OPERATOR'S & MAINTENANCE MANUAL

Model 270

12 MHz Programmable Function Generator

Valuetronics International, Inc.
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WAVETEK

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Instrument Part Number: 1000-00-0180

SECTION 1
GENERAL DESCRIPTION

1.1 MODEL 270

The Model 270, a 0.01 Hz to 12 MHz Programmable Function Generator, can operate as a continuous, triggered, gated or burst (Option 003) signal source at output amplitudes up to 20V peak-to-peak.

The generator can produce sine, triangle and square waves, as well as dc and external width.

Output level is specified from 10 mV to 10 Vp-p into 50Ω termination and 20 mV to 20 Vp-p into an open circuit with 3 digits of resolution. Offset can be programmed to vary the waveform base line up to ±10V, or in the dc function, to vary the dc output.

The function output is protected from external overvoltages up to 140 Vac and 200 Vdc. Activation of the protection circuits causes a GPIB service request and front panel error message.

Data entry is from the front panel or GPIB (IEEE 488-1978). Numeric input is entered in free format: fixed, floating or exponential notation. Parameters may be entered in any order. Internally, all entries are interactively checked for errors and displayed on the front panel, or available through the GPIB.

Up to 200 sets of complete front panel settings can be stored in memory and rapidly recalled. The memory has a non-rechargeable lithium battery backup for at least 6 months storage (typically 1 to 2 years). A "low battery" will be indicated on the display when the battery drops below 2.4 Volts.

WARNING

This equipment uses a BR-1/2A, 3V lithium battery that contains less than 0.3 grams of lithium. To prevent the release of a potentially harmful substance, DO NOT RECHARGE, SHORT CIRCUIT, DISASSEMBLE, OR APPLY HEAT TO THE BATTERY. In addition, observe correct polarity when replacing the battery.

Instruments manufactured prior to serial number 7230039 may be limited to 80 sets of stored settings without battery back-up. But if an option (previously identified as Option 001) was installed, there will be a total of 200 sets of stored settings with non-rechargeable battery back-up as described in this manual.

1.2 OPTIONS

Option 002 relocates the four front panel BNCs to the rear panel.

Option 003 adds the burst option. The burst option allows a programmable number of cycles (up to 1,048,200) in each burst. Burst rate is 12 MHz maximum.

1.3 SPECIFICATIONS

1.3.1 Versatility

Waveforms
Programmable sine, triangle, square, square complement, external width or dc.

Operational Modes
Continuous: Output continuous at programmed frequency.
Triggered: Output quiescent until triggered by an external signal, GPIB trigger or manual trigger, then generates one cycle at programmed frequency.
Gated: As triggered mode except output oscillates for the duration of the gate signal. The last cycle started is completed.

Frequency Range
10 mHz to 12 MHz.

Outputs
Function Output: Waveforms from 0.01 to 10 Vp-p into 50Ω (0.02 to 20 Vp-p into ≥50 kΩ). DC or offset programmable from −5V to +5V into 50Ω (−10V to +10V into ≥50 kΩ). Programmable on, off high Z (>500 kΩ), or off low Z (50Ω). Absolute peak amplitude plus offset may not exceed 5V into 50Ω (10V into ≥50 kΩ).

Source Impedance: 50Ω.
Protection: Output protected to 140 Vac or 200 Vdc without replacement of internal fuse.
Sync Output: TTL level square wave into 50Ω at programmed frequency.
TTL Compatible: ≤0.4V to ≥2.4V into 50Ω, ≤0.8V to ≥4.8V into ≥50 kΩ.
Source Impedance: 50Ω.
Timing: Concurrent with main output in square; lags sine and triangle by 90°.
Over/Undershoot: <10% into 50Ω.
Protection: Output protected against ±15V input minimum.

Inputs
VCG In: 0.01 to ±12V into 10 kΩ, for up to 1200:1 frequency change. 10V gives range max. 12V gives 20% overrange.
Slew Rate: 1.0V/μs.
Trig In: Level programmable: -10 to +10V, 20 mV resolution, ±500 mV accuracy (for signals with less than 10V/μs slew rate). Programmable to trigger on - or + signal slope.
Maximum Rate: 12 MHz (24 MHz for External Width).
Minimum Width: 20 ns.
Minimum Amplitude: 500 mVp-p to 1 MHz, 1 Vp-p to 24 MHz.
Protection: Inputs protected against ±50V input minimum.

1.3.2 Precision

Frequency
Resolution: 3 digits.
Accuracy: ±2%.
Repeatability: ±1% for 24 hr.
Jitter: ≤0.1% ±100 ps.

Amplitude
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V; 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±2% of programmed value and: ±5 mV for 0.1 to 1V (pk ampl + ofst <0.5V), ±20 mV for 1.01 to 10V, ±50 mV for all other.
Repeatability (24 hr): ±1% ±10 mV.
Flatness: 0.1 dB to 100 kHz, 1.5 dB to 12 MHz for output at 5 Vp-p.

Offset
Resolution: 3 digits or 10 mV when absolute peak amplitude plus offset >0.5V, 3 digits or 1 mV when absolute peak amplitude plus offset ≤0.5V.
Accuracy: ±40 mV in DC function.
Repeatability (24 hr): ±1% ±20 mV.

1.3.3 Waveform Quality

Sine Distortion (at 5 Vp-p):
THD less than:

<0.5%	10 mHz - 99.9 kHz
No harmonics above	
−40 dBc	100 kHz - 999 kHz
−30 dBc	1 MHz - 12 MHz

Time Symmetry: ±1% ±8 ns.
Square Transition Time: <15 ns.
Square Over/Undershoot: <5% of pk-pk amplitude ±20 mV.
Triangle Linearity: 99% to 100 kHz.

1.3.4 General

GPIB Programming
IEEE 488-1978 compatible. Non-isolated. Double buffered.

Address: 0-30, keyboard or internal switch selectable. Internal switch can lock out keyboard selection. Power-up address is internal setting.

Subsets: SH1 Complete source handshake, AH1 Complete acceptor handshake, T6 Basic talker, TE0 No extended talker, L4 Basic listener, SR1 Complete service request (software selectable), RL1 Remote/local and local lockout, PP0 No parallel poll capability, DC1 Complete device clear/selective device clear, DT1 Complete device trigger capability, C0 No controller capability, E2 Tri-state drivers.

Interface Timing
Freq - 14 ms, Amplitude - 14 ms, Offset - 14 ms, Mode-7ms, Waveform-14 ms, Execute-10 ms, Other-<22 ms.

Stored Settings
Nonvolatile memory for 200 stored settings.

Environmental
Temperature Range: 25°C ±10°C for spec operation, operates 0°C to 50°C, −50°C to +75°C for storage.
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation. Sea level to 40,000 ft for storage.
Relative Humidity: 95% at 25°C and sea level (non-condensing).
Dimensions: 21.7 cm (8.54 in.) wide (half-rack), 13.3 cm (5.25 in.) high, 39.4 cm (15.5 in.) deep.
Weight: 5.9 kg (13 lb).
Power: 90 to 105, 108 to 126, 198 to 231, or 216 to 252 volts rms; 48 to 66 Hz; 1 phase; <40 watts.

1.3.5 Options

002: Rear Panel Connectors

Front panel BNC's relocated to rear panel.

003: Burst Option

Programmable number of waveform cycles in a burst. Burst length: 1,048,200 max. Burst Rate: 12 MHz max.

SECTION 2
INSTALLATION AND INTERFACE

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

The generator can be used as a bench instrument or rack mounted. The 270 can be converted to rack mounts in the field by using the following kits.

Rack Mount Kit	Part Number	Reference Drawing
Single Instrument (left, right and center mounting)	1101-00-1043	0102-00-1043
Dual Instruments	1101-00-1041	0102-00-1041
Rack Slides	1101-00-1042	0102-00-1042

NOTE

The rack slides can only be used with dual rack mounted instruments.

Whether used on a bench or in a rack, ensure that there is no impedance to air flow at any surface of the instrument. Before rack mounting, it may be desirable to perform the initial checkout (paragraph 2.2.5) to verity operation of all functions.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 120 Vac line supply and with a ½ amp fuse.

Conversion to other input voltages requires a change in rear panel fuse holder voltage card position and fuse (figure 2-1) according to the following procedure.

