Simple test cases for analog computer

① Two coupled linear algebraic equations

$$3x_1 + 4x_2 = -3$$
$$2x_1 + 5x_2 = +12$$

(solution is $x_1 = -9,\ x_2 = +6$)

Analog computer implementation:

$$x_1 = -\left(1 + \frac{4}{3}x_2\right) = -(1 + 1.33x_2)$$

$$x_2 = -\left(-\frac{12}{5} + \frac{2}{5}x_1\right) = -(-2.40 + 0.400x_1)$$

② Damped oscillator

ODE: $\ddot{x} + 2\zeta\omega_n\dot{x} + \omega_n^2 x = 0$

ICs: $\dot{x}(0) \equiv v_0,\quad x(0) = x_0$

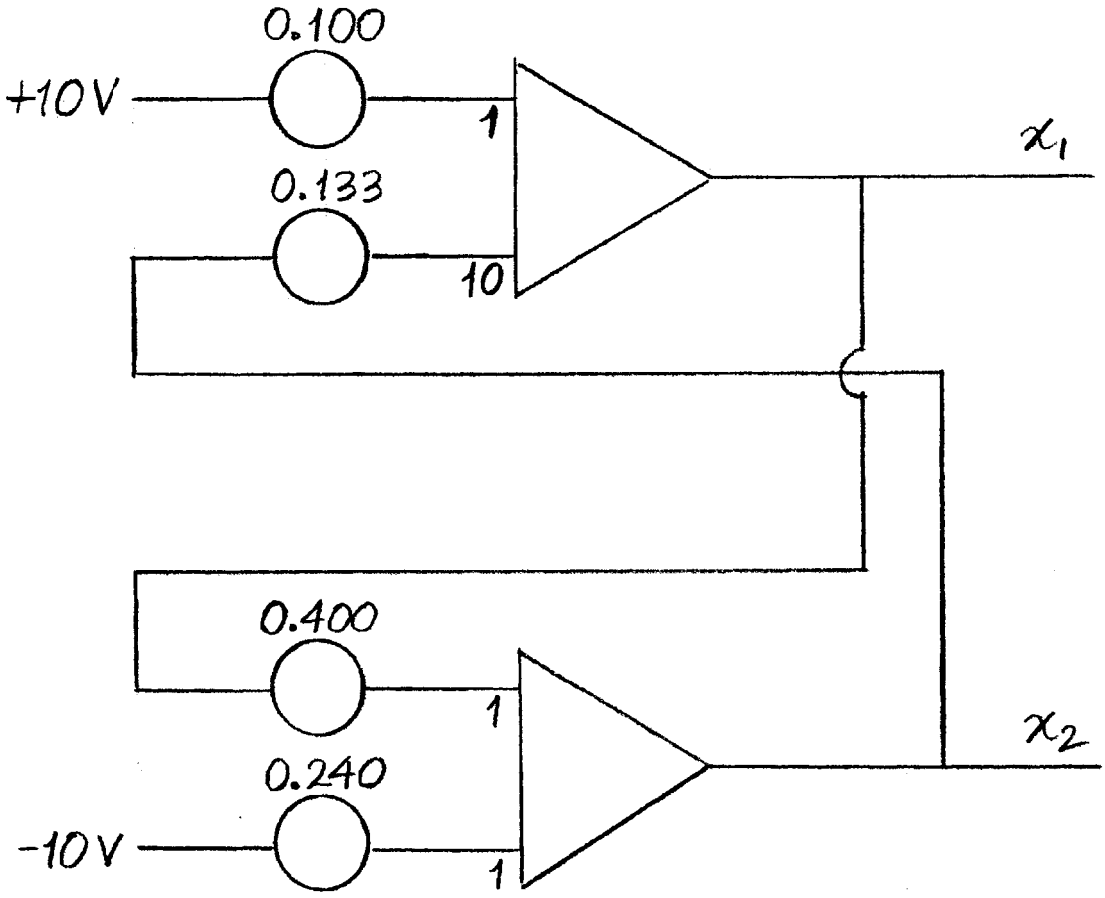
Analog computer implementation:

$$\frac{\ddot{x}}{\omega_n} = -\left(2\zeta\dot{x} + \omega_n x\right)$$

$$\dot{x}(t) = v_0 + \int_{\tau=0}^{\tau=t} \ddot{x}(\tau)\, d\tau$$

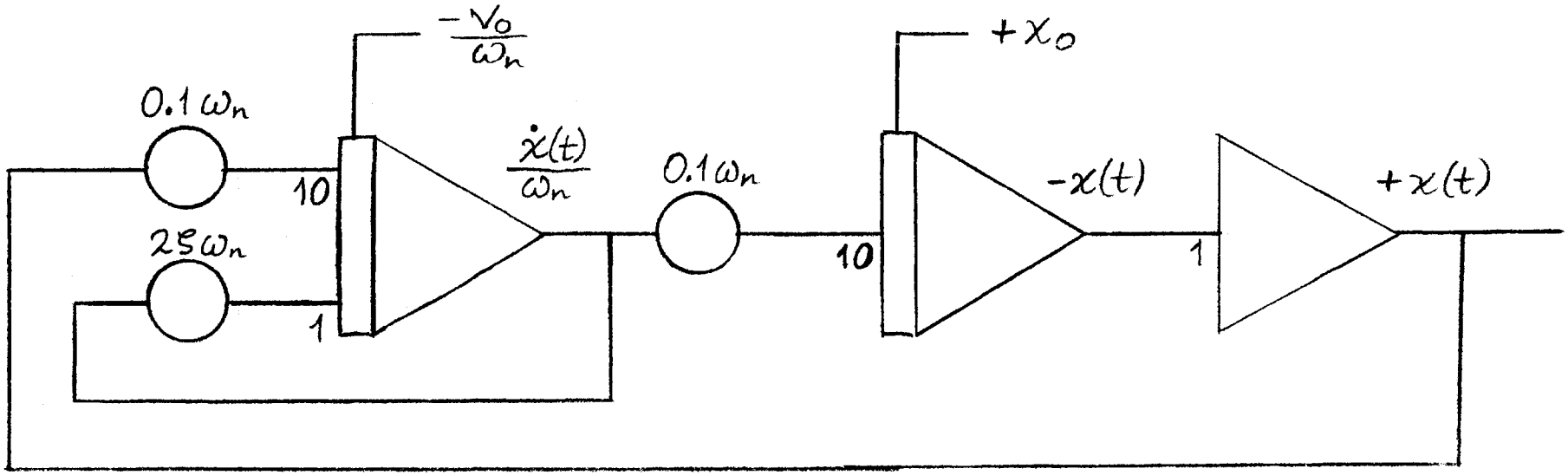
$$x(t) = x_0 + \int_{\tau=0}^{\tau=t} \dot{x}(\tau)\, d\tau$$

GP-10 circuit to solve coupled linear algebraic equations



GP-10 circuit for damped oscillator

Set coefficients and ICs in the IC mode, then switch to OP mode to produce time-dependent response.



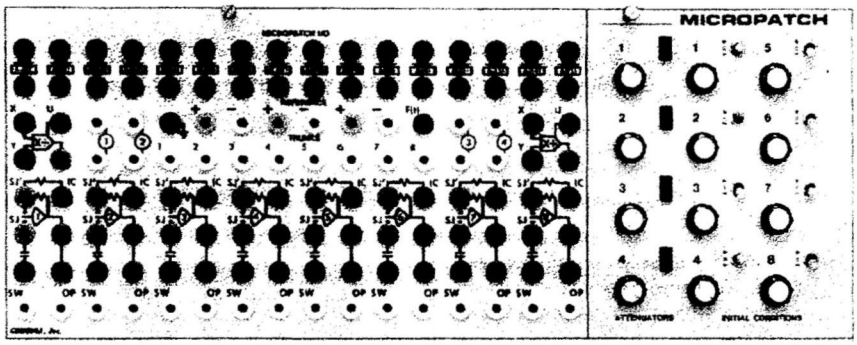
To make all three coefficient attenuation settings = 1, we can choose $\omega_n = 10$ rad/sec and $\zeta = 0.05$ ($\Rightarrow f_n = 1.59$ Hz $\approx f_d$).
In this case, we need not use the coefficient attenuators at all.
However, we still must use at least one IC attenuator for initial conditions.

COMDYNA, Inc.

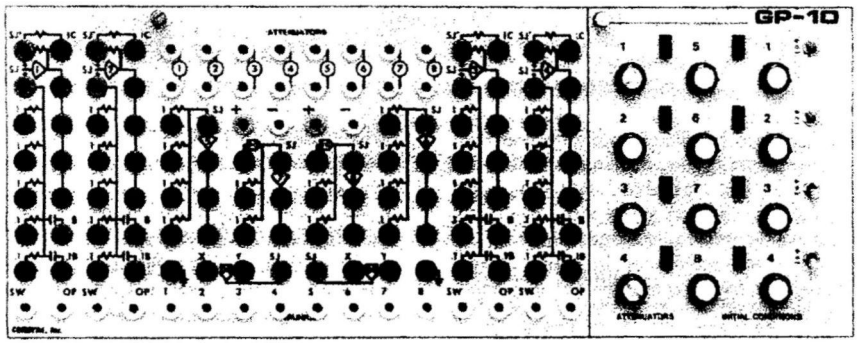
NEWS ITEMS

A NEW MODULAR, STACKABLE ANALOG/HYBRID COMPUTER

Micropatch, centerpiece, of the new 7000 Building Block analog/Hybrid computing system, replaces mechanical panels and patch cords with a digital computer controlled electronic switch network. Once programmed, Micropatch operates identically to traditional patch panel computers. Through a host digital computer, simulations are programmed directly from differential equation statements. From digital computer memory, stored simulation programs are instantly recalled for immediate use.



