

TWO-WAY™

Owner's Manual

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Using TWO-WAY

The TWO-WAY Computer Interface provides bidirectional communications between your PC and X-10 devices. Conveniently housed in the hood of an RS-232 connector, it contains a state-of-the-art surface-mount microprocessor and additional components for reliable computer-to-powerline communications.

Computer hobbyists and home automation enthusiasts can now use any computer with a standard RS-232 serial port to both send and receive X-10 signals using standard ASCII characters. Programming is simple. Examples are given in this manual and special software is supplied for Visual Basic under Windows. TWO-WAY supports all X-10 codes, full duplex operation, and collision detection (in case two X-10 events occur at the same time).

During operation, TWO-WAY is plugged into the computer's 25-pin serial port (or 9-pin serial port with standard adapter see Appendix 2). A standard telephone type cord connects it to a TW-523 Powerline Module (TW-523) which plugs into an electrical outlet.

Control your home or office using PC, laptop, notebook, or any computer or modem with an RS-232 serial port.

Features

Converts X-10 signals into standard ASCII characters (and vice versa)

Easy to install - Just plug into RS-232 port

Self-powered (Like the mouse, this peripheral device gets its power from the serial port that it plugs into.)

Requires minimal processing by the computer

Reads back what was transmitted

Easy to program. Only a few lines of Basic code are needed to send and receive X-10 signals. Special software for Visual Basic is included.

Measurements (overall): 2.4" x 3.8" x 1.0"

Requires a 2-Way Powerline Module (X-10 part No. TW-523)

Getting Started

What Is X-10?

A large and growing line of modules are available which use the powerline for communications. This means that without adding additional wiring it is possible to connect lamps, appliances, home security and other devices together into a total system for home or office automation. A few of the devices available are: Controllers and timers for sending X-10 signals, Lamp Modules, Appliance Modules, contact closure (pushbutton or switch) interfaces, 1-way computer interfaces, and now, this bidirectional ASCII interface.

Briefly, all X-10 commands consist of a HOUSE CODE (from A to P) followed by either a "UNIT CODE" or a "FUNCTION CODE." There are 26 UNIT CODES (from 1 to 16) and 16 FUNCTION CODES (for example, ON, OFF, DIM, BRIGHT, ALL UNITS OFF, ALL LIGHTS ON, etc.). To turn ON module F1, X-10 protocol first sends the HOUSE CODE "F" followed by the UNIT CODE "1" and then sends the HOUSE CODE "F" again, this time followed by the FUNCTION CODE "ON." -- In other words:

HOUSE	UNIT	HOUSE	FUNCTION
F	1	F	ON

In this case we say that module F1 is first SELECTED, and then when the ON FUNCTION CODE for HOUSE CODE F is sent (F ON), the selected module(s) for that HOUSE CODE (in this case, only module 1) is/are turned ON. When a HOUSE CODE plus

FUNCTION CODE comes along, IT APPLIES TO ALL THE MODULES THAT HAVE BEEN SELECTED for that HOUSE CODE. So, turning ON several X-10 modules simultaneously, instead of in sequence, is easy to do. For example, to turn ON in HOUSE CODE G, modules 1, 2 and 3 at the same time, the following X- 10 codes would be sent:

G 1 G2 G3 G ON

The selected module(s) for a particular HOUSE CODE stay selected UNTIL. A HOUSE CODE PLUS A UNIT CODE IS SENT FOLLOWING A FUNCTION CODE for that HOUSE CODE. When that happens, that UNIT CODE becomes the first new UNIT CODE to be selected for that HOUSE CODE.

In the above example, modules G1, G2 & G3 remain selected, and if the code G OFF were sent, modules G1, G2& G3 would all go to OFF together. But if the code G4 were sent, **G1**, G2 & G3 would no longer be selected -- the selected module is now G4.

