

HP 9500 SERIES AUTOMATIC TEST SYSTEMS





TYPICAL HP AUTOMATIC TEST SYSTEM

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Introduction

This brochure presents the HP 9500 SERIES AUTOMATIC TEST SYSTEMS. It offers you, as a potential user of Automatic Test Systems, most of the information needed to configure a system to meet your needs.¹

TEST COST SAVINGS

Automatic testing is no longer in the development stage, but has progressed to the point where current users of automatic test systems are realizing substantial savings in manpower and costs. Within 5 to 10 years the majority of production testing, laboratory calibration of instruments, testing of components and modules, and electronic equipment testing will be done automatically.

YOUR SYSTEM CAN PAY FOR ITSELF

In considering the purchase of Computer-Controlled Automatic Test Systems, you may ask, does such a system offer any advantages over manual or semi-automatic methods. Documented information reveals that current users of Hewlett-Packard Automatic Test Systems are making tests up to 60 times faster than previous methods, and in several instances users have found that their systems have paid for themselves with time and manpower savings in less than a year. Such dramatic savings are available to you.

WIDE CHOICE OF CAPABILITIES

As you read this brochure, you will find that Hewlett-Packard offers a selection of computers and a wide range of instruments from which you can configure a test system to fit your individual requirements. The 9500 Automatic Test System uses a modular building block approach which allows you to purchase a system with only a few instruments interfaced with the computer and later, as your measurement needs expand, other instruments can be added to your system.

¹ Your HP Systems Field Engineer is available to answer questions you might have regarding Automatic Test Systems. Also available from your nearest HP Sales Office is the following literature for the HP 9500:

- Selection Guide
- Customer Support
- HP BASIC for the HP 9500 Series Automatic Test Systems

Equipment Considerations

Equipment and instruments now available for HP 9500 Series Systems are listed in the System Configuration Tables in the rear of this brochure. Because the scope of instrumentation interfaced with 9500 Systems is continually growing, this list may not be completely up-to-date at all times. Don't hesitate to contact the factory through your local HP field engineer for any conventional requirements not listed in the tables, or for special requirements unique to your application.

In the process of configuring (or expanding) a HP 9500 Series system, there are several factors which must be considered and evaluated before final choices are made. The following paragraphs outline these factors.

TOTAL NUMBER OF I/O (INPUT/OUTPUT) CHANNELS

Peripheral equipment is interfaced to the computer with I/O interface boards which plug directly into the computer I/O channels. Peripheral equipment may require one or more I/O boards each and, therefore, may occupy one or more computer I/O channels. As a system grows in complexity and capability, the total number of I/O channels required could eventually exceed the capability of the computer mainframe and it will be necessary to add an I/O Extender to the system.

The Tables in the rear of this brochure show how many I/O channels are available or are required for each item listed.

TOTAL I/O BOARD POWER CONSUMPTION

The computer's mainframe power supply provides DC

power to I/O boards. Depending upon the peripheral equipment selected, the computer's available DC power may be exhausted before the total number of I/O channels in the computer mainframe are all filled. This will depend on the mix of I/O boards used, since I/O boards designed for different purposes require different amounts of power.

Since the mainframe power consumption for each I/O board is known, the total power consumption can be calculated and compared to the power capability of the computer. If the power consumption is greater than that allowable for the basic mainframe, an accessory power supply is available to augment the mainframe power supply on some computers. Before any firm quotations are made, the factory makes the necessary power supply calculations. For budgetary purposes it is always advisable to include the power supply extension option (HP 2160A) when using an HP 2116C Computer.

MEMORY REQUIREMENTS

As the system is configured, software must be added to the HP BASIC Interpreter to control each hardware item added to the system. The Tables in the back of this brochure show the approximate number of memory words required by each item listed. The sum of items selected for your system gives the total number of words of memory required to control the complete system. Add to this sum the number of words required for your longest anticipated Application Test Program (ATP) that is to be executed in the system. Guidance in estimating memory requirements is presented in the brochure "*HP BASIC for the HP 9500 Series Automatic Test Systems*", available from your local HP field sales office.

Available memory is also specified on the aforementioned Tables. This permits you to evaluate your memory requirements and select the appropriate computer and memory options. As Application Test Programs (ATPs) become more sophisticated, more memory may have to be added to accommodate single tests.

Core Memory

HP Automatic Test Systems can be supplied with 8K, 12K, 16K, 24K, or 32K core memory. The HP 2114C computer is available with up to 16K of core memory in increments of 4K. The HP 2116C is available with up to 32K core memory in the mainframe in increments of 8K.

Auxiliary Memory

Disk and Magnetic Tape auxiliary memories are available to provide quick access to a large library of test programs with minimum handling of paper tape. In addition, these options can be used to store data, greatly enlarging the data base available to your automatic test operations.

SOFTWARE CONFIGURATION

The Software Operating System for the 9500 Series uses the HP BASIC Interpretive Compiler and each software system is configured to match the hardware complement of the system, including all options purchased with the initial order. Software (punched paper tape) is furnished with each system and consists of an HP BASIC Interpretive Compiler with software drivers configured to match the

complement of hardware purchased. In addition, all software normally supplied with the HP Computer is also provided. However, only BASIC-callable instrument drivers are supplied with your 9500 System. Consult the factory, through your local HP field engineer, for information on subsequent field installation of options you may select.

RACK SPACE

Rack space requirements are listed in the Equipment Tables and Table XI is devoted to cabinets available from HP. For a realistic estimate of your required space, consider future expansion as well as your immediate requirements.

Table XI lists cabinets, accessories, drawers, and shelves. A good practice is to provide up to 20% excess rack space to allow yourself some freedom for placing instruments at convenient locations for operator view and/or control, or for grouping like types of instruments together.

SYSTEM LAYOUT

The final physical location of your system, and any problems in moving the system to that location should be considered. This determination may dictate if a single large cabinet, or several smaller cabinets would be most appropriate. Any special situations requiring 2 or 3 bay cabinets to be split for doorway access, or multiple 2 or 3 bay cabinets that are to be bolted together in the final installation site should be discussed with the factory.

Stimulus

Stimulus instruments provide the signals applied to the unit under test. These include power supplies, oscillators, function generators, synthesizers, pulse generators, etc. Representative instruments are described herein. However, other stimuli are also available. The specifications given here reflect the instrument's operation as interfaced to the computer. More complete specifications are available on individual instrument Technical Data Sheets which provide front (or rear) "terminal" instrument specifications. These specifications do not include degradation introduced by system cabling and switching (resistance, reflections, crosstalk, etc.)

Those items asterisked (*) are under control of the HP BASIC software supplied with the instrument.



HP 6130B-J20 AND HP 6131B-J20 DIGITAL VOLTAGE SOURCES

These Digital Voltage Sources are complete digital-to-analog links between the computer and any units being tested that require an accurately settable source of DC voltage. The difference between the two units consists of essentially a higher output voltage, with lower current capabilities on the 6131B as compared to the 6130B. The polarity, voltage value, and current limits are programmable.

Up to eight 6130B and/or 6131B power supplies can be controlled by the same I/O board. Both use the same software driver. If more than 8 supplies are required, a second I/O board and software driver can be added to the system.

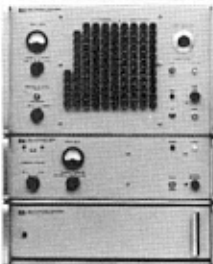
*6130B—Dual Range DC Output: -10 to +10V dc (in 0.5 mV increments) at 0 to 1A; -50 to +50V dc (in 5 mV increments) at 0 to 1A.

*6130B—Current Limit: 20, 50, 70, 100, 200, 500, 700, or 1000 mA. Current limit operates in both source and sink modes (sink limit is 500 mA).

*6131B—Dual Range DC Output: -10 to +10V dc (in 0.5 mV increments) at 0 to 0.5A; -100 to +100V dc (in 5 mV increments) at 0 to 0.5A.

*6131B—Current Limit: 20, 50, 70, 100, 200, or 500 mA. Current limit operates in both source and sink modes (sink limit is 250 mA).

Output Terminals: Output terminals are on a rear panel barrier strip. The common output terminal may be connected to ground, or the output can "float" up to 300V above ground.



HP 5105A/HP 5110B SYNTHESIZER HP 2759B PROGRAMMER

The HP 5105A/5110B Frequency Synthesizer provides any output frequency from 100 kHz to 500 MHz, selectable in steps as small as 0.1 Hz. The output frequency is derived from a precision single frequency source through direct synthesis, a technique which translates the stability and spectral purity of the source to the selected output.

The HP 2759B Synthesizer Programmer is designed to remotely program the synthesized output frequencies. As a system convenience, frequencies may be manually selected, at any time, by placing a front panel switch (on the Synthesizer) to "local" operation.

*Output Frequency:	0.1 MHz to 499.9999999 MHz.
*Incremental Frequency:	0.1 Hz through 100 MHz per step.
Output Voltage:	0 dBm \pm 1 dBm into 50 Ω resistive load.

(For Programmable Output Levels Refer to HP 355D-E46)



HP 355D-E46 VHF ATTENUATOR

This unit gives amplitude control of rf and ac voltage. It consists of an HP 355C and an HP 335D in series, both relay-controlled.

