UNIVAC 9480 SYSTEM

SYSTEM DESCRIPTION

SPERRY UNIVAC
COMPUTER SYSTEMS

UP-8000

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PRINTED IN U.S.A.

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1. INTRODUCTION

1.1. UNIVAC 9000 SERIES COMPUTER FAMILY

The UNIVAC 9000 Series is a computer family that embodies many bold, new design concepts in a unified and low-cost line of data processing equipment. The UNIVAC 9200 processor is a small, card-oriented data processing system with a basic internal storage capacity of 8,192 bytes. The 9200 System can be expanded to the higher performance card- or tape-oriented 9300 System. From this, it is easy to make the transition to the still more powerful tape- or disc-oriented UNIVAC 9480 System shown in Figure 1–1, which has a basic storage capacity of 65,536 bytes with a storage cycle of 600 nanoseconds per two bytes.

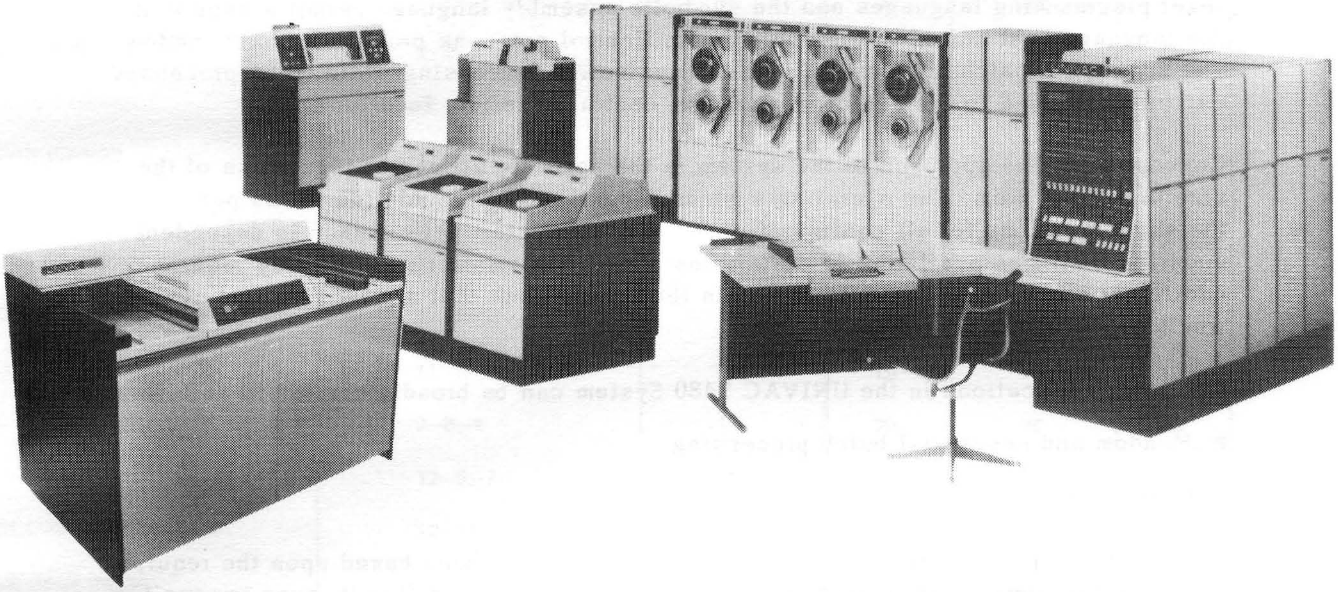


Figure 1–1. The UNIVAC 9480 System

Equipment expansions to larger systems or different configurations of the same system are compatible within the UNIVAC 9480 System. This highly desirable hardware compatibility also applies to software in the UNIVAC 9480 System. Programming compatibility within the wide range of data processing capability offered by the UNIVAC 9480 System allows maximum freedom for growth and expansion into larger equipment configurations.

The equipment and programming compatibility features of the UNIVAC 9000 Series allow the entire series to be thought of as essentially one large computer system whose size and configuration are adjustable over a wide range of data processing applications. From the user's point of view, this range of choice is the most economical because a system can always be selected to fit the needs of an installation. Costly time lags where the computing system can be ahead or behind the demands of the user are thereby eliminated.

The UNIVAC 9480 System offers speed, reliability, modularity, compactness, and, most significantly, economy to the user requiring random or sequential batch processing, or communications processing.

The operating system for the UNIVAC 9480 System consists of a comprehensive set of programming aids, control programs and utility services. It is modular in design to fulfill a wide range of data processing requirements. The user may write programs in the common higher level programming languages, COBOL and FORTRAN. These higher level programming languages and the symbolic assembly language permit a choice of the language best suited to the application. Control programs provide for both random and sequential batch processing, and communication processing. Data to be processed can be introduced to the system from either central or remote locations.

Conceptually, the approach to the system is the same for all users, regardless of the size of their system. The operating system is designed to provide (as far as possible) the same functions for all configurations; however, system performance is dependent upon the facilities available. In certain instances, the smaller systems may require additional passes over the data to obtain the same output that a more powerful system would produce in a single pass.

Computer applications in the UNIVAC 9480 System can be broadly classified as follows:

- Random and sequential batch processing
- Communications-oriented processing

In the past, the selection of data processing systems has been based upon the requirements of the primary application. In many cases, it has been difficult, even impossible, to acquire a system that could handle the broad range of potential applications. Until the present time, only the most expensive and sophisticated systems could process more than one category of application without degrading performance. The UNIVAC 9480 System can perform both of these application categories efficiently. Programs can be performed concurrently while sharing access to all facilities of this system.

CHARACTERISTICS

SYSTEM ORIENTATION	Tape/disc
DATA ORGANIZATION	8-bit byte
BASIC INTERNAL STORAGE	65,536 bytes
MAXIMUM INTERNAL STORAGE	262,144 bytes
STORAGE CYCLE TIME	600 nanoseconds/2 bytes
ADD (BINARY) INSTRUCTION TIME (TWO 32-BIT WORDS)	6 microseconds
DECIMAL MULTIPLY AND DIVIDE INSTRUCTIONS	Standard
EDIT INSTRUCTION	Standard
CARD READER	600 cpm or 1000 cpm
CARD PUNCH	250 cpm
READ/PUNCH	Optional
PRINTER	900 to 1100 lpm, 1200 to 1600 lpm, or 840, 1000, 2000 lpm
MAGNETIC TAPE RATE	34,160 bytes per second to 192,000 bytes per second
NUMBER OF MULTIPLEXER CHANNELS	1
MULTIPLEXER CHANNEL RATE	85,000 bytes per second
NUMBER OF SELECTOR CHANNELS	1 standard 1 optional
SELECTOR CHANNEL RATE	333,000 bytes per second
REGISTERS	16 for problem program functions 16 for Supervisor functions
DISC STORAGE	29.176 million bytes per drive or 58.35 million bytes per drive
COMMUNICATIONS	Up to 64 duplex lines

1.2. GROWTH AND COMPATIBILITY

The UNIVAC 9480 System hardware and software features are at the disposal of the user to any extent he wishes. A basic system can be supplemented by many optional features to meet a wide variety of system needs.

The modular design of the UNIVAC 9480 System, coupled with its high-speed main storage and I/O architecture, provides a dependable base for future extensions. Changes in business demands, applications, programming techniques, system configuration, or new input/output devices can be readily incorporated in the UNIVAC 9480 System. This architecture extends the usefulness of the initial planning, programming, and operational procedures used with the system.

The UNIVAC 9480 System is complemented by a wide variety of disc storage, magnetic tape, communications, punched card reading and punching, and high speed printing devices. Peripheral devices are available with different speeds, capacities, and industry data compatibility to permit each user to select the most profitable combination for his application.

The multiplexer channel enables many input/output devices to concurrently transfer data to and from the central processor at a rate of 85,000 bytes per second. Two selector channels are available with the system to provide a combined data exchange capability of 666,000 bytes per second.

The UNIVAC 9480 System central processor unit makes storage available on an incremental basis. Thus, each user can select a main storage capacity to best meet his specific requirements. Main storage can be expanded to 98K, 131K, 191K, and 262K bytes.

1.3. SOFTWARE FEATURES

The principal objective of the UNIVAC 9480 System is to make the full power of the processor system available to the user to solve his processing tasks. Implicit in this objective is the need that the software system be consistent with the capabilities of a small- to medium-scale computing system. To meet this objective, UNIVAC 9400 software is used for this member of the UNIVAC 9000 Series, and software documentation will be given in the UNIVAC 9400 System Programmer Reference manuals.

The Supervisor is a part of the operating system that operates with problem programs to provide the control necessary for optimum utilization of the UNIVAC 9480 System hardware and software. By use of the Supervisor, the hardware and software systems are effectively coordinated to satisfy the requirements of a growing number of diversified applications. Problems are handled directly and promptly with as little internal bookkeeping as possible without compromising the integrity of the computing system.

1.3.1. Modularity

Functional modularity has been employed in the design of the Supervisor to ensure its adaptation to a wide range of data processing applications. The user can tailor the Supervisor to his particular applications by parameter selection and specification of the various functional modules at systems generation time.

1.3.2. Multiprogramming

Utilization of central processor unit time is maximized by multiprogramming. A Supervisor can be generated to control from one to five problem programs. In this environment, problem programs are processed concurrently in the processing system. In addition to problem programs, many of the Supervisor functions are designed as autonomous activities capable of being processed as independent programs.

The multiprogramming technique employed by the Supervisor involves the distribution of processing time to independent programs based on program priorities, time allocations, and input/output equipment utilization. Consideration of these factors by the Supervisor assures the user that the distribution of processing time is efficient and equitable.

1.4. COMMUNICATIONS

The UNIVAC 9480 System can be used for communications-oriented data processing through the use of a UNIVAC Data Communications Subsystem (DCS) and the communications adapter. Each communications subsystem is attached to the UNIVAC 9480 System central processor unit by means of one of the eight subchannels provided in the standard multiplexer channel. The communication configurations provide for any number of simplex line positions up to a maximum of 64 input and 64 output lines. In the half or full duplex mode a total of 64 lines can be accommodated.

The maximum number of remote devices that can be used with the line terminals depends upon the type of device and the volume of data to be transmitted. The use of the dial mode allows the central processor to select remote devices automatically. Thus, the number of possible remote devices is virtually unlimited.

The accuracy of transmission can be controlled through an optional parity check on all transmitted data. Either odd or even parity check can be performed for each character in a message to the central processor unit. Similarly, odd or even parity can be generated for each character transmitted. In addition, a longitudinal redundancy check may be performed for each input message and generated for each output message.

The Data Communication Subsystem is compatible with Data-Phone* Service, TWX Networks, Telex**, and Wideband.

1.5. EQUIPMENT CONFIGURATIONS

The following diagrams (Figures 1–2 to 1–5) illustrate some of the system configurations that are available on the UNIVAC 9480 System. Figure 1–2 shows the UNIVAC 9480 System central processor unit and console configuration.

STORAGE 65K BYTES TO 262K BYTES	CENTRAL PROCESSOR UNIT	ONE MULTIPLEXER CHANNEL	OPERATOR'S CONSOLE
STORAGE PROTECTION (OPTIONAL)	COMMUNICATION ADAPTER (OPTIONAL)	SELECTOR CHANNEL #1 (STANDARD)	SELECTOR CHANNEL #2 (OPTIONAL)

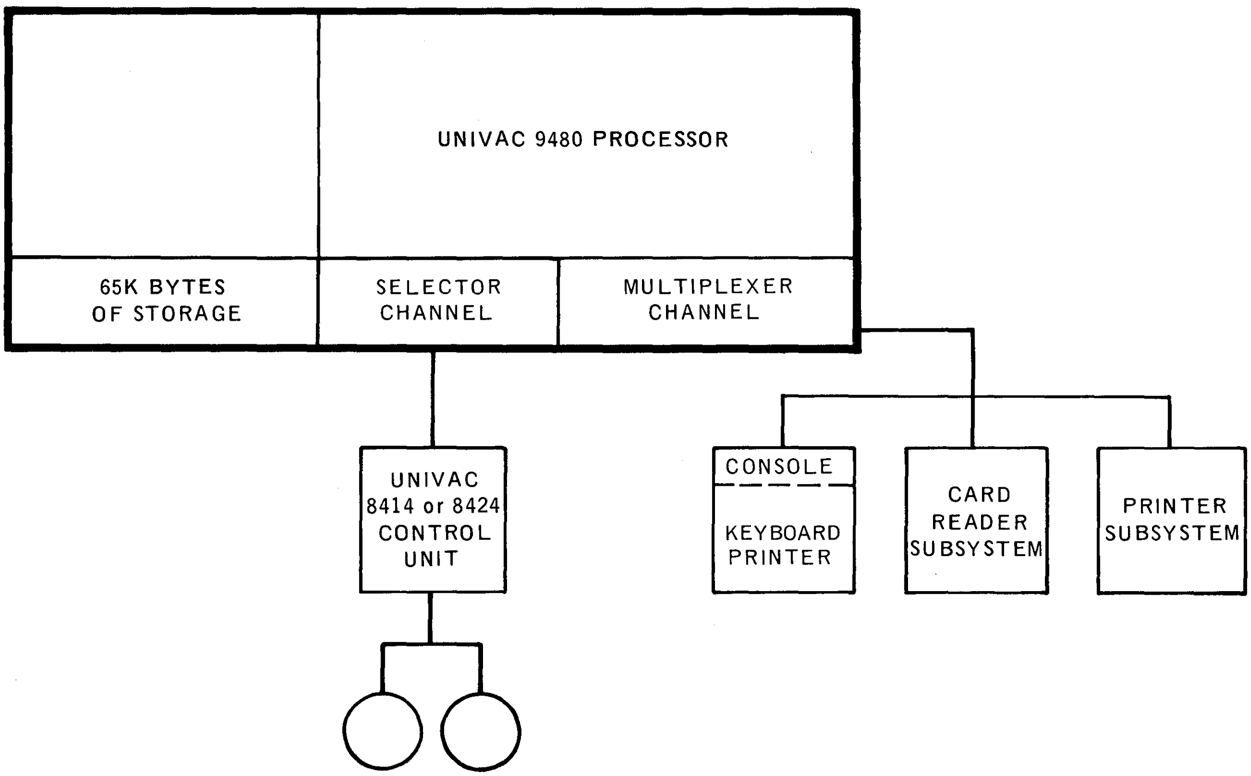
Figure 1–2. UNIVAC 9480 System Central Processor Unit and Console Configuration

*Trademark and Service Mark of A.T.& T. Co.
**Trademark of Western Union Telegraph Co.

The system configuration shown in Figure 1–3 provides a convenient transition from smaller disc-pack oriented systems. This system, as a result of the auxiliary disc storage, is suited for both scientific and business data processing. A few of the many applications possible with this system follow:

- Billing and accounts receivable
- Savings and loan
- Statistical analysis
- Payroll and labor distribution
- Production control
- Quality control
- Personnel analysis
- Engineering design
- Inventory control

Small files can be more efficiently referenced and maintained with the disc storage. Program libraries, as well as frequently used files, can always be available on disc and the system can be used for short irregularly scheduled runs concurrently with other processing.



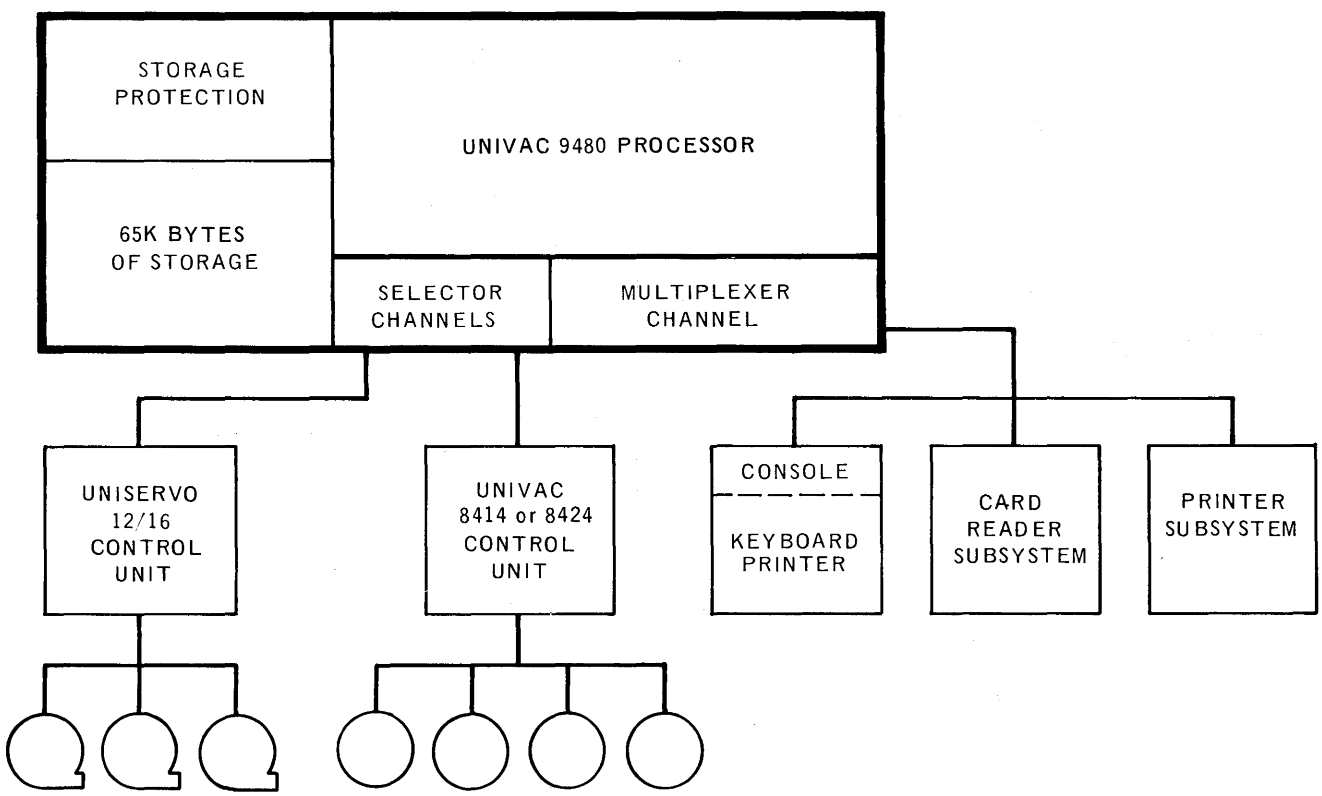
- 65,536 BYTES OF STORAGE
- CARD READER SUBSYSTEM
- PRINTER SUBSYSTEM (132 position)
- UNIVAC 8414 or 8424 CONTROL UNIT WITH TWO SPINDLES

Figure 1–3. UNIVAC 9480 System Basic Configuration (Disc Subsystem)

The system configuration shown in Figure 1–4 combines the advantages of the tape and the disc subsystems. A few of the many applications possible with this system follow:

- Billing and accounts receivable
- Insurance
- Pension
- Order entry
- Personnel statistics
- Sales statistics
- Production control
- Engineering design
- Inventory control

The broad flexibility of disc-stored program libraries and control stream technique provide software and system organization that has been previously available only in the largest computer systems. The tape and disc combinations are well suited for applications where there are large master files having a high percentage of updates each cycle. Also, the use of tapes saves disc-pack cost and provides a fast method of sequential processing. The discs provide program overlays, table storage, small file storage, and the flexibility of the disc-oriented operating system.



