

470



# SWEEP OSCILLATORS

## Synthesized Sweepers

Models 8340A, 8341A

- 1 to 4 Hz frequency resolution
- Low spurious and phase noise
- 100 ns pulse width capability (optional on HP 8341A)
- +10 dBm to -110 dBm calibrated output (optional on HP 8341A)
- Complete analog sweeper
- DC to 100 kHz amplitude modulation



HP 8341A



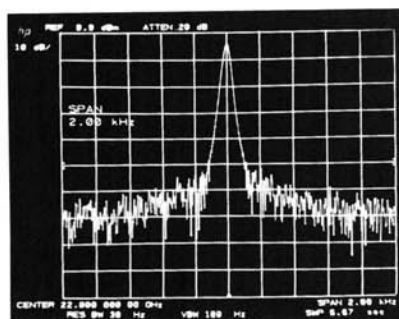
### HP 8340A/8341A Synthesized Sweepers

The HP 8340A and new 8341A Synthesized Sweepers deliver the combined high-performance of a synthesizer and a broadband sweep oscillator in one instrument that is completely controllable via the Hewlett-Packard Interface Bus (HP-IB). This efficient combination of performance and versatility is ideal for manual or automatic test systems and in many cases enables the HP 8340A/41A to replace a sweep oscillator, a frequency counter, an RF synthesizer, and a microwave synthesizer.

### Synthesizer Precision and Spectral Purity

The synthesized broadband frequency coverage (10 MHz to 26.5 GHz on the HP 8340A and 10 MHz to 20 GHz on the HP 8341A) and the precise 1 to 4 Hz frequency resolution (depending on the frequency band of the HP 8340A or 8341A) are generated by indirect synthesis techniques. These techniques enable the HP 8340A/41A to achieve the same low single-sideband phase-noise performance as the HP 8672A and HP 8673 series of Synthesized Signal Generators. The HP 8340A/41A long-term stability is also outstanding at  $1 \times 10^{-9}$ /day (see specification on following page for more information).

The HP 8340A/41A also feature CW switching times of better than 50 ms (typically <35 ms). Additionally, a "Fast Phase-lock" programming command can be used to reduce typical CW switching times to between 11 and 22 ms (depending on frequency step size and absolute frequency value).



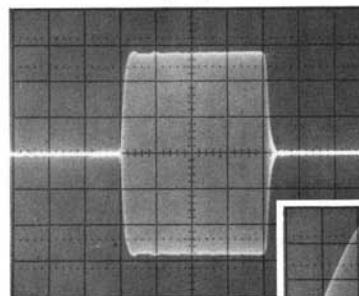
Spectrum Analyzer photo of HP 8340A signal at 22 GHz.

### Swept Capability

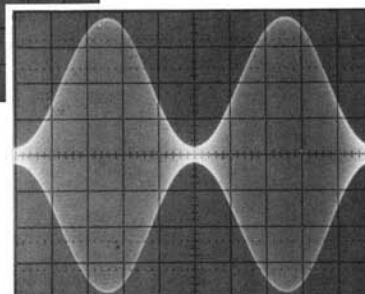
Analog sweep widths as narrow as 100 Hz or as broad as the full frequency range of the HP 8340A or 8341A permit rapid and thorough testing of any device within their broad frequency ranges. To simplify swept measurements, five frequency markers are provided along with useful marker functions such as marker sweep, marker to center frequency (MKR-CF), and marker difference. Direct compatibility with the HP 8510, 8756A/57A, 8410 and 8755 Network Analyzers also enhances the HP 8340A/41A's swept capability.

### Pulse and AM Modulation

The high performance pulse modulators of the HP 8340A/8341A Opt 006 offer >80 dB ON/OFF ratio and <25 ns rise and fall times. Pulse amplitudes are leveled for pulse widths as narrow as 100 ns. The HP 8340A/8341A Opt 006 also feature dc-coupled AM modulation with a 3 dB bandwidth of 100 kHz and a minimum depth of 90%. Pulse and amplitude modulation can be used simultaneously to simulate antenna scan patterns.



