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IBM System/370 Model 115
Functional Characteristics

This Technical Newsletter provides replacement pages for the subject publication. Pages to be inserted and/or removed are:

v through vii	135 through 142
79, 80	143, 144 – remove these two pages
107, 108	211 through 214

Changes have been made throughout the text on pages 135 through 142; we recommend that this section should be read in its entirety. On other pages, a change to the text or to an illustration is indicated by a vertical line to the left of the change.

Summary of Amendments

Pages 135 through 142 correct information about features available for an IBM 5203 Printer Model 3 attached to a System/370 Model 115. The remaining text pages are issued to correct other errors.

The figures entitled "5203 – Immediate Carriage Control Commands" and "5203 – Delayed Carriage Control Commands" have been replaced by a new figure: "5203 – Carriage Control Space and Skip Commands". Because of this replacement and the consequent renumbering of figures, there is now no Figure 75.

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

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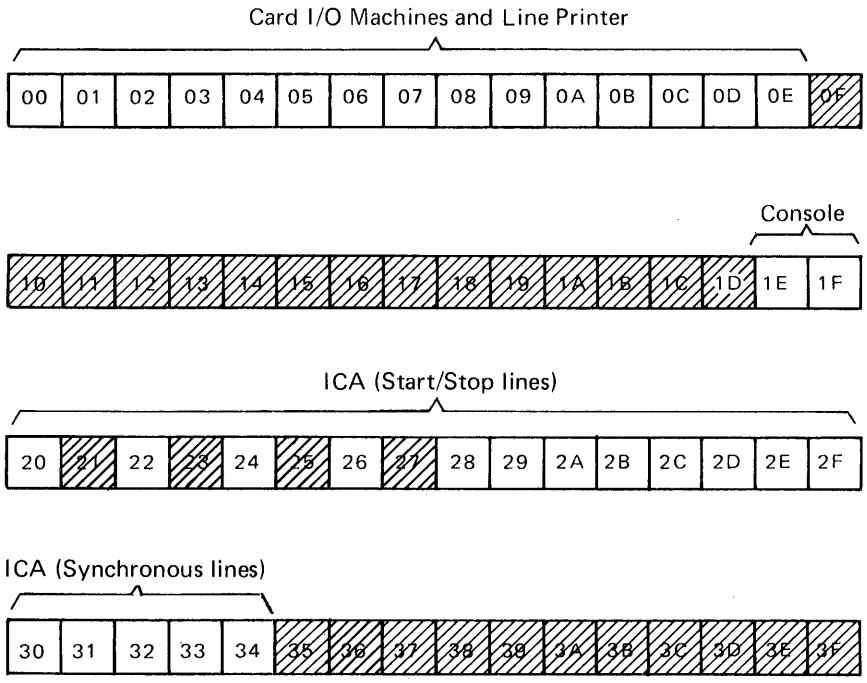
Illustrations

Note: The illustrations in this manual have a code number to the right of the caption. This is a publishing control number and is unrelated to the subject matter.

I/O Device Addresses

I/O device addresses are derived from the contents of the base register referenced by an I/O instruction, and the displacement contained in the instruction. The I/O address is calculated by the MIP which then selects the appropriate IOP or other subprocessor. The address ranges of attachable I/O devices operating in channel 0 are shown below.



Note: The above devices operate in channel 0. In all other channels, the device addresses depend on the control units or devices only: the MIP recognizes only the channd address. The device addresses range from 00 to FF (hex), and are decoded by the control units or their equivalents.

= Not used

Addressing I/O Devices Operating in Channel 0

Figure 56. Addressing I/O Devices Operating in Channel 0 [10835A]

low-speed I/O devices. When the channel is working in byte multiplexer mode (its normal mode of operation), several I/O devices can execute commands simultaneously by interleaved byte transfers over the I/O interface. However, a control unit capable of forcing burst mode may do so.

The multiplexer channel performs the following functions:

Interprets I/O instructions,
Translates I/O instructions into commands and controls at the interface,
Transfers data between I/O devices and main storage,
Requests interruptions.

The functions of the byte multiplexer channel are provided by an IOP, supplemented by front end circuitry. In byte multiplexer mode, the maximum channel data rate is 19,000 bytes per second. In burst mode, the maximum channel data rate is 29,000 bytes per second. When data chaining and channel indirect data addressing are specified in the CCW, the data rates decrease to 13,000 and 19,000 bytes per second, respectively.

Characteristics

The byte multiplexer channel provides all the functions necessary to process channel programs written according to the definitions in *System/370 Principles of Operation,* GA22-7000. The channel can operate in BC mode (when PSW bit 12 is off) or EC mode (when PSW bit 12 is set).

Note: All I/O instructions can be executed, but one exception should be noted. Although the 'start I/O fast release' instruction is accepted, it is executed as a normal 'start I/O' instruction.

Of the extended interface capabilities provided by the extensions to the System/360, the multiplexer channel implements only the I/O Error Alert function. It does not implement High-Speed Transfer, Interface Bus Extension, or Command Retry. These restrictions, however, do not affect the capability of attaching and operating all I/O devices which have data rates compatible with the channel.

Subchannels

Up to 32 subchannels can be provided for the byte multiplexer channel. A subchannel, also called a unit control word (UCW), holds the information necessary for controlling the current operation in the I/O device.

