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LOGIC ANALYZERS

Logic Analysis Systems

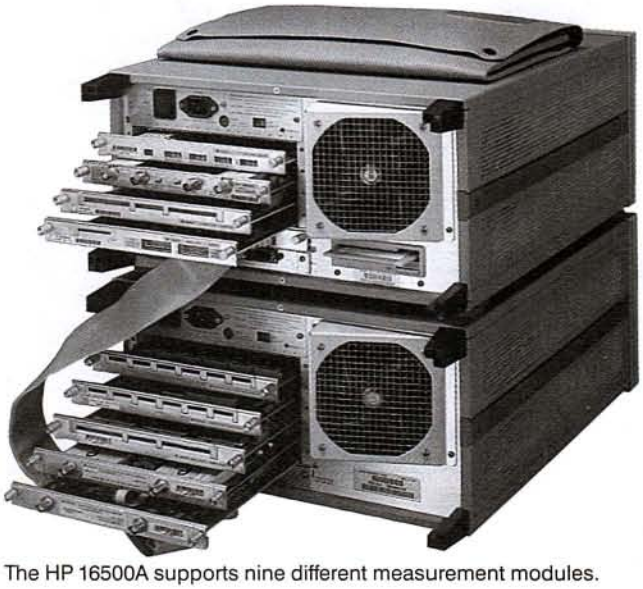
HP 16500A and Measurement Modules

- Modular, configurable logic analysis system
- Expandable, up to nine different measurement modules
- Powerful cross-module triggering
- 100-MHz state analysis
- Support for most microprocessors
- 1-GHz timing and pattern generation modules



HP 16500A shown with HP 16501A

DESIGNED FOR HP-IB SYSTEMS



The HP 16500A supports nine different measurement modules.

HP 16500A Modular Logic Analysis System

The HP 16500A logic analysis system can be configured for a wide range of measurement tasks, including microprocessor debug, hardware design verification and debug, software performance analysis, characterization, and functional pass/fail testing. Start with a focused system, then expand as your needs evolve.

The HP 16500A's five card slots accept nine different measurement modules. With the HP 16500A, you can do the following:

- Customize your own system by adding cards to the five card slots.
- Make time-correlated measurements between modules using the intermodule bus.
- Compare hardware measurement data with design simulation data.
- Program the HP 16500A with easily understood commands through HP-IB or RS-232C built-in interfaces.
- Store setups and measurement results in either of two built-in disk drives for fast recall or permanent record.
- Generate report-quality documentation with pushbutton ease.

HP 16501A Logic Analysis System Expansion Frame

The expansion frame provides an additional four* slots to your HP 16500A logic analysis system, giving you control of up to nine measurement modules from your HP 16500A's interface. With the expansion frame you can now cross-trigger up to nine measurement modules and then view your results on the same screen with 10 ns time correlation.

Configure Your System

The HP 16500A logic analysis system can be configured for your debug, characterization, systems integration, or pass/fail testing applications. Start with a focused system, then expand it as your needs evolve. For example, start with a 102-channel logic analyzer and a 2-channel oscilloscope, then add more capability as needed.

Color Touchscreen, Mouse, and Keyboard

Save time and reduce errors with the HP 16500A color touch screen. Simply point to the field you want to change; the touchscreen eliminates the need to search a front panel for the right button. Pop-up menus offer all choices at a glance, and the software does not allow you to make an incorrect choice. Front-panel operations can also be executed via mouse and/or keyboard providing complete user-interface flexibility.

Color discriminates between overlapped traces and emphasizes important points. In addition, you can customize for personal preference and environmental considerations. Even infrequent users spend less time making measurements and more time analyzing the results.

Data display areas are not touch-sensitive, so there is no need to worry about losing your latest acquisition.

Store Setups and Data Quickly

It is easy to store and retrieve measurement results and setups with the two built-in 3½-in disk drives. Use the back disk drive for the operating system, leaving the front disk free for measurement files.

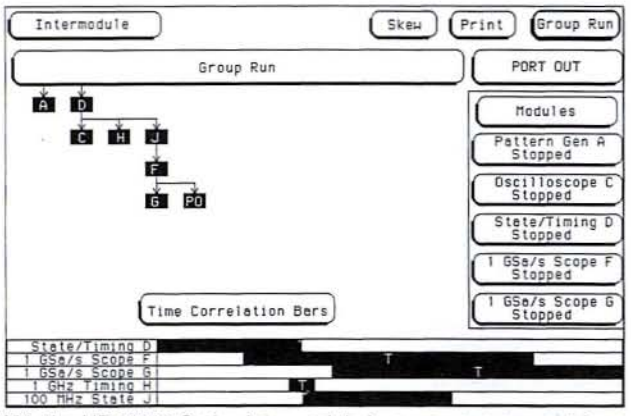
*The HP 16501A interfaces with the HP 16500A via an expansion frame interface card that occupies one of the HP 16500A's five module slots. The expansion frame has five slots, providing a total of nine measurement module slots when combined with the HP 16500A.

