370
REFERENCE
GUIDE

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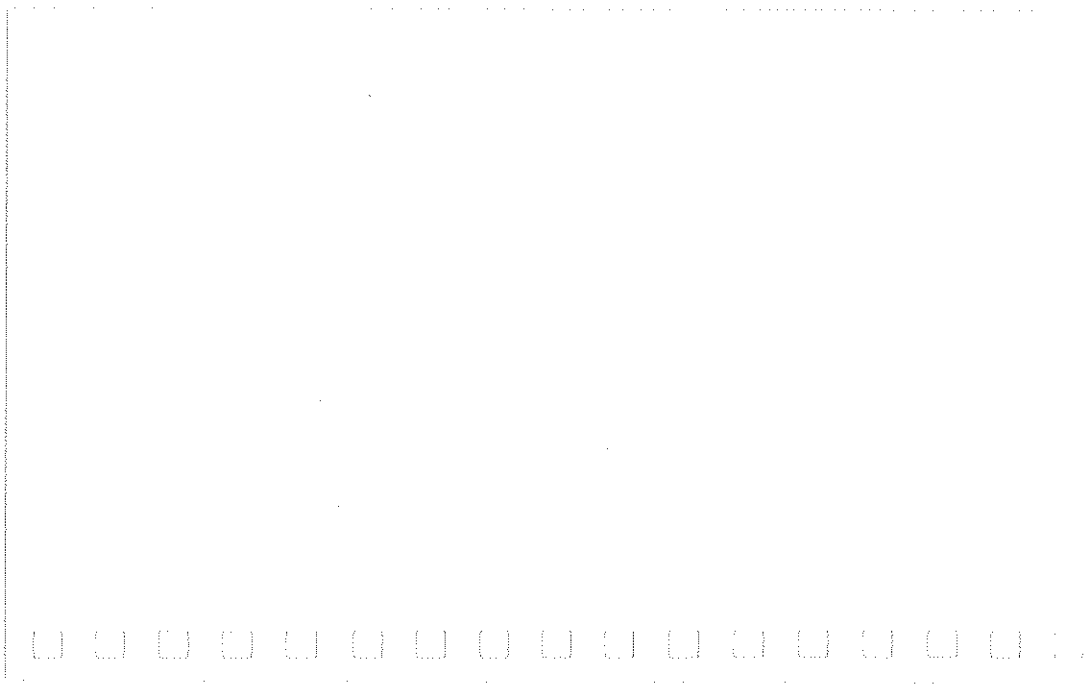

This Reference Guide consists of two sections. Section 1 "CONTROLS, INDICATORS AND CONNECTORS", includes brief description of all controls, indicators and connectors on the front and rear. Section 2, "GPIB", includes basic information about the command set and error messages.

This guide provides operator and programmer with a source of information for quick reference to operating descriptions, command descriptons and restrictions.

The Operator's Manual contains detailed information on operation and GPIB commands and their use.

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SECTION 1

CONTROLS, INDICATORS AND CONNECTORS

All controls, indicators and connectors required for normal operation of the 370 are located on the front and rear panels of the instrument. In addition, readout of the controls and measurement functions is provided on the crt. Become familiar with all these functions to effectively operate the 370.

CRT CONTROLS

INTENSITY Controls

There are three intensity controls: NON STORE/STORE, VIEW, and READOUT/ CURSOR. The DOT cursor intensity is always proportional to NON STORE/STORE or VIEW intensity. The READOUT/CURSOR intensity control has no effect on DOT CURSOR intensity.

NON STORE/ STORE	controls display brightness in the NON STORE or STORE modes.
VIEW	controls display brightness in the VIEW mode.
READOUT/ CURSOR	controls readout, Cross Hair Cursor, and Window display brightness.
FOCUS	controls display focus.
GRAT ILLUM	controls internal graticule illumination.
POSITION Controls	Operator-adjusted screwdriver controls that vertically and horizontally position the display. Adjustable range is at least one division. These adjustments do not affect the acquired curve data accuracy. CRT CAL controls (refer to DISPLAY section) are provided for accurate positioning.

TRACE ROTATION — Operator-adjusted screwdriver control for horizontal trace alignment. Once adjusted, readjustment is not required during normal instrument operation.

MEASUREMENT

The 370 has two measurement modes, REPEAT and SINGLE. These modes determine the step generator output mode.

REPEAT — The step generator creates the family of steps repetitively, making a continuous display of a family of characteristic curves. The characteristic curve family is displayed on the crt when the display mode is set to NON STORE, STORE or COMPARE. Stored curves produces a flicker-free display.

SINGLE — Step Generator produces a single family of steps each time the SINGLE key is pressed. The Collector Supply and the Auxiliary Supply always provide power regardless of the SINGLE function. In the Store or Compare modes, the display is refreshed each time SINGLE is pushed.

BUBBLE MEMORY INDEX

The internal bubble memory system stores characteristics curves and front-panel setups. The Bubble Memory Index display indicates the memory location that identifies where curves or setups are stored in the Bubble Memory. Up to sixteen storage displays and sixteen front panel setups can be stored in a bubble memory cassette.

Bubble Memory Index display and control	Indicates the bubble memory location for ENTER/TEXT, VIEW, SAVE and RECALL functions. The BUSY lamp indicates the bubble I/O operation. The control next to the up and down arrows allows selection of the memory location.

DISPLAY MODE

The Display mode controls select one of the following display modes:

NON STORE
STORE
COMPARE
VIEW

The 370 provides only one display mode at a time.

NON STORE	Provides a real-time analog display of DUT characteristics.
STORE	Digitally acquired curves are displayed on the crt. ACQ control setting (see DISPLAY description) selects the acquisition mode.
ENTER/TEXT	Stores the currently displayed digital storage curves in the bubble memory cassette. The Bubble Memory Index display indicates the memory location where the current display will be stored. The Enter function is not used with the Non Store and Compare display modes.

COMPARE	Displays STORE and VIEW curves simultaneously.
VIEW	Displays the previously entered curves from the bubble memory cassette. Bubble Memory Index display indicates the display curve identification number. CURVE ID number is displayed at the bottom right of the crt and is erased if any setting is changed. If any setting is changed while in View mode, the display mode is changed to Store mode automatically to reflect the setting change result.

SETUP

The setup save/recall function allows you to save or recall a group of front panel settings. All of the front panel settings, except those stated in TABLE 1-1, can be stored in or recalled from the bubble memory cassette. The up/down control selects the index number of the Bubble Memory.

SAVE — Front panel setups are saved in the bubble memory cassette when SAVE is pressed. The bubble memory index display indicates the index number of the Bubble Memory location where the setups are stored.

RECALL — Recalls a previously-stored group of 370 front-panel settings. When RECALL is pressed, the 370 is set to the front-panel settings stored in bubble memory, and the display mode is set to the STORE mode. SETUP ID number is displayed at the bottom center of the crt and is erased after any setting is changed.