The examples above uses the X-10 FUNCTION CODE “ON”. There are actually 16 X-10 FUNCTION CODES, but only six of them are generally used. The 6 generally-used FUNCTION CODES are:

<u>X-10 Function Code</u>		<u>Comment</u>
(long form)	(short form)	
ON	ON	Turns selected module(s) ON.
OFF	OF	Turns selected module(s)O
ALLOFF	A0	Turns all lamp and appliance modules in the current HOUSE CODE to OFF (Note: "A-ZERO").
LIGHTSON	LI	Applies only to Lamp Modules. Turns all Lamp Modules in the current HOUSE CODE to ON.
DIM	DI	Applies only to Lamp Modules.

The DIM command makes selected Lamp Modules dimmer. If a selected Lamp Module is OFF, using the DI command first turns it ON to FULL BRIGHTNESS and then dims it. The maximum amount of dimming that can occur is 20 steps, at which point the lamp will have an almost glow. The amount of dimming depends on how long the DIM button is held down on an X-10 mini controller. When TWO-WAY receives a DI command from the computer, the amount of dimming depends on the setting

of the REPETITION Value (described below).

BRIGHT	BR	Applies only to Lamp Modules.
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The BRIGHT command makes selected Lamp Modules brighter. If a selected Lamp Module is OFF, using the BR command first turns it ON to FULL BRIGHTNESS. The maximum amount of brightening that can occur is 20 steps, at which point the lamp is effectively full ON. The amount of brightening depends on how long the BRIGHT button is held down on an X-10 mini controller. When TWO-WAY receives a BR command from the computer, the amount of brightening depends on the setting of the REPETITION Value (described below).

NOTE: Appendix I lists all 16 FUNCTION CODES for reference purposes. TWO-WAY can send and receive all these codes, even though commercially-available modules generally do not use many of them.

The computer communicates with TWO-WAY in 3-character messages, followed by a <CR> (an ASCII 13) -- The first character is the HOUSE CODE, the next two characters are either the UNIT CODE (from 01 to 16) or the *short form* of a FUNCTION CODE (for example BR for "BRIGHTEN"). Letters may be in either uppercase or lowercase.

The 2-Way Powerline Interface usually sends back 4-character messages to the computer, followed by a <CR> (an ASCII 13) -- The first character is either:

! An exclamation point meaning a valid message was read from the powerline. The "!" is followed by a valid 3-character message.

? A question mark meaning the message sent to it by the computer was not a valid 3-character message followed by a <CR>. The "?" will be followed by the message it was sent.

> This is a caret. If the first character is a caret, the characters that follow did not originate from the powerline. When the caret is followed by XXX, the TW-523 Powerline Interface did not read back the same code it sent. This can happen when there is interference on the powerline, either caused by a noisy appliance or by another X-10 event occurring at the same time. A collision can be generated by sending a command with the computer and pressing a button on a Mini Controller at the same time. There will be a "collision" and >XXX will be received. In this case, the computer can be programmed to "retry" the command later. When the caret is followed by "R" plus a two-digit number from 01 to 20 (for example, RIO), TWO-WAY is echoing back a new Repetition setting used in Bright & Dim commands (discussed below). If TWO-WAY receives a message from the computer that is less than 3 characters, it will send back a question mark, followed by the characters it was sent.

Connecting TWO-WAY To The Computer

Plug TWO-WAY into an available RS-232 port. If necessary use a suitable 9-pin to 25-pin adapter (Appendix 2). Connect one end of the telephone cable supplied to TWO-WAY, and the other end to a TW-523 Powerline Interface. If you want to use a telephone cable other than the one supplied, note that you will need a standard 4-conductor cable which crosses red & green, and yellow & black wires. Plug the TW-523 Powerline Interface into an electrical outlet. Its red indicator light should turn ON. To test X-10 operation use a lamp connected to a Lamp Dimmer Module, an appliance connected to an Appliance Module, and a Mini Controller or equivalent available to generate X-10 events.

Terminal Operation

Most computers have terminal software available. For example, Windows comes with a Terminal found in the Accessories group. Many other terminal programs are available, such as PROCOMM, QUICKLINK and BITCOM. Terminal software is easy to obtain as shareware from online services such as CompuServe. Or you can simply use the AUTODRV software supplied with this product to run under Windows (See section on Running AUTODRV.EXE below.)