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HP 16500A Intermodule Bus (IMB)

IMB Lets You Make Measurements Never Before Possible with One Instrument

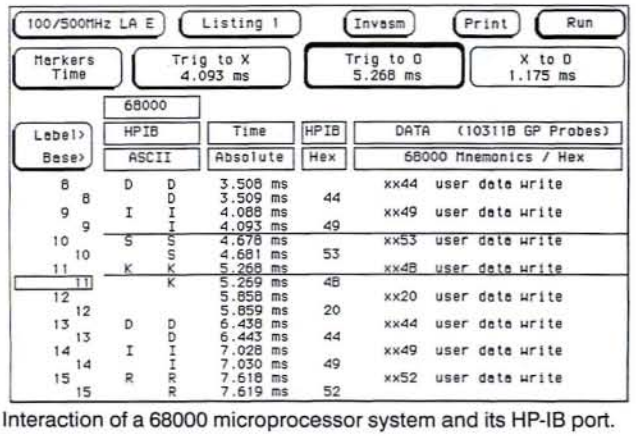
Run HP 16500 Series modules independently or combine their capabilities and correlate their acquisitions with 10-ns resolution to make measurements that previously required several instruments. The intermodule menu graphically communicates complex arming sequences in an easy-to-understand format. Use the time correlation bars for a quick overview of the measurements performed.



With the HP 16500 Series intermodule bus, you can arm or trigger one measurement module from another.

Analyze Systems with Multiple Microprocessors

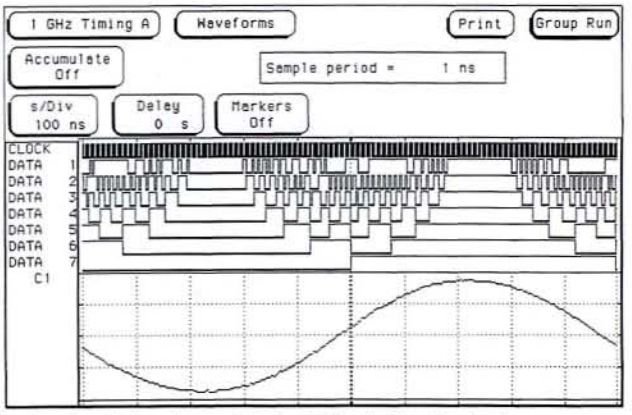
Capture states from separately clocked systems, such as multiple microprocessors or a microprocessor and its communications interface. Then analyze data flows between the systems with interleaved, time-correlated state displays.



Interaction of a 68000 microprocessor system and its HP-IB port.

Verify Mixed-Signal System Behavior

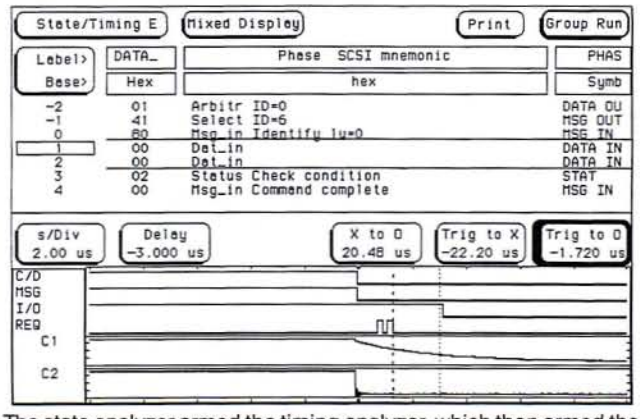
View the digital activity with up to 1-ns resolution in your mixed-signal system. Then display the time-correlated analog input signals captured with the built-in, 250-MHz digitizing oscilloscope to verify results.



Analog input signal correlated with its digitized output.

The Most Powerful Scope Trigger

Use the state analyzer to identify a problem sequence. Arm the timing analyzer with the state analyzer to trigger on a wide pattern. Then arm the oscilloscope with the timing analyzer to capture a signal's parametric behavior at the exact time.



The state analyzer armed the timing analyzer, which then armed the built-in scope to capture a hard-to-find fall-time violation.

