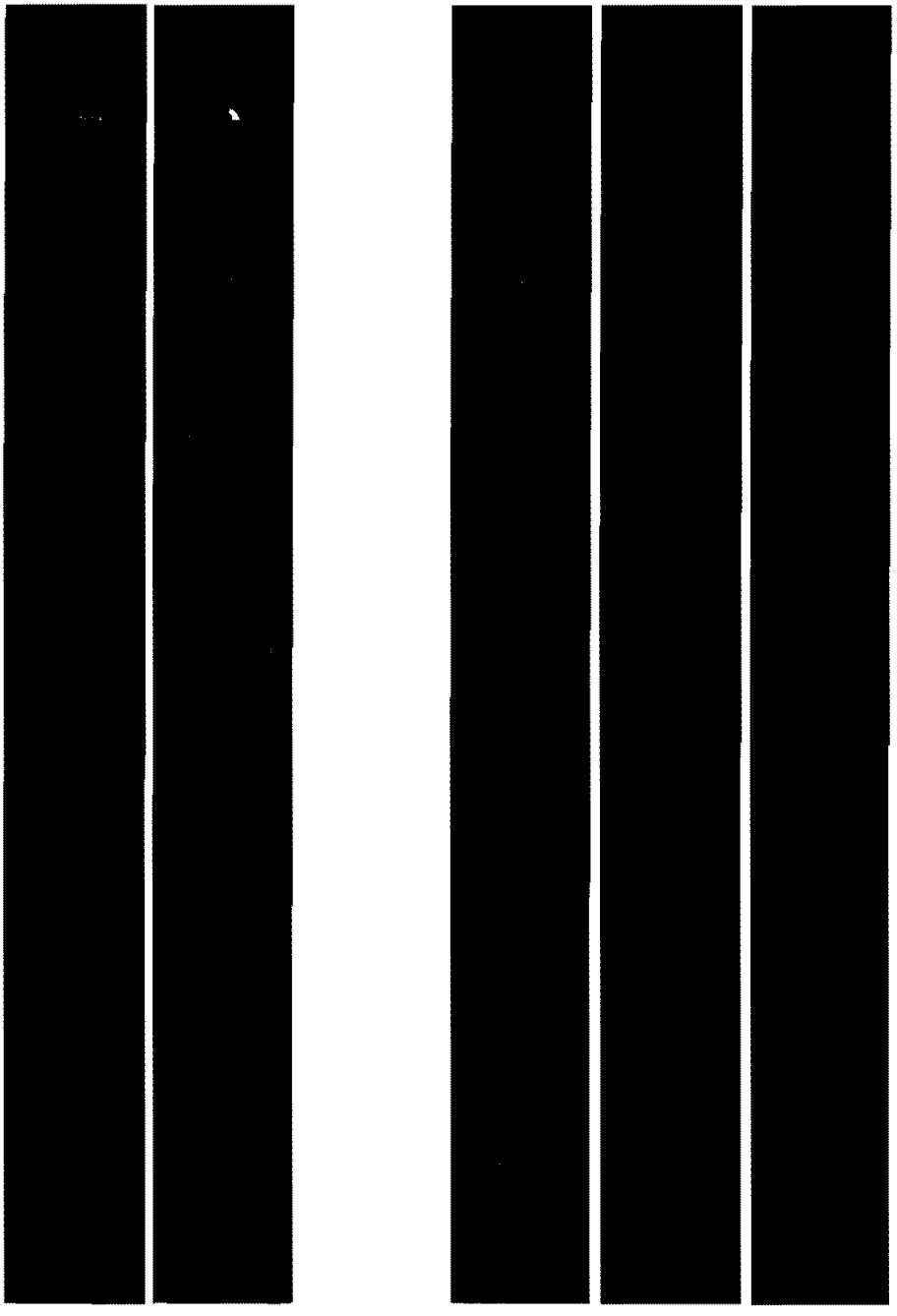
HEWLETT hp PACKARD

MEASUREMENT/COMPUTATION



1977

ELECTRONIC INSTRUMENTS AND SYSTEMS

ALPHABETICAL INDEX

ALPHABETICAL INDEX

MODEL NUMBER INDEX

New product listings are printed in bold face type

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HEWLETT-PACKARD INTERFACE BUS

Versatile interconnect system for instruments and controllers

HP-IB

- HP's implementation of IEEE Standard 488 and identical ANSI Standard MC 1.1
- Useful over wide range of problems, from simple to very complex—add capabilities as your system requirements grow
- Very broad selection of HP-IB instruments and accessory devices—available now
- Wide choice of computing controllers for the reduction, analysis, storage and management of measurement data

Make accurate, problem-oriented measurements, controlled by calculator or computer.

There are many measurement applications where interactive instruments coupled with a controller can provide superior, error-free results as compared with conventional manual methods. Such instrumentation systems have usually been beyond the practical reach of all but large-scale or high-volume users because of previous interfacing complexities and the associated high costs.

Now, three things combine to reduce significantly the engineering costs of putting a system together. These are: (1) the Hewlett-Packard Interface Bus, also known simply as "HP-IB"; (2) the recent development and growing number of "smart" instruments having internal processor capability; and (3) the advent of a broad choice of computing controllers, ranging from individual "friendly" keyboard units through those capable of multistation measurements and sophisticated data management.

Before further discussing the merits of instrumentation systems, it is important to note that substantial numbers of measurements will continue to be made manually. HP intends to continue to provide individual state-of-the-art instruments for making specific manual bench measurements. We do, however, see a clear trend toward these same instruments being utilized in instrumentation systems and interconnected via the HP Interface Bus.

Benefits of a systems approach

The decision to use a "system" instead of conventional manual methods must be based on an engineering evaluation of benefits vs. costs. Among the many benefits associated with a systems approach:

- More consistent results in repeated measurements — a system is not subject to operator fatigue.
- Greater throughput because systems are generally faster.
- More thorough testing because system speed allows more parameters to be measured in a shorter time.
- Results expressed in engineering or scientific units since many systems controllers are capable of on-line data manipulation.
- Greater accuracy because system errors can be measured automatically, stored, and accounted for in the results.
- "Adaptive" data acquisition wherein a system can be programmed to branch to other measurements to help pinpoint the problem when it senses an abnormal condition.

Relationship of HP-IB to present and proposed interface standards

Hewlett-Packard is committed to the overall advancement of measurement technology, and has for quite some time been working on the problems of simplifying and standardizing instrument interconnection.

Concurrent with the considerable practical experience HP has gained (with both HP-IB and interface techniques in general) over recent years has been the growing international interest in establishing a suitable standard for programmable measuring apparatus — a standard that will allow instrument systems to be configured from the products made by different manufacturers. European organizations, particularly in Germany, have been instrumental in initiating an international standardization effort.

In mid-1972, HP began to participate in various national and international standardization bodies. The U.S. Advisory Committee, composed of diverse interests represented by both users and manufaeturers, first established initial goals — and then adopted the interface concept utilized by the HP Interface Bus as an appropriate starting point. A draft document was subsequently written and evaluated by members of the Committee, and then submitted as the U.S. proposal to an IEC (International Electrotechnical Commission) Working Group in the autumn of 1972. Since then, the interface definition has undergone a number of minor changes to accommodate various needs at the international level.

