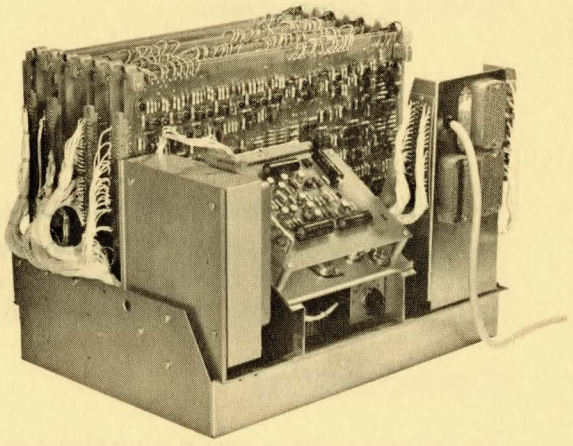
THE WYLE ARITHMETIC PROCESSOR



The Wyle Arithmetic Processor, Model AP-01, is an electronic unit which provides the full range of arithmetic operations in an unusually simple and economical package.

The Arithmetic Processor combines the arithmetic and data handling capability of the Wyle Scientific electronic calculator with the systems oriented interface logic that allows automatic data input and output and automatic control. In typical applications, the Arithmetic Processor may be reading data from a digital voltmeter, an analog-to-digital converter, a counter-timer, a shaft encoder, or nearly any other source of digital data. Under the control of a programmer such as a perforated tape reader, a card reader, magnetic tape, or electronic programmer, the Arithmetic Processor reads in and operates on the data. The results are then read out to visual displays, printers, digital-to-analog converters or whatever recording or controlling device is required.

On command, the unit will perform all common arithmetic operations and a wide variety of the "housekeeping" operations necessary to real flexibility in data processing operations. Six internal registers are provided, each with a capacity of 24 decimal digits. Three of these, the Multiplier-Quotient register (MQ), the Entry Register and the Accumulator Register (ACC) are involved in the mathematical operations. The other three registers are for the storage of intermediate results or constants. Decimal point position in these registers is selected by means of a manual switch and can range from a 21 digit, 3 decimal place number to a 3 digit, 21 decimal place number in steps of 3 digits. A decimal point is entered just as any other numeric data and data is automatically aligned about the pre-selected register position, and all results are similarly positioned. Data can be transferred from any of the six registers to any other register and data in any register can be shifted either right or left and data can be read out on command. Negative data is handled internally in nines complement form but readout is in absolute value and sign.

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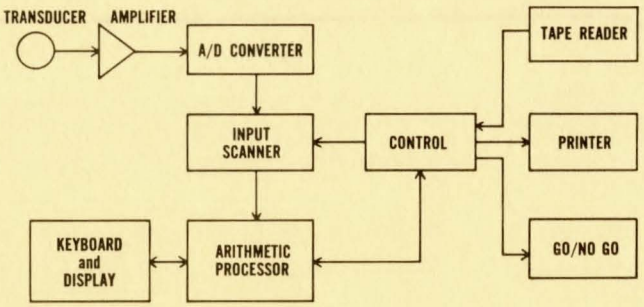


BLOCK DIAGRAM: Real Time System
This block diagram shows a generalized system, applicable to a variety of transducers and purposes.

The unit is particularly useful in linearizing data, converting to engineering units, comparing data against preset limits, or computing parameters which involve the relationship of two or more items of data. Specific areas of application include automatic checkout, quality control testing, test instrumentation, and automatic control.

Numeric Operations

The following table uses a symbolic notation to outline the way in which various registers are involved in the different arithmetic operations. In this notation:

ACC is read as "Accumulator Register"

(ACC.) is read as "Contents of the Accumulator Register"

(ENTRY) + (ACC) $\longrightarrow$ ACC is read as "Contents of the Entry Register are added to the contents of the Accumulator Register and the results appear in the Accumulator Register."