A subchannel may be shared or nonshared. A shared subchannel is used for a control unit that can have several devices attached, only one of which requires the subchannel at any one time. A nonshared subchannel is used for a control unit to which only one device is attached. Of the 32 subchannels available on the Model 115 the first eight can alternatively operate as shared subchannels. Each control unit associated with a shared subchannel may have up to 16 I/O devices attached.

When a subchannel is addressed by an I/O instruction, bit 0 of the address byte (Figure 57) shows whether the subchannel is nonshared (bit 0 = 0) or shared (bit 0 = 1). Bit 0 is not, however, part of the actual address and is ignored for addressing purposes. A nonshared subchannel is addressed by the seven low-order bits of the address byte. Device addresses 40 to 7F (hex) are available, subject to the restrictions noted in Figure 57.

A shared subchannel is addressed in terms of the associated control unit. Device addresses 80 to FF (hex) are available, subject to the restrictions noted in Figure 57. Bit 0 is ignored for addressing purposes, and bits 1, 2, and 3 address the subchannel. Bits 4 through 7 are used to address an I/O device or the shared subchannel. Thus, device addresses 90 through 9F, for example, all address shared subchannel 1. Because shared subchannels 0 through 7 use the same unit control words as nonshared subchannels 0 through 7, shared subchannel addresses must be chosen which do not conflict with nonshared subchannel addresses.

Interruption

Channel end status can be signaled by up to 32 control units and stored in the corresponding subchannels. Over a single interruption line, the MIP is informed that the multiplexer channel has interruptions waiting. When the MIP signals its readiness to process an interruption for the multiplexer channel, the microprogram selects one of the waiting interruptions and signals the address of the interrupting device to the MIP. The channel stores the CSW and releases the MIP.

Error Detection

The following types of errors are detected and logged by the multiplexer channel:

1. All *programming errors.*
2. *Protection check,* which occurs when a protected address is encountered during data transfer or chaining.
3. *Channel data check,* which occurs when bad parity is detected during transfer of data to or from main storage.
4. *Channel control check,* which occurs when bad parity is detected during transfer of control information to or from main storage, or from the IOP to the channel front-end registers.
5. *Interface control check,* which can occur when bad parity is detected in an address or status byte being transferred to main storage, or when more than one tag line is activated. Interface control check also occurs when an incorrect address is received by the channel in response to 'address out', or when an address is received from an I/O unit for which no UCW is assigned.

IBM 3340 Disk Storage, Models B1 and B2; IBM 3340 Disk Storage and Control Model A2

This section describes the commands, data formats, status reports, sense information, and error recovery procedures for the 3340 Disk Storage, Models B1 and B2, and the 3340 Disk Storage and Control Model A2 when under control of the direct disk attachment. A 3340 installation used with the Model 115 can consist of two, three, or four disk drives. The prerequisite Model A2 contains two disk drives and a control unit. One or two more drives can be added by attaching a 3340 Model B1 (one drive) or a 3340 Model B2 (two drives).

The characteristics of the IBM 3348 Data Modules used on the 3340 are shown in Figure 64.

	Model of Data Module	
	3348-35	3348-70
Cylinders per data module	348	696
Tracks per cylinder	12	12
Bytes per track	8,368	8,368
Bytes per cylinder	100,416	100,416
Bytes per module	34,944,768	69,889,536

Figure 64. Characteristics of 3348 Data Modules [10843A]

The 3348 Data Modules listed in Figure 64 can be used on any 3340. It is possible to change the drive capacity by changing the data module. The online storage capacity of a 3340 installation can thus vary from approximately 70 megabytes (2 drives with 3348-35 data modules) to approximately 280 megabytes (4 drives with 3348-70 data modules).

The data modules are initialized at the IBM plant. During a surface analysis the home addresses, and the eight-byte track descriptions in each record zero, are written. If a skippable defect is found on a track, the corresponding skip displacement bytes (see Figure 67) are written in the home address. During subsequent operations these bytes are used by the control unit to skip the defect. If the data areas of the modules become defective during service, an IBM utility program can be used to flag defective tracks and assign alternate tracks.

All 3340 models have an average access time of 25 ms, an average rotational delay of 10.1 ms, and a nominal read/write rate of 885,000 bytes per second.

3340 Commands

Figure 65 shows the commands which are available for the 3340.

Read Commands

Read commands are used to transfer information from the disk drives to main storage. 'Read data', 'read key and data', and 'read count key and data' commands can be executed in a special record overflow mode. All read commands except 'read initial program load' and 'read sector' can be executed in a special multi-track mode (see Figure 65).

Record overflow mode allows the processing of records which extend from one track to the next. Such records are known as overflow records. To indicate this overflow, the 'write special count, key and data' command is provided, which formats an overflow record segment with bit 4 set in the flag byte (see Figures 67 and 68). Whenever a read or *non-formatting* write command processes the data field of a flagged record, the operation is not terminated at the end of the data field but continues at the data field of record one on the following track. If this record is also flagged, the operation again continues onto the next track. If the advancing read/write head encounters an unusual condition or is inhibited by the file mask, the operation incomplete bit (sense byte 1, bit 7) is set.

The second special mode in which read commands (except 'read initial program load' and 'read sector') can be executed is multi-track mode. Multi-track mode can be set only when read or search commands are given. It is switched on when bit 0 of the CCW is set, causing the control unit to select automatically the read/write head with the next sequential number. This switching of heads takes place at the index point if bit 0 is set and if the data transfer specified in the command has not been initiated.

