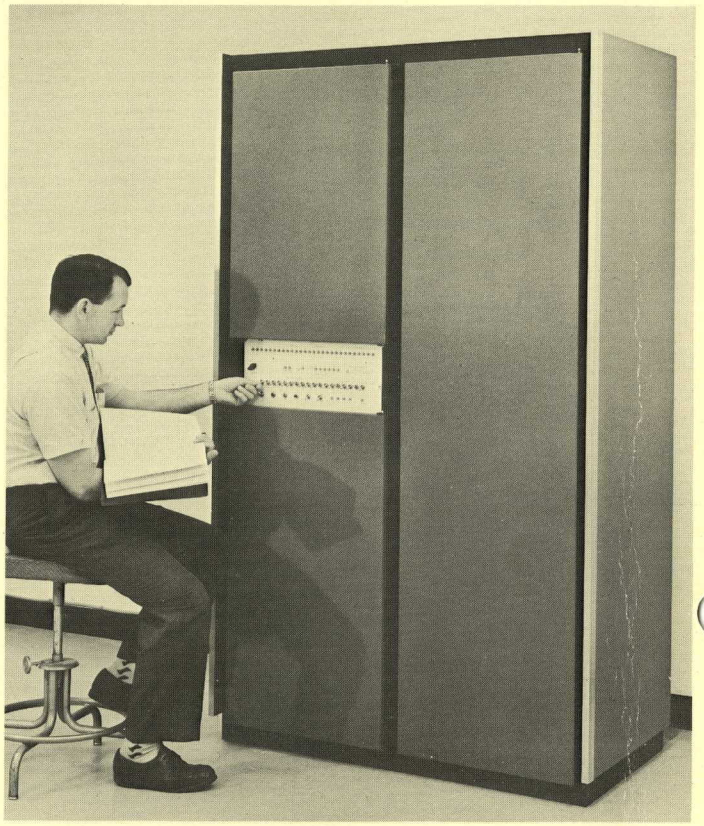
implementing computer control 518

THE TRW-330 CONTROL COMPUTER SYSTEM

Thompson Ramo Wooldridge Inc.
TRW Computers Company (division)

THE TRW-330 CONT

Performance is the hallmark of the TRW-330 computer control system, performance that stems from **flexibility** of system configuration, from **fast** operation, from **field-expandability** in three dimensions, and from proved **reliability**. The range of its performance is demonstrated by these typical TRW-330 system applications: controlling an ethylene plant for Petroleum Chemicals Inc., performing process research for Phillips Petroleum Company, controlling basic oxygen furnaces for Great Lakes Steel, switching TV sound and picture for the Columbia Broadcasting System, and completely automating a pair of 650-megawatt electric power generating units for the Tennessee Valley Authority.



FAST Completes typical programs at a rate of a thousand operations per second, sufficient for over 90 percent of all control installations. Special design features directed toward speed of operation are automatic scanning, literal addressing, and input and output buffering. The TRW-330 is the fastest drum-memory control computer available.

FLEXIBLE Magnetic drum memory is available in sizes from 7,424 to 130,304 words of general storage. The number of digital and analog inputs and outputs is virtually unlimited.

FIELD-EXPANDABLE Memory: to 130,304 words. Input-output capacity: can be increased at will by addition of modular plug-in units. Speed: to over 20,000 typical operations per second, by addition of the TRW-340 core processor, containing 4,096 to 16,384 words.

RELIABLE Design is based on reliability proved in the field with successful control computer installations, installations that have logged over 400,000 hours of on-line operation with total equipment uptime better than 99 percent. (In one application, a TRW-330 operated for 230 days without a single component failure.)

ROL COMPUTER SYSTEM

CHARACTERISTICS

GENERALIZED COMMAND LIST	Operating Time, Milliseconds
Load, Store, and Register Transfer	0.26
Add, Subtract, and Index	0.26
Multiply	
7-bit multiplier	1.30
14-bit multiplier	2.21
21-bit multiplier	3.12
27-bit multiplier	3.90
Divide	
7-bit quotient	1.43
14-bit quotient	2.34
21-bit quotient	3.25
27-bit quotient	4.03
Square Root	2.08
Jump	0.26
Extract and Merge	0.26
Shift	0.13 + 0.13/place
Block Transfer	0.26/word
Analog (Hi-Lo Limit) Scan	0.26/word
Digital Input	0.26
Digital Output	0.26
*Start Digital Output Buffer	0.26

*Buffer automatically outputs up to 712 numeric or 572 alpha-numeric characters. After ordering the output, the computer is free to continue with its program. A signal is received when the block output has been completed.

SPECIFICATIONS

MEMORY—7,424 to 130,304 words of general storage, in increments of 128 words.

DATA WORDS—28 bits, including sign (plus one parity bit on all memory operations).

INSTRUCTION WORDS—28 bits (plus one parity bit on all memory operations).

ADDRESSING—Modified sequential single-address.