In September 1974, the parent technical committee, IEC TC66, approved the main interface draft document for a formal ballot among the member nations of the IEC. Balloting took place in 1976, and it is anticipated that an IEC document will be available for publication in 1977. *The present definition of the HP-IB is compatible with the main IEC draft document.*

Meanwhile, the IEEE Standards Board has approved IEEE Standard 488-1975 "Digital Interface for Programmable Instrumentation", as published in April 1975.[1] The IEEE standard is based on work initiated by the IEC, and follows the general concepts of the document now under consideration by IEC member nations. *The HP Interface Bus is Hewlett-Packard's implementation of IEEE Standard 488.* (NOTE: In January 1976, the American National Standards Institute adapted the above and published it as ANSI Standard MC 1.1).

Why the HP Interface Bus name?

Over the past several years, HP has developed and sold instruments that are interfaceable via the basic digital techniques now adopted as the IEEE Standard (and contained in the final IEC draft document).

As the list of HP products available with the "new digital interface" has grown, our customers have in the past sought a convenient way to identify those products having

[1] To purchase a copy of the 80-page IEEE Standard 488-1975, contact: The Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, N.Y. 10017

the interface capability. In response, we in 1974 adopted the name "Hewlett-Packard Interface Bus" (commonly shortened to "HP Interface Bus" or simply "HP-IB"). We will continue to use the identifying name and this symbol:

HP-IB

Both will be used with appropriate HP products so that their interface capabilities may be readily identified.

As additional instrumentation interface standards become approved, HP will clearly indicate the relationship of the Hewlett-Packard Interface Bus to those standards — just as we have done with IEEE Standard 488-1975 (and identical ANSI Standard MC 1.1).

It should be pointed out that as a practical matter, device-dependent *operational* characteristics have been *excluded* from the IEEE and proposed IEC Standards definitions. In this way, users retain maximum flexibility in selecting instruments from different manufacturers and in utilizing each instrument's particular capabilities to best advantage.

The implications of this are put in perspective by the "Forward" message printed in IEEE Standard 488-1975: "*. . . a system configurator must have sufficient awareness of the options included in each of the devices in a system in order to ensure that the correct communication techniques are used.*"

Relative to the great progress made in standardizing three of the four interface system elements *(mechanical, electrical, functional)*, understanding the remaining device-dependent *operational* parameters referred to in the IEEE document is a relatively small but essential ingredient necessary to ensure complete operational systems.

It would be presumptuous for Hewlett-Packard to speak for other manufacturers; however, it is our objective to reduce as much as practical any device-related ambiguities associated with HP products operating per the IEEE Standard (and proposed IEC Standard). We expect to do this through product design considerations; through new message concepts, as well as further code and format guidelines; and through various printed materials and training activities.

How the HP Interface Bus operates

All active interface circuitry is contained within the various HP-IB devices, and the interconnecting cable (containing 16 signal lines) is entirely passive. The cable's role is limited to that of interconnecting all devices together in parallel, whereby any one device may transfer data to one or more other participating devices.

Every participating device (instrument, controller, accessory module) must be able to perform at least one of the roles of *TALKER, LISTENER* or *CONTROLLER*. A *TALKER* can transmit data to other devices via the bus, and a *LISTENER* can receive data from other devices via the bus. Some devices can perform both roles (e.g. a programmable instrument can *LISTEN* to receive its control instructions and *TALK* to send its measurement).

A *CONTROLLER* manages the operation of the bus system primarily by designating which devices are to send and receive data, and it may also command specific actions within other devices.

A minimum HP-IB system configuration consists of one *TALKER* and one *LISTENER*, but without a *CONTROLLER*. In this configuration, data transfer is limited to direct transfer between one device manually set to "talk only" and one or more devices manually set to "listen only" (e.g. a measuring instrument talking to a printer, for semi-automatic data logging).

The full flexibility and power of the HP-IB become more apparent, however, when one device which can serve as *CONTROLLER/TALKER/LISTENER* (e.g. calculator or computer) is interconnected with other devices which may be either *TALKERS* or *LISTENERS*, or both (e.g. frequency synthesizers, counters, power meters, relay actuators, displays, printers, etc.), depending on the application. An HP-IB *computing controller* participates in the measurement by scheduling measurement tasks, setting up individual devices so that they can perform these tasks, monitoring the progress of the measurement as it proceeds, and interpreting the results of the measurement. (See page 28 for additional details about HP-IB computing controllers.)

HP-IB connections and structure

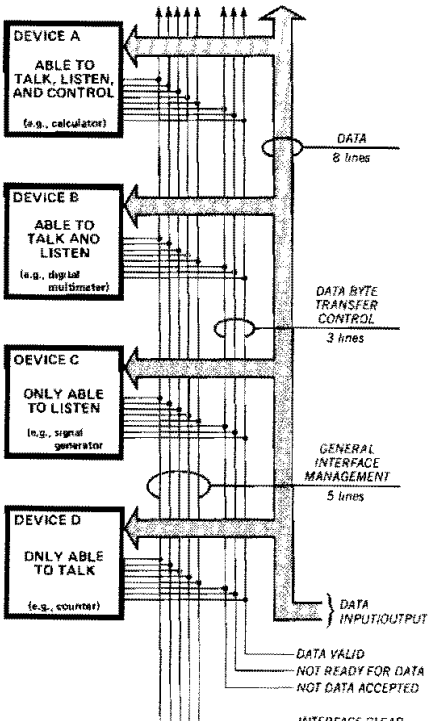
The 16 signal lines within the passive interconnecting HP-IB cable are grouped into three sets, according to their function.

Eight *DATA* lines carry coded messages in bit-parallel, byte-serial form to and from devices, with each byte being transferred from one *TALKER* to one or more *LISTENERS*. Data flow is bidirectional in that the same lines are used both to input program data and to output measurement data from an individual device. Data is exchanged asynchronously, enabling compatibility among a wide variety of devices. All interface messages (to set up, maintain, and terminate an orderly flow of device-dependent messages) are 7-bit coded. Device-dependent messages may be from 1 to 8 bits; however, the codes containing printable characters of the ASCII (American Standard Code for Information Interchange) code set are most commonly used, and messages containing numbers are typically presented in scientific notation (FORTRAN-type) format.

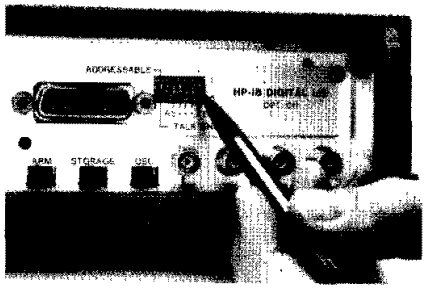
Three DATA BYTE TRANSFER CONTROL (handshake) lines are used to effect the transfer of each byte of coded data on the eight DATA lines.

The five remaining *GENERAL INTERFACE MANAGEMENT* lines ensure an orderly flow of information within the HP-IB system. One of these is called the "*ATTENTION*" line.

The controller dictates the role of each of the other devices by setting the *ATTENTION* line low (true) and sending talk or listen addresses on the *DATA* lines. (Addresses are manually set into each device at the time of system configuration, either by switches built into the device as shown above, or by jumpers on a PC board.) When the *ATTENTION* line is low, all devices must listen to the *DATA* lines. When the *ATTENTION* line is high (false), only those devices that have been addressed will actively send or receive data, while all others ignore the *DATA* lines.



