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HP 16500 Series Mainframe - Logic Analyzer/Oscilliscope

Published by flintyscott

HP 16500A, 16500B, 16500C "Logic Analyzers" are far more than just logic analyzers. These mainframes support many kinds of modules, including Digital Storage Oscilloscopes, Pattern Generators, and more.

Introduction

These mainframes and associated modules were sold and supported by HP (now Agilent) approximately from 1985 until about the year 2000. Depending on the installed modules, these systems can provide up to eight **500 MHz Digital Storage Oscilloscope** channels, or 340 Logic Analyzer channels (**up to 135 MHz State/500 MHz Timing**), or 128 High-Speed Logic Analyzer channels (**4 GHz**), or 64 channels of patterned digital output at 50 MHz, or almost any combination. And with a combination of modules these units can perform **intermodule triggering** (trigger any module from another; for example trigger two or more DSO channels and 64 Timing channels from one or more Timing/State/External channels). Each unit supported five modules, and 'B' and 'C' models could use an expansion frame to increase their total to nine modules. These systems are not directly supported by Agilent anymore, but most manuals (User's, Service and Programming) are still available through Agilent's Web Site (under Support) in .PDF format (along with the last released versions of their software).

Model Characteristics

These systems relied on a 9 inch diagonal color CRT display, and a touch screen Graphical User Interface - which is why there are few buttons, and a rotary knob, on the front panel. The three mainframes all rely on the same mechanical frame, but have differing CPU boards, front panels, and I/O capabilities. Note: A set of **Torx** drivers are necessary for performing any disassembly/assembly to these systems. All three models supported the GPIB instrument interface and an RS232 interface intended to allow an external computer (PC?) to program/control the unit (or connection to a printer).

The main differences are:

Model Optional I/O	CPU	Disk Drives	Keybrd/mouse	I/O
16500A	MC68000	Floppy 720KB (2)	HP specific	

16500B	MC68020	Floppy(1.4MB)/HD (500MB)	HP specific		10 M Ethr, Exp.
16500C	MC68030	Floppy(1.4MB)/HD (500MB)	PS/2	10 M Ethr, Exp.	

HP 16500A

The latest System software and Module files (Rev. 6.00) for the 'A' model supports most, but not all, of the HP 165XX modules. Exceptions tend to be the last versions of each type (for example: LA - 16554/5A/D, 16556A/D, 16557D; DSO - 16533A, 16534A; others - 16522A, 16535A). Agilent has a Logic Analyzer compatibility matrix in Acrobat Reader (.pdf) format on their Support site (search on "16500 compatibility" - thanks "aaeegg"). The 'A' model (floppy) disk format is not compatible with MS-DOS (as is true for the 'B' and 'C' models). A special MS-DOS utility is provided in the self-extracting .exe file for the 'A' model (System Rev 6.00 from Agilent) that can format and copy to these specially formatted disks. Note that one will need a computer running MS-DOS (or Windows 3, Windows 95/98/ME) to create floppy disks for these systems. Also, you will find that HD 720K 3.5 inch floppies are very hard to find now, but standard floppies can be used if the rectangular hole opposite the protect slide is masked with opaque tape). The 'A' units are slow to load their System software and Module files from the two floppies, but they perform just fine.

HP 16500B

The 'B' and 'C' systems replaced the rear Double-Sided 720 KB Floppy drive of the 'A' model with an internally-mounted 500 MB Quantum Fireball 3.5 inch Hard Drive (model 540AT), and the front 720 KB Floppy with the more recent 1.44 MB Double-Sided High-Density (2HD - note that these these floppy drives are NOT directly compatible with PC floppy drives, though PC drives can be modified to work: as per note from flamebug - thanks!). Note that the Hard Disk controller and/or the CPU Board firmware/BIOS will not recognize any other brand/type of Hard Disk (other than different sizes of the Quantum Fireball 3.5 Series XXXXAT). These models ('B' and 'C') both use MS-DOS formatted drives (FAT12 for the Floppy, and FAT16 for the HD - I think). All three models actually run the MS-DOS Operating System with a unique touch-screen GUI (with keyboard and mouse as an alternative). Both 'B' and 'C' systems boot up their System software, Module files, and Configuration files much faster than do 'A' units because of their faster Hard Drives. In the space below the back-panel cooling Fan (where the rear Floppy is located on the 'A' models) a blank panel hides the location for an optional I/O board. An optional I/O module, the **16500H** (with an RJ-45 TBase-T Ether jack in middle) or **16500L** (with DB-15 Ether AUI connector - need AUI-to-TBase-T adapter), installed in this location (with ribbon-cable connections to the CPU board) and a System software upgrade brings the 'B' model's capabilities very close to those of the 'C' model. The last version of System software for the 16500B models was Rev. 3.14.