HP 8341A Opt 006 pulse performance at 3 GHz. Pulse width = 200 ns.



HP 8340A AM performance at 22 GHz. AM rate is 50 kHz and depth is 90%.



## Output Power

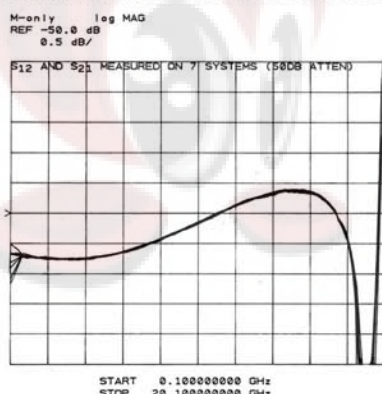
The HP 8340A/41A provide high output power which can be controlled down to  $-110$  dBm (opt. 001 or 004 on the HP 8341A) with  $0.05$  dB resolution. High power resolution is complemented by outstanding accuracy and flatness, as shown on the following page of specifications. The HP 8340A/41A also feature power sweep capability with  $>20$  dB dynamic range for complete characterization of level-sensitive devices.

## Usability and Programmability

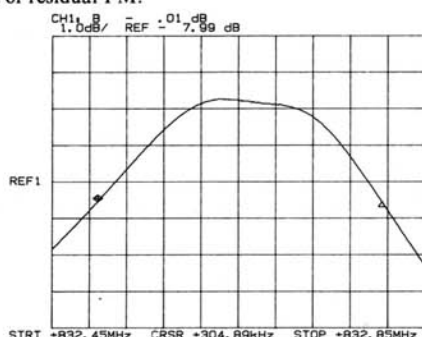
The ENTRY DISPLAYS of the HP 8340A/41A always show the active functions and their current values, which can be easily changed via the data entry keyboard, the step keys or the knob. This friendly and responsive interaction with the user makes the HP 8340A/41A very easy instruments to operate. Complete HP-IB programmability also enables the HP 8340A/41A to effectively interact with computers via simple-to-use programming codes (for example, a CW frequency of  $5$  GHz can be programmed by: CW 5 GZ). Other HP-IB enhanced features, such as the "Fast Phase-lock" command, let users easily and fully exploit the powerful capabilities of the HP 8340A/41A.

## Network Analyzer Companions

Besides being excellent stand-alone general purpose sources, the HP 8340A and new HP 8341A are also ideal sources for precision microwave network analysis. Examples of this are the HP 8340A/41A with the HP 8510 and HP 8756A/57A network analyzers. The new HP 8510 vector network analyzer brings tremendous measurement capability to the microwave engineer that was never before available. A significant portion of this capability depends on the stability, signal purity and source/analyzer interface of the sweeper used. An example of this high performance is shown in Figure 1 where a single device under test was measured seven times with seven completely different HP 8510/8340A test systems. The repeatability (system to system) is remarkable. When the HP 8512A or 8514A  $500$  MHz to  $18$  GHz test sets are used with the HP 8510, the  $10$  MHz to  $20$  GHz HP 8341A is the recommended source and when the HP 8513A or 8515A  $45$  MHz to  $26.5$  GHz test sets are used, the  $10$  MHz to  $26.5$  GHz HP 8340A is recommended.



Both the HP 8340A and HP 8341A can also be teamed with the HP 8756A and new HP 8757A scalar network analyzers for precision scalar analysis, for instance, magnitude-only applications where data at accurate frequencies is needed. In addition to this frequency accuracy, the HP 8340A/8341A have a "phase-locked sweep." For sweep widths of  $n \times 5$  MHz or less ( $n$  = frequency band number), one of the phase-locked loops is swept producing synthesizer class frequency accuracy and stability in a continuous sweep. As an example, see Figure 2 where an  $832$  MHz SAW resonator is swept over a width of  $400$  kHz by the HP 8341A with less than  $60$  Hz of residual FM.