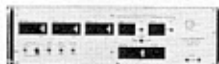
*Attenuation:	0 dB to 132 dB, in 1 dB steps.
Impedance:	50Ω (input and output).
Frequency:	DC to 1000 MHz.
Maximum Signal Power:	0.5 watt.



WAVETEK 157 WAVEFORM SYNTHESIZER

This unit is an accurate source of sine, square and triangular waveforms. An external analog input permits frequency modulation about an accurately programmed center frequency.

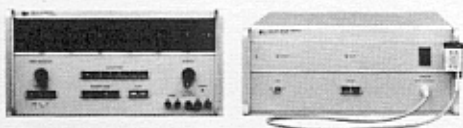
*Frequency Range:	0.0001 Hz to 1 MHz with 5-digit resolution.
*Amplitude:	1 mV to 10V peak-to-peak, into 50 ohms, with 3-digit resolution.
*Waveforms:	Sine, square, triangular.
*Mode:	Trigger (single cycle, gated output), Search (voltage-controlled output of center frequency), and Normal (programmed frequency output).
Output Impedance:	50Ω
Voltage Controlled Frequency:	The output frequency can be swept over 1000:1 ratio by an external analog input.



CHRONETICS 1012 PULSE GENERATOR

This unit provides pulse signals with a repetition rate from 9.9 Hz to 9.99 MHz (20 MHz in pulse-pair mode). The Pulse Generator may be externally triggered from dc to 20 MHz and an external gate control allows the generation of pulse bursts, either synchronously or asynchronously, under program control. It may be operated in either a single pulse or pulse-pair mode. The programmed delay determines the pulse separation in the pulse pair mode. A sync pulse output (1 volt positive \approx 10 ns) provides a reference trigger.

*Repetition Rate:	9.9 Hz to 9.99 MHz (6 ranges, 3 significant digits).
*Pulse Width:	20 ns to 9.99 ms (6 ranges, 3 significant digits).
*Rise Time:	<5 ns to 7.0 ms (2 significant digits, 6 ranges in common with fall time).
*Fall Time:	<5 ns to 9.9 ms (2 significant digits, 6 ranges in common with rise time).
*Pulse Delay:	<30 ns to 9.99 ms (6 ranges, 3 significant digits).
*Baseline Offset:	0 \pm 9.9V (1 range, 2 significant digits, and polarity).
*Pulse Amplitude:	0 \pm 9.9V (3 ranges, 2 significant digits, and polarity).
*Modes:	Single pulse pulse-pair.
*Gate:	synchronous, asynchronous, off.
*Trigger:	internal, external.



745A-H06 AC CALIBRATOR AND 746A HIGH VOLTAGE AMPLIFIER

Precision ac calibration voltages, programmable over the 10 Hz to 110 kHz frequency range, are provided by the HP 745 AC Calibrator. With addition of the HP 746A High Voltage Amplifier, a total amplitude range of 0.1 mV to 1100 volts is programmable as stimulus to a device under test. Where requirements are met with a maximum ac voltage of 110 volts, the 745A can be ordered without the High Voltage Amplifier.

Output Voltage:	1 mV to 110V rms; up to 1100V rms with HP 746A.
*Voltage Ranges:	1 mV, 10 mV, 100 mV, 1V, 10V, 100V; plus 1000V with 746A.
*Voltage Steps:	Steps of 10% of programmed ranges, plus 10% overrange.
*Voltage Sensing:	Local or remote on 1 mV, 10 mV, and 100 mV ranges; at end of special 746A output cable for 1 KV range.
Output Frequency:	10 Hz to 110 kHz.
*Frequency Ranges:	x 10, x 100, x 1K, x 10K.
*Frequency Steps:	44 frequencies: 11 selections per range are factory-set in unit steps from 1 to 11. This gives 10 Hz steps on the X10 range, 100 Hz steps on the X100 range, etc. Frequency selections are easily changed in the field.
Output Connections:	1 mV to 110V at front panel of HP 745A. 110V to 1100V is available at the end of the 746A front panel special protective cable assembly (only).
General:	Error Range and Error Measurement functions are deleted in the 745A-H06; amplitude selection switches and the frequency control are replaced by momentary push-button switches on the front panel.



FLUKE 3330A PROGRAMMABLE VOLTAGE/CURRENT CALIBRATOR

Precision dc voltages and currents are available as stimuli when the Fluke 3330A is included in the system.

For protection and system versatility, this instrument provides independent programmed control of both current and voltage limits. These parameters form an "EI Power Envelope" that can be used to protect devices from catastrophic over-voltage or excess current conditions such as might occur in repetitive testing of components, etc. In addition, a programmable "Crowbar" is available to protect loads from high compliance voltages during switching operations involving constant currents.

*Constant Voltage Outputs:	0 to ± 10.999999 V (1 μ V steps); ± 1.1 to ± 109.99999 V (10 μ V steps)
Available Currents:	0 to 100 mA (up to 100V) 0 to 50 mA (above 100V)
*Current Limit:	10 mA to 110 mA in 10 mA steps
*Constant Current Outputs:	0 to ± 1.0999999 mA (0.1 nA steps) ± 1.1 to ± 10.999999 mA (1 nA steps) ± 11 to ± 109.99999 mA (10 nA steps)
Compliance Voltage:	0 to 1000V (up to 11 mA) 0 to 500V (above 11 mA)
*Voltage Limit:	10% to 110% in 10% steps of selected voltage limit range.
Voltage Limit Range:	Manual selection on front panel 10, 100, 1000 volts.
*Mode:	Current or Voltage
*Crowbar:	"on" or "off" (5 ohm short across output terminals).
Output Connections:	Front and rear-panel outputs; polarity reversal on rear terminals only. Separate sense leads provide for 4-terminal connection to load.

Measurement

Measurement instruments provide for measuring signals from the unit under test, and also for checking applied stimulus signals. These instruments include digital voltmeters (for dc, ac, and resistance), counters (for frequency, time interval, and period), waveform analyzers, etc.

Representative instruments are listed below; others are available. The specifications given here reflect the instrument's operation as interfaced to the computer. Individual data sheets are also available from your HP field engineer which provide more complete front (or rear) "terminal" input specifications.

Those items asterisked (*) are under control of the HP BASIC software supplied with the instrument.



HP 2402A INTEGRATING DIGITAL VOLTMETER

The HP 2402A combines precision measurement and flexibility with the programming and electrical characteristics necessary for automatic test system use. Because the HP 2402A integrates the input signal, the effect of superimposed noise is greatly reduced. Plug-in options for expanded capabilities are also available with the HP 2402A.

Input Circuit:	Floated and guarded signal pair. Signal low and guard may be floated up to 500V above chassis ground. Maximum low-to-guard voltage is 50V.
*Ranges:	100 mV, 1V, 10V, 100V, and 1000V at full-scale. (autoranging, optional).
Over-Ranging:	To 130% of full-scale (except on 1000V range). Self-protected on any range against input voltages up to 1000V.
Input Impedance:	Standard on all ranges is 10 M Ω \pm 0.10%. An internal switch allows the option of greater than 1000 M Ω on the 100 mV, 1V, and 10V ranges.
Resolution:	One (1) part in 130,000 on a 6-digit display. The 100 mV range displays readings with a 1 μ V resolution.

The software provided with the standard voltmeter also controls the following options.

*Option 02: AC Measurement to 100 kHz.

*Voltage Ranges:	1, 10, 100, and 1000V full scale (max. input 240V peak on 1V range, 750V peak on all other ranges).
Over-Ranging:	To 130% of full scale, except on 1000V range.

*Option 03: Ohms Measurement.

*Ranges:	1 k Ω , 10 k Ω , 100 k Ω , 1 M Ω and 10 M Ω full scale.
Over-Ranging:	To 130% of full scale. Self-Protected on all ranges up to 50V accidentally applied across resistance leads.

*Option 05: Frequency Measurement.

Range:	5 Hz to 199.999 kHz
Resolution:	1 Hz
Input Impedance:	1 M Ω shunted to 150 pF
Input:	Amplitude range, 0.1 to 100V rms (front panel attenuator).
Gate Time:	1 second.



HP 5325B-H74 UNIVERSAL COUNTER

This unit is a general-purpose electronic counter with versatile measuring capabilities over the 0 to 20 MHz frequency range. Measurement capabilities include frequency, time-interval, period, period averaging, ratio, and multiratio of two frequencies.

*Frequency	0 to 20 MHz
Period & Period Average Range:	0 to 10 MHz
*Period Averaged:	1 to 10 ⁸
*Time Interval:	0.1 μ s to 10 ⁸ sec
*Ratio:	(F _a /F _b) (10) ^M , where M = 0 thru 8
Input:	Front or rear A and B input terminals, selectable by front panel switch.
Input Impedance:	1 M Ω , shunted by 85 pF
Trigger Level:	Preset to center triggering about 0V



HP 3450A DIGITAL MULTI-FUNCTION METER

True-rms ac voltage measurements (on signals up to 1 MHz), plus fully-guarded measurements of dc voltage and resistance, are provided by this 5-digit integrating digital multifunction meter. In addition, ratio-measurements are available. Auto-ranging is also provided over all ranges of all functions, and will be found especially useful in those applications where the applied signals may vary over a wide range.

*AC Voltage and Voltage Ratio:

	True rms
Frequency Range:	45 Hz to 1 MHz
*Voltage Range:	1.00000V to 1000.00V, full scale.
*Ratio Range:	1.00000 to 1000.00 full scale.