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LOGIC ANALYZERS

State and Timing Analysis Modules

HP 16550A, 16540A/D, 16541A/D, 16510B, and 16511B

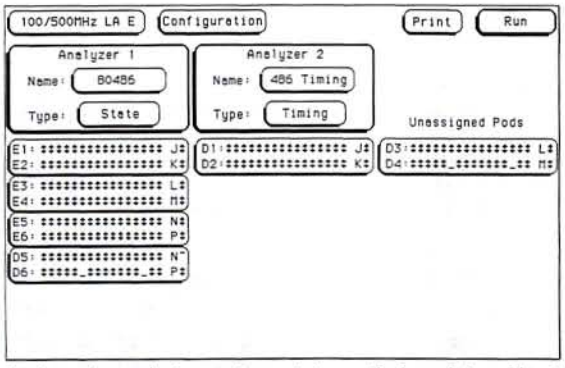
Key Specifications and Characteristics

	HP 16550A[1]	HP 16540A,D/16541A,D[2]	HP 16510B and 16511B[3]
Timing analysis rate	Conventional: 250/500 MHz* Transitional: 125/250 MHz* Glitch: 125 MHz	Conventional: 100 MHz	Transitional: 100 MHz Glitch: 50 MHz
State analysis rate	100 MHz	100 MHz	35 MHz
Channels/card	102/51*	16 (HP 16540A,D master cards) 48 (HP 16541A,D expansion cards)	80 (HP 16510B) 160 (80 max in timing, HP 16511B)
Clock channels	6 (of the 102 above)	2	5
Memory depth/channel	4 K/8 K*	4 K (A versions), 16 K (D versions)	1 K
Setup/hold time	3.5/0 ns to 0/3.5 ns adj. in 500 ps steps	4/0 ns, 2/2 ns, or 0/4 ns selectable	10/0 ns fixed
Minimum detectable glitch	3.5 ns	N/A	5 ns
Probe input R and C	100 kΩ and ~8 pF	100 kΩ and ~8 pF	100 kΩ and ~8 pF
Trigger terms	Patterns: 10 Ranges: 2 Edge and glitch: 2 Timers: 2	Patterns: 4 Ranges: 1	Patterns: 8 Ranges: 1 Edge: 1 Glitch: 1
Trigger sequence levels	12 in state and 10 in timing	4 in state and 4 in timing	8 in state and 2 in timing
Labels	126	126	20
Symbols	1000	500	200

State and Timing Analysis Modules

Capture State or Timing Data on All Channels

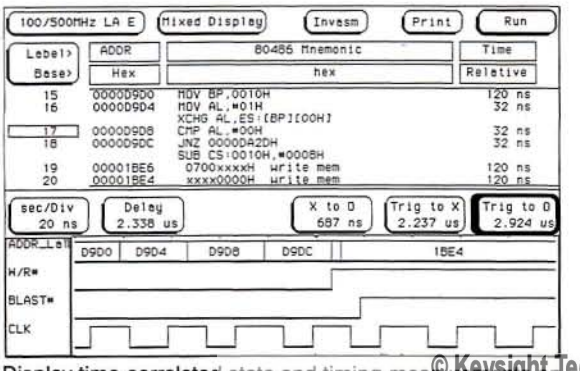
No need to connect special probes to view timing activity. All channels on HP state and timing analysis modules perform either state or timing (except the HP 16511B where 80 channels perform only state analysis). Set up your HP 16550A, 16510B, or 16511B analyzer to perform simultaneous state analysis on some channels and timing analysis on the rest.



Assign channels to capture state or timing data without moving probes.

Find Whether the Problem is in Software or Hardware

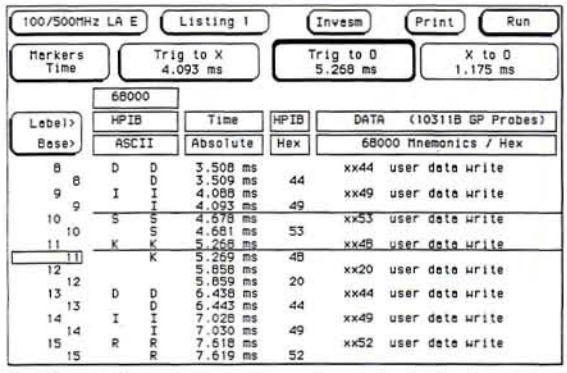
Arm the timing analyzer with the state analyzer to capture system behavior between states. Display both measurements on one screen and use time-correlated markers to identify the cause of problem states.



Display time-correlated state and timing measurements on the same screen.

Track Problems in Multiprocessor Systems or Between the Processor and its Interface Bus

Configure your HP 16550A, 16510B, or 16511B as two independent state analyzers that sample data using separate clocks. Time tagging of states lets you time-correlate and view the state listings interleaved on the same screen.



View interactions between two separately clocked systems.

Debug High-Performance Systems with Full Support for Your CISC or RISC Microprocessors

Today's high-performance processors already operate at bus rates in excess of 66 MHz. Because clock rates are one of the fastest ways to improve processor performance, you can expect bus rates to continue to increase. With up to 100 MHz state on the HP 16550A and the 16540A,D/16541A,D, modules, you can feel confident that you have the margin necessary for today's and tomorrow's systems.

In addition, HP state and timing analyzers bring you the broadest processor and bus support available (see pages 329-331). Supported processors include:

- Intel80186, 80286, 80386**, 80486**, 80860, 80960
- Motorola 68000, 68010, 68020, 68030, 68040, 88000
- MIPS R2000, R3000, R4000
- AMD AM29000
- TI TMS 320C30/31, 320C50
- SPARC 64901

Supported buses include: SCSI 1, 2, and 3; FutureBus+; MIL-STD 1553; EISA; MCA; IEEE-488 (HP-IB); RS-232; FDDI; VME; and VXI.

