

X10 DEBUGGING TIPS

INTRODUCTION

Although X10 powerline communications provides many great benefits, one of its biggest downsides is the potential reliability problems. In fact, the most frequent questions we receive from HomeVision users are about X10 problems in their homes. Over the years we've learned some good ways to help isolate these problems. We hope that these tips will help if you run into X10 problems, even if you're using a different home automation system.

Problems can generally be grouped into two categories:

1. Major problems: X10 never works
2. Intermittent problems: X10 sometimes works

There are many possible things that can cause such X10 problems. We will discuss troubleshooting the major problems, then address the much more common intermittent X10 problems.

SOLVING MAJOR X10 PROBLEMS

Let's start with the worst-case scenario: HomeVision is neither sending nor receiving X10 commands. In this situation, the problem lies in one of four places:

1. The HomeVision controller.
2. The X10 powerline interface device. This is usually a TW-523 or PSC05, although there are others. We'll refer to all of them as "TW-523" in this article.
3. The cable connecting the HomeVision controller to the TW-523.
4. A serious X10 signal degradation problem in your home.

So how do we troubleshoot these? Here goes ...

Check the TW-523 Module LED

First, verify that the red LED on the TW-523 module is lit. If not, make sure it's plugged into a live circuit. If the LED is still not lit, then the TW-523 is defective. If it is lit, the TW-523 is *probably* OK (although there's a chance something is wrong, which we'll cover shortly).

Check the HomeVision TW-523 LED

Next, check that the green "TW-523" LED on the HomeVision controller is lit. If it is, then HomeVision and the cable connecting it to the TW-523 module are probably OK – go on to the next section. If the LED is not lit, check the following:

1. Verify the phone cable connecting the controller to the TW-523 module is installed and the connectors are securely mated.
2. Make sure the phone cable is a *4-conductor* cable. Many cables contain only two conductors and will not work. The cable must be a "straight-thru" cable (the same type that connects your phone to your home's phone jack). "Cross-wired" cables *will not work*. You can determine the type of a cable by butting the connector ends together (as if trying to plug one connector into the other). When you do this, the colored wires will all be aligned if it's a "straight-thru" cable. Naturally, if the cable came with the HomeVision unit, it should be the correct type. However, we accidentally shipped the wrong cable once, so it's possible.
3. Try another cable. Although cable failures are rare, we've have seen it happen.

4. If the cable seems OK, try a different TW-523 module if possible. We've seen four instances where the TW-523 was defective right out of the box. Although we test our TW-523 modules before we ship them, most of our distributors don't purchase them from us. They instead obtain them from other sources, and very few test the modules.
5. If neither the TW-523 module nor the cable is defective, then the problem must lie with the HomeVision unit. However, we've never had a failure like this in our history, so we doubt you'll have this problem!

Check the HomeVision X10 TX LED

If the green "TW-523" LED on the HomeVision controller is lit, but you're still having major X10 problems, we need to dig further. We'll do this by transmitting some signals and checking the green "X10 TX" LED on HomeVision's front panel.

You can transmit X10 test signals from the X10 control screens in the PC software or video (TV) menu system (as well as using other ways that HomeVision users should be familiar with). When you send the command, watch the green "X10 TX" LED. Does it blink? If not, there is either something wrong with the HomeVision controller, or you haven't properly configured HomeVision to transmit X10 signals.

