

APPENDIX B

SPECIFICATIONS

Unless otherwise stated, the following specifications apply to the Channel A and Channel B outputs in all modes, with the internal combiner and all modulation off, and outputs terminated in 50 ohms. For tabular data, specifications apply at and above the stated frequency or amplitude range.

Specifications describe the instrument's warranted performance after a warm-up period of 30 minutes (except where noted). SUPPLEMENTAL CHARACTERISTICS are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters. Supplemental characteristics are denoted as *typical*, *nominal*, or *approximate*.

MODES

TWO-CHANNEL: Channels A and B are independent.

TWO-PHASE: Channels A and B are the same frequency, with a calibrated phase difference between them.

TWO-TONE: Channel B frequency must be within 100 kHz of the Channel A frequency.

PULSE: Channel B is the complement of the Channel A output.

WAVEFORMS

Sine, Square, Pulse and DC.

FREQUENCY

RANGE: DC to 13 MHz.

RESOLUTION: 1 μ Hz below 100 kHz, 1 mHz at or above 100 kHz.

ACCURACY: $\pm 5 \times 10^{-6}$ of selected value, 20°C to 30°C, at time of frequency reference calibration with standard instrument.

STABILITY: $\pm 5 \times 10^{-6}$ /year, 20°C to 30°C, with standard instrument.

MAIN SIGNAL OUTPUTS (Channels A and B, all waveforms unless noted)

IMPEDANCE: 50 $\Omega \pm 1\Omega$, DC to 100 kHz.

RETURN LOSS: > 20 dB, 100 kHz to 13 MHz.

CHANNEL ISOLATION: > 80 dB below the larger signal, or < -90 dBm, whichever is greater, 10 Hz to 13 MHz, sine wave only, Two-Channel and Two-Tone modes. For square wave and DC, typically > 80 dB to 5 MHz, typically > 65 dB to 13 MHz.

CONNECTOR: Front panel BNC (rear panel if Option 003).

FLOATING: Both outputs share the same ground and may be floated up to ± 42 V peak (AC & DC).

AC AMPLITUDE (All Waveforms)

RANGE (WITHOUT DC OFFSET):

Units Displayed	Function			
	Sine		Square & Pulse	
	min	max	min	max
peak-to-peak	1.000 mV	10.00 V	1.000 mV	10.00 V
rms	0.354 mV	3.54 V	0.500 mV	5.00 V
dBm(50 Ω)	-56.02	+23.98	-53.01	+26.99
dBV	-69.03	+10.97	-66.02	+13.98

RESOLUTION: 4 digits, or approximately 0.1% of value for peak-to-peak entry, 0.3% of value for rms entry, and 0.01 dB for dBm or dBV entry.

ACCURACY: Relative to selected value after performing self calibration.

Sine Wave:

	0.001 Hz	100 kHz	1 MHz	13 MHz
+ 23.98 dBm		± 0.1 dB	± 0.3 dB	± 0.6 dB
+ 3.98 dBm				± 0.8 dB
- 36.02 dBm		± 0.2 dB	± 0.5 dB	
- 56.02 dBm				± 1.0 dB

Square Wave and Pulse

(5 to 95% duty cycle):

	0.001 Hz	100 kHz	1 MHz	13 MHz
10.00 Vpp			$\pm 3.0\%$	$\pm 6.0\%$
1.00 Vpp	$\pm 2.0\%$			
100 mVpp		$\pm 5.0\%$		$\pm 8.0\%$

WAVEFORM CHARACTERISTICS**SINE WAVE SPECTRAL PURITY:**

Harmonic Distortion: Harmonically related signals will be less than the following levels relative to the fundamental, or < -90 dBm, whichever is greater.

	10 Hz	50 kHz	100 kHz	1 MHz	13 MHz
+ 23.98 dBm	-80 dBc	-70 dBc	-55 dBc	-30 dBc	
+ 13.98 dBm	-80 dBc	-80 dBc	-65 dBc	-50 dBc	
- 56.02 dBm	-80 dBc	-80 dBc	-65 dBc	-50 dBc	

Spurious: In Two-Channel mode, all non-harmonically related output signals (10 Hz* to 40 MHz) will be less than the following levels relative to the fundamental, or < -90 dBm, whichever is greater.

