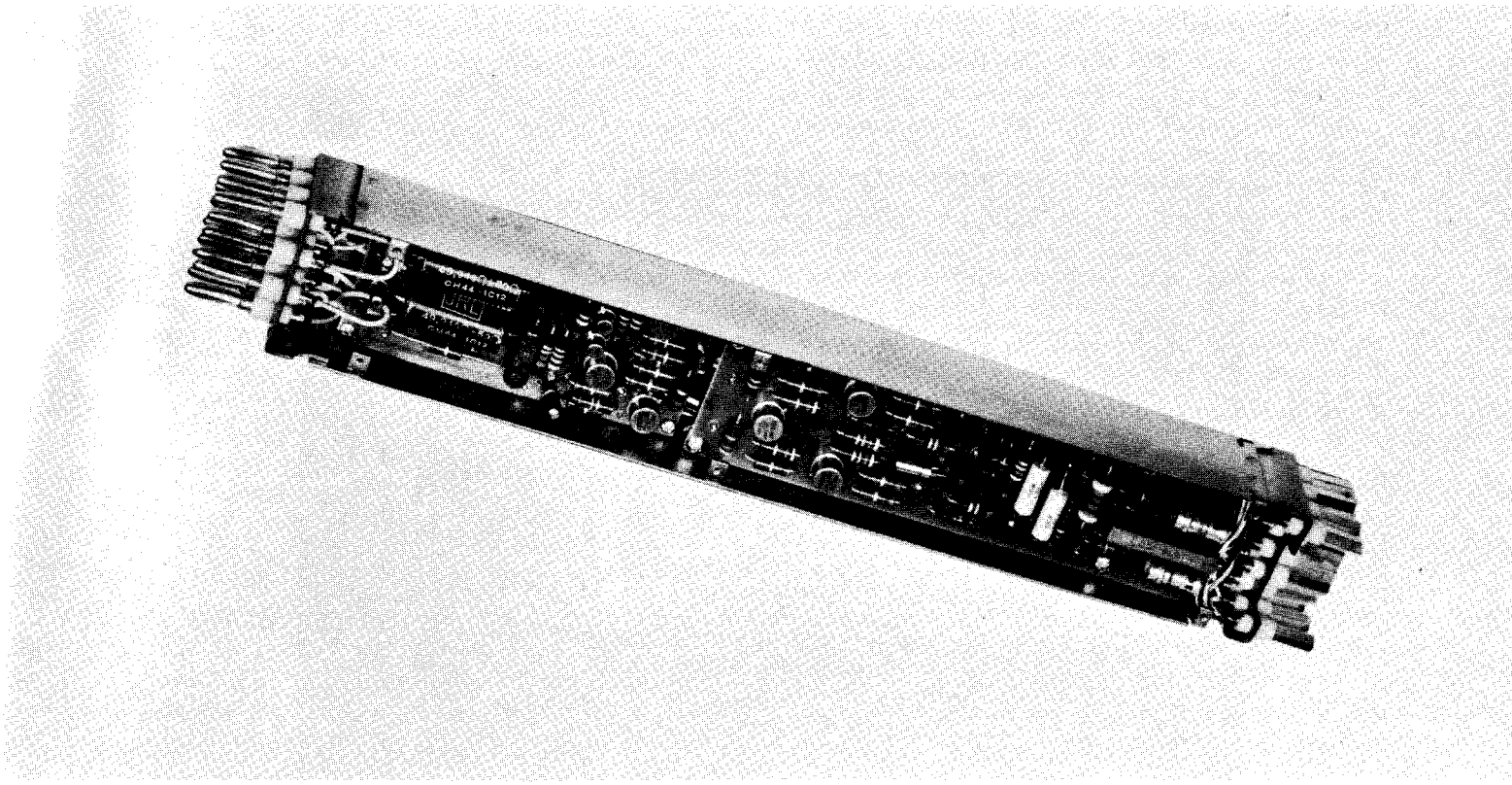
# PIR

PRODUCT INFORMATION RELEASE

*An Accessory for PACE 231R Analog Computing Systems.*

## MICROSTORE* Model 2.395

*a completely integrated solid-state system for the high-speed tracking, storage and switching of analog data points.*



*outstanding features of the PACE MICROSTORE*

**Completely Solid-State Circuits for Maintenance-Free Operation • Total Switching Time From "Track" to "Store" of Less Than 5 Microseconds • Switching Controlled from Either Master Control Unit or Electronic Control Comparator • Uncommitted Patch Panel Terminations for Increased Versatility – Mode of Operation is Determined by Patching – Converts Storage or High Gain Amplifier to a Switching Element • Control Comparator Can be Operated as Solid-State Relay for Either Repetitive or Real-Time Operation • Special "Latching" Input to Comparator Reduces the Number of Storage Elements Required in any Given Problem • Plug-In Modularized Design – Can be Field Installed in Existing 231R Computers**

**MICROSTORE is a trademark of Electronic Associates, Inc.*

(EAI reserves the right to revise its product specifications in accordance with its continuing program of product development.)