Interface connections and bus structure



Rear panel switches are set so instrument will either be addressable by controller in a multi-device system, or will simply "talk only" to another device such as a printer.

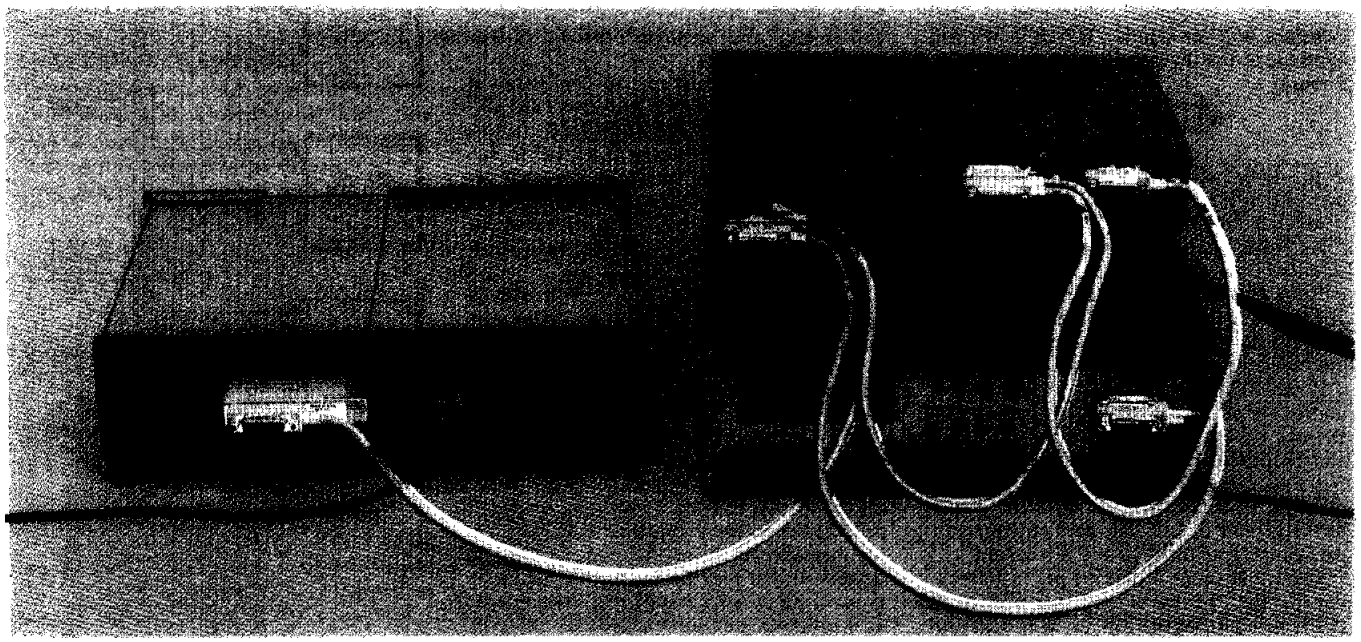
Several listeners can be active simultaneously, but only one talker can be active at a time. Whenever a talk address is put on the *DATA* lines (while *ATTENTION* is low), all other talkers are automatically unaddressed.

It is not possible in this limited space to go into detail on each signal line's role. But you should note that every HP-IB device need not be able to respond to all the lines. As a practical and cost-effective matter, each HP-IB device will usually be designed to respond only to those lines that are pertinent to its typical function on the bus. (Details appear in each device's operating manual.)

HEWLETT-PACKARD INTERFACE BUS

Versatile interconnect system for instruments and controllers

HP-IB



Rear view of an assembled 5-device HP-IB bench system. Note both single and stacked connections.

HP-IB specification summary

Interconnected devices: Up to 15 maximum on one contiguous bus.

Interconnection path: Star or linear bus network; total transmission path length 2 metres times number of devices or 20 metres, whichever is less (see HP 59403A for extending operating distance).

Message transfer scheme: Byte-serial, bit-parallel asynchronous data transfer using interlocked 3-wire handshake technique.

Data rate: One megabyte per second maximum over limited distances; 250–500 kilobytes per second typical over full transmission path (depends on device).

Address capability: Primary addresses, *31 TALK* and *31 LISTEN*; secondary (2-byte) addresses, *961 TALK* and *961 LISTEN*. Maximum of 1 *TALKER* and up to 14 *LISTENERS* at a time.

Control shift: In systems with more than one controller, only one can be active at a time. A currently active controller can pass control to another, but only designated system controller can assume control over others.

Interface circuits: Driver and receiver circuits are TTL-compatible.

Special notice to early purchasers of HP-IB products

Hewlett-Packard fully supports IEEE Standard 488, including the provision that ISO metric threads be used on the bus connector lock screw and corresponding stud mount. This means that present HP-IB products are coming to you already equipped with the proper metric thread connector hardware.

If you are among the many present users of HP-IB products purchased over the past few years, please note that the connector locking threads on early products are *non-metric* — and they are therefore not compatible with metric threaded connectors now being produced per the IEEE Standard.

Two different metal finishes are being used by HP to help you tell the difference between metric and non-metric connectors. Whereas the older non-metric parts have a shiny nickel finish, all *metric-threaded* lock screws and stud mounts have a *black* finish and the letter "M" stamped on them.

A special HP-IB Metric Conversion Kit has been set up by Hewlett-Packard to assist customers in converting the connectors on their older HP-IB products (instruments, cables, controller interfaces) to be compatible with the new standard metric-threaded connector. This conversion kit is available at modest cost, and is identified as Part Number 5060-0138. Please contact your HP field engineer or service representative for details.

Instruments and computing controllers for "do-it-yourself" HP-IB system solutions

Hewlett-Packard has an extremely broad range of HP-IB instruments and computing controller capabilities, as indicated on the following page — capabilities you can use in assembling a wide variety of system solutions, via HP-IB. We are committed to the HP-IB concept, and you may be assured that we will continue to add to this list of interfaceable products.

Each beneh instrument is, by itself, an exceptional performer in terms of providing signals, making measurements, or recording results. Each has the additional capability which allows its use in HP-IB instrumentation systems — either in "do-it-yourself" systems configured and assembled by users themselves, or in some of the standard systems which are designed, preassembled and supported by HP. While the HP-IB interface is optional in many instruments, it is increasingly becoming "standard" in some of the newer products.

Most principle functions on the instruments are HP-IB programmable. For specific details, please consult the appropriate catalog page, or the technical data sheet which is available for each product.

Just as with the instruments, HP's computing controllers which are available for use with HP-IB are all proven performers. Regardless of your need for reducing, analyzing, storing or managing measurement data, HP has a computing controller that should be right for your application.

Warranty considerations

Every HP-IB device (instrument or computing controller) carries the standard Hewlett-Packard warranty appropriate to that individual product — regardless of whether it is purchased separately as a stand-alone item for use in customer-assembled HP-IB systems, or furnished as part of a standard HP-IB system assembled by Hewlett-Packard.

HP additionally takes responsibility for *standard HP-IB systems* (designed and assembled by Hewlett-Packard — see page 24) performing as specified. However, software or interfacing which has not been provided by Hewlett-Packard as part of the standard system delivered by HP are not covered by this warranty.

