X2Y® Circuit 1 & Circuit 2 Configurations

Summary

A commonly asked question from engineers is “How do I use X2Y® components in my circuit?” To answer this question, one must first understand the proper printed circuit board (PCB) pad/trace layout requirements. Application Note 1001 - X2Y® G1/G2 Attachment is recommended for an explanation of the proper PCB pad/trace layout.

The next step is connecting the X2Y® component into a circuit. It should be noted that X2Y® components are NOT simply a discrete capacitive element, but a capacitive circuit that can be used in several different ways. Therefore, purpose of this application note is to show the advantages of the X2Y® structure as a capacitive circuit and to discuss the two most commonly used circuit configurations, Circuit 1 and Circuit 2.

X2Y® as a Complex Capacitive Circuit

Simply viewing an X2Y® component as a discrete capacitive element overlooks the benefits the unique structure has to offer. To properly implement and use X2Y® Technology, the reader of this application note needs to view the component as a complex capacitive circuit capable of several different modes.

To highlight X2Y® performance vs. a standard discrete element, Figure 1 - Figure 3 uses s21 measurements to investigate the current paths and the performance the structure has to offer as a circuit.

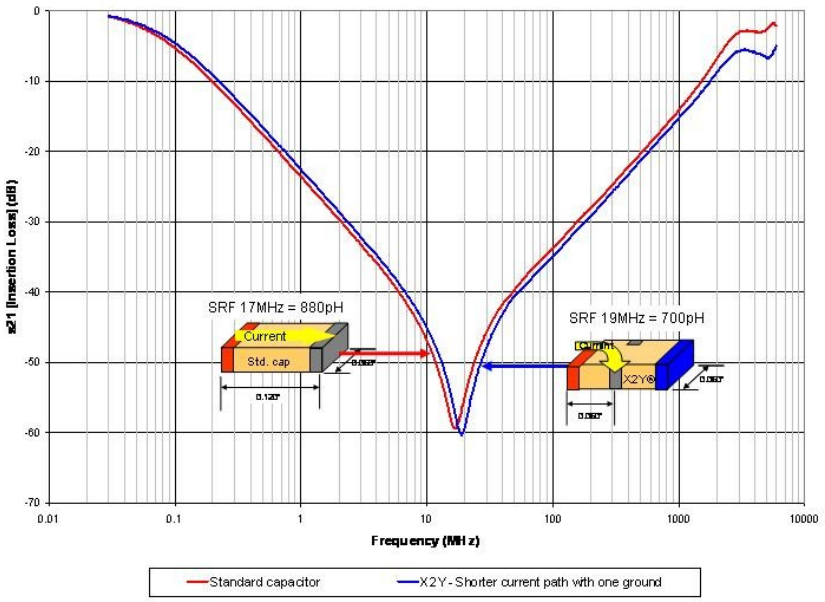

Figure 1. *X2Y® has a shorter path to ground which results in a smaller current loop. The result is a 1-2dB improvement in attenuation and 20% less inductance over standard surface mount capacitors.*

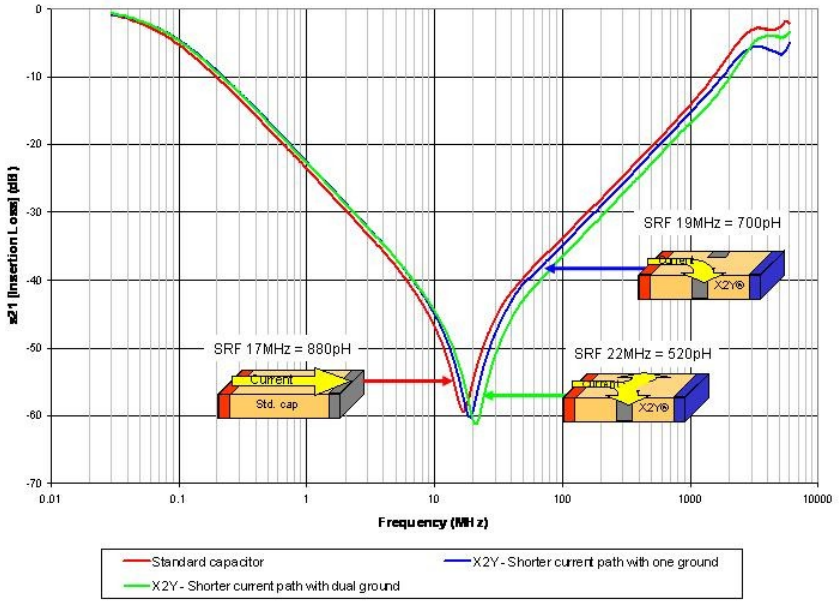

Figure 2. *The X2Y® structure is designed for a parallel connection to ground thus reducing attachment impedance. The result is a 3-4dB improvement in attenuation and 40% less inductance over standard surface mount capacitors*.

