CHAPTER 5
HP-IB REMOTE OPERATION

This chapter provides information about remote operation of the HP 853A Spectrum Analyzer Display (with a compatible spectrum analyzer plug-in) using an HP-IB[1] controller.

General Description

The HP 853A Spectrum Analyzer Display can be accessed for remote operation through HP-IB. The HP-IB connector and address switch are on the instrument rear panel. Interconnection between the HP 853A and the HP-IB controller is accomplished with an appropriate HP-IB interface, and may require an additional HP-IB interconnection cable (often supplied as an integral part of the HP-IB interface).

Communication between instruments on the HP-IB requires that a unique address be assigned to each instrument. The rear-panel address switch (Figure 40) is used to set the HP-IB address of the HP 853A.

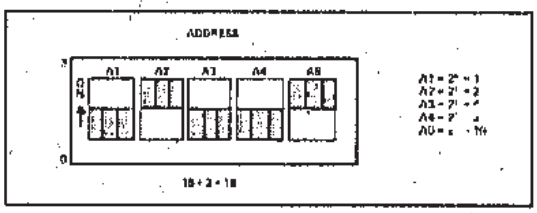


Figure 40. HP-IB Address Switch

HP-IB Capability

The complete bus capability of the HP 853A, as defined in IEEE STD 488 (or identical ANSI Standard MC1.1), is outlined in Table 4. Instrument responses to general bus commands and control signals are described in detail to aid in programming.

Specific HP-IB programming codes for the HP 853A are given in the syntax reference guide at the end of this chapter, and are summarized in Table 5. Sample programs written on an HP 85 controller, in the BASIC programming language, are presented in Appendix B to demonstrate the use of these programming codes.

[1]Hewlett-Packard Interface Bus, the Hewlett-Packard implementation of IEEE STD 488-1978 and ANSI STD, MC 1.1, 'Digital Interface for Programmable Instrumentation.'

Digital Display Coordinates

Trace data is stored in the trace memory of the HP 853A using the digital display coordinates shown in Figure 41. In references to the display coordinates for programming codes AP/BP, BA/BB, XY, TA/TB, IA/IB, and JA/JB, the coordinates in Figure 41 apply.

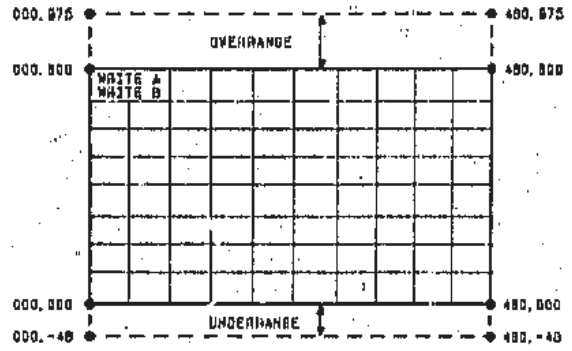


Figure 41. HP 853A Digital Display Coordinates

Within the range of the CRT graticule, there are a total of 481 x-axis values (0 to 480, with 48 points per division) and 801 y-axis values (0 to 800, with 100 points per division). The y-axis overrange values and underrange values are also noted in the figure.

Two lines of annotation near the top of the trace area of the CRT display are controlled by the programming codes CS, LL/LU, LP, and RU/RL.

Syntax Reference Guide

This Syntax Reference Guide is intended to provide, in detail, the required command format to be used when addressing the HP 853A from an external HP-IB controller, and to describe precisely the resulting HP-IB output. It is important to keep in mind that this guide is written from a controller point of view, as user-generated programs will always be executed in the controller, not in the spectrum analyzer display.

A pictorial flow representation is used to delineate the sequence of bytes or blocks of traffic across the bus. Literal ASCII characters are bold and shown in rounded envelopes. These are transmitted exactly as shown. Items

enclosed by rectangular boxes are blocks of bus traffic which require further explanation. Those used repeatedly are:

Output UNL TA21 LA18: UNListen, Talk Address 21, Listen Address 18[2] (ASCII code: ? U2)

Enter UNL LA21 TA18: UNListen, Listen Address 21, Talk Address 18[2] (ASCII code: ?5R)

Additional Commands Additional programming codes (two letter mnemonics) may follow within the same "Output" statement

Note that data bytes passed along the bus originate from the controller (controller is talker) until an "Enter" block is transmitted, at which time the spectrum analyzer display generates any succeeding data (display is talker).

In several cases, two programming codes are used in an identical fashion and are listed together. Each pair performs the same function either on Trace A or Trace B, or on the lower or upper CRT annotation line. Usage of only the first code listed is described; the second code may simply be substituted in its place.

A reference to a "digit" should be understood to refer to the ASCII code for one of the characters 1, 2, 3, 4, 5, 6, 7, 8, 9 or 0.