If the LED does blink, we know that HomeVision sent the signal to the TW-523. Now we need to determine if the TW-523 put it onto the power line OK. Transmit the signal again and watch the red LED on the TW-523 module. Does it blink off? If so, then we know the TW-523 successfully transmitted the signal (see the "TW-523 LED" side note for details). If the X10 device didn't respond, then the signal isn't getting through your home's electrical wiring (go to the "Solving Intermittent X10 Problems" section to troubleshoot it). However, if the TW-523 module LED did *not* blink off, then any of the following could be the problem:

1. The TW-523 is defective.
2. The phone cable is defective.
3. There's a very odd X10 signal problem in your home.

Obviously the first two problems can only be proven or solved by changing out the defective piece. Problem #3 is very uncommon, but we have seen it. How would you troubleshoot this? First, try plugging the TW-523 module into a different electrical outlet. You could use an extension cord and run it into another room. If necessary, you could also take HomeVision along with it into another room (you don't need to move your computer – you could simply program the HomeVision "Power Failure Recovery Event" to transmit an X10 test signal, then remove and reapply power each time you want HomeVision to transmit). If the TW-523 module's red LED starts blinking properly in the other room, then we're making good progress towards solving the problem. We know HomeVision, the TW-523, and the cable are OK. We then need to determine why the problem is occurring in the original AC outlet. It's most likely due to a device near the AC outlet degrading the X10 transmission or generating noise. Go to the "Solving Intermittent X10 Problems" section to troubleshoot it.

If the TW-523 module's LED won't blink from anywhere in your house when transmitting X10 signals, we'd suggest you take it to a neighbor's house and try it. If it won't blink there, either the module or HomeVision is defective.

TW-523 LED Note

The red LED on the TW-523 module is normally on. It will blink off only when it receives an X10 signal. However, the TW-523 should receive its own transmission. Therefore, it should blink off when transmitting (unless the signal is corrupted by external noise, preventing its reception). Most X10 transmissions consist of two signals, one for the device address (house and unit code) and one for the function. For example, when you execute an "A-1 On" command, the TW-

523 will transmit an "A-1" signal followed by an "A-On" signal (actually, "A-1" will be sent twice, then "A-On" sent twice, but that's not relevant to this discussion). Therefore, you would expect to see the TW-523 LED blink off twice during such a transmission.

Repeated Transmissions Note

When transmitting an X10 signal during your troubleshooting, you may notice the green HomeVision "X10 TX" LED blinking four or more times. This means HomeVision is repeating the transmission because it knows the first transmission failed. HomeVision can be configured to automatically repeat a failed transmission up to 31 times (see the Controller Settings Screen under the Configure menu). When this is occurring, the red LED on the TW-523 module will probably *not* be blinking (if it were blinking, meaning it received its own transmission, HomeVision would not repeat it). When you see this happening, you know you're experiencing X10 signal degradation problems in your home.

X10 Reception Problem

The problems discussed above usually affect both X10 transmission and reception. However, if you're only having problems with HomeVision receiving X10 signals from other devices, you should try the following test.

Use the external device (X10 mini-controller, X10 wall keypad, etc.) to transmit a signal to HomeVision and observe the HomeVision green "X10 RX" LED. If it blinks, then you know HomeVision received the signal OK. If HomeVision is not reacting to the signal as you expected, you probably have programmed HomeVision incorrectly. If LED does not blink, watch the red LED on the TW-523 and send another signal. If the LED does not blink off, there must be an X10 signal degradation problem in your home (troubleshooting this is discussed later). If the TW-523 module's LED *does* blink off, but the HomeVision "X10 RX" LED *doesn't* blink, then either the TW-523 or cable is faulty. Although it's possible for the HomeVision unit itself to be at fault, this is extremely unlikely.

SOLVING INTERMITTENT X10 PROBLEMS

Fortunately, the major problems discussed above are relatively uncommon. However, there are many more frequent problems that result in intermittent X10 operation. These are discussed below.

