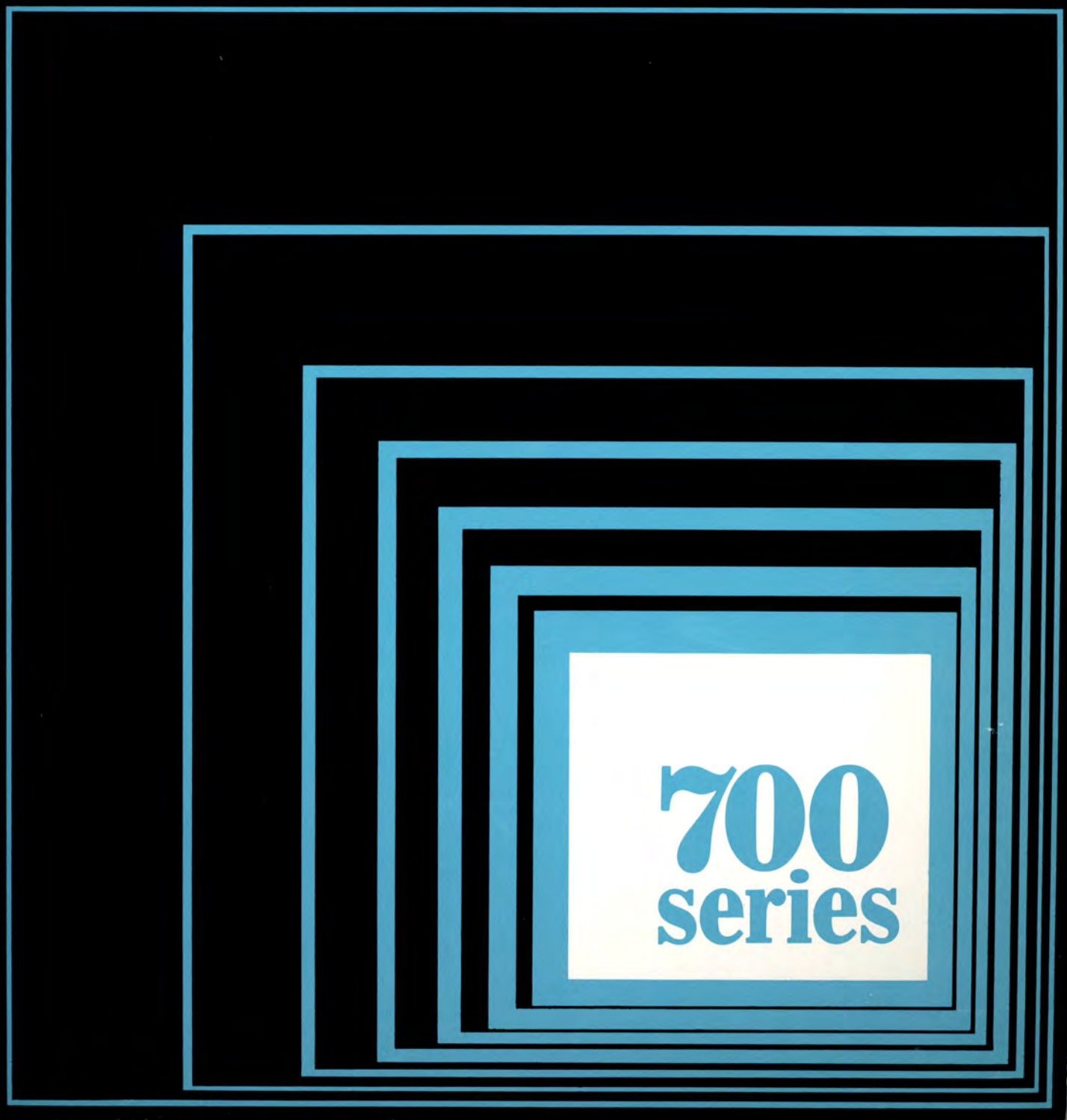
Raytheon Data Sys

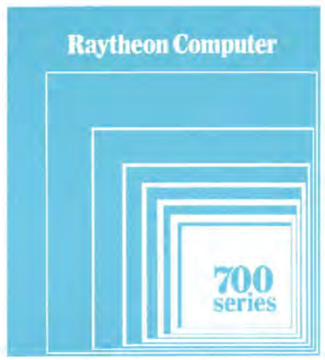
Snyder

Bulletin SP-352

Raytheon Computer



The only thing Raytheon Computer does is your job.



The Raytheon Computer 700 Series provides you with a range of 16-bit, general-purpose computers for on-line, real-time applications.

Emphasis in the 700 Series is on useability. One of our computers will get you on-line sooner and do your job better and for less money than any other competitive 16-bit computer made.

Useability is achieved through sophisticated hardware and a software library of over 400 field-proven, fully-documented programs and subroutines. For increased system flexibility, all processors are fully hardware and software compatible.

Supporting the 700 Series is a complete user training program, applications assistance and our international service organization.

Large computer capability at 16-bit computer prices

- Complete capability: processors, peripherals, interfaces, proven software and support.
- 16-bit CPU's with 900ns, 1.0μs, and 1.75μs cycle times.
- Direct I/O to the CPU, 4 addressable registers and 74 instructions.
- Prices from under $10,000.
- The most efficient core utilization in the 16-bit class.
- Instant interfaces for any application.
- Large computer capabilities:
  - executives, monitors and operating systems
  - true real-time interrupts
  - 74 powerful instructions that include bit, byte, and word manipulation
  - optional hardware multiply/divide, direct memory access, memory protect and an Array Transform Processor.

RAYTHEON

All Raytheon Computer 700 Series processors are 16-bit, fully-parallel computers for general-purpose and real-time computations. Functionally, all processors are identical except for cycle times (see table on page 5).

In the basic configuration, all processors include direct I/O to the CPU, 4 addressable hardware registers, 4096 word of core memory and 74 powerful instructions that include bit, byte and word manipulation. Many commands are commonly found only on large-scale computers and throughput of the 700 Series is significantly higher than in any other 16-bit processors.

The real-time capabilities of the 700 Series processors are enhanced by a completely automatic priority interrupt system, an I/O system that requires only two instructions for operation, direct memory access that services up to six devices while simultaneously executing programs, input/output monitors and real-time FORTRAN IV.

Instructions

The instruction set for the Raytheon Computer 700 Series consists of 74 instructions tailored for systems programming. Core is more efficiently utilized than in other 16-bit processors and there is more room left for your specific applications programs.

The instruction set includes a high proportion of basic, one-cycle instructions, so program execution times are shorter than on comparable machines. (We'd be glad to run a benchmark for you as proof.)

Approximately 25% of the instructions are Test and Jump instructions, making the 700 Series easier to program for control and test applications. Another 25% are Shift instructions, making the 700 Series unusually useful in data processing applications. And many of the instructions are byte, word and literal instructions, making the 700 Series extremely efficient in real-time applications.

Addressing

Addressing in the Raytheon Computer 700 Series is based on the largest page size in the 16-bit computer class. Up to 2048 words may be addressed directly without indexing. In program execution, this means less overhead instructions then in machines with smaller pages. Program execution times are significantly shortened.

