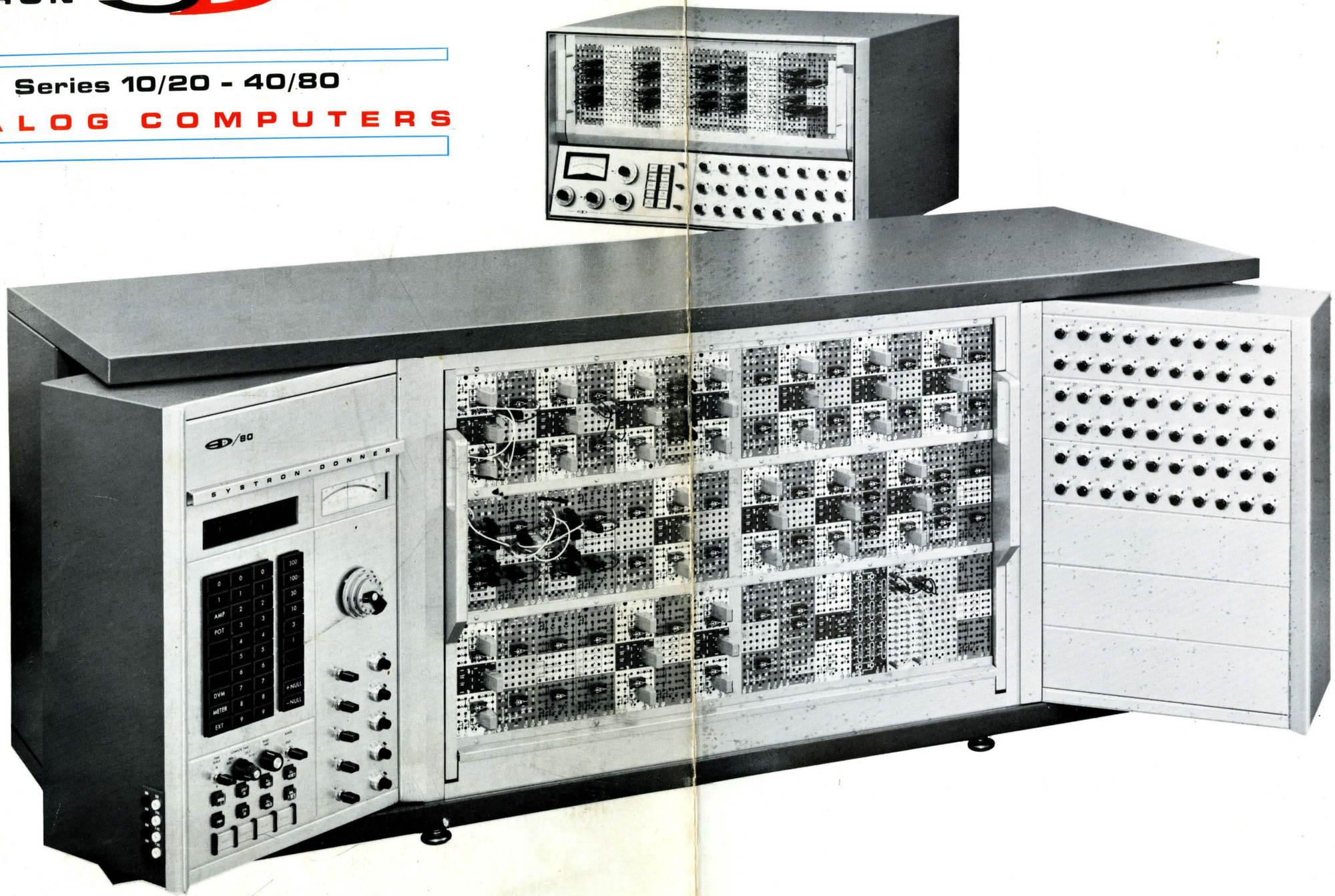
SYSTRON DONNER

Series 10/20 - 40/80

ANALOG COMPUTERS



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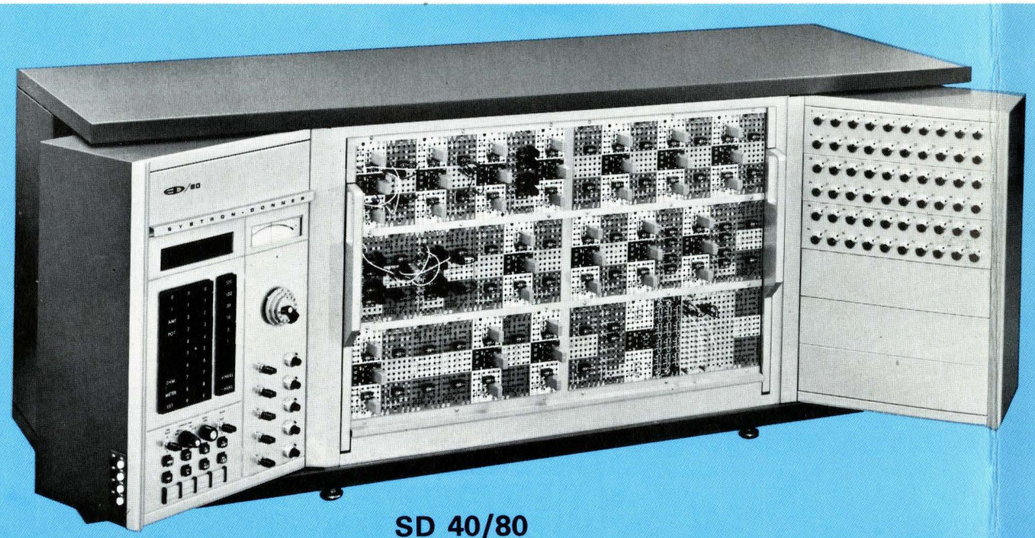
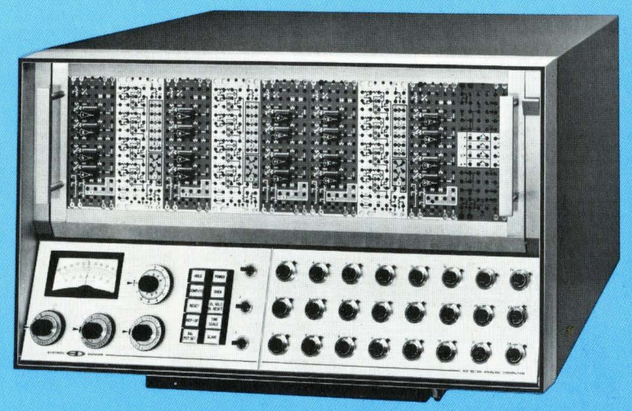
More than 13 years of experience stand behind the new SD 10/20-40/80 Analog Computer Series. No other portable system comes close to matching these Donner Computers in flexibility, problem solving capability, ease of expansion, and simplicity of programming and operation.

- **± 100-VOLT COMPUTING RANGE** means easier scaling and greater problem accuracy, plus full compatibility with existing ±100-volt computers.
- **SOLID-STATE DESIGN** assures high reliability and permits rugged use.
- **REMOVABLE PROBLEM BOARD** couples directly into plug-in computing modules which can be arranged into any convenient order.
- **VISUAL COMPUTER CIRCUITS** on patch panels match computer textbooks for easy, simple programming.
- **VOLTAGE AND CURRENT LIMITED CIRCUITS** provide protection against accidental shorts.
- **DIGITAL LOGIC IS BUILT IN** at no increase in size or decrease in analog capacity.
- **FULL ITERATIVE CONTROLS** — up to 100 cps REP-OP with reed relays or electronic switches.
- **PATCHABLE** electronic mode control and time scale.
- **EXPANDABLE MODULAR DESIGN** permits direct expansion to maximum limit.

In Addition to Big Computer Performance, the SD 10/20-40/80 Series Places Maximum Emphasis on Convenience Features:



