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4.1 Peripheral Transfers

A peripheral transfer is initiated by a 140/142 pair (or 141/142 pair if the drum) see 3.14, e.g.

140.1	0	*SR1
142	A1000	64

The 140 instruction specifies the mode, M (0 to 31), and the peripheral reserved for the job. The 142 instruction may specify a core store region.

For each type of device only some modes have been assigned and unassigned modes will cause illegal instructions action. If the specified peripheral is not reserved for the job (or is floating) then peripheral violation action occurs. If a region of store is involved it must be within reservations. For those 140/142 pairs which involved a transfer, if Y of the 142 instruction is zero or greater than 32767 then impermissible operand action occurs. If an output transfer is attempted with OVR set then writing with overflow set action occurs.

4.1.0 For all devices M = 13 interrogates the specified device. One word of information (see 5.5) is written into the register specified in the X-address of the 142 instruction. Its Y-address is ignored.

Except for the drum M = 16 causes the device to be disengaged. The X- and Y-addresses of 142 instruction are ignored. If this mode is used for magnetic tape by an object program illegal instruction action occurs.

4.1.1 Paper Tape Devices.

Readers

Programmers' peripheral name for a 7-track reader is *SRn, for a 5-track reader is *FRn. n is a number 0 to 31

X-address of 142 instruction specifies the core store starting address. Its Y-address specifies a number of characters.

The characters are read and stored 8 to a word starting at the m.s. end of the first word of the specified core store region. The rest of the word containing the last stored character is clear. Each character read is stored as a 6-bit internal character.

Assigned Modes

M = 1 Read and store 7-track, up to and including NL or at most Y characters,

M = 2 Read and store 7-track, Y characters.

M = 8 Read and store 5-track, Y characters.

M = 13 and M = 16.

Punches

Programmers' peripheral name for a 7-track punch is *SPn, for a 5-track punch is *FPn.

X-address of 142 instruction specifies the core store starting address. Its Y-address specifies a number of characters.

Starting at the m.s. end of the first word of the specified core store region internal characters are output.

Assigned modes

M = 21 Punch 7-track, up to and including NL or at most Y characters.
M = 21 Punch 7-track, Y characters. [This should be M=22. Ed]
M = 28 Punch 5-track, Y characters.
M = 13 and M = 16.

4.1.2 Card Devices

Readers (see also 4.4).

Programmers' peripheral name for 80 columns is *CRn, for 65 columns is *VRn.

A 140/142 pair causes at least one card to be read. X-address of 142 instruction specifies the core starting address. Its Y-address specifies the number of words of information to be stored. Information from 4 columns is stored in a word.

Assigned Modes

M = 1 Read, IBM code.
M = 2 Read, ICT code.
M = 4 Read, BULL. (Not on Orion 2)
M = 7 Read, IBM and binary.
M = 8 Read, ICT and binary.
M = 11 Read, BULL and binary. (Not on Orion 2)
M = 14 Read, binary.
M = 19 Read, binary and interstage. On Orion 2 the interstage button must be on for use by the extracode.
M = 13 and M = 16.

Punches (see also 4.5)

Programmers' peripheral name for 80 column card punch is *CPn.

X-address of 142 instruction specifies the core starting address, Its Y-address specifies the number of words to be transferred to the buffer store.

Assigned modes

M = 21   Fill data buffer, and punch one card (coded).
M = 22   Fill data and code buffers, and punch one card (binary). On Orion 2 the code buffer is in fact untouched.
M = 26   Fill code buffer.
M = 13 and M =16.

4.1.3 Line Printers

Programmers' peripheral name is *LPn.

X-address of 142 instruction specifies the core starting address. Its Y-address specifies the number of words to be transferred to the buffer store.

Assigned modes

M = 21   Fill data buffer and print a line with full char set.
M = 22   Fill data buffer and print a line with part char set.
M = 26   Fill code buffer.
M = 13 and M = 16.

4.1.4 Magnetic Tape (see 4.7)

Programmers' peripheral name is *MTn. For those modes involving a transfer, the X-address of the 142 instruction is the core starting address. Its Y-address specifies a number of words.

Reading

A 140/142 pair causes the next block to be read. At most Y words are stored. If the length of the block is less than or equal to Y then all block is stored. If the length of the block is greater than Y words then the first Y words read are stored; the rest of the block is read but not stored.

Assigned modes

M = 1   Read forwards

The next block looking forwards on the tape is read. The first word read (i.e. the first word of the block) is stored in the first word of the specified core store region. The second word read is stored in the second word of the region and so on until the block or at most Y words are stored.

M = 2   Read backwards

The next block looking backwards on the tape is read. The first word read (i.e. the last word of the block) is stored in the last word of the specified core store region. The second word read (i.e. the next to the last word of the block) is stored in the next to last word of the region and so on until the block or at most Y words are stored.

Writing

A 140/142 pair causes a block to be written on to the tape. The length of the block is the length of the specified core store region (i.e. Y words long). Writing is always forwards on to the tape and must be regarded as destroying everything on the tape beyond the point at which the writing is done. It is not permitted to write after reading backwards; it is permitted to write after reading forwards.

Assigned modes

M = 21 Leave long gap, write one block Y words in length
M = 22 Leave short gap, write one block Y words in length.

Other modes

M = 13 Interrogate
M = 14 Rewind

The X- and Y- addresses of the 142 instruction are ignored. When obeyed in an object program it causes an entry into OMP which then rewinds and leaves the tape repositioned ready to read Block 1 forwards (i.e. in the load position the program having continued.)

M = 16 Disengage

If obeyed in an object program it causes illegal instruction action.

M = 28 Erase

This erases information on the tape (Y words)

4.1.5 Drum (see 3.14)

The Y-address of 141 instruction is the relative drum starting address, X-address of 142 instruction specifies core starting address. Its Y-address specifies a number of words.

Assigned modes

M = 1 Read Y words from the drum to the core store
M = 2 Write Y words to the drum from the core store
M = 13 Interrogate.

4.1.6 Hough-Powell Device

Programmers' peripheral name is *HPn. Y-address of 142 specifies a number of words. This is reserved as a slow output device using 150/30.

Assigned modes

M = 1 Input Y words or up to End of Frame interrupt
M = 2 Input Y words suppressing End of Frame interrupt
M = 13 Interrogate
M = 16 Disengage
M = 22 Output Y words

4.1.7 IBM Tape Decks

Programmers’ peripheral name is *ITn Y-address of 142 specifies a number of words. This is reserved as a slow input device using 150/33 etc.

Assigned modes

M = 1   Read forwards
M = 2   Backspace
M = 13   Interrogate
M = 14   Rewind
M = 16   Rewind and Disengage
M = 21   Write binary block
M = 22   Write binary coded decimal block
M = 28   Erase

4.1.8 Electrodata Unit

This is treated as 3 devices for each M = 13 interrogates and M = 16 disengages the unit. Y-address of 142 specifies a number of characters. This is reserved as a slow output device using 150/30.   All 3 have to be reserved.

Programmers' peripheral name	Operation	Mode
*EAn	Read address	8
*ECn	Conditioning	22
*EDn	Read data	2

4.1.9 Ericsson Keyboard

Programmers’ peripheral name is *EKn. Y-address of 142 specifies a number of characters. This is reserved as a slow input device.

Assigned modes

M = 1   Read up to NL or at most Y characters.

M = 2   Read Y characters

M = 13 and M = 16

Flexowriters Type C

Programmers’ peripheral name is *FCn Y-address of 142 specifies characters. This is reserved as a slow output device.

Assigned Modes

M = 21   Print up to NL at most Y characters.

M = 22   Print Y characters

M = 13 and M = 16.

4.1.10 Orion 2 Extracode

On Orion 1, the data are transferred directly between the core-store area and the peripheral device. Once a 140/142 pair has initiated a transfer, subsequent instructions can be obeyed while the data are passing between the store and the peripheral. The peripheral lockouts and core-store lockouts are effected by hardware. The lockouts except for magnetic tape are advancing.

On Orion 2, the peripheral transfer instruction (140/142, 141/142, 140/154, 140/155) are performed by extracode. It also performs some processes which on Orion 1 are done in the peripheral control unit (e.g. conversion of a card-column to u and v characters) and also provides, for some peripherals the equivalent of lockouts.

Magnetic Tape and Drum Store (Fast devices). The data are transferred directly between the core-store and the peripherals as in Orion 1. The Core-Store area is lockout by means of a lockout tester in the hardware of the associated peripheral control unit.

Slow Input Peripherals

The extracode reads data into its own buffer areas (it double buffers for paper-tape readers; these are two 8-word buffers for each paper tape reader, and for cards two 20-word buffers for each card reader) and when the object-program obeys a 140/142 pair, the extracode then copies (142/142 pair) the required data from its buffers to the object program's input core-store area.

Note that the object-program cannot progress beyond a 140/142 pair until the transfer has been completed and the data are in object program's input region. Thus it is impossible for the program to attempt to use the data before they are all in the input region and therefore there is no need for lockouts on the input region.

For slow input devices, some or all of the data are already in the extracode buffers, having been read autonomously while instructions preceding the 140/142 pair were being obeyed.

Pressing of the select button on a reader causes the extracode to clear (or ignore) the data in its buffers.

