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Z-System Corner

Dr. S-100

Home Automation with X10

Real Computing

File Transfer Protocols

MDISK at 8 MHZ.

Introduction to Forth

Shell Sort in Forth

Z AT Last!

The Computer Journal

Founder

Art Carlson

Editor/Publisher

Bill D. Kibler

Technical Consultant

Chris McEwen

Contributing Editors

Brad Rodriguez

Matt Mercaldo

Tim McDonough

Frank Sergeant

Clem Pepper

Richard Rodman

Jay Sage

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Special Feature

All Readers

CP/M Automation

Home Automation with X10

by Rick Swenton

Here is an article that explains about using the appropriate system for the job. I think Rick shows what I have been talking about by using a CLASSIC system for modern day projects. The article also says all there is to be said about the current state of house and business controls. I do not think I have seen such a complete review as Rick provides. Great research job! BDK

HOME AUTOMATION

If you are an electronic hobbyist like me, you are likely involved in some kind of electronic wizardry in your home. Soon, you are bitten by the remote control bug. It is all around you! VCR, Stereo and TV infrared controllers, radio controlled garage door openers, photo electric and motion detectors, even people detectors for smart lighting control have invaded our homes.

Soon you discover a need to control AC line powered devices like lamps and appliances. You also wish you had switch wiring located at places you never thought you would ever need them. Enter the X10 Powerhouse system.

The X10 system is a versatile way to control lights and appliances by sending control signals through the existing house wiring. Using X10, you can control lights or appliances from anywhere in your home without the need to install special wiring. All you need is an AC outlet at each end.

Two basic parts are needed for a minimum system: A transmitting device and a receiving device. There is a wide variety of each in the X10 system. Transmitting devices come in the form of control units with ON/OFF/DIM switches

as well as radio controllers, infrared controllers, clock timers and an interface unit which can be operated with a contact closure or low voltage input.

Receiving units come in the form of lamp modules or appliance modules which plug into the wall receptacle, replacement wall switches, replacement duplex outlets, and interface modules with relay contact outputs.

The transmitting devices are called "controllers". The receiving devices are called "modules".

The formal name for the system is called "X10 Powerhouse". This is the same system sold under other names such as Radio Shack's "Plug 'n' Power". Compatible systems are sold by Sears, Stanley (Lightmaker), Heathkit and X10(USA) itself.

The most versatile X10 component is the CP-290 computer interface. This is a smart interface which connects to your computer's serial port and allows you to send commands to your X10 system. Before I discuss the details of the CP-290, perhaps you might like to know more about the X10 system and its components. After you go wild installing all these X10 components around your house like I did, you will soon discover how nice it would be to interface your home to your computer with the CP-290 interface.

Here are some of the features, in detail, of the X10 system:

All devices share some common features. The X10 system supports 16 separate unit codes in 16 separate house codes to yield a maximum support of 256

modules. You could have more than one module on the same address if you desired. By X10 convention, the house codes are lettered A through P and the unit codes are numbered 1 through 16. This means that the address of a device can range from A1 through P16. The original concept of the house code was to cope with things like people in an apartment building using X10 systems fed from the same power line. Each apartment could use a different house code but each would be limited to 16 devices. The success of such a system relies on the mutual cooperation and coordination of the users. In a single home located a sufficient distance from the neighbors, the house codes could be thought of as "zones" in the single house. For example, I have each floor in my house assigned to a specific house code. This means that an "All Units OFF" command issued from a first floor controller would only turn off all units located on the first floor.

Controllers:

There are several X10 control devices which send commands over the power lines. The smallest is the MC460 Mini-Controller. This device can control 8 modules (only the first 8 unit codes, it can not address modules 9 -> 16). It has switches for "All Lights On", "All Off", "Dim" and "Bright". The SC503 Maxi-Controller has all these features too but supports all 16 addresses instead of only 8. The TR2700 Telephone Responder allows you to control your first 8 unit codes over the phone and the RC5000 controller allows you to control the first 8 unit codes by radio remote control.