Channel Frequency Spurious Level

10 Hz to 1 MHz	-80 dBc
1 MHz to 13 MHz	-70 dBc

*Ground isolation must be maintained.

Integrated Phase Noise: For a 30 kHz band centered on a 10 MHz carrier (excluding ± 1 Hz about the carrier).

With option 001: < -63 dBc.

With standard instrument: typically < -60 dBc.

SQUARE WAVE AND PULSE CHARACTERISTICS:

Rise/fall time: ≤ 15 ns 10% to 90% at full output at 1 MHz.

Overshoot: $\leq 5\%$ of peak-to-peak amplitude at full output at 1 MHz.

Square Wave symmetry: $\leq \pm 1\%$ of period + 6ns.

Pulse Width range: 1% to 99% of period or 20 ns, whichever is greater.

Pulse Width resolution: 0.1% of period.

Pulse Width accuracy: $\leq \pm 1\%$ of period ± 20 ns.

DC ONLY

RANGE: 0 to ± 5.0 V.

RESOLUTION: 3 digits or 10 mV.

ACCURACY (AFTER PERFORMING SELF-CALIBRATION): ± 75 mV.

SPECIFICATIONS

DC OFFSET

RANGE: Maximum DC Offset is a function of the selected AC amplitude.

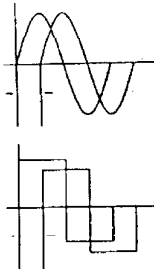
AC Amplitude	Max AC + DC	Max DC Offset
1.0 to 10.0 Vpp	± 5.0 V	± 4.5 V
0.1 to 1.0 Vpp	± 0.5 V	± 0.45 V
10 mV to 100 mVpp	± 50 mV	± 45 mV
1 mV to 10 mVpp	± 5 mV	± 4.5 mV

RESOLUTION: 4 digits.

DC ACCURACY (AFTER PERFORMING SELF-CALIBRATION):

	Mode	
	Sine Wave	Square Wave/Pulse*
10 Hz to 1 MHz	± 2.0% of max DC	± 2.0% of max DC
1 MHz to 13 MHz	± 5.0% of max DC	± 6.0% of max DC

* midpoint between peaks



PHASE OFFSET

The following specifications apply to the Phase Offset between Channels A and B in the Two-Phase mode only. Phase is defined as the difference in rising edge to rising edge (using the midpoint as the reference point) for sine and square waves.

RANGE: ± 720°.

RESOLUTION: 0.01°.

ABSOLUTE ACCURACY: in degrees with the following output waveforms on Channels A and B, equal amplitude levels, and either internal phase calibration or external phase calibration (using a power splitter and equal length cables).

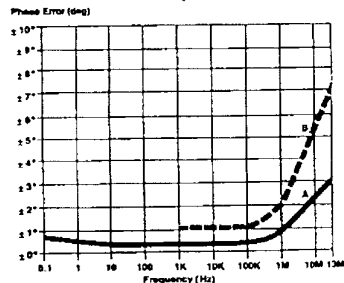
Sine/Sine Outputs:

Cal Mode	0.1 Hz	10 Hz	1 kHz	100 kHz	1 MHz	13 MHz
Internal ¹	± 0.5°	± 0.2°	± 0.2°	± 0.3°	± 2.0°	
Internal ²	± 0.8°	± 0.4°	± 0.4°	± 0.5°	± 3.0°	
External ¹		N/A	± 0.2°	± 0.3°	± 2.0°	

1 = Both amplitude levels
2 = Both amplitude levels

Typical performance

UNEQUAL LEVELS (Sine/Sine Mode)



A: Unequal Levels, Internal Cal.
B: Unequal Levels, External Cal.