Peripheral incidents (see 5.5) which are not signalled at the time they actually happen but at the time the data involved are handed over to the object program, are paper tape parity failures and card read check failures and illegal punching. Other incidents, operator attention or disabled, are signalled when they happen.

Reading punched paper-tape is now described to typify the handling of transfers used by slow devices. The isolated region of the working-store occupied and used by the extra codes includes two 8-word buffers for each paper-tape reader attached to the computer.

When a 140-instruction is encountered in the object-program, entry to the “140” extracode routines takes place.

From the device's name (e.g. *SR2) the routine determines which section of itself is appropriate for that type of device. Then a 146-instruction is obeyed, searching a table to find which physical device has the given programmers' name: this table is in fact part of the job's directory-entry. (If the search stops because a zero modifier has been encountered, then a peripheral violation is implied.) The extracode routine then causes another table to be searched to check that the mode and device-name are consistent and to select a section of the routine to carry out any special action required by the mode. The peripheral control unit involved is made ready for a transfer.

A return to the main program occurs next to obey any instructions pre-modifying the 142-instruction and then the 142-instruction itself causes re-entry to the extracodes. Upon this re-entry, lockouts and reservations are checked.

Suppose that this transfer is the first initiated on that reader by the object-program. Then, when the 140/142 instruction-pair is encountered in the object-program, the program is interrupted and recorded as waiting for the reader. The extracode routine then reads 8 words (64 characters) into the first of the extracode buffers. Note that 64 characters are read, regardless of the number actually called for by the object-program.

When the object-program is re-entered from the Time-sharer, the required number of characters (Y in the 142-instruction) is copied from the buffer into the object-program's input area.

If the object-program required not more than 64 characters, its demands are satisfied and it can continue. If, on the other hand, it required more than 64 characters, it is interrupted again. In either case, 64 more characters are read into the second extracode buffer. If the program required more than 64 characters then, when it is re-entered from the Time-sharer the remaining characters (up to the maximum of 64) are copied from the second buffer into the object-program's input region, and another 64 characters read into the first buffer.

Thereafter, whenever a 140/142 instruction-pair to read from that reader is encountered in the object-program, the characters called for are copied from one of the extracode buffers and, if the buffer is thereby "emptied", it is refilled with 64 more characters from the tape. If a transfer calls for more characters than are in the extracode buffer, those which are available are copied across, during which the Time-sharer is entered. When that part of the transfer is complete, a return to be object-program occurs for the next part of the transfer, which may or may not complete the transfer. Thus during "long" transfers, the object-program may be interrupted several times for one transfer.

From the above it follows that the tape is always read 64 characters at a time and tape-reading is never terminated because a "newline" character has been read, even when the object-program calls for transfers in mode 1; the effect of reading up to NL is achieved during the copying from the extracode buffers into the object-program's input region. Also it is desirable to have at least 127 characters (about 13 inches) of run-out (repeated upper-case) after the data on the tape in addition to any which would be called for by the program.

There is a slight increase in program efficiency if the object-program always calls for 64 characters.

Slow Output Peripheral Devices

The extracode buffer for a paper tape punch holds 128 characters, for a card punch holds one card, and for a line printer holds one line. The data from the object-program's core region is copied (142/142) into the extracode buffer and after any conversion, the device is started and the program returned to (if more than 128 characters on the paper tape punch were called for then return is to deal with the rest or the next 128 and so on). Peripheral incidents are signalled at the time they occur. For restart procedures note that the object-program core region is not locked out and the original data can be overwritten before the transfer has been completed; double buffering can be used to preserve the data in case of a failure occurring.

Entry to the Extracodes

The instructions which are extracoded are 102, 103, 125, 126, 140/142, 141/142, 140/154, 140/155 (156 when in monitoring or engineers mode). Division orders 40-45 when the quotient appears out of range when in fact it is not. 101 and 95 - certain operands require help from Extracode.

The function-number in an Orion instruction is a 7-bit quantity. However, it so happens that, for all the function-numbers except for 40-45 which are extracoded, the most significant of these is a 1; the extracoded function-numbers can therefore be distinguished from each other by considering the l.s. 6 bits only; the 45 and 125 case is looked for specially.

When an instruction with one of these particular function-numbers comes to be obeyed, the X- and Y-addresses are replaced and modified as necessary by the microprogram, after which:-

(a) the function-number is stored at absolute address 513, with the l.s. 2 bits of the function-number at the m.s. end of the word and the remaining 4 bits of the (effectively) 6-bit function-number at the l.s. end, i.e.

l.s. 2 bits of the function number — m.s. 4 bits of the function number

(b) the effective X-, Y- and Z-addresses are stored at absolute addresses 512, 514 and 515 respectively, in each case including the datum-point of the object-program.
(c) the control-number (address of the instruction) is set in the modifier half of register 516, OVR is represented by m.s. bit in that register (0 if OVR clear, 1 if set) and OVR is left clear; thus [516] is a link for return to the object-program.
(d) the control-number is reset to 517,
(e) the datum-point is set equal to 512,
(f) the "extracode flip-flop" is set. This is a 1-bit indicator which shows whether or not the extracode program is being obeyed.

When it is set:-

(a) testing for lockouts and reservations is inhibited,

(b) certain function-numbers when in extracode mode (the letter E is conventionally written after the number in this case) carry out quite different operations (e.g. 125E instruction has the effect, Test Lockout and Reservation Region for Input Transfer and does not standardise a floating-point number - its effect in non-extracode mode). These function-numbers are 20 to 27, 87, 102, 103, 105, 106, 107, 125 and 127 and 140.

Then the instruction in register 517 is obeyed. It is a 2-address 122-instruction which, using some Symbolic Addresses in lieu of the actual addresses, can be written as

122Y WS TABLE Al

The rearranged function number as explained above is used as a character-modifier in the 122 instruction: using the notation*

f_1 = value of the l.s. 2 bits of the function number ($0 \le f_1 \le 3$)
f_2 = value of the m.s. 4 bits of the (effectively 6 bit) function number ($0 \le f_1 \le 15$), then $[512]_m = f_2$ and $[512]_c = 2f_1$

and so word [TABLE + f_2] is shifted cyclically left $2f_1$ characters, i.e. f_1 quarter-words.

Now starting at address TABLE is a table in which each significant entry (12 bits) is the address at which the corresponding extracode routine starts.

Therefore, given a function, the 122-instruction selects the entry-point address of the corresponding routine, putting it at the l.s. end of register WS. The instruction in register 518 isolates those 12 bits which are then used to modify the destination address of an unconditional jump-instruction in register 519; this jump, of course, causes the appropriate extracode routine to be entered and obeyed. When entered, the extracode routine performs the following processes:-

(a) using the special “extracode” function 125, lockouts and reservations are checked,
(b) the instruction is simulated,
(c) the word in register 516 is used as a link for return to the main program, by means of the instruction.

87 1 516

This is essentially similar to a normal 87-instruction but with the addition effect of clearing the extracode flip-flop. Note that, since $[516]_m$ is the address of the instruction being simulated, the X-address in the 87 instruction must be 1.

*Denoting the group and position of the function-number by G and P respectively then

$$8G + P = 64 + 4f_1 + f_2$$

For full write up of Extracode see the site engineer who has such a write up.

4.3 PAPER TAPE READERS & PUNCHES

(See also general description in 4.1)

4.3.1 The following types of paper tape reader and punch are at present in use on Orion:

	(I.C.T. TR5	(300 characters/second)
readers	(I.C.T. TR7	(1000 characters/second)
	(Creed 25	(33 characters/second)
punches	(Creed 3000	(300 characters/second)
	(Teletype	(63 or 110 characters/second)

Of these Creed 3000 is for 7 track only on Orion, the others being 5 or 7 track as separate versions or by switch selection.

These devices are directed by a paper-tape Control Unit which can control up to four devices, in any combination of paper-tape readers, punches, or Flexowriters (a Flexowriter counting as two devices). As only one transfer at a time can take place on each Control Unit, at least two such units are normally provided. An Orion installation must have at least one paper-tape reader, one punch, and one Flexowriter.

