## OUTPUT

| Media | Speed | No. of Multiplexed Channels |
|---|---|---|
| Flexowriter | 10 chars/sec | |
| Teletype via Buffer | 10 char/sec | 7 |
| Charactron via display console | 15,000-20,000 ch/s | 30 |
| Flight strip via display console | 15,000-20,000 ch/s | 30 |
| Flight strip punch and printer | 10 char/sec | 12 |
| Data Link | 30 char/sec | 7 |
| Analog-Digital conv to radar trackers | 30 char/sec | 2 |
| Inter Computer via buffer | 200,000 char/sec | 1 |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

(For a minimum system)

| Type | Quantity |
|---|---|
| Tubes | 0 |
| Diodes | |
| About 5 types | 1,500 |
| Transistors | 23,000 |
| 2N393 | |
| 2N599 | |
| 2N416 | |
| 2N498 | |
| 2N404 | |
| 2N595 | |
| and a few others | |

## CHECKING FEATURES

Checking features include parity on all registers, and all information exchanges between units. A dual adder is used in the arithmetic unit. Complete checking is performed.

Maddocks Photo for Librascope Division, GP, Inc.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 3 Kw |
| Power, air conditioner | 2 Kw |
| Volume, computer | 140 cu ft |
| Area, computer | 23 sq ft |
| Floor loading | 20 lbs/sq ft |

Air conditioner is internal

| | |
|---|---|
| Weight, computer | 3,000 lbs |

Air conditioner is included in above

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 2 |
| Number in current operation | 1 |
| Number in current production | 2 |
| Time required for delivery | 12 months |

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Construction techniques utilized to insure reliability includes "NOR" circuitry, RTL logic, 100% incoming inspection, rigid testing, "worse, worse" case type of design, extensive field reports on failures plus immediate corrective action, and the use of double rank registers.

## ADDITIONAL FEATURES AND REMARKS

System is particularly suited to systems requiring random retrieval from large unsorted files and systems with large numbers of input-output devices.

Maddocks Photo for Librascope Division, GP, Inc.

## FUTURE PLANS

It is planned to change to a 6 microsecond memory cycle time and increase the pulse rate, which will reduce the operation times by a factor of 4. Also, index registers will be added and the drum capacity will be increased.

## INSTALLATIONS

Librascope Division of General Precision, Inc.
808 Western Avenue
Glendale 1, California

# LIBRASCOPE ASN 24

Librascope ASN 24 Airborne Digital Computer

## MANUFACTURER

Librascope Division
General Precision, Incorporated

Photo by Librascope Division, GP, Inc.

## APPLICATIONS

The ASN-24 Computer is a highly versatile general-purpose electronic digital computer which by virtue of its non-fixed internally-stored program, is easily adaptable to many commercial, scientific and military uses. In addition, its small size and weight and low power requirements make it particularly well suited for application in compact systems.

While the ASN-24 Computer can be utilized for extensive on-line general purpose computing applications, it has been designed primarily to satisfy the complex environmental and operational performance requirements of airborne/spaceborne systems real-time applications. The computations may be made from doppler derived ground speed, manually fed fixes, true heading, celestial position determination, and radio aids. Automatic inputs of the following form may be accepted. (When utilized with appropriate complementing input-output equipment):

Compass heading
Astro compass heading
True air speed
Doppler ground speed and drift angle
Inertial velocity
Radio aids
TACAN range and bearing
Automatic sextant (Celestial altitude and azimuth)
Altitude above terrain or above sea level
An internal standard for both sideral and solar time
Star tracker
New equipment as it is developed

Information may also be fed into the computer manually. Manually stored information may be latitude, longitude, range, bearing, wind force or angle, or any direct fix data not available from the aircraft's instrument.

Basic data necessary for navigation may be set manually into the computer before take-off, or in the air.

The ASN-24 will perform the following basic computations as well as solve other desired navigational problems:

Ground position in latitude and longitude with computing errors not to exceed 0.01% of distance traveled.

Ground track

Polar navigation

Great circle course and distance to alternate destinations

Magnetic variation and true heading

Wind direction and velocity (and has provision for wind memory)

Celestial fixes

Position from radar or radio aids (and will check these fixes for credibility)

Range and bearing to a moving target

Range and bearing to a collision point with a moving target

Time to destination

Altitude and azimuth of a celestial body

Image motion compensation and timing for aerial photography

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 25 |
| Binary digits/instruction | 25 |
| Instructions/word | 1 |
| Instructions decoded | not applicable |
| Arithmetic system | Fixed point |
| Instruction type | Two-address (One-plus-one) |

The "one-plus-one" addresses are of the operand and the next instruction.

Number range -1 to $+1 - 2^{-24}$

Instruction word format

| $P_{24}P_{23}P_{22}P_{21}P_{20}$ | $P_{19}P_{18}P_{17}P_{16}P_{15}$ | $P_{14}P_{13}P_{12}P_{11}P_{10}P_{9}$ | $P_{8}P_{7}P_{6}P_{5}P_{4}P_{3}$ | $P_{2}P_{1}P_{0}$ |
|---|---|---|---|---|
| $T_\alpha$ | $T_\beta$ | $S_\beta$ | $S_\alpha$ | 0 |

$T_\alpha$ ($P_{24}$ - $P_{20}$) represents the track address of the next instruction

$T_\beta$ ($P_{19}$ - $P_{15}$) represents the track address of the operand (except for transfer and store orders)

$S_\beta$ ($P_{14}$ - $P_{9}$) represents the sector address of the operand (except for transfer and store orders)

$S_\alpha$ ($P_{8}$ - $P_{3}$) represents the sector address of the next instruction

0 ($P_{2}$ - $P_{0}$) represents the order to be performed

Transfer Orders: ($T_\beta$, $S_\beta$) represents the track and sector addresses of the next instruction if the contents of the accumulator is positive

Store Orders: ($T_\beta$, $S_\beta$) defines the location into which the contents of the accumulator is stored, or defines the modified store order to be performed

Automatic built-in subroutines include Add, Subtract, Multiply, Divide, Extract, Clear and Add, Conditional Transfer on Sign of Accumulator, Store, and Modified Store (Multiple).

Registers include 4 recirculating registers. These are the Instruction, Accumulator, Multiplier, and Multiplicand.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 625 | 156 |
| Mult | 4219 | 3907 |
| Div | 4375 | 4063 |

Construction (Arithmetic unit only)

| | |
|---|---|
| Transistors | 382 |
| Diodes | 3553 |
| Capacitors | 347 |
| Transformers | 87 |
| Resistors | 1894 |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 2,560 | 64,000 | 10,000 Max<br>156 Min |

## INPUT

| Media | Speed |
|---|---|
| Incremental Pulse Train | 0-6000 pps |
| Shaft Position to Binary Coded Discs | Sample: 100/sec<br>Slew Rate: 800 bits/sec<br>Speed can be made higher |

Input/output equipment must be designed for each particular application; however, the particular design and wide applicability of the ASN-24 Computer insures minimum required design effort for input/output equipment.

## OUTPUT

| Media | Speed |
|---|---|
| Discretes (voltage pulses) | Max 100 pps |

Signals of various time lengths and amplitudes are possible. Signals used to excite other equipment, close relays, etc.

| | |
|---|---|
| Encoder Disc | Sample: 100 or 200/sec<br>Slew Rate: 800 bits/sec |

Can be coupled to synchro, potentiometer, or other similar type shaft mechanism.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Diodes | 3,553 |
| Transistors | 382 |

Only silicon diodes and transistors are used for high temperature operation capability. These units have high back resistance and low leakage characteristics at high temperatures. The higher collector voltage ratings of silicon transistors permit larger logic swings, these reducing the susceptibility of the computer to noise.

The resistors are 1/4 watt, carbon composition type, have low dielectric loss, DC resistivity, and high thermal shock resistance.

Most of the capacitors are a solid tantalum type which have high dielectric strength and

have no derating of voltage over a large temperature range. The very small capacitors are the subminiature ceramic type.

## CHECKING FEATURES

Routines programmed to check all instructions or order codes and the contents of the memory. Discrete signals, suitable for driving indicators, generated to indicate successful completion of check routines. The support equipment includes a Fill-Test Unit, which will fill and check memory contents in conjunction with a tape reader and control the computer program with one-step or loop operation. It also provides test route and synchronization signals for oscilloscope presentation of computer information and Card Checker will check operation of individual circuit and logic cards.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 0.132 Kw | 0.189 KVA | 0.7 pf |
| Does not include I/O | | | |
| Volume, computer | | 0.55 cu ft | |
| Area, computer | | 1.42 sq ft | |
| Weight, computer | | 37 lbs | |

System requires a suitable surface, table, etc., that is fairly steady, can support 31 lbs. etc. System requires only electrical power outlets, 28v DC and 3 phase, 400 cycle AC.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 4 |
| Number in current operation | 3 |
| Number in current production | 12 |
| Number on order | 16 |

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift |
|---|---|
| Supervisors | 4 |
| Analysts | 1 |
| Programmers | 3 |
| Clerks | 4 |
| Engineers | 20 |
| Technicians | 7 |
| Draftsmen | 13 |

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include extremely wide variety of applications, operation under sea-level to space environments, light weight, low power drain, in actual operation in field, programmable high speed (200 times (sec). Integration of inputs and/or extrapolation of outputs independent of main authentic section, and data read-out for telemeters.

Basic computer unit designed and in field operation, input-output can be designed to meet a multitude of applications with minimum cost and time expenditures. Tie-in with pulse integrating accelerometers.

Magnetic Memory Drum

Capacity and Tracks:
41 tracks (1600 bits/track) of non-volatile main memory, arranged as follows: 38 tracks with 1 read head each; 2 tracks with 1 read and 1 write head each; 1 track with 1 read head and a 200 bit recirculating register.
1 1600 bit clock track
2 25 bit recirculating registers (2 registers on each of 2 tracks)
1 25 bit recirculating register with 4 additional heads on the same track
1 track with head spacings for either 200 bit or 800 bit recirculation.

Speed:
6,000 rpm

Clock Frequency:
160 kc

Motor:
Location: Contained within drum
Power: 35 watts from 3 phase, 400 cycle, 208 volt Line-Line (60 watts starting power)

Runout:
0.0001 T.I.R.

Drum Assembly Dimensions (including shroud, a head mounting surface surrounding the drum proper; cover; and heads):
6 1/2 inch diameter x 5 11/16 inches long

Drum Assembly Weight (including shroud, cover and heads):
11 1/2 lbs

Drum Surface:
The entire drum surface is milled, similar to the clock track on many other drums (i.e. slotted), with the slots parallel to the axis of rotation. There are 1600 slots around the drum periphery. After milling, the slots are filled with 3M iron oxide.

Heads:
Separate read and write heads are used with this drum. Minimum readback from read head is 0.4 volts peak to peak. The write head requires a 300 ma peak current of 2 microseconds duration through a half-winding. Storage tracks with only read heads requires special techniques.

Environmental Specifications

Ambient Temperature Range:
-55° C to +100° C

Humidity:
Entire assembly can be hermetically sealed

Altitude:
Sea-level to space

Shock:
20g for 11 milliseconds

Vibration:
6g from 15 cps to 2000 cps

Constant Acceleration:
10g radially, 3g axially

## FUTURE PLANS

Many possible new applications being investigated and radiation testing of circuitry is being planned.

# LIBRASCOPE CP 209

Librascope Model CP 209

## MANUFACTURER

Librascope Division
General Precision, Inc.

## APPLICATIONS

System is used for airborne navigation and bombing ballistics, including loft, and real-time, high speed tracking problems.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 14 |
| Binary digits/instruction | 6 |
| Instructions/word | Variable-One, Two or Three |
| Instructions decoded | 30 |
| Arithmetic system | Fixed point |
| Incremental or Digital | Differential Analyzer |
| Instruction type | |
| System can process 8 operands, storing them in 3 parallel positions. | |
| Number range | $\pm (2^{27} - 1)$ |

Automatic built-in subroutines include integration and sine-cosine.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 59 | 59 |
| Mult | 59 | 59 |
| Div | 177 | 177 (by sub routine) |

| Construction (Arithmetic unit only) | |
|---|---|
| Vacuum-Tubes | 304 |
| Transistors | 100 |
| Condenser-Diodes | 4,500 |
| A-D inputs | 12 |
| D-A outputs | 14 |
| Arithmetic mode | Parallel Arithmetic Units operating Serially |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Medium | No. of Words |
|---|---|
| Magnetic Drum | 85 Computational Blocks with 4 Integrand Lines |

## INPUT

| Media | |
|---|---|
| Paper Tape | Used to fill Memory |
| Analog Digital Converters | 200 divisions/sec |
| Manual Inputs | |

## OUTPUT

| Medium | Speed |
|---|---|
| Digital-Analog Converters | 200 increments/sec |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | |
| 6021 | 33 |
| 6111 | 197 |
| 5784-WA | 36 |
| 5639 | 36 |
| Diodes | |
| 406621 | |
| Transistors | |
| 2N338 | |
| 2N657 | |

## CHECKING FEATURES

Checking features include a diagnostic routine programmed for maintenance.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 1.76 Kw |
| Volume, computer | 3.0 cu ft |
| Area, computer | 1.77 sq ft |
| Floor loading | 133 lbs concen max |
| Weight, computer | 133 lbs |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 48 |
| Number in current operation | 21 |
| Number in current production | 6 |
| Number on order | 5 |
| Anticipated production rates | 5/month |
| Time required for delivery | 10 months |

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift |
|---|---|
| Operators | 1 |
| Technicians | 1 |

Training made available by manufacturer to users includes a factory training course for maintenance men.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Fleet service records indicate that failure-free operation time averages 90%.

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include a stored program, retraceable sine-cosine operation, K-Line scaling for flexibility and exact multiplication.

Photo by Librascope Division, General Precision, Inc.

# LIBRASCOPE MK 38

Librascope Attack Console Mk 38 (U. S. Navy)

## MANUFACTURER

Librascope Division
General Precision, Inc.

Photo by Librascope Division

## APPLICATIONS

The system consists of a serial, incremental, computer consisting of two identical sections working from a common control and input-output section. It is used for real-time fire control problems.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Number of binary digits/word | 18 |
| Number of binary digits/instruction | 5 |
| Number of instructions per word | 18 |
| Number of instructions decoded | 70 |
| Arithmetic system | Fixed point |
| Instruction type | One-address operation orders |
| | Two-address increment orders |
| | Four-address distribution orders |

Operation orders consist of integration, remainder, digital servo, transfer, and sine-cosine generation.

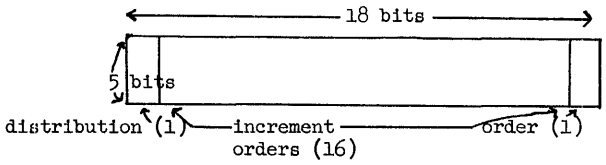
Distribution orders take the increment outputs of the operation orders and store them in temporary registers.

Increment orders communicate the increment outputs

between the operation orders and make decisions on incremental transfers.

Number range $\pm 2^{15}$

Instruction word format




## ARITHMETIC UNIT

| Operation | Time Microseconds |
|---|---|
| Integration | 72 |
| Remainder | 72 |
| Servo | 72 |
| Transfer | 72 |
| Sine-Cosine | 144 |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 6,874 | 122,112 | 4/bit |

## INPUT

| Media | Speed |
|---|---|
| Analog-digital convérters 32 max, 18 used | Each sampled every 10 millisec. |
| Switches 16 used | Each sampled every 10 millisec. |
| Paper Tape | 20 char/sec |

Tape reader is used for initial fill only.

## OUTPUT

| Media | Speed |
|---|---|
| Servo output 32 max, 15 used | Repositioned every 10 millisec. |
| Relay Lighter 16 used | Repositioned every 10 millisec. |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | None |
| Diodes | |
| 1N621 | 11,087 |
| 1N663 | 4,275 |
| 1N914 | 128 |
| 10Z10.7A | 4 |
| 1Z12 | 72 |
| SV128 | 1 |
| 1Z4.7 | 4 |
| 1N647 | 40 |
| SU122 | 40 |
| Transistors | |
| 2N697 | 1,686 |
| 2N699 | 29 |
| 2N1252 | 144 |
| 2N1253 | 704 |
| S4048 | |

## CHECKING FEATURES

Built in Test Program.
Marginal Check Power Supplies.
Card Tester.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

Power, computer

| Volts | cps | | Kw | KVA | PF |
|---|---|---|---|---|---|
| 115 | 400 | 3 | 2.74 | 3.92 | 0.70 |
| 115 | 400 | 1 | 1.109 | 2.64 | 0.42 |
| 115 | 60 | 1 | 0.032 | 0.115 | 0.28 |
| 28 | 60 | 1 | 0.29 | 0.29 | 1.00 |
| 28 | DC | | 0.294 | 0.294 | 1.00 |

| | |
|---|---|
| Volume, computer | 26.67 cu ft |
| Area, computer | 4.67 sq ft |
| Room size, computer | 8 x 9 ft |
| Power, air conditioner | Forced air |
| Weight, computer | 3,000 lbs, Total (Includes Analog Section) |

Refer to OP 2687 for installation requirements.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 14 |
| Number in current operation | 3 |
| Number in current production | 6 |
| Number on order | 54 |
| Anticipated production rates | 3 per month |

Above data is as of 29 June 60

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift |
|---|---|
| Supervisors | 1 |
| Operators | 2 |
| Technicians | 1 |

Training made available by manufacturer to users includes a 6 month course for Navy personnel at Key West for operation and maintenance of entire system.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

System features and construction techniques utilized by manufacturer to insure required reliability include built in test programs, giving both identical sections the same program for comparison testing, a card tester with fixed pattern for testing all circuit cards, silicon components used for greater heat stability, and pluggable etched circuits cards for quick replacement.

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include the option to reprogram the fixed program gives the computer the facility of handling a weapons system compatible with the number and range of analog-digital converters.

## FUTURE PLANS

Plans include continued adaptation of computing equipment to any rocket thrown torpedo or similar missile requirement. Incorporation of electric set and wire-guide torpedoes as well as other short range weapons.

# LIBRASCOPE MK 130

Librascope Digital Computer Mk 130 Mod 0 (U.S. Navy)

## MANUFACTURER

Librascope Division
General Precision, Inc.

## APPLICATIONS

Computer performs target motion analysis, target prediction, and data smoothing for Fire Control System Mk 113.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Number of binary digits/word | 18 bits plus sign |
| Number of digits per instruction | 5 bits for address orders<br>7 bits for non-address orders |
| Arithmetic system | Fixed point |

Floating point is programmed as a subroutine of two consecutive words; 8 bits are used for the exponent and 30 bits are used for sign and numeric value.

| | |
|---|---|
| Instruction type | One address |
| Number range | 0 to $(2^{19} - 1)$ |

Photo by Librascope Division

Instruction word format

Addressable order

| 1 | 5 | 1 | 12 |
|---|---|---|---|
| Sign | Order | B | Address |

Non-address order

| 1 | 13 | 5 |
|---|---|---|
| Sign | Non-Address Order | I/O Device Designation or Number of places for shifts |

Automatic built-in subroutines

The trapping of control is dependent on the overflow of the delay line (relative clock). When trapped, computer obeys the instruction in location $(0002)_{10}$ of memory.

Registers and B-boxes

One B Modification register, usually known as

index register.

Approximately 3,650 instructions are decoded for a fire control program.

There is also an indirect addressing feature available. A bit in the sign position is utilized for this purpose. This differs in that instead of referring to an address 0001 the desired address is found in location 0001. This process may be carried further.

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec. | Exclud. Stor. Access Microsec. |
|---|---|---|
| Add | 40 | 16 |
| Mult | 40-424 | 16-400 |
| Div | 40-460 | 16-436 |

| | |
|---|---|
| Construction (Arithmetic unit only) | Transistors |
| Arithmetic mode | Parallel |
| Timing | Synchronous |
| Operational | Sequential |

The machine has a microprogram unit which controls its function. The microprogram unit is synchronous, the arithmetic unit is asynchronous.

## STORAGE

| Medium | No. of Words | No. of Digits | Access Microsec. |
|---|---|---|---|
| Magnetic Core Memory | 4,096 | Sign digit + 18 digits | 20 |

No magnetic tape is associated with the Mk 130 Mod 0.

## INPUT

| Media | Speed |
|---|---|
| Switch Bank on test panel | Instantaneous |

Information is read directly into the accumulator.

| | |
|---|---|
| Analog Modules (Digital Data from Shaft encoders) | 157 times per second |

Information is converted from analog voltages to binary via I/O Buffer, is read into the K Register. From the K Register, the program gets the information into the Accumulator.

| | |
|---|---|
| Flexowriter or Ferranti tape reader | Photo reader original rate 530 chars/sec |

The speed is dependent on the amount of tape on the reel.

| | |
|---|---|
| Switches in Mk 50, Mk 51, and Mk 75 of FCS Mk 113 and all Mods, and Sensor operator's Mark Signals | 128 micro sec pulses |

Some of these signals are stretched to more than 2.25 seconds.

## OUTPUT

| Media | Speed |
|---|---|
| Analog Modules (Digital data from shaft encoder) | 157 times/sec |

Program transfers information from Accumulator to K Register, then via I/O Buffer to analog components.

| | |
|---|---|
| Light Banks on test panel | Instantaneous |

The accumulator and the counter register are displayed.

| | |
|---|---|
| Lights on Mk 51 of FCS Mk 113 all mods | Instantaneous |

For quality of sol'n lights, relative course light, constraint lights, etc.

| | |
|---|---|
| To relays in Mk 50, 51 and 75 of FCS Mk 113 all mods | Instantaneous |

To signal that range, course, speed, and bearing for a particular channel has been calculated and are available as analog information.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | None |
| Diodes | |
| 1N251 | 97 |
| 1N270 | 76 |
| 1N429 | 38 |
| 1N537 | 11 |
| 1N645 | 97 |
| 1N659 | 11,762 |
| 1N663 | 2,412 |
| 1N749 | 22 |

Does not include diodes in which less than 10 per type are used.

| | |
|---|---|
| Transistors | |
| 2N335 | 20 |
| 2N388 | 1,317 |
| 2N501 | 3,232 |
| 2N597 | 68 |
| 2N599 | 2,361 |
| 2N665 | 17 |

Does not include transistors in which less than 10 per type are used.

| | |
|---|---|
| Magnetic Cores | 82,000 |

Used in computer memory and switching.

The Mk 130 Mod 0 uses "resistor coupled transistor logic" (RCTL) or "nor" logic throughout.

## CHECKING FEATURES

Fixed checking features include a card test panel, capable of checking all circuit boards, a computer test panel, providing manual communication with all portions of computer, and a margin check panel, wherein switch settings determine voltage variation for marginal checking.

Optional checking features include a test console, which can duplicate computer test panel and in addition can furnish input/output facilities of flexowriter, high speed punch, switch inputs, camp outputs, digital shaft encoders, and output servo modules. It is used for factory checkout only.

Existing computer circuitry can be utilized to activate portable flexowriter or high speed punch without use of test console if desired. Portable input/output devices not available at this time but can be developed with minimum design effort.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | Power Kw | KVA | Factor | Remarks |
|---|---|---|---|---|
| Power, computer | 2.85 | 3.15 | 0.9 | 400 cps, 3Ø, 115V |
| | 1.97 | 1.54 | 0.8 | 60 cps, 1Ø, 115V |
| | .21 | .21 | 1.0 | 26V, DC |
| Volume, computer | | 27.4 cu ft | | |
| Area, computer | | 6.7 sq ft | | |
| Floor loading, computer | | 244 lbs/sq ft | | |
| | | 244 lbs concentrated max. | | |
| Weight, computer | | Approx. 1,647 lbs | | |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |
| Number in current production | 1 |
| Number on order | 8 |
| Anticipated production rates | 1 per month |
| Time required for delivery | 6-8 months |

## PERSONNEL REQUIREMENTS

Training made available by manufacturer to users includes a factory maintenance course on the Mk 130 digital computer, which comprises 3 to 4 weeks of instruction. The Mk 130 digital computer is an unmaned piece of equipment in its tactical application. Maintenance will be performed by user personnel (U.S. Navy) aided by Librascope Field Service.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

All circuitry is completely transistorized and mounted in readily accessible modules. Test points have been provided on all circuit modules and chassis assemblies for ease of maintenance. A circuit module tester capable of testing all circuit modules is provided as part of the digital computer. All subassemblies are accessible from the front of the computer. Diagnostic routines are available to the user. Circuitry is conservatively designed and will operate over an ambient temperature range of $0^{\circ}F$ to $110^{\circ}F$. During prototype evaluation only two failures have occurred in over 1000 hours of operation.

