Agilent 75000 SERIES C

Using Agilent Instrument Basic with the E1406A Command Module

User's Manual

Agilent Technologies

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Edition 1 Rev 2

Printing History

The Printing History shown below lists all Editions and Updates of this manual and the printing date(s). The first printing of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct the current Edition of the manual. Updates are numbered sequentially starting with Update 1. When a new Edition is created, it contains all the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this printing history page. Many product updates or revisions 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 product updates and manual updates.

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Safety Symbols

⚠	Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.	∿	Alternating current (AC).
		⎓	Direct current (DC).
⏚	Indicates the field wiring terminal that must be connected to earth ground before operating the equipment—protects against electrical shock in case of fault.	⚡	Indicates hazardous voltages.
		WARNING	Calls attention to a procedure, practice, or condition that could cause bodily injury or death.
⟂ or ⊥	Frame or chassis ground terminal—typically connects to the equipment's metal frame.	**CAUTION**	Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

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The following general safety precautions must be observed during all phases of operation, service, and repair of this product. 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 product. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type.
DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

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Agilent 75000 Series C Documentation

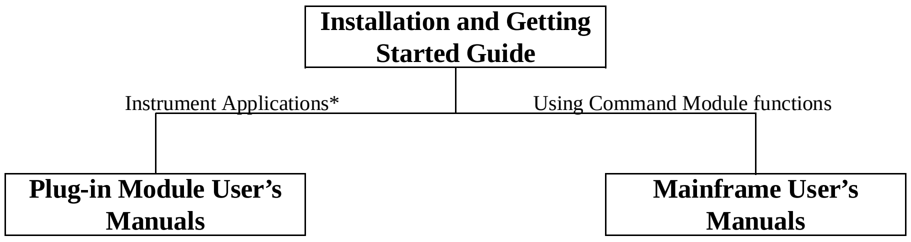
Suggested Sequence for Using the Manuals

C-Size VXIbus Systems Installation and Getting Started Guide. Contains step-by-step instructions for all aspects of plug-in module and mainframe installation.

Agilent E1406A Command Module User's Manual. Contains information on downloading user tables to modify (if necessary) configurations set up using the Installation and Getting Started Guide, information on using an RS-232 terminal as a "front panel" to your C-size system, and information on how interrupts are used. A command reference for the Agilent E1406A Command Module command set is included.

Using Agilent Instrument BASIC with the E1406A Command Module. Contains information on the version of Agilent Instrument Basic which can be installed in Flash ROM in your Agilent E1406A Command Module.

Plug-In Module User's Manuals. Contain programming and configuration information for the plug-in modules. These manuals contain examples for the most commonly-used functions and give a complete SCPI command reference for the module.


Installation and Getting Started Guide
Instrument Applications*
Using Command Module functions
Plug-in Module User's Manuals
Mainframe User's Manuals

* For Scanning Voltmeter Applications, refer to the Agilent E1326A/E1411A 5 1/2 Digit Multimeter User's Manual.

Suggested Sequence for Using the Manuals

Related Documents

Agilent E1401A Mainframe User's Manual. Contains installation information to prepare the mainframe for use and shows how to install plug-in manuals. This manual also contains a detailed hardware description of the mainframe.

Agilent Instrument BASIC User's Handbook. Includes three books: *Agilent Instrument BASIC Programming Techniques* , *Agilent Instrument BASIC Interfacing Techniques,* and *Agilent Instrument BASIC Language Reference* .

Beginner's Guide to SCPI. Explains the fundamentals of programming instruments using the Standard Commands for Programmable Instruments (SCPI) language. We recommend this guide to anyone who is programming with SCPI for the first time.

Tutorial Description of the General Purpose Interface Bus. Describes the technical fundamentals of the General Purpose Interface Bus (GPIB). This document also includes general information on IEEE 488.2 Common Commands. We recommend this document to anyone who is programming with IEEE 488.2 for the first time.

IEEE Standard 488.2-1987, IEEE Standard Codes, Formats, Protocols, and Common Commands. Describes the underlying message formats and data types used in TMSL and defines Common Commands. You will find this document useful if you need to know the precise definition of certain message formats, data types, or Common Commands. Available from: The Institute of Electrical and Electronic Engineers, Inc.; 345 East 47th Street; New York, NY 10017; U.S.A.

VXIbus System Specifications. Available from Agilent Technologies.

The VMEbus Specification. Available from: VMEbus International Trade Association; 10229 N. Scottsdale Road, Suite E; Scottsdale, AZ 85253; U.S.A.

About this Manual

Manual Content

This manual contains information on the use of IBASIC as implemented in the Agilent E1405/E1406 Command Modules. The manual is part of a manual set that includes the C-Size VXIbus Systems "Installation and Getting Started Guide" and various plug-in module user's manuals.

Chapter 1: Product Overview

This chapter contains a functional, electrical, and physical description of the Agilent E1406A Command Module.

Chapter 2: Modifying Your Configuration

This chapter explains how the Command Module's resource manager function configures your VXIbus system. It also contains information on using user-tables to override the (default) configuration performed by the resource manager.

Chapter 3: Using the Display Terminal Interface

This chapter shows you how to use an RS-232 terminal to operate instruments in the Series C mainframe. The terminal is connected to the Command Module via the Module's RS-232 port.

Chapter 4: Status and Interrupts

This chapter describes the status system structure used by the Command Module and how interrupts are enabled and serviced.

Chapter 5: Downloading Device Drivers

This chapter contains information on downloading device drivers into non-volatile memory using both GPIB and RS-232 connections.

Chapter 6: Downloading a New Operating System

This chapter contains information on downloading a new operating system into the E1406A Command Module flash RAM using both GPIB and RS-232 connections. It also contains a description of Command Module commands which are active when you are using the Loader instrument.

Chapter 7: System Instrument Command Reference

The command reference contains a detailed description of Command Module commands which are active when you are using the System instrument. It includes information on the choice of settings and examples showing the context in which the command is used.

Appendix A: Specifications

This section contains a list of the Agilent E1406A Command Module's operating specifications.

Appendix B: Error Messages

This section lists the error messages associated with the Command Module and their possible causes.

Appendix C: Command Module A16 Address Space

This appendix contains an address map of the A16 address space inside the Command Module. It includes information on how to determine the base address of a device whose registers are mapped into A16 space.

Appendix D: Sending Binary Data Over RS-232

This Appendix contains information on transferring binary files over an RS-232 interface. It includes information on how these files are coded for transmission.

Table of Contents

Chapter 1 Contents

Chapter 1

Getting Started

Using This Chapter

This chapter presents the basics of how to get started using IBASIC. You should be familiar with the operation of your C-Size mainframe, Command Module, and any instrument modules you will be using. This chapter contains the following sections:

Selecting IBASIC Mode of Operation

After you have installed and configured the mainframe, Command Module, and plug-in module(s) you will need to choose a mode of operation for IBASIC. IBASIC can run in either System Controller mode or Talk/Listen mode. The mode is set with the Sys Control - Talk/Listen switch on the Command module (bit 7 on the "GPIB Address" DIP switch).

Comparing Modes of Operation

To help you choose the mode of operation for your application, the following table compares major functions for System Controller and Talk/Listen mode. See *System Controller Mode Operation* or *Talk/Listen Mode Operation* for summaries of these functions. After you select the mode of operation, see *Setting IBASIC Mode of Operation* in this chapter to set the mode of operation.

System Controller vs. Talk/Listen Mode Operations

Function	System Controller Mode	Talk/Listen Mode
Create/Edit IBASIC Programs	Use RS-232 Terminal Use Terminal Emulator	Same as System Contoller mode
Use RAM Disks	Use DOS and LIF file systems Use ASCII, BDAT, and DOS/HP-UX files Store programs/data to RAM volumes	Same as System Controller mode
Use External Disks	Use DOS and LIF file systems Use ASCII, BDAT, and DOS/HP-UX files Store programs/data to external SS80 disk or tape	Cannot access disks from IBASIC computer
Control Internal Instruments	IBASIC computer via IBASIC interface Terminal via User interface	Same as System Controller mode plus can use external (GPIB) computer
Control GPIB Devices	IBASIC computer via GPIB interface	External computer via (external) GPIB interface
Control RS-232/422 Peripherals	RS-232 peripherals via built-in RS-232 port RS-232/422 peripherals via Agilent E1324A modules	Same as System Controller mode

System Controller Mode Operation

Figure 1-1 shows typical System Controller mode configuration. There are three primary functions for System Controller mode:

- Create/Edit IBASIC Programs
- Use Mass Storage Devices
- Control Instruments/Devices/Peripherals

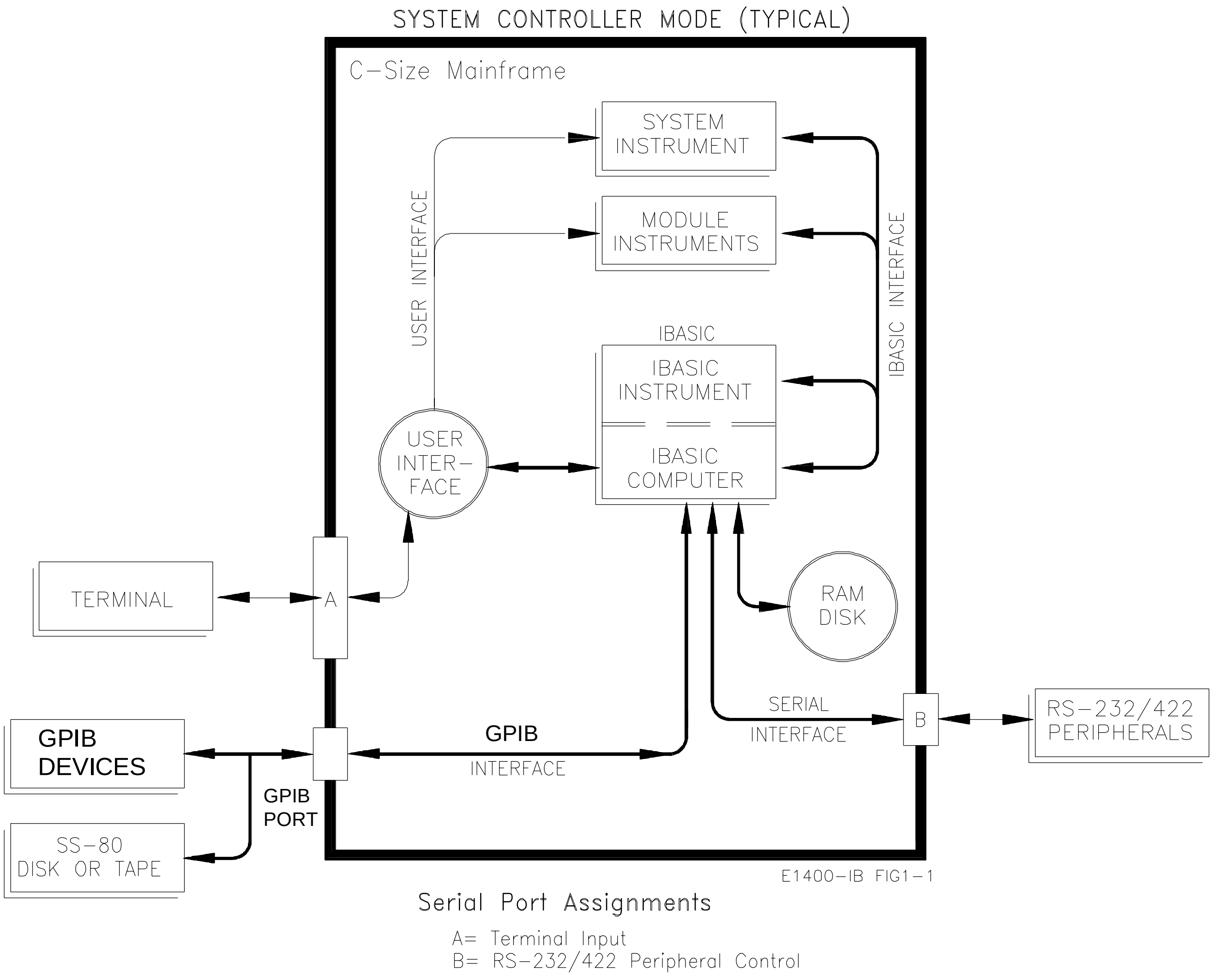


Figure 1-1. System Controller Mode Operation

Creating/Editing IBASIC Programs

In System Controller mode, you can create/edit IBASIC programs with an RS-232 computer or supported terminal and GET/SAVE program files. To create and edit IBASIC programs, you can access the IBASIC computer from a supported terminal, or from an RS-232 computer acting in terminal emulator mode. See the *Agilent E1406A Command Module User's Manual* for supported terminals.

Using Mass Storage Devices

In System Controller Mode, you can save programs and data to an external SS80 disk or tape drive on the GPIB, or to RAM volumes on the RAM disk. You can create up to 16 RAM volumes (RAM VOLs). RAM VOL 1 can be nonvolatile or volatile, while RAM VOLs 0 and 2 through 16 can be volatile only. The IBASIC computer can create DOS or LIF file systems and can use ASCII, BDAT, or DOS/HP-UX files.

Controlling Instruments/ Devices/ Peripherals

In System Controller mode, you can control the System instrument, plug-in module instruments, and the IBASIC instrument using the IBASIC computer via the IBASIC interface or using the front panel or supported terminal via the User Interface.

You can control external GPIB[1] devices (such as printers, voltmeters, disks, etc.) using the IBASIC computer via the GPIB interface. (If an external computer is connected as an GPIB device, the computer should be configured as non-Active Controller and Non-System Controller.)

When the interface is assigned to IBASIC, you can control an external RS-232 peripheral with the IBASIC computer via the built-in RS-232 interface. Or, you can control external RS-232/422 peripherals via the serial interfaces on up to seven Agilent E1324A plug-in modules.

1 The General Purpose Interface Bus (GPIB) is the implementation of the ANSI/IEEE 488.1 Standard Digital Interface for Programmable Instrumentation.

Talk/Listen Mode Operation

Figure 1-2 shows typical Talk/Listen mode configuration. There are three primary functions for Talk/Listen mode:

- Create/Edit IBASIC Programs
- Use Mass Storage Devices (RAM Volumes Only)
- Control Instruments/Devices/Peripherals

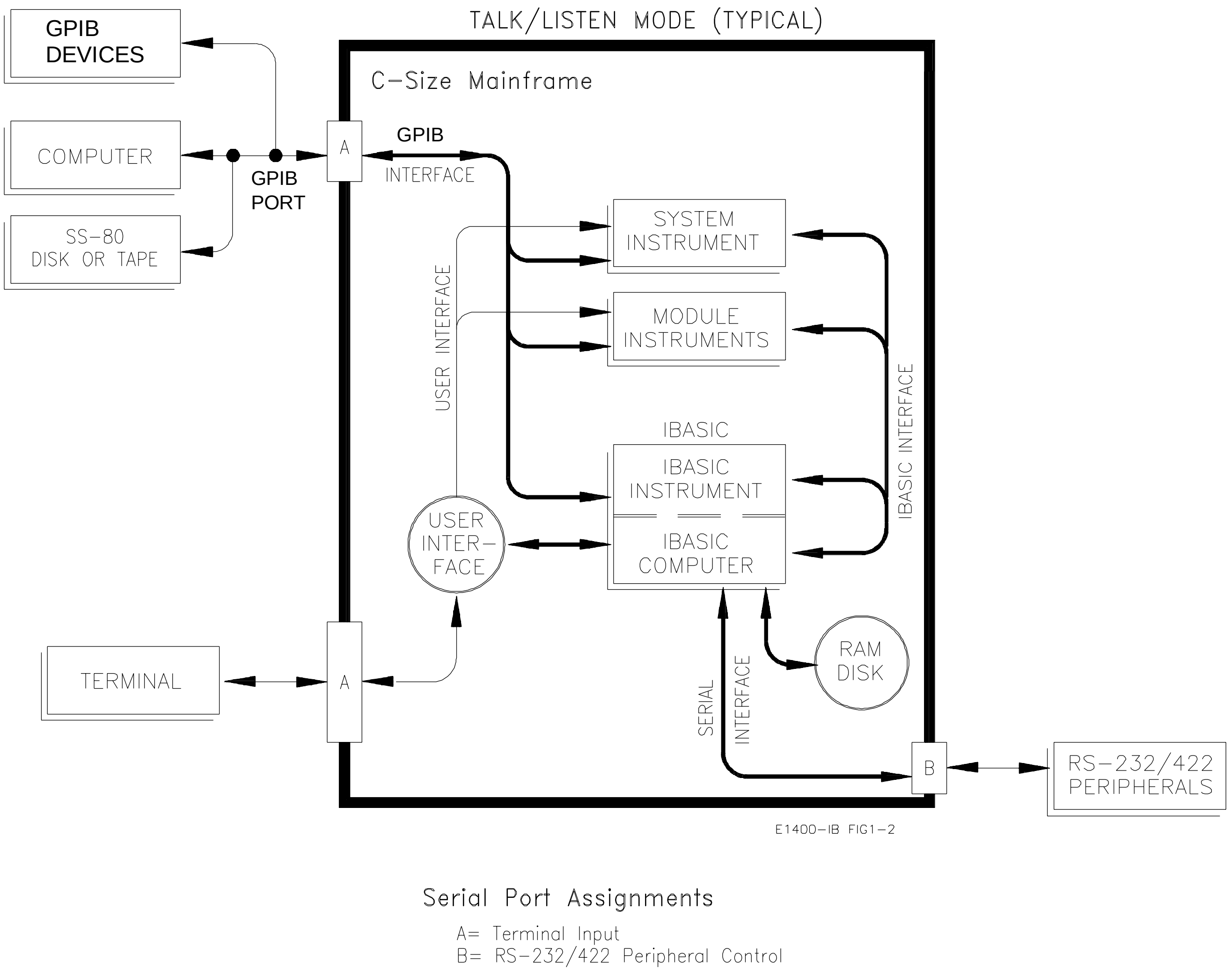


Figure 1-2. Talk/Listen Mode of Operation

Creating/Editing IBASIC Programs

In Talk/Listen mode, you can create/edit IBASIC programs with an RS-232 computer or supported terminal and GET/SAVE programfiles. To create and edit IBASIC programs, you can access the IBASIC computer via from a supported terminal, or from an RS-232 computer acting as a terminal emulator. See the *Agilent E1406 Command Module User's Manual* for supported terminals. You can also access the IBASIC computer from an external computer via GPIB.

Creating/editing IBASIC programs is the same for Talk/Listen mode as for System Controller mode. In Talk/Listen mode, you can download programs to the IBASIC computer from an external (GPIB) computer.

Using Mass Storage Devices

In Talk/Listen Mode, you can save programs and data to IBASIC memory or to RAM volumes on the RAM disk. You can create up to 16 RAM volumes (RAM VOLs). RAM VOL 1 can be nonvolatile or volatile, while RAM VOLs 0 and 2 through 16 are always volatile. The IBASIC computer can create DOS or LIF (Logical Interchange Format) file systems on RAM volumes and can use ASCII, BDAT, and DOS/HP-UX files.

Controlling Instruments/ Devices/ Peripherals

In Talk/Listen mode, you can control the System instrument, plug-in module instruments, and the IBASIC instrument using the IBASIC computer via the IBASIC interface and a supported terminal via the User Interface. With Talk/Listen mode, an external computer and the IBASIC computer can both control instruments.

You can control external GPIB devices (such as printers, voltmeters, disks, etc.) using an external computer via the (external) GPIB interface. For Talk/Listen mode, the IBASIC computer cannot control external GPIB devices.

When the interface is assigned to IBASIC, you can control an external RS-232/422 peripheral via the serial interfaces on up to seven Agilent E1324A plug-in modules. Controlling RS-232/422 peripherals with Talk/Listen mode is the same as with System Controller mode.

Note

System software will let you assert control of external RS232 devices via the built-in RS-232 interface. This is not generally recommended, since it will leave you without access to the User Interface unless you are using a plug-in Serial Interface card and a terminal to access the User Interface.

Setting IBASIC Mode of Operation

WARNING **SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should install, remove, or configure the system. Before you removing or installing a plug-in module, disconnect AC power and field wiring from the mainframe.**

The IBASIC mode of operation is set on the "GPIB Address" switch #1 (labeled "Controller") on the lower front right side of the IBASIC Command Module. See Figure 1-3 for the switch location.

Setting the "Controller" switch to "1" and selecting RESET from the System Instrument menu or cycling the C-size mainframe power sets System Controller mode. Setting the "Controller" switch to "0" and selecting RESET from the System Instrument menu or cycling Agilent E1400 power sets Talk/Listen mode.

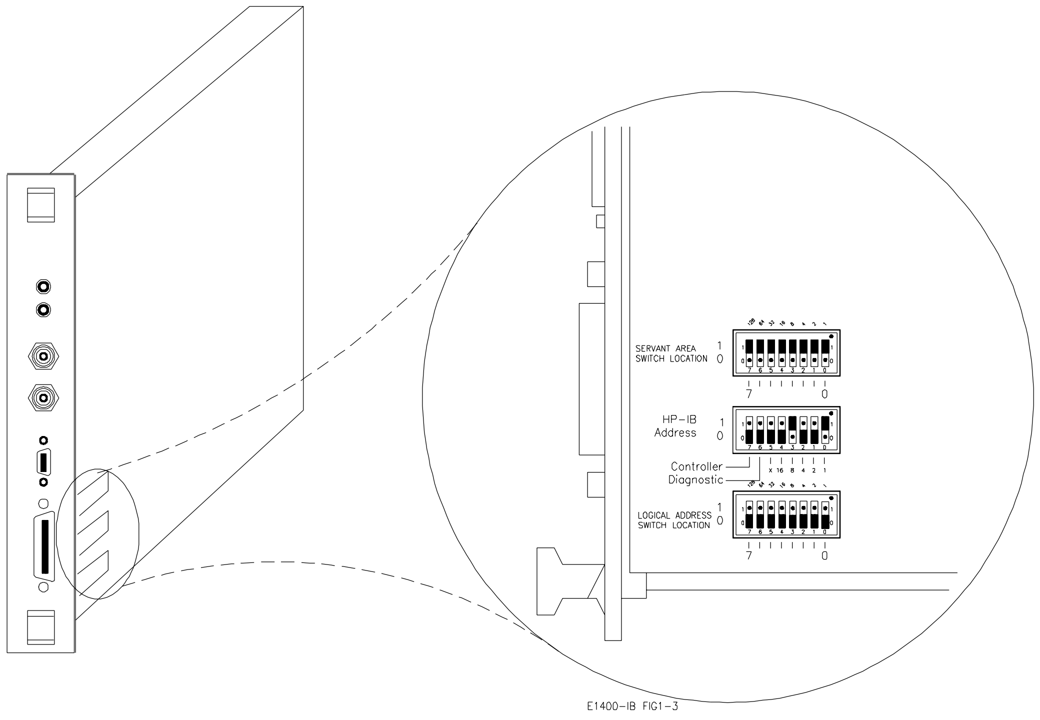


Figure 1-3. Setting IBASIC Mode of Operation

Chapter 2 Contents

Chapter 2

Creating and Editing Programs

Using this Chapter

This chapter shows you how to create and edit programs using a remote RS-232 terminal or terminal emulator. General IBASIC editing information is also in this chapter.

The user interface to IBASIC follows the model of other mainframe instruments. IBASIC is selected like the instruments, and can use the display only when it is the selected instrument.

Important

This chapter assumes that you are familiar with general remote terminal or terminal emulator operation. If this is your first time using a terminal or terminal emulator, refer to the tutorials in Chapter 2 or 3 of the Mainframe Manual before attempting to use this chapter.

NOTE

If you get "ERROR 2 MEMORY OVERFLOW" when running a program, one or more local variables are too large for the default memory size (32768 bytes). For example, the command INTEGER RDGS (16500) creates an integer array requiring 33000 bytes and will generate an error when you run the program. You can solve this problem by changing the local variables to common variables with the COM command (e.g., COM INTEGER RDGS (16500)) or by increasing memory size with the PROG:MALL command (e.g., OUTPUT 80903;"PROG:MALL 50000").

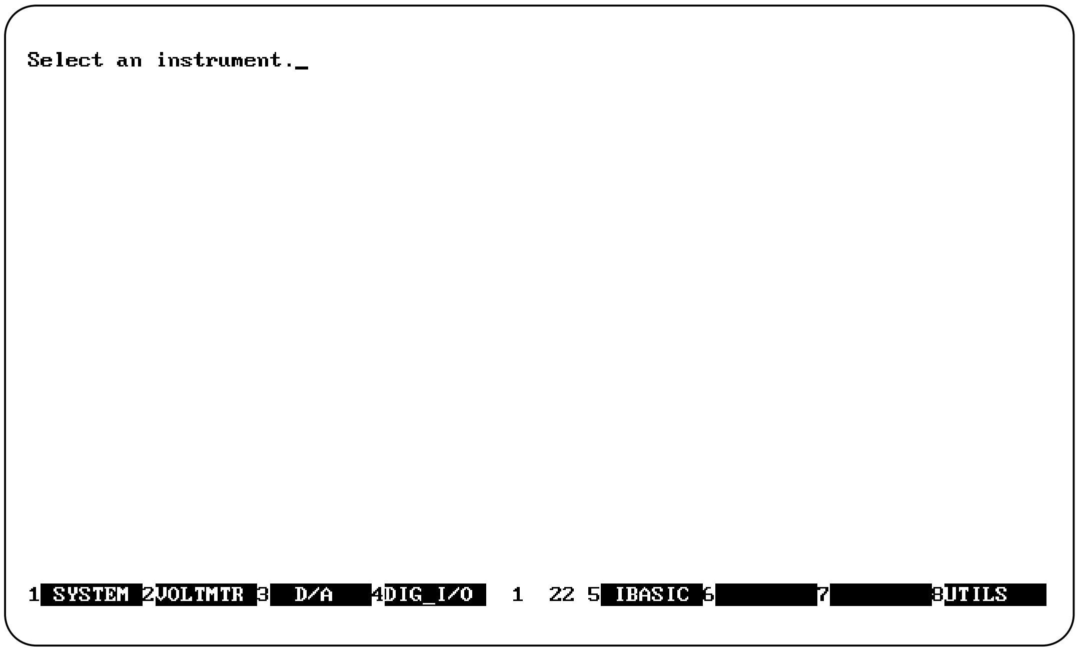
Using a Terminal

From a remote RS-232 terminal (or computer with terminal emulator), you can execute IBASIC commands, develop and debug programs, and interact with running programs. Programs can be edited with IBASIC's full screen editor. Refer to the Mainframe User's Manual for information on supported terminals and how to connect a terminal to the mainframe.

Selecting the IBASIC Instrument

When an RS-232 terminal (or emulator) is connected to the mainframe, the terminal will be automatically "captured" whenever mainframe power is cycled or the System Instrument is reset. When captured, the terminal displays the "*Select an instrument*" menu. A typical terminal display is:

To select the IBASIC Instrument, press the terminal's function key corresponding to the word IBASIC. For example, in the above display, press **f5.**



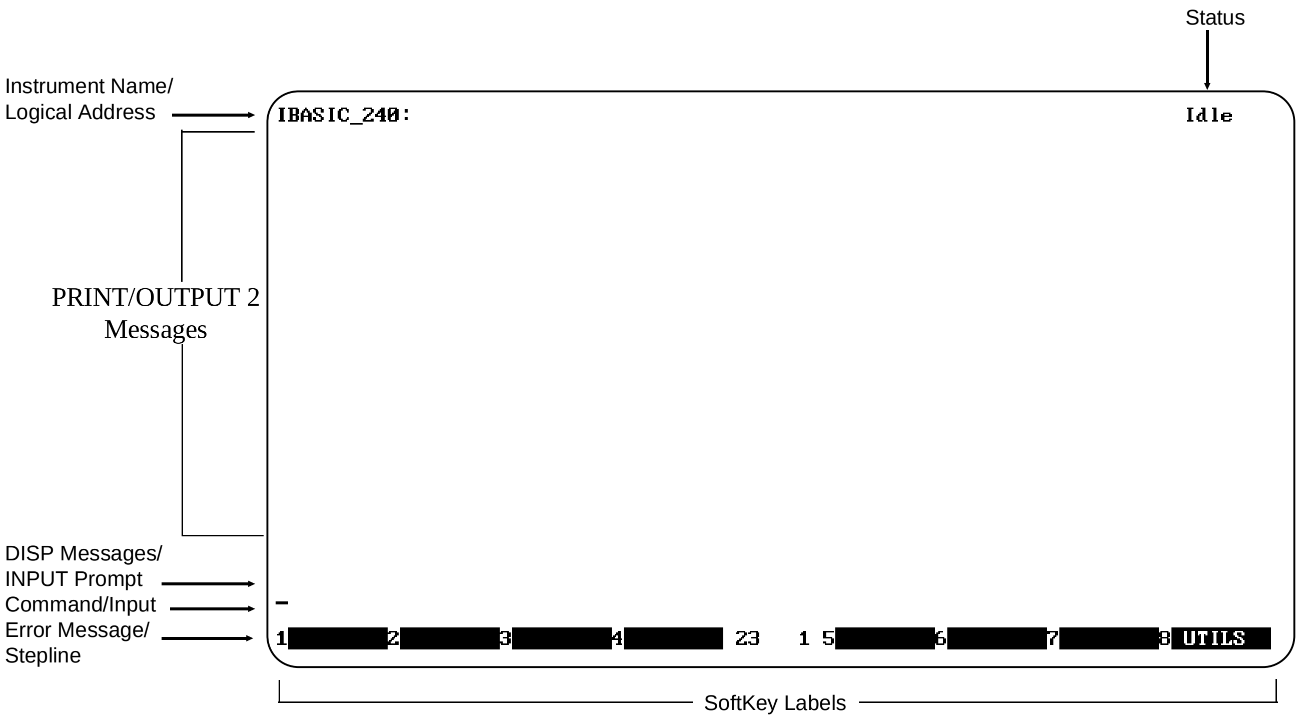
```
Select an instrument._

1 SYSTEM 2VOLTMTR 3  D/A    4DIG_I/O   1  22 5 IBASIC 6        7        8UTILS
```

NOTES

If the terminal has not been captured or does not display "Select an Instrument", you can select the IBASIC instrument by executing the SIIBASIC command from the terminal.

IBASIC Display

After selecting the IBASIC instrument, you should see a display similar to this (the display contents are explained below):



Instrument Name/Logical Address: Means you are using the IBASIC instrument. This line does not scroll off the display.

PRINT/OUTPUT 2 Messages: These 18 or 19 lines display PRINT or OUTPUT 2 messages. These lines are also used for program editing in Edit Mode.

DISP Messages/INPUT Prompt: This line displays DISP messages and prompts from INPUT statements.

Command/Input: This line displays commands and user-entered data in response to the INPUT statement. These lines scroll horizontally, if necessary (up to 160 characters).

Error Message/Stepline: This line displays error messages or the stepline (during single stepping).

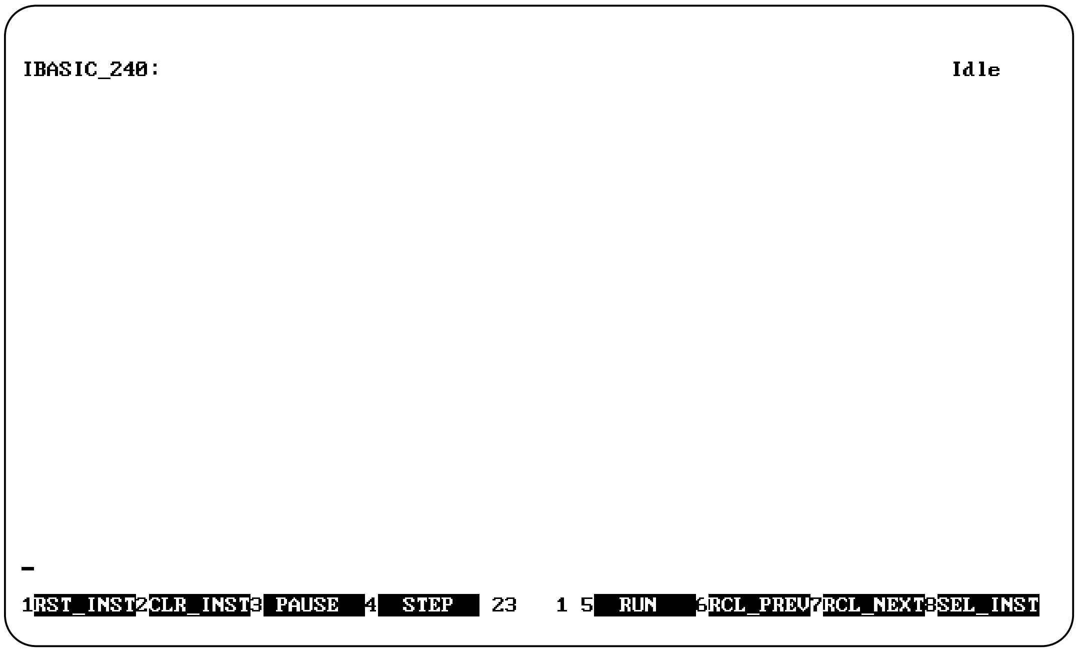
Status: Shows the state of the program as follows:

- *Running*: A command is being executed from the command input line, a program is running, or a program line is being executed by the **STEP** key.
- *Paused*: Program is paused (execute the CONT command to resume).
- *Editing*: You are in Edit Mode.
- *Input?*: IBASIC is waiting for you to respond to an INPUT command.
- *Idle*: No program activity (none of the above operations).

As with the front panel, when you select another instrument and then re-select IBASIC, the state of IBASIC will be the same as it was when last selected. All DISPs, prompts, error messages, user softkey labels, and input are re-written upon re-selecting IBASIC, but any PRINTs are not re-written.

UTILS Keys

As shown in the previous figure, one of the function keys is labelled **UTILS.** The **UTILS** key allows you to select the IBASIC utility function keys. After pressing **UTILS,** you will see these function key labels (each key is explained below):



```
IBASIC_240:                                                      Idle

_
1RST_INST2CLR_INST3 PAUSE  4  STEP   23   1 5  RUN   6RCL_PREV7RCL_NEXT8SEL_INST
```

RST_INST

Resets the IBASIC instrument (equivalent of a BASIC Reset) and clears all IBASIC input and output buffers (user interface and remote). **RST_INST** aborts a running program but does not destroy the program (see the *RST command in chapter 9 for details).

CLR_INST

Clears the user interface input and output buffers for IBASIC (remote buffers are not cleared) and returns to the IBASIC instrument display (IBASIC_240: _). Press **CLR_INST** whenever IBASIC is busy (except during power-on/reset sequence), is not responding, or to abort a command being entered from the terminal. **CLR_INST** will not abort a running program (use **RST_INST** for this).

PAUSE

Pauses a running program. Notice that there is not a Continue key available as a soft key. To continue a program after pressing **PAUSE**, type and execute the CONT command.

STEP

Executes a program line-by-line starting with the first program line.

RUN

Begins execution of a program.

RCL_PREV

Recalls the last command entered via the user interface. After recalling a command, it can be edited or re-executed (by pressing **Enter**). You can recall from a stack of previously executed commands by repeatedly pressing **RCL_PREV**. When you reach the bottom of the stack (the last line in the buffer), pressing **RCL_PREV** does nothing except to cause a beep. In Edit Mode, **RCL_PREV** recalls the last program line deleted with the **DEL_LN** key. Only the last deleted line (one line) can be recalled.

RCL_NEXT

Accesses commands in the opposite order to that of **RCL_PREV**. Pressing **RCL_NEXT** does nothing until you have pressed **RCL_PREV** at least twice. **RCL_PREV** key does not operate in Edit Mode.

SEL_INST

Returns to the *Select an instrument* menu.

Control Key Sequences

These functions are available by way of the following Control key sequences:

Clear Instrument = **CTRL C**
Select an instrument menu = **CTRL D**
Reset Instrument = **CTRL R**

Recall Prev = **CTRL F**
Back Space = **CTRL H**
Delete Char = **CTRL X**
Recall Next = **CTRL B**
Clear-to-End = **CTRL L**
Insert Line = **CTRL O**
Clear Line = **CTRL U**

Run = **CTRL G**
Pause = **CTRL P**
Cont = **CTRL Y**
Step = **CTRL T**

Move cursor to beginning of line = **CTRL A**
Move cursor to end of line = **CTRL Z**

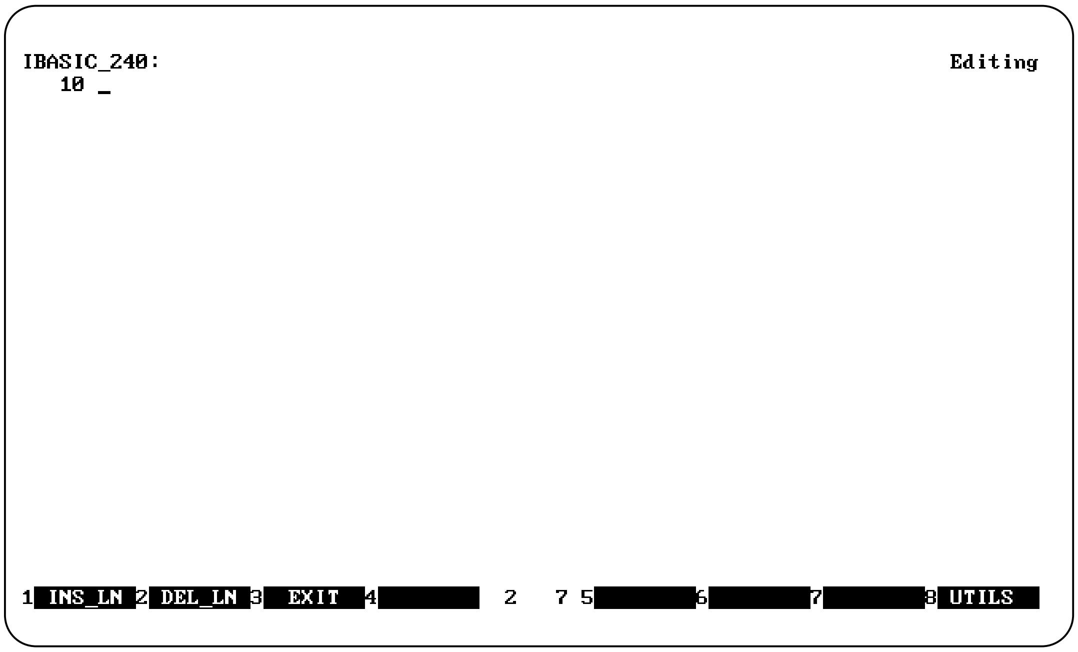
Edit Mode

Edit Mode allows you to create a program or to modify, add, or delete program lines in an existing program. You can get into Edit Mode by typing:

```
EDIT
```

followed by pressing **Enter**.

If there is no program in memory when you enter Edit Mode, the cursor appears on a line with the number 10, which is the default line number of the first program line. A typical display in Edit Mode is:



```
IBASIC_240:                                                         Editing
   10 _
```

At this point, you can begin entering program lines.

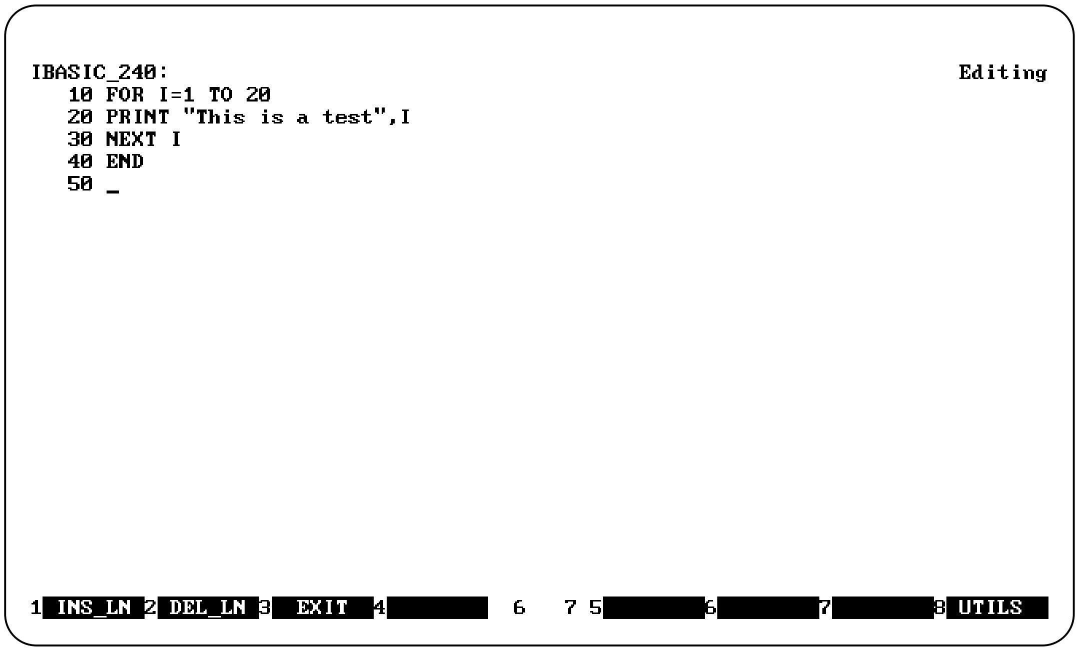
Entering Program Lines

To enter a program line, just type the IBASIC command characters at the keyboard. If you make any errors while typing, use the **Back Space** key or the left and right arrow keys to move the cursor to the erroneous character(s) and re-type them. The **Back Space** key erases characters as it moves the cursor. The left and right arrow keys do not erase characters (usually, you will need to use the **Delete** key to remove unwanted characters when using the left and right arrow keys). When editing, the display is in insert mode. That is, typed characters will be inserted into the string at the present cursor position.

NOTE If you move the cursor off of a line with the up or down arrow key, the line is not entered and changes made to that line are lost.

When the typed-in program line is exactly the way you want it, press **Enter** to store the line. (The cursor can be anywhere on the line when you store it; the system reads the entire line regardless of cursor position.)

For example, you can type-in the following program pressing **Enter** after each line:



```
IBASIC_240:                                                              Editing
   10 FOR I=1 TO 20
   20 PRINT "This is a test",I
   30 NEXT I
   40 END
   50 _
```

After entering the last line of the program, press **EXIT** to exit Edit mode. To execute the program, either press **UTILS - RUN** or type RUN and press Enter.

NOTE There are many ways to exit Edit Mode. Your choice depends upon what you want to do next. Pressing any one of the following utility keys exits Edit Mode and returns to the IBASIC instrument display: **PAUSE**, **RUN**, **STEP, ESC, CLR_INST**, or **RST_INST**.

Listing the Program

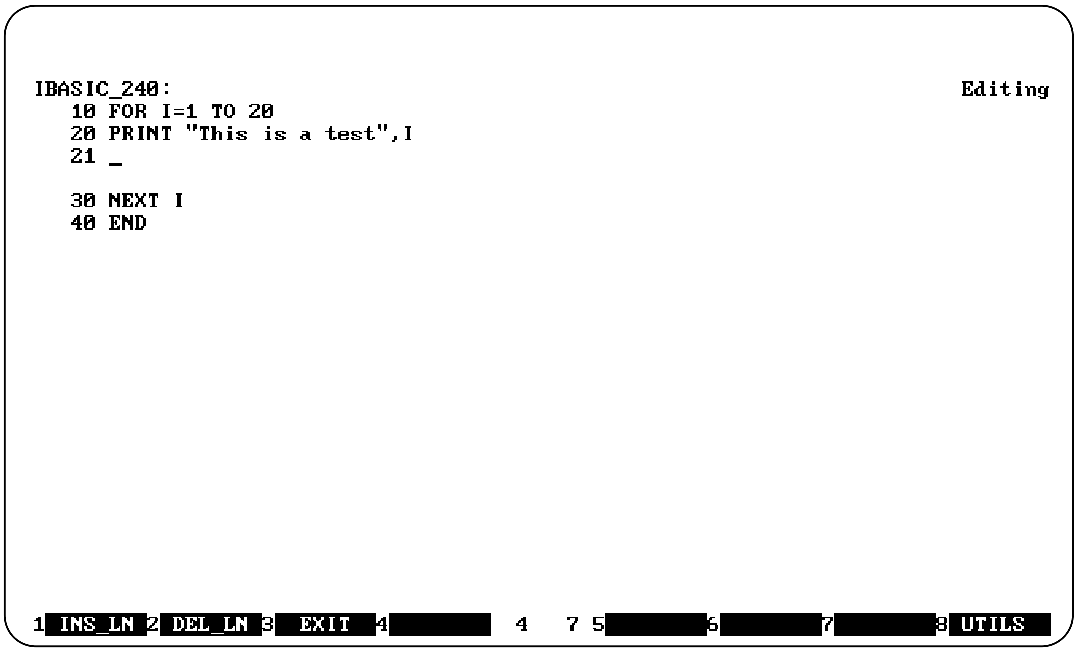
You can list the program by executing the following command:

LIST **Enter**

The system lists the program on the terminal display (default) or whichever device is the current PRINTER IS device.

Inserting Lines

Lines can be easily inserted into a program. As an example, assume that you want to insert a line between line 20 and line 30 in the existing program. In Edit Mode (type EDIT, press **Enter**), use the up or down arrow key to place the cursor on line 30 and press the **INS_LN** key. The program display "opens" and a new line number appears between line 20 and line 30:



```
IBASIC_240:                                                          Editing
   10 FOR I=1 TO 20
   20 PRINT "This is a test",I
   21 _

   30 NEXT I
   40 END
```

You can now begin typing. For example, type the following WAIT statement and press Enter:

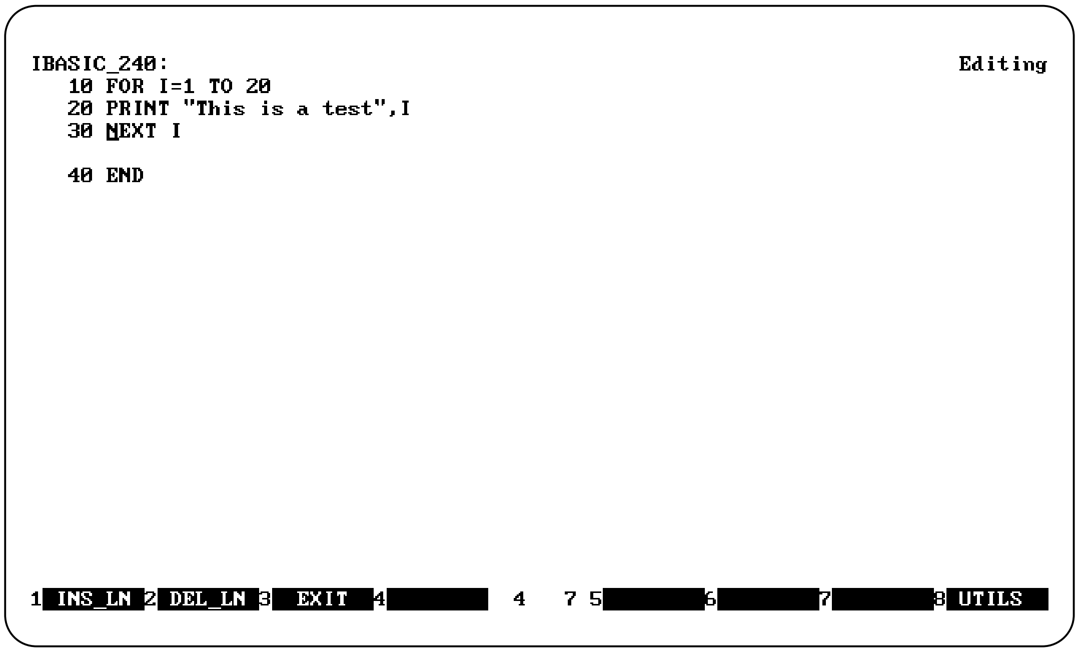
```
WAIT .5
```

Notice that as you entered the line, the line number for the next inserted line appears automatically. You can insert as many lines as you want with one insert operation. While inserting lines, the system numbers the new lines in increments of 1 starting with previous line number. If you insert more lines than are available between the current line and the next line, the next program line is renumbered to allow the insert operation to continue.

To cancel insert mode, press **f1 (INS_LN)** again. You can also cancel insert mode with an operation that causes a new current line to appear (such as scrolling with the up/down arrow keys).

Deleting and Recalling Lines

Lines can be deleted one at a time or in blocks. In Edit Mode, pressing **f2 (DEL_LN)** deletes the line with the cursor on it. For example, to delete line 21, use the up/down arrows to move the cursor to line 21. Press **f2**. Line 21 is deleted and the display shows:



```
IBASIC_240:                                                            Editing
   10 FOR I=1 TO 20
   20 PRINT "This is a test",I
   30 NEXT I

   40 END
```

If you press **DEL_LN** by mistake, you can recover the line by pressing **UTILS - RCL_PREV** and then store it by pressing **Enter**. Only the last deleted line (one line) can be recovered with this method.

When not in Edit Mode, you can use the DEL command to delete one or more program lines. However, when deleting a small number of lines, using the **f2 (DEL_LN)** key has these advantages:

- You can see the line before you delete it.
- Using DEL_LN saves the line in the recall buffer (the DEL command does not).

Therefore, DEL is more useful for deleting blocks of lines (described later in "Deleting Multiple Lines").

Editing in IBASIC

This section introduces you to some general concepts and skills involved in creating and editing IBASIC programs.

Automatic Syntax Checking

Before storing a program line, the IBASIC computer checks for syntax errors and also changes the letter-case of keywords and identifiers. Immediate syntax checking is a big advantage of writing programs on the IBASIC system. Many programming errors can be detected during program entry. This increases the chances of having a program run properly and cuts debugging time. If the syntax of the line is correct, the line is stored, and the next line number appears in front of the cursor.

If the system detects an error in the input line, it displays an error message at the bottom of the display and places the cursor at the location responsible for the error. For example, in the following program line, we have omitted the trailing quote:

```
    10  PRINT "Short Message
Error 949  Syntax error at cursor
```

Keep in mind that there is an endless variety of human mistakes that might occur, and that IBASIC is not very good at dealing with even slight ambiguities. As a result, you may not always agree with its diagnosis of the exact error or the error's location. (As in the above example, the error is flagged at the leading quote even though the error is caused by a missing trailing quote.) However, an error message always means that something needs to be fixed. For a complete list of errors and their meanings, refer to the Error Appendix in the Agilent Instrument BASIC Language Reference manual.

Upper or Lower Case Letters?

The IBASIC computer can recognize the upper- and lower-case requirements for most elements in a statement. You can type an entire statement using all upper-case or all lower-case letters. If the syntax is correct, and there are no "keyword conflicts" (discussed below), the system stores the program line. Upon LISTing or EDITing the program, however, the system uses these conventions:

- Keywords are all upper-case letters (CAT, GET, DISP, etc.)
- All variable names are listed with the first letter in upper-case and the rest in lower case (Var1, Rdgs, etc.).

This means that you usually do not have to bother with the Shift key when entering a program line. If there is a "keyword conflict", however, an error is reported. A keyword conflict occurs when you try to use a keyword as an identifier (variable name, line label, or subprogram name). If you need to use a keyword as an identifier, just change the letter-case of at least one letter in the identifier name. For example, change CAT to Cat or cAT and then press **Enter** again. A word containing a mixture of upper- and lower-case letters is assumed to be an identifier.

The system's assumptions about keywords versus identifiers won't cause problems if the line has the proper syntax. However, if you are guessing at a keyword or syntax, don't assume that you got the line right just because no error was reported when you stored it. For example, assume that you are trying to PRINT a statement to print a blank line; however, you misspell the keyword PRINT:

```
100  PRINY
```

The system does not report an error, because the line could legitimately be interpreted as an implied call to a subprogram named "Priny". In general, if the system puts lower-case letters in something you thought was a keyword, then it wasn't recognized as a keyword.

Copying Lines (By Changing Line Numbers)

Although the IBASIC computer supplies a line number automatically, you are not forced to use that number if you don't want to. To change the line number, simply back up the cursor and type in the line number you want to use. (The display automatically goes to overwrite mode when editing line numbers.) You can do this to existing lines as a way of copying them to another part of the program.

When you change a line number and store the line, the program is automatically scrolled so that the line just stored is one line above the current-line position. In other words, when you copy a line to a new location, the new location is displayed.

Here are some points to keep in mind when changing line numbers:

- Changing the line number of an existing line causes a copy operation, not a move. The line still exists in its original location.
- An existing line is replaced by any line entered with the same line number.
- Be careful that you don't accidentally replace a line because of a typing mistake in the line number.

More Details about Edit Mode

The EDIT command allows a line identifier parameter. For example, the following command tells the IBASIC computer to place the program on the display so that line 140 is in the current-line position.

```
EDIT 140
```

The line identifier also can be a line label. This makes it very easy to find a specific program segment without needing to remember its line number. For example, assume that you want to edit a sorting routine that begins with a line labeled Go_sort:. Simply type:

```
EDIT GO_SORT
```

The line labeled Go_sort: is placed in the middle of the display.

When the line identifier is not supplied, IBASIC assumes a line number as follows:

- If this is the first EDIT after a power-up, SCRATCH, SCRATCH A, or GET, the assumed line number is 10.
- If EDIT is done immediately after a program has paused because of an error, the number of the line that generated the error is assumed.
- At any other time, EDIT assumes the number of the line that was being edited the last time you were in Edit Mode.

A Closer Look at Listing a Program

All or part of your program can be displayed or printed by executing a LIST statement. The LIST statement allows parameters that specify both the range of lines to be listed and the printer address.

If you execute the LIST command without any parameters, the entire program is listed on the system printer. The default system printer after a power-on or SCRATCH A is the mainframe display (when using the front panel) or the terminal display (when using a terminal). The system printer can be changed using the PRINTER IS statement.

Starting and ending line numbers can be specified in the LIST statement. For example, the following command lists lines 100 through 200, inclusively.

```
LIST 100,200
```

The following example lists the last portion of the program, from line 1850 to the end.

```
LIST 1850
```

The line identifiers can also be labels. For instance, the following command lists the program from the line labeled "Rocket" to the end.

```
LIST Rocket
```

You can specify a different system printer and then use the LIST statement. For example:

```
PRINTER IS 701
LIST
```

The parameter 701 identifies the printer connected to the mainframe’s GPIB interface (select code 7). The printer itself has an address setting of 01. To designate the front panel or terminal display as the system printer, execute:

```
PRINTER IS 1
```

You can also specify the printer in the LIST statement. For example, the following command sends the entire program listing to an GPIB printer (address 01) without changing the system printer selection.

```
LIST #701
```

To specify both a printer and a range of lines, specify the printer number, a semicolon, and then the line numbers. For example, this command lists lines 200 through 500 to an external printer.

```
LIST #701;200,500
```

Renumbering a Program

After an editing session with many deletes and inserts, the appearance of your program can be improved by renumbering. This also helps make room for long inserts. Renumber programs with the REN command. The following example renumbers the entire program in memory using a beginning number of 10 and incremental line numbers of 10 (default values):

```
REN
```

You can also specify starting line number and the interval between lines. For example, the following example renumbers the entire program, using 100 for the first line number and an increment of 5.

```
REN 100,5
```

If the increment (second parameter) is not specified, 10 is assumed. For example, the command below renumbers the entire program, using 1000 for the first line number and an increment of 10.

```
REN 1000
```

You can also renumber only a specified portion of a program. For example, the following command renumbers only line numbers in the range 1000 to 2000:

```
REN 1000,10 IN 1000,2000
```

Deleting Multiple Lines

The DEL command can be used to delete several lines in a single operation. Blocks of program lines can be deleted by using two line identifiers in the DEL command.

The first number or label identifies the start of the block to be deleted. The second number or label identifies the end of the block to be deleted. The line identifiers must appear in the same order they do in the program. For example, the following command deletes lines 100 through 200, inclusively.

```
DEL 100,200
```

This command deletes all the lines from the one labeled "Block2" to the end of the program.

```
DEL Block2,32766
```

Making Programs Readable

This IBASIC language makes it easy to write self-documenting programs. Besides IBASIC's standard REM (remark) statement, additional documentation features are:

- Descriptive keywords (such as REPEAT. . UNTIL, LOOP, and so forth)
- Descriptive variable names (up to 15 characters)
- Descriptive line labels (up to 15 characters)
- End-of-line comments.

Contrast Between Documented and Undocumented Programs

Although this section deals primarily with commenting methods, all of the above features work together to make a readable program. The following examples show two versions of the same program. The first version is uncommented and uses "traditional" variable names.

```
5   !RE-SAVE "TAX1"
10 PRINTER IS 1
20 A=.03
30 B=.03
40 X=0
50 Y=0
60 C=A+B
70 PRINT "Item      Total      Total"
80 PRINT "Price     Tax        Cost"
90 PRINT "------------------------------"
100 P=0
110 INPUT "input item price",P
120 D=P*C
130 E=P+D
140 X=X+D
150 Y=Y+E
160 DISP "tax =";D;"item cost =";E
170 WAIT 5
180 PRINT P,X,Y
190 GOTO 100
200 END
```

The second version uses the features of Agilent's IBASIC language to make the program more easily understood.

```
5   !RE-SAVE "TAX2"
10 !This program computes the sales tax for
20 !a list of prices.  Item prices are input
30 !individually.  The tax and total cost for
40 !each item are displayed.  The running
50 !totals for tax and cost are printed on
60 !the display.
70 !
80 !Sales tax rates are assigned on lines X and x.
90 !The rates used in this program were in effect
100 !as of 1/1/90
110 !
120 PRINTER IS 1                    !Use display for printout
130 State_tax=.03                   !State tax = 3%
140 City_tax=.03                    !City tax = 3%
150 !
160 Total_tax=0                     !Initialize variables
170 Total_cost=0
```

```
180 Tax_rate=State_tax+City_tax
190 !Print column headers
200 PRINT "Item      Total      Total"
210 PRINT "Price     Tax        Cost"
220 PRINT "------------------------------"
230 !
240 LOOP
250 Price=0
260 INPUT "input item price",Price
270 Tax=Price*Tax_rate
280 Item_cost=Price+Tax
290 Total_tax=Total_tax+Tax     !Accumulate totals
300 Total_cost=Total_cost+Item_cost
310 DISP "Tax =";Tax;"Item cost =";Item_cost
320 WAIT 5
330 PRINT Price,Total_tax,Total_cost
340 END LOOP                          !Repeat loop for next item
350 END
```

Commenting Methods

There are two methods for including comments in your programs. The use of an exclamation point is shown in the second example program. The exclamation point marks the boundary between an executable statement and comment text. There does not have to be an executable statement on a line containing a comment. Therefore, the exclamation point can be used to introduce a line of comments, to add comments to a statement, or simply to create a "blank" line to separate program segments. Exclamation points may be indented as necessary to help keep the comments neat.

