
# Build Your Own Voice Recognition X-10 Control System

**by Dennis Shepard**

In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world. We have everything from our TVs, stereos, and VCRs, to our sprinklers, lights, and air conditioning on remote control. A very popular format used for remotely controlling lights and appliances has been the X-10 protocol which transmits signals over your household wiring to facilitate that control. These systems have been around for over 20 years now. The interfaces have developed to the point where you can link through your computer and telephone for controlling these devices.

Voice recognition has now made it possible to control X-10 modules using your own voice. A leading-edge technology company named Sensory has just developed a continuous listening mode, voice-recognition module for $49.95. It is with this module and an X-10 PL513 interface (available from X-10 for $19.95) that allows us to construct a complete voice-operated controller for around $100.00, depending on what you've already got on hand.

## What's a PL513?

It's pretty easy to guess that would be your first question. Because of the popularity of X-10, interface modules were designed to allow others to control the modules, namely, third-party developers and manufacturers. This opened up a whole new arena of outside products which could be compatible with the X-10 system.

To give you a better understanding, let's redefine what X-10 is. It's a protocol for sending signals over your power wiring to remotely control devices in your home/business. It does this by modulating a 120 kHz signal on the 60 Hz AC cycle. There is a starting sequence code (two cycles) followed by a house code (four cycles) followed by a key or function code (five cycles). So ... an 11-bit code is sent for each command.

**The PL513**

The PL513 module has a four-pin RJ11 standard phone jack attached to a small case which plugs into the AC power line. A red LED illuminates when power is present and dims whenever a valid X-10 command is sent. Inside the unit is a 120 KHz oscillator which interfaces to the power wiring plug. Also contained is an opto-isolator which provides an indication of when the AC cycle crosses zero. That's all there is to the interface. For those of you with a true engineering spirit, please visit X-10's website at http://www.x10.com. There you will find a 12-page document free for the downloading which covers all the specifications, including schematic, for the PL513. The document is entitled Technical Note for PL513\TW523.

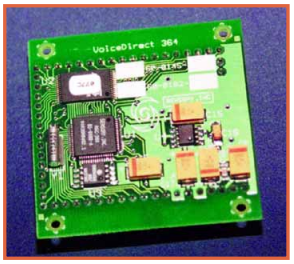
## What's the PIC for?

Another good question. Although the PL513 provides a power line interface and zero-crossing signals, it's a far cry from a smart interface. Let's go a little more in-depth into the protocol and I think you'll see what I mean. Each time a code is sent, you have to send a complementary bit immediately after each bit on each alternating half cycle. For example, the start code which is 1110, is sent as 1 0 1 0 1 0 0 1. This format is true for the house codes and key/function codes, as well. And you have to repeat it twice with three cycles of silence in between. And at least two repeats for each dim and brighten command *continuously* without any missing cycles.

And for the clincher, each one bit must be sent three times on each cycle. This allows the system to be used on three-phase power systems. Since a power cycle (each half) is 8.33 msec, a one msec burst happens at zero crossing (within 50 usec), and again at 2.778 msec and again at 5.556 msec. This is all available in detail with diagrams and explanations so do your brain a favor and get the spec sheet. I guarantee it'll be a lot easier to understand!

The PIC also decodes the signals from the VoiceDirect 364 module. It has eight output lines which can control up to 15 separate outputs. Outputs 1-8 are verbatim, but outputs 9-15 are output 8 + outputs 1-7. For example, output 12 would be output 8 + output 4. Obviously, some way of deciphering the outputs is needed, as well, so the PIC takes care of both decoding from the VoiceDirect 364 module and encoding the 11-bit code for each X-10 command sent to the PL513 module.

