# Build the Home Automation Gateway and control your home using QuickBasic programs, HomAtion 2000, or CyberHouse.

**Introduction:**
Have you been interested in automating your home, but want to do more than simply turn lights on and off using X10 from Powerhouse or Radio Shack? Have you wanted to integrate infra-red remote control, your hardwired devices such as security alarms and sprinklers, your personal computer and your X-10 controlled devices without paying the big ticket prices of high-tech home automation systems? Well, the Home Automation Gateway (Gate Way) does just that. This simple cost-effective device does all of those things. It 'connects' your PC via RS-232 to two way infra-red communications, two way X-10 power line carrier communications, hardwired inputs and hardwired outputs! You can write your own basic programs or use HomAtion 2000 or CyberHouse to control the Gate Way. This month, we'll build the X-10 and input/output section. In August, two way infra-red communications using the Gate Way will be covered.

**Usage:**
When the Gate Way is connected to your computer, you can write simple programs that 'listen' to inputs from virtually any infra-red universal remote controller, hardwired switches and sensors, and X-10 signals from your power lines. Then, based on your program, you can command the Gate Way to turn sprinklers on and off, activate alarms and electric door strikes, send X-10 commands to your lights and appliances, or send infra-red commands to your audio/video equipment.

**Construction:**
After completing part 1 of the construction, you can begin your testing. Construction for each subsequent part is optional, based on your needs.

*Part 1: Hardwired inputs and outputs:*

Photoplots have been provided if you wish to etch and drill your own circuit board. A fabricated circuitboard is available from the source list. Refer to **Figure 1** for the component locations.

Step 1: Power Supply Section:
Install Cpwr, U5, and Ctr3 to provide the Gate Way with the required regulated 5 volts. Any 9 volt 500 mA DC power adapter with a center positive 2.1 mm radial connector will be an adequate power source for the project. See the part's list for available sources.

Step 2: Digital Core Section:
Begin with the U1 socket. Because this board is a through-hole design, you will need a 52 pin PLCC socket to easily solder to the board. Install all microcontroller support circuitry and components: Rxtal, Xtal, CX1, CX2, Crst, Rrst, RXIRQ, RIRQ, CA2D, and RVh.

Step 3: RS-232:
Next, proceed to the installation of the RS-232 section. Install U4, U6, SCIC1, SCIC2, SCIC3, SCIC4, SCIC5, Rtx, Rrx.

Step 4: Inputs
Now, install RA1-RA8, RN1, and CTRA2D.

Step 5: Outputs:
The output section consists of U3, REL1, REL2, REL3, and REL4, along with CTR1A, CTR1B, and CTR1C.

*Part 2: Two way X-10 Communications:*

Step 1: Install the RJ-11 connector Ctr2 to interface to the TW-523.

Step 2: Install the resistors and diodes: Rx10_1 through Rx10_8, Dx10_1 through Dx10_6. Pay close attention to the placement of the diodes. The anodes (black lines) should be facing CtrA - Ctr C as shown on the silk screen. Install Qx10_1 with the flat side facing away from CtrA-CtrC as shown on the silk screen.

Step 3: Connect your TW-523 (available from suppliers in the source list) to the Gate Way using an **inverting** four conductor phone cord (also available from suppliers in the source list). Note: An inverting RJ-11 cord is one that when laid flat, the ends are exactly opposite each other. A non-inverting cord has one end flipped opposite of the other end.

**Testing:**
Now that the construction for this month is complete, we can begin testing.

**Establishing communication**: Testing RS-232
Using any terminal program, connect the Gate Way's RS-232 port to any serial port configured to 9600 baud, 1 start bit, 8 data bits, and 1 stop bit with no parity. Then, power up the Gate Way.
The Gate Way will always respond upon power up with a 'System Reset' message. The user can quickly determine that RS-232 transmit and receive is operating properly by sending an 'S'. Note that the Status Command 'S' must be capitalized. Send a carriage return <CR> at any time to clear the command buffer. Sending the 'S' requests that the Gate Way report the current status of it's operation. If it is not currently doing anything, a 'System Idle' response will be reported.

Checkout Inputs:

Inspect all solder joints and connections to your board. If everything looks OK, connect the Gate Way to your computer. Upon powerup, you should read 'System Reset' on the terminal screen followed by the status of all the digital inputs. If nothing is connected to the input section, the display should read:

System Reset
D71
D61
D51
D41
D31
D21
D11
D01.