The REM statement can also be used for comments. The exclamation point is neater and more flexible, but the REM statement provides compatibility with other BASIC languages. The REM keyword must be the first entry after the line identifier and must be followed by at least one blank.

Deleting a Program

You can use the SCRATCH command to delete all program lines from the IBASIC computer's memory. SCRATCH also clears all variables that are not in COM. (See the "Instrument BASIC Programming Techniques" manual for a description of COM.)

Clearing IBASIC Memory

You can use the SCRATCH C command to clear all variables from the IBASIC computer's memory. The current program and any softkey definitions are left intact.

You can use the SCRATCH A command to clear almost everything from the IBASIC computer's memory, restoring the system to its power-on state. The only things that are not cleared are the Recall buffers and the real-time clock.

IBASIC vs. HP Series 200/300 Editing Differences

IBASIC Edit Mode is similar to that used on HP Series 200/300 BASIC language computers. However, there are some differences. If you are familiar with the Series 200/300 computers you will want to note the following IBASIC Edit Mode differences.

- You cannot execute a command while in IBASIC Edit Mode. On Series 200/300 computers, you can execute a line in Edit Mode by entering the line without a line number. This feature is commonly used with a program line such as:

  ```
  10  !RE-SAVE "Progname"
  ```

  You can then re-save the program by deleting the line number and ! and executing the command. **This cannot be done in IBASIC.**

- In IBASIC, each program line is split into two fields; the line number field (first 5 characters) and the text field. Pressing **Shift** left arrow moves the cursor to the beginning of the text field, not to the beginning of the line number field as on Series 200/300 computers.

- The IBASIC editor is almost always in insert mode. That is, it inserts characters into the line rather than overwriting them. On Series 200/300 Computers, a key allows you to toggle between insert mode and overwrite mode. The IBASIC editor automatically goes into overwrite mode when you are editing the line number field of the program line. Only numbers and spaces can be typed into the line number field.

- In IBASIC Edit Mode, the up arrow key moves the cursor to the program line above the present line. The down arrow key moves to the program line below the present line. This is opposite to the directions on Series 200/300 Computers.

- In IBASIC Edit Mode, the **RCL_PREV** key recalls only the most recently deleted line. The recall buffer is only 1 line deep and is cleared whenever you exit Edit Mode.

- It is possible to enter program lines from the command input line (outside of Edit Mode) that will be too long to handle in Edit Mode. When this happens, IBASIC will place an asterisk (*) at the beginning of the program line. If you try to edit the line (by deleting the asterisk) the line will be truncated by the editor. HP Series 200/300 computers behave in a similar manner but do not place the asterisk at the beginning of the line.

Securing Programs

With the IBASIC system, you can use the SECURE statement to prevent program line(s) from being edited or listed.

CAUTION

Once a program is secured, it cannot be unsecured. Therefore, you should keep an unsecured back-up copy of all programs.

Executing this command prevents lines 30 through 60 of an existing program from being edited or listed:

```
SECURE 30, 60
```

Here is what the program might look like--either with the editor or as the output of a LIST statement:

```
10  ! Example of SECUREd program.
20  ! Begin password check routine.
30*
40*
50*
60*
70 ! End of password check.
80 END
```

If you want to secure the entire program, use this statement:

```
SECURE
```

Chapter 3 Contents

Chapter 3

Using RAM Volumes

How to Use This Chapter

You can create from 1 to 16 RAM volumes in system memory and an additional RAM volume in USER NRAM or optional plug-in memory. Like volumes on a disk drive, RAM volumes are used for storing programs and data. This chapter describes the type of RAM volumes and shows you how to create each type of RAM volume.

RAM Volumes

You can initialize RAM volumes in either LIF or DOS formats. You have these choices for creating RAM Volumes:

- You can create RAM Volume 1 in volatile or nonvolatile system memory.
- You can create RAM volume 0 and volumes 2 through 15 in volatile system memory only.
- You can create RAM volume 16 in nonvolatile user NRAM or optional plug-in memory.

NOTE

When you reserve space for RAM Volume 1 using DIAG:RDISK:CRE, RAM Volume 1 is placed in nonvolatile System Memory. If you do not reserve space for RAM Volume 1, it will be placed in volatile System Memory. RAM Volumes 0 and 2 through 15 are always placed in volatile System Memory.

Volatile vs. Nonvolatile RAM Volumes

Data stored in volatile memory is lost when power is removed or the mainframe is reset; data in nonvolatile memory is retained when power is removed. When RAM Volume 1 is in non-volatile memory, each 256-byte sector has a checksum associated with it. When a sector is written to, a checksum is computed and stored. Whenever the sector is read from, the checksum is re-computed and compared to the stored checksum. If the two checksums are different, "ERROR 88 Read data error" is generated to indicate the RAM Volume is corrupted. This ensures that a corrupt RAM Volume is detected before the data on it is used.

On volatile RAM volumes (including RAM Volume 1 if it is volatile) and RAM Volume 16, no checksum is saved. The access to volatile RAM is done at the fastest possible speed with a minimum of overhead. Read/write operations on RAM Volume 1 is about 20% slower when in non-volatile memory vs. volatile memory.

System Memory Space Assignments

Figure 3-1 shows typical system memory space consisting of softloaded instrument drivers (optional), User NRAM, Nonvolatile RAM Volume 1, and volatile RAM Volumes 0, and 2 through 15.

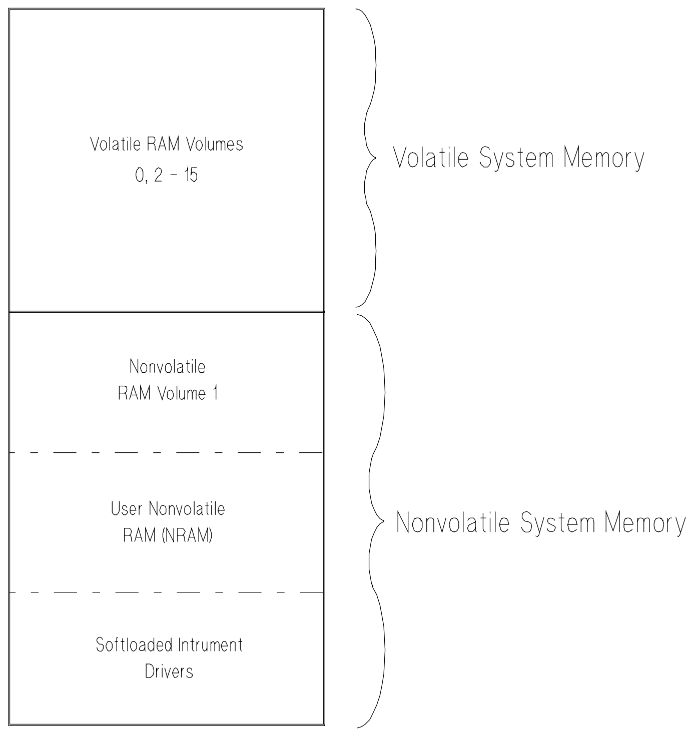


Figure 3-1. System Memory Space Assignments

CAUTION

Softloaded Instrument Drivers, User Nonvolatile RAM (NRAM), and RAM Volume 1 compete for the nonvolatile memory space. This means that changing a memory area invalidates the memory area(s) above it as shown in Figure 3-1. The order in which memory is allocated is very important. For example, creating or changing the size of the Instrument Driver area after creating NRAM and RAM Volume 1, invalidates NRAM and RAM Volume 1. Similarly, creating NRAM or changing the size of NRAM invalidates a previously created RAM Volume 1 and any data in RAM Volume 1 is destroyed.

Always allocate nonvolatile memory in this order:

1. Softload instrument drivers, if any.
2. Create User NRAM, if any.
3. Create RAM Volume 1.

After reserving this space, DO NOT change the size of the Instrument Driver area or change the size of User NRAM.

Creating RAM Volume 16

RAM Volume 16 allows you to use User NRAM or optional plug-in memory as a RAM Volume. Access to RAM Volume 16 is the same as for volatile RAM volumes (i.e., no checksums are computed and access is as fast as possible). When creating RAM volum 16, keep these things in mind:

- With the INITIALIZE command, the size parameter is ignored and the resulting size of the RAM volume will fill the space allocated for it by the DIAG:FILES 1,. . . and DIAG:FILES 2,. . . commands.
- If the memorydefined by the DIAG:FILES 1 and DIAG:FILES 2 command is no longer available (that is, you set NRAM to 0 or softloaded a driver which moved the base of NRAM), you must use the DIAG:FILES 1 and DIAG:FILES 2 commands to reset the addresses of RAM volume 16 before attempting to use it again. Failure to do this may result in a system crash.

NOTE

The following procedure and example assume you are placing RAM Volume 16 in User NRAM. If you want to place RAM Volume 16 in plug-in memory, skip steps 1 through 3, determine the starting address (refer to the plug-in memory documentation) , and continue with steps 4 and 5.

Procedure

1. Allocate space in Nonvolatile User RAM (NRAM) by executing DIAG:NRAM:CRE<*#bytes*> from the System Instrument (this destroys any existing data in NRAM).
2. Re-Boot the system by executing DIAG:BOOT from the System Instrument or by cycling mainframe power.
3. Find the starting address for NRAM by executing DIAG:NRAM:ADDR? from the System Instrument.
4. Reserve RAM volume 16 space by using the DIAG:FILES 1,<start address> and the DIAG:FILES 2, <end address> commands. Where
   <start address> is the starting address for NRAM
   <end address> is <start address> + number of bytes reserved for RAM Volume 16.
5. To initialize RAM Volume 16, from the IBASIC instrument, execute one of the following commands:

   INITIALIZE "LIF:MEMORY,0,16"

   Initialize RAM Volume 16 in LIF format

   INITIALIZE "DOS:MEMORY,0,16"

   Initialize RAM Volume 16 in DOS format

NOTES

Since you are not specifying a size in the INITIALIZE command, the default size fills reserved memory.
The minimum size for a DOS disk is 2560 bytes.
The minimum size for a LIF disk is 1536 bytes.

Example: Creating RAM Volume 16

This example creates RAM Volume 16 (in DOS format), 15k bytes long, in User NRAM.

CAUTION If NRAM has already been created, executing the following command destroys any existing information in NRAM.

From the System Instrument, execute:

```
DIAG:NRAM:CRE 15000
```
Reserve 15k bytes of User RAM (NRAM)

```
DIAG:BOOT
```
Re-boot the system to create NRAM

From the System Instrument, execute:

```
DIAG:NRAM:ADDR?
```
Determine starting address for NRAM (in this example, starting address = +16252928)

From the IBASIC Instrument, execute:

```
OUTPUT 80930;"DIAG:FILES 1,16252928"
```
Define starting address for RAM Volume

```
OUTPUT 80930;"DIAG:FILES 2,16267928"
```
Define ending point for RAM Volume (start address + #bytes)

```
INITIALIZE "DOS:MEMORY,0,16"
```
Initialize RAM Volume 16 (DOS format) to fill reserved NRAM

Creating Nonvolatile RAM Volume 1

When you reserve space for RAM Volume 1, it will be placed in nonvolatile memory. This procedure shows you the steps involved in creating a nonvolatile RAM Volume 1. This procedure can be done in either System Controller or Talk/Listen mode. An example showing how to create a nonvolatile RAM Volume 1 containing 100 sectors of 256 bytes each, follows this procedure.

CAUTION Re-initializing a RAM Volume destroys any data currently stored on that volume (volatile and nonvolatile).

Procedure

1. Check the maximum RAM volume space available (this is an optional step), by executing DIAG:RDISK:CRE? MAX from the System Instrument.
2. Reserve RAM Volume 1 space by executing DIAG:RDISK:CRE<*size*> from the System Instrument. Where <*size*> = (Number of Sectors x 258) + 24. Each sector requires 258 bytes (256 bytes for data, 2 bytes for checksum). The extra 24 bytes is for a header. For LIF format, the minimum number of sectors is 6, so the minimum *size* = (6 x 258) + 24 = 1572 bytes). For DOS format, the minimum number of sectors is 10, so the minimum *size* = (10 x 258) + 24 = 2604 bytes. (NOTE: If you did not reserve enough memory space, ERROR 67 Bad mass storage parameter is generated when you execute the INITIALIZE command in the next step.)
3. Re-Boot the system by executing DIAG:BOOT from the System Instrument or by cycling mainframe power.
4. To initialize RAM Volume 1, from the IBASIC instrument, execute one of the following commands:

   INITIALIZE "LIF:MEMORY,0,1",<*n*>

   Initialize RAM Volume 1 in LIF format

   INITIALIZE "DOS:MEMORY,0,1",<*n*>

   Initialize RAM Volume 1 in DOS format

   Where: <*n*> = number of 256-byte sectors; 6 sectors minimum for LIF; 10 sectors minimum for DOS. If you do not specify a size, the default size is the size of reserved memory determined by INT [(size of RDISK - 24) / 258]. For example, if you use DIAG:RDISK:CRE 65536, the default size for nonvolatile RAM Volume 1 = INT [(65536 - 24) / 258] = 253 sectors.

Example: Creating Nonvolatile RAM Volume 1

This example creates nonvolatile RAM Volume 1 (in LIF format) with 100 sectors.

From the System Instrument, execute:

DIAG:RDISK:CRE? MAX

Return the number of bytes available for RAM Vol. 1

DIAG:RDISK:CRE 25824

Reserve 100, 258 byte sectors (256 bytes for data and a 2 byte checksum in each sector) plus 24 bytes for the header.

DIAG:BOOT *Re-boot the system*

From the IBASIC Instrument, execute:

INITIALIZE "LIF:MEMORY,0,1",100

Initialize RAM Volume 1 (LIF format) for 100 sectors of nonvolatile RAM

Creating Volatile RAM Volumes

You can create RAM Volume 1 as nonvolatile or volatile and RAM Volumes 0 and 2 through 15 as volatile. (When you do not reserve space for RAM Volume 1, it will be placed in volatile memory.) This procedure shows you the steps involved in creating volatile RAM Volumes. You can do this procedure in either System Controller or Talk/Listen mode. An example showing how to create a volatile RAM Volume 1 and a RAM Volume 2 follows this procedure.

Procedure

1. To create volatile RAM Volume 0 execute one of the following commands from the IBASIC instrument:

   INITIALIZE "LIF:MEMORY,0,0", <*n*>

   Initialize volume 0 in LIF format

   INITIALIZE "DOS:MEMORY,0,0",<*n*>

   Initialize volume 0 in DOS format

   Where: <*n*> = number of 256-byte sectors; 6 sectors minimum for LIF, 10 sectors minimum for DOS. If you do not specify <*n*>, the default size is 1056 sectors.
2. To create volatile RAM volume 1 (if nonvolatile RAM Volume 1 space has not been assigned) , execute one of the following commands from the IBASIC instrument:

   INITIALIZE "LIF:MEMORY,0,1", <*n*>

   Initialize volume 1 in LIF

   INITIALIZE "DOS:MEMORY,0,1", <*n*>

   Initialize volume 1 in DOS
3. Repeat step 2 for each RAM volume you want to create each time incrementing the volume number (last field) in the command. For example, to initialize volume 2 for 50 sectors:

   INITIALIZE "LIF:MEMORY,0,2",50

   Initializes volume 2 in LIF

   INITIALIZE "DOS:MEMORY,0,2",50

   Initializes volume 2 in DOS

Example: Creating Volatile RAM Volumes

This example creates volatile RAM Volume 1 (in DOS format) with 100 sectors of 256 bytes and volatile RAM Volume 2 (in LIF format) with 20 sectors of 256 bytes.

From the System Instrument, execute:

DIAG:RDISK:CREATE 0

Ensure 0 memory space for nonvolatile RAM Volume 1

DIAG:BOOT

Re-boot the system

From the IBASIC Instrument, execute:

INITIALIZE "DOS:MEMORY,0,1",100

Initialize RAM Volume 1 (DOS format) for 100 sectors of volatile RAM

INITIALIZE "LIF:MEMORY,0,2",20

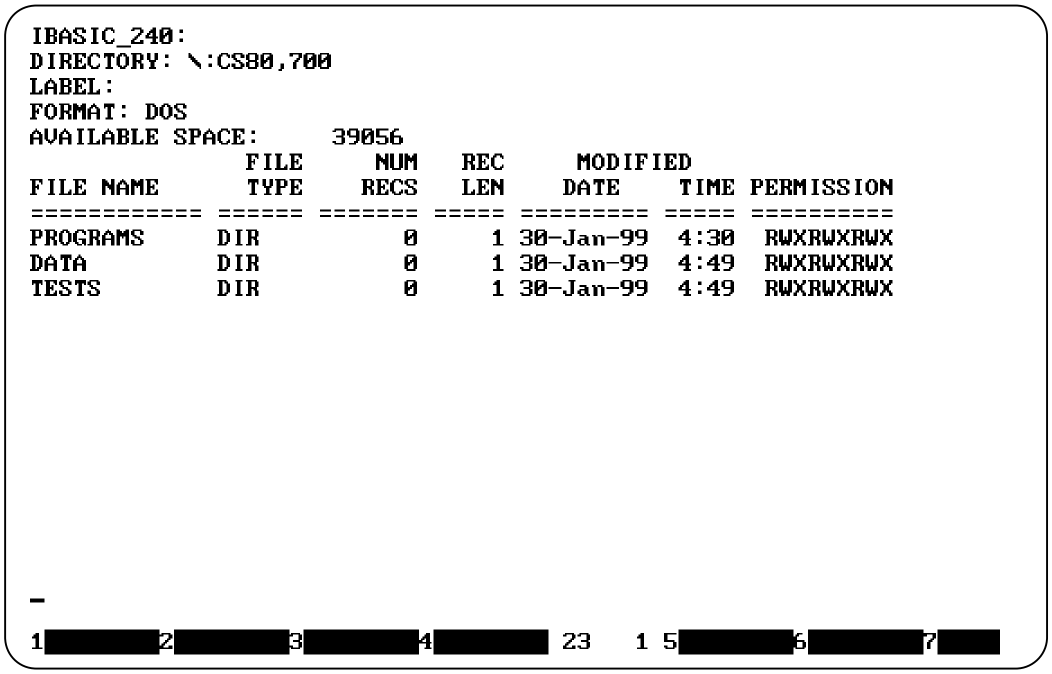
Initialize RAM Volume 2 (LIF format) for 20 sectors (256 bytes each) of volatile RAM

Checking a Volume's Format

You can determine whether or not a disk or RAM volume is initialized and the type of format (DOS or LIF) by cataloging the disk volume with the CAT command. The CAT command returns the contents of a mass storage volume (LIF format) or volume/directory (DOS format).

CAT ":,700,0,0"	*Checks hard disk volume 0 catalog*
CAT ":,700,1"	*Checks flexible disk catalog*
CAT ":MEMORY,0,0"	*Checks RAM Volume 0 catalog*

If the disk volume is initialized, a catalog is displayed showing the contents of the volume. You can determine whether the volume is DOS or LIF by looking at the catalog header. A LIF header/file listing is distinguished by the Volume Label "HP75K" and looks like this:



```
IBASIC_240:
DIRECTORY: \:CS80,700
LABEL:
FORMAT: DOS
AVAILABLE SPACE:     39056
               FILE     NUM   REC     MODIFIED
FILE NAME      TYPE    RECS   LEN    DATE    TIME PERMISSION
============ ====== ======= ===== ========= ===== =========
PROGRAMS     DIR          0     1 30-Jan-99  4:30  RWXRWXRWX
DATA         DIR          0     1 30-Jan-99  4:49  RWXRWXRWX
TESTS        DIR          0     1 30-Jan-99  4:49  RWXRWXRWX









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1        2        3        4        23   1 5        6        7
```
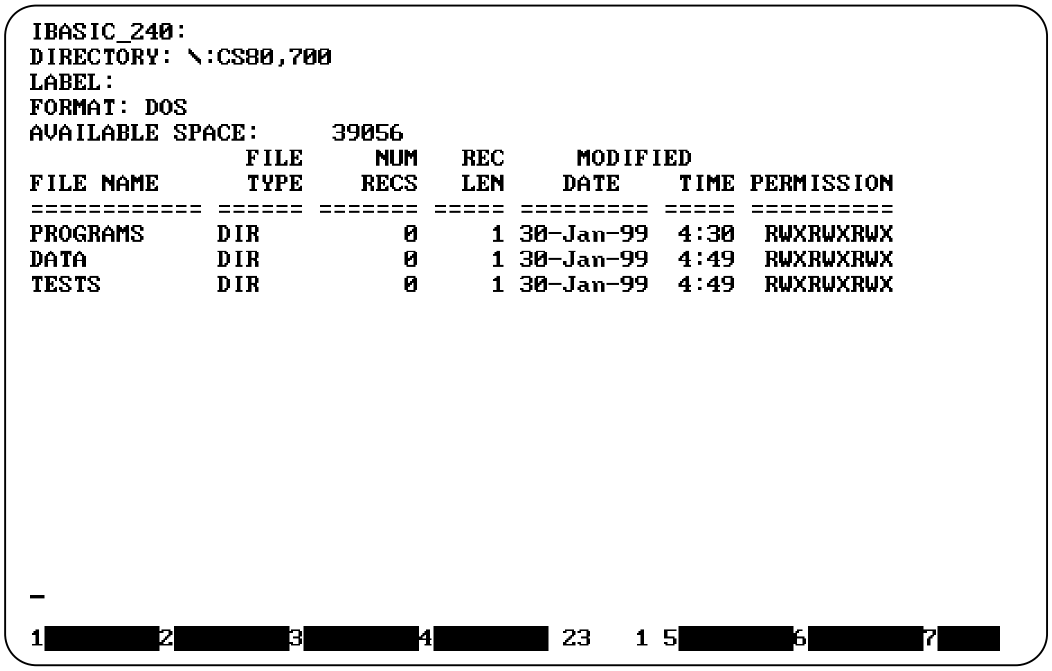

A DOS header/directory listing is distinguished by the Format "DOS" label and looks like this:



```
IBASIC_240:
DIRECTORY: \:CS80,700
LABEL:
FORMAT: DOS
AVAILABLE SPACE:     39056
               FILE     NUM   REC     MODIFIED
FILE NAME      TYPE    RECS   LEN    DATE    TIME PERMISSION
============ ====== ======= ===== ========= ===== ==========
PROGRAMS     DIR          0     1 30-Jan-99  4:30  RWXRWXRWX
DATA         DIR          0     1 30-Jan-99  4:49  RWXRWXRWX
TESTS        DIR          0     1 30-Jan-99  4:49  RWXRWXRWX









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1        2        3        4         23   1 5        6        7
```

For a flexible disk or the hard disk, if the disk or disk volume has not been initialized, "ERROR 85 Media uninitialized" occurs.

If a RAM Volume has not been initialized, "ERROR 76 Incorrect unit code in msvs" occurs.

In Case of Difficulty

Mass Storage Error Message	Cause
Error 52 Improper mass storage volume specifier.	The characters used for mass storage volume specified do not form a valid specifier. This could be a missing colon, too many parameters, illegal characters, etc.
Error 53 Improper file name.	The file name is too long or has characters that are not allowed. (Can also occur when using "*" or "?" in a file name when wildcards are not enabled or when a wildcard was used in other than the right-most position of a file name.) A LIF file name can be up to 10 characters long and is case dependant. LIF file names may contain any letter of the alphabet (upper and lower case), the digits 0-9, and the underscore character (_). You can also use the international characters: CHR$(160) - CHR$(254). A DOS file name can be up to 8 characters long with an optional extension name of up to 3 characters. DOS file names may contain any letter of the alphabet, the digits 0-9, the international characters CHR$(160) - CHR$(254), and these characters: ! # $ % ( ) - ^ _ { } ~
Error 54 Duplicate file name.	The specified file name already exists. It is illegal to have two files with the same name on one LIF volume or in a DOS directory.
Error 55 Directory overflow.	Although there may be room on the media for the file, there is no room for another file name. LIF Disks initialized by Agilent Instrument BASIC have room for over 100 entries in the directory. Small RAM volumes allow fewer entries.
Error 56 File name is undefined.	The specified file name does not exist or a wildcard operation did not match any file. Check the contents of the disk with a CAT command.
Error 58 Improper file type.	Many mass storage operations are limited to certain file types.
Error 59 End of file or buffer found.	For files: No data left when reading a file, or no space left when writing a file. For buffers: No data left for an ENTER, or no buffer space left for an OUTPUT or user RAM volume too small.
Error 60 End of record found in random mode.	Attempt to ENTER or OUTPUT a field that is larger than a defined record.
Error 62 Protect code violation.	Failure to specify the protect code of a protected file, or attempting to protect a file of the wrong type.
Error 64 Mass storage media overflow.	The disk is full. (There is not enough free space for the specified file size, or not enough contiguous free space on a LIF disk.) Or you have specified a size for a nonvolatile RAM volume that is larger than the reserved memory.
Error 66 INITIALIZE failed.	Too many bad tracks found. The disk is defective, damaged, or dirty.
Error 67 Illegal mass storage parameter.	A mass storage command contains a parameter that is out of range, such as a negative record number or an out of range number of records. Also occurs if you did not reserve enough memory space for a nonvolatile RAM volume.
Error 68 Syntax error occurred during GET.	One or more lines in the file could not be stored as valid program lines. (These lines will be stored as commented lines.) Also occurs if the first line in the file does not start with a valid line number.
Error 72 Drive not found or bad address.	The mass storage unit specifier contains an improper device selector, the disk drive is still powering-up, or no disk drive is connected.
Error 73 Improper device type in mass storage volume specifier.	The volume specifier has the correct general form, but the characters used for a device type are not recognized.
Error 76 Incorrect unit number in mass storage volume specifier.	Uninitialized RAM volume or the volume specifier contains a unit number that does not exist on the specified device.
Error 77 Operation not allowed on open file.	The specified file is assigned to an I/0 path name which has not been closed.
Error 78 Invalid mass storage volume label.	Usually indicates that the media has not been initialized on a compatible system. Could also be a bad disk. Can also occur when switching disk formats (DOS, LIF)
Error 79 File open on target device.	Attempt to copy an entire volume with a file open on the destination disk.
Error 80 Disk changed or not in drive.	No disk in the drive or the drive door was opened while a file was assigned.
Error 81 Mass storage hardware failure.	Also occurs when the disk is pinched and not turning. Try reinserting the disk.
Error 82 Mass storage volume not present.	Hardware problem or drive does not exist.
Error 83 Write protected.	Attempting to write to a write-protected disk. This includes many operations such as PURGE, INITIALIZE, CREATE, SAVE, OUTPUT, etc.
Error 84 Record not found.	Usually indicates that the media has not been initialized.
Error 85 Media not initialized.	
Error 87 Record address error.	Usually indicates a problem with the media.
Error 88 Read data error.	The media is damaged, or a nonvolatile RAM Volume is corrupted.
Error 89 Checkread error.	Error detected when reading data. The media is probably damaged.

Mass Storage Error Message	Cause
Error 90 Mass storage system error.	Usually a problem with the hardware or the media.
Error 93 Incorrect volume code in mass storage volume specifier.	The volume specifier contains a volume number that does not exist on the specified device.
Error 183 Permission denied.	Attempt to PURGE or write to a read only file
Error 189 Too many open files.	Only a fixed number of files can be open at one time. Close some of the files.
Error 291 Too many matches.	Too many matches on wildcard operation.
Error 292 Wildcards not allowed.	Some mass storage commands such as CREATE, INITIALIZE, and SAVE do not allow wildcards.
Error 293 Operation failed on some files.	The wildcard operation attempted does not succeed on all files found. When using wildcards and copying files from DOS to LIF, you may have DOS file names that are not legal LIF names. When this happens, legal files are copied, illegal files are skipped, and this error is generated.
Error 294 Wildcard matches >1 item.	A wildcard operating in File Name Completion mode expanded to more than one file name.
Error 295 Improper destination type.	Multiple files must be copied to directory not file.
Error 296 Unable to overwrite file.	Unable to overwrite file during copy operation.
Error 460 Directory not empty.	Attempt to PURGE a directory containing files (you must PURGE files first)

Chapter 4 Contents

Chapter 4

Mass Storage Concepts

How to Use This Chapter

In System Controller Mode, IBASIC can access RAM volumes and external SS-80 disk and tape drives. In Talk/Listen Mode, IBASIC can access Ram Volumes only. This chapter describes how to use these mass storage devices, discusses the LIF and DOS file systems, and shows you how to manage files in either system. This chapter contains the following sections:

- File systems (LIF and DOS)
- Managing files
- IBASIC file types
- Using wildcards
- Behavior differences between LIF and DOS file systems.

All commands shown in this chapter are executed from the IBASIC instrument (refer to Chapter 2 for more information on how to access the IBASIC instrument).

NOTE IBASIC uses SS80 drivers that operate GPIB disk drives such as the HP 9122, 9127, 9133, 9144, and 9153 drives.
When initializing in LIF, the default value for the Initializing Option is 0. When initializing in DOS, the default value for the Initializing Option is 2 for the HP 9122, 9127, and 9133 drives; 16 for the HP 9153 drive; and 0 for any other drive. The default values do not apply when the GPIB address of the disk drive is 8 or 9 (you must specify values). Refer to your disk drive manual for more information.

File Systems

IBASIC supports both LIF (HP's Logical Interchange Format) and MS-DOS file systems. The LIF file system is identical to that used by HP Series 200/300 BASIC language computers. LIF is a flat file system, that is, it cannot support subdirectories. The DOS file system is identical to that used on Personal Computers (PCs). The DOS file system is hierarchical, that is, it supports subdirectories.

Volumes, Directories, and Files

The information on a mass storage device is organized into volumes, directories, and files. To describe volumes, directories, and files we will use a file cabinet as an analogy. As shown in Figure 4-1, the mass storage device (disk drive or RAM disk) is analogous to the file cabinet itself.

A volume is where the directory, subdirectories (DOS only), and files are stored and is represented by one of the drawers in the cabinet. The hard disk can have up to 6 volumes, the RAM disk can have up to 17 volumes, and a flexible disk has only one volume.

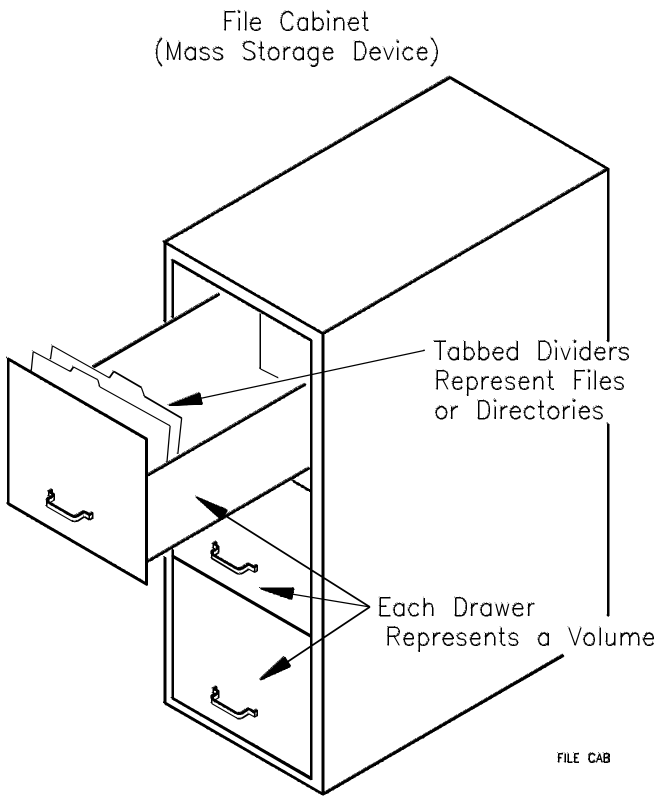


Figure 4-1. Mass Storage/File Cabinet Analogy

LIF File Structure

If the volume was formatted in LIF, each drawer of the file cabinet contains a large folder that represents the LIF directory. This directory holds the names and contents of all files on the volume. A file can be either an IBASIC program file or a data file (voltmeter readings, for example). Figure 4-2 is a graphical representation of a typical LIF directory and a number of files. The directory has no name and is shown in a box; the files are shown without boxes.

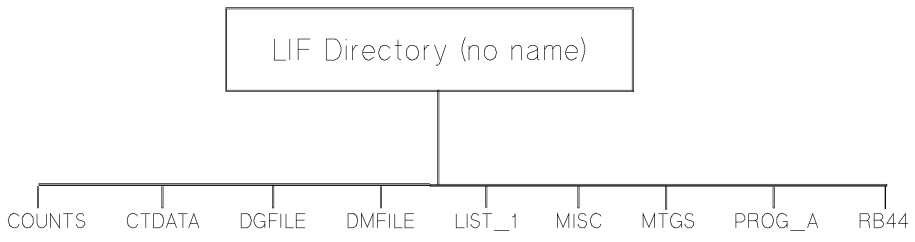


Figure 4-2. Typical LIF Directory/Files

DOS File Structure

If the volume was formatted in DOS, each drawer of the file cabinet contains a large folder that represents the DOS *root* directory. Within the folder are a number of named tab dividers each representing a lower-level directory (sometimes called subdirectories). Each lower-level directory can contain a number of program or data files. It can also contain the names of even lower-level directories. Similarly, these lower-level directories can also contain files or the names of even lower-level directories, and so on. This hierarchical directory/file structure is known as the DOS file structure.

Figure 4-3 is a graphical representation of the directories and files in a typical DOS file structure. The root directory and lower-level directories are shown in boxes and files are shown without boxes. Directories are arranged in levels. When you format a DOS disk volume, an unnamed root directory is created automatically on that volume. The root directory is the highest level on the volume. When you create a directory within the root directory, the new directory is a level below the root. From this directory, you can create directories at the next lower level, and so on.

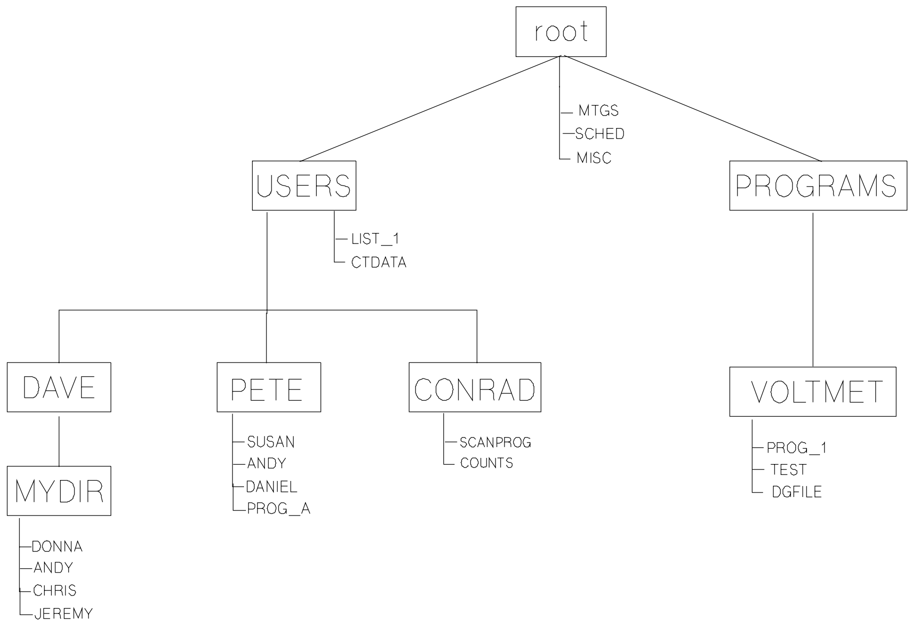


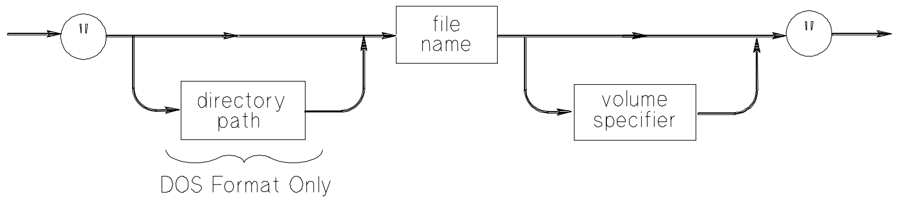
Figure 4-3. DOS File Structure

Specifying the Directory, File, and Volume

Files are identified by specifying the following information:

- The directory path where the file resides (DOS format only)
- The file name
- The mass storage volume specifier (MSVS)

The syntax of the file specifier is:



Directory Path (DOS Format Only)

To access a directory or file, you must specify its location in the hierarchical directory structure. You do this by listing the directories that trace a path to the directory or file of interest. This is called a directory path. Typically, you begin the path with a backslash (\) to indicate the root directory. You then list every directory in the path, in hierarchical order, and separate directory names and file names with a backslash. (You can also use forward slashes (/) to separate names.) Figure 4-4 shows a typical directory path from the root to the file "PROG_A" . In a command, this path is expressed as:

"\USERS\PETE\PROG_A"

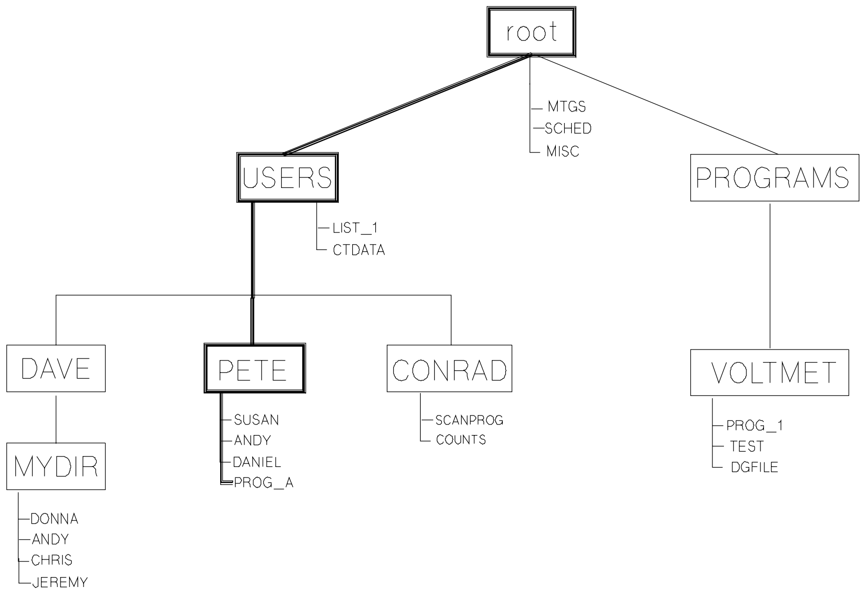


Figure 4-4. Typical Directory Path

The directory path to a file begins at either the root level or the current working directory. Each mass storage device has a current working directory. The current working directory is the directory specified by the most recent MASS STORAGE IS (or MSI) command on that drive. (If no MSVS is specified in a command, the file is assumed to be on the drive specified by the most recent MSI command.) If the directory or file is located in a directory at a level below your current working directory, you need only specify the route (without a leading slash or backslash) from the current directory. For example, if you are currently in the USERS directory, then the path to PROG_A is as shown Figure 4-5. In a command, this path is expressed as:

"PETE\PROG_A"

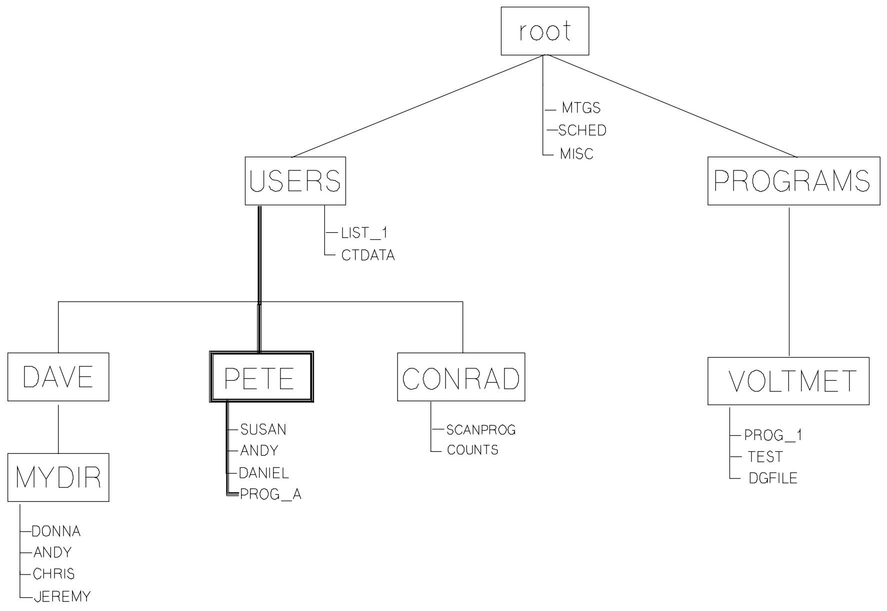


Figure 4-5. Path from USERS Directory

LIF File Names

A LIF file name can be up to 10 characters long and is case dependant. For example the file names "File1", "FILE1", "file1" and "FiLe1" represent different files. In IBASIC[1], LIF file names may contain any letter of the alphabet (upper and lower case), the digits 0-9, and the underscore character (_). You can also use the ASCII characters: CHR$(160) - CHR$(254). Spaces are ignored when used in a file name. A LIF file name longer than 10 characters generates an error.

NOTE

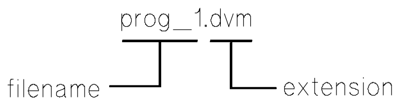
In IBASIC revision A.06.00 and earlier, the LIF file name characters were limited to letters of the alphabet (upper and lower case), the digits (0-9), the underscore character, and the ASCII characters chr$(160) through chr$(254).

---

1 Later versions of HP Series 200/300 BASIC and RMB-UX allow virtually any character to appear in a LIF file name. IBASIC uses the more restrictive character set described above.

DOS File Names

A DOS file name can be up to 8 characters long with an optional extension name of up to 3 characters. A period "." separates the file name from the extension. For example:



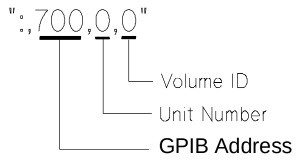
DOS file names are case independent. Although the name characters are stored as upper case ASCII in the DOS directory, the file may be referenced without regard to case. For example the file names "File1", "FILE1", "file1" and "FiLe1" all represent the same DOS file "FILE1". DOS file names may contain any letter of the alphabet, the digits 0 - 9, and these characters:

! # $ % ( ) - ^ _ { } ~

Spaces are ignored when used in a file name or extension. If you enter a DOS file name longer than 8 characters, it is truncated to 8 characters and no error is given. Similarly, if the extension name is longer than 3 characters, it is truncated to 3 characters and no error is given. If the name has more than one period, the first period is retained and separates the name from the extension. The extension name is then truncated at or before the second period and any remaining characters are ignored. For example "FILE1.AB.CDE" becomes "FILE1.AB".

Volume Specifier

The Volume Specifier directs a mass storage command to a particular volume on the appropriate disk drive. The following shows a typical Volume Specifier.



The **GPIB Address** is the GPIB address of the disk drives. The first digit (left-most) specifies the GPIB interface (typically 7). The last two digits specify the GPIB address setting of the disk drives. In the above example, the interface address is 7 and the disk drive address is 00, resulting in a combined address of 700. For the ramainder of this chapter the disk drive address is assumed to be 00.

The **Unit Number** specifies which disk drive to access. For disk drives with GPIB address 00 through 07, unit 0 is the hard disk drive and unit 1 is the flexible disk drive. For disk drives with GPIB address 08 or 09 the GPIB device address is set to 00 and the unit numbers are reversed; unit 0 is the flexible disk drive and unit 1 is the hard disk drive. In the above example, the hard disk drive will be accessed. If you do not have a hard disk, the flexible disk is always volume 0.

The **Volume ID** specifies which volume to access (for hard disk only). If you have only 1 volume on the hard disk, you do not need to specify a volume ID. However, if the hard disk contains multiple volumes, you must specify a volume ID whenever you access the hard disk. Omitting the volume ID will direct the command to volume 0.

NOTE

Volumes on the hard disk are numbered consecutively from 0. For example, if the hard disk is partitioned into four volumes, the volume IDs are 0, 1, 2, and 3.

The following command examples show how to access files in both LIF and DOS formats. Studying these examples will help to clarify the various volume, directory, and file specifiers and the differences between using DOS or LIF format. You will learn more about these individual commands later in this chapter.

Specifying a Default Directory/Volume

When using mass storage commands, you can specify the directory path (DOS format only) and volume in each command. You can also specify default values using the MASS STORAGE IS command (or its abbreviation MSI). After specifying a default directory/volume, all mass storage operations that do not specify a source or destination with either a directory path or a volume specifier will use the default directory/volume. For example, to set the default volume to volume 1 of the hard disk, execute:

```
MASS STORAGE IS ":,700,0,1"
```

or:

```
MSI ":,700,0,1"
```

If the volume is DOS format, you can also specify the current working directory:

```
MSI "\PROGRAMS\VOLTMET:,700,0,1"
```

or:

```
MSI "\PROGRAMS\VOLTMET"
```

If the default volume is already 700,0,1

NOTE

After re-booting the mainframe (cycling power or DIAG:BOOT), the default MSI is set to the mass storage device where an autostart program was found (see Autostarting Programs, later in this chapter). If no autostart program was found, the default MSI is set to the root directory (DOS only) on the last valid mass storage volume found during the power-on search sequence (search order = flexible disk, RAM Volume 1, second, and volume 0 of the hard disk last).

The following examples use the CAT command to show how to access volumes, directories, and files in both LIF and DOS formats with and without the use of the MSI command. The CAT command simply lists the directories or files on a mass storage device (you'll learn more about CAT in the next section). Studying these examples will help to clarify the various volume, directory, and file specifiers and the differences between using DOS or LIF format.

LIF Examples

```
CAT ":,700,0,0"
```

Catalogs vol. 0 of hard disk

or:

```
MSI ":,700,0,0"
```

Sets default drive/volume to hard disk, volume 0

```
CAT
```

Catalogs default drive/volume

```
CAT ":,700,1"
```

Catalogs flexible disk

or:

```
MSI ":,700,1"
```

Sets default drive to flexible disk (flexible disks can only have 1 volume)

```
CAT
```

Catalogs default drive

DOS Examples

```
CAT "\PROGRAMS\VOLTMET:,700,0,1"
```

Catalogs files in Programs\Voltmet directory on volume 1 of hard disk

```
MSI "\PROGRAMS\VOLTMET:,700,0,1"
```

Sets current directory path to Programs\Voltmet. Sets default drive/volume to hard disk, volume 1.

```
CAT
```

Catalogs current directory on default drive and volume

```
MSI "\:,700,0,1"
```

Returns current directory path to root. Sets default drive/volume to hard disk, volume 1.

If you want to specify a file that is not in the current working directory or on the default drive/volume, just specify the volume/directory in any of the mass storage commands. For example, if MSI is set to the hard disk and you want to catalog the flexible disk, execute:

```
CAT ":,700,1"
```

Managing Files

This section describes how to manage files (SAVE, GET, COPY etc.) in both the LIF and DOS file systems.

Creating Directories

You can create subdirectories on a DOS formatted disk or RAM volume using the CREATE DIR command. For example, to create a subdirectory named PROGRAMS directly below the root on volume 1 of the hard disk, execute:

```
CREATE DIR "\PROGRAMS:,700,0,1"
```

After creating a subdirectory, you can use the same command to create subdirectories below it. For example, to create a subdirectory named VOLTMET under the PROGRAMS directory, execute:

```
CREATE DIR "\PROGRAMS\VOLTMET:,700,0,1"
```

Cataloging Files

You can use the CAT command to determine the contents of a mass storage volume. The CAT command returns the contents of a mass storage volume (LIF format) or volume/directory (DOS format) to the PRINTER IS device (unless otherwise specified in the CAT command).

LIF Examples

CAT ":,700,0,0"

Catalogs hard disk volume 0

CAT ":,700,1"

Catalogs flexible disk

CAT ":MEMORY,0,0"

Catalogs RAM Volume 0 (the term MEMORY is optional, CAT ":,0,0" can also be used)

DOS Examples

CAT "\PROGRAMS\VOLTMET:,700,0,1"

Catalogs PROGRAMS\VOLTMET directory on hard disk volume 1

CAT "\PROGRAMS\VOLTMET:,700,1"

Catalogs PROGRAMS\VOLTMET directory on flexible disk

CAT "\PROGRAMS\VOLTMET:MEMORY,0,1"

Catalogs PROGRAMS\VOLTMET directory on RAM Volume 1

Saving Programs

You can write a program to a mass storage device using the SAVE command. The SAVE command creates an ASCII file (LIF) or DOS/HP-UX file (DOS) (these file types are discussed later in this chapter) and copies program lines into that file.

The following examples show how to save the program "TEST" to the various mass storage devices.

LIF Examples

MSI ":,700,0,0"

Sets default drive/volume to hard disk, volume 0

SAVE "TEST"

SAVEs the file on the default drive/volume

SAVE "TEST:,700,0,0"

SAVEs the file on hard disk, volume 0

SAVE "TEST:,700,1"

SAVEs the file on flexible disk

SAVE "TEST:MEMORY,0,0"

SAVEs the file to RAM Volume 0

DOS Examples

SAVE "\PROGRAMS\VOLTMET\TEST:,700,0,1"

SAVEs TEST program under PROGRAMS\VOLTMET directories on volume 1 of hard disk

MSI "\PROGRAMS\VOLTMET:,700,0,1"

Sets current directory path to PROGRAMS\VOLTMET. Sets default drive/volume to hard disk, volume 1

SAVE "TEST"

SAVEs program to current directory path on the default drive and volume

SAVE "\PROGRAMS\VOLTMET\TEST:,700,1"

SAVEs TEST program under PROGRAMS\VOLTMET directories on flexible disk

SAVE "\PROGRAMS\VOLTMET\TEST:MEMORY,0,1"

SAVEs TEST program under PROGRAMS\VOLTMET directories on RAM Volume 1

Re-Saving Programs

After you have created a program file (with the SAVE command), you can use RE-SAVE whenever you need to write the program back to the file. This allows you to edit or update an existing program and then easily replace the program in the same file. (If the file does not already exist, RE-SAVE behaves like the SAVE command and creates the file for the program.) The following examples show how to RE-SAVE the program "TEST" to the various mass storage devices.

LIF Examples

MSI ":,700,0,0"

Sets default drive/volume to hard disk, volume 0

RE-SAVE "TEST"

RE-SAVEs the file on the default drive/volume

RE-SAVE "TEST:,700,0,0"

RE-SAVEs the file on hard disk, volume 0

RE-SAVE "TEST:,700,1"

RE-SAVEs the file on flexible disk

RE-SAVE "TEST:MEMORY,0,0"

RE-SAVEs the file to RAM Volume 0

DOS Examples

RE-SAVE "\PROGRAMS\VOLTMET\TEST:,700,0,1"

RE-SAVEs TEST program under PROGRAMS\VOLTMET directories on volume 1 of hard disk

MSI "\PROGRAMS\VOLTMET:,700,0,1"

Sets current directory path to PROGRAMS\VOLTMET. Sets default drive/volume to hard disk, volume 1

RE-SAVE "TEST"

RE-SAVEs program to current directory path on the default drive and volume

RE-SAVE "\PROGRAMS\VOLTMET\TEST:,700,1"

RE-SAVEs TEST program under PROGRAMS\VOLTMET directories on flexible disk

RE-SAVE "\PROGRAMS\VOLTMET\TEST:MEMORY,0,1"

RE-SAVEs TEST program under PROGRAMS\VOLTMET directories on RAM Volume 1

Getting Programs

In System Controller Mode, you can retrieve a program from either disk drive or from a RAM volume. In Talk/Listen Mode, you can retrieve a program from a Ram Volume only.

The GET command retrieves a program or program segment from an ASCII or HP-UX file and places it in the IBASIC computer. When GET is followed by the file name only (no line numbers used), it clears any existing program from the IBASIC computer's memory and retrieves the specified program. By adding line numbers to the GET command, you can append program lines to an existing program and/or run the program at a specified line. Refer to Agilent Instrument BASIC Programming Techniques manual for more information on appending and running programs with GET.

The following examples show how to get the program "MY_PROG" from either disk drive or a RAM volume.

LIF Examples

MSI ":,700,0,0"

Sets default drive/volume to hard disk, volume 0

GET "TEST"

GETs file from the default drive/volume

GET "TEST:,700,0,0"

GETs file from hard disk, volume 0

GET "TEST:,700,1"

GETs file from flexible disk

GET "TEST:MEMORY,0,0"

GETs file from RAM Volume 0

DOS Examples

GET "\PROGRAMS\VOLTMET\TEST:,700,0,1"

GETs TEST program from PROGRAMS\VOLTMET directories on volume 1 of hard disk

MSI "\PROGRAMS\VOLTMET:,700,0,1"

Sets current directory path to PROGRAMS\VOLTMET. Sets default drive/volume to hard disk, volume 1

GET "TEST"

GETs program from current directory path on the default drive and volume

GET "\PROGRAMS\VOLTMET\TEST:,700,1"

GETs TEST program from PROGRAMS\VOLTMET directories on flexible disk

GET "\PROGRAMS\VOLTMET\TEST:MEMORY,0,1"

GETs TEST program from PROGRAMS\VOLTMET directories on RAM Volume 1

Copying Files

The COPY command allows you to copy an individual file or an entire volume. Any type of file can be copied. You can copy a file to the same volume or to a different volume. When you copy a file to the same volume, the new file name must be different from the existing file name (if it is in the same directory). You can copy DOS files to LIF volumes and vice versa. Refer to "Copy to/from DOS and LIF" later in this chapter for more information.

LIF Examples

MSI ":,700,0,0"

Sets default drive/volume to hard disk, volume 0

COPY "TEST" to "TEST:,700,1"

COPYs file from the default drive/volume to flexible disk using the same file name

COPY "TEST:,700,1" to "PROG_1:,700,0,0"

COPYs file from flexible disk to hard disk volume 0 using a different file name

MSI ":,700,0,0"

Sets default drive/volume to hard disk, volume 0

COPY "TEST:MEMORY,0,0" to "PROG_1"

COPYs file from RAM Volume 0 to default mass storage volume using different file name

DOS Examples

COPY "\PROGRAMS\VOLTMET\TEST:,700,0,1" to "TEST:,700,1"

COPYs TEST file from PROGRAMS\VOLTMET directories on volume 1 of hard disk to flexible disk (if the flexible disk is formatted in DOS, "TEST" goes to the current directory since no path was specified)

MSI "\PROGRAMS\VOLTMET:,700,1"

Sets current directory path to PROGRAMS\VOLTMET. Sets default drive/volume to flexible disk

COPY "TEST" to "\PROGRAMS\VOLTMET:,700,0,1"

COPYs file from current directory path on the default drive and volume to \PROGRAMS\VOLTMET directories on hard disk volume 1

COPY "\PROGRAMS\VOLTMET\TEST:MEMORY,0,1" to "\DCVOLT\PROG1:,700,1"

COPYs TEST file from PROGRAMS\VOLTMET directories on RAM Volume 1 to file PROG1 on DCVOLT directory of flexible disk

Copying an Entire Volume

The COPY command also allows you to copy the entire contents of a mass storage volume to another volume. You cannot copy a larger volume to a smaller volume. You can copy a smaller volume to a larger volume, however the size of the larger volume will be reduced to the size of the smaller volume. When you copy a LIF volume to a DOS volume, the DOS volume will be converted to LIF and vice versa.

CAUTION Copying a volume destroys all previous data on the destination volume.

