OPERATING MANUAL

FUNCTION GENERATOR

3314A

HEWLETT PACKARD

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MODEL 3314A
FUNCTION GENERATOR
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This manual contains the following four sections to help you operate the 3314A:

THE 3314A FUNCTION GENERATOR

an introduction to 3314A operation with instructions for quick and safe basic operational checks.

THE WAVEFORM LIBRARY

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

DETAILED OPERATING INFORMATION

alphabetically organized information about detailed 3314A operation.

REMOTE OPERATION

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

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.

This section contains information about the following subjects:

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 331 4A 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 "ttoetinq" 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 the installation section of the 3314A 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 selector on the rear panel. The selector setting should 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.

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

INSTALLATION INSTRUCTIONS (cant)

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

Table 1. **Line Fuse Selection**

Serial Number	Voltage Selected	Fuse Value	-hp- Part Number
less than 2141AOO200	100/120V 220/240V	O.SA SLO BLOW OAA SLO BLOW	2110-0336 2110-0340
2141 AOO200 and greater	100f120V 220/240V	1.0A SLO BLOW 0.5A SLO BLOW	2110-0312 2110-0202

CAUTION

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

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 LEOs

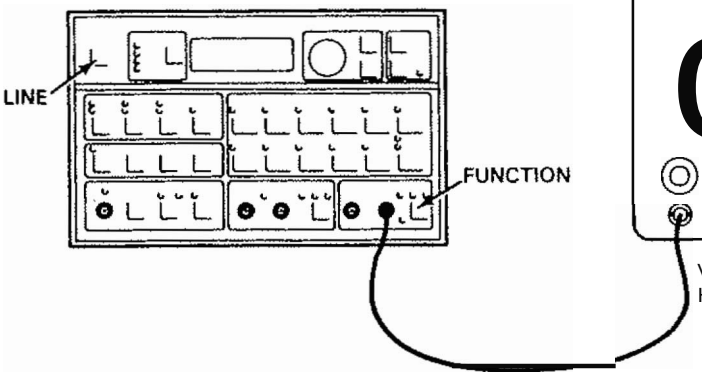
   -a CAL ALL to generate a full complement of calibration constants

   -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.

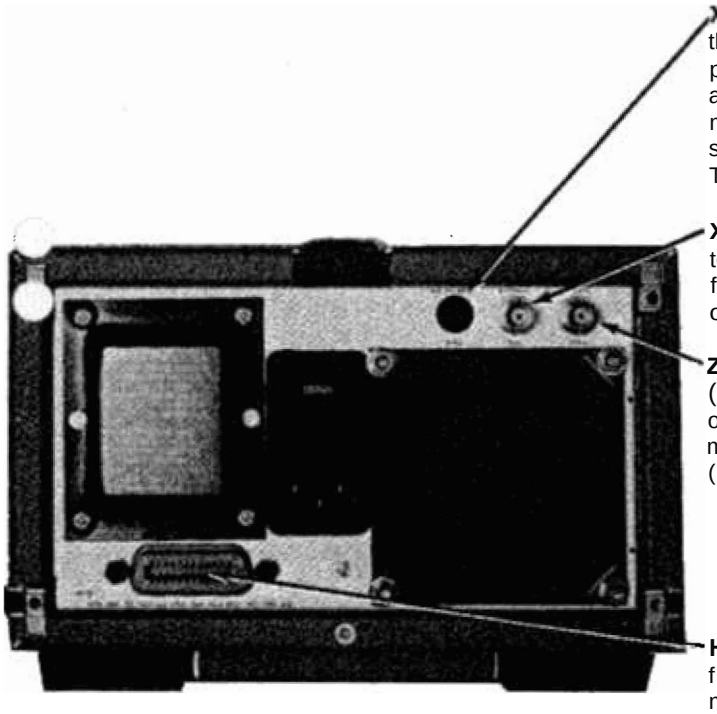
INSTALLATION INSTRUCTIONS (cant)



Operation Into ll Hi Z load is allowed except that the amplitude will be twice the amount displayed by the 3314A. The purity of the functions at high frequencies may be degraded because of the transmission line Impedance mismatch.

Figure 1. Basic Installation Verification

THE 3314A REAR PANEL



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 whan the Main Output is terminated into Son. This output whose capable of sourcing ± 30mA peak current without clipping. The upper frequency limit is 1MHz.

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.

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

HP-IB is used to control the operating of the 33 14A from a remote controller. This connector uses metric fasteners and is not compatible with older cables using english threated fasteners. Matric fasteners are available from -hp- to upgrade older cables.

Figure 2•. 3314A Rear Panel

THE 3314A FRONT PANEL

① Status

This group contains the HP-IB status indicators and the LCL key to switch control of the 3314A from remote to front panel operation. When the LCL key is preceded by the BLUE shift key, the 3314A displays its HP·IB address for 1/2 second. The HP-IB address is set from the front panel and stored in non-volatile memory. The factory setting Is 7. See "How to Change the 3314A's HP-IB Addresa" located In the HP-IB section of this manual.

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 Ie . Gated functions, sweaps and ARB operations are allowed. See "How to Use the GATEo Mode".

I **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° to +90°. See'How to Use the N CYCLE Mode".

1/2 **CYCLE Mode.** The 3314A outputs alternate 1/2 cycles of the selected funtlon 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° to +90°. See "How to Use the 1/2 CYCLE Mode".

Fin X • Mode. The 3314A will phase lock to the Trigger (reference) signal lind 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 60Hz to 20MHz. See • How to Use the PHASE LOCK Modes".

Fin + • Mode. The 3314A wlH phaee lock to the Trigger (r -ence) signal and output a frequency equal to the re .enca frequency divided by , N". The N parameter sets "N' from 1 to 1999. The frequency limits for both the 3 1A and the reference lire from 60Hz 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 continuoua ARB functions {FREE RUN Model and gated ARB (GATE Mode) ere allowed. See ' How to Use the ARB Mode".

Preset

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

④ 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. Reg/ster 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 ere created,

External Trigger

One EXT Trigger is e signal you apply to the Trigger *Va* port thet 88tlsities the selectable slope lind threshold conditlons (note that the Trigger Ifa port Is en Input when EXT Trigger is selected). EXT Triggers are level sensitive for Gate; edge sensitlva 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 ≥ JOOmVp-p. centered on the selected trigger threshold voltage.

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

Internal Trigger

The SWTR IITYl parameter sets the period of the internal trigger (note that the Trigger *Va* port Is an output when tNT trigger Is selected). This output signal is useful as a sync signal during sweeps, gate and burst operations.

CD External Modulation

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

Function

The MAIN OUTPUT. ThIs output has a characteristic output impedance of 600. Although operation Into other than 500 II allowed, the actual AC amplitude and DC offset will be dfferent 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 600 when terminated Into ≤500. When terminated Into >500. 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 peaka of the sine and triangle functIOIII lind coincident with the edges of the square function. This relationship Is inverted by Function Invert.

Entry/Sweep

Most of the keys /n this group are select keys for varieble entries. The top row contains select keys for the more universal pararneters. 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 SWfTR INTVL key is the select key for the sweep Interval (SW INTVLJ and for the internal trigger interval (TR INTVLI . When ARB is active, the sweep functions are redefined to ARB functions. The keys are renamed by the labels below them.

(10) Range

RANGE UP or DOWI (1 or I) keys multiply or divide the displayed value by 10 untit the 3314A's operating limits are reeched. this provides an extremely fest 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 p:"ameters are changed with the Modify knob. When in An X f .td Fin + N, Frequency Range Hold also inhibits auto-acquisition.

(R) Modify

All variable parameters (selected by keys in the Entry Group) are entered Into the 3314A using the Modify knob or the I or J keys. These controls change the value of the displeyed operating 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 dlglt is Incremented or decremented by 1 whenever rotation of the Modify knob ls sensed. The - end - keys move the cursor through the display.

MULTI SPEED (no digit la flashing). this mode is useful when making large chenges. The least significant digit In the dlspley ls incremented or decremented 1, 2, 4, 8, 16 or 32 times faster depending upon how fast you tum the Modify knob.

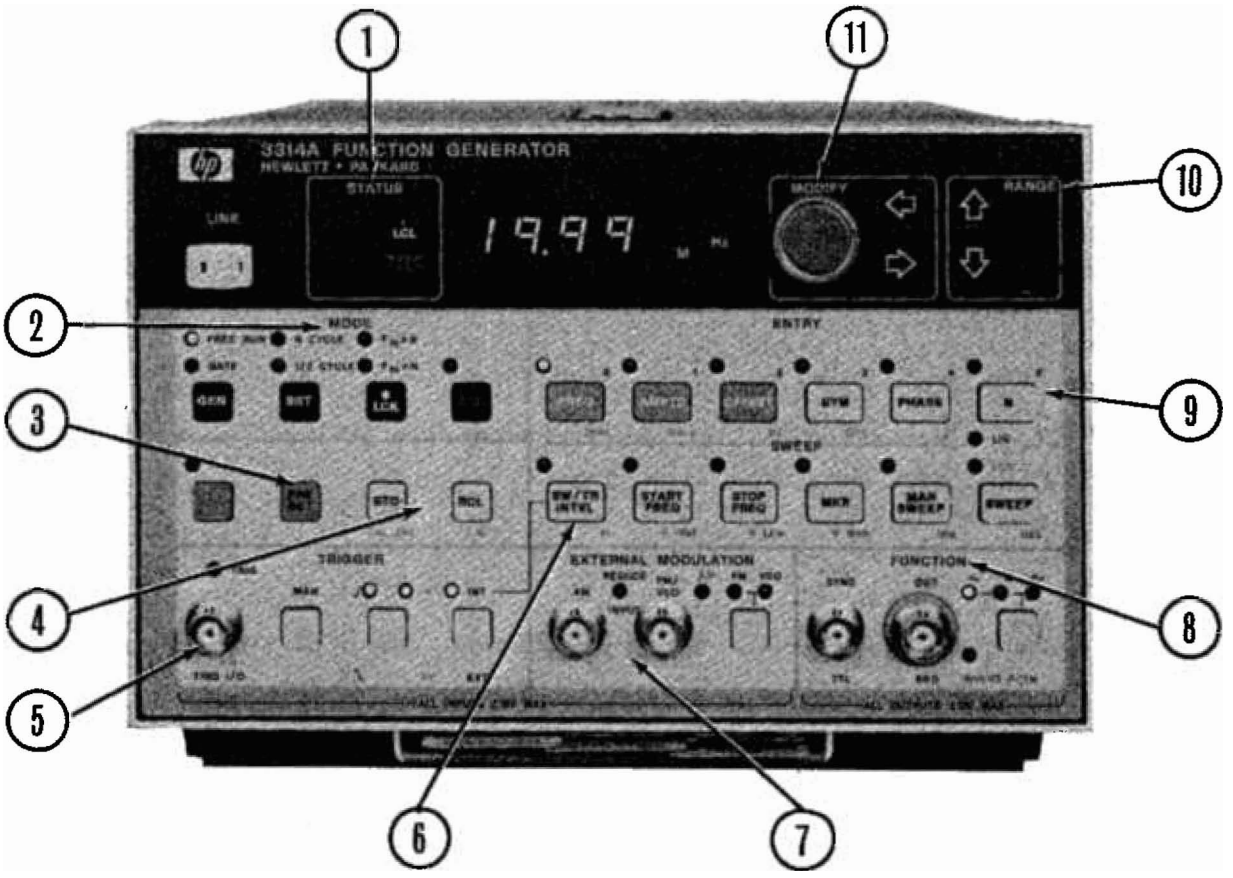


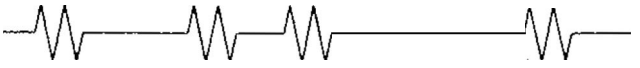
Figure 2b, 3314A Front Panel

MODES OF OPERATION

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

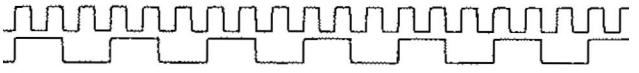
GATE Mode. The 3314A output signal is gated ON or OFF.

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

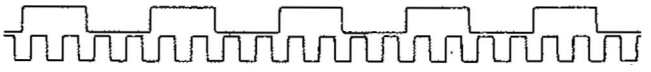


1/2 CYCLE Mode. The 3314A output signal is alternate *1/2* cycles.

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

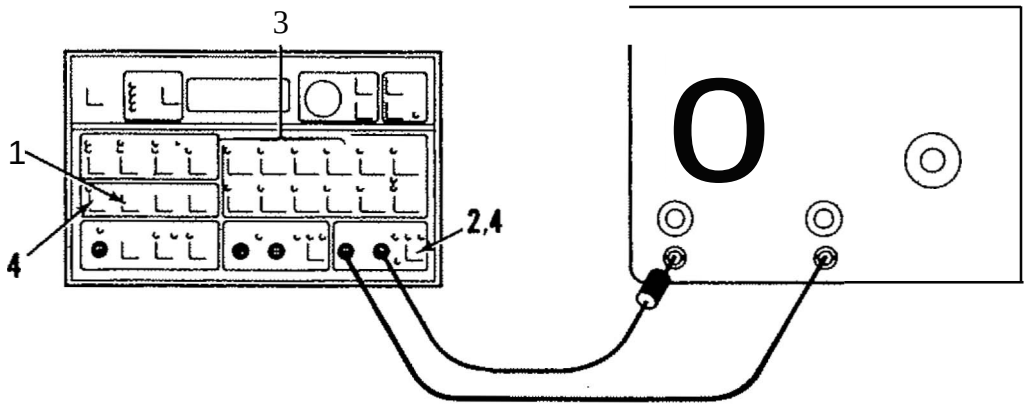


Fin ÷ N Mode. The 3314A output frequency is locked to and "1/N" times the reference frequency.



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

HOW TO USE THE FREE RUN MODE



500 FEEDTHRU TERMINATION (Optional) Not shown on BUCceeding drawings. Trigger from Channel 2 on the rising edge.

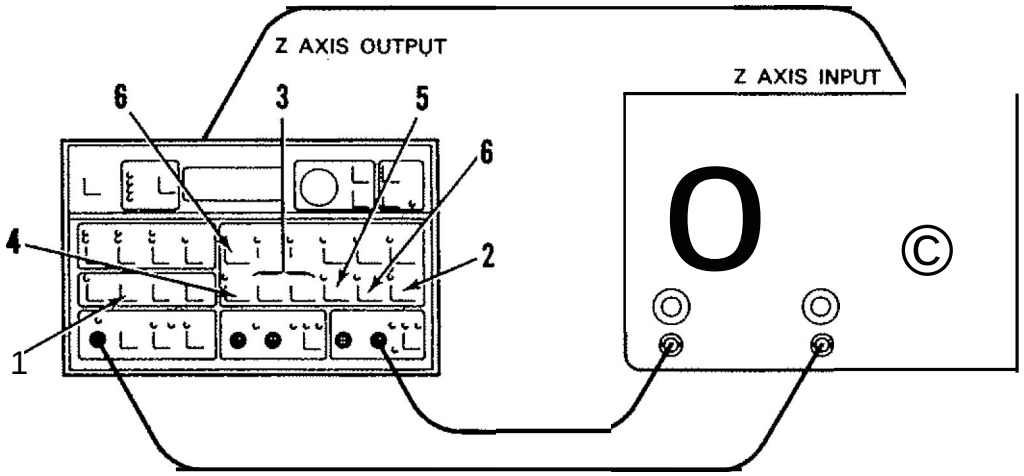
	PRESET	Sets the 3314A to Its basic operating state. This operating state is very useful as the common starting polnt for all operations. Note that FREE RUN is the active mode after instrument preset.
2	FUNCTION	Press this key to change the function from Sine to Square to Triangle to Function OFF and beck to Sine. Note that DC OFFSET is not affected by Function OFF.
3	FREQ AMPTD OFFSET SYM	Use the Modify knob and I or I keys to change the valua of these parameters. Note that AMPTD and OFFSET ara completely independent parameters end that variable symmetry is not allowed for frequencies ≥ 2MHz.
4	(blue shlftl 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: .001 Hz to 19.99MHz In 8 ranges
Amplitude: .00mVp-p to 10.00Vp-p In 4 ranges
Offset: ±.OOQVDC to ±6.QOVDC In 2 ranges
Symmetry: 5% to 95% for frequencies <2MHz

See waveforms 1 through IOin the Waveform Ubrllry.

HOW TO USE THE FREE RUN MODE (LINEAR SWEEPS)



A 500 Feedthrŭ Termination is optional to reduce the sensitivity of the oscilloscope's Z Axls input. Trigger from Channel 2 on the rising edge.

	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 le the active mode after instrument preset.
2	SWEEP	The 3314A's output frequency is now linearly sweeping from the Start Frequency to the Stop Freqeuncv 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 wnl cause the other to change If the ratio of Stop Frequency to Start Frequency would be < 1 or > tOO. The 331 4A will make the other pararneter'a light flash to alert you to this automatic parameter change.
4	SW/TR INTVL	Thls parameter sets the sweep tlme interval. When the INT Trigger Is selected, the sweep is from Start Frequency to Stop Frequency In this time. The sweep is repeated lifter the frequency resets. The reset time is approximately 10% of the sweep Intervel. 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 ill received.
6	MKR FREQ	The Z Axis output signal will intensify the trace when the sweep frequency equals the Marker Frequency.
6	MAN SWEEP FREQ	When manuel 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,V displays.

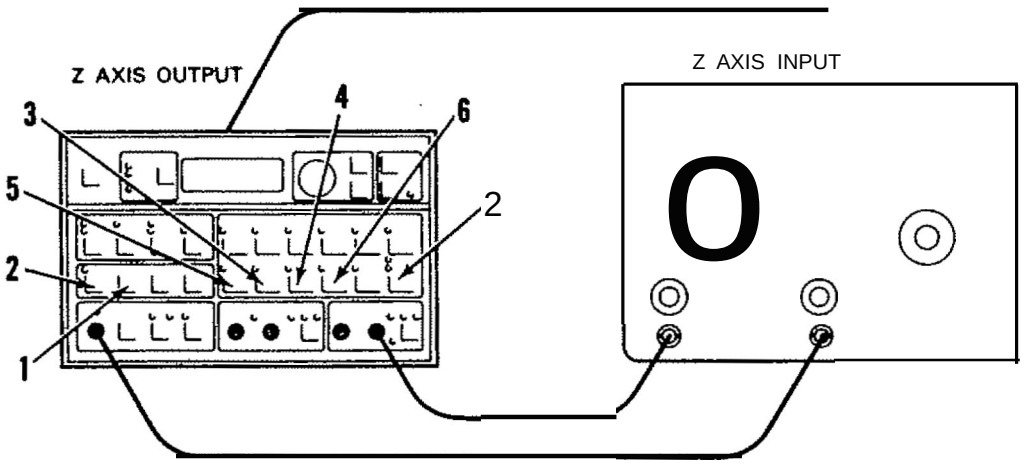
HOW TO USE THE FREE RUN MODE (LINEAR SWEEPS) (cant)

Linear Sweep Summary

Stop **Frequency must be ≥** Start **Frequency.**
Stop Freq + Start **Freq** ratio is from 1 to 100.
Sweep Interval renge **is** from 7.2Oms to 19999
Sweep Is **repetitive when** tNT **Trigger** III selected.
Sweep started by the **Trigger when** EXT **Trigger is selected.**

See **Waveforms** 11 through 16 In the Waveform Ubrery.

