GA22-7001-1

Systems

IBM System/370
System Summary

IBM

GA22-7001-1

Systems

IBM System/370
System Summary

IBM

Preface

This publication is intended to provide basic information about IBM System/370, the data processing system based on IBM System/360 but extending beyond the capabilities of that system. The objective of this publication is to help readers achieve a general understanding of this data processing system and of the interrelationships of its components. Briefly discussed are the system concepts, features, individual models, programming systems, and attachable input/ouptut devices of System/370.

A basic knowledge of data processing systems, such as that given in the *Introduction to IBM Data Processing Systems,* GC20-1684, is assumed. A list of abbreviations and notation forms follows the Contents. Also, use of the *Data Processing Glossary,* GC20-1699, may further help the reader.

This publication is divided into 8 sections. Sections 1 through 4 discuss the system structure, features, and programming systems; Section 5 gives an introductory explanation of teleprocessing; Section 6 presents summary information about individual system models; Sections 7 and 8 describe the system input/output devices.

In general, the sections should be read in sequence, since information presented in one section often depends on an understanding of information in previous sections.

More detailed information about System/370 is available in *IBM System/370 Principles of Operation,* GA22-7000, and the associated publication, *IBM System/360 Principles of Operation,* GA22-6821. For more information about any individual System/370 model or device, refer to the latest *System/370 SRL Newsletter,* GN20-0360, to see what publications are available.

Second Edition (January 1972)
This is a major revision of, and obsoletes, GA22-7001-0 and Technical Newsletters GN22-0387, GN22-0397, and GN22-0410.

Changes are periodically made to the specifications herein; before using this publication in connection with the operation of IBM systems, refer to the latest *System/360 and System/370 SRL Newsletter,* GN20-3060, for the editions that are applicable and current. A technical change to the text or to an illustration is indicated by a vertical line to the left of the change. Added material is indicated by a vertical line to the left of the addition.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

This manual was prepared by the IBM Systems Development Division, Product Publications, Dept. B98, PO Box 390, Poughkeepsie, N.Y. 12602. A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be sent to the above address. Comments become the property of IBM.

Abbreviations and Notation Forms

ALU	arithmetic-logic unit
ANSI	American National Standards Institute
BCD	binary-coded decimal
BSC	binary synchronous communications
bpi	bytes per inch
bps	bits per second
CPU	central processing unit
CRT	cathode-ray tube
DASF	direct-access storage facility
ICA	integrated communications adapter
I/O	input/output
IPL	initial program load
K	= 1,024 (in System/370)
lpm	lines per minute
MT/ST	Magnetic Tape Selectric® Typewriter
NRZI	non-return-to-zero-IBM
op code	operation code
PSW	program status word

Data Codes and Character Sets

ANSCS OCR	American National Standard Character Set for Optical Character Recognition
ASCII	American Standard Code for Information Interchange
EBCDIC	extended binary-coded decimal interchange code
ISO OCR-A	International Standards Organization Standards on Optical Character Recognition

Instruction Formats

RR	register-to-register
RS	register-and-storage
RX	register-and-indexed-storage
SI	immediate-operand-and-storage
SS	storage-to-storage

Programming Systems, Subsystems, and Languages

BTAM	Basic Telecommunications Access Method
DOS	Disk Operating System
IOCS	Input/Output Control System
MFT	Multiprogramming with a Fixed Number of Tasks (OS)
MVT	Multiprogramming with a Variable Number of Tasks (OS)
OS	Operating System
QTAM	Queued Telecommunications Access Method
RPG	Report Program Generator
TSO	Time-Sharing Option

IBM System/370 uses many of the functions already provided by System/360, but adds to these an extensive array of enhancements. Together they constitute a system of impressive performance.

System/370 offers the advantages of System/360, plus:

1. Faster internal performance.
2. Greater channel capabilities.
3. Integrated emulation of other IBM systems.
4. Added reliability, availability, and serviceability.
5. Enhanced functional capabilities.

Of special value is the ease with which users of System/360 can make the transition to a System/370 (Figures 1-1 and 1-2). Most System/360 input/output equipment, user programs, and programming systems can be used in System/370 without change.

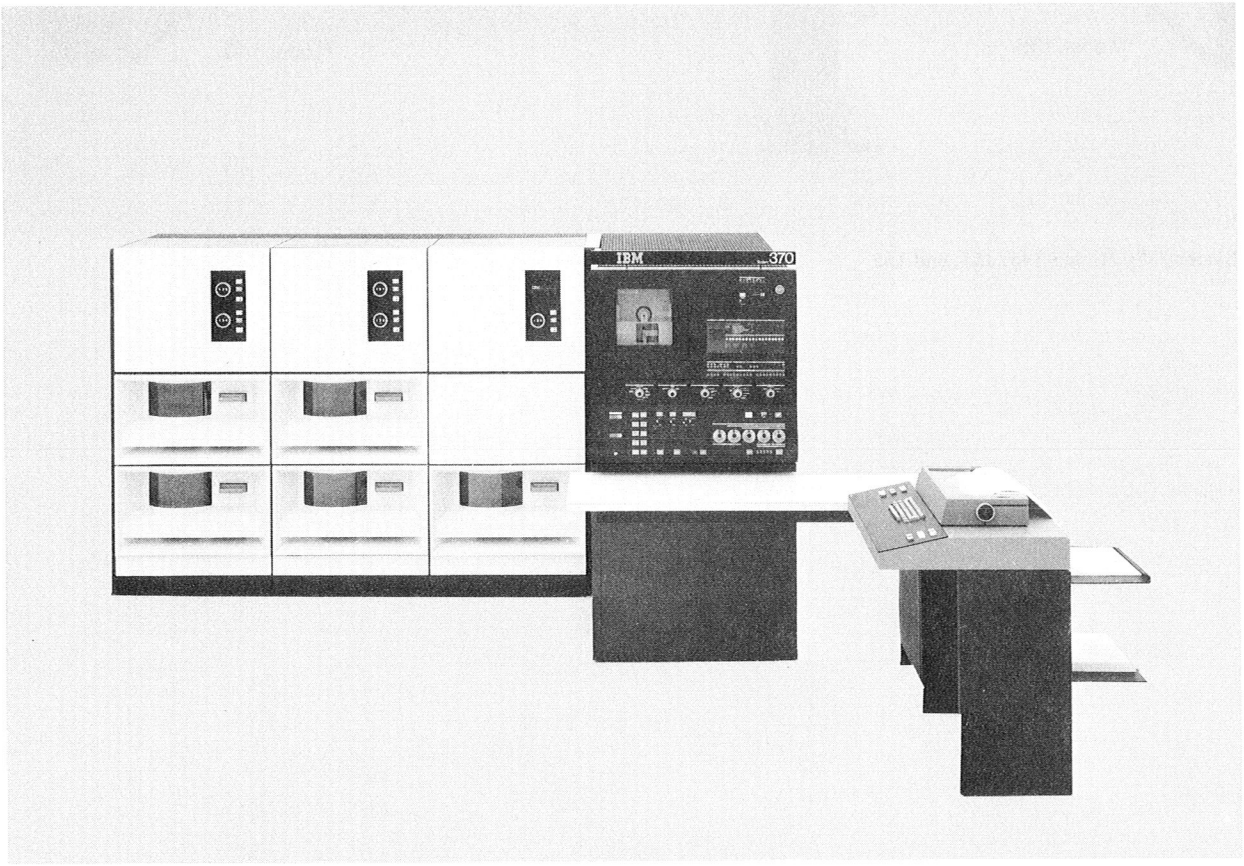


Figure 1-1. System/370 Model 135

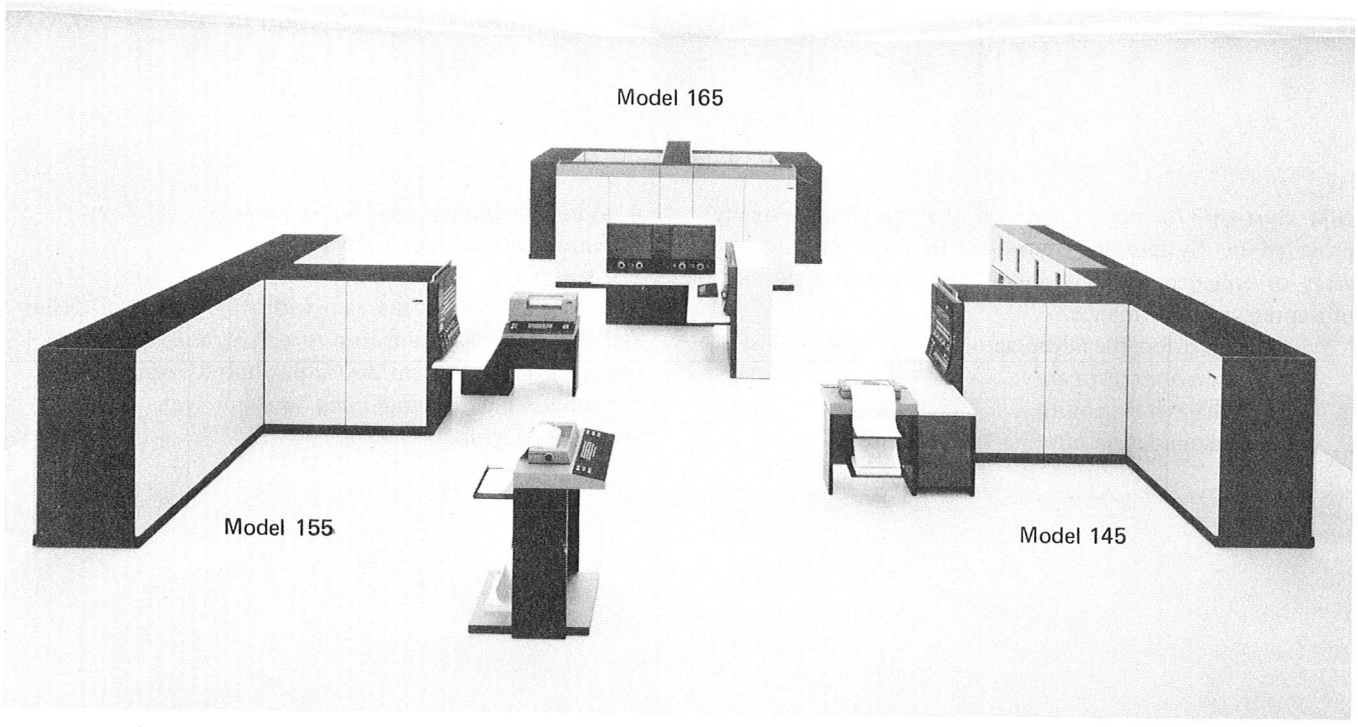


Figure 1-2. System/370 Models 145, 155, and 165

The basic structure of a System/370 model (Figure 2-1) includes main storage, a central processing unit (CPU), one or more channels and input/output devices, generally attached to channels through control units and the I/O interface.

Data Formats

The system transmits data between main storage and CPU in multiples of eight bits. Each eight-bit unit of data is called a *byte*, the basic building block of all formats in System/370. In CPU's and buffers, a ninth bit, the *parity* or *check* bit, is transmitted with each byte and carries odd parity in the byte. The parity bit cannot be affected by the program; its only purpose is to cause an interruption when a parity error is detected. In this manual, references to data exclude the mention of the associated parity bits.

Bytes may be handled separately, or they may be grouped in *fields*. The *halfword*, *word*, and *doubleword* are fields of consecutive bytes; a halfword has two bytes, a word has four bytes, and a doubleword has eight bytes. These fields make up the basic fixed-length data formats (Figure 2-2).

Data formats are either fixed-length or variable-length. During processing, the field length is either implied by the operation to be performed or it is stated explicitly as part of the instruction.

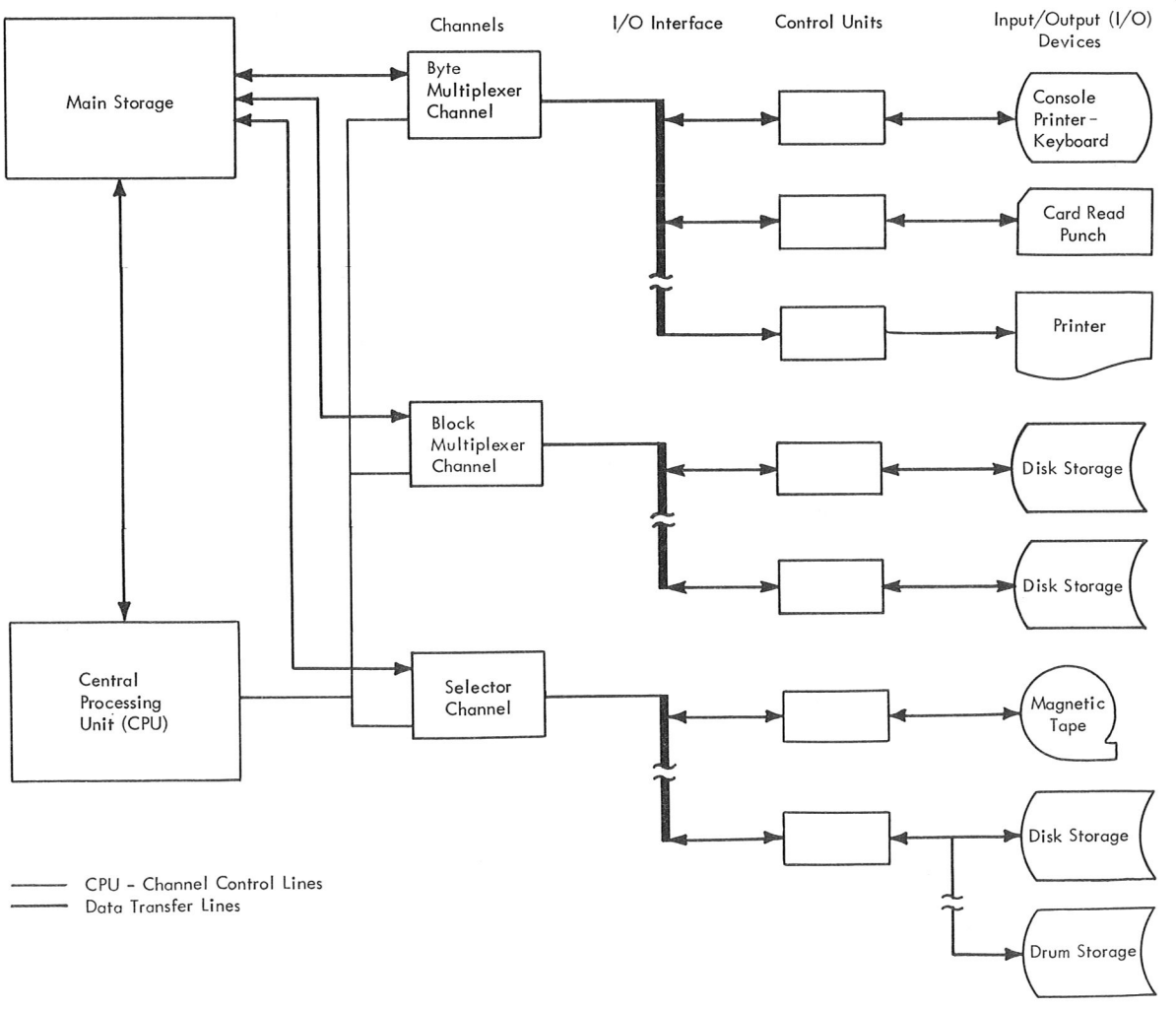


Figure 2-1. Organization of a Representative System/370 Model

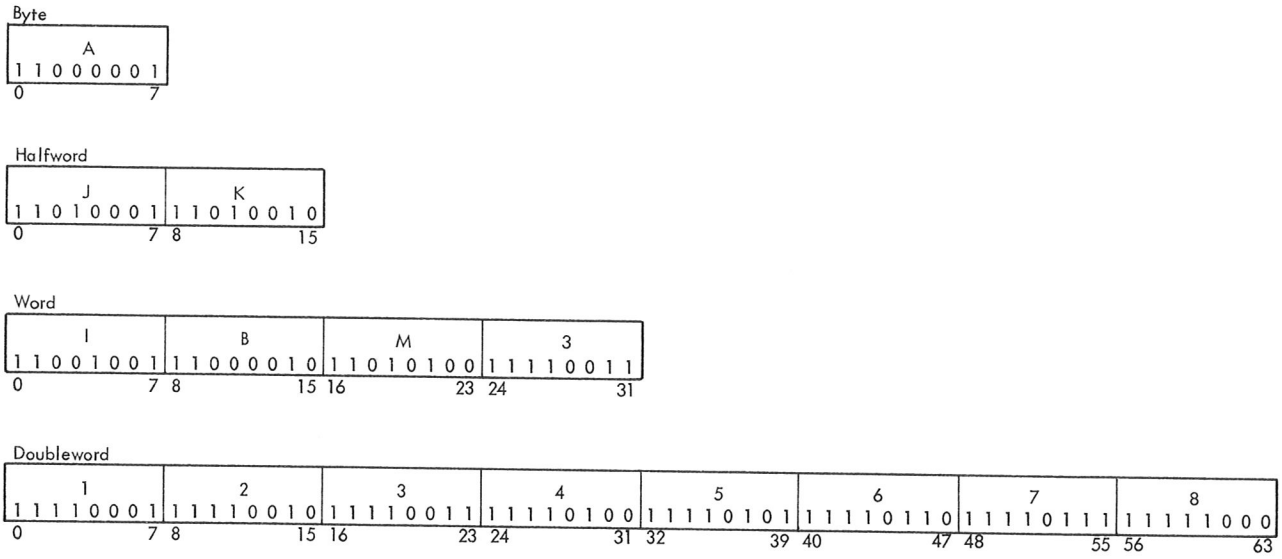


Figure 2-2. Basic Fixed-Length Data Formats (with EBCDIC-Coded Data)

Data Representation

In System/370, data (whether numeric, alphabetic, or alphameric) is processed in multiples of an eight-bit byte. The data may be in binary form (as numeric data for most scientific computations) or it may be in a binary *code*. Coding permits data to be represented by characters (for example, 1, 2, A, B, and *) on devices such as card readers, visual display units, and printers. These devices are code-dependent; that is, their operation depends on the code used to represent the characters.

The eight-bit byte provides for as many as 256 characters, which allows for future code expansion and permits System/370 to accept most present and future codes. The character code used internally in System/370 processing is the extended binary-coded-decimal interchange code (EBCDIC). The bit positions in EBCDIC (Figure 2-3) are numbered the same as those of bytes (left to right, 0-7).

MAIN STORAGE

Main storage provides the system with directly-addressable fast-access storage of data. Both data and programs must be loaded into main storage (from input devices) before they can be processed.

Addressing

Byte locations in main storage are consecutively numbered starting with 0; each number is the address of the corresponding byte. A group of bytes in storage is addressed by the leftmost byte of the group. The number of bytes in the group is either implied by the instruction format or explicitly defined by the instruction itself. Anticipating future storage needs, the addressing arrangement uses a 24-bit binary address, which gives System/370 the capability of addressing as many as 16,777,216 bytes of storage. This set of main-storage addresses includes some low-address locations reserved for special purposes.

Data Positioning

Restrictions on data positioning in main storage depend on several factors, such as whether the data field is variable or fixed-length. A variable-length field may be positioned on any byte boundary in usable main storage, but a fixed-length field (such as a halfword, word, or doubleword) may or may not, depending on what makes reference to this type of data field.

Two reference categories are briefly described in Section 3 with the *byte-oriented operand,* the feature that allows some fixed-length fields to be positioned on byte boundaries rather than only on *integral boundaries.*

A boundary is integral for a unit of data when its main storage address is a multiple of that unit's length in bytes. For example, halfwords (two bytes) should have main storage addresses that are multiples of two. Figure 2-4 shows integral boundaries for the common units of data, showing simplified main storage addresses as four-digit decimal numbers (0000, 0001, 0002, etc.) rather than the 24-digit binary numbers actually used. Sequential halfword addresses are shown on integral boundaries in Figure 2-4 as 0000, 0002, 0004, etc. For integral boundaries, words (four bytes) must have addresses that are multiples of four (shown in Figure2-4 as 0000, 0004, 0008, etc.), and doublewords (eight bytes) must have addresses that are multiples of eight (shown in Figure 2-4 as 0000, 0008, 0016, etc.).

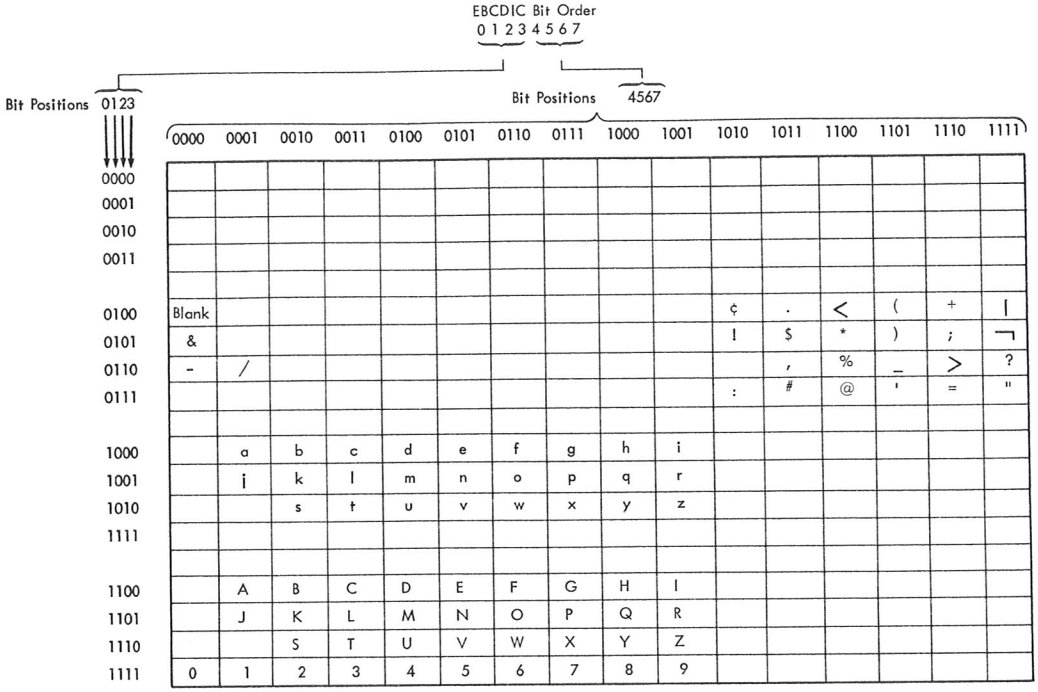


Figure 2-3. EBCDIC Character Codes (Excluding Control Characters)

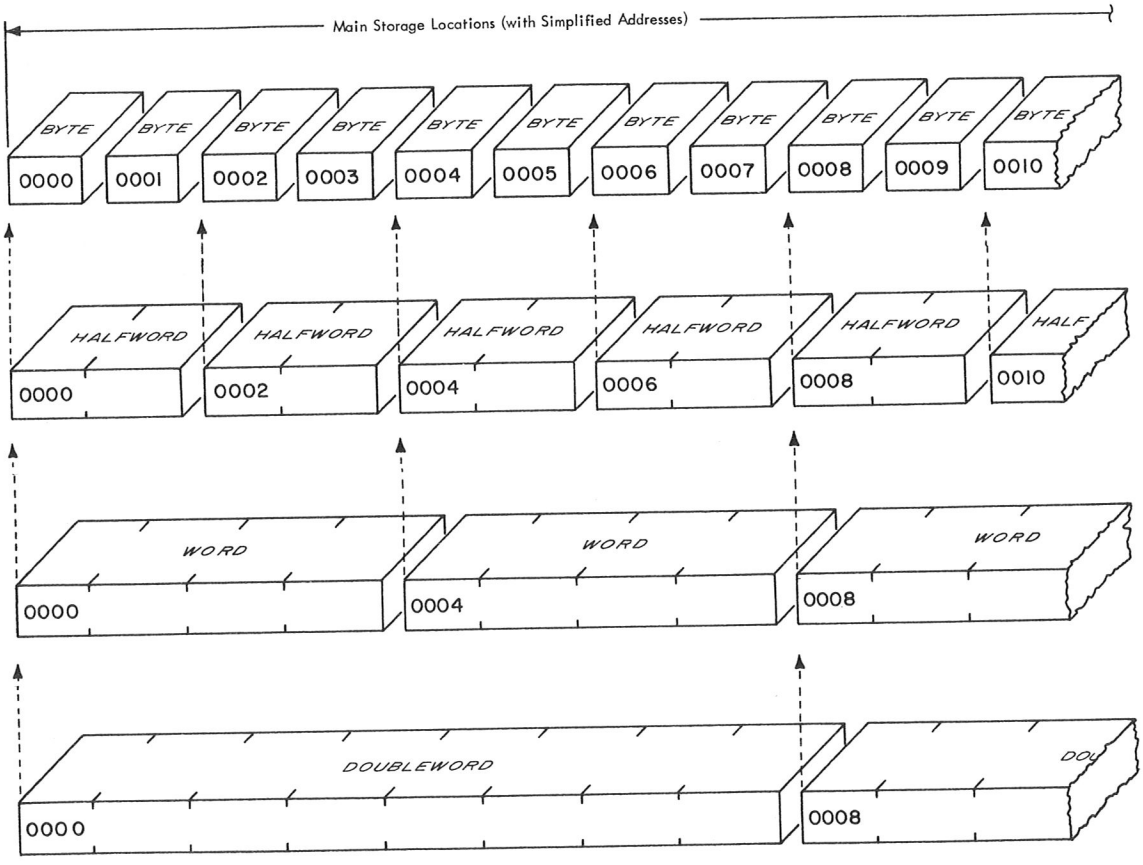


Figure 2-4. Representative Integral Boundaries for Halfwords, Words, and Doublewords in Main Storage

Performance Factors

The variety of main-storage units available for the System/370 models permits the system to be tailored to suit the individual needs of the user. The units differ in capacities, access widths, cycle times, and degrees of interleaving.

Depending on the model, storage capacities range from 96K (98,304) bytes to 4,096K (4,194,304) bytes. (In this manual, 1K = 1,024.)

Storage Access Width is the number of bytes transferred to or from main storage in each access. As access width increases, the quantity of data that may be transferred per unit time increases. The width, which is model-dependent, ranges from 2 to 16 bytes.

Storage Cycle Time is a measure of storage speed and is defined as the length of time that main storage is busy whenever a reference is made to it. Generally, the shorter the cycle time, the greater the number of operations that can be performed in any time interval. The storage cycle time is 2.07 microseconds or less, the exact value depending on the system model.

Storage interleaving, a model-dependent capability, increases the number of main-storage accesses started in a storage cycle, thereby significantly increasing the amount of data accessed per unit time.

CENTRAL PROCESSING UNIT

The central processing unit (CPU) is the controlling center of System/370. It provides facilities for:

Addressing main storage.
Fetching and storing data.
Arithmetic and logical processing of data.
Executing instructions in a desired sequence.
Initiating communication between main storage and input/output (I/O) devices.

Three prominent types of registers are provided by the CPU: general, floating-point, and control. The 16 *general registers* and 4 *floating-point registers* are accessible to the programmer and are capable of receiving data, holding it, permitting it to be operated on, and transferring it. The general registers are used primarily for fixed-point, logic, and addressing operations. The floating-point registers are used only for floating-point arithmetic.

The control registers provide for the handling of control information, which is used to control system operation. These registers are accessible to the control program by way of specific instructions. The number available with any system model depends on which installed functions require control registers.

Two major sections of the CPU are the system control section and the arithmetic/logic unit. The *system control section* directs the sequential accessing of instructions and coordinates both instruction execution and storage fetches.

The *arithmetic/logic unit*, as its name implies, performs the arithmetic and logic operations.

Arithmetic and Logic Operations

The arithmetic and logic operations fall into four classes:

Decimal arithmetic
Fixed-point arithmetic
Floating-point arithmetic
Logic operations

These classes differ in the data formats and field lengths used, the registers involved, and the operations provided.

Decimal Arithmetic

Decimal arithmetic, used principally for commercial applications, is performed on signed decimal numbers. Generally, decimal data entering and leaving the system via devices such as card reader-punches and printers is in *zoned* format (Figure 2-5). But for processing and for storage in direct-access and magnetic-tape devices, decimal data is in *packed* format (Figure 2-6). Packing fits two decimal digits (or one digit and sign) per byte. Because only four binary digits are needed to express one decimal digit, packing permits more efficient handling of decimal data.

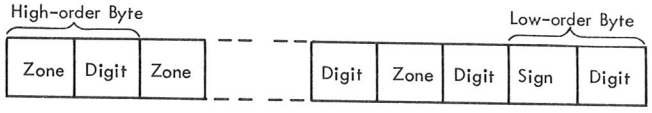


Figure 2-5. Zoned Decimal Number Format

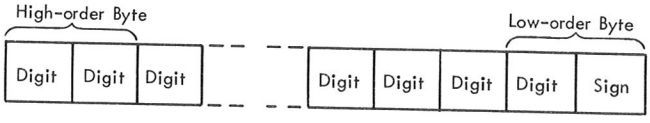


Figure 2-6. Packed Decimal Number Format

Packed data is taken from main storage, processed, and returned to storage without the data passing through any general registers; this is called *storage-to-storage* processing. The decimal field length, specified by the instruction, can be expanded to as many as 31 digits plus sign, all packed in up to 16 bytes.

Fixed-Point Arithmetic

Fixed-point arithmetic is used to perform arithmetic operations on both data and storage addresses. This combined use permits the fixed-point instructions (as well as several logic instructions) to be used in address computation, permitting shifting and logical manipulation of address components.

The fixed-point binary word (Figure 2-7), the basic arithmetic operand in System/370, has a 32-bit signed integer (a 31-bit integer with a high-order sign bit). Halfword operands can be specified in many operations where a full word is not needed, thus improving both performance and storage use.

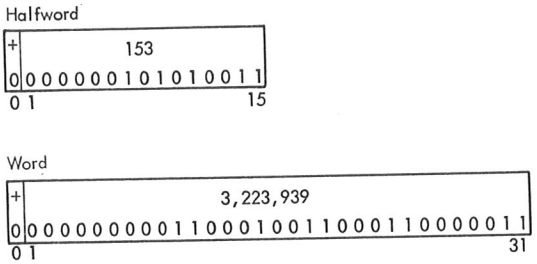


Figure 2-7. Fixed-Point Number Formats (with Signed Binary Data)

The 16 general registers, each four bytes (32 bits) wide, are used for fixed-point operations. General registers can also help keep fixed-point product and dividend precision by allowing adjacent registers to be coupled, effectively doubling the register width.

Floating-Point Arithmetic

Floating-point arithmetic, used primarily in scientific applications, greatly increases the speed, precision, and efficiency of computations. In System/370, this form of numeric representation can express positive or negative decimal values from about 10^{-78} to about 10^{76}.

Floating-point numbers may be short (24-bit fractions, with up to seven decimal-place precision), long (56-bit fractions, with up to 17 decimal-place precision), or extended (112-bit fractions, with about 34 decimal-place precision). Floating-point fractions are made up of hexadecimal (base 16) digits, each consisting of four binary digits and having equivalent decimal (base 10) values of 0-15. The short format (Figure 2-8) usually reduces execution times and increases the number of operands that can be stored, the long format (Figure 2-9) provides greater precision, and the extended format (Figure 2-10) provides about twice the precision of the long format. (See "Extended-Precision Floating-Point Feature," Section 3.)

Four floating-point registers, each eight bytes wide, are provided. The availability of these registers eliminates much fetching and storing of intermediate results. The 16 general registers are also used, primarily for indexing and address arithmetic.

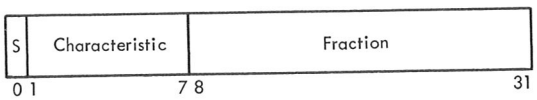


Figure 2-8. Short Floating-Point Number Format

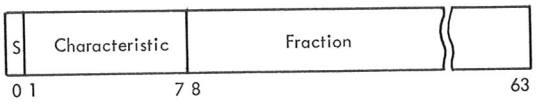


Figure 2-9. Long Floating-Point Number Format

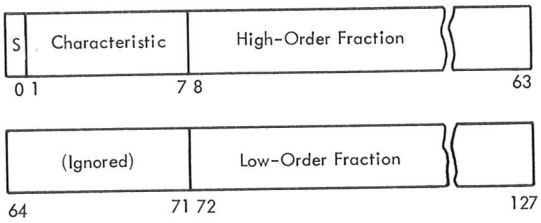


Figure 2-10. Extended Floating-Point Number Format

Logic Operations

The logic operations provide System/370 with the ability to logically manipulate data. The manipulations include: comparing, testing, translating (character for character), editing (sign and punctuation control), and moving logic data. The data may have either a fixed- or variable-length format (Figures 2-11 and 2-12). Fixed-length data, processed through the general registers, may be one to four bytes long; variable-length data, processed storage-to-storage, can extend to 256 bytes.

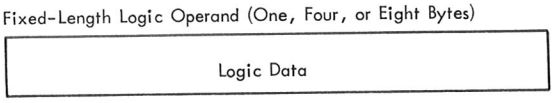


Figure 2-11. Fixed-Length Logic Format

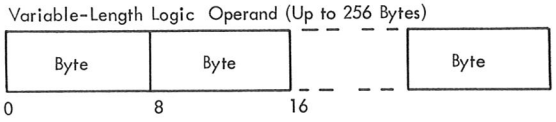


Figure 2-12. Variable-Length Logic Format

Instruction Formats

Main storage addressing and the execution of processing programs are directed by the CPU. The instructions that make up these programs may be of several different formats, identified by the format codes RR, RX, RS, SI, and SS (Figure 2-13).

RR denotes a register-to-register operation. The operands are in general registers and the results replace the first operand.

RX denotes a register-and-indexed-storage operation. The first operand is in a general register and the second operand is in a main storage location. This format includes a

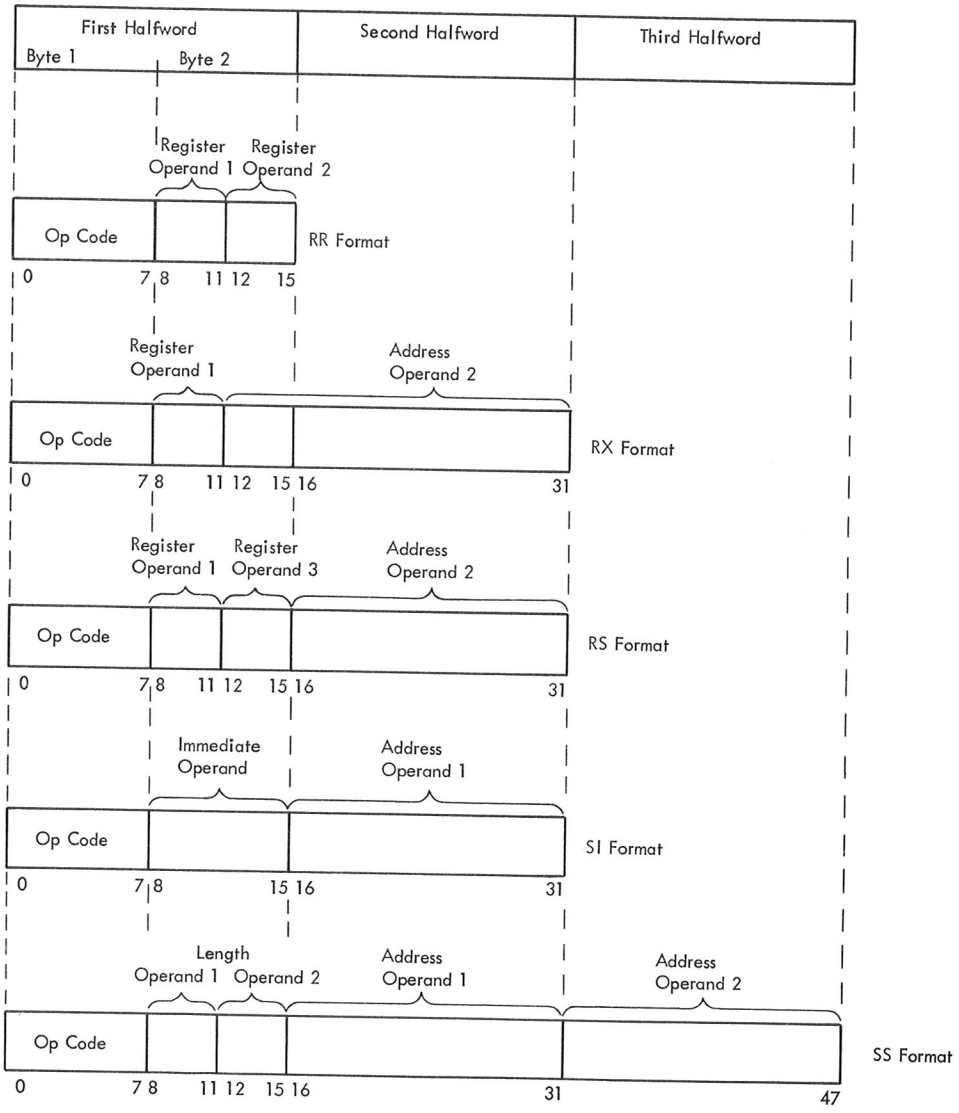


Figure 2-13. Basic Instruction Formats

quantity for indexing the main storage address; the quantity is contained within a general register, which is used as an index register and specified by the instruction. The results of an RX operation may replace the first operand, depending on the instruction.

RS denotes a register-and-storage operation. The first operand is in a general register, the second operand is in main storage, and a third may be specified by another general register.

SI denotes an immediate-operand-and-storage operation. The first operand is one byte of data carried in the instruction itself (the immediate operand), and the second operand is in main storage.

SS denotes a storage-to-storage operation. Both operands are in main storage.

Generally, the first byte of each of these formats gives the operation code (the "op code"), which identifies the operation to be performed; for some instructions, however, the first *two* bytes are used for the op code.

System Control Panel

The control panel, usually mounted on the CPU, provides the operator with manual control of the system. It gives the operator the ability to reset a system, to store and display information, and to load initial program information.

The need for operator manipulation of manual controls is minimized by the system design and by the governing control program, reducing the number and seriousness of operator errors.

A large-system capability permits the operator controls to also be mounted on a standalone console, such as the IBM 2150 Console.

INPUT/OUTPUT

An input/output operation transfers data between main storage and an I/O device. An I/O operation is initiated by a program instruction that generates a command to a *channel*. A *control unit* receives the command via the I/O *interface*, decodes it, and starts the I/O device.

Channels

Channels are the direct controllers of I/O devices and control units. They provide System/370 with the ability to read, write, and compute, all at the same time, by relieving the CPU of the task of communicating directly with the I/O devices.

Channels may be standalone units, complete with the necessary logical and storage capabilities, or they may time-share CPU facilities and be physically integrated with the CPU. The type available to any system model depends on the system model itself. In either case, the channel functions are identical. Channels may be implemented, however, to have different data transfer rates.

Functionally, the channel data path is divided into *subchannels.* To a programmer, each subchannel is a separate channel, and can be programmed as such.

Some subchannels can control several I/O devices, whereas others can control only one; these are called *shared* and *nonshared* subchannels, respectively.

System/370 has three types of channels: byte multiplexer, selector, and block multiplexer.

Byte Multiplexer Channels

Byte multiplexer channels separate the operations of high-speed devices from those of lower-speed devices. Channel operations are in either of two modes: *byte* mode for lower data rates, and *burst* mode for higher data rates.

In byte mode, the single data path of the channel can be shared by a large number of lower-speed I/O devices (such as card readers, printers, and terminals) operating concurrently; the channel receives and sends data to the I/O devices on demand.

Burst mode is forced by devices such as magnetic tape units, disks, or data cell storage, and is not under the control of the programmer. Such high-speed devices, having established a logical connection with a channel, usually stay connected to it for the duration of data transfer and thereby force the channel into burst-mode state.

The IBM 2870 Multiplexer Channel (Figure 2-14), the standalone unit used with Models 165 and 195, houses one byte multiplexer channel. Like the in-CPU byte multiplexer channels, 2870's have *byte multiplexer subchannels;* additionally, 2870's can have *selector subchannels.*

Byte multiplexer subchannels may operate in either byte or burst mode, and may be of either the shared or nonshared type. In byte mode, each can operate one low- or medium-speed I/O device concurrently, if the total load on the channel does not exceed the channel capacity. In burst mode, one byte multiplexer subchannel monopolizes the byte multiplexer channel and operates one higher-speed I/O device.

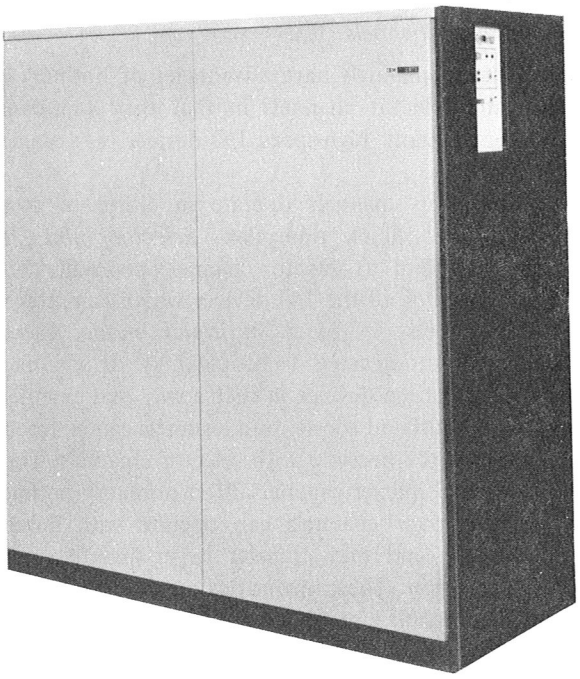


Figure 2-14. IBM 2870 Multiplexer Channel

Selector subchannels, which are of the shared type only, operate only in burst mode; each can operate one I/O device concurrently with the byte multiplexer subchannels but can control as many as 16 I/O devices.

Selector Channels

Selector channels transmit data to or from a single I/O device at a time. They can handle both high- and lower-speed I/O devices, but their burst-mode operation makes them especially suitable for high-speed devices. Each selector channel attaches up to eight I/O control units and can address as many as 256 I/O devices. One I/O device per selector channel can be transmitting data at any given time; no other I/O device on the channel can transmit data until all data is handled for the selected device.

In general, I/O operations on a selector channel are overlapped with processing, and all channels can operate simultaneously, provided that the processing unit's data rate capabilities are not exceeded. The maximum data rates for the selector channels vary with the System/370 models and the channel options available, and range from 1.3 to 1.85 million bytes per second.

The IBM 2860 Selector Channel, the standalone unit used with Models 165 and 195, is similar in appearance to the 2870 Multiplexer Channel (Figure 2-14), and can house one, two, or three selector channels.

Block Multiplexer Channels

Block multiplexer channels have advantages of both byte multiplexer and selector channels in that they can concurrently operate many high-speed I/O devices on a single data path.

Block multiplexer channels operate in either of two modes: selector or block multiplex. *Selector mode* is functionally equivalent to selector channel operation, permitting attachment of all the I/O devices which can attach to selector channels. In *block multiplex mode*, these channels permit interleaving (multiplexing) of channel programs for high-speed devices in such a way that channel programs can be initiated sooner and channels can be freed earlier than would be possible with selector channels. The byte and block multiplexer channels differ primarily in that the block multiplexer channels can operate with much faster I/O devices, and they transfer larger quantities of data per transmission. These quantities are referred to as *blocks*, and may include a number of records.

Block multiplexer channels provide a number of subchannels of the shared or nonshared type. The maximum data rates for block multiplexer channels vary with the System/370 models and channel options available, and range from 1.2 to 3.0 million bytes per second.

The IBM 2880 Block Multiplexer Channel, the standalone unit used with Models 165 and 195, is similar in appearance to the 2870, and houses either one or two block multiplexer channels.

I/O Devices

I/O devices fall into a number of categories, some of which overlap. They are used in and for:

Auxiliary storage
Machine and manual (keyed) input, both local and remote
Teleprocessing
Reading (or output) of external documents and displays
Process control
Data acquisition

Many I/O devices function with an external document, such as a punched card or a reel of magnetic tape. Others handle only electrical signals, such as those in process-control and data acquisition systems.

Control Units

Control units provide the logic circuitry and the storage areas (buffers) needed to operate the attached I/O devices. Yet, to the user, most control unit functions cannot be distinguished from I/O device functions.

A control unit may be single-path, shared-path, or multipath. A single-path unit, usually integrated with an I/O device, controls only one device. Both shared-path and multipath units can control more than one device and are usually standalone units. They differ in that a multipath unit permits several I/O devices to transfer data concurrently, whereas the shared-path unit does not.

I/O Interface

This set of lines provides a uniform method of attaching various I/O devices (through control units) to channels, making System/370 adaptable to a wide range of present and future devices and applications. The information format and the control signal sequences provided by the interface are independent of the type of control unit and channel.

INTERRUPTION SYSTEM

The interruption system permits System/370 to dynamically respond to equipment and programming errors, and greatly aids the efficient use of I/O equipment. To make the interruption procedure as short and simple as possible, switching between the interrupted program and the control program (the program that services interruptions) must be efficient.

The interruption system uses *program status words* (PSW's) to hold status and control information as in System/360. Additionally, System/370 uses control registers to regulate the interruption system.

As soon as an interruption occurs, all current status information, together with an identification of the cause of the interruption, is put into a PSW. This "old" PSW is stored at a fixed location. The system then automatically fetches a "new" PSW from a different fixed location. Each class of interruption uses two fixed locations in main storage: one to receive the old PSW when the interruption occurs, and the other to supply the new PSW that governs the servicing of that class of interruption.

After the interruption has been serviced, the CPU is restored by the control program to the status it had before the interruption.

Classes of Interruptions

The interruption system separates interruptions into five classes:

Program interruptions are caused by various kinds of programming errors and exceptions; the exact type of condition is identified in the program old PSW.

Supervisor Call interruptions are caused when the program issues an instruction to pass control to the part of the control program called the *supervisor*, which performs the supervisory functions associated with a task.

External interruptions are caused by an external device that requires attention, by the interval timer (an internal clocking device) going past zero, or by the operator pressing the interrupt key.

I/O interruptions are caused by an I/O unit ending an operation or otherwise needing attention. Identification of the device and channel causing the interruption is stored in the I/O old PSW; in addition, the status of the device and channel is stored in a fixed location.

Machine Check interruptions are caused by the machine-checking circuits detecting an error.

Disallowing of Interruptions

Most interruptions may be either allowed or temporarily disallowed. When an interruption is disallowed, it is either delayed or does not take place, the outcome depending mainly on the class of interruption. The following can be disallowed:

All I/O interruptions
All external interruptions
Some program interruptions
The machine-check interruption

Priority of Interruptions

During the execution of an instruction, several interruptive events may occur simultaneously. When this occurs, the competing interruption requests are serviced in a fixed order of priority.

(The next page is intentionally blank.)

This section describes the more prominent standard and optional features of System/370. Each feature is discussed under the heading for the system unit with which it is most easily associated.

Some features are standard for some System/370 models and optional for others; and some features are available to only certain models. (See Section 6 for the features available with any specific model.)

MAIN STORAGE FEATURES

Main (or processor) storage includes all storage that is directly addressable.

Main Storage Capacities

Main storage capacities offer a wide latitude in choosing the amount of storage required. The capacities vary from 96K (98,304) bytes to 4,096K (4,194,304) bytes, depending on the system model. Available models have a choice of several storage capacities, with each model's maximum capacity several times its minimum.

Storage Protection

Storage protection, made up of the store and fetch protection features, prevents the unauthorized changing or use of the contents of main storage. *Store protection* prevents the contents of main storage from being altered by storage addressing errors in programs or input from I/O devices. *Fetch protection* prevents the unauthorized fetching of data and instructions from main storage. As many as 15 programs (with associated main storage areas) can be protected at one time.

Protection is achieved by dividing main storage into 2,048-byte blocks and by associating a five-bit *storage key* (Figure 3-1) with each block. Each storage key may be thought of as a lock. Each block of storage, then, has its own "lock." Two instructions are provided for assigning and inspecting the key, which contains a four-bit *code*. The same code may be used by many blocks, using binary codes 0001-1111.

A user's right of access to storage is identified by a four-bit *protection key* (Figure 3-1), located in the program status word (PSW) or in a special word used in channel operations. The protection key may be thought of as the key for the "lock." During a main-storage reference (storing or fetching), the storage key is compared with the protection key associated with the reference. Access to the location is granted only when the four leftmost (high-order) bits of the storage key match the protection key, or when the protection key is zero (0000). When both the store and fetch protection features are installed, the rightmost (low-order) bit of the storage key determines whether fetch protection is operative for the storage block associated with that key. If the bit is 1, fetch protection is operative; if it is 0, it is inoperative.

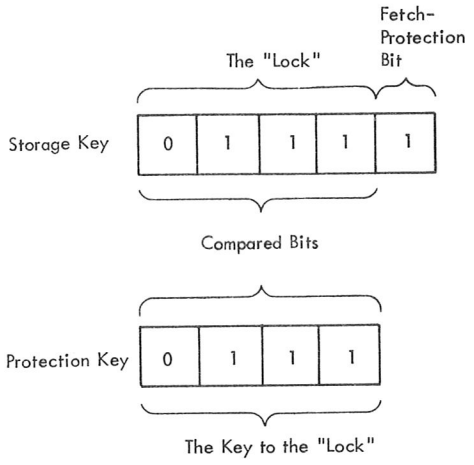


Figure 3-1. Storage and Protection Keys, Showing Matching Keys

High-Speed Buffer Storage

Buffer storage can sharply reduce the time required for fetching currently used sections of main storage. On the Model 165, for example, the CPU can obtain eight bytes from the buffer in two cycles (160 nanoseconds), and a request can be initiated every cycle. This compares with 18 cycles (1440 nanoseconds) required to obtain eight bytes directly from main storage.

Buffer operation is handled entirely by hardware and is transparent to the programmer, who doesn't need to adhere to any particular program structure in order to achieve close-to-optimum use of the buffer.

CENTRAL PROCESSING UNIT FEATURES

Instruction Sets

System/370 has four instruction sets: the standard, commercial, scientific, and universal (Figure 3-2). The instructions that make up the System/370 instruction sets include those used in System/360, plus thirteen new ones (described in *IBM System/370 Principles of Operation*, GA22-7000).

The *System/370 standard instruction set* includes the instructions in the System/360 standard instruction set, plus 13 additional instructions.

The System/370 standard instruction set and the System/370 decimal feature instructions (the System/360 decimal feature instructions plus one additional instruction) make up the *System/370 commercial instruction set*.

The System/370 standard instruction set and the System/360 floating-point feature instructions make up the *System/370 scientific instruction set*.

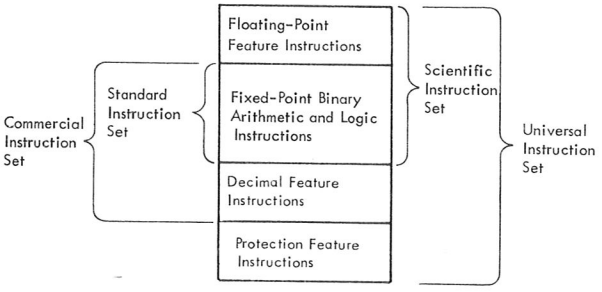


Figure 3-2. System/370 Instruction Sets

When the standard instruction set is combined with the decimal, floating-point, and protection feature instructions (see the discussion of storage protection under "Main Storage Features"), a *System/370 universal instruction set* is provided.

Decimal Feature

This feature, especially useful in commercial operations, permits storage-to-storage decimal arithmetic operations and adds two instructions to assist in editing output.

Floating-Point Feature

This feature, used primarily in scientific operations, permits calculations on data with a wide range of magnitude. Included with this feature are four 64-bit floating-point registers, which are used to perform these calculations. Operands can be selected for either 24-bit fractions (short precision) or 56-bit fractions (long precision).

Extended-Precision Floating-Point Feature

This feature permits floating-point operands to have 112-bit fractions (extended precision) compared to the 56-bit fractions available with long-precision floating-point arithmetic. It also permits results to be rounded from extended to long precision or from long to short precision.