SD 40/80

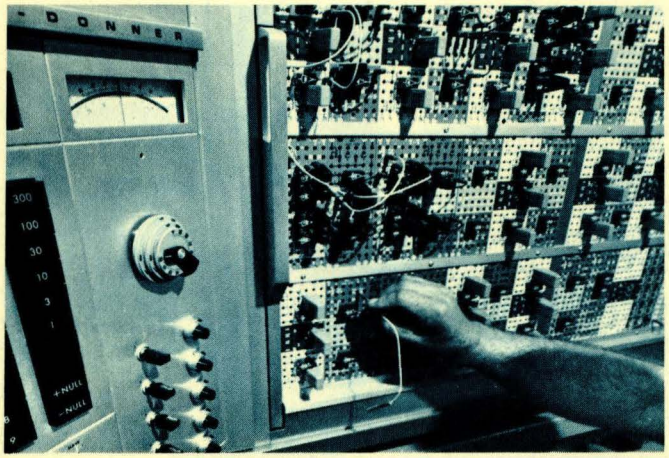


SD 10/20

Quick Reference Selection Guide

		SD 10/20		SD 40/80		
1 BASIC COMPUTER		TYPICAL COMPLEMENT				
Cabinet with complete Control Panel, Address Selector, Potentiometer Panel, computer power supply and ±100 volt dc reference system.		Modules	Amplif.	Modules	Amplif.	PAGES
2 COMPUTING MODULES	Maximum:	9	20	42	84	
Summers:						
Dual Summer, Module 3321				13	26	⑥
Quad Summer, Module 3325		5	20	1	4	③ ⑥
Integrators:						
Dual Integrator, Module 3320				14	28	② ⑦
Quad Integrator/Dual Multiplier/Function Relay, Module 3329		2				③ ⑦
Quad Integrator (no dual multiplier circuit)/Function Relay, Module 3329A						⑦
Non-Linear Modules:						
Dual Multiplier/Dual Inverter, Module 3323				6	12	⑧
High Accuracy Multiplier/Dual Inverter, Module 3323-1						⑧
Variable Diode Function Generator, Model 3351		4 or 4		15 or 10		⑨
High Resolution VDFG, Model 3352						⑨
Comparators:						
Dual Function Relay/Dual Inverter, Module 3322A				2	4	⑩
Quad Electronic Switch/Dual Inverter, Module 3324				3	6	⑩
3 HYBRID COMPONENTS						
Digital Logic Control Modules:						
Flip-Flops, Module 3326				3		⑩
Logic Gates, Module 3327				2		⑪
Combination Flip-Flops and Logic Gates, Module 3326A		1				⑪
Time/Event Control, Module 3328		1		1		⑪
4 POTENTIOMETER GROUP						
SD 10/20: 6 potentiometers per group, Module 3374		up to 24 pots				⑫
SD 40/80: 20 potentiometers per panel, Module 3370		up to 125 pots				⑫
5 COMPONENT UNIT TOTALS:		TYPICAL CAPACITY (*Maximum Normal Expansion)				
Operational Amplifiers		20*(32 special)		84*(120 special)		
Summers/Inverters		20*		64-84*		
Integrators		8-16*		20-50*		
Multipliers		4-8*		10-84*		
Function Relays		2		4		
Electronic Switches				8		
Variable Diode Function Generators	Model 3351:	4*		15*		
	Model 3352:	4*		10*		
Function Switches		3*		5		
Trunk Lines		30*		160*		
Coefficient Potentiometers		24*		125*		
Hybrid Components:						
Flip-Flops (12 per module)				36		
Gates (12 per module)				24		
Flip-Flops and Gates (6 of each per module)		6				
Timer-Counter		T/C		T/C		
6 PHYSICAL SPECIFICATIONS:						
Power Consumption		150 watts		650 watts		
Power Supply	Connections Provided for:	115, 220, 230, 240 and 250V ±10%, 50-400 cps				
Weight (fully expanded)		130 lbs (68 kg)		700 lbs (315 kg)		
Dimensions (length x height x depth)	Inches:	24 x 15 x 25		68 x 26 x 23		
	Centimeters:	61 x 38 x 63		172 x 66 x 58		

Prices available upon request. Shipment F.O.B. Concord, California

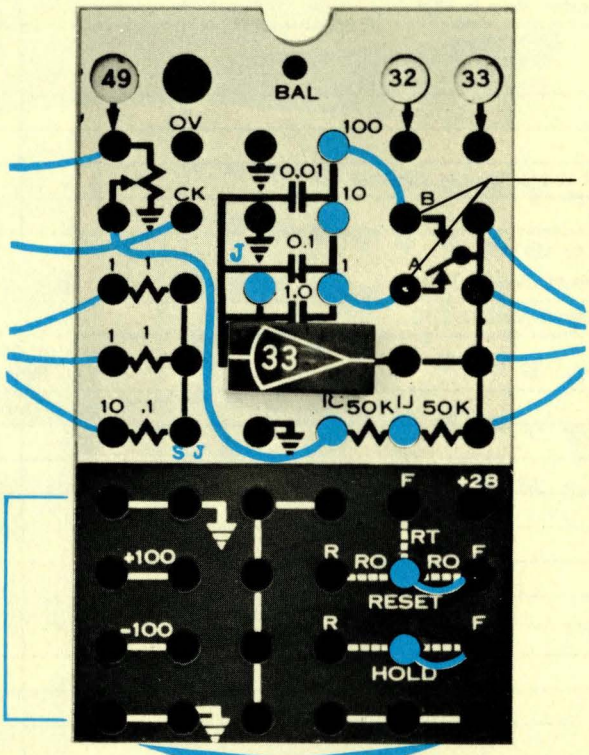


SD 40/80 Analog Computer

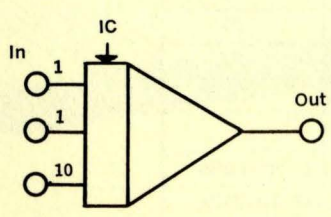
The patchboards for both the SD 10/20 and 40/80 computers have been carefully **human-engineered** for expert and neophyte alike. An outstanding convenience feature of the S-D patchboard layout is the use of **visual computer circuits** that match computer textbooks. This exclusive Systron-Donner feature of clearly showing computer circuits on the modular patch panels eliminates the need for specially trained computer programmers. With the SD 10/20 and 40/80 computers, programmer and operator are one and the same person. Not only does this greatly simplify programming, but it also gives the programmer-operator a much finer *feel* for both his problem and the computer. By actually *seeing* computer circuits,

Visual Circuits on Patch Panels

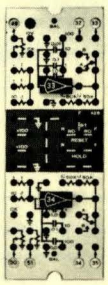
Illustrating the Integrator — The Control 'Heart' of any Computer



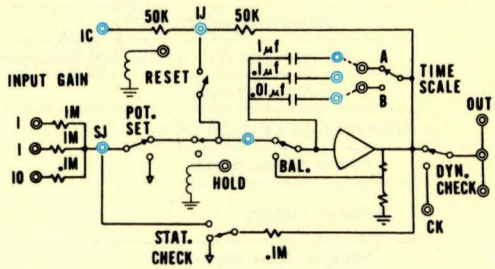
ALL ● TERMINALS PATCHABLE



[1] Integrator Amplifier Symbol.



[2] Dual Integrator Patch Panel (top amplifier section with mode control area enlarged above).



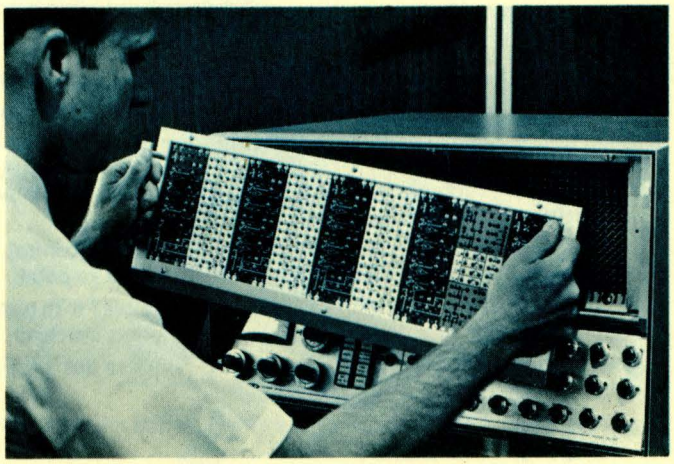
[3] Block diagram illustrating flexibility of circuit and patching convenience. Note that ● terminals are brought out to patch panel.

Problem Set-up

patch time is greatly reduced. The operator is thus able to spend more of his time communicating with his problem.

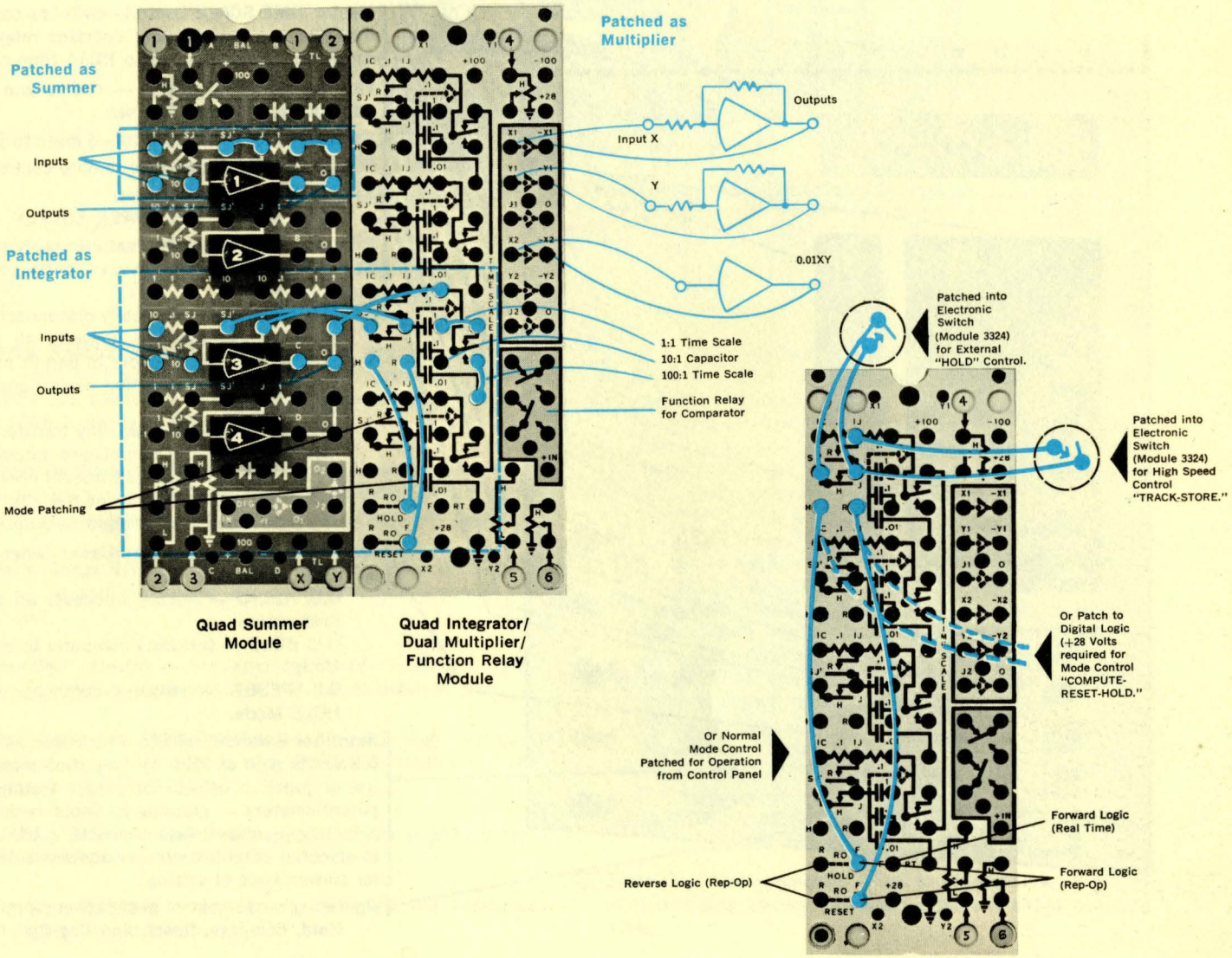
The problem boards are removable for off-line programming and couple directly into the plug-in computing modules which are housed in a universal, fully pre-wired patchbay. This direct coupling between patch terminals and computing modules provides a decrease in amplifier cross-coupling and lower system noise.