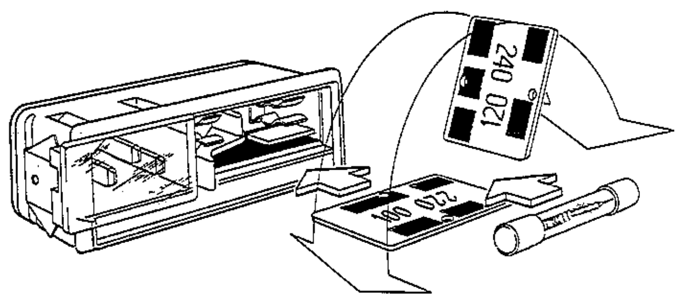


Figure 2-1. Voltage Selector and Fuse

1. Disconnect the power cord at the instrument, open fuse holder cover door and rotate fuse-pull to left to remove the fuse.
2. Remove the small printed circuit board and select operating voltage by orienting the printed circuit board to position the desired voltage to the top left side. Push the board firmly into its module slot.

Card Position	Input Vac	Fuse
100	90 to 105	3/4 amp
120	108 to 126	3/4 amp
220	198 to 231	3/8 amp
240	216 to 252	3/8 amp

3. Rotate the fuse-pull back into the normal position and insert the correct fuse into the fuse holder. Close the cover door.
4. Connect the ac line cord to the mating connector at the rear of the unit and the power source.

2.2.2 Signal Connections

NOTE

Use RG58U or equivalent 50Ω coaxial cables equipped with BNC connectors to distribute signals.

Instrument BNC connectors are:

TRIG IN. Acceptable trigger level and slope are programmable; −10 to +10 volts; 10 kΩ impedance.

SYNC OUT. TTL level square wave; 50Ω impedance

FUNC OUT. Up to 10 Vp-p into 50Ω impedance; up to 20 Vp-p into >50 kΩ impedance.

VCG IN. 0.01 to 12V; 10 kΩ impedance.

Signal ground may be floated up to ±42 volts with respect to chassis ground. Be aware that all signal grounds are common; thus, if one signal ground requires floating, all grounds must be floated together.

2.2.3 GPIB Connections

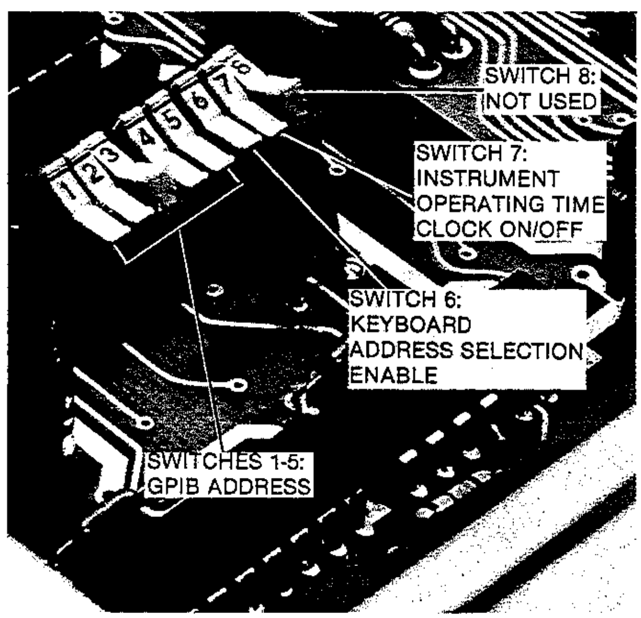
The GPIB I/O rear panel pin connections and signal names are given in table 2-1. The panel connector is an Amphenol 57-10240 or equivalent and connects to a GPIB bus cable connector (available from Wavetek in 1 and 2 meter lengths).

2.2.4 GPIB Address

For instruments on the General Purpose Interface Bus (GPIB), ensure that the instrument GPIB address is correct. The GPIB address can be changed by the internal switch (for access, remove the bottom cover, see figure 2-2) or the front panel GPIB ADRS key (e.g., ADRS 4 EXEC). The switch sections are labeled from 1 through 5 and their OFF position noted (OFF = Binary "0" in table 2-2). To verify the address, press ADR on the front panel. The device number (decimal) will be displayed. Upon power-up, the address is always that of the internal switch.

Table 2-1. GPIB Data In/Out

Pin	Signal	
1	DIO1	True When Low
2	DIO2	True When Low
3	DIO3	True When Low
4	DIO4	True When Low
5	EOI	True When Low
6	DAV	True When Low
7	NRFD	True When High
8	NDAC	True When High
9	IFC	True When Low
10	SRQ	True When Low
11	ATN	True When Low
12	Chassis Ground (⏚)	
13	DIO5	True When Low
14	DIO6	True When Low
15	DIO7	True When Low
16	DIO8	True When Low
17	REN	True When Low
18		Signal Ground (⏚)
19		Signal Ground (⏚)
20		Signal Ground (⏚)
21		Signal Ground (⏚)
22		Signal Ground (⏚)
23		Signal Ground (⏚)
24		Signal Ground (⏚)



NOTE: GPIB ADDRESS SELECTED IS DECIMAL 4: SWITCH 1 OFF, 2 OFF, 3 ON, 4 OFF, 5 OFF. (TABLE 2-2: 00100)

Figure 2-2. GPIB Address Selector Switch

Table 2-2. GPIB Address Codes

Device	ASCII		Switch Position					Hexa-decimal	
	Listen	Talk	1	2	3	4	5	Listen	Talk
0	(space)	@	0	0	0	0	0	20	40
1	!	A	1	0	0	0	0	21	41
2	"	B	0	1	0	0	0	22	42
3	#	C	1	1	0	0	0	23	43
4	$	D	0	0	1	0	0	24	44
5	%	E	1	0	1	0	0	25	45
6	&	F	0	1	1	0	0	26	46
7	'	G	1	1	1	0	0	27	47
8	(	H	0	0	0	1	0	28	48
9	)	I	1	0	0	1	0	29	49
10	*	J	0	1	0	1	0	2A	4A
11	+	K	1	1	0	1	0	2B	4B
12	,	L	0	0	1	1	0	2C	4C
13	—	M	1	0	1	1	0	2D	4D
14	•	N	0	1	1	1	0	2E	4E
15	/	O	1	1	1	1	0	2F	4F
16	0	P	0	0	0	0	1	30	50
17	1	Q	1	0	0	0	1	31	51
18	2	R	0	1	0	0	1	32	52
19	3	S	1	1	0	0	1	33	53
20	4	T	0	0	1	0	1	34	54
21	5	U	1	0	1	0	1	35	55
22	6	V	0	1	1	0	1	36	56
23	7	W	1	1	1	0	1	37	57
24	8	X	0	0	0	1	1	38	58
25	9	Y	1	0	0	1	1	39	59
26	:	Z	0	1	0	1	1	3A	5A
27	;	[	1	1	0	1	1	3B	5B
28	<	\	0	0	1	1	1	3C	5C
29	=	]	1	0	1	1	1	3D	5D
30	>	↑	0	1	1	1	1	3E	5E

NOTE

Address 31 is not allowed.

2.2.5 Initial Checkout and Operation Verification

Make the equipment setup as shown in figure 2-3 and perform the steps in table 2-3 to verify Model 270 operation. If further explanations are required, refer to figure 3-1 and table 3-1.

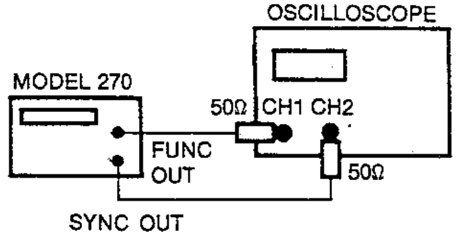


Figure 2-3. Setup

Table 2-3. Initial Checkout

Step	Test	Tester & Setup	Program	Desired Results
1	Wake-up State		Power: ON	Display: All segments, decimal points and commas light up for 1 sec (, typical of 20) then displays: WAVETEK MODEL 270
2	Wake-up Status		Press STAT key	Display (changes automatically): FREQ 1 KHz AMPLITUDE 5V OFFSET 0V MODE CONTINUOUS (0) FUNC SINE (0) NO BURST OPTION or BURST COUNT 2 OUTPUT OFF (0) TRIG SLOPE POS (0) TRIG LEVEL 1.5V
3	Status Search		STAT	Status display sequence stops.
4			↑	Status progresses forward.
5			↓	Status progresses backward.
6			STAT	Status display automatic sequence continues.
7	Display Test		DISP TEST	All segments, decimal points and commas light up. Back to last display when key released.
8	Beeper Test		Press FREQ key a few times	Beeper sounds everytime key is pressed.
9			Press ♪ then FREQ key a few times	Beeper is silent.
10			♪	Beeper enabled.
11	Command Recall		Press each of the 6 keys in the MAIN generator section 4 times then CMD RCL	Strings of characters shown on display. Characters are the ones shown on lower left of each key.