The HP 853A ignores extra delimiters such as CR (carriage return) and LF (line feed) in a command sequence

[2] Assumes controller address = 21, HP 853A address = 18.

Table 4. HP 853A Responses to General HP-IB Bus Commands

HP-IB Message	Related Mnemonics	Response
Data Trigger	GET	Issues a sweep trigger pulse (for proper use, spectrum analyzer should be in SINGLE SWEEP mode).
Clear	DCL, SDC	Interrupts a sweep in progress. Terminates unfinished commands. Clears any service requests. Resets trace arithmetic reference line to default position (refer to OF command). Resets annotation position to top-screen (refer to LP command). Resets digital averaging algorithm. Resets sweep.
Remote	REN	Enables remote programming of front panel controls.
Local	$\overline{\text{REN}}$, GTL	Front panel controls are not remotely programmable.
Local Lockout	LLO	Locks out local button on front panel (PLOT GRAT/ HP-IB CLEAR).
Require Service	RQS	Instrument may request service (refer to RS command).
Status Byte	SPE, SPD	Serial poll (instrument transmits status byte).
Abort	IFC	Unaddresses instrument.
Response Byte	PPC, PPU	Parallel poll (no response).

The interface functions supported by the HP 853A Spectrum Analyzer Display are: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0, E2 (as defined in IEEE STD 488-1978 and identical ANSI STD MC1.1).

sent from a controller. However, when the HP 853A is instructed to put out a sequence of data bytes, the complete sequence must be read by the controller before normal operation can be resumed. With the exception of binary trace data transfers (BA and BB), data byte sequences are terminated by transmitting the ASCII characters CR and LF with the End message (EOI bus line pulled "true"). Binary trace data sequences include no terminating CR LF, but the End message is sent during transmission of the final byte of the sequence (the final byte is the 962nd byte for BA and BB).

Pressing RESET on HP-IB controllers generates an interface clear (IFC) command on the bus, which unaddresses the HP 853A.

When an illegal two-character mnemonic is received by the HP 853A (one that is not included in the programming code set), bit 5 of the status byte is set and a SYNTAX ERR (error) message is displayed on the upper CRT annotation line. To remove the message, press HP-IB CLEAR (PLOT GRAT) for several seconds, or execute a Clear command over HP-IB.

Table 5. Summary of HP 853A Programming Codes

Mnemonic	Definition	Mnemonic	Definition
TA	Output trace A, decimal (ASCII) values	JA	Input trace A, binary values
TB	Output trace B, decimal (ASCII) values	JB	Input trace B, binary values
BA	Output trace A, binary values		
BB	Output trace B, binary values	CA	Clear (blank) trace A
		CB	Clear (blank) trace B
AP	Output peak coordinates, trace A		
BP	Output peak coordinates, trace B	TS, TSn	Take sweep (n=0–63)
XY	Output coordinates, current point in sweep	RSb	Set Request Service conditions (b=mask)
		OI	Output Device Identification
LU	Input upper CRT annotation line	OFn	Set INPUT–B→A offset (n=0–975)
LL	Input lower CRT annotation line	FP	Output front panel control settings
LPn	Set annotation line position (n=0–8)		
RU	Restore upper CRT annotation line		REMOTE OPERATION (REN enabled)
RL	Restore lower CRT annotation line		
CS	Output character string (CRT annotation lines)	ACn	Set TRACE A control (n=1–4)
		BCn	Set TRACE B control (n=1–4)
		DCn	Set DIGITAL AVERAGE control (n=0–1)
IA	Input trace A, decimal (ASCII) values		
IB	Input trace B, decimal (ASCII) values	ICn	Set INPUT–B→A control (n=0–1)

TA,TB Output trace A, output trace B, decimal (ASCII) values

Trace Out: Sequential y-coordinates (−50 to 975) for trace A or trace B. Format is 481 three-digit coordinates (including leading zeros and minus signs) separated by commas for a total of 1923 ASCII characters. The value −50 indicates a blanked trace.

Example:

	#1	#2	#3		#480	#481
ASCII Sequence	001,	−04,	012,	...	975,	100

BA,BB Output trace A, output trace B, binary values

Trace Out: Sequential y-coordinates (−50 to 975, in two's complement binary form) for trace A or trace B. Format is 481 two-byte coordinates for a total of 962 bytes. The value −50 indicates a blanked trace.

Example:

	#1	#2	#3	#480	#481
Byte sequence	ab	ab	ab	ab	ab

where a and b are 8-bit bytes. To represent the y-coordinate 820, the pair of 8-bit bytes would be

a = 00000011
b = 00110100

AP,BP Output peak coordinates of trace A, trace B

x,y: x,y coordinates (000 to 480, −48 to 975) of single maximum trace peak. Format is two 3-digit coordinates separated by a comma (7 ASCII characters).