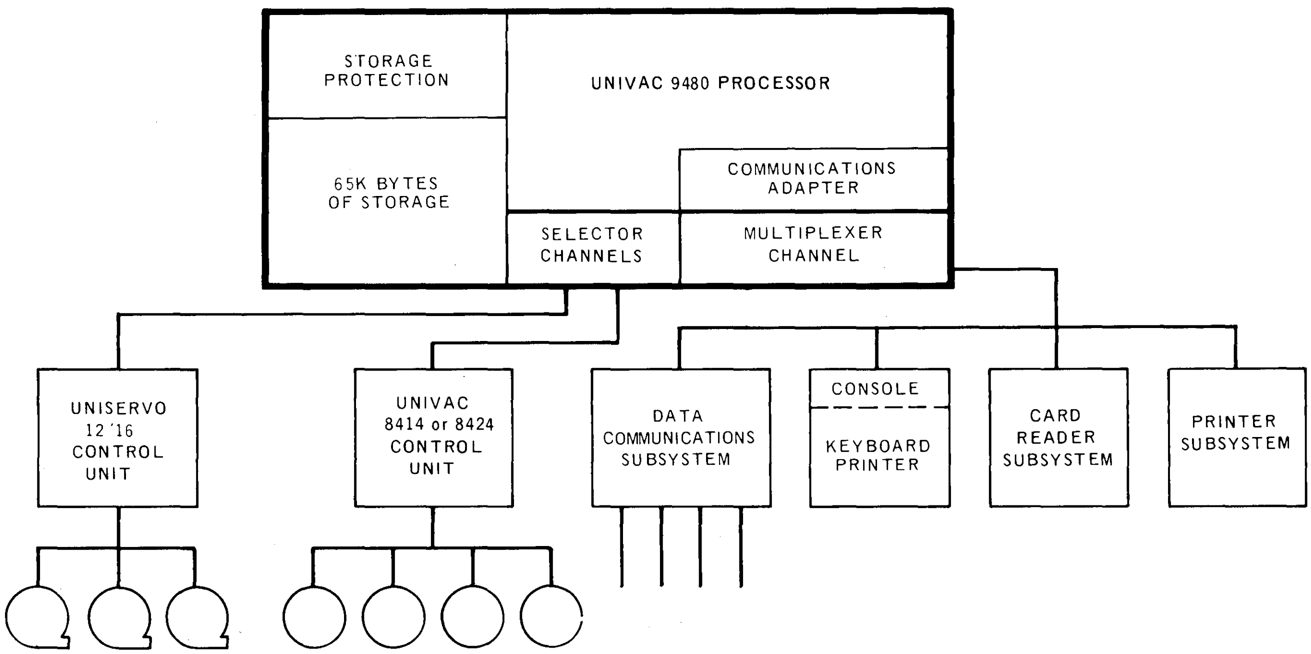
- PROCESSOR WITH MULTIPLEXER CHANNEL AND INTERRUPT TIMER
- CONSOLE WITH KEYBOARD AND PRINTER
- 65,536 BYTES OF STORAGE WITH STORAGE PROTECTION
- CARD READER SUBSYSTEM
- PRINTER SUBSYSTEM (132 position)
- UNISERVO 12/16 CONTROL UNIT WITH THREE TAPE UNITS
- UNIVAC 8414 or 8424 CONTROL UNIT WITH FOUR SPINDLES

Figure 1–4. Typical UNIVAC 9480 System Configuration (Disc Subsystem with Tape)

The system configuration shown in Figure 1–5 provides communication capability in addition to the capabilities of the disc and tape system illustrated in Figure 1–4. A few of the many applications provided by adding the communications facility follow:

- Inquiry systems
- Remote transaction processing
- Data collection from remote terminals

The multiprogramming capabilities of the system permit the communication applications to operate concurrently with batch programs initiated at the system site.



- PROCESSOR WITH MULTIPLEXER CHANNEL AND INTERRUPT TIMER
- CONSOLE WITH KEYBOARD AND PRINTER
- 65,536 BYTES OF STORAGE WITH STORAGE PROTECTION
- CARD READER SUBSYSTEM
- PRINTER SUBSYSTEM (132 position)
- UNISERVO 12/16 CONTROL UNIT WITH THREE TAPE UNITS
- UNIVAC 8414 or 8424 CONTROL UNIT WITH FOUR SPINDLES
- COMMUNICATIONS ADAPTER
- DATA COMMUNICATIONS SUBSYSTEM (DCS-4)

Figure 1–5. Typical UNIVAC 9480 System Configuration (Disc Subsystem with Tape and Data Communications Subsystem)

2. SYSTEM HARDWARE

2.1. The UNIVAC 9480 SYSTEM

The UNIVAC 9480 System is designed as a medium cost, high-performance, system with data processing and communication capability that is well within the reach of the majority of data processing users, and in which no compromise is made with operating potential. In the case of the processor storage and circuitry, the resulting high speed permits the UNIVAC 9480 System to compete favorably in the performance of any conventional data processing program.

2.2. CENTRAL PROCESSOR UNIT

Main storage, control, arithmetic, and input/output sections comprise the major parts of the central processor unit. These parts are described in the following paragraphs.

2.2.1. Main Storage Characteristics

The main storage of the UNIVAC 9480 System is contained in freestanding units with a 600-nanosecond cycle rate for each halfword (two bytes). The individually addressable units of main storage are called bytes. Each byte contains eight bits plus one bit for parity. Parity is such that the total number of ones in the byte, including the parity bit, is odd. The parity bit is generated when data is written into storage. Because the parity bit cannot be accessed by the program, a byte is considered in terms of the eight accessible bits when further discussed in this manual.

2.2.1.1. Addressing and Data Formats

Each eight-bit byte of main storage can be accessed by the problem program. These bytes are addressed consecutively from 0 through 262,143. Bytes may be accessed separately or in groups. The address of a group of bytes is addressed by the leftmost byte of the group. The bits in a byte are also numbered from left to right starting with zero.

Byte

b	b	b	b	b	b	b	b
0							7

Halfword formats consist of two consecutive bytes.

Halfword

b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b
0							7	8							15

Fullword formats consist of four consecutive bytes.

Fullword

b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b
0							7	8							15	16							23	24							31

Variable data formats consist of a variable number of consecutive bytes.

Variable Data Format

b	b	b	b	b	b	b	b	. . .	b	b	b	b	b	b	b	b
0							7		0							7
First Byte									Last Byte							

Fixed-length fields, such as halfwords and fullwords, have integral boundaries. Fixed-length fields must be loaded into main storage so that the address is evenly divisible by the field length (in bytes). Thus, a halfword must have an address that is a multiple of two and a fullword must have an address that is a multiple of four.

Variable-length data fields are not restricted by boundaries. Instruction lengths are 2, 4, or 6 bytes, and are restricted only to halfword boundaries.

2.2.1.2. Low-Order Storage

The low-order 512 bytes of main storage have been reserved to contain specific operating information. The data stored in these locations is accessed by the hardware and the operating system during the execution of the appropriate functions. The operating system provides for loading and protecting the appropriate data in these locations.

2.2.1.3. Storage Protection

Program protection in a multiprogrammed environment is achieved by the storage protection feature. The storage protection feature is controlled through the use of the Limits register, which limits the area that any one program can access for storage of data. The limits register is under control of the Supervisor which loads the address limits of the particular program in operation. An interrupt is generated whenever a write order attempts to address a location outside the bounds of the limits register.

2.2.2. Control Section

The control section controls the sequence in which instructions are executed, and it interprets and controls the execution of each individual instruction. The cycling of main storage is initiated by this section. All of the hardware aspects of interrupt handling, error checking, and protection are performed by the control section. The control section also maintains the instruction address counter and provides for the different processor modes of operation.

The central processor can reference two sets of 16 general purpose registers. Both sets are contained in low-order storage. One set is used by the Supervisor and the other set is used by problem programs. This design greatly reduces the interrupt processing time overhead required when only a single set of general registers is used. Thus, when the processing mode is changed between problem program and Supervisor modes, the following steps required in single register systems are unnecessary.

(1) Store the contents of problem program registers.

(2) Load the executive routine data into the registers.

(3) Store the executive routine data.

(4) Reload the problem data back into the registers.

These registers can be used for fixed-point arithmetic, logical arithmetic, and the indexing of both instruction and operand addresses. The capacity of each register is 32 bits (one word). The registers are identified by the hexadecimal numbers zero through F. The general purpose registers are addressable only through the specific instruction fields provided for their access.

2.2.3. Arithmetic Section

The arithmetic section performs all data manipulations including binary and decimal arithmetic, and logical operations such as data comparisons, shifting, and single or double indexing of operand addresses. The adder in this section performs arithmetic in twos complement form.

2.2.3.1. Binary (Fixed-Point) Arithmetic

A binary arithmetic operand can be either a 32-bit word or a 16-bit halfword. When possible, 16-bit operands should be specified to conserve storage. The sign of a binary operand is always the leftmost bit of the operand. The following figures illustrate the formats of halfword and fullword fixed-binary values.

Halfword

S	Integer
0	1 15

Fullword

S	Integer
0	1 31

When a halfword binary number is called from storage, it is always expanded to a right-justified fullword; the sign is extended to the left.

2.2.3.2. Decimal Arithmetic

Decimal number fields can be variable in length and can exist in two formats: unpacked decimal numbers and packed decimal numbers. Decimal operations including add, subtract, multiply, and divide, can be performed only on packed decimal numbers. Instructions are provided for converting decimal numbers from unpacked to packed and from packed to unpacked format.

In the unpacked decimal format, each byte contains one digit of a multidigit number. The byte is divided into two equal fields, a zone field and a digit field. A zone value is represented in the most significant four bits; the digit is represented in the least significant four bits. The zone portion of the least significant byte specifies the sign of the number. The unpacked format must be used when data is to be processed by certain I/O devices such as the printer. The following figure illustrates the format of a three-digit operand.

ZONE	DIGIT	ZONE	DIGIT	SIGN	DIGIT
0	7	8	15	16	23
Byte		Byte		Byte	

Unpacked Decimal Operand

In packed format, each byte contains two digits. The least significant four bits of the least significant byte provides the sign of the number. Packed decimal format is used for all decimal arithmetic operations. The following figure illustrates the format of a four-digit number.

ZERO	DIGIT	DIGIT	DIGIT	DIGIT	SIGN
0	7	8	15	16	23
Byte		Byte		Byte	

Packed Decimal Operand

Decimal numbers (0 through 9) are represented in the four-bit binary coded decimal form (0000 through 1001). The codes 1010 through 1111 are used for sign codes. The binary values 1011 and 1101 represent a minus sign and the binary values 1010, 1100, 1110 and 1111 represent a plus sign. This assignment of sign codes permits the use of either of two conventions: American National Standard Code for Information Interchange (ASCII) expanded to eight bits or Extended Binary Coded Decimal Interchange Code (EBCDIC). The codes 1010 (plus) and 1011 (minus) are used in ASCII; the codes 1100 (plus) and 1101 (minus) are used in EBCDIC. A control bit in the Program Status Word determines whether the system is to operate in the ASCII or the EBCDIC mode.

2.2.3.3. Logical Operations

Logical operations such as comparing, translating, editing, bit setting, and bit testing are performed by the arithmetic section. Logical operations can be performed on fixed-length operands and variable-length operands. Logical operations on fixed-length operands are performed in the registers; logical operations on variable-length operands are performed in main storage. The instruction format determines whether the logical operation is to be performed in main storage or in a register.

2.2.4. Input/Output Section

The input/output (I/O) section of the UNIVAC 9480 System central processor unit initiates, directs, and monitors the transfer of data between storage and the peripheral subsystems. After an I/O instruction has been transferred to the control unit from the control section, the data transfer is performed concurrently with other central processor functions.

The I/O section consists of the input/output channels and the standard UNIVAC 9000 Series I/O Interface which connects channels with the unit controllers. This interface is identical for all the I/O control units; it has been designed for use with all of the available peripheral devices, as well as for future devices.

Two selector channels are available in the UNIVAC 9480 System in addition to the multiplexer channel.

2.2.4.1. Multiplexer Channel

The central processor unit has one multiplexer channel which has eight physical connections to which either standard control units (for devices such as a card reader, card punch, or line printer) or Data Communications Subsystem (DCS) can be attached. The address format for the multiplexer channel provides for eight shared subchannel addresses and 128 nonshared subchannel addresses. Each standard control unit occupies one physical connection and uses one shared subchannel address. Each DCS occupies one physical connection but uses up to 32 nonshared subchannel addresses. The console is connected in such a manner that it uses shared subchannel address but it does *not* use a physical connection. Therefore, the multiplexer channel can accommodate any combination of Data Communication Subsystem(s) and up to seven standard control units by means of the eight physical connections.

Examples of low-speed devices are printers, card readers, card punches, UNISERVO VI-C Magnetic Tape Units, remote communication devices, I/O subsystems such as the UNIVAC 1004 or 1005 Subsystem, and the UNIVAC 9200 or 9300 Subsystem.

2.2.4.2. Selector Channel

Two selector channels are available: one is included in the basic processor; the second is available at the option of the user.

High-speed devices, such as UNISERVO 12 and UNISERVO 16 Magnetic Tape Units and UNIVAC 8414 or 8424 Disc Drive Units may only be connected to the selector channels by way of eight standard control units. Up to 16 I/O devices can be attached to each of the eight control units depending on the particular subsystem selected.

2.2.5. Interrupt Processing Control

The UNIVAC 9480 System contains a very efficient interrupt system that makes it a highly capable communications system. The UNIVAC 9480 Interrupt System provides the means by which the central processor unit changes from the problem program state to privileged or supervisor state. The seven types of interrupt employed in the UNIVAC 9480 System are listed below in order of priority:

- Supervisor Call Interrupt – This interrupt results from the execution of a supervisor call instruction. Status information provides the operating system with a link to parameter information in the calling program.

- Program Interrupt – This interrupt occurs when one of the following exceptions is recognized by the central processor unit.

  – Illegal operation

  – Privileged operation – a privileged instruction is encountered while the processor is in the problem state

  – Write Protection – attempting to write data in main storage that is outside the bounds specified by the limits register

  – Addressing Exception – reference to low-order storage while in the problem state.

  – Specification Exception – integral boundary reference error

  – Binary Arithmetic Overflow

  – Decimal Arithmetic Overflow

  – Decimal Divide Exception – a quotient digit is formed with a nonnumeric hexadecimal value

- Timer Interrupt – This interrupt is caused when the millisecond timer storage is decremented to zero.

- Selector Channel 1 Interrupt – This interrupt occurs when an interrupt condition has been generated on Selector Channel 1 by a device.

- Selector Channel 2 Interrupt – This interrupt occurs when an interrupt condition has been generated on Selector Channel 2 by a device.

- Shared Multiplexer Channel Interrupt – This interrupt occurs when an interrupt condition has been generated on a shared multiplexer channel. The status is stored in the appropriate Subchannel Control Word.

- Nonshared Multiplexer Channel Interrupt – This interrupt occurs when an interrupt condition has been generated on a nonshared multiplexer channel. The status is tabled which indicates the source and cause of the interrupt.

2.3. UNIVAC 9480 SYSTEM INSTRUCTION REPERTOIRE

The power and flexibility of the UNIVAC 9480 System is reflected in the instruction repertoire and execution times. The full repertoire includes 70 instructions, many of which offer several optional variations. The instruction set is supplemented by an input/output device instruction which controls each of the possible peripheral devices.

The UNIVAC 9480 System instructions fall into two functional categories:

- Supervisor
- Standard

2.3.1. Supervisor Instruction Set

The Supervisor (privileged) instruction set is used primarily by the software operating system when operating in the supervisory state. In this state, all instructions (Supervisor and standard) are valid and can be executed. The privileged general registers are selected and low-order storage can be addressed. Instructions in the Supervisor set cannot be executed in a problem program.

2.3.2. Standard Instruction Set

The standard (nonprivileged) instruction set is used to write programs for operation in the problem state (application and data processing programs). In this state, the Supervisor (privileged) instructions are invalid, the problem set of general registers is selected, and low-order storage cannot be addressed.

The standard instruction set provides instructions to process fixed-length binary numbers, packed and unpacked decimal numbers, and alphabetical characters. Data may be transferred between main storage and the problem set of general registers and from storage to storage. The operations of shifting, branching, and logical functions are also included.

2.3.3. Instruction Types

Instructions can be either 2, 4, or 6 bytes in length. In a two-byte (halfword) instruction, only registers are referenced. A four-byte (two halfword) instruction references main storage once. A six-byte (three halfword) instruction references main storage twice. All instructions must be located in storage on halfword boundaries, that is, have an even address. The six instruction types are:

- RR = a register to register operation
- RX = a register and indexed storage operation
- RS = a register and storage operation
- SI = a storage and immediate operand operation
- SS1 = a storage to storage operation (256-byte maximum length)
- SS2 = a storage to storage operation (16-byte maximum length)

The instruction formats for each type are shown and described in the following sections and are also summarized in Figure 2–1 and in 2.3.3.7.

2.3.3.1. Register to Register Instructions (RR)

The RR instructions are two bytes in length and are used primarily to process data between registers. The maximum data operand that can be handled is a fullword of 32 bits; the fullword may or may not be a signed binary number.

In this format, there are 14 instructions:

RR Instructions	Mnemonic OP Codes
Add	AR
AND	NR
Branch and Link	BALR
Branch on Condition	BCR
Branch on Count	BCTR
Compare	CR
Compare Logical	CLR
Exclusive OR	XR
Load	LR
Load and Test	LTR
OR	OR
Set Program Mask	SPM
Subtract	SR
Supervisor Call	SVC

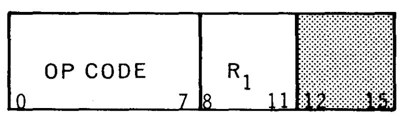
The source code formats of the RR instructions are:

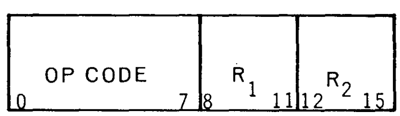
OP	R_1
OP	R_1, R_2
OP	I
OP	M_1, R_2

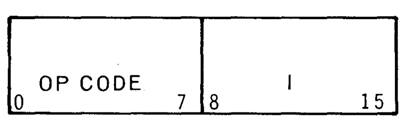
where:

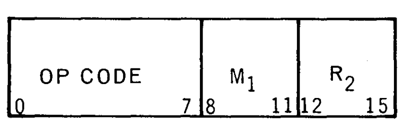
- OP is the mnemonic operation code.
- R_1 is an expression representing a register as operand 1.
- R_2 is an expression representing a register as operand 2.
- I is actual data expressed in bits to be used for control purposes.
- M_1 is a four bit data mask used in testing.

The object codes formed by these codes are:









2.3.3.2. Register to Indexed Storage Instructions (RX)

The RX instructions are four bytes in length and are used primarily to process data between registers and indexed storage. The maximum data operand that can be handled is a fullword of 32 bits; the fullword may or may not be a signed binary number.

In this format, there are 20 instructions:

RX Instructions	Mnemonic OP Codes
Add	A
Add Halfword	AH
AND	N
Branch and Link	BAL
Branch on Condition	BC
Branch on Count	BCT
Compare	C
Compare Halfword	CH
Compare Logical	CL
Exclusive OR	X
Insert Character	IC
Load	L
Load Address	LA
Load Halfword	LH
OR	O
Store	ST
Store Character	STC
Store Halfword	STH
Subtract	S
Subtract Halfword	SH

The source code formats of the RX instructions are:

OP $R_1, D_2(X_2, B_2)$

OP $M_1, D_2(X_2, B_2)$

where:

- OP   is the mnemonic operation code.
- R_1 is an expression representing a register as operand 1.
- M_1 is a four bit data mask used in testing.
- D_2 is an expression designating the displacement value of operand 2.
- X_2 is an expression designating a register whose contents are used to index the displacement and base address of operand 2.
- B_2 is an expression designating a register whose contents are added to the displacement value to form the effective address of operand 2.

The object codes formed by these source codes are:

OP CODE	R_1	X_2	B_2	D_2
0 7	8 11	12 15	16 19	20 31

OP CODE	M_1	X_2	B_2	D_2
0 7	8 11	12 15	16 19	20 31

The effective address of operand 2 is formed by adding the contents of the base register B_2 to the displacement value D_2; this may or may not be modified by adding the contents of index register X_2.

2.3.3.3. Register to Storage Instructions (RS)

The RS instructions are four bytes in length and are used to perform multiple register storage and shift operations.

In this format, there are seven instructions:

RS Instructions	Mnemonic OP Codes
Load Limits Register (privileged instruction)	LLR
Load Multiple	LM
Shift Left Single Logical	SLL
Shift Right Single Logical	SRL
Store Multiple	STM
Supervisor Load Multiple (privileged instruction)	SLM
Supervisor Store Multiple (privileged instruction)	SSTM

The source code formats of the RS instructions are:

OP $R_1, D_2(B_2)$

OP $R_1, R_3, D_2(B_2)$

where:

- OP is the mnemonic operation code.
- R_1 is an expression representing a register as operand 1, or a register which is the first register of a multiregister group.
- R_3 is an expression representing a register which is the last register of a multiregister group.
- D_2 is an expression designating the displacement value of operand 2.
- B_2 is an expression designating a register whose contents is added to the displacement value to form the effective address of operand 2.