Direct Control and External Interrupt

Direct control provides for exchanging control signals between two System/370 CPU's, between a System/370 CPU and a System/360 CPU, or between a System/370 and some specialized device, such as an analog-digital converter.

Direct control bypasses the channel by using the direct control instructions and six external interruption lines, each of which, when pulsed, sets up the conditions for an external interruption.

Interval Timer

This timer provides program interruptions on a program-controlled basis. The timer, which is updated by timing circuits, has a time resolution of 3.333 milliseconds (0.104 millisecond for the Model 195), and a total clock cycle of 15.5 hours.

Time-of-Day Clock

This feature provides a precise measure of time suitable for accurate elapsed time measurements and time-of-day indication. The clock's binary value, updated each microsecond (each quarter-microsecond in the Model 195), can be interrogated or set by provided instructions. The total clock cycle is approximately 142 years.

Byte-Oriented Operand

Before describing the function of this feature, a distinction needs to be made between privileged and nonprivileged instructions, both of which make reference to fixed-length data fields. Essentially, *privileged* instructions are those used solely with control programs, whereas *nonprivileged* instructions are used in processing or problem programs, as well as in control programs.

The byte-oriented operand feature removes the integral-boundary restriction from fixed-length fields referenced by *nonprivileged* instructions, permitting the fields to be located in main storage on byte boundaries without causing program interruptions. For optimum performance, however, these fixed-length fields should be located on integral boundaries, since significant performance degradation may result from the use of this feature.

Other fixed-length fields (including those referenced by privileged instructions) are unaffected by this feature, and must be located on integral boundaries.

CHANNEL FEATURES

Channel-to-Channel Adapter

This adapter provides a path for data transfers between two channels and synchronizes such transfers, providing systems with interchannel communication.

The channels are usually on separate systems. Connecting a channel of one system to a channel of another has the effect of interconnecting two CPU's.

The adapter uses one or two control-unit positions on each of the two connected channels, but only one channel need have the adapter.

Command Retry

Command retry, a control-unit-dependent feature, can cause a failing channel command to be retried without requiring an I/O interruption. The number of retries is device-dependent.

SYSTEM FEATURES

Compatibility Features for Other IBM Systems

A number of features are available that permit operation of certain models of System/370 by the use of programs written for other IBM systems. These compatibility features are combinations of circuitry and programming that make the System/370 able to read programs written for the other system and to function like that system. In many cases, the program runs much faster on System/370 than on the system for which it was written.

Compatibility features are also called *emulators*, but not simulators. The latter, although they may perform the same function, do so with programming alone and thus run slower.

A compatibility feature is particularly useful when the user needs time to convert his present programs to System/370 code but, at the same time, wants the advantages offered by System/370. In addition, using such a feature may eliminate the need for converting programs that are seldom used.

Sufficient storage and appropriate or equivalent I/O devices must be available for the use of a compatibility feature. Furthermore, the use of one compatibility feature may preclude the use of another. Under unusual conditions, a feature may not be able to maintain exact compatibility; for example, programs that are time-dependent may not yield identical results, and the handling of error conditions may differ.

OS/DOS Compatibility

This feature provides a System/370 model with the ability to execute DOS programs under OS control.

(The next page is intentionally blank.)

Section 4. System/370 Programming Systems

The System/370 programming support supplied by IBM is aimed at minimizing the time and effort required by the user to produce and process programs.

System/370 is program compatible (upward) from models of System/360 (excluding Models 20, 44 and 67). All programs written for System/360 operate on System/370 except those which:

1. Are time-dependent.
2. Are written to deliberately cause program exceptions.
3. Use machine-dependent data.
4. Use PSW bit 12 (the ASCII bit).
5. Use low-address main storage reserved for special purposes.
6. Use programs which depend on devices or facilities not available in System/370 (such as the integrated disk storage of the System/360 Model 44, or dynamic address translation of the System/360 Model 67).
7. Use programs requiring model-dependent System/360 functions.
8. Depend on main storage data retention when power is off.

Operating Systems—General Facts

An operating system is a collection of programs that provides for the preparation and execution of the user's problem programs (jobs). IBM-supplied operating systems are designed to match the needs of the equipment configuration and the customer's job requirements.

All operating systems are either tape-resident or direct-access-resident, and consist of two basic parts:

Control program
Processing (or problem) programs

Control Program

The control program is the framework of an operating system; it has three distinct functions:

Job management
Task management (Supervisor)
Data management

Job Management provides the facilities to read, interpret, initiate, and terminate jobs submitted for processing. It also provides the facilities for the operator to communicate with the system.

Task Management is the core of an operating system. Because it performs the supervisory functions associated with the execution of a task, it is often called the supervisor. The functions provided generally include interruption handling, resource allocation, fetching of non-resident routines, time supervision, and transient-error recovery.

Data Management provides the functions of record blocking and deblocking, space allocation on direct access devices, processing of labels, and the transfer of data between main storage and external devices, all by means of various *access methods*. These functions allow data sets (sometimes called data files), and their processing, the utmost independence from the I/O environment. The access methods, which are well-defined and consistent, handle data sets according to their basic organization: sequential, indexed sequential, direct, partitioned, etc. Some access methods provide automatic buffering facilities.

Processing Programs

A processing program is defined as any program that is not a control program. Processing programs are kept on tape or direct access devices, as collections of data sets known as libraries, and fall in three general categories:

Language Translators for Assembler, FORTRAN, COBOL, PL/I, etc.

Service Programs such as utilities and sort/merge.

User-Written Problem Programs that become part of the operating system library and are retrievable by name alone.

Specific Operating Systems

The operating systems supplied by IBM have been designed in modular fashion so that functions may be incorporated according to the need of the user and the size of his equipment configuration. The operating system is created and integrated with the equipment at the time of installation during an operation called *system generation*.

The IBM-supplied operating systems for the System/370 are:

System/360 Disk Operating System (DOS)
System/360 Operating System (OS)

DOS

DOS is 2311, 2314, or 3330 disk-resident on a system with the minimum recommended storage of 32K bytes. DOS provides a control program, five language translators (Assembler, RPG, FORTRAN, COBOL, and PL/I), utilities, sort/merge programs, and special-purpose library maintenance programs. DOS also provides a multiprogramming facility which allows several programs to be run concurrently. Communication functions are provided through the Basic and Queued Telecommunications Access Methods (BTAM and QTAM).

OS

OS is the most sophisticated and the most powerful of the IBM operating systems. At least 128K bytes are required;

the storage size must be estimated for each system according to the OS facilities actually needed. OS is resident on direct access devices having a data rate that the using model of System/370 is capable of accepting. OS offers two control programs:

Multiprogramming with a Fixed Number of Tasks (MFT)
Multiprogramming with a Variable Number of Tasks (MVT)

MFT reduces the problem of CPU wait-time by supervising the execution of more than one job at a time. Each job is executed in its own area of main storage. The size of each of these areas, or *partitions*, is established when the system is generated, but may be changed by the operator. MFT is especially useful to users who must process a wide variety of jobs that require a corresponding variety of computing system resources. The system's capability of providing partitions as small as 8K bytes is a distinct advantage to the user with many small jobs.

MVT also supervises execution of more than one job step at a time but, in addition, allocates main storage dynamically to each job. This configuration supports the large job as well as the customer who has many small jobs. Dynamic storage areas, called *regions*, can be as small as 12K bytes for MVT.

Before MVT can schedule a job, the programmer must request, through a control language, the amount of main storage required and the devices required. Because a single job will probably not require all of main storage nor all devices, the remaining resources can be given to other jobs. The programmer also has some control over the sequence of job scheduling. Instead of scheduling jobs in the order in which they are submitted, MVT schedules jobs according to specified priorities.

When more than one job is being executed at the same time, each job competes for the machine and program resources it needs. The main factor in resolving the competition for machine resources is the scheduling priority of the job. When two jobs are being executed, the job with the higher priority uses the CPU when needed.

MVT extends the idea of priorities beyond between-job competition for resources to competition within jobs; i.e., different priorities can be given to separate tasks of a job step.

The minimum storage capacities are 128K bytes for MFT and 256K bytes for MVT.

The Time Sharing Option (TSO), available with MVT, extends OS to provide general-purpose time sharing. This allows many terminal users to share machine and program resources concurrently. TSO provides a command language and processors to make most MVT facilities available to terminal users.

A diagram of OS is available on a card in color; see *Operating System/360 Chart,* GV25-6156.

Programming Systems Glossary

*Assemble**. To prepare a machine language program from a symbolic language program by substituting absolute operation codes for symbolic operation codes and absolute or relocatable addresses for symbolic addresses.

*Assembler**. A program that assembles.

*Compile**. To prepare a machine language program from a computer program written in another programming language by making use of the overall logic structure of the program, or generating more than one machine instruction for each symbolic statement, or both, as well as performing the function of an assembler.

*Compiler**. A program that compiles.

*Initial Program Loader (IPL)**. The procedure that causes the initial part of an operating system or other program to be loaded such that the program can then proceed under its own control.

IOCS. Input/Output Control System.

*Linkage**. In programming, coding that connects two separately coded routines.

Linkage Editor†. A program that produces a load module by: (1) transforming object modules into a format that is acceptable to fetch, (2) combining separately produced object modules and previously processed load modules into a single load module, (3) resolving symbolic cross references among them, (4) replacing, deleting, and adding control sections automatically on request, and (5) providing overlay facilities for modules requesting them.

Load Module†. (1) The output of the linkage editor. (2) A program in a format suitable for loading into main storage for execution.

*Macro Instruction**. An instruction in a source language that is equivalent to a specified sequence of machine instructions.

*Module**. A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading; for example, the input to, or output from, an assembler, compiler, linkage editor, or executive routine.

*Object Module**. A module that is the output of an assembler or compiler and is input to a linkage editor.

*Program Library**. A collection of available computer programs and routines.

* American National Standards Institute (ANSI) definition. Anyone desiring to reprint this definition is advised to seek permission from the American National Standards Institute, Inc.

† A *Data Processing Glossary* (GC20-1699) definition.

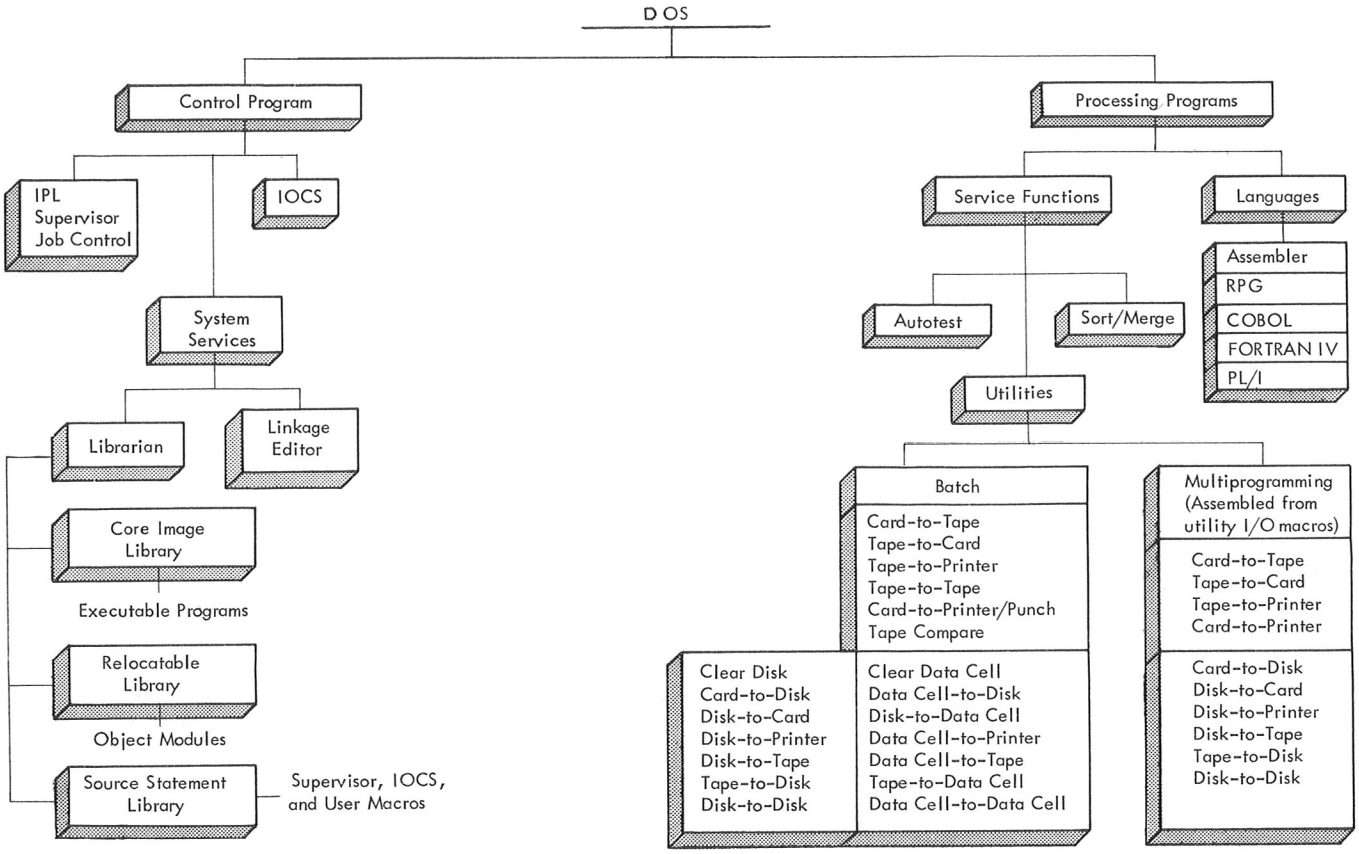


Figure 4-1. DOS Facilities

(The next page is intentionally blank.)

TELEPROCESSING

System/370 was designed so that it could serve as the data processing complex within a larger teleprocessing system (Figure 5-1).

Experience with real-time and teleprocessing systems indicates two major differences between teleprocessing systems and the more familiar batch processing systems: batch processing input is scheduled, whereas teleprocessing input is unscheduled; batch processing is usually serial, whereas teleprocessing is random. System/370 incorporates the ability to service these two teleprocessing characteristics.

As an example of how a teleprocessing system functions, suppose that a clerk in an insurance company's branch office receives a telephone call asking for information about an insured's account. Asking the caller to hold the line, the clerk enters the information request into a terminal, and the request is sent over a communications line to the System/370 at the insurance company's main office. When the request reaches the computer, several things happen. The computer interrupts processing whatever job it is working on (perhaps the payroll is being run) and saves all necessary data and instructions so that it can resume processing at exactly the point in the program it had reached before it was interrupted. As the information is received over the communications lines, the communications module in the control program converts the data into machine language, stores it in a buffer area, and checks to see that it was transmitted correctly.

The nature of the request may dictate that a number of different operations must be performed. To process the request, the teleprocessing program directs the System/370 to run through the appropriate policy file and bring the insured's record from storage. The program then searches the record for the information requested and sends it out over the communications lines to the clerk who originated the request. The clerk reads the information as it is typed out at his terminal and relays the information to the policyholder or adjuster waiting on the telephone. Back at the main office, the control program has returned the System/370 to its status prior to the interruption by the inquiry, and the computer has resumed processing the payroll program.

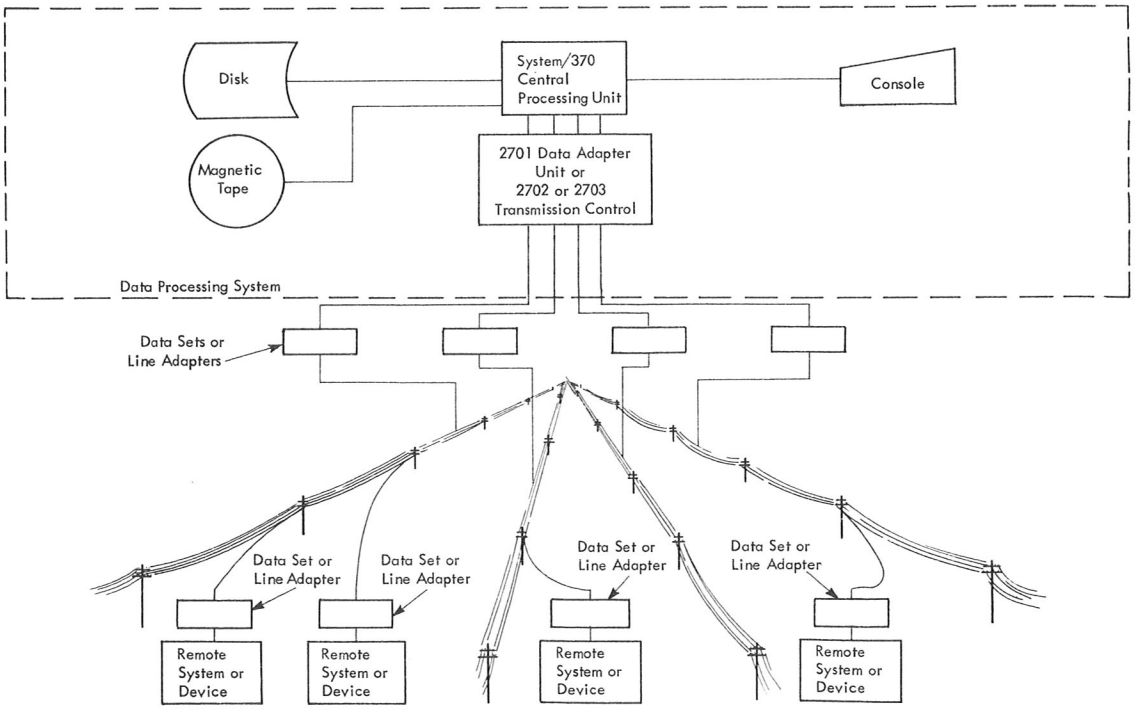


Figure 5-1. System/370 as a Teleprocessing System

Requirements of a Teleprocessing System

A careful examination of the preceding example reveals that any teleprocessing system must meet certain requirements. System/370 was designed to respond to all of these requirements without sacrificing its efficient performance of the ordinary batch data processing needs of science and industry.

Transmission Control Capability

The system may be servicing many locations, some on common communications lines and some on separate lines. Equipment and programming are therefore required to handle the multiple inputs arriving in unscheduled fashion into the system.

Program Switching

On a single transaction, the control program initiates several switches among the various programs; therefore, the processing unit must be designed to accomplish very rapid program switching.

Storage Protection

With multiple programs residing in the system at one time and with constant program switching and relocation taking place, it is imperative that there be a facility available that can prevent one program from changing another program's instructions and data.

Transmission Directions and Modes

A communications line (also called a communications channel or circuit) is a path for electrical transmission between two or more terminals. Basically, teleprocessing equipment can operate over three types of circuits: simplex, half-duplex, and duplex (also called full-duplex). These circuit names describe only directional capability.

Simplex Circuits can carry data in only one direction.

Half-Duplex Circuits can carry data in two directions but in only one direction at a time.

Duplex Circuits can carry data in two directions at the same time.

A network can consist of any combination of these circuits according to application requirements.

Modes

Information can be transmitted over the various types of communication lines by three different modes of transmission:

1. *Asynchronous Transmission* (also called serial start/stop) requires the use of start and stop bits to designate the beginning and ending of characters.
2. *Synchronous Transmission* eliminates the need for start and stop bits; a special pattern of bits is sent periodically to keep the transmitter and receiver operating in unison. The bit pattern is generated automatically and sent as required by the system.
3. *Parallel Transmission* allows all bits of a character to be transmitted simultaneously by providing a separate path for each bit in the code structure.

Most often a user obtains his communications lines from a communications common carrier. The common carrier leases him a private line for his exclusive use or connects him with the common-carrier (dial-up) network available to the public. A user can also purchase and maintain his own communications facilities, but these must be purchased from suppliers other than common carriers.

Terminal Connections to Communications Lines

In this System Summary the word "terminal" refers to a machine or group of machines capable of generating and/or receiving signals transmitted over a communications line. Within this definition, a terminal may range from a data processing system, such as System/370, to a single device, such as an IBM 2740 Communication Terminal. A terminal may be connected to another terminal by a point-to-point line or by a multipoint line. A *point-to-point* line connects a single terminal to another single terminal, whereas a *multipoint* line connects more than two terminals. On circuits with little traffic, use of the multipoint line often results in a cost saving. Terminals sharing the same line may or may not have the ability to communicate with each other.

Data Sets

A data set, also called a *modulator/demodulator* or *modem,* performs the modulation and demodulation functions necessary to provide compatibility between business machines and communications facilities. Modulation is the conversion of digital signals (from the business machine) to audio-frequency signals for transmission over communication lines. Demodulation reconverts the information for machine use.

Data sets may be furnished by communications common carriers, equipment suppliers, or by IBM. Those available as features for some devices are called IBM line adapters.

One data set is required at each interface between the communications facilities and the data processing equipment.

DATA ACQUISITION AND PROCESS CONTROL

A high-speed data acquisition system is designed to maintain constant communication with a process for such purposes as:

1. Determining whether the process is operating within acceptable limits.
2. Providing records for accounting or management decisions.
3. Providing a record of data obtained during a research experiment.

A process control system usually incorporates data acquisition facilities and has the additional capability of using the acquired data as a basis for supervising and controlling the process.

(The next page is intentionally blank.)

In this section, the more prominent features and characteristics of each model are brought together to describe each model individually. Figures 6-1 through 6-5 show the different System/370 models. Figure 6-6, which compares each model's prominent features and characteristics with those of the other models, appears at the end of this section. The devices that can attach to the individual System/370 models are described in the next two sections and are listed in Figures 7-1 and 8-1.

System/370 Model 135

The System/370 Model 135 (Figure 6-1), with storage capacities of up to 240K (245,760) bytes, offers System/370 reliability and performance at relatively low cost. Features such as error checking and correction (ECC) circuits and instruction retry increase Model 135 reliability, and monolithic storage circuits contribute significantly to performance.

Further enhancing the Model 135 are:

1. The console file, which provides the facility for loading control storage with the System/370 microprogram, diagnostic microprograms, or a system checkout program.
2. The alter/display function, which provides a means of displaying and altering main storage data at a printer-keyboard.
3. The CPU-integrated I/O adapters, which eliminate the need for external control units for some commonly used I/O devices.

Standard Features

System/370 commercial instruction set
Storage protection (store and fetch)
Byte-oriented operand
Time-of-day clock
Console file
Error checking and correction (in main and control storage)
Instruction retry
OS/DOS compatibility
Byte multiplexer channel (one: channel 0)
Interval timer
Monitoring
Command retry
Channel retry information

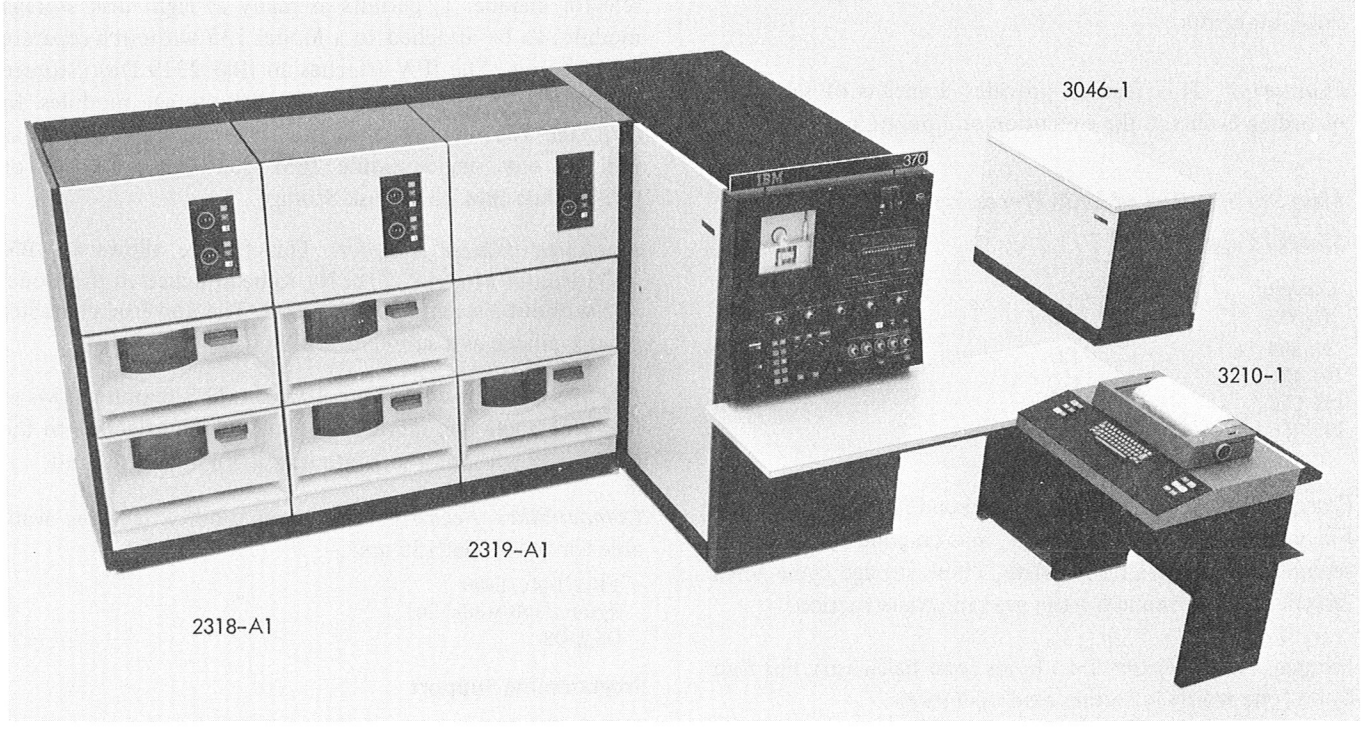


Figure 6-1. IBM System/370 Model 135 with IBM 2318 and 2319 Disk Storage, IBM 3210 Printer-Keyboard and IBM 3046 Power Unit

Optional Features

System/370 universal instruction set
Floating-point feature
Extended-precision floating-point feature
Direct control (with external interrupt)
Integrated file adapter (IFA)
Integrated printer adapter
First and second selector channels
Block multiplexer channel
Integrated communications adapter (ICA)
1401/1440/1460 compatibility
System/360 Model 20 compatibility
Expanded control storage
Adapter for 3210-1 or 3215-1 Console Printer-Keyboard

System Components

Central Processing Unit: IBM 3135 Processing Unit

Basic Machine Cycle Time: 275 to 1,430 nanoseconds (0.275 to 1.43 microseconds), depending on the type of instruction performed.

Instruction Sets: The System/370 commercial instruction set is standard with the Model 135. Adding the floating-point feature provides the System/370 universal instruction set.

Instruction Retry: Instruction retry automatically examines any instruction during whose execution an error is detected, and in most cases reattempts its execution.

Error Checking and Correction: For data read from main storage and control storage, error checking and correction circuits automatically detect all single- and double-bit errors and some multiple-bit errors, and automatically correct the single-bit errors.

Monitoring: This feature provides a means of selectively recording events in the execution of a program.

Main Storage: Part of 3135 Processing Unit

Storage Capacities:

Capacity (Bytes)	*Model*
98,304	FE
147,456	GD
196,608	GF
245,760	DH

Storage Cycle Time: 0.770 microsecond (770 nanoseconds) for main-storage read, 0.935 microsecond (935 nanoseconds) for main-storage write. These storage cycle times include the fetch time for the next microinstruction.

Storage Access Width: Two bytes (one halfword), but four bytes (one word) in certain read operations.

Control Storage: Part of 3135 Processing Unit

Control-Storage Capacity: 24K (24,576) bytes, expandable to 36K (36,864) bytes or 48K (49,152) bytes.

Channels: Part of 3135 Processing Unit

The Model 135 can have as many as four channels. One byte multiplexer channel is standard, and one or two selector channels can be added, in addition to the IFA, which is addressed as channel 1. For block multiplexer channels, the block multiplexer feature is added to each installed selector channel.

Each block multiplexer channel has one shared and 16 nonshared subchannels. The byte multiplexer channel may have 16, 64, 128, or 256 subchannels (up to eight shared of the 16, 64, or 128).

System

The basic system consists of the IBM 3135 Processing Unit, one IBM 3210 or 3215 Console Printer-Keyboard Model 1, and one IBM 3046 Power Unit Model 1.

System Control: The Model 135 is operated, monitored, and controlled through a system control panel on the CPU, and through the console printer-keyboard.

Console File: The console file, located on the system control panel, is used to load into control storage the microprogram required for system operation. As part of the loading operation, diagnostic microprograms check out the CPU and adapters. Other disks for the console file carry a diagnostic program for system checkout.

Integrated File Adapter (IFA): This feature, addressed as selector channel 1, permits as many as eight disk storage modules to be attached to a Model 135 without a separate control unit. The IFA attaches an IBM 2319 Disk Storage Model A1, which contains three disk storage modules. In turn, the 2319-A1 can attach a three-module 2319-A3 as well as one single-module IBM 2312 Disk Storage or two-module IBM 2318 Disk Storage.

Integrated Printer Adapter: This feature allows an IBM 1403 Printer Model 2, 7, or N1 to be attached to the Model 135 without a separate control unit. The universal character set is available as a subfeature.

Integrated Communications Adapter: This feature allows as many as eight communication lines to be attached to the Model 135 without a separate transmission control unit.

Compatibility Features: The compatibility features available for the Model 135 are:

1401/1440/1460
System/360 Model 20
OS/DOS

Programming Support

The Model 135 is supported by DOS and by OS with MFT.

System/370 Model 145

The System/370 Model 145 (Figure 6-2) is a versatile data processing system for both commercial and scientific applications. It provides efficient performance while preserving upward compatibility, and offers main storage capacities as large as 512K (524,288) bytes.

The performance of this model is further enhanced by:

1. System/370's notable reliability and serviceability features, such as its retry capabilities, error-logging facilities, extensive internal checking circuits, and error-checking and correction (ECC) circuits for main and control storage.
2. A console file, which provides a facility for loading control storage with either the System/370 microprogram, extensive microdiagnostics, or system tests.
3. An integrated disk storage facility, offering high performance and capacity.
4. An alter/display function, which provides a means of displaying and altering main storage without interfering with any concurrent I/O operations.

Standard Features

System/370 commercial instruction set
Byte-oriented operand
Selector channel (one)
Console file
Interval timer
Byte multiplexer channel (one channel 0)
Storage protection (store and fetch)
Time-of-day clock
Micro-instruction retry
Error checking and correction (in main and control storage)
Command retry
Channel retry information
OS/DOS compatibility
Monitoring

Optional Features

System/370 universal instruction set
Block multiplexer channel
Selector channels (as many as three)
Channel-to-channel adapter
Direct control (with external interrupt)
Floating-point feature (includes extended precision)
Adapter for a 3210-1 or 3215-1 Console Printer-Keyboard
Adapter for a 3210-2 Console Printer-Keyboard
Integrated file adapter (IFA)
Word buffer
1401/1440/1460 compatibility
1401/1440/1460, 1410/7010 compatibility

System Components

Central Processing Unit: IBM 3145 Processing Unit

Basic Machine Cycle Time: 202.5 to 315.0 nanoseconds (0.2025 to 0.315 microseconds), the exact time depending on internal CPU operations.

Instruction Sets: The System/370 commercial instruction set is standard with the Model 145. Adding the floating-point feature provides the System/370 universal instruction set.

Micro-instruction Retry: The ability to recover from many intermittent failures is provided through retry techniques performed by microprogram routines that save the source data before it is altered during an operation. When an error is detected, a microprogram returns the CPU to the beginning of the operation or to a point in the operation that was correctly executed, and the operation is continued.

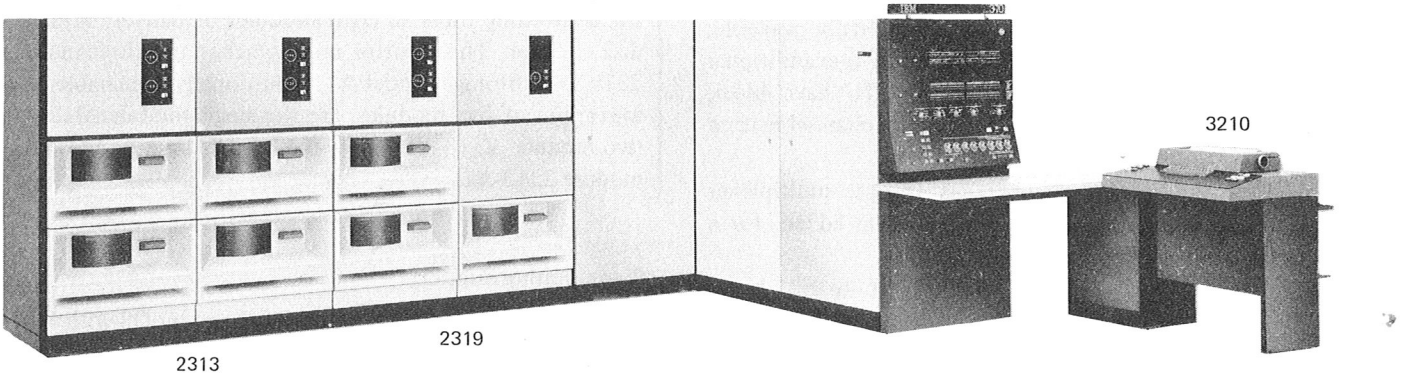


Figure 6-2. IBM System/370 Model 145 with IBM 2313 and 2319 Disk Storage and IBM 3210 Console Printer-Keyboard

Error Checking and Correction: For data read from main storage and control storage, error checking and correction circuits automatically detect all single- and double-bit errors and some multiple-bit errors, and automatically correct the single-bit errors.

Main Storage: Part of 3145 Processing Unit: also IBM 3345 Processor Storage Model 1 or 2

Storage Capacities:

Capacity (Bytes)	*Model*	*Storage Units*
163,840	GE	In-CPU
212,992	GFD	In-CPU
262,144	H	In-CPU
393,216	HG	In-CPU plus one 3345-1
524,288	I	In-CPU plus one 3345-2

Storage Cycle Times: 540.0 nanoseconds for main-storage read; 607.5 nanoseconds for a main-storage write.

Storage Access Width: Eight bytes (one doubleword).

Control Storage: Part of 3145 Processing Unit

Control-Storage Access Time: 109 nanoseconds.

Control-Storage Capacity: 32K (32,768) bytes*

*The Model 145 has a movable control-storage boundary that allows up to 64K (65,536) bytes of control storage, depending on the features installed. The additional control-storage capacity is at the expense of main storage. The storage boundary is determined at the time that the microprogram is compiled by IBM.

Channels: Part of 3145 Processing Unit

The Model 145 can have as many as five channels. One byte multiplexer channel and one selector channel are standard. Three additional selector channels are optionally available, but if the IFA feature is installed, then only one additional selector channel is optionally available. To have block multiplexer channels, the block multiplexer channel feature is added to selector channels.

The byte multiplexer channel has 16 byte multiplexer subchannels. Additional subchannels can be added, for a total of 32, 64, 128, or 256 subchannels.

Block multiplexer channels can have 16 to 512 block multiplexer subchannels of the nonshared type, in increments of 16.

Word Buffer: This feature increases the efficiency of the system by permitting assembly of up to four bytes of data before requiring a share cycle to transfer the data, thereby greatly improving channel speeds and CPU throughput.

If ordered, the word-buffer feature is installed on all attached selector channels.

System

Compatibility Features: The compatibility features available for the Model 145 are:

1401/1440/1460
1401/1440/1460, 1410/7010
OS/DOS

System Control: The Model 145 is operated, monitored, and controlled via the system control panel on the 3145 Processing Unit, and via the console printer-keyboard.

Console File: The console file, located under the operator's console table, is the initial microprogram loading (IMPL) device for the system. The file provides all microcode, on removable disks, for the system. Each disk contains a full control-storage load of system microcode. Disks supplied with the system provide the required microcode for system operation, emulators, diagnostics, and any other required microprogram material to be loaded into control storage.

Integrated File Adapter: This feature, assigned exclusive use of selector channels 1 and 4, incorporates a file control unit for controlling three to eight modules of natively attached disk storage. This control unit attaches the three-module 2319 Disk Storage Model A1. Additionally attachable, to a maximum of five modules, are the single-module 2312-A1, two-module 2318-A1, three-module 2319-A2, and four-module 2313-A1.

Programming Support

The Model 145 is supported by DOS and by OS with MFT or MVT.

System/370 Model 155

The IBM System/370 Model 155 (Figure 6-3) is a high-performance data processing system that provides the reliability, availability, and convenience demanded by business and scientific users, as well as by users with applications in communications or control.

The high performance of the Model 155 is the result in part of these features:

1. Access to 16 main-storage bytes in parallel.
2. Local storage used for CPU (general, floating-point, and control registers) and I/O applications.
3. High-speed buffer storage that stores currently used sections of main storage for faster accessing of data.
4. Read-only storage (ROS), which contains the micro-programs (ROS control words) that control CPU and I/O operations.
5. Overlap, where possible, of the instruction fetching and execution portions of CPU operations.
6. Overlap, where possible, of CPU and I/O operations.
7. Retry facilities in the CPU, channels, and control units.
8. An alter/display function that provides an easy method for storing small program loops or for making changes to programs already in storage.

Standard Features

System/370 universal instruction set
Storage protection (store and fetch)
Byte-oriented operand feature
High-speed buffer storage (8,192 bytes)
Error checking and correction (in main storage)
Time-of-day clock
Interval timer
Instruction retry
Channel retry
Command retry
Byte multiplexer channel (one: channel 0)
Block multiplexer channels (two: channels 1 and 2)
Monitoring

Optional Features

Extended-precision floating-point
Direct control (with external interrupt)
OS/DOS compatibility
1401/1440/1460 and 1410/7010 compatibility
7070/7074 compatibility
Channel-to-channel adapter
Block multiplexer channel (up to three, for channels 3, 4, and 5)
Byte multiplexer channel (one more, in place of the block multiplexer channel for channel 4)
Adapter for a 3210-1 or 3215-1 console printer-keyboard (one must be specified)
Adapter for 3210-2 console printer-keyboard (standalone)

System Components

Central Processing Unit: 3155 Processing Unit

Basic Machine Cycle Time: 0.115 microsecond (115 nanoseconds).

Instruction Set: The System/370 universal instruction set is standard on the Model 155.

Monitoring: This feature provides a means of selectively recording designated events in the execution of a program.

Instruction Retry: Instruction retry automatically examines any instruction during whose execution an error is detected, and in most cases reattempts its execution.

Error Checking and Correction: For data read from main storage, error checking and correction circuits automatically detect all single- and double-bit errors and some multiple-bit errors, and automatically correct the single-bit errors.

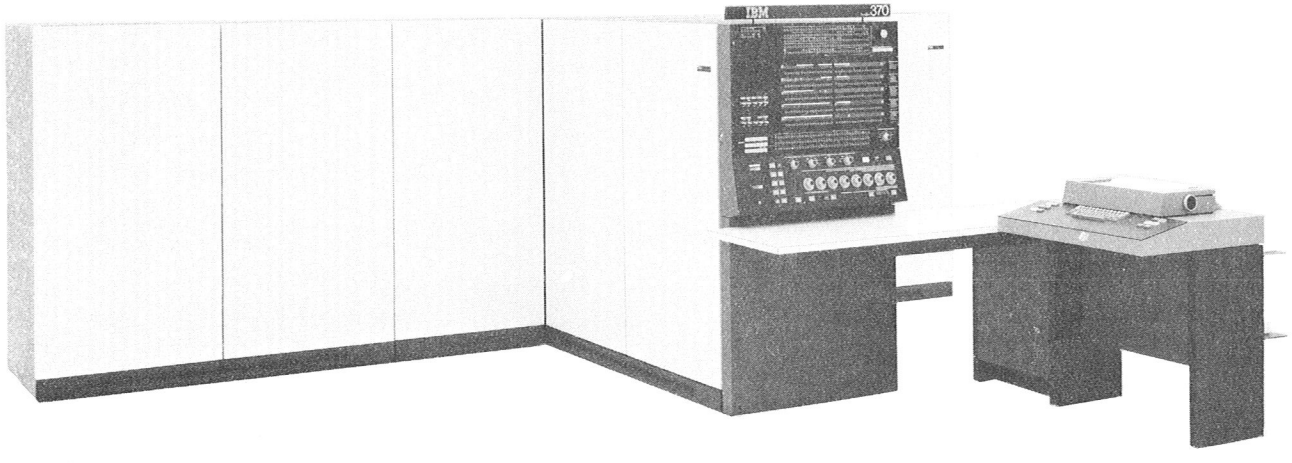


Figure 6-3. IBM System/370 Model 155 with IBM 3210 Console Printer-Keyboard

Main Storage: IBM 3360 Processor Storage Models 1-3

Storage Capacities:

Capacity (Bytes)	*Model*	*Storage Units*
262,144	H	One 3360-1
393,216	HG	One 3360-2
524,288	I	One 3360-3
786,432	IH	One 3360-1 and one 3360-3
1,048,576	J	Two 3360-3's
1,572,864	JI	Three 3360-3's
2,097,152	K	Four 3360-3's

Storage Cycle Time: 2.07 microseconds.

Storage Access Width: 16 bytes (one quadword).

High-Speed Buffer Storage: The 8,192-byte buffer storage can satisfy many requests for storage, making the effective storage access time much less than the actual main-storage cycle time.

Buffer Control Unit: This unit is the intermediary between main storage and the other system units. As such, it controls the accesses to the high-speed buffer storage and to main storage.

Channels: Part of 3155 Processing Unit

The system can have one byte multiplexer channel and as many as five block multiplexer channels, or two byte multiplexer channels (the second as an optional feature) and as many as four block multiplexer channels.

System

Compatibility Features: The compatibility features available for the Model 155 are:

OS/DOS
1401/1440/1460, 1410/7010
7070/7074

System Control: The Model 155 is operated, monitored, and controlled via the system control panel on the 3155 Processing Unit, and via the console printer-keyboard.

Programming Support

The Model 155 is supported by OS with MFT or MVT, as well as by DOS.

System/370 Model 165

The IBM System/370 Model 165 (Figure 6-4) is an information processing system designed for very high-speed, large-scale scientific and business applications.

Contributing significantly to the speed and power of the Model 165 are the main storage capacities, which range from 512K (524,288) bytes to 3,072K (3,145,728) bytes, and high-speed buffer storage, which can sharply reduce the time required for fetching currently used sections of main storage. Speed in accessing main storage is further increased by using multiple storage elements.

Reliability, availability, and serviceability are enhanced through instruction retry, main-storage error checking and correction (ECC), and manual storage capabilities.

Standard Features

System/370 universal instruction set
Extended-precision floating-point feature
Byte-oriented operand feature
High-speed buffer storage (8,192 bytes)
Direct control (with external interrupt)
Interval timer
Instruction retry
Channel retry
Command retry
Time-of-day clock
Storage protection (both store and fetch)

Optional Features

Buffer storage extension (to 16,384 bytes total)
High-speed multiply
Extended channels feature
7070/7074 compatibility
7080 compatibility
709/7090/7094/7094II compatibility
2860 Selector Channel (as many as six units, providing as many as six selector channels)
2870 Multiplexer Channel (as many as two)
Selector subchannels (as many as four on the first 2870, as many as two on a second one)
2880 Block Multiplexer Channel (with the extended channels feature, as many as seven units, providing as many as 11 block multiplexer channels)
Channel-to-channel adapter
Two-byte interface (for 2880)

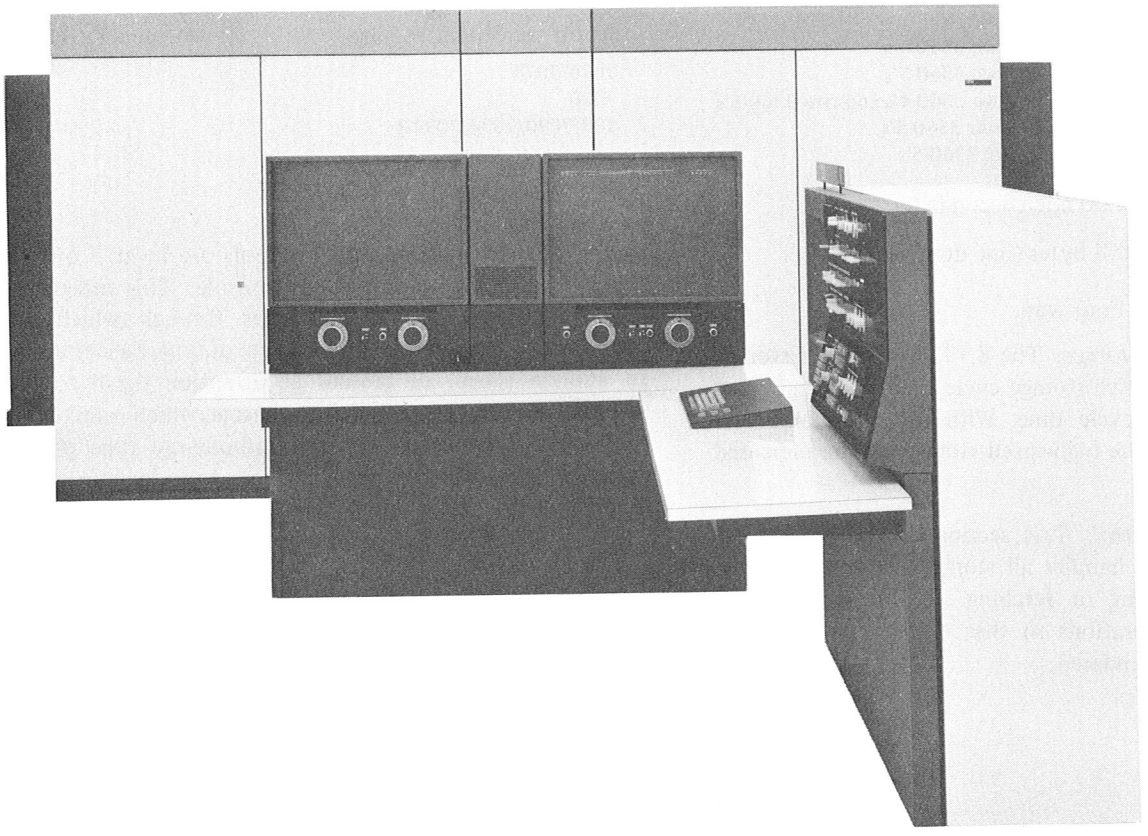


Figure 6-4. IBM System/370 Model 165 with IBM 3066 System Console

System Components

Central Processing Unit: 3165 Processing Unit

Basic Machine Cycle Time: 0.080 microsecond (80 nanoseconds).

Instruction Set: The System/370 universal instruction set is standard on the Model 165.

High-Speed Multiply: This feature substantially enhances internal performance on both fixed- and floating-point multiply operation by reducing multiplication time by one-half to one-third.

Instruction Retry: Instruction retry automatically examines any instruction during whose execution an error is detected, and in most cases reattempts its execution.

Error Checking and Correction: For data read from main storage, error checking and correction circuits automatically detect all single- and double-bit errors and some multiple-bit errors, and automatically correct the single-bit errors.

Main Storage: IBM 3360 Processor Storage Models 4 and 5

Storage Capacities:

Capacity (Bytes)	*Model*	*Storage Units*
524,288	I	Two 3360-4's
1,048,576	J	Two 3360-5's
1,572,864	JI	Two 3360-4's and two 3360-5's
2,097,152	K	Four 3360-5's
3,145,728	KJ	Six 3360-5's

Storage Cycle Time: 2.00 microseconds.

Storage Access Width: 8 bytes (one doubleword).

Storage Interleaving: Four-way.

High-Speed Buffer Storage: The 8,192-byte buffer storage can reduce the effective storage cycle time to a fraction of the actual storage cycle time. With the optional buffer expansion feature, the high-speed storage can be increased to 16,384 bytes.

Buffer Storage Control: This section of the Model 165 storage control unit handles all storage requests from the CPU for data storing or fetching. It also monitors all channel storage operations so that the high-speed buffer storage can be kept updated.

Channels: IBM 2860 Selector Channel Models 1-3, 2870 Multiplexer Channel, and 2880 Block Multiplexer Channel Models 1 and 2.

Channels may be attached to the CPU as follows:

Maximum Number of Channels or Channel Units	*Without Extended Channels Feature*	*With Extended Channels Feature*
Channel Units (Frames)	7	7
Channels	7	12
Byte Multiplexer Channels	2	2
Block Multiplexer Channels	6	11
Selector Channels	6	6
Byte Multiplexer and Selector Channels	7	7
Byte and Block Multiplexer Channels	7	12

Two-Byte Interface: This feature permits a 2880 Block Multiplexer Channel to transfer data at rates as high as 3.0 million bytes per second.

System

Compatibility Features: The compatibility features available for the Model 165 are:

7070/7074
7080
709/7090/7094/7094II

System Control: The system controls are located on the standalone IBM 3066 System Console. This integrated operator console provides facilities through which the operator may enter data, obtain visual output, be alerted by an audible alarm, or present an attention signal to the system. The integrated operator console, which is linked to the system console, shares the cathode-ray tube (CRT) display on the main control panel.

Programming Support

The Model 165 is supported by OS with MFT or MVT.

System/370 Model 195

The System/370 version of the Model 195 (Figure 6-5), while retaining the advanced architecture and programming support of the System/360 version, incorporates System/370 characteristics and features such as the expanded instruction set, the time-of-day clock, and the control registers.

This ultrahigh-performance data processing system is designed for high-speed large-scale scientific and commercial applications. Its scientific applications range from nuclear physics to weather forecasting and theoretical astronomy. In commercial applications, the Model 195 can be used, for example, as the control center of the most complex airline reservation systems, coast-to-coast time-sharing networks, or process control systems.

The power and speed of this advanced system are primarily the result of:

1. Improved circuit technology.
2. High performance of buffer storage for main storage accesses.
3. Buffering within the processor.
4. Very fast execution times.
5. A high degree of concurrency in operation.
6. Highly efficient algorithms, particulary in floating-point operations.

Processing proceeds concurrently in five separate highly autonomous units: main storage, the storage control unit and buffer storage, the instruction processor, the fixed-point/variable-field-length/decimal processor, and the floating-point processor. Furthermore, each unit may be performing several functions at one time. In the floating-point processor, for example, as many as three floating-point operations may be executed concurrently.

Standard Features

System/370 universal instruction set
High-speed buffer storage
Extended-precision floating-point
Byte-oriented operands
Storage protection (both store and fetch)
Time-of-day clock
Direct control (includes external interrupt)
Interval timer (9.6 kHz—about a 104-microsecond interval)
Display console
Remote operator control panel attachment
Emergency power-off control
Channel retry
Command retry
Monitoring

Optional Features

2860 Selector Channel (as many as six units, providing as many as six selector channels)
2870 Multiplexer Channel (as many as two)
Selector subchannels (as many as four on the first 2870, as many as two on a second one)
2880 Block Multiplexer Channel (with the extended channels feature, as many as seven units, providing as many as 13 block multiplexer channels)
Extended channels feature
Two-byte interface
Channel-to-channel adapter
2150 Console

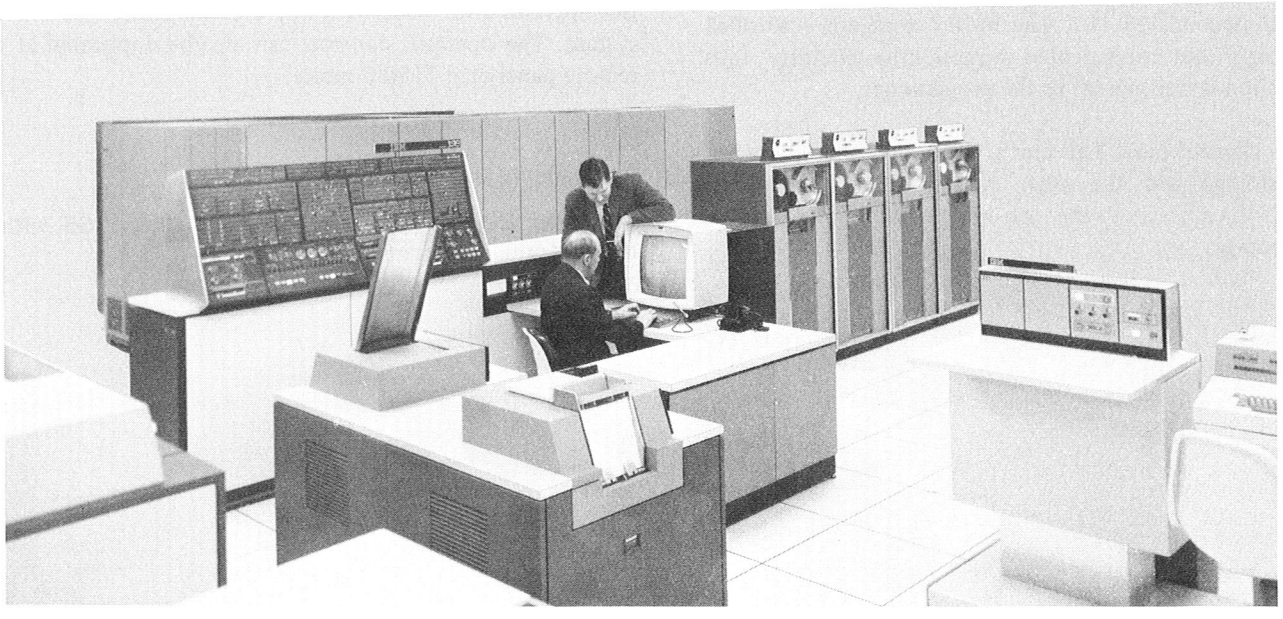


Figure 6-5. IBM System/370 Model 195

System Components

Central Processing Unit: 3195 Processing Unit

Basic Machine Cycle Time: 0.054 microsecond (54 nanoseconds).

