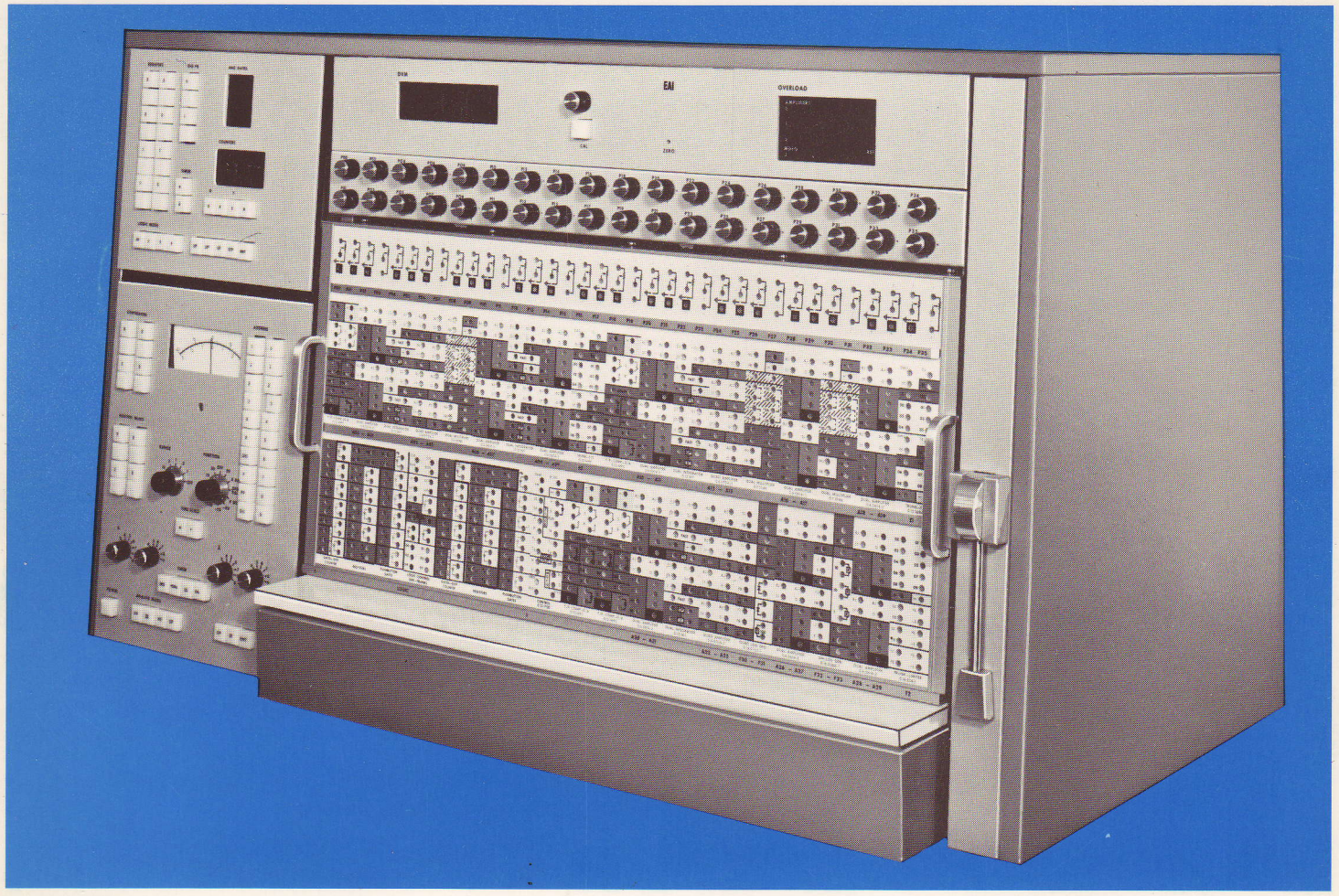
EAI®

ELECTRONIC ASSOCIATES INC.

380 ANALOG/HYBRID COMPUTING SYSTEM



Simulation . . .
A Computer Aided Creative Design Process That Gives You An Unbeatable Competitive Edge

Simulation, a computer aided creative design process, is especially effective as a problem solving tool. It provides the investigator with a powerful method of examination, experimentation and control of real time physical systems.

Applied in virtually any area of research, education and scientific investigation, simulation is the most economical and efficient means to solve a broad spectrum of analytic problems.

