UNIVAC II

Universal Automatic Computer Model II

MANUFACTURER

Sperry Rand Corporation
Remington Rand Univac Division

APPLICATIONS

General purpose digital computer

NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits per word	12
Decimal digits per instruction	6
Instructions per word	2
Instructions decoded	54
Instructions used	54
Arithmetic system	Fixed point
Instruction type	One address
Number range	Between -1 and +1

Decimal point occurs at the right of the sign digit.

ARITHMETIC UNIT

	Includ. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add time	160	120
Mult time	1,720	1,680
Div time	3,030	2,990
Construction	Vacuum tubes	
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Sequential	

Addition, subtraction and multiplication times given below include reading and executing the instruction. The time includes formation of the result in the accumulator. All instructions, however are performed at minimum latency rates.

Average Operating Speeds in Microseconds	
Addition or Subtraction	200 (11-digit numbers)
Multiplication	1,900 (11-digit numbers)
Division	3,700 (11-digit numbers)
Comparison	200 (12-digit numbers)
Transfer (Memory to Register or vice versa)	40/word + 80/Instruction

STORAGE

Medium	Magnetic Core
Capacity	2,000 Words: 24,000 characters (10,000 Words available about September 1957)
Memory Locations	0000 - 1999
Access time	Zero (Memory references begin during "Time Out")
Basic Cycle	20 microseconds
Construction	42 separate magnetic core planes, each one a rectangle 50 cores wide and 80 cores long.

Each of the planes is divided into two sections of 50 by 40 cores, making 2,000 cores in each section. Each section contains one core - for one binary position (bit) - of every one of the 2,000 words. The same relative binary position of the other half-word is held in a core in the same physical location in the other section of the plane. Thus each plane contains two binary positions in each of 2,000 words; the first and 43rd, for example, or the 9th and 52nd. Physically the memory is a rectangular prism 7-1/4 inches x 10 inches x 12-3/4 inches.

A memory location thus always implies two cores in all 42 planes. The two cores are determined by the intersection of one column of fifty possible columns with two rows of the 80 possible rows. One row is in each section of the plane. All 42 planes are used twice for each word.

Associated with the memory is a half-word insertion register of 42-bit capacity. Each bit is temporarily stored in a magnetic core of this register during a memory reference. Each of these register cores is associated with one of the 42 memory planes. To write into the memory, the first half of the word is placed in the insertion register and the address selector alerts the appropriate column and the proper row of the top section in each of the 42 planes. At the appropriate instant the information is transferred from each core of the insertion register to the selected core in the corresponding plane of the memory. 42 pulse times later, the second half word has been placed in the insertion register and the process is repeated in the lower section of the memory. Read-outs are accomplished in a reverse manner. The speed of the memory has been adjusted to the speed of the arithmetic portion of the UNIVAC which permits the transfer into or out of the memory of 12 characters in 40 microseconds. Word pulses flow from or to the High Speed Bus and the insertion register via a mechanism which converts from serial to parallel and vice versa, in 42 bit modules.

INPUT

Media	Speed
Magnetic Tape (Uniservo II)	20, 12.4, or 5 Kc digit rate; 100 in/sec
Keyboard	Manual
Unityper II	Manual (50 char/in density)
Card to Tape Converter	240 cards/min (80 or 90 col cards)
Paper Tape to Magnetic Tape Converter	200 char/sec (5, 6 or 7 channel)
Verifier	Keypunching (Verification of Unityper II Tapes)

The UNISERVO II

Purpose

The UNISERVO II transports tape over a standard magnetic head (for reading and recording) under the control of UNIVAC II.

Physical Specifications

The UNISERVO is housed in a cabinet, the upper section of which contains the reel mounts and is covered by a removable glass door. The front panel doors are interlocked such that the center drive is stopped whenever the doors are opened. The entire front cover is easily removed, giving access to the loops.

Height	62 inches
Width	30 inches
Depth	30 inches
Working Space	6 ft 5 in by 5 ft 9-3/4 in.
Weight	650 lbs.

Operation

Input Function. A UNISERVO may be used to read the coded, magnetic dots on the tape moving forward or backward and transfer the data in the form of electronic pulses to UNIVAC.

Output Function. A UNISERVO may be used to record the results of UNIVAC processing in the form of coded, magnetic dots on a metallic tape or a mylar tape moving forward.

Reel Mounts. The reel mounts hold the standard 6 inch and 8 inch reels for magnetic tape and an 11 inch reel for mylar tape.

Tape Handling System. There are 2 independent servo systems - the two reel motor servos. The center drive is a magnetic clutch and the control signal to the clutch is supplied by UNIVAC. The tape around the center drive hub is isolated from the tape reels by two loops of tape. The reel servos are controlled by loop size detectors.

The mylar spacer used on UNISERVO I, has been eliminated on UNISERVO II to accommodate the higher pulse writing density. A new hard surface to minimize head wear is being provided on UNISERVO II.

Standard Magnetic Head. The standard magnetic head reads from or records in 8 channels. Seven of the channels are used for the 7-pulse code of the UNIVAC System and the 8th channel is a sprocket channel.