HP 16500C

The 'C' model was the flagship mainframe. In addition to the faster CPU than the 'A' and 'B' models (with larger system RAM), it also included support for additional I/O such as standard PS/2 Keyboard and Mouse, High-Speed Interface to an HP 16501 Expansion Frame (for 5 additional modules), and most importantly a 10BaseT Ethernet interface.

The value of the Ethernet interface was in the system's support for the X-Windowing system. The last (only?) version of System software for the 16500C's was Rev. 1.00.

X-Windows and External Control

The X11 Windowing System has formed the foundation for Unix Operating System Graphical User Interfaces for decades. It is a client-server type of system, that allows remote "servers" (a Unix or Linux or Windows computer) to provide the user interface for client devices (such as an HP 16500C). This means that instead of relying on the HP16500C display and front panel controls a user can completely control (and display results from) the system from his computer. This is particularly useful for saving screen-shots of important displays.

Basic Operation

All three models operate the same way. The Power Supply is located above the card cage with the Cord receptacle and main On/Off switch. Once an AC cord is inserted and the main switch turned to the On position, the unit is switched On/Off via the small rocker switch on the lower left of the front panel.

Power-Up Self Test

When this is switched to the On position, the unit will power up and perform a series of Power-Up Self Tests, including:

ROM
RAM
Interrupts
Display
HIL (Human Interface Logic?) Controller
Front Panel
Touchscreen
Rear/Hard Disk ('A'/'B' and 'C')
Front/Floppy Disk ('A'/'B' and 'C')

These should all pass (obviously). If a properly formatted floppy disk is not inserted in the drive(s) before power is applied the associated Disk test will indicate "no disk". This is not the same as failure. Any failed tests will display "failed" in red in place of "passed" (to the left of the test label). The touchscreen test might also return an "impaired" status, yet still work (if this happens, it might later change to "passed" - especially with a little CAREFUL wiggling of power connections and/or loosening then re-seating of the power supply board). A Hard Disk failure most often means a failed Hard Disk, but might also mean a non-functional IDE Controller on the CPU Board, or just a bad connection to the Power Supply (see "impaired" status comment on touchscreen above). Quantum Fireball 1280AT, 1024AT, 540AT drives are occasionally available here on eBay (don't know whether other models, such as Fireball ST, EX, etc., will work in these systems, but I'm skeptical). It is possible to replace the Hard Disks, re-format and reload them with software from the .zip file (obtained from the Agilent Support website).

BOOTUP

Once PUST are finished the systems then tries to load the System software (the SYSTEM file), which for 'A' models must be on a Floppy in one of the two drives (SYSTEM is usually on Disk 1 in the set), on the Floppy for 'B' or 'C' models, or on the Hard Disk in the SYSTEM directory for 'B' and 'C' models). This is indicated by a green message "Loading SYSTEM File" below the PUST listing. If the SYSTEM file isn't found, then a yellow message "SYSTEM File Not Found" is displayed to the right side of the screen, and the system just waits. The unit will have to be power-cycled in order to re-boot (with a floppy containing the SYSTEM file, hopefully).

If the SYSTEM file is successfully loaded then it will try to load the necessary Module files (files that contain module-specific code), which is indicated by a green message. It will follow this with messages indicating loading of Software Options, Configuration files, and then finally performing Calibration (all green messages, some of which may not appear depending on the unit's configuration). If this sequence is successful the screen will switch to a graphical display as follows:

- On a brown background will be a blue rectangular section to the left of the screen that displays green panels with white text for each module found in the associated slot (from A through E, top to bottom respectively), if any (no modules leaves the panel all blue).

- Each module description panel is linked to it's associated slot in the graphical representation of the rear of the unit just to the right, in the center of the screen.