Whether you are designing servo-systems or tumbling space platforms . . . Whether you want to optimize existing designs or experiment with new ideas, you'll find a Desk-Top Analog/Hybrid Computer the ideal partner in your simulation process.

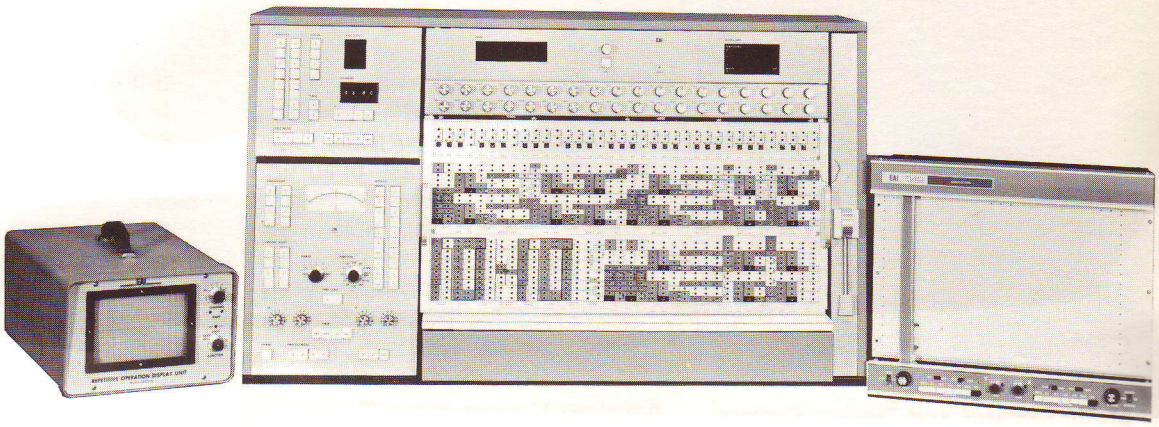
With analog/hybrid computer simulation, the investigator is "part of the loop" and responds to "creative feedback". He literally "talks" to his computer, questions his simulation model, demands the highest performance in experimenting with his model, and applies the lessons of experience at critical moments in the simulation. He requires that all his own mistakes be found and forgiven, while demanding error-free behavior on the part of his computer.

Hours, days, weeks or years of simulated dynamic processes can be examined on a desk-top computer in a matter of minutes. Results help to gain insights; establish feasibility; test, demonstrate and verify new ideas; compare alternatives; design systems; and teach students. All without risk or high cost equipment investments.

Where laboratory experiments produce voluminous analog data, the analog/hybrid computer serves as an ideal data reduction and statistical analysis system. Time consuming, costly conversion is eliminated, and the investigator can program special routines easily and quickly.

The new EAI 380, 10-volt, desk-top computer introduces low-cost hybrid computation techniques to the investigator. Simulation of physical systems, too complex to be handled by conventional analog modeling, takes on new dimensions through decision making and control logic. The 380 brings the elegance of large-scale computation to the desk-top class.

In short, analog/hybrid simulation yields optimum designs. Better system performance. Lower unit costs. (And better engineers and students.) Why not increase your organization's profit potential or teaching effectiveness through the use of analog and hybrid simulation techniques? Start with the EAI 380.



EAI 380
Analog/Hybrid Scientific Computer System

The EAI 380 Analog/Hybrid Computer is a 10-volt, desk-top, low-cost computer having sophisticated features previously available only in much higher-priced systems.

It is the smallest and most economical machine with hybrid capabilities in the EAI family of analog/hybrid systems. The 380 fills a need in education, research and industry for a low-cost computer able to demonstrate and perform modern hybrid techniques.

In its basic analog configuration of 10 computing amplifiers, the 380 is ideally suited to undergraduate instruction. It is easily and economically expandable to 54 amplifiers within the same main frame through the use of pre-wiring and convenient plug-in modules.

Control logic may be added directly to the computer, thus facilitating instruction. A data interface will be available for directly linking the EAI 380 to a digital computer for total hybrid operation.

In addition to its easy and economical expandability, additional versatility and flexibility have been designed into the new 380. Many of the field proven components of the larger 10V family of computers are utilized in the 380. Not only does this mean that a high confidence level of reliability has been built into the new computer (over 2000 sophisticated EAI desk-top computers field-tested and in operation since 1959), but also that the 380 is compatible with other 10-V computers for slaving in multi-console operation and future growth. Furthermore, as many of these components are interchangeable, additional economies are thus possible in multi-console installations.