Tape Speed. 100 inches per second (nominal). Tape Packing Density 120 characters/inch.

Magnetic Clutch. UNISERVO II is equipped with a magnetic clutch which provides the following:

Start-Stop time of 5 milliseconds maximum.

Reading or writing speed of 51 milliseconds for 720 characters (51 ms maximum to start, read 1 block, and stop).

Rewind of any number of UNISERVOS, up to and including 16, simultaneously.

Safety Switches. The UNISERVO is fully equipped with safety switches which apply brakes to the reels if either of the 2 loops exceeds the prescribed length.

Control. The control of a UNISERVO is maintained by UNIVAC and exercised during a program by the following types of instructions:

Read Forward
Read Backward
Record at high pulse density
Record at low pulse density
Rewind without interlock
Rewind with interlock

Connection to UNIVAC. As many as 16 UNISERVOS may be connected to UNIVAC II at any one time. The connection is made by means of a sectional trough on the top of the line of UNISERVOS and continuing from the first UNISERVO of the line to one corner of UNIVAC. UNISERVOS may be electrically interchanged without affecting the program.

Power Requirements

The main power for the UNISERVOS is supplied by UNIVAC.

OUTPUT

Media	Speed
Magnetic Tape (UNISERVO II)	20, 12.4, or 5 Kc digit rate
Uniprinter	10 char/sec (20 char/in density)
High Speed Printer	600 lines/min (130 char/line, maximum)
Tape to Card Converter	120 cards/min (80 col cards)
Magnetic Tape to Paper Tape Conversion	60 char/sec (5, 6 or 7 channel)
Magnetic Tape to Magnetic Tape Transrecorder	90 char/sec (Speed dependent upon communication facilities)

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	5,200
Tube types	20
Crystal diodes	18,000
Magnetic cores	184,000
Transistors	1,200
Separate cabinets	4

Above figures are approximate and do not include input-output devices.

CHECKING FEATURES

Checking Circuits

Whenever feasible, registers and other circuits appear in duplicate. Their contents are continuously compared so that inconsistencies between the data in the identical units give an indication of faulty operation, and stall the Computer. At this point, the instruction may be repeated.

The pulse code used in the UNIVAC System is so designed that all characters contain an odd number of pulses. At several strategic points within UNIVAC, every character is checked for an odd number of pulses. An indication is given whenever an even number of pulses is detected, and the Computer stalls. Other types of checking circuits cause UNIVAC to stall when other types of errors occur.

An error stop occurs if reference to a non-existent memory address is attempted.

An odd-even error in the transfer rI to rM will result in a transfer stop and the location of the error (rI address) will be indicated.

The 720 character count will be displayed on a modulus 100 counter.

"All ones" checker. In addition to the parity bits check on the High Speed Bus, a second checker establishes that the invalid "all ones" character is not inadvertently created by a system fault.

Input and output checkers also detect the invalid "all ones" character.

Built-in checking features are contained in the Card-to-Tape Converter, the Tape-to-Card Converter and the High Speed Printer.

Fusing

UNIVAC is completely fused in order that faults may be isolated. Each bay has its own set of fuses in addition to main fuses on all DC and AC potentials. If a fuse blows, power is shut off and an indicator circuit shows in which bay the blown fuse is located, and a "flag" indicates the specific fuse.

Voltage Monitoring

An automatic voltage monitoring system continuously monitors all critical DC potentials giving an alarm if any moves outside the prescribed limits.

POWER, SPACE AND WEIGHT

UNIVAC has a separate power supply unit. The UNIVAC II is designed to operate from a power service of 480 volts, 208 volts or 240 volts, three phase, 60 cycle. The system voltage must be specified in advance in order that the switch gear and 75 KVA transformer listed below may be properly supplied.

Power Requirement:

	KW	KVA	
Motor Generator	47.3	59.2	0.8 PF
Heaters	45.0	45.0	
Blower Motor	6.1	7.65	0.8 PF
Standby, etc.	2.0	2.0	
UNISERVO 16 x 1.5 KW	24.0	30.0	0.8 PF
	124.4	143.85	

UNIVAC II Power System

The electrical power system for UNIVAC II Central Computer and UNISERVOS consists of a packaged switchgear unit, a 75 KVA transformer, a 400 cycle motor generator set and a power supply unit. The power and control installation for the chilled water system and the peripheral equipment are discussed below. Wiring between units of the System is to be done by the user.

Switchgear. The switchgear unit controls the incoming power, the motor generator set supply and 400 cycle output circuit, the filament power and UNISERVO power, and it is the center of all power control circuits. The main line circuit breaker will be supplied according to the system voltage. The motor starter will always be supplied for 480 volts. Dimensions: 8 ft 4 in wide; 30 in deep; 6 ft high.

75 KVA Transformer. A 75 KVA transformer, air cooled type, is supplied for mounting by the customer. If the system voltage is 480 volts the transformer will be 480/208 and connected between the main line circuit breaker and the filament power circuit breaker. If the system voltage is 208 volts the transformer will be 208/480 and connected between the main line circuit breaker and the motor circuit breaker. If the system voltage is 240 volts the transformer will be 240/480 and connected between the main line circuit breaker and the motor circuit breaker.