The HP 8341A is particularly well suited for scalar analysis because of its excellent performance for the price. Previously, if greater frequency

accuracy and stability was required of a swept source, the sweeper was combined with a source-locking counter or simply stopped and counted in CW mode. Now with the  $10$  MHz to  $20$  GHz HP 8341A, you can obtain the highest quality frequency accuracy, stability, and phase noise along with an analog sweeper. The HP 8341A has all this built into a single easy-to-use instrument at a price comparable to a broadband sweeper/source-locking counter combination.

## HP 8340A/8341A Specifications

(see technical data sheet for complete specifications)

### HP-IB Interface Functions

The following codes describe the HP-IB electrical capabilities of the HP 8340A/41A using IEEE Std 488-1978 mnemonics: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, C1, C2, C3, C28, E1.

### Frequency

#### CW Mode (and Manual Sweep)

**Frequency Range:** HP 8340A,  $10$  MHz to  $26.5$  GHz  
HP 8341A,  $10$  MHz to  $20.0$  GHz

#### Frequency Resolution:

$1$  Hz,  $0.01$  to  $< 7.0$  GHz  
 $2$  Hz,  $7.0$  to  $< 13.5$  GHz  
 $3$  Hz,  $13.5$  to  $< 20.0$  GHz  
 $4$  Hz,  $20.0$  to  $26.5$  GHz (HP 8340A only)

**Accuracy:** Same as time base.

#### Time Base:

Internal  $10$  MHz time base.  
Aging Rate: less than  $1 \times 10^{-9}$ /day and  $2.5 \times 10^{-7}$ /year after 30 day warm-up.

Temperature Effect: typically  $< 1 \times 10^{-8}$  SUP10/°C.

Line Voltage Effect: typically  $< 1 \times 10^{-8}$  SUP11/  $\pm 10\%$  line voltage change.

**Switching time:**  $< 50$  ms to be within specified frequency resolution (PEAK function off).

(Fast Phase Lock Mode reduces typical switching time to  $< 20$  ms).

**Frequency Bands:** For bands 0 and 1, the output is derived from the fundamental frequency of the internal  $2.3$  to  $7.0$  GHz YIG-tuned oscillator ( $n = 1$ ). For bands 2 ( $7.0$ - $13.5$  GHz), 3 ( $13.5$ - $20$  GHz), and 4 ( $20.0$ - $26.5$  GHz), the output is derived from the 2nd, 3rd, or 4th harmonic of the oscillator ( $n = 2, 3$ , or 4).

### Swept Mode

#### Center Frequency/Sweep Width ( $\Delta F$ )

**Range:** HP 8340A:  $10.00005$  MHz to  $26.4999995$  GHz (center frequency);  $100$  Hz to  $26.49$  GHz (sweep width). HP 8341A:  $10.00005$  MHz to  $19.9999995$  GHz (center frequency).  
 $100$  Hz to  $19.99$  GHz (sweep width).

**Resolution:** approximately  $0.1\%$  of sweep width ( $\Delta F$ ).

**Readout Accuracy:** (sweep time  $> 100$  ms)

$\Delta F \leq n \times 5$  MHz:  $\pm 1\%$  of indicated sweep width ( $\Delta F$ ).  $\pm$ time base accuracy.

$n \times 5$  MHz  $< \Delta F < n \times 100$  MHz:  $\pm 2\%$  of indicated sweep width ( $\Delta F$ ).

$\Delta F \geq n \times 100$  MHz:  $\pm 1\%$  of indicated sweep width ( $\Delta F$ ), or  $\pm 50$  MHz, whichever is less.

Where  $n$  = harmonic multiplication number ( $1$  to  $4$ ). Refer to Frequency Bands description above.

#### Start/Stop Frequency

**Range:** HP 8340A:  $10$  MHz to  $26.4999999$  GHz (Start);  $10.0001$  MHz to  $26.5$  GHz (Stop) HP 8341A:  $10$  MHz to  $19.9999999$  GHz (Start)

$10.0001$  MHz to  $20.0$  GHz (Stop)

**Resolution:** same as Center Frequency/Sweep Width.

**Readout Accuracy:** with respect to sweep out voltage (sweep time  $> 100$  ms): same as Center Frequency/Sweep Width Mode.

