DC Motor Design with X2Y® Example B

Summary

This application note is the third in a series that deal with DC motor design. The first application note (Application Note #4001 - DC Motor Design with X2Y® Technology) provided 4 principles to follow when designing for EMC compliance. The purpose of this third application note is to show how to specifically apply those 4 principles to a design to improve EMI suppression.

Previously published work[1,2] has shown that X2Y® components offer superior performance as cost effective EMI suppression for DC washer pump motors (Figure 1). The purpose of this application note is to produce a retrofit production capable prototype end cap utilizing the X2Y® Technology.

Figure 1. *DC washer pump motor*.

End-Cap Design

The first step in the prototype end-cap design is to make a PCB the diameter of the motor housing (approximately 1 inch). The layout of the PCB consists of three regions, positive and negative power and motor housing reference (Figure 2). Next, slots are carved into the PCB to receive pins that connect the PCB to the DC motor and power supply.

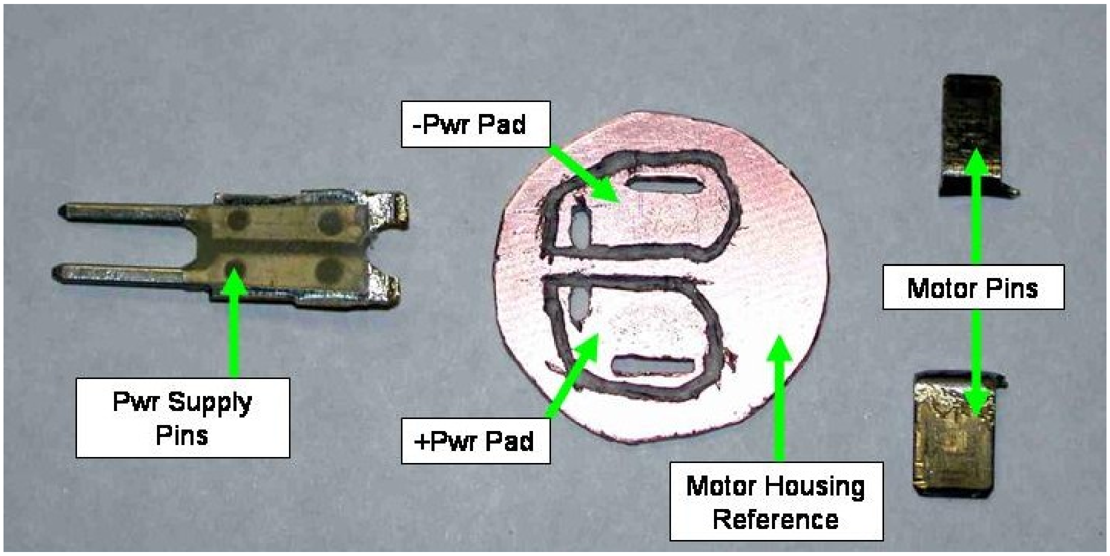
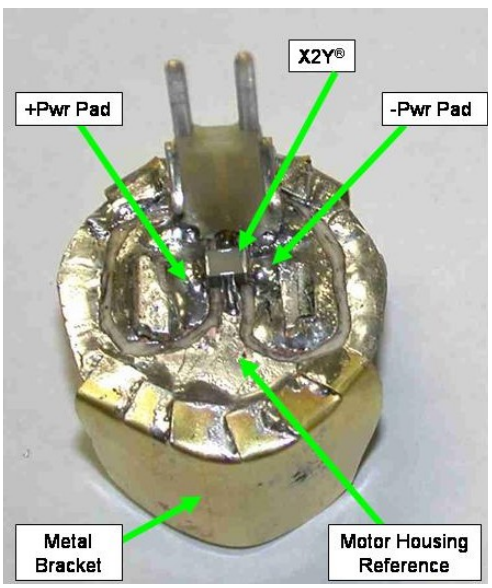


Figure 2. *End-cap PCB layout with connector pins*.

Once the pins are soldered to the PCB, brackets are then soldered to the motor housing reference region of the PCB. The brackets make contact with the motor housing completing the electrical circuit. The last step in the end-cap construction is to solder an X2Y® component to the PCB. The A and B nodes are attached to the positive and negative power supply respectively, and G1 and G2 are attached to the motor housing reference. The prototype in Figure 3 has a 1410 400nf X2Y®.



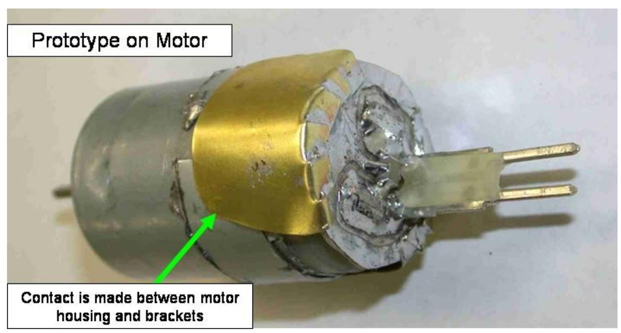


Figure 3. *X2Y® end-cap prototype*.