For timer controllers, there is the MT522 which allows you to manually control 8 modules and timer-control 4 modules to go on or off at specific times up to twice a day. It also has a security mode to simulate random on/off operation while you are away from home. The CR512 has all of the features of the timer-controller built into a clock radio. Both have battery back-up.

Another device which falls into the category of controller is the BA284. X10 calls this unit a Burglar Alarm Interface. Radio Shack calls it a Universal Interface, and I like this name better. This unit is a small box which plugs into any outlet. You would use this unit to control X10 modules with an external voltage or contact closure. You can configure this unit to control a single module of any type. You can also configure it to transmit the "All Lights On" command in addition to a single selected unit code. Finally, you can configure it to flash all your lights on and off, such as would be the case if you interfaced it to your alarm system. This interface is very versatile.

In general, the house code is selected with a thumb wheel or screwdriver operated rotary switch on controllers. While controllers can control all 16 house codes, it is mostly inconvenient to change the house code as though it was a user-operated feature. Usually, you dial-in the house code on a controller and leave it set.

Modules:

The LM465 Lamp Module is a small box which plugs into any AC outlet and can control up to 300 watts of incandescent light. It can dim or brighten the lamp and responds to the "All Lights ON" and "All OFF" commands.

The LM486 (2-prong) and LM466 (3-prong) Appliance Modules are also small boxes which plug into the AC outlet. They control their loads with a relay so they can operate things like TV's and air conditioners, up to 15 Amperes. Appliance modules do not respond to the "Dim" or "All Lights On" commands

but they do respond to the "All Units Off" command.

The SR227 is a duplex outlet which can control a 15 A load. This unit is a replacement for your existing wall outlet and unless you know what you are doing, you would be better off enlisting the help of an electrician. Like the appliance modules, the duplex outlet module does not respond to the "Dim" or "All Lights On" commands but it does respond to the "All Units Off" command.

The WS467 and WS4777 (3-way) are wall switch modules. They replace your existing wall switch and can control 500 watts of incandescent lamps. Consult with your electrician on this one too. If your wall switch controls wall receptacles in the room, keep in mind that these modules can only handle light bulbs and they may overheat or could even cause damage to anything other than a light plugged into the receptacle. Like the LM465 Lamp Module, the Wall Switch Modules can dim or brighten the lamp and respond to the "All Lights ON" and "All OFF" commands.

The HD243 (15 AMP) and HD245 (20 AMP) are heavy-duty plug-in modules to control high current 220 volt loads like air conditioners.

Finally, there is the TH2807 Thermostat Set-Back. You think I meant "Set-Back Thermostat" but I didn't! This unit is actually not a thermostat. It is simply a heater. You install it on the wall under your existing thermostat. When it is connected to an appliance module, you can use your control of the appliance module to operate the heater. When the heater heats the air around your thermostat, it "fools" it into thinking that the room is warmer than it really is, so it doesn't call for heat.

Of special interest to us hardware hackers are the BA-284 Universal Interface and the BA-506 Universal Module. The Universal Interface is essentially a controller which operates with a voltage or contact closure instead of the push of a button. The Universal Module is essentially a plug-in module but instead of an

AC receptacle for the load, it has two screw terminals with dry relay contacts.

Typical Applications

The X10 system can be put to work in many applications around the home or business. In my house, there are several lights which are timed to turn on and off automatically. Almost every room is equipped with an X10 wall switch. This means that the room lights can be turned on and off from the wall switch and from any X10 controller. Having an X10 controller located at the exit door allows me to use the "All Units Off" command to be sure the kids didn't leave their bedroom lights on. It saves me a trip to the second floor. Another application is a timed vacation schedule which is programmed to make the house appear to be occupied because the lighting in every room closely -- but not exactly -- resembles our normal activity. The timer security mode varies the timed events each time they are sent. My favorite application involved stealing a commercial idea which allowed your garage door opener to also control a remotely located light. I used a BA-284 Universal Interface and connected it to the lamp control relay in my garage door openers. I used an opto-coupler on each opener lamp relay and simply connected their output transistors in parallel to form an "OR" gate. When either opener lamp comes on, the large fluorescent lamps in the garage come on too.

