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VSD Output Filters Reduce Conducted EMI

The effectiveness of an “output filter” to reduce radiation off of the motor leads from a Variable Speed Drive and thereby reduce EMI on the powerline is examined. A ground plane was built in the laboratory by attaching a sheet of .032 inch aluminum to a 2 foot wide by 6 foot high by ¾ inch thick plywood panel. This ground plane was used to create an ideal situation where all components are connected to a common ground point and maximum bonding to the ground surface results in the lowest impedance RF ground possible. A 480 VAC 10 HP adjustable speed motor drive was mounted on this ground plane with input power connected via ½ inch solid metal conduit. The drive’s output was connected to a 7.5 HP motor via 20 feet of wire bundled together. The motor was attached to an eddy-current brake and loaded to a steady 8 Amps. Figure # 1 shows the conducted EMI present on the powerline without any EMI filters. The limit line in the graph is the CISPR 14 Class B limit.

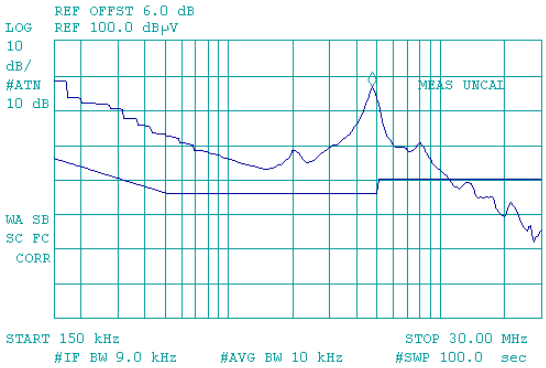

Fig. # 1 480 VAC 8 Amp. Load No Filter

A “HT20” powerline EMI filter was installed on the ground plane directly beneath the drive where the drive’s input terminals are located. The input wiring was now feeding the HT20 filter and the filter’s output was connected to the drive’s input terminals. A single 12 AWG wire was used to connect the drive’s ground terminal to the ground terminal on the filter’s load side. The effect of this combination is shown in Fig. #2.

In an attempt to improve the RF grounding between the filter and ASD, the ground wire was replaced with ½ inch wide braid. This change made a substantial improvement of approximately 10 dB. in the 200 kHz. to 7 MHz. frequency range as shown in Fig. # 3. Although the ASD was mounted directly on the ground plane, the changes noted from Fig. # 2 to Fig. # 3 indicate that internal grounding within the drive is not necessarily optimum from a RF standpoint.

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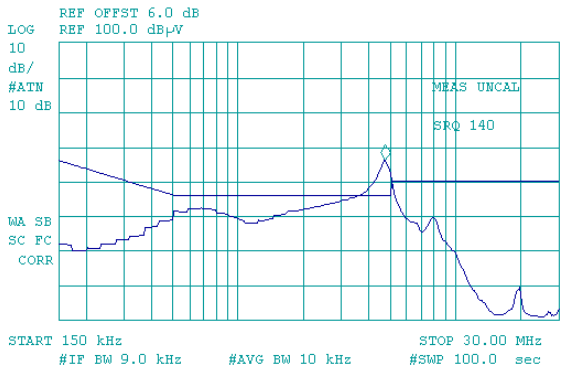

Fig. # 2 HT20 Filter with a Wire Ground

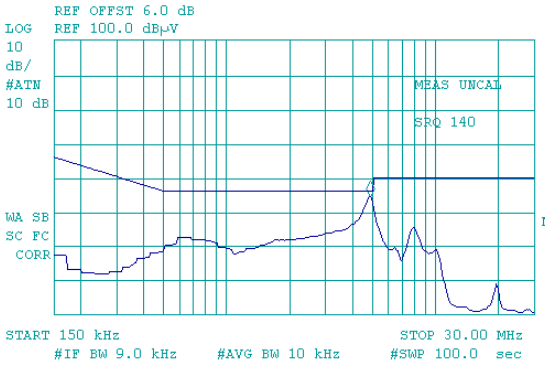

Fig. # 3 HT20 Filter with a Braided Ground

A “VHL25” output filter was now mounted next to the input filter, both filters located beneath the ASD on the ground plane. The wires from the output filter to the motor were routed to maintain separation from the powerline wires. Fig. # 4 indicates that emissions from 400 kHz. to 9 Mhz. were reduced, but emissions actually increased in the 150 kHz. to 300 kHz. range. This is a typical result due to the increase in RF ground currents being directed back to the ASD.

Since the existing setup is not a practical installation because of the exposed wiring and terminals, the filters were re-mounted into an enclosure which was mounted directly beneath the ASD. A Hoffman type enclosure was mounted directly beneath the the motor drive and two short conduit stubs were used to connect the enclosure to the drive housing. The input filter and the output filter were both mounted to the sub-chassis along with a vertical metal plate was ran the length of the sub-chassis. This plate divided the enclosure into two sections, isolating both the two filters and their associated wiring, from each other. Power from the mains entered through conduit at the bottom left side, connected to the input filter’s line terminals, ran from the filter’s load terminals output through one conduit stub, and ended at the drive’s input terminals. Output wires from the drive ran through the other conduit stub, connected to the output filter’s drive terminals, ran from the filter’s motor terminals, and exited the lower right side of the enclosure.