The object codes formed by these source codes are:

OP CODE	R_1		B_2	D_2
0 7	8 11	12 15	16 19	20 31

OP CODE	R_1	R_3	B_2	D_2
0 7	8 11	12 15	16 19	20 31

OP CODE		B_2	D_2
0 7	8 15	16 19	20 31

The effective address of operand 2 is formed by adding the contents of the base register B_2 to the displacement value D_2.

2.3.3.4. Storage and Immediate Operand Instructions (SI)

The SI instructions are four bytes in length and are used to provide control data for operation of the processor and peripherals. There are eleven instructions in this format.

SI Instructions	Mnemonic OP Codes
Add Immediate	AI
AND	NI
Compare Logical	CLI
Exclusive OR	XI
Halt and Proceed (privileged instruction)	HPR
Load Program State Word (privileged instruction)	LPSW
Move Immediate	MVI
OR	OI
Set System Mask (privileged instruction)	SSM
Start I/O (privileged instruction)	SIO
Test Under Mask	TM

The source code formats of the SI instructions are:

OP $D_1(B_1)$

OP $D_1(B_1),I_2$

where:

- OP is the mnemonic operation code.
- D_1 is an expression designating the displacement value of operand 1.
- B_1 is an expression designating a register whose contents is added to the displacement value to form the effective address of operand 1.
- I_2 is the actual data expressed in bits to be used as operand 2.

The object codes formed by these source codes are:

OP CODE		B_1	D_1
0 7	8 15	16 19	20 31

OP CODE	I_2	B_1	D_1
0 7	8 15	16 19	20 31

The effective address of operand 1 is formed by adding the contents of the base register (B_1) to the displacement value (D_1).

2.3.3.5. Storage to Storage Instructions (SS1)

The SS1 instructions are six bytes in length and are used to process data in storage where the operands are equal in length. The maximum operand may be 256 bytes in length.

In this format, there are nine instructions:

SS1 Instructions	Mnemonic OP Codes
AND	NC
Compare Logical	CLC
Edit	ED
Exclusive OR	XC
Move Characters	MVC
Move Numerics	MVN
Move Zones	MVZ
OR	OC
Translate	TR

The source code format for the SS1 instructions is:

OP $D_1(L, B_1), D_2(B_2)$

where:

- OP is the mnemonic operation code.
- D_1 is an expression designating the displacement value of operand 1.
- L is a value which states the length of both operand 1 and operand 2.
- B_1 is an expression designating a register whose contents is added to the displacement D_1 to form the effective address of operand 1.
- D_2 is an expression designating the displacement value of operand 2.
- B_2 is an expression designating a register whose contents is added to the displacement D_2 to form the effective address of operand 2.

The object code formed by this source code is:

OP CODE	L−1	B_1	D_1	B_2	D_2
0 7	8 15	16 19	20 31	32 35	36 47

The effective address of operand 1 is formed by adding the contents of base register B_1 to the displacement value D_1 and the effective address of operand 2 is formed by adding the contents of base register B_2 to the displacement value D_2.

2.3.3.6. Storage to Storage Instructions (SS2)

The SS2 instructions are six bytes in length and are used to process data in storage where the operands are unequal in length. The maximum operand can be 16 bytes in length.

In this format, there are nine instructions:

SS2 Instructions	Mnemonic OP Codes
Add Decimal	AP
Compare Decimal	CP
Divide Decimal	DP
Move with Offset	MVO
Multiply Decimal	MP
Pack	PACK
Subtract Decimal	SP
Unpack	UNPK
Zero and Add	ZAP

The source code format for these instructions is:

$$\text{OP} \quad D_1(L_1, B_1), D_2(L_2, B_2)$$

where:

- OP is the mnemonic operation code.
- D_1 is an expression designating the displacement value of operand 1.
- L_1 is a value designating the length of operand 1.
- B_1 is an expression designating a register whose contents is added to the displacement D_1 to form the effective address of operand 1.
- D_2 is an expression designating the displacement value of operand 2.
- L_2 is a value designating the length of operand 2.
- B_2 is an expression designating a register whose contents are added to the displacement D_2 to form the effective address of operand 2.

The object code formed by this source code is:

OP CODE	L_1-1	L_2-1	B_1	D_1	B_2	D_2
0 7	8 11	12 15	16 19	20 31	32 35	36 47

The effective address of operand 1 is formed by adding the contents of base register B_1 to the displacement value D_1 and the effective address of operand 2 is formed by adding the contents of base register B_2 to the displacement value D_2.

2.3.3.7. Instruction Formats

The basic instruction formats are illustrated in Figure 2–1 and an explanation of the symbols used is provided in Table 2–1. The subscripts 1, 2, and 3 indicate that the given field refers to operand 1, operand 2, or operand 3 respectively. In general, data are processed from operand 2 to operand 1, with the result often replacing the original contents of operand 1. Operand 3 is a special notation explained in the RS type instruction in 2.3.3.3.

Most instructions are two halfwords in length; however, the RR instructions require only one halfword and therefore are executed faster. The SS1 and SS2 instructions use three halfwords and require more execution time, which is dependent upon the length of the data processed by the instruction.

In the instruction formats in Figure 2–1, the first halfword contains the operation code, register numbers, immediate data, or length as specified by the individual instruction. The second halfword specifies either operand 1 or operand 2. The third halfword, when used, always specifies operand 2.

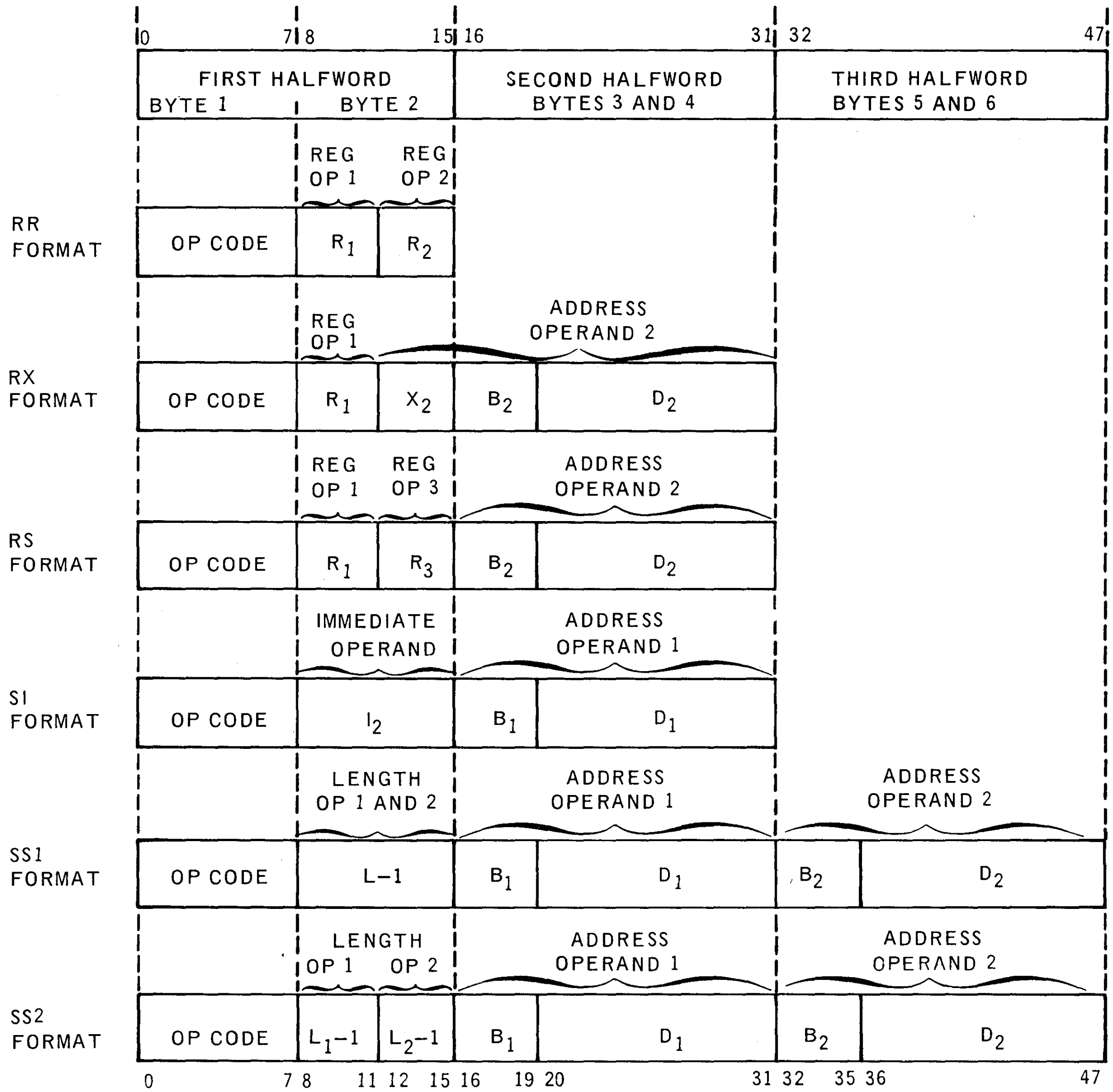


Figure 2–1. Basic Instruction Formats (Object Code Form)

The entries in Table 2–1 explain the meaning of the symbols used in describing the instruction formats in Figure 2–1.

SYMBOL	MEANING
OP CODE	Instruction operation code.
R_1	The number of the register addressed as operand 1, or a register which is the first register of a multi-register group.
R_2	The number of the register addressed as operand 2.
R_3	An expression representing a register which is the last register in a multiregister group.
X_2	The number of the register to be used as an index for operand 2 of an RX instruction.
I_2	The immediate data or device address used as operand 2 of a SI instruction.
L	The length of operands 1 and 2 as stated in source code.
L_1	The length of operand 1 as stated in source code.
L_2	The length of operand 2 as stated in source code.
B_1	The base register for operand 1.
B_2	The base register for operand 2.
D_1	The displacement for operand 1.
D_2	The displacement for operand 2.
OP1	Operand 1
OP2	Operand 2
OP3	Operand 3

Table 2–1. Symbols Used to Describe Operand Formats

2.4. CONSOLE

The UNIVAC 9480 System console provides a means of communication between the operator and operating system. The console consists of a keyboard, printer, switches, and indicators, which are housed in a platform attached to the processor as shown in Figure 2–2. The associated control and interface I/O logic is housed in the processor. The console is addressed through shared multiplexer subchannel 0.

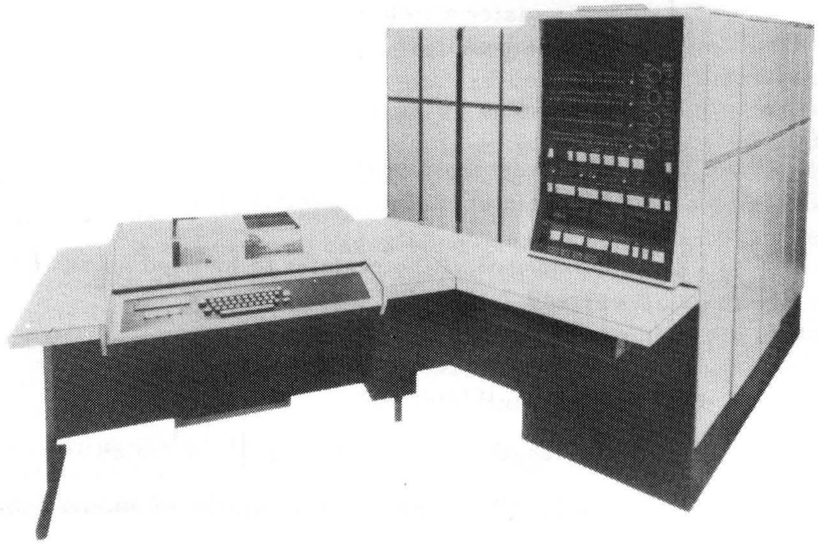


Figure 2–2. UNIVAC 9480 System Console

2.4.1. Keyboard Assembly and Control

The keyboard resembles a standard typewriter keyboard. This assembly consists of 46 keys and a core logic encoding network. Pressing one of the keys causes an EBCDIC code character and a sprocket pulse to be transmitted in bit parallel from the encoding network to the keyboard control logic interface.

The keyboard assembly and control is activated by a read command from the UNIVAC 9480 System central processor unit. This command is requested by pressing the ATTENTION switch located next to the printer, and it remains active throughout the input operation. During the input operation the printing of each character signifies that the particular character has been stored. The input operation can be terminated at any point by pressing the ET key. If an incorrect character is typed, pressing the DELETE switch located next to the printer also terminates the input operation.

2.4.2. Printer Assembly and Control

The UNIVAC 9480 System console printer is an incremental printer capable of printing at a maximum rate of 25 characters per second. The printer has a changeable font and can handle up to 132 print positions. It accepts six-part forms up to 14-7/8 inches in overall width.

The printer executes three nonprint functions: carriage return, line speed, and space.

2.4.3. Controls and Indicators

Seven controls and indicators are located on the console printer. These controls and indicators permit the operator to initiate or terminate a message to the operating system and to control paper movement.

The function of each of these is summarized in Table 2–2.

NAME	FUNCTION
INTERLOCK	This indicator is red when the printer casework is opened.
PRINT CHECK	This indicator is red when the printer actuator fuse is blown and the actuator will not operate.
PAPER CHECK	This indicator is red when two inches of paper remain in the printer.
READ	This indicator is white when the console is in the input mode.
HOME	A momentary-action switch (white) which activates the paper feed mechanism and advances paper to the next home position.
DELETE	This momentary-action switch is used to terminate the input operation and signals the processor to ignore the previous ATTENTION command.
ATTENTION	This momentary-action switch/indicator is used to solicit a read command; the indicator goes off when the attention status is received by the processor.

Table 2–2. Console Printer Controls and Indicators

2.5. INPUT/OUTPUT DEVICES

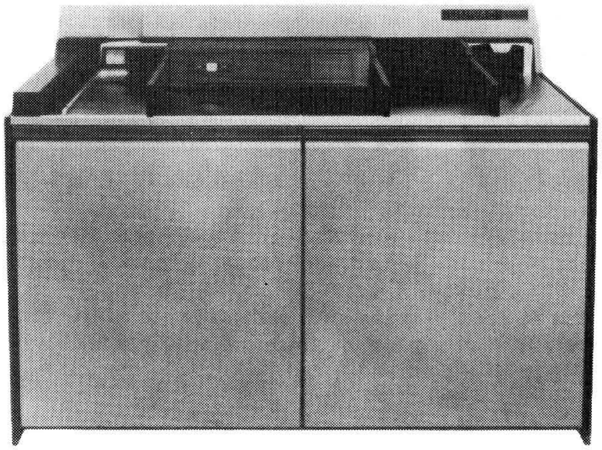
A full line of peripheral devices and subsystems is available for use with the UNIVAC 9480 System. These devices and subsystems are:

- UNIVAC 0716 Card Reader Subsystems
- UNIVAC 0604 Card Punch Subsystem
- UNIVAC 0768 Printer Subsystem
- Data Communications Subsystems
- UNIVAC 1004 or 1005 Subsystem
- UNIVAC 9200, 9200 II, 9300, or 9300 II Subsystem
- UNISERVO Magnetic Tape Subsystems
- UNIVAC 8414 Disc Subsystem
- UNIVAC 8424 Disc Subsystem
- UNIVAC 2703 Optical Document Reader (ODR)

- UNIVAC 0920 Paper Tape Subsystem
- UNISCOPE 100 Display Terminal
- UNIVAC DCT 500 Data Communications Terminal
- UNIVAC DCT 1000 Data Communications Terminal

Descriptions of these devices and subsystems follow.

2.5.1. UNIVAC 0716 Card Reader Subsystem



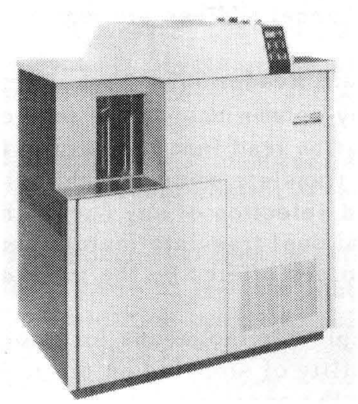
CHARACTERISTICS		
	UNIVAC 0716–00	UNIVAC 0716–02
CARD READING SPEED	600 cards/ minute	1000 cards/ minute
INPUT HOPPER CAPACITY	2400 cards	
OUTPUT STACKER CAPACITY	2 stackers–2000 cards each	
READ MODES	Image mode–160 6-bit characters/card Translate mode: EBCDIC–80 characters/card ASCII–80 characters/card compressed code–80 characters/card	
OPTIONAL FEATURES	51- or 66-column short card feeds Validity check Alternate stacker fill Dual translate Speed upgrade (0716–00 only)	

The UNIVAC 0716 Card Reader Subsystem includes a self-contained control unit and synchronizer that regulates flow of data and control signals to and from the reader mechanism. This control unit is attached to the UNIVAC 9480 System by means of the multiplexer channel. A separate multiplexer channel physical connection and shared subchannel address are required for the card reader subsystem.

The UNIVAC 0716 Card Reader Subsystem operates at a rate of 600/1000 cards per minute on a column-by-column basis. The read check feature is standard to ensure correct input. Information read from the card is transferred to the processor in either image mode or translate mode, which includes EBCDIC, ASCII, or compressed code. Image mode and selection of any one of the translate modes are standard features. The optional dual translate feature permits an additional selection from the two remaining choices offered by the translate mode.

Two output stackers provide the means for error selection as a standard feature in addition to the capability of stopping on error. An optional feature, alternate stacker fill, provides the capability of stacking 4000 cards: when stacker A is filled, the reader automatically begins to fill stacker B. The stop-on-error feature may be used with alternate stacker fill. The stacker carrousel wheel decelerates and stacks the cards at a rate which maximizes card handling care.

2.5.2. UNIVAC 0604 Card Punch Subsystem



CHARACTERISTICS	
CARD PUNCHING SPEED	250 cpm
INPUT HOPPER CAPACITY	1000 cards
OUTPUT STACKER CAPACITY	2 stackers - 1000 cards per stacker
PUNCH MODES	Image mode - 160 6-bit characters per card Translate mode - 80 characters per card
I/O CHANNELS	1 shared multiplexer subchannel
OPTIONAL FEATURE	Read before punching

The card punch operates at a rate of 250 cards per minute on a row-by-row basis (12 punching positions per card). Standard features include processing 80-column cards in either punched card code or main storage image code modes. Output cards can be directed to either stacker under control of the program.

The card punch includes a self-contained control unit and a synchronizer which regulates the flow of data and control signals to and from the punch mechanism. This control unit is attached to the UNIVAC 9480 System central processor unit by means of one of the eight physical connections provided in the standard multiplexer channel. A separate shared multiplexer subchannel address is required for each card punch.

An optional feature is the inclusion of the read/punch feature. The read/punch option allows prepunched cards to be sensed and read into the punch buffer from a prepunch station. This option does not fulfill the requirement for having an 80-column card reader in the system.

Data to be punched may be transferred to the output buffer in either of two formats. In the translate mode, each byte of data is translated by program into the corresponding card code. In the image mode, data transferred has the two most significant bits stripped from the byte. The remaining six bits are punched in image code in the upper or lower half of a card column. The image mode provides the means for punching up to 160 characters of information into a single 80-column card. A post-punch read station checks card punching and directs error cards to a selected output stacker.

2.5.3. UNIVAC 0768 Printer Subsystem

The UNIVAC 0768 Printer Subsystem is a freestanding, self-contained unit. The controlling and synchronizing circuitry, including the 132-character print buffer and the print mechanisms, are housed within the cabinet. This complete printer subsystem is connected to the UNIVAC 9480 System by means of the multiplexer channel. A separate multiplexer channel physical connection and shared subchannel address are required for each printer subsystem.

A forms container at the base of the unit houses the supply of forms being fed into the printer. Controls are provided to allow manual adjustment of paper tension, form thickness, paper alignment, vertical print positioning, horizontal print positioning, and advancement of forms. The forms-handling mechanism is designed to eliminate buildup of static electricity.

