

HP 8719C, 8720C, and 8722A/C network analyzers

# **QuickC Programming Guide**

**for use with MS-DOS  
personal computers**



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# Programming Basics

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## Introduction

This programming guide is an introduction to remote operation of the HP 8719C, 8720C and 8722A/C network analyzers using an HP Vectra personal computer (or IBM compatible), using a MS-DOS<sup>®</sup> operating system, with the HP 82335A HP-IB command library and Microsoft<sup>®</sup> QuickC 2.5. It is a tutorial introduction using C programming examples. This document is closely associated with the *HP-IB Programming Reference (HP part number 08720-90160)*, which provides complete programming information in a concise format. Included in the *HP-IB Programming Reference* is an alphabetical list of HP-IB mnemonics and their explanations.

The reader should become familiar with the operation of the network analyzer before controlling it over HP-IB. This document is not intended to teach C programming or to discuss HP-IB theory except at an introductory level. Refer to the documents listed below which are better suited to these tasks. 8

- For more information concerning the operation of the network analyzer, refer to the following:

*User's Guide (HP part number 08720-90136)*

*Operating and Programming Reference Section (within the HP 8719C, 8720C, 8722A/C Operating Manual, HP part number 08720-90135)*

- For more information concerning HP-IB and C, refer to the following:

*HP-IB Programming Reference (HP part number 08720-90160)*

*Using the HP 82335A HP-IB Interface and Command Library Manual (HP part number 82335-90005)*

*Microsoft QuickC: Up and Running*

*Microsoft QuickC: Tool Kit*

*C for Yourself*

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### Caution



The programming examples found in this guide are for **example** purposes only. They may require modification to work with your particular personal computer.

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## Start-up

### Required equipment

To run the examples in this programming guide, the following equipment is required:

1. 3\* HP 8719C, 8720C, or 8722A/C network analyzer.
2. The following computer equipment:
  - HP Vectra personal computer (or compatible) with Microsoft QuickC 2.5
  - HP 82335A HP-IB interface card or a compatible IEEE 488 interface card
  - MS-DOS 3.3 or higher
  - 512 Kbytes of memory. 9
3. HP 10833A/B/C/D HP-IB cables to interconnect the computer, the analyzer, and any peripherals.
4. Calibration kit and appropriate test port cables.
5. A device under test (DUT), such as the bandpass filter supplied with your instrument (HP part number 0955-0446).

### Configuring the HP 82335A HP-IB interface card

Configure the HP 82335A HP-IB interface card according to its respective manual. The HP-IB interface cannot share the same memory address, nor the same interrupt level with another card. If an expanded memory manager is used, make sure it does not use the same memory space as the HP-IB interface.

The example programs in this guide assume the HP-IB interface card is configured with select code 7. If it is not, the variables `ISC`, `INSTR`, and `DISPLAY`, in the following programs, will have to be changed to reflect a different select code.

### Using other computer equipment

Other versions of C can be substituted for QuickC. The programs in this guide are designed to be easily translated into other language versions.

9The programs in this guide are specific to the HP 82335A HP-IB command library which is part of the HP 82335A HP-IB interface card. Other IEEE 488 cards can be used; however, their I/O command library maybe different and the following example programs may have to be translated accordingly.

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#### Note



There maybe some HP 82335A command library commands that may not have an equivalent command in other IEEE 488 I/O command libraries. In this case, consult the manufacturer or program an equivalent command.

---



## Configuring Microsoft QuickC

It is important to configure Microsoft QuickC properly for correct operation with the HP 82335A HP-IB command library and the example programs in this guide. The following steps should be verified before continuing.

### 1. Installing QuickC.

When installing QuickC, choose either the small or large memory model. Refer to the QuickC manual for detailed installation information.

### 2. Copying the HP 82335A HP-IB command library.

It is assumed that QuickC is installed in the "qc25" directory on the default drive. Copy the following HP 82335A HP-IB command library files to their corresponding directories already created by the installation of QuickC.

```
CLHPIB.LIB      -> qc25/lib/CLHPIB.LIB
CHPIB.H        -> qc25/include/CHPIB.H
CFUNC.H        -> qc25/include/CFUNC.H
```

### 3. Customizing QuickC for the HP 82335A command library.

Load QuickC by typing "QC" at the prompt. Activate the options menu by clicking the mouse on the menu bar or by pressing the [ALT] [O] keys. Select the "environment" menu. Enter the following directory names:

```
binary and help files -> qc25/bin
include files         -> qc25/include
library files         -> qc25/lib
```

Select <OK> when done.

Again from the Options menu, select the "make" menu. Select the "linker flags" option. Enter the following for

```
"GLOBAL FLAGS: Stack Size": 4096
```

Also from this menu, enter the following for

```
"CUSTOM FLAGS: GLOBAL": qc25/lib/clhplib.lib
```

Select <OK> when done.

## Powering up the system

### 1. Set up the network analyzer as shown in Figure 1-1

Connect the instrument to the computer with an HP-IB cable. The instrument has only one HP-IB interface, but it occupies two addresses: one for the instrument and one for the display. The display address is the instrument address with the least significant bit complemented. The default addresses are 16 for the instrument and 17 for the display. Devices on the HP-IB cannot occupy the same address as the network analyzer.

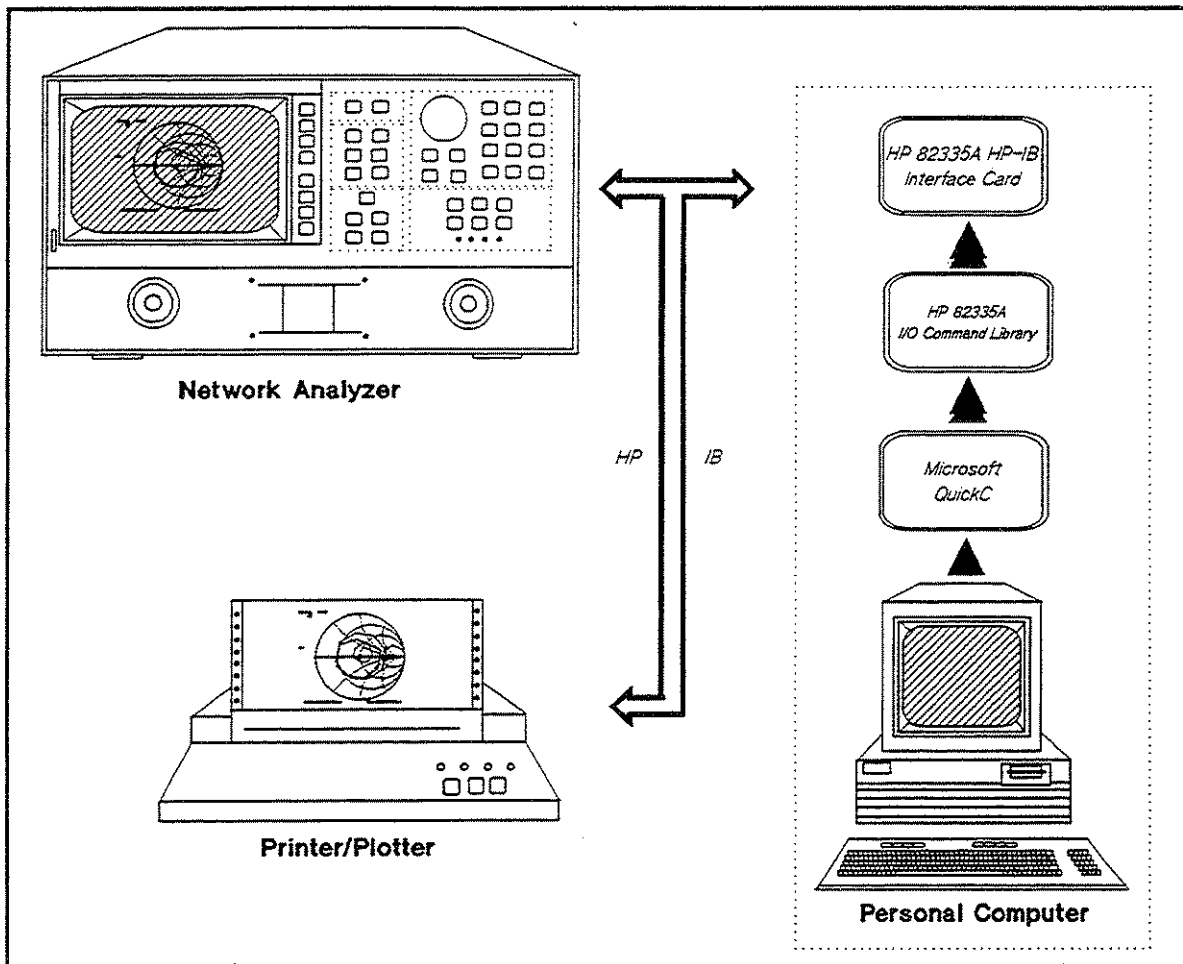


Figure 1-1. HP-IB connections in a typical setup

2. Turn the network analyzer on.

To verify the instrument HP-IB address, press **LOCAL** **SET ADDRESSES** and **ADDRESS: INSTRUMENT**. If the address has been changed from the default value 16, return it to 16 for the examples in this document by pressing **1** **6** **x1** and then presetting the instrument. Make sure the instrument is in either **USE PASS CONTROL** or **TALKER/LISTENER** mode, as indicated under the **LOCAL** menu. These are the only modes in which the network analyzer will accept commands over HP-IB.

---

## Programming techniques

### Introduction

The following example programs introduce the interfacing capabilities of the instrument with HP-IB and a computer. Each example program contains a description of the program, the program listing, a line by line explanation, and detailed instructions for running the program. Note that line numbers aren't used in C programs but are included in the program listings for functional explanations. For clarity, the HP-IB command library function names are shown in upper case. Remember that C is a case-sensitive language.

There are four basic steps in designing a program in C to send a simple command to the instrument:

1. Create a source file. This is a C program in text form. This file must contain the proper "#include" definitions and variable declarations, including the "main" function declaration.
2. Include in the main declaration the command to be sent. The command is sent with the HP-IB command library function IOOUTPUTS.
3. Compile and link the source file.
4. Run the compiled program.

These steps form the basis for programs that do more than send simple commands. More complex programs should contain additional routines, such as error checking and initializing, to support full I/O capabilities of the instrument.

### Error checking

Error checking should be performed after every HP-IB library call. Each HP-IB command library call returns a value corresponding to the error status of the current operation. An error handler routine is a convenient way of checking errors. For example, the following error routine could be used:

```
void error_handle (int error, char *routine)
{
    if (error !=NOERR)
    { /* If there is an error, print an error */
      /* message and exit */
      printf ("HP-IB error in call to
              %s: %d, %s\n", routine, error,
              errstr(error));
      exit(1);
    }
    return; /* No error, so return normally */
}
```

Using the above error routine, a command, for example, can be sent to the instrument as follows:

```
error_handle (IOOUTPUTS (716L,"PRES;",5), "IOOUTPUTS");
```

`error_handle`: Passes an error number and appropriate display string to the error handling routine.

`IOOUTPUTS(716L,"PRES;",5)`: Executes the HP-IB string data output command. 716L is the address. The data is directed to interface 7 (HP-IB) and out to the device at address 16 (the instrument). The "L" is required by the routine, which expects a long-integer. The command "PRES;" is the factory preset command for the instrument. "5" indicates that the command sent is five characters long.

---

## Note



Throughout this guide, the term HP-IB library command refers to an HP 82335A HP-IB command library function. The term instrument command refers to a set of commands which the instrument is programmed to process. All HP-IB library commands begin with the prefix IO-. For instance, IOOUTPUTS is an HP-IB library command, while PRES is an instrument command.

---

Each instrument command sent is executed automatically upon receipt, taking precedence over manual control. A command applies only to the active channel, except where functions are coupled between channels, just as with front panel operation. Most commands are equivalent to front panel functions.

The network analyzer automatically goes into remote mode when sent a command with the HP-IB command library IOOUTPUTS statement. This turns on the remote (R) and listen (L) HP-IB status indicators. In remote mode, all front panel keys except the local key are ignored. Pressing the **LOCAL** key returns the instrument to manual operation, unless the HP-IB library command IOLOCKOUT (7L) has been issued. This command puts the instrument into local lockout. The only way to get out of local lockout is to execute the IOLOCAL(7L) command, or to cycle instrument power, which will return to local operation.

The debug mode can be used to aid in trouble-shooting systems. When the debug mode is on, incoming HP-IB commands scroll across the instrument display. To turn the mode on manually, press **LOCAL**, **HP-IB DIAG ON**. To turn it on over HP-IB, execute:

```
error_handle (IOOUTPUTS (716L,"DEBUON;",7), "IOOUTPUTS")
```

## Command interrogate

When the operator has changed a setting from the front panel, the computer can find out the value of the new setting using the command interrogate function. If a question mark is appended to the root of a command, the value of that function is sent. For instance, `POWE -20 DB` sets the output power to -20 dBm, and `POWE?` outputs the current RF output power at the test port.

On/off commands can be also be interrogated. The reply is a one if the function is on, a zero if it is off. Similarly, if a command controls a function that is underlined on the network analyzer display when active, interrogating that command yields a one if the command is underlined, a zero if it is not. For example, there are nine options on the format menu, but only one is underlined at a time. The underlined option will return a one when interrogated.

## Held commands

When the network analyzer is executing a command that cannot be interrupted, it will hold off processing new HP-IB commands. It will fill the 16 character input buffer, and then halt HP-IB until the held command has completed execution. This action will be transparent to a program unless HP-IB timeouts have been set with the `IOTIMEOUT (7L,timeout_value)` command.

While a held command is executing, the instrument will still service the HP-IB interface commands, such as `IOSPOLL(716L,response_variable)`, `IOCLEAR (716L)`, and `IOABORT(7L)`. Executing `IOCLEAR(716L)` or `IOCLEAR(7L)` will abort a command hold off, leaving the held command to complete execution as if it had begun from the front panel. These commands also clear the input buffer, destroying any commands received after the held command. If the network analyzer has halted the bus because its input buffer was full, `IOABORT(7L)` will release the bus.

## Operation complete

Occasionally, there is a need to find out when certain operations have been completed. For instance, a program should not have the operator connect the next calibration standard while the instrument is still measuring the current one.

To provide such information, the network analyzer has an "Operation Complete" reporting mechanism that will indicate when certain key commands have completed operation. The mechanism is activated by sending either `OPC` or `OPC?` immediately before a command. Not all commands can be preceded with `OPC` or `OPC?`. If the operation complete mechanism was interrogated with `OPC?`, the network analyzer will output a one when the command completes execution. If `OPC` is used, the instrument will not output a response indicating an operation complete, instead it will set bit 0 of the status byte (see Figure 4-4)

The following procedure, when called, only returns when it has received a response following an `OPC()` command:

```
void opc ()
{
    int    one=1;
    char  reply;

    error_handle (IOENTERS (716L,&reply,&one), "IOENTERS");
}
```

For example, the following line sequence will not continue until a single sweep has been completed:

```
error_handle (IOOUTPUTS (716L,"SWET3S;OPC?;SING;",17), "IOOUTPUTS");
opc ();
```

The first line causes the instrument to single sweep for 3 seconds. Before the single sweep command is executed, it is preceded with `OPC?` which asks the instrument to output a one when done with the following command. The next line calls the procedure `OPC()` which will wait until the instrument outputs a response.

Note that to use the `OPC ()` routine, an instrument command must be preceded with `OPC?` and not `OPC`.

## Preparing for HP-IB control

At the beginning of a program, the instrument has to be taken from an unknown state and brought under computer control. One way to do this is with an abort/clear sequence. IOABORT(7L) is used to halt bus activity and return control to the computer. IOCLEAR(716L) will then prepare the instrument to receive commands by clearing syntax errors, the input command buffer, and any messages waiting at the output. The abort/clear sequence makes the instrument ready to receive HP-IB commands.

The next step is to set it to a known state. The most convenient way to do this is to send PRES, which returns the instrument to the factory preset state. If the factory preset cannot be used and the status reporting mechanism is going to be used, CLES can be sent to clear all of the status reporting registers and their enables. The user preset can be recalled by RECA5.

For example, the following initialize routine can be used to set up the instrument:

```
void initialize ()
{
    error_handle (IOABORT (7L), "IOABORT");
    error_handle (IOCLEAR (716L), "IOCLEAR");
    error_handle (IOTIMEOUT (7L,15.0), "IOTIMEOUT");
    error_handle (IOOUTPUTS (716L,"PRES;",5), "IOOUTPUTS");
}
```

This routine brings the network analyzer to a known state, ready to respond to HP-IB control. The IOTIMEOUT (7L,15.0) sets a timeout of 15 seconds, long enough for most commands. The timeout value passed must be a floating point integer, so a decimal point must be included.