HOW TO USE THE FREE RUN MODE (LOG SWEEPS)



Trigger from **Channel** 2 on **the rising edge.**

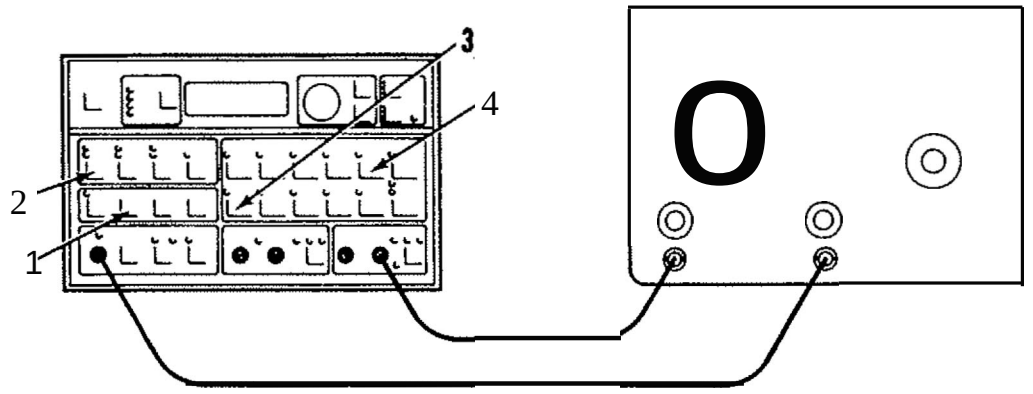
Step	Key	
	PRESET	**Sets the** 3314A to its basic **operating** state. **This operating state** III very useful **as the common starting** point **for** an **operations.** Note that FREE RUN **is the active mode** after **instrument preset.**
2	**(blue shift) SWEEP**	**The** 3314A'S **output frequency** III now **sweeping logarithmically from the** Start **Frequency** to **the** Stop **Frequency** In **the** time Interval eet by SWITA INTVL.
3	START FREQ	Setting **the** Start **Frequency** elso **sets the mantissa** of **the** Stop **Frequency (Log sweeps must be decade sweeps). When the Start Frequency is changed, the** Stop **Frequency automatically** tracka **these changes.** Note that the lower Stert **Frequency** limit III .2ooHz.
4	STOP FREQ	Note **that the** Stop **Frequency** sets **the number** of decades swept. **The** mantIsla of **the** Stop Frequency trackII **the** Stert **Frequency.**
5	SWITR 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** IIIgnal **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 decedes, 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 19998 per decade.

See Waveforms 16 **through** 20 In the Waveform Ubrary.

HOW TO USE THE GATE MODE



Trigger from Channel 2 on the rising edge.

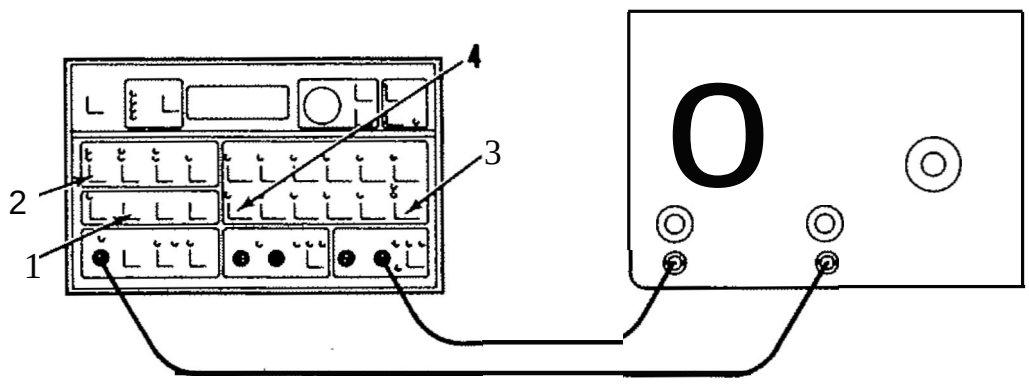
	PRESET	Presets the 3314A to e common starting point.
2	GEN	This key toggles the mode between Free Run and Gate. The 3314A'. output will be ON when the trigger level satisfies the slope and threshold conditions.
3	SWfTR INTVL	Sets the period of the Internal Trigger tnterval. The internal trigger signal has a 50% duty cycle and the output is gated on for slightly > 1/2 of the Trigger Interval.
4	PHASE	Sets the start end stop phase of the gated signal. The output is gated on immediately after the trigger level Is true. The output is gated off after the trigger level is false and the output algnal reaches the stop phase.

Gate Summary

Trigger Level gatea on and off.
SWrrR INTVL: .002ms to 19998
Start/Stop Phase: -90^0 to $+90^0$
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 Ubrery.

HOW TO USE THE GATE MODE (GATED SWEEPS)



Trigger from Channel 2 on the rising edge.

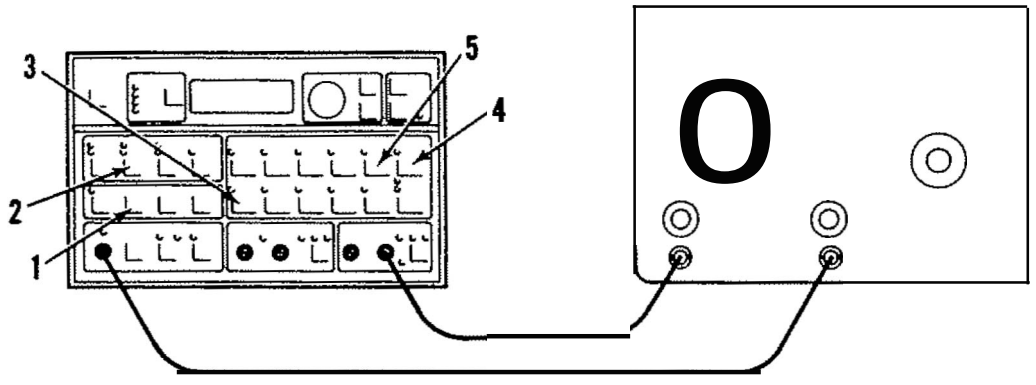
	PRESET	Presets the 3314A to a common starting point.
2	GEN	Thls key toggles the mode between Free Run and Gate. The 3314A's output will be ON when the trigger level satisfies the slope and threshold conditions.
3	SWEEP	Gated Sweeps are useful as "self-windowing" signals with sampling Fourier type spectrum analvzers, such as the -hp- 3582A. Self-windowing signals are needed when the analyzer's sampflng rate and the stimulus are unrelated.
4	SWITR INTVl	This parameter sets the Trigger Interval (the time between sweep starts). The actual time the output Is gated on Ithe sweep interval) Is -.9 of ths Trigger Interval.

Gated Sweep Summary

SW/TR INTVl: 7.2Oms to 1999s
Start/Stop Phase: not meaningful
Internal Trigger Duty Cycle: ~90%
Gated Log Sweeps are not allowed.
Trigger Ught indicates the presence of a trigger
SYNC output Is also gated

See Waveforms 26 through 30 In the Waveform Ubrary.

HOW TO USE THE N CYCLE MODE



Trigger from Channel 2 on the rising edge.

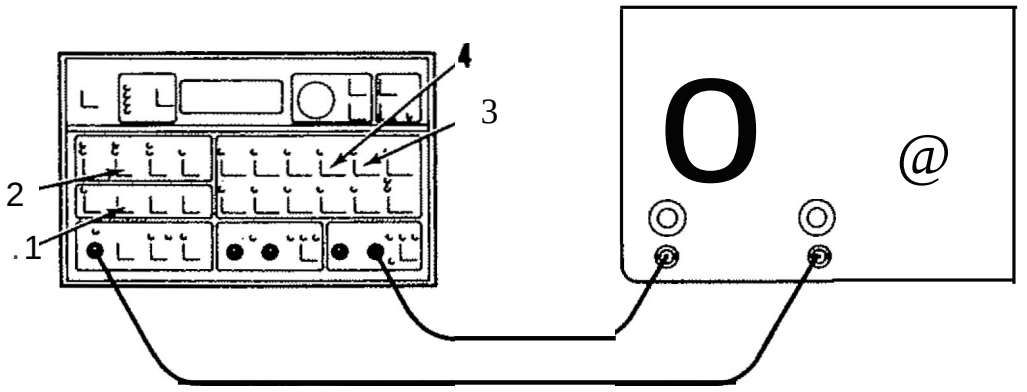
Step	Key	
	PRESET	Presets the 3314A to a common starting point.
2	SST	This key toggles the mode between N CYCLE and 1/2 CYCLE.
3	SW/TR INTVl	The Trigger Interval sets the time between the start of bursts. Note that if this time is shorter than the length of the burst, the output is a continuous signal.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

N Cycle Summary

N range: 1 to 1999
SWrrA INTVl: .002ms to 1999.
Stert/Stop Phase: -90° to +90°
SYM range: 5% to 95%

See Waveforms 31 through 36 In the Wavefonn Ubrary.

HOW TO USE THE 1/2 CYCLE MODE



Trigger from Channel 2 on the rising edge.

	PRESET	Presets the 331 4A to a common starting point,
2	BST	This key toggles the mode between N CYCLE and *1/2* CYCLE. The 3314A outputs alternate 1/2 cycles whenever a trigger fa received.
3	PHASE	This parameter sets the start/stop phase as In N CYCLE except that the start and stop phase alternate by 180⁰ .
4	SYM	Used with the Phase parameter to make pulses with variable overshoot (preshoot) and variable rise (fall) times.

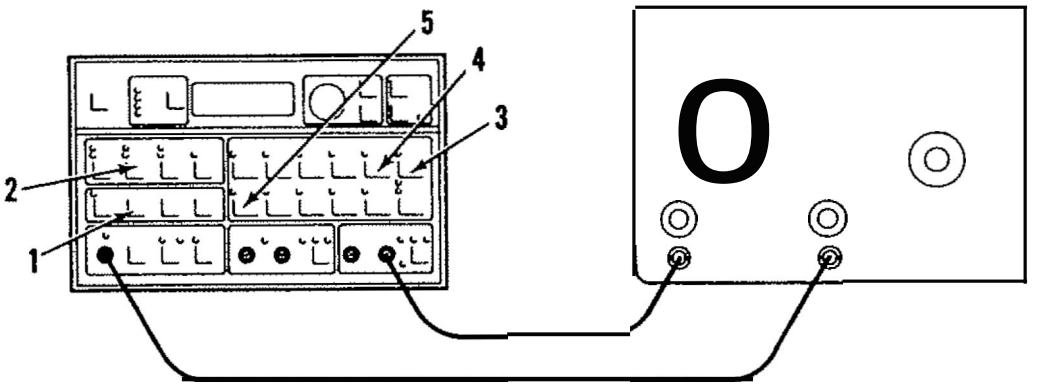
1/2 Cycle Summary

Start/Stop **Phase:** -90⁰ to +90°
SYM **range: 5%** to **95%**
SW/TR INTVl: .OO2ma to 1999.

See Wavaforms 36 **through** 40 In **the** Waveform **Library.**

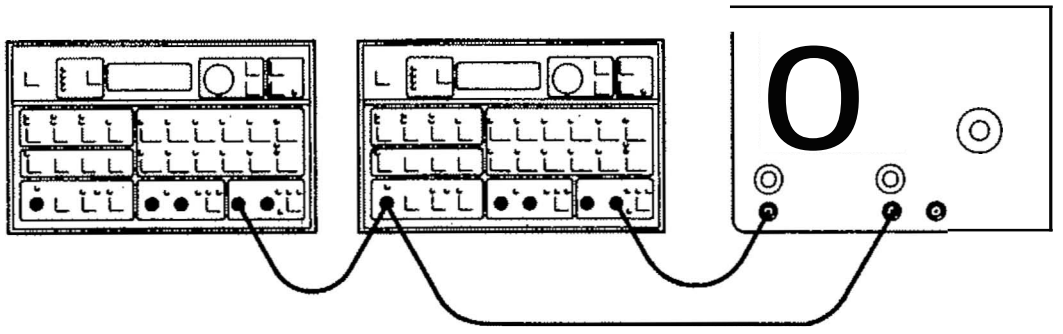
HOW TO USE THE PHASE LOCK MODES

INTERNAL PHASE lOCK



Trigger from **Channel** 2 ff An X N.
Trigger from **Channel** 1 If An ÷ N.

EXTERNAL PHASE LOCK



Step	Key	Actios
	PRESET	**Presets the** 3314A to ıı common startlng point.
2	ϕ LCK	**This key toggles the mode between** Fln X N **and** Fln ÷ N. Whlle **the** light Is **flashing, the** 3314A **is measuring the frequency** of **the reference signal, setting the** 3314A's **output frequency** to lin approximation **that** will be **within** the capture **range** of **the** phase locked loop **and then phase** loeka to **the reference.** The 3314A hall **acquired** lock **when the** light ıı on **continuously. When** EXT **Trigger** III selected, the 3314A **phase-locks** to lin external **signal** you apply to **the Trigger Input.**
3	N	**Use the** Modify knob to change **the ratio** of output **frequency** to reference **frequency.** Note that **the** 3314A **has** to reacquire lock **every** time N changes.
4	PHASE	**Use the** Modify **knob** to **change the phase relationship between the reference** and **output signal.** 1₀ of **phase refers** to t₀ of the lower **frequency signal** {either **reference** or oetput),
5	SWfTR INTVL	**This** parameter **sets** the period of **the** INTVL • **reference" signal when** INT Trigger **is selected.**

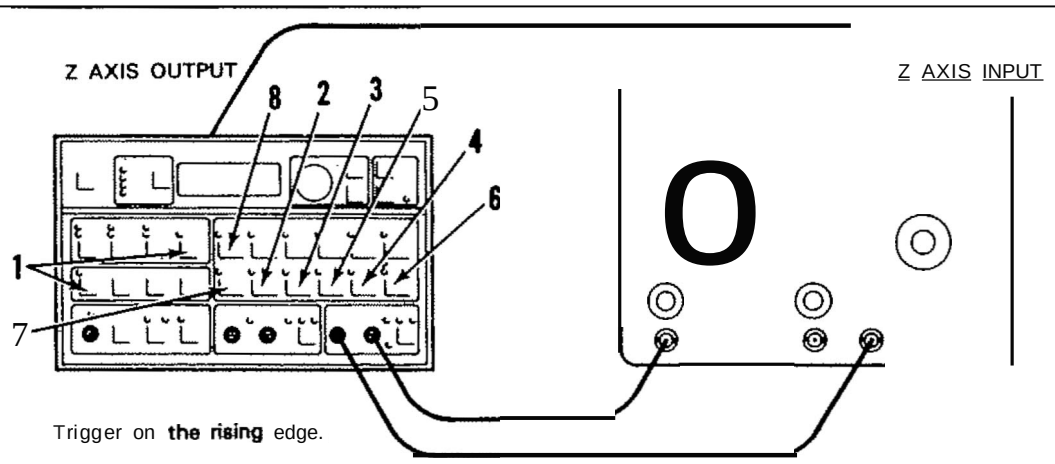
HOW TO USE THE PHASE LOCK MODES (cont)

Phase Lock Summary

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

See Woveforms 41 through 50 in the Waveform Ubrllry.

HOW TO USE THE ARB MODE



Trigger on the rising edge.

	(blue shift) ARB	Redefines the 3314A IIIS an ARBitrary Waveform Generator (the shifted function etso clears the currant 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 Haight of the current vector. The last vector closes the waveform. Its length is progremmable 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 paramater when V LEN Is very large.
4	INS	Each time this key is pressed, another vector is inserted Into the wavafonn.

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

6	V MKR	Use the Modify knob to change the current vector. Note that the intensified vector on the oscilloscope trecks V MKR.
6	DEL	Eech time this key Ill pressed, the current vector is removed from the ARB waveform. The last vector cannot be removed.
7	At	Thla parameter changes the period of the unit vector (V LEN = 1). Use the Modify knob to change this parameter.
B	FREQ	Use the Modify knob to change the repetition frequency of the entire ARB waveform. Note the 3314A actually computes a new Δ t.

ARB Mode Summary

The 3314A has slx ARB waveforms (accessed by RCL ARB 0 to 5).
There are 8 maximum of 160 vectors distributed among these 6 wllveforms (2 vectors per waveform. minimumI. The Initialized ARB waveform (also the minimum waveform) is a 2 vector waveform with V HGT = 000. V LEN = 1, V MKR - 1 end Δ t = .200ms.
V HGHT range: -1999 to +1999
V LEN range: 1 to 127
Δ t range: .200ms to 19.99ms
Phase range: -90^0 to $+90^0$ (sets the waveform closure between the peak-to-peak limits set by AMPTD). AMPTD sets the peak-to-peek limits that the ARB weveform must exist within.

See Waveforms 51 through 60 In the Waveform Ubrary.

THE WAVEFORM LIBRARY

This Waveform Library contains 60 oscillograms representing a cross-section of the 3314A's capabilities. The waveforms are organized into these groups.