*DC Voltage and Voltage Ratio:

*Voltage Range:	± 100.000 mV to ± 1000.00 V, full scale.
*Ratio Range:	± 1.00000 to ± 1000.00 , full scale.

*Resistance and Resistance Ratio:

Resistance Range:	100.000Ω to 10000.0 k Ω , full scale.
Ratio Range:	1.00000 to 1000.00 full scale.

Input Impedance

10 M Ω on all ranges.
* $10^1 \Omega$, program-selectable, on 10V range and below.

*Gate Time: 1/60 or 1/10 second.



HP 5360A/5365A/5379A COMPUTING COUNTER

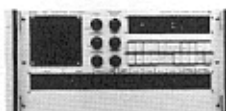
Automatic measurements of frequency, period, and time interval made with the HP 5360A are 3 to 100 times more accurate and/or more rapid than those possible with conventional cycle-counting instruments. The wide measurement range for frequency and period (0.01 Hz to 320 MHz), plus time interval measurement resolution down to 0.1 ns, make this counter especially desirable in automatic test systems.

*Frequency & Period Measurements (5365A Inputs)

	*Channel A Input	*Channel B Input
Range:	0.01 Hz – 10 MHz	1 kHz – 320 MHz
Input Impedance:	10 M Ω	50 Ω
Sensitivity:	100 mV rms, minimum	20 mV rms, minimum

*Time Interval Measurements (5379A Inputs)

Separation $ t_1 - t_2 $:	0 seconds minimum
Range:	T = +100 sec. (max.) to -100 sec. (min.)
Repetition Rate:	15 MHz, max. input rate
Input Impedance:	1 M Ω (inputs separate) 500 k Ω (inputs common)
Sensitivity:	300 mV, peak-to-peak, min.



AMC 1000 WAVEFORM ANALYZER

The AMC Model 1000 Waveform Analyzer has been interfaced to the HP Computer to provide waveform analysis of fast repetitive signals. The rise and fall times of pulse-type waveforms as well as the pulse width and propagation delay may be measured within the range from one second to 100 picoseconds with 3 digit resolution. Time measurements may be made between any two points on either the same or two different waveforms. Voltage amplitude measurements may also be made at any point on a waveform.

The Waveform Analyzer may accommodate up to 10 separate remote sampling probes. Both high impedance and 50 Ω type sampling probes are available.

*Time Measurements: Eight ranges from 10 ns/CM to 100 ms/CM with 3 digit resolution

Input Characteristics (Remote Sampling Probe Type 901)

*Voltage:	± 500 mV to ± 50 V in 3 ranges.
Rise Time:	1 ns.
Impedance:	1 M Ω , shunted by 8 pF.

Display & Output Characteristics:

4 digits plus sign, range, and quantity.

Converting & Conditioning

These instruments are used to convert signals to a form more easily measured, such as a dc voltage proportional to a high frequency ac voltage. These items consist of rf vector voltmeters, high frequency ac voltmeters, true rms voltmeters, etc. Use of these instruments normally requires system switching and a digital voltmeter.

Those items asterisked (*) are under control of the HP BASIC software supplied with the instrument.



HP 400E-H16 AC VOLTMETER

An HP 400E-H16 AC Voltmeter is used as an ac-to-dc converter. Its dc output is normally connected to the system digital voltmeter through the crossbar scanner or other system switching for digitizing the measurement results. The H16-option to the 400E removes the 300V range position (becomes "remote" position) for system use.

Frequency Range:	10 Hz to 10 MHz.
*Range:	1 mV to 100V full scale in 11 ranges.
Input Impedance:	10 M Ω shunted by 35 pF on the 1 mV to 1V ranges and 10 M Ω shunted by 20 pF on the 3V to 100V ranges.
AC/DC Converter Output:	1V dc output for full scale meter deflection.
Response Time:	1.5 seconds to within 1% of final value for a step change.



HP 3400A-J34 RMS VOLTMETER

The HP3400-J34 gives true RMS response for ac measurements, and is used as an ac-to-dc converter. The dc voltage output (proportional to meter deflection) is digitized by the system digital voltmeter, when connected through the crossbar scanner or other system switching. The J34-option removes the front panel range switch, so this unit is remotely-controllable only.

*Voltage:	1 mV to 100V full scale in 11 ranges.
Frequency:	10 Hz to 10 MHz
Response:	Responds to rms value (heating value) of input signals.
Response Time:	<5 seconds to final value for a step change.
Output:	Negative-1V dc = full scale.
Input Impedance:	1 mV to 0.03V range, 10 M Ω shunted by 15 pF. 1.0V to 100V range, 10 M Ω shunted by 15 pF.



HP 432A-H03 POWER METER

The HP 432A-H03 Power Meter measures power over a frequency range of 10 MHz to 40 GHz with appropriate thermistor mounts. The 432A includes a dc output proportional to power. Meter zeroing and range selection are programmable. Power range extends from 10 μ W to 10 mW (-20 to +10 dBm) in 5 dB steps. Power measurement can be extended beyond 10 mW with the use of precision calibrated attenuators.

*Power Range:	.01 mW to 10 mW (-20 dBm to +10 dBm) in seven ranges
Accuracy:	\pm 1% of full scale on all ranges
Response Time:	\sim 250 ms



HP 334-H15 DISTORTION ANALYZER

Total Harmonic Distortion of AC signals with fundamentals up to 100 kHz, plus AC voltage measurements to 300 volts RMS are provided by this fully-programmable Distortion Analyzer. In addition, measurements can be made on the modulation of amplitude-modulated RF waveforms within the 550 kHz to 65 MHz frequency range. Provision is made for the use of an external RF detector where other frequency ranges are required. Complete operation requires that the dc output (proportional to meter deflection) be cabled to the system digital voltmeter (through system-switching) for digitizing the measurement results.

Fundamental AC frequency

Range: 10 Hz to 100 kHz

*Fundamental frequency Programming (distortion mode):
3 digit resolution; $\pm 1\%$ accuracy.

*Distortion Mode Programming:
Manual or Auto-Null

*Input: Normal (AC) or RF

*AC Input Voltage: 300 μV to 300V rms (-60 dB to $+60$ dB) in 13 ranges. At least 0.3V rms required for full dynamic range of THD measurements.

AC Input Impedance: 1 M Ω $\pm 5\%$

RF Carrier Frequency Range:
550 kHz to 65 MHz

RF Carrier Input Level: At least 0.3V rms; 40V p-p ac or 40V peak transient, max.

RF Input Impedance: 4K ohm at 550 kHz, reducing to 140 ohm at 65 MHz.

*High Pass Filter: 3 dB point at 400 Hz, with 19 dB/octave rolloff. 60 Hz rejection is 40 dB.

DC Isolation: Signal-common isolated from system ground.

DC Output: 0 to +1V dc open-circuit, proportional to meter deflection ($Z_O = 1000$ ohm $\pm 10\%$).

AC Output: 0.1V rms $\pm 0.02\text{V}$ open circuit, for full-scale meter deflection. ($Z_O = 50$ ohm $\pm 10\%$).

AM Detector Output: 1V rms change in RF input causes 1V $\pm 5\%$ change in output ($Z_O = 5000$ ohm $\pm 10\%$). This connection is used as "input" for external RF detector.



HP 8405A-H16 VECTOR VOLTMETER

The HP 8405A-H16 Vector Voltmeter is added to the system for high frequency ac voltage and phase measurements. The dc outputs are normally connected to the system digital voltmeter through the crossbar scanner or other system switching for digitizing of the measurement results.

*Frequency Range: 1 MHz to 1 GHz in 10 overlapping bands.

*Voltage Range: 0.1 to 1000 mV full scale in nine 10 dB steps.

*Phase Range: End-scale ranges of $\pm 180^\circ$, $\pm 60^\circ$, $\pm 18^\circ$, and $\pm 6^\circ$. Measures phase difference between the fundamental components of the input signals.

*Phase Offset: 0° or 180°

*Functions: A or B channel.

Switching

Electrical switches provide the paths to connect stimulus and measurement equipment to the unit under test, and to each other for self-check. Switching must be chosen for the type signal to be carried (i.e., DC, RF, microwave, pulse, low level, high power), the number of connections to be made, and the speed with which it is to operate.

Available switches include crossbar scanners, relay trees, and general purpose switches. Representative instruments are shown below.



HP 9400A DISTRIBUTION SWITCH

The HP 9400A Distribution Switch is intended primarily for dc and low-frequency ac signals. The standard 9400A is made up of four relay trees, each four levels deep, providing a 4-pole, 16-throw switch for instrument inputs or outputs. A four-level deep switch allows high and low power supply leads and high and low remote voltage sense leads to be carried through the switch.

The 9400A is also available in two-tree (option 002) and three-tree (option 003) versions, where lesser switching capacity satisfies the application. The 9400A option 002 and 003 Distribution Switches can later be expanded to three- or four-tree capacity by adding one or two switch modules.

The input/output interface and the software driver for the 9400A accommodates all versions, from the two-tree through the four-tree version.

Contacts:	Fine silver, gold bonded.
Maximum Voltage:	500V peak.
Maximum Current:	3 amps switched with resistive load, 7 1/2 amps carry current after switching.
Maximum Power	135W switched with resistive load, 500W carry after switching.
Signal Frequency:	dc to approximately 100 kHz.
Contact Resistance:	300 m Ω max. from input to output.
Thermal Offset:	Typically 30 μ V at room temperature.
Operate Time:	30 ms, max.
Release Time:	40 ms, max.



