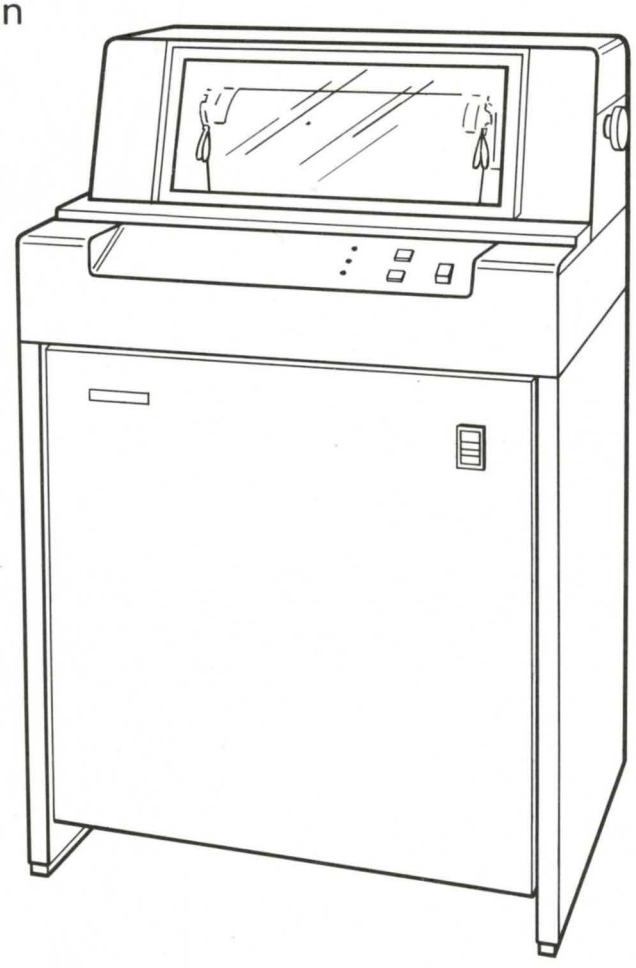
IBM

Series/1

GA34-0044-0

File No. S1-03

IBM Series/1
4973 Line Printer
Description



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First Edition (March 1977)

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Contents

Preface

This manual contains reference material and is a source of information about the IBM 4973 Line Printer Models 1 and 2, and the 4973 Printer Attachment Feature.

This publication is intended primarily for:

- Customer Programmers
- System Engineers
- Installation Managers

and others responsible for programming the 4973, and provides the necessary information to plan and modify I/O routines used in the 4973.

Chapter 1 is an introduction to the general characteristics and features of the printer.

Chapter 2 discusses the flow of data information to and from the printer. Specific topics are:

- I/O Commands
- I/O Operations
- Status Words
- Condition Codes

PREREQUISITE KNOWLEDGE

This book assumes the reader has a background in data processing concepts and is familiar with the hexadecimal numbering system as used in IBM systems. It is assumed the reader has a basic understanding of printers and their relationship to a processor and an understanding of stored program concepts, system and printer programming support.

PREREQUISITE PUBLICATIONS

IBM Series/1 Model 5 4955 Processor and Processor Features Description, GA34-0021.
IBM Series/1 Model 3 4953 Processor and Processor Features Description, GA34-0022.
IBM Series/1 System Summary, GA34-0035.

RELATED PUBLICATIONS

IBM Series/1 Installation Manual—Physical Planning, GA34-0029.
IBM Series/1 Configurator, GA34-0042.

Chapter 1. Introduction

The IBM 4973 Model 1 and Model 2 Line Printers (Figure 1-1) use a character belt to provide from 80 to 414 lines per minute printed copy.

The 4973 Model 1 Line Printer operates at nominal speeds of 155, 120, or 80 lines per minute. The Model 2 operates at nominal speeds of 414, 300, or 235 lines per minute. The operating speed of the two models is based on a character set length of 48, 64, and 96 characters respectively.

Both models of the printer connect to the IBM 4973 Attachment card (a prerequisite for the 4973) which is located in one of the following rack mounted units:

- IBM Series/1 Model 3 4953 Processor
- IBM Series/1 Model 5 4955 Processor
- IBM Series/1 4959 Input/Output Expansion Unit

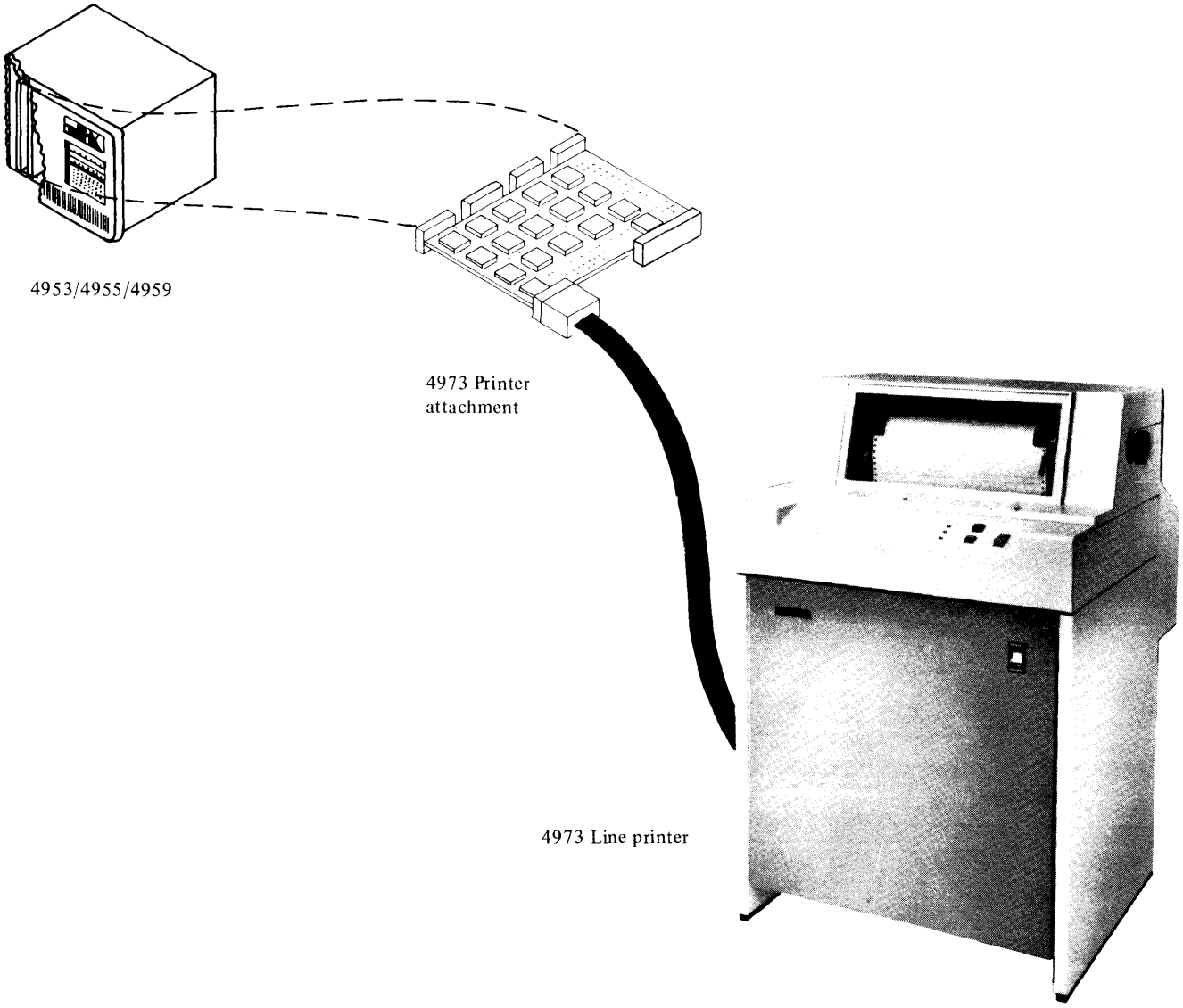


Figure 1-1. IBM 4973 Line Printer

PRINTER FUNCTIONAL DESCRIPTION

The IBM 4973:

- Is available in two models, 1 and 2, to provide various printing speeds
- Uses a print belt of various character set lengths
- Is controlled by a cycle stealing attachment
- Prints up to 132 characters per line (cpl)
- Prints 10 characters per inch (cpi)
- Spaces 6 or 8 lines per inch (lpi)
- Has paper jam detection
- Has variable width forms tractor
- Has an external forms stand (model 1)
- Has a forms stand enclosure (model 2)
- Has a control panel consisting of Ready, Printer Check, and Forms Check indicators and three switches for Space, Restore, and Enable/Disable

The print speed of the 4973 model 1 and model 2 is dependent on the character set length (number of characters in the set). The following chart shows the nominal line per minute speeds of the two models for the various character set lengths available:

Character Set	*4973 Model 1*	*4973 Model 2*
48	155 LPM	414 LPM
64	120 LPM	300 LPM
96	80 LPM	235 LPM

ATTACHMENT FUNCTIONAL DESCRIPTION

The attachment feature card:

- Connects the printer to the processor
- Transfers characters from the processor storage buffer to the printer through a belt translator
- Controls forms movement
- Initializes to the EBCDIC Character Set (see Appendix A)

Note. The using system's program defines the length of the forms and the overflow line on the form. When the overflow line is reached, forms movement and printing are stopped and an 'exception interrupt' is issued. Forms movement and printing resumes on the next 'Start' command.

