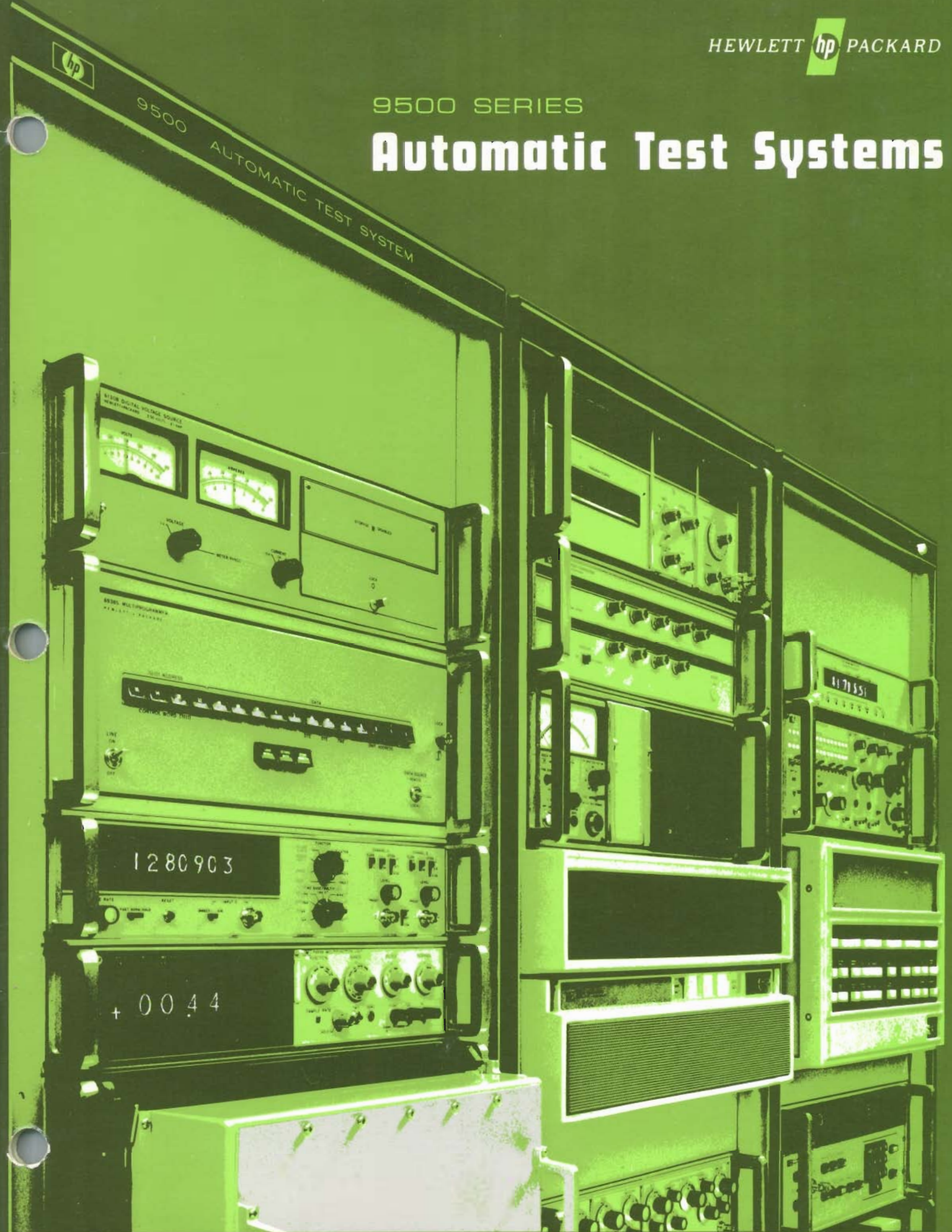HEWLETT **hp** PACKARD

9500 SERIES
Automatic Test Systems

HP Computer Museum
www.hpmuseum.net

For research and education purposes only.

Typical HP Automatic Test System

A COST EFFECTIVE SOLUTION TO YOUR TEST PROBLEM

Many testing facilities today are feeling the strain of the growth in test requirements brought about by the greater complexity and technical sophistication of modern electronic equipment. There is a cost-effective solution to this problem—the Hewlett-Packard 9500 series of Automatic Test Systems. These systems contain accurate and dependable stimulus and measurement instrumentation selected by the customer from a wide choice of standardized subsystems designed for 9500 systems. The instrumentation subsystems are controlled in the system by HP's 2100A minicomputer, which is incorporated into standard controller packages providing the customer a choice of two levels of capability. To this extensive selection, described in this brochure, HP is continually adding new components. Thus, the 9500 system is a flexible modular concept which allows you to buy a system matched to your current needs, however large or small, and expand with your future requirements simply by adding subsystems.

Reasons to buy an HP 9500 system...

Increase the Capacity of Your Operations

HP 9500 systems can increase test speeds over manual methods by many times. Maximum rates in most cases are limited only by the characteristics (settling times after application of stimulus) of the device under test. The much higher testing rate achieved with a 9500 system will significantly improve your testing "throughput". . . the volume of products that can be tested per unit time. Thus, production bottlenecks at test stations can be eliminated, with a consequent improvement in overall operating efficiency of your facility.

Improve Product Reliability

With the speed advantage of a 9500 automatic test system, it is practical to conduct many more tests on a device that you can afford with manual or semi-automatic testing techniques. You can therefore check or characterize your products or equipment far more completely, improving product reliability. And, sometimes more important, the Automatic Test System is not subject to fatigue – it performs its millionth test just as accurately as the first, without the human failings of parallax errors in meter readings, transposition of digits when logging results, or testing blunders. The testing program can catch virtually all faults at module or subassembly levels before they become costly troubleshooting puzzles during final checkout of complex systems. More thorough testing results in fewer field failures due to undetected deficiencies, thus warranty costs of new products are reduced and maintenance facilities are rewarded with fewer returns. If a service contract is involved, the financial return on the contract will be improved.

The improvement in data gathering and record keeping is itself a reason for employing an automatic test system with a computer memory. A 9500 system allows you to program only for useful data which may be read out at the end of each test and/or saved for future readout; for instance, for comparison at a future maintenance check or after a field failure. Each set of records can be labeled with its serial number, inserted by the system operator, printed out at end of test and sent along with the equipment to the customer.

Your Present People Can Run It

The prospect of a first automatic test system inevitably raises the question of who will operate it and how will it be operated. This seems like a high hurdle in a facility where all present equipment is manually operated. But it shouldn't be with an HP 9500 system – you can instruct this system in English-like HP ATS BASIC (see next page) and the results printed out are in the same idiom. After a nominal amount of training your technical personnel can write their own test programs, on-line, and instruct assistants on how to connect devices for testing and how to run the system through its push-button control panel.

Satisfied 9500 Users

HP has supplied 9500 systems to users engaged in almost every area of electronic endeavor—maintenance for the Army, Navy, and Air Force; research in commercial and military applications, and production of electronics. Some of these have been published for public information.

"Tester for Communication Equipment" – tests components, assemblies, and systems. Article published in Telecommunications, Feb. 1969, and HP Journal, Aug. 1969.

"Computer Controlled Automatic Test Systems" – tests thick film circuits and modules for hand-held transceivers (Magnavox). Described in HP bulletin 5952-1304.

"Depot Testing of Avionics Modules" (Hill AFB) – tests autopilots and navigational amplifiers. Described in HP bulletin 5952-1370.

"Automatic Analog Module Test System for Inertial Guidance and Navigation Systems" (Litton Industries). Described in HP bulletin 5952-1305.

"Automatic Test Equipment: Is There a Viable Solution" published in Microwave Systems News, July/Aug. 1971. Describes HP 9500 Testers used in the F111 Avionics Maintenance Programs and by the Royal Swedish Airforce for flight-line and depot testing of Viggen fighter avionics.

"Commercial ATS Revisited – Results vs. Promises" describes Telephone Touch-Tone Module Tester (ITT), Thin-film Substrate Production Tester (HP), and Digital Test System for large digital cards (HP). Technical paper by David S. Kline, 1971 WESCON.

We Invite You to Learn More

Since Hewlett-Packard introduced its first minicomputer over four years ago, we have built and delivered over 700 computer-controlled instrumentation systems. Several of your competitors might already be reaping the benefits of computer controlled automatic testing. Isn't it time you looked into it further? We invite you to learn more about our 9500 test systems. If you think you might have an automatic test application, feel free to call a Hewlett-Packard system specialist at your HP Sales Office (see listing on page 34). He will be glad to consult with you and tailor a system to satisfy your test requirements.

```
900    REM--------------------------------------------------------------
905    REM               WT-157 AC GEN STIM AMPL CK
907    GOSUB 9000
910    SSW(1,111)
911    SSW(1,12)
915    LET V=.672
920    LET F=1209
925    GOSUB 9200
935    DVMMU(1,M,1)
940    GOSUB 9000
945    IF FNA(M) GOTO 975
950    DSPLAY "WT-157 STIM CK FAILED; PGM ABORT",V;M
955    STOP
975    REM
1000    REM--------------------------------------------------------------
1005    REM                 MEAS #1 UUT ID CK
1007    LET I=1
1015    SSW(3,15)
1020    DVMSU(3,100000,0)
1025    LET V[I]=44000
1030    LET T[I]=.2
1045    WAIT (20)
1050    DVMMU(1,M[I],1)
1055    GOSUB 9000
1060    IF FNB(I) THEN 1090
1075
1085
1087
1088
1090
1100
1105
1115
1117
1118
1120
1130
1135
1140
1145
1150
1160
1165
1175
1180
1182
1183
1184
1186    STOP
1190    REM
1195    NEXT I
1197    SSW(0,15)
1200    REM--------------------------------------------------------------
1205    REM              MEAS #4 AC SIG APP CK PIN 11 TO 12,1
1210    SSW(1,97)
```