Instruction Set: The universal instruction set is standard on the Model 195.

Control Signal Exchange and External Interruption: The direct control feature is standard on the Model 195 and includes the external interrupt feature.

Time-of-Day Clock: Updated every 250 nanoseconds, this clock provides a precise measure of time suitable for accurate elapsed-time measurements and time-of-day indication.

Main Storage: Part of 3195 Processing Unit

Storage Sizes:

Capacity (Bytes)	*Processor Model*	*Type of Interleaving*
1,048,576	J1	8-way
2,097,152	K1	16-way
3,145,728	KJ1	8- and 16-way
4,194,304	L1	16-way

Storage Cycle Time: 0.756 microsecond.

Storage Access Width: Eight bytes (one doubleword).

High-Speed Buffer Storage: Most storage accesses are satisfied by this 32K-byte buffer storage, which in effect reduces the access time of most main storage accesses from 810 nanoseconds to 162. The buffer storage is controlled by an algorithm implemented in monolithic circuitry, thus its function is transparent to the programmer.

Storage Control Unit: This unit is the intermediary between main storage and the other system units. As such, it controls the accesses to the high-speed buffer storage and to main storage.

Channels: IBM 2860 Selector Channel Models 1-3, 2870 Multiplexer Channel, and 2880 Block Multiplexer Channel Models 1 and 2

Channels may be attached to the CPU as follows:

Maximum Number of Channels or Channel Units	*Without Extended Channels Feature*	*With Extended Channels Feature*
Channel Units (Frames)	7	8
Channels	7	14
Byte Multiplexer Channels	2	2
Block Multiplexer Channels	6	13
Selector Channels	6	6
Byte Multiplexer and Selector Channels	7	7
Byte and Block Multiplexer Channels	7	13

Note: Only block multiplexer channels can be attached via the extended channels feature.

Interchannel Connection: A channel-to-channel adapter can be attached for each selector channel on the Model 195, permitting each selector channel to communicate with a multiplexer channel or with another selector channel. This adapter uses one control-unit position on each of the two channels.

System

System Control: The system controls are located on a standalone system console (considered part of the CPU). Integrated with the system console is a display console (similar to a 2250 Display Unit Model 1), which provides the operator with visual two-way communication with the system. The operator controls can also be duplicated at a remote panel on a 2150 Console.

Programming Support

The Model 195 is supported by an MVT option of OS, with high-performance extensions available.

Features and Characteristics	Application on Models				
	135	145	155	165	195
Central Processing Unit (CPU)					
CPU model	3135	3145	3155	3165	3195
Basic machine cycle time (nanoseconds)	275-1,430	202.5-315	115	80	54
Instruction sets					
System/370 Commercial	std	std	-	-	-
System/370 Universal	opt	opt	std	std	std
Byte-oriented operand	std	std	std	std	std
Floating-point	opt	opt	std	std	std
Extended-precision floating-point	opt	opt	opt	std	std
Direct control (with external interrupt)	opt	opt	opt	std	std
Instruction retry or microinstruction retry	std	std	std	std	-
High-speed multiply	-	-	-	opt	-
Interval timer	std	std	std	std	std
Time-of-day clock	std	std	std	std	std
Monitoring	std	std	std	-	std
Main Storage					
Storage access width (number of bytes fetched per access)	2 or 4	8	16	8	8
Storage cycle time (nanoseconds)	770 read, 935 write	540 read, 607.5 write	2,070 (a)	2,000 (a)	756 (a)
Storage interleaving	-	-	-	4-way	8-or 16-way
High-speed buffer storage	-	-	std	std	std
Buffer storage extension	-	-	-	opt	-
Storage protection	std	std	std	std	std
Main-storage capacities (bytes)					
(Entries are system model prefixes)					
98,304 = FE	FE	-	-	-	-
147,456 = GD	GD	-	-	-	-
163,840 = GE	-	GE	-	-	-
196,608 = GF	GF	-	-	-	-
212,992 = GFD	-	GFD	-	-	-
245,760 = DH	DH	-	-	-	-
262,144 = H	-	H	H	-	-
393,216 = HG	-	HG	HG	-	-
524,288 = I	-	I	I	I	-
786,432 = IH	-	-	IH	-	-
1,048,576 = J	-	-	J	J	J1
1,572,864 = JI	-	-	JI	JI	-
2,097,152 = K	-	-	K	K	K1
3,145,728 = KJ	-	-	-	KJ	KJ1
4,194,304 = L	-	-	-	-	L1
Compatibility Features					
1401/1440/1460, 1410/7010	-	opt	opt	-	-
1401/1440/1460	opt	opt	-	-	-
7070/7074	-	-	opt	opt	-
7080	-	-	-	opt	-
709/7090/7094/7094 II	-	-	-	opt	-
OS/DOS	std	std	opt	-	-
System/360 Model 20	opt	-	-	-	-
Programming Support					
Disk Operating System (DOS)	yes	yes	yes	-	-
Operating System (OS)	yes	yes	yes	yes	yes

Figure 6-6. Comparison of IBM System/370 Models (Part 1 of 2)

Features and Characteristics	Application on Models				
	135	145	155	165	195
Channels					
Max. no. of channels per CPU	4 (c)	5	6	7	7
With extended channel feature	-	-	-	12	14
Block multiplexer	2	4	5	6	6
With extended channel feature	-	-	-	11	13
Byte multiplexer	1	1	2	2	2
Selector	3 (c)	4	-	6	6
Both byte and block multiplexer	3	5	6	7	7
With extended channel feature	-	-	-	12	14
Both byte multiplexer and selector	4 (c)	5	-	7	7
Max. no. of channel units (frames) per CPU	-	-	-	7	7
With extended channel feature	-	-	-	7	8
2880 Block Multiplexer Channel	-	-	-	6	6
With extended channel feature	-	-	-	7	7
2870 Multiplexer Channel (Byte mpx)	-	-	-	2	2
2860 Selector Channel	-	-	-	6	6
Subchannels (type and no., std or opt) (n=nonshared, s=shared) (b)					
Byte multiplexer, of 1st byte mpx channel					
16n+0s to 8n+8s	all	all	-	-	-
32n+0s to 24n+8s	-	all	-	-	-
64n+0s to 56n+8s	all	all	-	-	-
120n+8s	-	-	all	-	-
128n	-	-	H	-	-
128n+0s to 120n+8s	all	all	-	-	-
192n	-	-	HG	all	all
256n	all	all	I-K	-	-
Byte multiplexer, of 2nd byte mpx channel					
120n+8s	-	-	IH-K	-	-
128n	-	-	IH	-	-
192n	-	-	all	all	all
256n	-	-	J-K	-	-
Block multiplexer, of block mpx channels					
16n+1s	all	all	-	-	-
16s to 512s, in increments of 16	-	all	-	-	-
56n (max., with 1s)	-	-	-	all	all
96n+16s	-	-	H	-	-
160n+16s	-	-	HG	-	-
224n+16s	-	-	I	-	-
352n+16s	-	-	IH	-	-
480n+16s	-	-	J-K	-	-
Selector, of 1st byte mpx channel					
4s	-	-	-	all	all
Selector, of 2nd byte mpx channel					
2s	-	-	-	all	all
Channel-to-channel adapter	-	opt	opt	opt	opt

std = standard
opt = optional
- = not applicable

Notes:

(a) The storage cycle times given for Model 165 and 195 do not reflect the time reductions that are due to storage interleaving or, additionally for Models 155, 165 and 195, the time reduction resulting from the use of the high-speed buffer.

(b) Shared subchannels can control several I/O devices or modules having a common control unit; nonshared subchannels can control only one I/O device.

(c) Includes the integrated file adapter, addressed as a selector channel.

Figure 6-6. Comparison of IBM System/370 Models (Part 2 of 2)

A System/370 at any specific installation consists of a central processing unit, main storage, one or more I/O channels, and all online I/O equipment. Online means that the I/O equipment, whether local or remote, operates under program control. The following I/O devices and control units, arranged by category, can operate locally as part of System/370.

Direct Access Devices

2301 Drum Storage
2303 Drum Storage
2305 Fixed Head Storage Facility Models 1 and 2
2311 Disk Storage Drive
2312 Disk Storage Model A1
2313 Disk Storage Model A1
2314 Direct Access Storage Facility, A Series and B Series
2314 Storage Control Models A1 and B1
2318 Disk Storage Model A1
2319 Disk Storage Models A1, A2, A3, B1, and B2
2321 Data Cell Drive
2820 Storage Control Model 1
2835 Storage Control Models 1 and 2
2841 Storage Control Model 1
2844 Auxiliary Storage Control Model 1
3330 Disk Storage
3830 Storage Control Model 1

Display Devices

2250 Display Unit Models 1 and 3
2260 Display Station Models 1 and 2
2285 Display Copier Model 1
2840 Display Control Model 2
2848 Display Control Models 1, 2, 3, 21, and 22
3272 Control Unit Models 1 and 2
3277 Display Station Models 1 and 2

Magnetic Character Readers

1255 Magnetic Character Reader Models 1-3
1259 Magnetic Character Reader
1419 Magnetic Character Reader

Magnetic Tape Devices

2401 Magnetic Tape Unit Models 1-6 and 8
2415 Magnetic Tape Unit and Control Models 1-6
2420 Magnetic Tape Unit Models 5 and 7
2803 Tape Control Models 1, 2, and 3
2804 Tape Control Models 1, 2, and 3
2816 Switching Unit Model 1
3410 Magnetic Tape Unit Models 1, 2, and 3
3411 Magnetic Tape Unit and Control Models 1, 2, and 3
3420 Magnetic Tape Unit Models 3, 5, and 7
3803 Tape Control Model 1

Magnetic Tape Cartridge Devices

2495 Tape Cartridge Reader

Manual Controls

1052 Printer-Keyboard Model 7
2150 Console Model 1
3210 Console Printer-Keyboard Models 1 and 2
3215 Console Printer-Keyboard Model 1

Optical Readers

1287 Optical Reader Models 1-4
1288 Optical Page Reader Model 1

Printers

1053 Printer Model 4
1403 Printer Models 2, 7, and N1
1443 Printer Model N1
2821 Control Unit Models 1-3, 5, and 6
3211 Printer Model 1
3284 Printer Models 1 and 2
3286 Printer Models 1 and 2
3811 Control Unit Model 1

Punched Card Devices

1442 Card Read Punch Model N1
1442 Card Punch Model N2
2501 Card Reader Models B1 and B2
2520 Card Read Punch Model B1
2520 Card Punch Models B2 and B3
2540 Card Read Punch
2596 Card Read Punch Model 1
3505 Card Reader Models B1 and B2
3525 Card Punch Models P1, P2, and P3

Punched Tape Devices

1017 Paper Tape Reader Models 1 and 2
1018 Paper Tape Punch Model 1
2671 Paper Tape Reader Model 1
2822 Paper Tape Reader Control Model 1
2826 Paper Tape Control Model 1

Systems

2790 Data Communication System
3270 Information Display System

Input/Output (I/O) Device or Control Unit			Attaches to	Means of Attachment to System/370 Model					No. of I/O Devices or Lines Attachable
No.	Models	Name		135	145	155	165	195	
1017	1, 2	Paper Tape Reader	2826-1	m	m	m	–	–	(z)
1018	1	Paper Tape Punch	2826-1	m	m	m	–	–	(z)
1052	7	Printer-Keyboard	2150-1	–	–	bm	bmsx	bmsx	1 per 2150
1053	4	Printer	2848-1-3, 21, 22	bms	ms	bm	bmsx	bmsx	1 per 2848
1255	1-3	Magnetic Character Reader	S/360/370 Adapter	bms	bms	bm	–	–	1 per system
1259	2	Magnetic Character Reader	→	m	m	–	–	–	1 per system
1287	1-4	Optical Reader	→	m	m	m	mx	–	8 per system
1288	1	Optical Page Reader	→	m	m	m	mx	–	8 per system
1403	2, 7, N1	Printer	2821-1, 2, 3, 5	bms	bms	bm	bmsx	bmsx	(v)
			→	i	–	–	–	–	1 per system
1419	1	Magnetic Character Reader	S/360 Adapter (#7720)	bms	bms	bm	–	–	(d)
			S/360 Adapter (#7730)	m	m	m	m	–	(d)
1442	N1	Card Read Punch	→	bms	bms	bm	bmsx	bmsx	(d)
	N2	Card Punch	→	bms	bms	bm	bmsx	–	(d)
1443	N1	Printer	→	bms	bms	bm	bmsx	bmsx	(d)
2150	1	Console	→	See 1052					1 1052
2250	1	Display Unit	→	bms	bms	bm	bsx	bsx	(d)
	3	Display Unit	2840-2	bms	bms	bm	bsx	bsx	4 per 2840
2260	1	Display Station	2848-3	bms	bms	bm	bmsx	bmsx	8 per 2848
	2	Display Station	2848-1, 2, 21, 22	bms	bms	bm	bmsx	bmsx	(x)
2285*	1	Display Copier	2250-1, 3	See 2250					1 per 2250
2301	1	Drum Storage	2820-1	–	–	–	bs	bs	4 per 2820
2303	1	Drum Storage	2841-1	bs	bs	b	bs	bs	2 per 2841 (w)
2305	1	Fixed Head Storage (q)	2835-1	–	–	–	b	b	2 per 2835
	2	Fixed Head Storage (q)	2835-2	–	b	b	b	b	2 per 2835
2311	1	Disk Storage Drive	2841-1	bs	bs	b	bs	bs	8 per 2841 (w)
2312	A1	Disk Storage	2314-A1, 2319-A1	See 2314 – A Series and 2319-A1					(h) (o)
2313	A1	Disk Storage	2314-A1, 2319-A1	See 2319-A1 (for Model 145 only) and 2314-A Series					(h) (o)
2314	A Series	Direct Access Storage Facility (h)	2844-1 (i)	bs	–	b	bs	bs	1 per 2844
			→	bs	bs	b	bs	bs	(d)
	B Series	Direct Access Storage Facility	→	bs	bs	b	bs	bs	(j)
2314	A1	Storage Control	→	See 2314 – A Series					9 modules (h)
	B1	Storage Control	→	See 2314 – B Series					9 modules (j)
2318	A1	Disk Storage	2314-A1, 2319-A1	See 2314 – A Series and 2319-A1					(h) (o)
2319	A1	Disk Storage	→	i	i	–	–	–	
	A2	Disk Storage	2319-A1	See 2319-A1 (for Model 145 only)					(o)
	A3	Disk Storage	2319-A1	See 2319-A1 (for Model 135 only)					
	B1	Disk Storage	2314-B1	See 2314 – B Series					(j)
	B2	Disk Storage	2314-B1 (via 2319-B1)	See 2314 – B Series					(j)
2321	1	Data Cell Drive	2841-1	bs	bs	b	bsx	bsx	8 per 2841 (w)
2401	1-3	Magnetic Tape Unit	2803/04-1, 2	bms	bs	b	bsx	bsx	(n)
	4, 5	Magnetic Tape Unit	2803/04-2	bms	bs	b	bsx	bsx	
	6	Magnetic Tape Unit	2803/04-2	bs	bs	b	bsx	bsx	
	8	Magnetic Tape Unit	2803/04-3	bms	bs	b	bsx	bsx	
2415	1-6	Magnetic Tape Unit and Control	→	bms	bms	bm	–	–	(d)
2420	5	Magnetic Tape Unit	2803-2	bs	bs	b	bsx	bsx	(n)
	7	Magnetic Tape Unit	2803-2	bs	bs	b	bs	bs	(n)
2495	1	Tape Cartridge Reader	→	m	m	m	m	–	(d)

Figure 7-1. Attachment Data for Local I/O Devices and Control Units (Part 1 of 3)

Input/Output (I/O) Device or Control Unit			Attaches to	Means of Attachment to System/370 Model					No. of I/O Devices or Lines Attachable
No.	Models	Name		135	145	155	165	195	
2501	B1, B2	Card Reader	→	bms	bms	bm	bmsx	bmsx	(d)
2520	B1	Card Read Punch	→	bms	bms	bm	bmsx	bmsx	(d)
	B2, B3	Card Punch	→	bms	bms	bm	bmsx	bmsx	(d)
2540	1	Card Read Punch	2821-1,5,6	bms	bms	bm	bmsx	bcmsx	(v)
2596	1	Card Read Punch	→	bms	ms	bm	bmsx	bmsx	(d)
2671	1	Paper Tape Reader	2822-1	bms	bm	bm	–	–	1 per 2822
2701	1	Data Adapter Unit	→	bms	bms	bm	bmsx	bmsx	(k)
2702	1	Transmission Control	→	m	m	m	m	m	(k)
2703	1	Transmission Control	→	m	m	m	m	m	(k)
2715	1	Transmission Control Unit	→	See 2790					(g)
2790	–	Data Communication System	2715-1	m	m	m	m	m	–
2803	1, 2, 3	Tape Control (m)	→	See 2401 and 2420					(n)
2804	1, 2, 3	Tape Control (m)	→	See 2401					(n)
2816	1	Switching Unit	2803-1, 2	See 2401					(l)
2820	1	Storage Control	→	See 2301					4 2301's (t)
2821	1-3, 5, 6	Control Unit	→	See 1403 and 2540					(v)
2822	1	Paper Tape Reader Control	→	See 2671					1 2671
2826	1	Paper Tape Control	→	See 1017 and 1018					(z)
2835	1, 2	Storage Control	→	See 2305					2 2305's (u)
2840	2	Display Control	→	See 2250-3					4 2250-3's
2841	1	Storage Control	→	See 2303, 2311, and 2321					(w)
2844	1	Auxiliary Storage Control	→	See 2314 A-Series					1 2314
2848	1-3,21,22	Display Control	→	See 1053 and 2260					(x)
3210	1	Console Printer-Keyboard	→	i	i	m	–	–	(y)
	2	Console Printer-Keyboard	→	–	i	m	–	–	(y)
3211	1	Printer	3811-1	bms	bms	bm	bmsx	bmsx	1 per 3811
3215	1	Console Printer-Keyboard	→	i	i	m	–	–	(y)
3270	–	Information Display System	3272	bms	bms	bm	bmsx	bmsx	(r)
3272	1, 2	Control Unit	→	See 3270					(r)
3277	1, 2	Display Station	→	See 3270					(r)
3330	1	Disk Storage (p)	3830-1	bs	b	b	b	b	4 per 3830
3410	1	Magnetic Tape Unit	3411-1	bms	bms	b	–	–	3 per 3411-1
	2	Magnetic Tape Unit	3411-2	bms	bms	b	–	–	5 per 3411-2
	3	Magnetic Tape Unit	3411-3	bms	bms	b	–	–	5 per 3411-3
3411	1, 2, 3	Magnetic Tape Unit and Control	→	bms	bms	b	–	–	(d)
3420	3	Magnetic Tape Unit	3803-1	bms	bs	b	bsx	bsx	(n)
	5	Magnetic Tape Unit	3803-1	bs	bs	b	bs	bs	(n)
	7	Magnetic Tape Unit	3803-1	bs	s	b	bs	bs	(n)
3505	B1, B2	Card Reader	→	bms	bms	bm	bmsx	bmsx	(d)
3525	P1,P2,P3	Card Punch	3505	bms	bms	bm	bmsx	bmsx	(d)
3803	1	Tape Control	→	See 3420					(n)
3811	1	Control Unit	→	See 3211					1 3211
3830	1	Storage Control	→	See 3330					4 3330's
7770	3	Audio Response Unit	→	m	m	m	m	m	48 lines
–	–	Display Console	→	–	–	–	bmsx	bmsx	1 per system

Symbols

- i — Integrated adapter.
- b — Block multiplexer channel. (Housed in a 2880 Block Multiplexer Channel for Models 165 and 195.)
- m — Byte multiplexer channel. (Housed in a 2870 Multiplexer Channel for Models 165 and 195.)
- s — Selector channel. (Housed in a 2860 Selector Channel for Models 165 and 195.)
- x — Selector subchannel on 2870 Multiplexer Channel.
- → — See the information in the "Means of Attachment" columns.
- – — Not applicable.
- * — May no longer available.

Figure 7-1. Attachment Data for Local I/O Devices and Control Units (Part 2 of 3)

Notes (Circled Letters)

(d) No special restrictions; depends on number of available system channel control unit positions and, for some units, on channel loading considerations.

(g) The 2715 Transmission Control Unit Model 1, part of an IBM 2790 Data Communication System, can attach a combination of 2790 devices (IBM 2791 Area Stations and IBM 2795 and 2796 Data Entry Units) to a System/370 for local operation. The combinations range from as many as four 2791's having up to 120 2795's and 2796's to as many as 64 2791's having no 2795's or 2796's. With an optional feature (expanded capability), the 2715 can attach as many as 100 2791's and 2793's with as many as 1,024 2795's and 2796's.

(h) A 2314 A-Series Direct Access Storage Facility (DASF) consists of a 2314 Storage Control Model A1 and combinations of Model A1 units of 2312, 2313, and 2318 Disk Storage, forming a single interconnected unit. Each 2312-A1 provides one disk storage module, each 2313-A1 four modules, and each 2318-A1 two modules. A full-configuration 2314 A-Series, which consists of two 2313's and one 2312, has eight drives and one spare.

(i) The full-configuration 2314 A-Series DASF can have a 2844 as an auxiliary control unit.

(j) A 2314 Direct Access Storage Facility B-Series consists of a 2314 Storage Control Model B1, one 2319 Disk Storage Model B1, and up to two units of 2319 Disk Storage Model B2, forming a single interconnected unit having three, six, or nine (eight active, one spare) modules. Each 2319-B1 and -B2 has three disk storage modules.

(k)

Unit	*Mode of Half-Duplex Transmission*	*Max. No. of Lines*	*At Line Speeds (bps) up to*
2701	Asynchronous	4	600
	Synchronous	2	230,400
2702	Asynchronous	15	600
	Asynchronous	31	200
2703	Asynchronous	176	165
	Asynchronous	72	600
	Synchronous	48	2,400
	Synchronous	24	4,800

On the 2701 and 2703, the number and speeds of attachable lines are also functions of the CPU, the channels assigned, and the characteristics of the other devices attached to those channels.
The 2701 can attach up to four parallel data acquisition devices in place of either of its line attachment alternatives.

(l) 2816 permits switching up to eight drives among four controls. With a second 2816 and 16-drive addressing,4, 8, 12, or 16 drives can be switched among 2, 3, or 4 controls.

(m) 2803 is a single-channel control unit; 2804 is a two-channel control unit. A 2804 requires one control-unit position on each of two channels in the same system.

(n) Up to eight:
800-bpi drives (2401-1 to -3) per 2803/04-1.
800- and 1600-bpi drives (2401-1 to -6 and 2420-5, -7) per 2803-2.
800- and 1600-bpi drives (2401-1 to -6) per 2804-2.
800- and 1600-bpi drives (3420-3, -5, -7) per 3803-1.
2401-8's per 2803/04-3.

(o) The 2319 Disk Storage Model A1 has three disk storage modules and permits attachment of as many as five additional modules. Attachable to the 2319-A are the single-module 2312-A1, two-module 2318-A1, three-module 2319-A2 (for Model 145 only) or 2319-A3 (for Model 135 only), and four-module 2313-A1 (for Model 145 only).

(p) Each 3330 Disk Storage has two disk storage modules. One to four 3330's with a 3830 Storage Control form a 3330 Disk Storage Facility, a single interconnected unit.

(q) One or two modules of 2305 Fixed Head Storage and a 2835 Storage Control form a 2305 Fixed Head Storage facility, a single interconnected unit.

(r) A locally attached 3270 Information Display System has a 3272 Control Unit Model 1 or 2 controlling various combinations of up to 32 units of 3277 Display Station Models 1 and 2 and 3284 and 3286 Printer Models 1 and 2. The 3272-1 controls only model 1 devices, but the 3272-2 controls both model 1 and 2 devices.

(t) The maximum number of 2820's is:
two per logical channel, 2860-1 channel, or 2880-1 shared subchannel.
four per 2860-2 or -3 channel or 2880-2 shared subchannel.

(u) On the Model 155, 2835-2's are attachable to block multiplexer channels 1 and 2 only. Two 2835's can attach to channel 1; two can attach to channel 2.

(v) One 1403 and one 2540 per 2821-1.
One 1403 per 2821-2.
Two (or, with a third printer control, three) 1403's per 2821-3.
One 1404 and one 2540 per 2821-4.
Two (or, with a third printer control, three) 1403's and one 2540 per 2821-5.
One 2540 per 2821-6.

(w) The basic 2841 can control as many as eight 2311's or (with attachment features) up to eight access mechanisms from the following combinations:
with no 2303: any combination of 2311's and 2321's.
with one 2303: up to seven 2311's and 2321's but no more than three 2311's.
with two 2303's: no 2311's but up to six 2321's.
When a 2841 with one or more 2321's is attached to a selector subchannel of a 2870, no other devices can be attached to that subchannel.

(x) 2848-1: up to 24 2260-2's.
2848-2: up to 16 2260-2's.
2848-3: up to 8 2260-1's.
2848-21: up to 24 2260-2's.
2848-22: up to 16 2260-2's.

(y) One 3210-1 or 3215-1 is attachable (and required) on a Model 135, 145, or 155. One 3210-2 can be attached to a Model 145 or 155 in addition to either a 3210-1 or 3215-1.

(z) 2826-1 attaches up to two 1017's plus up to two 1018's; they can operate concurrently.

Figure 7-1. Attachment Data for Local I/O Devices and Control Units (Part 3 of 3)

Direct Access Devices

The direct access devices provide auxiliary storage that is large and relatively fast. These devices, which can access data directly as well as sequentially, use media such as magnetic disks, magnetic drums, and magnetic-strip data cells. Figures 7-2 through 7-11 show these devices, and Figure 7-12 compares their more prominent characteristics.

2301 Drum Storage; 2820 Storage Control

The IBM 2301 Drum Storage provides direct access storage of approximately four million bytes at a data rate of 1.2 megabytes per second. The high data rate is achieved partially by accessing four tracks in parallel rather than a single track, thus the common reference to this as a "parallel file." Data is recorded on and read from the rotating drum serially by half-byte: first the four high-order bits of the byte, then the four low-order bits.

The 2301 is similar to the IBM 2303 Drum Storage in rotational speed and capacity, and resembles it in external appearance (Figure 7-3). The 2301 records data on 800 tracks, divided into 200 addressable groups of four tracks each. Each such conceptual track can contain a single record of 20,483 bytes. Data records can be of variable length and can overflow from track to track. The access-motion time is zero, and the rotational delay to any record averages 8.6 milliseconds.

The IBM 2820 Storage Control provides the capability of attaching up to four 2301 Drum Storage units to a channel, for a total online direct access capacity of more than 16 million bytes or 32 million packed decimal digits and signs per 2820 attached.

The 2820 interprets and executes all control orders received from the channel, and checks the validity of the data transferred to or from the storage devices.

The optional two-channel switch permits switching a 2820 Storage Control between two channels.

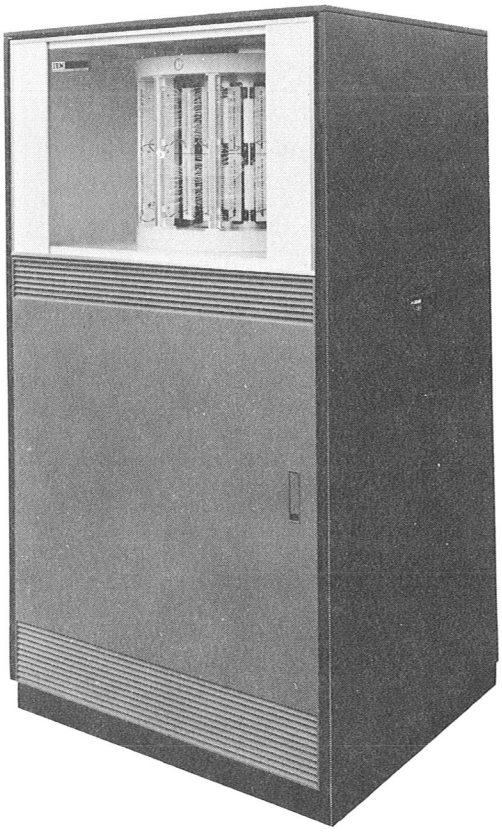


Figure 7-2. IBM 2303 Drum Storage

2303 Drum Storage

The IBM 2303 Drum Storage (Figure 7-2) provides direct access storage for 3.91 million bytes on the magnetic surface of a rotating drum. Two 2303's can be attached to each 2841 Storage Control, for total online storage of 7.82 million bytes per 2841.

The drum rotates at almost 3,500 revolutions per minute. Its surface is divided into 800 tracks; each track has a maximum data capacity of 4,892 bytes. The data transfer rate to or from the CPU is 303,800 bytes per second (or 607,600 packed decimal digits and signs).

Because of the assignment of a read/write head to each track, there is no delay in accessing a track. The rotational delay to a specific part of the track averages 8.6 milliseconds.

The 2303 is used for programming systems residence, rapid access to frequently used data, and other auxiliary storage functions.

2305 Fixed Head Storage Models 1 and 2; 2835 Storage Control Models 1 and 2

An IBM 2835 Storage Control with one or two modules of IBM 2305 Fixed Head Storage forms an IBM 2305 Fixed Head Storage facility (Figure 7-3). With its short access time and medium capacity, this facility provides System/370 with disk storage especially well-suited for applications such as programming systems residence and table or index storage.

Two models of the 2305 facility are available:

Model 1 consists of one 2835 Model 1 and one or two 2305 Model 1 modules.

Model 2 consists of one 2835 Model 2 and one or two 2305 Model 2 modules.

The speed and capacities of the 2305 facilities are:

	Model 1	*Model 2*
Storage capacity (rounded, megabytes)	5.4 or 10.8	11.2 or 22.4
Average access time (milliseconds)	2.5	5.0
Data transfer rate (megabytes per second)	3.0	1.5

Both models of the 2305 facility attach to System/370 via a block multiplexer channel. The Model 1 facility, having a data transfer rate of 3.0 million bytes per second, requires a 2880 Block Multiplexer Channel equipped with the two-byte interface feature.

2305 Fixed Head Storage

Each 2305 module has six 14-inch, oxide-coated disks permanently mounted within the module. Each module uses read/write heads having one or two read/write elements per track.

The primary characteristics of the 2305 modules are:

	Model 1	*Model 2*
Number of read/write elements per track	2	1
Number of addressable tracks	384	768
Number of spare tracks	48	96
Bytes per module	5,428,224	11,258,880
Rotation time (milliseconds)	10	10
Access time, maximum (milliseconds)	5.1	10.25
Access time, average (milliseconds)	2.5	5.0
Data transfer rate (megabytes per second)	3.0	1.5

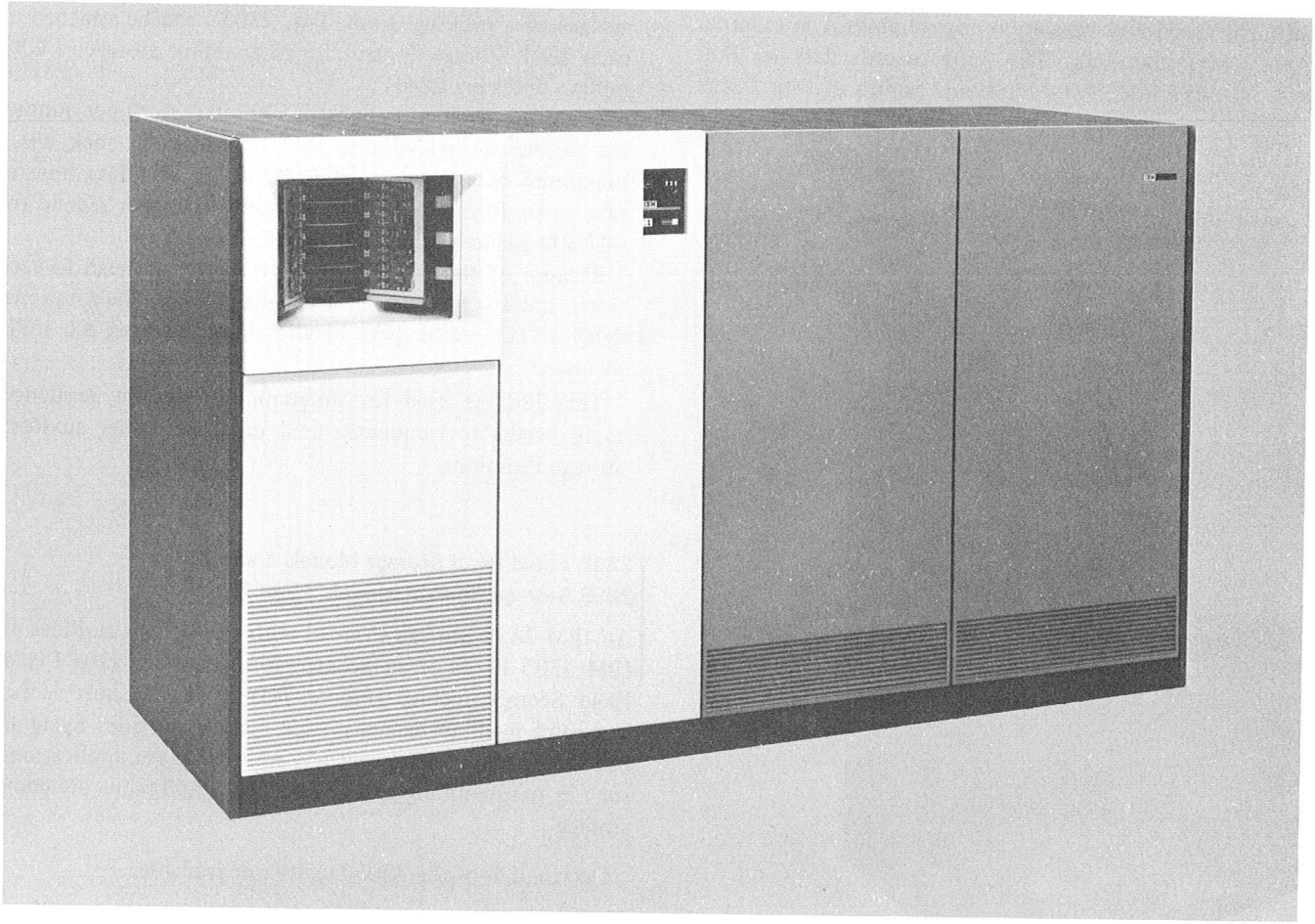


Figure 7-3. IBM 2305 Fixed Head Storage and 2835 Storage Control

2835 Storage Control

The 2835 interprets and executes all channel commands received from the block multiplexer channel. In addition, it provides the 2305 facility with error detection and correction capabilities by adding correction codes to each record.

Related to these capabilities are two methods for verification of data:

Full Read-Back Check: All just-written data is read back into main storage and compared with the original data.

Correction Code Check: The 2835 performs a non-comparative check of data validity, using the correction codes.

The 2835 standard features include:

Command Retry, which enhances error recovery by permitting the channel and control unit to retry operations without CPU program intervention.

Rotational Position Sensing, which increases channel availability by releasing the channel during most of record search time.

Multiple Requesting, which permits up to 16 record requests to be active in the storage facility, thereby permitting maximum use of the facility and contributing to improved response to system I/O requests.

An optional feature, the *two-channel switch*, permits two channels (of one system or of two separate ones) to have access to the 2305 facility.

2311 Disk Storage Drive Model 1

The IBM 2311 Disk Storage Drive (Figure 7-4) provides direct access storage for 7.25 million bytes (or 14.5 million packed decimal digits and signs) in a single disk pack. Eight disk storage drives can be attached to each IBM 2841 Storage Control, for a total on-line capacity of 58 million bytes per 2841. In addition, unlimited storage capacity is possible because the IBM 1316 Disk Pack in each drive can be easily removed and replaced with another (Figure 7-5).

Each disk pack has six 14-inch disks, mounted ½ inch apart on a vertical shaft. The inside ten disk surfaces are used for recording data, and the outermost two surfaces are protective plates. When the disk pack is installed in the drive, information is written on or read from the surfaces by magnetic read/write heads, mounted in pairs between each two disks on a movable comb-like access mechanism.

The data rate of the 2311 is 156,000 bytes per second, the average access-motion time is 75 milliseconds, and the average rotational delay is 12.5 milliseconds.

Figure 7-4. IBM 2311 Disk Storage Drive

Figure 7-5. IBM 1316 Disk Pack Being Placed in an IBM 2311 Disk Storage Drive

2314 Direct Access Storage Facility—A Series (2314 Storage Control Model A1 and 2312, 2313, and 2318 Disk Storage Model A1)
2314 Direct Access Storage Facility—B Series (2314 Storage Control Model B1 and 2319 Disk Storage Models B1 and B2)

The IBM 2314 Direct Access Storage Facility—A Series (Figure 7-6) consists of combinations of Model A1 units of IBM 2312, 2313, and 2318 Disk Storage and an IBM 2314 Storage Control Model A1. These devices form an interconnected unit that provides one to nine (eight active, one spare) disk storage modules. The 2312 provides one module, the 2313 provides four, and the 2318 provides two.

The B-Series 2314, however, consists of IBM 2319 Disk Storage (one Model B1 and up to two Model B2's) and an IBM 2314 Storage Control Model B1. These devices also form a single interconnected unit, but provide three, six, or nine (eight active, one spare) disk storage modules. Each 2319-B1 and B2 provides three modules.

The modules of a 2314 (both A-Series and B-Series) operate independently and use IBM 2316 Disk Packs (Figure 7-7). Each of these interchangeable packs has a storage capacity of 29.17 million bytes. Consequently, the A-Series can have, in rounded numbers, 29 million to 233 million bytes of online disk storage, in multiples of approximately 29 million bytes; the B-Series can have 87,175, or 233 million bytes of online storage. Both series can have unlimited offline storage.

For both series, the average access-motion time is 60 milliseconds, the average rotational delay is 12.5 milliseconds, and the data rate is 312,000 bytes per second.

Both the A- and B-Series have the same features. File scan and record overflow are both standard. File scan allows comparison on selected bytes—in effect, a search through the file for a specific record or condition. Record overflow permits more efficient use of storage by allowing a record to overflow from track to track to the end of the cylinder.

A special feature, the two-channel switch, is available to both series. Switching is under program control and may be used to switch the 2314 between two channels of a system or between two systems.

In addition to its own control unit, the A-Series 2314 can have the IBM 2844 Auxiliary Storage Control.

2844 Auxiliary Storage Control

An IBM 2844 Auxiliary Storage Control can be attached to a nine-module A-Series 2314. When attached, it provides:

1. A second path to the data. With the 2844 on a different channel of the same system, a second path increases throughput by permitting overlapped data transfers on any two drives. Also, the existence of two control units provides an alternate path to the data, should one storage control need preventive or emergency maintenance.

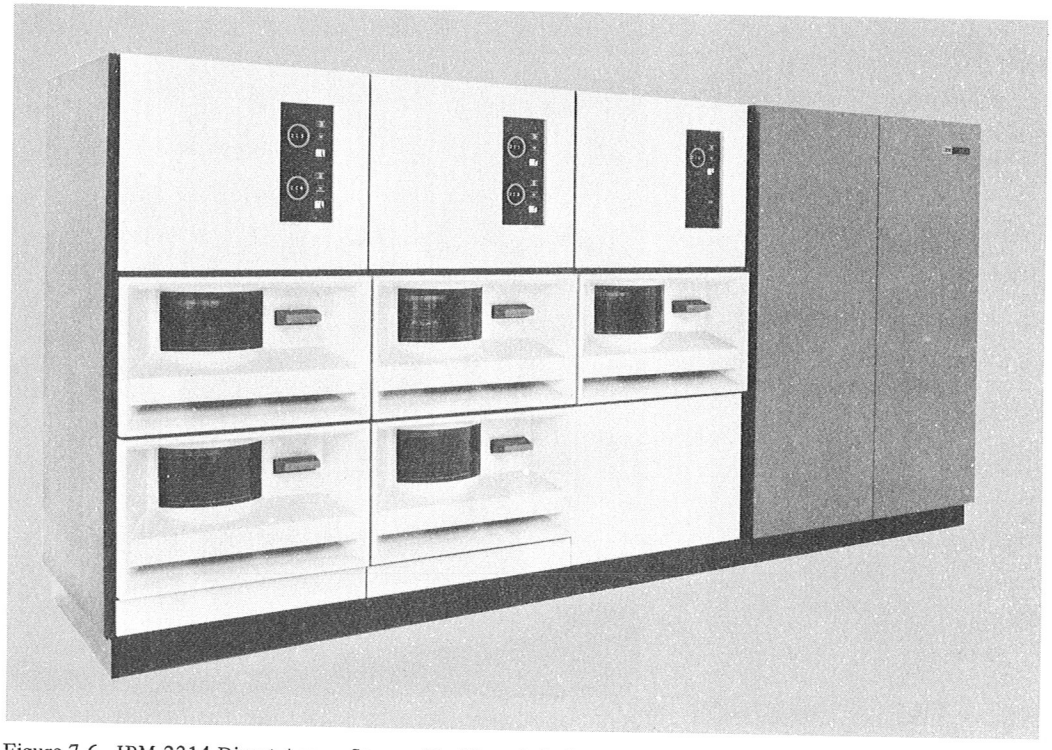


Figure 7-6. IBM 2314 Direct Access Storage Facility—A Series with Five Disk Storage Modules

2. Switching of module control. Under program control, any of the eight active drives in the A-Series 2314 may be switched between the two control units.

File scan and record overflow are standard features of the 2844. A two-channel switch may be installed on both the A-Series 2314 and the 2844, providing communications between the eight drives of the A-Series 2314 and up to four channels on one or more processing units.

2319 Disk Storage Models A1, A2, and A3

The IBM 2319 Disk Storage Models A1, A2, and A3 provide systems with direct access storage without requiring a channel—they attach via an integrated file adapter. Each 2319 contains three modules. The modules use the removable and interchangeable IBM 2316 Disk Pack, which has a storage capacity of 29.17 million bytes. Consequently, each 2319 has an online storage capacity of approximately 87 million bytes and unlimited offline storage.

The Model A1 (Figure 6-2) attaches to the integrated file adapter and permits attachment of as many as five additional modules. Attachable to the 2319-A1 are the three-module 2319-A2 or -A3, as well as the one-module 2312-A1, the four-module 2313-A1, and the two-module 2318-A1. The combinations of devices attachable to the 2319-A1 are system-dependent—the system models determine what devices can be attached.

The average access-motion time for the 2319-A's is 60 milliseconds, their average rotational delay is 12.5 milliseconds, and their data rate is 312,000 bytes per second.

2321 Data Cell Drive

The IBM 2321 Data Cell Drive (Figure 7-8) extends online direct access storage capabilities to a volume of data beyond that of other storage devices. It provides a large storehouse of readily available operating data such as part-by-part inventories, shop schedules, customer accounts of large companies, and manpower records.

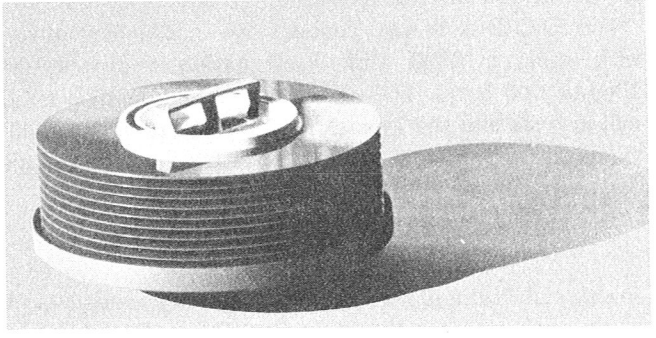


Figure 7-7. IBM 2316 Disk Pack

Each 2321 offers space for 392 million bytes (or 784 million packed decimal digits with signs) of online data, and has eight million bytes for alternate tracks. Eight 2321's can be attached to a 2841 Storage Control, for a total online capacity of 3.2 billion bytes or 6.4 billion packed decimal digits and signs per 2841 control unit. The data rate is 55,000 bytes per second.

Each data cell drive can contain as many as ten data cells, each having a capacity of 40 million bytes. The data cells are all removable and interchangeable among 2321's, permitting an open ended capacity for data cell libraries.

The storage medium is a strip of magnetic tape 2¼ inches wide by 13 inches long. Each data cell (Figure 7-9) contains 20 subcells of 10 strips each.

Upon activation, a data cell drive rotates its circular array of data cells and positions one of the 200 subcells (20 per cell) beneath an access station. Maximum rotation is 100 subcells because the array always rotates in the direction that requires less travel. When the addressed subcell is in position, the pickup head selects the addressed strip from among the 10 strips in the subcell. The strip is then placed on a small drum, rotated past a read/write head, and returned to its subcell.

The 100 tracks on each strip are grouped in five cylinders of 20 tracks; the read/write head is composed of 20 elements and can be moved to any one of five positions. In summary, a specific record is addressed by drive (one of 8), data cell (one of 10), subcell (one of 20), strip (one of 10), cylinder (one of 5), and read/write head element (one of 20). Variable-length records of up to 2,000 bytes long can be read and/or written in all available tracks before the strip is returned to its subcell.

Figure 7-8. IBM 2321 Data Cell Drive

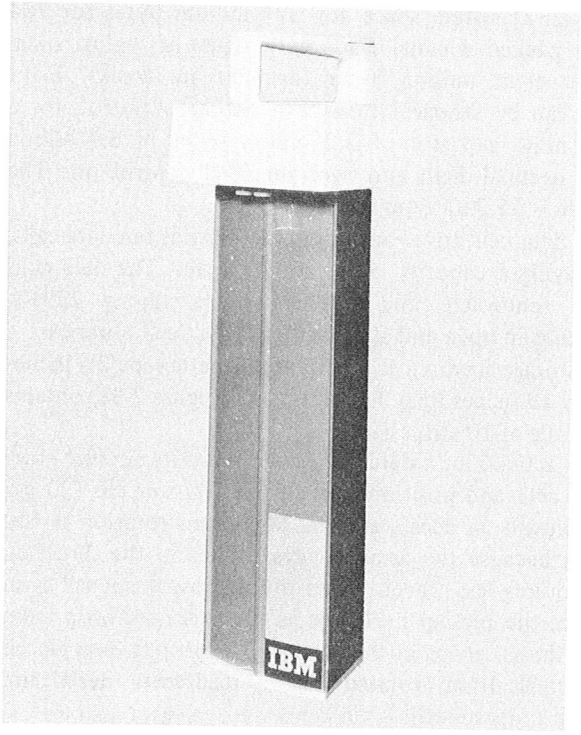


Figure 7-9. IBM 3021 Data Cell (with Top Cover)

Access-motion time to a record varies from 100 microseconds to 650 milliseconds. The minimum time occurs when only switching to another track within the same cylinder is performed. The maximum time occurs when a previous strip must be returned to its subcell, and the array rotated the maximum distance, before the new strip can be withdrawn and the specific record appear (after a complete rotation of the drum) under the read/write head. These and intermediate times (excluding *drum* rotational delay) are given in Figure 7-10. Rotational delay, once a strip is on the drum, is 0 to 50 milliseconds (25 average).

2841 Storage Control

An IBM 2841 Storage Control can control as many as eight 2303's, 2311's, and 2321's in different combinations. With no 2303, a 2841 can have as many as eight 2311's and 2321's in any combination; with one 2303, a 2841 can have as many as seven 2311's and 2321's in any combination having no more than three 2311's; and with two 2303's, a 2841 can have as many as six 2321's, but no 2311's.

The 2841 interprets and executes all orders from the system, and checks the validity of the data transferred to and from the "files" (direct access storage devices).

Optional Features

The *two-channel switch* permits switching a 2841 between two channels under program control.

Conditions	Time/Number of Subcell Moves			
	0 Subcell	1 Subcell	50 Subcell	100 Subcell
When only Read/ Write element selection is required	100 μs			
When only Read/ Write head Block motion is required	95 ms			
When No Strip is on the Drum*	175 ms	250 ms	350 ms	400 ms
When a previously Addressed Strip is on the Drum*	375 ms	450 ms	550 ms	600 ms

* Times given are for access to beginning of track.

Figure 7-10. IBM 2321 Seek Time

File scan permits searching through direct access storage for a specific record or condition. (This feature is not available for the 2303.)

The *record overflow* feature provides greater utilization of the available storage capacity by allowing a record to "overflow" from track to track to the end of the cylinder (in the 2303, to the end of the drum).

3330 Disk Storage; 3830 Storage Control

The IBM 3830 Storage Control and one to four units of IBM 3330 Disk Storage form a 3330 Disk Storage Facility (Figure 7-11), a modular high-performance large-capacity storage facility.

Its primary use is for direct access storage in such applications as airlines reservations, inventory and manufacturing control, graphic processing, message switching, time-sharing, and management information systems. Its functional parameters make it an excellent storage facility in applications requiring either direct or sequential processing. The 3330 can also be an effective systems residence device, in addition to providing large-capacity general-purpose storage.

The 3330 storage facility has a data rate of 806,000 bytes per second and a maximum capacity of 800,000,000 bytes.

The 3330 Disk Storage contains two independent drives, each using a 3336 Disk Pack having a capacity of 100,000,000 bytes. The average access-motion time is 30 milliseconds and the average rotational delay is 8.4 milliseconds. Each drive is mounted in a powered drawer for operator convenience and ease of changing disk packs.

The 3330 storage facility provides functions such as:

Rotational Position Sensing, which increases channel availability by releasing the channel during most of record search time.

Multiple Requesting, which permits up to eight channel command sequences (one per disk drive) to be active in the storage facility, thereby permitting maximum use of the facility and contributing to improved response to system I/O requests.

Command Retry, which enhances error recovery by permitting the channel and control unit to retry operations without CPU program intervention.

Extensive Error Detection and Correction Capabilities, which improve data integrity and facility reliability.

Two-Channel Switch (a special feature), which enables the control unit to attach to two channels and allows individual drives to be reserved for the exclusive use of either one of the channels.

The characteristics of the various direct access storage devices are compared in Figure 7-12.