Motor Generator Set. The motor generator set consists of a 75 HP motor and two 25 KVA, 0.9 power factor 400 cycle generators. The motor is served by 480 volts, 3 phase from the switchgear. The 400 cycle output is controlled by electrically operated circuit breakers in the switchgear. Control of 400 cycle voltage and excitation for the generators is by the exciter regulator units in the switchgear.

Base 93 in long x 24 in
Overall 104-1/8 in long x 29 in
Area - 15.8 sq. ft.
Floor Loading - 284 lbs./sq. ft.

Space Requirements

	Approximate Dimensions
Height	102-9/16 in.
Width	171-3/8 in.
Depth	94-3/4 in.
Working Space	16 ft. x 22 in.
Weight	16,000 lbs.

UNIVAC contains thirteen bays of chassis. These bays are arranged in a structure resembling a letter "C". There are two bays at each end, five bays along one side and four bays and a door allowing access to the interior of UNIVAC along the other side.

Each bay contains three-tiered sections. Each section contains twelve removable or plug-in type chassis. The chassis in each bay are accessible through doors which make up the casework. The core storage sections, however, contain 36 printed circuit chassis.

The inter-wiring between chassis is on the back boards of the sections and bays and is accessible from inside UNIVAC.

Cooling System Requirements. The heat generated by the 5,200 vacuum tubes and the electronic components requires a cooling system. The Central Computer, UNISERVOS and Power Supply are cooled by a circulating chilled water system. 130 gallons per minute of 50° water are required. A three way mixing valve with controls and a circulating pump are required for the Central Computer and UNISERVOS. The Power Supply Unit contains its own control. Water connections for the Power Supply may enter the cabinet either at the top or bottom. Water connections for the Central Computer and the UNISERVOS are at the sides near the floor and the piping may be run either on the ceiling or below the floor.

Refrigeration System Requirements. The Central Computer, UNISERVOS, and Power Supply Units require 35 Tons of refrigeration.

PRODUCTION RECORD

Delivery time 18 Months

COST, PRICE AND RENTAL RATE

Description	Base Monthly Rental 1 Shift 5 Day Week	Outright Sale Price F.O.B. Factory
UNIVAC II Central Computer with Power Supply and Supervisory Control Desk	$18,540.00	$970,000.00
UNISERVO II	450.00	20,000.00
UNIPRINTER	390.00	22,000.00
Extra Dolly Assembly for UNIPRINTER	122.50	7,000.00
UNITYPER II	90.00	4,500.00
VERIFIER	NOT CURRENTLY AVAILABLE	
HIGH SPEED PRINTER	3,300.00	185,000.00
CARD-TO-TAPE UNIT with 47 Character Code	2,520.00	142,100.00
CARD-TO-TAPE UNIT with 38 Character Code	2,500.00	-----
TAPE-TO-CARD UNIT	2,300.00	130,000.00
Perforated Tape to Magnetic Tape (PTM) Converter	1,800.00	108,000.00
Magnetic Tape to Perforated Tape (MTP) Converter	1,500.00	90,000.00

The High Speed Printer and the Card-to-Tape Unit with the 47 character code requires a customer furnished voltage regulator. Prices are subject to change without notice.

Rental charges include maintenance service, spare parts and test equipment. Separate maintenance contract and maintenance advisory service contract available to purchasers of UNIVAC Systems.

PERSONNEL REQUIREMENTS

The number of engineers, technicians and operators required depends upon the equipment complement of the UNIVAC System and the shift operation.

RELIABILITY AND OPERATING EXPERIENCE

Reliability and operating experience based on the formula: (Available Operating Time minus Lost Time) divided by (Scheduled Operating Time). The cumulative performance reports for UNIVAC I Central Computers averaged 93.0% for the past year.

FUTURE PLANS

Industrial Sample

Pacific Mutual Life Insurance Company

It is planned to replace existing equipment with the UNIVAC Model II.

ADDITIONAL FEATURES AND REMARKS

GENERAL

Buffer Units

Input buffer (rI) 60 words of Core Storage. Input character rate up to 40,000 per second - dependent upon speed of UNISERVOS.

Output buffer (rO) 60 words of Core Storage. Output character rates of 20,000; 12,400; and 5,000 per second.

Transfer buffer (rW) 9 words of Core Storage. Cooperates with main memory during V and W instructions to transfer up to 9 words at 25,000 words per second. Transfer buffer (rZ) 60 words of Core Storage.

Control of Operation

UNIVAC is controlled by instructions which are recorded on tape and read into the memory. The instructions are stored in successive memory locations beginning at 0000. Two instructions may be stored in each memory location.

Simultaneous reading, writing and computation are possible due to built-in buffer units. Univac can read from one UNISERVO, write on a second and rewind all other UNISERVOS simultaneously. Unless there is another read, write or rewind instruction immediately following, UNIVAC may continue to compute while reading, writing and rewinding operations are being performed.

