Technical Newsletter

This Newsletter No. GN24-0922
Date 25 Jan 1982

Base Publication No. GA24-3763-1
File No. 4300-01

Prerequisite Newsletters None

IBM 4341 Processor
Model Group 2
Functional Characteristics
and Processor Complex
Configurator

This Technical Newsletter provides replacement pages for the subject publication. These replacement pages remain in effect for subsequent versions unless specifically altered. Pages to be inserted and/or removed are:

3 to 12
35 to 38
53 to 56

If you are inserting pages from different Newsletters and *identical* page numbers are involved, always use the page with the latest date (shown in the change-page notice at the top of the page). The page with the latest date contains the most complete information.

A change to the text or to an illustration is indicated by a vertical line to the left of the change.

Summary of Amendments

Adds information on Engineering Scientific Assist feature, the Dual Address Space enhancement feature for ECPS:MVS, and other miscellaneous changes.

Note: Please file this cover letter at the back of the manual to provide a record of changes.

IBM Corporation, Product Publications, Department K10, Endicott, NY 13760

Printed in U.S.A.

Preface

This reference publication is for system analysts and programmers who require information about processor features, input/output characteristics, timings, machine instructions, and the functions of integrated I/O devices.

The reader is assumed to have a working knowledge of the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode*, Order No. GA22-7070, and the *IBM System/370 Principles of Operation*, GA22-7000, and to have had programming experience with System/360, System/370, or other 4300 Processors.

The main chapters cover:

- Introduction to the IBM 4341 Processor
- System Structure
- System Operation
- Input/Output Channel Characteristics
- Display Console
- Model-Dependent Information
- Facilities Descriptions
- Instruction Timings
- IBM 4341 Processor Model Group 2 Complex Configurator

Prerequisite Publications

IBM 4300 Processors Principles of Operation for ECPS:VSE Mode, Order No. GA22-7070

IBM System/370 Principles of Operation, GA22-7000

IBM 4300 Processors Summary and Input/Output & Data Communications Configurator, GA33-1523.

Associated Publications

IBM 4300 Processors Installation Manual–Physical Planning, Order No. GA24-3667

IBM 4341 Processors Operator's Guide, GA24-3669.

IBM 4341 Processor Model Group 2 Channel Characteristics, GA24-3780

IBM Input/Output Equipment Installation Manual–Physical Planning for System/360, System/370, and 4300 Processors, GA22-7064

IBM 3270 Information Display System Component Description, GA27-2749

IBM 3270 Information Display System Color and Programmed Symbols, GA33-3056

Introduction to Programming the IBM 3270, GC27-6999

IBM 3268 Printer Planning and Site Preparation Guide, GA27-3266

IBM Disk Pack and Cartridge Handling Procedures, GA26-5756

IBM Diskette–General Information Manual, GA21-9182

Multiply Add Facility, GA22-7082.

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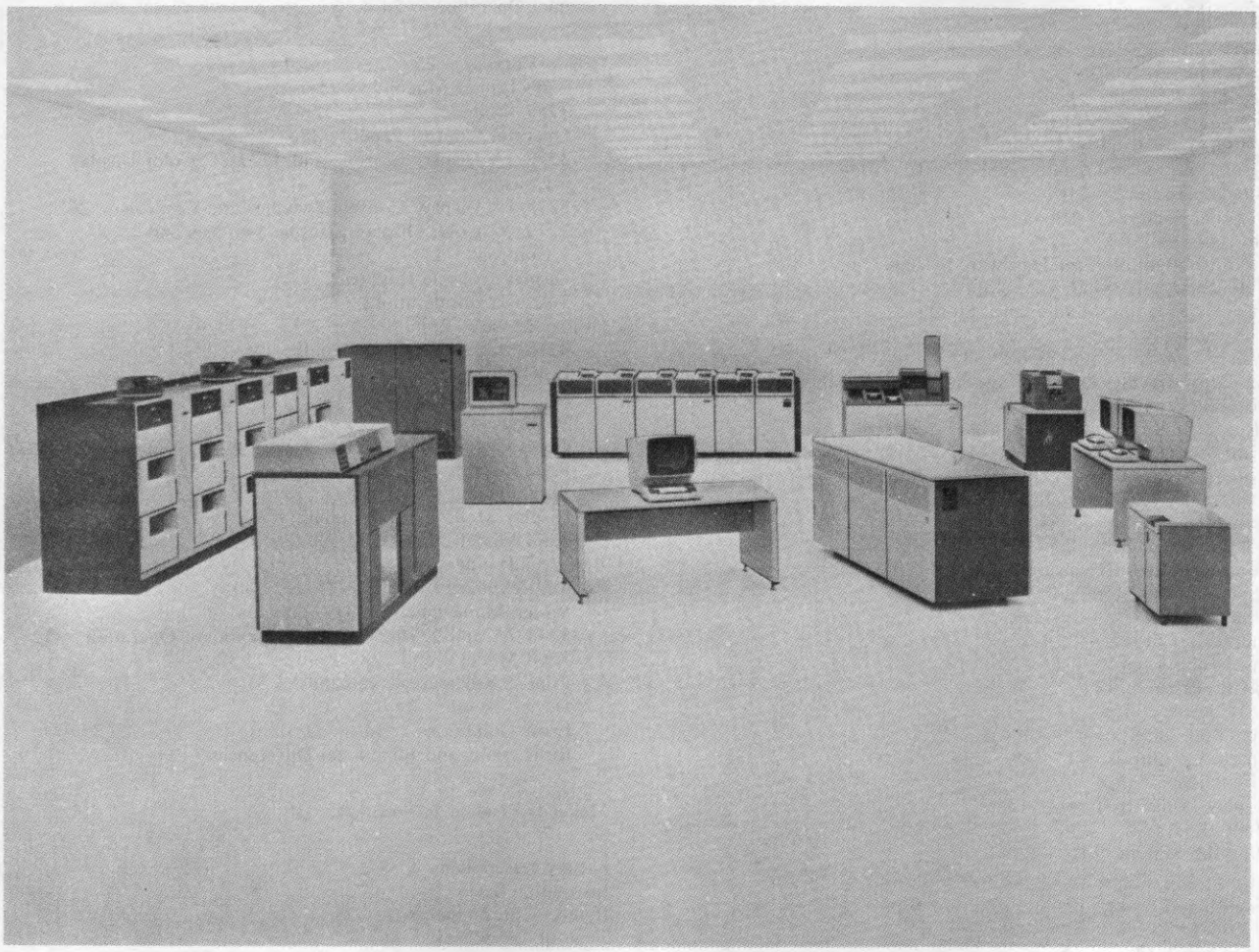