The **modular block** construction allows complete flexibility in final problem board configuration. It is thus possible to arrange modules in various combinations with minimal limitations in numbers of integrators, multipliers, comparators, etc.



SD 10/20 Analog Computer

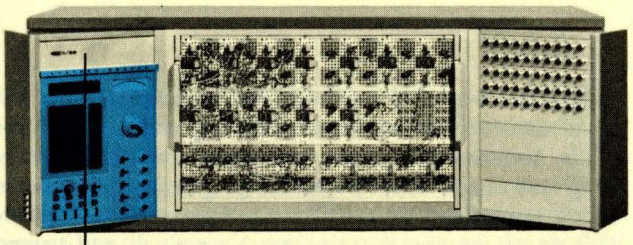
The Compact Quad Series for SD 10/20 Computer

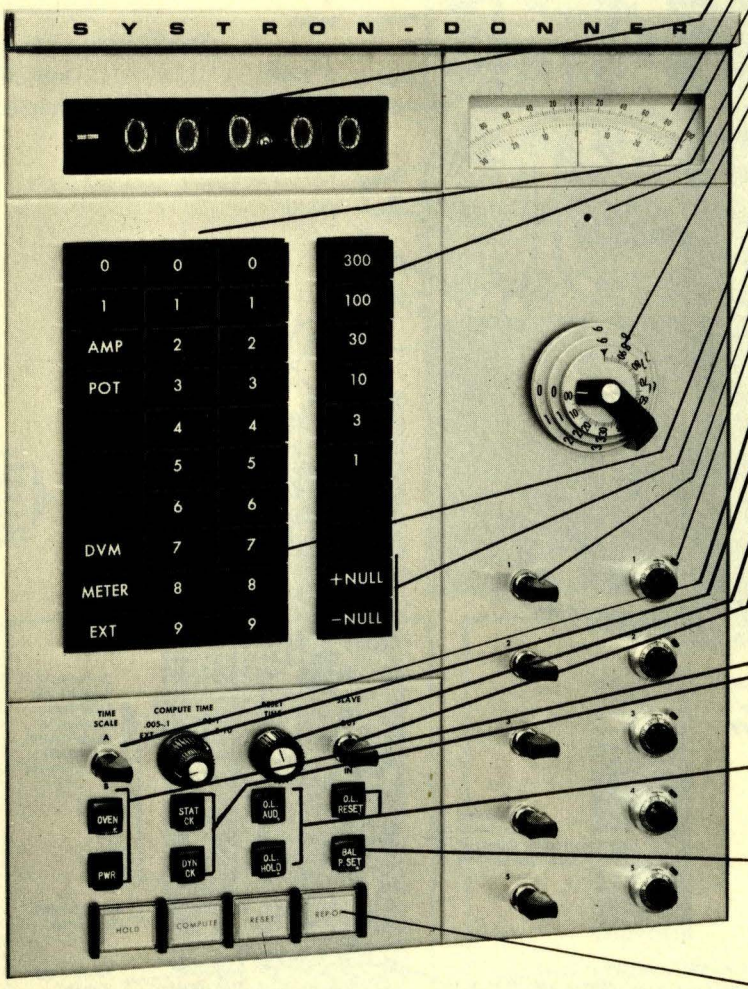


SD 40/80 Control Wing

Communicating with your problem in the quickest and easiest manner is a major convenience of the SD 40/80 Control Wing. You have the convenience of:

* **Digital Pushbuttons** for rapid address to check and adjust amplifiers and potentiometers.
* **Static and Dynamic** checks by simple pushbutton control to verify patching in an instant without the need to re-patch.
* **Instant Alarm Controls**, both visual and audible, with automatic transfer to HOLD at the occurrence of an overload.
* **Individual control of compute and reset times** for precise adjustment in iterative and rep-op modes.
* **Time Scaling** the problem with a single switch on the Control Wing.
* **Checking all amplifiers** with pushbutton control. Places all amplifiers in balance mode for simplified monitoring.





Function Generator Receptacle holds up to 15 Model 3351 (or 10 Model 3352 high resolution) V.D.F.G. plug-in cards.

0.01% Digital Voltmeter (optional)

Standard Panel Meter (direct and null modes)

200-point Digital Pushbutton Address Selector
Amplifiers: 00 to 84, Potentiometers: 000 to 125

Panel Meter Range Selector

Meter Zero

Null Meter Reference Potentiometer

Readout Selectors

± Null Selector for ±0.01% full-scale metering

5 Function Switches

Coefficient Potentiometers 1 to 5

Master **TIME SCALE** Control—switches capacitors that are patched and operates relays in integrator modules — up to 1000:1 time scale.

Variable **COMPUTE TIME** — coarse and fine adjustment — 5 msec to 5 sec.

Variable **RESET TIME** Control—5 msec to 5 sec.

SLAVE switch for complete remote control.

Self-lighting pushbuttons for:
OVEN POWER and POWER SUPPLY

Exclusive big computer feature: pushbutton **Static and Dynamic** checks without re-patching.

Static Check automatically disconnects all amplifier outputs and converts all integrators to × .1 Summers to permit an instant check for patching errors and all gain settings.

Dynamic Check automatically transfers all integrator amplifier patchboard outputs to a check voltage to permit instant check of initial derivatives, and to permit checking of connections from integrator outputs.

Automatic Visual and Audio Alarms (when any amplifier overloads)

O.L. AUDIO — buzzes whenever an overload occurs

O.L. HOLD — transfers computer to HOLD Mode

O.L. RESET — removes computer from HOLD Mode.

Amplifier Balance/Pot Set — changes all amplifiers to gain of 2500 for simplified monitoring of junction offset. For proper loading of potentiometers — grounds all input resistors, summing junctions. Also connects +100 volts to selected potentiometer on address selector for convenience of setting.

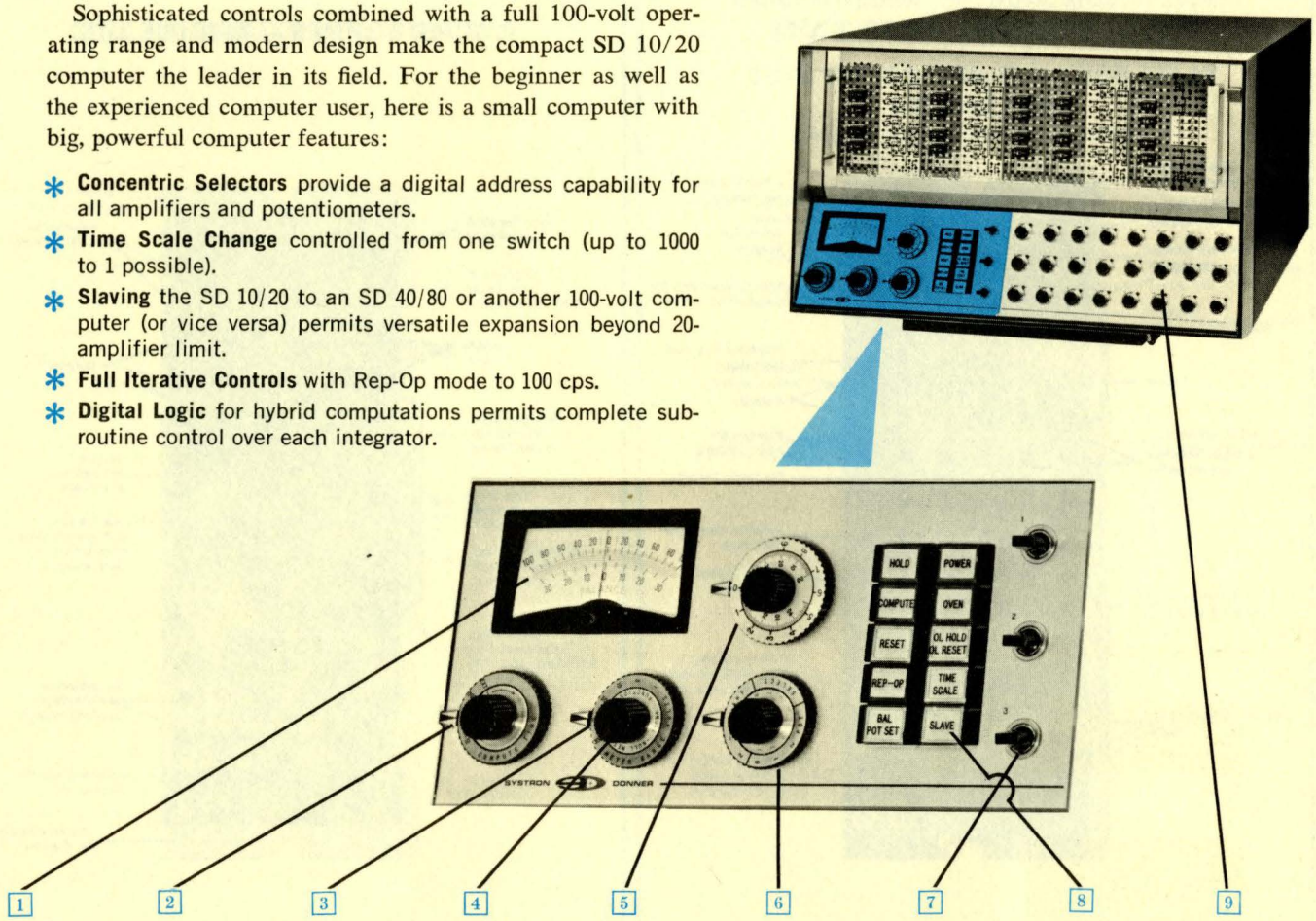
Operating mode control pushbutton panel for:
Hold, Compute, Reset, and **Rep-Op**

Problem Checking

SD 10/20 Control Panel

Sophisticated controls combined with a full 100-volt operating range and modern design make the compact SD 10/20 computer the leader in its field. For the beginner as well as the experienced computer user, here is a small computer with big, powerful computer features:

* **Concentric Selectors** provide a digital address capability for all amplifiers and potentiometers.
* **Time Scale Change** controlled from one switch (up to 1000 to 1 possible).
* **Slaving** the SD 10/20 to an SD 40/80 or another 100-volt computer (or vice versa) permits versatile expansion beyond 20-amplifier limit.
* **Full Iterative Controls** with Rep-Op mode to 100 cps.
* **Digital Logic** for hybrid computations permits complete subroutine control over each integrator.