Note: If you have any shorts to ground at the inputs, or have any input tied to ground, the status of that corresponding input will not be reported until it is either queried using the query 'D<CR>' command, or the input changes state. Now, take a grounded wire and touch each of the 8 inputs. For each time you ground an input, the Gate Way will respond: 'D*n*0' where *n* is the number of the input which is grounded. When the input senses the ground signal is no longer present, the Gate Way will respond with a 'D*n*1'.

Checkout Outputs:
The outputs are controlled using the following protocol:
'O*{field1}{field2}*<CR>'
Where *{field1}* is a single character detailing the specific output to be operated on and *{field 2}* is a single character detailing the function to be performed to the output:
Valid field 1 characters:
A: Relay 1
B: Relay 2

C:  Relay 3
D:  Relay 4
E:  Open collector output E
F:  Open collector output F
G:  Open collector output G
H:  Open collector output H

Valid field 2 characters:
1:  Turn Output ON
0:  Turn Output OFF
T:  Toggle state of output
P:  Pulse state of output at current programmed value (see programming below)
F:  Flash state of output at 50% Duty cycle according to the current programmed value (see programming below).
Q:  Query Output.  Note, you must have a valid field one for this command to work.

Query Output Response:
The query output enables the user to 'double check' the Gate Way's output state.  The Gate Way will respond with either a 1 or a 0 in the corresponding bit position for each output. When issuing the Query Output command, *field 1* must be valid, but it's value is ignored.  The response for this command is formulated from the output image stored in U1.  If an output is currently flashing, the response will be given of the state of the output at the exact time of transmission. Therefore, the user software would have to derive a flashing condition from multiple query output commands.

Query Output Response Format (from Gate Way to PC):

S*{field 1}{field 2}*

Note that Field 1 and Field 2 make up an 8 bit HEX value transmitted to the PC in ASCII.  The intention is that the user can quickly determine the state of all outputs and perform logical operations on them once they are converted from ASCII represented HEX to actual HEX for use in a PC program.
Field 1: (bit positions 0-3) *{DCBA}; where A, B, C, or D have the value of 0 or 1*
Field 2: (bit positions 4-7) *{HGFE}; where H, G, E, or F have the value of 0 or 1*

Bit position 0 = Output D
Bit position 1 = Output C
Bit position 2 = Output B
Bit position 3 = Output A
Bit position 4 = Output H
Bit position 5 = Output G
Bit position 6 = Output F
Bit position 7 = Output E

Programming:

The Gate Way can be programmed to pulse and flash the outputs described in the output section according to the following protocol:

P*{field1}* <CR>

Valid values for field 1 are:
9:  330 ms period for flash, 165 ms pulse
8:  400 ms period for flash, 200 ms pulse
7:  460 ms period for flash, 230 ms pulse
6:  528 ms period for flash, 264 ms pulse
5:  660 ms period for flash, 330 ms pulse
4:  800 ms period for flash, 400 ms pulse

3: 1056 ms period for flash, 528 ms pulse
2: 1648 ms period for flash, 824 ms pulse
1: 3.28 s period for flash, 1.64 s pulse
0: 16.8 s period for flash, 8.40 s pulse

Checkout X-10

After establishing communications, you should start by checking out that the powerline is functional for normal X-10 transmission. The Gate Way listens for X-10 conversation on the powerline upon Reset. Using an X-10 transmitter, attempt to activate any X-10 device. If the device responds, we have verified that the Gate Way and TW-523 is not interfering with normal PLC communication. If the device does not respond, we have a problem. Try it again but this time, disconnect the RJ-11 cable from the TW-523 and the Gate Way. Try the transmission again. If it responds, there is a problem with the transmit section of the Gate Way. Review the construction portion of the Gate Way. If it does not respond, try it again with the TW-523 unplugged. If your device responds now, the TW-523 you have is not functioning properly. If pin 1 on Ctr2 is asserted to ground, the TW-523 will constantly assert a 120 kHz signal on the powerline thereby jamming the powerline for any communications. The most probable cause would be that Dx10_1, Dx10_2, or Qx10_1 have been installed improperly.