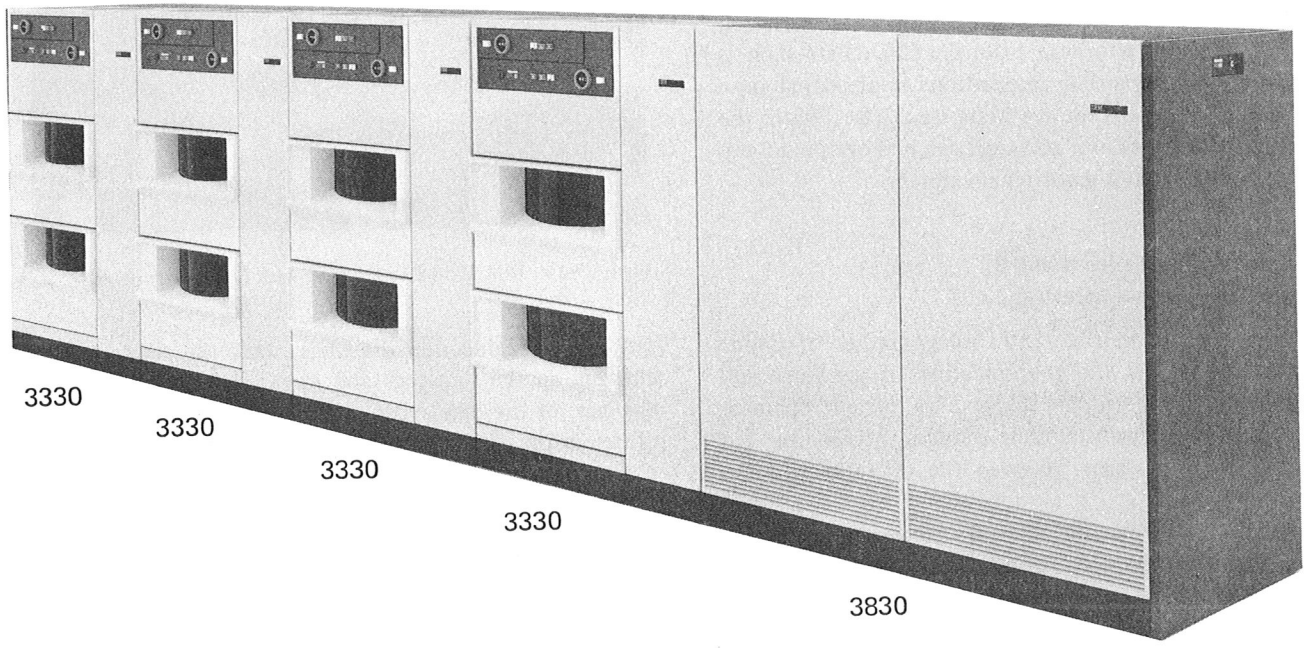


Figure 7-11. IBM 3330 Disk Storage Facility: IBM 3330 Disk Storage (Four Units) and IBM 3830 Storage Control

DIRECT-ACCESS DEVICE	DATA RATE (KILOBYTES/SEC)	CAPACITY AVAILABLE PER DEVICE (MEGABYTES)	CAPACITY AVAILABLE PER CONTROL UNIT (MEGABYTES)	ACCESS-MOTION TIME, AVERAGE (MILLISECONDS)	ROTATIONAL DELAY, AVERAGE (MILLISECONDS)	STORAGE MEDIUM
2301 Drum Storage	1,200	4.09	16.36	0	8.6	Drum
2303 Drum Storage	303.8	3.91	7.82	0	8.6	Drum
2305-1 Fixed Head Storage	3,000	5.4	10.8	0	2.5	Disk
2305-2 Fixed Head Storage	1,500	11.2	22.4	0	5.0	Disk
2311 Disk Storage Drive	156	7.25 Ⓐ	58	75	12.5	1316 Disk Pack
2314 A-Series DASF	312	233.4 Ⓑ	233.4 Ⓑ	60	12.5	2316 Disk Pack
2314 B-Series DASF	312	87.5/175/233.4	87.5/175/233.4 Ⓐ	60	12.5	2316 Disk Pack
2319 Disk Storage (All models)	312	87.5	-	60	12.5	2316 Disk Pack
2321 Data Cell Drive	55	392	3,200	550 Ⓓ	25	3021 Data Cell
3330 Disk Storage Facility	806	800 Ⓒ	800 Ⓒ	30	8.4	3336 Disk Pack

Notes:

Ⓐ Interchangeable storage media also provide unlimited offline capacity.

Ⓑ In 29.17-megabyte increments

Ⓒ In 200-megabyte increments.

Ⓓ Depends on the kind of access; see Figure 7-10.

Figure 7-12. Comparison of Characteristics of Direct Access Storage Devices

Display Devices

The IBM 2250 Display Unit (Figures 7-13 and 7-14) provides high-speed visual communication between the System/370 and its user. Tables, graphs, charts and alphameric data are displayed within the 12-inch square central area on the face of a 21-inch cathode ray tube (Figure 7-15). Keyboards and a light pen (Figure 7-16) supply the means for entry and change of computer information.

The IBM 2260 Display Station (Figure 7-17) is a lower-speed, table-top device for displaying computer output in alphameric form, either locally, or at installations up to thousands of miles distant from the CPU. Data such as insurance records or airline reservations is presented on a 4- by 9-inch area on the cathode ray tube. With the attachment of a keyboard, messages can be keyed in at any location, displayed, and sent to main storage.

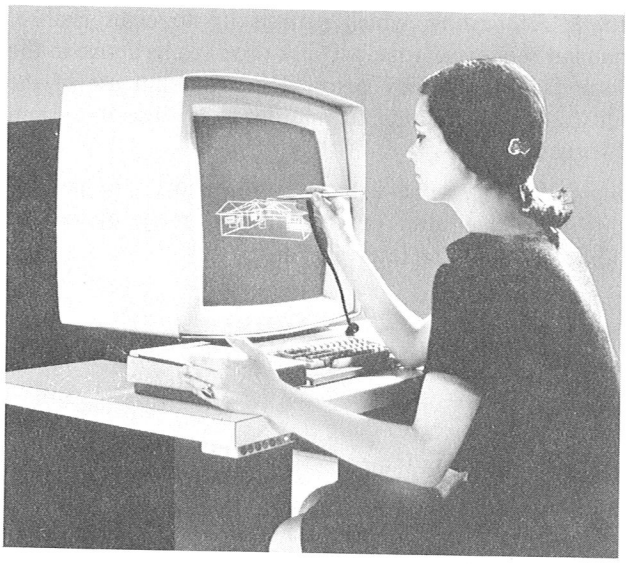


Figure 7-14. IBM 2250 Display Unit with Light Pen in Use

2250 Display Unit Models 1 and 3; 2840 Display Control Model 2

The general use of the IBM 2250 Display Unit is for on-line displaying, updating, and manipulating of drawings and alphameric data. It also has usage as a system operator console, in which it substantially reduces the time needed for transferring messages between the operator and the system.

Specific applications are innumerable: the display of readings from process control indicators, along with computer messages for operator guidance of the process; the display of engineering drawings, with the user sketching changes on the drawings and requesting the results of the changes; or the display of intermediate and/or final results of scientific calculations, in the form of curves, plotted points, bar graphs, or symbols.

The display area (Figure 7-15) contains over 1,000,000 display points that can be individually addressed by X and Y coordinates. The CRT beam is deflected to each point on the screen that is addressed by the program, intensifying

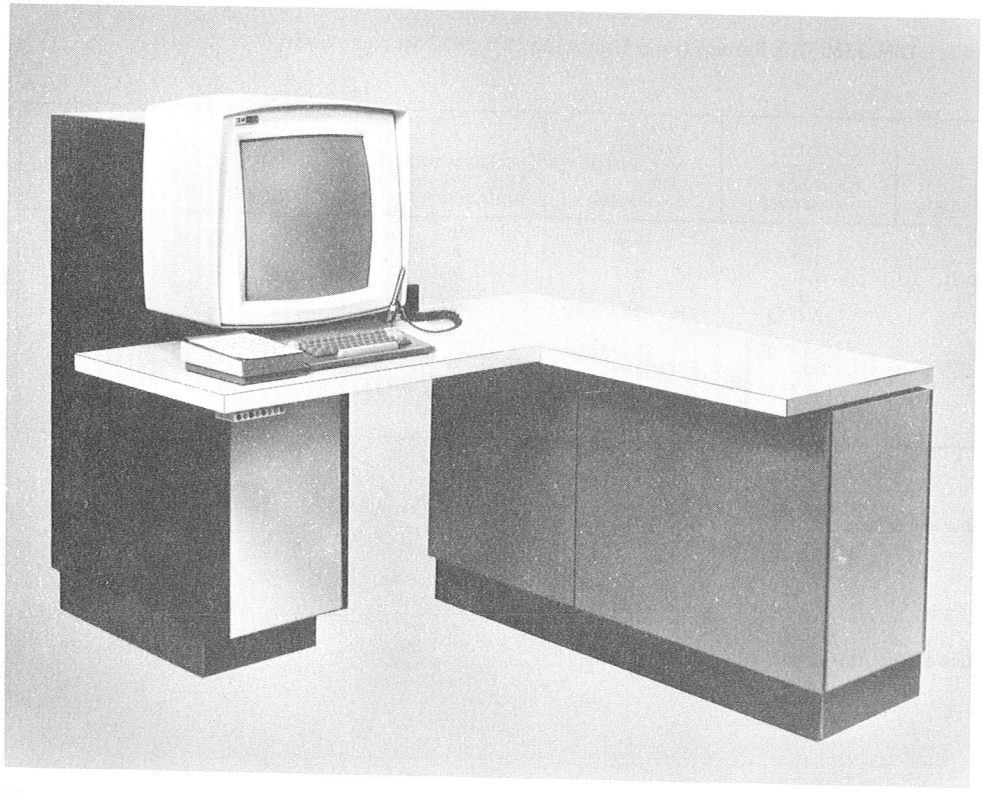
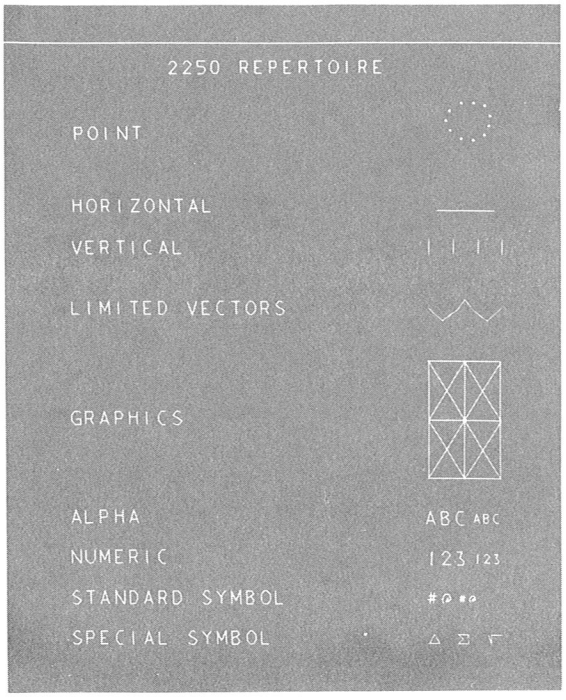


Figure 7-13. IBM 2250 Display Unit



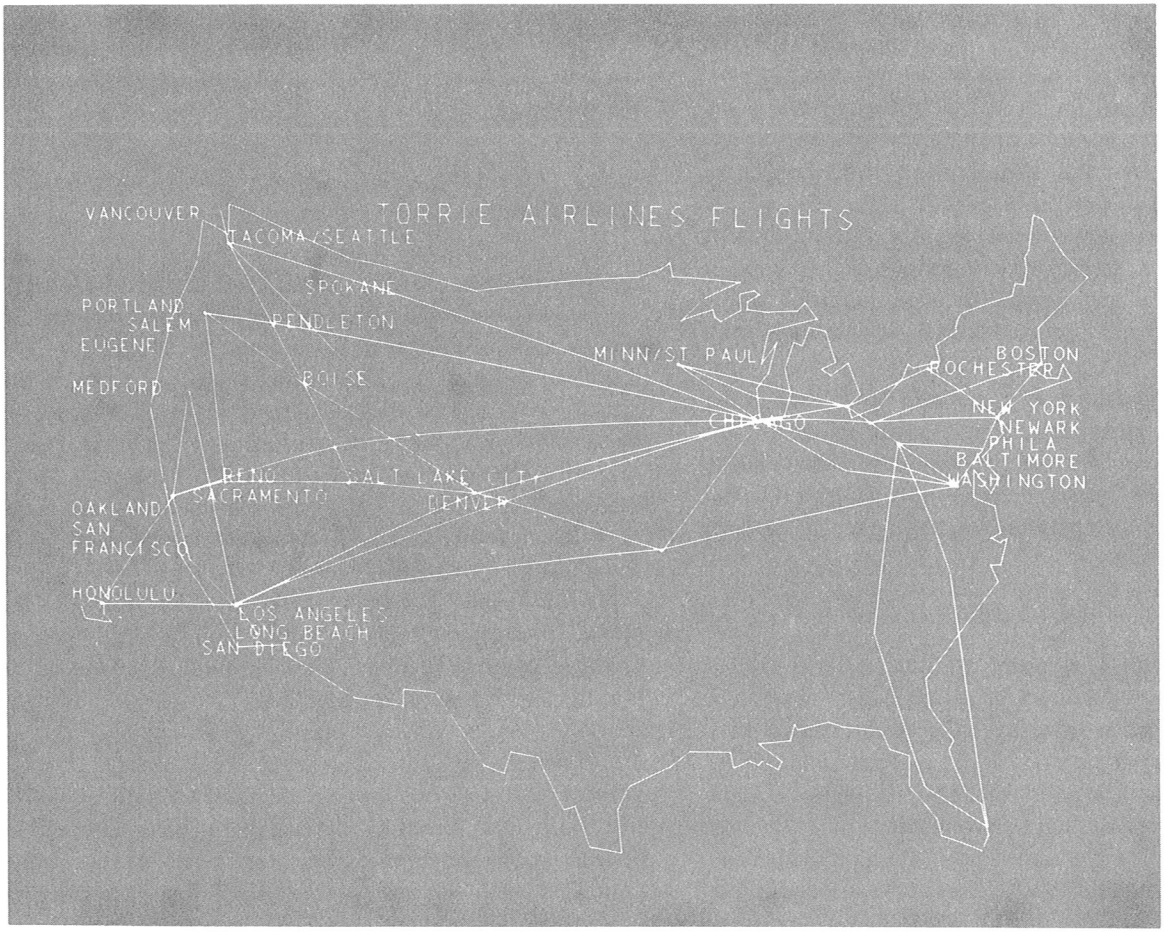


Figure 7-15. IBM Displays Showing Absolute Vector Graphics, Point Plotting, and Both Sizes of Alpha Characters

Figure 7-16. Fiber Optics Light Pen

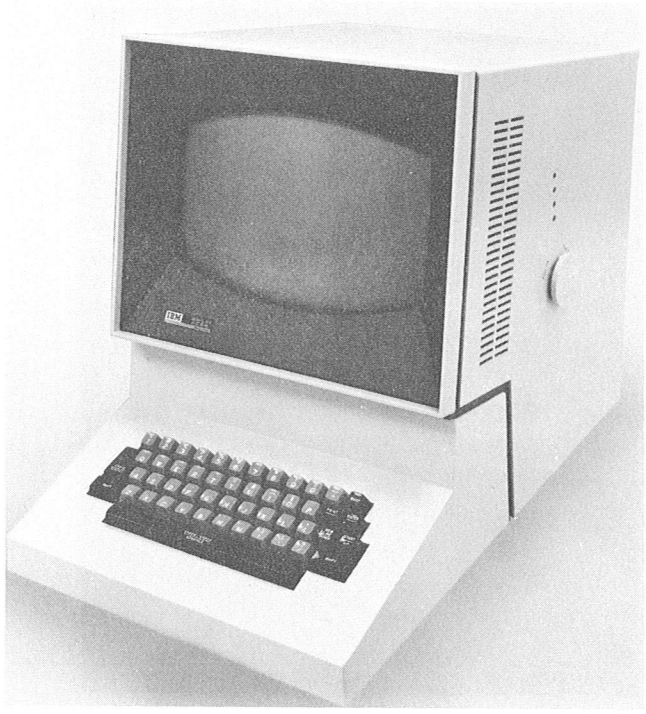


Figure 7-17. IBM 2260 Display Station with an Alphameric Keyboard

that point only if so directed by the program. If the beam motion is horizontal, vertical, or at 45 degrees, the path traversed by the beam on its way between one end point and the other can also be intensified; by this means, continuous horizontal and vertical lines of unlimited length or 45 degree lines of limited length are made visible. Lines can be displayed at any other angle as a series of dots. A further ability to display continuous straight lines of unlimited length at any angle is detailed under "Absolute Vectors and Control," discussed later in this device description.

The 2250 is available in two models, which vary in the location of the control unit, logical power in the buffer, and in the features that are standard. Model 1 has a self-contained control unit; Model 3 units are linked to the channel and CPU through an IBM 2840 Display Control Model 2.

Multiple Display

A 2840-2 can control as many as four Model 3 display units, each able to operate as far as 2,000 feet away from the 2840. The first two display units are attachable to a standard 2840; for the second two, a display multiplexer feature must be installed on the 2840. As many as eight control units can be attached to a channel.

Different images or the same image can be displayed on all display units simultaneously. The buffer storage in the 2840 is shared by all the 2250's attached, with portions being assigned to individual units by the program.

Light pen tracking can be performed simultaneously by the operator of each 2250 Model 3 without interference to the system.

Special Features

Light Pen (Figure 7-16), a standard feature for the Model 3, is a pen-like device that enables the operator to identify to the program a particular point, line, or character in the displayed image. The operator moves the pen point to the part of the image he wants to identify; the photo-detector associated with the pen, sensing light at that point, generates a signal for the program. The light pen can be used alone or in conjunction with a keyboard to rearrange or delete information, or to add lines from a base point already lighted by the CRT beam.

An "electronic" light pen can be provided alone for the Model 1. Alternatively, a "fiber optics" light pen is provided with the graphic design feature for the Model 1; it is a standard feature of the Model 3.

Programmed Function Keyboard is a 32-key general-purpose keyboard, the keys of which are basically unidentified, with their functions defined by application-oriented interpretation programs. Each key starts a subroutine associated with a particular program. For example, the subroutine might direct the CPU to enlarge, reduce, or delete the image displayed.

Alphameric Keyboard is a typewriter keyboard that permits the user to enter messages consisting of letters, numbers, and other symbols into computer storage. As the message is composed, it is displayed on the screen for verification or editing before it is transferred to main storage. This keyboard also controls the screen location of a movable dash symbol (cursor) that glows beneath the position at which the next character from the keyboard will be displayed.

Buffer (Standard Feature for Model 3) provides the Model 1 display unit with a choice of 4,096 or 8,192 bytes of internal storage. The 2840-2 provides, as a standard feature, 32,768 bytes of storage that are program-assignable to the attached Model 3 display units.

To maintain a display of information on the screen without a noticeable flicker, the display must be regenerated about 40 times per second (the maximum rate actually used). For an unbuffered display, regeneration would have to be performed by the computer. To free main storage and the channel for other functions and to allow the display unit to operate concurrently with the computer, the buffer is used to regenerate the display; the data that defines the image is transferred from main storage to the buffer only once. Also, the buffer is used for the assembling and editing of messages before they are transferred to main storage.

Transfers between main storage and buffer are at the rate of 4.2 microseconds per byte for Model 1, and at an effective rate of 2 microseconds per byte for the 2840 used with Model 3's. Thus, the buffer can accept data from the CPU at the rate of 238,000 bytes per second for Model 1, or 500,000 bytes per second for the 2840. (The 32K buffer in the 2840 can be completely rewritten in less than a tenth of a second.) In communication between the 2840 and Model 3's, the buffer is accessed at only 1 microsecond per byte. Points can be displayed as fast as 16.8 microseconds per point.

Character Generator (Standard Feature for Model 3) translates a byte, specifying an alphameric character, into the analog signals needed to trace the character on the face of the tube. It also relieves the program of the task of individually addressing a series of dots or lines, synthesized on the display, into the specified character. A single data byte from the CPU specifies one of the characters available with the character generator. Two character sizes are program selectable: basic size or 1½ times basic size. The screen has room for 3,848 basic-size characters (on 52 lines of 74 characters each) or 1,715 1½-size characters (on 35 lines of 49 characters each). The latter case is equivalent to about two thirds of a column on this page. The average time required to display alphameric data with this feature is 15 microseconds per character for the basic size or 17 microseconds for the 1½ size. The number of characters per second depends on the program. Characters can be displayed from the buffer at the rate of 60,000 per second.

Operator Control Panel (For Model 1 Only) duplicates the facilities in the operator control section of the system control panel on the processing unit of System/370 Model 165. One or two operator control panels can be installed on the 2250 Model 1.

Absolute Vectors and Control (Standard Feature for Model 3) enables the 2250 Model 1 to trace continuous straight lines at any angular position within the 12-inch by 12-inch display area on the CRT. A line (vector) can be drawn between any two addressable points. More than a million points are addressable: 1,024 on the X axis by 1,024 on the Y axis. XY coordinates are programmed to specify the point to which each vector is drawn.

Graphic Design (Standard Feature for Model 3) provides (1) incremental vectors and point plotting, (2) a special fiber optics light pen, (3) light pen control orders. For the Model 1, the absolute vectors and control feature is a prerequisite.

In the fiber optics light pen (Figure 7-16), light is transmitted from the screen back to a sensing device in the console through a flexible connection made of glass fibers. Also, instead of being used in conjunction with a foot switch, this new light pen has a tip switch that is operated by depressing the pen tip on the screen.

Through programming, the graphic design feature enables the user to locate the light pen on a blank part of the screen, or to track the pen's path, with a minimum of CPU interruption. Locating the pen (pen search) is done by momentarily sweeping the screen with characters or short vectors and saving the XY location of the one character or vector that activated the light pen. Pen search is a good way to initiate pen tracking.

In pen tracking, a small cross or box is displayed under the pen and moves with the pen; the cross or box supplies the light to keep the pen activated, and the program updates the symbol location. In one tracking technique, a light trail can be made to follow the pen much as an ink trail follows an ordinary pen. Alternatively, a single vector can be displayed from each starting point of tracking to the pen, for an effect called rubber banding. The incremental vectors and light pen control orders provided by the graphic design feature enable pen tracking to be directed by the CPU and buffer programs. (With the 2250 Model 3, only the buffer program is needed.) With the user's program as aided by this feature, there is no need for the CPU to compute every point on the tracking symbol as it is continually relocated, because resetting the starting point of the first vector moves the entire symbol to the new location.

With the incremental vectors, a line is drawn to any point on the screen, up to 0.74 inch from the absolute X and Y

values of the starting point, by specification of increments along the X and Y axes rather than by absolute specification of the destination point. The same distances and method of specification apply to incremental point plotting. With a series of changes in the starting point and by use of an appropriate subroutine within the buffer, an image such as a resistor or a rivet head can be made to appear at many places on the screen simultaneously.

Features of 2840 Model 2

The only special feature for the 2840 control is the display multiplexer, which permits the attachment of two additional 2250 Model 3's for a total of four. No more than one display multiplexer can be installed per 2840 Model 2.

Many functions can be performed totally within the standard 32K-byte buffer, thereby eliminating many interruptions and programming task-switching operations in the CPU.

Other standard features of the 2840-2 are the character generator, absolute vectors, incremental vectors, and light pen control orders that are provided with special features for the Model 1 display unit. The subroutine capability within the buffer permits the displaying of an image such as a resistor at many places on the screen even though the control orders appear only once in the buffer program.

2260 Display Station Models 1 and 2; 2848 Display Control Models 1, 2, 3, 21, and 22

The IBM 2260 Display Station (Figure 7-17), operating through an IBM 2848 Display Control, is an efficient and compact visual-display terminal. It provides immediate visual access to local or remote System/370 storage for data entry, retrieval, and revision.

Using the 2260, a user can store, retrieve, and display alphameric data conveniently and quickly. Via the 2260 keyboard, he can query the system for information about an account, a transaction, a production schedule, etc. The inquiry is quickly processed and the desired information is displayed on the 2260 cathode-ray-tube screen and retained there for as long as desired. The user can revise the information via the keyboard and return it to the computer for storage or additional processing. If the keyboard-equipped 2260 also has a printer feature, displayed information can be directed to a 1053 Printer, where it is printed in the same format as displayed on the 2260 screen. The basic 2260 (without a keyboard) is used when only the display of information is required.

Flexibility of Display Configuration

The 2260/2848 display configuration can vary from one display-only 2260 with one 2848 to a multiple-station complex consisting of many 2260's and 2848's in which each station can be used as a data-entry terminal. Because each 2260 can be operated independently, many unrelated display operations can be performed concurrently with no interaction between display stations.

A 2260 Display Station can operate within 2,000 cable-feet of its associated 2848. Display stations can be located strategically throughout an office building, manufacturing plant or similar facility, thus providing access to computer data at locations removed from the computer area.

When attached to the appropriate teleprocessing facilities, a 2260 can communicate with a computer located many miles away as easily as if both were in the same room.

Ease of Operation

After learning the functions of the special keys and characters, entering data via the keyboard is as simple as typing. The operator keys in the desired information and visually verifies it as it appears on the screen. If an error is made, the operator can backspace and correct it. The information can then be transferred to the computer by pressing another key.

Inquiries are addressed to the computer in the same way; the computer's response is displayed on the screen for action by the operator. The displayed data is updated, corrected, or deleted via the 2260 keyboard. The format of the data to be handled by the display station can be programmed beforehand to avoid entering repetitive information.

Model Differences

The basic differences between 2260 Models 1 and 2 are in the amount of data capable of being displayed within the 4-by-9-inch display area, as determined by the 2848 model, and the special features that permit expansion of the configuration.

The models of the 2848 differ in the service that they support. The 2848 Models 1, 2, and 3 are used primarily in inquiry-oriented configurations; Models 21 and 22 combine the advantages of the other models with increased data input capabilities.

2848 Model	*2260 Model*	*Max. No. of 2260's Per 2848*		*Display Capacity (Characters)*
		Without Expansion	*With Expansion*	
1	2	4	24	240 (6 lines, 40 char/line)
2	2	2	16	480 (12 lines, 40 char/line)
3	1	2	8	960 (12 lines, 80 char/line)
21*	2	12	24	240 (6 lines, 40 char/line)
22*	2	8	16	480 (12 lines, 40 char/line)

*Models 21 and 22 of the 2848 cannot be used for remote (teleprocessing) installations.

The 2848 contains a buffer that can hold up to 240, 480, or 960 bytes per display, depending on the model. It also contains the character generator that converts data from the channel or signals from the keyboard into the visual display.

All 2260's are attached to 2848's through display adapters, with each adapter providing control for two 2260's. Additional display adapters can be attached to a 2848 by adding expansion features to it, thereby extending the capability of the 2260/2848 display configuration, as shown in the preceding table.

Keyboards

Three different keyboards are available for the 2260: the alphameric, the numeric, and the alphameric with numeric inset. The alphameric keyboard is organized similarly to a typewriter keyboard. The numeric is arranged the same as a ten-key adding machine. On the alphameric with numeric inset, the numeric keys are inset in the keyboard in a block arrangement for rapid numeric data entry. All three have special symbol keys and control keys required to enter data.

The keyboard determines the characters and symbols that can be key-entered on a 2260, but does not determine which ones can be transmitted from System/370 storage (either main or auxiliary) for display on a 2260 screen. For example, a 2260 can display alphameric data even if it has only a numeric keyboard.

Printout on 1053 Printer Model 4

The contents of the 2848's buffer storage, or information from the channel, can be printed out on an IBM 1053 Printer Model 4 attached to the 2848. One printer can be attached to each 2848 in the system. The attachment requires a 1053 adapter in the 2848; when the 2848 is a Model 1 or 2, an expansion feature is also required. The buffer for a 1053 has a capacity of 1,223 bytes.

The 1053 is further described under "Printers."

2285 Display Copier

The IBM 2285 Display Copier (Figure 7-18) is a nonprogrammed attachment to the IBM 2250 Display Unit Models 1 and 3; it provides an 8½-by-11-inch paper copy of the information displayed on the 2250. The 2285 enables the 2250 user to record displayed information in a form that can be readily seen, used, and filed for future reference. To obtain a copy of the information displayed on the 2250, press the copy pushbutton on the 2285, which initiates a copy cycle. Analog signals are then switched from the 2250 to the 2285, where they drive a smaller cathode-ray tube (CRT). The image from the CRT is enlarged and projected onto dry-silver photographic paper. Once the paper is exposed, the analog signals are switched back to the 2250, which is again available for use. Completion of exposure also activates the paper transport mechanism, which advances the paper and cuts it to an 11-inch sheet. This exposed sheet is then developed by a heat roller (dry process), producing a black image on a light gray background. A five-position switch allows the operator to vary image density as desired. Both the setting of this switch and the vector and character content of the 2250 image govern the copy cycle time which, for all flicker-free images, will vary from 15 to 38 seconds (approximately).

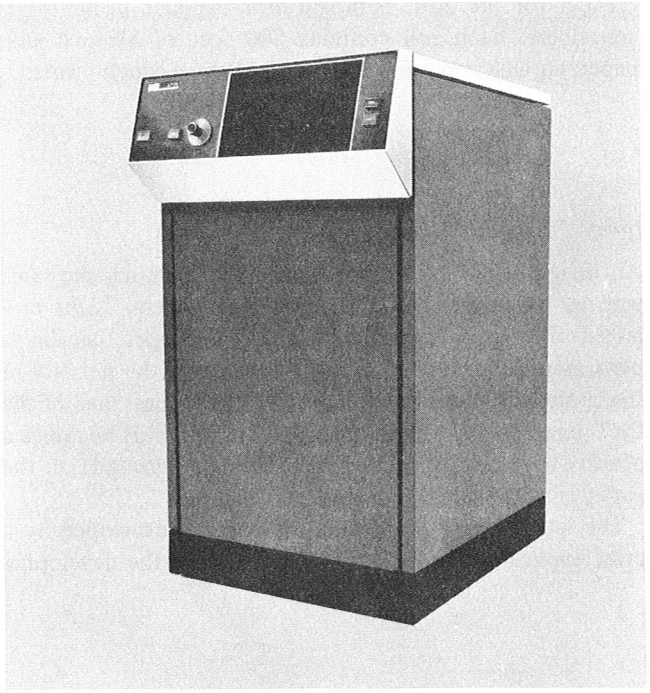


Figure 7-18. IBM 2285 Display Copier

A display copier attachment feature is required on the 2250 to enable attachment of a 2285. Also, the absolute vectors and control feature and a buffer are required on the 2250-1. The 2285 is conveniently located so that its controls, indicators, and hopper are easily accessible to the 2250 operator.

Paper

The copy medium used by the 2285 is a dry-silver paper. Dry-silver is a light-sensitive material with a developing agent that is coated on a paper stock. The coated paper is resistant to curl, has sufficient weight for easy handling, and has a feel similar to conventional non-coated paper—characteristics that make it suitable for many reference applications. It has excellent resolution and exposure latitude. Prints are neither moisture nor pressure sensitive, and can be written on with pen or pencil; pencil marks are easily erased.

Paper for the 2285 is in roll form supplied in light-tight containers. Each roll contains 500 feet of 8½-inch wide paper, enough paper for about 545 8½-by-11-inch prints.

Image Formation and Development

An image is formed on dry-silver paper in much the same way as on conventional photographic papers. Light projected from the 2285 CRT strikes the paper, causing a permanent latent image. The paper reverses the polarity of the projected image so that the negative appearance of the CRT image (bright image on dark background) becomes a positive image (black image on a light background) on the paper.

The latent image formed on the paper is developed by a brief application of heat. During this time, the developing agent and the exposed light-sensitive material, both coated on paper, react to form a visible image.

Copy

Copy from the dry processor is placed in the hopper, which can hold as many as 20 copies. The time required to obtain a completed paper copy is 12.5 seconds plus exposure time. A new copy cycle can be initiated after the previous exposure has been cut (about 5 seconds after exposure is complete). When the end-of-roll condition is reached, the ready light is turned off and the copy pushbutton is deactivated.

A right-reading image on the 2250 results in a right-reading image on paper. The 11-inch side of the copy is vertical, and the image area is approximately centered vertically. Horizontally, the image is off-centered to the right of the paper providing a ½-inch margin along the left side of the paper for hole punching or binding.

Magnetic Character Readers

The IBM magnetic character readers use magnetic-ink character recognition (MICR) to read and sort card and paper documents in banking applications. These devices operate on documents whose type font (MICR E13B), print quality, and code line arrangement meet the specifications recommended by the American Bankers Association.

1255 Magnetic Character Reader Models 1, 2, and 3

The IBM 1255 Magnetic Character Reader (Figures 7-19 and 7-20) can read and sort a variety of magnetically inscribed documents at relatively high speeds. The documents may be intermixed, and can range from 2.5 to 4.25 inches wide, 5.75 to 8.875 inches long, and 0.003 to 0.007 inch thick.

The speed of processing depends on the 1255 model as well as on factors such as document length and paper quality. Six-inch documents, for example, can be processed at 750 per minute by Models 2 and 3, and at 500 per minute by the Model 1. The 1255 has horizontal stackers, each of which can hold a 2.5-inch pile of documents. Models 1 and 2 have six stackers in one vertical bay, and the Model 3 has 12 in two bays.

In a typical application, the 1255 can be used to perform selective data storing from MICR-encoded checks for updating of demand-deposit accounts. Continuous document loading, optimum document stacking, and simplicity of operation help improve throughput.

The operator panel contains switches, indicators, and an operator-resettable document counter. This panel is grouped with the feed hopper and the stackers for operator convenience. This grouping also makes operator training easier, and helps minimize space requirements.

Among the optional features available for the 1255 are the following:

High-order Zero and Blank Selection, an offline feature for the Model 3, permits selection of certain documents into a specific stacker. These are documents that have only blanks in the sort position and in all higher order positions of the field.

Self-checking Number/Improved Recognition, in addition to performing the basic self-checking number function, reduces account number rejects. (The account field is especially subject to folds, banding, and print specification deviations.) Character rejects are reduced in proportion to the severity of document degradation, thereby reducing customer reconciliation expense.

Dash Symbol Transmission transmits the E13B dash symbol from the transit field to storage.

51-Column Card Sorting is used for reading and sorting 51-column cards.

The 1255 can also be used offline to perform fine sorting of checks (usually by account number) or validity checking without sorting. The operator panel provides for online/offline switching.

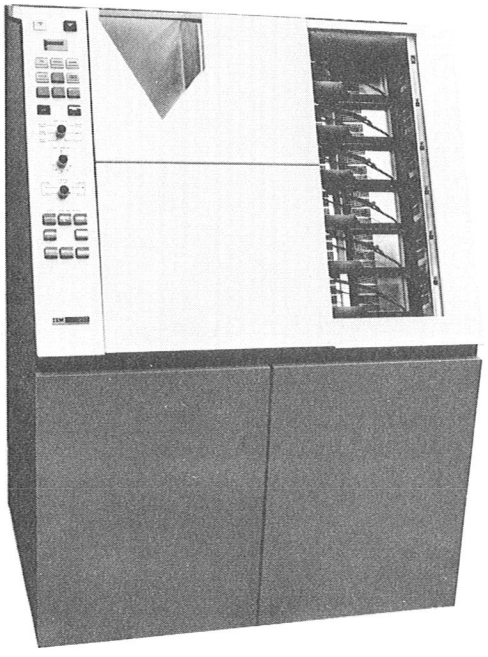


Figure 7-19. IBM 1255 Magnetic Character Reader Model 1 or 2

Figure 7-20. IBM 1255 Magnetic Character Reader Model 3

1259 Magnetic Character Reader Model 2

The IBM 1259 Magnetic Character Reader Model 2 (Figure 7-21) provides smaller banks with an economical device for reading magnetically inscribed card and paper documents at speeds up to 600 six-inch documents per minute.

The 1259 can handle intermixed paper and card documents ranging from 2.5 to 4.14 inches wide and 5.5 to 8.75 inches long. Documents less than 3.5 inches in length cause the machine to stop; documents at least 3.5 inches but less than 5.5 inches long are automatically rejected by the 1259 and are not read. When the document width is 4.00 inches or more, the document length must be 7.00 to 8.75 inches.

For operations with the 1259, the amount field and the transit-routing field on a check or other document are fixed lengths of ten and eight digits, respectively. The process-control field can vary in length from zero to six digits and the serial-number field from zero to ten digits. The account-number field may be fixed (at five to ten digits) or variable (at one to ten digits), as specified by the customer.

As a document is processed, the validity of each magnetic character, including special symbols, can be verified, and characters found to be invalid are sent as asterisks to the CPU. Additionally, a field-length check is made of all fixed-length fields being processed to ensure that all digits in the fields have been read. Documents must be directed under program control into one of the eleven stackers; otherwise, feeding stops, and the operator must reset the 1259.

1419 Magnetic Character Reader

An IBM 1419 Magnetic Character Reader (Figure 7-22) reads data inscribed magnetically on checks and other banking documents (Figure 7-23). The 1419 reads at speeds as high as 1,600 documents per minute. Specific speeds depend on document length as well as on the program.

As the documents are read, they may be sorted into as many as 13 classifications: A, B, 0-9, and R (reject). All magnetic inscriptions can be validity-checked.

Documents read may be of intermixed sizes and thicknesses, as typically encountered in check-handling operations. The standard minimum length is 6 inches; shorter documents, such as the 51-column postal money order, can be read into the system by the 1419 at a maximum rate of 1,960 per minute.

These shorter documents can be intermixed with standard-length documents, and can also be sorted if a no-charge special feature for that purpose is installed. If the feature is not installed on the 1419, 51-column cards and other documents less than 5 inches long are sent to the reject pocket. If the feature is installed, 1419 speed is reduced by an amount that increases slightly with the average length of documents and is 4.3 percent for 51-column cards, and 5.3 percent for 6-inch checks.

Many special features are available for the 1419, including an endorser to print the bank's endorsement on the back of each document at no reduction in operating speed. Other features most applicable to on-line operations with the System/370 are:

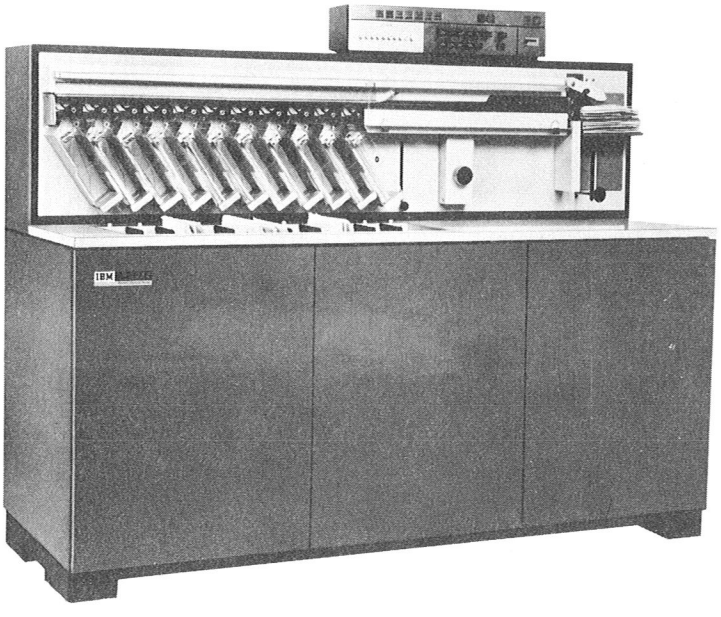


Figure 7-21. IBM 1259 Magnetic Character Reader

Feature	*Purpose*
Dash Symbol Transmission	Distinguish U. S. from Canadian transit-routing numbers (leftmost eight magnetic digits), to prevent duplications.
Batch Numbering	(Self-evident)
Self-Checking Number	Automatically perform mathematical proof that account numbers are correctly recorded and read.
Program Control for Pocket Lights	Improve control of output batches. Stops the reading-sorting and turns on pocket light(s) when a predetermined number of documents has entered one of the corresponding six pockets (with a second feature, 12 pockets) designated by the program.

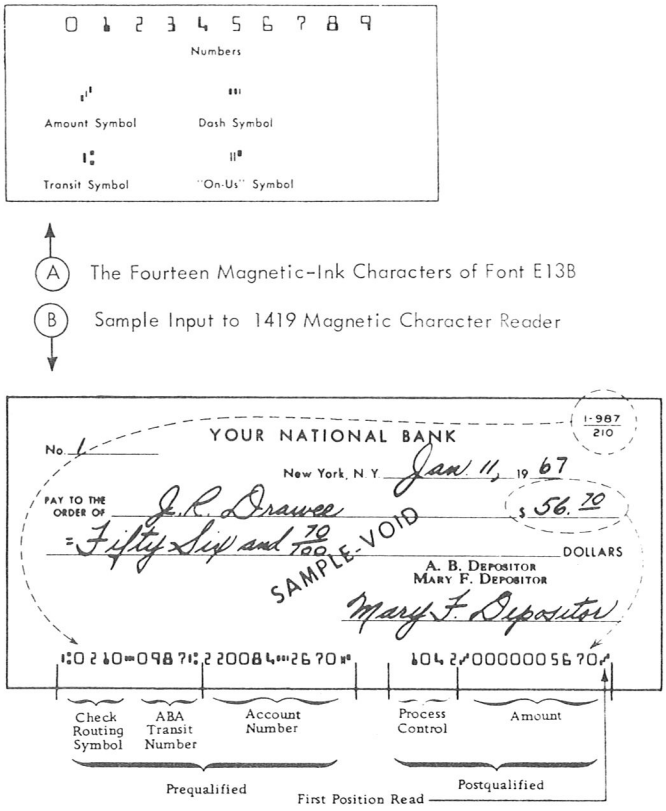


Figure 7-23. Magnetic Inscription–Translation of Characters and Definition of Fields

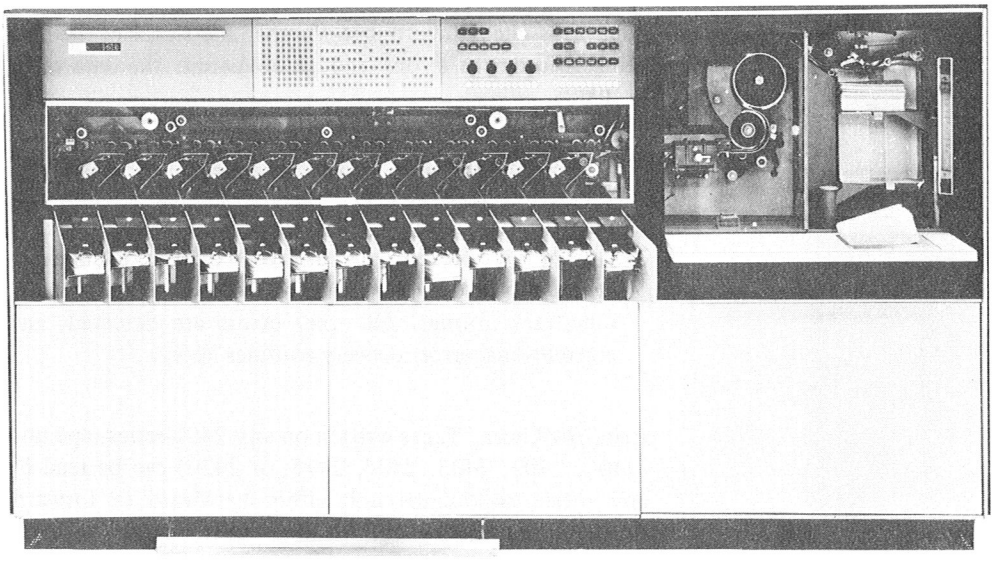


Figure 7-22. IBM 1419 Magnetic Character Reader

Magnetic Tape Devices

The System/370 magnetic tape units read and write on half-inch magnetic tape mounted on 8.5- and 10.5-inch reels and on minireels. The tape units, which operate at data densities up to 1,600 bytes per inch (bpi), use IBM Heavy Duty, Dynexcel, or Series/500 tape. Competitive tape formulations should meet the tape specifications described in Order Number GA32-0006.

These units operate in seven or nine-track format. The nine-track uses eight of the nine bits for data and the last one for parity. The data bits can represent an alphameric or special character, two decimal digits, one signed decimal digit, or eight binary digits.

Figures 7-24 through 7-31 illustrate the System/370 tape units, and Figure 7-32 (in table form) shows and compares the characteristics of these units.

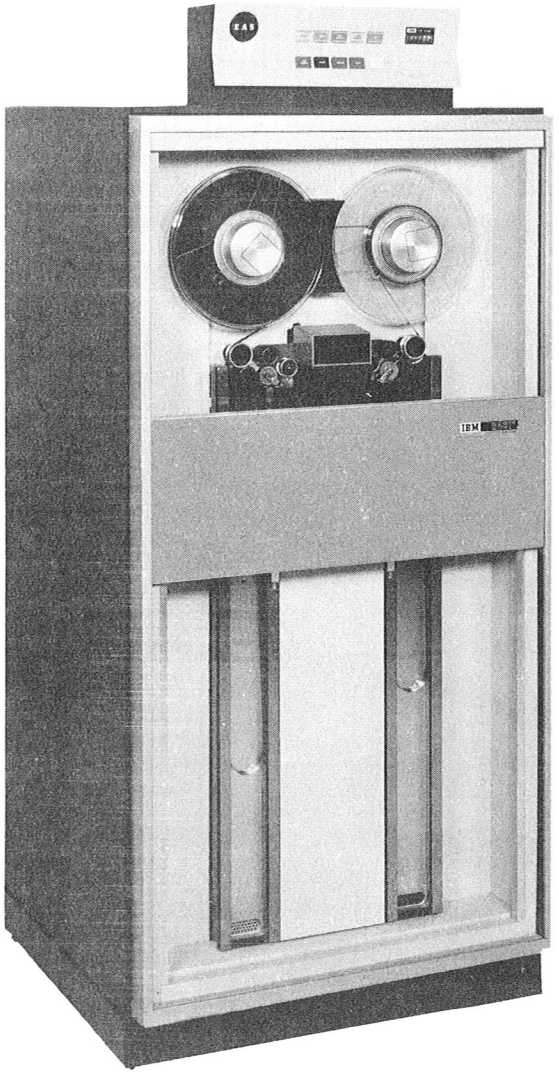


Figure 7-24. IBM 2401 Magnetic Tape Unit Model 2, 3, 5, or 6 (Using Transparent Reels)

2401 Magnetic Tape Unit Models 1-6 and 8

The IBM 2401 Magnetic Tape Unit (Figure 7-24) reads and writes on magnetic tape in seven- or nine-track format. Models 1 through 6 usually operate in nine-track format (at 800 or 1,600 bpi), but Models 1 through 3 can be made to operate in seven-track format (at 200, 556, or 800 bpi). The Model 8 operates in seven-track format only. With appropriate features on the tape control, the seven-track format is compatible with tapes written by 700- and 7000-series tape units (727, 729, 7330, 7335, 7701, 7702, and 7765).

The 2401 Models 1-3 use the non-return-to-zero-IBM (NRZI) method of recording information on tape; Models 4-6 use phase encoding. (In NRZI recording, only 1-bits are recorded; the absence of a 1-bit is interpreted as a 0-bit. In phase encoding, however, both 0-bits and 1-bits are recorded.) Phase encoding has advantages over NRZI in that it increases both reliability and data density and provides "in-flight" (during reading) correction of single track errors.

Standard Features

Parity Checking: This is done during tape reading (in both 800- and 1,600-bpi recording) and during read-back check of tape writing (in 800-bpi recording, and in 1,600-bpi recording if the control unit is a 2803-2 with 2420 attachment capability).

Amplitude Checking: In 1,600-bpi recording, the amplitude of the signal is checked against a predetermined threshold level. This check determines whether the signal of the data being recorded is strong enough to permit the data to be read.

Error Correction: Single track errors are automatically detected and corrected:

1. In flight, when using the 1,600-bpi nine-track format.
2. During the re-read of a record that contains one or more errors confined to a single track, when using the 800-bpi nine-track format. All other errors are detected, and conventional error recovery routines apply.

Read Backward: Tapes written on any 2400-series tape unit (2401, 2402, 2403, 2404, 2415, or 2420) can be read by any other 2400-series unit either backward or forward, provided the writing and reading units operate with the same tape density and format. However, the data conversion feature of a 2803 or 2804 Tape Control cannot be used when the 2401 is reading seven-track tape backwards.

Power Window: This tape access window (standard on most units) facilitates tape changes by opening automatically following a tape unload and closing automatically prior to a tape load operation. The power window can also be opened or closed at the touch of a button.

Quick-Release Latches: Each tape unit has quick-release latches to facilitate the mounting and removal of tape reels.

Optional Features

Dual Density 800-1,600 bpi (2401 Models 4-6): This feature allows a program to use a tape unit in either 800- or 1,600-bpi recording. It requires that the 2803 or 2804 Tape Control be equipped with a nine-track or seven-and-nine-track compatibility feature. (See the 2803 and 2804 descriptions for details.)

Simultaneous Read-While-Write: This feature is required on any 2401 attached to a 2804 (a two-channel simultaneous read-while-write tape control).

Mode Compatibility: This feature is required to attach 2401 Models 1-3 to a 2803 or 2804 Model 2.

2415 Magnetic Tape Unit and Control Models 1-6

The IBM 2415 Magnetic Tape Unit and Control (Figure 7-25), like the 2401, reads and writes on magnetic tape at data densities of 800 or 1,600 bpi. The operations of the 2415 are similar to those of a basic 2401, but the 2415 has data rates that are a downward extension of those available with a 2401.

Figure 7-25. IBM 2415 Magnetic Tape Unit and Control Model 1 or 4

Two, four, or six tape units are available with a 2415, depending on the model. Each tape unit operates independently, but only one can read or write at a time.

Model	*No. Tape Units*	*Data Rate (Bytes Per Second)*	*Data Density (Bytes Per Inch)*
1	2	15,000	800
2	4	15,000	800
3	6	15,000	800
4	2	30,000	1,600
5	4	30,000	1,600
6	6	30,000	1,600

As with the 2401, the 2415 Models 1-3 use the NRZI method of recording data; Models 4-6 use phase-encoding.

Standard Features

Parity Checking: This is done during tape reading (in both 800- and 1,600-bpi recording) and during read-back check of tape writing (in 800-bpi recording, and in 1,600-bpi recording if the control unit is a 2803-2 with 2420 attachment capability).

Amplitude Checking: In 1,600-bpi recording, the amplitude of the signal is checked against a predetermined threshold level. This check determines whether the signal of the data being recorded is strong enough to permit the data to be subsequently read.

Error Correction: The 2415 Models 4-6, using 1,600-bpi nine-track format, automatically detect and correct single track errors during tape reading. Conventional error recovery routines are applied for all other errors.

Read Backward: As with the 2401, tapes written on any 2400-series tape unit can be read by any other 2400-series tape unit either backward or forward, provided the writing and reading units operate with the same tape density and format. However, the data conversion feature cannot be used when reading seven-track tape backwards.

Quick-Release Latches: Each tape unit has quick-release latches to facilitate the mounting and removing of tape reels.

Optional Features

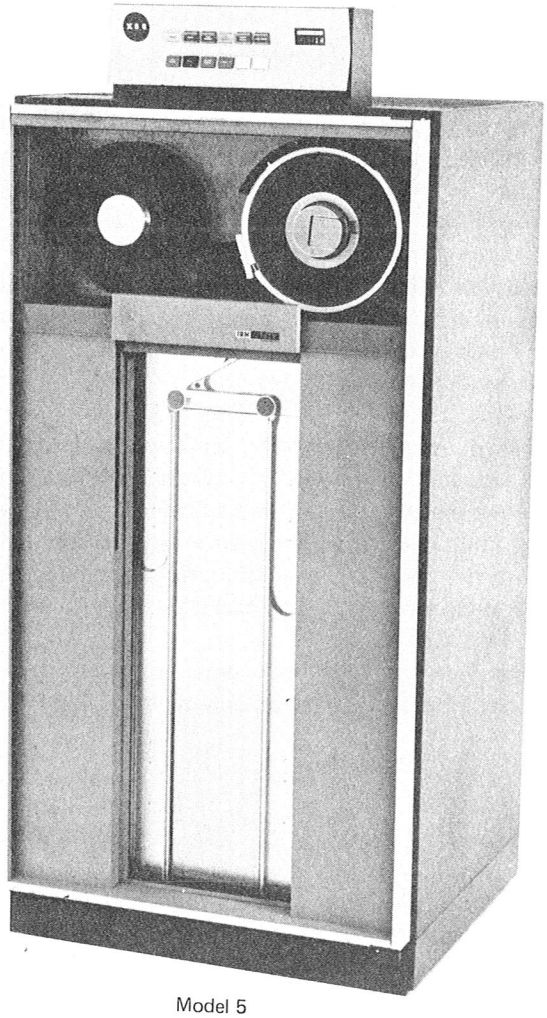
Seven-Track, Nine-Track, or Seven-and-Nine-Track Compatibility: These features are basically the same as those available for the 2803 and 2804 Tape Controls. Attachment of any one of these three on a 2415 precludes attachment of the others. Seven-track compatibility enables the 2415 tape unit to write or read seven-track tape; this provides

compatibility with tapes used by devices such as the IBM 727, 729, and 7330 Magnetic Tape Units. Nine-track compatibility enables the 2415 tape unit to write or read 800-bpi NRZI tapes in addition to 1,600-bpi tapes. Seven-and-nine-track compatibility (available only on Models 4, 5, and 6) satisfies the requirements of both of the other two features by permitting reading and writing both seven- and nine-track 800-bpi NRZI tapes.

