HEWLETT PACKARD

PCInstruments

Owner's Guide

HP 61017A Relay Actuator

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Notice

Printing History

New editions of this manual will incorporate all material since the previous edition. Update packages, which may be issued between editions, contain replacement and additional pages to be merged into the manual by the user.

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates which are incorporated at reprint do not cause the date to change.)

The instrument prefix number alongside the date refers to the first part of the serial number on the bottom of the instrument. This number indicates the version of the instrument that was available at the time that this manual was issued. However, note that, many instrument updates do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between instrument changes and manual updates.

Edition 1....May 1985....Instrument Prefix 2507A

Safety Summary

The following safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard assumes no liability for the customer's failure to comply with these requirements.

Ground the Instrument

To avoid potentially hazardous electrical shock, establish a safety ground before connecting user's circuits. Connect the output cable from the Power Pack to the Relay Actuator, and then connect the line cord from the Power Pack to the ac line. Detailed instructions are in the HP PC Instruments System Owner's Guide.

Do Not Exceed Input Ratings

Excessive input voltage and current will damage this instrument. Do not exceed 250 V dc, 250 V ac rms, or 350 V ac pk between channels or from any channel to ground. Do not exceed 1 A per channel or 4 A per unit. If your equipment is capable of delivering more than 1 A, an external 1 A fuse should be used to prevent accidental damage to the instrument.

Prevent Shorted Connections

To prevent shorted connections, do not strip wires back more than 0.2 in. (5 mm). Insert wires fully into connectors. Only use wire gauge between AWG 14 to AWG 28 (1.5 to 0.5 mm^2). Only use the form and type of connector originally supplied with this equipment.

Ensure Equipment Status

This instrument is under user's program control. Equipment failure, power failure, or program error may result in a hazardous situation. Any application requiring a failsafe method of ensuring equipment status must be provided by the installer. This includes devices such as

interlocks, thermostats, limit switches, or overpressure or overspeed sensor.

Safety Symbols

Instruction manual symbol: the product will be marked with this symbol when it is necessary for you to refer to the manual (see What's in this Guide?)

Indicates measuring earth (ground) terminal.

WARNING

The WARNING sign calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

What's in this Guide

This guide is a supplement to the HP PC Instruments System Owner's Guide. It contains specific information about your HP PC Instruments Relay Actuator, Model 61017A. You must read the System Owner's Guide before you read this guide. Warranty and service information is included in the PC Instruments Support Guide in front of your System Owner's Guide.

The System Owner's Guide discusses information that is common to all HP PC Instruments. It also contains specific information about your computer and HP PC Instruments System. If you are a first time user, refer to Table 3 in your System Owner's Guide for the proper reading sequence of your computer and PC Instruments Owner's Guides. If you are an experienced user and already have an installed system, you need only read this guide to learn how to operate and program your Relay Actuator.

Please insert this guide in the same hardcover binder as your System Owner's Guide. Here is a brief description of the contents of each chapter in this guide:

Chapter 1 - Product Description
Briefly describes the Relay Actuator, gives its specifications, and lists the items that you receive with it.

Chapter 2 - Trying Out Your Instrument
Gives simple step-by-step instructions that let you quickly perform some operations with nothing connected to the front panel.

Chapter 3 - Manual Instrument Control
Gives detailed operating information not covered in the simplified instructions of Chapter 2.

Chapter 4 · Front Panel Connections

Explains how to connect the Relay Actuator to your application.

Chapter 5 · Programming With BASIC

Describes how to control the Relay Actuator with a program. All programming statements for the Relay Actuator are explained. Simple programming examples are also included.

Appendix A · Programming Statement Summary

Lists all programming statements that apply to the Relay Actuator.

Appendix B · Verification Procedures

Contains verification procedures that you can use to verify the proper operation of the Relay Actuator if you suspect an instrument malfunction.

Appendix C · Error Messages

Lists all error messages that apply to the Relay Actuator.

1 Product Description

Introducing the the HP PC Instruments Relay Actuator

The HP PC Instruments Relay Actuator contains eight independently controllable relays. The Relay Actuator is controlled by a computer equipped with HP PC Instruments software and an interface card. The System Owner's Guide tells you all you need to know about the required software and interface card for your computer. Chapters 2 and 3 of this guide explain how to operate the Relay Actuator "manually" using the Soft Front Panel (computer display) while Chapter 5 describes programming statements you can use to control it from BASIC.

The Relay Actuator has eight channels consisting of one relay (single-pole single-throw) each. Figure 1-1 shows the details of one of these eight channels. These channels can be individually opened or closed from the Soft Front Panel or from a BASIC program. If you are programming your instrument from BASIC, you have the additional feature of being able to set all eight channels in any configuration (open or closed) simultaneously. Because the Relay Actuator must be enabled before any relay closures can occur, it will respond to the same commands and statements that apply to output instruments (i.e. ENABLE.OUTPUT).

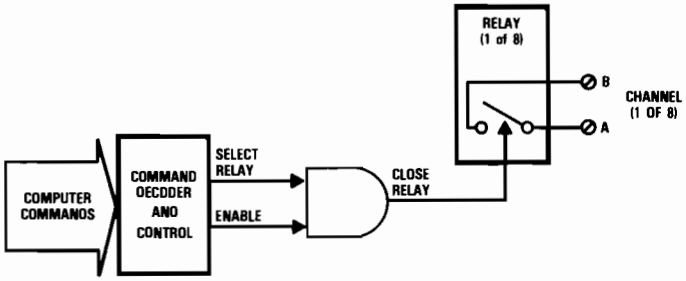

Figure 1-1. Relay Actuator Block Diagram

Items Supplied

In addition to this guide, check that you have received the following item with your Relay Actuator:

Power Pack - an ac power transformer with an attached one metre cable. The transformer type was determined by country of destination. Chapter 2 of the System Owner's Guide lists the different types and their part numbers.

