

AC Power Supplies and RFI

When powering a 12VDC receiver from an AC line power source you may 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 tempting to believe that all of the additional noise originates from within the power supply, but this is often not the case. It is also a common misconception that all linear power supplies powered from the AC mains are as quiet as batteries, and that all switching power supplies are noisy. The truth is more complicated and is due to the multiple routes by which RF Interference (RFI) can be induced into a receiver.

The main routes for RFI are:

1. **Transverse-mode conduction** of RF ripple superimposed on the DC power supply output 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.
2. **Common-mode coupling** of the antenna system to the AC power line through a power supply can introduce several types of RFI to sensitive receive systems. It is common-mode, since the potential exists between the AC input and DC output, not between either of the AC input or DC output conductors. The magnitude of this type of RFI depends on two main factors:
 - a. The impedance of the AC input to DC output of the power supply at the frequency of interest. All AC line powered supplies have a combination of inductive and capacitive coupling between the AC line and the DC output. This represents a path for RF energy to take if a difference in potential exists between the two. Measurements taken by PAE show linear and switching supplies to offer mainly capacitive coupling, with ~1000pF being average. At <100pF the Kx33 minimizes this coupling and the magnitude of this common-mode RFI.
 - b. The magnitude of antenna system voltage on the chassis of the rig. Well-implemented antenna systems with little imbalance and small common-mode feedline currents are less likely to cause this form of RFI. When operating with a high-impedance antenna like many end-fed long-wires, or while operating with an indoor antenna, the use of any line-operated supply can potentially induce antenna counterpoise currents to be coupled to the AC power system through the power supply. When using a linear supply the instantaneous input to output impedance will be modulated at the AC line frequency, leading to the hum commonly heard in older single-conversion receivers. In the case of a switching supply the coupling can be modulated by the dynamic impedance of the switching action and can cause RFI. Inserting a common-mode choke in the antenna feedline will reduce or eliminate the feedline current flow. An excellent reference on this subject can be found on K9YC's site:
<http://audiosystemsgroup.com/RFI-Ham.pdf>
We also offer the #33-410 Fair-Rite Ferrite Clamp-On core at our cost to help remediate the coupling:
<https://proaudioeng.com/accessories/>
Passing the DC power cable 6 to 8 turns through this core will effectively increase the common-mode impedance of the DC power cable by >3000 ohms@10MHz, effectively minimizing this source of RFI. We have had a couple of customers inquire as to why we did not integrate this ferrite into the design of the Kx33 itself. The answer is size, weight and cost, the ferrite is over 1/2 the weight, ~1/2 the size of the KX33, and would have greatly increased the cost. For 99% of all uses, the RFI performance of the Kx33 itself will be sufficient, and those users will enjoy a much smaller, lighter power supply at lower cost.
3. **Radiated RFI** from many sources can be picked up by the antenna system and appears as a signal in the receiver. In a well-designed supply like the PAE-Kx33, the external fields from the high-current PCB loop between the switching devices and transformer, as well as the fields of the transformer itself are extremely small. 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.

Out of ~1000 customers less than 1% have experienced any additional RFI caused by proper use of the Kx33. Of those that have, addition of the ferrite core has remediated the noise. We are sure you will be happy with the Kx33 or we will refund both your purchase and shipping costs, so there is no risk other than a small amount of your time evaluating it.