7000 ANALOG/HYBRID COMPUTING SYSTEMS



The availability of low cost analog multiplexers and digital interface devices has made electronic patching a practical reality. Taking advantage of recent integrated circuit developments, Micropatch is compatible and easily used with even the smallest microcomputers. For the first time, analog computers are programmed with common high level languages such as BASIC. PASCAL or FORTRAN. Treated as a digital computer peripheral, a Micropatch system can produce complex, nonlinear, high order simulations with only a few hundred bytes of a digital computer's usable memory.

Micropatch offers individuals not trained in the art of analog computer programming the opportunity to work with analog simulation models. From equations that are written in a state-variable form, a model is entered into the host digital computer via its keyboard/CRT. There the digital computer arranges equation statements into Micropatch switching commands, calculates coefficients and scales variables. Instantly the Micropatch is programmed and constants are entered. A simulation is ready to run only milliseconds after equation entry.

Convenient, unlimited program storage expands analog simulation into new dimensions of use. Once a model is digitally formatted it may be indefinitely stored. A virtual limitless number of analog models may be digitally stored and thus be available for instant use. An applications library can assume a live and accessible status as users may call simulations from a memory list. Interchange between libraries is encouraged as transfer can occur through written high level language statements or electronically through an exchange of discs or other mass storage devices.

A quick, useable access to a program library should enhance analog simulation's educational value. A keyboard entry is all that's needed to convert Micropatch into a physical system simulator. Through digital retrieval, one Micropatch system can become a chemical reactor, an automotive suspension, a non-linear vibrating membrane, a diseased heart, a servo controller or any physical phenomena that can be described with a set of ordinary differential equations. The simulation is perpetually on-call, ready for devotion to educational experiments. As patching and tedious program checkout are handled by the digital computer, a student spends virtually no time preparing the simulation for study

Quick recall of programs makes it feasible for a simulation, at any time, to be periodically analyzed. As frequently as desired, a researcher may retrieve and study a simulation. In the development of mathematical models frequent evaluations lay the foundations for minds to transform intuitive understandings into analytical derivations. Modifications, parameter changes and interactions with a model are the ingredients for successful math model developments. Micropatch's accessibility for repeated studies is expected to hasten the creation and validation of system models.

Once a model is declared valid, quick recall expands application possibilities. Analog simulations have proven records in product design, the selection of equipment or components, the development of operating procedures, the evaluation of safety considerations, the treatment of diseases and the optimization of processes. Convenient program storage will expand these proven application areas and open the door for analog simulation's entry into new and related fields of use.

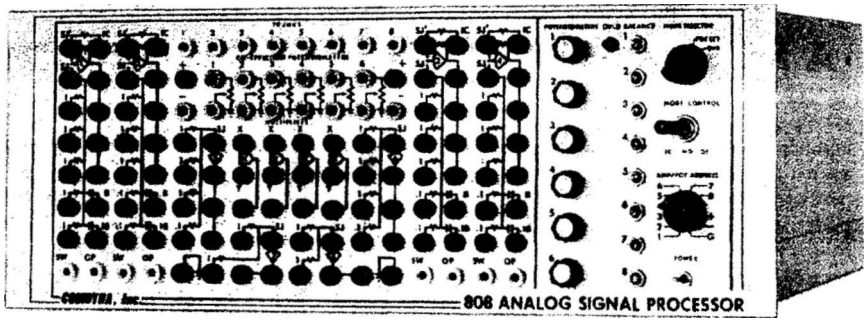
A major Micropatch design feature is that electronic patching is provided without sacrificing the versatility of traditional analog computers. All the non-linearities, discontinuities and empirical functions that analog computer programmers so artfully incorporate into simulations are equally within Micropatch's capabilities. Advanced operational techniques can be implemented if the programmer chooses.

The full range of analog computing functions is met with a combination of patch panel and electronic patching. Certain electronic switch terminations are brought to a patch panel where analog functions may be applied. Once a function is patch-

. . . continued on back page

GROWTH IN COMBINED UNIT SIMULATION SYSTEMS

An increasing number of organizations are finding that combined 808 Analog Signal Processors provide an excellent means of meeting medium and large simulation requirements. Six or more low cost 808 units, mounted into a standard electronic enclosure, can be operated by one 985 Control Unit. Linear and non-linear simulations requiring in excess of 50 amplifiers are well within the combined unit capacity.



808 Analog Signal Processor

Some of the more recent installations are given below:

- — Sperry Flight Systems, Phoenix, AZ
- — Sperry Avionics, Phoenix, AZ
- — Aerojet Strategic Propulsion Company, Sacramento, CA
- — Johns Hopkins University, Baltimore, MD
- — Bendix Corporation, N. Hollywood, CA
- — Hughes Aircraft Company, El Segundo, CA
- — TRW, Inc., Redondo Beach, CA
- — Boeing Corporation, Seattle, WA
- — General Electric Company, Evendale, OH
- — Grumman Aerospace Corporation, Beth page, NY

NEW COMPUTER... *cont. from front, page*

ed, if then is incorporated into the electronic switch network. By mixing patched functions with electronic programming, a Micropatch system can be arranged to meet a variety of computing requirements.