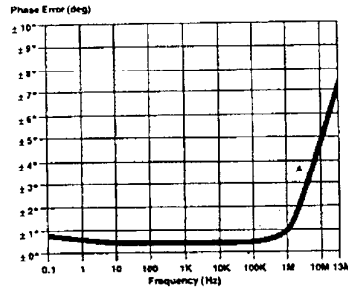
Square/Square Outputs:

Cal Mode	0.1 Hz	10 Hz	1 kHz	100 kHz	1 MHz	13 MHz
Internal ¹	± 0.5°	± 0.2°	± 0.2°	± 0.2°	± 0.7°	± 5.0°
Internal ²	± 0.8°	± 0.4°	± 0.4°	± 0.4°	± 1.0°	± 7.0°
External ¹		N/A		± 0.2°	± 0.7°	± 5.0°

1 = Both amplitude levels
2 = Both amplitude levels

Typical Performance

UNEQUAL LEVELS (Square/Square Mode)



A: Unequal Levels, Internal Cal.

STABILITY WITH TEMPERATURE:

typically ± 0.3°/phase/°C, 20°C to 30°C.

STABILITY WITH TIME:

± 0.1°/10 min after a 30 min warm-up.

± 0.02°/10 min after a 1 hr warm-up.

AMPLITUDE MODULATION

The following specifications apply to the Channel A and Channel B outputs with external modulation or to the Channel A output with internal modulation (Channel B is the modulation source). External amplitude modulation is allowed in any mode while internal amplitude modulation is allowed only in the Two-Channel mode.

WAVEFORMS: Sine, square, or pulse (pulse allowed in external only).

CARRIER FREQUENCY RANGE: DC to 13 MHz.

MODULATION FREQUENCY RANGE: DC to 100 kHz.

MODULATION DEPTH: 0 to 100%.

The following specifications apply at 10 MHz carrier frequency, 1 kHz modulation source, 80% modulation depth.

Envelope Distortion: < - 46 dB.

Incidental PM: ≤ 5° peak.

Modulation Index Accuracy (internal only): ± 5% of setting

Modulation Index Resolution (internal only): 0.1%.

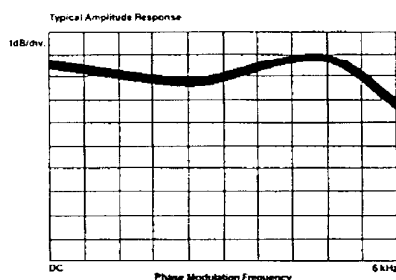
EXTERNAL MODULATION:

Channel A sensitivity: approximately - 1.0 V for 0%, + 1.0 V for 100%.

Channel B sensitivity: approximately + 1.0 V for 0%, - 1.0 V for 100%.

Input impedance: 10 KΩ nominal.

SPECIFICATIONS

**PHASE MODULATION**

The following specifications apply to the Channel A and Channel B outputs with external and synchronous phase modulation, and to the Channel A output with internal phase modulation (Channel B is the modulation source). External and synchronous PM are allowed in any mode while internal PM is allowed only in the Two-Channel mode.

WAVEFORMS: Sine, square, or pulse (pulse allowed in external only).

CARRIER FREQUENCY RANGE: DC to 13 MHz.

MODULATION FREQUENCY RESPONSE: DC to 200 Hz: ± 0.5 dB
DC to 5 kHz: -3 dB see typical plot

PHASE DEVIATION: $\pm 360^\circ$.

LINEARITY: $\pm 0.5\%$, best fit straight line.

DISTORTION (10 MHz CARRIER FREQUENCY, 1 kHz MODULATION SOURCE):

≤ -50 dBc for less than $\pm 45^\circ$ peak deviation.

≤ -37 dBc at $\pm 90^\circ$ peak deviation

INTERNAL MODULATION:

Phase deviation resolution: 1° .

Phase deviation accuracy: 5% of setting

EXTERNAL AND SYNCHRONOUS MODULATION:

Sensitivity: approximately $360^\circ/V$.

Input impedance: 3 K Ω nominal.

Incidental AM: $< 0.5\%$ at 360° peak deviation

FREQUENCY SWEEP

SWEEP TYPES:

Linear sweep: User selectable Start/Stop Frequencies and Sweep Time.