In all cases, overall operational responsibility for those HP-IB *systems assembled by a customer* from individual HP-IB devices shall rest with the customer.

Individual Hewlett-Packard products available with HP-IB (IEEE 488) capability

Products related to:	Model		Product name/characteristics	See Page
Stimulus	3320B	Option 007	Frequency Synthesizer: 0.01 Hz to 13 MHz	316
	3330B		Automatic Synthesizer/Sweeper: 0.1 Hz to 13 MHz	318
	6002A	Option 001	DC Power Supply: 200 W extended range	191
	8016A	Option 001	Word Generator: 9 × 32 bit	302
	8620C	Option 011	Sweep Oscillator: 10 MHz to 18 GHz	355
	8660A	Option 005	Synthesized Signal Generator: 10 kHz to 2.6 GHz	328
	8660C	Option 005	Synthesized Signal Generator: 10 kHz to 2.6 GHz	328
	8671A		Microwave Frequency Synthesizer: 2 to 6.2 GHz	334
	8672A		Synthesized Signal Generator: 2 to 18 GHz	332
	59308A		Timing Generator	26
	59501A		Power Supply Programmer: isolated D-to-A converter	26
Measurement	436A	Option 022	Power Meter: −70 dBm to +35 dBm, up to 18 GHz	372
	3437A		System Digital Voltmeter: high speed, 3½ digits	60
	3455A		Digital Voltmeter: 5½ or 6½ digits, auto calibration	62
	3490A	Option 030	Digital Voltmeter: 5 digits, self test	66
	3495A		Scanner: up to 40 channels, low thermal & relay	69
	3745A		Selective Level Measuring Set: CCITT FDM systems	504
	3745B		Selective Level Measuring Set: Bell FDM systems	504
	4261A	Option 101	Digital LCR Meter: auto range and auto balance	79
	4270A	Option 101	Automatic Capacitance Bridge	86
	4271A	Option 101	1 MHz Digital LCR Meter	81
	4272A	Option 101	1 MHz Preset C Meter	83
	4282A	Option 101	Digital High Capacitance Meter	84
	4942A	Option 010	Transmission Impairment Measurement System (TIMS)	500
	5312A		HP-IB Interface (Talker) for 5300B System	259
	5328A	Option 011	Universal Counter: to 512 MHz, 10 ns time interval	246
	5340A	Option 011	Automatic Microwave Counter: 10 Hz to 18 GHz	262
	5341A	Option 011	Automatic Microwave Counter: high speed, to 4.5 GHz	263
	5345A	Option 011	General Purpose Plug-In Counter	238
	5363A		Time Interval Probes	264
	5501A	Option 251	Laser Transducer: for accurate positioning	558
	8503A	Option 001	S-Parameter Test Set: 50 or 75 Ohm, for 8505A	420
	8505A	Option 001	RF Network Analyzer: 500 kHz to 1.3 GHz	418
	59303A		Digital-to-Analog Converter	26
	59306A		Relay Actuator: for programmable switches, attenuators	26
	59307A		VHF Switch: two 50 Ohm, bidirectional, dc to 500 MHz	26
	59309A		Digital Clock: month, day, hour, minute, second	26
	59313A		Analog-to-Digital Converter	26
	59500A		Multiprogrammer Interface Kit: for 6940B/6941B	532
Display	5150A	Option 001	Alphanumeric Thermal Printer: 20 columns	232
	59304A		Numeric Display: 12 LED characters, decimal point	26
			See also calculators, computers and peripherals	
Storage	3964A	Option 007	Instrumentation Tape Recorder: 4 channel	230
	3968A	Option 007	Instrumentation Tape Recorder: 8 channel	230
			See also calculators, computers and peripherals	
Translation	59301A		ASCII-to-Parallel Converter: string up to 16 characters	26
	59403A		HP-IB/Common Carrier Interface: RS232C or CCITT V24	26
Control and Computation	59310B		Interface for 21MX & 2100 Computers (see also p. 536)	28
	59405A	Option 020	Interface for 9820A Calculator	28
	59405A	Option 021	Interface for 9821A Calculator	28
	59405A	Option 030	Interface for 9830A/B Calculators (see also p. 529)	28
	98034A		Interface for 9825A Calculator (see also p. 528)	28
	98135A		Interface for 9815A Calculator (see also p. 527)	28
			For HP-IB data management, see also HP 1000 and HP 9640A, p. 546	

HEWLETT-PACKARD INTERFACE BUS

Versatile interconnect system for instruments and controllers HP-IB

A preassembled HP-IB system solution — the 8950A Automatic Transceiver Test System.

HP-IB applications information

Several application notes have been published, describing how selected HP instruments and computing controllers can be interconnected via HP-IB for solving a wide variety of measurement problems:

AN 164-2 provides basic information on using a Model 8660 synthesized signal generator with Model 9820/21/30 calculators.

All notes in the *AN 174* series describe how to use a Model 5345A electronic counter with Model 9820/21/30 calculators for many different measurements, as indicated by the following titles:

AN 174-1: measuring the transfer characteristic of a voltage controlled oscillator.

AN 174-2: measuring differential nonlinearity of a voltage controlled oscillator.

AN 174-3: measuring integral nonlinearity of a voltage controlled oscillator.

AN 174-4: measuring dual voltage controlled oscillator tracking error.

AN 174-5: determining probability densities (histograms).

AN 174-6: measuring the stability of a frequency source.

AN 174-7: measuring fractional frequency standard deviation (sigma) vs. averaging time (tau).

AN 174-8: measuring FM peak-to-peak deviation.

AN 174-9: making automatic phase measurements with the 5345A Electronic Counter.

AN 174-10: measuring electrical length (delay) of cables.

AN 174-11: measuring warm-up characteristics and aging rates of oscillators.

AN 174-12: measuring frequency sweep linearity of sweep generators.

AN 174-13: measuring the tuning step transient response of VCO's to 18 GHz.

AN 181-1: describes using Model 5340A frequency counter with Model 9820/21/30 calculators in 3 system configurations.

AN 181-2: describes a data acquisition system based on Model 5300B measuring system and Model 9820/21 calculators

AN 187-2: describes configuration of a 2–18 GHz synthesized frequency source using Model 8620C sweep oscillator and 9820/21/30 calculators.

AN 187-3: describes three configured systems for making microwave scalar measurements, using the Model 8620C sweep oscillator.

AN 187-5: describes the Model 8620C's programmable capabilities with the Model 9820/21/30 calculators.

AN 196: describes several HP-IB systems using Model 436A power meter.

AN 201-1: describes a computer-controlled HP-1B system for the automatic Quality Assurance evaluation of precision assistors.

AN 201-2: measuring differential nonlinearity of a voltage controlled oscillator, via computer-controlled HP-IB system.

In addition to the above printed application notes, Hewlett-Packard has video tapes dealing with the use of computing controllers for HP-1B.

Preassembled HP-IB system solutions . . . integrated and supported by HP

Many applications can be satisfied with standard HP-IB measurement systems. These systems are not only assembled and checked out at the factory — they are also fully integrated and documented, and HP assumes full responsibility for overall specified system performance. HP's standard HP-IB system warranty applies, and installation and maintenance agreements are available.