* Half-channel mode doubles memory depth, doubles maximum conventional timing speed, and doubles maximum transitional timing speed.

** Intel80386, 80486 are U.S. trademarks of Intel Corporation.

[1] Two HP 16550A boards may be connected together for 204-channel operation.

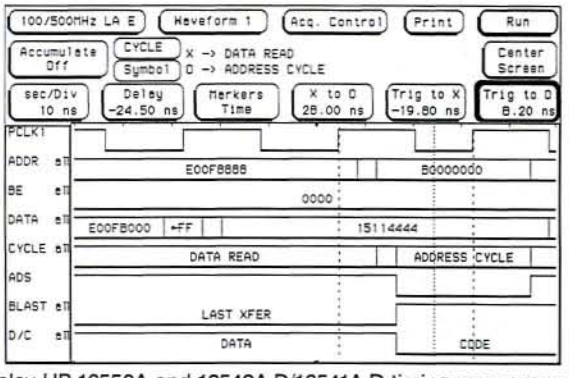
[2] HP 16541D expansion card requires HP 16540D master card. HP 16541A expansion card requires HP 16540A master card. Up to four HP 16541A,D cards are supported by each HP 16540A,D card respectively.

[3] HP 16511B builds with HP 16540B cards for 160-channel state analysis.

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Analyze Distant Timing Events with Transitional Timing

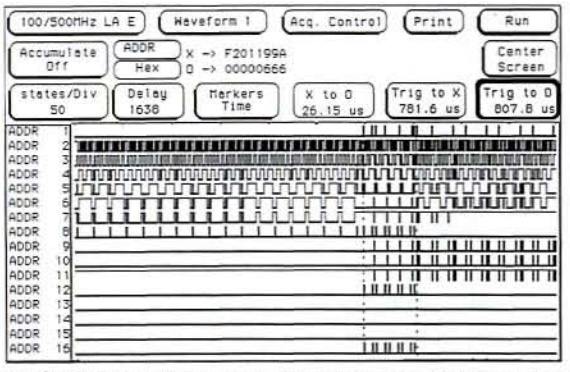
Capture events that are seconds apart maintaining up to 4-ns resolution with the HP 16550A, or 10-ns resolution with the HP 16510B. Transitional timing samples at full speed but only stores data when a transition occurs. This technique effectively extends the total time captured by the acquisition memory while maintaining high time resolution.



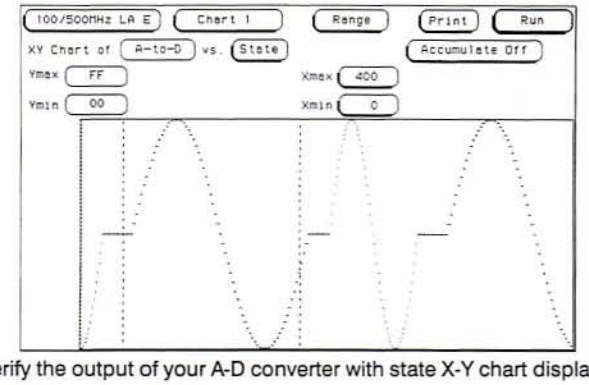
Display HP 16550A and 16540A,D/16541A,D timing measurements with bus values overlaid in the waveforms.

Enhance Troubleshooting with Flexible Display Modes

All state and timing analyzers let you display state measurements in listings, X-Y chart, or state waveforms. In addition to the waveform display, the HP 16550A and 16540A,D/16541A,D allow you to display timing information as a listing. Markers placed on one display are automatically updated in other display modes.



View entire state acquisition at a glance with state waveform display.



Verify the output of your A-D converter with state X-Y chart display.

Find Intermittent Errors Using Postprocessing

In state, set up compare mode to "run until compare not equal" to capture intermittent errors. Use compare for quick go/no-go testing of your product in manufacturing. State compare shows you the effects of system changes by comparing each sample in the current measurement to each sample in a previous measurement.

In timing, capture intermittent setup and hold violations using the specify-stop-measurement feature to repetitively acquire data until the time interval between two patterns violates a specified condition.

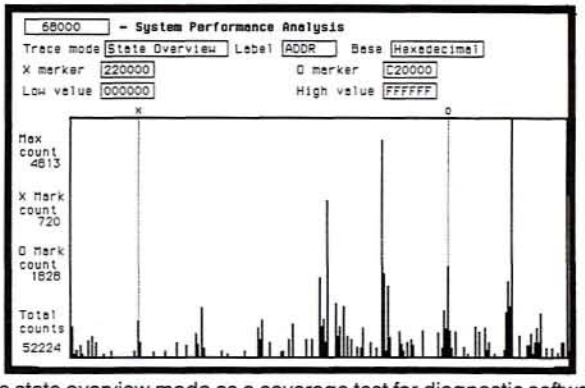
HP 10390A System Performance Analysis Software (HP 16550A, 16540A/D, 16510B, and 1650 Series)