A microswitch on each door is connected in parallel with the opto-coupler transistors. The switches are installed to be activated by the door in the up position. When the door is up, the garage fluorescents stay on, even after the opener lamp times-out.

At the office, I have an appliance module connected to the FM radio which plays music-on-hold into our phone system and background music into the office. All the equipment is located in the back room except for the X10 Mini-Controller located at the front desk. When the office staff reports to work, they can skip the daily excursion into the

back room and turn on the radio from their desk.

At church, I installed an appliance module on the sound system amplifier. In addition, I installed a universal module (dry contact closure) in parallel with the output of the FM wireless microphone receiver. Our church is located at a very high elevation and the FM wireless mic receiver picks-up many other signals when our portable mic is not powered-up. Now, from several locations in the church, we can disable the wireless mic receiver if we are not using it. You may ask why not just use an appliance module on the receiver's AC power line. Well, turning on the power causes a thump in the sound system as the receiver comes on. Putting the dry contacts in series with the audio leaves an open circuit (noise potential) at the amplifier input. Placing a short on the audio definitely mutes the audio from the receiver as well as any potential noise.

In reality, X10 applications are unlimited. You can turn on your sprinklers to water your lawn. You can control your heating and air conditioning. Using a special X10 interface, you can send and receive X10 commands using a dedicated controller such as the one Jay Sage has been describing. This interface, called the TW523, consists of only the very basic circuits to interface to the power line. Your host software must do all the timing in order to send or receive X10 codes. The nice part is that this box plugs directly into the wall receptacle. You connect to it with a modular phone jack. It isolates your controller safely from the power lines. Purchase of the TW523 gives you permission to use the proprietary X10 format signals.

One of my personal goals is to develop a custom system, similar to Jay's, but use X10 as the primary access to AC power control. I also envision a CRT screen used as a status board to scroll through displays of heating/air conditioning, lighting, and watering. It will also have a phone line interface to allow commands to be received remotely or even entered from any phone in the house. It will have a clock to schedule pro-

grammed events including security lighting and temperature set-backs.

Ken Davidson authored two articles about the power line interface. They appeared in the May/June 1988 and September/October 1988 issues of Circuit Cellar Ink. These articles are essential if you intend to integrate the interface into a dedicated controller system.

The Ultimate X10 Controller for Computer Junkies - The CP-290

The CP-290 is an intelligent interface to control your X10 modules with your computer. It connects to your serial I/O port and communicates in a manner very similar to an intelligent modem. Using the CP-290 you have the ability to turn units on or off directly from your computer keyboard as well as the ability to program the CP-290's event timer. There are 128 individual programmable events which can be set to turn things on or off at any predetermined time for selected days of the week. The CP-290 maintains an internal 24-hour 7-day clock. You do not need to keep your computer on or even connected to the interface. The interface will keep on transmitting the programmed event information over the power lines at the correct times. There is an internal 9-volt battery to maintain the programmed information during power failures.

The CP-290 comes with software. Only Apple-IIe, Commodore, Macintosh or IBM-PC software is available from X10. Other computers are supported by private companies but none, to my knowledge, have any commercial software available for use under CP/M. This is understandable since each CP/M computer accesses its serial I/O ports differently. At the time I purchased my CP-290, I only owned CP/M computers so the IBM or Macintosh software was of no value. It was obvious that if I wanted a comprehensive software package to run my CP-290 interface on CP/M systems, I would have to write one myself.

If you looked at the Programming Guide which came with the CP-290, you would quickly realize that it is no simple matter to write a program to control the inter-

face. The microprocessor in the CP-290 is a relatively simple controller with only 8K of RAM. The firmware command instructions are not consistent. All have a different number of bytes and most bytes have bit-mapped definitions. This means that for a program to talk to the CP-290, not only must it know how many bytes to send, it must also know which particular bits within certain bytes must be on or off.

Eventually I was able to develop a series of programs in Z80 assembly language to access the features of the CP-290. As time went on, I consolidated the individual utilities into one single program. Finally, with the help and encouragement from Al Hathway and Biff Bueffel, we honed and polished X10.COM into a full-featured program for CP/M and Z-System.

To give you a taste of the program, see the Menu Display on the next page.