Table 2-3. Initial Checkout (Continued)

Step	Test	Tester & Setup	Program	Desired Results
12			Press → then ←	Moves characters right then left 4 at a time.
13	GPIB Address And Status		ADRS 1 EXEC then 30 EXEC	Display: GPIB ADRS 1 then GPIB ADRS 30
14	Quality Assurance Procedure	Connect Model 270 and oscilloscope as shown in figure 2-3. Scope setting: CH1 2 V/div, horizontal 0.2 ms/div; CH2 2 V/div; trigger on CH2.	Press: RCL 2000 EXEC	Display: (0) BEGIN QA PROC Scope: CH1 5 Vp-p 1 kHz sine wave CH2 2.5 Vp-p 1 kHz square wave
15	Frequency: Exercises Each Frequency Bit and the Sine Wave Function.		Press: CURSOR ↑ once.	Display: (1) FREQUENCY Scope: CH1 5 Vp-p sine wave continuously sweeping from 1 kHz to 10 kHz. CH2 2.5 Vp-p square wave synchronous with CH1.
16	Amplitude: Exercises Each Amplitude Bit and the Triangle Wave Function.		Press: CURSOR ↑ once.	Display: (2) AMPLITUDE Scope: CH1 1 kHz triangle wave, amplitude continuously increases from 1V to 10 Vp-p. CH2 2.5 Vp-p square wave synchronous with CH1.
17	Offset: Exercises Each DC Offset Bit and Square Function.		Press: CURSOR ↑ once.	Display: (3) OFFSET Scope: CH1 1 Vp-p square wave. DC offset continuously increases from −4V to +4V. CH2 2.5 Vp-p square wave synchronous with CH1.
18	Trigger Circuit	Trigger Scope on CH1.	Press CURSOR ↑ once.	Display: (4) TRIGGER Scope: CH1 5 Vp-p 1 msec pulse. CH2 2.5 Vp-p 100 μs pulse, delayed 50 μs relative to positive edge CH1.
19	Gate Circuit		Press: CURSOR ↑ once.	Display: (5) GATE Scope: CH1 5 Vp-p 1 msec pulse. CH2 2.5 Vp-p Pulse burst: six 100 μs pulses.
20	Burst (Option 003 Not Installed). (Option 003 Installed)		Press: CURSOR ↑ once.	Display: NO BURST OPTION. Scope: Same as step 19. Display: (6) BURST Scope: CH1 5 Vp-p pulse with pulse width continuously stepping from 1.6 down to 0.2 ms. CH2 2.5 Vp-p 100μs pulse continuously stepping from 9 down to 2.
21	Quiescent State of Outputs		Press: CURSOR ↑ once.	Display: (7) END QA PROC Scope: CH1 −2.5 Vdc. CH2 0 Vdc.

SECTION 3
OPERATION

3.1 DATA ENTRY

Using the Model 270 is quite straightforward and easily understood by trial and error while the microprocessor "converses" with you during operation, informing you what was programmed, what is possible to program and when an error is made. Perform the procedures of table 2-3 to familiarize yourself with Model 270 operation. Key groups on the keyboard are shown in figure 3-1 and cross referenced to table 3-1, which in turn references the applicable text. Readouts that occur when keys are pressed are listed in Appendix C. When the operator starts keying in the parameter, no unit of measure is displayed until the parameter is terminated by a key other than a numerical entry key. Coded parameters, such as function, mode and output show their programmed argument in parentheses.

An audible tone indicates when a key is pressed. Pressing ♪ will prevent or restore the key tone. If there is no tone when keys are pressed, pressing ♪ restores the tone and vice versa.

Information exclusive to the GPIB is given in paragraph 3.15.

Additional reference information appears in the appendixes:

Appendix A - ASCII and IEEE (GPIB) Code Chart
Appendix B - Programming Command Summary
Appendix C - Displays
Appendix D - Output and Timing for Basic Modes and Functions.

3.2 POWER

Power is turned on and off with a front panel pushbutton. When the power is turned on, the entire display lights up for a display element test. Then after about 1 second, "WAVETEK MODEL 270" is displayed. When the power comes on, the output is automatically disabled.

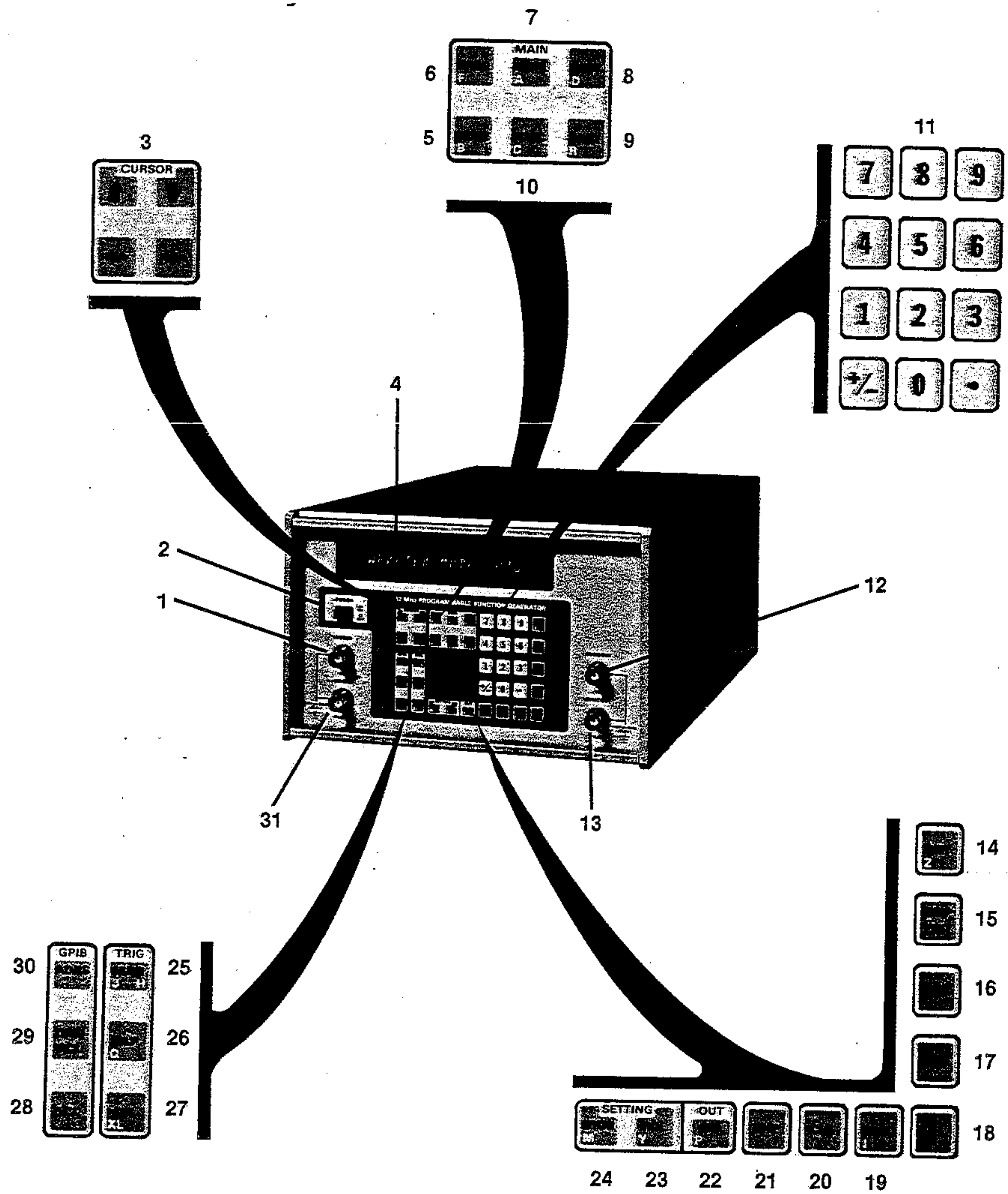
3.3 BASIC COMMAND STRUCTURE

The Model 270 is programmed by sending ASCII coded characters (ref: table 3-1 and Appendix A) to the microprocessor via one of the two possible input ports (keyboard or GPIB) shown in figure 3-2. If input characters are present on more than one input port, they are read first from the GPIB and then from the keyboard. Thus, if the GPIB port is continuously supplied with characters, then no characters will ever be read from the keyboard and the keyboard will appear dead to the user.

3.3.1 Characters

Characters used to program the 270 are divided into classes:

1. **Alphabetic Characters**—The characters A through Z (except E) select actions or commands. The X character used in front of another alphabetic character selects an alternate set of actions or commands. The X must directly precede the alphabetic character without intervening characters of any kind. For example, F selects frequency and XF selects percent frequency, but X F (where is a space character) selects frequency not percent frequency because a space character, not X, was placed immediately before the F. Alphabetic characters are generated from the keyboard by pressing the labeled action and parameter keys. The characters generated by such keys are printed in a corner of the key.
2. **Numeric Characters**—The characters 0 through 9, E, –, and decimal point (.).
3. **Special Character**—Quote (').