Here are some of the sophisticated features now available for the first time in a compact, low-cost computer:

- Mode slaving system for multi-console simulations and compatibility with all existing EAI desk-top computers.
- Electronic and logic mode control, with provision for multi-mode problem solutions.
- No velocity limiting within the bandwidth of the amplifiers permitting rep-op solutions up to 5,000 times real time.
- All non-linear function generators that are available in the larger computer line (bipolar, quarter square multipliers, sine/cosine, logarithmic functions).
- Variable diode function generators with self contained inverters and sloping amplifiers, and quick setup system.
- High speed electronic comparators, switches, and function relays.
- Self contained digital voltmeter.
- Integrated-circuit plug-in logic system expansion with digital clock.
- Sophisticated interval timer with solution rates from 1 millisecond to 9.9 seconds; simultaneous generation of logic time signal and analog ramp signal.

The EAI 380 Is The First Step To The Unbeatable Competitive Edge That Analog/Hybrid Computation Gives

The EAI 380 Analog/Hybrid computer is an important first step in gaining the advantages of modern hybrid techniques.

It is a logical first computer . . . and just as logical as a replacement when upgrading a laboratory or computation facility.

Because of its unique expandability, the 380 is ideally suited to the instruction needed today to gain proficiency in the rapidly-increasing application of hybrid computational techniques.

As the student's ability to comprehend and handle more complex problems increases, the 380 can be readily expanded to accommodate growing needs with the addition of control logic.

A data interface will be available so that the new system can be linked with a digital computer for full hybrid power.

Perhaps the most important fact about the EAI 380 is the broad range of experience that went into its design. During the last decade, EAI has installed over 2000 sophisticated desk-top computers, as well as hundreds of large-scale systems in important computational facilities around the world. The team that first made hybrid computing a practical reality, designed the largest nuclear system simulator, the most sophisticated space vehicle simulation computers, and a host of other advanced computer technology systems, designed and built the EAI 380. All of this experience is available to EAI 380 users.

EAI support is continuing . . . start with the installation. When you buy a 380 or any one of our desk-top analog/hybrid computers—an EAI service engineer will be calling on you to see that everything about your system is o.k. You get this installation call free. Part of the reason we do it is that there are EAI service centers all over the United States. But this isn't the most valuable of our services. With each 380 you get two man weeks of free instruction. The EAI Education and Training group offers a great number of courses at many locations, and you can choose the ones pinpointed to your problems.

Our interest doesn't end there. Only EAI gives you a continually updated Applications Reference Library, a series of studies that show analog and hybrid programming routines illustrating both general techniques and specific problem solutions. For example, we've recently introduced a new Educator's Demonstration Series to help busy professors in course preparation. And we keep you continuously informed with regular distributions of technical information and literature.

For additional technical back-up, we've established convenient EAI Computation Centers. EAI customers can call on the most sophisticated skills to solve simulation, design, optimization, data processing and other scientific/engineering problems. Nobody has the experience we have in analog and hybrid computation. And no other manufacturer of analog offers the extent of continuing post-delivery support.

We are adding the new 380 system to our Demonstration Van Program. Demonstration is the best way to appreciate the speed, economy and useful results that an analog/hybrid computer can provide. Just name the time and place—and type of application of interest. We'll set up a related demonstration at your plant, office or lab. That way you can get direct, hands-on experience with an appropriate simulation or data reduction problem. If you would like to discuss your problem first and find out more about the new 380 simply use the enclosed reply card.