Power Cord - connects the Power Pack to an ac source. Plug type was determined by the country of destination. Chapter 2 of the System Owner's Guide lists types and part numbers.

Instrument Interconnect Cable (8120-4631) - connects two stacked instruments to the interface. Refer to Chapter 2 of the System Owner's Guide.

Plug-In Terminal Block (1252-0839) - used to make your application connections to the Relay Actuator.

Update Pages - if applicable, update pages are included. Replace the obsolete pages with the new ones before you use this guide.

Table 1-1. Specifications

User Connections:
8 independent
single-pole channels

Channel Select Time:
<40 ms (using an OUTPUT statement)

Switching Characteristics:
Max voltage = 250 V dc;
250 V ac rms; 350 V ac pk
Max current =
1 A dc; 1 A ac rms per channel
4 A dc; 4 A ac rms per unit
Max power =
50 W dc; 250 VA ac per channel
200 W dc; 1000 VA ac per unit

Resistance:
<1 ohm typical (per channel)

Thermal Offset:
<6μV max (per channel)

Isolation Voltage Rating:
250 V dc; 250 V ac rms; 350 V ac pk between any terminals or terminal to ⊥)

DC Isolation Resistance:
$2x10^8$ ohms @ 40° C, 80% rh (open channel, channel to channel, or channel to ⊥)

Table 1-1 Specifications (cont.)

AC Characteristics:

(50 ohm termination)

	100 kHz	1 MHz	10 MHz
Crosstalk (channel to channel)	< −73dB	< −53dB	< −33dB
Feedthrough (open channel)	< −73dB	< −53dB	< −33dB
Insertion loss (closed channel)	<0.2dB	<0.3dB	<0.5dB

Capacitance

Open channel; channel to channel < 5pF

Closed channel < 25 pF

Channel to ⊥ <50pF

Operating Temperature Range:

0° C to 40° C

Storage Temperature Range

−40° C to +80° C

Dimensions:

Length = 295 mm (11.62 in.)

Width = 212 mm (8.35 in.)

Height = 64.5 mm (2.54 in.)

Weight:

0.95kg (2.09 lbs.)

Factory Defaults:

Label = RELAY.ACT.01(RELAY.ACT.02 for 2nd instrument)

Channels = no channel selected

Output = disabled

2 Trying Out Your Instrument

Introduction

The following step-by-step procedure allows you to perform some simple instrument operations. This procedure is especially suitable for first time users who want to quickly become familiar with the basic operation of the Relay Actuator. Chapter 3 contains additional operating information that you can use once you have learned the basics in this chapter.

The Procedure

Trying out your instrument consists of pointing to and selecting various interactive fields on the Soft Front Panel. Before you try out your Relay Actuator, you should have: connected it to the interface, applied power, loaded the operating system, renamed (or erased) HPSTATE.HPC to return the instrument to its factory default settings, and run PANELS as explained in Chapters 2 and 3 of your System Owner's Guide.

NOTE

If your instrument is connected to an application, be aware that following these instructions will close channel 3. You may want to disconnect your application connections.

Step 1 - If your Relay Actuator is not already in the Interactive Instrument Window, point to and select RELAY.ACT.01 from the label(s) listed in the System View window (see Figure 2-1). If you have many instruments connected to the interface, use the **ROLL UP SYS VIEW** softkey to view them all. When you select an instrument from the list, the ACTIVE indicator (located on the front of the instrument) lights up.

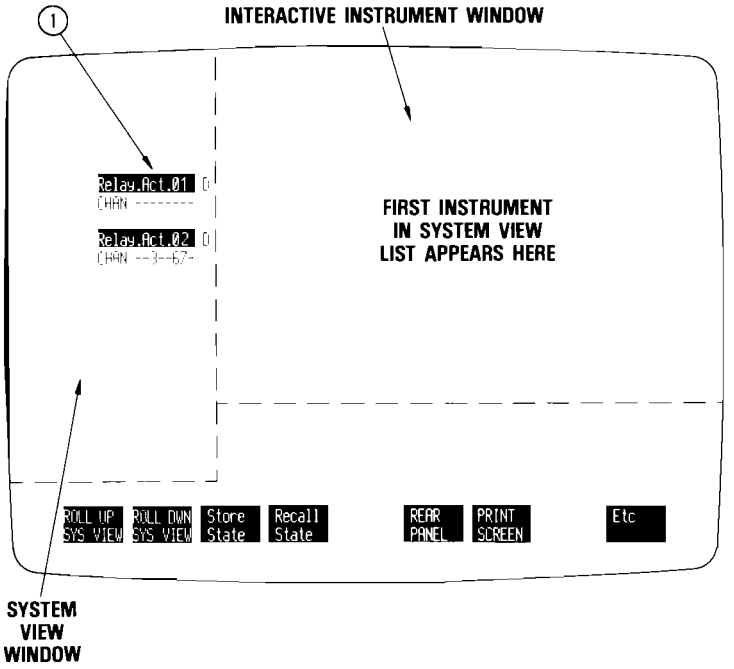

Figure 2-1. Select the Instrument

As shown in Figure 2-1, RELAY.ACT.01 is the factory default label for the Relay Actuator. If you have more than one Relay Actuator, each additional instrument is assigned a sequentially numbered default label (RELAY.ACT.02, RELAY.ACT.03, etc). The letter D after the label indicates that all channels are open (disabled) at this time. If the D

is absent, it means that any selected channels are closed. The numbers that appear on the line directly below the label indicate which channels are currently selected on your instrument. If a "-" character appears instead of a number, it means that the channel number that normally appears in that location is not selected at this time. Note that the status information under the RELAY.ACT.02 label indicates that channels 3, 6, and 7 are currently selected - but not enabled; on RELAY.ACT.02.