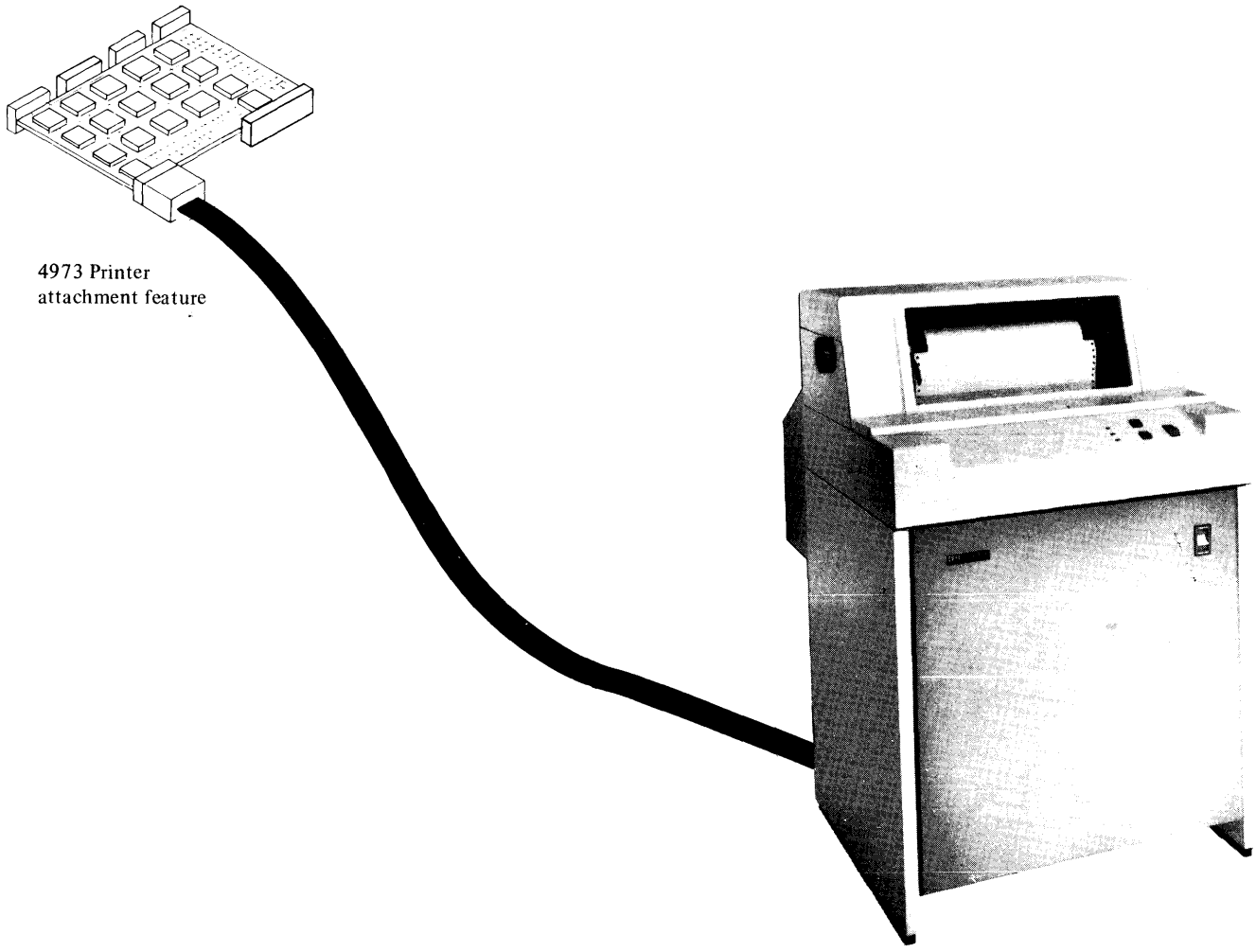


Figure 1-2. 4973 Line Printer and Attachment

BASIC COMPONENTS

The IBM 4973 Line Printers consist of three basic components:

- Printer
- Carriage
- Console

Printer

The printing unit consists of a 132 print position platen, print belt, ink ribbon, and print hammers (66 print hammers for model 1 and 132 print hammers for model 2). Printing is accomplished by the print hammers which selectively force the paper against the inked ribbon and the print belt. The print hammers are selected through the belt translator when the desired character on the belt is in the correct print position.

Carriage

Both models of the 4973 have a pin feed carriage which will handle up to six part forms. (See Appendix B for forms requirements.) The carriage will move the forms at either 6 or 8 lines per inch (lpi) under program control. Forms may also be skipped under program control at the rate of 12 inches per second.

Console

The printer console (Figure 1-3) consists of the following:

1. Indicators
   - Ready—The printer is ready to execute system commands
   - Printer Check—An error has occurred during a print operation
   - Forms Check—Either there are no forms in the printer or the forms failed to move under program control

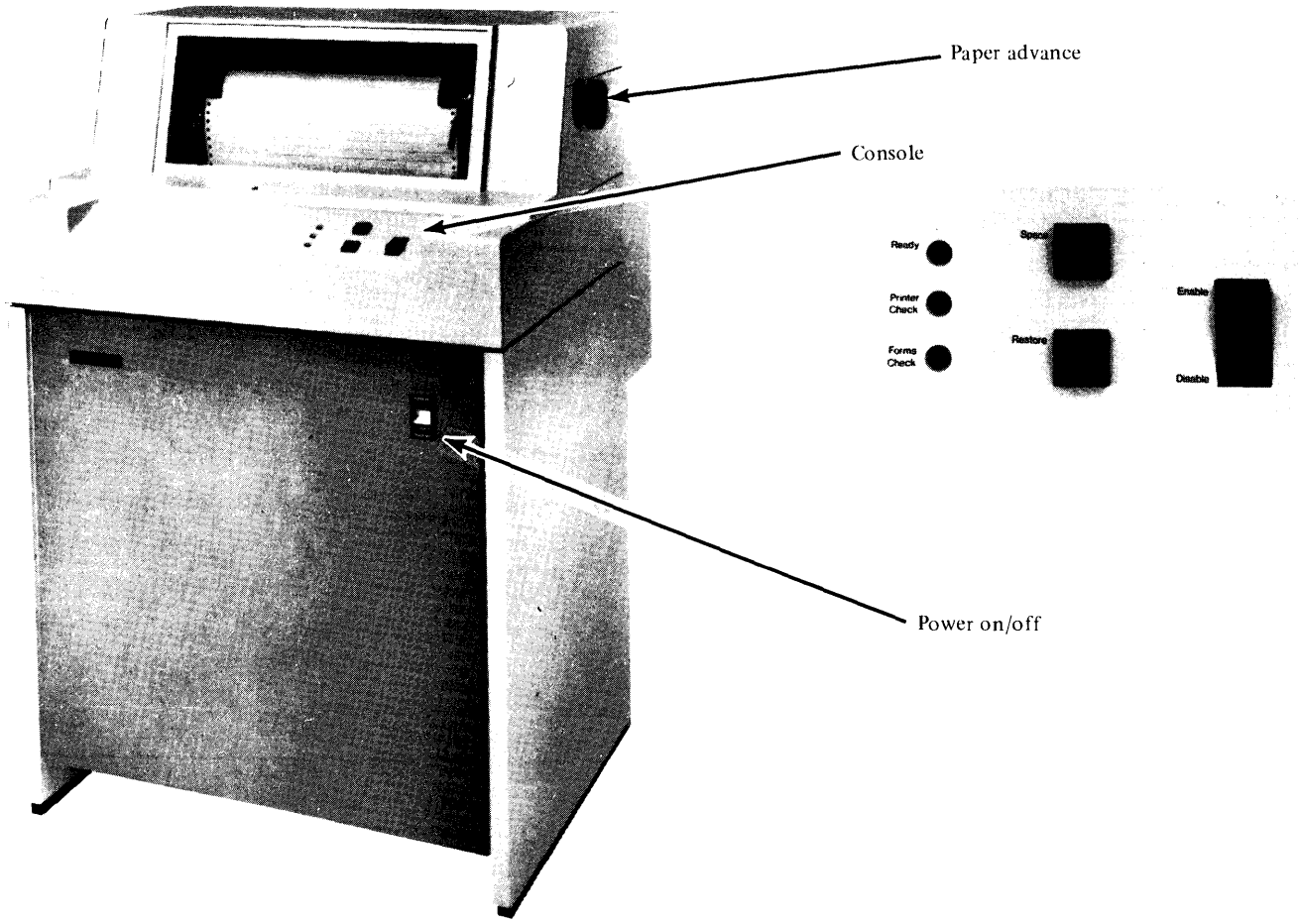


Figure 1-3. Printer Console

2. Switches
   - Enable/Disable—When in the Enable position, the printer will accept and execute commands from the system. The switch must be in the Enable position to print. To make the printer Not Ready, place this switch in the Disable position. To reset an error, move the switch to Disable then to Enable. Some errors require operator intervention such as 'end of forms' or 'forms jam'.
   - Carriage Restore—The carriage is positioned to line one of the forms. This switch is only active when the printer is Not Ready. With the cover open, only the vertical forms control is set to line 1 of the form. The cover must be closed to move the forms to line one.
   - Carriage Space—The carriage moves the forms one space. This switch is active only when the printer is Not Ready. Pressing the carriage space also causes the ribbon and print belt to move.
   - Power—Turns mainline power to the printer on or off. This switch is located on the front of the printer stand.