SYSTEM PROGRAMMING IS EASILY MASTERED

One of the most important considerations in acquiring and operating an automatic test system is the software (computer programs). Each new device to be tested requires a test program to be written. It is essential that these programs be easily written by the persons who understand the devices to be tested. The people with this knowledge are usually technicians or engineers, not professional programmers.
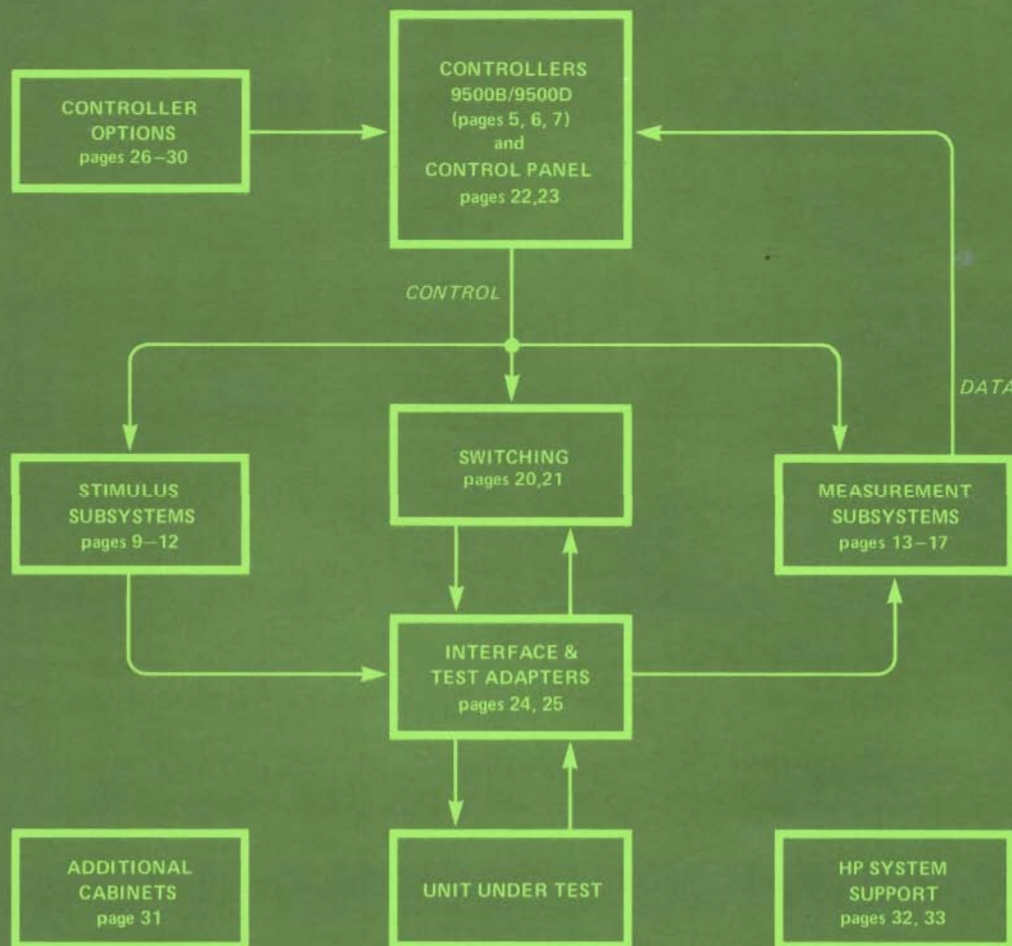
Test programs for an HP 9500 system are written in easy-to-understand and easy-to-use HP ATS BASIC.* HP ATS BASIC is a computer language made up of "English-like" statements along with abbreviations for test instruments, test parameters and switching. It is so simple that technical personnel can be writing their own programs after just a few hours of instruction. The HP ATS BASIC programming language is conversational; i.e., when you type a program statement and enter it, the system immediately checks it. If it is not acceptable, the system types out a coded error message informing you of the mistake. You then correct the mistake and continue entering your program. You will not get trapped into a seemingly endless cycle of finding an error, correcting it, and recompiling, to find yet another error, etc. which is often the case with non-conversational programming. HP ATS BASIC is also very powerful in that it contains all instrument control and timing statements required for operation of your 9500 system plus computational capabilities such as add, divide, and exponential and trigonometric functions.

*HP ATS BASIC for Automatic Test Systems is described in brochure 5952-1330. This is available from Hewlett-Packard Field Sales and Service Offices.

	CONTROLLERS 9500B/9500D (pages 5, 6, 7) and CONTROL PANEL pages 22,23	
CONTROLLER OPTIONS pages 26—30		
	CONTROL	*DATA*
STIMULUS SUBSYSTEMS pages 9—12	SWITCHING pages 20,21	MEASUREMENT SUBSYSTEMS pages 13—17
	INTERFACE & TEST ADAPTERS pages 24, 25	
ADDITIONAL CABINETS page 31	UNIT UNDER TEST	HP SYSTEM SUPPORT pages 32, 33

HP 9500 Test System Concept & Index

SYSTEM CONTROLLERS SIMPLIFY DESIGN

The Hewlett-Packard modular approach to Automatic Test Systems results in easy-to-use functional operation at a minimum cost. Modularity of instrumentation is provided by standardized subsystems while modularity of the computer and its peripherals is utilized in the standardized controllers.

Hewlett-Packard offers two different controllers combining peripherals, software and a minicomputer. In this way you can choose the controller capability which meets your requirements and your budget. Your choice of controller should take into account the number of instruments to be controlled, the scope of programming anticipated in its application; testing throughput rate required; and an allowance for future expansion of the system. However, if your present budget does not allow the highest level of capability to be purchased now, you may buy the minimum controller and add to it in the future.

Both controllers contain a control panel, a teleprinter, and a high speed tape reader which are used as input/output devices between the operator or programmer and the computer. These are called computer peripherals. Each also includes a one bay cabinet with 70 inches of rack space.*

In testing, the system is normally operated through the control panel which provides convenient push-buttons for system commands. There is also a set of buttons for inserting numbers into the system which may be used for entering device-under-test serial number, operator identification number, etc. A display for test status information is also provided on the panel.

*Consideration of usable rack space, input/output slots, and memory available for instrument drivers and user programs is covered in the brochure "Configuring Guide for HP 9500 Systems." (HP publication No. 5952-1332).

Choose one of these controllers to build
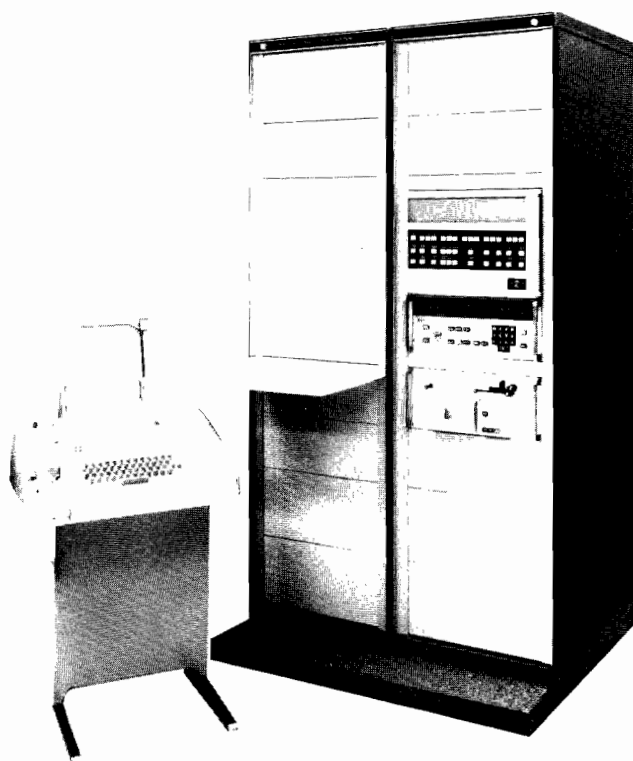
CONTROLLER COMPONENTS

COMPONENT*	CONTROLLER MODEL	
	9500B	**9500D**
Computer (2100A)	12K words †	16K words †
Punched Tape Reader (2748A)	●	●
Teleprinter (2752A)	●	●
Control Panel (9403A)	●	●
1-Bay 70'' Cabinet (2940A) **	●	●
Dual Magnetic Disc Memory (7900A)		●

* *Optional substitutes and additions are given on pages 26–31.*
** *Two bays shown in photo includes one optional bay.*
$\dagger$ *Core memory.*

from...

HP 9500B: This is the basic level of controller which includes components common to both levels of capability offered. The system's computer, (HP 2100A), controls system operation and provides data with the assistance of the following units: a teleprinter for user program preparation with the keyboard and hard copy printout of program listings and test data; a high speed tape reader which speeds up the loading of programs over the slower operating teleprinter. A control panel provides simple convenient control of the system for the operator. The 9500B controller is suitable where programs of moderate length are to be used with only occasional changes. It may be up-graded in the future at the user's facility to a 9500D controller by adding the disc memory unit.

HP 9500D: This is called the standard level of controller because it contains all the memory capacity normally desired in high throughput or multiple application systems. It includes a dual-disc magnetic memory with 2.5 million word capacity, in addition to all the components contained in the 9500B. Features are: fast calling of stored programs, linking of programs stored in several memory areas, linking from the main program to a subprogram and returning to the main program, and the ability to test with several languages (HP ATS BASIC, FORTRAN II, and HP Assembly) because of the very large memory capacity. One of the discs in the dual-disc drive is in a cartridge which may be conveniently replaced from the front panel for interchanging test program libraries, etc.

Select stimulus and measurement...

HP 9500 Series Systems are Configured Modularly, to Meet Your Needs Today and Tomorrow

Stimulus, measurement, and other capabilities for 9500 series systems are provided in subsystem packages. These packages are engineered carefully for hardware and test programming compatibility, and interchangeability with respect to the basic system and with respect to each other. Right now, you can choose from a wide variety of HP instrument and peripheral subsystems, as follows:

- DC, AC, pulse, and RF stimulus

- DC, AC, resistance, frequency, pulse, and time interval measurements

- Digital test

- Power, distortion, phase measurement, conversion, and conditioning

- Switching

- Optional system input/output peripherals

These subsystems are readily assembled into a system that satisfies your requirements today, at a cost that fits into your current budget. Other subsystems needed later are easily added or interchanged with those originally selected, to adapt your system to handle new assignments tomorrow.