## ADDITIONAL FEATURES AND REMARKS

Unique system advantages include a micro-program unit which can be modified to create new or variations of existing commands to tailor computer operation to suit individual situations without major redesign.

Photo by Librascope Division, General Precision, Inc.

Photos by Librascope Division, General Precision, Inc.

# LIBRATROL 500

Libratrol 500 Computing System

## MANUFACTURER

Librascope Division
General Precision Equipment Corporation

## APPLICATIONS

Manufacturer

General purpose computing where computing equipment must communicate directly with equipment external to the computer, via digital inputs or via voltage inputs.

General purpose computing where computing equipment must send control signals to equipment external to the computer.

Examples of applications are quality control for both continuous and batch production processes-real time, process control for both continuous and batch processes, and equipment test stand instrumentation (data acquisition, logging and calculation).

Frankford Arsenal

This computer is being incorporated into a breadboard of an automatic checkout system, the purpose of which is to automatically and rapidly test and evaluate the performance of combat vehicles. The above tasks include fault isolation of malfunctioning components or parts, the preparation of logictics data in the English language, and record keeping of items which pass through the test station. The first item to be so tested will be of the engine and transmission system of the M48A1 combat tank.

Photo by Public Service Company of Colorado

Public Service Co. of Colorado

Located on West 3rd Avenue and Lipan Street, Denver, Colorado, the system is used on-line for calculation of hourly gas loads delivered into company systems by suppliers. Input by telemeter from remote stations through digital converter to computer. It is also used off-line for calculation and printing of orifice meter deliveries to gas customers, input by paper tape, and miscellaneous engineering problems, as they arise.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 30 bits plus sign |
| Binary digits/instruction | 4 |
| Instructions per word | 1 |

Integrated System

| | |
|---|---|
| Instructions decoded | 16 |
| Arithmetic system | Fixed point |

Floating point is programmable.

| | |
|---|---|
| Instruction type | One address |

| 0 | 1 12 | 13 16 | 17 18 | 19 24 | 25 30 | 31 | Sp |
|---|---|---|---|---|---|---|---|
| Sign | | Instruc-tion | | Track | Sector | | Spacer |

A complete set of compiler and utility programs are available.

Registers include counter register, accumulator, and instruction register.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 7,750 (Mean access) | 250 |
| | 23,000 (Mean access) | 15,000 |
| | 23,000 (Mean access) | 15,000 |

Construction (Arithmetic unit only)

| | |
|---|---|
| Vacuum tubes | 175 |
| Diodes | 1,750 |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

Photo by Frankford Arsenal

Though operation is listed as being sequential, the input system of the LIBRATROL 500, since it is independent of the computing portion of the machine, is capable of inputting information while calculation is proceeding concurrently.

## STORAGE

Manufacturer

| Media | No. of Words | No. of Digits |
|---|---|---|
| Magnetic Drum (Main) | 4,096 | 126,976 |
| Magnetic Drum (Buffer) | 64 | 1,984 |

Access time is variable between 500 and 15,000 microseconds.

Magnetic tape will be developed.

Frankford Arsenal

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 4,096 | 31 binary | 9,000 (avg) |

Public Service

| | | |
|---|---|---|
| Magnetic Drum | 4,096 | 32 binary |

## INPUT

Manufacturer

| Media | Speed |
|---|---|
| Analog | 60 samples/sec |
| Digital | 60 char/sec |
| Paper Tape | 10 or 60 char/sec |
| Typewriter | 10 char/sec |

Above items are standard.

Frankford Arsenal

| | |
|---|---|
| Paper Tape | approx 5 char/sec |

Mechanical tape reader.

Flexowriter used and input also available through Flexowriter keyboard.

Public Service

| | |
|---|---|
| Electric Typewriter | 570 char/min |
| Analog-Digital Converter | 75 words/sec |

Data can be supplied by punched paper tape.

## OUTPUT

Manufacturer

| Medium | Speed |
|---|---|
| Paper Tape | 10 char/sec |

Frankford Arsenal

| | |
|---|---|
| Flexowriter | approx 8 char/sec |

Public Service

Electric Typewriter

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Manufacturer

| Type | Quantity |
|---|---|
| Tubes | |
| 6AN8 5915 5965 2D21 5687 5963 6197 3RP1A | Total 175 approx |

Photo by Librascope Division, General Precision

| | |
|---|---|
| Diodes | |
| 1N617 | 1,450 approx |

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

Manufacturer

| | |
|---|---|
| Power, computer | 2.5 Kw |
| Volume, computer | 49 cu ft |
| Area, computer | 13.7 sq ft |
| Room size | 24 sq ft |
| Floor loading | 78 lbs/sq ft |
| Weight, computer | 1,000 lbs (nominal) |

A separate 115 volt, 20 ampere circuit is recommended.

Frankford Arsenal

| | |
|---|---|
| Power, computer | 2.3 KVA |
| Volume, computer | 30 cu ft |
| Area, computer | 10 sq ft |
| Room size | 20 ft x 60 ft |
| Weight, computer | 1,000 lbs |

Public Service

| | |
|---|---|
| Power, computer | 2 Kw |
| Power, air condi (2 required) | 7.25 Kw each |
| Volume, computer | 47.4 cu ft |
| Volume, air conditioner | 89.4 cu ft each |
| Area, computer | 13.22 sq ft |
| Area, air conditioner | 29.8 sq ft each |
| Floor loading | 110 lbs/sq ft |
| Capacity, air conditioner | 7.5 Tons, each |
| Weight, computer | 1,450 lbs |

Reinforced floor (wood).

## PRODUCTION RECORD

Manufacturer

| | |
|---|---|
| Number produced to date | Over 400 |
| Number in current operation | 380 |
| Number in current production | 15 |
| Number on order | 15 |
| Time required for delivery | 3 months |

## COST, PRICE AND RENTAL RATES

Manufacturer

| | Cost |
|---|---|
| 1 Libratrol 500 Computer with 120 input channels and analog to digital converter | $84,500 |
| Frankford Arsenal | |
| Basic System | |
| Computer and Flexowriter | 89,000 |
| Additional Equipment | |
| Commutator extender | 5,000 |
| Digital inputs & high speed input mode | 20,000 |
| 300 magnetic latching mercury wetted relays | 20,000 |
| Spare parts | 5,000 |
| D/A converters (5) | 1,000 |
| Total | $51,000 |
| Public Service | |
| Basic System | |
| Computer, Digitizer, 1-Flexowriter | 90,000 |
| Additional Equipment | |
| 1-Flexowriter | 4,000 |

## PERSONNEL REQUIREMENTS

Manufacturer

| | One 8-Hour Shift | Two 8-Hour Shifts | Three 8-Hour Shifts |
|---|---|---|---|
| Supervisors | 1 | 1 | 1 |
| Programmers | 1 | 1 | 1 |
| Operators | 1 | 2 | 3 |
| Engineers | 1 | 1 | 1 |

Thirty days of instruction time is included in the sale price for programming and maintenance training of customer personnel.

Frankford Arsenal

| | One 8-Hour Shift | |
|---|---|---|
| | Used | Recommended |
| Programmers | 1.5 | 1.5 |

Method of training is informal.

Public Service

The department, which is the principal user of this computer has 16 employees. The two engineers in the department, program and maintain the computer. Two girls prepare tapes and, to a large extent, operate the computer, and file tapes and work sheets. While it is planned to train additional department personnel to work with the computer, there is no need for increasing the number of employees doing any one computer job.

Methods of training includes on-the-job training.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Manufacturer

The combination of conservatively rated, carefully engineered components, with simplicity of design, conspires to allow the computing elements to function with only 113 vacuum tubes. Reliability should normally exceed 99% up-time over a 6 month period.

Public Service

| | |
|---|---|
| Good time | 166 Hours/Week (Average) |
| Attempted to run time | 168 Hours/Week (Average) |
| Operating ratio (Good/Attempted to run time) | 0.988 |

Above figures based on period 1 May 60 to present
Time is available for rent to qualified outside organizations.

The reliability figures refer only to basic computer operation. We have had difficulty with input of data through the analog-digital system which has been combined with the computer. Reliability figures on the total system would be greatly lower. Because of the input problem the system has not as yet been accepted.

## ADDITIONAL FEATURES AND REMARKS

Public Service

An outstanding feature is that the system permits computer-controlled input of telemetered values. It has two Flexowriters (off-line and on-line) which are controlled by the program.

The fact that the system permits working off-line programs and a continuing on-line program is a unique advantage.

## FUTURE PLANS

Frankford Arsenal

It should be noted that the Libratrol 500 Computer has been assimilated into the Automatic Checkout equipment. It is now merely a component of the system, and is no longer identifiable as a Libratrol 500 Computer. The questionnaire answers, however, are with respect to the computer portion of the checkout system only, i. e., only the computer memory is discussed although additional memory capability is inherent in the checkout system.

Public Service

Possible replacement in 5 or 6 years is planned.

## INSTALLATIONS

U. S. Army Ordnance Arsenal, Frankford
Bridge and Tacony Streets
Philadelphia 37, Pennsylvania

Public Service Company of Colorado
900 15th Street
Denver, Colorado

# LIBRATROL 1000

Libratrol Computing System Model 1000

## MANUFACTURER

Librascope Division
General Precision Equipment Corporation

Photo by Librascope Division, General Precision, Inc.

## APPLICATIONS

System is intended for general purpose computing, where computing equipment must communicate directly with equipment external to the computer via digital or voltage (analog) inputs and where computing equipment must develop control signals to equipment external to the computer. Examples of applications are quality control for both contonuous and batch production processes-real time, process control for both continuous and batch processes, and equipment test stand instrumentation - data acquisition, logging, and calculations.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 32 |
| Binary digits/instruction | 5 |
| Instructions per word | 1 |
| Instructions decoded | 32 |
| Arithmetic system | Fixed point |
| Floating point is programmable. | |
| Instruction type | Two address |

Instruction word format

| | Operand Address | | Next Inst Address | | |
|---|---|---|---|---|---|
| S1 4 | 5 11 | 12 17 | 18 24 | 25 30 | 31 |
| Command | Track | Sector | Track | Sector | Address Modify Flag |

A complete set of compiler and utility programs are available.

Additive index register and double length accumulator.

Lower accumulator can be made to operate on eight words at a time.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 1,000 | 250 |
| Mult | 17,000 | 16,250 |
| Div | 17,000 | 16,250 |
| Arithmetic mode | Serial | |
| Timing | Synchronous | |
| Operation | Sequential | |

Though operation is listed as being sequential, the input system of the L-1000, since it is independent of the computing portion of the machine, is capable of receiving information while calculation is proceeding concurrently.

## STORAGE

| Media | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum (Main) | 8,000 | 256,000 | 250 |
| Magnetic Drum (Buffer) | 64 | 2,016 | 250 |
| Magnetic Tape | | | |
| No. of units that can be connected | | | 64 Units |

Magnetic tape is a future development.

## INPUT

| Media | Speed |
|---|---|
| Analog | 60 samples/sec (2,000 samples/sec optional) |
| Digital | 60 char/sec (Standard) |
| Paper Tape | 10/60 char/sec (Standard) |
| Typewriter | 10 char/sec (Standard) |

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape | 60 char/sec (Optional) |
| Typewriter | 10 char/sec (Standard) |
| Control (analog or digital) | 120 char/sec (Standard) |
| Line Printer | 300 char/sec (Optional) |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity | |
|---|---|---|
| Tubes | | |
| CRT | 1 | (digital display for monitoring) |
| Diodes | | |
| 1N617 | 2,400 | |
| Transistors | 650 | (basic system) |
| 2N1301 | | |
| 2N393 | | |
| 2N404 | | |
| 2N357 | | |
| 2N597 | | |
| 2N1130 | | |

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 2 Kw |
| Volume, computer | 48 cu ft |
| Area, computer | 12 sq ft |
| Room size | 24 sq ft |
| Capacity, air conditioner | 1 Ton |
| Weight, computer | 1,000-1,200 lbs |

Air conditioner is included and self-contained

## PERSONNEL REQUIREMENTS

One operator required for each shift.

Training made available by the manufacturer to the user includes programming and maintenance.

## FUTURE PLANS

Magnetic tape input and a core buffer unit are planned.

## INSTALLATIONS

Librascope Division
General Precision Equipment Corporation
808 Western Avenue
Glendale, California

# LINCOLN CG 24

Lincoln CG 24

## MANUFACTURER

Massachusetts Institute of Technology
Lincoln Laboratory

## APPLICATIONS

CG 24 is a general purpose computer attached to a long-range radar both for receiving detected echoes and for directing the antenna. It is operated in real time primarily for the collection and processing of radar tracking data. Storage of such data is made directly into high-speed memory under program control. The research was supported jointly by the Department of the Army, the Department of the Navy, and the Department of the Air Force under Air Force Contract No. AF 19(122)-458.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Number of binary digits/word | 24 plus sign |
| Number of binary digits/instruction | 24 |
| Number of instructions/word | 1 |
| Total number of instructions decoded | 46 |
| Arithmetic system | Fixed point |

Photo by Massachusetts Institute of Technology

Instruction type (Floating point sub-routines)
One address

Number range
$-1 \leq n \leq 1 - 2^{-24}$

Instruction word format

| Bit | 0-3 | 4-9 | 10-24 |
|---|---|---|---|
| | Index | Instruction | Address |

Registers and B-boxes include 5 sets of registers of 8 bits each and a real time clock register.

Negative numbers are treated in two's complement form.

Arithmetic algorithms handle either positive or negative numbers.

# CG-24 CHARACTERISTICS

## GENERAL

CONSTRUCTION: SOLID STATE

APPLICATION ····· GENERAL-PURPOSE PLUS REAL-TIME CONTROL

TIMING ····· SYNCHRONOUS, 330 Kcps.

OPERATION ····· SEQUENTIAL, SUBJECT TO SELF-MODIFICATION

## NUMERICAL SYSTEM

INTERNAL NUMBER SYSTEM ···· 27-BIT BINARY WORDS, INCLUDING TWO PARITY BITS

SINGLE-ADDRESS INSTRUCTIONS.

FIXED-POINT ARITHMETIC SYSTEM, PROGRAMMED FLOATING POINT SUBROUTINE.

## ARITHMETIC UNIT

ADDITION TIME ····· 24 μs (incl. memory access)

MULT.-DIV. TIME ····· 84 μs ( " " " )

SQUARE ROOT TIME ····· 300 μs ( " " " )

## STORAGE SYSTEM

8192 WORDS, COINCIDENT CURRENT MAGNETIC CORES, 12 μs CYCLE TIME

## TERMINAL EQUIPMENT

FLEXOWRITER

CRT DISPLAY WITH NUMERIC GENERATOR

PHOTOELECTRIC TAPE READER.

c314-16

Photo by Massachusetts Institute of Technology

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 24 | 12 |
| Mult | 84 | 74 |
| Div | 84 | 74 |

Construction, arithmetic unit only
Arithmetic unit consists of transistors and diodes.

Arithmetic mode — Parallel
Multiplication and division operations consist of serially adding or subtracting. Addition and subtraction are parallel operations.

Timing — Synchronous

Operation — Sequential and concurrent

## STORAGE

| Media | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Core | 8,192 | 27/word | 12 |
| Magnetic Tape | $5 \times 10^5$ binary words/tape | 24/word | 272 |

| | | |
|---|---|---|
| No. of units that can be connected | 7 | Units |
| No. of characters/linear inch | 200 | Chars/inch |
| Channels or tracks on tape | 7 | Tracks/tape |
| Blank tape separating each record | 0.75 | Inches |
| Tape speed | 75 | Inches/sec |
| Transfer rate | 15,000 | Chars/sec |
| Start time | 5 | Millisec |
| Stop time | 1.5 | Millisec |
| Average time for experienced operator to change reel of tape | 90 | Seconds |
| Physical properties of tape | | |
| Width | 1/2 | Inches |
| Length of reel | 1,200 | Feet |
| Composition | 0.0015 | in mylar |

The 7-channel digital tape units are Ampex FR-300 with packing density of 200 bits/inch in each channel. These are operated at 75 in. per second. Two units were installed in August 1960.

## INPUT

| Media | Speed |
|---|---|
| Magnetic Tape | 15,000 char/sec<br>6 binary digits/char |
| Paper Tape | 200 char/sec<br>6 binary digits/char<br>Ferranti Photoreader |
| Keyboard | Flexowriter |
| Manual | Toggle switch |

## OUTPUT

| Media | Speed |
|---|---|
| Magnetic Tape | 15,000 char/sec<br>6 binary digits/char |
| Paper Tape | 135 char/sec<br>6 binary digits/char<br>Soroban Punch |
| Keyboard | 570 ltrs/min<br>on line<br>Flexowriter |
| Display with camera | 18,000 octal digits/sec<br>Numbers are formed as Lissajou figures from X-Y inputs |

Two servo units are connected to the lower accumulator in such a fashion as to provide for program control of elevation and azimuth angle synchro data for a radar antenna.

In June 1960 an alpha-numeric display (using the 6 bit Flexowriter code) was connected to CG 24. It has added photographic facilities. It includes two CRT's. The speed is 75 microseconds per figure or letter.

An input buffer provides for real time input of radar position and range rate data.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | |
| K1354P11M | 1 |
| Ki354P7M | 1 |
| 5965 | 6 |
| 6080 | 2 |
| 6073 | 7 |
| 5651 | 4 |
| 6BL7 | 1 |
| 8013 | 2 |
| 12AX7 | 2 |
| 2D21 | 2 |
| CRT display circuits | |
| Diodes | |
| S347G | 21,700 |
| SG22 | 7,900 |
| HD2085 | 3,600 |
| Total | 33,200 |
| Transistors | |
| 4JD2A6 | 7,950 |
| 2N123 | 6,250 |
| 2N385 | 2,850 |
| M201Z | 875 |
| GT34 | 500 |
| CK750 | 320 |
| 904A | 185 |
| GT83 | 60 |
| Total | 18,930 |
| Magnetic Cores | |
| S-1 Ferrite | 229,376 |

Component count as of May 1958

## CHECKING FEATURES

Fixed

Core memory: parity check on each half word
Magnetic tapes: parity check (IBM mode)
Perforated tapes: modulo 25 check sum.

Optional

Magnetic tapes: Programmer may use error correcting mode. This provides 2 error detection, 1 error correction. The mode gives 3 of the 7 tracks for data.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 4.6 Kw (May 1960) |
| Power, air conditioner | 4.5 Kw (Including Room) |
| Volume, computer | 680 cu ft |
| Area, computer | 110 sq ft |
| Room size allocated | 1,200 sq ft |
| Capacity, air conditioner | 5 Tons |
| Weight, computer | 5,000 lbs |

The computer requires 110 sq. feet of floor space. A set of 3 rooms (total area 1200 sq. ft.) is devoted to computer, tapes, maintenance, stock and input buffers. The air conditioner supplies 2500 cu. ft/min. from an 11-inch high plenum underneath the computer proper. The air conditioner services other parts of the building. The 5 ton capacity is an estimated fair proportion. Computer logic power is derived from 400 cycle rotating machinery.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

System is not being produced.

## COST, PRICE AND RENTAL RATES

CG 24 was built as part of an experimental prototype system. It cost approximately $1,000,000.

## PERSONNEL REQUIREMENTS

| Typical Personnel | One 8-Hour Shift |
|---|---|
| Supervisors | 1 |
| Programmers | 4 |
| Operators | 1 |
| Engineers | 1 |
| Technicians | 1 |

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

CG 24 has been operating for about 2 years. It has been on power almost constantly, being operated an average of 8 hours per day.

Faults have been primarily due to connections (Arkless wiring originally unsoldered has been soldered), other contacts and receptacle pins, memory adjustments (generally not component failures), and photo reader (generally not component failures). Qualitatively, it is difficult to assign many (if any) semiconductor failures to aging. Rather, most are traceable to man-made shorts.

## ADDITIONAL FEATURES AND REMARKS

Unique system advantages include a very flexible arrangement for receiving and processing long range radar echo data, for directing antenna, and for simulating major parts of receiving and processing equipment.

## INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
Lexington, Massachusetts

# LINCOLN TX 0

Lincoln Test-Experimental Computer Model 0

## MANUFACTURER

Lincoln Laboratory
Massachusetts Institute of Technology

Photo by Lincoln Laboratory, Massachusetts Institute of Technology

## APPLICATIONS

Manufacturer

An experimental digital computer used to test advance design techniques, including very large core storage and transistor circuitry.

The research reported in this computing system description was sponsored jointly by the Army, Navy and Air Force under contract with the Massachusetts Institute of Technology.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 18 |
| Binary digits/instruction | 18 |
| Instructions/word | 1 |
| Instructions decoded | 25 |
| Arithmetic system | Ring-adder |
| Instruction type | One address |
| Number range | Not appropriate |

Three instructions are addressable and 1 is microprogrammable.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add time | 6 | 1 |
| Mult time | 1,000 | 1,000 |
| Div time | 1,000 | 1,000 |
| Construction | | 1,000 transistors |
| Arithmetic mode | | Parallel |
| Timing | | Synchronous |
| Operation | | Concurrent |

Computer performs 83,000 additions per second. Mulitply and divide is programmed.

## STORAGE

| Media | Words | Digits | Microsec |
|---|---|---|---|
| Magnetic Core | 65,536 | 18/word | 3 |
| Flip-flop | 1 | 18/word | 0.5 |
| Toggle Switch | 16 | 18/word | 3 |

A parity bit is additional. Read-rewrite time is 6 microseconds.

LINCOLN TX 0 and TX 2 Memory Plane Photo by Lincoln Laboratory, Massachusetts Institute of Technology

## INPUT

| Media | Speed |
|---|---|
| Photo Reader | 250 lines/sec |
| Flexowriter | Manual |
| Toggle Switch | Manual |

## OUTPUT

| Media | Speed |
|---|---|
| Flexowriter | 10 char/sec |
| Display (CRT) | 16 microsec/spot |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 440 |
| Tube types | 3 |
| Crystal diodes | 350 |
| Magnetic cores | 1,245,773 |
| Transistors | 3,500 |
| Separate cabinets | 5 |

Three major tube types, a small number of others. Most tubes are used in the large memory. The transistors are the Philco L-5122 Surface Barrier Transistor.

## CHECKING FEATURES

Parity check on memory systems. Marginal checking is built in.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 10 Kw |
| Volume, computer | 1,000 cu ft |
| Area, computer | 200 sq ft |
| Capacity, air conditioner | 40 Tons |
| Weight, computer | 4,000 lbs |

Above figures are approximate. Air conditioner is necessary for memory only.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced | 1 |
| Number in operation | 1 |

## ADDITIONAL FEATURES AND REMARKS

One picture shows close-up view of magnetic core memory plane and other picture shows random-access core memory, frame of memory-core selection-switch drivers, computer arithmetic element and control element, and computer operating console.

## INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
Lexington 73, Massachusetts

# LINCOLN TX 2

Lincoln Test Experimental Computer 2

## MANUFACTURER

Lincoln Laboratory
Massachusetts Institute of Technology

## APPLICATIONS

Computing system is used for scientific research and for the simulation, analysis, and control of real time systems.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 36 + 1 + 1 |
| Binary digits/instruction | 36 + 1 + 1 |
| Instructions per word | 1 |
| Instructions decoded | 64 |
| Arithmetic system | Fixed point (Ones complement binary) |
| Instruction type | Indexable; Indirect addressing on all instructions |
| Number range | $-(1 - 2^{-35})$ to $(1 - 2^{-35})$ |

Instruction word format

| 1 | 1 | 5 | 6 | 6 | 1 | 17 |
|---|---|---|---|---|---|---|
| meta bit | hold bit | configuration reg. no. | op code | Index register | indirect address bit | base address |

Photo by Lincoln Laboratory, MIT

All fixed programs are in toggle switch or plugboard storage.

Automatic coding includes standard compiler, which provides full symbolic coding facilities.

All four arithmetic registers and the exchange register are addressable as part of memory. There are sixty-four 18-bit parity-checked index registers.

Indirect addressing can be repeated indefinitely.

33 program (instruction) counters are provided, only one of which is used at a time.

Each in-out unit is associated with a program counter. Choice of program counter is determined by in-out unit, by program, and by relative priority of program counters.

Any instruction can specify a configuration of the computer during the execution of the instruction. A 36 bit operand word can be divided into one 36, one 27 and one 9, two 18, or four 9 bit subwords formed from the 9 bit quarters. The 9 bit quarters can be permuted among themselves. Any or all of the subwords can be used simultaneously. For example, two 18 bit multiplications are done by one multiply instruction in less time than one 36 bit multiplication.

Memory Stall

One bit of each computer memory word is used for parity checking. The other is used as a tag bit for program debugging.