Also included are paper advance knobs located on either side of the printer cover. These knobs allow the operator to manually move the forms.

Chapter 2. Programming Input/Output Operations

This chapter discusses the flow of data to and from the printer. Specific topics are commands, condition codes, status words, and I/O instructions.

DATA TRANSFER OPERATIONS

Data is transferred on the I/O channel, between the processor and the attachment, in a parallel operation (16 data bits plus 2 parity bits). The number of data words transferred and the direction in which they move on the channel is determined by the I/O command. The I/O command also determines whether data is transferred to or from main storage, under Direct Program Control (DPC) or in Cycle Steal (CS) mode.

DIRECT PROGRAM CONTROL (DPC)

When data is transferred under Direct Program Control, only one word of immediate data moves to or from main storage. After moving the immediate data, the processor continues processing other instructions.

CYCLE STEAL

When data is moved to or from main storage by a Cycle Steal Operation (stealing storage cycles), processing and I/O operations are overlapped. Overlapping allows the processor to execute other instructions while the printer is performing I/O operations.

OPERATE I/O INSTRUCTIONS

The following description is an overview of the Operate I/O instruction. Refer to the Processor Description Manuals listed in the "Prerequisite Publications Section" in the preface for a more detailed description.

All input/output operations between the processor and the printer are initiated by an operate I/O instruction. An address field (bits 16–31) and the R2 field (bits 8–10) in the Operate I/O instruction (Figure 2-1) point to a processor storage location containing an Immediate Device Control Block (IDCB).

The IDCB is a two-word block of storage that contains the device directed I/O commands. Before issuing the I/O instruction for an operation, the command field of the IDCB (bits 0–7) must be set, along with a device address (bits 8–15), and any field of immediate data required by the command in the IDCB (bits 16–31). The information specified in the immediate field depends on the command to be performed. The device address of the 4973 is limited to 128 (0–127) possible device address combinations. Bit 8 of the Device Address Field in the IDCB must be zero. Refer to the *IBM Series/1 Model 5 4955 Processor and Processor Features Description*, GA34-0021 or the *IBM Series/1 Model 3 4953 Processor and Processor Features Description*, GA34-0022, for a more detailed description of the I/O instruction.

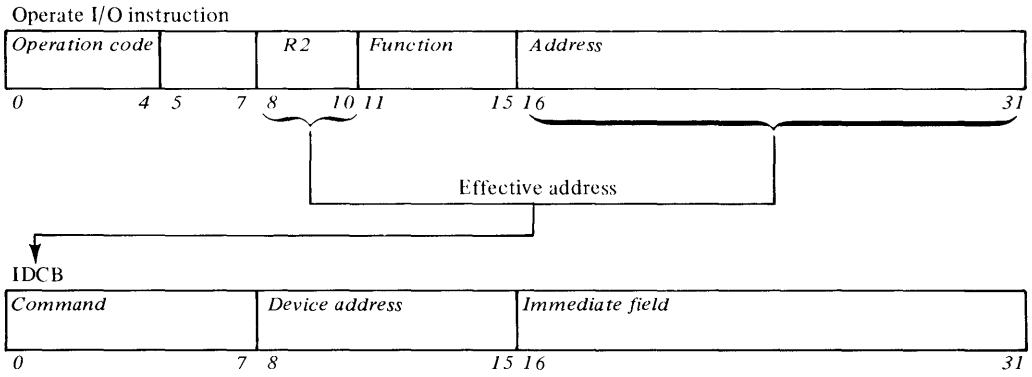


Figure 2-1. Operate I/O instruction and IDCB format

USING THE IDCB

An Immediate Device Control Block (IDCB) is required for every I/O command issued to the printer. The format of the IDCB is shown in Figure 2-2. Before issuing an I/O instruction, an I/O command must be stored in the associated IDCB. The immediate data field of the IDCB should contain either a data word or a DCB (device control block) address. I/O commands that execute under direct program control require a data word, while the commands that execute in cycle steal mode require a DCB address.

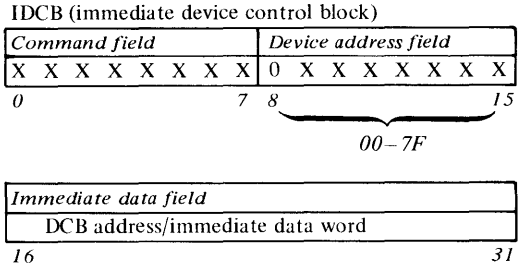


Figure 2-2. IDCB Format Control

USING THE DCB

A Device Control Block (DCB), comprised of eight contiguous words in main storage, must be reserved for every I/O operation that moves data in Cycle Steal mode. A separate DCB is required for:

- A Start command
- A Start Cycle Steal Status command
- All printer operations included in a DCB command chaining sequence

Device parameters that define and control the I/O operation must be stored in each DCB. (See Figure 2-3.) The bit significance of each DCB word will be covered in "DCB Format" later in this chapter.

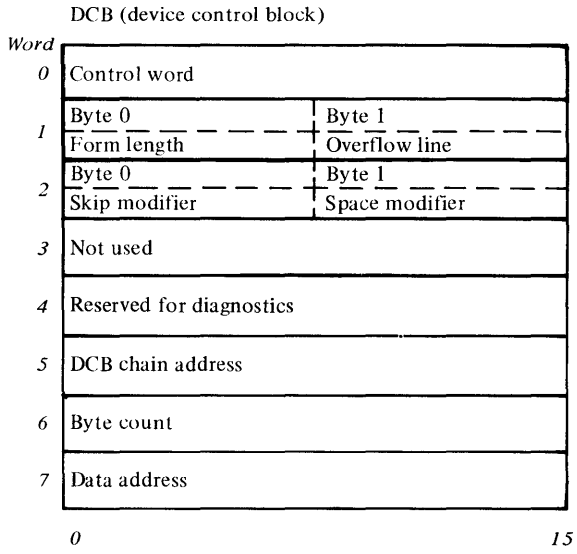


Figure 2-3. Device Control Block

INPUT/OUTPUT COMMANDS

The I/O command, stored in the IDCB, determines whether Direct Program Control or Cycle Steal mode is used to move data between main storage and the attachment during an I/O operation. The attachment responds to the following I/O commands:

Direct Program Control (DPC)

1. Prepare
2. Device reset
3. Read Device ID

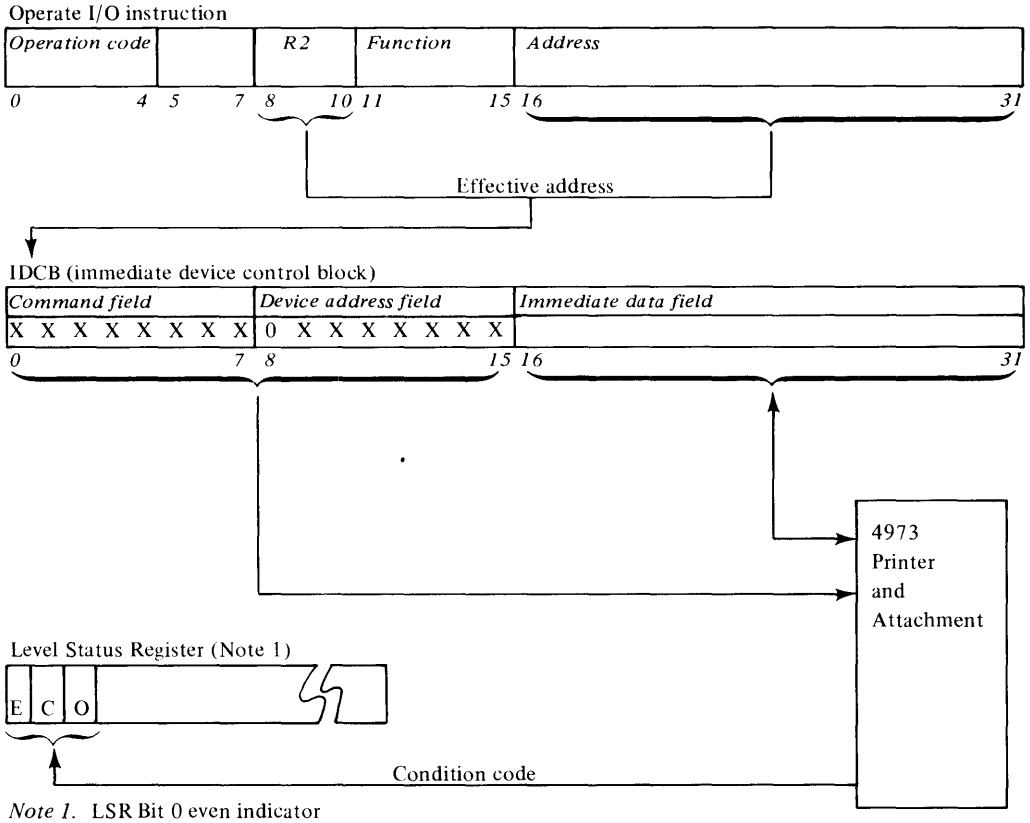
Cycle Steal Mode (CS)

1. Start
2. Start Cycle Steal Status

Command Execution Under DPC Mode

When the printer unit executes a Prepare, Device Reset, or Read ID command, a word of data is moved to or from the immediate data field of the IDCB in main storage. After execution of the command, the attachment reports a condition code that indicates whether the I/O operation succeeded or failed. See "Condition Codes" in this chapter. Processing operations are halted while the I/O operation is in progress. (See Figure 2-4.)