UNIVAC starts operating in accordance with the instructions stored in memory location 0000 and refers automatically to succeeding memory locations. Certain of the instructions read from the tapes the source data upon which the instructions operate and store the source data in the memory. Other instructions cause UNIVAC to record the results of the operations on tape.

The operation of UNIVAC is controlled by automatic sequencing. It may be interrupted by instructions that transfer the control of UNIVAC from one memory location to another memory location not in sequence. This mode of operation conserves space in the memory and requires a sub-routine to be stored only once in any part of the memory.

New Instructions

But for several minor exceptions, UNIVAC II executes all UNIVAC I instructions in exactly the same manner as UNIVAC I. Certain of these instructions, however, have been assigned new functions which serve to extend their overall flexibility. The V instruction, for example, will now transfer from one to nine words instead of merely two as was formerly the case, and the Y-Z instructions will now transfer groups of words ranging from ten to sixty in number in steps of ten words. Formerly, ten words and only ten words could be transferred when using this instruction. As a further example of the greater flexibility permitted in UNIVAC II, the extract function (or E instruction), formerly limited to register A, has been generalized so that it now covers all instructions which read out of the memory (A, B, D, L, M, N, P and S). The EF instruction permits recombination of selected characters from register A with the remaining characters of the word in memory location. Instruction A has been extended in usefulness also, and in addition, an I instruction (transfer from register L to memory) has been adopted as a standard command.

Overflow

With UNIVAC II the addition of a 1 to the control counter reading following overflow is automatic. When using UNIVAC I programs on UNIVAC II a special switch will inhibit the addition of 1 to the control counter reading following overflow and cause the 3rd instruction digit to be interpreted in the memory switch as a decimal zero regardless of its actual value. Therefore, in UNIVAC I programs where the 2nd and 3rd instruction digits have been used for overflow control, the presence of these digits will not influence the execution of the instruction.

Compatability Switch

A switch provides three circuit corrections to promote compatibility of UNIVAC I and II programs. Any other incompatibility will require program corrections. With the switch in position to handle UNIVAC I programs, the UNIVAC II will treat the 3rd instruction digit as zero, for V, W, Z and Y instructions, treat the 2nd instruction digit as zero and restore the UNIVAC I mode of overflow action on the Control Counter.

Tape Handling Operations

As many as 16 UNISERVOS may be connected to UNIVAC by a metallic duct carrying the necessary cables. UNIVAC can read from tapes mounted on these UNISERVOS with the tapes moving forward or backward. UNIVAC can record on a tape moving forward. It can read from one UNISERVO, write on a second and rewind all other UNISERVOS simultaneously. Unless there is another read, write or rewind instruction immediately following, UNIVAC may continue to compute while the reading, writing and rewinding operations are being performed.

Tape recording for UNIVAC II must be done according to the following:

Spacing per block (with 1 in between blocks)	4.60 in (3.60 in per block)
Pulse Density per inch	200 nominal
Blocks per reel	4,000 (metallic) nominal
Read time per block	51 msec. minimum (metallic and mylar)
Per Reel	3.4 Minutes minimum (metallic)
Rewind time per reel	3.1 Minutes (metallic)
Feet Utilized	1,535 ft (metallic) 2,400 ft (mylar

PROGRAMMING SPECIFICATIONS

General

Library and compiler routines for mathematical and commercial use, and service routines for maintenance uses, are available to the customer.

Modified or Added Instructions

I instruction providing for transfer of information from register rL to memory.

Field selection as specified by a second instruction digit F. For the instructions A, B, D, L, M, N, P and S it operates so that the word

transferred from memory location M contains only those digits from the columns of "m" which correspond to the columns in register F containing "odd" characters. The remaining column positions of the word, transferred from "m" to the receiving register contain decimal zeros.

The EFm instruction permits insertion into a word in memory location "m" of the characters in those columns of register A which correspond to the columns containing "odd" characters in register F. "Odd" characters in the UNIVAC code have a binary zero in the least significant binary position. rA will also contain the complete word which is restored at memory location "m".

Add to memory. The add to memory instruction is effected by adding a special designator (H) in the 2nd digit position of the A instruction. It results in the execution of an A instruction followed by an automatic H instruction. Register rA will retain the total (rX + rA) at the conclusion of the add to memory instruction. An equivalent subtractive operation is performed by the SH instruction.

Multiple Word Transfer

The Vn_1m_1, Wn_2m_2 word transfer instructions transfer one to nine words as specified by the numeric (n) appearing in the second digit position. Register rW provides the transfer storage. The transfer is made using V and W instructions as for UNIVAC I except that no reversal of position occurs in a 2 word transfer as may in UNIVAC I. Note also that if the second digits of the V and W instructions are not equal special transfers result. If $n_1 > n_2$. The first $(n_1 - n_2)$ words transferred from m_1 to rW are not transferred from rW to m_2. If $n_1 < n_2$. The $(n_2 - n_1)$ words transferred to rW by a previous V instruction are transferred to m_2 followed by the n_1 words of the current V instruction. When n = 0 the instruction will be processed as a skip instruction.