## Gate Way Protocol for X-10 Transmission and reception

X-10 Reception

The Gate Way will respond to X-10 signals received according to the following format:

X*nm*

Where *n* is the House code ASCII Character and *m* is the Key/Function Code ASCII character per the Gate Way X-10 Protocol table

X-10 Transmission

The Gate Way will build and send X-10 signals in a 'string' form as requested by the user. Request strings are limited to 16 characters. The format is as follows:

W*nm*<CR>

However, the user can send a command string according to the following format:

W*nmnmnm...*<CR> limited to 16 characters.
For example, to turn on House code A, unit 1, the user would send:
WA1AJ<CR> which consists of 6 characters.

Using the Dimming Functions:
The dimming function takes the first character after the dimming function (L or M) and sets the level to 1 of 16 levels. ASCII characters 0-9 correspond to the first 10 dimming levels; ASCII characters A-F correspond to dim levels 10-16. Since the Gate Way handles the dim level on it's own, dimming X-10 modules is smooth, not staggered.

For example: Dim House Code A, Units 3 and 4 to 50%:

'WA3A4AL8<CR>'

**Gate Way X-10 Protocol Table**

| House Code | ASCII Character *n* | Key Code | ASCII Character *M* |
|---|---|---|---|
| | | | |

| | | | |
|---|---|---|---|
| A | A | 1 | 1 |
| B | B | 2 | 2 |
| C | C | 3 | 3 |
| D | D | 4 | 4 |
| E | E | 5 | 5 |
| F | F | 6 | 6 |
| G | G | 7 | 7 |
| H | H | 8 | 8 |
| I | I | 9 | 9 |
| J | J | 10 | A |
| K | K | 11 | B |
| L | L | 12 | C |
| M | M | 13 | D |
| N | N | 14 | E |
| O | O | 15 | F |
| P | P | 16 | G |

Functions:

| Received Function | ASCII Character *m* | Received Function | ASCII Character *M* |
|---|---|---|---|
| All Units Off | H | Hail Request | P |
| All Lights On | I | Hail Acknlg | Q |
| On | J | Preset Dim | R |
| Off | K | Extended Data | S |
| Dim | L | Status = On | T |
| Bright | M | Status = Off | U |
| All Lights Off | N | Status Request | V |
| Extended Code | O | | |

Examples:

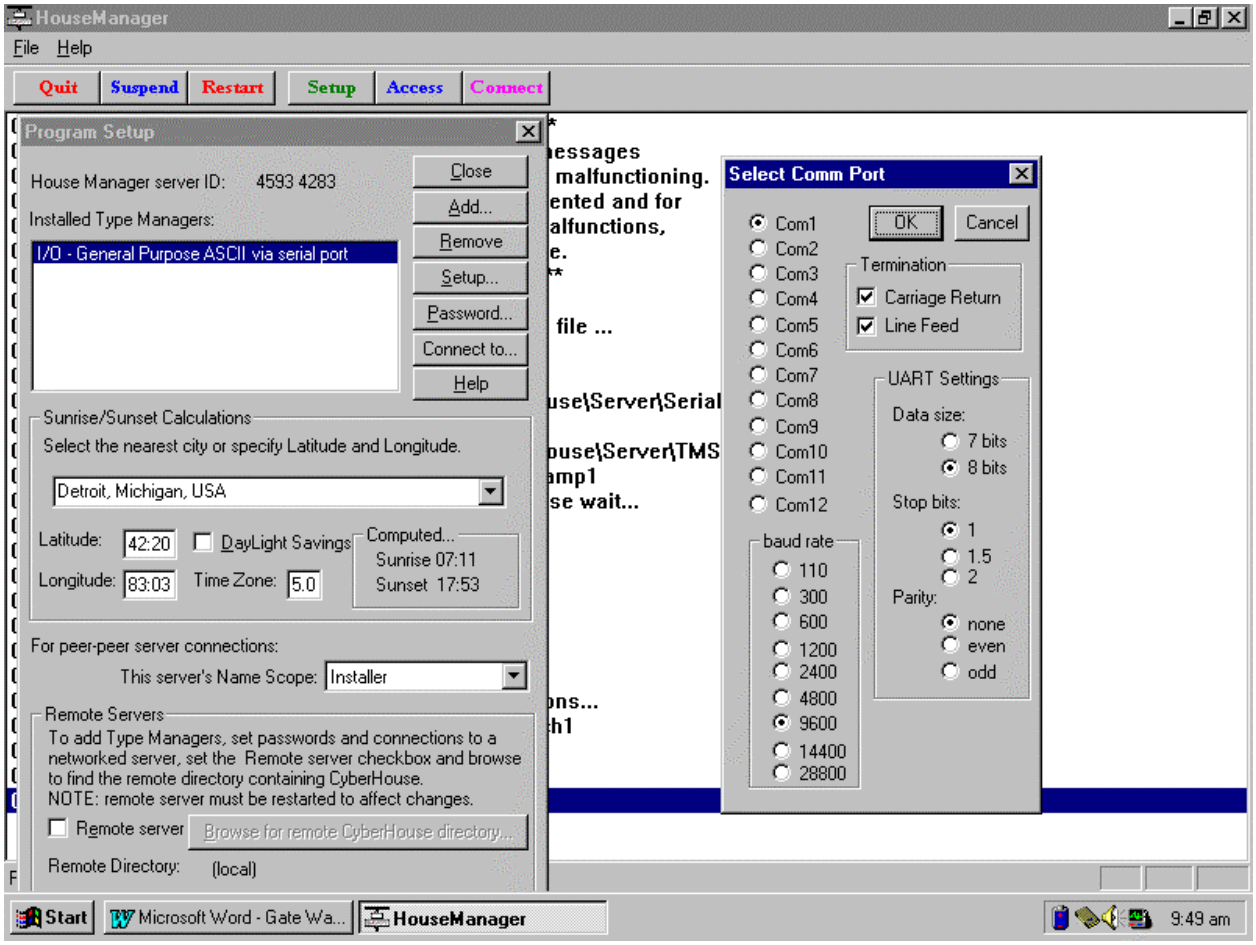
Basic:

```
CLS
BEGIN:
OPEN "com1:9600,n,8,1,BIN" FOR RANDOM AS #1
WAITFORTIME:
IF TIME$ = "08:00:00" THEN GOTO START
PRINT TIME$
COM(1) OFF
GOTO WAITFORTIME:
START:
COM(1) ON
ON COM(1) GOSUB RECEIVE
LINE INPUT #1, THROWOUT$
DO
LOOP UNTIL TIME$ = "15:30:00"
CLOSE #1
GOTO BEGIN
RECEIVE:
    COM(1) OFF

    LINE INPUT #1, GWYIN$

    PRINT GWYIN$
    COM(1) ON
    GOSUB TRANSMIT
    RETURN
TRANSMIT:
    COM(1) STOP

    IF RIGHT$(GWYIN$, 3) = "D01" THEN
        GWYOUT$ = "OA1"
    ELSEIF RIGHT$(GWYIN$, 3) = "D00" THEN
        GWYOUT$ = "OA0"
    ELSEIF RIGHT$(GWYIN$, 3) = "D11" THEN
        GWYOUT$ = "OB1"
    ELSEIF RIGHT$(GWYIN$, 3) = "D10" THEN
        GWYOUT$ = "OB0"
    ELSEIF RIGHT$(GWYIN$, 3) = "D21" THEN
        GWYOUT$ = "OC1"
    ELSEIF RIGHT$(GWYIN$, 3) = "D20" THEN
        GWYOUT$ = "OC0"
    ELSEIF RIGHT$(GWYIN$, 3) = "D31" THEN
        GWYOUT$ = "OD1"
    ELSEIF RIGHT$(GWYIN$, 3) = "D30" THEN
        GWYOUT$ = "OD0"
    ELSE IF RIGHT$(GWYIN$,3) = ‘d41’ THEN
        GWYOUT$= ‘WA1AJ’
    ELSE GWYOUT$ = ""
    LINE INPUT #1, THROWOUT$
    GWYIN$ = ""

    END IF
    PRINT RIGHT$(GWYIN$, 3)
    PRINT #1, GWYOUT$
    PRINT GWYOUT$
    COM(1) ON
    RETURN
```