EAI

ELECTRONIC ASSOCIATES, INC., *Long Branch, New Jersey*

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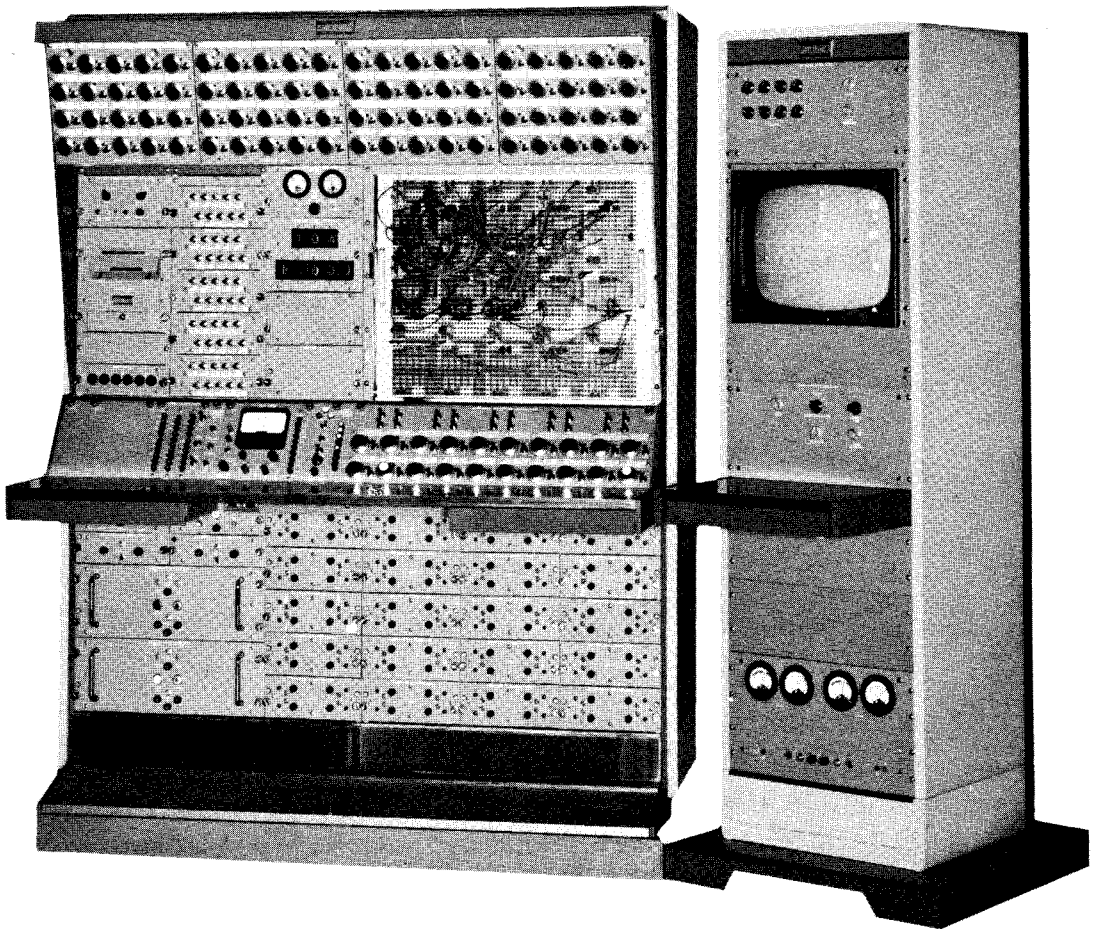
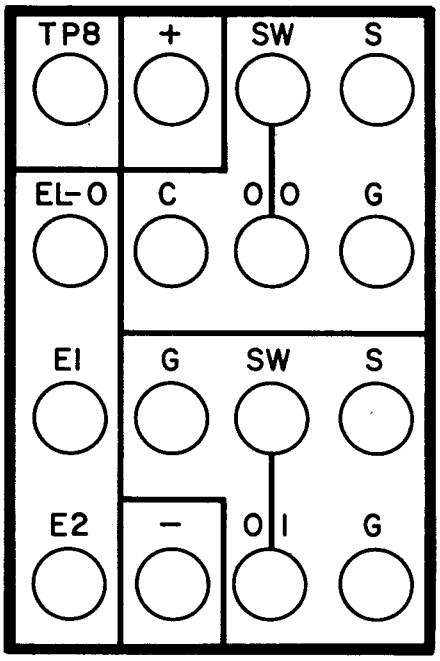
## *New EAI MICROSTORE Accessory Expands the Versatility of Repetitively Operated PACE® All-Electronic Analog Computing Systems.*