The basic arithmetic operations, expressed in this notation, are:

Addition	(ACC) + (ENTRY) $\longrightarrow$ ACC	- Timing = 10 milliseconds
Subtraction	(ACC) - (ENTRY) $\longrightarrow$ ACC	
Multiplication	(MQ) x (ENTRY) $\longrightarrow$ ACC	- Timing = 250 milliseconds (For product of two-4 digit numbers.)
Division	(ACC) – (ENTRY) $\longrightarrow$ ACC	
Square Root	$\sqrt{(ACC)}$ $\longrightarrow$ MQ	
Multiply + (ACC)	$+\left[(MQ) \times (ENTRY)\right] \longrightarrow$ ACC	
Multiply - (ACC)	$-\left[(MQ) \times (ENTRY)\right] \longrightarrow$ ACC	
Data Transfer	(Selected "FROM" Register) $\longrightarrow$ Selected "TO" Register	

Input Specifications

Both data and program inputs are brought in through the same interface logic and may be in either of two forms, coded or uncoded. A level of 0 ± 0.2 VDC on the INPUT SELECT line selects the coded inputs; -10 ± 2 VDC selects the uncoded inputs.

Coded Inputs

Data and program inputs appear as six level binary coded information where logic "one" is -10 ± 2 VDC and logic "zero" is 0 ± 0.2 VDC or an open switch. An ENTRY STROBE-C signal, a -10 ± VDC pulse, must occur simultaneously with the input code. A punched tape prepared on a Flexowriter or Dura MACH 10 will provide the appropriate codes. Twenty-four input codes are not used by the machine but are decoded and brought out to a separate 24-pin connector for use in controlling other system functions.

Uncoded Inputs

Thirty-nine separate lines are available for uncoded inputs. These correspond to the 39 functions performed by the Arithmetic Processor. A logic "one" (action) is 0 ± 0.2 VDC and a logic "zero" (no action) is +10 ± 2 VDC or an open circuit. An ENTRY STROBE-A signal, a -10 ± 2 VDC pulse, must occur simultaneously with the input command signal.

Specific operations which the machine will perform and for which there is a specific coded or uncoded input line are:

ADD	"TO" (Six lines to select register for data entry or destination of data being transferred.)
SUBTRACT	
MULTIPLY	"FROM" (Six lines to select the source of data in transfer operation.)
MULTIPLY +	TRANSFER (Initiates transfer operation.)
MULTIPLY -	
DIVIDE	FORWARD SPACE
SQUARE ROOT	BACK SPACE (These commands enable a single digit to be selected and then changed.)
SHIFT RIGHT	
SHIFT LEFT	
ENTER DIGITS (10 LINES)	
ENTER DECIMAL POINT	
CLEAR MQ	
CLEAR ENTRY	
CLEAR ACC	

Output Specifications

Data in the Accumulator Register can be transferred, one digit at a time to the output buffer register. Data in any other register must be transferred to the Accumulator Register before it is read out.

A summary of the signals provided by the Arithmetic Processor and those signals that must be supplied to it for readout operation is given below.

Signal	Description
READ	The READ line must be set to -10 ± 2 VDC and remain at this level during readout. When readout is complete, it should be reset to 0 ± 0.2 VDC.
SIGN	A SIGN output line drops from 0 ± 0.2 VDC to -10 ± 2 VDC if the number in the Accumulator is negative.
SIGN RESET	A pulse on this line, falling from 0 ± 0.2 VDC to -10 ± 2 VDC resets the SIGN output to the zero (0 ± 0.2 VDC) state.
DIGIT SELECT LINES	Five coded lines with weighted values of 1, 1, 3, 6, 12. The code on these lines selects the first digit to be read out so that it is not necessary to read all 24 digits. Logic "one" = -10 ± 2 VDC; logic "zero" = 0 ± 0.2 VDC. Digit 23 is the most significant digit.
DATA AVAILABLE	When the selected digit is available in the output buffer register, this line drops from 0 ± 0.2 VDC to -10 ± 2 VDC. It is automatically reset by the rising edge of either the DIGIT ADVANCE or the READ signal.
DATA LINES	The output of the buffer register is eight lines representing one decimal digit in 8421 BCD format. Both "true" and "false" lines are available. Logic "one" = -10 ± 2 VDC, logic "zero" = 0 ± 0.2 VDC.
DIGIT ADVANCE	To bring the next most significant digit into the output buffer register, the DIGIT ADVANCE line must receive a negative pulse from 0 ± 0.2 VDC to -10 ± 2 VDC with a minimum duration of 10 microseconds.
LAST DIGIT	This output goes to -10 ± 0.2 VDC when the next to the last digit is in the output register. It is automatically reset when DATA AVAILABLE is reset.
DECIMAL POINT	This output is a train of -10 ± 2 VDC pulses with a 200 microsecond duration occurring every 6.7 milliseconds. It begins when DATA

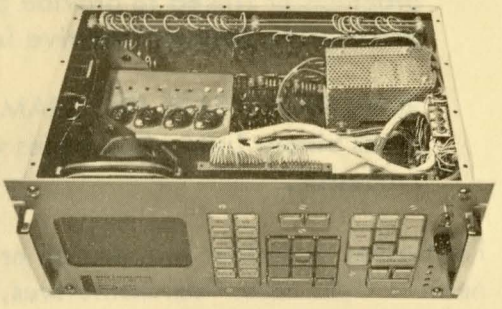
AVAILABLE for the "tens order" digit goes to logic one and stops when DATA AVAILABLE is reset.