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 4.8 | 1.4 |
| Mult | 9.6 - 19.2 | 5 - 17 (9 bit-36 bit) |
| Div | 19.6 - 80.0 | 17.2 - 75 (9 bit-36 bit) |

| | |
|---|---|
| Construction (Arithmetic unit only) | |
| Transistors | 8,800 |
| Arithmetic mode | Parallel |
| Timing | Synchronous |
| Operation | Concurrent |

The following table lists the number of thousands of arithmetic operations of a given type which can be executed per sec.

| Word Length in Bits | | 36 | 27 | 18 | 9 |
|---|---|---|---|---|---|
| Arithmetic | + | 200 | 200 | 400 | 800 |
| Operation | x | 50 | 67 | 17 | 400 |
| | ÷ | 13 | 17 | 48 | 200 |

Photo by Lincoln Laboratory, MIT

## STORAGE

| Media | No. of Words | Read-Write Time | No. of Digits/Word | Microsec |
|---|---|---|---|---|
| Magnetic Core S Memory | 65,536 | 6.4 | 36 + 1 + 1 | 3.4 |
| Magnetic Core T Memory | 4,096 | 4.4 | 36 + 1 + 1 | 2.2 |
| Toggle switch, plugboard, etc | 80 | 4.8 | 36 + 1 | 2.6 |
| Magnetic Core Index Memory | 64 | 3.4 | 18 + 1 | 0.6 |
| Magnetic Film Config. Memory | 32 | 0.8 | 9 + 1 | 0.3 |

| Magnetic Tape | |
|---|---|
| No. of units that can be connected | 512 Units |
| No. of lines /er linear inch | 330 Lines/inch |
| Channels or tracks on the tape | 10 Tracks/tape |
| Blank tape separating each record | 0 Inches |
| Tape speed | 30-1000 Inches/sec |
| Transfer rate | 3,300-37,500 Chars/sec |
| Start time | 250 Millisec |
| Stop time | 10,000-250 Millisec |
| Physical properties of tape | |
| Width | 3/4 Inches |
| Length of reel | 7,200 Feet |
| Composition | Mylar type 189 3M |

Tape reels are not changed.

Fixed address system (like drum). Variable read speed.
32 tape unit drives can be treated as $10^{10}$-bits of internal storage.
14" NARTB reel.
Recording channels are paired. One pair is used for timing marks, another for block marks, and the remaining three for information. Three lines of information form the standard unit of information, a 9 bit character.

## INPUT

| Media | Speed |
|---|---|
| Paper Tape | 3000 7 bit lines/sec peak speed |
| Speed is not constant. Accelerates slowly compared to line width. | |
| Keyboard | 10 6 bit char/sec |
| Lincoln Writer input | |
| Analog-Digital Converter | 40,000 11 bit samples/sec |
| Epsco Datrac converter | |
| Light pen/eye | Manual |
| Signals selected by operator | |
| Random No. Gen. | 18,000 9 bit words/sec |
| Radioactive source | |
| Miscellaneous Input | 80 KC |
| 9 channel pulse input to computer from miscellaneous devices. | |

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape | 180 7 bit lines/sec |
| Soroban punch | |
| Xerox printer | 20 lines/sec<br>1300 char/sec |
| 88 characters can be printed in 2 sizes. 6 bit vert. & 9 bit horiz. axes resolution. | |
| Typewriter | 10 6 bit char/sec |
| Lincoln Writer output | |
| CRT point display & Camera | 10 KC - 40 KC |
| 10 bit resolution in both axes | |
| Miscellaneous output | Up to 500 cycles |
| 9 channel switch for computer control of low rate devices | |
| Large board plotter | 15 in/sec slew speed |
| PACE plotter | |

Several input-output units can operate simultaneously so long as the time required by all the units operating does not saturate the central computer. Each unit has at most a single-line buffer; whenever a line of data needs to be transmitted to or from the central computer the unit causes the central computer to use its associated program counter. The machine can compute while in-out units are operating.

At peak rate, about 80,000 computer words/sec can be transferred into or out of the computer.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity | Use |
|---|---|---|
| Tubes | | |
| 6888 | 69 | Clock pulse amplifiers |
| 5998 | 312 | S memory |
| Z-2177 | 296 | S memory |
| Misc. Types | 88 | |
| Diodes | | |
| CTP592 | 3,000 | Input-output circuitry |
| 1N625 | 736 | Input-output circuitry |
| Misc. Types | 1,488 | Input-output circuitry |
| Transistors | | |
| L5122 | 26,042 | |
| L5134 | 31,928 | |
| 2N501 | 320 | |
| 2N357 | 1,016 | |
| Misc. Types | 2,227 | |
| Magnetic Cores | | |
| | 2,490,880 | S memory |
| | 155,648 | T memory |
| | 2,432 | X memory |

All the vacuum tubes are used in the 65,536 word memory and in the generation of the computer clock pulses.

Resistor coupled transistor logic in the central computer operates at a 5 megapulse per second rate.

Thin magnetic film memory contains 320 magnetic spots.

## CHECKING FEATURES

Checking features include a single bit odd parity check on all memories, a voltage margin check on all bias voltages, and a manual switching system selects circuits to be checked. A built-in sync system facilitates locating machine errors. A library of test programs are used which check the operation of the computer and which attempt to induce errors.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 20 Kw | 25.6 KVA | 0.8 pf |
| Power, air conditioner | 17 Kw | | |
| Area, computer | | 1,500 sq ft | |
| Area, air conditioner | | 350 sq ft | |
| Room size, computer | | 54 x 29 | |
| Room size, air conditioner | | 17 x 20 | |
| Capacity, air conditioner | | 25 Tons | |

Cables run through overhead wireways. Air conditioning ducts also runoverhead. An 8 ft high false ceiling is hung to cover these. Otherwise building is standard. Most power supplies are solid state. Principally required for memories.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |
| One-of-a-kind research computer | |

## PERSONNEL REQUIREMENTS

Problem originators are trained to use the computer. Paper-tape preparation facilities and utility programs available to all computer users.

Three engineering assistants and one technician are available to do routine maintenance and to make changes in the computer system.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

As a research machine, TX-2 operating experience is good but though data is kept on machine failures, no reliability figures have been computed.

Basic circuits and components are similar to MIT's TX-0 machine.

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include an operating thin magnetic film memory; 65,536 word magnetic core memory. Fixed address magnetic tape system. Multiple-sequence operation of computer and simultaneous operation of input-output units permits considerable flexibility in use of in-out units. Maximum execution time for any one arithmetic instruction can be reduced to one memory cycle time by overlapping instructions and memories.

Unique system advantages include multiple-sequence operation, configuration control over operands, thin magnetic film memory used in control element of computer, and 64 index registers stored in random access magnetic core memory.

The Lincoln Writer input-output unit permits considerable flexibility in communicating with the computer.

## FUTURE PLANS

Another 4096 word magnetic core memory will be installed in order to increase opportunities for overlapping operation of memories.

A magnetic tape unit will be installed which will be compatible with units used on many commercial computers.

Input-output units will be added as the needs develop.

A new control console will replace the present console.

## INSTALLATIONS

Lincoln Laboratory
Massachusetts Institute of Technology
P. O. Box 73
Lexington 73, Mass.

# LITTON C 7000

Litton Industries, Model C 7000

## APPLICATIONS

System is designed for real time control systems applications requiring very high computing rates.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 21 |
| Binary digits/instruction | 21 |
| Instructions per word | 1 |
| Instructions decoded | 35 |
| Arithmetic system | Fixed point<br>Two's complement system of arithmetic is used |
| Instruction type | One address |
| Number range | $-1$ to $+1-2^{-20}$ |

Instruction word format

| 00 | 01 06 | 07 09 | 10 20 |
|---|---|---|---|
| Break-point | Operation Code | Index Tag | Address |

Automatic built-in subroutines include square root and gray code to binary conversion.

Three index registers are included.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 4 | 2 |
| Mult | 26 (Average) | 22 |
| Div | 46 | 42 |

| | |
|---|---|
| Arithmetic mode | Parallel |
| Timing | Synchronous |
| Operation | Sequential |

Special hi speed multiplication technique is used. There is extensive overlapping in the execution of sequential instructions resulting in a very high speed computer.

## MANUFACTURER

Litton Industries
Electronic Equipment Division

## STORAGE

| Media | No. of Words | No. of Digits(Binary) | Microsec |
|---|---|---|---|
| Cores | 1,280 | 28,160 | 4 |
| Magnetic Drum | 12,800 | 281,600 | 5,000 (Avg) |

## INPUT

| Media | Speed |
|---|---|
| 128 Word Drum Buffer | 250 microsec avg to 1st word<br>4 microsec thereafter |
| Flexowriter | 10 char/sec |
| Paper Tape | 200 char/sec |

## OUTPUT

| Media | Speed |
|---|---|
| 512 Word Drum Buffer | 1,000 microsec avg to 1st word<br>4 microsec thereafter |
| Flexowriter | 10 char/sec |

## CHECKING FEATURES

Parity checks are built in on all core and drum memory transfer and storage. Program is automatically interrupted when error occurs and is detected.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 0.950 Kw |
| Volume, computer | 9.5 cu ft |
| Area, computer | 4 sq ft |
| Weight, computer | 320 lbs |

# LITTON DATA ASSESSOR

Litton Industries Data Assessor System

## MANUFACTURER

Electronic Equipments Division
Litton Industries

Photo by Litton Industries Electronic Equipments Division

## APPLICATIONS

System is designed for general purpose computing and for special purpose problems, which take advantage of the internal information transfer in the computer. The useful characteristics are dual half word arithmetic (simultaneous operation on two half words), real time input-output functions, large amounts of data comparison, external control and communication, and computer-computer communication.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 32 |
| Binary digits/instruction | 32 |
| Instructions per word | 1 |
| Instructions decoded | 55 |
| Arithmetic system | Fixed point |
| | 30 bits plus sign or two half words each of 15 bits plus sign |
| Instruction type | One address |
| Number range | Either $\pm (2^{30} - 1)$ or two half words of $\pm (2^{15} - 1)$ |

Input-output functions are automatic.

All B-box operations are included within each order. These include choice of B-box and whether the B-box itself should be modified.

Each command associated with information transfer contains stencil bits which allow full word, half word, or shifted half word transfer. In addition, it is possible to transfer a word logically multiplied by a stencil word.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 12 | 6 |
| Mult | 60-102 | 48-90 (half or full word) |
| Div | 60-102 | 48-90 (half or full word) |

A square root order is included. It takes 96 or 186 microseconds.

Construction (Arithmetic unit only)

| | |
|---|---|
| Transistors | 1,600 |
| Diodes | 17,000 |
| Arithmetic mode | Parallel |
| Timing | Synchronous |
| Operation | Concurrent |

## STORAGE

| Media | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Cores | 1,024 | 32 | 6 |
| Drum | 2,560 | 32 | 6-17,000 |

Up to eight independent magnetic tape units could be connected to the computer.

## INPUT

| Media | Speed |
|---|---|
| Data Link | 750 bits/sec |
| Analog/Digital Converter | 20 bits/6 microsec |
| Control Panel | |

Link and converter are programmable.

## OUTPUT

| Media | Speed |
|---|---|
| Cathode Ray Tube | 20 bits/6 microsec |
| Control Equipment | 30 bits/6 microsec |

Outputs are programmable. The input-output equipment specified is for a special purpose application. The input-output buffers can accept serial or parallel information up to a total maximum rate of 32 bits each 6 microseconds. The ability of each input buffer is programmable, but the various functions are controlled by the availability of external data.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM
## FUTURE PLANS

| Type | Quantity | |
|---|---|---|
| Diodes | 23,000 | |
| | 1,000 | memory |
| | 16,000 | logic |
| | 6,000 | clamps on the outputs or inputs of flip-flops or boosters or double inverters |
| Transistors | 3,100 | |
| | 275 | flip-flops at 4 each |
| | 200 | power boosters at 2 each |
| | 800 | double inverters at 2 each |
| Magnetic Cores | 34,000 | |

The basic building blocks of the system are 4 transistor flip-flops, 2 transistor power boosters, and 2 transistor double inverters. In addition, there are several cards of fast adder carry propogation logic. The major number of cards in the system contain diode logic. There are numerous cards which are required for the mechanization of the core memory. Plans include provision of a separate memory for input -output to avoid interference with computation, additional memory modules, and geranium modules with silicon for wide ambient temperature range.

## CHECKING FEATURES

There exists a parity bit in each word in core storage. If a parity bit failure occurs, or an incorrect order occurs, the error flip-flop turns on.

Program can be used to interpret error information. Under operator control, an error will either turn off the computer or cause the program to tally and classify such errors.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 1.5 Kw | 2.0 KVA | 0.75 pf |
| Volume, computer | | 21 cu ft | |
| Area, computer | | 9 sq ft | |
| Room size | | 7 ft x 7 ft x 7 ft high (Suitable for Helihut use) | |
| Floor loading | | 60 lbs/sq ft | |
| Weight, computer | | 500 lbs | |

The computer will work in an environment from 20°F to 100°F, and as such, no air conditioning was planned for the initial installation. Present system operates at 60 cps. A 400 cps model can be made available.

## PRODUCTION RECORD

| | |
|---|---|
| Number in current production | 1 |
| Number on order | 1 |
| Time required for delivery | 6-8 months |

## PERSONNEL REQUIREMENTS

One operator is required for each shift. The present mechanization contains a self checking program and as it works on a real-time problem, it proceeds automatically. Because of this, a single operator is all that is required.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY
## ADDITIONAL FEATURES AND REMARKS

The design of the circuits is based upon very conservative techniques in order to assure a high degree of reliability. The worst-case method of analysis has been used to insure that the circuits operate satisfactorily while being subjected to the most adverse combination of component tolerances and parameter variations. In addition, all of the components have been derated with respect to allowable dissipation, voltage, etc. Component characteristics, such as current gain, are based upon history-derived estimate of the end-of-life value.

Provision is made in the Data Assessor for automatic checking. If a parity error should occur in the core memory, or if an incorrect order should be read, the appropriate error flip flop will turn on and this information would be entered into the computer. A switch on the control panel can be set to either stop the computer after an error, or allow the program to analyze the error. The program can be set to determine and tally the various types of errors. The program can then either correct them if they occur rarely or stop the computer and alert the operator if they occur often.

The Data Assessor is mechanized to provide all the error checking information necessary for complete error detection and checking. The amount of error checking performed depends on the type of program used. Outstanding features include self modifying B-box operation, built in stencil in each order, dual half word arithmetic, programmable (serial or parallel) input-outputs, alarm clock, and simplified communication between computer components. The computer operates at the rate of about 75,000 operations per second. Each operation can occur between two sets of independent variables, such as X, Y navigation. Inputs-outputs do not interrupt the program.

# LOGISTICS

ONR ERA Logistics Computer

## MANUFACTURER

Engineering Research Associates, Inc.

## APPLICATIONS

Located at the Staughton Hall, 707 22nd Street, NW, Washington 7, D.C., the system is used for the numerical simulation of naval operations in the area of supply, mathematical studies in the area of matrix games, situations of attrition, and certain kinds of war game studies. System is also used directly as a research instrument in the development of concepts bearing upon data processing operations by the military.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Digits per word | 12 |
| Arithmetic system | Fixed point |
| Instruction type | Three address (approx) |
| Number range | $-(5.10^{11} - 1) \leqslant N \leqslant (5.10^{11} - 1)$ |
| Instruction word format | |

Normal mode of program storage is by way of wired instructions (many address) on a plugboard. A program may be stored internally and decoded by means of a control program wired on a plugboard. This latter method has been little used because of its low speed.

There are 15 registers.

Photo by George Washington University

## ARITHMETIC UNIT

| Operation | Incl. Stor. Access Microsec |
|---|---|
| Add | 500 |
| Mult | 500 - 1000 |
| Div | (Programmed division) |

| Construction (Arithmetic unit only) | |
|---|---|
| Vacuum-Tubes | 4,500 |
| Condenser-Diodes | 5,000 |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

System is serial in decimal digits, parallel in bits for each decimal digit.

## STORAGE

| Media | No. of Words | No. of Dig/Word | Access Microsec |
|---|---|---|---|
| Magnetic Drum | var. 14,000-37,000 | 12-4 | 16,000 |
| Magnetic Drum | 7,000-80,000 | 60-4 | 16,000 |
| High speed registers | 15 | 12 | 220 Kc Shift rate |

Total digit capacities of drums are about 185,000 and 400,000 respectively.

Second drum has usual read and write. The location or absence of a given word may be determined in one revolution by means of one of a system of SEARCH instructions.

## INPUT

| Media | Speed |
|---|---|
| Card (collator) | 240 cards/min |
| Paper Tape | 200 columns/sec |

Paper tape input are Ferranti readers. Card rate is alternating from each of two pockets.

## OUTPUT

| Media | Speed |
|---|---|
| Card | 50 cards/min |
| Paper Tape | 60 char/sec two |

Two paper tape outputs are teletype perforators.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | 4,500 |
| Diodes | 5,000 |
| Transistors | 10,000 |
| Magnetic Cores | 3,240 (bits) |

## CHECKING FEATURES

Most commonly used checking feature is that machine will detect presence of non-numeric binary codes and will stop or branch.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| KVA, computer | 19 |
| KVA, air conditioner | 22 |
| Volume, computer | 910 cu ft |
| Volume, air conditioner | 130 cu ft |
| Area, computer | 130 sq ft |
| Area, air conditioner | 18 sq ft |
| Room size, computer and air conditioner | 918 sq ft |
| Floor loading | 7.4 lbs/sq ft |
| | 86 lbs concen max |
| Capacity, air conditioner | 11 Tons |

Computer was installed in a gutted area of building with heavy floor. Further ceiling support was provided. Motor generator set was installed in a small addition to main building. Building was an apartment house.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

## COST, PRICE AND RENTAL RATES

Cost/Price for basic system

| | |
|---|---|
| Computer and one drum | $350,000 |
| Ferranti readers and tape punches | 4,000 |
| Total | $354,000 |

Cost/Price for additional equipment

| | |
|---|---|
| Input Output buffer | $ 95,000 |
| Second drum (see above) | 200,000 |

Computer and equipment cited is owned by Office of Naval Research.

Rental rates for additional equipment includes $200/ monthly for collator and punch used for Input-Output.

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift |
|---|---|
| Analysts | 3 |
| Programmers | 4 |
| Clerks | 2 keypunch operators |
| Engineers | 2 |
| Technicians | 2 |

Operation tends towards open shop.

Method of training used is "write, load and debug."

Additional shift operations are filled in by programming staff or by the hiring on temporary basis of "computer Watchers" when tending is all that is required.

No increase in engineering staff would probably be required if we ran 2 shifts all the time.

Computer is capable of protracted good time.

Personnel cited above is approximation of relatively informal organizational setup.

The engineers cited are capable of work at all levels of electronic engineering and have extensively modified the original computer (delivery February 1953) both logically and in the matter of capacity of certain elements.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Good time 37 Hours/Week (Average)

Operating ratio (Good/Attempted to run time) 0.9

Above figures based on period 1 Jan 56 to 30 Jun 56

Time is available for rent to outside qualified organizations.

Our down time figures would indicate that our "would have run if computer were OK time" would be about 10% of our good time, hence the indicated ratio. During 1958 and 1959 a heavy modification program has reduced good time. Our current (last six months) good time is 16, with a somewhat lower operating ratio, i.e. 0.75.

## ADDITIONAL FEATURES AND REMARKS

The search logic as noted above. Given that a certain register contained the word w, one or another of the search instructions would determine its absence, the address of its location )somewhere), or of its "next" location, or of its "first" location in about 16 milliseconds.

## FUTURE PLANS

A new adder is being built for this machine.

The operation is serial and digital addition will occur every two drum (shift) clocks instead of during the 7 now used.

Division, 11 decimal digits divided by 11 decimal digits plus signs will be installed.

## INSTALLATIONS

The George Washington University
Logistics Research Project
707 22nd Street, N. W.
Washington 7, D. C.

# MAGNEFILE B

Magnefile Electronic Data Processing System B

## MANUFACTURER

Electronics Corporation of America
Business Machines Division

## APPLICATIONS

Inventory control for retail sales department store.
Special purpose, no longer in production.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Decimal |
| Decimal digits/word | 8 |
| Instructions/word | Instructions wired in |
| Instructions used | 7 |
| Arithmetic system | Fixed point |
| Instruction type | One address |

Three addresses are entered simultaneously.

## ARITHMETIC UNIT

| | |
|---|---|
| Add time (exclud stor access) | 150,000 microsec |
| Construction | Vacuum tubes |
| Basic pulse repetition rate | 30 Kc/sec |
| Arithmetic mode | Serial |
| Timing | Asynchronous |
| Operation | Sequential |

## STORAGE

| Medium | Words | Access Microsec |
|---|---|---|
| Magnetic Drum | 4,040 | 300,000 |

## INPUT OUTPUT

| Medium | Speed |
|---|---|
| Full Keyboard | 4 char/sec |
| Typewriter | 7 char/sec |

Photo by Electronics Corporation of America

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | | |
|---|---|---|
| Tubes | 130 | 6 Types |
| Crystal diodes | 40 | |
| Different plug-in units | 10 | |
| Separate cabinets | 1 | |

## CHECKING FEATURES

Continuous checking total

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 0.6 Kw |
| Area, computer | 3.5 ft x 2.5 ft |
| Weight, computer | 400 lbs |

## COST, PRICE AND RENTAL RATES

Approximate cost of basic system $20,000.

## PERSONNEL REQUIREMENTS

One operator required during operation. A service technician is called when needed.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Passed Customer Acceptance Test 15 February 1954.

## INSTALLATIONS

B. Altman and Company
Fifth Avenue
New York, New York

# MAGNEFILE D

Magnefile Electronic Data Processing System Model D

## MANUFACTURER

Electronics Corporation of America
Business Machines Division

## APPLICATIONS

Inventory control. No longer manufactured.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Decimal |
| Decimal digits/word | 42 |
| Instructions/word | Instructions wired in |
| Instructions used | 77 |
| Arithmetic system | Fixed point |
| Instruction type | One address |

Three one-address commands are entered simultaneously.

## ARITHMETIC UNIT

| | |
|---|---|
| Add time (exclud stor access) | 100,000 microsec |
| Construction | Vacuum tubes |
| Basic pulse repetition rate | 40 Kc/sec |
| Arithmetic mode | Serial |
| Timing | Asynchronous |
| Operation | Sequential |

## STORAGE

| Media | Words | Access Microsec |
|---|---|---|
| Magnetic Drum | 8,000 | 50,000 |
| Magnetic Drum | 500 | 50,000 |

The larger drum stores 8,000 21 dec dig words.
The smaller drum stores 500 42 dec dig words.

## INPUT OUTPUT

| Media | Speed |
|---|---|
| Full Keyboard | Manual (4 char/sec) |
| Typewriter | 10 char/sec |

Remote keyboards may be added.

Photo by Electronics Corporation of America

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | | |
|---|---|---|
| Tubes | 140 | 4 Types |
| Crystal diodes | 240 | |
| Different plug-in units | 12 | |
| Separate cabinets | 1 | |

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 1 Kw |
| Area, computer | 5 ft x 3 ft |
| Weight, computer | 700 lbs |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced | 1 |

No longer in production

## COST, PRICE AND RENTAL RATES

Approximate cost of basic system $50,000. No longer in production.

## PERSONNEL REQUIREMENTS

One operator. On call technician.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Passed Customer Acceptance Test 5 August 1953.

## INSTALLATIONS

B. Altman and Company
Fifth Avenue
New York, New York

# MANIAC I

Mathematical Analyzer Numerical Integrator and Computer Model I

## MANUFACTURER

University of California
Los Alamos Scientific Laboratory

Photo by University of California, Los Alamos Scientific Laboratory

## APPLICATIONS

University of New Mexico Research Center
Located at University of New Mexico Research Center, 2206 Lomas Blvd., N.E. (Box 181), albuquerque, New Mexico, the system is used for general purpose scientific computations, providing a computer service to faculty and students of the university.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits per word | 40 |
| Binary digits/instruction | 8 |
| Instructions per word | 2 |
| Instructions decoded | 36 |
| Binary digits/instruction not decoded | 2 |
| Instructions used | 35 |
| Arithmetic system | Fixed point |
| Instruction type | One address |
| Number range | $-1 \leq n < 1$ |

## ARITHMETIC UNIT

| | Exclud Stor Access Microsec |
|---|---|
| Add time | 80 |
| Mult time | 1,000 |
| Div time | 1,000 |
| Construction | Vacuum tubes |
| Arithmetic mode | Parallel |
| Timing | Asynchronous |
| Operation | Concurrent |

## STORAGE

| Media | Words | Access Microsec |
|---|---|---|
| Electrostatic (CRT) | 1,024 | 8 - 16 |
| Magnetic Drum | 10,000 | 50 words in 83,000 |

Cathode Ray Tube is of the Williams type.