TABLE 1-1
Front Panel Controls Settings Not Stored

LEFT-RIGHT - STANDBY
COLLECTOR SUPPLY HIGH-LOW LOOPING COMPENSATION

TABLE 1-1 Front Panel Controls Settings Not Stored (cont)

DISPLAY MODE NON STORE STORE COMPARE VIEW ENTER/TEXT
SETUP RECALL SAVE
MEMORY Index

TABLE 1-1 Front Panel Controls Settings Not Stored (cont)

CRT CONTROL	
	INTENSITY
	FOCUS
	GRATICULE ILLUM
	POSITION
	TRACE ROTATION
GPIB	
	USER REQUEST/SRQ ID
	RESET TO LOCAL/REMOTE ADDR
PLOTTER	
	PLOT/BUSY CURVE

DISPLAY

HORIZONTAL

Selects horizontal deflection factors (VOLTS/DIV) and horizontal sources (COLLECTOR, BASE/EMITTER or STEP GEN). FULL Clockwise rotation: 1) Selects COLLECTOR voltage source, 2) Turns on the COLLECTOR indicator LED, 3) Displays crt readout for the horizontal deflection factor. In COLLECTOR position, horizontal deflection factor for COLLECTOR voltage can be selected from 50 mV to 500 V in 1-2-5 sequence. Counter-clockwise (ccw) rotation from 500V/DIV of COLLECTOR position enters BASE/EMITTER position and the BASE/ EMITTER indicator LED turns on. In BASE/EMITTER position, the control selects horizontal deflection factor of either BASE or EMITTER voltage from 50 mV to 2 V in 1-2-5 sequence of 6 steps. Either BASE or EMITTER voltage is determined by the CONFIGURATION mode, as follows:

CONFIGURATION	HORIZONTAL VOLTAGE
BASE: STEP GEN	BASE
BASE: OPEN (EXT)	BASE
BASE: SHORT (EMITTER)	BASE
EMITTER: OPEN (EXT)	EMITTER
EMITTER: STEP GEN	EMITTER

Full counterclockwise rotation selects STEP GEN, which turns on STEP GEN indicator LED, and the horizontal deflection factor and cursor readouts disappear.

VERTICAL	Selects vertical deflection factors and vertical sources (COLLECTOR or STEP GEN). Full ccw rotation of the VERTICAL control displays STEP GEN signal source and turns on STEP GEN LED. When STEP GEN is selected, the VERT/DIV and vertical cursor readouts disappear. When COLLECTOR source signal is selected, deflection factor (CURRENT/DIV) changes in 1-2-5 sequence. When either +LEAKAGE or −LEAKAGE mode is selected for COLLECTOR SUPPLY POLARITY (EMITTER LED turns on), emitter current can be measured and the vertical deflection factor is divided by 1000.
DISPLAY INVERT	Horizontally and vertically inverts NON STORE or STORE curve at graticule center; also lights INVERT LED.
CRT CAL	Provides signals for checking the vertical and horizontal calibration of the origin of the characteristic curve: CAL CHK: Check ten divisions of deflection. OFF: Normal operation mode. ZERO CHK: Calibrate zero divisions of deflection.

ACQ MODE

Determines data acquisition mode for storage display. This setting does not affect NON STORE or VIEW displays. Modes are:

HORIZ Envelope: When HORIZ Envelope is selected, the horizontal min/max envelopes of the waveforms are displayed. The envelope display continuously accumulates until a setting changes.

VERT Envelope: When VERT Envelope is selected, the vertical min/max envelopes of the waveforms are displayed. The envelope display continuously accumulates until a setting changes.

NORM: Conventional digital storage function.

4 Average: Selects 4 times averaging for accurate and precise measurement. This feature provides a filter effect to reduce display noise. The acquisition count is displayed in the upper-right graticule area.

32 Average: Selects 32 times averaging for accurate and precise measurement. This feature provides a filter effect to reduce display noise. The acquisition count is displayed in the upper-right graticule area.

MAG

Horizontally or vertically offsets and magnifies NON STORE and STORE curve displays. MAG function does not affect VIEW curves. INCR or DECR shifts the curves 0.5 division per step when MAG MODE is at x1. Total display offset control range is ± 10 divisions. Press INCR and DECR to cancel offset.

VERT X10: Vertically magnifies display by ten. INCR and DECR offset functions affect vertical position.

VERT X1: Offset value is added vertically without magnification. INCR and DECR offset functions affect vertical position.

OFF: No offset, no magnification. INCR and DECR offset functions are disabled.

HORIZ X1: Offset value is added horizontally with no magnification. INCR and DECR offset functions affect horizontal position.

HORIZ X10: Horizontally magnifies display by ten. INCR and DECR offset functions affect horizontal position.

CURSOR

CURSOR Mode

The 370 provides three cursor modes: DOT, CROSS and WINDOW. The cursor mode up/down control selects cursor mode. Cursor position is set by four arrow keys. Cursor readout is displayed in the cursor readout area discussed under READOUT DISPLAY. Readout resolution is ten bits. When the display mode is COMPARE, cursor readout indicates position of DOT cursor on STORE curve. Differences between DOT, CROSS and WINDOW are described below.

DOT: The bright dot moves on the displayed curve and the corresponding vertical and horizontal values are displayed on the crt. If a value exceeds graticule range, the corresponding cursor readout display blinks. DOT does not operate in the NON STORE mode.

CROSS: Horizontal and vertical trace (referred to as a cross hair) appear in the graticule area. The vertical and horizontal coordinates of the cross hair intersection point are displayed on the crt. The cross hair is available in all display modes.

WINDOW: Displays user-positioned rectangular "target window" to provide a "go/no-go" visual check reference. Operates in all display modes. Either the upper-right corner or the lower-left corner of the window is the reference. Reference coordinate values appear on the crt.

Arrow and FAST/SHIFT

Four ARROW keys, up (↑), down (↓), right (→) and left (←) are used to move the DOT, CROSS and WINDOW cursors. When the DOT cursor is selected, the cursor-move direction is defined as follows: Selection of the up (↑) or right (→) ARROW keys move the dot to the higher step curve position. Selection of the down (↓) or left (←) ARROW keys move the dot to the lower step curve position.

Pressing both the FAST/SHIFT key and one of the appropriate ARROW keys accelerates cursor movement.

Rapid change of AUX voltage value or STEP GEN OFFSET value is obtained by pressing both the FAST/SHIFT key and appropriate AUX or STEP GEN OFFSET keys.

Pressing both the FAST/SHIFT key and the PLOT/CURVE key causes the 370 to send only curve data to a plotter.

Pressing both the FAST/SHIFT key and the USER REQUEST/SRQ ID key displays the 370 firmware version on crt.