X10.COM can run in menu mode or from the CP/M command line. Here is an example of a typical X10 command entered from the command line. This command will turn-on a light with address D12 and dim the lamp to level 9.

```
X10 NOW D12 DIM 10
      |   |   |
      (1) (2) (3)
```

(1)-- House/Unit Code - A ->P, 1 -> 16 or ALL

(2)-- Function - ON, OFF or DIM

(3)-- Dim Level - 1 (dim) -> 16 (bright)

The CP/M command line is an ideal way to pass all the X10 commands to the CP-290 interface through ZCPR3 Aliases or other scripts.

It should be noted that the Libraries were used extensively during the development of X10.COM. SYSLIB, VLIB, Z3LIB, DSLIB and ZSLIB provided routines which greatly enhanced the power and versatility of X10.COM without having to re-invent the wheel at every turn. The Libraries made programming in Assembly Language a pure joy! This allowed us to create a program which ran well under ZCPR3 / NZ-COM as well as plain CP/M.

The hardware specific software for X10.COM is contained in an overlay file similar to IMP and MEX. We have provided overlays for many popular systems as well as a generic overlay to help you create a custom installation. The overlay also contains a spot for the terminal definitions. The terminal definitions are only required to run X10.COM under plain CP/M. We have an internal environment and TCAP in X10.COM because we wanted to create ready-to-run COM files for Heath and Kaypro which would run under plain CP/M. If you are running ZCPR3, X10.COM will use your currently defined terminal in the ZCPR3 TCAP.

X10 Mega-Systems

At the very high-end of X10 systems are commercially available products not provided by X10 USA but which use all X10 products as system accessories. These systems are usually found in the million-dollar mansions with the separate Audio/Video room which has electric drapes on the wall screen for the projection TV and a custom built 200 slot laser disc juke box.

The Enerlogic ES-1400 is a microprocessor based intelligent home control system. It uses an IBM (tm) compatible PC as the human interface but does not need the computer to be on or even connected to perform automated tasks (just

like the CP-290). What's special about the ES-1400 is that it is a TWO-WAY INTERFACE. It can also receive commands from other controllers and then make an intelligent decision based on the command just received. This opens the door to macro commands where the touch of one button somewhere in the house will cause the ES-1400 to "re-map" that command into a series of other commands which can occur now or at some time in the future.

Some of the suggested applications are to use motion sensors to turn-on selected room lighting when you are home but have them activate the alarm system when you are away.

The Enerlogic ES-1400 sells for about \$370.

The JDS Telecommand System 100 is a microprocessor controlled telephone interface. This unit will allow you to send any X10 command from any Touch-Tone (tm) telephone. This includes all phones inside your home as well as dial-up from outside. Think about it. You could call your home from the cellular car phone and start the air conditioning on that hot summer day while you are on your way home from work!

The Telecommand System 100 sells for about \$450.

Starting at \$2,000, Home Automation Inc. has the system for you. This is a microprocessor controlled "whole-house" system. This single unit provides two-way X10 interface, scheduling, heating/air-conditioning interface with temperature control, macro commands, 21-zone coverage for fire, burglary or emergency, alarm system with auto dialer and digital speech messages (name, address, type of emergency, etc). It also has local and dial-up telephone control.

The Future

X10 is the simplest way to control things without installing wiring by using existing AC power lines. The X10 system has been around for many years, so it is a proven system. However, X10 is not compatible with the new CEBus standards which are emerging today. CEBus (Consumer Electronics Bus) is a new way for devices in the house to communicate with each other, regardless of the manufacturer. CEBus can use power line, phone line, coax, infrared, RF or any combination to communicate. On the power line, it uses a scheme similar to X10 but at a higher speed and capacity. With CEBus, you could in theory program a scheduled event into your VCR from the front panel of your microwave oven! CEBus opens the door to phones, thermostats and alarm switches sharing the twisted pair wiring, appliance control sharing the power line wiring, and the audio/video sharing the coax wiring with routers interconnecting the three media and translating events between them. Of course, the consumer products need to be manufactured with the CEBus capability built-in to take advantage of the system.

