Alachua County Jan 2025 LabNLunch: Mitigating DC Inverter Noise

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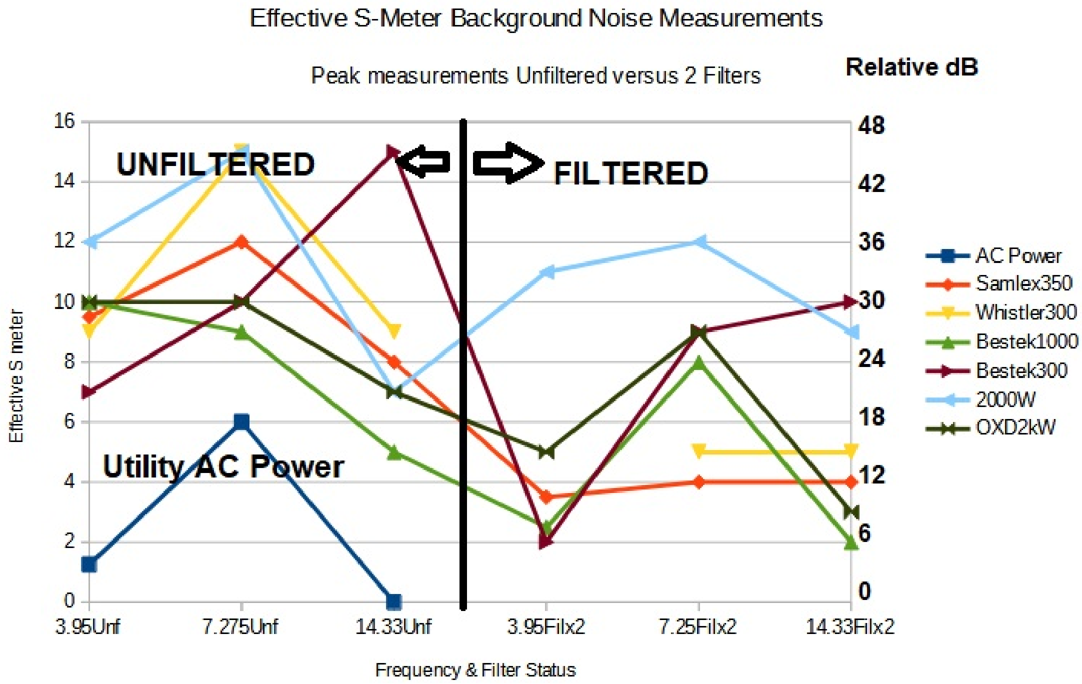
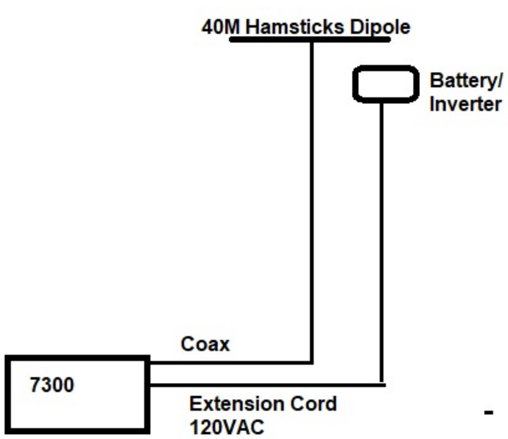


Our group is often confronted with the need to operate standard laptop computers for many hours, alongside HF transceivers. Many laptops require voltages in the 18-20VDC range, and DC-to-DC converters can be problematic for producing radio frequency interference. Also there is the concern of damaging expensive laptops with an incorrect voltage. Often it is simpler to use the manufacturer-supplied laptop charger, and simply provide it with 120VAC. Many of these chargers are in fact their own switching power supply, with an input DC power supply stage, and thus can function well even with a modified-sine wave "AC" input. Having 120VAC available also has many advantages in a disaster environment.

The problem remains that many DC inverters also produce quite significant radio frequency interference by themselves. Our group has produced several versions of common- and differential-mode filter systems to mitigate inverter-produced RFI. The January 11, 2025 Alachua County LabNLunch made measurements of baseline RFI from multiple volunteer-owned DC inverters, and measurements after adding mitigating filters.



