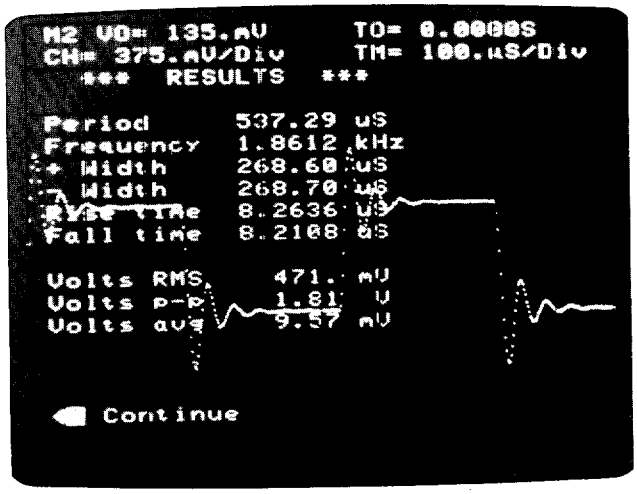
OSCILLOSCOPES & WAVEFORM ANALYZERS

Digitizing Oscilloscopes

Models 1980B, 1965A, 19860A, 1950A, 19800/19801

By performing waveform characterization and waveform comparison, this software provides an extremely versatile set of time-domain measurements. With the software package, the 1980 system can automatically characterize waveform parameters such as peak-to-peak voltage, rms voltage, frequency, pulse width, rise time, and fall time. Waveform comparison is a measurement technique that allows a computer to perform qualitative time-domain measurements. To perform a waveform comparison, the waveform must be compared to limits established for it. These limits can be derived from an ideal waveform generated by a computer or from a known "good" waveform. In this way, the computer, not the operator, can make the necessary judgments.



HP 19860A waveform characterization—the HP 19860A Digital Waveform Storage option and the HP Waveform Measurement Library can automatically characterize waveform parameters. This photo shows measurement results from the first-day Automatic Waveform Measurement Program. The program accounts for the ringing on the waveform when measuring parameters such as rise time and fall time. This program provides first-day measurement results without requiring any additional programming.

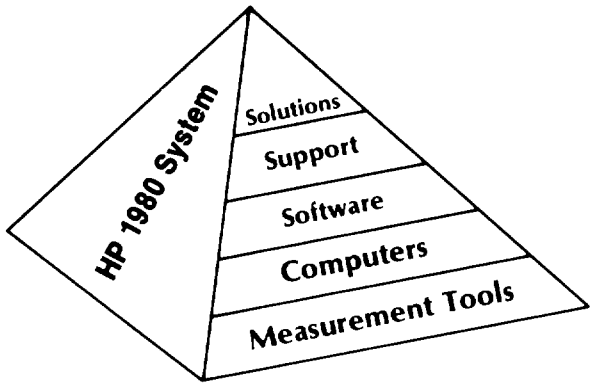
HP 1980 System Accessories

HP provides several accessories for the HP 1980 system. The HP 19811A Plot/Sequence ROM memorizes up to 6 sequences of 25 keystrokes that are executed when enabled. Any key sequence can be initiated when you press a pushbutton on an HP 1008XA probe, send a command over HP-IB, or set a timer in the HP 1965A. Additionally, the HP 19811A can send waveforms stored by the HP 19860A to a plotter in stand-alone configurations. A complete line of testmobiles and miniature probes is also available.

Improving Quality Through HP Automation

A test system based on the HP 1980 System and an HP computer can improve the quality of time-domain measurements. For example, the computer can automatically set up the HP 1980's front panel, eliminating operator errors. Measurements usually made by counting graticule lines can be made without operator intervention. In addition, the computer can make comparison measurements on waveforms, maintaining quality and reducing the required skill level of the operator. HP's Waveform Measurement Library is the software that accesses these capabilities to improve the quality of measurements.

HP 1980 SYSTEM - CORE OF A TEST SYSTEM



The HP 1980—A Test System's Central Measurement Device

The various components of the HP 1980 system together provide a very extensive set of time-domain measurement capabilities. There are two main categories of measurements that the HP 1980 system can make—characterization and comparison. The system can characterize waveform parameters including peak-to-peak voltage, rms voltage, frequency, pulse width, rise time, and fall time. The system also performs waveform comparisons, a measurement technique that allows a waveform to be tested against specified tolerance limits. The HP 1980 system's flexible measurement capability can improve the quality of measurements in automatic, semiautomatic, and manual environments.