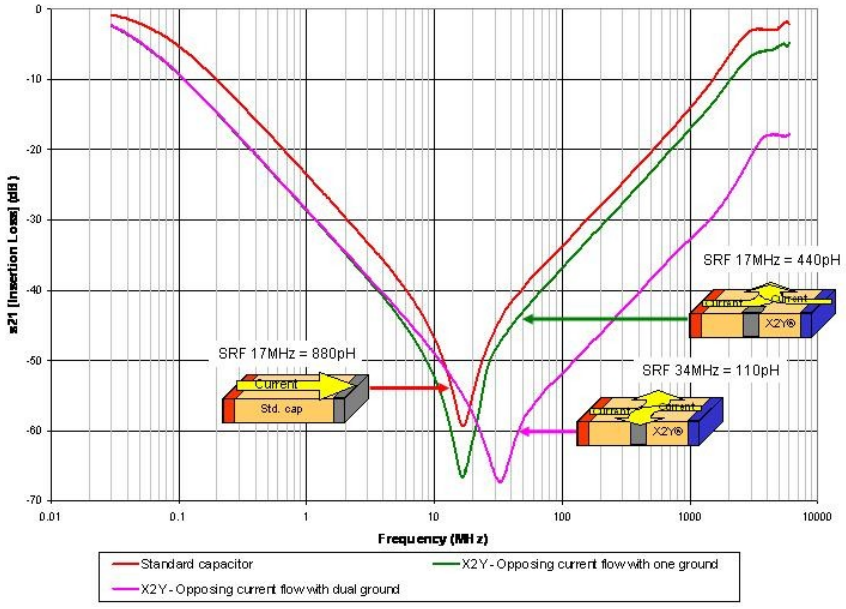

Figure 3. *When both the A and B terminals are connected, the structure forces current in opposing directions. When both the G1 & G2 terminals are connected mutual inductance is canceled thus resulting in a 15dB improvement in attenuation and nearly 75% less inductance versus when only a single G terminal is connected.* ***The key to viewing an X2Y® component as a circuit is to understand the passive cancellation that occurs internally****. Note: when both the A and B terminals are connected the capacitance value is doubled. The standard surface mount capacitor is plotted as a reference*.

Circuit 1 & Circuit 2

Let's now evaluate which X2Y® circuit configuration is appropriate for a design. The criteria for Circuit 1 and Circuit 2 configurations are shown in Figure 4.