## INPUT

| Media | Speed |
|---|---|
| Paper Tape | 1,024 words in 48 seconds |
| Magnetic Tape | 1,024 words in 45 seconds |

## OUTPUT

| Media | Speed |
|---|---|
| Printer (Teletype) | 36 words/min |
| Printer (Anelex) | 3,600 words/min |
| Paper Tape | 81 words/min |
| Magnetic Tape | 1,024 words in 45 seconds |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 2,400 |
| Tube types | 7 |
| Crystal diodes | 500 |
| Different plug-in units | 1 Electrostatic |
| | 6 Magnetic Drum |
| Separate cabinets | 4 |

Type 2BP1 cathode ray tubes (Williams) are used in the storage unit.

## CHECKING FEATURES

Check sum on filling storage by paper tape and magnetic tape.
Check sum on filling magnetic drum.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

University of California

| | |
|---|---|
| Power, computer | 35 Kw |
| Volume, computer | 128 cu ft |
| Area, computer | 20 sq ft |
| Capacity, air conditioner | 10 Tons |

U of New Mexico

Site preparation include channeled floor for air conditioning and power, ceiling ducts for air conditioning, and a special room for the motor-generators (D.C. supply).

## COST, PRICE AND RENTAL RATES

Approximate cost of basic system $250,000.
Approximate cost of high speed printer and magnetic drum $48,000.
Prices include development, construction and overhead.

## PERSONNEL REQUIREMENTS

U of New Mexico

System is to be operated and maintained by one person. It is expected to be operating prior to 1 Jan 1961 at the University of New Mexico.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U of New Mexico

| | |
|---|---|
| Average error-free running period | 5 Hours |
| Good time | 11,493 Hours |
| Attempted to run time | 12,399 Hours |
| Operating ratio (Good/Attempted to run time) | 0.93 |

Above figures based on period from Mar 52 to Jan 57
Passed Customer Acceptance Test Mar 52
Time is available for rent to outside organizations.
The machine was moved to the University of New Mexico in 1958. Installation was started in 1959.

## FUTURE PLANS

U of New Mexico

The machine is being studied by approximately six graduate students at the Master of Science level, with three masters thesis being written on proposed system changes, including, replacing the single channel tape system with a multi-channel system, a logical study of a program interchange between MANIAC I and a NATIONAL 102A, and modifications to the existing adder in the machine.

## INSTALLATIONS

University of New Mexico
Research Center
2206 Lomas Blvd. N.E.
Albuquerque, New Mexico

# MANIAC II

Mathematical Analyzer Numerical Integrator and Computer Model II

## MANUFACTURER

University of California
Los Alamos Scientific Laboratory

Photo by University of California, Los Alamos Scientific Laboratory

## APPLICATIONS

University of California, Los Alamos Scientific Laboratory

Located at Los Alamos, N. M., the system is used for studies in automatic programming, symbolic manipulations (e.g., algebra, differential calculus), mathematics, esp. combinatorial and algebraic transformations, Monte Carlo, crystallography, and general applied mathematics.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 48 |
| Binary digits/instruction | 24 |
| Instructions per word | 2 |
| Instructions decoded | 94 |
| Arithmetic system | Fixed and floating point |
| Instruction type | One address |
| Number range | $2^{112}$ |

Instruction word format

| 1 | 2 8 | 9 10 | 11 24 |
|---|---|---|---|
| Break Point | Order | Index | Address |

Automatic coding includes MADCAP (86 characters, full sub- and superscripting). Display quotients are planned.

Registers and B-boxes include 3 B-boxes, a universal register, a storage register and a remainder register.

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Mult | 180 avg | 180 avg |
| Div | 300 avg | 300 avg |

Construction (Arithmetic unit only)

| | |
|---|---|
| Vacuum tubes | 2,850 |
| Diodes | 1,040 |

| | |
|---|---|
| Arithmetic mode | Parallel |
| Timing | Asynchronous |
| Operation | Sequential |

## STORAGE

| Media | No. of Words | No. of Bin Dig/Word | Access Microsec |
|---|---|---|---|
| Cathode Ray Tube (Barrier Grid) | 12,288 | 49 | 15 (avg) |
| Magnetic Cores | 4,096 | 49 | 2.4 |

Magnetic Tape

| | | |
|---|---|---|
| No. of units that can be connected | 3 | Units |
| No. of chars/linear inch of tape | 300 | Char/inch |
| Channels or tracks on the tape | 1 | Track/tape |
| Blank tape separating each record | 6 | Inches |
| Tape speed | 60 | Inches/sec |
| Transfer rate | 18,000 | Char/sec |
| Start time | 25 | Millisec |
| Stop time | 30 | Millisec |
| Average time for experienced operator to change reel of tape | 60 | Seconds |
| Physical properties of tape | | |
| Width | 0.25 | Inch |
| Length of reel | 1,200 | Feet |
| Composition | 1 1/2 mil mylar sandwich | |

Two physical tracks on tape combine to form a single information channel.

## INPUT

| Media | Speed |
|---|---|
| Magnetic Tape | 270 words/sec |
| Paper Tape | 250 char/sec |
| Keyboard | Manual |

## OUTPUT

| Media | Speed |
|---|---|
| Magnetic Tape | 270 words/sec |
| Printer | 77,400 char/sec (max) |
| Punch | 60 char/sec |
| Electric Typewriter | 10 char/sec |

Printer speed is 900 lines/min.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | 5,190 |
| Diodes | 3,050 |
| Transistors | 1,160 |
| Magnetic Cores | 200,700 |

95% of the tubes are Type 5965. 5% are high power drives.

## CHECKING FEATURES

Parity check on electrostatic storage and magnetic tape.
Load sums for identification
(+) Exponent spill
Overflow
(-) Exponent spill

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 37 KVA |
| Volume, computer | 1,000 cu ft |
| Area, computer | 150 sq ft |
| Capacity, air conditioner | 15 Tons |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

## COST, PRICE AND RENTAL RATES

The total cost is about $350,000.

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift |
|---|---|
| Supervisors | 3 |
| Analysts | 4 |
| Programmers | 8 |
| Coders | 2 |
| Clerks | 1 |
| Operators | 1 |
| Engineers | 4 |
| Technicians | 4 |

Operation tends toward open shop.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

| | |
|---|---|
| Average error-free running period | Several Hours |
| Good time | 50 Hours/Week (Average) |
| Attempted to run time | 52 Hours/Week (Average) |
| Operating ratio (Good/Attempted to run time) | 0.96 |

Above figures based on period from 1958 to present
Time is not available for rent to outside organization.

## ADDITIONAL FEATURES AND REMARKS

3 indexing registers (B registers) for automatic, address modification and cycle counting (independent of arithmetic elements).

Semi-automatic exit from sub-routines.

Large base for floating point operation to increase speed of floating point additions.

"Madcap", Mathematical and Descriptions Coding Assembly Program, will translate a series of logical and algebraic statements into a computer ready code, this will use a seven hole tape, standard coding uses five holes. Tape reader can handle either.

## INSTALLATIONS

University of California
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico

# MANIAC III

Mathematical Analyzer Numerical Integrator and Computer

## MANUFACTURER

University of Chicago
Institute for Computer Research

## APPLICATIONS

This system will be used by all interested departments of the University of Chicago.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 48 |
| Instructions per word | 1 |
| Instructions decoded | 94 |
| Arithmetic system | Floating point |
| Instruction type | Two address |
| Number range | |
| Fraction range | $(1 - 2^{-39})$ to -1 |
| Exponent range | +127 to -127 |

Instruction word format

| 1 | 7 | 1 | 5 | 14 | 1 | 5 | 14 |
|---|---|---|---|---|---|---|---|
| Tag | Operation | Inflector | Modifier | Address | Inflector | Modifier | Address |

Registers and B-boxes
- 3 Arithmetic Registers
- 8 Transistor Storage Registers
- 8 Index Registers
- 2 Indicator Registers

Four different types of arithmetic (significant digit floating point, specified point, normalized, basic), all using same number format (exponent-fraction).

Special exponent used to denote absolute zero (essentially zero with exponent -(x).

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 24 + n/2 | 18 + n/2 |
| Mult | 71 | 65 |
| Div | 81 | 75 |

n = difference of exponents.

| | |
|---|---|
| Construction (Arithmetic unit only) | |
| Transistors | 10,000 |
| Condenser-diodes | 16,000 |
| Arithmetic mode | Parallel |
| Timing | Asynchronous |
| Operation | Concurent |

## STORAGE

| No. of Words | No. of Digits | Access Microsec |
|---|---|---|
| 8,192 | 48 | 1 |

Plans in progress to include an additional 8,192 words.

Magnetic Tape

| | |
|---|---|
| No. of units that can be connected | 4 Units |
| No. of char/linear inch of tape | 250 Char/inch |
| Channels or tracks on the tape | 8 Tracks/tape |
| Blank tape separating each record | 5 Inches |
| Tape speed | 150 Inches/sec |
| Transfer rate | 37,500 Char/sec |
| Start time | 5 Millisec |
| Stop time | 5 Millisec |
| Average time for experienced operator to change reel of tape | 60 Seconds |
| Physical properties of tape | |
| Width | 0.5 Inches |
| Length of reel | 2,500 Feet |
| Composition | Mylar |

## INPUT

| Media | Speed |
|---|---|
| Paper Tape | 350 char/sec |
| Keyboard (Typewriter) | Manual Alphabetic and numeric |
| Magnetic Tape | 37,500 char/sec |

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape | 60 char/sec |
| Typewriter | 10 char/sec |
| Line Printer | 600 lines/min |
| Magnetic Tape | 37,500 char/sec |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Diodes | 20,000 |
| Transistors | 12,000 |
| Magnetic cores | 500,000 |

## CHECKING FEATURES

Parity on tapes and core storage.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 2 Kw | 2 KVA | 1.0 pf |
| Area, computer | | 64 sq ft | |
| Room size, computer | | 25 ft x 30 ft | |
| Floor loading | | 50 lbs/sq ft max | |
| | | 20 lbs/sq ft | |
| | | 50 lbs concen max | |
| Weight, computer | | 600 lbs | |

Room temperature controlled to 75°F., humidity 40% - 60%. Cable ways under floor, or false floor.

## PERSONNEL REQUIREMENTS

Open shop policy.

## ADDITIONAL FEATURES AND REMARKS

All arithmetic performed on operands in exponent-coefficient form; several options for sealing of result allow calculation to be performed, "generalized fixed point", "normalized", significance-mode, or multiple-precision as convenient.

## INSTALLATIONS

University of Chicago
Institute for Computer Research
Chicago 37, Illinois

# MERLIN

MERLIN

## MANUFACTURER

Brookhaven National Laboratory

## APPLICATIONS

Located at Upton, New York, the system is used for Atomic Energy Commission programs, including areas of physics, chemistry, biology, medicine, reactor studies, acceleration design and meteorology.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Number of binary digits per word | 48 |
| Number of binary digits per instruction | 48 |
| Number of instructions per word | 1 |
| Number of instructions decoded | Approx 90 |
| Arithmetic system | Floating point<br>Fixed point |
| Instruction type | One address (mostly)<br>Two address (some) |
| Number range | $2^{-120} - 2^{120}$ |

Instruction word format

| Y | Z | b | b' | m | m' |
|---|---|---|---|---|---|

YZ = command (two hexadecimal characters)
b } B box address for 1st address, 2nd address
b' } (4 bits each)
m 1st memory address (16 bits each)
m' 2nd memory address

Automatic built-in subroutines
Square-root

Registers and B-boxes
6 B-boxes
3 shifting and 4 non-shifting registers, the latter for fast access storage, in Arithmetic Section
Pathfinder for subroutine return
16 bit Sense Register

48 bit word has one multi-address instruction. The numerical operand represents number in the form $2^{8e}$ X: four bits specify magnitude of exponent e, one bit its sign; 40 bits the magnitude of the fractional part X and one bit its sign. Of the remaining two bits of the word (tag bits), one may be automatically detected by control. Fetching of next sequenced instruction begins before completion of operation. MERLIN is patterned after MANIAC II (Los Alamos).

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec. | Exclud. Stor. Access Microsec. |
|---|---|---|
| Add | 8 μs (3.5) | - |
| Mult. | 140 μs | 130 |
| Div. | 330 μs | 320 |

Construction, arithmetic unit only

| Type | Quantity |
|---|---|
| Vacuum tubes | |
| 5956 | 800 |
| 6197 | 275 |
| Diodes | |
| T3G | 7,000 |

Arithmetic mode: Parallel

## STORAGE

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Electrostatic Barrier Grid Tube | 8,192 | 49 | 6 |

## INPUT

| Media | Speed | |
|---|---|---|
| Flexowriter | 10 char/sec | Friden |
| Paper Tape | 200 char/sec | Ferranti TR 2 |
| Magnetic Tape | 20K char/sec | Ampex FR 300 - 4 units |

## OUTPUT

| Media | Speed | |
|---|---|---|
| Flexowriter | 10 char/sec | Friden |
| Paper Tape | 60 char/sec | Teletype |
| Magnetic Tape | 20K char/sec | Ampex FR 300 |
| Printer | 10 lines (96 char)/sec | Shepard |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity | |
|---|---|---|
| Tubes | | |
| 5965 | 2,500 | Blocking Osc. Flip Flops and Cathode followers |
| 6197 | 400 | Pulse Drivers |
| 12E1 | 18 | Deflection Amplifiers and Pulse Amps. |
| 0A2 | 24 | Regulators |
| Diodes | | |
| T3G | 16,000 | Gating and Switching |
| T5G | 350 | Gating and Switching |
| IN643 | 150 | Gating and Switching |
| Zenor Diodes | | |
| Various | 40 | Bias Supplies |
| Transistors | | |
| 2N247 | 400 | Memory Read Amplifier and Buffer |
| 2N393 | 100 | Memory Discriminator |
| 2N344 | 300 | Memory Strobe and Parity |
| 2N1091 | 20 | Emitter Followers |
| Magnetic Cores | | |
| Various | 1,200 | Blocking Oscillator and Pulse Transformers |

## CHECKING FEATURES

Parity check at input/output and memory output.
Single bit error correction to be added at memory output.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 40 Kw | 45 KVA | 0.9 pf |
| Power, air conditioner | 16 Kw | 18 KVA | 0.9 pf |
| Volume, computer | | 1500 | cu ft |
| Area, computer | | 165 | sq ft |
| Room size, computer | | 1400 | sq ft |
| Volume, air conditioner | | 150 | cu ft |
| Area, air conditioner | | 25 | sq ft |
| Room size, air conditioner | | 1200 | sq ft |
| Capacity, air conditioner | | 20 | Tons |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

## COST, PRICE AND RENTAL RATES

Cost $600,000

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift Used |
|---|---|
| Supervisors | 1 |
| Analysts | 2 |
| Programmers | 7 |
| Clerks | 1 |
| Engineers | 2 |
| Technicians | 3 |

Operation tends toward open shop.

Formal two week course (1 1/2 hr/day).
Individual assistance as required.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is available for rent to outside organizations on a qualified basis.

Operating figures are not yet available.

Computer is in final stages of debugging and is available on a limited basis.

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include 4 fast access temporary storage registers.

## FUTURE PLANS

An additional 8000 words of Radechon memory will be incorporated with a self-correcting code. An 8000 word magnetic core memory will also be added.

Modifications, including specialized input-output equipment, will be undertaken on the basis of specific research requirements.

## INSTALLATIONS

Brookhaven National Laboratory
Upton, New York

# MINIAC II

MINIAC II

## MANUFACTURER

Marchant Calculators, Incorporated
(Now Smith-Corona Marchant, Inc.)
Data Processing Systems Division

Picture by The Atlantic Refining Company, Incorporated, Dallas, Texas

## APPLICATIONS

The Atlantic Refining Company
Scientific and engineering. Utilized by the Atlantic Refining Company's Research and Development Department for research and development in oil exploration and production. Scientific and engineering applications include synthetic seismograms, geophone responses, chemical process designs and fluid flow in porous media.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Bin coded and Hexa dec |
| Digits per word | 10 decimal |
| Digits per instruction | 10 decimal |
| Instructions per word | 1 |
| Instructions decoded | 71 |
| Arithmetic system | Fixed point |
| Instruction type | One address |

## ARITHMETIC UNIT

| | Includ. Stor. Access Microsec | | Exclud. Stor. Access Microsec |
|---|---|---|---|
| | Average | Maximum | |
| Add time | 11,200 | 21,200 | 450 |
| Mult time | 24,300 | 41,400 | 13,600 |
| Div time | 25,600 | 43,200 | 14,800 |
| Construction | | Vacuum tubes | |
| Basic pulse repetition rate | | 300 Kc/sec | |
| Arithmetic mode | | Serial | |
| Timing | | Synchronous (clocking channels on the drum) | |
| Operation | | Sequential | |

The add time, excluding storage access, given above, is equivalent to 3 word times. The operand and instruction times are included in all the above values.

## STORAGE

| Media | Words | Digits | Microsec Access |
|---|---|---|---|
| Magnetic drum | 4,096 | 10 plus sign | 1,200-10,000 |

256 words, 2,500 microsec average access, is optional.

## INPUT

| Media | Speed |
|---|---|
| Paper Tape (Flexowriter) | 600 char/min (6 channel tape) |
| Ferranti Photoelectric Reader | 300 words/min (limited by loading program) |
| Keyboard | Manual |

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape (Flexowriter) | 600 dig/min |
| Friden Punch | 30 char/sec (6 channel) |

Spare Flexowriter can also be used for the separate preparation of data and programs.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 850 |
| Tube types | 7 cover 95% |
| Crystal diodes | 2,000 |
| Separate cabinets | 1 |

There are 75 types of plug-ins at $10 each.
50% of the machine uses 7 types of plug-ins.
The major types of tubes are the 5963, 5687, 12BH7, 12AT7, 5965, 5915, 2D21.
A cold water supply and a desk for the Flexowriter is included.

## CHECKING FEATURES

Timing circuits
Twenty jacks for applying marginal voltages

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 5 KW, 220 volt |
| Space, computer | 91 cu ft, 20 sq ft |
| Space, air cond. | Dimensions 4.5 x 4.5 x 4.5 ft plus desk |
| Weight, computer | 2,000 lbs |
| Capacity, air cond. | 2 tons |

Designed for cooling by water between 60° and 65°F.

## PRODUCTION RECORD

| | |
|---|---|
| Produced | 1 Model C and 1 Model II |
| Operating | 1 Model C and 1 Model II |
| Delivery time | No longer manufactured |

## COST, PRICE AND RENTAL RATES

| | |
|---|---|
| Approximate cost of basic system | $85,000 |
| Approximate cost of Flexowriter | $ 2,950 |
| Approximate cost of Spare Flexowriter | $ 2,950 |

No maintenance contract.

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift | | Two 8-Hour Shifts | | Three 8-Hour Shifts | |
|---|---|---|---|---|---|---|
| | Used | Recom | Used | Recom | Used | Recom |
| Operators | 1 | 1 | 1 | 2 | 1 | 2 |
| Typist | 0 | 1 | 0 | 1 | 0 | 1 |

Methods of training used On the Job

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

| | |
|---|---|
| Good time | 42 Hours/Week |
| Attempted to run time | 48 Hours/Week |
| Operating ratio (Good/Attempted to run time) | 0.875 |

Above figures based on period from 26 Feb 60 to 26 Mar 60
Acceptance test 1 Mar 55
Time is not available for rent to outside organizations.

Magnetic drum replaced in 1958.

Converted from one-address to two-address operation in 1959.

## FUTURE PLANS

Incorporation of a Moseley system, to have the following items:
- Tape Translator
- X-Y Recorder
- Character Printer
- Curve Follower

## INSTALLATIONS

Atlantic Refining Company
Research and Development Laboratory
4500 W. Mockingbird Lane
Dallas, Texas

# MISTIC

Michigan State Digital Computer

## MANUFACTURER

Michigan State University

Photo by Michigan State University

## APPLICATIONS

Service facility for University staff and students on an open shop basis for general purpose computation.

Used for instructional purposes in several programming and numerical analysis courses which are offered for credit by the University.

Available for use on applicable sponsored research projects.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Number of binary digits per word | 40 |
| Number of binary digits per instruction | 20 |
| Number of instructions per word | 2 |
| Total number of instructions decoded | 186, of which 139 are unique |
| Arithmetic system | Fixed point |
| Instruction type | One-address |
| Number range | -1 to $+(1-2^{-39})$ |

Instruction word format

| ORDER | | ADDRESS | ORDER | | ADDRESS |
|---|---|---|---|---|---|
| Type | Variant | | Type | Variant | |
| 4 bits | 4 bits | 12 bits | 4 bits | 4 bits | 12 bits |

Two 40-bit shifting registers and one 40-bit fixed register for arithmetic operations.

Two separate 2-bit registers will hold a bank address for 16,384 word core memory, one register each for operands and instructions.

## ARITHMETIC UNIT

| Operation, Incl stor. access | Microseconds |
|---|---|
| Add time | 100 |
| Mult time | 1,000 |
| Div time | 1,100 |
| Excl stor. access | |
| Add time | 80 |
| Mult time | 980 |
| Div time | 1,080 |

| Construction (Arithmetic unit only) | |
|---|---|
| Vacuum tubes type | Quantity |
| 5844 | 580 |
| 7044 | 236 |
| 5670 | 120 |
| Arithmetic mode | Serial |

## STORAGE

| Media | Number of Words | Digits per Word | Access Microseconds |
|---|---|---|---|
| Cathode Ray Tube | 1,024 | 40 bin | 20 |
| Magnetic Core | 16,384 | 40 bin | 20 |

The MC memory will replace the CRT memory.

## INPUT

| Media | Speed |
|---|---|
| 5-level Photodiode Paper Tape | 300 char/sec |
| Cards | 200 cards/min |

Above speeds are maximum. Card decoding is programmed so that input is 100 cards/minute for most applications.

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape | 60 char/sec |
| Teletypewriter | 10 char/sec |
| Cards | 100 cards/min, max |

Cards are program decoded.
CRT output is under construction.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

Tubes

| Type | Quan |
|---|---|
| 5844 | 1,300 |
| 5670 | 650 |
| 7044 | 400 |
| 5726 | 100 |
| Misc. | 160 |
| Total | 2,610 |

## CHECKING FEATURES

Division algorithm automatically checks for overflow and division by 0.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 18.5 K.W., input to computer |
| Power, air conditioner | 10 K.W., including fan, water pump and cooling tower fan |
| Volume, computer | 500 cu ft |
| Volume, power supplies | 200 cu ft |
| Volume, air conditioner | 150 cu ft |
| Volume, cooling tower | 320 cu ft |
| Area, computer | 75 sq ft |
| Area, power supplies | 30 sq ft |
| Area, air conditioner | 32 sq ft |
| Area, cooling tower | 32 sq ft |
| Room, computer | 12 ft x 18 ft |
| Room, power supplies | 8 ft x 9 ft |
| Air conditioner | 10 Horsepower |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

## PERSONNEL REQUIREMENTS

| Typical Personnel | One 8-Hour Shift |
|---|---|
| Supervisors | 1 |
| Analysts | 2 |
| Programmers | 2 |
| Clerks | 1 |
| Librarians | 1 |
| Operators | 1 |
| Engineers | 1 |
| Technicians | 1 |

The computer is operated on an open-shop basis so that most of the functions other than direct operation and maintenance of the computer are taken care of by the various users.

## INSTALLATIONS

Michigan State University
East Lansing, Michigan

## FUTURE PLANS

A 40-bit 16,384 word core memory is under construction and will replace the existing 1,024 word CRT memory in the Fall of 1960.

A CRT output with an attached camera is also under construction which will permit analog output directly from the computer. This will be made available in the Fall of 1960.