VERIFY HOMEVISION TRANSMITTED SIGNAL

If you have a problem where it seems HomeVision is not properly controlling an X10 device, the first step is to determine if HomeVision is transmitting the correct X10 signals. We need to verify that your HomeVision schedule is properly set up and that the controller ran your command. As an example, assume you have a scheduled event to turn on light A-1 at sunset. First, we need to verify that the event runs when it should. The best way to do this is to include some serial transmission commands after the X10 command. For example, your scheduled event might look like this:

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X10: A1 (Front Porch) Force On
Serial port 1 transmit: "Turning A1 on at "
Serial port 1 transmit: Time and date
Serial port 1 transmit: Carriage return and line feed
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You can then view the serial messages sent to the PC by opening the terminal emulator screen in the PC software (you'll need to leave the screen open in order to capture messages from the controller). Another option is to turn on the software's logging capability so that all serial messages are written to a text file. If the light doesn't turn on when it should, you can view the terminal emulator screen or log file. If the "Turning A1 on at ..." message doesn't appear, you know the scheduled event didn't run and you can troubleshoot that. But if it ran, then you can be certain that HomeVision transmitted the X10 signal. Proceed to the next section to determine why the light didn't respond properly.

X10 COMMUNICATIONS PROBLEMS

Most X10 users will run into intermittent problems at some point - for example, a light that is supposed to turn on at 7:00PM doesn't. Many new X10 users who experience this assume that the automation controller (HomeVision or otherwise) didn't send the command when it should have. However, these are usually not the fault of the controller, but of X10 communications problems on the home's AC power lines. There are several general causes of such X10 signal problems:

- Electrical noise interfering with signal transmissions
- Signals not coupling across the two phases of the AC power line
- Weak signals in some areas of the home caused by devices that attenuate (reduce) the signal
- Weak signals caused by long distances between the transmitter and receiver

In addition to these general problems, there are several problems that can occur with specific devices. These are all discussed below. As a side note, Leviton has a useful technical manual that discusses troubleshooting X10 installations. The manual can be downloaded from their web site at <http://www.leviton.com/pdfs/dhctechman.pdf>.

Electrical Noise

X10 signals are transmitted by generating 1 millisecond, 120kHz "carrier" signals on top of the 60Hz AC power line voltage. The signal meaning (A-1, B-OFF, etc.) depends on the location of these 120kHz pulses relative to the power line zero-crossing points (the points at which there are zero volts across the two wires). Any noise in the range of 120kHz on the power line can interfere with X10 signals. This may cause the intended receiver to miss the signal, preventing it from turning on or off. This might also cause other receivers to incorrectly think the signal was meant for them, and they might respond incorrectly. Noise is one of the most common causes of intermittent X10 operation.

Following is a list of devices that, when operating, may generate noise:

- Appliances like electric razors, hair dryers, vacuum cleaners, food processors, electric carving knives, blenders, mixers, and similar items
- Compact fluorescent lamps and halogen lamps
- PC monitors
- Laser printers (while printing)
- Instant-on TVs (which use degaussing mechanisms to remove static electricity from the tube)
- High-speed electronic motor loads (such as grinders, motor-driven paint sprayers, and centrifuges)
- High frequency electronic ballasts, especially near their end of life
- Piezoelectric devices

- Wireless power line intercoms or baby monitors which use existing AC lines for voice transmission (these will typically kill all X10 communications within the home. There is no way to make them work – they must be removed)
- Wireless doorbells that use the house wiring
- High Pressure Discharge Lighting (HID), such as Sodium Vapor, Metal Halide, and Mercury lights

Some of these devices, such as fluorescent and HID lights, often generate noise when turning off, causing the X10 fixture to immediately turn back on. If you see this happen, you now know the cause!

The best way to diagnose these problems is with a signal strength meter that can show the amount of noise (and signal). The Elk Products ESM1 X10 signal meter is an economical choice (around \$60). The Monterey Instruments Powerline Signal Analyzer is a much more powerful tool for diagnosing all types of X10 problems, but is rather expensive (around \$300). Plug the meter into different outlets throughout your home and observe the amount of noise.

If you have noise, how do you find the source? There are several ways. If you have a meter, you can get close to the source by moving the meter to different electrical outlets looking for the highest reading. Then start unplugging devices from the power line until the noise goes away. If the meter doesn't help you get close, try shutting off individual circuits at the breaker panel. Once you've found the circuit that's causing the noise, you can unplug devices in that room to locate the culprit.