Examples (LIF and DOS)

COPY ":,700,1" to ":,700,0,2"

COPYs volume from flexible disk to hard disk volume 2

```
COPY ":MEMORY,0,1" to ":,700,0,2"
```
COPYs RAM Volume 1 to hard disk volume 2

Renaming Files

The RENAME command allows you to change the name of a file without disturbing the file's contents. For example, to change the name of a file from "CHTRY" to "CHTEST", use the following command:

```
RENAME "CHTRY" TO "CHTEST"
```

Using RENAME to Move DOS Files/Directories

You can also use the RENAME command to change a file's location in DOS directories and/or the DOS hierarchy. For example, the following command moves the file "TEST" from the "VOLTMET" directory (on the default volume) to the higher level directory "PROGRAMS":

```
RENAME "\PROGRAMS\VOLTMET\TEST" TO "\PROGRAMS\TEST"
```

You can also move a DOS directory to a different place in the DOS hierarchy. The following command moves the directory MYDIR to the next higher level in the DOS hierarchy:

```
RENAME "\USERS\DAVE\MYDIR" TO "\USERS\MYDIR"
```

By preceding the file name with a backslash or slash in the "new name" part of the command, you can move a file to the root. The following command moves the file "PROG_1" from its present directory to the root:

```
RENAME "\PROGRAMS\VOLTMET\PROG_1" TO "\PROG_1"
```

Purging Files

You can erase a file with the PURGE command. Purging a file deletes the directory entry for the file and releases the space reserved for the file. For example, the following command removes the file "CHTRY" from the current default volume:

```
PURGE "CHTRY"
```

Purging DOS Directories

You can use the PURGE command to remove DOS files and directories. The following restrictions apply to PURGE on DOS directories:

- PURGE works only with closed files and directories. You cannot purge a file currently open with an ASSIGN or a directory which is the current working directory of any DOS disk.
- A directory must be empty (must not contain any files or directories) before it can be purged. This means that to purge a directory, you must first purge all of its files and lower-level directories.

Autostarting Programs

You can create an autostart program that will automatically be retrieved and RUN by IBASIC whenever the mainframe is re-booted (power cycled or DIAG:BOOT command executed). You identify the file containing an autostart program by naming the file "AUTOST". You can save this program to the root directory of a flexible disk, RAM Volume 1, or volume 0 of the hard disk. Whenever the system is re-booted, IBASIC searches for an autostart file on the flexible disk first, RAM volume 1 second, and volume 0 of the hard disk last. After the mainframe and disk drive power-up sequences are completed, IBASIC runs the first autostart program it found. Even if you are autostarting from RAM volume 1 there will be a startup delay while the system checks for an autostart file on the floppy disk.

NOTE

If you do not have a hard disk, the autostart search order becomes RAM volume 1 first and flexible disk second. If you do not have a flexible disk, the search order is RAM volume 1 first and hard disk second.

After re-booting the mainframe, the default MSI is set to the mass storage device where an autostart program was found. If no autostart program was found, the default MSI is set to the root directory (DOS only) on the last valid mass storage volume found during the power-on search sequence (search order is the same as for the autostart program).

CAUTION

Always test a program before saving it as "AUTOST". It is possible to create a corrupt autostart program (on RAM volume 1 or the hard disk) that may lock-up the mainframe whenever it is re-booted.

If you have a flexible disk, you can recover from this situation by inserting a flexible disk containing a functional autostart file. The system will then find the flexible disk autostart file before it finds the corrupt file.

If you do not have a flexible disk and the corrupt autostart file is in RAM volume 1, you can press the **Reset Instr** key (front panel) or **CTRL R** (terminal) during the power-on sequence while "Testing ROM" is being displayed. Pressing this key aborts the normal power-on sequence and performs DIAG:BOOT:COLD instead. You can then PURGE or EDIT the corrupt autostart file.

If you do not have a flexible disk and the corrupt file is on the hard disk, you can select the IBASIC instrument during the power-on sequence and press **Reset Instr** (front panel) or **CTRL R** (terminal) while "IBASIC booting" or "IBASIC busy" is being displayed. Pressing this key aborts the normal power-on sequence. You can then PURGE or EDIT the corrupt autostart file.

Capturing a Display

The DIAG:IBAS:DISP<*device*> command allows IBASIC to "capture" a display following a re-boot. In addition, the IBASIC instrument will automatically be selected on the display device following a re-boot. This command can be used without an autostart program, but is particularly useful when used with an autostart program. For example, immediately following re-boot, IBASIC can capture a display and display user INPUT prompts or a warning such as *"Warning: Power Failure--reset all external equipment"*.

Example: Autostart with Display Capture

The following example captures the built-in RS232 interface (BUILtin) and runs an autostart program whenever the system is re-booted. You can also capture a terminal on a plug-in RS-232 card (1 - 7). Refer to the SCPI Command Reference for more information on these parameters.

From the IBASIC instrument, execute the following command:

```
OUTPUT 80930;"DIAG:IBAS:DISP  BUIL" Capture  display after
                                    re-boot
```

Now enter the following program:

```
10 DISP "This is an autostart test"       Display message
20 END
```

To save this program as an autostart program, execute one of these commands:

```
SAVE "AUTOST:,700,0,0"          Save autostart file on hard disk
                                volume 0
SAVE "AUTOST:,700,1"            Save autostart file on flexible
                                disk
SAVE "AUTOST:,MEMORY,1"         Save autostart file on RAM
                                volume 1
```

Now, when the system is re-booted, IBASIC will capture the display, get and run the AUTOST file, and display *"This is an autostart test"*.

NOTE

Initial PRINT commands from an autostart program may not be displayed if IBASIC re-boots before the display system does. This is most likely to happen when the autostart file is in RAM Volume 1. You can prevent this problem by using a short WAIT command (e.g., WAIT 5) as the first line in the autostart program or by using the DISP command instead of PRINT.

To return IBASIC to its normal mode of not capturing a display following re-boot, execute this command from the IBASIC instrument:

```
OUTPUT 80930;"DIAG:IBAS:DISP NONE"
```

IBASIC File Types

The IBASIC file system supports four different file types: ASCII, BDAT, DIR and DOS/HP-UX.

ASCII Files

ASCII files are stored on the disk as a series of variable length records. Each record consists of a 16-bit word followed by the number of bytes designated in the length word. If the length word contains an odd number, there is a one byte pad character at the end of the record so that all records start on an even byte boundary. The end of the file is denoted by a length word containing -1. ASCII files are created with the command:

```
CREATE ASCII "<filename>",size
```

Where *size* is the number of 256 byte blocks reserved for the file. The number of records in the file can continue to grow until 256 x *size* bytes are used. Attempting to write more than this to the file generates an IBASIC error 59 "End of file or Buffer found".

BDAT Files

BDAT files are stored on the disk as a 256 byte *system record* followed by a series of fixed length records. They are created with the command:

```
CREATE BDAT "<filename>",number_of_records[,record_size]
```

Where *number_of_records* is the maximum number of records that can be stored in the file and *record_size* is the size of each record. If the *record_size* is not specified, it defaults to 256 bytes.

Only the first 12 bytes of the BDAT system record are used. These 12 bytes contain three 4 byte integers with the following information:

- Integer 0: The 256 byte block containing the logical end of file.
- Integer 1: The offset of the End Of File in the above block.
- Integer 2: Maximum number of records as specified in CREATE BDAT.

The file directory contains the record length of each record as specified in the CREATE BDAT command.

DIR Files

DIR files are DOS directories or subdirectories. They are created with the command:

```
CREATE DIR "<directory name>"
```

DIR files can only be created on DOS disks or DOS RAM volumes.

DOS/HP-UX Files

DOS and HP-UX files are identical file types. DOS/HP-UX type files are created with the command:

```
CREATE "<filename>",size
```

Where *size* is the number of bytes needed for the file. The record length for a DOS/HP-UX file is 1 thus the number of bytes is the same as the number of 1 byte records.

NOTE

When executing the CAT command (CATalog) on a DOS/HP-UX file on a DOS disk, "DOS" is returned as the file type. On a LIF disk, "HP-UX" is returned as the file type. This is done to be compatible to some other Agilent products.

Using Wildcards

The wildcard characters allow you to use one command to perform operations on a number of files or to "complete the name" of file names you may be unsure of.

The wildcard characters are an asterisk "*" and a question mark "?". When wildcards are enabled, the "*" represents any number of characters in a file name. For example, AB* matches file names such as AB, ABC, ABX, ABCD, etc. If the "*" does not appear at the end of the name, any characters after the "*" are ignored. For example, XY*Z matches XY, XYA, XYABC, etc. The "?" represents a single character in a file name. For example, A?B matches AAB, ABB, A2B, etc. If the "?" appears at the end of the name as in AB?, it matches AB, ABC, ABX, etc.

Enabling/Disabling Wildcards

The WILDCARDS DOS and WILDCARDS OFF commands enable and disable wildcards, respectively. IBASIC defaults to WILDCARDS OFF. The "SCRATCH A" command resets IBASIC to WILDCARDS OFF. SCRATCH does not change the wildcards setting. When wildcards are not enabled, including "*" or "?" in a DOS or a LIF file name is illegal and generates "ERROR 53 Improper file name".

NOTE

The term WILDCARDS DOS is not limited to the DOS file system. It applies to wildcard operations on a LIF disk as well. The "DOS" term refers to the way wildcards are expanded to match file names. The wildcard expansion closely follows how the MS-DOS operating system treats wildcards.

Wildcards are only legal in the right most name in a DOS directory path (i.e. \DIR1\A*.X). If wildcards are used in other than the right-most position (i.e. \DIR*\ABC.X), an "ERROR 53 Improper file name" is generated.

File Names with Extensions

When using a DOS filename extension, a period is used to separate the filename from the extension. Since the period is not stored as part of the actual name, this has some rather subtle implications when using wildcards. If a wildcard is used that has no period, it only matches files that do not have extension names. For example, XY* matches XYA and XYB but not XY.A. Similarly, XY*.A matches XYA.A, XY.A, XYZ.A, and so on. AB*X.C matches AB.C, ABC.C ABCX.C, and so on. Using "*" matches all files with no extension names and "*.*" matches all files. LIF files do not allow the period in a file name (and LIF does not have extensions) so using "*" or "*.*" on a LIF disk matches all files on the disk.

IBASIC Commands that use Wildcards

Wildcards operate in either the *multiple name expansion mode* or *name completion mode*. The mode used depends on the command being executed.

Multiple Name Expansion Mode

The CAT and PURGE commands operate in *multiple name expansion mode*. This means the wildcard name expands to as many names as can be matched. If the operation attempted does not succeed on all files found, an "ERROR 293 Operation failed on some files" is generated.

LIF Examples

WILDCARDS DOS
Enables wildcards

CAT "T*:,700,0,0"
Catalogs all files starting with T on volume 0 of hard disk

CAT "CH??:,700,0,0"
Catalogs all 4-letter files starting with CH on volume 0 of hard disk

PURGE "VOLT*:,700,0,0"
PURGEs all files starting with the letters VOLT on volume 0 of hard disk.

DOS Examples

WILDCARDS DOS
Enables wildcards

CAT "\F*:,700,0,1"
Catalogs all subdirectories and files (without extensions) starting with "F" on root directory of hard disk volume 1

CAT "\F*.*:,700,0,1"
Catalogs all subdirectories and files (with or without extensions) starting with "F" on root directory of hard disk volume 1

CAT "\PROGRAMS*.TXT:,700,0,1"
Catalogs all files with TXT extension on PROGRAMS subdirectory of hard disk volume 1

CAT "\PROGRAMS\AMPS.*:,700,0,1"
Catalogs all file named AMPS (with or without extensions) on PROGRAMS subdirectory on hard disk volume 1

CAT "\PROGRAMS\CH??.*:,700,0,1"
Catalogs all 4-letter file names starting with CH (with any extension) on PROGRAMS subdirectory on hard disk volume 1.

PURGE "\PROGRAMS\VOLTS.*:,700,0,1"
PURGEs all files named VOLTS (with any extension) in the PROGRAMS directory on volume 1 of hard disk.

PURGE "\PROGRAMS*.CAP:,700,0,1"
PURGEs all files with CAP extension in the PROGRAMS directory on volume 1 of hard disk.

PURGE "\PROGRAMS*.*:,700,0,1"
PURGEs all files in the PROGRAMS directory on volume 1 of hard disk.

Name Completion Mode

The ASSIGN, GET, MASS STORAGE IS, MSI, RENAME, and RE-SAVE commands operate in File Name Completion mode. This means the wildcard name can match a single file name only. If it matches more than one file name, "ERROR 294 Wildcard matches> 1 item" is generated.

LIF Examples

WILDCARDS DOS

Enables wildcards

GET "TE*"

GETs file starting with TE from the default drive/volume

RENAME "CH*" TO "CHTEST"

Re-names file starting with CH to CHTEST on default drive

RE-SAVE "TE*"

RE-SAVEs the file on default drive/volume

DOS Examples

WILDCARDS DOS

Enables wildcards

GET "\PROGRAMS\VOLTMET\TE*:,700,0,1"

GETs file starting with TE (no extension) from PROGRAMS\VOLTMET subdirectories on volume 1 of the hard disk*

MSI "\PROGRAMS\VO*:,700,0,1"

Sets default directories/drive to PROGRAMS\ directory starting with VO on volume 1 of hard disk

RENAME "\PROGRAMS\VOLT\CH*" TO "\PROGRAMS\VOLT\CHTEST"

Re-names file starting with CH to CHTEST in PROGRAMS\VOLT directories

RE-SAVE "\PROGRAMS\VOLTMET\TE*:,700,0,1"

RE-SAVEs file starting with TE under PROGRAMS\VOLTMET directories on volume 1 of hard disk

Commands that do not use Wildcards

The CREATE, INITIALIZE, and SAVE commands do not allow wildcards ("ERROR 292 Wildcards not allowed" is generated).

Wildcards and the COPY Command

The COPY command operates in *multiple name expansion mode* on the first parameter and *name completion mode* on the second. This allows you to copy many files in one operation. If either COPY parameter does not match any file, "ERROR 56 File name is undefined" occurs. If the second parameter is NULL (i.e. "" or ":,0",. . .) it is assumed to refer to the current mass storage directory.

With wildcards enabled, the following situations are handled by COPY:

- If the source matches a single file name, the destination can match a single file name, a single directory name, or it must not exist (in which case it is created by the copy).
- If the source matches multiple file names, the destination must match a single directory name.

LIF Examples

WILDCARDS DOS

Enables wildcards

COPY "TE*:,700,0,0" to ":,700,1"

COPYs file from hard disk volume 0 to flexible disk

DOS Examples

```
WILDCARDS DOS
```
Enables wildcards

```
COPY "\PROGRAMS\VOLTMET\TE*:,700,0,1" to ":,700,1"
```
COPYs file starting with TE from PROGRAMS\VOLTMET directories on volume 1 of hard disk to flexible disk (if the flexible disk is formatted in DOS, "TEST" goes to current directory since no path was specified)

```
COPY "\PROGRAMS\VOLTMET\*.*:,700,1" to
"\PROGRAMS\VOLTMET:,700,0,1"
```
COPYs all files from \PROGRAMS\VOLTMET directory on flexible disk to \PROGRAMS\VOLTMET directory on hard disk volume 1.

Behavior Differences between LIF and DOS File Systems

Several file system operations in IBASIC behave differently depending on whether the target disk is a LIF or a DOS disk. The purpose for this is to simplify moving files between IBASIC and either a DOS or HP Series 200/300 computer. This allows IBASIC files written on DOS disks to be compatible with DOS software and files written on LIF disks to be compatible with HP Series 200/300 BASIC software.

ASCII and BDAT Files on DOS Disks

The DOS file system does not directly support ASCII and BDAT files. There is no field in the DOS directory to save information indicating whether a file is ASCII, BDAT or DOS/HP-UX so this information must be stored in the file itself. IBASIC does this by creating a 512 byte header on ASCII and BDAT files. This header is a 256 byte LIF disk header followed by a 256 byte LIF directory containing 1 file entry. The contents of the file begin immediately following the header. Any file whose first 512 bytes are not recognized as a LIF header followed by a LIF directory, is assumed to be a DOS/HP-UX file.

SAVE on DOS and LIF

The SAVE and RE-SAVE commands allow you to save a program in a disk file. To allow this file to be edited on an HP Series 200/300 BASIC or a DOS computer (using a standard DOS text editor) IBASIC identifies the type of disk and file being used and stores the information as follows:

- When saving to a DOS disk, IBASIC creates a DOS/HP-UX file and saves the program as a series of ASCII strings each terminated by a carriage-return/line-feed (CR/LF). This is the standard DOS text format and allows the resulting file to be edited by a DOS text editor.

- When saving to a LIF disk, IBASIC creates an ASCII file and saves each string with no terminator (the length word in each ASCII record eliminates the need for a string terminator). This is the same format used by SAVE on HP Series 200/300 BASIC computers so the resulting file can be retrieved directly by one of these computers.

RE-SAVE on DOS and LIF

If the file being RE-SAVED does not already exist, RE-SAVE behaves exactly as described previously with SAVE. If however, the file already exists, IBASIC preserves the file type and stores the information as follows:

- When a program is re-saved to an ASCII file on a LIF disk, or to a DOS/HP-UX file on a DOS disk, there is no change since these are the default file types on the respective disks.
- When a program is re-saved to an existing file, the original file type is retained.
- When a program is re-saved to a DOS/HP-UX file on a LIF disk, carriage-returns are removed automatically and only the line-feed portion of the line terminator is saved. This allows the program to be edited on an HP-UX machine since HP-UX uses only the LF as the line terminator.

COPY to/from DOS and LIF

When copying files from a LIF to a DOS disk, file types are preserved by the copy. An ASCII, BDAT and HP-UX file from a LIF disk copies directly to an ASCII, BDAT, or DOS file (respectively) on a DOS disk. There are, however, two things you must remember to avoid problems:

- LIF and DOS file names are not always compatible
- COPY does not re-format text files (CR/LF <> LF)

When using wildcards and copying files from DOS to LIF, you may have DOS file names that are not legal LIF names. When this happens, the files with legal names are copied, files with illegal names are skipped, and ERROR 293 - Operation failed on some files - is generated when the COPY finishes.

When copying DOS/HP-UX text files such as those generated by the SAVE or RE-SAVE, be aware that a text file on a LIF disk that contains LF terminators still contains only the LF terminators when copied to a DOS disk. The reverse is also true. A text file on a DOS disk containing CR/LF terminators still contains CR/LF terminators when it is copied to a LIF disk. This is not a problem for the IBASIC GET command since it handles either format regardless of the type of disk being used. However, this is a problem for some HP Series 200/300 BASIC computers so you need to be aware of the file type when exchanging programs on one of these computers.

DOS/HP-UX File Extensibility

LIF files are stored in a contiguous group of sectors on the disk. This means that a LIF file cannot expand beyond the size at which it was created. In addition, the order of files in the LIF directory is the same as the order of the file data area on the LIF disk.

The DOS file system does not require that files be saved contiguously on the disk. A DOS file may be split into several *allocation units* that can be scattered anywhere on the disk. This capability allows DOS files to be expanded as long as there is free space left on the DOS disk.

In IBASIC, ASCII and BDAT files on a DOS disk are created with a fixed size that cannot be expanded. However, file space for a DOS/HP-UX file on a DOS disk is not allocated when the file is created; it is allocated as the file is written. Thus the size specified in the CREATE command is ignored and the DOS/HP-UX file can expand up to the amount of available space on the DOS disk.

When using a LIF disk, you must specify adequate size when creating DOS/HP-UX files since the file cannot be expanded later.

In Case of Difficulty

Mass Storage Error Message	Cause
Error 52 Improper mass storage volume specifier.	The characters used for mass storage volume specified do not form a valid specifier. This could be a missing colon, too many parameters, illegal characters, etc.
Error 53 Improper file name.	The file name is too long or has characters that are not allowed. (Can also occur when using "*" or "?" in a file name when wildcards are not enabled or when a wildcard was used in other than the right-most position of a file name.) A LIF file name can be up to 10 characters long and is case dependant. LIF file names may contain any letter of the alphabet (upper and lower case), the digits 0-9, and the underscore character (_). You can also use the international characters: CHR$(160) - CHR$(254). A DOS file name can be up to 8 characters long with an optional extension name of up to 3 characters. DOS file names may contain any letter of the alphabet, the digits 0-9, the international characters CHR$(160) - CHR$(254), and these characters: ! # $ % ( ) - ^ _ { } ~
Error 54 Duplicate file name.	The specified file name already exists. It is illegal to have two files with the same name on one LIF volume or in a DOS directory.
Error 55 Directory overflow.	Although there may be room on the media for the file, there is no room for another file name. LIF Disks initialized by Agilent Instrument BASIC have room for over 100 entries in the directory. Small RAM volumes allow fewer entries.
Error 56 File name is undefined.	The specified file name does not exist or a wildcard operation did not match any file. Check the contents of the disk with a CAT command.
Error 58 Improper file type.	Many mass storage operations are limited to certain file types.
Error 59 End of file or buffer found.	For files: No data left when reading a file, or no space left when writing a file. For buffers: No data left for an ENTER, or no buffer space left for an OUTPUT or user RAM volume too small.
Error 60 End of record found in random mode.	Attempt to ENTER or OUTPUT a field that is larger than a defined record.
Error 62 Protect code violation.	Failure to specify the protect code of a protected file, or attempting to protect a file of the wrong type.
Error 64 Mass storage media overflow.	The disk is full. (There is not enough free space for the specified file size, or not enough contiguous free space on a LIF disk.) Or you have specified a size for a nonvolatile RAM volume that is larger than the reserved memory.
Error 66 INITIALIZE failed.	Too many bad tracks found. The disk is defective, damaged, or dirty.
Error 67 Illegal mass storage parameter.	A mass storage command contains a parameter that is out of range, such as a negative record number or an out of range number of records. Also occurs if you did not reserve enough memory space for a nonvolatile RAM volume.
Error 68 Syntax error occurred during GET.	One or more lines in the file could not be stored as valid program lines. (These lines will be stored as commented lines.) Also occurs if the first line in the file does not start with a valid line number.
Error 72 Drive not found or bad address.	The mass storage unit specifier contains an improper device selector, the disk drive is still powering-up, or no disk drive is connected.
Error 73 Improper device type in mass storage volume specifier.	The volume specifier has the correct general form, but the characters used for a device type are not recognized.
Error 76 Incorrect unit number in mass storage volume specifier.	Uninitialized RAM volume or the volume specifier contains a unit number that does not exist on the specified device.
Error 77 Operation not allowed on open file.	The specified file is assigned to an I/0 path name which has not been closed.
Error 78 Invalid mass storage volume label.	Usually indicates that the media has not been initialized on a compatible system. Could also be a bad disk. Can also occur when switching disk formats (DOS, LIF).
Error 79 File open on target device.	Attempt to copy an entire volume with a file open on the destination disk.
Error 80 Disk changed or not in drive.	No disk in the drive or the drive door was opened while a file was assigned.
Error 81 Mass storage hardware failure.	Also occurs when the disk is pinched and not turning. Try reinserting the disk.
Error 82 Mass storage volume not present.	Hardware problem or drive does not exist.
Error 83 Write protected.	Attempting to write to a write-protected disk. This includes many operations such as PURGE, INITIALIZE, CREATE, SAVE, OUTPUT, etc.
Error 84 Record not found.	
Error 85 Media not initialized.	Usually indicates that the media has not been initialized.
Error 87 Record address error.	Usually indicates a problem with the media.
Error 88 Read data error.	The media is damaged, or a nonvolatile RAM Volume is corrupted.
Error 89 Checkread error.	Error detected when reading data. The media is probably damaged.

Mass Storage Error Message	Cause
Error 90 Mass storage system error.	Usually a problem with the hardware or the media.
Error 93 Incorrect volume code in mass storage volume specifier.	The volume specifier contains a volume number that does not exist on the specified device.
Error 183 Permission denied.	Attempt to PURGE or write to a read only file
Error 189 Too many open files.	Only a fixed number of files can be open at one time. Close some of the files.
Error 291 Too many matches.	Too many matches on wildcard operation.
Error 292 Wildcards not allowed.	Some mass storage commands such as CREATE, INITIALIZE, and SAVE do not allow wildcards.
Error 293 Operation failed on some files.	The wildcard operation attempted does not succeed on all files found. When using wildcards and copying files from DOS to LIF, you may have DOS file names that are not legal LIF names. When this happens, legal files are copied, illegal files are skipped, and this error is generated.
Error 294 Wildcard matches >1 item.	A wildcard operating in File Name Completion mode expanded to more than one file name.
Error 295 Improper destination type.	Multiple files must be copied to directory not file.
Error 296 Unable to overwrite file.	Unable to overwrite file during copy operation.
Error 460 Directory not empty.	Attempt to PURGE a directory containing files (you must PURGE files first)

Chapter 5 Contents

Chapter 5

System Controller Mode Operation

Using This Chapter

This chapter shows how to use the IBASIC computer in System Controller mode to :

- Control instruments and external GPIB devices
- Control external RS-232/422 peripherals
- Store/retrieve data to disks and memory
- Enable instrument/device interrupts
- Synchronize instrument/device operations

NOTE All example programs in this chapter are assumed to have been downloaded into the IBASIC computer. See *Chapter 2 - Creating and Editing Programs* to create programs from sources other than an HP 9000 Series 200/300 computer. See *Chapter 6 - Talk/Listen Mode Operation* to create and download programs from an HP 9000 Series 200/300 computer.

System Controller Mode Overview

Figure 5-1 shows typical functions using the IBASIC computer for System Controller mode operation.

Controlling Instruments/GPIB Devices

The IBASIC computer communicates with internal instruments (the System instrument, plug-in module instruments, and the IBASIC instrument) via the IBASIC interface. Use OUTPUT 809ss; to send commands to a register based or message based instrument and ENTER 809ss; to return data from the instrument, where 09 = primary address of the Agilent C-size mainframe at power-on and ss = the instrument’s secondary address.

Message based instruments can also be accessed by logical address using OUTPUT 16[XX]XX or ENTER 16[XX]XX where [XX]XX is 0000-0255. The first two digits of [XX]XX are not required for logical addresses 00-99. This permits access to message based devices at other than secondary addresses.

For System Controller mode only, IBASIC computer communicates with external GPIB devices via the GPIB interface. For interface select code 7, use OUTPUT 7ppss to send commands to a device and ENTER 7ppss to return data from the device, where pp = device primary address and ss = secondary address.

Use the GPIB interface commands ABORT, CLEAR, LOCAL, LOCAL LOCKOUT, PASS CONTROL, REMOTE, SPOLL, and TRIGGER to control GPIB device states via the GPIB interface. Or, use the IBASIC interface commands ABORT, CLEAR, LOCAL, LOCAL LOCKOUT, REMOTE, SPOLL, and TRIGGER to control instrument states via the IBASIC interface.

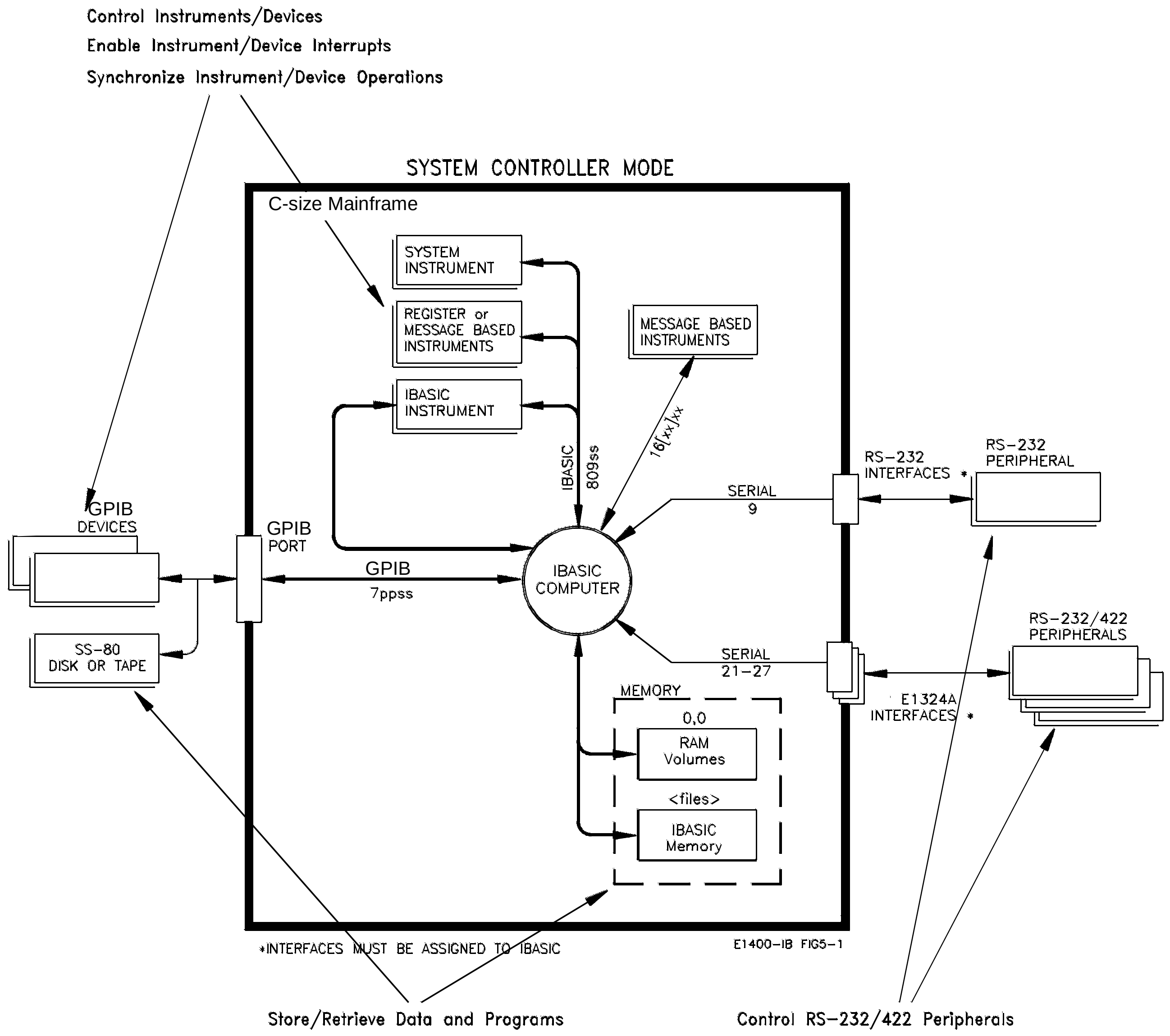


Figure 5-1. System Controller Mode Operations

Controlling RS-232/422 Peripherals

Control external RS-232 and RS-422 peripherals with the IBASIC computer via the serial interfaces. Up to seven Agilent E1324A plug-in modules can be installed in an Agilent C-size mainframe. When the RS-232/422 ports on an Agilent E1324A plug-in module are assigned to IBASIC, use OUTPUT 21; and ENTER 21; to control RS-232/ RS-422 peripherals via Agilent E1324A module #1,..., OUTPUT 27; and ENTER 27; via Agilent E1324A module #7.

Storing/Retrieving Data

For System Controller mode, data returned from instruments, GPIB devices, or RS-232/422 peripherals can be stored on external SS-80 disks or tapes, in RAM volumes, or in IBASIC memory. For this discussion we will be assuming a 9153 disk drive (one hard drive and one 3.5 inch floppy disk drive) at GPIB address 0.

Use MSI ":,700,0" to store data to the external 9153 hard disk;
MSI ":,700,1" to store data to the 3.5 inch disk; or
MSI ":,0, <RAM Volume #>" to store data to nonvolatile or volatile RAM volumes.
Use OUTPUT @File and ENTER @File to access data files, where ASSIGN @File TO "File" creates the path to the file.

Enabling Interrupts and Events

Interrupts can be sent to the IBASIC computer from external GPIB devices or from internal instruments when the appropriate interface is enabled with ENABLE INTR <sc>, where <sc> = interface select code. The IBASIC computer can be programmed to service interrupts and non-interrupt events with ON CYCLE, ON ERROR, ON INTR, ON KEY, or ON TIMEOUT.

Synchronizing Instruments/GPIB device operations

The IBASIC computer can be used to control operations between instruments and GPIB devices, to synchronize instrument/device operations with the IBASIC computer, and to pass control from the IBASIC computer to an external computer.

Controlling Instruments/GPIB Devices

In System Controller mode the IBASIC computer can communicate with internal instruments (the System instrument, plug-in module instruments, and the IBASIC instrument) via the IBASIC interface and with external GPIB devices via the GPIB interface. This section shows how to:

- Use GPIB/IBASIC interface commands
- Communicate with instruments via the IBASIC interface
- Communicate with GPIB devices via the GPIB interface

NOTE

You can also use the READIO and WRITEIO commands which allow for more flexibility in controlling instruments/devices with the IBASIC computer. See the READIO and WRITEIO commands in *Chapter 7 - IBASIC Command Reference* for information on these commands.

Using the GPIB/IBASIC Interfaces

The IBASIC computer uses a GPIB (General Purpose Interface Bus) interface to communicate with external GPIB devices, IBASIC interfaces (select codes 8 and 16) to communicate with internal instruments, and serial interfaces to communicate with external RS-232/422 peripherals (see Figure 5-1).

NOTE This discussion shows how to use the GPIB and IBASIC interfaces. See *Controlling RS-232/422 Peripherals* in this chapter for information on using the serial interfaces.

GPIB/IBASIC Interface Capabilities

Although the OUTPUT and ENTER statements are used to communicate with instruments and devices, GPIB and IBASIC interface commands, such as CLEAR and TRIGGER, can be used to control instrument or GPIB device states for actions such as setting instruments or devices to a known state, sending Trigger messages to the instruments or devices, etc.

GPIB Interface Commands

A standard GPIB interface connects the IBASIC computer to external GPIB devices via the GPIB port on the Agilent C-size mainframe controller. (If you are not familiar with GPIB, see *Tutorial Description of the General Purpose Interface Bus* for an introduction to the GPIB interface.) IBASIC supports all GPIB interface (bus) messages except Parallel Poll (PPOLL, PPOLL CONFIGURE, and PPOLL UNCONFIGURE) and SEND.

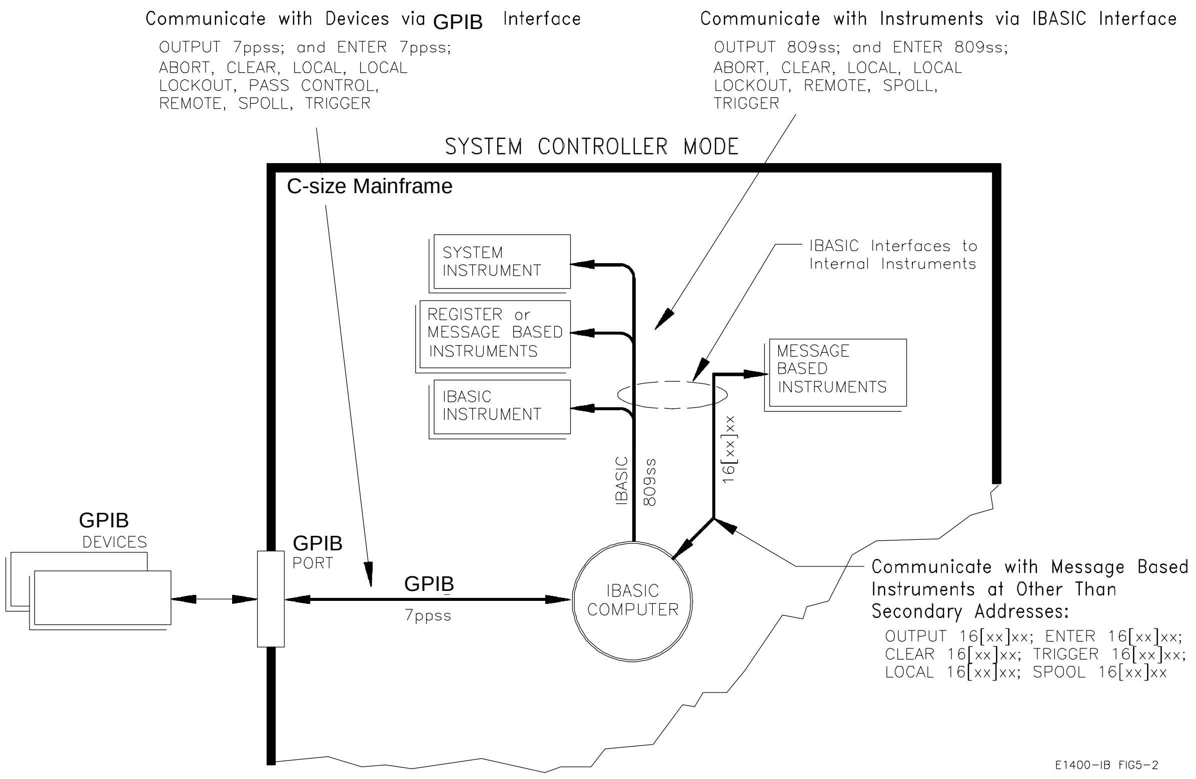

Communicate with Devices via GPIB Interface
OUTPUT 7ppss; and ENTER 7ppss;
ABORT, CLEAR, LOCAL, LOCAL LOCKOUT, PASS CONTROL, REMOTE, SPOLL, TRIGGER
Communicate with Instruments via IBASIC Interface
OUTPUT 809ss; and ENTER 809ss;
ABORT, CLEAR, LOCAL, LOCAL LOCKOUT, REMOTE, SPOLL, TRIGGER
SYSTEM CONTROLLER MODE
C-size Mainframe
SYSTEM INSTRUMENT
REGISTER or MESSAGE BASED INSTRUMENTS
IBASIC INSTRUMENT
IBASIC Interfaces to Internal Instruments
MESSAGE BASED INSTRUMENTS
IBASIC
809ss
16[xx]xx
GPIB DEVICES
GPIB PORT
GPIB
7ppss
IBASIC COMPUTER
Communicate with Message Based Instruments at Other Than Secondary Addresses:
OUTPUT 16[xx]xx; ENTER 16[xx]xx;
CLEAR 16[xx]xx; TRIGGER 16[xx]xx;
LOCAL 16[xx]xx; SPOOL 16[xx]xx
E1400-IB FIG5-2

Figure 5-2. Controlling Instruments/GPIB Devices

IBASIC Interface Commands

The IBASIC interface connects the IBASIC computer to internal instruments in the Agilent C-size mainframe. The IBASIC interface is very similar to the GPIB interface as supported by IBASIC, except PASS CONTROL is not used by the IBASIC interface.

The IBASIC Select Code 8 interface is NOT a physical interface and does not have exact equivalents for the ATN, IFC, REN, EOI, and SRQ lines of the GPIB interface. The IBASIC Select Code 8 interface is designed to act very much the same as the GPIB interface, where applicable.

The Select Code 16 interface uses similar commands but with differing results (see summary on next page).

GPIB/IBASIC Interface Command Comparisons

The following table summarizes the interface commands used for the GPIB and IBASIC interface, assuming an interface select code of 7 for the GPIB interface. In the table, pp = the external GPIB device primary address, and ss = the internal instrument or GPIB device secondary address. See *Chapter 7 - IBASIC Command Reference* in this manual for further information on the interface commands.

NOTE

Specific actions in response to an interface command may be different for each instrument/device. See the appropriate *Agilent 75000 Plug-In Module User's Manual* for information on instrument actions. See the appropriate user manual for information on GPIB device actions.

Summary of GPIB/IBASIC Interface Commands

Command	GPIB Interface Actions	IBASIC Interface Select Code 8 Actions	IBASIC Interface Select Code 16 Actions
ABORT	ABORT 7 breaks GPIB interface handshakes in progress	ABORT 8 sets interface to REMOTE "REN" true.	I/O operation not allowed
CLEAR	CLEAR 7 clears all GPIB devices. CLEAR 7ppss clears selected GPIB device.	CLEAR 8 clears all instruments. CLEAR 809ss clears selected instrument.	CLEAR 16 clears all message based instruments. CLEAR 16[XX]XX clears the selected message based instrument.
LOCAL	LOCAL 7 returns all GPIB devices to LOCAL state. LOCAL 7ppss returns selected device to LOCAL state. LOCAL LOCKOUT is cancelled on LOCAL 7.	LOCAL 8 returns all instruments to LOCAL state. LOCAL 809ss returns selected instrument to LOCAL state. LOCAL LOCKOUT is cancelled on LOCAL 8.	LOCAL 16 sends Clear Lock to all message based instruments. LOCAL 16[XX]XX sends Clear Lock to the selected message based instrument.
LOCAL LOCKOUT	LOCAL LOCKOUT 7 prevents GPIB devices set to REMOTE state from being operated from the front panel.	LOCAL LOCKOUT 8 prevents instruments set to REMOTE state from being operated in LOCAL mode.	I/O operation not allowed.
PASS CONTROL	PASS CONTROL 7pp passes Active Controller function to external computer.	PASS CONTROL does NOT apply to this interface.	PASS CONTROL does NOT apply to this interface.
REMOTE	REMOTE 7 sets GPIB REN line true. REMOTE 7ppss sets selected device to REMOTE state.	REMOTE 8 sets "REN" true. REMOTE 809ss sets the selected instrument to REMOTE state.	REMOTE 16 is not allowed. REMOTE 16[XX]XX sends Set Lock to the selected message based instrument.
SPOLL	SPOLL (7ppss) performs a Serial Poll of selected GPIB device.	SPOLL (809ss) performs a Serial Poll of selected instrument.	SPOLL (16[XX]XX) performs a Serial Poll of the selected message based instrument.
TRIGGER	TRIGGER 7 sends Trigger message to all addressed GPIB devices. TRIGGER 7ppss sends a trigger message to selected GPIB device.	TRIGGER 8 sends Trigger message to all addressed instruments. TRIGGER 809ss sends a trigger message to selected instrument.	TRIGGER 16 is not allowed. TRIGGER 16[XX]XX sends a word serial trigger message to the selected message based instrument.

Interface select code 7 for GPIB interface
Interface select code 8 and 16 for IBASIC interface
pp = device primary address
ss = instrument/device secondary address

Interface Command Examples

Four examples follow to show some ways the interface commands can be used to control instrument and GPIB device states. See *Synchronizing Instruments/GPIB Devices* in this chapter for examples using PASS CONTROL, SERIAL POLL, and TRIGGER. See *Chapter 7 - IBASIC Command Reference* for additional details on the interface commands.

Example: Aborting Interface Activity (ABORT)

```
ABORT 7
```

For System Controller mode ONLY, ceases activity on GPIB interface (select code 7)

Example: Clearing Instrument/Device (CLEAR)

```
CLEAR 80914
```

Clears the internal instrument at secondary address 14

```
CLEAR 722
```

For System Controller mode only, clears the GPIB instrument at address 722

```
CLEAR 1601
```

Sends a Word Serial Clear command to the message based device at logical address 1.

Example: Enabling Local State (LOCAL)

```
LOCAL 80914
```

Places an internal instrument at secondary address 14 in the LOCAL state.

```
LOCAL 722
```

For System Controller mode only, places GPIB device at address 722 in the LOCAL state.

Example: Setting Remote State (REMOTE)

```
REMOTE 80901
```

Sets instrument at secondary address 01 to REMOTE state

```
REMOTE 722
```

For System Controller mode only, sets GPIB device at address 722 to REMOTE state

Communicating with Instruments

For System Controller mode (and Talk/Listen mode), the IBASIC computer communicates with internal instruments via the IBASIC interface (interface select code 8) (see Figure 5-2). Since the IBASIC computer can communicate with many internal instruments, each instrument must have a unique address.

NOTE When System Controller mode is set, the IBASIC computer is the System Controller and has exclusive control over internal instruments. Thus, for System Controller mode, an external computer cannot access internal instruments via GPIB.

The address of an internal instrument for the IBASIC computer is 809ss, where ss = the secondary address of the instrument. For the Agilent C-size mainframe, internal instruments consist of the System instrument, plug-in module instruments, and the IBASIC instrument. The address of the System instrument is 80900 and the address of the IBASIC instrument is 80930. The default primary address of the Agilent C-size mainframe is 09. Neither the System instrument or the IBASIC instrument are message based devices, so they cannot be accessed from the Select Code 16 interface. Select Code 16 can be used to access any message based instrument using its logical address.

Use OUTPUT 809ss; to send commands to instruments via the IBASIC interface and use ENTER 809ss; to return data from instruments, where 8 = IBASIC interface select code (fixed), 09 = the instrument's primary address (programmable from the System instrument), and ss = the instrument's secondary address (00 through 30).

Communicating with Module Instruments

To control a plug-in module instrument with the IBASIC computer, use OUTPUT 809ss; and ENTER 809ss; statements where ss = the secondary address of the instrument. An example follows which uses the IBASIC computer to control an Agilent E1410A DMM at address 80903 to make DC voltage measurements.

NOTE See the appropriate Plug-In Module User's Manual for typical programs to control plug-in module instruments. To use the examples in those manuals for the IBASIC computer, change the instrument address from 709ss to 809ss. Otherwise, the listed programs can be used as shown for the IBASIC computer.

Example: Making DCV Measurement with Instrument

This program makes a DC voltage measurement using an Agilent E1410A DMM at address 80903. The input to the DMM is via the DMM rear panel terminals. The measurement result is displayed on the terminal connected to the built-in RS232 interface. See Figure 5-3 for typical connections.

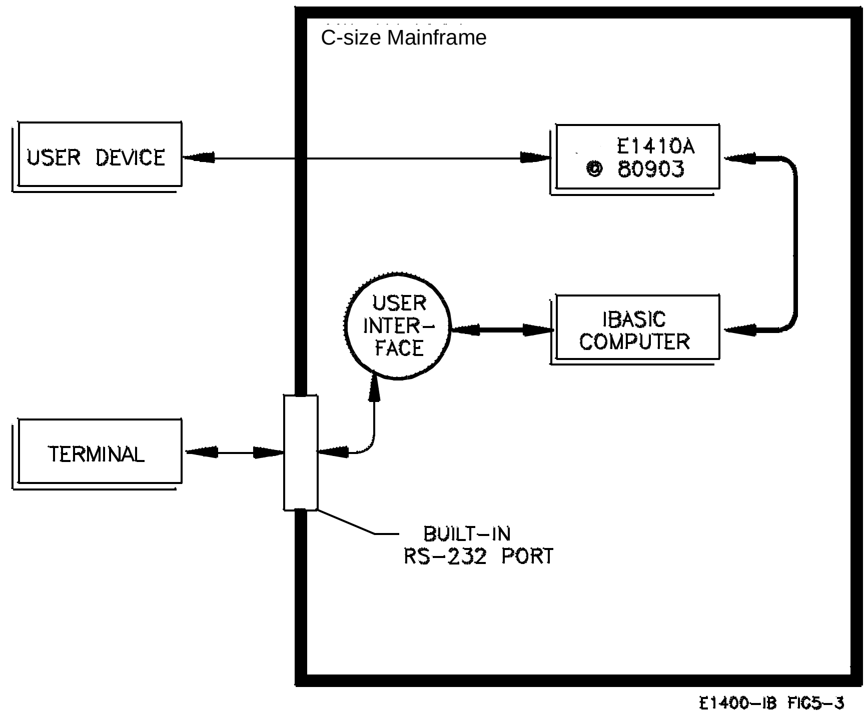


Figure 5-3. Example: Measure DCV with Instrument

5 !RE-SAVE "MEAS_DCV"	
10 ASSIGN @E1410 to 80903	*Assign DMM to the IBASIC instrument*
20 CLEAR @E1410	*Clear DMM/interface*
30 OUTPUT @E1410;"*RST"	*Reset DMM*
40 OUTPUT @E1410;"MEAS:VOLT:DC?"	*Make DCV measurement and query result*
50 ENTER @E1410;Volts	*Enter result*
60 PRINT "E1410A Voltage = ";Volts	*Display results*
70 END	

A typical result is: `E1410A Voltage = 1.254377`

NOTE

The same program could be used with Select Code 16 by changing line 10 to "10 ASSIGN @E1410 TO 1624" if the DMM is set to logical address 24.

Comunicating with the System Instrument

To control the System instrument with the IBASIC computer, use OUTPUT 80900 and ENTER 80900 statements. An example to read the time of day follows. See the *Agilent 75000 Mainframe User's Manual* for System instrument operations.

This program uses the IBASIC computer to read and display the time of day using the System instrument's internal clock. The System instrument's address is 80900.

```
5   !RE-SAVE "TIMECHEK"
10  OUTPUT 80900;"SYST:TIME?"        Query time of day
20  ENTER 80900;H,M,S                Enter time of day
30  PRINT  H,M,S                     Display time of day
40  END
```

A typical return (4:15:30 P.M.) is: 16 15 30

Comunicating with the IBASIC Instrument

The IBASIC instrument is treated the same as any internal instrument in the mainframe. Use OUTPUT 80930; and ENTER 80930; statements to control the IBASIC instrument from the IBASIC computer. A typical way to use the IBASIC instrument is to configure the RS-232/422 serial ports. See *Controlling RS-232/422 Peripherals* in this chapter for details.

Although the IBASIC instrument is addressed as an internal instrument, the IBASIC instrument is NOT a physical instrument and acts more like a message-based device than a register-based device. In the Agilent C-size mainframe, all plug-in module instruments (DVM, counters, etc.) are register-based devices.

Therefore, if the *WAI command is used on the IBASIC instrument (as would be the case for a register-based instrument to wait for command completion), sending a command to IBASIC will terminate very quickly. This occurs since the IBASIC computer begins executing the command (is running) separately from the IBASIC instrument that issued the command.

To force the IBASIC instrument to wait for the command or program completion, use the IBASIC instrument command PROG:WAIT? instead. The IBASIC instrument will then wait for the IBASIC computer to enter the idle (STOPped) or paused (PAUSe) state. See *Chapter 8 - SCPI Command Reference* for a description of the PROG:WAIT? command.

Communicating with GPIB Devices

For System Controller mode only, the IBASIC computer can communicate with external GPIB devices via the GPIB interface. External GPIB devices can be measurement devices (such as voltmeters or counters); a computer which is compatible with GPIB (such as an HP 9000 Series 200/300 computer) as long as the computer is NOT the System Controller; or one or more Agilent C-size mainframes.

NOTE

In System Controller mode, the Agilent E1406 is always the System Controller, although it may be the Active Controller or Non-Active Controller.

For System Controller mode, the IBASIC computer communicates with external GPIB devices (and the internal disks) via the GPIB interface. Use OUTPUT 7ppss; to send commands to devices and ENTER 7ppss; to return data from devices, where 7 = the (assumed) GPIB interface select code, pp = the device's primary address, and ss = the device's secondary address. Use the ABORT, CLEAR, TRIGGER, etc. commands for other operations. An example follows.

NOTE

See *Synchronizing Instruments/Devices* in this chapter for more examples of controlling external GPIB devices using the IBASIC computer.

Example: Making DCV Measurement with GPIB Device

This program shows one way to use the IBASIC computer to control an Agilent 3457A voltmeter at primary address 22 to make DC voltage measurements.

```
5   !RE-SAVE "ASGNPATH"
10  ASSIGN @Hp3457 to 722          Assign I/O path to Agilent
                                   3457A voltmeter
20  CLEAR @Hp3457                  Clear Agilent 3457A voltmeter
30  OUTPUT @Hp3457;"DCV"           Make Agilent 3457A voltage
                                   measurement
40  ENTER @Hp3457;A                Enter Agilent 3457A
                                   measurement
50  PRINT "3457A Voltage = ";A     Display Agilent 3457A
                                   measurement
60  END
```

A typical return is: `Agilent 3457A Voltage = 1.234674`

Controlling RS-232/422 Peripherals

In System Controller mode (and in Talk/Listen mode), the IBASIC computer can control external RS-232C or RS422 peripherals via an RS-232 or RS-422 interface on an Agilent E1324A Data Communications module (interface select codes 21 through 27) (see Figure 5-4). The internal RS232 interface is used to communicate with the controlling terminal. The steps involved in controlling RS-232/422 peripherals are:

1. Assign the interface to IBASIC
2. Configure the interface for your operation
3. Communicate with peripherals via the interface

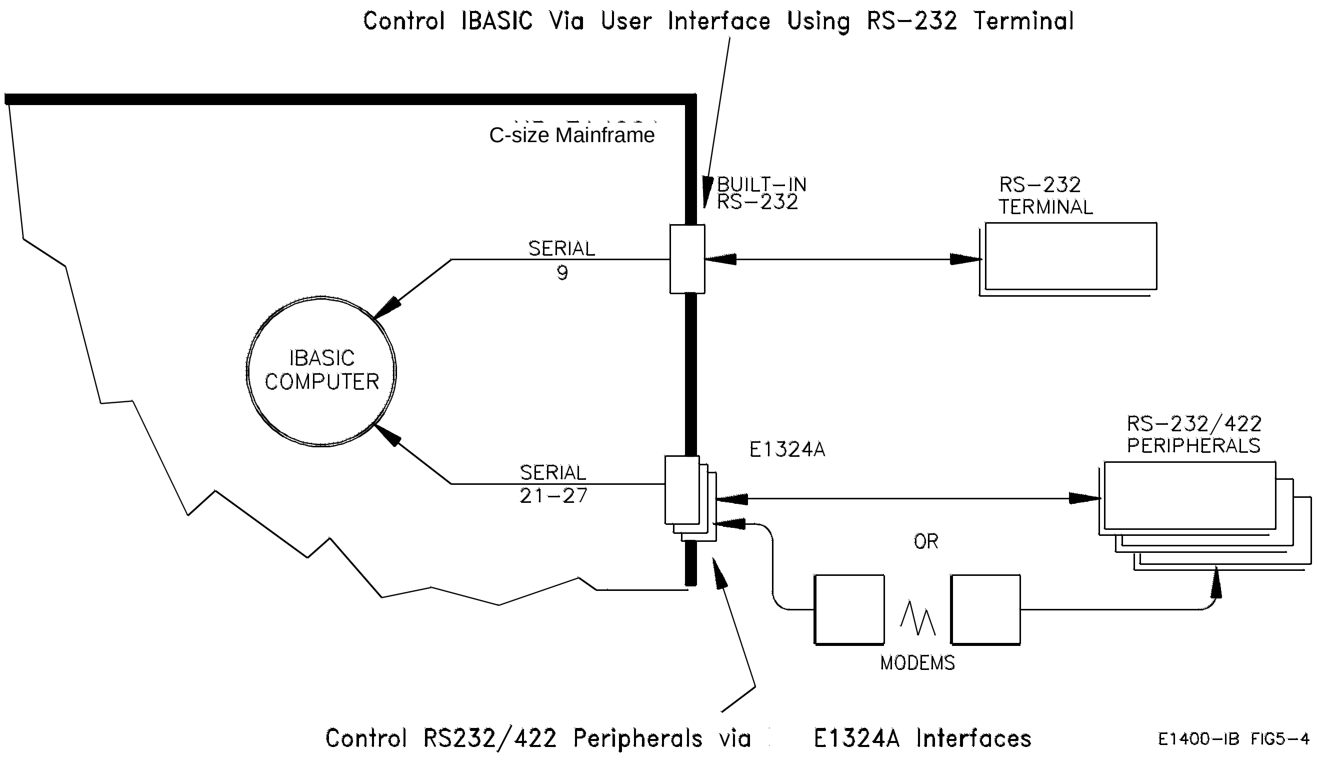


Figure 5-4. Controlling RS-232/422 Peripherals

Assigning the RS-232/422 Interface

For the IBASIC computer to communicate with RS-232/422 peripherals via an Agilent E1324A plug-in serial interface, the interface must first be **assigned** to the IBASIC computer.

Assigning the Built-In Interface

The default assignment for the built-in RS-232 interface is the User Interface (display system). Since there is no other means of controlling the IBASIC compluter unless a terminal is assigned to a Agilent E1324A serial interface, this serial interface should not be used to control other devices.

Assigning Agilent E1324A Interfaces

You assign an Agilent E1324A serial interface to the IBASIC computer by setting the LADD switch on the module to 241, 242, ...,247. Up to seven Agilent E1324A modules can be installed in an Agilent C-size mainframe. The following table shows interface assignments by module number:

Interface Assignments

Module #	LADD	...:SER[n]*	<sc>**
Built-in	None	0	9
1	241	1	21
2	242	2	22
3	243	3	23
4	244	4	24
5	245	5	25
6	246	6	26
7	247	7	27

* = [n] value in SYST:COMM:SER[n]... commands
** = <sc> value in OUTPUT <sc>; and ENTER <sc>;

NOTE See the Agilent 75000 Installation and Getting Started Guide for an explanation of Logical Addressing. See the Agilent 75000 Series B Agilent E1324A RS-232/422 Data Comm Module User's Manual for the LADD switch locations.

When the Agilent E1324A module(s) are assigned to the IBASIC computer, the IBASIC *instrument* and the module(s) form a single instrument. Since the IBASIC instrument has Logical Address (LADD) 240 (secondary address 30), to assign one Agilent E1324A module (module #1) set the module Logical Address to LADD 241. To assign two modules, set module #1 LADD to 241 and set module #2 LADD to 242. For three modules set LADDs 241, 242, 243, etc.

NOTE To enable the new Agilent E1324A port assignments, you must cycle mainframe power after setting the LADD switches. The LADD settings must be sequential starting with 241 (241, 242,...,247). Other LADD combinations, such as 241, 243, ... will result in one or more modules not being assigned to IBASIC.

Configuring the RS-232 Interface

After an RS-232 interface is assigned to IBASIC, you can configure the interface using SYST:COMM:SER[n]... commands. See *Chapter 8 - SCPI Command Reference* for SYST:COMM:SER[n]... command information.

To configure the RS-232 interface, you must direct the configuration commands to the IBASIC instrument using OUTPUT 80930;"SYST:COMM:SER[n]:..." commands, where [n] is the interface number.

Example: Configure RS-232 Interface

This example configures the built-in RS-232 interface and stores the parameters. The parameters are stored in nonvolatile RAM (when using the built-in interface), or an EEPROM on the plug-in interface (when using a plug-in interface). After storing the parameters, the corresponding serial interface is set to these values on power-up.

