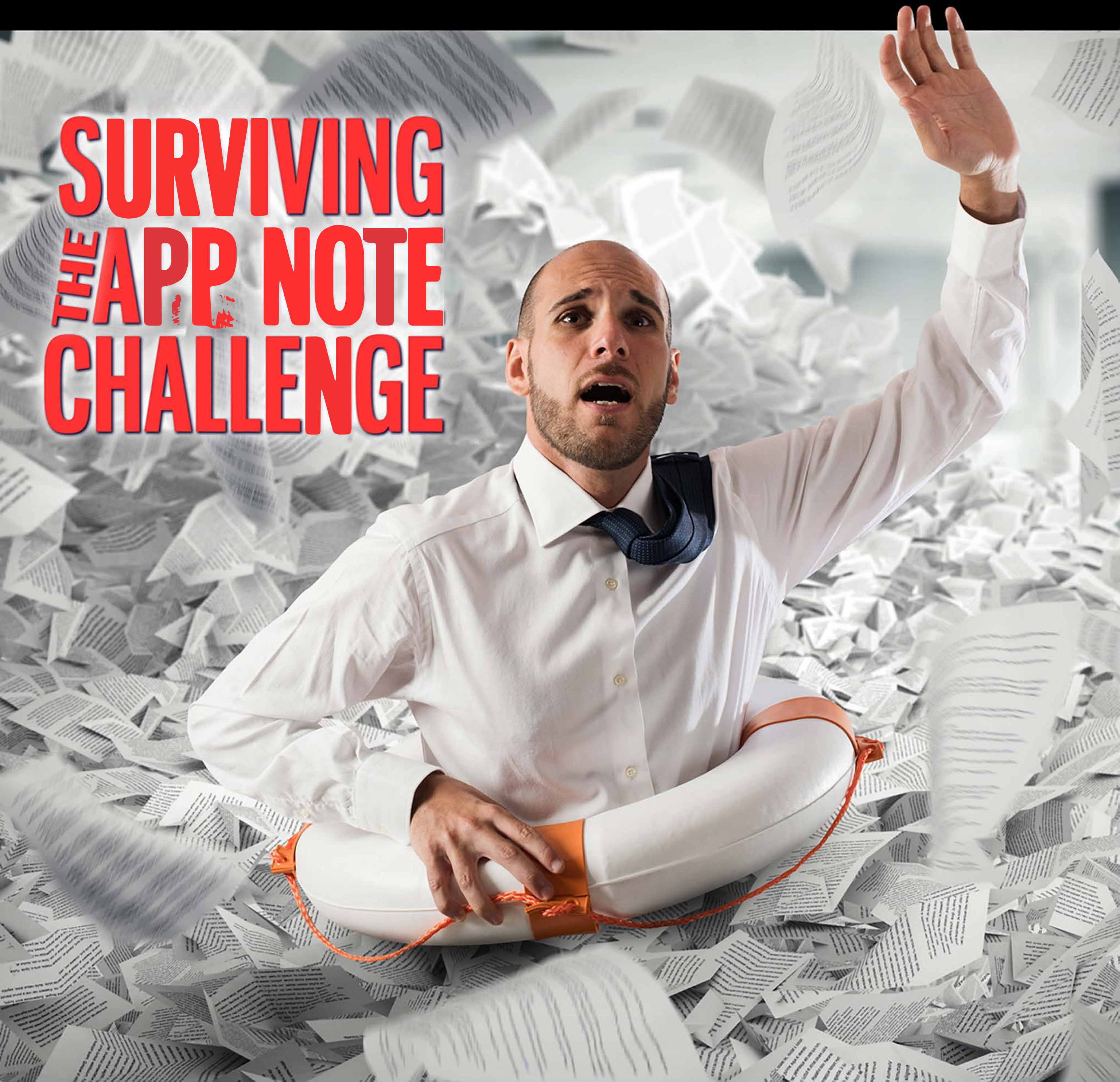
REPRINTED WITH PERMISSION

JUNE 2020

I-Connect007

DESIGN007 MAGAZINE

SURVIVING THE APP NOTE CHALLENGE



High-Frequency Circuit Material App Notes

Lightning Speed Laminates

Feature Column by John Coonrod, ROGERS CORPORATION

High-frequency circuit materials are used in a variety of diverse applications. Due to this diversity, it is difficult to write an application (app) note for a specific high-frequency circuit material.