Figure 1. IBM 4341 Processor Model Group 2 with Typical I/O Configuration

IBM 4341 Processor Model Group 2 Functional Characteristics

This publication is intended as a reference for users of the 4341; only items that are unique to the 4341 are discussed in detail. Effective use of this manual requires a comprehensive understanding of the information in the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode,* GA22-7070, as well as the *IBM System/370 Principles of Operation,* GA22-7000.

The 4341 Processor (Figure 1) is a high-availability data processing system that provides the reliability, performance, and convenience demanded by both business and scientific users. The 4341 is compatible with other 4300 Processors and is capable of running under current program operating systems.

Highlights

The 4341 offers Virtual Storage, System Control Program (SCP) support, and System/370 compatibility, implemented by using large scale integrated technology and large processor storage.

The 4341 Complex consists of the 4341 Model Group 2 and the IBM 3278 Model 2A Display Console or the IBM 3279 Model 2C Color Display Console. The processor provides arithmetic, logic and control functions, storage, channels, and system diskette drive.

Other significant 4341 Model Group 2 characteristics are:

- Ease of installation, with minimum disturbance of existing input/output configuration.
- DOS/VSE, OS/VS1, OS/VS2-MVS, and VM/370 program support.
- Balanced performance of decimal, commercial, and scientific instructions.
- Processor cycle time of 120 to 240 nanoseconds. The data path to storage is sixteen bytes wide. A high-speed buffer storage is standard.
- Processor storage of 2, 4, 8, 12, or 16 megabytes. (Some of this storage is required by the system, as described under "System Storage Requirements.")
- Improved reliability, availability, and serviceability (RAS), including instruction retry, error checking and correction (ECC) to provide single-bit error correction and double-bit error detection in processor storage. Error recording by the hardware itself and the Remote Support Facility (RSF) for remote maintenance are also provided.
- Six standard channels available consisting of one byte-multiplexer channel and five block-multiplexer channels. (Channel 4 can be selected as a second byte-multiplexer channel.)

  The channels are capable of overlapped operation from the instruction execution function of the 4341.

  The block-multiplexer channels "appear" as selector channels to I/O devices that do not block multiplex.

  An optional channel-to-channel adapter is also available.
- Two modes of operation selectable at initial microcode load (IML) time:
  - Extended Control Program Support VSE (ECPS:VSE) Mode — allows operation of an appropriately generated DOS/VSE system with enhanced performance.
  - System/370 Mode — allows operation of any program written for the System/360 or System/370 that does not violate the exceptions noted in "Compatibility with System/360, System/370, and Other 4300 Processors." For those system control programs (SCPs) that contain 4341 support, see "Programming Support."

    In this mode, three mutually exclusive options are available:

    ECPS:VS1 Assist – provides a hardware assist that reduces the processor time needed to execute certain frequently used supervisor functions in VS1, Release 7 or later. In this mode, other supported SCPs operate but without enhanced performance.

    ECPS:VM/370 Assist – reduces the processor time needed to execute certain frequently used supervisor functions in VM/370, Release 6 or later. In this mode, other supported SCPs operate but without enhanced performance.

    ECPS:MVS (enhanced) – allows the 4341 processor to operate with compatibility support of the System/370 extended facility while running in System/370 mode. This selection provides the System/370 facilities that are a prerequisite for operation in the MVS/SP environment. This option is enhanced by the inclusion of the Dual Address Space (DAS) Facility. The Control Store Expansion feature allows the concurrent operation of ECPS:VM/370 and ECPS:MVS.

- The Engineering Scientific Assist improves the performance of certain mathematical computations. The assist consists of one instruction, MULTIPLY AND ADD, that may be used in either System/370 mode or ECPS:VSE mode.