The network analyzer will not respond to HP-IB commands unless the remote line is asserted. When the remote line is asserted and the network analyzer is addressed to listen, it automatically goes into remote mode. Remote mode means that all the front panel keys are disabled except **LOCAL** and the line power switch. IOABORT (7L) asserts the remote line, which remains asserted until a IOLOCAL (7L) statement is executed. Another way to assert the remote line is to execute IDREMOTE (716L). This statement asserts remote operation and addresses the network analyzer to listen.

## Measurement Programming

The previous sections outlined some basic programming techniques, along with demonstrating how to send commands to the network analyzer. The next step is to organize the commands into a measurement sequence. A typical measurement sequence is shown in Figure 1-2.

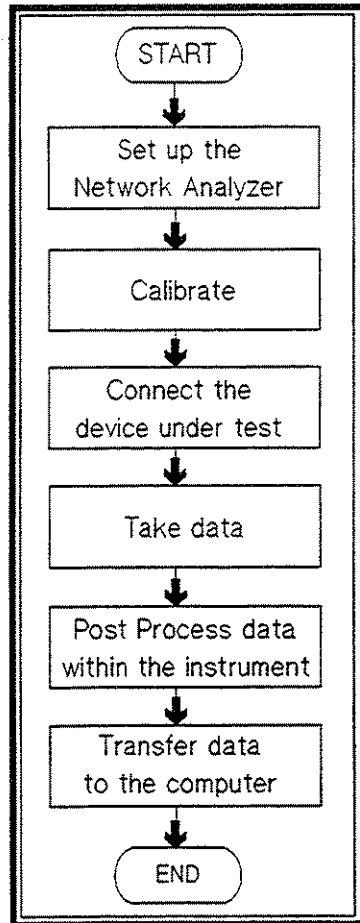


Figure 1-2. Typical Measurement Sequence

### ■ Set up the network analyzer

Define the measurement by setting all of the basic measurement parameters. These include all the stimulus parameters: sweep type, frequency, sweep time, number of points, and RF power level. They also include the parameter to be measured, and both IF averaging and IF bandwidth. These parameters define the way data is gathered and processed within the instrument. Each time one of the above parameters is changed, a new sweep must be triggered.

There are other parameters that can be set within the instrument that do not affect data gathering directly, such as smoothing, setting trace resolution (scale), or performing trace math. These functions are classed as post processing functions: they can be changed with the instrument in hold mode, and the data will correctly reflect the current state.

The save/recall registers is a rapid way of setting up an entire instrument state.

### ■ Calibrate

Measurement calibration is normally performed once the instrument state has been defined. Measurement calibration is not required to make a measurement, but it does improve the measurement accuracy.

There are several ways to calibrate the instrument.

- The simplest is to stop the program and have the operator perform the calibration from the front panel.
- Alternatively, the computer can be used to guide the operator through the calibration, as discussed in Example 2A,  $S_{11}$  1-port calibration and Example 2B, Full 2-port calibration.
- The last option is to transfer calibration data from a previous calibration back into the instrument as discussed in Example 6B, Reading calibration data.

■ Connect the device under test

The computer can be used to prompt the operator to connect and adjust the device and it can be also used to speed the adjustment process by setting up such functions as limit testing, bandwidth searches, and trace statistics.

■ Take data

Once the device is connected and adjusted, measure its frequency response, and store the data within the instrument so that there is a valid trace to analyze.

The single sweep command `SING` is designed to ensure a valid sweep. All stimulus changes are completed before the sweep is started, and the HP-IB hold state is not released until the formatted trace is displayed. When the sweep is completed the instrument is put into hold, freezing the data inside the instrument. A single sweep can be preceded with `OPC?`; therefore, it is easy to determine when the sweep has been completed.

The number of groups commands, `NUMGn`, is designed to work the same as a single sweep, except that it triggers  $n$  sweeps. This is useful, for example, in making a measurement with an averaging factor  $n$  ( $n$  can take on values between 1 and 999.) Both single sweep and number of groups restart averaging.

■ Post process data within the instrument

With valid data to operate on, the post-processing functions can be used. Referring ahead to Figure 2-5, any function that affects the data after the error correction stage can be used. The most useful functions are trace statistics, marker searches, electrical delay offset, time domain, and gating. If a 2-port calibration is active, then any of the four  $S$ -parameters can be viewed without taking a new sweep.

■ Transfer data to the computer

Lastly, read the results out of the instrument. All the data output commands are designed to ensure that the data transmitted reflects the current state of the instrument:

- `OUTPDATA`, `OUTPRAWn`, and `OUTPFORM`, etc. will transmit entire data traces.
- `OUTPLIML`, `OUTPLIMM`, and `OUTPLIMF` will transmit limit testing results.
- `OUTPMARK` will transmit the currently active marker's results. This command will activate a marker if one is not already selected.
- `OUTPMSTA` will transmit the statistics that have been calculated for data between the active marker and the delta reference marker. If there is no delta reference, the entire trace data is used.



□ OUTPMWID will transmit the results of a bandwidth search.  
Data transfer is discussed further in Examples 3A through 3C.



## Basic Programming Examples

---

### Example 1: Setting up a basic measurement

In general, the procedure for setting up measurements on the network analyzer via HP-IB follows the same sequence as if the setup was performed manually. There is no required order, as long as the desired frequency range, number of points and power level are set prior to performing the calibration.

This example illustrates how a basic measurement can be set up. The program will first select the desired S-parameter, the measurement format, and then the frequency range. Performing calibrations is described later.

Since the standard network analyzer has a frequency resolution of 100 kHz, it is required that all of the data points in the sweep be at some integer multiple of 100 kHz (10.1 MHz, 2.0011 GHz, 19.9985 GHz for example). Therefore, the actual frequencies that are set may be slightly different from those specified by the user. By interrogating the instrument, the user can determine the actual values of the start and stop frequencies. Note that if you are using a network analyzer which has 1 Hz frequency resolution, (Option 001), the actual frequencies set by the analyzer will be identical to those specified using the START and STOP commands.

#### Caution



The programming examples found in this guide are for **example** purposes only. They may require modification to work with your particular personal computer.

---

```

1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 1 */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize(void);
100:
110: void error_handle (int error, char *routine)
120: {
130:     if (error !=NOERR)
140:     {
150:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));

```

```

160:     exit(1);
170: }
180: return;
190: }
200:
210: void output (char *sendstr)
220: {
230:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
240: }
250:
260: void initialize ()
270: {
280:     error_handle (IOTIMEOUT (isc,5.0), "IOTIMEOUT");
290:     error_handle (IOABORT (isc), "IOABORT");
300:     error_handle (IOCLEAR (isc), "IOCLEAR");
310:     output ("PRES;");
320: }
330:
340: main ()
350: {
360:     char cmd[80];
370:     float f_start,f_stop;
380:
390:     initialize ();
400:     output ("CHAN1;S11;LOGM;");
410:     output ("CHAN2;S11;PHAS;DUACON;");
420:     printf ("Enter start frequency (GHz): ");
430:     scanf ("%f",&f_start);
440:     printf ("Enter stop frequency (GHz): ");
450:     scanf ("%f",&f_stop);
460:     sprintf (cmd,"STAR%fGHZ;STOP%fGHZ;",f_start,f_stop);
470:     output (cmd);
480:     output ("CHAN1;AUTO;CHAN2;AUTO;");
490: }

```

**Figure 2-1. Sample Program: Basic Programming Measurement**

### Program explanation

- |         |   |
|---------|---|
| Line 5  | Tell the compiler which file includes information on the standard I/O routines.                         |
| Line 10 | Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions. |
| Line 20 | Tell the compiler which file includes information on the HP-IB command library error constants.         |
| Line 40 | Define a variable to contain the HP-IB interface select code, 7.  |
| Line 50 | Define a variable to contain the instrument address, 716.   |

## 2-2 Basic Programming Examples

Line 70           Function prototype for the `error_handler ()` routine.

Line 80           Function prototype for the `output ()` routine.

Line 90           Function prototype for the `initialize ()` routine.

Line 110          Define a routine that handles errors returned from the HP-IB  
command library I/O functions.

Line 130          Check to see if there is an error.

Line 150          An error has occurred, so display a message and halt.

Line 180          No error has occurred, so return.

Line 210          Define a routine that outputs string commands and performs error  
trapping.

Line 230          Send a string to the instrument located at the value of `instr`, 716.  
Perform error checking.

Line 260          Define a routine to initialize the instrument.

Line 280          Define a timeout value of five seconds.

Line 290          Abort any HP-IB transfers.

Line 300          Clear the instrument's HP-IB interface.

Line 310          Preset the instrument.

Line 340          Main declaration

Line 360          Declare the needed variables.

Line 390          Call the `initialize ()` routine.

Line 400          Output commands to the instrument to switch to channel one, and  
measure the log magnitude of  $S_{11}$ .

Line 410          Output commands to the instrument to switch to channel two,  
measure the phase of  $S_{11}$ , and display both channel one and channel  
two.

Line 420          Request the start frequency.

Line 430          Input the start frequency.

Line 440          Request the stop frequency.

Line 450          Input the stop frequency.

Line 460          Create an output string to contain commands to tell the analyzer  
what the start and stop frequencies are.

Line 470          Output this string.

Line 480          Autoscale both channel one and channel two.

## Running the program

The program will set up a measurement of  $S_{11}$ , log magnitude on channel one, and  $S_{11}$ , phase on channel two, and turn on the dual channel display mode. When prompted for the start and stop frequencies, enter any value in GHz from .050 (50 MHz) to 13.5 GHz, 20 GHz, or 40 GHz. These will be entered in the instrument, and the actual frequencies that the instrument is set to will be displayed on the instrument.

---

## Performing a measurement calibration

This section will demonstrate how to coordinate a measurement calibration over HP-IB. The HP-IB command sequence follows the same key sequence required to calibrate from the front panel: there is a command for each step.

The general key sequence is to select the calibration, measure the calibration standards, and then declare the calibration done. The actual sequence depends on the calibration kit and changes slightly for 2-port calibrations, which are divided into three calibration sub-sequences.

### Calibration kits

The calibration kit definition tells the network analyzer what standards to use at each step of the calibration. The set of standards associated with a given calibration is termed a class. For example, measuring the short during a  $S_{11}$  1-port calibration is one calibration step. All of the shorts that can be used for this calibration step make up the class, which is called class  $S_{11}B$ . For the 2.4 mm, 3.5 mm, and 7 mm calibration kits, class  $S_{11}B$  has only one standard in it. For type-N calibration kits, class  $S_{11}B$  has two standards in it: male and female shorts.

When doing a  $S_{11}$  1-port calibration in 2.4 mm, 3.5 mm, or 7 mm, selecting **SHORT** automatically measures the short because there is only one standard in the class. When doing the same calibration in type-N, selecting **SHORTS** brings up a second menu, allowing the user to select which standard in the class is to be measured.

Doing an  $S_{11}$  1-port calibration over HP-IB is very similar. In 2.4 mm, 3.5 mm, and 7 mm, sending CLASS11B will automatically measure the short. In type-N, sending CLASS11B brings up the menu with the male and female short options. To select a standard, use STANA or STANB. The STAN command is appended with the letters A through G, corresponding to the standards listed under softkeys 1 through 7, softkey 1 being the topmost softkey.

The STAN command can be preceded with OPC?. A command that calls a class can only be preceded with OPC? if that class has only one standard in it. If there is more than one standard in a class, the command that calls the class only brings up another menu, and there is no need to OPC? it.

Hence, both the manual and HP-IB calibration sequences depend heavily on which calibration kit is active.

## Full 2-port calibrations

Each full 2-port measurement calibration is divided into three sub-sequences: transmission, reflection, and isolation. Each sub-sequence is treated like a calibration in its own right: each must be opened, have all the standards measured, and then be declared done. The opening and closing statements for the transmission sub-sequence are TRAN and TRAD. The opening and closing statements for the reflection sub-sequence are REFL and REFD. The opening and closing statements for isolation are ISOL and ISOD.

---

## Example 2A: $S_{11}$ 1-port calibration

To demonstrate coordinating a calibration over HP-IB, the following program does an  $S_{11}$  1-port calibration using the HP 85052B 3.5 mm calibration kit. This program simplifies the calibration for the operator by giving explicit directions on the computer display.

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 2A */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void opc (void);
100: void initialize (void);
110: void disp_prompt (char *);
120:
130: void error_handle (int error, char *routine)
140: {
150:     if (error !=NOERR)
160:     {
170:         printf ("HP-IB error in call to %s: %d,%s\n",
180:             routine, error, errstr(error));
190:         exit(1);
200:     }
210: }
220:
230: void output (char *sendstr)
240: {
250:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
260: }
270:
280: void opc ()
290: {
```

```

300:  int   one=1;
310:  char  reply;
320:
330:  error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
340: }
350:
360: void initialize ()
370: {
380:   error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
390:   error_handle (IOABORT (isc), "IOABORT");
400:   error_handle (IOCLEAR (isc), "IOCLEAR");
410:   output ("CLES;");
420: }
430:
440: void disp_prompt (char *prompt)
450: {
460:   char ch;
470:
480:   printf ("%s",prompt);
490:   printf (" , then press [RETURN]\n");
500:   ch=getche();
510: }
520:
530: main ()
540: {
550:   int  index;
560:
570:   initialize ();
580:   output ("CALK35MM;CLES;CALIS111;");
590:   disp_prompt ("Connect OPEN at port 1");
600:   output ("OPC?;CLASS11A;");
610:   opc ();
620:   disp_prompt ("Connect SHORT at port 1");
630:   output ("OPC?;CLASS11B;");
640:   opc ();
650:   disp_prompt ("Connect LOWBAND LOAD at port 1");
660:   output ("CLASS11C;OPC?;STANC;");
670:   opc ();
680:   disp_prompt ("Connect SLIDING LOAD at port 1");
690:   output ("STANB;");
700:   for (index=1; index<=5; index++)
710:   {
720:     disp_prompt ("Set SLIDE in position");
730:     output ("SLIS;");
740:   }
750:   output ("SLID;");
760:   printf("Computing calibration coefficients.\n");
770:   output ("DONE;OPC?;SAV1;");
780:   opc ();
790:   printf ("DONE\n");

```



**Figure 2-2. Sample Program: S<sub>11</sub> 1-Port Calibration****Program explanation**

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the error_handler () routine.
Line 80	Function prototype for the output () routine.
Line 90	Function prototype for the opc () routine.
Line 100	Function prototype for the initialize () routine.
Line 110	Function prototype for the disp_prompt () routine.
Line 130	Define a routine that handles errors returned from the HP-IB command library I/O functions.
Line 150	Check to see if there is an error.
Line 170	An error has occurred, so display a message and halt.
Line 200	No error has occurred, so return.
Line 230	Define a routine that outputs string commands and performs error trapping.
Line 250	Send a string to the instrument located at the value of instr, 716. Perform error checking.
Line 280	Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an OPC? command has been issued.
Line 310	Define a variable to hold the response.
Line 330	Input the response into the variable reply and do nothing with it.
Line 360	Define a routine to initialize the instrument.
Line 380	Define a timeout value of five seconds.
Line 390	Abort any HP-IB transfers.
Line 400	Clear the instrument's HP-IB interface.
Line 410	Clear the instrument's status.

Line 440 Define a routine to display a prompt and wait for **RETURN** to be pressed.

Line 480 Display the message prompt.

Line 500 Wait for a key to be pressed.

Line 530 Main declaration

Line 550 Declare the needed variables.

Line 560 Call the initialize () routine.

Line 580 Select the 3.5 mm calibration kit, clear the instrument status, and open the S<sub>11</sub> 1-port calibration.

Line 590 Display a prompt to connect an OPEN at port 1.

Line 600 Measure the standard. Since there is only one choice in this class, the CLASS command is OPC'able. Using the OPC? command causes the program to wait until the standard has been measured before continuing. This is very important because the prompt to connect the next standard should only appear after the first standard is measured.

Line 610 Wait for the OPC? command to return a response.

Line 620 Display a prompt to connect a SHORT at port 1.

Line 630 Measure the standard.

Line 640 Wait for the OPC? command to return a response.

Line 650 Display a prompt to connect a LOWBAND LOAD at port 1.

Line 660 Measure the standard. Since there is more than one standard in the loads class, the program must identify the specific standard within that class. The lowband load is the third softkey selection from the top in the menu; so to select a lowband load as the standard use the command STANC.

Line 670 Wait for the OPC? command to return a response.

Line 680 Display a prompt to connect a SLIDING LOAD at port 1.

Line 690 Select the appropriate softkey.

Line 700 It will require five different positions of the sliding load to properly characterize the directivity error term.

Line 720 Display a prompt to set the SLIDE.

Line 730 Measure the slide standard.

Line 750 Tell the instrument that the sliding load calibration has been completed.

Line 770 Affirm the completion of the calibration, and save the calibration.

## Running the program

The program assumes that the test port being calibrated is a 3.5 mm, either male or female. The program interacts with the operator through the computer. When the measurement calibration is complete, it will display DONE.

Before running the program, set up the desired instrument state. This program does not modify the instrument state in any way. Run the program, and connect the standards as prompted. When the standard is connected, press **RETURN** to measure it.

---

## Example 2B: Full 2-port measurement calibration

The following example shows how to perform a full 2-port measurement calibration using the HP 85052D calibration kit. In this example, the calibration process allows the removal of both the forward and reverse error terms, so that all four S-parameters of the device under test can be measured. Since the HP 85052D calibration kit is used, a broadband load will be used instead of the sliding load used in Example 2A. Use of the broadband load results in a more convenient calibration, since only one measurement is required for the load calibration, as opposed to five measurements when the sliding load is used.

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 2B */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void opc (void);
100: void initialize (void);
110: void disp_prompt (char *);
120:
130: void error_handle (int error, char *routine)
140: {
150:     if (error !=NOERR)
160:     {
170:         printf ("HP-IB error in call to %s: %d,%s\n",
180:             routine,error, errstr(error));
190:         exit(1);
200:     }
210: }
220:
230: void output (char *sendstr)
240: {
```

```

250:   error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
260: }
270:
280: void opc ()
290: {
300:   int   one=1;
310:   char  reply;
320:
330:   error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
340: }
350:
360: void initialize ()
370: {
380:   error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
390:   error_handle (IOABORT (isc), "IOABORT");
400:   error_handle (IOCLEAR (isc), "IOCLEAR");
410:   output ("CLES;");
420: }
430:
440: void disp_prompt (char *prompt)
450: {
460:   char ch;
470:
480:   printf ("%s",prompt);
490:   printf (", then press [RETURN]\n");
500:   ch=getche();
510: }
520:
530: main ()
540: {
550:   initialize ();
560:   output ("CALK35MM;CLES;CALIFUL2;REFL;");
570:   disp_prompt ("Connect OPEN at port 1");
580:   output ("OPC?;CLASS11A;");
590:   opc ();
600:   disp_prompt ("Connect SHORT at port 1");
610:   output ("OPC?;CLASS11B;");
620:   opc ();
630:   disp_prompt ("Connect BROADBAND LOAD at port 1");
640:   output ("CLASS11C;OPC?;STANA;");
650:   opc ();
660:   disp_prompt ("Connect OPEN at port 2");
670:   output ("OPC?;CLASS22A;");
680:   opc ();
690:   disp_prompt ("Connect SHORT at port 2");
700:   output ("OPC?;CLASS22B;");
710:   opc ();
720:   disp_prompt ("Connect BROADBAND LOAD at port 2");
730:   output ("CLASS22C;OPC?;STANA;");
740:   opc ();
750:   output ("REFD;");

