

## Errata

**Title & Document Type:** 3314A Function Generator Operating Manual

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# MODEL 3314A FUNCTION GENERATOR OPERATING MANUAL

Manual Part Number 03314-90000  
Microfiche Part Number 03314-90050

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## TABLE OF CONTENTS

	Page		Page
The 3314A Function Generator . . . . .	1	Free Run (Linear Sweeps) . . . . .	25
Modes of Operation . . . . .	1	11. 100Hz to 1kHz . . . . .	25
What's In This Manual . . . . .	2	12. Small Sweep Ratio (1.06:1) . . . . .	25
Abbreviated Installation Instructions . . . . .	3	13. Large Sweep Ratio (100:1) . . . . .	25
Meet the 3314A Function Generator . . . . .	7	14. TTL Level Sweeps . . . . .	25
How to Use the Free Run Mode . . . . .	9	15. TTL Level, 95% Symmetry Sweep . . . . .	25
Free Run Summary . . . . .	9	Free Run (Log Sweeps) . . . . .	26
How to Use the Free Run Mode (Linear Sweeps) . . . . .	10	16. Sweeping a Low Pass Filter . . . . .	26
Linear Sweep Summary . . . . .	11	17. 1 Decade Sweep . . . . .	26
How to Use the Free Run Mode (Log Sweeps) . . . . .	12	18. Audio Sweep (20Hz to 20kHz) . . . . .	26
Log Sweep Summary . . . . .	12	19. Sub-Audio Sweep (2Hz to 20kHz) . . . . .	26
How to Use the Gate Mode . . . . .	13	20. Low Frequency Sweep (.2Hz to 2Hz) . . . . .	26
Gate Summary . . . . .	13	Gate . . . . .	27
How to Use the Gate Mode (Gated Sweeps) . . . . .	14	21. Gated Sinewaves (Start/Stop Phase = $-45^\circ$ ) . . . . .	27
How to Use the N Cycle Mode . . . . .	15	22. Gated Sinewaves (SYM = 95%) . . . . .	27
N Cycle Summary . . . . .		23. High Frequency Gate . . . . .	27
How to Use the 1/2 Cycle Mode . . . . .	16	24. Gated TTL Level Pulses . . . . .	27
1/2 Cycle Summary . . . . .	16	25. Gated TTL Level Pulses . . . . .	27
How to Use the Phase Lock Modes . . . . .	17	Gated Sweeps . . . . .	28
Phase Lock Summary . . . . .	18	26. Basic Gated Sweep (10ms) . . . . .	28
How to Use the ARB Mode . . . . .	19	27. Small Ratio Gated Sweep (2.1) . . . . .	28
ARB Mode Summary . . . . .	19	28. Large Ratio Gated Sweep (100:1) . . . . .	28
The Waveform Library . . . . .	21	29. Audio Chirp . . . . .	28
Free Run . . . . .	23	30. Swept Squarewaves . . . . .	28
1. Large Signal With Large DC Offset . . . . .	23	N Cycle . . . . .	29
2. Small Signal With Large DC Offset . . . . .	23	31. 3 Cycle Burst . . . . .	29
3. Large Signal With Small DC Offset . . . . .	23	32. 7 Cycle Burst . . . . .	29
4. TTL (Squarewave With DC Offset) . . . . .	23	33. 2 Cycle Burst . . . . .	29
5. ECL (Squarewave With DC Offset) . . . . .	23	34. Haversine . . . . .	29
6. RAMPS (Variable Symmetry Triangle Wave) . . . . .	24	35. 4 Cycle Burst With Start/Stop Phase = $-45^\circ$ . . . . .	29
7. 100% Amplitude Modulation . . . . .	24	1/2 Cycle . . . . .	30
8. AM (Suppressed Carrier) . . . . .	24	36. Basic 1/2 Cycle . . . . .	30
9. AM With Function Invert . . . . .	24	37. Pulses With Overshoot . . . . .	30
10. VCO . . . . .	24	38. Pulses With Varying Rise/Fall Ratios . . . . .	30
		39. 1/2 Cycle With 95% Symmetry . . . . .	30
		40. 1/2 Cycle Trianglewaves . . . . .	30
		Fin X N . . . . .	31
		41. Squarewaves in Quadrature . . . . .	31
		42. 3 Pulses . . . . .	31
		43. Trianglewaves . . . . .	31
		44. Sinewaves . . . . .	31
		45. Squarewaves . . . . .	31

## TABLE OF CONTENTS (cont)

	Page		Page
Fin + N . . . . .	32	Mode . . . . .	61
46. Squarewaves . . . . .	32	Free Run . . . . .	61
47. Pulses . . . . .	32	Gate . . . . .	61
48. Pulses . . . . .	32	N Cycle . . . . .	61
49. Variable Symmetry . . . . .	32	1/2 Cycle . . . . .	61
50. Phase Locked Amplitude Modulation . . . . .	32	Fin X N . . . . .	62
ARB . . . . .	33	Fin + N . . . . .	63
51. Linear Steps . . . . .	33	Operator Alerts . . . . .	65
52. Exponential Steps . . . . .	33	Alerts While Programming DC Offset . . . . .	65
53. Exponential Charge/Discharge . . . . .	34	Alerts While Programming the	
54. Square Law Response . . . . .	34	Marker Frequency . . . . .	65
55. Exponential Response . . . . .	35	Alerts While Changing Modes . . . . .	65
56. Carotid Artery Pressure Wave . . . . .	35	Alerts While entering Linear	
57. sin(X)/X . . . . .	36	or Log Sweep . . . . .	66
58. 3 Note Chord (Major Triad) . . . . .	37	Alerts When Programming ARB	
59. Fourier Series Squarewave		Frequency . . . . .	66
[cosF - 1/3cos3F + 1/5cos5F] . . . . .	38	Outputs . . . . .	67
60. Damped Oscillations . . . . .	39	Main Signal Output . . . . .	67
Detailed Operating Information . . . . .	41	SYNC Output . . . . .	67
ARB . . . . .	43	Trigger Output . . . . .	68
How to PRESET an ARB Waveform . . . . .	43	X Axis/Phase Output . . . . .	68
How to Connect an Oscilloscope . . . . .	44	X3 Output (Option 001) . . . . .	68
Definitions . . . . .	44	Z Axis Output . . . . .	69
Calibration . . . . .	48	Preset . . . . .	70
CALibrate All . . . . .	48	How to COMPLETELY Preset the 3314A . . . . .	70
Amplitude Calibration . . . . .	48	Specifications . . . . .	71
Frequency Calibration . . . . .	49	Frequency Accuracy . . . . .	71
Calibration Disable, E04 . . . . .	50	Amplitude . . . . .	72
Calibration Enable . . . . .	50	DC Offset . . . . .	73
Data Entry . . . . .	51	Symmetry . . . . .	73
Modify Knob . . . . .	51	Phase . . . . .	74
Range Up or Down . . . . .	51	Function Characteristics . . . . .	74
Range Hold . . . . .	51	Internal Trigger Interval . . . . .	75
Amplitude Range . . . . .	52	Frequency Sweep . . . . .	75
Frequency Range . . . . .	52	Modulation . . . . .	75
Offset Range . . . . .	53	Option 001--Simultaneous X 3 Output . . . . .	76
Symmetry . . . . .	53	General . . . . .	77
Error Codes . . . . .	54	Store & Recall . . . . .	78
Errors While in Local . . . . .	54	How to Store and Recall	
Errors While in Remote . . . . .	54	Front Panel Settings . . . . .	78
External Modulation . . . . .	56	How to Recall ARB Waveforms . . . . .	78
Amplitude Modulation . . . . .	56	Remote Operation . . . . .	79
Amplitude Modulation Suppressed		The HP-IB . . . . .	81
Carrier . . . . .	58	What is the HP-IB . . . . .	81
Frequency Modulation . . . . .	58	How Does the HP-IB Operate . . . . .	81
Voltage Controlled Oscillator . . . . .	59	The 12 HP-IB Messages . . . . .	83
Functions . . . . .	60		
Operating Characteristics . . . . .	60		

## TABLE OF CONTENTS (cont)

	Page		Page
The 3314A and the HP-IB.....	84	The Data Message (Function Select Commands).....	92
The 3314A's HP-IB Capability.....	84		
3314A/HP-IB Verification.....	85	The Data Message (Data Entry Commands).....	96
Analyzing Bus Problems.....	85		
The 3314A's HP-IB Address.....	86	Data Message (Query Commands).....	97
How to View the 3314A's HP-IB Address.....	86	The Status Byte.....	98
How to Change the 3314A's HP-IB Address.....	86	The Trigger Message.....	99
Listen Only.....	87	HP-IB Programming Summary.....	101
Device/Listen/Talk Addresses.....	87	Sales and Support Offices.....	103
The Clear Message.....	88		
The Data Message.....	89		
The Data Message (Immediate Execute Commands).....	91		

# THE 3314A FUNCTION GENERATOR

The 3314A is a multi-mode, HP-IB programmable Function Generator featuring Sine, Square and Triangle functions from .001Hz to 19.99MHz. Sophisticated implementation of the operating modes (see below) plus precision control of the trigger signal make the 3314A a flexible, easy to use function generator.

## Modes of Operation

**FREE RUN Mode.** The 3314A output signal is continuous or swept.



**GATE Mode.** The 3314A output signal is gated ON or OFF.



**N CYCLE Mode.** The 3314A output signal is a counted burst of "N" cycles.



**1/2 CYCLE Mode.** The 3314A output signal is alternate 1/2 cycles.



**Fin X N Mode.** The 3314A output frequency is locked to and "N" times the reference frequency.



**Fin + N Mode.** The 3314A output frequency is locked to and "1/N" times the reference frequency.



**ARB Mode.** The 3314A is redefined as an Arbitrary Waveform Generator capable of producing user defined waveforms.



# WHAT'S IN THIS MANUAL

This manual contains six sections to help you operate the 3314A. These sections occur in this order:

## Abbreviated Installation Instructions (see page 3)

instructions to get your 3314A operating quickly and safely.

## Meet the 3314A (see page 7)

an overview of the 3314A front and rear panels to help you become familiar with major features.

## How to use the 3314A Function Generator (Basic Modes) (see page 9)

connection diagrams and annotated key sequences to learn how to use the function generator.

## The Waveform Library (see page 21)

sixty oscillograms representing a cross-section of the 3314A's capabilities with the control settings and HP-IB mnemonics.

## Detailed Operating Information (see page 41)

alphabetically organized information necessary to realize the full potential of the 3314A.

## Remote Operation (see page 79)

information to program the 3314A from the HP-IB, including a Programming Summary (the blue pages).

## ABBREVIATED INSTALLATION INSTRUCTIONS

These steps will let you install and make the most basic operational checks. These steps constitute the minimum safety checks that must be made whenever a 3314A is installed. Note that the 3314A is a Safety Class 1 instrument (provided with a protective earth terminal).

### **WARNING**

*The 3314A should never be connected to an AC power source without a protective earth terminal. The chassis and all exposed shields are connected to the earth terminal and "floating" or otherwise defeating this safety feature may subject the operator to lethal voltages.*

1. Check the 3314A for physical damage. Under no circumstances should a damaged 3314A be connected to power! Refer to "What To Do If Your 3314A Requires Service" located in the Service Manual.

### **WARNING**

*The integrity of the protective earth ground may be interrupted on a 3314A that is damaged. Under no circumstances should a damaged 3314A be connected to its AC power source.*

2. Check the line voltage select switches on the rear panel. These switches should be set to be compatible with the RMS voltage of your AC power source. The 3314A can operate from AC power sources with voltage deviations from +5% to -10% of the selected value.

### **CAUTION**

*Connecting a 3314A to an AC power source with the incorrect voltage selected will destroy the primary fuse.*

# ABBREVIATED INSTALLATION INSTRUCTIONS (cont)

3. Make sure that the line fuse is compatible with the voltage selected.

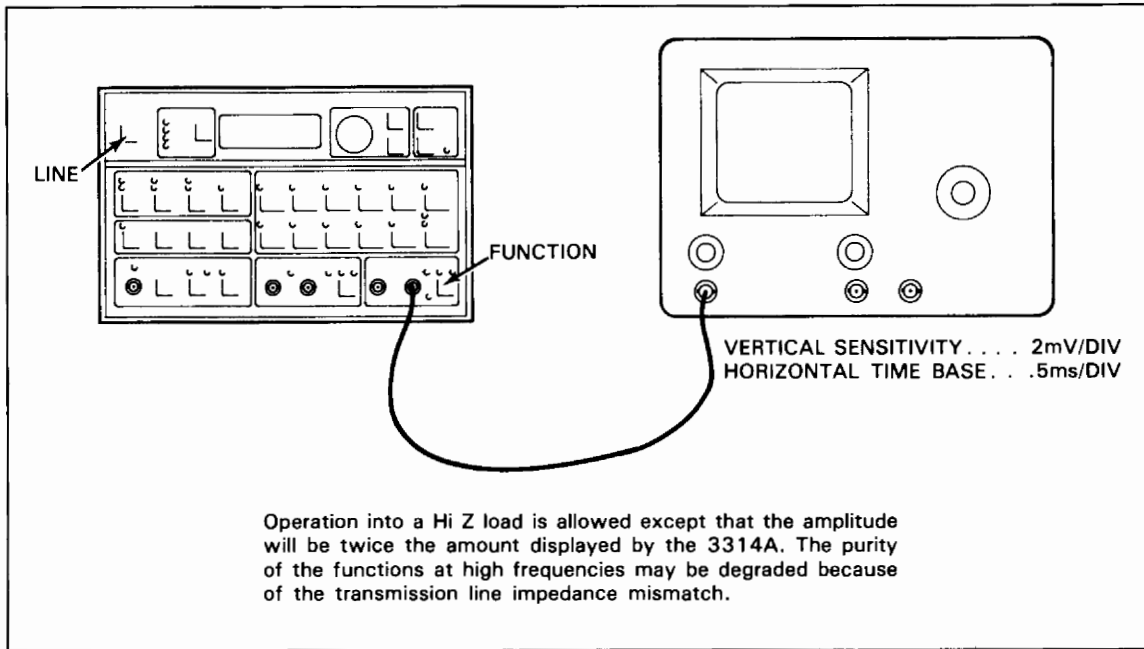
**Table 1. Line Fuse Selection**

Voltaga Selected	Fuse Value	-hp- Part Number
110/120V 220/240V	0.8A SLO BLOW 0.4A SLO BLOW	2110-0336 2110-0340
<b>CAUTION</b> <i>Using the wrong fuse value or fuse type will not protect the circuitry inside the 3314A and may result in damage to your 3314A.</i>		

4. Connect the power cord. Please contact your local -hp- Sales Office if you have any questions.
5. Set the LINE switch to the ON position. This switch is located in the upper left hand corner of the front panel. The following actions will occur:
  - a 2 second count down to allow electrical stabilization and test the front panel LEDs
  - a CAL ALL to generate a full complement of calibration constants
  - if the calibration failed, the appropriate error number will be displayed for 1/2 second and the 3314A will try to calibrate itself for another 20 seconds or until a calibration is successful
6. Connect the 3314A to an oscilloscope as shown in Figure 1 and verify that the 3314A's output is a 1kHz, 10mVp-p sinewave. Press the FUNCTION key to cycle the 3314A's function to squarewave, triangle, off and back to sinewave. The FUNCTION key is located in the lower right hand corner of the front panel.

More detailed installation procedures are located in Section 2 of the Service Manual.

# ABBREVIATED INSTALLATION INSTRUCTIONS (cont)



**Figure 1. Basic Installation Verification**

# MEET THE 3314A FUNCTION GENERATOR

## Status

the HP-IB status indicators and the LCL control of the 3314A from remote to front panel. The LCL key is preceded by the BLUE shift key. The LCL key displays its HP-IB address for 1/2 second. The address is stored in non-volatile memory. The factory setting is 7. See "How to Set the HP-IB Address" located in the HP-IB section of the 3314A manual.

## Modify

All variable parameters (selected by keys in the Entry Group) are entered into the 3314A using the Modify knob or the 1 or 1 keys. These controls change the value of the displayed parameter. The Modify knob has 2 basic operating modes called "Cursor" and "Multi Speed".

**CURSOR** (a digit is flashing). This mode is useful when making small changes or changes of constant increments. The flashing cursor digit is incremented or decremented by 1 whenever rotation of the Modify knob is sensed. The  $\leftarrow$  and  $\rightarrow$  keys move the cursor through the display.

**MULTI SPEED** (no digit is flashing). This mode is useful when making large changes. The least significant digit in the display is incremented or decremented 1, 2, 4, 8, 16 or 32 times faster depending upon how fast you turn the Modify knob.

## Range

**RANGE UP or DOWN** (↑ or ↓) keys multiply or divide the displayed value by 10 until the 3314A's operating limits are reached. This provides an extremely fast method to modify the displayed parameter.

**RANGE HOLD** inhibits auto-ranging of Frequency (8 ranges), Amplitude (4 ranges), and/or DC Offset (2 ranges) when these parameters are changed with the Modify knob. When in Fin X N and Fin + N, Frequency Range Hold also inhibits auto-acquisition.

## Entry

Most of the keys in this group are select keys for variable entries. The top row contains select keys for the more universal parameters. Note that the blue shifted definition of these keys presets the parameter. The second row contains the select keys for the 3314A's sweep capabilities. The SW/TR INTVL key is the select key for the sweep interval (SW INTVL) and for the internal trigger interval (TR INTVL). When ARB is active, the functions of the keys in the second row are redefined.



## Function

The **MAIN OUTPUT**. This output has a characteristic output impedance of 50Ω. Although operation into other than 50Ω is allowed, the actual AC amplitude and DC offset will be different from the displayed values and the quality of the functions will be degraded at higher frequencies due to transmission line impedance mismatches.

The **SYNC OUTPUT**. This output has a characteristic output impedance of 50Ω when terminated into ≤50Ω. When terminated into >50Ω, it will deliver TTL compatible levels of 0 to >2.5V. The maximum unloaded voltage is limited to ~3V. The edges of the sync signal are coincident with the peaks of the sine and triangle functions and coincident with the edges of the square function. This relationship is inverted by Function Invert.

## Internal Trigger

The TRIG I/O port sets the period of the internal trigger. The output signal is useful as a sync signal and burst operations.

## External Modulation

Type	Sensitivity	Range
AM	±1V ~ 100%	0% to > 100%
FM	±1V ~ ±1% of range	0% to ±1% deviation
VCO	10%/Volt	+10% to -80%, useable to -100%

Figure 2. MEET THE 3314A

## Mode

The 3314A has 7 basic operating modes. The trigger signal, either the 3314A's internal trigger source or an external signal you supply, is essential to every operating mode except FREE RUN with sweep off.

**FREE RUN Mode.** The 3314A outputs continuous Sine, Square, Triangle or ARB functions. Continuous functions, sweeps and ARB operations are allowed. See "How to Use the FREE RUN Mode".

**GATE Mode.** The output is "gated" ON and OFF by the Trigger level. Gated functions, sweeps and ARB operations are allowed. See "How to Use the GATE Mode".

**N CYCLE Mode.** The 3314A outputs a burst of N complete cycles of the selected function, starting when a Trigger edge is received. The N parameter sets the number of cycles from 1 to 1999. The start/stop phase is set with the Phase parameter from  $-90^\circ$  to  $+90^\circ$ . See "How to Use the N CYCLE Mode".

**1/2 CYCLE Mode.** The 3314A outputs alternate 1/2 cycles of the selected function when a Trigger edge is received. The start phase of the first 1/2 cycle (and the stop phase of the second 1/2 cycle) is set with the Phase parameter from  $-90^\circ$  to  $+90^\circ$ . See "How to Use the 1/2 CYCLE Mode".

**Fin X N Mode.** The 3314A will phase lock to the Trigger (reference) signal and output a frequency "N" times the reference frequency. The N parameter sets "N" from 1 to 1999. The frequency limits for both the 3314A and the reference are from 50Hz to 20MHz. See "How to Use the PHASE LOCK Modes".

**Fin + N Mode.** The 3314A will phase lock to the Trigger (reference) signal and output a frequency equal to the reference frequency divided by "N". The N parameter sets "N" from 1 to 1999. The frequency limits for both the 3314A and the reference are from 50Hz to 20MHz. See "How to Use the PHASE LOCK Modes".

**ARB Mode.** The ARB mode redefines the 3314A as an Arbitrary Waveform Generator. The output waveform consists of a series of voltage ramps called vectors. The operator has control over the number of vectors, the length of each vector in time and the height of each vector. Both continuous ARB functions (FREE RUN Mode) and gated ARB (GATE Mode) are allowed. See "How to Use the ARB Mode".

## Status

This group contains the HP-IB status indicator key to switch control of the 3314A from manual operation. When the LCL key is preceded by the status key, the 3314A displays its HP-IB address. The HP-IB address is set from the front panel address memory. The factory setting is 10000000. Change the 3314A's HP-IB Address" location of this manual.

## Preset

The Preset key initializes the 3314A to its basic operating state. This feature is especially useful to quickly recover from complex operating states.

## Store/Recall

Up to 5, non-ARB front panel control settings can be stored in registers 1 through 5 to be recalled in the future. Register 0 is reserved for the front panel setting at power off. In addition, 6 ARB waveforms can be recalled from ARB registers 0 through 5. ARB waveforms are automatically stored as they are created.

## External Trigger

One EXT Trigger is a signal you apply to the Trigger I/O port that satisfies the selectable slope and threshold conditions (note that the Trigger I/O port is an input when EXT Trigger is selected). EXT Triggers are level sensitive for Gate; edge sensitive for Burst, Phase Lock and Sweep operations.

Another EXT Trigger is the MAN key. You will have to press this key twice when in Gate mode, to simulate a complete trigger cycle (both levels). Once is sufficient for all other operations. The minimum signal that will consistently trigger the 3314A is  $\geq 200V_{p-p}$ , centered on the 3314's threshold voltage.

There are two EXT Triggers available from the HP-IB, the Group Execute Trigger (GET) and the "MN" programming command.

## Internal Trigger

The SW/TR INTVL parameter sets the period of the internal trigger (note that the Trigger I/O port is an output when internal trigger is selected). This output signal is used during sweeps, gate and burst operations.

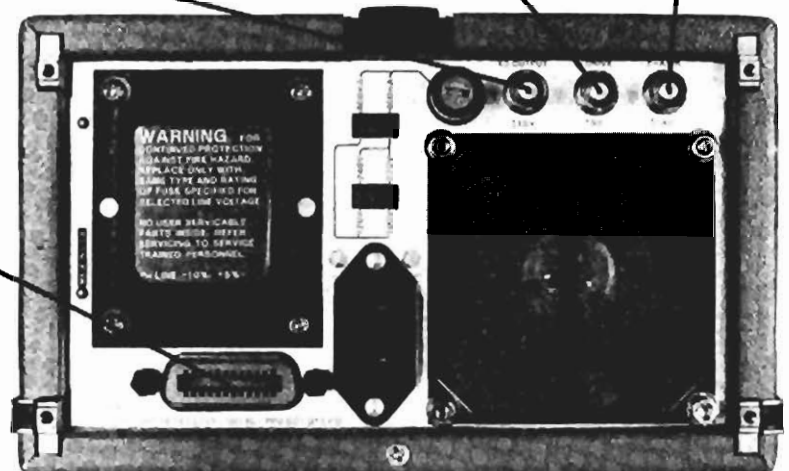


The **Z Axis** output produces voltage levels to blank ( $> +5V$ ) or enhance ( $< -5V$ ) the intensity of an oscilloscope display during sweep (intensifies the marker frequency and blanks the retrace) or ARB (intensifies the current vector).

The **X Axis** output produces a voltage ramp from  $-5V$  to  $+5V$  whose voltage is proportional to the sweep frequency. This output is useful to drive the X Axis of plotters and oscilloscopes.

The **X3** output (only instruments with Option 001 have this output) is a high voltage, low impedance output whose output voltage is 3 times the displayed amplitude and offset when the Main Output is terminated into  $50\Omega$ . This output is capable of sourcing  $\pm 30mA$  peak current without clipping. The upper frequency limit is  $1MHz$ .

The **HP-IB** is used to control the operation of the 3314A from a remote controller. This connector uses metric fasteners and is not compatible with older cables using english threaded fasteners. Metric fasteners are available from -hp- to upgrade older cables.

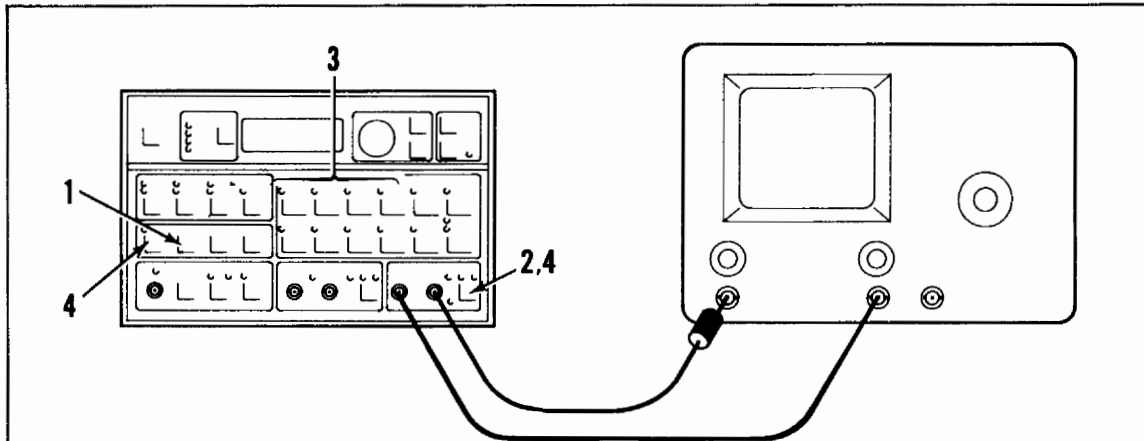


# MEET THE 3314A FUNCTION GENERATOR (cont)

**Table 2. Error Codes**

00	No error (HP-IB function, only)
--- OPERATOR ERRORS (non-ARB) ---	
01	Frequency/Symmetry conflict
02	Bus address entry error
03	Front panel key failure
04	Calibration measurements not performed
05	Allowed in sweep, only
06	Not allowed in sweep
07	Not allowed in log sweep
08	Store 0 not allowed
09	Non-volatile memory lost;battery down
--- OPERATOR ERRORS (ARB) ---	
10	Vector insert not allowed
11	Vector delete not allowed
18	Allowed in ARB, only
19	Not allowed in ARB
--- PLL ERRORS ---	
20	Unstable input frequency (Precludes auto-acquisition when in phase lock modes)
21	Input frequency outside of acquisition range
22	3314A output frequency would be out of range
23	SW/TR INTVL > 20ms (Decrease interval to $\leq 20$ ms)
24	Internal synthesis unlocked
--- CALIBRATION ERRORS ---	
30	} Frequency calibration error
31	
32	
34	} Amplitude calibration error
35	
36	
37	
38	
--- HP-IB ERRORS ---	
41	Mnemonic invalid
42	Definition number invalid
43	Data invalid
44	Units invalid
45	Range Hold not allowed
46	ARB/SWEEP parameter conflict
47	Not allowed in Manual Sweep
--- OVERLOAD ---	
50	AM or FM/VCO input voltage exceeds normal limits (HP-IB equivalent to the Reduce Input Light)
51	Output voltage exceeds safe operating limits

# HOW TO USE THE FREE RUN MODE



50Ω FEEDTHRU TERMINATION (Optional) Not shown on succeeding drawings. Trigger from Channel 2 on the rising edge.