First Class
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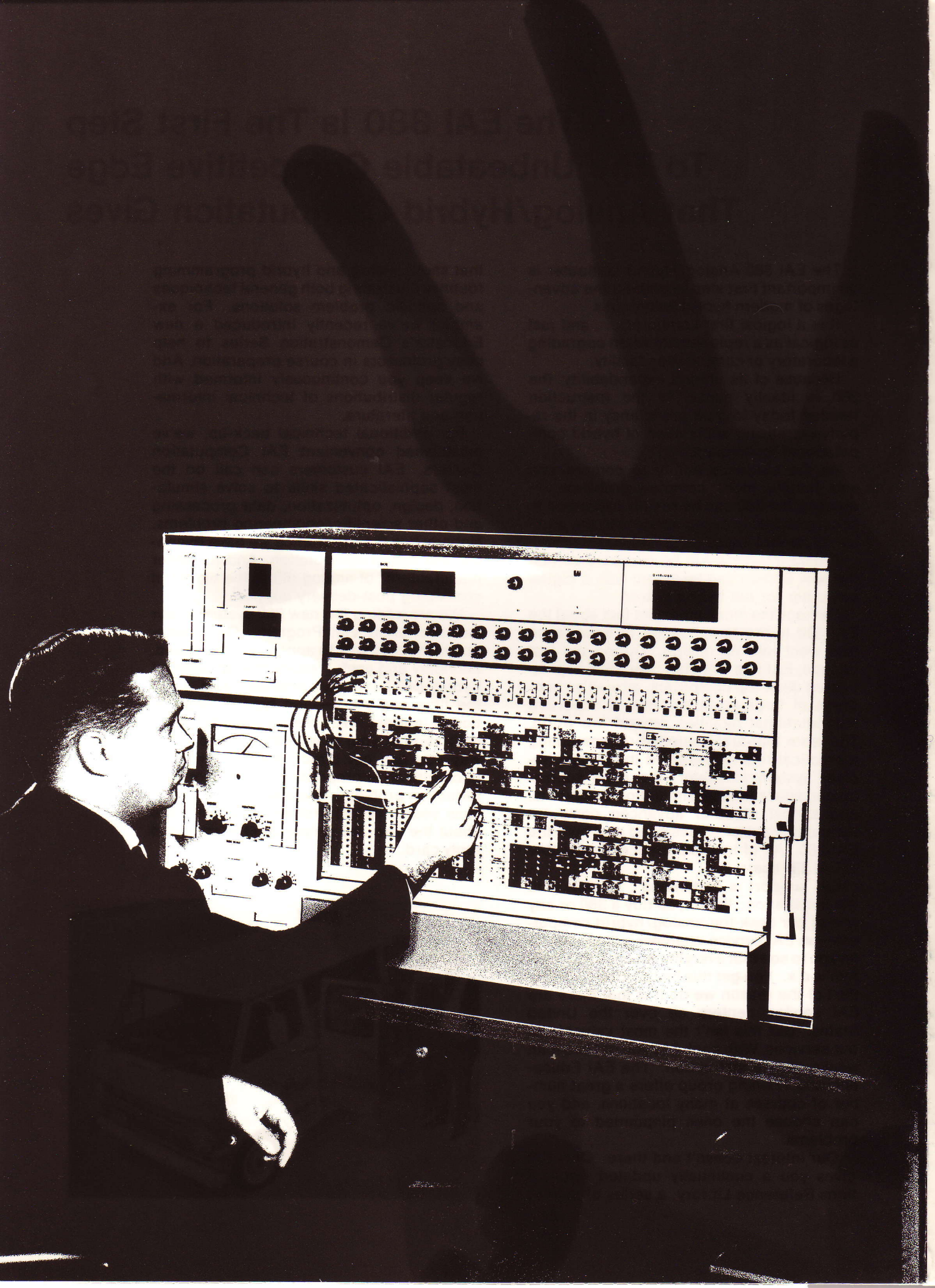

(PLEASE FILL IN CARD COMPLETELY)

☐ Please have sales engineer call to discuss my application.

EAI 380 Analog/Hybrid Computing System Equipment

Equipment Specifications

SUMMARY

a fully-expanded EAI 380 system is described as representative of the many configurations that are available to satisfy individual requirements.

COMPUTER CONSOLE

Mode Control and Timing System
Analog mode control selector —(with static test bus), time scale selector, repetitive operation interval timer, interval timer controls (with frequency multipliers), slave selector.

Addressing and Readout System
Parallel input keyboard, derivative check selector (with 0.1 attenuator), address selection matrix, analog voltmeter (with range selector), solid state digital voltmeter, comparator and function relay indicator/pushbutton control panel.

Overload Indicator System
Overload indicator panel, overload indicator bus (with automatic Hold and Storage feature), audible overload alarm (with volume control).

Analog Program System
Program bay (with latching mechanism), pre-program panel, programming cord and bottle plug kits.

Variable DFG Set-Up System
Amplifier balance selector, set-up amplifier (part of analog panel).