Optimize Your System's Performance

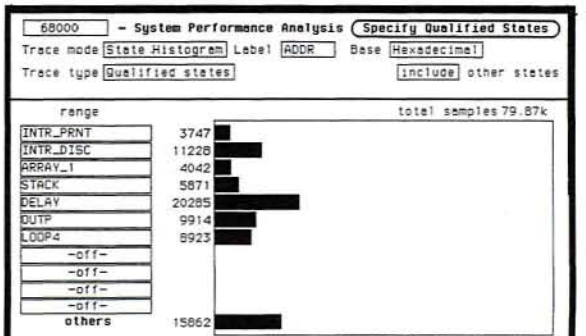
See an overall picture of your system to find the routines that are slowing performance. Find routines that are called most often, identify inefficient use of disks and peripherals, and find processes that use too much CPU time.

The HP 10390A system performance analysis software (SPA) converts your HP state analyzer into a powerful tool for finding bottlenecks in your system. SPA uses the state analyzer to sample your target system repetitively. The data captured is sorted into ranges before a new measurement is started after a random delay. The random delay ensures that the measurement will not sync on only a small portion of your system's code. After each acquisition, the captured information is translated into histograms and bar charts to present an accurate picture of your system's operation.

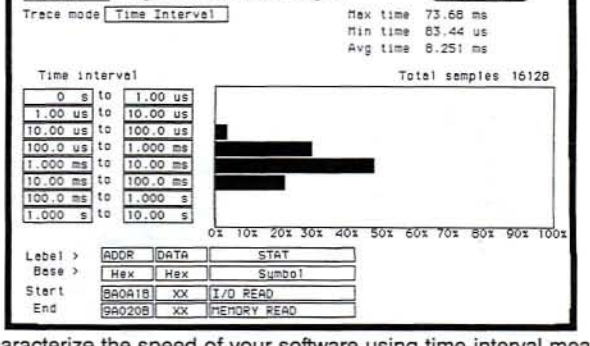
SPA performs three kinds of measurements: state overview, state histogram, and time interval measurements.



Use state overview mode as a coverage test for diagnostic software or to verify there are no accesses to protected memory segments.



Determine how often your system accesses specific routines. Use state histogram mode to characterize use of peripherals to optimize your system.



Characterize the speed of your software using time interval measurements. Find I/O routines that reduce system performance and measure the average, minimum, and maximum execution times.

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LOGIC ANALYZERS

Deep Memory Module and High-Speed Timing Module

HP 16542A and HP 16515A, 16516A

NEW

HP 16542A Deep Memory State and Timing Module

Collect and Analyze Large Streams of Data

The HP 16542A module provides high-speed, configurable, deep memory logic analysis for your HP 16500 Series system. Debug systems that process and transfer large streams of data, such as image processing systems, radar or other imaging systems, DSP systems, and telecommunications systems. Find the cause of intermittent system crashes by capturing up to 1 M of inverse-assembled states in your computer system. Perform benchmark testing and system performance analysis by acquiring up to 10 MB of data per run.

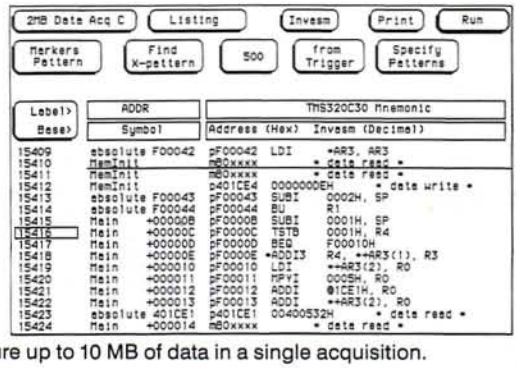
Key Specifications and Characteristics

	HP 16542A
Channels/card	16
Memory depth/channel/card	1 Mb/channels × 16 channels or 2 Mb/channels × 8 channels
Maximum memory depth/channel	1 Mb/channels × 80 channels 2 Mb/channels × 40 channels 5 Mb/channels × 16 channels* 10 Mb/channels × 8 channels*
Maximum state input clock rate	100 MHz
Timing analysis rate	100 MHz, fixed

*Requires HP E2430A memory expansion interface for multicard configurations.

Capture Entire Frames of Image Data

Capture and analyze image data from image processing systems, such as HDTVs, scanners, facsimiles, laser printers, and color photocopiers.



Capture up to 10 MB of data in a single acquisition.

Debug Digital Signal Processor Systems

Combine the HP 16542A with other HP 16500 Series modules for full DSP analysis in a single, easy-to-use mainframe. Use the HP 16550A 100-MHz state/timing analyzer to monitor code flow; the HP 16542A for memory-intensive data stream capture; and the HP 16532A 1-GSa/s oscilloscope for viewing parametric anomalies on the analog I/O streams.