Note. I/O commands that move data under DPC do not cause interrupts.

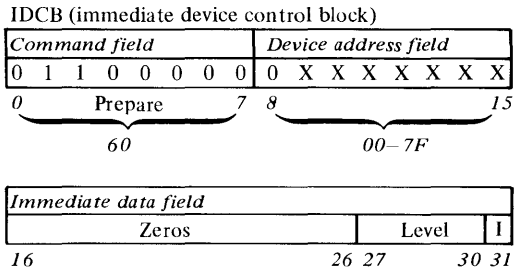


Note 1. LSR Bit 0 even indicator
Bit 1 carry indicator
Bit 2 overflow indicator

Figure 2-4. Direct Program Control I/O Operation

Prepare Command

Before the printer, via the attachment, can execute interrupt types of commands, it needs interruption parameters which control these commands. These parameters, stored in the IDCB immediate fields associated with a Prepare command, contain the level on which the attachment is to interrupt (bit 27–30), and an interrupt enable (bit 31), and are transferred to the attachment upon execution of Prepare commands. If the I-bit (bit 31) equals 1, the printer can interrupt. If the I-bit equals 0, the printer cannot interrupt. The Prepare command operates under DPC and does not itself cause an interrupt.



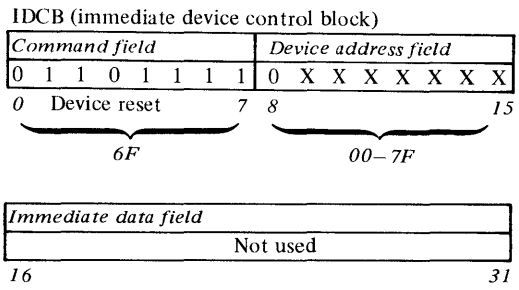
Device Reset

A Device Reset command will:

- Stop all cycle stealing, printing and carriage movement
- Reset Control, Status, and Pending interrupts
- Reset the ISB
- Stop the print belt
- Halt any Start command
- Not alter forms length

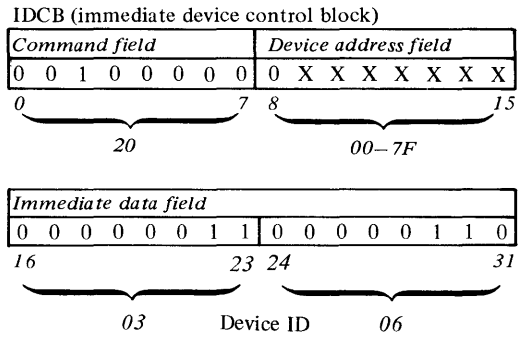
The Device Reset does not use or check the immediate data field of the IDCB. The command code and device address supply all needed information.

Note. Issuing a Device Reset while the carriage is moving requires forms alignment by the operator.



Read Device ID

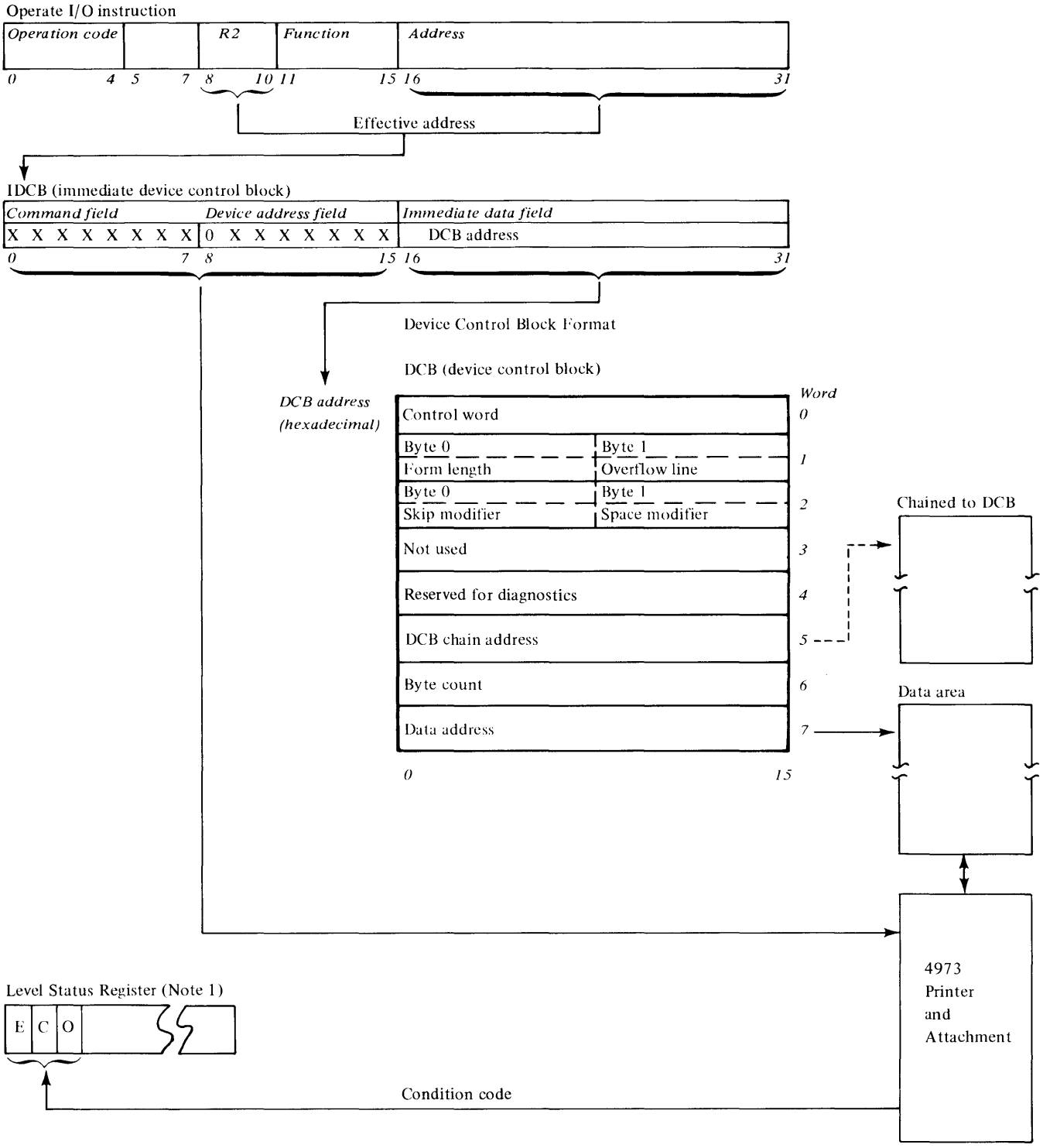
The Read Device ID command operates under DPC and transfers the device ID from the printer attachment into the immediate data field of the IDCB associated with that command. If the printer is busy or an interrupt is pending, condition code 1 is returned. No interrupt results from the Read Device command. The 4973 ID, 0306 HEX, is placed in the immediate data field.



Command Execution in Cycle Steal Mode

The Start command and the Start Cycle Steal Status command are interrupt-causing commands that move data in Cycle Steal mode. When the attachment receives and accepts either of these commands, it reports a condition code to the processor and begins command execution. The processor continues with other operations while the attachment is "busy" with the I/O operation. When the I/O operation is completed, the attachment sends an interrupt request to the processor. At interrupt presentation time, the attachment reports a condition code and transfers an interrupt ID word containing status information to the processor. See "I/O Status Information" in this chapter.

The immediate data field of an IDCB containing either a Start command or a Start Cycle Steal Status command must point to a Device Control Block (DCB). See Figure 2-5. The DCB must contain the control information and device parameters that are required to execute an I/O operation in Cycle Steal mode.



Note 1. LSR Bit 0 even indicator
Bit 1 carry indicator
Bit 2 overflow indicator

Figure 2-5. Cycle Steal I/O operation

DCB Format

The DCB (Figure 2-6) contains eight contiguous data words. DCB words 1 through 7 depend on the configuration of bits 8 through 11 of the Control Word (DCB) word 0).

DCB Word 0—Control Word

The Control word is the first word of the DCB. It is a 16-bit word that explains the cycle stealing operation, and contains two distinct bytes of control parameters to be used with the particular Start command to be performed. Figure 2-6 shows the DCB and Control Word 0.

Bits 1 3 4—Not Used. These bits are not supported and must be zero.

Bit 0—Chaining Flag. When set this bit indicates a command chaining operation. After completing the current DCB operation, the attachment will not interrupt but will fetch the next DCB pointed to by the Chain Address in DCB word 5. Command Chaining is valid only for a Start Command with a modifier of '0000' and is ignored and not checked for the other commands.

Bit 2—Input Flag. This bit indicates the direction of the Cycle Steal operation: 0 = out of main storage, 1 = into main storage.

