Operation The paper stacking trolley is fitted with a Paper Low microswitch. When the last sheet of paper leaves the trolley then indicator 47 is set. It will remain set until a new supply of paper is inserted.

Notes This indicator should be tested regularly throughout a print program e.g. after each document is printed.

Flowchart for a Paper Throw Program 3.4.9

A sample flowchart of a spacing routine is shown in Figure 25. Two examples are given overleaf of the selection of the appropriate sprag when it is known which sprag is engaged and how many spaces are required.

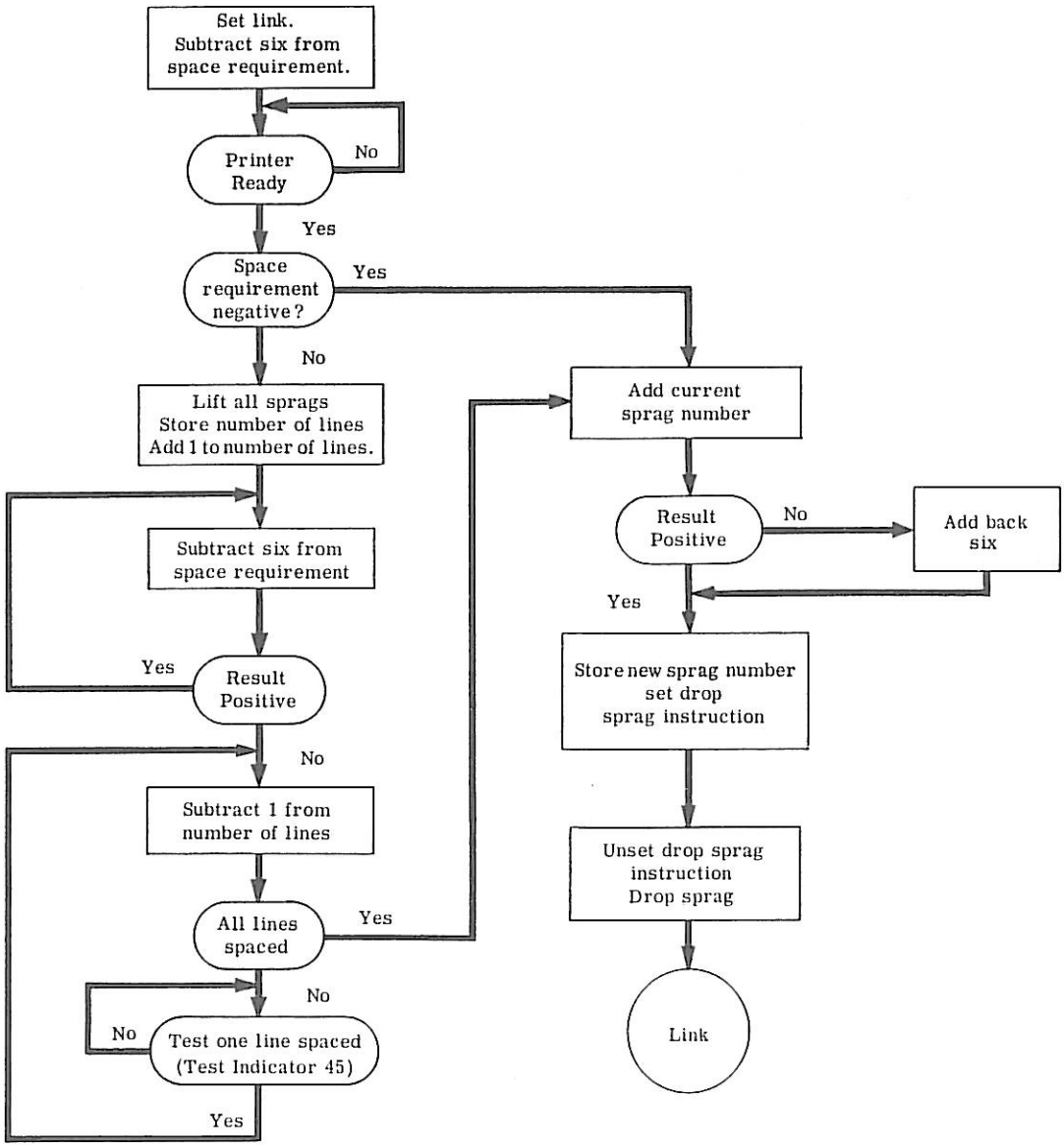


Figure 25: SPACING ROUTINE FOR PRINTER

Example 1

Sprag 5 engaged; space 3 lines

Number of spaces required = 3

Subtract 6 (constant) = 3 - 6 = - 3

Result negative: add the sprag engaged number (5) = - 3 + 5 = + 2 (Sprag No.)

Result positive: drop sprag number 2 immediately.

Example 2

Sprag 3 engaged; throw 7 lines

Number of spaces required = 7

Subtract 6 (constant) = 7 - 6 = + 1

Result positive: lift all sprags;

Subtract 6 again = 1 - 6 = - 5

Result negative: count lines spaced.

All lines spaced: add the sprag engaged number (3) = - 5 + 3 = - 2.

Result negative : add back 6 (constant) = - 2 + 6 = + 4: drop sprag number 4.

The line printer may be one of the following types:

(a) 120 print positions operating at a maximum speed of 600 lines a minute, or

(b) 120 print positions operating at a maximum speed of 300 lines a minute, or

(c) 80 print positions operating at a maximum speed of 300 lines a minute.

The following table lists the timings associated with the 600 lines a minute and 300 lines a minute printers respectively. The timings are not affected by the number of print positions.

	600 lines a minute Minimum Timings	300 lines a minute Minimum Timings
Interval between successive character times	1.2 ms	2.6 ms
Interval between successive line space indications at speed	6.9 ms	6.9 ms
Duration for which Indicator 45 ("Line Space Time") is set if not tested	3.1 ms	3.1 ms
Duration for which Indicator 43 ("Print Index Point Time") is set if not tested	550 to 800 μs	1150 to 1700 μs
Time to space first line (i.e. from time instruction given until the paper comes to rest)	32 ms	32 ms
Time each additional line will take after first line space	7.56 ms	7.56 ms

THE PAPER-TAPE READER 3.5

One or two paper-tape readers may be linked to the computer as additional units. If two paper-tape readers are specified they are incorporated in one free-standing unit. The paper-tape reader is capable of accepting 5-, 6-, 7- or 8-track tape, a Track-Select switch being set for the appropriate number of tracks on the tape to be read. Tape reading is achieved by means of photo-electric cells.

Interpretation within the Computer 3.5.1

It is recommended that British Standards Institute tape codes should be used although it is possible to use most standard paper-tape codes. British Standards Institute recommended tape codes are given in Part 6 of this manual.

A paper-tape character consists of a zone and numeric component; these components are represented on the tape tracks as shown in Figure 26. There are four numeric components (N1, N2, N4 and N8) on 5-, 6-, 7- and 8-track tape represented by tape tracks 1, 2, 3 and 4 respectively: 5-track tape has 1 zone (Z1) represented by track 5; 6-track tape has 2 zones (Z1 and Z2) represented by tracks 5 and 6. Both 7- and 8-track tape have zones represented by tracks 6 and 7 and 6, 7 and 8 respectively; track 5 is employed for parity purposes and is not read in the interpretation of a character.

When a valid character is read, it is entered into an 8-bit buffer store so that the zone and numeric components are each stored in 4 bits of the buffer. The contents of this buffer store are transferred to Register B as two digits, one representing the zone and one representing the numeric. The zone component will be read into position 1 of Register B and the numeric component will be read into position 7 of Register B.

The previous contents of positions 1 to 5 and 7 to 11 of Register B will be shifted one position to 2 to 6 and 8 to 12 respectively. The previous contents of positions 6 and 12 of Register B will be lost. In position 1 of Register B, those bits which are not employed in storing the zone components are automatically zeroized. Thus, when 8-track tape is being read, the 8-bit of position 1 is zeroized automatically as zone 7 is the maximum value possible in position 1, and when 6- or 7-track tape is being used, the 4 and 8-bits are zeroized as zone 3 is the maximum value possible in position 1. Similarly, 5-track tape has only one zone so the 2, 4 and 8 bits are zeroized automatically.

Valid Tape Characters

On 5-track paper tape all codes including those with parity errors will be valid characters with the exception of blank tape. Blank tape is that tape which has a row punched with a feed hole only, i.e. no data holes or parity hole punched.

On 6-, 7- and 8-track paper tape neither the blank tape code nor the erase (all data holes punched) code are recognized as valid characters.

No. of Tracks	Track No.	Computer Interpretation
5	1	N1
	2	N2
	3	N4
	4	N8
	5	Z1
6	1	N1
	2	N2
	3	N4
	4	N8
	5	Z1
	6	Z2
7	1	N1
	2	N2
	3	N4
	4	N8
	5	Parity
	6	Z1
	7	Z2
8	1	N1
	2	N2
	3	N4
	4	N8
	5	Parity
	6	Z1
	7	Z2
	8	Z4

(N = Numeric Z = Zone)

Figure 26: COMPUTER INTERPRETATION OF PAPER-TAPE CODE PUNCHINGS

Invalid characters are ignored and are not read into the computer. The detection of an invalid character does not stop the computer but the tape is fed until a valid character is detected.

Parity Checking 3.5.2

As stated above, a parity check is made only when 7- or 8-track tape is being read and tape track 5 is allocated to punching a parity bit.

When 7-track tape is read, odd parity will be checked automatically when each character is read and the parity bit will not be read into the computer.

When 8-track tape is being read, even parity will be checked when each character is read and the parity bit will not be read into the computer.

If a parity error is detected (i.e. even parity on 7-track tape or odd parity on 8-track tape) an indicator (61) will be set within the computer; this indicator may be tested by program. The indicator will be permanently unset when 5- or 6-track tape is being read, i.e. no parity check is being made.

Tape Read Instructions 3.5.3

Instruction 380050

Effect This instruction will cause a character to be read and the tape reader will then step to the next valid tape code.

Operation When a 380050 instruction is given, a valid character is read into the buffer store. The previous contents of the buffer (zone and numeric components of the last character read) will be transferred to positions 1 and 7 of Register B.

Notes When setting up the selected tape reader it is necessary to give two extra 380050 instructions. The first 380050 instruction will cause the first valid tape character to be positioned beneath the reading photo-electric cells. The second 380050 instruction will cause the character to be read into the reading buffer. The next 380050 instruction (given in the reading program) will cause the contents of the buffer to be transferred to Register B. It will be remembered that only positions 1 and 7 of Register B are affected when reading in data from the buffer store, thus the remaining ten positions of the register may contain rubbish.

Instructions 380051 and 380052

Effect Instruction 380051 selects paper-tape reader 1 for operation. Instruction 380052 selects paper-tape reader 2 for operation.

Operation A 380051 or 380052 instruction will select the appropriate paper-tape reader for operation and a subsequent 380050 instruction will cause the reading of tape to commence on the selected reader.

Indicator 60 Tape Reader Ready

Purpose This indicator is set when the selected paper-tape reader is ready to read a valid character.

Operation A 380051 or 380052 instruction will cause this indicator to be associated with paper -tape reader 1 or 2 respectively. Indicator 60 will be set automatically when the following three conditions are satisfied:

(a) The tape reader motor is running.

(b) The photo-electric cell lamp is on.

(c) A valid character is positioned beneath the photo-electric cell unit.

Indicator 60 will be unset if any of the above three conditions is not satisfied.

Notes Indicator 60 should be tested during a paper-tape read-in program before each tape code is read thus:

I	D	F	A	R		NARRATIVE
13	4	60	0014	B		Selected reader ready
	4	00	0013	B		
14		57	0012			Clear Register B
		38	0050			Read 1 tape character

Indicator 61 Parity Error

Purpose This indicator is set when a parity error is detected while reading 7- or 8-track tape.