```

```

760:   printf ("Computing reflection calibration coefficients\n");
770:   output ("TRAN;");
780:   disp_prompt ("Connect THRU [port 1 to port 2]");
790:   printf ("Measuring forward transmission\n");
800:   output ("OPC?;FWDI;");
810:   opc ();
820:   output ("OPC?;FWDI;");
830:   opc ();
840:   printf ("Measuring reverse transmission\n");
850:   output ("OPC?;REVT;");
860:   opc ();
870:   output ("OPC?;REVM;");
880:   opc ();
890:   output ("TRAD;");
900:   disp_prompt ("Isolate test ports");
910:   output ("AVERFACT16;AVERON;ISOL;");
920:   printf ("Measuring reverse isolation\n");
930:   output ("OPC?;REVI;");
940:   opc ();
950:   printf ("Measuring forward isolation\n");
960:   output ("OPC?;FWDI;");
970:   opc ();
980:   output ("ISOD;AVEROFF;");
990:   printf ("Computing calibration coefficients\n");
1000:  output ("OPC?;SAV2;");
1010:  opc ();
1020:  printf ("DONE");
1030: }

```

**Figure 2-3. Sample Program: Full 2-Port Measurement Calibration**

### Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the error_handler () routine.
Line 80	Function prototype for the output () routine.
Line 90	Function prototype for the opc () routine.
Line 100	Function prototype for the initialize () routine.
Line 110	Function prototype for the disp_prompt () routine.

Line 130 Define a routine that handles errors returned from the HP-IB command library I/O functions.

Line 150 Check to see if there is an error.

Line 170 An error has occurred, so display a message and halt.

Line 200 No error has occurred, so return.

Line 230 Define a routine that outputs string commands and performs error trapping.

Line 250 Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 280 Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an OPC? command has been issued.

Line 310 Define a variable to hold the response.

Line 330 Input the response into the variable reply and do nothing with it.

Line 360 Define a routine to initialize the instrument.

Line 380 Define a timeout value of five seconds.

Line 390 Abort any HP-IB transfers.

Line 400 Clear the instrument's HP-IB interface.

Line 410 Clear the instrument's status.

Line 440 Define a routine to display a prompt and wait for **RETURN** to be pressed.

Line 480 Display the message prompt.

Line 500 Wait for a key to be pressed.

Line 530 Main declaration

Line 550 Call the initialize () routine.

Line 560 Select the 3.5 mm calibration kit, clear the instrument status, and open the full 2-port calibration.

Line 570 Display a prompt to connect an OPEN at port 1.

Line 580 Measure the standard.

Line 590 Wait for the OPC? command to return a response.

Line 600 Display a prompt to connect a SHORT at port 1.

Line 610 Measure the standard.

Line 620 Wait for the OPC? command to return a response.

Line 630 Display a prompt to connect a BROADBAND LOAD at port 1.

Line 640 Measure the standard.

Line 650 Wait for the OPC? command to return a response.

Line 660 Display a prompt to connect an OPEN at port 2.

Line 670	Measure the standard.
Line 680	Wait for the OPC? command to return a response.
Line 690	Display a prompt to connect a SHORT at port 2.
Line 700	Measure the standard.
Line 710	Wait for the OPC? command to return a response.
Line 720	Display a prompt to connect a BROADBAND LOAD at port 2.
Line 730	Measure the standard.
Line 740	Wait for the OPC? command to return a response.
Line 750	Close the reflection calibration sub-sequence.
Line 770	Open the transmission calibration sub-sequence.
Line 780	Display a prompt to connect a THRU connection.
Line 800	Measure forward transmission.
Line 810	Wait for the OPC? command to return a response.
Line 820	Measure forward load match.
Line 830	Wait for the OPC? command to return a response.
Line 850	Measure reverse transmission.
Line 870	Measure reverse load match.
Line 890	Close the transmission calibration sub-sequence.
Line 900	Display a prompt to isolate test ports.
Line 910	Define an averaging factor of 16, turn on averaging, and open the isolation calibration sub-sequence.
Line 930	Measure reverse isolation.
Line 960	Measure forward isolation.
Line 980	Close the isolation calibration sub-sequence, and turn off averaging.
Line 1010	Wait until the instrument calculates the calibration coefficients before continuing.

## Running the program

The program assumes that the test ports being calibrated are 3.5 mm, either male or female, and that the HP 85052D 3.5 mm economy calibration kit is to be used (no sliding loads). The program will display DONE when the measurement calibration is complete.

Before running the program, set up the desired instrument state. This program does not modify the instrument state in any way. Run the program, and connect the standards as prompted. When the standard is connected, press **RETURN** to measure it.

---

## Data transfer

Trace information can be read out of the network analyzer in two ways:

- Data can be read off the trace point-by-point with markers, or
- the entire trace can be read out.

### Using markers to obtain trace data at specific points

To obtain data off the trace using a marker, the marker has to first be set to the desired frequency. This is done with the marker commands. For example, the instrument command `MARK1 1.56GHZ` would place marker one at 1.56 GHz. If the markers are in continuous mode, the marker value will be linearly interpolated from the two nearest points if 1.5600 GHz was not sampled. This interpolation can be prevented by putting the markers into discrete mode. The key sequence for this is `LOCAL`, `MKR`, `MARKER MODE MENU`, `MARKERS-DISCRETE`. To do it over HP-IB execute the instrument command `MARKDISC`. After executing this, note that the marker may no longer be precisely at 1.56 GHz. (This depends on the start and stop frequencies).

Another way of using the markers is to let the network analyzer pick the stimulus value on the basis of one of the marker search functions: maximum, minimum, target value, or bandwidth search. For example, the instrument command `SEAMAX` will initiate a one-time trace search for the trace maximum, and put a marker at that point. In order to continually update the search, turn tracking on. The key sequence is `MKR FCTN`, `MKR SEARCH`, `TRACKING`, `SEARCH-MAX`. To do it over HP-IB use the instrument commands: `TRACKON;SEAMAX;`. The trace maximum search will stay on until the search is turned off, tracking is turned off, or all markers are turned off.

Marker data is read out with the instrument command `OUTPMARK`. This command causes the network analyzer to transmit three numbers: marker value 1, marker value 2, and marker stimulus value. Refer to Table 2-1 for all the different possibilities for values one and two, and the stimulus value.



**Table 2-1. Units as a Function of Display Format**

Display Format	Marker Mode	OUTPMARK Marker Readout <sup>1</sup> value 1, value 2	OUTPFORM value 1, value 2
LOG MAG		dB, value 2 <sup>2</sup>	dB, value 2 <sup>2</sup>
PHASE		degrees, value 2 <sup>2</sup>	degrees, value 2 <sup>2</sup>
DELAY		seconds, value 2 <sup>2</sup>	seconds, value 2 <sup>2</sup>
SMITH	LIN MKR	lin mag, degrees	real, imag
CHART	LOG MKR	dB, degrees	real, imag
	Re/Im	real, imag	real, imag
	R + jX	real, imag ohms	real, imag
	G + jB	real, imag Siemens	real, imag
POLAR	LIN MKR	lin mag, degrees	real, imag
	LOG MKR	dB, degrees	real, imag
	Re/Im	real, imag	real, imag
LIN MAG		lin mag, value 2 <sup>2</sup>	lin mag, value 2 <sup>2</sup>
REAL		real, value 2 <sup>2</sup>	real, value 2 <sup>2</sup>
SWR		SWR, value 2 <sup>2</sup>	SWR, value 2 <sup>2</sup>

<sup>1</sup> The marker readout values are the marker values displayed in the upper right hand corner of the display. They also correspond to the value and auxiliary value associated with the fixed marker.

<sup>2</sup> Value 2 not significant in this form, but is included in data transfers.

### Example 3A: Data transfer using markers

The following program searches out the trace minimum and returns the marker values.

```

1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 3A */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize (void);
100:
110: void error_handle (int error, char *routine)
120: {
130:     if (error !=NOERR)

```

```

140:  {
150:      printf ("HP-IB error in call to %s: %d, %s\n",
              routine, error, errstr(error));
160:      exit(1);
170:  }
180:  return;
190: }
200:
210: void output (char *sendstr)
220: {
230:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
240: }
250:
260: void initialize ()
270: {
280:     error_handle (IOTIMEOUT (isc,5.0), "IOTIMEOUT");
290:     error_handle (IOABORT (isc), "IOABORT");
300:     error_handle (IOCLEAR (isc), "IOCLEAR");
310:     output ("CLES;");
320: }
330:
340: main ()
350: {
360:     float val[3];
370:     int length=3;
380:
390:     initialize ();
400:     output ("SING;MARK1;SEAMIN;FORM5;OUTPMARK;");
410:     error_handle (IOENTERA (instr,val,&length), "IOENTERA");
420:     printf("Value 1: %f\nValue 2: %f\nStimulus: %f\n",
           val[0],val[1],val[2]);
430: }

```

**Figure 2-4. Sample Program: Data Transfer Using Markers**

### Program explanation

- |         |   |
|---------|---|
| Line 5  | Tell the compiler which file includes information on the standard I/O routines.                         |
| Line 10 | Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions. |
| Line 20 | Tell the compiler which file includes information on the HP-IB command library error constants.         |
| Line 40 | Define a variable to contain the HP-IB interface select code, 7.  |
| Line 50 | Define a variable to contain the instrument address, 716.   |
| Line 70 | Function prototype for the error_handler () routine.  |
| Line 80 | Function prototype for the output () routine.   |

Line 90                   Function prototype for the initialize () routine.

Line 110                  Define a routine that handles errors returned from the HP-IB command library I/O functions.

Line 130                  Check to see if there is an error.

Line 150                  An error has occurred, so display a message and halt.

Line 180                  No error has occurred, so return.

Line 210                  Define a routine that outputs string commands and performs error trapping.

Line 230                  Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 260                  Define a routine to initialize the instrument.

Line 280                  Define a timeout value of five seconds.

Line 290                  Abort any HP-IB transfers.

Line 300                  Clear the instrument's HP-IB interface.

Line 310                  Clear the instrument's status.

Line 340                  Main declaration

Line 360                  Declare the needed variables.

Line 390                  Call the initialize () routine.

Line 400                  Perform a single trace, turn on marker one, place marker one at the single trace minimum, and output the marker data.

Line 410                  Input three values, the stimulus value, value one and value two.

Line 420                  Display both values, and the stimulus.

## Running the program

The values displayed by the computer should agree with the marker values, except that the second value displayed will be meaningless in some formats. To see the possibilities for different values, run the program three times: once in log magnitude format, once in phase format, and once in Smith chart format. To change display format, press **LOCAL**, **FORMAT**, and then select the desired format.

---

## Trace transfer

Getting trace data with a computer can be broken down into three steps:

1. Setting up the receive array.
2. Telling the network analyzer to transmit the data.
3. Accepting the transferred data.

Data is always stored in values, to accommodate real/imaginary pairs, for each data point. Therefore, the receiving array has to be two elements wide, and as deep as the number of points. The memory space for this array must be declared before any data is to be transferred to the computer.

## Data formats

The network analyzer can transmit data over HP-IB in five different formats. Of the five formats, Form 5 is the most appropriate for personal computers.

### ■ Form 1

Internal binary format. In this mode, each *point* takes 6 bytes. This means that a 201 point transfer takes 1,206 bytes. Re-formatting must be done in order to decode the information. This is the format the network analyzer uses to store data. Form 1 also has a four byte header.

### ■ Form 2

IEEE-754 32-bit floating point format. In this mode, each *number* takes 4 bytes. This means that a 201 point transfer takes 1608 bytes. This form also has a four byte header.

### ■ Form 3

IEEE-754 64-bit floating point format. In this mode, each *number* takes 8 bytes. This means that a 201 point transfer takes 3,216 bytes. This form also has a four byte header.

### ■ Form 4

ASCII data transfer format. In this mode, each *number* is sent as a 24 character string, each character being a digit, sign, or decimal point. Since there are two numbers per point, a 201 point transfer takes 9,648 bytes. This form does not have a four byte header.

### ■ Form 5

PC-compatible 32-bit floating point format. This mode is a modification of the IEEE-754 32-bit floating point format with the byte order reversed. Therefore, a 201 point transfer takes 1,608 bytes. This form also has a four byte header. In this mode, a MS-DOS personal computer can store data internally without reformatting it.

## Data levels

Different levels of data can be read out of the instrument (Refer to Figure 2-5)

### ■ Raw Data.

This is basic measurement data with no error correction applied. If a full 2-port measurement calibration is ON, there are actually four raw arrays kept: one for each raw S-parameter. The data is read out with the command `OUTPRAW{n}`, where `n` ranges from 1 to 4. Normally, only raw 1 is available and it holds the current parameter. If a 2-port calibration is ON, the four arrays refer to  $S_{11}$ ,  $S_{21}$ ,  $S_{12}$ , and  $S_{22}$  respectively. This data is always in real/imaginary pairs.

### ■ Error-corrected data.

This is data with error-correction applied. The array corresponds to the currently measured parameter, and is always in real/imaginary pairs. The error-corrected data is read out with `OUTPDATA`. `OUTPMEMO` reads the trace memory if available, which is also error-corrected data. Note that neither raw nor error-corrected data reflect such post-processing functions as electrical delay offset, trace math, or time domain gating.

### ■ Formatted data.

This is the array of data actually being displayed. It reflects all post-processing functions. The units of the array read out depends on the current display format. Refer to Table 2-1 for the various units as a function of display format. The formatted data is read out with `OUTPFORM`.

### ■ Calibration coefficients.

The results of a calibration are arrays of calibration coefficients which are used in the error-correction routines. Each array corresponds to a specific error term in the error model. The calibration coefficients can be read out with `OUTPCALC{n}`, where `n` ranges from 1 to 12.

Formatted data is generally the most useful, being the same information seen on the display. However if the post processing is unneeded or unwanted, as may be the case with smoothing, error-corrected data is more desirable. Error-corrected data also give you the opportunity to put the data into the instrument and apply post-processing at a later time.