Bits 5 6 7—Address Key. This is a 3-bit key presented by the attachment during data transfers to ascertain storage access authorization. An invalid

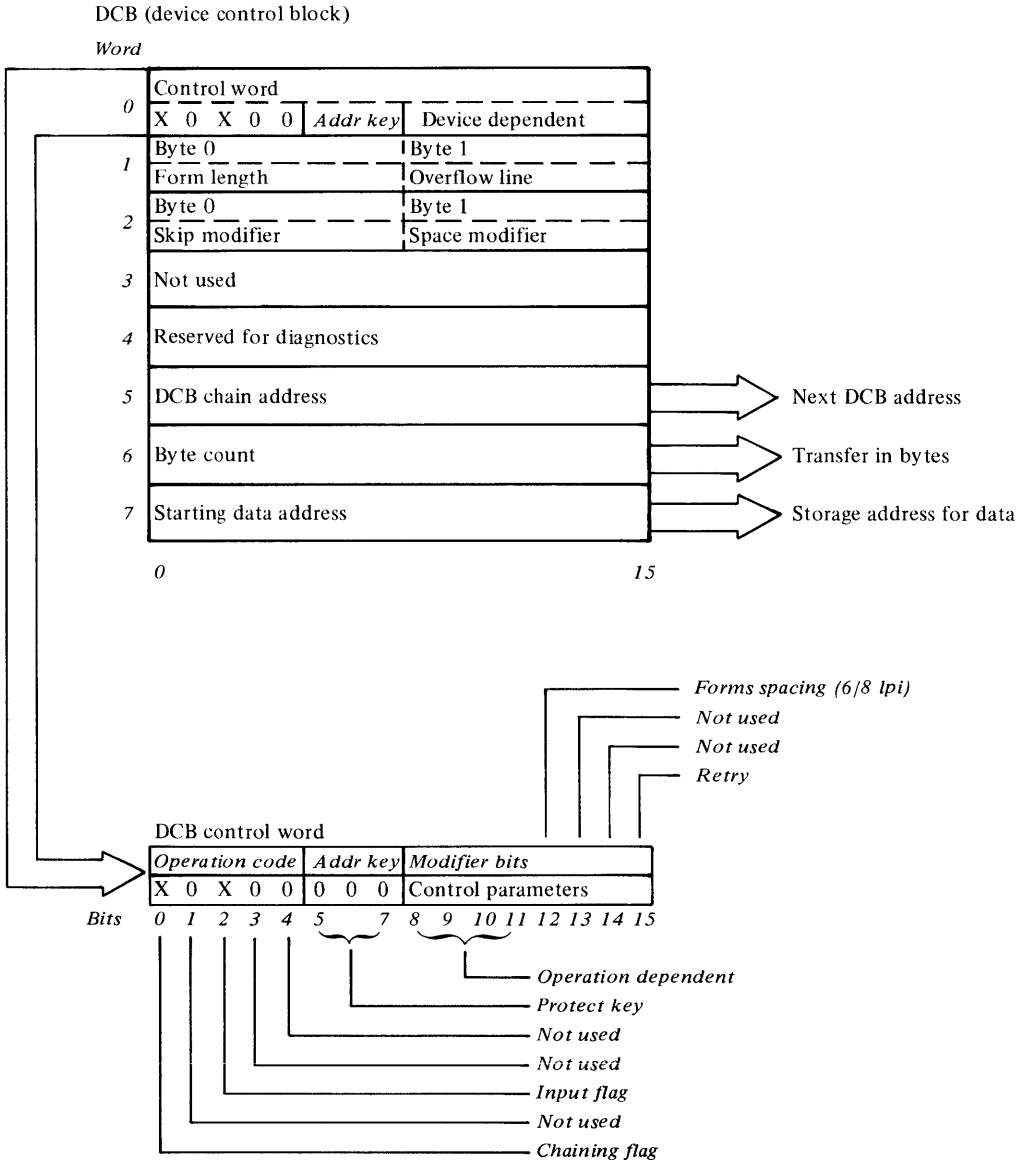


Figure 2-6. DCB and Control Word 0

addresss key will result in a protect check.

Bits 8 9 10 11—Operation Dependent. Used in conjunction with each other, these bits specify various operations. The following chart shows the bit configuration, the operation and the DCB words used for each operation. The Operations are discussed later in this text.

Bits 8 9 10 11	*Operation*	*Words Used*
0 0 0 0	Carriage Control and Print Line	2, 5, 6, 7
1 0 0 0	Set Forms Parameters, Carriage Control, and Print Line	1, 2, 5, 6, 7
0 1 0 0	Initialize Belt Translator	5, 6, 7
0 0 1 0	Transfer Belt Translator	5, 6, 7
0 0 0 1	Reserved for Diagnostics	4, 5, 6, 7

Bit 12—Forms Spacing. Used when bits 8, 9, 10, and 11 equal 1000, bit 12 specifies 6 lines per inch when set to 0 or 8 lines per inch when set to 1.

Bits 13 and 14—Not used.

Bit 15—Retry. When this bit is on, the attachment will attempt to complete execution of the last Start I/O command issued. If this bit is on, the remainder of the DCB must be the same as the DCB being executed at the time of the exception interrupt (the printer attachment knows what step of the execution was in process when the exception occurred, DCB transfer, data transfer, carriage movement or printing).

The attachment executes the necessary steps for completing the Start I/O command. The entire DCB is transferred to the printer. The data is transferred only if required. If the previous Start I/O command was successfully completed, the Retry Bit is ignored and the DCB is executed. After a Power On Reset, the command is executed as a normal DCB, and the other words in the DCB are checked and used if required. This command is terminated with a normal Device End interrupt, unless further exception conditions are detected and reported by an exception interrupt.

DCB Word 1—Forms Parameters

Byte 0 of DCB word 1 is the new form length. If it is less than the current line position, the current line position is set to line 1 of the form.

Byte 1 is the line where the printer is to stop form movement and/or printing and post an exception interrupt with bit 0 on in the ISB. Cycle Steal Status word 1 will have the overflow bit (11) set on. A Start Cycle Steal Status I/O command is issued to determine how many lines are required to complete the previous carriage operation (the residual line count) and/or the current line position status. Overflow interrupt is inhibited if Byte 1 = 0 or is greater than the form length (Byte 0).

DCB Word 2—Carriage Control

The Carriage Control Word specifies whether a skip or space is to take place. For a skip, the attachment calculates how far the forms must be moved to get to the specified line. To space, the user tells the attachment how many lines to move. The speed of the forms movement is the same regardless of the modifier used.

Byte 0 of the carriage control word is the skip. If this byte has a value of up to the form length, the forms will move to the specified line on the next form. If the skip modifier is greater than the form length, an interrupt is posted and the DCB specification check is set in the ISB.

If byte 0 = 0, byte 1 is inspected for a space. If byte 1 = 0, no forms movement will take place. If the space modifier is greater than zero the forms will move the number of lines specified. (If byte 0 is greater than zero, byte 1 is not checked.)

The maximum number of lines the forms can be moved with either a skip or space command is 255.

DCB Word 3—Not Used

DCB Word 4—Reserved for Diagnostics

DCB Word 5—Chaining Address

The Chaining Address is the location of the next DCB table to be executed. If the Chaining Address is odd, an interrupt is posted and a DCB specification check is set in the ISB. The Chaining Address is not checked unless the chaining flag is on in a valid control word.

DCB Word 6—Byte Count

This word specifies the byte count for a particular operation. If the byte count = 0, no data is transferred. If the byte count is greater than the maximum allowed for a particular operation, an interrupt is posted and a DCB specification check is set in the ISB.

DCB Word 7—Data Address

Word 7 is the system storage address for the data associated with the operation to be performed.

Operations

The printer operations depend on the configuration of bits 8, 9, 10, and 11 of the Control Word (DCB Word 0). These bit configurations are explained in the following text.

Bits 8 9 10 11 = 0000—Carriage Control and Print Line. Transfer one print line and carriage control data from the processor to the attachment. The input flag, bit 2, must be zero. This operation uses DCB Words 2, 5, 6, and 7. The maximum byte count for this operation is 132.

Bits 8 9 10 11 = 1000—Print and Carriage Control. Transfer all data necessary to print one line, specify forms length, specify overflow line and line spacing, and move the carriage.

Bit 12 of DCB Word 0, the Control Word, is used to indicate the forms spacing. The carriage spaces 6 lines per inch when bit 12 equals 0; and 8 lines per inch when bit 12 equals 1.

Note. If the line spacing is changed on other than line 1 of the form, the forms may have to be manually adjusted for line 1.

Bits 8 9 10 11 = 0100—Initialize Belt Translator. Initialize the belt translator with the data for the print belt character sets (48, 64, or 96). The 96 character set prints 94 characters because belt positions 87 and 88 are unprintable characters.

This operation will occur only if the input flag, bit 2, of the Control Word equals 0; and the byte count is less than 8.

DCB Words 5, 6, and 7 are used for this operation.

Bits 8 9 10 11 = 0010—Transfer Belt Translator. The transfer of belt translator data between main storage and the printer attachment. The direction of data flow is dependent on the Input flag. The belt translator data field includes the print belt position to be printed for each of the possible 256 HEX codes. An entry of zero indicates that no printing is required for that particular HEX code. The byte count for this operation is from 0 to 256. Transfer Belt Translator is used to load a translator other than the standard translator (see Appendix B).

Bits 8 9 10 11 = 0001—Reserved for Diagnostics.

Programming Considerations When Using the DCB

1. All words in the DCB are fetched. The contents of the words must be specified correctly.
2. The DCB address, chain address, and the status address must be even.