Step 2 - Once you select RELAY.ACT.01, the RELAY.ACT.01 information in the System View Window disappears, and a front panel representation of the Relay Actuator appears in the Interactive Instrument Window (see Figure 2-2). Notice that the display indicates no channels are selected. To operate RELAY.ACT.01, first point to and select the channel 3 field.

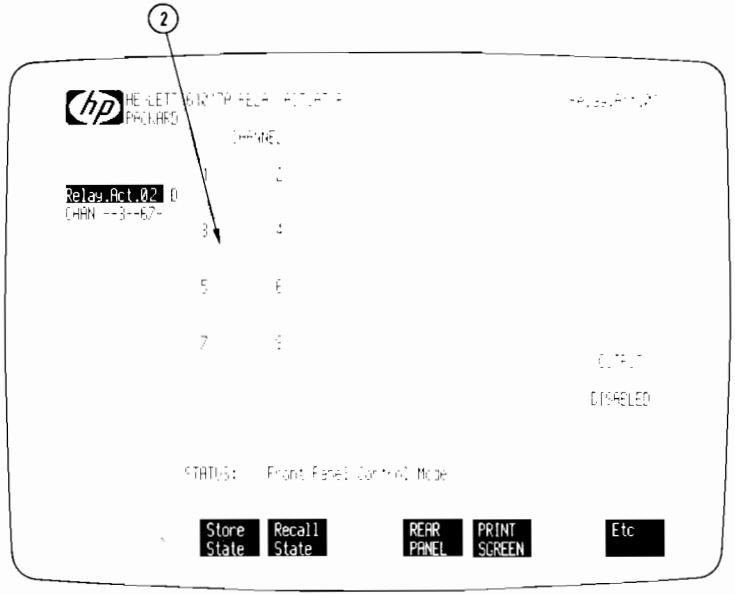

Figure 2-2. Select a Channel

Step 3 - When you point to and select the channel 3 field, its background turns bright (see Figure 2-3). Because the output field indicates DISABLED, the selection process did not close any relays on your instrument. The output must be enabled before the channel 3 relay can close. Point to and select DISABLED to enable the output. (The output field toggles between ENABLED and DISABLED.)

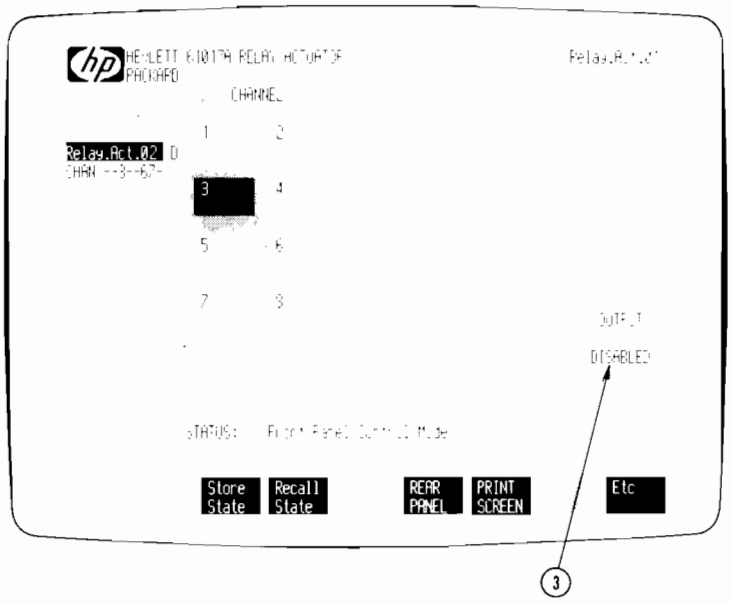

Figure 2-3. Enable the Output

The Result - With the output ENABLED, the channel 3 relay is now closed (see Figure 2-4). The background of any other channels that you select after the output has been enabled will also turn bright, and the relay for that channel will close. To try out a different instrument at this time, go to Chapter 2 of its guide; otherwise, press the etc. softkey and then the EXIT softkey.

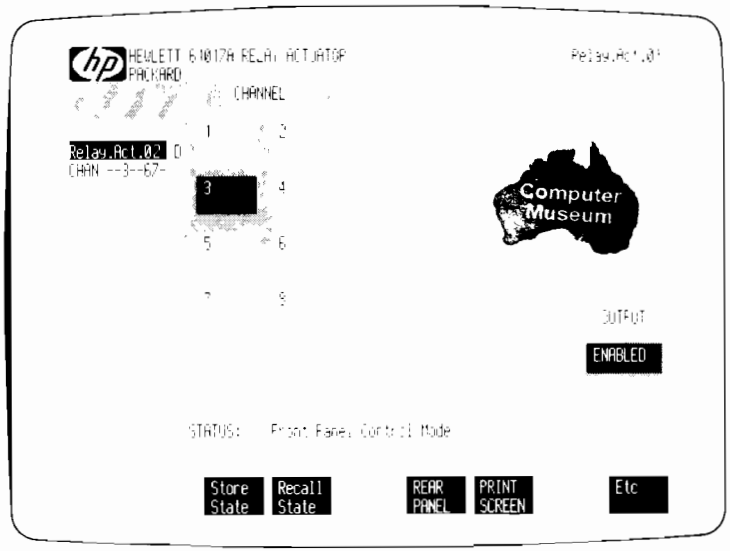

Figure 2-4. Channel 3 Closed

What to do Next

Now that you have finished trying out your instrument, the next thing you do depends upon the type of user you are. If you are an experienced PC Instruments user and are already familiar with the System Owner's Guide, read the remaining chapters in this guide. If you are a first time PC Instruments user, read Chapter 4 in the System Owner's Guide and Chapter 3 in this guide to learn all about manual instrument control. Table 3 in the System Owner's Guide gives the reading sequence of these guides for first time users.