## VoiceDirect to the rescue



**VoiceDirect Module**

Sensory Corporation is a high-tech company based in the silicon valley in California. Their website at http://www.sensoryinc.com pro-

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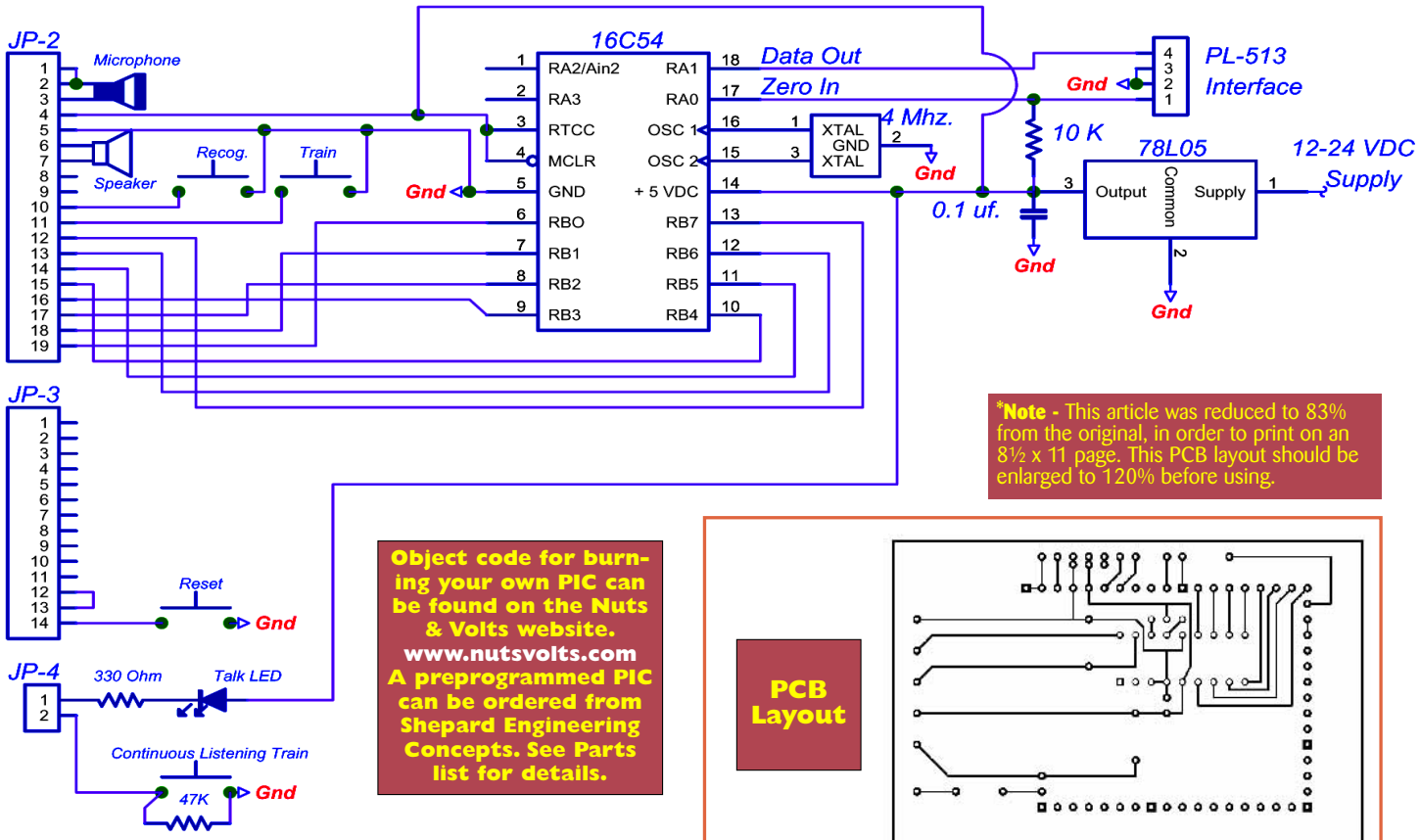
# Continuous Listening X-10 Voice Recognition System






***Note -** This article was reduced to 83% from the original, in order to print on an 8½ x 11 page. This PCB layout should be enlarged to 120% before using.