Radiated Emissions Results

To test the performance of the prototype end-cap, radiated emissions were measured in a GTem Cell with a spectrum analyzer from 100KHz – 1GHz. Measurements were recorded with three max-hold data runs in order to show worst case results.

For comparison, two different production end-caps were also measured. Motor #1 used 2 inductors and 2 standard capacitors and Motor #2 used a single x-capacitor (Figure 4).

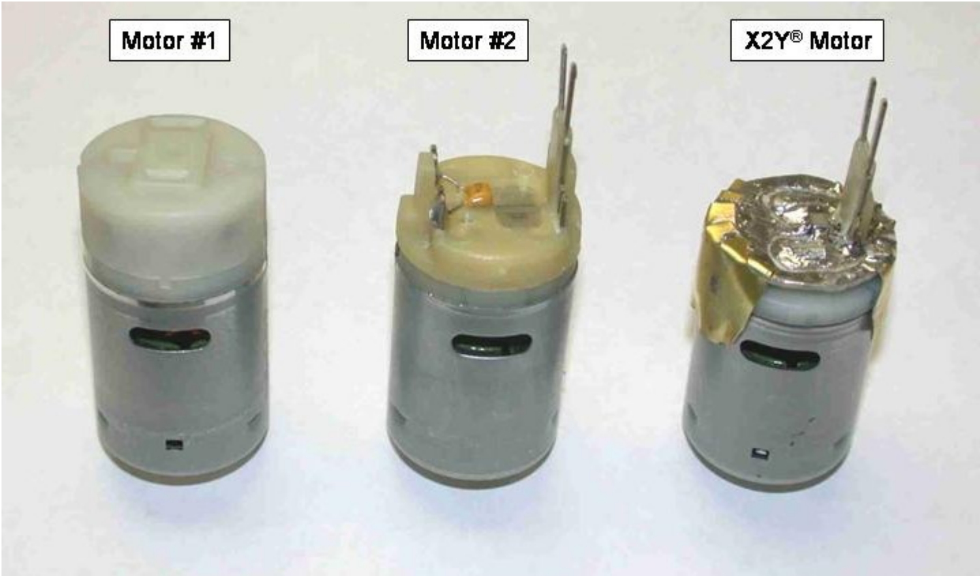


Figure 4. *3 different end-caps used to provide EMI suppression*.

Figure 5 is the measured radiated emissions. The X2Y® Motor had superior performance across the entire band, particularly at higher frequencies.

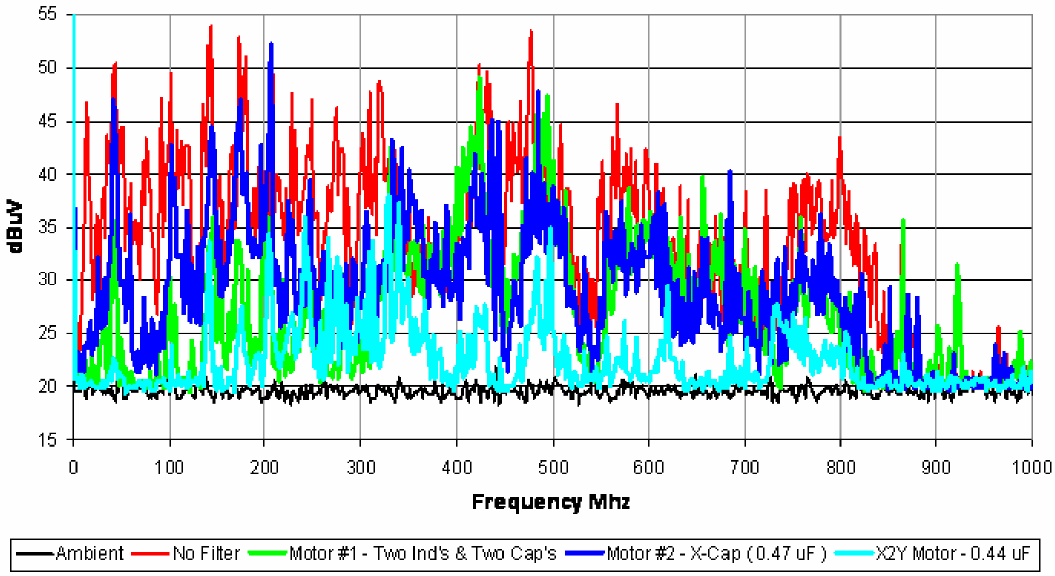


Figure 5. *Results of measured radiated emissions using 3 different types of filtering end-caps*.

If more EMI suppression is needed, a slight modification to the motor housing can produce significant reduction in emissions. Figure 6 shows two motors with the same armature in different motor housings. The only difference in the housings is a hole located near the brushes. (For a more detailed discussion on the impact holes have on radiated emissions see [Application Note #4001 - DC Motor Design with X2Y® Technology](#).) The X2Y® end-cap was placed on both motors and again radiated emissions were measured. Results are shown in Figure 7.