Our large page size also allows us to use a more efficient form of indirect addressing. Global indexing is our method of achieving microprogrammable indirect addressing. In use, particularly when sequencing, global mode indexing is faster than the usual hardware index registers because incrementing takes only 2, rather than 3, cycles. Global mode indexing also allows us to use our index register as a limited-function accumulator, increasing the power of our processors even more.

Options

Direct Memory Access:
The DMA channel allows up to six devices to input data simultaneously, concurrently with program execution. With six active devices, the data rate is limited only by the memory cycle time. In the case of the 706 CPU, the maximum transfer rate would thus be 1.1 megawords per second.

Priority Interrupt Expansion:
All processors come with one fully-automatic, real-time priority interrupt level. This may be expanded up to 16 levels and will handle up to 256 devices.

Memory Protect:
For multiprogramming applications, memory may be protected in segments as small as 128 words.

Multiply/Divide:
In hardware, these are performed in 7 and 10 cycles, respectively.

Memory Expansion:
Memory may be field-expanded in 4k increments to a total size of 32,768 words.

Memory Parity:
For data processing applications, this option generates a parity bit for every byte stored.

Power Fail-Safe:
An automatic shut-down and start-up procedure that allows the processor to be left unattended, with no risk of data or program loss and no wasted time.

700 Series Characteristics

	703	704	706
Cycle Time	1.75μs	1.0μs	900ns
Dimensions	5-1/4" H x 19" W x 25-1/2" D	15-3/4" H x 17-1/2" W x 23-1/2" D	5-1/4" H x 19" W x 25-1/2" D
Weight	155 lbs	75 lbs	155 lbs

General

Number System	Binary
Data Word (bits)	16
Instruction Word (bits)	16
Negative Numbers	2's complement
Memory Capacity	4-32k
Memory Type	Magnetic Core
Memory Organization	Page Organization (2048 words or bytes)
Direct Addressing	2048 words (32,768 using Memory Extension Register)
Means of Addressing Expanded Memory	Memory Extension Register

Registers

Addressable Registers	4
Hardware Index Registers	1

Instructions

Number of Instructions	74
Number of Memory Reference Instructions	15
Number of Index Instructions	9
Number of Shift Instructions	20
Number of Test/Jump Instructions	18
Number of Control, I/O and Data Generics	19

Other Instructions and Addressing

Byte Instructions	Load, store, compare, shift
Number of Addressing Modes	3
Literal Instructions	4
Comparison Instructions	Word, byte and literal byte
Shift & Rotate	Accumulator and index right or left, up to 15 positions
Logical AND	Logical product of accumulator and specified memory location
Logical OR	Exclusive/Inclusive OR between accumulator and specified memory location

Input/Output

I/O Lines	Separate 16-bit parallel data I/O and separate 8-bit parallel address

Interrupt System

Automatic Priority Interrupt	Yes
Maximum Number of Interrupts	16
Programmed Input/Output	Processor selects input/output data transfers from accumulator to device or from device to accumulator
Interrupt Type	Automatic Jump and Return to Interrupt Service Routine
DMA Type	Direct device to Memory, fixed priority, interlaced, optional
Real Time Clock	Optional

Display and Controls

Basic Display	P register, Index Register, Accumulator, Memory Buffer, Control Status and Instruction
Controls	RUN, HALT, RESET, Enter Data in Memory, Single Instruction, Step, Display Data in Memory, four Sense Switches and Lockout Switch

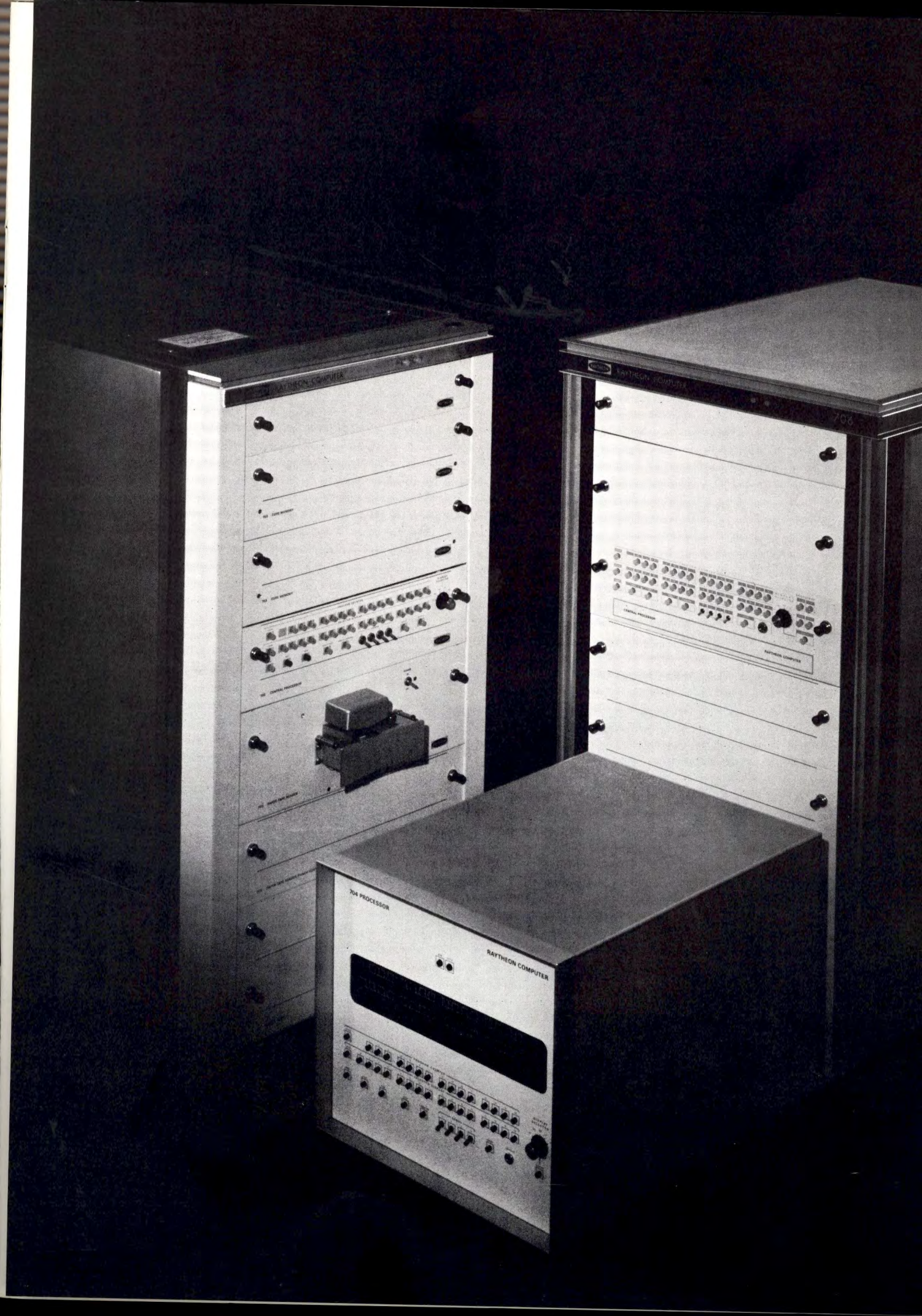
Environmental

Power Requirements	110 Volts AC, 50-60 cycle
Air Conditioning	None required
Temperature	0-40°C