Discrete sweep: 1 to 63 user selectable sequential elements. Each element consists of Channel A and B frequencies and the dwell time before switching to the next element.

LINEAR SWEEP:

Sweep forms: Triangle, ramp.

Sweep time: 5 ms to 1000 s, limited to 5 MHz/s to 500 MHz/s sweep rates.

Sweep Width: 25 μ Hz to 13 MHz.

DISCRETE SWEEP DWELL TIME: 5 ms to 1000 s between switching elements, limited to 5 MHz/s to 500 MHz/s sweep rates.

PHASE CONTINUITY: Sweep is phase continuous over the full frequency range.

OUTPUT COMBINER

The following specifications apply when Channel A and B are combined on the Channel A output with the Channel B output automatically turned off and terminated in 50 Ω . The combiner may be used in the Two-Channel, Two-Phase and Two-Tone modes only. DC offset is automatically set to 0 V when the combiner is on.

FREQUENCY RANGE: DC to 13 MHz.

RETURN LOSS: > 20 dB.

AMPLITUDE: The maximum settable levels of Channels A and B are each reduced by 6.02 dB.

AMPLITUDE ACCURACY: Add the following to the amplitude accuracy of Channel A or B, given on page 10.

DC to 100 kHz	± 0.1 dB
100 kHz to 13 MHz	± 0.3 dB

INTERMODULATION DISTORTION: In Two-Tone mode, third-order intermodulation products will be less than the following levels relative to the higher of the fundamentals. Both channels must be in the indicated frequency band with a minimum frequency separation of 10 Hz.

	10 Hz	1 MHz	13 MHz
+ 17.96 dBm		- 70 dB	- 45 dB
+ 7.98 dBm		- 80 dB	- 65 dB
- 56.02 dBm			

AUXILIARY OUTPUTS

SYNC A: Square Wave with the same frequency as Channel A.

Level: $V_{high} \geq 1.2$ V, $V_{low} \leq 0.2$ V into 50 Ω .

Output impedance: 50 Ω nominal.

Connector: Front panel BNC.

X-AXIS DRIVE: Linear ramp proportional to sweep time in linear sweep mode and discrete sweep (if dwell time is < 1000 s).

Level: 0 to +10 V DC.

Linearity: $\pm 0.2\%$ between 10% and 90% of ramp.

Accuracy: $\pm 4\%$ of full scale value, > 10 K Ω load.

Connector: Rear panel BNC.

Z-AXIS BLANK: TTL compatible level that is low during sweep.

Connector: Rear panel BNC.

SWEEP MARKER: TTL compatible level that makes a high-to-low transition at the selected marker frequency during linear sweep or is low during discrete frequencies, pulsing high for a minimum of 10 μ s between frequency changes.

Connector: Rear panel BNC.

10 MHz REFERENCE: $> + 3$ dBm output for frequency-locking additional instruments to the 3326A.

Impedance: 50 Ω nominal.

Connector: Rear panel BNC.

10 MHz OVEN OUTPUT (OPTION 001 ONLY): $> + 3$ dBm internal high stability frequency reference output for phase-locking other instruments.

Connector: Rear panel BNC.

20 - 33 MHz LO OUTPUT: ≥ 100 mW square wave output that is offset 20 MHz from the Channel B output frequency.

Impedance: 50 Ω nominal, AC coupled

Connector: Rear panel BNC.

SPECIFICATIONS

AUXILIARY INPUTS

EXTERNAL REFERENCE INPUT: For phase-locking the 3326A to an external frequency reference. Signal from 0 dBm to +20 dBm into 50 Ω . Reference must be 1, 2, 5 or 10 MHz \pm 10 ppm. Channel A phase stability with respect to external reference input is \pm 1 $^\circ$ C.

Connector: Rear panel BNC. With option 001 this input must be connected to the 10 MHz Oven Output.

EXTERNAL TRIGGER: TTL compatible level that initiates linear or discrete sweep on high to low transition.

Connector: Rear panel BNC.

CHANNEL A EXTERNAL PHASE CALIBRATION: For external or multiphase calibration.

Frequency range: 1 kHz to 13 MHz.