Several families of preassembled HP-IB systems are currently available, with more to come. The following systems offer maximum flexibility in terms of data manipulation and analysis, and in available accessories and peripherals, as used with computing controllers.

Data logging and data acquisition

Model 3051A Programmable Data Logger (page 70): economical data collection and analysis, interactive test capabilities.

Model 3052A Automatic Data Acquisition System (page 71): fast and precise low level measurements, powerful computation.

Network analysis

Model 3040A Network Analyzer (page 413): complete amplitude and phase characterization (also group delay, optionally), 50 Hz to 13 MHz.

Model 3042A Automatic Network Analyzer (page 414): identical to 3040A above, and includes HP 9825A computing controller.

Model 8507A Automatic RF Network Analyzer (page 418): measures complex impedance, transfer functions, group delay; 500 kHz to 1.3 GHz.

Spectrum analysis

Model 3044A Spectrum Analyzer (page 447): precise amplitude and frequency measurements, 10 Hz to 13 MHz.

Model 3045A Automatic Spectrum Analyzer (page 447): identical to 3044A above, and includes HP 9825A computing controller.

Frequency stability analysis

Model 5390A Frequency Stability Analyzer (page 468): short and long term characterization of precision frequency sources, 500 kHz to 18 GHz.

Transceiver testing

Model 8950A Automatic Transceiver Test System (page 486): for AM and FM transceivers, 2 to 1000 MHz, transmitting up to 100 W.

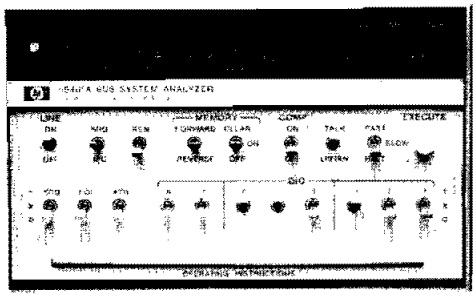
Digital circuit board testing

Model DTS-70 Digital Test System (page 553): for fast and accurate fault location on loaded digital printed circuit boards.

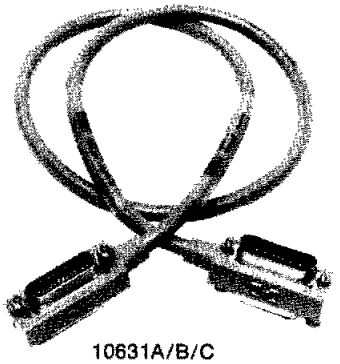
HEWLETT-PACKARD INTERFACE BUS

HP-IB **Versatile interconnect system for instruments and controllers**

Bus system analyzer, cables & accessory modules



59401A



10631A/B/C

59401A Bus system analyzer

The HP-IB (IEEE 488) concept has greatly simplified many of those things which have in the past made instrument interfacing a burdensome task. Even so, software errors can occur if the system designer does not completely understand the bus system or the capabilities of the instruments and other devices being interfaced. And hardware problems can occur if the instruments/devices are not functioning properly, or if they are not completely compatible with the bus standard.

The 59401A Bus System Analyzer is espeeially useful in design and service work. It simplifies and speeds up the diagnosis of software and hardware problems by allowing the user to see the status of all bus lines, including the actual characters on the bus data lines. Because the 59401A can also drive all bus lines, it can eompletely exercise another Talker, Listener or Controller — which is especially useful in verifying compatibility of new or user-designed products with the HP-IB.

There are several choices of analyzer operating speed. It may be operated at one character at a time (useful for software debugging), at 2 characters per second, or at regular bus speed. It may also be operated at a variable rate as determined by the external clock input.

The analyzer's 32 character memory can be used to store bus eharacters in the Listen mode, or to output characters to the bus in the Talk mode. When the analyzer is in the Compare mode, a stream of bus traffic may be stopped on a pre-selected character — and at that time, a trigger pulse is available, which is very useful when analyzing transient or timing problems related to the bus.

59401A Specifications

Display: monitors all bus lines. Represents data lines, any memory location, or DIO front panel switch settings; in octal code and ASCII character.

Listen mode: stores up to 32 characters of bus traffic in memory for real time and repetitive testing. In compare mode, halts bus traffic when a selected character is present, and user can display any one of the previous 31 characters stored in memory.

Timing: accept <750 ns; ready <750 ns.

Talk mode: bus lines can be driven directly from front panel switches; memory can be loaded from front panel switches for driving bus with a 32 character sequence.

Timing: (1) data changed >500 ns before DAV pulled low; (2) ATN driven low >1 μs before DAV pulled low; (3) DAV driven high <700 ns after NDAC is false; (4) DAV driven low <700 ns after NRFD is false, if conditions 1 and 2 are met.

Operating speeds: one character at a time, 2 characters per second, regular bus speed, or variable rate determined by external clock input; in either Listen or Talk mode.

External clock input: 1 standard power TTL gate input; ≤10 MHz repetition rate.

Compare output: provides 1 standard power TTL gate output (LOW TRUE) sync pulse when bus character is same as front panel switches.

HP-IB load: 1 bus load (capable of driving 14 other bus devices).

General

Temperature ranges: operating, 0 to 50°C; storage, −40 to +75°C.

Humidity: 95% relative, 0 to 40°C.

Power requirements: 100, 120, 220 or 240 V +5%, −10%; 48 to 66 Hz; ≤42 VA.

Dimensions: 205.1 mm W, 145.5 mm H, 495.3 mm D (8.075″ × 5.730″ × 19.500″)

Weight: net, 5.64 kg (12.44 lb).

Options and accessories

5061-0089, front handle kit

10631B 2 m (6.6 ft) bus cable, furnished

59401A Bus System Analyzer

HP-IB Interconnection cables

Three different length HP-IB cables are available. Both ends of each cable have a double-sided male/female connector, so that multiple cables may be conveniently stacked for parallel connection.

Metric threads are now standard on HP cable connector lock screws (and matching stud mounts on instruments), and indicated by a black finish and stamped letter "M". *Note that early HP-IB products were equipped with connectors having non-metric threads, and are therefore not compatible with the metric connectors.* Contact your nearby HP Sales and Service Offiee for an HP-IB Metric Conversion Kit, 5060-0138, available at nominal cost.

Model number and cable length

10631A HP-IB Cable, 1 m (3.3 ft)

10631B HP-IB Cable, 2 m (6.6 ft)

10631C HP-IB Cable, 4 m (13.2 ft)

HP-IB Accessory modules

Modules in the HP 59300, 59400 and 59500-series are ideal building blocks for use with instruments to extend measurement capabilities. All of the modules listed here can be interconnected via the HP-IB to HP measuring instruments, signal sources and recording devices capable of operating directly on the HP-IB (see rapidly expanding list on previous pages). In addition, these modules frequently serve as useful ways to interconnect with devices which are not themselves capable of direct HP-IB operation.

Instrument requirements differ. Some only output or accept data on the HP-IB. Others can be remotely programmed by ASCII characters sent along the HP-IB. These modules can work with instruments on any of these levels with or without a controller. Each module having controls can be operated stand-alone from its front panel, or it can be placed in automatic operation under program control.