- On the right side of the screen is either: For 'A' models - two green rectangular panels, the upper capped with a blue "button" labeled "GPIB" and containing a computer icon, and the lower capped by a "button" labeled "RS232" and showing a printer icon; both linked to their associated connectors on the unit's back panel. For 'B' and 'C' models, a single green panel with a list of blue "buttons" for available interfaces. Links run from each interface "button" to the associated connector on the rear panel view.

- On 'A' models a front panel representation is displayed in the center of the screen (above the rear panel view).

- At the top left of the screen is an elongated blue "button" labeled "System", in the top center another labeled "Configuration", and top right is another labeled "Print".

Blue "buttons" are touch-screen points that bring up a menu of choices, which are typically for selecting mode or for configuration. The "System" button will display a menu of the modules installed in the unit, and selecting one of them will cause the screen to switch to the configuration screen for that module. Selecting "System" will clear the menu list.

Testing Mainframe and Modules

HP provides separate test software for these systems and modules. This should be installed on the Hard Drives of 'B' and 'C' models (in the System directory), and on floppy Disks 5 and 6 for 'A' models (note that because not all tests will fit on a single floppy, the

test software PVTEST is located on both Disks 5 and 6 and all module test files except that for the 16517/18A 4 GHz Timing/State Analyzer are located on Disk 5). Performing any tests requires that the PVTEST code be loaded in place of the SYSTEM code. This is initiated by the following steps:

- Touch the "Configuration" button at the top center of the graphical screen to diplay the menu.

- Select/touch "Test".

- The graphical screen will change to a slot listing of modules, and a yellow warning message near the top will indicate that the "test system is loaded over existing system."

- In the center of the screen is a large blue rectangular button labeled "Load Test System"; touch this button.

- The display will go blank except for a green message that it is loading Test files.

- Once the Test software and files are loaded, a graphical display returns, but with the module and unit graphics panels having a brown rather than blue background, and the upper left screen button changed to "Test System" from "System".

- Mainframe or Module tests are selected from the menu displayed upon touching the "Test System" button.

- Upon selection of one of these tests, a group of dark brown buttons are displayed with labels indicating which test they represent. They are linked together via lines. A button labeled "All System Tests" is usually located in the lower right of the display. Touching this button will initiate all tests.

- As tests run, they commonly will display small green panels with white text indicating the function or part being tested.

- When all tests are complete for the Mainframe or Module, each button will show that test's status along the bottom of the button.

Return to the main Test display by selecting the button in the upper left labeled "xxxxxxxxx Test" - where xxxxxxx is the name of the test that had been selected from the menu - and selecting "Test System" at the top of the menu.

Return to the normal System by touching the Configuration button (top center) to display the menu, selecting "Test" at the bottom of the menu, and then touching the center box labeled "Touch Box to Exit Test System" (there will be a yellow warning message above this indicating the normal system will be loaded over the test system).

HP 16500A/B/C Modules

HP 16500 mainframes hold modules that perform actual test functions; the mainframe simply provides the power, user interface, and inter-module connections. Modules fall into several types:

- Logic Analyzer (LA), typically offering State or Timing modes for TTL, ECL or configurable digital logic levels and supporting from 68 to 102 channels plus clock and ground signals. Supported State-mode clocking ranges from a max of 25 MHz

(16510A) to 110 MHz (16555A/D), while Timing mode supports max clocking of up to 500 MHz (1655X LAs).

- Digital Storage Oscilloscope (DSO), providing DC-coupled high-sample-rate Analog-to-Digital conversion channels.

- High-Speed Logic Analyzer (HS-LA), supporting State/Timing of up to 1 GHz (16515A/16516A) or 4 GHz (16517A/16518A).

- Pattern Generation, as the 16520A/16521A Modules support up to 50 MHz programmable outputs.

- Miscellaneous.

Modules Commonly Found on eBay

- 16510A - State/Timing LA module: max 25 MHz (State)/100 MHz (Timing), 80 channels, 1 KSample buffer.

- 16510B - State/Timing LA module: max 35 MHz (State)/100 MHz (Timing), 80 channels, 1 KSample buffer.

- 16515A - High-Speed State/Timing LA module: max 1 GHz (both), 16 channels.

- 16516A - High-Speed State/Timing LA Expansion module: max 1 GHz (both), 32 channels.

- 16517A - High-Speed State/Timing LA module: max 4 GHz (both), 16 channels.

- 16518A - High-Speed State/Timing LA Expansion module: max 4 GHz (both), 32 channels.