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

FREE RUN

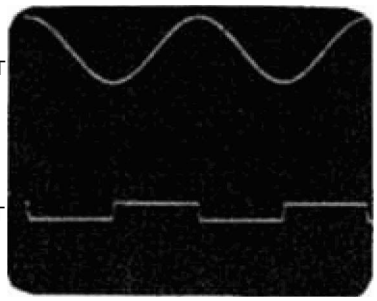
1. Large Signal With large DC Offset

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

PR MOI FR1MZ AP10VO OF5VO

MAIN OUTPUT

SYNC OUTPUT



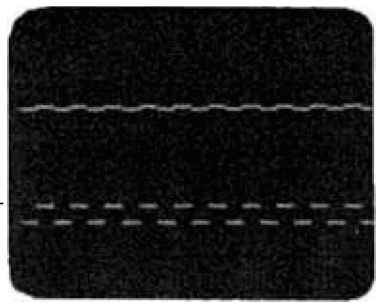
2. Small Signal With large DC Offset

PRESET
AMPUTUDE 400mVp-p
OffSET . . . . . -3.00Vdc
FUNCTION . . . . . Squarewava

PR AP400MV OF-3VO FU2

MAIN OUTPUT

SYNC OUTPUT



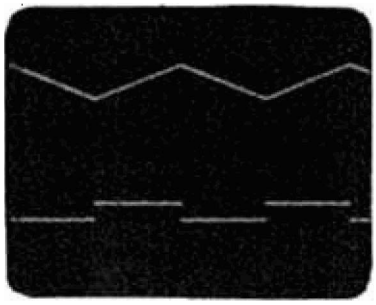
3. Large Signal With Small DC Offset

PRESET
AMPUTUDE 5Vp-p
OffSET . . . . . •250V
FUNCTION . . . . . Triangle

PR AP5VO OF.25VO RJ3

MAIN OUTPUT

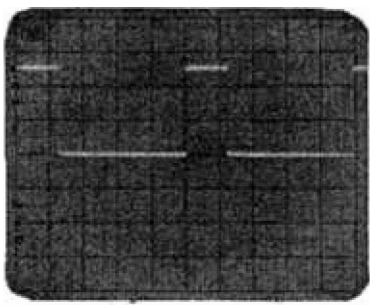
SYNC OUTPUT



4. TTL (Squarewave With DC Offset)

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

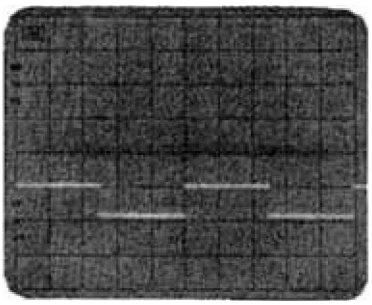
PR AP6VO OF2.6VO SY26PC FU2



5. ECl (Squarewave With DC Offset)

PRESET
AMPliTUDE . . . . . •85Vp-p
OFFSET -1.31V
FUNCTION Squarew8ve

PR AP.86VO OF-I.31VO FU2

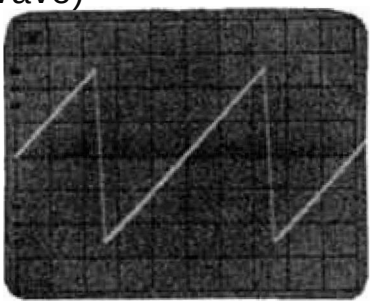


FREE RUN (cant)

6. RAMPS (Variable Symmetry Triangle Wave)

PRESET
AMPliTUDE . . . . . t QVp-p
SYM 95%
FUNCnON . . . . . Triangle

PR AP10VO SY96PC FU3

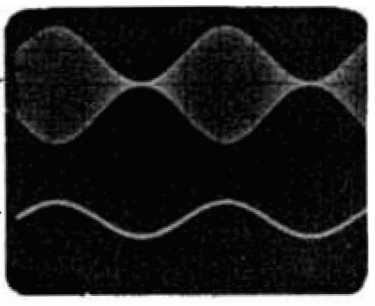


7. 100% Amplitude Modulation

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

PR FA1MZ AP7VO AM1

Signal at AM Input **is a** 2Vp-p. 1kHz **sine** wave.

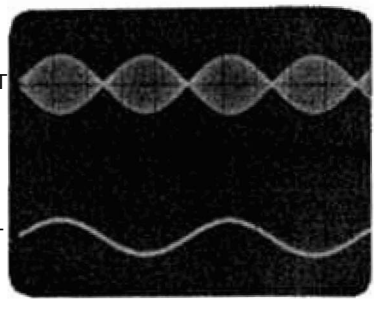


8. AM (Suppressed Carrier)

PRESET
FREQUENCY . . . . . t MHz
AMPUTUDE 7Vp-p
MODULAnON . . . . . AM

PR **FR**1MZ AP7VO AM 1

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

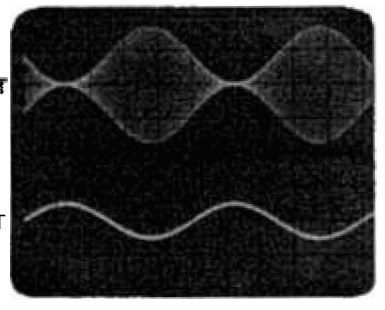


9. AM With Function Invert

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

PR FA1MZ AP7VO AM1 FI1

Signal at AM **Input** la e **2Vp-p,** 1kHz sine wave.

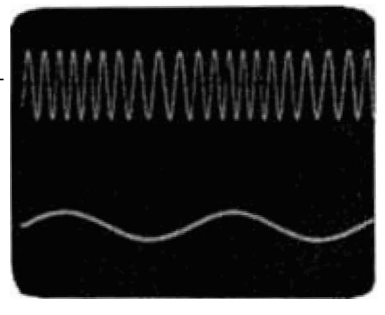


10. VCO

PRESET
MODE . . . . . Frea Run
FREQUENCY 1MHz
AMPliTUDE 10Vp-p
MODULAnON . . . . . VCO
FUNCnON . . . . . Sinewave

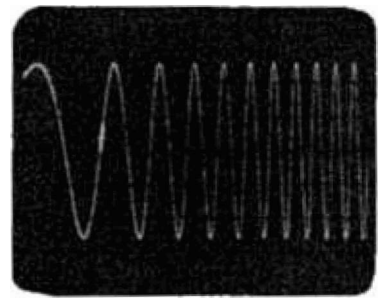
PR MOI FR1MZ AP10VO VC1 FUI

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



FREE RUN (Linear Sweeps)

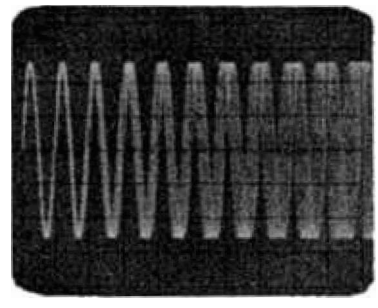
11. 100Hz to 1kHz



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

PR API0VO TI20MS STIOOHZ SP1KZ MK300HZ SWI

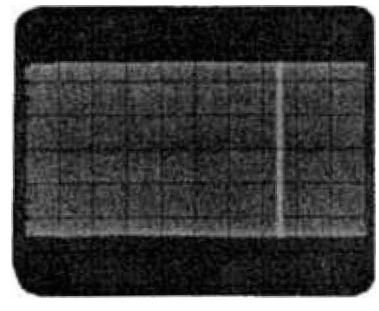
12. Small Sweep Ratio (1.06: 1)



PRESET
AMPliTUDE 10Vp-p
SWEEP INTERVAL 1COrns
START FREQEUNCY 5kHz
STOP FREQUENCY 503kHz
SWEEP TYPE . . . . . Linear

PR AP10VO TI100MS ST5KZ SP5.3KZ SWI

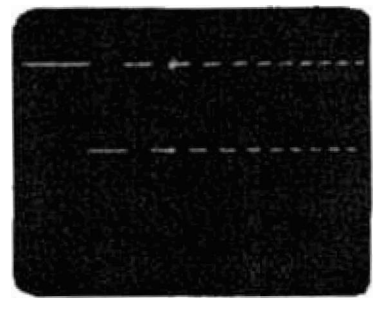
13. Large Sweep Ratio (100: 1)



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

PH AP10VO TII0MS ST199.9KZ SP19.99MZ MK16MZ SWI

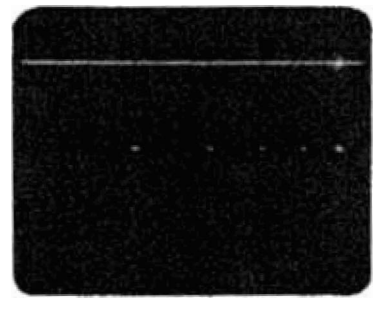
14. TTL Level Sweeps



PRESET
AMPliTUDE 5Vp-p
OFFSET . . . . . + 205Vdc
START FREQUENCY 2104Hz
STOP FREQUENCY 2014kHz
MARKER FREQUENCY 940Hz
SWEEP TYPE . . . . . Linear

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

15. TTL Level, 95% Symmetry Sweep

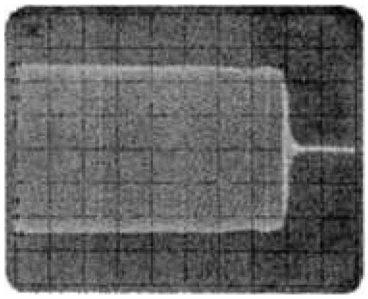


PRESET
AMPLITUDE 5Vp-p
OFFSET. . . . . + 2. 5V
SYMMETRY 95%
START FREQUENCy 10.81Hz
STOP FREQUENCY . . . . . 1081 Hz
MARKER FREQUENCY 1018Hz
SWEEP TYPE . . . . . Linear

PR AP5VO OF2.5VO SY96PC STIO.81Hz SP1081HZ MK1018HZ SWI

FREE RUN (Log Sweeps)

16. Sweeping a Low Pass Filter

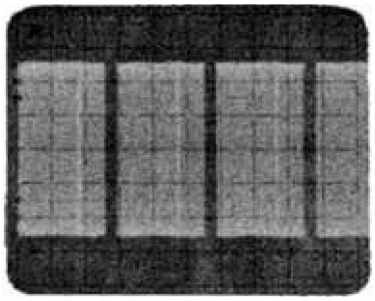


PRESET
AMPLITUDE 10Vp-p
SWEEP INTERVAL 40ms/DECADE
START FREQUENCY 510Hz
STOP FREQUENCY 5.1MHz
MARKER FREQUENCY 809kHz
SWEEP TYPE . . . . . Log

PR AP10VO T140MS ST510HZ SP5.1MZ MK809KZ SW2

Note: The X Axis control voltage is from the3314A's X Axis output. Note the Intensification every decade end at the Marker Frequency,

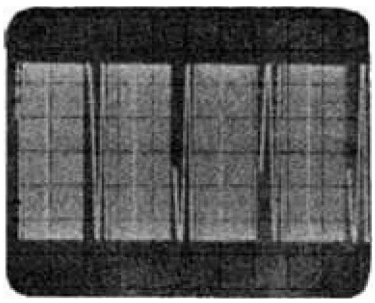
17. 1 Decade Sweep



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

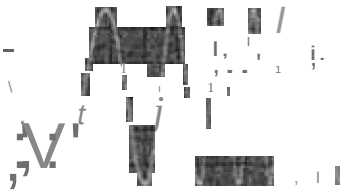
18. Audio Sweep (20Hz to 20kHz)



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

PR AP10VO TI40MS ST20HZ SP20KZ MK1KZ SW2

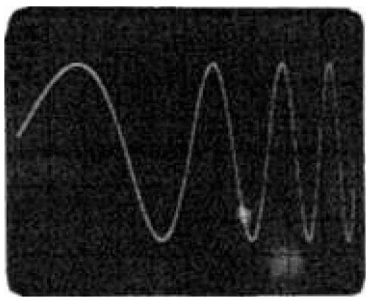
19. Sub-Audio Sweep (2Hz to 20Hz)



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

PR AP10VO TIISN ST2HZ SP20HZ MK13HZ SW2

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



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

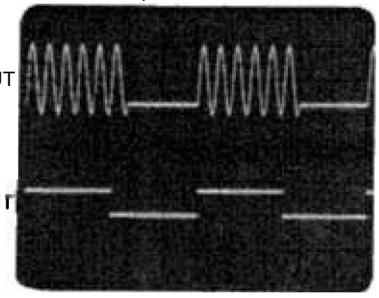
PR AP10VO TI5SN ST.2HZ SP2HZ MK.935HZ SW2

GATE

21. Gated Sinewaves (Start/Stop Phase — -45°)

PRESET
MODE . . . . . GATE
AMPLITUDE 10Vp-p
PHASE -45"
TRIGGER INTERVAL 1Oms

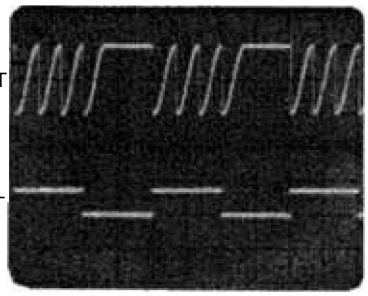
PR M02 AP10VO PH·45DG TIIOMS



22. Gated Sinewaves (SYM = 95%)

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

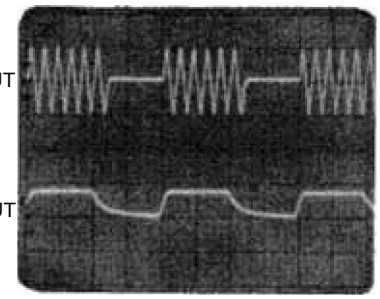
PR M02 FR298HZ AP10VO SY95PC PH90DG TI20MS



23. High Frequency Gate

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

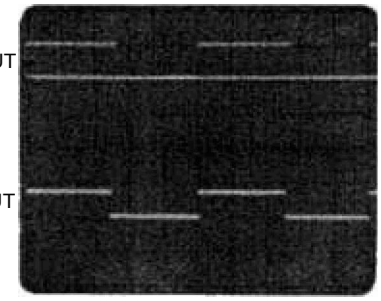
PR M02 FR5MZ AP10VO n .002MS FU3



24. Gated TTL Level Pulses

PRESET
MODE . . . . . GATE
FREQUENCY 15kHz
AMPliTUDE 5Vp-p
OFFSET 2.6Vdc
TRIGGER INTERVAL 2.5m3
FUNCTION Squarewave
INVERT FUNCTION . . . . . ON

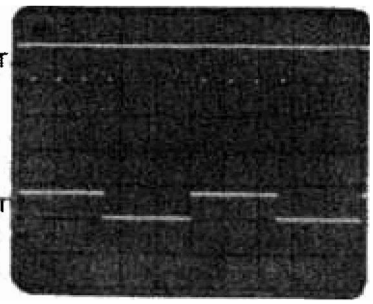
PR M02 FR15KZ AP5VO OF2.5VO TI2.5MS FU2 FII



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 M02 FR2.6KZ AP6VO OF2.6VO SY96PC TI2.5MS FU2

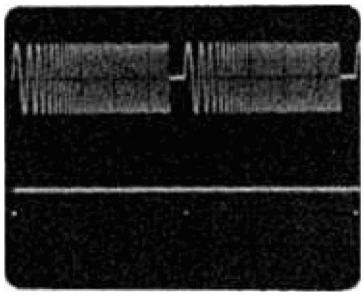


GATED SWEEPS

26. Basic Gated Sweep (1Oms)

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

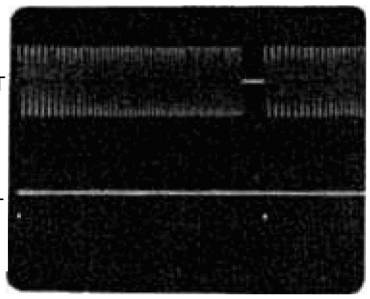
PR M02 AP10VO SW1



27. Small Ratio Gated Sweep (2: 1)

PRESET
MODE , , , Gate
AMPLITUDE ... 1OVp-p
SWEEP INTERVAL 7.2ms
START FREQUENCY 5kHz
STOP FREQUENCY 10kHz

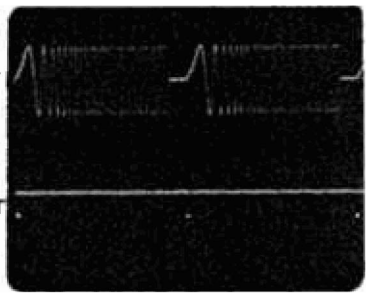
PR M02 AP10VO TI7.2MS ST5KZ SP10KZ



28. Large Ratio Gated Sweep (100: 1)

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

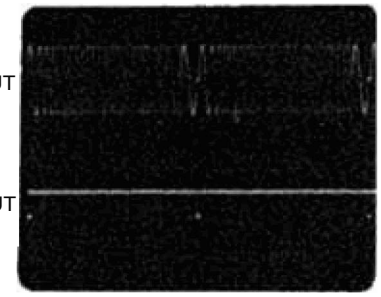
PR M02 AP10VO TI10MS srrooaz SP10KZ



29. Audio Chirp

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

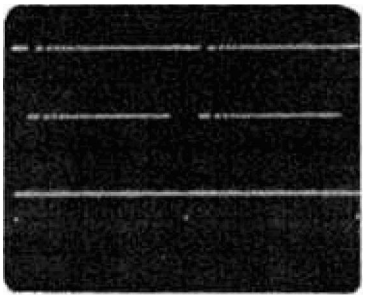
PR M02 AP10VO TI.1SN STlOOHZ SP1KZ SW1



30. Swept Squarewaves

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

PR M02 AP10VO TI10MS snOOHZ SP10KZ SWI FU2



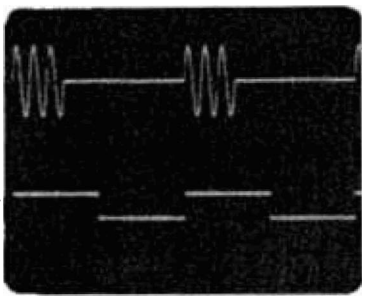
N CYCLE

31. 3 Cycle Burst

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

PR M03 AP10VO NM3EN

MAIN OUTPUT
TRIGGER OUTPUT

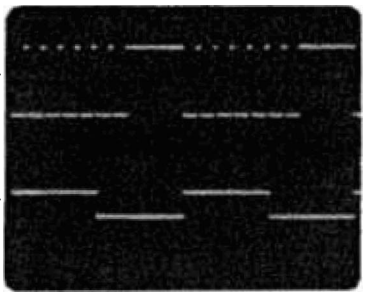


32. 7 Cycle Burst

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

PR M03 AP10VO SY20PC PH90DG NM7EN

MAIN OUTPUT
TRIGGER OUTPUT

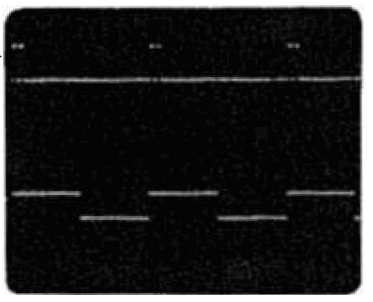


33. 2 Cycle Burst

MODE . . . . . N Cycle
AMPUTUDE . . . . . SVp-p
OFFSET 2.5Vdc
N 2
TRIGGER INTERVAL 16ms
FUNCTION . . . . . Squarewave
FUNCTION INVERT . . . . . ON

