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LOGIC ANALYZERS

Specifications And Characteristics

Models 1650A, 1651A, 16500A, 16510A, 16515/16A, 16520A/21A, 16530A/31A

HP 1650A, 1651A, 16510A Specifications

Probes

Minimum Swing: 600 mV peak-to-peak.
Threshold Accuracy: ±150 mV accuracy over the range −2.0 to 2.0 volts; ±300 mV accuracy over the ranges −9.9 to −2.1 volts and 2.1 to 9.9 volts.
Dynamic Range: ±10 volts about the threshold.

State Mode

Clock Repetition Rate: Single phase is 25 MHz maximum. With time or state counting, minimum time between states is 60 ns. Both mixed and demultiplexed clocking use master-slave clock timing; master clock must follow slave clock by at least 10 ns and precede the next slave clock by > 50 ns.
Clock Pulse Width: ≥10 ns at the threshold.
Setup Time: Data must be present prior to clock transition, ≥10 ns.
Hold Time: Data must be present after rising clock transition, 0 ns.

Timing Mode

Minimum Detectable Glitch: 5 ns wide at the threshold.

Characteristics

Probes

Input RC: 100 KΩ ±2% shunted by approximately 8 pF at the probe tip.
Minimum Input Overdrive: 250 mV or 30% of the input amplitude, whichever is greater.
Maximum Voltage: ±40 volts peak.
Threshold Setting: Threshold levels may be defined for pods 1 and 2 individually (HP 1651A). Threshold levels may be defined for pods 1, 2, and 3 on an individual basis and one threshold may be defined for pods 4 and 5 (HP 1650A/16510A).
Threshold Range: −9.9 to +9.9 volts in 0.1 volt increments.

State Analysis

Memory
Data Acquisition: 1024 samples/channel
Format Specification
Clock: Five clocks (HP 1650A/16510A) or two clocks (HP 1651A) are available and can be used by either one or two state analyzers at any time. Clock edges can be ORed together and operate in single phase, two phase demultiplexing, or two phase mixed mode. Clock edge is selectable as positive, negative, or both edges for each clock.
Clock Qualifier: The high or low level of four clocks (HP 1650A/16510A) or one clock (HP 1651A) can be ANDed with the clock specification. Setup time: 20 ns; hold time: 5 ns.
Trace Specification
Pattern Recognizers: Each recognizer is the AND combination of bit (0, 1, or X) patterns in each label. 8 pattern recognizers are available when one state analyzer is on. 4 are available to each analyzer when two state analyzers are on.
Range Recognizer: Recognizes data which is numerically between or on two specified patterns (ANDed combination of zeros and/or ones). One range term is available and is assigned to the first state analyzer turned on. The maximum size is 32 bits.
Qualifier: A user-specified term that can be anystate, nostate, a single pattern recognizer, range recognizer, or logical combination of pattern and range recognizers.
Sequence Levels: There are 8 levels available to determine the sequence of events required for trigger. The trigger term can occur anywhere in the first 7 sequence levels.
Branching: Each sequence level has a branching qualifier. When satisfied, the analyzer will restart the sequence or branch to another sequence level.
Occurrence Counter: Sequence qualifier may be specified to occur up to 65535 times before advancing to the next level.
Storage Qualification: Each sequence level has a storage qualifier that specifies the states that are to be stored.
Enable/disable: Defines a window of post-trigger storage. States stored in this window can be qualified.
Prestore: Stores two qualified states that precede states that are stored.

Tagging
State Tagging: Counts the number of qualified states between each stored state. Measurement can be shown relative to the previous state or relative to trigger. Maximum count is 4.4×10^{12}.
Time Tagging: Measures the time between stored states, relative to either the previous state or to the trigger. Maximum time between states is 48 hours. With tagging on, the acquisition memory is halved; minimum time between states is 60ns.
Symbols
Pattern Symbols: User can define a mnemonic for the specific bit pattern of a label. When data display is SYMBOL, mnemonic is displayed where the bit pattern occurs. Bit patterns can include zeros, ones, and don't cares.
Range Symbols: User can define a mnemonic covering a range of values. Bit pattern for lower and upper limits must be defined as a pattern of zeros and ones. When data display is SYMBOL, values within the specified range are displayed as mnemonic + offset from base of range.
Number of Pattern and Range Symbols: 100 per analyzer. Symbols can be down-loaded from a controller.

