POWER ELECTRONICS TECHNOLOGY
FOR ENGINEERS, DESIGNERS AND INTEGRATORS

Filter Components Cut Emissions and Output Noise

By David Ahronowitz, Century Electronics, Westlake Village Calif.

A new power supply design uses a combination of chassis capacitors, non-inductive snubber resistors and an inductor to achieve 500mVp-p and 35 dB reductions in output noise and radiated emissions, respectively.

Acting as unintended transmitting antennae, the main sources of radiation emissions from power supplies are the output cables. The radiated emissions from these cables are directly related to the power supply's conducted output noise. We tested this theory, showing that reducing this power supply output noise reduces the entire power supply's radiated emissions.

The unit used in this test is an ac-dc power supply used in airborne applications with full bridge topology, 25Vdc at 20A output, and a 115V, 400 Hz, 3-phase, "Y" input. **Fig. 1** shows the final power supply schematic with the input and output filter components added to suppress noise and radiation.

To show the process employed to "clean up" the power supply, we first looked at noise output and radiated emission before making modifications. Then, we added components and reviewed the noise and radiated emission at each step.

Fast switching current transitions are the source of the output noise in a switching power supply. Adding shielding around a power supply and the connecting wires usually satisfies radiation emissions, according to MIL-STD-461, RE102 requirements. **Fig. 2** shows the power supply output ripple and noise without additional filter components. **Fig. 3** shows the power supply output noise reading with the additional input/output chassis capacitors C1-9 shown in **Fig. 1**. **Fig. 4** shows the power supply radiated emission in accordance with MIL-STD-461, RE102—without additional filter components.

The differential measured output noise is mainly common-mode noise. You can use chassis capacitors to filter the output common-mode noise.

Fig. 5 shows the power supply radiated emission, RE102, with additional input/output chassis capacitors C1-9. As seen from these readings, the output noise and radiation levels dropped significantly (465mVp-p and 20dB).

A non-inductive wire-wound resistor used in an RC output rectifier snubber can reduce the turn-off spike affectivity. **Fig. 6** shows the power supply radiated emission, RE102, with additional input/output capacitors C1-9 and non-inductive snubber resistors R1 and R2. These results show 10mVp-p and 6dB noise reduction compared with those observed in **Fig. 3** and **5**.

A common-mode inductor together with the chassis capacitors form a good output filter and provide a return path for the common-mode noise. Looking at **Fig. 7**, you'll see the power supply radiated emission, RE102, with additional input/output capacitors C1-9, non-inductive snubber resistors R1 and R2 and common-mode output inductor L1.

Fig. 8 shows the power supply output noise with additional input/output chassis capacitors C1-9 and non-inductive snubber resistors R1 and R2.

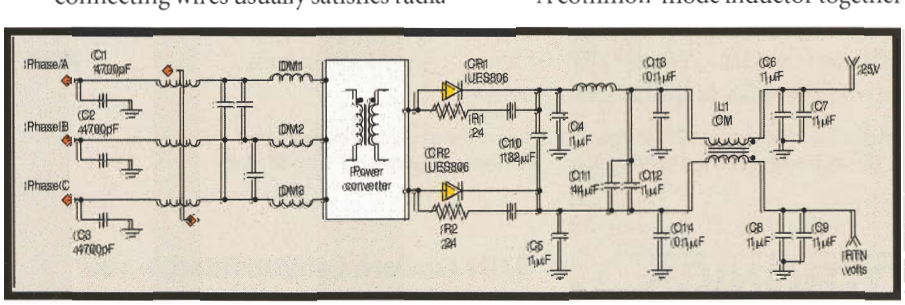

Fig. 1. *Final power supply schematic after modifications.*

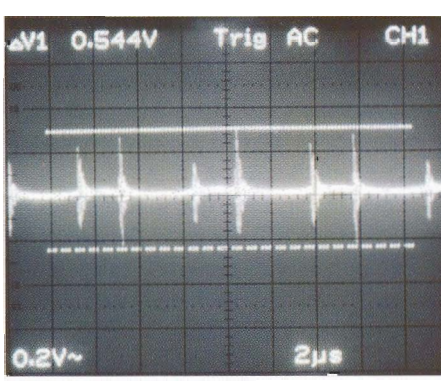

Fig. 2. *Power supply output ripple and noise without additional filter components.*

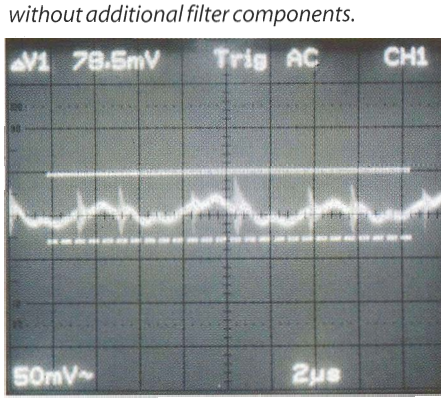

Fig. 3. *Power supply output noise with additional input/output chassis capacitors C1-9 shown in Fig. 1.*