Operation The execution of instruction 380051 or 380052 will cause this indicator to be associated with paper-tape reader 1 or 2 respectively.

Indicator 61 will be set when:

(a) the number of holes (data plus parity hole) punched in one row of a valid character in 7-track tape is found to be even, or

(b) the number of holes (data plus parity hole) punched in one row of a valid character in 8-track tape is found to be odd.

Indicator 61 is unset when tested by program.

Notes Indicator 61 should be tested during the read-in program and a section of the program should be devoted to parity errors. When setting up the selected tape reader it is advisable that indicator 61 should be unset (by testing) before the first tape character is read thus:

I	D	F	A	R		NARRATIVE
2		38	0050			Move to 1st Valid Tape Character
		38	0050			Read 1st Valid Tape Character
3	4	61	0004	B		Unset Parity Error Indicator

When 5- or 6-track tape is being read, no parity check is made and therefore indicator 61 is permanently unset.

Tape Read Programs 3.5.5

A flowchart for reading one character is shown in Figure 27. It is however strongly recommended that the standard I.C.T. subroutines for the paper-tape reader should be used. These subroutines, which enable a block of several characters to be read and stored, facilitate the following:

(a) Reading each valid paper-tape character and storing it in the correct position within the selected output word in I.A.S.

(b) An exit to the main program when:
   (i) the appropriate number of characters have been read and stored, and/or
   (ii) an end of data block code, specified by the programmer, is read from the tape.

A section of the subroutine effects the selection of the required paper-tape reader and a section for parity errors is also included.

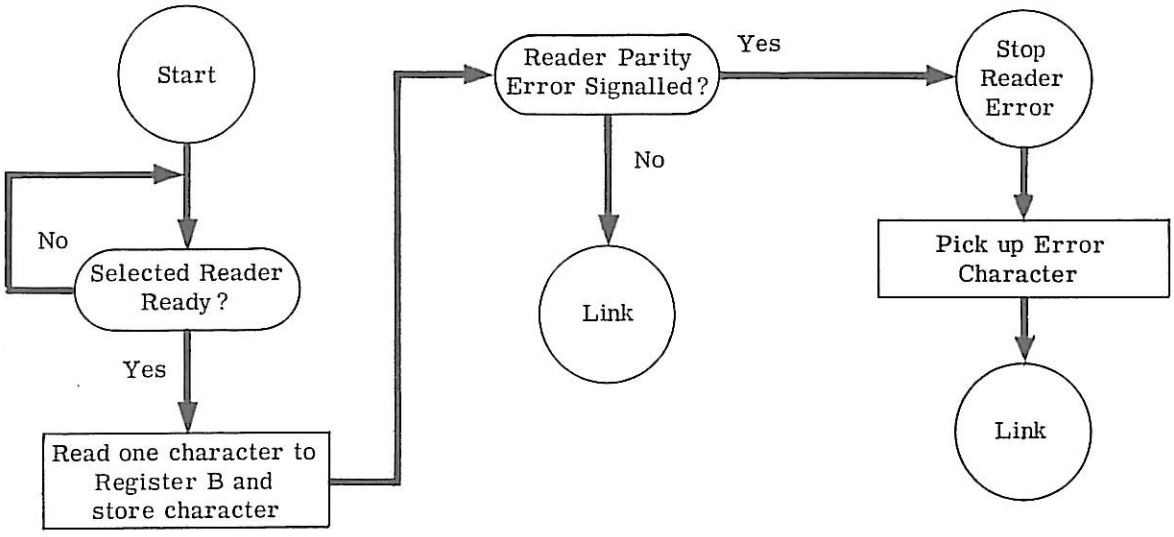


Figure 27: FLOWCHART FOR READING PAPER TAPE

Timings 3.5.6

The only timing relevant to the programmer is that tape is read at a maximum speed of 1000 characters a second; thus the average time required to read one tape character is 1 millisecond.

THE PAPER-TAPE PUNCH 3.6

One paper-tape punch may be fitted as an additional unit to the computer. The punch is available for 5-, 6-, 7- or 8-track tape and the number of tracks to be punched has to be specified when ordering.

Tape is punched at a punching station fitted with one punch knife for each tape track. The punched tape is read for checking purposes by photo-electric cells at a reading station located three characters beyond the punching station.

Output from the Computer 3.6.1

The zone and numeric components of the character to be punched must be located in positions 1 and 7 of Register B. When a punch instruction is given, the zone and numeric components are transferred to an 8-bit buffer and punched. The tape will be punched with the zone and numeric components as shown in Figure 28. Those bits of position 1 in Register B for which there is no corresponding paper-tape track must be zero. When a character is read from Register B to the buffer, the contents of Register B will be unchanged, i.e. Register B will not be shifted nor will its contents be lost.

	Zone Component Position 1 of Register B		Numeric Component Position 7 of Register B	
	Bit Number	Track Number	Bit Number	Track Number
5-track Tape	1	5	1	1
			2	2
			4	3
			8	4
6-track Tape	1	5	1	1
	2	6	2	2
			4	3
			8	4
7-track Tape	1	6	1	1
	2	7	2	2
			4	3
			8	4
8-track Tape	1	6	1	1
	2	7	2	2
	4	8	4	3
			8	4

Figure 28: COMPUTER INTERPRETATION OF OUTPUT TO PAPER TAPE

Checking Facilities 3.6.2

In 7- and 8-track paper tape, track 5 is allocated for parity purposes. When a character is punched, a parity bit is automatically generated to maintain odd parity in 7-track tape or even parity in 8-track tape. The parity bit is punched in track 5. The punched-tape codes are then read at the check-reading station and a parity check is made on the tape codes. If the parity check fails an indicator (67) is set within the computer.

No parity check is made on either 5- or 6-track tape and the Parity Check indicator remains unset.

Tape Punch Instructions 3.6.3

Instruction 380076

Effect This instruction will cause one character to be punched and one character to be read for parity checking.

Operation A 380076 instruction will cause one character (zone and numeric components in positions 1 and 7 of Register B) to be read into the 8-bit tape-punch buffer and thence to be punched.

A 380076 instruction will also cause one character to be read at the reading station for parity checking.

Notes A 380076 instruction must only be given when indicator 66 (Tape Punch Ready) has been tested and the punch found to be ready.

Tape Punch Indicators 3.6.4

Indicator 65 Tape Supply Low

Purpose This indicator is set when there is less than twenty feet of tape on the feed spool.

Operation Indicator 65 will be set as described above and unset automatically when there is more than twenty feet of tape on the feed spool. This indicator may be tested by program.

Notes Indicator 65 must be tested at convenient places in the program, e.g. at the beginning of every data block to be punched.

Indicator 66 Tape Punch Ready

Purpose Indicator 66 will be set automatically when the tape punch is ready to punch one character.

Operation Indicator 66 will be set when the following conditions are satisfied:

(a) The power supply to the tape punch is on.

(b) The 8-bit punch buffer is clear to accept a character from Register B.

The indicator will be unset if either of the above two conditions is not satisfied.

Notes Indicator 66 must be tested and found to be set before a 380076 instruction is given.

Indicator 67 Tape Punch Error

Purpose This indicator will be set when the parity check at the punch reading station fails.

Operation Indicator 67 will be set automatically if the parity check fails thus:

(a) The number of code holes read (data plus parity holes) in one row of 7-track tape is found to be even (i.e. in error).

(b) The number of code holes read (data plus parity holes) in one row of 8-track tape is found to be odd (i.e. in error).

Indicator 67 will be unset when tested by program.

Notes Indicator 67 should be tested after each punch instruction when 7- or 8-track tape is being punched. When indicator 67 is tested and found to be set (i.e. a parity error has occurred), the character which is in error is not the last character punched but a previously punched character because the reading station is located three tape codes beyond the punching station.

On the initial paper-tape loading condition (e.g. a new spool of tape) blank tape (tape punched with feed holes only) and perhaps spurious punching will be read at the reading station before a valid punched code is read. It is necessary therefore that parity error conditions which occur during tape run-in are ignored. Therefore indicator 67 must be tested before a character is punched to ensure that it is unset.

If blank tape is produced during a 7-track paper-tape punching program, it is necessary to suppress the punching of the parity bit which would normally be punched to give the correct odd parity condition. An additional bit must therefore be read into the punch buffer (via Register B) to simulate an odd parity condition and this additional bit must be positioned so that it will not be punched into the tape. For example,when blank tape is to be produced, the buffer store could hold a zone component of 4 and a numeric component of 0; thus odd parity would be detected and no parity hole would be punched. As the 4-bit of the zone component is not punched into 7-track tape, both zone and numeric are interpreted as zero and no code is punched.

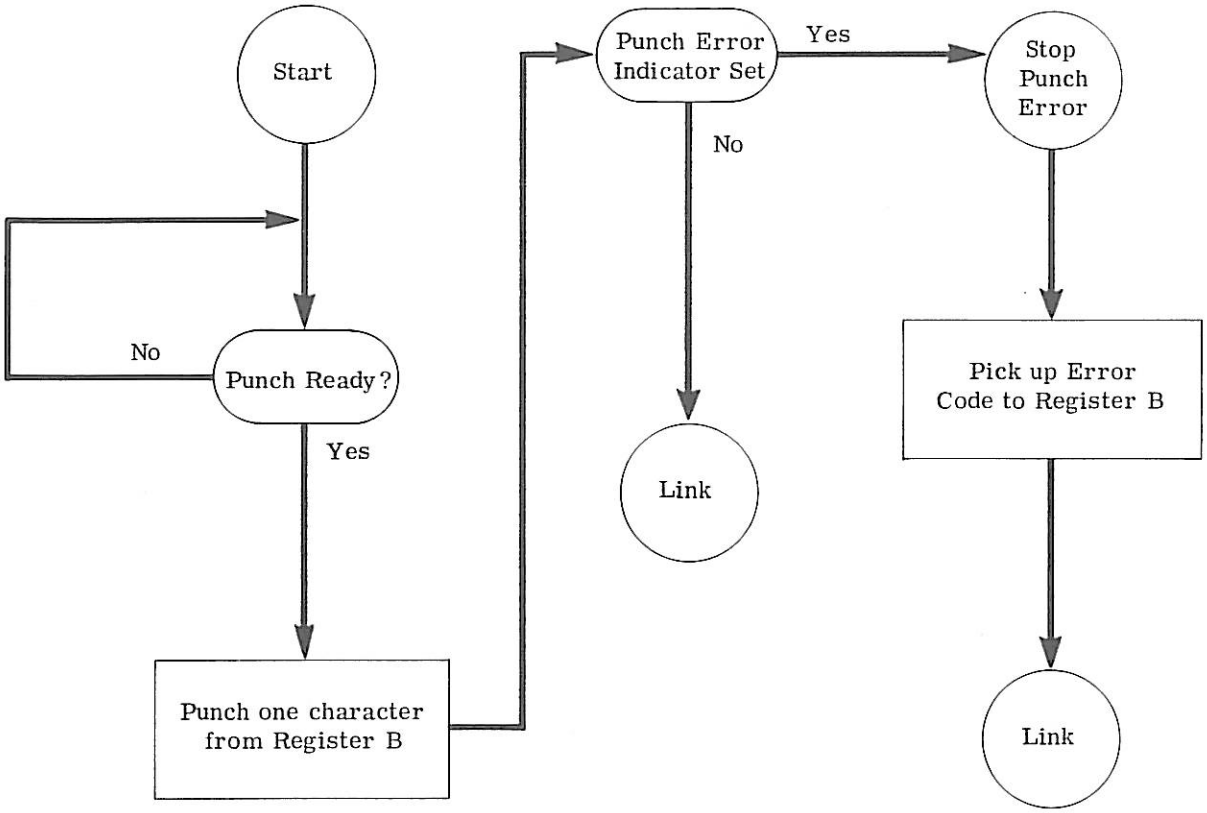


Figure 29: FLOWCHART FOR PUNCHING PAPER TAPE

Tape Punch Programs 3.6.5

A flowchart to punch one character is shown in Figure 29. It is strongly recommended that the standard I.C.T. subroutines for the paper-tape punch should be used. These routines allow for punching a block of several characters and provide the following facilities:

(a) Transferring the data to be punched from the appropriate successive locations in I.A.S. to Register B, positioning the individual zone and numeric component within positions 1 and 7 of this Register and punching the data.