[1] **Meter Readout Ranges:** 1, 3, 10, 30, 100, and 300 volts, and ± null. Full scale accuracy: 3%. Null position provides 0.02% F.S. resolution with reference potentiometer having a ±0.05% linearity at 25°C.

[2] **Compute Time Selector** — compute time continuously variable from 5 msec to 10 sec. Reset time varies from 5 msec to 5 sec, depending upon coarse steps of compute range.

[3] **Meter Range Selector** — with positions for 300 v, 100 v, 30 v, 10 v, 3 v, and 1 v. Serves also as sensitivity adjustment for ± null.

[4] **Function Selector** — for rapid choice of: + null, − null, Meter, External (connects selected bus to external jack).

[5] **Null Reference Potentiometer** — provides high accuracy readout using null method with 0.02% F.S. resolution. Linearity is ±0.05% at 25°C.

[6] **Address Selector** — address capability of 20 amplifiers and 24 potentiometers.

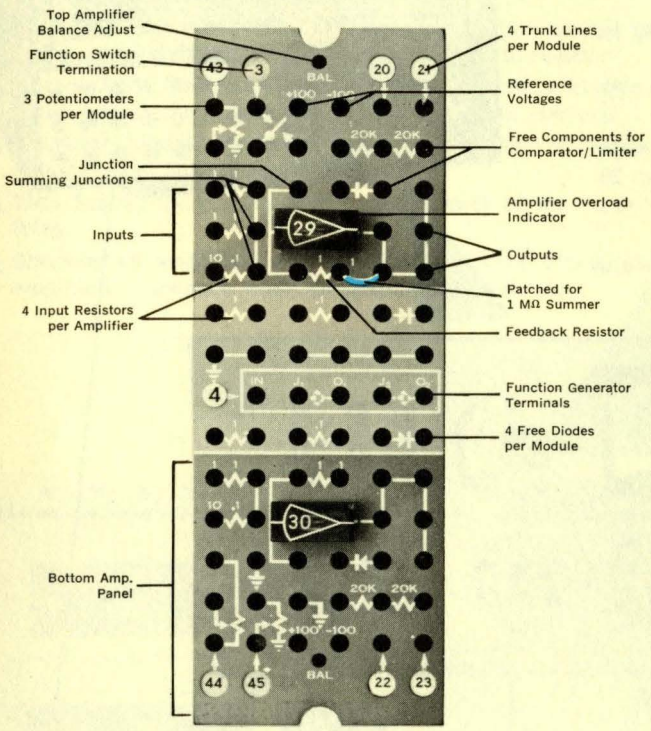
[7] **Function Switches** — provide manual switching flexibility in problem solutions.

[8] **Mode Selection** (lighted pushbuttons):
- **Hold** — places problem solution on all integrators into hold position.
- **Compute** — applies problem voltages to all integrators.
- **Reset** — applies initial condition voltages to integrators.
- **Rep-Op** — places integrators into a repetitive operation cycle. Compute time variable from 5 msec to 10 sec.
- **Bal/Pot Set** — disconnects junction and grounds the input resistor summing junctions of all amplifiers. Each amplifier is converted to a gain of 2500 for precision monitoring of junction offset.
- **Pwer On/Off** — energizes and de-energizes computer.
- **Oven** — indicates +28-volt oven power is on to maintain constant temperature of computing capacitors.
- **OL Hold, OL Reset** — lights up when any amplifier is overloaded. When depressed, computer goes into Hold; when released, normal operation is resumed.
- **Time Scale** — activates relays in each integrator module to change computing capacitor. (x 10, x 100, x 1000, depending on patchpanel connections.)
- **Slave** — permits operation of computer control circuitry from a second console.

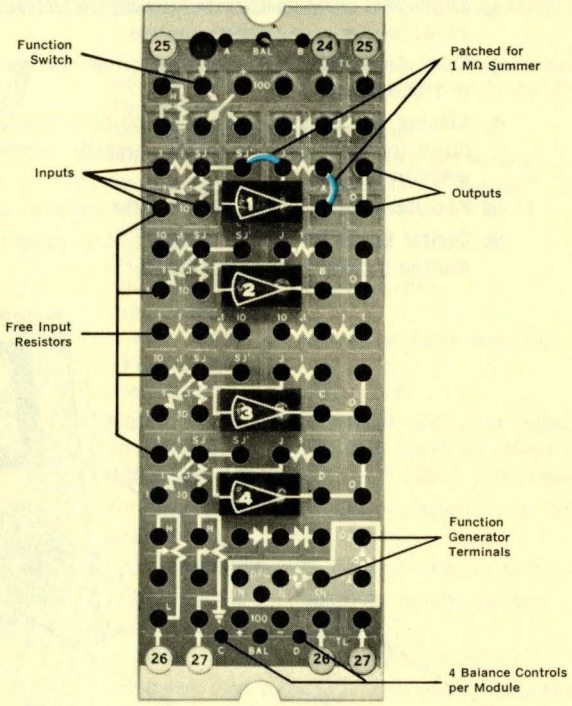
[9] **Coefficient Potentiometers** — up to 24, available in groups of 6, featuring 10-turn wire-wounds with lockable counting dials.

Summers

DUAL SUMMER — MODULE 3321



QUAD SUMMER — MODULE 3325

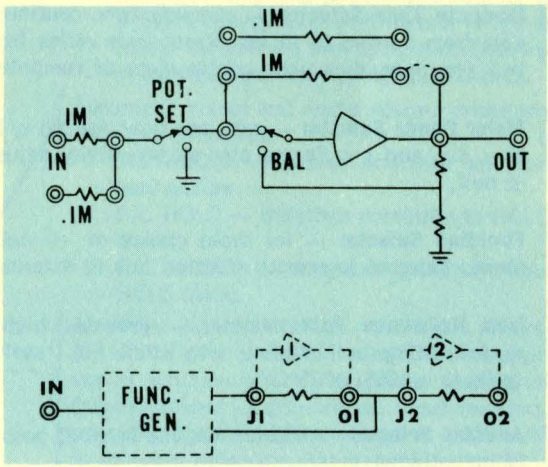


SPECIFICATIONS

Tolerance of Input and Feedback Resistors: 0.01%
Temperature Coefficient of 0.01% Resistors: ±5 ppm/°C
Bandwidth (R_{in}= R_{fb}= 100k, no capacitive loading at summing junction or output): >200 kc (within 3 db)
Bandwidth (R_{in}= R_{fb}= 1M): >50 kc (within 3 db)
Velocity limit: $>3 \times 10^6$ volt/second
Noise at output (R_{in}= R_{fb}= 1M with R_{in} grounded): <10 mv p-p (0 to 2 kc).
Cross talk at 100 cps (R_{in}= R_{fb}= 1M): <−66 db
Phase shift at 100 cps: <0.03°

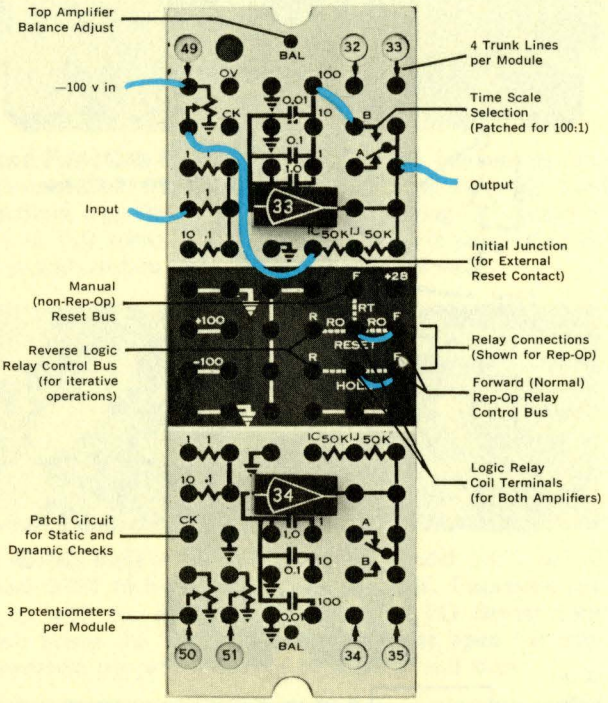
FEATURING:
4 Trunk Lines per Module
4 Diodes per Module
1 Function Switch per Module
Terminations for:
- 3 Potentiometers
- ±100-Volt Reference
- VDFG

Per Amplifier Channel:
- Average of 4 Input Resistors (any input network can be used with any amplifier channel).
- 1 Feedback Resistor