Terminal Settings should be:

2400 Baud
8 Data Bits
2 Stop Bit
No Parity

If **you type** <CR> (a Carriage Return, same as <ENTER>), TWO-WAY should respond with a “7.” This shows that the interface is “live.” Now try typing B01 <CR>. (Note: type B(zero)). The response should be !B01. This signifies that the X-10 code for HOUSE CODE B, Unit 1 was successfully sent to the powerline. At the **same time the** command is sent, the light on the 2-Way Powerline Interface should blink OFF, then return to ON.

At this time module B1 is SELECTED. To turn it ON, send the code BON <CR> (Note: B ON). The response should be !BON. This signifies that the X-10 code for HOUSE CODE B, FUNCTION CODE ON was successfully sent to the powerline. At the same time the command is sent, the light on the 2-Way Powerline Interface should blink OFF, then return to ON. If you have a lamp or appliance module connected to HOUSE CODE B, UNIT CODE 1, then it will turn ON. If you press the “All Lights Off button on a X-10 Mini Controller, you will see on your computer terminal !BA0. This means that for HOUSE CODE B, the All Units Off command was sent over the powerline. Press other buttons on the Mini Controller and observe the codes received by TWO-WAY.

Lamp Dimmer Operation

TWO-WAY can be sent a special command which tells it how much to brighten or dim a Lamp Module when a BR or DI code is sent. A value of 1 to 20 is saved in its "Repetition Register," or "R-Register" for short. For example, assume a lamp is ON that is connected to a Lamp Module with HOUSE CODE A, UNIT CODE 1. To dim that lamp to 50% brightness, use the following commands (note that R10 could be sent at any time before ADI):

Command	comment
A01	Select the module at HOUSE CODE A, UNIT CODE 1
R10	Set the R-Register to brighten or dim 10 steps. This value of 10 will remain in the R-Register until the next R command is sent. Commands from R0 to R20 are valid.
ADI	Dim the selected lamp 10 steps, leaving it at 50% brightness. Note that if DIM or BRIGHT commands are sent from an external device such as a Mini Controller, TWO-WAY receives one DI or BR command for every 3 DIM (or BRIGHTEN) steps sent. This results from the operation of the TW-523 Powerline Interface. To determine the approximate brightness of a light that has been dimmed from an external source, multiply the number of DI commands received by 3 to gauge the number of steps received by the Lamp Module.

Example Of Two-Way Communication Between The Computer And Powerline

This example illustrates an X- 10 "dialog" between a computer and TWO-WAY.

3-Char+C/R Message Sent From Coma.	Message Received from TWO-WAY	comments
G14		You select HOUSE CODE G, UNIT CODE 14.
	!G14	TWO-WAY echoes the command received from the powerline. The "!" means, "This was received from the powerline."
GON		You tell the lamp (or appliance) at HOUSE CODE G, UNIT CODE 14 to turn ON.
	!GON	TWO-WAY has read a GON command back from the powerline. Transmission OK.
R10		You set the Repetition-Register ("R-Register") in TWO-WAY to 10. This register is used for DIM and BRIGHT

	commands and contains a value from 1 (5%) to 20 (100%). The R-Register may be set at any time and retains its value until the next command that sets it, or until the computer is turned OFF.		collision has occurred. Note that in practice, this is a rare event
		G08	You resend the GO8 command.
		!G08	Transmission OK.
>R10	The caret (>) indicates “This was sent by TWO-WAY and did not come from the powerline.” The R-Register has been set to a value of 10.	GZ4	You send a meaningless code to the TWO-WAY.
GDI	Send DIM commands to the currently selected module(s) in HOUSE CODE G (here, only module G14 has been selected). The number of DIM commands sent will be the current value in the R-Register (10 at present).	?GZ4	Invalid code indicated. Nothing sent to the powerline.
		!A03	
		!AON	
		!ADI	
		!ADI	
		!ADI	Someone has used an external Mini Controller to turn a lamp ON at HOUSE CODE A, UNIT CODE 3, and has dimmed it to about half brightness.
!GDI	10 Dim codes sent to G14 if G14 was OFF or full ON before GDI was sent, G 14 will be left at 50% brightness.		
G08	You select HOUSE CODE G, UNIT CODE 8.	!B01	
		!BOF	Someone has used an external Mini Controller to turn OFF the module at HOUSE CODE B, UNIT CODE 1.
>XXX	TWO-WAY has not received anything from the powerline when it expected to receive a G08. Powerline noise or a		

Visual Basic Operation

Programmers of Visual Basic can quickly create sophisticated systems which integrate computer functions with the automation of lamps and appliances. Two Visual Basic programs are included with the 2-Way Computer Interface.