  The MULTIPLY AND ADD instruction performs a combination of vector multiplication and addition operations, which may replace the inner loop of common matrix computations and reduce processor calculation time.

- The IBM 3278 Model 2A Display Console or 3279 Model 2C Color Display Console is required for interaction with the 4341 for both operation and maintenance. The operator console keyboard with its operator control panel (OCP) is used for turning power on and off, for initial microcode load (IML), and for starting and stopping processor operations.

  Both the Display mode and the Printer/Keyboard Emulation mode are supported. In Display mode, the keyboard is used for input, and the display is used for the output of up to 20 lines of up to 80 characters each.

  In Printer/Keyboard mode, the keyboard is used for input. The display and a recommended 3268 Printer Model 2 or 3287 Printer Model 1, 2, 1C, or 2C are used for output. The display console and the printer appear to the system as a console printer/keyboard. This allows using an operating system that has been generated for a System/360 with a 1052 Printer-Keyboard or a System/370 with a 3210 or 3215 Console Printer/Keyboard. An optional alternate console (with one display/keyboard and one printer) can also be configured.

  The console also provides for *normal* versus *instruction step* processing, for address compare stopping, for altering certain registers and storage areas, and for displaying processor status.

  For maintenance and service support, the console can display and store the status of the 4341 complex and other pertinent servicing information. It also provides a means for using diagnostic tools.

  Up to three optional 3278 Model 2A Display Consoles, 3279 Model 2C Color Display Consoles, 3268 Model 2 Printers, or 3287 Model 1, 2, 1C, or 2C Printers can be configured (for a total of four). The optional printer has a separate address in display mode and requires multiple console support (MCS).

  Note: *The procedures for configuring 3268-2 or 3287 Printers depend on the operating system being used. For OS/VS1, for example, the 3287 is supported by specifying either a 3286 or 3210 Printer.*

  The 3278-2A and 3279-2C features other than those basic to the primary display console are not supported.

- The support processor for automatic analysis of failure symptoms. The result of this "self diagnosis" is a processor-generated *reference code* that contains information to guide the service representative to the failing unit. This reference code is logged on the system diskette, and displayed to alert the operator of possible machine malfunction.

- The system diskette drive for both IML of microcode and recording of errors for later diagnosis. The removable diskettes provide all the microcode required for initializing basic processor features (and optional features, when ordered), as well as diagnostics for the service representative.

- The Remote Support Facility (RSF) for optional use (when installed and authorized by the customer) to enhance hardware maintenance.

- The Remote Operator Console Facility for assisting the operation of a 4341 in a distributed data processing (DDP) environment.

Channel Configurations

The input/output channel configuration for the 4341 Model Group 2 is:

- One byte-multiplexer channel and five block-multiplexer channels. In *byte mode*, simultaneous operation of several low-speed devices is permitted. Data transfer can be interleaved.

  Note: *I/O devices that are subject to data overrun (that is, the possibility of data loss), such as magnetic tape units, are not supported in burst mode on the byte-multiplexer channel.*

  The five block-multiplexer channels permit simultaneous operation of high-speed devices. Block-multiplexer channels are for relatively high-speed burst operations. They can multiplex complete blocks of data, and thereby permit a device to disconnect only after channel end, or after a halt instruction has been executed. This facility allows the interleaved execution of several channel programs by one channel.

  The actual data rates depend on the types of devices being serviced and the effect of concurrent processor and channel activity. For channel data rates, refer to Figure 4.

- Channel 4 can be selected as a second byte-multiplexer channel. With this option, the configuration includes two byte-multiplexer channels and four block-multiplexer channels.

Most input/output devices that can be attached to IBM System/360 and IBM System/370 can be attached to the 4341 Processor. See *IBM 4300 Processors Summary and Input/Output & Data Communications Configurator*, GA33-1523.

Modes of Operation

The 4341 executes all the processing and input/output functions described in the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode*, as well as those functions described in the *IBM System/370 Principles of Operation*. The major difference between the mutually exclusive System/370 and ECPS:VSE modes is in the handling of virtual addresses.

- ECPS:VSE mode uses internal address translation for both processor and channel addresses. All storage addresses are virtual addresses.
- System/370 mode uses segment and page tables for processor dynamic address translation (DAT). Channel addresses are real addresses that are translated by the system control program (assisted by the channel indirect data addressing facility).

Programming Support

Programming support for the 4341 in ECPS:VSE mode is provided by DOS/VSE. In System/370 mode, programming support is provided by DOS/VSE, OS/VS1, OS/VS2-MVS, and VM/370. Note that in System/370 mode, VSE will not operate on 4341 Models N2 or P2.

Brief descriptions of these program support packages (and references to the publications that describe them in detail) are available from your IBM representative. Additional information about 4341 processing and input/output functions, and basic control (BC) and extended control (EC) modes, is presented in the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode* or, for System/370 mode, in the *IBM System/370 Principles of Operation.*

Remote Support Facility (RSF)

This facility (when installed and with customer authorization) provides the capability of remotely controlling the 4341 from an IBM RETAIN/370 site, and allows the on-site service representative to access the IBM RETAIN data bank for the latest service aids and information.