Integrators

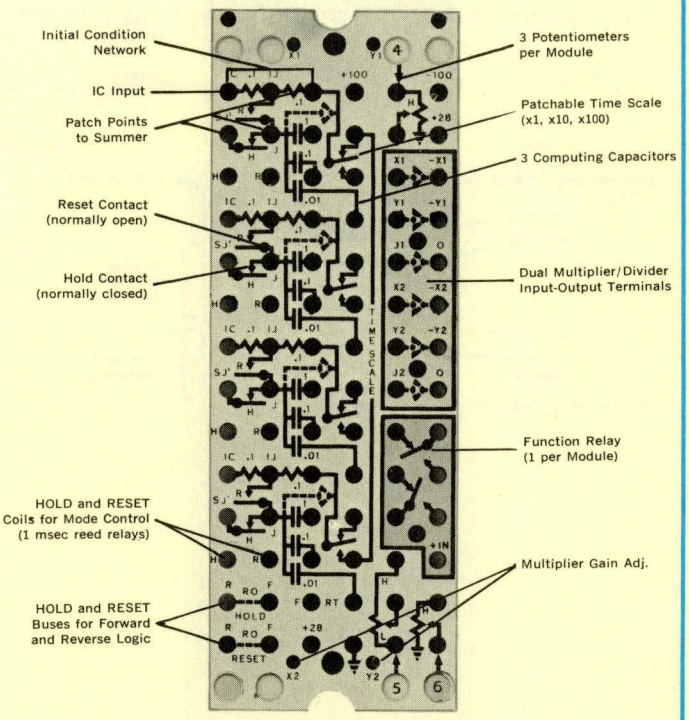
DUAL INTEGRATOR — MODULE 3320

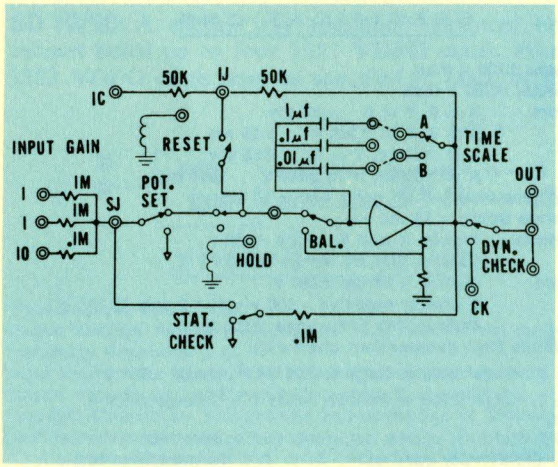


QUAD INTEGRATOR/DUAL MULTIPLIER/ FUNCTION RELAY — MODULE 3329

QUAD INTEGRATOR/FUNCTION RELAY MODULE 3329A

(Same as 3329 but without Dual Multiplier)





SPECIFICATIONS

Feedback Capacitors (in oven) 1 μF, 0.1 μF: Trimmable to better than 0.01%.
Feedback Capacitor 0.01 μF: ±1%
Tolerance of Input Resistors and Resistors in Reset Circuit: ±0.01%
Temperature Coefficient of 0.01% Resistors: ±5 ppm/°C
Nominal Temperature in Oven: 45°C
Temperature Regulatilon of Oven: ±1°C
Reset and Hold Relays: Reed Relay switching speed 1 msec, differential time <500 μsec typical
Integrator Drift (R_{in}= 1M, C_{fb}= 1 μF): 50 μv/sec typical, 100 μv/sec max.
Noise at output (with C_{fb}= 1 μF): <2 mv p-p (0 to 2 kc)
Bandwidth as Summer (R_c = 1M): >13 kc (within 3 db)

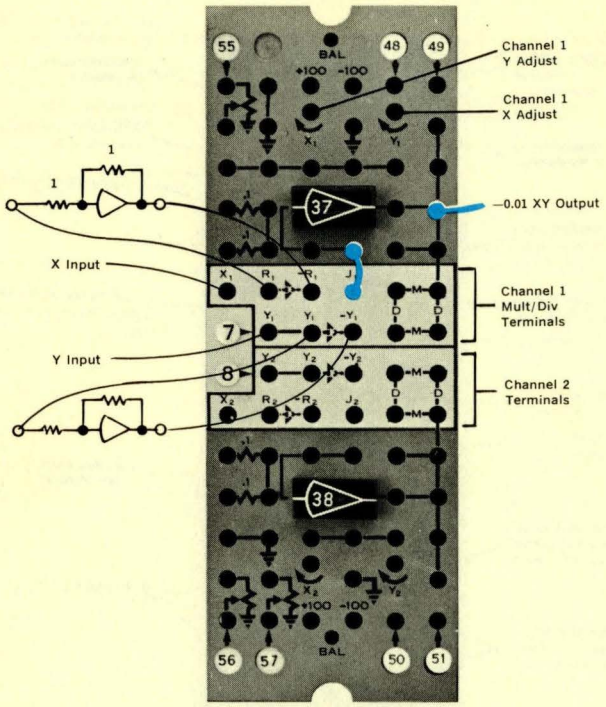
(See Page 8 for 3323 Dual Multiplier Specifications)
(See Page 10 for 3322A Function Relay Specifications)

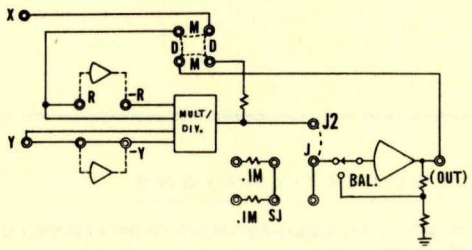
FEATURING:
- 3 Capacitors per Integrator
- 4 Trunk Lines per Module (3320 Only)
- Patchable Time Scale per Integrator
- Terminations for:
  - 3 Potentiometers
  - ±100-volt Reference
  - Mode Logic Buses

The patch panel is the same for both the 3329 and 3329A modules. Difference between modules: 3329 is supplied with dual multiplier cards built into the 3329 module. The 3329A is supplied without multipliers, but has provision for future addition of multiplier cards (simple field expansion).

Multipliers

DUAL MULTIPLIER/DUAL INVERTER MODULE 3323





SPECIFICATIONS

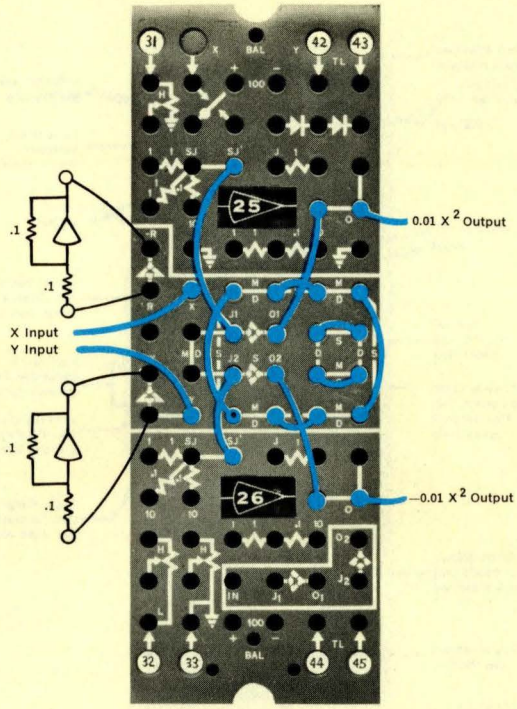
Frequency Response
Amplitude: $X = \pm 100$, $Y = 1 \sin \omega t$. } <3 db at 50 kc
$Y = \pm 100$, $X = 1 \sin \omega t$. }
Phase Shift: <0.1° at 100 cps
Input Resistance: Multiplier mode approx. 20 kΩ (varies with input levels)
Drift: $X = Y = \pm 100$ 25 mv per 2 hrs.
$X = Y = 0$ 5 mv per 8 hrs.
Noise: 20 mv p-p (0 to 10 kc)
Zero Offset: $X = Y = 0$ 20 mv max.
X or Y = 0 60 mv
Static Accuracy: 0.05%, 100 mv error typical

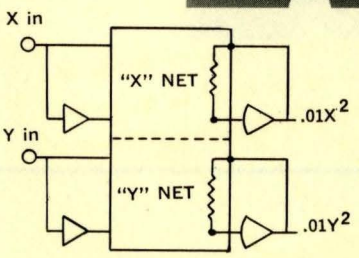
FEATURING:

Multiply, divide, squaring, and square root modes directly patchable

4 Trunk Lines per Module
Terminations for:
3 Potentiometers
±100-volt Reference

HIGH ACCURACY MUTIPLIER/DUAL INVERTER MODULE 3323-1





Patched for Squaring Mode

SPECIFICATIONS

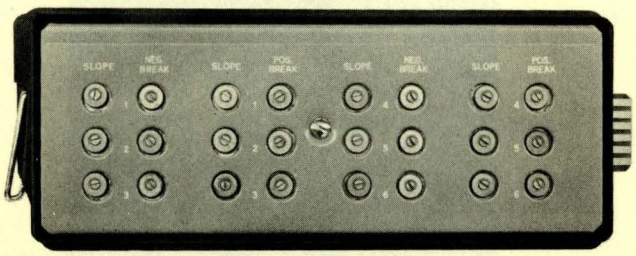
Input Range: ±100 v max.
Output Range: ±100 v max.
Static Errors: $X = 0$, $Y = 0$ ±2 mv
$X = 0$, $Y = \pm 100$ v ±15 mv
$X = \pm 100$ v, $Y = 0$ ±15 mv
$X = \pm 100$ v, $Y = \pm 100$ v ±30 mv
Frequency Response: —3 db point above 20 kc
Noise — Wide Band: <25 mv p-p
Multiply Mode: Inputs: X and Y, range ±100 v
Output: 0.01 XY, range ±100 v
Divide Mode: Inputs: X range ±100 v
Y always negative $-100 \text{ v} \leq Y < 0$ and $|X/Y| \leq 1$
Output: 100 X/Y, range ±100 v
Squaring Mode (two independent channels):
Input: X, range ±100 v. Output: 0.01 $|X|^2$, range ±100 v.
Input: Y, range ±100 v. Output: —0.01 $|Y|^2$, range ±100 v.