3 Manual Instrument Control

Introduction

The basics of selecting your instrument and closing a channel have already been discussed in Chapter 2 of this guide. This chapter covers additional details about operating your instrument. Chapter 4 of the System Owner's Guide describes the Soft Front Panel features (including softkeys) that are common to all instruments.

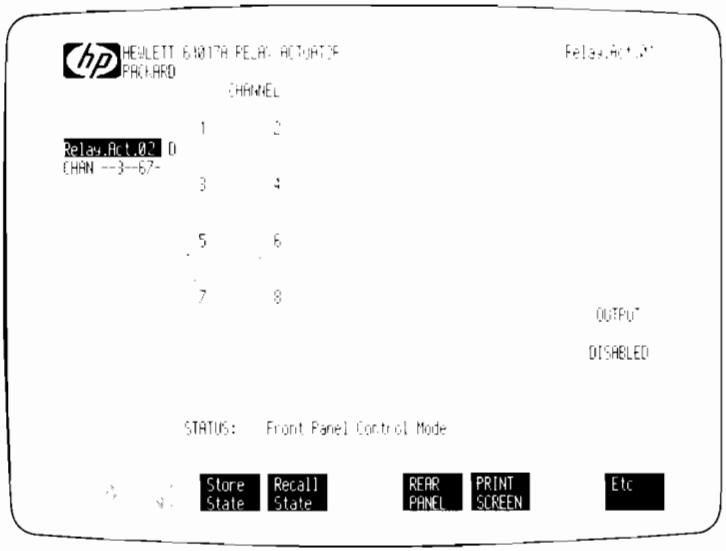

Figure 3-1. Relay Actuator Default Settings

Figure 3-1 shows the factory default screen graphics that appear when the first Relay Actuator in your PC Instruments System is selected. These defaults are: no channel selected, output disabled. The default label (RELAY.ACT.01) appears in the upper right corner of the

Interactive Instrument Window. The Interactive Instrument Window can display either the front panel or the rear panel of your instrument. Use the **FRONT PANEL** softkey to display the front panel. This is the panel that lets you operate your instrument. If the front panel that appears on your computer's display does not look like Figure 3-1, it means that a previous user has changed the default settings.

Closing a Channel

Closing a channel on the Relay Actuator consists of selecting a channel and enabling the output. Pointing to and selecting a channel on the computer's display turns the background of that field bright. When you point to and select a channel that is already bright, its background turns dark to indicate that it is no longer selected.

The output must be ENABLED for the selection process to also close the relays of the selected channels. Disabling the output opens all closed relays. With the output disabled, the selection process has no effect on any relays. This lets you visually verify which channels are selected before you close the relays. The **ENABLE OUTPUTS** and **DISABLE OUTPUTS** softkeys affect your instrument in the same way as the output ENABLED/DISABLED field.

If you exit the Soft Front Panel with the output enabled, the output will remain enabled. As long as you supply power to the instrument, the output will be enabled until the next time you enter the Soft Front Panel (run PANELS). Then the Relay Actuator will be initialized with the output disabled. However, the instrument will still remember which channels had been previously selected.

4 Front Panel Connections

Introduction

The following paragraphs describe how to make connections to the front panel of your Relay Actuator. You should become familiar with operating your instrument manually as explained in Chapters 2 and 3 of this guide before you make any front panel connections to your instrument. You may also want to read about programming your instrument in Chapter 5 before you make application connections.

WARNING

To avoid potentially hazardous electrical shock, establish a safety ground before making any front panel connections. Connect the output cable from the Power Pack to the Relay Actuator, and then connect the line cord from the Power Pack to the ac line (refer to Chapter 2 of the System Owner's Guide).

This instrument is under user's program control. Equipment failure, power failure, or program error may cause a hazardous situation to occur. Applications requiring a failsafe method of ensuring equipment status must be provided by the installer. When ac power is applied or removed, all relays open.

Application Connections

As shown in Figure 4-1, application (field-wire) connections are made on the plug-in terminal block that mates with the socket on the front of your instrument. Remove the terminal block to facilitate these wire connections.

CAUTION

Excessive input voltage and current will damage this instrument. Do not exceed 250V dc, 250V ac rms, or 350V ac pk between channels or from any channel to ground. Do not exceed 1A per channel or 4A per unit. If your equipment is capable of delivering more than 1A, an external 1A fuse should be used to prevent accidental damage to the instrument.

To prevent shorted connections, do not strip wires back more than 0.2 in. (5 mm). Insert wires fully into connectors.

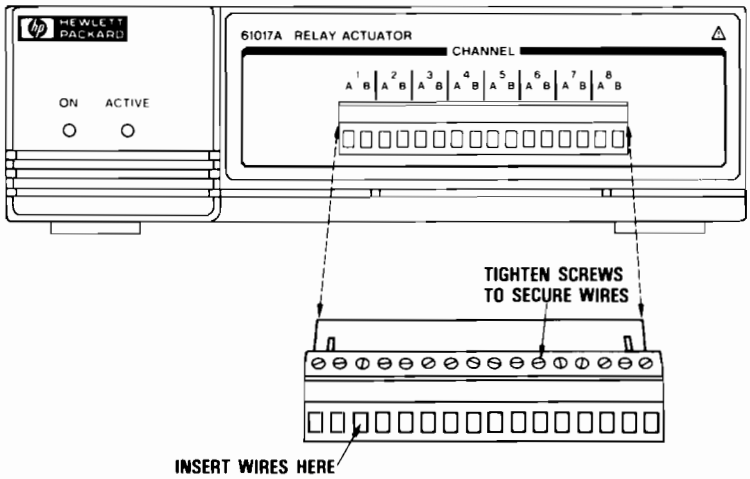

Figure 4-1. Application Connections

Loosen the screws on top of the terminal block. Strip your wires back approximately 0.2 in. (5 mm) and insert them in the square holes on the front of the terminal block. The screw terminals can accommodate wire sizes from AWG 14 to AWG 28 (Metric 1.5-0.5 mm^2). As shown in Figure 4-2, all "A" terminals are switched to the corresponding "B" terminals. Refer to the label on the front of your instrument or Figure 4-2 to make sure that you are inserting your wires into the correct opening.