PR AP5VO OF2.5VO NM2EN TI16MS FU2 FI1

MAIN OUTPUT
TRIGGER OUTPUT

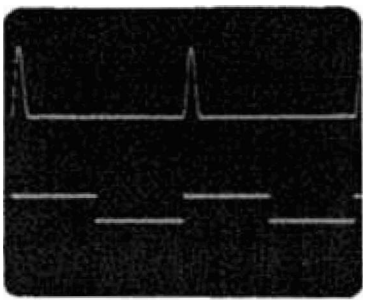


34. Haversine

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

PR M03 AP10VO PH-90DG NM1EN FU1

MAIN OUTPUT
TRIGGER OUTPUT

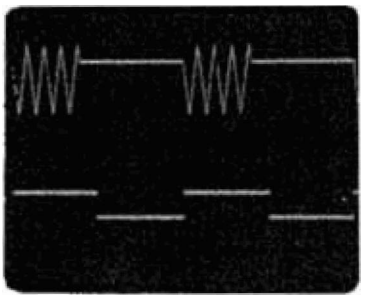


35. 4 Cycle Burst With Start/Stop Phase - -45°

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

PR M03 AP10VO PH-4SDG NM4EN FU3 FI1

MAIN OUTPUT
TRIGGER OUTPUT

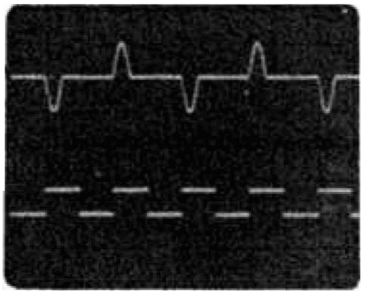


1/2 **CYCLE**

36. Basic 1/2 Cycle

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

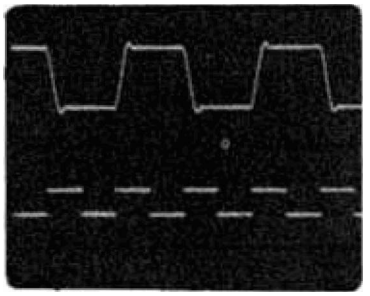
PR M04 FR200HZ AP10VO



37. Pulses With Overshoot

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

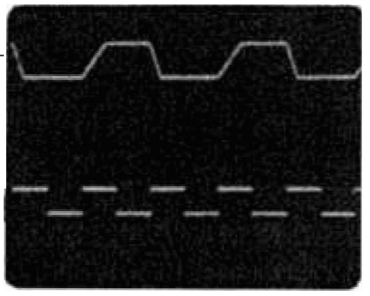
PR M04 FR200HZ AP10VO



38. Pulses With Varying Rise/Fall Ratios

PRESET
MODE . . . . . 1/2 Cycle
FREQUENCY 200Hz
AMPLITUDE **5Vp-p**
OFFSET . . . . . + 2.6Vdc
SYMMETRY **70%**
PHASE . . . . . 90°
TRIGGER INTERVAL 10ms
FUNCTION . . . . . Trlengle

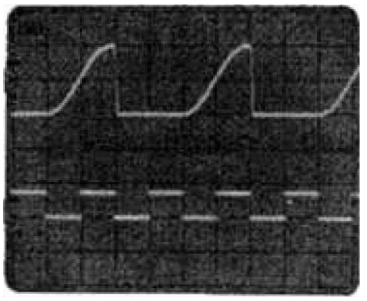
PR M04 FR200HZ AP5VO OF2.5VO SY70PC PH90DG FU3



39. 1/2 Cycle With 95% Symmetry

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

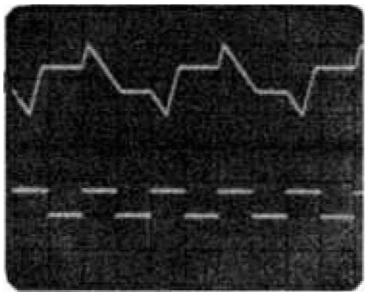
PR M04 FR100HZ AP10VO SY96PC PH90DG SL2



40. 1/2 Cycle Trianglewaves

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

PR M04 FR100HZ AP10VO SY26PC PH31DG FU3

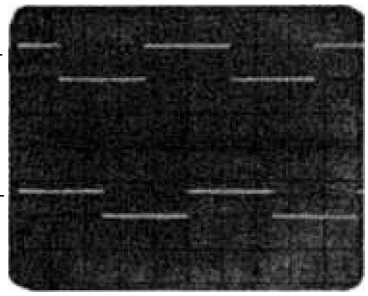


Fin X N

41. Squarewaves in Quadrature

PRESET
MODE . . . . . An X N
AMPLITUDE 5Vp-p
OFFSET 2.6Vdc
PHASE . . . . . 90°
N 1
TRIGGER INTERVAL 1ms
FUNCTION . . . . . SquarewBve

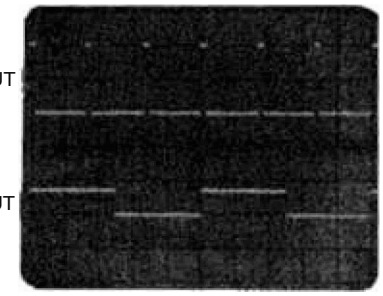
PR M06 AP6VO OF2.6VO PH90DG NM1EN n1MS FU2



42. 3 Pulses

PRESET
MODE . . . . . An X N
AMPUTUDE 10Vp-p
SYMMETRY 10%
N 3
FUNCTION . . . . . SQlJareWaVB

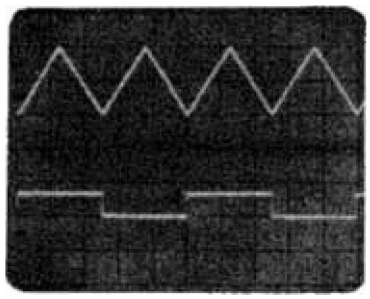
PR M05 AP10VO SY10PC NM3EN FU2



43. Trianglewaves

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

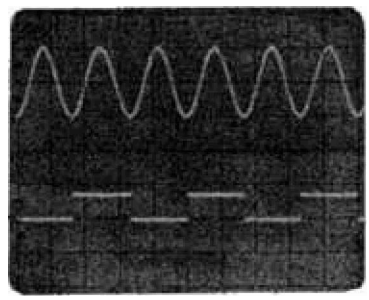
PR M06 API0VO NM2EN SR2 SL2 LV1 FU3
External Trigger Is a 100kHz. TTL squarewave



44. Sinewaves

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

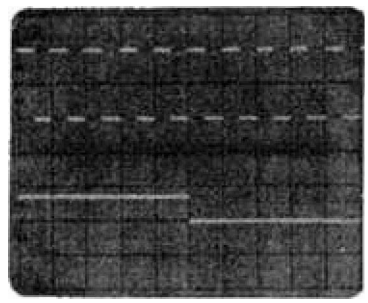
PR M05 AP10VO NM2EN TI16.66MS



45. Squarewaves

PRESET
MODE . . . . . An X N
AMPliTUDE 10Vp-p
N 10
FUNCTION . . . . . Squarewave

PR M06 AP10VO NM10EN FU2



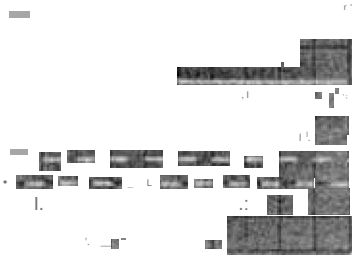
Fin N

46. Squarewaves

PRESET
MODE Fin N
AMPLITUDE 10Vp-p
N 10
FUNCTION Squarewave
TRIGGER INTERVAL 1.Oms

PR MOe AP10VO NM10EN FU2

MAIN OUTPUT



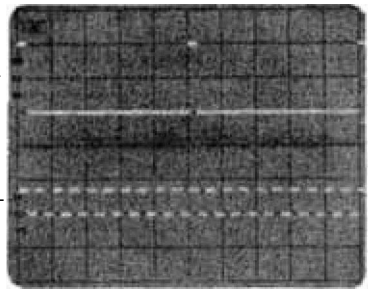
TRIGGER OUTPUT

47. Pulses

PRESET
MODE . . . . . Fin + N
AMPLITUDE 10Vp-p
SYMMETRY 5%
N 10
FUNCTION . . . . . Squarewave
TRIGGER INTERVAL 1.Oms

PR MOe AP10VO SY5PC NM10EN FU2

MAIN OUTPUT



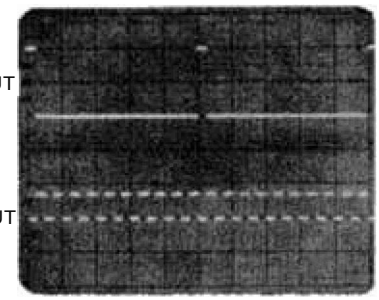
TRIGGER OUTPUT

48. Pulses

PRESET
MODE . . . . . An ... N
AMPliTUDE 10Vp-p
SYMMETRY 5%
PHASE . . . . . 18°
N 10
FUNCTION Squarewave
TRIGGER INTERVAL 1.Oms

PR MOe AP1DVO SY5PC PH180G NM10EN FU2

MAIN OUTPUT



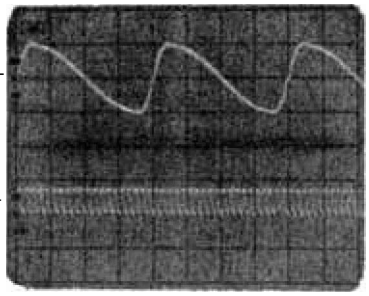
TRIGGER OUTPUT

49. Variable Symmetry

PRESET
MODE . . . . . Fin + N
AMPLITUDE 10Vp-p
SYMMETRY 20%
N 20
TRIGGER INTERVAL 002ms
FUNCTION . . . . . Sinewave

PR MOe AP10VO SY20PC NM20EN TI.002MS FUI

MAIN OUTPUT



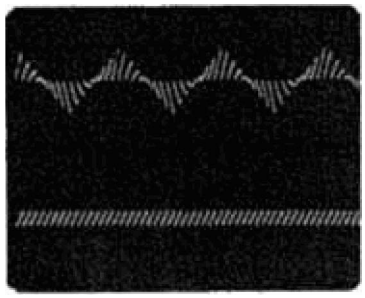
TRIGGER OUTPUT

50. Phase Locked Amplitude Modulation

PREseT
MODE . . . . . Fin ... N
AMPLITUDE 10Vp-p
N 15
TRIGGER SOURCE . . . . . EXT
TRIGGER LEVEL OV
TRIGGER SLOPE . . . . . (negative edge1
MODULATION AM
FUNCTION . . . . . Triangle
TRIGGER INTERVAL 1.Oms

PR MOe AP10VO NM16EN SR2 LV2 SL2 AMI FU3
Modulating signal and Trigger input Is a 10kHz, 2Vp-p Ramp.

MAIN OUTPUT



TRIGGER AND AM INPUT

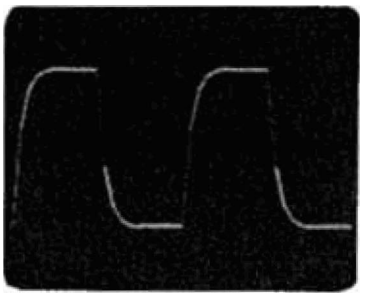
ARB

NOTE

Each ARB waveform contains a final vector. This is the Return to Start Vector where V HGT=1FOO and V LEN=1. See "ARB" in the DETAILED OPERATING INFORMATION section of this manual.

51. Exponential Charge/Discharge

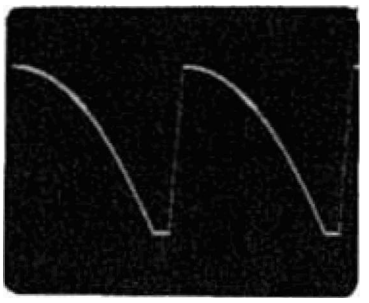
PRESET
MODE ARB
AMPlITUDE **10Vp-p**
PHASE •90°



Vector	V HGT=	V LEN=
1	1464	1
2	581	1
3	214	1
4	79	1
6	29	1
6	0	5
7	-1454	1
8	- 581	1
9	-214	1
10	- 79	1
11	-29	1
12	1	5

52. Square Law Response

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

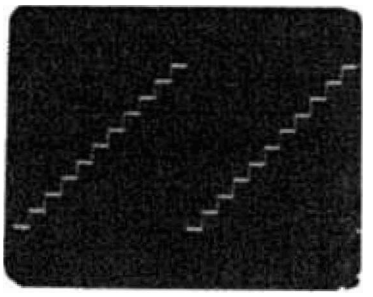


Vector	V HGT-	VLEN=
1	25	
2	76	
3	125	
4	175	
5	225	
6	275	
7	325	
8	375	
9	425	
10	475	
11	0	
12	1	

ARB (cant)

53. Linear Steps

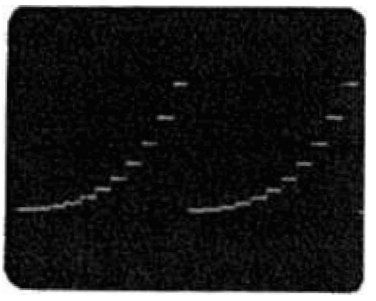
PRESET
MODE . . . . . ARB
AMPLITUDE 10Vp-p
PHASE . . . . . -900



Vector	Y HGT=	Y LEI-
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
IB	250	1
19	0	9
20	250	1
21	0	9
22	1	1

54. Exponential Steps

PRESET
MODE ARB
AMPUTUDE 10Vp-p
PHASE . . . . . •90°

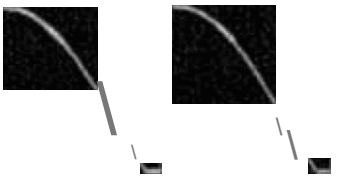


Vector	Y asr-	Y LEI-
1	0	9
2	15	1
3	0	9
3	34	1
5	0	9
6	57	1
7	0	9
B	87	1
9	0	9
10	124	1
11	0	9
12	170	1
13	0	9
14	229	1
15	0	9
16	303	1
17	0	9
18	397	1
19	0	9
20	514	1
21	0	9
22	1	1

ARB (cant)

55. Exponential Response

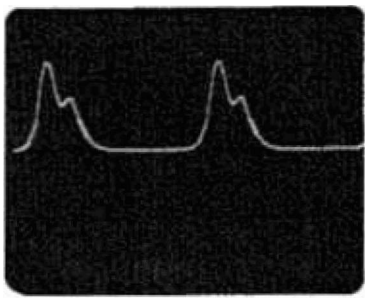
PRESET
MODE - ARB
AMPLITUDE 10Vp-p
PHASE . . . . . -90°
FUNCTION INVERT . . . . . ON



Vector	V HOT-	Y LEN=
1	19	
2	91	
3	169	
4	220	
5	274	
6	318	
7	350	
8	367	
9	364	
10	337	
11	0	
12	1	

56. Carotid Artery Pressure Wave

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

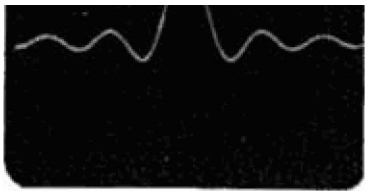


Vector	Y HBT-	Y LEN=
1	10	2
2	40	2
3	140	2
4	370	2
5	190	1
6	0	1
7	-190	1
8	- 300	1
9	- 140	1
10	0	1
11	90	1
12	0	1
13	- 160	2
14	-120	2
16	- 60	2
16	- 30	2
17	-10	2
18	0	1
19	0	1
20	1	19

ARB (cant)

57. sin(x}/x

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

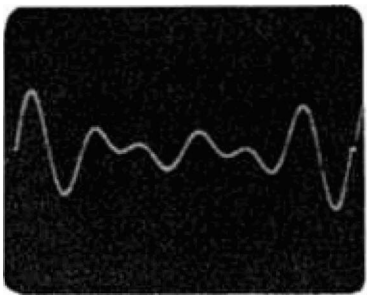


Vector	V HGT=	V LEN=	Vector	V HaT"	V LEI-	Vector	V HGT=	V LEI-
1	3		34	-70		87	70	
2	11		35	-80		68	72	
3	19		36	-41		69	66	
4	24		37	-15		70	53	
5	27		38	17		71	36	
6	27		39	53		72	17	
7	23		40	90		73	-3	
8	17		41	124		74	-20	
9	8		42	154		75	- 34	
10	-2		43	175		76	-43	
11	- 13		44	187		77	-47	
12	-22		45	186		78	-45	
13	-30		46	174		79	- 38	
14	- 34		47	160		80	-27	
15	- 34		48	116		81	- 16	
16	- 31	1	49	72		82	- 1	1
17	- 23	1	50	25		83	12	1
18	-12	1	51	- 25		84	23	1
19	1	1	52	-72		86	31	1
20	16	1	63	- 116		86	34	1
21	27		54	-150		87	34	
22	38		66	-174		88	30	
23	45		56	- 186		89	22	
24	47		57	- 187		90	13	
25	43		58	- 175		91	2	
26	34		59	-154	1	92	- 8	
27	20		60	- 124	1	93	-11	
28	3		61	-90	1	94	-23	
29	-17		62	- 53	1	95	-27	
30	- 36		63	- 17	1	96	- 27	
31	- 63		64	15		91	-24	
32	-66		66	41		98	-19	
33	-72		66	60		99	-11	
						100	1	

ARB (cant)

58. 3 Note Chord (Major Triad)

PRESET
MODE ARB
AMPLITUDE 10Vp·p

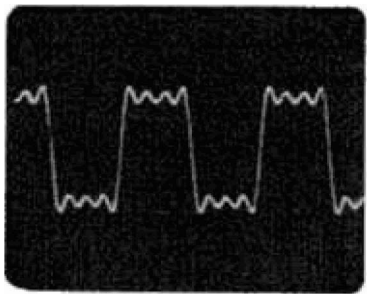


Vector	Y H&T-	V LEI-	Vector	Y HGY-	Y LEI-	Vector	V H&T-	V LEI-
1	278	1	34	29		67	29	
2	248	1	36	32		68	17	
3	193	1	36	26		69	-2	
4	119	1	37	11		70	-24	
5	33	1	38	-9		71	- 47	
6	- 55		39	-31		72	- 64	1
7	-1 34		40	- 50		73	-72	1
8	-1 97		41	-64		74	- 68	1
9	- 236		42	- 69		75	- 51	1
10	- 249		43	- 64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

ARB (cant)

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

PRESET
MODE ARB
AMPLITUDE 10Vp-p

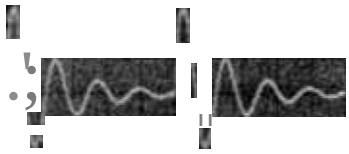


Vector	V M8T-	V lEI-	Vector	V MGT=	VlEl-	Vector	V MGT=	V LEI"
1	8		34	55		67	- 56	
2	21		35	55		68	-40	
3	30		36	43		69	-9	
4	31		37	23		70	35	
5	25		38	0		71	87	
6	12		39	-20		72	141	
7	-4		40	-33		73	190	
8	-21		41	- 38		74	228	
9	- 33		42	- 33		75	248	
10	- 38		43	-21		76	248	
11	-33		44	- 4	1	77	228	
12	- 20		45	12	1	78	190	
13	0		46	25	1	79	141	
14	23		47	31	1	80	87	
15	43		48	30	1	81	36	
16	55	1	49	21	1	82	-9	
17	55	1	60	8	1	83	-40	
18	40	1	51	-8	1	84	-55	
19	9	1	52	- 21	1	85	-55	
20	-35	1	53	-30	1	86	-43	
21	-87	1	64	- 31		87	-23	
22	-141	1	56	-25		88	0	
23	-190	1	56	-12		89	20	
24	- 228	1	57	4		90	33	
26	-248	1	58	21		91	38	
26	-248		59	33		92	33	1
27	-228		60	38		93	21	1
28	-190		61	33		94	4	1
29	-141		62	20		95	-12	1
30	-87		63	0		96	-25	1
31	-35		64	-23		97	-31	
32	9		65	-43		98	- 30	
33	40		66	- 55		99	-21	
						100	-8	

ARB (cont)

60. Damped Oscillations

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



Vector	V HGT=	V LEI-	Vector	V HGT=	V LEI-	Vector	V HGT=	V LEN=
1	383		35	- 91		67	- 13	
2	332		36	- 100		68	- 5	
3	263		37	- 102		69	3	
4	184		38	- 98		70	10	
5	98		39	- 88		71	16	
6	13		40	- 73		72	20	
7	-66		41	- 55		73	23	
8	- 136		42	- 34		74	25	
9	- 193		43	- 14		75	24	
10	- 233		44	7		76	23	
11	- 266		45	25		77	20	
12	-262		46	40		78	16	
13	-250		47	52		79	11	
14	- 225		48	60		80	6	
15	- 187		49	63	1	81	1	
16	- 140		50	63	1	82	-4	
17	- 88		61	58	1	83	- 8	
18	- 35		52	50	1	84	-11	
19	17		53	40	1	86	- 14	
20	64		54	28	1	86	-16	
21	104		55	15	1	87	- 16	
22	134		56	2	1	88	-15	
23	164		57	- 10	1	89	- 13	
24	163		58	- 21	1	90	- 11	
25	161		59	-29		91	- 8	
26	149		60	- 35		92	-5	
27	129		61	- 39		93	-2	
28	103		62	- 40		94	1	
29	72		63	- 38		95	4	
30	38		64	- 34		96	6	
31	5	1	66	- 28		97	8	
32	-26	1	66	- 21		98	9	
33	- 53	1				99	10	
34	- 76	1				100	10	
						101	0	

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. ARB waveforms are user defined waves made up of a series of voltage ramps called vectors. Each of the 3314A's six ARB registers contain at least two vectors. Since a maximum of 160 vectors are available, a single ARB waveform can contain up to 150 vectors. To build a waveform, determine the number of vectors, their lengths and heights, and most of the normal wave parameters allowed in the function generator definition.