HP 9400B MODULAR SWITCH

This switch is designed for computer-controlled test systems where several types of automatic switching would be required. This device consists of various modular relay boards housed in a card cage. Each modular relay board contains the associated drive and storage electronics. A "driver" board is also available to control devices outside the card cage, such as relays in adapters, RF and pulse type relays, high power relays, etc., that are often best located near the shortest signal path. Each card cage will accept up to 16 cards. The modular switching system can be easily expanded to several card cages controlled by one computer I/O board.



Modular Cards

Several types of cards are available for use with the 9400B. Specifications for these cards are as follows.

25000C Drive and Storage Card

Switching Capability:	32 NPN transistor collectors, with storage.
Max. Switching Voltage:	+30 Volts (externally supplied).
Max. Current Sink:	100 mA at +0.5V, max.

25000D General Purpose Relay Card

Switching Capability:	16 relays, with one Form-A and one Form-C switch per relay. Each relay has independent storage.
Maximum Voltage:	200V peak.
Maximum Current:	2 amps switched with resistive load, 3 amps carry current after switching.
Crosstalk:	-40 dB typically measured at 100 kHz on adjacent switch line terminated in 1 K Ω .

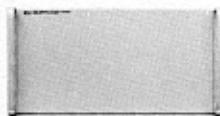
Signal Frequency:	DC to 100 kHz.
Initial Contact Resistance:	250 m Ω , max.
Thermal Offset:	Typically 50 μ V or less at 25°C.
Contact Life:	12,000,000 cycles at 28V dc, 100 mA, resistive load.
Operate Time:	20 ms, max.
Release Time:	5 ms, max.

25000H Reed Relay Card

Switching Capability:	32 relays, with one Form-A switch per relay (SPST-NO). Each relay has independent storage.
Maximum Voltage:	100V peak, open contacts. Recommended max. make voltage = 48V.
Maximum Current:	500 mA switching current. 1.0 amp carrying current.
Crosstalk:	-50 dB typical, measured at 100 kHz on adjacent switch line terminated in 1 K Ω .
Signal Frequency:	DC to approximately 100 kHz.
Initial Contact Resistance:	100 m Ω max. at 100 mA.
Thermal Offset:	Typically less than 100 μ V at 25°C.
Maximum Power:	10 Watt peak or continuous.
Typical Contact Life:	150,000,000 cycles at 12V dc, 100 mA, resistive load.
Operate Time:	2.0 ms maximum operate or release time.

25000J Distribution Card

Switching Capability:	16 Four-pole relays configured into a 1 X 16 four-level matrix. Each relay has electronic storage.
Maximum Voltage:	200V peak
Maximum Current:	2 amps switched, 3 amps carry current.
Crosstalk:	-50 dB, typical at 100 kHz on adjacent output line terminated in 1 K Ω .
Signal Frequency:	DC to approximately 100 kHz.
Initial Contact Resistance:	250 m Ω , max.
Thermal Offset:	Typically 50 μ V or less at 25°C.
Typical Contact Life:	12,000,000 cycles at 28V dc, 100 mA resistive load.
Operate Time:	20 ms, max.
Release Time:	5 ns, max.



HP 9400B/HP 2911A GUARDED CROSSBAR SCANNER

The HP 25000H Reed Relay Switch Card card may be used in the HP 9400B to control an HP 2911A-23 or HP 2911A-67 Guarded Crossbar Scanner. The HP 2911A provides for scanning up to 200 three wire measurement points. This control technique offers the advantage of eliminating the requirement for the usual HP 2911B Crossbar Scanner Control and associated computer interfacing, when the HP 9400B Modular Switch is used in a system. See 2911B-33/2911A for more information.



HP 2911B-33/2911A GUARDED CROSSBAR SCANNER

The HP 2911A Guarded Crossbar Scanner is used for measurement scanning. This unit provides low thermal offsets. Option 023 switches dc and ac voltage, frequency, and resistance signals to corresponding inputs of HP 2402A Integrating Digital Voltmeter. Option 67 provides for dc and ac voltage, and resistance input switching to the HP 3450A Multi-Function Meter. Ratio measurements on any pair of inputs are normally made by either voltmeter under program control by making two measurements and using the computer to calculate the ratio. The directly programmable ratio function available with the HP 3450A meter is normally not used in conjunction with the 2911A, Option 67 Guarded Crossbar Scanner.

Number of Channels:

200 3-wire channels are standard. A dc/ac voltage or frequency input occupies one channel; a resistance input occupies two channels.

Programmable:

Channel, function (voltage, frequency, or ohms).

Under certain conditions, it may be more economical to control the 2911A Guarded Crossbar Scanner via the HP 9400B Modular Switch in lieu of the HP 2911B. (See the HP 9400B/HP 2911A).

Cables:

The interconnecting cable(s) to the HP 2402A or HP 3450A are supplied with the HP 2911A.



HP 9402A SYSTEM INTERFACE PANEL

The HP 9402A System Interface Panel provides a general purpose low frequency cabling interface between the instrumentation in the 9500 Series Automatic Test System and the Unit Under Test (UUT). The 9402A allows the user to bring input/output cabling from selected stimulus, measurement, and switching instrumentation to the Interface Panel in order to provide the most flexible system. By selecting appropriate option numbers when specifying the 9402A, the user may define which instrument and switch connections will appear on the Interface Panel.

The user wires the UUT into the Interface Panel through an appropriate adapter. Connections between the UUT and the test system and between instruments within the system are made with patch cords on a removable panel or test adapter. Several removable test adapters can be used with each System Interface Panel so that different UUT's may be tested very quickly by simply connecting the pre-wired test adapter for that particular UUT to the System Interface Panel.

Interface cabling available with the 9402A Panel is shown in Table V. The panel contains a total of 1768 (34 X 52) pins. A predefined number of pins is assigned for each instrumentation cable available. In using this Table, an option number is selected for each instrument to be wired into the Panel. The number of pins used for each option is designated in the Table in brackets. For more than one instrument of a particular kind, the appropriate number of options must be specified. The total number of pins selected for all options ordered must not exceed the 1768 pin capacity of the panel. Typically, 10% or 20% of the pins should be reserved as spares.

For cables for instruments not specified contact HP for more information.

Several instruments have choices for more than one cable. The 2402A Digital Voltmeter has options for AC/DC, ohms, and frequency; cables are available with each of these options. The 400E AC Voltmeter, 3400A RMS Voltmeter, and 334A Distortion Analyzer have a choice of both input and output cables. Output cables are used to connect the analog outputs to a digital voltmeter in order to digitize the reading. The 9400B Modular Switch operates with particular PC Relay Cards. Options are available for each card ordered with the 9400B.

The 2911A Inputs are wired in groups of 10 three-wire channels or 5 six-wire channels. Up to 20 of these options can be specified. The 9402A output cable options specified for the 2911A will depend upon the voltmeter used with the 2911A. For use with the 2402A, choose any combination of options 307, 308, and 309 depending upon specified 2402A options, ohms, AC/DC, frequency, respectively. For use with the 3450A, specify option 310.

NOTE: If the DVM input is wired directly to the 2911A, 9402A options for the DVM input or 2911A output are not required.

The 9402A panel is usable beyond 100 kHz. The upper frequency limit of the Interface Panel depends upon the measurement requirements and the effect of inter-wire isolation and cable impedance mismatch on the desired test results.

Signal Frequency:	DC to 100 kHz
Number of Points:	1768 (34 X 52)
Maximum Voltage:	1000 VAC
Maximum Current:	5 Amps Continuous—15 Amps peak
Isolation Resistance:	2.5×10^{12} Ohms Min.
Contact Resistance:	5 Milliohms (m Ω) Typical
Pin-to-Pin Capacitance:	5 pF (excluding cabling)

Standard Computer Interfaces

In automatic testing it is often desirable to control other equipment, receive data from other equipment, sense contact closures, etc. HP provides a number of standard computer interfaces which are useful for such purposes.

These very same interfaces are used to control many of the peripherals listed in the Tables and are an integral part of the instrument-interface-software subsystem package designed for a specific purpose. In such cases, the software driver is tailored to suit the application, the parameters being in terms of frequency, volts, range, etc.

Standard computer interfaces shown include a general purpose software driver.

HP 12551B 16-BIT RELAY OUTPUT REGISTER

The Relay Register provides 16 floating Form-A contact closures which can be used for controlling one device, or may be subdivided in any combination to control several devices. The voltages switched through the relay contacts can differ from each other, and from computer ground, by as much as 100V peak. Contacts can be connected in series, parallel, or in series-parallel, with or without diode isolation.

Relay Contacts States:	All contacts are normally open when power is off.
Maximum Power:	10W peak or continuous, per contact.
Maximum Voltage:	100V peak or continuous.
Maximum Current:	500 mA per contact.
Life:	10 million operations under rated load.
Resistance:	0.1 ohm at 100 mA (higher at low current).
Settling Time:	1 ms, max.

HP 12554A 16-BIT DUPLEX REGISTER

The Duplex Registers enable you to interface HP computers to exchange input and output information with most digital devices. Each Duplex Register includes two independent registers which allow a two-way flow of information between the computer and an external device.