HP 9500 Series Systems Use Standard Instrumentation

"Off-the-shelf", commercially-available instruments are used wherever possible in the subsystems for 9500 Series Automatic Test Systems. This avoids the high costs and long lead times associated with the design of custom instruments. Costs are lower because development expenditures are spread over a large number of units. Since standard instruments must satisfy diverse requirements, they bring great versatility to the system. And because of the quantity of similar units produced, the reliability and performance of standard instruments are better established than is practical with custom instrumentation. The instruments used in 9500 series systems are thoroughly evaluated by an experienced systems engineering team that draws upon Hewlett-Packard's more than 30 years of contributions to the field of electronic instrumentation. In your system, our approach of using standard instruments will give you maximum versatility, reliability, and performance at the lowest cost.

The controllers discussed on the previous pages provide the solid foundation on which stimulus, measuring, switching, and other capabilities required for your system are added. The relationships of these capabilities in the total system are shown in the 'Test System Concept' illustration on page 4.

STIMULUS SUBSYSTEMS

Stimulus instrument subsystems provide the signals applied to the unit under test. These subsystems include power supplies, oscillators, function generators, synthesizers, pulse generators, etc. Standard stimulus subsystems are described herein. However, other stimulus instruments are also available.

The specifications given here reflect the operation of the stimulus instrument of the subsystem as interfaced to the computer. More complete specifications on individual instruments are given in Technical Data Sheets which provide front (or rear) "terminal" instrument specifications. However, these specifications do not include degradation introduced by system cabling and switching (resistance, reflections, crosstalk, etc.).

NOTE: Those items asterisked (*) are under control of the HP ATS BASIC software supplied with the subsystem.
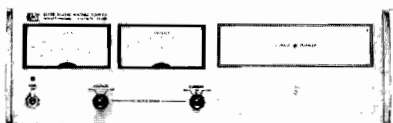
VOLTAGE SOURCES–DIGITALLY PROGRAMMED
(Subsystem 28010A)

This subsystem includes a choice of digitally controlled voltage sources of different output voltages and currents: the 6130B is standard; the 6131B and 6129B are options. Polarity, voltage, and current limits are programmable on all sources. Up to eight voltages sources may be controlled in the same subsystem using the same software driver. For more than eight, a second subsystem and software driver can be added to the system.

*HP 28010A: Includes HP 6130B. Dual Range DC Output: -16 to +16V dc (in 0.5 mV increments) at 0 to 1A; -50 to +50V dc (in 5 mV increments) at 0 to 1A.

Current Limit: 20, 50, 70, 100, 200, 500, 700, or 1000 mA. Current limit operates in both source and sink modes (sink limit is 250 mA).

*Option 001: Includes HP 6131B. Dual Range DC Output: -16 to +16V dc (in 0.5 mV increments) at 0 to 0.5A; -100 to +100V dc (in 5 mV increments) at 0 to 0.5A.

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

*Option 006: Includes HP 6129B. Dual Range DC Output: -16 to +16V dc (in 0.5 mV increments) at 0 to 5A; -50 to +50V dc (in 5 mV increments) at 0 to 5A.

Current Limit: 100, 250, 350, 500 mA. 1A, 2.5A, 3.5A, 5A. Current limit operates in both source and sink modes (sink limit is 2.5A).
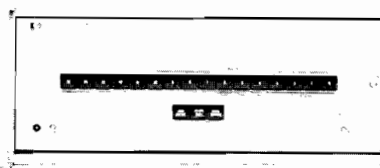
MULTIPROGRAMMER WITH HIGH CURRENT/LOW VOLTAGE DC POWER SUPPLY OPTIONS
(Subsystem 28030A)

Each 28030A subsystem includes a multiprogrammer to which power supplies are added of either a single type or any combination of two or three types. Therefore, the supplies are options to the multiprogrammer subsystem which controls them. The HP 6936A Multiprogrammer holds up to 15 interface cards for the supplies. Each supply uses two cards, one for voltage control and the other for current limit; thus, the HP 6936A can accommodate seven supplies in any combination of the three given below. A feature of this multiprogrammer is that it will control a chain of power supplies up to a maximum of 112 using only one I/O card and one software driver by adding extenders (HP 6937A).

*Option 002: Includes HP 6256B: 0–10V, 0–20A, programmed at 10 mV resolution and 2% current limit steps.

*Option 004: Includes HP 6267B: 0–40V, 0–10A, programmed at 10 mV resolution and 2% current limit steps.

*Option 006: Includes HP 6274B: 0–60V, 0–15A, programmed at 25 mV resolution and 2% current limit steps.

LOW FREQUENCY SIGNAL SOURCE
(Subsystem 28039A)

This subsystem contains the HP 3320B Frequency Synthesizer which provides completely programmable low distortion sine wave signals from 0.001 Hz to 13 MHz. Many of today's exacting requirements for signals of low distortion, high accuracy, stability, and resolution are met by this unit.

|	
*Frequency Ranges:	10 Hz, 100 Hz, 1000 Hz, 10 kHz, 100 kHz, 1000 kHz, & 10 MHz; 30% overrange on all ranges
*Frequency Resolution:	4 digit resolution with Vernier Out while in Local or Remote. 5 digit resolution with Vernier In while in Remote.
*Output Level:	26.99 dBm to -73 dBm (50 ohms) (50 μVrms to 5.0 Vrms)
Output Impedance:	50 ohms standard
Harmonic Distortion:	Better than -40 dB at maximum amplitude and frequencies > 0.1% of range
*Option 001:	Adds an additional 3320B Frequency Synthesizer to the Subsystem
Option 002:	Adds 5 MHz Reference Crystal Oven in place of standard crystal. Provides frequency stability of ±1 part in 10^8/day
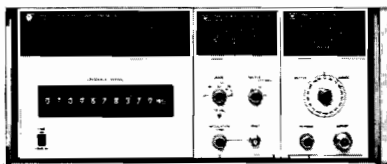
SYNTHESIZED SIGNAL GENERATOR
(Subsystem 28048A)

In this subsystem an HP 8660A Synthesized Signal Generator with RF section plug-in HP 86601A is employed to provide output frequencies from 10 kHz to 110 MHz. Modulation section plug-in HP 86632A, for AM/FM modulation, is included. This completely programmable instrument subsystem provides frequency standard stability at any frequency in 1 Hz steps over its frequency range. The plug-in construction allows up-dating in the future. Frequency of output is shown on a front panel 8-4-2-1 LED display. Specifications are as follows:

*Frequency Range:	10 kHz to 110 MHz
Frequency Resolution:	1 Hz

*Output Level (Remote):	+13 to -146 dBm in 1 dB increments (1 Vrms to 0.01 μVrms)
Output Level (Local):	+13 to -146 dBm, continuously adjustable
Output Impedance:	50 ohms
Harmonic Signals:	At least 40 dB below desired output signal
Spurious Signals:	At least 80 dB below the desired output signal
Switching Time:	Less than 5 ms to be within 100 Hz of new frequency selected
*Amplitude Modulation:	Modulation Depth: 0 to 95%. External rates: < 50 kHz. Internal rates: 400 Hz and 1 kHz
*Frequency Modulation:	Rate: 0 to 1 MHz. Internal rates: 400 Hz and 1 kHz

Deviation: 1 MHz, maximum |
| Option 001: | Increase stability of internal reference oscillator by 10 times. Aging rate: 3×10^{-9}/24 hrs. |
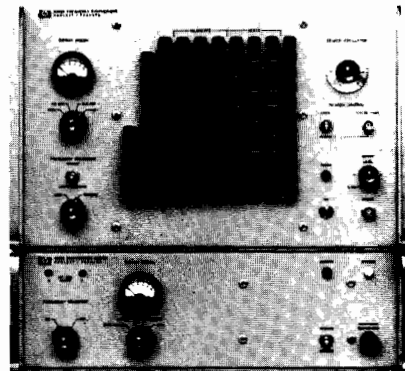
FREQUENCY SYNTHESIZER WITH HIGH RESOLUTION
(Subsystem 28004A)

The frequency synthesizer subsystem includes the HP 5105A and HP 5110B. It 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. 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
*Frequency Resolution:	0.1 Hz
Output Voltage:†	0 dBm ±1 dBm into 50Ω

† For programmable output levels, refer to HP 28009A attenuator.

PROGRAMMABLE VHF ATTENUATOR
(Subsystem 28009A)

This VHF attenuator subsystem gives programmable amplitude control of DC, RF, and AC voltages up to 1000 MHz. It consists of an HP 355C Attenuator and an HP 355D Attenuator 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

WAVEFORM SYNTHESIZER–SINE, SQUARE, TRIANGULAR
(Subsystem 28018A)

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
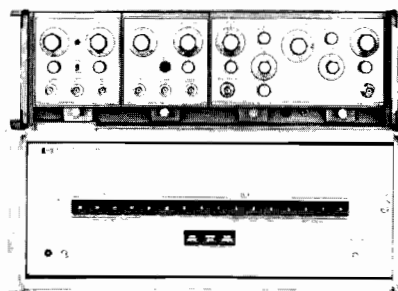
PULSE GENERATOR–PROGRAMMED RATE, DELAY, SLOPE, WIDTH, OFFSET, AMPLITUDE
(Subsystem 28033A)

The main instrument in this subsystem is the HP 1900A Pulse Generator. It is furnished with an HP 1905A Rate Generator plug-in for pulse rates from 25 Hz to 25 MHz, an HP 1908A Delay Generator plug-in providing advance or delay from 15 ns to 40 ms for the trigger output or double pluse mode variable separation, and an HP 1917A Variable Transition time output plug-in for rise and fall times as fast as 7 ns with variable width, variable offset, and variable amplitude. All of these features are programmable.

This subsystem uses the programmable options to the Model 1900A plug-ins. The programming signals are obtained from an HP 6936S Multiprogrammer which translates the digital computer commands to those required for the plug-ins. The multiprogrammer may also be used for certain programmed power supplies (refer to description under the HP 28030A Multiprogrammer Power Supply Subsystem).

One pulse generator uses seven output cards and the multiprogrammer holds 15 cards; thus, one multiprogrammer can handle two pulse generators or one pulse generator and four power supplies. Even more pulse generators and power supplies can be accommodated by adding a 6937S Multiprogrammer Extender.