Miscellaneous Control Signals

Various signals are available from the Arithmetic Processor to aid in timing and control of operations or to provide the system and/or the operator with specific information. These are summarized below.

Signal	Description
SYNCH	A pulse from 0 ± 0.2 VDC to -10 ± 2 VDC with a duration of 400 microseconds which occurs once for each internal machine cycle.
OVERFLOW	An output of -10 ± 2 VDC indicates that the result of some operation has exceeded the capacity of the machine. It is reset the next time the unit receives a "TO" or an Arithmetic Command.
INTERLOCK	This signal indicates that the unit is busy executing an instruction and cannot receive new data or commands. A logic "one" (-10 ± 2 VDC) indicates the machine is busy; a logic "zero" (0 ± 0.2 VDC) that it is free.

Optional Keyboard Display Unit



The Model KD-01 Keyboard Display unit provides the Arithmetic Processor with all the manual operation capability of the Wyle Scientific. It enables manual data entry and control of computation and provides a continuous visual display of all contents of all registers. It is a separate rack mounted unit which does not interfere with any of the operations previously described.

General Specifications

		Arithmetic Processor Model AP-01	Keyboard Display Model KD-01
PHYSICAL:			
	Width:	19-inch standard RETMA rack mounting	
	Depth:	18 inches	10 inches
	Height:	12-1/4 inches	8-3/4 inches
ELECTRICAL:			
	Voltage:	115 ± 10 VAC, 60 cps, single phase	
	Power:	160 watts	15 watts

PERIPHERAL EQUIPMENT

Wyle provides standard peripheral equipment for systems applications. Some of these are:

SCIENTIFIC AUXILIARY MEMORY .....Provides up to 24 additional storage registers in groups of 8 registers.

PLUG-IN PROGRAMMER .....Provides stored program capability. Sixteen patchboard programs of 32 steps each can be used as individual programs or linked to provide programs of up to 512 steps. The unit can be programmed to perform iterative loops, conditional transfer, branching, etc.

PERFORATED TAPE PROGRAMMER .....A photo-electric tape reader reads binary instruction codes which control the operation of the Arithmetic Processor.

For further technical information or assistance with particular applications, contact your nearest Wyle Sales Representatives, or write Wyle Laboratories, Digital Products Manager.

Prices are f.o.b. El Segundo, California, and are subject to change without notice.

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PERIPHERAL EQUIPMENT - WYLE ARITHMETIC PROCESSOR

The peripheral units described in the following paragraphs are designed to extend the capability of the Wyle Arithmetic Processor, Model AP-01. Various combinations of these units allow the construction of a variety of "special" systems, applicable to computing and control problems of all types. This rack mounted equipment is for use only with the Arithmetic Processor.

SCIENTIFIC AUXILIARY MEMORY (SAM)

The Scientific Auxiliary Memory (SAM) provides 8 additional storage registers of 24 digits each. Numbers may be transferred from any SAM register to any of the six standard registers in the AP-01 and vice versa. Numbers cannot be transferred directly from one SAM register to another. Numbers may not be entered directly into the SAM register, but must be transferred from one of the A/P registers. The KD-03 Keyboard-Display provides keys for manual control and input lines to the SAM allow automatic control from other peripherals such as PIP. Input lines use the same logic levels as A/P "uncoded" lines. Keys (or lines) provide TO designations and FROM designations for each of the ten registers for control of data transfers. One key is used for display control. When this key is activated, the contents of the previously selected FROM register are visually displayed in the CRT display position normally reserved for standard register R3. This does not affect the contents of either register or the status of previously established TO and FROM markers. Up to three SAM units may be used with each AP-01; the second and third SAM units are self-contained modules which plug into the first SAM unit.

PLUG-IN PROGRAMMER (PIP)

This unit provides the AP-01 with stored program capability. Sequences of instruction are stored as patch connections on a set of plug boards. Internal circuits sequentially activate the matrix inputs and the outputs provide control signals to the Arithmetic Processor. Up to 16 sequences of 32 steps each can be provided, a total of 512 possible program steps.