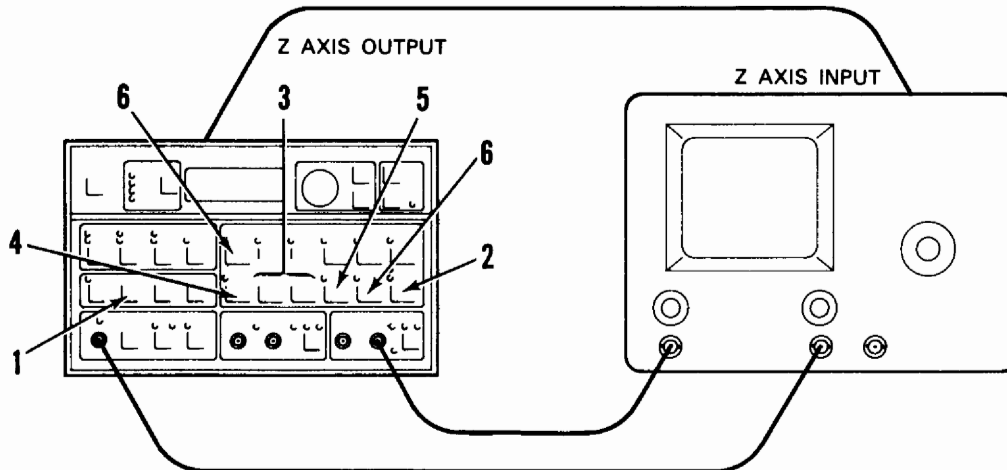
Step	Key	Action
1	PRESET	Sets the 3314A to its basic operating state. This operating state is very useful as the common starting point for all operations. Note that FREE RUN is the active mode after instrument preset.
2	FUNCTION	Press this key to change the function from Sine to Square to Triangle to Function OFF and back to Sine. Note that DC OFFSET is not affected by Function OFF.
3	FREQ AMPTD OFFSET SYM	Use the Modify knob and $\uparrow$ or $\downarrow$ keys to change the value of these parameters. Note that AMPTD and OFFSET are completely independent parameters and that variable symmetry is not allowed for frequencies $\geq 2\text{MHz}$ .
4	(blue shift) FUNCTION	Function Invert inverts the output signal. Note that DC OFFSET is not inverted and that the inversion is with respect to the SYNC output.

## Free Run Summary

Functions: Sine, Square, Triangle, Function Off  
 Frequency: .001Hz to 19.99MHz in 8 ranges  
 Amplitude: .00mVp-p to 10.00Vp-p in 4 ranges  
 Offset:  $\pm .000\text{VDC}$  to  $\pm 5.00\text{VDC}$  in 2 ranges  
 Symmetry: 5% to 95% for frequencies  $< 2\text{MHz}$

See waveforms 1 through 10 in the Waveform Library.

# HOW TO USE THE FREE RUN MODE (LINEAR SWEEPS)



A 50 $\Omega$  Feedthru Termination is optional to reduce the sensitivity of the oscilloscope's Z Axis input. Trigger from Channel 2 on the rising edge.

Step	Key	Action
1	PRESET	Sets the 3314A to its basic operating state. This operation state is very useful as the common starting point for all operations. Note that FREE RUN is the active mode after instrument preset.
2	SWEEP	The 3314A's output frequency is now linearly sweeping from the Start Frequency to the Stop Frequency in the time interval set by SW/TR INTVL.
3	START FREQ STOP FREQ	These two keys set the sweep limits. Note that changing one parameter will cause the other to change if the ratio of Stop Frequency to Start Frequency would be $< 1$ or $> 100$ . The 3314A will make the other parameter's light flash to alert you to this automatic parameter change.
4	SW/TR INTVL	This parameter sets the sweep time interval.  When the INT Trigger is selected, the sweep is from Start Frequency to Stop Frequency in this time. The sweep is repeated after the frequency resets. The reset time is approximately 10% of the sweep interval.  When the EXT Trigger is selected, the sweep is from Start Frequency to Stop Frequency in this time. The 3314A will output the Start Frequency until another EXT Trigger is received.
5	MKR FREQ	The Z Axis output signal will intensify the trace when the sweep frequency equals the Marker Frequency.
6	MAN SWEEP FREQ	When manual sweep is ON, the output frequency is limited to frequencies between the Start and Stop Frequencies. The X Axis output tracks these changes. This mode is useful when setting up plotters and other X,Y displays.

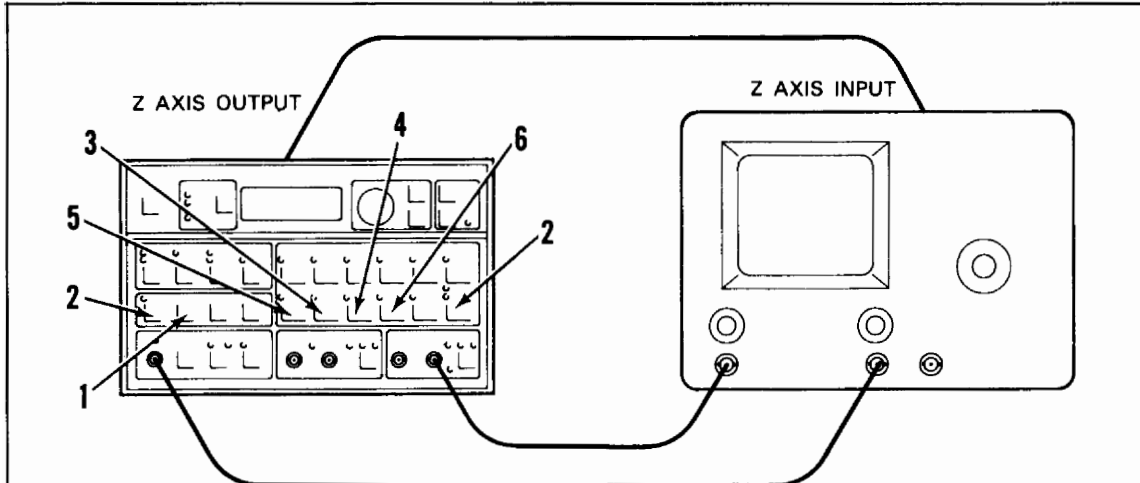
# HOW TO USE THE FREE RUN MODE (LINEAR SWEEPS) (cont)

## Linear Sweep Summary

Stop Frequency must be  $\geq$  Start Frequency.  
Stop Freq + Start Freq ratio is from 1 to 100.  
Sweep Interval range is from 7.20ms to 1999s  
Sweep is repetitive when INT Trigger is selected.  
Sweep started by the Trigger when EXT Trigger is selected.

See Waveforms 11 through 15 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

## HOW TO USE THE FREE RUN MODE (LOG SWEEPS)



Trigger from Channel 2 on the rising edge.

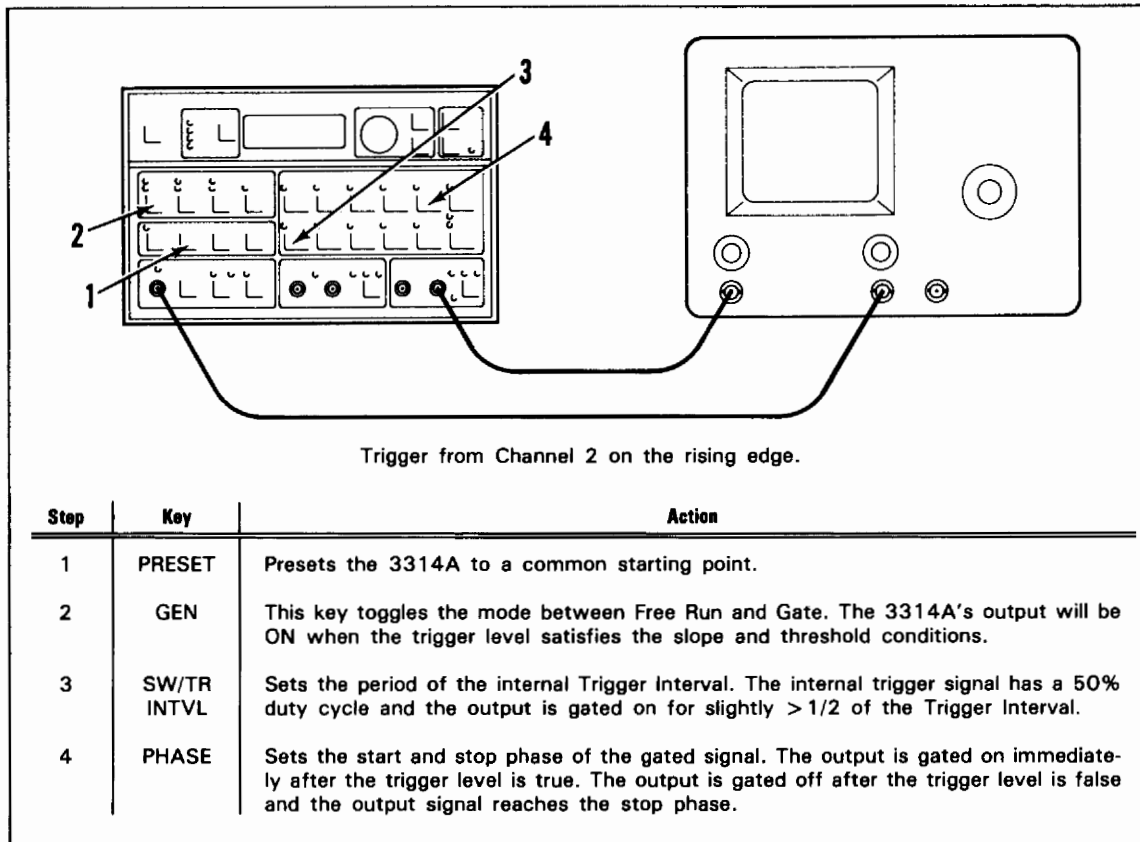
Step	Key	Action
1	PRESET	Sets the 3314A to its basic operating state. This operating state is very useful as the common starting point for all operations. Note that FREE RUN is the active mode after instrument preset.
2	(blue shift) SWEEP	The 3314A'S output frequency is now sweeping logarithmically from the Start Frequency to the Stop Frequency in the time interval set by SW/TR INTVL.
3	START FREQ	Setting the Start Frequency also sets the mantissa of the Stop Frequency (Log sweeps must be decade sweeps). When the Start Frequency is changed, the Stop Frequency automatically tracks these changes. Note that the lower Start Frequency limit is .200Hz.
4	STOP FREQ	Note that the Stop Frequency sets the number of decades swept. The mantissa of the Stop Frequency tracks the Start Frequency.
5	SW/TR INTVL	This parameter sets the sweep time interval exactly as it was implemented in Linear Sweep except that the time is now the time per decade. The lower limit is 40.0ms/decade.
6	MKR FREQ	The Z Axis output signal intensifies the trace when the Sweep Frequency is equal to the Marker Frequency.

### Log Sweep Summary

- Stop Frequency must be greater than the Start Frequency.
- Sweeps are decades, only. 1 decade to 7 decades.
- Start Frequency range: .200Hz to 1.999MHz.
- Stop Frequency range: 2Hz to 19.99MHz.
- Sweep Interval range: 40.0ms to 1999s per decade.

See Waveforms 16 through 20 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

# HOW TO USE THE GATE MODE

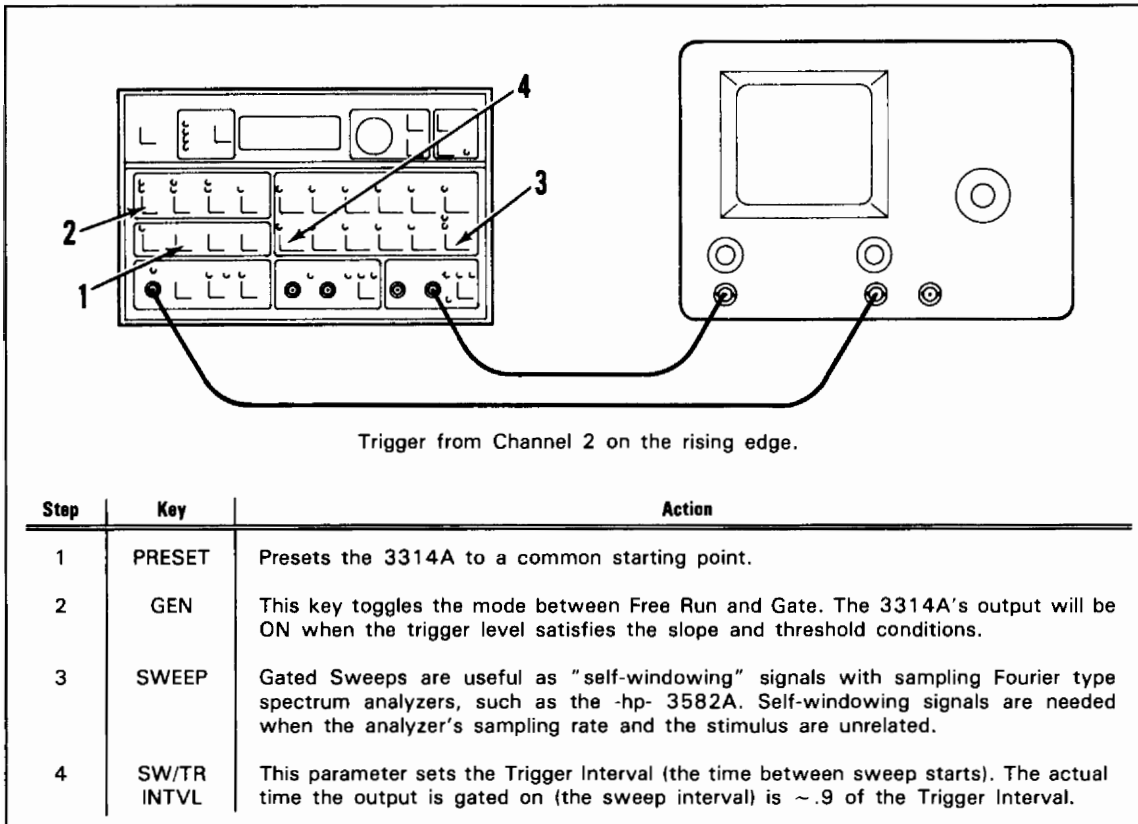


## Gate Summary

Trigger Level gates on and off.  
 SW/TR INTVL: .002ms to 1999s  
 Start/Stop Phase:  $-90^\circ$  to  $+90^\circ$   
 Internal Trigger Duty Cycle: slightly  $> 50\%$   
 Trigger light indicates the presence of a trigger  
 SYNC output is also gated

See Waveforms 21 through 25 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

## HOW TO USE THE GATE MODE (GATED SWEEPS)



### Gated Sweep Summary

SW/TR INTVL: 7.20ms to 1999s  
 Start/Stop Phase: not meaningful  
 Internal Trigger Duty Cycle:  $\sim 90\%$   
 Gated Log Sweeps are not allowed.  
 Trigger light indicates the presence of a trigger  
 SYNC output is also gated

See Waveforms 26 through 30 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

# HOW TO USE THE N CYCLE MODE

Trigger from Channel 2 on the rising edge.

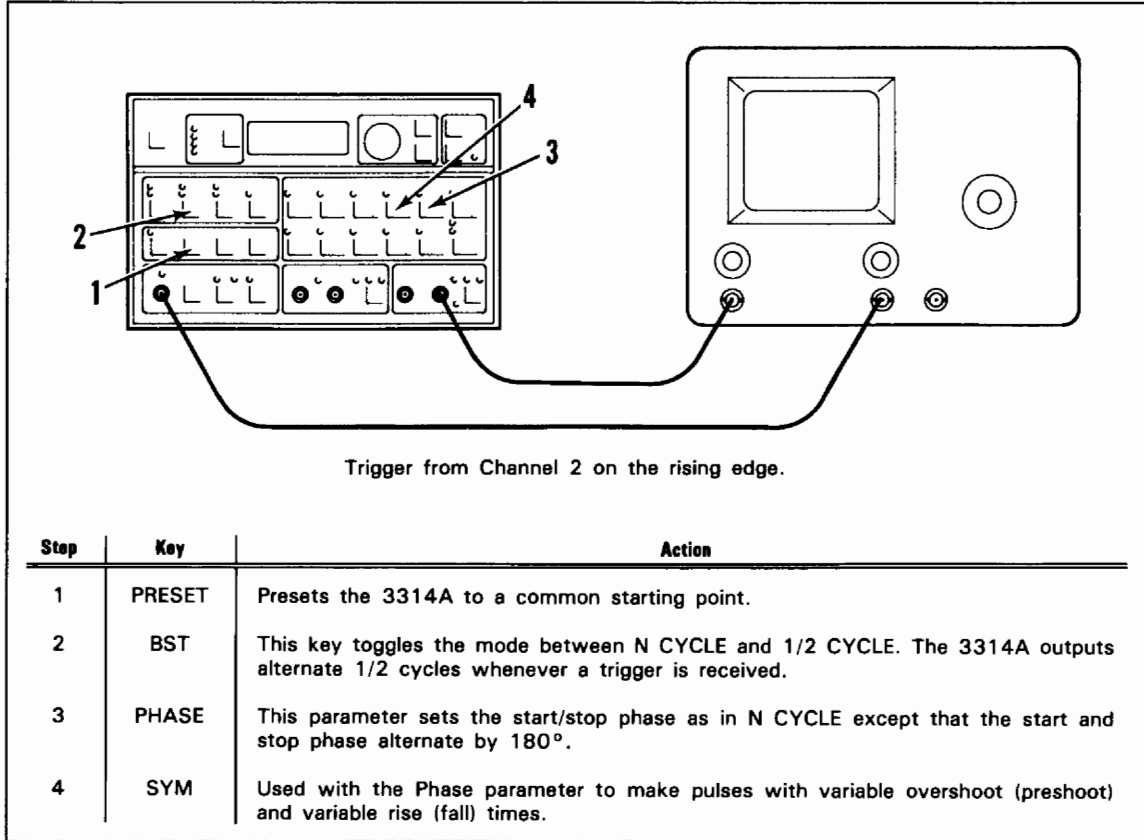
Step	Key	Action
1	PRESET	Presets the 3314A to a common starting point.
2	BST	This key toggles the mode between N CYCLE and 1/2 CYCLE.
3	SW/TR INTVL	The Trigger Interval sets the time between the start of bursts. Note that if this time is shorter than the length of the burst, the output is a continuous signal.
4	N	Use the Modify knob to set the number of cycles in every burst.
5	PHASE	This parameter sets the start and stop phase of the burst.

## N Cycle Summary

N range: 1 to 1999  
 SW/TR INTVL: .002ms to 1999s  
 Start/Stop Phase: -90° to +90°  
 SYM range: 5% to 95%

See Waveforms 31 through 35 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

# HOW TO USE THE 1/2 CYCLE MODE

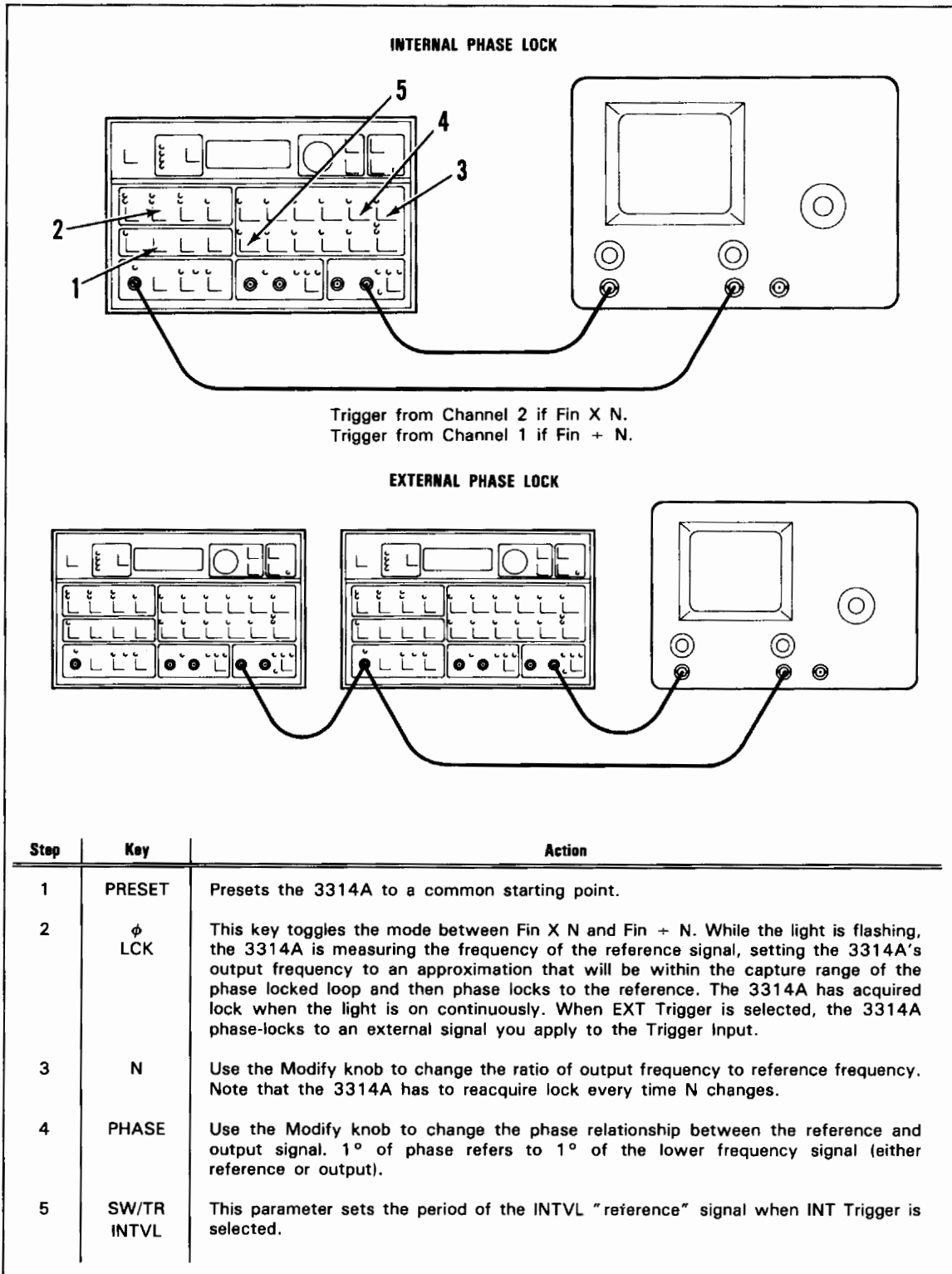


## 1/2 Cycle Summary

Start/Stop Phase: -90° to +90°  
 SYM range: 5% to 95%  
 SW/TR INTVL: .002ms to 1999s

See Waveforms 36 through 40 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

# HOW TO USE THE PHASE LOCK MODES



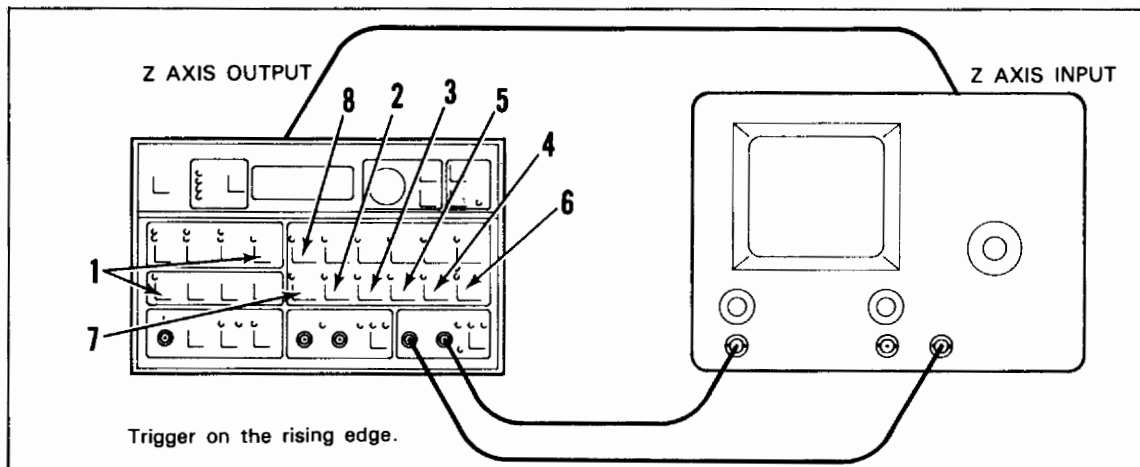
# HOW TO USE THE PHASE LOCK MODES (cont)

## Phase Lock Summary

N: 1 to 1999  
Reference Frequency Limits: 50Hz to 20MHz  
3314A Frequency Limits: 50Hz to 19.99MHz  
Acquire Time: <5 seconds under most conditions  
Phase Offset Range: -199.9° to +199.9°

See Waveforms 41 through 50 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

# HOW TO USE THE ARB MODE



Trigger on the rising edge.