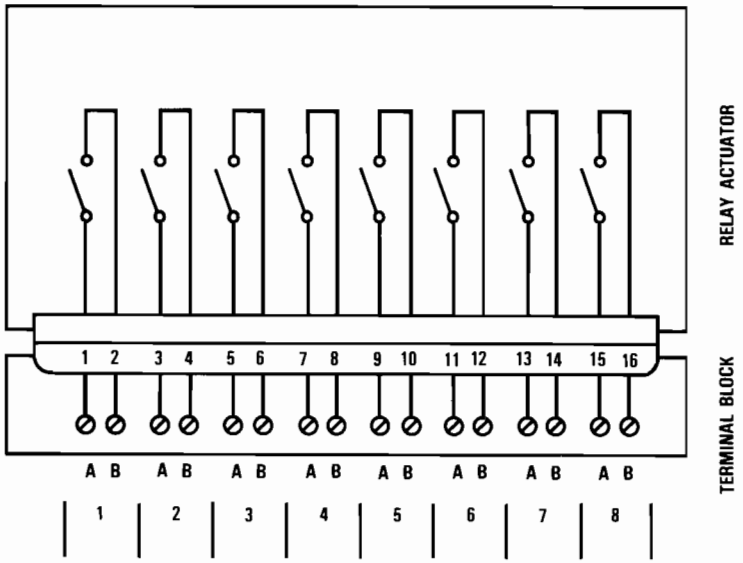

Figure 4-2. Internal Relay Connections

Matrix Switch Application

It is possible to connect two Relay Actuators together to form a 4x4 matrix switch as shown in Figure 4-3. Matrix switches are used in applications where it is necessary to connect single or multiple inputs to various outputs within a system. Although the example shows a 4x4 matrix, other configurations are possible.

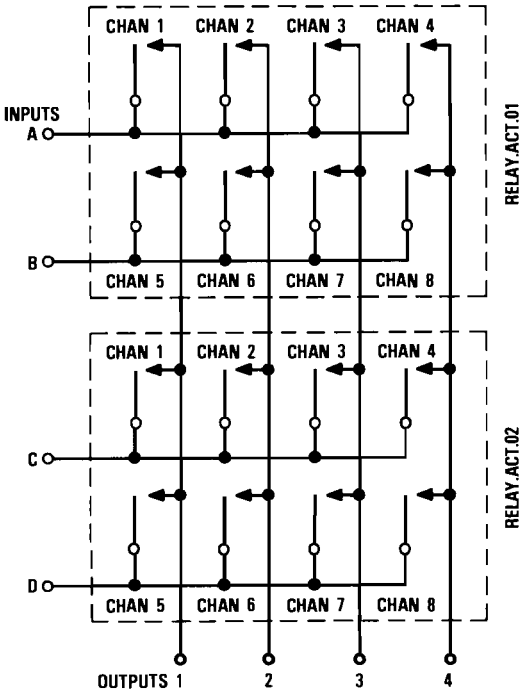

Figure 4-3. 4x4 Matrix Switch Diagram

Figure 4-4 shows the wiring connections for two Relay Actuators that form a 4x4 matrix switch. RELAY.ACT.01 controls the switches that are connected to inputs A and B; RELAY.ACT.02 controls the switches that are connected to inputs C and D. A program example for this specific wiring configuration is given in Chapter 5.

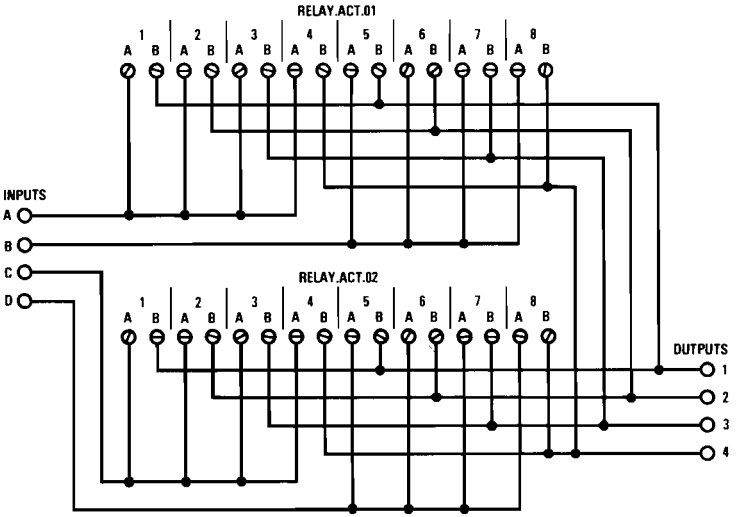

Figure 4-4. Matrix Switch Wiring Diagram

5 Programming with BASIC

Introduction

You can write a BASIC program to control the channels on your Relay Actuator. Before you attempt this, you should familiarize yourself with controlling the instrument manually (refer to Chapters 2 and 3). Also, you must already know how to write programs in BASIC before you can write your own application program. Chapter 5 of the System Owner's Guide contains information about how to develop and run your program. Before writing your program, you must first use the Soft Front Panel to create a Program Shell as explained in Chapter 4 of the System Owner's Guide. You can also use the Soft Front Panel to assign a label to the Relay Actuator and create one or more State files.