Read Data

The 'read data' command causes the contents of the data area of a record (see Figure 67) to be transferred to main storage. The data to be read is either:

1. The data area of the record following the next count area (excluding record zero – the track description record) encountered on the track, or
2. The data area of the record encountered when a 'read data' command is chained from a 'read count' or search command (other than 'search home address').

A parity bit is added to each byte of data sent to the direct disk attachment and the validity of the information read is verified. The next command in the chain is then read out, or, if the chain has been completely executed, channel end and device end are presented. If data overrun or data check is detected, the disk attachment retries the command, and if the retry is unsuccessful, channel end, device end, and unit check are set. The data in the key area is not checked during a 'read data' command.

Command Code				Operation	Type
Single Track		Multi-track			
Hex	*CCW Bits 01234567*	*Hex*	*CCW Bits 01234567*		
06	00000110	86	10000110	Read data	Read
0E	00001110	8E	10001110	Read key and data	
1E	00011110	9E	10011110	Read count, key and data	
16	00010110	96	10010110	Read record zero	
12	00010010	92	10010010	Read count	
1A	00011010	9A	10011010	Read home address	
02	00000010			Read initial program load	
22	00100010			Read sector	
05	00000101			Write data	Write
0D	00001101			Write key and data	
1D	00011101			Write count, key and data	
01	00000001			Write special count, key and data	
15	00010101			Write record zero	
19	00011001			Write home address	
11	00010001			Erase	
39	00111001	B9	10111001	Search home address equal	Search
31	00110001	B1	10110001	Search identifier equal	
51	01010001	D1	11010001	Search identifier high	
71	01110001	F1	11110001	Search identifier equal or high	
29	00101001	A9	10101001	Search key equal	
49	01001001	C9	11001001	Search key high	
69	01101001	E9	11101001	Search key equal or high	
04	00000100			Sense I/O	Sense
A4	10010100			Read buffered log*	
03	00000011			No-operation	Control
07	00000111			Seek	
0B	00001011			Seek cylinder	
1B	00011011			Seek head	
0F	00001111			Space count	
13	00010011			Recalibrate	
17	00010111			Restore	
1F	00011111			Set file mask	
23	00100011			Set sector	

* The 'read buffered log' command does not reset the buffered log information. This is done by the "save usage counters" manual operation.

Figure 65. 3340 Commands [10844]

A 'read data' command is executed whether or not it is preceded by any other command.

Read Key and Data

The 'read key and data' command causes the contents of the key and data areas of a record to be transferred to main storage. The key and data to be read are either:

1. The key and data areas of the record following the next count area (excluding record zero) to be encountered on the track, or
2. The key and data areas of a record encountered, when a 'read key and data' command is chained from a 'read count' command or from a search identifier command.

If the key length is zero, the 'read key and data' command is executed like a 'read data' command.

A parity bit is added to each byte of data sent to the direct disk attachment and the validity of the information read is verified. The next command in the chain is then read out, or, if the chain has been completely executed, channel end and device end are presented. If a data overrun, command overrun, or data check is detected, the disk attachment retries the command, and if the retry is unsuccessful, channel end, device end, and unit check are set.

A 'read key and data' command is executed whether or not it is preceded by any other command.

Read Count, Key and Data

The 'read count, key and data' command causes all areas (that is, count, key and data) of the next following record,

IBM 5203 Printer Model 3

This section describes the commands, status reports, sense information, and error recovery procedures for the 5203 Printer Model 3, when operating under control of the integrated printer attachment.

5203 COMMANDS

Write Commands

Write commands cause data to be transferred from main storage to the print line buffer; the data transfer is followed by the electro-mechanical print operation, including any carriage motion. The data transfer begins at the storage location designated by the data address (CCW bits 8 to 31) and proceeds in ascending order of address. The data transfer ends either when the print line buffer is filled or when the length count (CCW bits 48 to 63) has been reduced to zero, whichever occurs first. The count should be decimal 96, 120 or 132, depending on the print line width. If the output area contains more characters than appropriate for the print line width or if the count is less than the print line width, incorrect length (bit 41 in the CSW) is indicated unless the SLI flag is on and the CD flag is off in the current CCW. Channel end (bit 36 in the CSW) is indicated when the data transfer from main storage to the print line buffer has been completed. Device end (bit 37 in the CSW) is indicated when the mechanical print operation and any carriage operations have been carried out. Channel end and device end are interruption conditions (but only for the last command if chaining is in progress).

The printer attachment accepts the write commands shown in Figure 71.