FEATURING: Multiply, divide, squaring, and square root modes directly patchable
4 Trunk Lines per Module
2 Diodes per Module
1 Function Switch per Module
Terminations for:
3 Potentiometers
±100-volt Reference
VDFG

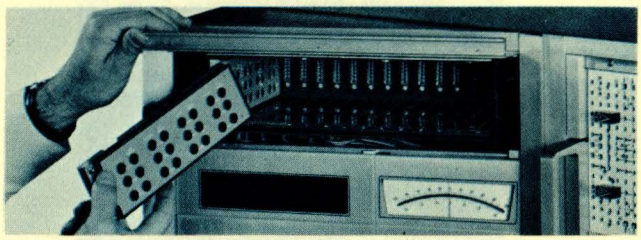
Turn Page for Comparators

Variable Diode Function Generators

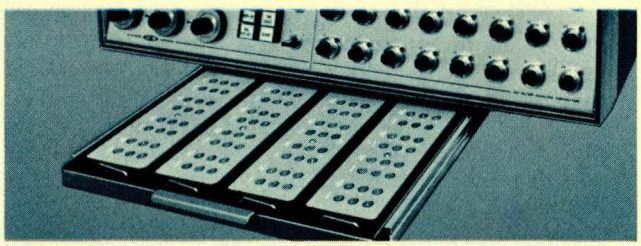
MODEL 3351



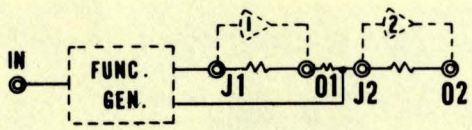
Fixed Function Cards: The 3351 VDFG (shown) and the high-resolution 3352 VDFG can be supplied with fixed functions, e.g., sine ±90°, cosine ±90°, Log |X| (range of X 1 to 100 volts). Each VDFG channel is terminated on the patchboard on Models 3321, 3322, and 3325.



SD 40/80: Built-in provision for 15 Model 3351 or 10 Model 3352 high-resolution VDFG cards. Functions are set up with the help of a Model 3341 FG Set-up Unit which brings the VDFG card out into the open for easy screwdriver pot adjustment of breakpoint and slope.



SD 10/20: A sliding tray (optional) mounted below the cabinet holds up to four 3351 VDFG cards. Four Model 3352 VDFG cards may be specified in place of the 3351.



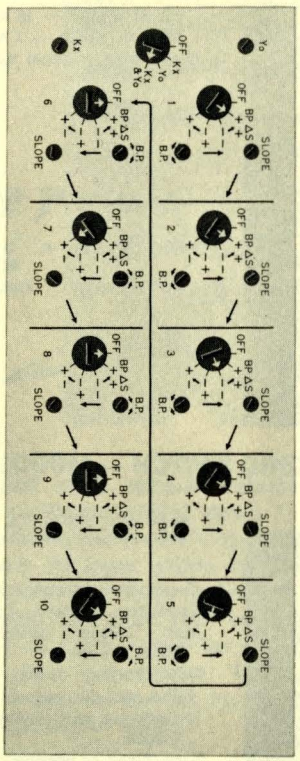
SPECIFICATIONS

Input Voltage: ±100 v max.
Output Voltage: Arbitrary function of input volt. within range ±100 v.
Frequency Response: 1 kc
Input Impedance: Greater than 45 kΩ (depends on function)
Output Impedance: Less than 0.1Ω (output Z of amplifier).
Function Simulation: Straight-line approximation of 12-line segments.
Line Segments: 12 breakpoints total
6 adjustable between 0 & +100 v, 6 adjust. between 0 & −100 v.
Slopes: Each segment has a max. adjustable slope of 2.5 v/v input.
(Larger slopes are obtainable by adding individual line segments.)
Noise: 150 mv p-p Power Requirements: ±100 v, ±6 ma

MODEL 3352

Features:

- Each breakpoint can be assigned anywhere between −100 and +100 volt range.
- Only one amplifier required if −X is available elsewhere.
- High resolution and low noise (only 50 mv p-p 0 - 2 kc).



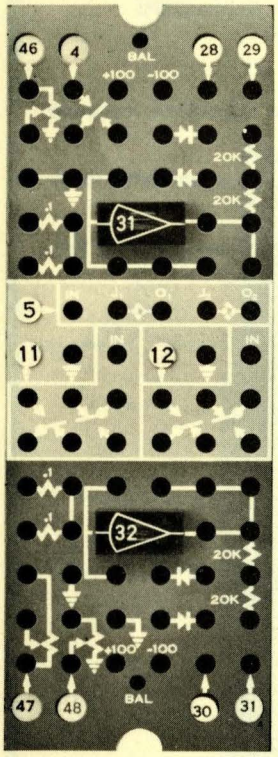
SPECIFICATIONS

Inputs Required: ±X (±X can be common for several functions of X)
Input Voltage: ±100 v max.
Output Voltage: Arbitrary function of input volt. within range ±100 v.
Input Impedance: Greater than 39 kΩ (depends on function)
Output Impedance: Less than 0.1Ω (output Z of amplifier).
Function Simulation: Straight-line approximation with 11 segments.
Noise: 50 mv p-p (DC to 2 kc)
Linear Segment Complement:
K_X adjustment: sets initial slope through origin of ±5 v/v max.
Y_O adjustment: sets Y at X = 0 (between ±100 v)
10 breakpoint-slope controls, each programmable to any of the following five combinations:

	No. 1	No. 2	No. 3	No. 4	No. 5
Breakpoint	+	−	−	+	off
Slope Change	+	−	+	−	off

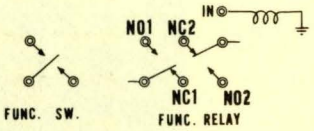
Max. Slope Change per Breakpoint: 2.5 v/v, breakpoints may be stacked together for increased slope change; 22-segment function generation possible by paralleling two Model 3352 VDFG cards.

DUAL FUNCTION RELAY/COMPARATOR MODULE 3322 AND MODULE 3322A

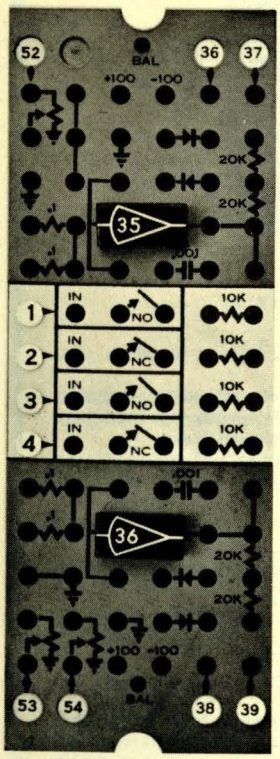


SPECIFICATIONS

Two Function Relays: Two Form C
Tolerance of Input and Feedback Resistors: 0.01%
Temperature Coefficient of 0.01% Resistors: ±5 ppm per °C
Bandwidth ($R_{in}n = R_{fb}$= 100k): >200 kc (within 3 db)
Noise at Output ($R_{in} = R_{fb} = 100$ k): <5 mv p-p (0 - 2 kc)
Phase Shift at 100 cps: <0.03°
Pull-in Time:
Module 3322 — 10 millisec
Module 3322A — 1 millisec
Energizing Voltage: ±28v to ±100v.

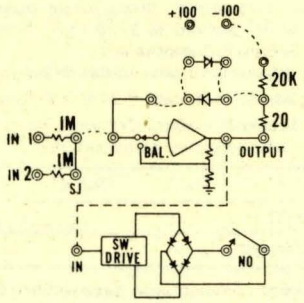


QUAD ELECTRONIC SWITCH — MODULE 3324



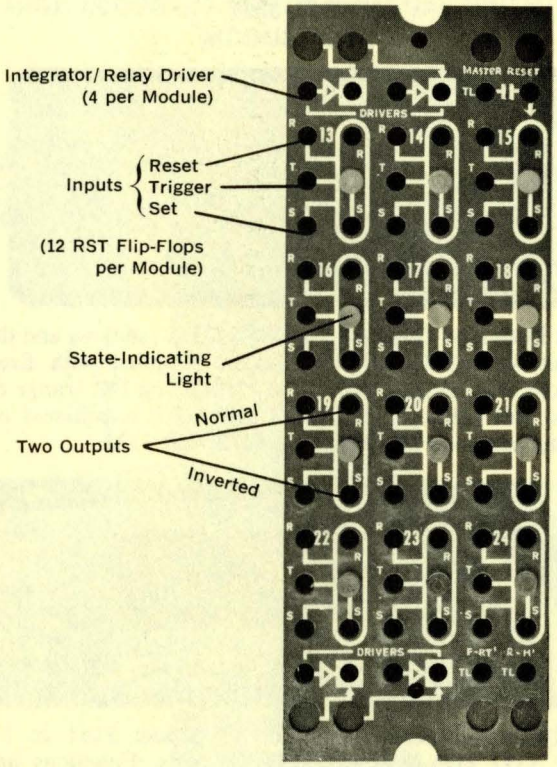
SPECIFICATIONS

Excitation Voltage: +20 to +100 v
Excitation Current: <2 ma
Max. Current passable through Switch: 3 ma
Max. Voltage across Switch with one side grounded: ±10 volt
Impedance with switch "ON": <200Ω
Rise Time of Switch (into a resistive load): 1 μsec
Error Current: $<5 \times 10^{-7}$ amps with Switch "ON"; $<10^{-9}$ amps with Switch "OFF."
Switch Rate: 1 kc max.
10 kΩ Resistors: Tolerance, 0.01%; Temp. Coefficient, 5 ppm/°C
0.001 μF Capacitors: Tolerance, ±1%, 500 w.v.d.c.



(CONNECTIONS SHOWN FOR COMPARATOR AMPLIFIER.)

FLIP-FLOP MODULE 3326



The flip-flop module contains 12 identical RST flip-flops and four relay drivers. Five patchboard terminals are available for each flip-flop, plus a state indicating lamp.

A logical 1 applied to the R or S input terminal will put the flip-flop in the R or S state, that is, the R or S output terminal will be a logical 1. The R and S inputs are direct-coupled. Driving the T terminal from a logical 0 to 1 will cause the flip-flop to change state. The R and S terminals may be either electrically or mechanically grounded to initiate action. All flip-flops may be simultaneously reset by one signal.