(b) Provision for an exit to the main program when:
  (i) an end of data block code, specified by the programmer, is detected, and/or
  (ii) the appropriate number of characters have been punched.

Timings 3.6.6

The only timing relevant to the programmer is that tape is punched at a maximum speed of 300 characters a second; thus the average time required to punch one tape character is 3.33 milliseconds.

One interrogating typewriter may be fitted to a 1300-series machine as an additional unit. The typewriter can operate in a type-in or type-out mode and the selection of the mode of operation is by program. Thus the typewriter may be used for keying in data while in the type-in mode and printing out data while in the type-out mode.

The typewriter consists basically of a keyboard and print unit. There is no mechanical link between the keyboard and the print unit except when the typewriter is being used in the type-in mode. Thus except for engineering maintenance the typewriter cannot be used off-line from the computer.

Keyboard

The layout of the typewriter keyboard is shown in Figure 30. It can be seen that a repertoire of 74 characters is available and this repertoire comprises 16 numeric characters 0 to 15, 26 alphabetic characters A to Z and 32 symbols; five function bars and five function keys are also fitted on the keyboard.

When the typewriter is in the type-in mode and the computer program is ready to accept data typed in, the Type indicator lamp will glow and the operator may commence typing. When the typewriter is in the type-out mode, the keyboard is locked and all keys are inoperative except for the Request Type-in key (labelled Type In) and the shift keys.

When a character key or function key is pressed (i.e. all function keys except the type-in key and shift keys), a code is automatically generated and a subsequent Type instruction enters this code into Register B.

Print Unit

The typewriter print unit operates under manual control during the type-in mode and under computer control during the type-out mode. It is possible to print out the same characters as arranged on the typewriter keyboard, i.e. the 16 numeric characters 0 to 15, the 26 alphabetic characters A to Z and the 32 symbols.

There are 44 type bars but the full repertoire of 74 characters and symbols is available as each type bar has an upper and lower shift component. (N.B. numeric characters 0 to 11 and the symbols Full Stop and Comma are arranged in both upper and lower case positions.)

A dual-coloured inked ribbon, red and black, is fitted between the print hammers and the stationery. When the typewriter is in the type-in mode the red ribbon is automatically set for printing and when the typewriter is in the type-out mode the black ribbon is automatically positioned for printing.

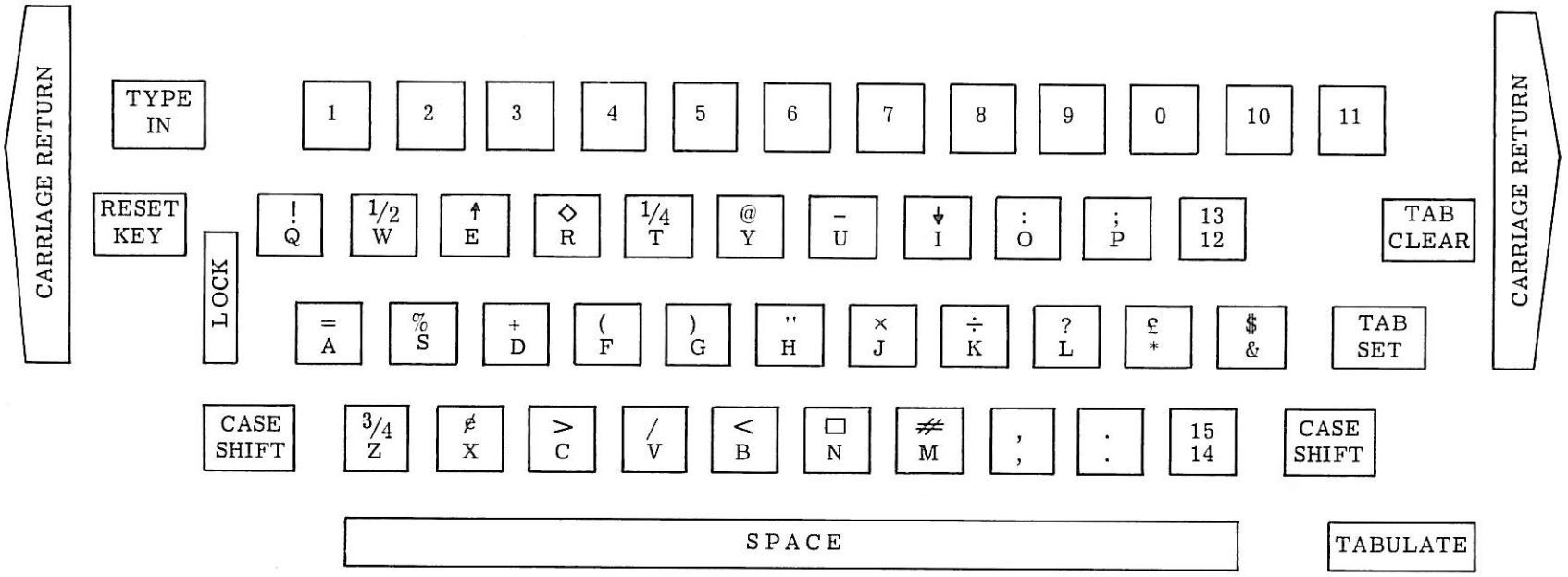


Figure 30: INTERROGATING TYPEWRITER: KEYBOARD LAYOUT

As in a normal typewriter, tabs are fitted and the tabs may be set to the required positions or cleared either manually or by computer program.

In the type-out mode, the typewriter carriage operates under computer control, i.e. it is operated by a space, line feed, tabulate or carriage return code from the computer.

A continuous stationery feeding device is fitted to the typewriter print unit. The maximum length of a continuous roll of stationery (single part) is 250 feet. The device is fitted with a Paper Present micro switch which will anticipate the running out of paper by approximately eight inches.

Representation within the Computer 3.7.1

All codes which are entered into the computer from the typewriter or transferred from the computer to the typewriter consist of a zone and numeric component. The zone and numeric components of each typewriter code for the 74 characters and symbols available are shown in Figure 31. The components of each code are represented as two digits. When a typewriter key has been pressed, a subsequent type instruction causes the zone and numeric components of the character concerned to be entered into positions 1 and 7 of Register B respectively. Similarly in the type-out mode, the zone and numeric components of a character to be printed must be positioned in positions 1 and 7 of Register B. When a type instruction is given, the zone and numeric components in Register B are transferred to a 7-bit buffer store.

It will be noted that the typewriter code is compatible with the computer code used in the punching of cards and printing on the line printer, the 10 and 11 representation being as in the card code. Zones 0, 6 and 7 are not of course included in the standard codes for the card punch and line printer.

It can be seen in Figure 31 that 'Do Nothing' is represented by zone 0 (as are all control codes) and numeric 1; if unallocated combinations of components are used for output for the typewriter, they will *not* produce 'Do Nothing' but a character may be erroneously typed for this code.

	ZONE							
Numeric	0	1	2	3	4	5	6	7
0	Space	0			*	£	,	¢
1	Do Nothing	1	A	J	&	$	=	×
2	Tabulate	2	B	K	S	%	<	÷
3	Set Tab	3	C	L	T	¼	>	?
4	Clear Tab	4	D	M	U	-	+	#
5	Carr. Return, L/F.	5	E	N	V	/	↑	□
6		6	F	O	W	½	(	:
7		7	G	P	X	.	)	;
8		8	H	Q	Y	@	"	!
9		9	I	R	Z	¾	↓	◊
10		10						
14		14						
15		15						

Figure 31: REPRESENTATION OF TYPEWRITER CODES IN COMPUTER

Instruction 380070

Effect A 380070 instruction will cause the typewriter to be set to the type-in mode.

Operation A 380070 instruction will cause the following:

(a) The typewriter keyboard will become released (if it had been previously locked by a 380071 instruction; see below).

(b) The Type indicator lamp on the typewriter will glow.

(c) The inked ribbon will be positioned so that data will be printed in red.

Notes When the typewriter is in the type-out mode and while the typewriter subroutine is not required, the typewriter keyboard will be locked by a 380071 instruction. Thus a safeguard is provided against the accidental operation of the keyboard.

As previously described, the Type indicator lamp will glow thus showing the operator that the typewriter is in the type-in mode. This provides a further safeguard to ensure that the type-in subroutine is in I.A.S. before data are typed in. A 380070 instruction must only be given after indicator 51 has been tested and found to be set.

Instruction 380071

Effect A 380071 instruction will cause the typewriter to be set to the type-out mode.

Operation A 380071 instruction will cause the following:

(a) The typewriter keyboard will be locked.

(b) The inked ribbon on the print unit will be positioned so that data are printed in black.

(c) The Type indicator lamp will be extinguished.

Notes The operation of any key on the keyboard other than the Request Type-in key will be ignored. This provides a safeguard against the accidental operation of the keyboard during the type-out mode.

It is advised that the keyboard should be locked (by a 380071 instruction) and released only when the keyboard is about to be operated; i.e. the keyboard should be locked when a type-out subroutine link is stored.

I	D	F	A	R
0	---	41	0000	01
		38	0071	–

A 380071 instruction may be given at any time, but it will only become effective when any operation in progress has been completed.

Instruction 380072

Effect When the typewriter is in the type-in mode, a 380072 instruction will cause the character being typed in to be read into Register B.

When the typewriter is in the type-out mode, a 380072 instruction will cause a character to be read from Register B to the 7-bit typewriter buffer, and printed.

Operation A 380072 instruction is given after the typewriter has been set in the type-in or type -out mode, i.e. after a 380070 or 380071 instruction.

TYPE-IN MODE: A 380072 instruction will cause the zone and numeric components of the character being keyed in to be entered into positions 1 and 7 of Register B respectively. The previous contents of positions 1 to 5 and 7 to 11 of Register B will be shifted into positions 2 to 6 and 8 to 12 respectively. The previous contents of positions 6 and 12 of Register B will be lost.

A 380072 instruction will also cause the function keys to operate as shown in Figure 32.

TYPE-IN MODE: after instruction 380072 given;

Function Key	Code Entering Register B		Action
	Position 1 (Zone)	Position 7 (Numeric)	
Space	0	0	Typewriter carriage spaced one character position to the left automatically.
Carriage Return	0	5	Typewriter carriage will be shifted automatically to right until left-hand margin stop is engaged; paper is simultaneously spaced vertically the amount set by manual control on print unit.
Clear Tab.	0	4	The tabulating setting will be cleared automatically at the position of the carriage when the key is pressed.
Set Tab	0	3	The tabulating setting will be set up automatically at the position of the carriage when the key is pressed.
Tab	0	2	Typewriter carriage will be moved automatically to the left to the next Tab Stop position.
Shift Key			When an additional key is simultaneously operated, the upper shift character for that key will be transferred to Register B.
Shift Lock			Causes Shift Key to be locked so that upper shift codes are transferred to Register B for any keys operated whilst lock is applied.

Figure 32: OPERATION OF FUNCTION KEYS

TYPE-OUT MODE: after instruction 380072 given;

Function Key	Code Entering Register B		Action
	Position 1 (Zone)	Position 7 (Numeric)	
Space	0	0	Typewriter carriage spaced one character position to the left.
Carriage Return	0	5	Typewriter carriage will be shifted to right until left-hand margin stop is engaged; paper is simultaneously spaced vertically the amount set by manual control on print unit.
Clear Tab	0	4	The tabulating setting will be cleared at the position of the carriage when code typed out.
Set Tab	0	3	The tabulating setting will be set up at the position of the carriage when the code is typed out.
Tab	0	2	Typewriter carriage will move to the left to the next Tab Stop position.

