

Summary

Many OEM's have electromagnetic compatibility (EMC) problems caused by the inherent switching internal to DC-to-DC converters. Noise voltage caused by the switching requires filtering at the output. Tradition discrete components have been able to provide adequate filtering performance and remain cost-effective for high volume production. Over the last few years, several trends have added complexity to the design equation. The push to make electronics smaller and faster with more circuitry to provide added features have resulted in more rigorous EMC requirements to maintain the design integrity.

The demands on discrete components to provide a broader range of filtering, remain cost-effective, and still provide an overall smaller electronic system package has lead industry searching for a new solution.

Currently the X2Y® Technology is production with DC motors as a filter replacing 5-7 discrete devices. The cost savings and increase broadband filtering performance has placed the X2Y® Technology as the standard in the DC motor industry. The next logical step for the technology would be filtering DC-to-DC converter applications. Thus this application note offers an alternative solution to the traditional filtering of DC-to-DC converters.

Traditional Filtering Solution

One solution to providing filtering for a DC-to-DC converter are inductors and capacitors in an LC filtering configuration to create an output "PI" filter. Figure 1 shows how one manufacture recommends using the internal output capacitors with external inductors and capacitors to build the "PI" filter.

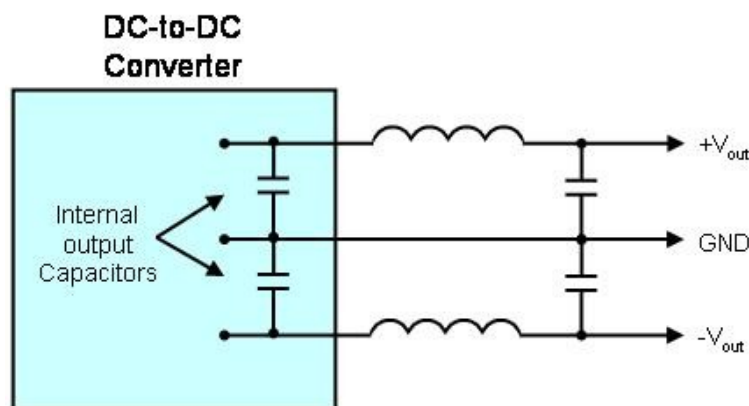


Figure 1. Typical "PI" filter used to filter DC-to-DC converters.

When choosing inductors for a design, it is important that the wire size is capable of handling the load current and that the core (usually made of ferrite material) does not saturate. The DC resistance can also be of concern depending on the

application. The limitation to inductors is that the ferrite material absorbs energy and releases it through heat, so inductor performance varies over temperature. In addition, the ferrite material is frequency limited to a maximum of 300-500 MHz.

Equivalent Series Resistance (ESR) and Equivalent Series Inductance (ESL) should be minimized when choosing output capacitors. ESR in effect becomes a voltage divider with the internal output resistance of the converter and ESL decreases the operating frequency that capacitance is supplied. Using multiple parallel capacitors that provide the total overall capacitance needed helps to lower ESR and ESL.

Capacitors, like inductors, can vary over temperature. In addition, aging can diminish capacitance with aluminum or tantalum capacitors resulting in poor reliability.

Using multiple discrete components also interject problems with impedance matching. For ceramic capacitors to remain cost effective for mass production, typically they have $\pm 5\%$ capacitive tolerances. Inductors generally have even larger tolerances when they are mass-produced.

The X2Y® Technology

The X2Y® structure consists of a standard bypass capacitor with alternating reference electrode plates, similar to a Faraday Cage (Figure 2). X2Y® components are a four terminal structure. . (Note: the X2Y® component's package is similar to a feedthrough capacitor's package, but the internal structures are entirely different.)

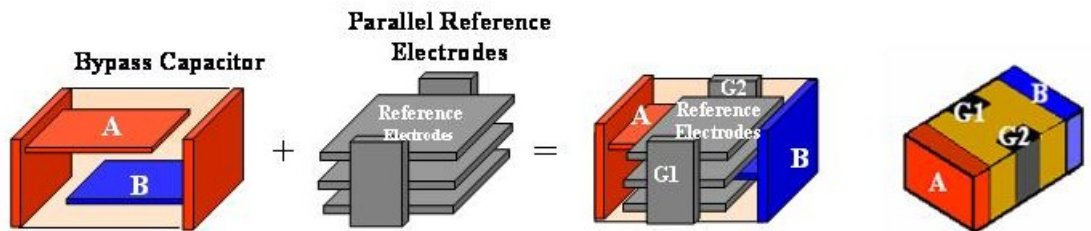


Figure 2. The X2Y® structure is a standard bypass capacitor and a “quasi” Faraday Cage.

The parallel reference structure makes an unbalanced single ended bypass capacitor into a symmetrically balanced dual capacitive circuit. X2Y® components have five major advantages over standard filters and passive devices.

- The ground (or reference) is brought internal to the component, a dielectric thickness away. With standard devices, the ground (or reference) is a separate trace or pad on the printed circuit board (PCB).
- The unique structure forces current flow in opposite directions allowing X2Y® components to cancel mutual inductance internally lowering the internal inductance, see Figure 3.

- c. Since X2Y® components have a common substrate, tolerances in a line-to-ground measured from either end terminal (A/B) to either side termination (G1/G2) is typically 1-2.5% or less.
- d. X2Y® components work in bypass; therefore they don't limit current or add DC resistance.
- e. As package size increase with X2Y® components, inductance is lowered due to the parallel structure. This is opposite of standard capacitors.

