IBM

Systems Reference Library

Tape Input/Output Instructions

IBM 1401 Data Processing System

IBM 1460 Data Processing System

This publication contains a description of the
instructions and timings used by the IBM 1401 and
1460 Data Processing Systems to operate the tape
units attached to them. The instructions and timings
for the following tape units are included in this
publication:

  IBM 729 Magnetic Tape Unit
  IBM 7330 Magnetic Tape Unit
  IBM 1011 Paper Tape Reader
  IBM 1012 Tape Punch

Preface

This publication is a portion of the reference text for the IBM 1401 and 1460 Data Processing Systems. The full set of manuals provides a detailed explanation of all the instructions used by the system to manipulate data. Detailed explanations of the instructions used with the required and available input/output units attached to the system are also included. The reader should be familiar with the *IBM 1401 System Summary*, Form A24-1401, or the *IBM 1460 System Summary*, Form A24-1496, and the various publications on programming material, such as Symbolic Programming System (SPS) and Autocoder.

The complete manual is divided functionally into these sections:

System Operation Reference Manual (A24-3067)

The sections are independent and do not have to be used in the order in which they appear. A System Reference Library can be compiled using those sections applicable to the user's machine configuration.

This publication is intended for programmers and systems personnel who have a general knowledge of the IBM 1401 or 1460 Data Processing Systems and who require a reference text for detailed information.

Other publications referenced here are, in most cases, prerequisites for a complete understanding of the material presented in this publication.

Contents

Magnetic-Tape Operations

Tape Units

IBM 729 Magnetic Tape Unit (Figure F-1)

The 1401 system can use either of four models of the IBM 729 Magnetic Tape Units (Model II, Model IV, Model V, and Model VI). (The Model VI operates at Model IV speeds only.) The 1460 system can use 729 II, 729 IV, 729 V, or 729 VI magnetic-tape units. Either tape-oriented system can accommodate as many as six IBM 729 tape units which are attached to the tape adapter on the 1401 (attached to the 1461 on the 1460). The IBM 729 dual-density tape unit makes it possible for the IBM 729 tape unit to operate with magnetic tapes recorded at either 200, 556, or 800 characters per inch.
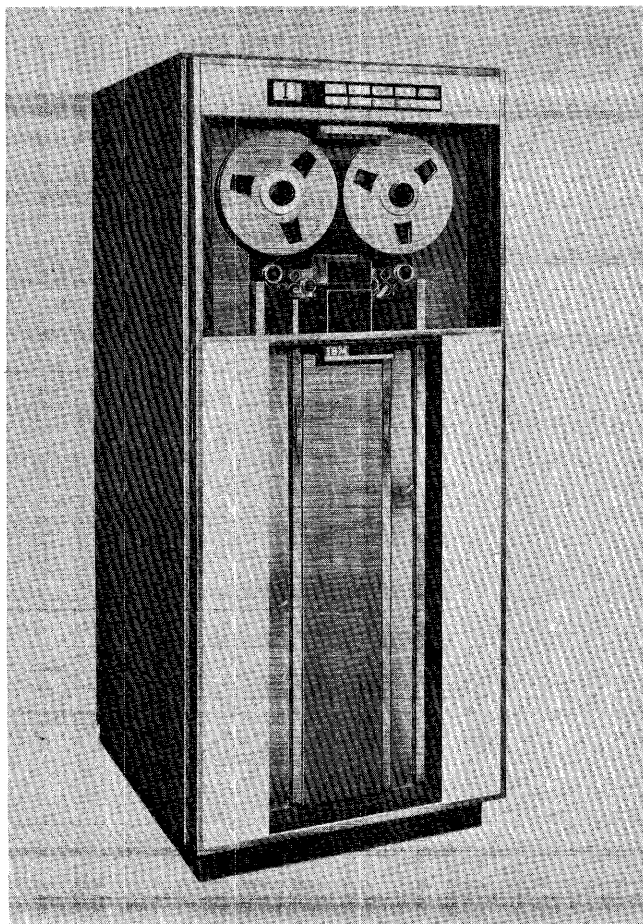
Figure F-1. IBM 729 Magnetic Tape Unit
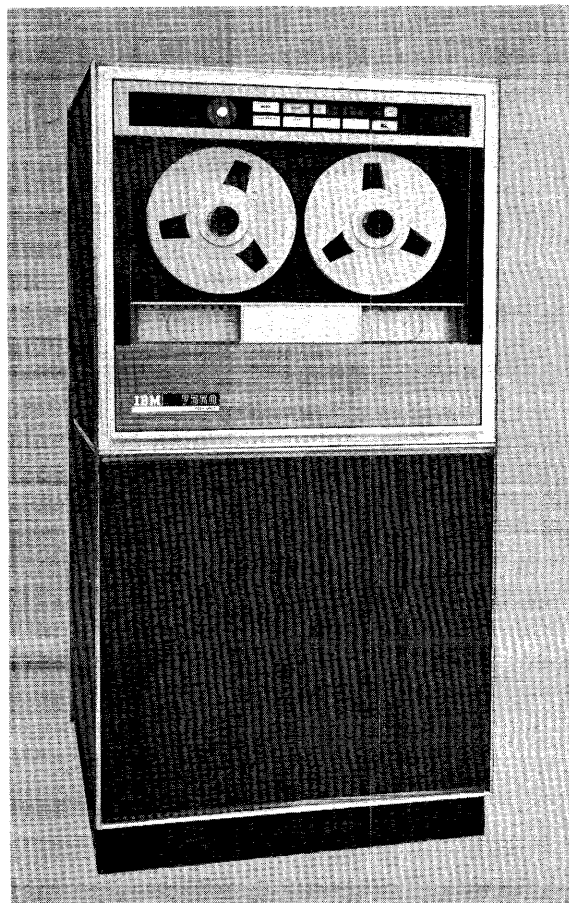
Figure F-2. IBM 7330 Magnetic Tape Unit

IBM 7330 Magnetic Tape Unit (Figure F-2)

The 1401 and 1460 systems can also use the 7330 tape units as an input-output medium. The primary difference between the 7330 and the 729 tape units is the procesing speed.

Data Flow

IBM magnetic-tape units function in the systems as both input and output devices. They transport the magnetic tape and accomplish the actual reading and writing of information, as directed by outside control from the stored program.

Magnetic Tape Instructions

Read Tape

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
SPS MU	M	%Ux	xxx	R
A RT				

Function. The tape unit specified in the A-address is started. The d-character specifies a tape read operation. The B-address specifies the high-order position of the tape read-in area of storage. The machine begins to read magnetic tape, and continues to read until either an inter-record gap in the tape record or a group-mark with a word-mark in core storage is sensed. The inter-record gap indicates the end of the tape record, and a group mark (code CBA 8421) is inserted in core storage at this point.

If the group-mark with a word-mark occurs before the inter-record gap is sensed, the transfer of data from tape stops, but tape movement continues until the inter-record gap is sensed.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms $+ T_M$. Time varies for type of tape unit and tape density used (see *Timing* section). $N = .0115$ (1401), $.006$ (1460)

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	Group mark + 1

Example. Read the record from tape unit 2 (labeled 2) into core storage. The high-order tape-record character is moved to INPUT (0419), the next character is moved to the next higher position (0420), etc., until transfer of data is stopped by an inter-record gap in the tape record, or a group-mark with a word-mark in core storage (Figure F-3).

SPS

LINE	COUNT	LABEL	OPERATION	(A) OPERAND ADDRESS	±	CHAR. ADJ.	IND.	(B) OPERAND ADDRESS	±	CHAR. ADJ.	IND.	d
0 1 0			M U	%U R				I N P U T				R

Autocoder

Label	Operation					OPERAND
	RT	2, INPUT				

Assembled Instruction: **M** %U2 419 R

Figure F-3. Read Tape (Move Operation)

F-2

Tape Positions	A	B	C	D
Tape Code	82	A841	41	C4
1401 Core Storage Locations	A	B	C	
1401 Meaning	0	5	4	
1401 Core Storage Code	C82	41W	4	

Figure F-4. Word-Separator Character Handling During Read Tape with Word Marks Operation

Read Tape with Word Marks

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
SPS LU	L	%Ux	xxx	R
A RTW				

Function. With the following two exceptions, this instruction is the same as READ TAPE. Word-separator characters (written with WRITE TAPE WITH WORD MARKS instruction) are translated to word marks during transmission into core storage. As in all load instructions, word marks encountered in the B-field will be cleared.

Word Marks. A word-separator character read from tape causes a word mark to be associated with the next tape character transferred into core storage (Figure F-4).

Timing. $T = N (L_I + 1)$ ms $+ T_M$.

Note. If a record has been written on tape by a WRITE TAPE WITH WORD MARKS instruction, it should be read back by a READ TAPE WITH WORD MARKS instruction so that word separator characters will be translated to word marks.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	Group-mark + 1

Example. Read the record from tape unit 5 (labeled 5) into core storage, and insert word marks where word-separator characters exist in the tape record. The high-order character is moved to INREC1 (0518), the next character is moved to the next higher position (0519), etc., until the transfer of data is stopped by an inter-record gap in the tape record, or until a group-mark with a word-mark is sensed in core storage (Figure F-5).

SPS

LINE	COUNT	LABEL	OPERATION	(A) OPERAND ADDRESS	±	CHAR. ADJ.	IND.	(B) OPERAND ADDRESS	±	CHAR. ADJ.	IND.	d
0 1 0			L U	%U5				INREC1				R

Autocoder

Label	Operation					OPERAND
	RTW	5, INREC1				

Assembled Instruction: **L** %U5 518 R

Figure F-5. Read Tape with Word Marks (Load Operation)

Write Tape

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
SPS MU	M	%Ux	xxx	W
A WT				

Function. The tape unit designated in the A-address is started. The d-character specifies a tape write operation. The data from core storage is written on the tape record. The B-address specifies the high-order position of the record in storage. A group-mark with a word-mark in core storage stops the operation. The group-mark with a word-mark causes an inter-record gap on the tape.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1) ms + T_M$.

Note. If a group-mark with a word-mark is the first character of B-address, the tape-adapter unit and the tape unit will hang up. The condition can be reset by pressing the start-reset key if the tape-select switch on the system console is in the N (normal) position.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	Group mark + 1

Example. Transfer the contents of core storage to tape unit 3 (labeled 3), starting at the location labeled OUTPUT (0525) and ending at the location of the first group-mark with a word-mark (Figure F-6).

Assembled Instruction: M   %U3   525   W

Figure F-6.   Write Tape (Move Operation)

Write Tape with Word Marks

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
SPS LU	L	%Ux	xxx	W
A WTW				

Function. This is the same as the write tape operation except that the WRITE TAPE WITH WORD MARKS instruction affects word marks in core storage.

1401 Core Storage Locations	A	B	C	
1401 Core Storage Code	C82	41W	4	
1401 Meaning	0	5	4	
Tape Positions	A	B	C	D
Tape Code	82	A841	41	C4

Figure F-7.   Word-Separator Character Handling During Write Tape with Word Marks Operation

Word Marks. A word mark associated with any position in core storage causes a word-separator character (A841) to be written automatically on tape, one character ahead of that which contained the word mark. Thus, word marks are translated to word-separator characters for tape storage (Figure F-7).

Timing. $T = N (L_I + 1) ms + T_M$.

Note. Load operations must be used when word marks are needed for identification in tape storage. If tape is written by a WRITE TAPE WITH WORD MARKS instruction, it must be read back by a READ TAPE WITH WORD MARKS instruction to ensure proper translation between the tape and core storage.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	Group mark + 1

Example. Transfer the contents of core storage to tape unit 6 (labeled 6). Insert a word-separator character where word marks exist in core storage, beginning at OUTREC (0696) and ending at the first group-mark with a word-mark in core storage (Figure F-8).

Assembled Instruction: L   %U6   696   W

Figure F-8.   Write Tape with Word Marks

Backspace Tape Record

Instruction Format.

Mnemonic	Op Code	A-address	d-character
SPS CU	U	%Ux	B
A BSP			

Function. The tape unit specified in the A-address backspaces over one tape record. The first inter-

record gap (IRG) encountered stops the backspace operation specified by the d-character, B.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms $+ T_M$.

Note. The system is interlocked for the duration of tape movement, for any instructions that have a percent (%) sign in the hundred's position of the A-address. Other functions are not affected.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	dbb

Example. Backspace tape unit 4 (labeled 4) until an IRG is sensed (Figure F-9).

SPS

Autocoder

Assembled Instruction: **U** %U4 B
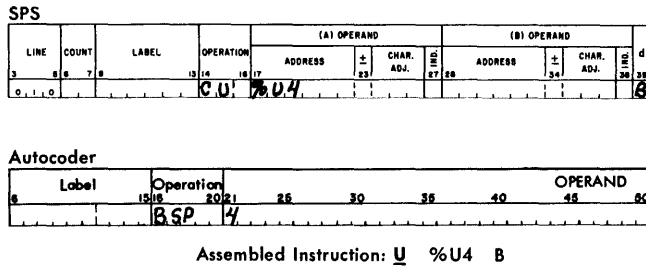
Figure F-9. Backspace Tape Record

Skip and Blank Tape

Instruction Format.

Mnemonic	Op Code	A-address	d-character
SPS CU	U	%Ux	E
A SKP			

Function. The tape unit, designated by the A-address, spaces forward and erases approximately 3.5 inches of tape. The actual skip occurs when the next WRITE TAPE instruction is given. This instruction makes it possible to bypass defective tape areas.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms. Processing can continue immediately after this operation. However, 40.5 ms for IBM 729 II, 27 ms for IBM 729 IV, 40.5 ms for IBM 729 V, 27 ms for IBM 729 VI (1460 only), and 108 ms for an IBM 7330 must be added to the next WRITE TAPE instruction time.

