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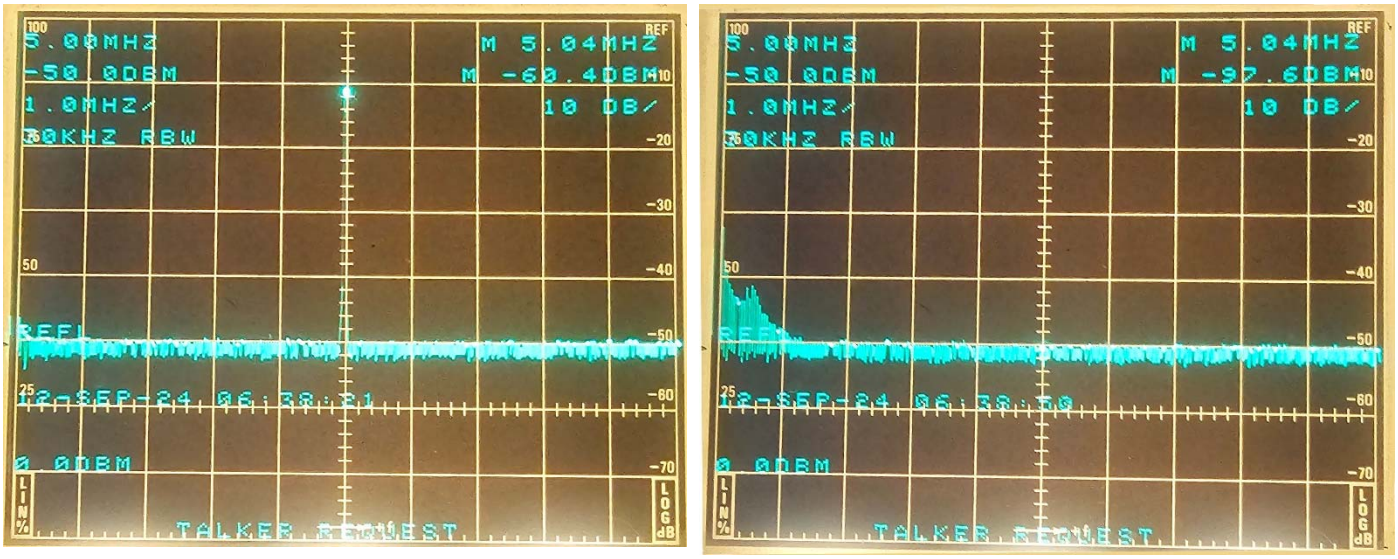
AC Power Supplies and RFI:

When powering a DC 12 V receiver from an AC line power source you may occasionally find the receive noise floor becomes contaminated with noise of various sorts which are not present when powered by a battery and isolated from the AC power system. It is a common misconception that all linear power supplies powered from the AC mains are as quiet as batteries and all switching power supplies are noisy. The truth is more complicated due to the multiple routes by which RF Interference (RFI) can be induced into a receiver, and these are:

1: Transverse or Differential-mode conduction.
This is RF ripple superimposed on the DC output which can introduce RFI into the equipment being powered. It is critical for the designer of a supply to resolve this source of noise inside the supply as it can cause radiated RFI if allowed to propagate on the DC power cord. We specifically designed the Kx33 to have extremely low RF ripple on the DC output and to date have not had any of this type of RFI reported.

Here are two spectrum analyzer images, the left one is showing our RF generator outputting a -60 dBm 5 MHz signal, the right one shows of a production Kx33 transverse RF output:



Although we guarantee less than 10 mV peak to peak from 1.8 to 30 MHz, the actual average RF output is much lower, for this particular Kx33 around 1.5 mV RMS, and that energy is concentrated below 1 MHz as the sweep shows. From 1.3 MHz to 10 MHz (sweep limit) the energy is at the noise floor of the Tektronix 2712 spectrum anayzer. These supplies do not output RF on the DC cable!

2: Common-mode currents from the antenna system.

These currents originate from antenna system imbalance and can use the coax feedline shield as an antenna counterpoise and conduct through the rig. In our experience het temporary antenna deployed in portable operations often have high common-mode currents and this is the main cause of any RFI. All AC power supplies have some degree of capacitive coupling between the AC input and DC output, and this antenna imbalance current can couple through the power supply DC cable and power supply to the AC line. Whether this coupling introduces noise depends on two main factors:

a. Balance and common-mode potential of the antenna system.