While in this mode, the IBM Remote Support personnel can perform online diagnosis as though he were at the customer's site. Logout data stored on the system diskette drive can be saved in RETAIN during the data link operation for later offline analysis. Microcode patches may also be applied remotely.

The remote connection is via a customer-supplied data access arrangement (DAA). For connection information, refer to the *IBM 4300 Processors Installation Manual–Physical Planning*, Order No. GA24-3667. Remote console operation from any IBM RETAIN terminal is through the link facility of RETAIN.

The system console is used to monitor RSF data transmission. The DISC key can be used to terminate data transmission at any time.

In customer installations where the IBM RETAIN facilities cannot be used, remote control is possible via an IBM 3275 Display Station (using a dial-up, 1200-baud, bisynchronous, switched line).

Remote Operator Console Facility

The Remote Operator Console Facility (optional feature) is an extension of the Remote Support Facility (RSF). When installed and enabled, the Remote Operator Console Facility is active in the support processor when 4341 power is on.

In a distributed data processing environment, Remote Operator Console Facility allows personnel at the host processor to dial up the remote 4341 and control the remote system from the host site. This control is accomplished through such system operation functions as IML/IPL, Reset, Restart, Compare/Trace, and Display/Alter.

To use the Remote Operator Console Facility, the remote 4341 system must be equipped with a customer-supplied auto-answer modem and data access arrangement. For details, refer to the *IBM 4300 Processors Installation Manual-Physical Planning*, Order No. GA24-3667. Communication with the Remote Operator Console Facility is by an IBM 3275 Display Station and by programming support (provided by IBM Program Products) designed to allow remote console communication.

In Remote Operator Console Facility mode, the optional security keylock feature on the 4341 system console (if installed) allows the host site to control the remote 4341 without interference from unauthorized personnel at the remote site.

Password verification is also part of the Remote Operator Console Facility; it protects against unauthorized access to the remote 4341. If a higher level of data security is required, an external encryption device may be attached to the dial-up link.

After the remote 4341 system is successfully initialized, normal transfer of data and control information between the host and the remote system should be handled through a standard communication network, such as 270X or 370X communication controllers.

Processor Features and Characteristics

The 4341 features and characteristics listed here are explained in detail in other sections of this manual (or in the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode* or the *IBM System/370 Principles of Operation).*

Standard Features

Standard features on the 4341 Model Group 2 are:

Model	*Processor Storage (Note 1)*
K2	2,097,152 bytes
L2	4,194,304 bytes
M2	8,388,608 bytes
N2	12,582,912 bytes
P2	16,777,216 bytes

Basic Control (BC) Mode
Byte-Oriented Operands
Channels (Note 2):
  One Byte-Multiplexer Channel
  Five Block-Multiplexer Channels
    or
  Two Byte-Multiplexer
  Four Block-Multiplexer Channels
Channel Command Retry
Clock Comparator and Processor Timer
Control Registers
Decimal Instructions
Dual Address Space (DAS) Facility
Dynamic Address Translation (in System/370 mode only)
Eight-Byte Parallel Data Flow within Processor (as well as a 16-byte data path between the processor and storage).
Engineering Scientific Assist
120- to 240-Nanosecond Processor Cycle
Error Checking and Correction (ECC) in Processor Storage
Extended Control (EC) Mode
Extended Control-Program Support (ECPS:VSE) Mode
Extended Precision Floating Point
External Signal
Floating-Point Instructions
High-Speed Buffer Storage
Instruction Retry
Interval Timer
Limited Channel Logout
Machine Check Handling
Move Inverse Instruction
Program-Event Recording (PER)
PSW Key Handling
Reloadable Control Storage
Storage Protection (Store and Fetch)
Store Status (System/370 mode) or Save (ECPS:VSE mode)
Subchannels (128 to 1024, Note 2)
Support Processor
System/370 Mode (Note 3)
  ECPS:VS1 Assist
  ECPS:VM/370 Assist
  ECPS:MVS (enhanced)
System/370 Universal Instruction Set
System Diskette Drive
Time-of-Day Clock
Virtual Storage

Notes:

1. *The actual processor storage available for application programs depends on the number of UCWs, etc. Refer to "System Storage Requirements."*
2. *From 128 to 1024 subchannels can be configured. Refer to "Input/Output Channel Characteristics."*
3. *BC mode and EC mode are submodes of both System/370 mode and ECPS:VSE mode.*

Optional Features

Optional features on the 4341 Model Group 2 are:

- Channel-to-Channel Adapter
- Additional Channel Control Unit Positions
- Remote Support Facility
- Remote Operator Console Facility
- Control Storage Expansion
- 3279 Model 2C Color Display Console

Prerequisites

3278 Model 2A Display Console or 3279 Model 2C Color Display Console (with operator control panel).

Note: *Any combination of three 3278-2A, 3279-2C, 3268-2, and/or 3287 devices is optional on the 4341 (in addition to the 3278-2A or 3279-2C Display Console). These devices are ordered separately.*

Minimum Configuration for Hardware System Maintenance

The following minimum configuration is required for hardware maintenance. The individual system control programs have their own minimum requirements depending on the SCP type and release level.