#### Frequency Markers

All 5 markers are independently variable and have the same specifications.

**Range:** HP 8340A:  $10$  MHz to  $26.5$  GHz.

HP 8341A:  $10$  MHz to  $20.0$  GHz.

**Resolution:** same as Center Frequency/Sweep Width.

**Readout Accuracy:** same as Center Frequency/Sweep Width.

**Readout Accuracy in MKR  $\Delta$  Mode:** same as Center Frequency/Sweep Width.

**Swept Frequency Accuracy** (of any frequency covered by the sweep): same as Center Frequency/Sweep Width Mode.





# SWEEP OSCILLATORS

## Synthesized Sweepers (cont.)

Models 8340A, 8341A

### Spectral Purity

Specifications apply to CW mode and all swept modes unless otherwise stated.

**Spurious Signals** (expressed in dB relative to the carrier level (dBc) at ALC level of 0 dBm).

**Harmonics** (up to 26.5 GHz) of output frequency: < -35 dBc

**Subharmonics and Multiples Thereof** (up to 26.5 GHz) of output frequency:

< -25 dBc, 7.0 to < 20.0 GHz  
< -20 dBc, 20.0 to 26.5 GHz (HP 8340A only)

**Non-Harmonically related spurious** (CW and Manual Sweep mode only):

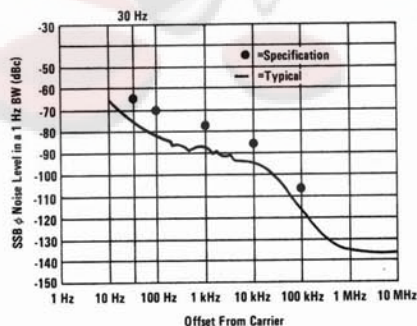
< -50 dBc, 0.01 to < 2.3 GHz  
< -70 dBc, 2.3 to < 7.0 GHz  
< -64 dBc, 7.0 to < 13.5 GHz  
< -60 dBc, 13.5 to < 20.0 GHz  
< -58 dBc, 20.0 to 26.5 GHz (HP 8340A only)

**HP 8340A Single-Sideband Phase Noise** (dBc/1 Hz Noise BW, CW Mode, all power levels)

Frequency Range (GHz)	Offset from Carrier				
	30 Hz	100 Hz	1 kHz	10 kHz	100 kHz
0.01 to < 2.3	-64	-70	-78	-86	-107
2.3 to < 7.0	-64	-70	-78	-86	-107
7.0 to < 13.5	-58	-64	-72	-80	-101
13.5 to < 20.0	-54	-60	-68	-76	-97
20.0 to 26.5	-52	-58	-66	-74	-95

**HP 8341A Single-Sideband Phase Noise** (dBc/1 Hz Noise BW, CW Mode, all power levels)

Frequency Range (GHz)	Offset from Carrier				
	30 Hz	100 Hz	1 kHz	10 kHz	100 kHz
0.01 to < 2.3	-	-67	-75	-83	-107
2.3 to < 7.0	-	-67	-75	-83	-107
7.0 to < 13.5	-	-61	-69	-77	-101
13.5 to < 20.0	-	-57	-65	-73	-97



Typical HP 8340A Phase Noise performance from 2.3 to 7.0 GHz.

**Typical Residual FM in CW Mode:**  $< n \times 60$  Hz rms

**Typical Residual FM in Swept Mode:**

$\Delta F > n \times 5$  MHz:  $< n \times 25$  kHz rms.

$\Delta F \leq n \times 5$  MHz: same as CW Mode.

Where  $n$  = harmonic multiplication number (1 to 4). Refer to Frequency Bands description above.