Example:

	x	y
ASCII sequence	240,	800

If the peak y-value occurs for two or more values of x, the leftmost point (lowest x-value) is returned.

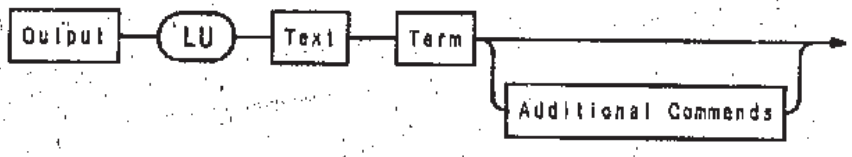
XY Output coordinates, current point in sweep

x,y: x,y coordinates (000 to 480, −48 to 975) of current point in sweep. Format is two 3-digit coordinates separated by a comma (7 ASCII characters).

Example:

	x	y
ASCII sequence	240,	800

LU,LL Input upper, lower CRT annotation line



Text: Up to 60 ASCII characters to appear on upper annotation line (LU) or lower annotation line (LL) on CRT.

Term: An ASCII terminating character ETX, LF, CR, or any byte in the range 0 to 31 decimal.

853A Display Character Set

32*-63	!"#$%&'()*+,-./0123456789:;<=>?
64-95	@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
96-127	`abcdefghijklmnopqrstuvwxyz{|}~

*Character 32 is a blank

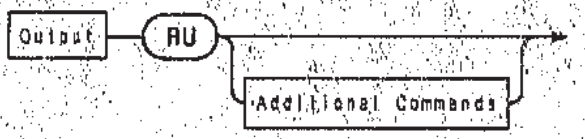
LPn Set annotation line position (n = 0 – 8)

n: For n = 1 to 8, positions both lines of CRT annotation in the nth division from the bottom CRT horizontal graticule line.

For n = 0, all CRT annotation is blanked.

Default value is n = 8.

RU,RL Restore upper, lower CRT annotation line



Returns CRT annotation to control labeling mode (clears annotation line sent using LU or LL code).

CS Output character string (CRT annotation lines)

Upper, Lower Line: Two 60-character ASCII strings corresponding to the characters displayed in the upper and lower CRT annotation lines. Each 60-character line is followed by an ETX.

IA,IB Input trace A, trace B, decimal (ASCII) values

Trace In: Sequential y-coordinates (–99 to 975) for trace A or trace B. Values less than –48 are blanked. Format is up to 481 one- to three-digit coordinates (including leading zeros and minus signs), each separated by a comma, space, CR, LF, or combination of these delimiters.

Term: Sequences with less than 481 coordinates must be terminated with a semicolon or additional two-letter programming code. Sequences with 481 coordinates must be terminated by a delimiter (comma, space, CR, LF, or combination) or by an additional two-letter programming code.

Example:

	#1	#2	#3	#4	#5	
ASCII sequence	0,	–4,	800,	–50,	0;	(5 coordinates)

Example:

	#1	#2	#3	#4	#5	
ASCII sequence	0 CR	–4 CR	800 CR	–50 CR	0 TS	(5 coordinates followed by Take Sweep code)

Example:

	#1	#2	#3		#480	#481	
ASCII sequence	–5	100	375	...	100	–5 CR LF	(ASCII spaces between coordinates)

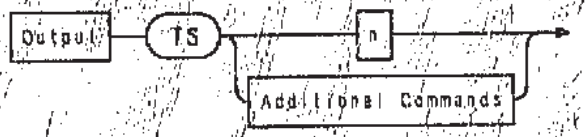
JA,JB Input trace A, trace B, binary values

Trace In: Sequential y-coordinates (−99 to 975, in two's complement binary form) for trace A or trace B. Values less than −48 are blanked. Format is 481 two-byte coordinates for a total of 962 bytes. Refer to **BA,BB** codes.

CA,CB Clear (blank) trace A, trace B

Blanks trace (all y-coordinates set to −50)

TS,TSn Take sweep (n = 0/− 63)

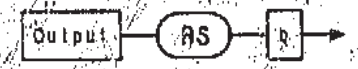


Triggers the spectrum analyzer to sweep and inhibits subsequent commands until sweeping is complete.

n: Specifies number of sweeps to be taken. If n is not specified, one sweep is executed.

During execution of the **TS** and **TSn** commands, the first five bits of the status register define a binary value indicating the total number of full and partial sweeps remaining. The status register may be accessed by a serial poll from the controller, and bit 6 will be low.

RSb Set Request Service conditions (b = mask)



Sets the instrument conditions that will trigger a service request. When one of these conditions occurs, the SRQ line is pulled and two bits of the status register are set – bit 6 and the appropriate bit for the particular service request condition. A serial poll from the controller resets the status register and SRQ line.

b: a one-byte mask for setting service request conditions (SRQ line pulled only by selected conditions). Mask value is set to 0 at power-on.