Outputs of different flip-flops can be connected together for OR gate action, or to any other digital logic output without damage, and without affecting flip-flop action.

Advantages of the Systron-Do

Three types of Digital Logic Modules provide hybrid computation capability as a standard part of the computer. They are inserted directly into the universal patchbay.

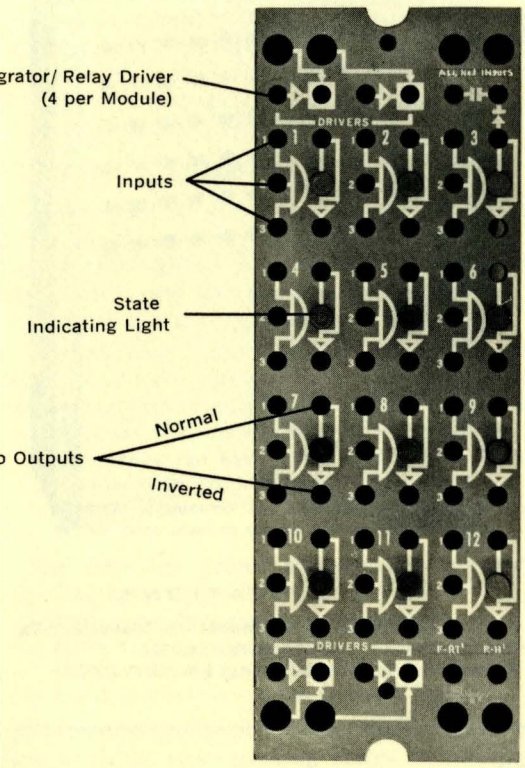
The digital logic outputs are positive-false type. A logical 0 (zero) is +15 volts or greater, and a logical 1 is approximately zero volts. Each digital module also contains one or more relay drivers which supply ±28 volts when energized.

The design concept of the SD Computer provides the necessary mode control relay and electronic switch comparator circuitry — forward-reverse logic for all integrators — to make this a very simple expansion.

The SD Digital Logic Control Modules follow the same philosophy as the other modules. By using the Model 3325 Quad Summer in conjunction with the various digital logic units, digital capacity in excess of that offered by competitively priced computers can be provided while maintaining the full amplifier capacity.

ic Control Modules

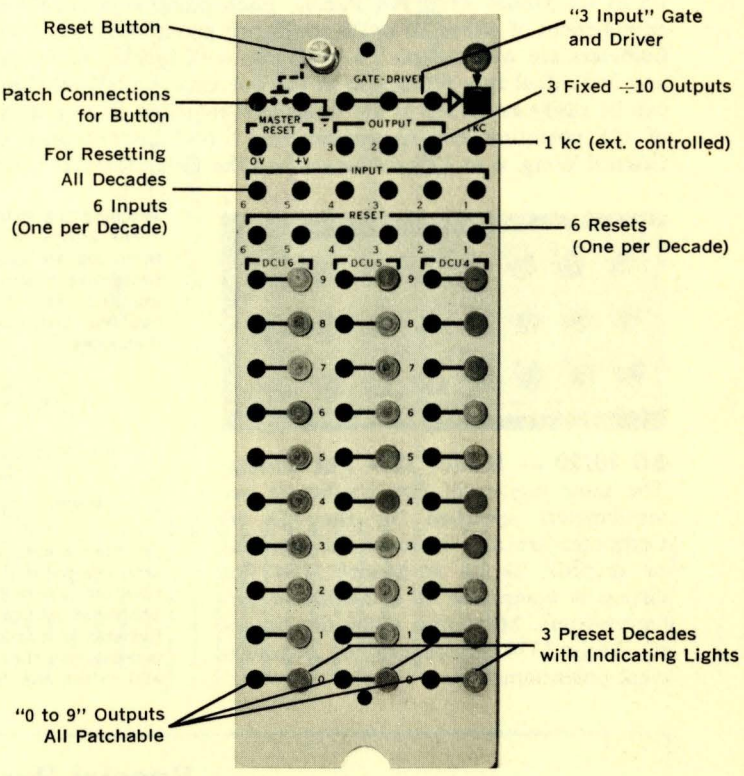
LOGIC GATES — MODULE 3327



The Model 3327 contains 12 identical AND gates and our relay drivers. Each gate has three input terminals, two utput terminals and a state indicating lamp.

The normal gate output is a logical 0 when any connected input is a logical 0. The number 1 input is internally onnected to +28 volts through a resistor so that unused ates will not have their lamps on. As a result, the number input must always be connected when a gate is to be sed. Electrical or mechanical grounding of number 1 input ill turn the indicating lamp on, and the normal output ill then be a logical 1, while the inverted output will be logical 0. Unused gate inputs can be left unconnected, hat is, if only two input coincidence is desired, the third nput may be left unconnected.

TIME/EVENT CONTROL — MODULE 3328



The digital clock module contains a 100 kc crystal-controlled oscillator divided down to a 1 kc output; three decimal counting units (DCU's) which give a logical output for each 10 input pulses and three counting DCU's with an output and lamp indication for each of the 10 decimal digits. The clock may be used for accurate timing using the 1 kc clock pulses for 1 millisecond time resolution, or as an event counter. The clock outputs may be connected in parallel for OR type action, or through AND gates for coincidence action.

Digital Matrix: 3 decade dividers, 3 10-line decade counters. Inputs/outputs individually patchable.

Internal Clock (crystal controlled): 1 kc or manual advance (with momentary logic-pushbutton) — 1 part in 10^5 stability.

Use as Clock (1 kc as input): Selectable, from 1 msec to 999 secs in patchable increments: 1 msec, 10 msec, 100 msec, 1 sec.

Combination Clock and Event Counter: Example A: use 3 digits as clock to get outputs in the range from 0.001 sec to 0.999 sec. Use other 3 digits for preset event counter to get outputs patchable in decade steps from 1 to 1000.

Indicators: 10-line visual indication for each of the three decade counters.

COMBINATION FLIP-FLOP AND LOGIC GATE MODULE 3326A

This module (not pictured) is a combination of the 3326 and 3327 modules. It features 6 identical RST flip-flops, 6 identical AND gates and four relay drivers.

l Computer Expansion System

These digital modules add the flexibility to achieve complete sub-outine control for "Integrator Mode." The unique counter can be sed as a pre-set timer with multiple outputs, a pre-set event counter ith multiple outputs, or a combination of both.

UTSTANDING FEATURES

NO INCREASE IN SIZE
No separate housing required
No separate patchboard required.

COMPUTER CAN STILL BE FULLY LOADED (using Quad Summer)

LIGHT FOR EACH FLIP-FLOP (located at Flip-Flop)

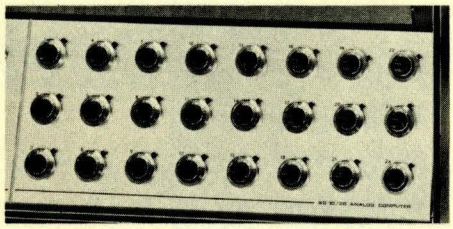
FLEXIBLE TIMING. Each command variable in selected increments to 1000 secs.

PRE-SET EVENT COUNTER. Up to 6 decades

ee inside back cover for more highlights on Digital Logic Control.)

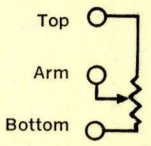
Coefficient Potentiometer Group

SD 40/80 — Model 3370 Pot Panel: Shown at right is the Potentiometer Wing of the SD 80 Computer. This hinged wing, which can be moved to any convenient angle facing the operator, can hold up to six Model 3370 Pot Panels. Each panel is available with a complement of either 10 or 20 coefficient potentiometers. All potentiometers are wire-wound 10-turn units with locking indicator dials and individual fuse protection at the pot arm. An SD 80 Computer can be easily expanded in the field panel-by-panel up to a maximum of 125 potentiometers (potentiometers 1 to 5 are mounted on the Control Wing, 6 to 125 are located on the Potentiometer Wing).

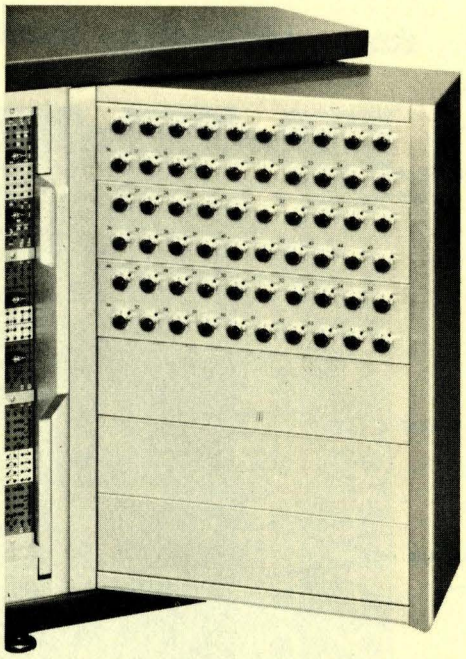


SD 10/20 — Model 3374 Pot Group: The same high-resolution coefficient potentiometers specified for the SD 80 Computer are also included as standard on the SD 10/20. A Model 3374 Pot Group is comprised of 6 coefficient potentiometers. Maximum mounting capacity is four 3374 groups totalling 24 coefficient potentiometers.

Patching the Potentiometers: Three groups of potentiometer terminals are located on each computing module. Each Module 3321, 3322, 3325, and 3329 has one 3-terminal group, as illustrated:



All other groups are 2-terminal with the bottom of the potentiometer internally grounded. The input voltage to the potentiometer is applied to the top terminal and the ouput is available at the arm terminal.



SPECIFICATIONS

Nominal Resistance: 30 kΩ. Resistance Tolerance: ±5%.
End Resistance: <10Ω. Linearity: ±0.25%.
Resolution: 0.01%. Power Rating: 2 watts at 25°C.