This section includes the following topics:

- Building an ARB Waveform
- Recalling an ARB Waveform
- Clearing an ARB Waveform
- ARB Waveforms and the HP-IB
- Definitions

Building an ARB Waveform

Building an ARB waveform will help you understand the way vector parameters such as height, length, and slope relate to each other and to waveform time and frequency.

With a 3314A and a dual trace oscilloscope, use the following procedure to build and display Waveform 51 (Exponential Charge/Discharge) in the WAVEFORM section of this manual.

1. To insure enough vectors are available, clear the ARB waveform registers. Two methods exist to clear registers. One clears all ARB and non-ARB registers in the non-volatile memory. The other clears only ARB registers. Clearing all registers is quickest. Hold the PRESET key of the 3314A down while turning on the power. The 3314A performs its normal turn on sequence and displays E09 verifying all registers have been cleared. To clear only the ARB registers, refer to "Clearing an ARB Waveform" in this section.

2. Set up the oscilloscope as follows:
   - Channel A vertical coupling 50Ω
     vertical sensitivity 2V/DIV
   - Channel B vertical coupling 50Ω
     vertical sensitivity 2V/DIV
   - Time Base 0.8ms/DIV
   - Trigger on Channel B

ARB (cant)

3. Connect your oscilloscope as shown in Figure 3. If your oscilloscope Z Axis input requires the opposite polarity than that provided by the 3314A, remember that this signal is helpful but not required.

   To view the trigger signal in this exercise, connect the 3314A SYNC to Channel B.

4. Position the Channel A trace one division above the center graticule.

5. Position the Channel B trace towards the bottom of the display.

6. Refer to Waveform 51 for the 3314A settings. Press the ARB key on the 3314A. You are now in ARB register O. The ARB mode redefines the SWEEP group key functions as indicated by the green labels beneath each key. The Modify knob changes the values in the 3314A display. The "001" indicates Vector 1 is the current vector. The 3314A SYNC frequency is now 2.5kHz.

   Press AMPTD and set the ARB maximum amplitude to 10Vp-p.

   Press PHASE and set the ARB phase to -90°.

7. You are ready to build Waveform 51. Two vectors currently exist in the waveform, Vector 1 (V HGT = 0, V LEN = 1) and Vector 2 (Return to Start Vector). You will modify Vector 1, then *insert* and modify vectors after it to build the waveform.

   To understand the effects of each keystroke and modification, observe the scope display as you press the keys and turn the knob.

   Press V HGT and set the height of Vector 1 to 1454. Press INS to insert a new Vector 2. V HGT is still the active function.

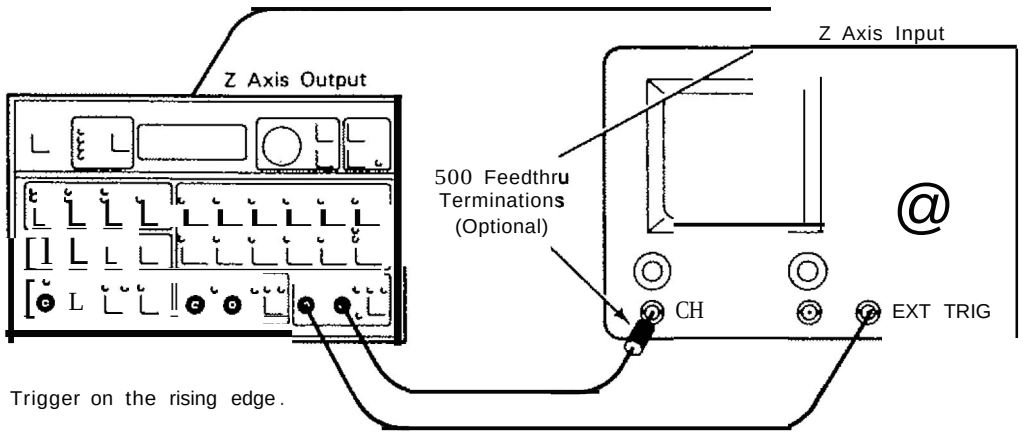
   Set Vector 2 V HGT to 581. Each vector's V LEN retains the default setting of 1. Press INS to insert Vector 3 and set its V HGT to 214.

   Insert and set the V HGT of Vectors 4, 5, and 6 as listed in the waveform table. After inserting Vector 6 and verifying its V HGT=O, press V LEN and set it to 5. Half of the waveform is complete.

   Insert and modify the V HGT and V LEN (if necessary) of the remaining vectors in the table.

   The waveform is complete after setting Vector 12 V HGT and V LEN.

ARB (cont)



The potarfty 3314A's Z Axis output is set at the factory to be compatible with oscilloscopes that intensify their display when a negative voltage Is applied to thslr Z Axis input. The Service Manual has Instructions for SERVICE TRAINED personnel who are eware of the potential hazards inside the 3314A to change the polarity of the 3314A's Z Axis output. Under no circumstances should any operator romoVII any screws, covers, shields or other 3314A components.

Figure 3. How To Connect An Oscilloscope

WARNING

The Z Axis polarity selection switch is located inside the 3314A where dangerous voltages, capable of causing death, are present. Refer switch position selection to service-trained personnel who are aware of the dangers involved and familiar with safe installation practices.

8. One last vector exists in the waveform. Press V MKR to display the number of Vector 12. Turn the Modify knob to display Vector 13. This is the Return to Start Vector which corresponds to the SYNC signal's negative pulse. This vector returns to the Start/Finish point and remains there until the ARB wave begins the next period. The V LEN is modifiable, but not the V HGT.

   To change the waveform characteristics, adjust FREQ, AMPTD, and OFFSET. Adjusting PHASE will distort the waveform. Modifying other ENTRY parameters is not allowed.

   It is easiest to build a waveform at maximum amplitude and frequency for ease of viewing, then change it as needed. To select individual vectors, press V MKR then dial to the desired vector. Modify V HGT and V LEN as necessary.

Recalling an ARB Waveform

The ARB key and the "AR1" HP-IB command enable the ARB definition of the 3314A. "ARx" (x = 0 through 5) will be displayed for ½ second after enabling ARB to indicate the active ARB wave. Pressing RCL, ARB, and then one of register 0 through 5 ("RWO" through "RW5" HP-IB commands) recalls one of six ARB waves.

Though you may store standard waveforms to specific registers after defining the parameters, ARB waveforms are simultaneously built and stored in the register of your choice in non-volatile memory. Even if power is lost, the wave parameters remain intact. Simply recall the ARB wave function to restore the output signal.

ARB (cant)

Clearing an ARB Waveform

Pressing the PRESET key of the 3314A while turning on power clears all non-volatile memory. This includes ARB and non-ARB waveform registers. To clear a particular ARB waveform register, first recall the desired waveform. Then press the BLUE shift and ARB keys (equivalent to the "AR2" HP-IB command). Other ARB waves are not affected.

To clear a waveform, the 3314A deletes vectors one at a time at a rate of about 100 vectors per second, beginning with the next to last vector. The cleared waveform is reduced to two vectors. Then it is initialized to the following default parameters:

Amplitude	100mVp-p	Number of Vectors	2
Δ 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	1FOO·
Modulation	OFF	Vector Length	1
Offset	OVDC	Trigger	Ext, / , 1V
Phase	0°	Vector Marker	1

• The last vector is the Return to Start Vector, which closes the waveform. Its vector height, displayed as "1 FOO", is not programmable.

ARB Waveforms and the HP-IB

If you have numerous or complicated ARB waveforms, you may wish to use a computer proqrarnto build the waveform rather than using the 3314A front panel. At the end of the REMOTE OPERATION section in this manual, there are examples of ARB programs. They are written for an -hp- 9000 Series 200/300 computer using the BASIC 4.0 programming language.

ARB (cant)

Definitions

This section contains definitions, descriptions, and other pertinent information needed to operate the ARB portion of the 3314A. Topics are listed in alphabetical order.

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. The Return to Start Vector cannot be deleted. When a vector is deleted:

- the vector pointed to by the Vector Marker and intensified by the Z Axis output is deleted.
- the subsequent vectors are renumbered.
- the Vector Marker is decremented by one and points to the vector that preceded the deleted vector. If Vector 1 is deleted, the Vector Marker remains pointed at the new Vector 1.

Δ t. Sets the time for each unit of Vector Length.

$0.2\text{ms} \leq \Delta t \leq 19.99\text{ms}$

The length in time of a vector:

Δ t * Vector Length

E10. Error 10-vector insert not allowed-appears when you try to use more than 160 vectors. Remember that there are only 160 vectors available and are distributed among six ARB waves. If five ARB waves contain the minimum of two vectors each, you can have up to 150 vectors in the remaining ARB wave.

Frequency. ARB frequency-the repetition rate of the ARB wave-is derived from Δ t. When ARB frequency is changed, a new Δ t is computed. The limited resolution of Δ t may prevent you from programming an exact desired frequency. Δ t programs much faster than ARB frequency.

ARB (cent)

The maximum frequency for an ARB waveform is 2.5kHz (2 vectors of O.2ms each). As you increase the number of vectors in a waveform, the frequency of the waveform decreases.

$$FREQ = \frac{1}{\Delta t * (V\ LEN_1 + V\ LEN_2 + \ldots + V\ LEN_n)}$$

where $O.2ms \leq \Delta t \leq 19.99ms$

In an extreme case, if you build a waveform with 150 vectors and set each vector to the maximum vector length of 127 with Δt set to 19.99ms, the minimum frequency for the waveform is 2.6mHz (381 seconds).

19.99ms * (127 * 150) = 381 seconds (6.3 minutes).

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

- the vector is inserted immediately after the current vector (the current vector is pointed to by the Vector Marker and intensified by the Z Axis output).

- the inserted vector has V HGT = 0, V LEN = 1.

- the vectors following the inserted vector are renumbered.

- the Vector Marker is incremented by 1 and points to the inserted vector.

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

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 threshold conditions. The output gates off after the trigger level changer waveform is completed.

ARB (contl

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 AMPTD. The Start/Finish point is the beginning point of the first vector.

- -90^0 sets the Start/Finish at the negative amplitude limit.

- 0^0 sets the Start/Finish midway between the limits.

- $+90^0$ sets the Start/Finish at the positive amplitude limit.

Return to Start **Vector.** The last vector of every ARB wave must close the waveform. Its Vector Height, displayed as *"1* FOO", is not programmable but Its length is. This vector slews directly to the Start/Finish point and remains there until the ARB wave repeats.

To reduce the effect of the nonprogrammable Vector Height, set the Start/Finish point of the ARB wave so the Return to Start Vector slope is zero ($\Delta V \div \Delta T = 0$). Adjust PHASE to obtain this characteristic.

Slope. $\Delta V \div \Delta T$ (the slope of a vector) is affected by V HGT but not by V LEN.

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

SYNC Output. The SYNC output is a TTL signal. The low portion occurs during the Return to Start Vector.

Vector Haight. V HGT sets the end point of every vector except the Return to Start Vector. Each count in the display sets the end point Yvolts from the vector's starting voltage.

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

Distortion may occur if the net vector height of a waveform is set to be greater than half of the amplitude setting. This is because the amplitude of the waveform must be within the limits set by the AMPTD function key.

ARB (cant)

The resolution (minimum end voltage step) is:

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

The voltage change can range from 0% (V HGT = 0) to 80% (V HGT = 1999) of the peak to peak amplitude setting in .04% steps, when V LEN = 1.

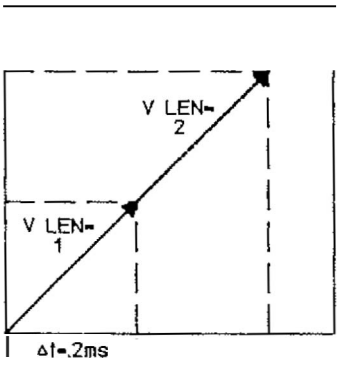
It is best to keep V LEN as small as possible. This reduces the number of discrete steps the 3314A must make to record the waveform and improves resolution. Also, if total V LEN for a waveform is very great, the waveform may drift appreciably.

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

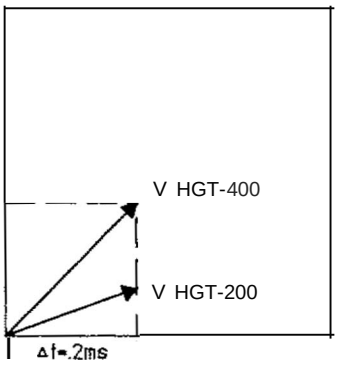
Vector Marker. The Vector Marker points to a single vector (called the current vector). The marker indicates the vector available for V HGT and V LEN modification and intensified by the Z Axis output.

Pressing V HGT or V LEN twice increments the Vector Marker. This feature is useful for quick reviews or edits of an ARB wave.

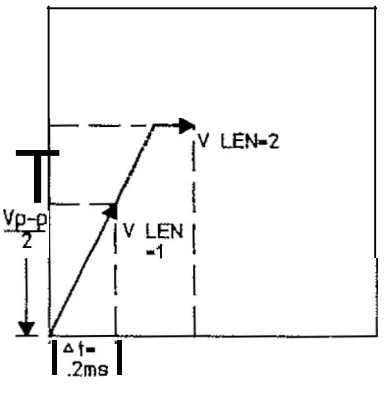
Effects of changing V IEN
where: V HGT - 400
V MKR - 1



Effects of changing V HGT
where: V LEN - 1
V MKR - ,



Effects when combined
V HGT and V LEN > $\frac{Vp-p}{2}$
where: V HGT - 1000
VMKR-1



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.

IOTE

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 331 4A to completely calibrate itself whether calibration measurements have been disabled or not:

-Power ON (also enables calibration measurements)
-PRESET or "PR" (also enables calibration measurementsl
-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 (cant)

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

-FUNCTION key or "FU"', "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 TIL level squarewave at the calibration frequency).

8	30 mil	< 15mVp-p at the programmed frequency
7	30 mil	< 15mVp-p at the programmed frequency
6	30 ms	< 15mVp-p at 100kHz
6	30 ms	< 15mVp-p lit 10kHz
4	30 ms	< 15mVp-p at 1kHz
3	100 ms	< 15mVp-p at 199.9Hz
2	500 ms	< 15mVp-p lit •
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
-Fixad 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 (cant)

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-1B, disables all amplitude and frequency calibration maasurements. 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"DEO". 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 (t or 1) 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 (cant)

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 "APRHO" via the HP-IB removes the Range Hold function.

Range Number	Maximum	Minimum	Resolution	Minimum With Range Hold
1	10.00mV	.OOmV	.01mV	.000v
2	I00.OmV	10.OmV	.1mV	.omv
3	1.000V	.1OQV	1mV	Omv
4	10.00V	1.OQV	10mV	OOmV

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	.OOl Hz	.001 Hz	.001Hz
2	19.99Hz	1.50Hz	.01Hz	.01Hz
3	199.9Hz	15.0Hz	.1Hz	.1Hz
4	1.999kHz	160Hz	1Hz	1Hz
6	19.99kHz	1.60kHz	10Hz	10Hz
6	199.9kHz	16.0kHz	100Hz	100Hz
7	1.999MHz	150kHz	1kHz	1kHz
8	19.99MHz	1.60MHz	10kHz	10kHz

DATA ENTRY (cant)

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 "OFRHO" via the HP-IB removes the Range Hold function.

Range Number	Maximum	Minimum	Resolution	Minimum With Range Hold
1	± 1.997Y	.OOOY	.002V	.000V
2	± 6.00V	2.00Y	.OlV	.OOV

Symmetry

Variable symmetry is not allowed in frequencv range 8 and conversely, frequencies ≥ 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 bltts) of the Status Byte are unmasked, that bit is set (= 1) and the SRO message is sent.

Errors While in Remote

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

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 (cant)

Table 3. Error Codes With Status Byte Bit#

Error #	Definition	Status Byte bit #
00	No Error (used via Hp-IB, Ofily)	
	-- OPERATOR ERRORS (non-ARB) - -	
01	Frequency/Symmetry conflict	0
02	Bus address entry error	0
03	Front panel failure/Invalid keycode	0
04	Calibration meesurernent not performed	1
05	Allowed in sweep, 0fI1y	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 IARBI -	
10	Vector Insert not allowed	0
11	Vector delete not allowed	0
18	Allowed in ARB, only	0
19	Not ellowed in ARB	0
	--- PLL ERRORS -	
20	Unstable input frequency	1
21	Input frsquencv 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
36	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 InvIIIId	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
61	Output voltage exceeds safe operating limits; or, excessive external voltage (greater than ± 15V peek] applied to main output. 3314A has disconnected itself.	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.