700 Series Instructions

CLASS	MNEMONIC	OPERATION	TIME (CYCLES)
LOAD/STORE	LDB**	Load Byte	2
	LDW	Load Word	2
	LDX	Load Index	2
	STB**	Store Byte	2
	STW	Store Word	2
	STX	Store Index	2
ARITHMETIC	ADD	Add	2
	SUB	Subtract	2
	MPY	Multiply*	7-10
	DIV	Divide*	10-11
LOGICAL	ORI	Inclusive OR	2
	ORE	Exclusive OR	2
	AND	Logical AND	2
COMPARE	CMB**	Compare Byte	2
	CMW	Compare Word	2
JUMP	JMP	Unconditional Jump	1
	JSX	Jump and Store Return in Index	1
SHIFT	SRA	Shift Right Arithmetic	1-5
	SLA	Shift Left Arithmetic	1-5
	SRA D	Shift Right Arithmetic Double	1-5
	SLA D	Shift Left Arithmetic Double	1-5
	SRL	Shift Right Logical	1-5
	SLL	Shift Left Logical	1-5
	SRL D	Shift Right Logical Double	1-5
	SLL D	Shift Left Logical Double	1-5
	SRC	Shift Right Circular	1-5
	SLC	Shift Left Circular	1-5
	SRC D	Shift Right Circular Double	1-5
	SLC D	Shift Left Circular Double	1-5
	SRL L**	Shift Right Logical Left Byte	1-5
	SLL L**	Shift Left Logical Left Byte	1-5
	SRL R**	Shift Right Logical Right Byte	1-5
	SLL R**	Shift Left Logical Right Byte	1-5
	SRC L**	Shift Right Circular Left Byte	1-5
	SLC L**	Shift Left Circular Left Byte	1-5
	SRC R**	Shift Right Circular Right Byte	1-5
	SLC R**	Shift Left Circular Right Byte	1-5
CONTROL	HLT	Halt	1
	INR	Interrupt Return	3
	ENB	Enable Interrupt	1
	DSB	Disable Interrupt	1
	SLM	Set Local Mode	1
	SGM	Set Global Mode	1
	CEX	Copy Extension to Index	1
	CXE	Copy Index to Extension	1
	SML	Select Memory Lower	1
	SMU	Select Memory Upper	1
	MSK	Mask Interrupts	1
	UNM	Unmask Interrupts	1
	SUS	Select User State*	1
	LPL	Load Protect Lower*	1
	LPU	Load Protect Upper*	1
DATA	CLR	Clear Accumulator	1
	CMP	Complement Accumulator	1
	INV	Invert Accumulator	1
	CXA	Copy Index to Accumulator	1
	CAX	Copy Accumulator to Index	1
I/O	DIN	Direct Input	2
	DOT	Direct Output	2
LITERAL	IXS	Increment Index and Skip if >0	1-2
	DXS	Decrement Index and Skip if <0	1-2
	LLB**	Load Literal Byte	1
	CLB**	Compare Literal Byte	1
SKIP	SAZ	Skip on Accumulator Zero	1
	SAP	Skip on Accumulator Plus	1
	SAM	Skip on Accumulator Minus	1
	SAO	Skip on Accumulator Odd	1
	SLS	Skip on Compare Less	1
	SXE	Skip on Index Even	1
	SEQ	Skip on Compare Equal	1
	SNE	Skip on Compare Not Equal	1
	SGR	Skip on Compare Greater	1
	SLE	Skip on Compare Less Than or Equal	1
	SNO	Skip on No Overflow	1
	SSE	Skip on Sense External	1
	SS0	Skip on Sense Switch Zero False	1
	SS1	Skip on Sense Switch One False	1
	SS2	Skip on Sense Switch Two False	1
	SS3	Skip on Sense Switch Three False	1

*Optional
**Byte Manipulation


RAYTHEON COMPUTER
704 PROCESSOR
RAYTHEON COMPUTER

The only thing Raytheon Computer does is your job.

RAYTHEON

The price/performance ratio of the Raytheon Computer 700 Series is the best in the industry. No matter what your application, we'll get you on-line sooner and do your job better and for less money than with any other comparable processors in the 16-bit computer class.

Some of our advantages are based on sophisticated hardware, like our device-independent I/O structure, our cycle-stealing Direct Memory Access option or our large memory page size (the largest in the class.)

Additional advantages are generated by our software. Because our central processors are fully software-compatible, our software has all been field proven, some of it by as much as three years of usage. We now have over 400 fully-documented programs and subroutines available off-the-shelf, ready to go to work in your systems today.

Raytheon Computer

700 series

Our processors do more per dollar than any other computer made

Systems in the field now are performing:

- **data acquisition and reduction** in seismic systems, medical research, analytical chemistry, instrumentation and telemetry systems and weather forecasting.
- **testing on semiconductors,** LSI chips, missile sub-systems and large computers.
- **monitor and control** functions for missile launches, bridge structural analysis, telescope positioning and process and numerical control.
- **simulation** of aircraft and computer systems.
- **data communication manipulation** in airline reservation systems, currency arbitrage systems, and service bureaus.

Raytheon Computer

700 series

The Raytheon Computer 703

The 703 is a low-cost, 16-bit computer ideally suited to be the central control element in data acquisition, data processing, industrial, commercial, engineering and scientific control systems.

Included in the minimal central processor configuration are a 4K core memory, an ASR33 Teletype, a Direct Input/Output bus, one level of Automatic Priority Interrupt and a cabinet complete with an operator's console.

Hardware can be expanded to a 32K memory system with all major peripherals, including disc. Software includes Real-Time FORTRAN IV and conversational FORTRAN, a real-time monitor, an integrated executive system and advanced hardware diagnostic routines.

The low priced 703 is perfect for replacing core buffers and provides design features, operating performance, and programming advantages that make it comparable to more expensive computers.

Performance

Word and byte manipulation instructions, a 1.75μs memory, a real-time priority interrupt system and hardware multiply-divide make the 703 performance comparable to larger computers. Load word, load byte, add and subtract instructions execute in 3.5μs. Hardware multiply-divide, available as an option, executes in 17.5 and 24.5μs respectively.

Compatible Hardware for easy Systems design

For system expansion beyond standard peripherals, there's an almost endless line of compatible Raytheon Computer IC analog and digital modules plus data acquisition and processing instruments made up from these modules.

In addition to the compatible hardware, Raytheon Computer Field Application Engineers provide application and systems design assistance. Raytheon Computer also offers automatic wire wrapping service to user specifications so that systems are delivered assembled, wired and ready to use, at lower cost than if the user performed the assembling and wiring functions himself.