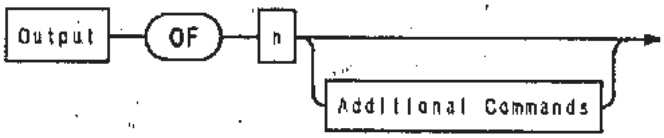
Status Register Bit	Description of Service Condition	Mask Value (Decimal)
0	End of Sweep	1
1	Not used	(2)
2	Fast Sweep Error	4
3	INPUT–B→A Error	8
4	Digital Average/MAX HOLD Error	16
5	Syntax Error	32
6	Universal HP-IB Service Request Bit (set when service condition exists)	(64)
7	Not used	(128)

For example, a mask value of 61 (1 + 4 + 8 + 16 + 32) enables all possible service request conditions. The mask must be sent as the binary byte 00111101.

OI Output Device Identification

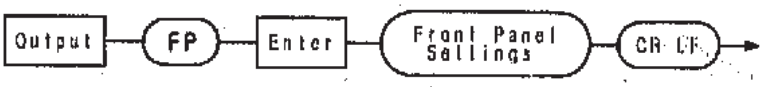
Instrument returns a three-character string, "853", for identification.

OFn Set INPUT – B→A offset (n = 0 – 975)



n: Sets x-coordinate of reference trace during trace arithmetic. Value is initially set to 400 (mid-screen) or 800 (top graticule line) by position of jumper internal to instrument.

FP Output front panel control settings

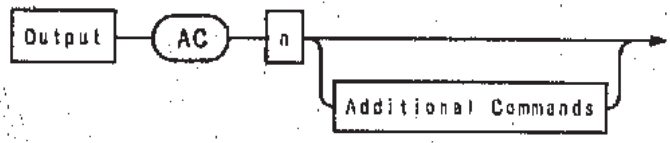


Front Panel Settings: A 12-character string representing current display control settings. Format is twelve ASCII bytes in the form of control setting codes: **"ACmBCmDCnlCn"**

where m = 1–4
n = 0,1

REMOTE OPERATION (REN required)

ACn,BCn Set TRACE A, TRACE B control (n = 1 – 4)



Remotely control trace functions.

n: n = 1 CLEAR WRITE
n = 2 MAX HOLD
n = 3 STORE VIEW
n = 4 STORE BLANK

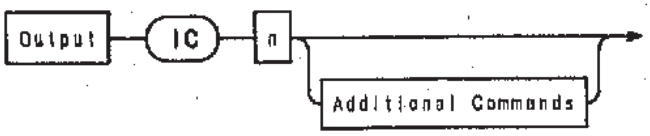
Remote operation is denoted by a "■" appearing next to display function callouts, just to left of graticule.

DCn Set Digital Average control (n = 0,1)

Remotely control digital averaging.

n: n = 0 Turn OFF
n = 1 Turn ON

ICn Set INPUT – B→A control (n = 0,1)



Remotely control trace normalization.

n: n = 0 Turn OFF
n = 1 Turn ON

APPENDIX A
AMPLITUDE CONVERSIONS

CONVERSION EQUATIONS

The following equations allow conversion from dBm to dBmV or dBV in a 50Ω system.

dBm + 107 dB = dBμV

dBm + 47 dB = dBmV

dBmV + 60 dB = dBV

If it is desired to convert from logarithmic units to linear units, then the equations given below will be useful. Keep in mind that the logarithmic levels are all referenced to linear units.

That is:

0 dBm referenced to 1 mW
0 dBmV referenced to 1 mV
0 dBμV referenced to 1 μV

To calculate a linear level, simply take the antilog of the logarithmic level.

dBm to P(mW)

$$dBm = 10 \log \frac{P}{1\ mW},\ P = \log^{-1} \frac{dBm}{10}$$

dBmV to V(mV)