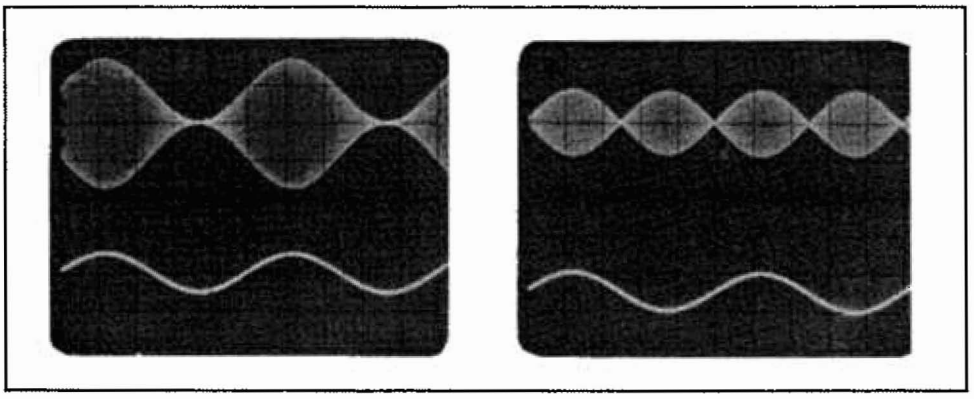


Figure 4. 100% and >100% Amplitude Modllation

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

Input Impedance	10kO
Input Sensitivity	2Vp-p = 100% (+1V = 2 times carrier ampl) (-1V = 0 times carrier amp!)
Modulation	. O 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 (cant)

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

$$\text{VenveJope(Vp-p}\} = \left(\frac{\text{Vmodulation}}{2} + \frac{1}{2} \right) \times \text{VcarrierlVp-p}\}$$

where Vcarrier = the 3314A's displayed amplitude and
-10V ≤ Vmodulation ≤ +10V

Observations:

-The carrier amplitude is 1/2 the displayed value when VmoduJation = OV.
-The envelope = 0Vp-p when Vmodulation = -IV.
-The carrier is 180^0 out of phase when Venvelope is negative IVmodulation is more negative than -1V}.
-The Reduce Input light will come on when modulation is ≥ 100%.

AM Input Overload. The Reduce Input light will come on whenever the AM modulation is ≥ 100%. AM modulation ≥ 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 ϕ 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 corn-ponent of the modulating signal controls the amplitude of the carrier from inverted carrier (-2V offset) to suppressed carrier (-1V offset) to normal carrier (+OV off-set). The Reduce Input light and "E50" are inhibited while in either of the ϕ Lock modes when the phase locked loop is unlocked.

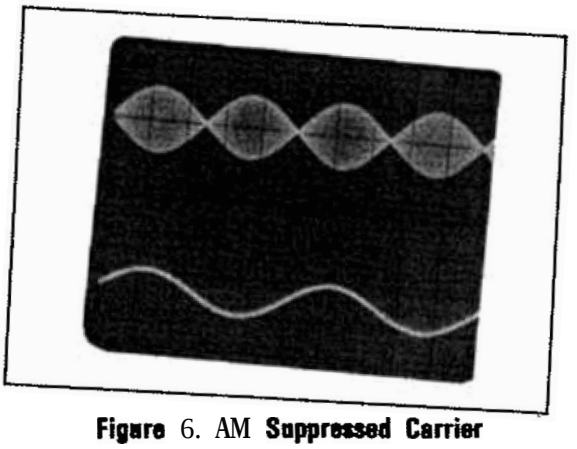


Figure 6. AM Suppressed Carrier

Frequency Modulation

The 3314A's output signal can be Frequency Modulated to deviations of ±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	10kO
Input Sensitivity	2Vp-p = ±1% of freq range (+1Vpeak = +1%) (-1Vpeak = -1%)
Modulation	0 to ±1% deviation
3dB Bandwidth	100Hz to 100kHz (AC coupled)

EXTERNAL MODULATION (cant)

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 ± 10V. The Reduce Input light and "E50" are inhibited while in either of the ϕ 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 ≥ 100 counts in the frequency display.

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

Input Impedance	10kΩ
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 ϕ 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	001 Hz to 19.99MHz
	.001 Hz to 1MHz, Opt 001
Amplitude Range	01 mVp-p to t Ovp-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 = Ovp-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
SWITR 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 satifies 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 satifies the trigger slope and threshold conditions will initiate a 1/2 cycle burst.

MODE (cant)

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 ± 10%.

2. The reference frequency change must be within the bandwidth of the 3314A's phase locked loop.

MODE (cant)

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

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

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 331 4A 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 (cant)

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

1. The 331 4A'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:

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

where A = 1 if the EXT REF FREQ is < 2MHz
A = 5 if the EXT REF FREQ is ≥ 2MHZ

Note that the 331 4A 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'1 **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 8 signal that is proportional to the reference frequency. You will probably have to turn auto-acquisition off with FREQ Range Hold and set the 331 4A'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 ϕ 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 331 4A 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 SRO 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:

.xxOVdc
.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 $\pm 199.9^0$ to $\pm 90^0$. If the Phase prior to changing modes was $> \pm 90^0$, the 331 4A will set the phase = 0^0 and "Alert" the operator.

OPERATOR ALERTS (cant)

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/(multiples of Δ 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 500. This output must be terminated with a 50Ω load before the displayed amplitude is correct and before the specifications apply. Operation into >50Ω is allowed with a proportional increase in amplitude and offset. Operation into <50Ω is allowed with a proportional decrease in amplitude and offset. When operating into other than 500, expect the performance to decrease, especially at higher frequencies because of transmission line mis-matches.

Output Overload "£51". The 3314A disconnects itself from the output connector and displays E51 for two reasons:

- The output voltage exceeds safe operating limits of ± 15V peak. The output voltage is limited to ± 15V peak before clipping occurs.

- An external voltage greater than ± 15V peak is applied to the 3314A output.

The 3314A reconnects itself when the error condition is corrected.

SYNC Output

This fully protected output has a characteristic output impedance of - 500 when terminated into ≤500. When terminated into >500, it will deliver TTL compatible levels (OV to >2.5V). The maximum unloaded voltage is limited to - 3V. The SYNC output will disconnect itself from externally applied voltages outside the range of -.5V to +5.5V.

OUTPUTS (cont)

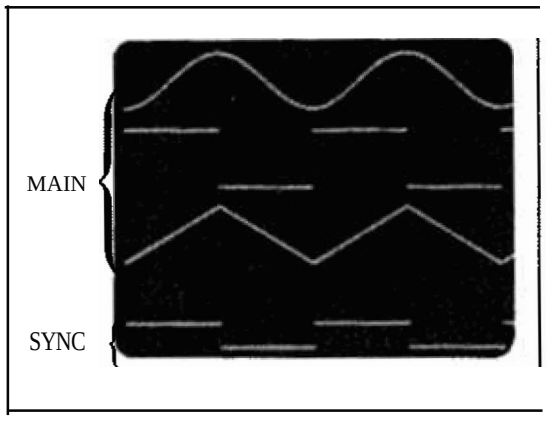


Figure 6. SYIC **Output Relationships**

Trigger Output

The Trigger port is an output when the selected trigger source is internal. This port provides a squarewave (OV and - 3V) from a 1kΩ source impedance whose edges are related to the internal trigger interval generator. The Trigger port is protected from externally applied voltages up to ± 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)

The X3 output amplitude and DC offset equal three times the displayed values if the Main output is terminated into 50Ω and the X3 output into more than 5000. This output cannot source more than 30mA peak or ± 15V peak. This means the waveform will clip if you add any DC offset to a 30Vp-p signal.

OUTPUTS (cont)

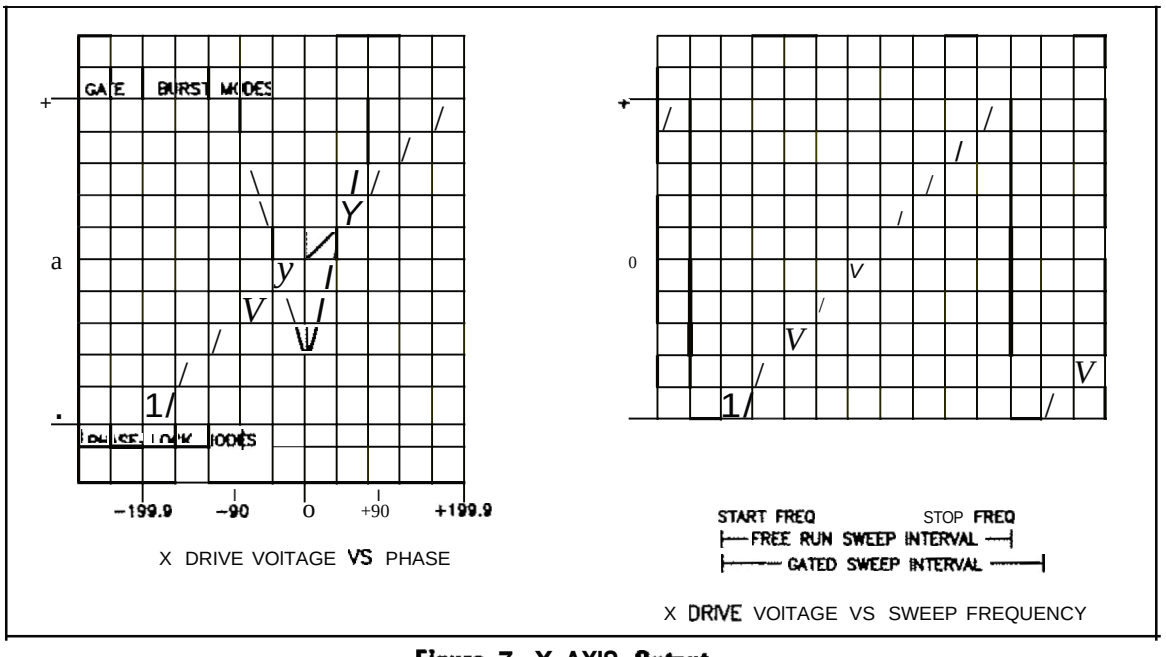


Figure 7. X AXIS Output

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.

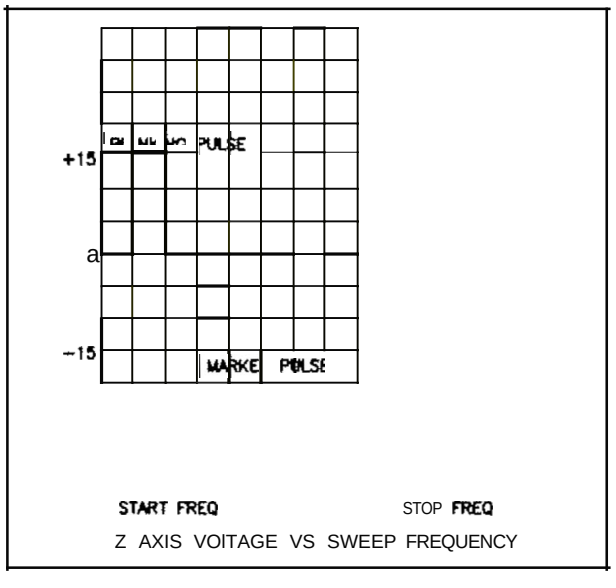


Figure 8. Z AXIS Output

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 tum on)	SRQ Mask (Status Byte)	not affected
Amplitude Modulation	Oft	Stort Frequency	1kHz
ARB Mode	Off	Status Byte (HP·IBJ	not affected
ARB Wllveforms	not affected	Stop Frequency	10kHz
Calibration	Executes a CAL ALL	Storage Registers	not affectlld
Dllta Transfer Mode	not affected	Sweep	Off
Δ t (ARB)	not affected		
Display Errors (HP·IBI	not affected	Sweep Mask (Status Byte)	not affected
Frequency	1kHz	Sweep Interval (Linear)	10ms
Frequency Modulation	Off	Sweep Interval (Log)	40ma
		Symmetry	50%
Function Invert	Off		
Manuel Sweep	Off	Trigger Interval	10ms
Marker Frequency	6kHz	Trigger Slope	/ (positive)
Mode	Free Run	Trigger Source	Internal
N	1	Trigger Threshold	IV (TTLI
		VCO	Off
Offset	ovec		
Phase	o Degrees	Vector Height (ARB)	not affected
PU Mask (Status Bytel	not effected	Vector Length (ARBI	not affected
Range Hold	Off	Vector Marker (ARB)	not affected

The BLUE shifted ARB kay or the - AR2- HP-IB command, intitializes the current ARB waveform. The following ARB parameters are affected:

Function	Initialized Condition	Function	Initialized Condition
Amplitude	100mVp-p	Vector *11*	
Δ t	O.2me	Vector Height	000
Frequency	2.6kHz	Vector Length	001
Function	Triangle		
Function Invert	Off	Vector *12*	
		Vector Height	lFOO •
Mode	Free Run	Vector Length	001
Modulation	Off		
Offset	OVDC	Trigger Slope	/ (positive)
Phase	O Degrees	Trigger Source	External
Number of Vectors	2	Trigger Threshold	IV
		Vector Marker	001

*The Vectoe Height of the last vector is - 1FOO· to indicate that It le not programmable.

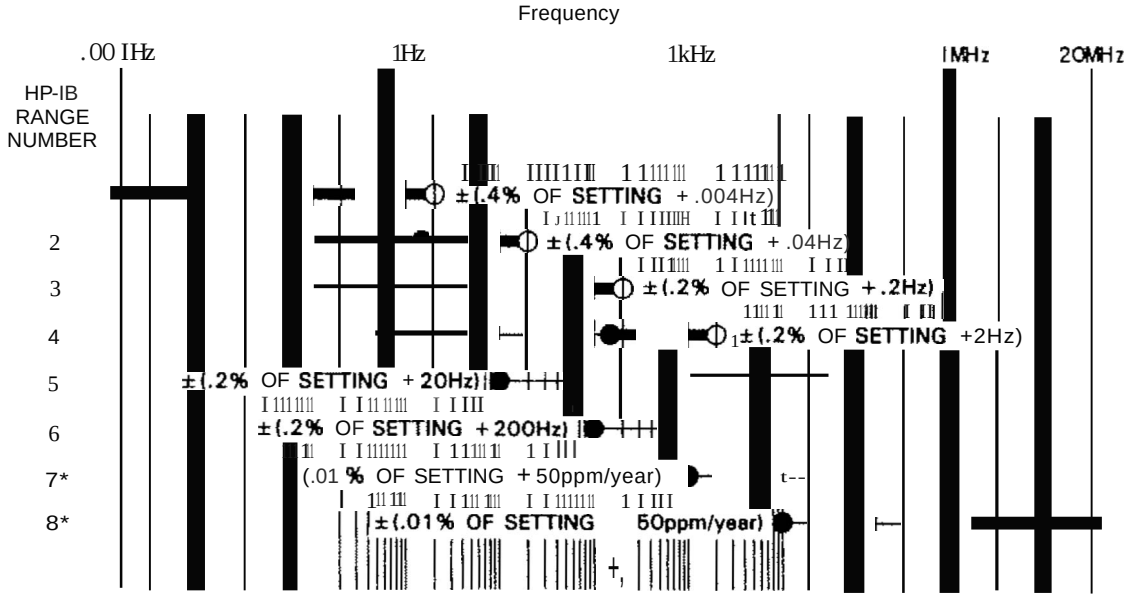
How to COMPLETELY Preset the 3314A

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.

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

* FREQUENCY IS SYNTHESIZED IN RANGES 7 AND 81N 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 (cant)

Amplitude

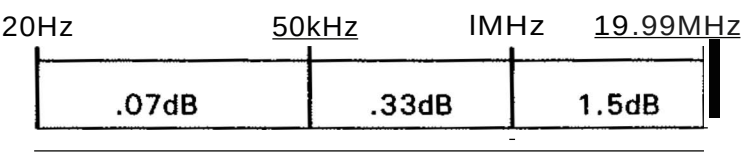
Absolute Amplitude Accuracy:

± (1% of display + .035Vp-p), sinewave and squarewave
± (1% of display + .06Vp-p), triangle

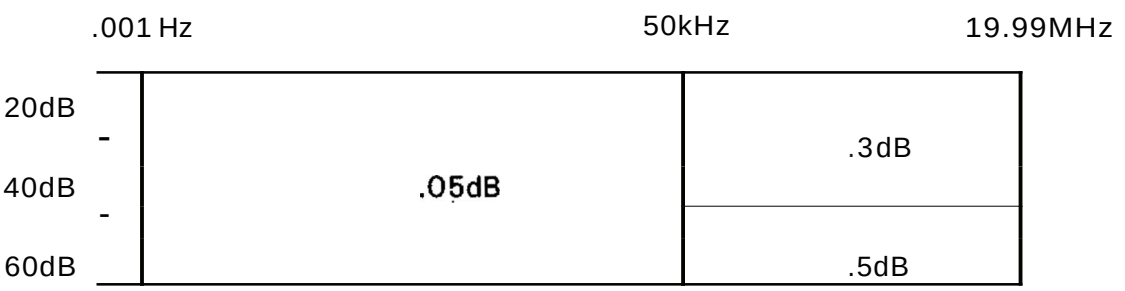
Amplitudes: 1.00Vp-p to 10.00Vp-p (Range 4)
Frequency: 10kHz
Auto-Range: ON

Flatness-sine wave:

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



Step Attenuator Accuracy:



SPECIFICATIONS (cont)

DC Offset

Offset Accuracy:

±(3% of display +10 mVDC +0.5% of AC Amplitude Range)

Frequency: < 100kHz
Auto-Range: ON

Residual DC Offset:

< ±.5% of AC Amplitude Range

Setting: OVDC
Frequency: ≤ 100kHz

If option 001 :

< ± .5% of AC Amplitude Range ± 500μV

Symmetry

Symmetry Accuracy (Fixed):

50% ±0.2%

Fixed Symmetry: 50% (SYM light OFF)
Frequency: 1Hz to 100kHz
Function: square wave

Symmetry Accuracy (Variable)

± 0.5% of period:

Frequency: 1Hz to 100kHz
Function: square wave

SPECIFICATIONS (cont)

Phase

Phase Offset-Phase lock Modes:

Accuracy: ± 2° (50Hz to 25kHz)

Phase Offset is referenced to the signal output for Fin ÷ N or the trigger input for Fin X N.