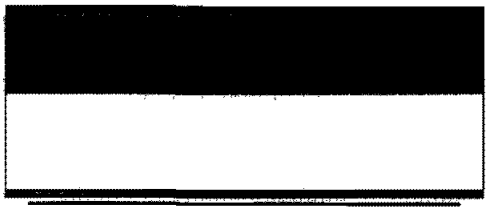
Module provision for stand-alone, local operation also has important system benefits. The operator can set up and check out the system under manual control, avoiding otherwise complex and time consuming error tracing. Each module has status indicator lights that make it easy to monitor operation.

These modules are housed in cabinets which are part of HP's new "System II" program (see page 474). This extremely flexible enclosure system makes it easy to lock products together horizontally or vertically, for bench or rack use.

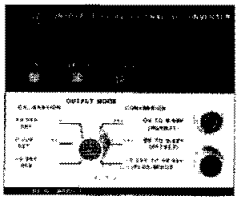
HEWLETT-PACKARD INTERFACE BUS

Versatile interconnect system for instruments and controllers HP-IB

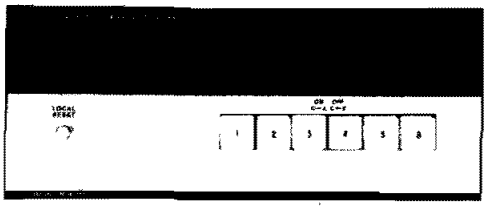
Accessory modules



59301A

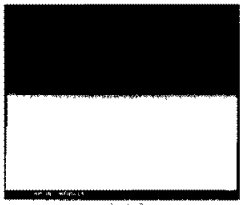


59303A

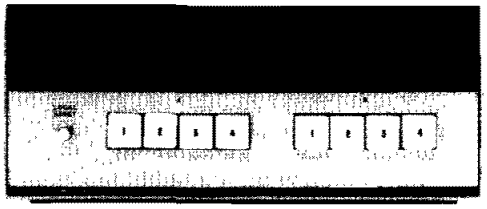


59306A

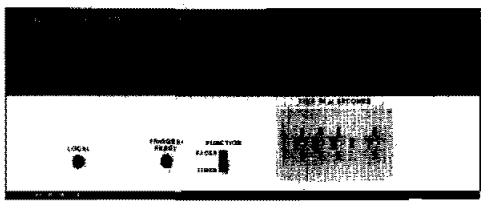
59304A



59309A

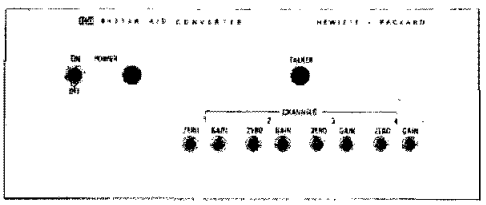


59307A



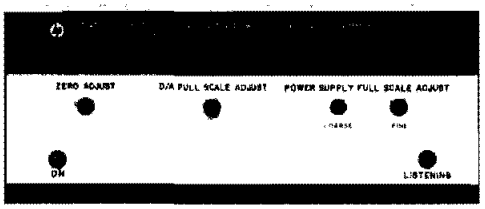
59308A

NEW



59313A

NEW



59501A

59301A ASCII-parallel converter

The 59301A accepts byte-serial ASCII characters on the HP Interface Bus and converts them to parallel output. A string of up to 16 characters terminated by linefeed is converted and placed upon the output lines; the linefeed character signals execution of a print command (strobe). With the 59301A, instruments with the HP-IB interface can be operated with HP 5050B/5055A Printers and their accessories; a switch selects output to be formatted as print format or hexadecimal format; requires two output cables, HP 562-16C (not furnished).

The 59301A can additionally be used with HP 6128C thru 6145A (Option J99) digitally-controlled power supplies, for HP-IB programmable voltage and current.

59303A digital-to-analog converter

Accepts an ASCII string and converts any three consecutive digits to analog voltage accurate to 0.1% in 30 μs. Fully programmable via the HP-IB or operates stand-alone from the front panel. Offers three output modes for conversion: normal, offset, or plus-minus (9.99 volts to −9.99 volts) to make it convenient for operating strip chart recorders.

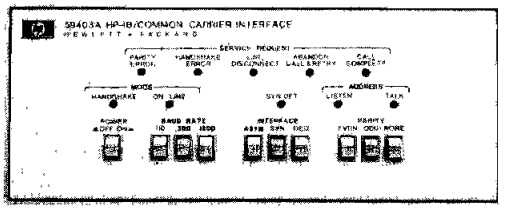
A primary application for the HP 59303A is to present on a logging device the data points being taken during a measurement, such as with the HP 5345A Counter. No controller is required for operation. Compatible logging devices include strip chart recorders, X-Y plotters, and displays.

59304A numeric display

Presents a highly visible readout of up to 12 characters and decimal point. Operates as an HP-IB monitor displaying Bus traffic, or it can be addressed to display such things as frequency readout or intermediate calculator results.

59306A relay actuator

This module has six Form-C relays that provide for control of external devices either manually from front panel pushbuttons or remotely from the HP-IB. Relay contacts are specified to handle 0.5 amp. Use the 59306A with HP 8761A/B SPDT switches for HP-IB programmable microwave switching dc-18 GHz; use it with HP 8494 thru 8496G/H attenuators for HP-IB programmable attenuation dc-18 GHz.



59403A

59307A dual VHF switch

This module offers a pair of single throw 4-pole switches (dc to 500 MHz, 50 ohm) optimized for fast risetime (1 ns) pulse waveforms. Switches are independent and bidirectional, and can be operated either from front panel pushbuttons or remotely from the HP-IB.

59308A timing generator, 59309A digital clock

This HP-IB programmable timing family offers time-of-day and precision timed intervals over a wide range from sub-seconds to days. The clock and generator are independent of each other and can operate under program control or stand-alone. The 59309A HP-IB Digital Clock displays month, day, hour, minute, and second; and upon command outputs time via the Interface Bus to logging devices. Time can be updated by remote command. The clock accepts a small internal battery to provide glitch-free power and more than a day's standby; alternatively, the clock operates up to a year on standby supplied by ordinary D-size batteries. The 59308A Timing Generator provides pacing and timing signals output for remote use via the Interface Bus or on rear panel BNC's. Timed intervals can be selected by thumbwheels or can be programmed to have precise lengths from microseconds to minutes to more than a day. Accepts trigger inputs from front panel pushbutton, from rear panel connectors, or remotely via the Bus.

Rear panel BNC's output TTL and FCL levels with switch selection of square wave or pulse and of positive-going or negative-going edge. Output pulses are 500 ns ±100 ns wide, rise time 50 ns.

59313A analog-to-digital converter

This medium-speed 4-channel unit can accept a full scale input of ±10 V dc on each channel, individually selectable in four ranges. It also has a program-controlled reverse channel for driving small signal lamps, relays, or TTL circuits. An HP-1B controller can command this unit to perform a single conversion, or initiate a series of internally-paced conversions at one of six selectable rates (up to 200/s if one channel; up to 50/s on each of four channels). Sampling can also be initiated externally by TTL transition or contact closure to ground.

