TECHNICAL PUBLICATION

RF and Microwave: Design Challenges in PCBs

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INTRODUCTION

Technology and automation are the driving forces to use more complex devices. This in itself promotes consumer electronics providers to include more and more functionality into traditional devices that were used for only one purpose.

Let’s just look at a few familiar devices such as cell phones, PDAs, MP3 players, digital cameras, and GPS units. All of these are now mature products and most consumers own one and some cases all of them. Now looking at the “Road Warrior” of a couple years back, we remember a person with multiple devices attached to their belt representing those devices. In the airport, during those days, there always was a competition for power outlet to charge those gadgets.

Now we don’t want to carry all of these individual marvels and electronics companies have answered the challenge by performing an amazing fit of engineering, miniaturization and manufacturing of electronics wizardry to satisfy consumer demand for newer toys.

A cell phone is no longer a device that is used to just talk on. Instead it is an amazing technology that allows users do so much more. These new wonders are email capable, manage contacts, update calendars, provide entertainment, take pictures, and even in some cases provide a GPS device that keeps you from getting lost or tracks the whereabouts of your kids.

What does that all mean to engineers that need to face all the challenges to provide a device that we all use? I want to examine only one aspect of this challenge for supporting PCB design that incorporates RF and microwave devices.

RF AND MICROWAVE

RF and microwave implementation in PCB designs is not a new concept. PCB designers have been doing it for many years if not couple of decades. The question is how hard engineers had to work to get RF/Microwave elements incorporated then and how can it be done today. Electronics Design Automation (EDA) has bought us the use of computers for PCB design and has increased designer productivity. Most advances in automation typically were aimed at digital circuitry and auto-routing.

To help designers that need to manipulate RF and microwave shapes, the EDA industry needs to understand how these type designs are created.

Typically electrical engineers use RF simulators to model the circuit that they design. Once the desired electrical performance is achieved, the simulator can produce a representation of the copper shape for this circuit in most cases. The most common way this is achieved is when copper shapes are defined in DXF format. DXF is a standard that AutoCAD introduced for exchanging data between different CAD systems.

Most CAD systems today can import the DXF files, but the bigger question is how the DXF file is interpreted during the import. If the DXF file is not converted properly to become an intelligent copper shape, the designer still has to do a lot of manual manipulation of the imported file. The image may just be a compilation of disjointed lines that mean nothing to CAD tool.

At this time the designer may try to trace over unintelligent shapes to recreate this shape in native CAD format. Any time the retracing happens, it introduces human error and the shape may not be exactly the same size. This is unacceptable as any variations, no matter how small they are, lead to poor or incorrect performance excepted from electrical simulation.

Electrical CAD systems should provide control during the import of the DXF complex Copper shape with as little human interaction as possible. Designers need to maintain control of the layers coming from DXF and re-map them to electrical CAD system layers as well as possess the ability to convert DXF into exact and usable copper shapes (see Figure 1).

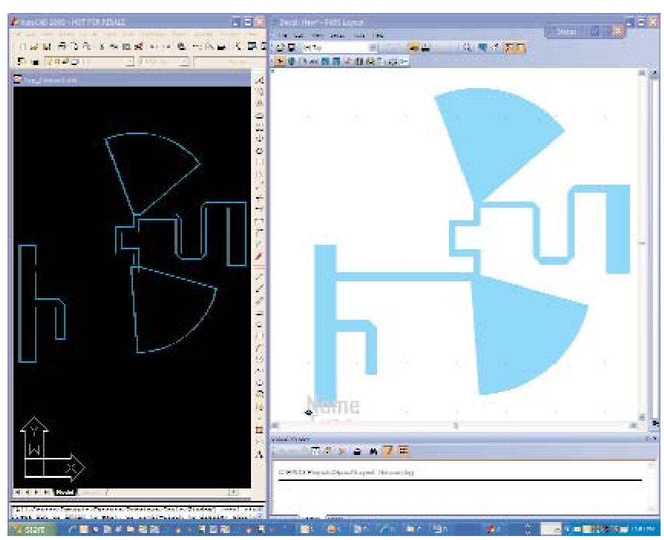

Figure 1.

DESIGN PROCESS TECHNIQUES

The next important aspect of designing copper shapes for RF and microwave is the ability to create Gerber files with sharp corners. Usually if a designer is using a 50 mils line to draw a shape, during Gerber output the design ends up with a small Radius from plotting with a 50 mils round line. A good PCB CAD system knows how to implement this important aspect of line thicknesses in Gerber format (see Figure 2).