Increasing Test System Throughput

The productivity of a test system can be evaluated by its measurement throughput. There are several steps associated with a measurement: after a waveform from a unit under test is connected to a test system, the instruments must be set up to view or store the waveform. Next, the measurement tools gather and transfer data to a computer for analysis. Together, these steps determine the throughput of a system. Because the HP 1980 and an HP computer provide automatic setup, acquisition, and analysis capabilities, they can increase the throughput of your test system.

The HP 1980 system is designed to increase measurement throughput of systems in automatic, semiautomatic, and manual environments. The HP 1980 system is ideal for automatic applications, because it provides full programmability, flexible measurement capability, and the application software needed to automate time-domain measurements. In semiautomatic applications, the HP 1980 system with an HP computer can increase throughput by automatically setting up its front panel and guiding an operator through a test procedure via text on the CRT. Manual applications can also benefit from features such as Auto-Scope and Save/Recall registers.

HP's Complete Product Support

HP provides many services to help you be successful integrating the HP 1980 into a test system. In addition to product notes that discuss specific measurements, a Waveform Measurement Seminar is available that teaches you how to get the best results from the HP 1980 system. Also, HP's System Engineering Organization can provide consulting services and can help you to develop programs for your particular application.

HP 1980B Specifications

Operating Modes

Voltage vs time (V vs T); channel 1 vs 2 (1 vs 2); monitor mode for logic state display with HP Model 1607A (X–Y–Z).

Vertical Display Modes (V vs T)

Channel 1; channel 2; channels 1 and 2 displayed on alternate sweeps (ALT); channels 1 and 2 displayed by switching between channels at approx 400 kHz rate with blanking during switching (CHOP); automatic selection of alternate for sweep speeds >1 ms/div and chop for sweep speeds ≤1 ms/div (AUTO-CHOP/ALT); channel 1 plus 2 algebraic addition (1 + 2), channel 1 and/or 2 may be inverted; and either main or delayed trigger signal.

Vertical Amplifiers (2)

Bandwidth: 3 dB down from a 5 div reference signal (0° to +40°C).
DC-coupled: dc to 100 MHz in 50 Ω and 1 MΩ input modes.
AC-coupled: <10 Hz to ≥100 MHz.
Bandwidth limit: limits upper bandwidth to approx 20 MHz.
Input coupling: ac, dc, 50 Ω (dc), ground. Ground position disconnects input connector and grounds amplifier input.
Input RC: ac or dc, 1 MΩ ±2% shunted by approx 16 pF; 50 Ω(dc), 50 Ω ±3%.
Maximum input voltage: 50 Ω, 5 V rms; 1 MΩ, ac or dc coupled, 250 V (dc + peak ac) at ≤1 kHz.
Deflection factor: range, 2 mV/div to 10 V/div; accuracy, ±3%; 3 digits of resolution.
Vertical position: range, baseline can be adjusted ±15 major div from center graticule line (possible 10 div off-screen); accuracy, ±(2% of reading +0.3 major div).
ΔV (channel 1 or 2): range, ±15 times the deflection factor selected for that channel; accuracy, ±4% (for a Δ≤10 major div).

Channel 1 + 2

Amplifier: bandwidth and deflection factors are unchanged.
Differential (channel 1-2 or channel 2-1): CMRR is at least 20 dB from dc to 20 MHz with common mode signal amplitude equivalent to 10 div and one channel adjusted for optimum rejection.
Trigger view: displays internal or external trigger signal for either main or delayed sweep.

Horizontal Display Modes (V vs T)

Main, main intensified, delayed, and dual. Dual simultaneously displays main intensified and delayed sweep.

Main and Delayed Time Bases

Range: 5 ns/div to 1 s/div; 3 digits of resolution.
Accuracy*

Speed	Accuracy*
5 ns/div to 9.99 ns/div (center 8 div)	±3%
10 ns/div to 9.99 ms/div (first 10 div)	±3%
10 ms/div to 1 s/div (first 10 div)	±4%

*Within ±10°C of the temperature at which the instrument was calibrated. For temperatures beyond the ±10°C range and within 0° to +55°C, add 1% and 2% from 0.5 s/div to 1 s/div.