Notes. The SKIP AND BLANK TAPE instruction should be given immediately preceding a WRITE TAPE instruction for the tape unit specified by both instructions.

The system is interlocked for the duration of tape movement, for any instructions that have a percent sign (%) in the hundred's position of the A-address. Other functions are not affected.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	dbb

Example. Erase tape on tape unit 5 (labeled 5) when the next write operation is ordered for that unit (Figure F-10).

SPS

Autocoder

Assembled Instruction: **U** %U5 E
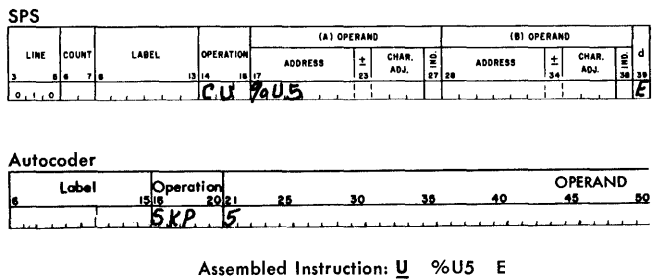
Figure F-10. Skip and Blank Tape

Write Tape Mark

Instruction Format.

Mnemonic	Op Code	A-address	d-character
SPS CU	U	%Ux	M
A WTM			

Function. This instruction causes a tape mark character (8421) to be recorded immediately following the last record on tape. When the tape mark is read back from a tape, the end-of-reel indicator is turned on. This signals the system program that the end of a major group of records has been reached (end-of-file) or the end of utilized tape has been reached.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms $+ T_M$.

Note 1. The system is interlocked for the duration of tape movement, for any instructions that have a percent sign (%) in the hundred's position of the A-address. Other functions are not affected.

Note 2. A group mark will be read into the second position of the tape read-in area unless this position contained a group-mark with a word-mark. In this case, the group-mark with a word-mark will be regenerated into this position.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	dbb

Example. Insert a tape mark on the tape in tape unit 3 (labeled 3), Figure F-11.

SPS

				(A) OPERAND				(B) OPERAND				
LINE	COUNT	LABEL	OPERATION	ADDRESS	±	CHAR. ADJ.	IND.	ADDRESS	±	CHAR. ADJ.	IND.	d
3	6 7 8		13 14 16 17		23	27 28			34		38 39	
0 1 0			C U	%U3								M

Autocoder

Label	Operation							OPERAND	
6	15 16 20 21	25	30	35	40	45	50		
	W T M	3							

Assembled Instruction: **U** %U3 M

Figure F-11. Write Tape Mark

Diagnostic Read

Instruction Format.

Mnemonic	Op Code	A-address	d-character
SPS (none)	U	%Bx or	A
A (none)		%Ux	

Function. This instruction causes the tape unit specified in the A-address to reposition its tape to the next inter-record gap (IRG) without transmitting any data to core storage. If the tape record contains a first character tape mark, the end-of-file (EOF) indicator is turned on.

This instruction is useful in skipping records or files on tape. The system is free to proceed with internal processing during the tape movement.

The tape operations are interlocked until the check character of the record being skipped is sensed.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms $+ T_M$.

Note. The system is interlocked for the duration of tape movement, for any instructions that have a percent sign (%) in the hundred's position of the A-address. Other functions are not affected.

Rewind Tape

Instruction Format.

Mnemonic	Op Code	A-address	d-character
SPS CU	U	%Ux	R
A RWD			

Function. This instruction is usually given after an end-of-reel condition, and causes the selected tape unit to rewind the tape. When the operation is initiated, the tape unit is, in effect, disconnected from the system.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms. Rewind time is 1.2 minutes per 2,400-foot reel for the IBM 729 II, .9 minute for the IBM 729 IV, 1.2 minutes for the IBM 729 V, .9 minute for the IBM 729 VI (1460 only), and 13.3 minutes for the IBM 7330, but it is not calculated with program time. Processing can continue approximately 10 ms after this instruction is interpreted.

Note. Processing unit not interlocked during tape-movement time.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	dbb

Example. Rewind the tape in tape unit 1 (labeled 1), Figure F-12.

SPS

				(A) OPERAND				(B) OPERAND				
LINE	COUNT	LABEL	OPERATION	ADDRESS	±	CHAR. ADJ.	IND.	ADDRESS	±	CHAR. ADJ.	IND.	d
3	6 7 8		13 14 16 17		23	27 28			34		38 39	
0 1 0			C U	%U1								R

Autocoder

Label	Operation							OPERAND	
6	15 16 20 21	25	30	35	40	45	50		
	R W D	1							

Assembled Instruction: **U** %U1 R

Figure F-12. Rewind Tape

Rewind Tape and Unload

Instruction Format.

Mnemonic	Op Code	A-address	d-character
SPS CU	U	%Ux	U
A RWU			

Function. This instruction causes the tape unit specified in the A-address to rewind its tape. At the end of the rewind, the tape is out of the vacuum columns, and the reading mechanism is disengaged. The unit is effectively disconnected from the system, and is not available again until the operator restores it to a ready status.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms. Rewind time is 1.2 minutes per 2,400-foot reel for the IBM 729 II, .9 minute for

the IBM 729 IV, 1.2 minutes for the 729 V, .9 minute for the 729 VI (1460 only), and 2.2 minutes for the IBM 7330, but it is not calculated with program time.

Processing can continue approximately 10 ms after this instruction is interpreted by a system using IBM 729 tape units, or 4.5 seconds in a system using IBM 7330 tape units.

Note. Processing unit not interlocked during tape-movement time.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%4x	dbb

Example. Rewind the tape in tape unit 5 (labeled 5), and make it unavailable to the stored program, at the completion of the rewind operation (Figure F-13).

SPS

LINE	COUNT	LABEL	OPERATION	(A) OPERAND				(B) OPERAND				d
				ADDRESS	±	CHAR. ADJ.	IND.	ADDRESS	±	CHAR. ADJ.	IND.	
0 1 0			C U	%U5								U

Autocoder

Label	Operation					OPERAND	
	RWU	5					

Assembled Instruction: **U** %U5 U

Figure F-13. Rewind Tape and Unload

Note. This instruction must be executed immediately following a tape read or tape write operation to ensure correct results and reset the EOR indicator OFF, if it is ON. If another tape unit is selected before a BRANCH IF END-OF-REEL INDICATOR ON instruction is executed, the indicator remains ON and a false EOR condition specifying the wrong tape unit results.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	BI	dbb

Example. Test the tape unit just used for an end-of-reel condition. If there is an EOR condition, branch to TAPER1 (0685) for the next instruction. If no EOR exists, continue the program with the next sequential instruction (Figure F-14).

SPS

LINE	COUNT	LABEL	OPERATION	(A) OPERAND				(B) OPERAND				d
				ADDRESS	±	CHAR. ADJ.	IND.	ADDRESS	±	CHAR. ADJ.	IND.	
0 1 0			B	TAPER1								K

Autocoder

Label	Operation					OPERAND	
	BEF	TAPER1					

Assembled Instruction: **B** 685 K

Figure F-14. Branch if End of Reel

Branch if End of Reel

Instruction Format.

	Mnemonic	Op Code	I-address	d-character
SPS	B	B	xxx	K
A	BEF			

Function. The end-of-reel (EOR) indicator turns on in the system processing unit if a tape mark is read by the system or if a *reflective spot* is sensed during a write tape operation. This instruction tests the indicator and causes an automatic branch to the I-address if the indicator is ON. If it is OFF, the program continues normally.

Word Marks. Word marks are not affected.

Timing.
  Without indexing:
    $T = N (L_I + 1)$ ms.
  With indexing:
    $T = N(L_I + 2)$ ms.

Branch if Tape Error

Instruction Format.

	Mnemonic	Op Code	I-address	d-character
SPS	B	B	xxx	L
A	BER			

Function. If an error occurs in transmission between a tape unit and the system during a tape read or tape write operation, an error indicator turns on in the system and the tape light on the console glows red. This instruction tests the error indicator, and branches to the I-address for the next instruction if the indicator is ON. If it is OFF, the program continues with the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.
  Without indexing:
    $T = N (L_I + 1)$ ms.
  With indexing:
    $T = N(L_I + 2)$ ms.

Note. The BRANCH IF TAPE ERROR instruction must be given after a tape read or write operation, because any tape operation on any tape unit causes the indicator to turn off. The information read from tape always enters core storage with odd-bit parity.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	BI	dbb

Example. Read a tape record from the tape unit 3 (labeled 3) into core-storage area labeled TAPEIN (0629) and test for a tape error. If there is an error, branch to TAPER2 (0539) for the next instruction. If there is no error, continue processing with the next sequential instruction (Figure F-15).
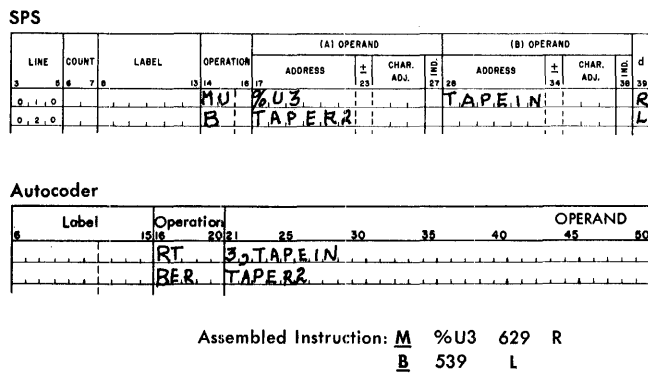
SPS

LINE	COUNT	LABEL	OPERATION	(A) OPERAND				(B) OPERAND				d
				ADDRESS	±	CHAR. ADJ.		ADDRESS	±	CHAR. ADJ.		
0 1 0			M U	%U3				TAPEIN				R
0 2 0			B	TAPER2								L

Autocoder

Label	Operation	OPERAND
	RT	3,TAPEIN
	BER	TAPER2

Assembled Instruction: **M** %U3 629 R
                                  B 539 L

Figure F-15. Branch if Tape Error

Magnetic-Tape Operating Considerations

IBM 729 Magnetic Tape Unit

If the 729 is in *write* status, to change to *read* status the program must *backspace* over those records that are to be read. The tape unit must then be changed back to *write* status (W_1, W_2, W_3, B_3, B_2, R_2, R_3, W_4, W ...).

This results in unchecked tape on the first record written after *backspace.*

The 729 cannot be switched directly from write to read status (W_1, W_2, R_3, R_4).

If the 729 is in *read* status, the tape unit can be changed directly from read to write status (R_1, R_2, W_3, W_4).

IBM 7330 Magnetic Tape Unit

If the 7330 is in *write* status, to change to *read* status the program must *backspace* over those records that are to be read. The tape unit must then be changed back to *write* status (W_1, W_2, W_3, B_3, B_2, R_2, R_3, W_4, W ...). This results in unchecked tape on the first record written after *backspace.*

The 7330 cannot be switched directly from write to read status (W_1, W_2, R_3, R_4).

If the 7330 is in *read* status, to change to *write* status the program must *backspace* over the last record read and then rewrite that record. The 7330 then continues in write status (R_1, R_2, B_2, W_2, W_3, W ...).

The 7330 cannot be switched directly from read to write status (R_1, R_2, W_3, W_4).

Figure F-16 is a summary of 1401 and 1460 magnetic-tape operating considerations.

For detailed information concerning magnetic tape and IBM magnetic-tape units, refer to the IBM Reference Manual, *Magnetic Tape Units,* Form A22-6589.

Dust or damage to the magnetic tape is the most frequent cause of errors detected during write operations. Such imperfections are usually isolated; so, in order to skip the defective section, the system has been provided with an instruction that causes the tape to space forward approximately 3.5 inches when the next write operation is initiated. While the tape is passed, this short length is erased so that extraneous data is not sensed when the tape is read. The tape-write operation continues after the skip is completed.

When writing from load point, a space of 3.5 inches also occurs prior to writing the record, and start time is increased about 27 milliseconds.

Magnetic Tape Timing

All tape units in a 1401 system are under the control of a tape-adapter unit (a 1461 on the 1460 system). The tape-adapter unit (TAU) can control the operations of only one tape unit at a time. If one tape unit is busy, no other tape unit can be used until all operations on the busy one have been completed. The execute time of a tape instruction varies according to the type and model tape units used in the system.

C is the character rate in milliseconds based on the setting of the tape density switch.

N is the number of characters in the record.

CN is record time (number of characters in the record, times the character rate).

Start time is the time necessary for the tape unit to accelerate to operating speed.

Stop time is the time necessary for the tape unit to decelerate and stop.

Record check time is the time it takes to read or write the check character. This time is based on the read-write head gap (the distance that separates the read and write heads) and the time it takes a single character written on tape to travel from the write head to the read head.

Load Point Time. When reading or writing from load point, a space of 3.5 inches occurs prior to reading

STATUS	OPERATION	CAN BE PERFORMED			
		729	REMARKS	7330	REMARKS
Read	R_1 B_1 W_1 W_2 W----	Yes	Updating tape label	Yes	Updating tape label
	R_1 R_2 Skip W_3 W----	Yes	Results in unchecked tape	Yes	Results in unchecked tape Skip must be over known blank area
	R_1 R_2 W_3 W---	Yes	Unchecked tape in record W_3	No	Write head is over first part of next record (W_3)
	R_1 B_1 W_1 R_2	No	Changing from W to R causes bits in the inter-record gap	No	Changing from W to R causes bits in the inter-record gap
Write	W_1 B_1 R_1 W_2 W----	Yes	Unchecked tape on record W_2	Yes	Unchecked tape on record W_2
	W_1 W_2 Blank Area R_3 R----	Not Recom.	Results in bits in the inter-record gap and possible error on R_3	Not Recom.	Results in bits in the inter-record gap and possible error on R_3
	W_1 W_2 R_3 R_4	No	Changing from W to R causes bits in the inter-record gap	No	Changing from W to R causes bits in the inter-record gap
	W_1 B_1 R_1 R_2	No	Changing from W to R causes bits in the inter-record gap	No	Changing from W to R causes bits in the inter-record gap
Rewind	R_3 R_4 R_5 R_w	Yes		Yes	
	W_3 W_4 W_5 R_w	Yes	Causes extraneous bits after W5 (label)	Yes	Causes extraneous bits after W_5 (label)

R —read
W —write
B —backspace
R_w —rewind

Figure F-16. Summary of IBM 1401 and 1460 Magnetic Tape Operating Considerations

or writing a record and the start time is increased about 27 milliseconds.