With the addition of the MICROSTORE accessory the PACE 231R Analog Computer can now perform point storage functions in real time and at repetitive operation speeds – and with the precision and reliability of the PACE wide bandwidth computing components the concept of point storage for the solution of problems on the analog computer takes on new significance. MICROSTORE combines with the PACE High Speed Repetitive Operation System to add still more versatility to the EAI family of precision analog computing equipment.



*PACE 231R Computing System equipped with High Speed Repetitive Operation (HSRO) and Display Unit. The combination of MICROSTORE and accurate high-speed repetitive operation makes possible many new techniques and applications for the analog computer. The HSRO accessory permits the computer to be operated alternately as a real-time or repetitive computing device – repetitive solution times of from 10 to 80 milliseconds are available – with no loss in real time computing accuracy. Change from real-time to repetitive operation is accomplished by a single control – without reprogramming or repatching the problem. Display unit allows simultaneous display of up to eight variables on an electronically generated display grid.*



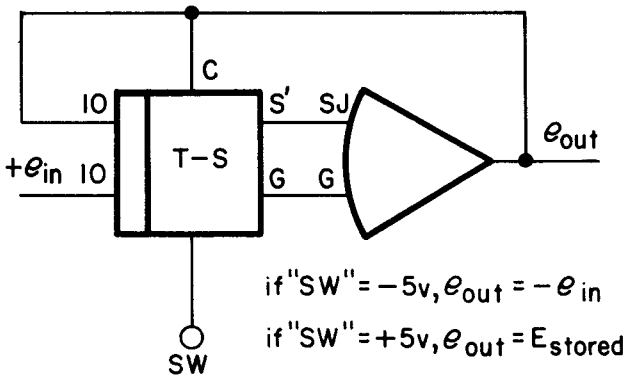

*Typical MICROSTORE Pre-Patch Panel layout. Terminations labeled + and – signify comparator outputs according to the algebraic sum of its input signals.*

**PATCH PANEL TERMINATIONS** are of the uncommitted type permitting maximum flexibility in the use of the MICROSTORE logic units. Two gates and one electronic control comparator are terminated in a single patching module – up to ten such modules may be conveniently placed on a standard 231R Pre-Patch Panel.

MICROSTORE operation requires only the use of high gain amplifiers with associated network resistors – any standard summer or summer-integrator amplifier may be utilized with appropriate patching. Three general functional modes of operation are possible – the patching determines the mode of operation obtained.

## TRACK AND STORE

Patching for normal track and store operation is shown below. Input and feedback resistors are patched from the amplifier network. The amplifier mode is determined by the polarity of the switch input (SW); if the input is negative, the amplifier will TRACK; if the input is positive, the amplifier will STORE. This input is provided by either the master drive unit or the control comparator.

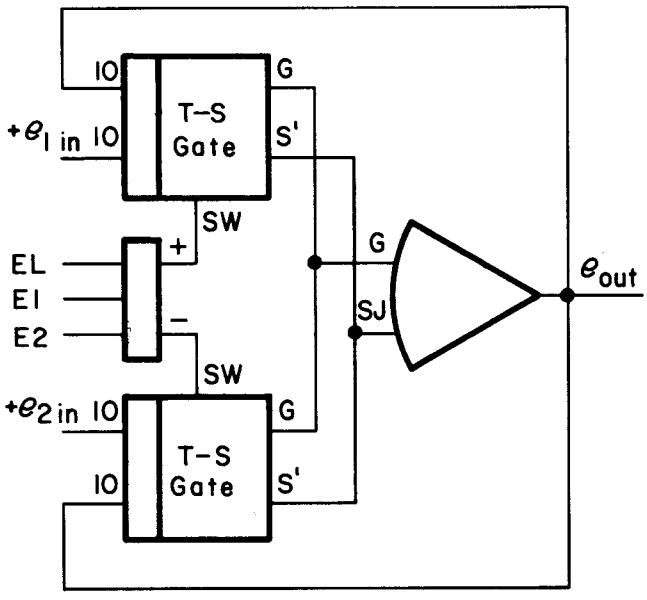



CIRCUIT 2A

*Computer symbol for Track and Store Amplifier. Switching signals are obtained from the master drive unit or a control comparator.*