*Repetition Rate:	25 Hz to 25 MHz (6 ranges)
*Pulse Delay:	15 ns to 10 ms (6 ranges)
*Pulse Width:	15 ns to 40 ms (7 ranges)
*Rise & Fall Times:	7 ns to 100μs (5 ranges)
*Pulse Amplitude:	0.2 to 10V, pp
*Pulse Polarity:	Positive or negative
*Baseline Offset:	0 to ±2.5V (1 range)
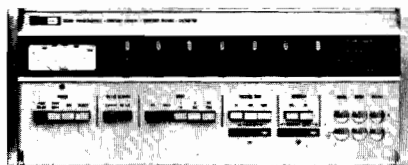
PROGRAMMABLE VOLTAGE/CURRENT CALIBRATOR (Subsystem 28020A)

Precise DC voltages and currents are available as stimuli from this subsystem, which includes the Fluke 3330B Calibrator. It 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 ±10.999999V (1 µV steps)
±11.00000 to ±109.99999V (10 µV steps)
±110.0000 to ±1099.9999V (100.0 µV steps)

Available Currents:	0 to 100 mA (10V & 100V ranges) 0 to 50 mA (1000V range)
*Current Limit:	1 mA to 110 mA in 10 mA steps)

*Constant Current Outputs:

0 to ±1.0999999 mA (0.1 nA or 1 nA steps)
±1 to ±10.999999 mA (1 nA steps)
±11 to ±109.99999 mA (10 nA steps)

|	
Compliance Voltage:	0 to 1000V (1 & 10 mA ranges) 0 to 500V (100 mA range)
*Voltage Limit:	10% to 110% in 10% steps of programmed voltage limit range
*Voltage Limit Range:	10, 100, 1000 volts
*Mode:	Current or Voltage
*Crowbar:	"on" or "off" (5 ohms short across output terminals)
Output Connections:	Rear-panel outputs with polarity reversal. Separate sense leads provide for 4-terminal connection to load.
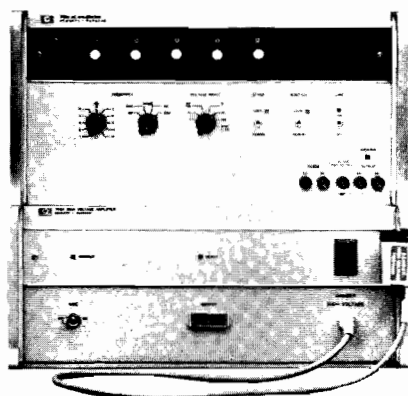
PROGRAMMABLE AC CALIBRATOR (Subsystem 28014B)

Precise AC calibration voltages, programmable over the 10 Hz to 110 kHz frequency range, are provided by the 745A-H18 AC Calibrator in this subsystem. With addition of the HP 746A-H17 High Voltage Amplifier (Option 001), a total range of 0.1 Vrms to 1100 Vrms is obtained for stimulus to the device under test. Local and remote voltage sensing is included with programmable selection on the 1V, 10V, and 100V ranges.

*Voltage Ranges (Vrms):	1 mV, 10 mV, 100 mV, 1V, 10V, 100V, 1000V (with Option 001)
*Voltage Steps:	5 digits programmable and selectable with 10% overrange to the 6th digit
*Output Frequency:	11 frequencies on each of 4 decade ranges from 10 Hz to 110 kHz
Output Connections:	Front panel connector. Option 001 has a high voltage protective cable assembly
General:	Error Range and Error Measurement functions provided on the standard HP 745A are deleted

MEASUREMENT SUBSYSTEMS

Measurement subsystems measure signals from the unit-under-test, and also check applied stimulus signals. These subsystems include digital voltmeters (for DC, AC, and resistance) counters (for frequency, time interval, and period), waveform analyzers, etc.

Standard subsystems are listed below; however, others are also available. The specifications given here reflect the subsystem'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. However, these specifications do not include degradations introduced by system cabling and switching resistance, reflections, crosstalk, etc.)

NOTE: Those functions asterisked (*) are under control of the HP ATS BASIC software supplied with the instrument.

HIGH SPEED MULTIFUNCTION DIGITAL VOLTMETER
(Subsystem 28037A)

This subsystem contains the HP 3480B Digital Voltmeter with the HP 3484A Multifunction plug-in for DC, AC, and resistance measurements, plus supporting hardware and software. It includes autoranging across all of its ranges for any function, such that the range with the highest resolution is always selected. Overranging is 50 percent, which enhances resolution. The first reading on the new range is always correct due to automatic delay selection. The 3480B/3484A features a fast response time for DC and resistance measurements. The display is 4-digits plus overrange.

*DC Voltage

  *Voltage Range: ±100.00 mV to ±1000.0V, full scale in 5 decades

  *Measurement Speed (Filter Out):

    1000 per second

*Option 001 (Sample & Hold): Holds changing input voltages

*Option 002 (Resistance): 100.00Ω to 10.00 MΩ, full scale in 6 decades

  *Measurement Speed (Filter Out):

    1000 per second

*Option 003 (AC Voltage, true rms value)

  Frequency Range (0.1 to 1V):

    1 Hz to 10 MHz

  Frequency Range (10 to 100V):

    1 Hz to 1 MHz

  *Voltage Range: 100.0 mV to 1000.0Vrms, full scale in 5 decades

HIGH RESOLUTION DIGITAL VOLTMETER
(Subsystem 28002A)

This subsystem includes the HP 2402A DVM along with I/O card, cables, and software. It provides precision measurements 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. The display is 5 digits with 30 percent overranging. Plug-in options for expanded capabilities are listed below.

Input Circuit: Floated and guarded signal pair

  *Voltage Ranges: ±100 mV to ±1000V, full scale in 5 decades (autoranging optional)

*Option 002 (AC Measurement to 100 kHz)

  *Voltage Ranges: 1V to 1000Vrms, full scale in 5 decades (max. input 140V peak on 1V range, 750V peak on all other ranges)

*Option 003 (Resistance Measurement)

  *Ranges: 1 kΩ to 10 MΩ, full scale in 5 decades

*Option 005 (Frequency Measurement)

  Range: 5 Hz to 199.999 kHz

  Input: Amplitude range, 0.1 to 100Vrms (front panel attenuator)

  Gate Time: 1 second

DIGITAL MULTIFUNCTION METER
(Subsystem 28001A)

Included in this subsystem is the HP Model 3450A Multi-function Meter. This integrating type DVM provides true-RMS AC voltage measurements (on signals up to 1 MHz), plus fully-guarded measurements of DC voltage and resistance. In addition, ratio measurements are available. Auto-ranging is also provided on all ranges of all functions, and will be found especially useful in those applications where the applied signals may vary over a wide range. The display is 5-digits with 20 percent overranging.

*DC Voltage and Voltage Ratio

*Voltage Range:	± 100.000 mV to ± 1000.00V, full scale in 5 decades
*Ratio Range:	1.00000 to 1000.00 full scale in 4 decades

Input Impedance

10 MΩ on all ranges
*10^{10} Ω, program-selectable on 10V range and below

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

Option 001 (AC Measurement)

*AC Voltage and Voltage Ratio:

True RMS

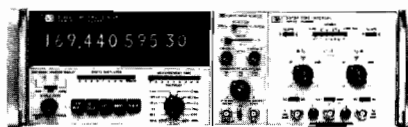|	
Frequency Range:	45 Hz to 1 MHz
*Voltage Range:	1.00000Vrms, to 1000.00Vrms, full scale in 4 decades
*Ratio Range:	1.00000 to 1000.00 full scale in 4 decades

Option 002 (Resistance Measurement)

*Resistance and Resistance Ratio

Resistance Range:	100.000Ω to 10000.0 kΩ, full scale, in 6 decades
Ratio Range:	1.00000 to 1000.00 full scale in 4 decades

COMPUTING COUNTER
(Subsystem 28015A)

This subsystem features the HP 5360A Computing Counter with the HP 5365A Input Module and the HP 5379A Time Interval plug-in. 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 MΩ	50Ω
Sensitivity:	100 mVrms, min.	20 mVrms, min.

*Time Interval Measurements (5379A Inputs)

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

550 MHz TIMER/COUNTER
(Subsystem 28038A)

The HP 5327B Timer/Counter/DVM is the basis for the HP 28028A Subsystem. By combining three types of measurements in one instrument, a very versatile automatic test system component is provided in which all functions are programmable. Some of its features are: programmed trigger points; time interval averaging for time interval discrimination in the sub-nanosecond range; 100 nanosecond resolution of one-shot measurements; five DVM measurement times and three ranges; plus the counter functions of period, period-average, ratio, totalize, and scale.

(Subsystem 28038A cont'd)

Frequency Measurements

Input Channel A & B

Range:	0–50 MHz
Sensitivity:	100 mVrms (min.)
Impedance:	1 MΩ

Input Channel C	*Prescaled (DC Coupled)	*Direct (AC Coupled)
Range:	0–550 MHz	1 kHz to 50 MHz
Sensitivity:	100 mVrms	5 mVrms
Impedance:	50Ω	50Ω

Period Measurements

*Period Range:	0 to 10 MHz
*Time Interval	
One-shot range:	$0.1\mu s$ to 10^9 sec
Averaged range:	0.15 ns to 10 sec

*Digital Voltmeter (single ended)

Measurement Technique: Voltage to Frequency Conversion

*Measurement Times: 1 msec to 10 sec

*Resolution (1 sec. Measurement Time)

10 volt range:	$100\mu V$
100 volt range:	1 mV
1000 volt range:	10 mV
Readout:	7 digits
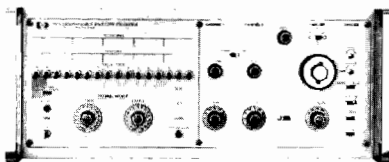
WAVEFORM ANALYZER
(Subsystem 28036A)

Designed for waveform analysis of fast repetitive signals, this subsystem includes the HP 1150A Programmable Waveform Processor and an HP 1331A X-Y Display for viewing the waveforms during set-up. It will perform measurements of rise and fall times of pulses, as well as pulse amplitude, pulse width, and pulse delay. These measurements are all programmable using HP ATS BASIC calls. The subsystem software includes routines for calculating time-domain pulse-parameter values from digitized data returned from the 1150A. Another feature of the 1150A is the "Learn"
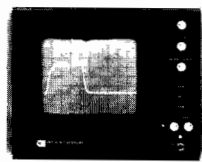
mode of operation, where the instrument functions are programmed, and digitized measurement results obtained, according to manually-set front panel controls. This is especially useful where test set-ups are variable or indeterminable in advance.

