Active Surface Actuator RFI Problems

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Introduction

After selecting the motor we would use to drive the actuators, we had a quick look at the RFI generated by the motors. From what we saw, it looked like capacitors to ground and ferrite beads on each motor lead should suppress the RFI to an acceptable level. Unfortunately, after we received the actuators and checked them out in the field the RFI was at an unacceptable level. Figure 1 shows a baseline noise level and the noise level with 9 actuators running. We found that by grounding the shields in the actuator cable at the connector end the RFI could be reduced but not eliminated, see figure 2.

The test setup consisted of a log periodic antenna, 50 feet from the actuators, 50 feet of RG-214, an amplifier with 30 db gain and a spectrum analyzer.

RFI Filtering

Since we were still able to see the motors with the shields grounded it was necessary to investigate more filtering. The approach investigated, was to install an additional barrier inside the motor can, to shield the connector to the outside world from the RFI generated by the motor.

To be able to see the RFI generated by the motor, I used the setup as shown in figure 3. Using this setup I tried many different combinations of filters. After extensive testing, respectable results could be obtained with a simple feed-thru capacitor. It seemed that the addition of chokes or toroids to the filter didn’t improve the filter enough to justify the cost.

By this time I had enough confidence in the filtering system as shown in figure 4 to do some tests in the field. For the following tests we had two actuators running and had the antenna 25 feet from the actuators. The first test was a repeat of the test described above. Figure 5 was with shields not grounded at the connector and figure 6 was with the shields grounded. As you can see the RFI is still evident with the shields grounded at the connector. The next set of tests was with the RFI filter as shown in figure 4 installed. We tried both cases, shields not grounded (figure 7) and shields grounded (figure 8) and in either case we weren’t able to see the RFI.

The last step in the RFI problem was to find a way the filters could be installed easily. Using wire braid and filter plates worked but would be time consuming to implement on 2400 actuators. With the help of Dave Seaman another can was found that could be installed inside the outside can. This arrangement is shown in figure 9. While evaluating the can I also tried different methods of sealing the inside can to the outside can. I found that using a mesh gasket between the cans didn’t offer any significant improvement. But, when we install the inner can it is important that the nut holding the can be as tight as possible. It probably would be good to use a large washer to distribute the pressure over a larger area on the inner can. Using the setup as shown in figure 3 we got some favorable results with the new filter system. Looking at figures 10 and 11 you can see the comparison between a filtered and unfiltered motor. To see a comparison between the background noise and the motor noise see figures 12 and 13. Although we can still see the motor in the lab setup (figure 3), I feel that with the present motor can this is the best we can do.
To do any better would require two stages of filtering.

**Conclusions**

With filtering and grounding the shields of the twisted pairs at the connectors we will reduce the RFI as much as is possible with our present arrangement of the actuators. The installation of the filters will take some time, rough guess of 15 to 20 minutes for each actuator. The best guess cost is listed below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Inside can with punched holes (3) guess $3</td>
<td>$7,275</td>
</tr>
<tr>
<td>Feed-thru capacitors, quote $0.65</td>
<td>$3,250</td>
</tr>
<tr>
<td>Push on terminals, .39 &amp; .36 each</td>
<td>$1,875</td>
</tr>
<tr>
<td>Hookup wire</td>
<td>$500</td>
</tr>
<tr>
<td>Hardware, 4-40 cap screw etc.</td>
<td>$945</td>
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</tbody>
</table>

**TOTAL**  
$13,845

The only quote I had was the feed-thru capacitors all others are a good guess and we might be able to get better prices.

One other thought on the RFI problem is that maybe the retro-fitted motors (brush problem) won’t be as bad as the ones we have been testing. But, relying on the motors RFI improving would be tempting fate.
Figure 3

4 turns of wire went in the end, pair going to motor.
1455 EDT, 15 Oct 92 ACTUATOR MOTOR RFI TEST AT 85-1 (2 MOTORS)

PEAK HOLD 1 MIN. EACH TRACE
ANTENNA 25' FROM MOTORS
CABLE SHIELD NOT GROUNDED AT MOTORS

Fig 5
-30 dB, 1415 EDT, 15 Oct 92. Actuator motor RFI test at 85-1 (2 motors)

-240 kHz

PEAK HOLD 1 MIN. EACH TRACE

Antenna 25' from motors.
Motor cable shield grounded at motor both ends.

Fig 6
-30 dBm 290 MHz

1530 EDT 15 Oct 92 ACTUATOR MOTOR RFI TEST AT 85-1 (2 MOTORS)

PEAK HOLD 1 MIN. EACH PLACE
ANTENNA 25' FROM MOTORS
CABLE SHIELD NOT GROUNDED AT MOTORS
FILTER IN

Fig 7