Timing Analysis

Transitional Timing Mode: Sample is stored in acquisition memory only when the data changes. A time tag stored with each sample allows reconstruction of waveform display. Time covered by a full memory acquisition varies with the number of pattern changes in the data.
Sample Period: 10 ns
Maximum Time Covered by Data: 5000 seconds
Minimum Time Covered by Data: 10.24 μs
Glitch Capture Mode: Data sample and glitch information is stored every sample period.
Sample Period: 20 ns to 50 ms in a 1-2-5 sequence dependent on sec/div and delay settings.
Time Covered by Data: Sample period × 512
Waveform Display
Accumulate: Waveform display is not erased between successive acquisitions.
Overlay Mode: Multiple channels can be displayed on one waveform display line. Primary use is to view summary of bus activity.
Maximum Number of Displayed Waveforms: 24
Time Interval Accuracy
Sample Period Accuracy: 0.01% of sample period.
Channel-to-channel Skew: 4 ns typical
Time Interval Accuracy: ±(sample period + channel-to-channel skew + 0.01% of time interval reading)
Trigger Specification
Asynchronous Pattern: Trigger on an asynchronous pattern less than or greater than specified duration. Pattern is the logical AND of specified low, high or don't care for each assigned channel. If pattern is valid but duration is invalid, there is a 20 ns reset time before looking for patterns again.
Greater than Duration: Minimum duration is 30 ns to 10 ms with 10 ns or 0.01% resolution, whichever is greater. Accuracy is +0 ns to −20 ns. Trigger occurs at pattern + duration.
Less than Duration: Maximum duration is 40 ns to 10 ms with 10 ns or 0.01% resolution, whichever is greater. Pattern must be valid for at least 20 ns. Accuracy is +20 ns to −0 ns. Trigger occurs at the end of the pattern.
Glitch/Edge Triggering: Trigger on glitch or edge following valid duration of asynchronous pattern and while the pattern is still present. Edge can be specified as rising, falling or either. Less than duration forces glitch and edge triggering off.

Measurement And Display Functions

Autoscale (Timing Analyzer Only): Autoscale searches for and displays channels with activity on the pods assigned to the timing analyzer.

Acquisition Specifications

Arming: Each Analyzer can be armed by the Run key, the other Analyzer, the external trigger in port (HP 1650A/1651A) or the Intermodule Bus (HP 16500A).

Trace Mode: Single mode acquires data once per trace specification; repetitive mode repeats single mode acquisitions until stop is pressed or until time interval between two specified patterns is less than or greater than a specified value, or within or not within a specified range. There is only one trace mode when two analyzers are on.

Labels: Channels may be grouped together and given a 6-character name. Up to 20 labels in each analyzer may be assigned with up to 32 channels per label. Primary use is for naming groups of channels such as address, data, and control busses.

Indicators

Activity Indicators: Provided in the Configuration, State Format, and Timing Format menus for identifying high, low, or changing states on the inputs.

Markers: Two markers (X and O) are shown as dashed lines in the display.

Trigger: Displayed as a vertical dashed line in the timing waveform display and as line 0 in the state listing display.

Marker Functions

Time Interval: The X and O markers measure the time interval between one point on a timing waveform and trigger, two points on the same timing waveform, two points on different waveforms, or two states (time tagging on).

Delta States (State Analyzer Only): The X and O markers measure the number of tagged states between one state and trigger, or between two states.

Patterns: The X or O marker can be used to locate the nth occurrence of a specified pattern before or after trigger, or after the beginning of data. The O marker can also find the nth occurrence of a pattern before or after the X marker.

Statistics: X to O marker statistics are calculated for repetitive acquisitions. Patterns must be specified for both markers, and statistics are kept only when both patterns can be found in an acquisition. Statistics are minimum X to O time, maximum X to O time, average X to O time, and ratio of valid runs to total runs.