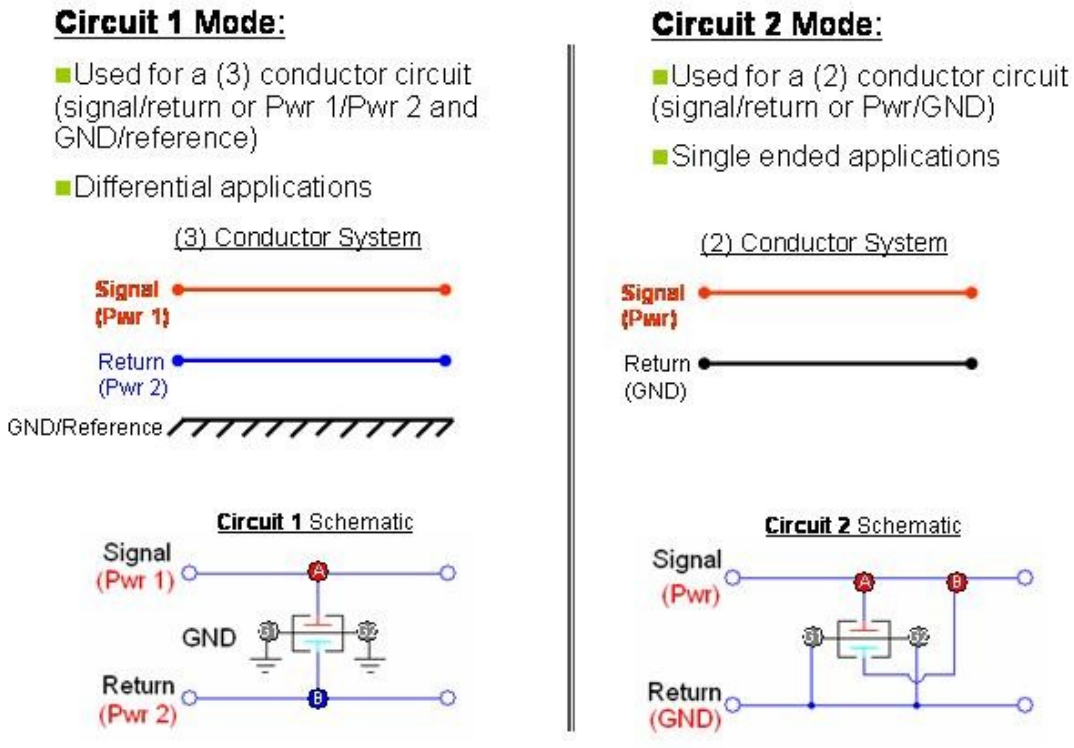

Figure 4. *Comparison criteria of Circuit 1 and Circuit 2.*

To fully appreciate the electromagnetic differences between Circuit 1 and Circuit 2, let's examine the E- and H-fields internal to the structure of the two different configurations (Figure 5 and Figure 6). *(For more information on modeling the internal structure see Application Note 1003 - Internal Model of X2Y®.)*

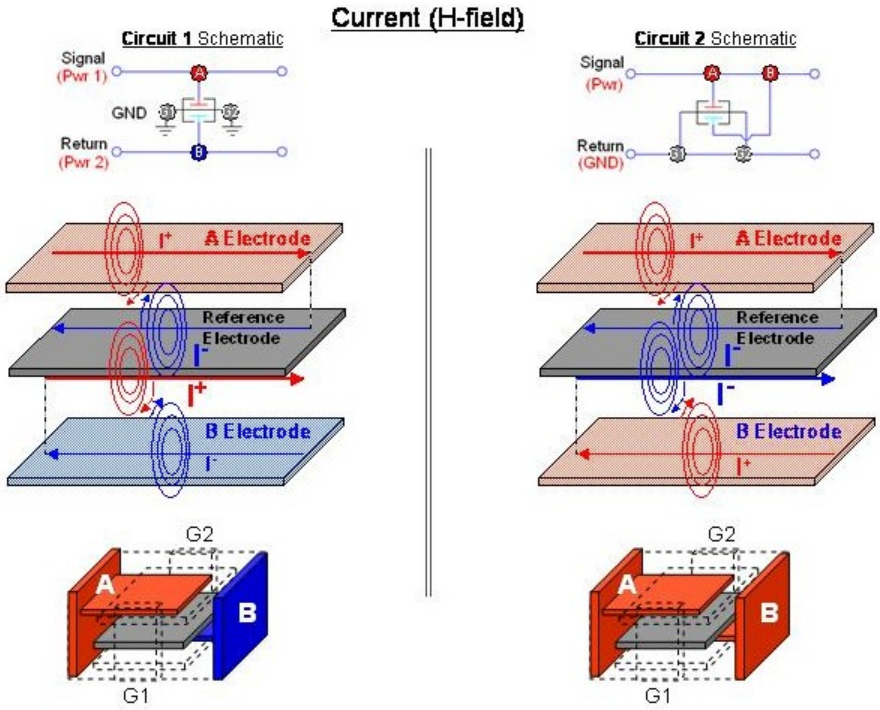

Figure 5. *For Circuit 1 and Circuit 2 the H-field cancels internally at the reference electrode*.