Command Code									Command
Hex	*CCW Bits*								
	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	
01	0	0	0	0	0	0	0	1	Write without spacing
09	0	0	0	0	1	0	0	1	Write and space 1 after printing
11	0	0	0	1	0	0	0	1	Write and space 2 after printing
19	0	0	0	1	1	0	0	1	Write and space 3 after printing
89	1	0	0	0	1	0	0	1	Write and skip to channel 1 after printing
91	1	0	0	1	0	0	0	1	Write and skip to channel 2 after printing
99	1	0	0	1	1	0	0	1	Write and skip to channel 3 after printing
A1	1	0	1	0	0	0	0	1	Write and skip to channel 4 after printing
A9	1	0	1	0	1	0	0	1	Write and skip to channel 5 after printing
B1	1	0	1	1	0	0	0	1	Write and skip to channel 6 after printing
B9	1	0	1	1	1	0	0	1	Write and skip to channel 7 after printing
C1	1	1	0	0	0	0	0	1	Write and skip to channel 8 after printing
C9	1	1	0	0	1	0	0	1	Write and skip to channel 9 after printing
D1	1	1	0	1	0	0	0	1	Write and skip to channel 10 after printing
D9	1	1	0	1	1	0	0	1	Write and skip to channel 11 after printing
E1	1	1	1	0	0	0	0	1	Write and skip to channel 12 after printing

Notes:

1. If a write and skip command specifies a channel for which no code exists in the buffer, the carriage does not move and the command ends with unit check set in the CSW and the no channel found bit 6 in sense byte 0.
2. If a write and skip command orders the carriage to go to the channel at which it is currently located, the form moves until that channel is detected the next time.

Figure 71. 5203 Write Commands [10850]

Carriage Control Commands

Carriage control commands consist of space and skip commands and the 'load carriage control buffer' command. For space and skip commands, the command code is transferred to the printer attachment, then channel end is indicated in the initial status and the carriage operation is started. Device end is indicated when the mechanical operation is completed at the 5203. Device end is an interruption condition for space and skip commands, unless command chaining is in progress.

Figure 72 shows the space and skip commands available for the 5203.

Carriage Control Buffer Structure

The 5203's carriage is not controlled by paper tape (the method used in the IBM 1403 Printer and other IBM high-speed line printers). Instead, the 5203 employs a 112-byte carriage control buffer.

Each carriage control buffer byte represents one line on the forms sheet; byte 1 represents the first line of a sheet, byte 112 represents the last line of a sheet (assuming the largest possible sheet, which is 14 inches from fold to fold). Each byte may be loaded with a number ranging from 0 to 12 (corresponding to the channel numbers punched in the familiar carriage control paper tape, used on the IBM 1403 Printer and others). The zero represents no channel designation ("no punch"). To designate the actual length of a form (specified on tape-controlled carriages by cutting the control tape to size) an end-of-sheet specification can be set into any byte of the buffer. The buffer byte codes are shown in Figure 73.

The end-of-sheet specification causes the counter (which monitors the position of the carriage) in the printer attachment to wrap around when end-of-sheet is recognized. For information about correct end-of-sheet code placement see the next paragraph.

Command Code								Command
	CCW Bits							
Hex	0	1	2	3	4	5	6	7	
0B	0	0	0	0	1	0	1	1	Space 1
13	0	0	0	1	0	0	1	1	Space 2
1B	0	0	0	1	1	0	1	1	Space 3
8B	1	0	0	0	1	0	1	1	Skip to channel 1
93	1	0	0	1	0	0	1	1	Skip to channel 2
9B	1	0	0	1	1	0	1	1	Skip to channel 3
A3	1	0	1	0	0	0	1	1	Skip to channel 4
AB	1	0	1	0	1	0	1	1	Skip to channel 5
B3	1	0	1	1	0	0	1	1	Skip to channel 6
BB	1	0	1	1	1	0	1	1	Skip to channel 7
C3	1	1	0	0	0	0	1	1	Skip to channel 8
CB	1	1	0	0	1	0	1	1	Skip to channel 9
D3	1	1	0	1	0	0	1	1	Skip to channel 10
DB	1	1	0	1	1	0	1	1	Skip to channel 11
E3	1	1	1	0	0	0	1	1	Skip to channel 12

Notes:

1. If a skip command specifies a channel for which no code exists in the buffer, the carriage does not move and the command ends with unit check set in the CSW and the no channel found bit (bit 6) set in sense byte 0.
2. If a skip command orders the carriage to go to the channel at which it is already located, and the preceding command moved the carriage, the carriage does not move and channel end and device end are presented. If the preceding command was a write without space, the carriage moves until the specified channel is detected next time.

Figure 72. 5203 – Carriage Control Space and Skip Commands [10840]

Hex	Buffer Byte Code Bits								Meaning
	0	1	2	3	4	5	6	7	
00	0	0	0	0	0	0	0	0	No channel (no punch)
01	0	0	0	0	0	0	0	1	Channel 1
02	0	0	0	0	0	0	1	0	Channel 2
03	0	0	0	0	0	0	1	1	Channel 3
04	0	0	0	0	0	1	0	0	Channel 4
05	0	0	0	0	0	1	0	1	Channel 5
06	0	0	0	0	0	1	1	0	Channel 6
07	0	0	0	0	0	1	1	1	Channel 7
08	0	0	0	0	1	0	0	0	Channel 8
09	0	0	0	0	1	0	0	1	Channel 9
0A	0	0	0	0	1	0	1	0	Channel 10
0B	0	0	0	0	1	0	1	1	Channel 11
0C	0	0	0	0	1	1	0	0	Channel 12
0D..FF	0	0	0	1	0	0	0	0	End-of-sheet

Note: All codes from 0D to FF (hex) are interpreted as end-of-sheet codes.

Figure 73. 5203 – Carriage Control Buffer Byte Codes [10841A]

Assigning the End-of-Sheet Code: The end-of-sheet code must be set into the buffer byte that represents the last printable line of a given sheet. The last printable line of a sheet is determined by multiplying the sheet length (in inches) by the desired line spacing, which can be either six lines or eight lines per inch.