CAUTION

Card parameters can be changes as often as desired but the EEPROM has a limited number of write cycles (10,000) so the DIAG:COMM:SER[n]:STORE command should not be used excessively when dealing with a plug-in interface.

```
5   !RE-SAVE "SETPARAM"
10   Ib=80930.
        IBASIC instrument  address
20   CLEAR Ib
        Clear input/output  buffers
30   OUTPUT Ib;"*CLS"
        Clear status/error queue
70   OUTPUT Ib;"SYST:COMM:SER1:BAUD 9600"
         Set 9600 baud rate
80   OUTPUT Ib;"SYST:COMM:SER1:BITS   8"
        Set  8 data character bits
90   OUTPUT Ib;"SYST:COMM:SER1:PAR:CHECK OFF"
        Disable receive data parity checks
100   OUTPUT Ib;"SYST:COMM:SER1:PAR:TYPE NONE"
        Incoming data must not include parity bit. No parity  bit
        transmitted.
110   OUTPUT Ib;"SYST:COMM:SER1:SBIT  1"
        Set one stop bit
150   OUTPUT Ib;"SYST:COMM:SER1:TRAN:AUTO ON"
        Links transmit pacing to receive pacing protocol
160   OUTPUT Ib;"SYST:COMM:SER1:PACE XON"
        Enable XON/XOFF pacing
170   OUTPUT Ib;"SYST:COMM:SER1:PACE THR:STOP 6144"
        Set XOFF threshold for 80 characters
180   OUTPUT Ib;"SYST:COMM:SER1:PACE THR:STAR 2048"
        Set XON threshold for 20 characters
220   OUTPUT Ib;"SYST:COMM:SER1:CONT:DTR ON"
         Set  DTR control line ON
230   OUTPUT Ib;"SYST:COMM:SER1:CONT:RTS ON"
        Set RTS control line ON
270   OUTPUT Ib;"DIAG:COMM:SER1:STORE"
        Store in nonvolatile RAM
280   END
```

Communicating via RS-232 Interface

When an RS-232 interface is assigned to IBASIC and the interface is configured for the desired operation, the IBASIC computer can communicate with an external RS-232 peripheral using OUTPUT <*sc*>; and ENTER <*sc*>; statements. Where <*sc*> = 9 for the built-in, or 21 through 27 for the plug-in interfaces.

Example: Control Printer via Agilent E1324A Interface

This program controls an external RS-232 printer at select code 21 using the RS-232 interface on Agilent E1324A module #1. Note that the interface must have been assigned to IBASIC by setting LADD 241 and cycling mainframe power. For this example, the default settings for pacing and modem control lines are used. (See *Serial Interface Commands* for default settings.)

```
5    !RE-SAVE "GET_CAT"
10   Ib=80930.
       IBASIC instrument address
20   CLEAR Ib
       Clear input/output buffers
30   OUTPUT Ib;"*CLS"
       Clear status/error queue
40   OUTPUT Ib;"SYST:COMM:SER1:BAUD 9600"
       Set 9600 baud rate
50   OUTPUT Ib;"SYST:COMM:SER1:BITS 8"
       Set 8 data character bits
60   OUTPUT Ib;"SYST:COMM:SER1:PAR:CHEC OFF"
       Disable receive data parity checks
70   OUTPUT Ib;"SYST:COMM:SER1:PAR:TYPE NONE"
       Incoming data must not include parity bit. No parity bit
       transmitted.
80   OUTPUT Ib;"SYST:COMM:SER1:SBIT 1"
       Set one stop bit
90   PRINTER IS 21
       Direct data output to select code 21
100  PRINT "This line should appear on the printer at"
110  PRINT "select code 21 followed by a CATALOG"
120  PRINT "of the current disk"
130  CAT
140  END
```

Serial Interface Examples

The following example programs demonstrate several ways to use an RS-232 serial interface on an Agilent E1324A plug-in module. These examples assume that an RS-232 terminal is attached to the RS-232 port.

This program demonstrates line oriented ENTER and OUTPUT operations on a serial port.

```
10    ! RE-SAVE "LINE_IO"
20    DIM Line$[80]
30    Serial=921
40    !
50    ! ENTER and OUTPUT lines on Select Code 9.
60    !
70    ! With a Terminal connected to the built-in RS-232 port
80    ! and that port assigned to IBASIC, this program
90    ! demonstrates simple line-by-line I/O using the
100    ! ENTER and OUTPUT statements.
120    ! The program will remain in the ENTER statement appending
130    ! typed characters to the Line$ string until a Line Feed
140    ! character is received signifying an end-of-line.  The
150    ! Line Feed is not placed in the ENTERed string.
160    !
170    ! A Carriage Return immediately followed by a Line Feed
180    ! will be treated as a Line Feed.
200    ! Carriage Return = CNTL-M
210    ! Line Feed       = CNTL-J
220    !
230    ! As you type on the terminal you will not normally see
240    ! any characters being echoed.
250    !
260    ON ERROR GOTO Error_check    ! Set up to trap errors
270    CLEAR Serial        !Clear the receive and transmit buffers
280    I=1                          ! keep a count of lines
290    DISP "Entering lines from the terminal..."
300    LOOP
310      !OUTPUT prompt to terminal, then ENTER response
320      OUTPUT Serial;"Enter a line terminated with LF (CNTL-J):"
330      ENTER Serial;Line$
340      ! Echo the response to the terminal
350      OUTPUT Serial USING "K,X,DDD,3(K)";"Line",I,": '",Line$,"'"
360      ! Continue to LOOP until an error or BREAK is detected
370      I=I+1                      ! increment the line count
380    END LOOP
390    !
400  Error_check:!
410    ! Get the ENTER Status to determine what caused the error.
420    Err=READIO(Serial,4)
```

```
430     BEEP                    ! Signal an error
440     DISP ""                 ! Clear the display line
450     OUTPUT Serial;ERRM$     !Print error message on terminal
460     !
470     ! Look at each bit of the returned status to determine
480     ! which error condition(s) were detected.
500     OUTPUT Serial;"Error(s) detected on Select Code";Serial
510     IF BIT(Err,11) THEN OUTPUT Serial;"  Buffer error"
520     IF BIT(Err,10) THEN OUTPUT Serial;"  Device error"
530     IF BIT(Err,9) THEN OUTPUT Serial;"  BREAK"
540     IF BIT(Err,8) THEN OUTPUT Serial;"  Framing error"
550     IF BIT(Err,7) THEN OUTPUT Serial;"  Parity error"
560     IF BIT(Err,6) THEN OUTPUT Serial;"  Overrun error"
570     OUTPUT Serial;"End of Program"
580     END
```

This program demonstrates serial I/O with ENTER USING to get a single character at a time from a serial port without requiring a Line Feed (or Carriage Return / Line Feed) after each character.

```
10     ! RE-SAVE "CHAR_IO"
20     DIM Char$[1]
30     Serial=921
40     !
50     ! ENTER single characters on Select Code 9.
70     ! With a Terminal connected to the built-in RS-232 port, and the
80     ! port assigned to IBASIC, this program demonstrates entering
90     ! character at a time with ENTER and USING.
120     ! The program will wait in the ENTER for a character to
130     ! be typed on the terminal.  Then it will display the
140     ! character (if it is printable) and the numeric value
150     ! of the received character on the terminal.
170     ON ERROR GOTO Error_check    ! Set up to trap errors
180     CLEAR Serial                 ! Empty receive and transmit buffers
190     DISP "Entering characters from the terminal..."
200     OUTPUT Serial;"Type some characters on the terminal:"
210     LOOP
220       ENTER Serial USING "#,A";Char$
230       Code=NUM(Char$)
240       IF Code>31 AND Code□<127 THEN
250         OUTPUT Serial USING "K,X,DDD,X,3(K)";"Code
=",Code,"""",Char$,""""
260       ELSE
270         OUTPUT Serial USING "K,X,DDD,X,K";"Code
=",Code,"<non-printing>"
280       END IF
290       !Continue to LOOP until an error or BREAK is detected
300     END LOOP
```

```
310    !
320  Error_check:!
330    ! Get the ENTER Status to determine what caused the error.
340    Err=READIO(Serial,4)
350    BEEP                  ! Signal an error
360    DISP ""               ! Clear the display line
370    OUTPUT Serial;ERRM$    !Print error message on terminal
380    !
390    ! Look at each bit of the returned status to determine
400    ! which error condition(s) were detected.
420    OUTPUT Serial;"Error(s) detected on Select Code";Serial
430    IF BIT(Err,11) THEN OUTPUT Serial;"  Buffer error"
440    IF BIT(Err,10) THEN OUTPUT Serial;"  Device error"
450    IF BIT(Err,9) THEN OUTPUT Serial;"  BREAK"
460    IF BIT(Err,8) THEN OUTPUT Serial;"  Framing error"
470    IF BIT(Err,7) THEN OUTPUT Serial;"  Parity error"
480    IF BIT(Err,6) THEN OUTPUT Serial;"  Overrun error"
490    OUTPUT Serial;"End of Program"
500    END
```

This program demonstrates the use of READIO and WRITEIO on the serial interface with ON CYCLE to allow non-blocking I/O. The program will not wait in an I/O statement if no characters are available, but will return to the main program and continue processing. Since the RS-232 interfaces in the Agilent E1406 is buffered at the interrupt level by the operating system, with appropriate protocols set up, This method will allow very flexible serial I/O with no loss of characters.

```
10     ! RE-SAVE "CYCLE_IO"
20     Serial=921
30     CLEAR Serial         !Empty the receive and transmit buffers
40     !
50     ! Demonstrate non-blocking serial I/O using an ON CYCLE
60     ! subroutine to read and echo characters typed on the
70     ! serial interface.  The main loop of this program executes
80     ! repeatedly while every 0.1 seconds the serial interface
90     ! is checked to see if any characters have been received.
100    !
110    OUTPUT Serial;"Typed characters will be echoed..."
120    Quit=0                 ! Initialize the Quit flag
130    ON CYCLE .1 GOSUB Serial_io !Set the ON CYCLE interval
140    LOOP            ! The main program loop
150      FOR I=1 TO 10000
160        DISP "n =";I,"n*n =";I^2
170        IF Quit THEN GOTO Quit_code
180      NEXT I
190    END LOOP
200  Quit_code:!
210    DISP ""
```

```
220    OUTPUT Serial;"End of Program"
230    STOP
240 !
250 Serial_io:!
260   ! This subroutine is executed every ON CYCLE interval.
270   ! It checks to see if any characters have been received
280   ! and then echoes back to the serial interface.  If a
290   ! carriage return is received, a line feed is echoed as
300   ! as well.  If the Escape character is received, the Quit
310   ! variable is set which tells the main program to terminate.
330   !
340   ! Read serial interface status and mask off all but the error bits
360   Status=BINAND(READIO(Serial,3),DVAL("FC0",16))
370   IF Status THEN
380     OUTPUT Serial;""
390     OUTPUT Serial;"Serial card error detected:"
400     OUTPUT Serial;"  Status = ";DVAL$(Status,16);"h"
410     Quit=1                    ! Quit if an error occurred
420     RETURN
430   END IF
440   Cnum=READIO(Serial,1)       ! read a character
450   IF Cnum=-1 THEN RETURN      ! return if no characters
460   !
470   IF Cnum=27 THEN             ! quit if CNTL-Z is typed
480     Quit=1
490     OUTPUT Serial;""          ! force a CR/LF output
500     RETURN
510   END IF
520   ! Echo the received character back to the terminal
530   ! and loop until the WRITEIO of the character succeeds.
540 Write_loop:!
550   WRITEIO Serial,1;Cnum
560   IF (READIO(Serial,2)) THEN GOTO Write_loop
570   !
580   IF Cnum=13 THEN      !Do Line Feed after Carriage Return
590     Cnum=10
600     GOTO Write_loop
610   END IF
611   GOTO Serial_io        ! empty receive buffer before returning
620   RETURN
630   !
640 END
```

Storing/Retrieving Data

This section gives guidelines to store and retrieve data collected from internal instruments, GPIB devices, or RS-232/422 peripherals into IBASIC memory or into mass storage devices (external SS-80 disk or tape drives or RAM volumes).

See *Chapter 4 - Managing IBASIC Files* for information about IBASIC file types. See the *Agilent Instrument BASIC Programming Techniques Manual* for information about directing data flow and the *Agilent Instrument BASIC Interfacing Techniques Manual* for information about using I/O paths.

For System Controller mode, the IBASIC computer can store data collected from internal instruments, external GPIB devices, or external RS-232/422 peripherals (see Figure 5-5). Data can be stored to and retrieved from the IBASIC memory or mass storage devices (external SS-80 disk or tape drives or RAM volumes). **In this chapter we are assuming an external HP 9153 disk drive (hard disk plus floppy disk) at GPIB address 0.**

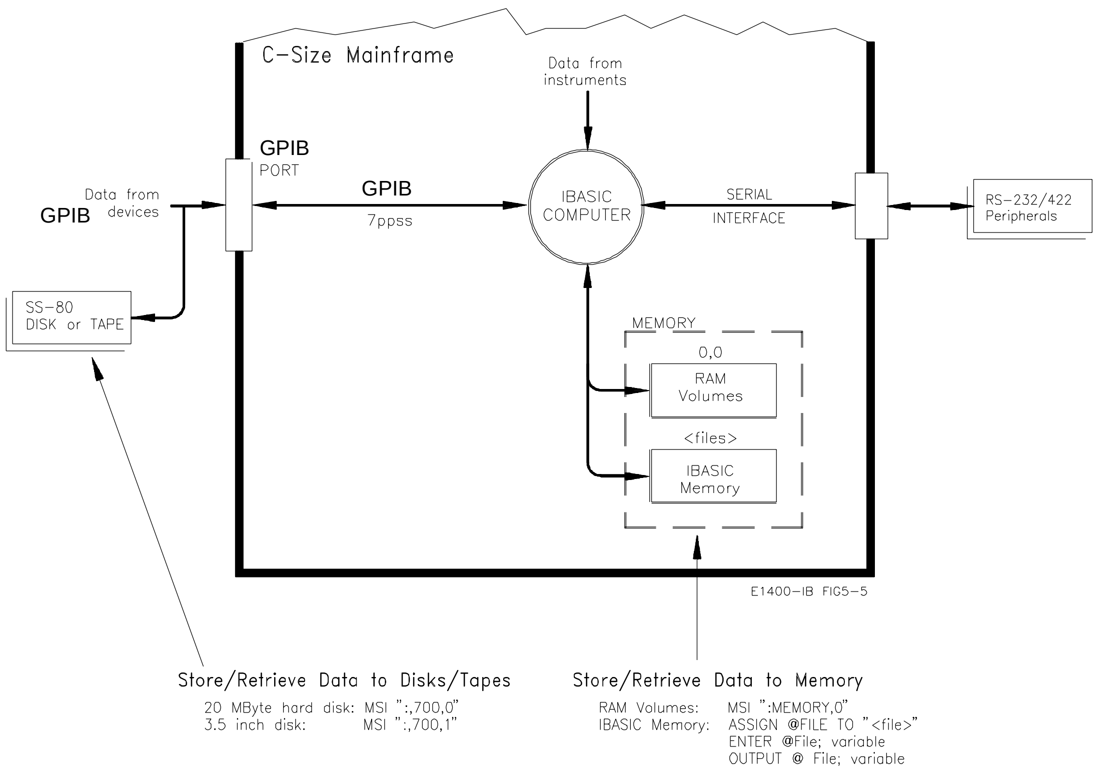


Figure 5-5. Storing/Retrieving Data

Steps to Store Data

There are seven main steps to store data in data files on a disk drive, or in volatile and nonvolatile RAM volumes on the RAM disk
(see Figure 5-6):

(1) Define a file/array in the IBASIC computer
(2) Specify the default mass storage device
(3) Create a data file on the mass storage device
(4) Assign an I/O path name to the data file

(5) Enter data into IBASIC computer variables/arrays
(6) Write the data into the data file
(7) Close the I/O path to the data file

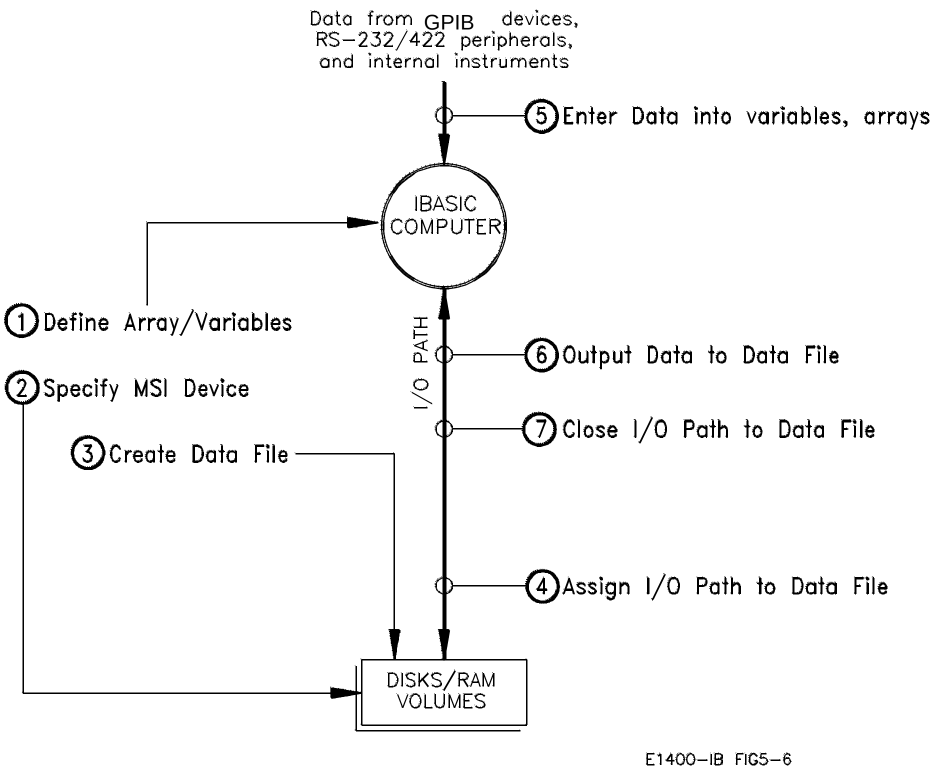

Data from GPIB devices, RS-232/422 peripherals, and internal instruments
5 Enter Data into variables, arrays
IBASIC COMPUTER
1 Define Array/Variables
2 Specify MSI Device
3 Create Data File
I/O PATH
6 Output Data to Data File
7 Close I/O Path to Data File
4 Assign I/O Path to Data File
DISKS/RAM VOLUMES
E1400-IB FIG5-6

Figure 5-6. Steps to Store Data

The following table summarizes typical commands to store data from instruments, GPIB devices, or RS-232/422 peripherals to a disk and to RAM volumes using these seven steps. For IBASIC operation, ASCII, BDAT, and DOS/HP-UX files can be created on mass storage devices. Note that only steps (1) and (5) are required to store data in IBASIC memory.

Storing Data to Disks/RAM Vols

Step	Typical Commands
1 Define Computer variables	REAL Volts Array(1:10)
2 Specify Mass Storage	MSI ":,700,0" (20 MByte hard disk)
	MSI ":,700,1" (3.5 inch disk)
	MSI ":,<unit> <volume>,"
	MSI ":,0,0" - MSI ":,0,16" (RAM vols)
3 Create Data File	CREATE <type> "file_name", size [a]
4 Assign I/O Path	ASSIGN @Path_name TO "file_name"
5 Enter Data into Computer	ENTER 809ss;variable (Instruments)
	ENTER 7ppss;variable (GPIB devices)
	ENTER 9; variable (RS-232)
	ENTER <sc>; variable (Agilent E1324A)[b]
6 Write Data to Data File	OUTPUT @Path_name; variable
7 Close I/O Path to Data File	ASSIGN @Path_name TO *

a <type> can be ASCII, BDAT, or DOS/HP-UX
b <sc> = 21 for Agilent E1324A module #1,..., = 27 for module #7

Storing Data to IBASIC Memory

For System Controller mode, the IBASIC computer can store data from instruments, GPIB devices, and RS-232/422 peripherals into IBASIC memory. An example follows to store data into IBASIC memory (variable space).

Example: Storing Data to IBASIC Memory

This program uses an Agilent E1410A DMM instrument at address 80903 to make 10 DC voltage measurements. The results are stored in IBASIC memory and are then displayed on the terminal.

```
5    !RE-SAVE "STOR_MEM"
10   REAL Dcv_rgs(1:10)                  Create IBASIC computer array
                                         for 10 readings
20   OUTPUT 80903;"CONF:DCV"             Configure DMM for DC
                                         voltage measurements
30   OUTPUT 80903;"TRIG:COUN 10"         Set system for 10 triggers
40   OUTPUT 80903;"INIT"                 Trigger DMM, store the
                                         readings in DMM memory
50   OUTPUT 80903;"FETC?"                Get readings from DMM
                                         memory
60   ENTER 80903;Dcv_rgs(*)              Enter readings into IBASIC
                                         memory
70   PRINT USING "#,K,/";Dcv_rgs (*)     Display readings on terminal
80   END
```

A typical return is:

```
3.245637
3.245385        10 readings
    .
    .
3.244967
```

Storing Data to Disks

For System Controller mode, the IBASIC computer can store data from instruments, GPIB devices, or RS-232/422 peripherals to the 20 MByte hard disk or to the 3.5 inch disk. The disks are specified as the default mass storage device with the MASS STORAGE IS (MSI) address for the disk. Typically, the MSI address for the 20 MByte hard disk is ":,700,0" and the address for the 3.5 inch disk is ":,700,1".

Example: Storing Data to Disk

This program shows a way to store instrument data to a hard disk using the IBASIC computer. As shown in Figure 5-7, an Agilent E1410A DMM at address 80903 (a) makes 10 voltage measurements and (b) sends the results to the IBASIC computer where they are stored in REAL array Dcv in IBASIC memory.

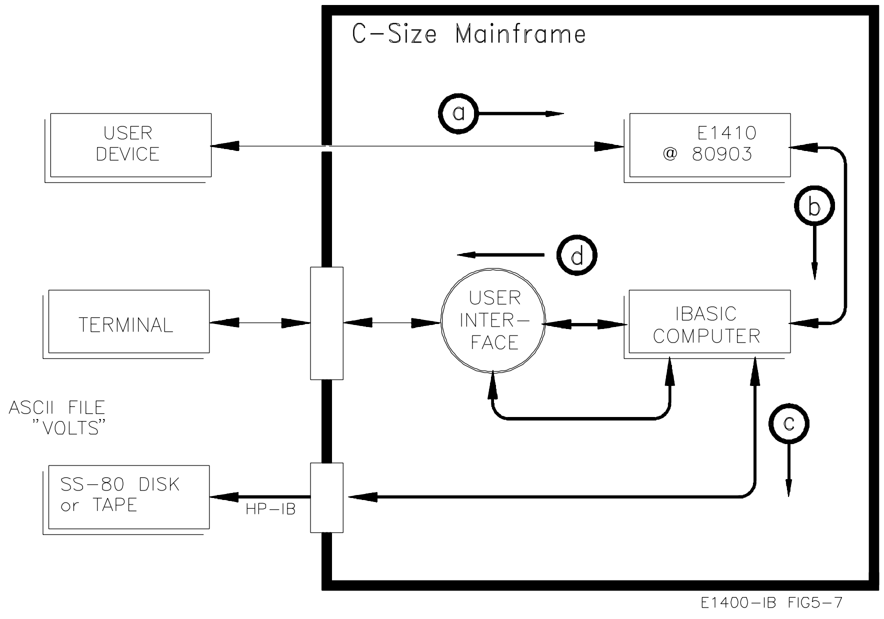


Figure 5-7. Storing Data to Disk

The results are then stored on the hard disk in ASCII data file "Volts" (c) and are retrieved from the data file and displayed on the terminal (d). Note that line 320 (close I/O path) is not necessarily required, since line 360 closes the I/O path and then reopens the path. The ASSIGN statement (line 170) is required to reset the file pointer back to the beginning of the file.

NOTE This program can be used to save data to the 3.5 inch disk by changing line 70 to 70 MASS STORAGE IS ":,700,1". *See Storing Data to RAM Volumes* for information on storing data to RAM volumes.

```
5    !RE-SAVE "STOR_HD"
10   ! Step 1: Define Computer File/Array
20   !
30   REAL Dcv (1:10)
```
Dimension REAL array in IBASIC memory
```
40   !
```

```
50    ! Step 2: Specify MSI Device
70    MASS STORAGE IS ":,700,0"
```
Set 20 MByte hard disk as MSI device
```
80    ON ERROR GOTO Already_Created
```
If ASCII file "Volts" is already created, do not attempt to create data file
```
90    !
100   ! Step 3: Create Data File
120   CREATE ASCII "Volts",10
```
If not already created, create ASCII file "Volts" with length of 10 (256-byte) blocks
```
130   Already_Created:  OFF ERROR     Turn off ERROR message
140   !
150   ! Step 4: Assign I/O Path to Data File
160   !
170   ASSIGN @File TO "Volts";FORMAT ON
```
Assign I/O path to data file "Volts". Use FORMAT ON since ASCII file is specified
```
180   !
190   ! Step 5: Enter Data into Computer File
210   FOR I = 1 to 10                 Begin loop to make 10 DCV
                                      readings
220     OUTPUT 80903;"MEAS:VOLT:DC?"  Make 10 DCV readings
230     ENTER 80903; Dcv(I)           Save reading in IBASIC
                                      computer array Dcv
240   NEXT I                          Increment count
250   !
260   ! Step 6: Output Data to Data File
280   OUTPUT @File;Dcv(*)             Send data to file "Volts"  on
                                      hard disk
290   !
300   ! Step 7: Close I/O Path to Data File
320   ASSIGN @File to *               Close I/O path to file "Volts"
330   !
340   ! Display data on terminal
360   ASSIGN @File TO "Volts";FORMAT ON
```
Reassign I/O path to file "Volts"
```
370   FOR I = 1 to 10                 Loop to transfer 10 readings to
                                      terminal
380   ENTER @File; A(I)               Transfer reading to terminal
390   PRINT USING "#,K,/";A(I)        Display reading on terminal
400   NEXT I                          Increment count
410   END
```

A typical return is:
```
3.245637
3.245385        10 readings
   .
   .
3.244967
```

Storing Data to RAM Volumes

After a RAM volume has been created on the RAM disk, you can store data from instruments, GPIB devices, or RS-232/422 peripherals to data files on RAM volumes. You can create nonvolatile or volatile RAM volume 1 and/or volatile RAM volumes 0 and 2 through 16. See *Chapter 4 - Managing IBASIC Files* for information on creating and using RAM volumes.

Example: Storing Data to RAM Volume

This program shows one way to use the IBASIC computer to store instrument data on (volatile) RAM volume 1 (RAM VOL1). As shown in Figure 5-8, an Agilent E1410A DMM at address 80903 (a) makes 10 DC voltage measurements and sends the results to the IBASIC computer, which are stored in array Dcv in IBASIC memory.

The results are then sent to the RAM disk and stored in DOS data file "Volts_1" on RAM VOL1 (b). The results are then retrieved from "Volts_1" and displayed on the terminal (c). Note that line 330 (close I/O path) is not necessarily required, since line 370 automatically closes the I/O path and then reopens the path.

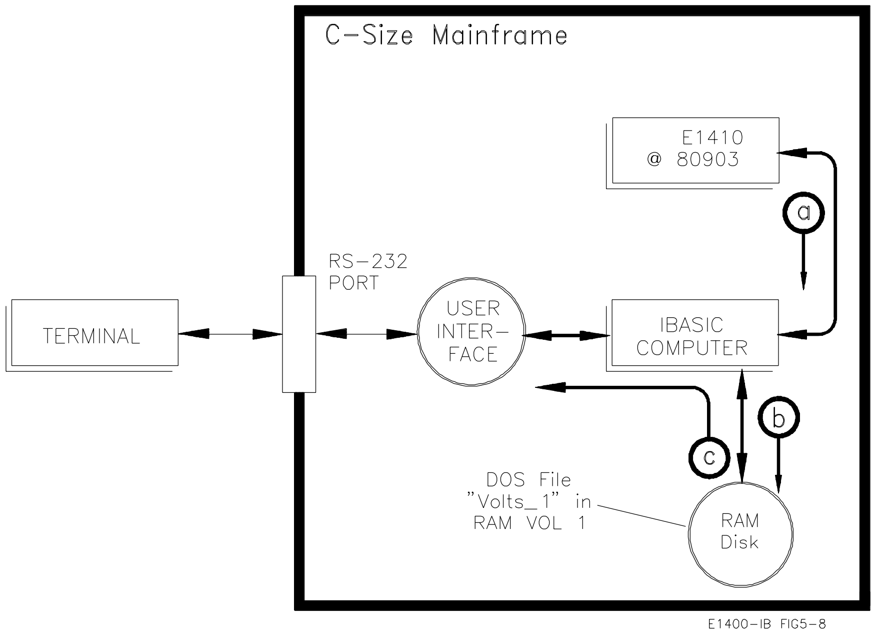


Figure 5-8. Storing Data to a RAM Volume

```
5    !RE-SAVE "STOR_RAM"
10   ! Step 1: Define Computer File/Array
20   !
30   REAL Dcv (1:10)                    Dimension REAL array in
                                        IBASIC memory
40   !
50   ! Step 2: Specify MSI Device
60   !
70   INITIALIZE "DOS:MEMORY,0,1",10Initialize RAM VOL 1 to DOS
                                        format
80   MASS STORAGE IS ":MEMORY,0,1"Set RAM VOL 1 as MSI
                                        device
```

```
90    ON ERROR GOTO Already_Created
```
If DOS file "Volts_1" is already created, do not attempt to create data file
```
100    !
110   ! Step 3: Create Data File
120   !
130   CREATE "Volts_1",1
```
If not already created, create DOS file "Volts_1"
```
140   Already_Created:  OFF ERROR
```
Turn off ERROR message
```
150   !
160   ! Step 4: Assign I/O Path to Data File
170   !
180   ASSIGN @File TO "Volts_1";FORMAT OFF
```
Assign I/O path to data file "Volts_1". Use FORMAT OFF since DOS file is specified.
```
190   !
200   ! Step 5: Enter Data into Computer File
210   !
220   FOR I = 1 to 10
```
Begin loop to make 10 DCV readings
```
230      OUTPUT 80903;"MEAS:VOLT:DC?"
```
Make 10 DCV readings
```
240      ENTER 80903; Dcv(I)
```
Save reading in IBASIC computer array Dcv
```
250   NEXT I
```
Increment count
```
260   !
270   ! Step 6: Output Data to Data File
280   !
290   OUTPUT @File;Dcv(*)
```
Send data to file "Volts_1" on RAM VOL 1
```
300   !
310   ! Step 7: Close I/O Path to Data File
320   !
330   ASSIGN @File to *
```
Close I/O path to "Volts_1"
```
350   ! Display data on terminal
360   !
370   ASSIGN @File TO "Volts_1";FORMAT OFF
```
Reassign I/O path to file "Volts_1"
```
380   FOR I = 1 to 10
```
Loop to transfer readings to terminal
```
390      ENTER @File; A(I)              Transfer reading to terminal
400      PRINT USING "#,K,/";A(I)       Display reading on terminal
410   NEXT I                            Increment count
420   END
```

Enabling Interrupts and Events

This section gives guidelines to:

- Enable instrument interrupts
- Enable GPIB device interrupts
- Enable program branching for events
- Service interrupts and events

Interrupts and Events Overview

For System Controller mode, the IBASIC computer can sense and respond to **interrupts** from instruments via the IBASIC interface or from external GPIB devices via the GPIB interface. (The IBASIC computer does not recognize interrupts from the Serial interfaces.)

The IBASIC computer can also sense and respond to **events** input to the IBASIC computer. Interrupts and events can be used to alert the IBASIC computer to suspend its operation and to determine what service is required (see Figure 5-9).

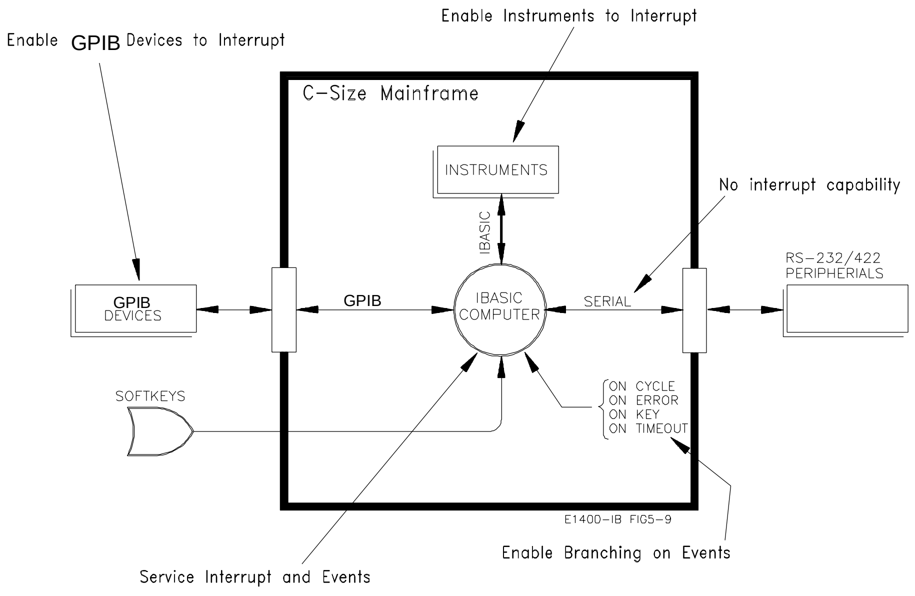


Figure 5-9. Enabling/Servicing Interrupts/Events

Interrupt and Event Types

Events and interrupts can cause the IBASIC computer to branch to a **service routine** when the interrupt or event occurs. This is called **event-initiated branching**. For IBASIC, the commands to enable event-initiated branching are the ON CYCLE, ON ERROR, ON KEY, and ON TIMEOUT event commands and the ON INTR interrupt command.

The following table summarizes the actions resulting from execution of the ON CYCLE, ON INTR, ON ERROR, ON KEY, and ON TIMEOUT commands. For event-initiated branching to occur, interrupts must be *explicitly* enabled, while events are *automatically* enabled when the associated event command is executed.

Command	Type	Initiates Branching When:
ON CYCLE	Event	Specified number of seconds have elapsed
ON ERROR	Event	Trappable error occurs
ON INTR	Interrupt	IBASIC or GPIB interface generates interrupt
ON KEY	Event	Specified terminal softkey is pressed
ON TIMEOUT	Event	I/O timeout on IBASIC, GPIB, or Serial interface

Conditions for Event-Initiated Branches

Four conditions are required for an interrupt or an event to cause the IBASIC computer program to take an event-initiated branch, as shown. In this manual, the term "event-intiated branch" refers to a computer branch taken as a result of an interrupt from the IBASIC or GPIB interface OR as a result of a non-interrupt event, such as an error message or interface timeout.

- Event-initiated branch is defined
- Interrupt or event is enabled
- Interrupt or event occurs and is logged
- Interrupt priority vs. system priority

Event-Initiated Branch is Defined

For interrupts and events, you must define an event-initiated branch with an ON-event-branch statement and create a service routine. A service routine is any legal branch location for the type of branch specified (GOSUB, GOTO, CALL, or RECOVER).

Interrupt or Event is Enabled

Before an event-initiated branch can be initiated by an interrupt from an IBASIC or GPIB interface, the interface must be enabled to interrupt with an ENABLE INTR <*sc*> command. Events are automatically enabled when an ON-event-branch command (such as ON CYCLE or ON ERROR) is executed. For example:

```
ON INTR 8 GOSUB Chk_data
```

Branches to subroutine Chk_data when an interrupt occurs on the IBASIC interface.

```
ON CYCLE 600 CALL Chime
```

Branches to subprogram Chime when the ON CYCLE event occurs (every 10 minutes).

Interrupt or Event Occurs and is Logged

For event-initiated branching to occur, the interrupt or event must occur and be **logged** by the IBASIC system. For example, if an undefined softkey is pressed but the event has not been set up (with ON KEY) to cause an event-initiated branch, there will be no action other than a beep to indicate an error.

Interrupt Priority is Greater than System Priority

The priority for the interrupt or event must be greater than the current system priority as set with SYSTEM PRIORITY. See *Servicing Interrupts and Events* for details on priority.

Enabling Instrument Interrupts

There are four actions required to enable an instrument to generate an interrupt to the IBASIC computer via an IBASIC interface (see Figure 5-10):

- Enable Instrument Standard Events
- Enable Instrument Service Request
- Enable Branching on IBASIC Interrupt
- Enable IBASIC Interface Interrupts

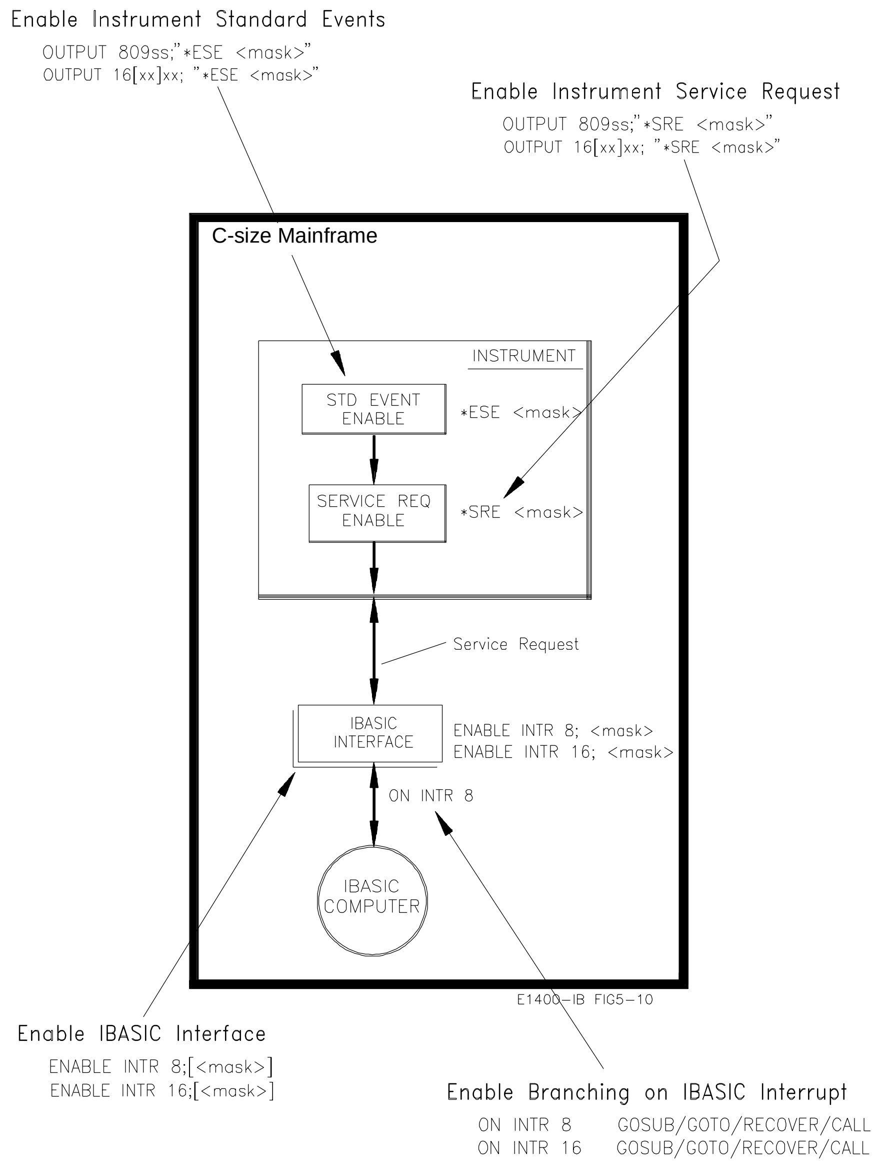

Enable Instrument Standard Events
OUTPUT 809ss;"*ESE <mask>"
OUTPUT 16[xx]xx; "*ESE <mask>"
Enable Instrument Service Request
OUTPUT 809ss;"*SRE <mask>"
OUTPUT 16[xx]xx; "*SRE <mask>"
C-size Mainframe
INSTRUMENT
STD EVENT ENABLE
*ESE <mask>
SERVICE REQ ENABLE
*SRE <mask>
Service Request
IBASIC INTERFACE
ENABLE INTR 8; <mask>
ENABLE INTR 16; <mask>
ON INTR 8
IBASIC COMPUTER
E1400-IB FIG5-10
Enable IBASIC Interface
ENABLE INTR 8;[<mask>]
ENABLE INTR 16;[<mask>]
Enable Branching on IBASIC Interrupt
ON INTR 8 GOSUB/GOTO/RECOVER/CALL
ON INTR 16 GOSUB/GOTO/RECOVER/CALL

Figure 5-10. Enabling Instrument Interrupts

Enabling Instrument Standard Events

The first action to enable instrument interrupts is to enable the Standard Events which can set bit 5 (ESB) of the instrument's Status Byte Register.

Figure 5-11 shows the minimum instrument status register set for an instrument in the mainframe. The Standard Event Status Group consists of a Standard Event register and a Standard Event Enable register.

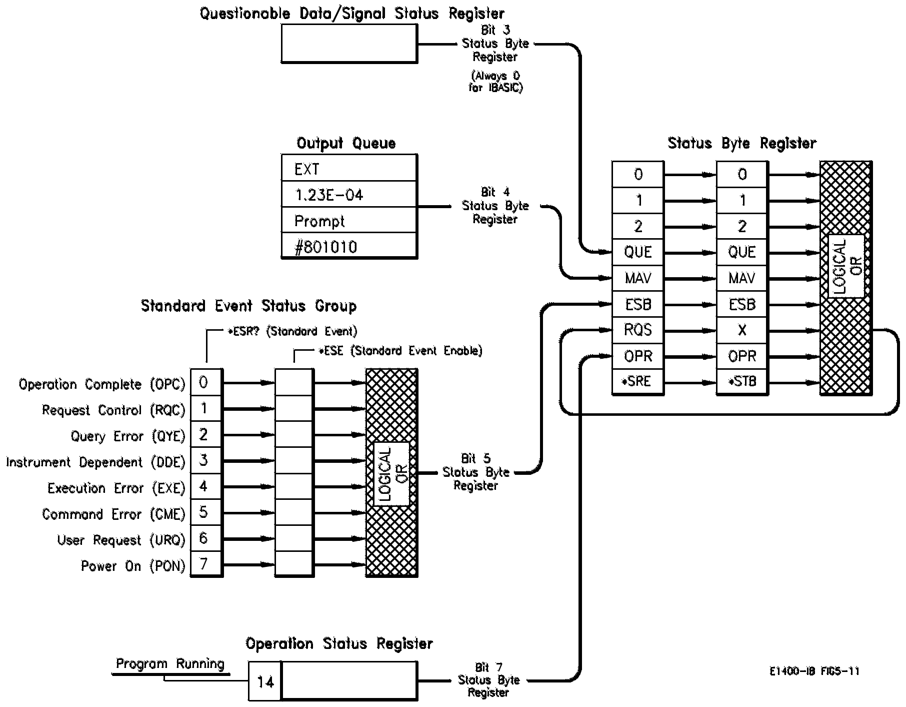


Figure 5-11. Instrument Status Registers

To enable the condition(s) which will set the bit 5 in the Status Byte register, use *ESE <*mask*>. *You can check the conditions currently enabled with the *ESR? command. For example:*

*ESE 1

Enables Operation Complete (OPC) (bit 0)

*ESE 33

Enables the OPC bit and the Command Error (CME) (bit 5) (relative bit weights are 1 and 32).

The following table shows the Standard Event Register conditions for an instrument which are recognized by IBASIC. If one or more bits are enabled (with *ESE) and the Standard Event(s) occurs, bit 5 of the Status Byte register is set.

Instrument Standard Event Status Register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not Used by IBASIC	User Request (URQ)	Command Error (CME)	Execution Error (EXE)	Instrument Dependent (DDE)	Query Error (QYE)	Request Control (RQC)	OperationComplete(OPC)
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Enabling Instrument Service Request

The next step is to enable an Instrument Service Request (SRQ) which is generated from the instrument's Status Byte Register. Use *SRE <*mask*> to enable the condition(s) which will generate an SRQ to the IBASIC interface. The Status Byte register for an instrument follows.

Instrument Status Byte Register

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Operation Status Bit (OPR)	Service Request (RQS)	Standard Event Bit (ESB)	Message Available (MAV)	Always 0			
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

The Questionable Data/Signal Status Register always sends a 0 to the Status Byte Register (bit 3). Only the "Program Running" condition of the Operation Status Register is reflected in the Status Byte Register (bit 7). When an IBASIC program is running, bit 7 is set; when a program is not running, bit 7 is cleared (bit 7 is read-destructive).

Bit 6 (SRQ) is used to generate the SRQ to the IBASIC interrupt. When bits 4, 5, or 7 are enabled AND are set true, bit 6 is set true and generates an SRQ signal to the IBASIC interface. You can enable any combination of bits 4, 5, and 7 on the Status Byte Register. For example:

```
OUTPUT 80903;"*SRE 16"
```

When bit 4 (MAV) of the instrument at secondary address 03 goes true, bit 6 is set and an SRQ is generated to the IBASIC interface.

Enabling Branching on IBASIC Interrupt

When an instrument and an IBASIC interface are enabled to interrupt, the IBASIC computer can be programmed to branch to a service routine when an interrupt is received from the IBASIC interface.

The ON INTR 8, <*priority*> GOTO/GOSUB/RECOVER/CALL command defines an event-initiated branch to be taken when an interrupt is received from the IBASIC interface. The <*priority*> parameter sets the software priority for the interrupt. (See *Software Priority* in this chapter for information on software priority.) For example:

ON INTR 8 GOSUB 500

Branches program to line 500 when an interrupt is received from the IBASIC interface. Software priority is 1 (default)

ON INTR 8,3 CALL Service

Branches program to subprogram Service on IBASIC interface interrupt. Software priority is 3

ON INTR is disabled by DISABLE INTR or DISABLE and deactivated by OFF INTR. When an interrupt occurs on the IBASIC interface, an implicit DISABLE INTR is performed for the interface. Another ENABLE INTR must be performed to re-enable the interface.

Example: Enabling Instrument Interrupts

This example shows a way to interrupt the IBASIC computer after an Agilent E1410A DMM has taken 10 DC voltage measurements.

```
10 ! RE-SAVE "INTR8"
20 COM @E1410
30 ASSIGN @E1410 TO 80904.
40 CLEAR @E1410
```
Get DVM's attention
```
50 OUTPUT @E1410;"*CLS;*RST"
```
Clear status and reset hardware
```
60 WAIT .2
```
Wait for instrument reset
```
70 OUTPUT @E1410;"SAMPLE:COUNT 10"
```
Set number of readings to take
```
80 OUTPUT @E1410;"*ESE 1;*SRE 32"
```
Enable interrupt on operation complete
```
90 ON INTR 8 CALL Service1410
```
Configure routine for interrupt
```
100 ENABLE INTR 8;2
```
Enable SRQ interrupts on Select Code 8
```
110 OUTPUT @E1410;"INIT;*OPC"
```
Initiate measurements and tell instrument to set OPC bit in ESE

```
120 !
130 ! Wait here for interrupts
140 ! to be serviced
150 !
160 LOOP
170 END LOOP
180 END
190 !
200 ! Service Routine for DVM
210 !
220 SUB Service1410
230   COM @E1410
        Have access to instrument address
240   REAL Volts(1:10)
        Configure variable storage
250   OUTPUT @E1410;"FETCH?"
        Request measurement results
260   ENTER @E1410;Volts(*)
        Enter results
270   Stats26=SPOLL(@E1410)
        Clear "SRQ"
280   OUTPUT @E1410;"*ESR?"
        Clear Standard Event Status Register
290   ENTER @E1410;Esr
        Read status
300   FOR I=1 TO 10
310      PRINT "Volts ";I;" = ";Volts(I)
320   NEXT I
330   ENABLE INTR 8
        Re-enable for next interrupt
340   OUTPUT @E1410;"INIT;*OPC"
        Re-start measurement process
350   SUBEND
```

A typical return is:

```
Volts 1 =  -1.052826
Volts 2 =  -.8443604        10 Readings repeat until Basic Reset
      .
      .
Volts 10 = -.367774
```

Enabling IBASIC Interface Interrupts

The IBASIC interface, when enabled, can signal the computer that an instrument interrupt has occurred. Although an instrument is enabled to send an SRQ to the IBASIC interface, the interface must also be enabled to relay the interrupt to the IBASIC computer. Use ENABLE INTR 8;[<*mask*>] or ENABLE INTR 16;[<mask>]to enable the IBASIC interface to signal an interrupt to the IBASIC computer. The register map for the IBASIC interface follows.

IBASIC Interface Registers for Select Codes 8 and 16

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Not Used				End-or-Identify (EOI)	Not Used		
Value= -32768	Value= 16384	Value= 8192	Value= 4096	Value= 2056	Value= 1024	Value= 512	Value= 256
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Not Used						Service Request (SRQ)	Not Used
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

The IBASIC interfaces (select code 8 and 16) only recognize the SRQ (Service Request) bit (bit 1, value = 2) and EOI (End-Or-Identify) bit (bit 11, value = 2048). Thus, to enable an IBASIC interface to generate an interrupt to the IBASIC computer the allowable values are:

```
ENABLE INTR 8;2
```
Enables SRQ interrupts only

```
ENABLE INTR 8;2048
```
Enables EOI interrupts only

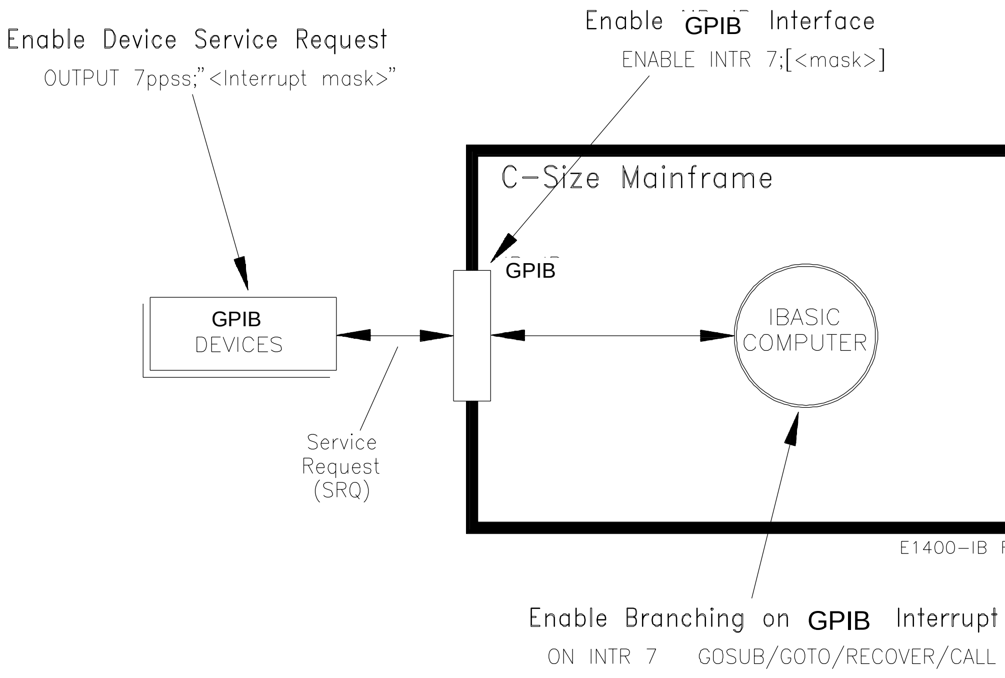
```
ENABLE INTR 16;2050
```
Enables SRQ and EOI interrupts

You can set an IBASIC interface timeout value with the ON TIMEOUT command. With a timeout value, the computer can branch to a service routine when the handshake response from an instrument takes longer than the timeout value. See *Using the ON TIMEOUT Event* in this chapter for details.

Enabling GPIB Device Interrupts

For System Controller mode ONLY, the IBASIC computer can detect and service interrupts from external GPIB devices via the GPIB interface (see Figure 5-12). There are three actions required to enable an interrupt from an external GPIB device via the GPIB interface:

- Enable GPIB Device Service Request
- Enable Branching on GPIB Interface Interrupt
- Enable GPIB Interface Interrupts



Enable Device Service Request
OUTPUT 7ppss;"<Interrupt mask>"
Enable GPIB Interface
ENABLE INTR 7;[<mask>]
C-Size Mainframe
GPIB
GPIB DEVICES
IBASIC COMPUTER
Service Request (SRQ)
E1400-IB FIG5-12
Enable Branching on GPIB Interrupt
ON INTR 7 GOSUB/GOTO/RECOVER/CALL

Figure 5-12. Enabling GPIB Device Interrupts

Enabling GPIB Device Service Request

Most GPIB devices have a Status Byte Register (or equivalent) which can be enabled to send an interrupt signal to the GPIB interface. See the device's user manual for information on enabling the Status Byte register to generate an interrupt signal to the GPIB interface.

Enabling Branching on GPIB Interrupt

When an GPIB device and the GPIB interface are enabled to interrupt, the IBASIC computer can be programmed to branch to a service routine when an interrupt is received from the GPIB interface. The ON INTR <*sc*>, <*priority*>GOTO/GOSUB/RECOVER/CALL command defines an event-initiated branch to be taken when an interrupt is received from the GPIB interface.

The <*priority*> parameter sets the software priority (from 1 to 15) for the interrupt. See *Software Priority* in this chapter for information on software priorities. ON INTR is disabled by DISABLE INTR or DISABLE and deactivated by OFF INTR.

NOTE

The software priority setting can affect the actions for ON INTR interrupts. See *Software Priority* for details.

For example:

```
ON INTR 7 GOSUB 500
```

Branches program to line 500 when an interrupt is received from the GPIB interface (select code 7) (software priority 1)

```
ON INTR 7,3 CALL Service
```

Branches program to subprogram Service on GPIB interface interrupt (select code 7) (software priority 3)

Enabling GPIB Interface Interrupts

The GPIB interface Service Request (SRQ), when enabled, generates an interrupt request to the IBASIC computer. As shown in Figure 5-13, there are two types of interrupts: the **service request** (SRQ) which originates at the GPIB device, and the **hardware interrupt** which indicates a specific condition at the interface.

To enable an external GPIB device to interrupt the IBASIC computer, the GPIB interface must be enabled with an ENABLE INTR <*sc*>;[<*mask*>] command. The following table defines the events that can cause the GPIB interface to generate an interrupt signal to the IBASIC computer.