Figure 33: OPERATION OF FUNCTION KEYS

TYPE-OUT MODE: A 380072 instruction will cause the zone and numeric component of a character in positions 1 and 7 of Register B to be transferred to the 7-bit typewriter buffer and printed if it is a code to be typed. The buffer may however hold a code which operates the typewriter; the codes will operate the typewriter as shown in Figure 33.

Notes A 380072 instruction must only be given after the typewriter has been set to the type-in or type-out mode and after indicator 51 (Typewriter Ready, see below) has been tested and found to be set.

Typewriter Indicators 3.7.3

Indicator 50 Paper Supply Low

Purpose Indicator 50 will be set when the supply of paper in the continuous stationery feed device is low.

Operation This indicator will be set when the Paper Present micro switch has detected the absence of paper. The micro switch will be actuated when there is less than about eight inches of paper left on the platen. Indicator 50 will be unset when a new supply of paper is inserted.

Notes Indicator 50 should be tested at a convenient point in a typewriter program.

Indicator 51 Typewriter Ready

Purpose When the typewriter is in the type-in mode, indicator 51 will be set when a code is keyed in.

When the typewriter is in the type-out mode, indicator 51 will be set when the print unit is ready for operation.

Operation

TYPE-IN MODE: When the typewriter is in this mode of operation, indicator 51 will be set when a key is pressed with the exception of the Request Type-in key and the shift keys. This indicator is unset when a 380072 instruction is given. Indicator 51 will also be unset if the power supply fails.

TYPE-OUT MODE: When the typewriter is in this mode of operation, indicator 51 will be set when the print unit is ready to accept a 380072 instruction. This indicator will be unset when a 380072 instruction is given and accepted and remains unset until the action initiated by the 380072 instruction is complete. Indicator 51 will also be unset if the power supply fails.

Notes Indicator 51 must be tested and found to be set before a 380070 or 380072 instruction is given.

Indicator 52 Request Type-in

Purpose Indicator 52 will be set when the Request Type-in key is pressed.

Operation As stated above indicator 52 will be set when the Request Type-in key on the typewriter keyboard is pressed to signal that the operator is ready to use the typewriter for input purposes. Indicator 52 is unset only when tested by program.

Notes Indicator 52 can be tested at convenient points in a program to ascertain whether the typewriter is required for input purposes.

Indicator 53 Carriage at End

Purpose Indicator 53 will be set when the typewriter carriage passes the last typeable position during its movement from left to right.

Operation When the typewriter carriage reaches the right-hand margin stop, indicator 53 will be set. This indicator is unset when the typewriter carriage leaves the left-hand margin stop.

Notes Indicator 53 can be tested between the testing of indicator 51 and finding it set and giving a 380072 instruction. If it is found to be set the only acceptable orders are 'Do Nothing' or 'Line Feed'.

A counter is usually set to a figure which is equal to the number of characters or spaces for which the typewriter carriage is to be moved and a Line Feed instruction is given when this figure is reached. Thus if indicator 53 is tested and found to be set before this figure is reached, an error has occurred.

When the length of typed data required per printed line is variable, indicator 53 can be tested between the testing of indicator 51 and a 380072 instruction being given.

Indicator 59 Typewriter Mechanical Failure

Purpose Indicator 59 is set when a type bar fails to operate after a 380072 instruction.

Operation As previously described a 380072 instruction will cause the contents of positions 1 and 7 of Register B to be read out to activate a specific type bar. Should the type bar not be activated, then indicator 59 will be set. Indicator 59 will be unset when tested by program.

Notes The programming implications (which are somewhat complex) need not concern the programmer, as the testing of indicator 59 is included, as appropriate, in the various subroutines available from the Subroutine Library.

Interrogating Typewriter Programs 3.7.4

Programs for the Interrogating Typewriter are complex and somewhat involved. It is recommended that the proven subroutines be used whenever possible. Careful study of these subroutines will enable a programmer to become conversant with the programming requirements for the typewriter.

Timings 3.7.5

The *maximum* rate of operation is ten characters a second, exclusive of line feed and tabulating times etc.; a change of shift is approximately equivalent to one character time.

THE ONE-INCH (90kc/s) AND HALF-INCH ($22\frac{1}{2}$kc/s) MAGNETIC-TAPE SYSTEMS 3.8

Magnetic-tape units can be linked to the computer and used as extra storage for program and for data words. Magnetic tape has the advantage that its storage capacity is virtually unlimited and also that reels of tape can be used for permanent storage. Unlike information recorded on the magnetic drum, information recorded on magnetic tape can be removed from the computer and preserved for use on a future run. Information cannot be written onto a tape unless the spool has a writing ring fitted onto it by the operator. This prevents the accidental overwriting of master information.

Each tape unit is capable of handling one reel of tape at a time. When the tape is in motion it passes from one tape spool past the read/write heads where information is read from or recorded on the tape, and onto another spool. From one to eight magnetic-tape units may be linked to the computer and it is possible to read from one unit and write to another unit simultaneously.

A tape control unit acts as a link between the central processor and the individual units. The tape control unit consists of a read unit and a write unit each containing a buffer store for use when reading or writing tape. Program instructions are available for controlling the tapes. Words may be transferred from magnetic tape to I.A.S. and vice versa, the transfers taking place by way of the appropriate buffer and Register A.

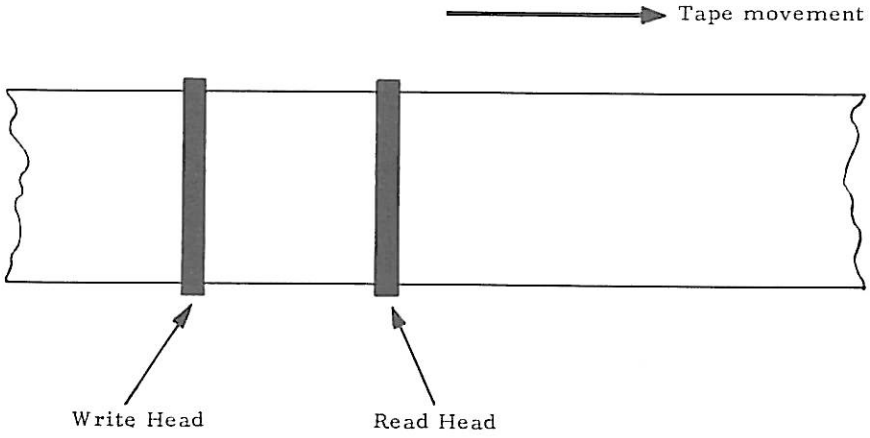


Figure 34: READ/WRITE HEADS

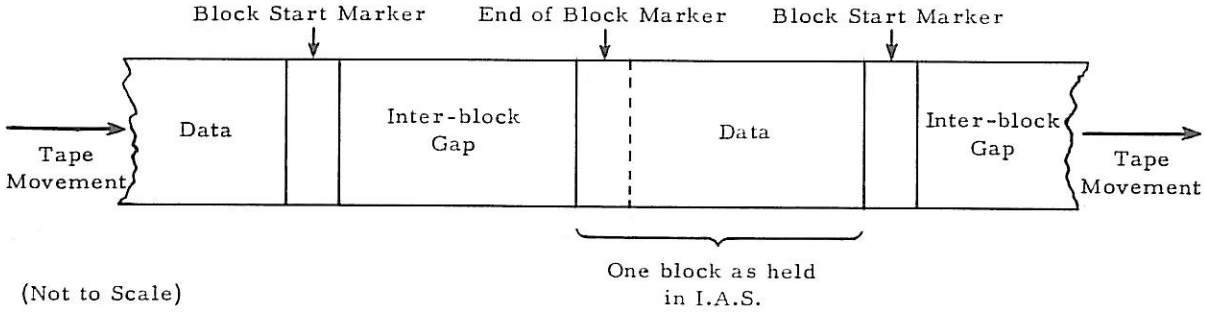
Single instructions initiate the transfer of consecutive words between tape and I.A.S., the unit of transfer being called a block. There is no restriction on the number of words in a block other than the size of I.A.S. and the remaining length of the tape. The average length of blocks should be not less than ten words.

The last word of each block is the end of block marker. This consists of a word containing data bits in all positions, i.e. a word with $\overline{15}$ in every digit position. When writing to tape the programmer must position the end of block marker in the I.A.S. word immediately following the last data word of the block. A write instruction causes writing to commence at a specified word of I.A.S. Consecutive words are written to tape up to and including the end of block marker. A read instruction causes a block to be read into I.A.S., starting at a specified word. The end of block marker is read and stored in I.A.S. as the last word of the block.

When reading or writing is taking place, the tape moves past the read/write heads at a constant speed. When a write order is obeyed, there is a slight delay before the first word of the block is written to tape. If the tape is starting from rest, then the tape is moving at full speed by the time the first word is written. When the end of block marker has been written to tape there is a delay, while the tape is still moving, during which the end of block marker is check-read. These delays during writing to tape cause gaps on the tape between consecutive blocks. These gaps are called 'inter-block gaps'. They are erased by the write head and therefore contain no information.

Immediately before the first data word of a block is written to tape, a 'block start marker' is automatically written which consists of three words of special code which are distinct from any data configuration. On subsequent reading, the block start marker indicates to the read unit that the first word of the block is about to reach the read head.

The tape layout is summarized below:



(Not to Scale)

If a write instruction is given within a short period of time, called the 'fixed delay', of the previous end of block marker being checked, then writing takes place immediately without the tape stopping. In this case the inter-block gap is termed a 'short gap'.

If a write instruction is not given within the fixed delay period then writing cannot take place until the tape has stopped and re-started, resulting in a further delay while the tape comes to a stop and then accelerates again to full speed. In this case the inter-block gap is termed a 'long gap'.

During tape reading, the fixed delay is a short period after the reading of a previous end of block marker. If a read instruction is given within the fixed delay, reading takes place without the tape stopping. If a read instruction is not given in the fixed delay period, reading cannot take place until the tape has stopped and re-started. The stopping and starting takes place in the inter -block gap, the short gap being sufficiently long for this to occur.

Just before the end of a tape there is an end of tape marker. An indicator is set if this marker is detected on reading or writing tape.

There is an early end of tape marker which can be inserted in the tape at a convenient position before the end of tape marker. Thus the program has warning that the end of tape is approaching and this allows the necessary action to be taken.

Tape Organization 3.8.2

It is recommended that certain blocks should be written on the tape for organizational purposes only. It is important that the correct tape reels should be loaded for the job to be run and for this reason the first block on tape is made an identification block. This is called the 'beginning of tape label', and should be recorded on the tape when the tape is written and checked whenever it is read. There is a recommended layout for this block and also for the last block on a particular tape and for the final block of a tape file. General routines are available for reading and writing tape and for creating and checking label blocks. These 'housekeeping' routines are described in Part 5 and full details are given in the tape manual (Magnetic-tape Housekeeping Routines and Conventions).

Checking Facilities 3.8.3

Each digit is represented on the tape by four data bits; in addition to the four data bits, additional bits are generated and held on the tape for checking purposes. The arrangement of the check bits is such that the vast majority of multiple transfer errors can be detected and single -bit transfer errors can be detected precisely. Indicators are set if any errors are detected. If a single-bit error occurs on reading tape, then the error is not only detected but automatically corrected in the computer.

When information has been written to tape, the tape passes to the read head and the information read back into the computer, where it is automatically checked for transfer errors which may have occurred during writing. If an error occurs on writing tape, the tape should be backspaced and the block re-written. If the error is persistent, then that section of tape can be cancelled and the block written on the next section. Cancelled tape is ignored when it is subsequently read. Data is transferred from I.A.S. to the tape control unit from whence it is written to tape. When the end

of block marker is detected in the tape control unit, the transfer from I.A.S. ceases and the end of block marker is written to tape. If an error should occur in the writing of the end of block marker, the check-reading system will not detect the end of the block but will read the inter-block gap; when this is detected the check-reading system causes the tape to stop.