For example: A 12-inch sheet multiplied by eight lines per inch results in 96 printable lines per sheet. The end-of-sheet code must be assigned to line 96 (buffer byte 96). A 12-inch sheet used with six lines per inch spacing results in 72 printable lines per sheet, so the end-of-sheet code must be assigned to line 72. Correct end-of-sheet code assignment ensures that the carriage control buffer remains in synchronism with the form. If the end-of-sheet code is not assigned to the last printable line of a sheet, the control counter wraps around to zero too early (or too late), causing information for the next sheet to be printed on the last lines of the previous sheet. There is no error indication to show that the counter is not synchronised with the form.

Load Carriage Control Buffer

The 'load carriage control buffer' command code is:

Hex	CCW Bits 0 1 2 3 4 5 6 7
63	0 1 1 0 0 0 1 1

Data is transferred from main storage to the carriage control buffer, starting at the main storage location specified in bits 8 to 31 of the CCW and proceeding in ascending order of address. The buffer is loaded in ascending order of position and this continues until the end-of-sheet code is detected, the buffer is filled, or the CCW count is reduced to zero, whichever occurs first.

If there is no end-of-sheet code, the buffer contents can be used for skip control but the line counter will wrap to zero when the largest allowable sheet (14 inches) plus 1 would wrap (this is the default value assumed in the absence of an end-of-sheet code). Consequently, in cases where the forms length is not 113, the operation is asynchronous (the counter is not synchronized with the forms). If a channel 1 code is absent, forms end is not recognized, the CARRIAGE RESTORE key has no function, and a forms check occurs. This is because the printer indicates "end of form" only when the FORMS switch has been operated and the channel 1 is detected thereafter. In the absence of a channel 1 code, the function of the CARRIAGE RESTORE key is suppressed to prevent the carriage runaway that would otherwise occur.

If the count in the 'load carriage control buffer' CCW is either greater than 112 or less than 112 (decimal), incorrect length is indicated unless the SLI flag bit is on and the CD flag bit is off in the CCW.

Channel end and device end are both presented when the load operation is completed.

UCS Commands

Universal character set (UCS) commands are always accepted because the UCS feature is a standard feature of the 5203 attachment. These commands should, however, only be given to a 5203 Printer which is equipped with the corresponding UCS feature; otherwise, incorrect characters may be printed.

Figure 74 shows the UCS commands available for the 5203.

Command Code									Command
Hex	CCW Bits 0	1	2	3	4	5	6	7	
F3	1	1	1	1	0	0	1	1	Load UCS buffer with folding
FB	1	1	1	1	1	0	1	1	Load UCS without folding
73	0	1	1	1	0	0	1	1	Block data check
7B	0	1	1	1	1	0	1	1	Allow data check

Figure 74. 5203 UCS Commands [10854]

Load UCS Buffer with Folding

The 'load UCS buffer with folding' command causes data to be transferred from main storage to the UCS buffer. The data transferred represents the chain image. During transfer, the EBCDIC codes of the first, second, and third quadrants of the standard EBCDIC table are "folded" into the fourth quadrant of this table so that four different EBCDIC codes cause one and the same character to be printed. Because the quadrants of the EBCDIC table are identified by bits 0 and 1 of a byte, folding is technically accomplished by suppressing bits 0 and 1 during code comparison so that, effectively, the quadrant specification is ignored.

The data transfer begins at the main storage location specified in bits 8 to 31 of the CCW and proceeds in ascending order of address until the 240-byte UCS buffer is filled or the length count (bits 48 to 63 of the CCW) has been reduced to zero, whichever occurs first. At the end of the data transfer channel end and device end are both indicated. The UCS buffer remains loaded until it is reloaded or power goes off.

Note: The UCS buffer is automatically initiated at IMPL time. The initial data is the standard 48-character set. This set is overwritten by the first UCS buffer load command, and the new UCS data is automatically recorded on the diskette. The backup data on the diskette is used when machine-check situations require that the attachment is reloaded with microprogram.

Load UCS Buffer without Folding

The 'load UCS buffer without folding' command is identical to the 'load UCS buffer with folding' command except that folding does not occur. Only one EBCDIC code corresponds to each print character.

Block Data Check

The 'block data check' command provides the means to suppress data checks that can occur if, for example, the print line buffer contains a character bit pattern that is not available in the UCS buffer.

The 'block data check' command causes neither data transfer nor any mechanical operation. Only the command code is transferred, and channel end and device end are both set in the initial status. When 'block data check' is given, data checks are suppressed until an 'allow data check' command is given, power goes off, or a power-on reset occurs.

Note: The 'block data check' command for the 5203 is not subject to any restriction in use. It can be given at any time, and can be included in a command chain. Its blocking function is, however, effective only in UCS operations.

Allow Data Check

The 'allow data check' resets the effect of a previously-issued 'block data check' command. The 'allow data check' command need only be given to reset a 'block data check' command; if neither command is given, data checks are allowed.

The 'allow data check' command causes neither data transfer nor any mechanical operation. Only the command code is transferred and both channel end and device end are set in the initial status.

Note: The 'allow data check' command can be given at any time, and can be included in a command chain.

Automatic UCS Buffer Initialization/Reloading

The UCS buffer is automatically loaded with a standard 48-character set at IMPL time, enabling the 5203 to operate even if no chain image is loaded. Any load UCS buffer command overwrites the initial value and the new pattern is at the same time recorded on the diskette. In case of processor damage, the UCS buffer is automatically reloaded from the diskette so that the pattern last used is available.