4.3.2 MODES

Reading and punching of paper tape are effected by compound instructions such as:

```
140.8    0        *FR1     read (5 track) 10 chars
142      BUFFER   10       into BUFFER onwards

140.21   0        *SP1     punch (7 track) up to NL or 10
142      BUFFER   10       characters at most from BUFFER
```

The modes associated with paper tape devices are:

	(1	read 7 track up to NL but most Y characters
readers	(2	read 7 track Y characters
	(8	read 5 track Y characters
	(21	punch 7 track up to NL but at most Y characters
punches	(22	punch 7 track Y characters
	(28	punch 5 track Y characters

PUNCHED TAPE CODES
(7- and 5-track)

7-TRACK CODES

Value in Orion	Tape	Character UC	Character LC
0	● ·	SP	SP
1	· ●		
2	· ●	NL	NL
3	● · ●●	PT	PT
4	·●	TB	TB
5	● ·● ●	BS	BS
6	● ·●●	LC	LC
7	·●●●	UC	UC
8	●·		
9	●●· ●		
10	●●· ●		
11	●· ●●		
12	●●·●	ST	ST
13	●·● ●	PN	PN
14	●·●●	PF	PF
15	●●·●●●	/	:
16	● ·	0	,
17	●● · ●	1	[
18	●● · ●	2	]
19	● · ●●	3	<
20	●● ·●	4	>
21	● ·● ●	5	=
22	● ·●●	6	UL
23	●● ·●●●	7	|
24	●●●·	8	(
25	● ●· ●	9	)
26	● ●· ●	10	$
27	●●●· ●●	11	£
28	● ●·●	½	?
29	●●●·● ●	+	&
30	●●●·●●	-	*
31	● ●·●●●	.	;

Value in Orion	Tape	Character UC	Character LC
32	● ·		
33	● ● · ●	A	a
34	● ● · ●	B	b
35	● · ●●	C	c
36	● ● ·●	D	d
37	● ·● ●	E	e
38	● ·●●	F	f
39	● ● ·●●●	G	g
40	● ●●·	H	h
41	● ●· ●	I	i
42	● ●· ●	J	j
43	● ●●· ●●	K	k
44	● ●·●	L	l
45	● ●●·● ●	M	m
46	● ●●·●●	N	n
47	● ●·●●●	O	o
48	●●● ·	P	p
49	●● · ●	Q	q
50	●● · ●	R	r
51	●●● · ●●	S	s
52	●● ·●	T	t
53	●●● ·● ●	U	u
54	●●● ·●●	V	v
55	●● ·●●●	W	w
56	●● ●·	X	x
57	●●●●· ●	Y	y
58	●●●●· ●	Z	z
59	●● ●· ●●		
60	●●●●·●		
61	●● ●·● ●		
62	●● ●·●●		
63	●●●●·●●●	ER	ER

5-TRACK CODES

Value in Orion	Tape	Printer FIGS.	Printer LETS.
0	·	FS	FS
16	· ●	1	A
24	·●	2	B
8	·●●	*	C
20	●·	4	D
4	●· ●	(	E
12	●·●	)	F
28	●·●●	7	G
18	● ·	8	H
2	● · ●	≠	I
10	● ·●	=	J
26	● ·●●	-	K
6	●●·	v(%)	L
22	●●· ●	LF	M
30	●●·●	SP	N
14	●●·●●	,	O

Value in Orion	Tape	Printer FIGS.	Printer LETS.
17	● ·	0	P
1	● · ●	>	Q
9	● ·●	≥	R
25	● ·●●	3	S
5	● ●·	→	T
21	● ●· ●	5	U
29	● ●·●	6	V
13	● ●·●●	/	W
3	●● ·	×(÷)	X
19	●● · ●	9	Y
27	●● ·●	+	Z
11	●● ·●●	LS	LS
23	●●●·	.	.
7	●●●· ●	n(')	?
15	●●●·●	CR	£(π)
31	●●●·●●	ER	ER

Note. This code is that used with Pegasus, Mercury and Sirius. The symbols in parentheses are Mercury Autocode characters.

Abbreviations used in these Tables

BS = backspace
CR = carriage return
ER = erase
FS = figure shift
LC = lower case
LF = line feed
LS = letter shift
NL = newline
PF = punch off
PN = punch on
PT = paper throw
SP = space
ST = stop code
TB = tabulate
UC = upper case
UL = underline

4.3.4 PARITY

On 7 track paper tape the 5th track is used only for checking purposes and is punched so as to make the total number of holes in each character odd. When reading, the bit corresponding to this 'parity' track is checked to ensure that the character has been read correctly and is then removed, the remaining six bits giving the correct internal code without conversion. On output the control unit examines the character to be punched and inserts a parity bit if required. The 7 bit character is then transmitted to the punch where, before punching, the electronics check parity. The incident PARITY FAIL is signalled in the event of failure of this test.

5 track tape has no parity check and in this code the internal values are not taken as the direct bit equivalent of the punching.

The code lists for 5 and 7 track paper tape are shown in section 4.3.3.

4.3.5 GENERAL DESCRIPTION

Readers

Tape is fed from a loose coil placed in standard tape trough into a bin, or, when great lengths are involved (TR7 only), fed between two spools in a servo-controlled system. The tape is driven by rollers past the photo-electric reading head. By this means the tape is read after which the data are transferred to the core store via the control unit.

Punches

The tape feeds from a spool and is pulled through the punch unit in a series of jerking movements. When the tape is stationary in the punching position a die block pushes the tape upwards onto the punch pins which have already been set to correspond to the required character (in the case of the Teletype the punch pins move downwards onto the paper). The paper is pierced by the pins then lowered and advanced 1/10" to the next position for another character to be punched.

On the Creed 3000 only, the tape is read back by a photo-electric sensing device after three punching cycles. A comparison is made of the character sensed and that which should have been punched three cycles previously. Failure of this test causes the incident PARITY FAIL, the punch being disengaged and the job halted.

If, due to a programming error, the value of a character to be punched on a 5 track punch lies in the range 32-63, a logical not-equivalent operation is performed between the m.s. bit of the six and the l.s. The l.s. 5 bits of the result are then taken as the value of the character to be output.

e.g. 101010 becomes 01011

101011 becomes 01010.

4.3.6 TIMING OF OPERATIONS

The machine cycle times are:

TR5 - 3 ms	Creed 25 - 30 ms	Teletype (63) - 16 ms
TR7 - 30 ms	Creed 3000 - 3 ms	Teletype (110) - 9 ms

Maximum operating speed will be maintained if the next read/punch instruction is issued not later than one cycle time from commencement of reading/punching the last character indicated by the previous read/punch instruction. (Actually about 1 ms earlier than this because of time spent in the time sharer). Because of sharing time with other programs the amount of mill time available to the program during a peripheral transfer is uncertain, but, if the program requires to use more mill time than indicated above, the device will operate at less than full speed.

4.3.7 CONTROLS, INDICATORS AND INCIDENTS

The reader display has the following controls and indicators:

ENGAGE	Push button and indicator	
DISENGAGE	Push button and indicator	
MAINS	Push button and indicator	
SELECT	Push button and indicator	Illuminated blue during transfers, otherwise white.
7 TRACK/5TRACK	Push button and indicator	The mode is indicated by whichever half is illuminated: yellow for 7-track, blue for 5-track. Pressing the button changes the mode.

Reading Incidents:

Message	Cause	OMP default action
ADDRESS FAIL	Parity failure detected in address of working store register or add- ress from which transfer is being attempted	Job halted. Reader disengaged. Message printed on Flexowriter
DISABLED	Mains supply switched off *Door or cover open *Paper tear	Job halted. Reader disengaged. Message printed on Flexowriter
PARITY FAIL	Even no. of holes detected in 7 track paper tape due to mis-punching or mis-reading	Job halted. Reader disengaged. Message printed on Flexowriter
WRONG MODE	Program or operating error in using incorrect mode	Job halted. Reader disengaged. Message printed on Flexowriter

Message	Cause	OMP default action
OMP	Failure during input of primary input directives (* TR7 only)	Job halted. Reader disengaged. Further message on Flexowriter (as above) giving cause.

The following controls and indicators apply to the Creed 3000 and Teletype punches:

ENGAGE	Push button and indicator	
DISENGAGE	Push button and indicator	
MAINS	Push button and indicator	
SELECTED	Indicator	Illuminated blue when punching
TAPE LOW	Indicator	Illuminated amber when tape supply is low or if tape breaks before reaching the tape sensing device
RUN OUT	Push button and indicator	Pressing this button causes UC characters to be punched

Punching Incidents

Message	Cause	OMP default action
ADDRESS FAIL	Parity failure detected in address of working store register or address from which transfer is being attempted	Job halted. Punch disengaged. Message printed on Flexowriter.
DISABLED	Mains supply switched off *Cover of punch raised *Tape breaks or runs out	Job halted. Punch disengaged. Message printed on Flexowriter.
PARITY FAIL	Even no. of holes found on 7 track punch. Or * failure of read-back check.	Job halted. Punch disengaged. Message printed on Flexowriter.
WRONG MODE OPERATOR	Program error Tape supply low	Punch disengaged. Message printed on Flexowriter.
OUTPUT LOST ON	Failure of OMP initiated transfer	Message printed on Flexowriter.

(* Creed 3000 only)

4.3.8 END OF TAPE

The end of tape, or a break in the tape, will be detected only by the TR7 reader operating in the "with spooling" mode: the job will be halted and a DISABLED incident signalled. The exact result of reading past end of tape on the TR5 reader and the TR7 "without spooling" depends upon the physical end of tape itself. For a character to be sensed illumination at the sprocket hole track must switch off and then on. If the paper is torn straight across a hole or across the gap between characters all tracks will be illuminated and an erase character sensed. No further characters will be sensed as the sprocket hole illumination stays on. If the tear is diagonal the last few characters sensed may be incorrect as extra holes are illuminated, or may give rise to parity failure (7 track only), or may end with an erase character as above. A further possibility is that the last character may be correctly read but no further characters sensed. Unless the end of tape causes parity fail, the reader will appear to be permanently busy - in a state to read the next character presented. No error indication will be given to the operator. Such an occurrence will necessitate a restart and programmers should therefore avoid the possibility of reading past end of tape by providing a means of detecting an end of data configuration on a paper tape.