### RF Output

#### Output Power Range

**HP 8340A Maximum Levelled Power** (0°C to +35°C)

Frequency Range	Specified	Typical
0.01 to < 2.3 GHz	+10.0 dBm	+12 dBm
2.3 to < 7.0 GHz	+12.0 dBm	+16 dBm
7.0 to < 13.5 GHz	+10.0 dBm	+12 dBm
13.5 to < 20.0 GHz	+ 9.0 dBm	+11 dBm
20.0 to < 23.0 GHz	+ 3.0 dBm	+ 5 dBm
23.0 to 26.5 GHz	+ 1.0 dBm	+ 3 dBm

### HP 8341A Maximum Levelled Power (0°C to +35°C)

+10 dBm, 0.01 to 20.0 GHz

**Minimum Settable Power:** HP 8340A, -110 dBm, 0.01 to 26.5 GHz; HP 8341A, - 20 dBm, 0.01 to 20.0 GHz.

**RF Off:** When the RF key is turned off, the POWER dBm display will read OFF and a 0 dBm signal out of the RF connector will typically be attenuated to a level of < -100 dBm. Additional attenuation of the signal may be achieved by using the internal step attenuator.

### Output Power Resolution

**ENTRY DISPLAY:** 0.05 dB

**POWER dBm Display:** 0.1 dB

**HP 8340A Output Power Accuracy** (0°C to +55°C)

Output Level Range	Frequency Range (GHz)		
	0.01 to < 2.3	2.3 to < 20	20 to 26.5
+20 to +10 dBm	-	±1.8 dB	±2.3 dB
+10 to -9.95 dBm	±0.9 dB	±1.5 dB	±2.0 dB
-10 to -19.95 dBm	±1.2 dB	±2.0 dB	±2.5 dB
-20 to -49.95 dBm	±1.5 dB	±2.3 dB	±2.8 dB
-50 to -79.95 dBm	±1.8 dB	±2.6 dB	±3.1 dB
-80 to -100 dBm	±2.1 dB	±2.9 dB	±3.4 dB
-100 to -110 dBm (typically)	±2.9 dB	±3.7 dB	±4.2 dB

### HP 8341A Output Power Accuracy

Output Level Range	Frequency Range (GHz)	
	0.01 to < 2.3	2.3 to 20
+20 to -10 dBm	-	±1.6 dB
+10 to -10 dBm	±0.9 dB	±1.3 dB
-10 to -20 dBm	±1.7 dB	±2.1 dB

Accuracy specifications include power level variations with frequency and temperature (i.e. flatness, which is given below).

### HP 8340A Flatness (Internally levelled)

Output Level Range	Frequency Range (GHz)		
	0.01 to < 2.3	2.3 to < 20	20 to 26.5
+20 to +10 dBm	-	±1.2 dB	±1.7 dB
+10 to -9.95 dBm	±0.6 dB	±1.1 dB	±1.6 dB
-10 to -19.95 dBm	±0.9 dB	±1.6 dB	±2.1 dB
-20 to -49.95 dBm	±1.2 dB	±1.9 dB	±2.4 dB
-50 to -79.95 dBm	±1.4 dB	±2.2 dB	±2.7 dB
-80 to -100 dBm	±1.7 dB	±2.5 dB	±3.0 dB
-100 to -110 dBm (typically)	±1.9 dB	±3.1 dB	±3.6 dB

### HP 8341A Flatness (internally levelled)

Output Level Range	Frequency Range (GHz)	
	0.01 to < 2.3	2.3 to 20
+20 to +10 dBm	-	±1.0 dB
+10 to -10 dBm	±0.6 dB	±0.9 dB
-10 to -20 dBm	±0.8 dB	±1.5 dB

**Output Level Switching Time:** typically < 10 ms to be within ±0.1 dB of final value with no attenuator change (internal leveling only).

**Stability with Temperature:** typically ±0.01 dB/°C.

**Output Impedance:** 50Ω nominal.

**Source SWR** (internal leveling only):

Typically < 1.3:1, 0.01 to < 2.6 GHz.

Typically < 1.6:1, 2.3 to < 18.0 GHz.

Typically < 2.0:1, 18.0 to 26.5 GHz. (20.0 GHz for HP 8341A)





## Power Sweep

### Range:

Displayed: 0 to 40 dB/sweep

Actual: At least 10 dB at any given frequency (at least 20 dB in DECOUPLED mode; see Figure 2 below).