Minimum Configuration with Demountable Direct Access Storage

- 4341 Processor
- 3278-2A Display Console or 3279-2C Color Display Console
- Access to one of the following groups of devices:
  - 1 Card Image I/O device* and
  - 2 Direct Access devices** and
  - 1 Hard-Copy Output device,

  or:

- 1 Card Image I/O device* and
- 1 Direct Access device** and
- 2 Magnetic Tape devices*** and
- 1 Hard-Copy Output device,

or:

- 1 Card Image I/O device* and
- 3 Magnetic Tape devices*** and
- 1 Hard-Copy Output device.

* *Card Image* is defined as:
- Any supported card reader, or
- An addressable diskette input/output unit (such as a 3540) and key-to-diskette capability, or
- A magnetic tape drive and provisions for entering card-image formatted records onto magnetic tape, or
- Capability provided by the customer through his operating system facilities to create card-image format on either tape or diskette. The customer must supply an operator to key the card images at the direction of the service representative.

** Must be demountable Direct Access Storage Device (DASD).

*** If 2400 Series, seven-track, magnetic tapes are used, Data Conversion features (No. 3228 and 3236) must be installed on the 2803 or 2804 Tape Control unit.

Minimum Configuration with Nondemountable Direct Access Storage

For configurations with nonremovable direct access storage devices (DASD), the following devices constitute the minimum configuration for hardware maintenance, provided the first forty cylinders on a nonremovable drive (other than the system residence drive) are made available for the generation and maintenance of service programs. This space must be allocated for initial installation, for modifications to the configuration, and for the application of maintenance facility updates.

- IBM 4341 Processor
- IBM 3278-2A Display Console or 3279-2C Color Display Console
- Card Image I/O device (See * above)
- Nonremovable DASD:
  IBM 3350 — The first 40 cylinders of a drive dedicated when required.
  IBM 3370 — The first 64K blocks dedicated during maintenance.

  Note: *After use of the 3350 or 3370 by the service representative, this drive may need to be reformatted by the customer for customer use.*
- Magnetic Tape device
- Hard-Copy Output device.

Additional Requirements for Installation and Operational Maintainability

In all configurations, each processor must use IBM programs (or equivalent) that provide for error recording, with elements for handling machine check interruptions and for recording status of the processor when a failure is detected. Routines for error recording are contained in some releases of DOS/VSE, OS/VS1, OS/VS2-MVS, and VM/370. IBM's ability to service configurations that do not meet the above requirements may be impaired with an effect on system availability.

To further enhance maintainability and availability, it is recommended that provisions be made for the Remote Support Facility.

System Residence and Maintenance Storage Requirements

Optimum performance and maximum availability are obtained when a disk-storage facility is provided. The DOS, VS1, MVS, and VM/370 operating systems *require* a disk storage facility. These storage requirements are assumed to be attached through a block-multiplexer channel.

System Storage Requirements

A portion of processor storage is required for dynamic tables. This reduces the amount of processor storage available for user programming. Depending on the processor configuration, the reduction of available processor storage may be from 14K bytes to 112K bytes. The reduction is the sum of the requirements of user selectable options:

- Installed storage size (processor model), plus
- Number of unit control words (UCWs) selected, plus
- Mode of operation, as shown in the following:

Mode of Operation	Model K2 (2 Megabytes) Processor Storage Required	Model L2 (4 Megabytes) Processor Storage Required	Model M2 (8 Megabytes) Processor Storage Required	Model N2 (12 Megabytes) Processor Storage Required	Model P2 (16 Megabytes) Processor Storage Required
ECPS:VSE	43,008 Bytes	45,056 Bytes	49,152 Bytes	53,248 Bytes	57,344 Bytes
System/370	6,144 Bytes	6,144 Bytes	6,144 Bytes	6,144 Bytes	6,144 Bytes

Number of UCWs	Processor Storage Required
128	8,192 Bytes
next 32	+2,048 Bytes
next 32	+2,048 Bytes
etc.,	etc.,
up to:	up to:
1024	65,536 Bytes

Compatibility with System/360, System/370, and other 4300 Processors

An important difference between the System/370 and the 4300 processors when operated in ECPS:VSE mode is the concept of virtual storage being mapped to real storage under hardware and microcode control. *Real storage* is the amount of storage that is physically installed. The apparent storage (called *virtual storage* can be any amount of storage that an application requires, up to 16,777,216 bytes.

Any program written for IBM System/370 can operate on the 4341 Processor in System/370 mode, if it:

1. Is not time-dependent.
2. Does not depend on system facilities (storage size, I/O equipment, optional features, etc.) being present when the facilities are not included in the configuration.
3. Does not depend on system facilities (interruptions, operation codes, etc.) being absent when the facilities are included in the 4341.
4. Does not depend on results or functions that are defined in the *Principles of Operation* to be unpredictable or model-dependent.

Any program written for the 4300 processors in ECPS:VSE mode operates on the 4341 Processor, if the program follows the above rules.

Any program written for the System/360 operates on the 4341 if it follows the above rules and does not depend on functions that differ between System/360 and System/370. The System/370 functions that differ from System/360 functions are described in an appendix of the *IBM System/370 Principles of Operation.*

For additional information about compatibility, see *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode*, GA22-7070.