Punches halt when the tape supply reaches a pre-determined low level. If the tape breaks whilst the punch is operating, a DISABLED incident is signalled and the device disengaged.

4.3.9 Orion 2 Differences

The information in the preceding sections 4.3.1. etc. refers in general to both Orion 1 and Orion 2. Described here are the differences to be noted when reading these for Orion 2.

Section 4.3.1. The Creed 3000 and I.C.T. TR7 are not available. Each peripheral has its own control unit.

4.4 PUNCHED CARD READERS

4.4.1 The type of card reader currently available is the I.C.T. 593 End Fed Card Reader. There are two models.

One is built to read 80 column cards with rectangular holes. The other, 80 or 65 column cards with circular, oval or rectangular holes and normal and interstage punchings. The change from 80 to 65 columns is effected by a manual switch, and by fitting a special reading head on the reader. Each card reader requires a card control unit. This unit controls the operation of the reader, carries out code conversion and passes information in units of a word to the central computer as it becomes available. A special control unit is required for interstage working.

4.4.2 MODES FOR READING CARDS

A card read is initiated in the normal way by a compound instruction e.g.

```
140.1   0       *CR1
142     INPUT   20
```

For 65 column cards the programmers' name begins *VR instead of *CR.

4.4.2.1 80 Column Cards.

There are seven modes for reading 80 column cards, the complete card or cards must be read in one of these modes:-

1. I.B.M.
2. I.C.T.
4. BULL.
7. I.B.M. and BINARY,
8. I.C.T. and BINARY.
11. BULL and BINARY.
14. BINARY.

In modes 1, 2 and 4 partial conversion of each column is carried out by hardware before the result is stored as two characters. Conversion from this form to that required within the computer is carried out by program. In mode 14, the complete card image is stored. Modes 7, 8 and 11, which combine both these forms, are intended for reading those cards which have undisciplined punching of a type which cannot be decoded using the 2 character form alone.

4.4.2.2 65 Column Cards.

There are eight modes for reading 65 column cards, the complete card or cards must be read in one of these modes:-

1. I.B.M. (Normal).

2. I.C.T. (Normal).

4. BULL. (Normal).

7. I.B.M. and BINARY (Normal).

8. I.C.T. and BINARY (Normal).

11. BULL and BINARY (Normal).

14. BINARY. (Normal).

19. BINARY, (Normal and Interstage).

Modes 1, 2, 4, 7, 8, 11 and 14 read normal punching as for 80 column cards. In mode 19, the complete card image of the normal punching and also the complete image of the interstage punching are stored.

4.4.3 TWO CHARACTER FORM

In the I.B.M., I.C.T. and BULL modes, each column of the card is examined to produce two 6-bit characters u and v. The individual bits of the characters are numbered 0 - 5.

(a) Character u

Bits 2-5 of character u are a direct copy of the upper curtate, the upper curtate rows and the placing of bits being defined by the mode of reading as follows:-

Position in Character	0	1	2	3	4	5
I.B.M. (modes 1 and 7)	-	-	10	11	0	8
I.C.T. (modes 2 and 8)	-	-	10	11	0	1
BULL (modes 4 and 11)	-	-	0	7	8	9

(The 12 Card rows are named 10, 11, 0, 1, 2, ... 8, 9 throughout this description, row 10 being the top row and row 9 the bottom row)

(b) Character v

The character v is formed by converting the punching in a column to a number 0 - 11, which is placed in positions 2 - 5 of the character. Row 10 of the card (the top row) produces 10. Rows 11, 0, 1, ... 9 produce 11, 0, 1, ... 9 respectively. If there are two or more holes in a column, the action is dependent on the placing of the holes:-

(i) Where there is one hole which is not a permissible upper curtate hole (e.g. not 10, 11, 0, 8 in the I.B.M. code) this hole is taken to form v.

(ii) Where all the holes in the column are within the permissible upper curtate, that hole nearest the 9's edge is taken to form v.

(iii) Where there are two (or more) holes outside the upper curtate the value of v is made zero. In addition a 1-bit is placed in position 0 of u to indicate an error condition. The remainder of the card is read normally. If the card has been read in Modes 1, 2 or 4, an error interrupt occurs on completion of reading the card, and the card is deflected to the reject pocket. This error interrupt is not given in Mode 7, 8 or 11, nor is the card rejected.

(c) Checking

Two types of check are carried out on each column, the result of the check being indicated by placing bits in positions 0 and 1 of v. This indication is used in the 100 convert instruction to ensure that the column contains the correct type of information. The checks are:-

(i) Position 0 of v contains 0 unless there is more than one hole in rows 1-9.

(ii) Position 1 of v contains 1 unless there is either no hole or more than one hole in rows 0-9.

4.4.4 BINARY IMAGE

In the binary image mode, an exact copy of each bit in the column is placed in the store, packed 4 columns to a word. Each column is represented by two 6-bit characters termed ba and bb. Character ba contains data from rows 10, 11, 0, 1, 2, 3 and character bb from rows 4 - 9.

4.4.5 STORAGE OF DATA

The transfer of data from the card read control to working store is in units of one word, causing a 16 microsecond hesitation per word. The placing of characters for each mode is shown below, where u_1 indicates character u from Column 1 etc.:-

Modes	1, 2, 4	7, 8, 11
Word 0	u_1 - u_4, v_1 - v_4	u_1 - u_4, v_1 - v_4
Word 1	u_5 - u_8, v_5 - v_8	ba_1 - ba_4, bb_1 - bb_4
	etc.	etc.

Modes	14	19
Word 0	u_1 - u_4, v_1 - v_4	ba_1 - ba_4, bb_1 - bb_4 Normal
Word 1	u_5 - u_8, v_5 - v_8	ba_1 - ba_4, bb_1 - bb_4 Interstage
	etc.	etc.

The number o£ words to be transferred is specified in the Y-address of the 142 function in the card feed instruction. Any number of words can be called for and more than one card can be read on one card feed instruction. When a whole card is not read the card passes the reading station and the rest of the information on it is therefore not accessible on this pass.

No. of words	Mode	80 column cards	65 column cards
17	1, 2, 4	68 columns	1 card
20	1, 2, 4	1 card	1 card and 12 columns
40	7, 8, 11	1 card	1 card and 6 columns
17	14	68 columns	1 card
20	14	1 card	1 card and 12 columns
34	19	------	1 card

The seventeenth word transferred on a 65 column card, (or the 33rd and 34th using modes 7, 8, 11 and 19) contains only one column of information, and the other 3 column positions contain zeros. When more than one card is read on one 65 column card feed instruction, columns 1, 2, 3 and 4 of the second card are transferred to the eighteenth word (or 35th and 36th words using modes 7, 8, 11 and 19).

4.4.6 INPUT CONVERSION INSTRUCTIONS

Instructions 100 and 104 are used to convert information read in by any of the 2 character modes to the form required in the computer.

4.4.6.1 100 Instruction

This instruction converts mixed radix numbers in character form to binary integers. In addition to conversion, facilities are provided to check or ignore characters, the type of action required on each digit being specified by placing bits in the two most significant bits of each radix character as follows:-

(a) 00 Convert if position 0 of v is clear (i.e. check for not more than one hole in rows 1 - 9).

(b) 01 (+16) Convert if positions 0 and 1 of v contain 01 (i.e, check for a single hole in rows 0 - 9).

(c) 10 (+32) Convert regardless of contents of v.

(d) 11 (+48) Multiply product by radix digit but ignore character v.

The sequence of events at each character is as follows, where x_n and y_n represent the n^{th} characters in registers X and Y.

a) Multiply product by bits 2-5 of y_n.

b) Unless bits 0 and 1 of y_n are 11,

i) Carry out checks on bits 0 and 1 of x_n as specified by bits 0 and 1 of y_n.

ii) Check that the number represented by bits 2-5 of x_n is less than that given by bits 2-5 of y_n.

iii) Add bits 2-5 of x_n to product.

In all cases except (d), the digit v is checked to ensure that it contains a smaller number than the corresponding radix number. (A full description of the 100 instruction is given in section 3.10). The following example illustrates the use of the 100 instruction in connection with cards.

Assume register X contains a decimal number in character positions x_3 - x_6 to be converted to a binary integer and that x_0, x_1 and x_2 contain unwanted information. The 100 instruction will convert the number and check that positions x_3 - x_6 contain digits which originated from a column containing a single hole in rows 0-9, if y, the radix word is as follows:-

Position	y_0	y_1	y_2	y_3	y_4	y_5	y_6	y_7
Contents	0+48	0+48	0+48	10+16	10+16	10+16	10+16	1+48
Action	Ignore and clear product			Convert and check for single hole in rows 0-9 checking that v contains numbers less than 10.				Ignore and preserve product

4.4.6.2 104 Instruction

This instruction converts the 4 pairs of characters contained in X and forms 4 characters by looking up a table starting in Y and placing the result in the lower half of Z, (or of X in 2-address type).

(3) $z' = z$ shifted left 4 characters + 4 characters formed.

(2) $x_m' =$ 4 characters formed. $x_u' = 0$

(A full description of the 104 instruction is given in section 3.10).

The method of table look-up is to use bits 2-5 of v to indicate a word pair in the table and bits 2-5 of u to indicate the character in the word pair. The table is therefore 24 words long. Using this technique, any of the 3, 4 or 5 zone codes can be converted. The method is illustrated by the tables on page 9.