IBM 729 II Tape Timings

During a 729 II *read* operation, the tape adapter unit or 1461 is interlocked for 10.7 + CN ms (Figure F-17). This includes:

> 10.5 ms — start time
> .2 ms — record check time for high-density tape (.6 for low-density tape)
> CN ms — record time

During the same read operation, the processing unit is interlocked for 10.5 + CN ms. This includes:

> 10.5 ms — start time
> CN ms — record time

Therefore, in a tape-read operation, processing can take place during the 2.1-ms stop time. A tape-transmission-error condition can be recognized .2 ms after the processing interlock is released. If the tape transmission-error-test instruction is given during this .2 ms period, the processing unit is interlocked until the error indicator can be tested.

During a 729 II tape *write* operation, the tape-adapter unit or 1461 is interlocked for 11.7 + CN ms (Figure F-17). This includes:

> 7.5 ms — start time
> 4.2 ms — record check time for high-density tape (4.6 for low-density tape)
> CN ms — record time

During the same write operation, the processing unit is interlocked for 7.5 + CN ms. This includes:

> 7.5 ms — start time
> CN ms — record time

Therefore, in a tape-write operation, processing can take place during the 5.1 ms stop time. A tape-transmission-error condition can be recognized 4.2 ms after the processing interlock is released. If the tape-transmission-error-test instruction is given during this 4.2 ms period, the processing unit is interlocked until the error indicator can be tested. The difference between the .2 ms record check time of reading and the 4.2 ms record check time of writing is due to the read-write head gap time (4.0 ms).

For job-timing estimates of tape read-write operation, the normal formula 10.8 + CN ms can be used.

IBM 729 IV Tape Timings

During a 729 IV *read* operation, the tape-adapter unit or 1461 is interlocked for 6.8 + CN ms (Figure F-18).
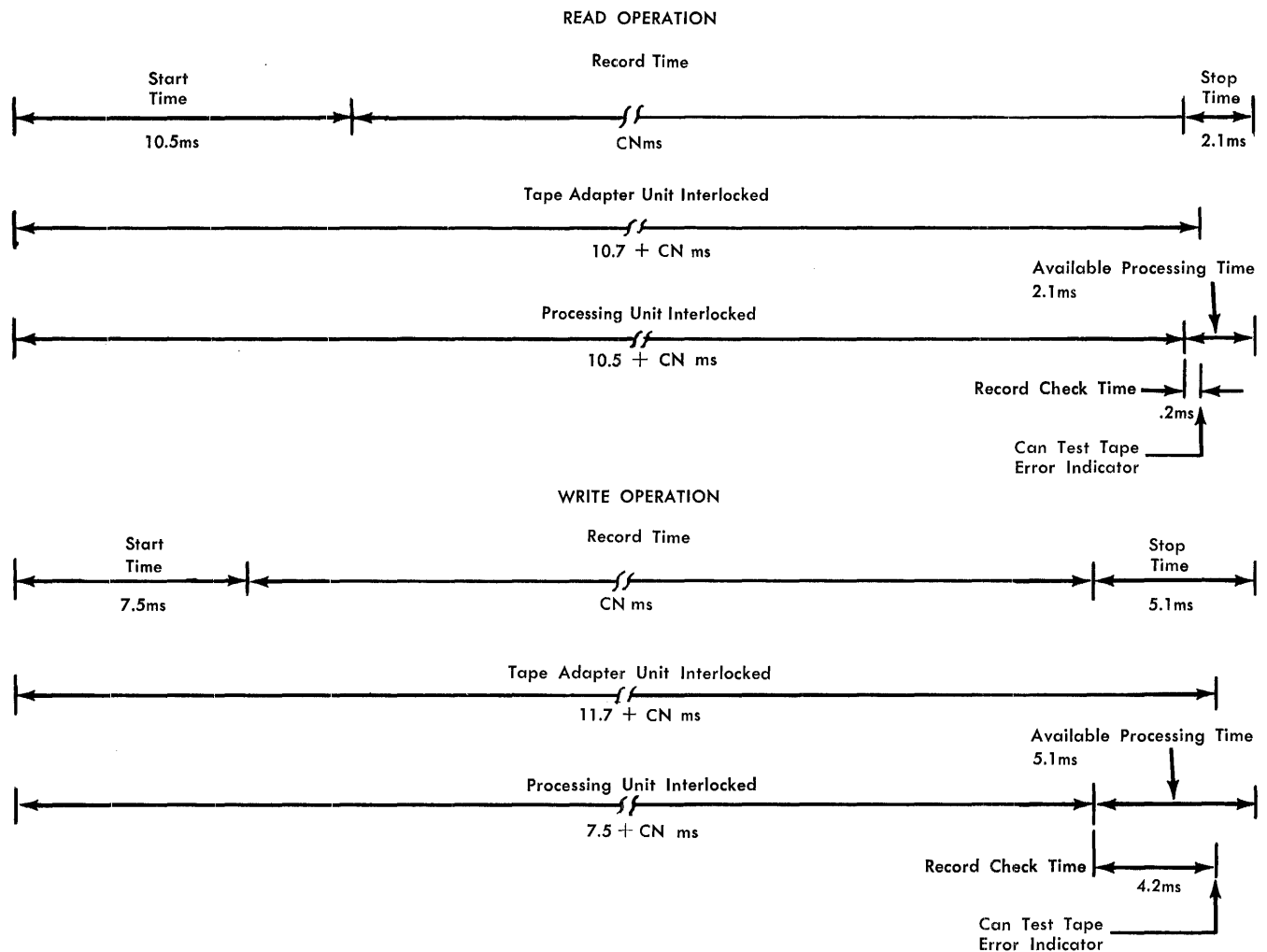
READ OPERATION

Record Time

Start Time 10.5ms   CNms   Stop Time 2.1ms

Tape Adapter Unit Interlocked
10.7 + CN ms

Available Processing Time
2.1ms

Processing Unit Interlocked
10.5 + CN ms

Record Check Time →| |←
.2ms

Can Test Tape
Error Indicator

WRITE OPERATION

Record Time

Start Time 7.5ms   CN ms   Stop Time 5.1ms

Tape Adapter Unit Interlocked
11.7 + CN ms

Available Processing Time
5.1ms

Processing Unit Interlocked
7.5 + CN ms

Record Check Time
4.2ms

Can Test Tape
Error Indicator

Figure F-17. ibm 729, Model ii, Read-Write Operation Timings

This includes:

   6.7 ms — start time
    .1 ms — record check time for high-density
          tape (.4 for low-density tape)
   CN ms — record time

During the same read operation, the processing unit is interlocked for 6.7 + CN ms. This includes:

   6.7 ms — start time
   CN ms — record time

Therefore, in a tape-read operation, processing can take place during the 2.1-ms stop time. A tape-transmission-error condition can be recognized .1 ms after the processing interlock is released. If the tape-transmission-error-test instruction is given during this .1-ms period, the processing unit is interlocked until the error indicator can be tested.

During a 729 iv tape *write* operation, the tape-adapter unit or 1461 is interlocked for 7.8 + CN ms (Figure F-18).

This includes:

   5 ms — start time
   2.8 ms — record check time for high-density
          tape (3.0 for low-density tape)
   CN ms — record time

During the same write operation, the processing unit is interlocked for 5 + CN ms. This includes:

   5 ms — start time
   CN ms — record time

Therefore, in a tape-write operation, processing can take place during the 3.8 ms stop time. A tape-transmission-error condition can be recognized 2.8 ms after the processing interlock is released. If the tape-transmission-error-test instruction is given during this 2.8-ms period, the processing unit is interlocked until the error indicator can be tested. The difference between the .1-ms record check time of reading and the 2.8-ms record check time of writing is due to the read-write head gap time (2.7 ms).
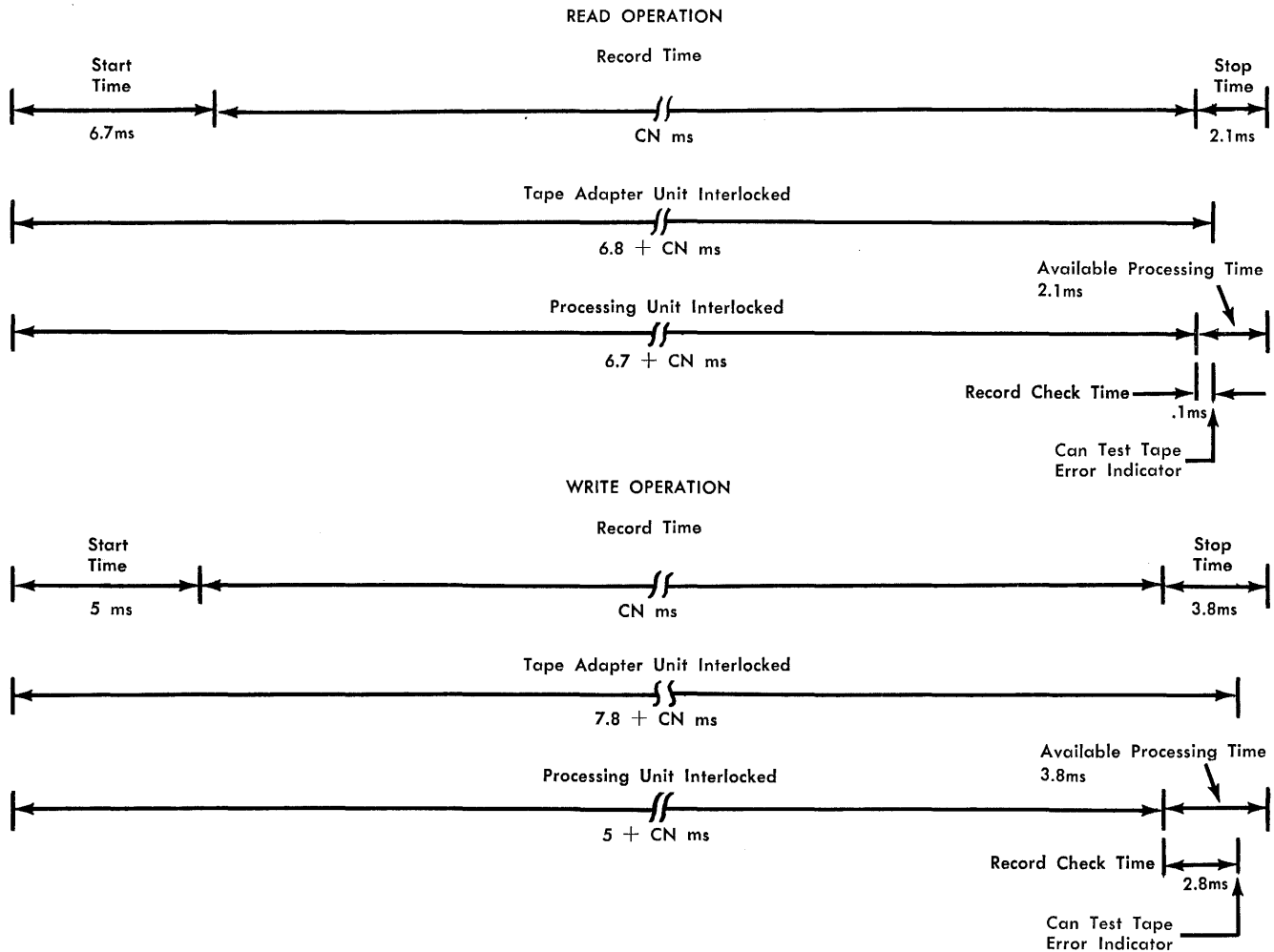
READ OPERATION

WRITE OPERATION

Figure F-18. IBM 729, Model IV, Read-Write Operation Timings

For job-timing estimates of tape read-write operations, the nominal formula 7.3 + CN can be used.

IBM 729 V Tape Timings

During a 729 v read operation, the tape-adapter unit or 1461 is interlocked for 10.7 + CN ms (Figure F-19). This includes:

> 10.5 ms — start time
> .2 ms — record check time for high-density
> tape (.6 for low-density tape)
> CN ms — record time

During the same read operation, the processing unit is interlocked for 10.5 + CN ms. This includes:

> 10.5 ms — start time
> CN ms — record time

Therefore in a tape-read operation, processing can take place during the 2.1-ms stop time. A tape-transmission-error condition can be recognized .2 ms after the processing interlock is released. If the tape-trans-

mission-error-test instruction is given during this .2-ms period, the processing unit is interlocked until the error indicator can be tested.