Amplitude range: 1 to 10 V peak-to-peak.

Impedance: 50 Ω nominal.

Waveform: Sine wave or square wave with 50% duty cycle.

Connector: Rear panel BNC.

CHANNEL B EXTERNAL PHASE CALIBRATION: For external or multiphase calibration. Specifications identical to Channel A external phase calibration input.

Connector: Rear panel BNC.

CHANNEL A EXTERNAL AMPLITUDE MODULATION: See modulation specifications.

Connector: Rear panel BNC.

CHANNEL B EXTERNAL AMPLITUDE MODULATION: See modulation specifications.

Connector: Rear panel BNC.

CHANNEL A EXTERNAL PHASE MODULATION/SYNCHRONOUS PHASE MODULATION: See modulation specifications.

Connector: Rear panel BNC.

CHANNEL B EXTERNAL PHASE MODULATION: See modulation specifications.

Connector: Rear panel BNC.

SAVE/RECALL MEMORY

Ten non-volatile memory locations. Front panel setups can be stored in memory locations 1 through 9. Last front panel setup is saved in memory location 0 when power is removed. Use of discrete sweep overwrites memory locations 1 through 9 with the 63 discrete elements, where an element consists of Channel A and B frequencies and the dwell time between elements.

HP-IB CONTROL

CAPABILITY: Compatible with IEEE Standard 488-1978. All front panel functions, except line switch and HP-IB address, are programmable. Special HP-IB only functions include Service Requests, diagnostics, device trigger for external trigger, and front panel display secure mode. The 3326A is compatible with most HP 3325A HP-IB mnemonics.

INTERFACE FUNCTIONS: SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, CO, E1.

TYPICAL SWITCHING TIMES (EXCLUSIVE OF PROGRAMMING TIME):

Frequency (to within \pm 10ppm):

\leq 10 ms for a 100 kHz step.

\leq 25 ms for a 1 MHz step.

\leq 70 ms for a 10 MHz step.

Phase (to within \pm 1 $^\circ$): \leq 15 ms

Amplitude (to within amplitude specifications): \leq 30 ms.

OPTIONS

OPTION 001 HIGH STABILITY FREQUENCY REFERENCE

Improves frequency stability and integrated phase noise characteristics.

STABILITY: \pm 5×10^{-8} /week, after 72 hours continuous operation, \pm 1×10^{-7} /mo. after 15 days continuous operation.

WARM-UP TIME: Reference will be within \pm 1×10^{-7} of final value 15 minutes after turn-on at 25 $^\circ$ C for an off time of 24 hours.

PHASE NOISE: see Sine Wave Spectral Purity section on page B1.

OPTION 002 HIGH VOLTAGE OUTPUT

Increases output level by a factor of 4 and expands the allowable DC offset range. The following specifications apply to the Channel A and Channel B outputs in all modes with the internal combiner off.

FREQUENCY RANGE: DC to 1 MHz.

OUTPUT IMPEDANCE:

DC to 50 kHz: $<$ 2 Ω .

50 kHz to 1 MHz: $<$ 10 Ω .

AMPLITUDE:

Range: 4 mV to 40 Vpp into 1 k Ω load with $<$ 200 pF, without DC offset. Levels are 4 times the standard instrument ranges. Amplitude is entered in peak-to-peak units only.

Accuracy: \leq \pm 12% of peak-to-peak value for sine, square, and pulse for 400 mV to 40 Vpp values.

SINE WAVE HARMONIC DISTORTION: Harmonically related signals will be less than the following levels relative to the fundamental, into 1 k Ω , no DC offset.

	10 Hz	50 kHz	100 kHz	1 MHz
40.00 Vpp				
12.64 Vpp	-75 dB	-65 dB	-40 dB	
400 mVpp	-80 dB	-75 dB	-55 dB	

SPECIFICATIONS

SQUARE WAVE AND PULSE**CHARACTERISTICS:**

Rise/fall time: ≤ 150 ns, 10% to 90% at full output with 1 k Ω , 200 pF load

Overshoot: $\leq 10\%$ of peak-to-peak amplitude at full output with 1 k Ω , 200 pF load.