Capture Data Bursts with Multirecord Mode

Use multirecord mode to specify a recurring trigger pattern and data stream length so that multiple data bursts or occurrences of real-time events may be captured in a single acquisition. Only data within these boundaries are stored, thereby using acquisition memory more effectively.



HP E2430A memory expansion interface allows one probe to drive up to five HP 16542A data acquisition cards for up to 80 Kbytes of memory depth.

HP 16515A/16516A High-Speed Timing Module

Measure Precise Time Relationships with 1-ns Resolution

Make time-interval measurements or view the order of events in your high-speed system with 1 ns single-shot resolution on every HP 16515A/16516A channel. Up to 80 channels in one HP 16500A mainframe lets you avoid having to move probes to find the problem.

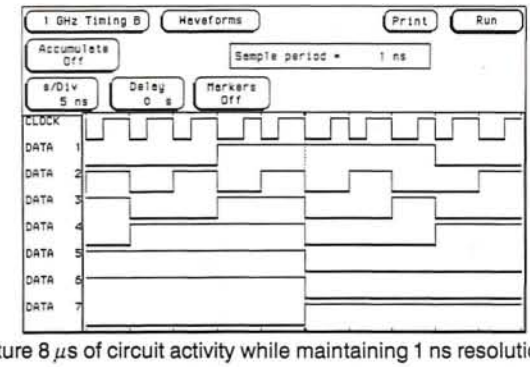
Key Specifications and Characteristics

	HP 16515A/16516A
Maximum sample rate	1 GHz
Channels/card**	16/16
Memory depth/channel	8 K
Time-interval accuracy	± [sample period + 0.01% of time interval reading + 1 ns + (0.5 ns if across pods)]
Input dynamic range	±7 V
Probe input resistance	10 kΩ ±2%
Probe input capacitance	~3 pF

**HP 16516A expansion card requires HP 16515A master card. Only one HP 16516A expansion card is supported by each HP 16515A.

Find the Cause of Elusive Problems

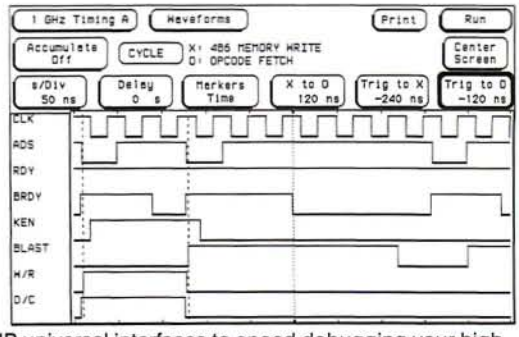
Find and analyze events that occur up to 8 μs before or after the trigger event. Capture data over many clock cycles while retaining precise edge placement information. Use the 8 K memory depth to find problems when you are not sure exactly where to trigger.



Capture 8 μs of circuit activity while maintaining 1 ns resolution.

Debug High-Performance Microprocessors

Speed up connection to microprocessors using HP's universal interfaces. A 1-GHz termination adapter and configuration software simplify connection of the HP 16515A/16516A timing analyzer to high-performance microprocessors such as the Motorola 68040 and others.



Use HP universal interfaces to speed debugging your high performance microprocessor.

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HP 16532A and HP 16530A/16531A Digitizing Oscilloscopes

Built-In, Full-Featured Digitizing Oscilloscopes

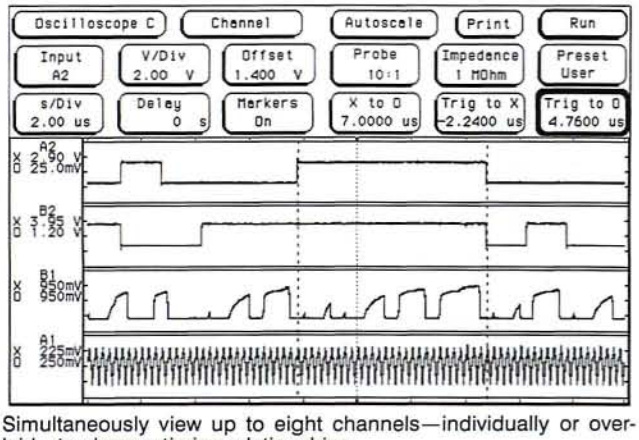
The HP 16532A and HP 16530A/16531A offer the advantages of a full-featured digitizing oscilloscope integrated into your logic analyzer. You can choose from either the 250-MHz bandwidth HP 16532A or the 100-MHz bandwidth HP 16530A/16531A modules. Both offer digitizing advantages such as autoscale, automatic measurements, powerful triggering, and negative time viewing.