Sweep Delay

Time delay: range, 0 to 9.9999 s; resolution, displayed, 5 digits; HP-IB, 100 ps at any delay, possible 11 digits.
Accuracy*

	Delay or Time Interval	
Sweep Speed	<200 μs	≥200 μs
5 ns/div to 9.99 ns/div	±(2 ns + 0.1% of reading)	±(0.05% of reading)
≥10 ns/div	±(2 ns + 0.1% of reading + 1% of dly'd s/div x 10 div)	±(0.05% of reading + 1% of dly'd s/div x 10 div)

*Within one hour of a delay self-calibration and in constant ambient temperature.

Delay jitter: 0.002% of delay time; at 10 MHz ±10 kHz, 0.01% of delay time.
Time interval (ΔT): in intensified, dual, or delayed horizontal display modes, a zero time reference can be set anywhere in the delay range and a ΔT measurement made from that point.
Resolution, accuracy: same as time delay.
Frequency (1/ΔT): calculates and displays reciprocal of time interval measurement; resolution, same as ΔT. As frequency increases, insignificant digits are truncated; accuracy, same as time delay.
Digital delay: range, 0 to $10^8 - 1$ events; resolution, 1 event; maximum rep rate, 15 MHz with a 50% duty cycle.

Triggering (main and delayed time bases)

Main Time Base

Triggered: specified level and slope generates a sweep.
Auto-triggered: baseline displayed in absence of a trigger signal; triggering is same as triggered above approx 10 Hz.
Single: sweep occurs once with same triggering as triggered mode.

Delayed Time Base

Auto-sweep after delay: delayed sweep starts at end of delay time.
Triggered sweep after delay: sweep can trigger after delay.
Digital delay: delayed sweep starts a specified number of events after start of main sweep.
Sources: selectable from channel 1, channel 2, enhancement module, or external. Line frequency triggering for main sweep only. Main and delayed independently selectable.

Internal Trigger Level

Range: ±20 major divisions from center horizontal graticule line.
Resolution: 0.02 major divisions; coarse or fine slew rates.
Accuracy: ±(3% of reading + 0.4 major div).

External Trigger Level

Range: ±1.2 V from ground reference; in ÷ 10, ±12 V.
Resolution: ÷1, 2 mV; ÷ 10, 20 mV; coarse or fine slew rates.
Accuracy: ±(3% of reading + 40 mV); ÷ 10, ±(3% of reading + 400 mV).

Line Trigger Level

Range: ±20 relative units.
Resolution: steps of 0.02; fine or coarse slew rates.
Slope: positive or negative slope within trigger signal range.

Sensitivity

Internal: <10 mV/div, at least 1.4 div from dc to 25 MHz increasing to 3 div at 100 MHz; ≥10 mV/div at least 0.7 div from dc to 25 MHz increasing to 1.5 div at 100 MHz.
External: ÷10, at least 500 mV p-p from dc to 25 MHz increasing to 1.2 V p-p at 100 MHz; ÷ 1, at least 50 mV p-p from dc to 25 MHz increasing to 120 mV p-p at 100 MHz.
Coupling (internal and external): ac, attenuates signals <10 Hz; dc, direct coupled; HF rej, attenuates signals above approx 35 kHz; LF rej, attenuates signals below approx 35 kHz.

External Trigger Inputs (main and delayed)

Input RC: ac or dc, 1 MΩ ±2% shunted by approx 15 pF; 50 Ω (dc), 50 Ω ±3%.
Maximum input voltage: 50 Ω (dc), 5 V rms; 1 MΩ, ac or dc coupled, 250 V (dc + peak ac) at ≤1 kHz.

1 vs 2 Operation

Bandwidth: Y-axis (channel 1), same as channel 1 in V vs. T; X-axis (channel 2), dc to 4 MHz.
Phase difference: ≤3° dc to 100 kHz.
Deflection factors: same as Vertical Amplifiers.

Cathode-Ray Tube and Controls

Type: post-accelerator, approx 22 kV accelerating potential, aluminized P31 phosphor.
Graticule: 10 x 10 div internal graticule; 0.2 subdivision markings on major horizontal and vertical axes; 10 x 12 cm display area.
Trace and character intensity: adjustable in relative steps of 1 from 0 to 99.

General

Bus compatability: as defined in IEEE Std 488-1978 is SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP0, DC0, DT1, C0, and E2.
HP-IB interface functions: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP0, DC0, DT1, C0, and E2. (See HP-IB section of this catalog.)

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Digitizing Oscilloscopes

Models 1980B, 1950A, 1965A, 19860A, 19800/19801

HP 1980B Specifications (cont.)