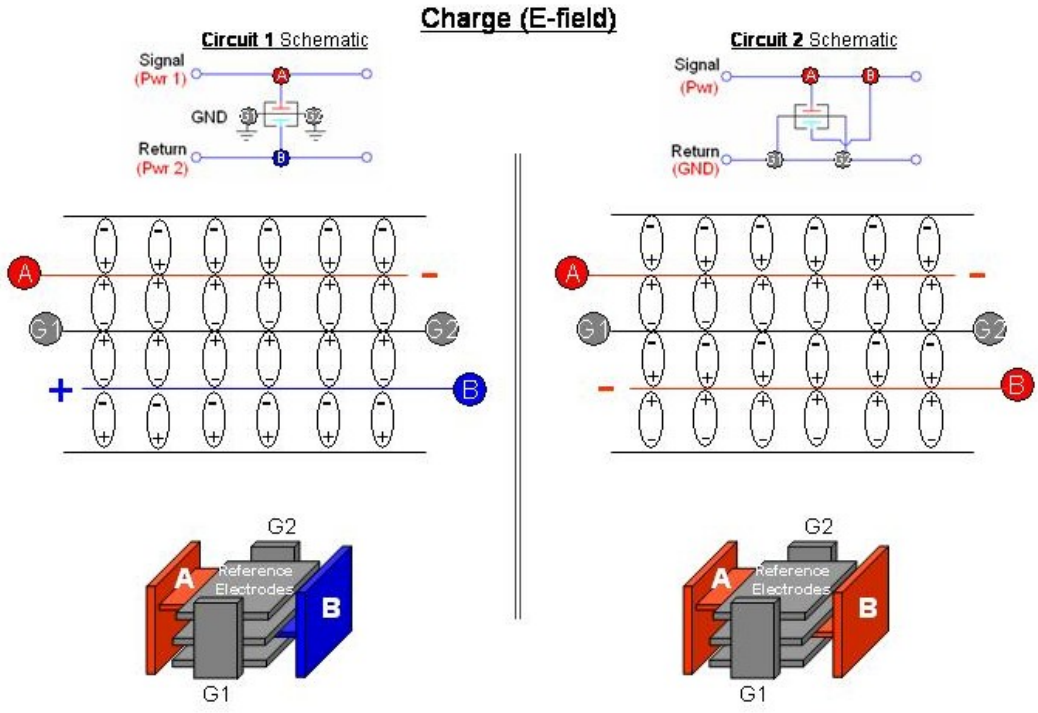

Figure 6. *For Circuit 1 the E-field cancels at the shared reference electrode, while for Circuit 2 the E-field is shunted to the reference electrodes, which are attached to the return path*.

Selecting a Component Value

Does the circuit configuration matter when selecting a component value? The short answer is YES. When selecting an X2Y® component value for Circuit 1 both the differential (Line-to-Line) and common mode (Line-to-GND) "pass" functions need to be considered. When selecting an X2Y® component value for Circuit 2, only the common mode function (Line-to-GND) needs to be considered. Figure 7 is an example of the differential and common mode "pass" functions.

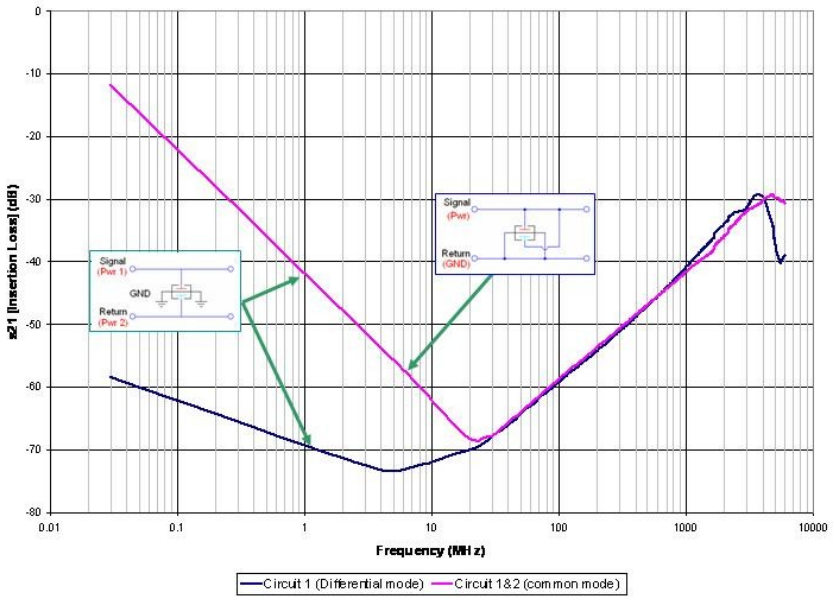

Figure 7. *"Pass" Function for Circuit 1 & Circuit 2.*

Conclusion

What does this mean to the design engineer? Circuit 1 is the most effective configuration to provide the best broadband filtering and decoupling performance. Circuit 2 is an alternative option for single-ended applications where Circuit 1 use is not possible.

For more information on circuit configurations, applications, or benefits that X2Y® Technology offer go to our website www.x2y.com or use the contact information at the end of this application note to get answer for specific questions.

Note: Performance results reported in this and other application notes can only be achieved with patented X2Y® components sourced from X2Y® licensed manufacturers or their authorized distribution channels.

Contact Information

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