Applications

The Raytheon Computer 703 is being used in applications such as radar data processing, aircraft and helicopter checkout systems and seismic data processing. The 703 is also being designed into systems for message switching, manufacturing test, engine test, signal processing and traffic control.

Features and Characteristics

- 16-bit word length
- 2's complement arithmetic
- 74 hardware instructions
- Direct and indexed addressing
- 4K to 32K Memory
- Byte and word addressing
- Byte manipulation
- Register entry and display control panel
- Programmed word transfer via 16-bit I/O bus
- 1.75μs cycle time
- Real Time Priority Interrupt System
- Software Package — IC diagnostics, assembler, FORTRAN compiler, and executive routines

Options

Direct memory access channels; buffered/unbuffered
High-speed hardware multiply/divide
Real time clock
Peripherals include ASR 33 or 35 with paper tape reader and punch, magnetic tape, line printer, paper tape reader and punch, card reader and punch, disc and Raytheon's line of data systems equipment.

Raytheon Computer

700 series

The Raytheon Computer 704

The Raytheon Computer 704 provides the best price/performance ratio of any computer in the 16-bit general-purpose class.

It has all the versatility, capability and compatibility of large computers, but at small computer prices. Even in its minimum configuration, the Raytheon Computer 704 is a useful tool. The basic 704 includes 74 instructions, word and byte manipulation, 4k of 1.0μs core memory (expandable to 32k), a real-time automatic priority interrupt system, direct I/O to the CPU and four addressable hardware registers. The Raytheon 704 becomes an even more powerful tool with the addition of a real-time clock, hardware multiply/divide, high-speed direct memory access and other available options.

Raytheon Computer's standard peripherals such as teletype, paper tape, card equipment, magnetic tape units, disc, analog converters, timers and plotters can be added in the field as needed. And expanding your equipment beyond these standard devices is not a major design effort. Raytheon Computer will supply any of a large line of analog or digital cards, or data acquisition and processing equipment made up from these cards, to tailor the 704 exactly to your application.

Because the Raytheon Computer 704 is fully software-compatible with our other 700 Series computers, more than 400 programs and subroutines are available off-the-shelf. All have been tested, debugged and proven in data processing and acquisition, instrumentation and communication systems.

Our library includes conversational FORTRAN and a USASI-superset FORTRAN IV, real-time executives and monitors that enable you to perform real-time batch processing, and the fastest, most accurate math library in the 704's class. In addition, an extensive list of other user-directed software is available and the 704 is ready to go to work the day you plug it in.

Packaging of the 704 provides high reliability, minimum downtime and ease of maintenance. The computer is entirely self-contained, with the central processor, memory and power supply in a case that can be desk-top or rack mounted. Additional memory expansion or interface cards plug into built-in connectors inside the case. All logic functions are implemented in TTL IC's on easily accessible plug-in cards. In case of malfunction, our SENSOR diagnostic analyzer locates the problem to reduce your downtime. With each Raytheon Computer 704, you also get free maintenance training and programmer training plus the support of our international service organization.

The Basic Raytheon Computer 704 Configuration

The minimum configuration of the 704 included in the low purchase price consists of:

- Central processor unit, 16-bit words, 74 instructions
- 4096 words of core with 1.0μs cycle time
- Byte manipulation instructions
- Direct and indexed addressing
- Largest page size in its class (2048 words)
- One level of real-time automatic priority interrupt (expandable to 16)
- Operator console with a lockout key switch

It also includes the following software:

- X-Ray system executive
- Real-time device independent concurrent input/output system
- Conversational FORTRAN
- Conversational Assembler (SYM I)
- Relocating, linking loader
- Symbolic editor
- Diagnostics
- Complete math library (9-digit accuracy)
- Utility programs

Raytheon Computer 704 Options

Memory expansion to 32,764 words
High-speed direct memory access
Memory parity
Hardware multiply/divide
Hardware bootstrap
Real-time clock
Interrupt expansion to eight or sixteen levels
ASR 33 or 35 teletype
Multiplexing 12-bit A/D converter plug-in card
Power fail-safe

Raytheon Computer

700 series

The Raytheon Computer 706

The 706 is directed toward the user who requires an expandable, reliable low-cost processor with large computer compatibility and capability.

With its 900ns cycle time and powerful software, it is particularly suited for real-time multiprogramming applications. The processing speed, modular expandability and manipulation characteristics of the 706 are typical of much larger and costlier machines.

The three-way combination of cost/performance/capability makes the Raytheon Computer 706 a natural competitive choice for data acquisition and logging, simulation, traffic control, automatic production and process control, medical research, communications control and general computation.

Responsive Input/Output Structure

Parallel input/output data can be directed over either of two buses, the standard Direct Input/Output Bus or the optional Direct Memory Access Bus. The DIO bus is used for programmed transfers at word rates up to 278KHz. The six channel DMA can be provided for more demanding applications involving word rates up to 1.1MHz.

The Automatic Priority Interrupt system can be expanded to 16 levels. It has a window of 900ns and an interrupt service time of 2.7μs. Interrupt control is programmable.

A new simplified and economical approach to custom-built systems interfaces is provided with the 706—the Raytheon Computer Applications Interface Device (AID) System. Interfacing the 706 with data systems or peripheral equipment is convenient, quick and economical.

Expandable

In addition to memory and mainframe options, peripherals such as paper tape, card equipment, line printer, magnetic tape, disc, analog converters, timers and plotters can easily be added in the field. Several models of each type of peripheral equipment are offered to meet price/performance requirements.

Comprehensive Software

In the 706, the user is provided with a comprehensive software system with efficiency and speed unmatched in computer systems of similar class. The 706 program library includes over 400 programs and routines.

The software includes types usually found only in large scale computer systems, such as our Multiprogramming System (MPS) and Real-Time FORTRAN IV. MPS is a disc-based operating system which permits multiple real-time tasks to be run concurrently with automatic batch processing. Features include dynamic task swapping and hardware inter-task protection and a time based periodic job scheduler.

Low Cost, High Performance

The minimum 706 system configuration includes the following standard equipment features:

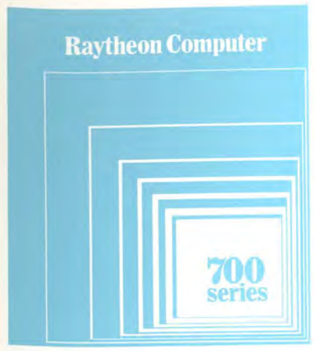
- Central Processor, 16-bit words, 74 instructions
- 4096 words of core memory with 900ns cycle time
- ASR 33 Teletypewriter with paper tape reader and punch
- One level of Automatic Priority Interrupt
- Operator Console with a lockout key switch
- Hardware Bootstrap
- System cabinet

The BASIC Software System shipped with this configuration contains XRAY system executive, IOS real-time device independent input/output system, conversational FORTRAN, assembler and relocatable loader, symbolic editor, diagnostic, MATH library and utility programs.

The Raytheon Computer 706 arrives ready to solve problems.

Peripheral Equipment for the Raytheon Computer 700 Series

A full line of peripherals is available to meet various price/performance requirements.