The Yn_1m_1, Zn_2m_2 pair of instructions permits the transfer of groups of 10, 20, 30, 40, 50, or 60 words as designated by a numeric (1 through 6) in the second digit position of the instruction. The Y, Z instructions use rZ as transfer storage. If the second digits of the Y and Z instructions are not equal, special transfers result. If $n_1 > n_2$. The first $(n_1 - n_2)$ tens of words transferred from M_1 to rZ will not be transferred to M_2. If $n_1 < n_2$. The $(n_2 - n_1)$ tens of words transferred to rZ by a previous Y instruction are transferred to m_2, followed by the n_1 tens of words of the current Y instruction. When n = 0, 7, 8, or 9, the instruction will be processed as a skip instruction.

Tape Writing Density Controls

5nm instruction causes writing of 200 pulses per inch except that manual countermanding pushbuttons will be provided to select one or more UNISERVOS on which the 5nm instruction will be interpreted as calling for a 124 pulse per inch writing density. These manual pushbuttons will be in addition to those available for block subdivision and delta (.) second digit decoding of in/out instructions.

7nm instruction causes writing at 50 pulses per inch. Block subdivision controls will operate as in UNIVAC I with all densities. Block divisions (space between blocks) will be 1 inch except for the 124 ppi density. This will be 2.4 inches.

Memory Clear

A protected switch will provide for memory clear (rM) to decimal zero. Register rM will clear on read-in.

Buffer Register Clear

Registers rO, rI, rZ and rW clear <u>only</u> on read-in.

Instruction Execution Time

Basic machine cycle is reduced from four to three cycles (α cycle is omitted).

All instructions are performed at minimum latency rates.

UNIVAC 60

Universal Automatic Computer Model 60

MANUFACTURER

Sperry-Rand Corporation
Remington Rand Univac Division

APPLICATIONS

Business and scientific data processing.

Industrial Sample
Bureau of Mines
Scientific calculations.

NUMERICAL SYSTEM

Internal number system	Biquinary, decimal, and alphabetic
Decimal digits per word	Variable from 1 to 10 digits plus sign
Number of digits per instruction	Not internally programmed
Arithmetic system	Fixed point, variable
Instruction type	Three address
Number range	Variable

ARITHMETIC UNIT

The timing is synchronous.

The operation is sequential.

One full cycle on the computer requires 400 milliseconds. 75 milliseconds are required for feeding, sensing, and punching the card. 325 remain for calculation. If the calculation requires more than 325 milliseconds, the computer automatically waits until the end of calculation signal has been given before punching, feeding and sensing the next card. Buffing is not used.

The purpose of the electronic computing unit is:

To connect card columns for sensing, punching, and reproducing.

To set constant values.

To set the machine for the operations to be performed and the sequence of the operations.

To perform all calculations with an electronic accumulator.

To store the values calculated.

To check each arithmetic step.

To visibly read all elements of all arithmetic steps.

The arithmetic unit uses floating point but storage uses a selected fixed point.

The biquinary code is as follows:

Digits	Biquinary Code
0	0
1	1,0
2	2
3	1,2
4	4
5	1,4
6	6
7	1,6
8	8
9	1,8

Alphabetic characters are wired to become two or three numeric characters at the input level. For example, an A becomes 111, a C becomes 99. See STORAGE.

Negative numbers are carried as the tens complement of the number. A negative sign indicates that the value is negative instead of positive.

The location of the decimal point is varisble and may be arbitrarily assigned to each input and storage location.

There is only one arithmetic register, called the accumulator. It has a capacity of 22 digits. The computation of each program step takes place within the accumulator. For example, an addition would be performed as follows:

1) Clear the accumulator
2) Enter the first value according to its decimal location.
3) Enter the decimal location of the second value.
4) Shift the first value to align with the decimal of the second value.
5) Enter the second value, performing the process of addition.
6) Enter the decimal location of the result storage and shift the result to align with it.
7) Place the result in the result storage.
8) Subtract value two from the result.
9) Subtract value one from the result of 8).
10) Check to be certain that the accumulator is zero.

Each step is balanced to zero before the computer continues to the next step. The four possible steps and the method used to check each are:

Step	Proof
Value 1 + Value 2 = Result	Result - Value 2 - Value 1 = 0
Value 1 - Value 2 = Result	Result + Value 2 - Value 1 = 0
Value 1 x Value 2 = Result	Result ÷ Value 2 - Value 1 = 0
Value 1 ÷ Value 2 = Result	Result x Value 2 - Value 1 = 0

The computer will not continue unless the step checks to zero.

The computer has automatic decimal alignment. Programs have been developed which use a floating point method, although the computer is operating with automatic alignment.

Scaling may be accomplished by multiplying or dividing the number by a factor, or changing the decimal location by a selector.

An overflow stops the computer.

The remainder is dropped off in the final result, although it is used during the proof of the step.