Power Distribution System
Bus-bar distribution matrix, power supply monitor selector, ± 10 volt reference supply Analog system power supplies.

Logic System Expansion
Program bay (part of analog panel), general purpose logic communication lines, programming cord kit, one megahertz system clock logic mode control selector, slave selector, logic gate state indicators, register indicator/pushbutton controls, digital function switch, indicator/pushbutton controls, preset counter controls, logic power supplies.

Control Interface System Expansion
Console selector, analog and logic mode control register, analog address register, analog value register, time scale selector.

Analog Computing Components **

Summer-Integrators	10
Summers	18
High Gain Inverters	12
Other Inverters	16
Other Amplifiers (assigned to variable function generators)	4
Other Amplifiers (assigned to comparators)	4
Track/Store networks	4
Handset Coefficient Attenuators	36
Multipliers (quarter-square)	4
Ten Segment Variable Function Generators	4
Sine/Cosine Function Generators	2
Logarithmic Function Generators	4
Feedback Limiters	3
Free Resistors and Diodes	6

Logic Conversion Components

Digital-to-Analog Electronic Switches*	8
Analog (voltage) Comparators	4
Function Relays (DPDT)	4

Parallel Logic Elements

General Purpose Logic Gates	16
General Purpose Registers (each with four flip-flops)	2
Preset Counter/Timers	2
Logic Differentiators	3
Digital Function Pushbuttons	2

Trunk Line Terminations

Analog Panel Trunks	30
Logic Panel Trunks	6

Peripheral Equipment

X-Y Plotter	1
Rep-Op Display Scope	1
2 Channel Strip-Chart Recorder	1

In addition, each integrator may also be coverted to a switched amplifier (electronic switch) by removing one bottle plug.

***This is a representative system, greater flexibility exists among the number of integrators, multipliers and DFG's.*

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ADVANCED SYSTEMS ANALYSIS AND COMPUTATION SERVICES/ANALOG COMPUTERS/DIGITAL COMPUTERS/HYBRID ANALOG-DIGITAL COMPUTATION EQUIPMENT/ANALOG AND DIGITAL PLOTTERS/SIMULATION SYSTEMS/SCIENTIFIC AND LABORATORY INSTRUMENTS/INDUSTRIAL PROCESS CONTROL SYSTEMS/PHOTOGRAMMETRIC EQUIPMENT/RANGE INSTRUMENTATION SYSTEMS/TEST AND CHECK-OUT SYSTEMS/MILITARY AND INDUSTRIAL RESEARCH AND DEVELOPMENT SERVICES/FIELD ENGINEERING AND EQUIPMENT MAINTENANCE SERVICES.

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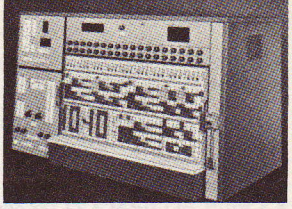

EAI® 380

ANALOG/HYBRID COMPUTING SYSTEM

SPECIFICATIONS*

APRIL 15, 1969

I. SYSTEM SPECIFICATIONS

1.0 COMPUTER POWER REQUIREMENTS (45.149)

Voltage	110/120 VAC—220/240 VAC
Frequency	50/60 HZ
Power	150W Maximum (Fully Expanded)

2.0 MECHANICAL

Size	24.5 Inches High, 43 Inches Wide, 21.4 Inches Deep
Weight	310 Pounds (Fully Expanded)

3.0 REFERENCE SYSTEM (43.104-1)

Output Voltage	+10VDC and −10VDC
Output Current	250 MA Each Output
Balance	Better than 0.01%

4.0 REPETITIVE OPERATION TIMER (2.1395)

Number of Time Periods	2
Range Each Period	1 MS to 9.9 Sec

5.0 DIGITAL VOLTMETER (26.279)

Number of Digits	4
Range	±15.00 Volts
Accuracy (Relative to Computer Reference)	±0.1%
Resolution	±0.1%
Input Impedance	10 Megohms
Readings per Second	5
Conversion Time	100 milliseconds, constant