Low-Speed Paper Tape Reader/Punch and Printer

Teletype Models ASR-33 or 35 read and punch paper tape at 10 characters per second. All transfers are character buffered and occur over the standard DIO bus. Both ASCII and ASCII-8 modes are included.

High-Speed Paper Tape Reader and Punch

Reads 8-channel paper tape at 300 characters per second. Contents of selected memory programs or data can be punched onto paper tape at 110 characters per second. The data transfer is character buffered and utilizes the standard DIO bus.

Card Reader and Punch

Standard 12-row, 80-column punched cards can be read at 400 cards per minute or 1100 cards per minute. Data and programs can be output in hollerith or binary at 100-400 cards per minute with the card punch. Data is buffered in parallel on a column basis and transferred over the standard DIO bus for both input and output.

Line Printer

Printed copy can be output at 245, 360, 600 or 1000 lines per minute, 132 columns wide. Full line and character buffering is provided with the standard 64 character set. Control for automatic page formatting is included.

Seven-Track and Nine-Track Synchronous Magnetic Tape

7-track and 9-track IBM-compatible magnetic tape units are available. Models with speeds of 25, 36 or 75 ips and densities of 200, 556 or 800 bpi are available to provide you with the best possible cost/performance ratio for your application.

These magnetic tape systems provide effective data flow for low and high-speed application requirements. Lateral parity, LRC and CRC checks assure accuracy of data.

Direct program control over the standard DIO bus operates the lower speed 25 ips drive. All data transfers occur between the accumulator and the controller. Up to four units can be accommodated by a single controller.

Random Access Disc Storage

The fixed head disc provides 385,024 words of bulk storage. Average access time on any of the 64 tracks is 16.6 ms. Word transfers up to 143KHz are obtained via the Direct Memory Access Bus. Each controller can handle up to four disc drives.

A movable head disc is also available using the IBM 2316 disc drive or equivalent. Data transfer rate is 312,000 bytes/sec and disc capacity is over 29 million bytes. Up to 4 disc drives can be operated with a single controller.

Real-Time Clocks

Various time-of-day clocks, interval timers, and elapsed-time counters are available. Typically, only the standard DIO bus and one interrupt level are required.

Analog Instruments

Raytheon Computer's exclusive MINIVERTER™ and MULTIVERTER® are standard analog "front end" instruments. Each includes a multiplexer, sample-and-hold amplifier and an analog-to-digital converter in a single compact unit. Conversion rates range from 15 to 100 KHz and resolution from 10 to 15 bits in binary or BCD modes. Up to 128 input channels can be provided. Accuracy varies from 0.1% to 0.01% ± ½ LSB, depending upon the device used.

Conversion to analog signals for 10 to 15-bit digital data is provided by a variety of precision digital-to-analog converters. Up to 16 channels can be housed in a single 19-inch drawer. Typical accuracy is 0.05% ± ½ LSB with ± 10 volts full scale operation.

Teletype Multiplexer

Concurrent operation of up to 16 teletype terminals — ROs, ASRs or KSRs — is provided by the TTY Multiplexer at 10 char/sec over the standard DIO bus. EIA standard 232 B level conversion for modem operation is available.

Data Set Interface

To accommodate data communications over remote lines, various modern controllers for half or full duplex operation are available. Transmission is either synchronous or asynchronous with rates varying from teletype to wideband.

The only thing Raytheon Computer does is your job.

With Raytheon Computer software, you'll never have to write a systems program. We have operating systems for even the minimum configurations of all our processors.

And even your applications programming will be easier because we have a library of over 400 field-proven, fully-documented programs and subroutines available off-the-shelf. Our programs take less core and work faster than competitive software, so you'll be able to do more and do it faster on a smaller computer.

Our software contains executives and monitors for multiprogramming systems, disc and mag tape operating systems, the only small computer Sort/Merge package and a number of features commonly found only in much larger computer systems.

Raytheon Computer

700 series

The most complete, most efficient software in the 16-bit computer class

- Over 400 field-proven, fully documented programs and subroutines.
- Real-time and multiprogramming systems.
- Assemblers and compilers.
- Monitors and executives.
- FORTRAN IV.
- Math library.
- Diagnostics and test programs.
- Application programs.

RAYTHEON

The Raytheon Computer 700 Series is an integrated hardware/software system providing advanced design in software as well as hardware.

Hardware/software architecture allows for modular growth from a 4096 word processor with ASR 33/35 to a 32,768 word system with disc and other major peripherals. Features are incorporated for the programmer who is constructing real-time, time-sharing control programs. XRAY EXEC, PREP, Symbolic Program Editor, TRACE and SYM I are innovations that provide a convenient man-machine interface in program preparation, debugging and execution.

Customers benefit from reduced memory requirements, greater speed, efficient utilization, comprehensive diagnostics, and detailed documentation. Unique capability is presented in a specially developed package for detection and identification of hardware faults.

Programming systems vary from the simple to the sophisticated. As the system grows, the modular software expands. Each software system contains an assembler (SYM), a system-fitted I/O monitor and executive program; PREP, Symbolic Program Editor; TRACE; and the System Editor.

Monitors and Executives

Raytheon Computer provides fast, efficient executives and monitors for any size of computer system (see chart, page 17). The full power of the sophisticated interrupt system and real-time instructions of the 700 Series of computers can be fully exploited, whether your application calls for our minimum hardware configuration or for everything we've got.

If you're on-line with one of our more powerful systems, you'll find that our Real Time (disc) Operating System (RTOS) and Multiprogramming System (MPS) are integral hardware/software systems that give you a powerful real-time capability. The MPS has facilities for dynamic task-swapping, hardware inter-task protection, and time shared job scheduling. Programs and data in memory are fully protected from inadvertent destruction by our hardware memory protect.

Assemblers and Compilers

SYM I. For systems with only 4K of memory and an ASR 33, the one-pass SYM I assembler provides unparalleled capabilities. It requires only one pass of the source program to produce a source listing, object listing, and object tapes. Object program output may be either relocatable or absolute. Advanced assembler features include forward defined symbols, 11 pseudo operations including TRUE/FALSE conditional directives, operand expressions, and MACRO subroutine calls.

The assembler includes a PREP option which allows the user to prepare his program in the conversational mode with assembler assistance. Another option permits programs to be assembled directly into memory for immediate execution without requiring a load phase.

SYM II. The SYM II assembler is a fast and powerful two-pass system with procedural capabilities. In larger system configurations, it processes statements internally at rates in excess of 3,000 statements per minute for each pass and its throughput rate is limited only by the speed of the system peripherals.

SYM II produces either absolute or relocatable output. Procedures, subroutine macros, and thirty pseudo operations simplify programming and multiple assemblies can be run without reloading SYM II.

Conversational Fortran. Conversational FORTRAN enables the user of small systems to develop effective programs without knowledge of the computer's internal structure. It combines the conversational ease of BASIC with the capabilities of the "most used" subset of FORTRAN IV.