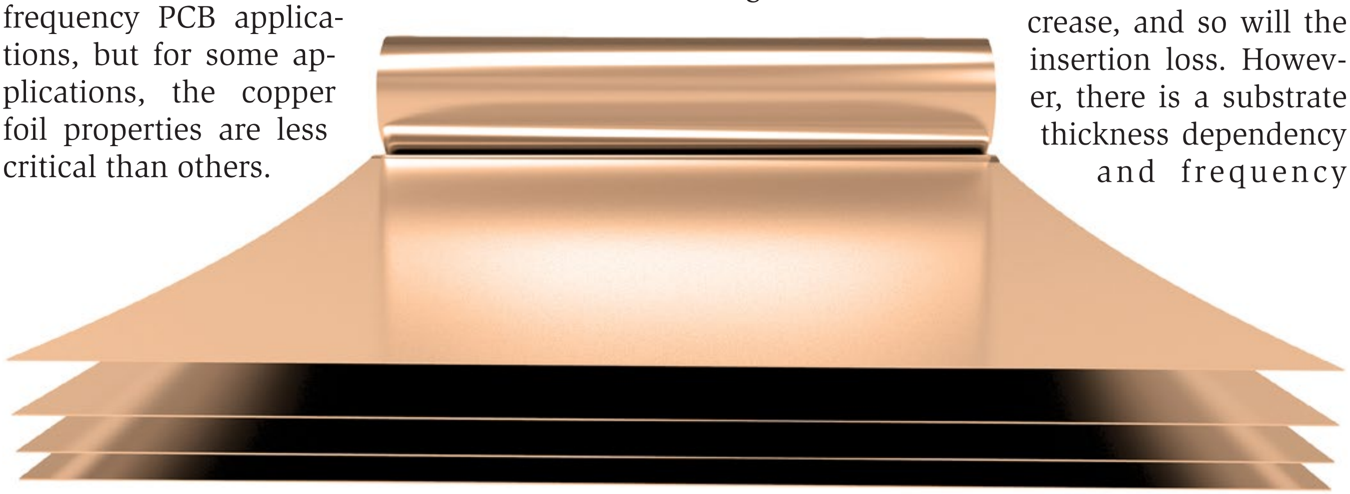
Combine that with the fact that one designer can use a different circuit design technique than another designer for the same circuit application, and that could make one high-frequency material a better choice than another based on design technique. Rogers Corporation has app notes, but not as many as one may assume, and for a good reason.

The app notes for high-frequency circuit materials are typically related to a large-scale topic. For example, Rogers has an app note on the copper foils used in high-frequency PCB applications. This app note covers the different manufacturing processes to create a copper foil, different types of copper foils, and properties of the copper foil as they relate to high-frequency performance and measurement values of the critical properties.

Copper foil is obviously critical to high-frequency PCB applications, but for some applications, the copper foil properties are less critical than others. The same circuit application may be very sensitive to copper properties at high-frequency, but at lower frequencies, the copper properties may be much less critical. Unfortunately, the topic of critical copper properties for different RF PCB applications is a large subtopic and cannot be addressed in a relatively short app note.

To expand on the copper comments, the copper surface roughness of a copper foil can be very influential for high-frequency applications. To be more specific, the copper surface roughness at the substrate-copper interface can have an impact on insertion loss and phase response, which is related to dielectric constant (Dk).

Basically, if the copper surface is rougher, the propagating wave will slow down, and the circuit will behave as though it has a higher Dk. This is true regardless of the Dk property of the substrate. Additionally, a rougher copper surface will cause increased conductor loss, which is a component of insertion loss. As copper roughness increases, the conductor loss will increase, and so will the insertion loss. However, there is a substrate thickness dependency and frequency



dependency for the effects that roughened copper has on high-frequency performance.

If the circuit application is operating at a low frequency, the copper surface may not have any influence on the RF performance. However, when frequency increases to the point of the skin depth having the same dimension as the copper surface roughness, the surface roughness can certainly impact insertion loss and phase response. As the frequency continues to increase, which causes a thinner skin depth, the roughened surface of the copper will have an increased influence on RF performance.

Continuing with more detail on the copper foil surface roughness, the substrate thickness can exaggerate the RF effects of copper surface roughness. Here's a simple analogy: When the copper planes are close together, which is the case for a circuit using a thin substrate, the copper surface roughness effects will be more significant. As opposed to using a thick substrate and the copper planes being farther apart, the copper surface roughness will have less impact on the RF performance of the circuit.

When the copper planes are close together, which is the case for a circuit using a thin substrate, the copper surface roughness effects will be more significant.

Another example of a high-frequency circuit material app note is related to space applications. The circuit material testing requirements for space are well-defined through agencies like NASA and other similar organizations. Rogers has an app note which gives a summary of specific high-frequency circuit materials tested per NASA requirements.

There are typically many different circuit applications for one space system, and each circuit application may have different material property needs; however, the overriding specification may be the NASA data, for example. Given the list of high-frequency circuit materials that will meet the NASA requirements, some materials may be good for power amplifier applications, and other materials may be good for antenna radiating elements. Typically, the designer will need to perform a trade-off analysis with the list of materials that are acceptable to the NASA requirements and consider the different properties of the materials for their space application.

Another app note that Rogers offers is related to laminates which have resistive foil embedded in the laminate. The resistive foil laminates can be used for a wide range of PCB applications, and the app note cannot cover all aspects of these applications.

The app note can, however, cover the critical topics associated with these types of laminates, and the topics may or may not be applicable to a specific application. For this app note, the main issues related to resistive foil laminates are discussed. In general, these issues are a normal variation of the visual appearance of the resistive layer and the resistor tolerance which can be achieved by using these laminates to make planar resistors.

While app notes are a very good tool for the designer to use, the app notes which a high-frequency circuit material supplier will issue are typically not like an app note that a component supplier would issue.

The app note for a material supplier will usually address the different nuances of the material, which may or may not be critical to a particular PCB application. It is the designer who will need to understand how the app note applies to their design, but it is always suggested that the designer consults with the material supplier if there is any confusion on the app notes or related datasheets. **DESIGN007**

John Coonrod is technical marketing manager at Rogers Corporation. To read past columns or contact Coonrod, click here.

I-Connect007

GOOD FOR THE INDUSTRY

FREE SUBSCRIPTION

myiconnect007.com

mediakit.iconnect007.com

EDITORIAL CONTACT

Andy Shaughnessy
andy@iconnect007.com
+1 404.806.0508 GMT-5

SALES CONTACT

Barb Hockaday
barb@iconnect007.com
+1 916 365-1727 GMT-7

www.iconnect007.com