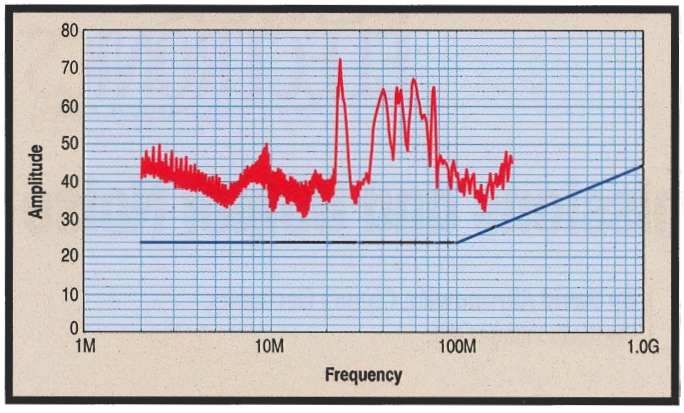

Fig. 4. *Power supply radiated emission without additional filter components.*

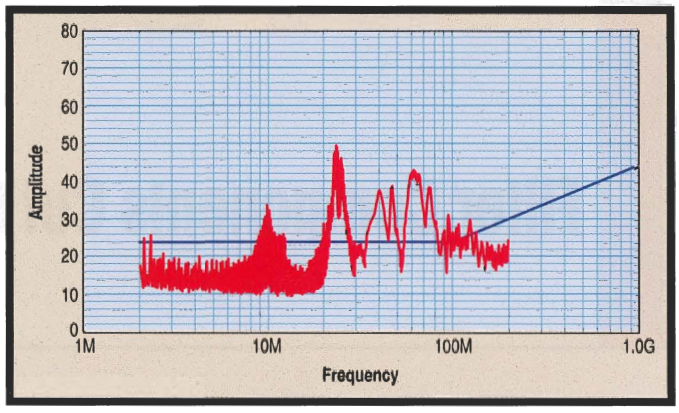

Fig. 5. *Power supply radiated emission with additional input/output chassis capacitors C1-9.*

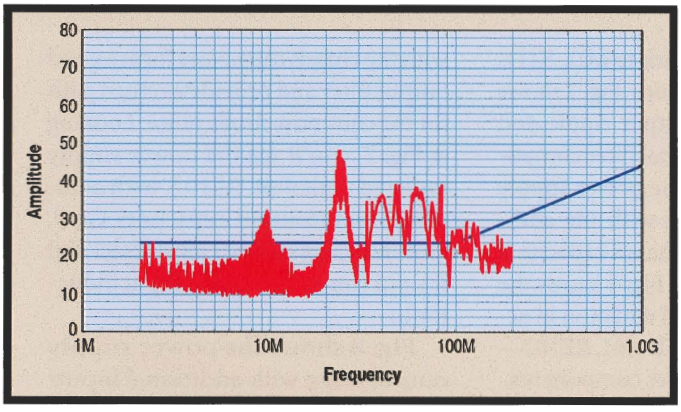

Fig. 6. *Power supply radiated emission with additional input/output capacitors C1-9 and non-inductive snubber resistors R1 and R2.*

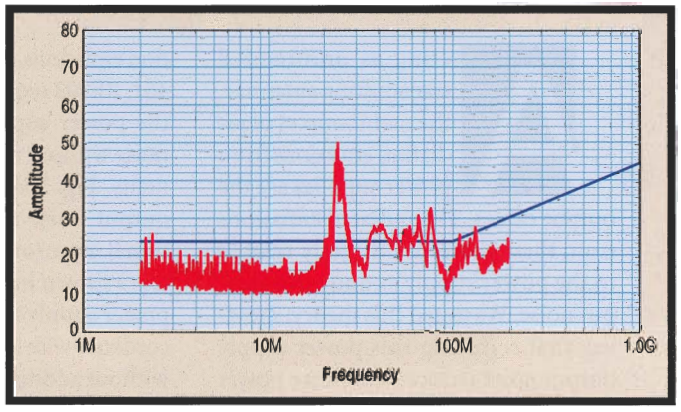

Fig. 7. *Power supply radiated emission with additional input/output capacitors C1-9, non-inductive snubber resistors R1 and R2 and common-mode output inductor L1.*

Fig. 9 shows the power supply output noise with additional input/output chassis capacitors C1-9, non-inductive snubber resistors R1 and R2 and common-mode output inductor L1.

These results show that in combination, these three modifications to the circuit reduce output noise by about 500mVp-p, and in the process reduce radiated emissions by about 35 dB at 50 MHz.

During the power supply development, even if the power supply meets the output noise specification requirements, it's important to further reduce the power supply output noise. As we have seen, a power supply with low output noise will help the system meet the radiation emission requirements during the system qualification without the need for additional shielding around the power supply or the connecting cables.

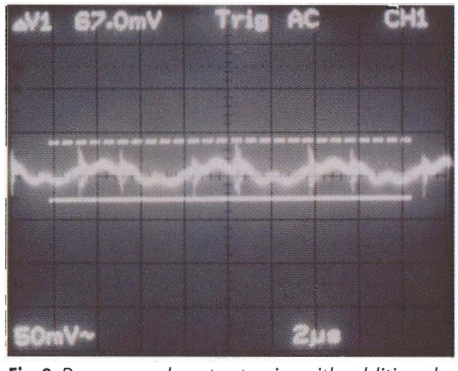

Fig. 8. *Power supply output noise with additional input/output chassis capacitors C1-9 and non-inductive snubber resistors R1 and R2.*

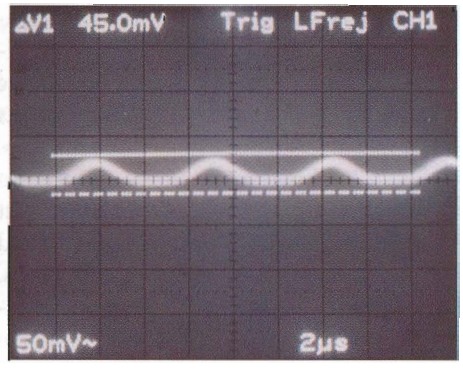

Fig. 9. *Power supply output noise with additional input/output chassis capacitors C1-9, non-inductive snubber resistors R1 and R2 and common-mode output inductor L1.*

This unshielded power supply didn't fully meet the MIL-STD-461, RE102 limits, when initially installed. However, the final system did meet the radiation emissions requirements after making the filtering modifications. **PETech**