

Low Cost Method for Comparison of Radiated Emissions Using a Toolbox.

Introduction

A low cost method for comparisons of measured radiated emissions from small DC motors is demonstrated using a standard toolbox. The toolbox needs only minor modifications for effective use. Quick feedback is useful to the filter designer as changes to either filter placement and or the motor housing are made.

The Toolbox

A standard Craftsman® toolbox is purchased for this demonstration. Although other toolboxes could be used, the edges of this box were especially conducive to a good EMI seal with little effort. The first adaptation was removal of the paint from the edges of the box with a small grinder. This provides a good conductive seal to contain high frequency radiation. Next, conductive copper/nickel tape was used on the same edges to provide an even tighter seal, which provided a quiet ambient noise floor.

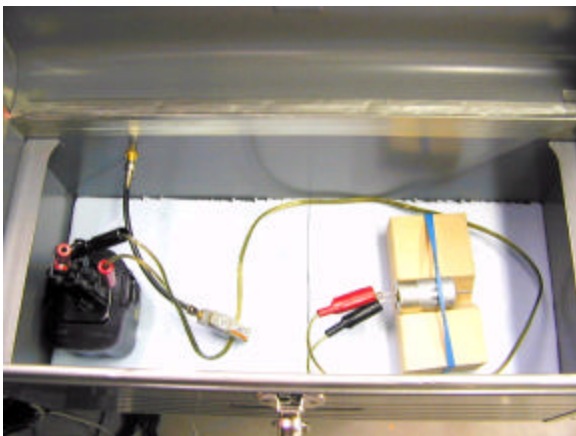


Fig 1. A standard toolbox with modifications.

Additionally, the edges of the box were bent out slightly so that the edges came together with friction when the lid was closed.

Fixturing was then added to the toolbox including; an SMA bulkhead connector at the back of the box, a six inch double shielded SMA cable and 3/4" Styrofoam board material. The Styrofoam, purchased from a local hardware

store, was used to isolate the DUT from the metal bottom of the box. A 12V battery powered the motor with a three-foot wire harness. Test emissions measurements were taken with a Fischer¹ probe on either one lead, or on both leads simultaneously.



Fig 2. Jim Muccioli, quest speaker at the 2001 EMC Fest in Detroit demonstrates the full test setup.

DC Motors

Small DC motors used in automotive applications are noisy from an EMI standpoint. In the past, very minimal filtering was required and little consideration was paid to the design of the motor case from an EMI standpoint.



Fig 3. 12V DC Motor used for comparisons.

Today however, EMC standards within the Automotive Industry continue to tighten as electronics devices used in the motor vehicle compartment increase in density. Broadband filtering is required to protect the various electrical components in a vehicle and standards requiring suppression beyond 1 GHz are now required by some automobile manufacturers. A small 12V DC windshield washer pump motor is used for this demonstration. This type of motor can reach

30,000 rpm's and is considered very noisy. Emissions measurements in the toolbox on an unfiltered motor confirm this.

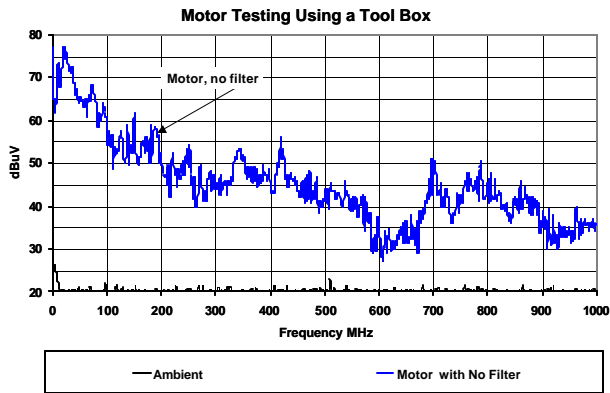


Fig 4. Measurements of an unfiltered 12V DC Motor

Quieting The Motor

Various methods to quiet the motor were used and measured in the toolbox for comparison. In this demonstration, the motor manufacturer had established a filter solution using seven filter devices, including ferrites inductors and standard capacitors. Shielding with conductive copper/nickel tape was also added to the plastic end cap to prevent coupling around the filter. This solution was then base lined in the toolbox.

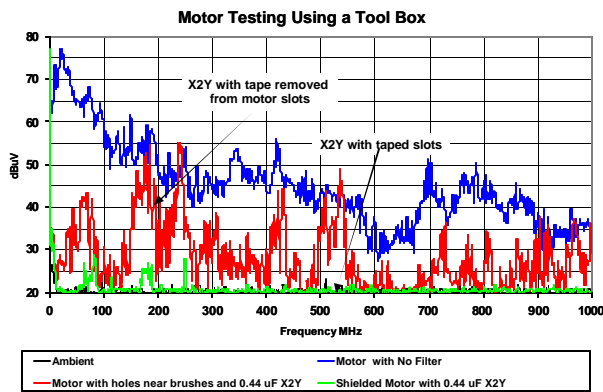


Fig 5. Manufacturer's solution base lined.

Two additional solutions were tried using a single component filter called X2Y®². Although all the motors tested used the same shielding tape layout for the plastic end cap and motor housing, the second X2Y solution removed the shielding tape covering the open slots in the motor case. This highlighted the fact that open slots can radiate fields like an antenna at specific frequencies, especially when the slots are near the noise source.

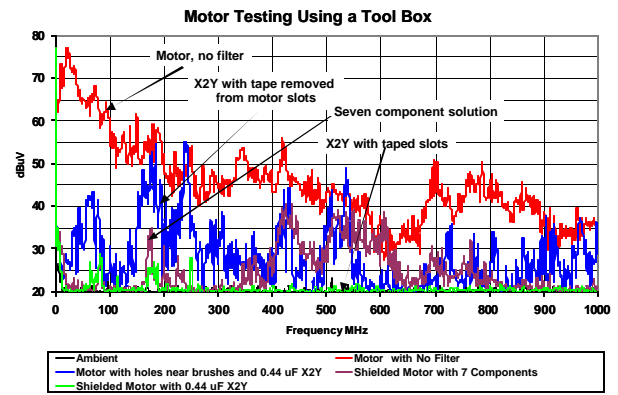


Fig 6. All variations are measured and compared

Conclusion

The modified toolbox provided adequate feedback to the design engineer during the prototype stages of filter development. Even small variations in the solutions such as removing the shielding tape from the open slots in the motor housing showed up clearly when measured in the toolbox environment. This method provides a quick, inexpensive and portable way to check changes during the development process, prior to testing in a more elaborate test environment.

Negatives to this methodology can be resonance's that could develop in the toolbox or inadequate seal at the box edges. To more fully mitigate these issues, a test chamber as described in an earlier paper³ should be utilized.

These and other motor filter techniques can be accessed at www.jastech-emc.com.

End Notes

¹ Fisher Communications, Probe: FCC F-36-4 100KHz to 1000MHz, www.fischercc.com

² X2Y® Patented Circuit Architecture, www.x2y.com

³ "Broadband KuTEM Omni Cell Testing of Small DC Motors for a Low Cost Filter Solution", James P. Muccioli, Anthony A. Anthony, William M. Anthony, Douglas S. Walz. Presented at the 2000 IEEE EMC Symposium, Washington, DC

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