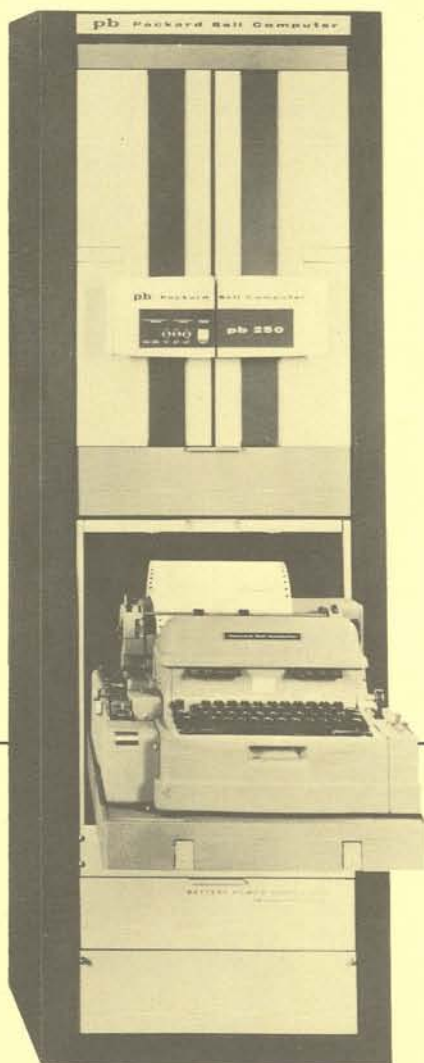
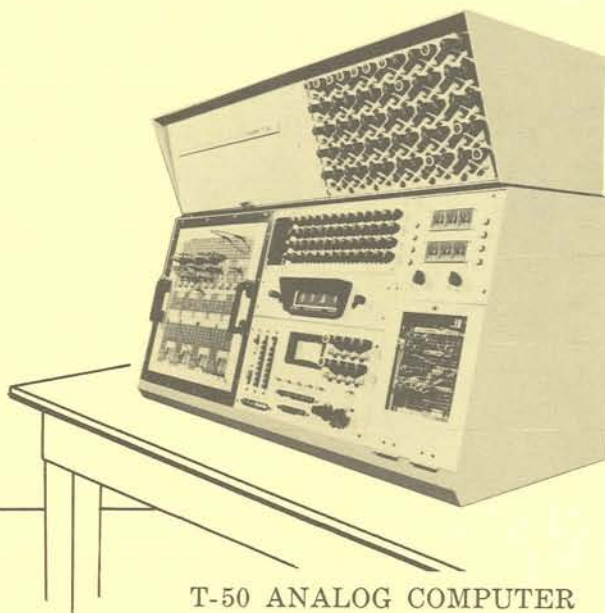


From Packard Bell Computer . . .

HYCOMP® 250—THE FIRST DESK TOP HYBRID ANALOG/DIGITAL COMPUTING SYSTEM



PB250
DIGITAL COMPUTER



T-50 ANALOG COMPUTER

Low-cost, high-speed hybrid computing is now a reality with Hycomp 250, which packages the Packard Bell PB250 digital computer and Packard Bell conversion equipment for integrated operation with any one of several desktop analog computers. Included are the T-50 from Computer Products, Inc., Electronic Associates' TR10 and TR48 and others.

This new approach to hybrid computing prices the PB250 with Flexowriter plus necessary conversion equipment for 64-channels of analog-to-digital communications and vice versa at \$49,500; thus, the system complete with analog computer will be a fraction of the cost of large-scale hybrid computing systems.

Interest in hybrid computing is rising sharply, but utilization of this advanced computing technique by all who could benefit has been slowed by the high cost of conventional hybrid equipment. Price tags of \$350,000 to \$750,000 for a large-scale hybrid system limit to a small group those organizations which can participate. Now, with the Hycomp 250, a high-performance hybrid computing system for study and development of hybrid solutions and training of personnel is available at a surprisingly low cost.

Packard Bell
Computer



FEATURES

LOW COST—\$49,500 for PB250 Digital Computer and complete High Speed Conversion.

SYSTEM READY FOR USE—Includes the cables and connectors for plug-in to the analog computer. No additional engineering required. *Connect and compute!*

12 BIT, 64 KC, A/D CONVERTER—Latest analog-to-digital and digital-to-analog converters from a line that is the industry standard.

PROVEN PERFORMANCE—PB250 computer is being used in more than a score of hybrid systems, more than 150 other applications.

EASILY EXPANDED—64-channel address capability built in. Modular plug-in construction. Complete line of PB250 peripheral equipment available.