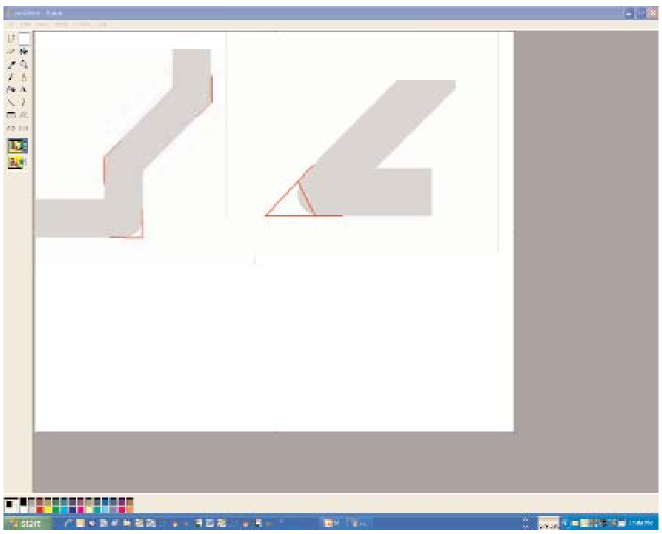

Figure 2.

Now let's talk about chamfered corners that are routinely are used to in RF and microwave circuits. Designers need an automated way to specify the ratio of the chamfering that needs to be produced based on design. The distance between the 90 degree corner and chamfer is critical (see Figure 3.1 and 3.2).

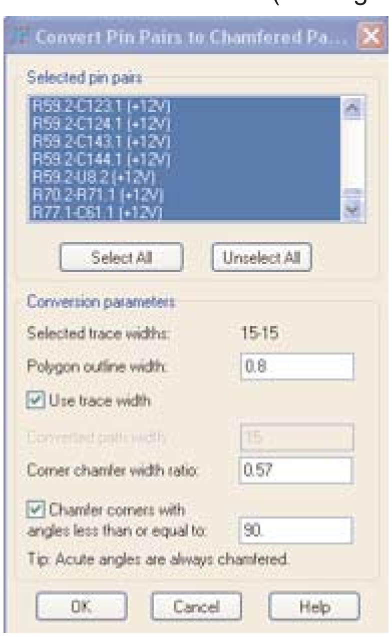

Figure 3.1.

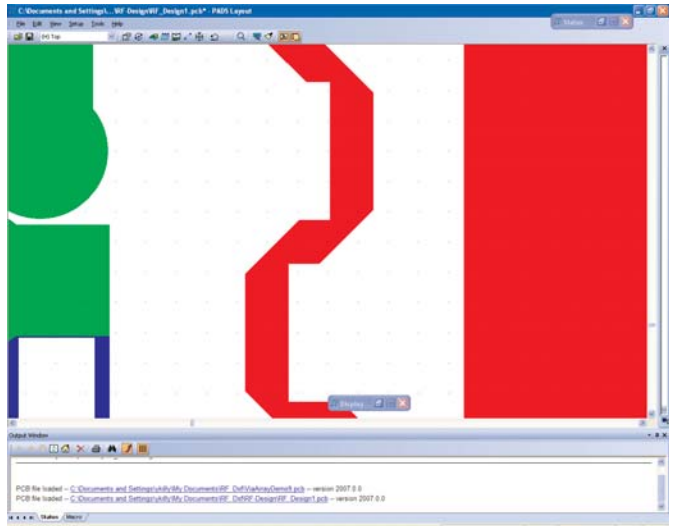

Figure 3.2.

Coplanar/wave guide is consistently used in RF and Microwave designs as well. Designers may do this manually and it is a laborious, long and error prone proposition because as the designer needs to control the specific distance between the Trace and Vias as well as the distance between one via and another. If these distances are not maintained, the circuit will not perform as designed. Again a good CAD system can provide control and automate the creation of coplanar/wave guide shielding with vias (see Figure 4).

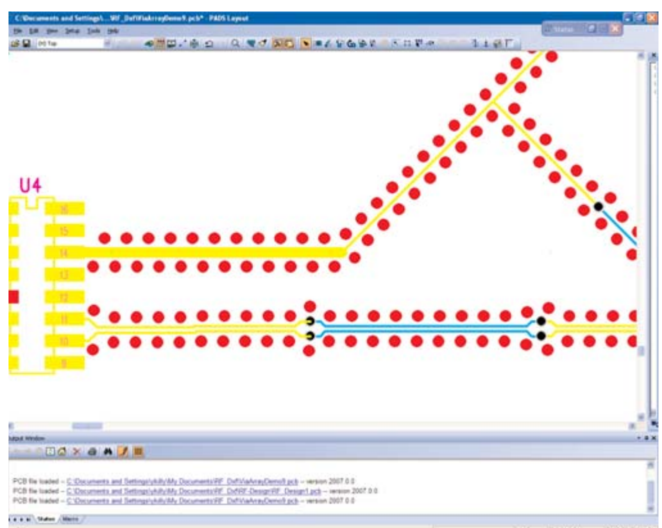

Figure 4.

