Technote # 120

Rev. 8/7/2022

Avoiding R.F.I. Problems in Amateur Radio Accessories

Rev.1

BRIEF:

   This brief outlines the sources of R.F. interference from wall power transformers and/or poor clock frequency choices made in small Ham radio accessories. These sources can be conducted via grounds and radiated interference. The Wavenode wattmeters are fully F.C.C. and CE compliant for type A and type B equipment. We provide analog power supplies with our meters, and have carefully chosen microprocessor and USB interface clock frequencies that will not radiate even small amounts of energy in any Amateur Radio usage bands. For weak-signal DXing, satellite, and EME usage this is quite important.

DETAILS:

   First, let's discuss wall transformers used for everything from LED lighting to other accessories.   These come in two types, either simple analog or switching type:

Simple 60 Hz transformer, rectifier diode, and smoothing capacitor. No switching occurs, but these are un-regulated outputs. Be sure your equipment can handle the unregulated output voltage.

They are for **either** 120 or 230 VAC operation, but NOT UNIVERSAL.

Switching type regulator. These are typically universal for either 100, 120 or 230 VAC operation. Higher efficiency, but do have radiated and ground-conducted R.F. emissions. They may meet F.C.C. compliance, but the plastic case will allow some switch-frequency emissions. **It is best to avoid these if possible.**

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 Now let's discuss microprocessor and USB interface clocking.   The USB interface, by definition, is a single-ended data transfer type, not differential.   Differential is almost always the preferred signaling mode for lowest emitted R.F.I. , but USB is not specified this way. This means that the USB cable shield carries the return signal current and can radiate clock harmonics. The USB full-speed clock rate is 48 MHz with a data rate of 12 MBits/sec.

   The designer needs to choose a clock rate that does not radiate energy in any frequency of interest to the Amateur Radio operator.   Wavenode meters use a single 5.99 MHz crystal to clock the processor and USB interface device (FTDI Corp. FT245BL). The FTDI USB device multiplies this 5.99 MHz clock up to 47.92 MHz. This puts any harmonic energy of the crystal oscillator outside of the Amateur radio bands, especially the 3rd harmonic of the Wavenode USB clock at 143.76 MHz.   This 3rd harmonic lies safely below the 144.0-144.3 MHz weak signal portion of the 2-meter Hamband.

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   Last, lets discuss RF radiation from the USB cable itself. As mentioned above, the USB signaling scheme is not differential and some radiation is almost unavoidable from the interfacing cable without effective common-mode chokes.   The USB cable will not only radiate, but is <u>susceptible</u> to high R.F. energy in the radio environment getting onto the USB signaling wires and upsetting the data.   This can "break" the USB data path and halt the Wavenode software, or even "hang" the PC if enough energy gets into the PC. For this reason, we supply a USB cable with large ferrite cores at each end. Three turns are provided on each core and this is very effective as a common-mode choke to prevent problems on all frequencies.   High R.F. environments may require ferrite cores on <u>all</u> PC cables, including mouse, keyboard, peripherals and AC power cord.

Wavenode supplied USB cable with 3-turn ferrite cores at each end.