1. Communications Server

AUTODRV.EXE

This terminal-style program can be run at any time under Windows. It puts a small control panel on the screen allowing direct communication between the keyboard and TWO-WAY. X-10 signals both sent and received are indicated. In addition, Visual Basic programs can easily send and receive messages to/from this server using DDE (Dynamic Data Exchange) -- with just a few lines of code, powerline data received by TWO-WAY will appear in your label control(s) and data placed in your label control(s) will be sent to TWO-WAY. RS-232 communication is taken care of by AUTODRV.EXE. Using AUTODRV, more than one program can share TWO-WAY under Windows.

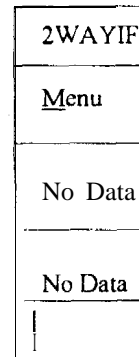
2. Demonstration Visual Basic Program

ZWAYIF.MAK

This program pops up a window and sends and receives commands to/from AUTODRV. It detects if AUTODRV is running, and if not, runs it. By inspecting this program and its operation, you can use it as the basis for writing programs which do not need to handle the RS-232 port directly.

Running AUTODRV.EXE

First, connect TWO-WAY to the computer and to the TW-523 Powerline Interface and plug it into an electrical outlet. Run AUTODRV.EXE under Windows by clicking on its icon in the X-10 group or use the Program Manager. An icon appears on the screen. Click on it and a small window appears:



<-- Title Of Window

<-- Click Here To Bring Up A Menu Of Options

<-- These two lines show the latest data received by the 2-Way Interface.

<-- Type desired commands in this text box to send commands to TWO-WAY. Commands are sent when ENTER is pressed.

Commands can be in uppercase or lowercase, and can be combined as follows: **B16<ENTER> BON<ENTER>** can be combined into **B 16-ON<ENTER>**.

When you click on the **Menu** button, the following window appears:

MENU	<-- Title Of Window
<u>R</u>un	<-- Click Here To Return To Run Window
<u>C</u>om = 1	<-- Click Here To Select Com 1,2,3 or 4
<u>M</u>inimize	<-- Click Here To Make This Run As An Icon
E<u>x</u>it	<-- Click Here To Terminate Program

Select The COM Port

If you are using a COM port other than the default COM1, after bringing up the AUTODRV window, click on the Menu button, then click on the Com button until the Com port you are using is selected. Then click on Run to return to the Communications Window.

Note: This program may be called from the command line or from a SHELL statement in a Visual Basic program. When this is done, the COM port may be specified as a number from 1 to 4.

For example, to start AUTODRV.EXE and have it use COM Port 2, use the command line:

```
AUTODRV.EXE 2
```

(Run AUTODRV invisibly by adding the letter "i" to the command line.)

Test Operation

Transmitting Using Keyboard Input

Connect a lamp to a Lamp Module at HOUSE CODE B, UNIT CODE 1. Now turn it ON by putting the text cursor in the bottom text box (if not already there) and typing:

```
B01 <ENTER>  
BON <ENTER>  
(Or type B 1 -ON <ENTER>)
```

The lamp should turn ON. Be careful to distinguish the zero (0) from the letter "oh" (O). If you type in an invalid code, such as BXN <ENTER>, the TWO-WAY will respond with:

```
?BXN
```

There are 20 steps from full DIM to full BRIGHT. If you want to DIM your lamp to approximately half brightness, tell TWO-WAY you want to dim 10 steps by typing:

RIO <ENTER>

2WAYIF will respond with:

=RIO

Now dim the lamp by typing:

B01 <ENTER>

BDI <ENTER>

and brighten the lamp by typing:

BBR <ENTER>

Note: B01 will stay selected until another HOUSE CODE plus UNIT CODE is sent.