If you don't have a meter, you can try a portable AM radio tuned to an unused frequency near the low end of the dial (around 550 to 650kHz). A noise source near 120kHz will often generate 5th and 6th order harmonics near this AM band. Carry the radio with you and move it near AC outlets while listening to the noise. The louder it is, the closer you are to the source. Use the noise to guide you, and you'll hopefully find the source.

If you don't have a meter or radio, it's harder to isolate the noise source. You could turn off breakers or unplug devices until the X10 devices start working again. If you use this approach, you'll want to have a transmitter transmitting continually so you don't have to transmit manually. With HomeVision, you can program a periodic event to run every loop and have it toggle a specific X10 device on and off. You can then plug an X10 appliance module into an AC outlet and see if it turns on and off. You could plug a lamp into the module, but this requires you to see the light to know if the signal is getting through. This is fine if you're in the room with it, but more difficult if you're in the garage turning breakers on and off. An alternative is to plug a radio into the module. Crank up the volume and you can hear the radio turn on and off from a long distance away. Another option is to use a chime module that you can hear chime each time an X10 signal is received.

After you've identified the noise source, you have are several options:

1. Remove the noisy equipment
2. If the noise is coming from a device equipped with a power cord, you can use a plug-in noise filter (Leviton 6288, ACT AF100 or AF120, or X10 Pro XPPF)
3. If the noise is coming from a wired-in device, you can use a wired-in noise block (Leviton 6287 or X10 Pro XPF)

Poor Phase Coupling

In most homes, power enters the home on three wires – two hot wires and one neutral wire. Each hot wire provides 110VAC relative to the neutral wire. Each of these two “phases” provides power to half of your home's 110V circuit breakers. 220V breakers take their power from across the two hot wires.

In order for X10 devices on one phase to control devices on the other, the X10 signal must cross over to the other phase. If you have poor coupling between the phases, a signal transmitted from one phase may not reach the intended receiver on the opposite phase. An X10 signal transmitted on one phase will partially couple to the other at the breaker panel, but the signal may be weakened. It might also couple through a 220V appliance while it's operating.

There are several symptoms that indicate a coupling (or "bridging") problem:

- You can't control any outlets in one room, but you can control an adjacent room fine. This typically means the rooms are on opposite phases.
- If you move the X10 transmitter to another location on the opposite phase, you can then control devices that you previously couldn't control.
- X10 devices work OK for a while, then stop working again. This often occurs when phase-coupling is occurring in a 220V appliance while it's operating. Turning the appliance on causes X10 signals that weren't previously working to start working. Then as soon as the appliance is turned off, the signals stop working again. This can be especially difficult to isolate if the appliance is cycling on and off, as often happens with HVAC units.

One quick way to help determine if you have a bridging problem is to turn on your stove or other 220V appliance while X10 transmissions are failing. If the X10 transmissions start working, you likely have a bridging problem. However, even if X10 doesn't start working, it doesn't mean you don't have a coupling problem. Sometimes the coupling provided by the stove, clothes dryer, or similar appliance is only minimal.

Another test is to set several lamp or appliance modules to the same X10 address as the device this isn't working right. Plug them into different rooms on different AC phases. Transmit an X10 signal to them and see which, if any, respond. If some, but not all, respond, you may have a coupling problem (although it could also be a noise or signal strength problem near the non-functioning receiver(s)). If none respond, you probably have a more serious problem such as: 1) massive noise throughout the house, or 2) a device attenuating the signal near the transmitter.

There are two general solutions to a coupling problem:

1. Passive phase coupler. For example, use the Leviton 6299, ACT CP000, or X10 Pro XPCP couplers, which mount inside your breaker box. There are also some newer devices that simply plug into a 220V outlet. Some users make their own coupler using a high-voltage capacitor, although we don't recommend this (they're not quite as effective as a tuned coupler, and there are potential safety issues).
2. Active coupler/repeater. This also mounts inside (or next to) the breaker box and is discussed in detail in a later section.