## ELECTRONIC SWITCHING

Since the MICROSTORE gates are essentially precision electronic ON-OFF switches they may be utilized to perform high speed switching. When patched as shown below, the gate will pass an input voltage to an amplifier when it is ON (positive switching voltage) thus, utilizing two gates and a comparator, a high speed SPDT switch is obtained. Switch control voltages may be obtained from either the master drive unit or from the electronic control comparator as shown. If $E_L$ = +5 volts, $e_0 = -e_{1in}$, or if $E_L$ = –5 volts $e_0 = -e_{2in}$, regardless of the inputs at E1 and E2. With no input on EL, if E1 + E2 $\geq$ +10 mv, $e_0 = -e_{1in}$ or if E1 + E2 $\leq$ –10 mv, $E_0 = -e_{2in}$.

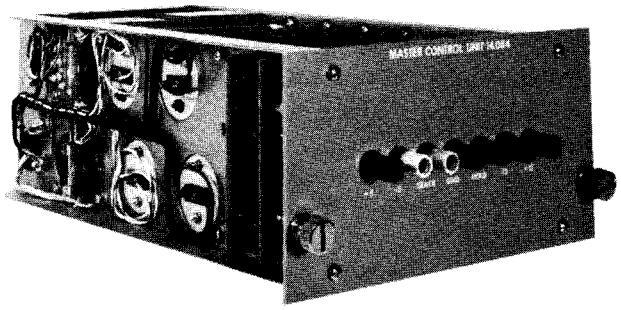



CIRCUIT 2B

*Computer Symbol for Track and Store Gate*

## MASTER CONTROL UNIT

A plug-in chassis provides regulated solid-state power supplies to supply power for the operation of up to ten MICROSTORE modules, and a Master Drive Unit for controlling the track-store gates. The master drive control card is a transistorized, plug-in printed circuit unit which provides a bi-polar square wave for controlling track-store gates under computer mode control. It receives the REP-OP drive as an input and converts this signal by suitable shaping and adjustable time delay into two complementary outputs of plus and minus five volts. These control voltages can than be used to control the operation of track-store units as desired.

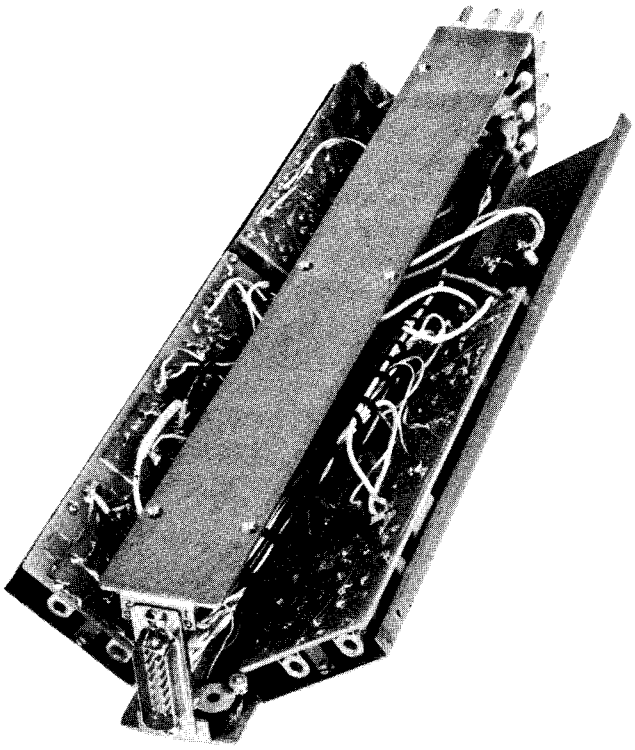


## TRACK AND STORE GATE NETWORK

These networks contain the high-speed switching circuits necessary for the control of the so-called "track-store" amplifier storage. MICROSTORE track-store gates may be used for high-speed switching functions or in conjunction with a summing amplifier to provide tracking and storage of problem voltages. Each network contains a storage capacitor and a six-diode gate that is capable of operating as a precision electronic ON-OFF switch. The gate is turned ON or OFF by the ±5 volt control signals generated by the Master Drive Unit or the Electronic Control Comparators. Two gate networks and a control comparator are mounted in a plug-in module which is inserted into the rear of the computer patch bay, within the temperature stabilized oven.