Control No-Op Command

The 'control no-op' command (command code 00000011) performs no function in the 5203. When this command is given, channel end, device end, and any other status conditions that exist at the time are indicated in the initial status.

Read Commands

No 'read' command is available for the 5203. A 'read' command issued to the printer is rejected.

Sense Command

The 'sense' command is usually given when unit check has been set in the CSW, and provides a means of transferring up to six bytes of sense information from the printer attachment to main storage. The sense bytes contain information about errors or unusual conditions in the printer or its controlling front end; the operating system

analyzes this information before taking appropriate action to recover from the error(s). The 'sense' command code is:

Hex	*CCW Bits 0 1 2 3 4 5 6 7*
04	0 0 0 0 0 1 0 0

The sense information is stored into the main storage location specified by CCW bits 8 to 31, in ascending order of address. The number of sense bytes to be transferred is specified in CCW bits 48 to 63. Channel end and device end are both set when the transfer of sense information to main storage is completed.

For details of the information that can be obtained by use of the 'sense' command, see "5203 Sense Information" in this section.

5203 STATUS INFORMATION

The following text gives the meanings of the status indications which are given in response to 5203 commands.

Unit Status

The unit status is indicated in bits 32 to 39 of the CSW. The unit status is directly related to a command that has been given to, completed by, or terminated by the 5203. The bits are assigned the following meanings:

Bit	*Designation*
32	Attention (not used)
33	Status modifier (not used)
34	Control unit end (not used)
35	Busy
36	Channel end
37	Device end
38	Unit check
39	Unit exception

Attention (Bit 32)

The attention bit is not used.

Status Modifier (Bit 33)

The status modifier bit is not used.

Control Unit End (Bit 34)

The control unit end bit is not used.

Busy (Bit 35)

The busy bit, when set, indicates that the printer and its controlling front end logic are occupied with executing some previously-initiated operation. If busy is set together with channel end or device end, it indicates a pending status.

Channel End (Bit 36)

The channel end bit, when set, indicates that the data transfer part of a 5203 command, or the transfer of the command code, is completed.

Device End (Bit 37)

The device end bit, when set, indicates that the 5203 has completed the mechanical portion (if any) of an operation. Device end thus signals that the printer is free to accept and execute a new command. Device end is set alone when the printer is manually transferred from the not-ready to the ready state (when the printer's START key is pressed).

Unit Check (Bit 38)

The unit check bit is set for various errors or other unusual conditions that may have occurred in the 5203 and/or its controlling front end logic. Because the setting of unit check does not define the error condition, a 'sense' command should be issued to the 5203. The contents of the sense bytes will show the actual cause of unit check being set. For details of the conditions that can cause unit check to be set, see "5203 Sense Information" in this section.

The setting of unit check breaks command chaining.

Unit Exception (Bit 39)

The meaning of the unit exception indication depends on the command during whose execution the bit was set.

If unit exception is set during execution of a *'load carriage control buffer' command,* the channel 1 code is missing. This indicates that forms control is incorrect (or absent) and the RESTORE key is not operational.

If unit exception is set during execution of a *command causing carriage motion* a channel 12 code has been detected during a space operation. The meaning of channel 12 is assigned by the programmer.

Channel Status

The channel status information is recorded in bits 40 to 47 of the CSW; the bits have the following meanings assigned:

Bit	*Designation*
40	Program-controlled interruption
41	Incorrect length
42	Program check
43	Protection check
44	Channel data check
45	Channel control check
46	Interface control check (not used)
47	Chaining check (not used)

The channel status bits have the same standard functions for the 5203 as for any other device attached via a channel, integrated adapter, or integrated attachment. These functions are described for the 2560 under "2560 Status Information" in the section "IBM 2560 Multi-function Card Machine, Models A1 and A2". For a more detailed description of the channel status bits, see *IBM System/370 Principles of Operation,* GA22-7000.

Note: A set PCI flag bit in the first CCW after a 'start I/O' instruction is not recognized if the 'start I/O' instruction finds the 5203 is not available.

5203 SENSE INFORMATION

Sense Byte 0

The bits in sense byte 0 have the following meanings assigned:

Bit	*Designation*
0	Command reject
1	Intervention required
2	Bus out check (not used)
3	Equipment check
4	Data check
5	Chain buffer parity check
6	No channel found
7	Channel 9

Command Reject (Bit 0)

The command reject bit, when set, indicates that the current command was rejected because it was not assigned to the 5203. A read command being issued causes command rejection. The fact that the current command has been rejected is indicated by *unit check* being set in the initial status. Setting of unit check causes chaining (if specified) to be suppressed.

Intervention Required (Bit 1)

The intervention required bit, when set, indicates that operator intervention is necessary because the 5203 has lost the ready state. The ready state is lost in the following situations:

1. The 5203's STOP key is pressed.
2. The train cartridge is not properly seated or has been removed.
3. The rear unit is open or the forms chute points upward (in the load position).
4. A forms jam has occurred (switching on the CHECK light).
5. The forms have run out (switching on the FORMS light).
6. A carriage sync check has occurred (switching on the CHECK light).
7. A chain sync check has occurred (switching on the CHECK light).
8. An overheat condition (thermal overload) occurred in the hammer unit or the 5203's electronics gate.
9. A hammer driver could not be reset, or the CE hammer-on check switch was accidentally operated, causing the coil protect bit (bit 2, sense byte 2) to be set.
10. The hammer bar right home position could not be detected or the shift clutch failed.
11. The check circuitry is defective, setting the any-hammer-on check bit, and also forcing the coil protect check bit, in sense byte 2.
12. An error occurred in the subscan counter, setting the subscan ring check bit in sense byte 2.
13. A chain buffer address register check has occurred.