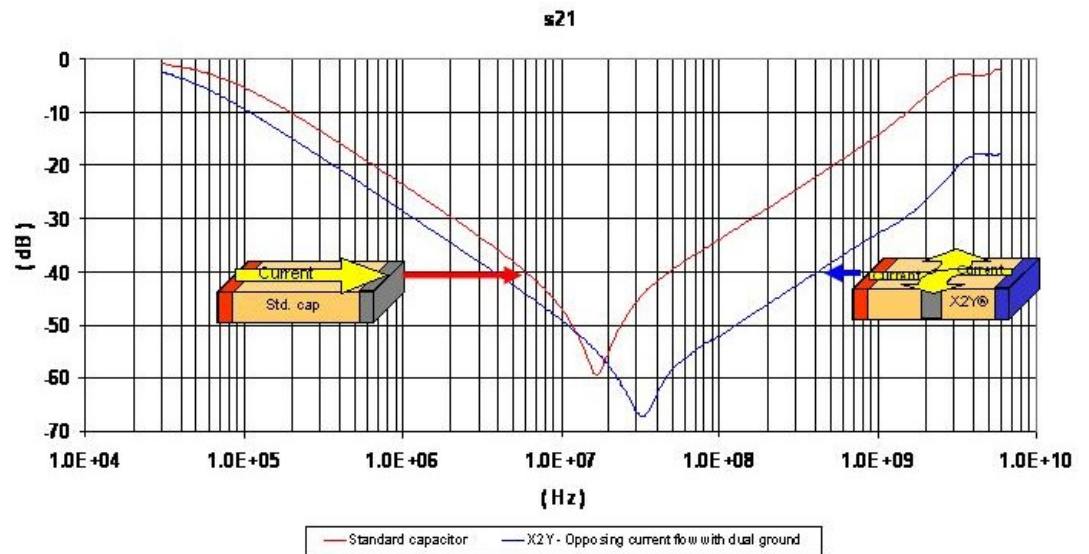


Figure 3. X2Y® components cancel mutual inductance to lower the internal inductance and resistance.

Implementing X2Y® Technology

Implementing X2Y® components does not require major design changes. X2Y® components come in standard surface mount packages (0603, 0805, 1206, 1210, 1410, and 1812). Figure 4 - Figure 6 show three configurations of how to implement and connect X2Y® components.

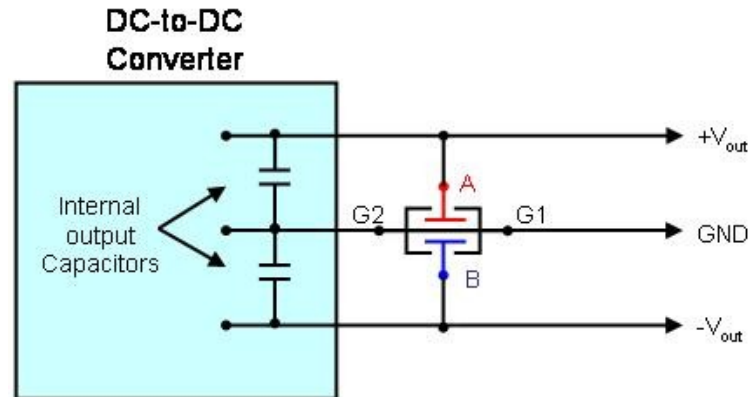


Figure 4. Retrofitting a current design with an X2Y® component using CIRCUIT 1.

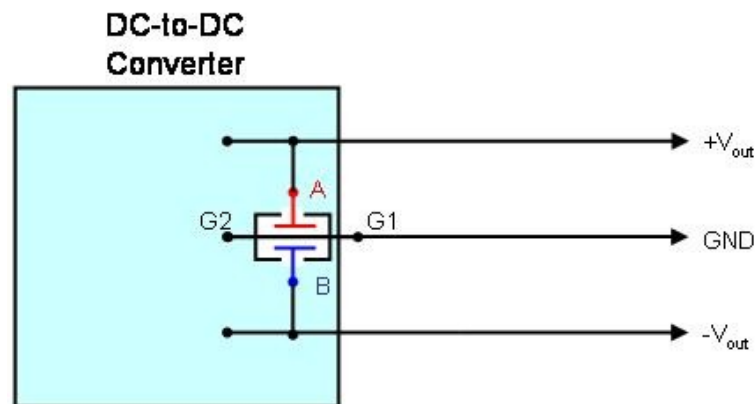


Figure 5. Designing with an X2Y® component using CIRCUIT 1 in the converter package would be the ideal because it reduces parasitics.

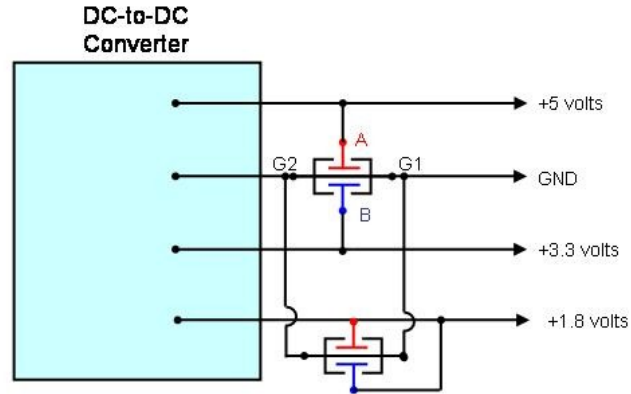


Figure 6. Design using X2Y® components in a CIRCUIT 1 and CIRCUIT 2 configurations.

Conclusion

X2Y® components offer a cost-effective solution for the broadband filtering requirements need for today's DC-to-DC converters with minimal design changes. In addition, using X2Y® components reduce the number of discrete components saving valuable PCB space.

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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