An important aspect of compatibility is the disk data format. With System/360 and System/370, the Count-Key-Data (CKD) architecture is used. The 4341 supports disk units with both the CKD format and Fixed-Block Architecture (FBA) formats. Existing disk volumes can be mapped onto system disk devices.

Data Representation

The 4341 is both character- and word-oriented. The basic addressable unit is an eight-bit byte (a character, two decimal digits, or eight bits). This provides for efficient use of storage and for high effective input/output rates for decimal data, variable field lengths, broad and flexible code conversion, decimal arithmetic, 32-bit words and 16-bit halfwords for fixed-point arithmetic, 32-bit words and 64-bit doublewords for floating-point arithmetic, and for instructions for such functions as translate and edit.

Processor Storage Characteristics

The 4341 Model Group 2 is available in five processor storage sizes:

Model K2: 2,097,152 bytes (2 megabytes)
Model L2: 4,194,304 bytes (4 megabytes)
Model M2: 8,388,608 bytes (8 megabytes)
Model N2: 12,582,912 bytes (12 megabytes)
Model P2: 16,777,216 bytes (16 megabytes)

Virtual storage capability is provided to increase the effective use of processor storage.

Keyboard Differences

The 3278-2A or 3279-2C and emulated keyboards differ in both the number of keys and the keyboard layout. Because all the keys on the 3278-2A and 3279-2C can be used even if the emulated printer/keyboard has no corresponding key, it is possible to read and write characters that are not implemented on the emulated device.

Note that the Carriage Return key on the emulated keyboard is not implemented. Programs that require the use of this key are not supported in printer/keyboard emulation mode.

Model-Dependent Information

This section addresses the 4341 implementation of certain 4300 Processors facilities and functions. (The terms used here are defined elsewhere in this manual, or in the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode* or in the *IBM System/370 Principles of Operation.)*

Addressing of Natively Attached I/O Devices
I/O addresses 0F0 through 0FF are reserved for internal use for natively attached devices.

Condition Code Setting
The nullification of the NC, CLC, OC, XC, TRT, and ZAP instruction execution does not cause the instruction to be executed as if it were specified as a no operation. The condition code may be altered by any of these six instructions even though the instruction has been nullified.

Detection of a PSW Loop
A continuous string of interruptions (PSW loop) may be indicated if pressing the Stop key does not stop processing. Under this condition, a system reset may be necessary to stop.

Segment Table Entry
The 4341 does not check bits 4-7, 29, and 30 of the segment table entry for zeros.

Timing Facility Damage
The 4341 does not distinguish between the failure of the three timing facilities: TOD clock, CPU timer, and clock comparator. Any failure of hardware timing facilities causes all three facilities to enter the error state.

Storage Size and Page Capacity Count (PCC)
When in ECPS:VSE mode, the virtual storage size is 16,777,216 bytes and cannot be altered (as described in the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode).* No *storage size control* is on the display console. The value of the page capacity count (PCC) is always 8192.

Timer and Clock Resolution
The interval timer is updated every 3.328 milliseconds. The processor skips one update every 625 updates to derive the average of 3.333 milliseconds. The conditions of losing a decrement update are:

- When the Interval Timer control on the display console is set to Off
- When the processor is not in the operating state
- When the Rate Control on the display console is set to Instruction Step.

The time-of-day clock resolution is one microsecond. The 1-MHz oscillator has a tolerance of 0.0027 percent.

The CPU timer and clock comparator have the same resolution as the time-of-day clock. Time-of-day clock updates that are interrupted during an instruction retry are readjusted following the retry.

Reference and Change Recording
The recording of reference and change bits is accurate with the following exceptions:

- The reference bit may be set because of storage operand fetching of a nullified or suppressed instruction.
- The reference bit may be set because of prefetching of an instruction (instruction buffering). Prefetching can be a minimum of one instruction up to a maximum of four instructions ahead. This can be a minimum of two bytes and, up to a maximum of eight bytes in advance.
- The reference bit may be set because of channel prefetching of CCW, IDAW, or data during an output operation.
- The reference bit will not be set, if following a RRB or a SSK instruction, which sets the reference bit to zero, all subsequent accesses to the storage block find the data in the high speed buffer.
- Change bits may be set for the operands of a unit of operation that is nullified because of a page translation exception. For example, the destination operand of a Move instruction may cross a page boundary and encounter a page translation exception at the boundary. In this case, the instruction is nullified so that the portion of the operand up to the boundary is restored to its original value, but change bits may remain set after the nullification of the instruction.

Nontransparent Suppression and Nullification

The channel may observe the effect of temporary storage change of a partially executed, but nullified or suppressed, instruction. This can occur because of an operand access exception, access retry (due to lack of pretest), and instruction retry.