CHARACTERISTICS

	UNIVAC 0768–00/01 PRINTER SUBSYSTEM	UNIVAC 0768–02/03 PRINTER SUBSYSTEM
PRINTING SPEED (single-line spacing)	900 lpm – 63 contiguous characters 1100 lpm – 49 contiguous characters 1200 lpm – 63 contiguous characters 1600 lpm – 43 contiguous characters	840 lpm –94 contiguous characters 1000 lpm–87 contiguous characters 2000 lpm–repeated subset of 14 contiguous characters
NUMBER OF CHARACTERS	Maximum of 63 different characters consisting of alphabetic characters (A–Z), numeric characters (0–9), 27 punctuation marks and symbols	Maximum of 94 different characters consisting of alphabetic characters (A–Z and a–z), numeric characters (0–9), 32 punctuation marks and symbols
PRINT POSITIONS PER LINE	132 print positions (including spaces) per line	
HORIZONTAL PRINT SPACING	10 print positions per inch	
VERTICAL PRINT SPACING	Either 6 or 8 lines per inch as determined by form control tape	
FORM ADVANCE RATE	33 inches per second at 6 lines per inch spacing 22 inches per second at 8 lines per inch spacing	
FORM WIDTH	4 to 22 inches	
FORM LENGTH	1 to 22 inches	
NUMBER OF FORM COPIES	Up to six-part forms	
FORM ADVANCE	Loop control	
LINE ADVANCE	Single, double, or triple spacing under program control	

2.5.3.1. UNIVAC 0768–00/01 Printer Subsystem

The UNIVAC 0768–00/01 Printer Subsystem is a drum printer that prints a maximum of 1100 lines per minute (lpm) depending on the number of characters used. The full character set comprises 63 printable characters on a drum three inches in diameter. If all of the characters to be printed on a line are contained within a 49 contiguous-character subset on the drum and single spacing is specified, printing is at 1100 lpm. If more than 49 contiguous characters are specified and spacing other than single spacing is desired, printing speed decreases accordingly. A speed-up feature (F1071–00) is available, which increases the line printing rate to a maximum of 1600 lines per minute. A 1600 lpm rate is obtained by using a single-spaced, 43 contiguous-character subset. If more than 43 contiguous characters are specified and spacing other than single spacing is desired, printing speed decreases accordingly.

2.5.3.2. UNIVAC 0768–02/03 Printer Subsystem

The UNIVAC 0768–02/03 Printer Subsystem is a drum printer that prints a maximum of 840, 1000, or 2000 lines per minute depending on the number of characters used. The full character set comprises 94 printable characters (including upper and lower case letters) on a drum five inches in diameter. Printing occurs at 840 lpm when 94 contiguous characters are used. Printing occurs at 1000 lpm when 87 contiguous characters are used. Printing speed increases to 2000 lpm when a numeric set of 14 contiguous characters is used.

2.5.4. Data Communications Subsystem

Communications-oriented data processing is obtained through the use of the UNIVAC 9480 System with from one to four Data Communications Subsystems (DCS) and a communications adapter. Each Data Communications Subsystem (DCS-1, DCS-4, or DCS-16) can accommodate 1, 4, or 16 duplex lines, depending on the type. Each subsystem must be connected to one of the eight physical connections of the multiplexer channel. Circuitry is included in the DCS to control data transmission between the UNIVAC 9480 System central processor unit and the line terminals. The DCS establishes the priority for individual lines when service is requested simultaneously. Also, the DCS signals the operating system when a data transfer between the DCS and the central processor has been lost.

The subsystem can take a variety of forms, depending upon the particular installation. The modular elements comprising the subsystem (that is, line terminal controller, line terminal, communication interface unit, automatic dialing adapter, and timing assembly) are described in the following paragraphs. A block diagram, Figure 2–3 shows the interconnections between UNIVAC 9480 System central processor unit, Data Communications Subsystem, and remote devices.

2.5.4.1. Line Terminal Controller

The line Terminal Controller provides control for the various line terminals and the automatic dialing adapter.

2.5.4.2. Line Terminal

One or more line terminals can be used in half-duplex and full-duplex mode as data handlers either for sending or receiving information to or from the central processor. Several types of line terminals are available to provide low- and medium-speed asynchronous operation or to meet synchronous high-speed requirements. Data characters may range from four to eight bits in size (level) depending on the model and mode of the line terminal. Line terminal characteristics are summarized in Table 2–2.

FEATURE	DESCRIPTION
NUMBER OF TERMINALS	1, 4, or 16
TYPE of OPERATION	Half-duplex, full-duplex mode
LINE TERMINAL DATA TRANSFER RATE	Low speed – 75 to 300 bits per second Medium speed – 300 to 1800 bits per second Synchronous (voice grade) – 2000 to 4800 bits per second Syncronous (broadband data terminal) – 40,800 to 50,000 bits per second Synchronous (Wideband) – 230,400 or 250,000 bits per second
LINE TERMINAL CHARACTER SIZE	Low Speed – 5 or 8 bit Medium Speed – 4 to 8 bit Synchronous – 5 to 10 bit
SPECIAL APPLICATION	■ One dialing adapter can be attached to a DCS-4 (or four dialing adapters in the case of a DCS-16) to permit the processor to control an A.T.& T. 801 A or 801 C Automatic Calling Unit. ■ A parallel line terminal (input only) enables the UNIVAC 9480 System to interface with a Touch-Tone* telephone; it operates at 10 characters per second by means of an A.T.& T. 403 Data Set (2 out of 8 code). ■ A Dual Channel Access feature allows two UNIVAC 9480 System multiplexer channels to access the same DCS-16 through operator intervention.

Table 2–3. Line Terminal Characteristics

**Registered Service Mark of A.T. & T. Co.*

2.5.4.3. Communications Interface

The communications interface connects a line terminal with a common carrier line. The available Communication Interfaces meet both the EIA RS 232B (Industry Standard Interface) and the MIL–STD–188B (Electrical Circuit Compatibility–Government) specifications. Each input/output line requires one Communication Interface.

2.5.4.4. Asynchronous Timing Assembly

The asynchronous timing assembly provides a clock source for asynchronous line terminals. A single unit provides one baud rate for an entire Data Communications Subsystem. Asynchronous timing assemblies are available in baud rates up to 2400 baud. Each different speed asynchronous line terminal requires an asynchronous timing assembly. The maximum number of ATA's is eight in the case of the DCS-16.

2.5.4.5. Synchronous Timing Assembly

The synchronous timing assembly provides a clock source for synchronous communication. Clock signals are supplied for transmission, and provide the baud rates of 600, 1200, and 1800. These assemblies are needed only in a synchronous mode of operation where an asynchronous modem is used or where there is no external synchronized clock.

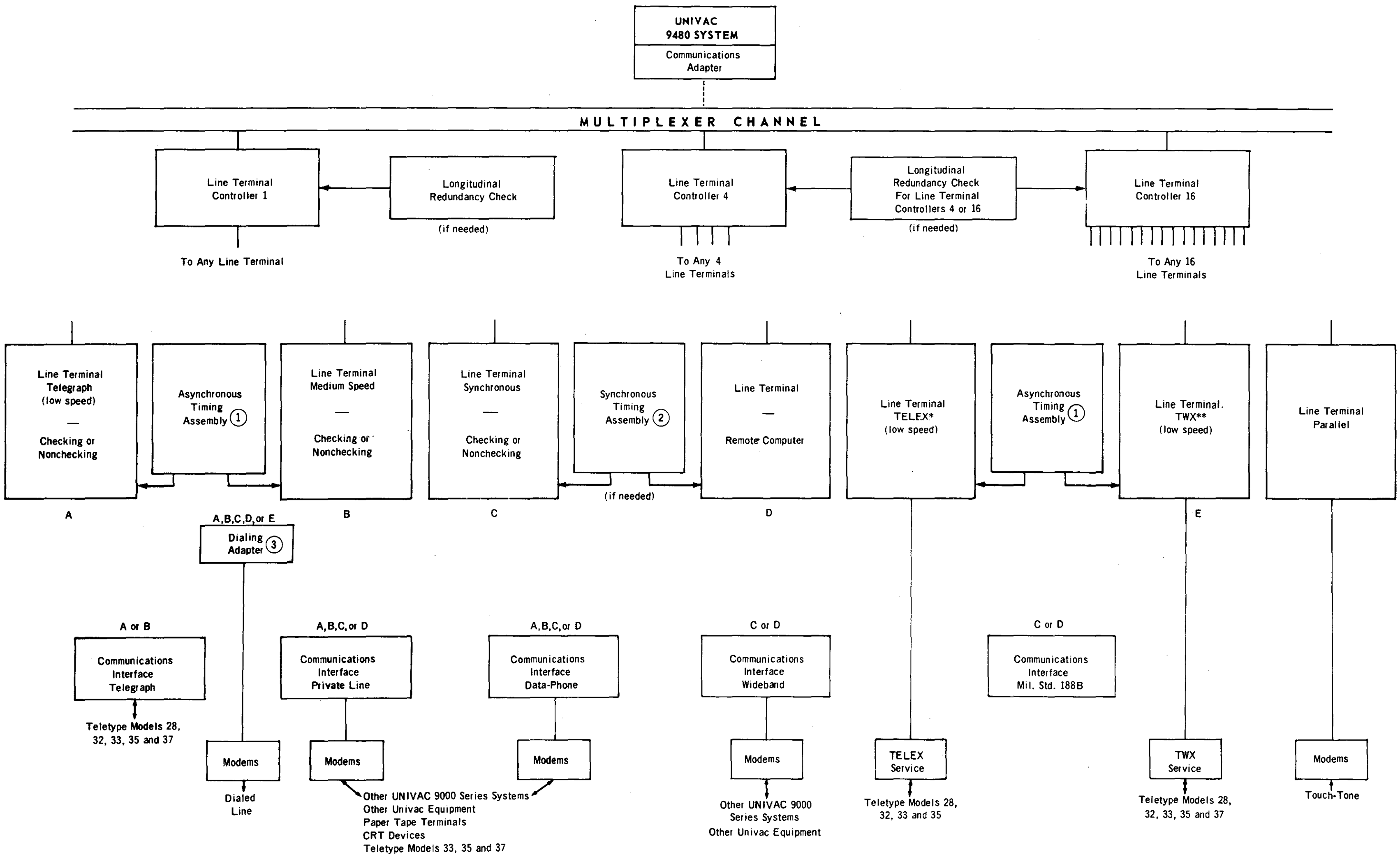
2.5.4.6. Configurations

The Data Communications Subsystem configurations have been classified into the following types:

- DCS-1 provides either one half-duplex or full-duplex position.
- DCS-4 provides either four half-duplex or full-duplex positions.
- DCS-16 provides either 16 half-duplex or full-duplex positions.

The configuration shown in Figure 2–3 shows a UNIVAC Data Communications Subsystem connected to some of the more commonly used remote devices. It should be noted that each remote device requires a specific combination of the following units:

- Line Terminal Controller
- Line Terminal
- Timing Assembly – Asynchronous Timing Assembly or Synchronous Timing Assembly
- Dialing Adapter
- Communication Interface
- Modem

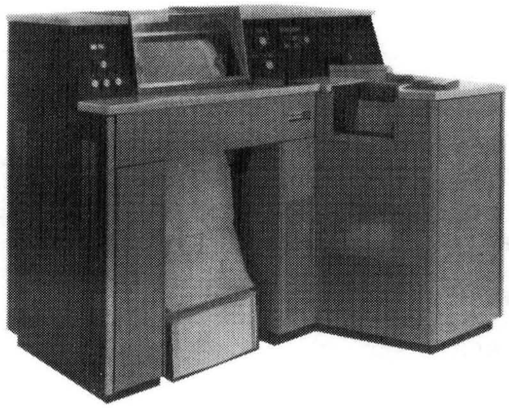


① One required for each different asynchronous speed within a DCS; eight maximum with DCS-16.
② Required only for synchronous communication without a clocking modem.
③ Maximum one per LTC-4, four per LTC-16. Used in conjunction with an LT which uses voice band Data-Phone or TWX service.

Figure 2–3. UNIVAC 9480 System Data Communications Subsystem

**Trademark of Western Union Corporation*
***Trademark of The American Telephone and Telegraph Company*

2.5.5. UNIVAC 1004 or 1005 Subsystem



The UNIVAC 1004 or 1005 Subsystem is a powerful processing unit with arithmetic, logical, and editing capabilities allied to a modular 961-character core storage. Standard peripheral units are a 400 cpm or 615 cpm card reader, a line printer operating at 400 lpm or 600 lpm with a 63 character set and 132 character print line width. A card punch operating at 200 cards per minute may also be included. Functions of the standard peripheral units (including the card punch) are available to the UNIVAC 9480 System when this subsystem is in online mode.

Optional units for the offline configuration are a second bank of 961 characters of core storage, a second card reader (400 cpm), a card punch or card read/punch (200 cpm), UNIVAC 1001 Card Controller, paper tape reader (400 cps), a paper tape punch (110 cps), and one or two UNISERVO VI-C Magnetic Tape Units.

A UNIVAC 1004 or 1005 Subsystem can be connected online, by means of one of the eight physical connections of the basic multiplexer channel and a 1004/1005 channel adapter, to the UNIVAC 9480 System to provide card reading, card punching, and printing capability.

A special plugboard is required when the UNIVAC 1004 or 1005 Subsystem is to be used only with the UNIVAC 9480 System. The UNIVAC 1004 or 1005 Subsystem retains its freestanding processing power when used in this configuration. The UNIVAC 1004 or 1005 Subsystem can be switched to offline mode at any time to operate as a standard freestanding system.

By attaching one of several types of line terminals, this subsystem can function as a remote data processor connected through a communications line to the UNIVAC 9480 System. Transmission at speeds of 2000, 2400 or 40,800 bauds is possible, depending upon the types of line terminals and communications facility employed.

For a detailed description of this subsystem, see UNIVAC 1004 and 1005 Description Manuals UP-4052, UT-2541, UT-2543, and UT-3927 (current versions).

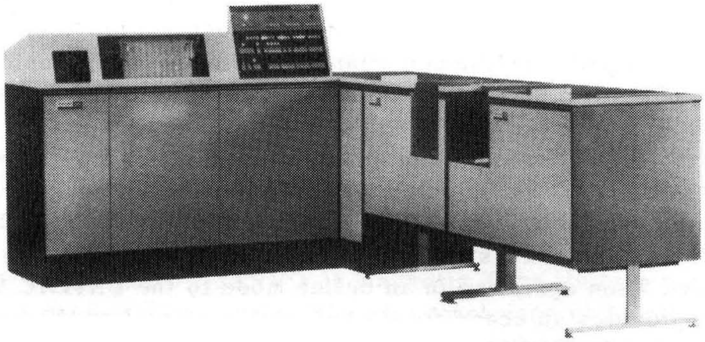
CHARACTERISTICS

ONLINE AND OFFLINE	
CARD READING SPEED	400 or 615 cpm
CARD PUNCHING SPEED	200 cpm
PRINTING SPEED	400 or 600 lpm
PRINTABLE CHARACTERS	63 plus space
NUMBER OF CHARACTERS PER LINE	132
NUMBER OF LINES PER INCH	6 or 8
MAIN STORAGE	961 character positions
NUMBER OF INPUT/OUTPUT CHANNELS USED	1
OFFLINE ONLY	
CARD READING SPEED	400 cpm auxiliary reader or 1000 or 2000 cpm with UNIVAC 1001 Card Controller
MAIN STORAGE	1922 character positions
MAGNETIC TAPE	One or two UNISERVO VI-C Tape Units
MAGNETIC TAPE CODE CONVERSION	Available in UNIVAC 1004 Subsystem using the automatic translate feature
TAPE TRANSFER RATE	8,500; 23,700; and 34,200 characters per second
RECORDING DENSITY	200, 556, or 800 ppi
PAPER TAPE READ	400 characters per second
PAPER TAPE PUNCH	110 characters per second
REQUIRED FEATURES	
PUNCH STACKER SELECT*	
80-COLUMN READ CAPABILITY**	
CODE IMAGE READ**	
CHANNEL ADAPTER	

** If a punch is included in the UNIVAC 1004 or 1005 Subsystem configuration.*

*** If a UNIVAC 1004 or 1005 Subsystem is the only card reading facility in the UNIVAC 9480 System configuration.*

2.5.6. UNIVAC 9200/9200 II/9300/9300 II Subsystem



CHARACTERISTICS

	9200 SUBSYSTEM	9200 II SUBSYSTEM	9300 SUBSYSTEM	9300 II SUBSYSTEM
		ONLINE AND OFFLINE		
MAIN STORAGE	8192 8-bit bytes	8192 8-bit bytes	8192 8-bit bytes	16,384 8-bit bytes
NUMBER OF CHANNELS	One multiplexer I/O subchannel	One multiplexer I/O subchannel	One multiplexer I/O subchannel	One multiplexer I/O subchannel
PRINTING	250/300 lpm (63-character print bar) or 500/600 lpm (16-character numeric font)	250/300 lpm (63-character bar) or 250/500 lpm (16-character numeric font	600 lpm (63-character print font) or 1200 lpm (16-character numeric font)	600 lpm (63-character print font) or 1200 lpm (16-character numeric font)
CARD READING SPEED	400 cpm	400/600 cpm	600 cpm	600 cpm
STUB CARDS	Stub card read (51 and 66 column)	Stub card read (51 and 66 column)	Stub card read (51 and 66 column)	Stub card read (51 and 66 column)
UNIVAC 1001 SUBSYSTEM	1000 cpm	1000 cpm	1000 cpm	1000 cpm
CARD PUNCHING SPEED	75 to 200 cpm (column)	75 to 200 cpm (column) or 200 cpm (row)	75 to 200 cpm (column) or 200 cpm (row)	75 to 200 cpm (column) or 200 cpm (row)
INSTRUCTION EXECUTION	104 microseconds add decimal instruction time (two 5-digit fields)	104 microseconds add decimal instruction time (two 5-digit fields)	52 microseconds add decimal instruction time (two 5-digit fields)	52 microseconds add decimal instruction time (two 5-digit fields)
		OFFLINE ONLY		
PREREAD	Preread in punch feedpath	Preread in punch feedpath	Preread in punch feedpath	Preread in punch feedpath
STACKER SELECT	Punch stacker select control control	Punch stacker select control	Punch stacker select control	Punch stacker select control
MAGNETIC TAPE	Not available	UNISERVO VI-C Magnetic Tape Subsystem	UNISERVO VI-C Magnetic Tape Subsystem	UNISERVO VI-C Magnetic Tape Subsystem
MAIN STORAGE CAPACITY	16,384 8-bit bytes maximum	32,768 8-bit bytes maximum	32,768 8-bit bytes maximum	32,768 8-bit bytes maximum
DISC STORAGE	UNIVAC 8410 Disc Subsystem	UNIVAC 8410, 8411, or 8414 Disc Subsystems	UNIVAC 8410 Disc Subsystem	UNIVAC 8410, 8411, or 8414 Disc Subsystems
COMMUNICATIONS	Data Communications Subsystem	Data Communications Subsystem	Data Communications Subsystem	Data Communications Subsystem
PRINTER LINE SPACING	8 lpi	8 lpi	8 lpi	8 lpi
		REQUIRED FEATURES		
PRINT POSITION REQUIREMENT	132 print positions	Print position expansion	Print position expansion	Print position expansion
INTERCONNECTION REQUIREMENT	Channel Adapter UNIVAC 9200/9300 Subsystems	Channel Adapter UNIVAC 9200/9300 Subsystems	Channel Adapter UNIVAC 9200/9300 Subsystems	Channel Adapter UNIVAC 9200/9300 Subsystems

The UNIVAC 9200, 9200 II, 9300, or 9300 II Subsystem is a standard version of the UNIVAC 9200, 9200 II, 9300, or 9300 II System, respectively. It is connected to the UNIVAC 9480 System by means of a channel adapter housed in the subsystem and attached to one of the eight physical connections provided in the standard multiplexer channel. The channel adapter precludes the inclusion of more than one other internal control unit in the UNIVAC 9200, 9200 II, 9300, or 9300 II System.