Power: 100, 120, 220, 240 Vac, +5 to −10%; 48 to 440 Hz; 300 VA max with expansion module and plug-in ROMs, standard, 200 VA max.
Weight: net, approx 18.2 kg (40 lb). Shipping, approx 24.1 kg (53 lb).
Dimensions: (HP 1980A) 278 H x 213 W x 543 D mm (10.9 x 8.4 x 21.4 in); (HP 1980B) 143 H x 427 W x 543 D mm (5.6 x 16.8 x 21.4 in).
Operating environment: temperature, 0° to +55 °C; humidity, to 95% relative at +40°C; altitude, to 4 600 m (15 000 ft); vibration, vibrated in three planes for 15 min each with 0.38 mm (0.015 in) excursion, 10 to 55 Hz.
Accessories furnished: one blue light filter HP P/N 01980-02701; one 2.3 m (7.5 ft) power cord; one expansion module panel cover, HP P/N 01980-24106; two Operating/Programming Manuals; one service manual; one binder with divider tabs; two HP 10081A, 10:1 divider probes approx 2 m (6 ft) long.

HP 1950A Specifications

Vertical Display Modes

Channels 3 and 4 independently selected; channel 3 vs 4; channel 3 + 4; either or both channels may be inverted.

Vertical Amplifiers

Bandwidth: same as HP 1980.
Input RC: same as HP 1980, channels 1 and 2.
Deflection factors: 2 mV/div to 10 V/div, ±3%, 3 digit resolution.
ΔV (Channel 3 or 4): same as HP 1980, channels 1 and 2.

General

Operating environment: same as HP 1980A/B.
Weight: net, approx 1.5 kg (3.3 lb). Shipping, 2.2 kg (4.8 lb).
Power: supplied by HP 1980.
Accessories furnished: one operating and service manual; two HP 10081A, 10:1 divider probes, approx 2 m (6.6 ft) long.

HP 1965A Specifications

Frequency A

Range: 100 mHz to 100 MHz
Note: refer to Triggering for minimum pulse-width requirements.

LSD Displayed: $\frac{10\text{ ns}}{\text{sample time}} \times$ frequency (9 digits maximum)

Unarmed and Armed Modes

Resolution: $+/-(2 \times \text{LSD}) +/-1.4 \times \frac{\text{trigger error}}{\text{sample time}} \times$ frequency

Accuracy: +/− resolution +/− time base error × frequency

Gated Mode

Resolution: $+/- \frac{\text{period resolution}}{\text{period}} \times$ frequency

Accuracy: $+/- \frac{\text{period accuracy}}{\text{period}} \times$ frequency

** Refer to period—gated mode specifications.

Period A

Range: 10 ns to 10 s

LSD displayed: $\frac{10\text{ ns}}{\text{sample time}}$ period (9 digits maximum)

Unarmed and Armed Modes

Resolution: $+/-(2 \times \text{LSD}) +/-1.4 \times \frac{\text{trigger error}}{\text{sample time}} \times$ period

Accuracy: +/−resolution +/−time base error × period

Gated Mode

Resolution: $+/- \frac{10\text{ ns} + (1.4 \times \text{trigger error})}{N \times \sqrt{\text{sample time}/(\text{period} \times N)}}$

Accuracy: $+/-$ resolution $+/-$(time base error × period) $+ \frac{4\text{ ns}}{N}$

Where N is the number of cycles gated per sweep.

Time Interval A→B

Range: +/−10 ps to +/−10 s.

LSD displayed: $\frac{10\text{ ns}}{\sqrt{(\#\text{ of averages})}}$

Number of Averages	LSD
1	10 ns
100	1 ns
10 000	100 ps
1 000 000	10 ps

Resolution: +/−LSD +/−start trigger error/$\sqrt{(\text{ of averages})}$ +/−stop trigger error/$\sqrt{(\text{ of averages})}$

Accuracy: +/−resolution +/−time base error × time interval +/−trigger level timing error +/ − systematic error

RATIO A/B

Range: 10E−9 to 10E9

Resolution: $+/- \frac{\text{period B}}{\text{sample time}} \times \text{ratio} +/- \frac{\text{trigger error}}{\text{sample time}} \times \text{ratio}$

Accuracy: same as Resolution

Events A (Gated)

Range: 0 to 1000 megabits

Events A During B

Range: 0 to 1000 megabits
Minimum time between B pulses: 75 ns

Totalize A

Range A: 0 to 1000 megabits
LSD: 1 count of input
Resolution: +/−LSD
Accuracy: same as Resolution