Pressing both the FAST/SHIFT key and the GPIB RESET TO LOCAL key displays selected GPIB address and GPIB termination mode on crt.

Pressing both FAST/SHIFT and ENTER/TEXT enters Text Editing mode, which permits user comments to be displayed on-screen. In TEXT editing mode, 1) Press NON STORE to erase the text line, 2) Rotate the VERTICAL control to select the desired text character, 3) Rotate the HORIZONTAL control to move the text on the screen. Once editing is completed, press FAST/SHIFT and ENTER/TEXT together to exit text editing. Pressing RECALL, STORE, VIEW or COMPARE cancels text editing mode.

STEP GENERATOR

STEP/OFFSET AMPLITUDE and STEP MULTI .1X

STEP/OFFSET AMPLITUDE control selects step/offset amplitude range and step generator output mode. The step amplitude ranges from 50 nA to 200 mA per step in current output mode and from 50 mV to 2 V per step in voltage output mode in a 1-2-5 sequence. The VOLTS or AMPS LED indicates the selected output mode.

The STEP MULTI .1X control provides 0.1 times multiplication (division by 10) of the step amplitude setting. The STEP MULTI .1X does not affect the offset amplitude setting.

OFFSET

AID and OPPOSE keys control offset value. The offset value ranges from plus 10 to minus 10 times the STEP/OFFSET AMPLITUDE at 1% resolution. The offset value is displayed on the crt.

	AID: The step offset with the same polarity as the polarity setting adds to the step generator output. OPPOSE: The step offset with the opposite polarity as the polarity setting subtracts from the step generator output.
LIMIT	Selects current limit when the 370 step generator is in voltage output mode. The LED indicates the selected current limit. The voltage limit for current source mode is fixed at seven volts.
NUMBER OF STEPS	Selectable between 0 and 10; LED indicates selected number. Number 0 means Step Generator output is DC (constant). When the COLLECTOR SUPPLY POLARITY mode is +LEAKAGE or −LEAKAGE, the actual number of steps is automatically set to 0.

PULSE

LONG or SHORT pulse mode is enabled and the step generator supplies either pulsed current or voltage to the base terminal, as selected. Pulse width: 80 uS for SHORT and 300 uS for LONG. Selecting OFF disables Pulse mode. Selecting PULSE mode automatically selects the DC mode of COLLECTOR SUPPLY polarity function.

POLARITY and INVERT

POLARITY indicator indicates the step generator output polarity determined by the COLLECTOR SUPPLY POLARITY settings, CONFIGURATION, and the INVERT setting. Pressing INVERT reverses the step generator output polarity. The LED next to the INVERT key indicates if the inverted state is selected. When the configuration control is set to BASE COMMON, pressing INVERT does not effect the actual Step Generator polarity, and the polarity indicator does not change; only the INVERT indicator changes. Table 1-2 shows the Step Generator Polarity in relation to the Collector Supply Polarity, Configuration mode and INVERT key. For example, if the mode is EMITTER COMMON and the POLARITY is +(full-wave), +DC, or +LEAKAGE, the INVERT key controls the Step Generator Polarity.

TABLE 1-2
Step Generator Polarity

		CONFIGURATION mode setting	
	POLARITY	BASE COMMON	EMITTER COMMON
COLLECTOR SUPPLY Setting	+ +DC +LEAKAGE	−	+(INVERT OFF) −(INVERT ON)
	− −DC −LEAKAGE	+	−(INVERT OFF) +(INVERT ON)
	AC	−	+(INVERT OFF) −(INVERT ON)

COLLECTOR SUPPLY

WARNING

Following use of the 370 at high power settings, the device, fixture, or protective cover may be hot enough to cause injury. Avoid touching any of these items until cooled.

WARNING

Up to 2000 V may appear at the front-panel collector terminals. To avoid injury or equipment damage, do not remove the protective cover or defeat the protective interlock switch.

MAX PEAK VOLTS HIGH-LOW MAX PEAK VOLTS

MAX PEAK VOLTS is set by two controls. When the HIGH-LOW control is at 2000V (HIGH), the maximum collector supply peak volts is 2000V, and the LED at the MAX PEAK VOLTS control is lighted. When at LOW, 16, 80 or 400 V maximum peak volts is selectable by using the up/down control. (The LED indicates the selected maximum peak volts.) When the MAX PEAK VOLTS setting is changed, the VARIABLE COLLECTOR SUPPLY output automatically goes to zero.

MAX PEAK POWER WATTS

The LED indicates the selected MAX PEAK POWER WATTS. This control does not affect the Variable Collector Supply output. When MAX PEAK VOLTS HIGH-LOW is set to the HIGH range (2000V), the available maximum peak power is less than or equal to 50W. The relationship between MAX PEAK POWER and SERIES RESISTORS is shown in Table 1-3.

TABLE 1-3
Max Peak Power vs. Series Resistors

	16V	80V	400V	2000V
220 W	0.26 OHM	6.4 OHM	160 OHM	——
50	1.3	32	800	20K OHM
10	6.4	160	4K	100K
2	32	800	20K	500K
0.4	160	4K	100K	2.5M
0.08	800	20K	500K	12.5M

POLARITY

There are seven collector supply polarity modes:

+LEAKAGE
+DC
+(full-wave)
AC
−(full-wave)
−DC
−LEAKAGE

The LED indicates the selected mode. When the collector supply polarity is changed or switched to or from AC, the variable collector supply output goes to zero. Trace origin is at graticule lower left corner when a plus mode is selected, at graticule center when AC is selected, and at graticule upper right corner when a minus mode is selected.

+LEAKAGE and −LEAKAGE: Vertical sensitivity is increased 1000 times. Vertical amplifier measures emitter current. Collector Supply mode is automatically set for DC voltage output. The step generator furnishes offset to the base terminals with no steps. The number of steps in STEP GENERATOR indicator does not change, but the actual number of steps in the ±LEAKAGE mode goes to zero.

+DC and −DC: When +DC or −DC is selected, the collector supply applies a dc voltage equal to the peak value set by the VARIABLE COLLECTOR supply control.

+ (full-wave) and − (full-wave): When either is selected, a full-wave rectified sine wave of + or − polarity, respectively is applied to the collector terminals and either a positive or negative staircase is applied to the base terminals from the step generator.

AC: Selecting ac polarity applies a sinusoidal voltage to the collector terminals. The step generator output is positive-going.

