

1. Introduction

The X-10 code format is the «De Facto» standard for Power Line Carrier (P.L.C.) transmission. The code format was first introduced in 1978 for the Sears Home Control System and the Radio Shack Plug'n Power System.

Since then, X-10 has developed and manufactured O.E.M.* versions of its Home Control System for many companies including Leviton Manufacturing Co., General Electric, C&K Systems, Schlage Lock Co., Stanley Health/Zenith Co., Honeywell, NORWEB, and Busch Jaeger.

All of these systems use the X-10 code format. All are compatible and virtually all Home Systems use X-10 with PLC Modules.

The X-10 code format is patented

However, in order for others to take advantage of the cost effective X-10 Modules, a range of Power Line Interfaces are offered as ways of coupling X-10 compatible signals onto the AC power line.

2. Transmission theory

X-10 transmissions are synchronised to the zero crossing point of the AC power line. Power line interfaces provide 50 Hz. square wave with a max. delay of 100 µsec from the zero crossing point of the AC power line. The maximum delay between signal envelope input and 120 KHz. output bursts is 50 µsec.

A Binary 1 is represented by a 1 millisecond burst of 120 KHz, at the zero crossing point and a Binary 0 by the absence of 120 KHz. These 1 millisecond bursts are transmitted three times to coincide with the zero crossing points of all three phases in a three phase distribution system. Figure 1 shows the timing relationship of these bursts relative to zero crossing.

*O.E.M. Original Equipment Manufacturer

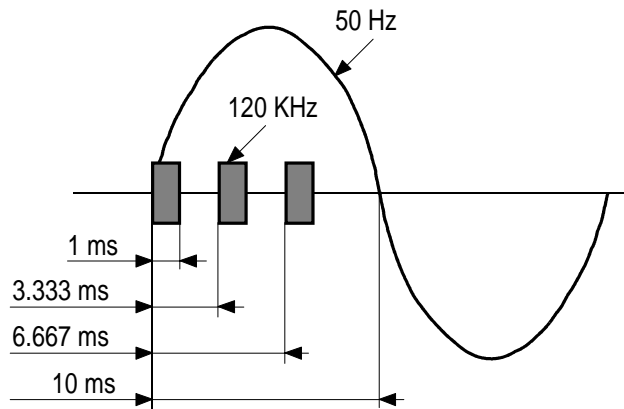


Figure 1

NOTE:

For clarity, the signals in Figure 1 are shown as they would be seen through a high pass filter. The 50 Hz waveform is only shown for reference. In reality the signals are actually superimposed on the 50 Hz. waveform and look more like that shown in Figure 2.

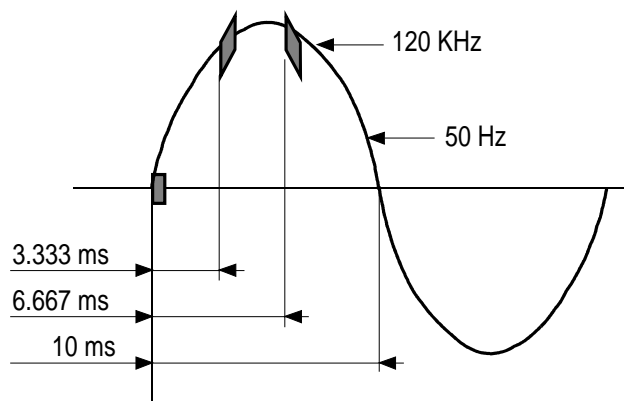


Figure 2

A complete code transmission encompasses eleven cycles of the power line. The first two cycles represent a Start Code. The next four cycles represent the House Code and the last five cycles represent either a Number Code (1 thru 16) or a Function Code (On, Off etc...). This complete block, (Start Code, House Code, Key Code) is transmitted in groups of 2 with 3 power line cycles between each group of 2 codes. Bright and dim are exceptions to this rule and are transmitted continuously (at least twice) with NO gaps between codes. See Figure 3.