The programs may be addressed and operation initiated in the following ways.

1.	Keyboard	Simultaneous actuation of a PIP selection key and a manual key initiates the PIP program which corresponds to the numeral.
2.	Card Reader	The PAC card reader will recognize a punch in the "STOP" column and a number from 1 to 8 punched in the same row as designated the program sequence of the number punched.
3.	Other Sequence	One program sequence may refer to another sequence, thus allowing "chains" of up to eight sequences for a total of 512 steps.

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4.	Arithmetic Processor	Signals from coded data sources, such as a perforated tape, can be decoded in AP-01 decoder circuits and used to select a sequence.
5.	Unconditional Transfer	Any one sequence may be designated as "Master" sequence. The Master sequence may refer to another sequence at step "x." The referenced sequence is executed and the Master sequence resumes at step "x" + 1.
6.	Conditional Transfer	The Sequencer will execute a "skip on -" (controlled by sign of data in the Acc. register), and the program step to be skipped can refer to another program so that if the result is +, the program control will automatically transfer to a new program.

A manual single-step mode of operation is available for program checkout, and is initiated by a switch on the rear of the unit.

PERFORATED TAPE PROGRAMMER

This unit permits the Arithmetic Processor to receive instruction inputs from an 8-level punched paper tape reader. The coded inputs are read into the AP-01 decoder circuits. Those codes which are not used to directly command A/P operations are decoded and may be distributed to other peripherals or to external equipment. A Remex photo-electric tape reader is included.

When used with other peripheral equipment, such as the SAM or PIP, the system operation may be under control of the Paper Tape Programmer. Start/stop control of the reader is coordinated with interlock signals received from the A/P or from the other peripheral units to prevent reading of new instructions until the preceding instruction has been executed. Tapes may be prepared on a Flexowriter or a Dura Mach 10.

DATA INPUT MULTIPLEXER (DIM)

The Data Input Multiplexer provides the interface logic, buffer storage and parallel to serial conversion required to couple external data sources such as digital voltmeters, counters, A/D converters, etc., to the Arithmetic Processor. Data is read in one character at a time and the standard unit will accomodate six BCD data characters, the decimal point and sign. The decimal may be either a specific code occurring in the sequence of characters or a separate BCD code representing scale factor. One signal initiates a complete six-digit read-in cycle. DIM may be expanded to three 6-digit numbers.

TYPEWRITER INTERCOUPLER

This unit couples a Wyle Arithmetic Processor to an IBM Model B Output Writer. On receipt of a "print" command the unit prints, one digit at a time, the data contained in the Accumulator Register. If the data is negative, in nine's complement form, it is automatically converted to absolute value and sign format prior to printout. Up to 24 digits and decimal point may be printed. Print rate is 10 characters per second, maximum.

LINE PRINTER INTERCOUPLER

This unit couples the Arithmetic Processor to a serial entry printer. On receipt of a "print" command the interface logic automatically controls the printout of up to 11 digits of data from the Accumulator register of the Arithmetic Processor. Print rate is two lines per second. Printout is in absolute value and sign format and any field of 11 digits can be selected from the 24 available digits.

SCIENTIFIC INTERFACE LOGIC

This unit, the Wyle Model IL-01, provides the circuits necessary to couple a standard Wyle Scientific electronic calculator to external automatic I/O devices. The input/output characteristics of the combined Scientific calculator and the Interface Logic are identical to the characteristics of the Wyle Arithmetic Processor Model AP-01, when used with the Keyboard-Display unit.

INPUT/OUTPUT CONTROL MODULE

The Input/Output Control Module provides the necessary mechanical connections to tie peripherals to the Arithmetic Processor and distributes the various interlock and addressing signals. Only one such unit is necessary to connect a complete set of peripherals to the Arithmetic Processor. One control module is required however many peripheral devices are used. A minimum basic unit can be used initially and expanded as peripheral units are added.

GENERAL INFORMATION

All units are designed to mount in a standard 19-inch electronics cabinet. Solid-state circuitry packaged as plug-in printed circuit modules are used throughout. All units provide compatible signal levels. An I/O Control Module is required when any of the described equipment is used with an Arithmetic Processor.

For further information or assistance in applying these units to specific requirements, contact Wyle Laboratories, Products Division or the representative in your area.