This subsystem is a freestanding offline system which may be operated offline or online to the UNIVAC 9480 System and may include all peripheral units and hardware features available in the UNIVAC 9200, 9200 II, 9300, or 9300 II System configurations. The subsystem can be operated offline or online with the UNIVAC 9480 System. When operating in an online mode to the UNIVAC 9480 System, this subsystem provides an economical combination of card reading, card punching, and printing for the UNIVAC 9480 System. However, as a software convention, when the subsystem is used online with the UNIVAC 9480 System, operations must be performed according to the specific requirements and configurations of the UNIVAC 9480 System and the UNIVAC 9200, 9200 II, 9300, or 9300 II Subsystem.

When operating in the online mode, main storage of the subsystem contains a control program to perform card reading, card punching, and printing operations. These operations can be performed simultaneously by the subsystem in either offline or online mode. When operating in offline mode, the UNIVAC 9200, 9200 II, 9300, or 9300 II System may include the use of magnetic tape subsystems, disc subsystems, and Data Communications Subsystems.

When the subsystem is online, I/O operations are initiated from the UNIVAC 9480 System central processor unit by sending functional commands to the subsystem by means of the channel interface. The subsystem accepts these commands and the data transfers in the sequence they were requested. The subsystem instruction set is identical to that of the UNIVAC 9200, 9200 II, 9300, or 9300 II System.

By attaching one of several types of line terminals, this subsystem can function as a remote data processor connected through a communications line to the UNIVAC 9480 System. Transmission at speeds of 2000, 2400 or 40,800 bauds is possible, depending upon the types of line terminals and communications facility employed.

For a description of this subsystem, see *UNIVAC 9200/9200 II/9300/9300 II Systems Description Manual, UP–7806* (current version).

2.5.7. UNISERVO Magnetic Tape Subsystems

Two types of magnetic tape subsystems are available for use with the UNIVAC 9480 System. These are the UNISERVO 12/16 Subsystem and the UNISERVO VI–C Subsystem. The UNISERVO 12/16 Subsystem can be attached to the central processor unit through one or two optional selector channels, while the UNISERVO VI–C Subsystem must be attached through the multiplexer channel. The recording modes employed on all NRZI and phase-encoded tape units are industry standard compatible, thereby ensuring interchangeability of data tapes with tape units of other processors.

2.5.7.1. UNISERVO 12/16 Magnetic Tape Subsystem

A UNISERVO 12/16 Magnetic Tape Subsystem for the UNIVAC 9480 System is available in two forms: UNISERVO 12 Magnetic Tape Subsystem and UNISERVO 12/16 Magnetic Tape Subsystem. The UNISERVO 12 Magnetic Tape Subsystem includes one UNISERVO 12 control unit and accommodates from one to sixteen UNISERVO 12 Magnetic Tape Units. The UNISERVO 12/16 Magnetic Tape Subsystem includes one UNISERVO 12/16 control unit and accommodates from one to sixteen UNISERVO 12 Magnetic Tape Units, UNISERVO 16 Magnetic Tape Units, or any combination of both types of tape units.

Both UNISERVO 12 and UNISERVO 16 Magnetic Tape Units are available in nine-track and seven-track models. The nine-track tape units produce the higher rate of throughput. At this recording level, data is phase encoded in nine-bit frames across the width of the tape. Each frame contains eight data bits plus one parity bit (one byte). The coding scheme for nine-track tapes is EBCDIC, which is the internal code of the central processor.

An optional dual-density feature can be added to the nine-track units. This feature enables each UNISERVO 16 Magnetic Tape Unit, or UNISERVO 12 Magnetic Tape Unit (master unit) and the nine-track slave units it controls, to read and write data in the Non-Return to Zero (NRZI) mode at a density of 800 bytes per inch. When this feature is included, the recording mode and density are controlled through the program instructions.

In the seven-track recording level, data is recorded in seven-bit frames (NRZI only) across the width of the tape. In this case, each frame contains six data bits plus one parity bit. The control unit automatically converts the internal code of the central processor unit (EBCDIC) to or from six-bit (BCD) when seven-track tape units are used. A special data convert feature is required to read and write three eight-bit bytes of information in four six-bit frames. Either method of reading and writing can be selected under program control.

Reading can take place with the tape moving either forward or backward. The ability to read magnetic tape backward in operations such as sorting and merging gives to the system increased processing time that is normally used in rewinding the tape reel.

Writing can take place when the tape is moving in a forward direction only. The number of records to be included in each record block is established through directives to the operating system; the block size can be up to 4096 bytes in length. A minimum block size of 18 bytes is imposed when recording in seven- or nine-track NRZI (compatible) mode to allow automatic detection of noise blocks.

Optional features are available to produce concurrent execution of multiple tape functions in addition to rewind. These simultaneous operation features must be added to the control unit, to each UNISERVO 12 master unit, and to each UNISERVO 16 Magnetic Tape Unit. When these features are included, the subsystem must be connected to the central processor unit through two selector channels. In this configuration, simultaneous read/read, read/write, and write/write capability is provided for UNISERVO 16 Magnetic Tape Units. Also, simultaneous read/read and read/write capabilities are provided for UNISERVO 12 Magnetic Tape Units; simultaneous write/write capability on two UNISERVO 12 Magnetic Tape Units is available through separate master units.

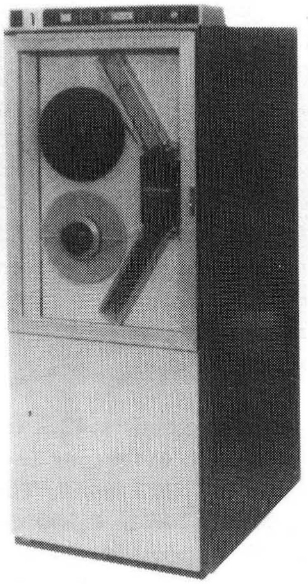
UNISERVO 12/16 Magnetic Tape Control Units can be accessed by two selector channels; therefore, a second central processor unit can be interfaced with the same bank of magnetic tape units. In this configuration, auxiliary storage is provided for two independent UNIVAC 9480 Systems; however, the magnetic tape subsystem can be accessed by only one processor at a time. Subsystem characteristics are summarized in Table 2–4.

A parity check is performed for each character and block (horizontal and vertical) read or written. A read-after-write head allows immediate verification of all data written.

MODEL	COMBINATION OF COMPONENTS	DATA TRANSFER RATE	PULSE DENSITY	RECORDING MODE
UNISERVO 16 Magnetic Tape Units (9-Track)	Standard	192,000 bytes per second	1600 ppi	Phase Encoded
	Standard plus Dual Density 1 per Control and 1 per Tape Unit	96,000 bytes per second	800 ppi	NRZI
UNISERVO 16 Magnetic Tape Units (7-Track)	Standard	96,000 characters per second	800 ppi	NRZI
UNISERVO 12 Magnetic Tape Units (9-Track)	Standard	68,320 bytes per second	1600 ppi	Phase Encoded
	Standard Plus Dual Density 1 per Control and 1 per Master Unit	34,160 bytes per second	800 ppi	NRZI
UNISERVO 12 Magnetic Tape Units (7-Track)	Standard (density under control of the read/write instructions)	34,160 characters per second	800 ppi	
		23,740 characters per second	556 ppi	NRZI
		8,540 characters per second	200 ppi	

Table 2–4. UNISERVO 12/16 Magnetic Tape Subsystem Characteristics

2.5.7.1.1. UNISERVO 12 Magnetic Tape Unit



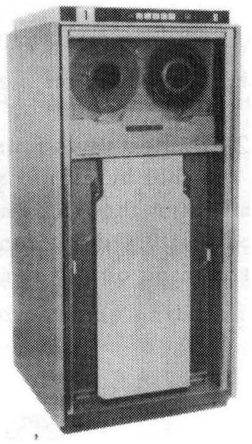
CHARACTERISTICS	
TAPE SPEED	42.7 inches per second
TAPE DIRECTION READING WRITING	 Forward or backward Forward
TAPE WIDTH	0.5 inch
TAPE LENGTH	2,400 feet
THICKNESS	1.5 mils
BLOCK LENGTH	Variable
INTERBLOCK GAP	0.75 inch (7-track) 0.6 inch (9-track)
INTERBLOCK GAP TIME (7-TRACK)	17.6 milliseconds (non-stop) 23.6 milliseconds (start-stop)
INTERBLOCK GAP TIME (9-TRACK)	14.1 milliseconds (non-stop) 20.1 milliseconds (start-stop)
REVERSAL TIME	25 milliseconds
REWIND TIME	3 minutes (2,400 feet)
DUAL DENSITY	Optionally available
SIMULTANEOUS OPERATION	Optionally available

The UNISERVO 12 Magnetic Tape Unit is a low-cost tape handler with moderate speed. The master/slave concept is employed in the logic of these units. The master unit, having the power supply and control circuitry, governs up to three additional slave units. There are no differences in programming for master or slave units. UNISERVO 12 Magnetic Tape Units can be added to the subsystem one at a time providing the first unit is a master unit. A combination of three slave units and a master unit is called a quad.

UNISERVO 12 Magnetic Tape Units are available in both nine-track and seven-track models. The nine-track tape units read and write data in the phase encoded mode at a density of 1600 bytes per inch. If the optional dual-density feature is added, the nine-track units can also write at 800 bytes-per-inch density. The seven-track UNISERVO 12 Magnetic Tape Units read and write in NRZI mode only. These units can be programmed to read and write data at densities of 200, 556, or 800 frames per inch.

The physical tape passing speed is 42.7 inches per second, giving nine-track tape a transfer rate of 68,320 bytes per second in the phase encoded mode, or 34,160 bytes per second in NRZI mode. The seven-track tape units transfer data in NRZI mode at 34,160, 23,740 or 8,540 characters per second, depending upon the density selected.

2.5.7.1.2. UNISERVO 16 Magnetic Tape Unit



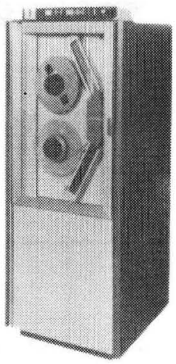
CHARACTERISTICS	
TAPE SPEED	120 inches per second
TAPE DIRECTION READING WRITING	 Forward or backward Forward
TAPE WIDTH	0.5 inch
TAPE LENGTH	2,400 feet
THICKNESS	1.5 mils
BLOCK LENGTH	Variable
INTERBLOCK GAP	0.75 inch (7-track) 0.6 inch (9-track)
INTERBLOCK GAP TIME (7-TRACK)	6.25 milliseconds (non-stop) 9.25 milliseconds (start-stop)
INTERBLOCK GAP TIME (9-TRACK)	5.0 milliseconds (non-stop) 8.0 milliseconds (start-stop)
REVERSAL TIME	10 milliseconds
REWIND TIME	2 minutes (2,400 feet)
DUAL DENSITY	Optionally available
SIMULTANEOUS OPERATION	Optionally available

The UNISERVO 16 Magnetic Tape Unit is a high-performance tape unit. These units can be added to the subsystem individually until the maximum of 16 is reached. UNISERVO 16 Magnetic Tape Units are available in nine-track and seven-track models.

The UNISERVO 16 Magnetic Tape Unit reads and writes data in phase encoded mode at 1600 bytes per inch. If the optional dual-density feature is added, the nine-track units can also write data in NRZI mode at 800 bytes per inch. The seven-track model reads and records data in NRZI mode at a density of 800, 556, or 200 characters per inch, depending on the density selected.

Physical tape speed is 120 inches per second, giving the nine-track tape unit a maximum transfer rate of 192,000 bytes per second in the phase-encoded mode, or 96,000 bytes per second when the NRZI mode is used. Seven-track tape is recorded only in NRZI mode with a data transfer rate of 96,000, 66,720, or 24,000 characters per second, depending on the density selected.

2.5.7.2. UNISERVO VI-C Magnetic Tape Subsystem



CHARACTERISTICS	
TAPE SPEED	42.7 inches per second
TAPE DIRECTION READING WRITING	 Forward or backward Forward
TAPE WIDTH	0.5 inch
TAPE LENGTH	2,400 feet
THICKNESS	1.5 mils
BLOCK LENGTH	Variable
INTERBLOCK GAP	0.6 inch (9-track)
INTERBLOCK GAP TIME	14.1 milliseconds (non-stop) 20.1 milliseconds (start-stop)
REVERSAL TIME	25 milliseconds
REWIND TIME	3 minutes (2,400 feet)
SIMULTANEOUS OPERATION	Optionally available (with second subsystem)

The UNISERVO VI-C Subsystem is a low-cost, nine-track magnetic tape subsystem suitable for use with the UNIVAC 9480 System. This subsystem consists of a control unit and two magnetic tape units. The master/slave concept is employed in the logic of the UNISERVO VI-C Subsystem. The master unit, having the power supply and control circuitry, governs the functions of a slave unit; however, each unit is treated alike from a programming or operating system viewpoint. Subsystem characteristics are summarized in Table 2–5.

UNISERVO VI-C Magnetic Tape Units record data in eight-bit EBCDIC code. Each frame recorded across the width of the tape contains eight data bits plus a parity bit. Data is recorded in NRZI mode at a density of 800 bytes per inch.

MODEL	COMBINATION OF COMPONENTS	DATA TRANSFER RATE	PULSE DENSITY	RECORDING MODE
UNISERVO VI-C (9-track)	Standard	34,160 bytes per second	800 ppi	NRZI

Table 2–5. UNISERVO VI-C Magnetic Tape Subsystem Characteristics

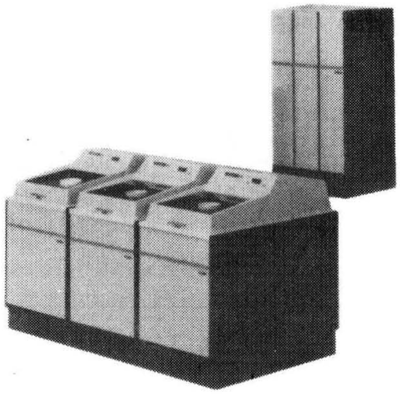
2.5.8. UNIVAC Disc Subsystems

The availability of two different disc subsystems enables the user to choose the disc storage facilities best suited to the installation. These facilities include the lower cost UNIVAC 8414 Disc Subsystem and the high performance, large capacity UNIVAC 8424 Disc Subsystem.

A disc subsystem is attached to the processor by means of a selector channel. These subsystems offer many advantages in standard data processing as well as in communications operations, especially in applications where rapid file processing is more prevalent. Large storage capacity is combined with rapid accessibility to provide convenient intermediate storage. Removable and interchangeable disc packs permit the user to store much of the total file capacity offline.

These subsystems allow an installation to make use of an extensive operating system without undue main storage utilization or loss of operating efficiency. The rapid access time of the subsystems permits lesser used program segments to be stored externally and read into main storage only when required. This arrangement affords efficient usage of main storage. Because the operating system is disc oriented, handling, access, and transfer time required for compiling or assembling programs and for input/output operations is reduced. This allows all the magnetic tape units to be used to meet primary input/output data demands.

2.5.8.1. UNIVAC 8414 Disc Subsystem



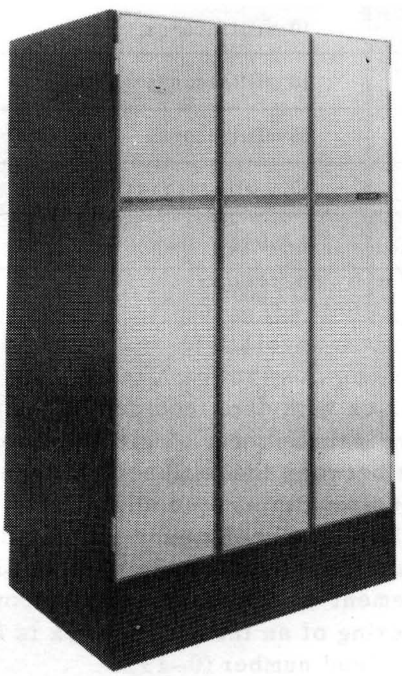
CHARACTERISTICS	
NUMBER OF DISC DRIVE UNITS PER SUBSYSTEM	2–8
NUMBER OF DISC DRIVE UNITS PER CABINET	1
NUMBER OF R/W HEAD ACCESSOR MECHANISMS	1
NUMBER OF R/W HEADS PER DISC DRIVE UNIT	20
NUMBER OF TRACKS PER DISC SURFACE*	203
NUMBER OF RECORDING SURFACES PER DISC DRIVE UNIT	20
NUMBER OF ADDRESSABLE TRACKS PER SURFACE	200
NUMBER OF ADDRESSABLE TRACKS PER DISC DRIVE UNIT	4000
MAXIMUM NUMBER OF BYTES PER TRACK	7294
CAPACITY (8-BIT BYTES PER DISC PACK)	29,176,000
MINIMUM ARM POSITIONING TIME	20 milliseconds
AVERAGE ARM POSITIONING TIME	60 milliseconds
MAXIMUM ARM POSITIONING TIME	130 milliseconds
MINIMUM LATENCY TIME	0 milliseconds
MAXIMUM LATENCY TIME	25 milliseconds
AVERAGE ACCESS TIME	72.5 milliseconds
MAXIMUM ACCESS TIME	155 milliseconds
DISC DRIVE SPEED	2400 rpm
STORAGE TRANSFER RATE	312,000 bytes per second

* Capacity includes three alternate tracks that can be used if any of the 200 addressable tracks become defective.

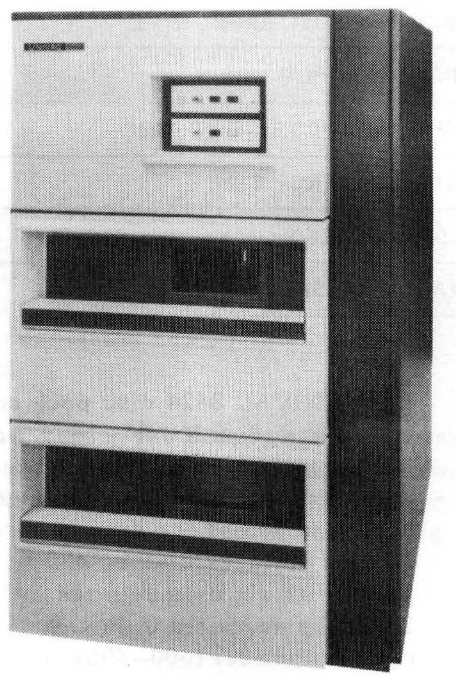
Each UNIVAC 8414 disc pack contains 11 discs with the data recorded on 20 inside surfaces. Twenty read/write heads are mounted on a single accessor mechanism which moves the heads in unison between the periphery and the central area of the disc. The accessor mechanism can assume any one of 203 positions across the disc surface; this simultaneous head movement on the 20 disc surfaces creates 200 addressable data recording cylinders in the disc pack, with three cylinders reserved for replacement tracks. Each cylinder contains 20 tracks numbered 0 through 19. The addressing of an individual track is by cylinder number (000–202) and by read/write head number (0–19).

The 8414 Disc Subsystem has an optional feature which permits simultaneous operation of two disc drives.