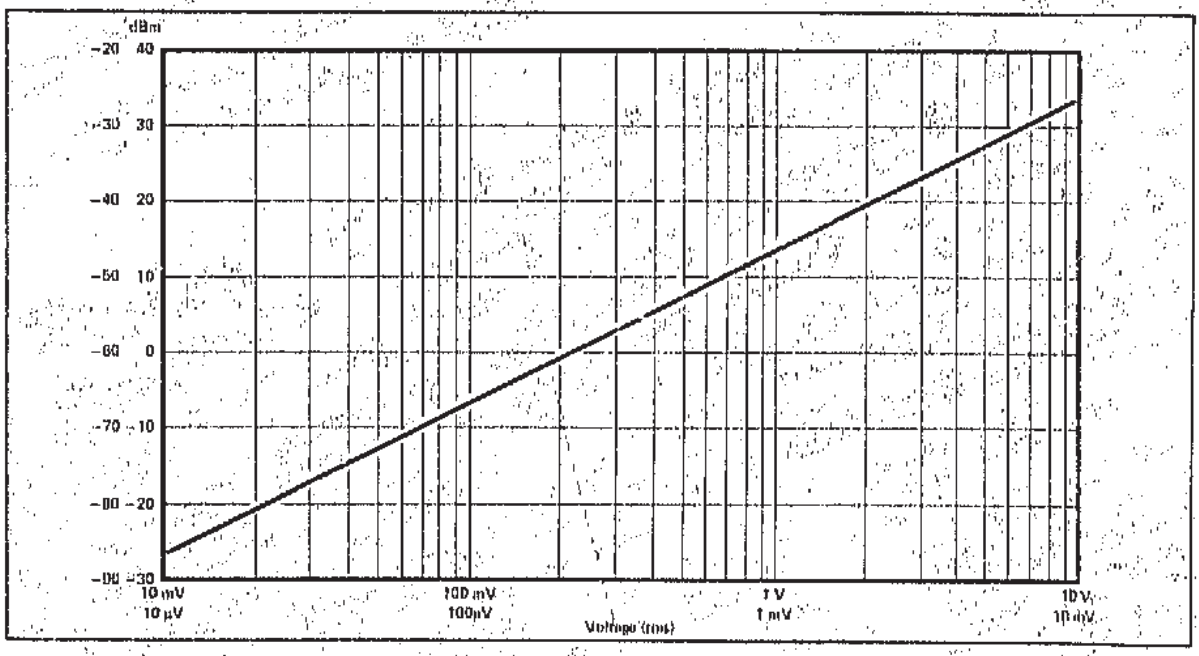
$$dBmV = 20 \log \frac{V}{1\ mV},\ V = \log^{-1} \frac{dBmV}{20}$$

dBμV to V(μV)

$$dB\mu V = 20 \log \frac{V}{1\ \mu V},\ V = \log^{-1} \frac{dB\mu V}{20}$$

Figure A-1 can be used to convert from dBm to voltage in a 50Ω system.

Conversion from dBm to volts can be made whether the Amplitude Scale is in LOG or LIN. To read voltage, position the signal on the reference level line of the CRT. Read the REFERENCE LEVEL in dBm and find its equivalent voltage from the conversion chart.



Conversion Chart, dBm to Voltage (for 50 Ohms)

APPENDIX B
PROGRAMMING EXAMPLES FOR THE HP 853A

The following examples illustrate some of the ways the entire command set of the HP 853A may be used when operated with the HP-85 BASIC language controller. It is assumed that the user has a prior knowledge of controller operation and the BASIC programming language.

The programming codes and examples are divided into four functional categories: Labeling, Trace Data I/O, Sweep Control and Instrument Status, and Display Remote Operation.

A user new to the system should first work through the examples to become familiar with the various programming codes, and then refer back to this Operation manual as needed when developing programs (refer to Chapter 5 for a detailed HP-IB syntax reference guide for the HP 853A).

The following programs assume the selectable interface address is 7 and the HP 853A HP-IB address is set to 18 (see Chapter 5).

If an illegal two-letter mnemonic is sent to the HP 853A (i.e., one that is not included in the programming code set), the message SYNTAX ERR will appear on the CRT. To remove the SYNTAX ERR message, send the command CLEAR or press HP-IB CLEAR (PLOT GRAT) on the HP 853A front panel for several seconds. Clearing the HP 853A status register also removes the message; refer to the **RS** programming code in Chapter 5 for details.

Labeling

LU,LL Input upper, lower CRT annotation line

The **LU** or **LL** programming code allows the transfer of up to 60 characters selected from the ASCII character set (see **LU,LL** codes in Chapter 5) to each of the two CRT display lines. To demonstrate the use of both display lines with the alphanumeric character set, run the following program:

```
10 OUTPUT 718 ;"LUTHE 853A CAN
   ANNOTATE 60 TOTAL SPACES WIT
   HIN EACH DISPLAY BUFFER"
20 OUTPUT 718 ;"LL0123456789 a
   quick brown fox jumped over
   the lazy dog's back"
```

The controller executes an OUTPUT statement to transfer the character string in a free-field format. To prevent unnecessary bus traffic, compact field formatting transfers no leading or trailing spaces:

```
10 OUTPUT 718 USING "K" ; "LU N
   o extra spaces!"
```

RU,RL Restore upper, lower CRT annotation line

To restore the upper and lower lines of annotation to the power-on condition, use the following commands:

```
10 OUTPUT 718 ;"RU"
20 OUTPUT 718 ;"RL"
```

or

```
10 OUTPUT 718 ;"RU RL"
```

LPn Set annotation line position (n = 0 to 8)

This programming code is provided to change the position of the annotation lines relative to the CRT graticule lines (the bottom graticule line is designated n = 1). It helps ensure that labels do not interfere with a displayed signal. An example program demonstrates the use of the LP code:

```
10 OUTPUT 718 ;"LU THIS IS A TE
   ST!"
20 OUTPUT 718 ;"LP3"
30 OUTPUT 718 ;"LP7"
40 OUTPUT 718 ;"RU RL"
```

The labels can be moved from the turn-on position, n = 8, to other vertical levels, but will be blanked when they interfere with the trace.