The round-off of sums, differences, products and quotients depends on the decimal location of the result storage. The accumulator unit has 22 posi-

tions, as follows:

M Sections

1 2 3 4 5 6 7 8 9 10 11

A Sections

11 10 9 8 7 6 5 4 3 2 1

All results are placed in storage from positions 10-1 of the A Section. Each storage is assigned a decimal location for the program involved. A location of 4/3 would mean that three places are to be retained in the result following the decimal. If the result of any step-addition, subtraction, multiplication, or division contains more places than those allowed in the result storage, the additional digits will be located in the M section, beginning in column 11. When the result is placed in the storage unit, they are thereby rounded off. Rounding off requires an addition step.

Comparisons are made by two subtraction steps. Each step has two branchings, plus and minus. Zero is always considered plus. The first step of the two would be value 1 minus value 2. If the result is minus, value 2 is greater than value 1. If the result is plus, value 1 is equal to or greater than value 2. The second step would be value 2 minus value 1. If the result is minus, value 1 is greater than value 2. If the result is plus, value 1 and value 2 are equal.

Control Unit

The computer has no stored program.

The input-output panel indicates the card fields to be sensed, punched and reproduced. The constant program panel indicates the program to be followed, step by step, and the constant values which will be used.

The computer operates on a three address system. Each program step, which is externally wired, contains the following six instructions, in the following form:

V1 Pr V2 = R - BR + BR

V1	The storage, constant, or card-read field to be used as value 1.
Pr	The process (+, -, x, ÷)
V2	The storage, constant, or card-read field to be used as value 2.
R	The storage into which the result is to be placed.
-BR	The next step or operational function to be performed if the sign of the result is minus.
+BR	The next step or operational function to be performed if the sign of the result is plus.

Breakpoint stops may be included in the program. At the plus or minus branching of any step an instruction requiring a division of 0 by 0 or a number by 0 may be given. Both of these steps cause the computer to stop, and a corresponding light is lit.

The electronic computing unit contains a control panel with a dial. Each step may be dialed in turn. For each step value 1, value 2, the result, the process, the branching, all decimal locations and whether the step checks may be read from the panel.

The computer will stop under the following conditions:

1) Empty feeding magazine.
2) Full receiving magazine or chip pan.
3) Sensing of alpha
4) Zero divided by zero
5) Number divided by zero
6) Incorrect voltage
7) Temperature too high
8) Overflow condition on a step
9) Failure to check.

STORAGE

Media	Words
Vacuum Tube	6

The code system used is biquinary. Each column of storage contains 5 tubes, representing the digits 1, 3, 5, 7, and 9. There is no tube for zero, which is represented by the fact that none of the tubes are lit. An odd digit is represented by the corresponding tube 1, 3, 5, 7, or 9. An even digit is represented by the odd digit which is immediately lower in value, plus the 9. Therefore, a 2 is 1 plus 9, a 4 is 3 plus 9, a 6 is 5 plus 9 and an 8 is 7 plus 9.

The word length in storage is ten digits (columns) plus sign.

Alphabetic characters require five columns of storage for two characters, three columns for a single character. A single word can therefore contain 4 columns of alphabetic characters as opposed to 10 columns of numeric characters.

Storage is actually part of the computing unit. There is no buffing unit.

INPUT

Media

Card Sensing-Punching Unit

The purpose of the Card Sensing-Punching unit is to sense and punch tabulating cards and to indicate and control general machine operation.

A maximum of 36 words (card read fields) may be used in one program. Up to 60 digits may be divided as necessary among 36 words. The sign of each field is in addition to the 60 digits.

A 90 column punched card code is used. This is the same biquinary code as is used in the storage unit. All 36 words are sensed simultaneously on one cycle. Five columns are required to sense two columns of alphabetic information; three columns are required to sense one column of alphabetic information.

OUTPUT

Media

Card Sensing-Punching Unit

CIRCUIT ELEMENTS ENTIRE SYSTEM

Bureau of Mines

Tubes	2,148
Separate cabinets	2

CHECKING FEATURES

Bureau of Mines

All operations internally checked by reverse operation.

POWER, SPACE AND WEIGHT

Card Sensing-Punching Unit

The Card Sensing-Punching Unit measures 2 ft. 11 in. long, 2 ft. 6 in. wide, 5 ft. 9 in. high, and weighs 1,020 lbs. This unit may operate from any of the following power services:

a) 208 volt single phase, 4 wire, 60 cycles
b) 230 volt single phase, 3 wire, 60 cycles
c) 220 volt single phase, 3 wire, 60 cycles
d) 120 volt three phase, 4 wire, 60 cycles

e) 220 volt three phase, 3 wire, 60 cycles
f) 220 volt three phase wye system, 50 cycles.

The Electronic Computing Unit measures 7 ft. 2 in. wide, 2 ft. 6 in. deep, 5 ft. 9 in. high and weighs 2,210 lbs.

The unit operates from the same power sources as the Card Sensing-Punching Unit.

The unit is ventilated by fan forced room air.

Bureau of Mines
System requires 138 cu. ft. and 25.2 sq. ft. and weighs 3,230 lbs.