The setting of the intervention required bit causes *unit check* to be set in the CSW at the initiation of a 'start I/O' or 'test I/O' instruction or at device end time, depending on when the condition arises. Intervention required is reset when the printer is restored to the ready state.

Bus Out Check (Bit 2)

The bus out check bit is not used.

Equipment Check (Bit 3)

This bit indicates a program-correctable error that occurred in the 5203 or the front end logic. The error is corrected the next time the printer is selected for a 'start I/O', 'halt I/O', or 'halt device' instruction.

The equipment check bit is set by one or more of the nine error conditions which are represented by the bits of sense bytes 4 and 5. For details of these conditions, see "Sense Byte 4" and "Sense Byte 5" in this section.

The detection of an equipment check causes unit check to be set at the time device end (with or without channel end) is set.

Note: Setting of the equipment check bit does not cause the 5203 to lose the ready state.

Data Check (Bit 4)

The data check bit can only be set when data checks are not prevented by a 'block data check' command. Data check will then be set if the print line buffer contains a character pattern for which no matching pattern is found in the UCS buffer during a UCS print operation. This is usually due to a wrong program being used.

The fact that data check is set is indicated by unit check being set in the CSW at device end time.

Chain Buffer Parity Check (Bit 5)

The chain buffer parity check bit is set to indicate a chain buffer parity error. The presence of a chain buffer parity check causes unit check to be set at channel end time.

No Channel Found (Bit 6)

The no channel found bit is set when a skip command or a write and skip command did not find the channel code (in the carriage control buffer) to which the carriage was to advance. The setting of the no channel found bit causes unit check to be set at device end time.

Channel 9 (Bit 7)

The channel 9 bit, when set, indicates that a channel 9 code was detected in the carriage control buffer during the execution of a space command or a write and space command. The same situation when caused by a manual space or any of the skip commands does not set the channel 9 bit. The setting of the channel 9 bit causes unit check to be set at device end time.

Sense Byte 1

Sense byte 1 is not used.

Sense Byte 2

The bits in sense byte 2 represent eight conditions, any of which can cause the 5203 to lose its ready state. The setting of one of these bits causes the intervention required bit to be set in sense byte 0. The bits in sense byte 2 have the following meanings assigned:

Bit	*Designation*
0	Interlock (chain gate open)
1	Forms check (jam)
2	Coil protect check
3	Subscan ring check
4	Chain buffer address register check
5	Hammer unit shift check
6	Any-hammer-on check
7	Thermal overload

Interlock (Bit 0)

The interlock bit is set to indicate that the 5203's rear unit is open, a train cartridge is removed or not properly seated, or the forms chute is in the load position.

Forms Check (Bit 1)

The forms check bit, when set, indicates a paper jam.

Coil Protect Check (Bit 2)

The coil protect check bit, when set, indicates that power was removed from the hammer circuits to prevent damage to the hammer coils.

Subscan Ring Check (Bit 3)

The subscan ring check bit is set if there is an error in the subscan ring counter (hardware) or a drum emitter failure.

Chain Buffer Address Register Check (Bit 4)

This bit is set to indicate that there is a loss of synchronism between the chain position and chain buffer addressing at home pulse time (at this time, both should be in step).

Hammer Unit Shift Check (Bit 5)

The hammer unit shift check bit, when set, indicates a failure in a shift clutch, clutch photo emitter, or hammer bar right home switch.

Any-Hammer-On Check (Bit 6)

The any-hammer-on check bit is set to show that protection of the hammer coils is no longer possible because of a failure in the coil protect monitoring circuits or because the CE any-hammer-on test switch was operated. This bit can also mean that the 'any-hammer-on' latch was not turned off, because a hammer failed to fire.

Thermal Overload (Bit 7)

The thermal overload bit, when set, shows that hammer power was removed due to overheating in the hammer unit or the 5203's electronics gate.

Sense Byte 3

Sense byte 3 is not used.

Sense Byte 4

The bits in sense byte 4 represent eight error conditions, any one of which can cause the equipment check bit to be set in sense byte 0. An equipment check caused by a condition in sense byte 4 is a program-correctable error.

Bit	*Designation*
0	Hammer reset failure check
1	No fire check
2	Misfire check
3	Print data buffer parity check
4	Check bit buffer parity check
5	Chain buffer parity check
6	Buffer address register check
7	Clock check

Hammer Reset Failure Check (Bit 0)

This bit, when set, indicates that a hammer driver failed to reset when addressed for resetting.

No Fire Check (Bit 1)

The no fire check bit, when set, indicates that a hammer failed to fire when addressed for firing.

Misfire Check (Bit 2)

The misfire check bit, when set, indicates that a hammer fired without being addressed.

Buffer Parity Checks (Bits 3, 4, and 5)

The buffer parity check bits for the print data buffer, check bit buffer and chain buffer are set to indicate parity errors in the buffers concerned.