59403A HP-IB/common carrier interface

This module provides a way to extend the separation of component parts in an HP-1B system by more than the 20 metre maximum transmission path length specified in various interface Standards, and it is especially useful for production or remote site applications. Distances up to 1000 metres are possible by using two 59403A modules (one at each location) interconnected by a dedicated and shielded two-twisted-pair cable. And even longer distances can be achieved by using a telephone line (with appropriate modems) instead of the dedicated cable.

The distance between HP-IB devices may be extended by up to 1000 metres, using two 59403A's; even further with modems.

Each 59403A module converts HP-IB data and control lines to a serial bit stream of digital information for transmission over the dedicated or telephone lines, and vice versa in the reverse direction. In both cases, operation is full duplex, so that (for example) one HP-IB device at a remote location can request service from the controller at the same time the controller is sending data to another HP-IB device at the remote location.

The recommended dedicated cable is available from HP as Part Number 8120-1197 (Belden type 8723). The 59403A is designed to operate with 110, 300 and 1200 baud asynchronous or synchronous full duplex modems which are EIA RS232C or CCITT V24 compatible. In the U.S., Bell 103A modems with "soft carrier turn-off" are recommended for use on the direct dial (DDD) network. (Check with your local telephone authorities regarding data communication regulations.)

59501A power supply programmer (isolated DAC)

This single-channel digital-to-analog converter can control a wide range of power supplies (output voltage, or current), as well as other analog programmable devices. It may also be used as a low level signal source, depending on the speed of the controller. It has two output ranges (0–1 and 0–10 V dc in unipolar mode; −1 to +1 and −10 to +10 V dc in bipolar mode), as well as photo-isolators which electrically separate HP-IB control and data lines from power supply circuitry by up to 600 V dc.

General

Operating environment: operating temperature, 0 to 50°C; relative humidity, to 95% at 40°C.

Power: HP 59300-series: 115 or 230 V (±10%); 50–400 Hz; 15 VA max. (HP 59313A, 18 VA max.). HP 59403A and HP 59501A: 110, 120, 220, or 240 V (+5%, −10%); 48–63 Hz; 60 VA max.

Accessories supplied: each 59403A is provided with one dedicated line connector HP Part Number 1251-3764 (Switchcraft 2504M). Note that 10631-series HP-1B interconnection cables must be purchased separately.

HP-IB accessory modules

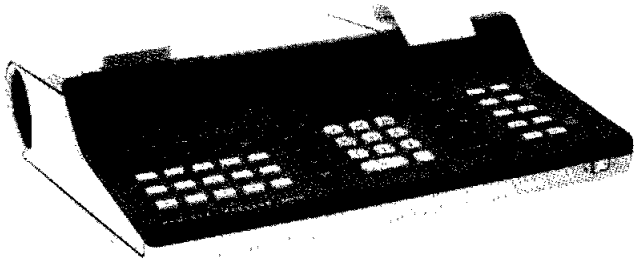
Model	Description	Dimensions -- max. height[1] × width × depth mm (inches)	Net Weight kg (lb)	Shipping Weight kg (lb)	
59301A	ASCII-to-parallel Converter	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	1.70 (3.78)	2.32 (5.16)	
59303A	Digital-to-analog Converter	101.6 × 105.9 × 294.6 (4 × 4.17 × 11.6)	2.61 (5.80)	3.17 (7.04)	
59304A	Numeric Display	101.6 × 105.9 × 294.6 (4 × 4.17 × 11.6)	1.23 (2.73)	1.58 (3.51)	
59306A	Relay Actuator	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.64 (5.87)	3.23 (7.18)	
59307A	VHF Switch	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.64 (5.87)	3.23 (7.18)	
59308A	Timing Generator	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.10 (4.67)	3.83 (8.51)	
59309A	HP-IB Digital Clock	101.6 × 105.9 × 294.6 (4 × 4.17 × 11.6)	1.70 (3.78)	2.84 (6.31)	
59313A	Analog-to-digital Converter	101.6 × 212.9 × 345.4 (4 × 8.38 × 13.6)	5.45 (12.0)	6.36 (14.0)	
59403A	HP-IB/Common Carrier Interface	101.6 × 212.9 × 430.0 (4 × 8.38 × 16.9)	4.50 (10.0)	6.10 (13.5)	
59501A	Power Supply Programmer	101.6 × 212.9 × 294.6 (4 × 8.38 × 11.6)	2.61 (5.80)	3.17 (7.04)	

[1] Height above includes feet, with feet removed height is 88.1 mm (3.47 inches).

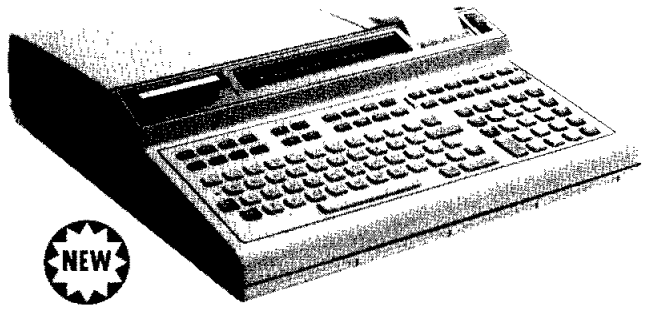
HEWLETT-PACKARD INTERFACE BUS

Versatile interconnect system for instruments and controllers HP-IB

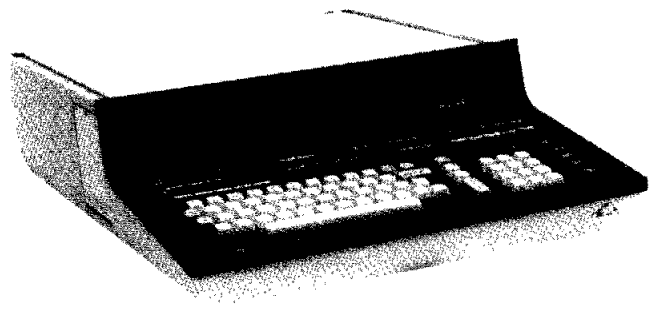
Computing controllers/interfaces



HP 9815A computing controller (HP 98135A Interface)



HP 9825A computing controller (HP 98034A Interface)



HP 9830A/B computing controller (HP 59405A Interface)

A separate controller is not required for simple HP-IB configurations (e.g. data logging). However, the full flexibility and potential of the Hewlett-Packard Interface Bus are more obvious when used with HP computing controllers.

Role of a computing controller

In addition to managing the flow of information over the bus, the computing controller in an operating measurement system actively participates by scheduling measurement tasks, by setting up individual devices so they can perform the tasks, by monitoring the progress of the measurement as it proceeds, and by interpreting the results of the measurement.

HP computing controllers serve another important function by providing access to a large number of display, input/output and data storage peripherals. These include plotters, line printers, floppy disks, tape cassettes, etc. Additionally, HP computing controllers can perform the job of interfacing with other instrument subsystems or computer systems using serial communication links—thereby gaining access to common data bases, sharing results, etc.

Finally, a computing controller can provide the tools for program development. These will normally include an editor that can be used in generating source programs, debug aids that can be used in analyzing and modifying program flow, and a means of storing and recalling programs and/or results.