Micropatch is one of two 7000 Building Block units. The other is the model GP-10 traditionally patched analog computer. A 7000 system may be composed of one or more of either or a combination of both. Modular and stackable, Micropatch and the GP-10 are the building blocks that provide the flexibility needed to efficiently construct simulation systems. Each may be operated alone for small applications or blocked together to meet practically any sized requirement. Systems may begin small and grow as demands increase. Large systems may be disassembled into smaller ones. The building block organization lets purchasers buy no more equipment than is necessary to handle the job.

Structured much like the Comdyna GP-6, each GP-10 computing *unit handles* up to fourth order simulations, has four time scales per integrator, a full complement of non-linear elements and utilizes GP-6 accessories. Also like the GP-6, the GP-10 offers quality analog computing at a low cost. Inclusion of GP-10 units into a 7000 system provides the opportunity to minimize the overall cost per operation. A blend of the GP-10 with Micropatch yields the best possible cost effective system.

To mix electronic and patched programming, Micropatch utilizes a transfer function approach to handle the terms of a differential equation model. Each term of a state variable equation is treated as an input/output function of a variable or variables. Whether a term is linear, nonlinear, simple or complex, it is viewed by the programmer as a transfer function. Inherent to the basic Micropatch switching network are the combined functions of sign determination and multiplication by a constant. These are the basic Micropatch transfer functions. Equations with terms having only these operations are limited to linear simulations. To produce other functions, the basic linear operations must be combined with operations that are created through patched techniques. To include a patched function:

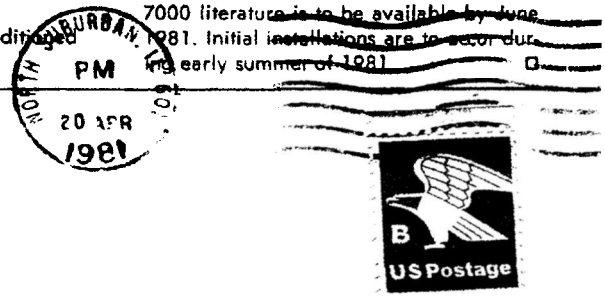
1. A term's variable is electronically directed to a specific panel output location.
2. The selected variable is conditioned by patched operations.
3. The conditioned variable is patched to a specific Micropatch panel input location.
4. The input is electronically given a designated sign, digitally attenuated and connected as one term of a selected equation.

In addition to its programming versatility, a major strength of the 7000 Series is its strong capabilities to interact with digital computers. Distinguishing features include an ail electronic amplifier address, analog/digital and digital/analog conversion and an interface for bidirectional digital computer data transfer. As a hybrid computer, the 7000 may be operated entirely from the host digital computer as well as from a desk top control module.

Although most attention will likely focus on the unique, electronic patching network, we believe that the most powerful feature of the 7000 Building Block Series is its adaptability to meet a diversity of analog/hybrid computing requirements. Whether small or large, patch cord or electronically programmed, a system can be structured for every budget and need.

7000 literature is to be available by June 1981. Initial installations are to occur during early summer of 1981.

COMDYNA, Inc.
COMPUTERS FOR DYNAMIC ANALYSIS
305 Devonshire Road Barrington, Illinois 60010