II. ANALOG AND INTERFACE COMPONENTS

2.0 OPERATIONAL AMPLIFIER SPECIFICATIONS

2.1 GENERAL

Circuitry	All Solid State
Chopper	Electro-Mechanical
drive	60 HZ
Output Voltage	±10 V Minimum
Output Current	20 MA Minimum
Total DC Open Loop Voltage Gain	
at DC	1.8×10^7 Typical
at 100 HZ	30,000 Typical
at 1 KHZ	4,000 Typical
Velocity Limit	25×10^6 Volts/Sec Minimum

(There is no velocity limit within the bandwidth of the amplifier)

Amplifier Stable with Capacitor Loadings up to:

on Summing Junction	.001 μfd Minimum
on Output	.03 μfd Minimum

2.2 SUMMER (6.614-2)

Number of X 1 Inputs	2
Number of X 10 Inputs	2
Resistor Accuracy Ratio Input and Feedback Resistors	±.01% Maximum
Resistor Ratio Stability (3 Years)	±.005% Maximum

2.2.1 Standard Input and Feedback

Resistor	100 K Ohms
Bandwidth (3 db Down 20 Volts PP Input)	125 KHZ Minimum
Phase Shift	at 100 HZ .04° Maximum
	at 1 KHZ 0.4° Maximum
Amplitude Error	at 100 HZ .02% Maximum
	at 1 KHZ 0.1% Maximum
Total Instantaneous Dynamic Error	at 100 HZ .075% Maximum
	at 1 KHZ .75% Maximum
Offset Voltage (Referred to Summing Junction)	20 μVolts Maximum
DC Offset Temperature Drift	2 μVolts/°F Maximum
Noise (Full Bandwidth)	1.5 MV PP Maximum

2.2.2 Standard Input and Feedback

Resistor	10 K Ohms
Bandwidth (3 db Down 20 Volts PP Input)	400 KHZ Minimum
Phase Shift	at 100 HZ 0.01° Maximum
	at 1 KHZ 0.1° Maximum
Amplitude Error	at 100 HZ .02% Maximum
	at 1 KHZ 0.1% Maximum
Total Instantaneous Dynamic Error	at 100 HZ .023% Maximum
	at 1 KHZ .23% Maximum
Offset Voltage (Referred to Summing Junction)	20 μVolts Maximum
DC Offset Temperature Drift	1 μVolt/°F Maximum
Noise (Full Bandwidth)	1.5 MV PP Maximum

2.3 QUAD INVERTER (6.704-3)

Standard Input and Feedback Resistor	10 K Ohms
Resistor Accuracy Ratio Input and Feedback Resistor	±.01% Maximum
Resistor Ratio Stability (3 Years)	±.01% Maximum
Bandwidth (3 db Down 20 Volts PP Input)	300 KHZ Minimum
Phase Shift	at 100 HZ .015° Maximum
	at 1 KHZ .15° Maximum
Amplitude Error	at 100 HZ .02% Maximum
	at 1 KHZ .1% Maximum
Total Instantaneous Dynamic Error	at 100 HZ .031% Maximum
	at 1 KHZ .31% Maximum
Offset Voltage (Referred to Summing Junction)	20 μVolts Maximum
DC Offset Temperature Drift	1 μVolt/°F Maximum
Noise (Full Bandwidth)	1.5 MV PP Maximum

3.0 INTEGRATOR SPECIFICATIONS (12.1611 DUAL) and (12.1728 SINGLE)

Number of X 1 Inputs Per Integrator	3
Number of X 10 Inputs Per Integrator	2
Number of IC Inputs Per Integrator	1
Logic Control Input Levels	+5V and OV
Capacitor Sizes	10, 1, 0.02, 0.002 μfd
Capacitor Accuracy	1 μfd and 10 μfd manufactured to ± .05% —all others adjustable
Resistor Accuracy Ratio Feedback to Input Resistor	± .01% Maximum
Switch Time (IC to OP, or OP to IC)	1 μSec Maximum
Switch Time (OP to H, or H to OP)	2 MS Maximum
Drift...in Hold	25 μVolts/Sec Maximum
Reset Time (10 V to 0.1%) 10.0 μfd	3 MS Maximum
0.02 μfd	50 μSec Maximum