Machine Check Handling

Machine check handling is implemented in the 4341 as follows:

- CR14 Machine Check Control Bits:

  Bit 4: Recovery Report Mask
  Bit 6: External Damage Report Mask

- Machine Check Interruption Code (MCIC):

  Bit 0: System Damage
  Bit 1: Instruction Processing Damage
  Bit 2: System Recovery
  Bit 3: Interval Timer Damage
  Bit 4: Timing Facility Damage
  Bit 15: Delayed
  Bit 16: Storage Error
  Bit 18: Storage Key Error Uncorrected
  Bit 20: PSW EMWP Validity
  Bit 21: PSW Mask and Key Validity
  Bit 22: PSW Program Mask and Condition Code Validity
  Bit 23: PSW Instruction Address Validity
  Bit 24: Failing Storage Address Validity
  Bit 27: Floating-Point Register Validity
  Bit 28: General Register Validity
  Bit 29: Control Register Validity
  Bit 31: Storage Logical Validity
  Bit 46: CPU Timer Validity
  Bit 47: Clock Comparator Validity

- Other CR14 and MCIC bits are not set by the 4341.

CCW Prefetch

The channels do not prefetch a CCW for data chaining on input operation.

Power-On State

Before the operator control panel (OCP) indicates power-on complete, the following components must have completed power-on in the sequence:

1. Support Processor
   System Diskette Drive
   Adapters
   Display Console
2. Processor
3. Channel-to-Channel Adapter
4. Channel Attached I/O Devices.

Power to these components is controlled by the OCP power control.

The optional 3278-2A Display or 3279-2C Color Display Consoles (alternate console) and console printers enter the power-on state by operator activation of their power-on switches.

Facility Descriptions

This section describes some of the significant 4341 facilities.

Instruction Set

The universal instruction set is implemented in the 4341. For details on instruction word formats and definitions, refer to *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode*, GA22-7070 or *IBM System/370 Principles of Operation*, GA22-7000.

Model Group 2 supports the Engineering Scientific Assist feature. For details on this feature, refer to *Multiply and Add Facility*, GA22-7082.

Byte-Oriented Operands

The byte-oriented operand facility allows the processor storage operands of unprivileged instructions to appear on any byte boundary without causing a specification exception and a program interruption.

This facility applies to fixed-point operands, floating-point operands, and logical operands. It does not apply to instruction addresses, privileged instructions, and channel command words (CCWs). For the definition and limitations of boundary alignment operations, refer to the *IBM 4300 Processors Principles of Operation for ECPS:VSE Mode* or the *IBM System/370 Principles of Operation.*

Note: *Optimum performance for RS and RX format instructions occurs only when operands are aligned.*

Time-of-Day Clock

The time-of-day clock provides a consistent measurement of elapsed times that can be used to indicate the time of day. The facility consists of a 64-bit binary counter with bit positions that correspond to those of a fixed-point number in doubleword format. Time is measured by the clock increasing its value incrementally, in accordance with the rules of fixed-point arithmetic. Bit position 51 of the counter is incremented at 1-microsecond intervals.

The instructions included are: Store Clock and Set Clock. The Store Clock instruction allows the clock to be inspected and causes bits 0 through 51 of the current clock value to be placed in processor storage; bits 51 through 63 are stored as zero. The Set Clock instruction allows the clock to be set to a specific value and causes bits 0 through 51 of the current clock value to be replaced by an operand that is designated by the instruction; bits 52 through 63 are not used.

The clock value stored by a Store Clock instruction may be affected by I/O interference.

When system power is turned off, the clock value is lost.

Some check stops lose the value of the time-of-day clock.

Once the time-of-day clock has been enabled, and made operational with the Set Clock instruction, it maintains a constant rate of increase. The full cycle of the clock is about 143 years. This timing operation is *not* affected by:

- Any normal activity or event in the system
- Wait state
- Stopped state
- Instruction-step mode
- Single-cycle mode
- Test mode*
- System reset
- Initial Program Load (IPL) procedure
- Initial Microcode Load (IML) procedure

* The clock value is lost when the time-of-day clock microdiagnostic tests are performed.

Time-of-Day Clock Instructions

The clock value can be accessed by the Store Clock instruction. This causes the current clock value to be stored in a processor storage location specified by the instruction.

The clock can be set to a specific value by the privileged Set Clock instruction. This causes the current clock value to be replaced by the value specified in the instruction. The Set Clock instruction changes the clock value only when the TOD CLK setting is ENABLE SET.

Clock Comparator and CPU Timer

The clock comparator provides for an interruption when the time-of-day clock reaches a value specified by the programmer. The interruption is allowed by setting bit 20 in control register 0 and the external mask bit in the PSW.

The clock comparator has the same format as the time-of-day clock. It consists of bits 0 through 47, which are compared with the corresponding bits of the time-of-day clock. A clock comparator interruption is indicated as an external interruption with an interruption code of 1004 (hex).

The programmer can inspect the clock comparator by using the Store Clock Comparator instruction and can set the comparator by using the Set Clock

Pattern Character Type	*Significance Indicator*	*Source Digit*	*EB Value*	*SA - Sign Adjustment Add if digit is the last before:*			*EMK Adjustment*
				Sign B	*Sign D*	*+Sign*	*add if EDMK*
	Off	0	1380	360	360	360	0
Digit	Off	1-9	1620	540	720	720	240
Selector	On	0	1380	540	720	840	0
	On	1-9	1500	540	720	840	0
Signifi-	Off	0	1920	540	720	600	0
cance	Off	1-9	2040	540	720	720	240
Starter	On	0	1740	480	660	780	0
	On	1-9	1860	480	660	780	0
		First Byte of Pattern					
Field Separator		Yes	600				
		No	960				
Message	Off	Yes	600				
Char.	Off	No	960				
	On	---	720				

Table 2. ED and EDMK Pattern Character Timings

Effect of Hardware-Assist Features on Performance

The ECPS:VM/370 Assist and ECPS:VS1 Assist facilities simulate certain frequently used functions in hardware. The effect that these have on performance depends on the workload being executed and the frequency with which it requests services that are assisted.