DC ONLY AND DC OFFSET**CHARACTERISTICS:**

DC Only Range: 0 to ± 20 V.

DC Offset Range: ± 20 V independent of the AC amplitude range. DC + AC peak must be less than 20 V.

DC Offset Accuracy: ± 100 mV $\pm 1\%$ of setting.

OUTPUT COMBINER: The following specifications apply when Channel A and B are combined on the Channel A output (Channel B output is off). The combiner may be used in the Two-Channel, Two-Phase and Two-Tone modes. DC offset is automatically set to 0 V when the combiner is on.

INTERMODULATION DISTORTION:

Third-order intermodulation products will be less than the following levels relative to the higher of the fundamentals (sine wave only). Both channels must be in the indicated frequency band with a minimum frequency separation of 10 Hz.

	10 Hz	100 kHz	1 MHz
20.00 Vpp	-60 dB	-40 dB	-40 dB
6.32 Vpp	-75 dB	-55 dB	-55 dB
200 mVpp			

MAXIMUM OUTPUT CURRENT: 80 mA peak-to-peak.

OPTION 003 REAR PANEL**MAIN SIGNAL OUTPUTS**

Replaces front panel Channel A and B outputs with rear panel outputs.

GENERAL**OPERATING ENVIRONMENT:**

Temperature: 0°C to 55°C

Relative Humidity: 95%, 0°C to 40°C.

Altitude: $\leq 4,572$ m (15,000 ft).

STORAGE ENVIRONMENT:

Temperature: -40°C to +75°C.

Altitude: $\leq 15,240$ m (50,000 ft).

POWER: 100/120/220/240 V, $\pm 5\%$, -10%; 48 to 66 Hz, 120 VA, 290 VA with all options, 100 VA standby

WEIGHT: 27 kg (60 lbs.) net, 37 kg (81 lbs.) shipping.

DIMENSIONS: 177 mm H x 425.5 mm W x 497.8 mm D (7" x 16 - 3/4" x 19 - 5/8").

ACCESSORIES INCLUDED:

1 ea. Operating Manual (HP Part Number 03326 - 90000). 1 ea. Service Manual (HP Part Number 03326 - 90010).

ACCESSORIES AVAILABLE:

15507A Ground Isolator for breaking signal grounds between input and output connectors, thereby isolating a connector from the chassis ground.

11048C 50 Ohm Feed Thru Termination for terminating outputs in 50 Ω .

11652 - 60009 50 Ohm BNC Power Splitter, 11667A 50 Ohm Type N Power Splitter for use in external and multiphase calibration.

03326 - 84401 Service Accessory Kit for trouble-shooting and repair of the 3326A. Includes extender boards and cables.

9211 - 2656 Transit Case for rugged protection, transportation, and storage.

RELATED EQUIPMENT

1980B Oscilloscope Measurement System (DC to 100 MHz)

3561A Dynamic Signal Analyzer (125 μ Hz to 100 kHz)

3585A Spectrum Analyzer (20 Hz to 40 MHz)

3586C Selective Level Meter (50 Hz to 32.5 MHz)

ORDERING INFORMATION:

USA List Prices Only

3326A Two-Channel Synthesizer \$9,200

Option 001 High Stability Frequency Reference add 650
(to retrofit order HP Part Number 03326-88801)

Option 002 High Voltage Output add 300
(to retrofit order HP Part Number 03326-88802)

Option 003 Rear Panel Main Signal Outputs N/C
(to retrofit order HP Part Number 03326-88803)

Option 907 Front Handle Kit add 60
(to retrofit order HP Part Number 5061-0090)

Option 908 Rack Flange Kit add 35
(to retrofit order HP Part Number 5061-0078)

Option 909 Rack Flange and Front Handle Kit add 90
(to retrofit order HP Part Number 5061-0084)

Option 910 Extra Operating Manual add 100

Option 914 Delete Service Manual less 115

15507A Ground Isolator 275

11048C 50 Ohm Feed Thru Termination 30

9211-2656 Transit Case 540

03326-84401 Service Accessory Kit 250