In these tables the Erase character (value 63) is placed in all the positions of the table which do not correspond to a character in a particular code, to signify an illegal punching. Illegal punchings can be detected by scanning the result of the conversion for erase characters.

Certain codes have minor variations. The most common are:-

I.B.M.	$ for £
I.B.M. and BULL	& for 11 - for 10

The tables are constructed for ease of punching. The punching equivalents for bits 2-5 of u, forming one argument of the table, are shown at the top. The top row (10 in the I.B.M. code) provides the entry to the odd numbered words in the table. Bits 2-5 of v, shown down the page, form the other argument. (Bits 3-5 of u give the position in the word, and bits 2-5 of v and bit 2 of u give the word in the table).

For simplicity, letters and symbols have been shown in the table. These must be rewritten as numbers before acceptance by symbolic input, the required equivalent internal representation being substituted for each character.

The internal code chosen will depend on the individual program or user requirements. As far as possible, the flexowriter upper case code should be followed. The 'hardware' limits the choice of code in two ways:-

a) The output conversion instruction (101) inserts a 1-bit in the 16 position of each character, as it is being converted. The numbers 0-11 must therefore be represented by values 16 - 27.

b) The various control characters e.g. Newline, Paper Throw, Tabulate have a given action on a particular machine. It is not possible to change the interpretation of these values.

The conversion table on page 10 shows the method of writing program constants to convert the I.C.T. New 4 Zone code to an internal code assuming that:-

a) Values 16 - 27 represent numbers 0 - 11.

b) Values 33 - 58 represent alphabetic characters A - Z.

c) Value 13 represents the symbol &.

Further tables for common punched card codes are shown on Page 11. In all the codes, there may be minor variations in different punched card installations. In the older codes, certain of the characters have a dual significance (e.g. the alphabetic character I and numeral 1 may be represented by a single character). In these cases, the alphabetic equivalent has been shown. If a particular card field contains alpha characters only, it will be possible to assign the required value using these tables. Fields containing numerical data only will normally be converted direct to binary using the 100 instruction. If there are alpha-numeric fields, it is impossible to distinguish between these characters.

Code Shown and Mode used		IBM (COMMERCIAL SET) Mode 1 or 7							
Position in word		0	1	2	3	4	5	6	7
Punching represented by char. u.		(........10.........)							
		-	-	-	-	Ц	Ц	Ц	Ц
		-	-	0	0	-	-	0	0
		-	8	-	8	-	8	-	8
Word in Table.	Char. v. bits 2-5								
0	0 or	Sp	▓	0	▓	▓	▓	▓	▓
1	space	▓	▓	▓	▓	▓	▓	▓	▓
2	1	1	▓	/	▓	J	▓	▓	▓
3		A	▓	▓	▓	▓	▓	▓	▓
4	2	2	▓	S	▓	K	▓	▓	▓
5		B	▓	▓	▓	▓	▓	▓	▓
6	3	3	#	T	,	L	£	▓	▓
7		C	.	▓	▓	▓	▓	▓	▓
8	4	4	@	U	%	M	*	▓	▓
9		D	□	▓	▓	▓	▓	▓	▓
10	5	5	▓	V	▓	N	▓	▓	▓
11		E	▓	▓	▓	▓	▓	▓	▓
12	6	6	▓	W	▓	O	▓	▓	▓
13		F	▓	▓	▓	▓	▓	▓	▓
14	7	7	▓	X	▓	P	▓	▓	▓
15		G	▓	▓	▓	▓	▓	▓	▓
16	8	▓	8	▓	Y	▓	Q	▓	▓
17		▓	H	▓	▓	▓	▓	▓	▓
18	9	9	▓	Z	▓	R	▓	▓	▓
19		I	▓	▓	▓	▓	▓	▓	▓
20	10	▓	▓	▓	▓	▓	▓	▓	▓
21		Ц	▓	▓	▓	▓	▓	▓	▓
22	11	▓	▓	▓	▓	Ю	▓	▓	▓
23		▓	▓	▓	▓	▓	▓	▓	▓

Code Shown and Mode used		ICT (NEW 4 ZONE) Mode 2 or 8							
Position in word		0	1	2	3	4	5	6	7
Punching represented by char. u.		(........10.........)							
		-	-	-	-	Ц	Ц	Ц	Ц
		-	-	0	0	-	-	0	0
		-	8	-	8	-	8	-	8
Word in Table.	Char. v. bits 2-5								
0	0 or	Sp	▓	0	▓	▓	▓	▓	▓
1	space	▓	▓	▓	▓	▓	▓	▓	▓
2	1	▓	1	▓	&	▓	J	▓	▓
3		▓	A	▓	▓	▓	▓	▓	▓
4	2	2	▓	S	▓	K	▓	▓	▓
5		B	▓	▓	▓	▓	▓	▓	▓
6	3	3	▓	T	▓	L	▓	▓	▓
7		C	▓	▓	▓	▓	▓	▓	▓
8	4	4	▓	U	▓	M	▓	▓	▓
9		D	▓	▓	▓	▓	▓	▓	▓
10	5	5	▓	V	▓	N	▓	▓	▓
11		E	▓	▓	▓	▓	▓	▓	▓
12	6	6	▓	W	▓	O	▓	▓	▓
13		F	▓	▓	▓	▓	▓	▓	▓
14	7	7	▓	X	▓	P	▓	▓	▓
15		G	▓	▓	▓	▓	▓	▓	▓
16	8	8	▓	Y	▓	Q	▓	▓	▓
17		H	▓	▓	▓	▓	▓	▓	▓
18	9	9	▓	Z	▓	R	▓	▓	▓
19		I	▓	▓	▓	▓	▓	▓	▓
20	10	▓	▓	▓	▓	▓	▓	▓	▓
21		Ю	▓	▓	▓	▓	▓	▓	▓
22	11	▓	▓	▓	▓	Ц	▓	▓	▓
23		▓	▓	▓	▓	▓	▓	▓	▓

Code Shown and Mode used		BULL (OLD CODE) Mode 4 or 11							
Position in word		0	1	2	3	4	5	6	7
Punching represented by char. u.		(........0..........)							
		-	-	-	-	7	7	7	7
		-	-	8	8	-	-	8	8
		-	9	-	9	-	9	-	9
Word in Table.	Char. v. bits 2-5								
0	0 or	Sp	▓	▓	▓	▓	▓	▓	▓
1	space	0	▓	▓	▓	▓	▓	▓	▓
2	1	1	U	L	▓	C	▓	▓	▓
3		▓	▓	▓	▓	▓	▓	▓	▓
4	2	2	V	M	▓	D	▓	▓	▓
5		▓	▓	▓	▓	▓	▓	▓	▓
6	3	3	W	N	▓	E	▓	▓	▓
7		▓	▓	▓	▓	▓	▓	▓	▓
8	4	4	X	P	▓	F	▓	▓	▓
9		▓	▓	▓	▓	▓	▓	▓	▓
10	5	5	Y	Q	▓	G	▓	▓	▓
11		▓	▓	▓	▓	▓	▓	▓	▓
12	6	6	Z	R	▓	H	▓	▓	▓
13		▓	▓	▓	▓	▓	▓	▓	▓
14	7	▓	▓	▓	▓	7	▓	▓	▓
15		▓	▓	▓	▓	B	▓	▓	▓
16	8	▓	▓	8	▓	▓	▓	▓	▓
17		▓	▓	K	▓	▓	▓	▓	▓
18	9	▓	9	▓	▓	▓	▓	▓	▓
19		▓	T	▓	▓	▓	▓	▓	▓
20	10	Ц	▓	▓	▓	▓	▓	▓	▓
21		▓	▓	▓	▓	▓	▓	▓	▓
22	11	Ю	S	J	▓	A	▓	▓	▓
23		▓	▓	▓	▓	▓	▓	▓	▓

The symbol ▓ represents erase
The symbol * represents asterisk (word 8, I.B.M. Code).
The notation (......10.......) or (......0.......) means:-
If the row (10 or 0) is not punched, take the first word of the word pair,
If the row (10 or 0) is punched, take the second word of the word pair.

Sample card-input code conversion table for use with the 104-instruction, in a form acceptable to Symbolic Input.