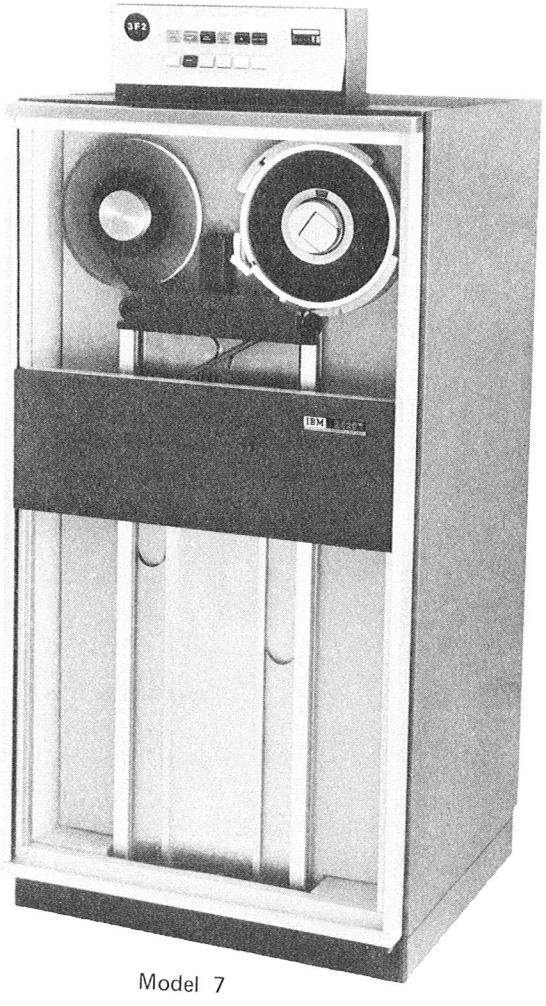
Data Conversion: This feature is the same as the data conversion feature available for the 2803 Tape Control. This program-controlled feature permits seven-track tape units to read and write data in binary form rather than binary-*coded* form. On a write operation, three 8-bit bytes are converted to four 6-bit tape characters; on a read operation, the sequence is reversed. This feature cannot be used when reading seven-track tapes backwards.

2420 Magnetic Tape Unit Models 5 and 7

The IBM 2420 Magnetic Tape Unit (Figure 7-26), which reads and writes at 1,600 bpi, offers increased reliability, speed, and convenience to System/370 users. It does this with features such as cartridge loading, automatic tape threading, and an advanced tape transport.



Model 5



Model 7

Figure 7-26. IBM 2420 Magnetic Tape Units Models 5 and 7

Cartridge Loading

An optional accessory of the 2420 is the Wraparound Cartridge (Figure 7-27) for standard 10½-inch reels. The cartridge protects tape from dust and the hazards of handling and eliminates reel positioning. Once the cartridge is mounted, the tape automatically threads, feeds, and rewinds on command. The cartridge-enclosed tape reels can be used interchangeably with standard reels and may be removed from the cartridge for use on other 2400-series tape units.

Automatic Threading and Rewind

The 2420 provides reduced setup time because of automatic threading. The only requirements are that the free end of the tape be properly trimmed and that it be positioned on the threader chute. The tape is automatically threaded through the tape path from the supply reel to the take-up reel, loaded into the vacuum columns, and positioned at the load point. This operation takes less than 10 seconds. Tape is rewound in the vacuum column at approximately 500 inches per second; therefore, a 2,400-foot reel can be rewound in about 1 minute. Rewind time for less than 2,400 feet of tape is approximately proportional to the amount of tape to be rewound; for example, 1,200 feet of tape is rewound in about 30 seconds and 600 feet is rewound in about 15 seconds.

Figure 7-27. IBM 2420 Magnetic Tape Unit Model 7 with Wraparound Cartridge

Advanced Tape Transport

The tape transport for the 2420 uses a minimum number of mechanical parts, thereby increasing reliability and reducing tape wear. A single drive capstan moves the tape forward and backward across the read/write head while the oxide surface of the tape touches only the read/write head and the tape cleaner. During rewind operation, the tape remains in the vacuum columns, resulting in less stress on the tape.

Other Standard Features

Other features of the 2420 are: parity and amplitude checking, phase-encoded method of recording data, powered access window and quick-release latch.

Parity is checked during both tape reading and writing; signal amplitude is checked (against a predetermined threshold level) during tape writing.

Phase-encoded recording permits single track errors (the most common type) to be corrected in flight, resulting in improved throughput. Multiple track errors are indicated to the program. An added benefit is the interchangeability of the phase-encoded tapes among Models 4-6 of the 2401-2415 tape units, as well as Models 5 and 7 of the 2420 Magnetic Tape Unit.

The power window and the quick-release latch facilitate operator functions. The power window closes automatically during a load operation and opens automatically following the completion of a rewind-and-unload command. The quick-release facilitates the mounting and removal of the tape reel and cartridge.

Tape Control and Unit Switching

A 2803 Tape Control Model 2 (with a serial number above 14000 but below 30000 and with the appropriate 2420 attachment feature) can control as many as eight tape units

in any combination of 2420 Models 5 and 7 and 2401 Models 4-6. With additional features, 2401 Models 1-3 can be included in this combination. Switching among these units is provided by the 2816 Switching Unit Model 1.

2803 Tape Control Models 1, 2, and 3; 2804 Tape Control Models 1, 2, and 3

The IBM 2803 and 2804 Tape Controls (Figure 7-28) can both handle as many as eight tape units. The 2803 is a one-channel control unit and requires one control-unit position on a channel. The 2804, however, is a two-channel control unit and requires one control-unit position on each of two channels. The 2804 attaches to two channels in a manner that permits a read operation on one tape unit to be overlapped with a simultaneous write operation on another unit.

The two units are each available in three models:

Model 1 of the 2803 and 2804 controls units of 2401 Models 1-3.

Model 2 of the 2803 and 2804 also controls units of 2401 Models 1-3, provided the 2803 or 2804 is equipped with either the nine-track or seven-and-nine-track compatibility feature. In addition to this, the Model 2 of the 2803 and 2804 controls units of 2401 Models 4-6. Model 2 of the 2803 can also control units of 2420 Models 5 and 7, provided the 2803 has a serial number 14001-29999 and is equipped with a 2420 attachment.

Model 3 of the 2803 and 2804 controls units of 2401 Model 8 only.

Optional Features

Seven-Track Compatibility: This feature enables a 2401 Model 1-3 to write or read seven-track tape at 200, 556, or 800 characters per inch; this provides tape compatibility with devices such as the IBM 729 and 7330 Magnetic Tape Units. The seven-track compatibility feature is required if any attached 2401 (Models 1-3) has a seven-track head. As part of the feature, a code translator is included to translate the BCD interchange code to EBCDIC.

Nine-Track Compatibility: In keeping with the flexibility that provides for any practical variation in requirements, an optional nine-track compatibility feature is available for Model 2 of the 2803 and 2804 to allow the reading and writing of nine-track tape at 800 bpi as well as 1,600 bpi. This feature is required when:

1. Any attached 2401 (Models 1-3) has a nine-track head.
2. Any attached 2401 (Models 4-6) has the dual-density feature.

Seven- and Nine-Track Compatibility: The seven-track and nine-track compatibility features are mutually exclusive on the same tape control. However, instead of either feature, an optional seven- and nine-track compatibility feature can be installed on Model 2 of the 2803 or 2804 to provide all the advantages of both features.

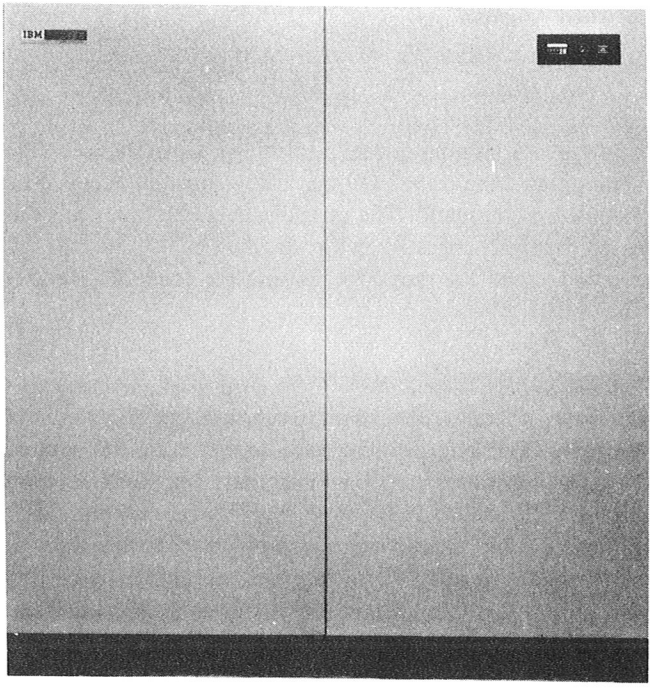


Figure 7-28. IBM 2803 or 2804 Tape Control

Sixteen-Drive Addressing (2803 Models 1 and 2): This feature enables a 2803 to address as many as sixteen 2401 Magnetic Tape Units that are attached to the 2803 through 2816 Switching Unit Model 1's. This feature is not needed unless a 2803 must have the capability of addressing more than eight tape units.

Data Conversion: This program-controlled feature, available to tape controls with seven-track compatibility, permits seven-track tape units to read and write data in binary form rather than binary-coded form. On a write operation, three 8-bit bytes are converted to four 6-bit characters; on a read operation, the sequence is reversed. This feature cannot be used when reading seven-track tapes backwards.

2420 Attachment (2803 Model 2): When equipped with this feature the 2803 can attach and control any combination of 2420 Models 5 and 7 and 2401 Models 4-6 that does not exceed eight. (2401 Models 1-3 can be included in this combination if appropriate features are installed on the 2803 Model 2.) Field installation of the 2420 attachment can be made only on a 2803-2 with a serial number above 14000 but below 30000.

2816 Switching Unit Model 1

The IBM 2816 Switching Unit (Figure 7-29) provides a means of assigning a common group of magnetic tape units to more than one tape control, thus allowing still more

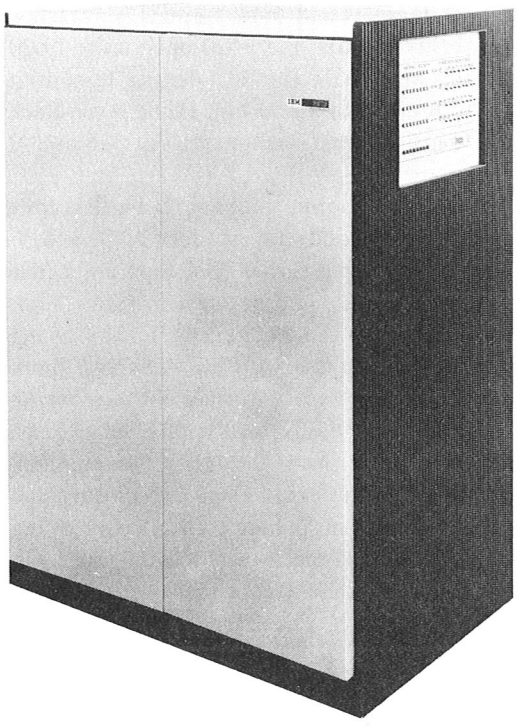


Figure 7-29. IBM 2816 Switching Unit

flexibility in tape configurations and the minimizing of such configurations: for instance, by allowing a control to have access to a tape unit that is attached to another control. The 2816 introduces other advantages, including such unbalanced sort operations as three inputs to six outputs or vice versa, with the consequent minimum of time for manual mounting and demounting of reels.

With the 16-drive addressing feature installed on the appropriate tape controls and the use of two IBM 2816 Switching Units, a maximum of 16 tape units may be controlled in common by a maximum of four tape controls. The minimum is control of four tape units by two tape controls; any combination between the minimum and maximum is available. For more than eight tape units, the second switching unit is required. The switching of tape units on the 2816 is completely under program control, on a per-record basis.

Model 1 of the switching unit is used for switching tape units in any mixture of 2401 Models 1-6 and 2420 Models 5 and 7; however, the 2816 requires a tape unit intermix feature for switching 800-bpi tape units to a 2803 Model 2.

The tape controls involved must be either 2803 Model 1 or 2803 Model 2; the 2816 cannot switch both Models 1 and 2 on the same system.

If the 16-drive addressing feature is not installed on a tape control, it can control only the first eight tape units in the tape pool.

3410 Magnetic Tape Unit Models 1, 2, and 3; 3411 Magnetic Tape Unit and Tape Control Models 1, 2, and 3

- Data rates from 20 to 80 kilobytes/second.
- Compact design.
- Monolithic circuitry.
- Table-height horizontal transport deck.
- Simplified tape-threading path.
- Push-pull quick release latch.
- Extended diagnostic capabilities.
- Independent tape-unit attachment.
- Single- or dual-density operation.

The 3410 and 3411 (Figure 7-30), both available in three models, provide data rates between 20 and 80 kilobytes per second. Both the 3410 and 3411 are desk-height units with tapes mounted horizontally rather than vertically. A transparent sliding cover, similar to the cover of a roll-top desk,

Figure 7-30. IBM 3410 Magnetic Tape Unit Model 1, 2, or 3

provides easy access to the tape reels. A simplified tape-threading path and a push-pull quick release latch (for faster mounting and removing of the tape supply reel) further increase ease of operation.

The two units look alike, and each contains one tape unit, but the 3411 also contains the common control unit and power supply. The 3411-1 can attach up to three 3410-1's, the 3411-2 up to five 3410-2's, and the 3411-3 up to five 3410-3's.

The diagnostic capabilities permit normal servicing to be done from the front, and internal cables between the tape units and the tape control eliminate under-the-floor cables. Both these features allow the units to be placed side by side and close to walls, thereby allowing better use of space. Additionally, the method of attaching a 3410 to a 3411 (radial attachment) allows a 3410 to be taken out of operation for maintenance without changing cables or interrupting any of the other units.

For Models 2 and 3 of both the 3410 and 3411, the dual-density feature is available. This feature allows these nine-track units to read and write in either 800-bpi (NRZI) or 1,600-bpi (PE) mode. This feature is especially useful in library conversion and for data interchange between systems. Where only 1,600-bpi operations are performed, the single-density feature is required.

Single track read errors are corrected in flight in 1,600-bpi operation, and track-in-error correction is provided for nine-track 800-bpi operation. Parity is checked during both reading and writing, and signal amplitude is also checked during writing.

3420 Magnetic Tape Unit Models 3, 5, and 7
3803 Tape Control Model 1

- Data rates from 120 to 320 kilobytes/second (in 1,600-bpi operation).
- Single- or dual-density operation.
- Automatic tape reel latching.
- Automatic tape threading.
- Rewind time as low as 45 seconds for 2,400-foot reel.
- Monolithic circuitry.
- Extended diagnostic capabilities.
- Economical tape-unit switching.
- Independent tape-unit attachment.

3420 Magnetic Tape Unit

The 3420 (Figure 7-31), available in three models, offers a range of data rates to better meet the needs of users. For example, Models 3, 5, and 7 have data rates of 120, 220, and 320 kilobytes per second, respectively, in 1,600-bpi operation.

A choice of tape densities and track formats is available. With the single-density feature, the 3420 operates at 1,600 bpi with nine-track tape. With the dual-density feature, it can operate at both 800 and 1,600 bpi. If the seven-track feature is installed instead, the 3420 operates at 556 or 800 bpi on seven-track tape.

Each 3420 model has a shorter nominal read-access time (4.0, 2.9, and 2.0 milliseconds for Models 3, 5, and 7, respectively) than comparable earlier IBM tape units. The time savings can significantly improve system throughput.

Several features built into the 3420 ensure reliability and make it especially easy to use. A *pneumatic reel latch* automatically locks the tape reel in place. With *automatic threading,* an operator can easily load a tape in seconds. *Optical tachometers,* built into the drive, sense small variations in the speed of the capstan and reel motors, and generate corrective signals. This precise control is one of the keys to the 3420's fast read-access and rewind times. On the 3420-7, for example, a 2,400-foot reel of tape can be rewound in only 45 seconds. The 2420-7, in comparison, requires 60 seconds.

Tape wear and contamination are minimized by extensive use of air bearings and surface treatments. The path that the tape takes through the drive, from reel to reel, allows the recording side of the tape to touch only two surfaces: the tape cleaner and the read/write head.

3803 Tape Control

The 3803 (Figure 7-31) is half the size of earlier control units and uses monolithic circuitry for all its logic and control functions. Its monolithic read-only control storage contains all the information needed to coordinate efficient operation of the 3420's. This control storage also provides diagnostic capabilities that can quickly pinpoint problems.

Via radial attachment, up to eight 3420's can be connected to a 3803 in a way that allows a 3420 to be taken out of operation for maintenance without changing cables or interrupting any of the other units. (Earlier IBM tape units are connected to their control unit serially through adjacent units.)

The 3803 has a *tape-switching* feature that permits as many as sixteen 3420's to be switched among two, three, or four 3803's. This capability, which does not require a separate unit, permits one or more CPU's through multiple control units, to access tape units that otherwise might not be available to them.

With the two-channel switch, the 3803 can attach to a second channel and can therefore switch between two channels under program control.

Features corresponding to those determining the 3420's operating tape densities and track formats (that is, single density, dual density, and seven-track) are also required for the 3803.

Figure 7-31. IBM 3420 Magnetic Tape Unit Model 3, 5, or 7 and IBM 3803 Tape Control Model 1

Magnetic Tape Unit		Data Rates (kilobytes/sec)				Tape Speed (inches/sec)	Nominal Read Access Time* (millisec)	Nominal Interblock Gap (inch)		Nominal Interblock-Gap Time (millisec)		Rewind Time (sec) (2400' reel)	Rewind and Unload Time (sec) (2400' reel)
No.	Model	at 200 bytes/inch (7-track NRZI)	at 556 bytes/inch (7-track NRZI)	at 800 bytes/inch (7- or 9-track NRZI)	at 1,600 bytes/inch (9-track PE)			7-track	9-track	7-track	9-track		
2401	1	7.5	20.85	30	--	37.5	10.8	0.75	0.6	20	16	180	132
	2	15	41.7	60	--	75	6.4	0.75	0.6	10	8	84	90
	3	22.5	62.5	90	--	112.5	5.2	0.75	0.6	6.6	5.3	60	66
	4	--	--	--	60	37.5	10.8	--	0.6	--	16	180	132
	5	--	--	--	120	75	6.4	--	0.6	--	8	84	90
	6	--	--	--	180	112.5	5.2	--	0.6	--	5.3	60	66
	8	15	41.7	60	--	75	8.4	0.75	--	10	--	84	90
2415	1-3	3.75	10.425	15	--	18.75	11.5	0.75	0.6	40	32	240	240
	4-6	3.75	10.425	15	30	18.75	12.8	0.75	0.6	40	32	240	240
2420	5	--	--	--	160	100	3.9	--	0.6	--	6	72	78
	7	--	--	--	320	200	2.5	--	0.6	--	3	60	66
3410/3411	1	--	--	--	20	12.5	15	--	0.6	--	48	--	180
	2	--	--	20	40	25	12	--	0.6	--	24	--	180
	3	--	--	40	80	50	6	--	0.6	--	12	--	120
3420	3	--	41.7	60	120	75	4	0.75	0.6	10	8	70	76
	5	--	69.5	100	200	125	2.9	0.75	0.6	6	4.8	60	66
	7	--	111.2	160	320	200	2	0.75	0.6	3.75	3	45	51

* The read access time is the interval of time from the beginning of a forward read, when the tape is not at load point, until the first data byte is read after the tape is brought up to speed from a stopped state. The times given for the 2401 and 2415 are estimates for a properly adjusted unit.

Figure 7-32. Comparison of Characteristics of IBM Magnetic Tape Units

Magnetic Tape Cartridge Devices

2495 Tape Cartridge Reader

The IBM 2495 Tape Cartridge Reader (Figure 7-33) transfers data stored on magnetic tape cartridges to an IBM System/370. The 2495 is program-controlled and reads tape-stored data at 900 characters per second; each character is parity-checked as it is transferred to the channel. As many as 12 tape cartridges, each containing 100 feet of 16-millimeter sprocketed magnetic tape, can be loaded into the 2495 feed (autoloader) at one time. Each tape can hold up to 23,000 characters of information (equivalent to about 300 fully punched cards). The 2495 accepts cartridges generated on either the IBM 50 Magnetic Data Inscriber or the IBM Magnetic Tape SELECTRIC® Typewriter (MT/ST) System.

Initially, the tape cartridges are placed in the autoloader. When the start button is pressed, the first cartridge is mounted in the tape read station and is prepared for reading.

Each subsequent cartridge is automatically loaded. Tape is read and rewound at about 45 inches per second under program control. After a tape has been read and rewound, it is automatically unloaded, placed in the stacker, and the following cartridge is loaded—all within approximately 5 seconds.

The IBM 50 Magnetic Data Inscriber, an independent device, records information in System/370-compatible code on nine tracks across the width of 16-millimeter tape. It uses cartridges that are physically similar to those used with the IBM MT/ST System; because of differing magnetic properties, however, the tapes are not to be used interchangeably. On the IBM 50, information is magnetically inscribed on tape by means of a keyboard similar to that of an IBM card punch. The operator can select from as many as eight data formats from a pre-punched program card. The IBM 50 will also verify tapes made on other IBM 50 units.

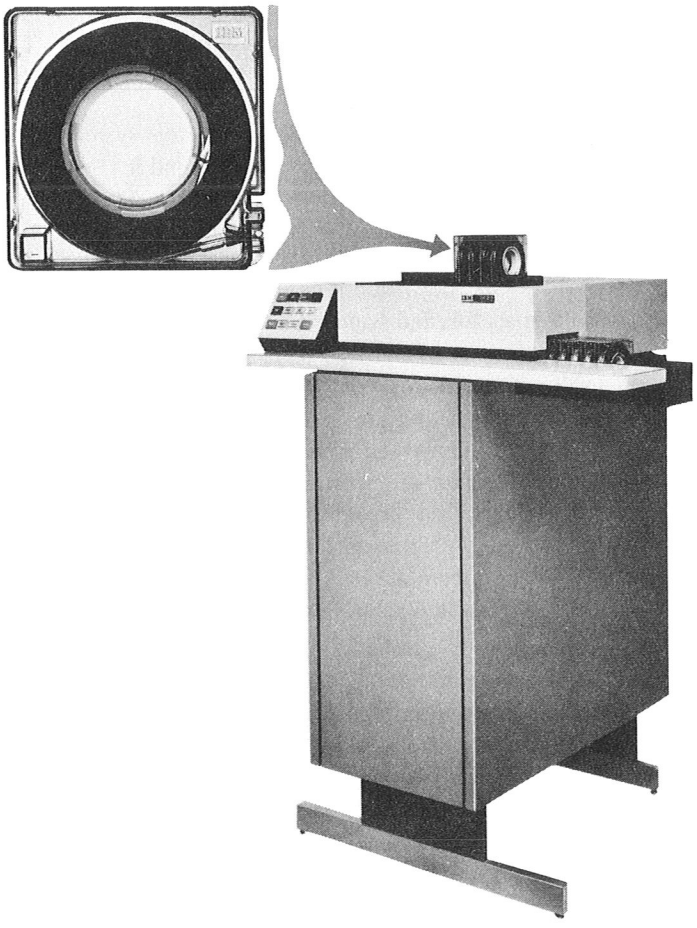


Figure 7-33. IBM 2495 Tape Cartridge Reader and Magnetic Tape Cartridge

1052 Printer-Keyboard Model 7

The IBM 1052 Printer-Keyboard (Figure 7-34) can be attached to the system for communication between the operator and the system (for example, such operator-program changes as program checking or correcting and job logging). Facilities are provided for interrupting the CPU and for signalling the end of the operator's transmission.

The typewriter-style keyboard and the printing function can be used independently—the keyboard for system input and the printer for computer output. The 1052 has a stationary carriage and a spherical, interchangeable printing element.

The nominal speed of the Model 7 is 15.5 characters per second. Line spacing is set at 6 lines per inch and character spacing is set at 10 characters per inch. The maximum line length is 12.5 inches, for up to 125 characters.

The 1052 attaches to a System/370 channel via a 1052 adapter, which can be installed within an IBM 2150 Console. The 1052 requires a control-unit position on the channel.

2150 Console

The IBM 2150 Console provides the System/370 with a duplication of the operator's controls at a station removed from the CPU (Figure 7-35). A location is provided on the freestanding 2150 for mounting one or two operator control panels.

The 2150 Console includes an operator's chair, a program-controlled audible alarm, and an adapter for the IBM 1052 Printer-Keyboard Model 7.

Figure 7-34. IBM 1052 Printer-Keyboard

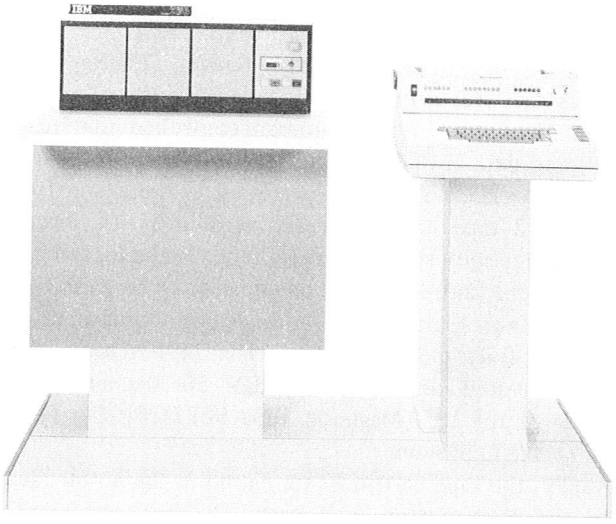


Figure 7-35. IBM 2150 Console and 1052 Printer-Keyboard

3210 Console Printer-Keyboard Models 1 and 2

The IBM 3210 Console Printer-Keyboard Model 1 permits communication between the system and the operator. The printer-keyboard can also interrupt the CPU and signal the end of the operator's transmission.

The printer-keyboard is mounted on the system table with a form stand located on the floor behind it.

The typewriter-style keyboard contains 44 character keys, Shift, Lock, New Line keys, and a Space Bar that manually perform the usual typewriter functions. In addition, there are keys and lights provided for generating control signals for, and signaling answers from, the CPU.

The printer, a low-profile IBM SELECTRIC® Printer especially adapted for the 3210, uses a spherical print element having 88 graphic characters, any of which may be printed either from the system or manually from the keyboard. The characters have an optimized arrangement on the element that permits minimal machine wear. The machine uses a fabric ribbon in a standard Selectric cartridge, and operates at approximately 15.5 characters per second (about 64.5 milliseconds per character) when either printing or spacing. Carrier return speed is about 15 inches per second.

In addition to printing, the printer provides spacing, carrier-return, indexing, and shifting functions.

The printer uses a 15-inch carriage, featuring a pin-feed platen for positive feeding of marginally punched forms. This platen accommodates a maximum of one original and five carbon copies of pin-feed forms having a hole-to-hole width of 13-1/8 inches. Vertical line spacing is six lines per inch when single spacing, or three lines per inch when double spacing. The horizontal print line is 12.5 inches long, equalling 125 characters per line.

The 3210 Model 2 (Figure 7-36) has all of the basic features of the Model 1, but is used some distance from the central processing unit.

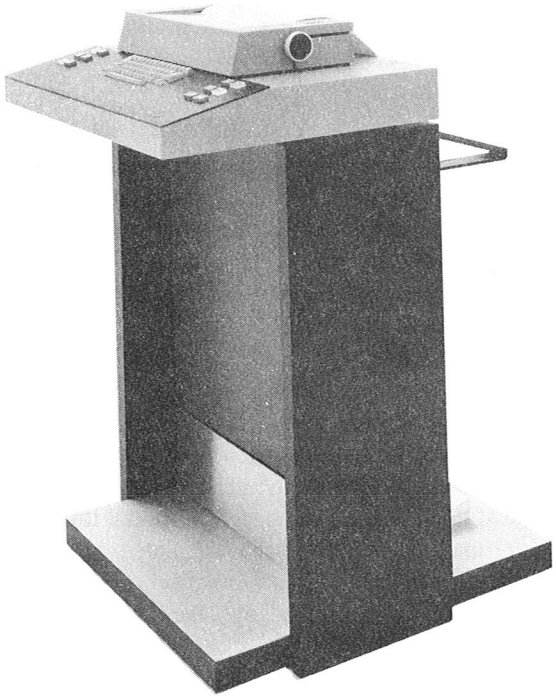


Figure 7-36. IBM 3210 Console Printer-Keyboard Model 2

3215 Console Printer-Keyboard

The 3215 Console Printer-Keyboard (Figure 7-37) permits communication between the system and the operator, and provides printed output. Under program control, printing occurs at up to 85 characters per second, depending on the system. Character spacing is 10 characters per inch and up to 126 characters per line. Both left and right margins are fixed according to the platen width used. Vertical single spacing is six lines per inch; double spacing is three lines per inch.

All power, control, and data signals come from the central processing unit. The 3215 prints 26 alphabetic, 10 numeric, and up to 29 special characters from Extended Binary Coded Decimal Interchange Code (EBCDIC).

Other unique graphics are available to accommodate language and special character needs.

All functions of the 3215 are controlled by the system either manually or by program control: printing, spacing, carrier-return, and vertical spacing.

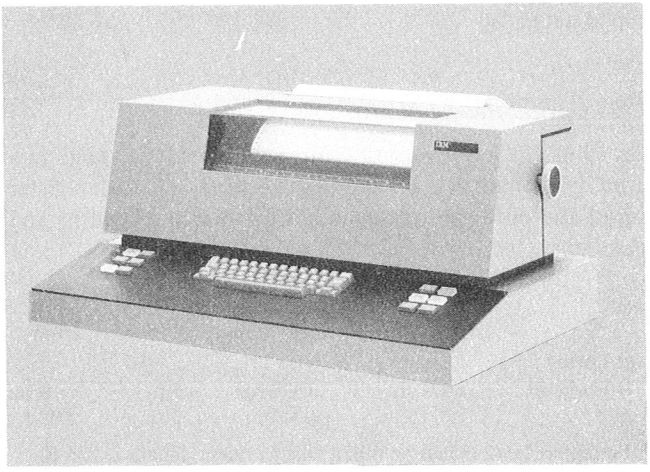


Figure 7-37. IBM 3215 Console Printer-Keyboard

Optical Readers

1287 Optical Reader Models 1, 2, 3, and 4; 1288 Optical Page Reader Model 1

The IBM 1287 Optical Reader (Figure 7-38) and the 1288 Optical Page Reader (Figure 7-39) can read data from documents with different formats, orientations, types of data, and field lengths. The 1287 and 1288 can eliminate the need for several input conversion steps (for example, card punching, verifying, and taping), thereby providing substantial reductions in data preparation costs and improving overall system efficiency.

The 1287 or 1288 enables the data of source documents to be organized in fixed- or variable-length fields, in columns or rows, and to be read in any sequence. With special features, the 1287 and 1288 can read hand-printed and pencil-marked data, in addition to machine-printed or typed data.

1287 Optical Reader Models 1, 2, 3, and 4

The IBM 1287 is a versatile optical reader; it can read data from both journal rolls (adding-machine and cash-register tapes) and cut-form documents, in a variety of widths and lengths:

	Width		*Length*	
	Min.	*Max.*	*Min.*	*Max.*
Cut-Form Documents	2-1/4 in.	3-1/2 in.	3 in.	9 in.
Tapes	1-5/16 in.	4-1/2 in.	3 ft.	200 ft.*

*If a tape is 3-1/2 inches or wider, the maximum length is 175 ft.

Rates of Processing Data (Throughput): The speed of document processing depends primarily on the size of each document and the number of characters and fields to be read, and is calculated from formulas. Other variables are the type of data being read (machine-printed, hand-printed, or pencil-marked), printed-character registration or alignment, use of on-line correction, and the organization of the processing program.

Typical rates are approximately 665 three-inch documents per minute (reading one field of 20 machine-printed characters) and approximately 100 six-inch documents per minute (reading 50 fields of hand-printed characters).

Journal-roll throughput depends primarily on the number of characters per line and the number of lines per inch. For example, a cash-register tape 2 inches wide with four 10-character lines per inch can be read at about 3,300 lines per minute.

The optimum tape reading speeds can be calculated from a formula that takes into consideration factors such as the tape width, the number of lines per inch and characters per line, the type style, and the margin width. Actual throughput, however, may be less than the calculated optimum because of factors such as on-line correction, line rescan, marking of lines containing unreadable characters, and the user's program.

Character Recognition: The 1287 reads alphameric type and symbols that are compatible with both the American National Standard Character Set for Optical Character Recognition (ANSCS OCR) font Size A and the International Standards Organization Standards on Optical Character Recognition font (ISO OCR-A Size 1).

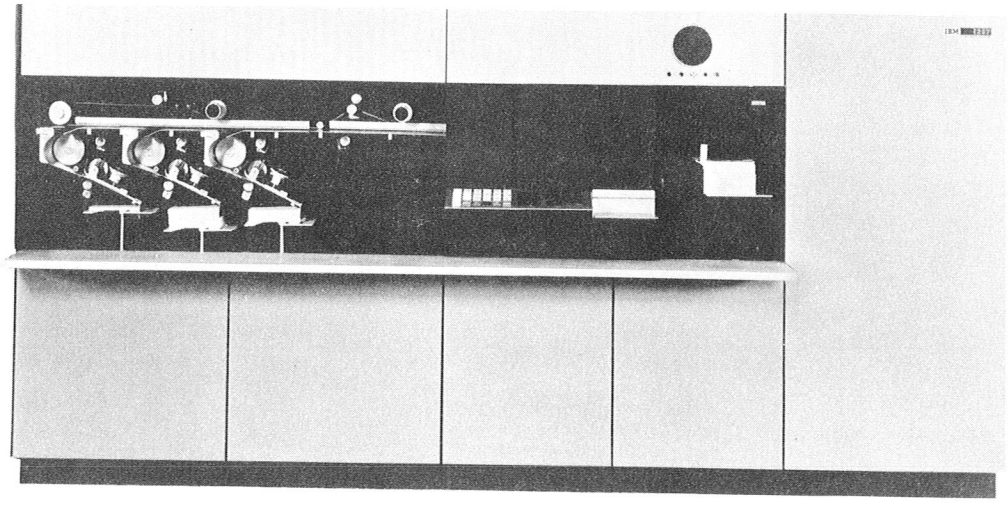


Figure 7-38. IBM 1287 Optical Reader

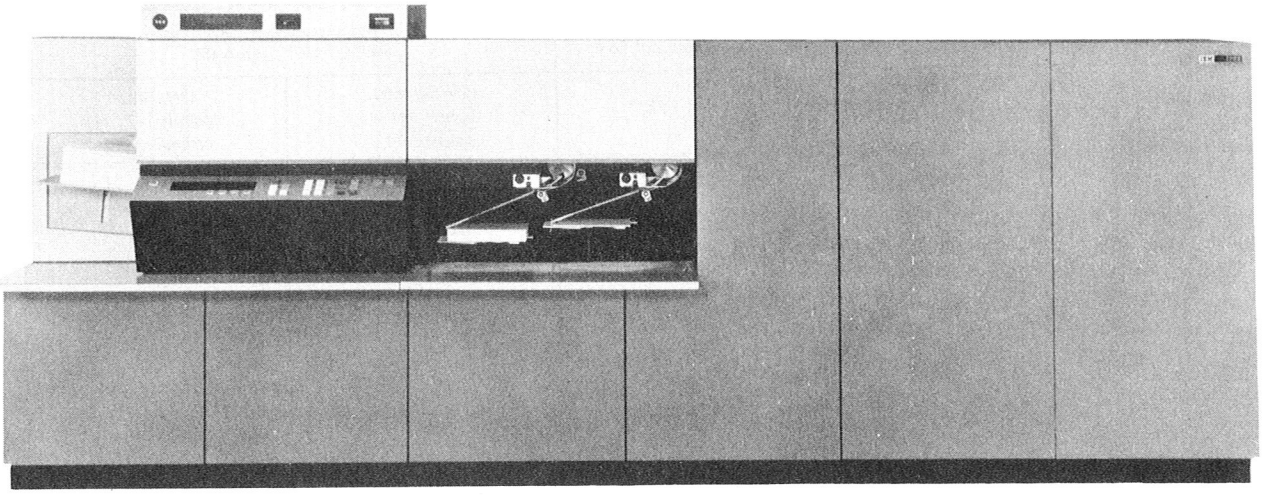


Figure 7-39. IBM 1288 Optical Page Reader

The 1287 has a selection of fonts to choose from (Figure 7-40). It can have either the IBM 1428 font or the ANSCS OCR numeric font subset sizes A and C as a standard feature, or the two together as a special feature. Other fonts and features that may be added to provide the 1287 with expanded reading capability include:

NCR Optical Font (NOF)
Farrington Selfchek* 7B font
Numeric handwriting
Optical mark reading
Expanded symbol set

When the combined 1428 and ANSCS OCR fonts feature is used, the 1287 can read each font separately in pre-identified fields in a document. Selection of the font to be read for a specific field or document type is under program control; however, when journal rolls are read on Models 2 and 4, font selection (1428 or ANSCS OCR-A) is under operator control.

The NCR Optical Font (NOF) feature permits 1287 Models 2 and 4 to read journal tapes written in NOF. The reading of this type style and IBM 1428 or ANSCS OCR-A type style is interchangeable and is controlled by the operator.

Farrington Selfchek 7B font feature permits reading characters imprinted on documents by credit plate imprinters.

The numeric handwriting feature permits the 1287 to read handprinted numbers and letters (0-9 and C, S, T, X, and Z, blockprinted with a No. 2 pencil or with HB lead), and numbers preprinted in Gothic 3/16" font.

*Trademark of the Farrington Manufacturing Company

Optical mark reading permits the 1287 to recognize penciled lines entered as data. The marks (made with a No. 2 pencil) may be vertical, slanted 45 degrees, or horizontal.

The expanded symbol set increases the reading capability of 1287 Models 3 and 4 by enabling them to read the following symbols created by the IBM SELECTRIC® typewriter or its equivalent:

+ = [ ] % ? " '

When the 1287 encounters a character it does not recognize, it automatically initiates a rescan. If the character is not recognized after 10 rescans, the 1287 either displays the character on a cathode-ray tube for keyboard (online) correction by the operator, or bypasses the character and sends a substitute character to storage for later (offline) correction, then goes to the next character. When journal rolls are read on Models 2 and 4, the operator can correct unrecognizable characters online, or the lines containing unrecognizable characters are marked for offline correction.

Serial Numbering: An optional serial numbering feature permits the 1287 to number documents sequentially from 00000 to 99999; however, the printing is not suitable for reading by the machine. The feature uses a ten-position numbering head. The first five numbers are for repetitive printing of items (such as dates and batch number); the other five numbers may be set either to repeat a given set of numbers or to number sequentially. Documents smaller than 3 inches wide by 4.75 inches long cannot be processed by machines having this feature. The operator controls which documents will be numbered.

1287 Standard Font	1287 Standard Font		1287 Optional Font	1287 Optional Font	1287 Models 3 and 4, and 1288 ANSCS OCR Size A (5)	
IBM 1428 Font	ANSCS OCR		NOF*	7B**	IBM Selectric Typewriter or Equivalent	IBM 1403 Models 1-7, N1 or Equivalent
	Size A	Size C				
0 1 2 3 4 5 6 7 8 9 C N S T X Z I (1) ⌿ (2) blank	0 1 2 3 4 5 6 7 8 9 C N S T X Z (4) I (1) blank (3)	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9 b p d Y H M blank	0 1 2 3 4 5 6 7 8 9 blank (3)	0 A N : 1 B O ; 2 C P . 3 D Q , 4 E R / 5 F S - 6 G T * 7 H U $ 8 I V & 9 J W | Y K X — Z L Y M Z blank Expanded Symbol Set + % = ? { ' } "	0 A N 1 B O 2 C P . 3 D Q , 4 E R / 5 F S - 6 G T * 7 H U $ 8 I V & 9 J W Y K X Z L Y M Z blank

*NCR Optical Font shown by permission of National Cash Register Co.
**7B shown by permission of Farrington Manufacturing Co.

(1) Recognized on cut-form documents only.
(2) Recognized on journal rolls only.
(3) No blanks are transmitted in either ANSCS OCR Size C or Farrington 7B font.
(4) In ANSCS OCR Size A font, the characters C,N,S,T,X, and Z are available for use on journal rolls only.
(5) ANSCS OCR Size A is usable only on cut-form documents on the 1287 Model 4.

NOTE: Characters and symbols are shown reduced in size.

Figure 7-40. Characters and Symbols Acceptable by IBM 1287 or 1288

Model Differences: Model 1 can read documents having as many as 24 lines of printed data from each document, each line having as many as 88 characters.

Model 2 performs the same functions as Model 1, and in addition can read 38 characters per line from continuous rolls of paper, such as cash-register or adding-machine tapes. The Model 2 is designed for easy changeover from documents to journal rolls (or vice versa) in seconds. In journal roll reading, the rolls are threaded automatically, and the operator can control the fields to be scanned by setting a dial.

Models 3 and 4 differ from Models 1 and 2 in that they have the added capability of reading the ANSCS OCR-A font produced by a SELECTRIC® typewriter or an IBM 1403 Printer.

Document Flow: The input hopper of the 1287 can hold a 12-inch stack of documents, and the three output stackers can each hold 4 inches of documents. Each document is fed to the read station; from there the program sends it to one of the three output stackers, one of which is normally reserved for documents containing unrecognizable characters. The machine can be adjusted to overflow automatically between the other two stackers to extend the length of document runs without stopping to remove or adjust the stacker contents. All documents are automatically counted.

1288 Optical Page Reader Model 1

The IBM 1288 Optical Page Reader (Figure 7-39) reads data from cut-form documents that range in size from 3 by 6.5 inches to 9 by 14 inches. Because the 1288 can read mixed data from documents smaller than punched cards and as large as legal-size forms, it can be used in a variety of applications in government, business, and industry.

Rates of Processing Data (Throughput): The speed of document processing depends primarily on the size of each document, the format (if any), and the organization of the processing program, and is calculated from formulas which take these factors into consideration. Typical throughputs are approximately 328 forms per minute for punched cards with 12 characters on each of two lines, and approximately 14 per minute for 8½-by-11-inch (letter-size) documents with 65 characters on each of 50 lines.

Character Recognition: The 1288, like the 1287, reads symbols and alphameric characters compatible with the ANSCS OCR-A and ISO OCR-A Size 1 fonts. The machine's reading capability may be expanded with special features, such as the numeric handwriting feature, the optical mark reading feature, and the expanded symbol set, all described previously for the 1287.

Whenever the 1288 encounters a hand-printed character that it does not recognize, it automatically rescans the character. If the character remains unreadable, then the 1288 transmits a substitute character to the central processing unit and ejects the document (under program control) into one of two stacker pockets for offline correction.

Serial Numbering: This feature, described previously for the 1287, is also available with the 1288. The smallest document that can be numbered on a 1288 with this feature is 3 by 6½ inches, the minimum document size handled by the 1288.

Format Flexibility: The 1288 can process both formatted and unformatted documents. In formatted mode, under program control, the 1288 reads fixed- and variable-length fields in any sequence. In unformatted mode, however, the machine reads multiple and continuous variable-length lines of alphameric data, up to six lines per inch, right- or left-justified.

Document Flow: The input hopper of the 1288 can hold a 10-inch stack of documents, and the two output stackers can hold either a 4½-inch stack of short documents or a 3-inch stack of long documents. Each document, after being read, is sent (under program control) to one of the two output stackers, one of which is normally reserved for documents containing unrecognizable characters.

Printers

1053 Printer Model 4

The IBM 1053 Printer is a small unit similar to the IBM 1052 Printer-Keyboard (Figure 7-34) but has the printer function only and no keyboard for entry of data. The 1053 prints at 14.8 characters per second.

The 1053 connects to a system via the IBM 2848 Display Control for printout in a display application. (See "2260 Display Station.")

1403 Printer Models 2, 7, and N1

Three different models of the IBM 1403 Printer (Figures 7-41 and 7-42) can be attached to the System/370:

Printer Model	*Printing Positions*	*Maximum Rated Speed (Lines Per Minute)*
1403-2	132	600
1403-7	120	600
1403-N1	132	1,100

Models 2 and N1 can operate at still higher speeds with the universal character set feature, described later.

The 1403 is controlled and buffered by the 2821 Control Unit, which also provides the attachment to a channel. One, two, or three 1403's can be controlled by each 2821, depending on the 2821 model. (See "2821 Control Unit Models 1-3, 5, and 6.")

Models 2 and 7 use a chain of linked characters for printing, and the Model N1 uses a train of characters not linked together. As an optional feature, an interchangeable chain cartridge adapter is available for the Models 2 and 7. (At least one IBM 1416 Interchangeable Train Cartridge is required for each Model N1.) Either cartridge adapts the 1403 for quick and convenient changing of type fonts or character arrangements for special printing jobs.

Characters are printed ten to the inch, and lines are spaced either six or eight to the inch under operator control. An auxiliary ribbon-feeding special feature adapts the Models 2 and 7 for the use of polyester ribbons, which give sharper impressions. This feature is standard on the Model N1.

The Model 7 is the only model that does not have a dual-speed carriage—a feature that provides high-speed skips at 75 inches per second when skipping is more than eight lines. Skipping speed on the Model 7 is 33 inches per second.

The 1403 Model N1 (Figure 7-42) differs from the other models in featuring sound-absorbent covers extending to the floor, power-operated front and top covers, and a forms cart.

The selective tape listing feature and the universal character set feature are available for Models 2 and N1.

Selective Tape Listing

The selective tape listing feature provides the capability of substituting longitudinal strips for the normal paper sheet forms. Four 3.1-inch tapes, eight 1.5-inch tapes, or a combination of these less than 13.2 inches wide, may be printed. Up to 29 characters can be printed on a 3.1-inch tape, or up to 13 on a 1.5-inch tape. Each tape is

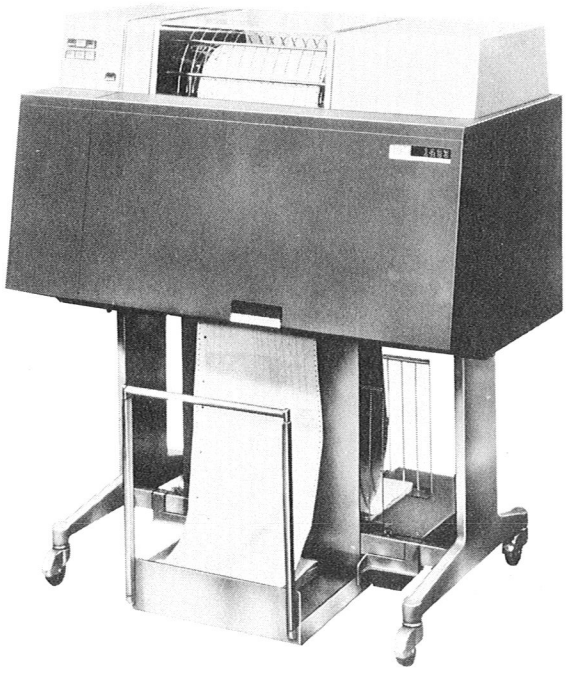


Figure 7-41. IBM 1403 Printer Models 2, 3, and 7

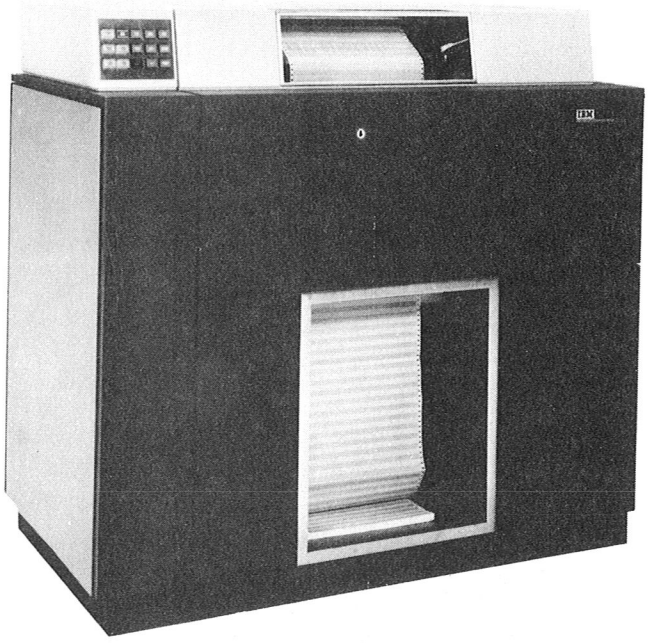


Figure 7-42. IBM 1403 Printer Model N1

individually line-spaced under program control, with no skipping permitted. Changing from tapes to standard forms, or vice versa, is easily accomplished by an operator.

A newer selective tape listing feature is available for a Model N1. This feature permits skipping at the rate of 33 inches per second over a distance fixed by Field Engineering adjustment at a value within the range of 3 to 22 inches; this is in lieu of the repetitive line spacing required by the other version of the feature. Operation is quieter. Changeover from tape listing mode to full-sheet printing is made still easier; this and other new operator conveniences have a beneficial effect on the feature's overall efficiency.

Universal Character Set

The universal character set feature (UCS) provides the user with the ability to load from cards, into a special storage area in the IBM 2821 Control Unit, any set of discrete codes up to a maximum of 240. The codes in 2821 storage correspond specifically and sequentially with the characters on the train or chain. The user may order any characters for a given set, including custom designs for special applications.

The chain or train has 240 type positions, which, prior to UCS, were divided into five identical sets of 48 characters each. The rated maximum printing speed of a given printer is based, partially, on this division into five identical sets. If characters are included only one, two, or even four times on the chain or train, the rated maximum printing speed is necessarily reduced. The reduction, however, is not linear, because of other factors than the number of character sets (e.g., single spacing vs. skipping). Conversely, if the characters are included *more* than five times, the printing speed is increased beyond the rated maximum.

As already indicated, the Model 2 has a maximum rated speed of 600 lines per minute (lpm) when its chain contains the conventional five sets. If the installed set contains 240 different characters—the widest possible variety—printing takes place on the Model 2 at up to 140 lpm. Under the same conditions, printing takes place on the 1403 Model N1 at up to 310 lpm. The maximum printing speeds, with UCS, are controlled electronically and are 750 lpm for Model 2, and 1400 lpm for Model N1.

2821 Control Unit Models 1-3, 5, and 6

The IBM 2821 Control Unit contains the control and buffer circuitry to transmit information between the associated System/370 channel and the 2540 Card Read Punch, and/or one 1403 Printer Model 2, 7, or N1.

The 2821 Model 6 contains controls and buffer circuitry to transmit information between its associated channel and one 2540 Card Read Punch, with no printer attachment.

Each of the five models of the 2821 provides control for the following types and quantities of I/O devices:

2821 Model	*Max. No.*	*Printers Type and Model*	*Also 2540 Card Read Punch?*	*Max. Units Controlled*
1	1	1403-2, 7, or N1*	yes	2
2	1	1403-2, 7, or N1*	no	1
3	2(or 3*)	1403-2, 7, or N1*	no	2(or 3*)
5	2(or 3*)	1403-2, 7, or N1*	yes	3(or 4*)
6		None	yes	1

*Requires a special feature.

The buffers in the 2821 permit the transfer of accumulated data to and from the channel at a much faster rate per byte than would be possible by direct transfer to or from the attached device.