TABLE 1-4
Collector Supply Polarity Functions

POLARITY	Vertical Display Source	Collector Supply Output	Number of Steps
+LEAKAGE	EMITTER	+DC	0
+DC	Collector	+DC	as selected
+ (NPN)	Collector	+rectified sine wave	as selected
AC	Collector	sine wave	as selected
− DC	Collector	−rectified sine wave	as selected
−DC	Collector	−DC	as selected
−LEAKAGE	Emitter	−DC	0

LOOPING COMPENSATION	which neutralizes the effects of internal and adapter stray capacitance. Does not compensate for device capacitance.
VARIABLE COLLECTOR SUPPLY	Allows variable control of collector supply voltage within range set by MAX PEAK VOLTS control. Clockwise (cw) rotation increases the collector supply output voltage, and ccw rotation decreases it. The control has no stops. The VARIABLE COLLECTOR SUPPLY bar graph indicator shows the approximate collector supply output as a percent of MAX PEAK VOLTS.
COLLECTOR SUPPLY DISABLED	Indicates that the collector supply is disabled. Actuation of the safety interlock or a fault condition (such as excessive power consumption) may disable the collector supply output.
WARNING	Red light indicates that the collector supply is enabled and dangerous voltage is applied to the collector terminals.

LIMITER — Indicates that the automatic protection is operating. The protection circuit protects the current-sensing resistors from overheating.

AUX SUPPLY

AUX SUPPLY — The auxiliary voltage supply produces up to ±40 V at up to 10 mA, or up to ±20 V at up to 100 mA. The (↑) and (↓) keys are used to set the auxiliary supply output voltage. The output voltage is supplied to the AUX SUPPLY OUT connector. The auxiliary voltage setting is displayed on the crt readout area. Simultaneously pushing the two keys sets the auxiliary supply to zero volts.

CONFIGURATION CONTROLS AND INDICATORS

CONFIGURATION — The CONFIGURATION up/down control selects base and emitter terminal choices. The control also determines the DUT terminal to which the Step Generator is connected. The Collector Supply is connected to the collector terminals in all control positions. COMMON is connected to ground, but through the current-sense resistor in the LEAKAGE MODE. When BASE COMMON is selected, the STEP GENERATOR INVERT key is disabled.

READOUT DISPLAY

The 370 CRT has an internal printed graticule and characters (VERT/DIV, HORIZ/DIV, etc.) for internal setups.

GRAT ILLUM controls the brightness of the graticule and printed characters. Figure 1-1 illustrates the screen readout areas. The types of readout information are:

Setup Readout
Text
Error Messages
Curve/Setup ID
Average Count

Setup Readout. The appropriate readouts for VERT/DIV, PER/STEP, OFFSET, AUX, cursor measurement readouts for vertical and horizontal, and the Beta or gm/div readout are displayed on each column.

When the VIEW mode is selected, readout data that was stored in bubble memory are displayed. When the Step Generator source is selected, the VERT/DIV or HORIZ/DIV readout disappears.

Text. To identify the stored curves or front-panel settings, the text message can be written on the top of the CRT graticule area.

No more than 24 characters can be written in the text area. The 370 recognizes lower-case "u" as "micro" and displays the Greek letter "μ" instead.

Text can be stored with the VIEW curve data or the setup data in the Bubble Memory.

Error Messages. The error messages (operation error, I/O error, emergency error, etc.) are displayed on this area (14 characters maximum). This error message disappears after any setting change.

Curve/Setup ID. The Curve ID in VIEW or COMPARE display mode shows the VIEW memory index number for the VIEW curve currently displayed. The Curve ID does not appear in NON STORE or STORE display mode.

The Setup ID shows the SETUP memory index number for the current setup that is recalled by pressing RECALL. Any setup change erases the Setup ID.

Average Count. The number of counts averaged is displayed in this area when the AVG function is selected and operating.

Figure 1-1 is an example of the CRT readout, where the text message is "TEXT CAN BE WRITTEN HERE", the error message is "BUBBLE NOMEN", and the current setup and view data are recalled from index number 2.

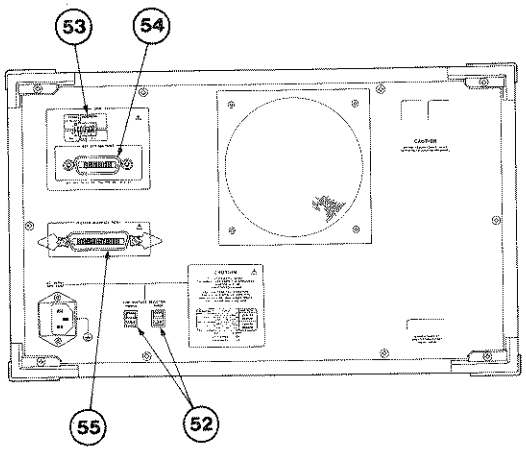


Figure 1-1. CRT readout area.

GPIB

USER REQUEST/ SRQ ID	Sends SRQ over the GPIB to the controller.The LED indicator illuminates until the SRQ is cleared. If FAST/SHIFT is pressed with USER REQUEST/SRQ ID, the instrument software version is displayed at the bottom of the crt; for example: V81.1,F0.02
RESET TO LOCAL REMOTE ADDR	Changes the operating mode of the 370 from remote to local. The instrument is placed in remote operation through the GPIB. When the 370 is under remote control, the REMOTE ADDR LED indicator illuminates. If FAST/SHIFT and RESET TO LOCAL/REMOTE ADDR are pressed simultaneously, the bus address and terminator are displayed at the bottom of the crt screen; for example: GPIB: LF/EOI,01

PLOTTER

PLOT/CURVE

When the PLOT/CURVE key is pressed while the display mode is the STORE or VIEW mode and the appropriate plotter is connected to the Plotter Interface, the 370 sends the appropriate HPGL commands to a plotter via the 8-bit parallel plotter interface, and the BUSY indicator turns on. The plotter receives the HPGL command and starts. The BUSY indicator LED turns off and the 370 sends the SRQ status via GPIB after the information is sent. If PLOT/CURVE and FAST/SHIFT are pressed simultaneously, only curves are plotted. Data from CURVE ID, SETUP ID and ERROR MESSAGE are not plotted. If PLOT/CURVE is pressed while sending data to a plotter, nothing occurs. Refer to the Rear Panel discussion for Plotter Interface Connector details.

BUBBLE MEMORY

Bubble Memory	Provides data storage capability. Sixteen families of curves can be stored or recalled by the ENTER/TEXT, VIEW and COMPARE keys. Sixteen Setups can be stored or recalled by pressing the SAVE or RECALL key. Press eject button to remove cassette.

CONNECTORS

Adapter	Allows connection of various test connector adapters.
STEP GEN OUT	Step Generator signal is available at this terminal.