Step	Key	Action
1	(blue shift) ARB	Redefines the 3314A as an ARbitrary Waveform Generator (the shifted function also clears the current waveform to its initial state). An ARB waveform consists of a series of voltage ramps called vectors.
2	V HGT	Use the Modify knob to change the Vector Height of the current vector. The last vector closes the waveform. Its length is programmable but not its height.
3	V LEN	Use the Modify knob to change the Vector length of the current vector. Note that the slope does not change and that the waveform may clip at the peak-to-peak limit set with the AMPTD parameter when V LEN is very large.
4	INS	Each time this key is pressed, another vector is inserted into the waveform.

Repeat steps 2 through 4 to build an ARB waveform. The intensified portion of the oscilloscope display is the current vector.

5	V MKR	Use the Modify knob to change the current vector. Note that the intensified vector on the oscilloscope tracks V MKR.
6	DEL	Each time this key is pressed, the current vector is removed from the ARB waveform. The last vector cannot be removed.
7	$\Delta t$	This parameter changes the period of the unit vector ( $V LEN = 1$ ). Use the Modify knob to change this parameter.
8	FREQ	Use the Modify knob to change the repetition frequency of the entire ARB waveform. Note the 3314A actually computes a new $\Delta t$ .

## ARB Mode Summary

The 3314A has 6 ARB waveforms (accessed by RECAL ARB 0 to 5).

There are a maximum of 160 vectors distributed among these 6 waveforms (2 vectors per waveform, minimum). The initialized ARB waveform (also the minimum waveform) is a 2 vector waveform with V HGT = 000, V LEN = 1, V MKR = 1 and  $\Delta t = .200ms$ .

V HGT range: -1999 to +1999

V LEN range: 1 to 127

$\Delta t$  range: .200ms to 19.99ms

Phase range:  $-90^\circ$  to  $+90^\circ$  (sets the waveform closure between the peak-to-peak limits set by AMPTD).

AMPTD sets the peak-to-peak limits that the ARB waveform must exist within.

See Waveforms 51 through 60 in the Waveform Library. Error Codes are on the back of the "Meet the 3314A" fold-out.

## THE WAVEFORM LIBRARY

This Waveform Library contains 60 oscillograms representing across-section of the 3314A's capabilities. The waveforms are organized into nine basic groups.

<b>Free Run</b>	Waveforms 1 through 10
<b>Free Run (Linear Sweep)</b>	Waveforms 11 through 15
<b>Free Run (Log Sweep)</b>	Waveforms 16 through 20
<b>Gate</b>	Waveforms 21 through 25
<b>Gated Sweep</b>	Waveforms 26 through 30
<b>N Cycle</b>	Waveforms 31 through 35
<b>1/2 Cycle</b>	Waveforms 36 through 40
<b>Fin X N</b>	Waveforms 41 through 45
<b>Fin + N</b>	Waveforms 46 through 50
<b>ARB</b>	Waveforms 51 through 60

# FREE RUN

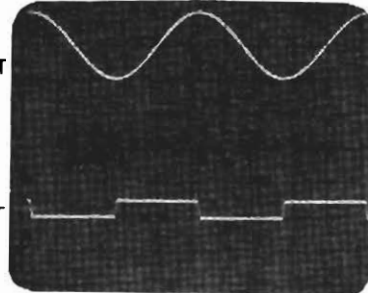
## 1. Large Signal With Large DC Offset

PRESET  
MODE ..... Free Run  
FREQUENCY ..... 1MHz  
AMPLITUDE ..... 10.00Vp-p  
OFFSET ..... + 5.00Vdc

PR MO1 FR1MZ AP10VO OF5VO

MAIN OUTPUT

SYNC OUTPUT



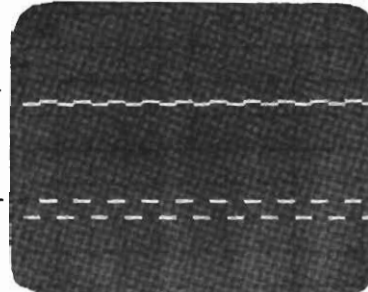
## 2. Small Signal With Large DC Offset

PRESET  
AMPLITUDE ..... 400mVp-p  
OFFSET ..... -3.00Vdc  
FUNCTION ..... Squarewave

PR AP400MV OF-3VO FU2

MAIN OUTPUT

SYNC OUTPUT



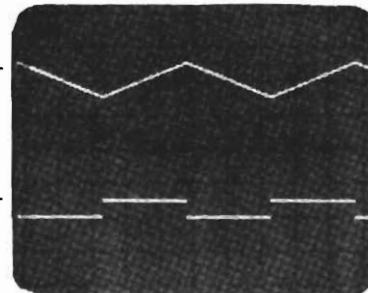
## 3. Large Signal With Small DC Offset

PRESET  
AMPLITUDE ..... 5Vp-p  
OFFSET ..... .250V  
FUNCTION ..... Triangle

PR AP5VO OF.25VO FU3

MAIN OUTPUT

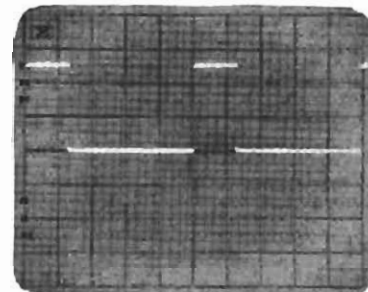
SYNC OUTPUT



## 4. TTL (Squarewave With DC Offset)

PRESET  
AMPLITUDE ..... 5.00Vp-p  
OFFSET ..... 2.50V  
SYMMETRY ..... 25%  
FUNCTION ..... Squarewave

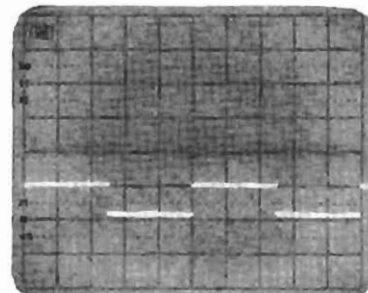
PR AP5VO OF2.5VO SY25PC FU2



## 5. ECL (Squarewave With DC Offset)

PRESET  
AMPLITUDE ..... .85Vp-p  
OFFSET ..... -1.31V  
FUNCTION ..... Squarewave

PR AP.85VO OF-1.31VO FU2

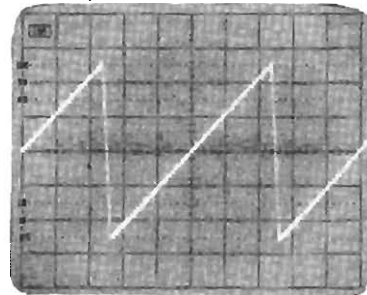


# FREE RUN (cont)

## 6. RAMPS (Variable Symmetry Triangle Wave)

PRESET  
 AMPLITUDE ..... 10Vp-p  
 SYM ..... 95%  
 FUNCTION ..... Triangle

PR AP10VO SY95PC FU3



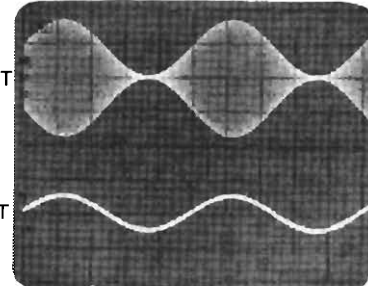
## 7. 100% Amplitude Modulation

PRESET  
 FREQUENCY ..... 1MHz  
 AMPLITUDE ..... 7Vp-p  
 MODULATION ..... AM

PR FR1MZ AP7VO AM1

Signal at AM input is a 2Vp-p, 1kHz sine wave.

MAIN OUTPUT



AM INPUT

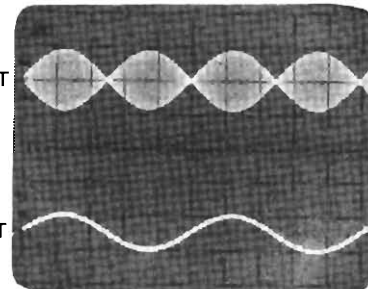
## 8. AM (Suppressed Carrier)

PRESET  
 FREQUENCY ..... 1MHz  
 AMPLITUDE ..... 7Vp-p  
 MODULATION ..... AM

PR FR1MZ AP7VO AM1

Signal at AM input is a 2Vp-p, 1kHz sine wave with -1Vdc offset.

MAIN OUTPUT



AM INPUT

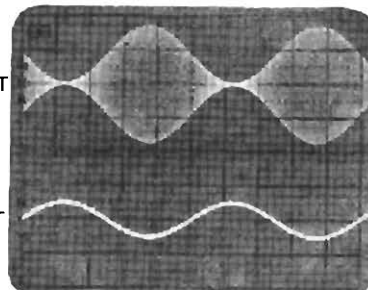
## 9. AM With Function Invert

PRESET  
 FREQUENCY ..... 1MHz  
 AMPLITUDE ..... 7Vp-p  
 MODULATION ..... AM  
 FUNCTION INVERT ..... ON

PR FR1MZ AP7VO AM1 FI1

Signal at AM input is a 2Vp-p, 1kHz sine wave.

MAIN OUTPUT



AM INPUT

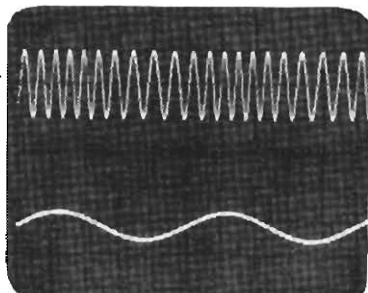
## 10. VCO

PRESET  
 MODE ..... Free Run  
 FREQUENCY ..... 1MHz  
 AMPLITUDE ..... 10Vp-p  
 MODULATION ..... VCO  
 FUNCTION ..... Sinewave

PR MO1 FR1MZ AP10VO VC1 FU1

Modulating signal is a 100kHz, 4Vp-p Sinewave with -1Vdc offset.

MAIN OUTPUT



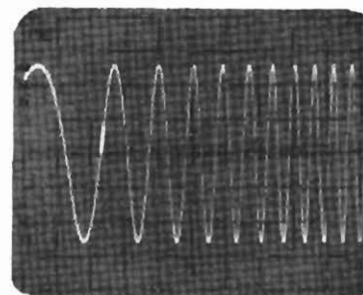
VCO INPUT

# FREE RUN (Linear Sweeps)

## 11. 100Hz to 1kHz

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 20ms  
START FREQUENCY ..... 100Hz  
STOP FREQUENCY ..... 1kHz  
MARKER FREQUENCY ..... 300Hz  
SWEEP TYPE ..... Linear

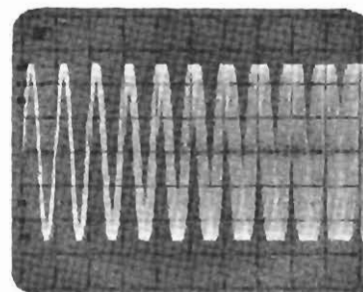
PR AP10VO TI20MS ST100HZ SP1KZ MK300HZ SW1



## 12. Small Sweep Ratio (1.06:1)

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 100ms  
START FREQUENCY ..... 5kHz  
STOP FREQUENCY ..... 5.3kHz  
SWEEP TYPE ..... Linear

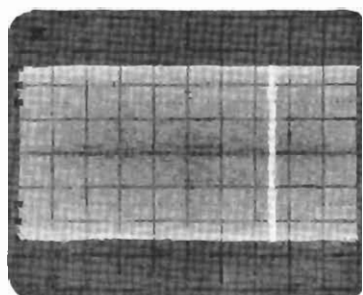
PR AP10VO TI100MS ST5KZ SP5.3KZ SW1



## 13. Large Sweep Ratio (100:1)

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 10ms  
START FREQUENCY ..... 199.9kHz  
STOP FREQUENCY ..... 19.99MHz  
MARKER FREQUENCY ..... 15MHz  
SWEEP TYPE ..... Linear

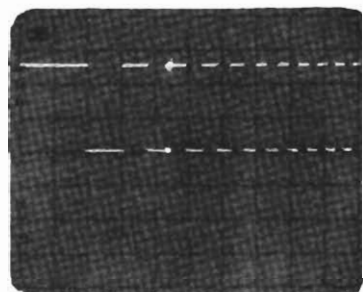
PR AP10VO TI10MS ST199.9KZ SP19.99MZ MK15MZ SW1



## 14. TTL Level Sweeps

PRESET  
AMPLITUDE ..... 5Vp-p  
OFFSET ..... +2.5Vdc  
START FREQUENCY ..... 21.4Hz  
STOP FREQUENCY ..... 2.14kHz  
MARKER FREQUENCY ..... 940Hz  
SWEEP TYPE ..... Linear

PR AP5VO OF2.5VO ST21.4HZ SP2.14KZ MK940HZ SW1



## 15. TTL Level, 95% Symmetry Sweep

PRESET  
AMPLITUDE ..... 5Vp-p  
OFFSET ..... +2.5V  
SYMMETRY ..... 95%  
START FREQUENCY ..... 10.81Hz  
STOP FREQUENCY ..... 1081Hz  
MARKER FREQUENCY ..... 1018Hz  
SWEEP TYPE ..... Linear

PR AP5VO OF2.5VO SY95PC ST10.81Hz SP1081HZ MK1018HZ SW1



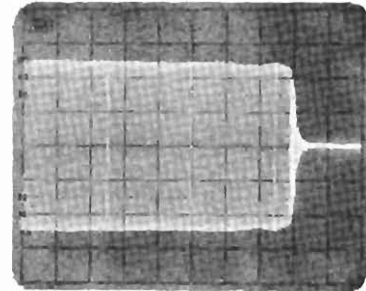
# FREE RUN (Log Sweeps)

## 16. Sweeping a Low Pass Filter

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 40ms/DECADE  
START FREQUENCY ..... 510Hz  
STOP FREQUENCY ..... 5.1MHz  
MARKER FREQUENCY ..... 809kHz  
SWEEP TYPE ..... Log

PR AP10VO TI40MS ST510HZ SP5.1MZ MK809KZ  
SW2

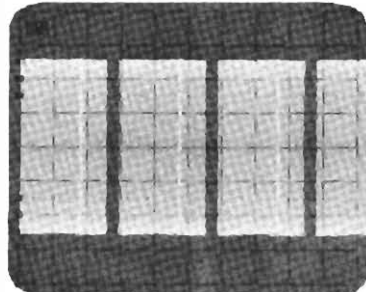
Note: The X Axis control voltage is from the 3314A's X Axis output. Note the intensification every decade and at the Marker Frequency.



## 17. 1 Decade Sweep

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 50ms/DECADE  
START FREQUENCY ..... 1999kHz  
STOP FREQUENCY ..... 19.99MHz  
MARKER FREQUENCY ..... 10MHz  
SWEEP TYPE ..... Log

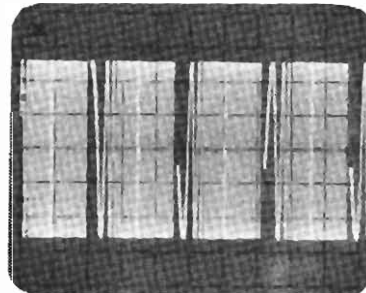
PR AP10VO TI50MS ST1999KZ SP19.99MZ MK10MZ  
SW2



## 18. Audio Sweep (20Hz to 20kHz)

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 40ms/DECADE  
START FREQUENCY ..... 20Hz  
STOP FREQUENCY ..... 20kHz  
MARKER FREQUENCY ..... 1kHz  
SWEEP TYPE ..... Log

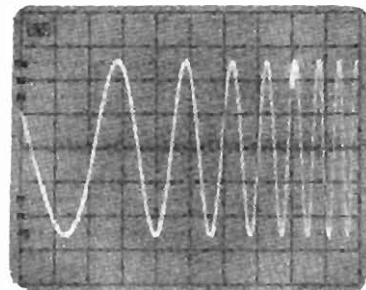
PR AP10VO TI40MS ST20HZ SP20KZ MK1KZ SW2



## 19. Sub-Audio Sweep (2Hz to 20Hz)

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 1s/DECADE  
START FREQUENCY ..... 2Hz  
STOP FREQUENCY ..... 20Hz  
MARKER FREQUENCY ..... 13Hz  
SWEEP TYPE ..... Log

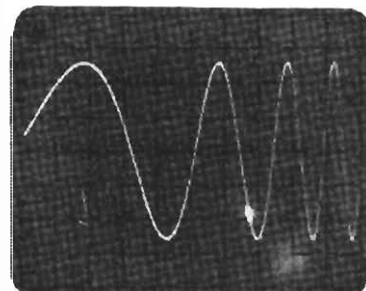
PR AP10VO TI1SN ST2HZ SP20HZ MK13HZ SW2



## 20. Low Frequency Sweep (.2Hz to 2Hz)

PRESET  
AMPLITUDE ..... 10Vp-p  
SWEEP INTERVAL ..... 5s/DECADE  
START FREQUENCY ..... .2Hz  
STOP FREQUENCY ..... 2Hz  
MARKER FREQUENCY ..... .935Hz  
SWEEP TYPE ..... Log

PR AP10VO TI5SN ST.2HZ SP2HZ MK.935HZ SW2



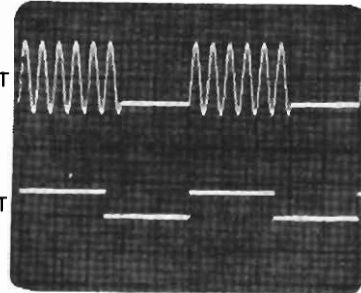
# GATE

## 21. Gated Sinewaves (Start/Stop Phase = $-45^\circ$ )

PRESET  
 MODE ..... GATE  
 AMPLITUDE ..... 10Vp-p  
 PHASE .....  $-45^\circ$   
 TRIGGER INTERVAL ..... 10ms

PR MO2 AP10VO PH-45DG TI10MS

MAIN OUTPUT  
 TRIGGER OUTPUT

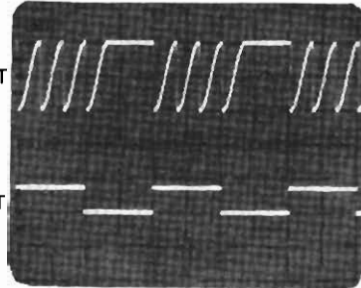


## 22. Gated Sinewaves (SYM = 95%)

PRESET  
 MODE ..... GATE  
 FREQUENCY ..... 298Hz  
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 95%  
 PHASE .....  $90^\circ$   
 TRIGGER INTERVAL ..... 20ms

PR MO2 FR298HZ AP10VO SY95PC PH90DG TI20MS

MAIN OUTPUT  
 TRIGGER OUTPUT

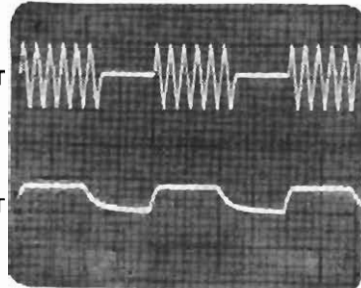


## 23. High Frequency Gate

PRESET  
 MODE ..... GATE  
 FREQUENCY ..... 5MHz  
 AMPLITUDE ..... 10Vp-p  
 TRIGGER INTERVAL ..... .002ms  
 FUNCTION ..... TRIANGLE

PR MO2 FR5MZ AP10VO TI.002MS FU3

MAIN OUTPUT  
 TRIGGER OUTPUT

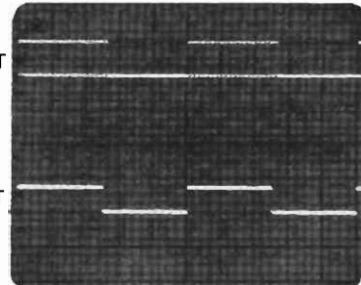


## 24. Gated TTL Level Pulses

PRESET  
 MODE ..... GATE  
 FREQUENCY ..... 15kHz  
 AMPLITUDE ..... 5Vp-p  
 OFFSET ..... 2.5Vdc  
 TRIGGER INTERVAL ..... 2.5ms  
 FUNCTION ..... Squarewave  
 INVERT FUNCTION ..... ON

PR MD2 FR15KZ AP5VO OF2.5VO TI2.5MS FU2 FI1

MAIN OUTPUT  
 TRIGGER OUTPUT

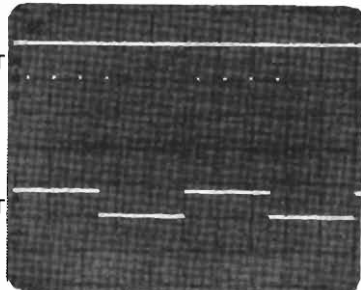


## 25. Gated TTL Level Pulses

PRESET  
 MODE ..... GATE  
 FREQUENCY ..... 2.6kHz  
 AMPLITUDE ..... 5Vp-p  
 OFFSET ..... 2.5Vdc  
 SYMMETRY ..... 95%  
 TRIGGER INTERVAL ..... 2.5ms  
 FUNCTION ..... Squarewave

PR MD2 FR2.6KZ AP5VO OF2.5VO SY95PC TI2.5MS FU2

MAIN OUTPUT  
 TRIGGER OUTPUT



# GATED SWEEPS

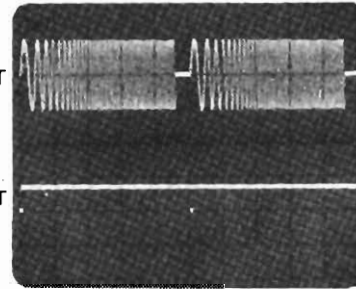
## 26. Basic Gated Sweep (10ms)

PRESET  
 MODE ..... Gate  
 AMPLITUDE ..... 10Vp-p  
 SWEEP TYPE ..... Linear

PR M02 AP10VO SW1

MAIN OUTPUT

TRIGGER  
 OUTPUT



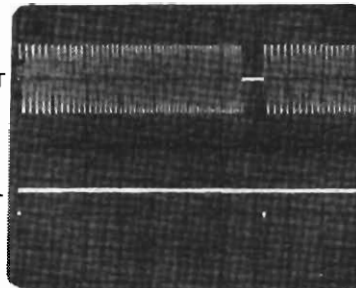
## 27. Small Ratio Gated Sweep (2:1)

PRESET  
 MODE ..... Gate  
 AMPLITUDE ..... 10Vp-p  
 SWEEP INTERVAL ..... 7.2ms  
 START FREQUENCY ..... 5kHz  
 STOP FREQUENCY ..... 10kHz

PR M02 AP10VO T17.2MS ST5KZ SP10KZ

MAIN OUTPUT

TRIGGER  
 OUTPUT



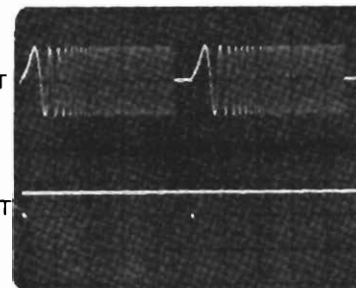
## 28. Large Ratio Gated Sweep (100:1)

PRESET  
 MODE ..... Gate  
 AMPLITUDE ..... 10Vp-p  
 SWEEP INTERVAL ..... 10ms  
 START FREQUENCY ..... 100Hz  
 STOP FREQUENCY ..... 10kHz

PR M02 AP10VO T110MS ST100HZ SP10KZ

MAIN OUTPUT

TRIGGER  
 OUTPUT



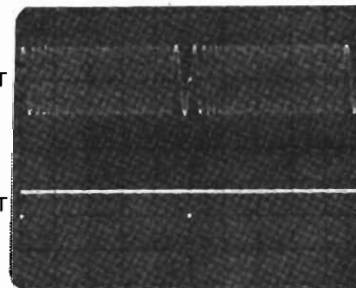
## 29. Audio Chirp

PRESET  
 MODE ..... Gate  
 AMPLITUDE ..... 10Vp-p  
 SWEEP INTERVAL ..... 100ms  
 START FREQUENCY ..... 100Hz  
 STOP FREQUENCY ..... 1kHz  
 SWEEP TYPE ..... Linear

PR M02 AP10VO T1.1SN ST100HZ SP1KZ SW1

MAIN OUTPUT

TRIGGER  
 OUTPUT



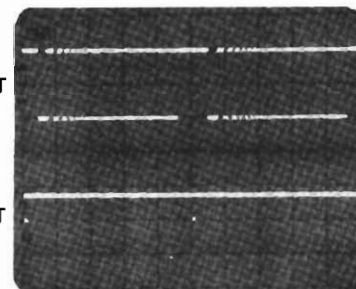
## 30. Swept Squarewaves

PRESET  
 MODE ..... Gate  
 AMPLITUDE ..... 10Vp-p  
 SWEEP INTERVAL ..... 10ms  
 START FREQUENCY ..... 100Hz  
 STOP FREQUENCY ..... 10kHz  
 SWEEP TYPE ..... Linear  
 FUNCTION ..... Squarewave