During a 729 v write operation, the tape-adapter unit or 1461 is interlocked for 11.7 + CN ms (Figure F-19). This includes:

> 7.5 ms — start time
> 4.2 ms — record check time for high-density
> tape (4.6 for low-density tape)

During the same write operation, the processing unit is interlocked for 7.5 + CN ms. This includes:

> 7.5 ms — start time
> CN ms — record time

Therefore in a tape-write operation, processing can take place during the 5.1-ms stop time. A tape-transmission-error condition can be recognized 4.2 ms after the processing interlock is released. If the tape transmission-error-test instruction is given during this 4.2-ms

READ OPERATION

Record Time

Start Time — 10.5ms | CNms | Stop Time — 2.1ms

Tape Adapter Unit Interlocked
10.7 + CN ms

Processing Unit Interlocked
10.5 + CN ms

Available Processing Time
2.1ms

Record Check Time → .2ms

Can Test Tape Error Indicator

WRITE OPERATION

Record Time

Start Time — 7.5ms | CN ms | Stop Time — 5.1ms

Tape Adapter Unit Interlocked
11.7 + CN ms

Processing Unit Interlocked
7.5 + CN ms

Available Processing Time
5.1ms

Record Check Time — 4.2ms
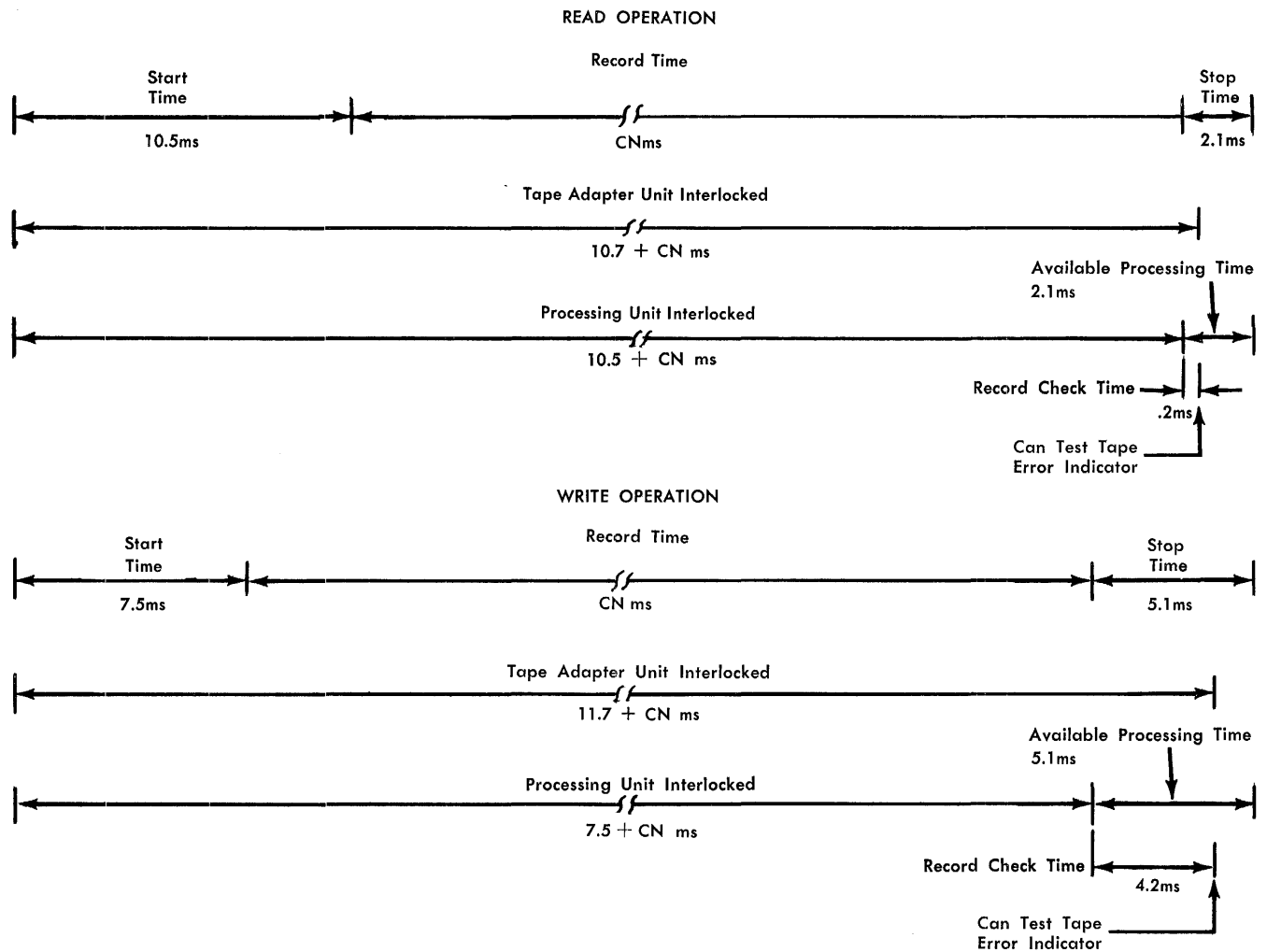
Can Test Tape Error Indicator

Figure F-19. IBM 729, Model V, Read-Write Operation Timings

period, the processing unit is interlocked until the error indicator can be tested. The difference between the .2-ms record check time of reading and the 4.2-ms record check time of writing is due to the read-write head gap time (4.0 ms).

For job-timing estimates of tape read-write operations, the nominal formula 10.8 + CN ms can be used.

IBM 729 VI Tape Timings

During a 729 VI read operation, the tape-adapter unit or 1461 is interlocked for 6.8 + CN ms (Figure F-20). This includes:

> 6.7 ms — start time
> .1 ms — record check time for high-density tape (.4 for low-density tape)
> CN ms — record time

During the same read operation, the processing unit is interlocked for 6.7 + CN ms. This includes:

> 6.7 ms — start time
> CN ms — record time

Therefore in a tape-read operation, processing can take place during the 2.1-ms stop time. A tape-transmission-error condition can be recognized .1 ms after the processing interlock is released. If the BRANCH IF TAPE ERROR instruction is given during this .1-ms period, the processing unit is interlocked until the error indicator can be tested.

During a 729 VI write operation, the tape-adapter unit or 1461 is interlocked for 7.8 + CN ms (Figure F-20). This includes:

> 5 ms — start time
> 2.8 ms — record check time for high-density tape (3.0 for low-density tape)

During the same write operation, the processing unit is interlocked for 5 + CN ms. This includes:

> 5 ms — start time
> CN ms — record time

Therefore in a tape-write operation, processing can take place during the 3.8-ms stop time. A tape-trans-

READ OPERATION

Record Time

Start Time — 6.7ms

CN ms

Stop Time — 2.1ms

Tape Adapter Unit Interlocked
6.8 + CN ms

Available Processing Time
2.1ms

Processing Unit Interlocked
6.7 + CN ms

Record Check Time → .1ms

Can Test Tape
Error Indicator

WRITE OPERATION

Record Time

Start Time — 5 ms

CN ms

Stop Time — 3.8ms

Tape Adapter Unit Interlocked
7.8 + CN ms

Available Processing Time
3.8ms

Processing Unit Interlocked
5 + CN ms

Record Check Time — 2.8ms
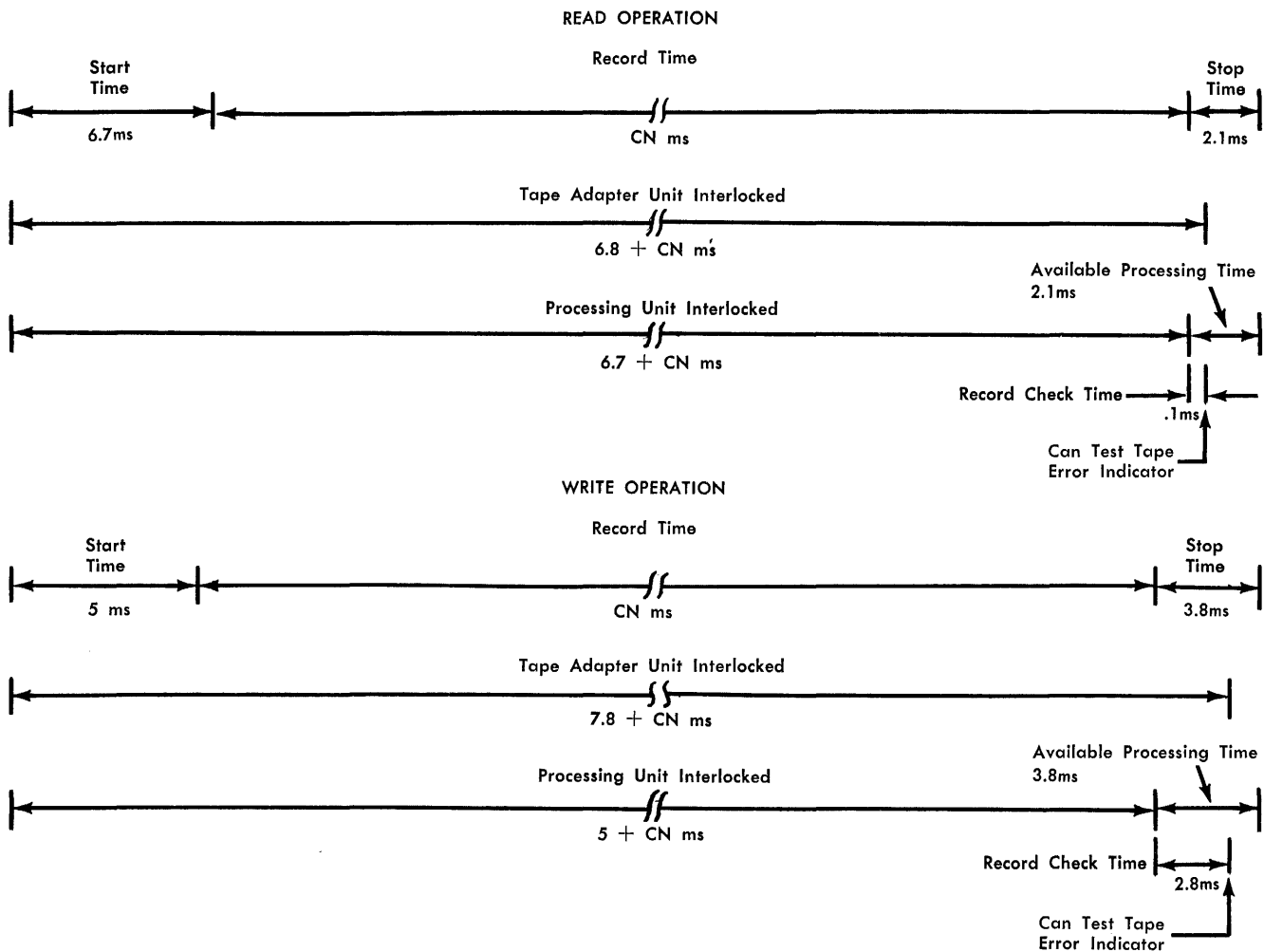
Can Test Tape
Error Indicator

Figure F-20. IBM 729, Model VI, Read-Write Operation Timings

mission-error condition can be recognized 2.8 ms after the processing interlock is released. If the tape-transmission-error-test instruction is given during this 2.8-ms period, the processing unit is interlocked until the error indicator can be tested. The difference between the .1-ms record check time of reading and the 2.8-ms record check time of writing is due to the read-write head gap time (2.7 ms).

For job-timing estimates of tape read-write operations, the nominal formula 7.3 + CN ms can be used.

IBM 7330 Tape Timings

During a 7330 tape-read operation, the tape-adapter unit or 1461 is interlocked for 20.5 + CN ms (Figure F-21). This includes:

10.3 ms — start time
9.8 ms — stop time
.4 ms — record check time for high-density tape (1.0 ms for low-density tape)
CN ms — record time

During the same read operation, the processing unit is interlocked for 10.4 + CN ms. This includes:

10.3 ms — start time
.1 ms — part of the .4 ms record check time
CN ms — record time

Therefore, in a tape-read operation, processing can take place during 10.1 ms of stop time and record-check time. A tape-transmission-error condition can be recognized .3 ms after the processing interlock is released.

During a 7330 tape-write operation, the tape-adapter unit is interlocked for 20.3 + CN ms (Figure F-21). This includes:

5.0 ms — start time
6.6 ms — stop time
8.7 ms — record check time for high-density tape (9.3 ms for low-density tape)
CN ms — record time

During the same write operation, the processing unit is interlocked for 5 + CN ms. This includes:

5.0 ms — start time
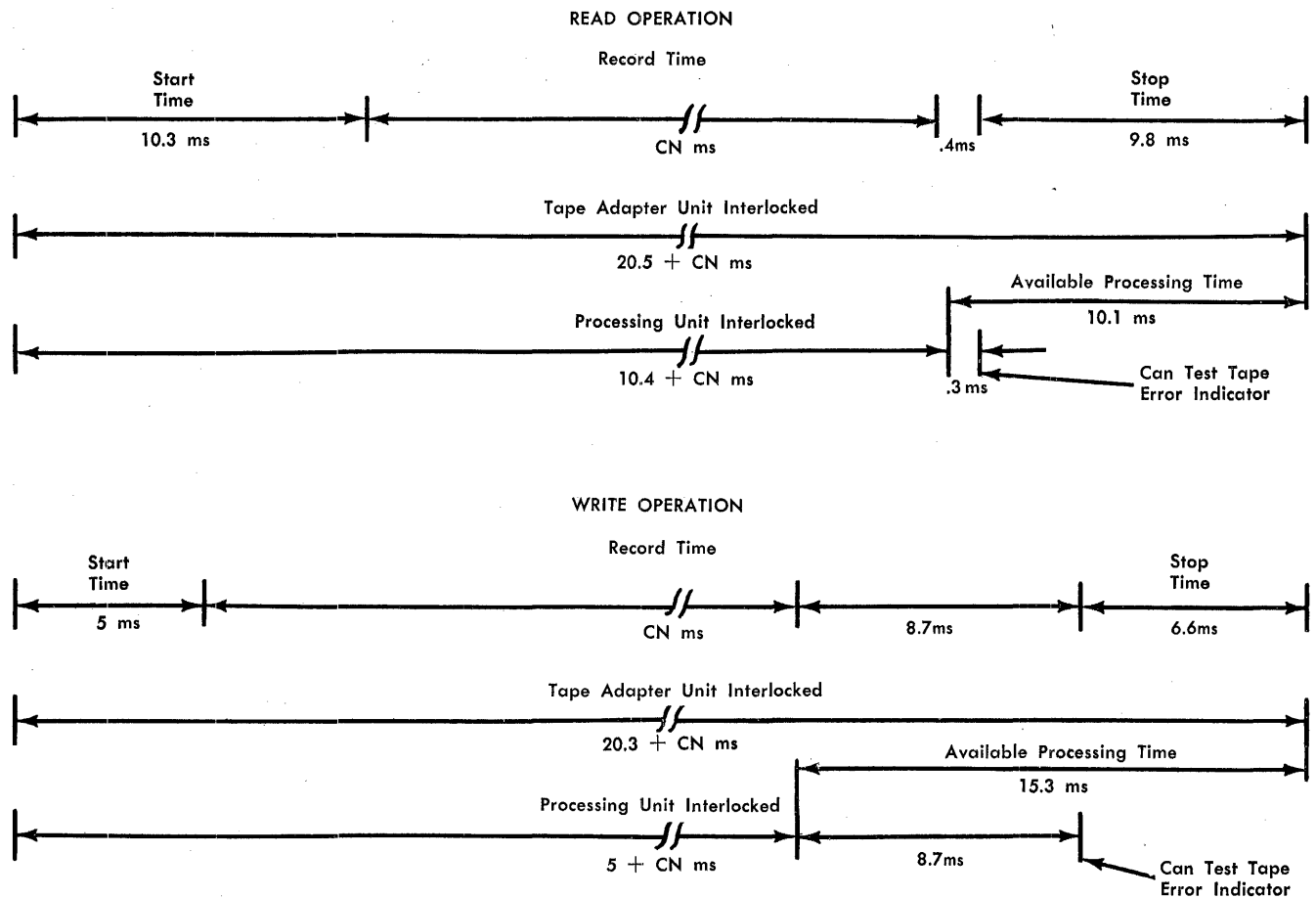CN ms — record time

READ OPERATION

Figure F-21. IBM 7330 Read-Write Operation Timings

Therefore, in a tape-write operation, processing can take place during the 15.3-ms stop time. A tape-transmission-error condition can be recognized 8.7 ms after the processing interlock is released. If the tape-transmission-test instruction is given during this 8.7-ms period, the processing unit is interlocked until the error indicator can be interrogated. The difference between the .4-ms record check time of reading and the 8.7-ms record check time of writing is due to the read-write head gap time (8.3 ms).

For job-timing estimates of read operations in either high- or low-density, use the formula $20.1 + C (N + 7)$ ms, where the factor C (7) is the record check time.

For job-timing estimates of write operations in either high- or low-density, use the formula $19.9 + C (N + 7)$ ms, where the factor C (7) is the record check time, and 8.3 ms of the 19.9 ms is the read-write head gap time.

IBM 1011 Paper Tape Reader

The IBM 1011 Paper Tape Reader (Figure F-22) for the IBM 1401, and 1460 Data Processing Systems is an input device controlled by stored programs in the same manner as other input-output equipment (card reader, card punch, and printer).

Information punched in paper tape can be read by the IBM 1011 directly into any area of 1401, or 1460 core storage. Any character punched in 5-track telegraphic, 8-track IBM, or many other paper-tape codes can be encoded into any valid 1401/1460 character through the flexibility of control-panel wiring on the tape reader.

Instructions

The instructions described in this section are for the IBM 1401, and 1460 Data Processing Systems.

Read from Paper Tape

Instruction Format.

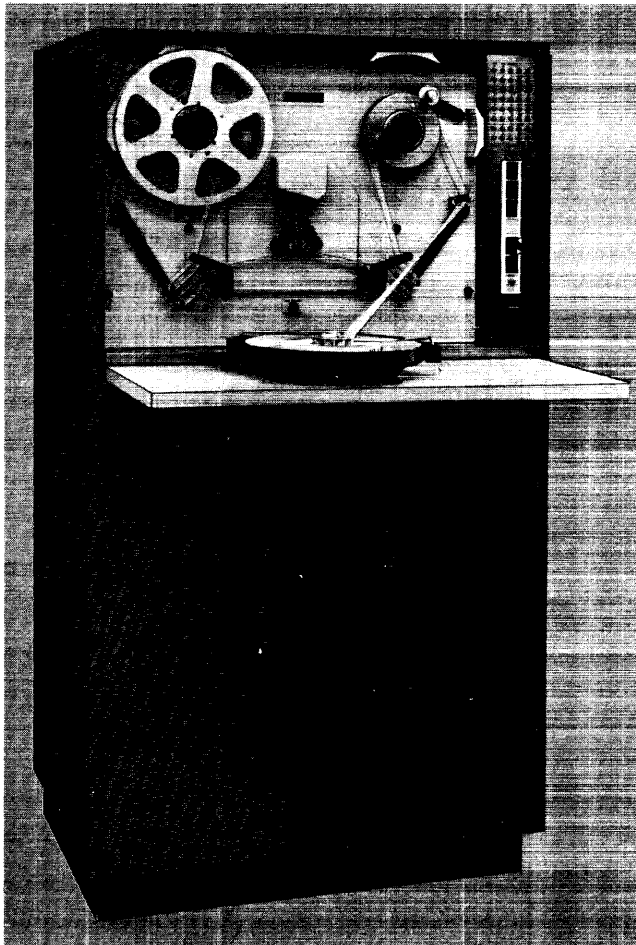| Mnemonic	Op Code	A-address	B-address	d-character
MU	M	%P1	BBB	R

Figure F-22. IBM 1011 Paper Tape Reader

Function. This instruction causes data to be read from the paper-tape reader into core storage, beginning at the B-address.

The M Op code specifies that the operation will be performed in the *move* mode. When the M operation code is used, word marks are not transferred into core storage with the data read from the paper tape, and word marks in the core-storage paper-tape read-in areas are undisturbed. The A-address, %P1, is the code assigned to both the IBM 1011 Paper Tape Reader and the IBM 1012 Tape Punch.

The B-address specifies the core-storage position (high-order) that receives the first character of information from the paper-tape reader. The succeeding characters are read into the adjacent higher-numbered core-storage positions.

The d-character R specifies a read operation. The read operation ends either by detection of a group-mark with a word-mark in core storage (signifies the end of the read-in area), or by reading an EOR (end-of-record character) character punched in the tape.

Any paper-tape character can be used as an end-of-record character. Wiring the assigned end-of-record character decode-exit hub to the end-of-record IN hub terminates the paper-tape read operation and enters a group mark in core storage.

Note. If a group-mark with a word-mark in core storage is used to terminate the paper-tape-read operation, the character read into the A-register, when the group-mark with a word-mark is sensed, will be lost.

Word Marks. Word marks are not affected.

Timing. $T = N (L_I + 1)$ ms + record transmission time. $N = .0115$ (1401), .006 (1460).

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%71	B + message length + 1

Example. Read record from paper-tape reader 1 into core storage. The high-order paper-tape character is moved to READIN (541), the next character is moved to the next higher position (542), etc., until the transfer of data is stopped. The transfer is stopped either by the detection of a group-mark with a word-mark in core storage (signifies the end of the read-in area), or by reading an EOR (end-of-record) character punched in the tape (Figure F-23).

Autocoder

Label	Operation	OPERAND
	MU	%P1,READIN,R

Assembled Instruction: M %P1 541 R

Figure F-23. Read from Paper Tape

Read from Paper Tape with Word Marks

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
LU	L	%P1	BBB	R

Function. This instruction is similar to the READ FROM PAPER TAPE instruction, except that word marks are removed from the paper-tape read-in area in core storage, and word-separator characters read from the paper-tape reader causes the insertion of a word mark in core storage with the next character read from the 1011. The L Op code specifies that the operation will be performed in the load mode, which results in the word mark control already discussed.

Word Marks. Word marks are removed from the paper-tape read-in area in core storage, and word-separator characters read from the paper-tape reader cause a word mark to be associated with the next character read from the 1011.

Timing. $T = N (L_I + 1)$ ms + record transmission time.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%71	B + message length + 1

Example. Read record from paper-tape reader 1 into core storage, except that word marks are removed from the paper-tape read-in area in core storage, and a word separator character read from the paper-tape reader causes a word mark to be inserted in core storage with the next character read from the 1011. The high-order paper-tape character is moved to RDPTWM (418), the next character is moved to the next higher position (419), etc., until the read operation ends either by detection of a group-mark with a word-mark in core storage, or by reading an EOR (end-of-record) character punched in the tape (Figure F-24).

Autocoder

Label	Operation					OPERAND
	15 16 20 21	25	30	35	40	45 50
	L U	%P1 R D P T W M , R				

Assembled Instruction: L %P1 418 R

Figure F-24. Read from Paper Tape with Word Mark

Branch if Input-Output Indicator On

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	B	III	1

Function. When a parity error is detected during a read operation, the PE hub provides an error output

(8-track tape only). When the error condition occurs, the error character is suppressed and a special output is made available on the paper-tape-reader control panel. This signal can be used to either substitute a unique error character, or delete that position. Refer to CONTROL and SPECIAL PURPOSE hubs in IBM *1011 Paper Tape Reader*, Form A26-5754.

The detected parity error also turns on the input-output error latch in the system. A paper-tape-read operation should always be followed by a BRANCH IF INPUT-OUTPUT INDICATOR ON instruction. This instruction checks the status of the input-output error latch. If the latch is ON, the system branches to the error subroutine. If the latch is OFF, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$$T = N (L_I + 1) ms.$$

Branch (without indexing):

$$T = N (L_I + 1) ms.$$

Branch (with indexing):

$$T = N (L_I + 2) ms.$$

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	dbb
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch, if input-output indicator is on, to PARERR (661) error subroutine (Figure F-25).

Autocoder

Label	Operation					OPERAND
6	15 16 20 21	25	30	35	40	45 50
	B I N	P A R E R R , 1				

Assembled Instruction: B 661 1

Figure F-25. Branch if Input-Output Indicator On

Branch if Paper Tape Reader Ready

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	B	III	2

Function. This instruction checks the status of the tape-reader-ready indicator. If the paper-tape reader is

not ready, when tested, the program goes to the next sequential instruction. If the paper-tape reader is ready, when tested, the program branches to the subroutine that begins at the core-storage position specified by the instruction I-address.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N (L_I + 1)$ ms.

Branch (without indexing):

$T = N (L_I + 1)$ ms.

Branch (with indexing):

$T = N (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	*dbb*
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch to READY (767) for the location of the subroutine controlling the paper-tape reader (Figure F-26).

Autocoder

Label	Operation						OPERAND	
6	15 16 20	21	25	30	35	40	45	80
	B I N	R E A D Y , , 2						

Assembled Instruction. B̲ 767 2

Figure F-26.   Branch if Paper Tape Reader Ready

IBM 1012 Tape Punch

The IBM 1012 Tape Punch (Figure F-27) attached to the IBM 1401, or 1460 Data Processing Systems is an output device controlled by stored programs in the same manner as other input-output equipment (card reader, card punch, and printer).

The IBM 1012 Tape Punch operates at the rate of 150 tape characters per second, using 5-, 6-, 7-, or 8-track paper tape, supplied from a reel. Data, stored in the core-storage area of 1401, or 1460 systems and ready to be punched, is converted to the appropriate tape code by using a translation program that includes the appropriate stored code table.

Instructions

The instructions described in this section are for the 1401, and 1460 operating with the IBM 1012 Tape Punch.
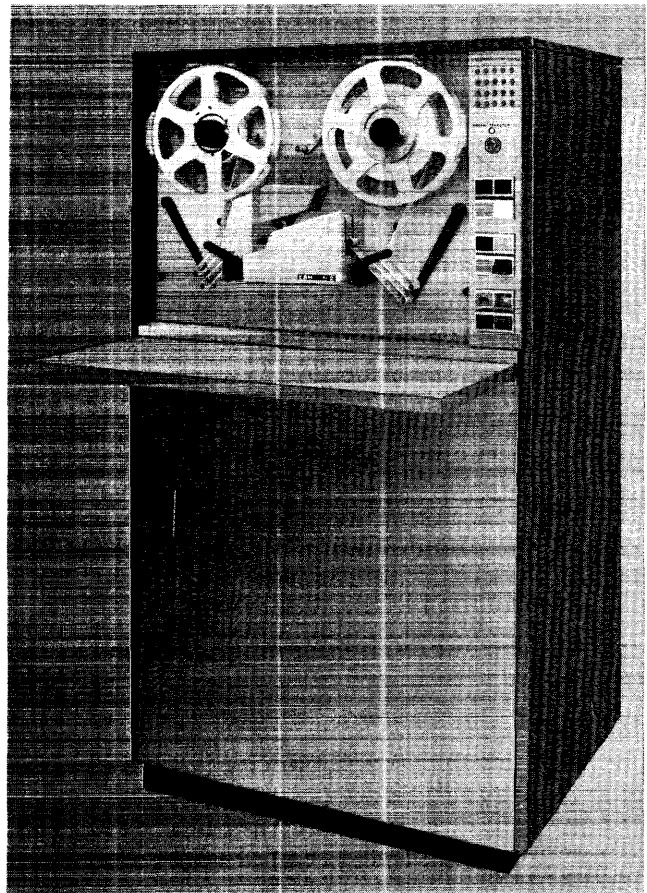
Figure F-27.   IBM 1012 Tape Punch

Write on Tape Punch

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
MU	M̲	%P1	BBB	W

Function. This instruction causes one vertical tape column to be punched. The M̲ Op code specifies an operation in the move mode. When the M̲ operation code is used, word marks are not transferred from core storage to the tape punch. The A-address, %P1, is the code assigned to both the IBM 1011 Paper Tape Reader and the IBM 1012 Tape Punch.

The B-address specifies the first core-storage position (high-order) of the 3-position field. The 3-position field contains the total bit configuration that will be punched in one vertical column in the tape. The d-character W specifies a write operation.

Word Marks. Word marks are not affected.