# MOBIDIC A

Mobile Digital Computer A AN/MYK-1(v)

## MANUFACTURER

Sylvania Electric Products, Incorporated

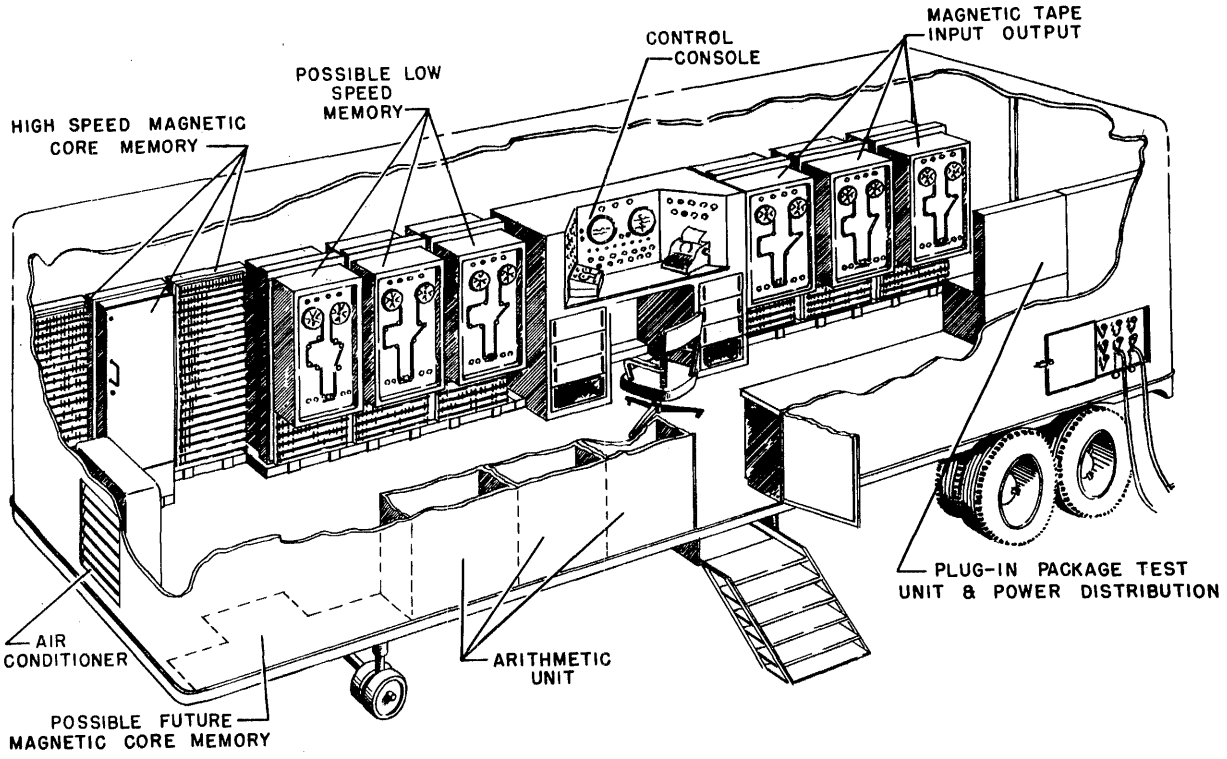



Photo by Sylvania Electric Products, Inc.

## APPLICATIONS

Presently located at the Needham Industrial Park, the MOBIDIC "A" is a mobile, highly-reliable, high speed, general purpose computing facility for use by field commanders for combat support data processing, combat control data processing, combat computation, and logistic computations.

The Real Time System consist of Real Time Input-Output registers, both of which are capable of communicating with an external device (including another MOBIDIC) over nine lines (6 data, 1 parity, 2 control). The Input system incorporates a program interupt feature.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 36 plus sign & parity bits |
| Binary digits/instruction | 36 plus spare & parity bits |
| Instructions per word | 1 |
| Instructions decoded | 52 |
| Arithmetic system | Fixed point |
| Assumed binary point at left end of word, between bits 36 & 37 | |
| Instruction type | One address |
| Some instructions are two address, e.g. load, move, etc. | |
| Number range | $-(1 - 2^{-36})$ to $+(1 - 2^{-36})$ |

Instruction word format

Standard Computer Instruction Word

| 38 | 37 | 36 31 | 30 28 | 27 16 | 15 13 12 1 |
|---|---|---|---|---|---|
| Parity | Spare | Op. Code | Index Reg. Selection | Minor Address | Major Address |

Input-Output Instruction Word

| 38 | 37 | 36 31 | 30 22 | 21 16 | 15 13 12 1 |
|---|---|---|---|---|---|
| Parity | Spare | In-Out Comd | Word-Block Counter | Device Selec-tion | Storage Address |

Automatic coding includes the Mobidic Assembly Program.

Registers include 6 in the Central Processor, 4 Index, 2 in the Communications Converter, and 2 in the In/Out Converter.

Instructions consist of 15 Arithmetic, 8 Transfer, 17 Logical, 3 Sense, and 9 Input-Output instructions.

Index Registers are expansible to a total of 7.

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 16 | 8 |
| Mult | 86 | 78 |
| Div | 88 | 88 |

Construction (Arithmetic unit only)
Transistors 6,000
Arithmetic mode Parallel
Timing Synchronous
Operation Sequential

Mostly sequential, however processing may proceed during input-output operations.

## STORAGE

| Media | No. of Words | No. of Bits/word | Access Microsec |
|---|---|---|---|
| Core Memory (2) | 4096 each | 40 | 8 |

Expandable to a total of 7 memories.

Magnetic Tape
No. of units that can be connected 63 Units
No. of chars/linear inch of tape 300 Chars/inch
Channels or tracks on the tape 8 Tracks/tape
Blank tape separating each record 1.5 Inches
Tape speed 150 Inches/sec
Transfer rate 45,000 Chars/sec
Start time 1.5 Millisec
Stop time 1.5 Millisec
Average time for experienced operator to change reel 120 Seconds
Physical properties of tape
Width 1/2 Inches
Length of reel 3600 Feet
Composition 1 mil mylar

The 40 bit word length in storage is made up of:
36 bit magnitude
1 bit sign
1 bit parity
1 busy-bit
1 spare-bit
40 Total in storage

## INPUT

| Media | Speed |
|---|---|
| Paper Tape 5 channel 11/16 inch tape | 200 char/sec (start-stop) to 270 char/sec |
| Paper Tape 8 channel 1 inch tape | 200-270 char/sec |
| Real Time Channel character by character | 120,000 char/sec |
| Cards | 200 cards/min |

The Real Time System was designed to operate with the Collins Kineplex equipment whose speed is 300 characters/sec. or with another MOBIDIC; however, it can operate with any compatible transmission equipment.

## OUTPUT

| Media | Speed | |
|---|---|---|
| Paper Tape 5 channel | 100 char/sec | 11/16" tape |
| Paper Tape 8 channel | 100 char/sec | 1 inch tape |
| Real Time | 120,000 char/sec | char by char |
| Flexowriter | 10 char/sec | |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Diodes | |
| SG-225 | 6,000 |
| Transistors | |
| 2N393 | 32,000 |
| Magnetic Cores | 311,200 |

## CHECKING FEATURES

Checking features include parity on memory transfer and input-output, overflow, non-existant memory, non-existant instruction, and non-existant device (I/O). Marginal checking may also be performed. Diagnostic Routines to check the machine and indicate instruction which fail and aid in the localization of failures are available.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 29.76 Kw | 37.2 KVA | 0.8 pf |
| Power, air conditioners | 4.64 Kw | 5.8 KVA | 0.8 pf |
| Volume, computer | 1,440 cu ft | | |
| Area, computer | 240 sq ft | | |
| Floor loading | 300 lbs/sq ft | | |
| | 240 lbs concen max | | |
| Volume, two air conditioners | 72 cu ft | | |
| Area, two air conditioners | 48 sq ft | | |
| Capacity, two air conditioners | 6 Tons | | |
| Weight, computer | 12,000 lbs | | |
| Weight, air conditioners | 1,200 lbs | | |

The computer is mounted in a 30 foot van, air conditioning ducts on the right and left ceilings, and the heater duct at floor level behind the I/O converters, Central Processor, and memory units.

Air-conditioning is for operator comfort only.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |
| Time required for delivery | 18 months |

System is being tested and evaluated.

## COST, PRICE AND RENTAL RATES

Large computer system such as this one is seldom duplicated from one installation to another. Individual problem and application normally requires unique configuration and special features that establish either purchase or lease price. Upon completion of a feasibility study when the requirements are known, along with a calculated growth, costs could be determined.

## PERSONNEL REQUIREMENTS

Training will be dependent on the requirements of the user. However, it is recommended that personnel have a minimum of 4 weeks of formal class room lectures followed, if possible, by closely supervised on-the-job-training.

Number of operating personnel will depend on the requirements of the user.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Time is not available for rent to outside organizations.

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include ruggedization for field use. System operates between -25°F to 125°F and 0 to 97% relative humidity. It is built on a modular basis, expansible in memory (to 7), I/O converter (up to 4), and I/O equipment (to 63).

Unique system advantages include containment in 240 sq ft. It is a completely mobile, large scale, general purpose system. System is designed for reliability, mobility, flexibility, fixed plant, and strategic installation, with minimum space requirements, and minimum pre-installation cost, such as air conditioning and power. This machine is a member of the Army FIELDATA Family of Computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

## INSTALLATIONS

One MOBIDIC will be installed for the 7th Army Stock Control Center in Germany. Other systems will be installed to cover a wide range of applications.

# MOBIDIC B

Mobile Digital Computer B AN/MYK-2(v)

## MANUFACTURER

Sylvania Electric Products, Incorporated

## APPLICATIONS

The MOBIDIC B is a duplexed general purpose computer being developed for inclusion into a tectical army operation center. The machine's mechanized instruction list was selected for optimized operation in the processing of data rather than for scientific calculations. The two machines may be synchronized together and run as one machine or they may be used separately.

The MOBIDIC B has two real time in-out registers and possible sources of such real time data are radar equipment, weather stations, drone aircraft and other MOBIDICS. This computer is also suited for applications such as message switching centers. One processor receives the incoming message and does the incoming processing and then stores the message in the common mass memory. The second processor would serve as the output message processor, taking the message from the common mass memory completing the processing and transmitting it out. If one machine failed, the second could handle the work at a reduced system speed.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 36 plus sign bit & parity |
| Binary digits/instruction | 36 plus spare bit & parity |
| Instructions/word | 1 |
| Instructions decoded | 55 + 9 special subroutine instructions |
| Arithmetic system | Fixed point |
| Assumed binary point at left end of word, between bits 36 and 37 | |
| Instruction type | One address |
| Some instructions are two address, e.g. load, move, etc. | |
| Number range | $-(1 - 2^{-36})$ to $+(1 - 2^{-36})$ |

Instruction word format

| 38 | 37 | 36 31 | 30 28 | 27 16 | 15 13 12 1 |
|---|---|---|---|---|---|
| Parity | Spare | Op. Code | Index Reg. Selection | Minor Address | Major Address |

Standard Computer Instruction Word

| 38 | 37 | 36 31 | 30 22 | 21 16 | 15 13 12 1 |
|---|---|---|---|---|---|
| Parity | Spare | In-Out Comd | Word-Block Counter | Device Selection | Storage Address |

Input-Output Instruction Word

Automatic coding includes MOBIDIC Assembly Program.

Registers include 8 in the central processor, 2 in the communications converter, 2 in the In/Out Converter and 7 index registers.

Instructions consist of 15 Arithmetic, 9 Transfer, 18 Logical, 3 Sense, 10 Input-Output, and 9 Special instructions.

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 42 | 34 |
| Mult | 88 | 80 |
| Div | Not mechanized | |

Construction (Arithmetic unit only)

| | |
|---|---|
| Transistors | 6,000 |
| Arithmetic mode | Parallel |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Media | No. of Words | No. of Bits/word | Access Microsec |
|---|---|---|---|
| Magnetic Core | 8,192 | | 8 |
| Disk | $6.25 \times 10^6$ | 8 | $1 \times 10^6$ |

Expansible to a total of 7 core memories of 4,096 words each

Magnetic Tape

| | |
|---|---|
| No. of units that can be connected | 63 Units |
| No. of chars/linear inch of tape | 300 Chars/inch |
| Channels or tracks on the tape | 8 Tracks/tape |
| Blank tape separating each record | 1.5 Inches |
| Tape speed | 150 Inches/sec |
| Transfer rate | 45,000 Chars/sec |
| Start time | 1.5 Millisec |
| Stop time | 1.5 Millisec |
| Average time for experienced operator to change reel | 120 Seconds |
| Physical properties of tape | |
| Width | 1/2 Inches |
| Length of reel | 3,600 Feet |
| Composition | 1 mil mylar |

## INPUT

| Media | Speed |
|---|---|
| Paper Tape 5 channel | 200 char/sec (start-stop) |
| 11/16 inch tape | 270 char/sec |
| Paper Tape 8 channel | 200-270 char/sec |
| 1 inch tape | |
| Real Time Channel | 120,000 char/sec |
| character by character | |
| Cards | 200 cards/min |

The Real Time System was designed to operate with the Collins Kineplex equipment whose speed is 300 characters/sec. or with another MOBIDIC; however, it can operate with any compatible transmission equipment.

## OUTPUT

| Media | Speed | |
|---|---|---|
| Paper Tape 5 channel | 100 char/sec | 11/16" tape |
| Paper Tape 8 channel | 100 char/sec | 1 inch tape |
| Real Time | 120,000 char/sec | char by char |
| Flexowriter | 10 char/sec | |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Diodes | |
| SG225 | 6,000 |
| Transistors | |
| 2N393 | Approx. 30,000 |
| Magnetic Cores | 655,360 |

## CHECKING FEATURES

Checking features include parity on memory transfer and input-output, overflow, non-existant memory, non-existant instruction, and non-existant device (I/O). Marginal checking may also be performed. Diagnostic Routines to check the machine and indicate instruction which fail and aid in the localization of failures are available.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 34.2 Kw | 42.75 KVA | 0.8 pf |
| Power, air conditioner | 6.6 Kw | 8.25 KVA | 0.8 pf |
| Volume, computer | | 690 cu ft | |
| Volume, air conditioner | | 72 cu ft | |
| Area, computer | | 115 sq ft | |
| Area, air conditioner | | 48 sq ft | |
| Weight, computer | | 12,600 lbs | |
| Weight, air conditioner | | 1,200 lbs | |
| Capacity, air conditioner | | Two at 1.5 Tons each | |

Air conditioners are for personnel comfort only

Computer is mounted in a 30 ft van and a shelter of approximately the size of an S-109.

## PRODUCTION RECORD

| | |
|---|---|
| Number in current production | 1 |
| Number on order | 1 |
| Time required for delivery | 18 months |

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include reggedization for field use. System operates between -250°F to +125°F and 0 to 97% relative humidity. It is built on a modular basis, expansible in memory (to 4), I/O converter (up to 4), and I/O equipment (to 63).

Unique system advantages include containment in 335 sq ft. It is a completely mobile, large scale, general purpose system. System is designed for reliability, mobility, flexibility, fixed plant, and strategic installation, with minimum space requirements, and minimum pre-installation cost, such as air conditioning and power. This machine is a member of the Army FIELDATA Family of Computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

The 40 bit word length in storage is made up of:

| | |
|---|---|
| 36 | bit magnitude |
| 1 | bit sign |
| 1 | bit parity |
| 1 | busy-bit |
| 1 | spare-bit |
| 40 | Total in storage |

# MOBIDIC C D & 7A

Mobile Digital Computer C, D, 7A AN/MYK-1(v)

**MANUFACTURER**

Sylvania Electric Products, Incorporated

## APPLICATIONS

MOBIDIC C, D, and 7A are mobile highly reliable, high speed, general purpose computing systems for use by the field commanders for combat support data processing, combat control data processing, combat computations and logistic computations.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 36 plus sign & parity bits |
| Binary digits/instruction | 36 plus spare & parity bits |
| Instruction per word | 1 |
| Instructions decoded | 52 |
| Arithmetic system | Fixed point |
| Assumed binary point at | left end of word, between bits 36 & 37 |
| Instruction type | One address |
| Some instructions are two address, e.g. load, move, etc. | |
| Number range | $-(1 - 2^{-36})$ to $+(1 - 2^{-36})$ |

Instruction word format

Standard Computer Instruction Word

| 38 | 37 | 36 31 | 30 28 | 27 16 | 15 13 12 1 |
|---|---|---|---|---|---|
| Parity | Spare | Op. Code | Index Reg. Selection | Minor Address | Major Address |

Input-Output Instruction Word

| 38 | 37 | 36 31 | 30 22 | 21 16 | 15 13 12 1 |
|---|---|---|---|---|---|
| Parity | Spare | In-Out Comd | Word-Block Counter | Device Selection | Storage Address |

Automatic coding includes the Mobidic Assembly Program.

Registers include 6 in the Central Processor, 4 Index, 2 in the Communications Converter, and 2 in the In/Out Converter.

Instructions consist of 15 Arithmetic, 8 Transfer, 17 Logical, 3 Sense, and 9 Input-Output instructions.

Index registers are expansible to a total of 7.

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 16 | 8 |
| Mult | 86 | 78 |
| Div | 88 | 80 |

Construction (Arithmetic unit only)

| | |
|---|---|
| Transistors | 6,000 |
| Arithmetic mode | Parallel |
| Timing | Synchronous |
| Operation | Sequential |

Operation is primarily sequential, however processing may proceed duting input-output operations.

## STORAGE

| Medium | No. of Words | No. of Bits/word | Access Microsec |
|---|---|---|---|
| Magnetic Core | 2 ea (4096) total 8192 | 40 | 8 |

Expansible to a total of 7 magnetic core memories of 4,096 words each.

Magnetic Tape

| | | |
|---|---|---|
| No. of units that can be connected | 63 | Units |
| No. cf chars/linear inch | 300 | Chars/inch |
| Channels or tracks on the tape | 16 | Tracks/tape |
| Blank tape separating each record | 1-1/2 | Inches |
| Tape speed | 1-150 | Inches/sec |
| Transfer rate | 300-45,000 | Chars/sec |
| Start time | 3 | Millisec |
| Stop time | 3 | Millisec |
| Average time for experienced operator to change reel | 120 | Seconds |
| Physical properties of tape | | |
| Width | 1 | Inch |
| Length of reel | 3,600 | Feet |
| Composition | Mylar | |

MOBIDIC C & MOBIDIC D each have (8) tape units while MOBIDIC 7A has 11.

## INPUT

| Media | Speed |
|---|---|
| Paper Tape 5 channel 11/16 inch tape | 200 char/sec (start-stop) to 270 char/sec |
| Paper Tape 8 channel 1 inch tape | 200-270 char/sec |
| Real Time Channel character by character | 120,000 char/sec |
| Cards | 200 cards/min |

## OUTPUT

| Media | Speed | |
|---|---|---|
| Paper Tape 5 channel | 100 char/sec | 11/16" tape |
| Paper Tape 8 channel | 100 char/sec | 1 inch tape |
| Real Time | 120,000 char/sec | |
| Flexowriter | 10 char/sec | char by char |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Diodes | |
| SG225 | 6,000 |
| Transistors | |
| 2N393 | 30,000 |
| Magnetic Cores | 335,872 |

MOBIDIC is a completely Solid State computer

## CHECKING FEATURES

Parity on memory transfer and input-output, over flow, non-existant memory, non-existant instruction, non-existant device (I/O), marginal checking, and diagnostic programs to check the machine and indicate instructions which fail and aid in the localization of failures.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 44.8 Kw | 56 KVA | 0.8 pf |
| Power, air conditioner | 9.28 Kw | 11.6 KVA | 0.8 pf |
| Volume, computer | | 2,880 cu ft | |
| Volume, air conditioner | | 72 cu ft | |
| Area, computer | | 480 sq ft | |
| Area, air conditioner | | 48 sq ft | |
| Weight, computer | | 7,000 lbs | |
| Weight, air conditioner | | 600 lbs ea | |
| 1200 lbs - Total for 1 van | | | |
| 2400 lbs - Total for 2 vans | | | |
| Capacity, air conditioner | | 1 1/2 Tons | |
| | | 18,000 BTU/hr each | |

No special site requirements. MOBIDIC C, D, 7A are mounted in two 30' vans. KVA & Kw ratings include air conditioning for two vans. Kw and KVA maximum for entire system. Air conditioning is for operator comfort only. Air conditioners are two per van. All figures are for two vans.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 - AN - MYK - 1(v) |
| Number in current operation | 1 |
| Number in current production | 3 |
| Time required for delivery | 18 months |

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include reggedization for field use. System operates between -25°F to +125°F and 0 to 97% relative humidity. It is built on a modular basis, expansible in memory (to 7), I/O converter (up to 4), and I/O equipment (to 63).

Unique system advantages include containment in 480 sq ft. It is a completely mobile, large scale, general purpose system. System is designed for reliability, mobility, flexibility, fixed plant, and strategic installation, with minimum space requirements, and minimum pre-installation cost, such as air conditioning and power. This machine is a member of the Army FIELDATA Family of Computers. It uses the FIELDATA code and is compatible with other FIELDATA machines.

The 40 bit word length in storage is made up of:

| | |
|---|---|
| 36 | bit magnitude |
| 1 | bit sign |
| 1 | bit parity |
| 1 | busy-bit |
| 1 | spare-bit |
| 40 | Total in storage |

# MODAC 404

Mountain Systems Digital Automatic Computer

## MANUFACTURER

Airborne Instruments Laboratory, Incorporated (Parent)
Mountain Systems, Incorporated

## APPLICATIONS

Statistical and business data processing, accounting, coding and controls.
System is no longer being manufactured.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Decimal digits/word | 6 |
| Decimal digits/instruction | 2 |
| Instructions decoded | 8 |
| Arithmetic system | Fixed point |
| Instruction type | One address |
| Number range | 0 to 999,999 |

Programming system is designed for special application. Operations include addition, subtraction, unit entry, bulk entry and transfer.

Photo by Reader's Digest Association

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add time | 25,000 | 240 |
| Construction | | Vacuum tubes |
| Basic pulse repetition rate | | 150 Kc/sec |
| Arithmetic mode | | Serial |
| Timing | | Asynchronous |
| Operation | | Sequential |

The addition time given above is for the addition of two 6-digit decimal numbers.

## STORAGE

| Medium | Words | Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 20,000 | 120,000 | 25,000 |

Access time given above is average. System stores 500,000 binary digits in 50 milliseconds access time.

Photo by Reader's Digest Association

## INPUT

| Media | Speed |
|---|---|
| Paper Tape | 200 char/sec |
| Punched Cards (Rem. Rand Tab) | 4 cards/sec |

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape | 200 char/sec |
| Punched Cards (Rem. Rand Tab) | 4 cards/sec |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 1,000 |
| Tube types | 3 |
| Crystal diodes | 2,000 |
| Separate cabinets | 1 |

## CHECKING FEATURES

Address check

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 3 Kw |
| Volume, computer | 120 cu ft |
| Area, computer | 20 sq ft |
| Weight, computer | 1,500 lbs |

## PRODUCTION RECORD

Reader's Digest Association

| | |
|---|---|
| Number produced | 1 |
| Number in operation | 1 |

## COST, PRICE AND RENTAL RATES

Reader's Digest Association

Approximate cost of basic system $100,000.

System is no longer in production.

## PERSONNEL REQUIREMENTS

Reader's Digest Association

| Daily Operation | Engineers | Tech and Operators |
|---|---|---|
| One 8-hour shift | 0 | 1 |

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Reader's Digest Association

| | |
|---|---|
| Good time | 6,000 Hours |
| Attempted to run time | 6,188 Hours |
| Operating ratio (Good/Attempted to run time) | 0.97 |

Figures based on period from Sep 55 to Jan 57

Passed Customer Acceptance Test Sep 54

Additional features include external programming, dual entry to memory with single address and an address check.

System no longer manufactured.

# MODAC 410

Mountain Systems Digital Automatic Computer Model 410

## APPLICATIONS

Business data processing.
System is no longer being manufactured.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Decimal - Excess 3 |
| Decimal digits per word | 10 |
| Arithmetic system | Fixed point |
| Instruction type | One address |
| Number range | 0 to 10 decimal digits |

Program is stored internally and on tape.

## ARITHMETIC UNIT

| | Exclud Stor Access Microsec |
|---|---|
| Add time | 600 |
| Mult time | 7,000 |
| Div time | 7,000 |
| Construction | Vacuum tubes, magnetic elements and diodes |
| Rapid access word registers | 50 |
| Basic pulse repetition rate | 150 Kc/sec |
| Arithmetic mode | Serial |
| Timing | Asynchronous |
| Operation | Sequential |

Computer is serial with buffer storage.

## STORAGE

| Medium | Words | Access Microsec |
|---|---|---|
| Magnetic Drum | 5,000 | 7,500 |

50,000 decimal digits stored.
Buffer storage in magnetic cores.

## INPUT

| Media | Speed |
|---|---|
| Punched Tape | 400 char/sec |
| Punched Cards | 600 cards/min |

## OUTPUT

| Media | Speed |
|---|---|
| Punched Tape | 60 char/sec |
| Punched Cards | 600 cards/min |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 600 |
| Tube types | 3 |
| Crystal diodes | 3,000 |
| Magnetic elements | 1,000 |
| Number of different plug in units | 5 |
| Number of separate cabinets | 2 |

## MANUFACTURER

Airborne Instruments Laboratory, Incorporated
Mountain Systems Incorporated

## CHECKING FEATURES

Number checks
Address checks
Odd number check

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 4 Kw |
| Volume, computer | 40 cu ft |
| Area, computer | 20 sq ft |
| Weight, computer | 1,000 lbs |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced | 1 |
| Number in operation | 1 |

System out of production.