SOFTWARE—Full library of digital computer software including CINCH Interpreter, an engineering/scientific compiler, A/D Conversion I/O subroutines, trigonometric subroutines, etc.

FREE TRAINING—Two-week programming course and 3-week maintenance course included in computer price.

PB250 COMPUTER

The PB250 computer contains 2320 22-bit words of memory which can communicate data at a 2 mc/sec rate. Memory may be expanded to 15,888 words in increments of 256 words at any time by plugging in memory modules. Thus, if a problem requires slightly more memory than available, only the capacity needed can be added. A Flexwriter electric typewriter equipped with a paper tape reader and punch is supplied as the basic I/O device.

The PB250 has the lowest component count of any high speed general purpose computer. Over a period of three years, 1,000,000 hours of operating experience indicates a 1000 hour MTBF.

The PB250 has 51 commands ideally suited for systems applications. Included are variable length multiply, divide and *square root*, and many double precision, shifting, conditional, and logic com-

USES

INVESTIGATION OF HYBRID COMPUTING TECHNIQUES with a minimum investment.

SIMULATION. Hybrid computation capability for small to medium real-time hybrid simulation applications and for other design and mathematical model investigations.

TRAINING. Personnel can be trained in combined systems application and programming at low cost. Sampled data system operation can be studied directly.

GENERAL PURPOSE COMPUTING. PB250 may be used for compiler or machine language oriented problem solving.

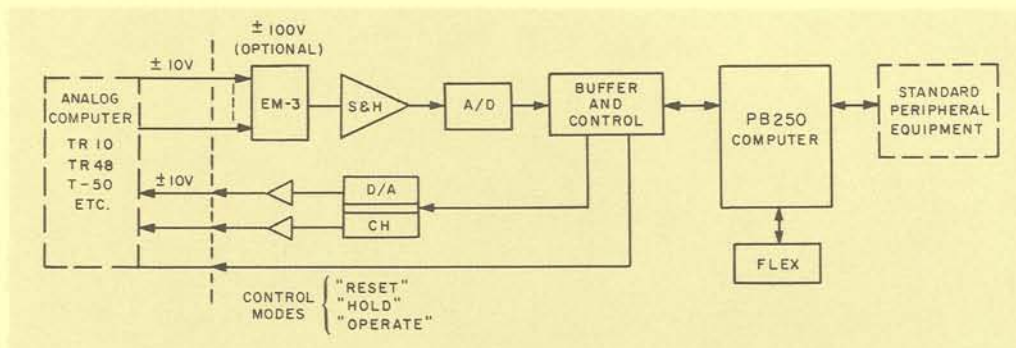
DATA ACQUISITION AND REDUCTION. System may be used to acquire, store and reduce data in laboratory or field applications.

APPLICATION AREAS

Combined Analog/Digital Simulation
Multiparameter Optimization Studies
Sampled Data Systems Studies
Operations Research Studies
Partial Differential Equations
Spectrometry and other laboratory data reduction requirements

mands. Addition, subtraction, load, store, read, and many other commands are executed in one word time of 12 microseconds. Multiply, divide, square root, and other variable length commands normally requires 1 word time per bit, e.g., 10-bit multiply requires 132 microseconds, full word 22-bit multiply requires 279 microseconds.

The PB250 is designed for systems applications requiring high speed I/O and sophisticated computation. Three basic I/O systems allow the use of a built-in parallel 8-bit buffer channel, serial inputs of 22-bits or more, and the availability of up to 29 sense lines and 32 control lines. A full line of optional peripheral equipment includes IBM compatible magnetic tape, card reader, high speed paper tape punch and reader, and digital plotter. A battery power supply is available which allows the computer to operate during a power failure.



PB250 Computer, conversion and control with standard connections for EAI TR10; TR20; TR48; CPI T-50 and adaptable to other machines.

SYSTEM DESCRIPTION

The Hycomp 250 system (see Block Diagram) is composed of the PB250 General Purpose Digital Computer, A/D and D/A Conversion System, and analog mode control subsystem. Data, addresses, and mode commands are transmitted via a 2 MC high speed buffer and control unit.

The A/D system is comprised of the Packard Bell EM3 Multiplexer, SH3 Sample and Hold Unit, and ADC 21-12B-B Analog-to-Digital Converter.

The EM3 Multiplexer may be either randomly addressed or sequentially stepped through the A/D channels. It is expandable in two-channel increments by plug-in modules. Space is provided on these modules for voltage divider resistors to accommodate voltages greater than 10 volts full scale. A standard option provides ± 100 volts to accommodate inputs from full-scale analog computers.

The SH3 Sample and Hold Unit reduces the aperture time of the A/D conversion system from the 14.4 usec conversion time of the ADC 21 to 1 usec.