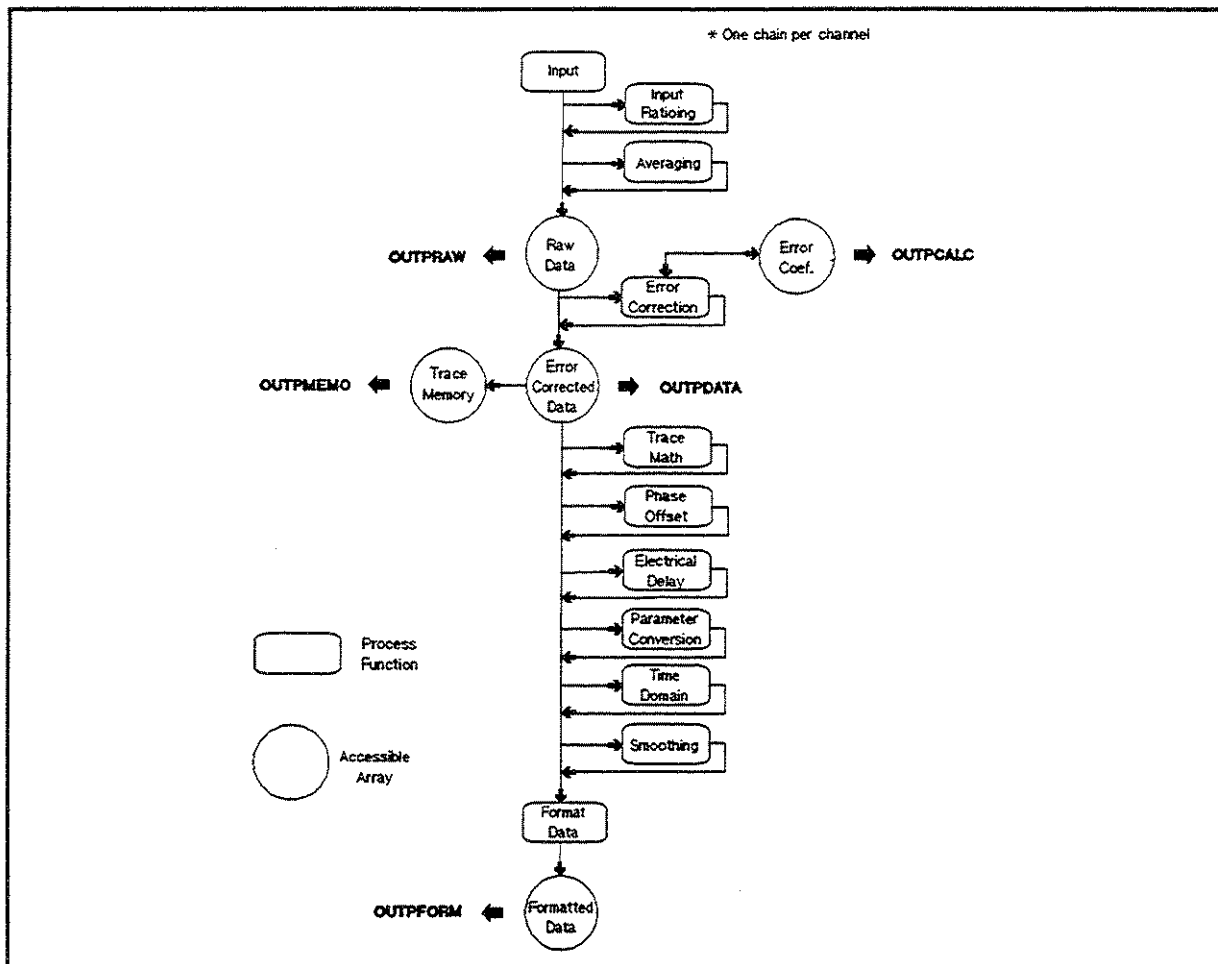


Figure 2-5. Data processing chain

### Example 3B: Data transfer using Form 4 (ASCII transfer)

In Form 4, each number is sent as a 24 character string, each character being a digit or decimal point. Since there are two numbers per point, a 201 point transfer in Form 4 takes 9,648 bytes

```

1:  /* HP 8719C, 8720C, 8722A QuickC IPG Program 3B */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
  
```

```

90: void opc (void);
100: void initialize (void);
110:
120: void error_handle (int error, char *routine)
130: {
140:     if (error !=NOERR)
150:     {
160:         printf ("HP-IB error in call to %s: %d, %s\n",
                  routine, error, errstr(error));
170:         exit(1);
180:     }
190:     return;
200: }
210:
220: void output (char *sendstr)
230: {
240:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
250: }
260:
270: void opc ()
280: {
290:     int one=1;
300:     char reply;
310:
320:     error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
330: }
340:
350:
360: void initialize ()
370: {
380:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
390:     error_handle (IOABORT (isc), "IOABORT");
400:     error_handle (IOCLEAR (isc), "IOCLEAR");
410:     error_handle (IOMATCH (isc,'\n',0), "IOMATCH");
420:     output ("PRES;");
430: }
440:
450: main ()
460: {
470:     char ascii_dat[550];
480:     int elements=550,i,j;
490:
500:     initialize();
510:     output ("POIN 11;OPC?;SING;");
520:     opc ();
530:     output ("FORM4;OUTPFORM;");
540:     error_handle (IOENTERS (instr,ascii_dat,&elements), "IOENTERS");
550:     for (i=0; i<528; i=i+50)
560:     {
570:         printf ("\nPoint: %2d Value 1: ",(i/50)+1);
580:         for (j=1; j<=24; j=j+1)

```

```

590:     printf ("%c",ascii_dat[i+j]);
600:     printf (" Value 2: ");
610:     for (j=1; j<=24; j=j+1)
620:         printf ("%c",ascii_dat[i+j+24]);
630:     }
640: }

```

**Figure 2-6. Sample Program: Data Transfer Using Form 4**

### Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the <code>error_handler ()</code> routine.
Line 80	Function prototype for the <code>output ()</code> routine.
Line 90	Function prototype for the <code>opc ()</code> routine.
Line 100	Function prototype for the <code>initialize ()</code> routine.
Line 120	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 140	Check to see if there is an error.
Line 160	An error has occurred, so display a message and halt.
Line 190	No error has occurred, so return.
Line 220	Define a routine that outputs string commands and performs error trapping.
Line 240	Send a string to the instrument located at the value of <code>instr</code> , 716. Perform error checking.
Line 270	Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an <code>OPC?</code> command has been issued.
Line 310	Define a variable to hold the response.
Line 320	Input the response into the variable <code>reply</code> and do nothing with it.
Line 360	Define a routine to initialize the instrument.
Line 380	Define a timeout value of 45 seconds.
Line 390	Abort any HP-IB transfers.



Line 400 Clear the instrument's HP-IB interface.

Line 410 Disable character matching. This command defines the character used by IOENTERB and IOENTERS for termination. The "lf" enter terminator should be turned off because "lf" is a valid binary value.

Line 420 Preset the instrument.

Line 450 Main declaration

Line 470 Define the needed variables.

Line 500 Call the initialize () routine.

Line 510 Set the number of points sampled to eleven and perform a single trace.

Line 520 Wait for the GPC? command to return a response.

Line 530 Define the data format as Form 4 (ASCII transfer), and request the instrument's formatted data.

Line 540 Input the data from the instrument.

Line 550 Define a loop to display the data. Each point has 50 bytes associated with it. There are two values which occupy 24 bytes each, and two bytes to signal the termination of the string.

Line 580 Loop 24 times to display the first value.

Line 590 Display the first value.

Line 610 Loop 24 times to display the second value.

Line 620 Display the second value.

## Running the program

Changing the display format will change the data sent with the OUTPFORM transfer. Refer to Table 2-1 for a list of how data is provided by format. The data from OUTPFORM reflects all the post processing such as time domain, gating, electrical delay, trace math, smoothing, etc.

Relating the data from a linear frequency sweep to frequency can be done by interrogating the start frequency, the frequency span, and the number of points. Given that information, the frequency of point N in a linear frequency sweep is just:

$$F = \text{Start\_frequency} + (N-1) \times \text{Span}/(\text{Points}-1)$$

Alternatively, it is possible to read the frequencies directly out of the instrument with the OUTPLIML command. OUTPLIML reports the limit test results by transmitting the stimulus point tested, a number indicating the limit test results, and then the upper and lower limits at that stimulus point, if available. The number indicating the limit results is a -1 for no test, 0 for fail, and 1 for pass. If there are no limits available, zeros are transmitted as the upper and lower limits.

### Example 3C: Data transfer using Form 5, PC-compatible 32-bit floating point format.

Form 5 transfers two numbers for each trace point. Each number is a four byte real number. Form 5 also has additional four byte header. The first two bytes are the ASCII characters "#A" that indicate that a fixed block length transfer follows, and the next two bytes form an integer containing the number of bytes in the block to follow. Thus, a 201 point transfer requires 1612 ( $201*4*2+4$ ) bytes.

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 3C */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chplib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize (void);
100: void opc (void);
110:
120: void opc ()
130: {
140:     int    one=1;
150:     char  reply;
160:
170:     error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
180: }
190:
200:
210: void error_handle (int error, char *routine)
220: {
230:     if (error !=NOERR)
240:     {
250:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
260:         exit(1);
270:     }
280:     return;
290: }
300:
310: void output (char *sendstr)
320: {
330:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
340: }
350:
360: void initialize ()
```

```

370: {
380:   error_handle (IOTIMEOUT (isc,15.0), "IOTIMEOUT");
390:   error_handle (IOABORT (isc), "IOABORT");
400:   error_handle (IOCLEAR (isc), "IOCLEAR");
410:   error_handle (IOMATCH (isc,'\n',0), "IOMATCH");
420:   output ("CLES;");
430: }
440:
450: main ()
460: {
470:   int   bytes,i,length;
480:   float data[50];
490:   char  header[2];
500:
510:   initialize();
520:   output ("POIN 11;OPC?;SING;");
530:   opc ();
540:   output ("FORM5;OUTPFORM;");
550:   length=2;
560:   error_handle (IOENTERS (instr,header,&length), "IOENTERS");
570:   error_handle (IOENTERB (instr,&bytes,&length,1), "IOENTERB");
580:   printf ("Header: %s\nNumber of bytes: %d\n\n",header,bytes);
590:   length=bytes;
600:   error_handle (IOENTERB (instr,data,&length,1), "IOENTERB");
610:   for (i=0; i<=20; i=i+2)
620:     printf ("Point: %5d,   Value 1: %f,   Value 2: %f\n",
              (i/2)+1,data[i],data[i+1]);
630: }

```

**Figure 2-7. Sample Program: Data Transfer Using Form 5**

### Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the error_handler () routine.
Line 80	Function prototype for the output () routine.
Line 90	Function prototype for the initialize () routine.
Line 100	Function prototype for the opc () routine.

Line 120 Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an OPC? command has been issued.

Line 150 Define a variable to hold the response.

Line 170 Input the response into the variable reply and do nothing with it.

Line 210 Define a routine that handles errors returned from the HP-IB command library I/O functions

Line 230 Check to see if there is an error.

Line 250 An error has occurred, so display a message and halt.

Line 280 No error has occurred, so return.

Line 310 Define a routine that outputs string commands and performs error trapping.

Line 330 Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 360 Define a routine to initialize the instrument.

Line 380 Define a timeout value of 15 seconds.

Line 390 Abort any HP-IB transfers.

Line 400 Clear the instrument's HP-IB interface.

Line 410 Disable character matching. This command defines the character used by IOENTERB and IOENTERS for termination. The "lf" enter terminator should be turned off because "lf" is a valid binary value.

Line 420 Clear the instrument's status.

Line 450 Main declaration

Line 470 Define the needed variables.

Line 510 Call the initialize () routine.

Line 520 Set the number of points sampled to eleven and perform a single trace.

Line 530 Wait for the OPC? command to return a response.

Line 540 Define the data format as Form 5 (PC-compatible 32-bit floating point integer transfer), and request the instrument's formatted data.

Line 550 Define a variable, length, to contain the number of bytes to read from the instrument.

Line 560 Input the header.

Line 570 Input the number of bytes in the block to follow. Put this in the variable, bytes.

Line 580 Display the header and the number of bytes.

Line 590 Assign the variable, length, the number of bytes to read.

Line 600 Read the data.

Line 610            Loop enough times to display all the data points.  
Line 620            Display the point number, value one and value two.

### **Running the program**

Run the program. It will set the number of points to eleven, and display the header and number of bytes required to input the data. It will also show the two values associated with each of the eleven data points.



## Advanced Programming Examples

---

### Using list frequency mode

The list frequency mode allows selection of specific points or frequency spacing between points at which measurements are to be made. Sampling specific points reduces the measurement time, since additional time is not spent measuring device characteristics at unnecessary frequencies.

---

### Example 4: Setting up a list frequency sweep

This example shows how to create a list frequency table and transmit it to the network analyzer. The command sequence for entering a list frequency table imitates the key sequence followed when entering a table from the front panel: there is a command for every key press. Editing a segment is also the same as the key sequence, but the network analyzer automatically re-orders each edited segment in order of increasing start frequency.

The list frequency table is also carried as part of the learn string. While it cannot be modified as part of the learn string, it can be stored and easily recalled.

This example takes advantage of the computer's capabilities to simplify creating, adding to, and editing the table. The table is entered and completely edited before being transmitted to the network analyzer.

```

1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 4A */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30: #include <graph.h>
40:
50: #define isc      7L
60: #define instr    716L
70:
80: int  points[30],start[30],stop[30];
90:
100: void error_handle (int, char *);
110: void output (char *);
120: void initialize (void);
130: void getsegment (int);
140: int edit(void);
150:
160: void error_handle (int error, char *routine)

```

```

170: {
180:   if (error !=NOERR)
190:     {
200:       printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
210:       exit(1);
220:     }
230:   return;
240: }
250:
260: void output (char *sendstr)
270: {
280:   error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
290: }
300:
310: void initialize ()
320: {
330:   error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
340:   error_handle (IOABORT (isc), "IOABORT");
350:   error_handle (IOCLEAR (isc), "IOCLEAR");
360:   output ("PRES;");
370: }
380:
390: void getsegment (int number)
400: {
410:   _settextwindow (20,0,25,80);
420:   _clearscreen (_GWINDOW);
430:   _settextwindow (0,0,25,80);
440:   _settextposition (20,0);
450:   printf ("Start Frequency (GHz)? ");
460:   scanf ("%d",&start[number]);
470:   printf ("Stop Frequency (GHz)? ");
480:   scanf ("%d",&stop[number]);
490:   printf ("Number of Points? ");
500:   scanf ("%d",&points[number]);
510:   if (points[number] == 1) stop[number]=start[number];
520:   _settextposition (number+1,0);
530:   printf ("%d",number);
540:   _settextposition (number+1,20);
550:   printf ("%d",start[number]);
560:   _settextposition (number+1,40);
570:   printf ("%d",stop[number]);
580:   _settextposition (number+1,60);
590:   printf ("%d",points[number]);
600: }
610:
620: int edit()
630: {
640:   int   edit_t;
650:
660:   _settextposition (24,0);

```