Vertical Channels

Bandwidth:	DC to 1 GHz
*Ranges:	2 mV to 200 mV/div. (7 ranges in 1, 2,5 sequence)
Accuracy:	3% all ranges without correction. Up to 1% with software correction
Input Impedance:	50 ohms†

Horizontal Scan

Direct Range:	10 ns/div. to 50μs/div. (12 ranges in 1, 2, 5 sequence)
*Expanded Range:	2:1 to 100:1 in a 1, 2, 5 sequence with respect to Direct Range. Greatest expansion at highest rate is effectively 0.1 ns/div.
Accuracy:	3% without correction, 1% with software correction

Measurement Limits

Pulse Times (Rise, Fall, Width):

	< 0.1 ns, min.
	> 50 μs, max.
Pulse Amplitude:	1.6V (p-p pulse), max.
	2 mV (p-p pulse), min.†
Pulse Delay $(t_{p1}-t_{p2})$:	< 0.1 ns to < 500 μs max.

Triggering Source

Source:	Internal or External, mode selected manually
Stability:	Operates over a wide range of pulse parameters

X–Y Display (HP 1331A-C04)

Persistence:	Variable
Inputs:	X,Y, and Z from 1150A
Modes:	Write, Store, and Erase
Size:	1/2 rack width

†HP 1120A probes are included for high impedance measurements and pre-attenuation.

DISTORTION ANALYZER
(Subsystem 28031A)

This subsystem contains the fully-programmable Distortion Analyzer, HP Model 334A-H15, for measurement of Total Harmonic Distortion of AC Signals with fundamentals up to 100 kHz, plus AC voltage measurements to 300 volts RMS. In addition, modulation measurements on amplitude-modulated RF waveforms within the 550 kHz to 65 MHz frequency range can be made. There is provision for use of an external RF detector where other frequency ranges are desirable. 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.

*Distortion Measurements

Frequency Range:	50 Hz to 100 kHz
*Frequency Digit Settings:	3 digit resolution; ±1% accuracy
*Null Programming:	Manual or Automatic
*High Pass Filter:	3 dB point at 400 Hz, with 19 dB/ octave roll-off. 60 Hz rejection is 40 dB
Input Voltage:	At least 0.3Vrms required for full dynamic range of Total Harmonic Distortion measurements

AM Detector

Frequency Range:	550 kHz to 65 MHz
Maximum Input:	40V p-p to 40V peak transient

*Voltage Measurements

*AC Input Voltage:	300 μV to 300V rms full-scale, in 13 ranges
Input Impedance:	1 MΩ ±5%

DIGITAL CLOCK FOR DATE AND TIME
(Subsystem 28051A)

The Digital Clock subsystem consists of an HP K21-5321B with supporting interfacing hardware and software. It offers several functions: provides the day and time of day data; measures time intervals between program check points; and provides standard pulse trains for system use. The front panel display of the HP K21-5321B shows the day of year, hour, minute, and second; output data also includes milli-seconds. An Error Indicator light warns if the power has been interrupted or when data output is temporarily stored by a hold signal, and a Data Hold light indicates the storage of data ready for read-out. Front panel clock controls are for stopping, setting, starting, and for leap year.

Time interval resolution is one millisecond. Pulse trains are available with periods of .01 msec to 1 sec in decade steps.
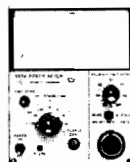
POWER METER—10 MHz to 10 GHz
(Subsystem 28023A)

The HP 432A-H03 Power Meter is the basis of this subsystem which measures power over a frequency range of 10 MHz to 10 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 μW 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)
Accuracy:	±1% of full scale on all ranges
Response Time:	250 ms approx.
Thermistor Mount:	HP 478A: 10 MHz to 10 GHz
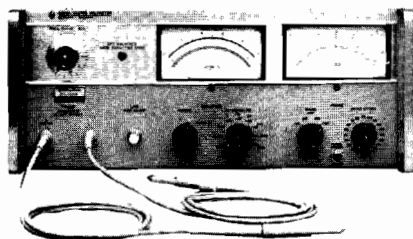
VECTOR VOLTMETER
(Subsystem 28005A)

This subsystem includes the HP 8405A-H16 Vector Voltmeter. It is added to the system for high frequency AC voltage and phase measurements. The 8405A DC outputs are normally connected to the system digital voltmeter through the crossbar scanner or other system switching to digitize the 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 $\pm 180°$, $\pm 60°$, $\pm 18°$, and $\pm 6°$. Measures phase difference between the fundamental components of the input signals
*Phase Offset:	$0°$ or $180°$
*Function:	A or B channel
Probe Input Impedance:	0.1 MΩ shunted by 1.5 pF, approx., 1 MΩ shunted by 1 pF, approx., with 10:1 divider

Digital test subsystem adds versatility...

DIGITAL TEST SUBSYSTEM

*A 28035A Digital Test Subsystem can be included
in any HP 9500 Automatic Test System either with
or without analog subsystems for combined analog/
digital testing or digital testing alone, respectively.
The 28035A Digital Test Subsystem is designed for
functional logic testing using a test pattern type of
program for efficient exercising of all UUT logic
pins in parallel. Thus, the program can be like a
"truth table" for the UUT. This digital test subsys-
tem meets the requirements for testing most inte-
grated circuitry now in general usage. The UUTs
may be ICs, printed circuit cards, logic modules,
or assembled equipment.*
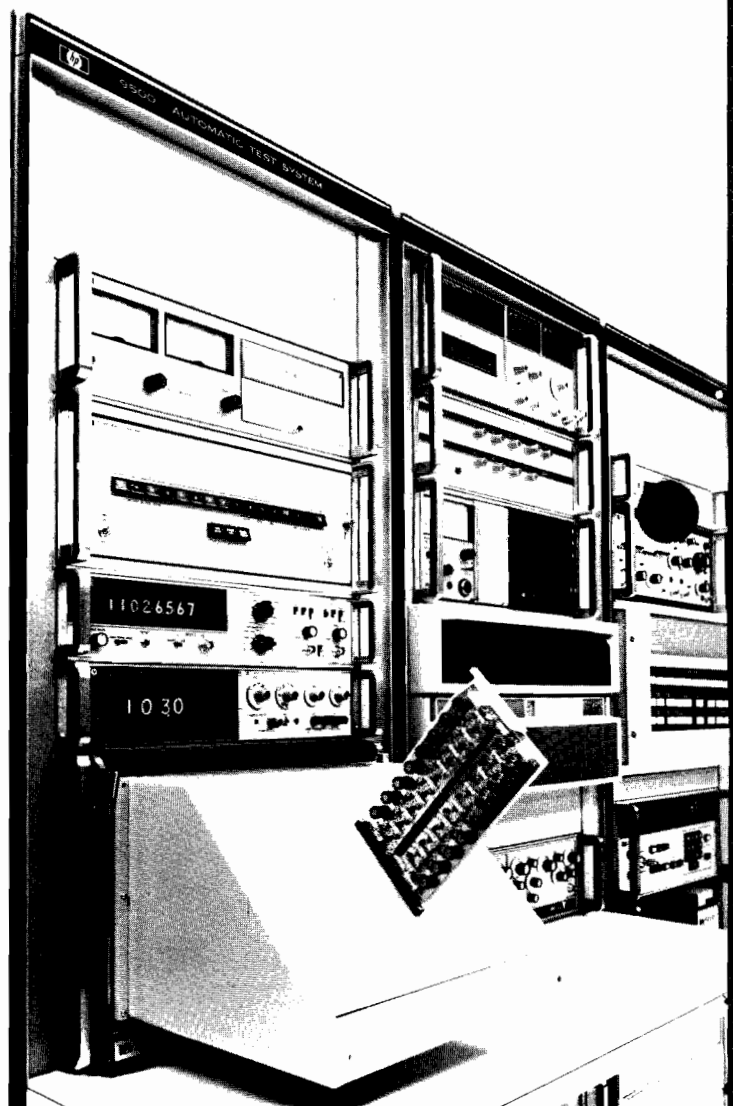
*Typical 9500 System with digital test capability. The digital test
subsystem is rack mounted below the shelf.*

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*Other information on the HP 9500 system digital tester is presented in the July 1971 issue of HP Journal in the article "General
Purpose Test System gets Digital Capability." An HP data sheet on the 28035A (Literature No. 5952-1327) is also available.*
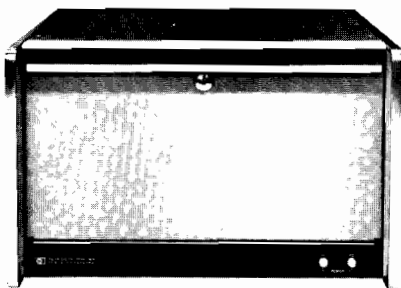
DIGITAL TEST SUBSYSTEM
(Subsystem 28035A)

The HP 28035A Digital Test Subsystem in a 9500 system offers features which are of considerable advantage in production, maintenance and repair, and laboratory applications. When combined in a 9500 system with analog subsystems, devices requiring analog stimulation for digital responses and vice versa, may be tested as well as testing in either mode alone. Pin capacity is provided in 12-pin increments up to 240 pins which may all be used simultaneously to test according to a programmed logic pattern. It is easy to program the digital test subsystem in HP ATS BASIC and, using "0" and "1" logic symbology, to set up logic test conditions.

In operation each pin is either an input or an output under computer control. The subsystem and reference supplies can be self-tested by comparing input and output lines. The speed at which a UUT can be tested depends upon several factors: the UUT-dependent settling time, the DTU-dependent number of pins under test, and the software. A maximum rate (no settling time) is 22,000 tests/second for 12 pins.

The 28035A subsystem includes the following: the HP 9401B DTU (Digital Test Unit) which holds up to 23 printed circuit cards; power supplies for operation of the DTU (but not the supplies required for logic level references* or the UUT), the computer input/output card, and cables. A single DTU accommodates up to ten Option 003 12-pin test cards for testing up to a maximum of 120 UUT pins. A DTU extender can be added to test up to a maximum of 240 UUT pins.