MEASUREMENT SYSTEM

We set up a measurement system **designed expressly to emphasize noise from the inverters**. A compromise antenna of two 40-meter "ham stick" type elements connected to make a dipole was set at about 8 feet outside the front door and porch. Only about 10 feet from this compromised antenna, battery and inverter systems were placed (so the antenna could easily pick up radiated noise). Further, both coaxial cable and 120VAC extension cord spanned about 50 feet from the front of the house back to a table with the ICOM 7300 measurement radio, near each other. A coaxial RF common mode filter at the transceiver was bypassed to further increase sensitivity to common mode currents in the extension cord, which was used to power the 7300 for inverter tests. **This is obviously a truly worst-case situation, designed to make inverter noise quite visible and allow us to work at mitigating it!**

Getting objective readings requires some effort. The S-meter scale on the ICOM 7300 is known to approximate 3 dB per S-unit. (See: https://geekblog.febo.com/?p=378) However, the dB markings above S9 are roughly correct. Those dB markings were converted to equivalent "Icom S-meter readings" and relative dB values are also indicated in the graph of the measurements.

Preamp #2 was used for all measurements, to increase sensitivity. For each measurement, an LDG auto-tuner was used to maximize impedance matching (with proper identification). A baseline was first taken with the system powered by utility AC through an MFJ 4230 switching power supply. The baseline is shown in the lower left portion of the measurement graphs in dark blue.

The obvious "peaks" in the 7 MHz reading compared to the other bands may likely result from the compromise antenna being originally manufactured expressly for this band. The S6 reading for noise on AC utility power is typical in my home situation for that band. The 3.5 MHz readings are quite low and probably result from the poor antenna performance at that band. However, the same antenna was used for all tests, and optimally tuned for each test.

As detailed above, the physical setup was designed to make inverter noise prominent. Our group was properly surprised after making the baseline measurements with the 7300 powered from a battery and then using utility AC to the MFJ power supply. **Powering from one of the DC inverters made a horribly obvious increase in noise! Everyone was quite impressed.**

For each type of inverter tested, measurements were first made without any filters, and then with two filters on the AC output of the filter:

(1) Right at the AC output of the inverter under test out on the porch, a CW4L2-20A T EMI Filter rated at 20Amps AC, available at https://www.amazon.com/dp/B09NND96FQ. This utility filter appears to be similar to https://www.reelenelectric.com/product/20A-Single-Phase-Double-Pole-Guide-Rail-Type-EMI-Filter.html, with a published common- and differential mode specification of 60 to 80 dB reduction in common- or differential-mode noise in the 1-20 MHz range-- but those measurements are made in a laboratory 50-ohm environment.

(2) At the end of the extension cord by the radio and DC power supply, a simple common mode filter of 9 turns of extension cord around a FT-240-43 ferrite was used for all tests, after initial tests with the Samlex 350 inverter showed the addition of the 2nd filter reduced noise by approximately 10 dB at 3.5 and 7 MHz. We built these filters in a 2020 LabNLunc (https://www.nf4rc.club/how-to-docs/lab-n-lunch-projects/common-mode-ac-line-choke/) (Additionally, only for the Samlex 350, the measurement also included a five-turn wrap of the DC inverter input wiring around an FT-240-43 core; this was judged too difficult for most other inverters due to physical wiring issues and lack of time.)

CONCLUSIONS

The results some clear conclusions and some inverter winners as well. **Using two filters on the AC line was a clear winner over simply one at the inverter output.** Adding common mode filtering on the inverter inputs was difficult to impossible on some of the filters due to their size of wire and lengths available. We judged it should be done if possible. The Bestek 1000 watt sine wave inverter (https://www.amazon.com/BESTEK-Inverter-Digital-Display-Charging/dp/B07XYR1BS3) had impressively reduced RFI compared to most other inverters, and the Samlex 350 (https://www.donrowe.com/Samlex-SSW-350-12A-p/ssw-350-12a.htm) also performed quite well. While we have less experience with the Samlex unit, two of our members have used the BESTEK unit and reported little problem. I would recommend either of those modestly priced inverters for groups needing emergency access to 120VAC power.