This chapter describes the statements that you can use in your program to control the Relay Actuator. These statements fall into two categories: system and instrument. System statements affect other instruments in your system. Instrument statements affect only the specified (labeled) Relay Actuator.

NOTE

If the programming statements in this chapter fail to execute, you may have a program error. Refer to Chapter 5 in the System Owner's Guide which discusses error handling methods. Appendix C of this guide lists the error messages that apply to the Relay Actuator.

How Statements Control the Relay Actuator

Figure 5-1 shows how the programming statements discussed in this chapter control the Relay Actuator. From the diagram you can see that the OUTPUT, CLOSE.CHANNEL, and OPEN.CHANNEL statements load the data that selects (or deselects) specific channels into the relay select register. Whether the relays that are associated with the selected channels will close depends on whether the ENABLE.SYSTEM or the DISABLE.SYSTEM statement has also been programmed. If the ENABLE.SYSTEM statement is programmed, the relays of the selected channels will close. If the DISABLE.SYSTEM statement is programmed, the OUTPUT and CLOSE.CHANNEL statements cannot close any channels. The INITIALIZE statement simultaneously selects the channels and enables or disables the relays.

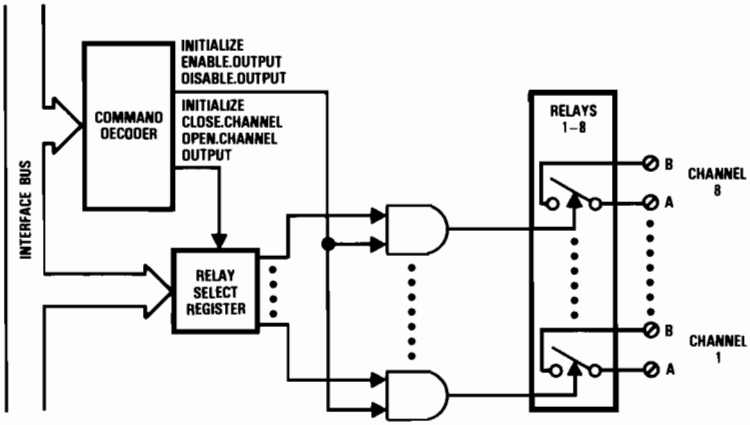

Figure 5-1. How Statements Control the Relay Actuator

System Programming Statements

All of the system statements are discussed in Chapter 5 of the System Owner's Guide. Only three of them apply to the Relay Actuator:

INITIALIZE.SYSTEM*(statefile)* - where *statefile* is the string variable that is equal to a State filename that was assigned when operating from the Soft Front Panel. The State filename must also include the .HPC extension. The INITIALIZE.SYSTEM statement sets all Relay Actuators in your system to the settings contained in a previously created State file. All other instruments in your system are also initialized. Wherever it is used in a program, the INITIALIZE.SYSTEM statement will override the results of any previously issued instrument statements. If this statement is not used in your program, the Relay Actuator will be initialized with the factory default settings (see Table 1-1).

NOTE

The Rear Panel information contained in the State file must agree with your present hardware set-up. Rear Panel mode is described in Chapter 4 of the System Owner's Guide.

ENABLE.SYSTEM - closes the relays of the selected channels on all Relay Actuators in your system. This statement allows you to select a channel before actually closing the relay of that channel. The relay of the selected channel will only close after the ENABLE.SYSTEM statement is programmed. This statement also enables all other output instruments in your system.

DISABLE.SYSTEM - opens any closed relays on all Relay Actuators in your system. This statement also disables all other output instruments in your system.

Instrument Programming Statements

Instrument programming statements only program the instrument that is specified by the *label* parameter. This parameter is either the factory default label (RELAY.ACT.01 for the first Relay Actuator in your system) or the user defined label that is assigned to the Relay Actuator when the instrument is labeled in Rear Panel mode. The instrument statements that program the Relay Actuator are described as follows.

INITIALIZE*(label,statefile)* - same as INITIALIZE.SYSTEM but sets only the specified Relay Actuator to a previously assigned state. Although the State file contains information about the other instruments in your system, only the information that applies to the Relay Actuator will be retrieved.

Example:

```
1010 FILE$=''YOURFILE.HPC''
1020 CALL INITIALIZE(RELAY.ACT.01,FILE$)
```

This example sets RELAY.ACT.01 to the settings contained in the file YOURFILE.HPC. YOURFILE.HPC can be any State file that you created and named when operating from the Soft Front Panel. Note that the .HPC extension must accompany the State filename. Depending upon the information in this file, your Relay Actuator can be initialized with the output enabled or disabled.

CLOSE.CHANNEL*(label,value)* - where *value* is a single-precision variable that must only be set to a number from 1 to 8. This statement selects a specific channel on the Relay Actuator. If an ENABLE statement is in effect, or if the instrument was initialized with the output enabled, the relay of the selected channel will close. Program execution will wait until the relay closes before continuing.

Example:

```
1010 SWITCH.3=3
1020 CALL CLOSE.CHANNEL(RELAY.ACT.01,SWITCH.3)
```

This example selects channel 3 on RELAY.ACT.01. Line 1010 assigns the value 3 to the variable SWITCH.3. Line 1020 selects channel 3. The variable name SWITCH.3 is an example of using a variable name that can be meaningful within the context of a specific application.

OPEN.CHANNEL*(label,value)* — where *value* is a single-precision variable that must only be set to a number from 1 to 8. This statement deselects a specific channel on the Relay Actuator. If the relay of the specified channel had been closed, this statement will cause the relay to open. Program execution will wait until the relay opens before continuing.