When tape is being read, single-bit errors are detected precisely and automatically corrected. If multiple-bit errors occur then the tape should be backspaced and the block re-read. Data is read from tape to the tape control unit from whence it is transferred to I.A.S. When the end of block marker is detected in the tape control unit, tape reading ceases and the end of block marker is stored in I.A.S. If a multiple error should occur in reading the end of block marker, the end of the block will not be detected. Therefore the incorrect end of block marker will be transferred to I.A.S. as a normal data word and the inter-block gap will be read. The inter-block gap is detected on reading and this will cause the tape to stop. If a single-bit error occurs on reading the end of block marker, this is automatically corrected and the end of block is detected in the normal manner.

Tape Deck Addresses and Queueing 3.8.4

Each tape unit has an eight-point rotary switch which enables the unit to be allocated an address in the range 1 to 8. This applies to all tape units irrespective of the number of units linked to the computer. The tape deck address is specified in magnetic-tape instructions.

When the loading spool is correctly fitted, the operation of the Allocate button on the tape unit causes the address set on the eight-point switch to be seized by that unit, provided the address is not already allocated to another unit. When the tape unit has seized an address it is under computer control and is governed by instructions referring to that deck address.

If a second unit is allocated an address which has already been seized, then it queues and waits until an unload instruction is given to that address. The first unit then ceases to be under computer control and the second unit automatically seizes the address and comes under computer control.

A tape unit may be queued at any time provided that there is no other tape unit already in the queue.

Any attempt to allocate the same deck address to a third unit will have no effect.

All magnetic-tape instructions have function 39, the various instructions being distinguished by their address digits. A summary of the instructions is given in Figure 35.

Tape Write Instruction

Effect This instruction causes one block to be written from I.A.S. to magnetic tape.

Operation Starting at a specified word of I.A.S., successive words are written on tape, up to and including the end of block marker.

Notes The instruction is double-length and is made up as follows:

First half	Function digits	- 39
	First two address digits	- 00
	Third address digit	- 1
	Fourth address digit	- Tape deck address - i.e., a number in the range 1 to 8
Second half	Function digits	- 00
	Address digits	- Address of first I.A.S. word to be written to tape.

Thus the instruction

D	F	A	R
	39	0012	
	00	0035	10

causes a block to be written to deck address 2 starting at word 35 block 10.

During the execution of this instruction the write unit is occupied. Further instructions to the specified tape deck or write or cancel instructions to any tape deck cause the Tape Order Error indicator to be set.

Tape Read Instruction

Effect This instruction causes one block to be read into I.A.S. from magnetic tape.

Operation Information from tape is stored in successive words of I.A.S. up to and including the end of block marker.

Notes The instruction is double-length and is made up as follows:

First half	Functions digits	-	39
	First two address digits	-	00
	Third address digit	-	2
	Fourth address digit	-	Tape deck address - i.e., a number in the range 1 to 8
Second half	Function digits	-	00
	Address digits	-	Address of first I.A.S. word in which information is to be stored.

Thus the instruction

D	F	A	R
	39	0021	
--	---	------	---
	00	0050	37

causes a block to be read from deck address 1 and stored in I.A.S. starting at word 50 block 37.

During the execution of this instruction the read unit is occupied. Further instructions to the specified tape deck or read or backspace instructions to any tape deck cause the Tape Order Error indicator to be set.

Backspace Instruction

Effect This instruction causes the tape to be backspaced one block.

Operation The tape on a specified deck is rewound one block. When it has stopped the tape is positioned so that the block can be read, written or cancelled. The previous block is unaltered.

Notes The instruction is a single-length instruction as follows:

Function digits	-	39
First two address digits	-	00
Third address digit	-	3
Fourth address digit	-	Tape deck address

Thus the instruction

D	F	A	R
	39	0034	
--	---	------	---

causes the tape on deck address 4 to be rewound one block.

During the execution of this instruction the read unit is occupied. Further instructions to the specified tape deck or read or backspace instructions to any tape deck cause the Tape Order Error indicator to be set.

After backspacing the read unit becomes ready when the block start marker is detected. The Deck Address Ready indicator does not become set until the tape movement is stopped. Therefore the Deck Address Ready indicator should be tested after a backspace instruction rather than the Read Unit Ready indicator. When the Deck Address Ready indicator is set, the tape deck is ready to accept another instruction.

Cancel Instruction

Effect This instruction causes a block of tape to be cancelled.

Operation The tape is cancelled by writing zeros onto certain of the data and check bits, forming a pattern which is distinct from any possible data configuration. One block is cancelled, the end of the block being detected by the check-reading of the inter-block gap. The latter contains a zero in all bit positions and is therefore distinct from cancelled tape.

Cancelled tape is ignored by subsequent read or backspace instructions and no error indicators are set.

Notes The instruction is a single-length instruction as follows:

Function digits	-	39
First two address digits	-	00
Third address digit	-	4
Fourth address digit	-	Tape deck address

Thus the instruction

D	F	A	R
	39	0041	

causes a block of tape to be cancelled on tape deck address 1.

A cancel instruction should always be preceded by a backspace or rewind instruction.

During the execution of the cancel instruction the write unit is occupied. Further instructions to the specified tape deck or write or cancel instructions to any tape deck cause the Tape Order Error indicator to be set.

Rewind Instruction

Effect This instruction causes the tape on a specified deck to be rewound to the beginning of the tape.

Operation The tape on the specified deck is rewound to the beginning of the tape. A subsequent read or write instruction causes the first block on tape to be read or a new block to be written.

Notes The instruction is a single-length instruction as follows:

Function digits	-	39
First two address digits	-	00
Third address digit	-	5
Fourth address digit	-	Tape deck address

Thus the instruction

D	F	A	R
	39	0056	

causes the tape on tape deck address 6 to be rewound to the begining of the tape.

While the tape is being rewound, any further instruction to the same tape deck causes the Tape Order Error indicator to be set. Any tape instructions can be carried out on other decks.

Unload Instruction

Effect This instruction causes the tape on a specified tape deck to be rewound ready for removal from the unit.

Operation The tape on the specified deck is rewound on the loading spool and the spool made ready for removal. When a tape has been unloaded the tape deck is no longer under computer control.

Notes The instruction is a single-length instruction as follows:

Function digits	-	39
First two address digits	-	00
Third address digit	-	6
Fourth address digit	-	Tape deck address

Thus the instruction

D	F	A	R
	39	0062	

causes the tape on tape deck address 2 to be rewound on the loading spool ready for removal.

Any instruction to a deck for which the unload instruction has been accepted causes the Tape Order Error indicator to be set. Any tape instructions can be carried out on other decks. If the deck is queued by another deck, then the unload instruction causes the deck address to be seized by the second deck. The second deck is then controlled by instructions specifying that deck address.

The following notes deal with consecutive instructions to the same tape deck:

If a read instruction follows a write or cancel instruction no assumption can be made about the information which is read. This is because of certain tolerances on the lengths of the inter-block

Digit Positions	1 2	3	4	5	6	7	8	9 10 11 12	
Instruction	Function	0	0	Command	Deck Address	0	0	I.A.S.	
Write	3 9	0	0	1	1-8	0	0	I.A.S. Address	Double Length Instructions
Read	3 9	0	0	2	1-8	0	0	I.A.S. Address	
Backspace	3 9	0	0	3	1-8				Single Length Instructions (May be in either half of word)
Cancel	3 9	0	0	4	1-8				
Rewind (Back to start of spool)	3 9	0	0	5	1-8				
Unload (Tape rewound on spool)	3 9	0	0	6	1-8				

Figure 35: SUMMARY OF MAGNETIC-TAPE INSTRUCTIONS, AS HELD IN THE COMPUTER

gaps. For example, if a block is overwritten by another block of the same data length then the second block may occupy slightly more tape than the original, thus overwriting the beginning of the next block.

Errors may also arise if a write instruction follows a read instruction to the same unit. This is because of the distance between the write head and the read head. When a block has been read the tape stops with the read head positioned in the inter-block gap. Since the read head follows the write head, however, some of the tape following the inter-block gap may already have passed the write head. This means that part of a previously recorded block may be left on the tape between the block just read and the block being written, thus causing errors when the tape is subsequently read. To avoid this, a write or cancel instruction should not follow a read instruction to the same deck, unless the relevant part of the tape has been previously cancelled, or the whole tape has been previously erased (by an engineer).

A cancel instruction should normally be used only if a section of tape is found to be persistently faulty. When the errors are discovered, the relevant block has passed the read/write heads and the tape must be backspaced so that the correct section is cancelled. A cancel instruction should therefore always be preceded by a backspace instruction.

The following table summarizes the instructions which may follow each other:

First instruction	Next instruction to the same tape deck			
	Write	Read	Backspace	Cancel
Write	Yes	No	Yes	No
Read	Yes if tape previously cancelled	Yes	Yes	No
Backspace	Yes	Yes	Yes	Yes
Cancel	Yes	No	Yes	No

Indicators 81 to 88 Deck Address Ready

Purpose These indicators are used to test if a tape deck is ready for use, before giving instructions to operate it. Indicators 81 to 88 may also be used to test whether a read/write operation has been completed prior to checking it.

Operation There are eight of these indicators, one for each possible deck address. The indicators are numbered 81 to 88, and are associated with deck addresses 1 to 8 respectively.

The Deck Address Ready indicator is automatically set if:

(a) The appropriate deck address has been seized by a tape unit, and

(b) the tape deck is not busy, i.e., no tape instruction is currently being executed on that deck, and

(c) the tape deck is mechanically ready.

The indicator is unset if any of the above conditions are not satisfied, indicating that the deck is not ready to receive an instruction.

Notes For example the instruction

D	F	A	R
4	83	0012	B

tests whether deck address 3 is ready for use, if it is ready a jump is made to word 12 of the current block.

The appropriate Deck Address Ready indicator should be tested before giving a tape instruction. This prevents a tape order error due to an instruction being given to a deck which is not ready.

Indicator 89 Transport Mechanically Ready

Purpose This indicator is used in conjunction with the Deck Address Ready indicators. If one of the indicators 81 to 88 is unset, this indicator can be used to discover which of the possible conditions caused it to be unset.

Operation Indicator 89 is automatically set if:

(a) the last Deck Address Ready indicator to be tested was found to be set, or

(b) the last Deck Address Ready indicator was unset because the tape deck was busy.

The indicator is automatically unset if the last Deck Address Ready indicator was unset:

(a) because the address had not been seized by a tape deck, or

(b) because the tape deck was not mechanically ready.

Notes Indicator 89 should be tested when one of the indicators 81 to 88 is found to be unset.

If indicator 89 is set the tape deck is busy and the program must wait until the deck is not busy before giving it an instruction.

If indicator 89 is unset, operator action is required. The address has not been correctly allocated or there is a mechanical failure. Thus the instructions:

I	D	F	A	R
5	4	81	0007	B
	4	89	0005	B
6		11	2002	

will cause the following:

If deck address 1 is ready for use a jump is made to word 7 of the block which continues with the tape program.

If deck address 1 is not ready indicator 89 is tested. If indicator 89 is set the tape deck is busy, so a jump is made to re-test indicator 81 to see if the deck is no longer busy. If indicator 89 is unset the computer is stopped with 2003 displayed in CR3. This indicates to the operator that action must be taken.

If a tape deck becomes mechanically unready, indicator 89 will become unset after a delay of up to 500 milliseconds.

Indicator 80 Tape Order Error

Purpose This indicator is set if a tape instruction is given which cannot be accepted.

Operation Indicator 80 is automatically set if:

(a) A tape instruction is given to a deck address which has not been seized by a tape unit.