NOTE: Features are keyed to Table 3-1

Figure 3-1. Controls and Connectors

Table 3-1. Function Cross Reference

Location in Figure 3-1	ASCII Character	Function	Action (A) or Parameter (P)	Paragraph
1	———	VCG Input	———	3.8.1.3
2	———	Power	———	3.2
3	———	Cursor	A	3.6
4	———	Display	———	3.15.9
5	B	Mode	P	3.8.5
6	F	Frequency	P	3.8.1.1
7	A	Amplitude	P	3.8.2
8	D	Offset	P	3.8.3
9	R	Burst	P	3.8.6
10	C	Function	P	3.8.4
11	0 thru 9, •, ±	Number Characters	P	3.3.1
12	———	Function Output	———	3.10.1
13	———	Sync Out	———	3.10.4
14	Z	Reset	A	3.12
15	———	Display Test	A	3.13
16	———	Status	A	3.14
17	———	Service Request	A/P	3.15.5
18	———	♪ (Tone On/Off)	A	3.1
19	I	Execute	A	3.5
20	———	Clear	A	3.11
21	E	Exponent	P	3.3.3
22	P	Output On	P	3.10.2
23	Y	Recall Settings	P	3.9.2
24	M	Store Settings	P	3.9.1
25	J	Manual Trigger Pressed	A	3.7
25	H	Manual Trigger Released	A	3.7
26	Q	Trigger Slope	P	3.7
27	XL	Trigger Level	P	3.7
28	———	Local Control Enable	A	3.15.8
29	———	Command Recall	A	3.15.10
30	———	GPIB Address	A	3.15.2.1
31	———	Trigger Input	———	3.7
———	XU	Recall Next Lesser Numbered Program	A	3.9.2
———	XW	Recall Next Greater Numbered Program	A	3.9.2
———	XG	GET Mode	P	3.15.7
———	XQ	SRQ Mode	P	3.15.5.1
———	XT	Talk Message	P	3.15.4
———	XV	Terminator Select	P	3.15.6
———	XF	Percent Frequency	P	3.8.1.2

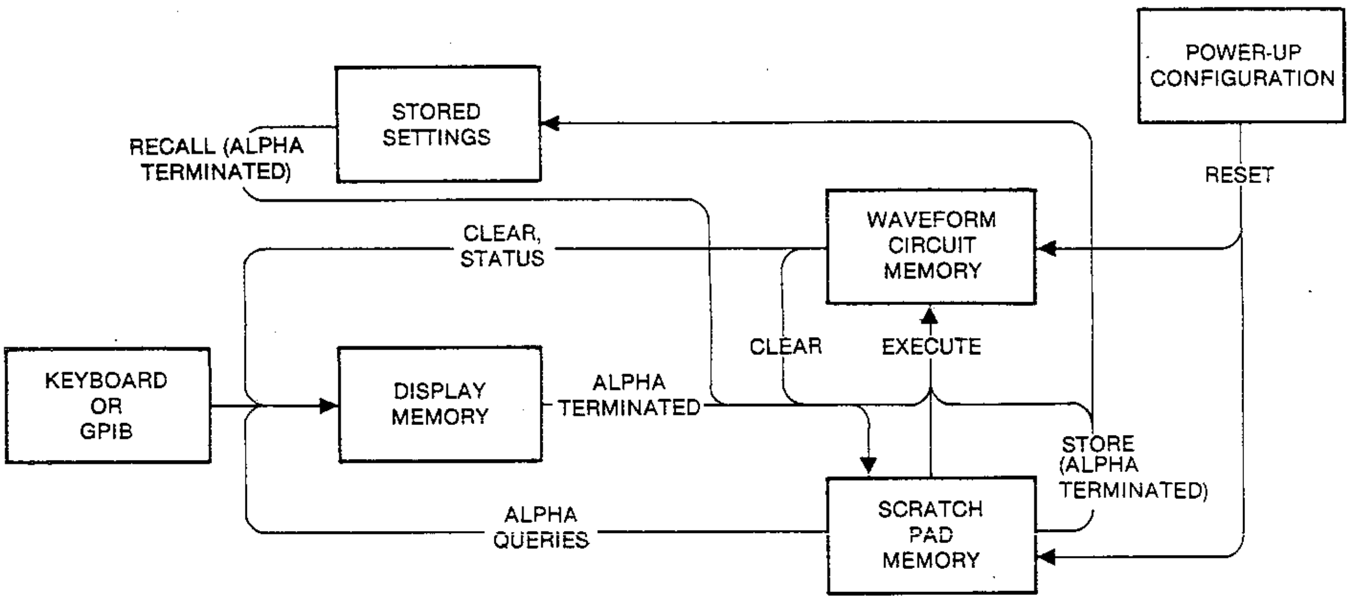


Figure 3-2. Memory Structure

4. **Terminator Character**—Initially the ASCII new line character (NL). This can be changed by programming.
5. **Nonprogramming Characters**—Any character not in one of the previously described classes. They have no effect on programming and may be interspersed freely among programming characters, except after X (refer to item 1).

3.3.2 Action Vs Parameter

The alphabetic characters are used to select either actions or parameters (ref: table 3-1). An action is a sequence of events which happens when the letter that selects it is programmed or the key that selects it is pressed. There is no need for a numberical suffix. A programming parameter has one or two letters (and most have keys) plus a numeric value which controls some aspect of the instrument's operation.

To program an action, simply program the proper alphabetic character from either the front panel or GPIB port. The action will then take place, but only if the instrument is in the *enable* state at the moment when that character is read by the microprocessor (ref: REN, paragraph 3.15.1).

To examine the current value of a parameter, simply program the proper alphabetic character from either the front panel or GPIB port. The current value is then displayed on the front panel. Display occurs whether or not the instrument is enabled. If the character programmed does not correspond to a legal parameter in the instrument, nothing happens.

3.3.3 Programming Parameter Values

The numeric characters (**0** through **9**, **E —**) are used to program new parameter values. Data entry is free format, i.e., fixed point, floating point and exponential notation, or scientific notation.

Fixed Point — Decimal remains at far right.
Floating Point — You program the decimal point. It floats to the left in its designated position as you enter more numerals.
Exponential Notation — A value, then **E** followed by the exponent of a times ten multiplier. When the value (mantissa) is limited to one digit, exponential notation is called scientific notation.

To change a parameter value, first program the alphabetic character which selects the desired parameter (**F** = frequency, etc.). Next, program the new value using numeric characters. Any sequence of characters which gives the new value is acceptable. For example, all of the sequences in table 3-2 cause the value 100 to be programmed.

The numbers to the left of the **E** are the mantissa; the digits to the right (only two are allowed) are the exponent. The result value is the mantissa times 10 to the exponent power: for example 9.99 E2 = 9.99×10^2 = 999.

Table 3-2. Examples of Value Programming

ASCII	Keyboard	Standard Notation
100	100	100
0100	0100	100 (leading zeroes are ignored)
1E2	1 EXP 2	1×10^2
.01E4	.01 EXP 4	$.01 \times 10^4$
.01E304	.01 EXP 304	$.01 \times 10^4$ (last two exponent digits only are used)
1000E-1	1000 EXP ±1	1000×10^{-1}
1E-2-	1 EXP ±2 ±	$1 = 10^2$ (two minus signs cancel)
1E.2	1 EXP .2	1×10^2 (decimal points in exponent are ignored).

Only one decimal point and one E (keyboard EXP) are allowed per number; additional ones are ignored. The sign toggle character may appear any number of times. It causes the sign of the mantissa (if E has not been programmed) or the exponent (if E has been programmed) to be reversed (if negative, then positive, and vice versa) each time it appears. Any number of nonprogramming characters may be interspersed with the numeric characters, as they have no effect. If an undesired value is entered prior to execution (I or keyboard EXEC), the CLR key can be used to erase it.

Several parameters required codes for specific selections; for example, function codes 0 through 3 select sine wave, triangle wave, square wave and complement square wave. Refer to Appendix B for codes.

Since the number input format is so general, the microprocessor must be told when the last numeric character has been entered so it can evaluate the number. This is done by programming either an alphabetic, special or terminator character. When this is done, the new value is rounded off (ref: table 3-3) and tested to see if it is a legal value for the setting being changed (ref: paragraph 3.4). If it is legal, the new value is entered into the instrument's scratch pad memory; however, it is not yet sent to the waveform circuits. That is usually done by programming the I action (EXEC key on the front panel). Other methods of execution are GET and cursor, which are described later. An asterisk (*) on the display indicates that the new parameter value programmed has not been executed and resides in scratch pad memory only (ref: figure 3-2). All parameter values may be erased before execution by using the CLR key, the value stored in scratch pad is erased and the original value is displayed.