Timing. T = N (L$_I$ + 1) ms + transmission time.
N = .0115 (1401), .006 (1460).

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%71	B + 3

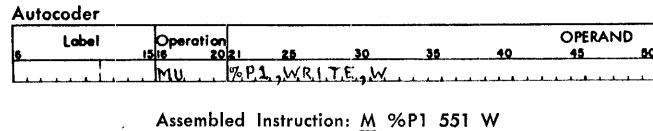*Example.* Read record from address labeled WRITE (551) and punch into paper tape (Figure F-28).

Autocoder

Label	Operation	OPERAND
	MU	%P1,WRITE,W

Assembled Instruction: M %P1 551 W

Figure F-28.   Write on Tape Punch

Tape Punch Readback Check

Instruction Format.

Mnemonic	Op Code	A-address	B-address	d-character
MU	M	%P1	BBB	R

Function. This instruction reads one vertical tape column when a readback check is desired on the characters punched in the tape. The M Op code specifies an operation in the move mode. When the M operation code is used, word marks in core storage are not removed or affected. The A-address, %P1, is the code assigned to both the IBM 1011 Paper Tape Reader and the IBM 1012 Tape Punch.

The B-address specifies the first core-storage position (high-order) of the 3-position field. The 3-position field contains the total bit configuration of the character being read from the tape at the reading station. The d-character R specifies a read operation.
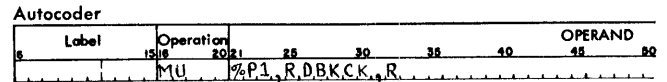
Word Marks. Word marks are not affected.

Timing. T = N (L$_I$ + 1) ms + transmission time.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	%71	B + 3

Example. Read one vertical paper-tape column for checking character punched in tape. RDBKCK (686) specifies the first core-storage position (high-order) of the 3-position field. (Figure F-29).

Autocoder

Label	Operation	OPERAND
	MU	%P1,RDBKCK,R

Assembled Instruction: M %P1 686 R

Figure F-29.   Tape Punch Readback Check

Backspace Tape

Instruction Format.

Mnemonic	Op Code	d-character
SS	K	A

Function. This instruction moves the tape backward one vertical column. The program then goes to the next sequential instruction.
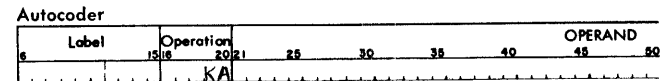
Word Marks. Word marks are not affected.

Timing. T = N (L$_I$ + 1) ms.

Address Registers After Operation.

I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
NSI	dbb	dbb

Example. Move tape backwards one vertical column (Figure F-30).

Autocoder

Label	Operation	OPERAND
	KA	

Assembled Instruction: K A

Figure F-30.   Backspace

Backspace Tape and Branch

Instruction Format.

Mnemonic	Op Code	I-address	d-character
SSB	K	III	A

Function. This instruction is similar to the BACKSPACE TAPE instruction, except that the location of the next instruction is taken from the I-address.

Word Marks. Word marks are not affected.

Timing. T = N (L$_I$ + 1) ms.

I-Add. Reg	A-Add. Reg.	B-Add. Reg.
NSI	BI	dbb

Example. Move the tape backwards one vertical column and branch to BKSPBR (777) for the next instruction (Figure F-31).
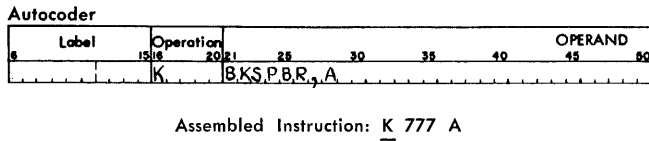
Autocoder

Label	Operation	OPERAND
	K	B,K,S,P,B,R,,A

Assembled Instruction: <u>K</u> 777 A

Figure F-31. Backspace Tape and Branch

Branch if in Backspace Operation

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	<u>B</u>	III	1

Function. This instruction checks to see whether the tape punch is executing a backspace operation. The backspace operation condition is present from the time the tape punch is signaled to execute the backspace operation until the operation is completed.

If a backspace operation is in progress, when checked, the program branches to the subroutine that starts at the I-address specified in the instruction. If a backspace operation is not in process, when checked, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N (L_I + 1)$ ms.

Branch (without indexing):

$T = N (L_I + 1)$ ms.

Branch (with indexing):

$T = N (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	dbb
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

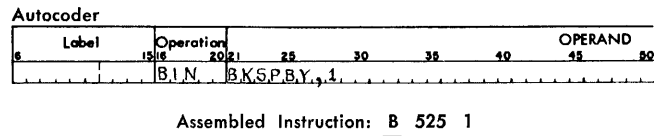*Example.* Test for backspace operation, branch to BKSPBY (525) for the next instruction (Figure F-32).

Autocoder

Label	Operation	OPERAND
	B,I,N	B,K,S,P,B,Y,,1

Assembled Instruction: <u>B</u> 525 1

Figure F-32. Branch if in Backspace Operation

Branch if Tape Punch Ready

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	<u>B</u>	III	2

Function. This instruction checks to see whether the tape punch is in a ready condition. The tape punch is considered in a ready condition when each of the following conditions is satisfied:

1. Tape properly loaded.

2. Tape tension is normal.

3. Electrical power is supplied.

4. Start switch has been pressed.

If the tape punch is in a ready condition, when checked, the program branches to the subroutine that starts at the I-address specified in the instruction. If the tape punch is not in a ready condition, when checked, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N (L_I + 1)$ ms.

Branch (without indexing):

$T = N (L_I + 1)$ ms.

Branch (with indexing):

$T = N (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	dbb
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch to BTPRD (818) for the punch sub-routine (Figure F-33).

Label	Operation		OPERAND
	B.I.N.	B.T.P.R.D.,2.	

Assembled Instruction: B 818 2

Figure F-33. Branch if Tape Punch Ready

Branch if Tape Punch Not Ready to Accept Data

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	B	III	3

Function. This instruction checks to see whether the tape punch is in the correct mechanical position to accept data. The IBM 1012 Tape Punch punches tape at the speed of 150 characters per second (6.6 milliseconds between characters). The data can be accepted during a 1.5-millisecond (ms) portion of the 6.6-ms time interval between characters.

If the tape punch is not in correct mechanical position to accept data, when checked, the program branches to the subroutine that starts at the I-address specified in the instruction. If the tape punch is in correct mechanical position to accept data, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N \ (L_I + 1)$ ms.

Branch (without indexing):

$T = N \ (L_I + 1)$ ms.

Branch (with indexing):

$T = N \ (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	dbb
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch to NOPCH (343) subroutine that starts at the I-address specified (Figure F-34).

Label	Operation		OPERAND
	B.I.N.	N.O.P.C.H.,3.	

Assembled Instruction: B 343 3

Figure F-34. Branch if Tape Punch Not Ready to Accept Data

Branch if Tape Punch is Not Ready to Read

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	B	III	4

Function. This instruction checks to see whether the reading portion of a punch cycle has been reached. The IBM 1012 Tape Punch punches tape at the speed of 150 characters per second (6.6 milliseconds between characters). A 1.8-millisecond (ms) portion of the 6.6 ms time interval between characters is reserved for the actual read operation.

If the reading portion of a punch cycle has not been reached, when checked, the program branches to the subroutine that starts at the I-address specified in the instruction. If the reading portion of a punch cycle has been reached, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N \ (L_I + 1)$ ms.

Branch (without indexing):

$T = N \ (L_I + 1)$ ms.

Branch (with indexing):

$T = N \ (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	dbb
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch to NORD (381) subroutine that starts at the I-address specified (Figure F-35).

Label	Operation		OPERAND
	B.I.N.	N.O.R.D.,4.	

Assembled Instruction: B 381 4

Figure F-35. Branch if Tape Punch Not Ready to Read

Branch if Tape Punch Overextended

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	B	III	5

Function. This instruction checks to see whether a previous punch (or read) operation occurred within the alloted time during the last possible punch (or read) cycle.

If a punch (or read) operation did not occur within the allotted time, it usually indicates a machine malfunction, and the tape punch can be stopped through programming. This condition:

1. Always exists when the tape punch is idle

2. Exists until a punch (or read) operation starts

3. Never exists when the tape punch is punching (or reading) at its maximum speed.

If a punch (or read) operation did not occur within the allotted time, when checked, the program branches to the subroutine that starts at the I-address specified in the instruction. If a punch (or read) operation did occur within the allotted time, when checked, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N (L_I + 1)$ ms.

Branch (without indexing):

$T = N (L_I + 1)$ ms.

Branch (with indexing):

$T = N (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	*dbb*
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch to OVER (820) subroutine that starts at the I-address specified (Figure F-36).

Autocoder

Label		Operation							OPERAND	
6	15 16	20 21	25	30	35	40	45	50
		B I N	O V E R , , 5							

Assembled Instruction: B 820 5

Figure F-36. Branch if Tape Punch Overextended

Branch if Supply Reel Low or Chad Box Full

Instruction Format.

Mnemonic	Op Code	I-address	d-character
BIN	B	III	6

Function. This instruction checks to see whether either an end-of-reel (supply reel low) condition exists or the chad box is full or not in position. Additional punching can occur after the supply-reel-low condition occurs, but the amount of additional punching depends upon the length of the records being punched.

If the supply reel is low, or the chad box is full or not in position, when checked, the program branches to the subroutine that starts at the I-address specified in the instruction. Otherwise, the program goes to the next sequential instruction.

Word Marks. Word marks are not affected.

Timing.

No Branch:

$T = N (L_I + 1)$ ms.

Branch (without indexing):

$T = N (L_I + 1)$ ms.

Branch (with indexing):

$T = N (L_I + 2)$ ms.

Address Registers After Operation.

	I-Add. Reg.	A-Add. Reg.	B-Add. Reg.
No Branch (no indexing)	NSI	BI	*dbb*
Branch (no indexing)	NSI	BI	Blank
Branch (with indexing)	NSI	BI	NSI

Example. Branch to SRLCBF (904) subroutine that starts at the I-address specified (Figure F-37).

Autocoder

Label		Operation							OPERAND	
6	15 16	20 21	25	30	35	40	45	50
		B I N	S R L C B F , , 6							

Assembled Instruction: B 904 6

Figure F-37. Branch if Supply Reel Low or Chad Box Full

IBM 1012 Programming Concepts

The basic logic of programmed translation is based on a programming device known as *character selection*. Character selection uses a stored table to translate the

system characters to the pattern required by the ɪʙᴍ 1012 Tape Punch. This method of translation makes a control panel unnecessary.

A stored-program routine controls the over-all operation of the 1012. PTAPE (punch tape), a macro instruction, will be provided in the Autocoder library of routines. The operand of the PTAPE instruction is the symbolic name of the output area to be punched. A second operand is used to designate whether the routine is to punch standard Teletype* (5-track) code or ɪʙᴍ standard (8-track) code. Therefore, when punching is desired, the programmer need merely write PTAPE with the appropriate operand(s). The Autocoder processor then generates the necessary instructions to punch the tape.

The programs used for 6- and 7-track operation are basically the same as those used for 5- and 8-track operation. The major difference is in the stored table used for translating the system BCD codes into punch codes.

Once the theory of operation and the 5- and 8-track programs are understood, altering the program and the stored table is a simple task.

The decoding routine is within the 6.6 millisecond time interval between characters in the record that are to be punched. No attempt is made to overlap this time with the user's program. A special test is made for the 5-track tape to automatically generate mode-change characters where appropriate.

A brief description of the theory of operation is given to aid the user in understanding the over-all operation of the ɪʙᴍ 1012 Tape Punch. The examples used are not necessarily the only methods of programming the various operations. The examples are used primarily as an aid in simplifying the explanations. The methods, constants, and stored code tables used in the following explanations do not necessarily represent these items as they will appear in the macro instruction *PTAPE*.

The theory of operations (8-track operation) is explained in the following order:

1. Move character from record into test location
2. Decode to a table address
3. Get table argument for punching
4. Punch character in tape
5. Read-check.
6. End-of-record routine
7. Automatic error correction
8. End-of-reel routine
9. Five-track tape operation.

* Trademark of Teletype Corporation

1. Move Character from Record into Test Location

The record to be punched in tape can be any length (within the limits of available core storage) and may be stored in any system core-storage location. When a new record is ready to be punched into tape, a 3-position field (the record address), is initialized to the first (high-order) position of the record. This field is moved to the A-address of a move instruction which, when executed, moves the first record character to a location in core storage where it can be analyzed. A character compare instruction then checks the character for an end-of-record indication. An equal compare causes a branch to the end-of-record routine; otherwise the program advances to the decode routine.

2. Decode to a Table Address

A table address (Figure F-38) is developed for every character in the record. After the character is moved from the record into another core-storage location, it is analyzed to develop the table address. This is accomplished in the following manner.