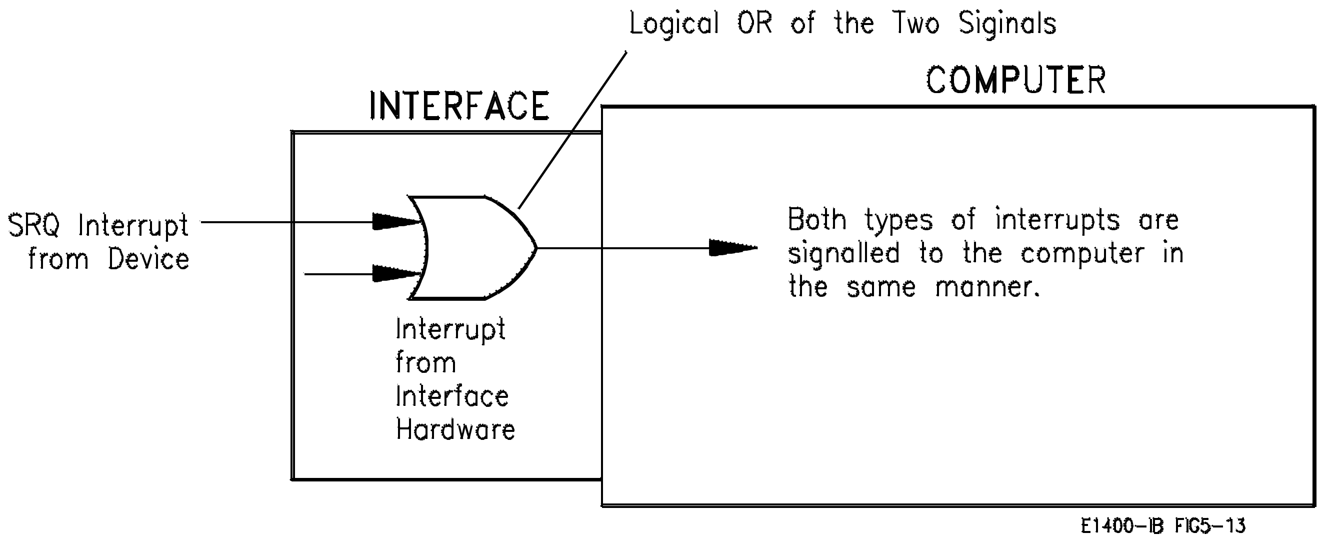

Logical OR of the Two Siginals
COMPUTER
INTERFACE
SRQ Interrupt from Device
Both types of interrupts are signalled to the computer in the same manner.
Interrupt from Interface Hardware
E1400-IB FIG5-13

Figure 5-13. GPIB Interface Interrupts

GPIB Status Register 4 Interrupt Status

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Active Controller	Parallel Poll Con- figuration Change	My Talk Address Received	My Listen Address Received	EOI Received	SPAS	Remote/ Local Change	Talker/ Listener Address Change
Value=-32768	Value=16384	Value=8192	Value=4096	Value=2056	Value=1024	Value=512	Value=256
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Trigger Received	Hand- shake Error	Unrecog- nized Universal Command	Secondary Command While Addressed	Clear Received	Unrecog- nized Addressed Command	SRQ Received	IFC* Received
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

* Since the Agilent E1406 is always System Controller, this bit will never cause an interrupt

Example: Branching on GPIB Interrupt

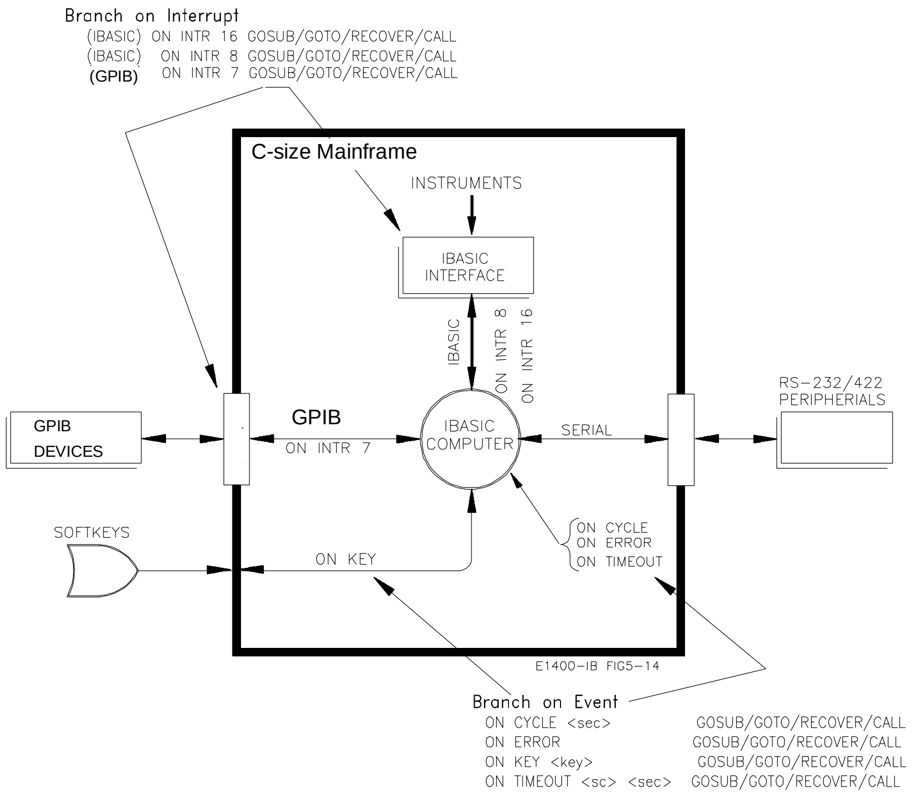
This program shows a way to enable branching to a service routine on interrupt from an Agilent 3456A DVM.

```
10 ! RE-SAVE "INTR7"
20 REAL Reading
30 ASSIGN @Hp3456 TO 722              Assign address
40 CLEAR @Hp3456                      Clear state of DVM
50 OUTPUT @Hp3456;"SM104T4"
       Interrupt on measurement complete
60 ON INTR 7 GOSUB Get_reading
       Configure for service branching
70 ENABLE INTR 7;2                    Enable SRQ interrupt
80 TRIGGER @Hp3456                    Start measurement sequence
90 !
100 ! Loop here and display count and results
110 !
120 LOOP
130    DISP Count_,Reading
140 END LOOP
150 Get_reading:!                     Routine to service interrupt
160   Stats=SPOLL(@Hp3456)            Clear instrument SRQ
170   ENTER @Hp3456;Reading           Read voltage
180   Count_=Count_+1                 Increment counter
190   ENABLE INTR 7
       Re-enable interrupts on interface
200   TRIGGER @Hp3456                 Restart measurement
210 RETURN                            Return to calling program
220 END
```

Enabling Branching on Events

In addition to recognizing and servicing interrupts from the GPIB or IBASIC interface, the IBASIC computer can be enabled to recognize and service **events** when a predefined action occurs. With the ON-event-branch commands, the IBASIC computer can be enabled to branch (event-initiated branching) to a line label, line number, or subprogram when the event occurs.

Figure 5-14 shows the events and interrupts recognized by the IBASIC computer which can initiate computer branching. See *Chapter 7 - IBASIC Command Reference* for additional information on the ON-event-branch commands. See *Enabling Instrument Interrupts* or *Enabling GPIB Device Interrupt* s for information on computer branching on interrupts.



Branch on Interrupt
(IBASIC) ON INTR 16 GOSUB/GOTO/RECOVER/CALL
(IBASIC) ON INTR 8 GOSUB/GOTO/RECOVER/CALL
(GPIB) ON INTR 7 GOSUB/GOTO/RECOVER/CALL
C-size Mainframe
INSTRUMENTS
IBASIC INTERFACE
IBASIC
ON INTR 8
ON INTR 16
RS-232/422 PERIPHERIALS
GPIB DEVICES
GPIB
ON INTR 7
IBASIC COMPUTER
SERIAL
SOFTKEYS
ON KEY
ON CYCLE
ON ERROR
ON TIMEOUT
E1400-IB FIG5-14
Branch on Event
ON CYCLE <sec> GOSUB/GOTO/RECOVER/CALL
ON ERROR GOSUB/GOTO/RECOVER/CALL
ON KEY <key> GOSUB/GOTO/RECOVER/CALL
ON TIMEOUT <sc> <sec> GOSUB/GOTO/RECOVER/CALL

Figure 5-14. Interrupts/Events for Program Branching

The following table summarizes the actions resulting from execution of the ON CYCLE, ON ERROR, ON KEY, and ON TIMEOUT commands. Recall that for event-initiated branching to occur, interrupts must be *explicitly* enabled, while events are *automatically* enabled when the associated event command is executed.

Events Recognized by the IBASIC Computer

Event Command	Initiates Progrzam Branching When:
ON CYCLE <seconds>	Specified number of seconds have elapsed
ON ERROR	Trappable error occurs
ON KEY <key selector>	Specified terminal softkey is pressed
ON TIMEOUT <sc>,<seconds>	I/O timeout on IBASIC, GPIB, or Serial Interface

Using the ON CYCLE Event

ON CYCLE <*seconds*>, [<*priority*>] GOTO, GOSUB, RECOVER, or CALL initiates an event-initiated branch each time the specified number of <*seconds*> has elapsed. ON CYCLE is disabled by DISABLE and is deactivated by OFF CYCLE. If the cycle time is so short the computer cannot service it, the interrupt is lost.

NOTE The software priority set can affect the actions for ON CYCLE events. See *Software Priority* for details.

For example:

```
ON CYCLE 1 GOSUB One_sec
```

Transfers program execution to subroutine One_sec each second.

```
ON CYCLE 3600,3 CALL Chime
```

Transfers program execution to subprogram Chime once every hour (priority = 3)

Using the ON ERROR Event

The ON ERROR GOTO, GOSUB, RECOVER, or CALL command defines and enables an event-initiated branch which results from a trappable error. ON ERROR has the highest priority (17) of any event-initiated branch and this priority cannot be changed. ON ERROR can interrupt *any* event-initiated service routine. ON ERROR is deactivated by OFF ERROR, but is not affected by DISABLE.

For example:

```
ON ERROR GOTO 1200
```

Transfers program execution to line 1200 when a trappable error occurs

```
ON  ERROR CALL Report
```

Transfers program execution to subprogram Report when a trappable error occurs

Using the ON KEY Event

The ON KEY <*key selector*> [LABEL <*prompt*>], [<*priority*>] GOTO, GOSUB, RECOVER, or CALL command initiates an event-initiated branch when the specified terminal softkey is pressed.

The valid range for the <*key selector*> parameter is 1-7. The LABEL of any key is bound to the current ON KEY definition, so when a definition is changed or restored the LABEL changes accordingly. ON KEY is disabled by DISABLE, deactivated by OFF KEY, and temporarily deactivated when the program is paused or executing INPUT commands.

NOTE The software priority set can affect the actions for ON KEY events. See *Software Priority* for details.

For example:

ON KEY 1 GOTO 150

Transfers program execution to line 150 when softkey 1 is pressed

ON KEY 5 LABEL "Chime",3 CALL Chime

Transfers program execution to subprogram Chime (priority 3) when softkey 5 is pressed

Using the ON TIMEOUT Event

The ON TIMEOUT < *select code*>, <*seconds*> GOTO, GOSUB, RECOVER, or CALL command initiates an event-initiated branch when an I/O timeout occurs on the IBASIC, GPIB, or Serial interface.

NOTE

The IBASIC computer does not recognize the ON INTR *interrupt* from the Serial interfaces (select codes 9 and 21 - 27), but does recognize the ON TIMEOUT *event* for the Serial interfaces.

Since there is no default system timeout, if ON TIMEOUT is not in effect for the interface an instrument, GPIB device, or RS-232/422 peripheral can cause the program to wait indefinitely.

When ON TIMEOUT is in effect, the specified branch occurs if an INPUT or OUTPUT is active on the interface and the interface has not responded within the number of <*seconds*> specified.

ON TIMEOUT has an effective software priority of 16 which cannot be changed. Timeouts apply to ENTER and OUTPUT statements, and to PRINTER IS devices when they are external. ON TIMEOUT is deactivated by OFF TIMEOUT. DISABLE does not affect ON TIMEOUT.

For example:

ON TIMEOUT 8, 10 GOTO 770

Causes the program to branch to line 770 if the IBASIC interface has not responded within 10 seconds after any I/O statement

ON TIMEOUT 7,5 GOSUB Message

Causes the program to branch to subroutine Message if the GPIB interface has not responded within 5 seconds after any I/O statement

Servicing Events and Interrupts

For event-initiated branching to occur an interrupt or event must occur **and** be logged by the IBASIC system. If an undefined softkey is pressed but the event has not been set up with ON KEY to cause an event-initiated branch, no action (other than a beep to indicate an error) occurs.

When the IBASIC computer receives an interrupt or event which has been set-up, if the computer is enabled to branch (with ON INTR, ON CYCLE, etc.) the event or interrupt will be serviced by the computer. The way interrupts and events are serviced depends on the interrupt or event **software priority** and the service routine **system priority**.

Example: Servicing Interrupts and Events

This program shows a way to service interrupts from an instrument and from an GPIB device using ON CYCLE, ON ERROR, ON KEY, and ON TIMEOUT. It will continuously display a count and voltage. Pressing F1 prints the current MSI catalog and returns to counting. You must do a Basic Reset to exit.

```
10 ! RE-SAVE "EVENTS"
20 ASSIGN @E1410 TO 80904             Assign address of E1410
30 ASSIGN @Hp3456 TO 722              Assign address of Agilent3456
40 CLEAR @E1410                       Get DVM's attention
50 OUTPUT @E1410;"*CLS;*RST"
      Clear status and reset hardware
60 WAIT .2                            Give time for reset
70 ON CYCLE 1 GOSUB Take_reading      Interrupt every 1 second
80 ON KEY 1 LABEL "CAT" GOSUB Cat_ CAT disc on key 1 depression
90 LOOP
100   ON ERROR GOTO Over1             Set for error condition
110   PRINT 1/0                       Force error
120   PAUSE                           If no error, then pause
130  Over1:OFF ERROR                  Turn off error branching
150   ON TIMEOUT 7,.1 GOTO Over2      Enable timeout detection on 7
160   ENTER @Hp3456;Volt
      Request a reading which was not made because it was not
     requested
170   PAUSE                           If reading received, pause
180  Over2:! off timeout 7            Turn off timeout detection
190   DISP Count_,Dcvolt
      Display E1410 reading and count
200 END LOOP
220   Take_reading:                   ON CYCLE routine
230   OUTPUT @E1410;"MEAS:VOLT:DC?"   Request measurement
240   ENTER @E1410;Dcvolt             Read results
250   Count_=Count_+1                 Increment count
260 RETURN                            Return from interrupt
270 Cat_:CAT ":,700"
280 RETURN
290 END
```

Priority Definitions

The interrupt or event **software priority** is the priority assigned to an interrupt or to an event with an ON INTR or ON-event command. The range is 1 through 15, with 15 being the highest software priority. ON TIMEOUT has an effective software priority of 16, while ON ERROR has an effective software priority of 17. The priorities of ON TIMEOUT and ON EVENT cannot be changed.

The service routine **system priority** is the priority of the service routine currently being executed. If no service routine is currently executing, the system priority is 0. If a service routine is currently executing, the system priority is the same as the software priority assigned for the routine. The system priority can be changed with the SYSTEM PRIORITY command. See *Changing System Priority* in this chapter for details.

Software Priority

An interrupt or some events can be assigned a software priority with an ON-event-branch <*priority*> command, where <*priority*> = 1 through 15 with 15 being the highest priority. The following table shows the software priority structure for the IBASIC system

IBASIC Software Priorities for Events and Interrupts

Event/Interrupt	Range	Notes
ON CYCLE	1 - 15	
ON ERROR	17	Highest priority - cannot be changed
ON INTR	1 - 15	
ON KEY	1 - 15	
ON TIMEOUT	16	Priority cannot be changed

Logging Events and Interrupts

To service interrupts or events, the IBASIC computer first **logs** the occurrence of an interrupt or event which is enabled to branch (with ON INTR, ON CYCLE, etc.). Then, the interrupt/event's software priority is checked against the priority of the service routine currently executing (the system priority).

If the system priority is higher than the software priority assigned to the interrupt or event, the interrupt or event will not be serviced until the currently-executing service routine completes.

NOTE IBASIC only services events or interrupts at the end of a line execution.

Example: Servicing Events by IBASIC Computer

For example, consider the following two lines of code, and assume the system priority = 0 (no service routine currently executing).

```
100  ON KEY 1,3 Call Key_1
```

Causes the program to branch to subprogram Key_1 when softkey k1 is pressed and assigns software priority 3 to the event

```
110  ON KEY 2,4 Call Key_2
```

Causes the program to branch to subprogram Key_2 when softkey k2 is pressed, and assigns software priority 4 to this event.

Figure 5-15 shows a typical sequence of actions when softkey k1 is pressed and then softkey k2 is pressed. If k2 is pressed after k1 is pressed, but while Key_1 is executing, Key_1 execution is temporarily interrupted and the Key_2 routine is executed. When Key_2 is finished, Key_1 resumes execution where it was temporarily interrupted. This is because softkey k2 was assigned a higher software priority than k1.

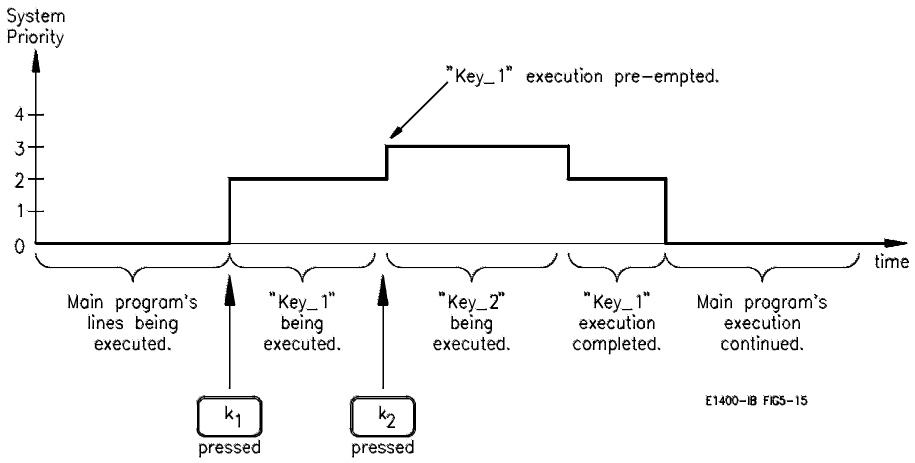


Figure 5-15. Higher Software Priority Takes Precedence

In contrast, Figure 5-16 shows a typical sequence of actions when k1 is pressed after k2 is pressed. In this case, Key_2 finishes execution before executing Key_1. The event of pressing k1 is *logged* but not *serviced* until the routine with higher software priority completes.

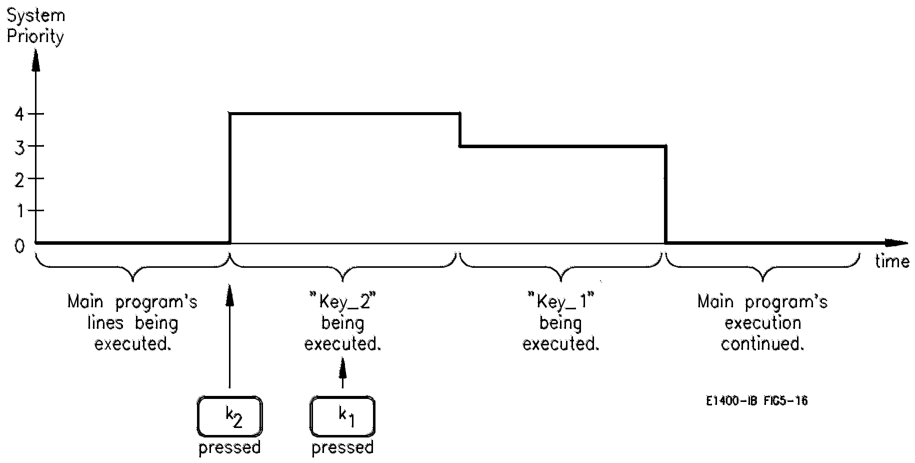


Figure 5-16. Lower Software Priority Event Must Wait

Changing System Priority

The system priority assigned to an executing service routine is set by the software priority of the event or interrupt which caused the branch to the service routine. For example, if an event has software priority 5, the service routine has system priority

5 when it begins execution (the service routine has system priority 0 when not executing).

If you do not want the service routine to be disturbed by events or interrupts of higher software priority you can use the SYSTEM PRIORITY command to set the system priority to a higher level than would normally occur as a result of the computer branch. You can determine the current system priority with SYSTEM$("SYSTEM PRIORITY") which returns a string value from 0 through 15.

Example: Changing System Priority

For this program segment, when KEY 2 (softkey 2, software priority 2) is pressed, the system priority for subroutine Key_2 is set to 2. To ensure that Key_2 operation is not disturbed by pressing KEY 3 (software priority 3), line 370 sets system priority to 3 so that a priority of 4 or greater is required to interrupt the Key_2 routine. When the routine finishes execution, the system priority is lowered to 0.

```
10   ! RE-SAVE "PRIORITY"
20   ON KEY 1 LABEL "ALPHA",1 GOSUB Key_1
```

Pressing Key 1 starts the Key_1 routine, which displays the letters of the alphabet.

```
30   ON KEY 2 LABEL "COUNT",2 GOSUB Key_2
```

Pressing Key 2 starts the Key_2 routine, which counts from 1 to 1000. If the Key_1 routine is running it is interrupted. The Key_1 routine will resume after the Key_2 routine is finished.

```
40   ON KEY 3 LABEL "END",3 GOTO Key_3
```

Exit routine if Key 3 is pressed. If the Key_2 routine is running the exit will not happen until it is finiched.

```
50   LOOP
```

Loop and wait for an interrupt

```
60   WAIT .2
70   A=A+1
80   END LOOP
90   Key_1:!
```

Key_1 routine displays the alphabet

```
100   FOR C=32 TO 64
110      WAIT .1
120      C$=CHR$(C)
130      DISP C$
140   NEXT C
150   RETURN
```

```
160  Key_2:!
```

Key_2 routine counts from 1 to 1000

```
170    SYSTEM PRIORITY 3
180    FOR I=1 TO 1000
190      DISP I
200    NEXT I
210    SYSTEM PRIORITY 0
220  RETURN
230  Key_3:!
```

Key_3 routine exits thre program once the Key_2 routine stops running.

```
240    DISP "End Program"
250  END
```

Servicing Pending Interrupts/Events

If the IBASIC computer is interrupted while executing a program line, all interrupts and events are logged and line execution continues until the line is completely executed or until the line is exited as a result of a user-defined function. When the line is exited, IBASIC begins servicing all pending interrupts/events in the following order.

1. Highest software priority first, lowest software priority last.
2. Events with the same software priority and interface select code (such as softkeys with the same software priority) are serviced in the order they occurred.

Logging of other events/interrupts may still take place when current events/interrupts are being serviced. Thus, events/interrupts of higher hardware priority will interrupt the current activity to be logged.

Events/interrupts which also have higher software priority will interrupt the current activity to be serviced. As a result, events/interrupts of high hardware and software priority can potentially be serviced many times between program lines.

Synchronizing Instrument/Device Operations

This section gives guidelines to use the IBASIC computer in System Controller mode to:

- Control instruments/GPIB devices
- Synchronize instruments/GPIB devices
- Pass control to external computer

Controlling Instruments/GPIB Devices

For System Controller mode, the IBASIC computer can control both internal instruments and external GPIB devices. Use OUTPUT 809ss; and ENTER 809ss; to control instruments via the IBASIC interface, where ss=the instrument's secondary address.

Assuming an GPIB interface select code of 7, use OUTPUT 7ppss; and ENTER 7ppss; statements to control external GPIB devices via the GPIB interface, where pp=the device's primary address and ss=the device's secondary address.   Similar results can be achieved using Select Code 16 and the message based device logical address. The examples in this section will all use Select Code 8.

Example: Controlling Instruments/Devices

This example shows a way to use the IBASIC computer in System Controller mode to control an internal instrument (Agilent E1410A DMM at address 80903) and an external GPIB device (an Agilent 3457A DMM at address 722) to make DC voltage measurements. See Figure 5-17 for typical connections.

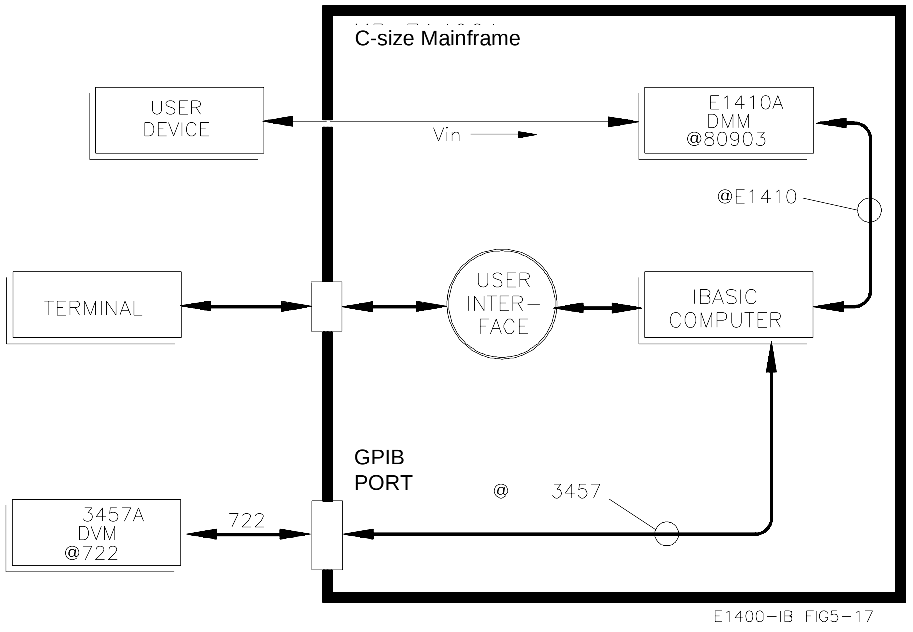


Figure 5-17. Controlling Instrument Devices

```
5    !RE-SAVE "GPIB_INS"
10   ASSIGN @E1410 to 80903
```
Assign I/O path to Agilent E1410A
```
20   ASSIGN @Hp3457 to 722
```
Assign I/O path to Agilent 3457A DMM
```
30   OUTPUT @E1410;"MEAS:VOLT:DC?"
```
Make DCV measurement with Agilent E1410A DVM
```
40   ENTER @E1410;A
```
Enter Agilent E1410A DVM measurement
```
50   PRINT "Agilent E1410A Voltage = ";A
```
Display E1410A measurement
```
60   OUTPUT @Hp3457;"PRESET"
```
Sets Agilent 3457A DVM to DC volts, autoranging, and synchronous trigger. The reading is then automatically triggered by the ENTER: command.
```
70   ENTER @Hp3457;B
```
Triggers and enters Agilent 3457A DVM measurement
```
80   PRINT "Agilent 3457A Voltage = ";B
```
Display Agilent 3457A measurement
```
90   END
```

A typical return is:
```
Agilent E1410A Voltage = 2.343657
Agilent 3457A Voltage = 3.241458
```

Synchronizing Instrument/Device Operations

With System Controller mode, several methods are available to synchronize operations among instruments, GPIB devices, and the IBASIC computer. Four ways to synchronize instruments and devices discussed in this section are to use:

- Agilent E1406 Ports
- The IBASIC computer
- The *OPC? command
- The *OPC command

Synchronization Using Ports

For System Controller mode, the IBASIC computer and the Agilent E1406 TRIG OUT and EVENT IN ports can be used to synchronize operations between instruments and GPIB devices. (See the *E1406A Command Module User's Manual* for an explanation of TRIG OUT and EVENT IN port operations.)

Example: Synchronization Using Ports

This program uses the Agilent E1400 Trig Out and Event In ports to synchronize an external multimeter (Agilent 3457A at address 722) to an internal multimeter (Agilent E1410A and Agilent E1345A multiplexer at address 80914). Since synchronization is independent of the IBASIC computer, readings must be stored in Agilent 3457A reading memory. See Figure 5-18 for typical connections.

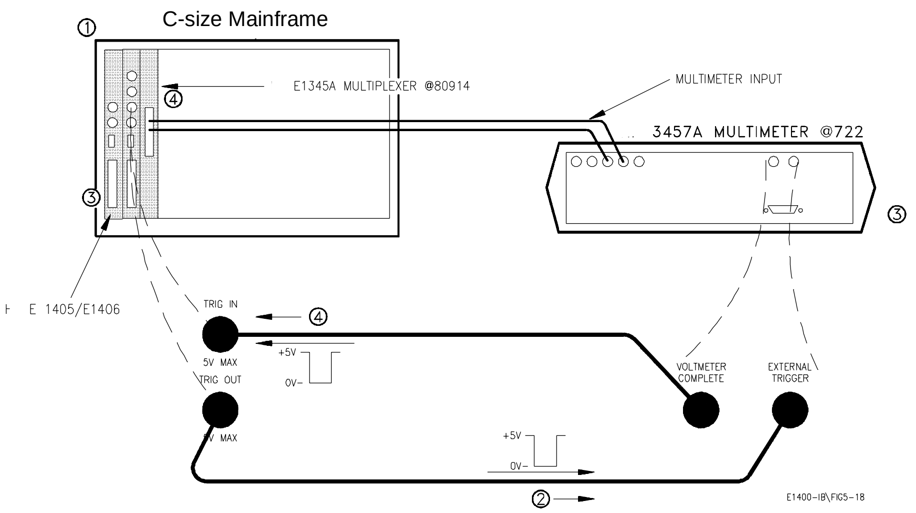


Figure 5-18. Synchronizing Using Ports

The sequence of operation is:

1. INIT (line 50) closes multiplexer channel number 100.
2. Channel 100 closure generates a pulse at the Trig Out port that triggers the multimeter to take a reading.
3. When the reading is complete, the reading is stored in multimeter memory.
4. The multimeter then outputs a pulse from its Voltmeter Complete port to the Event In port on the Agilent E1406. This pulse signals the multiplexer to advance to the next channel in the scan list.
5. Steps (2) - (4) are repeated until all channels have been scanned.

```
10 ! RE-SAVE "PORTSYNC"
20 DIM A(15)
30 CLEAR 722                        Clear GPIB voltmeter
40 OUTPUT 722;"PRESET"              Preset voltmeter to known state
50 OUTPUT 722;"MEM FIFO"
     Set voltmeter memory for first-in first-out operation
60 OUTPUT 722;"TBUFF ON"
     Turn voltmeter trigger buffer ON
70 OUTPUT 722;"TRIG EXT"
     Set voltmeter to look for external trigger
80 OUTPUT 722;"NRDGS 1,AUTO"
     Set number of readings per trigger to one
90 OUTPUT 80914.;"*RST"             Reset multiplexer
```

```
100 OUTPUT 80914.;"OUTP ON"
        Activate trigger output on action complete
110 OUTPUT 80914.;"TRIG:SOUR EXT"
        Set multiplexer trigger source to external
120 OUTPUT 80914.;"SCAN:PORT ABUS"
130 OUTPUT 80914.;"SCAN (@100:115)"
        Set up multiplexer scan
140 OUTPUT 80914.;"*OPC?"
        Ask for operation complete indication
150 ENTER 80914.;B                    Wait for operation complete
160 OUTPUT 80914.;"INIT"              Initiate scanning sequence
170 ENTER 722;A(*)                    Read data array from voltmeter
180 FOR I=0 TO 15
190   PRINT A(I)                      Display data
200 NEXT I
210 END
```

Synchronization Using IBASIC Computer

The IBASIC computer can be used to provide synchronization to instruments or GPIB devices by triggering the instrument or device via the Agilent E1406 TRIG OUT port.

Example: Synchronization Using IBASIC Computer

This program uses the Agilent E1406 Trig Out port to synchronize an external GPIB device (Agilent 3457A DVM at address 722) to an internal instrument (Agilent E1345A multiplexer at address 80914). The IBASIC computer enters each reading and sends a TRIGGER command to advance the multiplexer to the next channel in the scan list. See Figure 5-19 for typical connections.

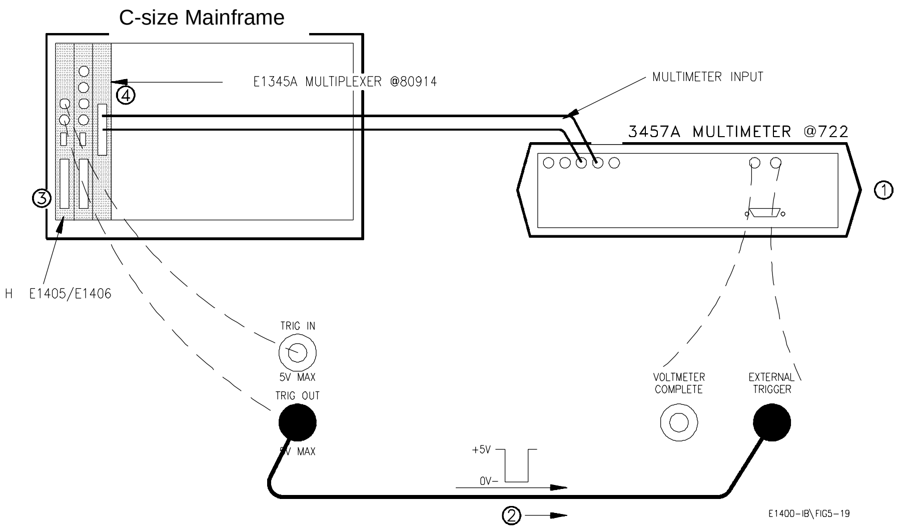


Figure 5-19. Synchronizing Using a Computer

The sequence of operation is:

1. INIT (line 50) closes multiplexer channel number 100.
2. Channel 100 closure causes a pulse on Trig Out port that triggers the multimeter to take a reading.
3. When the reading is complete it is sent to the IBASIC computer (line 70).
4. The IBASIC computer sends the TRIGGER command (line 90) to the multiplexer, which advances it to the next channel in the scan list.
5. Steps (2) - (4) are repeated until all channels have been scanned and all readings taken.

```
5    !RE-SAVE "COMPSYNC"
10   OUTPUT 722;"TRIG EXT;DCV"
```
Set DVM to external trigger, DC voltage measurements
```
20   OUTPUT 80914;"OUTP ON"
```
Enable TRIG OUT port
```
30   OUTPUT 80914;"TRIG:SOUR BUS"
```
Set multiplexer to advance scan on TRIGGER
```
40   OUTPUT 80914;"SCAN (@100:110)"
```
Specify scan list (channels 100 to 110)
```
50   OUTPUT 80914;"INIT"
```
Close first channel (starts scanning cycle)
```
60   FOR I=1 TO 10
```
Loop 10 times
```
70      ENTER 722;A
```
Enter reading (IBASIC computer waits until reading taken and received)
```
80      PRINT A
```
Display reading on terminal
```
90      TRIGGER 80914
```
Trigger multiplexer to advance to next channel
```
100  NEXT I
```
Increment count
```
110  END
```

Synchronization Using *OPC?

The *OPC? command causes a specified instrument to place an ASCII "1" in the instrument's Output Queue (see Figure 5-11) when all pending operations (such as making voltage measurements or outputting a voltage) are complete.

By requiring the IBASIC computer to read the *OPC? response before continuing program execution, you can provide synchronization between one or more instruments and the IBASIC computer.

Example: Synchronization Using *OPC?

This program uses the *OPC? (operation complete query) command to synchronize operations between two instruments and the IBASIC computer. The example uses an Agilent E1328A D/A Converter module (DAC) at address 80909 and an Agilent E1410A DMM at address 80903.

The application requires the DAC to output a voltage to a device under test (DUT). After the voltage is applied, the DMM measures the response from the DUT. Using the *OPC? command ensures the voltage measurement will be made only *after* the voltage is applied by the DAC. See Figure 5-20 for typical connections.

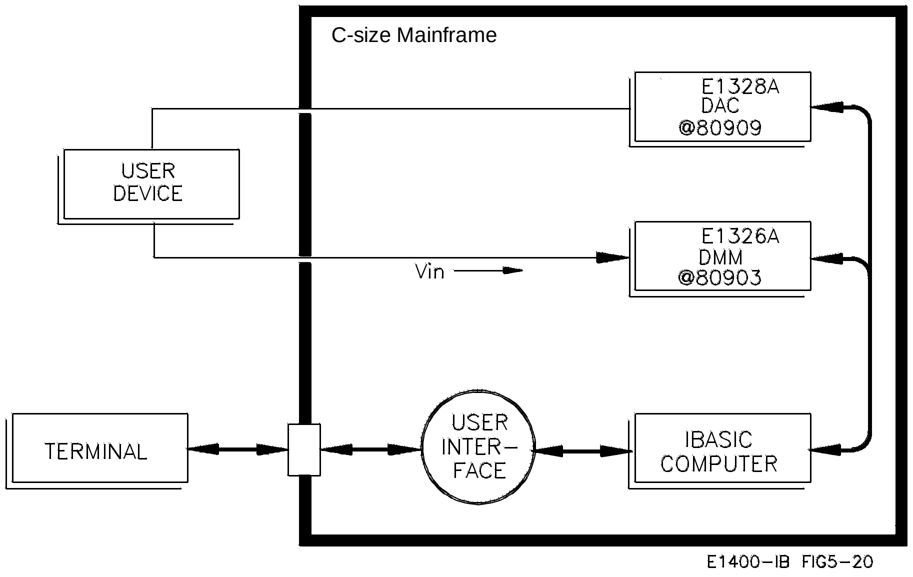


Figure 5-20. Synchronizing Using *OPC?

```
5    !RE-SAVE "OPCSYNC"
10   OUTPUT 80909;"SOUR:VOLT1 5;*OPC?"
```
Configure DAC to output 5V on channel 1. Place a "1" in the DAC's Output Queue when done.

20 ENTER 80909;A	*Wait for *OPC? response from DAC*
30 OUTPUT 80903;"MEAS:VOLT:DC?"	*Measure DC voltage on DUT with DMM*
40 ENTER 80903;A	*Enter DUT voltage reading*
50 PRINT "DUT Voltage =";A	*Display DUT voltage reading*
60 END	

Synchronization Using *OPC

The *OPC command causes the specified instrument to set bit 0 (Operation Complete) in its Standard Event Register (see Figure 5-11) when all pending operations for the instrument are complete.

By enabling the Operation Complete bit in the Standard Event Register (with *ESE 1); bit 5 of the Status Byte Register (with *SRE 32); an IBASIC interface interrupt (with ENABLE INTR 8); and an event-initiated branch (with ON INTR 8), the computer can do other operations while waiting for the interrupt to occur (when instrument operations are complete).

Although either *OPC or *OPC? can be used for synchronization, the advantage of using *OPC is that the computer can do other operations while waiting for the response caused by *OPC. However, when using *OPC the Operation Complete bit (bit 0) in the Standard Event Register must be the only bit enabled. If other bits are also enabled, this method may not work properly.

Example: Synchronization Using *OPC

This example uses an Agilent E1328A D/A Converter module (DAC) at address 80909 and an Agilent E1410A DMM at address 80903. The application requires the DAC to output a voltage to a device under test (DUT). After the voltage is applied, the DMM measures the response from the DUT. See Figure 5-21 for typical connections.

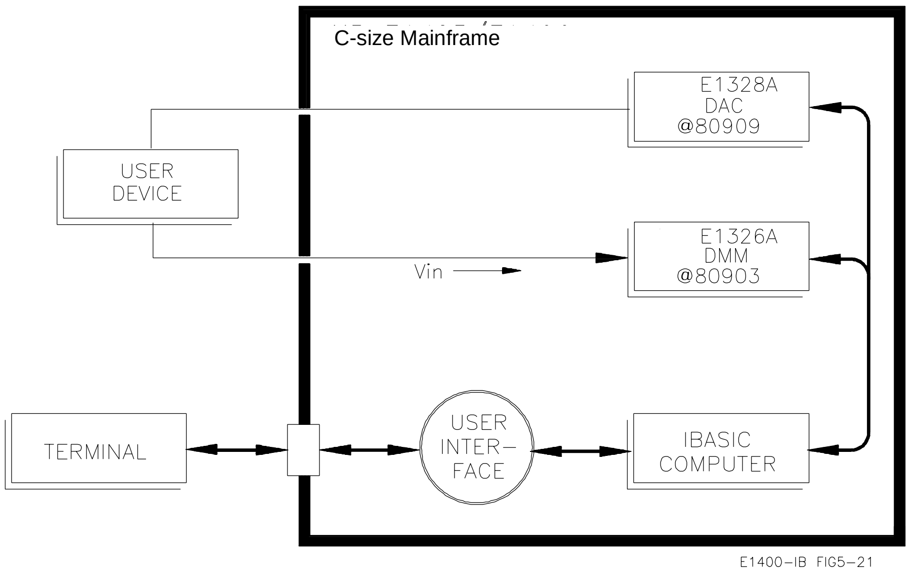


Figure 5-21. Synchronizing Using *OPC

In contrast to the *OPC? example, this program uses the *OPC command to synchronize the IBASIC computer and the two instruments. The advantage of using *OPC rather than *OPC? is the IBASIC computer can do other operations while waiting for the instrument(s) to complete operations.

However, for this method the Operation Complete bit (bit 0) must be the only enabled bit in the Standard Event Status Register (*ESE 1). If other bits (such as error bits) are enabled, this method may not work properly.

```
10   !RE-SAVE "OPCSYNC2"
20   OUTPUT 80909;"*CLS"
```
Clear all status structures on DAC
```
30   OUTPUT 80909;"*ESE 1"
```
Enable Standard Event Register OPC bit (bit 0)
```
40   OUTPUT 80909;"*SRE 32"
```
Enable Status Byte Register ESB bit (bit 5) to send SRQ when DAC completes operations
```
50   OUTPUT 80909;"SOUR:VOLT1 5;*OPC"
```
Configure DAC, set Operation Complete bit when done
```
60   ON INTR 8 GOTO Meas
```
Branch to Meas (line 80) when DAC operations complete
```
70   ENABLE INTR 8;2
```
Enable IBASIC interface to interrupt on SRQ
```
80   LOOP
90   ! (Computer can do other operations here)
100  END LOOP
110 Meas: !
120    OUTPUT 80903;"MEAS:VOLT:DC?"
```
Measure DC voltage with DMM
```
130    PRINT "DUT Voltage =";A
```
Display reading on terminal
```
140   END
```

Passing Control to External Computer

For proper GPIB operation, only one computer on the GPIB can be the System Controller. However, one computer can be the System Controller while another computer is the Active Controller. For System Controller mode only, the IBASIC computer wakes up as the System Controller and the Active Controller.

Thus, for System Controller mode the Active Controller function can be passed from the IBASIC computer to an external computer via the GPIB interface with the PASS CONTROL command. In general, the external computer should not be set for System Controller function when using PASS CONTROL. This permits IBASIC to perform a RESET or ABORT 7 to regain Active Controller function.

Example: Passing Control to External Computer

This example shows a way to use the IBASIC computer as the Active Controller to store data in the external GPIB hard disk and then pass Active Controller function to an external computer so that the data can be transferred to the external computer.

For this program, System Controller mode must be set and the external computer (HP 9000 Series 200/300 computer with GPIB interface 7) should be set for Non-System Controller function. See Figure 5-22 for typical connections.

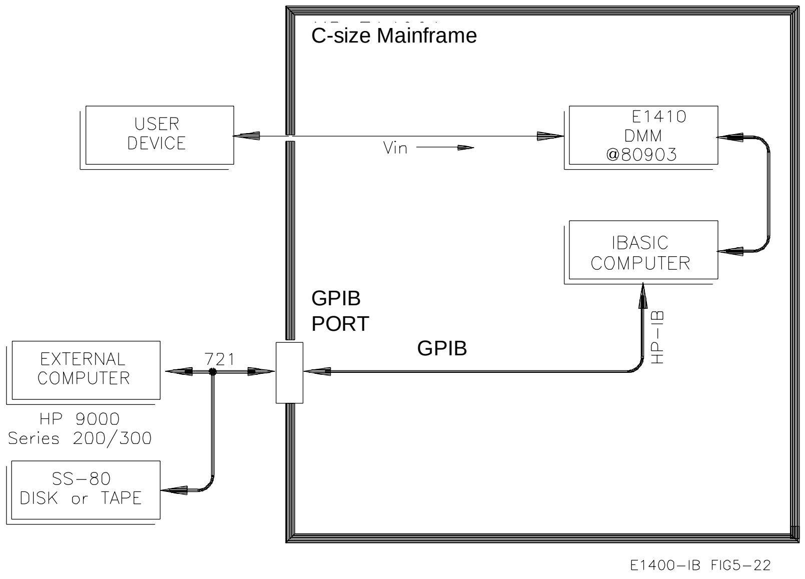


Figure 5-22. Passing Control

Run this program first in the HP 9000 Series 200/300 computer:

```
10   ! RE-SAVE "PASSCTL2"
20   REAL Volts(1:10)                    Create array for readings
30   ON INTR 7 GOTO Have_control
      Set up branch on PASS CONTROL
40   ENABLE INTR 7;-32768.
      Enable detection of PASS CONTROL
50   !
60   ! Wait here until control passed
70   !
80   LOOP
90     DISP "WAITING FOR CONTROL ";Count_
100     Count_=Count_+1
110   END LOOP
120 Have_control:OFF INTR 7             Deactivate interrupt
130   ASSIGN @File TO "DATA1:,700"      Set up path to file
140   ASSIGN @Comp709 TO 709
      Set up path to Command Module
150   ENTER @File;Volts(*)              Read data from file
160   ASSIGN @File TO *                 Close data file
170   FOR I=1 TO 10                     Print selected results
180     PRINT Volts(I)
190   NEXT I
200   PASS CONTROL @Comp709             Return control
210   DISP "DONE"
220   END
```

Run this program second in the IBASIC computer:

```
10 ! RE-SAVE "PASSCTL1"
20 REAL Volts(1:10)                    Create array for readings
30 ON ERROR GOTO Already_there         If already created then skip
40 CREATE BDAT "DATA1:,700,0",50       Create data file
50 Already_there:!
60 ASSIGN @File TO "DATA1:,700,0"      Set up path to file
70 ASSIGN @E1410 TO 80903.             Set up path to DVM
80 ASSIGN @Comp721 TO 721
      Set up path to HP Series 200/300
90 CLEAR @E1410                        Get the DVM's attention
100 OUTPUT @E1410;"*CLS;*RST"
      Clear its status and reset hardware
110 WAIT .2                            Give it time to reset
120 OUTPUT @E1410;"SAMPLE:COUNT 10"
      Configure for 100 measurements
130 OUTPUT @E1410;"INIT;:FETCH?"
      Initiate and retrieve measurements
140 ENTER @E1410;Volts(*)              Read measurements in array
150 OUTPUT @File;Volts(*)              Store measurements to file
160 ASSIGN @File TO *                  Close file
170 ON INTR 7 GOTO Active_control
      Set up branch for PASS CONTROL
180 ENABLE INTR 7;-32768.
      Enable detection of PASS CONTROL
190 PASS CONTROL @Comp721
      Pass control to HP Series 200/300
200 !
210 ! Wait until other computer passes control back
230 LOOP
240   DISP "WAITING FOR CONTROL ";Count_
250   Count_=Count_+1
260 END LOOP
270 !
280 Active_control:OFF INTR 7          Deactivate interrupt
290 DISP "CONTROL RETURNED"
300 ASSIGN @File TO "DATA1:,700,0""          Set up path to file
310 ENTER @File;Volts(*)               Read data from file into array
320 ASSIGN @File TO *                  Close file
330 FOR I=1 TO 10                      Print selected results
340   PRINT Volts(I)
350 NEXT I
360 DISP "DONE"
370 END
```

Chapter 6 Contents

Chapter 6

Talk/Listen Mode Operation

Using This Chapter

This chapter gives guidelines to use Talk/Listen mode operation to:

- Use PROGram commands
- Control instruments
- Control RS-232/422 peripherals
- Store/retrieve data to memory
- Enable instrument interrupts and events
- Synchronize instrument operations

NOTES

This chapter does not show how to use an external computer to control external GPIB devices. See your computer manual for these applications.

All example programs in this chapter are written for an HP 9000 Series 200/300 (or equivalent) computer. If you use a different computer, see your computer manual for possible syntax differences.

In this chapter, the term "external computer" means any computer which is compatible with GPIB operation, such as an HP 9000 Series 200/300 computer or equivalent. The term "GPIB computer" also refers to the external computer.

Talk/Listen Mode Overview

Figure 6-1 shows typical functions for Talk/Listen mode operation. Talk/Listen mode is very similar to System Controller mode except that System Controller mode allows more IBASIC computer functions.

With Talk/Listen mode you can control instruments using both an external computer via the GPIB interface and the IBASIC computer via the IBASIC interface. However, you cannot access any external GPIB devices (including the disk drives) from the IBASIC computer while in Talk/Listen mode. In System Controller mode an external computer cannot be used for instrument control directly but you can access external GPIB devices (including the disk drives) using the IBASIC computer.

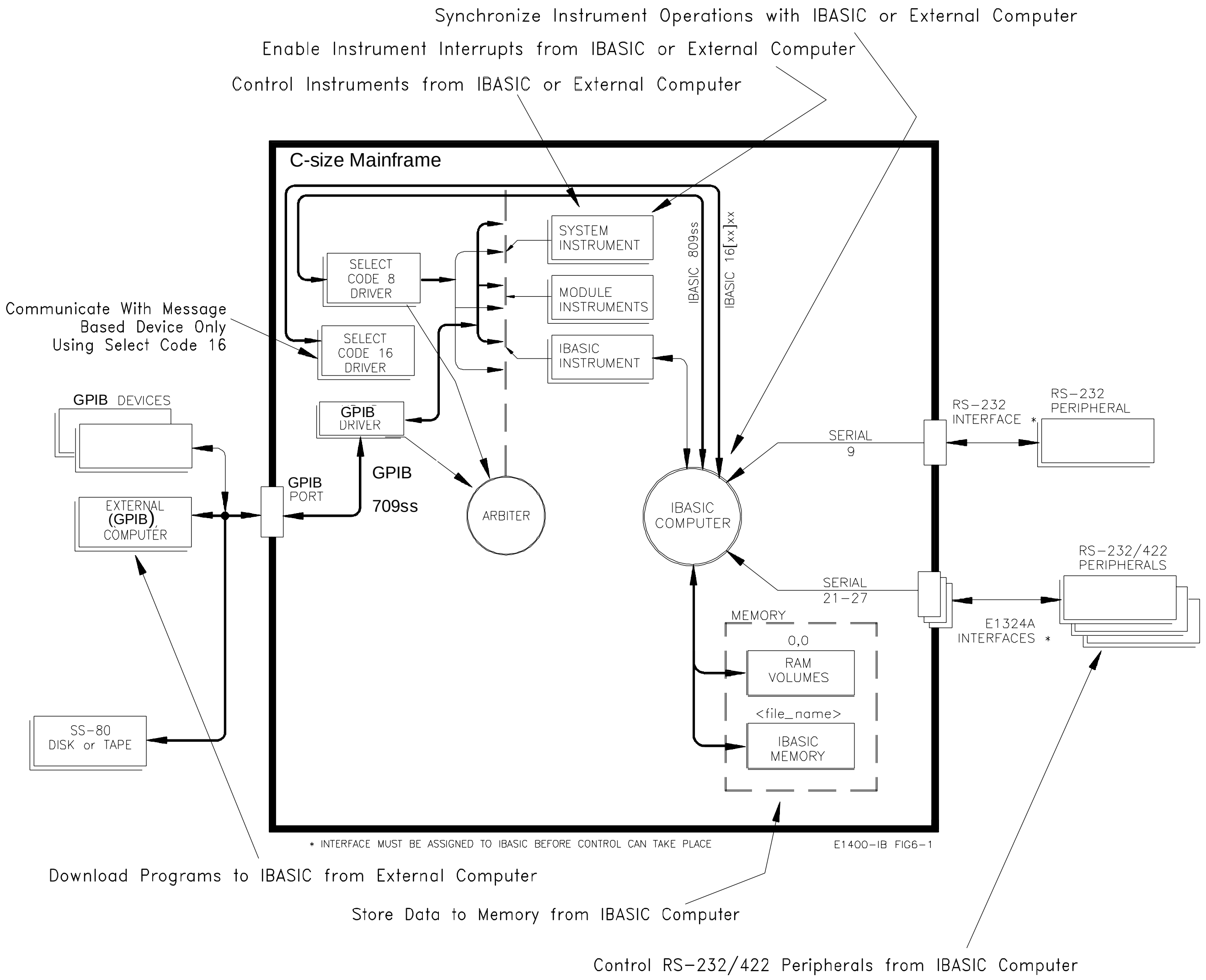

Synchronize Instrument Operations with IBASIC or External Computer
Enable Instrument Interrupts from IBASIC or External Computer
Control Instruments from IBASIC or External Computer
C-size Mainframe
SELECT CODE 8 DRIVER
SYSTEM INSTRUMENT
MODULE INSTRUMENTS
IBASIC INSTRUMENT
IBASIC 809ss
IBASIC 16[xx]xx
Communicate With Message Based Device Only Using Select Code 16
SELECT CODE 16 DRIVER
GPIB DEVICES
GPIB DRIVER
GPIB 709ss
GPIB PORT
ARBITER
IBASIC COMPUTER
EXTERNAL (GPIB) COMPUTER
RS-232 INTERFACE *
RS-232 PERIPHERAL
SERIAL 9
SERIAL 21-27
RS-232/422 PERIPHERALS
E1324A INTERFACES *
MEMORY
0,0
RAM VOLUMES
<file_name>
IBASIC MEMORY
SS-80 DISK or TAPE
* INTERFACE MUST BE ASSIGNED TO IBASIC BEFORE CONTROL CAN TAKE PLACE
E1400-IB FIG6-1
Download Programs to IBASIC from External Computer
Store Data to Memory from IBASIC Computer
Control RS-232/422 Peripherals from IBASIC Computer

Figure 6-1. Talk/Listen Mode Operation

Using PROGram Commands

With Talk/Listen mode, you can create programs on an external computer and download a program to the IBASIC computer. Only one program at a time can be resident in the IBASIC computer. The downloaded program can be queried and controlled using the PROGram subsystem commands.

Controlling Instruments

For Talk/Listen mode, the IBASIC computer or the external computer can control an instrument. At any one time, an instrument can be assigned to the external computer, to the IBASIC computer, or unassigned (not assigned to either).

You can use the ABORT, CLEAR, LOCAL, LOCAL LOCKOUT, REMOTE, SPOLL, and TRIGGER commands to control an assigned instrument's state from the external computer or from the IBASIC computer. (PASS CONTROL is not supported in Talk/Listen mode.)

Controlling RS-232/422 Peripherals

For Talk/Listen mode, when the interface is assigned to IBASIC you can control external RS-232 peripherals via the built-in RS-232 interface or control external RS-232 and RS-422 peripherals via Agilent E1324A plug-in module interfaces.

Storing/Retrieving Data

For Talk/Listen mode, the IBASIC computer can store/retrieve data to IBASIC memory and to RAM volumes, but not to the 20 MByte hard disk or the 3.5 inch disk.

Enabling Interrupts and Events

For Talk/Listen mode, the IBASIC computer can detect and service interrupts from the IBASIC interfaces and from defined events, but not from external GPIB devices.

Synchronizing Instrument Operations

For Talk/Listen mode, the IBASIC computer can synchronize operations between instruments, but not between instruments and external GPIB devices. You can also synchronize instruments operations using both the IBASIC computer and an external computer.

Using PROGram Commands

With Talk/Listen mode, you can download a program created on an external computer (HP 9000 Series 200/300 or equivalent) to the IBASIC computer and control/query the downloaded program using the PROGram subsystem commands. Only one program at a time can be downloaded to the IBASIC computer. Figure 6-2 shows the main functions and associated PROGram subsystem commands to download and control/query IBASIC programs.

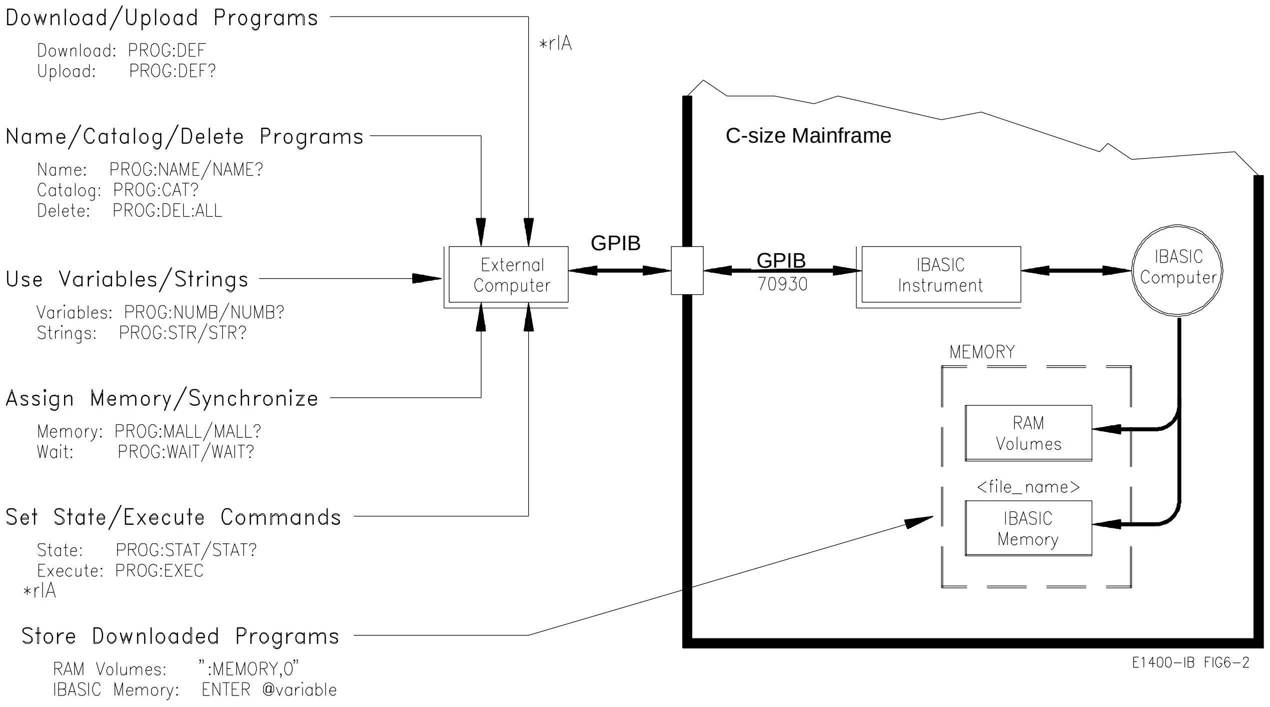


Figure 6-2. Using PROGram Subsystem Commands

Downloading and Uploading IBASIC Programs

Programs created on an HP 9000 Series 200/300 (or equivalent) computer can be downloaded to the IBASIC computer using PROGram:DEFine commands and can be uploaded from the IBASIC computer using the PROGram:DEFine? command.

The path to download programs is from the external computer to the IBASIC instrument (address 70930) via the GPIB interface. The IBASIC instrument accepts the program lines from the external computer and sends the "shell" IBASIC program to the IBASIC computer.

Downloading Programs

Program lines are downloaded to the IBASIC computer using **indefinite length block parameters**. For indefinite length block data, END must immediately follow the last byte of block data to force termination of the program message.

For example, OUTPUT @IBASIC;"PROG:DEF #0" indicates that the program lines which follow are to be sent in indefinite block parameter format. Thus, an END statement is required after the last line of the program to be downloaded.

Example: Downloading Program Lines to IBASIC Computer

This program shows one way to download program lines to the IBASIC computer from an HP 9000 Series 300 computer. The actual program to be stored in the IBASIC computer (downloaded in lines 140 to 170) is:

```
10   FOR I = 1 TO 100
20       PRINT I
30   NEXT I
40   END
```

The program listing is:

```
90   !RE-SAVE "DOWNLD1"
100  ASSIGN @IBASIC to 70930
```
Assign I/O path to IBASIC instrument from GPIB computer
```
110  CLEAR @IBASIC
```
Clear IBASIC instrument
```
120  OUTPUT @IBASIC;"*RST;*CLS;PROG:DEL:ALL"
```
Reset IBASIC instrument, and delete any downloaded program
```
130  OUTPUT @IBASIC;"PROG:DEF #0"
```
Program lines to be downloaded in indefinite length block format
```
140  OUTPUT @IBASIC;"  10  FOR I = 1 TO 100"
```
First line of downloaded program
```
150  OUTPUT @IBASIC;"  20      PRINT I"
160  OUTPUT @IBASIC;"  30  NEXT I"
170  OUTPUT @IBASIC;"  40  END" END
```
Last line of downloaded program with EOI asserted
```
180  END
```

NOTE This program only downloads the code to the IBASIC computer. You must run the program from the IBASIC computer.