**Resolution:** 0.05 dB/sweep

### Accuracy:

Starting Power Level: Same as Output Power Accuracy Power Sweep Width and Linearity:

**Resolution:** 0.05 dB/sweep

### Slope Compensation

**Calibrated Range:** 0 to 0.4 dB/GHz

**Resolution:** 0.001 dB/GHz

### External Leveling

**XTAL** allows the HP 8340A/41A to be externally leveled by crystal detectors of positive or negative polarity.

**METER** allows power meter leveling with any HP power meter.

**Range:** 500  $\mu$ V (–66 dBV) to 2V (+6 dBV) for **XTAL** or **METER** modes.

**Accuracy:** leveled voltage is shown in **ENTRY DISPLAY** in dBV. Accuracy of actual voltage at EXT INPUT relative to the displayed value is as follows:

$\pm 0.5$  dB,  $\pm 0.2$  mV.

**Loop bandwidth:** nominally 30 kHz in **XTAL** mode, 0.7 Hz in **METER** mode.

**Input Impedance:** nominally 1 M $\Omega$ .

## Pulse Modulation

Specifications apply only to CW frequencies. Pulse modulation is standard in the HP 8340A and available as option 006 in the HP 8341A.

**ON/OFF Ratio:** >80 dB.

**Rise ( $T_R$ ) and Fall ( $T_F$ ) Times:**  $\leq 25$  ns.

**Minimum Internally Leveled RF Pulse Width ( $T_{RF}$ ):**  $\leq 100$  ns.

**Minimum Unleveled RF Pulse Width:** typically <25 ns.

### Pulse Repetition Frequency:

100 Hz to 5 MHz (when internally leveled)

Typically dc to 20 MHz in non-leveled operation

**Maximum Peak Power:** same as CW and swept modes. See **RF OUTPUT** specifications.

**Accuracy of Internally Leveled RF Pulse ( $V_P$ ) (relative to CW level)**

Pulse Width	Frequency Range (GHz)		
	0.01 to 0.4	0.4 to <2.3	2.3 to 26.5*
100 to <200 ns	—	+3/–0.3 dB	+1.5/–0.3 dB
200 to <500 ns	—	+1.5/–0.3 dB	$\pm 0.3$ dB
$\geq 500$ ns	—	$\pm 0.3$ dB	$\pm 0.3$ dB
1 to <2 $\mu$ s (typically)	+3/–0.3 dB	—	—
2 to <5 $\mu$ s (typically)	+1.5/–0.3 dB	—	—
$\geq 5$ $\mu$ s (typically)	$\pm 0.3$ dB	—	—

\*20.0 GHz for HP 8341A opt. 006

**Settling Time:** Settling time states the typical amount of time needed for the internally leveled RF pulse amplitude to be within 10% of its final value after a change in the pulse amplitude has been initiated. In the HP 8340A/41A, for pulse widths <10  $\mu$ s, settling time is the greater of 70  $\mu$ s or the time to generate 7 pulses. For pulse widths  $\geq 10$   $\mu$ s, settling time is 70  $\mu$ s divided by the duty cycle. Settling time can be reduced by pressing **SHIFT AM**, which effectively increases the ALC bandwidth. **SHIFT AM** also has the effect of causing some degradation in the pulse envelope as well as raising the minimum pulse repetition frequency from 100 Hz to 1 kHz.

**Overshoot, Ringing ( $V_{OR}/V_P$ ):** <15% typically.

**Pulse Width Compression ( $T_V - T_{RF}$ ):**  $\pm 5$  ns typically.

**Delay Time ( $T_D$ ):** 50 ns typically.

**Video Feedthrough ( $V_F/V_P$ ):**

<100%, 0.01 to <0.4 GHz

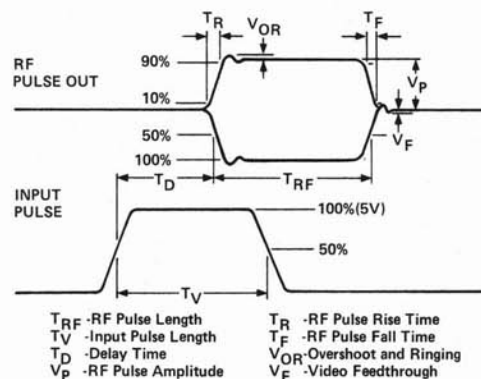
<5%, 0.4 to <2.3 GHz (for output power levels  $\leq +8$  dBm)