CS Output character string (upper, lower CRT annotation lines)

All display annotation can be transferred to a 122-character string, dimensioned in the controller and then printed:

```
10 DIM C$[122]
20 OUTPUT 718 ;"CS"
30 ENTER 718 ; C$
40 PRINT C$
```

The array in line 10 is dimensioned to store the character strings from both annotation lines. A "CS" programming code calls for the transfer of display characters into the string array. Statement 40 results in a display of the character string on the controller. The ASCII controller code for specifying end-of-text (ETX) is included in the character string, accounting for the two extra characters dimensioned.

Trace Data I/O

TA,TB Output trace decimal (ASCII) values
BA,BB Output trace binary values

Speed, storage requirements, and programming convenience govern the choice of trace data output techniques, i.e., the optimum use of the commands **TA,TB** and **BA,BB**. Three different methods follow:

Method I (ASCII decimal data transfer into integer array)

Method I provides fast transfer of all 481 trace values from the HP 853A to a numeric array dimensioned in the controller (≈1.75 sec). After reformatting, the trace data can be processed by the controller. The array storage requirement is 3366 bytes (3 x 481 + 1923 = 3366) of controller memory. The following example includes the transfer of trace data to the controller and reformatting into an integer array:

```
10 DIM A$[1923]
20 INTEGER B(480)
30 OUTPUT 718 ;"TA"
40 ENTER 718 ; A$
50 FOR I=0 TO 480
60 J=4*I+1
70 B(I)=VAL(A$[J,J+2])
80 NEXT I
```

String array A$ is assigned a length of 1923 characters; the numeric array B is dimensioned as a 481-value INTEGER array to save storage space (3 bytes/value vs. 8 bytes/value). The TA instruction is sent and the string A$ is transferred in lines 30 – 40. This string now must be converted to a numeric array of 481 values, accomplished in the For..... .NEXT loop set up in lines 50 – 80.

Method II (Direct ASCII decimal transfer and storage)

Method II is convenient for temporary storage of trace values when no data processing is required. The following example shows the use of the **IA** programming code (which inputs ASCII decimal trace values) to return a stored trace to the HP 853A:

```
10 DIM A$[1923]
20 OUTPUT 718 ;"TA"
30 ENTER 718 ; A$
40 PAUSE
50 OUTPUT 718 ;"IA",A$
```

Method II is convenient because it requires less array storage (1923 bytes), but the data is in string form (conversion is necessary before numerical calculations can be made). The trace transfer time is approximately 1.28 seconds for **TA** and approximately 0.70 second for **IA** (refer to **IA,IB** for further details).

Method III (Fast trace transfer for storage)

When the fastest possible transfer of trace values is required, Method III is the best choice. This method transfers trace values in binary form as quickly as possible for later conversion to a numeric array.

```
10 DIM A$[970]
20 IOBUFFER A$
30 OUTPUT 718 ;"BA"
40 TRANSFER 718 TO A$ FHS
```

A$ is dimensioned 8 bytes more than transferred (i.e., 2 bytes/value x 481 + 8 bytes = 970 bytes). The IO BUFFER statement designates A$ to have a working length of 962 when executed. The **BA** programming code is sent in line 30 to call for a transfer of byte values, and line 40 provides for a fast hand-shake (FHS) TRANSFER. The time required to transfer a full trace is approximately 155 msec.

When it is necessary to convert A$ into numeric data, the following code can be used:

```
50 INTEGER B(480)
60 FOR I=0 TO 480
70 J=2*I+1
80 B(I)=256*NUM(A$[J])+NUM(A$[J
   +1])
90 NEXT I
```

Two 8-bit bytes are required to specify the full range, −48 to 975, of the digital CRT display: the first byte carries the two most significant bits, and the second byte carries the eight least significant bits. To combine each pair of bytes from A$ into a single numeric value, it is necessary to convert both string values to numeric values, multiply the first by $2^8 = 256$, and add it to the second. Note that this program works only for positive trace values; for underrange values, test for 2's complement and make the appropriate conversion.