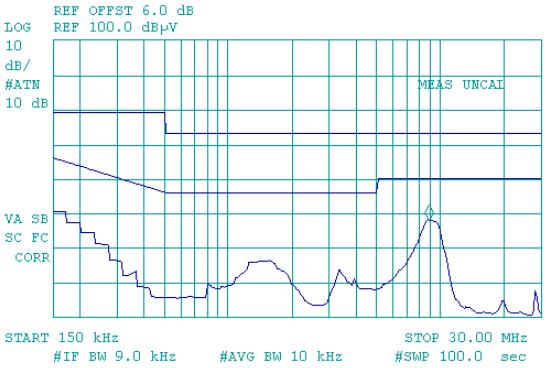

Fig. # 4 HT20 Input Filter &
VHL25 Output Filter at Drive

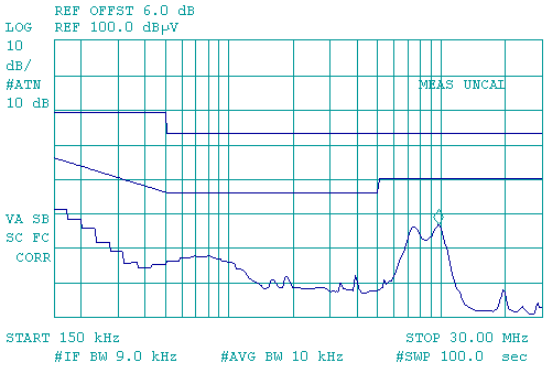

Fig. # 5 Both HT20 Input Filter &
VHL25 Output Filter in Box

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Fig. # 5 shows that although there was some minor shifting of the emission spectrum with the filter combination mounted in the enclosure, an adequate RF ground was obtained by using conduit stubs to connect between the motor drive and Hoffman enclosure.

The tests using a HT20 two stage EMI filter and shown in Fig. # 3 and Fig. # 5 were repeated with a HL20 single stage EMI filter. The test results shown in Fig. # 6 and # 7 were similar with somewhat more noise present in the low frequencies due to the lower attenuation obtained from a single stage filter.

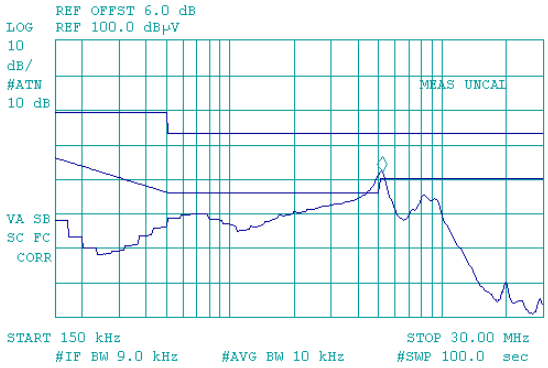

Fig. # 6 HL20 Filter with a Braided Ground

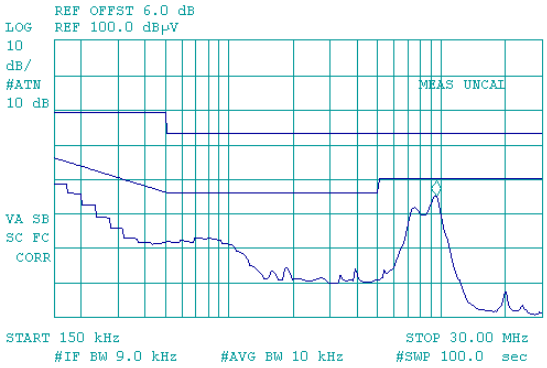

Fig. # 7 Both HL20 Filter & VHL25 Output Filter in Box

Summarizing key points:

1.) The addition of an output filter at the output terminals of an ASD will reduce the amount of radiation emitted off of the leads to the motor. This reduction can be seen as a reduction of the EMI present on the powerline.
2.) The output filter will increase the EMI ground currents and can increase the EMI levels present in the low frequency 150 kHz. to 500 kHz. range. This will often necessitate a change to a higher attenuation input filter, to maintain compliance with the conducted EMI specification. If a single stage “L” section filter was used before the addition of the output filter, now a two stage “T” section filter may be required.
3.) Using short length solid metal conduit to connect the drive to the enclosure for the filters can provide a near optimum RF ground path for the reduction of EMI.

Emission Control, Ltd. is dedicated to providing “EMC Solutions for Conducted EMI”. Since 1984, we have been focused on the design and manufacturing of the highest quality and most effective line of EMI filters available. We have no other objectives.

If you have a special product or application, which requires EMI filtering; we can supply our experience and expertise early in your planning, so as to achieve the most efficient and cost effective filter solution. Our in-house test facilities are available to guarantee your product will meet the applicable emission standards. We maintain a complete quality control system from design, through all phases of production, and to final delivery. We remain committed to our goal of providing a defect free product on which you can depend.

Whether you require a standard catalog filter, a modified standard, a full custom designed unit, or a short delivery cycle; we are determined to provide the individual level of service needed to meet your satisfaction.