XTB-ANR X10 Active Noise Reducer

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Our electrical systems have become vastly more complex since the 70's when the X10 protocol was developed. We now have to deal with all sorts of devices that load down X10 signal levels and generate electrical noise that prevents X10 modules from properly decoding commands. Many of us are using signal boosters to provide adequate signal levels, but the noise problem can be more difficult to resolve.

X10 commands are sent as a series of signal bursts coupled to the powerline. Presence of a burst signifies a logic "1", and absence a logic "0". Noise near the X10 carrier frequency can fill in those blank frames, making it impossible for a receiving module to decode the command unless it includes AGC to raise its detection threshold above the background noise level.

X10 has been adding AGC to modules and switches as they are updated, but there is still a large installed base of older X10 devices that can be blocked from decoding commands by even a low level of in-band powerline noise.

Until now, we were pretty much forced to isolate noise sources from the powerline with X10 filters. Like the XTBR and XTB-IIR do for signal levels, the XTB-ANR Active Noise Reducer provides an alternate way to deal with powerline noise.

The XTB-ANR is essentially an intelligent “super signal sucker”. While severely attenuating noise, it is constantly monitoring the powerline looking for potential X10 signals that rise above the background noise level. When such a signal is detected, it switches off the attenuator during the X10 zero-crossing transmit window. An internal jumper can be removed to also allow Insteon commands to also pass without being attenuated.

The most important feature of the XTB-ANR is its ability to attenuate even “in-band” noise. Simple passive filters like the X10 XPNR cannot do that because it would also attenuate the X10 signal. But since the XTB-ANR is capable of recognizing the unique signature of the X10 signal, it can usually discriminate between in-band powerline noise and valid X10 signals.

XTB-ANR operation

The XTB-ANR works like inverse AGC to severely attenuate powerline noise while leaving X10 (and optionally Insteon) signals relatively unaffected. Unlike a typical X10 filter, the XTB-ANR does not connect directly between the noise source and the powerline. It can be plugged into any AC receptacle to reduce the noise on that circuit.

The XTB-ANR received a significant upgrade during the summer of 2016. It now functions in a "stealth" mode, and only switches on the attenuation ,when it recognizes powerline noise that might interfere with X10 operation. The benefit is that in an installation with a lot of signal suckers attenuating both signal and powerline noise, the XTB-ANR will not add additional attenuation to already weak X10 signals unless it becomes necessary.

The LED normally glows dimly whenever the XTB-ANR is plugged in to indicate it is active and monitoring the powerline. The new firmware also includes a basic noise monitor, which periodically flashes the LED multiple times to indicate the approximate powerline noise level in 10mV increments.

Very brief flashes indicate the noise level when the attenuation is not active, and longer flashes indicate the remaining noise level with the attenuator switched on. As little as 40mV of in-band noise can prevent an X10 module without AGC from decoding commands. The LED will also flash brightly when it recognizes an X10 command, allowing the X10 or Insteon signal to pass. That gives an indication of how X10 signals are propagating though the system.

A typical signal sucker looks like a 0.1uF capacitor across the powerline. That has a reactive impedance of 13 ohms at the X10 carrier frequency. The XTB-ANR looks functionally like a 1.0uF capacitor when on, placing a ten times heavier load on powerline noise.

The effectiveness of the XTB-ANR depends on the output impedance of the noise source. It works well with devices that generate moderate noise levels. High power devices like variable speed motor controllers or photovoltac power converters, usually have relatively low output impedance, and they may still have to be isolated with individual filters.

Installing the XTB-ANR

The XTB-ANR will attenuate any noise on the circuit it is plugged into. Since it functions like a "super signal sucker", its effectiveness depends on the source impedance of the noise generator. The distributed inductance of the powerline causes the amplitude of noise to decrease as it propagates away from the source just like X10 signals. The XTB-ANR is best installed between the noise source and any X10 devices at a point that maximizes the line inductance between it and the noise source.

In most cases, plugging the XTB-ANR into a receptacle near the distribution panel may be the best configuration. That will prevent noise coming in on any circuit from being radiated back onto all other circuits on that phase. In some cases with a serious noise source, better results may be obtained with the XTB-ANR plugged directly into that circuit between the noise source and the distribution panel. If X10 devices are on both phases, plugging an XTB-ANR into each phase near the distribution panel will reduce all noise throughout the home, including most noise coming in over the utility feed. Since the XTB-ANR has little effect on X10 signals, additional units can be installed at strategic locations to address particularly noisy installations.

The XTB-ANR is quite effective against most electronic devices that generate powerline noise as a side effect of their normal operation. We have discovered two devices that create so much noise that even the XTB-ANR is not able to attenuate it sufficiently. One is an Echelon smart electric meter whose powerful transmitter produces a very strong signal at the distribution panel. The other is a LED light that produces a horrendous amount of noise centered right on the X10 passband. It saturated the noise readout on the XTBM, and even attenuating that noise by a factor of 10 was not sufficient for nearby X10 devices to function properly. So individual filters may still be needed on particularly nasty noise sources.

The XTB-ANR can be used in combined X10/Insteon systems. A small jumper inside the unit labeled TP/INST must be removed to enable Insteon compatibility. In that configuration, the XTB-ANR always turns off the attenuator at the beginning of each Insteon transmit window. If a signal near 131KHz switches on at that point, the attenuator remains off throughout the entire Insteon window. Because the second half of the Insteon window overlaps the X10 transmit window, that reduces its ability to discriminate between valid X10 commands and noise, so that option should only be used for combined X10/Insteon systems.

Single-Circuit Installation examples:

panel ---- outlet ---- outlet ---- **X10 device** ---- **ANR** ---- **NOISE**

(Locate the ANR between the noise and the X10 device.)

panel ---- **X10 device ---- ANR** ---- outlet ---- outlet ---- **NOISE**

(If possible, use line inductance to increase noise output impedance.)

panel ---- outlet ---- **NOISE** ---- **ANR** ---- outlet ---- **X10 device**

(Try this if that one X10 device does not work with the ANR at the panel.)

Summary

X10 reliability problems are usually due to either weak signals or electrical noise on the powerline. Weak signals are caused by the large number of electrical loads found in our homes today, particularly those that have become known as "signal suckers". They include computers, monitors, and newer flat-panel TVs. Powerline noise is commonly caused by electrical devices with switching power supplies, such as high-efficiency "wall-wart" power modules, compact fluorescent light bulbs, and even the newer 120V LED bulbs.

By allowing potential X10 signals to pass at almost full intensity, but severely attenuating background noise that might be erroneously detected by X10 modules as a “1” bits, the XTB-ANR simulates the AGC action for X10 modules that do not incorporate that feature.

The basic noise monitor now incorporated in the XTB-ANR allows a quick check of the background noise level. As long as it indicates 3 flashes or less, the background noise level should be low enough for reliable X10 operation.

Measurements show the XTB-ANR can reduce noise from a typical noise source by about a factor of 10. Combining the XTB-ANR to combat noise with the XTBR or XTB-IIR to boost signal levels should solve the major problems we face with our X10 systems today.

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