## COST, PRICE AND RENTAL RATES

Approximate cost of basic system $120,000.
Price includes input and output equipment described. Other equipment dependent upon specific application.
System is no longer being manufactured.

## PERSONNEL REQUIREMENTS

One operator required during operation.

## ADDITIONAL FEATURES AND REMARKS

Special translator or converter feature reads an abbreviation on a punched card, looks up corresponding code from a list of 5,000 and punches a code number into the same card at a reading and punching rate of 500 per minute.

High speed tallying feature performs 1,440,000 unit additions per hour into selected registers.

Transactions, from a total of 4,000 categories, can be read at random and added to an appropriate one of 4,000 registers.

System no longer being manufactured.

## INSTALLATIONS

Readers Digest Association, Incorporated
Condensed Book Club
Pleasantville, New York

# MODAC 414

Mountain Systems Digital Automatic Computer Model 414

## APPLICATIONS

Reader's Digest Association, Incorporated
Large scale translation, statistical processing and general purpose computation.
System is no longer being manufactured.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal and alphanumeric |
| Decimal digits/word | 6 |
| Decimal digits/instruction | 2 |
| Instructions decoded | 12 |
| Arithmetic system | Fixed point |
| Instruction type | One address (for general purpose applications) |

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add time | 8,000 | 288 |
| Mult time | 8,000 | 8,000 |
| Div time | 8,000 | 8,000 |
| Construction | Vacuum tubes and magnetic cores | |
| Arithmetic mode | Serial | |
| Timing | Asynchronous | |
| Operation | Sequential<br>Concurrent for punched cards in any of three modes. | |

The multiply and divide times given above include re-record time.

## STORAGE

| Media | Words | Characters | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 6,000 | 36,000 | 8,000 |
| Magnetic Drum | 4 | 24 | 576 |
| Magnetic Cores | 2 | 12 | 288 |

## INPUT

| Media | Speed |
|---|---|
| Punched Cards | 360 cards/min |
| Paper Tape | |

Paper tape is used for report programming and testing.

## MANUFACTURER

Airborne Instruments Laboratory, Incorporated (Parent)
Mountain Systems, Incorporated

## OUTPUT

| Media | Speed |
|---|---|
| Punched Cards | 360 cards/min |
| Paper Tape | 20 char/sec |

Punched cards are used for translation and paper tape for reports.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 2,000 (approx) |
| Tube types | 3 (major) |
| Crystal diodes | 3,000 (approx) |
| Magnetic cores | 396 |

## CHECKING FEATURES

Odd-even checks on numerical calculations are used.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 5 Kw |
| Volume, computer | 240 cu ft |
| Area, computer | 40 sq ft |
| Weight, computer | 3,000 lbs |

## PRODUCTION RECORD

| | |
|---|---|
| Number produced | 1 |
| Number in operation | 1 |

System is no longer being manufactured.

## COST, PRICE AND RENTAL RATES

Approximate cost of basic system $150,000.
System is out of production.

## PERSONNEL REQUIREMENTS

| Daily Operation | Engineers | Tech and Operators |
|---|---|---|
| One 8-hour shift | 0 | 2 |

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Passed Customer Acceptance Test October 1956.
System is no longer being manufactured.

## INSTALLATIONS

Reader's Digest Association, Incorporated
Condensed Book Club
Pleasantville, New York

# MODAC 5014

Mountain Data Processor Model 5014

## MANUFACTURER

Airborne Instruments Laboratory, Incorporated (Parent)
Mountain Systems, Incorporated

## APPLICATIONS

Manufacturer
Business data processor. System no longer being manufactured.

Hickok Manufacturing Company, Incorporated
A perpetual inventory, furnishing reports to the Central Planning and Packaging Departments.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 20 |
| Binary digits/instruction | 60 |
| Arithmetic system | Decimal-binary |
| Instruction type | One address, consisting of two parts. Address "A" selects a magnetic drum read-record head and address "B" selects a particular location on the drum. |

Photo by Airborne Instruments Laboratory, Inc.

| | |
|---|---|
| Number range | "A" ranges from 0 to 66<br>"B" ranges from 0 to 150 |

## ARITHMETIC UNIT

| | Microsec |
|---|---|
| Add time (Includ stor access) | 32 |
| Construction | Vacuum tubes, using a combination of trigger pairs, pullers, and cathode followers. A crystal diode matrix is also used. |
| Arithmetic mode | A combination series-parallel shift register is utilized. |
| Timing | Synchronous |
| Operation | Sequential |

Three types of pulses are used to control operation.
Serial feed is by use of 5 channel paper tape.
Basic operations are addition, subtraction and "reading out" a balance.

## STORAGE

| Media | Words | Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 10,000 | 50,000 | |
| Shift Register | 1 | 5 | 32 |
| Paper Tape | | | |

Paper tape is utilized for permanent storage in order to release the magnetic drum for other purposes.

The magnetic drum is 8 inches long and 7 inches in diameter. There are 66 recording heads. The address system is composed of a relay pyramid and an electronic counter.

## INPUT

| Medium | Speed |
|---|---|
| Paper Tape | 600 char/min |

Above tape is 5-channel tape, which is prepared by an IBM 063 Card-to-Tape Converter or a Flexowriter typewriter.

## OUTPUT

| Medium | Speed |
|---|---|
| Paper Tape | 600 char/min |

Direct to paper tape or via a Flexowriter typewriter.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 535 |
| Tube types | 8 |
| Crystal diodes | 150 |
| Separate cabinets | 4 |

Crystal diode types used are the 1N35 and the 1N116. Tube types used are the 5965, 5915, 6AN5, 12BH7, 12AX7, 2D21, 5963, and 6AS6. All four cabinets are inter-cabled.

The IBM 063 Card-to-Tape Converter and the Flexowriter are located in an adjoining room. The Flexowriter can be cabled directly to the computer so as to print out in hard copy as the computer is in operation.

## CHECKING FEATURES

Checking is performed by using predetermined "heads" and "spots" on the drum and tapes with known answers. A visual check is made.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Volume, computer | 120 cu ft |
| Area, computer | 16 sq ft |
| Four cabinets | 2 x 2 x 7.5 ft each |
| Weight, computer | 600 lbs |

## COST, PRICE AND RENTAL RATES

Hickok Manufacturing Company, Inc.

| | |
|---|---|
| Approximate cost of basic system | $85,000 |
| Approximate cost of Flexowriter | 1,200 |

Rental rates of IBM 063 Card to Tape Converter ($65.00 plus $6.50 tax)/month.

System is no longer manufactured.

## PERSONNEL REQUIREMENTS

Hickok Manufacturing Company, Inc.

One operator and 1 clerk are utilized to operate the system on a one 8-hour shift/week basis. One engineer is utilized for developing methods and procedures.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

| | |
|---|---|
| Average error-free running period | 30 Hours |
| Good time | 145 Hours/Week |
| Attempted to run time | 168 Hours/Week |
| Operating ratio (Good/Attempted to run time) | 0.87 |

Figures based on the last three years.

Passed Customer Acceptance Test July 1954

System is no longer being manufactured.

## INSTALLATIONS

Hickok Manufacturing Company, Incorporated
Rochester, New York

# MONROBOT III

Monroe Computer Model III

## MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

Photo by Monroe Calculating Machine Company, Electronics Division

## APPLICATIONS

Air Force Cambridge Research Center
Scientific calculation.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Decimal digits/word | 20 |
| Decimal digits/instruction | 10 |
| Instructions per word | 1 |
| Instructions decoded | 11 |
| Instructions used | 11 |
| Arithmetic system | Fixed point |
| Instruction type | Four address |
| Number range | $10^{-10} \leq n \leq 10^{10} - 1$ |

## ARITHMETIC UNIT

| | Incl Stor Access Microsec |
|---|---|
| Add time | 120,000 |
| Mult time | 540,000 |
| Div time | 540,000 |
| Construction | Vacuum tubes |
| Basic pulse repetition rate | 10 Kc/sec |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Media | Words | Access Microsec |
|---|---|---|
| Magnetic Drum | 100 numbers | 15,000 |
| Magnetic Drum | 100 instructions | 15,000 |

## INPUT

| Media | Speed |
|---|---|
| Keyboard | Manual |
| Paper Tape | 10 dig/sec |

## OUTPUT

| Media | Speed |
|---|---|
| Typewriter (Flexowriter) | 10 dig/sec |
| Paper Tape (Flexowriter) | |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 800 |
| Tube types | 4 |
| Crystal diodes | 100 |

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 2.5 Kw |
| Space, computer | Desk size |
| Weight, computer | 1,000 lbs |

## PRODUCTION RECORD

Number produced 1
No longer in production.

## PERSONNEL REQUIREMENTS

One technician or mathematician is required to operate system.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

| | |
|---|---|
| Good time | 28 Hours |
| Attempted to run time | 35 Hours |
| Operating ratio (Good/Attempted to run time) | 0.80 |

Figures based on period 1 Feb 55 to 1 Sep 56
Passed Customer Acceptance Test 1 Feb 55

Approximately 1 hour/day is required for maintenance, therefore "attempted to run time" is considered to be 40-5, or 35 hours.

## INSTALLATIONS

Air Force Cambridge Research Center
Computing Laboratory
Cambridge 39, Massachusetts

# MONROBOT V

Monroe Computer Model V

## MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

Photo by Monroe Calculating Machine Company, Electronics Division

## APPLICATIONS

Computing problems normally encountered by Topographic Troops in surveying operations.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Decimal digits/word | 20 |
| Decimal digits/instruction | 10 |
| Arithmetic system | Fixed point |
| Instruction type | Four address |

## ARITHMETIC UNIT

| | Includ Stor Access Microsec |
|---|---|
| Add time | 120 (approx) |
| Mult time | 540 (approx) |
| Div time | 540 (approx) |
| Construction | Vacuum tubes |
| Basic pulse repetition rate | 10 Kc/sec |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Media | Words | Access Microsec |
|---|---|---|
| Magnetic Drum | 300 | 18,000 |
| Paper Tape | | |

Access time on drum is for 100 twenty digit numbers. Drum is 6 inches in diameter, 20 inches long and rotates at a speed of 3,550 rev/min.

## INPUT

| Media | Speed |
|---|---|
| Keyboard | Manual |
| Paper Tape (Reader) | 570 char/min |

## OUTPUT

| Medium | Speed |
|---|---|
| Typewriter (Flexowriter) | Reader 570 char/min<br>Printer 400 char/min |

Photo by U. S. Army Corps of Engineers, Engineer Research and Development Laboratories

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 800 (approx) |
| Crystal diodes | 1 |
| Tube types | 5814A, 5726, 5751, 5844, 6005, and 5725 |

## CHECKING FEATURES

Storage selection indicators.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 5 Kw |
| Area, computer | 44 1/2 in x 72 in x 31 in Desk |
| Weight, computer | 1,686 lbs, including Flexowriter |

## PRODUCTION RECORD

Number produced 1
No longer in production.

## COST, PRICE AND RENTAL RATES

Manufacturer
System is no longer being manufactured.
Engineer Research and Development Laboratories
Approximate cost of basic system $86,074.

## PERSONNEL REQUIREMENTS

Engineer Research and Development Laboratories
One person required for operation and one person required for servicing unless one person is trained to perform both operation and servicing.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating ratio (Good/Attempted to run time) 0.85
Passed Customer Acceptance Test March 1955
Computer has operated for several days without any down time; however, the only actual figure is the 2,069 hours taken from the running time meter.

## ADDITIONAL FEATURES AND REMARKS

Pre-addressed tapes
Single cycle operation where program is checked line for line.
Pre-determined automatic sequencing.
Shock-mounted for van installation; mobile.

## INSTALLATIONS

U. S. Army Corps of Engineers
Topographic Engineering Department
Engineer Research and Development Laboratories
Fort Belvoir, Virginia

# MONROBOT VI

Monroe General Purpose Computer Model VI

## MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

Photo by Monroe Calculating Machine Company, Electronics Division

## APPLICATIONS

Scientific calculation.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Decimal digits/word | 20 |
| Decimal digits/instruction | 10 |
| Instructions per word | 2 |
| Instructions used | 200 |
| Arithmetic system | Fixed point |
| Instruction type | Four address |
| Number range | ± xxxxx xxxxx . xxxxx xxxxx |

Fixed point is centrally located

## ARITHMETIC UNIT

| | Incl Stor Access Microsec |
|---|---|
| Add time | 135,000 |
| Mult time | 600,000 |
| Div time | 600,000 |
| Construction | Vacuum tubes and crystal diodes |

| | |
|---|---|
| Basic pulse repetition rate | 10 Kc/sec |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

Automatic positioning of numerical results about the decimal point.

## STORAGE

| Medium | Words | Access Microsec |
|---|---|---|
| Magnetic Drum | 200 | 16,670 max |

4,000 digits of magnetic drum storage.

## INPUT

| Media | Speed |
|---|---|
| Keyboard | Manual |
| Punched Tape | 10 char/sec |
| Punched Card | 17 cards/sec |

Punched tape is optional to 60 char/sec.

Standard teletype or Kleinschmidt units for tape processing.

Photo by Monroe Calculating Machine Company, Electronics Division

## OUTPUT

| Media | Speed |
|---|---|
| Printed Copy | 10 char/sec |
| Punched Tape | 10 char/sec |
| Punched Card | 17 char/sec |

Standard teletype or Kleinschmidt units. 60 char/sec. Punched tape and punched card is optional.

## CHECKING FEATURES

Parity checks
MAID (Monrobot Automatic Internal Diagnosis) and dual arithmetic and control units.

## INSTALLATIONS

Several systems are at U. S. Air Force installations in Japan and Germany. These are under Monroe maintenance. The systems installed in the United States are not under Monroe maintenance.

Howard University

# MONROBOT IX

Monroe Calculating Machine IX

## MANUFACTURER

Monroe Calculating Machine Company

## APPLICATIONS

System is used primarily for billing, and invoice writing.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 62 bits |

A plugboard program is used.

| | |
|---|---|
| Instructions decoded | 16 |
| Arithmetic system | Fixed point |
| Instruction type | One address |
| Number range | 0 to $10^{18}$ |

System has 15 registers.

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 12,000 | 3,000 |
| Mult | 13,500 | per decimal digit of multiplier |
| Div | 54,000 | per decimal digit of quotient |

Construction (Arithmetic unit only)

| | |
|---|---|
| Vacuum-Tubes | 64 |
| Diodes | 1,000 |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

Multiplication is accomplished by manual input of the multiplier digits. Therefore, actual speed is operator limited.

During division the quotient digits are printed, and the actual speed is therefore printer limited.

## STORAGE

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 15 | 18 decimal dig | 12,500 avg |

## INPUT

| Media | Speed |
|---|---|
| Electric Typewriter | 10 char/sec |
| Plugboard | 10 char/sec |

Plugboard is used for constants and alphabetic characters.

Typewriter input is operator limited.

## OUTPUT

| Media | Speed |
|---|---|
| Electric Typewriter | 10 char/sec |
| Numerical and alphabetic | |
| IBM 024 Card Punch | 10 char/sec |
| Numerical | |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | |
| Primarily 5965 | 74 |
| Diodes | |
| Primarily 1N636 | 1,000 |

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| KVA, computer | 0.75 |
| Volume, computer | 32 cu ft |
| Area, computer | 10.6 sq ft |
| Floor loading | 40 lbs/sq ft |
| | 150 lbs concen max |
| Weight, computer | 450 lbs |

Site preparation not necessary.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 70 |
| Number in current operation | 70 |
| Time required for delivery | 3 - 6 months |

## COST, PRICE AND RENTAL RATES

| | |
|---|---|
| Computer with Typewriter | $9,650 |
| List of additional equipment | |
| IBM (024) Intercoupler (IBM 024 - see IBM price list) | $ 500 |

90-day guarantee parts and labor. Service contract price is $500.

## PERSONNEL REQUIREMENTS

One clerk is required for each 8-hour shift.

Ordinary typists are trained at customer location in one day.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Ambient temperature to 130°F
Voltage margins, ±25%
Pre-aged tubes used throughout.

## ADDITIONAL FEATURES AND REMARKS

Computer has fewer tubes (74) than any other product known to us. Calculation is so fast operator experiences no delay. System handles fractions of any kind, feet, inches, gross, dozen, board feet, etc. Foreign currency such as pounds, shillings, pence, are handled. Step-rate utility billing is automatically performed.

System operates as a decimal machine externally. Input and output conversion are automatic. Decimal shift left and shift right instructions make this possible.

## FUTURE PLANS

Punched tape output planned soon.

# MONROBOT XI

Monroe Calculating Machine Mark XI

## MANUFACTURER

Litton Industries
Monroe Calculating Machine Division

Photo by Monroe Calculating Machine Division

## APPLICATIONS

The Monrobot Mark XI is a stored-program, general purpose electronic business computer capable of operation with a wide variety of input-output equipment.

Instruction word format

| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instruction | | | | | | Address | | | | | | | | | |

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 32 including sign |
| Binary digits/instruction | 16 |
| Instructions/word | 2 |
| Instructions decoded | 27 |
| Instructions used | 27 |
| Arithmetic system | Fixed point; programmed floating point |
| Instruction type | One address |
| Number range | 0 to $2^{31} - 1$ or 0 to $\pm 10^9$ or 0 to $\pm$ 2, 147, 483, 647 |

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 9,000 | 3,000 |
| Mult | 34,000 | 28,000 |
| Div | 500,000 | 500,000 |

Division is programmed.

| | |
|---|---|
| Construction (Arithmetic unit only) | |
| Transistors | 190 |
| Diodes | 1,675 |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Medium | No. of Words | No. of Digits | Average Access Microsec |
|---|---|---|---|
| Magnetic Drum | 1,024 | 32,768 | 6,000 |

## INPUT

| Media | Speed |
|---|---|
| Punched Paper Tape | 20 char/sec |
| Electric typewriter | 10 char/sec |
| 16-key numeric keyboard | 10 char/sec |
| 80-column card | 16 col/sec |
| Teletypewriter | 10 char/sec |

The machine can accomodate any three of the above input devices simultaneously. Punched paper tape may be any code, 5 to 8 level. Quoted input and output speeds include conversion to and from binary as well as translation of any tape language to machine code. Higher speeds are possible using pure binary input and output.

## OUTPUT

| Media | Speed |
|---|---|
| Punched Paper Tape | 20 char/sec |
| Electric Typewriter | 10 char/sec |
| 80-column Card | 16 col/sec |
| Teletypewriter | 10 char/sec |

The machine can accomodate any three of the above output devices simultaneously. Punched paper tape may be any code, 5 to 8 level.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | |
| 5727 | 10 - 30 (10 tubes/output device) |
| Diodes | |
| Primarily 1N636 | 2,300 |
| Transistors | |
| Primarily 2N412 | 383 |

## CHECKING FEATURES

Parity check on input and output.
Parity may be omitted.

Action taken on parity failure depends upon program. With Teletype or other parity-less codes, parity is not used.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 0.850 Kw | 0.940 KVA | 0.9 pf |
| Volume, computer | | 48 cu ft | |
| Area, computer | | 15 sq ft | |
| Room size | | 10 ft x 10 ft | |
| Floor loading | | 30 lbs/sq ft | |
| | | 100 lbs concen max | |
| Weight, computer | | 375 lbs | |

System requires 15 amp, 110 volt, AC, 60 cps line.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 7 |
| Number in current operation | 6 |
| Time required for delivery | 6 - 9 months |

## COST, PRICE AND RENTAL RATES

| | |
|---|---|
| Cost of computer with operator desk, 1 typewriter, 1 tape reader, and 1 tape punch | $24,500 |
| Additional Equipment | |
| 16-key numeric keyboard | 300 |
| Tape Reader | 1,250 |
| Tape Punch | 700 |
| Typewriter | 2,350 |
| Buffer for third device | 600 |

Above prices are approximate.

Monthly rental of computer with operator desk, 1 typewriter, 1 tape reader, and 1 tape punch, including service $700

Maintenance contracting is $1,200/year after 90-day service guarantee.

## PERSONNEL REQUIREMENTS

Manufacturer makes a programmers' school available to users. One operator is required for each 8-hour shift. Virtually no operator training is required.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Conservative solid-state design assures long life and wide margins under all but the most extreme operating conditions. Pluggable printed circuit boards provide trouble-free operation as well as ease of maintenance. Monrobot XI operates with full ±25% voltage margins at 110°F ambient.

## ADDITIONAL FEATURES AND REMARKS

The Monrobot Mark XI accepts alpha-numeric information in any code from up to three independent input devices and can output information to any combination of three independent devices.

System can simultaneously prepare independent output documents in any format, and can merge transaction and unit record input tapes in any format.

# MONROBOT MU

Monroe Multiple-Unit General Purpose Computer

## MANUFACTURER

Monroe Calculating Machine Company
Electronics Division

Photo by Monroe Calculating Machine Company, Electronics Division

## APPLICATIONS

Item inventory and monetary accounting.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal and sexadecimal |
| Binary digits/word | 96 |
| Decimal digits/instruction | 12 |
| Instructions per word | 2 |
| Instructions decoded | 36 |
| Instructions used | 36 |
| Arithmetic system | Fixed point (arbitrarily located) |
| Instruction type | Three address (modified) |
| Number range | Variable |

Words may be made up of either numeric or alpha-numeric characters.

## ARITHMETIC UNIT

| | Includ Stor Access Microsec |
|---|---|
| Add time | 8,000 |
| Mult time | 68,000 |
| Div time | 77,000 |
| Construction | Vacuum tubes and crystal diodes |
| Basic pulse repetition rate | 60 Kc/sec (rapid access) 104 Kc/sec (general storage) |
| Arithmetic mode | Serial |
| Timing | Synchronous |
| Operation | Sequential |

## STORAGE

| Media | Words | Access Microsec |
|---|---|---|
| Magnetic Drums | 20,000/drum (general storage) | 25,000 (avg) |
| Magnetic Drum | 10 (rapid access) | 1,600 |
| Magnetic Tape (2) | 12,000/unit | |

The large capacity drums are for general storage and utilize saturable core reactors for track selection. The number of drums utilized is based upon application requirements.

## INPUT

| Media | Speed |
|---|---|
| Keyboard (Flexowriter) | 10 char/sec |
| Keyboard (Model 28 Teletype 12 Units) | 6 char/sec |
| Paper Tape (Ferranti) | 200 char/sec |
| Magnetic Tape | 400 char/sec |

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape (Flexowriter) | 10 char/sec |
| Printed Page (Flexowriter) and Model 28 Teletype) | 10 char/sec |
| Magnetic Tape | 400 char/sec |

## CHECKING FEATURES

Parity checks
MAID (Monroe Automatic Internal Diagnosis)
System used for malfunction detection and location.

## INSTALLATIONS

System was installed for the U. S. Air Force under Contract No. AF33(616)-2158.

# NAREC

Naval Research Electronic Computer

## MANUFACTURER

U. S. Naval Research Laboratory

## APPLICATIONS

General purpose scientific calculation and data processing.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 48 |
| Binary digits/instruction | 24 |
| Instructions/word | 2 |
| Instructions decoded | 44 |
| Arithmetic system | Fixed point |
| Instruction type | One address |
| Number range | -1 to +1 |

Instruction word format

| Address | | | | Order | |
|---|---|---|---|---|---|
| 4 | 4 | 4 | 4 | 4 | 4 |

Half-word, six four-bit sexadecimal characters

Automatic built-in subroutines include punched tape input and output routines and variable length data transfer instructions (2 address).

Automatic coding includes floating point interpretive routines, containing standard mathematical subroutines as basic instructions.