The last but not the least important part of ensuring the RF or microwave design works is shielding areas with vias. Today as before, designers can manually produce this using elbow grease and a lot of time. Yet automation brings shortened design cycle times and most importantly, adherence to rules and the batch checking of these rules. It is important for designer to specify the rules for via pattern generation and CAD system to the rest of the work. The rules may include:

- What type of via to use for what Copper area?
- What net the via needs to attach itself to?
- What is the distance that needs to be maintained from the edge of the Copper area to a Via?
- What is a distance from one via to the next one?
- What type of pattern does the via use?
- Can Faraday Cage be generated by adding Vias only to outer edge of the Copper Area?
- More (see Figure 5.1 and 5.2)

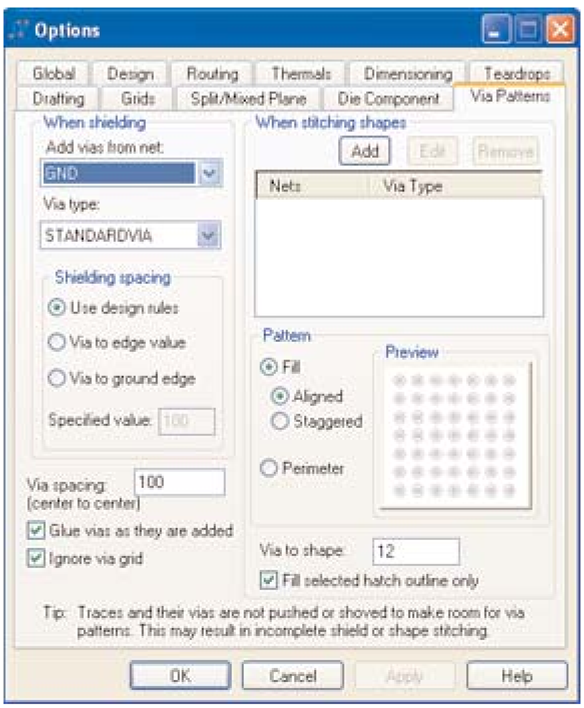

Figure 5.1.

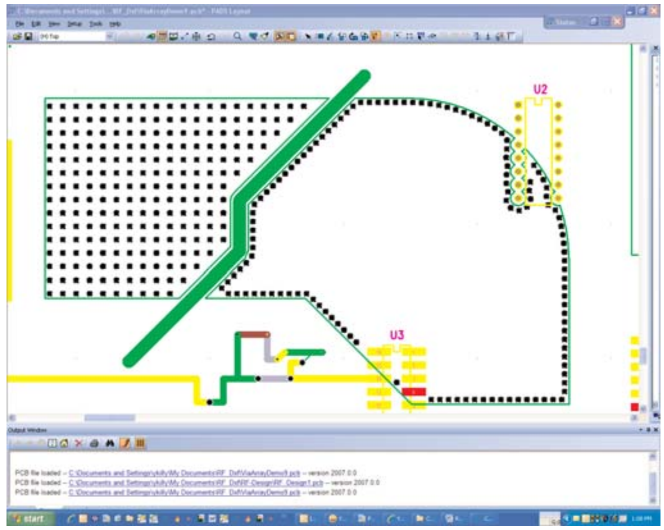

Figure 5.2.

Automation for above techniques has raised the bar for EDA vendors to eliminate manual processes that designers have resorted to create designs with RF and microwave elements.

CONCLUSION

Without the support of EDA CAD systems, engineers are bogged down by manually creating complex copper shapes, chamfered corners, via patterns, etc. That is time that can be spent innovating by working smarter not just harder. Improvements in ability to manipulate RF and microwave elements by EDA vendors allow designers to concentrate more on implementing increased functionality and reducing the size of devices with wireless capabilities.

ABOUT THE AUTHOR

Yan Killy has over 20 years of experience in PWB design for switching power supplies and analog and digital equipment. He possesses extensive knowledge of mechanical fastening for electronic assemblies, bare board fabrication and testing in addition to comprehensive knowledge of U.L., C.S.A. and TUV/VDE safety requirements.

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