4.0 MULTIPLIER SPECIFICATIONS

4.1 HIGH ACCURACY (7.146 and 7.150-1)

Circuitry	All Solid State
Modes of Operation	
7.146	1 Channel, Multiply, Divide, Dual Square, Dual Square Root, and 1 Channel, Multiply, Divide
7.150	2 Channels, Multiply, Divide
Feedback Resistor, Used with Output Amp	10 K Ohms
Adjustment Cycle (Nominal)	6 Months
Static Error—(X + Y) ≤20 Volts	±0.025% of Full Scale (±5 MV) Maximum
	±0.015% of Full Scale...(±3 MV) Typical
Both Inputs Zero	±0.0025% of Full Scale (±0.5 MV) Maximum
Bandwidth (3 db Down: y = 10VDC; X = 20 VPP)	200 KHZ Minimum
Phase Shift at 100 HZ	0.02° Maximum
1 KHZ	0.2° Maximum
Total Instantaneous Dynamic Error at 1 KHZ	±0.25% of Full Scale (±50 MV) Maximum
Input Impedance	1.6 K Ohms

4.2 STANDARD (7.148)

Circuitry	All Solid State
Modes of Operation	1 Channel, Multiply, Divide, Dual Square, Dual Square Root and 1 Channel Multiply, Divide
Feedback Resistor, Used with Output Amp	10 K Ohms
Adjustment Cycle (Nominal)	6 Months
Static Error—(X + Y) ≤20 Volts	±0.4% of Full Scale (±80 MV) Maximum
	±0.2% of Full Scale (±40 MV) Typical

Both Inputs Zero	±0.0025% of Full Scale (±0.5 MV) Maximum
Bandwidth (3db Down: Y = 10 VDC; X = 20 VPP)	200 KHZ Minimum
Phase Shift at 100 HZ	.026° Maximum
at 1 KHZ	.26° Maximum
Total Instantaneous Dynamic Error at 1 KHZ	±0.25% of Full Scale (±50 MV) Maximum
Input Impedance	1.6 K Ohms

4.3 HIGH ACCURACY (7.153 and 7.156)

Identical to the 7.146 and 7.150-1 multipliers with the addition of X and Y inverter amplifiers.

5.0 TRACK STORE SPECIFICATIONS (12.1694)

Number of Modes	3 (Track, Store, IC)
Logic Control	+5 V and OV
Switching Time	1 μSec Maximum
Drift in Store—Long Term	250 μVolts/Sec Maximum
Reset Time (10 V to 0.1%)	50 μSec Maximum

6.0 COMPARATOR SPECIFICATIONS (12.1695)

Circuitry	All Solid State (containing its own amplifier)
Number of Inputs	2
Input Voltage Range (Nominal)	±12 V
Input Impedance	10 K Ohms
Output Voltage	OV or +5 V (Logic Level) and Complement
Control	Manual Pushbuttons, Plus Latching Input
Sensitivity (Including Hysteresis)	±5 MV Maximum
Switching Time	1 μSec Maximum
Indication	Individual Indicator for Each Comparator

7.0 DIGITALLY CONTROLLED ANALOG SWITCH (12.1695)

Circuitry	All Solid State
Switch Control "ON" State	+5V (Logic Level)
"OFF" State	OV (Logic Level)
Input Voltage Range	±10 V
Analog Input Impedance	10 K Ohms
Static Error	±.015% Maximum
Propagation Time	1 μSec Maximum

8.0 SINE-COSINE GENERATOR (16.360-1)

Circuitry	All Solid State
Input Scale Factor	20° / Volt
Input Range	±9 V Maximum
Output for Plus Input	−10 Sine θ, or ±10 Cos θ
Adjustment Cycle (Nominal)	6 Months
Static Error for:	
−5 ≤V EO ≤+5V	±6 MV Maximum
−10 V ≤EO≤− 5V	±8 MV Maximum
+5 V ≤EO≤+10V	±8 MV Maximum
OV Input	±2 MV Maximum
Bandwidth	40 KHZ Minimum
Phase shift at 1 KHZ	1° Maximum
	0.5° Typical
Amplitude Error at 1 KHZ	1.5% Maximum

9.0 QUAD LOG X FUNCTION GENERATOR (16.355-1)

(Two plus units, two minus units)

Circuitry	All Solid State
Scale Factor	$E_o = -5 \log_{10} (10\ X)$
Input Range Plus Unit	0.1 V to +10 V
Minus Unit	0.1 V to −10 V
Static Error Log X (Actual input deviation from theoretical input for a given output)	1.0% fs Maximum
Anti-Log X	1.0% fs Maximum
Input Impedance at 10 V	22 K Ohms
at .1 V	4 K Ohms