<u>I.C.T. NEW 4 ZONE CODE. (Mode 2 or 8).</u>

Char. Pos. / Word.	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
0	0,	63,	16,	63,	63,	63,	63,	63	Sp		0					
1	63,	63,	63,	63,	63,	63,	63,	63								
2	63,	17,	63,	13,	63,	42,	63,	63		1		&		J		
3	63,	33,	63,	63,	63,	63,	63,	63		A						
4	18,	63,	51,	63,	43,	63,	63,	63	2		S		K			
5	34,	63,	63,	63,	63,	63,	63,	63	B							
6	19,	63,	52,	63,	44,	63,	63,	63	3		T		L			
7	35,	63,	63,	63,	63,	63,	63,	63	C							
8	20,	63,	53,	63,	45,	63,	63,	63	4		U		M			
9	36,	63,	63,	63,	63,	63,	63,	63	D							
10	21,	63,	54,	63,	46,	63,	63,	63	5		V		N			
11	37,	63,	63,	63,	63,	63,	63,	63	E							
12	22,	63,	55,	63,	47,	63,	63,	63	6		W		O			
13	38,	63,	63,	63,	63,	63,	63,	63	F							
14	23,	63,	56,	63,	48,	63,	63,	63	7		X		P			
15	39,	63,	63,	63,	63,	63,	63,	63	G							
16	24,	63,	57,	63,	49,	63,	63,	63	8		Y		Q			
17	40,	63,	63,	63,	63,	63,	63,	63	H							
18	25,	63,	58,	63,	50,	63,	63,	63	9		Z		R			
19	41,	63,	63,	63,	63,	63,	63,	63	I							
20	63,	63,	63,	63,	63,	63,	63,	63								
21	26,	63,	63,	63,	63,	63,	63,	63	Ю							
22	63,	63,	63,	63,	27,	63,	63,	63					Ц			
23	63,	63,	63,	63,	63,	63,	63,	63								

The numbers enclosed within the box represent the actual code table as prepared for Symbolic Input.

IBM SCIENTIFIC SET. (Mode 1 or 7)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp		0					
1								
2	1		.		J			
3	A							
4	2		S		K			
5	B							
6	3	=	T	,	L	π		
7	C	/						
8	4	'	U	(	M	*		
9	D	)						
10	5	→	V		N	≠		
11	E							
12	6	Ø	W		O	>		
13	F							
14	7	≡	X		P	?		
15	G	»						
16		8		Y		Q		
17		H						
18	9		Z		R			
19	I							
20								
21	+							
22					-			
23								

HOLLERITH 3 ZONE (Mode 2 or 8)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp		0				B	
1			N					
2		1				C		
3		P						
4	2				D			
5	Q							
6	3				E			
7	R							
8	4				F			
9	T							
10	5				H			
11	U							
12	G				J			
13	V							
14	7				K			
15	W							
16	S				L			
17	X							
18	9				M			
19	Y							
20								
21	Z							
22					A			
23								

HOLLERITH OLD 4 ZONE. (Mode 2 or 8)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp		0					
1								
2		1		C		B		
3		A						
4	2		F		E			
5	D							
6	3		I		H			
7	G							
8	4		L		K			
9	J							
10	5		O		N			
11	M							
12	6		R		Q			
13	P							
14	7		U		T			
15	S							
16	8		X		W			
17	V							
18	9		&		Z			
19	Y							
20								
21	Ц							
22					Ю			
23								

HOLLERITH 5 ZONE. (Mode 2 or 8)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp		0					
1								
2		1		&		J		
3		A						
4	2	%	S		K			
5	B							
6	3	¼	T		L			
7	C							
8	4	-	U		M			
9	D							
10	5	/	V		N			
11	E							
12	6	½.	W		O			
13	F							
14	7	.	X		P			
15	G							
16	8	@	Y		Q			
17	H							
18	9	¾	Z		R			
19	I							
20								
21	Ю							
22					Ц			
23								

POWERS 32 CHARACTER. (Mode 2 or 8)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp		0					P
1			C					
2		I					Q	
3		D						
4	2					R		
5	E							
6	3					T		
7	F							
8	4					U		
9	H							
10	5					V		
11	J							
12	G					W		
13	K							
14	7					X		
15	L							
16	S					Y		
17	M							
18	9					Z		
19	N							
20								
21	A							
22						B		
23								

POWERS 39 CHARACTER. (Mode 2 or 8)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp		0					
1								
2		1		S		J		
3		A						
4	2		T		K			
5	B							
6	3		U		L			
7	C							
8	4		V		M			
9	D							
10	5		W		N			
11	E							
12	6		X		O			
13	F							
14	7		Y		P			
15	G							
16	8		Z		Q			
17	H							
18	9				R			
19	I							
20								
21	Ю							
22					Ц			
23								

BULL NEW CODE. (Mode 4 or 11)

Word No. \ Char. Pos.	0	1	2	3	4	5	6	7
0	Sp							
1	0							
2	1	U	L	)	C	%		
3								
4	2	V	M	x	D	$		
5								
6	3	W	N	:	E	£		
7								
8	4	X	P	<	F	◊		
9								
10	5	Y	Q	>	G	☐		
11								
12	6	Z	R	≠	H	△		
13								
14					7			
15					B			
16			8					
17			K					
18		9		-		*		
19		T		(		'		
20	Ц	.	I	+	O	/		
21								
22	Ю	S	J	=	A	,		
23								

4.4.7 I.C.T. 593 END FED CARD READER

General Description

This card reader reads 80 column or 65 column cards at 600 cards per minute. The machine consists of a card hopper on the right of the machine and a card stacker on the left connected by a card track, the whole assembly being inclined to the rear. Cards are fed into the hopper face down, column 1 to the left. Card movement from right to left is initiated by two feed knives which move the bottom card under rollers. The rollers move the card past the reading head and round a U bend to enter the left side of the stacker, column 1 now to the right. There is a device which lifts all the cards in the stacker every machine cycle to allow cards unrestricted entry to the bottom of the stacker.

Card Hopper

The hopper has a maximum capacity of 2000. Cards are fed in two separate stages; a 'reservoir' of about 1500 cards is held up by a special clamp, while a separate, lower 'working block' of about 400 cards is served by a micro-switch which arranges to release approximately 75 cards from the reservoir into the working block when the level becomes low. Card feeding will continue until the level of cards has reached 200, when it will be stopped unless the card weight is in position. To restart the machine either more cards or the card weight must be placed in the hopper and the engage button pressed. If the card weight is in place at 200 cards, the cards will run through uninterruptedly. The card weight may be placed at any time after the reservoir has become empty. Cards may be placed on top of the reservoir while the machine is running.

Card Reading

The reading head has two read positions spaced one column apart. As the columns pass the read positions they are read at each by a set of 12 photo-electric cells corresponding to the 12 index rows of a card. The control unit carries out a row-by-row comparison of the readings. If any of the columns has been misread, the card is sent automatically to the reject pocket, which is located at the bottom left side of the machine. This pocket has a capacity of 500 cards. There is no facility to deflect cards by program into this pocket.

Timing of Operations

One machine cycle takes 100 ms. Once started, the machine operates continuously, feeding cards at a certain point in this 100 ms. cycle whenever a card-call signal is received from the card control unit. Since continuous operation of this machine causes wear, the machine is automatically switched off if a card is not called in a period of a minute. The machine remains ‘engaged’. A subsequent card call will re-start the machine and feed a card when full speed is reached. To maintain full reading speed a card-call signal must be sent to the machine within 4 ms. of check reading the last column of the previous card. (This allows about 3 ms. of program time after leaving the tine-sharer following the interrupt on completion of reading the card). If a card-read is initiated while the previous card is still being read, this card-read instruction will be locked out until the previous card read is completed. If a card read is not initiated in time, one machine cycle will elapse before the next card is fed. The reading of the card takes 57 ms. The remaining 43 ms. of the cycle represents the gap between cards.

Controls and Lights.

The following controls and lights are placed on the display panel on the card reader:

‘Engage’ Push Button and Indicator,

‘Disengage’ Push Button and Indicator.

‘Select’ Push Button and ‘Busy’ Indicator.

'Card-Wreck or Misfeed'	Indicator.	
'Card Levels'	Indicator.	[Hopper Low (200 cards) or Stacker Warning (2000 cards) or reject pocket full (500 cards)].
'Manual'	Indicator.	
'Mains On'	Indicator.	[or 65-80 column switch/indicator in the case of the 65 column machine].

Operating Procedure

Cards are fed face down, column 1 leading.

The following conditions result in monitor action, (see Section 5.5.2)

a) Card Misread.

b) Illegal punching in modes 1, 2 or 4.

c) Card Misfeed.

d) Card Wreck.

e) Hopper empty.

f) Hopper below 200 cards without weight in place.

g) Stacker full. (2000 cards).

h) Reject Pocket full. (500 cards).

Action on Cards Low in multi-card transfers

If the 'Card levels' indicator is set during a multi-card transfer, other than during the last card, then the transfer is abandoned at the end of the current card, no further cards being fed. Any program which uses multi-card transfers must deal with this - there are two suggested ways of doing so:

(a) A restart could be set up for Code 4 (see 5.5.2). This should look at the current address in the X address position of the interrogation information. This is the address of the first card image not read and hence the number of cards not read can be deduced. The restart can disengage the reader then initiate a transfer to read the cards not read before returning to the main program by a 150/25 instruction as usual.

(b) Before each transfer the program could clear the region concerned with a 143 instruction. If the default restart took place and the transfer was abandoned it would appear to the programmer as though a few blank cards had been read - the program would presumably ignore these.

It is possible for a transfer to be abandoned even if it only asks for one card - this occurs if one initiates a transfer with card levels set; in this case no card is read or fed. This can only happen if (a) the program's restart on card levels asks for another card without disengaging or (b) the operator removes cards or the card weight between transfers.

Cards Low and Hopper Empty

Cards Low

When the last card that can be fed has been fed, a cards level indicator is set which causes an OPERATOR interruption. In general the interruption occurs after the card has been successfully read; the card will appear in the stacker. The OMP default action in this case will be adequate.