- 16520A - 50 Mbps Pattern Generator, 12 channels.

- 16521A - 50 Mbps Pattern Generator, 48 channels.

- 16522A - 200 MVector/sec Patter Generator, 20 channels (40@100MHz), 256 KB depth/ch.

- 16530A - 400 MSample/sec (MS/sec) Timebase (for 16531A Acquisition Module, no User/Ref Manuals available on the Agilent Support Site, only Programming Manual).

- 16531A - 100 MHz Digital Storage Oscilloscope (DSO), two 400 MS/sec A-to-D channels, 6 bit, 4 KSample buffers (no Reference or User Manuals; only Programming Manual available on Agilent Support site).

- 16532A - 250 MHz DSO, two 1 GigaSamples/sec (GS/sec) A-to-D channels, 8 bits, 8 KSample Buffers.

- 16533A - 250 MHz DSO, two 1 GS/sec A-to-D channels, 8 bits, 32 KSample Buffers.

- 16534A - 500 MHz DSO, two 2 GS/sec A-to-D channels, 8 bits, 32 KSample Buffers.

- 16535A - Multiprobe 2-Output Control Module, multiplexes up to hundreds of analog probes down to two Oscilloscope inputs.

- 16540A - 100 MHz 16 Channel State Analysis Module, 4 KSample buffer (no manuals on Agilent Support pages).

- 16541A - 100 MHz State Analysis Expansion Module (no manuals on Agilent Support pages).

- 16550A - 100 MHz State/500 MHz Timing LA Module, 102 Channels, 4 KSample Buffer.

- 16554/5A/D - 70/100 (16554A) and 110/500 MHz LA Modules (16555A/D), 68 Channels, 500 KSample (16554A)/1 MSample (16555A)/2 MSample (16555D) Buffer.

- 16556A - 100/400 LA Module, 68 Channels, 1 MSample Buffer.

- 16557D - 135/500 LA Module, 68 Channels, 2 MSample Buffer.

Probes

All modules require some form of connection to the electronics to be tested.

Digital Storage Oscilloscope (DSO) Modules

For DSO modules (16530/31A, 16532A, 16534A) an oscilloscope probe is required for each channel (two per module). Note that each DSO module has probe specifications that must be met for a proper match (impedence and capacitance), as displayed on the back panel of the module near each channel's BNC connector. Note also that because DSO probes are connected at the back panel of HP 16500 systems (unlike regular Oscilloscopes), long **(1.5 meter or 2 meter) probe cables are necessary** for convenient usage. HP made probes that work very well.

- HP 10441A/B - 500 MHz passive 10:1 probe, 6-9 pF, 1 MOhm, 2 meter cable (for 16532/3/4A).

- HP 10433A - 300 MHz passive 10:1 probe, 10-16 pF, 1 MOhm, 2 meter cable (for 16531A).

State/Timing Logic Analyzer Modules

All of these modules (16510A/B, 16550A, 16554/5A/D, 16556A, 16557D) use cables terminated at 40-pin IDC-type connectors (compatible with cables used by the HP 1650 series Logic Analyzers). The 16510A/B and 16511A modules have five such cables, unshielded and all permanently attached (and always in the way and in danger of being damaged). The 16550A LA module has six such unshielded cables connected to the module via three securable connectors (two cables per connector). Later LA modules (16554/5A/D and 1556/7A) all have four shielded cables (with or without optional Ferrite filters clamped onto them) connected to the module through two connectors.

In order for these modules to work properly (and meet their specifications) the correct termination is required. This generally means that HP probes must be used. There are two types commonly used (and available, both on used/new on eBay and new from Agilent):

- HP Flying-Lead Probe Adapter with individual (flying) leads for each signal, plus clock and ground.

- HP Termination Adapter with signals, clock and ground brought to a standard 20-pin IDC plug (used with a standard IDC 20-pin header). The is a lower-speed Adapter for the 16510/11 while the -63203 is faster (1 GHz?) for the 1655X LA line.

High-Speed State/Timing and Pattern Generator

These modules all have cables different than the 40-signal one used by standard LA

modules (typically with fewer signals). They are terminated uniquely, typically with a variant of the individual flying lead that is individually grounded.

What Is It Worth/Does It Cost?

A seller naturally wants to know the marketable value of a mainframe or module, and a buyer wants to know what price is reasonable. Naturally on eBay, an auction site, a wide range of selling prices can be seen for any specific HP 16500 series model or module.