Example: Downloading Previously Stored Programs

The previous downloading program example is acceptable for a small program. However, for a large program or one which has been previously stored, typing the line entries may be cumbersome or time-consuming. This example shows a way to download the same previously-stored program from an HP 9000 Series 300 computer to the IBASIC computer.

The file (called *DOWNLD3* in the program) is assumed to be stored on floppy disk. To use this program, substitute the file name you want to download in place of *DOWNLD3* in line 30.

In the program, lines 10 through 40 dimension an array and assign I/O paths, while lines 80 through 100 configure the IBASIC instrument to accept the program to be downloaded (downloading format is indefinite length block parameter).

Lines 110 through 150 takes one program line at a time from *DOWNLD3* and sends it to the IBASIC computer, until all program lines are transferred, and the program then goes to Done. Line 210 lists the downloaded program lines on the IBASIC display, line 220 runs the program, and line 230 closes the I/O path to *DOWNLD3*.

```
5     !RE-SAVE "DOWNLD4"
10     DIM In$[160]
```
Dimension array In$ long enough for IBASIC program line
```
20     ASSIGN @IBASIC to 70930.
```
Assign IBASIC instrument to Series 300 computer
```
30     ASSIGN @File TO "DOWNLD3:,700,1";FORMAT ON
```
Assign I/O path to file "DOWNLD3"
```
40     ON END @File GOTO Done
50     !
60     ! Configure IBASIC for downloaded program
80     CLEAR @IBASIC
```
Clear IBASIC instrument
```
90     OUTPUT @IBASIC;"*RST;*CLS;PROG:DEL:ALL"
```
Reset/clear IBASIC instrument, and delete program in IBASIC computer.
```
100    OUTPUT @IBASIC;"PROG:DEF #0"
```
Send program lines in indefinite length block parameter form
```
110    LOOP
120      In$=" "
130      ENTER @File;In$
140      OUTPUT @IBASIC;In$
150    END LOOP
160  Done:  !
170    OUTPUT @IBASIC;"  "  END
```
END required for indefinite length block parameter form
```
180    !
190    ! List and run downloaded program
210    OUTPUT @IBASIC;"PROG:EXEC 'LIST'"
```
Program lists on current display system connected to IBASIC
```
220    OUTPUT @IBASIC;"PROG:STATE RUN"
230    ASSIGN @File TO *
240    END
```

The contents of *DOWNLD3*are:

```
5     !RE-SAVE "DOWNLD3"
10     FOR I = 1 TO 100
20       PRINT I
30     NEXT I
40     END
```

Uploading Programs

To upload a program from the IBASIC computer to an external computer, use OUTPUT 70930;"PROGram:DEFine?" followed by ENTER statements to the external computer. Program lines from downloaded IBASIC programs are uploaded to the external computer in **definite length block response data** format.

Example: Uploading Program Lines

This example uploads the previous 4-line IBASIC program from the IBASIC computer and prints it on the IBASIC display.

```
10   ! RE-SAVE "UPLOAD2"
20   DIM In$[160]                         Allocate for max length line
30   ASSIGN @IBASIC TO 70930.              Set path to IBASIC instrument
40   CLEAR @IBASIC                        Get IBASIC's attention
50   OUTPUT @IBASIC;"PROG:DEF?"  Request program upload
60   !
70   !  Now strip off the Definite Length Block Header
80   !
90   ENTER @IBASIC USING "#,A";Pound$[1,1] Read the #
100  ENTER @IBASIC USING "#,A";Length$[1,1]
110  Length=VAL(Length$[1,1])
120  FOR I=1 TO Length
130     ENTER @IBASIC USING "#,A";N$[I,I]
140  NEXT I
150  !
160  ! The remainder of upload is actual program lines separated
170  ! by CR/LF and terminated with EOI on LF.  Enable interrupt
180  ! on recognizing EOI with last request.
190  !
200  ON INTR 7 GOTO Done                 Enable branch on Interrupt
210  ENABLE INTR 7;2048                  Enable EOI interrupt
220  LOOP                                Loop until EOI received
230    ENTER @IBASIC;In$
240    PRINT In$
250  END LOOP
260 Done:  !
270  END
```

The actual program listing, which must be in the IBASIC computer, is:

```
10   FOR I = 1 TO 10
20     PRINT I
30   NEXT I
40   END
```

Controlling/Querying Programs

In addition to downloading and uploading IBASIC programs, the PROGram subsystem commands can be used to control and query downloaded programs. A summary of the PROGram commands follows. See *Chapter 8 - SCPI Command Reference* for further information on the PROGram subsystem commands.

Naming IBASIC Programs

Only one program can be resident in the IBASIC computer at a time. If desired, you can name the program with PROGram:NAME and return the program name with the PROGram:NAME? command. If a downloaded program has a name, PROGram:NAME? returns the name. If the program is not named or a program is not downloaded, PROGram:NAME? returns "PROG".

Cataloging IBASIC Programs

You can also use the PROGram:CATalog? command to see if a progam already exists. If the program exists, PROGram:CATalog? returns the name. If no program has been created, PROGram:CATalog? returns the null string (""). A program can be created with PROG:DEF# or by typing in any IBASIC command from the Display system connected to IBASIC.

Deleting IBASIC Programs

Use PROGram:DELete:ALL to delete a downloaded IBASIC program from IBASIC memory. A downloaded program in the RUNning state cannot be deleted. Sending PROGram:DELete:ALL when the program is running results in a "PROGRAM CURRENTLY RUNNING" error and the program is not deleted. You can use PROG:STATE STOP to stop the program before sending PROG:DEL:ALL.

Assigning Values to Program Variables

When a variable is defined in a downloaded program, you can assign a value to the variable using PROGram:NUMBer <*varname*>,<*nvalue*> from an external computer. PROGram:NUMBer? will return the current value of the variable. If <varname> is longer than 12 characters, a delimiter (') is required. For example:

```
OUTPUT 70930;"PROG:NUMB B,10"
```

Assigns value 10 to variable B

```
OUTPUT 70930;"PROG:NUMB 'number_devices',1"
```

Assigns value of 1 to number_devices. Delimiter required since variable name is longer than 12 characters.

Set Contents of Program Strings

When a string variable or array is defined in a downloaded program, you can use PROGram:STRing <*varname*>,<*svalue*> to set the contents of the variable or array. You can use PROGram:STRing? to return the current contents of the variable or array. For example:

```
OUTPUT 70930;"PROG:STR B, 'B = Result'"
```

String assigned to variable B$ is 'B = Result'

Assigning IBASIC Memory Space

If required, you can use PROGram:MALLocate <*nbytes*>|*DEFault* to reserve IBASIC memory space for subroutine stack space and variables other than COM variables. When *DEFault* is specified, the Agilent E1406 calculates the amount of space required. You can use PROGram:MALLocate? to return the amount of space currently allocated, when the IBASIC program is STOPped .

Using Program Wait

PROGram:WAIT and PROG:WAIT? cause the IBASIC instrument to wait until the current operation is complete before executing the next command. For example:

```
10    OUTPUT 70930;"PROG:DEF #0" END
```

Defines a zero-length program so commands can be sent to the IBASIC computer

```
20    OUTPUT 70930;"PROG:EXEC 'WAIT 5';WAIT?"
```

Wait 5 seconds, then WAIT? returns a "1"

```
30    ENTER 70930;Value
```

Returns 1 to indicate end of WAIT time

NOTE Using *WAI or *OPC? for this example will not work, since *WAI or *OPC? will not wait for the IBASIC computer to finish its command, but will only wait for the IBASIC instrument to read and send the command.

Setting SRQ at Program End

On occation you may wish to generate an SRQ (Service ReQuest) when a program ends, so that you can continue with another routine, notify the operator, etc. The following program segment should be run from the external computer after you have downloaded a program to the IBASIC controller, and will accomplish this:

```
!Download the program you wish to run to the IBASIC controller

!Set up the controller to recognize SRQ. This program would be
100  OUTPUT @IBAS; "*ESE 1;*SRE 32"
```

Set the controller to generate an SRQ on OPC (OPeration Complete)

```
200  OUTPUT @IBAS;"PROG:STATE RUN"
```

Run the program

```
300  OUTPUT @IBAS;"PROG:WAIT;*OPC"
```

Wait for program to end and set OPC

```
!Continue with the rest of your program
```

Setting Program State

PROGram:STATe RUN|PAUSe|STOP|CONTinue sets the state of a downloaded program, and PROGram:STATe? returns the current state of the program. See the PROGram:STATe command in *Chapter 8 - SCPI Command Reference* for the effects of changing program states.

Executing IBASIC Commands

PROGram:EXECute <'*program_command*'> executes the IBASIC command specified. However, PROGram:EXECute 'RUN' will not be executed if a downloaded program is currently running. For example:

```
OUTPUT 70930;"PROG:EXEC: 'LIST'"
```

Lists the program lines of a downloaded program

```
OUTPUT 70930;"PROG:EXEC: 'RUN'"
```

Causes a program not in RUNning state to run

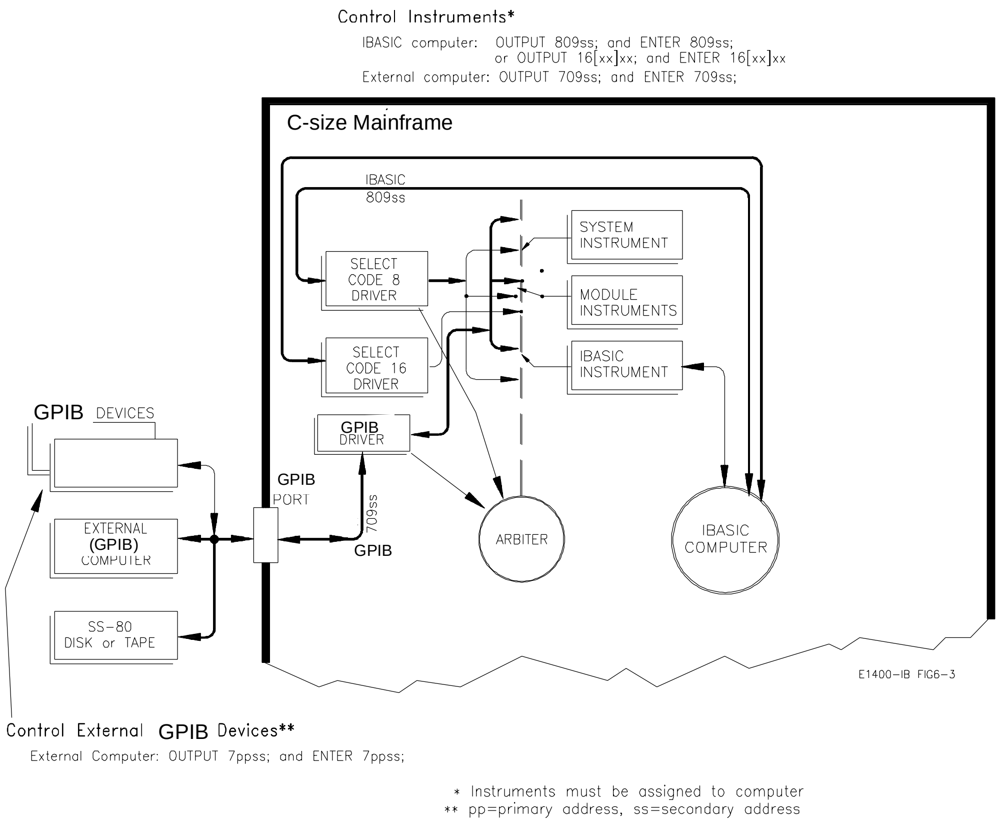
Storing Downloaded Programs

Programs which have been downloaded to the IBASIC computer can be stored in a non-volatile RAM volume and used for autostarting. See *Chapter 2 - Creating and Editing Files* for details.

For Talk/Listen mode, the IBASIC computer cannot address an GPIB disk, so downloaded programs cannot be stored on these disks. The program to be downloaded can be stored in the disks from an external computer, retrieved by the external computer, and then downloaded via the PROGram subsystem commands. See *Chapter 8 - SCPI Command Reference* for information on the PROGram commands.

Controlling Instruments

For Talk/Listen mode, instruments (plug-in module instruments, the System instrument, and the IBASIC instrument) can be controlled by an external computer via the GPIB interface or by the IBASIC computer via the IBASIC interfaces (see Figure 6-3).



Control Instruments*
IBASIC computer: OUTPUT 809ss; and ENTER 809ss;
or OUTPUT 16[xx]xx; and ENTER 16[xx]xx
External computer: OUTPUT 709ss; and ENTER 709ss;
C-size Mainframe
IBASIC 809ss
SELECT CODE 8 DRIVER
SELECT CODE 16 DRIVER
GPIB DRIVER
SYSTEM INSTRUMENT
MODULE INSTRUMENTS
IBASIC INSTRUMENT
GPIB DEVICES
EXTERNAL (GPIB) COMPUTER
SS-80 DISK or TAPE
GPIB PORT
709ss
GPIB
ARBITER
IBASIC COMPUTER
E1400-IB FIG6-3
Control External GPIB Devices**
External Computer: OUTPUT 7ppss; and ENTER 7ppss;
* Instruments must be assigned to computer
** pp=primary address, ss=secondary address

Figure 6-3. Instrument Control - Talk/Listen Mode

Assigning Instruments to Interfaces

An instrument can be controlled by only one interface at a time. For an interface to control an instrument, the instrument must first be **assigned** to the interface. An instrument can be assigned to GPIB, select code 8, select code 16, or can be unassigned (assigned to no interface).

Any combination of instruments can be assigned or unassigned. For example, an Agilent E1410A voltmeter instrument could be assigned to the GPIB interface and an Agilent E1332A counter instrument assigned to the IBASIC select code 8 interface at the same time.

In Figure 6-3, the System instrument is shown assigned to the IBASIC select code 8 interface, the module instruments are shown as unassigned, and the IBASIC instrument is shown assigned to the GPIB interface.

Select code 16 can acquire only message based instruments. Since neither the SYSTEM or IBASIC are message based, they cannot be controlled using select code 16.

GPIB and IBASIC can arbitrate between secondary address instruments only. It is possible to program an instrument from ***both*** select code 8 and select code 16 if it has both a secondary and logical address. Please see *Synchronizing Instrument/Device Operations* later in this chapter for more information on handling this type of arbitration. To minimize arbitration problems, select code 16 should be used only for devices at non-secondary addresses.

NOTE

You will usually not need to assign instruments unless you use an external computer and the IBASIC computer to control of the same instrument. See *Synchronizing Instrument/Device Operations* to assign instruments to computers for two-computer operation.

Controlling Instruments with IBASIC Computer

For Talk/Listen mode, controlling instruments with the IBASIC computer is identical to that for System Controller mode. See *Controlling Instruments/GPIB Devices* in *Chapter 5 - System Controller Mode Operation* for more information and examples.

NOTE

For Talk/Listen mode, the IBASIC computer is not connected to the GPIB interface, so external GPIB devices cannot be controlled by the IBASIC computer in Talk/Listen mode.

Controlling Instruments with External Computer

As shown in Figure 6-3, with Talk/Listen mode an external computer (such as an HP 9000 Series 200/300 computer) can control instruments via the GPIB interface. For an HP 9000 Series 200/300 computer, use OUTPUT 709ss; and ENTER 709ss; statements to communicate with an instrument at secondary address ss.

See the appropriate *Agilent 75000 Plug-In Module User Manual* for information to control an instrument from an external computer when an HP 9000 Series 200/300 (or equivalent) computer is used. See the appropriate plug-in manual and your computer manual to control instruments from an external computer if you use another computer.

You can also control instrument states with the ABORT, CLEAR, LOCAL, LOCAL LOCKOUT, REMOTE, SPOLL, and TRIGGER commands. See *Using the GPIB/IBASIC Interfaces* in *Chapter 5 - System Controller Mode Operation* for details.

Controlling RS-232/422 Peripherals

In Talk/Listen mode (and in System Controller mode), the IBASIC computer can control external RS-232C peripherals via the built-in RS-232 interface (interface select code 9) or via an RS-232 or RS-422 interface on an Agilent E1324A Data Communications module (interface select codes 21 through 27).

NOTE Controlling RS-232/422 peripherals is identical to the operation for System Controller mode. See *Controlling RS-232/422 Peripherals* in *Chapter 5 - System Controller Mode Operation* for information and examples.

Storing/Retrieving Data

For Talk/Listen mode, data collected from instruments or external RS-232/422 peripherals can be stored in IBASIC memory or in RAM volumes.

NOTE Storing data to IBASIC memory or to RAM volumes is identical to the operation for System Controller mode. See *Storing/Retrieving Data* in *Chapter 5 - System Controller Mode Operation* for information and examples.

With Talk/Listen mode, the IBASIC computer cannot access an GPIB SS-80 disk or tape drive and an external computer must be used to store data from external GPIB devices to the disks. See your computer manual for procedures to store data to the internal disks.

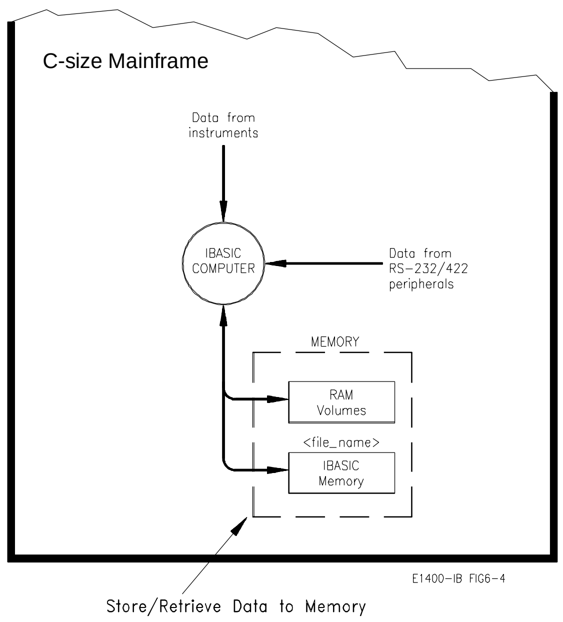


Figure 6-4. Storing/Retrieving Data

Enabling Interrupts and Events

With Talk/Listen mode the IBASIC computer can detect and service an interrupt from the IBASIC interface and the ON CYCLE, ON ERROR, ON KEY, and ON TIMEOUT events (see Figure 6-5). However, with Talk/Listen mode the IBASIC computer cannot detect or service interrupts from the GPIB interface.

NOTE Enabling instrument interrupts and events is identical to the operation for System Controller mode. See *Enabling Interrupts and Events* in *Chapter 5 - System Controller Mode Operation* for information and examples.

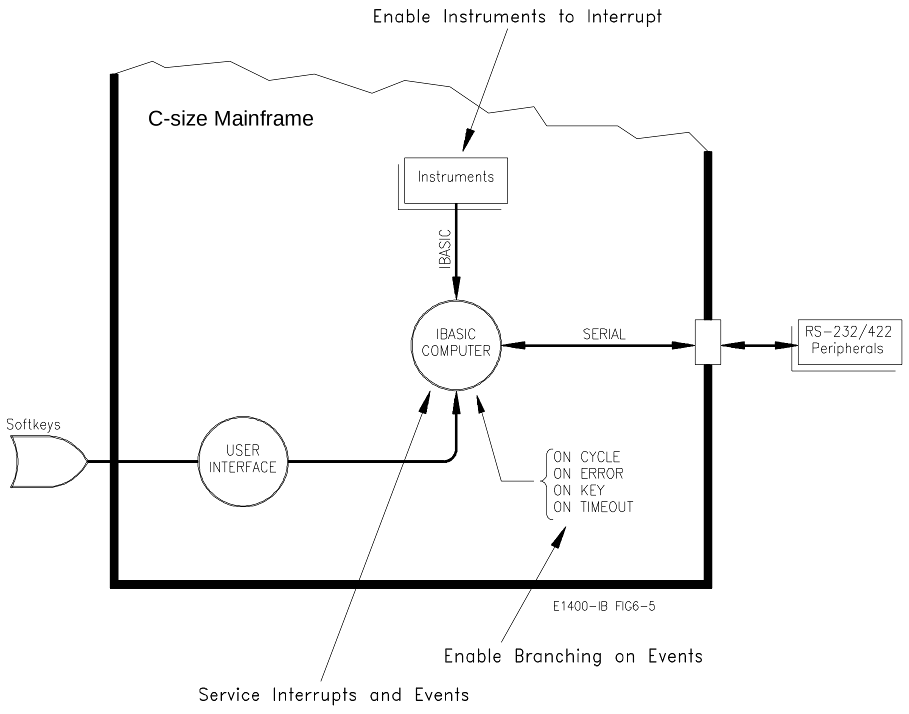


Figure 6-5. Enabling Interrupts and Events

Synchronizing Instrument/Device Operations

This section gives guidelines to synchronize instrument operations with the IBASIC computer when Talk/Listen mode is set. It also gives guidelines to synchronize instrument/GPIB device operations using an external computer and the IBASIC computer when Talk/Listen mode is set.

Synchronize Instruments Using IBASIC Computer

For Talk/Listen mode, the IBASIC computer can synchronize operations between instruments, but cannot synchronize operations between instruments and external GPIB devices. Some methods of synchronization use triggering (TRIGGER command) and the Operation Complete (*OPC and *OPC?) commands.

NOTE

See *Synchronization Using IBASIC Computer*, *Synchronization Using *OPC?*, and *Synchronization Using *OPC* in *Chapter 5 - System Controller Mode Operation* for some example ways to synchronize instrument operations using the IBASIC computer.

Synchronize Instruments Using Two Computers

A primary advantage of using Talk/Listen mode is that both an external computer (GPIB computer) and the IBASIC computer can be used to control instruments. In addition, the GPIB computer can control external GPIB devices via GPIB (the IBASIC computer cannot control external GPIB devices in Talk/Listen mode).

You will probably use only one computer to control any given instrument. However, you may want to "share" control of an instrument by first controlling the instrument with the IBASIC computer and then shifting control to the external computer or vice-versa. In this case, you will need to **assign** the instrument to the appropriate computer.

Instrument Assignment Overview

Before an instrument can be controlled by an external computer or by the IBASIC computer, the instrument must be assigned to the computer via one of 3 interfaces (select code 8, select code 16, and the GPIB interface). Figure 6-6 shows the method used to assign instruments to the external computer or to the IBASIC computer. There are four aspects of assigning an instrument to a computer:

- Requesting the instrument
- Arbitrating the request
- Releasing the instrument
- Assigning the instrument

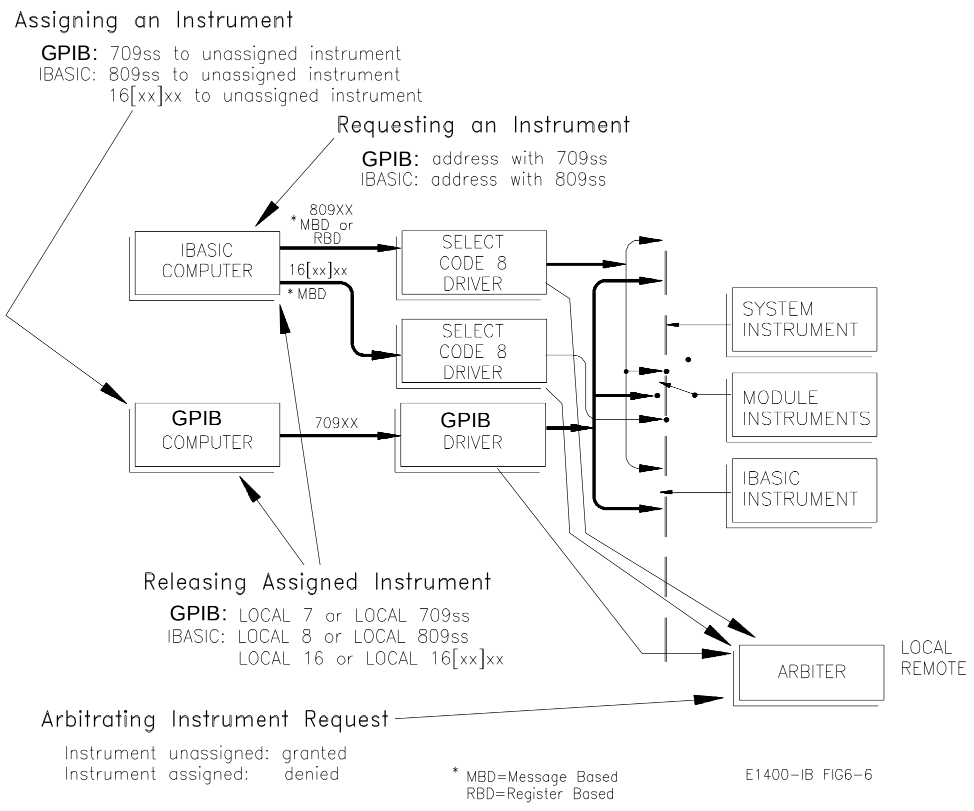

Assigning an Instrument
GPIB: 709ss to unassigned instrument
IBASIC: 809ss to unassigned instrument
16[xx]xx to unassigned instrument
Requesting an Instrument
GPIB: address with 709ss
IBASIC: address with 809ss
809XX
* MBD or RBD
16[xx]xx
* MBD
IBASIC COMPUTER
SELECT CODE 8 DRIVER
SELECT CODE 8 DRIVER
GPIB COMPUTER
709XX
GPIB DRIVER
SYSTEM INSTRUMENT
MODULE INSTRUMENTS
IBASIC INSTRUMENT
Releasing Assigned Instrument
GPIB: LOCAL 7 or LOCAL 709ss
IBASIC: LOCAL 8 or LOCAL 809ss
LOCAL 16 or LOCAL 16[xx]xx
ARBITER
LOCAL
REMOTE
Arbitrating Instrument Request
Instrument unassigned: granted
Instrument assigned: denied
* MBD=Message Based
RBD=Register Based
E1400-IB FIG6-6

Figure 6-6. Assigning Instruments to Computers

Requesting an Instrument

At any one time, an instrument can be assigned to the IBASIC computer via the IBASIC select code 8 or select code 16 interface , to an external computer via the GPIB interface, or can be unassigned (not assigned to either computer).

To request an instrument, the computer requesting the assignment issues an addressed command (such as OUTPUT) containing the primary and secondary address (or the logical address if select code 16 is being used) of the instrument to be assigned. Any addressed command will request instrument assignment, since the address statement actually initiates the request.

For example, OUTPUT 709ss; from the external computer requests assignment of the instrument at primary address 09 and secondary address ss to the external computer. Or, OUTPUT 809ss; from the IBASIC computer requests assignment of the instrument at primary address 09 and secondary address ss to the IBASIC computer.

Arbitration with select code 16 **only** occurs when a device has **both** a secondary address and a logical address. For example, a device with a logical address of 8 would normally be assigned a secondary address of 1 (LADD/8). In this situation OUTPUT 80901, OUTPUT 1608, and OUTPUT 160008 all refer to the same device. If so, arbitration **must** take place if the instrument is to function properly. To avoid confusion over this matter you should keep the use of select code 16 to a minimum, using it only for devices at non-secondary addresses. With a small amount of care in setting up the system it is usually possible to place all instruments at secondary addresses and avoid the use of select code 16 entirely.

Arbitrating an Assignment Request

When the assignment request is issued from an interface the **arbiter** grants or denies the request. If the instrument is already assigned to another interface the request is denied until the instrument is released by the computer to which the instrument is assigned (see *Releasing an Instrument*). A denial is denoted by the lack of communication with the instrument, as though the instrument did not exist.

For example, suppose the System instrument is assigned to the external computer. A request to assign the System instrument to the IBASIC computer will be denied until the System instrument is released by the external computer.

For the IBASIC computer, when an assignment request is denied the IBASIC interface will "hang" and not continue. For the external computer, the GPIB interface may or may not hang, depending on the other devices on the bus. You will have to detect "hanging" with the ON TIMEOUT capability and retry until successful.

NOTE

Devices at non-secondary addresses are not arbitrated and can only be accessed via select code 16.

Releasing an Instrument

To release an assigned instrument from a computer (to unassign the instrument), use LOCAL 709ss to release an assigned instrument at secondary address=ss from the external computer, use LOCAL 809ss to release an assigned instrument at secondary address=ss from the IBASIC computer, or use LOACL 16[XX]XX to release an assigned instrument at logical address=[XX]XX from the IBASIC computer.

NOTE

If an instrument is not assigned to either side, an addressed LOCAL command first acquires it and then releases it.

Releasing all Assigned Instruments

Use LOCAL 7 to release all *assigned* instruments from the external computer. Use LOCAL 8 or LOCAL 16 to release all *assigned* instruments from the IBASIC computer. After the assigned instruments are released with a LOCAL 7 or LOCAL 8 command, you must send a REMOTE 7 or REMOTE 8 to allow the instruments to be released again. The transition from REMOTE to LOCAL of the interface will release all assigned instruments. This is not necessary for select code 16 since it does not try to completely emulate GPIB operations as does select code 8.

Do not Send LOCAL Immediately

When sending OUTPUT 709ss; or OUTPUT 809ss; from the computer, do not send LOCAL 709ss or LOCAL 809ss to release the instrument until the command associated with the OUTPUT statement has completed. The act of releasing the instrument will clear the input and output buffers and may abort a command before it completes. This is applicable only to register based devices manufactured by Agilent.

Instrument Status Information is Retained

When a register based instrument is released from an interface, the input/output information is lost but status information (such as SPOLL, SRQ, and ERRORS) is retained.

Suppose an instrument at address 80903 generated an SRQ which was logged but not serviced by the IBASIC computer before a LOCAL 80903 command was generated. In this case, this instrument is released from the IBASIC computer (unassigned).

If the instrument is then assigned to the external computer, the SRQ interrupt for the instrument is still retained. This may cause the external computer to respond to an interrupt generated, but not serviced by, the IBASIC computer.

Assigning the Instrument

When the assignment request has been granted by the arbiter (the instrument is currently unassigned), the instrument is assigned to the computer. Once an instrument is assigned to an interface it cannot be assigned to another interface until the instrument is released with a LOCAL command from the computer which "owns" the instrument.

An instrument is assigned to an interface when an addressed command, such as OUTPUT 709ss;, CLEAR 709ss, OUTPUT 809ss;, TRIGGER 809ss, etc. is issued from the interface. If the addressed instrument is already assigned to another computer, the request is denied.

Example: Using Timeout Value with Instrument Request

When a computer requests assignment of an instrument, the arbiter checks the status of the instrument. If the instrument is assigned to another computer, the arbiter denies the request until the other computer releases the instrument.

If the computer to which is instrument is assigned is running a long (or continuous) program, the requesting computer may have to wait indefinitely for the instrument to be released. This program shows one way to use ON TIMEOUT so that the requesting computer will wait a specified time before cancelling and re-initiating a request for the instrument.

For this example, assume an Agilent E1410A DMM at secondary address 03 is assigned to the IBASIC computer and the IBASIC computer is running the following (downloaded) program. With this program, the instrument is continuously assigned (line 20) and then released (line 40) by the IBASIC computer.

```
5   !RE-SAVE "ASSIGN1"
10  LOOP
20      OUTPUT 80903;"MEAS:VOLTS:DC?"
30      ENTER 80903;A
40      LOCAL 80903
50      DISP A
60  END LOOP
```

The above program poses no problem for instrument assignment until the external computer requests assignment of the instrument. If the request occurs before the instrument has been released by the IBASIC computer, the request is denied and the external computer may "hang" indefinitely awaiting the instrument assignment.

To avoid this, the following program allows the external computer to wait for 0.1 seconds (line 110) when requesting the instrument assignment (line 120). If the request is denied (instrument was not released by the IBASIC computer), the program returns to line 120 and tries the request again.

This loop continues until the request is granted and the instrument is assigned to the external computer. When the instrument is assigned, the instrument makes a DC voltage measurement and returns the result to the computer CRT. The instrument is then released from the external computer.

```
90   !RE-SAVE "ASSIGN2"
100   LOOP
110     ON TIMEOUT 7,.1 GOTO Line
120   Line: OUTPUT 70903;"MEAS:VOLT:DC?"
130     OFF TIMEOUT 7
140     ENTER 70903;A
150     DISP A
160     LOCAL 70903
170  END LOOP
180  END
```

NOTE

Line 120 might better be replaced by State = SPOLL (70903). The SPOLL operation will request data and force a timeout even though other GPIB devices on the bus (such as an GPIB Bus Analyzer) may be in the LISTEN mode. In this case, the OUTPUT statement will not "hang".

ON TIMEOUT can also be used on the IBASIC side, but is not necessry since IBASIC will wait for the arbiter to grant the request. This is a capability not possible on the GPIB side.

Chapter 7 Contents

Chapter 7

IBASIC Command Reference

Using This Chapter

This chapter shows the Agilent Instrument BASIC (IBASIC) commands supported by the IBASIC instrument in the Agilent E1406. It includes alphabetical and functional listings of supported IBASIC commands.

When an IBASIC command for the Agilent E1406 differs from that shown in the *Agilent Instrument BASIC Language Reference Manual*, the command is described in the *IBASIC Command Differences* section of this chapter.

IBASIC Commands Not Supported

The following table shows IBASIC commands described in the *Agilent Instrument BASIC Language Reference Manual* but *not* supported by the IBASIC instrument in the Agilent E1406.

IBASIC Commands Not Supported by Agilent E1406

Command	Description
DRAW	Draw line on display
GCLEAR	Clears the graphics display
MOVE	Move logical/physical pens from current position
PEN	Selects pen used for plotting

IBASIC Commands Alphabetical Listing

The following table shows an alphabetical listing of IBASIC commands supported by the IBASIC instrument. Unless indicated by a * entry, the command is implemented by the IBASIC instrument as described in the *Agilent Instrument BASIC Language Reference Manual*. See the *IBASIC Command Differences* section of this chapter for a description of * entry commands.

Command	**Description**
* = See IBASIC Command Differences section for command description ** = See Chapter 2 - Creating and Editing Programs for command description	
ABORT*	Ceases activity on specified interface
ABS	Returns absolute value of its argument
ACS	Arccosine function
AND	Logical AND
ASCII	See CREATE ASCII
ASN	Arcsine function
ASSIGN	Assign I/O path name and attributes
ATN	Arctangent function
BASE	Lower bound of array
BDAT	See CREATE BDAT
BEEP	Produces audible tone
BINAND	Returns bit-by-bit, logical AND of its arguments
BINCMP	Returns bit-by-bit complement of its argument
BINEOR	Returns bit-by-bit, exclusive OR of its arguments
BINIOR	Returns bit-by-bit, inclusive OR of its arguments
BIT	Returns 1 or 0 for value of specified bit
CALL	Call specified SUB subprogram
CASE	See SELECT...CASE
CAT	Lists contents of mass storage directory
CHR$	Converts numeric value to ASCII character
CLEAR*	Clears devices or interfaces
CLEAR SCREEN	Clear contents of alpha display
CLS	See CLEAR SCREEN
COM	Dimensions COMMON memory area
CONT	Resumes execution of PAUSed program
CONTROL	See PASS CONTROL
COPY	Copy file or disk
COS	Returns cosine of angle of argument
CREATE	Creates an HP-UX file
CREATE ASCII	Creates an ASCII file
CREATE BDAT	Creates a BDAT file
CREATE DIR	Creates a DOS (HFS) directory
CRT	Returns 1, the device selector of the CRT display
DATA	Contains data which can be read by READ
DEF FN	Start of FUNCTION subprogram
DEG	Selects degrees as angle measure
DEL	Deletes selected program line(s)
DIM	Dimension REAL arrays, strings, and string arrays
DISABLE	Disables some event-initiated branches
DISABLE INTR	Disables interrupts from an interface
DISP	Sends display items to CRT display
DIV	Returns integer part of quotient

Command	Description
* = See IBASIC Command Differences section for command description ** = See Chapter 2 - Creating and Editing Programs for command description	
DROUND	Round expression to specified number of digits
DVAL	Converts character string to a REAL whole number
DVAL$	Converts whole number into equivalent string
EDIT**	Allows user to edit program
ELSE	See IF...THEN
ENABLE	Reenable branches suspended by DISABLE
ENABLE INTR	Enable interrupts on specified interface
END	End of main program
END IF	See IF...THEN
END LOOP	See LOOP
END SELECT	See SELECT...CASE
END WHILE	See WHILE
ENTER	Input data and assign values entered to variables
EOL	See ASSIGN and PRINTER IS
ERRL	Returns 1 if most recent error occurred in line
ERRLN	Returns program line number of most recent error
ERRM$	Returns error message text for most recent error
ERRN	Returns number of most recent program error
ERROR	See OFF ERROR and ON ERROR
EXOR	Returns 1 or 0, basied on logical exclusive-OR
EXP	Raises e to power of the argument
FN	Transfer execution to user-defined function
FNEND	See DEF FN
FOR..NEXT	FOR...NEXT loop
FORMAT	See ASSIGN
FRACT	Returns fractional part of value of argument
GET	Reads ASCII or DOS (HP-UX) file
GOSUB	Transfer execution to specified subroutine
GOTO	Transfer execution to specified line/label
IF...THEN	Provides conditional branching
IMAGE	Image specifier for ENTER, OUTPUT, PRINT, etc.
INITIALIZE	Formats mass storage media
INPUT	Assigns keyboard inputs to program variables
INT	Returns greatest integer <= expression
INTEGER	Declare INTEGER var and dim INTEGER arrays
INTR	See OFF INTR and ON INTR
IVAL	Converts string into an INTEGER
IVAL$	Converts an INTEGER into a string
KBD	Returns 2, the keyboard select code
LEN	Returns number of characters in argument
LET	Assigns values to variables
LGT	Returns logarithm (base 10) of argument
LIST	Lists program or definitions in memory
LOCAL*	Returns specified devices to local state
LOCAL LOCKOUT*	Prevents returning specified device to local state
LOG	Returns logarithm (base e) of argument
LOOP	Repeat loop until EXIT IF statement is logically true
LWC$	Replace uppercase with lowercase characters
MASS STORAGE IS	Specifies system mass storage device

Command	Description
* = See IBASIC Command Differences section for command description ** = See Chapter 2 - Creating and Editing Programs for command description	
MAX	Returns largest value in list of arguments
MAXREAL	Returns largest REAL number available
MIN	Returns smallest value in list of arguments
MINREAL	Returns smallest REAL number available
MOD	Returns the remainder of a division
MODULO	Returns integer remainder of a division
MSI	See MASS STORAGE IS
NEXT	See FOR...NEXT
NOT	Returns 1 if argument is 0, returns 0 otherwise
NUM	Returns ASCII value of first character in argument
OFF CYCLE*	Cancels branches enabled with ON CYCLE
OFF ERROR	Cancels branches enabled with ON ERROR
OFF INTR	Cancels branches enabled with ON INTR
OFF KEY	Cancels branches enabled with ON KEY
OFF TIMEOUT	Cancels branches enabled with ON TIMEOUT
ON CYCLE*	Enables branch when specified time has elapsed
ON ERROR	Enables branch when error is generated
ON INTR	Enables branch when interrupt is generated
ON KEY	Enables branch when softkey is pressed
ON TIMEOUT	Enables branch when I/O timeout occurs
OR	Returns 1 or 0 - based on inclusive-or of arguments
OUTPUT	Outputs items to specified destination
PASS CONTROL	Pass Active Controller function to GPIB device
PAUSE	Suspends (pauses) program execution
PI	Returns approximate value for pi
POS	Returns first position of substring within string
PRINT	Sends items to PRINTER IS device
PRINTER IS	Specifies system printing device
PRIORITY	See SYSTEM PRIORITY
PROUND	Returns argument value, rounded to power-of-ten
PRT	Returns 701, default selector for external printer
PURGE	Deletes a file from a directory
RAD	Selects radians as angle measure
RANDOMIZE	Selects a seed for the RND function
RANK	Returns number of dimensions in an array
READ	Reads values from DATA statements
READIO*	Provides additional I/O reading capabilities
REAL	Reserves storage for REAL variables and arrays
RECOVER	See ON... statements
REM	Allows comments in a program
REMOTE*	Places specified device(s) in REMOTE state
REN	Renumber program lines for program in memory
RENAME	Changes file or directory name
REPEAT...UNTIL	Loop until the UNTIL statement is logically true
RE-SAVE	Creates/rewrites ASCII or HP-UX file
RESTORE	Specifies DATA statement using with next READ
RETURN	Return execution to line following invoking GOSUB
REV$	Returns string formed by reversing char sequence
RND	Returns a pseudo-random number 0 <num<1

Command	Description
* = See IBASIC Command Differences section for command description ** = See Chapter 2 - Creating and Editing Programs for command description	
ROTATE	Returns integer value of shift with wrap-around
RPT$	Returns string repeated specified number of times
RUN	Begins program execution at specified line
SAVE	Creates ASCII or HP-UX file and copies lines to file
SCRATCH	Erases all or selected portions of memory
SECURE	Protects program lines so they cannot be listed
SELECT...CASE	Provide conditional execution of program segments
SGN	Returns 1, 0, or -1 for pos, zero, neg arguments
SHIFT	Returns integer value of shift without wrap-around
SIN	Returns the sine of the argument
SIZE	Returns number of elements of array dimension
SPOLL*	Returns serial poll response of selected device
SQRT	Returns square root of argument
STEP	See FOR...NEXT
STOP	Terminates execution of program
SUB	First statement in a SUB subprogram
SUBEND	See SUB
SUBEXIT	Allows multiple exits from a SUB subprogram
SYSTEM ID	See SYSTEM$
SYSTEM PRIORITY	Sets system priority to specified value
SYSTEM$	Returns system status and configuration
TAB	See PRINT and DISP
TABXY	See PRINT
TAN	Returns tangent of angle of argument
TIMEDATE	Returns value of real-time clock
TIMEOUT	See OFF TIMEOUT and ON TIMEOUT
TRIGGER*	Sends TRIGGER message to selected devices
TRIM$	Returns string without leading/trailing ASCII spaces
UNTIL	See REPEAT...UNTIL
UPC$	Replace lowercase with uppercase characters
USING	See DISP, ENTER, LABEL, OUTPUT, and PRINT
VAL	Converts string expression to numeric value
VAL$	Returns string representation of argument value
WAIT	Wait before executing next statement
WHILE	Execute loop as long as WHILE is true
WIDTH	See PRINTER IS
WILDCARDS	When enabled, use to represent file names
WRITEIO*	Provides additional I/O write capability

IBASIC Commands by Function

The following table shows a functional grouping of IBASIC commands supported by the IBASIC instrument. Unless indicated by a * entry, the command is implemented by the IBASIC instrument as described in the *Agilent Instrument BASIC Language Reference Manual*. See the *IBASIC Command Differences* section of this chapter for a description of * entry commands. See *Chapter 10* of the *Agilent Instrument BASIC Programming Techniques Manual* for further information on IBASIC commands by function.

General Math Operations

Category	Command	Description
Relational Operators	=	Equality
	<>	Inequality
	<	Less than
	<=	Less than or equal to
	>	Greater than
	>=	Greater than or equal to
General Math Functions	+	Addition operator
	-	Subtraction operator
	x	Multiplication operator
	/	Division operator
	^	Exponentiation operator
	ABS	Returns agrument absolute value
	DIV	Returns integer portion of division
	DROUND	Returns rounded value of expression
	EXP	Raises base e to specified power
	FRACT	Returns fractional part of expression
	INT	Returns integer part of expression
	LET	Assigns values to variables
	LGT	Returns logarithm (base 10) of argument
	LOG	Returns logarithm (base e) of argument
	MAX	Returns largest value in list of arguments
	MAXREAL	Returns largest number available
	MIN	Returns smallest value in list of arguments
	MINREAL	Returns smallest number available
	MOD	Returns remainder of integer division
	MODULO	Returns the modulo of division
	PI	Returns approximation of pi
	PROUND	Returns value rounded to power of ten
	RANDOMIZE	Modifies seed used by RND
	RND	Returns pseudo-random number
	SGN	Returns sign of argument
	SQRT (or SQR)	Returns square root of argument

General Math Operations (cont'd)

Category	Command	Description
Binary Functions	BINAND	Returns bit-by-bit logical -and of two args
	BINCMP	Returns bit-by-bit complement of argument
	BINEOR	Returns bit-by-bit exclusive-or of two args
	BINIOR	Returns bit-by-bit inclusive-or of two args
	BIT	Returns state of specified bit in argument
	ROTATE	Returns shifted value, with wraparound
	SHIFT	Returns shifted value, without wraparound
Trigonometric Functions	ACS	Returns the arcosine of argument
	ASN	Returns the arcsine of argument
	ATN	Returns the actangent of argument
	COS	Returns cosine of argument
	DEG	Sets degrees as unit of angle measurement
	RAD	Sets radians as unit of angle measurement
	SIN	Returns sine of argument
	TAN	Returns tangent of argument

Array/String/Logical Operations

Category	Command	Description
Array Operations	BASE	Returns lower bound of array dimension
	RANK	Returns number of dimensions in array
	SIZE	Returns number of elements in array dim
String Operations	&	Concatenates two string expressions
	CHR$	Converts numeric value to ASCII character
	DVAL	Converts alternate-base to numeric value
	DVAL$	Converts numeric value to alternate-base
	IVAL	Converts alternate-base to INTEGER number
	IVAL$	Converts INTEGER number to alternate-base
	LEN	Returns number of characters in string
	LWC$	Returns lowercase value of string
	NUM	Returns decimal value of first char in string
	POS	Returns position of string in string expression
	REV$	Reverses order of characters in string
	RPT$	Repeats characters in string number of times
	TRIM$	Removes leading/trainling blanks from string
	UPC$	Returns uppercase value of string
	VAL	Converts string of numerals to numeric value
	VAL$	Returns string representing numeric value
Logical Operators	AND	Returns 1 or 0 based on logical AND of 2 args
	EXOR	Returns 1 or 0 based on exclusive-or of 2 args
	NOT	Returns 1 or 0 based on complement of arg
	OR	Returns 1 or 0 based on inclusive-or of 2 args

Program Control Operations

Category	Command	Description
Entry/ Editing	EDIT**	Allows user to edit program
	LIST	Lists program lines to system printer
	REM and !	Allows comments on program lines
	REN	Renumber lines for program in memory
	SECURE	Protects program lines - cannot be listed
Debugging	ERRL	Indicates if error occurred on specific line
	ERRLN	Returns line number of most recent error
	ERRM$	Returns text of last error message
	ERRN	Returns most recent program execution error
Program Control	CALL	Transfer program execution to subprogram
	CONT	Resumes execution of PAUSed program
	DEF FN/FNEND	Defines bounds of function subprogram
	END	Stops program execution - marks end of prog
	FN	Calls user-defined function
	FOR...NEXT	Defines loop to be repeated number of times
	GOSUB	Transfers program to specified subroutine
	GOTO	Transfers program to specified line
	IF..THEN ELSE	Conditional execution of program segment
	LOOP/EXIT IF/END LOOP	Looping with conditional exit
	PAUSE	Suspends program execution
	REPEAT...UNTIL	Execute prog segment until condition is true
	RETURN	Transfer back to main prog from subroutine
	SELECT...CASE	Execute one program segment of several
	STOP	Terminates program execution
	SUB/SUBEND	Defines bounds of a subprogram
	SUBEXIT	Transfer control from subprog
	WAIT	Wait specified number of seconds
	WHILE	Execute prog segment whle cond is true

** = See Chapter 2 - Creating and Editing Programs for command description

Instrument Control Operations

Category	Command	Description
Device Input/Output	ASSIGN	Assigns I/O path to mass storage or devices
	BEEP	Produces audible tone
	CRT	Returns device selector or CRT
	DATA	Specifies data accessible via READ
	DISP	Outputs items to CRT display
	ENTER	Inputs data from device, file, or string
	IMAGE	ENTER, OUTPUT, DISP, PRINT formats
	INPUT	Inputs data from keyboard to variables
	KBD	Returns device selector of the keyboard
	OUTPUT	Outputs items to device, file, or string
	PRINT	Outputs items to PRINTER IS device
	PRINTER IS	Specifies device for PRINT, CAT, LiST
	PRT	Returns device selector of external printer
	READ	Inputs data from DATA lists to variables
	READIO*	Provides additional I/O read capabilities
	RESTORE	READ accesses specified DATA statement
	SYSTEM$	Returns system status/configuration
	TAB	Moves print position to specified point
	TABXY	Specifies print position on internal CRT
	TIMEDATE	Returns value of real-time clock
	WRITEIO*	Provides additional I/O write capabilities
Interface Control	ABORT*	Terminate interface activity
	CLEAR*	Places specified devices in known state
	CLEAR SCREEN	Clear contents of alpha display
	CLS	See CLEAR SCREEN
	LOCAL*	Returns specified devices to LOCAL atate
	LOCAL LOCKOUT*	Disables front-panel control of devices
	PASS CONTROL	Pass Active Controller function to device
	REMOTE*	Places specified devices in REMOTE state
	SPOLL*	Returns Serial Poll byte from device
	TRIGGER*	Sends Trigger message to specified devices
Event-Initiated Branching	ENABLE/DISABLE	Enables/disables event-initiated branching
	ENABLE INTR/DISABLE	Enables/disables interrupts set by ON INTR
	ON CYCLE*/OFF CYCLE*	Enables/disables interrupts set by ON CYCLE
	ON ERROR/OFF ERROR	Sets up event-initiated branch for prog error
	ON KEY...LABEL/OFF KEY	Sets up event-initated branch for softkeys
	ON TIMEOUT/OFF TIMEOUT	Sets up event-initiated branch for I/O timeout
	SYSTEM PRIORITY	Sets min priority level for event-init branches

* = See IBASIC Commend Differences section for command description

Mass Storage/Memory Operations

Category	Command	Description
Mass Storage	ASSIGN CAT COPY CREATE CREATE ASCII CREATE BDAT CREATE DIR GET INITIALIZE MSI PURGE RENAME SAVE/RE-SAVE WILDCARDS	Assign I/O path and attributes to a file List mass storage directory contents Copy mass storage files and volumes Creates HP-UX file on mass storage media Creates ASCII file on mas storage media Creates BDAT file on mass storage media Creates DOS (HFS) directory on mass media Reads ASCII file into memory as a program Formats mass storage media (Lif directory) Specifies defaul t mass storage device Deletes file from directory Changes a file's name Creates/rewrites ASCII or HP-UX file When enabled, use to represent file names
Memory Allocation	COM DIM INTEGER REAL SCRATCH	Dimension, reserve memory for common area Dimension, reserve memory for REAL var Dimension, reserve memory for INTEGER var Dimension, reserve memory for full-prec var Erase all or selected portions of memory

IBASIC Command Differences

This section describes the IBASIC commands supported by the IBASIC instrument in the Agilent E1406 which are *not* described in the *Agilent Instrument BASIC Language Reference Manual* or have a description different from that shown in the *Agilent Instrument BASIC Language Reference Manual.*

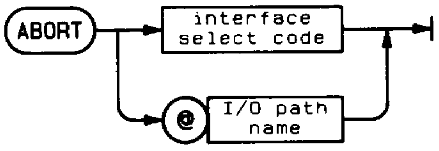
Each command description assumes the command is issued from the IBASIC computer.

NOTE See *Chapter 1* in the *Agilent Instrument BASIC Language Reference Manual* for a description of IBASIC command structure and syntax drawings.

ABORT

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC interfaces (select code 8 or 16), ABORT does nothing, since no operations are occurring except under IBASIC control. For the GPIB interface (select code 7) (System Controller mode only), ABORT ceases activity on the GPIB interface.



Item	Description	Range
interface select code	numeric expression, rounded to an integer	7 for GPIB and 8 for IBASIC
I/O path name	name assigned to the IBASIC or GPIB interface	-

Example Statement

ABORT 7

For System Controller mode ONLY, ceases activity on GPIB interface (select code 7)

Semantics

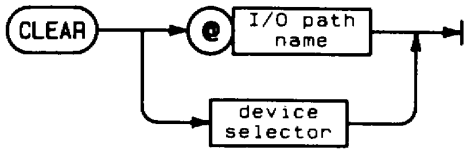
Executing ABORT ceases activity on the specified interface - other interfaces may not be specified. If the IBASIC computer is the System controller but is not currently the Active Controller, executing ABORT 7 causes the IBASIC computer to assume active control. See the ABORT command in the *Agilent Instrument BASIC Language Reference Manual* for a summary of GPIB bus actions for the ABORT command.

CLEAR

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC interfaces (select code 8 or 16), when the instrument(s) are assigned to the IBASIC computer, CLEAR 8 or CLEAR 16 sets all acquired instruments to a pre-defined, instrument-dependent state., while CLEAR 809ss sets the acquired instrument at secondary address ss to a pre-defined, instrument-dependent state.

For the GPIB interface (select code 7) (System Controller mode only), CLEAR 7 sets all external GPIB devices to a pre-defined, instrument-dependent state, while CLEAR 7ppss sets the external GPIB instrument at primary address pp and secondary address ss to a pre-defined, device-dependent state.



Item	Description	Range
I/O path name	name assigned to a device or devices	any valid name (see ASSIGN)
device selector	numeric expression, rounded to an integer	(see Glossary)

Example Statements

CLEAR 80901

Clears the instrument at secondary address 01, if the instrument is assigned to IBASIC

CLEAR 722

For System Controller mode only, clears external GPIB instrument at address 22

Comments

The IBASIC computer must be the active controller to execute a CLEAR 7 command. When interface 8 is specified, the CLEAR is sent to all devices which are assigned to IBASIC (owned by IBASIC) and are addressed to listen.

CLEAR 8 and CLEAR 16 do the following to an instrument owned by IBASIC:

- Clears the input buffer and output queue.
- Resets the command parser.
- Disables any operation that would prevent *RST execution.
- Disables the Operation Complete and Operation Complete Query modes.

CLEAR 8 and CLEAR 16 do not affect:

- Any settings or stored data in the instrument except the Operation Complete and Operation Complete Query modes.
- Any instrument operation in progress except as stated above.
- The Status Byte Register, except to clear the Message Available (MAV) bit as a result of clearing the Output Queue.

See the CLEAR command in the *Agilent Instrument BASIC Language Reference Manual* for a summary of GPIB bus actions for the CLEAR command.

CLEAR 9 and CLEAR 21 - 27:

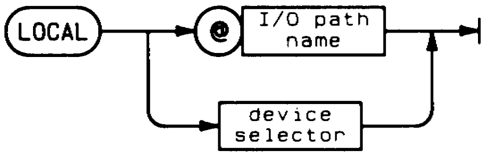
For the Serial interfaces, CLEAR clears the receive and transmit buffers, but does not affect baud rate or other configuration settings.

LOCAL

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC interfaces (select code 8 and 16), LOCAL 8 or LOCAL 16 places all instruments which are assigned to IBASIC in the LOCAL state, while LOCAL 809ss or 16[XX]XX places an assigned instrument at secondary address ss in the LOCAL state. For message based devices the LOCAL command also issues a word-serial Clear Lock.

For the GPIB interface (select code 7) (System Controller mode only), LOCAL 7 places all external GPIB devices in the LOCAL state, while LOCAL 7ppss places an external GPIB device at primary address pp and secondary address ss in the LOCAL state.



Item	Description	Range
I/O path name	name assigned to a device or devices	any valid name (see ASSIGN)
device selector	numeric expression, rounded to an integer	(see Glossary)

Example Statements

LOCAL 7

For System Controller mode only, places all external GPIB devices in the LOCAL state.

LOCAL 80901

Places an internal instrument at secondary address 01 in the LOCAL state

Semantics

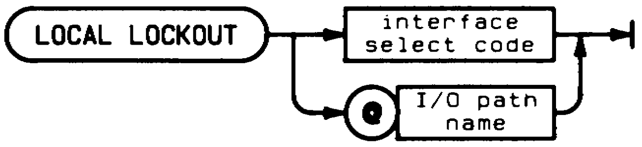
- If only interface select code 8 is selected, all instruments on the interface which are assigned to IBASIC are returned to their LOCAL state and any LOCAL LOCKOUT is cancelled.
- If only interface select code 7 is selected (System Controller mode only), all GPIB devices on the interface are returned to their LOCAL state and any LOCAL LOCKOUT is cancelled.
- If a primary address is included, the LOCAL command is sent to a specific listener and LOCAL LOCKOUT is not disabled for any other instrument or device.
- For interface select code 8 (IBASIC), when a LOCAL 8 command is sent, all instruments previously assigned to the IBASIC computer are released (unassigned). However, a REMOTE 8 must be sent following the LOCAL command for a subsequent LOCAL command to release assigned instrument(s). For example, LOCAL 80903 releases an instrument at secondary address 03 if the instrument was previously assigned to IBASIC.
- See the LOCAL command in the *Agilent Instrument BASIC Language Reference Manual* for a summary of GPIB bus actions for the LOCAL command.

LOCAL LOCKOUT

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC interface (select code 8), executing LOCAL LOCKOUT prevents all instruments that are assigned to IBASIC and are set to the REMOTE state from being operated from their virtual front panels on the terminal.

For the GPIB interface (select code 7), executing LOCAL LOCKOUT prevents all external GPIB devices which are set to the REMOTE state from being operated from their own front panels.