2.5.8.2. UNIVAC 8424 Disc Subsystem



CONTROL UNIT

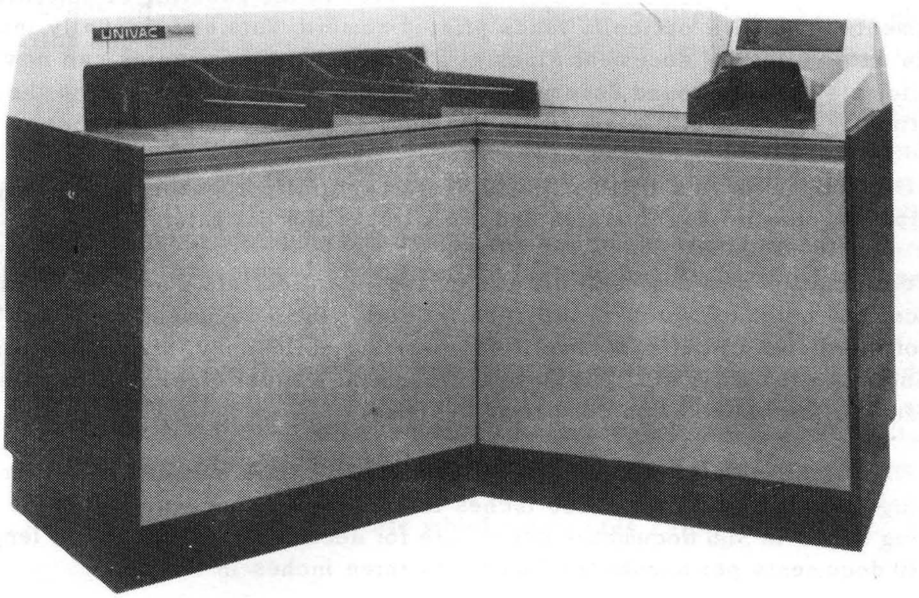


DISC STORAGE UNIT

CHARACTERISTICS	
NUMBER OF DISC STORAGE UNITS PER CONTROL UNIT	1–4
NUMBER OF DISC DRIVES PER STORAGE UNIT	2
NUMBER OF R/W HEAD ACCESSOR MECHANISMS	1
NUMBER OF R/W HEADS PER ACCESSOR MECHANISM	20
NUMBER OF TRACKS PER DISC SURFACE	406
NUMBER OF RECORDING SURFACES PER DISC PACK	20
NUMBER OF ADDRESSABLE TRACKS PER SURFACE	400
NUMBER OF ADDRESSABLE TRACKS PER DISC PACK	8,000
MAXIMUM NUMBER OF BYTES PER TRACK	7,294
CAPACITY (8-BIT BYTES PER DISC PACK)	58,352,000
MINIMUM ARM POSITIONING TIME	10 milliseconds
AVERAGE ARM POSITIONING TIME	30 milliseconds
MAXIMUM ARM POSITIONING TIME	55 milliseconds
AVERAGE LATENCY TIME	12.5 milliseconds
DISC DRIVE SPEED	2,400 rpm
STORAGE TRANSFER RATE	312,000 bytes per second

Each UNIVAC 8424 disc pack contains 11 discs with data recorded on the 20 inside surfaces. Twenty read/write heads are mounted on a single accessor mechanism which moves the heads in unison between the periphery and the central area of the disc. The accessor mechanism can assume any one of 406 positions across the disc surface; this simultaneous head movement on the 20 disc surfaces creates 400 addressable data recording cylinders in the disc pack, with six cylinders reserved for replacement tracks. Each cylinder contains 20 tracks numbered 0 through 19. The addressing of an individual track is by cylinder number (000–405) and by read/write head number (0–19).

2.5.9. UNIVAC 2703 Optical Document Reader (ODR) Subsystem



CHARACTERISTICS	
DOCUMENT FEED RATE	300 documents per minute for OCR documents 6 inches in length
DOCUMENT SIZES AND WEIGHTS	Height—2.75 to 4.25 inches Length—3 to 8.75 inches Paper weights—20- to 62-pound paper, based on a ream (500 sheets) of 17- by 22-inch paper
HOPPER	One provided — documents may be loaded while reader is operating
OPTICAL CHARACTER RECOGNITION	Reads a single printed line of numeric data and special symbols
FONT RECOGNITION	UNIVAC H-14 font or numeric subset of USASCSOCR at customer selection
STACKERS	Three provided — stacker selection under program and hardware control
FEATURES	600-document-per-minute speed upgrade Modulus 10 check digit verification Mark read Punch card read Validity check

The UNIVAC 2703 Optical Document Reader (ODR) Subsystem provides UNIVAC 9480 System users with an additional and unique type of input medium. It is unique in that it represents a major advancement in the handling of optically read documents. The ODR optically reads printed numeric data and manually inscribed marks on a variety of document sizes at low cost. More companies can now afford to automate the turnaround document applications which are common in the public utilities, insurance, oil, retail trade, banking, and publishing industries.

The ODR connects to a UNIVAC 9480 System central processor unit by way of a multiplexer channel and operates under control of the computer.

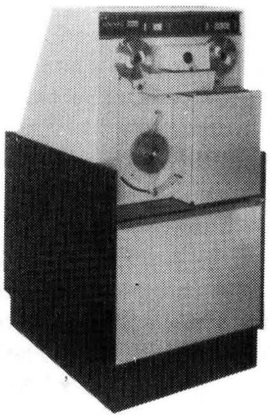
The combination of a dual-belt document feed, a solid-state photoelectric sensing device, and carousel stackers provides for very gentle document handling. The use of integrated circuits, a simplified operating philosophy, and contemporary styling make the UNIVAC 2703 Optical Document Reader highly compatible with the Univac third generation computing systems.

The ODR is capable of reading printed numeric and mark encoded data from documents ranging in size from 2.75 by 3.00 inches to 4.25 by 8.75 inches. The basic document reading speed is 300 documents per minute for documents six inches in length and up to 350 documents per minute for documents three inches in length.

Other optional features offered with the ODR include a 600-document-per-minute speed upgrade, modulus 10 check digit verification, mark read, punch card read, and validity check.

The UNIVAC H–14 font is used with the ODR; however, the United States of America Standard Character Set for Optical Character Recognition (USASCSOCR) Size A font is offered to the customer as an option.

2.5.10. UNIVAC 0920 Paper Tape Subsystem



CHARACTERISTICS	
TAPE READING SPEED	300 characters per second (with tape punched 10 characters per inch)
TAPE PUNCHING SPEED	110 characters per second (with tape punched 10 characters per inch)
TAPE WIDTH	11/16 inch or 1 inch
PAPER TAPE CODES	5-level (11/16 inch tape) 5-, 6-, 7-, or 8-level (1 inch tape)
AVERAGE REWIND ON TAPE SPOOLER	40 inches per second
I/O CHANNEL	1 shared multiplexer subchannel

The UNIVAC 0920 Paper Tape Subsystem consists of a control unit, a paper tape reader with a reader synchronizer and/or a paper tape punch with a punch synchronizer. The control unit provides the necessary synchronization and interface between the reader and/or punch synchronizer(s) and the UNIVAC 9480 System. The synchronizer unit(s) regulate the transfer of data between the tape reader or tape punch and the control unit. The entire subsystem is housed in a freestanding cabinet and is connected to the UNIVAC 9480 System central processor unit by means of one of the eight physical connections provided in the standard multiplexer I/O channel.

The control unit handles paper tape codes of five, six, seven, or eight levels. During the reading or punching of less than eight levels, all data is enclosed in the least significant bit positions of the byte, and the control unit zerofills any unused most significant bit positions. The reading and punching of binary data from paper tape is possible and is selected by program option. When reading and punching binary data, the program connector is bypassed and all eight levels of the tape character are transferred to main storage with tape channels 1 through 8 corresponding to bit positions 7 through 0, respectively. The translation of all paper tape codes to EBCDIC is performed by the software.

Simultaneity of read and punch operations is accomplished by connecting two control units to the paper tape subsystem.

Spooling features are optional for both the tape reader and tape punch. The tape spooler hubs for the tape reader can accommodate snap-on supply and take-up reels of 5-inch diameter (300-foot capacity). The tape take-up spooler hub for the tape punch can accommodate snap-on reels of 5-inch diameter; a larger hub is used to accommodate snap-on reels of 8-inch diameter (1000-foot capacity).

2.5.11. UNISCOPE 100 Display Terminal

UNISCOPE 100 Display Terminal

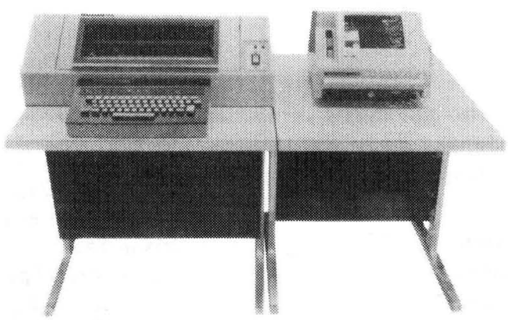
CHARACTERISTICS

NUMBER OF TERMINALS	1–31
DISPLAY CAPACITY	480, 512, 960, or 1024 characters
DISPLAY FORMAT	32 characters per line x 16 lines 64 characters per line x 16 lines 80 characters per line x 12 lines 80 characters per line x 6 lines
DISPLAY CHARACTER SET	96 symbols
KEYBOARD	Numeric, alphanumeric, or combination of numeric and alphanumeric 8 cursor control keys 5 editing keys
CONTROLLER STORAGE CAPACITY	1024 seven-bit characters
DATA TRANSFER RATE	Dependent on interface
INTERFACE	Communication (telephone) line RS 232B synchronous Western Electric 201A–2000 bps Western Electric 201B–2400 bps Western Electric 203 –Up to 9600 bps Collins TE 216A –Up to 4800 bps Lenkurt 26C –Up to 2400 bps Milgo 4400/4800 –Up to 4800 bps Rixon Sebit –Up to 4800 bps RS 232B asynchronous Western Electric 202C Western Electric 202D MIL 188B with clock MIL 188B synchronous CCITT synchronous or asynchronous Computer channel interface Multiplexer Interface Parallel interface (for printer connection)

The UNISCOPE 100 Display Terminal is a two-way remote terminal device that makes it possible to hold direct data communication with the central processor unit. Each terminal is keyboard operated and contains a cathode ray tube for message display. The keyboard includes a typewriter, cursor control, and editing keys. The cathode ray tube displays central processor unit output messages, and displays input messages for composition and editing before being transmitted to the central processor unit. Each character entered by an operator is immediately displayed and stored in the control unit storage.

The UNISCOPE 100 Display Terminal provides input/output message buffering, refresh storage, character generation, and control logic. Special interfaces for direct central processor unit connection and hard-copy output are available. A variety of presentation formats are offered which provide a total display capacity of 480, 512, 960, or 1024 characters. Because of its modular construction, the UNISCOPE 100 Display Terminal can operate either as a data entry or as a display device and can be conveniently located at the central processor unit, or at a remote station where it is connected to the system by way of telephone lines. Up to 31 UNISCOPE 100 Display Terminals may be connected to a single communication line or to a UNIVAC 9480 System Multiplexer Channel/DCS by means of the UNISCOPE 100 Multiplexer and Channel Expansion feature. This general purpose feature is available for use with all of the communication line interfaces provided on the UNISCOPE 100 Display Terminal, thus permitting a mixture of single and multiple units on one communications system. The feature also provides broadcasting of output messages to multiple devices.

2.5.12. UNIVAC DCT 500 Data Communications Terminal



CHARACTERISTICS

TRANSMISSION CODE	8-level ASCII
INTERFACES	EIA Standard RS-232/CCITT Internal Modem
TRANSMISSION MODE	Half-duplex or full-duplex (2- or 4-wire)
TRANSMISSION RATE	110, 150, or 300 bits per second (selectable)
PRINTING RATE	30 characters per second
FONT SELECTIONS	ASCII, EBCDIC A (Business)/H (Scientific)
PRINTABLE CHARACTERS	63 plus space
PRINT POSITIONS PER LINE	132 (adjustable tractor)
PAPER TAPE READER/PUNCH RATE	50 characters per second

The UNIVAC DCT 500 Data Communications Terminal is a low-cost, unbuffered, asynchronous keyboard/printer terminal similar in operation to a teletypewriter, and provides up to 132-column format and five carbons. The UNIVAC DCT 500 can replace existing teletypewriters with little or no changes in the software handlers for point-to-point communications networks over voice-grade telephone toll lines or private lines. In a multiparty polled environment the UNIVAC DCT 500 operates in accordance with ASCII procedures

The UNIVAC DCT 500 can operate in a receive-only mode, a keyboard send/receive mode, or an automatic send/receive mode. The basic printer system (minimum equipment) can be expanded to include a keyboard and a 1-inch paper tape read/punch unit at any time. Additional optional equipment is available to allow for multistation operation.

The optional features include:

- Automatic answering
- Master/slave operation
- Print monitor
- Internal modem
- Paper tape

2.5.13. UNIVAC DCT 1000 Data Communications Terminal

CHARACTERISTICS	
CARD READING SPEED	40 cards per minute
CARD PUNCHING SPEED	35 cards per minute
PRINTING SPEED	30 characters per second
PRINTING POSITIONS PER LINE	132 (adjustable tractor)
PRINTABLE CHARACTERS	63 plus space
PAPER TAPE SPEEDS	50 characters per second
BUFFER STORAGE	320 character capacity in two buffers, 160 characters each
TRANSLATOR SELECTIONS	ASCII Code EBCDIC H (Scientific) Code EBCDIC A (Business) Code Binary with additional feature
TRANSMISSION METHOD	Block by block
TRANSMISSION MODE	Half-duplex; 2- or 4-wire (nonsimultaneous; two-way transmission)
TRANSMISSION FACILITIES	Voice-grade telephone toll exchange or private line
TRANSMISSION RATE	Synchronous 300, 1200, or 1800 bits per second; synchronous 4800 bits per second

The UNIVAC DCT 1000 Data Communications Terminal is a fully buffered, 30 character-per-second incremental printer that can be expanded to include a keyboard, card reader, card punch, paper tape reader/punch, and an auxiliary printer. The UNIVAC DCT 1000 Data Communications Terminal transmits data or receives data from a local or remote processor or to a remote terminal in a conversational or batch mode.

2.5.13.1. Data Buffers

Two 160-character buffers are standard on the UNIVAC DCT 1000 Data Communications Terminal. These buffers facilitate the following:

- Automatic blocking

  This eliminates complicated and time-consuming operator functions and minimizes training.

- Automatic error correction

  This eliminates manual correction protection procedures such as reloading cards and retyping input data.

- Error-free output

  All messages are completely checked for character errors, block errors, duplicate blocks, or lost blocks; the result is that no errors are entered in the output medium.

- High transmission speeds

  The full capability of the line can be utilized because the transmission rate can be much higher than the I/O rate. On party line systems, this yields data throughput on a line which is the sum of the throughputs of the individual terminals.

2.5.13.2. Polling System

The UNIVAC DCT 1000 Data Communications Terminal has complete polling and address recognition capabilities, which allows the processor to completely control up to 31 terminals on a single line. The terminals may be connected in a series string in different geographical locations or at a single point on the UNIVAC Terminal Multiplexer.

3. PROGRAMMED SYSTEMS SUPPORT

3.1. OPERATING SYSTEM

The software systems support provided for the UNIVAC 9480 System has been designed to meet the total computing and operating requirements of today's advanced data processing problems. The data processing capabilities of the system are carefully controlled and directed by means of comprehensive software packages that provide strong operating links between the UNIVAC 9480 System power and the user data processing problems. The degree of effective utilization of any computing system is in direct proportion to the scope and versatility of the software. In developing the UNIVAC 9480 System, Univac has drawn upon many years of experience in multi-programming, and communications oriented systems. The result is a system easy to operate and easy to use; yet it is a system which ensures user program integrity in a demanding business environment.

3.1.1. Supervisor

The Supervisor within the operating system of the UNIVAC 9480 System is responsible for the administration of control commands to the computer system. It coordinates all input/output activity and other services provided by components of the operating system. It schedules processing time to the many jobs in a multi-programming environment and then supervises the execution of these jobs.

The major unit of work in the UNIVAC 9480 System is considered a job; each job can be subdivided into job steps or individual programs. The Supervisor exercises a serial control over the job steps and at the same time applies a parallel control to the various jobs so that they may be executed concurrently.

The Supervisor is designed in such a way that it is easy to use in any data processing situation, provides maximum utilization of the computer's facilities, and handles problems directly, efficiently, and promptly with the major portion of time allotted to the user's programs.

3.1.1.1. Multiprogramming

The Supervisor permits concurrent processing of user programs with system functions. In disc-oriented systems, a Supervisor can be generated to control from one to five problem programs being executed concurrently in the computing system. In tape-oriented systems, a Supervisor can be generated to control one or more symbiont programs in addition to the execution of one main problem program. Many Supervisor functions in both disc-oriented and tape-oriented systems are designed as autonomous activities capable of being executed as independent programs.

The multiprogramming technique employed in this system involves the distribution of processing time to programs based on program priorities, time allocation, and input/output utilization.

Program synchronization is accomplished through the combined operation of the interrupt handlers and the program switching routine, and is controlled by time allocation with the facilities provided by the unique seven-level interrupt structure of the UNIVAC 9480 System. Thus the Supervisor provides the user with efficient and equitable distribution of processing time to programs being executed in the system.

Five program priorities are provided by the Supervisor. Three of these program priorities are intended for the following types of user programs:

- Problem Program Priority Level 1 – Message control program. The highest priority level available to the user is intended for the time-critical message control program required by systems involved in data communications processing. Essentially, this program is an extension of the Supervisor, provided as an element of the software package in the form of Procs, parametrically defined by the user to suit his data communications applications, and loaded into the system by Job Control.

- Problem Program Priority Level 2 – Batch programs with high input/output utilization.

  The majority of batch-type programs involving frequent input/output utilization is assigned to the second level of user priority. Symbiont programs, executed under control of the tape operating system, may be assigned to this program priority. In tape systems, it is suggested that the main program be assigned to problem program priority 3, even though it may be considered a batch program. This is not a requirement because programs on a given priority level are cycled by means of time allocation.

- Problem Program Priority Level 3 – Batch programs with low input/output utilization.

  User programs, which are primarily of the computational type with low input/output utilization, are assigned to the lowest user-priority level. In tape systems, the main program can be, and usually is, assigned to this program priority level.

The user can designate priority levels in the job control stream by specifying level 1, 2, or 3 according to the known requirements of the problem programs. Actually, there are no restrictions as to the uses of user-priority levels 2 and 3. User's experience in program mixing will determine the particular uses of these two priority levels.

3.1.1.2. Timer and Simulated Day Clock Services

The millisecond timer is a standard hardware feature of the UNIVAC 9480 System central processor unit. The timer services routine provides various services by means of this timer. Timer services provided by the Supervisor are:

- Time Allocation

  The division of processing time to the jobs on a given program priority level is controlled through time allocation; that is, each job is given equal time on a cyclic basis so that all jobs on a given priority level may operate concurrently and share the full processing power of the central processor unit.

Time allocation is automatically provided for all programs using the time values supplied by the user at systems generation time. These time intervals can range from 10 to 4000 milliseconds. Each time the program switcher activates a problem program, it requests an allotment of processing time from the timer services routine. This request results in setting a software alarm clock that, when time expires, causes the program switcher to gain control. If the program does not voluntarily surrender control to the central processor before its time interval expires, an interrupt is generated and the program switcher routine is given program control to determine if another program of equal priority is ready to accept program control.

- Job Accounting

  The estimated maximum run time for each problem job may be submitted to the system. If an estimated run time is not submitted in this manner, a standard job time limit set by the user at system generation time is used. When program control is taken from a problem program, the timer services routine adds the amount of time used to a time counter in the job preamble. The total elapsed processing time is then compared to the estimated run time for the job. If the estimated run time is reached, a message is printed at the system console to notify the operator of this condition. The operator can then allot more processing time to the job or initiate abort procedures.

- Time of Day

  A day clock is simulated by the timer services routine that is accessible to problem programs. The millisecond time of day, as a binary integer, or the hours-and-minutes time of day, in packed decimal format, can be retrieved. In addition to these services, the hours-and-minutes time of day is also maintained in EBCDIC in the form hh:mm and is printed as a prefix to all console messages. This time is also printed when the ATTENTION key is depressed at the system console.

- Software Timer Alarms

  Each program in the system can request notification upon the expiration of a specified interval of time.

3.1.1.3. Shared Routine Coding

Routines may be used by more than one problem program in the multiprogramming environment. Control and linkage are functions of the Supervisor, employing two techniques. These techniques are:

- Serially reusable routines – requests for use are queued, then executed in sequence of job priority.

- Re-entrant coding – allows for concurrent execution of routines by two or more requesting jobs. This facility is available only for the data management portions of the operating system.

3.1.1.4. Operator Communication

Facilities are provided to permit communication between the operator and Supervisory or problem program. All messages are printed at the operator's console and may be automatically time stamped by means of the operator communications functions of the Supervisor.

Supervisor messages to the operator are full text messages either stating that operator intervention or choice is required before processing can resume or providing information for inclusion in the system's chronological log. Operator messages to the Supervisor are either replies to previous messages issued by the Supervisor or commands directing the Supervisor in its operations. The format and content of the reply depend upon requirements of the Supervisor message being answered.