PR M02 AP10VO T110MS ST100HZ SP10KZ SW1 FU2

MAIN OUTPUT

TRIGGER  
 OUTPUT



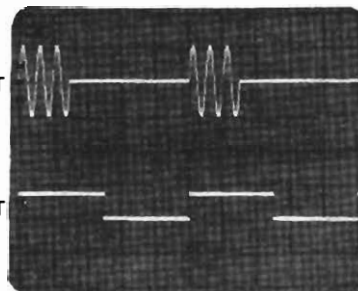
# N CYCLE

## 31. 3 Cycle Burst

PRESET  
 MODE ..... N CYCLE  
 MAIN OUTPUT  
 AMPLITUDE ..... 10Vp-p  
 N ..... 3

PR MO3 AP10VO NM3EN

TRIGGER OUTPUT

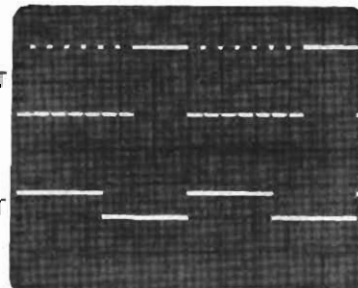


## 32. 7 Cycle Burst

PRESET  
 MODE ..... N Cycle  
 MAIN OUTPUT  
 AMPLITUDE ..... 10Vp-p  
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 20%  
 PHASE ..... 90°  
 N ..... 7

PR MO3 AP10VO SY20PC PH90DG NM7EN

TRIGGER OUTPUT

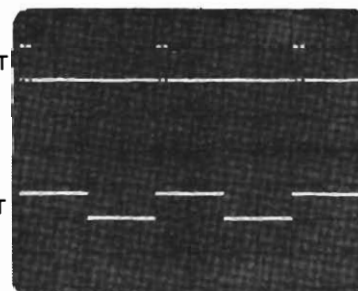


## 33. 2 Cycle Burst

MODE ..... N Cycle  
 MAIN OUTPUT  
 AMPLITUDE ..... 5Vp-p  
 OFFSET ..... 2.5Vdc  
 N ..... 2  
 TRIGGER INTERVAL ..... 16ms  
 FUNCTION ..... Squarewave  
 FUNCTION INVERT ..... ON

PR AP5VO OF2.5VO NM2EN TI16MS FU2 FI1

TRIGGER OUTPUT

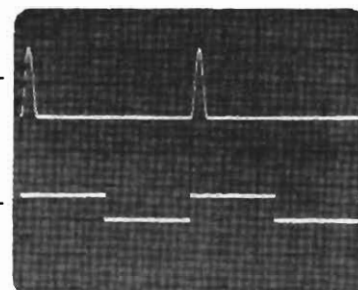


## 34. Haversine

PRESET  
 MODE ..... N Cycle  
 MAIN OUTPUT  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -90°  
 N ..... 1  
 FUNCTION ..... Sinewave

PR MO3 AP10VO PH-90DG NM1EN FU1

TRIGGER OUTPUT

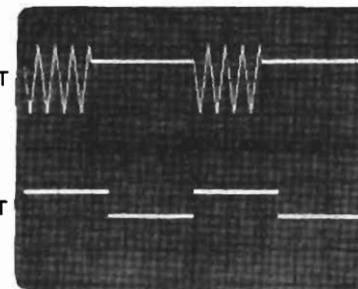


## 35. 4 Cycle Burst With Start/Stop Phase = -45°

PRESET  
 MODE ..... N Cycle  
 MAIN OUTPUT  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -45°  
 N ..... 4  
 FUNCTION ..... Triangle  
 FUNCTION INVERT ..... ON

PR MO3 AP10VO PH-45DG NM4EN FU3 FI1

TRIGGER OUTPUT

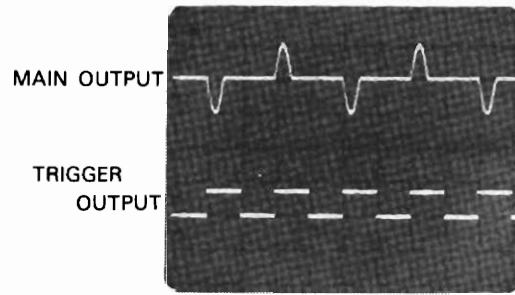


# 1/2 CYCLE

## 36. Basic 1/2 Cycle

PRESET  
 MODE ..... 1/2 Cycle  
 FREQUENCY ..... 200Hz  
 AMPLITUDE ..... 10Vp-p

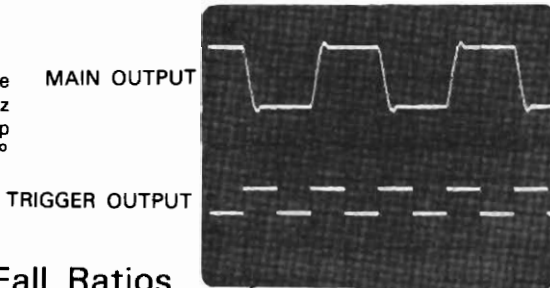
PR MO4 FR200HZ AP10VO



## 37. Pulses With Overshoot

PRESET  
 MODE ..... 1/2 Cycle  
 FREQUENCY ..... 200Hz  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -60°

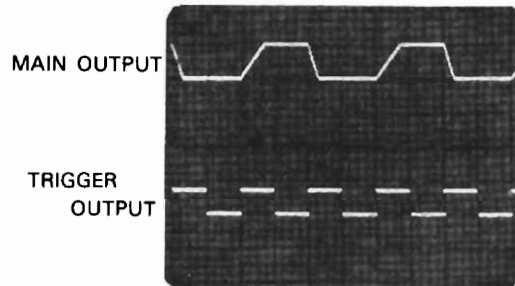
PR MO4 FR200HZ AP10VO



## 38. Pulses With Varying Rise/Fall Ratios

PRESET  
 MODE ..... 1/2 Cycle  
 FREQUENCY ..... 200Hz  
 AMPLITUDE ..... 5Vp-p  
 OFFSET ..... +2.5Vdc  
 SYMMETRY ..... 70%  
 PHASE ..... 90°  
 TRIGGER INTERVAL ..... 10ms  
 FUNCTION ..... Triangle

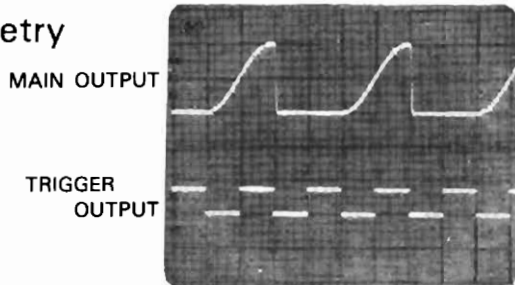
PR MO4 FR200HZ AP5VO OF2.5VO SY70PC PH90DG  
 FU3



## 39. 1/2 Cycle With 95% Symmetry

PRESET  
 MODE ..... 1/2 Cycle  
 FREQUENCY ..... 100Hz  
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 95%  
 PHASE ..... 90°  
 TRIGGER SLOPE ..... \ (negative edge)

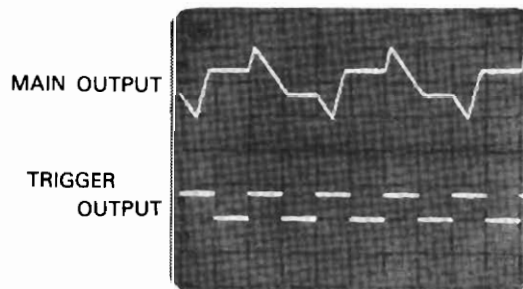
PR MO4 FR100HZ AP10VO SY95PC PH90DG SL2



## 40. 1/2 Cycle Trianglewaves

PRESET  
 MODE ..... 1/2 Cycle  
 FREQUENCY ..... 100Hz  
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 28%  
 PHASE ..... 31°  
 FUNCTION ..... Triangle

PR MO4 FR100HZ AP10VO SY28PC PH31DG FU3



# Fin X N

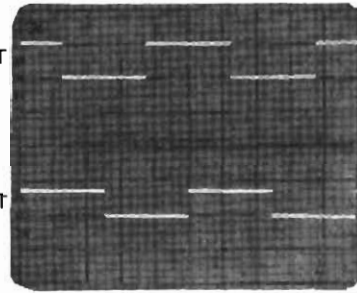
## 41. Squarewaves in Quadrature

PRESET  
MODE ..... Fin X N  
AMPLITUDE ..... 5Vp-p  
OFFSET ..... 2.5Vdc  
PHASE ..... 90°  
N ..... 1  
TRIGGER INTERVAL ..... 1ms  
FUNCTION ..... Squarewave

PR MO5 AP5VO OF2.5VO PH90DG NM1EN T11MS FU2

MAIN OUTPUT

TRIGGER  
OUTPUT



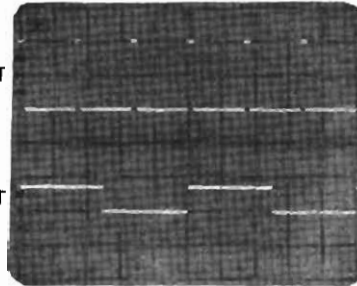
## 42. 3 Pulses

PRESET  
MODE ..... Fin X N  
AMPLITUDE ..... 10Vp-p  
SYMMETRY ..... 10%  
N ..... 3  
FUNCTION ..... Squarewave

PR MO5 AP10VO SY10PC NM3EN FU2

MAIN OUTPUT

TRIGGER  
OUTPUT



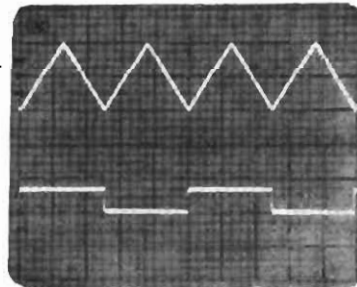
## 43. Trianglewaves

PRESET  
MODE ..... Fin X N  
AMPLITUDE ..... 10Vp-p  
N ..... 2  
TRIGGER SOURCE ..... EXT  
TRIGGER SLOPE ..... \ (negative edge)  
TRIGGER THRESHOLD ..... 1V  
FUNCTION ..... Triangle

PR MO5 AP10VO NM2EN SR2 SL2 LV1 FU3  
External Trigger is a 100kHz, TTL squarewave

MAIN OUTPUT

TRIGGER  
OUTPUT



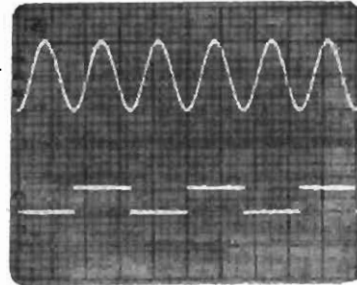
## 44. Sinewaves

PRESET  
MODE ..... Fin X N  
AMPLITUDE ..... 10Vp-p  
N ..... 2  
SW/TR INTVL ..... 16.66mS

PR MO5 AP10VO NM2EN T116.66MS

MAIN OUTPUT

TRIGGER  
OUTPUT



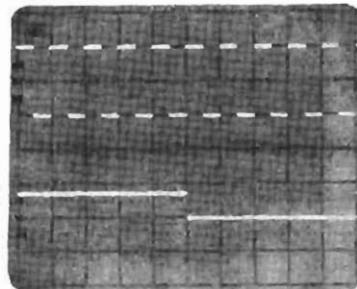
## 45. Squarewaves

PRESET  
MODE ..... Fin X N  
AMPLITUDE ..... 10Vp-p  
N ..... 10  
FUNCTION ..... Squarewave

PR MO5 AP10VO NM10EN FU2

MAIN OUTPUT

TRIGGER  
OUTPUT



$$F_{in} \div N$$

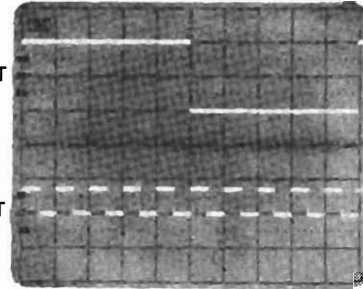
## 46. Squarewaves

PRESET  
 MODE .....  $F_{in} + N$   
 AMPLITUDE ..... 10Vp-p  
 N ..... 10  
 FUNCTION ..... Squarewave

PR MO6 AP10VO NM10EN FU2

MAIN OUTPUT

TRIGGER  
 OUTPUT



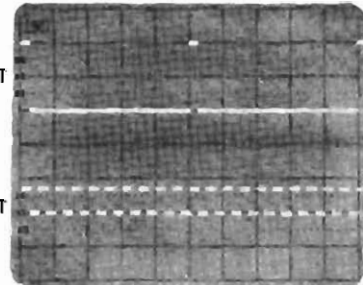
## 47. Pulses

PRESET  
 MODE .....  $F_{in} + N$   
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 5%  
 N ..... 10  
 FUNCTION ..... Squarewave

PR MO6 AP10VO SY5PC NM10EN FU2

MAIN OUTPUT

TRIGGER  
 OUTPUT



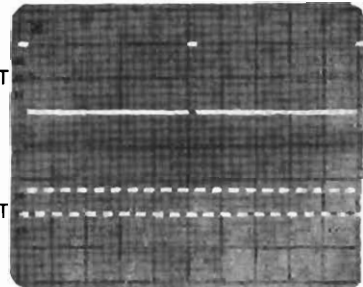
## 48. Pulses

PRESET  
 MODE .....  $F_{in} + N$   
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 5%  
 PHASE ..... 18°  
 N ..... 10  
 FUNCTION ..... Squarewave

PR MO6 AP10VO SY5PC PH18DG NM10EN FU2

MAIN OUTPUT

TRIGGER  
 OUTPUT



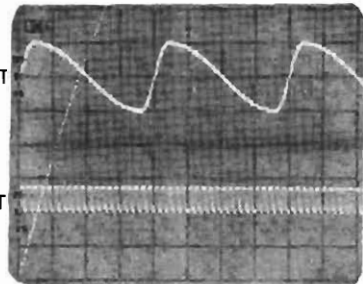
## 49. Variable Symmetry

PRESET  
 MODE .....  $F_{in} + N$   
 AMPLITUDE ..... 10Vp-p  
 SYMMETRY ..... 20%  
 N ..... 20  
 TRIGGER INTERVAL ..... .002ms  
 FUNCTION ..... Sinewave

PR MO6 AP10VO SY20PC NM20EN T1.002MS FU1

MAIN OUTPUT

TRIGGER  
 OUTPUT



## 50. Phase Locked Amplitude Modulation

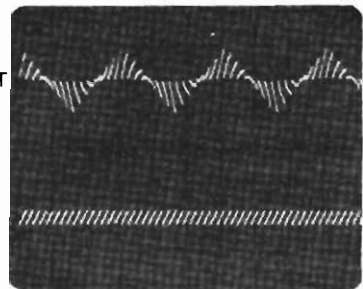
PRESET  
 MODE .....  $F_{in} + N$   
 AMPLITUDE ..... 10Vp-p  
 N ..... 15  
 TRIGGER SOURCE ..... EXT  
 TRIGGER LEVEL ..... 0V  
 TRIGGER SLOPE ..... (negative edge)  
 MODULATION ..... AM  
 FUNCTION ..... Triangle

PR MO6 AP10VO NM15EN SR2 LV2 SL2 AM1 FU3

Modulating signal and Trigger input is a 10kHz, 2Vp-p Ramp.

MAIN OUTPUT

TRIGGER  
 AND AM  
 INPUT

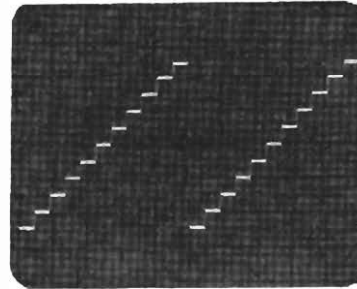


# ARB

## 51. Linear Steps

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -90°

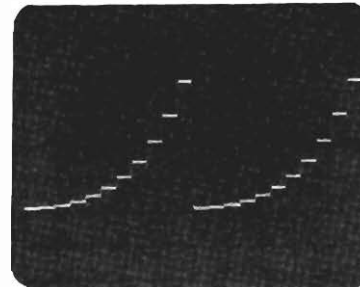
Vector	V HGT=	V LEN=
1	0	9
2	250	1
3	0	9
4	250	1
5	0	9
6	250	1
7	0	9
8	250	1
9	0	9
10	250	1
11	0	9
12	250	1
13	0	9
14	250	1
15	0	9
16	250	1
17	0	9
18	250	1
19	0	9
20	250	1
21	0	9
22	1	1



## 52. Exponential Steps

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -90°

Vector	V HGT=	V LEN=
1	0	9
2	15	1
3	0	9
3	34	1
5	0	9
6	57	1
7	0	9
8	87	1
9	0	9
10	124	1
11	0	9
12	170	1
13	0	9
14	229	1
15	0	9
16	303	1
17	0	9
18	397	1
19	0	9
20	514	1
21	0	9
22	1	1

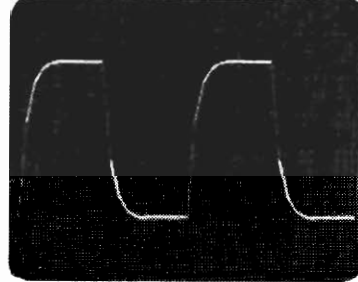


## ARB (cont)

### 53. Exponential Charge/Discharge

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -90°

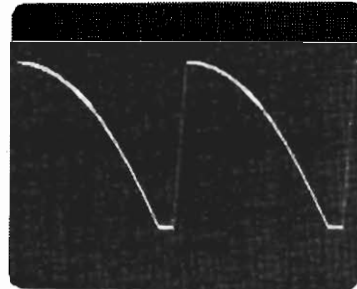
Vector	V HGT=	V LEN=
1	1454	1
2	581	1
3	214	1
4	79	1
5	29	1
6	0	5
7	-1454	1
8	-581	1
9	-214	1
10	-79	1
11	-29	1
12	1	5



### 54. Square Law Response

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -90°  
 FUNCTION INVERT ..... ON

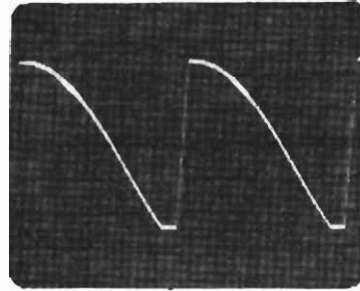
Vector	V HGT=	VLEN=
1	25	1
2	75	1
3	125	1
4	175	1
5	225	1
6	275	1
7	325	1
8	375	1
9	425	1
10	475	1
11	0	1
12	1	1



# ARB (cont)

## 55. Exponential Response

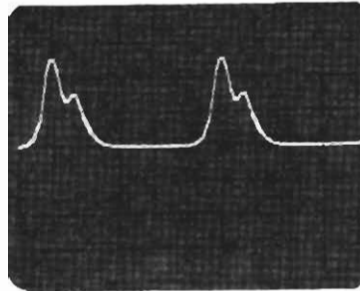
PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p  
 PHASE ..... -90°  
 FUNCTION INVERT ..... ON



Vector	V HGT=	V LEN=
1	19	1
2	91	1
3	159	1
4	220	1
5	274	1
6	318	1
7	350	1
8	367	1
9	364	1
10	337	1
11	0	1
12	1	1

## 56. Carotid Artery Pressure Wave

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p

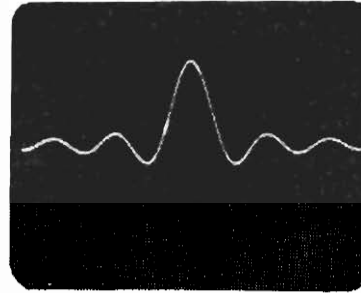


Vector	V HGT=	V LEN=
1	10	2
2	40	2
3	140	2
4	370	2
5	190	1
6	0	1
7	-190	1
8	-300	1
9	-140	1
10	0	1
11	90	1
12	0	1
13	-160	2
14	-120	2
15	-60	2
16	-30	2
17	-10	2
18	0	1
19	0	1
20	1	19

# ARB (cont)

57.  $\sin(x)/x$

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p

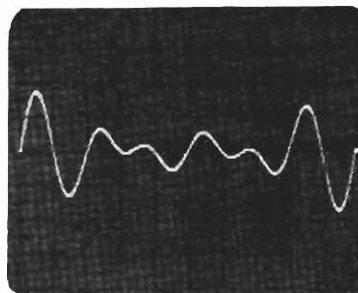


Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=
1	3	1	34	-70	1	67	70	1
2	11	1	35	-60	1	68	72	1
3	19	1	36	-41	1	69	66	1
4	24	1	37	-15	1	70	53	1
5	27	1	38	17	1	71	36	1
6	27	1	39	53	1	72	17	1
7	23	1	40	90	1	73	-3	1
8	17	1	41	124	1	74	-20	1
9	8	1	42	154	1	75	-34	1
10	-2	1	43	175	1	76	-43	1
11	-13	1	44	187	1	77	-47	1
12	-22	1	45	186	1	78	-45	1
13	-30	1	46	174	1	79	-38	1
14	-34	1	47	150	1	80	-27	1
15	-34	1	48	115	1	81	-15	1
16	-31	1	49	72	1	82	-1	1
17	-23	1	50	25	1	83	12	1
18	-12	1	51	-25	1	84	23	1
19	1	1	52	-72	1	85	31	1
20	15	1	53	-115	1	86	34	1
21	27	1	54	-150	1	87	34	1
22	38	1	55	-174	1	88	30	1
23	45	1	56	-186	1	89	22	1
24	47	1	57	-187	1	90	13	1
25	43	1	58	-175	1	91	2	1
26	34	1	59	-154	1	92	-8	1
27	20	1	60	-124	1	93	-17	1
28	3	1	61	-90	1	94	-23	1
29	-17	1	62	-53	1	95	-27	1
30	-36	1	63	-17	1	96	-27	1
31	-53	1	64	15	1	97	-24	1
32	-66	1	65	41	1	98	-19	1
33	-72	1	66	60	1	99	-11	1
						100	1	1

# ARB (cont)

## 58. 3 Note Chord (Major Triad)

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p

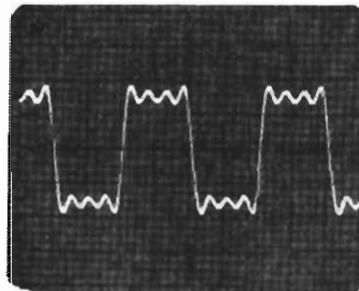


Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=
1	278	1	34	29	1	67	29	1
2	248	1	35	32	1	68	17	1
3	193	1	36	26	1	69	-2	1
4	119	1	37	11	1	70	-24	1
5	33	1	38	-9	1	71	-47	1
6	-55	1	39	-31	1	72	-64	1
7	-134	1	40	-50	1	73	-72	1
8	-197	1	41	-64	1	74	-68	1
9	-236	1	42	-69	1	75	-51	1
10	-249	1	43	-64	1	76	-21	1
11	-236	1	44	-49	1	77	18	1
12	-198	1	45	-25	1	78	61	1
13	-142	1	46	3	1	79	104	1
14	-74	1	47	33	1	80	139	1
15	-4	1	48	61	1	81	161	1
16	62	1	49	81	1	82	166	1
17	115	1	50	92	1	83	150	1
18	150	1	51	92	1	84	115	1
19	166	1	52	81	1	85	62	1
20	161	1	53	61	1	86	-4	1
21	139	1	54	33	1	87	-74	1
22	104	1	55	3	1	88	-142	1
23	61	1	56	-25	1	89	-198	1
24	18	1	57	-49	1	90	-236	1
25	-21	1	58	-64	1	91	-249	1
26	-51	1	59	-69	1	92	-236	1
27	-68	1	60	-64	1	93	-197	1
28	-72	1	61	-50	1	94	-134	1
29	-64	1	62	-31	1	95	-55	1
30	-47	1	63	-9	1	96	33	1
31	-24	1	64	11	1	97	119	1
32	-2	1	65	26	1	98	193	1
33	17	1	66	32	1	99	248	1
						100	278	1
						101	1	1

# ARB (cont)

## 59. Fourier Series Squarewave [cosF-1/3cos3F+ 1/5cos5F ]

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p

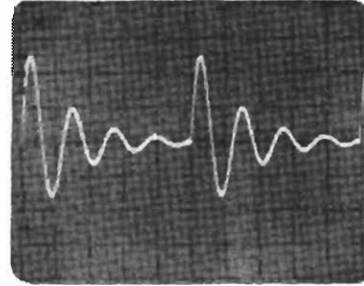


Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=
1	8	1	34	55	1	67	-55	1
2	21	1	35	55	1	68	-40	1
3	30	1	36	43	1	69	-9	1
4	31	1	37	23	1	70	35	1
5	25	1	38	0	1	71	87	1
6	12	1	39	-20	1	72	141	1
7	-4	1	40	-33	1	73	190	1
8	-21	1	41	-38	1	74	228	1
9	-33	1	42	-33	1	75	248	1
10	-38	1	43	-21	1	76	248	1
11	-33	1	44	-4	1	77	228	1
12	-20	1	45	12	1	78	190	1
13	0	1	46	25	1	79	141	1
14	23	1	47	31	1	80	87	1
15	43	1	48	30	1	81	35	1
16	55	1	49	21	1	82	-9	1
17	55	1	50	8	1	83	-40	1
18	40	1	51	-8	1	84	-55	1
19	9	1	52	-21	1	85	-55	1
20	-35	1	53	-30	1	86	-43	1
21	-87	1	54	-31	1	87	-23	1
22	-141	1	55	-25	1	88	0	1
23	-190	1	56	-12	1	89	20	1
24	-228	1	57	4	1	90	33	1
25	-248	1	58	21	1	91	38	1
26	-248	1	59	33	1	92	33	1
27	-228	1	60	38	1	93	21	1
28	-190	1	61	33	1	94	4	1
29	-141	1	62	20	1	95	-12	1
30	-87	1	63	0	1	96	-25	1
31	-35	1	64	-23	1	97	-31	1
32	9	1	65	-43	1	98	-30	1
33	40	1	66	-55	1	99	-21	1
						100	-8	1

# ARB (cont)

## 60. Damped Oscillations

PRESET  
 MODE ..... ARB  
 AMPLITUDE ..... 10Vp-p



Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=	Vector	V HGT=	V LEN=
1	383	1	35	-91	1	67	-13	1
2	332	1	36	-100	1	68	-5	1
3	263	1	37	-102	1	69	3	1
4	184	1	38	-98	1	70	10	1
5	98	1				71	16	1
			39	-88	1			
6	13	1	40	-73	1	72	20	1
7	-66	1	41	-55	1	73	23	1
8	-136	1	42	-34	1	74	25	1
9	-193	1	43	-14	1	75	24	1
10	-233	1				76	23	1
			44	7	1			
11	-256	1	45	25	1	77	20	1
12	-262	1	46	40	1	78	16	1
13	-250	1	47	52	1	79	11	1
14	-225	1	48	60	1	80	6	1
15	-187	1				81	1	1
			49	63	1			
16	-140	1	50	63	1	82	-4	1
17	-88	1	51	58	1	83	-8	1
18	-35	1	52	50	1	84	-11	1
19	17	1	53	40	1	85	-14	1
20	64	1				86	-15	1
			54	28	1			
21	104	1	55	15	1	87	-15	1
22	134	1	56	2	1	88	-15	1
23	154	1	57	-10	1	89	-13	1
24	163	1	58	-21	1	90	-11	1
25	161	1				91	-8	1
			59	-29	1			
26	149	1	60	-35	1	92	-5	1
27	129	1	61	-39	1	93	-2	1
28	103	1	62	-40	1	94	1	1
29	72	1	63	-38	1	95	4	1
30	38	1				96	6	1
			64	-34	1			
31	5	1	65	-28	1	97	8	1
32	-26	1	66	-21	1	98	9	1
33	-53	1				99	10	1
34	-75	1				100	10	1
						101	0	1

# DETAILED OPERATING INFORMATION

This section contains detailed discussions about the following topics:

- ARB
- CALIBRATION
- DATA ENTRY
- ERROR CODES
- EXTERNAL MODULATION
- FUNCTIONS
- MODE
- OPERATOR ALERTS
- OUTPUTS
- PRESET
- SPECIFICATIONS
- STORE & RECALL

# ARB

The ARB mode redefines the 3314A as an ARBitrary waveform generator. Arbitrary waveforms are user defined waves made up of a series of voltage ramps called vectors. There are a maximum of 160 vectors distributed among six ARB waves with a minimum of two vectors per wave. The user has control over the length and height of each vector and the number of vectors plus most of the normal wave parameters allowed in the function generator definition.