10.0 VARIABLE DIODE FUNCTION GENERATOR (2.960)

Circuitry	All Solid State
Input Voltage Range	±10 V
Output Voltage Range	±10 V
Number of Segments	10, or Paired for 20
Parallax	±10 V
Slope Selection Switch	
Minimum Position	1V/V
Maximum Position	32V/V
Adjustment Breakpoint and Slope	Ten-turn Potentiometers
Frequency Response Characteristics	
(Employing SCI Measurement Techniques for a 10-segment Function)	
Bandwidth (3db Down 20 Volts PP Input)	100 KHZ Minimum
Total Instantaneous Dynamic Error	
at 100 HZ	.05% of Full Scale Maximum
at 1 KHZ	.5% of Full Scale Maximum
Phase Shift	
at 100 HZ	.03° Maximum
at 1 KHZ	0.3° Maximum
Noise, SCI 10-segment, 790 KHZ SCI Filter	6 MV PP Maximum
Temperature Drift (SCI)	1 MV/°F Maximum
Inverter Mode, Bandwidth (3db Down 20 Volts PP)	350 KHZ Minimum

11.0 POTENTIOMETERS

	2.1376-1	2.1376-0
Type	Wirewound	Composition
Rotation	10 Turn	10 Turn
Resistance	5K Ohms ± 5%	5K Ohms ± 30%
Resolution	0.02% or Better	

12.0 VARIABLE LIMITER (16.363)

Used in conjunction with a 100 K/100 K Amplifier

Maximum Limit	10 Volts
Minimum Limit	1 Volt
Slope after Limit	<8 Millivolt/Volt

13.0 FUNCTION SWITCHES (12.1695)

Number of Switches	4
Relay	DPDT Reed Type
Control	Manual Pushbuttons plus Set & Reset Input
Indication	Individual Indicator for each Relay

III. DIGITAL COMPONENTS

1.0 GENERAL SPECIFICATIONS

Logic Level	0 and +4V, Nominal
Fan Out	7 Logic Inputs, Plus 150 Feet of Trunk Cable
Circuitry	All Solid State

2.0 CENTRAL DIGITAL CLOCK (36.195)

Internal Frequency (Crystal Controlled)	1 MHZ
Patch Panel Outputs	100 KHZ
	10 KHZ
	1 KHZ
	100 HZ
	10 HZ
Pulse Width of Clock Signals	1μS (Nominal)

3.0 LOGIC GATE CARD (51.385)

Modes	AND NAND, OR, NOR
Number of Gates	7 Each 2 Inputs
	1 Each 4 Inputs
Outputs	"True" and Complement

4.0 GENERAL-PURPOSE REGISTER (51.389)

Modes of Operation
- 4 Independent Flip-Flops
- 4-Bit Shift Register
- 4-Bit Parallel Load Buffer Register
- 4-Bit Binary Up Counter (Carry Out at 16 Count)
- 4-Bit Binary Down Counter (Carry Out at 16 Count)

Inputs and Their Normal State

Enable Bit EO, 1, 2, 3	HIGH
Enable Carry In	HIGH
Carry In	LOW
Set	LOW
Reset	LOW
Serial In	LOW
Shift	LOW
Clear	LOW
Down	LOW

5.0 COUNTER/TIMER CARD (38.047)

Each Counter/Timer Card provides four decades (two each Two Decade Counters), with pre-set decimal coded thumbwheel switches.

Patch Panel Inputs and their Normal State

Set	LOW
Clear	LOW
Carry In	LOW
Patch Panel Outputs	Count Out (Co) and $\overline{(Co)}$
Count Out Pulse Occurs When the Count Reaches	00
	Carry In (Ci) Is High
Timer Range	1 μSec to 9.9 Sec

6.0 DIFFERENTIATOR CARD (22.800-1)

Outputs	"TRUE" (1) and Complement for Each Differentiator
Complement per Card	3

IV. REPETITIVE OPERATION DISPLAY (34.035)

Display Area	4½" x 6¼"
Input Range	±10 Volts
Accuracy (Includes linearity ripple and pin cushion)	±3% of Full Scale
Writing Speed	Up to 20,000 Inches per second
Inputs	4
Modes	Y versus time and Crossplot (Y versus X)

*Specifications are given for components operating in the computer with measurements being made at the console program panel. Subject to change without notice.

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