Key Specifications and Characteristics

	HP 16532A	HP 16530A/16531A
Sample rate	1 GSa/s	400 MSa/s
Bandwidth*	250 MHz	100 MHz
Rise time**	1.4 ns	3.5 ns
Time interval accuracy	±150 ps	±1 ns
ADC resolution	8 bits	6 bits
Waveform record length	8000	4096
Channels per card***	2	0/2
Max. single time base channels	8	8
Max. channels per system	18	14

Use as a Standalone Scope with Many Channels

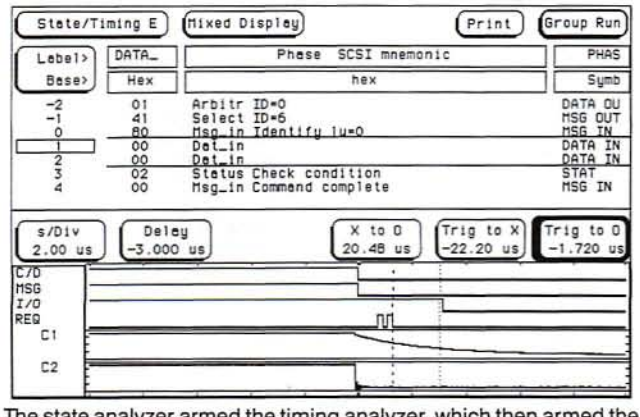
You can capture up to eight analog channels simultaneously (single time base) with either model. You can measure slow and fast events by adding additional oscilloscope modules to create a multiple time base digitizing oscilloscope. For large channel count measurements, you can configure as many as 18 HP 16532A scope channels in a single system.



Simultaneously view up to eight channels—individually or overlaid—to observe timing relationships.

Combine Scope with Other Logic Analysis Modules

You can arm or trigger the oscilloscope from any other module in the HP 16500 Series to capture and display the analog events that affect your digital system.



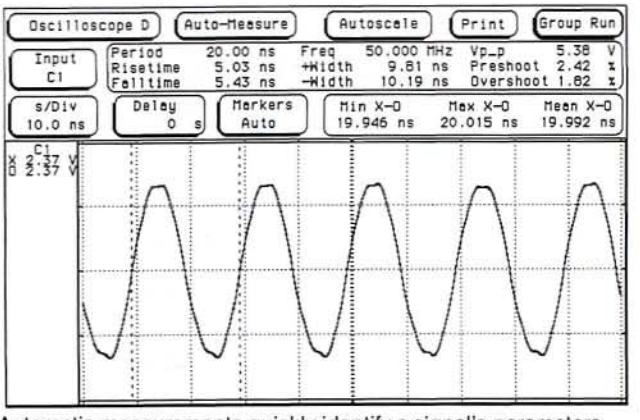
The state analyzer armed the timing analyzer, which then armed the built-in scope to capture a hard-to-find fall-time violation.

Automatic Setup, Measurements, and Time Markers Save You Time

Select Autoscale and the scope scales the time, voltage, and trigger levels instantly for a stable display of your waveforms. Use automatic measurements to analyze a signal's behavior easily. Markers can be used to measure voltage and timing relationships. Plus, automatic marker placement and statistics allow you to characterize a circuit quickly.

Automatic measurements display:

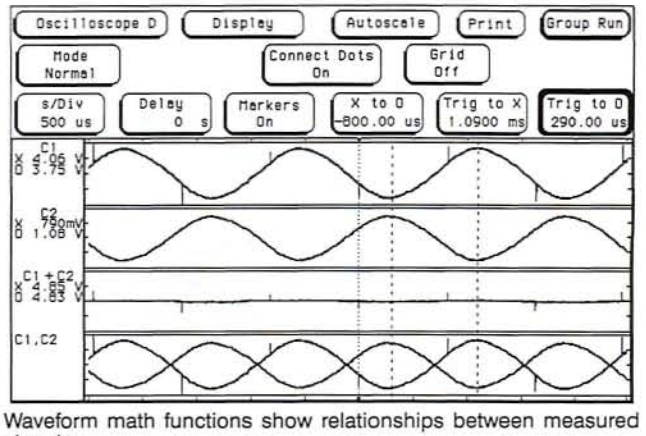
Frequency	Period
Rise time	Fall time
+Pulse width	−Pulse width
Overshoot	Preshoot
Peak-to-peak voltage	



Automatic measurements quickly identify a signal's parameters.

Flexible Display Modes Help You Find Signal Problems

Capture random signal variations or metastable states with the accumulate mode. Filter out noise with the average mode. Show true single-shot events with the single mode. Scan many periods of the waveform easily with the connect-the-dots feature. Analyze differential waveforms with the A-B mode.



Waveform math functions show relationships between measured signals.

*Specifications
**Rise time is calculated from: Rise time = 0.35/bandwidth
***HP 16531A acquisition cards require HP 16530A time base card. Up to four HP 16531A cards are supported by each HP 16530A. HP 16532A cards have a time base plus two acquisition channels on each card.

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LOGIC ANALYZERS

Pattern Generator Modules and CAE Links

HP 16520A, 16521A

HP 16520A/16521A Pattern Generator Module

Functionally Test Your Designs

The HP 16520A and HP 16521A digital pattern generator module is the perfect tool for functional testing of your digital design. Use standard connectors to connect to your DUT and avoid the need to design custom fixtures. Correlate data captured with other HP 16500 Series modules to verify correct operation. Use in automated test environments to pass or fail products quickly, using only one instrument. Save time normally spent developing custom test hardware used for stimulus.