(b) An instruction is given to a tape deck which is not mechanically ready.

(c) An instruction is given to a tape deck which is busy.

(d) A write or cancel instruction is given to any tape deck while either instruction is already being executed.

(e) A read or backspace instruction is given to any tape deck while either instruction is already being executed.

(f) A write or cancel instruction is given to a deck which has not had a writing ring fitted to the tape spool.

The indicator is unset by program test.

Notes When indicator 80 is set the Tape Order Error light on the console is lit. If the Optional Stop switch is on, the computer stops automatically when there is a tape order error, CR3 containing the faulty instruction with 1 added to it. In the latter case starting the computer causes the Tape Order Error light to go out, but the indicator remains set until tested by program.

The setting of the indicator normally indicates that a program error has occurred. The correct testing of the other tape indicators should ensure that indicator 80 is never set.

Indicator 70 Write Unit Ready

Purpose This indicator is used to test whether the write unit is busy.

Operation Indicator 70 is set automatically when a write or cancel instruction has been completed, indicating that the write unit is ready to accept another instruction.

It is unset automatically when a write or cancel instruction is accepted.

Notes Indicator 70 should be tested before a write or cancel instruction to ensure that the write unit is ready and to prevent a possible tape order error. For example instructions:

I	D	F	A	R
10	4	70	11	B
	4	00	10	B
11		39	0013	
		00	0005	15

will cause the following:

Indicator 70 is repeatedly tested until the write unit is ready. When the write unit is ready the instruction to write to deck address 3 is obeyed.

Indicator 72 Read Unit Ready

Purpose This indicator is used to test whether the read unit is busy.

Operation Indicator 72 is set automatically when a read or backspace instruction has been completed, indicating that the read unit is ready to accept another instruction.

It is unset automatically when a read or backspace instruction is accepted.

Notes Indicator 72 should be tested before a read or backspace instruction to ensure that the read unit is ready and to prevent a possible tape order error.

Indicator 74 Any Errors

Purpose This indicator is used to detect whether any transfer errors have occurred during writing or reading tape.

Operation Indicator 74 can be associated with writing or reading. When the Write Unit Ready or Write Master indicators are tested, indicator 74 is associated with writing. When the corresponding read indicators are tested, it is associated with reading. For explanation purposes indicator 74 is referred to as W74 when writing and R74 when reading and this convention also applies to indicators 75, 76 and 77.

W74 is set if any errors are detected when information is written to tape.

W74 is automatically unset when a write or cancel instruction is accepted.

R74 is set if any error is detected on reading. R74 is set even if the error is a single-bit error which has been automatically corrected.

R74 is unset automatically when a read instruction is accepted.

Notes R74 is unaffected when a section of tape is read which has been previously cancelled. Indicator 74 is associated with writing or reading according to the last Unit Ready or Master indicator to be tested. A test of indicator 74 should therefore be immediately preceded by a test of one of the indicators 70, 71, 72 or 73.

Indicator 75 Multiple Errors

Purpose This indicator is used to detect any multiple-bit transfer errors which occur during writing or reading tape.

Operation Indicator 75 can be associated with writing or reading. When the Write Unit Ready or Write Master indicators are tested, indicator 75 is associated with writing. When the corresponding read indicators are tested, it is associated with reading. Indicator 75 is referred to as W75 when writing and R75 when reading.

W75 is set if any errors other than single-bit errors occur on writing.

W75 is automatically unset when a write or cancel instruction is accepted.

R75 is set if any errors other than single-bit errors occur on reading.

R75 is unset when a read instruction is accepted.

Notes R75 is unaffected when a section of tape is read that has previously been cancelled. Indicator 75 is associated with writing or reading according to the last Unit Ready or Master indicator to be tested. A test of indicator 75 should therefore be immediately preceded by a test of one of the indicators 70, 71, 72 or 73.

Indicator 76 End of Tape

Purpose This indicator is used to detect the end of tape marker.

Operation Indicator 76 can be associated with writing or reading. When the Write Unit Ready or Write Master indicators are tested, indicator 76 is associated with writing. When the corresponding read indicators are tested, it is associated with reading. Indicator 76 is referred to as W76 when writing and R76 when reading.

W76 is set when the end of tape marker is detected during writing or cancelling.

W76 is unset by program test.

R76 is set when the end of tape marker is detected during reading.

R76 is unset by program test.

Notes Indicator 76 is associated with writing or reading according to the last Unit Ready or Master indicator to be tested. A test of indicator 76 should therefore be immediately preceded by a test of one of the indicators 70, 71, 72 or 73.

Indicator 77 Early End of Tape and Short Block

Purpose This indicator is used to detect the early end of tape marker or to detect a short block consisting of four words.

Operation Indicator 77 can be associated with writing or reading. When the Write Unit Ready or Write Master indicators are tested, indicator 77 is associated with writing. When the corresponding read indicators are tested, it is associated with reading. When writing, indicator 77 is called the Early End of Tape indicator and is referred to as W77. When reading, indicator 77 is called the Short Block indicator and is referred to as R77.

W77 is set when the early end of tape marker is detected during writing or cancelling.

W77 is unset by program test.

R77 is set when a short block, consisting of exactly four words including the end of block marker, is detected on reading. Short blocks may be used for identification purposes and are used as label blocks by the housekeeping routines.

R77 is unset by program test.

Notes Indicator 77 is associated with writing or reading according to the last Unit Ready or Master indicator to be tested. A test of indicator 77 should therefore be immediately preceded by a test of one of the indicators 70, 71, 72 or 73.

Indicator 71 Write Master

Purpose This indicator is used to test if writing has been successfully completed.

Operation Indicator 71 is set if any of the indicators W74, W76 or W77 is set, i.e., if:

(a) any errors have been detected on writing, or

(b) if the end of tape marker has been detected during writing, or

(c) if the early end of tape marker has been detected during writing.

Indicator 71 is unset when W74, W76 and W77 are all unset.

Notes If indicator 71 is unset it follows that writing has been successful and no special action need be taken. Only if indicator 71 is set is it necessary to test W74, W76 and W77 to establish which exceptions condition has arisen.

Indicator 73 Read Master

Purpose This indicator is used to test whether reading has been successfully completed.

Operation Indicator 73 is set if any of the indicators R75, R76 or R77 is set, i.e., if:

(a) Multiple errors have been detected while reading.

(b) The end of tape marker is detected on reading.

(c) A short block has been read.

Indicator 73 is unset when R75, R76 and R77 are all unset.

Notes If indicator 73 is unset it follows that reading has been successful (single-bit errors being corrected automatically) and no special action need be taken. Only if indicator 73 is set is it necessary to test R75, R76 and R77 to establish which exceptions condition has arisen.

INDICATOR	TITLE	SET BY	UNSET BY
70	Write Unit Ready	Write Unit not busy	Write or cancel instruction
71	Write Master	W74, W76, W77 becoming set	Unsetting of all three indicators
72	Read Unit Ready	Read Unit not busy	Read or backspace instruction
73	Read Master	R75, R76, R77 being set	Unsetting of all three indicators
74 W74	Write Any Errors	Any bit errors written	Write or cancel instruction
74 R74	Read Any Errors	Any bit errors read	Read instruction
75 W75	Write Multiple Errors	Multiple bit errors written	Write or cancel instruction
75 R75	Read Multiple Errors	Multiple bit errors read	Read instruction
76 W76	Write Final End of Tape	Final end of tape marker	Program test
76 R76	Read Final End of Tape	Final end of tape marker	Program test
77 W77	Write Early End of Tape	Early end of tape marker	Program test
77 R77	Read Short Block	Short block read	Program test
79	Writing Ring Present	Writing ring present on spool and transport mechanically ready and address seized on deck last tested.	Writing ring not present on spool transport not mechanically ready or address not seized on deck last tested
80	Tape Order Error	Unacceptable instruction	Program test
81 to 88	Deck Address (1-8) Ready	Address seized and tape deck not busy and mechanically ready	Address not seized or tape deck busy or not mechanically ready
89	Transport mechanically ready	Transport mechanically ready and address seized on deck last tested.	Transport not mechanically ready or address not seized on deck last tested.

Figure 36: SUMMARY OF MAGNETIC-TAPE INDICATORS

Indicator 79 Writing Ring Present

Purpose This indicator is used to ensure that a writing ring has been fitted before a write instruction is given.

Operation This indicator is associated with the last Deck Address Ready indicator to be tested.

Indicator 79 is set if a writing ring is present on the tape deck for which the last Deck Address Ready indicator was tested and if indicator 89 (Transport Mechanically Ready) is set.

It is unset if the writing ring is absent, or if indicator 89 (Transport Mechanically Ready) is unset. If a tape deck becomes mechanically unready, indicator 79 will become unset after a delay of up to 500 milliseconds.

Notes Indicator 79 should be tested before writing to tape. This ensures that a writing ring has been fitted and prevents a possible tape order error.

The Secure lamp on the tape unit is lit when no writing ring is present on the loaded reel.

Program Interrupt Facility 3.8.7

Once a tape instruction has been initiated it is carried out automatically and does not require constant program control. This means that other programs can be obeyed while the tape is in motion. An automatic interrupt facility is incorporated to cater for the transfer of words between I.A.S. and the tape control unit. Thus the need for any program control during the reading or writing of tape is eliminated. This enables the programmer to make maximum use of the time available while the tape is in motion.

When a rewind or unload instruction is being obeyed, there is no transfer between I.A.S. and magnetic tape and thus any instruction may be obeyed other than a tape instruction to the same deck.

During a cancel or backspace instruction there is no transfer between I.A.S. and magnetic tape and any instructions can be obeyed other than drum transfers or tape instructions to the same deck. Drum transfers cannot be obeyed since they use the same clocking system as the tape decks.

Reading Tape

Information read from tape is transferred into a special register, Register G. Register G is a register used as a buffer store when tape reading is taking place, and can be considered as being in two halves, each consisting of two 6-digit registers and a small buffer. The layout of the registers is shown diagrammatically in Figure 37.

Information is read from tape into the small buffers and thence it is transferred into the two 6-digit registers.

When a complete word is contained in the 6-digit registers the tape control unit indicates to the central processor that it is ready to interrupt the main program in order to transfer the word to I.A.S.

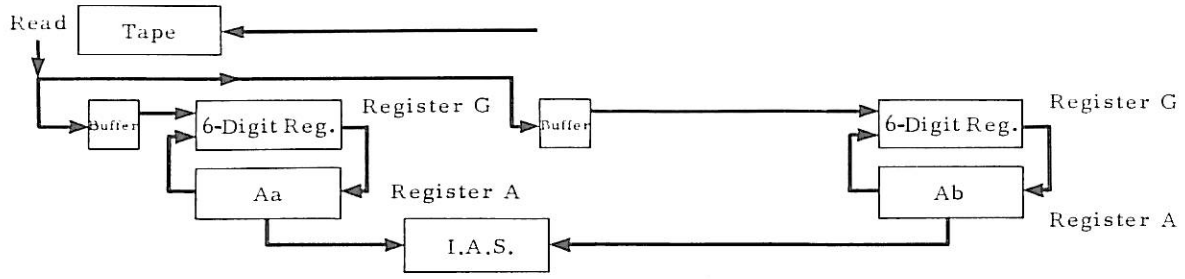


Figure 37: TAPE READ

When the current program instruction has been completed the tape control unit breaks in. The contents of the registers are circulated so that they are interchanged with the contents of Register A. The data from tape is now contained in Register A and is transferred to I.A.S. When the transfer has been completed, the contents of the registers are again interchanged with those of Register A. The original contents of Register A have thus been restored and the main program continues until the next word has been read into the registers, when it is again interrupted.