Totalize A − B

Range: 0 to 2000 megabits
LSD: 1 count of input
Resolution: +/−LSD
Accuracy: same as Resolution

Totalize A ± B

Range: −1000 megabits to 1000 megabits
Display: continuous update for input repetition rates up to 5 MHz; beyond 5 MHz, display is updated when measurement is completed.
LSD: 1 count of input
Resolution: +/−LSD
Accuracy: same as Resolution

Auto-Parameters

Repetition rate: 15 Hz to 20 MHz, such that period − time parameter >35 ns.
Note: time parameter is parameter being measured, except the time parameter for duty cycle is pulse width, and time parameter for phase shift is propagation delay.

Maximum input undershoot + overshoot: 10%
Minimum peak-to-peak amplitude: 3 divisions and 35 mV

Resolution: +/−LSD +/−start trigger error/$\sqrt{(\#\text{ of averages})}$ +/−stop trigger error/$\sqrt{(\#\text{ of averages})}$
Time parameter accuracy: +/−resolution +/ −(time base error × time interval) +/−auto trigger error +/−systematic error
Note: systematic error for rise time, fall time, pulse width, and duty cycle is 1 ns. Systematic error for propagation delay and phase shift is 2 ns.

Auto-trigger error: $+/- \frac{1\%\text{ of input p-p voltage}}{\text{slew rate at start trigger point}}$

$+/- \frac{1\%\text{ of input p-p voltage}}{\text{slew rate at stop trigger point}}$

Time Base

Standard high stability, temperature-compensated crystal oscillator.
Frequency: 10 MHz
Aging rate: <1 part in 10E7 per month
Short term: <1 part in 10E9 rms for one-second average; <2 parts in 10E6, 0°C to 55°C
External time base input: front-panel BNC accepts 10 MHz 1 V rms to 10 V rms into 50 Ω. Time base selected to external via soft key selection.

Triggering

Minimum +/− pulse widths: main = 5.0 ns (100 MHz maximum); delayed = 6.25 ns (80 MHz maximum)

Definitions

Systematic error: timing error due to propagation delays between start(A) and stop(B) trigger paths.
Common source (main-to-main or delayed-to-delayed): 500 ps
Dual source with equal vertical sensitivities: 1 ns
Dual source with unequal vertical sensitivities: 2 ns.

HP 19860A Digital Waveform Storage Specifications

Vertical

Analog bandwidth: dc to 100 MHz; ac coupled lower limit is <10 Hz; 3 dB down from a 5 div reference; 0° to 40°C.
Acquisition window: ≥±4.5 div from center horiz graticule line.
Matching of data to CRT graticule lines:[1] ±2% of full scale.

Matching of Digitized to Real Time Traces[1]

Sine Wave, Percent of Full-Scale		
10 Hz	1 kHz	1 MHz
±1.5%	±1.5%	±2.5%

Excludes first data point. In repetitive mode, trigger rep rate must be 1 Hz or faster. In single sweep mode, trigger must occur within 1 s of digitize command, otherwise exclude first five data points. Data for this specification is acquired using the Auto-Cal default mode of a full Auto-Cal.
Absolute accuracy of data: ±(accuracy of vertical channel + matching of digitized trace to real-time trace + matching of data to graticule line).
DC offset: <0.2 div from real-time trace at time of data acquisition.
[1]Full scale is ten divisions.

RMS Noise[2]

Waveform Storage Mode	2 mV/div to 9.99 mV/div	10 mV/div to 10 V/div
Normal	0.75%	0.5%
8 Averages or Filtered	0.4%	0.25%

[2]Measured by grounding the vertical input, digitizing, and calculating the RMS value of the data.

Horizontal

Acquisition window: main horizontal display mode (main s/div x 10 div); in intensified and delayed (delayed s/div x 10 div). In intensified and delayed, the acquisition window can be delayed 0 to 9.9999 s from main trigger point.
Time offset from real-time trace: −(≤30 ns).
Timing accuracy: ±(2 ns + 0.2% of the acquired time window).
Jitter: 0.002% of delay time + 1 ns; at 10 MHz ±10 kHz, 0.01% of delay time + 1 ns.