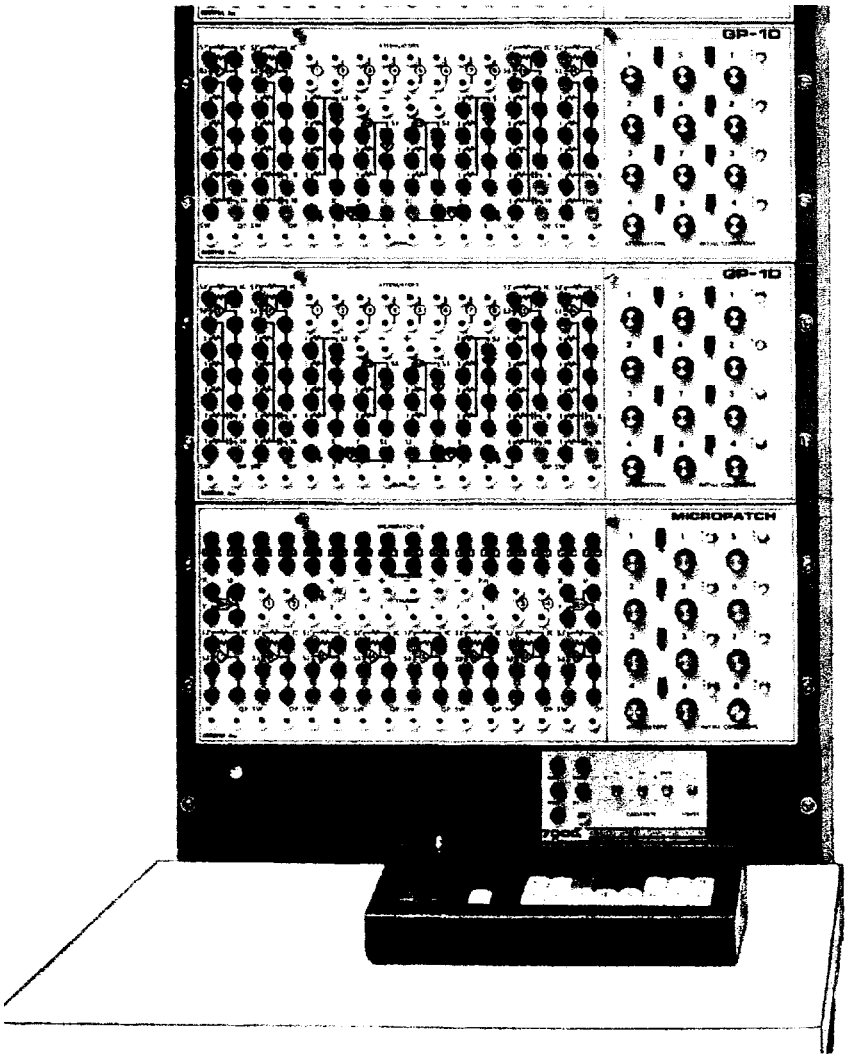
May 1983

SIMULATOR TIE-INS... an aid to control systems development

In the analysis of control designs there is often a need to test and develop physical components in a working environment. As the electrical analogs of real apparatus, analog simulators provide such environments. Where parts or ail of actual facilities can be replaced by a simulator tie-in, a physical component can be tested under realistic but predictable operating conditions.

Comdyna 7000 analog/hybrid computer systems are designed for tie-in applications. They are accurate, inexpensive and can be configured to the exact size of a simulation requirement. Mountable into an electronic rack or enclosure, a 7000 simulator is quickly integrated into laboratory facilities. Good trunking enables signals to be easily transported to and from instrumentation and control devices. A large and sturdy patching area of standard banana plugs and jacks facilitates the programming of simulation models and their tie-in with physical equipment.

7000 simulators are also designed for easy tie-in to microcomputing systems. Standard models offer a microcomputer interface with an instruction set for multiplexing analog variables and converting the variables to digital data. With the MICROPATCH option analog simulation programs can be electronically patched and digitally stored. With the multiplying digital/analog converter expansion, simulation parameters may be digitally set and controlled by microcomputer programs.

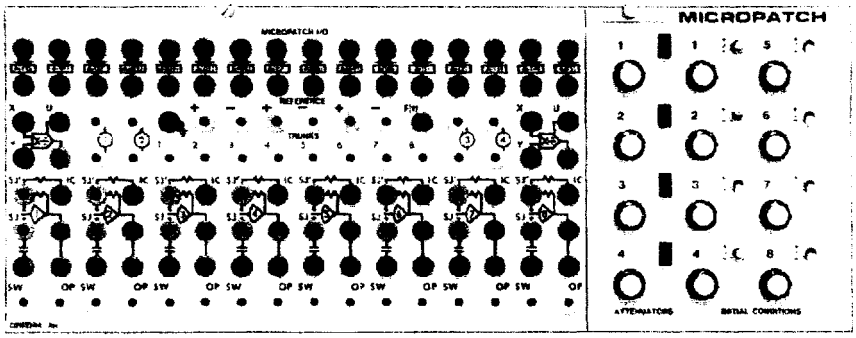


The 7000 Analog/Hybrid Computing Systems offers a building block construction that can be configured to specific simulation requirements.

MICROPATCH... now available for the Apple II

MICROPATCH programs can now be formatted, stored and executed with the Apple II processor. By entering a set of state-variable differential equations into the Apple, a MICROPATCH program can be electronically patched for immediate use as a pure analog computer simulation or as an Apple based hybrid computer simulation. Once formatted, the MICROPATCH program can be stored and recalled with use of the Apple's disc and controller.

While the Apple package offers plug-in convenience, the software is not limited to the Apple processor. Written in BASIC, the program is easily transferred to other computers. With the entry of a few machine language routines, the BASIC program of any microcomputer can be utilized.



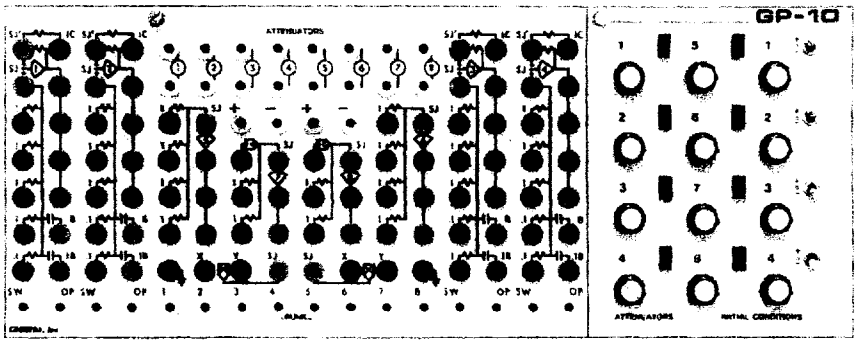
MICROPATCH is a computing unit of the 7000 Analog/Hybrid Computing Systems. It operates identically to traditional analog computers except that an electronic switching network replaces patch cord programming and digital computer storage replaces mechanical patch panels. MICROPATCH simulations have the same hands-on benefits as patch panel computer simulations. They can be tied into physical equipment or used as stand-alone simulators.