Memory utilization is optimized with this one-pass compiler so that large programs can be run (100 statements in 4k of core, 500 statements in 8k of core). A LOCATE declaration statement, similar to DIMENSION, links assembly language I/O subroutines to the FORTRAN program and provides data arrays common to both types of programs. This allows data to be acquired efficiently under control of the FORTRAN program used for processing.

A very fast floating point function library provides 9 decimal digit accuracy. Other features include a run-time TRACE option, binary logical functions and a program PREP mode. The capabilities of Conversational FORTRAN make it possible for users of Raytheon Computer systems to prepare data acquisition, process control and other application programs in FORTRAN, rather than assembly language, thus saving time and money.

Real-Time Fortran IV. Real-Time FORTRAN IV is an extended superset of ASA Standard FORTRAN. It has the fastest execution time of any other FORTRAN in this computer class. Extended features include:

- Relaxation of syntax restrictions
- Real-time capabilities
- Mixed expressions and compound statements
- N-dimensional arrays and generalized subscripts
- Multiple replacements in statements
- Mid-precision floating point numbers
- Double-precision integer numbers
- Extended relational operators and expressions
- In-line symbolic machine instruction

The compiler, in one-pass, produces symbolic text for input to the SYM II assembler at internal rates in excess of 1,200 statements per minute so that compilation speeds are limited only by the user's peripheral devices.

Library Programs

System Generation. Several system processors prepare and edit paper tape, magnetic tape and disc libraries. Two System Generation programs (SYSGEN 1 and SYSGEN 2) provide automatic generation of the absolute and relocatable disc libraries. A library extension processor permits programs to be replaced or added to the disc library after system generation. A System Editor maintains libraries on magnetic tape or paper tape.

Loaders. Relocatable and absolute loaders are provided for all 700 Series software systems. The relocatable loaders feature automatic library search, augmented memory allocation, and relocatable correction records. Options include printing a load map, loading TRACE/DEBUG, and executing despite missing.

Real-Time (disc) Operating System (RTOS) and Multiprogramming System (MPS) both contain two libraries on the disc: the processor library and the relocatable library. The processor library contains programs which are in core image format, while the relocatable library contains those programs and subroutines whose locations in memory are determined by the system loader at load time. Each library has its own directory containing a list of the programs and their location on the disc. In this way, programs are located directly without a time-consuming serial search process.

FORTRAN IV Library. Our FORTRAN IV library contains 107 subroutines which perform 74 intrinsic and external functions, including all functions specified in ASA Standard FORTRAN and 19 additional functions. All functions are designed for fast execution in real-time environments, and the entire library is coded in machine language, with algorithms chosen for fast execution.

Math Library. A comprehensive set of 37 mathematical operations for SYM I and SYM II users are included in the Math Library. The library includes Double Precision Fixed Point and Floating Point Packages, in addition to Fixed Point multiply/divide subroutines and Binary/BCD conversion routines. No additional hardware is required for operation of the above routines, although allowance is made for the hardware MPY/DIV option for significant increased speed of associated double precision/floating point operations. A precision of 9 decimal digits is provided by both double precision fixed point and floating point formats. The problems of fixed point scaling are eliminated with floating point operation and the programmer can take advantage of its wide numerical range, $10\pm^{38}$.

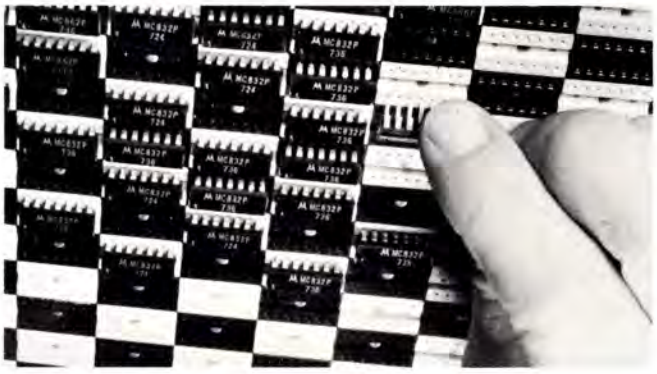
A complete set of very fast floating point trigonometric and transcendental functions are also provided. Scaling factors associated with fixed point functions are eliminated and the full range of $10\pm^{38}$ is incorporated with a precision of 9 decimal digits. Functions include sine, cosine, square root, arctangent, exponential, hyperbolic, tangent, and natural logarithm.

Sensor Diagnostics

Unique in the 700 Series class of machines, SENSOR hardware diagnostics test and verify operational integrity. SENSOR programs and procedures are organized and documented to simplify the job of maintenance personnel and reduce system down time to minutes.

The SENSOR package includes technical programs and procedures designed to detect and isolate malfunctions in the central processing unit. When a malfunction occurs, whether it's major or minor, or in the event of routine system testing, diagnostic programs are bootstrap loaded into the CPU. SENSOR procedures provide fault detection and isolation instructions in the event bootstrap loading is unsuccessful.

Once loaded, error messages typed by the diagnostic program, and use of technically annotated program listings with fault isolation information, enable rapid repair of faulty components. Typically, CPU faults are isolated to six or fewer integrated circuits and, in many instances to an individual IC element.



Also included in the SENSOR package are numerous performance test programs designed to test the proper operation of the 700 Series peripherals. These programs provide software performance test capability as they exercise the XRAY EXEC, I/O drivers and other basic software elements in the same way operational software utilizes the system.

Contract Software Services

Many computer users do not have the experience to effectively implement special programs. As a result, many employ programming consultants to prepare their specific application programs.

Recognizing this requirement, Raytheon Computer will assume total systems responsibility for both hardware and software upon request. Dedicated system programs are quoted on a fixed price, or time and material basis.

The total system approach provides fully operational systems immediately, ready to be used.

HARDWARE CONFIGURATION / SOFTWARE AVAILABLE	MINIMUM CONFIGURATION ★ Central Processor ★ ASR 33 ★ 1 level of interrupt ★ 4k of core memory	ADD OPTIONS: ★4k memory expansion ★High speed paper tape reader	ADD OPTIONS: ★4-level automatic interrupt expansion ★Direct Memory Access ★Disc or magnetic tape	ADD OPTIONS: ★8 level automatic interrupt expansion ★8k memory expansion ★Memory protect ★Real-time clock ★Operator interrupt
ASSEMBLERS AND COMPILERS				
SYM I/Prep Assembler [1]	—	—	—	—
Conversational FORTRAN [2]				
SYM II Assembler		—	—	—
Real Time FORTRAN IV				
PROGRAM GENERATION				
Symbolic Program Editor	—	—	—	—
Symbolic Program Preparation [1]				
FORTRAN Program Preparation [2]				
Trace/Debug				
MONITORS AND EXECUTIVES				
X-RAY Exec	—	—	—	—
Resident Monitor [3]				
Input/Output Software (IOS)				
Paper Tape Input/Output System (PTIOS)				
Standard Operating System (SOS)		—	—	—
Magnetic Tape Operating System (MTOS)				
Real-Time Operating System (RTOS)			—	—
Multiprogramming System (MPS)				
LIBRARY PROGRAMS				
Basic Loader	—	—	—	—
Conversational FORTRAN Library				
Math Library				
Standard Loader				
System Editor				
Real-Time FORTRAN IV Library		—	—	—
Disc Loader				
System Generators				
Sort/Merge				
DIAGNOSTICS				
Sensor	—	—	—	—

1 — SYM I Assembler also includes Prep Program
2 — FORTRAN Program PREP is part of Conversational FORTRAN Package
3 — X-RAY Exec and Resident Monitor are combined for minimum system

The only thing Raytheon Computer does is your job.