## How to PRESET an ARB Waveform

The BLUE shift ARB key and "AR2" HP-IB command initializes the current ARB wave. Other ARB waves are not affected. The ARB waveform is reduced to two vectors, Height = 0, Length = 1. The ARB wave is reduced by deleting vectors one at a time, beginning with the next to last vector at a rate of ~100 vector deletions per second and then initializing the remaining vectors.

The following ARB parameters are affected when an ARB wave is cleared:

Amplitude . . . . .	100mVp-p	Number of Vectors . . . . .	2
$\Delta t$ . . . . .	0.2ms	Vector #1	
Frequency . . . . .	2.5kHz	Vector Height . . . . .	0
Function . . . . .	Triangle	Vector Length . . . . .	1
Function Invert . . . . .	OFF	Vector #2	
Mode . . . . .	Free Run	Vector Height . . . . .	1F00 *
Modulation . . . . .	OFF	Vector Length . . . . .	1
Offset . . . . .	0Vdc	Trigger . . . . .	Ext, /, 1V
Phase . . . . .	0°	Vector Marker . . . . .	1

\*The last vector is the return to start or close the waveform vector. Its vector height is not programmable! The 3314A displays "1F00" whenever the Vector Marker is set to the last vector and vector height is the displayed parameter.

## How ARB Waveforms are Recalled

The ARB key and "AR1" enable the ARB definition of the 3314A. "Arx" (x = 0 through 5) will be displayed for 1/2 second after ARB has been enabled to indicate the active ARB wave. The RCL, ARB and then 0,1,2,3,4 or 5 keys, or "RWO" through "RW5" HP-IB commands, recalls one of six ARB waves. As an ARB wave is built, the current settings are automatically stored in non-volatile

## ARB (cont)

memory. Even if power is lost, the wave parameters remain intact and using the recall ARB wave function will restore the output signal.

### How to Connect an Oscilloscope

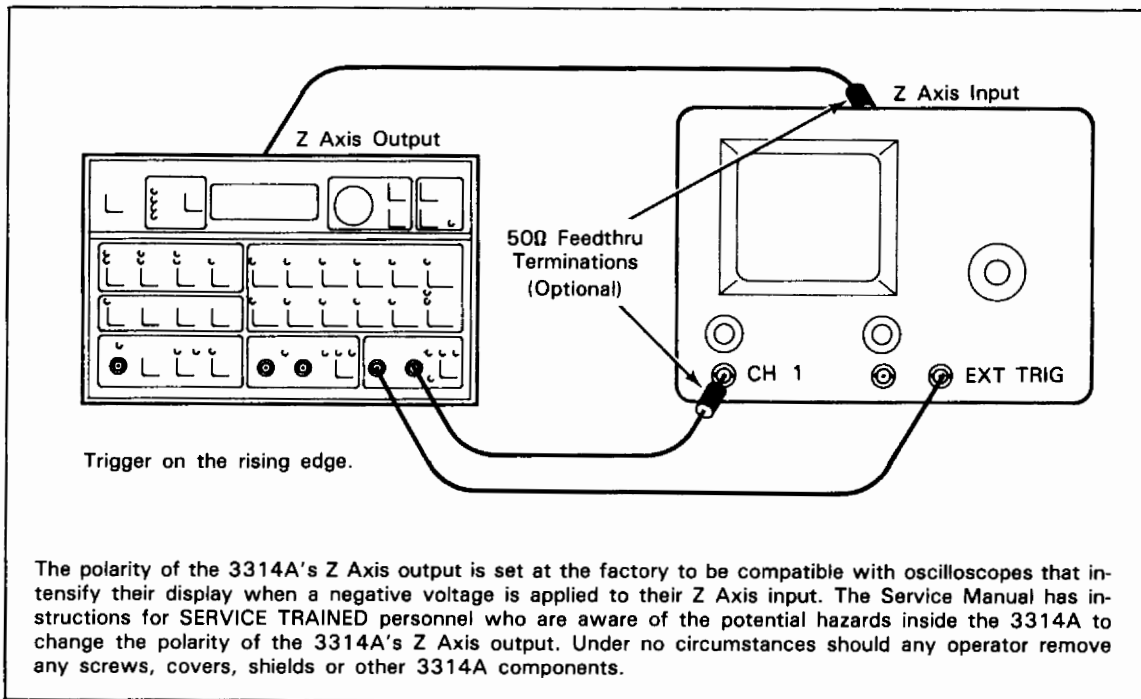
The Z Axis output has been designed to intensify the current vector because it is easy to become confused as to which vector is being modified when ARB waves grow to more than about five vectors. The 3314A is factory set to be compatible with oscilloscopes that intensify the trace when a negative voltage is applied to the Z Axis input. All 3314As have been set at the factory to output a  $< -5V$  level during the current vector and 0V during all other vectors. A  $50\Omega$  feedthru may be required to reduce the sensitivity of the Z Axis input on certain oscilloscopes.

### Definitions

This section contains definitions, descriptions and other pertinent information that is required to operate the ARB portion of the 3314A. The following topics are covered in alphabetical order.

- Amplitude
- Delete Vector
- $\Delta t$
- Frequency
- Insert Vector
- Invert Function
- Mode (Free Run or Gate)
- Offset
- Phase
- Preset ARB Wave
- Return To Start Vector
- Slope
- Recall ARB Wave
- SYNC Output
- Vector Length
- Vector Height
- Vector Marker

## ARB (cont)



**Figure 3. How To Connect An Oscilloscope**

**Amplitude.** Amplitude sets the peak-to-peak voltage that the ARB wave must exist within (not affected by DC Offset). The peak to peak amplitude also affects the resolution of V HGT (see Vector Height).

**Delete Vector.** The Delete Vector function deletes 1 vector from the current ARB wave. When a vector is deleted:

- the current vector is deleted (the current vector is the vector pointed to by the Vector Marker and intensified by the Z Axis output).
- the vectors are renumbered.
- the Vector Marker is decremented by 1 and points to the vector that preceded the deleted vector.

The last (return to start) vector cannot be deleted. If the first vector is deleted, the Vector Marker remains pointed at vector number 1.

**$\Delta t$ .** Sets the unit length of all vectors.  $0.2\text{ms} \leq \Delta t \leq 19.99\text{ms}$ . The length of each vector in time is  $\Delta t$  (seconds/unit length) times the Vector Length (unit lengths).

## ARB (cont)

**Frequency.** ARB frequency is the repetition rate of the ARB wave and is derived from  $\Delta t$ . When ARB frequency is changed, a new  $\Delta t$  is computed. Because of the limited resolution of  $\Delta t$ , you may not be able to get the exact desired frequency.  $\Delta t$  programs much faster than ARB Frequency.

$$\text{FREQ} = \frac{1}{\Delta t * (V \text{ LEN}_1 + V \text{ LEN}_2 + \dots V \text{ LEN}_n)}$$

where  $.200\text{ms} \leq \Delta t \leq 1.999\text{ms}$   
or  $2.00\text{ms} \leq \Delta t \leq 19.99\text{ms}$

**Insert Vector.** The Insert Vector function adds 1 vector to the current ARB wave. When a vector is inserted:

- the vector is inserted immediately after the current vector (the current vector is the vector pointed to by the Vector Marker and intensified by the Z Axis output).
- the inserted vector has Vector height = 0, Vector Length = 1.
- the vectors are renumbered.
- the Vector Marker is incremented by 1 and points to the inserted vector.

**Invert Function.** Invert Function inverts the output signal with respect to the SYNC output. The DC Offset is not affected.

**Mode.** The only modes allowed in ARB are Free Run and Gate.

- Free Run outputs a continuous signal. All triggers are ignored.
- Gate outputs a continuous signal while the trigger level satisfies the slope and threshold conditions. The output will gate off after the trigger level changes and the waveform is completed.

**Offset.** DC Offset from -5V to +5V is implemented in ARB exactly as in the Function Generator definition.

**Phase.** Phase sets the start/finish point of the ARB wave between the peak to peak limits set by Amplitude. The start/finish point is the end point of the last vector.  $-90^\circ$  sets the start/finish at the negative amplitude limit;  $0^\circ$  sets the start/finish midway between the limits; and  $+90^\circ$  sets the start/finish at the positive amplitude limit.

## ARB (cont)

**Return To Start Vector.** The last vector of every ARB wave must close the waveform. Its Vector Height is not programmable. This vector slews to the Start/Finish point as quickly as possible and remains there until the ARB wave is repeated. "1FO0" will be displayed as this vector's height. To reduce the effect of this non-programmable vector, start the ARB wave where its slope = 0 ( $\Delta V \div \Delta T = 0$ ). Use the Phase function to set the Start/Finish point between the peak to peak amplitude.

**Slope.**  $\Delta V \div \Delta T$  (the slope of a vector) is not affected by Vector Length.

$$\Delta V \div \Delta T = \frac{.0008 * V \text{ HGT} * \left( \frac{\text{Amplitude (Vp-p)}}{2} \right)}{\Delta t \text{ (seconds)}}$$

**SYNC Output.** The SYNC output signal is a TTL low during the last (return to start) vector.

**Vector Height.** Vector Height sets the end point of every vector except the last vector. Each count in the display sets the end point X volts from the vector's starting voltage.

$$\text{where } X = .0008 * V \text{ HGT} * V \text{ LEN} * \frac{\text{Amplitude (Vp-p)}}{2}$$

The resolution (minimum end voltage step) is:

$$\text{Resolution} = .0008 * V \text{ LEN} * \frac{\text{Amplitude (Vp-p)}}{2}$$

The voltage change can range from 0% ( $V \text{ HGT} = 0$ ) to 80% ( $V \text{ HGT} = 1999$ ) of the peak to peak amplitude setting in .04% steps, when Vector Length = 1. As the Vector Length increases, the resolution decreases.

**Vector Length.** The length of a vector in time is determined by  $\Delta t$  (the unit length of every vector) and Vector Length (variable from 1 to 127 for each vector). To determine each vector's time, multiply its Vector Length by  $\Delta t$ .

**Vector Marker.** The Vector Marker points to a single vector (called the current vector). This is the only vector for which V HGT and V LEN can be changed and is the vector intensified by the Z Axis output.

# CALIBRATION

The 3314A has amplitude and frequency calibration routines to insure that its performance equals or exceeds the specifications listed in Table 1-1, Specifications in the Service Manual.

## NOTE

*Specifications apply within 24 hours and 5°C of a CAL  
ALL performed after a 30 minute initial warm-up.*

A 3314A calibration loads new calibration constants into the internal circuitry to insure that the 3314A meets its specifications. In most cases, this requires a measurement routine to generate new data. In cases where accurate correction data is already available, the measurement cycle is not performed. Calibration Disable and Enable refer to the measurement cycle, not the act of calibration.

## CALibrate All

A CAL ALL takes ~2 seconds to generate 29 amplitude and frequency calibration constants. The following operations cause the 3314A to completely calibrate itself whether calibration measurements have been disabled or not:

- Power ON (also enables calibration measurements)
- PRESET or "PR" (also enables calibration measurements)
- CAL (BLUE shift RCL) (also enables calibration measurements)
- "CA" (does not enable calibration measurements)

The main signal output will be <15mVp-p at various frequencies, the sync output will be active and "CAL" will be displayed during all calibrations. The 3314A's measurement routine is modified slightly during sweeps to insure accuracy.

## Amplitude Calibration

Amplitude calibration occurs whenever the function changes. During an amplitude calibration measurement, the sync output is active (output is a 10kHz, TTL level, squarewave).

Function	Time	Main Output
ALL	< 200ms/function	< 15mVp-p at 10kHz

## CALIBRATION (cont)

The following operations result in an amplitude calibration of the new function:

- FUNCTION key or "FU1", "FU2" or "FU3"
- RECALL 0 through 5 if a new function is recalled
- ARB entry (no measurement) or exit

You cannot force the 3314A to only measure amplitude calibration constants from the front panel while calibration measurements are disabled. From the HP-IB, "CEFUxCD" (where x = the number of the current function), will enable calibration measurements, execute an amplitude calibration and then disable calibration measurements.

### Frequency Calibration

Frequency calibrations occur whenever the frequency range changes. During calibration measurements, the sync output is active (output is a TTL level squarewave at the calibration frequency).

Range #	Time	Main Output
8	30 ms	< 15mVp-p at the programmed frequency
7	30 ms	< 15mVp-p at the programmed frequency
6	30 ms	< 15mVp-p at 100kHz
5	30 ms	< 15mVp-p at 10kHz
4	30 ms	< 15mVp-p at 1kHz
3	100 ms	< 15mVp-p at 199.9Hz
2	500 ms	< 15mVp-p at *
1	500 ms	< 15mVp-p at *

\* The 3314A makes 7 measurements at various frequencies to compute the calibration constants for ranges 1 and 2.

The following operations result in a frequency calibration of the new frequency range:

- During frequency entry when a range change occurs
- At mode changes
- RECALL 0 through 5
- Fixed to variable symmetry
- Variable symmetry exit
- Preset symmetry (BLUE shift SYM)
- Preset frequency (BLUE shift FREQ)
- Sweep entry (no measurement) or exit
- ARB entry (no measurement) or exit
- VCO OFF to ON while in ranges 7 or 8

## CALIBRATION (cont)

The following operations generate new frequency calibration constants, regardless of calibration measurement disable:

- CAL FREQ (BLUE shift PRESET) (does not enable calibration measurements)
- "CF" (does not enable calibration measurements)

Note: The BLUE shifted function of the PRESET key is not marked on the front panel. Sweep and ARB must be also be OFF.

### Calibration Disable, E04

The CAL OFF (BLUE shift STO) key or the "CD" command from the HP-IB, disables all amplitude and frequency calibration measurements. While calibration measurements are disabled, the 3314A will use the calibration constants previously computed and display "E04" (Calibration Not Performed). Since a complete calibration is the only calibration type that generates all 29 constants, it is important to do a CAL ALL (BLUE shift RCL) or "CA", prior to calibration disable and at regular intervals there after. A CAL ALL should be performed every 24 hours or whenever the temperature changes more than 5°C.

The primary advantage for using calibration disable is the time saved when operating via the HP-IB. Note, when operating via the HP-IB with calibration disabled, set Display Errors OFF "DE0". If Display Errors is ON, E04 will be displayed for 1/2 second every time a calibration measurement is not performed. During the time E04 is displayed, all 3314A HP-IB functions are halted.

### Calibration Enable

Power ON, the PRESET key, "PR" HP-IB command, the CAL ALL (BLUE shift RCL) key and the "CE" HP-IB command, enable amplitude and frequency calibration measurements. All of these operations cause the execution of a complete calibration, except "CE".

# DATA ENTRY

All variables are entered into the 3314A with the MODIFY knob and the RANGE UP or DOWN (↑ or ↓) keys. Variables are entered literally from the HP-IB, see HP-IB Programming for more details.

## Modify Knob

The MODIFY knob has 2 distinct modes: a multi speed mode to quickly make large changes and a cursor mode for fine tuning or making constant increments. The 3314A is in cursor when a digit in the display is flashing. The flashing digit is incremented or decremented by 1 every time rotation of the MODIFY knob is sensed. The LEFT and RIGHT ARROW keys move the digit through the display. When no digit is flashing, the 3314A is in the multispeed mode. The display is incremented by 1,2,4,8,16 or 32 depending upon how fast you rotate the Modify knob.

## Range Up or Down

The RANGE UP key multiplies the display by 10. The RANGE DOWN key divides the display by 10. If the result would be operation outside the limits of the 3314A, the key and the HP-IB commands "RU" or "RD" are ignored.

## Range Hold

Frequency, Amplitude and Offset are implemented in the 3314A with several different hardware configurations, called ranges. Range Hold allows the user to limit the operation to a single hardware configuration. The advantage of Range Hold is that the range of operation without a discrete step is increased. Another advantage from the front panel is the extended range of constant increments. Since the 3314A's output frequency is synthesized in frequency ranges 7 and 8, Range Hold can increase the range of synthesized output frequencies down to 1kHz. The primary disadvantage is reduced resolution in the lower portion of each range.

## DATA ENTRY (cont)

### Amplitude Range

The 3314A's output level can be set from .00mVp-p to 10.00Vp-p in 4 amplitude ranges. To assert Range Hold from the front panel, press the AMPTD key and then the BLUE shift UP or DOWN ARROW key. To assert Range Hold from the HP-IB, send "APRHx" where x is the Range Number. Note that the amplitude will change when Range Hold is asserted from the HP-IB if the current entry is outside the normal limits or the selected range. Pressing the AMPTD key and then the BLUE shifted UP or DOWN ARROW key or "APRH0" via the HP-IB removes the Range Hold function.

Range Number	Maximum	Minimum	Resolution	Minimum With Range Hold
1	10.00mV	.00mV	.01mV	.00mV
2	100.0mV	10.0mV	.1mV	.0mV
3	1.000V	.100V	1mV	0mV
4	10.00V	1.00V	10mV	00mV

### Frequency Range

The 3314A's output frequency can be set from .001Hz to 19.99MHz in 8 frequency ranges. To assert Range Hold from the front panel, press the FREQ key and then the BLUE shift DOWN ARROW key. To assert Range Hold from the HP-IB, send "FRRHx" where x is the Range Number. Note that the frequency will change when Range Hold is asserted from the HP-IB if the current entry is outside the normal limits of the selected range. Pressing the FREQ key and then the BLUE shifted DOWN ARROW key or "FRRHO" via the HP-IB removes the Range Hold function.

Range Number	Maximum	Minimum	Resolution	Minimum With Range Hold
1	1.999Hz	.001Hz	.001Hz	.001Hz
2	19.99Hz	1.50Hz	.01Hz	.01Hz
3	199.9Hz	15.0Hz	.1Hz	.1Hz
4	1.999kHz	150Hz	1Hz	1Hz
5	19.99kHz	1.50kHz	10Hz	10Hz
6	199.9kHz	15.0kHz	100Hz	100Hz
7	1.999MHz	150kHz	1kHz	1kHz
8	19.99MHz	1.50MHz	10kHz	10kHz

## DATA ENTRY (cont)

### Offset Range

The 3314A's DC Offset can be set from -5V to +5V in 2 offset ranges. To assert Range Hold from the front panel, press the OFFSET key and then the BLUE shifted DOWN ARROW key. To assert Range Hold from the HP-IB, send "OFRHx" where x is the Range Number. Note that the offset will change when Range Hold is asserted from the HP-IB if the current entry is outside the normal limits of the selected range. Pressing the OFFSET key and then the BLUE shifted DOWN ARROW key or "OFRH0" via the HP-IB removes the Range Hold function.

Range Number	Maximum	Minimum	Resolution	Minimum With Range Hold
1	$\pm 1.997V$	.000V	.002V	.000V
2	$\pm 5.00V$	2.00V	.01V	.00V

### Symmetry

Variable symmetry is not allowed in frequency range 8 and conversely, frequencies  $\geq 2MHz$  can only be programmed when SYM equals 50% and the SYM light is off. "EO1" will be displayed when these two parameters are in conflict.

# ERROR CODES

The 3314A constantly monitors several internal functions for out of tolerance operation and checks every operator entry for procedural errors.

## Errors While in Local

When an error is detected, "Exx" will be displayed for 1/2 second. If the appropriate bit(s) of the Status Byte are unmasked, that bit is set (= 1) and the SRQ message is sent.

## Errors While in Remote

"Exx" will be displayed for 1/2 second if Display Errors has not been turned off by "DE0". While "Exx" is displayed, all 3314A HP-IB activity is halted. If the appropriate bit(s) of the Status Byte are unmasked, that bit is set (= 1) and the SRQ message is sent.

The HP-IB command "QER" queries errors. The next time the 3314A is addressed to talk after "QER" is received, "ERxx" will be returned, where xx is the error number.

If the appropriate bit of the Status Byte is unmasked, an Error Code will set that bit and set SRQ (Service Request). The affected bits are:

- bit #0, indicating an operator error or 3314A failure

- bit #1, used as a flag for certain operating conditions

- bit #3, indicating an Output Overload condition

# ERROR CODES (cont)

**Table 3. Error Codes With Status Byte Bit#**

Error #	Definition	Status Byte bit #
00	No Error (used via HP-IB, only)	
	--- OPERATOR ERRORS (non-ARB) ---	
01	Frequency/Symmetry conflict	0
02	Bus address entry error	0
03	Front panel failure/Invalid keycode	0
04	Calibration measurement not performed	1
05	Allowed in sweep, only	0
06	Not allowed in sweep	0
07	Not allowed in log sweep	0
08	Store 0 not allowed	0
09	Non-volatile memory lost;battery down	0
	--- OPERATOR ERRORS (ARB) ---	
10	Vector insert not allowed	0
11	Vector delete not allowed	0
18	Allowed in ARB, only	0
19	Not allowed in ARB	0
	--- PLL ERRORS ---	
20	Unstable input frequency	1
21	Input frequency outside of acquisition range	1
22	3314A output frequency would be out of range	1
23	SW/TR INTVL >20ms	1
24	Internal phase locked loop, unlocked	0
	--- FREQUENCY CALIBRATION ERRORS ---	
30	No frequency detected	0
31	Frequency error exceeds correction capability	0
32	Frequency unstable during calibration	0
	--- AMPLITUDE CALIBRATION ERRORS ---	
34	Signal amplitude outside measurement range	0
35	Signal amplitude gain too high	0
36	Signal amplitude gain too low	0
37	Signal amplitude gain exceeds correction capability	0
38	Signal amplitude gain offset exceeds correction capability	0
	--- HP-IB ERRORS ---	
41	Mnemonic invalid	0
42	Definition number invalid	0
43	Data invalid	0
44	Units invalid	0
45	Range Hold not allowed	0
46	ARB/SWEEP parameter conflict	0
47	Not allowed in MAN Sweep	0
	--- OVERLOAD ---	
50	AM or FM/VCO input voltage exceeds normal operating limits	1
51	Output voltage exceeds safe operating limits;	3

# EXTERNAL MODULATION

The 3314A modulation capabilities include Amplitude Modulation (AM), Amplitude Modulation Suppressed Carrier (AMSC) and Frequency Modulation (FM). The 3314A can also be used as a Voltage Controlled Oscillator (VCO). All of these operations require an external modulating signal.

## Amplitude Modulation

The 3314A's output signal (the carrier) can be amplitude modulated to >100%. The sense of the AM input, along with the carrier, is inverted when Invert Function is asserted.

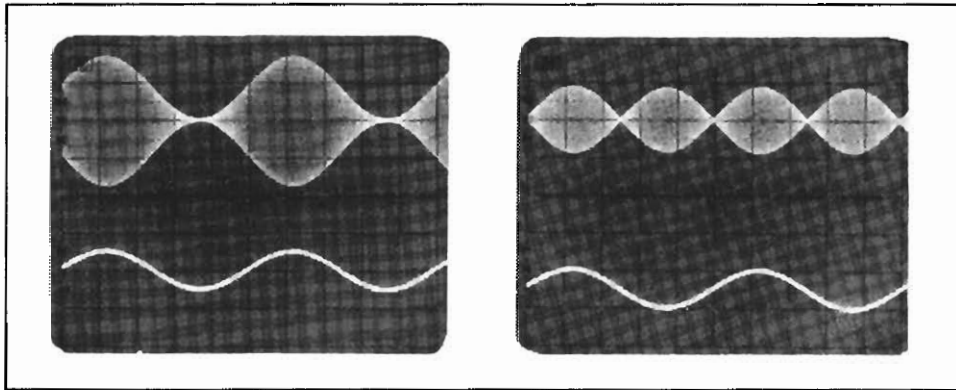


Figure 4. 100% and >100% Amplitude Modulation

**AM Input Characteristics.** The AM input has these operating characteristics (all values are approximate):

Input Impedance	10k $\Omega$
Input Sensitivity	2Vp-p = 100% (+1V = 2 times carrier ampl) (-1V = 0 times carrier ampl)
Modulation	0 to >100%. Maximum limited by envelope clipping. see AM Input Overload
3dB Bandwidth	DC to 100kHz
Envelope Distortion	see AM Specifications
Carrier Ampl with no input	1/2 Displayed Amplitude

## EXTERNAL MODULATION (cont)

The equation defining the relationship of instantaneous modulation voltage to the envelope amplitude is:

$$V_{\text{envelope}}(V_{p-p}) = \left( \frac{V_{\text{modulation}}}{2} + \frac{1}{2} \right) \times V_{\text{carrier}}(V_{p-p})$$

where  $V_{\text{carrier}}$  = the 3314A's displayed amplitude and  
 $-10V \leq V_{\text{modulation}} \leq +10V$

Observations:

- The carrier amplitude is 1/2 the displayed value when  $V_{\text{modulation}} = 0V$ .
- The envelope =  $0V_{p-p}$  when  $V_{\text{modulation}} = -1V$ .
- The carrier is  $180^\circ$  out of phase when  $V_{\text{envelope}}$  is negative ( $V_{\text{modulation}}$  is more negative than  $-1V$ ).
- The Reduce Input light will come on when modulation is  $\geq 100\%$ .