3. Trouble shooting

GENERAL FAILURE

If you should detect problems in the operation of the system in spite of correct installation, read this chapter carefully.

- Are the mains master fuses (63 A) installed? Are the fuses of the single circuits switched on?
- Are the filters/phase couplers correctly installed? If the phase inputs and output have been confused, the X-10 signal is suppressed.

If the system still does not work, or only works sometimes, active interferences within the mains network can be the reason. Active interferences can be caused by high power appliances that do not have sufficient interference suppression (e.g. industrial machinery). Normally, those devices are situated outside the house mains network, so that their interferences are sufficiently suppressed by the filter/phase coupler. An exception are carrier frequency intercom systems (so-called «wireless» intercoms or electronic baby-sitters that use the mains cable for signalling). Even if such a device is being used within the house network, the system should work correctly as the receivers have been designed to operate with «baby phones». The receivers can detect if the signal is an X-10 signal and disregard the «baby phone» signal. In case you encounter problems nevertheless:

- Disconnect the carrier frequency intercom and all its local modules/receivers from mains.

Even in this case, there are no problems. If you operate a carrier frequency intercom and the X-10 system at the same time, there will only be an interference when the intercom transmits at the same time as (e.g. when the baby cries) an X-10 command is being sent at that very same moment.

If the system still does not work, or if it only works partially, passive interference sources within the mains network can be the reason. Passive interferences are caused by appliances with phase-parallel capacitors and high power. They act as a big filter that attenuates the signal.

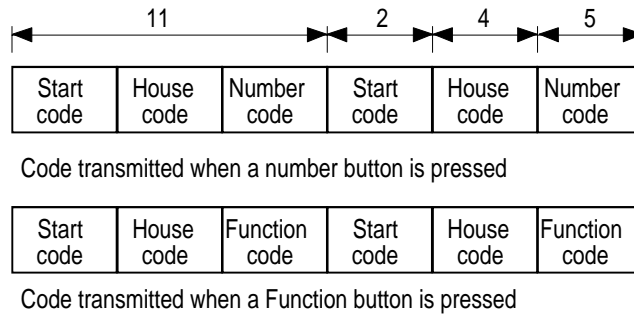


Figure 3: Power line cycles

Within each block of data, each four or five bit code should be transmitted in true and complement form on alternate half cycles of the power line. I.E. if a 1 millisecond burst of signal is transmitted on one half cycle, (binary 1) then no signal should be transmitted on the next half cycle, (binary 0). See Figure 4 below.

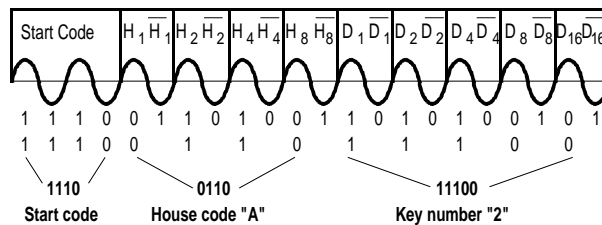


Figure 4

The sensitivity of the receiver electronics is very high so that the system works perfectly in most cases, even when there are passive interferences present. If you nevertheless encounter operation problems, there is probably an exceptionally strong passive interference source connected somewhere in the house. It can happen that this interference source (appliance) only affects the function of the receiver in its vicinity or within the same fuse circuit.

- Disconnect all big appliances from mains consecutively in the fuse circuit where problems have arisen (i.e. switch off appliance and disconnect plug). Check correct function each time.

When you have found the appliance that is giving you trouble, there are several possibilities:

- The appliance can be operated in a mains fuse circuit that is connected in front of the filter/phase coupler.
- The mains fuse circuit of the appliance in question can be connected in front of the filter/phase coupler (e.g. the basement circuit if the interference is caused by work-shop machinery).
- Advise the customer to replace the appliance (e.g. when it is too old and does not comply with current regulations and norms).

If the appliance must be operated like it was up to now, you can obtain a special filter from X-10.

If after checking all points the system still does not work, the signal level in the house mains network has to be checked. To effect this, please consult X-10.