COST, PRICE AND RENTAL RATE

Approximate cost of basic system $75,000.
Rental rate of basic system, standard shift $690 - $1,050/month.
Second shift operation charge is an additional 50% of the Standard Rate.
Third shift operation charge is an additional 50% of the Standard Rate.
Maintenance, including cost of parts, except due to customer negligence, is included in the rental rates above.
The charge for maintenance to a customer who purchases, rather than leases, but who requires maintenance operations is $3,750 per year for a machine less than 6 years old and $4,500 for a machine 6 to 11 years old.
Customer's personnel are trained at no extra charge.

Bureau of Mines
Rental rate is $690 per month. Maximum capacity is $1,275 per month.

PERSONNEL REQUIREMENTS

Bureau of Mines
One 8 Hour shift requires 2 technician-operators.

ADDITIONAL FEATURES AND REMARKS

The UNIVAC 60 and UNIVAC 120 Systems are similar, except with regard to such items as storage capacity, price, rental rate, and service costs.

INSTALLATIONS

Industrial Sample
U. S. Bureau of Mines
4800 Forbes Street
Pittsburgh 13, Pennsylvania

UNIVAC 120

Universal Automatic Computer Model 120

MANUFACTURER

Sperry-Rand Corporation
Remington Rand Univac Division

APPLICATIONS

Business and scientific data processing

Government Sample

U. S. Army Ordnance Corps - Frankford Arsenal
System is used in the following fields:

Field Service National Stock Accounting - Fire Control Instruments
Gage Accounting
Production Control
Payroll Accounting
Internal Arsenal Accounting including Fiscal, Budget, Property, and Cost Accounting.
Scientific Computations in the field of fluid, dynamics, interior ballistics, theoretical physics and certain aspects of nuclear physics.

U. S. Army Ordnance Corps - Watertown Arsenal
System is utilized for punched card tabulating and functions in payroll, cost accounting and job scheduling extensions.

Industrial Sample

San Francisco Stock Exchange
Computation of money values and Federal Tax on stock purchase and sales tickets (clearing statements). Computation of values and tax is accomplished simultaneously at the rate of 150 cards/minute.

NUMERICAL SYSTEM

Internal number system	Biquinary, decimal, and alphabetic
Decimal digits per word	Variable from 1 to 10 digits plus sign
Number of digits per instruction	Not internally programmed
Arithmetic system	Fixed point, variable
Instruction type	Three address
Number range	Variable

ARITHMETIC UNIT

The timing is synchronous.

The operation is sequential.

One full cycle on the computer requires 400 milliseconds. 75 milliseconds are required for feeding, sensing, and punching the card. 325 remain for calculation. If the calculation requires more than 325 milliseconds, the computer automatically waits until the end of calculation signal has been given before punching, feeding and sensing the next card. Buffing is not used.

The purpose of the electronic computing unit is:
To connect card columns for sensing, punching, and reproducing.
To set constant values.
To set the machine for the operations to be performed and the sequence of the operations.
To perform all calculations with an electronic accumulator.
To store the values calculated.
To check each arithmetic step.
To visibly read all elements of all arithmetic steps.

The arithmetic unit uses floating point but storage uses a selected fixed point.

The biquinary code is as follows:

Digits	Biquinary Code
0	0
1	1,0
2	2
3	1,2
4	4
5	1,4
6	6
7	1,6
8	8
9	1,8

Alphabetic characters are wired to become two or three numeric characters at the input level. For example, an A becomes 111, a C becomes 99. See STORAGE.

Negative numbers are carried as the tens complement of the number. A negative sign indicates that the value is negative instead of positive.

The location of the decimal point is variable and may be arbitrarily assigned to each input and storage location.

There is only one arithmetic register, called the accumulator. It has a capacity of 22 digits. The computation of each program step takes place within the accumulator. For example, an addition would be performed as follows:

1) Clear the accumulator
2) Enter the first value according to its decimal location.
3) Enter the decimal location of the second value.
4) Shift the first value to align with the decimal of the second value.
5) Enter the second value, performing the process of addition.
6) Enter the decimal location of the result storage and shift the result to align with it.
7) Place the result in the result storage.
8) Subtract value two from the result.
9) Subtract value one from the result of 8).
10) Check to be certain that the accumulator is zero.

Each step is balanced to zero before the computer continues to the next step. The four possible steps and the method used to check each are:

Step	Proof
Value 1 + Value 2 = Result	Result - Value 2 - Value 1 = 0

Value 1 - Value 2 = Result	Result + Value 2 - Value 1 + 0
Value 1 x Value 2 = Result	Result ÷ Value 2 - Value 1 = 0
Value 1 ÷ Value 2 = Result	Result x Value 2 - Value 1 = 0

The computer will not continue unless the step checks to zero.

The computer has automatic decimal alignment. Programs have been developed which use a floating point method, although the computer is operating with automatic alignment.

Scaling may be accomplished by multiplying or dividing the number by a factor, or changing the decimal location by a selector.

An overflow stops the computer.

The remainder is dropped off in the final result, although it is used during the proof of the step.