Operating Characteristics

Repeatability of data: approx 2% for waveforms acquired within 8 hours and within 20°C to 30°C. To optimize repeatability of waveform data, use either a minimum of 8 averages or filtered mode, for signals <100 Hz use dc or 50 Ω dc input coupling.
Vertical resolution: 10 bits, approx 0.1% of full scale.
Auto-Cal: pre-acquisition calibration of sampling efficiency that also sets offset and gain data correction factors. Offset and gain factors are used for post-acquisition data correction to match a digitized trace to a real time trace.
Sample density: selectable 1, 3, 6, 11, 21, 51, 101, 251, 501 points at any sweep speed.
Minimum time between points: repetitive, 100 ps, clocked by HP 1980 delay generator; single-shot, 19.8 μs, clocked by HP 1980 processor clock.
Acquisition mode: repetitive, 999 μs/div to 5 ns/div, two sweeps per point; single-shot, 1 s/div to 1 ms/div, one sweep per waveform.
Averaging: each sample point may be averaged 2, 4, 8, 16, 32, or 64 times in repetitive mode to reduce noise; N + 1 sweeps required per point, where N = number of averages.
Filter: approx 1 MHz low pass filter selectable in single-shot.
Cursors: start and stop cursors for memories (M1 and M2) to measure voltage from center graticule line, time from main trigger point, or ΔV and ΔT measurements on stored waveforms.

General

Operating environment: same as HP 1980B.
Weight: net, 0.4 kg (13 oz). Shipping, 0.9 kg (2 lb).

HP 19800A/B, 19801A/B/C Description

Series HP 1980 Application Software is available for HP Series 80 computers (HP 19801A/B/C) and HP Series 200 computers (HP 19800A/B). Application software is available for the HP Series 1000 computers through the HP Plus program; contact your local HP Sales Office for more details.

Measurement Programs

Automatic waveform measurement program: automatically characterizes many different kinds of waveforms, displays measurement results, and can plot waveforms for permanent records. This program uses Trigger Flag and the HP 19860A Digital Waveform Storage.
User-interactive waveform measurement program (HP 19800 only): provides interactive menus allowing you to characterize waveform parameters, control waveform data bases, and obtain hardcopy output of results or waveforms. Measurements include pulse parameters and two-channel time intervals. This program uses Trigger Flag and the HP 19860A Digital Waveform Storage.
Universal counter measurement program (HP 19800 only): automatically characterizes waveform parameters using the HP 1965A. Trigger levels for rise time, fall time, and pulse width measurements are determined by digitally storing trigger view and determining top and base using a histogram.
Gated time interval measurement program (HP 19800 only): leads user through the process of making a gated time interval measurement with the HP 1965A. Measurement setups can be saved and recalled at a later time.

Library Subprograms

1. The waveform characterization subprograms perform a wide range of parametric time-domain measurements by using the data captured by both the HP 19860A and Trigger Flag.
2. The waveform comparison subprograms perform limit test on waveform parameters to determine whether a given waveform is acceptable according to a specified set of tolerances.
3. The waveform setup subprograms reduce test times and eliminate operator setup errors by automatically setting up the HP 1980A/B. Within this group is a subprogram that automatically rescales the waveform if there is insufficient information within the waveform data for the measurement.
4. The waveform data management subprograms control the HP 19860A and direct the movement of waveform data records. With these subprograms, permanent records of key waveforms can be made. Accessing these records eliminates needless repetition and simplifies the documentation of procedures and results.
5. The general utilities subprograms simplify the development of application programs. For example, they initialize the system, help debug programs being developed, manage instrument setup data, output results and plot waveforms onto HP graphics printers and plotters.
6. The HP 1965A subprograms set up and control the counter functions. They also perform statistical analysis on measurement results.

Ordering Information

	Price
HP 1980S Oscilloscope Measurement System	N/C
Use the system model number when ordering a system mainframe with expansion modules, enhancements, and computer products. Any model number can also be ordered individually. Using the system model ensures coordination of shipments and compatibility of instruments, computers, and software	
HP 1980B Oscilloscope Measurement System (rack)	$10,600
HP 1950A 100 MHz Two-channel Expansion Module	$2,550
HP 1965A 100 MHz Gated Universal Counter	$2,550
HP 19811A Plot/Sequence ROM	$500
HP 19860A Digital Waveform Storage	$3,000
HP 19800A/B Waveform Measurement Library	$1,020
HP 19801A/B/C Waveform Measurement Library	$1,020
HP 1980A/B+24A Waveform Measurement System	$2,450
Training	
HP 19807A Service Extender for expansion modules	$530