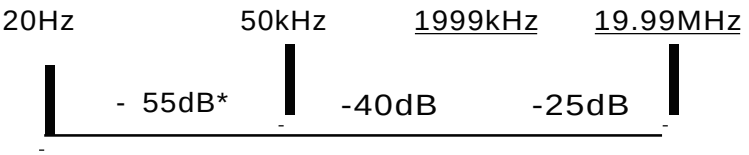
Start/Stop Phase--Burst Modes:

Accuracy: ± 3° (applies from .001 Hz to 1kHz)

Function Characteristics

Sine Harmonic Distortion:

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



Square Wave Rise/Fall Time:

≤ 9ns, 10% to 90% of a 10 Vp-p output

Square Wave Aberrations:

5% of (High Settled Amplitude - Low Settled Amplitude)
Where Settled Amplitude" is the voltage on the pulse top or bottom measured lOOns after the appropriate zero crossing.

Frequency: ≤ 1MHz
Amplitude: 10Vp-p

10% of p-p Aberrations relative to programmed amplitude.
Frequency: > 1MHz
Amplitude: 10Vp-p

SPECIFICATIONS (cont)

Triangle Linearity:

±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.

Internal Trigger Interval

Period Accuracy: ±(0.01% + 50 ppm/year) of displayed interval (excluding sweep intervals)

Frequency Sweep

Sweep Frequency Accuracy--Manual Sweep:

±(0.2% of Stop Freq +0.1% of Stop Freq Range), Stop Freq Range s200kHz
±1% of Stop Freq, Stop Freq in 2MHz Range
±3% of Stop Freq, Stop Freq in 20MHz Range

Modulation

Amplitude Modulation Envelope Distortion:

-s -40dB

Carrier: = 1MHz, 10Vp-p, sine wave
Modulating Input: 1kHz, sine wave
Index of Modulation: 95%

VCO Linearity:

±0.15% of p-p frequency, .1Hz through 200kHz Range
±1% of p-p frequency, 2MHz Range
±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 X3 Output

Specifications apply when the X3 Output is terminated with > 500Ω and < 500pf and when the Main output is terminated with 500.

The X3 Output is usable into all loads until the output current limits at about 30mA peak or the output voltage clips at about 15V peak.

X3 Gain Accuracy:

± 1% at 10kHz

X3 Output amplitude ≅ (3 ± 1%) x Main Output Amplitude

Sine Power Flatness:

Relative to full output power at 10kHz

20Hz	50kHz	500kHz	1MHz
±.1dB	±.5dB	± 1.5dB	

Harmonic Distortion (Rear Panel):

All harmonically related signals will be below these levels, relative to the fundamental.

20Hz	50kHz	1MHz
-53dB	- 38dB	

Square Wave Rise/Fall Time (Rear Panel):

< 200ns, 10% to 90% at full output.

Residual DC Offset (Rear Panel):

≤ 40mVDC

SPECIFICATIONS (cant)

General

Specifications apply when:

Main signal output is terminated into 50 ±0.1 ohms
Warm-up is ≥30 minutes
Within ± 50 C, and 24 hours of last internal calibration
Temperature 0° to 55°C
Relative Humidity ≤95% at 40 ^{0}C
Altitude ≤ 15,000 ft.

Storage Limits:

Temperature -40^{0} to +75°C
Altitude ≤ 50,000 ft.

Power:

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

Weight:

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

SPECIFICATIONS (cant)

Option 001

Amplitude Range:

AC only to 30Vp-p or 60mAp-p before clipping.
DC only to ± 15VDC or ± 30mADC before clipping
AC + DC to ± 15V peak or ± 30mA peak before clipping

Frequency Range:

DC to 1MHz

Output Resistance:

< 2Ω at 10kHz

Relationship of the X3 Amplitude to the 3314A's displayed amplitude:

$$\text{X3 AMPTD} = 3 \left[2 \times \text{Display} \frac{\text{Main Output Load}}{\text{Main Output Load} + 50} \right]$$

STORE & RECALL

The 3314A has 12 Waveforms storage registers, six for non-ARB waveforms and six for ARB waveforms. For non-ARB waveforms, register 0 automatically retains the current front panel settings at power off; registers 1 through 5 are reserved for the operator. The ARB registers 0 through 5 store waveforms as they are built in them. The contents of all 12 registers, stored in non-volatile memory are retained whenever power is turned off.

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-IBI 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

Programming ARB Waveforms

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 when programmed to schedule measurement tasks, set up instruments, monitor the measurements, and analyze the results.

All examples in this section use the -hp- 9000 Series 200/300 computer and the BASIC 4.0 programming language.

THE HP-IB (cant)

HP-IB Specifications Summary

lamber **of Interconnected Devices:**

Up to 15 maximum on one contiguous bus.

Interconnection Pltb/MIXllRlim **Cable Length:**

Star or linear bus network; total tranmission 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.)

Centrol **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

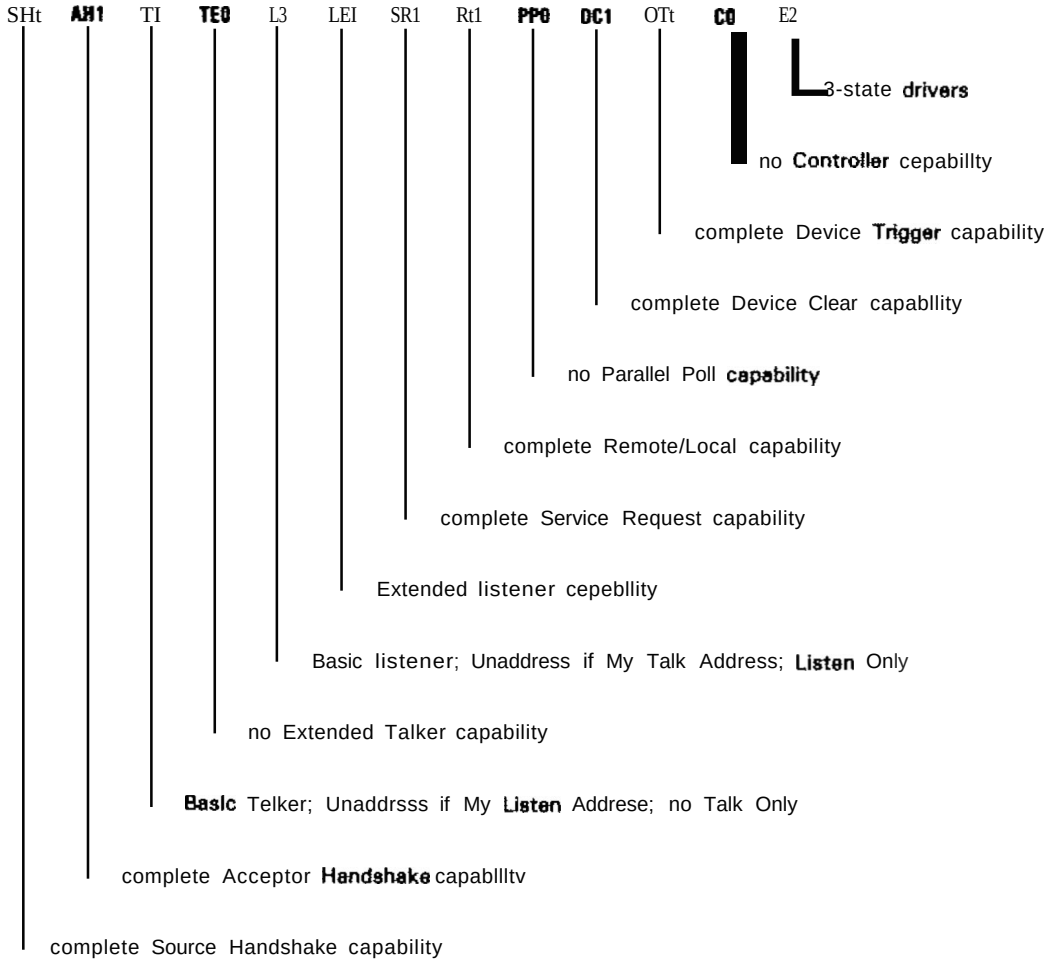
There are 12 specific messages that can be sent via the HP-IB. You may not use all 12, nor does the 3314A respond to all 12, however, knowledge about each is required if you wish to optimize your HP-IB system.

Message	Example
CLEAR Causes the 3314A to reconfigure SII If the PRESET key had been pressed. (see THE CLEAR MESSAGE)	CLEAR 7 CLEAR 707 OUTPUT 707;"PR"
CLEAR LOCKOUT/SET LOCAL Enables the 3314A'II LOCAL key lind switches all devices from remote to local	LOCAL 7
DITA 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;"QEA"
LOCAL Switches control of the 3314A from remote to local.	LOCAL 707
LOCAL LOCKOUT Disables the 3314A'. LOCAL key to secure the system from casual operator interference.	LOCAL LOCKOUT 7
PARALLEL POLL Controller request that 8t1 devices previously programmed to respond, send their Status Bit. The 3314A does not respond.	
PASS CONTROL ShiftII system control from one controller to another. The 3314A does not respond.	
REMOTE Switches control of the 3314A from local to remote when It is addressed.	REMOTE 7 REMOTE 707
REQUEST SERVICE When unmasked, one or a combination of 3314A operating conditions can set bus line SAO true, requesting service from the controller. (see THE 5TATU5 BYTE)	
SERIAL POLL Controller request that the 3314A send its Statu. Byte. Encoded into the B bits are the states of several 3314A operating parameters. (see THE STATUS BYTE)	5TATUS 707;5
TAKE CONTROL/ABORT I/O Unconditional assumption of control by the system controller; halts all bus actlvlty. The 3314A becomes unaddressed.	ABORTIO 7
TRIGGER The 3314A responds to a Hp·IB Trigger as It would to any other external triggaer to gate the output signal on or off, start N or 1/2 Cycle bursts and start single sweeps. (see THE TRIGGER MESSAGEl	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 your specific controller's operating manual and find the section describing the HP-IB REMOTE Message. After sending REMOTE to the 3314A, the HP-IB RMT status light should illuminate. If this does not occur, recheck the cabling, the 3314A address, and the syntax of the controller statement. This BASIC language example should place the 3314A into REMOTE operation:

```
REMOTE 707
```

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 7 will unaddress all devices. The Device address (set from the 331 4A 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 overriden 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	T"	Listen	
0	@	SP	
1	A	[	
2	B	▪	
3	C	'	
4	0	$	
5	E	%	
6	F	&	
7	G	▪	{3314A factory setting)
8	H	t	
9	I	}	
10	J	▪	
11	K	+	
12	L	,	
13	M	.	
14	N		
15	0	/	
18	P	0	
17	Q	1	
18	R	2	
19	S	3	
20	T	4	
21	U	6	{usually the controllerl
22	V	8	
23	W	7	
24	X	8	
25	y	9	
26	Z	:	
27	(	;	
28	\	<	
29	I	▪	
30	^	>	
Listen Only			

THE CLEAR MESSAGE

The 3314A responds to the device clear message (DCI), the selected device clear message (SOC) and the command "PR^{n} by configuring itself to its initialized state.

The following examples clear or preset the indicated devices.

CLEAR 7	Clears all devices on bus 7
CLEAR 707	Clears 3314A only
OUTPUT 707;"PR"	Presets 3314A only

The following table indicates the 3314A functions affected by the CLEAR message. Notice that "Status Byte (HP-IB)" is cleared by this message, but it is unaffected by a preset.

Function	Preset Condition	Function	Preset Condition
Amplitude	100mVp-p (1OmVp-p et tum onl	Range Hold	Off
Amplitude Modulation	Off	SRO Mask (Status Byte)	not affected
ARB Mode	Off	Stert Frequency	1kHz
ARB Waveforms	not affected	Status Byte (HP-IB)	cleared
Calibretlon	Executes a CAL ALL	Stop Frequency	10kHz
Data Transfer Mode	not affected	Storage Registers	not affected
Δ 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%
Menuel Sweep	Off	Trigger Intervel	1Oms
Merker Frequency	6kHz	Trigger Slope	/ (positive)
Mode	Free Run	Trigger Source	lntarnal
N	1	Trigger Threshold	1V rrru
Offset	OVDC	VCO	Off
Phase	O Degrees	Vector Height (ARB)	not effected
PU Mllsk [Status Bytel	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 "M02" would be sent. M02 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

The first example commands the 3314A to perform a calibration. The second example commands the 3314A to perform a calibration, disable the calibrate function, then range up.

```
OUTPUT 707;"CA"
OUTPUT 707;"CACDRU"
```

The Immediate Execute commands are:

Calibrate All	CA
Calibrate **Disable**	CD
Calibrate Enable	CE
Calibrate Frequency	CF
Delete Vector IARB)	DV
Insert Vector IARB)	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

The first example commands the 3314A to enable Amplitude Modulation. The second example commands the 3314A to enable Amplitude Modulation, then disable Frequency Modulation.

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

THE DATA MESSAGE
(Function Select Commands) (cant)

Th function select commands are:

Function and Selection	Command and Qualifier
"Amplitude Modulation	AM
OFF	0
ON	1
"ARB	AR
OFF	0
ON	1
ON and Initialize	2
Data Transfer Mode	OM
Unbuffered (serial)	1
96 Byte Buffer	2
Display Errors	DE
OFF	0
ON	1
Frequency Modulation	FM
OFF	0
ON	1
Funtlon Invert	FI
No Inverston	0
Inverted	1
Function Select	FU
AC OFF (DC ONLVI	0
Sine	1
Square	2
Triangle	3
Manual Sweep	MA
OFF	0
ON	1
Mode Select	MO
Free Run	1
Gata	2
N Cycle	3
1/2 Cycle	4
An X N	6
Fin / N	6
PLL Mask (bit '6)	PM
Masked (always = 0)	0
= 1 on acquiring lock	1
= 1 on losing lock	2
= 1 on either	3
Range Hold	RH
OFF	0
Range 1	1
Range 2	2
Range 3	3
Range 4	4
Range 6	6
Range 6	6
Range 7	7
Range B	8

Function and Selection	Command and Qualifier
Recall Front Panel	RC
Register 0	0
Register 1	1
Register 2	2
Register 3	3
Register 4	4
Register 5	6
Recall ARB Wave	RW
Sets ARB ON and recalls	
Wave 0	0
Wave 1	1
Wave 2	2
Wave 3	3
Wave 4	4
Wave 6	6
SRO MASK (see the textl	
Store Front Penel	SO
Ragister 1	1
Register 2	2
Register 3	3
Register 4	4
Register 5	5
Sweep	SW
OFF	0
Unear (100:1 maxI	1
Log (7 decades max)	2
Sweep Mask (bit #5)	SM
Masked (alweys = 0)	0
= 1 at sweap start	1
= 1 at sweep stop	2
= 1 at either	3
Trigger Threshold Level	LV
+ 1 Volts	1
0 Volts	2
Trigger Slope	SL
Positive	1
Negetive	2
Trigger Source	SR
Internal	1
External	2
VCO	VC
OFF	0
ON	1

THE DATA MESSAGE
(Function Select Commands) (contl

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) (cant)

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

MI	3	Z	●	Status lit Number
@	MASK	MASK	MASK	MASK
A	MASK	MASK	MASK	UNMASK
B	MASK	MASK	UNMASK	MASK
C	MASK	MASK	UNMASK	UNMASK
0	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
I	UNMASK	UNMASK	MASK	MASK
M	UNMASK	UNMASK	MASK	UNMASK
N	UNMASK	UNMASK	UNMASK	MASK
0	UNMASK	UNMASK	UNMASK	UNMASK

MH	7	●	5	4	Status Bit Number
@	MASK		MASK	MASK	
A	MASK		MASK	UNMASK	
B	MASK		UNMASK	MASK	
C	MASK		UNMASK	UNMASK	
0	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	
I	UNMASK		MASK	MASK	
M	UNMASK		MASK	UNMASK	
N	UNMASK		UNMASK	MASK	
0	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.

The first example commands the 3314A to set its amplitude to 1.23Vp-p. The second example commands the 3314A to set its amplitude to 1.23Vp-p and its frequency to 10.7MHz.

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

It is unnecessary to send a prefix repeatedly if you are programming the same function. The following statements, if sent sequentially, change the frequency to the indicated values.

```
OUTPUT 707;"FR1MZ"
OUTPUT 707;"2MZ"
OUTPUT 707;"3MZ"
```

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

THE DATA MESSAGE
(Query Commands)

The syntax for query functions is:

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

In this example, the first statement commands the 3314A to return the value of the amplitude setting. The second statement provides a variable in which to place the value.

```
OUTPUT 707;"OAP"
ENTER 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	OOF
Amplttude Modulation	OAM	Phase	OPH
ARB Mode	OAR	Start Frequency	OST
ARB Wave Number	ORW	Stop Frequency	asp
At	OOT	Sweep	OSW
Error Code	OER	Symmetry	OSV
Frequency	QFR	Trigger Interval	an
Frequency Modulation	QFM	Trigger level	OIV
function Invert	OFI	Trlgger Slope	OSI
Function Select	OFU	Trigger Source	OSR
Manuel Sweep	QMA	VCO	QVC
Marker Frequency	OMK	Vector Height	OVH
Mode	QMO	Vector Length	OVI
N	ONM	Vector Marker	OVM

THE STATUS BYTE

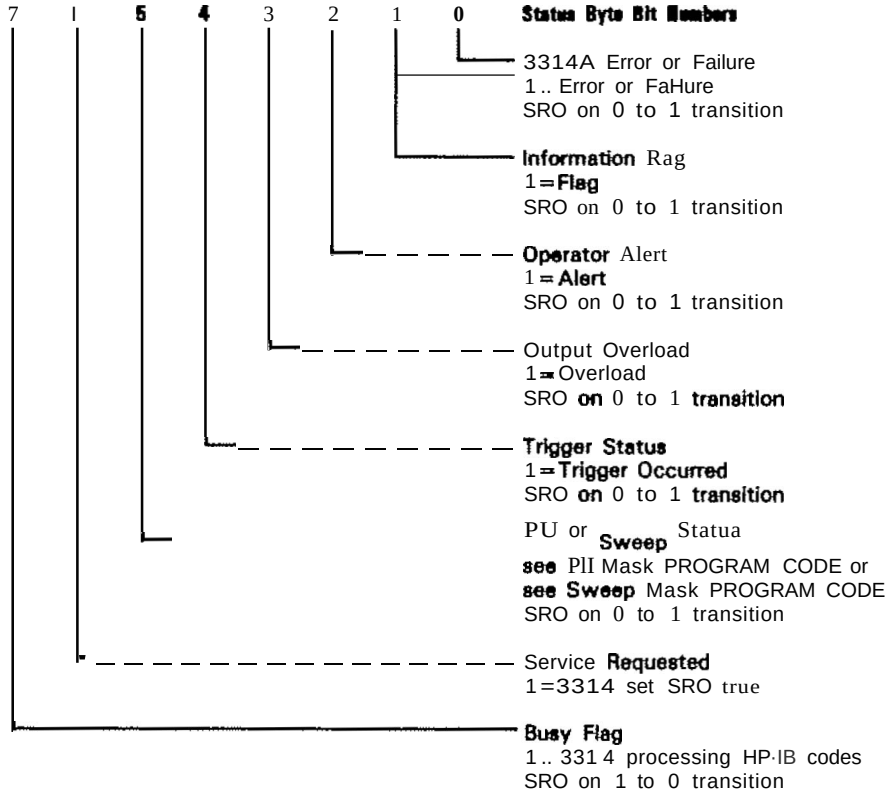
The Status Byte is an 8 bit word that the 3314A will output when involved in a Serial Poll. The state of each bit (1 or 0) indicates the status of an internal 3314A function. A bit will be set after that bit has been unmasked and the bit condition is satisfied. After the Status Byte is sent (all bits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

Exceptions that automatically reset a bit-and send another SRO message-immediately after the 3314A sends its Status Byte are:

OVERLOAD
TRIGGER when in Gate Mode
BUSY FLAG (no SRO sent)

The following statement reads the 3314A's Status Byte.