## ELECTRONIC CONTROL COMPARATOR

The control comparator provides a means of controlling the MICROSTORE gates from an algebraic summation of two problem variable inputs. Two outputs are available for controlling the gate mode with a negative sum of comparator input voltages; one output is negative five volts and the other output is positive five volts. When the summation becomes positive, the output state reverses. A third comparator "latching" input ($E_L$) is available for overriding the other two inputs. This input allows a control signal of ±5 volts (either from mode control or problem variables) to maintain a desired mode of the comparator regardless of the summation of input voltages. The latching feature is effective for overriding the comparator inputs during the computer RESET mode to maintain a stored value until the next OPERATE cycle, thus saving a track-store network.



## *Some General Applications of the PACE MICROSTORE.*

MICROSTORE increases the versatility of the PACE Analog Computers. It extends the usefulness of analog computation by providing precision components for performing high-speed switching and simulation of logic functions for real-time and repetitive computations. Its high speed memory capabilities extend the range of analog applications by making it possible to solve problems in a sequential manner with the accompanying economic benefits of time-sharing of computing components and by the solution of equations through the use of high-speed iterative procedures.

**DATA AND CURVE FITTING** – Problems often arise where it is desired to establish suitable "mechanisms" or equations whose solution matches that of experimental data gathered from a real process. When the data is a series of points track-store units may be employed to pick-off the point solutions for comparison purposes. If the data is in curve form a technique employing automatic parameter changes may be used where the circuits for evaluating the error criterion and making parameter changes utilize MICROSTORE units.

**BOUNDARY VALUE PROBLEMS** – This important class of problems involves the solution of differential equations in which the problem is to find the initial conditions for which the solutions (a) are stable, periodic or continuous, or (b) satisfy certain specified final conditions. Automatic solution techniques are sometimes useful where the initial conditions are varied until the error is reduced to zero. The use of MICROSTORE memory together with simple iterative techniques represents a powerful tool for such problems.

**STAGEWISE CALCULATIONS** – Many of the separation operations in chemical engineering are calculated in a serial or stage-wise manner where the results of one calculation are required as inputs to the next calculation, but the equations remain essentially the same. MICROSTORE is ideally suited for the solution of such problems as a storage device for the results of each calculation whether computation is made in real time or repetitive operation.

**SERIAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS** – The solution of partial differential equations used to represent physical systems often requires excessive non-linear equipment when parallel solution is attempted. Serial solution is sometimes effective where the repetition of circuitry is traded for a single basic circuit together with storage and interpolation schemes. Iterative techniques may also be effectively employed. The accuracy problems inherent in curve generation from point storage must be considered but this approach represents an area where MICROSTORE may be used to advantage.

**OPTIMIZATION TECHNIQUES** – Various kinds of sampling and storage are required for system optimization whether "on-line" in a plant or as a computational technique. The use of MICROSTORE track-store units permits automatic parameter evaluation to be extended to that of model or plant optimization by automatic techniques in which process variables (real or simulated) are changed to satisfy an economic or other criterion.

## *Technical Data*

**INSTALLATION** – The MICROSTORE accessory may be installed in the field by an EAI Field Engineer. Standard Expansion Group, Model 2.395, provides five MICROSTORE modules and the wiring for a total of ten. Five additional MICROSTORE modules are added by Expansion Group, Model 2.396.

## SPECIFICATIONS

*Control Comparator*

Sensitivity ..... 10 mv differential

Switching Time ..... 10 $\mu$sec

Signal Input Impedance ..... 50,000 ohms

Outputs ..... two control channels of ±5V each

Driving Capability .... up to 10 track and hold gates

*Track and Hold Gate (With standard .005 mf capacitor)*

D.C. Offset ..... ±10 mv

Switching Input ..... ±5 volts

A.C. Offset ..... ±25 mv

Switching Time ..... 5 microseconds

Drift in Hold (with any input from 0 to 100 volts)... .....80 mv/sec for 8 hour period

Frequency Response (200 volts p-p input)

Max. Inst. Error (includes amplitude error plus phase shift)

| Cps. | |
|---|---|
| 100 | 0.2 volts |
| 500 | 1.5 volts |
| 1000 | 2.5 volts |

*Master Drive Unit*

Outputs ..... two control channels of ±5V each

Delay (Used to compensate for any mechanical delay induced by rep. op. choppers) ..... ..... variable from 100 to 500 $\mu$sec

Driving Capability ..... at least 20 T & H gates

Input ..... received from rep. op. timing unit

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