RAYTHEON

Raytheon Computer
700 series

Interfacing with peripherals or other systems is more than a problem in engineering; special programming is often required for effective communications. In many cases, this special programming costs more than the hardware for the interfaces.

Raytheon Computer has an integrated hardware/software system that solves both problems. Interfacing is inexpensive, programming is efficient and execution is fast.

Our input/output system gets you on-line sooner, for less money

- Instant hardware interfaces for any equipment, data processing or process control, analog or digital, from DVM's to spectrophotometers.
- Device-independent software that allows devices to be changed without any changes in the programming.
- Simplicity. Two instructions completely operate the I/O System, no matter what device is being controlled.
- Power. Maximum word rate is 278 KHz with the Direct Input/Output (DIO) channel in the minimum configuration, 1.1 MHz with optional Direct Memory Access (DMA) for the 706 processor.

Direct Input/Output (DIO)

The DIO channel, included in the basic processor configuration, is used for program transfers between the accumulator and up to 16 peripheral controllers. The DIO channel is used for data transfers with slow speed devices and also for control of peripheral devices which operate on the DMA channel.

The modular design of the input/output system makes it possible to field expand or re-configure at any time.

Data transfers, device commands, and status requests are executed in two machine cycles. Data and status are transferred between the accumulator and the selected device by either of two methods, program controlled or interrupt controlled. This mode is most useful where data is volatile or dependent upon irregular conditions.

Direct Memory Access (DMA)

The DMA channel, available as an option, is used for direct access to memory without programmed intervention. It can accommodate up to 6 high-speed peripheral devices, each having its own level of priority. The priority is completely separate from the Automatic Priority Interrupt System of the central processor. The DMA channel operates in a cycle-stealing mode. When the central processor does not require the use of memory during the execution of an instruction, computation and memory access by the DMA channel can occur simultaneously. Maximum transfer through the DMA channel can be up to the speed of the memory.

The DMA is most effectively used with devices such as disc, magnetic tape, and high-speed data acquisition instruments where fast response to a data transfer request is required. Maximum wait time for the highest active input/output request is one cycle. Cycle stealing never requires more than one machine cycle per memory access. DMA devices are also interfaced to the DIO bus for the transmission of commands, memory data transfer parameters and status information.

Automatic Priority Interrupt System

The Automatic Priority Interrupt System has access to the central processor via the DIO channel and is used to provide rapid response by the central processor to external conditions in the Input/Output System.

The basic configuration has one level of priority interrupt as standard and can be expanded to 16 levels. Each level can be assigned to a specific peripheral device or it can be shared by a number of devices. Every processor in the 700 Series has five instructions which allow the programmer to achieve full utilization of the interrupt system.

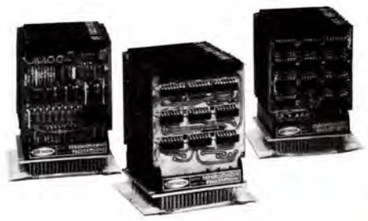
Full interrupt response time is 3 cycles following receipt of an interrupt with a duration of at least one cycle. An automatic hardware sequence verifies that no higher interrupt level is pending or active and stores the program counter, machine status, and jumps to the linkage address for that particular level. No software polling of devices is required to determine the source of the interrupt. A higher priority level request can immediately interrupt the service routine of an active lower level. Pertinent information is efficiently saved under hardware control and an automatic return can be made upon completion of the service of the higher level.

AID System

AID — Applications Interface Device — provides a method for attaching data systems or peripheral equipment to 700 Series processors. It is made up of modular functional components which allow the interface to be adapted to a wide variety of device characteristics. This flexibility permits configuration of the interface hardware for optimum performance of the overall computer application.

Functionally, AID performs as a data channel in communicating with the central processor by providing timing and control for the transfer of data over either the DIO channel or the DMA channel. Data may be assembled and buffered at the interface and transfers made on a demand-response basis with the peripheral equipment. This provides a means of attaching devices whose data and speed characteristics differ greatly from those of the central processor. AID functional blocks include buffered data channels, analog-digital conversion equipment, sampling timers, elapsed time clocks, status testing, event counters and sense/control lines.

AID is intended for interfacing instrumentation and control systems, and provides an economical means to meet a wider range of unique device requirements.



A/D Converters

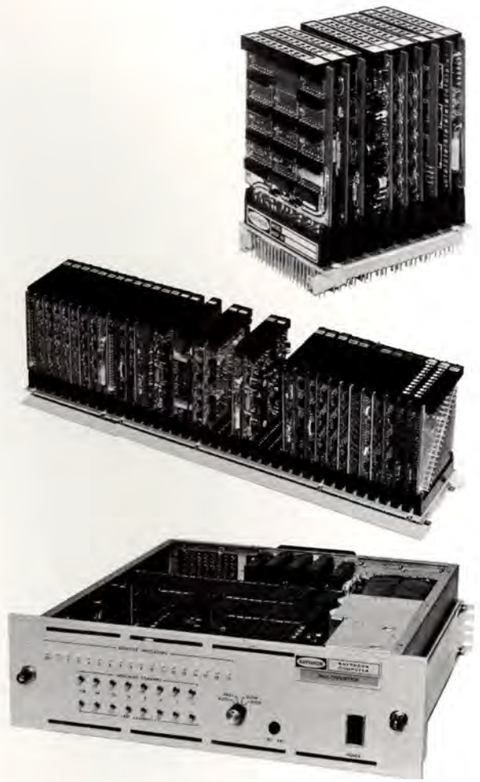
Raytheon Computer builds an extensive line of analog-to-digital conversion equipment, including basic ADC's, multiplexing ADC's, simultaneous sample-and-hold equipment, and multiplexing equipment. This equipment is available in single or multiple channels and in a variety of physical configurations *completely wired, tested,* and *documented.* Resolution is available in 10-bit, 12-bit, and 15-bit binary, and in 3-digit BCD.