DCB Command Chaining

DCB command chaining is executed when the current DCB comes to a normal completion and a new DCB is fetched without issuing a new Operate I/O instruction.

The first DCB in the chain contains the address of the next DCB. As each operation in the sequence is completed, the attachment uses the chain address stored in the current DCB to select the next DCB. The chained-to DCB is examined to determine which operation is next in the sequence and whether the associated device parameters are valid. DCB command chaining operations continue until a DCB is fetched having the chaining bit in the control word (DCB word 0) set to zero. This indicates the last operation in the chain.

If an error occurs, chaining to succeeding DCBs is automatically suspended and the attachment sends an interrupt request to the processor. The attachment does not request an interrupt until the printer has completed the last operation in the chain. By using command chaining, the processing time required to execute I/O operations is reduced.

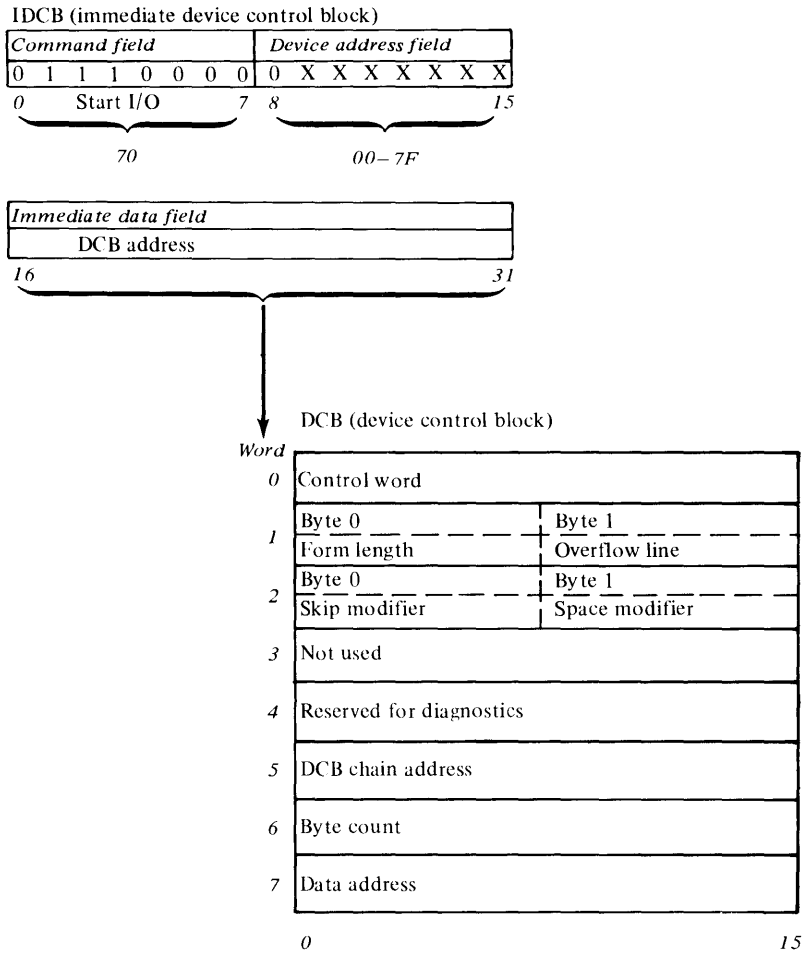
Start Command

The Start command initiates all printer operations that transfer data to or from main storage in cycle steal mode. As a result of initiating this command, an interrupt request is presented to the processor when the operation is completed.

The Operate I/O instruction must point to an IDCB containing a Start command and an immediate field containing the address of the DCB.

DCB Word 0, Control Word, contains the applicable control parameters for a given operation. See "DCB Word 0—Control Word".

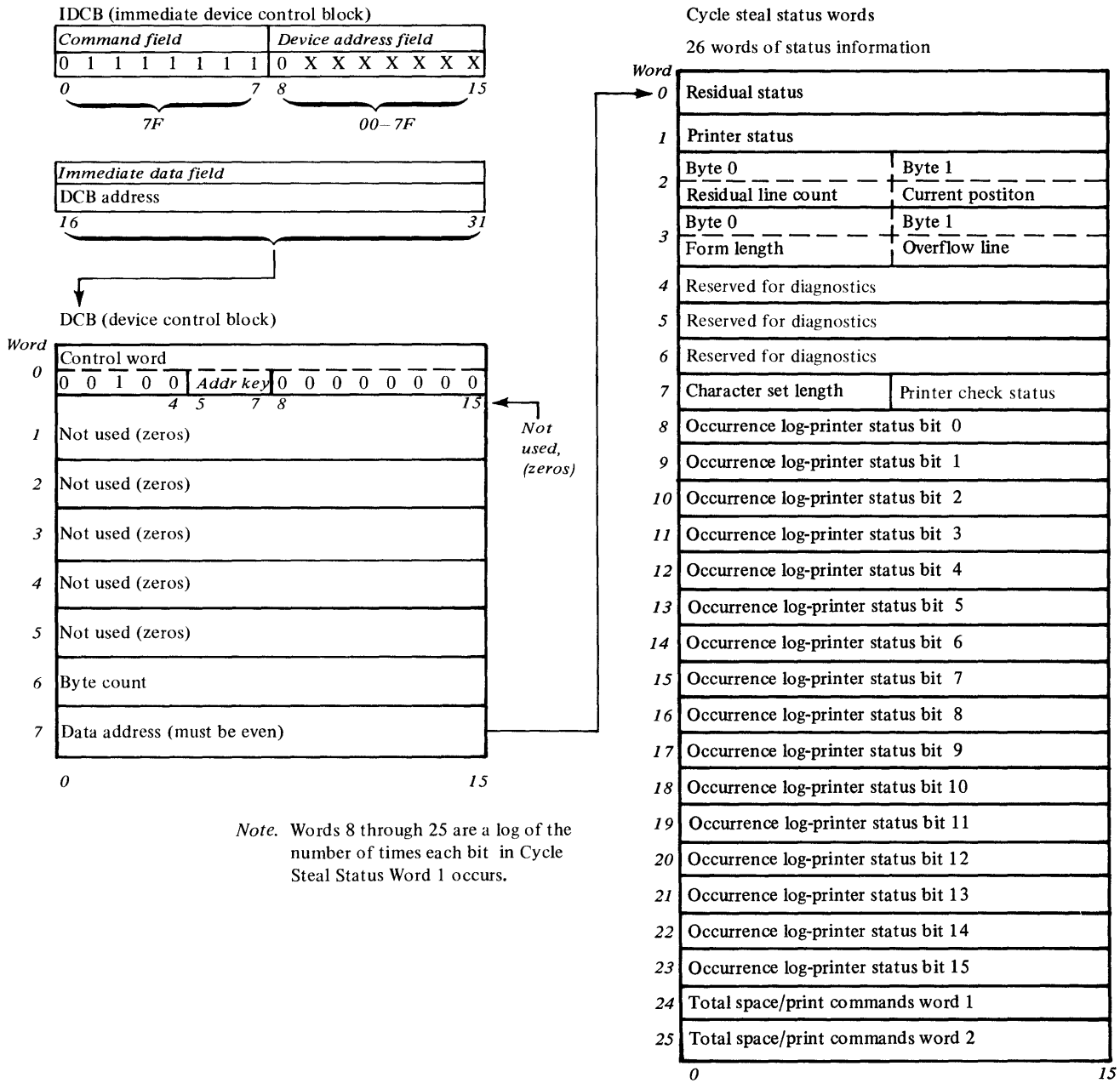
Note. A Start command issued to print or space while the printer is Not Ready, will cause an interrupt with condition code 2 (Exception) and bit 0 (Device Status Available) set in the ISB. The start command will not be executed.



Start Cycle Steal Status Command

The Start Cycle Steal Status command initiates the transfer of up to 26 words of status information from the printer attachment to main storage. This status information is used to determine why a given command did not execute properly. The main storage address is specified in word 7 of the applicable DCB. This command operates in cycle steal mode and causes the attachment to present an interrupt request when execution is complete.

The Start Cycle Steal Status command requires 1) an operate I/O instruction with the address of an IDCB, 2) an IDCB with the address of the DCB, and 3) a DCB. Figure 2-7 shows the formats of the IDCB, DCB and 26 words of status information.



Note. Words 8 through 25 are a log of the number of times each bit in Cycle Steal Status Word 1 occurs.

Figure 2-7. Start Cycle Steal Status Command

I/O STATUS INFORMATION

After execution of a given command in either DPC or cycle steal mode, status information will be reported to the processor for analysis of that command's execution. There are three types of data that can make up this status information:

- Condition codes
- Interrupt ID word
- Cycle Steal Status

Condition Codes

A condition code is reported to the processor for every Operate I/O instruction and upon presentation of a priority interruption. The condition code is available in the even, carry and overflow bit positions of the Level Status Register (LSR).

Condition codes reported at the completion of an Operate I/O instruction are:

Condition Code	*Meaning*
0	Device not attached
1	Busy
2	Busy after reset
3	Command reject
4	Not used
5	Interface data check
6	Not used
7	Satisfactory

Condition codes reported during priority interruptions are:

Condition Code	*Meaning*
0	Not used
1	Not used
2	Exception
3	Device end
4	Attention
5	Not used
6	Not used
7	Not used

Condition Code 2—Exception

This code is reported when an error or exception condition is associated with the interrupt. This condition is described in the Interrupt Status Byte (ISB) and the Cycle Steal Status Words (Figure 2-7).