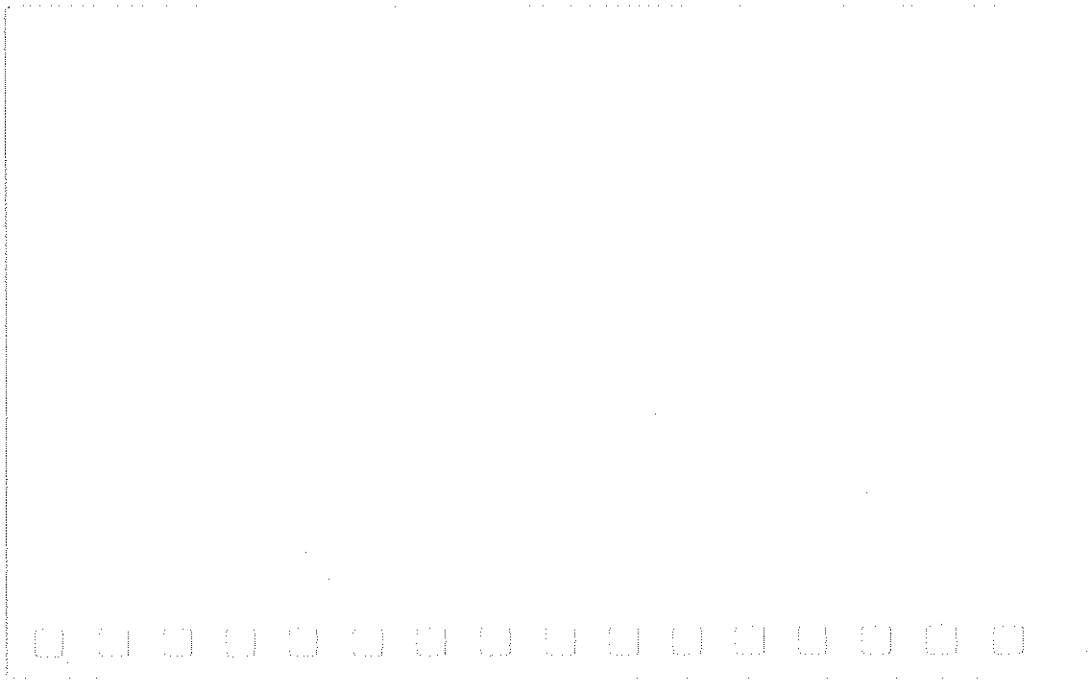
EXT BASE EMIT INPUT	Allows input of an externally generated signal to either the base terminals or emitter terminals of the DUT as determined by the CONFIGURATION control.
AUX OUT	Auxiliary Supply Output Terminal.
GROUND	Allows external access to ground reference.

LEFT-RIGHT-STANDBY

Left-Right-Standby	Selects the device to be tested (left or right). When Left and Right are pressed simultaneously, both devices are selected.

REAR PANEL

Line Voltage Selector	Selects either 115 V or 230 V nominal ac power source, either High or Low voltage operation for each line voltage selection.
GPIB Address	Selects GPIB address and message terminator.
GPIB Interface Connector	Interfaces IEEE-488 Standard Bus Interface Connector.
Plotter Interface Connector	Interfaces to a Plotter.



SECTION 2
PROGRAMMING

GPIB

This section describes the command set and error messages required for remotely controlling the 370. The section consists of:

Alphabetical Command Listing.
Syntax discussion.
Functional Command Listing.
Errors and Event Codes
Sample Program.

COMMAND LIST

SYNTAX

Mnemonics

Most mnemonics can be shortened by entering the first three characters. Either upper-case or lower-case characters are accepted.

Input Messages

One or more message units can be transmitted as a message. Message units contain ASCII characters; binary may also be used for waveforms.

Message Unit Delimiter (;)

Message units are separated by the ASCII code for the semicolon (;). A semicolon is optional following the last message unit.

Message Terminator (TERM)

The end-of message terminator can be either the END message (EOI asserted concurrently with the last data byte), or the ASCII code for line feed (LF), sent as the last data byte.

The active terminator is selected by the rear-panel GPIB ADDRESS switch.

Format Characters

Format characters can be inserted at many points to make a message more intelligible, but are required only if included as a literal element (ie., circle or ovals) with no bypass. Format characters include space (SP), carriage return (CR), line feed (LF), comma (,), and all other ASCII control characters.

Header

Header elements are mnemonic labels that represent a function; for example, VCS for variable collector supply and PKV for max peak volts.

Header Delimiter (SP)

A space (SP) separates a header from any arguments.

Argument Delimiter (,)

A comma (,) separates multiple arguments.

Link Argument Delimiter

A colon (:) must separate link arguments

Numbers

The defined element NRX is a decimal number in any of three formats; NR1, NR2 and NR3. NR1 is an integer (no decimal point), NR2 is a floating point number (decimal point required), and NR3 is a floating point number in scientific notation. NRX arguments either select the value of a continuous function. Numbers within the range are rounded.

COMMAND LIST

Tables 2-1 through 2-3 list all 370 GPIB commands and queries. The first column lists the name or header of the command. The second column lists arguments associated with the command. The third column lists link arguments associated with the first argument. The last column lists brief descriptions of each command and the related argument.

BNF notation is used herein to define communication with the 370. The symbols are as follows:

< >	Defined element.
:: =	Is Defined As.
{ }	Grouping.
[ ]	Optional, May Be Omitted.
¦	Exclusive Or (one or the other, but not both).
...	May be repeated one or more times.

The division of classes and command groups conforms with 370 GPIB Commands discussed earlier.

Table 2-1
FRONT PANEL CONTROLS

DISPLAY Command Group

Command	Argument	Link	Definition
DISplay	NSTore		Selects NON STORE mode.
	STOre		Selects STORE mode.
	VIEw	<NR1>	Selects VIEW mode. <index> ::= 1 ¦ 2 ¦ ... ¦ 16
	COMpare	<NR1>	Selects COMPARE mode. DISPLAY COMPARE:<index> <index> ::= 1 ¦ 2 ¦ ... ¦ 16
	INVert	ON	Selects display invert mode.
		OFF	Disables display invert mode.

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
	CRTcal	ZERochk OFF CALchk	Sets the crt check mode.
DISplay			Responds with display data. DISPLAY <mode1>,<mode2>,<mode3> <mode1> ::= NSTORE ¦ STORE ¦ VIEW:<NR1> ¦ COMPARE:<NR1> <mode2> ::= INVERT:OFF ¦ INVERT:ON

			<mode3> ::= CRTCAL: ZEROCHK ¦ CRTCAL:OFF ¦ CRTCAL:CALCHK
ENTer	<NR1>		Store the displayed curve data in the memory location specified by the argument. ENTER <index> <index> ::= 1 ¦ 2 ¦ ... ¦ 16
VERT	STEp COLlect	<NRX>	Selects vertical source and amps/div. Requires an NR1-3 type number for amps/div. Will return NR3 in query form. VERT <source>[:<amp>] Current ranges allowed: COLLECT <amp> ::= {1.0E−6 −2.0E+0}

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
			(COLLECTOR POLARITY not leakage mode) COLLECT <amp> ::= {1.OE−9−2.OE−3} (COLLECTOR POLARITY leakage mode)
	OFFset	<NR2>	Sets vertical display offset VERT OFF:<val> <val> ::= ±10.0 by 0.5
VERt?			Responds with the vertical source, amps/div, and display offset: VERT <source> [:<amp>], OFFSET:<val>