Output Levels (Ground true/Positive false)

"1" state:	0 to +0.5V, 12 mA sink max.
"0" state:	+12V, 10K ohms source

Input Levels (Ground true/Positive false)

"1" state:	0 to +0.5V, 12 mA sink, max.
"0" state:	+8V

Bias and Impedance: +8V through 700 ohms

NOTE: This card also available with negative voltage (Ground false, Negative true) logic.

HP 12566A MICROCIRCUIT INTERFACE CARD (16-Bit Duplex)

This card enables you to interface HP computers to exchange input and output information with most digital devices with DTL/TTL output voltage levels. It is designed as a general-purpose microcircuit interface. Included are 16-bit input and output storage registers which provide temporary storage during data transfer. Two independent registers allow a two-way flow of information between the computer and an external device.

Data Inputs (Ground-true, Positive-false)

"0" Level:	+2.4 to +5V, bias +3V, Z = 300Ω to +5V
"1" Level:	0 to +0.5V at mV, bias +3V, Z = 300Ω to +5V

Data Outputs (Ground-true, Positive-false)

"0" Level:	+2.4 to +5V, Z = 1 kΩ
"1" Level:	0 to +0.5V, current sink (max) = 31 mA

NOTE: This card is also available with negative voltage (Ground false, Negative true) logic.

Computer Input/Output

A wide variety of traditional computer peripherals is available to provide for inputting programs, commands and data, or for outputting test results. To operate in the HP BASIC language, a teleprinter is required for input/output, and a paper tape reader is also required for high speed input.



HP 2752A TELEPRINTER

This unit (a modified Teletype ASR-33) combines a typewriter, a keyboard, a tape reader, and a tape punch. Data and instructions may be entered via the keyboard. Output information is printed on the typewriter paper at a maximum rate of 100 words per minute and may be recorded simultaneously by punching on one-inch 8-level paper tape. Tape punching speed is 10 characters per second. *If heavy use of the Teleprinter exceeds 5 hours per day, an HP 2754B Teleprinter (modified ASR-35) should be used.*



HP 2754B HEAVY DUTY TELEPRINTER

The heavy-duty Teleprinter (a modified Teletype ASR-35) is recommended where use exceeds 5 hours per day or 30 hours per week. It performs the same function as the HP 2752A and it operates at the same 10 character per second speeds.



HP 2748A PAPER TAPE READER

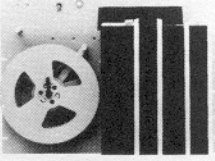
The HP 2748A permits HP BASIC programs to be read into the computer at the rate of 500 characters per second. High speed is desirable if the system is frequently reprogrammed for different test problems. The reading technique is photoelectric, character-by-character, through holes in the tape. The tape must be one inch wide and made from any material with a transmissivity of 60% or less. The HP 2748A is equipped with a panel-mounted container for holding the tape during the read operation.

Normally the High Speed Reader is controlled only by the "system commands" of HP BASIC; i.e., it is used only to read in new *programs*. However, an auxiliary software driver is available for reading in *data* from punched paper tape (under application test program control) during test program execution. See Read/Punch Data CALL in the Miscellaneous Section.



HP 2758A TAPE READER-REROLLER

The HP 2758A Punched-Tape Reader-Reroller provides all the capabilities of the HP 2748A and offers automatic rerolling of the tape into a storage container as it is read which eliminates tape-rewinding and protects tape from dirt, tearing, and tangling. Material with less than 60% transmissivity is acceptable, but metal mylar tape cannot be used in the canister.



HP 2753A HIGH SPEED TAPE PUNCH

The HP 2753A provides increased speed and convenience of operation and greatly reduces program preparation time. Punch rate is 120 characters per second on 8-level, one-inch wide paper tape that can be read back into the computer by either the teleprinter or the photoreader.

Normally, the punch is under control of "system commands" of HP BASIC and is used only to punch out the *program* that has been prepared, or edited in memory. There is an auxiliary software driver available for punching out *data* on paper tape (under applications test program control) during test program execution. See Read/Punch Data CALL in the Miscellaneous Section.



HP 2600A KEYBOARD DISPLAY TERMINAL

The HP 2600A Keyboard Display Terminal provides the user with the ability to rapidly access data from the computer as well as to input programs and data through its keyboard. It accepts data from the computer at rates up to 240 characters per second—24 times faster than a 10 character per second teleprinter. Data is buffered in the Terminal and refreshed on the cathode ray tube to provide visual persistence to the operator. Up to 25 lines, 72 characters in length can be displayed. In addition to rapidly displaying program listings and data, the CRT display is very useful for viewing simple graphical displays of data. The higher speed of the CRT Terminal makes this capability more useful than plotting the data on a teletype terminal. Programs are available in HP BASIC to convert data point pairs, for example, into X-Y coordinate displays. Visual messages to the operator are easily included in test programs.

This unit may be used in place of or with a teleprinter. With a teleprinter a hard copy printout is also available for record keeping purposes. When both the Keyboard Display Terminal and teleprinter are used, control is transferred from one to the other by a simple software command.

Miscellaneous

There are many features that can be added to systems as flexible as the HP 9500 Series. Even though the costs for these features are nominal, a judicial choice is required since these features occupy system "space" either in memory and/or I/O channels.

Below are listed brief descriptions of those items offered on the "Miscellaneous" table.

HP 12539A TIME BASE GENERATOR (SOFTWARE CLOCK)

The HP 12539A generates real time intervals derived from a crystal oscillator. This circuitry is included in one card that plugs into an I/O channel in the computer. It is used as the source of timed interrupts for a "software clock".

The software clock can be used as an elapsed-time or a time-of-day clock by either setting it to zero or to the actual time of day. Once set, the elapsed time, (or time of day) is available under program control to record the duration of tests, or the time of day at the beginning, or at the end of tests, etc.

Resolution:	1 second
Readout:	0 to 23 hours, 0 to 59 minutes, 0 to 59 seconds
Setability:	Manual, +0.5 sec
Repeatability:	±1 sec
Aging Rate:	2 parts per million per week

HP 25104Y SWITCH-REGISTER INTERROGATOR

The HP 25104Y is a software routine that operates in conjunction with the computer's front panel switch register. It adds a CALL statement that allows the test program to read the setting of the switch register.

By allowing your test program to check the setting of selected front-panel switches, branching decisions can be made based on the operator's setting of these switches, resulting in more effective testing techniques in many applications.

HP 25106C READ/PUNCH DATA CALL

This software driver, when included in the configured HP BASIC System, adds the capability of punching out test results on the High Speed Paper Tape Punch. In addition, these results can be read back-in through the High Speed Photoreader (at a later time) for data analysis, preparation of test reports, etc.

Standard HP BASIC provides only for the punching and reading of *programs*. The HP 25106C software adds the capability for punching and reading *data* (in binary format) on the punched paper tape.

Storage of your test results on punched paper tape can provide an economical means of accumulating all your test results for later data analysis and test report preparation.

Auxiliary Memory

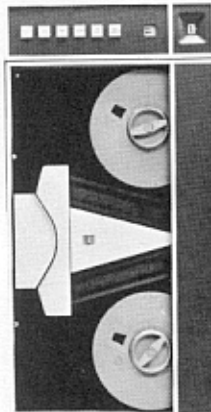
The 9500 Automatic Test Systems execute the test program that is resident in memory. This results in two limitations. First, the program being executed is limited in size by the memory available to the applications test program. Second, each new or different program must be loaded into memory before it can be executed.

The first limitation can usually be overcome by segmenting the tests into portions that can be accepted comfortably by the available memory. The amount of memory that is available for test program is determined by the size of the test system; that is, how many instrument software drivers are required to be resident in memory, what other software features are required in addition to the HP BASIC interpretive software system itself, and how much memory the system has. Normally, 1500 to 2000 words of available memory for an executable test program is a reasonable minimum for average testing. As a first approximation, each statement in a BASIC program takes on the average, 15 words of core. The less memory available, the more segmenting that must be done for long test programs.

Program segmenting requires two or more program loading operations and execution before the test can be completed. The program loading problem also becomes critical if the type of units to be tested changes often, requiring a manual search for, and loading of, the appropriate test program. This would also require the storage of numbers of paper tapes in the testing area.

Auxiliary memory systems are available to solve these problems, and as a bonus, data storage capability is also provided.

Magnetic tape and disk auxiliary memory systems are described briefly below. Not only do these provide for program and data storage, but each "system" provides unique extensions to the HP BASIC language for better utilization of system capabilities.



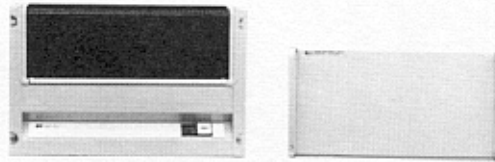
HP 2020B-H27 MAGNETIC TAPE AUXILIARY MEMORY SYSTEM

This Auxiliary Memory System for HP BASIC provides additional storage capacity using the HP 2020B-H27 Digital Magnetic Tape Unit. The HP 2020B-H27 Digital Magnetic Tape Unit produces 7-track tapes in IBM compatible NRZI format on 10½" standard reels. This provides 2400 feet of tape at selectable 200 or 556 bpi. Assuming no record or file gaps, a 2400 foot reel of tape can store approximately 1.9 million 16-bit computer words at 200 bpi or 5.2 million words at 556 bpi. Program access time depends on the number of test programs on the tape. For example, assume 100 test programs, each program 5000 computer words long are on the magnetic tape. Search time for a new program would be 120 seconds worst case. The longest possible search time for a 2400 foot reel of tape (programs or data) would be approximately 19 minutes. (This is equivalent to 1000 test programs, each 5000 computer words in length.)