Condition Code 3—Device End

This code is reported when no error exception or attention conditions occur during the I/O interruption. A normal termination of the operation has occurred.

Condition Code 4—Attention

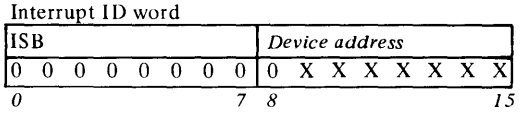
This code is reported when the printer goes Ready after being in the Not Ready state.

Along with the interrupt condition code, the attachment also transfers an interrupt ID word which provides additional information on interrupting conditions.

Interrupt ID Word

Acceptance of an I/O interrupt causes the attachment to place the ID word in register 7 (R7) of the interrupted level. For condition code 2 the Interrupt ID word consists of the Interrupt Status Byte (ISB) and the address of the interrupting device. The first byte will be zero for all other condition codes. The format is as follows:

Interrupt ID word



Interrupt Status Byte

The ISB stores accumulated status information.

The format of the ISB is:

Bit 0—Device Dependent Status Available
Bit 1—Delayed Command Reject
Bit 2—Not Used
Bit 3—DCB Specification Check
Bit 4—Storage Data Check
Bit 5—Invalid Storage Address
Bit 6—Protect Check
Bit 7—Interface Data Check

Bit 0—Device Dependent Status Available. Additional status information (residual address and status bits), is available in the Cycle Steal Status Words (Figure 2-7). A Start Cycle Steal Status Command must be issued to get this information.

Bit 1—Delayed Command Reject. The 4973 cannot execute a command because of an incorrect parameter in the IDCB or the printer is offline.

This bit is only set in the ISB when the attachment is incapable of recording the condition with condition codes during the I/O instruction. The operation in progress is terminated and an interrupt request is generated. Condition code 2 is reported at interrupt accept time. The Residual Address is not relevant to error recovery (see Cycle Steal Status Word 0).

Bit 2—Not used (always 0).

Bit 3—DCB Specification Check. The 4973 cannot execute the command because a parameter in the DCB is incorrectly specified to perform the desired operation.

Example: An odd byte chaining address, an odd address for start cycle steal status, an invalid command in the control word or an incorrect count.

Condition code 2 is reported at interrupt accept time. The Residual Address will be the last word of the DCB.

Bit 4—Storage Data Check. Storage Data Check is set during cycle steal output operations only. It indicates that the storage location accessed during the current output cycle contained bad parity. The parity in main storage is not corrected. The attachment issues the status in the ISB and terminates the operation.

Condition Code 2 is reported at interrupt time.

Bit 5—Invalid Storage Address. Set on as a result of a cycle steal I/O operation when the main storage address presented by the attachment for data or DCB access exceeds the storage size fitted on the system. The attachment records the status and terminates the operation. Condition Code 2 is reported at interrupt time.

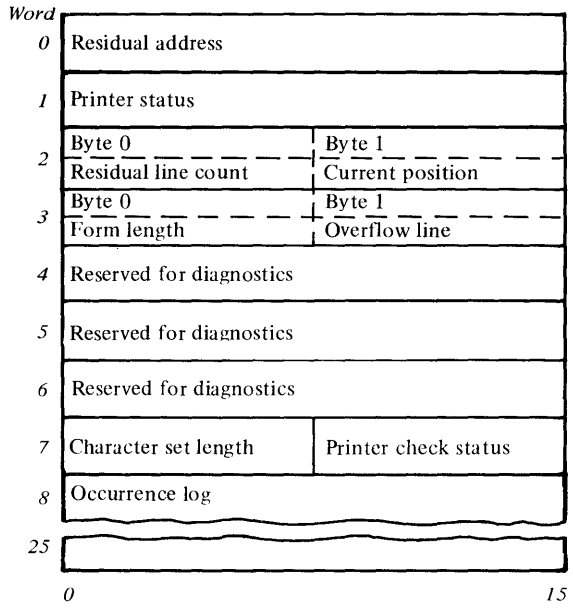
Bit 6—Protect Check. Set when the attachment attempts to access a storage location without the correct storage address key. (Refer to the *IBM Series/1 Model 5 4955 Processor and Processor Features Description*, GA34-0021, or the *IBM Series/1 Model 3 4953 Processor and Processor Features Description*, GA34-0022). Condition code 2 is reported at interrupt time.

Bit 7—Interface Data Check. This bit is set when a parity error is detected on a cycle steal data transfer. The condition can be detected by the attachment or by the channel. In either case, the operation is terminated and an interrupt is reported to the processor.

Condition code 2 is presented at interrupt accept time.

Cycle Steal Status

Up to 26 words of status information are transferred to the processor upon execution of the Start Cycle Steal command. Normal error recovery requires only the first 8 status words being transferred. This is accomplished by using a byte count of 16. This information has the following format and meaning:



Word 0—Residual Address

This address will be the storage location of the last attempted cycle steal transfer. This address may be a DCB or data address. If the last transfer attempted was a word transfer, the Residual Address will be pointing to the odd byte of the word. A cycle steal status will not alter the residual address. A Device Reset, System Reset or a Halt I/O command may cause the residual address to be indeterminate. Only the Power On Reset will reset the residual address to zero.

Word 1—Printer Status

When bit 0 of the ISB is set ON, Printer Status Word 1 will further explain the condition that caused the exception interrupt (CC2). This status will not be reset until the next Start command other than a Start Cycle Steal Status command. The information in the Printer Status word is not necessarily current but reflects the status at the time of the last non-cycle steal status interrupt.

Bit 0—Printer Power Off. The attachment receives no response from the printer when a data wrap sequence is executed. This means the power to the printer is off.

The remaining status bits in the device status word may not be valid if bit 0 is on.

Bit 1—Attachment Storage Check. The attachment has detected an error when accessing the controller storage.

Bit 2—Over Temperature. The Printer has detected an overtemperature condition.

Bit 3—Disabled. The Enable/Disable switch is in the Disable position.

Bit 4—Throat Open. The printer throat is open.

Bit 5—Cover Open. The printer cover is open.

Bit 6—Off Line Test Mode. The printer is executing off line tests and is not available for system use. When off line testing has ended an attention interrupt is posted.

Bit 7—Forms Jammed. If the forms should be moving under program control but no movement is detected, this bit is set. When this check occurs, the previous space command may have failed.

Bit 8—Hammer Check. If the attachment detects a hammer active when it should be inactive (or inactive when it should be active), this bit will be set.

Bit 9—External Interface Check. When the exception is posted, the attachment does a diagnostic checkout of the external cable interface. This check bit is set if the cable is disconnected, a grounded or an open signal line exists, or there is a bad line driver.

Bit 10—Printer Interface Check. When the 4973 attachment turns interface lines on or off it checks to see if the appropriate lines switched on the printer interface. If a line does not switch properly, bit 10 is set.

Bit 11—Overflow. This bit is set if the forms have stopped on the overflow line. If the forms were to move beyond the overflow line there is a residual line count in Device Status word 2. No printing occurs for the current DCB. The residual address can be anywhere in the print line.

Bit 12—End of Forms (EOF). At the completion of a forms movement operation the forms switch is checked. If the switch is open (indicating no forms), the End of Forms bit is set and an exception interrupt is posted. No printing is attempted when this condition is detected. The EOF condition occurs when there is approximately 152 mm (6 inches) of paper remaining in the printer.

Note. If a multi-line forms movement command has been given in the command for which this exception interrupt is given, the amount of paper remaining in the printer may be reduced by the number of lines the command spaced. Print commands must be issued with no spacing in order to print on any of the remaining paper.

Bit 13—Belt Sync Check. A 'belt home' pulse did not occur at the proper time.

Bit 14—Belt Speed Check. The print belt did not come up to speed within 2 seconds after the print command.

Bit 15—4973 Model 2 Installed. This bit is on when a 4973 Model 2 is installed. No exception interrupt will be caused by this bit.

Word 2—Residual Line Count—Current Position

The Residual Line Count (Byte 0 of Status word 2) contains the number of lines the forms would have to move to complete the forms control of the last operation. This count is not valid if an error occurred during the transfer of the last DCB. Normally this count is zero.

On an overflow interrupt, if the carriage is to move beyond the overflow line, the *remaining* lines required to be moved to complete the operation are in the Residual Line Count. If a check such as hammer check or sync check occurs during forms movement, the *number* of lines that remain to be moved to complete the forms operation are in the Residual Line Count.

Current forms position (Byte 1 of Status word 2) always contains the current line position of the forms (1–255). This position will not be changed by manual movement of the forms.

Word 3—Forms Length—Overflow Line

The form length (Byte 0 of Status word 3) and the overflow line (Byte 1 of Status word 3) are the most recent forms parameters successfully transferred to the printer from the system. If no forms parameters have been transferred, the default values of form length equal to 66 and overflow line equal to 0 will be presented.

Word 4, 5, and 6—Reserved For Diagnostics

Word 7—Character Set Length

Byte 0, the Character Set Length, is a binary count determined by the printer attachment. The count is normally 48, 64, or 96 (30, 40, 60 HEX) to represent the number of characters detected between home pulses. The count is set to zero after power on reset until the belt has been brought up to speed and into sync.