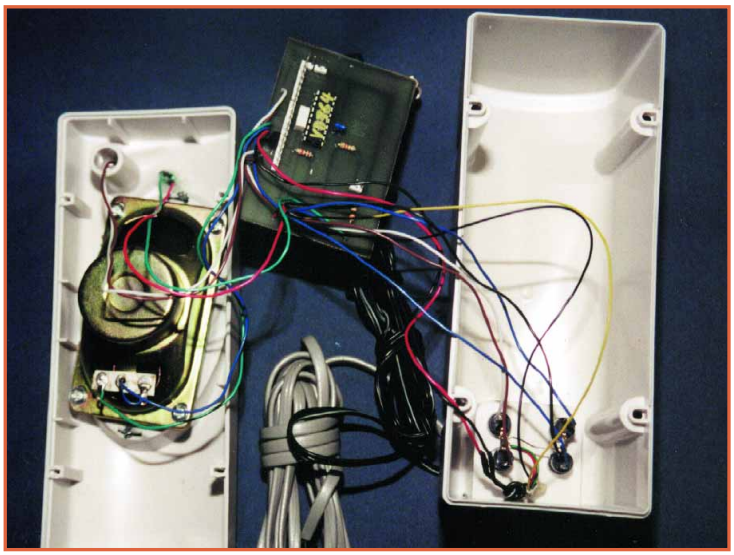
**Object code for burning your own PIC can be found on the Nuts & Volts website. www.nutsvolts.com A preprogrammed PIC can be ordered from Shepard Engineering Concepts. See Parts list for details.**

**PCB Layout**

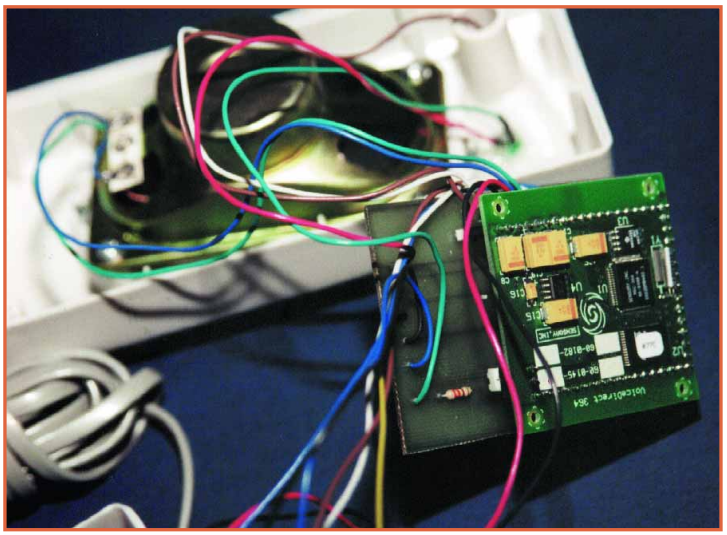


vides a wealth of information and technical background. They are the manufacturers of the VoiceDirect series of voice-recognition modules for whom I am a consultant/developer. They have developed modules which had the necessary support circuitry and firmware to make their modules a plug-and-go solution to many needs. The kit contains the microphone, speaker, switches, and resistors necessary for a stand-alone application.

Until recently, however, the units required some form of physical interaction to initiate a voice-recognition mode. They required a 'recognize' line to be pulled low for 100 msec to initiate that mode. Although this wasn't a major problem, it was somewhat of a nuisance. The newer units have their latest 364 chip which is faster



**Our prototype had the microphone mounted in the enclosure with the LED visible from the front. I just drilled a couple of holes and mounted it with some clear adhesive.**



**The VoiceDirect 364 module comes as a 2" x 2" assembly with standard posts to accept 0.1" male headers. This allows the module to be piggybacked on a perf board or PCB for compact installation.**

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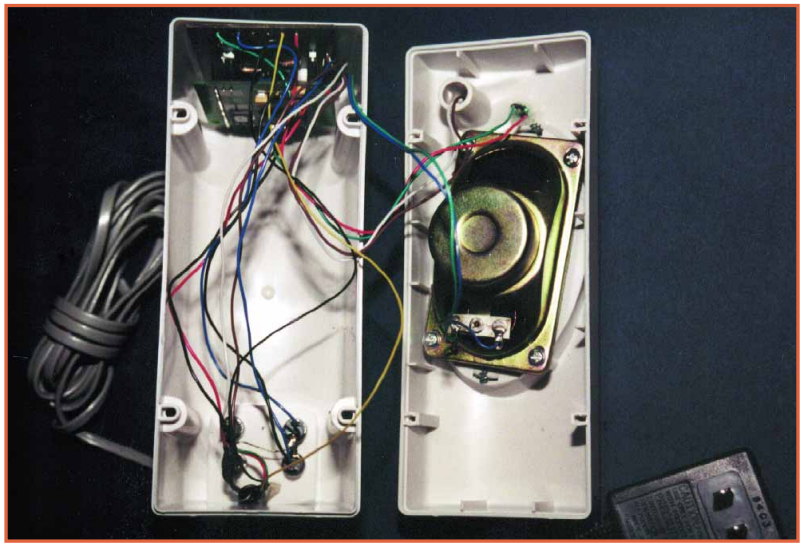