It is possible that the indicator will be set at the beginning of the transfer, in which case the transfer will be lost. If this occurs with the last readable card it will not be read but will be deflected into the reject pocket. There will have to be a restart to re-read this card, though see "Action on Cards low in multicard-transfers (b)"

Hopper Empty

In this case both OPERATOR and DISABLED incidents are signalled. It is recommended that several blank cards should always terminate a pack so that this case will not occur.

4.4.8 Orion 2 Differences

The information in this section refers in general both to Orion 1 and Orion 2. Described here are the differences to be noted when reading the subsections for Orion 2.

The main differences are that the conversion to u and v characters is done by the extracode and not by hardware, and that Modes 4 and 11 are not available for both 80 and 65 columns.

Section 4.4.2.1. Mode 19 (binary and interstage) is available for 80 columns - the interstage button must be “on” for use by extracode when this mode is used.

4.5 Mechanical Printers and Card Punches

The following types of mechanical printer and card punch, all of which are controlled by the same type of control unit, are currently available for use in an Orion system.

ICT 665 Line Printer
582 Card Punch

ANELEX Type 4-1000 Printer

4.5.1 Control Unit

When a transfer to a printer or punch has been initiated the appropriate core store area is weakly locked-out and computing resumed. The transfer of data to the control unit and the completion of the required function proceeds autonomously. On completion of the function an interrupt occurs.

Incidents which occur during the function will cause Monitor action to take place (see Section 5.5.3). If the object program includes restart action it should be noted that parallel output devices seldom give the correct transfer addresses but will give the current addresses in the lock-out box of the parallel output control, which may be for a transfer connected with another object program using a different printer or punch. It should also be noted that the only core store lock-out which occurs is during the transfer to the data or code buffer, and when this transfer has been completed the program is allowed to continue. Any incidents which occur during the transfer of the information from the buffer to the printer or punch will not give as the link, the address of the transfer, but the address reached by the object program.

The control unit is capable of operating all of the peripherals attached to it currently. There are two buffer stores in the control unit associated with each peripheral, termed the Data and Code Buffers. Each of these stores consists of 6 nickel delay lines, which hold 128 6-bit characters in parallel. The last characters are not usable by the programmer and the effective length of each buffer is therefore 120 characters. The Data Buffer contains data to be output. The Code Buffer contains information which dictates the code interpretation for the data in the corresponding Data Buffer.

4.5.2 Transfer of Data to Buffer Store

Transfers to the printers and punches are initiated in the normal way using a compound instruction, e.g.

```
140.21  0        *CP1      for Card Punch
142              OUT       10

140.21  0        *LP1      for Mechanical Printers
142              OUTP      15
```

When a transfer is initiated, the buffer is automatically cleared and then filled word by word from the core store. The Y-address of the 142 order contains the number of words to be transferred. For the printers the Y-address may not exceed 15 words, and for the card punch the maximum is 10 words for a coded interpretation, and 20 words for binary. If these numbers are exceeded the buffer will overflow and cause monitor action to take place. (See Section 5.5.3.)

The modes associated with card punches and printers are as follows:-

Card Punch	Mode 21	Fill the data buffer and punch a card in accordance with the contents of the code buffer.
	Mode 22	Fill the data and code buffers and punch a card in binary.
	Mode 26	Fill the code buffer.
Line Printer	Mode 21	Fill the data buffer and print a line in accordance with the contents of the code buffer.
	Mode 22	Fill the data buffer and print a line in accordance with the contents of the code buffer, using a restricted set of printing characters.
	Mode 26	Fill the code buffer.

The total time for transferring a complete block of 15 words is of the order of 2 ms. but the central computer only loses 0.24 ms. of this time in hesitations. The core store area concerned is locked out for this 2 ms. period, this lockout being lifted when the transfer is complete. The printer or punch concerned is locked out when the operation commences and remains locked out until the operation has been completed. The process of transfer is identical for both data and code buffers, but while the data buffer is refilled for every line or card, it is normally necessary to fill the code buffer only once per program.

4.5.3 Data Buffer

This buffer contains the data to be output in the particular code set by the program. For printing purposes the data buffer may also contain the control characters New Line, Paper Throw and Tabulate which have a fixed value 2, 3 and 4 respectively and may not be used as values in the code buffer, (they may be used for the card punch code values). With each control character a further character is used to specify certain action as described below, both characters count towards the maximum of 120 characters for a transfer. These values cause a similar interpretation on any of the printers, although the exact interpretation varies.

New Line NL (Value 2)

This character is followed by a character indicating the number of lines to be moved. These two characters terminate the transfer, no further characters being read into the buffer. The following conditions will result in no paper feed.

a) The second character is zero.
b) The last character of the transfer is NL.
c) The transfer does not contain the character NL.

If the number of new lines requested is greater than 5 on the 665 printer, or 3 on the Anelex, the paper movement will be terminated if a 'Top of Form' marker is encountered before the correct number of new lines have been completed. It is recommended that the paper throw facility should be used whenever it is necessary to move to a specific position on another page, by paper throw to 'top of form', followed by a new line transfer to the required position.

Paper Throw PT (Value 3)

This causes the paper to be 'thrown' until a certain position has been reached and like NL terminates the transfer. The next character indicates which of several possible throws are to be used on the Anelex Printer. On the ICT Printer whatever value is set in the next character the throw will always be to the head of the form.

The paper throw channels 1 to 7 can each have as many holes punched in them as required. Using standard stationery with 66 lines to a sheet, each channel can have up to the maximum of 66 holes. A paper throw character followed by a channel number will cause a throw until the next hole in the channel is found, or to the 'Top of Form' if Channel 0 is detected first. In this way one channel can be used to specify the format on a form, and each transfer can be followed by the same paper throw character, and one 8-channel loop could be used to specify 7 different formats using one channel each. If PT is the last character of the transfer the paper throw is to 'top of form'.

Tabulate TB (Value 4)

This character, in association with the following character, provides a facility for skipping to a pair of print positions. For TB the 120 print positions numbered 0-119 from the left hand end of the printer, are taken as 60 pairs of positions numbered 0-59 and the print position where printing will take place is double the value of the character following TB, e.g.

to print A in position 100, transfer 4, 50, A

to print A in position 101, transfer 4, 50, 0, A

Tabulate positions do not have to be used in numeric order, e.g. a transfer 4,40,A,4,2,A is permissible and will result in A being printed in positions 4 and 80.

Information will be lost if characters 60,61,62,63 follow the tabulate character, and also if there are more characters sent after a TB than there are positions left on the printer, e.g. 4,50 followed by 25 characters will result in the last 5 characters being lost.

The tabulate facility could be misused to attempt to print two characters in one position, (e.g. 4,6,A,B,C,D,E,4,8,X,Y,Z). If this is done the results are somewhat unpredictable. If it is required to overprint a character two lines must be printed without moving the paper. For engineering reasons a gap of approx. ½ revolution of the barrel is necessary between consecutive firings of the same hammer, and so ideally the programmer must arrange a delay of at least 30 ms. between these lines, when using the 665 printer.

If the data contains a character which is not set in the code buffer a space will occur on the paper, or a blank column on a card. Character 0 (zero) and 63 (erase) will always cause this to happen as these have a special significance in the code buffer.

4.5.4 Code Buffer

This buffer specifies which characters of the internal computer code correspond to each index point of the punch or printer. The index point is defined as each row on the card punch, or each position on the print wheel of the printer. The internal representations of the characters to be output at each index point are placed in groups in the code buffer, the groups being separated by erase characters, value 63. If an index point is not being set, binary zero, i.e. a space character should be used to separate two erase characters. If erroneously two or more erase characters are set in consecutive positions they will only be counted as one, they do not cause an unset index point.

The principle can best be explained by an example. The following table shows the code table necessary to interpret an internal code to the new Hollerith 4-zone code on a card punch, assuming the 10 row, the top row, of the card is punched first. All characters which result in a hole in the 10 row are listed first, then all in the 11 row, etc. Some characters are mentioned twice, e.g. 'A' which results in a hole in row 10 and row 1.

The code table is as follows»-

10ABCDEFGHI	Erase	10th row
11JKLMNOPQR	Erase	11th row
0&STUVWXYZ	Erase	0 row
1AJ&	Erase	1st row
2BKS	Erase	2nd row
3CLT	Erase	3rd row
4DMU	Erase	4th row
5ENV	Erase	5th row
6FOW	Erase	6th row
7GPX	Erase	7th row
8HQY	Erase	8th row
9IRZ	Erase	9th row

The appropriate group of characters is examined at each index point to test for equivalence with a character in the data buffer. Wherever there is a coincidence a hole is punched or a character printed in the appropriate column or print position.

For simplicity, letters and symbols have been shown in the table above and in other tables in this section. These would have to be written as numbers for acceptance by symbolic input, the appropriate equivalent internal representation being substituted. It is important to realise that the internal code is assigned arbitrarily by the programmer, but it is recommended that as far as possible the code used should be compatible with the standard code buffer used by the Monitor program. (See Section 5.6.2 for the card punch and Section 5.6.3 for the printers). In particular, it should be stated that to reserve a card reader a 'document card' is required in the standard code, and if a card punch is reserved with a 150/33 or 150/34 instruction, in the first instance the standard code will be set and a document name will be punched. If the object program is using a different code, this must be set after the 'document card' has been output, and if a further document is required at a later point in the program, it should be noted that the 150/33 or 150/34 instruction does not reset the standard code if the punch has already been reserved for the program. This could result in a 'document card' in a non-standard code which could not be used for reserving a card reader. It is recommended that one of the following actions should be taken so that the correct 'document card' is output.

a) The punch should be relinquished before the 150/33 or 150/34 instruction.

b) The object program should set the standard code before the 150/33 or 150/34 instruction.