ANALOG-TO-DIGITAL CONVERSION

The ADC 21-12B-B is a 12-bit converter (11 bits plus sign) of the successive approximation type and operates at 1.2 usec per bit conversion rate. The ADC 20-15B-B, a 15-bit converter, is optionally available.

The A/D conversion system requires 48 usec per channel for a complete conversion, including sequential channel selection, sample and hold, conversion and storage in a PB250 memory location; 72 usec are required per complete cycle with random channel selection.

BUFFER AND CONTROL

The Buffer and Control unit provides 6 bits of address and 12 bits (or 15 bits) of data from the PB250 by means of the Block Serial Output BSO Command. The address and data may be stored in the same word or separate words at the programmer's option.

For A/D input, one of the 64 addresses (00_8) denotes the multiplexer. As many data bits as required are used to select the multiplexer channel number, if random channel selection is desired, or the starting channel number for sequential operation. In sequential mode, the channel counter in the multiplexer is automatically advanced by the End of Conversion Pulse of the A/D converter.

Operation of the A/D system is under control of the Buffer and Control unit after initial addressing of the multiplexer, i.e., after the Sample and Hold is switched to sample, then to hold, and conversion is begun. Proper delays are provided by the control unit. The End of Conversion pulse generates a parallel data transfer from the ADC to the Buffer. The Buffer

is then read into the PB250 at the proper time as determined by program timing or by testing a flip-flop set by the End of Conversion pulse, with the Transfer on External Signal (TES) Command. This flip-flop also inhibits conversion of the next channel until it is cleared by the Block Serial Input (BSI) Command that unloads the buffer to PB250 memory.

DIGITAL-TO-ANALOG CONVERSION

The Digital-to-Analog Conversion System uses the Packard Bell DAC 20-12B-B (± 11 bits) Digital-to-Analog converter. The outputs of these converters are buffered by AMP-06 amplifiers to provide ± 10 volts with 10 milliohms output impedance at DC. DAC20-14B-B (± 13 bit) converters are available as an option.

The DAC's are addressed from the 6-bit address code of the Buffer and Control Unit. Data is transferred in parallel from the Buffer to the DAC units.

Operation of the D/A channels is by output of a Block Serial Output Command (BSO) which presents both address and data to the Buffer. The address and data may be located in one PB250 word or in adjacent memory locations at the programmer's option. In either case, only one BSO need be given since the number of words on which this command operates is specified in the command, and the bits of the word which are shifted are determined by a mask stored in the PB250 (see PB250 Programming and Reference Manual, SP-174).

ANALOG MODE CONTROL

Analog Mode Control is provided by a set of three double-throw relays. These three relays are controlled by a 3-bit register which is addressed and set in the same manner as the DAC's. The three relays are completely under program control. Thus, relay contacts can be wired identically like the master mode control relays which switch computer mode control voltage in the analog computer. This wiring is provided for any make of analog computer listed.

Optional solid-state mode control of the T-50 Analog Computer or any analog computer so equipped is provided by eight additional bits of the mode control register. Four separate mode controls are thus provided to operate the integrators in four separate groups selectable from the Electronic Mode Control Panel. Each pair of lines is buffered so that it may drive from one to all of the T-50 integrators. The additional eight bits may also drive any solid state logic with which the T-50 may optionally be equipped.

Eight Transfer on External Signal (TES) inputs, expandable to 26, are provided for sensing the contact positions of relay comparators or the outputs of solid state comparators. These are supplied with a cable and connector for connection to the trunks or EMC panel to match the various analog computers.



102440194

PB250 COMPUTER

Type

Serial, binary, internal program

Command Structure

Single address with index register and next instruction location tag

Number of Commands

51

Operation Times

Add/subtract—12 μ sec

Double precision add—24 μ sec

Multiply—276 μ sec

Divide—252 μ sec

Square root—252 μ sec

Access time range—12 to 3,072 μ sec

Fast access time range—12 to 192 μ sec

Maximum operation rate—41,666 instructions per sec

Word Length

21 bits plus sign

Memory

Capacity—2,320 words (up to 15,888 words optional)

Power Requirement

115 volts, 60 cps, 110 watts

Standard Input/Output

Model FX-IT Flexowriter (table mount) or Model FX-IR (rack mount) with paper tape reader and punch

11 control input lines

32 control outputs on 5 lines

High speed block input/output at 2 mc/sec

Optional Input/Output and System Equipment

Model HSR-1 paper tape reader (300 characters/sec)

Model HSP-1 paper tape punch (110 characters/sec)

Model MTU-1 magnetic tape handlers (up to six)

Model CR-2 card reader (100 cards/minute)

CPS-30-01 Battery power supply

CDR-10-01 Digital Graph Recorder.

