

Build Your Own VoiceDirect/X-10 Interface Controller

We are about to introduce you to the most versatile product we have ever developed. No doubt, because we are about to build the most sought after product which modern technology has been able to produce. First, let me thank Sensory Inc. for allowing me to become their FIRST Internet distributor and for the technology of their VoiceDirect Speech Recognition Kit. It is because of this kit that it's possible for this project to become a reality.

This will also be the most complicated product we have produced thus far. The reason is simple, we didn't want to come up with a "watered down" version. We wanted to give you a system which would address ALL house codes and channels, albeit not at the same time. But then again, no other X-10 interface does that either.

HOW IT BEGAN

Every product has it's inception in the imagination. This one is no different. Ever since I purchased my first X-10 control system from Radio Shack over 15 years ago, I've been dreaming of an interface like this. Now, for some details. X-10 is a protocol which modulates a 120 kHz. frequency on your 60 Hz. Power Line. The way it works is a zero-crossing signal is derived from the transmitting unit by monitoring the power waveform. Once this point is determined, a series of codes are sent out by synchronizing the timing of the presence or absence of this 120 KHz. signal at given intervals. The device on the other end decodes these signals and if the HOUSE CODE and CHANNEL matches... bingo...the unit responds to the command.

Rather than go and redesign the controller itself, we decided to take advantage of Radio Shack's Mini-Controller (#61-2677) and modify it to satisfy our needs. It's actually cheaper to do this than to buy the parts. A better part of Engineering is to determine which of many options at each stage of development yields the best result for the money! Now, we're going to assume that you've already purchased the controller and we will begin the details of how this modification will be made.

MODIFYING THE CONTROLLER

Remove the unit from the box, and discard the paperwork and packing materials. You won't need the warranty because the modifications will immediately void it. But rest assured, if you follow the directions, you shouldn't have any problems.

Start by removing the four Phillips screws from the bottom. Once removed, the enclosure will separate into two halves with several items mounted between the top half and the PCB. These will include six rocker switches, the rotary HOUSE CODE switch and the CHANNEL RANGE slide switch. All of these will be discarded so don't worry when the pieces fall out. You won't have to put them back in.

Once you separate the PCB from the case, you'll notice some metal buttons taped down to the top of the PCB. These are the actual switch contacts which the rocker switches operate. Remove the tape and discard these as well. We won't be using them either. The whole idea is to get the circuit board down to a point where we can modify it to suit our needs.

If you will examine the PCB, you'll see that the slide switch has 3 contact areas. The one in the middle goes to + Vcc on the PCB. This is the source of power for the HOUSE CODE and CHANNEL RANGE addressing. This hookup is covered in the spreadsheet entitled 'Interface Pinout' on the website. Basically, you need to arrange 6 DIP switches and tie + Vcc to one side of all 6 switches and the other side to the IC pins noted. These pin numbers, of course, correspond to the only IC on the controller, NOT to any of the interface we are constructing. We will be using Opto-Isolators to couple the signals between the VoiceDirect system and the X-10 system. Please note that these systems are ELECTRICALLY ISOLATED from each other for safety reasons and there should be no interconnecting wiring between them. Please note that the Opto-Isolators used provide over 5,000 volts of isolation between each system.

The next step involves the actual wiring to the Opto-Isolators. If you will examine the PCB for the 12 locations where the snap metal contacts were previously installed, you will see that each position consists of a CENTER contact and 3 RIM contacts. The 3 RIM contacts are connected together. In fact, the UPPER set of RIM contacts are tied together and go to + Vcc THRU a 3.3K Ohm resistor (labeled R9 on the PCB). You'll notice the LOWER set of RIM contacts are tied together and go to DC Common. This is located on pins 13 and 17 of the IC as well.

You'll also notice that the CENTER of each UPPER and LOWER contact are tied together and go to one of six pins on the IC. These details are covered on the interfacing schematic as to which goes where. Be sure to observe the proper hookup to the Opto-Isolators because the CENTER of the UPPER contacts goes to the EMITTER. The CENTER of the LOWER contacts goes to the COLLECTOR. This is done because the COLLECTOR has a positive reference in regard to the EMITTER. The UPPER row is referenced COLLECTOR to + Vcc (thru R9) and the LOWER row is referenced EMITTER to DC Common. This should take care of the actual modifications of the X-10 PCB. However, if you want, you can carefully cut the PCB in half with a hacksaw to eliminate the unused portion which the switches occupied. I say do this CAREFULLY because the PCB isn't fiberglass reinforced and can crack if you're not careful.