Table 3-3. Round Offs

Parameter	Resolution
Frequency	Up to 3 digits, 0.1 mHz minimum.
Amplitude and Offset	
Absolute Peak Amplitude Plus Offset >0.5V	Up to 3 digits, 10 mV minimum.
Absolute Peak Amplitude Plus Offset ≤0.5V	Up to 3 digits, 1 mV minimum.
Trigger Level	Up to 3 digits, 20 mV minimum.
All Other Parameters	To nearest integer.

3.4 ERRORS

When an illegal value is programmed or interdependent parameter errors are detected, an error signal is indicated on the front panel or GPIB. Keyboard class 1, 2 and 3 errors are indicated on the front panel display and by a double "beep" of the key tone. For errors made via the GPIB (but not the keyboard), the service request line (SRQ) is asserted, providing a service request mode (XQ) has been selected (ref: paragraph 3.15.5). The controller can then serial poll its instruments to verify that the 270 sent the SRQ and can then inquire as to the nature of the 270 error. The method of reporting errors on the GPIB is given in paragraph 3.15.4.

3.4.1 Class 1 Errors

Class 1 errors are caused by programming values outside the legal limits of the parameter being programmed. For example, programming an amplitude of 500 volts will cause a parameter error when the next alpha character is programmed. At this time, the 270 disregards the new values and retains the previously programmed values in scratch pad memory (see figure 3-2).

3.4.2 Class 2 Errors

Class 2 errors are interparameter inconsistencies, such as the dc offset and peak amplitude greater than 5V into 50Ω. Tests are made every time an execute (I) is given, a setup is stored (M) or a cursor key is pressed. Resulting errors are displayed, and transfers of values are made to waveform circuits or storage regardless of the error indicated. Notice that upon receiving a Group Execute Trigger (refer to paragraph 3.15.7), the 270 programmng is executed without error checking.

3.4.3 Class 3 Error

Class 3 error occurs if an empty stored setting is retreived. The error is displayed and the state of the 270 remains unchanged from the previously executed program.

3.5 EXECUTING THE PROGRAM

A program or setting can be executed, i.e., transferred to the waveform circuits by execute commands, GET (Group Execute Trigger) command, and the action keys: CURSOR ↑ and CURSOR ↓.

GPIB I and the front panel EXEC key are execute commands that cause parameter value and inter-parameter tests to be made and transfer the programmed values to the waveform generation circuits.

GET is a GPIB only command (no front panel key) that causes the 270 to execute and trigger, but without time consuming microprocessor error checks (ref: paragraph 3.15.7).

CURSOR ↑ and CURSOR ↓ are exclusively front panel functions which perform an execute with error checks after each digit increment or decrement.

GPIB Z and the front panel RESET are commands which reset the 270 to the original power up conditions (as described in table 2-3, step 2) and perform an automatic execute.

An asterisk (*) on the display indicates that the new parameter value programmed has not been executed and resides in scratch pad memory only (ref: figure 3-2).

3.6 CURSOR

The four cursor keys can modify a parameter value or code.

NOTE

The modified value is automatically executed.

The ← and → cursor keys move the cursor left and right; cursor position indicated by a flashing digit on the display. The ↑ and ↓ cursor keys increment and decrement, respectively, the flashing digit. Holding a cursor key down causes a continued change at a constant rate.

The ↑ and ↓ keys can also increment and decrement parameter codes, such as function and mode codes. Cursor positioning (← →) is not necessary for codes and codes do not flash to indicate cursor position.

When storing a program, press STORE key and then ↑. The program will be stored in the next memory location in numerical sequence. Keys ↑ and ↓ can also be used to recall stored settings in numerical sequence.

Cursor ← and → keys increment change command recall and error displays by shifting the display 4 characters to the left or right, respectively.

3.7 TRIGGER, LEVEL AND SLOPE

Triggered and gated modes of the main generator are initiated by trigger. Triggers are: an external signal at the TRIG IN BNC on the front panel, manual trigger at MAN TRIG key on the front panel or **J** (and **H**) commands via the GPIB.

J (pressing MAN TRIG) - Start trigger for the main generator. In gated mode, the main generator is gated on.

H (releasing MAN TRIG) - In gated mode, terminates the output of the main generator (the last cycle started is always completed).

Q followed by its code selects triggering either on the rising edge of the trigger signal or the falling edge:

Q0 Selects triggering on the rising edge (↗) of the trigger signal.

Q1 Selects triggering on the falling edge (↘) of the triggering signal.

XL followed by its value selects the signal trigger level. The value can be in the −10 to +10 Vdc range with 3 digit resolution.

3.8 GENERATOR

The following sections describe the primary parameters related to generator operation. The block of keys envolved is labeled MAIN on the front panel.

3.8.1 Frequency

Direct frequency programming, percentage frequency programming and voltage controlled frequency (VCG) are discussed in these sections.

3.8.1.1 Frequency (F)

Selecting **F** followed by a value programs, in hertz, the generator frequency.

Frequency data entry is free format entry: fixed point (F1000), floating point (F10.1), and exponential notation (F10E3).

Each time a frequency is programmed the 270 microprocessor determines the best one of nine internal frequency ranges for operation. Each frequency range and its limits are shown in table 3-4. Firmware automatically changes frequency ranges as necessary. These are ranges associated with ASCII **F** programming, as opposed to ASCII **XF** (ref: paragraph 3.8.1.2) programming or VCG (ref: paragraph 3.8.1.3) operation.

3.8.1.2 Percent Frequency (XF)

XF, a GPIB exclusive parameter, followed by a value (0 to 100) programs frequency in percent of frequency range (0 to 100% in 0.1% increments).

Internal to the 270, there are nine decade ranges as shown in table 3-4. Maximum frequency is limited to 100% of a range; for example: the 10^6 range is limited to 10 MHz. The minimum frequency can be programmed to 0% with derated frequency accuracy. At 0%, the actual output frequency may be 0 Hz.

3.8.1.3 VCG Frequency

A signal, either dc or ac, applied to the VCG IN BNC can be used to externally control the frequency of the FUNC OUT signal. A positive voltage applied to the VCG IN connector will increase the generator frequency within a range, and a negative voltage will decrease the frequency within a range.

Frequency, using the VCG IN, can only be changed within a frequency range. Table 3-4 shows the nine frequency ranges, internal to the 270, and the limits for each range.

Figure 3-3 illustrates the VCG voltage required to change the programmed frequency to a desired output frequency. Frequency range must be selected before applying the VCG signal. For example, if 500 Hz is programmed, the 270 selects the 10^2 range (ref: table 3-4). As shown in the example of figure 3-3, the "Frequency Mantissa of Program" is 5 and a 5V "VCG IN" changes the "Frequency Mantissa of Output' to 10. Since operation is in the 10^2 range, output frequency is 1 kHz. Another example is a 1200:1 frequency sweep from 1 kHz to 1.2 MHz using 0.01 to 12.0 volt VCG signal. Table 3-4 shows that the frequency range is 10^5. To get in that range, program an value in the 10^5 "F" range. Next, program **F0**, from which, the 0.01 VCG voltage will cause the output to be 1 kHz, and a 0.01 to 12 volt VCG input will cause a 1 kHz to 1.2 MHz frequency sweep.

3.8.2 Amplitude

An **A** followed by a value (up to 3 digits) programs the amplitude at the function output. Amplitude is programmed in volts peak-to-peak from 10 mV to 10 Vp-p specified into a 50Ω load. See table 3-2 for value programming, table 3-3 for round offs, and paragraph 3.10 for function output.

Amplitude and offset resolution is dependent upon the sum of the peak amplitude and offset voltages. When the peak amplitude plus the offset voltage is greater than 0.5V, amplitude and offset resolution is limited to 10 mV. Yet, the amplitude and offset resolution is 1 mV when the peak amplitude plus offset is less than 0.5V.

Table 3-4. Internally Selected Frequency Ranges

RANGE NAME	ACTUAL RANGES (Hz)* "F" RANGES**	"XF" RANGES	VCG RANGES
10^6	1.00M - 12.0M	0 - 10.0M	10.0k - 12.0M
10^5	100k - 999k	0 - 1.00M	1.00k - 1.20M
10^4	10.0k - 99.9k	0 - 100k	100 - 120k
10^3	1.00k - 9.99k	0 - 10.0k	10.0 - 12.0k
10^2	100 - 999	0 - 1.00k	1.00 - 1.20k
10^1	10.0 - 99.9	0 - 100	100m - 120
10^0	1.00 - 9.99	0 - 10.0	10.0m - 12.0
10^{-1}	100m - 999m	0 - 1.00	1.00m - 1.20
10^{-2}	10.0m - 99.9m	0 - 100m	100μ - 120m

* "F" ranges are applicable to keyboard and GPIB operation where parameter **F** is used.
"XF" ranges are applicable to GPIB operation where percentage frequency parameter **XF** is used.
VCG ranges are applicable when external voltage is used to control frequency.