HP 16530A/16531A 400 Megasample/s Digitizing Oscilloscope

Specifications

Vertical (at BNC)

Bandwidth (−3 dB): dc to 100 MHz (dc-coupled)

Range: 40 mV to 16 V full scale (adjustable with 2-digit resolution).

DC Gain Accuracy: ±3% of full scale (valid within ±10°C of auto-calibration temperature)

Analog-to-digital Conversion (ADC) Resolution: ±1.6% of full scale (6 bits)

DC Offset Accuracy: ±1% of offset ±3.2% of full scale (valid within ±10°C of auto-calibration temperature).

DC Offset Range/Resolution:

Vertical Range	Offset Range	Offset Resolution
<800 mV	±800 mV	1 mV
≥800 mV	±16 V	20 mV

Voltage Measurement Accuracy (DC):

Single Cursor (X or O): = Gain accuracy + ADC resolution + offset accuracy.

Dual Cursor (X to O measurements on the same waveform): = Gain accuracy + 2 (ADC resolution)

Horizontal

Range: 50 ns to 100 s full scale, adjustable with 3-digit resolution.

Time Interval Measurement Accuracy (dual channel for deskewed channels with equal rise and fall times):

±0.75 ns ±0.2% of timebase range ±0.02% of reading (2.5 ns sample period)

± sample period ±0.2% of timebase range ±0.02% of reading (≥ 5 ns sample period)

Delay (Time Offset)

Pre-trigger Range: 4096 × sample period

Post-trigger Range: 500 screen diameters

Resolution: Fine adjustment to 0.2% of screen diameter

Vertical

Transition Time (10% to 90%): ≤ 3.5 ns

Input Coupling: dc

Input RC: 1 MΩ ±2% or 50 ohm ±3%, shunted by approximately 13 pF.

Maximum Safe Input Voltage: 1 MΩ input, ±40 V (dc + peak ac), 50 Ω input, ± 5 V (dc + peak ac)

Probe Factors: Any integer ratio from 1:1 to 1:1000, to scale the oscilloscope to represent voltages seen at the probe tip.

Time Base

Deskewing: Skew between channels can be nulled out to compensate for probe cable lengths.

Digitizer

Resolution: 6 bits (1 part in 64)

Digitizing Rate: up to 400 megasamples/second

Digitizing Technique: Real-time digitizing; each 4K record is acquired on a single acquisition.

Acquisition Memory Size: 4096 samples per channel

Waveform Display

Display Formats: Waveforms can be displayed in an overlapping and/or non-overlapping format.

Display Resolution: 500 points horizontally.

Display Modes

Single: New acquisitions replace old acquisitions on screen.

Accumulate: New acquisitions are added to the screen and displayed with older acquisitions until screen is erased.

Average: New acquisitions are averaged with older acquisitions with updated waveform displayed until erased.

Overlay: Up to 8 acquired waveforms can be overlayed in the same display area.

Connect-the-dots: Provides a display of the sample points connected by straight lines.

Waveform Reconstruction: When there is insufficient data to fill every horizontal location, a post-acquisition reconstruction filter fills in the missing locations.

Waveform Math: Display capability of A−B and A+B functions is provided.

Measurement Aids

Markers: Two vertical markers are provided for measurements of time and voltage. Capabilities are: measure voltage of X and O on each analog waveform; measure time from X to trigger, O to trigger, and X to O; automatic marker placement by specifying voltage level, edge number, and rising or falling edge type; run until X to O greater than, less than, in-range, and not-in-range provides selective event search; X to O statistics (mean, max, and min) provide analysis of time interval deviation.

Automatic Measurements: The following pulse parameter measurements can be performed automatically:

Frequency	Rise time	+ pulse width
Period	Fall time	− pulse width
Vpp	Preshoot	$V_{top\text{-}base}$
	Overshoot	

Setup Aids

Autoscale: Autoscale sets the vertical and horizontal ranges, offset, and trigger level to display the input signals. Requires an amplitude above 10 mV peak, and a frequency between 50 Hz and 100 MHz.

Presets: Scale the vertical range, offset, and trigger level to predetermined values for displaying ECL or TTL waveforms.

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