3.1.1.5. Transient Area Management

The Transient Scheduler routine coordinates all activity between calling programs and transient routines. Transient routines are self-relocating, stored as absolute load modules on the system resident device, and loaded into system transient areas of main storage only when needed by the operating system or problem programs. Transient routines are considered logical extensions of the calling programs but are executed as system priority level 3. All transient routines are designed to operate within a single main storage transient area provided by the Supervisor. In cases where transient routines exceed the size of a transient area, overlay segments are retrieved; therefore, the effective size of transient routines is virtually unlimited.

The user can select certain transient routines at system generation time for inclusion in the main storage resident portion of the Supervisor to reduce the retrieval time and thereby increase the efficiency of the system. This may be desirable because of differences in the user's program response requirements, the size of available main storage, and the frequency of use of certain supervisory facilities.

Examples of the type of functions performed by transient routines are:

- Data Management – Open and Close files
- Job Control – Cancel, end-of-job, and subroutines required when establishing jobs in the system
- Supervisor – Checkpoint, certain operator commands, and extensions of supervisory functions

Communications between problem programs or the operating system and the transient scheduler are accomplished by the use of macro instructions.

- Disc Systems

  Transient routines in disc systems are stored in a reserved portion of the execution area on the system resident disc device at system generation time, so that they can be quickly and efficiently located when requested.

- Tape Systems

  Transient routines in tape systems are stored in the load library on the system resident device. Constructing a system resident tape is a function of the UNIVAC 9480 Librarian. Transient routines are stored in object load module format and may be interspersed with other load modules of the operating system and user programs. To reduce the amount of time required to retrieve transient routines, the user may choose to repeat certain routines at strategic places on the system tape.

  As a system convention, the names of all transient routines begin with the character $, because it is assumed that the user may desire to repeat the system transient functions in a single load library. This convention is established by the UNIVAC 9480 Librarian and is used to direct the program locator to search forward on the assumption that another copy of the requested routine may be present before the end of the load library is reached. If the load library is reached without having found the requested transient, the system tape is positioned at the beginning of the load library and a forward search is initiated.

3.1.1.6. Interrupt Handling

The decoding and processing of all machine interrupts are handled automatically by the interrupt handler function of the resident Supervisor and are of no concern to the programmer when writing a problem program. Seven types of interrupts can be processed by the interrupt handler in the order of their priority:

- Supervisor Call (SVC) – initiated by encountering a Supervisor Call instruction in the problem program. The SVC instruction is used as a means of communication from the problem program to the Supervisor.

- Program – this interrupt occurs under the following conditions:

  – Illegal operation

  – Privileged operation attempted in the problem state

  – Attempting to write data in main storage outside of the bounds specified by the limits register

  – A reference to low-order storage while in the problem state

  – Binary arithmetic overflow

  – Decimal arithmetic overflow

  – A quotient digit formed with a nonnumeric hexadecimal value.

- Timer – when the timer is decremented to binary zeros, a hardware interrupt occurs and the timer continues to count through zero.

- Selector Channel 1 – the fourth level of interrupt and the highest associated with I/O operations. An interrupt occurs whenever channel 1 requires servicing by the software.

- Selector Channel 2 – the fifth level of interrupt and second for I/O operations. An interrupt occurs whenever channel 2 requires servicing by the software.

- Shared Multiplexer Subchannel – level six interrupt. An interrupt occurs whenever a low speed onsite peripheral device requires servicing by the software.

- Nonshared Multiplexer Subchannel – lowest level interrupt. An interrupt occurs whenever a remote line terminal requires servicing by the software.

3.1.1.7. Input/Output Control System (IOCS)

All activity between the central processor unit and its peripheral devices is controlled by a group of routines known as the channel scheduler, which provides I/O queuing, dispatching, posting, and error detecting services.

The programmer can communicate directly with the channel scheduler by using physical IOCS macro instructions. Whenever these macros are used, the programmer must supply the channel command words and provide any of the logical functions required by the problem program, such as blocking and deblocking records, checking for wrong length records, swapping buffer areas, and detecting and bypassing checkpoint records if they are interspersed with data records.

3.1.1.8. Disc Auxiliary Storage

The availability of disc auxiliary storage for use by the operating system has increased the processing power of the UNIVAC 9480 System. The designers of the operating system have, at every opportunity, taken advantage of this feature. The user can select certain routines at system generation time for inclusion in main storage to reduce retrieval time and thereby increase the efficiency of the system. The two functional types of routines in the Supervisor control program are:

- Resident Routines

  This category comprises those routines that are frequently used by the Supervisor and require permanent residence in main storage. This category is referred to as the resident portion of the Supervisor.

- Transient Routines

  This category comprises those routines not frequently used and which can be kept in disc auxiliary storage and loaded into main storage only when needed. Routines in this category are designed to function in special main storage transient areas reserved for the operating system. When needed, a transient routine is located in an index of transient routines, read from the resident disc auxiliary storage into a main storage transient area, executed as an extension of the requesting program, and, if not needed immediately by another program, released from the transient area. Transient routines are serially reusable and self-initializing.

3.1.2. Data Management

Data Management is that part of the software that provides a convenient and easy-to-use interface between problem programs and the hardware-oriented I/O portions of the Supervisor. The Data Management facilities provide organizational benefits such as record blocking and deblocking, buffering, data validation, and label processing.

Many aspects of file processing are common, although the data contained in the files is vastly different. To exploit the similarity evident in so many file processing programs and utilize this similarity to a much greater degree than on other systems, the Data Management facilities consist of subprograms of common code that are part of the operating system. At system generation time, the user selects those subprograms, or parts of subprograms, that are needed to process the specific files. The result is a saving in storage space by having only one file processor program for all the files rather than several repetitive file processor programs tailored to each specific file. To further increase efficiency, specialized linkages are provided between the user's file table, generated by the Define The File macro instructions, and the subprograms of common coding. These linkages are generated in sequences peculiar to the Define The File call. This eliminates large areas of slow interpretative code. Thus the user has the advantage of common code balanced in an efficient combination of declarative and interpretative code.

The initiation and termination procedures for file processing (OPEN and CLOSE) are necessarily long and exacting, and involve a large amount of coding. In the UNIVAC 9480 System, these macro instructions exist as system transient routines. The space used by the OPEN transient coding is used, then overlaid with other Supervisor control coding; this coding is in turn overlaid with the CLOSE transient coding to terminate the file.

The user has several methods by which a file can be accessed in the UNIVAC 9480 System. The method chosen is determined by the overall use of the file in the application, the composition of the file to be processed, the time available to reach each record, and the device to be used as a storage medium. A discussion of the various access methods follows.

3.1.2.1. Sequential File Processing

All files with records following one another in a serial or physically adjacent manner are handled by a sequential access method. Devices that have sequential files include magnetic tapes, card readers, printers, punches, and discs.

A file definition macro instruction is supplied for each appropriate device. Record or block level handling macro instructions are also supplied.

3.1.2.2. Nonsequential File Processing

Nonsequential processing is suitable for disc storage devices only. Specific access methods implemented for the UNIVAC 9480 System are the direct access method and the indexed sequential access method. File declaration macro instructions are supplied for each access method as well as a variety of processing macro instructions suitable for handling the data.

3.1.2.2.1. Direct Access Method

The direct access method permits a data file on a disc storage device to be accessed by record where the record address is specified by the user. The record address is specified by means of an identification address or a key field. The macro calls permit records to be read, written, replaced, deleted, or inserted at specific addresses within the file.

3.1.2.2.2. Indexed Sequential Access Method

The indexed sequential access method is a method whereby the user specifies a key field to access his records. The file is created from presorted input records and stored in conjunction with a hierarchy of indices. The user key is stored along with the disc storage device address in an index which is sequential on the basis of the key number. The index feature enables advantage to be taken of the direct access properties of the hardware in that any record can be accessed by finding its location in the index and then going to that location.

3.1.3. Job Control

Data and programs to be processed may be introduced to the UNIVAC 9480 System as a group of programs, each program containing its own control information. This approach to work submission is defined as a job control stream. Job Control controls the execution of these work tasks, transition between job steps, restarting of jobs, and termination of jobs.

In disc systems, job control streams are stored in direct access storage files for subsequent selection and execution. The system operator selects jobs to be evaluated for available facilities. If facilities are sufficient and available, the job is selected and queued ready for processing time. In tape systems, control streams are not stored on auxiliary storage, but are processed as they are introduced by the card reader.

Transition from the normal termination of one job control stream to another is automatic with messages to the operator for mounting of tapes, setting up the printer, and performing other physical adjustments to the system. A procedure is available to provide automatic checkpoints for restarting a job.

In addition to normal job termination, job suspension and cancellation are available through operator or program intervention.

3.1.4. Message Control Program

The Message Control program provides the user with the capability of generating his own message control and message processing programs. The Message Control program controls the input/output from communication lines with the same ease as the input/output control for either tape or disc.

Macro instructions are provided to construct a complete Message Control program that controls the flow of messages to and from a variety of commonly used remote terminals and user message processing programs. Messages of fixed or variable length flow from the remote terminals to be queued in main storage. From main storage, messages are then used by the message processing program. If disc storage is used, the flow of messages is from remote terminals to disc storage to be queued in the order specified by the user. From disc storage messages are then used by the message processing program.

Inasmuch as the Message Control program is generated by macro instructions, the user can specify the communications equipment configuration and the number and size of buffer areas to be used in both main storage and disc storage. Also, the user can specify functions such as message code translation, routine, time stamping, sequencing of messages, and error checking. The ability to specify modules of the Message Control program allows the user to create a unique Message Control program for specific installation requirements.

3.2. LANGUAGE PROCESSORS

Language Processors are provided to allow the user of the UNIVAC 9480 System a great deal of flexibility in preparing programs. Programs may be written in Assembly language, COBOL, and FORTRAN, or through the facilities provided by the Report Program Generator.

The symbolic language of the Assembler provides a simple and convenient method of writing programs through the use of mnemonic instruction codes, Assembler directives, data generation instructions, Assembly time modification instructions, and the powerful macro generation calls.

The user may elect to write programs in the language provided by COBOL or FORTRAN. COBOL provides the user with a language for data processing problem solutions involving maintenance and processing of large volumes of files while FORTRAN provides a language for solving scientific or mathematical problems.

The program written in the FORTRAN or COBOL language is input to another program called the compiler. This compiler translates the FORTRAN or COBOL program into a code more nearly in a form ready to be executed by the computer. (The code must be altered by one more program, the Linkage Editor, before it is ready for execution.)

The Report Program Generator provides for the automatic preparation of accurate report programs. The user describes the input records, the calculations to be performed, and the output records. The Report Program Generator produces an object program that will prepare the desired report.

3.3. SERVICE AND UTILITY ROUTINES

Service and Utility routines are provided to remote the burden from the user of accomplishing common operational functions in the UNIVAC 9480 System. Some of these functions include sorting data according to a specified order and merging data to facilitate processing, maintaining files on magnetic tape and/or disc storage, and linking output modules of language processors into a single executable program.

3.3.1. Sort/Merge Program

The Sort/Merge program provides the user with a highly efficient sorting and merging capability over a wide range of data processing requirements. The routine sequences files containing any volume of records.

■ Scheduling

Sorting of large files accumulated can be expedited by sorting the input records in batches as they become available. The ordered subfiles can be held until the last batch is available. The subfiles can then be merged with the last batch after it has been sorted to produce a completely ordered file.

■ Facility Requirements

The Sort subroutine uses main storage primarily for temporary storage of data. While the Sort subroutine functions in the minimum main storage configuration, it automatically expands the size of its working storage areas in larger configurations. This expansion of sort work areas permits significantly faster operation when the facilities are not shared with other programs.

The Sort subroutine is modular in design when more than one system of auxiliary storage (magnetic tape or disc) is available and can be expanded to take advantage of the entire configuration. These facilities can be used either as exclusive alternatives or in combination.

■ Input/Output

Records may be delivered directly to the Sort subroutine as output from a problem program without first being written on an output file. The records can be received from any input file and in any format permitted by the operating system. The size of the records to be sorted or merged depends upon the hardware facilities available, rather than the Sort and Merge logic. The records may be of fixed size or they may be of variable length. Records are delivered directly to a user program without first being written on an output file. Also, the ordered records can be written to any medium and in any format permitted by the operating system.

■ Keys

Ordering of the records is based on key fields specified by the user. Any choice between ascending and descending sequence may be specified separately for each key field. Key field types include:

- alphanumeric
- unsigned binary
- signed zoned decimal
- signed packed decimal
- signed binary

If the desired ordering criterion cannot be defined by the specification of key fields, the user may elect to supply his own code to determine which of any given pair of records is to appear first in the final ordered sequence.

- Execution of Own Code

  The Sort and Merge function can transfer control to user-supplied code when equality of specified key fields is detected. Thus the user may consolidate the contents of like records to reduce the overall quantity of data to be processed.

- Restart

  A convenient restart procedure is available to reproduce, if necessary, any ordered subfile. Merging may be scheduled separately from the initial stages of sorting.

3.3.2. Library Services

The libraries are files usually described to the system at system generation according to individual installation parameters. Any number of libraries may exist so long as the established formats are observed. A system library is required and must be defined as such to the system.

Input to the language processors, such as the Assembler, FORTRAN, COBOL, etc., may exist as part of a library. The processors, in turn, output information in prescribed format to be entered in a library. Specification of which library is to be used is supplied in the job control stream.

UNIVAC 9480 System software includes the service routines necessary to establish, display, and alter the contents of the libraries. The routines necessary for interface between the processors and the library also are provided.

Facilities in response to control cards are provided also for the user to dump selected elements of the specified library onto tape or cards and to re-enter the dumped elements later directly into the file.

3.3.3. Linkage Editor

The primary function of the Linkage Editor is to link output object modules (the output of a complete processor run in a particular language) into one load module that is suitable for loading and execution by the Supervisor control program. The Linkage Editor also performs the following functions:

- Searches the appropriate library and incorporates object modules, other than those in its primary input, either upon request or automatically.

- Performs program modification by deleting and rearranging control sections as directed by the Linkage Editor control statements.

- Produces an overlay structure for loading by the Supervisor control program.

- Reserves storage automatically for the common storage requests generated by a language processor.

- Provides diagnostic messages.

3.3.4. Utility Programs and Program Testing Aids

The utility programs transfer data from one peripheral unit to another, or from one area of a peripheral unit to another, and provides for manipulating (creating, changing, deleting) files to best suit the user's requirements. The control information required by some of these programs is furnished as parameters by means of the job control stream and, in some cases, is supplied by the problem program.

The UNIVAC 9480 System software includes two program testing aids: a dynamic (snapshot) dump, and a terminal (postmortem) dump. The snapshot dump is used primarily as a program debugging aid. It provides (by user specification) a listing of register contents, control information, or the contents of any range of addresses in the user's program. It permits the program to be continued after the specified information is listed. The postmortem dump is used when a program is terminated by the Supervisor because of an error or abort condition. This dump provides complete listings of all aspects of the user's program. In this case the program must be reloaded before attempting to restart.

3.4. INFORMATION MANAGEMENT SYSTEM

The Information Management System (IMS 4) is an information handling system which is based on present data file formats and serviced by the UNIVAC 9480 System. IMS 4 stores and processes data while allowing the retrieval of current information upon request. It allows the data within files to be changed. Transactions are also processed as they occur.

Communications capability is present to allow inquiries from local or remote sites. Retrieval, alteration, and processing may be controlled through a UNISCOPE 100 Display Terminal or a keyboard terminal such as the UNIVAC DCT 500 Data Communications Terminal. Within moments of an inquiry, the requested information is printed or displayed at a terminal. Records solicited may be updated then, either by keyin or by calling processing routines. The displayed information can be in a predetermined amount and format, with explanatory heading or comments.

IMS 4 is easy to use. Simple operating instructions are provided by entering from the command OPEN LEARN. Access to files is protected by a password scheme which is chosen by the user.

The current data files of the user make up the data base. These files must be stored on direct access devices such as the UNIVAC 8414/8424 Disc Subsystem. IMS 4 is designed to allow normal processing concurrently with the handling of inquiries. IMS 4 has its own complete software which works through the UNIVAC 9480 System hardware and operating system to link the data base with the inquiries from the terminals.

3.5. SOFTWARE CONFIGURATOR

	TAPE OPERATING SYSTEM	DISC OPERATING SYSTEM
Minimum Hardware Requirements	Card Reader (1) Printer (2) 4 Tape Units	Card Reader (1) Printer (2) 2 Discs (8414 or 8424) (4)
Supervisor		
Multiprogramming	No	Yes (5)
Time Allocation	Yes	Yes
Simulated Day Clock	Yes	Yes
Interval Timer Services	Yes	Yes
Storage Protection (6)	Yes	Yes
Transient Area Management	Yes	Yes
Automatic Buffering	No	Yes
Program Check Point	Yes	Yes
Communications (7)		
Main Storage Queuing	Yes	Yes
Disc Queuing	No	Yes (9)
Data Management		
Sequential Access Method	Yes	Yes
Direct Access Method	Yes (3)	Yes
Index Sequential Access Method	Yes (3)	Yes
Job Control		
Control Stream Buffering	Yes – Tape only	Yes – Disc and Disc from Tape
Program Restart	Yes	Yes
Assembler	Yes	Yes
COBOL (8)	Basic	Yes (8)
FORTRAN	Yes	Yes
Report Program Generator	Yes	Yes
Soft Merge	Yes	Yes
Library Services	Yes	Yes
Linkage Editor	Yes	Yes
Utility Programs	Yes	Yes
Program Testing Aids	Yes	Yes

(1) Card Reader may be standard online card reader or a card reader on 9200/9300 Subsystem or 1004/1005 Subsystem.

(2) Printer may be standard online printer or a printer on 9200/9300 Subsystem or 1004/1005 Subsystem.

(3) UNIVAC 8414 or 8424 Disc Subsystem required.

(4) Two 9-track tape drives are required for software distribution and system generation (SYSGEN).

(5) From 1 to 5 user programs depending on user selection at system generation time.

(6) Write protect hardware feature required.

(7) Data Communications Subsystem hardware required.

(8) Basic COBOL requires 4 magnetic tape units (1 system, 3 work) – it will also operate with the DOS using 3 work tapes.

(9) Additional disc drives above the minimum of 2 may be required, depending on user requirements.

APPENDIX A. UNIVAC 9480 SYSTEM INSTRUCTIONS

The following is a listing of all the UNIVAC 9480 System Instructions by type, showing the mnemonic source code, the hexadecimal operation code and the timing in microseconds.

RR TYPE INSTRUCTIONS

DESCRIPTION	MNEMONIC CODE	OPERATION CODE	TIMING IN MICROSECONDS
Add	AR	1A	6.0
AND	NR	14	6.0
Branch and Link	BALR	05	6.0
Branch on Condition	BCR	07	4.2
Branch on Count	BCTR	06	7.2
Compare	CR	19	6.0
Compare Logical	CLR	15	6.0
Exclusive OR	XR	17	6.0
Load	LR	18	4.8
Load and Test	LTR	12	4.8
OR	OR	16	6.0
Set Program Mask	SPM	04	6.0
Subtract	SR	1B	6.0
Supervisor Call	SVC	0A	7.8

RX TYPE INSTRUCTIONS

Add	A	5A	6.0
Add Halfword	AH	4A	6.0
AND	N	54	6.0
Branch and Link	BAL	45	4.8
Branch on Condition	BC	47	3.0
Branch on Count	BCT	46	6.0
Compare	C	59	6.0
Compare Halfword	CH	49	6.0
Compare Logical	CL	55	6.0
Exclusive OR	X	57	6.0
Insert Character	IC	43	4.2
Load	L	58	4.8
Load Address	LA	41	4.8
Load Halfword	LH	48	6.0
OR	O	56	6.0
Store	ST	50	6.0
Store Character	STC	42	4.2
Store Halfword	STH	40	4.2
Subtract	S	5B	6.0
Subtract Halfword	SH	4B	6.0

NOTE: In the RX instructions the timing is increased by 1.2 μs when the index (X) field is not equal to zero.

RS TYPE INSTRUCTIONS

DESCRIPTION	MNEMONIC CODE	OPERATION CODE	TIMING IN MICROSECONDS
Load Limits Register *	LLR	81	6.0
Load Multiple	LM	98	$2.4 + (2.4 \times f)$
Shift Left Single Logical	SLL	89	$11.4 + (1.2 \times C_1)$
Shift Right Single Logical	SRL	88	See note
Store Multiple	STM	90	$2.4 + (2.4 \times f)$
Supervisor Load Multiple*	SLM	B8	$2.4 + (2.4 \times f)$
Supervisor Store Multiple*	SSTM	B0	$2.4 + (2.4 \times f)$

C_1 is the least significant four bits of $D_2 + (B_2)$.