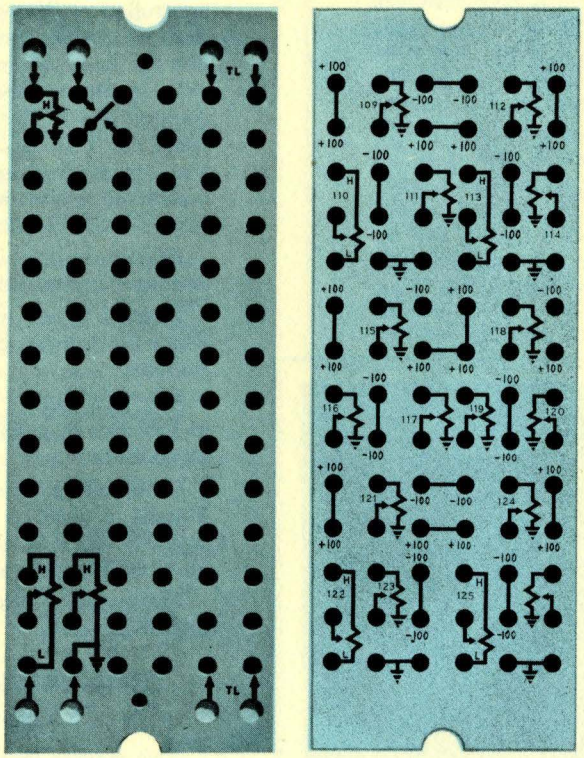
Special Purpose Modules

UTILITY MODULE 3346

This module is a unit for mounting non-standard computing components and networks. It also brings function switches, coefficient pot and trunk lines from the module connector to the patchboard.

The basic 3346 module is made up of a mother board and Vector-board breadboard material. It has a matrix of holes on 0.1-inch grid spacing. Terminals, to accept component leads, can be inserted into the grid holes. The Vector-board is easily removed for changing networks.

The patch panel (shown) comes with coefficient pot and function switch symbols. The surface is suitable for pencil application so the operator can easily hand letter appropriate symbols for the special networks built into this module.



POT-TERMINATOR MODULE 3347

Designed for convenient termination of up to 18 coefficient potentiometers (in 14 2-terminal and 4 3-terminal groups) in one plug-in module, the 3347 module makes it possible to terminate on the patchboard potentiometers not terminated on available computing modules.

For example, a total of 30 computing modules allows for termination of up to 90 coefficient potentiometers. Should the requirement call for more than 90 potentiometers, the Pot-Terminator module would provide terminations for the additional potentiometers.

State-of-the-Art Computer Features

Of the many sophisticated convenience and performance features designed into this new SD computer series, two features are of paramount importance: **built-in digital logic control** and **Static/Dynamic Check**. Until now, both of these features have been included only in large computation center machines at a premium cost. Systron-Donner offers these exclusive big computer features as standard equipment and thus places a most powerful programming tool at the disposal of all anàlog computer users.

DIGITAL LOGIC CONTROL

Digital control, the new way of multiplying the efficiency of an analog computer, can be included in the SD 40/80 as well as the small 10/20 computers. The SD hybrid computer expansion system (described on pages 10 - 11) is comprised of three types of compact plug-in modules.

The advantages gained by digital control in an analog computer are of far-reaching significance. Here are some important new advantages made possible by SD's Digital Logic Control:

1. Track and hold operation by individual integrators.
2. Sub-routines can be flexibly programmed at different speeds depending on decisions made by logical equations.
3. Program statements can be arranged into a flow chart quite similar to those used in digital computation.

The flexibility gained through this interplay of analog/digital equipment results in:

1. Better and greater problem-solving capacity.
2. Ability to solve a wide range of problems that before could not easily be handled by an analog computer.
3. Speed. Problem solving time is greatly reduced.

Through digital logic control, sub-routines start and terminate when the corresponding binary control variables change state as logical functions of:

1. External control (switches, relays controlled by external devices).
2. The states of timers or sub-routine counters.
3. Analog-comparator decisions.

The interplay of binary control variables and analog computation results in a special *hybrid analog-digital* structure. Relays or electronic switches implement analog sub-routine changes under control of digital (binary) control variables and constitute the digital-to-analog interface of the computer. Analog solutions, in turn, can modify digital control.

The combination of the three SD digital logic modules (Flip-Flops, Gates, Time/Event Control) results in a most flexible hybrid analog-digital structure. The operator can easily set all Reset-Compute-Hold intervals of integrators with the Time/Event Control Module.

A typical example that illustrates the use of SD's digital logic is mode control of iterative integrators. In iterative operation (IO), results obtained during or at the end of one solution of the problem are used to change parameters or the circuit configuration (switching) for the next solution. The following figure shows how in IO, integrators are paired into normal and complementary (opposite) logic to implement iterative solutions:

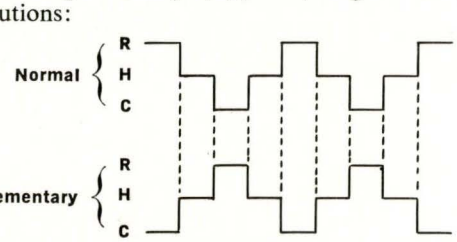


Figure 1. Mode Duty Cycle for Integrators in Iterative Operation

Additionally, in the SD system it is possible to insert a delay of the Hold-mode command to the Complementary Integrators. This delay is important because it enables the C Integrators to store the final values of their inputs in a problem solution where the C Integrators are tracking rapidly changing problem variables.

The Reset-Compute-Hold modes are, of course, settable to any desired intervals, and it is this new degree of freedom imparted to integrators that illustrates the importance of digital logic control. The diagram below depicts a good application of the SD digital logic circuit:

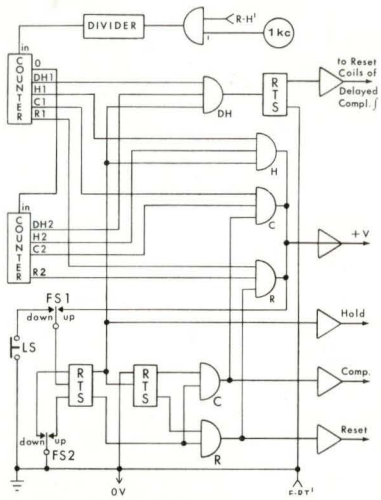


Figure 2. Iterative Operation Logic Control Circuit

STATIC/DYNAMIC CHECK FEATURE

Preparation and running of an analog computer problem involves the following general steps:

1. Analyze physical system
2. Establish set of differential equations describing physical system
3. Solve equations for highest derivative
4. Diagram computer solution
5. Determine scale factors
6. **Patch problem and set coefficient gains.**
7. **Verify the problem patching and gain settings**
8. **Check all amplifiers**
9. Run Problem

Running the problem usually requires only a few minutes. The preceding steps, however, may require hours. A significant part of this time is spent on verifying the patchboard connections and coefficient potentiometer settings.

The **Static Check** feature permits the operator to insert automatically arbitrary voltages instead of initial condition voltages. With this simple pushbutton check, the operator can immediately verify whether all integrator inputs have been patched correctly. It also eliminates resetting the initial condition potentiometers.

The **Dynamic Check** pushbutton feature permits an automatic verification of all patched capacitor values. It thus lets the operator make an instantaneous check on the proper selection of integrating capacitors without disturbing the completed problem connections.

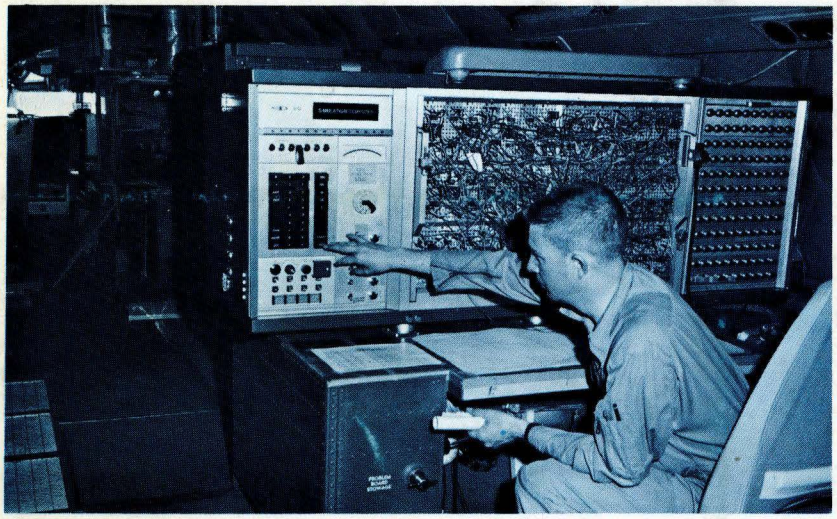
In the SD 40/80 computer series, these automatic verification features help save the operator hours in his program preparation task. Instead of needing to concentrate most of his time on program verification, the operator now has more time to communicate with his problem on the computer.

Built-in Quality and Reliability

MASS PRODUCTION

High quality and reliability standards are built into each SD computer. These are important benefits derived from a mass-production system and a Quality Assurance Program which provides the same stringent quality and reliability controls on SD's flight instrumentation as well as computer line. Shown here is a portion of the SD 40/80 computer assembly line where each computer moves progressively from initial to final assembly and checkout.

Photo courtesy The Boeing Company



HIGH PERFORMANCE

The Boeing Company selected the SD 80 (shown here in operation inside a 707 jet) for the supersonic transport development program. Field proven performance, rugged and compact design were key SD 80 computer features for this critical requirement.

TECHNICAL SALES ASSISTANCE

Systron-Donner's Total Computer Program is geared to assist you in every way possible. Computer Seminars, given by leading computer experts, are held at regular intervals. Factory field support and applications engineering assistance is offered from the factory as well as computer engineering representatives.

Address of nearest S-D Engineering Representative

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