Buffer Address Register Check (Bit 6)

The buffer address register check bit is set when an addressing error causes a subscan to seem excessively long.

Clock Check (Bit 7)

The clock check bit is set when extra clock steps (possibly due to "noise") are detected.

Sense Byte 5

Bit 0 in sense byte 5 represents one further error condition (in addition to those in sense byte 4) which, when set, causes the equipment check bit to be set in sense byte 0. This equipment check is a program-correctable error.

Bit	*Designation*
0	Open coil check
1	(Not used)
2	(Not used)
3	(Not used)
4	(Not used)
5	(Not used)
6	(Not used)
7	(Not used)

Open Coil Check (Bit 0)

The open coil check bit, when set, indicates that a hammer coil has burnt out.

5203 ERROR RECOVERY

The following text describes the minimum action the operating system should take to deal with errors or other unusual conditions that may occur. Errors and other unusual conditions are usually indicated by the setting of unit check or any of the other status bits (except an end condition or busy) in the CSW.

Unit Check in CSW

When a command ends with unit check set in the CSW, the operating system should issue a 'sense' command and subsequently inspect at least sense byte 0 to find the reason for the unit check. The following text describes the suggested error recovery procedures for errors shown by bits set in sense byte 0.

Command Reject (Sense Byte 0, Bit 0)

The most likely cause of command reject being set is that a command not assigned to the 5203, such as a 'read' command, has been issued. The operating system should trace back the program and provide a message advising the system programmer to correct the error.

Intervention Required (Sense Byte 0, Bit 1)

If the intervention required bit is set, the printer has lost its ready state and manual intervention is required. The operating system should analyze sense bytes 2 and 3 because these bytes contain error information not indicated by the 5203's indicator lights. If sense bytes 2 and 3 show the cause of the error, an appropriate message should then be issued to the operator advising him of the error and requesting him to press the printer's START key (to restore the ready state).

If the error is not obvious from the information in sense bytes 2 and 3, the message should advise the operator to check the indicator lights on the 5203 operator panel. These lights, as described below, can suggest the reason for the printer losing its ready state.

INTERLOCK Light On: The operator should make certain that the train cartridge is properly mounted, the rear unit is closed, and the forms chute is in the feed position (downward).

FORMS Light On: The operator should check whether new forms must be inserted. In case of end-of-forms, the printer continues printing and the FORMS light is switched on when the channel 1 code is found in the buffer. The operator must then insert new forms and press the 5203's START key. (The end-of-forms feelers must be set into their cutouts, otherwise the FORMS light remains on.)

CHECK Light On: An error has occurred either in the 5203 or in the front end. Errors in the printer can be conditions such as a forms jam, a thermal overload (hammer unit or electronics gate), a chain sync check, any-hammer-on check, a carriage sync check, and so on.

Hardware malfunctions of this type may be overcome by pressing the 5203's START key. However, in case of repeated hardware errors, CE attention is required.

Equipment Check (Sense Byte 0, Bit 3)

If the equipment check bit is set, the operating system should analyze the data provided by sense bytes 4 and 5, and issue a message to the operator advising him of the condition. The program should then retry the last command or display the last print line on the video display. Equipment check conditions are not usually so severe that a retry would be ineffective. However, if equipment check persists, the CE should be notified.

Data Check (Sense Byte 0, Bit 4)

If the data check bit is set, the print pattern sent to the 5203 cannot be printed with the train cartridge currently fitted. In this case, the train cartridge should be changed and the job should be repeated.

Chain Buffer Parity Check (Sense Byte 0, Bit 5)

If the chain buffer parity check bit is set, the operating system should display the last line to be printed and repeat the operation. If the error persists, the CE should be notified. Reloading of the UCS buffer is not required because the hardware reloads the buffer automatically.

No Channel Found (Sense Byte 0, Bit 6)

If the no channel found bit is set, the carriage control buffer has been loaded with information that is not appropriate for the current program. The operating system should either reload the carriage buffer or issue a message that indicates what type of control information should be loaded. The operator may also be advised to check the forms on the printer to determine which control program is required.

Channel 9 (Sense Byte 0, Bit 7)

If the channel 9 bit is set, the operating system should take the appropriate action, depending on the use and meaning of channel 9. Setting of the channel 9 bit may indicate a programming error such as the wrong carriage control information for the current program.

Unit Exception in CSW

If the unit exception bit is set, a channel 12 code was detected during spacing and interpretation depends on the meaning which the programmer has assigned to channel 12.

Channel Data Check in CSW

The channel data check bit is usually set as a result of a parity error in the data transferred (such as in a buffer load operation) between main storage and the printer attachment. The error is not severe because the parity has been corrected. The output at the printer is, however, unreliable and the operating system should either retry the operation or use the video screen to display the contents of the output area as it should have been printed. Retry should in any case be attempted. Repeated channel data checks require CE attention.

Note: If channel data check is set, the operating system should analyze storage location 176, which contains the limited channel logout. This logout shows how far the operation progressed and/or how it was terminated.

Channel Control Check in CSW

If the channel control check bit is set, the operation was either terminated or not started due to a severe error in the Model 115's main storage controller or internal bus system. Retry should be attempted and, if unsuccessful, the CE should be notified.

Note: If channel control check is set, the operating system should analyze storage location 176, which contains the limited channel logout. This logout shows how far the operation progressed and/or how it was terminated.

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