A passive coupler is less expensive, but an active repeater has the advantage that it also amplifies the signal. Before buying a passive coupler, be sure you don't also have a general signal strength problem. If you later have to add an active repeater, your passive coupler will be removed and have been a waste of money.

Signal Attenuators

Any device that attenuates 120kHz signals will cause problems. For example, some electrical devices have a capacitor across the power line or use other filters to reduce high frequencies – these can seriously degrade nearby X10 signals. Common problem devices include:

- PC power supplies
- Uninterruptible Power Supplies

- Surge protectors or filtered power strips
- A/V equipment
- Dimming switches other than X10 types (especially larger ones)

You can troubleshoot these problems in the same manner as noise problems discussed above. A signal meter is extremely helpful for these problems as well. Note that these items don't have to be operating to cause problems. Just plugging them in can attenuate X10 signals. When troubleshooting, make sure you *unplug* the devices and not just turn them off (although it's OK to shut off the circuit breaker – that completely isolates them from the rest of the house).

After you've identified the offending device, you either remove the device or isolate it from the wiring with a filter or noise block.

Low Signal Strength

The further an X10 signal travels in your home, the weaker it becomes. If the signal has to travel to the breaker panel at the other end of your home, cross over to the opposite phase, then return to the far end to reach a device on the phase opposite the transmitter, the signal will be severely weakened. The larger your home and the more X10 devices you have, the worse this problem will be. In general, we've found that homes over 2500 square feet often have this problem, while those under 2000 typically don't (of course, there are always exceptions).

The best way to diagnose this problem is with a signal strength meter and an X10 transmitter that transmits continually. With HomeVision, you can program a periodic event to run every loop and have it transmit an X10 signal. You could also use the Leviton 6385 to transmit the signals and the Leviton 6386 to measure the signal strength. Start the transmissions and use the signal meter at various locations. If the signal becomes too low as you move away from the transmitter, you know you have a signal strength problem. Try this test while transmitting from different locations. It's best to pick at least one transmit location as far from the breaker panel as possible, and measure the signal far from the breaker on the opposite phase (since the longest path may be through the breaker at the other end of the home). Turn off all 220V appliances while testing so you don't get any extra phase coupling.

If you have a signal strength problem, the only practical solution is to use an X10 signal "repeater". You may have heard of these devices referred to by many terms, such as "amplifier", "repeater", "active coupler", "coupler/repeater", etc. All refer to a device that receives a signal on one phase and transmits it onto the other phase at a higher signal strength (typically 5-7 volts). Commonly-used repeaters include the Leviton 6201 (or their newer HCA02-10E), the ACT CR230 and CR234, and the X10 Pro XPCR.

Installation tip: If possible, locate your HomeVision unit near the breaker panel. This minimizes the distance signals have to travel when crossing AC phases, resulting in higher signal strength at the receiver. This might eliminate the need for a repeater.

OTHER X10 PROBLEMS

Besides the general X10 problems discussed above, there are a variety of more application-specific problems.

Stray X10 Signals

If you have neighbors who also use X10, you might receive signals that they transmit. One way to detect this problem is to have HomeVision log all received X10 signals. If it reports some for house and unit codes you don't use, they may have come from outside the home. Contact your neighbors to see if they are using X10. The best solution to this problem is to add a whole-house noise blocker (such as the Leviton 6284 or ACT CP303). If you can't do this, you can add a

signal attenuator (Leviton 6285) to the breaker panel to reduce the incoming signal. However, this will also reduce signal strength within your home, so a repeater should also be used.