Operating Characteristics

Input/Output Capacity:	12 Terminals provided by each Option 003 dual-card test unit
	120 Terminals, maximum per 9401B
	240 Terminals, maximum with 9401B Extender
Operating Speed:	22,000 tests/sec. maximum

Programmable Test Delay for UUT Settling Time

1μsec to 4095μsec (1μsec steps)

Test Counter (keeps tally on tests for each UUT)

Counts up to 4095 tests

Test Synchronization (to start test after UUT connection)

Internal to system, such as from Control Panel, or External from user supplied actuator.

Reference supplies required are one each for high and low logic levels for drivers and for comparators. If these are to be programmed separately, four of the 28010A subsystems may be used. If they are not to be programmed then HP manually operated supplies, such as the Model 6253A two output supply, is suitable.

Switching for connection paths...

SWITCHING SUBSYSTEMS

Electrical switches provide the paths to connect stimulus and measurement equipment to the unit under test, and to each other for self-checking. Switching must be chosen for the type of signal to be carried (e.g., 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.
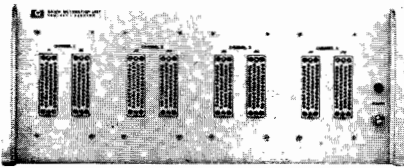
DC & LOW FREQUENCY AC DISTRIBUTION SWITCH
(Subsystem 28012A)

This subsystem incorporates the HP 9400A Distribution Switch which is intended for distribution of DC and low-frequency AC stimulus signals. The standard unit is made up of four relay trees, each four levels deep, providing a 4-pole, 16-throw switch for stimulus instrument 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.

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
Signal Frequency:	DC to approximately 100 kHz
Contact Resistance:	500 mΩ typical from input to output
Thermal Offset:	Typically 30μV at room temperature
Operate Time:	3 ms, maximum
Release Time:	40 ms, maximum

MODULAR SWITCHING SUBSYSTEM
(Subsystem 28013A)

The 28013A subsystem is designed for applications where several types of automatic switching are required. This subsystem includes the 9400B Modular Switch which houses a number of modular relay cards. Each modular relay card contains associated drive and storage electronics. A "driver" card is also available to control devices outside the card cage, such as relays, etc., that are often best located near the shortest signal path. Each 9400B will accept up to 16 cards. The modular switching subsystem can be easily expanded to a total of thirty-two, 9400B units controlled by one computer I/O board. Option 002 adds one 9400B modular switch unit.

MODULAR CARDS FOR THE 28013A SUBSYSTEM

Several types of cards are available for use with the 28013A Modular Switching Subsystem. Specifications for these cards are as follows:

Drive and Storage Card (Option 005)

Used as driver for external relays and special devices; e.g., for high current switching, special high frequency switches, and indicator lamps.

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

Equivalent switching is available in the 28013A Modular Switching Subsystem Option 008 (a 1 x 16 relay tree per plug-in card) which can be combined with other 28013A options.
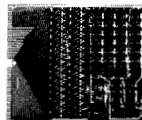
General Purpose Relay Card (Option 006 for 28013A)

Output connections of this relay card can be wired for special configurations (e.g., as a 4 x 4 matrix switch) and for system cabling. Includes "electronic confirm" line on each storage element which may be used to operate switch closing indicators.
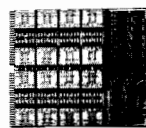
Switching Capability:	16 relays, with one Form-A and one Form-C switch per relay. Each relay has independent storage
Maximum Voltage:	200V peak
Maximum Current:	2 amps switched with resistive load, 3 amps carry current after switching
Crosstalk:	-40 dB typically measured at 100 kHz on adjacent switch line
Signal Frequency:	DC to 100 kHz
Contact Resistance (typ.):	<500 mΩ at 100,000 operations
Thermal Offset:	Typically 50μV or less at 25°C
Contact Life:	1,000,000 cycles at 28V dc, 100 mA resistive load
Operate Time:	20 ms, maximum
Release Time:	5 ms, maximum

Reed Relay Card (Option 007 for 28013A)

Contains 32 independent single level switches which may be connected in various configurations such as to handle ten 3-wire signal lines. It is useful for switching resistive loads or relay programming and to control the Crossbar Scanner (Options 003 & 004).

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 KΩ
Signal Frequency:	DC to approximately 100 kHz
Contact Resistance (typ.):	<100 mΩ at 100 mA
Thermal Offset:	Typically less than 100μV 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

Distribution Card (Option 008 for 28013A)

This card has a relay tree which is four levels deep providing 1 x 16 switching suitable for distribution of DC and low frequency AC signals.

Switching Capability:	16 four-pole relays, configured into a 1 x 16 four-level switch. Each relay has electronic latching
Maximum Voltage:	200V peak
Maximum Current:	-50 dB, typical at 100 kHz on adjacent output line terminated in 1 KΩ
Signal Frequency:	DC to approximately 100 kHz
Contact Resistance (type):	<500 mΩ at 100,000 operations
Thermal Offset:	Typically 50μV or less at 25°C
Typical Contact Life:	1,000,000 cycles at 28V dc, 100 mA resistive load
Operate Time:	20 ms, maximum
Release Time:	5 ms, maximum
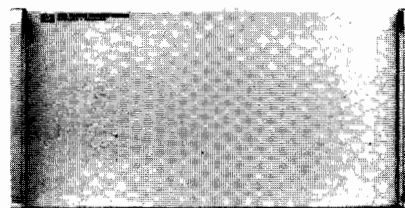
Guarded Crossbar Scanner (Options 003, 004 & 011 for 28013A)

The guarded crossbar scanner option to Subsystem 28013A contains the HP 2911A Guarded Crossbar Switch. It features low thermal offsets for accuracy in measurement scanning. It is available in three versions. The first is Option 003 for switching DC, AC, resistance, and frequency inputs to the 28002A digital voltmeter subsystem. The second is Option 004 for switching DC, AC, and resistance inputs to the 28001A multifunction voltmeter subsystem. The third is Option 011 for switching DC, AC, and resistance inputs to the 28037A multifunction meter subsystem.

Ratio measurements on any pair of inputs can be made either by using the voltmeter in the ratio mode or by making two measurements and using the system computer to make a calculation. The latter is the usual method employed in 9500 systems.

This subsystem contains 200 3-wire channels as standard. It is arranged so that DC and AC voltages or frequency inputs occupy one channel and resistance inputs occupy two channels. The channel and function are programmable. An Option 007 Reed Relay card is used for control. The crossbar scanner options include the Reed Relay card.

System control unit designed

SIMPLE CONTROL OF AUTOMATIC TESTING

Control of HP 9500 Series Automatic Test Systems is simplified by the HP 9403A Control Panel shown on the following page. In addition to providing all of the controls required for go/no-go testing, this panel includes a Supervisory/Operate lock-out switch to make the system tamper-proof when it is being used by relatively inexperienced operators. (The Supervisory position is used for program preparation.)

for operator convenience...
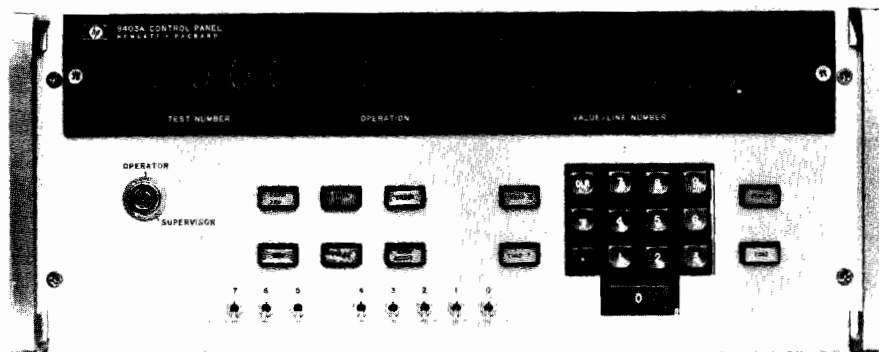
SYSTEM OPERATION WITH THE CONTROL PANEL

The Control Panel is designed to make operation of the system more convenient for testing than is afforded by a keyboard terminal alone. In the 9500B system, programs are loaded from punched-paper tape fed into the high speed photoreader. Using the Control Panel the operator pushes the LOAD button to command the system to load. After the program is loaded the READY indicator lights.

For the 9500D system, the assigned program number is entered on the Control Panel Keyboard (this number will appear on the Value/Line No. display of the panel), then the operator pushes the INPUT button to enter the number in the "Job Stack" of the disc. The program is then loaded and its number is displayed by the TEST NUMBER display of the panel.

The operator then starts the test by pushing the RUN button which lights the RUN indicator. This indicator remains lighted until the end of the test unless there is a "PAUSE" in the test. Pauses may be programmed during the test to permit adjustments to be made on the Unit Under Test. The PAUSE indicator lights during these periods. The nature of the adjustment to be made is signaled by a number in the OPERATION display. After the operator has performed the required action, he restarts the test by pushing the RUN button.

The Control Panel can be used to enter numbers needed by the program. The operator does this when the INPUT indicator lights. There are ten numerical keys and the minus key and decimal point keys to enter the required data. As with adjustments, the OPERATION indicates the nature of the data to be entered. A check of the data entered is provided by a decimal VALUE display above the keyboard. A CLR (clear) key on the keyboard can be used to clear an incorrect value so that the correct value can be keyed in. When the displayed number is correct, it is entered by pushing the INPUT button. This procedure is repeated if the test needs more then one number. After all numbers have been entered, testing restarts automatically.

The system provides for programmed yes/no branching. When the test reaches a yes/no response point, it lights the YES/NO indicators simultaneously. The operator signals his choice by pushing the YES or the NO button. Testing resumes automatically. While the test is running, it may be desirable to switch to an alternate sequence. This capability is provided by the TRAP 1 and TRAP 2 buttons. Pressing either TRAP initiates the alternate sequence which has been programmed as the system's response to that particular trap command. There are also switch register switches to cause transfer of control to specified statement numbers according to whether a switch is up or not.

At the end of the test, indicators signal that the Unit Under Test has either passed or failed. An ERROR indicator is provided to signal errors during the test, such as a turned-off subsystem.