IA,IB Input trace integer values

These commands allow the controller to output up to 481 integer trace values into trace A or trace B. Values in the range −48 to 975 are displayed at corresponding levels on the CRT; values less than −48 are blanked. **IA** and **IB** are useful for re-entering trace data that has been previously stored using the **TA** or **TB** programming codes (see Method II), or for transferring a controller-generated "trace" (such as a test limit line stored in trace B).

Place the HP 853A display in the CLEAR WRITE A and STORE VIEW B modes, then run the following example:

```
10 OUTPUT 718 ;"IB"
20 FOR I=0 TO 60
30 OUTPUT 718 ;300,300,300,300,
   -50,-50,-50,-50
40 NEXT I
```

The programming code **IB** in line 10 instructs the HP 853A to receive a numeric string of values for trace B. Lines 20–40 set up a sequence of display values for transfer (the value −50 blanks the trace). When the data transfer is complete, the result is a dashed limit line viewed in trace B.

JA,JB Input trace binary values

Data transfer over the interface bus can be performed more rapidly by using the **JA** or **JB** programming codes rather than **IA** or **IB**. The following example shows how these programming codes can be used to compare a stored trace with a current trace:

```
10 DIM A$[970]
20 IOBUFFER A$
30 OUTPUT 718 ;"BA"
40 TRANSFER 718 TO A$ FHS
50 DISP LEN(A$)
•
•
•
90 OUTPUT 718 USING "K,B" ; "JA
   "
100 TRANSFER A$ TO 718 FHS
```

Lines 10 – 50 transfer the 481 two-byte binary values from trace A to the string array A$, with a fast handshake, and then display the length of A$.

In Line 90, the USING "K,B" format is sent with the **JA** programming code to output a string of byte values, with no end-of-line sequence (CR or LF), to the HP 853A. Line 100 causes a fast TRANSFER of data from string A$.

AP,BP Output peak coordinates
XY Output coordinates of current point in sweep

It often happens that the only data point required is the peak value of the 481-point CRT trace. To obtain the x- and y-axis coordinates (0 to 480, 0 to 975) of the maximum response, use the **AP** or **BP** programming code for trace A or trace B respectively. If there is more than one response at the peak level (i.e., two identical values in different "X" locations), then the left-most "X" will be returned after you enter the code:

```
10 OUTPUT 718 ;"AP"
20 ENTER 718 ; X,Y
30 DISP X,Y
```

The x,y coordinates of the current point in a manual sweep can be transferred using the **XY** programming code, allowing the controller to monitor display data while in the manual sweep mode.

```
10 OUTPUT 718 ;"XY"
20 ENTER 718 ; X,Y
30 DISP X,Y
```

Sweep Control and Instrument Status

TS,TSn Take n sweeps (n = 0 to 63)

The **TS** programming code allows the triggering of spectrum analyzer sweeps from a controller. This capability can be used to initiate sweeps when the analyzer is in either the single or continuous sweep mode.

NOTE

It is important to have an updated trace before transferring data.

When sent to the HP 853A, the **TS** programming code triggers a sweep and inhibits subsequent commands until that sweep is complete. Upon completion of the sweep, the system resumes normal operation. Consider the following example:

```
10 OUTPUT 718 USING "#,K" ; "TS
   "
20 BEEP
30 OUTPUT 718 ;"LU No display u
   ntil end-of-sweep."
40 PAUSE
50 OUTPUT 718 ;"RU"
60 OUTPUT 718 ;"TS20"
```

After putting the spectrum analyzer plug-in in single sweep mode, set the sweep time to 0.5 sec/DIV and run this program. Receipt of the **TS** code initiates a sweep, at which time a tone is generated by line 20, indicating that the controller is free to proceed, but the HP 853A is not. The message on line 30 will be displayed on the HP 853A CRT only after the end-of-sweep.

If the USING "#,K" were to be omitted in line 10, the controller would attempt to transmit the usual terminating CR and LF after the ASCII characters TS. These cannot be accepted until the spectrum analyzer has completed its sweep, so line 20 (representing all other controller and non-HP 853A bus activity) would effectively be held up until the end-of-sweep occurs. The USING "#,K" format with the **TS** code allows other bus activity during the sweep.

After the program PAUSE, return the SWEEP TIME/DIV to AUTO and then press CONTINUE on the controller. Line 50 restores the upper display line to normal mode. The "**TS20**" programming code, in line 60, triggers a set of 20 sweeps and holds up bus activity until the set of sweeps is complete.

RSb Set request service conditions (b = mask)

A serial poll may be performed to check the contents of the HP 853A status register, which indicates certain conditions in the instrument (refer to the HP-IB syntax reference guide in Chapter 5). Any combination of conditions can be enabled by sending a request service mask over the bus to the HP 853A (conditions not selected will not pull the SRQ line). For example, to enable all available request service conditions, the mask must be the binary equivalent of the decimal sum of each component, or 61 (1 + 4 + 8 + 16 + 32 = 61). Sending a mask replaces any previous mask enabled in the HP 853A. The mask is set to a default value of 0 at power-on.