**A small computer speaker enclosure is a good choice for mounting the unit. Pushbutton switches can be easily installed in the back.**

and more accurate than its earlier predecessors. It also has a continuous listening mode which can use a 'gateway' word to precede each of the 15 commands it will respond to. This makes it completely voice-operated!

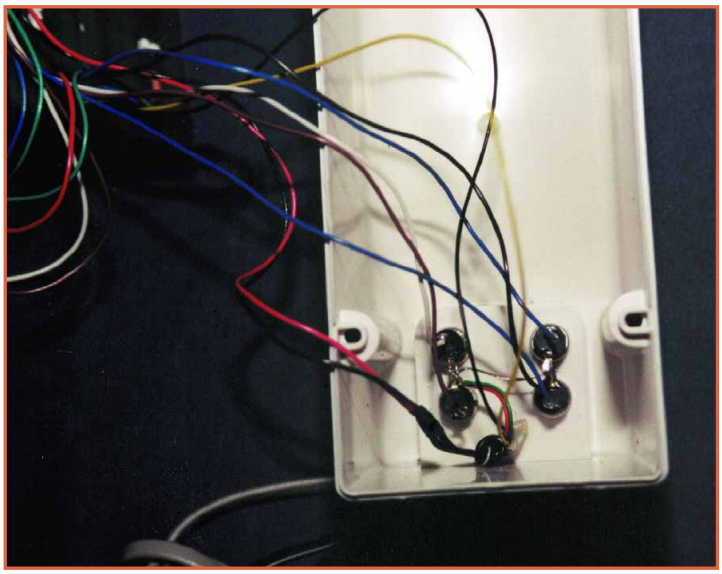
I have actually prototyped an earlier version using a proximity detector located inside the top of a small speaker enclosure to initiate the recognition mode and would pulse the line low every three seconds for continuous voice prompting. Then I used another command to silence the unit after I had spoken whatever commands I needed. This worked quite well, but it required some physical contact to get the unit to respond.

## The circuitry involved

From a hardware point of view, this is an extremely simple circuit. It consists of a PIC 16C54 microcontroller, 4 MHz ceramic resonator, 78L05 voltage regulator, VoiceDirect 364 module, three resistors, and four switches. The PL513 interface plugs into the wall and attaches through a standard RJ-11 phone cord. An external wall wart power supply completes the circuitry.

## Putting it all together

Now that we've discussed the various pieces of the system, it's time to put it all together. The VoiceDirect 364 module comes as a 2" x 2" assembly with standard posts to accept 0.1" male headers. This allows the module to be piggy-backed on a perf board or PCB for compact installation. A small computer speaker enclosure (without amplifier) is a good choice for mounting the unit. Obviously, you can use your own imagination and mount the unit anywhere you want ... including out of sight! Our prototype had the microphone mounted in the enclosure with the LED visible from the front. I just drilled a couple of holes and mounted it with some clear adhesive.



**Four SPST momentary contact push-button switches allow you to easily enter and exit the training mode and access system functions.**

## Setting it up

Once the unit is assembled, we're ready to set it up for proper operation. On power up, the speaker will beep once to let you know the VoiceDirect module is okay. The talk LED will flash but extinguish if no training has occurred. Pressing the CL train (continuous listening mode) button will prompt you to say "word 1" and repeat it a second time. It will also tell you if it got it right, or if it didn't, and even why it didn't! Once you have trained your 'gateway' word, you're ready to train each of the 15 commands.