Despite what some less-informed end-fed antenna enthusiasts claim, An antenna is a two-terminal device, which means the current flowing in each conductor will be equal by definition and 180° out of phase from each other. This is the physical mechanism by which an antenna sets up the electromagnetic field it radiates. Many antenna systems have an impedance imbalance between for example, the two halves of a dipole, or between the main radiator and counterpoise as is the case with most end-fed antennas. In these cases the imbalance current flows back down the ***outside*** of the coax feedline shield turning it into an active part of the antenna system. This will affect the antenna pattern in both receive and transmit as well as allow the feedline to receive ambient noise. The rig chassis, the power supply, and AC mains are then all in a series path for these common-mode currents making them an active part of the antenna system as well.

Inserting a high impedance in this series current path will greatly reduce or eliminate the current. A common-mode choke in the antenna feedline at the antenna feedpoint is the best way to reduce or eliminate this common-mode current flow. Choking the DC power lead is a second-best solution. We strongly recommend you read the excellent reference on this subject which can be found on K9YC's site: http://audiosystemsgroup.com/RFI-Ham.pdf

b. The AC input to DC output impedance of the power supply.

All AC line powered supplies appear to RF as a capacitor between the AC line input and the DC output. This can be a path for RF energy to take if a difference in potential exists between the two. When using a linear supply the RF current will be modulated at the AC line frequency, leading to the buzz commonly heard in older single-conversion receivers. When using a switching supply the coupling can be modulated by the switching action and can cause RFI. Measurements taken of many power supplies show most linear and switching supplies offer on average >1000 pF of capacitive coupling between the AC input and DC output. At <100 pF the Kx33 greatly minimizes this coupling and the magnitude of this common-mode RFI current. This makes choking common-mode currents much easier with the Kx33 than with other power supplies as the AC input to DC output impedance is more than 10 times higher.

For cases where an antenna system may present common mode potential we include a Fair-Rite mix 31 Snap-It core with every Kx33 which can be used to make a common-mode choke. This is simply done by winding the small diameter DC output cable of the Kx33 through the provided mix 31 core 3-4 turns. This will effectively increase the common-mode impedance through the Kx33 by 800 to 1000 ohms @10 MHz, effectively minimizing this current path through the supply. If additional ferrite products are desired we offer a range of Fair-Rite Ferrite Snap-It and toroid cores at low cost to our customers at:
https://proaudioeng.com/fair-rite-ferrites/

We made the decision not to integrate a large ferrite choke inside the Kx33 itself in order to minimize size and weight. There are over 5000 Kx33s operating all over the world, and for 99% of all users, the RFI performance of the Kx33 itself will be sufficient, and if additional common-mode choking is required the additional core can be employed.

3. Radiated RFI.

This RFI can come from many sources and can be picked up by the antenna system or many other cables with poorly designed shield terminations and appear as a signal in the receiver. In a well-designed supply like the Kx33, the external fields from all internal circuitry are extremely small. We have not yet had a report of a Kx33 radiating RFI, however, in order to minimize the pickup of any radiated RFI we recommend placing the supply the full length of the DC supply cord away from the rig.

We are sure you will be happy with the Kx33 or we will refund both your initial purchase and shipping costs. There is no risk other than a small amount of your time evaluating it.

Kx33 Specifications:

Input Voltage: AC 100-130, 200-250 V, auto-switching
Input Current: 0.7 A : AC 115 V full-load,
0.3 A : AC 230 V full-load.
Input Frequency: 50 Hz ~ 60 Hz
Output Voltage @ plug (+/- 0.1V): DC 14.4 V no load,
DC 14.4 V at 0.2 A load,
DC 14.0 V at 4.0 A load.
DC 13.9 V at 5.0 A load
Output Current: 4 A maximum continuous, 5 A for 30 seconds min..
Maximum Ripple: 10 mV (30 MHz BW).
Protection: over-voltage, over-current, over-temperature, short-circuit.
MBTF: >50,000 hours.
Approvals: FCC, GS, TUV, CE, PSE, KC, SAA, CCC
Dimensions (excluding cables): 2" x 1.25" x 4.5" (50 mm x 32 mm x 114 mm)
Cable Length: AC line cord - 58" (1400 mm),
DC power cable - 78" (2000 mm)
Weight: supply: 9.3 oz. (264 g), AC cord: 3.4 oz. (96 g),
total: 12.7 oz. (360 g)
Warranty: 1 year from date of purchase.

Pro Audio Engineering reserves the right to make changes to product specifications which preserve or improve performance and do not affect suitability for the intended use powering HF communications equipment.