Wide choice of HP computing controllers

Hewlett-Packard has a continuum of HP-IB (IEEE 488) computing controllers from which to select. If your interfaced-system application is of the "lab bench" variety (as in engineering design or metrology), you may prefer to use one of the desk-top keyboard units such as the 9815A, 9825A or 9830A/B. On the other hand, if your application calls for complex or high volume production testing at multiple locations, simultaneously, and in several programming languages, your choice will probably be one of the solutions offered by the HP 1000 (incorporating a 21MX computer).

Regardless of which HP computing controller you choose initially, the universality of the HP-IB interface means you have great flexibility in changing or expanding the control portion of your interfaced measurement system, as your needs change or grow.

HP-IB interfaces for each of our computing controllers are described below. For more comprehensive details on the computing controllers themselves, please consult pages 527-529, 536 and 546.

98135A HP-IB interface for 9815A

HP's most economical computing controller is the 9815A desk-top unit, for handling the less complex tasks associated with small systems. If you are familiar with HP's hand-held personal calculators, you'll feel at home with the 9815A's Reverse Polish Notation (RPN) language. The keyboard has a 10-key numeric pad, 15 special function keys, program language and control keys, editing keys, and 28 scientific function keys including trigonometric functions. The 9815A has a built-in 16-character numeric display as well as a thermal printer having alphanumeric capability. It also contains a high-speed bidirectional magnetic tape data cartridge system.

For HP-IB applications, the 9815A can accept one *Model 98135A Interface*, which plugs into one of the two I/O slots on the 9815A. The interface has a 1.8 metre cable terminated in an HP-IB connector with metric fasteners, and it allows the 9815A to communicate with up to a maximum of 14 HP-IB instruments or peripheral devices. If your application requires an interrupt capability, please see other HP computing controllers, since interrupt is not available with the 9815A/98135A.

98034A HP-IB interface for 9825A

The 9825A desk-top computing controller is an extremely flexible performer. It uses HPL, a high-level, formula-oriented programming language which offers power and efficiency for handling equations, data manipulation, and input/output operations. HPL provides for subroutine nesting and flags, and allows 26 simple variables and 26 multidimensional array variables, limited only by the size of the 9825A's memory. Also, HPL has a language compatibility with the HP 9820A and HP 9821A, permitting programs for these earlier models to be converted for use with the 9825A.

Significant capabilities of the 9825A include two-level priority interrupt (for controlling several instruments or peripherals requiring attention at unpredictable rates or times), live keyboard, direct memory access, multidimensional arrays, automatic memory record and load, and an extended range of internal computation. The 9825A has a typewriter-like keyboard with upper/lower case, a numeric pad, and 12 special function keys (shiftable to 24). It has a built-in 32-character alphanumeric display and a 16-

HP 1000 computer system (utilizing a 21MX controller and one or more HP 59310B Interfaces)

character printer (both upper/lower case), as well as a high-performance data cartridge system. There are three I/O slots and four ROM slots.

The *Model 98034A Interface* is required for operating the 9825A in HP-IB applications. A 9825A equipped with a "General I/O" ROM can handle fundamental HP-IB input/output operations; with an "Extended I/O" ROM, the 9825A is capable of complete HP-IB control. Each 98034A Interface has a 4 metre cable terminated in an HP-IB connector with metric fasteners, and can control up to 14 HP-IB devices, in conjunction with the 9825A. Up to three of the interfaces may be plugged directly into the 9825A I/O slots—and as many as 14 interfaces (up to 14 devices each) can be connected to one 9825A, through the use of a Model 9878A I/O Expander.

59405A HP-IB interface for 9830A/B

The familiar and easy-to-use BASIC language is used with 9830A/B desk-top computing controllers. BASIC is a formal, interactive language which appeals to beginners as well as experienced programmers. An additional benefit is that BASIC is a standard computer language; programs you develop initially for 9830A/B HP-IB systems can be later adapted with minimum effort for use with a 21MX computing controller—if your HP-IB system requirements expand to require full computer capabilities available via the 21MX.

User-available read/write memory within mainframe ranges from a minimum of 3520 (8-bit) bytes in the standard HP 9830A, up to a maximum of 30,144 bytes in the HP 9830B with option 001. An external mass memory subsystem is available for allowing 9830A/B computing controllers to handle up to 4.8 million bytes of information. Standard 9830A/B's have a 32-character alphanumeric display, built-in tape cassette, and keyboard which includes special function keys. There are 4 I/O slots, and many peripherals are optionally available.

A 9830A or 9830B can control up to 14 HP-IB devices via a *Model 59405A Option 030 Interface*, plugged into one I/O slot—and an appropriate ROM (provided with the interface) also plugged into the computing controller. Included with the interface is a 4 metre cable terminated with HP-IB connector with metric fasteners, as well as a User's Guide (59300-90002).

59405A HP-IB interface for 9820A and 9821A

The HP 59405A interface described above is also available for earlier computing controllers. *For the HP 9820A, order Model 59405A Option 020 Interface*, which includes the appropriate ROM and User Guide (59300-90001). *For the HP 9821A, order Model 59405A Option 021* (same User Guide).

59310B HP-IB interface for HP 1000 (& 21MX-series)

The HP 1000 computing controller is especially well suited for broad measurement and data management requirements such as those found in quality assurance, production testing, etc. This is because the HP 1000 (combining a 21MX computer and Real Time Executive Software) is capable of concurrently controlling multiple clusters of HP-IB test and measuring equipment which may be organized into separate physical or functional groupings, each of which may have up to 14 HP-IB devices per cluster. The HP 1000 also: (1) makes it possible to develop new programs while existing programs are actively controlling and communicating with the bus-interfaced devices; (2) can be programmed in HP Real Time BASIC, QUERY, FORTRAN, and HP Assembly language; and (3) can be linked to distributed computer networks to achieve centralized test record maintenance, yield analysis, and work order scheduling and tracing.

Each separate bus cluster (of up to 14 HP-IB devices) connected to the HP 1000 requires one *Model 59310B Interface*. Two variations of this interface are also available for OEM or "do-it-yourself" end user assembly of HP-IB/21MX systems. The *Model 59310B Option 422* provides the broadest range of capabilities—and includes a driver, utility software and a manual supporting operation in HP's disc-based RTE-II and RTE-III Real Time Executive systems. For very simple applications, *Model 59310B Option 423* includes a driver, utility software and a manual that support operation in HP's memory-based Basic Control Systems (BCS). A diagnostic routine for quickly confirming correct operation is included in both versions, and each interface has a 4 metre cable terminated in an HP-IB connector with metric fasteners.

Compatibilities between various HP computers and operating systems are indicated below. The 21MX-series computers include the HP 2105A, HP 2108A, HP 2112A and HP 1000; note that the 59310B interface may also be used with earlier models HP 2100A/S.

	HP 1000	HP 2105A	HP 2108/12A	HP 2100A/S
RTE-II:	Yes	No	Yes	Yes
RTE-III:	Yes	No	Yes	No
BCS:	No	Yes	Yes	Yes

For preconfigured/assembled 21MX/HP-IB computing controller systems, please also see the HP 9640A.

HP-IB interface model number

59310B: interface, RTE-II/III for HP 1000
59310B Option 422: RTE for 21MX and 2100A/S
59310B Option 423: BCS for 21MX and 2100A/S
59405A Option 020: interface for 9820A
59405A Option 021: interface for 9821A
59405A Option 030: interface for 9830A/B
98034A: interface for 9825A
98135A: interface for 9815A