VoiceDirect Module

This is the heart of the system. The Voice Recognition Kit comes as a fully-functional module with microphone, speaker, and switches included. We will configure it for the standalone mode of operation by placing a jumper between terminals 12 & 13 of JP3. Rather than duplicate the setup, please turn to page 3 of the instruction manual which accompanies the kit. You'll see a complete wiring diagram for hookup. Although only the first 3 outputs are shown, the rest follow in order (outputs 4-8 are JP2 terminals 15-19). This should be clear enough once you look at the documentation. Now, let's take a step-by-step look at the interfacing in order that you will have a complete understanding of the system's operation.

Control/Timer Interface

The Control/Timer Interface is the circuitry which initiates the recognition mode, disables the recognition mode, provides logic for the high channel multiplexer, and provides timing for the system prompting. We'll cover the multiplexing in the next sections. IC 1 is a 4001 quad NOR logic gate. Half of it is used as a Set-Reset Latch. The output is tied to the reset pin of the 555 timer chip (IC 2). As long as the reset is LOW, the timer is disabled. By bringing pin 8 of IC 1 HIGH, the timer chip is enabled and begins its timing function. Once a timing cycle is completed, the recognize pin (terminal 10 of JP2) is toggled low and the system will prompt you for a response. We'll cover this more in detail on the startup and training section later in the article.

Low Channel Multiplexer

The VoiceDirect Module has an interesting decoding sequence for the 15 channels of outputs. It uses outputs 1-8 verbatim, but it uses output 8 together with outputs 1-7 to generate outputs 9-15. Because of this, a simple decoder has been implemented. We decided to use a 74LS245 octal bus transceiver chip. We'll be strapping the Data Direction line to send data in one direction only. We have tied the ENABLE LOW line to VoiceDirect Output 8 which will enable the outputs thru a buffer when channels 1-7 are selected, and DISABLE them when VoiceDirect Channel 8 is HIGH.

High Channel Multiplexer

We've run the ENABLE LOW line thru one of the NOR gates of IC 1. This DISABLES the upper channels because the Enable line is inverted in relationship to the Low Channel Multiplexer. This means that when VoiceDirect Output 8 is LOW, the High Channel Multiplexer is DISABLED. And when VoiceDirect Output 8 is HIGH, the Enable line on IC 4 is LOW, and these outputs are enabled. This provides a simple solution to the channel selection problem.

Command Interface 1-2-3

These 3 schematics are identical in operation. Once the decoding has taken place thru the multiplexers, the outputs are coupled thru 220 Ohm current limiting resistors to the Opto-Isolators. These units have an LED on one side and a photo-transistor on the other. This transistor is NPN which means that the collector is more POSITIVE in respect to the EMITTER. As we discussed previously in the controller modifications, it's real important to observe the polarities on these devices. One backward connection will create problems so be careful!

Power Supply

A separate power supply is required because the controller is unable to supply the power required for the interface circuitry. Using a standard step-down transformer, full wave bridge, filter capacitor, voltage regulator, and bypass capacitor. Be careful with the polarity of all components and check your power supply BEFORE tying it to the rest of the system. If you don't have ~ 5.0 VDC, find the problem. Solid state devices are VERY UNFORGIVING of either reversed polarity or overvoltage.

The Vocabulary

This is where it gets real interesting. Because the wiring is configured to correlate word # with system function, we'll go ahead and define that here. They are as follows:

<u>Word #</u>	<u>Function</u>
1	1 st Channel ON
2	1 st Channel OFF
3	2 nd Channel ON
4	2 nd Channel OFF
5	3 rd Channel ON
6	3 rd Channel OFF
7	Silence
8	Multiplexer (not used separately)
9	4 th Channel ON
10	4 th Channel OFF
11	Brighten Lights
12	Dim Lights
13	All Lights ON
14	All Units OFF

Hopefully, you won't be thoroughly confused at this point. Let's go over this in finer detail. The VoiceDirect module will prompt you for words when it is in the Training mode. More on the actual procedure later in the article. The first convention we need to understand is that you can have a 1st-4th channel. Depending on the CHANNEL RANGE selected via the DIP switches to the controller, those channels can correspond to 1-4, 5-8, 9-12, or 13-16. That's why we have labeled them in this way.