HP 7970 MAGNETIC TAPE AUXILIARY MEMORY

The HP 7970 Digital Magnetic Tape Unit produces 9-track tapes in IBM compatible NRZI format on 10-1/2" standard reels. A density select switch provides 200, 556, or 800 bpi density. Up to 11.5 million 16-bit words can be stored at 800 bpi on a 2400 foot role of tape, assuming no record gaps. Tape speed is 37.5 inches per second. Up to 4 tape units can be controlled by the computer.



HP 9300N/9300P DISK CARTRIDGE DRIVE AUXILIARY MEMORY SYSTEM

This Disk Auxiliary Memory System for HP BASIC provides additional storage of approximately 750,000 words of memory using the HP 9300N Disk Cartridge Drive with the 2116C (600,000 words with 2114C). The HP 9300N Disk Cartridge Drive is a movable-head, replaceable cartridge disk memory with 400 tracks, and an average access time of 90 ms. The HP 9300P is the associated power supply.

The Configured HP BASIC Software System can be stored on and retrieved from the disk. If the Software System in core is destroyed, it can be reloaded from disk as can Test Programs and data.

The Auxiliary Memory System provides the user with the following system capabilities:

- Loading the configured HP BASIC Software System into core from disk.
- Storing Test Programs written in HP BASIC on disk (contiguous integral sectors are allocated to each program as needed).
- Loading HP BASIC Test Programs from disk under operator control.
- Executing HP BASIC Test Programs under operator control.
- Inactivating (deleting) Test Programs on disk.
- Repacking the disk.
- Storing and recovering data under control of an HP BASIC Test Program.
- Linking Test Programs so that a new program can be loaded from disk under control of a resident Test Program and automatically executed. (This new program replaces the requesting program in core.)

This Auxiliary Memory System requires a minimum of 16K Core Memory with the HP 2116C; 12K minimum with the HP 2114C.

The configured HP BASIC Software System is stored and retrieved from the tape. If the Software System in core is destroyed, it can be reloaded from tape, as can be the Test Programs and data.

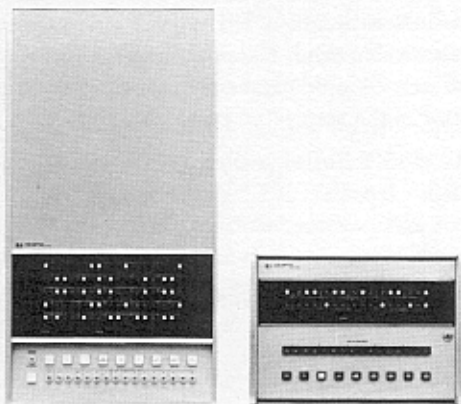
This Auxiliary Memory System provides the user with the following system capabilities.

- Storing the configured HP BASIC Software System on Magnetic Tape.
- Loading the Software System into Core from Magnetic Tape.
- Store and retrieve HP BASIC Test Programs on Magnetic Tape.
- Execute HP BASIC Test Programs.
- Store and retrieve data on Magnetic Tape.
- Link between HP BASIC Programs (new program replaces the requesting program in core).
- Position the Magnetic Tape as desired including Rewind, End-of-File, and End-of-Record.
- Catalog the Programs that are active on Magnetic Tape.
- Release data area so that it may be reused—normally inhibited to protect the data.

This Auxiliary Memory System requires a minimum of 16K Core memory.

Computers, Mainframe Options & Extenders

The HP Computers are stored-program, general-purpose, digital computers particularly suited for automatic test systems.



TWO COMPUTERS AVAILABLE

The HP computer family offers a choice of two models: 2116C, and 2114C. Both are 16-bit machines, sharing the same word structure (and software). Plug-in options for the computers include Memory Parity to permit checks of words transferred in and out of memory and Power Failure Interrupt with Automatic Restart Capability.

Though foremost in everybody's mind, the choice of computer usually should be made last, since the computer requirements are not known until all other requirements for stimulus, measurement, switching, etc., have been determined. Even then, additional consideration must be given to future system expansion, and the size of test programs. In the automatic test system environment, some of the finer characteristic differences between the HP computers are usually insignificant, and the choice of computer is usually based on present needs and expandability for future requirements.

COMPUTER SPEED

The difference in computer speed (the 2116C takes less time than the 2114C to execute instructions), is usually negligible with respect to operator interaction and set-up time. For more dedicated high-volume production test systems or for digital logic test systems involving thousands of tests without operator intervention, this 20% difference in computer speed could be significant.

KEY COMPUTER CAPABILITIES

A resume of computers and computer options is as follows:

PARAMETER	2116C	2114C
Memory Cycle Time	1.6 μ s	2.0 μ s
Minimum Memory Requirement (1)	8K Words	8K Words
Maximum Mainframe Memory	32K Words	16K Words
Mainframe I/O Channels	16	6
Additional Extender I/O Channels	16 or 32	17
Mainframe Auxiliary Power	Yes	No
DMA	2 Channels	1 Channel
Memory Parity Check	With Interrupt	With Interrupt
Power Fail Interrupt with Automatic Restart	Yes	Yes

(1) Minimum memory requirement is for HP 9500 Series only.

PARITY ERROR

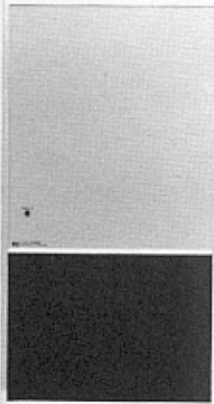
Parity error detection with computer interrupt causes a typed-out error diagnostic on the 2114C and 2116C computers.

POWER FAIL/AUTOMATIC RESTART

At some facilities, the possibility of an ac power line failure must be considered. The addition of the power fail option to the computer offers added flexibility in dealing with these unpredictable occurrences.

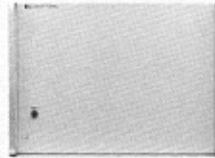
Where it is important to assure that all programmable instruments are restarted properly (proper switch connections made, correct voltage output levels re-established, etc.), the power fail option and associated HP BASIC CALL statement will be found indispensable. They allow the user to write (in BASIC—for each of his test programs) an appropriate restart sequence in which he can re-program all instruments appropriately, then restart, or continue the test.

Power Fail is not compatible with the HP 2020B-H27 Magnetic Tape Auxiliary Memory System, but is recommended for the HP 9300N/9300P AMS.



HP 2150B I/O EXTENDER

The HP 2150B Extender is designed for use with the 2116C computer only, and provides 32 additional I/O channels to the computer.



HP 2151A I/O EXTENDER

The HP 2151A provides I/O expansion for HP computers. The extender will add 16 I/O channels to the HP 2116C and 17 channels to the HP 2114C. This makes a total of 32 channels available with the HP 2116C and 23 channels with the HP 2114C.

The 2151A contains its own independent power supply. Its capability is sufficient for 17 I/O cards.



HP 2160A POWER SUPPLY EXTENDER

The HP 2160A Power Supply is used to provide auxiliary power to the 2116C computer only when power required for I/O cards exceeds the reserve power available in the computer main frame.

Cabinets

Cabinets are normally ordered with the system, and all the instruments in the system are installed in the cabinets with required instrument support rails in place, and with blank panels installed to cover all unoccupied panel space. The only exceptions are freestanding instruments such as the HP 2752A or HP 2754B Teleprinters and HP 2600A Keyboard Display Terminal. Installation time is minimized by having the system completely assembled in cabinets. Cables between instruments within cabinets are installed and the system is ready for use.

The HP 9500 Series Automatic Test Systems use the HP 2940A Series Cabinets. These cabinets are fully-wired, ready-to-use enclosures. Choices include one-, two-, and three-bay cabinets with 56-, and 70-inch panel openings. Usable depth of the cabinets (27 inches) is compatible with all HP computers and HP instruments. The cabinets are finished in 'Textured Blue' enamel that matches the color used for most Hewlett-Packard instruments.

All cabinets are equipped with a hinged rear door with recessed handle. Lockable latch is standard. They are equipped with a caster base, and a front base extension prevents tip over when any heavy instrument is swung out for servicing.

Overall dimensions are as follows:

Width:	21" per bay
Depth:	37-3/4" (includes 7-3/4" base extension)
Height:	78-1/4" (70" bay) 64-1/4" (56" bay).

The most common cabinet accessories required are storage drawers and shelves (also referred to as writing or working surfaces). A choice of two different sizes of storage drawers is provided. These occupy 3-1/2" or 5-1/4" of rack space. Single bay shelves are available either fixed or slide-out. Two-bay shelves are available fixed only. Blank panels and extra instrument support rails are also available, as well as rack mounting combining cases for HP 1/3- and 1/2-module instruments.



How To Configure A System

This section guides you through the four easy steps to configure a 9500 Series Automatic Test System of your own.