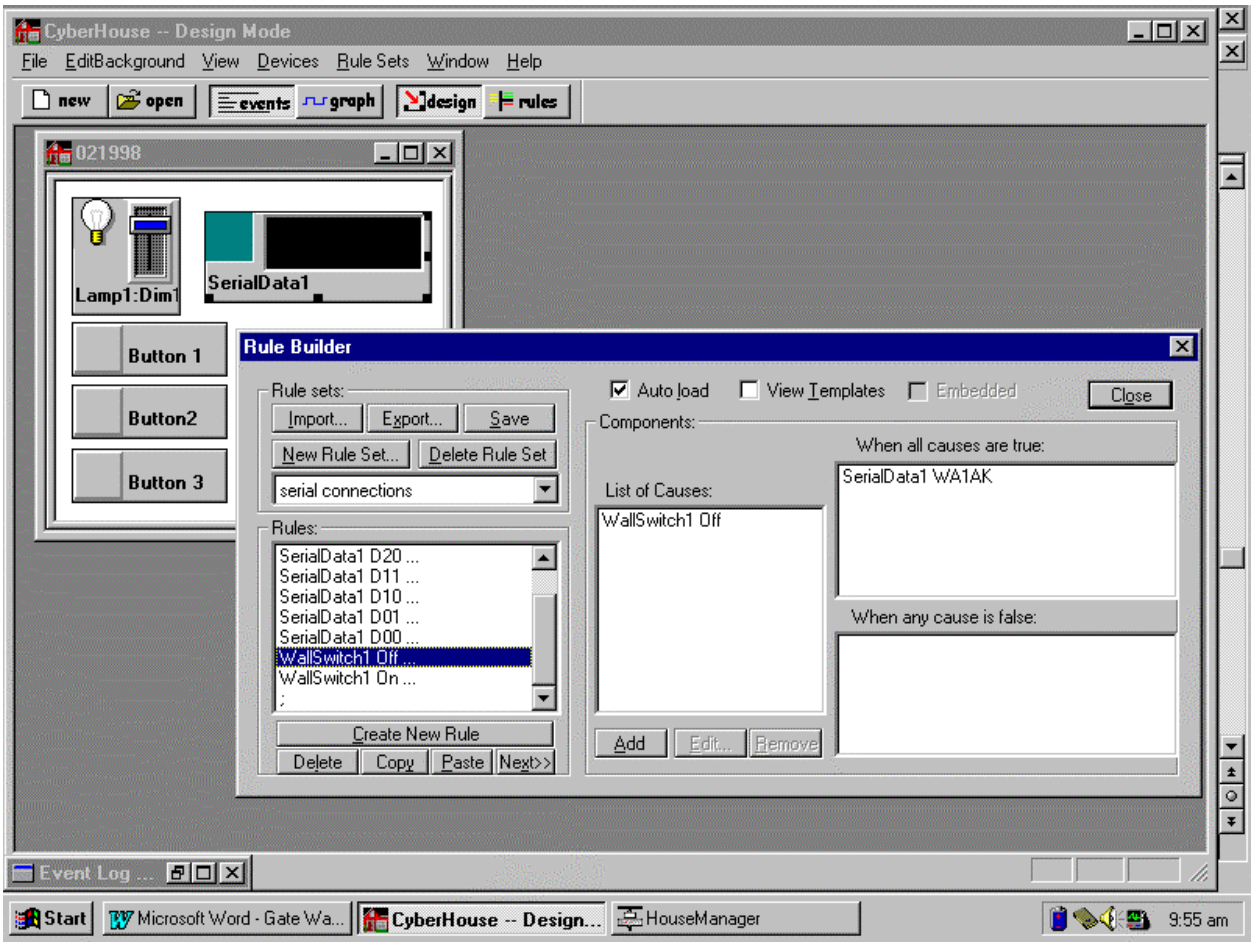
This listing shows how you can use the Gate Way’s hardwired inputs to control outputs based on time of day.