When the tape control unit is ready to break in, the program is interrupted at the end of the instruction it is obeying. If it is obeying a multibeat instruction, e.g. multiplication, the break-in takes place at the end of the micro-instruction currently taking place. Drum transfers cannot be obeyed while reading is taking place since they use the same clocking system as the tape decks and also take longer than the frequency at which the break-in occurs, and cannot be interrupted in the middle of execution. Great care should be taken if other peripheral units are used while the tape is moving since the interruptions from the tape control unit upset the timings. In particular the full P.P.F. cannot be used during tape-reading and printing should not take place while reading one-inch (90 kc/s) tape. Processing should not take place on the current block while it is still being read since, if any transfer error occurs, the whole block is re-read.

Writing Tape

Information to be written to tape passes through a register, Register F. Register F is used as a buffer store and can be considered as being in two halves, each consisting of a 6-digit register and a small buffer. The layout of the registers is shown diagrammatically in Figure 38.

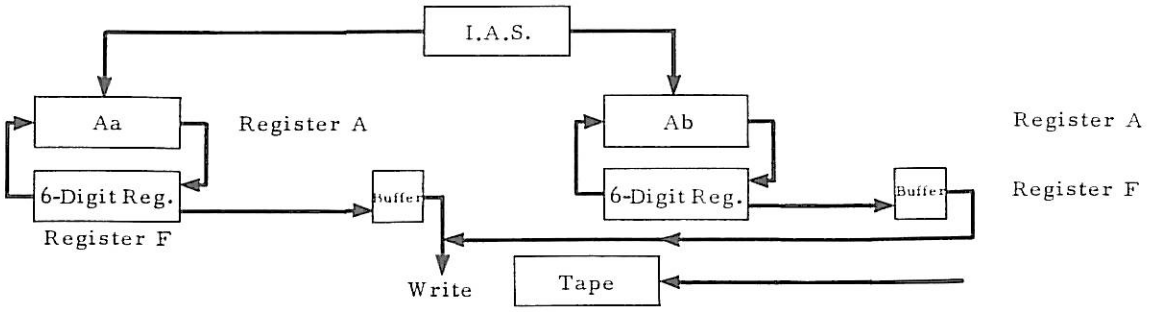


Figure 38: TAPE WRITE

When a word is to be written to tape the contents of the 6-digit registers are interchanged with those of Register A. A word is then written from I.A.S. to Register A and the contents of the registers again interchanged. The original contents of Register A have thus been restored and the word to be written to tape is held in the two 6-digit registers. The word is written to tape via the small buffers. When the 6-digit registers have become empty the tape control unit is ready to receive another word from I.A.S. and a request to break in is made to the central processor.

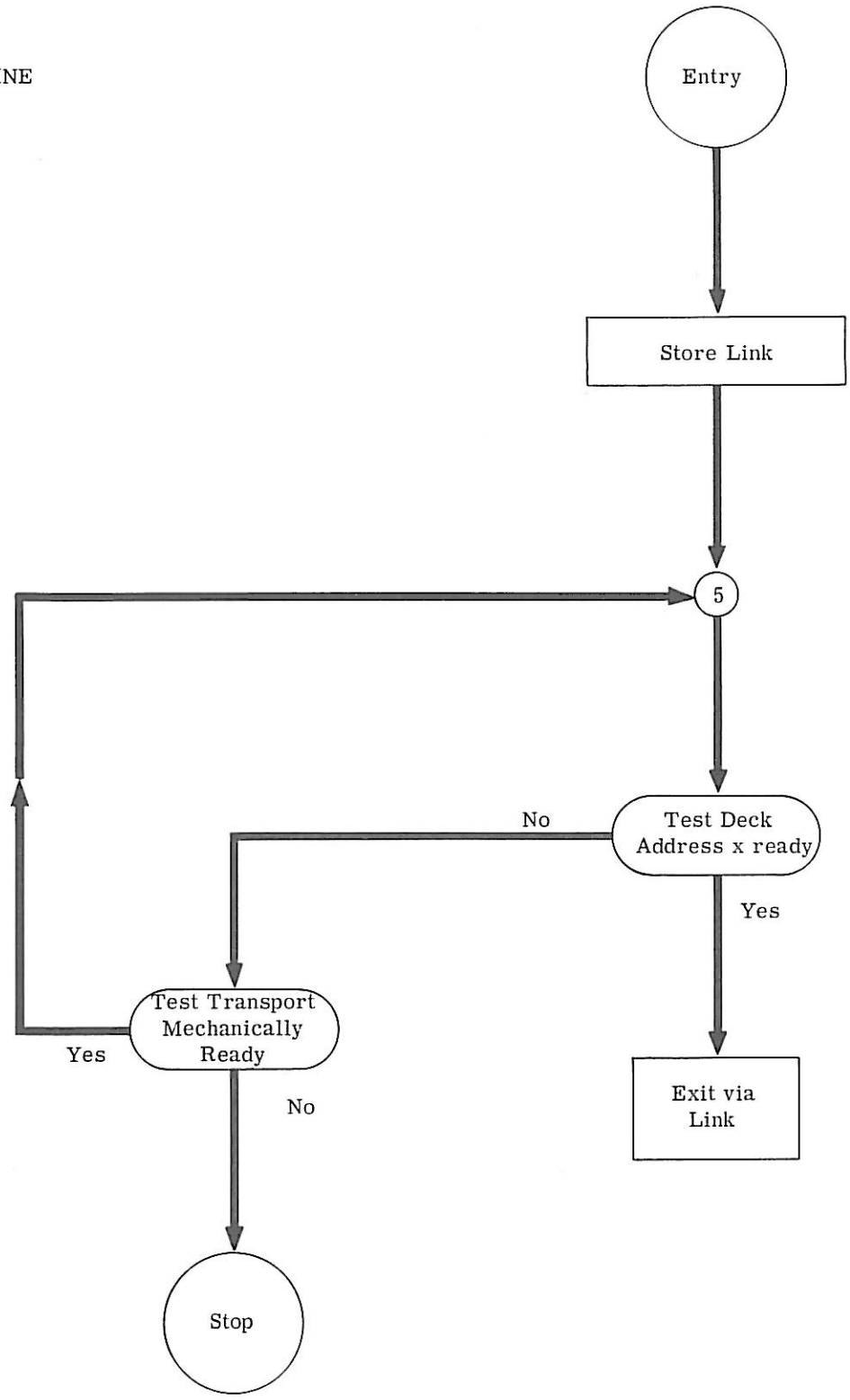
The program is interrupted at the end of the instruction it is obeying, or at the end of the micro instruction if it is obeying a multibeat instruction. Drum transfers cannot be obeyed while writing is taking place as they use the same clocking system as the tape decks and also take longer than the frequency at which the break-in occurs and cannot be interrupted in the middle of execution. Great care should be taken if other peripheral units are used while the tape is moving since the interruptions from the tape control unit upset the timings. In particular the full P.P.F. cannot be used during tape writing and printing should not take place while writing one-inch (90 kc/s) tape. Processing should not take place on the block which is being written to tape since if any transfer error occurs, the whole block is re-written.

It is possible to read from one tape deck and write to another tape deck simultaneously. In this case the main program is interrupted by both the read unit and the write unit, the read unit taking preference if they should both require to break in at the same time.

The time-sharing with a tape read or write program is effected as follows:

When the read or write instruction has been given, a jump is made from the tape program to the section of program which is to be time-shared with the reading or writing. This program is then executed with occasional automatic interruptions from the tape control unit when a transfer involving I.A.S. occurs. When the program has been completed a return is made to the tape program which, when the transfer has been completed, tests the necessary indicators to ensure that the block has been correctly read or written. If a section of the main program takes longer to complete than the reading or writing of the block, the tape will have stopped before control is returned to the tape program; this however does not matter. If drum transfers occur within the time-sharing program they should be preceded by tests of Read and Write Units Ready indicators (72 and 70) to check that the tape transfer has been completed. Facilities for time-sharing when reading or writing tape are provided with the tape housekeeping routines.

DECK
TESTING
SUBROUTINE



Deck not correctly allocated
or there is a mechanical failure.

Correct fault and restart from beginning.

Flowcharts for reading and writing magnetic tape are included as an illustration of the use of the various indicators and instructions. These flowcharts do not cover all the housekeeping procedures in the standard routines and are intended as an example only. It is assumed that beginning of tape labels have already been written or checked. Reading and writing takes place on tape deck address x. The value of x would be entered as a parameter at the start of the routine.

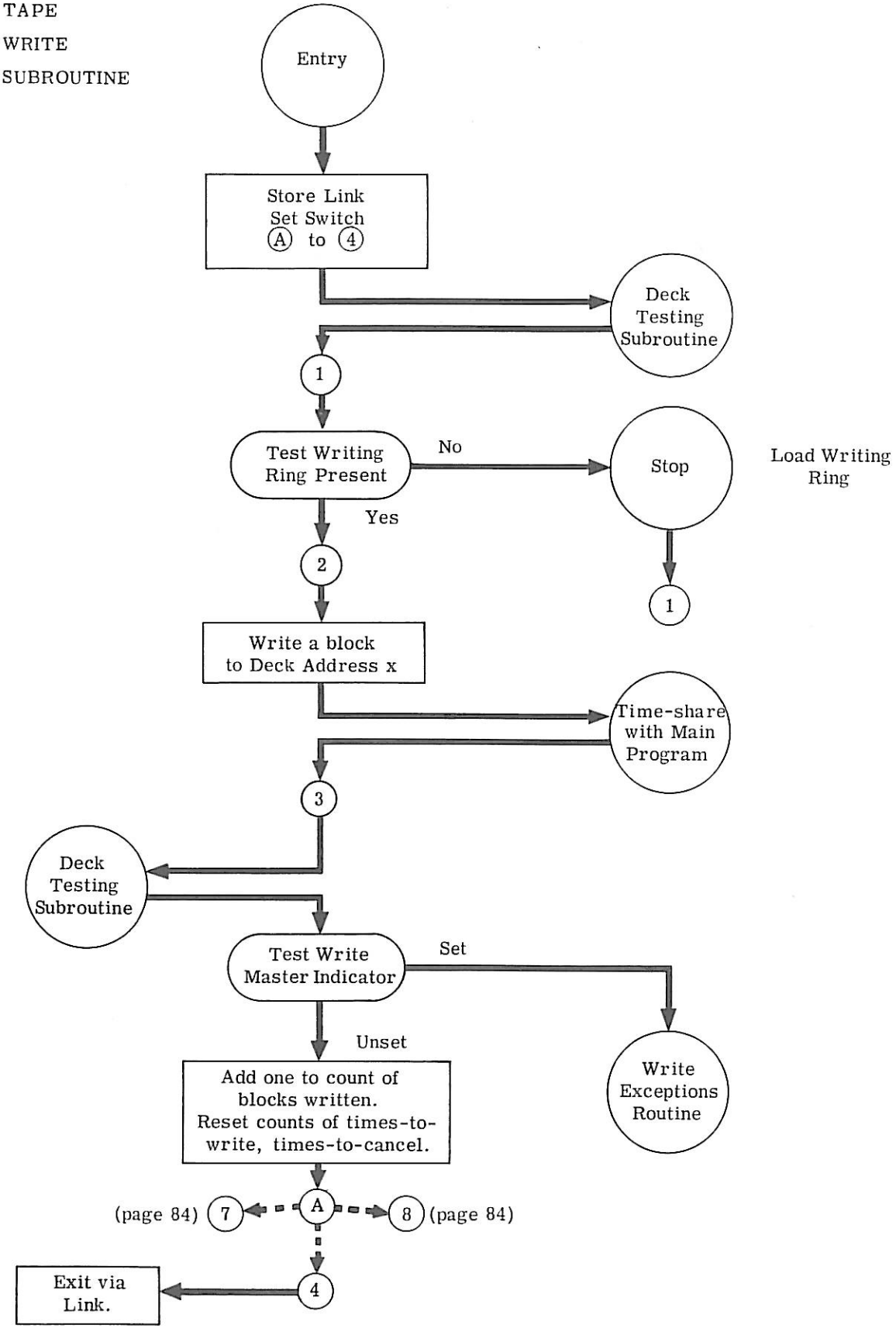
Deck Testing Subroutine

This routine determines if deck address x is busy. It may be used to ensure that a tape deck has finished obeying the current instruction and is ready to receive a further instruction. The use of this routine prevents any tape order errors arising due to instructions being given to decks which are busy.