Item	Description	Range
I/O path name	name assigned to an interface select code	any valid name (see ASSIGN)
interface select code	numeric expression, rounded to an integer	7 for GPIB and 8 for IBASIC

Semantics

- The IBASIC computer must be the Active Controller to execute LOCAL LOCKOUT. LOCAL LOCKOUT does not cause interface reconfiguration but issues a universal command which is received by all devices on the interface, whether addressed or not. (Some Agilent E1406 User Interface operations such as menu control and display scrolling are still active in Local Lockout mode.)
- If an internal instrument is in the LOCAL state when LOCAL LOCKOUT is sent, the instrument remains in the LOCAL state. LOCAL LOCKOUT does not become effective until the instrument receives a REMOTE message and is addressed to listen. If an instrument is in the REMOTE state when LOCAL LOCKOUT is sent, Agilent E1406 front panel control is immediately disabled for that instrument.
- After executing LOCAL LOCKOUT via the IBASIC interface (select code 8), you can enable front panel keyboard control by sending the LOCAL 8 command or by cycling power. The LOCAL 809ss (ss = secondary address) command enables the front panel for that instrument, but a subsequent REMOTE command disables it.
- Sending LOCAL 8 removes LOCAL LOCKOUT for all instruments assigned to IBASIC and places them in the LOCAL state (releases the instruments). When the instrument is assigned to IBASIC, sending LOCAL 809ss (ss = secondary address) places the selected instrument in the LOCAL state (releases the instrument).
- For System Controller mode only, sending LOCAL 7 removes LOCAL LOCKOUT for all external GPIB devices and places them in the LOCAL state. Sending LOCAL 709ss (ss = secondary address) places selected external GPIB devices in the LOCAL state.

OFF CYCLE

Keyboard Executable	No
Programmable	Yes
In an IF...THEN...	Yes

This statement cancels event-initiated branches previously defined and enabled by an ON CYCLE statement.

Example Statement

OFF CYCLE

Cancels event-initiated branches previously defined with ON CYCLE

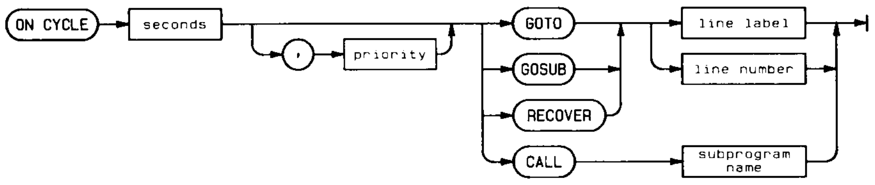
Semantics

When OFF CYCLE is executed, any pending ON CYCLE branches for the affected interface(s) are lost and further ON CYCLE events are ignored.

ON CYCLE

Keyboard Executable	No
Programmable	Yes
In an IF...THEN...	Yes

This statement defines and enables an event-initiated branch to be taken each time the specified number of seconds has elapsed.



Item	Description	Range
seconds	numeric expression, rounded to the nearest 0.01 second	0.01 through 167772.16
priority	numeric expression, rounded to an integer. Default = 1	1 through 15
line label	name of a program line	any valid name
line number	integer constant identifying a program line	1 through 32 767
subprogram name	name of a SUB subprogram	any valid name

Example Statements

ON CYCLE 1 GOTO 1200

Go to line 1200 every second, with (default) software priority 1

ON CYCLE 3600, 12 CALL Report

Call subprogram Report every hour, with software priority 12

Semantics

- The most recent ON CYCLE (or OFF CYCLE) definition overrides any previous ON CYCLE definition. If the new ON CYCLE definition occurs in a different context from the previous ON CYCLE definition, the old definition is restored when the calling context is restored, but the time value of the new ON CYCLE definition remains in effect.

- The highest software priority for ON CYCLE is 15 which is less than the (fixed) priority of 16 for ON TIMEOUT and 17 for ON ERROR. CALL and GOSUB service routines get the priority specified in the ON... statement which set up the event-initiated branch. The system priority is not changed when a GOTO branch is taken.
- Any specified line label or line number must be in the same context and the ON CYCLE statement. CALL and GOSUB will return to the next line that would have executed if ON CYCLE had not occurred, and the system priority is restored to that existing before ON CYCLE.
- RECOVER forces the program to go directly to the specified line in the context containing the ON CYCLE statement. When RECOVER forces a change of context, the system priority is restored to that existing in the original (defining) context at the time the original context was exited.
- CALL and RECOVER remain active when the context changes to a subprogram, unless the change in context is caused by a keyboard-originated call. GOSUB and GOTO remain active when the context changes to a subprogram, but the branch cannot be taken until the calling context is restored.
- ON CYCLE is disabled by DISABLE and deactivated by OFF CYCLE. If the cycle value is so short that the computer cannot service it, the interrupt from the event is lost.

READIO

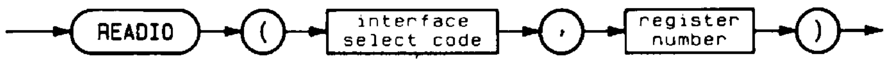
Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

READIO (and WRITEIO) provide interface control functions not available with ENTER and OUTPUT. For IBASIC, READIO reads the contents of the specified hardware register for the:

- GPIB interface (select code 7)
- IBASIC interface (select code 8) (VXI device registers)
- Built-in RS-232C interface (select code 9)
- Agilent E1324A RS-232C/422 interfaces (select codes 21-27)

READIO also reads the specified byte or word of IBASIC memory (select codes 9826 and -9826). You can use parameter 9827 to read the address of a variable in IBASIC memory.

NOTE Unexpected results may occur with select codes 9826 and 9827.



Item	Description	Range
select code	numeric expression, rounded to an integer	1 through 31; ±9826; 9827
register number or memory address	numeric expression, rounded to an integer	hardware-dependent

Example Statements

PRINT "VXI Card LADD, Reg#" = READIO(8, Ladd*256 +Reg)

*Display contents of register I for instrument at logical address LADD, where register address = 256*LADD + Register#*

Write_status = READIO(9,2)

Assign the value in register 2 of the built-in RS-232 port to variable

Peek_byte = READIO(9826,Mem_addr)

Read a byte of data from IBASIC memory address Mem_addr

Mem_addr = READIO(9827,Array(I))

Read address of variable in IBASIC memory

Semantics

READIO and WRITEIO are added to provide I/O functions not available with OUTPUT and ENTER. For IBASIC, READIO can be used with:

- GPIB Interface (select code 7)
- IBASIC Interface (select code 8) (VXI device registers)
- RS-232/422 Serial Interfaces (select codes 9, 21-27)
- IBASIC Memory (select codes 9826, 9827)

Using READIO With GPIB Interface (Select Code 7)

To use READIO from the IBASIC computer via the GPIB interface (select code 7), the Agilent E1406 must be set for System Controller mode. The READIO registers for the GPIB interface follow.

READIO Registers for GPIB Interface

Register	Title
3	Interrupt Enable/Request Status
4	Interrupt Status
5	Controller Status and Address
17	Interrupt Status 0 (*)
19	Interrupt Status 1 (*)
21	Interface Status
23	Control-Line Status
29	Command Pass-Through
31	Data-Line Status(*)

* = READIO operation changes state of the interface

GPIB READIO Register 3 **Interrupt Enable/Request Status**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Interrupt Enabled	Interrupt Requested	X	X	X	X	X	X
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

X = Bit not implemented on internal GPIB (interface select code 7)

GPIB READIO Register 4 Interrupt Status

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
Active Controller	Parallel Poll Configu-ration Change	My Talk Address Received	My Listen Address Received	EOI Received	SPAS	Remote/ Local Change	Talker/ Listener Address Change
Value=-32768	Value=16384	Value=8192	Value=4096	Value=2048	Value=1024	Value=512	Value=256
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Trigger Received	Hand-shake Error	Unrecog-nized Universal Command	Secondary Command While Addressed	Clear Received	Unrecognized Addres-sed Com-mand	SRQ Received	x
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

GPIB READIO Register 5 Controller Status and Address

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
System Controller	Not Active Controller	X	X	X	X	X	X
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bit 7 is set (1) if the interface is the System Controller.
Bit 6 is set (1) if the interface is not the current Active Controller and clear (0) if it is the Active Controller.
X = Bit not implemented on internal GPIB (interface select code 7).

GPIB READIO Register 17 **MSB of Interrupt Status**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
MSB Interrupt	LSB Interrupt	Byte Received	Ready for Next Byte	End Detected	SPAS	Remote /Local Change	My Address Change
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bit 7 set (1) indicates an interrupt has occurred whose cause can be determined by reading the contents of this register.
Bit 6 set (1) indicates an interrupt has occurred whose cause can be determined by reading Interrupt Status Register 1 (READIO Register 19).
Bit 5 set (1) indicates a data byte has been received.

Bit 4 set (1) indicates this interface is ready to accept the next data byte.
Bit 3 set (1) indicates an End (EOI with ATN=0) has been detected.
Bit 2 set (1) indicates a Remote/Local State change has occurred.
Bit 0 set (1) indicates a change in My Address has occurred.

GPIB READIO Register 19 **LSB of Interrupt Status**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Trigger Received	Handshake Error	Unrecognized Command Group	Secondary Command While Addressed	Clear Received	My Address Received (MLA or MTA)	SRQ Received	IFC Received
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bit 7 set (1) indicates a Group Execute Trigger command has been received.
Bit 6 set (1) indicates an Incomplete-Source-Handshake error has occurred.
Bit 5 set (1) indicates an unidentified command has been received.
Bit 4 set (1) indicates a Secondary Address has been sent while in the extended-addressing mode.

Bit 3 set (1) indicates the interface has entered the Device-Clear-Active State.
Bit 2 set (1) indicates My Address has been received.
Bit 1 set (1) indicates a Service Request has been received.
Bit 0 set (1) indicates the Interface Clear message has been received.

GPIB READIO Register 21 **Interface Status**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
REM	LLO	ATN True	LPAS	TPAS	LADS	TADS	LSB of Last Address
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bit 7 set (1) indicates this interface is in the Remote State.
Bit 6 set (1) indicates this interface is in the Local Lockout State.
Bit 5 set (1) indicates the ATN signal line is true.
Bit 4 set (1) indicates this interface is in the Listener-Primary-Addressed State.

Bit 3 set (1) indicates this interface is in the Talker-Primary-Addressed State.
Bit 2 set (1) indicates this interface is in the Listener-Addressed State.
Bit 1 set (1) indicates this interface is in the Talker-Addressed State.
Bit 0 set (1) indicates this is the least-significant bit of the last address recognized by this interface.

GPIB READIO Register 23 **Control-Line Status**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ATN True	DAV True	NDAC [1] True	NRFD [1] True	EOI True	SRQ [2] True	IFC True	REN True
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

A set bit (1) indicates the corresponding line is currently true, while a 0 indicates the line is currently false. [1] Only if addressed to TALK, otherwise not valid.
[2] Only if Active Controller, else not valid.

GPIB READIO Register 29 **Command Pass-Through**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

This register can be read during a bus holdoff to determine which Secondary Command has been detected.

GPIB READIO Register 31 **Bus Data Lines**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

A set bit (1) indicates the corresponding GPIB data line is currently true, while a 0 indicates the line is currently false.

Using READIO With IBASIC Interface (Select Code 8)

For READIO and the IBASIC interface, the form to read the value of a register on an instrument is Read_addr = READIO (8, Ladd*256 + Reg#) where Ladd is the Logical Address of the instrument, and Reg# is the register number for the instrument. A 16-bit INTEGER number is returned.

Using READIO With Serial Interfaces (Select Codes 9, 21-27)

To use READIO with the RS-232/422 serial interfaces, the built-in RS-232 port must first be assigned to IBASIC with DIAG:COMM:SER:OWNER IBASIC sent to the System instrument and/or the Agilent E1324A plug-in module (s) must be assigned to IBASIC by setting the LADDR switch(es) to 241, 242, ..., 247.

Then, the first Agilent E1324A module (module #1) has LADD 241 and select code 21, the second module has LADD 242 and select code 22,...,and the seventh module has LADD 247 and select code 27. Note that LADDs must be sequential and contiguous. For example, you cannot use LADD 242 without having LADD 241.

With READIO/WRITEIO, the program can send an RS-232C BREAK signal and read the status of the interface. (This cannot be done with ENTER/OUTPUT.) The READIO register map for the RS-232/422 serial interfaces (select codes 9, 21-27) follows.

READIO Register Map for Serial Interfaces

Reg #	Title	Returns
0	Card Identification	0 for built-in and plug-in modules
1	Read Data Register	Decimal code for character returned or -1 if no character was received (does not wait for a character).
2	Write Data Status	0 if the last WRITEIO to WRITEIO Register 1 was successful, 1 if unsuccessful.
3	Port Status	Status of the serial port (changes state of interface) - see Bit Map following.
4	ENTER Status	Status of the last ENTER statement. See Bit Map following.
5	Port Configuration	32-bit quantity reflecting current port configuration.
6	Buffer Size	Size of the port's I/O buffers.

Bit Map for READIO Registers 3 and 4

Bit	Information	Bit	Information	Bit	Information
15-1211	Unused	7	Parity Error	3	DSR Line Status
10	Buffer Error*	6	Overrun Error	2	CTS Line Status
9	Device Error**	5	DCD Line Status	1	RTS Line Status
8	Break Error***	4	RI Line Status	0	DTR Line Status
	Framing Error				

* = Received data buffer overflow
** = Errors not covered by other bits
*** = Break was received (framing error often present)

Using READIO With IBASIC Memory (Select Codes 9826, 9827)

To use READIO with the IBASIC memory, use select code 9826 to read ("Peek") a byte of data from a register or use select code -9826 to read a word of data from the register. Select code 9827 is used for the address of a variable or array element . For example, Peek_byte=READIO (9826, Mem_address) reads a byte of data from memory while Peek_word=READIO (-9826 , Mem_address) reads a word of data from memory. An example way to find the address of an array in IBASIC memory is:

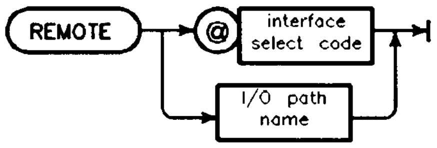
```
10   INTEGER A(1:10)
20   Addr = READIO (9827,A(1))
```

REMOTE

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC interface (select code 8), REMOTE 8 places all addressed instruments in the REMOTE state. REMOTE 16 is not supported. REMOTE 809ss and REMOTE 16[XX]XX send the word-serial Set Lock command.

For the GPIB interface (select code 7) (System Controller mode only), REMOTE 7 places all external GPIB devices having remote/local capabilities in the REMOTE state.



Item	Description	Range
I/O path name	name assigned to a device or devices	any valid name (see ASSIGN)
interface select code	numeric expression, rounded to an integer	7 for GPIB, 8 for IBASIC

Example Statement

```
REMOTE 722
```

For System Controller mode only, sets external GPIB device at primary address 22 to REMOTE state

Semantics

If only the interface select code (7 or 8) is specified, the REMOTE state for all devices on the interface having remote/local capabilites is enabled. If primary addressing is used, only the specified devices are placed in the REMOTE state.

When the IBASIC computer is the System Controller, or at power-on or reset, or when ABORT is executed interface devices are automatically enabled for the REMOTE state and switch to REMOTE when they are addressed to listen.

See the REMOTE command in the *Agilent Instrument BASIC Language Reference Manual* for a summary of GPIB bus actions for the REMOTE command.

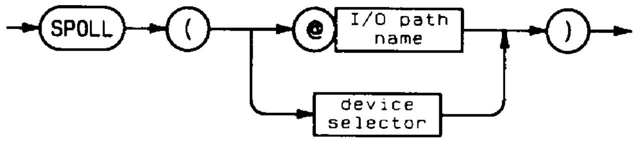
SPOLL

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC interface (select code 8 or 16), SPOLL returns an integer containing the Serial Poll response from an addressed internal instrument. SPOLL returns the weighted sum of all bits which are set in the addressed instrument's Status Byte Register.

For the GPIB interface (select code 7) (System Controller mode only), SPOLL returns an integer containing the Serial Poll response from an addressed external GPIB device. SPOLL returns the weighted sum of all bits which are set in the addressed instrument's Status Byte Register.

NOTE See the appropriate *Agilent 75000 Plug-In Module User's Manual* for a description of the instrument's Status Byte Register. See the appropriate device programming manual for a description of external GPIB device Status Byte Registers.



Item	Description	Range
I/O path name	name assigned to a device	any valid name (see ASSIGN)
device selector	numeric expression, rounded to an integer	must include a primary address (see Glossary)

Example Statements

```
Dvm_stat=SPOLL(80901)
```

Sends Serial Poll to internal instrument at secondary address 01 and clears bit 6 (RQS) of the instrument's Status Byte Register

```
Ext_stat=SPOLL(722)
```

For System Controller mode only, sends Serial Poll to external GPIB device at primary address 22 and clears bit 6 (RQS) of the device's Status Byte Register

Semantics The SPOLL command, like the *STB? Common Command, returns the weighted sum of all set bits in an instrument's or device's Status Byte Register. However, SPOLL differs from *STB? in that SPOLL clears bit 6 (RQS) of the Status Byte Register, while *STB? does not clear bit 6 of the register.

The IBASIC computer must be the Active Controller to execute SPOLL on interface 7.

See the SPOLL command in the *Agilent Instrument BASIC Language Reference Manual* for a summary of GPIB bus actions for the SPOLL command.

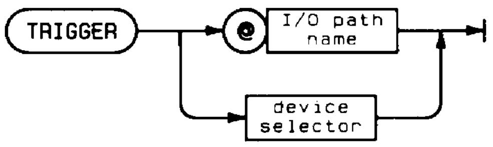
TRIGGER

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

For the IBASIC select code 8 interface executing TRIGGER 809ss triggers the instrument at secondary address=ss.

For the IBASIC select code 16 interface TRIGGER 16[XX]XX sends a word-serial trigger command to a selected device.

For the GPIB interface (select code 7 - System Controller mode only), executing TRIGGER 7 triggers all external GPIB devices that are addressed to listen, while executing TRIGGER 7ppss triggers the external GPIB device at primary address pp and secondary address ss.



Item	Description	Range
I/O path name	name assigned to a device or devices	any valid name (see ASSIGN)
device selector	numeric expression, roundd to an integer	(see Glossary)

Example Statements

TRIGGER 80901

Sends a trigger to an internal instrument at secondary address 01

TRIGGER 70922

For System Controller mode ONLY, sends a trigger to an external GPIB device at secondary address 22

Semantics

If only the interface select code (7 or 8) is specified, all instruments or devices on that interface that are addressed to listen are triggered. If a primary or secondary address is used, only the addressed instrument or device is triggered.

TRIGGER triggers an internal instrument or external GPIB device when *all* the following conditions are true:

- The instrument's or device's trigger source is set to BUS (TRIG:SOUR BUS command)
- The instrument or device is in the Wait For Trigger state.
- The instrument or device is addressed to listen.

See the TRIGGER command in the *Agilent Instrument BASIC Language Reference Manual* for a summary of GPIB bus actions for the TRIGGER command.

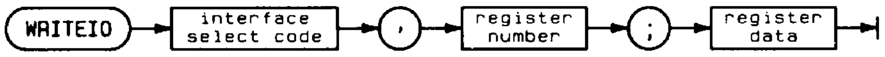
WRITEIO

Keyboard Executable	Yes
Programmable	Yes
In an IF...THEN...	Yes

WRITEIO (and READIO) provides interface functions not available with ENTER and OUTPUT. For IBASIC, WRITEIO writes data to the specified hardware register for the:

- GPIB interface (select code 7)
- IBASIC interface (select code 8) (VXI instrument registers)
- Built-in RS-232C interface (select code 9)
- Agilent E1324A RS-232C/422 interfaces (select codes 21-27).

WRITEIO also writes a specified byte or word to IBASIC memory (select codes 9826 and -9826). Use parameter 9827 to execute MC 68000 object code in memory.



Item	Description	Range
select code	numeric expression, rounded to an integer	1 through 31; -31 through -1; ±9826; 9827
register # or memory address	numeric expression, rounded to an integer	-2^{31} through $+2^{31}$ - 1 (hardware-dependent)
register or memory data	numeric expression, rounded to an integer	-2^{31} through $+2^{31}$ - 1

Example Statements

```
WRITEIO  8,Ladd*256+Reg#;Set_pctl
```

*Write data to register of instrument, where register address = LADD*256 + Reg#*

```
WRITEIO  9,1;Data_ser
```

Write data to register 1 of built-in RS-232C serial port

```
WRITEIO 9827,Jsr_address;DO_data
```

Use for CSUB execution

Semantics

Since the Agilent E1406 does not support STATUS and CONTROL, READIO and WRITEIO are added to provide interface functions not available with OUTPUT and ENTER. For IBASIC, WRITEIO can be used with:

- GPIB Interface (select code 7)
- IBASIC Interface (select code 8) (VXI instrument registers)
- RS-232/422 Serial Interfaces (select codes 9, 21-27)
- IBASIC Memory (select codes 9826, 9827)

Using WRITEIO With GPIB Interface (Select Code 7)

To use WRITEIO with the GPIB interface (select code 7), the Agilent E1406 must be set for System Controller mode. To use WRITEIO with the GPIB interface, use a positive select code value to write a byte of data to a register or use a negative select code value to write a word of data to the register. The WRITEIO registers for the GPIB interface follow.

WRITEIO Registers for the GPIB Interface

Register	Title
0	Reset Interface*
3	Interrupt Enable
4	Release Holdoff
17	MSB of Interrupt Mask
19	LSB of Interrupt Mask
23	Auxiliary Command Register
25	Address Register
27	Serial Poll Response
29	Parallel Poll Register
31	Data Out Register

* Equivalent to RESET 7

GPIB WRITEIO Register 3 Interrupt Enable

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Enable Interrupt	X	X	X	X	X	X	X
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

X = bits 6 through 0 not implemented on GPIB interface (interface select code 7).

GPIB WRITEIO Register 4 **Release Holdoff**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 X
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

x = Writing anything to this register releases NDAC holdoff. If non-zero, accept last secondary address as valid. If zero, do not accept last secondary address(stay in LPAS or TPAS).

GPIB WRITEIO Register 17 **MSB of Interrupt Mask**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Unused	Unused	Byte Received	Ready for Next Byte	End Detected	SPAS	Remote/ Local Change	My Address Change
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Setting a bit of this register enables an interrupt for the specified condition.

GPIB WRITEIO Register 19 **LSB of Interrupt Mask**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Trigger Received	HandshakeE rror	Unrecognized Command Group	Secondary Command While Addressed	Clear Received	My Address Received (MLA or MTA)	SRQ Received	IFC Received
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Setting a bit of this register enables an interrupt for the specified condition.

GPIB WRITEIO Register 23 **Auxiliary Command Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Set	X	X	Auxiliary Command Function				
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bit 7 is set (1) for a Set operation and clear (0) for a Clear operation.
Bits 6 and 5 are "don't cares".
Bits 4 through 0 are Auxiliary-Command-Function-Select bits.

NOTE The commands shown in the following table can be sent to the interface by sending the specified numeric values to GPIB WRITEIO Register 23.

GPIB WRITEIO Register 23 - Auxiliary Commands

Decimal Value	Auxiliary Command Description
0	Clear Chip Reset
128	Set Chip Reset
1	Release ACDS holdoff. If Address Pass Through is set, it indicates an invalid secondary
	has been received.
129	Release ACDS holdoff. If Address Pass Through is set, it indicates a valid secondary
	has been received.
2	Release RFD holdoff.
130	Same command as decimal 2 (above).
3	Clear holdoff on all data.
131	Set holdoff on all data.
4	Clear holdoff on EOI only.
132	Set holdoff on EOI only.
5	Set New Byte Available (nba) false.
133	Same command as decimal 5 (above).
6	Pulse the Group Execute Trigger line, or clear the line if it was set by decimal command
	134.
134	Set Group Execute Trigger line.
7	Clear Return To Local (rtl).
135	Set Return To Local (must be cleared before the device is able to enter the Remote state).
	Causes EOI to be sent with next data byte.
8	Same command as decimal 8 (above).
136	Clear Listener State (also cleared by decimal 138).
9	Set Listener State.
137	Clear Talker State (also cleared by decimal 137).
10	Set Talker State.
138	Go To Standby (gts; controller sets ATN false).
11	Same command as decimal 11 (above).
139	Take Control Asynchronously (tca; ATN true).
12	Same command as decimal 12 (above).
140	Take Control Synchronously (tcs; ATN true).
13	Same command as decimal 13 (above).
141	Does not apply to Agilent E1406.
14	Does not apply to Agilent E1406.
142	Clear the Interface Clear line (IFC).
15	Set Interface Clear (IFC maintained > 100 usec).
143	Clear the Remote Enable (REN) line
16	Set Remote Enable
144	Request control (after TCT is decoded, issue this to wait for ATN to drop and receive
17	control).
	Same command as decimal 17 (above).
145	Release control (issued after sending TCT to complete a Pass Control and set ATN false).
18	Same command as decimal 18 (above).
	Enable all interrupts.
146	Disable all interrupts.
19	Pass Through next Secondary Command.
147	Same command as decimal 20 (above).
20	Set TI delay to 10 clock cycles (2 us at 5 MHz).
148	Set TI delay to 6 clock cycles (1.2 us at 5 MHz).
21	Clear Shadow Handshake.
149	Set Shadow Handshake.
22	Set RSV2.
150	
152	

GPIB WRITEIO Register 25 **Address Register**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Enable Dual Addressing	Disable Listen	Disable Talker	Primary Address				
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bit 7 set (1) enables the Dual-Primary-Addressing Mode.
Bit 6 set (1) invokes the Disable-Listen function.
Bit 5 set (1) invokes the Disable-Talker function.
Bits 4 through 0 set the device's Primary Address (same address bit definitions as READIO Register 5). Writing to this register also sets the Agilent E1406 non-volatile mainframe address to the value of the Primary Address.

GPIB WRITEIO Register 27 **Serial Poll Response Byte**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Device-Dependent Status	Request Service (RSV1)	Device-Dependent Status					
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

Bits 7 and 5 through 0 specify the Device-Dependent Status.
Bit 6 sends an SRQ if set (1).

NOTE

Given an unknown state of the Serial Poll Response Byte, it is necessary to write the byte with Bit 6 set to zero followed by a write of the byte with bit 6 set to the desired final value. This will ensure that an SRQ will be generated if desired (RSV1).

RSV2 can be used to set the SRQ bit with a Serial Poll automatically clearing this bit. When RSV1 is used, you must clear bit 6 with another WRITEIO command.

GPIB WRITEIO Register 29 **Parallel Poll Response**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

A 1 sets the appropriate bit true during a Parallel Poll, while a 0 sets the corresponding bit false. Initially, and when Parallel Poll is not configured, this register must be set to all zeros.

GPIB WRITEIO Register 31 **Data-Out Register**

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
EOI*	DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
Value = 256	Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

* = Setting this bit asserts EOI with the data byte specified in bits 0 through 7

Using WRITEIO With IBASIC Interface (Select Code 8)

To use WRITEIO to write to instruments via the IBASIC interface (select code 8), the form is WRITEIO 8, Ladd*256 + Reg#; Datum where Ladd is the Logical Address of the instrument to be written to, Reg# is the register number on the instrument, and Datum is a 16-bit INTEGER number.

Using WRITEIO With Serial Interfaces (Select Codes 9, 21-27)

To use WRITEIO for a serial interface, the built-in RS-232 port must first be assigned to IBASIC with DIAG:COMM:SER:OWNER IBASIC sent to the System instrument or the Agilent E1324A plug-in module(s) must be assigned to IBASIC by setting the LADD switch(es) to 241, 242, ..., 247.

Then, the first Agilent E1324A module (module #1) has LADD 241 and select code 21, the second module has LADD 242 and select code 22,..., and the seventh module has LADD 247 and select code 27. Note that LADDs must be sequential and contiguous. For example, you cannot use LADD 242 without having LADD 241.

With READIO/WRITEIO, the program can send an RS-232C BREAK signal and read the status of the interface. (This cannot be done with ENTER/OUTPUT.) The WRITIO register map for the RS-232/422 serial interfaces follows.

WRITEIO Register Map for RS-232/422 Serial Interfaces

Reg #	Title	Action
0	Interface Reset	Clears transmit/receive buffers*
1	Write Data	Write character to serial port without waiting
2	Send Break	Send break to serial port

* = Does not change port settings such as baud rate, etc.

There are two steps to write data to a serial interface using WRITEIO (and READIO):

1. Use WRITEIO <*sc*>,1;Data to write data to the Write Data register (WRITEIO register 1) for the code to be used.
2. Use READIO (<*sc*>,2) to read the results from READIO register 2 (Write Data Status). If "0" is returned, the write to WRITEIO register 1 was successful. If "1" is returned, the write was not successful, and the process must be repeated.

For example:

```
100  WRITEIO 21,1;Data_ser
```

Writes data to WRITEIO register 1 (Write Data register)

```
110  A = READIO (21,2)
```

Reads READIO register 2 (Write Data Status register). If the write was successful, 0 is returned. If unsuccessful, 1 is returned and you should repeat the process.

Using WRITEIO With IBASIC Memory (Select Codes 9826, 9827)

To use WRITEIO with the IBASIC memory, use a positive select code value to write a byte of data to a memory address or use a negative select code value to write a word of data to a memory address. However, you cannot access memory locations below $1E000_h$.

Using select code 9826 allows you to write directly into IBASIC memory addresses. Using select code 9827 allows you to execute a machine-language JSR ("Jump to Subroutine") instruction.

Using select code 9826 lets you write directly into IBASIC memory addresses. For example:

```
WRITEIO 9826, Mem_address; Data_byte
```

Writes a byte of data to IBASIC memory

```
WRITEIO -9826, Mem_address; Data_word
```

Writes a word of data to IBASIC memory

The second parameter in WRITEIO is the memory address of the byte or word to be written and is interpreted as a decimal address. For example, an address of 100 000 is 10^5. The third parameter is also interpreted as a decimal number.

CAUTION

Writing into certain memory addresses may damage your computer's hardware. (See your computer manuals for a description of the computer architecture.). To avoid this, only write into numeric array variables with WRITEIO. Agilent Technologies cannot be held liable for any damages caused by improper use of this feature.

Using select code 9827 lets you execute an MC 68000 machine-language JSR ("Jump to Subroutine") instruction. One parameter can be specified in the WRITEIO statement (DO_data in the example below), which will be written in the processor's DO register before the JSR instruction is executed and pushed onto the A7 stack.

The following example program shows one way to place a machine-language subroutine in an INTEGER array and then jumping to this subroutine.

```
10      DATA   (INTEGER  values of MC 68000 machine-language
20      DATA    instructions go here.)
          .
100   INTEGER Int_array (1:100)
110   READ Int_array(*), DO_data                   !Read instructions
115   !                                              and DO register data
120   Jsr_addr=READIO(9827,Int_array(1))         !Get JSR address
130   WRITEIO 9827, Jsr_addr;DO_data              !Put data in DO, then do
140   PRINT "Returned from subroutine"                JSR
            .
            .
```

For this program, IBASIC first keeps a copy of the MC 68000 processor registers D0 through D7 and A0 through A6 on the stack. Then the value represented by the expression DO_data is placed in the DO register and is pushed onto the stack, and a machine-language JSR instruction is executed. The value of the expression Jsr_addr is the address of an INTEGER array that contains machine-language instructions. The value of Jsr_addr is forced to an even address before the JSR is executed.

The last instruction in the subroutine should return control to IBASIC with an RTS ("Return from Subroutine") instruction. IBASIC will first restore the processor registers and pop the data value (from the stack) to the state they were in before the JSR was performed (by the WRITEIO statement).

Register A7 (the stack pointer) must have the same value at the final RTS as it had when IBASIC executed the JSR. The other processor register can be used freely in the assembly routine. IBASIC then resumes program execution at the line following the WRITEIO statement.

Chapter 8 Contents

Chapter 8

SCPI Command Reference

Using This Chapter

This chapter describes the Standard Commands for Programmable Instruments (SCPI) commands which apply to the IBASIC instrument in the Agilent E1406. Chapter contents are:

- **SCPI Conformance Information** shows SCPI commands implemented by the IBASIC instrument.
- **SCPI Command Overview** summarizes SCPI command structure and parameter types.
- **SCPI Command Descriptions** describes the SCPI commands which apply to the IBASIC instrument. The SCPI commands must be sent to the IBASIC instrument at secondary address 30. For example:

  OUTPUT 80930;"DIAG:IBAS:DISP BUIL"

  Command sent from IBASIC

  OUTPUT 70930;"DIAG:IBAS:DISP BUIL"

  Command sent from external controller

SCPI Conformance Information

The following tables show the *Standard Commands for Programmable Instruments* Standard Version 1990.0 SCPI confirmed commands and commands that are not part of the 1990.0 SCPI standard but are implemented by the IBASIC instrument. Commands that are not part of the SCPI Standard Version 1990.0 definition are indicated by a [Not SCPI] entry in the *Notes* column. The SCPI commands must be sent to the IBASIC Instrument at address 80930. For example:

DIAGnostic Subsystem Commands for IBASIC

Keyword	Parameter Form	Notes
DIAGnostic		
:COMM		[Not SCPI]
:SER[n]		
:STORe		
:FILESystem	<parameter>,<value>	
:FILESystem?	<parameter>	
:IBASic		
:BLOCKsize	<bytes>	
:BLOCKsize?		
:DISPlay	<parameter>	
:DISPlay?		
:STACKsize	<bytes>	
:STACKsize?		
:SYNC		
[:CLOCk]		
[:CLOCk]?		

PROGram Subsystem Commands for IBASIC

Keyword	Parameter Form	Notes
PROGram		
:CATalog?		[query only]
[:SELected]		
:DEFine	<program_code>	
:DEFine?		
:DELete	<progname>	[no query]
:EXECute	<program_command>	[no query]
:MALLocate	<nbytes>|DEFault	
:MALLocate?		
:NAME	<progname>	
:NAME?		
:NUMBer	<varname> [,<nvalues>]	
:NUMBer?	<varname>	
:STATe	RUN|PAUSe|STOP|CONTinue	
:STATe?		
:STRing	<varname> [,<svalues>]	
:STRing?	<varname>	
:WAIT		
:WAIT?		

SYSTem Subsystem Commands for IBASIC

Keyword	Parameter Form	Notes
SYSTem		
:COMMunicate		
:SERial[n]		
:CONTrol		[Not SCPI]
:DTR	ON|OFF|STANdard|IBFull	[Not SCPI]
:DTR?		[Not SCPI]
:RTS	ON|OFF|STANdard|IBFull	[Not SCPI]
:RTS?		[Not SCPI]
[:RECeive]		
:BAUD	<baud_rate>|MIN|MAX	
:BAUD?	[MIN|MAX]	
:BITS	7|8|MIN|MAX	
:BITS?	[MIN|MAX]	
:PACE		
[:PROTocol]	XON|NONE	[Not SCPI]
[:PROTocol]?		[Not SCPI]
:THReshold		[Not SCPI]
:STARt	<characters>|MIN|MAX	[Not SCPI]
:STARt?	[MIN|MAX]	[Not SCPI]
:STOP	<characters>|MIN|MAX	[Not SCPI]
:STOP?	[MIN|MAX]	[Not SCPI]
:PARity		
:CHECk	1|0|ON|OFF	
:CHECk?		
[:TYPE]	EVEN|ODD|ZERO|ONE|NONE	
[:TYPE]?		
:SBITs	1|2|MIN|MAX	
:SBITs?	[MIN|MAX]	
:TRANsmit		
:AUTO	1|0|ON|OFF	
:AUTO?		
:PACE		
[:PROTocol]	XON|NONE	[Not SCPI]
[:PROTocol?]		[Not SCPI]
:ERRor?		

SCPI Command Overview

This section summarizes SCPI command format and structure. See the *Beginner's Guide to SCPI* (available from your Agilent Technologies Sales and Support Office) for a complete description of SCPI command formats and structure.

SCPI Command Format

As defined in the *Standard Commands for Programmable Instruments Manual,* Standard Commands for Programmable Instruments (SCPI) commands are organized into a hierarchial command structure and are grouped into **subsystem** command groups.

The subsystem command structure generally consists of a top-level (**root**) command and one or more **lower-level** commands. Each command consists of a **keyword** and (possibly) one or more **parameters**. Commands can be **abbreviated** or can be **implied**. Implied commands appear in square brackets ([]), but the brackets are not sent with the command.

A **colon** (:) always separates a command from the next-level command. Unless specified, a command always has a **query** version which is the command followed by a question mark (?). Lower-level commands may or may not have **parameters**. Parameters (when specified) can be required or optional. Optional parameters are enclosed in square brackets ([]), but the brackets are not sent with the command.

For example, in the following command table, PROGram is the keyword for the PROGram subsystem command group and is the root command, :CATalog? is a first-level (required) command, [:SELected] is a first-level implied command, :DEFine is a second-level command, and :DEFine? is the query version of :DEFine.

Typical PROGram Subsystem Commands

Keyword	Parameter
PROGram	
:CATalog?	
[:SELected]	
:DEFine	<program_code>
:DEFine?	

The parameter for :DEFine is <*program_code*>. Since the parameter is not enclosed in square brackets ([]), it is a required parameter. You can use colons to form commands using keywords from different levels. Two examples are: PROGram:CATalog? and PROGram:SELected:DEFine <*program_code*>.

SCPI Command Types

SCPI commands can be **required**, **abbreviated**, or **implied** and usually have a **query** form. In addition, some commands have what appears to be a **variable** syntax.

Required Commands

Commands in the syntax tables which are not enclosed in square brackets ([]) are **required** commands and must be sent in the form shown. (See Abbreviated Commands which follows.)

Abbreviated Commands

The command syntax shows most commands as a mixture of upper- and lower-case letters. The upper-case letters indicate the short form of the command and must be used. The lower-case letters are optional and can be used as desired in the command. You can use all upper-case, all lower-case, or a mixture of letters.

For example, if the command syntax shows DEFine, then DEF or DEFINE is acceptable. Other forms of DEFine, such as DEFIN or DE will generate an error. Since upper-case and lower-case letters can be used, DeFiNe, def, define, etc. are also acceptable.

Implied Commands

Implied commands appear in square brackets ([]) in the command syntax. (Note that the brackets are not part of the command and are not sent to an instrument.) When you send a lower-level command without sending the preceding implied command, the instrument responds as if the implied command had been sent.

For example, since [:SELected] is an implied command for the PROGram subsystem, PROGram:SELected:DEFine <program_code> and PROGram:DEFine <program_code> are equivalent.

Query Commands

Unless noted, all SCPI commands have a **query** version formed by adding a question mark (?) to the command. For example, PROG:DEF? is the query version of the PROG:DEF command. In this manual, commands which do not have a query version are indicated by [no query] in the subsystem command table. Commands which are query ONLY are indicated by a [query only] entry in the table.

Variable Command Syntax

A few commands use what appears to be a variable syntax. For example, in SYST:COMM:SER[n], the "n" is replaced by a number from 0 through 7. In this case, no space is left between the command and the number since the number is NOT a parameter, but is part of the command syntax. Since [n] is optional, if no value is entered for "n", a default value is used.

SCPI Command Parameters

Some SCPI commands have parameters which can be required or optional. In this manual, <> denotes a required parameter and [] denotes an optional parameter. The <> and [] notations are not part of the parameter and are not sent with the command.

If you do not specify a value for an optional parameter, the instrument chooses a default value. For example, consider the command SYST:COMM:SER1:CONT:BAUD? [MIN|MAX]. The command sent without a parameter returns the current baud rate.

The command sent with the MIN parameter returns the minimum baud rate available, while the command sent with the MAX parameter returns the maximum baud rate available. The following table summarizes SCPI command parameter types.

SCPI Parameter Types

Parameter Type	**Description**	**Examples**
Numeric	Decimal representation of numbers including optional signs, decimal points and scientific notation.	100, 100., -1.23, 4.56e<space>3
Extended Numeric	Same as Numeric plus MAX, MIN, and DEFault parameter values.	100, 100., -1.23, MAX, MIN, DEF Discrete
Boolean	Represents a single binary condition that is either TRUE or FALSE. One of four possible values: ON|OFF|1|0.	ON Boolean TRUE OFF Boolean FALSE
String	Contains virtually any set of ASCII characters. Must begin with a single or double quote and end with the same character (a delimiter).	’this is a string’ "this is also a string" ’single quote inside brackets [”]’
Indefinite Length Block	Typically used to transfer large quantities of related data. General form is #0,<data_bytes><new line><^END>.	OUTPUT @Box;"#0ABC",END sends ABC as indefinite length block parameter.
Definite Length Block	General form is #<num_digits><num_bytes> <data_bytes> where <num_digits> specifies how many digits are in <num_bytes> and <num_bytes> specified the number of data bytes in <data_bytes>.	OUTPUT @Box;"#13ABC" sends ABC as definite length block parameter, where 1 = one digit follows and 3 = 3 bytes in the digit.
Non-decimal Numeric	Specify settings in hexadecimal, octal, or binary formats.	#b0101 = binary for decimal 5 #Q71 = octal for decimal 57 #hFA = hexadecimal for decimal 250

SCPI Response Data Formats

SCPI command **response data** is data returned from an instrument to the IBASIC computer or to an external computer. The following table summarizes response data formats.

Response Data Types

Response Data Type	**Description**	**Examples**
Real	Decimal numbers in fixed decimal notation or in scientific notation.	1.23E+0, 1.23, -100.0
Integer	Decimal representations of integer values including optional signs.	0, +100, -100
Discrete	Returns short form of specific set of values.	INT, EXT, POS, NEG
String	Similar to string parameters, except use only double quotes as delimiters.	"This IS valid" "SO IS THIS "" " "I said, ""Hello!"""
Definite Length	General form is #<num_digits><num_bytes><data_bytes>, where <num_digits> specifies number of digits in <num_bytes> and <num_bytes> specifies how many bytes of data follow in <data_bytes>.	#16SAMPLE 6 bytes of data #2111.1,2.2,3.3 11 bytes of data #19???+++!!! 9 bytes of data
Indefinite Length	General form is #0<data_bytes><new_line><^END>.	#0this is a sample block #01111111110000000011111111
Hexa-decimal	Format values as base 16 numbers. H and A-F are always upper-case.	#H0F0F, #H1A1A, #H2B2B Octal
Binary	Format values as base 2 numbers. B is always upper-case.	#B00001111, #B00000000

DIAGnostic Subsystem Commands

For IBASIC, the DIAGnostic subsystem can be used to adjust the Agilent E1406 file system, set memory sizes, and adjust the IBASIC operating system clock time. The DIAGnostic subsystem commands table for the IBASIC instrument follows.

DIAGnostic Subsystem Commands for IBASIC

Keyword	Parameter Form	Description
DIAGnostic		
:COMM		
:SER[n]		
:STORe		Sets current RS-232 parameters as power-on defaults
:FILESystem	<parameter>,<value>	Allows adjustment of IBASIC file system
:FILESystem?	<parameter>	Query IBASIC file system parameters
:IBASic		
:BLOCKsize	<bytes>	Sets memory size IBASIC requests from operating system
:BLOCKsize?		Query memory size - return is number of bytes
:DISPlay	<parameter>	Use to connect IBASIC to display at power-on
:DISPlay?		Query current DISPlay parameter specified
:STACKsize	<bytes>	Sets run-time stack size for IBASIC at power-on
:STACKsize?		Query stack size parameter
: SYNC		
[:CLOCK]		Set IBASIC clock to within one second of real-time clock
[:CLOCK]?		Query time difference between IBASIC and real-time clock

:COMMunicate :SERial[n]:STORe

DIAGnostic:COMMunicate:SERial[n]:STORe stores the serial communications parameters (such as BAUD, BITS, PARity, etc.) into non-volatile storage for the serial interface specified by [n] in SERial[n].

Comments

- Until DIAG:COMM:SER[n]:STORe is executed, communication parameter values are stored in *volatile* memory, and a power failure will cause the settings to be lost.
- DIAG:COMM:SER(1-7):STOR causes an Agilent E1324A to store its settings in an on-board EEROM. Since this EEROM write cycle takes nearly one second to complete, wait for this operation to complete before attempting to use that serial interface.
- The Agilent E1324A's EEROM used to store its serial communication settings has a finite lifetime of approximately ten thousand write cycles. Even if your application program sent the STORe command once every day, the lifetime of the EEROM would still be over 27 years. However, do not use the STORe command to an Agilent E1324A more often than necessary.
- **Related Commands:** all SYST:COMM:SER[n]:... commands

Example **Store Settings for Agilent E1324A Module #3.**

```
DIAG:COMM:SER3:STOR
```

Stores current settings for RS-232 parameters in Agilent E1324A module #3 EEROM

:FILESystem

DIAGnostic:FILESystem <*parameter*>, <*value*> allows the user to adjust the IBASIC file system by modifying parameters stored in nonvolatile RAM. Modifying these parameters allows the user to trade memory use for performance.

Parameters

The following table defines the **DIAGnostic:FILESystem** *parameters* and *values* which can be set and shows the range of *value* and the default *value*. Unless indicated, all *values* are 16-bit unsigned quantities.

Para-meter	Parameter Description	Range of *value*	Default*value*
1	USER_START: Memory address of the start of a user-defined RAM disk that will become memory volume ":,0,16" after it is initialized. Zero means user RAM disk not present.	24 bits	0
2	USER_END: Memory address one byte past the end of a user-defined RAM disk. This value must be greater than USER_START value.	24 bits	0
3	FILE_BUFFER: One for each file which can be opened.	512 - 65535	2048
4	COPY_BUFFER: Used to copy files and during media initialization. One/each task using file system.	1024 - 65535	32768
5	SECTOR_BUFFER: Used by low-level disk read/write routines for partial sector reads and writes.	512 - 65535	1024
6	FAT_BUFFER: Used for DOS disks to keep track of the file allocation table. One for each disk unit that can be on-line at a time.	512 - 65535	4608
7	TRANS_METHODS: Reserved - DO NOT CHANGE!	4 - 32	5
8	FILE_SYSTEMS: Reserved - DO NOT CHANGE!	3 - 32	4
9	MAX_UNITS: Maximum number of disks that can be on-line. Any IBASIC command that causes a reference to the disk (MSI, CAT, ASSIGN, etc.) puts the disk on-line if the disk exists.	3 - 32	10
10	INITIAL_UNITS: Memory is reserved for this many disks at power-on. If more disks are required (up to MAX_UNITS), memory is allocated when disks needed.	0 - MAX_UNITS	3
11	MAX_FILES: Maximum number of files that can be open at once for the entire file system.	6 - 256	30
12	INITIAL_FILES: At power-on, memory is reserved for the number of files specified.	0 - MAX_FILES	10
13	DISK_WAIT: Number of seconds Agilent E1406 will wait for a disk to power up while searching for the AUTOST program. If a disk is not readable after this time, AUTOST is not performed.	0 - 65535	60
14	AUTOSTART: If zero,IBASIC will not AUTOST, thus avoiding the DISK_WAIT at power-on. If non-zero, IBASIC searches available disks for an AUTOST program (see parameters 15-26).	0 or any non-zero number	1
15*	DISK1_TYPE:	N/A	1
16*	DISK1_SC: Select Code (and Primary Addr if type = 1)	N/A	700
17*	DISK1_UNIT: Mass Storage Unit Number of disk	N/A	1
18*	DISK1_VOL: Mass Storage Volume Number of disk	N/A	0
19*	DISK2_TYPE:	N/A	3

:FILESystem

Para-meter	Parameter Description	Range of *value*	Default*value*
20*	DISK2_SC: Select Code (and Primary Addr if type = 1)	N/A	0
21*	DISK2_UNIT: Mass Storage Unit Number of disk	N/A	1
22*	DISK2_VOL: Mass Storage Volume Number of disk	N/A	0
23*	DISK3_TYPE:	N/A	1
24*	DISK3_SC: Select Code (and Primary Addr if type = 1)	N/A	700
25*	DISK3_UNIT: Mass Storage Unit Number of disk	N/A	0
26*	DISK3_VOL: Mass Storage Volume Number of disk	N/A	0
27**	TMARRAY_START: Address of the beginning of the transfer method array (query only). This is the address of the first element of an array of four 32-bit pointers to transfer method functions for disks (the functions that know how to physically read and write to the disk).	0-3	
28***	FSARRAY_START: The address of the beginning of an array of (FILESYSTEM) 32-bit pointers to structures describing the disk types (LIF or DOS) the file system can recognize.	0 - n	
1000	RAMVOL0_START (Query only): The starting memory address of "MEMORY,,0,,0". If this RAMVOL has not been defined, 0 is returned.		
1001	RAMVOL1_START (Query only): The starting memory address of "MEMORY,,0,,1". If this RAMVOL has not been defined or it is non-volatile, 0 is returned.		
1002-1015	RAMVOL2_START - RAMVOL15_START (Query only): The starting memory address of any of the nonvolatile RAM volumes 2 through 15. If the RAMVOL has not been defined, 0 is returned.		
1016	RAMVOL16_START (Query only): The starting memory address of "MEMORY,,0,,16". If this RAMVOL has not been defined, 0 is returned.		

* = See Default Search Order for AUTOST in Comments
** = See Transfer Method Array in Comments
*** = See File Type Structures in Comments

Comments

- **Default Search Order for AUTOST**. Parameters 15 - 26 of the DIAG:FILESystem command determine which disks the Agilent E1406 will search for the AUTOST program. Three disks will be searched. The default search order follows (the Volume # must be 0 for RAM volumes and 3.5 inch disks).

DISK 1 = 3.5 inch disk	- ":,700,1"
DISK 2 = Nonvolatile RAM Disk	- ":0,1"
DISK 3 = Hard Disk Drive	- ":,700,0"

  Parameters 15-18 describe the first disk searched. Parameters 19-22 describe the second disk searched. Parameters 23-26 describe the third disk searched.

- **Disk Types 1 and 3 Recognized**. The Agilent E1406 recognizes only disk type 1 (GPIB SS80) and disk type 3 (MEMORY). Thus, the Default *value* column for DISKn_TYPE (parameters 15, 19, and 23) must be 1 or 3.
- **Disk Wait.** Even when autostarting from a RAM volume, IBASIC will wait for the floppy disk to power up to check for the "AUTOST" program on the floppy. The wait time is set by parameter 13. If the floppy is recognized before this time has elapsed, and there is no "AUTOST" program on the floppy, IBASIC will boot on the RAM volume.
- Hard Disk Settings. The hard disk must be set to address 0 for the default search to work. If you set your disk to a different address, modify the DISKn_SC (parameters 16, 20, or 24) to the new address. For example, if you set the hard disk to address 2, set DISK3_SC (parameter 24) to 702.
- **Transfer Method Array**. TMARRAY_START (parameter 27) defines the address of the first element of an array of four 32-bit pointers to transfer method functions for disks. The element numbers are:

Element #	Transfer Method
0	NULLDEV (returns ERR8 - don't replace this!)
1	EXTERNAL (returns ss80tm)
2	INTERNAL (returns uninittm - can be redefined)
3	MEMORY (returns ramtm)

- **File Type Structures**. FSARRAY_START (parameter 28) defines the address of the beginning of an array of (FILESYSTEMS) 32-bit pointers to structures describing the disk types (LIF or DOS) that the file system can recognize. The array is searched from high element to low element whenever a disk is first checked to see if the disk contains a recognized file system. If the disk is recognized, the search ends. The element numbers are:

Element #	File System Type
0	Unrecognized (do not replace this!)
1	LIF
2	DOS
n	(NULL) - marks the end of the list

Related Commands: None

Example

Disable AUTOSTART Search

```
DIAG:FILES  14,0
```

Since <value> is 0, the Agilent E1406 will not attempt to find an AUTOST program and the DISK_WAIT (parameter 13) wait time will not occur at power-on.

:FILESystem?

DIAGnostic:FILESystem? returns the current value for the DIAGnostic:FILESystem *parameter* specified.

Comments

- **Related Commands**: DIAG:FILESystem

Example **Read AUTOSTART Parameter Value**

```
DIAG:FILES? 14
```

Returns 1 if AUTOSTART (parameter 14) is enabled or returns 0 if AUTOSTART is disabled.

:IBASic:BLOCKsize

DIAGnostic:IBASic:BLOCKsize <*bytes*> sets the size of memory that IBASIC requests from the operating system whenever more memory is required for program storage.

Parameters

Name	Description	Range	Default
bytes	Sets size of memory IBASIC will request.	1024 - 65536 bytes	8192 bytes

Comments

- **Setting BLOCKsize.** The *bytes* parameter can be set at any time, but changes take effect only with the next system reset or power-on. Setting *bytes* = 0 causes the operating system to use the default setting (8192 bytes).
- **Related Commands:** DIAG:IBAS:STAC

Example **Set IBASIC Memory Block Size**

```
DIAG:IBAS:BLOCK 16384
```

After system reset or after cycling power, sets 16384 bytes as the size of the memory block IBASIC will request if more memory is required for program storage.

:IBASic :BLOCKsize?

DIAGnostic:IBASic:BLOCKsize? returns the current value for the DIAGnostic:IBASic:BLOCKsize *bytes* parameter.

Example **Read IBASIC Memory Block Size**

```
DIAG:IBAS:BLOCK?
```

Returns the size of memory of the memory block IBASIC will ask for after a system reset or power is cycled.

:IBASic:DISPlay

DIAGnostic:IBASic:DISPlay <*parameter*> allows the built-in RS-232 port or Agilent E1324A plug-in module RS-232 ports to be automatically connected to IBASIC at power-on.

Parameters

Name	Description	Range
NONE	IBASIC not connected to any display	N/A
BUILtin	IBASIC is connected to built-in RS-232 port if port is type A (see Comments)	N/A
number	IBASIC is connected to Agilent E1324A RS-232 port if port exists and is type A (see Comments). *number* = 1 connects Agilent E1324A #1 port, etc.	1-7

Comments

- **Serial Ports Must be Assigned to User Interface**. For the DIAG:IBASic:DISPlay command to work, the RS-232 port(s) must be assigned to the User Interface (port type A) with DIAG:COMM:SER:OWN SYST. The Agilent E1324A serial ports are assigned to the User Interface by setting the LADD switches to 1, 2,...,7.
- **Related Commands:** DIAG:FILESystem

Example **IBASIC Set on Built-in RS-232 Interface**

```
DIAG:IBAS:DISP BUIL
```

When command is executed and power is cycled, the terminal connected to the buiult-in RS-232 interface shows IBASIC_240:

:IBASic:DISPlay?

DIAGnostic:IBASic:DISPlay? returns the current value for the DIAGnostic:IBASic:DISPlay parameter specified.

Example **Read DIAG:IBAS:DISP Parameter Value**

```
DIAG:IBAS:DISP BUIL
```

Connects built-in RS-232 port to IBASIC computer after power is cycled.

```
DIAG:IBAS:DISP?
```

Returns "BUIL" since the built-in RS-232 port is connected to IBASIC.

:IBASic:STACKsize

DIAGnostic:IBASic:STACKsize <*bytes*> sets the run-time stack size allocated to IBASIC at power-on. The IBASIC stack is used for arrays and variables which are not in COM memory and for temporary storage when an IBASIC program is run. DIAG:IBAS:STACK also sets the initial value returned by the PROGram:MALLocate ? command after a power-on cycle.

Parameters

Name	Description	Range	Default
bytes	Sets run-time stack size for IBASIC at power-on.	3072 bytes - available memory	32768 bytes

Comments

- **Setting STACksize.** The *bytes* parameter can be set at any time, but the change takes effect only with the next system reset or power-on. Setting *bytes* = 0 causes the operating system to use the default setting (32768 bytes).
- **Corrections for Memory Overflow Error.** If ERROR 2 **-** Memory Overflow occurs when the RUN command is issued for an IBASIC program, the stack size is too small. To correct this, you can use the DIAG:IBAS:STACK command to increase stack size, cycle power, and retry the program.
- **Corrections Using COM Blocks.** You can also define large arrays in the program in a COM block. Since COM memory is not taken from the stack requirements for the program, you may be able to run the program without cycling power.
- **Related Commands:**DIAG:IBAS:BLOC, PROG:MALL

Example

Set IBASIC Stack Size

```
DIAG:IBAS:STACK 16384
```

After system reset or cycling power, sets 16384 bytes as the size of the run-time stack for IBASIC (the default value for the PROG:MALL command).

:IBASic: STACKsize?

DIAGnostic:IBASic:STACKsize? returns the current value for the DIAGnostic:IBASic:STACKsize *bytes* parameter.

Comments

Related Commands: DIAG:IBAS:STACK

Example

Read IBASIC Run-Time Stack Size

```
DIAG:IBAS:STACK?
```

Returns the size of the run-time stack for IBASIC.

:IBASic:SYNC

DIAGnostic:IBASic:SYNC[:CLOCk] resets the IBASIC operating system clock to within one second of the real-time clock.

Parameters None

Comments

- **Setting Operating System Clock.** All IBASIC times are derived from the operating system clock. The operating system clock is set to the real-time clock at system reset, at power-on, or when the real-time clock is set with SYST:TIME.
- **Operating System Clock Errors.** The operating system clock may lose time during certain operations when interrupts are turned off for more than 10 msec. The DIAG:IBASic:SYNC[:CLOCK] allows you to set the operating system clock to within one second of the battery-backed real-time clock.
- **Operating System Clock Errors Effect on TIMEDATE.** Since all IBASIC times are derived from the operating system clock, errors in this clock will affect the TIMEDATE reported by IBASIC and the time/date stamp on files in the file system.
- **Related Commands:** SYST:TIME, SYST:TIMEDATE

Example **Set IBASIC Clock**

```
DIAG:IBAS:SYNC
```

Sets the operating system clock time to within one second of the real-time clock time.

:IBASic:SYNC?

DIAGnostic:IBASic:SYNC[:CLOCk]? returns the number of seconds difference between the time on the real-time clock and the time on the operating system clock to within one second. The result is accurate if the two clocks are within 12 hours of each other.