Using CyberHouse:

To configure the Gate Way to function with CyberHouse, you need to have the Generic Serial I/O Type Manager Installed. Then, you can use all of CyberHouse's features with your new Gate Way. First, launch House Manager, install 'I/O General Purpose ASCII via serial port' and configure your settings as shown:



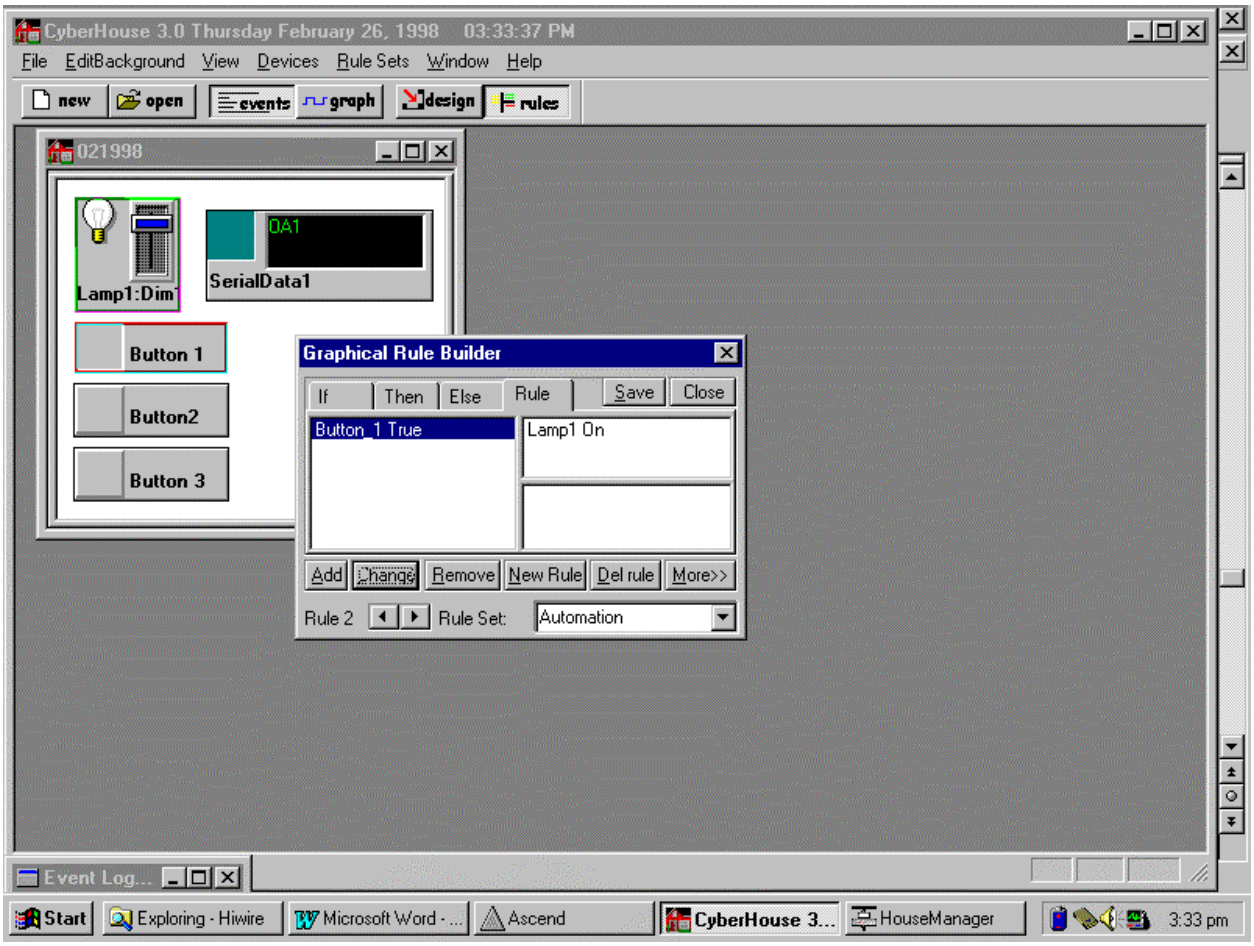
Once you have your Serial I/O driver configured, launch CyberHouse, and begin defining your connections




Under the Device menu, add the devices you wish to control using the Gate Way. Above, the snapshot shows three digital inputs, a lamp, and the SerialData1 driver. You 'connect' Lamp1 and the buttons to the SerialData port by creating short rules such as:

If SeriaData1 D20 Then Button 3 False
If SerialData1 D21 Then Button 3 True

And so on… It is advantageous to first 'connect' the devices to CyberHouse using one set of rules, then perform your automation using another set of rules. Suppose I wish to turn Lamp1 (WallSwitch1) on whenever Button 1 is true: I'd add a rule as such:




This way, you can keep your automation rule set separate from your connection rule set.