** Firmware automatically selects "F" ranges regardless of the format used in programming frequency.

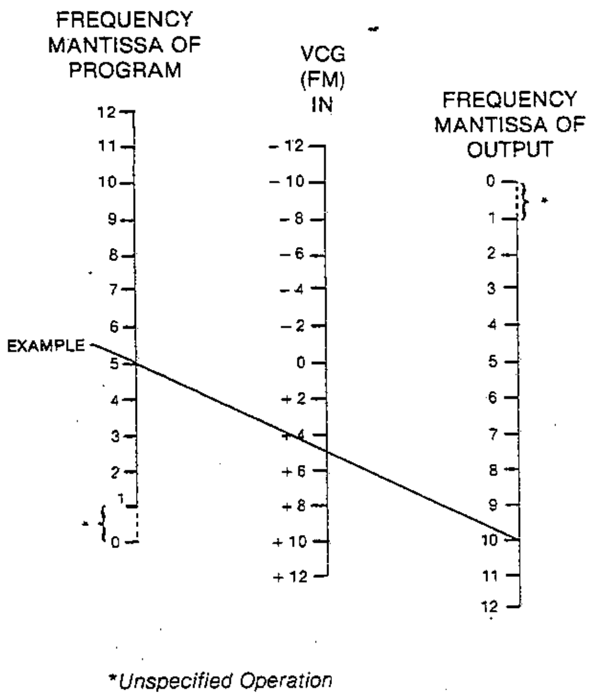


Figure 3-3. VCG (FM) Nomograph

3.8.3 Offset

D followed by a value (up to 3 digits) offsets the function output from 0 to ±5V specified into a 50Ω load. Offset is programmed in volts dc. See table 3-2 for round offs, and paragraph 3.10 for function output and load operation. Offset value may be modified by the cursor (ref: paragraph 3.6).

Amplitude and offset resolution is dependent upon the sum of the peak amplitude and offset voltages (ref: paragraph 3.8.2).

3.8.4 Function

C followed by a single digit parameter value selects function at the FUNC OUT BNC. Five function codes are used.

C0 Selects sine wave.

C1 Selects triangle wave.

C2 Selects square wave in phase with SYNC OUT.

C3 Selects complement square wave 180° out of phase with SYNC OUT.

C4 Selects dc output voltage. The dc level is set by programming offset as described in paragraph 3.8.3.

C5 Selects external width. In external width, the output pulse period and width is fixed by the trigger signal, while output level is adjustable by normal programming (ref: figure 3-4).

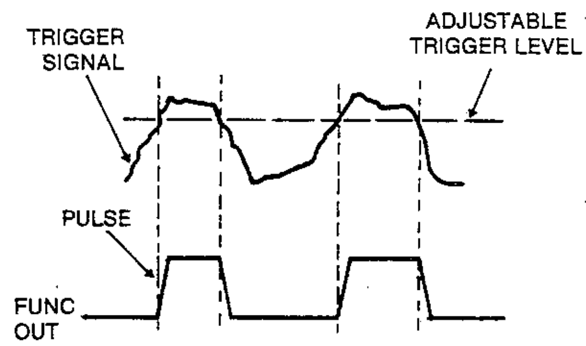


Figure 3-4. External Width

External width requires no mode selection but requires trigger slope and level selection; refer to paragraph 3.7.

Pulse width is between the manual trigger push and release, ASCII **J** and **H** via the GPIB, or TRIG IN signal crossing and recrossing the trigger level value.

3.8.5 Modes

B followed by its code (0 through 2) selects the operating mode. The selected mode is indicated on the front panel readout when the MODE key is pressed. Two modes depend on a trigger. Refer to paragraph 3.7 for trigger slope and level selection.

B0 Selects continuous operation of the main generator.

B1 Selects triggered mode. The generator is triggered by external signal, manual trigger, or GPIB commands. When triggered, one cycle is generated.

B2 Selects gated mode. The onset of the trigger, regardless of its source (ref: mode **B1**), enables the generator for the duration of the trigger signal plus the time required for the completion of the last cycle started.

B3 Selects burst mode (Option 003). Burst is the output of a preprogrammed number of cycles each time the generator is triggered (ref: paragraph 3.8.6).

3.8.6 BURST

R followed by a value (1 to 1,048,200) denotes the number of cycles in a burst. Duration of a burst is dependent upon the programmed frequency. Because burst mode is a triggered function, trigger slope and level (ref: paragraph 3.7) must be programmed.

3.9 STORED SETTINGS

Up to 200 different sets of front panel settings can be stored in and recalled from Random Access Memory (RAM). Nonvolatile memory is battery backed for 6 month (minimum) retention of settings.

WARNING

This equipment contains a BR-½A, 3V lithium battery, that contains 0.3 grams of lithium. To prevent the battery from releasing a potentially harmful substance, DO NOT RECHARGE, SHORT CIRCUIT, DISASSEMBLE, OR APPLY HEAT TO THE BATTERY. In addition, observe correct polarity when replacing the battery.

3.9.1 Storing Program Sets

Program sets may be stored by keyboard or GPIB command. To store the program set that is in scratch pad memory (ref: figure 3-2), enter **M** followed by the storage location (1 through 200). The next alpha programmed is the terminator, which allows the storage to occur. If a program was previously stored in that location, it will be erased and replaced by the new set. When a program is stored, the settings are tested for errors in the same manner as with an execute command (ref: paragraph 3.5). The program is always stored, whether or not errors were detected. Programs can be stored without interrupting the output of the 270 if a terminator other than EXEC (I) is used: this is possible because it is the scratch pad memory that is stored rather than the actual settings of the waveform circuits (ref: figure 3-2). Notice that during 270 operation, scratch pad memory can be changed and stored without affecting 270 output.

3.9.2 Recalling Stored Programs

The information stored in a program may be recovered either from the front panel or by a command over the GPIB. To recall, program a **Y** followed by the number of desired program. When the next alpha entry is made, the settings stored in the selected program are transferred to display memory and the scratch pad memory (ref: figure 3-2). Then data is available to be sent to the waveform circuitry of the instrument, or, if desired, it may be examined and altered by use of the front panel keys.

The identifying numbers of programs in RAM range from 1 through 200. If the number of a program which does not exist or an illegal identifying number is programmed, an error will result.

A special location, RCL 0, contains the last executed settings. When power is turned off, RCL 0 contains the last executed settings prior to power off.

Pressing the cursor ↑ key or programming **XW** causes the program next in sequence after the last program accessed to be recalled. This provides an automatic way to recall a sequence of programs. However, the programs need not be numbered consecutively. If there is no program following the last program accessed, an error occurs.

Pressing the cursor ↓ key or programming **XU** is similar to the cursor ↑ or **XW** action previously described, except that programs are recalled in descending numeric order.

3.9.3 High Speed Recall of Stored Programs

The Group Execute Trigger (GET) allows a rapid GPIB recall of stored programs. In the GET mode of operation, the program is recalled and executed, and the waveform circuits are triggered, all within 2.5 ms of receiving the GET command. There are three possible modes of GET operation (ref: paragraph 3.15.7). There is no error checking in GET mode.

3.9.4 Deleting Programs

To delete a program, program the letter **M** followed by a *minus* sign and a number (except 0) of the program to be removed. When the number is terminated (by the next alpha character), the program is removed from storage; there is no other effect.

3.10 OUTPUTS

3.10.1 Function Output

At power-up and reset the FUNC OUT signal is turned off.

3.10.2 Output On/Off

P followed by a code switches the output on or off.

P0 Internally disconnects the signal from the FUNC OUT BNC (as described in paragraph 3.10.1) making the signal unavailable at the connector. In **P0**, the function output presents a high source impedance at the BNC.

P1 Internally connects the signal to FUNC OUT BNC.

P2 Internally disconnects the signal from FUNC OUT making the signal unavailable. The function output source impedance is approximately 50Ω.

3.10.3 Output Protection

The function output is protected from short circuits and external overvoltages to over 200 Vdc or 140 Vac without damage to internal circuits.

Overvoltages are handled by using two methods: an overvoltage protection circuit and an output protection fuse.

The overvoltage protection circuit will detect external voltages of greater than ±15 Vdc and less than 200 Vdc or 140 Vac at the function output BNC and disconnect the output amplifier from the function output. The disconnection time is approximately 2 ms, but time can vary depending upon the level of the external voltage.