Compatibility with CEBus could diminish your X10 investment in the near future. However, there are clever people out there who would enjoy developing a bridge between X10 and CEBus. It shouldn't be that hard to do.

Conclusion

The X10 system is a powerful and versatile system to control lights and appliances around the home without the need

```

+-----+
|  |||  X10.COM --> X-10 CP290 Computer Interface for CP/M  |||  |
|  |||  Copyright 1989, 1990, 1991 by Rick Swenton  |||  |
+-----+

Current Drive/User: C10:                               Version 3.3

+-----+
| Primary Commands                Secondary Commands        |
+-----+
[N]ow      - Immediate direct command  [A]rea     - Change drive/user
[E]vent    - Program an event          [B]ase     - Change base housecode
[U]pload   - Upload events from disk   [D]ownload - Download events to disk
[R]ead     - Read and display events   [P]rint    - Print Events on Printer
[C]lear    - Clear selected Events     [T]ime     - Display the Time/Day
[F]iles    - Display UPLOAD files      [S]et      - Set the Time/Day
[H]elp     - Help with specific commands [I]nterface - Diagnostic self-test
[M]onitor  - Display Activity

+-----+
| [Q]uit   - Exit the program (also X or ^C) |
+-----+

Enter selection:

```

to install special wiring. The CP-290 Interface makes it easy to control your home by programming events on your PC clone or better yet, your new YASBEC system! Once you get started with the basic X10 system, it is very difficult to break the habit of expanding the system on a weekly basis. It took a little time for my family to acclimate to the unconventional light switches and power controllers. Now, it is a way of life.

Publications:

Electronic House
747 Church Road, G-11
Elmhurst, IL 60126-1420
(219) 256-2060
\$14.95 per year MC/VISA/AMEX

Circuit Cellar INK
4 Park Street Suite 20

Vernon, CT 06066
(203) 875-2751
\$17.95 per year MC/VISA

Other:

There is a special user area in GENie dealing with Home Automation. GENie is an on-line subscription computer service. In the Home Automation area in GENie, you will find a roundtable -- a two-way dialog of people interested in home automation as well as computer programs available for downloading.

To sign-up for GENie, call client services at 1-800-636-9636 or write

GE Information Services
401 North Washington Street
Rockville, Maryland 20850

The program X10.COM is available for downloading on GENie. Version 3.3 is

called X10-C33.LBR which contains ready-to run COM files for Heath, Kaypro, Ampro and SB-180 and the Users Manual. X10-S33.LBR contains the source code files including the overlays and extended TCAP files.

X10.COM is also available on the TCC BBS (203) 673-8752, Jay Sage's BBS (617) 965-7259 and several RCP/M systems on the west coast.

Biff Bueffel is currently preparing release 3.4 of X10.COM and should be available "real soon now".

The following notes pertain to the Cross-Reference table:

* DAK is currently having financial problems and may be in the midst of bankruptcy proceedings. It's possible that some good deals may be available

Cross-Reference of X10 Products

Product	X10	HeathKit*	Radio Shack	Crutchfield	DAK*
Lamp Module	LM465	BC-465	61-2683	009LM465	9779
Appliance 2 prong	LM486	AM-486	61-2681	009AM468	
Appliance 3 prong	LM466	BC-466	61-2684	009AM466	
Wall Switch	WS467	BC-467	61-2683	009WS467	9780
Wall Switch 3-way	WS4777	BC-4777	61-2686	009WS4777	
Wall Receptacle	SR227	BC-227	61-2685	009SR227	
220V 15A Appliance	HD243	HD-243			
220V 20A Appliance	HD245	BC-245			
Thermostat Set-Back	TH2807	BC-2807			
Mini Controller	MC460	MC-460	61-2677A		
Maxi Controller	C503	BC-503	61-2690	009SC503	4622
Radio Controller	RC5000	BC-5000	61-2675	009RC5000	4712
Telephone Controller	TR2700	BC-2700			
Universal/Alarm	BA284	BC-284	61-2687		
(Interface external system inputs such as alarm systems)					
Universal Module		UM-506			5690
(Interface external system outputs such as sprinklers or drapery openers)					
Whole House Control		URC-5000			
(Infrared hand-held VCR-style remote control for X10 and TV/VCR/Stereo, etc)					
Command Center		URC-3000			
(The receiver portion needed with the hand-held URC-5000)					
Sensor Chime		SL-5321			
Timer	MT522	MT-522	61-2679	009MT522	4973
Timer/Radio	CR512				
Computer Interface	CP290P	BC-290P	905-2087	009CP290P	

now or in the future. There's also some risk.