			<source> ::= STEP ¦ COLLECT <amp> ::= amps/div <val> ::= display offset value
HORiz	STEp		Selects the horizontal source and volt/div.
	COLLect	<NRX>	Use a NR1-3 type number for volt/div. Returns NR3 in query form
	BASe	<NRX>	Voltage ranges allowed: HORIZ <source> [:<volt>] COLLECT <volt> ::= {5.0E−2 −5.0E+2} BASE <volt> ::= {5.0E−2 −2.0E+0}
	OFFset	<NR2>	Sets horizontal display offset HORIZ OFFSET:<val> val ::= {±10.0 by 0.5}

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
HORiz?			Responds with horizontal source, volt/div and display offset: HORIZ <source> [:<volt>], OFFSET:<val> <source> ::= STEP ¦ COLLECT ¦ BASE <volt> ::= volt/div <val> ::= display offset value
ACQuire	ENVelope NORmal AVG	VERt HORiz 4 32	Sets the acquisition mode.

ACQuire?			Responds with the acquisition mode: ACQUIRE <mode> :<val> <mode> ::= ENVELOPE ¦ NORMAL ¦ AVG <val> ::= VERT ¦ HORIZ ¦ 4 ¦ 32
MAG	VERt	1	Sets volt/div or amps/div magnifier to X 1 or X 10.
		10	
	OFF		
	HORiz	1	
		10	
MAG?			Responds with the magnifier mode: MAG <mode> [:<val>] <mode> ::= VERT ¦ OFF ¦ HORIZ <val> ::= 1 ¦ 10

Table 2-1 FRONT PANEL CONTROLS (cont)

CURSOR CONTROL Command Group

Command	Argument	Link	Definition
CURSor	OFF		Currently displayed cursor disappears. CURSOR OFF
DOT	<NR1>		Sets the dot cursor on the specified curve data position. DOT <data> <data> ::= curve data position {1 −1024}
DOT?			Responds with the dot cursor position: DOT <NR1>
CROss	<NR1>,	<NR1>	Sets the cross-hair cursor to specified position on crt.

			CROSS <data1>, <data2> <data1> ::= horizontal position {0 – 1000} <data2> ::= vertical position {0 – 1000}
CROss			Responds with the cross-hair cursor position: CROSS <NR1>, <NR1>
WINdow	<NR1>, <NR1>, <NR1>, <NR1>		Sets the window cursor to the specified position on crt. WINDOW <data1>,<data2>, <data3>,<data4> <data1> ::= Lower-left horizontal {0-1000}

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
			<data2> ::= Lower-left vertical {0-1000} <data3> ::= Upper-right horizontal {0-1000} <data4> ::= Upper right vertical {0 – 1000}
WINdow?			Responds with the window position: WINDOW <NR1>,<NR1>, <NR1>,<NR1>
COLLECTOR SUPPLY CONTROL Command Group			
PKVolt	16		Sets maximum peak volts except 2000. Maximum peak volts 2000 must be set manually.

	80 400		PKVOLT <set> <set> ::= 16 ¦ 80 ¦ 400
PKVolt?			Responds with maximum peak volts: PKVOLT <set> <set> ::= 16 ¦ 80 ¦ 400 ¦ 2000
PKPower	220.0 50.0 10.0 2.0 0.4 0.08		Sets max peak power in watts. PKPOWER <set> <set> ::= 220.0 ¦ 50.0 ¦ 10.0 ¦ 2.0 ¦ 0.4 ¦ 0.08
PKPower?			Responds with max peak watts: PKPOWER <set> <set> ::= 220.0 ¦ 50.0 ¦ 10.0 ¦ 2.0 ¦ 0.4 ¦ 0.08

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
CSPol	PLEakage PDC PNOrmal AC NNOrmal NDC NLEakage		Selects collector supply polarity and mode. CSPOL <mode> <mode> ::= PLE ¦ PDC ¦ PNO ¦ AC ¦ NNO ¦ NDC ¦ NLE PLE ::= +LEAKAGE, PDC ::= +DC PNOR ::= +(fullwave), AC ::= AC, NNOR ::= −(fullwave),

			NDC ::= −DC , NLE ::= −LEAKAGE
CSPol?			Reports collector supply polarity and mode: CSPOL <mode> <mode> ::= PLEAKAGE ¦ PDC ¦ PNORMAL ¦ AC ¦ NNORMAL ¦ NDC ¦ NLEAKAGE
VCSpply	<NR2>		Sets the variable collector supply. The argument data is a percentage value. VCSPPLY <data> <data> ::= 0.0 ±100.0 (by 0.1 %)

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
VCSpply?			Reports variable collector supply volts: VCSPPLY <data> <data> ::= 0.0 ±100.0 (by 0.1 %)
HILowsw?			Reports HIGH-LOW switch status: HILOWSW LOW ¦ HIGH
STEP GENERATOR Command Group			
STPgen	CURrent	<NRX>	Sets step generator source to <amps/step> or <volt/step>.
	VOLtage	<NRX>	Requires NR1-3 input. STPGEN <source> ::= CUR ¦ VOL:<val> Returns NR3.

			Step ranges allowed: CURRENT <val> ::= {5.0E−8 − 2.0E−1} VOLTAGE <val> ::= {5.0E−2 − 2.0E+0}
	NUMber	<NR1>	No. of steps to be generated. STPGEN NUMBER:<val> <val> ::= 0 ¦ 1 ¦ 2 ¦ ... ¦ 10
	INVert	ON OFF	Sets step generator invert mode. STPGEN INVERT:<mode>
	MULt	ON OFF	Sets step generator .1X mode. STPGEN MULT:<mode>
	PULse	OFF SHORT LONG	Pulse duration 80 sec. 300 sec. STPGEN PULSE:<mode>

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
	CLimit	<NR2>	Sets step generator current limit STPGEN CLIMIT:<val> <val> ::= 0.02 ¦ 0.1 ¦ 0.5 ¦ 2.0
	OFFset	<NRX>	Sets Step Generator Offset STPGEN OFFSET:<val> <val> ::= {±10.0 by 0.1}
STPgen?			Reports Step Generator source, amps/step or volts/step, number of steps, pulse mode, offset, invert mode, .1X mode, and current limit. STPGEN NUMBER:<num>, PULSE: <pulse>,

			OFFSET: <offset>, INVERT: <invert>, MULT: <mult>, CLIMIT: <clim>, <amp> <num> ::= number of steps (NR1) <pulse> ::= pulse mode (ON ¦ OFF) <offset> ::= step generator offset (NR2) <invert> ::= step generator invert mode (ON ¦ OFF) <mult> ::= step generator .1X mode (ON ¦ OFF) <clim> ::= step generator current limit. (NR2) <amp> ::= CURRENT:amps/div> VOLTAGE:volts/div

Table 2-1 FRONT PANEL CONTROLS (cont)

CONFIGURATION Command Group

Command	Argument	Link	Definition
CONfig	BSGen BOPen BSHort ESGen EOPen		Sets Configuration mode. CONFIG <mode> <mode> ::= BSG ¦ BOP ¦ BSH ESG ¦ EOP BSG ::= BASE STEP GEN & EMITTER COMMON BOP ::= BASE OPEN & EMITTER COMMON BSH ::= BASE SHORT & EMITTER COMMON

PLOt	ALL CURve		Selects and starts plotter output. PLOT ALL ¦ CUR ALL ::= FULL mode CUR ::= CURVE mode
PSTatus?			Reports plotter status PSTATUS READY ¦ BUSY READY ::= idle mode BUSY ::= busy mode
AUX	<NR2>		Sets AUX output voltage to argument value. <NR2> = ±40.000 by 0.02 increments.