```

670:  printf ("Edit which segment (0=exit)? ");
680:  scanf ("%d",&edit_t);
690:  return (edit_t);
700: }
710:
720: main ()
730: {
740:  int  edit_num,i;
750:  float segments;
760:  char  cmd[80];
770:
780:  initialize();
790:  output ("EDITLIST;");
800:  for (i=0; i < 30; i=i+1);
810:    output ("SDEL;");
820:  printf ("Number of segments? ");
830:  scanf ("%f",&segments);
840:  _clearscreen (_GCLEARSCREEN);
850:  _settextposition (1,0);
860:  printf ("SEGMENT");
870:  _settextposition (1,20);
880:  printf ("START");
890:  _settextposition (1,40);
900:  printf ("STOP");
910:  _settextposition (1,60);
920:  printf ("NUMBER OF POINTS\n");
930:  for (i=1; i<=segments; i=i+1)
940:    getsegment (i);
950:  edit_num=edit();
960:  while (edit_num != 0)
970:  {
980:    getsegment (edit_num);
990:    edit_num=edit ();
1000: }
1010: output ("EDITLIST;");
1020:   for (i=1; i<=segments; i=i+1)
1030:   {
1040:     sprintf (cmd,"SADD;STAR%dGHZ;STOP%dGHZ;POIN%d;SDON;",
              start[i],stop[i],points[i]);
1050:     output (cmd);
1060:   }
1070:   output ("EDITDONE;LISFREQ;");
1080: }

```

**Figure 3-1. Sample Program: Setting Up a List Frequency Sweep**

## Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 30	Tell the compiler which file includes information on screen commands.
Line 50	Define a variable to contain the HP-IB interface select code, 7.
Line 60	Define a variable to contain the instrument address, 716.
Line 80	Define some global variables. These contain the start, stop, and number of points for each of the segments.
Line 100	Function prototype for the <code>error_handler ()</code> routine.
Line 110	Function prototype for the <code>output ()</code> routine.
Line 120	Function prototype for the <code>initialize ()</code> routine.
Line 130	Function prototype for the <code>getsegment ()</code> routine.
Line 140	Function prototype for the <code>edit ()</code> routine.
Line 160	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 180	Check to see if there is an error.
Line 200	An error has occurred, so display a message and halt.
Line 230	No error has occurred, so return.
Line 260	Define a routine that outputs string commands and performs error trapping.
Line 280	Send a string to the instrument located at the value of <code>instr</code> , 716. Perform error checking.
Line 310	Define a routine to initialize the instrument.
Line 330	Define a timeout value of 45 seconds.
Line 340	Abort any HP-IB transfers.
Line 350	Clear the instrument's HP-IB interface.
Line 360	Preset the instrument.
Line 390	Define a routine to input each of the segments.
Line 410	Define a window to include the bottom half of the screen.
Line 420	Delete the above window.
Line 430	Return the window back to full screen.
Line 440	Position the text.

Line 470           Input the start frequency.  
Line 480           Input the stop frequency.  
Line 500           Input the number of points.  
Line 510           If the number of points is equal to one, then the stop frequency  
                  should equal the start frequency.  
  
Line 520           Position the inputted text in a column format.  
Line 530           Display the segment number.  
Line 540           Position the next column.  
Line 550           Display the start frequency.  
Line 560           Position the next column.  
Line 570           Display the stop frequency.  
Line 580           Position the next column.  
Line 590           Display the number of points.  
Line 620           Define a routine to determine which segment to edit and return that  
                  segment value.  
  
Line 660           Position the text to be displayed.  
Line 680           Input the segment number to edit.  
Line 690           Return the segment number.  
Line 720           Main declaration  
Line 740           Define the needed variables.  
Line 780           Call the initialize () routine.  
Line 790           Edit the segment list in the instrument.  
Line 800           Loop to delete the segment list.  
Line 830           Input the number of segments to enter.  
Line 840           Clear the screen.  
Line 850           Position the text for the header.  
Line 860           Display the SEGMENT header.  
Line 880           Display the START header.  
Line 900           Display the STOP header.  
Line 920           Display the NUMBER OF POINTS header.  
Line 930           Loop to input the segments.  
Line 940           Input each segment.  
Line 950           Determine which segment to edit.  
Line 960           If the segment does not equal zero then continue, otherwise go to line  
                  1010.  
Line 980           Re-input the segment to be edited.

Line 990	Determine which segment to edit.
Line 1010	Edit the segment list in the instrument.
Line 1020	Loop to output the segment list to the instrument.
Line 1040	Create an appropriate string that adds a segment with the correct start and stop frequencies, and number of points.
Line 1050	Output this string.
Line 1070	Declare the editing done, and activate the frequency list sweep mode.

## Running the program

The program displays the frequency list table as it is entered. During editing, the displayed table is updated as each line is edited. The table is not re-ordered. At the completion of editing, the table is entered into the instrument, and the list frequency mode turned on.

Any segments already in the frequency list table will be deleted by the program. Thus, new segments will be entered on top of the old ones.

---

## Using limit lines

There are two steps to performing limit testing under HP-IB control. First, limits must be specified and loaded into the analyzer. Second, the limits are activated, the device is measured, and its performance to the specified limits is signaled by a pass or fail message on the display.

---

## Example 5A: Setting up limit lines

This example shows how to create a limit table and transmit it. The command sequence for entering a limit table imitates the key sequence followed when entering a table from the front panel: there is a command for every key press. Editing a limit is also the same as the key sequence, but remember that the instrument automatically re-orders the table in order of increasing start frequency.

The limit table is also carried as part of the learn string. While it cannot be modified as part of the learn string, it can be stored and recalled with very little effort.

This example takes advantage of the computer's capabilities to simplify creating and editing the table. The table is entered and completely edited before being transmitted. To simplify the programming task, options such as entering offsets are not included.

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 5A */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30: #include <graph.h>
```

```

40:
50: #define isc      7L
60: #define instr    716L
70: #define fl       'FL'
80: #define sl       'SL'
90: #define sp       'SP'
100:
110: int   l_type[30],lower[30],stimulus[30],upper[30];
120:
130:
140: void error_handle (int, char *);
150: void output (char *);
160: void initialize (void);
170: void getlimit (int);
180: int edit(void);
190:
200:
210: void error_handle (int error, char *routine)
220: {
230:     if (error !=NOERR)
240:     {
250:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
260:         exit(1);
270:     }
280:     return;
290: }
300:
310: void output (char *sendstr)
320: {
330:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
340: }
350:
360: void initialize ()
370: {
380:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
390:     error_handle (IOABORT (isc), "IOABORT");
400:     error_handle (IOCLEAR (isc), "IOCLEAR");
410:     output ("PRES;");
420: }
430:
440: void getlimit (int number)
450: {
460:     _settextwindow (19,0,25,80);
470:     _clearscreen (_GWINDOW);
480:     _settextwindow (0,0,25,80);
490:     _settextposition (19,0);
500:     printf ("Stimulus Value (GHz)? ");
510:     scanf ("%d",&stimulus[number]);
520:     printf ("Upper Limit Value (dB)? ");
530:     scanf ("%d",&upper[number]);

```

```

540: printf ("Lower Limit Value (dB)? ");
550: scanf ("%d",&lower[number]);
560: printf ("Limit Type (1=Flat, 2=Sloped, 3=Point)? ");
570: scanf ("%d",&l_type[number]);
580: _settextposition (number+1,0);
590: printf ("%d",number);
600: _settextposition (number+1,15);
610: printf ("%d",stimulus[number]);
620: _settextposition (number+1,30);
630: printf ("%d",upper[number]);
640: _settextposition (number+1,45);
650: printf ("%d",lower[number]);
660: _settextposition (number+1,60);
670: switch (l_type[number])
680: {
690:     case 1: printf ("FL");
700:             break;
710:     case 2: printf ("SL");
720:             break;
730:     case 3: printf ("SP");
740:             break;
750: }
760: }
770:
780: int edit()
790: {
800:     int edit_t;
810:
820:     _settextposition (24,0);
830:     printf ("Edit which limit (0=exit)? ");
840:     scanf ("%d",&edit_t);
850:     return (edit_t);
860: }
870:
880: main ()
890: {
900:     int edit_num,i;
910:     float limits;
920:     char cmd[80];
930:
940:     initialize();
950:     output ("EDITLIML;");
960:     for (i=0; i < 30; i=i+1)
970:     {
980:         output ("SDEL;");
990:     }
1000:     printf ("Number of limits? ");
1010:     scanf ("%f",&limits);
1020:     _clearscreen (_GCLEARSCREEN);
1030:     _settextposition (1,0);
1040:     printf ("LIMIT");

```

```

1050:  _settextposition (1,15);
1060:  printf ("STIMULUS");
1070:  _settextposition (1,30);
1080:  printf ("UPPER");
1090:  _settextposition (1,45);
1100:  printf ("LOWER");
1110:  _settextposition (1,60);
1120:  printf ("TYPE\n");
1130:  for (i=1; i<=limits; i=i+1)
1140:      getlimit (i);
1150:  edit_num=edit();
1160:  while (edit_num != 0)
1170:  {
1180:      getlimit (edit_num);
1190:      edit_num=edit ();
1200:  }
1210:  output ("EDITLIML;");
1220:  for (i=1; i<=limits; i=i+1)
1230:  {
1240:      sprintf (cmd,"SADD;LIMS%dGHZ;LIMU%dDB;LIML%dDB;",
                stimulus[i],upper[i],lower[i]);
1250:      output (cmd);
1260:      switch (l_type[i])
1270:      {
1280:          case 1: output ("LIMTFL;SDON;");
1290:                  break;
1300:          case 2: output ("LIMTSL;SDON;");
1310:                  break;
1320:          case 3: output ("LIMTSP;SDON;");
1330:                  break;
1340:      }
1350:  }
1360:  output ("EDITDONE;LIMILINEON;LIMITESTON;");
1370: }

```

**Figure 3-2. Sample Program: Setting Up Limit Lines**

### Program explanation

- |         |   |
|---------|---|
| Line 5  | Tell the compiler which file includes information on the standard I/O routines.                         |
| Line 10 | Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions. |
| Line 20 | Tell the compiler which file includes information on the HP-IB command library error constants.         |
| Line 30 | Tell the compiler which file includes information on screen commands.                                   |
| Line 50 | Define a variable to contain the HP-IB interface select code, 7.  |

Line 60            Define a variable to contain the instrument address, 716.

Line 70            Define a variable to contain the string 'FL' for flat line. This string is sent to the instrument when a flat line is desired.

Line 80            Define a variable to contain the string 'SL' for sloped line. This string is sent to the instrument when a sloped line is desired.

Line 90            Define a variable to contain the string 'SP' for single point. This string is sent to the instrument when a single point is desired.

Line 110           Define some global variables. These contain the stimulus, upper and lower limits, and the line type of the limit line.

Line 140           Function prototype for the error\_handler () routine.

Line 150           Function prototype for the output () routine.

Line 160           Function prototype for the initialize () routine.

Line 170           Function prototype for the getlimit () routine.

Line 180           Function prototype for the edit () routine.

Line 210           Define a routine that handles errors returned from the HP-IB command library I/O functions

Line 230           Check to see if there is an error.

Line 250           An error has occurred, so display a message and halt.

Line 280           No error has occurred, so return.

Line 310           Define a routine that outputs string commands and performs error trapping.

Line 330           Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 360           Define a routine to initialize the instrument.

Line 380           Define a timeout value of 45 seconds.

Line 390           Abort any HP-IB transfers.

Line 400           Clear the instrument's HP-IB interface.

Line 410           Preset the instrument.

Line 440           Define a routine to input each of the limit lines.

Line 460           Define a window to include the bottom half of the screen.

Line 470           Delete the above window.

Line 480           Return the window back to full screen.

Line 490           Position the text.

Line 510           Input the stimulus.

Line 530           Input the upper limit.

Line 550           Input the lower limit.

Line 570           Input the line type.



Line 580            Position the inputted text in a column format.

Line 590            Display the limit line number.

Line 600            Position the next column.

Line 610            Display the stimulus.

Line 620            Position the next column.

Line 630            Display the upper limit.

Line 640            Position the next column.

Line 650            Display the lower limit.

Line 660            Position the next column.

Line 670            Display the appropriate limit line type corresponding to each of the  
three values.

Line 780            Define a routine to determine which limit line to edit and return that  
segment value.

Line 820            Position the text to be displayed.

Line 840            Input the limit line number to edit.

Line 850            Return the limit line number.

Line 880            Main declaration

Line 900            Define the needed variables.

Line 940            Call the `initialize ()` routine.

Line 950            Edit the limit line list in the instrument.

Line 960            Loop to delete the limit line list.

Line 1010           Input the number of limit lines to enter.

Line 1020           Clear the screen.

Line 1030           Position the text for the header.

Line 1050           Display the LIMIT number header.

Line 1060           Display the STIMULUS header.

Line 1080           Display the UPPER limit header.

Line 1100           Display the LOWER limit header.

Line 1120           Display the limit line TYPE header.

Line 1130           Loop to input the limit lines.

Line 1140           Input each limit line.

Line 1150           Determine which limit line to edit.

Line 1160           If the limit line number does not equal zero then continue, otherwise  
go to line 1220.

Line 1180           Re-input the limit line to be edited.

Line 1190           Determine which limit line to edit.

Line 1210	Edit the limit line list in the instrument.
Line 1220	Loop to output the limit line list to the instrument.
Line 1240	Create an appropriate string that adds a limit line with the correct stimulus, and upper and lower limits.
Line 1250	Output this string.
Line 1260	Determine which string to output to the instrument corresponding to the type of limit line (flat, sloped, or single point).
Line 1360	Declare the editing done, and activate the limit lines and test.

### Running the program

The program displays the limit table as it is entered. During editing, the displayed table is updated as each line is edited. The table is not reordered. At the completion of editing, the table is entered, and limit testing mode is turned on. This example program will delete any existing limit lines before entering the new limits.

---

### Example 5B: PASS/FAIL tests

This example demonstrates the use of the limit/search fail bits in event status register B to determine whether a device passes the specified limits. Limits can be entered manually, or by Example 5A.

The limit/search fail bits are set and latched when limit testing or marker search fails. There are four bits, one for each channel for both limit testing and marker search. Their purpose is to allow the computer to determine whether the test/search just executed was successful. To use them, clear event status register B, trigger the limit test or marker search, and then check the appropriate fail bit.

In the case of limit testing, the best way to trigger the limit test is to trigger a single sweep. By the time the SING command finishes, limit testing will have occurred. A second consideration when dealing with limit testing is that if the device is tuned during the sweep, it may be tuned into and then out of limit, causing a limit test pass when the device is not in fact within limits.

In the case of marker searches (max, min, target, and widths), outputting marker or bandwidth values automatically triggers any related searches. Hence, all that is needed is to check the fail bit after reading the data.

Several sweeps in a row should be performed before determining whether or not a device has passed. This gives confidence that the device has passed not due to settling or tuning. Upon running the program, the number of sweeps for qualification has to be entered. For slow sweeps, a small number such as two is appropriate. For very fast sweeps, where the device needs time to settle after tuning and the operator needs time to get away from the device, as many sweeps as six or more might be appropriate.

```
1: /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 5B */
2:
```

```

5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chplib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void opc (void);
100: void initialize (void);
110: void disp_prompt (char *);
120:
130: void error_handle (int error, char *routine)
140: {
150:     if (error !=NOERR)
160:     {
170:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
180:         exit(1);
190:     }
200:     return;
210: }
220:
230: void output (char *sendstr)
240: {
250:     error_handle (IOOUTPUTS(instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
260: }
270:
280: void opc ()
290: {
300:     int  one=1;
310:     char reply;
320:
330:     error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
340: }
350:
360: void initialize ()
370: {
380:     error_handle (IOTIMEOUT (isc,15.0), "IOTIMEOUT");
390:     error_handle (IOABORT (isc), "IOABORT");
400:     error_handle (IOCLEAR (isc), "IOCLEAR");
410:     output ("CLES;");
420: }
430:
440: void disp_prompt (char *prompt)
450: {
460:     char ch;
470:
480:     printf ("%s, then press [RETURN]\n",prompt);
490:     ch=getche();

```

```

500: }
510:
520: main ()
530: {
540:     float e_stat;
550:     int   fail_flag,i,stat,qual_tests;
560:
570:     initialize ();
580:     printf ("Number of test for qualification? ");
590:     scanf ("%d",&qual_tests);
600:     fail_flag=0;
610:     printf ("Test #: ");
620:     for (i=1; i<=qual_tests; i=i+1)
630:     {
640:         output ("OPC?;SING;");
650:         opc ();
660:         printf ("%d...",i);
670:         output ("ESB?;");
680:         error_handle (IOENTER (instr,&e_stat), "IOENTER");
690:         stat=e_stat;
700:         if (stat & 16) fail_flag=1;
710:     }
720:     if (fail_flag == 1) printf ("\nDEVICE FAILED!\n");
730:     else printf ("\nDEVICE PASSED!\n");
740: }

```

**Figure 3-3. Sample Program: PASS/FAIL tests**

### Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the error_handler () routine.
Line 80	Function prototype for the output () routine.
Line 90	Function prototype for the opc () routine.
Line 100	Function prototype for the initialize () routine.
Line 110	Function prototype for the disp_prompt () routine.
Line 130	Define a routine that handles errors returned from the HP-IB command library I/O functions

Line 150            Check to see if there is an error.

Line 170            An error has occurred, so display a message and halt.

Line 200            No error has occurred, so return.

Line 230            Define a routine that outputs string commands and performs error trapping.

Line 250            Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 280            Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an OPC? command has been issued.

Line 310            Define a variable to hold the response.

Line 330            Input the response into the variable reply and do nothing with it.

Line 360            Define a routine to initialize the instrument.

Line 380            Define a timeout value of 15 seconds.

Line 390            Abort any HP-IB transfers.

Line 400            Clear the instrument's HP-IB interface.

Line 410            Clear the instrument's status.

Line 440            Define a routine to display a prompt and wait for **RETURN** to be pressed.

Line 480            Display the message prompt.

Line 490            Wait for a key to be pressed.

Line 520            Main declaration

Line 540            Declare the necessary variables.

Line 570            Call the initialize () routine.

Line 590            Determine the number of tests needed for qualification.