Registers:

- 7 - 48 bit parallel registers in arithmetic section, including one adder and one inverter of which two are directly programmable.
- 1 - 48 bit parallel register in control section

Official United States Navy Photo

- 1 - 16 bit parallel register in control section (program counter)
- 1 - 48 bit serial - parallel output buffer register
- 2 - 48 bit multiple use comparator registers
- 1 - 48 bit core memory information register
- 1 - 14 bit core memory address register
- 2 - 48 bit and 1 - 16 bit manual switch registers

## ARITHMETIC UNIT

| | Incl. Stor. Access Microsec | Exclud. Stor. Access Microsec |
|---|---|---|
| Add | 22 | 6 |
| Mult | 300-600 | same (approx range)=450 |
| Div | 575-725 | same (approx range)=650 |

Division = 10 per digit (excluding access) for numerator = 0

Construction (Arithmetic unit only)

| Type | Quantity |
|---|---|
| Vacuum tubes | |
| 5687 | 600 |
| 5670 | 600 |
| 6AN5 | 100 |
| Total | 1,300 |
| Transistors | 0 |
| Crystal diodes | 16,000 |
| Arithmetic mode | Parallel |
| Timing | Asynchronous |
| Operation | Sequential |

Input-output is partially concurrent

## STORAGE

| Media | No. of Words | No. of Digits |
|---|---|---|
| Magnetic core | 16,384 | 786,432 |
| Memory cycle time is 8 microseconds | | |
| Magnetic drum | 8,192 | 393,216 |
| Maximum drum access is 33,333 microseconds | | |
| Magnetic tape | | |
| No. of units that can be connected | 16 Units | |
| No. of chars/linear inch | 600 Chars/inch | |
| Each line across the tape contains 2 characters of 8 bits each. Packing density = 300 lines/inch. | | |
| Channels or tracks on the tape | 16 Tracks/tape | |
| Blank tape separating each record | .75 Inches | |
| Tape speed | 120 Inches/sec | |
| Transfer rate | 72 KC Chars/sec | |
| Start time | 3 Millisec | |
| Stop time | 2 Millisec | |
| Physical properties of tape | | |
| Width | 1 Inch | |
| Length of reel | 2400-3600 Feet | |
| Composition | Mylar | |

The above information on magnetic tape is preliminary only, as definite plans are now being formulated. The tape system should be installed in the NAREC by July 1961.

## INPUT

| Media | Speed |
|---|---|
| Magnetic Tape | 120 in/sec |
| Paper Tape | 25-100 in/sec |

Dual speed photoelectric reader at 250 and 1000 char/sec using mylar-aluminum foil and paper tape.

## OUTPUT

| Media | Speed |
|---|---|
| Paper Tape | 60-110 char/sec |
| High and medium speed paper tape punches | |
| Magnetic Tape | 120 in/sec |
| Line Printer | |

Line Printer will be installed by July 1961.
Speed of 600-1200 lines/minute is anticipated.

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity | |
|---|---|---|
| Tubes | | |
| 5687 | 600 | |
| 5670 | 600 | |
| 6AN5 | 100 | |
| | 1,300 | |
| Does not include electrostatic memory which is being replaced by magnetic core memroy. | | |
| Diodes | | |
| 1N89 | 16,000 | |
| SG22 | 1,800 | |
| DR211 | 7,000 | |
| 1N690 | 4,000 | |
| 650C5 | 250 | Zener Diodes |
| 651C0 | 350 | (Texas Instruments) |
| 651C7 | 600 | |
| | 30,000 | |
| 1N89 used in arithmetic section. All others used in magnetic core memory. | | |
| Transistors | | |
| 2N1478 | 1,000 | |
| 2N600 | 500 | |
| 2N1122 | 3,000 | |
| 2N1123 | 300 | |
| | 4,800 | |

All Philco transistors are used in Telemeter Magnetics Core Memory.

| | | |
|---|---|---|
| Magnetic Cores | | |
| .050 inch x .030 inch | 900,000 | |
| Telemeter Magnetics 501-10 | | |
| Capacitors | 10,000 | (core memory) |
| | 3,000 | (arith. section) |
| | 13,000 | |
| Resistors | 20,000 | (core memory) |
| | 7,000 | (arith. section) |
| | 27,000 | |

## CHECKING FEATURES

Automatic comparison bit by bit of all transfers between registers in arithmetic and control sections by means of 2 - 48 bit comparator registers.

Magnetic tape system will have conventional parity checks and sense instructions.

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | |
|---|---|
| Power, computer | 25 Kw |
| Power, air conditioner | 15 Kw |
| Volume, computer | 1,000 cu ft |
| Area, computer | 125 sq ft |
| Room size, computer | 30 ft x 80 ft |
| Capacity, air conditioner | 25 Tons |
| Weight, computer | 5,000-10,000 lbs |

Site preparation included concrete trenches in floor for power wiring and coaxial cables. Power includes both M-G sets and electronic power supplies.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

## COST, PRICE AND RENTAL RATES

Total system cost approximately $1,500,000.

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift | Two 8-Hour Shifts |
|---|---|---|
| Supervisors | 2 | 2 |
| Programmers | 10 | 20 |
| Clerks | 2 | 2 |
| Engineers | 1 | 2 |
| Technicians | 3 | 5 |

Operation tends toward semi-open shop. Includes programmers in central facility and in other groups of the Laboratory. Programmers above includes analysts and coders. The above does not provide for magnetic tape or printer operation. Technicians above includes operators.

Training made available by manufacturer includes in-service programming courses by Research Computation Center for rest of the NRL.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Approximately 1 hour per shift is required for scheduled maintenance.

Operating efficiency (ratio of good time to scheduled operating time) has averaged 85% over the past four years (1956-1960) of full time operation. This is expected to improve considerably in the future due to the current replacement of electrostatic storage by magnetic core storage.

## ADDITIONAL FEATURES AND REMARKS

Outstanding features include a special console, which displays the contents of core memory address abd information registers and permits direct manual read and write to core memory locations.

Unique system advantages include computation monitored from control console without loss of time to stop computer at desired location or instruction in many different ways in order to facilitate program and machine checking. Instruction code and layout is very simple to use and remember, yet is extremely powerful and flexible.

Flexowriters are used in parallel to print results of several problems simultaneously. A centralized operating area consists of photoelectric tape readers, high speed punch, Flexowriter and core memory console adjacent to main control console.

## FUTURE PLANS

Magnetic core memory installed in October 1960. Magnetic tape system and line printer will be installed by July 1961.

## INSTALLATIONS

U. S. Naval Research Laboratory
Washington 25, D. C.

# NATIONAL 102 A

National Cash Register Company
Model CRC 102A
Built by former Computer Research Company

## MANUFACTURER

National Cash Register Company

Photo by U. S. Army Chemical Center

## APPLICATIONS

Manufacturer
General purpose scientific applications
Chemical Warfare Laboratories, U.S. Army
Chemical Center
Scientific
U.S. Naval Ordnance Test Station (China Lake)
Data reduction general purpose
U.S. Naval Postgraduate School
Located at Monterey, California, the system is used for scientific applications, including student and faculty research in practically all phases of the physical sciences, for data processing, including weather prediction, and for simulation, including electronics systems and games (business, industrial and military).

Holloman Air Development Center (ARDC)
Trajectory calculations, heat transfer problems, solution of various kinds of linear simultaneous equations and other algebraic equations.

U.S. Air Force School of Aviation Medicine
Located at Brooks Air Force Base, Texas, the system is used for matrix algebra (Covariance, symmetric and non-symmetric mult. and inversion programs, corr), factor analysis (Factoring the correlation matrix and rotating the factor vector), for general analysis statistics (Mean, variance, and st. deviations; and analysis of variance), time series analysis (Circular serial correlation, autocorrelations, periodograms), and for Monte Carlo methods, generating pseudo random fractions (runs, means, frequency).

## PROGRAMMING AND NUMERICAL SYSTEM

| Manufacturer | |
|---|---|
| Internal number system | Binary |
| Binary digits/word | 42 (One for timing) |
| Binary digits/instruction | 41 |
| Instructions per word | 1 |
| Instructions decoded | 27 |
| Instructions used | 27 |
| Arithmetic system | Fixed point |
| Instruction type | Three address |
| Number range | $-(1-2^{-36})$ to $(1-2^{-36})$ |

Photo by U.S. Naval Post Graduate School
Official Photograph U.S. Navy

## ARITHMETIC UNIT

| | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 19,900 | 7,400 |
| Mult | 37,500 | 25,000 |
| Div | 38,500 | 25,800 |
| Construction | 300 Vacuum tubes<br>4,000 Diodes | |
| Rapid access word registers | 8 | |
| Basic pulse repetition rate | 100 Kc/sec | |
| Arithmetic mode | Serial | |
| Timing | Synchronous | |
| Operation | Sequential | |

The speed can be increased by a factor of 8 when a buffer is used.

## STORAGE

| Media | Words | Microsec Access |
|---|---|---|
| Magnetic Drum | 1,024 | 12,500 (avg) |
| Magnetic Tape | 112,800/reel | 6,000 |

Up to 7 tape units may be used with one computer.
Magnetic drum rotates at 40 rev/sec.

## INPUT

| Manufacturer<br>Media | Speed |
|---|---|
| Flexowriter | Typing Speed |
| Punched Paper Tape | 10 char/sec |
| Magnetic Tape | 1.6 char/millsec |
| U.S. Army Chemical Center | |
| Flexowriter | Typing Speed |
| Punched Paper Tape | 10 char/sec |
| Magnetic Tape | 64 words/sec |
| U.S. Naval Ordnance Test Station | |
| Punched Paper Tape | 10 char/sec |
| IBM Cards (523 modified) | 50 cards/min |
| U.S. Naval Post Graduate School | |
| Paper Tape | 10 char/sec |
| Cards | 60 cards/min |
| | 240 words/min |
| Magnetic Tape | 60 words/sec |
| School of Aviation Medicine | |
| Flexowriter | Typing Speed |
| Punched Paper Tape | 10 char/sec |
| IBM Cards | 50 or 100 cards/min |
| Magnetic Tape | 1.6 char/millisec |

## OUTPUT

| Manufacturer<br>Media | Speed |
|---|---|
| Magnetic Tape | 600 char/sec |
| Flexowriter | 10 char/sec |
| Punched Paper Tape | 10 char/sec |
| U.S. Army Chemical Center | |
| Magnetic Tape | 64 words/sec |
| Flexowriter | 10 char/sec |
| Punched Paper Tape | 10 char/sec |
| U.S. Naval Ordnance Test Station | |
| Flexowriter | 10 char/sec |
| Punched Paper Tape | 10 char/sec |
| IBM Cards (523 modified) | 50 cards/min |

U.S. Naval Post Graduate School

A digital point is used, which operates independently of computer. No conversion is necessary for plotting. The plotter is manufactured by the California Computer Products Corporation.

| | |
|---|---|
| Paper Tape | 10 char/sec |
| Cards | 60 cards/min |
| Magnetic Tape | 60 words/sec |
| School of Aviation Medicine | |
| Flexowriter | 10 char/sec |
| Paper Tape | 10 char/sec |
| Cards | 50 or 100 cards/min |
| Magnetic Tape | 600 char/sec |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| | |
|---|---|
| Tubes | 400 |
| Tube types | 12 |
| Crystal diodes | 8,000 |

U.S. Army Chemical Center

Tube types used include 12AT7, 12BH7, 6BQ7, 5687, 5963, 6080, 5881, and 6AN5. System utilizes 265 tubes and 6,000 diodes and consists of operators console, computer proper, and magnetic tape unit.

## CHECKING FEATURES

Duplicate recording on magnetic tape
"Overflow" alarm"
"No command" alarm

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| Manufacturer | | | |
|---|---|---|---|
| Power, computer | 7.7 Kw | | |
| Weight, computer | 2,700 lbs | | |

U.S. Army Chemical Center

Computing system occupies 135 cu ft, air conditioner 48 cu ft. The computing system weighs 3,400 lbs, air conditioner weighs 12,000 lbs. The capacity of the air conditioner is 6 Tons.

U.S. Naval Ordnance Station

System operates a 230v ±5% line, liberates 35,000 BTU/hour. Computer occupies 72 cu ft and 12 sq ft (Dimensions are 30 by 59 by 73 inches).

U.S. Naval Post Graduate School

| | | | |
|---|---|---|---|
| Power, computer | 5.5 Kw | 7.7 KVA | 0.71 pf |
| Volume, computer | | 108 cu ft | |
| Volume, air conditioner | | 360 cu ft | |
| Area, computer | | 18 sq ft | |
| Area, air conditioner | | 36 sq ft | |
| Room size | Approx | 2,800 sq ft | |
| Floor loading | | 200 lbs/sq ft | |
| | | 700 lbs concen max | |
| Capacity, air conditioner | | 25 Tons | |
| Weight, computer | Approx | 2,000 lbs, total | |

Lobby section of one of the school buildings was partitioned. False flooring, air conditioning and power were installed in the laboratory section which houses two computers (CDC 1604 and NCR-CRC-102A) and their associated peripheral equipment.

School of Aviation Medicine

| | | | |
|---|---|---|---|
| Power, computer | 5.5 Kw | 7.7 KVA | 0.7 pf |
| Volume, computer | | 72 cu ft | |
| Area, computer | | 12 sq ft | |
| Room size | | 20 ft x 12 ft | |
| Floor loading | | 225 lbs/sq ft | |
| | | 60 lbs concen max | |
| Capacity, air conditioner | | 5 Tons | |
| Weight, computer | | 2,700 lbs | |
| Air conditioner | | central unit | |

System required primary power source due to sensitivity to power fluctuations.

## PRODUCTION RECORD

| Manufacturer | |
|---|---|
| Produced | 16 |
| Operating | 16 |

## COST, PRICE AND RENTAL RATES

U.S. Army Chemical Center

| | |
|---|---|
| Approximate cost of basic system | $70,000 |
| Approximate cost of additional equipment | $25,000 |
| Rental rates for basic system | $ 2,400/month |

U.S. Naval Post Graduate School

Computer, 2 tape drives, console, Flexowriter (paper tape reader and punch), point plotter cost approximately $100,000.

Rental rates for additional equipment, to include the 2 IBM 523, IBM 402, IBM 082, and IBM 026 is $600 per month.

Approximately $9,500 per year is paid to the National Cash Register Company for maintenance service.

School of Aviation Medicine

The 102A Computer cost approximately $80,000.
The 126A Magnetic Tape Unit cost approximately $15,000.
Two IBM Summary Punches (No. 523) rent at approximately $2,100 per year.
Air Force personnel perform servicing of the system.

## PERSONNEL REQUIREMENTS

U.S. Army Chemical Center

One 8-hour shift requires 1 engineer and 1 technician-operator.

U.S. Naval Ordnance Test Station

One 8-hour shift requires 1 engineer, 2 programmers, and 1 "open shop" personnel.

U.S. Naval Post Graduate School

The computers are available for student and faculty research 24 hours per day. Those students and faculty who have been checked-out on the operation of the computers and peripheral equipment are permitted out-of-hours production runs on the computers. Potentially the school has approximately 1,000 programmer-operators under this system. At the present time the CDC 1604 operates approximately 14 hours per day and the NCR 102A 20 hours per day, 7 days per week.

Course work is given in the Engineering School on programming, operation and applications.

Seminars are given at the school.

School of Aviation Medicine

| | One 8-Hour Shift |
|---|---|
| Analysts | 1 |
| Programmers | 1 |
| Operators | 1 |
| Engineers | 1 |

Operation tends toward open shop.

On-the-job training (OJT) is given.

Gulf Research and Development Company

Central computing section consists of 1 engineer, 1 operator, 1 secretary-librarian, and 5 administrative, numerical analysis and programming personnel, for slightly more than an 8-hour shift.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

U.S. Army Chemical Center

| | |
|---|---|
| Good time | 3,380 hours |
| Attempted to run time | 5,200 hours |
| Operating ratio (Good/Attempted to run time) | 0.65 |

Figures based on a 2.5 year period

Passed Acceptance Test Jun 54

U.S. Naval Ordnance Test Station

| | |
|---|---|
| Average error-free running period | 80 hours |
| Operating ratio (Good/Attempted to run time) | 0.90 |

Figures based on period 1 Jan 55 to 10 Nov 56

Passed Acceptance Test 1 Jun 54

U.S. Naval Post Graduate School

Passed Acceptance Test Summer of 1953

Time is not available for rent to outside organizations.

Since August 1958, the NCR 102A has averaged in excess of 100 hours per week operating time and has averaged less than 2 hours per week of forced down-time due to equipment failure. Each working day there is a two hour preventive maintenance period.

School of Aviation Medicine

| | |
|---|---|
| Good time | 36 Hours/Week (Average) |
| Attempted to run time | 40 Hours/Week (Average) |
| Operating ratio (Good/Attempted to run time) | 0.90 |

Above figures based on period from Fall 54 to 1 Jul 59

Time is not available for rent to outside organizations.

## ADDITIONAL FEATURES AND REMARKS

Holloman Air Development Center (ARDC)

Two systems have been in use since 1953. Additional input/output equipment includes 3 magnetic tape units (NCR 128), and 1 summary card punch (IBM 523).

U.S. Army Chemical Center

The three-address system permits ease of programming and coding not present in one or two address systems.

Additional features include: Bit positions available in the structure of commands for flagging internal addresses for automatic coding and repositioning of programmed routines. Logic designed such that automatic links to and from subroutines are accomplished easily. Large storage capacity and three-address commands. Tape unit searches independently of the computer, once the block address is set up. High speed paper tape input reader. A visual display of the control register while computing and when idle. All logical diodes accessible, diodes are of clip-in type, plug-in units replaceable for repair.

U.S. Naval Post Graduate School

The system is used primarily for the education of the officers in the Engineering School. Other computing time after normal training hours is used by government agencies in the Monterey area on a non-interference basis.

The plotter output is considered to be a very valuable part of the system permitting rapid observation of results. The binary information is plotted directly on graph paper, thus avoiding the problem of converting to decimal. The plotter has three plotting symbols.

Gulf Research and Development Company

Auxiliary equipment consists of:

2 NCR 126 Magnetic Tape Units.

Two Flexowriters, each capable of serving as the input-output device for the computer. A third Flexowriter, not modified, for input-output functions.

One IBM 514 Reproducing Punch, modified for use as an output device.

A photoelectric paper tape system based upon a Ferranti reader has been constructed.

Two more one-word recirculating registers have been made addressable, making them correspond roughly to the accumulator and Q-register of a typical one-address computer.

## INSTALLATIONS

Holloman Air Development Center (ARDC)
Holloman Air Force Base, New Mexico

School of Aviation Medicine
Randolph Air Force Base, Texas

Chemical Warfare Laboratories
U. S. Army Chemical Center, Maryland

U. S. Naval Ordnance Test Station
China Lake, California

U. S. Naval Post Graduate School
Monterey, California

A. V. Roe, Ltd.
Malton, Ontario, Canada

Great Lakes Pipe Line Company
Kansas City, Missouri

Gulf Research and Development
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania

Polytechnic Institute of Milan
Milan, Italy

Royal Canadian Air Force
Edmunton, Alberta, Canada

# NATIONAL 102D

NCR CRC Model 102 D

## MANUFACTURER

The National Cash Register Company

## APPLICATIONS

Manufacturer

General purpose scientific application

Pitman-Dunn Laboratories

The system is used for general scientific computing, to include trajectories, other differential equations, interior and exterior ballistics, fire control problems, curvefitting, solution of algebraic equations, simulations, etc.

The National Cash Register Company

Located at the Research and Development Division, The National Cash Register Company, Dayton, Ohio, the system is used to support the physical and chemical investigations of the Research and Development Division by processing experimental data originating in the research and engineering laboratories. Work in such fields as logical design, wiring diagrams for logical systems, cam design, and statistical analysis of data are typical of the applications made.

Photo by The National Cash Register Company

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Decimal digits/word | 9 plus 6 bin dig/word |
| Binary digits/instruction | 42 |
| Instructions per word | 1 |
| Instructions decoded | 27 |
| Arithmetic system | Fixed point |
| Instruction type | Three address |
| Number range | $-(1-10^{-9})$ to $+(1-10^{-9})$ |
| or | |
| | $-(1-2^{-36})$ to $+(1-2^{-36})$ |

1 Computer, 2 Control Consol, 3 High Speed Paper Tape Reader, 4 Magnetic Tape Units, 5 High Speed Paper Tape Punch

Photo by The National Cash Register Company

## ARITHMETIC UNIT

| Manufacturer | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| Add | 7,800 | 4,000 |
| Mult | 21,100-49,100 | 15,000 |
| Div | 21,100-53,200 | 15,500 |
| Construction | Vacuum tubes | |
| Rapid access word registers | 8 | |
| Basic pulse repetition rate | 100 Kc/sec | |
| Arithmetic mode | Serial | |
| Timing | Synchronous | |
| Operation | Sequential | |

## STORAGE

| Manufacturer Media | Words | Digits | Access Microsec |
|---|---|---|---|
| Magnetic Drum | 1,024 | 43,008 | 12,500 avg |
| Magnetic Tape | 102,000/reel | 918,000/reel | |

| Pitman-Dunn Laboratories Media | No. of Words | No. of Digits/Word | Min Access Microsec |
|---|---|---|---|
| Magnetic Drum | 1,032 | 14 octal or 9 decimal | 390 |
| Magnetic Tape | 110,000 | Same | |

Magnetic tape searches approx. 90"/sec., reads/writes 15"/sec. (approx. 59 words/sec)

## INPUT

| Manufacturer Media | Speed |
|---|---|
| Paper Tape (Flexowriter) | 10 char/sec |
| Paper Tape (Photoelectric) | 200 char/sec |
| Magnwtic Tape | 600 char/sec |
| Keyboard (Flexowriter) | Manual |
| Punched Cards | 4,000 char/min |
| Pitman-Dunn Laboratories | |
| Keyboard or Paper Tape | 6 char/sec |
| Hi-Speed Tape Reader | 160 char/sec |
| Magnetic Tape | 59 words/sec |
| IBM Card Reader | 100 cards/min |

Six channel Flexowriter is used. Cards contain 4 words each.

Photo by The National Cash Register Company

## OUTPUT

| Manufacturer Media | Speed |
|---|---|
| Paper Tape (Flexowriter) | 10 char/sec |
| High Speed Punch | 60 char/sec |
| Magnetic Tape | 600 char/sec |
| Punched Cards | 4,000 char/min |
| **Pitman-Dunn Laboratories** | |
| Typed Page | 6 char/sec |
| Paper Tape (High Speed) | 60 char/sec |
| Card (IBM) | 100 cards/min |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Manufacturer | |
|---|---|
| Tubes | 425 |
| Tube types | 15 |
| Crystal diodes | 8,500 |

## CHECKING FEATURES

Manufacturer

Duplicate recording on magnetic tape
"Overflow" alarm
"No command" alarm

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| Manufacturer | | | |
|---|---|---|---|
| Power, computer | 7.7 Kw | | |
| Area, computer | 250 sq ft | | |
| Weight, computer | 2,700 lbs | | |
| **Pitman-Dunn Laboratories** | | | |
| Power, computer | 8.2 Kw | 11.6 KVA | 0.71 pf |
| Power, air conditioner | | 61.5 KVA | |
| Volume, computer | | 154.5 cu ft | |
| Volume, air conditioner | | 2,318 cu ft | |
| Area, computer | | 49 sq ft | |
| Area, air conditioner | | 206.5 sq ft | |
| Room size, computer | | 19 ft x 39 ft | |
| Room size, air conditioner | | 11 ft x 25 ft | |
| Floor loading | | 84 lbs/sq ft | |
| | | 425 lbs concen max | |
| Capacity, air conditioner | | 60 Tons 720,000 BTU | |
| Weight, computer | | 4,110 lbs | |
| Weight, air conditioner | | 6,600 lbs | |
| Weight, cooling tower | | 2,500 lbs | |

Power includes Input-Output systems.

One 5 KVA and one 10 KVA Sol A transformers are used for voltage regulation. Power outlets for main computer and auxiliary equipment were installed. Air

conditioner services personnel and an analog computer also.

## COST, PRICE AND RENTAL RATES

Manufacturer

| | |
|---|---|
| Approximate cost of basic system | $65,000 |
| Approximate cost of additional equipment | |
| Magnetic Tape Unit Model 126 | $16,000 |
| High Speed Reader Model 160 | 9,500 |
| High Speed Punch Model 170 | 5,000 |
| Flexowriter | 2,900 |
| Rental rates for basic system | $2,400/month |
| Rental rates for additional equipment | |
| High Speed Reader Model 160 | 275/month |
| High Speed Punch Model 170 | 220/month |
| Flexowriter | 150/month |

Pitman-Dunn Laboratories

Computer w/console, Flexowriter mag. tape unit, hi-speed reader, hi speed punch, including transportation and installation cost $83,370.

Off-line Flexowriter cost $2,900 additional.

IBM equipment includes 2-523's, 2-026's, 1-082, 1-085, 1-514, and 1-402, which rents at $12,624/year.

Maintenance for purchased equipment is $12,624/year.

## PERSONNEL REQUIREMENTS

Pitman-Dunn Laboratories

| | One 8-Hour Shift |
|---|---|
| Analysts | 1 |
| Programmers | 2 |
| Technicians | 1 |

Photo by the Georgia Institute of Technology

Operation tends toward closed shop.

Methods of training includes basic programming course and use of the programming manuals. Programmers code and run their own problems.