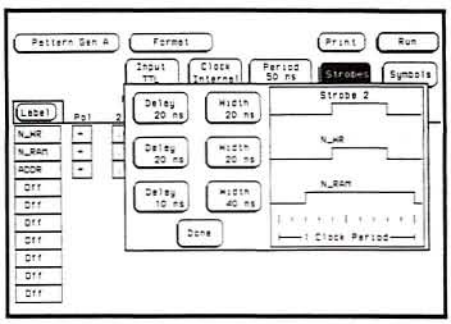
Key Specifications and Characteristics

	HP 16520A/16521A
Max data rate	50 Mb/s
Channels/card[1]	12 NRZ, 3 RZ/48 NRZ
Max channels/system	366
Memory depth/channel	4095 bits
Output levels	ECL, TTL, CMOS[2]

[1]HP 16521A expansion cards require HP 16520A master card. Up to four HP 16521A cards are supported by each HP 16520A.
[2]CMOS voltage levels require an HP 10348A CMOS buffer pod.

Continue Your Designs without Having to Wait

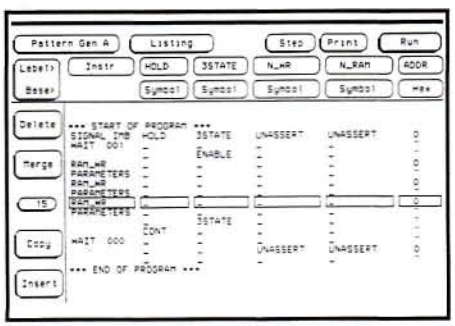
Use the HP 16520A/16521A as a substitute for missing boards, ICs, or buses. Instead of waiting for the missing pieces, you can continue to test and verify your design.



Three return-to-zero (RZ) channels can be used to simulate clock signals.

Debug Digital Circuits Easily

Quickly generate the patterns necessary to put your circuit in a desired state, or single-step your circuit through a series of states. Conveniently enter patterns in hex, octal, binary, decimal, or symbol bases. Easily edit data with Delete, Insert, Copy, and Merge functions. Use macros to specify repeating patterns, without re-entering them.



Symbols can be used to display data in your system's mnemonics, making debugging and documentation easier.

Create Stimulus Patterns Automatically

Automatically convert state data acquired with your HP 16510B or HP 1650 Series logic analyzer into pattern generator programs, using the HP 10392A state-to-pattern generator link. The HP 10392A software runs in the HP 16500A logic analysis system mainframe and does not require an external computer.

CAE Link Software

Verify Your Hardware by Using Simulation Vectors

Perform functional verification of your simulated design by transferring and translating simulation vectors to your HP 16500 system. Compare actual circuit behavior with simulation results to detect and isolate design faults. Using simulation vectors as the basis for your prototype verification, you can develop just the tests you need to verify that your design works.



CAE link between an HP 16500A and a workstation running TSSI software.

Save Time with Links Between Simulation and Prototype Tests

For functional prototype verification, you can quickly and easily transfer and translate just the test vectors you need. CAE links eliminate manual re-entry of test vectors and make the development of test suites easy.

Transfer Prototype Test Vectors to Manufacturing Tests

You can develop a core set of test vectors, make sure they fully test your product's functionality in the lab, then hand the completed design and test vectors to manufacturing. Plus, you can correlate the behavior of your DUT with simulated behavior by using HP 16500 Series modules. These permit you to monitor behavior of the device while it is in the test fixture. Captured data can then be compared to simulated data to determine if the test, tester, or design is at fault.

Begin Your ASIC Design Cycle with Real-World Test Vectors

Capture test vectors from the systems that your new ASIC will be designed to replace. Use HP 16500 Series acquisition modules to capture real data from key points in the system. Then transfer the test vectors back to the simulation environment for use as behavioral test data. This process lets you verify that your ASIC design behaves properly in your system before you send it to the foundry.

HP and TSSI: Working Together to Improve Your Productivity

The HP 16500 Series is supported by Test Systems Strategies, Inc. (TSSI) of Beaverton, Oregon (USA). TSSI markets software that links design and testing. TSSI supports most simulators in addition to supporting many popular ASIC verification, IC, and board testers.

TSSI supports HP 16500 Series pattern generator modules and all HP state and timing analyzers. You can capture system behavior with any of these analyzers and then transfer that information into TSSI's proprietary waveform database, where it can then be transferred to testers or simulators.

TSSI also supports the Compare mode found in all HP state analyzers. This means you can compare simulation results with acquisitions to detect system faults.

TSSI software runs on DEC VAX, HP workstations, Sun 3/Series, PCs, and other computer systems.

For more information about TSSI, contact your HP sales representative.

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