Here's the sequence of events:

The Gate Way sends a D10 to CyberHouse
'Serial Connections' rule set commands Button 1 true upon receipt of a 'D10' from the serial port.
'Automation' rule set commands Lamp 1 ON from Button 1 true
'Serial Connections' rule set commands Serial Output = WA1AJ
The Gate Way receives the command 'WA1AJ' which translates to House Code A, Unit 1, turn ON!

So, you see how quickly you can have your Home Automation Gate Way controlling your house with either simple basic programs, or highly configurable complex home automation software.

Next Month: Two Way Infra-Red and automating your Home using the Gate Way with CyberHouse and HomAtion 2000.

Parts List
Gate Way:

Part 1: Inputs, Outputs, and X-10

**Inputs and Outputs**

Resistors

All resistors are 1/4 watt 5%:
Rtx, Rrx, RVh - 1k ohm
RXtal 10M ohm
RA1-RA8, RIRQ,RXIRQ, Rmodb, RRst - 4.7k ohm
RN1 4.7K Resistor Network (Bournes)

Capacitors - Ceramic disc:
SCIC1-SCIC5 .1 uF 100V
CX1, CX2 18 pf 500V

Capacitors: - Electrolytic
CA2D - 1uF 50 V
Cpwr - 10 uF 25 V
Crst - 4.7 uF 50 V

Semiconductors:
U1 - Microcontroller - MC68HC11A8 (Motorola)
U3 - Relay Driver – UCN-5841A (Allegro or Micrel)
U4 - RS-232 Transceiver MAX202 (Maxim)
U5 - 5 Volt regulator - 7805 (JRC/NJR corp)
U6 Dual 4 channel analog multiplexer - 74HC4052 (Fairchild) May use jumpers for part 1 (see text)

Other Components
Socket for U1 -- 52 pin PLCC (AMP)
Xtal - 8 MHz crystal (CTS Corp)
Right angle DB9 Connector (Thomas & Betts)
Ctr1A, Ctr1B, Ctr1C, CtrA2D - 10 way terminal blocks (Altech)
Ctr3 - right angle power connector (CUI Stack)
REL1- REL4 - double throw, double pole relays (Aromat)

**X-10**

Resistors
Rx10_1, Rx10_2, Rx10_3, Rx10_6 - 10 Kohm
Rx10_4, Rx10_5, Rx10_7 - 100 ohm
Rx10_8 - 5 Kohm

Other Components
Dx10_1, Dx10_2, Dx10_3, Dx10_4, Dx10_5,Dx10_6 - Low Current Switching diodes
Qx10_1 2N904 NPN Transistor
Ctr2: Modular right angle (AMP p/n 520242-2)

Devices
TW-523 Two Way Universal Powerline Interface
RJ-11 Phone cord (inverting)
RS-232 cable
9 V Power Supply

Part 2: Two Way Infra-Red Communications

Resistors:
R1, Rwake, ROFA1 - 1 Kohm
R_IR - 100 ohm
ROFA2 4.7 Kohm

Capacitors:
C_IR - 10 uF

Other Components
Qwake, QOFA - 2N3904 NPN Transistors
CTR4: (Amp p/n 640455-4 )
U2: Everlight IR Receiver Module (38KHz center frequency or equivalent) Also available at Radio Shack
U6 Dual 4 channel analog multiplexer - 74HC4052 (Fairchild)

Devices
Universal Electronics OFA 5 Remote Control (www.ueic.com) unmodified

**The following components are available from:**
**Smart Electronics Corporation**
P. O. Box 99358
Troy, MI 48099-9358
SmartElect@aol.com

http://www.smartgateway.com

- **Etched, drilled, and silk screened PC board: $18.00**
- **Pre-programmed 68HC11A8 microcontroller: $20.00**
- **Gate Way kit: All board mounted components including pre-programmed 68HC11 for final project: $99.98**
- **RS-232 cable : $6.00 (available with kit or full assembly order only)**
- **Power Supply: $6.00 (available with kit or full assembly order only)**
- **Gate Way full assembly fully tested: $149.98**
- **TW-523 Two Way Power Line Interface: $18.00**
- **Modified OFA 5 Remote with Fabricated Cable: $35.00**