RF Transceiver Problems

X10 TM751 and RR501 RF transceivers are known to have an “endless dim” problem. In certain situations, they can repeatedly transmit X10 dim (or brighten) signals onto the power line, corrupting X10 transmissions from other devices. Another problem can occur if you have more than one of these devices. The TM751 does not monitor the AC line to see if it is colliding with X10 commands already being sent (the RR501 *does* monitor the line before starting a transmission). As a result, two or more transceivers could corrupt each other’s signals. If you have such devices, disconnect them while troubleshooting other X10 problems.

Repeater Problems

While X10 repeaters are necessary in many installations, they can introduce some of their own problems.

X10 “brighten” and “dim” commands are usually sent by repeating the signal over and over. Unfortunately, some repeaters (such as the Leviton 6201) may skip every other signal instead of repeating all signals. This works fine for some X10-type switches, but others may miss some of the commands and not dim or brighten as much as expected. This would result in lights on AC phases opposite HomeVision not dimming or brightening as much as lights on the same phase. If you have this problem, you can use the HomeVision “slow dim” commands instead of the regular X10 commands. The “slow dim” commands place a gap between each dim (or brighten) signal, eliminating this problem (although it will take much longer to dim or brighten the light). Note that this problem only occurs with brighten and dim signals, not any other X10 signals.

Some repeaters also have problems with the “extended code” X10 signals. These signals are commonly used for the newer switches that support lighting scenes, status polling (for two-way devices), and similar features. It appears that the Leviton 6201 does not repeat these codes at all. The ACT CR230 repeaters may incorrectly retransmit these codes. This apparently is caused by how ACT implemented their own “extended code” protocol. One common problem occurs when it is used with a two-way module. When the module is first plugged in, it transmits an extended code message. The repeater incorrectly repeats ACT’s own protocol message, which in turn causes some two-way modules to retransmit their initial message, and the whole process repeats forever!

If you’re having odd X10 problems, try turning the repeater off and see if the problem goes away. If it does, contact the repeater manufacturer. They may have a newer model that solves the problem or may know of a work-around.

Wall Switch Turns On But Not Off

I have one light in my home that always turns on when it should, but frequently won’t turn off. Believe it or not, there is a logical explanation for this. The following explanation is based on an article by Dave Rye of X10 (USA) Inc.

The wall switch module is wired in series with the light bulb. This means the power line signals have to pass through the filament of the bulb in order to complete the circuit. A hot lamp (one that is currently on) has a higher electrical resistance than a cold lamp. Therefore, it takes a slightly higher signal amplitude to turn a switch off than it takes to turn it on. The signal strength may be barely high enough to turn the light on, but not enough to turn it off.

SwitchLinc Problems

The SwitchLinc switches provide a large number of great features. Unfortunately, they are known to have several problems. The most common problem we've heard of is that they randomly turn themselves on and off. The problem seems to be more common when a repeater is used. High signal strengths or noise seem to confuse the switch's receive circuitry into thinking a valid command was received, and the switch responds accordingly.

Another problem is that the SwitchLinc switches which have transmit capabilities attenuate X10 signals. The manufacturer says that if you are using more than 20 X10 transmitters and/or 2-way SwitchLincs, you may encounter this problem. Using a repeater doesn't solve this problem. They make an LS ("Low Suck", their words, not ours!) version that doesn't have this problem (because it removes the transmit function). If you're planning on using these switches, be aware of this problem.

CONCLUSION

If you use X10, you will inevitably experience some of the problems described here. Hopefully this information will help you resolve the problem as quickly and painlessly as possible. This is the price we all pay for enjoying the many benefits of X10 technology!

DISCLAIMER

We've done our best to describe problems that can occur with some specific devices. We've provided company names and model numbers where possible to help readers determine if they might experience the problem. However, we cannot guarantee that everything we've said about such devices is precisely correct. Manufacturers make frequent design changes, and problems that we've described might have since been fixed. But since readers may be using older products, we felt it best to provide whatever information we could on all these products.