The next convention we need to understand is using VoiceDirect Channel 7 for a Reset function. We did this because we have paired the functions together (as evidenced by the way we formatted it in the table). If we had a component failure (such as an IC failed) we didn't want you to be able to turn ON the lights without also being able to turn OFF the lights. For that reason, we wanted to give you the ability to silence the system in the lower channels. We also decided to reserve VoiceDirect Channel 8 for multiplexing only. Otherwise, you'd be activating another function each time you selected a High Channel function.

The rest of the assignments should be fairly straight forward. We don't use VoiceDirect Channel 15 in the project, but you can modify the High Channel Multiplexer to enable a 15th channel...should you have the need. One final note which is covered in more detail in the kit documentation. The more successful you are in making your phrases different from one another, the more successful you will be in having your commands recognized. Try varying the number of words per phrase, the number of consonants per word, and the order of word phrases. For example, you can have 3 words on all your phrases, but you should vary the number of consonants in order. **Bedroom On** has two words in a 2,1 consonant order. **Everything On** has 2 words in a 3,1 consonant order. By using a little insight and forethought, you too can enjoy the satisfaction of a Speech Recognition System which obeys your commands...

Setup and Training

You will need to remove IC2 (555 timer chip) from the circuitry before energizing the system. It goes without saying that you should invest in sockets for everything and check your wiring before installing any IC's. I always energize the circuit without IC's installed and check voltages at Vcc and DC Common (or Gnd). You can save yourself a lot of grief this way!

You'll probably notice the reed relay controlled by the timer output. It's there to allow you to select training mode as strict or relaxed. Any solid state device here would affect recognition accuracy and complicate things. You'll see that the relay output is tied to the RECOGNIZE line on the VoiceDirect Module. The push-button pulses this line LOW for recognition mode. When the IC is installed, it pulls the line LOW all the time and the system won't initiate Recognize Mode. It also keeps someone from pushing buttons and erasing your voice template with the chip installed. You'll notice in the schematic that the Training and Reset push-buttons are wired normally.

Now...it's time to energize the system. You'll go through the standard Training Mode and then initialize the system. The system will be silent until you ENABLE it. We have left this option wide open for your IMAGINATION. Let's offer you a few suggestions though. A push-button, a proximity detector (see Quantum Research on the links page for complete details), a photocell, a motion detector, a temperature sensor, a sound sensor (like a clapper or whistle switch)...and the list goes on and on...

As you have noticed by now, we didn't design a microcontroller interface for this product. The VoiceDirect Kit has it's own microcontroller internally to take care of all the functions we needed. The system will prompt you for the words, tell you if it can't recognize it and why, and even tell you which output it is about to energize. This is an incredible device! You won't believe what else we're developing but we'll keep that under wraps until the appropriate time.

As you can probably tell, we're very excited to bring you such an innovative product. And we've just scratched the surface. We are a consulting and engineering firm and we want to be service to you. If you can think of some device you'd like to have designed which includes Speech Recognition...let us know. We can develop a cost-effective solution to suit your needs in a professional environment.

Pricing and Availability

Since we are a distributor for the Sensory Inc. VoiceDirect kits, we aren't selling anything EXCEPT the kit. All other components are available elsewhere. We recommend Digikey Corp. for the interface parts and Radio Shack for the mini-controller and power supply components. The cost is \$ 55.00 postpaid within the continental U.S. This includes the retail cost of \$ 49.95 FOR THE KIT and \$ 5.05 for postage and handling. And, of course, we'll ship anywhere in the world if you pay the additional postage. Be sure and make your payments payable to: Dennis Shepard.

Because we expect a tremendous demand for the kits, we don't want to be caught short-handed. Please email us when you mail your order so we can make sure we have enough kits in stock. That way we can ensure that we will be able to continue our company policy to "ship the same day the order is received". Please let your friends and colleagues know about us...thank you again for your continued business.

<http://home.att.net/~dennis.shepard>