Example:

```
1010 SWITCH.3=3
1020 CALL OPEN.CHANNEL(RELAY.ACT.01,SWITCH.3)
```

This example deselects channel 3 on RELAY.ACT.01. Line 1010 assigns the value 3 to the variable SWITCH.3. Line 1020 deselects channel 3.

OUTPUT*(label,value)* - where *value* is a single-precision variable that must only be set to a number from 0 to 255. This statement selects and deselects specific channels on the Relay Actuator. The numbers 0 to 255 represent an eight-bit binary value that programs all eight channels simultaneously. Using a single OUTPUT statement to program your Relay Actuator is therefore easier and much faster than using up to eight CLOSE.CHANNEL or OPEN.CHANNEL statements.

The following table shows the decimal values that program specific channels. A value of zero deselects all channels. A value of 255 selects all channels. To program multiple channels, simply add up the decimal values for all of the channels you want to program and use that value in the OUTPUT statement. Note that the value 255, which selects all eight channels, is the sum of all of the decimal values that select the individual channels.

Decimal Value	Effect
0	No channels selected
1	Channel 1 selected
2	Channel 2 selected
4	Channel 3 selected
8	Channel 4 selected
16	Channel 5 selected
32	Channel 6 selected
64	Channel 7 selected
128	Channel 8 selected
255	All channels selected

Example:

```
1010 VALUE=100
1020 CALL OUTPUT(RELAY.ACT.01,VALUE)
```

This example selects channels 3, 6, and 7 on RELAY.ACT.01. Line 1010 assigns the value 100 to the variable *value*. The value 100 is the sum of 4, 32, and 64 (which select channels 3, 6, and 7). Line 1020 causes channels 3, 6, and 7 to be selected. Any channels that were previously selected on RELAY,ACT.01, would no longer be selected.

ENABLE.OUTPUT*(label)* - same as ENABLE.SYSTEM except that it closes the relay of the selected channels only on the specified Relay Actuator.

Example:

```
1010 CALL ENABLE.OUTPUT(RELAY.ACT.01)
```

This example closes the relay of any selected channels on RELAY.ACT.01.

DISABLE.OUTPUT *(label)* - same as DISABLE.SYSTEM except that it opens any closed relays only on the specified Relay Actuator.

Example:

```
1010 CALL DISABLE.OUTPUT(RELAY.ACT.01)
```

This example opens any closed relays on RELAY.ACT.01.

Channel Closure Example

Before you can try out this program, you must first use the Soft Front Panel to generate a Program Shell. Then exit the Soft Front Panel and run PCIBAS. Load the Program Shell and type in the lines shown in the example after line 1000. Once you have finished typing in the sample program, save your program and then run it.

Normally you would also use the Soft Front Panel to save a State file for all of the instruments in your PC Instruments System. Then you could use an INITIALIZE statement in your program to set the Relay Actuator to the settings that you previously saved in the State file. Because the INITIALIZE statement is not used in this example, your Relay Actuator will be set to the factory default settings (see Table 1-1). This means you must program each function of your instrument separately. When writing your own program, use the same labels in your instrument statements that you assigned to the Relay Actuator when using the Soft Front Panel. The following program uses the default label RELAY.ACT.01 in the instrument statements. It first selects and then closes the channel 2, 3, 4, and 5 relays.

```
program shell
        .
        .
1000 'User program starts at this line

1010 A=2
1020 CALL CLOSE.CHANNEL(RELAY.ACT.01,A)
1030 B=3
1040 CALL CLOSE.CHANNEL(RELAY.ACT.01,B)
1050 C=4
1060 CALL CLOSE.CHANNEL(RELAY.ACT.01,C)
1070 D=5
1080 CALL CLOSE.CHANNEL(RELAY.ACT.01,D)
```

These statements select channels 2 through 5. A, B, C, and D are variable names that contain the information which selects each channel in turn.

```
1090 CALL ENABLE.OUTPUT(RELAY.ACT.01)
```

This statement closes the relays of channels 2-5.

```
1100 END
```

The previous program will execute faster if you use an OUTPUT statement instead of the CLOSE.CHANNEL statements. It also uses less programming space. Thus, the following lines can replace lines 1010 through 1080 in the previous program.

Example:

```
1010 VALUE=30
1020 CALL OUTPUT(RELAY.ACT.01,VALUE)
```

The value 30 was arrived at by adding the decimal values 2, 4, 8, and 16 together. These decimal values program channels 2 through 5. These channels will be the only ones selected on the instrument after the output statement has executed.

Matrix Switch Example

This example shows you how to program a 4x4 matrix switch. For this application to work, you need two Relay Actuators. Figure 4-4 in Chapter 4 shows the wiring connections for each Relay Actuator. You must connect the wires as shown in that figure for the following example program to work properly.

Figure 5-2 shows the decimal values that must be programmed when using an OUTPUT statement to select specific channels on RELAY.ACT.01 and RELAY.ACT.02. To select multiple channels on an instrument, simply add the decimal values of each channel that you want to select together and use that value in your OUTPUT statement. The following program simultaneously connects input A to output 1, input B to output 2, input C to output 3, and input D to output 4.