The National Cash Register Company

| | One 8-Hour Shift |
|---|---|
| Supervisors | 1 |
| Coders, Programmers & Analysts | 3 |
| Technicians | 1 |

Operation tends toward open shop. Individuals may have programs entirely written by department personnel, written by themselves with assistance from department, or written entirely by thwmselves. Individuals desiring running time for a problem most commonly supply their own operator.

Methods of training used includes on-the-job training of department personnel, informal training of other research personnel.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Pitman-Dunn Laboratories

| | |
|---|---|
| Average error-free running period | 4 Hours |
| Good time | 26 Hours/Week (Average) |
| Attempted to run time | 39 Hours/Week (Average) |
| Operating ratio (Good/Attempted to run time) | 0.67 |

Above figures based on period 1 Apr 59 to 30 Apr 60

Passed Customer Acceptance Test Jan 58

Time is not available for rent to outside organizations.

4 hours of preventive maintenance is performed.

The National Cash Register Company

| | |
|---|---|
| Good time | 28.5 Hours/Week (Average) |
| Attempted to run time | 32 Hours/Week (Average) |

High Speed Reader

Operating ratio (Good/Attempted to run time) 0.89
Above figures based on period from Jul 59 to Aug 60
Time is not available for rent to outside organizations.

## ADDITIONAL FEATURES AND REMARKS

Pitman-Dunn Laboratories

Outstanding features include 3 address system, which is easy to use.

Photo by The National Cash Register Company

## FUTURE PLANS

Pitman-Dunn Laboratories

System expected to be replaced by second quarter Fiscal Year 61 with system comparable with DATATRON 205, IBM 650, or UNIVAC Solid State.

High Speed Punch

Photo by The National Cash Register Company

## INSTALLATIONS

Dow Chemical Company
Midland, Michigan

Rice Electronic Computer Center
Georgia Institute of Technology
Atlanta, Georgia

Research and Development Division
The National Cash Register Company
Dayton, Ohio

The National Cash Register Company
Hawthorne, California

Pitman-Dunn Laboratories
Frankford Arsenal
Philadelphia, Pennsylvania

# NATIONAL 107

National Cash Register Corporation Model 107

## MANUFACTURER

National Cash Register Corporation

Photo by U. S. Naval Academy

## APPLICATIONS

Located in Ward Hall, U. S. Naval Academy, the system is used to demonstrate to Naval Academy faculty and midshipmen, automatic calculations using a large data processing/scientific type digital computer.

## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary coded decimal |
| Decimal digits/word | 11 |
| Decimal digits/instruction | 2 |
| Instructions/word | 1 + sign |
| Instructions decoded | 22 |
| Arithmetic system | Fixed point |
| Instruction type | Three address |
| Number range | $-(1 - 10^{-9}) \leq x \leq 1-$ |

The excess-three system of binary coded decimal notation is used.

## ARITHMETIC UNIT

| | | Incl Stor Access |
|---|---|---|
| Operation Time | | Microsec |
| Add | | 15,000 |
| Mult | | 40,000 |
| Div | | 40,000 |
| Construction (Arithmetic unit only) | | |
| Vacuum-tubes | 625 | |
| Diodes | 2,040 | |
| Arithmetic mode | Parallel | |
| Parallel by bit, serial by digit. | | |
| Timing | Synchronous | |
| Operation | Sequential | |

## STORAGE

| Media | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Drum | 11,000 | 121,000 | 3,000 |

Magnetic Tape

| | | |
|---|---|---|
| No. of units that can be connected | 99 | Units |
| No. of char/linear inch of tape | 134 | Char/inch |
| Channels or tracks on the tape | 10 | Tracks/tape |
| Blank tape separating each record | 10 | Inches |
| Tape speed | 15 | Inches/sec |
| Transfer rate | 2,010 | Char/sec |
| Start time | 3 | Millisec |
| Stop time | 3 | Millisec |
| Average time for experienced operator to change reel of tape | 120 | Seconds |
| Physical properties of tape | | |
| Width | 1 | Inch |
| Length of reel | 3,600 | Feet |
| Composition | Mylar or Acetate | |

All tape must initially be pre-clocked off-line.

## INPUT

| Media | Speed |
|---|---|
| Card (IBM) | 100 cards/min |
| Magnetic Tape | 15 in/sec, 121 char/in |
| Paper Tape | 120 char/min |
| Keyboard (Flexowriter) | Manual |

## OUTPUT

| Media | Speed |
|---|---|
| High Speed Printer | 600 lines/min, 120 char/line |
| Magnetic Tape | 15 in/sec, 121 char/in |
| Cards (IBM) | 100 cards/min |
| Typewriter (Flexo) | 120 char/min |
| Paper Tape | 120 char/min |

## CIRCUIT ELEMENTS OF ENTIRE SYSTEM

| Type | Quantity |
|---|---|
| Tubes | 800 |
| Diodes | 2,500 |

## CHECKING FEATURES

Unwanted Digit
Command Check
Overflow
Conditional Halt

## POWER, SPACE, WEIGHT, AND SITE PREPARATION

| | | | |
|---|---|---|---|
| Power, computer | 208 Volts | 3 phase | 60 cps |
| Power, air cond | 208 Volts | 3 phase | 60 cps |
| Volume, computer | 65,774 cu ft | | |
| Volume, air conditioner | 126 cu ft | | |
| Area, computer | 1,711 sq ft | | |
| Area, air conditioner | 18 sq ft | | |
| Room size, computer | 1,800 sq ft | | |
| Capacity, air conditioner | 15 Tons | | |
| Weight, computer | 12,000 lbs | | |
| Weight, air conditioner | 1,000 lbs | | |

Building was modified for computer installation.

## PRODUCTION RECORD

| | |
|---|---|
| Number produced to date | 1 |
| Number in current operation | 1 |

Produced for U. S. Navy Bureau of Aeronautics to their design specifications.

## COST, PRICE AND RENTAL RATES

Basic System

Original cost, $1,000,000 to Navy BUAER (original owner). System consists of control console, arithmetic section, high speed printer, 8 magnetic tape units, and memory section.

Additional Equipment

For the IBM 514, IBM 523, IBM 024, the total rent is $108.00 per month (including educational discount 60%).

## PERSONNEL REQUIREMENTS

| | One 8-Hour Shift |
|---|---|
| Supervisors | 1 |
| Operators | 2 |
| Technicians | 3 |

Operation tends toward open shop.

Methods of training used is classroom and on-the-job training.

## RELIABILITY, OPERATING EXPERIENCE, AND TIME AVAILABILITY

Operating experience over four year period approximately 98% of scheduled production at previous location in Washington, D. C. (Navy Bureau of Weapons).

## ADDITIONAL FEATURES AND REMARKS

Outstanding features are block search on tape handles at rate of 600 words/sec, off-line preparation and verification of tape input, and large memory with maximum of 10 word access.

## FUTURE PLANS

Addition of X-Y plotter and weapons system simulation for educational purposes.

## INSTALLATIONS

U. S. Naval Academy
Weapons Department
Annapolis, Maryland

# NATIONAL 304

National Cash Register 304

## MANUFACTURER

National Cash Register Company

Photo by National Cash Register Company

## APPLICATIONS

Manufacturer

The system is a general-purpose data processing system for industrial, governmental and educational organizations. It is intended for commercial and scientific applications. All commonly-used inputs and outputs, a magnetic tape system with unique characteristics, and flexibility in system organization result in a powerful system with versatility of application.

U.S. Marine Corps, Camp Lejeune

Located on the base, the system is used for USMC personnel accounting.

U.S. Marine Corps, Camp Pendleton

Located at the U. S. Marine Corps, Camp Pendleton the system will be used to maintain current magnetic tape records on approximately one half the Active and Organized Reserve Establishments of the Marine Corps. Weekly, Changed Record Tapes will be forwarded to Headquarters, Marine Corps to overlay Headquarters' Tape Records. Headquarters will prepare personnel reports for itself, Navy Department, and Department of Defense from its Magnetic Tape Files. Meanwhile, this installation will prepare "Field Personnel Reports" for 14 major field commands in the western complex. (DPI, MCB, Camp Lejeune, North Carolina performs the same function for the eastern complex, i.e., the other half of the Marine Corps.) Implementation of the system is scheduled for August 1960.

U.S. Marine Corps, Headquarters

Located at the Arlington Navy Annex, the system is utilized for military personnel accounting.

The three U.S. Marine Corps NCR 304 Data Processing Systems are utilized in an integrated Military Personnel Accounting and Reporting System. The systems located in California and North Carolina servicing the two major Marine Corps bases and reporting to the system located in Washington D. C.

American United Life Insurance Company

Located at 30 W. Fall Creek Parkway, N. Dr. - Indianapolis, Indiana, the system is used to maintain Master Tape Files of policyholders, agents, payroll, general ledger, mortgages, securities, update daily any transactions that affect any master record or file, compute commissions, journalize daily - Maintain accounting controls, balance books of account. Perform premium billing and policy conservation advices, control disbursements, bank reconciliations, and compute dividends, cash values, premiums, reserves, interest, etc.

S. C. Johnson & Son, Inc.

Located at 1525 Howe Street, Racine, Wisconsin, the system is used for order processing, inventory control, accounts receivable, credit and collection, freight allocation, sales statistics, and allied financial reports.

National Cash Register Company, Hawthorne

Located at the National Cash Register's Electronics Division, Hawthorne, California, the system is used for electronic data processing service to business, industry and government. Complete facilities for handling customer created input - punched paper tape and cards. It is used for program check out for 304 customers. The system is used internally by the National Cash Register Company for programming research, automated logical design, and data processing. Back up support for other 304 systems is additional use.

Photo by National Cash Register Company

Bureau of Yards and Docks

Located at the Bureau of Yards and Docks, Washington D. C., the system is used for the management of the Military Construction Program, the inventory of Automotive Equipment, the inventory of Construction Equipment, and for engineering applications.

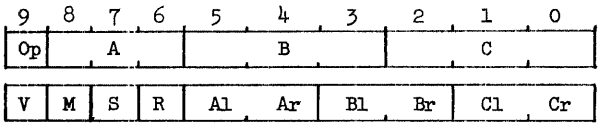
## PROGRAMMING AND NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary Coded Decimal |
| Alphanum char/word | 10 |
| Alphanum char/word | 5 - 60 |
| Words/instruction | 1/2 - 6 |
| Instructions decoded | 83 one address |
| | 37 three address w/variations |
| Arithmetic system | Floating point |
| MICROFLOW provides exponents in range of -50 to + 49 and automatic normalizing of result | |
| | Fixed point |
| Automatic alignment takes place | |
| Instruction type | One address (MICROFLOW) |
| | (Scientific-type) |
| | Three address (Multi-address) |
| | (Business-type) |
| Number range | $-(1-10^{-10})$ to $+(1-10^{-10})$ |

Photo by American United Life Insurance Company

Instruction word format

The command structure of the 304 system is unique in a number of aspects. The instructions are basically 3 address plus a number of other functions or capabilities that are built into the execution of the instruction. The basic instruction word format for arithmetical operations such as add, subtract, etc., is illustrated:




Op = Operation Code

A = Address of Operand

B = Address of Operand

C = Putaway or Jump Address

V = Variation & Self-Linking designator

M = Auto-monitor level

S = Combinations of A, B, or C to be relative to Index Register

R = Index Register

Al, Ar = left and right field of A Address

Bl, Br = left and right field of B Address

Cl, Cr = left and right field of C Address

The programmer in translating procedures for the 304 System will use the NEAT (National's Electronic Autocoding Technique) format. The programmer might write the following to add the Old Quantity on Hand to the Number Received to arrive at the New Quantity on Hand:

```
ADD (V) (R) OQOH QREC NQOH
```

The NEAT assembly process will translate the NEAT format into the necessary absolute machine language.

It could be considered that all instructions in the basic 304 Command List are automatic built-in subroutines. There are a number of operation codes that were designed specifically for business data processing such as Edit, Merge, Move, Sift (or table look-up), and Summarize that are powerful instructions and in some cases are self-incrementing.

As an example, the Merge instruction will serve to illustrate the nature of these business-type opera-

Official Marine Corps Photo

Camp Lejeune, N. C.

tions. Specified in NEAT format would be the following mnemonic designators and parameters:

Designate first word, first item, each string
Number of items in each string
Relative position of Major Key (if any), within item
Relative position of Minor Key within item
Number of keys (1 or 2) for the Merge
Length of each item
Specify three exits (Cutoff Merge only)

NEAT (National's Electronic Autocoding Technique) was in operation before the first deliveries of the National 304 System. This system enables systematic organization in the approach to a problem, an assembly-compiler and a complete library of generators, service programs, and subroutines. COBOL or COBOL-like language will become part of the system in a reasonable time.

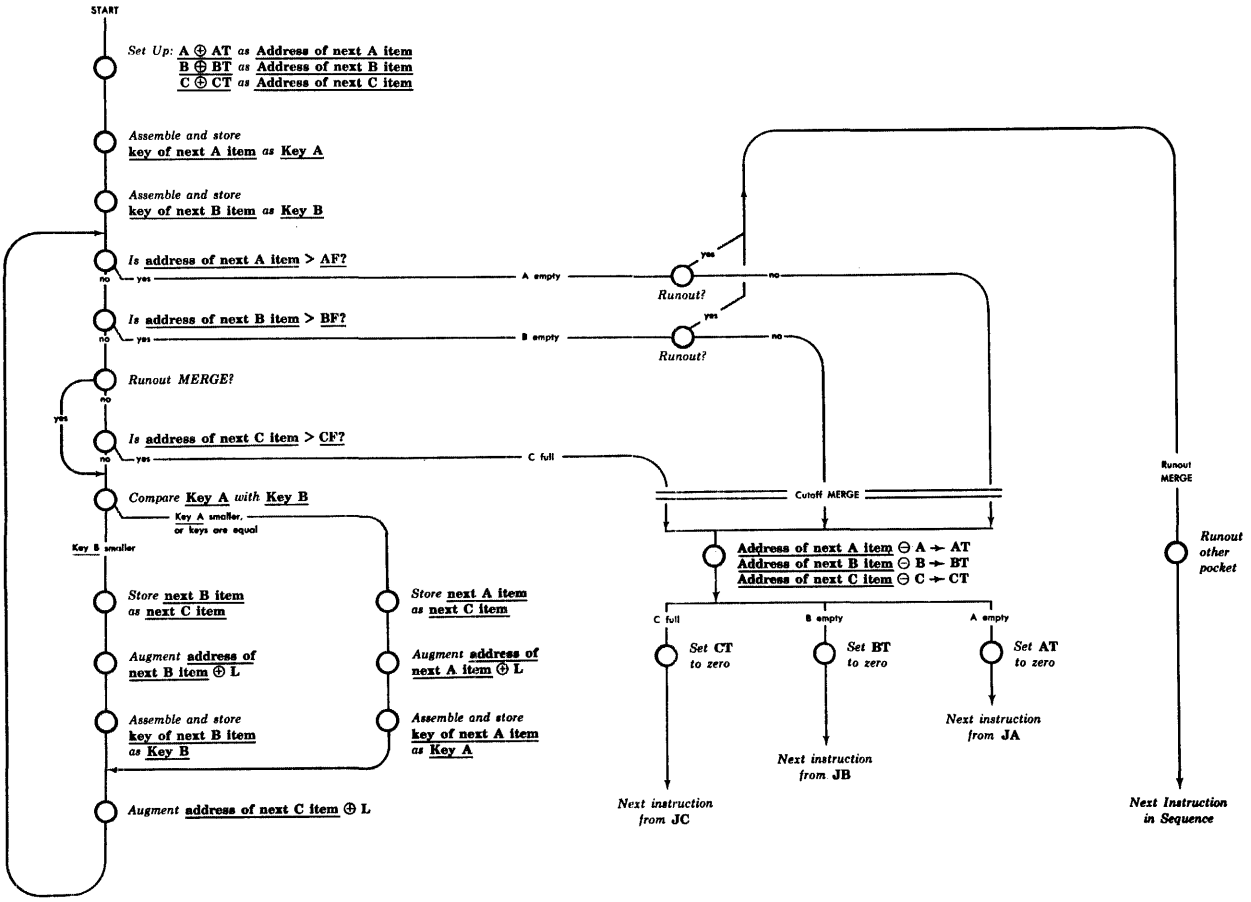
Each instruction may be relative to one of 10 Relative Index Registers. The particular Index Register and the portions of the instruction which are to be relative are specified within the instruction.

## ARITHMETIC UNIT

| Operation | Incl Stor Access Microsec | Exclud Stor Access Microsec |
|---|---|---|
| MICRO-FLOW SINGLE ADDRESS MODE | | |
| Add | 120 | 60 |
| Mult | 1,320 | 1,260 |
| Div | 3,480 | 3,420 |
| BUSINESS-TYPE THREE ADDRESS | | |
| Add | 60 (10+R+L) | 60 (9+R+L) |
| Mult | 60 (17+R+L+X) | 60 (16+R+L+X) |
| Div | 60 (14+R+L+2Q+Y) | 60 (13+R+L+2Q+Y) |

R = 1 If relative to Index Register
R = 0 If not
L = 2 If self-linking occurs
L = 0 If not
X = Sum plus significant digits of multiplier
Q = Number of digits in quotient
Y = Sum of digits of the quotient

Construction (Arithmetic unit only)
Due to interlaced circuitry, number of elements are included in the total for the 304 Processor.
Arithmetic mode Serial by word, parallel by character
The adder is implemented with two diode-matrix half adders and one diode full adder.
Timing Synchronous in Central Processor
Asynchronous to or from peripheral units




Merge Flow Diagram

Operation — Sequential internally
Concurrent with copy or search of magnetic tape or printing

## STORAGE

| Media | Manufacturer No. of Words | No. of Alpha-Numeric | Access Microsec |
|---|---|---|---|
| Magnetic Core | 2400-4800 | 24,000-48,000 | 6/alphanum |
| Magnetic Tape, per reel | 850,000 | 8,500,000 | 2 1/2 min |

| | |
|---|---|
| No. of units that can be connected | 64 Units |
| No. of chars/linear inch of tape | 200 Chars/inch |
| Channels or tracks on the tape (including parity and markers) | 8 Tracks/tape |
| Blank tape separating each record | None |
| Tape speed | 150 Inches/sec |
| Transfer rate (alpha-numeric characters) | 30,000 Chars/sec |
| Start time | 3.5 Millisec |
| Stop time | 3.5 Millisec |
| Average time for experienced operator to change reel | 30 Seconds |

Physical properties of tape

| | |
|---|---|
| Width | 1/2 Inch |
| Length of reel | 3,600 Feet |
| Composition | 1 mil mylar, laminated |

The unique 304 magnetic tape system is composed of sub-systems of National 330 Controllers and National 332 Magnetic Tape Handlers. The Central 304 Processor may handle up to eight 330 Controllers, and each Controller may handle up to eight Handlers to provide an upper limit of 64 Handlers available.

A record on magnetic tape may contain 10 or more words. Multiple variable-length records may be written onto magnetic tape with a single acceleration. The contents of one magnetic tape may be read and simultaneously written onto another tape unit until a desired record is reached. The copying may be shared with computing, printing, input or output. Several copy operations may be in progress simultaneously.

All conditions which may arise during magnetic file operations are automatically detected and identified by the Processor without programmed testing. Then a standard routine, called STEP (Standard Tape Executive Program), will perform all tape management

Production

Photo by National Cash Register Company

operations including:

Repeat in case of error, write "Skip" record after proper number of tries
Repeat, or jump, on busy Handler or Controller
Indicate attempt to use locked-out tape
Alternate Tape Units at end of tape
Tape identification, and label-checking
Memory dump, and rescue points
Log of tape operations
Executive control over sequencing from one program to the next, or overlays

The time-sharing ability of magnetic tape copy allows for convenient file-splitting, or multi-programming of different jobs where reference to the file is for less than every record. Thus, completely independent programs can be written and checked out, then tied together with the timing interlace being performed by the equipment.

In order to improve the efficiency of Magnetic File Operations, any quantity of numeric information may be packed from 6-bit code to 4-bit code with a single instruction. Thus, utilization of tape storage, and transport speed, will both be increased by 50% for numeric information.

When the packed information is brought into memory, a single instruction will reverse the transformation. Only that information requiring arithmetic operation need be unpacked; sorting, table lookup, and all other logical operations, can be performed on packed information.

U.S. Marine Corps, Camp Lejeune

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Core Memory | 2400 | 10 | 60/word time |

U.S. Marine Corps, Camp Pendleton

| | |
|---|---|
| Magnetic Core | 2400 |

U.S Marine Corps, Headquarters

| | |
|---|---|
| Magnetic Core | 2400 |
| Magnetic Tape | 864,000 |

American United Life Insurance Company

| | |
|---|---|
| Magnetic Core | 4800 |
| Magnetic Tape | 850,000 |

Official Marine Corps Photo

Camp Pendleton, California

S. C. Johnson & Son, Inc.

| Medium | No. of Words | No. of Digits | Access Microsec |
|---|---|---|---|
| Magnetic Core | 2400 | 10 | |

National Cash Register Company, Hawthorne

| | | | |
|---|---|---|---|
| Magnetic Core | 4800 | | 6/alpha-num char |
| Magnetic Tape (10 char/word) | 1.08 million word/reel | | 3 min |

Bureau of Yards and Docks

| | | | |
|---|---|---|---|
| Magnetic Core | 4800 | 48,000 | 60 |

Magnetic Tape may be considered as storage medium.

## INPUT

Manufacturer

| Media | Speed | |
|---|---|---|
| Punched Cards | 2000 cards/min | Photo-electric |
| Punched Paper Tape | 1800 char/sec | Photo-electric |
| Magnetic Tape | 30 Kc | alpha-numeric |

Punched Cards and Punched Paper Tape may be handled on-line with the 304 Processor or converted to magnetic tape with the 320 Multi-Purpose Converter.

U.S. Marine Corps, Camp Lejeune

| Media | Speed |
|---|---|
| Magnetic Tape | |
| Punched Cards | |
| Flexowriter typing | |
| Flexowriter Paper Tape | |

U.S. Marine Corps, Camp Pendleton

| | |
|---|---|
| Magnetic Tape | |
| Punched Cards | |
| Console Typewriter | |

U.S. Marine Corps, Headquarters

| | |
|---|---|
| Magnetic Tape | |
| Punched Cards | |
| Punched Paper Tape | |
| Flexowriter | |

American United Life Insurance Company

| | |
|---|---|
| Paper Tape Reader | 2,000 char/sec |
| Optical Reader - choice of 3 codes | |
| Punched Card Reader | 2,500 cards/min |
| 90 column cards - read optically | |
| Magnetic Tape | 30,000 char/sec |
| 200 char/in - 3,600' reels | |
| Console Typewriter | 10 char/sec |
| Modified Flexowriter | |

Official Marine Corps Photo

S. C. Johnson & Son, Inc.

| Media | Speed |
|---|---|
| Magnetic Tape | 30,000 char/sec |
| Punched Paper Tape | 1,800 char/sec |
| Punched Cards | 2,000 cards/min |
| Console Flexowriter | 10 char/sec |

National Cash Register Company, Hawthorne

| | |
|---|---|
| NCR 380 Card Reader | 2,000 cards/min |
| NCR 360 Paper Tape Reader | 1,800 char/sec |
| Console | 10 char/sec |
| Magnetic Tape | 30,000 char/sec |

The Paper Tape Reader can handle 6 codes. Three core matrices are on the unit.

Bureau of Yards and Docks

| | |
|---|---|
| Magnetic Tape | 30,000 char/sec |
| 3600 ft = $8.5 \times 10^6$ char | |
| Paper Tape | 1,800 char/sec |
| 3 code option, 10 char/in | |
| Punched Cards | 2,000 cards/min |
| 1 card = 80 chars | |
| Console Typewriter | 10 char/sec max. |
| Manual type-in or paper tape read | |

## OUTPUT

Manufacturer

| Media | Speed |
|---|---|
| Punched Paper Tape | 60 char/sec |
| Line Printer | 850-1200 printing 850 alpha numeric 5040 spacing 1200 numeric (lines/min) |
| Punched Cards | 100 cards/min |
| Magnetic Tape | 30,000 char/sec |

The Paper Tape Punch or the High Speed Line Printer may be controlled on-line by the 304 Processor or off-line by the 320 Multi-Purpose Converter. The Line Printer may also be controlled off-line by the 322 Printer Converter. Punched cards can be produced off-line using an IBM 523 with source information on magnetic tape and under control of the 320 Converter.

U.S. Marine Corps, Camp Lejeune

| | |
|---|---|
| Magnetic Tape | |
| Flexowriter typing & punching | |
| Punch Cards | |
| Printer | |

IBM Type 523 as IBM card output media