May 1983

DATA ACQUISITION WITH THE GP-10

Small analog computers are highly useful to digital data acquisition programs. Simple patch panel functions can reduce software requirements, increase operating speeds and add parallelism to signal processing. Analog computer variables are voltage signals like raw measurements but they are superior for conversion and handling by the digital computer.

The GP-10 analog computing unit offers an inexpensive and convenient addition to a digital data acquisition facility. The GP-10, with microcomputer interface, is a complete data acquisition system. No matter what type of conversion is used, the GP-10 analog unit provides front end operations that include general purpose filtering, signal conditioning and arithmetic manipulation of instrumentation variables. Operations that would otherwise burden the digital computer program can often be handled with a few analog panel connections.



As a complete data acquisition unit, the GP-10 plugs into a microcomputer I/O bus. Microcomputer routines multiplex the analog computer variables, control the analog/digital converter and sense single bit logic states. The universal parallel interface port is adaptable to all microcomputer models. A standard interface with software is available for the Apple II.

Where the applications concern both data acquisition and control, digital/analog converters can be included. The user thus has the options to construct continuous controllers from analog patch panel components, utilize digital control with either voltage or multiplying digital/analog converters or apply state control with the interface unit's single bit outputs.

From a selection of computing and interface options, a GP-10 can be custom configured to meet a wide range of signal handling needs. Prices start under $1,000.

ANALOG COMPUTER HANDBOOK

The text and laboratory work book, written by Dr. Violet B. Haas, Electrical Engineering Department, Purdue University, has been published by Publications Press, P.O. Box 1998, Bloomington, IN, 47402. Books may be purchased directly from the publisher or from Comdyna, Inc. at $9.00 each.

Dr. Haas developed the handbook for use in an undergraduate controls program. Material and experiments cover analog computer programming, dynamic systems simulation and fundamentals of control theory. All experiments can be handled with the Comdyna GP-6 analog computer.

HYBRID PHARMACOKINETICS

Pharmacokinetics simulations are now being performed on a hybrid computing system that consists of the GP-10 analog simulation unit and Apple II microcomputer. in the simulation of drug absorption, distribution and elimination in the body, the Apple inputs the simulated drug regimens and monitors digitized drug concentrations.

Analog simulations have proved useful in the research, education and clinical application of pharmacokinetics models. The inclusion of a central processor has added the capabilities to store and retrieve patient data, perform statistical analyses, compile reports and aid the deployment of drug models. All the benefits of analog computer simulation regarding the development of mathematical models and prediction of patient drug doses has been maintained or enhanced.

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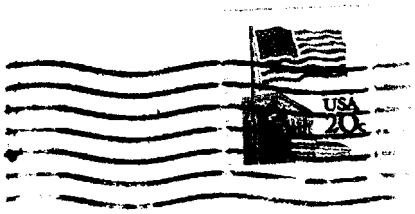

December 1984

PRICE SHEET

COMDYNA, Inc

Each Comdyna analog/hybrid computer that is included herein is priced by adding options and features to a basic configuration. Section A that follows lists general accessories that may be used with all or most systems and do not require installation at the time of the system's purchase.

WARRANTY

All products are covered by a one year warranty. In event of an operational defect, the product will be repaired by either replacing the defective part or repaired at the factory, at no cost, providing that the defect is not the result of abuse. The warranty covers defects in workmanship and all electronic malfunctions.

SEVEN DAY CONSIGNMENT - EVALUATION PURCHASE

Purchase orders may be accepted on a seven day consignment-evaluation basis. On this basis, one standard system will be consigned to purchaser for a seven day evaluation period. After the seven day period, the unit is either accepted or it may be returned and the purchase order cancelled. Consignee is to be responsible for the unit's safekeeping during the period and for shipping charges. To be effective, the purchase order must state "Seven Day Consignment-Evaluation."