The output protection fuse will blow when an external voltage exceeds 200 Vdc or 140 Vac. When the fuse is blown, the display shows OUTPUT FUSE BLOWN, providing the function out is terminated with 50Ω, during one of the following cycles: after selecting Reset, at power up, after output on/off, or during the internal protection check. If the fuse is blown, remove the top cover, pull out the fuse (located at the rear of the main board), turn the fuse over and insert it. If the display continues to read OUTPUT FUSE BLOWN, replace with a new fuse block (Wavetek part number 1208-00-0977).

3.10.4 Sync Outputs

The SYNC OUT is a 0V to approximately 5V (TTL) signal from a 50Ω source. SYNC OUT is coincident with FUNC OUT. Timing relationships are shown in Appendix D.

3.11 CLEAR ENTRY

The CLR key erases a parameter value which is being entered. The key removes the numeric digits entered after the last parameter letter entry but prior to execution. A clearable entry can be identified by either of two methods: an asterisk preceding the parameter or a cursor line (_) following the last number. The display is replaced by the previous value (scratch-pad value) of the parameter being programmed.

3.12 RESET

The RST key returns the 270 waveform parameters to their power-on condition. The readout becomes "RESET". Significant parameters values and conditions are given in table 2-3, step 2.

3.13 DISPLAY TEST

The DISP TEST key lights all 20 sets of character segments and semicolon as shown in table 2-3 step 1.

3.14 STATUS

Pressing STAT automatically displays the current waveform generator status one parameter and value at a time (ref: Appendix C). When STAT is pressed a second time the cycling immediately stops.The parameters can then be manually searched by using the CURSOR (↓ or ↑) keys (ref: table 2-3, steps 3 through 6).

3.15 GPIB

Almost all of the information in Section 3 is applicable to the General Purpose Interface Bus (GPIB) programming of the 270, but the information in this paragraph is *exclusive* to the GPIB.

The GPIB interface is an implementation of IEEE Standard 488-1978. It supports the following interface functions: SH1-Complete source handshape, AH1-Complete acceptor handshake, T6-Basic talker, TE0-No extended talker, L4-Basic listener, SR1-Complete service request (software select), RL1-Remote/local and local lockout, PP0-No parallel poll capability, DC1-Complete device clear/selective device clear, DT1-Complete device trigger capability, E2-Tri-state drivers. The talk capability allows a device to send data (such as error message readings) out over the bus. The listen capability allows a device to receive data (such as device programming information) from the bus.

3.15.1 Bus Lines Defined

The GPIB consists of 16 negative true signal lines:

DIO1 - DIO8	Data In/Out Lines
ATN	Attention
REN	Remote Enable
DAV	Data Available
NRFD	Not Ready For Data
NDAC	Not Data Accepted
EOI	End Or Identify
SRQ	Service Request
IFC	Interface Clear

1. **DIO1 - DIO8**—These eight lines (Data IN/Out) are used to send commands from the controller and transfer data back and forth between instruments and the controller.

2. **ATN**—This line (Attention) is operated only by the controller. It specifies whether the information on lines DIO1 - DIO8 is data (ATN false) or a command (ATN true). Whenever ATN is set true, no activity is allowed on the bus except for controller-originated messages; additionally, every device connected to the bus is required to receive and process every command sent by the controller.
3. **REN**—This line (Remote Enable) controls whether devices on the GPIB are in local or remote modes. In local mode, devices respond to front panel commands and do not respond to GPIB originated commands. In remote mode, the situation is reversed: GPIB originated commands are obeyed, while front panel commands are ignored. The 270 enters the remote state when it receives its listen address (ref: paragraph 3.15.2.1) and REN is enabled. The 270 then stays in the remote mode until the REN line is put in the local state, a Go To Local (GTL) command is received or the LCL front panel key is pressed (ref: paragraph 3.15.2.4, item 4).
4. **DAV, NRFD, NDAC**—These are the "handshake" lines (Data Valid, Not Ready For Data and Not Data Accepted) which regulate the transmission of information over the lines DIO1 -DIO8. For each command or data byte transferred, a complete handshake cycle occurs. This handshake is designed to hold up the bus until the slowest devices has accepted the information.
5. **EOI**—When ATN is false, EOI (End Or Identify) indicates that the data on lines DIO1 - DIO8 is the last byte of a data message. When the 270 receives a data byte with EOI true, the 270 automatically supplies a terminator character (ref: paragraph 3.15.6) following the data byte. When the 270 transmits the last byte of a message (which is always a terminator character), it also sets EOI true.
6. **SRQ**—This line (Service Request) is used by the 270 and other devices on the bus to signal the controller that they request attention. (Ref: paragraph 3.15.5 for 270 Service Request Enable.) Since the SRQ line is common to all devices, additional tests must be made to determine which devices are signaling. The controller performs a Serial Poll to accomplish this.
7. **IFC**—This line (Interface Clear) is used by the controller to reset the interface logic in all devices connected to the bus to a known initial state.

3.15.2 Commands

Commands are sent over lines DIO1 - DIO8 with ATN true. They are divided into five classes.

1. Listen Addresses
2. Talk Addresses
3. Secondary Addresses
4. Universal Commands

   DCL—Device Clear
   SPE—Serial Poll Enable
   SPD—Serial Poll Disable
   LLO—Local Lockout
5. Addressed Commands

   GTL—Go To Local
   SDC—Selective Device Clear
   GET—Group Execue Trigger

These commands and command groups are shown with their binary codes in Appendix A and further explanation follows.

3.15.2.1 Listen Addresses

Listen addresses are used to command a device to read any data bytes transmitted over lines DIO1 -DIO8. There are 31 different available addresses (hexadecimal codes 20 through 3E, ASCII codes **SP** through >). A 32nd address, called unlisten (hexadecimal **3F**, ASCII ?), is used to command all devices to not read data bytes. The 270 listen address is selected by internal switches (figure 2-2) or by front panel keyboard; e.g., ADRS 1 EXEC for address number one. Either method of selection specifies the lower 5 bits of the address (ref: table 2-2). Pressing the front panel ADRS key displays the GPIB address as a decimal device number. At power-on the address is always that set by internal switches. Another internal switch (figure 2-2) can lock out address selection by front panel keyboard if desired. Each time ADRS is pressed, **XA** will appear in the CMD RCL string. The address can not be programmed from the GPIB.

3.15.2.2 Talk Address

Talk addresses are used to command a device to transmit data over lines DIO1 - DIO8 whenever ATN is false. There are 31 different available addresses (hexadecimal codes **40** through **5E**, ASCII codes @ through ^). A 32nd address, called untalk (hexadecimal **5F**, ASCII _) is used to command all devices to cease talking. The lower 5 bits of the 270 talk address are selected by the same rear panel switches used to select the listen address. Thus, if the 270 listen address is hexadecimal **21** (ASCII !), the talk address is hexadecimal **41** (ASCII **A**). Pressing the front ADRS key displays the GPIB address as a decimal device number.

3.15.2.3 Secondary Address

Secondary addresses are used following a talk or listen address to provide the ability to address more than the 31 devices provided for by simple talk or listen addresses. Secondary addresses are ignored by the 270.

3.15.2.4 Universal Commands

Universal commands are used to command a device to perform designated actions. Universal commands are recognized at all times. Universal commands performed by the 270 are:

1. **Device Clear (DCL)**—Resets the 270 to the initial power on settings. Refer to table 2-3, step 2 for power on conditions. DCL affects all devices on the bus. This information is also set into the waveform generating circuitry.
2. **Serial Poll Enable (SPE)**—Causes the instrument to engage in a serial poll by responding with the serial poll status byte when addressed as a talker. Data line DIO7 will be on, if service is being requested on the SRQ line. When the status byte is read, it is reset to an ASCII blank, and the SRQ line is released (of course, it may still be held down by other devices). The status byte is also available by reading the 270 talk message number 1. When this message is read, the status byte is reset and SRQ released as for the serial poll.
3. **Serial Poll Disable (SPD)**—Discontinues serial poll. Returns instruments to normal talk modes.
4. **Local Lockout (LLO)**—Causes the GPIB interface to enter a state where the front panel LCL key is inoperative. Once in this state, the only way to take the interface out of it is to put the REN line in the local state (ref: paragraph 3.15.1, item 3). Local lockout must be sent to the 270 to totally disable front panel modification of the state of the instrument.