<0.2%, 2.3 to 26.5 GHz (20.0 GHz for HP 8341A opt. 006)

**Sidbands caused by a pulse input when PULSE is OFF:** typically <–50 dBc with a 30 kHz squarewave input from .01 to 7.0 GHz.

**Pulse Input:** TTL compatible. (Open circuit is TTL high level and keeps RF on). Damage level +12V, –20V.

## Pulse Definitions:



## Amplitude Modulation

Specifications below apply when the HP 8340A/41A are internally leveled, for waveforms whose envelope peak is at least 1 dB below maximum specified power.

**AM Depth:** 0–90%. Actual available depth will be greater than this in many cases and is determined by the difference of the maximum leveled power available at frequency of interest and –30 dBm.

**AM Sensitivity:** (at a 1 kHz rate and 30% depth) 100%/V  $\pm 5\%$ . AM depth is linearly controlled by varying input level between 0 and  $\pm 1$  V peak. Nominal input impedance is 600 $\Omega$ .

**AM Bandwidth (30% Depth, PULSE off):** dc coupled, 3 dB point >100 kHz.

**AM Frequency Response (Flatness) Relative to a 1 kHz Rate at 30% depth (PULSE off):**  $\pm 0.20$  dB, dc to 10 kHz.

**Distortion:** typical values are given in Figure 3 below.

**Incidental  $\phi M$  in Peak Radians (Rates  $\leq 10$  kHz, 30% Depth):** <0.4 typically

**Incidental FM:** Incidental  $\phi M \times$  Modulation Frequency.

**AM Input Impedance:** nominally 600 ohms.

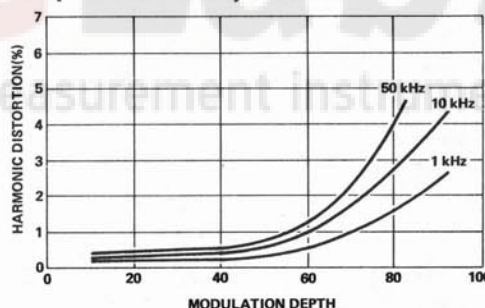


Figure 3. Typical HP 8340A AM distortion for various modulation rates and depths.

## Ordering Information

	Price
HP 8340A Synthesized Sweeper	\$69,100
Option 001 Front Panel RF Output Without Attenuator	less \$2,000
Option 004 Rear Panel RF Output With Attenuator	add \$200
Option 005 Rear Panel RF Output Without Attenuator	less \$1,800
Option 006 Delete Pulse Modulation	less \$4,000
Option 007 Relaxed Phase Noise Specifications	less \$3,500
Option 910 Extra Operating and Service Manual	add \$400
HP 8341A Synthesized Sweeper	\$44,000
Option 001 Front Panel RF Output With Attenuator	add \$2,000
Option 002 +13 dBm Output Power, 2.3 to 18.6 GHz	add \$4,000
Option 004 Rear Panel RF Output With Attenuator	add \$2,200
Option 005 Rear Panel RF Output Without Attenuator	add \$200
Option 006 Pulse Modulation	add \$4,000
Option 007 Improved Phase Noise Specifications	add \$3,500
Option 910 Extra Operating and Service Manual	add \$400
<b>Common Options</b>	
Option 806 Rack Mount Slide Kit	add \$110
Option 850 HP 8410B/C Interface Cable	add \$100
Option 908 Rack Flange Kit	add \$35
Option 913 Rack Flange Kit for Instruments With Front Handles	add \$40
Option 914 Delete Service Manual	less \$350
08340-60134 Support Kit	add \$650