SOFTWARE (partial list)

Program for control of Multiplexer, Sample & Hold, Analog-to-Digital Converter, Digital-to-Analog Converter and Flexowriter I/O

Floating Point Interpreter

Engineering/Scientific Compiler

Trigonometric Subroutines

Decimal Input/Output Routines

Logarithm bases 2, e, 10

Exponential bases 2, 3, 10

Best Fit

Double Precision Routines

OPTIONAL FEATURES

Solid State Mode Control:

1. 4 pairs of digital signal level lines for driving CPI T-50 Solid State Switches
2. Digital Register:.....12 bits per register with optional relay drivers
3. Full 22-Bit Buffer:.....Adds 4 bits to buffer to allow input of 22-bit word or use of 15-bit ADC
4. ADC-20-15B-B:.....15-bit (14 bits plus sign) 0.01%, 2 μ sec/bit converter instead of ADC 21. Requires 22-bit buffer
5. DAC 20-14B-B:.....14-bit (13 plus sign) 0.01% DAC with AMP-06
6. Parallel Digital Inputs:.....Gates for one set of 15 (or 22) parallel digital inputs, set only, including address decoding for setting input with B50 command

A/D CHANNELS

EM3 Multiplexer

Input Voltage Range:..... ± 10 volts standard

Optional Ranges Available: ± 1 volt to ± 128 volts

Overvoltage Input:..... ± 100 volts maximum

Input Impedance:.....50k shunted by $300 + 9.5N$ pf (for non-selected channel 100 megohms minimum)

Output Impedance:..... $R_n + 200 \pm 20$ ohms

Attenuation:..... $R_n + 200 \pm 20$

50,000 + R_n

Loading:.....100k ohms minimum

Noise:.....< 1 millivolt peak-to-peak

Linearity Error:..... $\pm 0.015\%$ of input (maximum)

Offset Error:..... ± 1 millivolt maximum (for $R_n = 1k$)

SH3 Sample and Hold

Frequency Response

in Sample Mode:.....3 db down at 100 KC for ± 1 volt input

Settling Time:.....10 μ sec to .01% for 20 volt swing

Noise:..... ± 1 mv.

Linearity:......01%

Stability:......01% $\pm .001\%/^{\circ}C$.

Aperture Time:.....Less than 1 μ sec.

Overload Recovery

Time:.....Less than 100 msec.

Hold Time:.....Less than 16 μ volts per microsecond droop. (approx. .01% accuracy for 70 μ sec. hold time)

Temperature Range:.....25 $\pm 20^{\circ}C$.

ADC21-12B-B Analog-to-Digital Converter

Word Length:.....12 bit bipolar or unipolar

Accuracy (% F.S.):......025% $\pm 1/2$ LSB

Conversion Speed:.....75 kc (10 bits)

Conversion Time/Bit:.....1.2 μ s/bit

Long Term Stability

(% F.S.):......02%

Input Voltage:..... ± 10 volts

Input Impedance:.....1000 Ω /volt

Conversion Cycle:.....number of bits plus one

Conversion Format:.....binary (2's complement for negative output)

Operating Modes:.....asynchronous and synchronous

Digital Inputs:.....isolated

Digital Outputs:.....isolated

Temperature Range:.....10 $^{\circ}C$ to 50 $^{\circ}C$

Voltage Reference

Stability:..... $\pm .001\%$

Warm Up Time:.....10 minutes to stated accuracy

Display:.....Amperex lights

D/A Channels

DAC 20-12B-B with AMP-06 output buffer amplifiers

Number of Channels:.....4 expandable to 56 in 1 channel increments

Word Length:.....12 bits

Output Voltage:..... ± 10 volts, ± 100 volts (optional)

Accuracy:.....0.01% $+ 1/2$ LSB

Output Impedance:.....10 milliohms at DC

Output Settling Time:.....10 μ sec for 10-volt change

Output Current:.....20 ma @ 10 volts

Output Rate from PB250: 36 μ sec/channel (27,770 channels/su)

Channel Selection:.....Random addressable under Program Control

Hybrid System

Relay Mode Control:.....Reset, Hold, and Operate

Digital Signal Inputs:.....8 Transfer on External Signal (TES) Lines expandable to 26 in increments of 6

Buffer and Control:.....18 bits, with 6 address, 12 data, control logic. Indicator lights for data and address

Physical

PB250 Computer and Conversion System housed in one rack. Dimensions: Height—73 inches; Width—24 inches; Depth—28 inches; plus table mounting Flexowriter (Flexowriter also available mounted in computer rack).

Weight:

Power:

Cooling:

600 lbs.

115V, 60 cps, 8 amps

Self-contained fans

Packard Bell
Computer