Tips

- Don't pay much attention to the prices listed for modules/systems by online Test Equipment Rental or Used Test Equipment companies. They are based on what corporations (used to) pay for this kind of equipment (and what HP/Agilent used to charge for this stuff when new). That market, if it still exists, has little to no relevance on eBay (though quite a few eBay stores and sellers don't seem to know this yet - they must not watch many auctions for this equipment).

- Be very careful about untested Mainframes or Modules. All Mainframes, especially 'B' and 'C' models, have Test software and files and are thus able to test the Mainframe and Modules before an auction/sale (and show photos of the results). Buying a Mainframe without this proof that it (and any installed Modules) work fine is very risky - especially if sold As-Is. This is true of a 16500A seller as well as 'B' and 'C' sellers - if they don't have the Test software/files then they don't have a working, functional system.

- Even if a seller provides a reasonable or generous Return policy a buyer could be out over $100 just for the round trip shipping costs (these are big and heavy)! It pays to buy units that are fully functional.

- Ideally as a buyer one would like to obtain a complete, usable system at one time. This would include both analog and digital channels (at least one DSO module and one State/Timing LA module) and the necessary probes (at least two Oscilloscope probes, and from one to four or more LA probes). Otherwise you might find yourself with a functional Logic Analyzer, Digital Storage Oscilloscope, or combination system but no way to actually use it (without probes). I have noticed that few auctions (or Buy It Now sales) include probes. Given the time and effort required to research probes, and acquire them, it is worth a significantly higher selling price if the probes are included.

- Remember that the mainframes are big and heavy. Shipping (and packaging) will run anywhere from $40 to $70 dollars, with recent averages somewhere around $55 -60 (U.S. Continental only, depends on fuel surcharge), and this is added on top of the selling price.

Typical Auction Prices

What follows is the range of prices that I have seen during the last one to two years for HP 16500 Series mainframes and modules on eBay (that are not obviously broken). As you will see for the A/B/C system prices, they can be a good to very good value in test equipment.

- 16500A - Go for as little as $50 (without full disk sets and without modules), to as much as $150 (with disks and a module or two - typically a 16510B or 16550A LA

module). With a 100 MHz DSO (16530A/31A) and 16550A (or pair) but no probes they're around $200-300, and with probes the price might be $300-450. These are rarely fully tested (all module input channels and probes tested), which should fetch a higher price.

- 16500B - Mainframes for as little as $100 and as high as $250. With 100 MHz DSO (16530A/31A) and 16555A (or pair of 16550As) but no probes they're around $250-300, and with probes the price might be $350-450. With 250 MHz DSO (16532A) and 16555A, and probes maybe $400-$500. Fully tested possibly higher. With 16500H (10BaseT Ethernet) add $50-100.

- 16500C - Mainframes for as little as $150 and as high as $500. With 100 MHz DSO (16530A/31A) and 16555A (or pair of 16550As) but no probes might be around $350-500, and with probes the price might be $400-550. With 250 MHz DSO (16532A) and 16555A, and probes maybe $500-$600. Fully tested possibly higher.

- 16530/31A - This is the basic 100 MHz/400 MSa/s DSO. Board sets sell for $75-125, possibly more if tested.

- 16533A - Any mainframe with a working 500 MHz DSO module is automatically worth $150-200 just for this module. Add this to the prices above in place of a 16532A.

- 16534A - Any mainframe with a working 500 MHz DSO module is automatically worth $350+ just for this module. Add this to the prices above in place of a 16532A.

- 16510A/B - maybe $15.

- 16515/16A - as pair around $60-100 with probe leads. Without probe leads?

- 16517/18A - 16517A alone $75-100, with 16518A maybe $100-175 (16518A only works with 16517A, so without one they're worthless). This assumes probe leads. Without them is just a used electronics board.

- 16520/21A - Without probe adapters, which are hard to find, they aren't very useful. With probe adapters around $35-55.

- 10433A - Oscilloscope probe for 16531A, $25-45 complete (ground and sping clip). Less if not complete.

- 10441A/B - Oscilloscope probe for 16532/3/4A, $35-55 complete (ground and spring clip). Less if not complete.

I hope you've found this helpful.

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Based in United States, flintyscott has been an eBay member since Sep 13, 2005

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