As an approximate indication of magnitude, the following are given: ECPS:VM/370 Assist reduces the VM/370 supervisor CPU busy time by approximately 74 percent of its value without the assist when running VS/1 under VM/370 with the batch job stream PACE.

When running CMS alone under VM/370 with ECPS:VM/370 Assist, the supervisor CPU busy time is reduced by approximately 44 percent of its value without the assist.

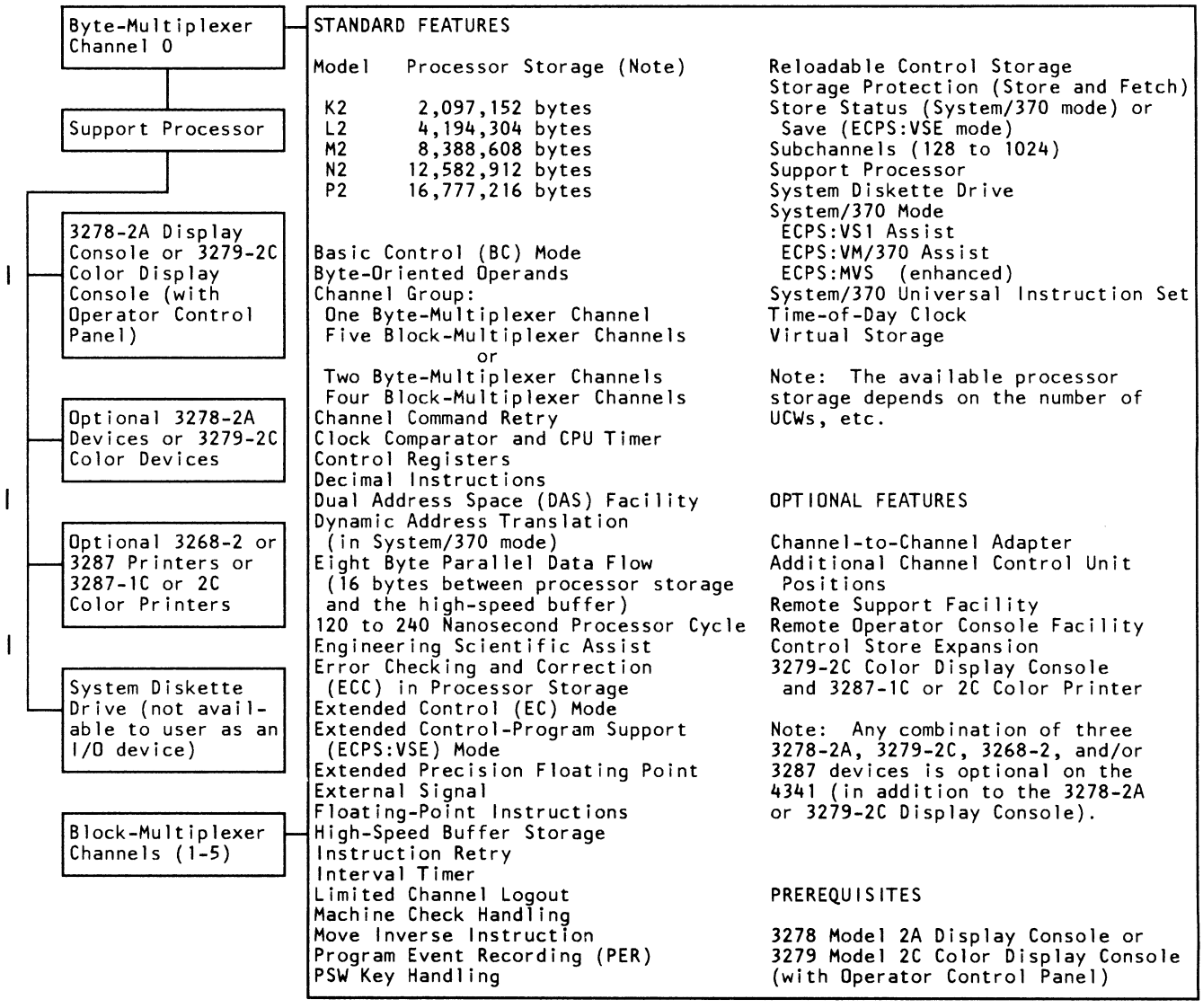
ECPS:VS1 Assist reduces the supervisor state time for VS/1 running the announcement job stream by approximately 12 percent.

ECPS:VM/370 Assist and ECPS:VS1 Assist are mutually exclusive facilities.

If the Control Store Expansion feature is installed, ECPS:VM and ECPS:MVS can be run concurrently and provide a relative batch throughput improvement of 180 to 400 percent over the VM environment with only the ECPS:MVS assist present.

Engineering Scientific Assist improves the native assembler code of equal function up to 30 percent.

4341 Processor Model Group 2 Complex Configurator



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