DESCRIPTION	QTY	UNIT	EXT
7000 ANALOG/HYBRID COMPUTING SYSTEMS			
Primary System			
Chassis *completely wired does not include power supply or 7976 interface network.*		$ 125	
Desk top 7003 (single computing units only)		125	
Rack Mount, 7013 (single or multiple units)	select one . . . . 1 ea.		_____
Power Supply			
Low Current, 7116 (single units)		95	
Medium Current, 7117 (2-4 units)		145	
High Current, 7118 (5-8 units)	select one . . . . 1 ea.	195	_____
Interface Network, 7976 *required tor Micropatch and for use of 7986 control unit or external digital computer.*	optional . . . . 1 ea.	175	_____
Control Unit 7986 *requires 7976 network*	optional . . . . 1 ea.	675	_____
Analog/Digital Converter, 7093 *12 bit w/8 bit DAC curve generator*	optional . . . . 1 ea.	345	_____
Microcomputer Connecting Cable see *Section A*	optional . . . . 1 ea.		_____
COMPUTING UNITS			
GP-10 Basic *inc. wired chassis, 2* ea. *911 quad amp, grps., patch cord set.*	quantity . . . . ___ea.	895	_____
Control and Address Group, 7979 *requires 7976 interface network.* (1 per basic)	optional . . . . ___ea.	165	_____
Integrating Capacitor Group *1:1, 10:1, 400:1 and 4000:1 time* scales. (1 per basic)	optional . . . . ___ea.	250	_____
Dual Multiplier Network *see Section A* (1 per basic)	optional . . . . ___ea.		_____
Alternate integrating Capacitor Groups			
1:1 Time Scale, 7171		115	_____
10:1 Time Scale, 7172		55	_____
400:1 Time Scale, 7173		40	_____
4000:1 Time Scale, 7174		40	_____

DESCRIPTION		QTY	UNIT	EXT
MICROPATCH Basic *inc. wired chassis, 1 ea. 7979 control/ address, 1 ea. 7912 quad integrator, 1 ea. 7975 quad switch, patch cord set*	quantity	___ea.	1935	_____
Quad integrator, 7912 (expansion 1 per basic)	optional	1 ea.	345	_____
Attenuator-Switch Group, 7975 (expansion 1-3 per basic)	optional	___ea.	795	_____
Attenuator-Switch Group, 7975A *alternate to 7975, same except attenuators are 12 bit resolution.*	optional	___ea.	945	_____
Dual Multiplier/Divider, 7282 *1 % FS accuracy* (1 per basic)	optional	___ea.	170	_____
Alternate multiplier, 0.5% *accuracy*	add		100	_____
Alternate multiplier, *0.1% accuracy*	add		275	_____
Patch Cord Set, 7840 (additional patch cords for expanded unit)	optional	___ea.	60	_____
MULTIPLYING DIGITAL/ANALOG CONVERTERS				
Eight Channel Assembly, 796 *ten bit resolution, printed circuit board, used with 7976 interface.*	quantity	___ea.	650	_____
Eight Channel Assembly, 796A *same as 796 except resolution is twelve bits.*	quantity	___ea.	795	_____
Installation in Comdyna computing units *consult factory*				
Patch Panel and Chassis, 796C *Rack mountable chassis, completely wired for patched inputs and outputs of two 796 MDAC assemblies.* (1 per two 796 assemblies)	optional	___ea.	195	_____
GP-6 DESK TOP ANALOG COMPUTER				
Inc. standard eight amplifier basic unit, slow time and repetitive operation feature, digital voltmeter readout, dual multiplier network-1% accuracy, patch cord set and microcomputer interface connector.	quantity	___ea.	1845	_____
Alternate multiplier, 0.5% *accuracy*	add	___ea.	100	_____
Alternate multiplier, *0.1% accuracy*	add	___ea.	245	_____
Cassette Training Program, 101	quantity	___ea.	55	_____
Tutor Cassette Player, 615	quantity	___ea.	95	_____
MICROHYBRID I INTERFACE UNIT				
Standard Basic Unit *inc. fully wired chassis, asynchronous logic functions, sixteen channel multiplexer, patch cord set, GP-6 connecting cable.*	quantity	___ea.	1075	_____
I/O Port, 932, (one per basic)	optional	___ea.	80	_____
Quad Amplifier Group, 911 (one per basic)	optional	___ea.	130	_____
Dual Downcounter Group, 938 (one per basic)	optional	___ea.	115	_____
Analog/Digital Converter *see below* (one per basic)	optional	___ea.		_____
Multiplying Digital/Analog Converter see *below* (one-four per basic)	optional	___ea.		_____
Microcomputer Connecting Cable see Section A (one per basic)	optional	___ea.		_____
766 INTERFACE UNIT				
Basic Unit *inc. desktop chassis, GP-6 connecting cable, eight channel multiplexer, flat cable for 24 bit parallel I/O*	quantity	___ea.	250	_____
Microcomputer interface options (one per basic)				
Apple II	optional	___ea.	95	_____
Other Microcomputer Models *(consult factory)*	optional	___ea.		_____
Analog Digital Converter *see below* (one per basic)	optional	___ea.		_____
Multiplying Digital/Analog Converter *(see below)* (one or two per basic	optional	___ea.		_____