A constant is moved to the A-address of a ᴍᴏᴠᴇ instruction. The constant would be the starting location of the table plus two. Assume the stored table starts in

Table Address	B	A	8	4	2	1	1401 Char	Card Code
0- 2	X	X					&	2
*3- 5								
*6- 8								
9-11	X	X	X		X	X	.	2-3-8
12-14	X	X	X	X		X	□	2-4-8
15-17	X	X	X	X	X		[	2-5-8
18-20	X	X	X	X	X		<	2-6-8
21-23	X	X	X	X	X	X	‡	2-7-8
*24-26								
*27-29								
30-32	X						−	1
*33-35								
*36-38								
39-41	X		X		X	X	$	1-3-8
42-44	X		X	X			*	1-4-8
45-47	X		X	X		X	]	1-5-8
48-50	X		X	X	X		;	1-6-8
51-53	X		X	X	X	X	Δ	1-7-8
*54-56								
*57-59								
60-62		X					⌀	2-8
*63-65								
*66-68								
69-71	X	X		X	X		,	0-3-8
72-74	X	X	X				%	0-4-8
75-77	X	X	X		X		v	0-5-8
78-80	X	X	X	X			\	0-6-8
81-83	X	X	X	X	X		⧞	0-7-8
*84-86								
*87-89								
90-92							B L	No Punch
*93-95								
*96-98								
99-101			X		X	X	#	3-8
102-104			X	X			@	4-8
105-107			X	X		X	:	5-8
108-110			X	X	X		>	6-8
111-113			X	X	X	X	√	7-8
*114-116								
*117-119								

Table Address	B	A	8	4	2	1	1401 Char	Card Code
120-122	X	X	X		X		?	12-0
123-125	X	X				X	A	12-1
126-128	X	X			X		B	12-2
129-131	X	X			X	X	C	12-3
132-134	X	X		X			D	12-4
135-137	X	X		X		X	E	12-5
138-140	X	X		X	X		F	12-6
141-143	X	X		X	X	X	G	12-7
144-146	X	X	X				H	12-8
147-149	X	X	X			X	I	12-9
150-152	X			X		X	!	11-0
153-155	X					X	J	11-1
156-158	X				X		K	11-2
159-161	X				X	X	L	11-3
162-164	X			X			M	11-4
165-167	X			X		X	N	11-5
168-170	X			X	X		O	11-6
171-173	X			X	X	X	P	11-7
174-176	X		X				Q	11-8
177-179	X		X			X	R	11-9
180-182	X	X		X			‡	0-2-8
183-185	X				X		/	0-1
186-188	X				X		S	0-2
189-191	X				X	X	T	0-3
192-194	X			X			U	0-4
195-197	X			X		X	V	0-5
198-200	X			X	X		W	0-6
201-203	X			X	X	X	X	0-7
204-206	X	X					Y	0-8
207-209	X	X				X	Z	0-9
210-212			X		X		0	0
213-215						X	1	1
216-218					X		2	2
219-221					X	X	3	3
222-224				X			4	4
225-227				X		X	5	5
228-230				X	X		6	6
231-233				X	X	X	7	7
234-236			X				8	8
237-239			X			X	9	9

*Not Used

Figure F-38.   Table Address Chart

Figure F-39. Eight-Track Code Table

Starting Location of Table →

(G.M.)

&				.	□	[	<	‡			
1 6				1 5 3	1 7 4	1 5 5	1 5 6	1 7 7			

-				$	*	]	;	Δ			
1				1 3 3	1 1 4	7 5	1 3 6	1 1 7			

⅍				,	%	V	\	⧺			
3 2				7 3	5 4	1 3 5	7 6	5 7			

(T.M.)

Blank				#	@	:	>	ᴛ̄			
2				1 1 3	3 4	1 1 5	1 1 6	3 7			

?	A	B	C	D	E	F	G	H	I
1 7 2	1 4 1	1 4 2	1 6 3	1 4 4	1 6 5	1 6 6	1 4 7	1 5 1	1 7 1

‖	J	K	L	M	N	O	P	Q	R
1 1 2	1 2 1	1 2 2	1 1	1 2 4	1 5 1	1 6 1	1 2 7	1 3	1 1 1

‡	/	S	T	U	V	W	X	Y	Z
5 2	6 1	6 2	4 3	6 4	4 5	4 6	6 7	7 1	5 1

Last Location In Table →

0	1	2	3	4	5	6	7	8	9
4	1 1	2	2 3	4	2 5	2 6	7	1 1	3 1

3 Positions of Core Storage used for Each Character in Table
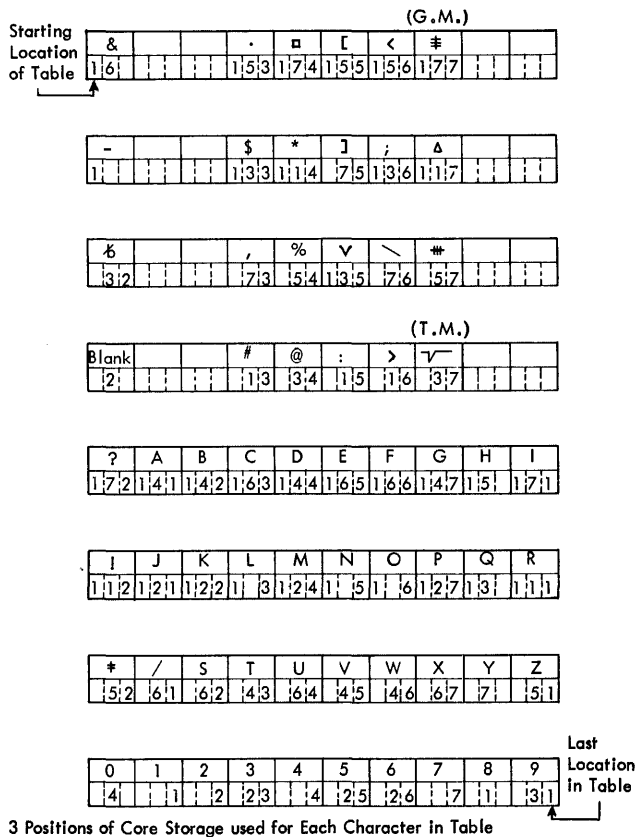
location 400. The constant used would be 402. The character to be punched is now analyzed to develop a table address. If the character contains a B-bit only, the constant 30 is added to the number (402) already in the A-address of the MOVE instruction. An A-bit only, adds the constant 60, no zone-bits adds the constant 90; and if the character contains A- and B-bits, nothing is added. A further test determines whether the character is a special character or blank. The constant 120 is also added to the A-address of the MOVE instruction if the character is *not* a blank or special character. Furthermore, the sum of the digit bits in the character being analyzed is tripled and also added to the number already developed. As an example, assume the character B (BA2) is being analyzed. The presence of an A- and B-bit would add nothing; however, 120 would be added because B is not a special character. The 2 bit is tripled, adding 6 to the number. The table address developed would therefore be 402 plus 120, plus 6, or a total of 528.

Figure F-39 illustrates the arrangement of the characters in the table, and the bit pattern for punching

that is contained in each 3-position character location. Assuming the starting location of the table is 400, the address 528 would direct the system to the low-order position of the 3-position location for the character B.

3. Get Table Argument for Punching

The table address for the character to be punched is developed in the A-address location of a MOVE instruction. The MOVE instruction, when executed, moves the proper field from the table and places it in an unused 3-position storage location referred to as QD. The character is now ready for punching using the bit pattern in location QD.

4. Punch Character in Tape

The punch instruction $\underline{M}(\%P1)(BBB)W$ is executed next, which causes data to be transferred to the 1012 for punching. The address in the punch instruction refers to the high-order position of the 3-position field (QD) that contains the bit pattern to punch one vertical column in the tape.

Figure F-40 illustrates the bit pattern to tape-punching translation.

5. Read-Check

Because of the delay between punching and reading, the punching bit pattern for four characters must be retained for checking. Four consecutive 3-position fields are set aside for this purpose.

As noted in the punch routine, the bit pattern to be punched is moved from the stored table into location QD. By a method described later, the character bit pattern for the column of the tape that can be read during this punch cycle is put in location QA.

The read instruction $\underline{M}(\%P1)(BBB)R$ causes data to be transferred from the reading station into three consecutive core-storage locations beginning in (BBB). The data transfer is in accordance to the pattern shown in Figure F-41. This is similar to the punch transfer but with direction reversed. The 3-position field into which data is read is compared to the contents of location QA. Thus, the punched tape is given a bit-by-bit comparison check. If punching and reading were correct, the BRANCH COMPARE instruction would not cause a branch to the error routine, but would continue to the next sequential instruction. After a valid compare, the contents of the four fields (QD, QC, QB, and QA) are shifted in preparation for the next read-check instruction. The program is then directed to the beginning to process the next character in the record.

6. End-of-Record Routine

Any one of many characters can be assigned as an EOR (end-of-record) character. However, to simplify the
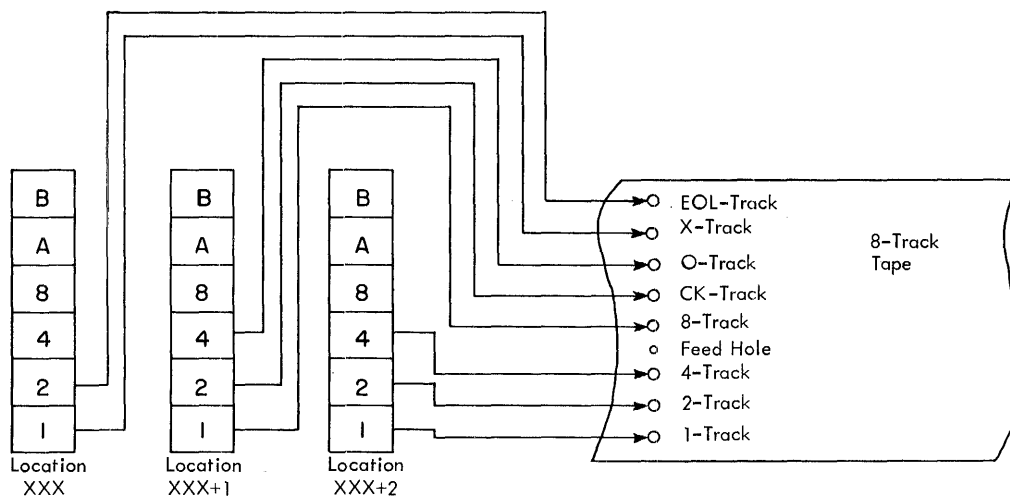
Figure F-40. Eight-Track Bit Pattern to Tape Punching Translation
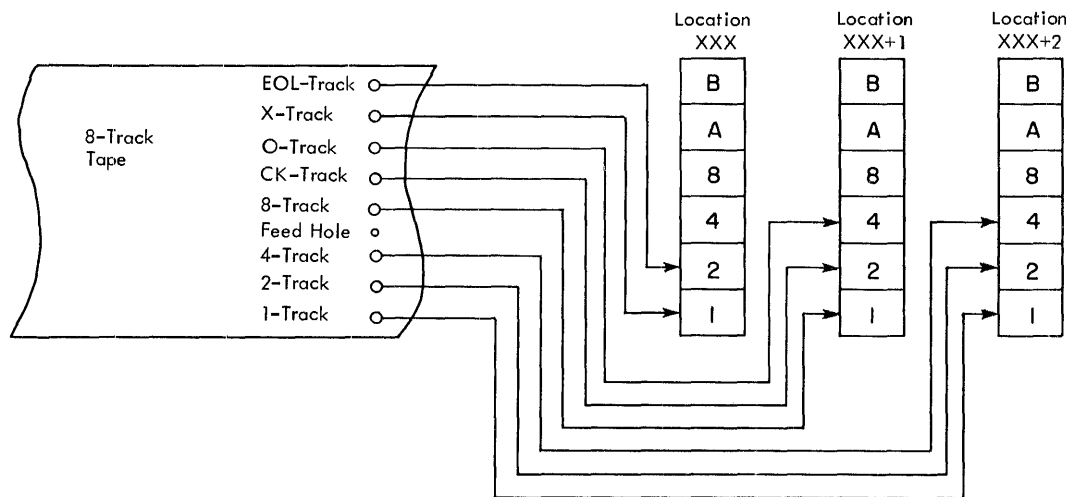

Figure F-41. Eight-Track Tape Punching to Bit-Pattern Translation

explanation of this routine, assume that a group-mark with a word-mark is used. The main program routine checks every character to determine whether or not it is a goup mark. If a group mark is detected, a further check determines whether a word mark is present. If a word mark is detected, this signifies an end-of-record character, and the system branches to the end-of-record routine. Figure F-42 illustrates the cycle-by-cycle operation of the punch and the relationship of the characters in locations QD, QC, QB, and QA during an end-of-record routine. Assume that EOL (end-of-line) is the tape representation for the end-of-record character and that the record to be punched consists of A, B, C, D, E, F, and end-of-record character.