The column binary special feature can be installed on the 2821 Model 1, 5, or 6 to allow multiple punching in rows 1-7 of a card column, or reading of such multiple punches, by the 2540. This feature is *not* required to read or punch EBCDIC. (See "2540 Card Read Punch.")

1443 Printer Model N1

The IBM 1443 Printer Model N1 (Figure 7-43) prints from 200 to 600 (maximum) lines per minute, depending on the number of characters in the set being used.

13-character set—600 lines per minute
39-character set—300 lines per minute
52-character set—240 lines per minute
63-character set—200 lines per minute

The 52-character set is standard, and the other sets are available through the selective character set special feature. The user may order any characters for any set, including custom-made designs of special graphics.

The standard printed line for all sets is 120 characters long, spaced horizontally at 10 characters to the inch. Twenty-four additional printing positions are available as a special feature, raising the total number of printing positions to 144.

All characters of the print set are on a single type bar that moves back and forth across the paper. The bar is so made that each different character passes each print position. Printing takes place when the character to be printed corresponds with the character read from the printer's self-contained storage buffer.

A tape-controlled carriage, working under program control, advances paper and provides the vertical print formats. Lines are spaced six or eight to the inch under operator control. Skipping is 15 inches per second.

No external control unit is required; the control circuits and print storage buffer are within the 1443 Model N1.

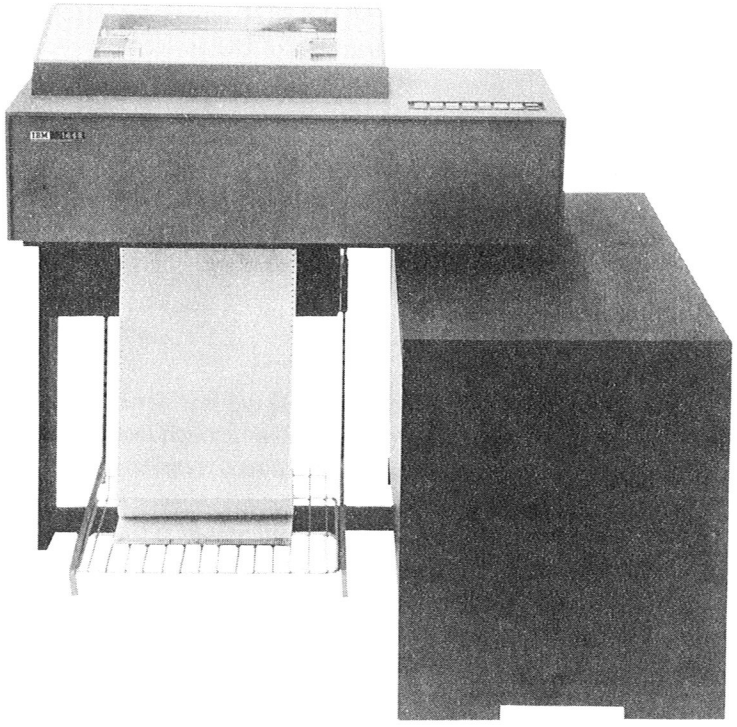


Figure 7-43. IBM 1443 Printer Model N1

3211 Printer; 3811 Control Unit

The IBM 3211 Printer (Figure 7-44) is a high-speed printer with speeds of 2,000 lines per minute single spacing, using a 48-element character set. The printer uses a train of characters that are not linked together. Characters are printed 10 to an inch, and lines are spaced either six or eight to the inch under program control. In addition to the high-speed printing, other features of the printer are:

Interchangeable train cartridge
Universal character set
Program-controlled carriage
Self-adjusting power stacker
Automatic forms-thickness control
Motorized cover

Interchangeable Train Cartridge: This cartridge contains a continuous train of 432 characters. EBCDIC permits using up to 254 different characters (alphabetic, numeric, and special) on a print train.

Universal Character Set: The universal character set permits optimizing the character arrangement to maximum printing speeds. This feature allows selecting the characters best suited for maximum speed for different applications.

Program-Controlled Carriage: The vertical format for each form is stored in the control unit by the program. Forms movement (spacing and skipping) is initiated by the program in accordance with the stored format. Line feeding (6 or 8 lines per inch) is also controlled by the stored format.

Self-Adjusting Power Stacker: The self-adjusting power stacker advances and stacks the forms for optimum high-speed forms movement according to the thickness of the forms.

Automatic Forms-Thickness Adjustment: The automatic forms-thickness control adjusts the platen for the correct clearance for the forms used. This assures maximum print quality and maintains sufficient clearance for high-speed forms movement.

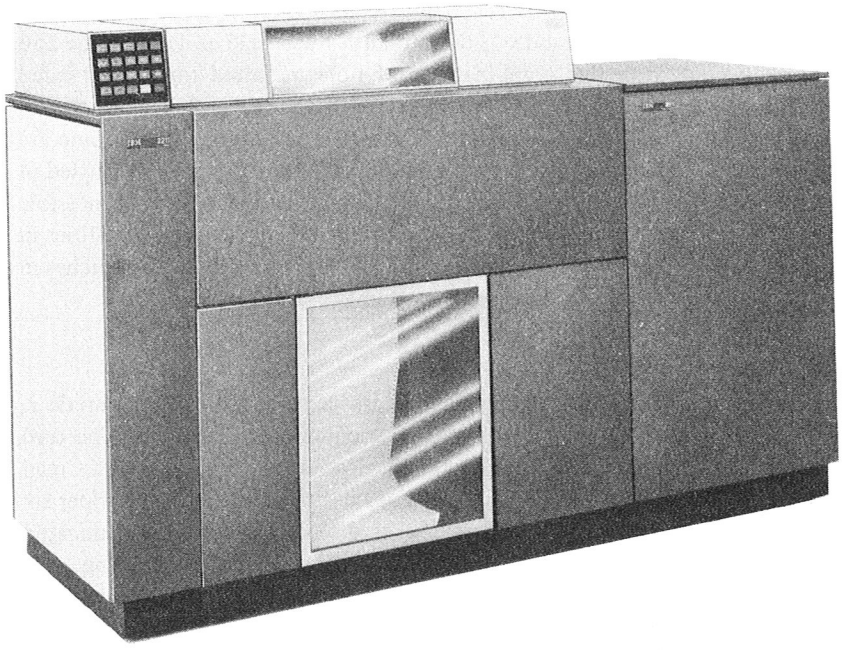


Figure 7-44. IBM 3211 Printer and IBM 3811 Control Unit

Motorized Cover: The cover on the printer gives controlled access to the forms transport area. When a forms condition arises, the cover movement immediately alerts the operator that attention is required.

The printer speed depends on the arrangement of the characters within the type array and the number of arrays in the print train. Optimizing the universal set permits each application to attain maximum printing speeds, depending on the frequency of the characters in the print train. Speeds of up to 2,500 lines per minute, with reduced character sets and customized print trains, are possible.

The 3211 is controlled and buffered by the 3811 Control Unit. The control unit, physically attached to the 3211, contains the electronic circuitry needed to adapt the printer to the channel.

Punched Card Devices

1442 Card Read Punch Model N1

The IBM 1442 Card Read Punch Model N1 uses a single common card path for reading and punching, and reads and punches cards serially by card column. Serial card feeding, past a read and then a punch station, makes it possible for the program to read data from a card and then punch data (such as the results of a calculation) into the same card during a single card pass. The Model N1 reads or punches cards at the following maximum rates:

Reading – 400 cards per minute
Punching – 160 card columns per second

Punching speed depends on the location of the last column punched. Interspersed blank columns between fields are considered punched columns. In terms of cards per minute, the rated speed for punching columns 1-10 is 265 cpm; for punching columns 1-80, 91 cpm.

No external control unit is required; the control circuits are within the 1442. The 1442 is not buffered.

The read hopper holds 1,200 cards. Card movement is from the hopper to the read station, to the punch station, then to one of the two stackers (pockets). The stackers hold 1,300 cards each, and cards can be removed from either stacker without stopping the machine.

The appearance of the unit is similar to that of the 1442 Model N2 shown in Figure 7-45.

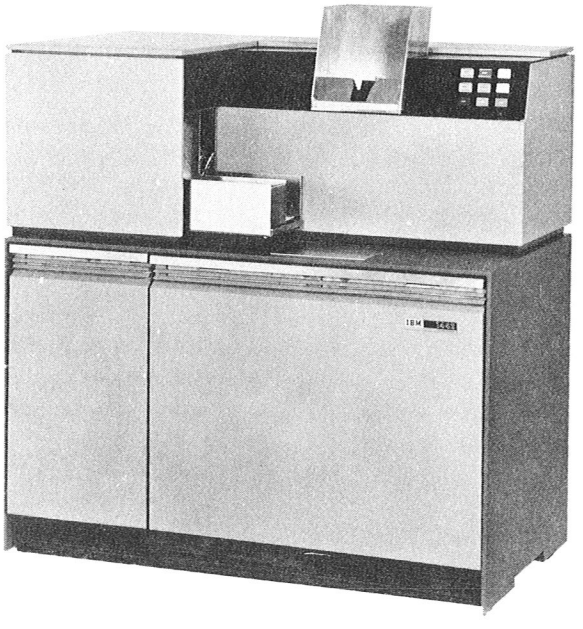


Figure 7-45. IBM 1442 Card Punch Model N2

Data Mode 1

In data mode 1, the Model N1 can read and punch the 256 different combinations of holes required for the extended binary coded decimal interchange code (EBCDIC). For 256 combinations, multiple punches in a single card column are required; however, no more than one punch is permitted in rows 1-7. (Rows 12, 11, 0, 8, and 9 allow 32 possible combinations, which, multiplied by the eight possibilities in rows 1-7, equal the required 256.) For multiple punches in rows 1-7, the special card image feature is required.

Data Mode 2

Operations using the card image feature are in data mode 2, which is the card image or column binary mode. The card image feature permits the low-order six bits of bytes read from the CPU to be punched alternately into the upper six and lower six rows of a card, enabling 160 such truncated bytes to be placed in the card. When reading, the information is read column by column and transmitted to the CPU byte by byte, the two high-order bits (0 and 1) set to zero.

1442 Card Punch Model N2

The IBM 1442 Card Punch Model N2 (Figure 7-45) may be connected to the System/370 to provide the card punching function only. Punching operations, speeds, internal controls, punching in data mode 2, and all other features related to punching are identical to those of the 1442 Card Read Punch Model N1, except that the Model N2 has only a single 1,300-card stacker.

2501 Card Reader Models B1 and B2

Models B1 and B2 of the IBM 2501 Card Reader (Figure 7-46) are externally identical, but the maximum card-reading rate of Model B1 is 600 per minute; of Model B2, 1,000 per minute. The Model B1 can be used for primary card input or as a console reader. Model B2 can be used for primary card input, often with the 2520 Card Punch Model B2 for maximum card processing speeds.

No external control unit is required; the control circuits are within the 2501. The 2501 is not buffered.

Reading of cards is accomplished by photocells that convert the light passing through punched holes into electrical energy. Cards are read serially by column. The feed hopper has a 1,200-card capacity, and cards can be removed from the single 1,300-card stacker without stopping the reader.

The 2501 can read EBCDIC in standard data mode 1. For the 256 combinations in EBCDIC, multiple punches in a single card column are required; however, no more than one punch is permitted in rows 1-7. For multiple punches in

Figure 7-46. IBM 2501 Card Reader

rows 1-7, the special card image feature is required. For a description of reading in card image mode, see "Data Mode 2" in the 1442-N1 description.

2520 Card Read Punch Model B1

The IBM 2520 Card Read Punch Model B1 (Figure 7-47) reads and punches cards at a maximum rate of 500 per minute. Operation of the 2520 Model B1 is the same as for the 1442-N1 or 2501 with respect to serial-by-column card reading, and is like the 1442-N1 in that:

1. The feed hopper has a 1,200-card capacity.
2. Cards can be removed from either 1,300-card stacker while the machine is running.
3. Cards are moved past a read station and then past a punch station.
4. Prepunched cards can be fed through the punching station without a special feature.

As in the 2501, cards are read by photocells that convert the light passing through punched holes into electrical energy.

The punching operation of the 2520 differs from that of the 1442; punching is parallel by row instead of serial by column. Each card is fed in parallel and read serially while the preceding card, its axis turned 90 degrees, is passing the punching station (Figure 7-48).

No external control unit is required; the control circuits are internal. The 2520 punching operations are buffered; the reading operations are not buffered.

The 2520 can read and punch EBCDIC in the standard data mode 1. For the 256 combinations in EBCDIC, multiple punches in a single card column are required; however, no more than one punch is permitted in rows 1-7. For multiple punches in rows 1-7, the special card image feature is required. For a description of reading and punching in the card image mode, see "Data Mode 2" in the 1442-N1 description.

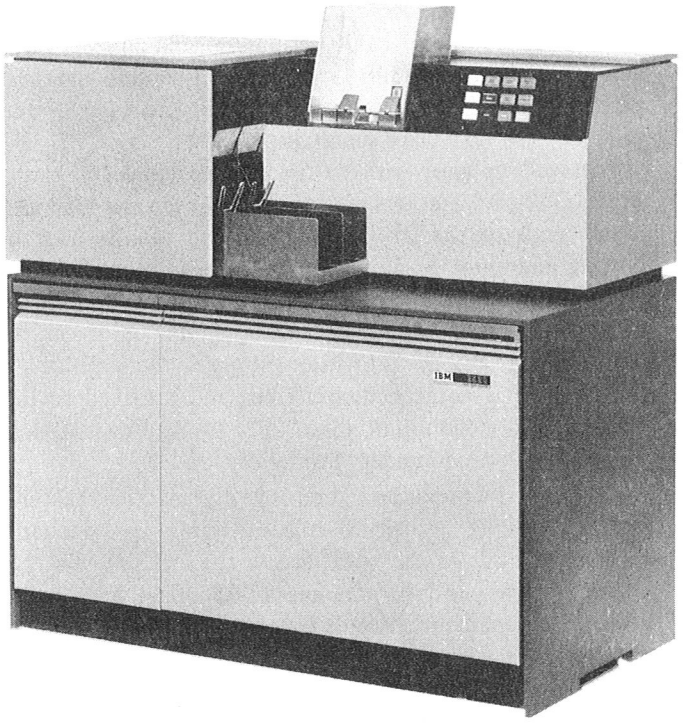


Figure 7-47. IBM 2520 Card Read Punch Model B1

2520 Card Punch Models B2 and B3

The IBM 2520 Card Punch Model B2 or B3 may be connected to the System/370 to provide the punching function only. Models B2 and B3 are externally identical (and the same as the 2520-B1 shown in Figure 7-47), but the maximum card-punching rate of Model B2 is 500 per minute; of Model B3, 300 per minute.

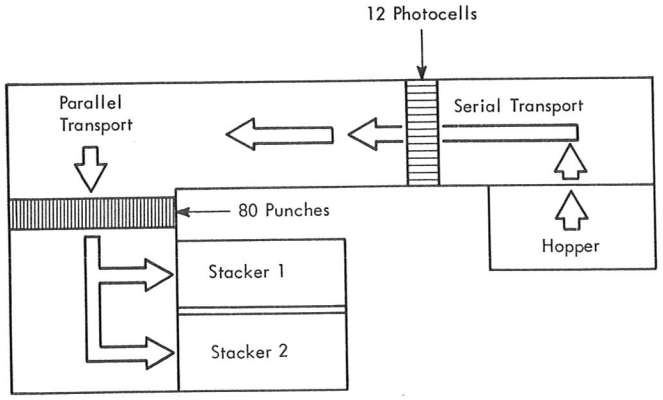


Figure 7-48. Card Path in IBM 2520 Card Read Punch Model B1

Internal controls, punch buffering, punching in data mode 2, the punching speed of Model B2, and all other features related to punching are identical to those of the 2520 Card Read Punch Model B1.

2540 Card Read Punch

The IBM 2540 Card Read Punch (Figure 7-49) reads cards at a maximum rate of 1,000 per minute, and punches cards at a maximum rate of 300 per minute. The card reading and punching sections are separate entities, and reading and punching can take place simultaneously.

The read hopper, with its file feed, holds 3,100 cards. Five 1,350-card stackers are located between the read and punch ends of the 2540; three stackers can be used in reading and three in punching. The center pocket can be fed with either punched or read cards, but should be reserved for one or the other during a run. Cards can be removed from any pocket without stopping the machine.

The 2540 is controlled, buffered, and attached to the channel by a control unit. (See "2821 Control Unit Models 1-3, 5, 6," discussed under "Printers.")

An optional 51-column interchangeable read feed feature permits feeding either 51-column cards or standard 80-column cards in the read feed of the machine. The 51 columns correspond to columns 15-65 of an 80-column card. (Fifty-one column cards may be postal money orders, installment payments, inventory cards: for example, a detached 51-column stub from an 80-column card.) Installation of this feature permanently reduces the maximum card-reading speed to 800 cards per minute. The first two read pockets are modified so that the operator can adjust for either 80- or 51-column operation. During the time that the pockets are set for 51-column cards, the capacity of the two pockets is reduced to 800 cards each and longer cards cannot be fed.

An optional punch feed read feature enables the 2540 to punch output data into the same card from which input data was read. (Column binary cards cannot be read in the punch feed.) Unless this feature is installed, only blank cards can be fed through the punching section.

The 2540 can read and punch EBCDIC. For the 256 combinations in EBCDIC, multiple punches in a single card column are required; however, no more than one punch is permitted in rows 1-7. For multiple reading or multiple punches in rows 1-7, the column binary special feature must be installed on the 2821. Column binary cards are read or punched exactly as described under "Data Mode 2" in the 1442-N1 description.

2596 Card Read Punch Model 1

The IBM 2596 Card Read Punch (Figure 7-50) reads and punches 96-column cards and provides 96-column card data interchange between System/3 and System/370. This unit reads cards at a maximum rate of 500 per minute, with buffering to prevent overrun. The fully buffered punch unit punches cards at a maximum rate of 120 per minute.

Figure 7-49. IBM 2540 Card Read Punch

The read and punch sections each have a 2,000-card hopper, and two 600-card stackers, one for normal stacking and one for selective stacking. No external control unit is required; the control circuits are within the 2596.

As an option, the special interpretive printing feature is available. This permits printing of three lines of 32 characters each on the card, in the same pass as it is being punched, without loss of card punching speed. The interpreter function is operator-controlled by an on-off switch on the operator panel.

3505 Card Reader Models B1 and B2; 3525 Card Punch Models P1, P2, and P3

The 3505 Card Reader (Figure 7-51) has a maximum reading rate of 800 or 1,200 cards per minute (Models B1 and B2, respectively), a 3,000-card input hopper, and two 1,750-card nonprogrammed stackers.

The device associated with the 3505, the 3525 Card Punch (Figure 7-52), operates at rates up to 100, 200, or 300 cards per minute (Model P1, P2, or P3, respectively). The 3525 attaches to a system via the 3505's control unit. With special features, the 3525 can read, punch, and print, all in a single pass, feeding cards from a 1,200-card hopper and loading them into either of two program-selectable 1,200-card stackers.

The fully buffered control unit, housed within the 3505:

1. Contains its own processing unit and resident programs for error detection and recovery assistance.

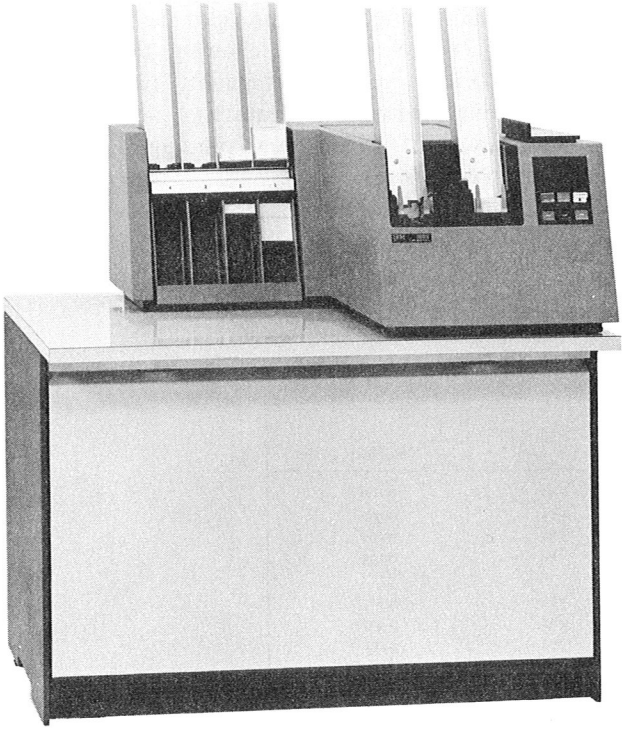


Figure 7-50. IBM 2596 Card Read Punch

Figure 7-51. IBM 3505 Card Reader

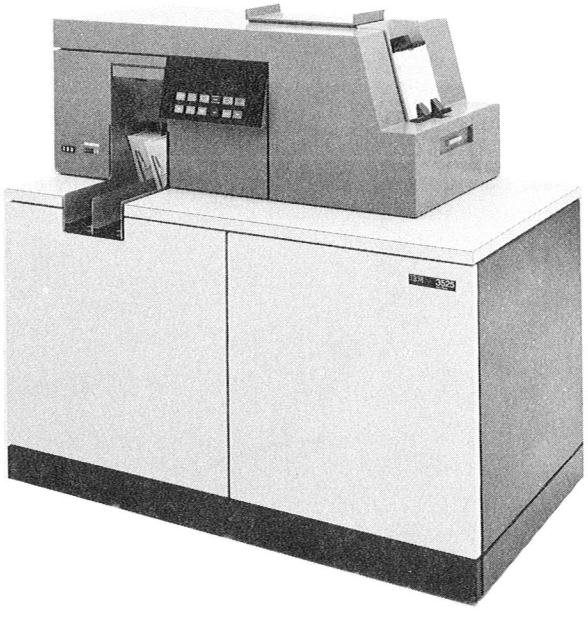


Figure 7-52. IBM 3525 Card Punch

2. Keeps a log of recent errors (especially helpful in device maintenance).
3. Prevents channel overrun.
4. Ailows card data to be transferred in burst mode.

Both the 3505 and 3525 have recovery-oriented operator panels. The operator panel indicators show the precise action to be performed for all normal stops and most error stops, or they direct the operator to a corrective procedure. Operating keys are situated in the same general area for ease of control.

For card reading and punching, data is handled in EBCDIC (data mode 1) or card image (data mode 2) under program control. EBCDIC data read by the 3505, or by the 3525 equipped with the card read feature, is checked for validity according to the following rule: any combination of punches in a single column is valid if it contains no more than one punch in rows 1 through 7. Printing done by the 3525 is in EBCDIC, using either an EBCDIC or ASCII character set.

Card reading in the 3505 is serial by column; in the 3525 equipped with the card read feature, it is parallel by row.

The error-recovery support needed for the 3505 and 3525 is less than that needed for I/O devices such as the 2540 Card Read Punch, because many of the functions performed by program support are not performed by the 3505 and 3525 (for example, automatic feed retry and automatic punch retry).

Both the 3505 and 3525 have error-retry capabilities. The 3505 retries cards which fail to feed on the first try, and signals a hopper misfeed if subsequent retries are unsuccessful. On recognizing a card with a punch error, the 3525 sends that card to an error stacker for later examination and reattempts correct punching.

Some of the more prominent special features of the 3505 are:

1. The selective stacker, which adds a 1,750-card third stacker that permits time-independent card selection under program control.
2. Read column eliminate, which suppresses the reading of data from specified card columns and substitutes blanks in these columns in the buffer.
3. Optical mark read, which gives the card reader the ability to read penciled marks and machine-printed nonreflective ink marks from cards.

Special features of the 3525 are:

1. The card read feature, which provides the punch with optical punched-hole sensing, allowing the 3525 to execute 3505 read programs compatibly. (Read column eliminate is included with this feature.)
2. Two-line card print, which allows printing of two lines near the top of the card.
3. Multiline card print, which provides the 3525 with printing of up to 25 lines on the card, under program control.

Figure 7-53 summarizes the essential characteristics of all card equipment discussed.

Card Unit	Read Speed (Cards/Min)	Punch Speed	Read and Punch Same Card in One Pass	Self-Contained Control Unit	Buffers
1442-N1	400	160 card col/sec†	yes	yes	none
1442-N2	---	160 card col/sec†	---	yes	none
2501-B1	600	---	---	yes	none
2501-B2	1,000	---	---	yes	none
2520-B1	500	500 cards/min	yes	yes	punch
2520-B2	---	500 cards/min	---	yes	punch
2520-B3	---	300 cards/min	---	yes	punch
2540-1	1,000*	300 cards/min	yes	no	read, punch
2596-1	500	120 cards/min	no	yes	read, punch
3505-B1	800	---	---	yes	read
3505-B2	1,200	---	---	yes	read
3525-P1	100**	100 cards/min	yes	no	read, punch, print
3525-P2	200**	200 cards/min	yes	no	read, punch, print
3525-P3	300**	300 cards/min	yes	no	read, punch, print

*800 if 51-column interchangeable read feed feature is installed.
**With read feature installed.
†265 cards per minute punching columns 1-10; 91 cards per minute punching all 80 columns.

Figure 7-53. Comparison of Characteristics of System/370 Card Devices

Punched Tape Devices

1017 Paper Tape Reader Models 1 and 2; 1018 Paper Tape Punch; 2826 Paper Tape Control Unit Model 1

The IBM 1017 Paper Tape Reader (Figure 7-54) reads 5-, 6-, 7-, and 8-track paper tape and laminated polyester tape at a rate of up to 120 characters per second. Tape width is 11/16 inch for 5-track telegraphic code, 7/8 inch for 6- and 7-track codes (including 6-track advanced feed hole and Japanese format), and 1 inch for 8-track codes. Reading and backspacing are program-controlled on a character-by-character basis. Bit configurations transmitted correspond directly with character hole patterns read. Any code translation must be performed by the program after characters have been read into main storage. Parity checking (odd, even, or none) is determined by a switch on the operator panel.

The 1017 Model 1 reads strips of tape only. The Model 2 is equipped with a reeler, for reading both tape strips and reeled tape.

The IBM 1018 Paper Tape Punch (Figure 7-55) punches 5-, 6-, 7-, and 8-track paper tapes and most laminated polyester tapes at a speed of up to 120 characters per second. Tape width is 11/16 inch, 7/8 inch, or 1 inch. Three punching options are available:

Standard punching (5-, 6-, 7-, or 8-track)
Advanced feed hole punching (6-track)
Japanese tape punching (6-track)

Punching is program-controlled on a character-by-character basis. Character hole patterns punched correspond directly to bit configurations transmitted. Any code translation must be done by programming before characters are transferred for punching. Backspacing capability is available as a part of the error correction special feature and

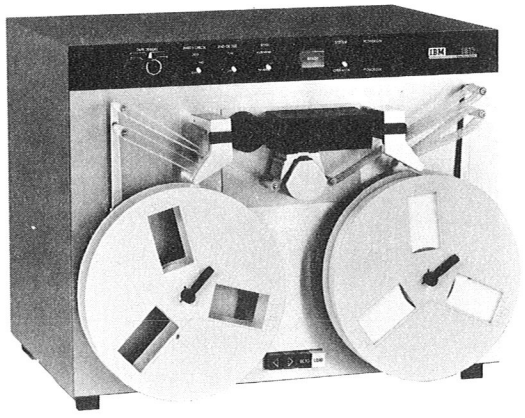


Figure 7-54. IBM 1017 Paper Tape Reader

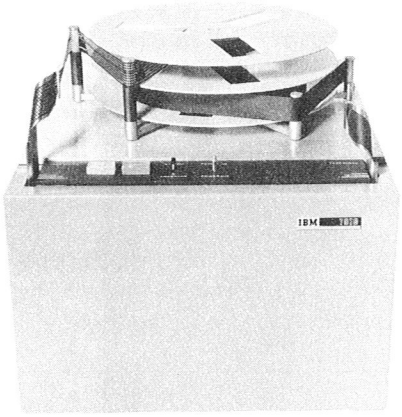


Figure 7-55. IBM 1018 Paper Tape Punch

is program-controlled. The standard 1018 punches strips of tape from a supply roll on top of the machine. The take-up mechanism (special feature) allows winding of tape on a take-up reel on top of the supply reel.

The 1017 and the 1018 can be attached to the 2826 Paper Tape Control Unit (Figure 7-56). The 2826 attaches to the byte multiplexer channel of System/370. Input records can be separated by an end-of-record (EOR) character. Any character not used for other purposes can serve as an EOR character. The character to be recognized during read operations as the EOR character is determined by the setting of eight toggle switches on the 2826 control panel.

The 2826 can control as many as two readers and two punches, all of which can operate simultaneously.

A special feature of the 2826, punch checking, in conjunction with the 1018's error correction feature, permits recognition and correction of parity discrepancies during punching operations.

2671 Paper Tape Reader; 2822 Paper Tape Reader Control

The IBM 2671 Paper Tape Reader (Figure 7-57) photoelectrically reads strips of 5-, 6-, 7-, or 8-channel paper tape at a rate of up to 1,000 characters per second. Tape width is 11/16 inch (for 5-track telegraphic code), 7/8 inch (6- and 7-track codes), or 1 inch (8-track codes). Tape code translation is under program control.

Various switches on the 2671 provide operator convenience and program efficiency. Examples are: end-of-record indications, parity checking (odd, even, or none), track suppression, and transmission or nontransmission to the CPU of the indications of deleted positions on tape.

The paper tape reader and the 2822 Paper Tape Reader Control (Figure 7-57) are normally attached to System/370 through the byte multiplexer channel, but may be attached to another channel on some models (Figure 7-1).

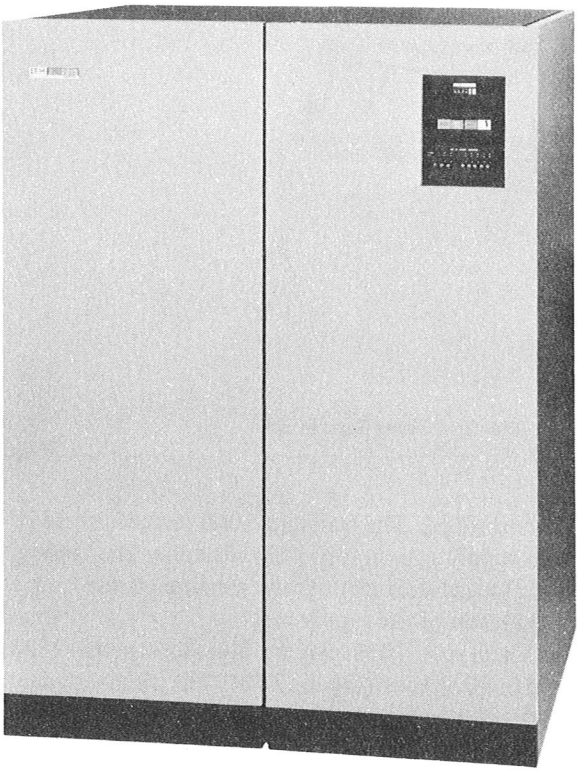


Figure 7-56. IBM 2826 Paper Tape Control Unit

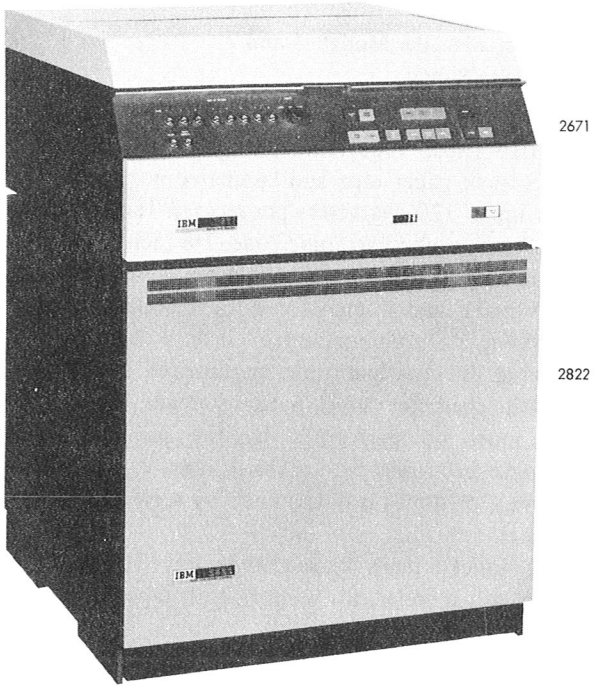


Figure 7-57. IBM 2671 Paper Tape Reader and 2822 Paper Tape Reader Control

The basic 2671 reads strips of paper tape from 9 inches to 20 feet in length, including a 6-inch leader and 3-inch trailer. Spooling facilities are optional. With the supply option feature, 10½-inch reels of paper tape can be fed (from the outside of the reel). If the optional center roll feeding feature is added, tape can also be fed from the center of 10½-inch rolls. With the take-up option feature, the tape can be rewound on 10½-inch reels.

After acceleration time (about 8 milliseconds), the data rate reaches 1,000 characters per second for strips. With the spooling facilities, the data rate varies between 500 and 1,000 characters per second, depending on the length of a record.

The 2671 is especially designed for data communications, source recording, scientific data processing, and data acquisition.

Systems

3270 Information Display System

The IBM 3270 Information Display System (Figure 7-58) is a group of display stations, control units, and printers that meets the alphameric display requirements of inquiry, data entry, source recording, transaction processing, and manual input from the display operator console. Attached locally, the 3270 system provides data transfer rates of up to 650,000 characters per second. (The remotely attached 3270 is discussed in Section 8 under "Systems.")

In this system, multiple keyboards can be provided for work station flexibility. For example, records may be changed or updated faster and key entry volume may be substantially increased because the transactions are online.

The 3270 system may consist of up to 32 devices, and can include 480- or 1,920-character display stations and 40- or 66-character/second printers.

A local 3270 (Figure 7-59) is made up of combinations of the following units:

3272 Control Unit Model 1 or 2
3277 Display Station Model 1 or 2
3284 Printer Model 1 or 2
3286 Printer Model 1 or 2

3272 Control Unit Models 1 and 2

The IBM 3272 Control Unit permits *local* attachment to a System/370. The system may include IBM 3277 Display Stations, 3284 Printers, and 3286 Printers.

The 3272 Model 1 has a 480-character buffer, and attaches any of the three Model 1 I/O devices. The 3272 Model 2 has a buffer capable of handling devices of up to 1,920 characters, and attaches any of the three Model 1 or Model 2 I/O devices. (The mandatory 3277 Display Station must be a Model 2.)

The 3272 provides attachment of up to four separate I/O devices, and permits speeds of up to 650,000 characters per second.

3277 Display Station

The IBM 3277 Display Station uses a CRT for display, and a keyboard or light pen (or both) to permit an operator to display and manipulate alphameric data on the screen. The Model 1 has a 480-character buffer and a 40 character/sec printout rate. The resultant 12 lines of 40 characters include 36 alphameric and 27 special characters. The Model 2 has a 1,920-character buffer and a display of 24 lines of 80 characters each.

Individual fields of data on the screen can be program-defined for attributes such as protected or unprotected storage, alphameric or numeric displays, non-displays, and normal or brightened character intensity. Program definition may also allow or disallow selector light-pen detection.

3284 and 3286 Printers

The IBM 3284 Printer Model 1 has a 480-character buffer and a 40-character/sec printout rate. The Model 2 has a 1,920-character buffer and a 40-character/sec printout rate.

Figure 7-58. IBM 3270 Information Display System

The IBM 3286 Printer Model 1 has a 480-character buffer and a 66-character/sec printout rate. The Model 2 has a 1,920-character buffer and a 66-character/sec printout rate.

Both printer types use the EBCDIC character set; both have ASCII character sets available as optional features.

Example Display System Configurations

At least one display station *with a keyboard* must be attached to a control unit. A buffer in the device (display station or printer) stores digitally-coded data from the control unit for display or printing. The buffer permits simultaneous message composition from a keyboard and display image presentation at each display station.

Optional System Features

Optional features include:

Keylock, which provides key-operated security control of the display image.

Selector Light Pen, which provides selection of parts of a display image for further processing.

Copy, which provides copy facility from one display to another display or to a printer.

Audible Alarm, which sounds when a character is entered into the next-to-last position on the screen.

Non-displayed Keying Mode, which permits data to be entered into the system but not displayed on the screen.

Operator Identification Card Reader, which reads encoded information from a magnetically-striped plastic card that identifies the operator.

Keyboard, which provides selection of input from data entry, typewriter, or operator console. (Typewriter and operator console keyboards are available with or without function keys.)

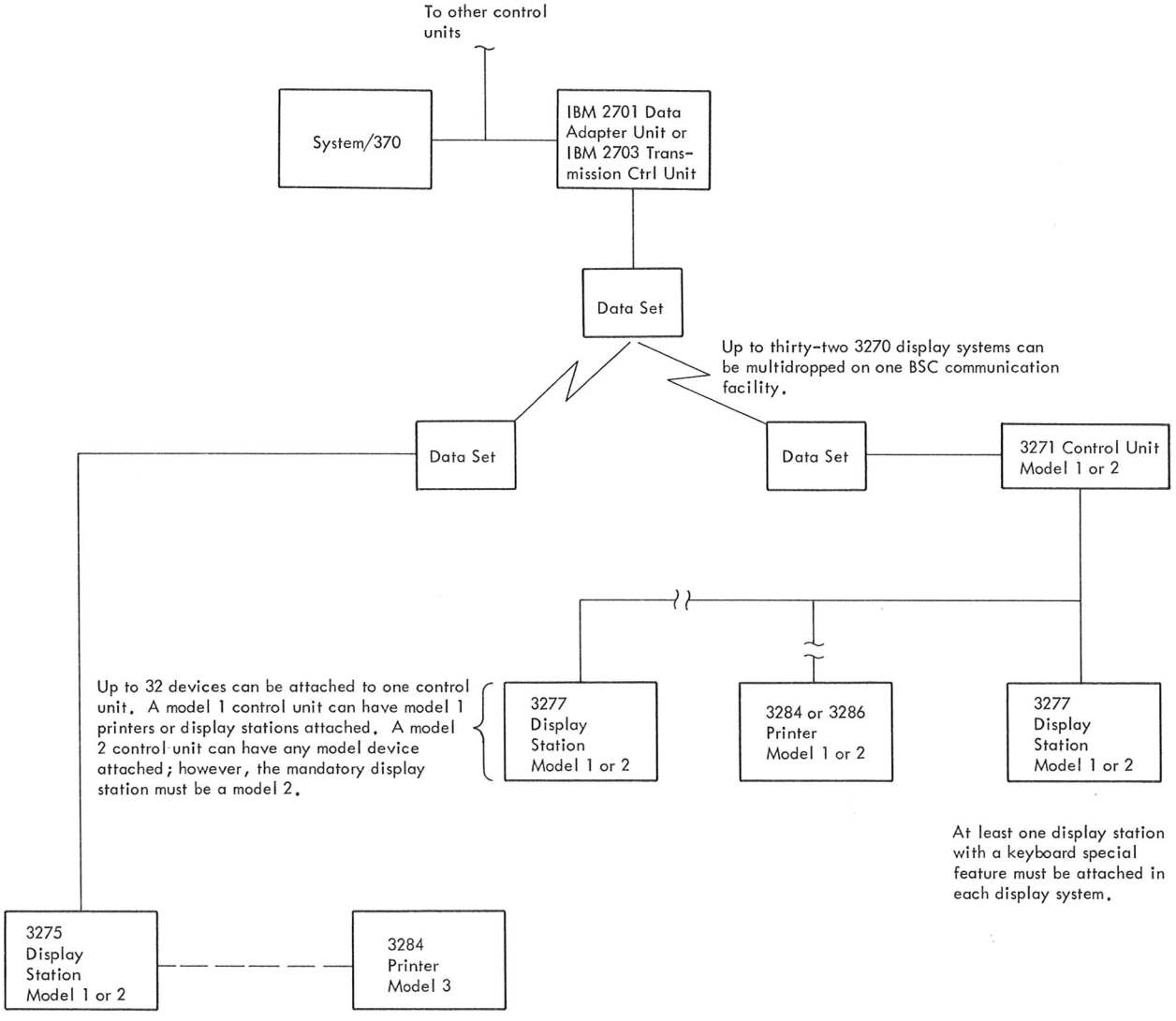


Figure 7-59. Locally Attached IBM 3270 Display System

The following remote I/O devices and systems (terminals) and their associated devices are attachable online to System/370. The possible connections to the various System/370 models are listed in Figure 8-1. For more information see *IBM Teleprocessing System Summary*, GA24-3090, which contains brief descriptions of all IBM teleprocessing terminals, and *IBM SRL Bibliography Supplement–Teleprocessing and Data Collection*, GA24-3089, which contains a complete list of all publications pertaining to IBM teleprocessing equipment.

Audio Response Devices

7770 Audio Response Unit Model 3†

Data Acquisition and Process Control Systems

1070 Process Communication System
1800 Data Acquisition and Control System

Display Devices

2260 Display Station Models 1 and 2
2265 Display Station
2845 Display Control
2848 Display Control Models 1, 2, and 3
3271 Control Unit Models 1 and 2
3275 Display Station Models 1 and 2
3277 Display Station Models 1 and 2

Keyboard and Terminal Devices

1001 Data Transmission Terminal
1013 Card Transmission Terminal
1092 Programmed Keyboard Models 1 and 2
1093 Programmed Keyboard Models 1 and 2
2721 Portable Audio Terminal
2740 Communication Terminal Models 1 and 2
3735 Programmable Buffered Terminal

Line Adapter Units

2711 Line Adapter Unit

Systems

1030 Data Collection System
1050 Data Communication System
1060 Data Communication System
1130 Computing System
2770 Data Communication System
2790 Data Communication System
3270 Information Display System
System/3 Models 6 and 10
System/7
System/360 Models 20-195
System/370 Models 135-195

Transmission Control Devices

2701 Data Adapter Unit†
2702 Transmission Control†
2703 Transmission Control†

† Locally attached to a System/370 CPU, used to connect various terminals to System/370.

Terminal			Remote Attaching Unit	Local Attaching Unit	Local System/370 Model				
No.	Models	Name			135	145	155	165	195
1001	1	Data Transmission Terminal	–	7770	m	m	m	m	m
1013	1	Card Transmission Terminal	–	2701	bms	bms	bm	bmsx	bmsx
1030	–	Data Collection System	1031#	2701, 2702, or 2703	See 2701, 2702, 2703				
1050	–	Data Communication System	1051#	2701, 2702, or 2703 →	See 2701, 2702, 2703				
					i	–	–	–	–
1060	–	Data Communication System	1061#	2701	bms	bms	bm	bmsx	bmsx
				2702 or 2703	m	m	m	m	m
1070	–	Process Communication System	1071#						
1092	1, 2	Programmed Keyboard	–	7770	m	m	m	m	–
1093	1, 2	Programmed Keyboard	–						
1130	–	Computing System	1131#	2701	bms	bms	bm	bmsx	bmsx
1800	–	Data Acquisition and Control System	Communication Adapter	2703	m	m	m	m	m
				→	i	–	–	–	–
2260	1	Display Station	2848-3						
	2	Display Station	2848-1,-2	2701	bms	bms	bm	bmsx	bmsx
2265	1	Display Station	2845	→	i	–	–	–	–
2701	1†	Data Adapter Unit	–	→	bms	bms	bm	bmsx	bmsx
	1	Data Adapter Unit	–	2701	bms	bms	bm	bmsx	bmsx
				2703	m	m	m	m	m
				→	i	–	–	–	–
2702	1†	Transmission Control	–	→	m	m	m	m	m
2703	1†	Transmission Control	–	→	m	m	m	m	m
	1	Transmission Control	–	2701	bms	bms	bm	bmsx	bmsx
				2703	m	m	m	m	m
				→	i	–	–	–	–
2711	1	Line Adapter Unit	–	2702 or 2703	m	m	m	m	m
				→	i	–	–	–	–
2721	1	Portable Audio Terminal	–	7770	m	m	m	m	m
2740	1, 2	Communication Terminal	–	2701	bms	bms	bm	bmsx	bmsx
2741	1	Communication Terminal	–	2702 or 2703	m	m	m	m	m
2760	1	Optical Image Unit	2740-1	→	i	–	–	–	–
2770	–	Data Communication System	2772#						
2780	1-4	Data Transmission Terminal	–	2701	bms	bms	bm	bmsx	bmsx
				2703	m	m	m	m	m
2790	–	Data Communication System	2715-2#	→	i	–	–	–	–
2845	1	Display Control	–	2701	bms	bms	bm	bmsx	bmsx
2848	1-3	Display Control	–	→	i	–	–	–	–
3270	–	Information Display System	3271-1, -2#	2701	bms	bms	bm	bmsx	bmsx
3275	1, 2	Display Station	–	2703	m	m	m	m	m
3277	1, 2	Display Station	3271-1, -2#	→	i	–	–	–	–
3735	1	Programmable Buffered Terminal	–	2701 or 2703	See 2701, 2703				
				→	i	–	–	–	–
7770	3†	Audio Response Unit	–	→	m	m	m	m	m
–	6	System/3	5406#	2701 or 2703	See 2701, 2703				
–	10	System/3	5410#	→	i	–	–	–	–
–	–	System/7	5010#	2701, 2702, or 2703	See 2701, 2702, 2703				
				→	i	–	–	–	–
–	20	System/360	–						
–	25	System/360	2701, 2703, or i	2701	bms	bms	bm	bmsx	bmsx
–	22-195	System/360	2701 or 2703	2703	m	m	m	m	m
–	135	System/370	2701, 2703, or i	→	i	–	–	–	–
–	145-195	System/370	2701 or 2703						

Symbols

- i Integrated communications adapter.
- b Block multiplexer channel.
- m Byte multiplexer channel
- s Selector channel
- x Selector subchannel (special feature for 2870 Multiplexer Channel).
- → See the information in the "Local System/370 Model" columns.
- – Not applicable.
- † Locally attached to a System/370 central processing unit.
- * May not be available.
- # Part of the remote system.

Figure 8-1. Attachment Data for Remote I/O Devices and Systems (Terminals)

Transmission Control Devices

Just as local cable-connected input/output devices require a control unit to interface their attachment to the system channels, devices that transmit over communications lines also require a control unit to perform interface matching, character assembly, and transmission control. In System/370 teleprocessing configurations, these functions are usually performed by the IBM 2701 Data Adapter Unit, the IBM 2702 Transmission Control, and the IBM 2703 Transmission Control.

2701 Data Adapter Unit

The IBM 2701 Data Adapter Unit (Figure 8-2) provides for the on-line connection to System/370 of a variety of local and remote systems and devices. The connection can occur over private or common-carrier communications facilities (Figure 8-3).

Eight 2701's can be attached to a System/370 channel, each occupying one control unit position. With the second channel interface special feature, the 2701 can be attached to any other channel on the same CPU or to a channel on another CPU. This means that different terminal devices on the 2701 can operate via separate channels. However, the assignment of terminals to channels is permanent; once a terminal is assigned to a particular channel, it can operate only via that channel.

Each 2701 provides for the attachment of up to four half-duplex (two ways, alternately) asynchronous communications lines with line speeds up to 600 bits per second, or up to four (maximum of two operating simultaneously) half-duplex synchronous communications lines with line speeds up to 230,400 bits per second, or up to four parallel data acquisition devices (word width of 16 to 48 bits). Various combinations of the data communications and data acquisition devices are possible within any given 2701.

All necessary bit-byte and word-byte conversions, interface matching, and data control for attaching specific terminal devices is accomplished by the functional sections of the 2701. Many optional features are available for further refinement in meeting user requirements.

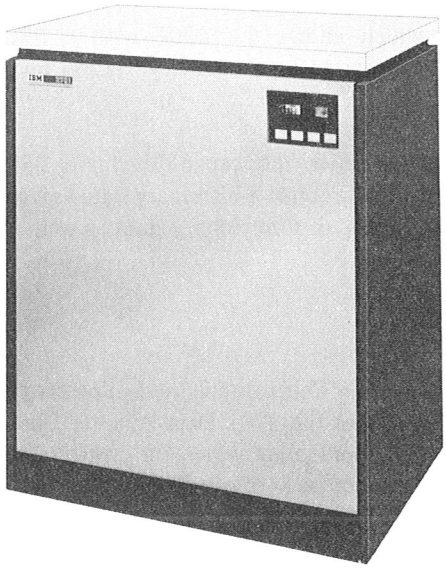


Figure 8-2. IBM 2701 Data Adapter Unit

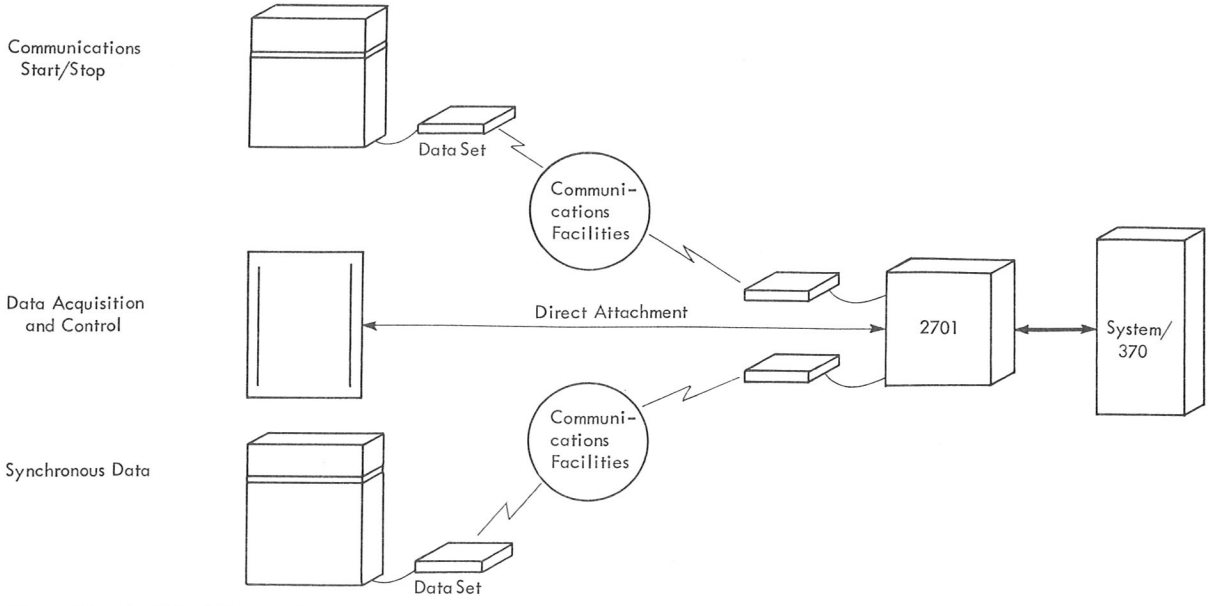


Figure 8-3. An IBM 2701 in a System Environment

Optional Features

Optional features available for the 2701 include:

Autocall, which provides automatic dialing capabilities on appropriate communications facilities.

Second Channel Interface, which provides for the attachment of a second channel to the 2701.

Dual Code, available only with binary synchronous communications (BSC) attachment features, which allows either of two codes to be program-selected.

Station Selection, which allows the 2701 with a BSC attachment feature to operate as a tributary station on a leased communications line.

Transparency, which provides the capability for a BSC attachment to transmit and receive 8-bit binary data as well as EBCDIC or ASCII codes, or 6-bit binary data as well as Six-Bit Transcode.

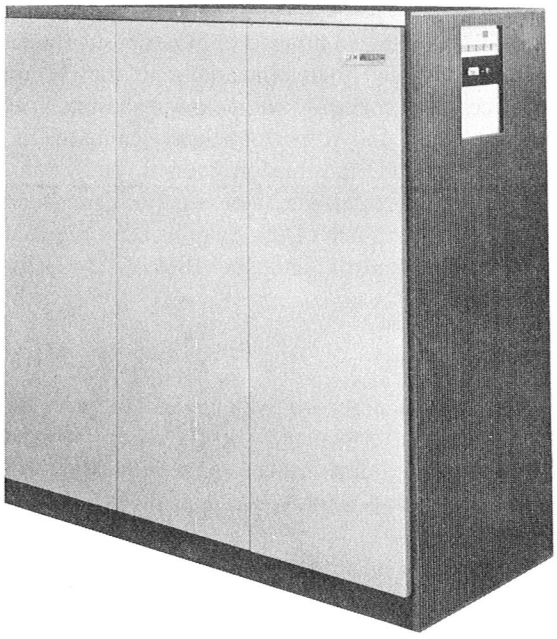


Figure 8-4. IBM 2702 Transmission Control

2702 Transmission Control

The IBM 2702 Transmission Control (Figure 8-4) performs functions similar to those of the 2701 Data Adapter Unit. The 2702 Transmission Control provides for the on-line attachment to System/370 of various asynchronous systems and I/O devices via private or common-carrier transmission facilities.