1. Make a Block Diagram

A picture is worth a thousand words. Every system should start as a block diagram. Put the computer at the top, leaving room for computer input and output devices, with stimulus on the left, measurement on the right, and switching in the middle. Then proceed as follows:

- Select required stimulus instruments
- Select measurement instruments
- Select converting and/or conditioning equipment
- Select any standard interfaces required to control any special user equipment or for other purposes.
- Select switching requirements
- Select interface panel
- Select computer input and output devices
- Make any miscellaneous selections desired
- Is auxiliary memory required? If so select auxiliary memory.

2. Totalize I/O Channel, and Memory Requirements

Add up the total I/O channel and memory requirements from the information given in the tables. For memory

requirements add the expected number of words that would be required for applications test programs. A minimum of 1,500 to 2,000 words for test programs is recommended. As a user becomes more experienced and the test programs become more sophisticated, more memory will be required.

3. Choose a Computer and Extender

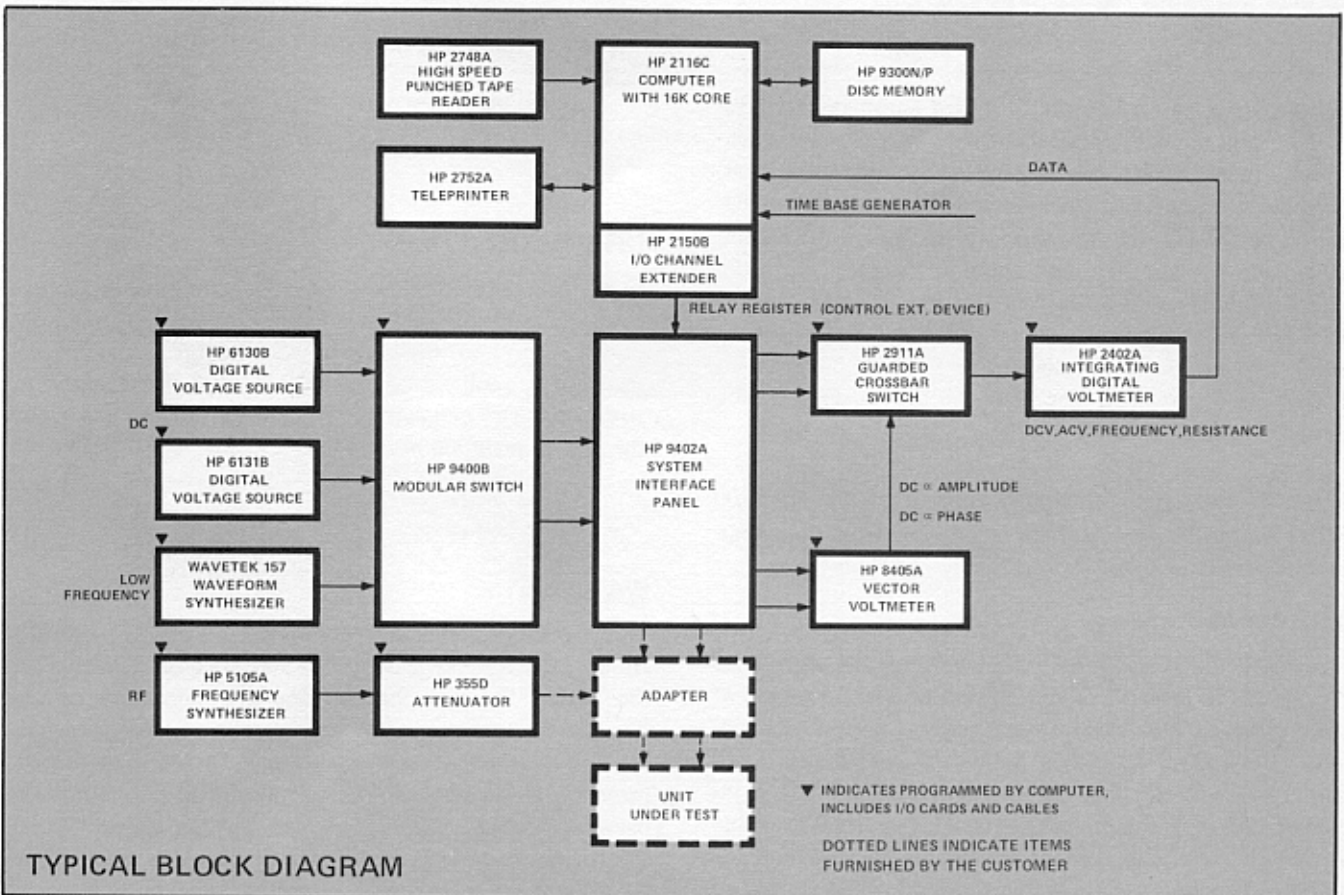
The choice of computer and appropriate options and extenders must be made last since the computer requirements are not known until all the automatic test system requirements have been fulfilled.

- Make a choice of computer and extender options to satisfy the requirements of total memory and I/O channels.
- Select computer mainframe options. Select power fail interrupt and parity error check if desired.

4. Cabinet Requirements

- Choose cabinet or cabinets with 20% more rack space than requirements totalized from the table.
- Make a rack layout of the system, allowing for shelves and drawers. Be sure to include any space required for miscellaneous equipment.

NOTE: For special requirements or additional information, please contact the factory.



Systems Support

The price of a Hewlett-Packard automatic test system includes systems engineering, software instrument drivers, basic operating system, fabrication, assembly, test, checkout, documentation, training, installation, and 90 day on-site warranty service. Software included allows operation of all equipment interfaced to the computer by statements in the HP BASIC Language. Standard HP quality assurance procedures are conducted to assure reliable and acceptable system operation prior to delivery to a customer. The system is also covered by the Hewlett-Packard warranty.

A brochure describing Customer Support for the HP 9500 Series Automatic Test Systems is available from your nearest HP Sales Office.

TRAINING

System operation training is available during the acceptance testing at the factory, or during the installation period at the customer's site. This informal training period normally lasts 1 to 3 days, depending on system complexity. Standard two-week HP computer programming training is included. A computer maintenance training course is available at standard cost. Maintenance courses are also available for all HP instruments used in systems.

DOCUMENTATION

Documentation supplied with each system includes a system configuration manual and manuals for the computer, instruments, and peripherals used in the system. These manuals contain service, operation, and maintenance instructions. The manuals are commercial quality and enable the user to maintain his system.

WARRANTY

The warranty on each system provides for on-site service by HP at no charge for a period of 90 days after delivery. For the period between 90 days and the remainder of the one-year system warranty, any travel and living expenses for HP are charged to the customer. Parts and service are provided at no charge. The warranty also covers non-HP manufactured products contained in the system, unless specifically excluded, or if a shorter period is specified by HP prior to the purchase of the system.

TABLE I
STIMULUS INSTRUMENTS

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
6130B	J20	Digital Voltage Source (First One)	(207) ²	(1) ²	(5.25)	120	44
	6130B-J20	Digital Voltage Source (Up to 7 Additional Units)			(5.25)	120	44
6131B	J20	Digital Voltage Source (First One)	(207) ²	(1) ²	(5.25)	120	44
	6131B-J20	Digital Voltage Source (Up to 7 Additional Units)			(5.25)	120	44
5105A		Frequency Synthesizer	(54)	(1)	(10.50)	35	90
	5110B	Synthesizer Driver			(5.25)	35	67
	2759B	Programmer			(5.25)	50	32
157	S-134	Waveform Synthesizer (Wavetek)	(168)	(1)	¹ (7.00)	50	27
1012		Pulse Generator (Chronetics)	(442)	(2)	¹ (7.00)	100	35
745A	H06	AC Calibrator	(120)	(1)	(8.75)	100	80
	746A	High Voltage Amplifier	(50)	(1)	(7.00)	850	85
3330A		DC Voltage/Current Calibrator (Fluke)	(337)	(2)	¹ (8.75)	130	65

¹ Includes 1-3/4" blank panel to clear support rails.

² Up to 8 total HP 6130B and HP 6131B DVS may be controlled with one I/O channel and one software driver.

TABLE II
MEASUREMENT INSTRUMENTS

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
2402A		Integrating Digital Voltmeter	(106)	(2)	(5.25)	150	56
	001	Autoranging					
	002	AC Measurement					
	003	Ohms Measurement					
	005	Frequency Measurement					
3450A	04-05-06	Multi-Function Meter	(194)	(2)	(3.50)	75	50
	001	AC Converter					
	002	Ohms Converter					
5325B	H74	Universal Counter	(512)	(2)	(3.50)	35	17
5360A		Computing Counter	(691)	(1)	(5.25)	250	61
	5365A	Input Module					
	5379A	Time Interval Unit					
1000		Waveform Analyzer, Automated Measurements Corp.	(356)	(2)	¹ (10.50)	270	135
	901-10	High Impedance Probe (2 supplied) (Other Probes; Consult factory)					

¹ Includes 1-3/4" blank panel to clear support rails.

TABLE III
CONVERTING AND CONDITIONING INSTRUMENTS
 (Used with Measurement or Stimulus Instruments)

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
400E	H16	AC Voltmeter	(65)	(1)	¹	5	8
3400A	J34	RMS Voltmeter	(65)	(1)	¹	7	11
8405A	H16	Vector Voltmeter	(135)	(2)	(7.00)	35	35
355D	E46	Attenuator	(61)	(1)	¹	15	18
432A	H03	Power Meter	(18)	(1)	¹	5	10
334A	H15	Distortion Analyzer	(502)	(1)	(5.25)	65	34

¹ 1/3 HP Module—Requires 7" Rack Mounting Combining Case—Can Share with other HP Modules.