To ensure that tape deck address x is mechanically ready the appropriate Deck Address Ready indicator and indicator 89 (Transport Mechanically Ready) are repeatedly tested until the deck ceases to be busy and is ready to receive another instruction. If the tape deck is not mechanically ready, then the deck has not been correctly allocated or there is a mechanical failure. The fault should be corrected and the job restarted from the beginning.

The Deck Testing routine has been made into a subroutine since it is used in several places by the other routines.

TAPE
WRITE
SUBROUTINE



Tape Write Subroutine

This routine writes a block from I.A.S. to magnetic tape on deck address x. A test is made to ensure that writing has been successfully completed and a count (initially zero) of the number of blocks which have been written is updated.

A test is made to ensure that a writing ring has been fitted before an attempt is made to write. The Deck Testing routine is entered before this test since it tests the Deck Address Ready indicator and thus associates the Writing Ring Present indicator with the correct deck address.

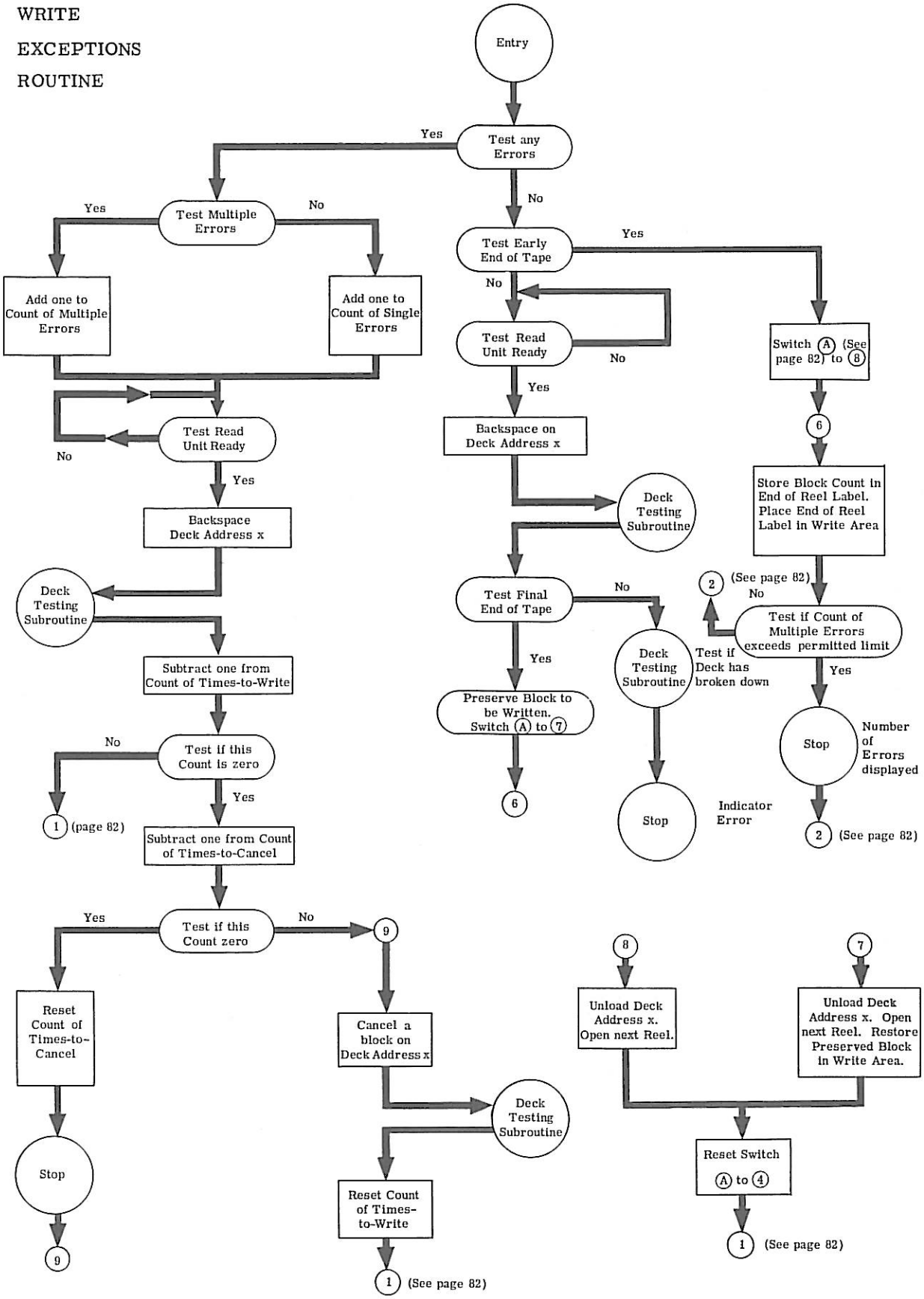
When the write instruction has been given, an exit is made so that the writing routine can be time-shared with the main program. On return to the write routine, the Deck Testing routine is entered to test whether writing has been completed. When the block has been written, indicator 71 (Write Master) is tested. If it is unset then there have been no writing errors and no special conditions have arisen, and the block count is updated. The times-to-write and times-to-cancel counts are used when transfer errors occur.

The times-to-write count corresponds to the number of attempts which must be made to write on a particular section of tape before cancelling that section. The times-to-cancel count corresponds to the number of sections of tape upon which attempts are made to write before giving an indication that the tape is faulty. If indicator 71 (Write Master) is set, then an error (or exceptional case) has arisen and the Write Exceptions routine is entered.

WRITE

EXCEPTIONS

ROUTINE



Write Exceptions Routine

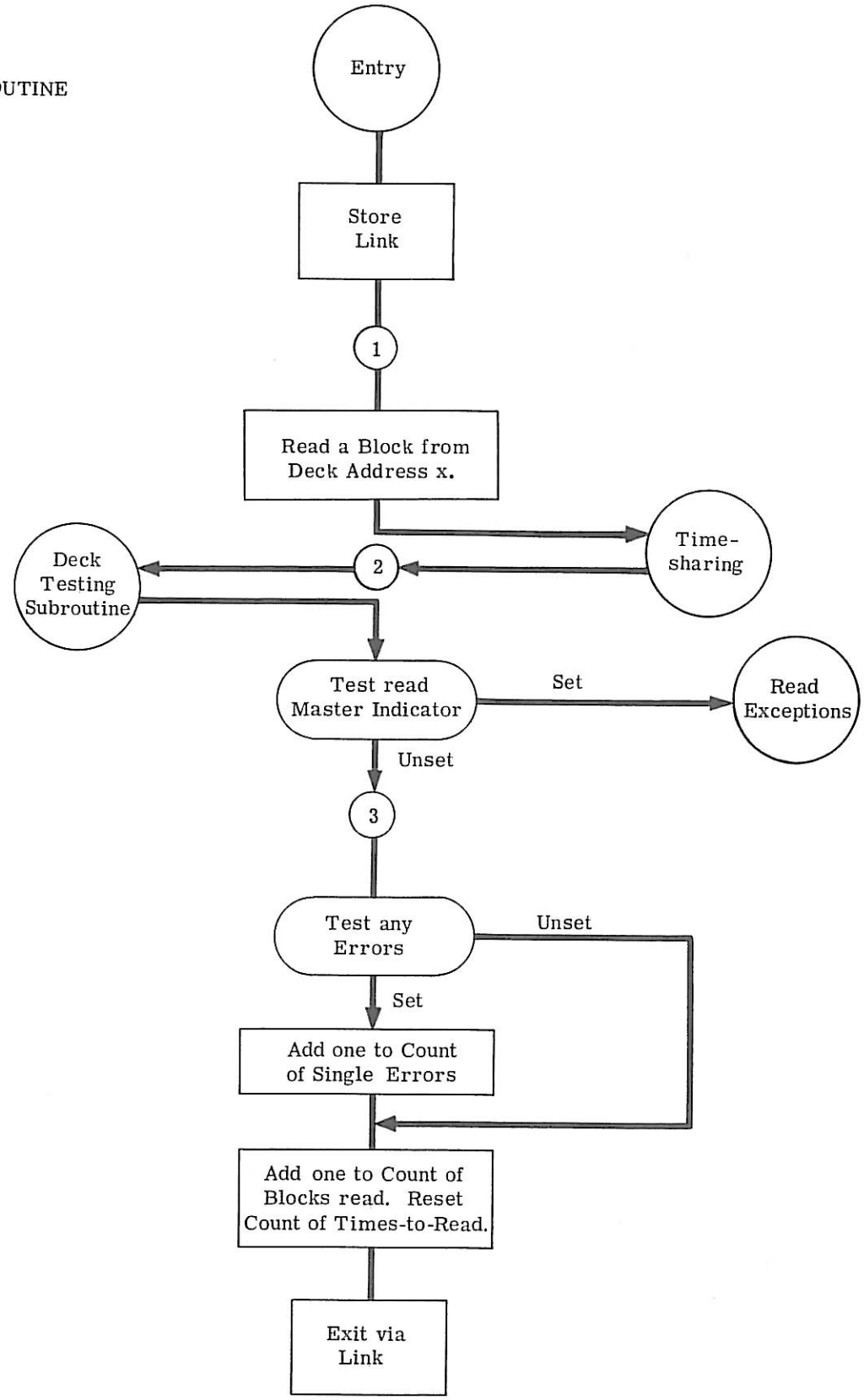
The Write Exceptions routine discovers which exceptions condition has arisen and deals with it appropriately.

A count is kept (initially zero) of any single- or multiple-bit errors which occur. If an error occurs, the tape is backspaced and another attempt made to write on the same section of tape. If necessary several attempts are made until the times-to-write count is reduced to zero. When the count is reduced to zero the block is cancelled and writing is attempted on the next section. If the times-to-write count is reduced to zero on the next section then this too is cancelled. Attempts are made, if necessary, on successive sections until the times-to-cancel count has been reduced to zero. When the count is reduced to zero the computer stops with an indication that there are repeated errors. Restart causes further attempts to be made on following sections of tape.

If the early end of tape marker is detected then a short block is written to tape as the last block on the reel. This is called the end of reel label and has a special format to distinguish it from other short blocks. The block count is stored in the end of reel label. A test is made to discover whether the multiple errors have exceeded the permitted number. If the permitted number is exceeded the computer stops with the number of single and multiple errors displayed. When the end of reel label has been correctly written, deck address x is unloaded and a new reel is opened.

The final end of tape should never be detected, since the end of reel label is written immediately after the block in which the early end of tape marker was read. If, however, the final end of tape is detected, the block which has just been written is preserved. The tape is backspaced and the end of reel label is written in place of the last block. When the new reel has been opened the preserved block is written as the first data block of the new spool.

TAPE
READ
SUBROUTINE



Tape Read Subroutine

This routine reads a block from deck address x and stores it in I.A.S. A test is made to ensure that reading has been successfully completed and a count (initially zero) of the number of blocks which have been read, is updated.

When the read instruction has been given, an exit is made so that the read routine can be time-shared with the main program. When the block has been completely read, indicator 73 (Read Master) is tested. If this indicator is unset no special conditions have occurred. Indicator R74 (Any Errors) is then tested to determine if any single-bit errors have occurred, these having been automatically corrected and requiring no special action. The count of single-bit errors is updated if necessary and the number of blocks read count is also updated. A times-to-read count is used when errors occur. This count corresponds to the number of attempts which are to be made to read a block before the attempt is abandoned and the computer stopped. If indicator 73 is set, then a multiple error (or exceptional case) has arisen and the Read Exceptions routine is entered.