The 2702 Transmission Control occupies one control unit position on a byte multiplexer channel. As many as eight 2702's can be attached to any byte multiplexer channel, and the operation of each is in byte mode. Every attached communications line requires one subchannel.

The 2702 is a modular unit with a variety of features to meet a customer's data communications needs. It is flexible in line capacity, transmission code, and speed. The basic 2702 can have 15 half-duplex lines and operate at speeds up to 180 bits per second for any and all attached communications lines. All lines can operate simultaneously. With special features, the transmission speed of the basic 15 lines can be increased to 600 bits per second, or as many as 16 additional lines, operating in start-stop mode with speeds up to 200 bits per second, may be added. However, the two features are mutually exclusive.

Data transmission is serial-by-bit with the terminals and serial-by-byte with the channel. The 2702 converts data bytes from the processing unit into bits for transmission to the terminals and assembles incoming serial data into bytes for transfer to processor storage where messages are assembled.

Optional Features

Optional features available for the 2702 include:

Speed Extension, which permits the 2702 to operate at speeds up to 600 bits per second when only the basic 15 lines are attached.

31-Line Expansion, which expands the line-handling capabilities of the 2702 to 31 half-duplex lines that operate at a combined speed of 200 bits per second. The 31-line expansion feature and the speed extension feature cannot both be installed on any 2702.

Additional Selective Speed, which provides for installation of an additional selective speed on terminal controls where more than one speed is available. Without this feature, a terminal control can operate terminals at one speed only.

Autocall, which provides automatic dialing of remote terminals under control of the processor program.

Two-Processor Switch, which attaches one 2702 to the byte multiplexer channels of two System/370 processing units. The 2702 is switched between the two channels under program control.

2703 Transmission Control

The IBM 2703 Transmission Control performs functions similar to those of the 2701 Data Adapter Unit and the 2702 Transmission Control. The 2703 directs and controls information flow between System/370 and a variety of remote communications terminals over private and common-carrier transmission facilities.

The 2703 occupies one control-unit position on a byte multiplexer channel. It requires one nonshared byte multiplexer subchannel for each attached half-duplex line.

The 2703 is flexible in line capacity, transmission code, and speed. In asynchronous (start/stop) mode, the basic unit with appropriate features operates at speeds up to 600 bits per second with eight half-duplex lines attached; up to 64 more half-duplex lines can also operate with the basic unit with no loss of speed. At speeds up to 165 bits per second, the unit can operate with as many as 176 half-duplex lines. Many line-speed combinations are possible; only the system configuration determines the limitation.

In synchronous (binary synchronous) mode, the 2703 can operate at speeds up to 4,800 bits per second with up to 24 half-duplex lines attached, and at up to 2,400 bits per second with up to 48 half-duplex lines attached.

The 2703 permits continuous automatic polling of most IBM terminals without causing program interruptions when negative responses are received. In communications with the attached terminals, the 2703 transmits and receives serially-by-bit and serially-by-character. Character buffering of up to four bytes can be accomplished within the unit. When communicating with the channel, the 2703 operates in multiple-byte multiplex mode to request or to transfer a group of up to four bytes each time a line requires service. On both input and output operations with the channel, any message buffering is performed by the CPU; the 2703 does not impose any restrictions on message length. All necessary bit-byte conversions, data control, and matching to common-carrier equipment are accomplished in the transmission control.

Optional Features

Optional features available for the 2703 include:

Autocall, which provides automatic dialing of remote terminals under control of the processor program.

Two-Processor Switch, which enables the 2703 to attach to two byte multiplexer channels. Operations occur over only one interface at a time.

Line Speed Option, which makes available as many as seven different line speeds for use with the 2703.

Line Adapter Units

2711 Line Adapter Unit

The IBM 2711 Line Adapter Unit (Figure 8-5) enables the users of the 2702 and 2703 Transmission Controls to package IBM line adapters within one unit. Each 2711 can contain as many as 32 line adapters. The IBM line adapters modulate and demodulate signals over communications facilities in a manner similar to that of the common-carrier data sets that would otherwise be needed to perform these functions. Use of the 2711 Line Adapter Unit with IBM line adapters in lieu of common-carrier data sets offers improved flexibility of system design and economy.

Three types of line adapters can be installed. They provide facilities for:

1. Communication over limited distances (8 miles or less).
2. Communication over privately owned or leased common-carrier facilities.
3. Simultaneous sharing of a voice-grade line by as many as four low-speed terminal lines. (Each low-speed line may be operated either point-to-point or multipoint.)

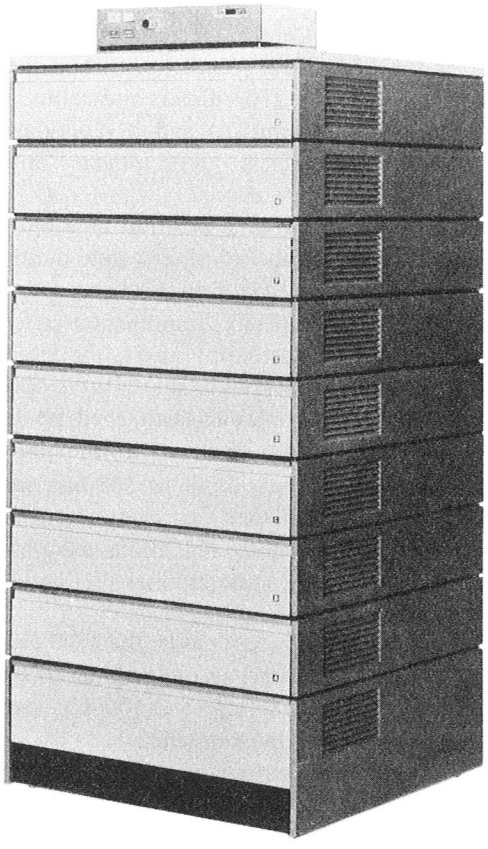


Figure 8-5. IBM 2711 Line Adapter Unit (with Maximum Number of Line Adapter Modules)

Functional Sections

The 2711 Line Adapter Unit contains two functional sections, the line adapter module and the line adapter.

Line Adapter Module: Each feature provides for the attachment of four line adapters. The basic 2711 can accommodate up to four IBM line adapters. If more than four are required, up to seven additional line adapter modules can be added to provide for a total of 32 line adapters per 2711.

Line Adapters: Line adapters enable the matching of 2702 or 2703 signals with those of the communications line. One line adapter is required for each communications line.

Keyboard and Terminal Devices

1001 Data Transmission Terminal

The IBM 1001 Data Transmission Terminal (Figure 8-6) is a combination punched card and keyboard unit used for direct transmission to a 7770 Model 3 Audio Response Unit. The audio response unit is, in turn, connected to System/370 via a byte multiplexer channel. The 1001 transmits at 12 characters per second over common-carrier leased private line telephone service, common-carrier switched telephone networks, or privately owned voice-grade facilities. The connection between the 1001 and the audio response unit is established by dialing a telephone.

1092 and 1093 Programmed Keyboards Models 1 and 2

The IBM 1092 Programmed Keyboard (Figure 8-7) and the IBM 1093 Programmed Keyboard (Figure 8-8) can be connected to System/370 over common-carrier communications facilities to a 7770 Audio Response Unit Model 3.

When transmitting to an audio response unit, the 1093 may be used alone, but the 1092 must be used in tandem with the 1093. Transmission to an audio response unit occurs at 12 characters per second.

All data entered from these keyboards can be visually checked before it is entered into the system because the data keys pressed (one per column) remain latched until manually restored. Scanning and transmission of the keyed data occur when the terminal is polled, following depression of the start button.

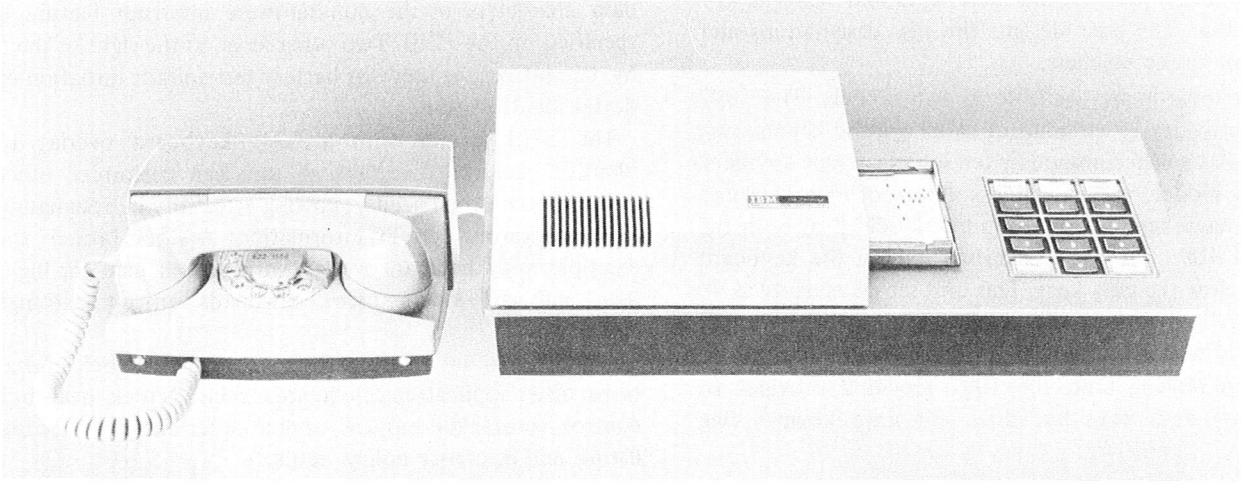


Figure 8-6. IBM 1001 Data Transmission Terminal

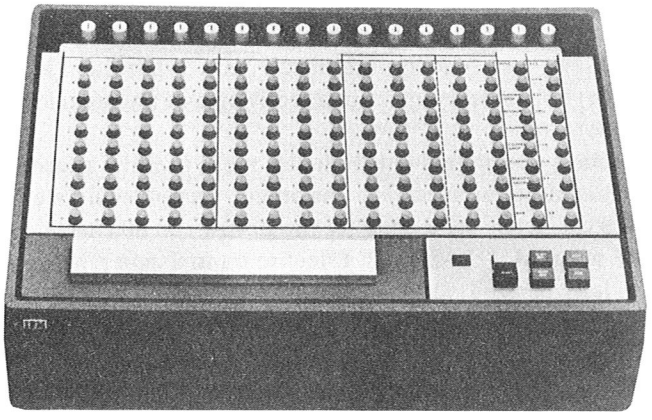


Figure 8-7. IBM 1092 Programmed Keyboard

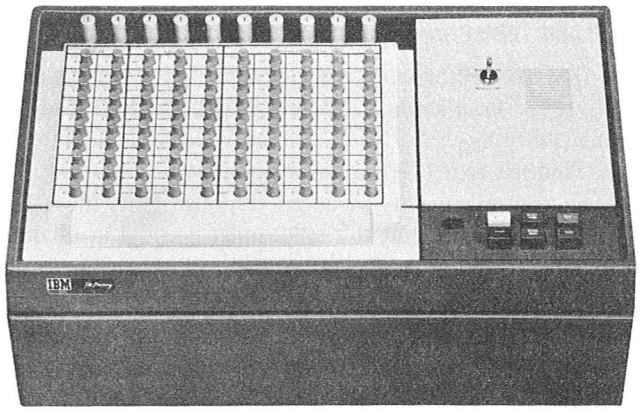


Figure 8-8. IBM 1093 Programmed Keyboard

The 1092 and 1093 are designed to accept plastic keymats that are available from IBM. These prepunched but unprinted sheets fit over the data keys and serve as key identification. The user designs the key designations and prints them on the keymats.

Both keyboards are available in two models. The 1092 Model 1 provides 15 columns of data keys and keymat ring supports that can accommodate ten looseleaf type keymats. The 1093 Model 1 provides ten columns of data keys and does not have keymat ring supports. Model 2 of both the 1092 and 1093 provides a sensing unit on the keyboard directly below the data keys. This unit senses as many as 48 differently coded keymats; each keymat can be used individually with these Model 2 keyboards. In addition to having this sensing unit, the 1092 Model 2 provides 16 columns of data keys but does not have keymat ring supports.

2721 Portable Audio Terminal

The IBM 2721 Portable Audio Terminal (Figure 8-9), when used with a standard telephone, provides quick and easy access to a System/370 from distances of several feet to hundreds of miles. The 2721 permits data entry, as well as inquiry, and response communications with a System/370.

The terminal is equipped with a removable cover, is compact (about 16 inches wide, 4 inches high, and 10 inches deep), is lightweight (about 10 pounds), and can operate with either battery or ac power. (Battery power allows the terminal to operate from locations where a power outlet is not readily available, such as at a roadside telephone.) An ac-powered battery charger, with an automatic cutoff to prevent overcharging, is built into the 2721.

An IBM 7770 Audio Response Unit Model 3 provides spoken replies to the 2721 to verify input data, or to answer inquiries. The user may listen to the response with an earphone or a speaker. The earphone permits the user to receive a reply without disturbing others in the immediate area and, in high-noise environments, such as in some manufacturing operations, permits easier listening. The speaker can be used where a number of people may want to hear the response simultaneously. The volume control on the terminal may be used with either listening device.

A terminal identification capability, specified by a three-character code, is built into each 2721. The code is assigned by IBM or by the customer, at the customer's option.

The keyboard, arranged in a 5-row by 12-column matrix, provides:

26 alphabetic characters (A-Z)
10 numerics (0-9)
11 special characters (& - + / , . $ * % @ space)
1 special numeric (00)
5 control keys (Call End, Execute, Cancel, Verify, and Repeat)
2 optional end-of-inquiry keys (# and 000)
5 function keys (assigned by the customer)

The end-of-inquiry keys, # and 000, can be reassigned as data characters if the non-hardware interrupt feature is specified on the 7770. Two other keys, to the right of the 5 by 12 matrix, are used for battery test and for initiation of device identification.

The 2721 comes with a basic keyboard overlay to identify each of the keys. A user can customize other overlays to his own needs, allowing versatility in designating keys to convey certain information. A stock broker, for example, may have an overlay with keys named for high, low, and last stock prices, dividends, price-to-earnings ratios, etc.

Applications are many and diverse. Besides stock quotations, other applications are in areas such as stock inventory control, central file inquiry, on-line order entry, real estate listing, and insurance policy status.

2740 Communication Terminal Models 1 and 2

The IBM 2740 Communication Terminal (Figure 8-10) features a SELECTRIC® typewriter appropriately modified for use as a general-purpose communication terminal. Thus, the 2740 can function alternately as a typewriter (local mode) or as a data sending and receiving unit (communicate mode).

Data is transmitted in half-duplex mode over the attached communications lines. The maximum transmission rate is 14.8 characters per second for the 2740-1 and 60 characters per second for the 2740-2. Effective transmission rates may be less, because varying typing speeds affect the 2740-1 operating speed. Special features available for the 2740-2 may also increase or decrease the transmission rate. In either mode, the 2740 can be operated by any typist with a minimum of additional training. System control keys and indicator lights are conveniently located alongside the typewriter keyboard.

The 2740 is available in two models. The 2740-1 can communicate with other 2740-1 terminals directly or with System/370; the 2740-2 is designed exclusively for communication with System/370.

Figure 8-9. IBM 2721 Portable Audio Terminal Being Operated at a Roadside Telephone

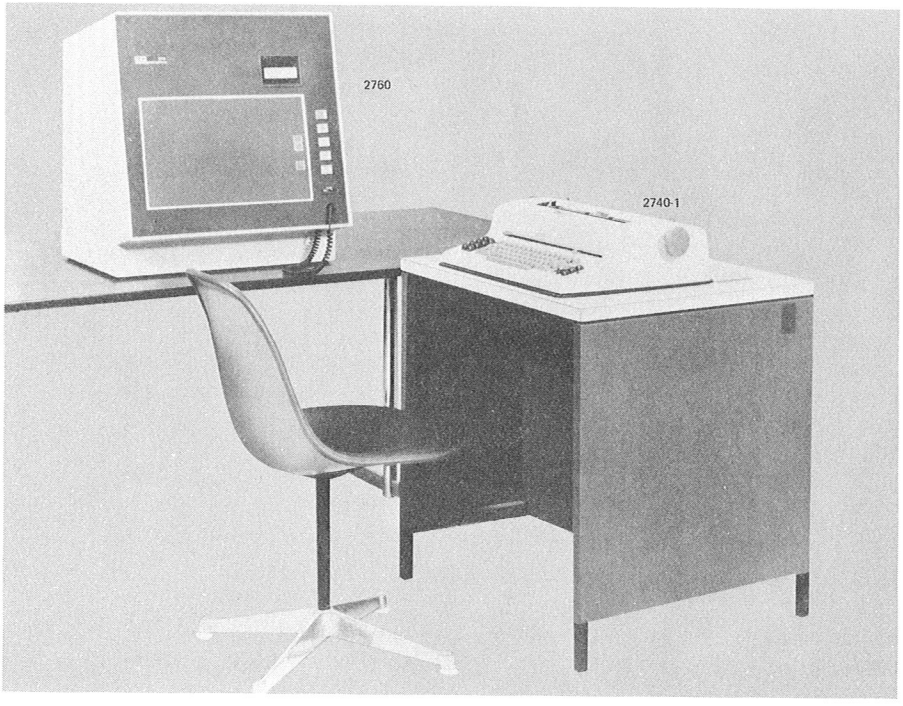


Figure 8-10. IBM 2740 Communication Terminal Model 1 with IBM 2760 Optical Image Unit

The types of operation that can be specified for the 2740-1 are:

1. Between two terminals over either leased common-carrier private lines or common-carrier switched networks.
2. Between a terminal and a System/370 over the above-mentioned facilities.
3. Between a terminal and two or more other terminals over leased common-carrier private lines.
4. Between a System/370 and two or more terminals over leased common-carrier private lines.

When the 2740-1 is operating in communicate mode, each message character keyed at the sending terminal is printed at both the sending and receiving terminals. The 2740-2 is designed to enable the key input from the typewriter keyboard to be printed at the sending terminal, stored in a buffer, and subsequently transmitted to a System/370.

The buffer storage on the 2740-2 provides improved operation through:

Faster transmission to and from the CPU buffer.
Visual verification before transmission.
Easier correction of keying errors.

Some of the many applications for which the 2740-1 is designed are:

Intracompany Communication: Internal communication between company departments can be easily handled with the 2740-1.

Intercompany Correspondence: To aid in sales and to expedite customer orders, a 2740-1 can be installed in the purchasing department of major customers.

Executive Correspondence: Effective two-way communications can be easily maintained between the executive offices and the sales or manufacturing locations by using the 2740-1.

Remote Inquiry and Reply: Using the 2740-1, persons having access to a central processing unit can handle inquiry and reply operations without leaving their department areas.

The buffer storage on the 2740-2 makes it particularly well-suited for remote inquiry and reply operations. Among the specific uses for this model are: payment entry, journal entry, administrative messages, file updating, and record renewal.

2741 Communication Terminal

The IBM 2741 Communication Terminal (Figure 8-11) is a modified SELECTRIC® typewriter with electronic controls that enable it to operate as a remote conversational terminal, thus permitting direct access to System/370. The 2741, when it is not being used for communications, may be used for normal office typing. Intended primarily for text-handling and scientific applications, the 2741 Communications Terminal permits persons at remote points to utilize the problem-solving capability of the System/370 on a time-sharing basis. Some of the uses of the terminal are:

Online scientific computation.
Online computer programming.
Text handling (especially technical writing, proposal writing, and editing).

The 2741, considered by itself, is a typewriter capable of encoding the characters typed and presenting the signal to a communications channel. Therefore, the applications of this terminal are mostly determined by the program used by the System/370 with which it is associated.

One central processing unit can service many 2741's. The maximum number of terminals that can be used in one configuration depends on either the communications facilities selected or the capacity and equipment of the computer system.

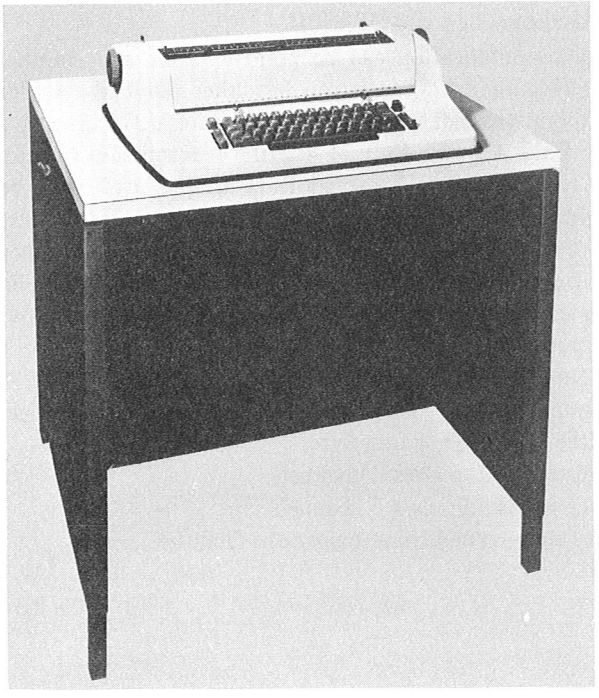


Figure 8-11. IBM 2741 Communication Terminal

2760 Optical Image Unit

The IBM 2760 Optical Image Unit (Figure 8-10), an I/O attachment for a 2740 Communication Terminal Model 1, provides the user with the capability of entering visual data into a remotely located computer.

The 2760 operates online, providing input data to a central processing unit (CPU) by way of an image projection screen and a radio-frequency (RF) probe. The operator needs no keyboard training; he needs only the ability to recognize illustrations (color or black and white) or words, phrases, and sentences in his own language. All the data used for a job may be displayed on the dual-purpose screen.

To communicate with the computer, the operator points the probe at an appropriate location on either half of the screen. The right half displays data projected from a 16-millimeter filmstrip mounted in a cartridge. The cartridge is easily inserted or removed by the operator. Each filmstrip may contain up to 151 images, of which 128 can be specially tailored to a customer's applications. Film feeding is either under operator control or computer program control. In either case, an image counter keeps the CPU program aware of the film frame being viewed. The left half of the screen displays a set of auxiliary response points, used to enter fixed or semi-fixed data, any group of which may be called for in a particular job. A job may require one or more patterns of response points, each pattern labeled by an overlay. Each side of the screen has 120 possible response points, positioned in a 10 by 12 matrix.

Each response of the probe is transmitted as a pair of coordinates for a given frame and can represent a number, word, phrase, or sentence. The CPU program translates the coordinates into meaningful data.

A single selection from an image displayed on the screen results in data identification, transaction classification, and entry of this data into the system–all in the operator's language, which could be Spanish, Japanese, French, or any other desired by the customer.

2780 Data Transmission Terminal

The IBM 2780 Data Transmission Terminal (Figure 8-12) enables large volumes of card data to be transmitted at line speeds with punched or printed output. It consists principally of a printer similar to the 1443 Printer; a card read punch similar to the 1442 Card Read Punch; a line buffer that stores data received, or to be transmitted, over a communications line; and a binary synchronous adapter, which controls the flow of data over the communications lines and maintains synchronization between the transmitting and receiving terminals.

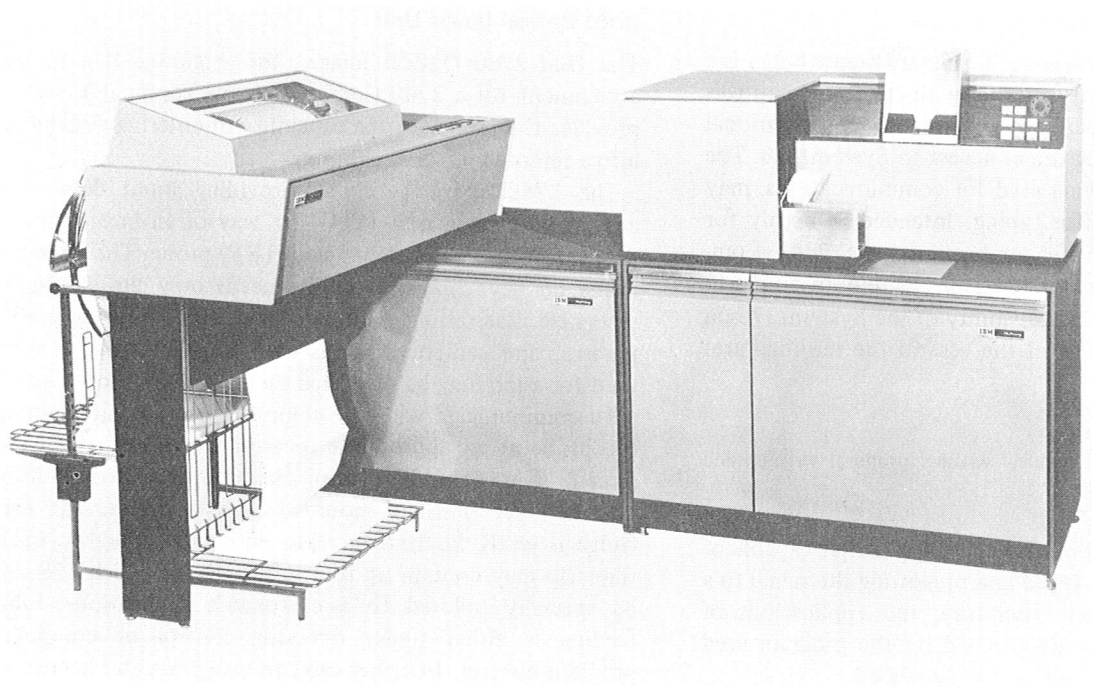


Figure 8-12. IBM 2780 Data Transmission Terminal

The 2780, available in four models with any of three codes, permits a variety of system configurations. The four models are:

Model 1–Card read or print
Model 2–Card read or card punch or print
Model 3–Print only (used as a receiving terminal only)
Model 4–Card read or card punch

Models 1-3 print at a maximum speed of 300 lines per minute. The actual speed depends on the communications facilities used and the number of characters in the character set:

39-character set –300 lines per minute
47/52-character set–240 lines per minute
63-character set –200 lines per minute

Models 1, 2, and 4 read at a maximum speed of 400 cards per minute; each contains one card stacker.

Models 2 and 4 punch at a maximum speed of 355 cards per minute.

The actual throughput speed of the card read punch depends on the number of card columns that are read or punched, the code used, and the communications facilities selected.

The 2780 can also be used offline to perform a card-reader-to-printer listing operation. The 2780 is capable of operating with any one of three code structures. The choice depends on the application. However, for system compatibility, the same code must be chosen for all terminals on a particular communications line. The three available codes are: the six-bit transcode (six-bit transmission code), EBCDIC (extended binary coded decimal interchange code), and USASCII.

The communication can be point-to-point with another 2780 (Figure 8-13), or it can be either point-to-point or multipoint (special feature) with the System/370 through a 2701 Data Adapter Unit or a 2703 Transmission Control Unit (Figure 8-14). The 2701 Data Adapter Unit must be equipped with a synchronous data adapter type II (SDA-II), and the 2703 Transmission Control Unit must be equipped with a synchronous base type 1A or 1B adapter. The 2780 operates in half-duplex mode over any of the following five communications facilities:

1. Common-carrier switched telephone network.
2. Common-carrier leased private line telephone service, either two-wire or four-wire.
3. Western Union class E channels.
4. Western Union class F channels.
5. Privately-owned communications facilities.

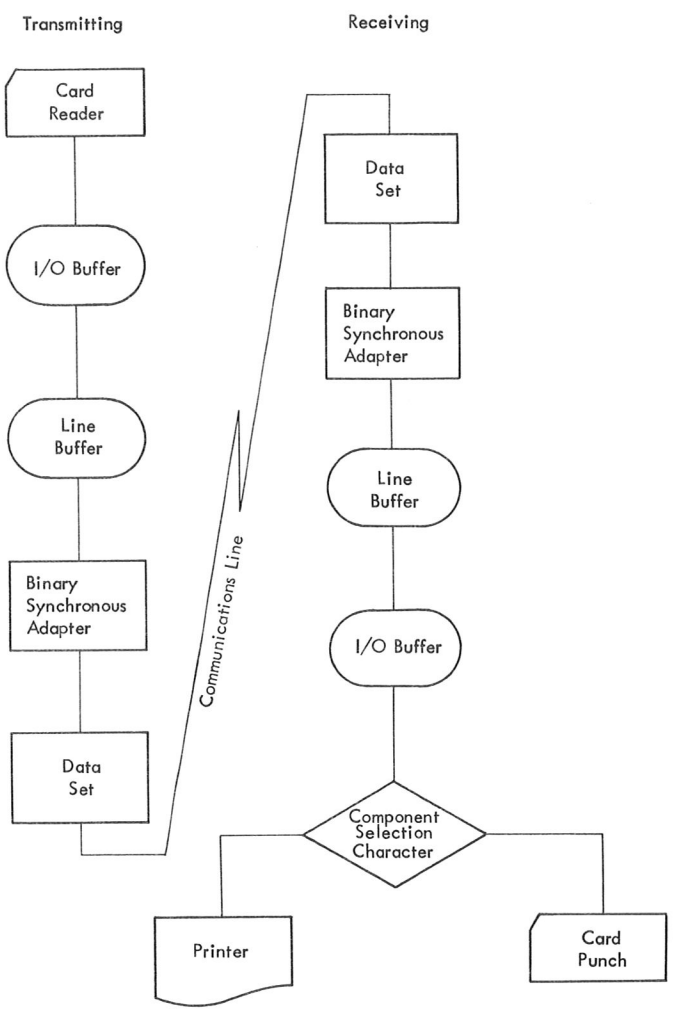


Figure 8-13. Data Flow, Terminal-to-Terminal Operation

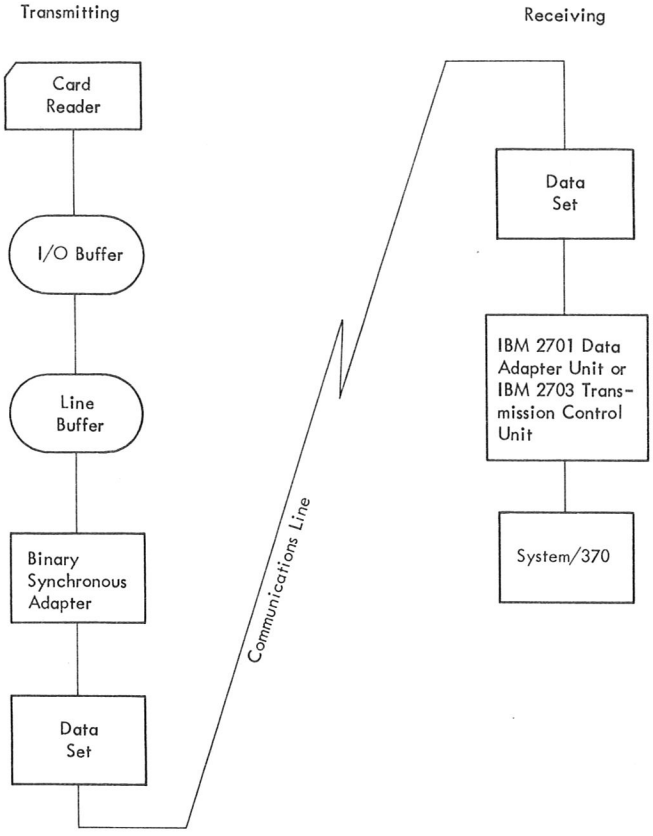


Figure 8-14. Data Flow, Terminal-to-Computer Operation

3735 Programmable Buffered Terminal

The IBM 3735 Programmable Buffered Terminal consists of a specially designed keyboard coupled with a Selectric® II Printer (Figure 8-15). Under program control, the 3735 stores information generated during source-document preparation for later transmission to a central System/370. Typically, the IBM Selectric keyboard printer prepares preprinted (fixed-format) forms and stores a full day's operator output for unattended transmission to the CPU, and the CPU can return data for use in the next day's operation.

In a typical installation, the 3735 can be used in an office for order entry, billing, inventory control, claims (related policies), or any accounting operations. During daily document preparation the 3735 provides operator guidance (setup instructions, exception messages, indication of keying or procedural errors); programmed forms control (automatically positioning data within the predefined fields); format and edit operations (center, left/right justify, underline, character fill, decimal-comma insertion); logical decisions (conditional field skipping and entry); arithmetic operations (add, subtract, multiply, and divide); and power typing (automatic printing of information previously entered or internally generated).

A disk storage device within the control unit contains the terminal control program, form description programs, and user data storage. Basic storage capacity is about 62,800 bytes. The storage capacity is expandable in increments of 41,800 bytes to a total capacity of approximately 146,400 bytes.

The 3735 uses the binary synchronous method of communications line control; thus it is compatible with most systems and programs using this method of line control. Transmission may be 1,200, 2,000, or 2,400 bps.

Standard features include:

Switched Network Operation, which permits communications transfer through telephone lines normally used for dialed telephone calls.

Auto Answer, which permits transmission and reception of messages on an unattended basis.

Optional features include:

Synchronous Clock, for use with data sets that do not have an internal clock.

Keylock, a key-operated security switch on the control unit, which limits I/O operation of the keyboard/printer.

Forms Stacker, which permits placement of continuous forms (out of carton) on the stand above floor level, and provides for forms stacking after printing.

Multipoint Data Link Control, which allows multiple 3735's to be used on the same communication line with a CPU.

5496 Attachment, to attach to 5496 Data Recorder.

Figure 8-15. IBM 3735 Programmable Buffered Terminal

Display Devices

2260 Display Station Models 1 and 2; 2848 Display Control Models 1, 2, and 3

The IBM 2260 Display Station operates through the IBM 2848 Display Control in both local and remote applications. In remote applications, the 2848 communicates with a central System/370 installation via common-carrier communications facilities, a 2701 Data Adapter Unit, and appropriate data sets.

A choice of two data set adapters permits data transmission, in duplex mode, at 1,200 or 2,400 bits per second (120 or 240 bytes per second). The bytes include the start, stop, and check bits transmitted with each seven-bit character.

For more information about the 2260 and 2848, see "Display Devices," Section 7.

2265 Display Station; 2845 Display Control

An IBM 2265 Display Station (Figure 8-16), coupled with an IBM 2845 Display Control, forms a display system that provides rapid visual access (via communications facilities) to data stored in a remotely located System/370. This display system is ideally suited to applications that require immediate data acquisition capabilities at a relatively low cost. Inquiries concerning an account, a transaction, or a production schedule can be sent quickly and easily to a remote System/370 from the keyboard of the 2265. After computer processing, the desired visual data is displayed on the 2265 screen and can then be analyzed, modified if necessary, and, when desired, returned to the computer for further processing and storing.

The 2265/2845 display system is similar in function to the 2260/2848 display system and is fully compatible with those units. A possible 2265/2845 configuration is shown in Figure 8-17. Note that only one 2265 can be attached to a 2845.

The 2265 contains a 14-inch cathode-ray tube on which as many as 960 alphameric characters can be displayed. Two display formats are available: 15 lines with 64 characters per line (10.4-inch by 4.8-inch frame) and 12 lines with 80 characters per line (10.4 inch by 3.12 inch frame). The 2265 is equipped with an alphameric keyboard, which can be located up to 5 feet from the display screen.

A nondestructive cursor, an automatically inserted visual marker denoting the position on the 2265 screen that the next character to be entered will occupy, is standard on the 2265. It appears as _ immediately below the next character to be entered and may be moved about freely without interference to characters on the screen. The destructive cursor, an optional feature, appears on the screen as a heavy horizontal bar (—). When the destructive cursor is moved to a character position containing a character, the character is erased.

Figure 8-16. IBM 2265 Display Station with Alphameric Keyboard

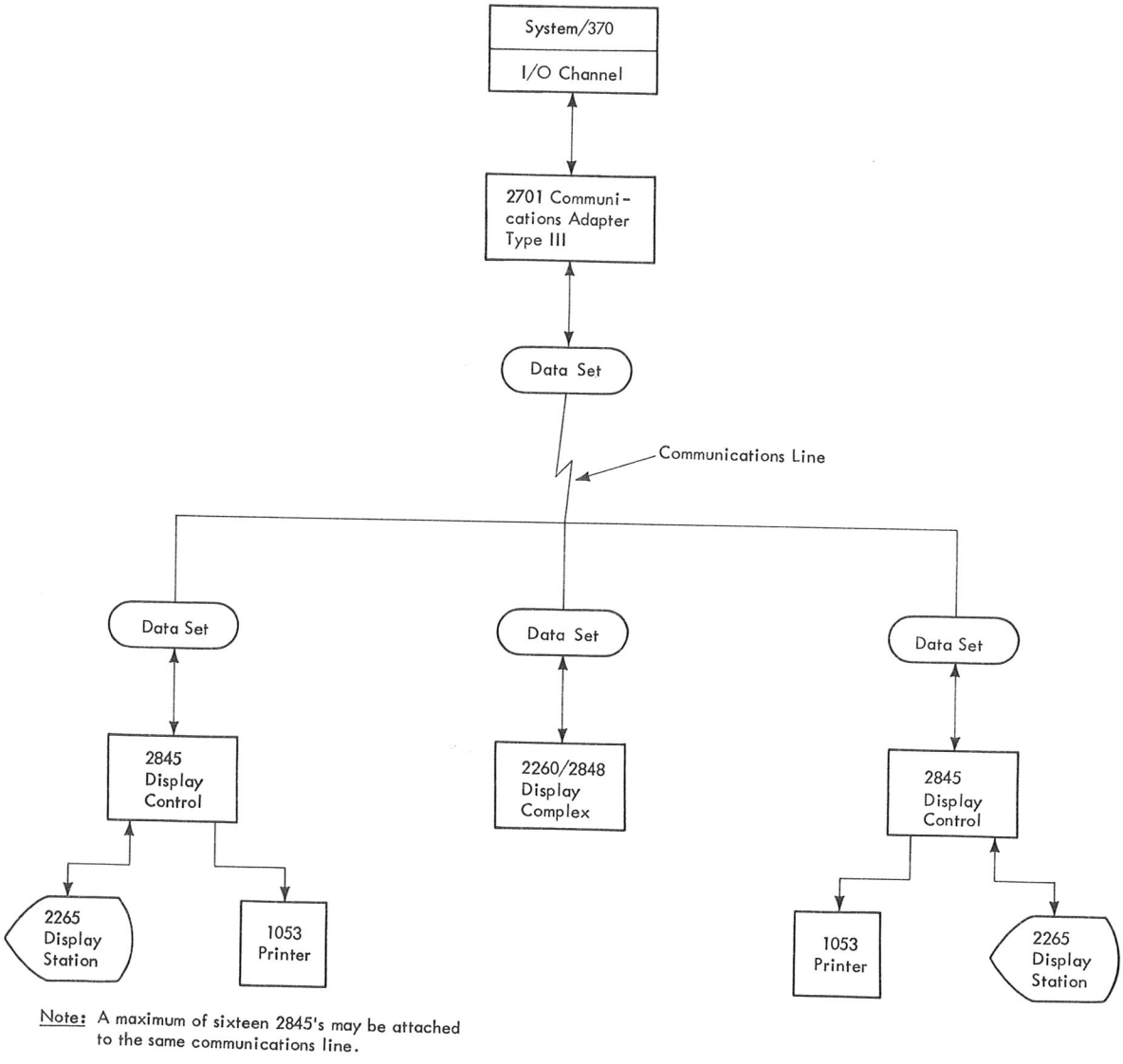


Figure 8-17. Typical Connection on an IBM 2845 Display Control to a Remote CPU in a Multidrop (Multistation) Communication Network

The 2845 is designed for remote attachment to a System/370 I/O channel through a 2701 Type III Communications Adapter. The 2845 transmits data over ordinary leased telephone lines in stop/start, half-duplex mode at speeds of 1,200 or 2,400 bits per second. As many as sixteen 2845's may be attached to the same communications line.

An optional line addressing feature and a 1053 adapter feature are available. The line addressing feature permits the writing of a CPU-generated message to begin at the start of any chosen line. The 1053 adapter feature permits the attachment of a 1053 Printer Model 4 to a 2845 Display Control for obtaining paper copy of data sent from the CPU or displayed on the 2265 screen.

Systems

1030 Data Collection System

The IBM 1030 Data Collection System (Figure 8-18) provides a fully integrated online data collection system, capable of operating within one plant or between plants. The various components of the 1030 system together form an effective management information system that diminishes the gap between the time when data is originated and the time when it becomes available for use. Some of the applications of the 1030 system include:

Scheduling
Dispatching
Attendance reporting
Inventory maintenance
Labor distribution and performance

The 1030 system collects digital information from diverse reporting stations and transmits it at 60 characters per second to a central System/370 for recording, processing, and analyzing.

Connection to the System/370 is effected via either the 2701 Data Adapter Unit or the 2702 or 2703 Transmission Control. Transmission occurs over half-duplex privately-owned communications lines or common-carrier leased private lines.

Units that may be combined into a 1030 configuration include:

IBM 1031 Input Station
IBM 1032 Digital Time Unit
IBM 1033 Printer (online systems only)
IBM 1035 Badge Reader

1031 Input Station enables the 1030 system to accept input data in various forms; the system can accept alphameric data from standard 80-column punched cards and numeric data from punched plastic badges, manual entry units, and data cartridges. As many as 24 IBM 1031's can be attached to a 1030 system.

1032 Digital Time Unit provides time-of-day information for the entire data collection system.

1033 Printer provides online 1030 Data Collection Systems with printed output at locations remote from the central System/370. 1033 printers, in combination with 1031 input stations, offer full online inquiry and reply capabilities with the System/370 processing unit.

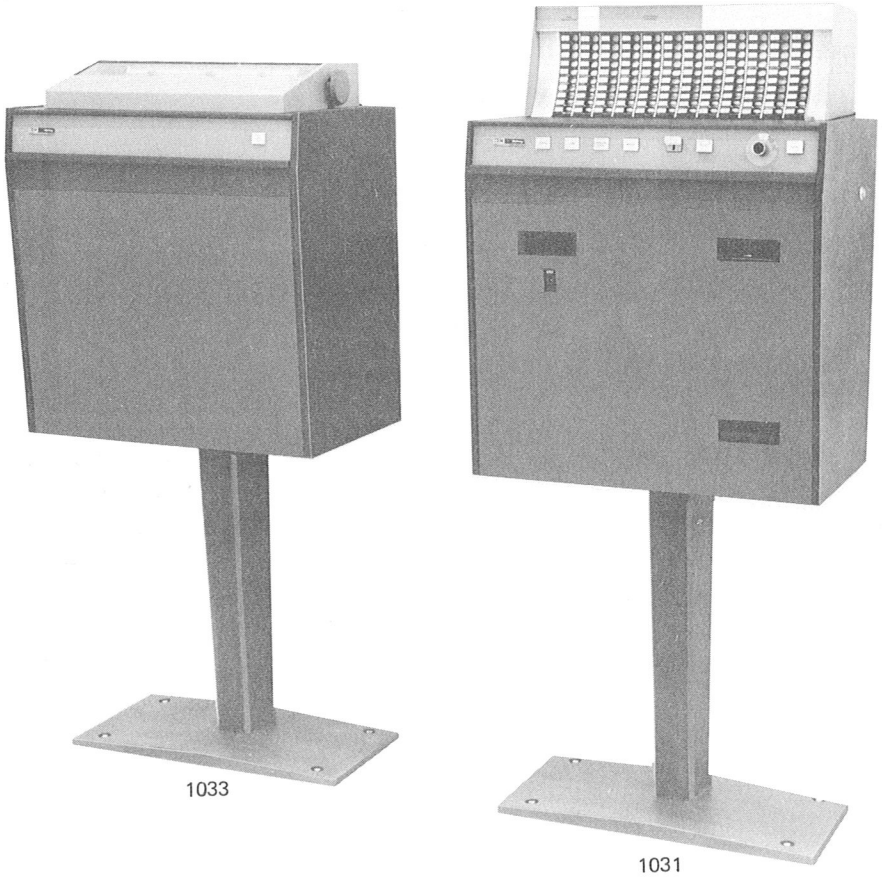


Figure 8-18. Units of an IBM 1030 Data Collection System: IBM 1033 Printer and IBM 1031 Input Station

1035 Badge Reader transmits numeric data at 60 characters per second from 22-column (card-stub size) badges via a 1031 Input Station. As many as four 1035's can be connected to a 1031. Functionally, the 1035 Badge Reader units can be thought of as providing an extension of the badge reading capability of the 1031 unit with which they are associated.

1050 Data Communication System

The IBM 1050 Data Communication System (Figure 8-19) is a multipurpose office-oriented teleprocessing system. This versatile system is designed for a wide range of applications in such industries as:

Transportation	Distribution
Manufacturing	Insurance
Research	Refining

In particular, the 1050 system can perform such functions as:

Document Writing of sales orders, insurance policies, payrolls, engineering specifications, etc.

Direct Inquiry and Response (real-time operation) with a central processing unit.

Remote Printing of business records and invoices, thus supplying to remote locations full documentation of business transactions.

Exception Reporting of data about work orders, credit ratings, inventory adjustments, traffic movements, etc.

Intracompany Communication to provide rapid distribution of memorandums, directives, administrative reports, etc.

The 1050 Data Communication System can be connected to System/370 via the 2701 Data Adapter Unit, the 2702 or 2703 Transmission Control, or the 2712 Remote Multiplexer. Transmission can occur at 14.8 characters per second in half-duplex mode over leased private, common-carrier switched, or privately owned telephone networks, and either directly between locations, through switching centers, or through message exchanges. The 1050 system is capable of simultaneous home-loop operation (local operation between units of the same 1050 configuration) and line-loop operation (over communications lines to another 1050 system or a System/370).

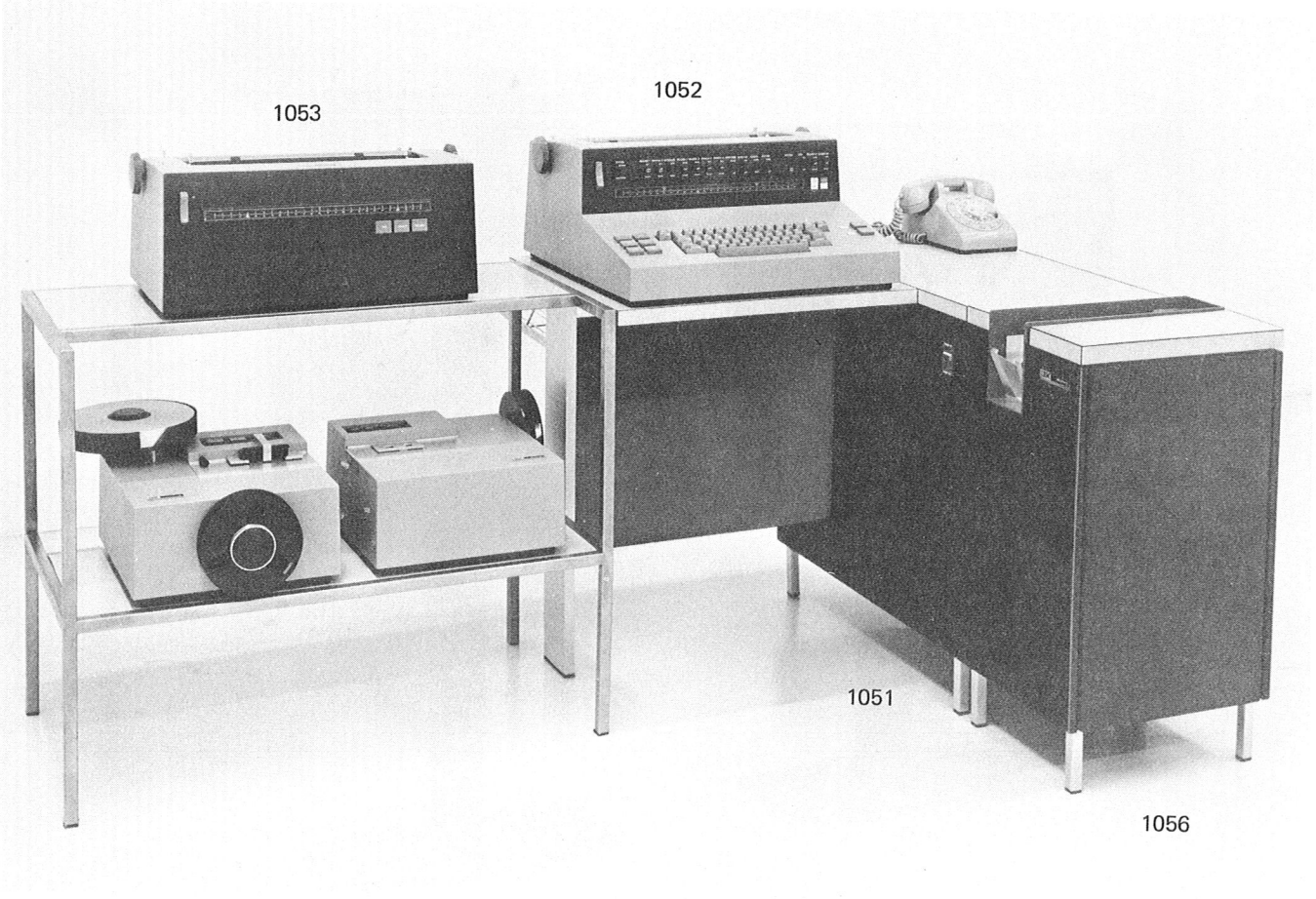


Figure 8-19. IBM 1050 Data Communication System

Data may be entered into the 1050 system by manual keying, by punched cards, by punched paper tapes, and by edge-punched documents. Output from the system may be printed documents, punched cards, punched paper tape, or edge-punched documents.

The versatility of the 1050 system is due in large part to the many configurations it may assume. The minimum configuration contains only an IBM 1051 Control Unit and a receive-only printer; configurations for a wider variety of uses may be designed from combinations of the following available components:

1051 Control Unit
1052 Printer-Keyboard
1053 Printer
1054 Paper-Tape Reader
1055 Paper-Tape Punch
1056 Card Reader
1057/1058 Card Punch or Printing Card Punch
1092 and 1093 Programmed Keyboards

The 1051 Control Unit is required in all configurations. It contains the power supply, code translator, data channels, and control circuitry for the 1050 system. All components are electrically connected through the control unit.

For information about the direct connection of 1050 system components to System/370, see the descriptions of the 1051 Control Unit and the 1052 Printer-Keyboard under "Manual Controls" in Section 7. For information about the 1092 and 1093 Programmed Keyboards, see "1092 and 1093 Programmed Keyboards," Section 8.

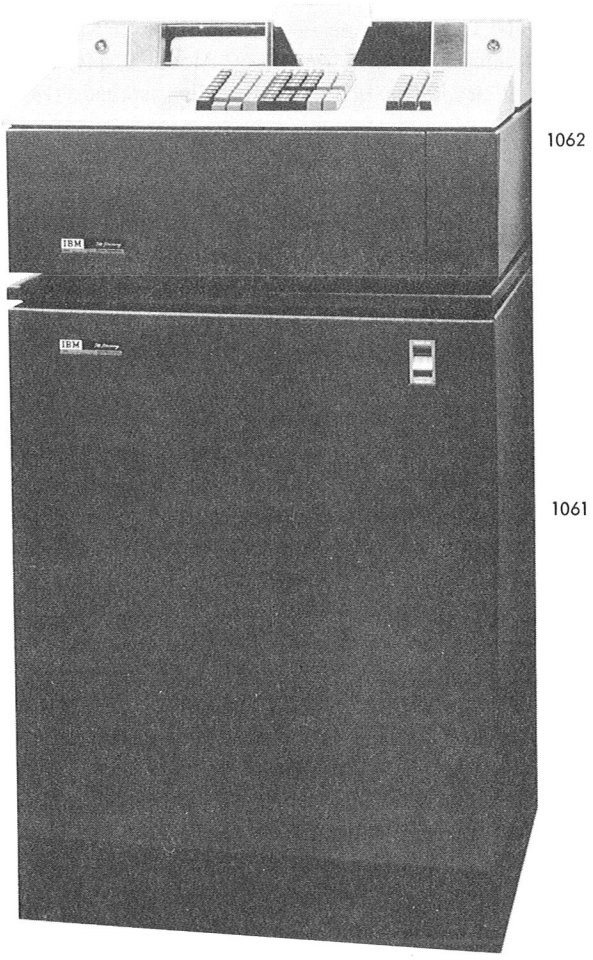


Figure 8-20. IBM 1060 Data Communication System

1060 Data Communication System

The IBM 1060 Data Communication System (Figure 8-20) improves services in such institutions as savings banks, savings and loan associations, and commercial banks. It brings the speed and power of the modern computer to the tellers' windows of these institutions, efficiently performing the many accounting functions associated with any particular bank transaction. With this system, any teller, at any window, both at the bank's main office and at its widely scattered branch offices, can access all necessary records for any customer. As the daily transactions proceed, the 1060 system provides each customer with an accurate, updated record of his account. The system also provides each teller with this same account information and continuously maintains his balance on hand.