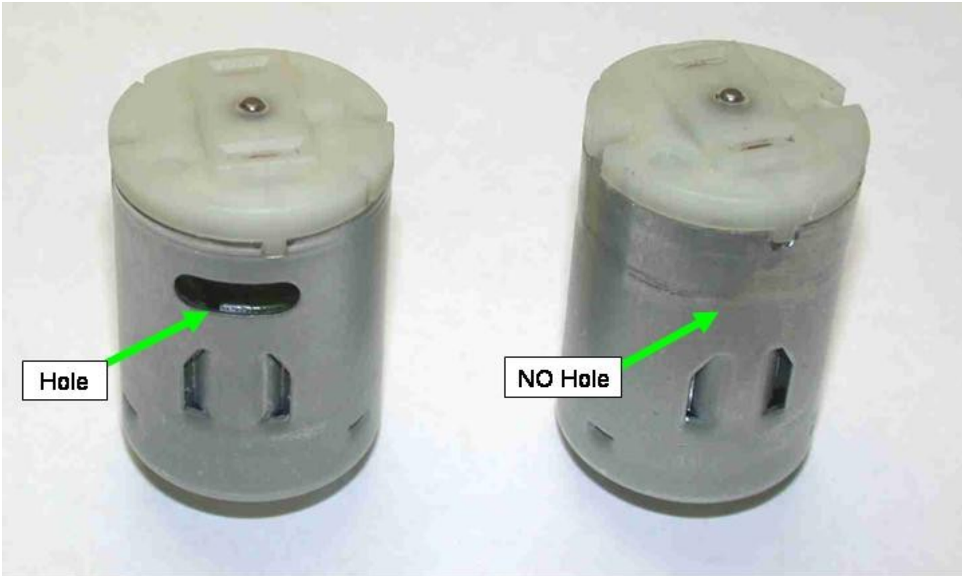


Figure 6. *Enclosing holes on a motor housing helps to lower radiated emissions.*

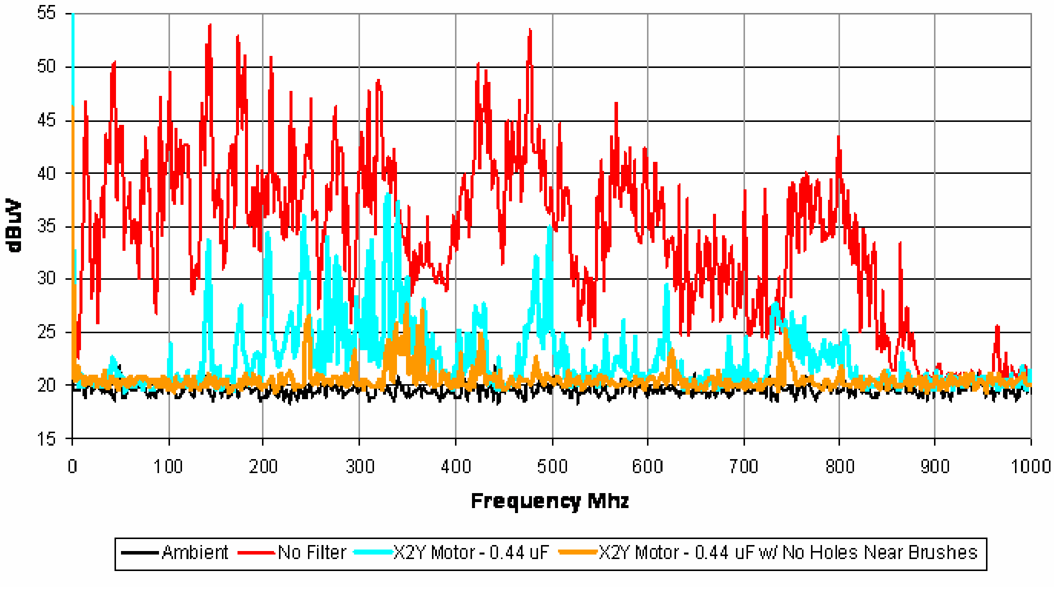


Figure 7. *DC motor housing with and without a hole using the X2Y® end-cap prototype.*

Conclusion

This application note demonstrated a DC motor end-cap prototype that provided superior performance over standard production end-caps. The prototype was specifically designed to provide a retrofit and be simple enough to provide a cost-effective solution for mass production.

Note: The PCB designed in this application note was for only an X2Y® component. Modifications to the PCB can include other electronic features and components.

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.

References

[1] Muccioli, James P., Anthony A. Anthony, William M. Anthony, Douglas S. Walz. "Broadband Testing of Low Cost Filter Solutions for DC Motors". Presented at the Electrical Manufacturing & Coil Winding Association Expo 2000. Cincinnati, OH, Nov. 1, 2000. http://www.jastech-emc.com/emcpapers.htm.

[2] Muccioli, James P., Anthony A. Anthony, William M. Anthony, Douglas S. Walz. "Broadband KuTEM Omni-Cell Testing of Small DC Motors for a Low Cost Filter Solution". 2000 IEEE International Symposium on Electromagnetic Compatibility. Washington, DC, August 21-25, 2000. http://www.jastech-emc.com/emcpapers.htm.

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