TABLE IV
SWITCHING
 (Prices Do Not Include Any Wiring To or From Switching)

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
9400A		Distribution Switch (4 Relay Trees)	(33)	(1)	(7.00)	160	50
9400A	002	Distribution Switch (2 Relay Trees)	(33)	(1)	(7.00)	160	50
9400A	003	Distribution Switch (3 Relay Trees)	(33)	(1)	(7.00)	160	50
9400B		Modular Switch (Will Accept up to 16 Cards Below)	(177)	(1)	¹ (15.75)	212	50
	25000C	Drive and Storage Card (32 Drivers)					
	25000D	General Purpose Relay Card (16 Relays, 1 Form A and 1 Form C Each)					
	25000H	Reed Relay Card (32 Form A Reeds)					
	25000J	Distribution Card 1 X 16 Matrix 4 Levels Deep					
	9400B	"Add on" Modular Switch (Will Accept up to 16 Cards Above)			(10.50)	212	50
	2911A-23	Crossbar Switch (Includes One 25000H Card and 60243B Power Supply) (For 2402A)	(150)		² (12.25)	26	64
	2911A-67	Crossbar Switch (Includes One 25000H Card and 60243B Power Supply) (For 3450A)	(150)		² (12.25)	26	64
2911A	023	Guarded Crossbar Switch (For 2402A)	(43)	(1)	(8.75)	23	60
	2911B-033	Crossbar Scanner Control			(5.25)		34
2911A	067	Guarded Crossbar Switch (For 3450A)	(43)	(1)	(8.75)	23	60
	2911B-033	Crossbar Scanner Control			(5.25)		34

¹ 5-1/4" Rack Adapter Included Will Hold Up to Four Supplies For Extra Relay Power if Required.

² 3-1/2" Rack Adapter for Power Supply Included.

TABLE V
INTERFACE PANEL

Model Number	Option or Accessory Number	Description	Number of Pins	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
9402A		System Interface Panel	1768	N/A ⁴	14.0	None	30
	101	HP 6130B Output Cable	(6)				
	102	HP 6131B Output Cable	(6)				
	103	HP 745A Output Cable	(4)				
	104	Wavetek 157 Output Cable	(2)				
	105	Fluke 3330A Output Cable	(6)				
	201	HP 2402A AC/DC Input Cable	(3)				
	202	HP 2402A Ohms Input Cable	(6)				
	203	HP 2402A Frequency Input Cable	(2)				
	204	HP 3450A Input Cable	(6)				
	205	HP 5325A A & B Input Cables	(6)				
	206 ¹	AMC 1000, High Z Input Cables (Two)	(4)				
	207	HP 400E AC Input Cable	(2)				
	208	HP 400E DC Output Cable	(2)				
	209	HP 3400A AC Input Cable	(2)				
	210	HP 3400A DC Output Cable	(2)				
	211	HP 8405A DC Output Cables	(4)				
	212	HP 334A AC Input Cable	(2)				
	213	HP 334A DC Output Cable	(2)				
	214	HP 432A DC Output Cable	(2)				
	301	HP 9400B - 25000C Cable	(36)				
	302	HP 9400B - 25000D Cable	(80)				
	303	HP 9400B - 25000H Cable	(64)				
	304	HP 9400B - 25000J Cable	(72)				
	305 ²	HP 2911A - 10 Channel 3-Wire Cable	(30)				
	307	HP 2911A-023 6-Wire Ohms Output Cable	(6)				
	308	HP 2911A-023 3-Wire AC/DC Output Cable	(3)				
	309	HP 2911A-023 2-Wire Frequency Output Cable	(2)				
	310	HP 2911A-067 6-Wire Output Cable	(6)				
	401	HP 12551B - Relay Register I/O Cable	(36)				
	402	HP 12554B - 16-Bit I/O Cable	(36)				
25001A ³		Test Adapter					

¹ Up to 10 input probes available on each AMC 1000, 2 pins required per cable.

² Up to 20 option 305's can be ordered.

³ One each supplied with 9402A.

⁴ N/A = Not applicable.

TABLE VI
STANDARD COMPUTER INTERFACES
(Plug Directly Into Computer)

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
12551B		Relay Output Register		(1)	1	1	4
12554A		16-Bit General Purpose Duplex Register	(239)	(1)	1	1	4
12566A		Microcircuit Interface	²	(1)	1	1	4

¹ Plugs directly into computer.

² General Purpose Driver—Only one per system. Handles Any Number of Relay, GP, and Microcircuit Registers.

TABLE VII
COMPUTER INPUT AND OUTPUT DEVICES

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
¹ 2752A		Teleprinter	³	(1)	⁴	230	92
¹ 2754B		Heavy Duty Teleprinter	³	(1)	⁵	350	270
² 2748A		High Speed Punched Tape Reader	^{3,6}	(1)	(8.75) ⁷	240	25
² 2758A		Tape Reader—Reroller	^{3,6}	(1)	(8.75)	633	60
2753A		High Speed Punched Tape Output	^{3,6}	(1)	(14.0)	450	82
2600A		Keyboard-Display Terminal	(55)	(1)	⁸	200	55

¹ Choice of One Required

² Choice of One Required

³ Included with Computer

⁴ Free Standing 33" High 26" Wide 19" Deep

⁵ Free Standing 34" High 40" Wide 24" Deep

⁶ Software for read/punch data is available—See Table VIII

⁷ 1-3/4" Panel included with AC Outlet

⁸ Not Rack Mounted; 14" High, 18" Wide, 18" Deep

TABLE VIII
MISCELLANEOUS

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
12539A		Time Base Generator (Software Clock)	(82)	(1)	²	²	4
¹ 25104Y		Switch Register Interrogator Call	(40)	1	1	1	
¹ 25106C		Read/Punch Data Call	(293)	1	1	1	

¹ Software Only—No Hardware Involved

² Plugs Directly Into Computer Mainframe

TABLE IX
AUXILIARY MEMORY

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
^{1,2} 2020B	H27	7 Channel Magnetic Tape Input/Output (Dual Density)	(903)	(2)	(42)	970	275
^{1,2} 9300N		Disk Memory (Moving Head-Cartridge)	(1,024)	(2)	(12.25)	800	100
	9300P	Disk Memory Power Supply			(8.75)	600	50
7970	226	9 Channel Magnetic Tape Input/Output	(1,300)	(2)	(24)	500	100

¹ Require 16K Memory Option

² Choose only one

**TABLE X
COMPUTER AND MAINFRAME OPTIONS**

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
² 2116C		Computer with 8K Memory	2,841 ⁵	16	(31.5)	1,600	330
	005	Additional 8K Memory	11,033 ⁵				
	006	Additional 16K Memory	19,225 ⁵				
	007	Additional 24K Memory	27,417 ⁵				
	12591A	Parity Error Interrupt	(8)				
	12588A	⁴ Power Fail/Automatic Restart	(30)				
¹ 2160A		Power Supply Extension			(7.00)	345	50
³ 2151A	12596A	I/O Extension to 32 Channels (Total)		16	(12.25)	800	125
³ 2150B	001	I/O Extension to 48 Channels (Total)		32	(31.5)	1,600	330
² 2114C	003	Computer with 8K Memory	2,841	6	(12.25)	800	150
	004	Additional 4K Memory	6,937 ⁵				
	005	Additional 8K Memory	11,033 ⁵				
	12598A	Parity Error Interrupt	(8)				
	008	⁴ Power Fail/Automatic Restart	(30)				
2151A	12593A	I/O Channel Extension to 23 Channels (Total)		17	(12.25)	800	125

¹ For budgeting purposes, always include power supply extension with associated computer.

² Choice of one computer required

³ Choose only one

⁴ Not available with 2020-H27 Mag Tape

⁵ Core Memory available for instrument drivers and test programs.

**TABLE XI
CABINETS**

Model Number	Option or Accessory Number	Description	Words of Memory	I/O Channels	Rack Space (Inches)	Power Required (Watts)	Weight (Lbs)
2940A	156-16-52	Cabinet, 1 Bay 56" Panel Area with Base Extension, 115V ac			56	50	280
2940A	256-26-53	Cabinet, 2 Bay 112" Panel Area with Base Extension, 115V ac			112	100	471
2940A	356-36-54	Cabinet, 3 Bay 168" Panel Area with Base Extension, 115V ac			168	150	672
2940A	170-16-52	Cabinet, 1 Bay 70" Panel Area with Base Extension, 115V ac			70	50	332
2940A	270-26-53	Cabinet, 2 Bay 140" Panel Area with Base Extension, 115V ac			140	100	554
2940A	370-36-54	Cabinet, 3 Bay 210" Panel Area with Base Extension, 115V ac			210	150	796
	12672A	Storage Drawer (3-1/2 Inch)			(3.50)		20
	12673A	Storage Drawer (5-1/4 Inch)			(5.25)		20
	12674A	Writing Surface (Shelf) 1 Bay Slide Out			(3.50)		30
	12675A	Writing Surface (Shelf) 1 Bay Fixed			(1.75)		30
	12676A	Writing Surface (Shelf) 2 Bay Fixed			(1.75)		50

HEWLETT  PACKARD

AUTOMATIC MEASUREMENT DIVISION

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Printed in U.S.A.

5952 - 1331 (10/70)