Line 600            Set the fail\_flag to zero. The fail\_flag determines if the device has failed. A one represents a failure.

Line 610            Display the current test number text.

Line 620            Loop to test the device.

Line 640            Perform a single trace.

Line 650            Wait for the OPC? command to issue a response.

Line 660            Display the current test number.

Line 670            Request event status register B byte.

Line 680            Input the event status register B byte.

Line 690            Convert the floating point integer to an integer.

Line 700            If bit 4 is set, then the device has failed, so set the fail\_flag.

Line 720

If the fail\_flag is set, then the device has failed, otherwise, it has passed.

### Running the program

Set up a limit table on channel one for a specific device either manually, or using the program in Example 5A. The recommended device is the bandpass filter supplied with the instrument (HP part number 0955-0446). Run the program, and enter the number of sweeps desired for pass qualification. After entering the number of sweeps, connect the filter. When enough sweeps in a row pass, the computer displays DEVICE PASSED. For the bandpass filter, the suggested limits are as follows.

**Table 3-1. Suggested Limits**

Seg	Stimulus (GHZ)	Upper (dB)	Lower (dB)	Type
1	8.0	-70	-200	FL
2	9.0	-70	-200	SP
3	9.4	-60	-200	SL
4	10.0	-3	-200	SP
5	10.2	0	-3	FL
6	10.3	0	-3	SP
7	10.5	-3	-200	SL
8	11.1	-60	-200	SP
9	11.5	-70	-200	FL
10	12.5	-70	-200	SP

These are only suggestions. Your filter may vary slightly, and the limits may need to be modified to allow the filter to pass. The program assumes a response calibration (thru calibration) or full 2-port calibration has been performed prior to running the program. Try causing the filter to fail by loosening the cables connecting the filter and then re-tightening them.

---

## Storing and recalling instrument states

The following examples demonstrate ways of storing and recalling instrument states over HP-IB. Example 6A coordinates disk storage, while Example 6B shows an example of how to read calibration data. Example 6A can be easily applied to the coordination of printer and plotters.

There are three operating modes with respect to HP-IB, as set under the **LOCAL** menu: system controller mode, talker/listener mode, and pass control mode. System controller mode is used when no computer is present. The other two modes allow the computer to coordinate certain actions: in talker/listener mode the computer can control the network analyzer, as well as coordinate plotting and printing, and in pass control mode the computer can pass active control to the network analyzer so that it can plot, print, or load/store to disk. Peripheral control is the major difference between the two modes.

If the network analyzer is in pass control mode and receives a command telling it to plot, print, or store/load to disk, it sets bit one in the event status register to indicate that it needs control of the bus. If the computer then uses the HP-IB library control command, IOPASSCTL to pass control, the network analyzer will return control back to the computer when its operation is complete.

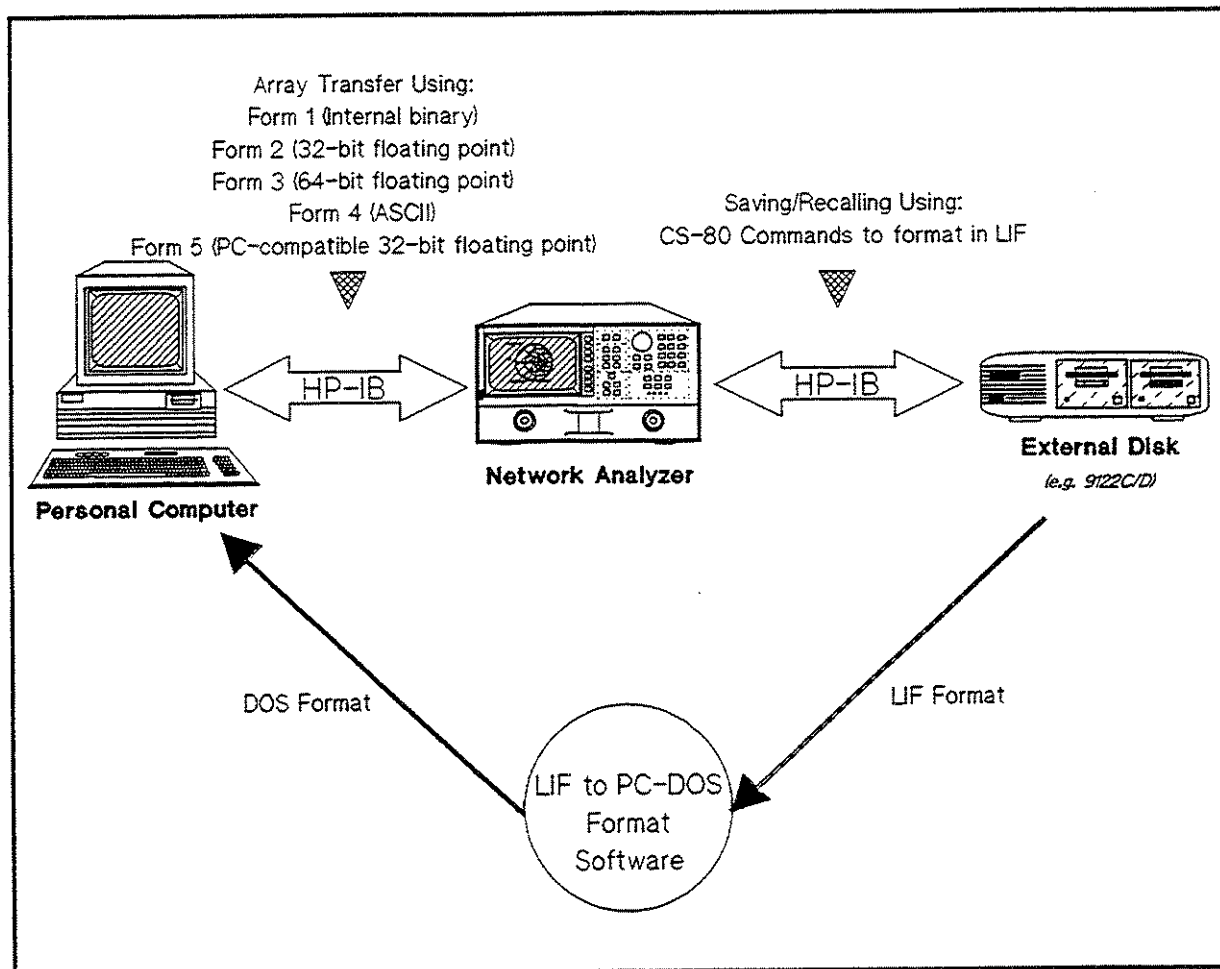
Control should not be passed to the network analyzer before it has set event status register bit one, (Request Active Control.) If the network analyzer receives control before the bit is set, control is immediately passed back.

While the network analyzer has control, it is free to address devices to talk and listen, as needed. The only functions denied it are the ability to assert the interface clear line (IFC), and the remote line (REN). These are reserved for the system controller. As active controller, the network analyzer can send messages to and back from printers, plotters, and disk drives.

---

### Example 6A: Coordinating disk storage

Referring to Figure 3-4, a personal computer can transfer data to the instrument using any five array transfer formats. The instrument then can transfer this data to an external drive using CS-80 commands to store the data in LIF format. A LIF formatted disk can be converted to a DOS formatted disk through addition software.



**Figure 3-4. Data transfer paths**

To have the instrument store an instrument state on disk, specify the state name by titling a file using TITFn, then specify a STORn of that file, where n is the file number, 1 to 5. On receipt of the store command, the instrument will request active control. When control is received, the instrument will store the instrument state on disk as defined under the **SAVE**, **STORE TO DISK**, **DEFINE STORE** menu.

To have the network analyzer load a file from disk, title the file with TITFn, and then request a LOADn of that file. The best way of learning what the register titles on the disk are, is to use the sequence **RECALL**, **LOAD FROM DISK**, **READ FILE TITLES**.

Note that the instrument assumes that the address of the disk drive is correctly stored in its HP-IB addresses menu under the **ADDRESS: DISK** entry. The default address for an external disk drive is 0.

The instrument command USEPASC puts the instrument in pass control. This is necessary if the instrument is to receive control. When the computer has passed control and the instrument is ready to pass back control, the instrument will pass control to the address under **LOCAL**, **SET ADDRESSES**, **ADDRESS: CONTROLLER**. This address should be the default 30 address. If this is not 30, change it by **3 0 x1**.



---

**Note**

The default address can be changed with the library command IOCONTROL (716L,7,bus\_address), where bus\_address is the address of the controller. The library command IOSTATUS (716L,7,bus\_address) will determine the current bus address.

The address of the controller must be properly set so that controller return is possible.

---

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 6A */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60: #define quote    '''
70:
80: void error_handle (int, char *);
90: void output (char *);
100: void opc (void);
110: void initialize (void);
120:
130: void error_handle (int error, char *routine)
140: {
150:     if (error !=NOERR)
160:     {
170:         printf ("HP-IB error in call to %s: %d, %s\n",
180:             routine, error, errstr(error));
190:         exit(1);
200:     }
210: }
220:
230: void output (char *sendstr)
240: {
250:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
260: }
270:
280: void opc ()
290: {
300:     int  one=1;
310:     char reply;
320:
330:     error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
340: }
350:
360: void initialize ()
370: {
```

```

380:   error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
390:   error_handle (IOABORT (isc), "IOABORT");
400:   error_handle (IOCLEAR (isc), "IOCLEAR");
410:   output ("CLES;");
420: }
430:
440: main ()
450: {
460:   int   hpib,stat;
470:   char  ch,cmd[80],name[8];
480:
490:   initialize ();
500:   output ("ADDRCONT30;USEPASC;");
510:   printf("File name to SAVE (up to 8 char.)? ");
520:   scanf("%s",&name);
530:   sprintf (cmd,"CLS;ESE 2;OPC?;TITF1%c%s%c;STOR1;",quote,name,quote);
540:   output (cmd);
550:   printf ("\nSaving on Disk...");
560:   do
570:     error_handle (IOSPOLL (instr,&stat), "IOSPOLL");
580:   while (!(stat & 32));
590:   error_handle (IOPASSCTL (instr), "IOPASSCTL");
600:   do
610:     error_handle (IOSTATUS (isc,4,&hpib), "IOSTATUS");
620:   while (hpib != 1);
630:   printf ("Done.\n\n");
640:   printf ("HIT [RETURN] to recall instrument state.\n");
650:   ch=getch();
660:   printf ("Loading...");
670:   sprintf (cmd,"CLS;ESE 2;OPC?;TITF1%c%s%c;LOAD1;",quote,name,quote);
680:   output (cmd);
690:   do
700:     error_handle (IOSPOLL (instr,&stat), "IOSPOLL");
710:   while (!(stat & 32));
720:   error_handle (IOPASSCTL (instr), "IOPASSCTL");
730:   do
740:     error_handle (IOSTATUS (isc,4,&hpib), "IOSTATUS");
750:   while (hpib != 1);
760:   printf ("Done.\n");
770: }

```

Figure 3-5. Sample Program: Coordinating Disk Storage

## Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 80	Function prototype for the <code>error_handler ()</code> routine.
Line 90	Function prototype for the <code>output ()</code> routine.
Line 100	Function prototype for the <code>opc ()</code> routine.
Line 110	Function prototype for the <code>initialize ()</code> routine.
Line 130	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 150	Check to see if there is an error.
Line 170	An error has occurred, so display a message and halt.
Line 200	No error has occurred, so return.
Line 230	Define a routine that outputs string commands and performs error trapping.
Line 250	Send a string to the instrument located at the value of <code>instr</code> , 716. Perform error checking.
Line 280	Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an <code>GPC?</code> command has been issued.
Line 310	Define a variable to hold the response.
Line 330	Input the response into the variable <code>reply</code> and do nothing with it.
Line 360	Define a routine to initialize the instrument.
Line 380	Define a timeout value of 45 seconds.
Line 390	Abort any HP-IB transfers.
Line 400	Clear the instrument's HP-IB interface.
Line 410	Clear the instrument's status.
Line 440	Main declaration
Line 460	Define the needed variables.
Line 490	Call the <code>initialize ()</code> routine.
Line 500	Set the instrument state as pass control.
Line 520	Input the file name to be saved.

Line 530            Prepare a string to clear the instrument's status, specify bit two of the event status register to be summarized by bit five of the status byte, specify a disk file, and save.

Line 540            Output this string.

Line 560            Loop until bit five of the status byte is set, thus indicating that the instrument is ready to take control.

Line 570            Read the status byte.

Line 590            Pass control to the instrument.

Line 600            Loop until the interface is active controller.

Line 610            Read the current interface status.

Line 640            Display a message that the program is ready to recall the saved instrument state.

Line 650            Wait for a key to be pressed.

Line 670            Prepare a string to clear the instrument's state, specify bit two of the event status register to be summarized by bit five of the status register, specify a disk file, and load.

Line 680            Output this string.

Line 690            Loop until bit five of the status byte is set, thus indicating that the instrument is ready to take control.

Line 700            Read the status byte.

Line 720            Pass control to the instrument.

Line 730            Loop until the interface is active controller.

Line 740            Read the current interface status.

### Running the program

Put a formatted disk in the disk drive, and set the disk address, unit number, and volume number for that drive. Run the example and enter a valid file name. The program will save the current instrument state, wait for **RETURN** to be pressed, and load the previously saved state. When the program pauses, change the instrument state so that a change will be noticeable.

---

## Example 6B: Reading calibration data

This example demonstrates how to read and write measurement calibration data.

The data used to perform measurement error correction is stored in up to twelve calibration coefficient arrays. Each array is a specific error coefficient and always contains a real and imaginary part corresponding to the each point in the sweep. The five data formats also apply to the transfer of calibration coefficient arrays.

A computer can read out the error coefficients using the command `OUTPCALC{n}`, where `n` can range from 1 to 12. Each calibration type uses only as many arrays as needed, starting with array one. Therefore, it is necessary to know the type of calibration that was used to produce the coefficients (ie. 1-port vs. 2-port). Attempting to read an array not being used in the current calibration causes the "REQUESTED DATA NOT CURRENTLY AVAILABLE" warning. Refer to the *HP-IB Programming Reference (HP part number 08720-90160)* for the definitions of calibration types, standard classes, and calibration coefficients.

A computer can also store calibration coefficients in the instrument. To do this, declare the type of calibration data about to be stored just as if you were about to perform that calibration. Then instead of calling up different classes, transfer the calibration coefficients using the `INPUCALC{n}` (`n` ranges from 1 to 12) command. When all the coefficients are in, activate the calibration by issuing the mnemonic `SAVC`, and take a sweep.

This example reads the response calibration coefficients from a response calibration, using Form 1, into an array, from which they can be examined, modified, stored, or put back into the instrument. In Form 1, each data point is sent out as it is stored inside the network analyzer, in a six byte binary string. Hence, it is a very fast transfer, using only 1,206 bytes to transfer 201 points, but it is difficult to interpret by the computer since it is not a standard data format. (Real/imaginary data uses the first two bytes for the imaginary fraction mantissa, the middle two bytes for the real fraction mantissa, the fifth byte for additional resolution when transferring raw data, and the last byte as the common power of two).

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 6B */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize (void);
100: void opc (void);
110:
120: void opc ()
130: {
140:     int    one=1;
150:     char  reply;
160:
170:     error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
```

```

180: }
190:
200:
210: void error_handle (int error, char *routine)
220: {
230:     if (error !=NOERR)
240:     {
250:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
260:         exit(1);
270:     }
280:     return;
290: }
300:
310: void output (char *sendstr)
320: {
330:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
340: }
350:
360: void initialize ()
370: {
380:     error_handle (IOTIMEOUT (isc,15.0), "IOTIMEOUT");
390:     error_handle (IOABORT (isc), "IOABORT");
400:     error_handle (IOCLEAR (isc), "IOCLEAR");
410:     output ("CLES;");
420: }
430:
440: main ()
450: {
460:     int  bytes,i,length;
470:     char  ascii_dat[1300],carline='\n',ch,cmd[80],header[2],response;
480:
490:     initialize();
500:     output ("CORRON;OPC?;SING;");
510:     opc ();
520:     output ("CALIRESP?;");
530:     length=1;
540:     error_handle (IOENTERS (instr,&response,&length), "IOENTERS");
550:     if (response == '0')
560:     {
570:         printf ("Calibration Response data not available.\n");
580:         exit (1);
590:     }
600:     output ("FORM1;OUTPCALC01;");
610:     length=2;
620:     error_handle (IOMATCH (isc,'\n',0), "IOMATCH");
630:     error_handle (IOENTERS (instr,header,&length), "IOENTERS");
640:     error_handle (IOENTERB (instr,&bytes,&length,2), "IOENTERB");
650:     printf ("Header: %s\nNumber of bytes: %d\n\n",header,bytes);
660:     length=bytes;
670:     error_handle (IOENTERB (instr,ascii_dat,&length,1), "IOENTERB");

```

```

680:    printf ("\nData is now loaded using Form 1.\n\n");
690:    printf ("\nPress [RETURN] to re-transmit calibration\n");
700:    ch=getch();
710:    initialize ();
720:    output ("CALIRESP;FORM1;");
730:    error_handle (IOEOL (isc,&carline,0), "IOEOL");
740:    error_handle (IOEOI (isc,0), "IOEOI");
750:    output ("INPUCALCO1");
760:    length=2;
770:    error_handle (IOOUTPUTS (instr,header,length), "IOOUTPUTS");
780:    error_handle (IOOUTPUTB (instr,&bytes,length,2), "IOOUTPUTB");
790:    length=bytes;
800:    error_handle (IOOUTPUTB (instr,ascii_dat,length,1), "IOOUTPUTB");
810:    error_handle (IOEOL (isc,&carline,1), "IOEOL");
820:    error_handle (IOEOI (isc,1), "IOEOI");
830:    output ("SAVC;CONT;");
840: }

```

**Figure 3-6. Sample Program: Reading Calibration Data**

### Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the <code>error_handler ()</code> routine.
Line 80	Function prototype for the <code>output ()</code> routine.
Line 90	Function prototype for the <code>initialize ()</code> routine.
Line 100	Function prototype for the <code>opc ()</code> routine.
Line 120	Define a routine that when called will only return when it receives a response from the instrument. This routine is called after an OPC? command has been issued.
Line 150	Define a variable to hold the response.
Line 170	Input the response into the variable <code>reply</code> and do nothing with it.
Line 210	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 230	Check to see if there is an error.
Line 250	An error has occurred, so display a message and halt.