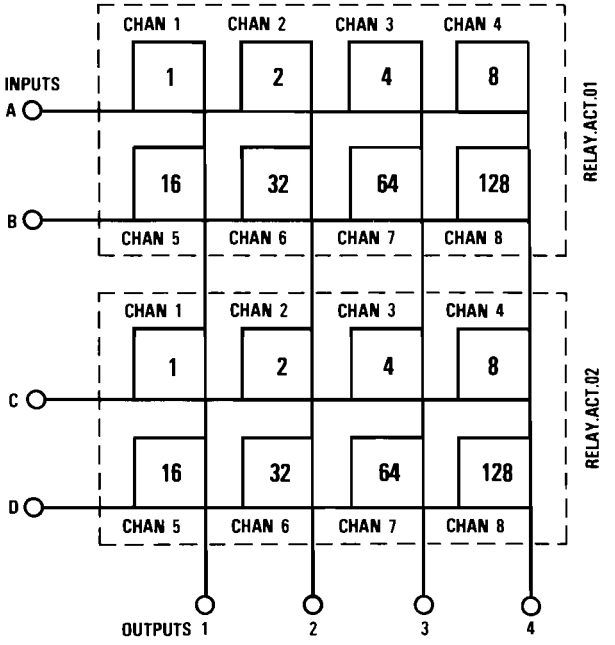

Figure 5-2. Matrix Switch Programming Diagram.

CAUTION

Depending on your application, possible damage can occur to your equipment if more than one switch is closed in the same row or column. Take precautions where necessary.

```
program shell
      .
      .
1000 'User program starts at this line

1010 CALL DISABLE.SYSTEM
```

This statement disables the outputs on both Relay Actuators.

```
1020 VALUE=33
1030 CALL OUTPUT(RELAY.ACT.01,VALUE)
```

These statements select channels 1 and 6 (1+32) on RELAY.ACT.01.

```
1040 VALUE=132
1050 CALL OUTPUT(RELAY.ACT.02,VALUE)
```

These statements select channels 3 and 8 (4+128) on RELAY.ACT.02.

```
1060 CALL ENABLE.SYSTEM
```

This statement enables the outputs on both Relay Actuators, thereby closing four relays simultaneously.

```
1070 END
```

The matrix switch program uses a DISABLE.SYSTEM statement at the beginning of the program to bring both Relay Actuators to a ''safe'' state before the relays are programmed. This must be done each time the relays are programmed to a different setting since the Relay Actuator has no break-before-make feature. Because the DISABLE.SYSTEM statement also disables other output instruments in your system, you could use the DISABLE.OUTPUT statement to accomplish the same task. Thus, the following two lines can replace line 1010 in the previous program.

Example:

```
1010 DISABLE.OUTPUT(RELAY.ACT.01)
1020 DISABLE.OUTPUT(RELAY.ACT.02)
```

The disadvantage in using DISABLE.OUTPUT statements is that the matrix switch relays are not disabled simultaneously. This also applies when enabling both Relay Actuators using ENABLE.OUTPUT statements.

A Programming Statement Summary

The following is a summary of the programming statements that can be used to control the Relay Actuator. You can use this summary as a reference guide for spelling and syntax of the available statements.

System Statements

DISABLE.SYSTEM
ENABLE.SYSTEM
INITIALIZE.SYSTEM*(statefile)*

Instrument Statements

CLOSE.CHANNEL*(label,value)*
DISABLE.OUTPUT*(label)*
ENABLE.OUTPUT*(label)*
INITIALIZE*(label,statefile)*
OPEN.CHANNEL*(label,value)*
OUTPUT*(label,value)*

B Verification Procedures

Introduction

Verification procedures for your Relay Actuator are included with your PC Instruments software. Instructions on how to load and run these procedures are given in Appendix B of your System Owner's Guide. Step-by-step instructions to guide you through each part of the procedures will appear on your computer's display when you run the Relay Actuator verification program. This appendix lists the equipment required to verify the Relay Actuator and briefly describes the actual tests performed on the Relay Actuator.

Equipment Required

You must have an installed PC Instruments Interface Card and a Relay Actuator. In addition, an ohmmeter is needed to measure the resistance of the relay contacts. If you have a PC Instruments Digital Multimeter in your system, you can use it to test your Relay Actuator. The multimeter must be connected to the same interface card as the Relay Actuator that is under test. This makes the procedure faster and more convenient than when you use a non-PC Instruments multimeter. Remember that no verification is performed on the PC Instruments Digital Multimeter in this test and it is assumed that it is functioning correctly.

If you want to use your own multimeter to test the Relay Actuator, it must be able to measure resistance with a resolution of 50 milliohms and an accuracy of +.35%. Before you can run the test, you must connect the meter leads from terminal A to terminal B of channel #1.

NOTE

It is not necessary to observe polarity when testing the relays.

What the Test Does

When you first run the verification program, it does a system level verification that partially tests all instruments in your system. This part of the test checks that the interface and instruments respond to commands issued by the computer. It is described in Appendix B of your System Owner's Guide.

After your Relay Actuator passes the system level verification, it will appear in a menu along with the other instruments in your system. This menu is the starting point for the instrument-specific verification tests for all of your instruments. To continue testing your Relay Actuator, you must select it from this list and press the TEST softkey (f7). (When you select an instrument from the list, the ACTIVE indicator on the front of the instrument lights up.) Specifically, the Relay Actuator verification allows you to check that each relay in your instrument opens and closes completely by measuring the resistance of each channel. You are prompted to move the meter leads from channel to channel until all eight channels have been tested.

If you are using the PC Instruments Digital Multimeter to test your Relay Actuator, the verification test will automatically determine whether the individual relays pass or fail the test. A message to that effect will appear on your screen. If you are using your own multimeter to test the relays, the program will print the expected results of each test on the screen. Based on the reading of your multimeter, you must then determine if the relay has passed or failed.

In Case of Trouble

It is important that you complete all verification tests on both the system and instrument level. If your Relay Actuator does not pass these tests, consult your PC Instruments Support Guide for information on the PC Instruments exchange program.

C Error Messages

The following error messages apply to the Relay Actuator. When programming your instrument from BASIC, error messages are only returned when you use the error handling routines described in Chapter 5 of the System Owner's Guide.

804 - Channel number is invalid
806 - System error