HeathKit has ended production of electronic kits. At this time, they are still in the home automation products business.

The Computer interface CP290P comes with a serial cable which can directly connect to the H89 modem port 330. The other H89 serial ports can be used but the gender of the connector needs to be changed from female to male and pins 2 and 3 need to be swapped.

You can order any product directly from X10 (USA) Inc. They accept major credit cards. You can also stop into your local Radio Shack store for most of the common products.

X10 (USA) INC.
91 Ruckman Road
Closter, NJ 07624-0420
(201) 784-9700
(800) 526-0027

DAK Industries
8200 Remmet Ave.
Canoga Park, Ca 91304
(800) 325-0800 - Order
(800) 888-9818 - Tech Info

Crutchfield
1 Crutchfield Park
Charlottesville, VA 22906
(800) 446-1640

HeathKit
Benton Harbor, MI 49023
(800) 253-0570

Radio Shack
1500 One Tandy Center
Forth Worth, TX 76102
(817) 390-3011

Home Control Concepts
P.O. Box 27983
San Diego, CA 92198
(800) 828-8537 Order (cards ok)
(619) 484-0933 Info and Support
HCC is a high volume distributor carrying a wide variety standard and EXOTIC X10 Products. They do have a \$100 minimum order but prices are low!

CLASSIFIED and FOR SALE

For Sale: Televideo terminal boards. Have 3 of 950 and 1 of 925, still in working order. I am willing to remove all electronics from the case and ship to you. \$25 each, plus UPS shipping fees. Call Bill at *TCJ*, (916) 645-1670.

For Sale: HP2621 terminal with printers. These HP terminal were working, but recent moving has damaged some cabling. Will take out all boards and ship to you for \$25 each, plus UPS shipping. Call Bill at *TCJ*, (916) 645-1670.

For Sale: Lexidata 3400 RGB CAD system. High resolution graphic station without any docs. Will sell boards (6809 video CPU) or entire system. Can ship boards, but cabinet and power supply too heavy. Entire system includes monitor and would require motor freight, \$250. Small parts or boards are negotiable (else will part it out). Call Bill at *TCJ*, (916) 645-1670.

For Sale: GIMIX 6809 SS-50 floppy disk controllers. Have six to sell at \$25 each. These are like new and docs maybe had

for a fee. An entire system is available with software and documents. If interested contact Bill at *TCJ*, (916) 645-1670.

The Computer Journal Classified section is for items FOR SALE. It is priced and setup the same as *NUTS & VOLTS*. If you currently have an ad running in *NUTS & VOLTS*, just send us a copy of the ad and your invoice from them, along with your check, and we will publish it in the next *TCJ*.

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SUPPORT WANTED

Wanted: SAGE/Stride CP/M68K or UNIX software. Have a SAGE IV, (actually II but labeled wrong - a real classic) with 500K of memory. Also looking for hard drive for same. Want source code for CP/M BIOS and BOOT disk. Have entire P-System with source for that BIOS and ROMs. Complete set of DOCS and will copy what you might need in exchange for software and or support. UNIX may not run on my system, but feel that I need to collect this information before it disappears for good. Call Bill at *TCJ* (916) 645-1670.

Wanted: Help with NORTHSTAR ADVANTAGE, these hard sectored disk systems are still running, but hard to get disk for. Need modem program and other support software on hard sectored disk. Any modifications to go soft sector out there??? Contact Jack care of *TCJ*, (916) 645-1670.

Wanted: Software and advice on HP 125. Is there anybody in my area that can help me? How about local clubs or organizations? Leslie Jones, 1206 Overdale Rd., Orlando, FL 32825, (407) 240-2189.

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