Tester to UUT interface...
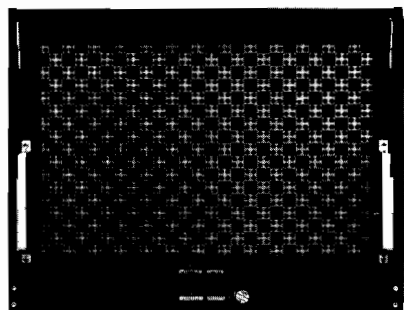
HP 9402A SYSTEM INTERFACE PANEL

The HP 9402A System Interface Panel provides a general-purpose, low-frequency cabling interface between the 9500 system instrumentation and the UUT (Unit Under Test). The 9402A has a patch-board front panel which is plugged into a rear panel as may be seen in the photo (opposite page). This is connected through cable assemblies to the 9500 system. These interface rear-panel cable assemblies are available as options to the 9402A for each of the 9500 subsystems. They are listed in the 9500 System Configuring Guide (Literature No. 5952-1332).

The user conveniently patches his UUT to the interface front-panel points going to the appropriate switching subsystem cables. UUT connectors and adapters can be mounted over the interface front panel (using the HP 25001 Adapter Panel) so that the whole assembly, with instrumentation patches and UUT patches, can be quickly changed. Changing front-panel assemblies is accomplished by releasing clamping handles at the sides of the panel, removing the panel, plugging in the desired assembly and clamping it by pushing in the handles.

The 9402A is primarily intended as a low frequency interface; however, it is usable beyond 100 kHz. The practical upper frequency limit 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 amp continuous–15 amps peak
Isolation Resistance:	2.5×10^{12} Ohms, minimum
Contact Resistance:	5 mΩ, typical
Pin-to-Pin Capacitance:	5 pF (excluding cabling)
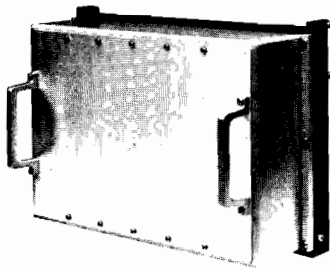
25001A ADAPTER PANEL
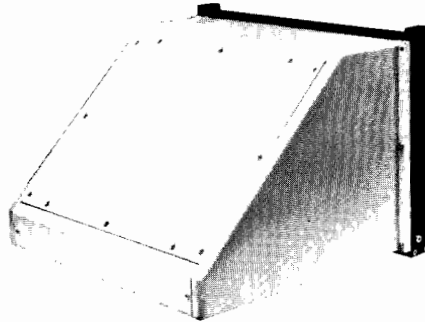
25001B ADAPTER PANEL
(Can be installed either side up)

## ADAPTER PANELS WITH PATCH BOARD MATRIX (25001A, 25001B)

An adapter panel fastened to an interface patch-board matrix is a convenient method of mounting UUT connectors. The matrix is the removable portion of the 9402A System Interface Panel. It is designed for modifying the interface quickly to accommodate different test requirements. One adapter panel with patch-board matrix is supplied with each 9402A. Any number of additional adapter panels, each with a patch board matrix, can be ordered.

The adapter panels are available with two types of frames illustrated above. Model 25001A gives a vertical front panel; Model 25001B may be mounted to give a sloping front panel, or inverted to give a horizontal panel.

USABLE PANEL DIMENSIONS

25001A: 11.75" (298.45 mm) x 7.75" (196.85 mm)

25001B: 12" (304.8 mm) x 9.5" (241.3 mm)
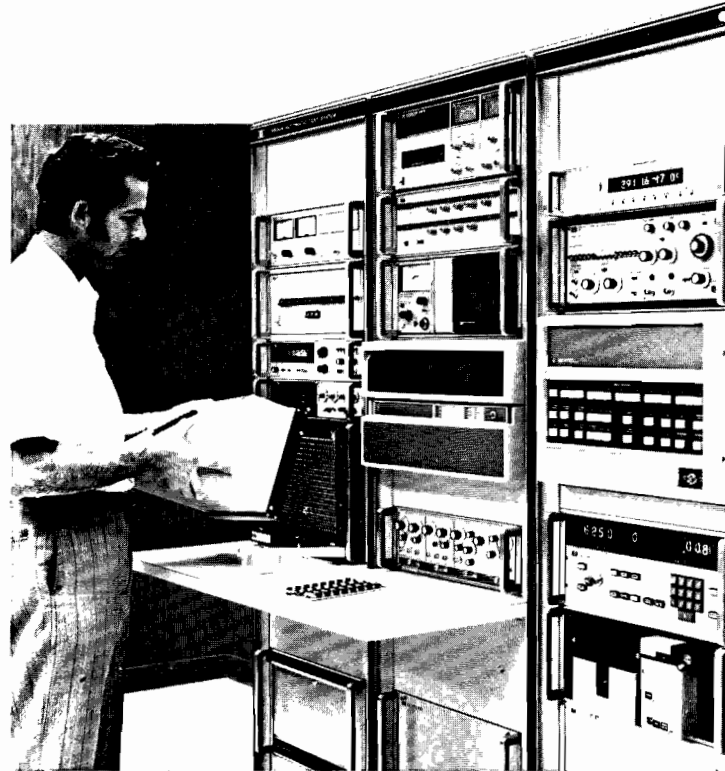
Attaching removable portion to fixed portion of Interface Panel

Computer interfacing and I/O expansion...

COMPUTER INTERFACE SUBSYSTEMS AND I/O EXTENDER

In automatic testing it is often desirable to control other equipment or control UUT related switching such as sense contact closures for power supply "remote sense" lines. HP provides a number of standard computer interfaces which are useful for such purposes. Standard computer interfaces shown include a general purpose software driver.

16-BIT DUPLEX REGISTER
(Subsystem 28025A)

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 for 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 maximum
"0" state:	+12V, 10K ohms source

Input Levels (ground true, positive false)

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

Bias and Impedance: +8V through 700 ohms

NOTE: Option 001 of this card is for negative voltage (ground false, negative true) logic.

16-BIT MICROCIRCUIT INTERFACE CARD
(Subsystem 28026A)

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, $Z=300\Omega$ to +5V
"1" Level:	0 to +0.5V, bias +3V, $Z=300\Omega$ to +5V, current required 15 mA

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: Option 001 of this card is for negative voltage (ground false, negative true) logic.

16-BIT RELAY OUTPUT REGISTER
(Subsystem 28024A)

The Relay Register Subsystem 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.

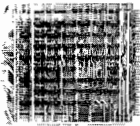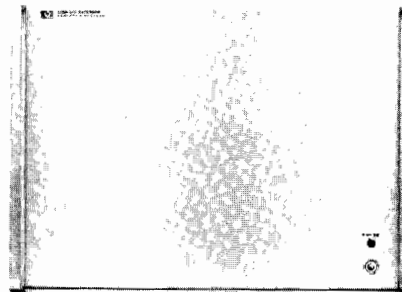|	
Relay Contact States:	All contacts are normally open when power is off
Maximum Power:	10W peak or continuous, per contact
Maximum Voltage:	100V peak or continuous
Maximum Current:	500 mA per contact
Life:	10 million operations under rated load
Resistance:	0.1 ohm at 100 mA (higher at low current)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

HP I/O EXTENDER
(Subsystem 28056A)

The HP I/O Extender is designed for use with the 2100A computer, and provides 31 additional I/O channels to the computer. The fourteenth I/O slot of the computer is used for an extender interface card; thus the 32 slot extender gives a total of 45 I/O channels. The extender has its own integral power supply.

Peripherals for controller expansion...

OPTIONAL CONTROLLER EQUIPMENT

The modular controllers for HP 9500 systems described on pages 5, 6 and 7 may be modified or added to, with one or more of the following input/output units.
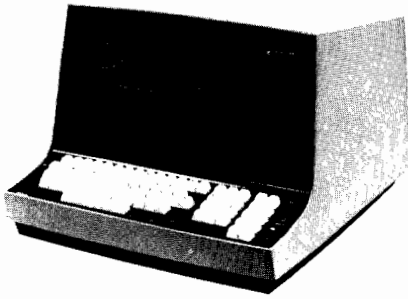
KEYBOARD DISPLAY TERMINAL
(Subsystem 28028A)

The HP 28028A Keyboard Display Terminal, when used in place of a teleprinter, provides the user with the ability to access data rapidly from the computer as well as to input programs and data through its keyboard. Operation is almost noiseless, thus, it is quite desirable for use in office and laboratory environments, where a hard copy record is not needed. 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 terminals 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.


HEAVY DUTY TELEPRINTER
(Subsystem 28041A)

This unit may be used in place of, or with the light-duty (ASR-33) teleprinter. The heavy-duty Teleprinter (a modified Teletype ASR-35) is recommended where use exceeds five hours per day or 30 hours per week. It performs the same function as the light duty teleprinter which is standard with the controllers, and it operates at the same 10 characters per second speed.
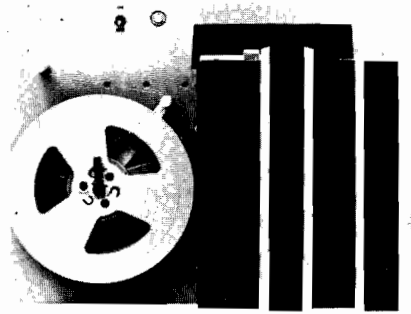

HIGH SPEED TAPE PUNCH
(Subsystem 28044A)

The HP 28044A greatly reduces time for punching program tape. 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.
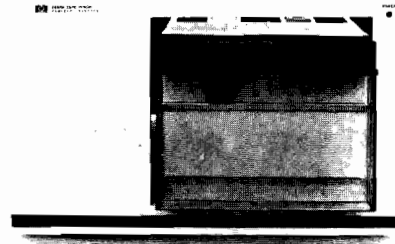

MEDIUM SPEED TAPE PUNCH
(Subsystem 28054A)