3.15.2.5 Addressed Commands

Addressed commands are used to command a device to perform designated actions. Addressed commands are recognized only when the instrument is addressed as a *listener*. Addressed commands performed by the 270 are:

1. **Go To Local (GTL)**—Commands are 270 to go to the local mode (ref: to paragraph 3.15.1 for explanation of the REN line).
2. **Selective Device Clear (SDC)**—Resets the 270 to initial power on conditions. Refer to paragraph 3.12 for power on conditions. SDC affects only the selected unit.
3. **Group Execute Trigger (GET)**—Causes the actions specified by the GET mode (**XG**) code (ref: paragraph 3.15.7). If the 270 microprocessor is idle (i.e., not processing a previously sent programming string), a GET command will be completed within 2.5 ms of receipt. Otherwise, it will not be done until current programming is processed.

3.15.3 Data Transfer

In addition to accepting programming characters, the 270 will transmit status information over the bus. To program the instrument, first send the listen address (with ATN on), followed by the programming data (in ASCII, with ATN off). The instrument microprocessor accepts the data as fast as possible, until either 64 characters are received or there is a pause during the transfer of data. At that time, the entire string of received characters is scanned by the microprocessor, which carries out the scan and accepts the next 64 character string. Whenever the microprocessor is finished scanning a string, it puts a display on the front panel which reflects the state of input processing at that point. If the EOI line is asserted while sending a character to the 270, the currently programmed terminator character will be put into the input string following the character with the EOI.

3.15.4 Talk Mode

To read a message from the 270, send the talk address (with ATN on) over the bus. The instrument will then send the message currently selected by the Talk Mode (**XT**) setting. The last character of the 270's message will be the currently programmed terminator character with the EOI line asserted.

XT followed by a code (0 through 8) selects the kind of message the 270 will send when it is addressed as a talker on the GPIB.

XT0 Programming Error List (only errors from GPIB input). A typical error string is E 1F 2AD 3Y. Some error string characteristics are:

- a. All error strings begin with E.
- b. Most recent error is at the end of string.
- c. Errors are separated by spaces.
- d. Class 1 Error: A 1 followed by programming character that caused the error.

e. Class 2 Error: A 2 followed by the two conflicting program characters.

f. Class 3 Error: A 3 followed by M (Store) or Y (Recall).

g. Error strings can be up to 80 characters including E and blanks.

h. After transfer, the instrument clears the error string.

XT0 is the power-up talk mode.

XT1 Poll Byte Response: The byte sent if a serial poll was performed. The controller, by reading this byte, causes the instrument to clear the poll byte and reset the SRQ line if asserted. The pole byte sent is described in Table 3-5.

XT2 The most recently selected parameter and its value. Example: FREQ 1E3. If no parameter is selected; e.g., power-on state or reset, then returns: NO PARAMETER SELECTED.

XT3 The entire instrument setup after last execute. Example: F1E3A5D0C0P0Q0XL1.5.

XT4 The instrument setup when execute is received; same format as **XT3**.

XT5 Instrument Identification: WAVETEK MODEL 270 V(1.0). 1.0 identifies the software version number.

XT6 The time since the instrument was powered on. Example Time: 1.3. Unit of measure is hours with 0.1 hour resolution (6 minutes).

XT7 The accumulated operating time. Example: TOTAL TIME: 306.2.

NOTE:

Toggling switch 7 (figure 2-2) clears the instrument-operating-time clock. With SW7 on, the clock runs during power on. With SW7 off, the clock clears to zero.

XT8 The number of stored settings installed. For the standard 270: STORED SETTINGS 200.

3.15.5 SRQ (Service Request)

3.15.5.1 SRQ Mode

XQ followed by a value (0 through 255) selects the conditions under whch the 270 asserts the SRQ line and rsv bit. The equivalent binary value is a "mask" for the serial poll response byte (ref: table 3-5). The binary mask selects certain conditions that will be recognized as conditions that asserts the SRQ line and rsv bit. All other conditions are ignored (masked).

Table 3-5. Serial Poll Response Byte

Bit Decimal Position	Bit Binary Position*	Bit Name	Bit Description
128 (MSB)	1000 0000	SRQ Key	A front panel key (ref: paragraph 3.15.5.2).
64	0100 0000	rsv	Request for service.
32	0010 0000	Undefined	Undefined bit.
16	0001 0000	Undefined	Undefined bit.
8	0000 1000	Low Battery	Indicates a low battery level for memory back-up battery (ref: paragraph 3.9).
4	0000 0100	Fuse Blown	Indicates output amplifier fuse is blown (ref: paragraph 3.10).
2	0000 0010	Output Protection	Indicates output protection is tripped (ref: paragraph 3.10)
1 (LSB)	0000 0001	Program Error	Indicates a program error; it can be either class 1, 2 or 3 error (ref: paragraph 3.4).

**Binary Code: 1 = Selected*
0 = Not Selected

Table 3-1 shows the serial poll response byte. Each of the 8 bits represent a condition that, if selected by the SRQ mode, will assert the GPIB's SRQ line and the serial poll byte's rsv bit. Each bit maybe selected individually or in various combinations. The rsv bit (weight 64) and the two undefined bits (weights 16 and 32) will have no affect if selected.

For example **XQ1** dictates that the SRQ line and the serial poll byte's rsv bit are asserted when there is a program error; such as, frequency beyond the 270's limits. The serial poll response byte will be 01000001.

In another example, **XQ131** dicates that the SRQ line and the rsv bit are asserted when a program error has occurred, the output protection is enabled, and the SRQ key is pressed. The serial poll response byte will be 11000011.

XQ1 is the SRQ power up mode.

3.15.5.2 SRQ Key

The SRQ key is located on the front panel of the 270. To use the SRQ key, the 270 must be in the local mode and the SRQ mode bit weight 128 must be selected (ref: table 3-5). Under these conditions, pressing the SRQ key asserts the SRQ line of the GPIB.

3.15.6 End of String or Terminator Specification

XV followed by its argument designates a new End Of String (EOS) or terminator character. The argument is the decimal value of the ASCII character that is to be the new terminator: an EOS character recognized by the 270. Any ASCII character except NUL is accepted.

The terminator character has two uses. During output, it is appended to the end of every response to a talk request on the GPIB. During input, it signals, the end of a group of programming characters. Since it is always recognized, even in a quoted string, it can be used to insure that the instrument is in a known state, so that following programming characters will be interpeted correctly.

At power on time, the EOS character is the line feed control character, ASCII character LF (10_{10}). When the 270 issues a talk message, the EOS character is the last byte sent. In addition, the End Or Identify (EOI) line is pulsed low (END message) during the EOS character transmission. If the GPIB controller does not look for the END message (EOI line low), and it does not recognize the Line Feed (LF) as a string terminator, a new EOS character will be needed. For example, to change the EOS character from an LF to a Carriage Return (CR), program **XV**13.

3.15.7 GET Mode

XG followed by its code selects what actions occur when a Group Execute Trigger (GET) command is sent to the 270. The code may be **0, 1** or **−1.**

0 Upon receipt of GET, the programmed waveform values are transferred to the waveform generator circuits, and then the microprocessor sends a trigger pulse if the mode is not continuous. This is the same sequence of events that would occur if an execute, then a trigger action (**IJ**) were programmed, except that no error checking is done. GET MODE 0 is the default (power up) condition.

1 Upon receipt of GET, the stored setting next in sequence after the last stored setting accessed is recalled, if it exists. Then the actions described for code **0** are performed. This is the same sequence of events that would occur if a next setting, an execute and a trigger action (**XWIJ**) were programmed, except that no error checking is done.

−1 Upon receipt of GET, the stored setting previous in sequence before the last stored setting accessed is recalled if it exists. Then the actions described for code **0** are performed. This is the same sequence of events that would occur if a previous setting, an execute and a trigger action (**XUIJ**) were programmed, except that no error checking is done.

3.15.8 Local

The front panel LCL key switches the GPIB interface to the local mode if it is not locked out (ref: paragraph 3.15.2.4, item 4).

3.15.9 Display

The single quote character (') is used to program a string of characters to be displayed on the front panel display. Program a single quote, the characters to be displayed, followed either by another single quote or by the terminator character. When the second quote or the terminator is programmed, the first 20 characters programmed after the first quote are displayed on the front panel. If fewer than 20 characters are programmed, then blanks are added to fill the display.

Examples (∧ indicates a blank character)

Three Programmed Inputs

1. '20∧CHARACTER∧LIMIT'
2. 'THIS∧STRING∧IS∧TOO∧LONG∧TO∧DISPLAY∧ENTIRELY'
3. ' ∖ '
   (no characters in string)

The Resulting Displays

1. 20∧CHARACTER∧LIMIT∧∧
2. THIS∧STRING∧IS∧TOO∧L
3. (blank display)

3.15.10 Command Recall

Pressing **CMD RCL** displays the last 40 parameters, values and actions (all in ASCII Code) sent to the 270 from the keyboard and the GPIB. The display shows only 20 characters at a time, and the CURSOR ← and → must be used to see the entire 40 character program string.