The following example program demonstrates the use of the **RS** code along with a series of illegal conditions which, until corrected, will generate SRQ messages and set appropriate bits in the HP 853A status register:

```
10 OUTPUT 718 USING "K,B" ; "RS
   ",61
20 OUTPUT 718 ;"YZ"
30 OUTPUT 718 ;"AC2DC1"
40 S=SPOLL(718)
50 DISP S
60 PAUSE
70 OUTPUT 718 ;"AC1DC1"
80 IF S<>0 THEN GOTO 40
90 LOCAL 718
```

In line 10, the mask value is set to 61, thus enabling all request service conditions. The USING "K,B" format outputs the mask value as one 8-bit byte to the HP 853A. With the mask set, the illegal mnemonic **YZ** sent in line 20 causes the SYNTAX ERR(OR) message to appear on the HP 853A CRT until a serial poll is performed (this error condition has a decimal mask value of 32).

The display state selected in line 30 (refer to **ACn, BCn, DCn** commands) causes an additional request service condition (the decimal value 16 represents this Digital Average/MAX HOLD error state). Note the HP 853A CRT annotation indicating remote control (henceforth called "remote indicators").

In lines 40–50 a serial poll is performed; the decimal value of the status register contents (including the universal HP-IB SRQ bit; a decimal value of 64) is then displayed by the controller. Initially, a value of 112 is returned (16 + 32 + 64 = 112). This serial poll clears the syntax error condition and removes the error message SYNTAX ERR from the HP 853A CRT.

The program stops at the PAUSE statement in line 60. Line 70 is executed by pressing the HP-85 CONTINUE key; this selects a legal display state, removing all service request conditions. The program initiates another serial poll and the value 80 (16 + 64 = 80) is returned, since this was the last status register content prior to clearing all error conditions.

A final press of the CONTINUE key executes one additional serial poll, returning the value 0 to indicate that no enabled service request conditions occurred since the previous serial poll. The instrument is then returned to local control.

OI Output Device Identification

The programming code **OI** can be used to identify whether an HP 853A is connected to the interface bus. The controller identifies a device as an HP 853A if the string "853" is returned when using the following program:

```
10 DIM A$[4]
20 OUTPUT 718 ;"OI"
30 ENTER 718 ; A$
40 DISP A$
```

Display Remote Operation

All HP 853A display states and signal processing modes are programmable over the HP-IB. The HP 853A responds to a remote front panel command the same way it does to a manual front panel change.

ACn,BCn Set trace control

The front panel display state of trace A or trace B can be selected by sending the respective **ACn** or **BCn** programming codes.

The value n takes on the following meanings:

n = 1 for CLEAR WRITE
n = 2 for MAX HOLD
n = 3 to STORE VIEW
n = 4 to STORE BLANK

For example, the following lines can be used to remotely program a new front panel setting:

```
10 OUTPUT 718 ;"AC1"
20 OUTPUT 718 ;"BC2"
```

or

```
10 OUTPUT 718 ;"AC1BC2"
```

Note that a square remote indicator is displayed on the CRT.

DCn Set digital average control
ICn Set INPUT — B→A control
OFn Set INPUT — B→A offset

Display processing of trace data can be controlled remotely using the above programming codes. The value n takes on the following meanings:

DCn: Digital average mode,
n = 0 for Normal
= 1 for Digital average

ICn: Normalize state,
n = 0 for INPUT — B→A OFF
= 1 for INPUT — B→A ON

OFn: Normalize offset state,
n = 0 to 975 for vertical offset value on CRT
(For default values refer to the HP-IB syntax guide)

To achieve digital averaging over, for example, 30 sweeps, place the spectrum analyzer in SINGLE SWEEP mode and RUN this example:

```
10 OUTPUT 718 ;"AC1BC1DC1"
20 OUTPUT 718 ;"TS 30"
30 LOCAL 718
```

FP Output front panel control settings

This command interrogates the HP 853A display for its current front panel control settings. The HP 853A can output the present status of **ACn, BCn, DCn, ICn** over the bus into a 12-character string dimensioned in the controller. This string array can later be passed back to the HP 853A to return the front panel to its original state:

```
10 DIM A$[12]
20 OUTPUT 718 ;"FP"
30 ENTER 718 ; A$
40 DISP A$
.
.
.
80 OUTPUT 718 ;A$
```

CA,CB Clear trace memory

Either trace memory can be completely blanked by sending a **CA** or **CB** programming code to the HP 853A (all values of trace memory are set to −50, indicating blanks).