**AM Input Overload.** The Reduce Input light will come on whenever the AM modulation is  $\geq 100\%$ . AM modulation  $\geq 100\%$  can be sensed from the HP-IB when bit #1 of the Status Byte is unmasked. The Reduce Input light's HP-IB equivalent is "ER50". Envelope distortion occurs when the output clips at approximately 10% over the maximum amplitude allowed in each amplitude range. Note: Amplitude modulation  $>100\%$  will not necessarily distort the AM envelope. The AM envelope is distorted when distortion sidebands are present, not when the ratio of total sideband power to carrier power is greater than 1. A synchronous AM detector is required to recover the modulating signal undistorted. Note that a non-synchronous detector such as a peak detector, cannot recover the modulating signal, undistorted. The Reduce Input light and "E50" are inhibited while in either of the  $\phi$  Lock modes when the phase locked loop is unlocked.

## EXTERNAL MODULATION (cont)

### Amplitude Modulation Suppressed Carrier

Note that the Reduce Input light will be ON during Suppressed Carrier operations and should be ignored. The carrier is suppressed whenever the modulating signal is offset by approximately -1VDC (+1V if function invert is asserted). The DC component of the modulating signal controls the amplitude of the carrier from inverted carrier (-2V offset) to suppressed carrier (-1V offset) to normal carrier (+0V offset). The Reduce Input light and "E50" are inhibited while in either of the  $\phi$  Lock modes when the phase locked loop is unlocked.

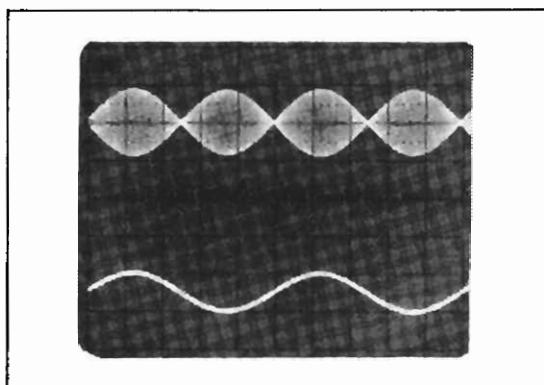


Figure 5. AM Suppressed Carrier

### Frequency Modulation

The 3314A's output signal can be Frequency Modulated to deviations of  $\pm 1\%$  of the frequency range. The sense of the FM input is not affected by Function Invert. The deviation is constant for all carrier frequencies in the same frequency range as long as the modulating signal is constant.

**FM Input Characteristics.** The FM input has the following characteristics (all values are approximate):

Input Impedance	10k $\Omega$
Input Sensitivity	2Vp-p = $\pm 1\%$ of freq range (+1Vpeak = +1%) (-1Vpeak = -1%)
Modulation	0 to $\pm 1\%$ deviation
3dB Bandwidth	100Hz to 100kHz (AC coupled)

## EXTERNAL MODULATION (cont)

**FM Input Overload.** The Reduce Input light will be ON when the AC component of the modulating signal exceeds 2Vp-p. The DC component is inconsequential as long as the signal peak is less than  $\pm 10V$ . The Reduce Input light and "E50" are inhibited while in either of the  $\phi$  Lock modes when the phase locked loop is unlocked.

### Voltage Controlled Oscillator

The 3314A's output frequency can be controlled over a range of +10% to -100% of the programmed frequency. Note that there must be  $\geq 100$  counts in the frequency display.

**VCO Input Characteristics.** The VCO input has the following input characteristics (all values are approximate):

Input Impedance	.....	10k $\Omega$
Input Sensitivity	.....	10% per Volt
		(+1V = +10%)
		(-10V = -100%)
Specified Linear Range	.....	+10% to -80%
Linearity	.....	see VCO Specifications
3dB Bandwidth	.....	DC to 100kHz

**VCO Input Overload.** The Reduce Input light will be ON when the input signal exceeds +1V or -10V. The Reduce Input light and "E50" are inhibited while in either of the  $\phi$  Lock modes when the phase locked loop is unlocked.

# FUNCTIONS

The 3314A outputs Sine, Square and Triangle functions and Arbitrary waveforms (see ARB) with a related signal from the SYNC output. When functions are Off, only DC Offset remains.

## Operating Characteristics

These operating characteristics apply to all functions.

Frequency Range	.001Hz to 19.99MHz .001Hz to 1MHz, Opt 001
Amplitude Range	.01mVp-p to 10Vp-p .03mVp-p to 30Vp-p, Opt 001
Variable Symmetry	5% to 95%, Freq < 2MHz
DC Offset	± 5VDC, independent of Ampl ± 15VDC, Opt 001
Invert Functions	AC component is inverted, DC component not affected
Function OFF	AC component = 0Vp-p, DC component not affected

**Haversine.** The Haversine function is a special sub-set of the Sine function which is especially suited to driving mechanical systems. To output a Haversine, set the 3314A controls as shown:

Mode	N CYCLE
N	1
Frequency	sets the period of each Haversine
Trigger	Internal
SW/TR INTVL	sets repetition rate of individual Haversines
Phase	-90degrees
Symmetry	changes ratio of rising to falling time without affecting the period
Offset	1/2 of AMPTD (-1/2 of AMPTD if +90°)

# MODE

The 3314A is a multi-mode function generator including:

## GENERATOR

Free Run

Gate

## BURST

N Cycle

1/2 Cycle

## PHASE LOCK

Fin X N

Fin ÷ N

## ARB

see the ARB topic

## Free Run

The 3314A output is continuous when in Free Run. Triggers are ignored unless the 3314A is sweeping, when they are used as sweep start signals.

## Gate

The 3314A output is controlled by the trigger level. When the trigger level satisfies the trigger slope and threshold conditions, the output is ON. The output will gate OFF at the output signal's first transition through the Stop Phase after the trigger signal changes level.

## N Cycle

The 3314A output is a counted burst of N whole cycles. The trigger edge that satisfies the trigger slope and threshold conditions will initiate an N cycle burst.

## 1/2 Cycle

The 3314A output is alternate 1/2 cycles (180°). The trigger edge that satisfies the trigger slope and threshold conditions will initiate a 1/2 cycle burst.

## MODE (cont)

### Fin X N

The 3314A output frequency will be N times the reference frequency. The reference and 3314A frequencies are limited from 50Hz to 19.99MHz.

Lock acquisition by the 3314A is completely automatic unless Frequency Range Hold is asserted. Whenever the reference frequency drifts more than 10%, the 3314A auto-acquisition re-establishes phase lock. When the Fin X N light is flashing, the 3314A is acquiring phase lock. The acquisition procedure used by the 3314A is:

- measure the reference frequency.
- display E20 and stop acquisition if the reference frequency is unstable.
- set the 3314A frequency to N times the reference frequency.
- turn the phase locked loop ON and acquire lock.

The 3314A will not proceed past the measurement step if the reference frequency is changing (see Pre-Tuning the 3314A's Oscillator). The 3314A may be able to acquire phase lock to a changing reference if you try the following:

- while in FREE RUN, set the 3314A frequency to N times the reference frequency.
- set Frequency Range Hold ON.
- change the mode to Fin X N.

At this time, there are 2 primary concerns which will preclude acquiring phase lock.

1. The 3314A's output frequency is limited to +10% and -50% of the displayed value. Note that the Fin X N light will flash when the frequency exceeds  $\pm 10\%$ .
2. The reference frequency change must be within the bandwidth of the 3314A's phase locked loop.

## MODE (cont)

The approximate bandwidth of the phase locked loop can be determined using this formula:

$$\text{B.W.} = .2 \left( \frac{\text{DISPLAYED FREQ}}{2N * A} \right) .72$$

where A = 1 if the EXT REF FREQ is < 2MHz

A = 5 if the EXT REF FREQ is ≥ 2MHz

N = selected N parameter

Note that the 3314A will not update its frequency display unless the loop goes out of lock (the Fin X N light flashes) and Frequency Range Hold is OFF.

### Fin ÷ N

The 3314A output frequency is the reference frequency divided by N. The reference and 3314A frequency range is limited from 50Hz to 19.99MHz.

Lock acquisition by the 3314A is completely automatic unless Frequency Range Hold is asserted. Whenever the reference frequency drifts more than 10%, the 3314A auto-acquisition re-establishes phase lock. When the Fin ÷ N light is flashing, the 3314A is acquiring phase lock. The acquisition procedure used by the 3314A is:

- measure the reference frequency.
- display E20 and stop acquisition if the reference frequency is unstable.
- set the 3314A frequency to N times the reference frequency.
- turn the phase locked loop ON and acquire lock.

The 3314A will not proceed past the measurement step if the reference frequency is changing (see Pre-Tuning the 3314A's Oscillator). The 3314A may be able to acquire phase lock to a changing reference if you try the following:

- while in FREE RUN, set the 3314A frequency to the reference frequency divided by N.
- set Frequency Range Hold ON.
- change the mode to Fin ÷ N.

## MODE (cont)

At this time, there are 2 primary concerns which preclude acquiring phase lock.

1. The 3314A's output frequency is limited to +10% and -50% of the displayed value.
2. The reference frequency change must be within the bandwidth of the 3314A's phase locked loop.

The approximate bandwidth of the phase locked loop can be determined using this formula:

$$\text{B.W.} = .2 \left( \frac{\text{DISPLAYED FREQ}}{2A} \right) .72$$

where A = 1 if the EXT REF FREQ is < 2MHz

A = 5 if the EXT REF FREQ is ≥ 2MHz

Note that the 3314A will not update its frequency display unless the loop goes out of lock (the Fin ÷ N light flashes) and Frequency Range Hold is OFF.

### **Pre-tuning The 3314A's Oscillator**

The 3314A's phase-lock capability can be greatly extended if you pre-tune its oscillator frequency using the VCO or FM modulation capabilities.

Use the VCO input if you have a signal that is proportional to the reference frequency. You will probably have to turn auto-acquisition off with FREQ Range Hold and set the 3314A's center frequency manually. Any error between the VCO input signal and the reference frequency must be corrected by the 3314A's PLL and hence, must be within the loop bandwidth. The 3314A's output frequency can range +10% to -50% without losing lock.

Note that when the 3314A's output frequency deviates >10% from the displayed frequency, one of the  $\phi$  LCK lights will flash. This does not necessarily indicate an out of lock condition.

# OPERATOR ALERTS

The 3314A will automatically re-program certain parameters when an operator selects related functions or in the case of DC Offset, Marker Frequency and ARB Frequency, when the operator tries to program the 3314A to values that are not allowed. This feature helps the operator by not forbidding an operation because of an arbitrary operating rule, or because the functions were selected out of order. Since the operator may not expect these changes, the 3314A has Operator Alerts.

The operator is "Alerted" from the front panel when the 3314A causes the altered parameter's light to flash on and off very quickly.

The operator is "Alerted" from the HP-IB by the SRQ message, only if bit #2 of the Status Byte is unmasked. Note that bit #2 will never be set if masked.

## Alerts While Programming DC Offset

The 3314A only allows DC Offsets of:

- .xx0Vdc
- .xx2Vdc
- .xx5Vdc
- .xx7Vdc

If you attempt to set the Offset to some other value, .xx3 for example, the 3314A will set the Offset to the closest allowed offset and "Alert" the operator.

## Alerts While Programming The Marker Frequency

If you attempt to set the Marker Frequency outside of the limits set by the Start and Stop Frequencies, the 3314A will set the Marker Frequency to the closest sweep end frequency and "Alert" the operator.

## Alerts While Changing Modes

When you change from either of the Phase Lock modes to any other mode, the Phase parameter limits change from  $\pm 199.9^\circ$  to  $\pm 90^\circ$ . If the Phase prior to changing modes was  $> \pm 90^\circ$ , the 3314A will set the phase =  $0^\circ$  and "Alert" the operator.

## OPERATOR ALERTS (cont)

### Alerts When Entering Linear or Log Sweep

When you enter either sweep type or change from Linear to Log Sweep, the lower time limit changes from .002ms (non-sweeping Trigger Interval) to 7.20ms (Linear Sweep Interval) to 40.00ms (Log Sweep Interval). The 3314A will set the time to the new lower limit and "Alert" the operator.

### Alerts When Programming ARB Frequency

ARB Frequency is limited to  $1/(\text{multiples of } \Delta t)$ . If you attempt to set the ARB Frequency to a value that is not allowed, the 3314A will select the closest allowed frequency and "Alert" the operator.

# OUTPUTS

The 3314A has the following outputs:

- Main Signal Output
- SYNC Output
- Trigger Output (active when Trigger is internal)
- X Axis/Phase Output
- Z Axis Output
- X3 Output (Option 001)

All of the connectors are of the BNC type. The shields are connected to the 3314A's chassis and protective earth terminal.

## Main Signal Output

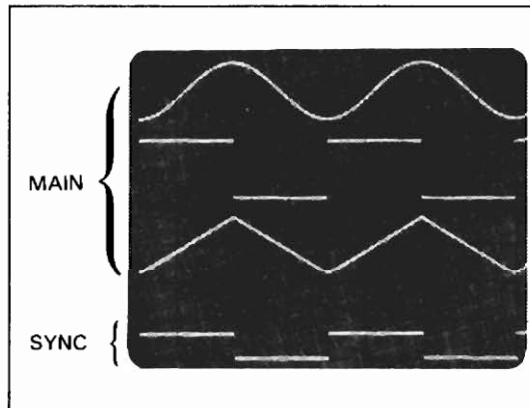
This fully protected output has a characteristic output impedance of  $50\Omega$ . This output must be terminated with a  $50\Omega$  load before the displayed amplitude is correct and before the specifications apply. Operation into  $>50\Omega$  is allowed with a proportional increase in amplitude and offset. Operation into  $<50\Omega$  is allowed with a proportional decrease in amplitude and offset. When operating into other than  $50\Omega$ , expect the performance to decrease, especially at higher frequencies because of transmission line mis-matches.

**Output Overload "E51"**. The 3314A main signal output will disconnect itself from externally applied voltages greater than  $\pm 15V$  peak. E51 is displayed while this voltage is present. The 3314A will automatically reconnect itself after the voltage is removed.

## SYNC Output

This fully protected output has a characteristic output impedance of  $\sim 50\Omega$  when terminated into  $\leq 50\Omega$ . When terminated into  $>50\Omega$ , it will deliver TTL compatible levels (0V to  $>2.5V$ ). The maximum unloaded voltage is limited to  $\sim 3V$ . The SYNC output will disconnect itself from externally applied voltages outside the range of  $-5.5V$  to  $+5.5V$ .

## OUTPUTS (cont)



**Figure 6. SYNC Output Relationships**

### Trigger Output

The Trigger port is an output when the selected trigger source is internal. This port provides a squarewave (0V and  $\sim 3V$ ) from a  $1k\Omega$  source impedance whose edges are related to the internal trigger interval generator. The Trigger port is protected from externally applied voltages up to  $\pm 15V$ .

### X Axis/Phase Output

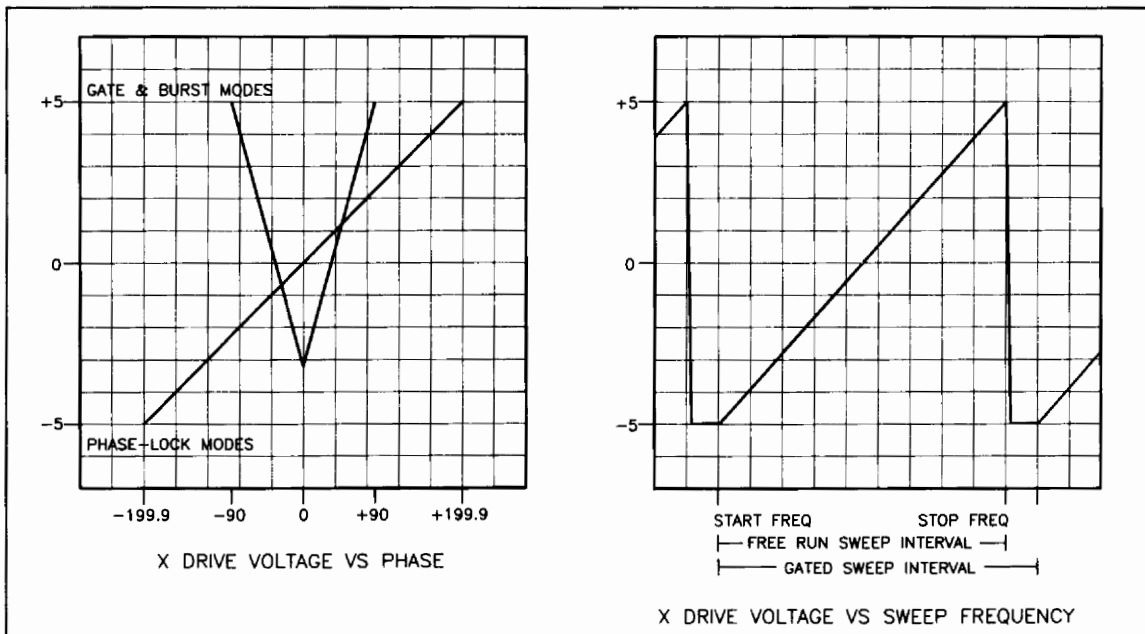
When sweeps are active, this output produces a voltage ramp from  $-5V$  to  $+5V$  whose voltage is proportional to the sweep frequency.

When sweeps are not active, this output produces a voltage from  $-3.2V$  to  $+5V$  that is proportional to the magnitude of the Start/Stop Phase or  $-5V$  to  $+5V$  that is proportional to the Phase offset during phase locked loop operation.

### X3 Output (Option 001)

When the Main output is terminated into  $50\Omega$  and the X3 Output is terminated into  $>500\Omega$ , the output amplitude and DC offset will be 3 times the displayed value. This output cannot source more than  $30mA$  peak current without clipping the output waveform.

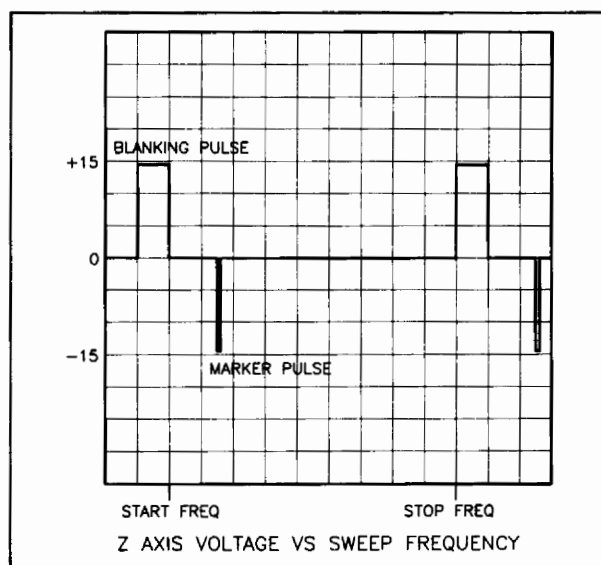
## OUTPUTS (cont)



**Figure 7. X AXIS Output**

## Z Axis Output

This output produces three voltage levels to control the intensity of an oscilloscope display. The sense of this output can be inverted by Service Trained Personnel using instructions located in the Service Manual.



**Figure 8. Z AXIS Output**

# PRESET

The PRESET key and the "PR" HP-IB command reconfigure the 3314A to an initialized state. This configuration is especially useful as a repeatable operating state to begin programming from and as a quick way to recover from complex operating states. The 3314A functions and their initialized states are:

Function	Preset Condition	Function	Preset Condition
Amplitude	100mVp-p (10mVp-p at turn on)	SRQ Mask (Status Byte)	not affected
Amplitude Modulation	Off	Start Frequency	1kHz
ARB Mode	Off	Status Byte (HP-IB)	not affected
ARB Waveforms	not affected	Stop Frequency	10kHz
Calibration	Executes a CAL ALL	Storage Registers	not affected
Data Transfer Mode	not affected	Sweep	Off
$\Delta t$ (ARB)	not affected	Sweep Mask (Status Byte)	not affected
Display Errors (HP-IB)	not affected	Sweep Interval (Linear)	10ms
Frequency	1kHz	Sweep Interval (Log)	40ms
Frequency Modulation	Off	Symmetry	50%
Function Invert	Off	Trigger Interval	10ms
Manual Sweep	Off	Trigger Slope	/ (positive)
Marker Frequency	5kHz	Trigger Source	Internal
Mode	Free Run	Trigger Threshold	1V (TTL)
N	1	VCO	Off
Offset	OVDC	Vector Height (ARB)	not affected
Phase	0 Degrees	Vector Length (ARB)	not affected
PLL Mask (Status Byte)	not affected	Vector Marker (ARB)	not affected
Range Hold	Off		

The BLUE shifted ARB key or the "AR2" HP-IB command, initializes the current ARB waveform.

The following ARB parameters are affected:

Function	Initialized Condition	Function	Initialized Condition
Amplitude	100mVp-p	Vector #1	
$\Delta t$	0.2ms	Vector Height	000
Frequency	2.5kHz	Vector Length	001
Function	Triangle	Vector #2	
Function Invert	Off	Vector Height	1F00 *
Mode	Free Run	Vector Length	001
Modulation	Off	Trigger Slope	/ (positive)
Offset	OVDC	Trigger Source	External
Phase	0 Degrees	Trigger Threshold	1V
Number of Vectors	2	Vector Marker	001

\*The Vector Height of the last vector is "1F00" to indicate that it is not programmable.

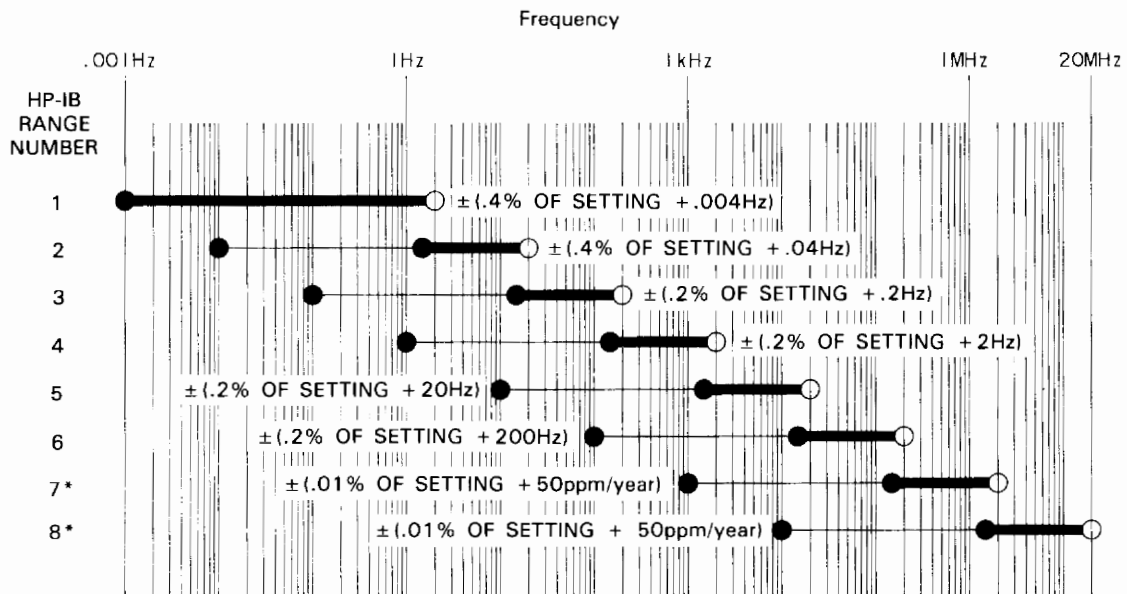
## How to COMPLETELY Preset the 3314A

If you hold the PRESET key in while power is cycled Off and then On, the 3314A resets all of its memory. After the normal start up, the 3314A will display "E09" for 1/2 second. This feature should be used whenever you think the 3314A is malfunctioning to clear the non-volatile memory.

# SPECIFICATIONS

The specifications listed here are taken from the Service Manual at the time this manual was printed. They may not apply to your instrument if the manuals were not printed at the same time. Refer to the Service Manual to determine the exact specifications that apply to your instrument. This table contains specifications only. The rest of this manual deals with operating characteristics and includes specifications where necessary.

## Frequency Accuracy



●—○ DENOTES FREQUENCY RANGE USING AUTO-RANGING.

●— DENOTES EXTENDED FREQUENCY RANGE USING RANGE HOLD.

○ FREQUENCIES UP TO BUT NOT INCLUDING THIS POINT ARE ALLOWED.

\* FREQUENCY IS SYNTHESIZED IN RANGES 7 AND 8 IN THE FREE RUN MODE WITH VCO = OFF.

ACCURACY APPLIES IN THE FREE RUN MODE WITH SYMMETRY = 50% (FIXED), AND VCO = OFF AND WITH RANGE HOLD ON OR OFF.