DESCRIPTION		QTY	UNIT	EXT
Converters for Microhybrid I and 766 Interface				
Analog/Digital, 7091 *8 bit plus sign*	....		95	
Analog/Digital, 7093 *12 bit plus sign and includes 8 bit DAC curve generator.*	....		345	
Multiplying Digital/Analog, 937 *8 bit resolution*	....		75	
Multiplying Digital/Analog, 935 *12 bit plus sign resolution*	....		125	
808 ANALOG SIGNAL PROCESSOR				
Basic Unit *inc. fully wired rack mount chassis, two 911 quad amplifier groups but without integrating capacitors, patch cord set*	quantity	ea.	995	
Expanded Integrating Capacitor Set *inc. four 1:1, 10:1, 400:1 and 4000:1 time scale integrating capacitors with time scale relay.*	optional	ea.	250	
Dual Multiplier Network *see Section A* (one or two per basic)	optional	ea.	—	
809 ANALOG SIGNAL PROCESSOR				
Basic Unit *inc. fully wired rack mount chassis, two 911 quad amplifier groups but without integrating capacitors, card programming facilities.*	quantity	ea.	995	
Integrating Capacitors see *below* (one or two sets per basic)				
Dual Multiplier Network *see Section A* (one or two per basic)	optional	ea.	—	
General Program Card, model 400	optional	ea.	25	
Amplifier Balance Program Card, model 410	optional	1 ea.	32	
Control Connector *male 10 pin*	optional	ea.	7	
General Programming Kit	optional	ea.	45	
Integrating Capacitors for 809 and alternates for 808				
1:1 Time Scale		ea.	115	
10:1 Time Scale		ea.	50	
400:1 Time Scale		ea.	40	
4000:1 Time Scale		ea.	40	
Other time scales consult factory				
CONTROL UNIT, MODEL 785				
Organizes up to *six 808/809 Analog Signal Processors into a single operating system, inc. digital voltmeter readout, slow and fast time base, repetitive operation timing unit, push button mode control and amplifier address switches.*	quantity	ea.	750	
MATH MODEL SIMULATOR				
Self-contained instructional package inc. complete Math Model Simulator and "Introduction to Systems and System Simulation" text and laboratory work book.	quantity	ea.	495	
Analog/digital and Digital/analog Converter Expansion *eight bits including sign with Apple II connecting cable.*	optional	ea.	195	
SECTION A (ACCESSORIES AND GENERAL OPTIONS)				
MULTIPLIER/DIVIDERS				
Multiplication/division accuracy is selected from a choice of three dual multiplier networks. The plug-in assemblies may be field installed and exchanged on a full credit basis to upgrade existing systems.				
Dual Multiplier Network, 782-1 *1% full scale accuracy*	....		150	
Dual Multiplier Network, 782-.5 0.5% *full scale accuracy*	....		250	
Dual Multiplier Network, 783- *0.1% full scale accuracy*	....		395	

DESCRIPTION	QTY	UNIT	EXT
SECTION A (ACCESSORIES AND GENERAL OPTIONS)			
SIMULATION SUB-SYSTEMS			
The following may be furnished in either desktop or rack mounting housings			
Variable Diode Function Generator, 701 eleven segments, fixed breakpoints	quantity	ea. 165	
Variable Diode Function Generator, 709 eleven segments, variable breakpoints	quantity	ea. 205	
Transfer Function Simulator, 771 inc. power supply	quantity	ea. 350	
Three Mode Controller, 717 inc. power supply	quantity	ea. 350	
Attenuator Expansion Group, 731 inc. seven potentiometers with push button coefficient setting switches.	quantity	ea. 250	
The following are printed circuit assemblies.			
Variable Diode Function Generator, 705 Dual channels, eleven segments each, variable breakpoints, screw driver set adjustments.	quantity	ea. 350	
Sine-Cosine Input Card, 450 signal shaping input for 705 VDFG, enables VDFG to produce 360 degree sine-cosine functions.	quantity	ea. 125	
MICROCOMPUTER INTERFACE CABLES			
Apple II plugs into peripheral connector	quantity	ea. 150	
TRS-80plugs into parallel port	quantity	ea. 170	
AIM 65 plugs into parallel port	quantity	ea. 180	
Other microcomputer models consult factory.			
BANANA PLUG MODULES AND ELEMENTS			
D/A Electronic Switch, 9302	quantity	ea. 35	
Comparator Feedback Element, 9390	quantity	ea. 12	
Single Pole, Double Throw Function Switch, 9408	quantity	ea. 22	
Coefficient Attenuator, 9447	quantity	ea. 25	
Adjustable Hard Limiter, 9517	quantity	ea. 40	
Zero Limiter, 9528	quantity	ea. 20	
Adjustable Dead Space, 9520	quantity	ea. 35	
Absolute Value, 9560	quantity	ea. 49	
Hysteresis, 9570	quantity	ea. 75	
3 Input Summer Network, 9700	quantity	ea. 21	
Patchable Diode, 9780	quantity	ea. 10	
PROGRAMMING AND LEARNING AIDS			
"**Analog Computer Handbook**" by Dr. Violet B. Haas a laboratory text and work book.	quantity	ea. 9	
PATCHING AIDS			
Pamona Shorting Plug	quantity	ea. 3	
Stack-up Patch Cords 5, 8 or 12 inch lengths	quantity	ea. 4	
Stack-up Patch Cords custom length	quantity	ea. 8	
Patch Cord Kits 44 patch cords: 5, 7, 10, 12 inch lengths	quantity	ea. 85	
220 VOLT OPERATION add per system	quantity	ea. 35	

October, 1982

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