```
STATUS 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.

The following examples trigger the indicated devices.

TRIGGER 7	Triggers all devices on bus 7 (GET)
TRIGGER 707	Triggers 3314A only (GET)
OUTPUT 707,"MN"	Activates 3314A manual trigger

Mode	
Free Run no sweep	-no action
sweep	-Starts the sweep. The sweep stops and resets to the start frequency, llUtomatlcslly. -Ignored lf the 3314A ls sweeping.
Gete no sweep	-Gates Output ON if trigger slope is positive or ARB and then sets trigger alope to negative. -Gates Output OFF if trigger slope is negative and then sets trigger slope to positive.
sweep	-Stsrts the sweep and gates the output ON lf the aweep is not actlve and the trigger slope is positive and then sets the trigger slope to negatlve. The sweep stope, and the output ls gated OFF, automatlCtllly. -Bets the trigger stope to positive lf lt ls negative. Used as an arming signal to prepare for the next gate.
N Cycle	-Gates N Cycles of the output signal ON if the output ls OFF. -Ignored while the output ls ON.
1/2 Cycle	-Getes alternate 1/2 cycles of the output signal ON.
An X N	-Thls operation ls not useeble because of the asynchronous nature of the HP-IB.
An / N	-This operation ls not useable beceuse of the asynchronous nature of the HP-IB.

PROGRAMMING ARB WAVEFORMS

If you have numerous or complicated ARB waveforms, you may wish to use computer programs to store and build them rather than using the 3314A front panel. This section contains examples of code that accomplish different tasks useful for ARB operation. They are written for an -hp- 9000 Series 200/300 computer using the BASIC 4.0 programming language.

The limit of 160 vectors allowed in ARB makes this storage method useful. If you need to save several waveforms with more than 160 vectors among them, this method prevents you from manually recording and re-entering vector settings.

By modifying the following programs, you can:

- read vector values from the 3314A to arrays, then store them to a host computer's mass storage device.

- enter vector parameters directly to an array, then write them to a 3314A ARB register.

- design a custom waveform and store vector parameters to a mass storage device.

- automatically generate vector values for waveforms represented by equations.

Reading and Writing Vector Parameters

The following example contains two parts. The first part reads vector values from ARB register 0 into an array. The second part writes the array contents to ARB register 1, building the waveform. To use this program as an exercise, build Waveform 51 in the WAVEFORM LIBRARY section of this manual. If you need help building an ARB waveform, see "ARB" in the DETAILED OPERATING INFORMATION section.

```
! Read vector values from 3314A ARB register 0
!
ALLOCATE Vector(12,2)              Array collects vector data
!
OUTPUT 707;"RW0"                   ! Recall ARB register 0
!
FOR Marker=1 TO 12                   12 vectors used in example
  OUTPUT 707;"VM",Marker,"EN"        Select vector marker number
  OUTPUT 707,"QVH"                   Query the vector height
  ENTER 707;Height                   Read vector height into variable
  OUTPUT 707,"QVL"                   Query the vector length
  ENTER 707;Length                   Read vector length into variable
  Vector(Marker,1)=Height            Write Height into array
  Vector(Marker,2)=Length            Write length into array
NEXT Marker                          Query/Read next vector values
!
! Write vector values to 3314A ARB register 1 (builds waveform)
!
OUTPUT 707;"PRO                    Preset 3314A
OUTPUT 707;"RW2 ARZ"               Recall and Clear registers 2, 3,
OUTPUT 707,"RW3 ARZ"                  4, and 5 so enough vectors are
OUTPUT 707,"RW4 AR2"                  available for new waveform
OUTPUT 707,"RW5 ARZ"
OUTPUT 707,"RW1 AR2"               Recall and Clear register 1
OUTPUT 707,"API0VO PH-90DG"        Set 3314A: 10Vp-p & -90 deg phase
!
FOR Marker=1 TO 12                                  12 vectors in waveform
  OUTPUT 707;"VH",Veetor(Marker,1),"EN"             Set vector height
  OUTPUT 707;"VL",Veetor(Marker,2),"EN"             Set vector length
  IF Marker<12 THEN OUTPUT 707,"IV"                 Insert 12 vectors
NEXT Marker                                         Repeat loop
!
END
```

Automatic Waveform Construction

The next example demonstrates how to calculate the vector parameters of a waveform represented by an equation. The source of this example is Waveform 60 in the WAVEFORM LIBRARY- Damped Oscillations. If using the table, you must manually enter 100 vector heights to build this waveform. However, by representing the waveform with the equation

$$e^{-at}(\sin bt)$$

you can automatically calculate and enter the values, building a similar waveform.

```
! Initialize computer and 3314A
!
RAD                          Express angles as radians
OUTPUT 707;"PR"              PRESET 3314
OUTPUT 707;"RW1 AR2"
OUTPUT 707;"RW2 AR2"         Recall and Clear registers 1, 2, 3,
OUTPUT 707;"RW3 AR2"            4, and 5 so enough vectors are
OUTPUT 707;"RW4 AR2"            available for new waveform
OUTPUT 707;"RW5 AR2"
OUTPUT 707;"RW0 AR2"         Recall and Clear register 0
OUTPUT 707;"AP10VO"          Set 3314A to 10Vp-p
!
! Initialize variables
!
E=2.718                      Euler's constant
Cycles=5                     Sine argument coefficient (number of cycles)
Abs_ht=0                     Absolute height of current vector head
Prev_ht=0                    Absolute height of previous vector head
Rel_ht=0                     VHGT of current vector (Abs_ht - Prev_ht)
Scale_factor=2000            Scales VHGTs to 3314A AMPTO setting
Delta=2*PI/100               Step increment for independent variable T)
!
! Calculate VHGTs write it to 3314A
!
FOR T=1 TO 100               Start loop -- 100 VHGT values in waveform
  !
  ! Calculate absolute height
  Abs_ht=Scale_factor*(E^(-T*Delta))*SIN(T*Delta*Cycles)
  !
  Rel_ht=Abs_ht-Prev_ht              Calculate new VHGT relative to old
  OUTPUT 707,"VH",Rel_ht,"ENTER"     Program new VHGT on 3314A
  Prev_ht=Abs_ht                     Prepare for next VHGT calculation
NEXT T                               Repeat loop
!
END
```

The following example demonstrates the adaptability of the previous program. Modified as shown, it calculates vector parameters for and builds Waveform 57 in the WAVEFORM LIBRARY defined by the equation

$$\frac{\sin(x)}{x}$$

```
! Initialize COMputer and 3314A
!
RAD                          Express angles as radians
OUTPUT 707;"PR "             Preset 3314A
OUTPUT 707; "RU1  ARZ"
OUTPUT 7071"RW2  ARZ"        Recall and Clear registers 1, 2, :3.
OUTPUT 707,"RW3  ARZ "          4, and 5 so enough vectors are
OUTPUT 707;"RW4  AR2"           available for new waveform
OUTPUT 707; "RWS  AR2"
OUTPUT 7071"RW0 ARZ"         Recall and Clear register 0
OUTPUT 7071"API0VQ"          Set 3314A to 10Vp-p
!
! Initialize variables
!
Cycles=5                     Sine argUMent coefficient (nUMber of cycles)
Abs_ht=0                     Absolute height of current vector head
Prev_ht-0                    Absolute height of previous vector head
Rel_ht-0                     V H6T of current vector (Abs_ht - Prev_ht)
Scale_factor=1300            Scales V H6Ts to 3314A AMPTD setting
Delta=2*PII100               Step increMent for independent variable X
!
! Calculate V H6T; write it to 3314A
!
FOR X--S0.1  TO 50           Start loop -- 100 V HGT values
  !
  1 Calculate absolute height
  Abs_ht=Scale_factor*((SIN(X*Delta*Cycles))/(X*Delta*Cycles)
  !
  Rel_ht=Abs_ht-Prev_ht              Calculate new V HGT relative to old
  OUTPUT 707; "VH" ,Rel_ht ,"EN IV"  Program new V H6T on 3314A
  Prev_ht=Abs_ht                     Prepare for next V H6T calculation
NEXT X                               Repeat loop
!
END
```

As you adapt these examples, be aware of variations:

- The number of vectors used is arbitrary. A larger number improves resolution. The number of vectors is used to determine "Delta" and count the number of loops. Adjust the loop counter range as needed to avoid division by zero as in the sine(xl/x example.

- Modify "Scale_factor" so waveform amplitude fits in the 3314A AMPTD setting.

- After generating a waveform, you may need to adjust V HGTs at the waveform endpoints and PHASE to improve closure. You can modify FREQ, AMPTD, and OFF-SET to change other characteristics.

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 eddress, 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. Usten Only Is set by incrementing the address past 30.

3314A Programming Codes

3314A Function	HP-IB Codes		Format of Returned Data
	Program	Query	
Amplitude	AP	QAP	AP 000000dd.ddVO or
mdk-Volt p-p	MV		AP 000000d.dddVO or
Volt p-p	vO		AP 00000o.ddddVO or
			AP 00000.OSSSeVO
Ampl Modulation	AM	QAM	AMd
Off	0		
ON	1		
ARB	AR	QAR	ARd
OFF	0		
ON	1		
ON/Clear Wave	2		
Calibrate All	CA		
Calibrate Disable	CO		
Calibrate Enable	CE		
Calibrate Freq	CF		
Data Transfer Mode	DM		
Unbuffered	1		
96 Byte Buffer	2		
Delete Vector	OV		
Δ	DT	QOT	DT 00000.0ddddSN ...
milli-Seconds	MS		OT 0000.00ddddSN
Seconds	SN		
Display Errors	DE		
Off	0		
ON	1		
Error Codes		QER	ERdd
Frequency	FR	QFR	FR 00ddddddddHZ or
Hertz	HZ		FA 000000ddd.dHZ or
kilo-Hertz	XZ		FR 000000dd.ddHZ or
Mega-Hertz	MZ		FI\ 000000d.dddHZ
Freq Modulation	FM	QFM	FMd
OFF	a		
ON	1		
Function Invert	A	OFt	Fld
OFF	0		
ON	t		
Function	FU	QFU	FUd
OFF	a		
Sine	1		
Square	2		
Triangle	3		
Insert Vector	IV		
Manual Sweep	MA	QMA	MAd
OFF	0		
ON	1		
Manual Trigger	MN		
Marker Frequency	MK	QMK	MK 00ddddddddHZ Dr
Hertz	HZ		MK 000000ddd.dHZ or
kilo-Hertz	KZ		MK 000000dd.ddHZ or
Mega-Hertz	MZ		MK 000000d.dddHZ
Mode	MO	QMO	MOd
Free Run	1		
Gele	2		
N Cycle	3		
1/2 Cycle	●		
Fin X N	5		
Fin ÷ N	e		
N	NM	QNM	NM 000000dddd.EN
Enter	EN		
Offset	OF	QOF	OFs00000000d.ddVO or
Volts DC	va		OFs000000d.dddVO
Phase	PH	QPH	PHs000000ddd.dDG PHASE
degr··	DG		
PLL Status Mask	PM		
(bit 6 of Status Byte)			
Masked	a		
·· 1 Lock	1		
· 1 Unlock	2		
= 1 either	3		

3314A Function	HP-IB Codes		Format of Returned Data
	Program	Query	
Preset	PR		
Range Down	RD		
Range Hold	RH		
OFF	0		
OC Offset	1 to 2		
Amplitude	3 to 4		
Frequency	7 to 8		
Range Up	RU		
Recall (non-ARB)	RC		
Regist..	0 to 5		
Recall Wave (ARB)	RW	QRW	RWd
ARB ON and recall			
Wave	0 to 5		
SRQ M..... bits 0-3	ML		
Mask	● to 0		
SRQ Mask, bits . -7	MH		
Mask	● to 0		
Start Frequency	ST	QST	Sf 00ddddddddHZ or
Hertz	HZ		ST 000000ddd.dHZ or
kilo-Hertz	KZ		ST 000000dd.ddHZ or
Mega-Hertz	MZ		ST 000000d.dddHZ
Stop Frequency	SP	QSP	SP 00ddddddddHZ or
Hertz	HZ		SP 000000ddd.dHZ or
kilo-Hertz	KZ		SP 000000dd.ddHZ or
Mega-Hertz	MZ		SP 000000d.dddHZ
Store (non-ARB)	SO		
Register	1 to 8		
Sweep	SW	QSW	SWd
OFF	0		
Linear	1		
Log	2		
Sweep Status Mask	SM		
(bit 5 of Status Byte)			
Masked	0		
= 1 at Start	1		
= 1 at Stop	2		
= 1 either	3		
Symmetry	SY	QSY	SY 00000000dd.PC
Percent	PC		
Sweep/Trig Interval	n	an	Tl 000000dddd.SN or
milli-Seconds	MS		n 000000ddd.dSN or
Seconds	SN		11 000000dd.ddSN or
			TI 000000d.dddSN or
			Tl 000000.ddddSN or
			Tl 00000.0ddddSN or
			n 0000.00ddddSN
Trigger Level	LV	OLV	LVd
1V Threshold	t		
ov Threshold	2		
Trigger Slope	SL	QSL	SLd
Positive	1		
Negative	2		
T_ Source	SR	QSR	SRd
Internal	1		
External	2		
VCO	vc	avc	VCd
OFF	0		
ON	t		
Vector Height	VH	QVH	VHs000000dddd.EN
Enter	EN		
Vector Length	VI	aVI	VL 000000dddd.EN
Enter	EN		
Vector Marker	VM	QVM	VM 000000dddd.EN
Enter	EN		

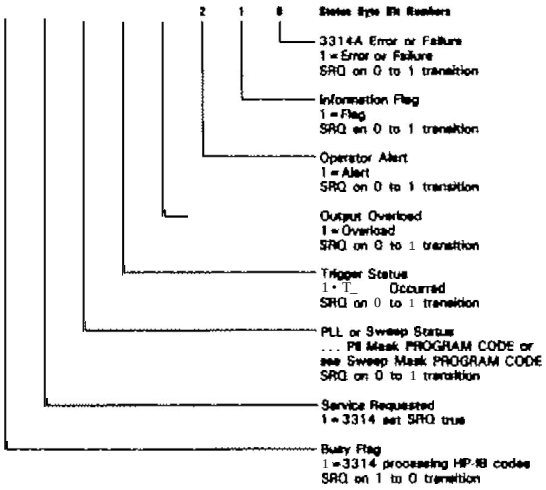
d = ASCII digits 0 to 9.
s = sign bit, ASCII space or -,
All other characters are exactly as shown.

All returned data is followed by an ASCII carriage return and line feed. EOI rernalns false.

HP-IB PROGRAMMING SUMMARY (cant)

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 (SAO line truel when a bit of the Status Byte is unmasked and the operating conditJon to set that bit exists. Masking is not affected by PRESET or CIEAR 7. All bits except bit 7 wilt set SRO at the 0 to 1 logic transition. Bit 7 will set SRO 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.

MR				
●	MASKED	MASKED	MASKED	MASKED
"	MASKED	MASKED	MASKED	UNMASKED
a	MASKED	MASKED	UNMASKED	MASKED
c	MASKED	MASKED	UNMASKED	UNMASKED
0	MASKED	UNMASKED	MASKED	MASKED
E	MASKED	UNMASKED	MASKED	UNMASKED
F	MASKED	UNMASKED	UNMASKED	MASKED
a	MASKED	UNMASKED	UNMASKED	UNMASKED
H	UNMASKED	MASKED	MASKED	MASKED
I	UNMASKED	MASKED	MASKED	UNMASKED
J	UNMASKED	MASKED	UNMASKED	MASKED
K	UNMASKED	MASKED	UNMASKED	UNMASKED
L	UNMASKED	UNMASKED	MASKED	MASKED
M	UNMASKED	UNMASKED	MASKED	UNMASKED
N	UNMASKED	UNMASKED	UNMASKED	MASKED
0	UNMASKED	UNMASKED	UNMASKED	UNMASKED

MH			
@	MASKED	MASKED	MASKED
A	MASKED	MASKED	UNMASKED
B	MASKED	UNMASKED	MASKED
C	MASKED	UNMASKED	UNMASKED
D	MASKED	MASKED	MASKED
E	MASKED	MASKED	UNMASKED
●	MASKED	UNMASKED	MASKED
G	MASKED	UNMASKED	UNMASKED
H	UNMASKED	MASKED	MASKED
I	UNMASKED	MASKED	UNMASKED
J	UNMASKED	UNMASKED	MASKED
K	UNMASKED	UNMASKED	UNMASKED
L	UNMASKED	MASKED	MASKED
"	UNMASKED	MASKED	UNMASKED
N	UNMASKED	UNMASKED	MASKED
0	UNMASKEO	UNMASKED	UNMASKED

Error Codes

Bit #	Definition	Byte
00	No errors since errors were last queried (HP-IB function, only)	
	- OPERATOR ERRORS (non-ARB) -	
01	Frequency/Symmetry conflict	0
02	Bus address entry error	0
03	Front panel key stuck	0
04	Calibration measurements 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
f1	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 capture range	1
22	3314A output frequency would be out of range	1
23	Internal interval >20ms	1
2'	Internal synthesis unlock"	0

Bit #	Definition	Byte
	-- FREQUENCY CALIBRATION ERRORS -	
30	No frequency detected	
31	Frequency error exceeds correction capability	
32	Frequency unstable during calibration	
	- AMPLITUDE CALIBRATION ERRORS -	
34	Signal amplitude outside measurement range	0
35	Signal amplitude gain too high	0
3.	Signal amplitude gain too low	0
37	Signal amplitude gain out of limit	0
38	Signal amplitude gain offset out of limit	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	C
";	Not allowed In Manual Sweep	0
	-- OVERLOAD --	
SO	AM or FM/VCO Input voltage exceeds normal operating — (HP-IB function only)	
51	Output voltage exceeds safe operating limits; or, excessive external voltage (greater than ± 15V peak) applied ec main output. 3314A has disconnected itself.	

INDEX

A

B

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INDEX (Continued)

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N

INDEX (Continued)