Line 280 No error has occurred, so return.

Line 310 Define a routine that outputs string commands and performs error trapping.

Line 330 Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 360 Define a routine to initialize the instrument.

Line 380 Define a timeout value of 15 seconds.

Line 390 Abort any HP-IB transfers.

Line 400 Clear the instrument's HP-IB interface.

Line 410 Clear the instrument's status.

Line 440 Main declaration

Line 450 Define the needed variables.

Line 490 Call the initialize () routine.

Line 500 Switch debug on, correction on, and perform a single trace.

Line 510 Wait for the OPC? command to issue a response.

Line 520 Request if calibration response is active.

Line 530 Define a variable, length, that contains the length of the inputted data. In this case, only one byte.

Line 540 Input the response.

Line 550 If the response is zero, then calibration response is not active and therefore its data is not available.

Line 580 Exit.

Line 600 Request calibration coefficients of array one, using form 1 (binary internal format).

Line 610 Set the length of the header and number of bytes of the block to follow to two.

Line 620 Disable character matching. This command defines the character used by IOENTERB and IOENTERS for termination. The "lf" enter terminator should be turned off because "lf" is a valid binary value.

Line 630 Input the header.

Line 640 Input the number of bytes in the block to follow.

Line 650 Display the header and the number of bytes in the block.

Line 670 Read in the calibration coefficient data.

Line 680 Display a confirmation that data has been loaded.

Line 700 Wait for a **RETURN**.

Line 710 Initialize the instrument to remote, in case the user has changed the instrument calibration.

Line 720 Open the calibration response menu. Prepare for a Form 1 transfer.



Line 730            Disable End of Line (EOL) character. This command defines the character used by IOOUTPUT, IOOUTPUTA, IOOUTPUTB, and IOOUTPUTS for termination. The "lf" enter terminator should be turned off because "lf" is a valid binary value.

Line 740            Disable End Or Identify (EOI).

Line 750            Request the analyzer to input calibration data.

Line 770            Output the header.

Line 780            Output the number of bytes in the block to follow.

Line 800            Output the calibration coefficients.

Line 810            Enable End of Line (EOL) character as the "lf" enter terminator.

Line 820            Enable End Or Identify (EOI).

Line 830            Create a calibration set based on the current error coefficient arrays loaded. Turn on the continuous sweep trigger mode.

### **Running the program**

Before executing the program, perform a response calibration. Run the program, and when it pauses, perform a different calibration. When the program resumes, the old calibration data will be loaded in and activated.

The program will determine if response calibration data is active. If it is not, it will halt and display an appropriate message.



## Miscellaneous/Reference Programming Examples

---

### Example 7: Key Trapping

It is possible to sense operator action with the front panel keys. The user request bit, bit 6, in the event status register is set whenever a front panel key is pressed or the knob is turned, whether the instrument is in remote or local mode. Each key has a number associated with it. The number of the key last pressed can be read with the KOR? and the OUTFKEY commands. With KOR?, a knob turn is reported as a negative number encoded with the number of counts turned. With OUTFKEY, a knob turn is always reported as a negative one.

Refer to the *HP-IB Programming Reference (HP part number 08720-90160)* for the codes of the front panel keys.

In this example, the OUTFKEY command is used to re-define the top four and eighth softkeys.

```

1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 7 */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize (void);
100:
110: void error_handle (int error, char *routine)
120: {
130:     if (error !=NOERR)
140:     {
150:         printf ("HP-IB error in call to %s: %d, %s\n",
                  routine, error, errstr(error));
160:         exit(1);
170:     }
180:     return;
190: }
200:
210: void output (char *sendstr)
220: {
230:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
240: }
250:

```

```

260: void initialize ()
270: {
280:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
290:     error_handle (IOABORT (isc), "IOABORT");
300:     error_handle (IOCLEAR (isc), "IOCLEAR");
310:     output ("PRES;");
320: }
330:
340: main ()
350: {
360:     int  keycode,status;
370:     float value;
380:
390:     initialize ();
400:     output ("CLES;ESE64;MENUOFF");
410:     printf ("Ready...\n");
420:     do
430:     {
440:         do
450:             error_handle (IOSPOLL (instr, &status), "IOSPOLL");
460:             while (!(status & 32));
470:             output ("OUTPKEY;");
480:             error_handle (IOENTER (instr, &value), "IOENTER");
490:             keycode=value;
500:             switch (keycode)
510:             {
520:                 case 60: printf ("Calibration #1\n");
530:                     break;
540:                 case 61: printf ("Test #1\n");
550:                     break;
560:                 case 56: printf ("Calibration #2\n");
570:                     break;
580:                 case 59: printf ("Test #2\n");
590:                     break;
600:                 case 10: printf ("Abort \n");
610:                     break;
620:                 default: printf ("*** UNDEFINED ***\n");
630:                     break;
640:             }
650:             output ("CLES;ESE64;");
660:         }
670:     while (keycode !=10);
680:     output ("MENUON;");
690: }

```

**Figure 4-1. Sample Program: Key Trapping**

## Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the <code>error_handler ()</code> routine.
Line 80	Function prototype for the <code>output ()</code> routine.
Line 90	Function prototype for the <code>initialize ()</code> routine.
Line 110	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 130	Check to see if there is an error.
Line 150	An error has occurred, so display a message and halt.
Line 180	No error has occurred, so return.
Line 210	Define a routine that outputs string commands and performs error trapping.
Line 230	Send a string to the instrument located at the value of <code>instr</code> , 716. Perform error checking.
Line 260	Define a routine to initialize the instrument.
Line 280	Define a timeout value of 45 seconds.
Line 290	Abort any HP-IB transfers.
Line 300	Clear the instrument's HP-IB interface.
Line 310	Preset the instrument.
Line 340	Main declaration
Line 360	Declare the needed variables.
Line 390	Call the <code>initialize ()</code> routine.
Line 400	Clear the instrument's status, specify bit six of the event status register to be summarized by bit five of the status byte, and turn off the softkey menus.
Line 420	Do until <code>keycode</code> is equal to ten. <code>keycode</code> contains the current key code for the front key pressed.
Line 450	Loop until bit five of the status register is set. This indicates that bit six of the event status register is set.
Line 470	Request the key code of the key just pressed.
Line 480	Input the key code.

Line 490            Convert the key code to an integer.

Line 500            If the key code is any of the top four or eighth softkeys, then display an appropriate message, otherwise, the key pressed is undefined.

Line 650            Clear the status register and specify bit six of the event status register to be summarized by bit five of the status byte.

Line 680            Turn the softkey menus back on.

## Running the program

The program will turn off the current softkey menu and trap the first four and eighth softkeys. When any of the first four softkeys are pressed, a softkey specific message is displayed on the screen. The eighth softkey is defined as ABORT, and will terminate the program.

---

## Example 8: CRT Graphics

The following example program illustrates how to display graphics on the instrument. Graphics can be drawn by sending HP-GL (Hewlett-Packard Graphics Language) commands to the network analyzer display.

The display address is the instrument address with the least significant bit complemented. If the instrument address is 716 then the display address will be 717. In the following program, the routine `disp_output` sends output commands to address 717.

---

### Note



This program uses the QuickC math include file and the HP-IB include file. Including both of these files causes QuickC to issue a warning that the variable `ERANGE` has been defined twice. For this example program, the warning can be disregarded.

---

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 8 */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30: #include <math.h>
40:
50: #define isc      7L
60: #define instr    716L
70: #define display  717L
80:
90: void error_handle (int, char *);
100: void disp_output (char *);
110: void output (char *);
120: void initialize (void);
130:
140:
150: void error_handle (int error, char *routine)
```

```

160: {
170:     if (error !=NOERR)
180:     {
190:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
200:         exit(1);
210:     }
220:     return;
230: }
240:
250: void disp_output (char *sendstr)
260: {
270:     error_handle (IOOUTPUTS (display,sendstr,strlen(sendstr)),
                "IOOUTPUTS");
280: }
290:
300: void output (char *sendstr)
310: {
320:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
330: }
340:
350: void initialize ()
360: {
370:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
380:     error_handle (IOABORT (isc), "IOABORT");
390:     error_handle (IOCLEAR (isc), "IOCLEAR");
400:     output ("PRES;");
410: }
420:
430: main ()
440: {
450:     int    x,y;
460:     double i=0;
470:     char   cmd[80];
480:
490:     initialize ();
500:     disp_output ("AF;CS;SP4;PU;PA 0,1500;PD;PA 5850,1500;");
510:     disp_output ("SP5;PU;PA 0,2000;PD;PA 5850,2000;");
520:     disp_output ("SP4;PU;PA 0,2500;PD;PA 5850,2500;");
530:     disp_output ("PU;SP2;PA 0,2000;");
540:     do
550:     {
560:         i=i+(3.14/10);
570:         x=i*370;
580:         y=(sin(i)*500)+2000;
590:         sprintf (cmd,"PD;PA%d,%d;",x,y);
600:         disp_output (cmd);
610:     }
620:     while (i < (3.14*5));
630:     disp_output ("SL.16,.20;SP5;PU;PA 700,1000;LBS I N E   W A V E\3;");
640:     disp_output ("SL.16,.20;SP1;PA 100,3950;LBHewlett Packard\3;");

```

**Figure 4-2. Sample Program: CRT Graphics****Program explanation**

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 30	Tell the compiler which file include information on the math functions.
Line 50	Define a variable to contain the HP-IB interface select code, 7.
Line 60	Define a variable to contain the instrument address, 716.
Line 70	Define a variable to contain the instrument display address, 717.
Line 90	Function prototype for the <code>error_handler ()</code> routine.
Line 100	Function prototype for the <code>disp_output ()</code> routine.
Line 110	Function prototype for the <code>output ()</code> routine.
Line 120	Function prototype for the <code>initialize ()</code> routine.
Line 150	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 170	Check to see if there is an error.
Line 190	An error has occurred, so display a message and halt.
Line 220	No error has occurred, so return.
Line 250	Define a routine that outputs string commands to the instrument display and performs error checking.
Line 270	Send a string to the instrument located at the value of <code>display</code> , 717. Perform error checking.
Line 300	Define a routine that outputs string commands to the instrument and performs error trapping.
Line 320	Send a string to the instrument located at the value of <code>instr</code> , 716. Perform error checking.
Line 350	Define a routine to initialize the instrument.
Line 370	Define a timeout value of 45 seconds.
Line 380	Abort any HP-IB transfers.
Line 390	Clear the instrument's HP-IB interface.
Line 400	Preset the instrument.



Line 430	Main declaration
Line 450	Define the needed variables.
Line 490	Call the initialize () routine.
Line 500	Output the following command sequence to the instrument display: erase the user graphics display, turn off measurement display, select color four, pen up, pen position 0, 1500, pen down, pen draw to 5850,1500. This prepares the graphics display, and draws a single line.
Line 510	Draw a second line using color five.
Line 520	Draw a third line using color four.
Line 530	Position the pen to begin drawing a sine wave.
Line 540	Loop to draw a sine wave.
Line 560	The variable i is the radian sine value. i is increased by 1/10th of pi. For increased resolution, this value should be increased.
Line 570	Scale the x-axis.
Line 580	Scale the y-axis.
Line 590	Prepare a string to draw 1/20th of the period of a sine wave.
Line 600	Output this string to the instrument display.
Line 620	Loop until two and half periods have been completed.
Line 630	Select character size, color five, and place label "S I N E W A V E" at position 700, 1000 on the display.
Line 640	Select character size, color one, and place label "Hewlett Packard" at position 100, 3950 on the display.

## Running the program

The program will display a sine wave along with two text labels on the instrument. The HP-GL commands can perform three basic types of functions:

- Label text,
- Change line types and colors, and
- Draw lines.

Using key trapping to take over the instrument's front panel along with HP-GL commands, a custom user interface can be easily created.

---

## Status Reporting

The network analyzer has a status reporting mechanism that gives information about specific functions and events inside the instrument. The status byte is an eight bit register with each bit summarizing one aspect of the instrument state. For example, the error queue summary bit will always be set if there are any errors in the queue. The value of the status byte can be read with the IOSPOLL statement. This command does not automatically put the instrument in remote mode, thus giving the operator access to the front panel functions. The status byte can also be read by sending the command OUTPSTAT. Reading the status byte does not affect its value.

The status byte summarizes the error queue, as mentioned before. It also summarizes two event status registers that monitor specific conditions inside the instrument. The status byte also has a bit that is set when the instrument is issuing a service request over HP-IB, and a bit that is set when network analyzer has data to send out over HP-IB. See Figure 4-4 for a definition of the status registers.

---

### Example 9A: Using the error queue

The error queue holds up to 20 instrument errors and warnings in the order that they occurred. Each time the analyzer detects an error condition, it displays a message on the CRT and puts the error in the error queue. If there are any errors in the queue, bit three of the status byte will be set. The errors can be read from the queue with the OUTPERRD command, which causes the analyzer to transmit the error number and error message of the oldest error in the queue.