To receive X-10 Signals from external source, press buttons on an X-10 Mini Controller or other X-IO signal source and observe that the last two commands sent are shown in the two AUTODRV data windows.

Exploring ZWAYIF.MAK

First, connect TWO-WAY to the computer and to the TW-523 Powerline Interface plugged into an electrical outlet. Start Visual Basic and bring up the 2WAYIF.MAK project (normally found in the \VB\2WAYIF directory). This project has a single form with a label, a text box, and 3 option buttons. This program first determines if the X-10 Communications Server, AUTODRV, is running and if not, starts it up. The code is commented to explain how it works.

Using the LinkItem and LinkTopic properties, it establishes a DDE link with AUTODRV. Now, whenever an X-10 command is read by TWO-WAY from the powerline, it appears as the Caption of Label 1. And, whenever the <ENTER> key is pressed after entering text into text box tbxUser, the text is sent via Label1 to AUTODRV.EXE which then sends it to over the RS-232 COM port and into TWO-WAY. Similarly, data received by TWO-WAY goes to AUTODRV.EXE, which then sends it to the Caption of Label1 via the LinkNotify routine.

Clicking on the Option Button labelled "A01 AON" turns ON a lamp connected to a module at HOUSE CODE A, UNIT CODE 1, and clicking on the Option Button labelled "A01 AOF" turns the lamp OFF. These Option Buttons simply put text into Label1 which then automatically sends the text to AUTODRV.EXE using the LinkExecute method.

Clicking on the Option Button labelled "End Svr" shows how

AUTODRV can be terminated from another Visual Basic program. This is done by sending the message “END” to AUTODRV.EXE. Upon receiving this message, that program will terminate. The break in DDE communications causes an error, which is trapped in the code block starting at statement label Error1

Troubleshooting

If you can't receive a “?” on a terminal program when you press the <ENTER> key as discussed above under “terminal operation,” check to make sure all the cable connections are firm -- TWO-WAY must be plugged in to the computer (via a suitable adapter cable, if necessary), the telephone cord should be the one supplied with the unit, and must be plugged in at one end to the TWO-WAY and at the other to the TW-523 Powerline Interface. And, the TW-523 Powerline Interface must be plugged in to the wall, its red indicator light showing ON, except when an X-10 signal is sent, at which time it blinks OFF for a short time.

Make sure the settings of the terminal are 2400 baud, 8 bits, 1 stop bit, No Parity.

The operation of TWO-WAY is subject to all the potential problems that may occur when the powerline is **used** for communications. The transmitting strength of the TW-523 Powerline Interface is equal to the strength of a Mini Controller, and its receiving strength is equal

to a lamp or Appliance Module. If signal strength is marginal, which may be due to long distances from transmitter to receiver, or by certain appliances which present heavy loads to the communications signal sent on the powerline, reliability can suffer.

In addition, certain appliances may at certain times inject noise onto the powerline, hindering signal communications. Try moving modules around to improve reliability if necessary. If necessary, unplug appliances such as TV sets (even if they are off) one at a time, to see if the problem goes away. If an offending “noisy” appliance is found, install an X-10 noise filter on it. Other approaches include installing an X-10 signal bridge at or near the circuit breaker, which gives the communications signal an easy path from one leg of the powerline circuit to the other leg. An X-10 signal amplifier may also be installed.

Appendix 1 – List of All 16 X-10 FUNCTION CODES

TWO-WAY

Function

Code	Function
A0	All Units Off
L1	All Lights ON
ON	ON
OF	Off
DI	Dim
BR	Bright

Commercial modules usually don't respond to the following codes:

LO	All Lights Off
EC	Extended Code
HR	Hail Request
HA	Hail Acknowledge
PO	Pre-Set Dim 0
P1	Pre-Set Dim 1
ED	Extended Data(Analog)
S1	Status=ON
so	Status=OFF
SR	Status Request

Appendix 2 -- 9-Pin to 25-Pin RS-232 Adapter Wiring

9-Pin Female Pin	25-Pin Male Pin
1	8
2	3
3	2
4	20
5	7
6	6
7	4
8	5
9	22