# SPECIFICATIONS (cont)

## Amplitude

### Absolute Amplitude Accuracy:

$\pm(1\% \text{ of display} + .035\text{Vp-p})$ , sine wave and square wave  
 $\pm(1\% \text{ of display} + .06\text{Vp-p})$ , triangle

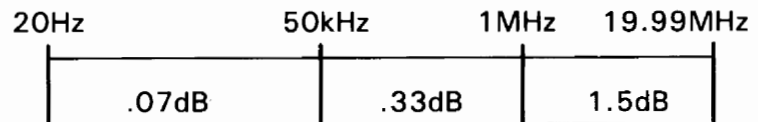
Amplitudes: 1.00Vp-p to 10.00Vp-p (Range 4)

Frequency: 10kHz

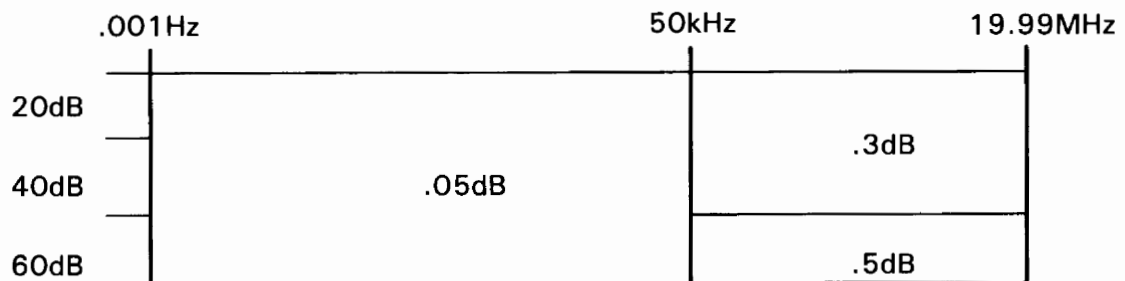
Auto-Range: ON

### Flatness--sine wave:

Relative to 10kHz, 1.00 V to 10.00Vp-p (Range 4)



### Step Attenuator Accuracy:



## SPECIFICATIONS (cont)

### DC Offset

Offset Accuracy:

$\pm(3\% \text{ of display} + 10 \text{ mVDC} + 0.5\% \text{ of AC Amplitude Range})$

Frequency: < 100kHz

Auto-Range: ON

Residual DC Offset:

<  $\pm.5\%$  of AC Amplitude Range

Setting: OVDC

Frequency:  $\leq 100\text{kHz}$

### Symmetry

Symmetry Accuracy (Fixed):

50%  $\pm 0.2\%$

Fixed Symmetry: 50% (SYM light OFF)

Frequency: 1Hz to 100kHz

Function: square wave

Symmetry Accuracy (Variable)

$\pm 0.5\%$  of period:

Frequency: 1Hz to 100kHz

Function: square wave

## SPECIFICATIONS (cont)

### Phase

Phase Offset--Phase lock Modes:

Accuracy:  $\pm 2^\circ$  (50Hz to 25kHz)

Phase Offset is referenced to the signal output for  $F_{in} \div N$  or the trigger input for  $F_{in} \times N$ .

Start/Stop Phase--Burst Modes:

Accuracy:  $\pm 3^\circ$  (applies from .001Hz to 1kHz)

### Function Characteristics

Sine Harmonic Distortion:

Individual harmonics will be below these levels, relative to the carrier level. Offset = 0V. Function Invert = OFF. \*Add 4dB for ambient temperature 0 to 5°C or 45 to 55°C.

20Hz	50kHz	1999kHz	19.99MHz
- 55dB*	- 40dB	- 25dB	

Square Wave Rise/Fall Time:

$\leq 9\text{ns}$ , 10% to 90% of a 10 Vp-p output

Square Wave Aberrations:

$< 5\%$  at 10 Vp-p output

Triangle Linearity:

$\pm 0.2\%$  of the p-p voltage

Frequency: .01 Hz to 1kHz, Amplitude = 10 Vp-p

Deviation is from a best fit straight line, from 10% to 90% of each ramp.

## SPECIFICATIONS (cont)

### Internal Trigger Interval

Period Accuracy:  $\pm(0.01\% + 50 \text{ ppm/year})$  of displayed interval (excluding sweep intervals)

### Frequency Sweep

Sweep Frequency Accuracy--Manual Sweep:

$\pm(0.2\%$  of Stop Freq  $+0.1\%$  of Stop Freq Range), Stop Freq Range  $\leq 200\text{kHz}$

$\pm 1\%$  of Stop Freq, Stop Freq in 2MHz Range

$\pm 3\%$  of Stop Freq, Stop Freq in 20MHz Range

### Modulation

Amplitude Modulation Envelope Distortion:

$\leq -40\text{dB}$

Carrier: = 1MHz, 10Vp-p, sine wave

Modulating Input: 1kHz, sine wave

Index of Modulation: 95%

VCO Linearity:

$\pm 0.15\%$  of p-p frequency, .1Hz through 200kHz Range

$\pm 1\%$  of p-p frequency, 2MHz Range

$\pm 3\%$  of p-p frequency, 20 MHz Range

-8 Vdc to +1 Vdc input (-80% to +10%)

Deviation is from a best fit straight line.

## SPECIFICATIONS (cont)

### Option 001--Simultaneous X 3 Output

Specifications for Option 001 were not available for this printing.

# SPECIFICATIONS (cont)

## General

### Specifications apply when:

Main signal output is terminated into  $50 \pm 0.1$  ohms  
Warm-up is  $\geq 30$  minutes  
Within  $\pm 5^\circ\text{C}$ , and 24 hours of last internal calibration  
Temperature  $0^\circ$  to  $55^\circ\text{C}$   
Relative Humidity  $\leq 95\%$  at  $40^\circ\text{C}$   
Altitude  $\leq 15,000$  ft.

### Storage Limits:

Temperature  $-40^\circ$  to  $+75^\circ\text{C}$   
Altitude  $\leq 50,000$  ft.

### Power:

100/120/220/240 V, +5% -10%, 48 to 66 Hz  
90 VA maximum

### Weight:

7.3 kg (16 lbs) net  
10.5 kg (23 lbs) shipping

### Dimensions:

132.6 mm (5.22 in) high  
212.3 mm (8.36 in) wide  
419.0 mm (16.50 in) deep

### Accessories Included:

11048C 50 ohm feed through

### Accessories:

Transit case for one 3314A; -hp- #9211-2677

## STORE & RECALL

The 3314A has 6 registers (0 through 5) where non-ARB front panel settings can be stored. Register 0 is reserved for the front panel setting at power off. Register 1 through 5 are reserved for the operator. In addition to these non-ARB registers are 6 more ARB registers (ARB 0 through ARB 5).

### How to Store and Recall Front Panel Settings

You can store the current (non-ARB) settings using the STO key followed by one of the keys in the top row of the Entry key group. The register number where the settings will be stored are located to the upper right of each key. To recall a front panel, use the RCL key followed by one of the Entry keys. RCL 0 will recall the front panel setting when the 3314A last lost power or was turned Off. Note that if a series of power failures occurs, you will still be able to recover the last front panel setting you used.

### How to Recall ARB Waveforms

There are 6 ARB waveforms stored in the 3314A. The wave parameters are stored into the proper ARB register as the waveform is created. There is no key or command to store an ARB waveform. To recall a waveform, use the RCL and ARB keys, followed by one of the keys in the Entry Group. The number to the upper right of each key indicates the ARB wave that will be recalled. The 3314A will display "Arx" for 1/2 second to indicate which ARB wave was recalled.

# REMOTE OPERATION

This section contains remote (HP-IB) operating information organized into the following topics:

## The HP-IB

- What is the HP-IB
- How does the HP-IB operate
- HP-IB specifications summary
- The 12 HP-IB Messages

## The 3314A and the HP-IB

- The 3314A's HP-IB capability
- 3314A/HP-IB verification
- Analyzing bus problems

## The 3314A's HP-IB Address

- How to view the 3314A's HP-IB Address
- How to change the 3314A's HP-IB Address
- Listen Only

## The Clear Message

## The Data Message

- Immediate Execution Type Commands
- Function Select Type Commands
- Data Entry Type Commands
- Query Type Commands

## The Status Byte

- Bit Definitions
- Masking the Status Byte

## The Trigger Message

## HP-IB Programming Summary

# THE HP-IB

## What Is The HP-IB

The Hewlett Packard Interface Bus is an easy to use, high performance bus structure that links the 3314A and other instruments, desktop computers and minicomputers into automated measurement systems. The HP-IB is a worldwide instrumentation interface standard (IEEE Standard 488-1978, ANSI Standard MC 1.1 and IEC Recommendation 625-1).

## How Does The HP-IB Operate

All of the active interface circuits are contained within the various HP-IB devices. The interconnecting cable is entirely passive. The cable's role is limited to connecting all of the devices in parallel, so that data can be transferred from one device to another.

Every participating device must be able to perform at least one of these roles: TALKER, LISTENER, or CONTROLLER. A TALKER transmits data to other devices called LISTENERS. Most devices can perform both roles, but not at the same time. A CONTROLLER manages the operation of the bus system by designating which device is to Talk and which device(s) are to Listen at any given time. The 3314A can be a Talker and a Listener, however, it has no Controller capabilities.

The minimum HP-IB system consists of one TALKER and one LISTENER without a CONTROLLER. In this configuration, data transfer is limited to one direction because one device must be manually set to "TALK ONLY" and the other device must be manually set to "LISTEN ONLY". The 3314A can be set to Listen Only, but not to Talk Only.

The full flexibility and power of the HP-IB is realized when a CONTROLLER is added to the system. An HP-IB CONTROLLER participates in the measurement by being programmed to:

- schedule measurement tasks
- set up instruments
- monitor the measurement
- interpret and operate upon the results

# THE HP-IB (cont)

## HP-IB Specifications Summary

### **Number of Interconnected Devices:**

Up to 15 maximum on one contiguous bus.

### **Interconnection Path/Maximum Cable Length:**

Star or linear bus network; total transmission path length = 2 metres times number of devices, or 20 metres, whichever is less.

### **Message Transfer Scheme:**

Byte-serial, 8 bit-parallel asynchronous data transfer using a 3 wire handshake.

### **Data Rate:**

One megabyte per second, maximum over limited distances, actual data rate depends upon the capability of the slowest device involved in the transmission. (The 3314A's maximum data rate is approximately 3ms per character when using Data Transfer Mode 2.)

### **Address Capability:**

Primary addresses: 31 talk, 31 listen. Secondary addresses: 961 talk, 961 listen. 1 Talker and 14 listeners, maximum at one time. (The 3314A does not have secondary, extended address capability.)

### **Control Shift:**

In systems with more than one controller, only one can be active at a time. The active controller can pass control to another controller, but only the system controller can assume unconditional control. Only one system controller is allowed. The system controller is hard-wired to assume bus control after a power failure or other catastrophic calamity.

### **Interface Circuits:**

Driver and receiver circuits are TTL compatible.

## THE HP-IB (cont)

### The 12 HP-IB Messages

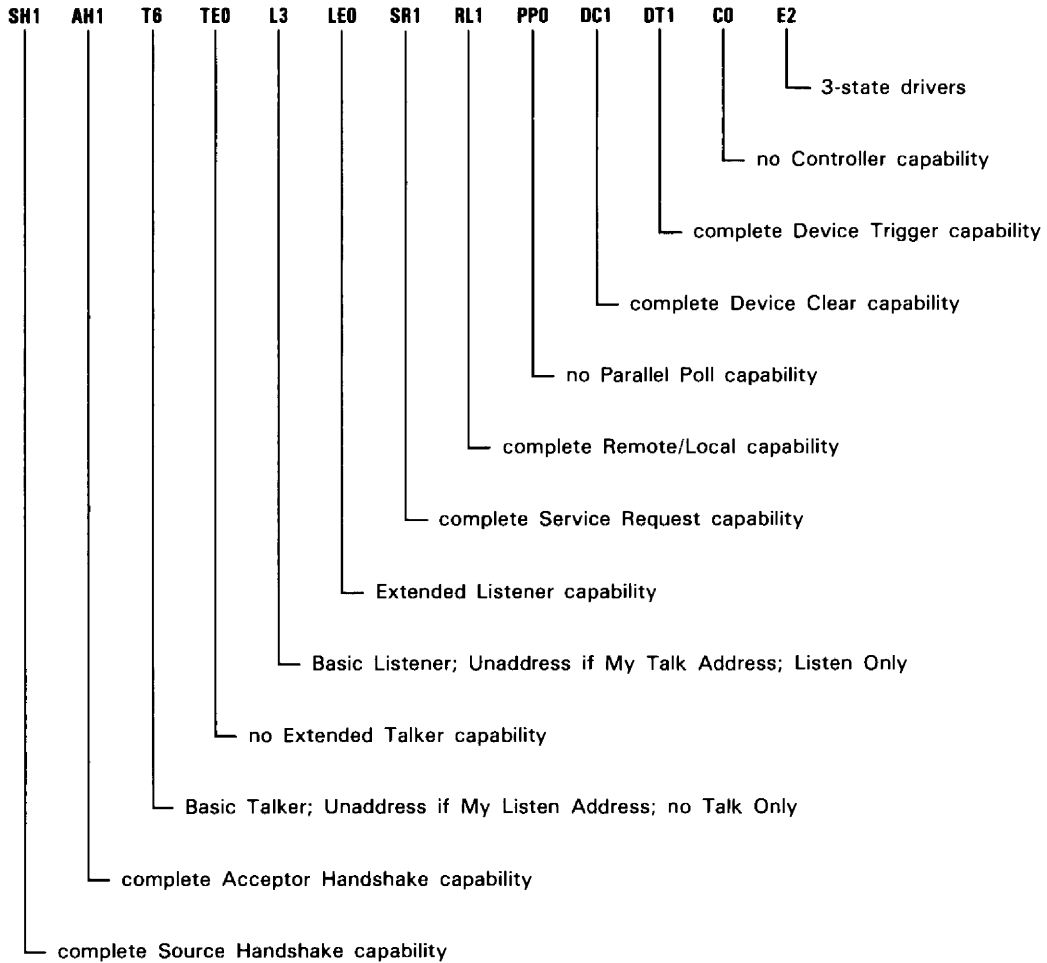
There are 12 specific messages that can be sent via the HP-IB. You may not use all 12, nor does the 3314A respond to all 12, however, knowledge about each is required if you wish to optimize your HP-IB system.

Message	Example (-hp-9845)
<b>CLEAR</b> Causes the 3314A to reconfigure as if the PRESET key had been pressed. (see THE CLEAR MESSAGE)	CLEAR 7 CLEAR 707 OUTPUT 707;"PR"
<b>CLEAR LOCKOUT/SET LOCAL</b> Enables the 3314A's LOCAL key and switches all devices from remote to local	LOCAL 7
<b>DATA</b> This message is used to configure the 3314A. This message is also used to make the 3314A return information requested with query. (see THE DATA MESSAGE)	OUTPUT 707;"CA" OUTPUT 707;"MO2" OUTPUT 707;"FR2MZ" OUTPUT 707;"QER"
<b>LOCAL</b> Switches control of the 3314A from remote to local.	LOCAL 707
<b>LOCAL LOCKOUT</b> Disables the 3314A's LOCAL key to secure the system from casual operator interference.	LOCAL LOCKOUT 7
<b>PARALLEL POLL</b> Controller request that all devices previously programmed to respond, send their Status Bit. The 3314A does not respond.	
<b>PASS CONTROL</b> Shifts system control from one controller to another. The 3314A does not respond.	
<b>REMOTE</b> Switches control of the 3314A from local to remote when it is addressed.	REMOTE 7 REMOTE 707
<b>REQUEST SERVICE</b> When unmasked, one or a combination of 3314A operating conditions can set bus line SRQ true, requesting service from the controller. (see THE STATUS BYTE)	
<b>SERIAL POLL</b> Controller request that the 3314A send its Status Byte. Encoded into the 8 bits are the states of several 3314A operating parameters. (see THE STATUS BYTE)	STATUS 707;S
<b>TAKE CONTROL/ABORT I/O</b> Unconditional assumption of control by the system controller; halts all bus activity. The 3314A becomes unaddressed.	ABORTIO 7
<b>TRIGGER</b> The 3314A responds to a HP-IB Trigger as it would to any other external trigger to gate the output signal on or off, start N or 1/2 Cycle bursts and start single sweeps. (see THE TRIGGER MESSAGE)	TRIGGER 7 TRIGGER 707 OUTPUT 707;"MN"

# THE 3314A AND THE HP-IB

## THE 3314A's HP-IB Capability

The 3314A has these capabilities, as defined by IEEE Standard 488-1978:



The 3314A's data transfer rate is approximately 3ms per character when using Data Transfer Mode 2. Data transfer rate is dependent upon the specific Programming Code sent in Data Transfer Mode 1.

## THE 3314A AND THE HP-IB (cont)

### 3314A/HP-IB Verification

Refer to the Controller Operating Manual and find the section describing the HP-IB REMOTE Message. When this message is sent to the 3314A, the REMOTE annunciator should light. If this does not occur, recheck the cabling, the 3314A address and the syntax of the controller statement. Here are 2 examples of the REMOTE Message as implemented by several -hp- controllers:

```
REMOTE 707    -hp- 9826/9835/9845/85 "BASIC"  
rem 707      -hp- 9825/9826 "HPL"
```

### Analyzing Bus Problems

Hardware and software problems tend to have the same set of symptoms on the HP-IB. In response to the need to quickly find the source of the problem, -hp- developed the 59401A Bus System Analyzer. It simplifies diagnosis of bus problems by allowing the user to see the status of all bus lines, including the actual ASCII characters on the bus data lines. Because the 59401A can drive all bus lines, it can completely exercise another Talker, Listener, or Controller.

# THE 3314A's HP-IB ADDRESS

## How To View The 3314A's HP-IB Address

The 3314A's HP-IB address is set to 7 at the factory and stored in a non-volatile memory (there are no address switches). To make the 3314A display its address:

1. Press the BLUE shift key and then the LOCAL key. The current address will be displayed for 1/2 second.

## How To Change The 3314A's HP-IB Address

Every device on the HP-IB must have a unique address. The 3314A address can be set at any address between 0 and 30, inclusive. When choosing an address, remember that the controller also has an address (usually 21). To change the HP-IB address:

1. Press the RECALL and then the LOCAL key to display the current HP-IB address.
2. Rotate the Modify knob to change the HP-IB address.
3. Press the STORE and then the LOCAL key to execute the entry.

The 3314A's HP-IB address is stored in a non-volatile memory. If the contents of this memory is destroyed, the HP-IB address defaults to 7. The 3314A will display E09 at power on when the contents have not been retained.

The Talk and Listen addresses are ASCII characters. When a device receives one of these characters while ATN is true, it will become addressed. The ASCII character ? will unaddress all devices. The Device address (set from the 3314A front panel) is used by most newer HP-IB controllers which automatically send the Talk and Listen address characters.

## THE 3314A's HP-IB ADDRESS (cont)

### Listen Only

When the HP-IB address is incremented past 30, the 3314A switches to Listen Only and displays "L-O". In this mode, the 3314A receives every byte of information on the bus, and assumes that the code was intended for its own use. If information is sent to the 3314A that it can not understand, the 3314A will ignore those commands and set the appropriate errors. If the 3314A is addressed to Talk, the bus will "hang up" because the 3314A's Talk capability is overridden by Listen Only. The primary application for Listen Only, is in a HP-IB system with a Talk Only device, such as a card reader.

### Device/Listen/Talk Addresses

Use the table that follows if you are using a controller in the command mode or a controller that requires the talk and listen addresses instead of the device address:

**Table 5. HP-IB Addresses**

Device	Talk	Listen
0	@	SP
1	A	!
2	B	"
3	C	#
4	D	\$
5	E	%
6	F	&
7	G	'
8	H	(
9	I	)
10	J	*
11	K	+
12	L	,
13	M	-
14	N	.
15	O	/
16	P	0
17	Q	1
18	R	2
19	S	3
20	T	4
21	U	5
22	V	6
23	W	7
24	X	8
25	Y	9
26	Z	:
27	[	;
28	\	<
29	]	=
30	^	>
Listen Only		

# THE CLEAR MESSAGE

The 3314A responds to the device clear message (DCL), the selected device clear message (SDC) and the command "PR" by configuring itself to its initialized state.

Basic Language (-hp-9845) EXAMPLES:

```
all on 7      CLEAR 7
3314A only   CLEAR 707
3314A only   OUTPUT 707;"PR"
```

HPL LANGUAGE (-hp-9825) EXAMPLES:

```
all on 7      clr 7
3314A only   clr 707
3314A only   wrt 707;"PR"
```

The functions affected by the clear message with the "preset" conditions are:

Function	Preset Condition	Function	Preset Condition
Amplitude	100mVp-p (10mVp-p at turn on)	Range Hold	Off
Amplitude Modulation	Off	SRQ Mask (Status Byte)	not affected
ARB Mode	Off	Start Frequency	1kHz
ARB Waveforms	not affected	Status Byte (HP-IB)	not affected
Calibration	Executes a CAL ALL	Stop Frequency	10kHz
Data Transfer Mode	not affected	Storage Registers	not affected
$\Delta t$ (ARB)	not affected	Sweep	Off
Display Errors (HP-IB)	not affected	Sweep Mask (Status Byte)	not affected
Frequency	1kHz	Sweep Interval (Linear)	10ms
Frequency Modulation	Off	Sweep Interval (Log)	40ms
Function Invert	Off	Symmetry	50%
Manual Sweep	Off	Trigger Interval	10ms
Marker Frequency	5kHz	Trigger Slope	/ (positive)
Mode	Free Run	Trigger Source	Internal
N	1	Trigger Threshold	1V (TTL)
Offset	0VDC	VCO	Off
Phase	0 Degrees	Vector Height (ARB)	not affected
PLL Mask (Status Byte)	not affected		

# THE DATA MESSAGE

The Data Message is used to send Programming Codes to the 3314A. Programming Codes and front panel key functions have a 1 to 1 relationship in most cases, that is, to change the mode to Gate, the Program Code "MO2" would be sent. MO2 is the remote equivalent of pressing the GEN key in local. Exceptions to this rule are:

Front panel functions not allowed in remote operation:

- Shift Cursor Right
- Shift Cursor Left
- Continuous Tuning (The Modify knob)
- HP-IB Address Viewing and Selection
- BLUE shift key (shifted functions have their own programming codes)

Remote functions not allowed from the front panel:

- Data Transfer Mode Selection
- Display Errors (ON or Off)
- SRQ Mask
- Status Byte Masking
- Status Byte

3314A Program Codes have been categorized into 4 distinct groups to help explain them. The 3314A does not distinguish between these categories. The 4 categories are:

## **Immediate Execute Commands**

2 letter commands causing immediate action

## **Function Select Commands**

2 letter prefix plus a qualifier digit that selects a particular state of that function

## THE DATA MESSAGE (cont)

### **Data Entry Commands**

2 letter prefix followed by numerical data and then a 2 letter suffix denoting the units and executing the entry

### **Query Commands**

Q followed by a 2 letter command to make the 3314A return the state or exact value of the queried parameter

# THE DATA MESSAGE (Immediate Execute Commands)

The syntax for execution commands is:

OUTPUT-----command-----EOS

EOS (End of String) = ASCII Line Feed

BASIC LANGUAGE (-hp-9845) EXAMPLES:

OUTPUT 707;"CA"

OUTPUT 707;"CACDRU"

HPL LANGUAGE (-hp-9825) EXAMPLES:

wrt 707,"CA"

707,"CACDRU"

The Immediate Execute commands are:

Function	Command
Calibrate ALL	CA
Calibrate Disable	CD
Calibrate Enable	CE
Calibrate Frequency	CF
Delete Vector (ARB)	DV
Insert Vector (ARB)	IV
Manual Trigger	MN
Preset	PR
Range Down	RD
Range UP	RU

## THE DATA MESSAGE (Function Select Commands)

The syntax for function select commands is:

OUTPUT-----command-----qualifier-----EOS

EOS (End Of String) = ASCII Line Feed

BASIC LANGUAGE (-hp-9845) EXAMPLES:

```
OUTPUT 707;"AM1"  
OUTPUT 707;"AM1FM0"
```

HPL LANGUAGE (-hp-9825) EXAMPLES:

```
wrt 707,"AM1"  
wrt 707,"AM1FM0"
```

# THE DATA MESSAGE

## (Function Select Commands) (cont)

The function select commands are:

Function and Selection	Command and Qualifier	Function and Selection	Command and Qualifier
Amplitude Modulation	AM	Recall Front Panel	RC
OFF	0	Register 0	0
ON	1	Register 1	1
ARB	AR	Register 2	2
OFF	0	Register 3	3
ON	1	Register 4	4
ON and Initialize	2	Register 5	5
Data Transfer Mode	DM	Recall ARB Wave	RW
Unbuffered (serial)	0	Sets ARB ON and recalls	
96 Byte Buffer	1	Wave 0	0
Display Errors	DE	Wave 1	1
OFF	0	Wave 2	2
ON	1	Wave 3	3
Frequency Modulation	FM	Wave 4	4
OFF	0	Wave 5	5
ON	1		
Function Invert	FI	SRQ MASK (see the text)	
No inversion	0		
Inverted	1	Store Front Panel	SO
Function Select	FU	Register 1	1
AC OFF (DC ONLY)	0	Register 2	2
Sine	1	Register 3	3
Square	2	Register 4	4
Triangle	3	Register 5	5
Manual Sweep	MA		
OFF	0	Sweep	SW
ON	1	OFF	0
Mode Select	MO	Linear (100:1 max)	1
Free Run	1	Log (7 decades max)	2
Gate	2		
N Cycle	3	Sweep Mask (bit #5)	SM
1/2 Cycle	4	Masked (always = 0)	0
Fin X N	5	= 1 at sweep start	1
Fin / N	6	= 1 at sweep stop	2
PLL Mask (bit #5)	PM	= 1 at either	3
Masked (always = 0)	0		
= 1 on acquiring lock	1	Trigger Threshold Level	LV
= 1 on losing lock	2	+ 1 Volts	1
= 1 on either	3	0 Volts	2
Range Hold	RH		
OFF	0	Trigger Slope	SL
Range 1	1	Positive	1
Range 2	2	Negative	2
Range 3	3		
Range 4	4	Trigger Source	SR
Range 5	5	Internal	1
Range 6	6	External	2
Range 7	7		
Range 8	8	VCO	VC
		OFF	0
		ON	1

## THE DATA MESSAGE (Function Select Commands) (cont)

**DATA TRANSFER MODE.** There are 2 HP-IB data transfer modes: Unbuffered and Buffered. At turn-on, the 3314A data transfer mode is unbuffered. As each command is accepted by the 3314A, it is executed. The next byte of HP-IB information cannot be accepted until the previous command has been processed. The second mode loads up to 96 bytes of HP-IB data into a buffer. When the EOS (End of String) character is received, the 3314A starts to process the commands in the order they were received. The maximum data rate in the buffered mode is 3ms per character.