The main program routine is in effect until an end-of-record character is detected. At the beginning of step 3 (Figure F-42), an EOR character is detected and the EOL constant (2, blank, blank) is moved into location QD. During punch cycle 3 (Figure F-42), the EOL code is set up in the punch magnets, the character F is punched, and the character D is read. Because EOL is the last character in the record to be punched, nothing is set up in the punch magnets during punch cycle 4. Because EOL was set up during the previous cycle, it is punched in punch cycle 4. The tape is always advanced after punching takes place, which makes a read operation necessary during punch cycle-4. Without the extra read operation, character E would not have been read and checked. After EOL is punched and an escapement moves the tape, the contents of the Q locations are shifted to the right so that locations QD, QC, and QB contain EOL codes, and location QA contains the code for character F. At
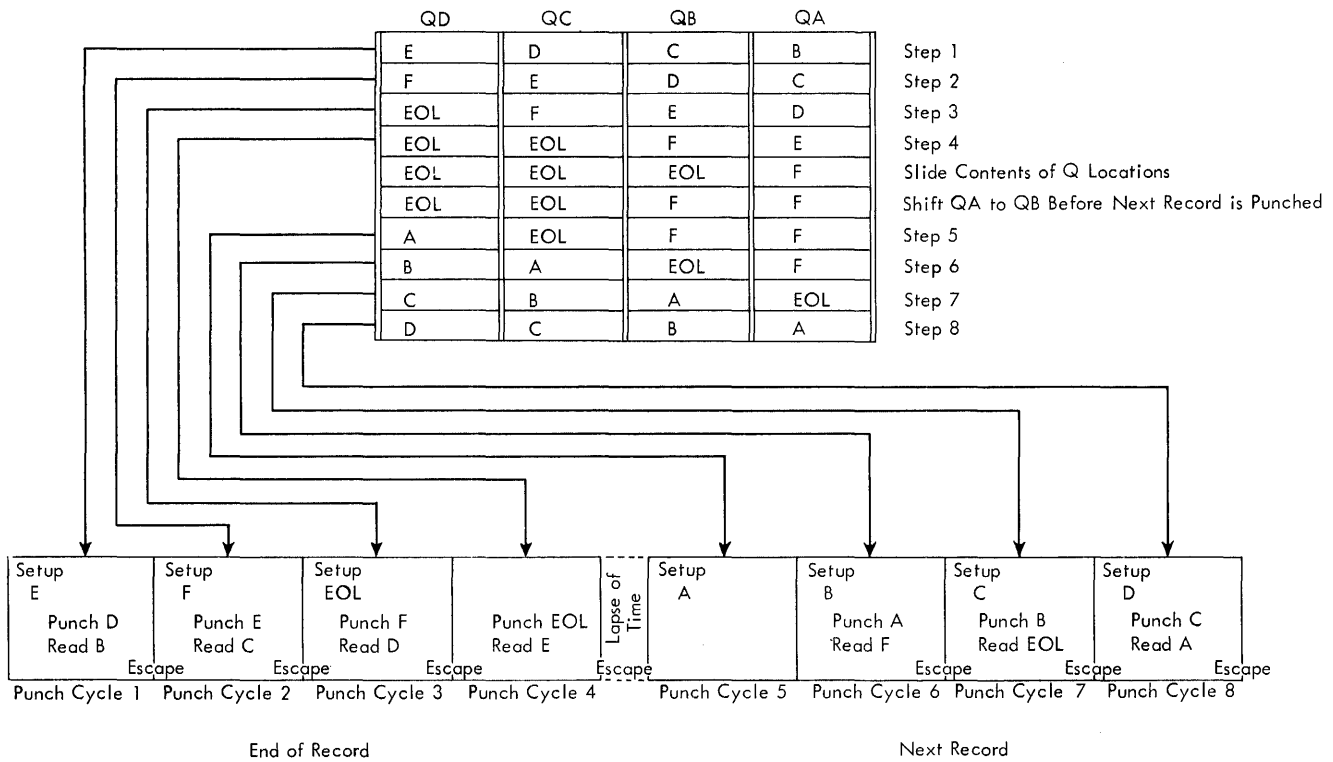
	QD	QC	QB	QA	
	E	D	C	B	Step 1
	F	E	D	C	Step 2
	EOL	F	E	D	Step 3
	EOL	EOL	F	E	Step 4
	EOL	EOL	EOL	F	Slide Contents of Q Locations
	EOL	EOL	F	F	Shift QA to QB Before Next Record is Punched
	A	EOL	F	F	Step 5
	B	A	EOL	F	Step 6
	C	B	A	EOL	Step 7
	D	C	B	A	Step 8

| Setup E / Punch D / Read B | Setup F / Punch E / Read C | Setup EOL / Punch F / Read D | Punch EOL / Read E | Lapse of Time | Setup A | Setup B / Punch A / Read F | Setup C / Punch B / Read EOL | Setup D / Punch C / Read A |

Escape Escape Escape Escape Escape Escape Escape

Punch Cycle 1 Punch Cycle 2 Punch Cycle 3 Punch Cycle 4 Punch Cycle 5 Punch Cycle 6 Punch Cycle 7 Punch Cycle 8

End of Record   Next Record

Figure F-42. End-of-Record Punch and Read Routine

the completion of cycle 4, all characters in the record have been punched, including EOL. However, the character F and EOL remain to be read and checked. At this time, a new record is ready to be punched. The contents of QA is shifted into location QB before the first character in the next record is processed.

The first character of the next record (assume A) is moved into location QD. During punch cycle 5, character A is set up in the punch magnets. A read operation does not take place during cycle 5 because the character F is read and checked in the next punch cycle. During punch cycle 6, character B is set up, character A is punched, and character F is read and checked. During punch cycle 7, character C is set up, character B is punched, and EOL is read and checked. The main program routine continues until the next end-of-record character is detected in the record.

7. Automatic Error Correction

The system program branches to the automatic error-correction-program routine when an unequal compare condition is detected following a read-check instruction. When an error is detected, the tape is backspaced until the character in error is under the punch station. The tape is then moved in a forward direction and four delete codes (all tracks punched except EOL) are punched. The constant 177 is the bit pattern for punch-

ing all tracks in the tape, except EOL. The delete codes that are punched are also read back and checked. A valid EOL may be encountered when the delete codes are checked (a hole punched in all tracks). This condition is recognized by the program routine, but no action is taken. When the tape is read later as an input to another system, this condition (even parity) signals an error. However, control-panel wiring or a program subroutine can be used to circumvent this condition. If an unequal compare (except EOL) is detected when the delete codes are checked, the error is corrected by branching to the normal error-correction routine.

After the delete codes have been punched, the characters that were deleted are now repunched, These characters are still in locations QD, QC, QB, and QA. These characters are punched starting with QA through QD.

8. End-of-Reel Routine

An end-of-reel test is made after every end-of-record program routine has been completed. After EOL has been punched (EOR), an appropriate end-of-file character (if required) can be punched in the tape. The last character in the record, EOL, and the end-of-file character (if required), are read back and checked before the end-of-reel program routine is completed.
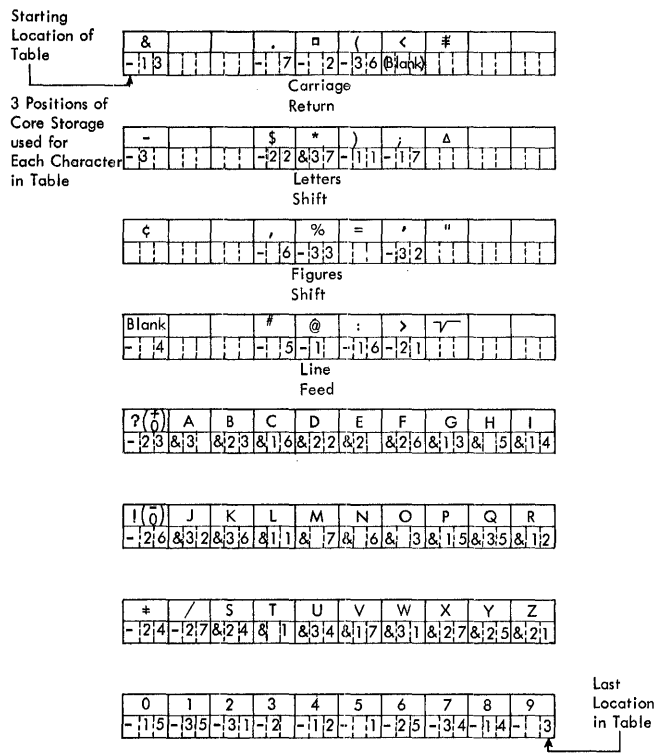
Figure F-43. Five-Track Code Table

After a new reel of tape has been installed, pressing the feed switch on the 1012 causes delete codes to be punched in the leader portion of the tape. Pressing the start key on the 1012 places the 1012 in a ready status. The last two delete codes punched in the leader portion of the tape are read and checked when the first record is punched in the new reel of tape.

9. Five-Track Tape Operation

Basically, 5-track tape operation is similar to 8-track tape operation, with a limited number of exceptions.

Only 58 characters are punched when using 5-track tape, which necessitates the use of a different code table (Figure F-43). To properly identify a character punched in the tape, a figures-shift or letters-shift code must precede the punched character, if a mode change takes place.

Development of the stored-table address (see Figure F-38) remains the same as for 8-track operation (described in *Decode to a Table Address* section). The code number assigned to each character in the stored table differs from the code assigned to each character in the 8-track code table.

Figure F-43 illustrates the code assigned to each of the 58 characters in the stored table. Only two positions of each 3-position field are used for the bit pattern of the code number. The high-order position of the 3-position field contains a dash (B-bit) or ampersand (A- and B-bits). The dash signifies a figures-shift character, and the ampersand signifies a letters-shift character. After the table address has been developed for a character to be punched, the contents of the 3-position table location are moved into location QD. The high-order position of QD is analyzed to determine whether the character is a figures-shift, or letters-shift character. After the mode of the character has been established, it is compared with the mode the 1012 is presently in. If a figures-shift character is to be punched and the 1012 is in a letters-shift mode, a change in mode is required. If a letters-shift character is to be punched and the 1012 is presently in figures-shift, a change in mode is required.

If a change in mode is required, one of two constants is moved into location QD. The constant is 33 if a change to figures-shift is required, or 37 if a change to letters-shift is required. These constants, when decoded (Figure F-44), punch either a figures-shift or letters-shift code in the tape. The character to be
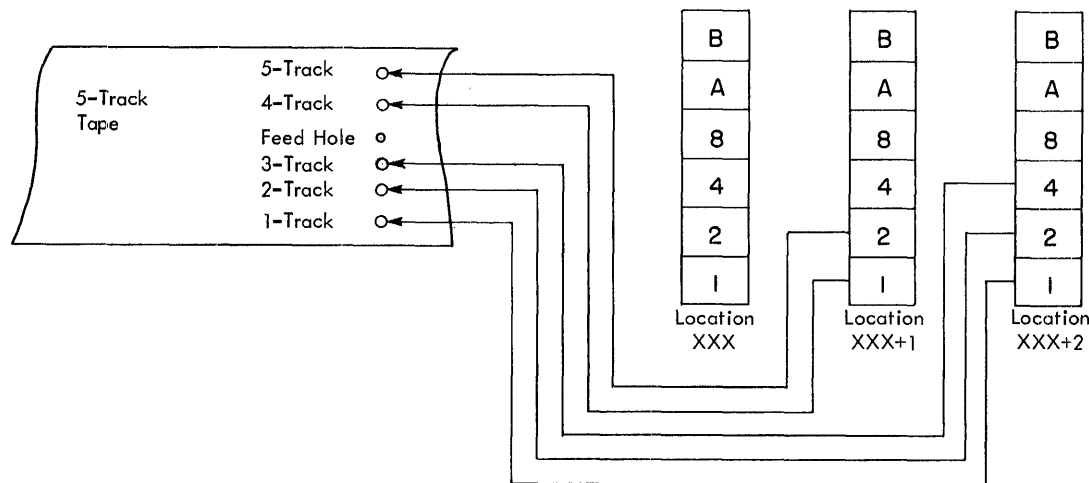

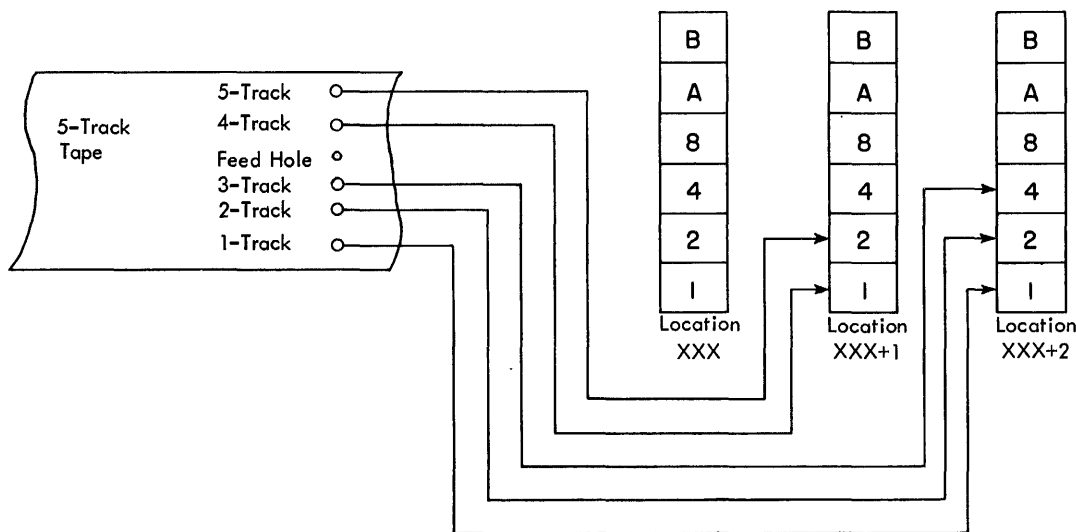Figure F-44. Five-Track Bit Pattern to Tape Punching Translation

Figure F-45. Five-Track Tape Punching to Bit Pattern Translation

punched is then moved back into location QD and punched. If a mode change is not required, punching takes place from QD without moving the constants. When a mode change is executed, it is retained to identify what mode the 1012 is presently in.

When a READ-CHECK instruction is executed, the high-order position of location QA is not involved in the comparison. However, if an error is detected, the bits in the high-order position of QA indicate the shift of the character when it is repunched. Figure F-45 illustrates the 5-track tape punching to bit-pattern translation.

Special Feature: IBM 1012 Read Feature

The addition of the read feature to the IBM 1012 allows the 1012 to operate as a reader (input to a using system) or as a punch (output from a using system). The mode of operation is controlled by a READ/PUNCH switch that is installed on the 1012 in a blank position next to the rewind switch.

When the READ/PUNCH switch is set to READ, the IBM 1012 Tape Punch is modified as follows:

1. All punching is inhibited.

2. The reel sense arm's function is inhibited. The trailing end of the tape is, therefore, allowed to feed from the supply reel without causing the machine to stop.

3. The supply arm's lower-limit switch is bypassed. The trailing end of the tape is therefore, allowed to pass the reading station without causing the machine to stop.

4. The feed switch, when pressed, causes the tape to advance without being punched with feed codes.

Program Instructions

The existing 1012 I/O instructions are used for the read-tape operations. For example, with the READ/PUNCH switch set to READ, a punch-blank instruction followed by a read instruction causes the information at the read station to be transmitted to the processing unit and the tape to be moved one character position. A punch-blank instruction followed by a read instruction is required for each character to be read.

The same considerations for starting and stopping the tape for punching, apply for reading as well. The read operation, for timing purposes, is the same as readback check.

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