Each individual command is set up using the train (non-CL) button. It needs to be pressed for each word because the system doesn't know beforehand how many commands it will be responding to. Once training is complete, you can put the system into operation by pressing the recognize button. At that time, the talk LED will light indicating the system has entered the continuous listening mode. Reset will reinitiate the Voice Direct module.

Pressing the recognize button or CL train button will extinguish the LED and take the system out of listening mode. The system can be erased by holding down BOTH the train and recognize buttons together for at least one second. The system will respond with "memory erased." There are lots of other prompts like "spoke too soon," "similar to previous word," "please talk louder." It's all covered in the documentation which accompanies the module and which is also available on Sensory's website.

In operation, the talk LED is lit and will flash to let you know it's recognized the proper 'gateway' word. If it recognizes the next word as well, the appropriate command is sent. It will also tell you which command number was sent. If not, the unit has to recognize the 'gateway' word again before it will recognize another command.

Basically, the system will literally "talk you through it" (no pun intended) on the set-up. Since the commands are hard coded in the PIC, here's the breakdown of actual commands by channel number in the system:

| Command Word | Function (X-10) |
|---|---|
| 1 | Channel 1 |
| 2 | Channel 2 |
| 3 | Channel 3 |
| 4 | Channel 4 |
| 5 | Channel 5 |
| 6 | Channel 6 |
| 7 | Channel 7 |
| 8 | Channel 8 |
| 9 | All Units Off |
| 10 | All Lights On |
| 11 | On |
| 12 | Off |
| 13 | Dim |
| 14 | Brighten |
| 15 | Not used |

Well, that pretty well covers the system. We

hope you will get as much excitement and enjoyment out of your system as we did ours! I even stayed up all night playing with the system when the prototype was developed.

Of course, I'll have to confess that I do have an espresso machine, so I'm quite sure that helped. **NV**

Although the house code is set in firmware to House Code 'A,' any single house code will be programmed free of additional charge when requested with your order. Two different kits are available from Shepard Engineering Concepts. The first one consists of the preprogrammed PIC, ceramic resonator, and 78L05 voltage regulator for $20.00 delivered anywhere in the continental US. The second kit includes the VoiceDirect 364 module ONLY and all components included above for $70.00 including S&H anywhere in the continental US. See parts list for details.

## Continuous Listening X-10 Voice Recognition System Parts List

| | |
|---|---|
| C1 | 0.1 uF 50 WVDC monolithic capacitor, RadioShack #272-109 or equal |
| *CR1 | 4.00 MHz ceramic resonator, Digi-Key #PX400-ND or equal |
| *IC1 | Microchip Technology PIC #16C54-XT/P microcontroller<br>Digi-Key PIC#16C54-XT/P-ND (requires programming) |
| JP-x | see below |
| LED1 | T1¾ green LED, RadioShack #276-022 or equal |
| MIC1 | Omnidirectional electret microphone element, RadioShack #270-092 or equal |
| PS1 | Power supply 9-24 VDC 100 mA output, RadioShack #273-1767 or equal |
| R1 | 330 ohm 1/4W 5% carbon resistor, RadioShack #271-1342 or equal |
| R3 | 10K ohm 1/4W 5% carbon resistor, RadioShack #271-1335 or equal |
| S1-S4 | SPST momentary contact push-button switch, RadioShack #275-1547 or equal |
| *VR1 | 78L05 5 VDC 100 mA voltage regulator, Digi-Key #78L05ACZ-ND or equal |
| *Voice Recognition module | VD364 voice recognition module, sensory #VD364 |
| Misc. | 4/c phone cord w/RJ-11 plug attached, small enclosure w/8 ohm speaker, 0.1" male headers, hook-up wire, etc. |

* The following items are available directly from:

**Shepard Engineering Concepts**
**9309 Coulter Court, Bakersfield, CA 93311**
**web —** http://home.att.net/~dennis.shepard/
**email —** dennis.shepard@worldnet.att.net

A kit of programmed IC1, CR1, and VR1 are available for $20.00 ppd. A kit including these items and the voice recognition module are available for $70.00 ppd. These prices are for the continental US only. **Please make payment to: Dennis Shepard.** Preferred payment is by money order, certified check, or Western Union.