The HP 28054A subsystem contains a medium speed tape punch along with all necessary hardware and software. This is a quiet running, reliable, compact unit which punches 75 characters per second into either Mylar, plastic, or paper tape. Incorporating this punch into an HP 9500 system provides the ability to prepare programs much more rapidly than with a teleprinter alone, by speeding up tape punching significantly. It prepares 8-level, one-inch wide tape for reading back into the computer through the high speed photoreader or the teleprinter.
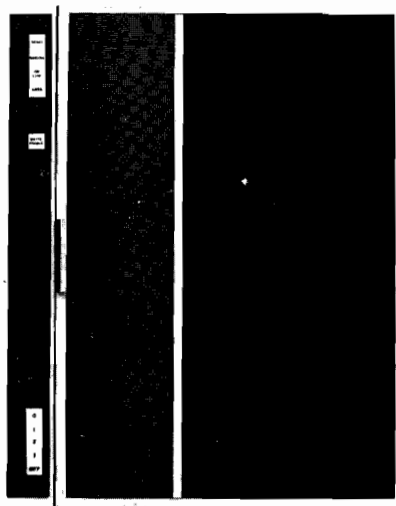
MAGNETIC TAPE MASS STORAGE
(Subsystem 28032A)

This subsystem contains the HP 7970B Digital Magnetic Tape Unit which is configured for 9-track operation in IBM compatible NRZl format. It accepts standard 10-1/2" (2400 ft.) reels. Recording mode density is at 800 cpi (characters per inch) and the tape motion is set at a forward speed of 37.5 inches per second. More than 9 million, 16-bit words can be stored on a 2400 foot reel of tape with 2048 character records. The 9500 system can control up to four of the 28032A magnetic tape subsystems. The magnetic tape subsystem incorporated into the 9500 system allows the user to store and retrieve data on magnetic tape at high speed.
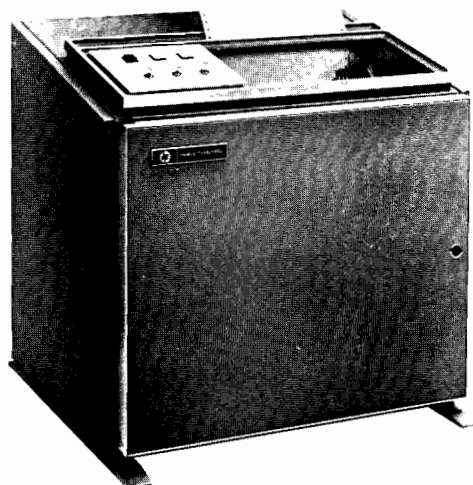
LINE PRINTER
(Subsystem 28029A)

This table top line printer subsystem (HP Model 2767A) offers you a higher speed printout for your 9500 system than is possible with a teleprinter. A mobile base to hold the line printer is available as an option (Option 002).

If your system application requires hard copy of large amounts of data the line printer is an excellent peripheral to include. It prints 80 columns at 356 lines per minute and 20 columns at 1100 lines per minute.

The 28029A subsystem has been designed for maximum operator convenience; for instance, status-at-a-glance type indicators minimize operator attention; no paper threading is necessary and vertical paper tensioning is adjusted automatically; a front opening drum-gate makes paper loading and ribbon changing easy; and the controls are conveniently located on a single panel.

Additional cabinets...

Each controller includes a one-bay cabinet with 70" (less controller panel space) available for subsystems. Additional cabinets can be ordered with the system. All the instruments furnished with 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. Exceptions are external equipment such as the Teleprinters, Keyboard Display Terminals or Line Printer. Installation time is minimized by having the system delivered, already assembled in cabinets. Cables between instruments within cabinets are installed such that after the external peripherals are connected, 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-bays, with 70-inch panel openings, added to the standard one-bay controller cabinet. The usable depth of the cabinets is 27 inches which accommodates all HP computers and HP instruments.

All cabinets are equipped with a hinged rear door with recessed handle; lockable latch is standard. The cabinets are equipped with casters, and a front base extension which prevents tip-over when any heavy instrument is pulled out for servicing.

Overall dimensions are as follows:

Width: 21" (533 mm) per bay

Depth: 37-3/4" (959 mm): includes 7-3/4" (197 mm) base extension

Height: 78-1/4" (1988 mm): 70" (1778) 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" (89 mm) or 5-1/4" (133 mm) of rack space. Single and double 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.

Support for your 9500 system...


QUALITY ASSURANCE

Hewlett-Packard's commitment to your successful application of 9500 series systems begins with a careful analysis of your system requirements and expert counseling on your system's configuration. Equally careful attention is given to components used in your system, assembly of your system, installation, final checkout, and after-sale support. This minimizes the risk involved in complex system integration.

TRAINING

HP provides a one-week user training course with every 9500 series system. The course covers:

- The ATS BASIC Language

- Principles of computer operation

- UUT interfacing and the use of switching

- Efficient methods of writing test programs

- Management and documentation of a testing operation

- Principles of instrumentation

Instruction includes hands-on experience. The purchase of each 9500 series system includes training for two persons. Additional persons can be trained for a modest tuition charge. Training for 9500 systems is more fully described in HP publication 5952-1329. HP computer maintenance training courses are also offered at additional cost to those customers planning to maintain their own systems. Additional training is performed by the HP installation engineer who will give on-site operating instructions to your technical personnel. Special training is also available.
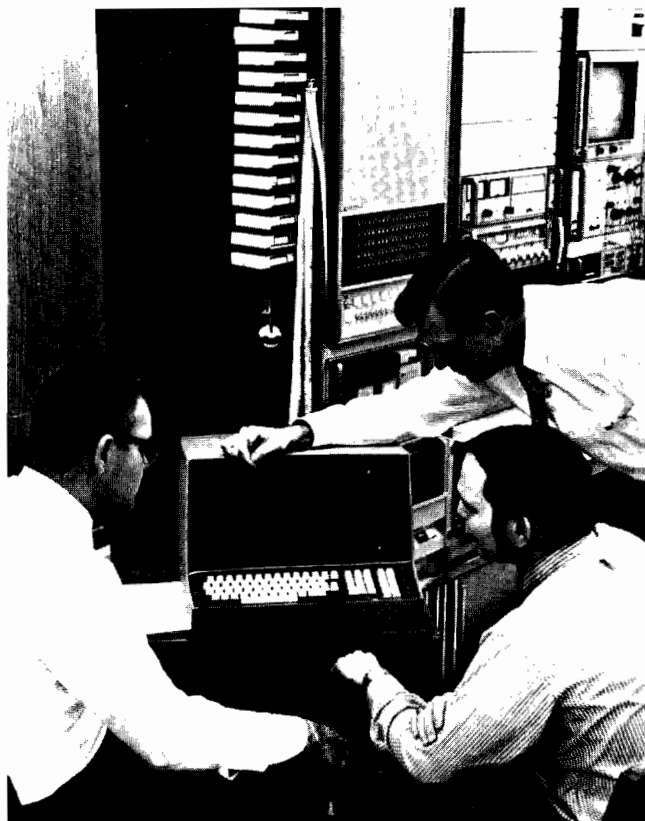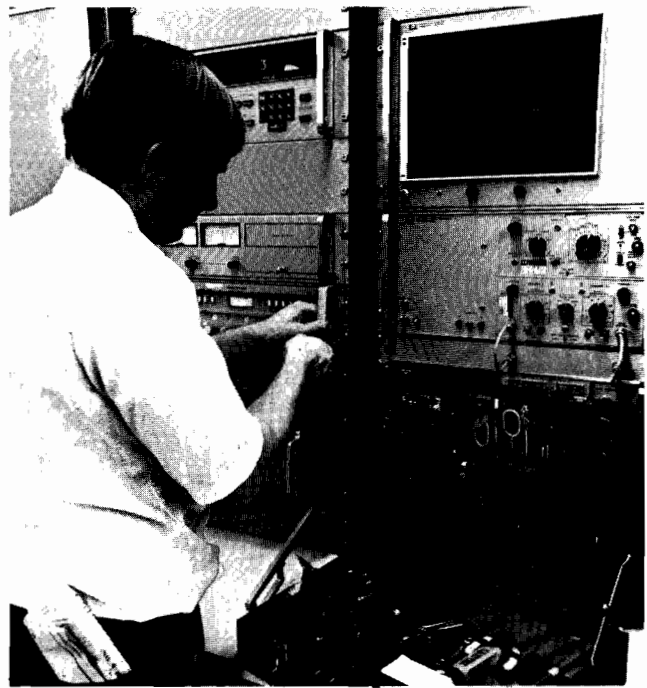
DOCUMENTATION

HP is well-known for the quality and thoroughness of its operating and service manuals. The documentation provided includes: programmers' reference manuals for the software furnished; operating procedures; and technical descriptions with diagnostic and maintenance procedures for the hardware furnished.

DATA CENTERS

Four regional data centers in the U.S., one in Canada, four in Europe and one in Japan have been established to meet the needs of HP computer system users. (These locations are flagged in the list of world-wide sales and service offices on the rear page.) At these centers, you can purchase the assistance of experienced system engineers and system analysts in the development of successful solutions to your automatic test system applications.

SERVICE

Service and parts assistance are supported by some 700 people comprising the HP customer service organization. More than 140 HP field sales offices located in North America and abroad provide rapid and convenient support for Hewlett-Packard systems. Customers need not correspond with a factory several thousand miles away for service, replacement parts, and technical assistance. Backing up local offices are four regional service centers in the United States and major service centers in both the United States and Europe. The centers are equipped with extensive replacement parts inventories. Board exchange programs for computers and other complex instruments enable systems to be returned to normal service with minimal down-time.

SYSTEMS WARRANTY

All Hewlett-Packard electronic measuring systems, including the instruments, peripherals and software which are a part thereof, are warranted to be free from defects in material and workmanship for a period of 90 days. We will repair or replace, without charge, any items which prove to be defective during the warranty period. Warranty service will be performed on-site at the customer's facility in the United States, Canada and Western Europe and near other designated HP service facilities.*

SERVICE CONTRACT

A Service Contract with HP may be attained to provide regular preventive maintenance and on-site servicing, thus insuring maximum utilization of your system. The contract will be tailored to best fit your needs including the period between maintenance calls, response time normally expected, travel expenses, verification tests, and duration of the agreement. The service contract provides you with these advantages.

- Known annual cost
- No staffing problem
- No additional overhead expense
- Minimum down-time in case of failure

No other warranty is expressed or implied. We are not liable for consequential damages.
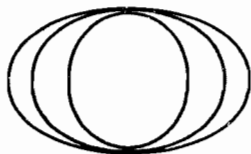
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