Table 2-1 FRONT PANEL CONTROLS (cont)

Command	Argument	Link	Definition
AUX?			Reports AUX output voltage: AUX <data> <data> ::= ±40.00 (0.02 step)
LRSsw?			Reports LEFT-RIGHT-STANDBY switch status LRSSW LEFT ¦ RIGHT ¦ STANDBY ¦ BOTH
COVer?			Reports protective cover status COVER ON ¦ OFF ON for cover open OFF for cover closed

Table 2-2
DISPLAY-DATA AND CRT READOUT I/O

WAVEFORM TRANSFER Command Group			
Command	**Argument**	**Link**	**Definition**
WFMpre	<string>		Load waveform preamble data. WFMPRE WFID:<wfid>,ENCDG: BIN,NR.PT:<point>,PT.FMT: XY,XMULT:<x multi>,XZERO: 0,XOFF:<x off>,XUNIT:V, YMULT:<y multi>,YZERO:0, YOFF:<y off>,YUNIT:A, BYT/NR:2,BN.FMT:RP,BIT/NR: 10,CRVCHK:CHKSMO,LN.FMT: <format>

Table 2-2 DISPLAY-DATA AND CRT READOUT I/O (cont)

Command	Argument	Link	Definition
			<wfid> ::= "INDEX <num>/ VERT <amp>/ HORIZ <volt> /STEP <step> /OFFSET <offset>/BGM <para>/ AUX<aux>/ACQ <acq>/ TEXT <txt>" <num> ::= Memory location number <amp> ::= Vertical amp/div readout

			<volt> ::= Horizontal volts/div readout <step> ::= Step amplitude readout
			<offset> ::= Step offset readout <para> ::= Beta or gm readout <aux> ::= Aux Supply readout <acq> ::= Curve acquisition mode (AVG ¦ NOR ¦ ENV) <txt> ::= Text area readout <point> ::= curve point no. (1 - 1024) <x multi> ::= <NR3> = horizontal scale factor <x off> ::= <NR1> = horizontal scale offset

Table 2-2 DISPLAY-DATA AND CRT READOUT I/O (cont)

Command	Argument	Link	Definition
			<y multi> ::= <NR3> = vertical scale factor <y off> ::= <NR1> = vertical scale offset <format> ::= VECTOR ¦ DOT
WFMpre	NR.PT	<NR1>	Sets input points no. from curve command (1 to 1024)
WFMpre?			When WFMpre? is received, 370 reports waveform preamble data: WFMPRE WFID:"<wfid>",ENCDG: BIN,NR.PT:<point>,PT.FMT: XY,XMULT:<x multi>,XZERO:

0,XOFF:<x off>,XUNIT:V,
YMULT:<y multi>,YZERO:0,
YOFF:<y off>,YUNIT:A,BYT/
NR:2,BN.FMT:RP,BIT/NR:10,
CRVCHK:CHKSMO,
LN.FMT:<format>

<wfid> ::= INDEX <num>/VERT
<amp>/HORIZ
<volt>/ STEP
<step> /OFFSET
<offset>/BGM
<para> /AUX
<aux>/ACQ <acq>
/TEXT <txt>

<num> ::= Memory location number

<amp> ::= Vertical amp/div readout

<volt> ::= Horizontal volts/div readout

Table 2-2 DISPLAY-DATA AND CRT READOUT I/O (cont)

Command	Argument	Link	Definition
			<step> ::= Step amplitude readout <offset> ::= Step offset readout <para> ::= Beta or gm readout <aux> ::= Aux Supply readout <acq> ::= Curve acquisition mode (AVG ¦ NOR ¦ ENV) <txt> ::= Text area readout <point> ::= curve point no. (1 - 1024) <x multi> ::= <NR3> = horizontal scale factor <x off> ::= <NR1> = horizontal scale offset

			<y multi> ::= <NR3> vertical scale factor <y off> ::= <NR1> = vertical scale offset <format> ::= VECTOR ¦ DOT
WFMpre?	NR.PT:	<NR1>	Reports NR.PT waveform preamble data. WFMPRE NR.PT:<point> <point> ::= 1 ¦ 2 ¦ ... ¦ 1024
CURve	<string>		Loads curve data. CURVE CURVID:<crvid>, %<binary data> <crvid> ::= "INDEX <NR1>" <binary data> ::= <binary count> <binary point> <checksum>

Table 2-2 DISPLAY-DATA AND CRT READOUT I/O (cont)

CRT READOUT TRANSFER Command Group

Command	Argument	Link	Definition
CURve?			Reports curve data. CURVE CURVID:<crvid>, %<binary count> <binary point> <checksum> <crvid> ::= "INDEX <NR1>" <binary count> ::= two bytes representing no. of data points + 1 <binary point> ::= 8-bit byte (001...1FF) <checksum> ::= 2's complement of the modulo 256 sum of the preceding binary data bytes and

			binary count, except "%" preceding the binary data count.
WAVfrm?			Reports waveform preamble and curve data. Response is the same as is returned for WFMpre?;CURVE?
REAdout?			Sends displayed cursor readout: READOUT <readout> <readout> ::= <amps>,<volts> <readout> ::= ? <amps>,? <volts> (cursor is overflow)
TEXt	<string>		Displays text on crt. Text "<text>" <text> ::= max. 24 characters
TEXt?			Reports text on crt. Text "<text>" <text> ::= max. 24 characters

Table 2-3
SYSTEM COMMANDS and QUERIES

INSTRUMENT PARAMETER Command Group			
Command	**Argument**	**Link**	**Definition**
SET?			Reports front-panel settings. Response is the same as returned for CONFIG?; CSPOL?;ACQUIRE?;HORIZ?; VERT?;MAG?;DISPLAY?; STPGEN?;PKPOWER?;PKVOLT?; AUX?;MEASURE?;RQS?;OPC?; HILOWSW? followed by cursor mode response.