Comments

- **One Second Resolution Between Clocks**. The resolution between the real-time and IBASIC operating system clocks is one second. Therefore, a returned value of 0 or -1 indicates the two clocks are synchronized.
- **Clock Time Relationship**. If the returned value is negative, the IBASIC operating clock is behind the real-time clock. If the returned value is positive, the IBASIC operating clock is ahead of the real-time clock.
- **Related Commands**: DIAG:IBAS:SYNC[:CLOCK]

Example **Read Clock Time Differences**

```
DIAG:IBAS:SYNC?
```

Returns the time difference (in seconds) between the real-time and operating system clock times

PROGram Subsystem Commands

The PROGram subsystem provides the means to generate and control an IBASIC program which is resident in the Agilent E1406. Using the PROGram subsystem, you can list programs; create, download, and upload programs; execute downloaded programs; and set or query the state of programs. The PROGram subsystem commands table for IBASIC follows.

PROGram Subsystem Commands for the IBASIC Instrument

Keyword	Parameter Form	Description
PROGram		
:CATalog?		Lists IBASIC program name, if any
[:SELected]		
:DEFine	<program_code>	Use to download IBASIC program
:DEFine?		Use to upload IBASIC program
:DELete	<progname>	Delete IBASIC program from Agilent E1406
:EXECute	<program_command>	Execute IBASIC command specified
:MALLocate	<nbytes>|DEFault	Reserves memory for IBASIC arrays/variables
:MALLocate?		Query memory space allocated for IBASIC
:NAME	<progname>	Assign a name to a downloaded IBASIC program
:NAME?		Query name of downloaded IBASIC program
:NUMBer	<varname> [,<nvalues>]	Assign values to numeric program variables
:NUMBer?	<varname>	Query value of numeric program variables
:STATe	RUN|PAUSe|STOP|CONTinue	Set state of downloaded IBASIC program
:STATE?		Query downloaded IBASIC program state
:STRing	<varname> [,<svalues>]	Set contents of string variables
:STRing?	<varname>	Query contents of string variables
:WAIT		Wait to execute next command
:WAIT?		WAIT query

:CATalog?

PROGram:CATalog? lists the IBASIC program name. If an IBASIC program name exists, the program name is returned. If no name is assigned to the program, PROG is returned. If an IBASIC program is not downloaded, the null string ("") is returned.

Comments

- **Can Define Only One IBASIC Program.** Only one IBASIC program can be defined at a time.
- **Related Commands**: PROG:CAT
- ***RST Condition:** A reset entered via the interface sets the IBASIC program to the STOPped state and changes the IBASIC program name to PROG. A reset generated by IBASIC acts the same except it will not cause the IBASIC program to go to the STOPped state.

Example **Query IBASIC Program**

```
PROG:CAT?
```

Returns program name or returns PROG if name not assigned.
Returns "" (null string) if no IBASIC program is downloaded.

:DEFine

PROGram:DEFine <*program_code*> is used to create and download programs to the Agilent E1406.

Comments

- **Downloading IBASIC Programs**. Only one IBASIC program can be downloaded at a time. To download a new IBASIC program, you must first delete (with PROG:DEL) an existing IBASIC program. Attempting to download a new program without first deleting the existing program results in an "Illegal Program Name" error.

- Using other PROG commands. You must define a program before you can use PROG:EXECute or PROG:MALLocate. If necessary you can define a dummy program with the following line of code from an external computer:

  ```
  OUTPUT 70939;"PROG:DEF #0" END
  ```

- **Rules for Downloading Programs.** Downloaded programs must use definite or indefinite length block parameters containing lines of program code (SCPI parameter types are defined on page 8-6). Each line must be separated by <CR> or <CR> <LF>. Any line with a syntax error is turned into a comment and a "Program Syntax" error is generated.

- **Downloaded Programs Exceeding Memory.** When the size of a program to be downloaded exceeds memory available in the Agilent E1406, program lines are saved up to the point of memory overflow. When memory overflow occurs, a "Program Syntax" error is generated.

- **Uploading IBASIC Programs.** IBASIC programs are uploaded (using PROG:DEF?) as definite length block response data. For an IBASIC program to be uploaded, the program must be in the PAUSed or STOPped state. If a program is in the RUN state, a "Program Currently Running" error is generated.

- **Related Commands:** PROG:DEL

- ***RST Condition:** A reset entered via the interface sets the IBASIC program to the STOPped state and changes the IBASIC program name to PROG. A reset generated by IBASIC acts the same except it will not cause the IBASIC program to go to the STOPped state.

Example

Download IBASIC Program From External Computer

```
OUTPUT 70930;"*RST;*CLS;PROG:DEL:ALL"
```

Clears all status registers, and deletes IBASIC program if it exists.

```
OUTPUT 70930;"PROG:DEF #0"
```

Downloads program using indefinite length block parameters.

```
OUTPUT 70930;"    10 DIM C$[80]"
```

Typical line for downloaded program using IBASIC and SCPI commands.

```
OUTPUT 70930;"    40 END" END
```

Last line of downloaded program - must include the END statement

DEFine?

PROGram:DEFine? uploads an IBASIC program from the Agilent E1406 into an GPIB computer.

Comments **Related Commands**: PROG:DEF

Example **Upload IBASIC Program to External Computer**

```
OUTPUT 70930;"PROG:DEF?"
```
Uploads program using definite length block response data.

```
ENTER statement
```
See Chapter 6 - Talk/Listen Mode Operation for an example

:DELete

PROGram:DELete deletes a downloaded IBASIC program from IBASIC memory in the Agilent E1406.

Comments

- **Cannot Delete RUNning Programs**. If an IBASIC program is in the RUN state when PROGram:DELete:ALL is executed, a "Program Currently Running" error is generated and the program is NOT deleted.
- This does not delete the selected program name, if one has been assigned using the PROG:NAME command. If you query for the program name using PROG:NAME? you will get the previously selected name, even though the program is no longer in memory.
- **Related Commands:** PROG:STAT

Example **Delete IBASIC Program**

```
PROG:DEL
```
Deletes IBASIC program if the program is not in the RUN state.

:EXECute

PROGram:EXECute <'*program_command*'> executes the IBASIC command specified.

Parameters

Parameter Name	Type	Range of Values	Default
Program_command	string	Supported IBASIC Commands	None

Comments

- **Cannot Execute RUNning Programs**. If an IBASIC program is in the RUN state when PROGram:EXECute is attempted, a "Program Currently Running" error is generated and the command is NOT executed.
- **An IBASIC program must already have been defined.** If not, attempting to use PROG:EXEC will generate an "Illegal Program Name" error.
- **Illegal Commands.** If the string data representing an IBASIC command is not legal, a "Program Syntax Error" is generated.
- **Related Commands:** PROG:STAT
- ***RST Condition:** None

Example **Execute IBASIC Command**

```
PROG:EXEC 'BEEP'
```
Causes audible BEEP

:MALLocate

PROGram:MALLocate <*nbytes*>|*DEFault* reserves memory space for IBASIC arrays and variables and subprogram stack plus the temporary storage required needed by a RUNning IBASIC program. Common variables are allocated from System memory on demand.

Parameters

Parameter Name	Type	Range of Values	Default
nbytes	numeric	880 - available memory	32768

Comments

- **Using DEFault Setting**. When the *nbytes* parameter is specified, *nbytes* bytes of memory space are allocated for the IBASIC program arrays and variables and temporary storage required by the RUNning program. When *DEFault* is used, IBASIC calculates the amount of memory space required.
- **An IBASIC program must already have been defined.** If not, attempting to use PROG:MALL will generate an "Illegal Program Name" error.
- **Related Commands:** DIAG:IBAS:STACK

Example **Allocating IBASIC Memory Space**

```
PROG:MALL 50000
```
Allocates 50000 bytes of memory space for arrays and variables and subprogram stack for temporary storage needed by a RUNning IBASIC program.

:MALLocate?

PROGram:MALLocate? returns the number of bytes allocated in IBASIC memory for IBASIC arrays and variables and subprogram stack.

Comments

- **Related Commands:** PROG:MALL

Example **Return IBASIC Memory Allocated**

```
PROG:MALL?
```
Returns number of bytes reserved in IBASIC memory for IBASIC arrays and variables.

:NAME

PROGram:NAME <*progname***>** selects a named program for use with future PROG commands. Since only a single program can be downloaded at any one time with IBASIC, you will not need this command.

Comments

- **Name Not Related to File Name**. The IBASIC program name has NO relationship to any file name from which the program may have been loaded.
- **Related Commands:** PROG:NAME?
- ***RST Condition:** A reset entered via the GPIB interface sets the IBASIC program to the STOPped state and changes the IBASIC program name to

PROG. A reset generated by IBASIC acts the same except it will not cause the IBASIC program to go to the STOPped state.

Example **Name IBASIC Program**

```
PROG:NAME Volts
```

Selects program name Volts for future PROG commands.

:NAME?

PROGram:NAME? returns the selected program name (if any). Returns "PROG" if no program name has been selected. Returns a null string ("") if no program is downloaded.

Comments **Related Commands**: PROG:NAME

Example **Return Program Name**

```
PROG:NAME?
```

Returns program name (if any). Returns PROG if no program name is assigned. Returns "" if no program is downloaded.

:NUMBer

PROGram:NUMBer <*varname*>, <*nvalues*> sets the value(s) of numeric program variables or arrays in an IBASIC program.

Parameters

Parameter Name	Type	Range of Values	Default
varname	string	Any ASCII characters	None
nvalues	numeric		None

Comments

- **IBASIC Program Must First Exist.** If an IBASIC program is not defined (as set with PROG:DEF), attempting to use PROG:NUMB generates an "Illegal Program Name" error.
- **Using <*varname*>**. The variable specified in <*varname*> must be an existing variable in the IBASIC program or a "Illegal Variable Name" error will be generated. <*varname*> can be either character data or string data.
- **<*varname*> Over 12 Characters.** If the variable name is longer than 12 characters, a delimiter (') is required.
- **Using <*nvalues*>**. <*n values*> is a list of comma-separated numeric values used to set <*varname*>. If <*varname*> cannot hold all the specified <*nvalues*>, a "Parameter Not Allowed" error is generated.
- **Related Commands**: PROG:NUMB?
- ***RST Condition:** None.

Example **Assign Values to Variables**

```
PROG:NUMB B,10
```

Assign a value of 10 to variable B

```
PROG:NUMB  'number_devices',1
```

Assign value of 1 to variable number_devices. Delimiter required since variable name is longer than 12 characters.

:NUMBer?

PROGram:NUMBer? <*varname*> queries the value(s) of the specified numeric variable in the IBASIC program. Variable contents are returned as a comma-separated list.

Comments

Related Commands: PROG:NUMB

Example

Return Value of Variable

```
PROG:NUMB B,10
```
Assign a value of 10 to variable B.

```
PROG:NUMB? B
```
Returns a value of 10.

:STATe

PROGram:STATe <*state*>sets the state of an IBASIC program.

Parameters

Parameter Name	Type	Range of Values	Default
state	discrete	RUN | PAUSe | STOP | CONTinue	None

Comments

- **IBASIC Program States.** The following table shows the effect of setting the STATe to the desired state from each of the possible current states. In some cases, a "Settings Conflict" error is generated.

State Requested	Current State		
	RUN	**PAUSe**	STOP
RUN	Error (-221)	RUN	RUN
CONTinue	Error (-221)	RUN	Error (-221)
PAUSe	PAUSe	PAUSe	STOP
STOP	STOP	STOP	STOP

- **Related Commands**: None
- ***RST Condition**: A reset entered via the interface sets the IBASIC program to the STOPped state and changes the IBASIC program name to PROG. A reset generated by IBASIC acts the same except it will not cause the IBASIC program to go to the STOPped state.

Example

Set IBASIC Program to RUN State

```
PROG:STAT:PAUS
```
Pauses IBASIC Program

```
PROG:STAT:CONT
```
Sets IBASIC Program to RUN state.

:STATe?

PROGram:STATe? queries the current state of the IBASIC program.

Comments

Related Commands: PROG:STAT

Example

Return State of IBASIC Program

```
PROG:STAT:PAUS
```
Pauses IBASIC Program.

```
PROG:STAT?
```
Returns PAUSe as IBASIC program state.

:STRing

PROGram:STRing <*varname*>, <*svalues*> sets the contents of string program variables and arrays in an IBASIC program.

Parameters

Parameter Name	Type	Range of Values	Default
svalues	numeric	Valid string characters	None

Comments

- **IBASIC Program Must First Exist.** If an IBASIC program does not exist (as set with PROG:DEF), attempting to use PROG:STR generates an "Illegal Program Name" error.
- **Using <*varname*>**. The variable specified in <*varname*> must be an existing variable in the IBASIC program or a "Illegal Variable Name" error will be generated. <*varname*> can be either character data or string data.
- **Using <*svalues*>**. <*svalues*> is a list of comma-separated strings used to set <*varname*>. If <*varname*> cannot hold all the specified <*svalues*>, a "Parameter Not Allowed" error is generated.
- **Related Commands**: None
- ***RST Condition:** None.

Example

Assign Contents to String Variable

```
PROG:STR B, 'B = Result'
```
String assigned to variable B$ is 'B = Result'

:STRing?

PROGram:STRing? <*varname*> returns the contents of the specified string variable in the IBASIC program.

Comments

Related Commands: PROG:STR

Example

Return Contents of Variable

```
PROG:STR B, 'B = Result'
```
Assign 'B = Result' to variable B$.

```
PROG:STR?
```
Returns "B = Result" (double quotes are part of the return)

:WAIT

PROGram:WAITcauses the Agilent E1406 to wait until the current program is in the STOPped or PAUSed state before executing the next command.

Parameters None

Comments

- **Related Commands**. None
- ***RST Condition:** None.

Example **Set Program WAIT**

```
PROG:WAIT
```

Commands to be executed do not execute until the current IBASIC program is STOPped or PAUSed.

:WAIT?

PROGram:WAIT? has the same effect as the PROG:WAIT command, except PROG:WAIT? returns a value of 1 to indicate the IBASIC program is no longer running.

Comments

- **Related Commands**: PROG:WAIT

Example **Return WAIT Status**

```
100  OUTPUT 70930;"PROG:WAIT?"
```

External computer waits until IBASIC program is STOPped or PAUSed

```
200  ENTER 70930;A
```

Returns 1 when IBASIC program is STOPped or PAUSed

SYSTem Subsystem Commands

The SYSTEM command subsystem for the IBASIC Instrument allows you to configure serial communications ports operations. The SYSTem subsystem commands table for the IBASIC instrument follows.

SYSTem Subsystem Commands for IBASIC

Keyword	Parameter Form	Description
SYSTem		
:COMMunicate		
:SERial[n]		
:CONTrol	ON|OFF|STANdard|IBFull	
:DTR		Sets mode for modem control line DTR
:DTR?	ON|OFF|STANdard|IBFull	Returns current mode of DTR line
:RTS		Sets mode for modem control line RTS
:RTS?		Returns current mode of RTS line
[:RECeive]		
:BAUD	<baud_rate>|MIN|MAX	Set transmit/receive baud rate
:BAUD?	[MIN|MAX]	Returns current or allowable baud rate
:BITS	7|8|MIN|MAX	Sets number of data bits in data frame
:BITS?	[MIN|MAX]	Returns number of bits in data frame
:PACE		
[:PROTocol]	XON|NONE	Sets receive pacing protocol state
[:PROTocol]?		Returns receive pacing protocol state
:THReshold		
:STARt	<char_count>	Sets input buffer level at which XON sent
:STARt?	[MIN|MAX]	Returns current or allowable STARt level
:STOP	<char_count>	Sets input buffer level to send XOFF
:STOP?	[MIN|MAX]	Returns current or allowable STOP level
:PARity		
:CHECk	1|0|ON|OFF	Enables/disables receive parity checks
:CHECk?		Returns receive parity check state
[:TYPE]	EVEN|ODD|ZERO|ONE|NONE	Sets type of receive/transmit parity
[:TYPE?]		Returns current parity type setting
:SBITs	1|2|MIN|MAX	Sets receive/transmit #stop bits
:SBITs?	[MIN|MAX]	Returns #stop bits set
:TRANsmit		
:AUTO	1|0|ON|OFF	Links/unlinks pacing protocol
:AUTO?		Returns current pacing linkage
:PACE		
[:PROTocol]	XON|NONE	Sets transmit pacing protocol
[:PROTocol]?		Returns pacing protocol state
:ERRor?		Returns oldest error message

:COMMunicate :SERial[n]:

The **SYStem:COMMunicate:SERial[n]:...** commands set and/or modify the configuration of the serial interface(s) that are assigned to the IBASIC instrument. The interface affected by the command is specified by a number (zero through seven) which replaces the [n] in the **:SERial[n]** command.

Comments

- **Assigning Ports to IBASIC.** Assign the built-in RS-232 port to IBASIC with DIAG:COMM:SER[:OWNER] IBASIC sent to the System instrument. Assign the RS-232/422 ports on an Agilent E1324A plug-in module to IBASIC by setting the Logical Address (LADDR) switches on the modules to 241, 242, ...,247.
- **Assigning a number to [n]**. The number zero specifies the built-in RS-232 interface while one through seven specify an Agilent E1324A plug-in module number. For example, Agilent E1324A module #1 is at logical address 241 (when assigned to IBASIC), etc.
- **Card Numbers Must be Contiguous**. The Agilent E1324A module installed at address 241 becomes card #1, the card at address 242 becomes card #2, etc. The logical addresses for the Agilent E1324A modules must start at 241 (to be assigned to IBASIC) and must be contiguous (no unused logical addresses).
- **Serial Communication Command Storage**. Serial communications commands take effect *after* the end of the program message containing the command. Serial communication settings for the built-in RS-232 interface are stored in non-volatile RAM and used at power-up and DIAG:BOOT[:WARM].
- Serial communication settings for the Agilent E1324A Datacomm interface are stored in its on-board non-volatile EEROM *only* after the DIAG:COMM:SER[n]:STORe command is executed.
- **Serial Communication Parameter Defaults**. DIAG:BOOT:COLD sets the serial communication parameters to the following defaults: BAUD 9600, BITS 8, PARity NONE, SBITs 1, DTR ON, RTS ON, PACE XON.

Example **Setting Baud Rate for Agilent E1324A Module Port**

```
SYST:COMM:SER2:BAUD 9600
```

Sets baud rate 9600 for Agilent E1324A module #2 (must also have module #1)

:COMMunicate :SERial[n] :CONTrol:DTR

SYSTem:COMMunicate:SERial[n]:CONTrol:DTR <*dtr_cntrl*> controls the behavior of the Data Terminal Ready output line. DTR can be set to a static state (ON|OFF), can operate as a modem control line (STANDard), or can be used as a hardware handshake line (IBFull).

Parameters

Name	Description	Range	Default
bytes	Sets size of memory IBASIC will request.	1024 - 65536 bytes	8192 bytes

Comments

- **<dtr_cntl> Parameter Definitions**. The selected DTR control setting is in effect *after* the end of the program message containing the DTR command. The following table defines each value of *dtr_cntrl*:

Value	Definition
ON	DTR line is asserted
OFF	DTR Line is unasserted
STANDard	DTR will be asserted when the serial interface is ready to send *output* data. Data will be sent as soon as the connected device asserts DSR (data set ready).
IBFull	While the input buffer is not yet at the :STOP level, DTR is asserted. When the input buffer reaches the :STOP level, DTR will be unasserted.

- We recommend you set ...DTR and ...RTS to STANdard when operating a modem.
- DIAG:BOOT:COLD will set ...DTR to ON
- **Related Commands**: SYST:COMM:SER[n]:CONT:RTS, SYST:COMM:SER[n]:PACE:THR:STARt, SYST:COMM:SER[n]:PACE:THR:STOP
- ***RST Condition:** No change

Example **Asserting the DTR Line**

```
SYST:COMM:SER1:CONT:DTR ON
```

Sets the serial interface on Agilent E1324A module to assert the DTR line

:COMMunicate :SERial[n] :CONTrol:DTR?

SYSTem:COMMunicate:SERial[n]:CONTrol:DTR? returns the current setting for DTR line control.

Example **Query DTR Control Setting**

```
SYST:COMM:SER1:CONT:DTR?
```

Query DTR Control setting for serial interface on Agilent E1324A module #1

```
ENTER statement
```

Returns "ON", "OFF", "STAN", or "IBF"

:COMMunicate :SERial[n] :CONTrol:RTS

SYSTem:COMMunicate:SERial[n]:CONTrol:RTS <*rts_cntrl*> controls the behavior of the Request To Send (RTS) output line. RTS can be set to a static state (ON | OFF), can operate as a modem control line (STANdard), or can be used as a hardware handshake line (IBFull).

Parameters

Name	Description	Range	Default
bytes	Sets size of memory IBASIC will request.	1024 - 65536 bytes	8192 bytes

Comments

- **<rts_cntl> Parameter Definitions**. The selected RTS control setting is in effect *after* the end of the program message containing the RTS command.The following table defines each value of *rts_cntrl*:

Value	Definition
ON	RTS line is asserted
OFF	RTS line is unasserted
STANdard	RTS will be asserted when the serial interface is able to send output data. Data will be sent if the connected device asserts CTS (clear to send).
IBFull	While the input buffer is not yet at the :STOP threshold, RTS is asserted. When the input buffer reaches the :STOP threshold, RTS is unasserted.

- We recommend you set ...DTR and ...RTS to STANdard when operating a modem.
- DIAG:BOOT:COLD will set ...RTS to ON
- **Related Commands**: SYST:COMM:SER[n]:CONT:DTR, SYST:COMM:SER[n]:PACE:THR:STARt, SYST:COMM:SER[n]:PACE:THR:STOP
- **Related Commands:** SYST:COMM:SER[n]:CONT:DTR
- ***RST Condition:** No change

Example **Unasserting the RTS Line**

```
SYST:COMM:SER1:CONT:RTS OFF
```

Unasserts the RTS line for the serial interface on Agilent E1324A module #1

:COMMunicate :SERial[n] :CONTrol:RTS?

SYSTem:COMMunicate:SERial[n]:CONTrol:RTS? returns the current setting for RTS line control.

Example **Query RTS Control Line Setting**

```
SYST:COMM:SER1:CONT:RTS?
```

Query RTS control line setting for serial interface on Agilent E1324A module #1

```
ENTER statement
```

Returns "ON", "OFF", "STAN", or "IBF"

:COMMunicate :SERial[n] [:RECeive]:BAUD

SYSTem:COMMunicate:SERial[n][:RECeive]:BAUD <*baud*> sets the baud rate for the built-in RS-232 serial port or for the RS-232/422 ports on an Agilent E1324A plug-in module.

Parameters

Name	Description	Range	Default
bytes	Sets size of memory IBASIC will request.	1024 - 65536 bytes	8192 bytes

Comments

- Attempting to set *baud_rate* to other than the values shown in the above table generates error -222.
- **Baud Rates**. DIAG:BOOT:COLD sets default baud rate of 9600. MIN sets baud rate of 300, MAX sets baud rate of 19200.
- ***RST condition:** No change.

Example **Setting Baud Rate to 1200**

```
SYST:COMM:SER1:BAUD 1200
```
Set baud rate of 1200 bps for Agilent E1324A plug-in module #1

:COMMunicate :SERial[n] [:RECeive]:BAUD?

SYSTem:COMMunicate:SERial[n][:RECeive]:BAUD? [MIN | MAX] returns the current baud rate setting if no parameter is sent, returns the maximum allowable setting if MAX is sent, or returns the minimum allowable setting if MIN is sent.

Example **Query Current Baud Rate**

```
SYST:COMM:SER1:BAUD?
```
Query baud rate for Agilent E1324A module #1

```
ENTER statement
```
Returns baud rate

:COMMunicate :SERial[n] [:RECeive]:BITS

SYSTem:COMMunicate:SERial[n][:RECeive]:BITS <*bits*> sets the number of bits to be used to transmit and receive data.

Parameters

Name	Description	Range	Default
bytes	Sets size of memory IBASIC will request.	1024 - 65536 bytes	8192 bytes

Comments

- **MIN|MAX Settings.** MIN sets 7 stop bits and MAX sets 8 bits. Attempting to set *bits* to other than values shown generates error -222.
- **Disallowed Bit Combinations**. Although the ...BITS command operates independently of the PARity[:TYPE] and the ...SBIT (stop bits) command, two combinations of the ...BITS command are disallowed because of their data frame bit width. The following table shows the possible combinations:

BITS	PARity[:TYPE]	SBITs	Frame Bits
7	NONE	1	9 - disallowed
7	NONE	2	10
7	Yes	1	10
7	Yes	2	11
8	NONE	1	10
8	NONE	2	11
8	Yes	1	11
8	Yes	2	12 - disallowed

- **Default Data Width**. DIAG:BOOT:COLD sets the default data width of 8 bits.
- **Related Commands:** SYST:COMM:SER[n]:PAR, SYST:COMM:SER[n]:SBIT
- ***RST Condition:** No change

Example **Setting Data Width to 7 Bbits**

```
SYST:COMM:SER1:BITS 7
```
Set data with to 7 bits for Agilent E1324A plug-in module #1

:COMMunicate :SERial[n] [:RECeive]:BITS?

SYSTem:COMMunicate:SERial[n][:RECeive]:BITS? [MIN | MAX] returns the current data width if no parameter is sent, the maximum allowable setting if MAX is sent, or the minimum allowable setting if MIN is sent.

Example **Query Current Data Width**

```
SYST:COMM:SER1:BITS?
```
Query data width setting for Agilent E1324A plug-in module #1

```
ENTER statement
```
Returns 7 or 8

:COMMunicate :SERial[n] [:RECeive]:PACE [:PROTocol]

SYSTem:COMMunicate:SERial[n][:RECeive]:PACE[:PROTocol] <*protocol*> enables or disables receive pacing (XON/XOFF) protocol.

Parameters

Name	Description	Range	Default
bytes	Sets size of memory IBASIC will request.	1024 - 65536 bytes	8192 bytes

Comments

- **Using XON/XOFF thresholds**. While ...PROT is XON, the serial interface will send XOFF when the buffer reaches the ...STOP threshold, and XON when the buffer reaches the ...STARt threshold.
- **XON/XOFF Control Characters**. The XON character is control Q (ASCII 17_{10}, 11_{16}). The XOFF character is control S (ASCII 19_{10}, 13_{16}).
- DIAG:BOOT:COLD sets ...PACE to XON.
- **Related Commands:** …[PROT]:THR:STAR, …[PROT]:THR:STOP
- ***RST Condition:** No change

Example **Enable XON/XOFF Handshaking**

```
SYST:COMM:SER1:PACE:PROT XON
```

Enable XON/XOFF handshake for Agilent E1324A plug-in module #1

:COMMunicate :SERial[n] [:RECeive]:PACE [:PROTocol]?

SYSTem:COMMunicate:SERial[n][:RECeive]:PACE[:PROTocol]? returns the current receive pacing protocol.

Example **Query XON/XOFF Protocol**

```
SYST:COMM:SER1:PACE:PROT?
```

Querries Agilent E1324A plug-in module #1 to see if XON/XOFF protocol is enabled

```
ENTER statement
```

Returns "XON" if enabled or "NONE" if disabled

:COMMunicate :SERial[n] [:RECeive]:PACE :THReshold:STARt

SYSTem:COMMunicate:SERial[n][:RECeive]:PACE:THReshold :STARt <*char_count*> configures the input buffer at which the specified interface may send the XON character (ASCII 11_{16}), assert the DTR line, and/or assert the RTS line.

Parameters

Parameter Name	Type	Range of Values	Default
char_count	numeric	1 through 99 for built-in RS-232 1 through 8192 for Agilent E1324A	None

Comments

- **Determining Input Buffer Size**. To determine the input buffer size for the serial interface you are using, send SYST:COMM:SER[n]:PACE:THR:STAR? MAX. The returned value is the buffer size.
- **PACE:PROT XON Must be Set**. ...THR:STAR has no effect unless ...PACE:PROT XON, ...CONT:DTR IBFull, or ..CONT:DTR IBFull has been sent.
- **...STARt/STOP Default Value**. The default STARt and STOP thresholds for the built-in and plug-ins are:

	STARt	STOP
Built-in RS-232	10	65
Plug-in Modules	2048	6144

- ...STARt must be set to less than ...STOP.
- **Related Commands:** ...PACE:PROT XON|NONE, ...CONT:DTR, ...CONT:RTS
- ***RST Condition:** No change

Example **Set Interface to Generate XON**

```
SYST:COMM:SER1:PACE:THR:STAR 10
```

Set interface on Agilent E1324A to send XON when input buffer contains 10 characters.

:COMMunicate :SERial[n] [:RECeive]:PACE :THReshold:STARt?

SYSTem:COMMunicate:SERial[n][:RECeive]:PACE:THReshold :STARt? [MIN | MAX] returns the current start threshold if no parameter is sent, the maximum allowable setting if MAX is sent, or the minimum allowable setting if MIN is sent.

Comments

- **Determining Input Buffer Size.** To determine the size of the input buffer for the serial interface you are using, send SYST:COMM:SER[n][:REC]:PACE:THR:STAR? MAX. The returned value is the buffer size.

Example

Query Current STARt Threshold

SYST:COMM:SER1:PACE:THR:STAR?

Query start threshold value for serial interface on Agilent E1324A module #1

ENTER statement

Return threshold value

:COMMunicate :SERial[n] [:RECeive]:PACE :THReshold:STOP

SYSTem:COMMunicate:SERial[n][:RECeive]:PACE:THReshold:STOP <*char_count*> configures the input buffer level at which the specified interface may send the XOFF character (ASCII 13_{16}), deassert the DTR line, and/or deassert the RTS line.

Parameters

Parameter Name	Type	Range of Values	Default
char_count	numeric	1 through 99 for built-in RS-232 1 through 8192 for Agilent E1324A	None

Comments

- **Determining Input Buffer Size**. To determine the size of the input buffer of the serial interface you are using, send SYST:COMM:SER[n]:PACE:THR:STOP? MAX. The returned value is the buffer size.

- **PACE:PROT XON Must be Set**. ...THR:STOP has no effect unless ...PACE:PROT XON, ...CONT:DTR IBFull, or ..CONT:DTR IBFull has been sent.

- **STARt/STOP Default Value**. The default STARt and STOP thresholds for the built-in and plug-ins are:

	STARt	STOP
Built-in RS-232	10	65
Plug-in Modules	2048	6144

- ...STOP must be set to greater than ...STARt.

- **Related Commands:** ...PACE:PROT XON|NONE, ...CONT:DTR, ...CONT:RTS

- ***RST Condition:** No change

Example

```
SYST:COMM:SER1:PACE:THR:STOP 80
```

Set serial interface on Agilent E1324A module #1 to send XOFF when input buffer contains 80 characters.

:COMMunicate :SERial[n] [:RECeive]:PACE :THReshold:STOP?

SYSTem:COMMunicate:SERial[n][:RECeive]:PACE:THReshold: STOP? [MIN | MAX] returns the current stop threshold if no parameter is sent, the maximum allowable setting if MAX is sent, or the minimum allowable setting if MIN is sent.

Comments

- **Determining Size of Input Buffer**. To determine the size of the input buffer of the serial interface you are using, send SYST:COMM:SER[n]:PACE:THR:STOP? MAX. The returned value will be the buffer size.

Example **Query Current Stop Threshold**

```
SYST:COMM:SER1:PACE:THR:STOP?
```

Query STOP threshold for serial interface on Agilent E1324A module #1

```
ENTER statement
```

Returns numeric value

:COMMunicate :SERial[n] [:RECeive] :PARity:CHECk

SYSTem:COMMunicate:SERial[n][:RECeive]:PARity:CHECk <*check_cntrl*> controls whether or not the parity bit in received serial data frames will be considered significant.

Parameters

Parameter Name	Type	Range of Values	Default
check_cntrl	boolean	1 | 0 | ON | OFF	None

Comments

- **Parity Check Off**. When *check_cntrl* is set to 0 or OFF, received data is not checked for correct parity. Transmitted data still includes the type of parity as set with ...PARity[:TYPE].
- **Related Commands:** SYST:COMM:SER[n]:PAR[:TYPE]
- ***RST Condition:** No change

Example **Set Parity Check ON**

```
SYST:COMM:SER1:PAR:CHEC ON
```

Set parity check to ON for serial interface on Agilent E1324A module #1

:COMMunicate :SERial[n] [:RECeive] :PARity:CHECk?

SYSTem:COMMunicate:SERial[n][:RECeive]:PARity:CHECk? returns the state (ON/OFF) of parity checking.

Example **Check Parity Status**

SYST:COMM:SER1:PAR:CHEC?

Query parity check status (ON/OFF) for serial interface on Agilent E1324A module #1

ENTER statement

Returns 1 if ON, 0 if OFF

:COMMunicate :SERial[n] [:RECeive] :PARity[:TYPE]

SYSTem:COMMunicate:SERial[n][:RECeive]:PARity[:TYPE] <*type*> configures the type of parity to be checked for received data, and generated for transmitted data.

Parameters

Parameter Name	Type	Range of Values	Default
type	discrete	EVEN | ODD | ZERO | ONE | NONE	None

Comments

- **PARity[:TYPE] Values:** The following table defines each value of *type*: Attempting to set *type* to other than values shown generates error -222.

Value	Definition
EVEN	If …PARity:CHECK is ON, the received parity bit must maintain even parity. The transmitted parity bit will maintain even parity.
ODD	If …PARity:CHECK is ON, the received parity bit must maintain odd parity. The transmitted parity bit will maintain odd parity.
ZERO	If …PARity:CHECK is ON, the received parity bit must be a zero. The transmitted parity bit will be a zero.
ONE	If …PARity:CHECK is ON, the received parity bit must be a logic one. The transmitted parity bit will be a logic one.
NONE	A parity bit must not be received in the serial data frame. No parity bit will be transmitted.

- **Disallowed Combinations**. Although the ...PARity[:TYPE] command operates independently of the …BITS or …SBITs commands, two combinations are disallowed because of their data frame bit width (see the following table):

BITS	PARity[:TYPE]	SBITs	Frame Bits
7	NONE	1	9 - disallowed
7	NONE	2	10
7	Yes	1	10
7	Yes	2	11
8	NONE	1	10
8	NONE	2	11
8	Yes	1	11
8	Yes	2	12 - disallowed

- **...PAR:CHECK ON Must be Set**. Received parity will not be checked unless SYST:COMM:SER[n]:PAR:CHEC ON has been sent. Transmitted data will include the specified parity whether …PAR:CHEC is ON or OFF.
- DIAG:BOOT:COLD sets PARity to NONE.
- **Related Commands:** …PAR:CHEC 1|0|ON|OFF, ,…SER[n]:BITS 7|8, …SER[n]:SBIT 1|2
- ***RST Condition:** No change

Example **Set Parity Check/Generation ODD.**

```
SYST:COMM:SER1:PAR ODD
```
Set ODD parity for serial interface on Agilent E1324A module #1
```
SYST:COMM:SER0:PAR:CHEC ON
```
Enable parity check/gen.

:COMMunicate :SERial[n] [:RECeive] :PARity[:TYPE]?

SYSTem:COMMunicate:SERial[n][:RECeive]:PARity[:TYPE]? returns the type of parity checked and generated.

Example **Query Type of Parity Checking Set**

```
SYST:COMM:SER1:PAR?
```
Query parity type for serial interface on Agilent E1324A module #1
```
ENTER statement
```
Returns EVEN, ODD, ZERO, ONE, or NONE

:COMMunicate :SERial[n] [:RECeive]:SBITs

SYSTem:COMMunicate:SERial[n][:RECeive]:SBITs <*sbits*> sets the number of stop bits to be used to transmit and receive data.

Parameters

Parameter Name	Type	Range of Values	Default
sbits	numeric	1 | 2 | MIN | MAX	None

Comments

- Attempting to set *sbits* to other than the values in the above table generates error -222.
- **Disallowed Combinations**. Although the ...SBITs command operates independently of the …BITS or …PARity[:TYPE] commands, two combinations are disallowed because of their data frame bit width. The following table shows the possible combinations:

BITS	PARity[:TYPE]	SBITs	Frame Bits
7	NONE	1	9 - disallowed
7	NONE	2	10
7	Yes	1	10 7
8	NONE	1	10
8	NONE	2	11
8	Yes	1	11
8	Yes	2	12 - disallowed

- DIAG:BOOT:COLD sets SBITs to 1.
- **Related Commands:** SYST:COMM:SER[n]:BAUD
- ***RST Condition:** No change

Example **Setting 2 Stop Bits**

```
SYST:COMM:SER1:SBITS 2
```
Sets 2 stop bits for serial interface on Agilent E1324A module #1

:COMMunicate :SERial[n] [:RECeive]:SBITs?

SYSTem:COMMunicate:SERial[n][:RECeive]:SBITs? [MIN | MAX] returns the current stop bit setting if no parameter is sent, the maximum allowable setting if MAX is sent, or the minimum allowable setting if MIN is sent.

Example **Query Current Stop Bit Setting**

```
SYST:COMM:SER1:SBIT?
```
Query number of stop bits for serial interface for Agilent E1324A module #1 (:REC is implied)

```
ENTER statement
```
Returns 1 or 2

:COMMunicate :SERial[n] :TRANsmit:AUTO

SYSTem:COMMunicate:SERial[n]:TRANsmit:AUTO <*auto_cntrl*> when ON sets the transmit pacing mode to be the same as that set for receive pacing. When OFF, the transmit pacing mode may be set independently of the receive pacing mode.

Parameters

Parameter Name	Type	Range of Values	Default
auto_cntrl	boolean	0 | 1 | OFF | ON	None

Comments

- **AUTO Always ON for Agilent E1324A**. AUTO is always ON for an Agilent E1324A. Trying to set OFF or 0 will generate an error.
- DIAG:BOOT:COLD sets ...AUTO to ON.
- **Related Commands:** SYST:COMM:SER[n]:REC:PACE:PROT, SYST:COMM:SER[n]:TRAN:PACE:PROT
- ***RST Condition:** TRAN:AUTO ON

Example **Link Transmit Pacing With Receive Pacing**

```
SYST:COMM:SER0:TRAN:AUTO ON
```
Link transmit/receive pacing for built-in RS-232 interface.

:COMMunicate :SERial[n] :TRANsmit:AUTO?

SYSTem:COMMunicate:SERial[n]:TRANsmit:AUTO? returns the current state of receive to transmit pacing linkage.

Comments

- **AUTO Always ON for Agilent E1324A**. AUTO is always ON for an Agilent E1324A. In this case, ...AUTO? always returns a 1.

Example **Query Receive to Transmit Linkage**

```
SYST:COMM:SER0:TRAN:AUTO?
```
Query receive to transmit linkage for built-in RS-232 interface

```
ENTER statement
```
Returns 1 for AUTO ON, 0 for AUTO OFF

:COMMunicate :SERial[n] :TRANsmit:PACE [:PROTocol]

SYSTem:COMMunicate:SERial[n]:TRANsmit:PACE[:PROTocol] <*protocol*> enables or disables the transmit pacing (XON/XOFF) protocol (built-in RS-232 interface only).

Parameters

Parameter Name	Type	Range of Values	Default
protocol	discrete	XON|NONE	None

Comments

- **XOFF Halts Data Transmission**. Receipt of an XOFF character (ASCII 19_{10}, 13_{16}) will hold off transmission of data until an XON character (ASCII 17_{10}, 11_{16}) is received.

- DIAG:BOOT:COLD sets ...PACE to XON.
- **Related Commands:** SYST:COMM:SER[n]:TRAN:AUTO
- ***RST Condition:** No change

Example **Set XON/XOFF Transmit Pacing**

```
SYST:COMM:SER0:TRAN:PACE:PROT XON
```
Set XON/XOFF transmit pacing for built-in RS-232 interface

:COMMunicate :SERial[n] :TRANsmit:PACE [:PROTocol]?

SYSTem:COMMunicate:SERial[n]:TRANsmit:PACE[:PROTocol]? returns the current transmit pacing protocol.

Example **Check Transmit Pacing Protocol**

```
SYST:COMM:SER0:TRAN:PACE:PROT?
```
Query transmit pacing protocol state for built-in RS-232 interface

```
ENTER statement
```
Returns "XON" or "NONE"

SYSTem:ERRor?

SYSTem:ERRor? returns the oldest entry in the IBASIC instrument's error/event queue. The return contains an error number in range [-32768, 32767] and an error message. 0, "No error" is returned when the queue is empty (no errors).

Comments

- **Event/Error Queue Operation**. The error queue is first-in, first-out. If the queue overflows, the last error/event in the queue is replaced with error -350, "Queue overflow".
- **Clearing Event/Error Queue.** The event/error queue is cleared on power-up, when a *CLS command is received, or when the last error item is read from the queue.

Chapter 9 Contents

Chapter 9

Common Command Reference

Using this Chapter

This chapter describes the IEEE 488.2 Common (*) Commands which apply to the IBASIC Instrument. See the *Tutorial Description of the General Purpose Interface Bus* for additional information on IEEE 488.2 Common Commands.

Common Command Groups

The following table shows the Common Commands implemented by the IBASIC Instrument by Command Group. In this chapter, Common Commands are described alphabetically by Command Group.

The examples in this chapter assume the Common commands are issued by an external computer and that Talk/Listen mode is set.

Common (*) Commands for the IBASIC Instrument

Group	Mnemonic	Description
Test/Identity Commands	*IDN? *RST *TST?	Identification Query Reset Self-Test Query
Synchronization Commands	*OPC *OPC? *WAI	Operation Complete Operation Complete Query Wait to Continue
Status and Event Commands	*CLS *ESE *ESE? *ESR? *SRE *SRE? *STB?	Clear Status Standard Event Enable Standard Event Enable Query Standard Event Query Service Request Enable Service Request Enable Query Read Status Byte Query
Macro Commands	*DMC *EMC *EMC? *GMC? *LMC? *PMC	Define Macro Enable Macro Enable Macro Query Get Macro Contents Query Learn Macro Query Purge Macros

Test/Identity Commands

The Test/Identity commands include *IDN?, *RST, and *TST?.

*IDN?

Identification query. Returns the identity of the IBASIC instrument.

Comments

The response from *IDN? consists of the following four fields (fields are separated by commas):

- Manufacturer
- Model number
- Serial number (returns 0 if not available)
- Firmware revision (returns 0 if not available)

Example

5 !RE-SAVE "IDNQUERY"	
10 DIM A$[50]	*Dimension array for ID fields*
20 OUTPUT 70930;"*IDN?"	*Queries identity of IBASIC instrument*
30 ENTER 70930;A$	*Places ID fields in array*
40 PRINT A$	*Prints ID fields*
50 END	

A typical IBASIC instrument response is: Hewlett-Packard,IBASIC,0,A.03.00

*RST

Reset. Causes the IBASIC Instrument to perform a BASIC Reset.

Comments

*RST resets the IBASIC instrument as follows:

- Stops a running program (sets IBASIC to idle state), but does not delete the program
- Resets variables (variables will then be out of context)
- Resets all interfaces assigned to IBASIC (internal IBASIC, GPIB, or Serial)
- Clears the selected display and exits EDIT mode

*RST does not affect:

- The instrument address
- The output queue
- The Service Request Enable Register
- The Standard Event Enable Register
- Protected user data

Example

```
OUTPUT 70930;"*RST"
```

Resets the IBASIC Instrument

*TST?

Self-test query. Always returns a 0; no IBASIC self-test is performed.

Synchronization commands

The synchronization commands include *OPC, *OPC?, and *WAI. These commands can be used by IBASIC to ensure synchronization between an instrument and the IBASIC computer or between multiple instruments. These commands are not meant to be used on the IBASIC Instrument itself since the Operation Complete event or Wait Event occurs when the IBASIC parser has parsed a command--not when that command has finished being executed. Refer to *Synchronizing Instrument/Device Operations* in Chapter 5 or to the Agilent E1406 User's Manual for information on how these commands can be used with instruments other than the IBASIC Instrument.

Status and Event Commands

Status and event commands can be used to determine the status of the IBASIC Instrument. For an SCPI instrument, the Status system consists of a Questionable Data/Signal Status Register, an Operation Status Register, a Standard Event Status Group, and a Status Byte Register.

However, the IBASIC instrument uses the Standard Event Status Group, the Status Byte Register, and bit 14 (program running) of the Operation Status Register. For the IBASIC Instrument, the Questionable Data/Signal Status Register always returns 0.

The Standard Event Status Group consists of two registers (Standard Event and Standard Event Enable) and is set by the *ESE and *ESR? commands. *ESE? can be used to query the state of the Standard Event Enable Register.

The Status Byte Register is set/cleared by the *SRE and *STB? commands. *SRE? can be used to query the state of the Service Request Enable on the Status Byte Register. Note that bits 0 through 3 and bit 7 of the Status Byte Register are always 0. The Status Byte summary bit is bit 6 (RQS) on the Status Byte Register.

*CLS

Clear status command. The *CLS command clears the Standard Event Status Group registers, the Status Byte register, and the error queue for the IBASIC instrument.

Comments

*CLS also clears bits 4, 5, and 7 of the Status Byte register (*STB? must be sent to clear bit 6.)

*CLS does not affect enabling bits in the Status Byte register or the Standard Event Status Group registers. However, *CLS disables the operation complete function (*OPC command) and the operation complete query function (*OPC? command).

Example

```
OUTPUT 70930;"*CLS"
```

Clears the Standard Event Status Group registers, Status Byte register and the error queue for the IBASIC instrument.

*ESE <*mask*>

Standard Event Enable . Enables one or more events in the Standard Event Enable Register to be reported in bit 5 (Standard Event summary bit) of the Status Byte Register.

Comments An event is enabled by specifying the appropriate decimal weight for *ESE <*mask*>. To enable more than one event, specify the sum of the decimal weights.

Example

```
OUTPUT 70930;"*ESE 48"
```

Enables bits 4 and 5 of the Standard Event Enable Register for the IBASIC Instrument. Respective decimal weights are 16 + 32 = 48.

*ESE?

Standard event enable query. Returns the weighted sum of all enabled bits in the Standard Event Enable register.

Example

```
5  !RE-SAVE "ESEQUERY"
10 OUTPUT 70930;"*ESE?"          Sends standard event enable
                                 query
20 ENTER 70930;A                 Places response in variable
30 PRINT A                       Displays response
40 END
```

*ESR?

Standard Event Query. Returns the weighted sum of all set bits in the Standard Event Register.

Comments After reading the Standard Event Register, *ESR? clears the register. The events recorded in the Standard Event Register are independent of whether or not those events are enabled with the *ESE command.

Example

```
5  !RE-SAVE "ESRQUERY"
10 OUTPUT 70930;"*ESR?"          Query Standard Event Register
                                 state
20 ENTER 70930;A                 Place response in A
30 PRINT A                       Displays response
40 END
```

*SRE <*mask*>

Service Request Enable. *SRE identifies which Service Request events will generate a Service Request (SRQ).

Comments When a Service Request event occurs, the event sets a corresponding bit in the Status Byte Register, whether or not the event has been enabled by *SRE. However, when an event enabled by *SRE occurs, the event sets a bit in the Status Byte Register and issues an SRQ to the computer.

An event is enabled to generate an SRQ by specifying its decimal weight in the *SRE <*mask*> parameter. To enable more than one event, specify the sum of the decimal weights for the events.

Example

```
10 OUTPUT 70930;"*ESE 16"
```

Enables Execution Error bit (bit 4) of the Standard Event Enable Register.

```
20 OUTPUT 70930;"*SRE 32"
```

Enables bit 5 of the IBASIC Instrument's Status Byte Register. This will generate an SRQ whenever an Execution Error occurs.

---

*SRE?

Service request enable query. Returns the weighted sum of all enabled events (those enabled to generate SRQ) in the Status Byte register of the IBASIC instrument.

Example

```
5  !RE-SAVE "SREQUERY"
10 OUTPUT 70930;"*SRE?"        Query service request enable
20 ENTER 70930;A               Places response in variable
30 PRINT A                     Displays response
40 END
```

If bits 4 and 5 are enabled to generate an SRQ, the return is 48 (16 for bit 4 + 32 for bit 5).

---

*STB?

Read Status Byte Query. Returns the weighted sum of all set bits in the Status Byte Register.

Comments

You can read the state of the Status Byte Register using the *STB? command or the Serial Poll (SPOLL) command. Both commands return the weighted sum of all set bits in the register. However, *STB? does not clear bit 6 (Service Request) of the Status Byte Register, while SPOLL does clear bit 6 of the register.

No other Status Byte Register bits are cleared by either method except Message Available (bit 4) which may be cleared as a result of reading the response to *STB?.

Example

```
5  !RE-SAVE "STBQUERY"
10 OUTPUT 70930;"*STB?"        Query Status Byte Register
                               contents for the IBASIC
                               Instrument
20 ENTER 70930;A               Places response in variable
30 PRINT A                     Displays response
40 END
```

Macro Commands

The Macro commands (*DMC, *EMC, *EMC?, *GMC, *GMC?, *LMC, and *PMC) can be used to define and use macros (a sequence of commands) to replace a set of commands. Macros are particularly useful when using an external computer with the mainframe in Talk/Listen mode. In this situation, macros can be used to dramatically reduce the number of characters transferred over the GPIB bus which reduces bus overhead and maximizes transfer speed. An example follows the macro command descriptions that shows most macro operations.

*DMC <label>

Define Macro Command. Allows the user to assign a sequence of commands to a macro label.

Comments

IBASIC executes the macro when it encounters the macro <*label*> as a command. To define a macro, send *DMC followed by a string designating the macro label. Following the <*label*>, send an *Arbitrary Block Program Data* element defining the macro. The macro <*label*> may be either a command or a query.

The macro <*label*> cannot be the same as a Common Command or Common Command Query, but it may be the same as a device-dependent command. If macros are enabled, when a macro <*label*> is the same as a device-dependent command, the device executes the macro rather than the device command.

PROGram commands that download character strings and numeric data are not supported inside macros. These unsupported commands are: PROG:STRING, PROG:NUMB, and PROG:DEF. For example, the following statement is not supported and will cause errors:

```
OUTPUT @IBASIC:"*DMC ""M1"",#219 PROG:STRING A,'A=1'"
```

*EMC <number>

Enable Macro Command. Enables/disables macros for a device.

Comments

Sending *EMC 0 disables all macros. Sending *EMC <*number*> in the range -32767 to +32767 enables macros. Standard rounding rules for <*number*> apply.

Example

```
*EMC  0.4
```

Disables all macros, since 0.4 rounds to 0.

```
*EMC -12.4
```

Enables macros, since <number> is in range of -32767 to +32767.

*EMC?

Enable macro query. Allows user to determine if macros are enabled. The *EMC? command returns 1 when macros are enabled or returns 0 when macros are disabled.

*GMC?

Get Macro Contents Query. Returns the current definition of a macro.

Comments

Send *GMC? followed by the <*label*> string of a macro. The device responds with a *Definite Length Arbitrary Block Response Data* element containing the macro definition.

Example

```
*GMC? "SWEEP_SET"
```

Returns the macro definition for the macro "SWEEP_SET"

*LMC?

Learn macro query. Returns the labels of all currently defined macros. The return consists of strings separated by commas. The return is the same whether macros are enabled or disabled.

*PMC

Purge Macros Command. Deletes all macros in memory which were defined with the *DMC command. All macro sequences and labels are removed from memory.

Macro Example

```
10   ! RE-SAVE "MAN1"
20   ASSIGN @IBASIC TO 70930.
30   CLEAR @IBASIC
40   OUTPUT @IBASIC;"*RST;*CLS;:prog:del:all"
       IBASIC reset, clear status, delete current program
50   OUTPUT @IBASIC;"prog:def #0"
       Download following program
60   OUTPUT @IBASIC;"10 LOOP"
70   OUTPUT @IBASIC;"20   DISP I"
80   OUTPUT @IBASIC;"25   I=I+1"
90   OUTPUT @IBASIC;"30 END LOOP"
100  OUTPUT @IBASIC;"40 END" END
       END of downloaded program
110  OUTPUT @IBASIC;"*PMC"
       Purge current macros
120  OUTPUT @IBASIC;"*DMC ""R"",#214prog:state run"
       Macro R = RUN program
130  OUTPUT @IBASIC;"*DMC ""C"",#215prog:state cont"
       Macro C = CONTinue program
140  OUTPUT @IBASIC;"*DMC ""P"",#215prog:state paus"
       Macro P = PAUSE program
150  OUTPUT @IBASIC;"*DMC ""S"",#215prog:state stop"
       Macro S = STOP program
160  OUTPUT @IBASIC;"*DMC ""BEEP"",#216prog:exec 'BEEP'"
       Macro BEEP causes a beep
170  OUTPUT @IBASIC;"*DMC ""GET_I"",#212prog:numb? i"
       Macro GET_I will get value of I variable
```

```
180  OUTPUT @IBASIC;"*DMC ""ERR"",#19syst:err?"
```
Macro ERR queries error queue

```
190  OUTPUT @IBASIC;"*EMC 1"
```
Enable macros

```
200  OUTPUT @IBASIC;"R;ERR"
```
RUN program, check for errors

```
210  ENTER @IBASIC;In$
220  PRINT In$
```
Retrieve error (if any)

```
230  FOR I=1 TO 500
240    OUTPUT @IBASIC;"GET_I"
```
Get value of I from running IBASIC program

```
250    ENTER @IBASIC;I_
260    DISP I,I_
270    IF (I MOD 30)=0 THEN OUTPUT @IBASIC;"P;BEEP;C"
```
Every 30 counts pause, beep, continue

```
280  NEXT I
290  OUTPUT @IBASIC;"S"
```
STOP program

```
300  END
```

Appendix A Contents

Appendix A

IBASIC and HP Series 200/300 Differences

The IBASIC language is similar to that used on HP Series 200/300 BASIC language computers. However, there are some differences. If you are familiar with the Series 200/300 computers you will want to note the following IBASIC differences.

Floating Point Math

Since various HP Series 200/300 BASIC and IBASIC platforms use slightly different floating point and transcendental functions, it is never a good idea to rely on exact equality of floating point results.

The following sample program gives an example of why:

```
10 A=1-COS(0)
20 PRINT A
30 END
```

IBASIC prints 1.11022302463E-16

HP Series 200/300 BASIC prints 0

Timeout when Entering Data from a Device

When IBASIC times-out waiting for input from a device or gets an interface error, an extra character is returned. The following example shows what happens for the timeout case:

```
5     !RE-SAVE "TIMEOUT"
10     ON TIMEOUT 9,1 GOTO Tmout ! serial card
20     OUTPUT 9 USING "#,K";"AB" ! Send a 2 character string with
                                  !no terminator.
30     ENTER 9,A$                 ! Enter the string this will time out
40     GOTO No_tmout
50  Tmout:
60     PRINT LEN(A$)              ! IBASIC prints 3
70                                ! HP Series 200/300 BASIC    prints 2
80 No_tmout:
90 !...
100    END
```

The solution for IBASIC is to strip the extra character from the string if a timeout is detected. Add the following line to do this:

```
 65    A$=A$[1,LEN(A$)-1]
```

A similar fix can be used for the device error case.

Enter from a Device with no Enter List does not Wait

```
10   ! Enter from the keyboard with no ENTER list
20   ENTER 2    ! HP Series 200/300 BASIC waits for the RETURN
                ! key
30              ! IBASIC falls through without waiting
40   !...
50   ENTER 2,X$! Solution for IBASIC is to enter to
60          ! A string but ignore the returned data.
70          ! This operates the same in HP Series 200/300 BASIC
              and IBASIC.
```

Format Off Enter to a String Does Not Look for Length Word

```
10    ASSIGN @F TO 9;FORMAT OFF
20    ENTER @F;A$
```

HP Series 200/300 BASIC expects a 4 byte length word to precede the string characters. IBASIC does not look for a length word. It puts each character into the string as it is received until an interface error, timeout or string overflow occur. ENTERing numbers operates the same as HP Series 200/300 BASIC.

String Variable Entry

If an input statement is used to enter into a string variable which has been dimensioned to length n, and the user enters a string that is too long, an error is generated and Ibasic remains in input state, but the variable is set equal to first n characters which were entered. HP Series 200/300 BASIC does not assign anything to that variable in this case.

For example, during the input in the following program:

```
10 DIM A$[4]
20 INPUT A$
30 PRINT A$
40 END
```

If the user enters "abcdef", this will cause an error to be reported, and the input will be executed again. If the user then enters a return, on IBASIC A$ will be set to "abcd", while on HP Series 200/300 BASIC it will be set to null string.

Nested I/O

HP Series 200/300 BASIC permits nesting of I/O statements to as many levels as there are different interface select codes. HP Series 200/300 BASIC would permit the following:

```
10 PRINTER IS 701
20 PRINT FNNested
30 END
40 DEF FNNested
50 OUTPUT 822;"string"
60 RETURN 0
70 FNEND
```

This program will not run in IBASIC as stated. To accommodate the same functionality in IBASIC, the following can be done:

```
10 PRINTER IS 701
20 Result=FNNested
25 PRINT Result
30 END
40 DEF FNNested
50 OUTPUT 822;"string"
60 RETURN 0
70 FNEND
```

Subprograms and ON Conditions

In IBASIC, when using an ON condition (such as ON KEY) to call a subprogram, you cannot use parameter lists in the SUB statement. If you do, you will generate *Error 9 Improper number of parameters*. On HP Series 200/300 BASIC computers, the error occurs when the program line containing the ON condition is executed. In IBASIC, the error occurs when the ON condition occurs. For example, this program generates Error 9 in IBASIC when key 1 is pressed:

```
10 ON KEY 1 CALL SUB A
20 GOTO 20
30 END
40 SUB A(B)
50 !...
60 !...
70 SUBEND
```