Using the IBM 1062 Teller Terminal, a teller can key transaction information from his window to a remotely located System/370. After System/370 verifies the accuracy of the transmitted information and updates its records, it causes the teller terminal to print out on a customer's passbook any unposted interest, the current transaction amount, and the new balance in his account. The terminal also prints a complete record of both the transmitted and received data on the teller's terminal-record tape. If the system discovers any exceptional conditions, such as an account tied up in estate or uncollected funds, it immediately informs the teller of these conditions.

The 1060 system, when joined via communications lines with a System/370, forms a complete teleprocessing system. To the System/370, the 1060 appears as a terminal. Connection of the two systems requires either a 2701 Data Adapter Unit or a 2702 or 2703 Transmission Control. Transmission occurs at 14.8 characters per second in half-duplex mode. An odd parity BCD code is used for transmission.

The 1060 system comprises two compact units:

IBM 1061 Control Unit: The 1061 is basically the electronic unit of the system. It contains the central logic, code translators, accumulators, data channels and control circuitry for the system and supplies power to the 1062. The 1061 supplies the line control governing transmission of data to and from a 2701, 2702, or 2703.

A 1061 Model 1 controls one 1062 Teller Terminal Model 1. A 1061 Model 2 controls one 1062 Model 1 and one 1062 Model 2 or, if the offline feature is installed, two 1062 Model 1's.

IBM 1062 Teller Terminal: The 1062 is basically the mechanical unit of the system. The 1062 contains a print unit, a terminal-record tape, a document feed, a keyboard, a program tape unit (Model 1 only), and various keys, lights and switches. Each 1062 terminal can serve two tellers.

1130 Computing System

The IBM 1130 Computing System, when equipped with a synchronous communications adapter, can function as a remote processor terminal to a centrally located System/370 and as a local standalone computer, and can easily switch from one function to the other.

The 1130 itself, an economical and compact general-purpose system, is particularly easy to use. The person needing computer solutions to his problems can learn to use the system with a minimum of training and experience. In addition, IBM relieves the user of detailed programming and provides for the statement of problems in familiar language.

The basic system consists of an IBM 1131 Central Processing Unit (Figure 8-21) with an integral console printer and keyboard, and either punched card or paper tape I/O devices. The central processing unit (CPU) contains main storage, logic circuits, and attachment controls for the I/O devices. The 1131 uses a high-speed data channel for effective simultaneous operation of I/O devices. This unit features parallel arithmetic and indirect addressing, and has three index registers.

The I/O devices available to the 1130 include:

1055 Paper Tape Punch Model 1
1132 Printer Model 1 or 2
1134 Paper Tape Reader Model 1
1231 Optical Mark Page Reader Model 1
1403 Printer Model 6 or 7
1442 Card Punch Model 5
1442 Card Read Punch Model 6 or 7
1627 Plotter Model 1 or 2
2250 Display Unit Model 4
2310 Disk Storage Models B1 and B2
2501 Card Reader Model A1 or A2

Operated as a remote processor terminal, the 1130 system (equipped with a synchronous communications adapter) can communicate with a System/370 over common-carrier-provided facilities or over privately owned facilities. The 1130 communicates with System/370 usually by way of a 2701 Data Adapter Unit or 2703 Transmission Control. Data communications are half-duplex and are transmitted at 600, 1,200, 2,000, 2,400 or 4,800 bits per second, the rate depending on what communications facilities are used. Common-carrier services for these communications may be either half-duplex or duplex.

2770 Data Communication System

The IBM 2770 (Figure 8-22) is a general-purpose terminal system designed for batched-data transmission as well as for inquiry-and-response communications. It transmits and receives data through a variety of input and output devices, and can communicate with System/370 via point-to-point and multipoint communications lines.

This terminal provides for transmission of bulk data via punched cards, punched tape, magnetic tape (IBM 50 Magnetic Data Inscriber cartridges), or magnetic-ink-encoded documents. For inquiry and data-entry applications, the 2770 uses a keyboard, display station, or printer.

Available to the system in different combinations are:

50 Magnetic Data Inscriber
545 Output Punch Model 3 (nonprinting) or 4 (printing)
1017 Paper Tape Reader Model 1 or 2
1018 Paper Tape Punch
1053 Printer Model 1
1255 Magnetic Character Reader
2203 Printer Model A1 or A2
2213 Printer Model 1 or 2
2265 Display Station Model 2
2502 Card Reader Model A1 or A2
5496 Data Recorder

The 2770 uses an IBM 2772 Multi-purpose Control Unit to attach and control the different I/O devices, and to transmit data. This unit transmits data on telephone-grade lines at 1,200, 2,000, and 2,400 bits per second, using binary synchronous communications (BSC) techniques. The 2772 can attach to a multipoint line facility with other BSC-equipped devices and systems, such as a 2780 Data Transmission Terminal, 1130 Computing System, or System/360 Model 20, using a System/370 as the control station for the multipoint network.

Among the 2770's standard features are an alphameric keyboard, two 128-character buffers, and an audible alarm (to alert the operator when intervention is required).

The 2770 system has applications in diverse areas of business, government, and private and public institutions. In a business operation for example, it may be used in management offices for data collection and for inquiry and display; in business offices for payrolls and accounting; in manufacturing plants for production and quality reports; in warehouses for shipping and receiving information and for parts inventory; and in sales offices for ordering, invoicing, and sales information.

Optional Features

Buffer Expansion doubles the capacity of the two buffers, which increases line efficiency.

EBCDIC Line Transparency enables the 2770 to send and receive control characters as data, negating their control function. This feature is required in some applications.

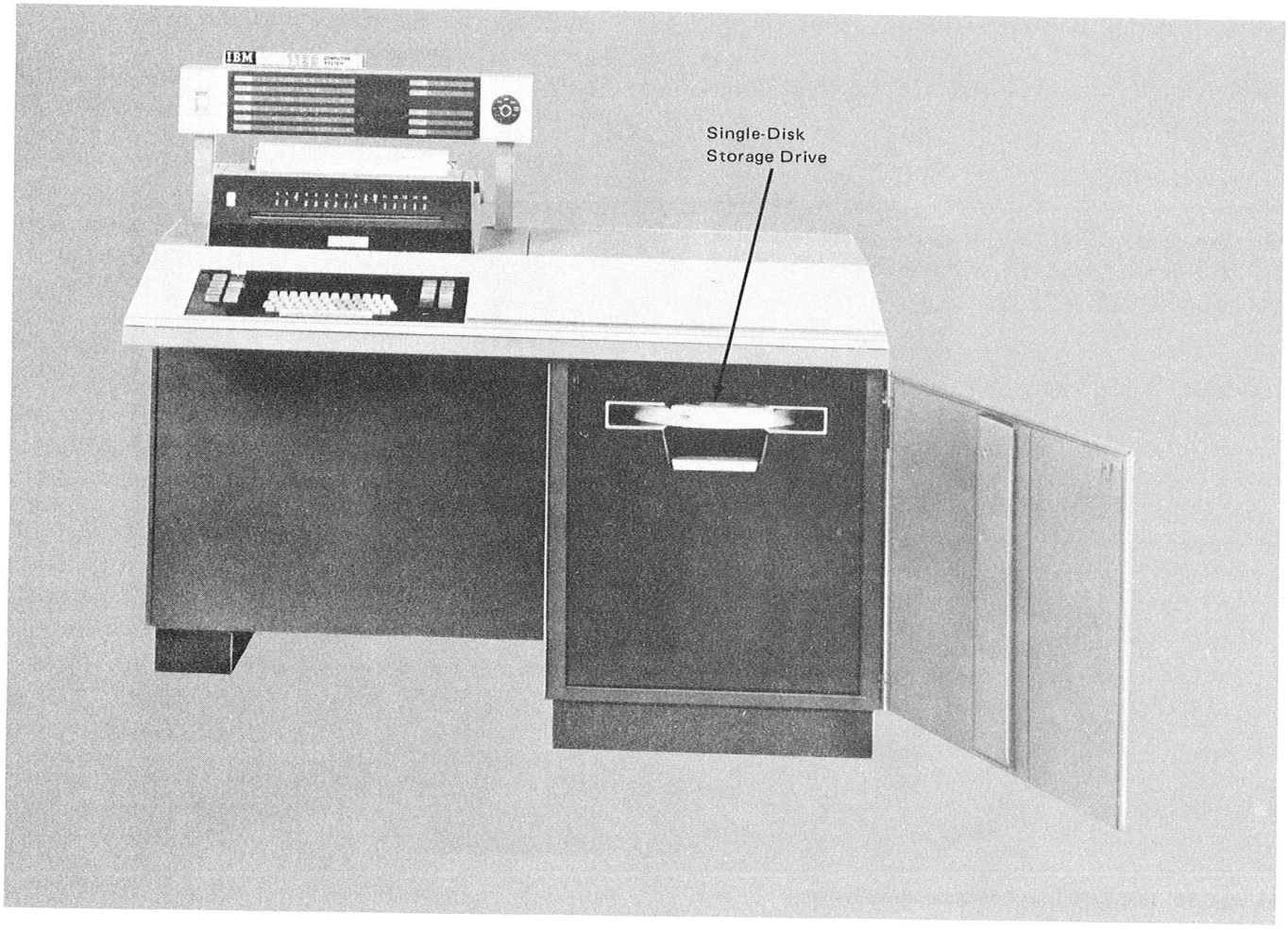


Figure 8-21. IBM 1131 Central Processing Unit Model 2A or 2B, with Single-Disk Storage Drive

Multipoint Data Link Control allows more than one 2770 to be connected to a multipoint line.

Identification allows a 2770 on a switched network to identify itself as a 2770.

Keyboard Correction provides for correcting keyed data in the buffer.

Automatic Answering permits automatic handling of incoming calls from a central computer or another terminal, over common-carrier switched facilities.

2790 Data Communication System

The 2790 Data Communication System (Figure 8-23) is a two-way in-plant data communication and production reporting system. It provides for rapid information transfer from 2795 or 2796 Data Entry Units (located at various plant sites) to 2791 or 2793 Area Stations, which connect to a system controller and processor (Figure 8-24). The 2790 also provides for interrogation of a System/370.

In a typical application, the 2790 system can be used as a shop-floor control system to collect information on machine operations, work progress, stock status, material availability, and quality control. The area stations and 1035 Badge Readers can be used as a high-speed attendance-reporting system. The area stations can also be used to retrieve information stored in System/370.

The 2790 system, when attached to a System/370, can consist of various combinations of the following units:

2715 Transmission Control Unit (one)
2791/2793 Area Stations (up to 100)
2795/2796/2797 Data Entry Units (up to 32 per 2791 Model 1 or 2793, to a maximum of 1,024)
1035 Badge Readers (up to three per 2791-1)
1053 Printers (one per 2791-1 or 2793)
2740 Communication Terminal (one)
2798 Guidance Display Units (up to 12)
Customer-provided digital devices

2715 Transmission Control Unit Models 1 and 2 provide terminal control, transaction assembly, data-entry checking, message routing, transaction storage, and transfer of data to and from a System/370. The 2715 Model 1 is used for local

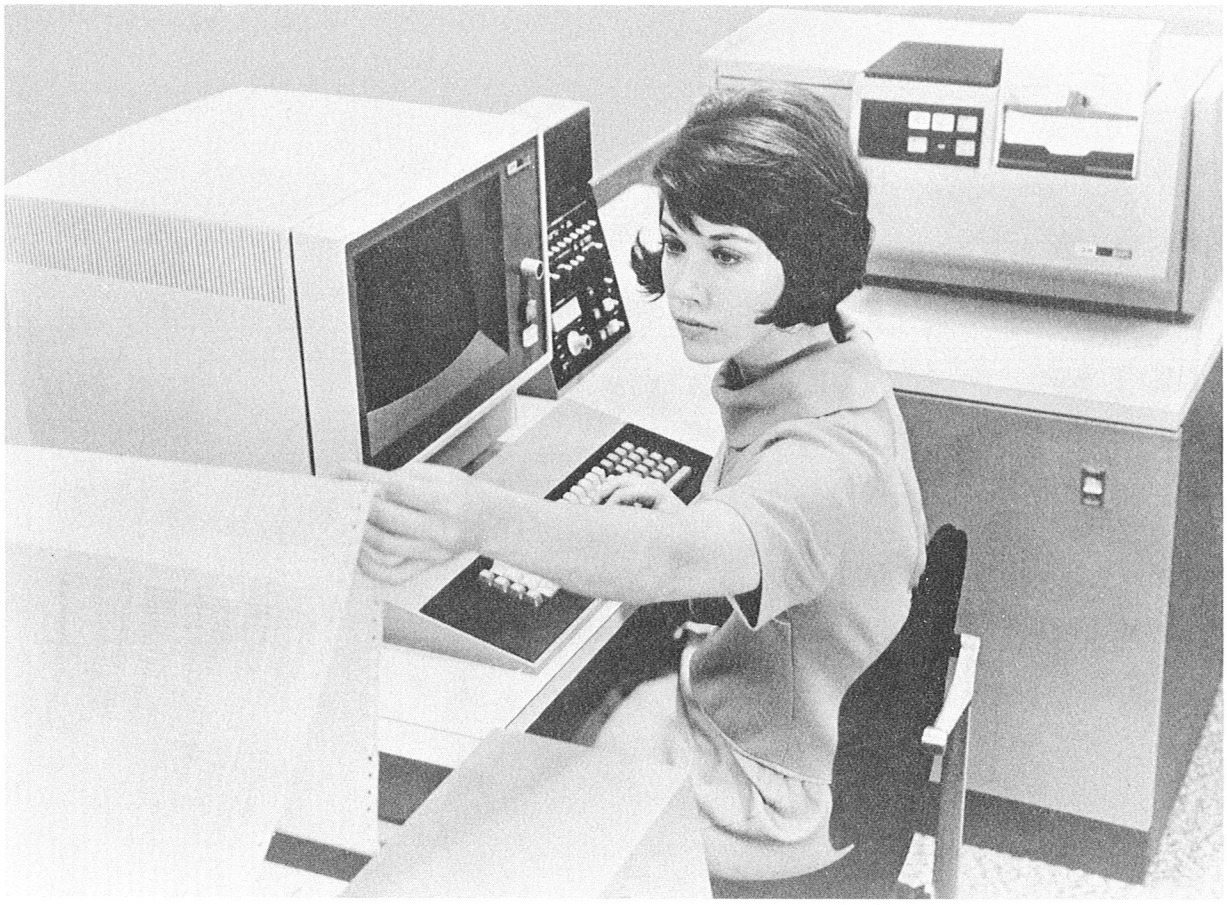


Figure 8-22. IBM 2770 Data Communication System

operation with a System/370, and the 2715 Model 2 (with binary synchronous communications adapter) is used for remote operations.

The 2790 permits data entry through 2795, 2796, and 2797 Data Entry Units attached to 2791-1 or 2793 Area Stations. The 2791-1 permits data entry by punched card, employee badge, and key entry. A program-controlled display panel guides the operator in entering data, and a visual display panel permits verification of keyed data prior to transmission. (All these functions are also performed by the 2791-2).

Both the 2791-1 and 2793 can attach up to 32 data entry units and a 1053 Printer. The 2791-1, however, can also attach customer-provided digital read-in devices and up to three 1035 Badge Readers.

The 2795, 2796, and 2797 Data Entry Units are compact industrial units for reporting job and machine status and production information. Designed for use by production employees at their work location, these units transmit up to 40 characters per second to the 2791 Model 1 or 2793 Area Station by way of a two-wire line.

The 2795, 2796, and 2797 are similar in that they permit data entry by punched card, badge, and ten-position code-selection dials. They differ in that the 2795 and 2797 have two dials compared to the 2796's four. They differ also in that the 2796 and 2797 both have manual entry—the 2796 via four rocker thumbwheel switches, the 2797 via a ten-key keyboard with six-digit visual display.

The 2798 Guidance Display Unit is a versatile and compact data entry and output unit for multistep interactive transactions. This buffered unit features a 56-character alphameric keyboard, eight control keys, and a 16-position visual display for verification of keyed data before transmission. The 2798 attaches via a 2791-1 or 2793 Area Station.

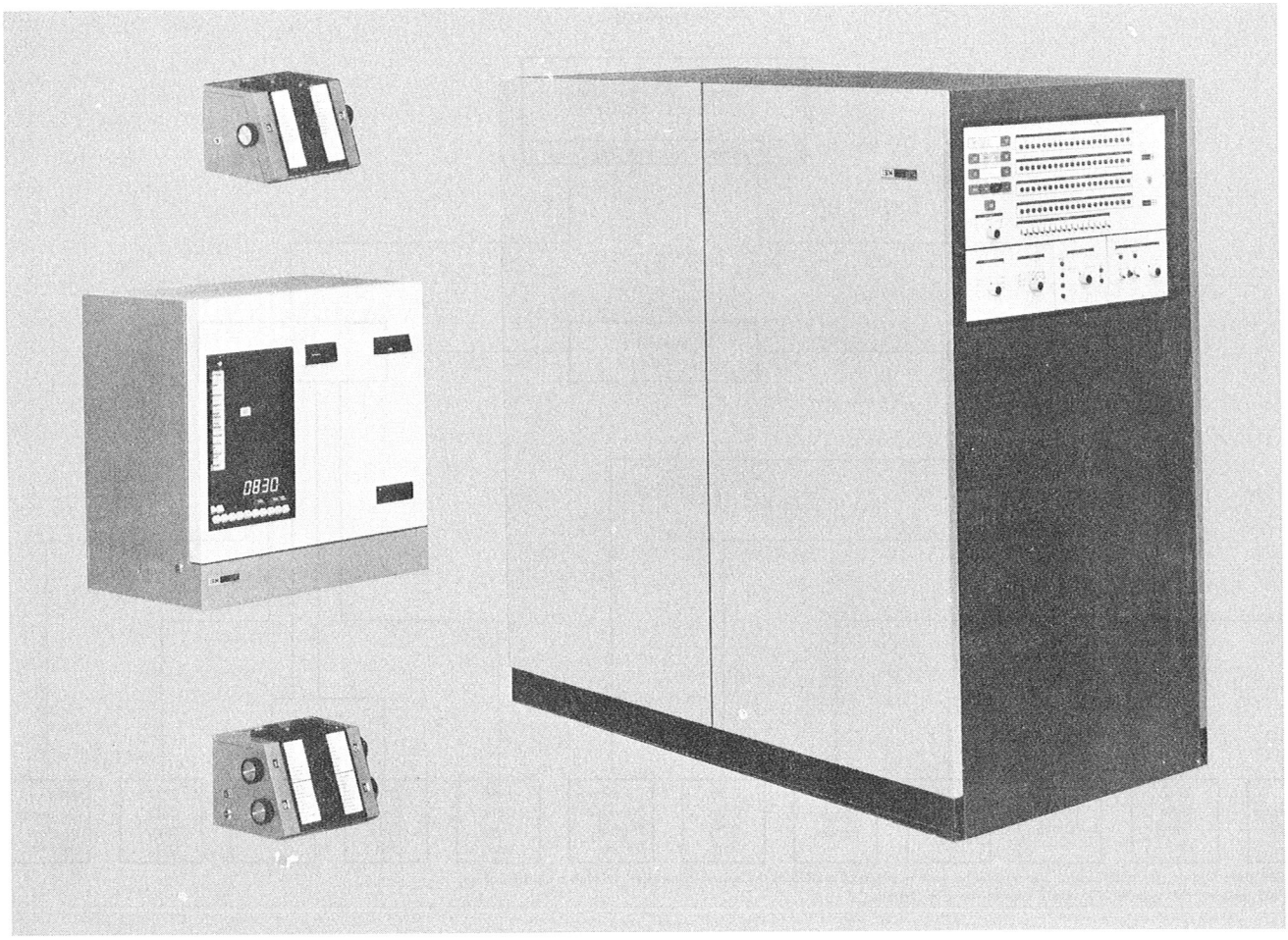


Figure 8-23. Several Units of the IBM 2790 Data Communication System

3270 Information Display Station

The IBM 3270 Information Display System (Figure 8-25) is a group of display stations, control units, and printers that meets the alphameric display requirements of inquiry, data entry, source recording, transaction processing, and manual input from the display operator console. Attached remotely, the 3270 system provides line speeds of up to 4,800 bits per second (bps). (The locally attached 3270 is discussed in Section 7 under "Systems.")

In this system, multiple keyboards can be provided for work station flexibility. For example, records may be changed or updated faster and key entry volume may be substantially increased because the transactions are online. The number of display stations that can be supported by a single communications line is greatly increased over previously announced display systems.

The 3270 system may be a single device or it may consist of up to 32 devices. The system can include 480- or 1,920-character display stations and 40- or 66-character printers. The entire system is also compatible with other binary synchronous communications (BSC) devices.

A remote 3270 (Figure 8-26) is made up of combinations of the following units:

3271 Control Unit Model 1 or 2
3275 Display Station Model 1 or 2
3277 Display Station Model 1 or 2
3284 Printer Model 1, 2, or 3
3286 Printer Model 1 or 2

3271 Control Unit Models 1 and 2

The IBM 3271 Control Unit permits *remote* attachment of a 3270 system to a System/370. The system may include IBM 3275 and 3277 Display Stations, and IBM 3284 and 3286 Printers.

The 3271 Model 1 has a 480-character buffer, and attaches any of the Model 1 I/O devices. The 3271 Model 2 has a buffer capable of handling devices of up to 1,920 characters, and attaches any of the Model 1 or Model 2 I/O devices. (The mandatory 3277 display station must be a Model 2.)

The 3271 provides attachment of up to 32 separate I/O devices, and permits transmission speeds of 1,200, 2,000, 2,400, or 4,800 bps.

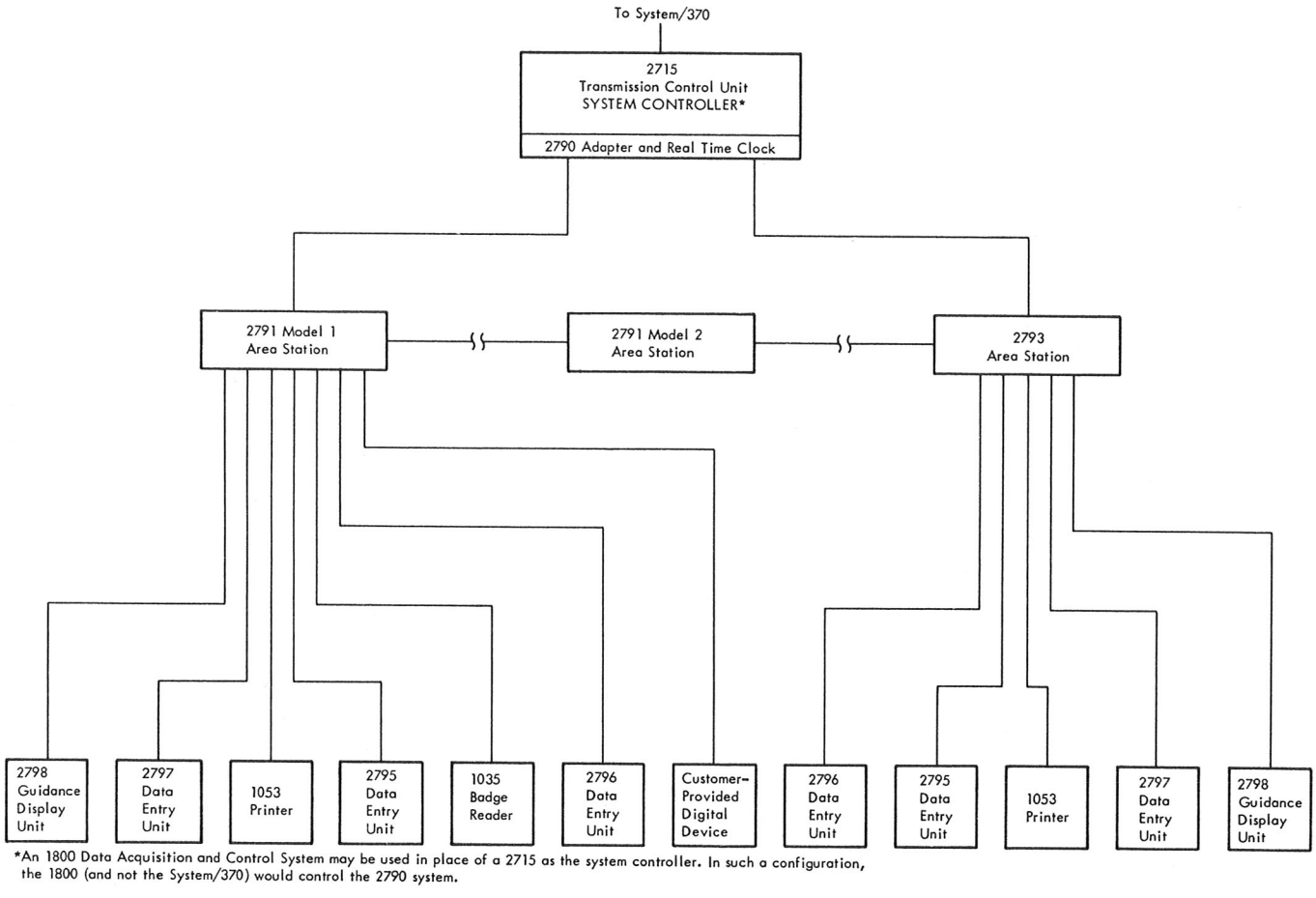


Figure 8-24. A Simplified Configuration of a 2790 Data Communication System

3275 Display Station

The IBM 3275 Display Station provides control and display of alphameric information on its screen. The Model 1 displays 480 characters in 12 lines of 40 characters each. The Model 2 displays 1,920 characters in 24 lines of 80 characters each. Basic features include dual brightness, protected data, compacted data, and character addressing. Both models use the EBCDIC character set; both have ASCII character sets available as optional features.

The 3275 Display Station Model 1 or 2, as a standalone remote display system (Figure 8-26), provides added convenience for locations requiring a single display device. The 3275 does not require a control unit and is, therefore, more economical than a control unit with a 3277 Display Station attached. The 3275 can be expanded by attaching a 3284 Printer Model 3 to provide a paper copy of computer messages.

3277 Display Station

The IBM 3277 Display Station uses a CRT for display, and a keyboard or light pen (or both) to permit an operator to display and manipulate alphameric data on the screen. The Model 1 has a 480-character buffer and a 40-character/sec printout rate. The resultant 12 lines of 40 characters include 36 alphameric and 27 special characters. The Model 2 has a 1,920-character buffer and a display of 24 lines of 80 characters each.

Individual fields of data on the screen can be program-defined for attributes such as protected or unprotected storage, alphameric or numeric displays, non-displays, and normal or brightened character intensity. Program definition may also allow or disallow selector light-pen detection.

3284 and 3286 Printers

The IBM 3284 Printer Model 1 has a 480-character buffer and a 40-character/sec printout rate. The Model 2 has a 1,920-character buffer and a 40-character/sec printout rate. The Model 3 has no buffer; the printout rate is 40 character/sec.

The IBM 3286 Printer Model 1 has a 480-character buffer and a 66-character/sec printout rate. The Model 2 has a 1,920-character buffer and a 66-character/sec printout rate.

Both printer types use the EBCDIC character set; both have ASCII character sets available as optional features.

Figure 8-25. IBM 3270 Information Display System

Example Display System Configurations

At least one display station *with a keyboard* must be attached to a control unit. A buffer in the device (display station or printer) stores digitally-coded data from the control unit for display or printing. The buffer permits simultaneous message composition from a keyboard and display image presentation at each display station.

Optional System Features

Optional features include:

Keylock, which provides key-operated security control of the display image.

Selector Light Pen, which provides selection of parts of a display image for further processing.

Copy, which provides copy facility from one display to another display or to a printer.

Audible Alarm, which sounds when a character is entered into the next-to-last position on the screen.

Non-displayed Keying Mode, which permits data to be entered into the system but not displayed on the screen.

Operator Identification Card Reader, which reads encoded information from a magnetically-striped plastic card that identifies the operator.

Keyboard, which provides selection of input from data entry, typewriter, or operator console. (Typewriter and operator console keyboards are available with or without function keys.)

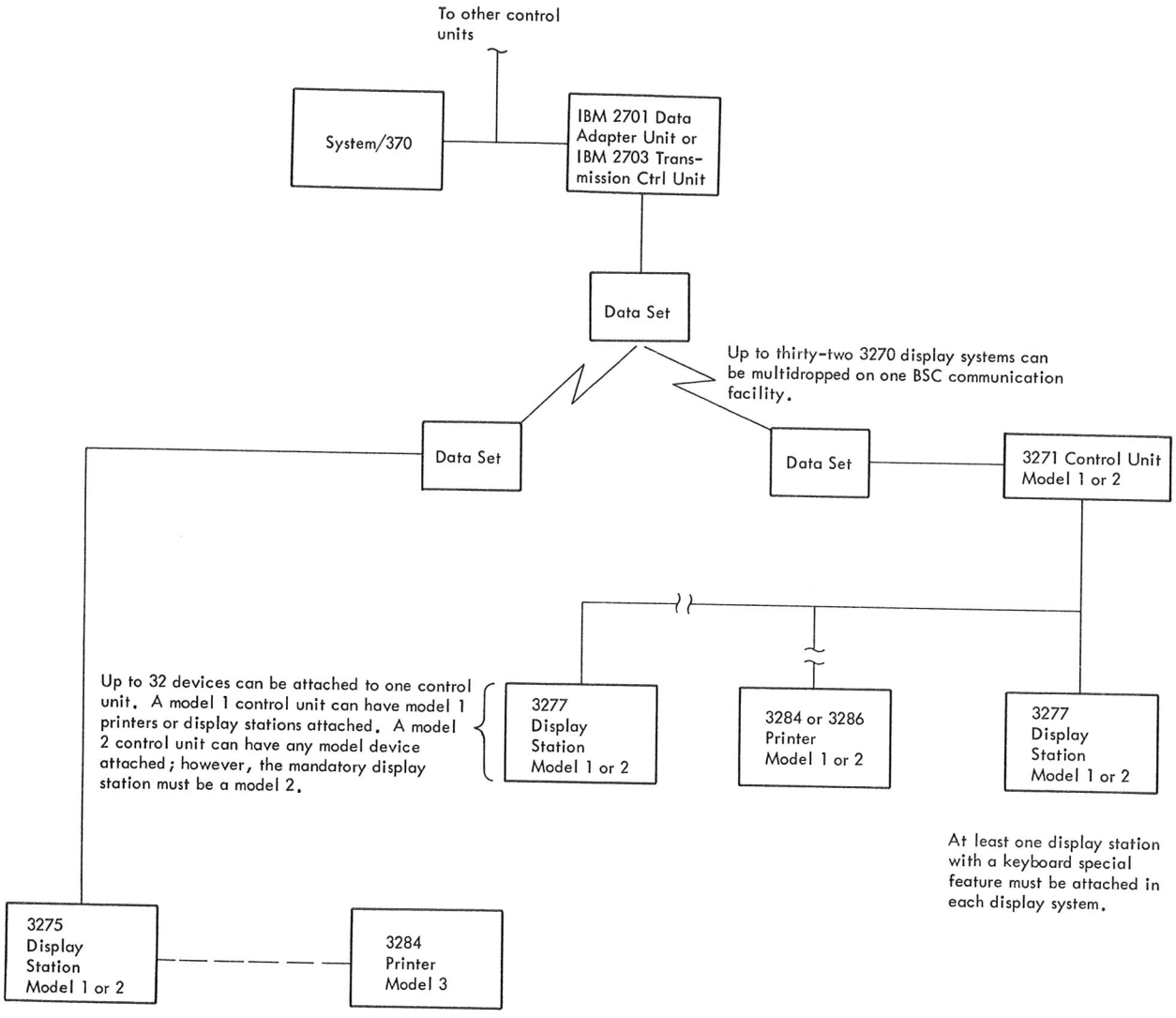


Figure 8-26. Remotely Attached IBM 3270 Display System

Audio Communications Devices

7770 Audio Response Unit Model 3

The IBM 7770 Audio Response Unit Model 3 (Figure 8-27), designed for operation with System/370, provides a spoken response to digital inquiries from terminals such as IBM 1092 and 1093 Programmed Keyboards, 1001 Data Transmission Units, 2721 Portable Audio Terminals, and telephones. The spoken response is composed from an American English vocabulary prerecorded in a male or female voice on a magnetic drum within the 7770. The response is transmitted over appropriate common-carrier communications facilities back to the inquiring terminal. When the 7770 is operating in conversational mode, the inquiry-response sequence may be repeated any number of times without redialing the 7770.

To make an inquiry of the 7770, the calling party enters a series of characters from his terminal. The 7770 passes these characters one by one via the byte multiplexer channel to the System/370, which processes the inquiry and sends a response message back, character by character, to the 7770. This response message is a series of drum word addresses that the 7770 uses to select the proper words for its spoken reply. There is no limitation on the length of the inquiry or of the response.

The 7770 Audio Response Unit Model 3 attaches to System/370 via the byte multiplexer channel. Each 7770 occupies one control-unit position and requires one byte multiplexer subchannel for each communications line. The basic 7770 handles four half-duplex, voice-grade communications lines, but this capacity can be expanded in four-line increments to 48 lines. Random inquiries on all input/output lines can be responded to simultaneously. All data sets must be provided by a common carrier.

Each 7770 comes with a 32-word vocabulary that can be expanded in 16-word increments to a maximum of 128 words. Vocabulary words may be specified by the user according to message requirements. However, lengthy words must be split and will count as two words. The vocabulary can be changed at any time by removing the drum and replacing it with another having a different vocabulary. One word of each user vocabulary must be silence.

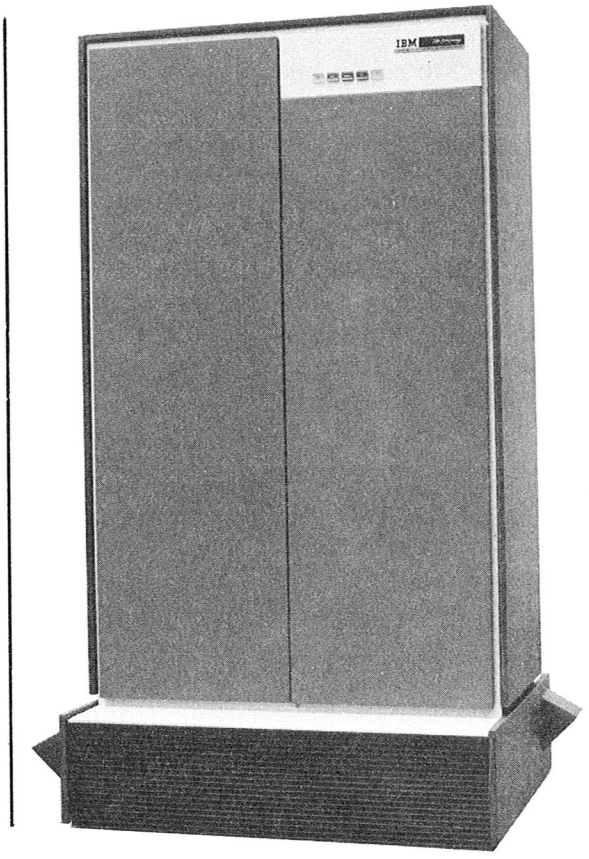


Figure 8-27. IBM 7770 Audio Response Unit

Special Features

I/O Line Expander: Each I/O line expander feature provides for four additional input/output lines. A maximum of 11 of these features is allowed.

I/O Line Frame: This feature provides an additional frame when the number of input/output lines exceeds 16.

I/O Line Panel: An I/O line panel is required for each group of eight input/output lines or portion thereof added beyond the first eight lines. A maximum of five panels is allowed.

Additional Vocabulary Words: Increments of 16 words may be added up to the maximum of 128 words.

End of Inquiry (EOI) Disable: Allows EOI character on pushbutton telephones to be used as a data character instead of an EOI character.

Data Acquisition and Process Control Systems

Two basic System/370 configurations have been designed to satisfy the requirements for real-time data acquisitions, analysis, and process control:

1. IBM 1070 Process Communication System.
2. IBM 1800 Data Acquisition and Control System.

Each of these basic configurations can accept both analog and digital electrical signals from such devices as thermocouples, pressure transducers, flow meters, analytical instruments, and contacts. They can also provide both analog and digital electrical signals to actuators, analog controllers, annunciators, lights, and contacts.

1070 Process Communication System

The IBM 1070 Process Communication System (Figure 8-28) is a data acquisition and control system designed for two-way data communication over standard communications lines between remote process locations and a central data processing system. The 1070 system has the necessary ruggedness and compactness to allow its use in a wide variety of industrial environments. The 1070, for example, can collect and transmit data from refineries, chemical plants, paper mills, steel mills, and manufacturing areas. The 1070 equipment at each process area can be either operator-oriented or fully automatic. Except for the 1053 printer, all 1070 units can be mounted in a standard 19-inch rack.

When the 1070 is connected to System/370, the two systems form a complete management information system. With this system, management can supervise quality and production, schedule jobs to take advantage of available equipment or to meet emergency needs, and perform online accounting. The 1070 system connects the System/370 through a 2701 Data Adapter Unit or a 2702 or 2703 Transmission Control. As many as twenty-six 1070 terminals may be attached to one communications line. The 1070 transmits and receives in half-duplex mode over voice- or subvoice-grade lines at 14.8 or 66.6 binary-coded-decimal characters per second), depending on which model of the 1071 Terminal Control is chosen. When operating at 134.5 bits per second, 1070 and 1050 systems may be mixed on the same communications line. Transmission at this rate may take place over leased common-carrier telephone lines, Western Union leased subvoice-grade service, or privately-owned communications lines. Transmission at 600 bits per second may take place over leased common-carrier or privately-owned communications facilities. All data transmitted and received is checked for validity.

The 1070 system consists of the following units:

1071 Terminal Control (one required in each system)
1072 Terminal Multiplexer (one required in each system; up to six can be installed)

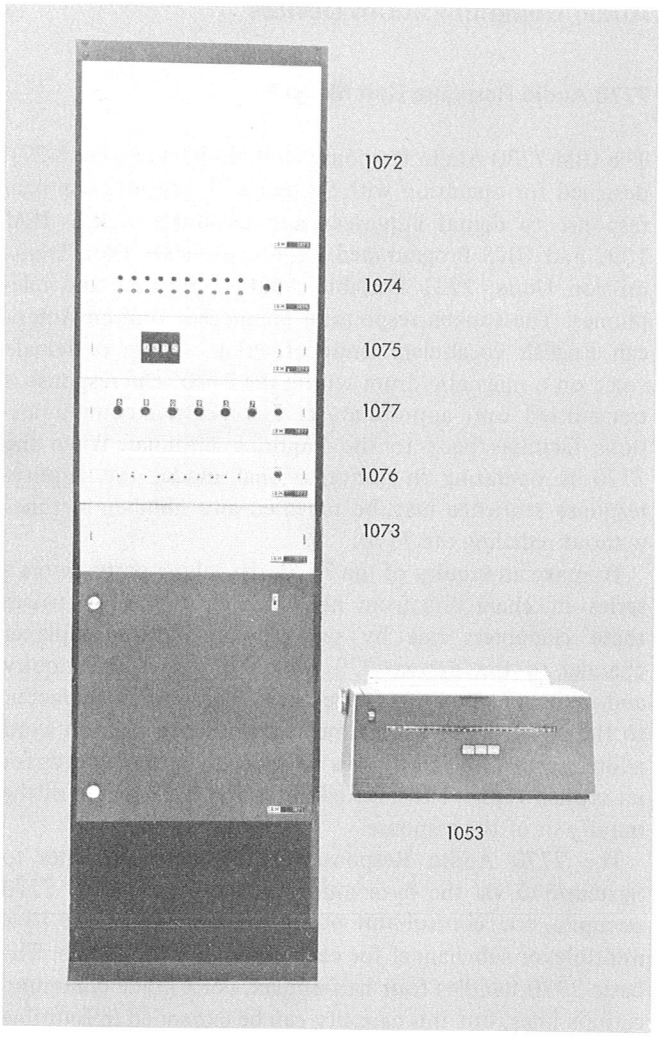


Figure 8-28. IBM 1070 Communication System

1073 Terminal Units
Process Operator Console Units
1074 Binary Display
1075 Decimal Display
1076 Manual Binary Input
1077 Manual Decimal Input
1078 Pulse Counter
1053 Printer

IBM 1071 Terminal Control: This unit is the control center of the 1070 terminal. All data to and from System/370 is channeled through it. The basic 1071 contains logic for addressing 50 input/output points. This capacity can be expanded to 300 points, in modules of 50. (A point is a termination for a pair of wires.) The 1071 provides contact sense, decimal, and BCD input; in addition, it performs contact operate functions, analog-to-digital conversion (via set-point stations) and controls all operator communication units.

IBM 1072 Terminal Multiplexer: This unit can provide terminal posts and switching relays for 50 process signals.

IBM 1073 Terminal Units: These units sense and control the opening and closing of switches that operate user devices.

Process Operator Console Units: These units allow the operator at the process location to enter binary and decimal data, and to receive a binary or decimal display or a printed output.

1800 Data Acquisition and Control System

The IBM 1800 Data Acquisition and Control System (Figure 8-29) is a versatile, high-performance system designed to handle a wide variety of real-time applications such as process control, industrial testing, and high-speed data acquisition. Unlike conventional data processing equipment, the 1800 system is designed primarily to monitor and record a wide variety of data as it is generated. Each system, however, is individually tailored to meet specific system requirements. In addition, the 1800 system can be linked to System/370, either to increase the total system computing power or to form a management information system in which production-line data is used to update inventory records, perform cost accounting, or handle other general business data processing jobs.

Among the continuous process control applications for which the 1800 system is suited are petroleum refining, chemical processing, steel rolling, pipeline monitoring, and power generation. The high-speed data acquisition facilities of the 1800 system are especially useful in missile prelaunch and manufacturing checkout, nuclear reactor analysis, medical-clinical analysis and monitoring, medical research, and many other applications.

1801/1802 Processor-Controller

The 1800 system is available with either the 1801 or 1802 Processor-Controller. The 1802 includes circuitry and control for connection and operation of the IBM 2401 and 2402 Magnetic Tape Units. Both the 1801 and 1802 are available in two models: the Model 1 has a main storage cycle of 4 microseconds; and the Model 2, 2 microseconds. Both models are available with four main storage capacities, ranging from 4K to 32K words (K=1,024, and each 18-bit word has 16 data bits, one storage protection bit, and one parity bit). Main storage capacity may be expanded by adding an IBM 1803 Core Storage Unit, permitting main storage to expand to 40K, 48K, 56K, or 64K words. Systems equipped with this unit have a storage cycle time of 2.25 microseconds.

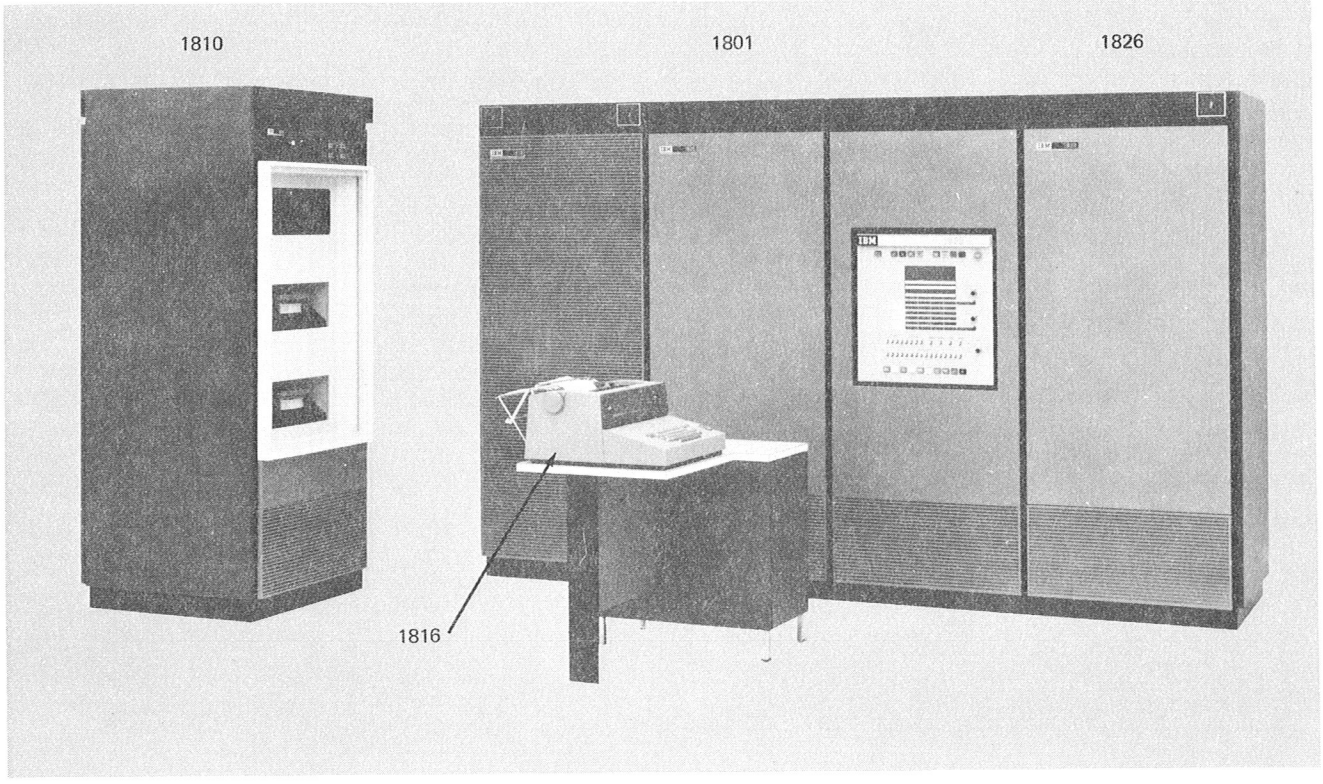


Figure 8-29. IBM 1800 Data Acquisition and Control System

Each processor-controller provides three data channels (operating at speeds up to 500,000 words per second in burst mode with the 2-microsecond main storage), three index registers, three interval timers, a powerful instruction set, indirect addressing, twelve levels of interrupt, and a storage protection feature. As many as 12 more data channels, a selector channel, and 12 additional levels of interrupt may be added as special features. The selector channel provides the facilities for attaching up to eight 2311 Disk Storage Drives. Through the use of shared files on the 2311's, the 1800 can exchange data with System/370 or another 1800.

The 1800 system can have a variety of I/O devices for real-time process control and data processing.

Real-time process I/O devices enable the 1800 system to accept either analog or digital input signals and provide analog or digital output signals for control or display purposes.

Data-processing I/O devices enable the 1800 system to perform the necessary data processing for data analysis, editing, and control purposes. These devices are also used to provide instructions for process and control room operators as well as reports for management review.

The I/O devices available to the 1800 include:

1053 Printer Model 3
1054 Paper Tape Reader Model 2
1055 Paper Tape Punch Model 2
1442 Card Read Punch Models 6 and 7
1443 Printer Model 1 or 2
1627 Plotter Model 1 or 2
1810 Disk Storage
1816 Printer-Keyboard
2311 Disk Storage Drive with 2841 Storage Control
2401 Magnetic Tape Unit Models 1-3

Remote Terminal Operation

Operated as a remote processor terminal, the 1800 system (equipped with a synchronous communications adapter in an 1826 Data Adapter Unit) can communicate with a System/370 over common-carrier-provided facilities or over privately owned facilities. The 1800 communicates with System/370 usually by way of a 2701 Data Adapter Unit or 2703 Transmission Control. Data communications are half-duplex and are transmitted at 600, 1,200, 2,000, 2,400, or 4,800 bits per second, the rate depending on what communications facilities are used. Common-carrier service for these communications may be either half-duplex or duplex.

Where more than one page reference is given, the major reference first. See the end of the index for machine-numbered units.

IBM System/370 System Summary
Order No. GA22-7001-1

READER'S COMMENT FORM

Your views about this publication may help improve its usefulness; this form will be sent to the author's department for appropriate action. Using this form to request system assistance or additional publications, however, will delay response. *For more direct handling of such request, please contact your IBM representative or the IBM Branch Office serving your locality.*

Possible topics for comment are:

Clarity Accuracy Completeness Organization Index Figures Examples Legibility

What is your occupation? _____

Number of latest Technical Newsletter (if any) concerning this publication: _____

Please indicate in the space below if you wish a reply.

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments.)

Cut or Fold Along Line

GA22-7001-1

YOUR COMMENTS, PLEASE . . . . . .

This manual is a reference source for systems analysts, programmers and operators of IBM systems. Your comments will help us produce better publications for your use. Each reply will be carefully reviewed by the persons responsible for writing and publishing this material. All comments and suggestions become the property of IBM.

Note: Please direct any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative or to the IBM branch office serving your locality.

fold fold

FIRST CLASS
PERMIT NO. 419
POUGHKEEPSIE, N.Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

Postage will be paid by:

International Business Machines Corporation
Department B98
P.O. Box 390
Poughkeepsie, New York 12602

fold fold

IBM

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
(U.S.A. only)

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
(International)

CUT ALONG THIS LINE

IBM System/370 System Summary Printed in U.S.A. GA22-7001-1

IBM System/370 System Summary
Order No. GA22-7001-1

READER'S COMMENT FORM

Your views about this publication may help improve its usefulness; this form will be sent to the author's department for appropriate action. Using this form to request system assistance or additional publications, however, will delay response. *For more direct handling of such request, please contact your IBM representative or the IBM Branch Office serving your locality.*

Possible topics for comment are:

Clarity Accuracy Completeness Organization Index Figures Examples Legibility

What is your occupation? _____

Number of latest Technical Newsletter (if any) concerning this publication: _____

Please indicate in the space below if you wish a reply.

Thank you for your cooperation. No postage stamp necessary if mailed in the U.S.A. (Elsewhere, an IBM office or representative will be happy to forward your comments.)

Cut or Fold Along Line

GA22-7001-1

YOUR COMMENTS, PLEASE . . . . . .

This manual is a reference source for systems analysts, programmers and operators of IBM systems. Your comments will help us produce better publications for your use. Each reply will be carefully reviewed by the persons responsible for writing and publishing this material. All comments and suggestions become the property of IBM.

Note: Please direct any requests for copies of publications, or for assistance in using your IBM system, to your IBM representative or to the IBM branch office serving your locality.

fold fold

FIRST CLASS
PERMIT NO. 419
POUGHKEEPSIE, N.Y.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

Postage will be paid by:

International Business Machines Corporation
Department B98
P.O. Box 390
Poughkeepsie, New York 12602

fold fold

IBM®

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
(U.S.A. only)

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
(International)

CUT ALONG THIS LINE

IBM System/370 System Summary Printed in U.S.A. GA22-7001-1

GA22-7001-1

IBM System/370 System Summary Printed in U.S.A. GA22-7001-1

IBM

International Business Machines Corporation
Data Processing Division
1133 Westchester Avenue, White Plains, New York 10604
(U.S.A. only)

IBM World Trade Corporation
821 United Nations Plaza, New York, New York 10017
(International)