STATUS AFTER POWER AND RESETS

During Power On Reset the following actions occur:

- The printer performs Internal Register, Data Flow and Storage Tests. The printer will remain Busy if these tests fail. If they are successful the printer initializes the Belt Translator Buffer with the specified character set and clears all internal buffer locations.
- The forms length is initialized to 66 lines.
- The overflow line is initialized to line 0. The forms are assumed to be positioned on line one.
- The residual address is set to zero.

During System and Printer Resets, or Halt I/O:

- Printing stops.

The printer may stop part way through printing a character or spacing a line. If the forms stop between lines, registration must be restored by the operator.

- All pending interrupts are reset. If the printer was in the process of updating the storage address registers (Residual Address) when the reset occurs, the Residual Address may be indeterminate.
- The Belt Translator buffer will not be altered.

Appendix A. EBCDIC Character—Hexadecimal Equivalents

The following table contains the Standard EBCDIC character set and EBCDIC codes for the 48, 64, and 96 character print belts. The 48 character set consists of belt positions 1 to 48, the 64 character set consists of 1 to 64, and the 96 character set consists of 1 to 96.

Belt Position	*EBCDIC (Hex)*	*Character*	
1	F1	1	
2	F2	2	
3	F3	3	
4	F4	4	
5	F5	5	
6	F6	6	
7	F7	7	
8	F8	8	
9	F9	9	
10	F0	0	
11	7B	#	Number Sign
12	7C	@	At Sign
13	61	/	Slash
14	E2	S	
15	E3	T	
16	E4	U	
17	E5	V	
18	E6	W	
19	E7	X	
20	E8	Y	
21	E9	Z	
22	50	&	Ampersand
23	6B	,	Comma
24	6C	%	Percent Sign
25	D1	J	
26	D2	K	
27	D3	L	
28	D4	M	
29	D5	N	
30	D6	O	
31	D7	P	
32	D8	Q	
33	D9	R	
34	60	–	Minus Sign, Hyphen
35	5B	$	Dollar Sign
36	5C	*	Asterisk
37	C1	A	
38	C2	B	
39	C3	C	
40	C4	D	
41	C5	E	
42	C6	F	
43	C7	G	
44	C8	H	
45	C9	I	
46	4E	+	Plus Sign
47	4B	.	Period, Decimal
48	7D	'	Apostrophe, Prime

Belt Position	*EBCDIC (Hex)*	*Character*	
49	4A	¢	Cent Sign
50	4C	<	Less than sign
51	4D	(	Left Parenthesis
52	4F	|	Logical Or
53	5A	!	Exclamation Point
54	5D	)	Right Parenthesis
55	5E	;	Semicolon
56	5F	¬	Logical Not
57	E0	\	Reverse Slant
58	6D	_	Underscore
59	6E	>	Greater than Sign
60	6F	?	Question Mark
61	7A	:	Colon
62	7E	=	Equal Sign
63	7F	"	Quotation Mark
64	79	`	Grave Accent
65	6A	¦	Broken Vertical Line
66	81	a	
67	82	b	
68	83	c	
69	84	d	
70	85	e	
71	86	f	
72	87	g	
73	88	h	
74	89	i	
75	C0	{	Open Brace
76	D0	}	Closing Brace
77	A1	~	Tilde
78	91	j	
79	92	k	
80	93	l	
81	94	m	
82	95	n	
83	96	o	
84	97	p	
85	98	q	
86	99	r	
87	18	(Unprintable) ⊗	Cancel
88	9C	(Unprintable) ¤	Lozenge
89	A2	s	
90	A3	t	
91	A4	u	
92	A5	v	
93	A6	w	
94	A7	x	
95	A8	y	
96	A9	z	

Appendix B. Belt Translator

The Transfer Belt Translator operation causes transfer of a belt translator table defining representation of characters on the standard belt. (The standard belt along with EBCDIC HEX codes of Appendix A is self initialized and does not require this operation.) The location of the translator table is defined by DCB Word 7. The relative address within the table represents the character HEX code while the contents of the table location identify the position (in HEX) of the character on the print belt relative to the home pulse position. Any translator table location that contains a HEX code of '00' will result in printing a blank (no character printed) for the character code represented by the table location.

The following chart shows the contents of a translator table representative of the standard 94 character set of Appendix A. The "HEX ADD" is the relative HEX address within the translator table and is the HEX code which will cause the belt position defined by the contents of that location to be printed. For example, HEX code 4A will cause belt position 31 (HEX) to be printed (the engraved character at this position is "¢").

The maximum byte count for this operation is 256. Any HEX address that is not entered during a Transfer Belt Translator will remain unchanged.

HEX ADD	*HEX Belt Pos*	*HEX ADD*	*HEX Belt Pos*	*HEX ADD*	*HEX Belt Pos*	*HEX ADD*	*HEX Belt Pos*
00	00	20	00	40	00	60	22
01	00	21	00	41	00	61	0D
02	00	22	00	42	00	62	00
03	00	23	00	43	00	63	00
04	00	24	00	44	00	64	00
05	00	25	00	45	00	65	00
06	00	26	00	46	00	66	00
07	00	27	00	47	00	67	00
08	00	28	00	48	00	68	00
09	00	29	00	49	00	69	00
0A	00	2A	00	4A	31	6A	41
0B	00	2B	00	4B	2F	6B	17
0C	00	2C	00	4C	32	6C	18
0D	00	2D	00	4D	33	6D	3A
0E	00	2E	00	4E	2E	6E	3B
0F	00	2F	00	4F	34	6F	3C
10	00	30	00	50	16	70	00
11	00	31	00	51	00	71	00
12	00	32	00	52	00	72	00
13	00	33	00	53	00	73	00
14	00	34	00	54	00	74	00
15	00	35	00	55	00	75	00
16	00	36	00	56	00	76	00
17	00	37	00	57	00	77	00
18	00	38	00	58	00	78	00
19	00	39	00	59	00	79	40
1A	00	3A	00	5A	35	7A	3D
1B	00	3B	00	5B	23	7B	0B
1C	00	3C	00	5C	24	7C	0C
1D	00	3D	00	5D	36	7D	30
1E	00	3E	00	5E	37	7E	3E
1F	00	3F	00	5F	38	7F	3F

HEX ADD	*HEX Belt Pos*	*HEX ADD*	*HEX Belt Pos*	*HEX ADD*	*HEX Belt Pos*	*HEX ADD*	*HEX Belt Pos*
80	00	A0	00	C0	4B	E0	39
81	42	A1	4D	C1	25	E1	00
82	43	A2	59	C2	26	E2	0E
83	44	A3	5A	C3	27	E3	0F
84	45	A4	5B	C4	28	E4	10
85	46	A5	5C	C5	29	E5	11
86	47	A6	5D	C6	2A	E6	12
87	48	A7	5E	C7	2B	E7	13
88	49	A8	5F	C8	2C	E8	14
89	4A	A9	60	C9	2D	E9	15
8A	00	AA	00	CA	00	EA	00
8B	00	AB	00	CB	00	EB	00
8C	00	AC	00	CC	00	EC	00
8D	00	AD	00	CD	00	ED	00
8E	00	AE	00	CE	00	EE	00
8F	00	AF	00	CF	00	EF	00
90	00	B0	00	D0	4C	F0	0A
91	4E	B1	00	D1	19	F1	01
92	4F	B2	00	D2	1A	F2	02
93	50	B3	00	D3	1B	F3	03
94	51	B4	00	D4	1C	F4	04
95	52	B5	00	D5	1D	F5	05
96	53	B6	00	D6	1E	F6	06
97	54	B7	00	D7	1F	F7	07
98	55	B8	00	D8	20	F8	08
99	56	B9	00	D9	21	F9	09
9A	00	BA	00	DA	00	FA	00
9B	00	BB	00	DB	00	FB	00
9C	00	BC	00	DC	00	FC	00
9D	00	BD	00	DD	00	FD	00
9E	00	BE	00	DE	00	FE	00
9F	00	BF	00	DF	00	FF	00

Appendix C. Printer Forms

The 4973 Printer uses a forms tractor to be used with continuous single/multipart margin punched forms.

All forms must meet the following requirements:

DIMENSIONS

Minimum thickness	.08 mm (.003 inches)
Maximum thickness	.5 mm (.02 inches)
Minimum width	88.9 mm (3.5 inches)
Maximum width	381 mm (15.0 inches)
Minimum distance between folds	76.2 mm (3.0 inches)
Maximum distance between folds	355.6 mm (14.0 inches)
Maximum copies	original plus five

FORMS WEIGHT

Single-part Forms

Minimum weight	57 grams/sq. meter 15 lbs/ream (17" x 22")
Maximum weight	90 grams/sq. meter 24 lbs/ream (17" x 22")

Multi-part Forms

Paper

Minimum	41 grams/sq. meter 11 lbs/ream (17" x 22")
Maximum	49 grams/sq. meter 13 lbs/ream (17" x 22")

Carbon

Minimum	26 grams/sq. meter 7 lbs/ream (17" x 22")
Maximum	34 grams/sq. meter 9 lbs/ream (17" x 22")

Remember, when using forms:

- Do not use continuous form card stock in model 1.
- Do not use stapled forms.
- Do not use partially separated forms.

For more detailed information on printer forms, refer to *IBM Form Design Reference Guide For Printers*, GA24-3488.

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GA34-0044-0

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