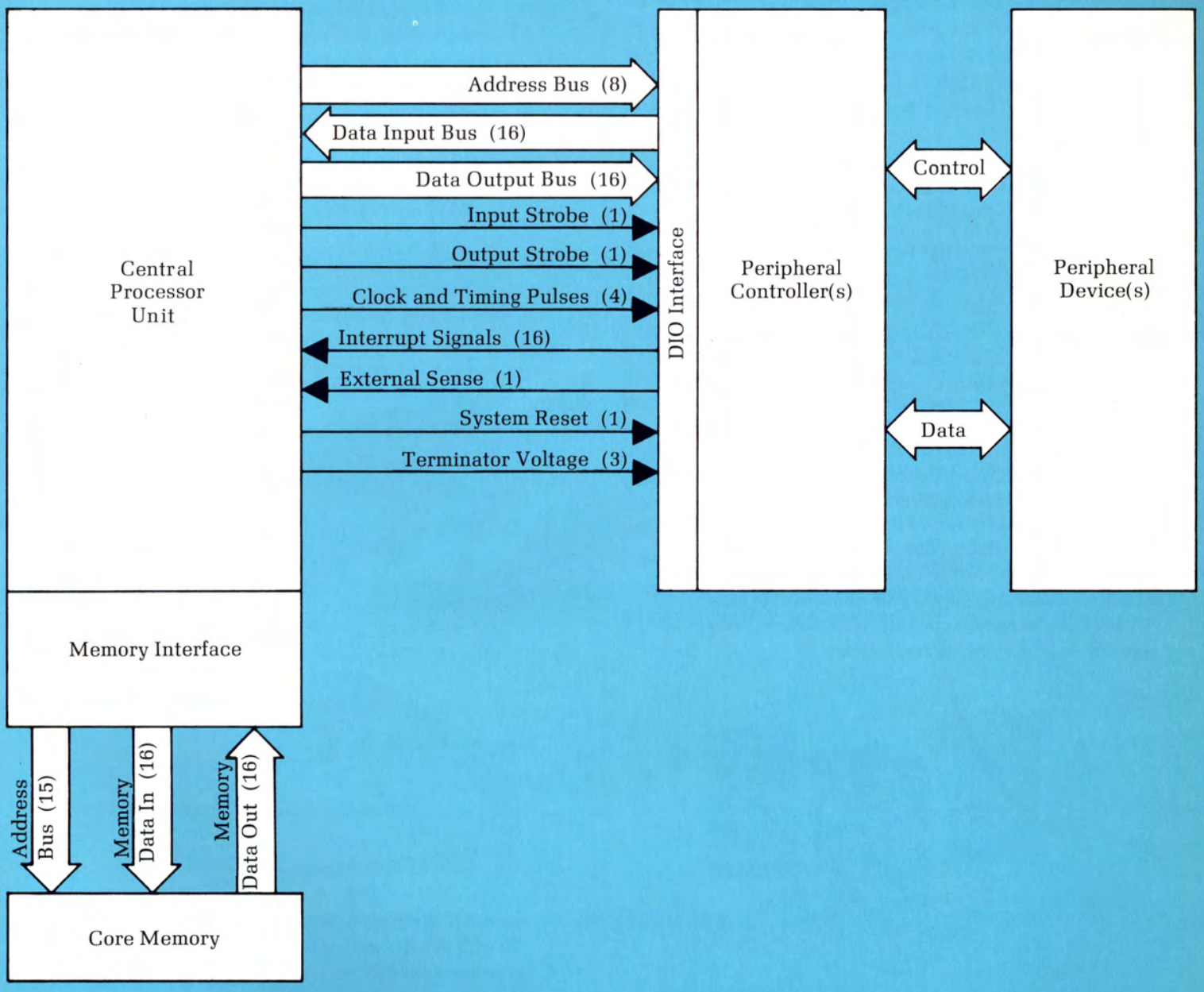
Raytheon Computer multiplexing ADC's (Miniverters™) feature a MOS-FET multiplexer, a sample-and-hold amplifier, and an A/D converter in a single chassis. A variety of options in packaging, speed and performance is available. The units are supplied fully wired and tested in connector block assemblies or case mounted. The 15-bit unit, referred to as the Multiverter III®, features 100 KHz throughput and low power consumption.

D/A Converters

Digital-to-analog conversion equipment is available from Raytheon Computer in a wide range of configurations and types. Resolution of 10 and 12-bits binary is provided. (Consult the factory for availability of 14 and 15-bit resolution.) Capacities range from single channel DAC's contained on two printed circuit cards to up to 48 channels rack mounted with front panel controls and indicators. The units are all high-speed, low-cost DAC's with high-packing density.

The rack mounted configurations (standard 19-inch Retma) are fully assembled, *wired and tested,* and contain the necessary drive and storage electronics. They also offer several options such as front panel controls, computer interface and power supplies. Up to four channels of D/A conversion can be provided fully wired and tested in a connector block assembly. These units include input storage register, output operational amplifiers, reference supplies and data and address drivers.




Central Processor Unit
Memory Interface
Address Bus (15)
Memory Data In (16)
Memory Data Out (16)
Core Memory
Address Bus (8)
Data Input Bus (16)
Data Output Bus (16)
Input Strobe (1)
Output Strobe (1)
Clock and Timing Pulses (4)
Interrupt Signals (16)
External Sense (1)
System Reset (1)
Terminator Voltage (3)
DIO Interface
Peripheral Controller(s)
Control
Data
Peripheral Device(s)

Raytheon Computer

700 series

Service and support

By developing the 700 Series systems and software in-house, Raytheon Computer has developed an organization with significant depth and technical capabilities. You can depend on better support in training, warranty, documentation, systems programming and program library.

Training

At regular intervals, Raytheon Computer offers programming and maintenance training classes as part of the service provided to customers. These courses are conducted at the Raytheon Computer facilities in Santa Ana, California, and include instruction by experienced personnel together with training manuals and supplies. Classes are confined to small groups assuring adequate individual attention to attendees. By conducting classes at Raytheon Computer's headquarters, the full resources of its technical staff and computer facilities are available to support training activities. Raytheon Computer will also conduct classes at individual customer sites for a nominal retainer.

Warranty

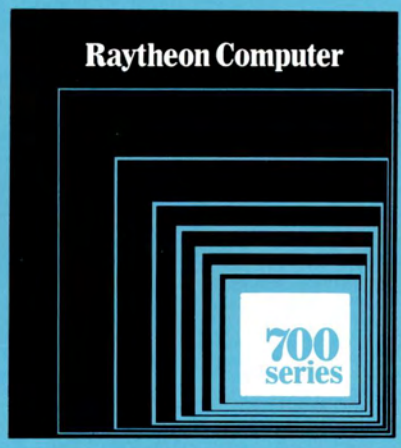
Raytheon Computer 700 Series equipment is warranted for a period of 90 days following shipment. Software is warranted for a period of one year. Raytheon Computer warrants that all software delivered is free from logical defects and performs to applicable published specifications. Any defective programs will be corrected or replaced.

Documentation

A complete set of supporting documentation is delivered with each computer. Software documentation includes fully annotated source listings, detailed flow charts and complete operational and maintenance descriptions. With thorough documentation, the customer can take advantage of the full capabilities of our hardware and software. The documentation also provides the tools necessary to modify or expand the software to meet special requirements.

Service

For your assistance, Raytheon Computer maintains a qualified staff of systems-oriented Applications Engineers. Field applications engineers are assigned throughout the country to assist you with logic design, special circuits and system implementation. We also maintain a staff of factory applications engineers to provide assistance as required. Raytheon Computer maintains sales and service centers in strategic cities throughout the United States. If you should ever require service or additional information about any of our products, please write or phone Collect to your nearest Raytheon Computer office.



RAYTHEON

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