**DISPLAY ERRORS.** All errors are displayed for about 1/2 second immediately after they are detected. While they are displayed, no other programming can occur.

**MANUAL SWEEP.** Manual Sweep can be turned ON and OFF via the HP-IB, however, the real importance of Manual Sweep is in the local operating mode. Manual Sweep Frequency cannot be set via the HP-IB.

**PLL MASK.** Bit 5 of the Status Byte is maskable. Depending upon the mask, and the state of the PLL (phase locked loop), bit 5 will be set (1) or reset (0). Before bit #5 will be set, both the Status Byte mask and the PLL mask must be set.

## THE DATA MESSAGE

### (Function Select Commands) (cont)

SRQ MASK. Each bit of the Status Byte (except bit #6) can be masked (no Service Request) or unmasked (Service Request when = 1) via the HP-IB. Note that a bit cannot be set until after it has been unmasked. This function is not available from the front panel. The Program Codes to Mask/Unmask the Status Byte are:

		3	2	1	0	Status Bit Number
ML	@	MASK	MASK	MASK	MASK	
	A	MASK	MASK	MASK	UNMASK	
	B	MASK	MASK	UNMASK	MASK	
	C	MASK	MASK	UNMASK	UNMASK	
	D	MASK	UNMASK	MASK	MASK	
	E	MASK	UNMASK	MASK	UNMASK	
	F	MASK	UNMASK	UNMASK	MASK	
	G	MASK	UNMASK	UNMASK	UNMASK	
	H	UNMASK	MASK	MASK	MASK	
	I	UNMASK	MASK	MASK	UNMASK	
	J	UNMASK	MASK	UNMASK	MASK	
	K	UNMASK	MASK	UNMASK	UNMASK	
	L	UNMASK	UNMASK	MASK	MASK	
	M	UNMASK	UNMASK	MASK	UNMASK	
	N	UNMASK	UNMASK	UNMASK	MASK	
	O	UNMASK	UNMASK	UNMASK	UNMASK	

		7	6	5	4	Status Bit Number
MH	@	MASK		MASK	MASK	
	A	MASK		MASK	UNMASK	
	B	MASK		UNMASK	MASK	
	C	MASK		UNMASK	UNMASK	
	D	MASK		MASK	MASK	
	E	MASK		MASK	UNMASK	
	F	MASK		UNMASK	MASK	
	G	MASK		UNMASK	UNMASK	
	H	UNMASK		MASK	MASK	
	I	UNMASK		MASK	UNMASK	
	J	UNMASK		UNMASK	MASK	
	K	UNMASK		UNMASK	UNMASK	
	L	UNMASK		MASK	MASK	
	M	UNMASK		MASK	UNMASK	
	N	UNMASK		UNMASK	MASK	
	O	UNMASK		UNMASK	UNMASK	

SWEEP MASK. Bit 5 of the Status Byte is maskable. Depending upon the mask and the state of the sweep, bit 5 will be set (= 1) or reset (= 0). Before bit #5 will be set, both the Status Byte mask and the Sweep mask must be set.

# THE DATA MESSAGE (Data Entry Commands)

The syntax for data entry commands is:

OUTPUT----prefix----data----units----EOS EOS (End Of String) = ASCII Line Feed

Numeric entries must be in fixed point format. Floating point entries are not allowed and cause Error 41.

BASIC LANGUAGE (-hp-9845) EXAMPLES:

OUTPUT 707;" AP1.23VO"  
OUTPUT 707;" AP1.23VOFR10.7MZ"

HPL LANGUAGE (-hp-9825) EXAMPLES:

wrt 707," AP1.23VO"  
wrt 707," AP1.23VOFR10.7MZ"

Function and Units	Command and Units	Function and Units	Command and Units
Amplitude	AP	Start Frequency	ST
milli-Volts p-p	MV	Hertz	HZ
Volts p-p	VO	kilo-Hertz	KZ
$\Delta t$	DT	Mega-Hertz	MZ
milli-Seconds	MS	Stop Frequency	SP
Seconds	SN	Hertz	HZ
Frequency	FR	kilo-Hertz	KZ
Hertz	HZ	Mega-Hertz	MZ
kilo-Hertz	KZ	Symmetry	SY
Mega-Hertz	MZ	Percent	PC
Marker Frequency	MK	Sweep/Trigger Interval	TI
Hertz	HZ	milli-seconds	MS
kilo-Hertz	KZ	Seconds	SN
Mega-Hertz	MZ	Vector Height	VH
N	NM	Enter	EN
Enter	EN	Vector Length	VL
Offset	OF	Enter	EN
Volts DC	VO	Vector Marker	VM
Phase	PH	Enter	EN
Degrees	DG		

# THE DATA MESSAGE (Query Commands)

The syntax for query functions is:

OUTPUT-----command-----EOS EOS (End Of String) = ASCII Line Feed

BASIC LANGUAGE (-hp-9845) EXAMPLES:

```
OUTPUT 707;" QAP"
ENTER 707;A
```

HPL LANGUAGE (-hp-9825) EXAMPLES:

```
wrt 707," QAP"
red 707,A
```

A query function makes the 3314A return the selected sub-set of the function, or the exact value of the variable queried. The query must be the last command sent to the 3314A. After receiving a query command, the 3314A must be addressed to Talk. The 3314A can only respond to 1 query at a time.

The query commands are:

Function	Command	Function	Command
Amplitude	QAP	Offset	QOF
Amplitude Modulation	QAM	Phase	QPH
ARB Mode	QAR	Start Frequency	QST
ARB Wave Number	QRW	Stop Frequency	QSP
$\Delta t$	QDT	Sweep	QSW
Error Code	QER	Symmetry	QSY
Frequency	QFR	Trigger Interval	QTI
Frequency Modulation	QFM	Trigger Level	QLV
Function Invert	QFI	Trigger Slope	QSL
Function Select	QFU	Trigger Source	QSR
Manual Sweep	QMA	VCO	QVC
Marker Frequency	QMK	Vector Height	QVH
Mode	QMO	Vector Length	QVL
N	QNM	Vector Marker	QVM

# THE STATUS BYTE

The Status Byte is an 8 bit word that the 3314A will output when involved in a Serial Poll. The state of each bit (1 or 0) indicates the status of an internal 3314A function. A bit will be set after that bit has been unmasked and the bit condition is satisfied. After the Status Byte is sent (all bits reset to 0), the bit(s) will not be set again if the condition(s) does not change.

Exceptions that will automatically reset a bit immediately after the 3314A sends its Status Byte are:

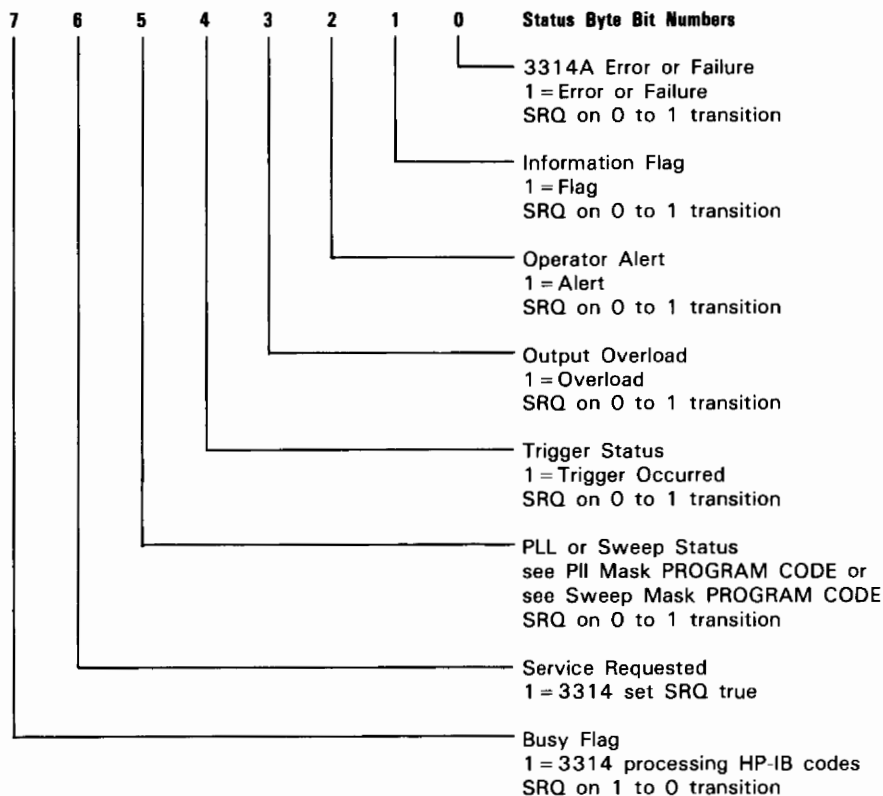
OVERLOAD  
TRIGGER when in Gate Mode  
BUSY FLAG

## BASIC (-hp-9845) EXAMPLE

STATUS 707;S

## HPL (-hp-9825) EXAMPLE

rds (707)→S



# THE TRIGGER MESSAGE

The HP-IB Group Execute Trigger (GET) message, the MN Programming Code (Manual Trigger) and pressing the MAN key cause the same action within the 3314A. In all cases the trigger source must be external (Programming Code SR2) and the 3314A must be addressed to Listen before the 3314A will respond. The 3314A responds to the GET command within 2ms. The 3314A responds to MN within 12ms. Triggers received when the 3314A is actively sweeping or producing ARB waveforms may take up to 50ms.

## BASIC LANGUAGE (-hp-9845) EXAMPLES:

```

all devices on 7      TRIGGER 7
3314A only           TRIGGER 707
3314A only           OUTPUT 707;"MN"
    
```

## HPL LANGUAGE (-hp-9825) EXAMPLES:

```

all devices on 7      trg 7
3314A only           trg 707
3314A only           wrt 707,"MN"
    
```

Mode	Action
Free Run no sweep	-no action
sweep	-Starts the sweep. The sweep stops and resets to the start frequency, automatically. -Ignored if the 3314A is sweeping.
Gate no sweep	-Gates Output ON if trigger slope is positive or ARB and then sets trigger slope to negative. -Gates Output OFF if trigger slope is negative and then sets trigger slope to positive.
sweep	-Starts the sweep and gates the output ON if the sweep is not active and the trigger slope is positive and then sets the trigger slope to negative. The sweep stops, and the output is gated OFF, automatically.  -Sets the trigger slope to positive if the sweep is not active and the trigger slope is negative. Used as an arming signal to prepare for the next gate.  -Ignored while the 3314A is sweeping.
N Cycle	-Gates N Cycles of the output signal ON if the output is OFF. -Ignored while the output is ON.
1/2 Cycle	-Gates alternate 1/2 cycles of the output signal ON.
Fin X N	-This operation is not useable because of the asynchronous nature of the HP-IB.
Fin / N	-This operation is not useable because of the asynchronous nature of the HP-IB.

# HP-IB PROGRAMMING SUMMARY

## HP-IB Address

The 3314A's HP-IB address is set at the factory to 7. To view the current HP-IB address, press the BLUE shift key and then the LOCAL key. To change the HP-IB address, press the RECALL and then the LOCAL keys, rotate the TUNING KNOB until the desired address is displayed and then press the STORE and LOCAL keys. Listen Only is set by incrementing the address past 30.

## 3314A Programming Codes

3314A Function	HP-IB Codes		Format Of Returned Data	3314A Function	HP-IB Codes		Format of Returned Data
	Program	Entry			Program	Entry	
Amplitude milli-Volt p-p Volt p-p	AP MV VO	QAP	AP 000000dd.ddVO or AP 000000d.dddVO or AP 000000.dddVO or AP 00000.0dddVO	Preset	PR		
Ampl Modulation OFF ON	AM 0 1	QAM	AMd	Range Down	RD		
ARB OFF ON ON/Clear Wave	AR 0 1 2	QAR	ARd	Range Hold OFF DC Offset Amplitude Frequency	RH 0 1 to 2 1 to 4 1 to 8		
Calibrate All	CA			Range Up	RU		
Calibrate Disable	CD			Recall (non-ARB) Register	RC	0 to 5	
Calibrate Enable	CE			Recall Wave (ARB) ARB ON and recall Wave	RW	QRW	RWd
Calibrate Freq	CF			SRQ Mask, bits 0-3 Mask	ML	@ to 0	
Data Transfer Mode Unbuffered 96 Byte Buffer	DM 1 2			SRQ Mask, bits 4-7 Mask	MH	@ to 0	
Delete Vector	DV			Start Frequency Hertz kilo-Hertz Mega-Hertz	ST HZ KZ MZ	QST	ST 00000000.HZ or ST 0000000d.dHZ or ST 0000000d.dddHZ or ST 000000d.dddHZ
Δ t milli-Seconds Seconds Display Errors OFF ON	DT MS SN DE 0 1	QDT	DT 00000.0dddSN or DT 0000.00dddSN	Stop Frequency Hertz kilo-Hertz Mega-Hertz	SP HZ KZ MZ	QSP	SP 00000000.HZ or SP 0000000d.dHZ or SP 0000000d.dddHZ or SP 000000d.dddHZ
Error Codes		QER	ERdd	Store (non-ARB) Register	SO	1 to 5	
Frequency Hertz kilo-Hertz Mega-Hertz	FR HZ KZ MZ	QFR	FR 00000000.HZ or FR 0000000d.dHZ or FR 000000d.dddHZ or FR 000000d.dddHZ	Sweep OFF Linear Log	SW	QSW	SWd
Freq Modulation OFF ON	FM 0 1	QFM	FMd	Amplitude	AP	QAP	AP 000000dd.ddVO or
Function Invert OFF ON	FI 0 1	QFI	FI d	Sweep Status Mask (bit 5 of Status Byte) Masked = 1 at Start = 1 at Stop = 1 either	SM		
Function OFF Sine Square Triangle Insert Vector	FU 0 1 2 3 IV	QFU	FU d	Symmetry Percent	SY PC	QSY	SY 00000000d.PC
Manual Sweep OFF ON	MA 0 1	QMA	MA d	Sweep/Trig Interval milli-Seconds Seconds	TI MS SN	QTI	TI 00000000d.SN or TI 0000000d.dSN or TI 000000d.dddSN or TI 000000.dddSN or TI 00000.0dddSN or TI 0000.00dddSN
Manual Trigger	MN			Trigger Level 1V Threshold OV Threshold	LV 1 2	QLV	LVd
Marker Frequency Hertz kilo-Hertz Mega-Hertz	MK HZ KZ MZ	QMK	MK 00000000.HZ or MK 0000000d.dHZ or MK 000000d.dddHZ or MK 000000d.dddHZ	Trigger Slope Positive Negative	SL 1 2	QSL	Sld
Mode Free Run Gate N Cycle 1/2 Cycle Fin X N Fin + N	MO 1 2 3 4 5 6	QMO	MO d	Trigger Source Internal External	SR 1 2	QSR	Srd
N Enter	NM EN	QNM	NM 00000000d.EN	VCO OFF ON	VC 0 1	QVC	Vcd
Offset Volts DC	OF VO	QOF	OF=0000000d.ddVO or OF=000000d.dddVO	Vector Height Enter	VH EN	QVH	VH=00000000d.EN
Phase degree	PH DG	QPH	PH=00000000d.dDG PHASE	Vector Length Enter	VL EN	QVL	VL 00000000d.EN
PLL Status Mask (bit 5 of Status Byte) Masked = 1 at Lock = 1 at Unlock = 1 either	PM 0 1 2 3			Vector Marker Enter	VM EN	QVM	VM 00000000d.EN

d = ASCII digits 0 to 9.

s = sign bit, ASCII space or -.

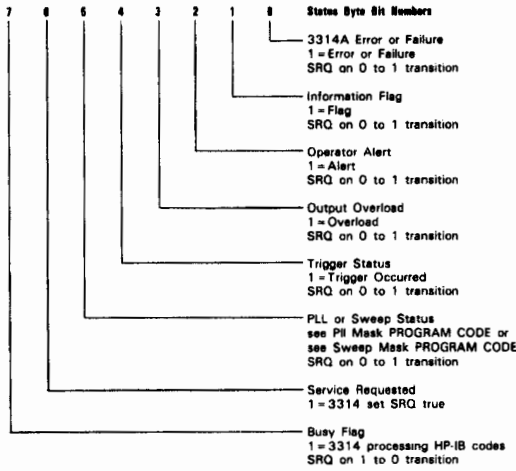
All other characters are exactly as shown.

All returned data is followed by an ASCII carriage return and line feed with HP-IB EOI true, concurrent with the line feed.

# HP-IB PROGRAMMING SUMMARY (cont)

## Status Byte

Bits of the Status Byte are set (1) only after unmasking that bit and the condition is met. All bits are reset immediately after the Status Byte is sent.



## Unmasking The Status Byte

The 3314A will Request Service (SRQ line true) when a bit of the Status Byte is unmasked and the operating condition to set that bit exists. Masking is not affected by PRESET or CLEAR 7. All bits except bit 7 will set SRQ at the 0 to 1 logic transition. Bit 7 will set SRQ at the 1 to 0 logic transition and is useful when using Data Transfer Mode 2, indicating when the 3314A is ready to be programmed again.

ML	3	2	1	0	Bit Number	MH	7	6	5	4	Bit Number
@	MASKED	MASKED	MASKED	MASKED		@	MASKED		MASKED	MASKED	
A	MASKED	MASKED	MASKED	UNMASKED		A	MASKED		MASKED	UNMASKED	
B	MASKED	MASKED	UNMASKED	MASKED		B	MASKED		UNMASKED	MASKED	
C	MASKED	MASKED	UNMASKED	UNMASKED		C	MASKED		UNMASKED	UNMASKED	
D	MASKED	UNMASKED	MASKED	MASKED		D	MASKED		MASKED	MASKED	
E	MASKED	UNMASKED	MASKED	UNMASKED		E	MASKED		MASKED	UNMASKED	
F	MASKED	UNMASKED	UNMASKED	MASKED		F	MASKED		UNMASKED	MASKED	
G	MASKED	UNMASKED	UNMASKED	UNMASKED		G	MASKED		UNMASKED	UNMASKED	
H	UNMASKED	MASKED	MASKED	MASKED		H	UNMASKED		MASKED	MASKED	
I	UNMASKED	MASKED	MASKED	UNMASKED		I	UNMASKED		MASKED	UNMASKED	
J	UNMASKED	MASKED	UNMASKED	MASKED		J	UNMASKED		UNMASKED	MASKED	
K	UNMASKED	MASKED	UNMASKED	UNMASKED		K	UNMASKED		UNMASKED	UNMASKED	
L	UNMASKED	UNMASKED	MASKED	MASKED		L	UNMASKED		MASKED	MASKED	
M	UNMASKED	UNMASKED	MASKED	UNMASKED		M	UNMASKED		MASKED	UNMASKED	
N	UNMASKED	UNMASKED	UNMASKED	MASKED		N	UNMASKED		UNMASKED	MASKED	
O	UNMASKED	UNMASKED	UNMASKED	UNMASKED		O	UNMASKED		UNMASKED	UNMASKED	

## Error Codes

ER #	Definition	Status Byte Bit #	ER #	Definition	Status Byte Bit #
00	No errors since errors were last queried (HP-IB function, only)			--- FREQUENCY CALIBRATION ERRORS ---	
	--- OPERATOR ERRORS (non-ARB) ---		30	No frequency detected	0
01	Frequency/Symmetry conflict	0	31	Frequency error exceeds correction capability	0
02	Bus address entry error	0	32	Frequency unstable during calibration	0
03	Front panel key failure	0		--- AMPLITUDE CALIBRATION ERRORS ---	
04	Calibration measurements not performed	1		Signal amplitude outside measurement range	0
05	Allowed in sweep, only	0	34	Signal amplitude gain too high	0
06	Not allowed in sweep	0	35	Signal amplitude gain too low	0
07	Not allowed in log sweep	0	36	Signal amplitude gain out of limit	0
08	Store 0 not allowed	0	37	Signal amplitude gain offset out of limit	0
09	Non-volatile memory lost; battery down	0	38		
	--- OPERATOR ERRORS (ARB) ---			--- HP-IB ERRORS ---	
10	Vector insert not allowed	0	41	Mnemonic invalid	0
11	Vector delete not allowed	0	42	Definition number invalid	0
18	Allowed in ARB, only	0	43	Date invalid	0
19	Not allowed in ARB	0	44	Units invalid	0
	--- PLL ERRORS ---		45	Range Hold not allowed	0
20	Unstable input frequency	1	46	ARB/SWEEP parameter conflict	0
21	Input frequency outside of capture range	1	47	Not allowed in Manual Sweep	0
22	3314A output frequency would be out of range	1		--- OVERLOAD ---	
23	Internal interval >20ms	1	50	AM or FM/VCO input voltage exceeds normal operating limits (HP-IB) function only	1
24	Internal synthesis unlocked	0	51	Output voltage exceeds safe operating limits; 3314A has disconnected itself	3



# MANUAL CHANGES

-hp- Model 3314A

## FUNCTION GENERATOR

Manual Part Number 03314-90000

This supplement contains important information for correcting manual errors and additional information to make this manual more complete.

To use this supplement:

1. Make all ERRATA corrections. Note that these changes are organized by serial number.
2. Add all the ADDENDA information.

### ERRATA

**CHANGE NO. 1, applies to all 3314As.**

**Page 7.** Change the minimum external trigger signal that will consistently trigger the 3314A from 200Vp-p to 300mVp-p centered on the selected trigger threshold voltage.

**Page 19.** Change the first sentence in the ARB Mode Summary to read:

The 3314A has 6 ARB waveforms (accessed by RCL ARB 0 to 5).

**Page 21.** The last sentence should read:

The waveforms are organized into ten basic groups.

**Page 33 through 39.** The V HGT of the last vector should read "1FO0" for all waveforms.

**Page 77.** Change the power consumption to read:

95 VA maximum

**Page 88.** The preset condition of the Status Byte (HP-IB) should be:

Cleared (not affected by "PR") instead of not affected.

**Page 93.** Change the definition numbers for DATA TRANSFER MODE to:

Data Transfer Mode	DM
Unbuffered (serial)	1
96 Byte Buffer	2

**Page 98.** The second paragraph should read:

Exceptions that will automatically reset a bit (and send another SRQ message) immediately after the 3314A sends its Status Byte are:

- Overload
- Trigger when in Gate Mode
- Busy Flag (no SRQ)

**Page 99.** Change the fifth entry in the ACTION column to read:

-Sets the trigger slope to positive if the trigger slope is negative. Used as an arming signal to prepare for the next gate.

Delete:

Ignored while the 3314A is sweeping.

1 July 1982

**Page 101.** "Display Errors" should not be indented.

Delete the second "Amplitude" entry.

**CHANGE NO. 2, applies to 3314As with serial numbers 2141A00200 and greater.**

**Page 4.** For instruments with serial numbers greater than 2141A00199, replace Table 1, located on Page 4, with this new Table 1. Instruments with serial numbers from 2141A00101 through 2141A00199 should still use the .4A or .8A fuses.

Table 1. Line Fuse Selection

Voltage Selected	Fuse Value	-hp- Part Number
110/120V	1A SLO BLO	2110-0312
220/240V	0.5A SLO BLO	2110-0202



*Using the wrong fuse value or fuse type will not protect the circuitry inside the 3314A and may result in damage to your 3314A.*

### ADDENDA

**Page 45.** Add this paragraph at the bottom of the page.

E10. "E10" is displayed when you have used all 160 vectors. Recall that there are only 160 vectors available and these are distributed among six ARB waves. If five ARB waves contain the minimum (2 vectors each), you can have up to 150 vectors in the remaining ARB wave.

**Page 46.** Add the sentence to the end of the "INSERT VECTOR" topic.

If the Vector Marker is pointing to the last vector, a new vector #1 is inserted.

**Page 47.** Add this paragraph to the bottom of the page.

Note that the Vector Marker is automatically incremented when either the V HGT or the V LEN keys are pressed twice. This feature is very useful to quickly review or edit the ARB wave.

**Page 87.** Add this sentence to the end of the MAIN SIGNAL OUTPUT topic.

The output voltage is limited to  $\pm 15V$  peak before clipping will occur.

**Page 88.** Add this sentence to the end of the X3 OUTPUT topic.

The output voltage is limited to  $\pm 15V$  peak. You can not output a 30Vp-p AC signal with any DC Offset without clipping.

**Page 78.** Add this sentence to the end of the first paragraph.

All 12 registers are non-volatile, that is, all the stored information is retained, even after a power failure.

Supplement A for 03314-90000

Page 68. Add this sentence to the bottom of the page.

It is not necessary to send the prefix over and over if you are programming only one 3314A parameter. In the program example that follows, frequency is being changed from 1 to 2 to 3MHz.

OUTPUT 707;" FR 1 MZ"  
OUTPUT 707;" 2 MZ"  
OUTPUT 707;" 3 MZ"