INSTRUCTION FORMAT—Two fields: a 10-bit command field and a 16-bit operand field (two bits not interpreted in instruction words). The operand field of an instruction may contain either an operand address or a 16-bit operand. (TRW-340 uses same format.)

NUMBER SYSTEM—2's complement binary.

OPERATION—Serial.

REGISTERS—Accumulator and five programmable registers: two 28-bit arithmetic registers, one 16-bit arithmetic register, one 16-bit index register, and one 8-bit counting register. Two additional index registers available.

CLOCK FREQUENCY—245 kc.

POWER CONSUMPTION—500 watts. No special air-conditioning required.

CABINETS—Assembled in two (or more, as required for each installation) vertical rack-and-panel cabinets bolted together to form a convenient package. Each cabinet is 84 inches high, 23 inches wide, and 24 inches deep. Rugged industrial construction is used throughout.

SOFTWARE—Features PROCOMP, a compiler especially designed for process control programming, and compatible with all other major language formats such as FORTRAN and ALGOL. Also includes utility package, assembler, and complete library of subroutines and interpretive routines. TRW-330 software is available to extend machine capabilities to scientific and general-purpose applications.

The TRW-330 design is based on experience, the unparalleled experience of the company that has designed and installed more control computer systems than anybody else in the field: TRW Computers Company. This experience is your assurance of control system performance and reliability. For further information concerning TRW-330 (and TRW-340) computer systems for specific industrial control problems, call or write any of these TRW offices.

TRW Computers Company, 8433 Fallbrook Avenue, CANOGA PARK, CALIFORNIA—telephone 346-6000

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TRW-330 INPUT/OUTPUT SUBSYSTEMS

INPUT/OUTPUT EQUIPMENT

Operator's console, with indicators, displays, pushbuttons, and multi-position switches. Electric typewriters. Paper-tape readers and punches. Magnetic tape units. Punched card input/output.

ANALOG INPUTS

The analog input subsystem accepts variable-voltage inputs from instruments that measure pressures, flows, temperatures, and other process conditions. The basic subsystem can provide for up to 1024 analog inputs; more can be accommodated by adding extra modules. Through a buffer, the inputs are automatically sequenced into memory at the nominal rate of 60 per second; no program running time is consumed for this operation; however, the frequency and sequence in which instrument values are read can be changed by program control. Higher input rates are available in special system configurations.

ANALOG OUTPUTS

The analog output subsystem uses data words in memory to regulate controller setpoints and adjust valves and other controls. The basic subsystem can provide for up to 128 analog outputs; more can be accommodated by adding extra modules. Through a buffer, these data words are converted to analog values and automatically applied to output devices; again, no program running time is consumed for this operation. The settings of the output devices are maintained by individual memory elements. Output signals can be pulses of fixed or variable duration, or currents or voltages in a variety of ranges. Program-controlled outputs can also be supplied.

DIGITAL INPUTS

The digital input subsystem accepts input signals that represent the on-or-off status of switch or relay contacts, time-of-day signals, and information from operator-controlled equipment. The basic subsystem can provide for up to 829 digital inputs; more can be accommodated by adding extra modules. The digital input subsystem can include pulse counters and sequence event recorders, in which digital inputs are used to accumulate counts of events and the order in which closely spaced events occur; these systems operate without interrupting the computer's control or data-gathering program; event sequences can be recorded at rates up to 60 per second, and count signals can be recorded at rates up to several thousand per second.

DIGITAL OUTPUTS

The digital output subsystem provides signals for on-off control and for operator communication via peripheral output equipment. The basic subsystem can provide for up to 576 digital outputs; more can be accommodated by adding extra modules. Where advisory control is desirable, special displays can be provided at remote operating locations; these displays use alphanumeric symbols and indicator lights to present data in engineering units. Pulse train outputs can be provided for stepping operations or motor jogging.

PRIORITY INTERRUPT

The interrupt subsystem allows conditions outside the TRW-330 to interrupt computations; the computer retains the partial results of calculations in memory while it responds to the interrupt; after handling the emergency, and if necessary, warning the operator, the 330 resumes its calculations at the place where it was interrupted. The priority interrupt system can handle a number of separate interrupt sources in the order of their importance both with respect to each other and to the program in progress; for each interrupt line, the 330 has a unique response, so that no executive routine is required to locate the interrupt source. The basic priority interrupt subsystem can provide for up to 92 interrupt lines; more can be accommodated by adding extra modules.

FAIL-SAFE DESIGN

Fail-safe and self-check features are an integral part of the design and programming of TRW computer systems. Equipment or power failure of any kind causes automatic lockup of all controllers at their most recently calculated setpoints. Any output or outputs may be taken off computer control and controlled manually. A fail-safe detector restarts the program and alerts the operator if it is not reset by the computer program at regular intervals.

EXPERIENCE

Every TRW-330 system includes the experience—in analysis, design, manufacturing, installation, and startup—of the world's leading control computer organization.

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