INIt			Resets instrument as if the power was turned off, then turned back on. Instrument functions are reset as shown below.

Function	INIT Value		Function	INIT Value
DISPLAY	STORE		CURSOR	OFF
DISPLAY CRT	OFF		DISPLAY INV	OFF
HORIZ OFFSET	0.0		STP CUR	50.0E-9
STP OFF	0.0		STP PULSE	OFF
STP INV	OFF		PKPOWER	0.08
CSPOL	PNORMAL		HORIZ COL	5.0E+2

Table 2-3 SYSTEM COMMANDS and QUERIES (cont)

Command	Argument	Link	Definition	
OPC	OFF		ACQ	NORMAL
MEASURE	REPEAT		MAG	OFF
VERT OFFSET:	0.0		AUX	0.00
STP NUM	5		STP CLI	0.02
STP MUL	OFF		VCS	0.0
PKVOLT	16		CONFIG	BSG
VERT COL:	2.0E+0		RQS	ON
INSTRUMENT PARAMETER Command Group				
Command	**Argument**	**Link**	**Definition**	
TESt?			Initiates ROM and RAM check routine. TEST ROM: <hex>, RAM: <hex>	

ID?			Reports the instrument ID: ID SONY-TEK/370, /V81.1, <fwv> <fwv> ::= current ¦ firmware version
HELp?			Reports list of all valid command headers: CONFIG,READOUT,TEXT,CROSS, DOT,WINDOW,CURSOR,DISPLAY, ACQUIRE,MAG,HORIZ,VERT, STPGEN,MEASURE,ENTER, RECALL,SAVE,PLOT, PSTATUS, HILOWSW,LRSSW,COVER,AUX, PKVOLT,PKPOWER,CSPOL, VCSPPLY,WFMPRE,CURVE, WAVFRM,RQS,OPC,EVENT, TEST,INIT,ID,SET

Table 2-3 SYSTEM COMMANDS and QUERIES (cont)

STATUS AND ERROR REPORTING Command Group

Command	Argument	Link	Definition
RQS	ON OFF		Enable service requests. Disable service requests.
RQS?			Reports RQS status. RQS ON ¦ OFF
OPC	ON OFF		Enables operation-complete service request. Disables operation-complete service request.
OPC?			Reports OPC status. OPC ON ¦ OFF

EVEnt?			Returns detailed information about the event. EVENT <code> <code> ::= See Table 2-4.

ERROR AND EVENT CODES

When RQS ON is selected, the 370 responds with the current event code that corresponds to the current status byte. If the 370 is polled twice with no intervening event query, the pending event code is discarded.

When RQS OFF is selected, the 370 responds with the status report only to an EVENT? query, and the status byte is always cleared.

Table 2-4
Status Byte and Event Code

Status Byte	Event Code	Meaning
System Event		
0	0	No error
65	401	Power on
66	402	Operation complete (MASK OPC)
67	403	User request (RQS key)
68	404	Plotter output complete
69	405	Collector supply recovered
Command	101	Command header error
Error	103	Command argument error
97	106	Command syntax error
	108	Checksum error
	109	Byte count error

Execution Error 98	201	Command not executable in local mode
	203	Output buffer overflow; remaining output lost
	204	Setting conflicts
	205	Argument out of range
Internal Error 99	303	Phase lock system failed series Resistor is overheated
	305	
	306	Plotter fail
	307	Bubble I/O error

SAMPLE PROGRAMS

Sending commands to the 370

The following BASIC statements set the 370 Vertical Signal Source to "Collector Current (100 mA/div)", Horizontal Signal Source to "Collector Voltage (1 volt/div)" and Step Generator to ten steps "Current Source" with 2 microamperes per step.

```
100      Print #z:"VERT COL:0.1"
200      Print #z:"HORIZ COL:1"
300      Print #z:"STP CUR:2E-6,NUM:10"
```

The GPIB address for the 370 should be given in variable "z".

This program can be compressed into a single line:

```
100      Print #z:"VERT COL:0.1;HORIZ COL:1;STP CUR:2E-6;NUM: 10"
```

SRQ handling

The 370 EVENT query and response gives the user more detailed status of the 370. The following is a simple subprogram for SRQ handling. The 370 event code is reported as well as the status byte.

```
1000    Sub srqhand
1010    Poll status, address;z ! z=370 GPIB address
1020    Print "SRQ from the 370, status= ";status
1030    Input #z prompt "EVENT?" :event$
1040    Print "      event = ";event$
1050    Resume
1060    End
```

The next sample program sends commands input from the console device keyboard to the 370.

```
100     Open #1:"gpib0 (pri="&str$ (z )&",eom= (0 ):"
```

```
110     Dim a$ to 500
120     On srq then call srqhand
130     Enable srq
140     Input prompt "Enter message ":p$
150     Print #1:p$
160     If pos (p$,"?",1)=0 then goto 140
170     Input #1:a$
180     Print a$
190     Goto 140
200     End
```

If the command is a query such as "SET?", then the 370 response is displayed on the console device screen.

Acquiring Instrument Settings with "SET?" query

A complete instrument setting information for the 370 is obtained by sending a "SET?" query command.

```
200      Dim a$ to 500
210      Input prompt 'SET?" #z:a$

print a$
CURSOR OFF; MEASURE REPEAT; ACQUIRE NORMAL; DISPLAY STORE, INVERT:OFF;
CRTCAL:OFF; HORIZ COLLECT:500.0E-3, OFFSET: 0.0; VERT COLLECT:50.0E-6,
OFFSET: 0.0;MAG OFF; PKVOLT 16; PKPOWER 0.08; CSPOL NNORMAL; CONFIG BSGEN;
STPGEN  NUMBER:4,  PULSE:LONG,  OFFSET:  0.00,  INVERT:ON,  MULT:OFF,
CLIMIT:0.02, CURRENT:20.0E-6; AUX 0.00; VCSPPLY 36.6; RQS ON; OPC OFF;
HILOWSW LOW
```

In this case, a string variable "a$; contains almost all of the 370 current settings. To retrieve the previous settings even after changes have occurred, send the "a$" back to the 370.

```
300      Print #z:a#
```

Acquiring Waveform Data from the 370

The following three programs are routines that retrieve waveform data from the 370. Line 100 in each sample program defines the End-of-message terminator as "EOI only". This prevents binary bytes in the data stream that are equivalent to ASCII "CR/LF" character strings from stopping a binary data transfer.

The EX1 program gets waveform preamble and curve data separately into w$ and d$. Since these variables are in ASCII format, the curve data must be converted to numerical data as required.

The EX2 program receives curve data only. Curve data is stored in the array "cuv".

EX3 program stores curve data under numerical variable "d". One of the differences between EX2 and EX3 is the result array. Curve data transfer requires four bytes for each data point. Two bytes each for "X" and "Y" axis. The EX3 program automatically combines these two bytes (16 bits) and results in an integer value.