```
1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 9A */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize (void);
100:
110: void error_handle (int error, char *routine)
120: {
130:     if (error !=NOERR)
140:     {
150:         printf ("HP-IB error in call to %s: %d, %s\n",
                  routine, error, errstr(error));
160:         exit(1);
170:     }
180:     return;
```

```

190: }
200:
210: void output (char *sendstr)
220: {
230:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
240: }
250:
260: void initialize ()
270: {
280:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
290:     error_handle (IOABORT (isc), "IOABORT");
300:     error_handle (IOCLEAR (isc), "IOCLEAR");
310:     output ("PRES;");
320: }
330:
340: main ()
350: {
360:     int  hpib,length,stat;
370:     char  err_data[80];
380:
390:     initialize ();
400:     top:
410:     error_handle (IOLOCAL (instr), "IOLOCAL");
420:     do
430:         error_handle (IOSPOLL (instr,&stat), "IOSPOLL");
440:     while (!(stat & 8));
450:     output ("OUTPERRO;");
460:     length=80;
470:     error_handle (IOENTERS (instr,err_data,&length), "IOENTERS");
480:     printf ("%s",err_data);
490:     goto top;
500: }

```

**Figure 4-3. Sample Program: Using the Error Queue**

### Program explanation

- |         |   |
|---------|---|
| Line 5  | Tell the compiler which file includes information on the standard I/O routines.                         |
| Line 10 | Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions. |
| Line 20 | Tell the compiler which file includes information on the HP-IB command library error constants.         |
| Line 40 | Define a variable to contain the HP-IB interface select code, 7.  |
| Line 50 | Define a variable to contain the instrument address, 716.   |
| Line 70 | Function prototype for the error_handler () routine.  |
| Line 80 | Function prototype for the output () routine.   |

Line 90                   Function prototype for the initialize () routine.

Line 110                  Define a routine that handles errors returned from the HP-IB  
command library I/O functions

Line 130                  Check to see if there is an error.

Line 150                  An error has occurred, so display a message and halt.

Line 180                  No error has occurred, so return.

Line 210                  Define a routine that outputs string commands and performs error  
trapping.

Line 230                  Send a string to the instrument located at the value of instr, 716.  
Perform error checking.

Line 260                  Define a routine to initialize the instrument.

Line 280                  Define a timeout value of 45 seconds.

Line 290                  Abort any HP-IB transfers.

Line 300                  Clear the instrument's HP-IB interface.

Line 310                  Preset the instrument.

Line 340                  Main declaration

Line 360                  Declare the needed variables.

Line 390                  Call the initialize () routine.

Line 400                  Label this point as top:.

Line 410                  Put the instrument into local mode.

Line 430                  Loop until bit three of the status is set. This is the error queue bit.

Line 450                  Request the error message.

Line 460                  Define the length of the error message to be an arbitrary number,  
80.

Line 470                  Input the error message. On return, the variable length contains the  
actual length of the message.

Line 480                  Display the error message.

Line 490                  Loop unconditionally to top:.

### Running the program

Preset the network analyzer and run the program. Nothing should happen at first. To get something to happen, press a blank softkey. The message "CAUTION: INVALID KEY" will appear followed by a second message "NO ERRORS". Hence, to clean the error queue, you can either loop until the no errors message is received, or until the bit in the status register is cleared. Note that throughout all this, the front panel is in local mode.

To break from the program loop, press <CTRL-Break>, followed by a blank softkey.

Because the error queue will keep up to 20 errors, it is important to clear out the error queue whenever errors are detected so that old errors are not associated with the current instrument

state. Not all messages displayed are put in the error queue: operator prompts and cautions are not included.

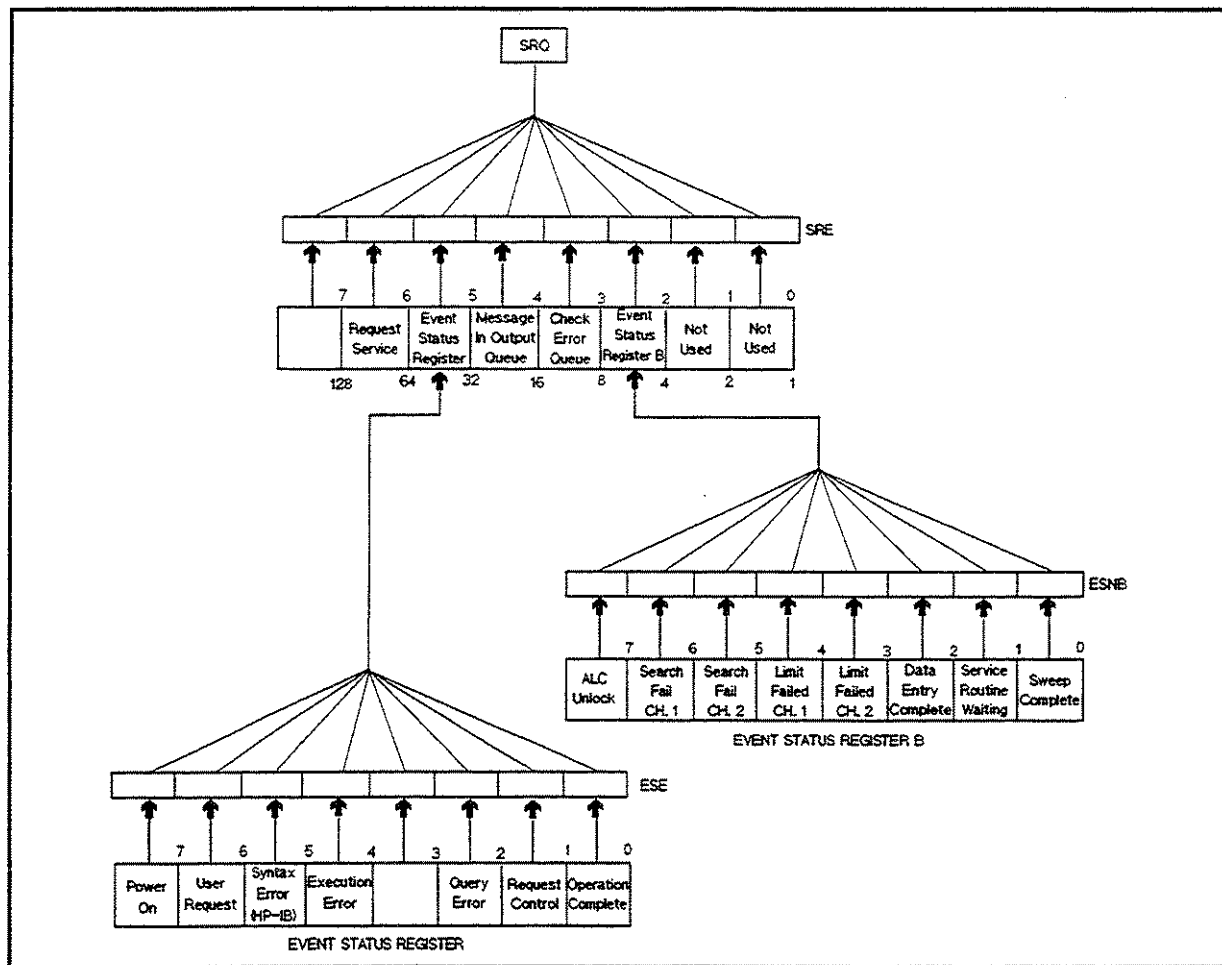


Figure 4-4. Status reporting system

### Example 9B: Using the status registers

The other two key components of the status reporting system are the event status register, and event status register B. These eight bit registers consist of latched event bits. A latched bit is set at the onset of the monitored condition, and is cleared only by a read of the register or by clearing the status registers with CLES.

This program uses the instrument command KOR? to determine a key press. The keycode encoding with KOR? is as follows. Clockwise rotations of the knob are reported as numbers from -1 to -64, -1 being a very small rotation. Counterclockwise rotations are reported as the numbers -32767 to -32703, -32767 being a very small rotation. Hence, clockwise rotations don't need any decoding at all, and counterclockwise rotations can be decoded by adding 32,768. There are approximately 120 counts per knob rotation, and the sign of the count depends on the direction the knob was turned.

```

1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 9B */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L
60:
70: void error_handle (int, char *);
80: void output (char *);
90: void initialize (void);
100:
110:
120: void error_handle (int error, char *routine)
130: {
140:     if (error !=NOERR)
150:     {
160:         printf ("HP-IB error in call to %s: %d, %s\n",
                  routine, error, errstr(error));
170:         exit(1);
180:     }
190:     return;
200: }
210:
220: void output (char *sendstr)
230: {
240:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
250: }
260:
270: void initialize ()
280: {
290:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
300:     error_handle (IOABORT (isc), "IOABORT");
310:     error_handle (IOCLEAR (isc), "IOCLEAR");
320:     output ("PRES;");
330: }
340:
350: main ()
360: {
370:     float e_stat,keycode;
380:     int  stat;
390:
400:     initialize ();
410:     top:
420:     do
430:     {
440:         output ("ESR?;");
450:         error_handle (IOENTER (instr,&e_stat), "IOENTER");
460:         stat=e_stat;
470:     }

```

```

480:   while (!(stat & 64));
490:   output ("KOR?");
500:   error_handle (IOENTER (instr,&keycode), "IOENTER");
510:   if (keycode >= 0) printf ("Key ");
520:       else if (keycode < -400.0) keycode=keycode+32768;
530:   printf ("code = %.0f\n",keycode);
540:   goto top;
550: }

```

**Figure 4-5. Sample Program: Using the Status Registers**

### Program explanation

Line 5	Tell the compiler which file includes information on the standard I/O routines.
Line 10	Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions.
Line 20	Tell the compiler which file includes information on the HP-IB command library error constants.
Line 40	Define a variable to contain the HP-IB interface select code, 7.
Line 50	Define a variable to contain the instrument address, 716.
Line 70	Function prototype for the error_handler () routine.
Line 80	Function prototype for the output () routine.
Line 90	Function prototype for the initialize () routine.
Line 120	Define a routine that handles errors returned from the HP-IB command library I/O functions
Line 140	Check to see if there is an error.
Line 160	An error has occurred, so display a message and halt.
Line 190	No error has occurred, so return.
Line 220	Define a routine that outputs string commands and performs error trapping.
Line 240	Send a string to the instrument located at the value of instr, 716. Perform error checking.
Line 270	Define a routine to initialize the instrument.
Line 290	Define a timeout value of 45 seconds.
Line 300	Abort any HP-IB transfers.
Line 310	Clear the instrument's HP-IB interface.
Line 320	Preset the instrument.
Line 350	Main declaration
Line 370	Declare the needed variables.

Line 400            Call the `initialize ()` routine.

Line 410            Label this point as `top:`.

Line 420            Loop until bit six of the event status register is set.

Line 440            Request the event status register.

Line 450            Input the event status register.

Line 460            Convert floating point integer to an integer value.

Line 490            Request the key code of the key just pressed.

Line 500            Input the key code.

Line 510            If the key code is greater than or equal to zero, then no decoding is necessary, and the key pressed is not a knob count.

Line 520            Otherwise, the key code needs decoding.

Line 530            Display the key code.

Line 540            Loop unconditionally to the position of `top:`.

### Running the program

Run the program. Pressing a front panel key causes the computer to display the keycode associated with that key. Note that since the instrument is in remote mode, the normal function of that key is not executed. In effect, we have taken over the front panel and can now re-define the keys.

To break from the program loop, press `<CTRL-Break>`.

---

## Example 10: Passing data to other application programs

The following example creates a formatted data file that can be sent to/recalled from an application-specific program.

The program performs two data transfers from the instrument. The first, using `OUTPLIML` with Form 4 (ASCII transfer format), reads out limit data to obtain the stimulus frequencies. `OUTPLIML` reads out the stimulus frequency, result, upper limit, and lower lower limit of limit data. Since stimulus frequency is only needed, the other values are discarded.

The second data transfer uses `OUTPFORM` with Form 5 (PC-compatible 32-bit floating point format) to read out magnitude data.

```

1:  /* HP 8719C, 8720C, 8722A/C QuickC IPG Program 10 */
2:
5:  #include <stdio.h>
10: #include <cfunc.h>
20: #include <chpib.h>
30:
40: #define isc      7L
50: #define instr    716L

```



```

60:
70: void error_handle (int, char *);
80: void output (char *);
90: void pad (int);
100:
110: void error_handle (int error, char *routine)
120: {
130:     if (error !=NOERR)
140:     {
150:         printf ("HP-IB error in call to %s: %d, %s\n",
                routine, error, errstr(error));
160:         exit(1);
170:     }
180:     return;
190: }
200:
210: void output (char *sendstr)
220: {
230:     error_handle (IOOUTPUTS (instr,sendstr,strlen(sendstr)), "IOOUTPUTS");
240: }
250:
260: void pad (int pad_num)
270: {
280:     char pad[40];
290:
300:     error_handle (IOENTERS (instr,pad,&pad_num), "IOENTERS");
310: }
320:
330: main ()
340: {
350:     char ascii_dat[15],filename[10],header[2],reply;
360:     int bytes,elements,i,one=1;
370:     float data,points,seek_len;
380:     FILE *f_ptr;
390:
400:     error_handle (IOTIMEOUT (isc,45.0), "IOTIMEOUT");
410:     error_handle (IOABORT (isc), "IOABORT");
420:     error_handle (IOCLEAR (isc), "IOCLEAR");
430:     error_handle (IOMATCH (isc,'\n',0), "IOMATCH");
440:     output ("OPC?;SING;");
450:     error_handle (IOENTERS (instr,&reply,&one), "IOENTERS");
460:     output ("POIN?;");
470:     error_handle (IOENTER (instr,&points), "IOENTER");
480:     printf ("Save under what DOS file name? ");
490:     gets (filename);
500:     f_ptr=fopen (filename,"w+");
510:     if (f_ptr != NULL)
520:     {
530:         printf ("\n\nSaving ... ");
540:         output ("FORM4;OUTPLIML;");
550:         elements=15;

```

```

560:     for (i=0; i<points; i++)
570:     {
580:         pad(2);
590:         error_handle (IOENTERS (instr,ascii_dat,&elements), "IOENTERS");
600:         pad(38);
610:         fprintf (f_ptr,"%s,                \n",ascii_dat);
620:     }
630:     fseek (f_ptr,17L,SEEK_SET);
640:     output ("FORM5;OUTPFFORM;");
650:     elements=2;
660:     error_handle (IOENTERS (instr,header,&elements), "IOENTERS");
670:     error_handle (IOENTERB (instr,&bytes,&elements,1), "IOENTERB");
680:     elements=4;
690:     for (i=0; i<points; i++)
700:     {
710:         error_handle (IOENTERB (instr,&data,&elements,1), "IOENTERB");
720:         fprintf (f_ptr,"%f",data);
730:         error_handle (IOENTERB (instr,&data,&elements,1), "IOENTERB");
740:         fprintf (f_ptr,"%f",data);
750:         seek_len=i+1;
760:         seek_len=(seek_len*48)+17;
770:         fseek(f_ptr,seek_len,SEEK_SET);
780:     }
790:     fclose (f_ptr);
800:     printf ("done!\n");
810: }
820:     else printf ("Could not open file\n");
830: }

```

Figure 4-6. Sample Program: Passing Data to Other Application Programs

### Program explanation

- |          |   |
|----------|---|
| Line 5   | Tell the compiler which file includes information on the standard I/O routines.                         |
| Line 10  | Tell the compiler which file includes information on the HP 82335A HP-IB command library I/O functions. |
| Line 20  | Tell the compiler which file includes information on the HP-IB command library error constants.         |
| Line 40  | Define a variable to contain the HP-IB interface select code, 7.  |
| Line 50  | Define a variable to contain the instrument address, 716.   |
| Line 70  | Function prototype for the error_handler () routine.  |
| Line 80  | Function prototype for the output () routine.   |
| Line 90  | Function prototype for the pad () routine.  |
| Line 110 | Define a routine that handles errors returned from the HP-IB command library I/O functions              |

Line 130            Check to see if there is an error.

Line 150            An error has occurred, so display a message and halt.

Line 180            No error has occurred, so return.

Line 210            Define a routine that outputs string commands and performs error trapping.

Line 230            Send a string to the instrument located at the value of instr, 716. Perform error checking.

Line 260            Define a routine that reads a specified number of bytes from the instrument located at the value of instr, 716. The passed variable pad\_num determines the number of bytes to read and discard.

Line 330            Main declaration

Line 350            Declare the needed variables.

Line 400            Define a timeout value of 45 seconds.

Line 410            Abort any HP-IB transfers.

Line 420            Clear the instrument's HP-IB interface.

Line 430            Disable character matching. This command defines the character used by IOENTERB and IOENTERS for termination. The "lf" enter terminator should be turned off because "lf" is a valid binary value.

Line 440            Perform a single trace.

Line 450            Determine when the trace has been completed.

Line 460            Ask for the number of points sampled.

Line 470            Input the number of points sampled.

Line 480            Determine the filename to save the formatted data.

Line 500            Open the filename.

Line 510            If there are no errors in opening the file, continue, otherwise go to line 820.

Line 530            Displaying the "Saving ... " message.

Line 540            Ask for the results of a limit test in Form 4.

Line 550            Define a variable, elements, to contain the length of the sent data values.

Line 560            Loop and read the data.

Line 580            Disregard the first two characters.

Line 590            Input the stimulus value.

Line 600            Disregard the next 38 characters, which contain the results of a limit test, and the upper and lower limits of limit data.

Line 610            Output the stimulus values to a file.

Line 630            Prepare to write to the file the second and third columns, the first and second data values. Specifically, offset seventeen characters from the beginning of the file.

Line 640            Ask for the trace data in Form 5.

Line 650            Define the variable, `elements`, to contain the length of the header and number of bytes in the data block to follow.

Line 660            Input the header.

Line 670            Input the number of bytes in the data block to follow.

Line 680            Define the length of each point. Since each point is sent as a 32-bit floating point integer, the length of each point is four bytes long.

Line 690            Loop and read the data.

Line 710            Input the first value.

Line 720            Output the first value to the second column in the file.

Line 730            Input the second value.

Line 740            Output the second value to the third column in the file.

Line 750            The variable `seek_len` contains the offset from the beginning of the file to the placement of the second column.

Line 770            Position the file pointer to the next line of the second column.

Line 790            Close the file.

Line 800            Display "done!".

Line 820            If the file could not be opened, display an appropriate message.

### Running the program

Set up the instrument with a DUT connected. Run the program. The program will ask for a filename to save data. Note that if this filename exists, it will be erased with no warning.

The stored data is formatted in three columns separated by commas. The first column is the stimulus frequency, the second column is the first value, and the third column is the second value. Refer to Table 2-1 for the units on value one and value two with respect to the display format.

Note that since the program does not store data in arrays, but rather in a file, it is not limited to the amount of memory available to it. Thus it is not limited to the number of points sampled.