The round-off of sums, differences, products and quotients depends on the decimal location of the result storage. The accumulator unit has 22 positions, as follows:

M Sections

1 2 3 4 5 6 7 8 9 10 11

A Sections

11 10 9 8 7 6 5 4 3 2 1

All results are placed in storage from positions 10-1 of the A Section. Each storage is assigned a decimal location for the program involved. A location of 4/3 would mean that three places are to be retained in the result following the decimal. If the result of any step-addition, subtraction multiplication, or division contains more places than those allowed in the result storage, the additional digits will be located in the M section, beginning in column 11. When the result is placed in the storage unit, they are thereby rounded off. Rounding off requires an addition step.

Comparisons are made by two subtraction steps. Each step has two branchings, plus and minus. Zero is always considered plus. The first step of the two would be value 1 minus value 2. If the result is minus, value 2 is greater than value 1. If the result is plus, value 1 is equal to or greater than value 2. The second step would be value 2 minus value 1. If the result is minus, value 1 is greater than value 2. If the result is plus, value 1 and value 2 are equal.

Control Unit

The computer has no stored program.

The input-output panel indicates the card fields to be sensed, punched and reproduced. The constant program panel indicates the program to be followed, step by step, and the constant values which will be used.

The computer operates on a three address system. Each program step, which is externally wired, contains the following six instructions, in the following form:

V1 Pr V2 = R - Br. + Br.

V1	The storage, constant, or card-read field to be used as value 1.
Pr	The process (+, -, x, ÷)
V2	The storage, constant, or card-read field to be used as value 2.
R	The storage into which the result is to be placed.
-BR	The next step or operational function to be performed if the sign of the result is minus.
+BR	The next step or operational function to be performed if the sign of the result is plus.

Breakpoint stops may be included in the program. At the plus or minus branching of any step an instruction requiring a division of 0 by 0 or a number by 0 may be given. Both of these steps cause the computer to stop, and a corresponding light is lit.

The electronic computing unit contains a control panel with a dial. Each step may be dialed in turn. For each step value 1, value 2, the result, the process, the branching, all decimal locations and whether the step checks may be read from the panel.

The computer will stop under the following conditions:

1) Empty feeding magazine.
2) Full receiving magazine or chip pan.
3) Sensing of alpha.
4) Zero divided by zero
5) Number divided by zero
6) Incorrect voltage
7) Temperature too high
8) Overflow condition on a step
9) Failure to check.

STORAGE

Media	Words
Vacuum Tube	12

The code system used is biquinary. Each column of storage contains 5 tubes, representing the digits 1, 3, 5, 7, and 9. There is no tube for zero, which is represented by the fact that none of the tubes are lit. An odd digit is represented by the corresponding tube 1, 3, 5, 7, and 9. An even digit is represented by the odd digit which is immediately lower in value, plus the 9. Therefore, a 2 is 1 plus 9, a 4 is 3 plus 9, a 6 is 5 plus 9 and an 8 is 7 plus 9.

The word length in storage is ten digits (columns) plus sign.

Alphabetic characters require five columns of storage for two characters, three columns for a single character. A single word can therefore contain 4 columns of alphabetic characters as opposed to 10 columns of numeric characters.

Storage is actually part of the computing unit. There is no buffing unit.

INPUT

Media

Card Sensing-Punching Unit

The purpose of the Card Sensing-Punching unit is to sense and punch tabulating cards and to indicate and control general machine operation.

A maximum of 36 words (card read fields) may be used in one program. Up to 120 digits may be divided as necessary among 36 words. The sign of each field is in addition to the 120 digits.

A 90 column punched card code is used. This is the same biquinary code as is used in the storage unit. All 36 words are sensed simultaneously on one cycle. Five columns are required to sense two columns of alphabetic information; three columns are required to sense one column of alphabetic information.

OUTPUT

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COST, PRICE AND RENTAL RATE

Approximate cost of basic system $97,500.
Rental Rate of basic system, standard shift $1,000 - $1,275.
Second shift operation charge is an additional 50% of the Standard Rate.
Third shift operation charge is an additional 50% of the Standard Rate.
Maintenance, including cost of parts, except due to customer negligence, is included in the rental rates above.
The charge for maintenance to a customer who purchases, rather than leases, but who requires maintenance operations is $4,875 per year for a machine less than 6 years old and $5,850 per year for a machine 6 to 11 years old.
Customer's personnel are trained at no extra charge.

PERSONNEL REQUIREMENTS

Industrial Sample
San Francisco Stock Exchange
One 8 Hour shift requires one operator.

RELIABILITY AND OPERATING EXPERIENCE

Industrial Sample
San Francisco Stock Exchange
Operating ratio (Good/Attempted to run) 0.96

INSTALLATIONS

Government Sample
Frankford Arsenal
Philadelphia, Pennsylvania

Watertown Arsenal
Watertown 72, Massachusetts

Industrial Sample
San Francisco Stock Exchange
301 Pine Street
San Francisco, California

ADDITIONAL FEATURES AND REMARKS

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