C_2 is the least significant six bits of $D_2 + (B_2)$.

f is the number of full words.

** privileged instruction*

NOTE: The timing of the Shift Right Single Logical in microseconds is determined in the following manner:

CONDITION	TIMING
$C_2 = 0$	11.4
$0 < C_2 < 16$	$54.0 - (2.4 \times C_1)$
$C_2 = 16$	15.6
$C_2 > 16$	$54.6 - (2.4 \times C_1)$
$C_2 = 32$ or 48	16.2

SI TYPE INSTRUCTIONS

Add Immediate	AI	93	4.2
AND	NI	94	4.2
Compare Logical	CLI	95	4.2
Exclusive OR	XI	97	4.2
Halt and Proceed *	HPR	99	6.0
Load Program Status Word*	LPSW	82	7.2
Move Immediate	MVI	92	4.2
OR	OI	96	4.2
Set System Mask *	SSM	80	6.0
Start I/O *	SIO	9C	6.0 + CU Time †
Test under Mask	TM	91	6.0

† yields an approximate time factor

** privileged instruction*

SS1 TYPE INSTRUCTIONS

AND	NC	D4	$15.0 + (2.4 \times n)$
Compare Logical Character	CLC	D5	$15.0 + (2.4 \times n)$
Edit	ED	DE	$13.8 + (3.6 \times n) + (1.2 \times n_s)$
Exclusive OR	XC	D7	$15.0 + (2.4 \times n)$
Move Characters	MVC	D2	$15.0 + (2.4 \times n)$
Move Numeric	MVN	D1	$15.0 + (2.4 \times n)$
Move Zones	MVZ	D3	$15.0 + (2.4 \times n)$
OR	OC	D6	$15.0 + (2.4 \times n)$
Translate	TR	DC	$13.8 + (4.8 \times n_1)$

n is the number of result bytes

n_1 is the number of bytes in operand one

n_s is the number of signs in operand two

SS2 TYPE INSTRUCTIONS

DESCRIPTION	MNEMONIC CODE	OPERATION CODE	TIMING IN MICROSECONDS
Add Decimal	AP	FA	$15.0 + (2.4 \times n_1)$*
Compare Decimal	CP	F9	$15.0 + (2.4 \times n_1)$*
Divide Decimal	DP	FD	$26.4 \times (n_1 - n_2) \times (n_2 + 2.99) - (10.8 \times n_2) - 23.5$
Move with Offset	MVO	F1	$15.0 + (2.4 \times n_1)$
Multiply Decimal	MP	FC	$21.6 \times (n_1 - n_2) \times (n_2 + 2.68) - (10.8 \times n_2) - 15.3$
Pack	PACK	F2	$12.6 + (4.8 \times n_1)$
Subtract Decimal	SP	FB	$15.0 + (2.4 \times n_1)$*
Unpack	UNPK	F3	$15.0 + (2.4 \times n_1)$
Zero and Add	ZAP	F8	$15.0 + (2.4 \times n_1)$*

n_1 is the number of bytes in operand one

n_2 is the number of bytes in operand two

** plus $4.8 + (2.4 \times n_1)$ when the result must be recomplemented*

† yields an approximate time factor

APPENDIX B. ASCII, EBCDIC, AND PUNCHED CARD CODES

		Bit Positions 7, 6, 5							
		000	**001**	**010**	**011**	**100**	**101**	**110**	**111**
Bit Positions 4, 3, 2, 1	**0000**	NUL	DLE	SP	0	@	P	`	p
	0001	SOH	DC1	! ①	1	A	Q	a	q
	0010	STX	DC2	"	2	B	R	b	r
	0011	ETX	DC3	#	3	C	S	c	s
	0100	EOT	DC4	$	4	D	T	d	t
	0101	ENQ	NAK	%	5	E	U	e	u
	0110	ACK	SYN	&	6	F	V	f	v
	0111	BEL	ETB	'	7	G	W	g	w
	1000	BS	CAN	(	8	H	X	h	x
	1001	HT	EM	)	9	I	Y	i	y
	1010	LF	SUB	*	:	J	Z	j	z
	1011	VT	ESC	+	;	K	[	k	{
	1100	FF	FS	,	<	L	\	l	¦ ②
	1101	CR	GS	–	=	M	]	m	}
	1110	SO	RS	.	>	N	∧ ①	n	~
	1111	SI	US	/	?	O	_	o	DEL

③ ④

⑤

NOTES:

ASCII bits are numbered from the left in descending numerical sequence: 7 6 5 4 3 2 1

① The following optional graphics can be substituted in the character set:

¬ for ∧ | for !

② For 63-character printers, the following substitution is made:

\ for ¦

③ Sixty-three printable character set.

④ Graphics available by use of the type 0768-02 printer, which prints a 94-character set (DEL is not a graphic).

⑤ Ninety-four printable character set.

Table B–1. ASCII (American Standard Code for Information Interchange) Character Codes

	Bit Positions 0, 1, 2, 3															
Bit Positions 4, 5, 6, 7	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	NUL	DLE	DS ①		SP	&	–						{ ④	} ④	\ ④	0
0001	SOH	DC1	SOS ①				/		a ④	j	~ ④		A	J		1
0010	STX	DC2	FS ①	SYN					b	k	s		B	K	S	2
0011	ETX	DC3							c	l	t		C	L	T	3
0100									d	m	u		D	M	U	4
0101	HT		LF						e	n	v		E	N	V	5
0110		BS	ETB						f	o	w		F	O	W	6
0111	DEL		ESC	EOT					g	p	x		G	P	X	7
1000		CAN							h	q	y		H	Q	Y	8
1001		EM						` ④	i	r	z		I	R	Z	9
1010					[	]	¦ ③	:								
1011	VT				.	$	,	#								
1100	FF	FS		DC4	<	*	%	@								
1101	CR	GS	ENQ	NAK	(	)	_	'								
1110	SO	RS	ACK		+	;	>	=								
1111	SI	US	BEL	SUB	! ②	¬ ②	?	"								

NOTES:

EBCDIC bits are numbered from the left in ascending numerical order:

0 1 2 3 4 5 6 7

① DS, SOS, FS are the control characters for the EDIT instruction and have been assigned for ASCII mode processing so as not to conflict with the corresponding character positions previously assigned in the EBCDIC chart. As these characters are not outside the range as defined in ANSI X3.4–1968, they must not appear in external storage media, such as ANSI standard tapes. This presents no difficulty due to the nature of the EDIT instruction.

② The following optional graphics can be substituted in the character set:

∧ for ¬

| for !

③ For 63-character printers, the following substitution is made:

\ for ¦

④ The lowercase alphabet and indicated graphics are introduced by use of the type 0768–02 printer, which prints a 94-character set.

Table B–2. EBCDIC (Extended Binary Coded Decimal Interchange Code) Character Codes

Character	Printed Symbol	Card Punches	ASCII		EBCDIC	
			Hexadecimal	Decimal	Hexadecimal	Decimal
Letters						
Uppercase A	A	12–1	41	65	C1	193
Uppercase B	B	12–2	42	66	C2	194
Uppercase C	C	12–3	43	67	C3	195
Uppercase D	D	12–4	44	68	C4	196
Uppercase E	E	12–5	45	69	C5	197
Uppercase F	F	12–6	46	70	C6	198
Uppercase G	G	12–7	47	71	C7	199
Uppercase H	H	12–8	48	72	C8	200
Uppercase I	I	12–9	49	73	C9	201
Uppercase J	J	11–1	4A	74	D1	209
Uppercase K	K	11–2	4B	75	D2	210
Uppercase L	L	11–3	4C	76	D3	211
Uppercase M	M	11–4	4D	77	D4	212
Uppercase N	N	11–5	4E	78	D5	213
Uppercase O	O	11–6	4F	79	D6	214
Uppercase P	P	11–7	50	80	D7	215
Uppercase Q	Q	11–8	51	81	D8	216
Uppercase R	R	11–9	52	82	D9	217
Uppercase S	S	0–2	53	83	E2	226
Uppercase T	T	0–3	54	84	E3	227
Uppercase U	U	0–4	55	85	E4	228
Uppercase V	V	0–5	56	86	E5	229
Uppercase W	W	0–6	57	87	E6	230
Uppercase X	X	0–7	58	88	E7	231
Uppercase Y	Y	0–8	59	89	E8	232
Uppercase Z	Z	0–9	5A	90	E9	233
Lowercase a	a	12–0–1	61	97	81	129
Lowercase b	b	12–0–2	62	98	82	130
Lowercase c	c	12–0–3	63	99	83	131

Table B–3. Punched Card, ASCII, and EBCDIC Codes (Part 1 of 5)

Character	Printed Symbol	Card Punches	ASCII		EBCDIC	
			Hexadecimal	Decimal	Hexadecimal	Decimal
Lowercase d	d	12–0–4	64	100	84	132
Lowercase e	e	12–0–5	65	101	85	133
Lowercase f	f	12–0–6	66	102	86	134
Lowercase g	g	12–0–7	67	103	87	135
Lowercase h	h	12–0–8	68	104	88	136
Lowercase i	i	12–0–9	69	105	89	137
Lowercase j	j	12–11–1	6A	106	91	145
Lowercase k	k	12–11–2	6B	107	92	146
Lowercase l	l	12–11–3	6C	108	93	147
Lowercase m	m	12–11–4	6D	109	94	148
Lowercase n	n	12–11–5	6E	110	95	149
Lowercase o	o	12–11–6	6F	111	96	150
Lowercase p	p	12–11–7	70	112	97	151
Lowercase q	q	12–11–8	71	113	98	152
Lowercase r	r	12–11–9	72	114	99	153
Lowercase s	s	11–0–2	73	115	A2	162
Lowercase t	t	11–0–3	74	116	A3	163
Lowercase u	u	11–0–4	75	117	A4	164
Lowercase v	v	11–0–5	76	118	A5	165
Lowercase w	w	11–0–6	77	119	A6	166
Lowercase x	x	11–0–7	78	120	A7	167
Lowercase y	y	11–0–8	79	121	A8	168
Lowercase z	z	11–0–9	7A	122	A9	169
Numerals						
0	0	0	30	48	F0	240
1	1	1	31	49	F1	241
2	2	2	32	50	F2	242
3	3	3	33	51	F3	243
4	4	4	34	52	F4	244
5	5	5	35	53	F5	245
6	6	6	36	54	F6	246

Table B–3. Punched Card, ASCII, and EBCDIC Codes (Part 2 of 5)

Character	Printed Symbol	Card Punches	ASCII		EBCDIC	
			Hexadecimal	Decimal	Hexadecimal	Decimal
7	7	7	37	55	F7	247
8	8	8	38	56	F8	248
9	9	9	39	57	F9	249
Symbols						
Exclamation point	!	12–8–7	21	33	4F	79
Quotation mark, dieresis	"	8–7	22	34	7F	127
Number sign, pound sign	#	8–3	23	35	7B	123
Dollar sign	$	11–8–3	24	36	5B	91
Percent sign	%	0–8–4	25	37	6C	108
Ampersand	&	12	26	38	50	80
Apostrophe, acute accent	'	8–5	27	39	7D	125
Opening parenthesis	(	12–8–5	28	40	4D	77
Closing parenthesis	)	11–8–5	29	41	5D	93
Asterisk	*	11–8–4	2A	42	5C	92
Plus sign	+	12–8–6	2B	43	4E	78
Comma, cedilla	,	0–8–3	2C	44	6B	107
Minus sign, hyphen	–	11	2D	45	60	96
Period, decimal point	.	12–8–3	2E	46	4B	75
Slash, virgule, solidus	/	0–1	2F	47	61	97
Colon	:	8–2	3A	58	7A	122
Semicolon	;	11–8–6	3B	59	5E	94
Less than	<	12–8–4	3C	60	4C	76
Equal sign	=	8–6	3D	61	7E	126
Greater than	>	0–8–6	3E	62	6E	110
Question mark	?	0–8–7	3F	63	6F	111
Commercial at symbol	@	8–4	40	64	7C	124
Opening bracket	[	12–8–2	5B	91	4A	74
Closing bracket	]	11–8–2	5D	93	5A	90
Reverse slash	\	0–8–2	5C	92	E0	224
Circumflex	∧	11–8–7	5E	94	5F	95

Table B–3. Punched Card, ASCII, and EBCDIC Codes (Part 3 of 5)

Character	Printed Symbol	Card Punches	ASCII		EBCDIC	
			Hexadecimal	Decimal	Hexadecimal	Decimal
Underline	—	0–8–5	5F	95	6D	109
Grave accent	`	8–1	60	96	79	121
Opening brace	{	12–0	7B	123	C0	192
Closing brace	}	11–0	7D	125	D0	208
Vertical line	¦	12–11	7C	124	6A	106
Overline, tilde	~	11–0–1	7E	126	A1	161

Character	Card Punches	ASCII		EBCDIC	
		Hexadecimal	Decimal	Hexadecimal	Decimal
Nonprintable Characters					
ACK (Acknowledge)	0–9–8–6	06	6	2E	46
BEL (Bell)	0–9–8–7	07	7	2F	47
BS (Backspace)	11–9–6	08	8	16	22
CAN (Cancel)	11–9–8	18	24	18	24
CR (Carriage return)	12–9–8–5	0D	13	0D	13
DC1 (Device control 1)	11–9–1	11	17	11	17
DC2 (Device control 2)	11–9–2	12	18	12	18
DC3 (Device control 3)	11–9–3	13	19	13	19
DC4 (Device control 4)	9–8–4	14	20	3C	60
DEL (Delete)	12–9–7	7F	127	07	7
DLE (Data link escape)	12–11–9–8–1	10	16	10	16
DS (Digit select)	11–0–9–8–1	80	128	20	32
EM (End of medium)	11–9–8–1	19	25	19	25
ENQ (Enquiry)	0–9–8–5	05	5	2D	45
EOT (End of transmission)	9–7	04	4	37	55
ESC (Escape)	0–9–7	1B	27	27	39
ETB (End of transmission block)	0–9–6	17	23	26	38
ETX (End of text)	12–9–3	03	3	03	3
FF (Form feed)	12–9–8–4	0C	12	0C	12
FS (File separator)	11–9–8–4	1C	28	1C	28

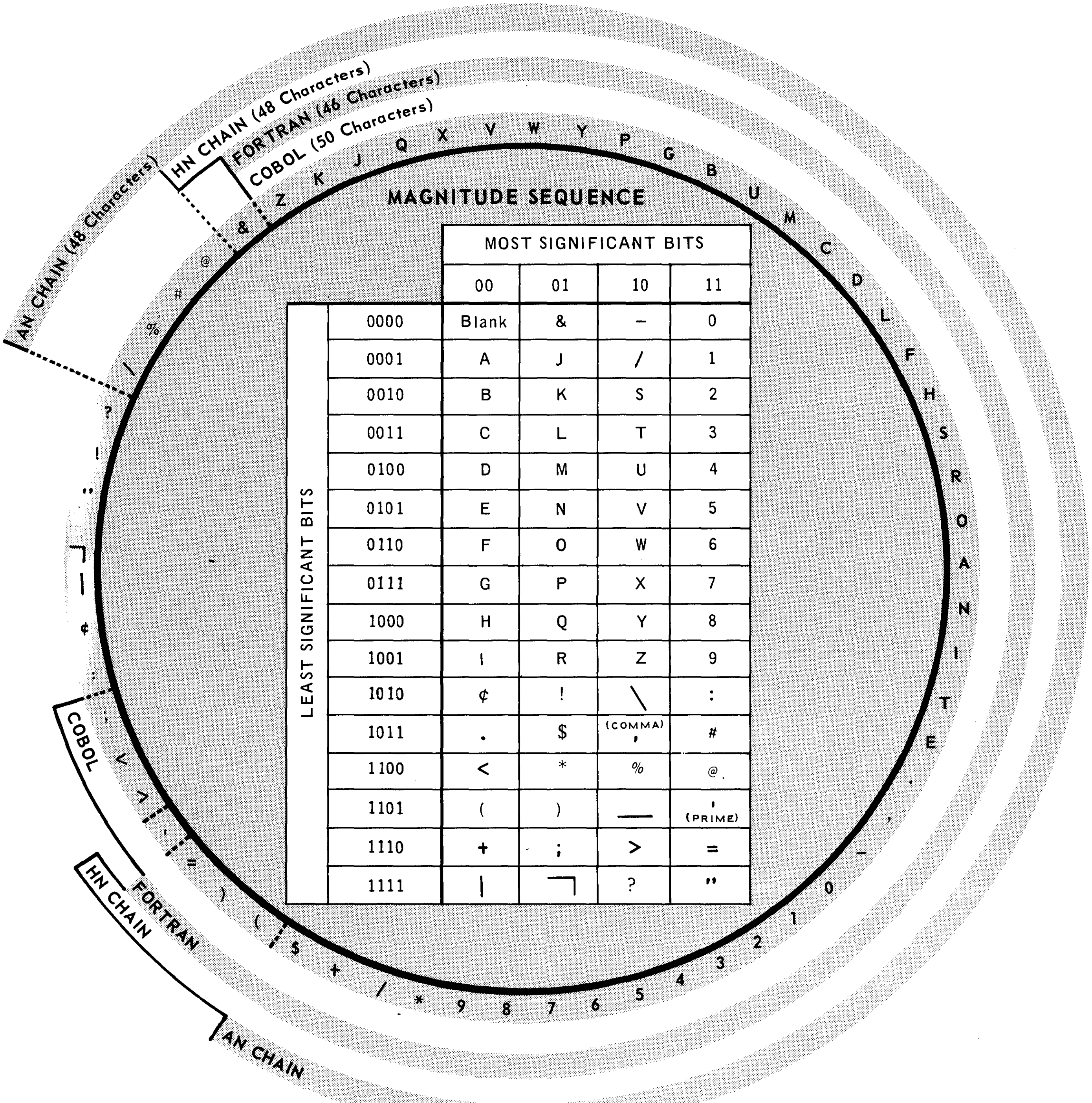
Table B–3. Punched Card, ASCII, and EBCDIC Codes (Part 4 of 5)

Character	Card Punches	ASCII		EBCDIC	
		Hexadecimal	Decimal	Hexadecimal	Decimal
FS (Field separator)	0–9–2	82	130	22	34
GS (Group separator)	11–9–8–5	1D	29	1D	29
HT (Horizontal tabulation)	12–9–5	09	9	05	5
LF (Line feed)	0–9–5	0A	10	25	37
NAK (Negative acknowledge)	9–8–5	15	21	3D	61
NUL (Null)	12–0–9–8–1	00	0	00	0
RS (Record separator)	11–9–8–6	1E	30	1E	30
SI (Shift in)	12–9–8–7	0F	15	0F	15
SO (Shift out)	12–9–8–6	0E	14	0E	14
SOH (Start of heading)	12–9–1	01	1	01	1
SOS (Significance start)	0–9–1	81	129	21	33
SP (Space)		20	32	40	64
STX (Start of text)	12–9–2	02	2	02	2
SUB (Substitute)	9–8–7	1A	26	3F	63
SYN (Synchronous idle)	9–2	16	22	32	50
US (Unit separator)	11–9–8–7	1F	31	1F	31
VT (Vertical tabulation)	12–9–8–3	0B	11	0B	11

Table B–3. Punched Card, ASCII, and EBCDIC Codes (Part 5 of 5)

APPENDIX C. LINE PRINTER CHARACTER SET

PRINT DRUM SEQUENCE



		MOST SIGNIFICANT BITS			
		00	01	10	11
LEAST SIGNIFICANT BITS	0000	Blank	&	–	0
	0001	A	J	/	1
	0010	B	K	S	2
	0011	C	L	T	3
	0100	D	M	U	4
	0101	E	N	V	5
	0110	F	O	W	6
	0111	G	P	X	7
	1000	H	Q	Y	8
	1001	I	R	Z	9
	1010	¢	!	\	:
	1011	.	$	(COMMA) ,	#
	1100	<	*	%	@
	1101	(	)	—	' (PRIME)
	1110	+	;	>	=
	1111	|	¬	?	"

NOTE: ASCII set is the same except for the following: ¢ = ∧, | = [, ¬ =]