4.5.5 Buffer Store Cycle Time

The store cycle time of the complete buffer store depends on the number of peripheral devices connected to the control unit and the number of times each store is examined in a store cycle. The buffers have a cycle of .512 ms. The control unit interrogates each buffer in turn, the sequence of interrogation being determined by hardware built into the control unit. Each buffer must be interrogated in the appropriate half of the cycle. For example, the control unit could be arranged to interrogate buffers in sequence

01 23 01 24

In this arrangement the store cycle time is 2.048 ms. (.512 x 4). Buffers 0, 1 and 2 are examined every 1.024 ms. and buffers 3 and 4 every 2.048 ms.

For any given peripheral device the control unit requires to examine the associated buffer at each index point. If each of several different characters involves a print or punch at that index point, this buffer must be examined the appropriate number of times (e.g. in the card code above, the buffer must be examined 10 times at the 0 row since each of the ten characters O&STUVWXYZ requires a hole to be punched in the 0 row.

These factors impose two limitations:

a) the number of peripheral devices which can be served by one control unit is limited to 8. For this purpose the ICT 665 hammer printer counts as two devices.

b) the maximum number of characters which can be specified for punching or printing at any index points depends on the time available on that peripheral type of device and the number of peripheral devices attached to the control unit.

	No. of devices	4	8
	Cycle time of buffer store	1.024 ms	2.048 ms
Device Type	Time available at each index point in m.s.		
ICT 665 Printer	1.3	1	1
ICT 582 Punch	38	36	18

The limitation of 18 will prove embarrassing only if it is required to punch either the new Bull or the full IBM Scientific codes. If required, the punches may be treated in the same way as the ICT printer, i.e. as 2 machines, where the appropriate buffer is examined twice in a store cycle. This allows any code to be punched but reduces the upper limit of the number of devices which can be connected to one control unit.

4.5.6 Punching of Binary Cards

Binary punching of cards differs considerably from the other modes in that there is no interpretation necessary and the complete card image held in the store is punched on the card. Card Punch Mode 22 transfers up to 20 words to the control unit, which punches a binary card. The first ten words are stored in the data buffer and subsequently punched in rows 10 - 3, the top half of the card. The second ten words are stored in the code buffer and punched in rows 4 -9 of the card.

It is normal to transfer 20 words exactly. If less than 20 are transferred, only part of the card is punched; e.g. a transfer of 15 words will result in punching of the top 6 rows in all columns and the bottom 6 rows in columns 1 to 40 only. Position 0 of the first word corresponds to row 10 of card column 1, position 0 of the eleventh word corresponds to row 4 of card column 1 and position 47 of the 20th word to row 9 of card column 80 etc. If normal alpha-numerical punching is to continue after punching a binary card, the code buffer must be refilled.

4.5.7 I.C.T. 665 Hammer Printer

General Description

This device is a line at a time printer capable of a speed of up to 800 lines per minute. There are 120 columns on the printer and a selection of 50 characters. The print barrel, consisting of 120 type wheels, each of which has 50 characters around its circumference, revolves continuously in front of the paper. 120 corresponding print hammers located behind the paper are actuated individually to strike the paper against the associated print wheel when the appropriate printing character is passing the hammer. The paper is stationary while a line of printing occurs, and is moved using sprocket holes between lines of print. Format control is entirely by computer program.

Printing

The print barrel has 120 wheels, spaced 10 to the inch, each with 50 characters. A character timing disc fitted to the end of the print barrel provides a signal to the control unit as each print row passes. A counter reflecting the current barrel position is maintained in the control unit. When printing, the control unit checks for equivalence between the character placed in the code buffer corresponding to this barrel position with the data in the information buffer and releases the appropriate hammer where equivalence occurs.

<u>Paper Feed</u>

Between lines of print the paper is moved by tractors. On this printer, the number of lines required to move the paper from its current position is given by the character following a new line character. (See Section 4.5.3) Paper throw results in movement of the paper until a printed black 'Mark' on the side of the paper is detected by a photocell. The paper movement is actually stopped 5 lines after the 'mark' is detected, and for this reason paper throw must not be called for distances of less than 6 lines from the bottom of the sheet, or the throw will be to the next but one sheet. If more than 5 new lines are requested, a paper throw is called for 5 lines less than the number of new lines required. If the black mark is detected during this throw, the paper movement will stop after a further 5 lines. This may result in an incorrect number of new lines.

<u>Timing of Operations</u>

A printing cycle can be divided into 2 parts, printing and paper movement. The print barrel revolves continuously at 800 r.p.m. ± 5 per cent (one revolution takes 75 ms.). Printing time depends on the mode of printing.

Mode 21 prints an alpha-numeric line asynchronously.

Printing commences wherever the print barrel happens to be and continues for one revolution. Printing therefore takes a fixed time of 75 ms.

Mode 22 prints a line containing the first 26 characters on the print wheel (i.e. all characters except C to Z using the Commercial Barrel), synchronously. Printing commences at the first character and the time is therefore the access time to the first character + 39 ms.

Paper movement time is given by the formula $25 + 8(x - 1)$ ms. where x is the number of lines required.

Using Mode 21 the time for one line and one space is 100 ms. (600 lines/minute). When using Mode 22, printing will be carried out at 800 lines/minutes if 2 or less spaces are required between lines. However, if this number is exceeded, the rate will drop to 400 lines/minute. In this case, or whenever the access time is greater than 39 ms., Mode 21 yields a higher printing rate than Mode 22.

In either mode, the lockout of the data buffer is not lifted until paper movement finishes.

Paper Details

The paper must be sprocket fed and interleaved.

The maximum overall width of stationery is 16 inches, the margins at this width being 2 inches on either side of the 12 inch printing area. The minimum width is 6 inches overall. The tractors are adjustable to any width between these extremes,

One original plus 3 copies are obtained with suitable stationery.

The original copy is obtained using a broad inked ribbon. This ribbon, running between two spools located above and below the print position, reverses automatically when it reaches either end. The 3 copies are obtained using one-time carbon interleaved between the copies. This carbon moves with the stationery.

Character set

There are three character sets at present available on the 665 printers. These are as follows, in the order in which the characters are arranged in the print wheels.

1 Commercial Barrel

0 ½ 1 - 2 + 3 . 4 , 5 £ 6 % 7 (8) 9 * 10 & 11 /
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

2 Scientific Barrel

0 = 1 - 2 + 3 . 4 , 5 π 6 ' 7 (8) 9 * < ? > /
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

3 Swedish Barrel (ICT Gothenburg)

0 ¼ 1 ½ 2 ¾ 3 - 4 + 5 . 6 x 7 % 8 ‰ 9 & / A B C D
E F G H I J K L M N O P Q R S T U V W X Y Z Å Ä Ö

The code buffer is filled with the internal representation of these characters separated by erase characters (i.e. for the Commercial Barrel

0 Er ½ Er .... Y Er Z Er).

The code buffer is filled as shown for both Modes 21 and 22. As already stated, Mode 22 only prints the first 26 characters of the print wheel, and if characters in the last 24 are sent, a space will occur. The whole code buffer need not be set for Mode 22.

Controls and Indicators

The printer display carries the following controls and indicators.

ENGAGE	Push Button and Indicator	
DISENGAGE	Push Button and Indicator	
START LOCAL	Push Button	This is only operative when the printer is disengaged, and causes the motors to start. The button stays depressed until either the Stop Local, Disengage or Engage buttons are pressed.
STOP LOCAL	Push Button	If the printer is disengaged and the motors running under the action of the Start Local button, this button immediately stops the motors and releases the Start Local button. If the printer is engaged, this button causes the printer to be disengaged after 100 ms.
RUN OUT	Push Button	When pressed, the paper will run out until either the 'mark' is detected or the button released. If the printer is engaged when the button is pressed, it will disengage before the paper moves. If the paper is incorrectly loaded and a mark not detected, after a nominal 2 seconds of paper movement it will stop
POWER ON	Indicator	Shows green light if the power supplies are functioning normally.
PAPER LOW	Indicator	Indicates when the last sheet of paper has left the paper trolley. About 2 feet of paper is left, and can be used, but when this has been used the printer will automatically stop regardless of any signals from the computer. When the Paper Low lamp is lit, it is impossible to engage the Printer.

HAMMER FUSE	Indicator	Indicates that a fuse has blown or the printer is disabled
PAPER FEED BUSY	Indicator	
BUSY	Indicator	

In addition, there is an emergency stop button which should only be touched in an emergency, as some time will be needed to restart the printer.

Operating Procedure

The following conditions result in monitor action:

a) Low paper — This condition occurs when the last sheet of paper leaves the paper trolley

b) Disabled — This condition occurs when:

(i) The last sheet of paper has passed the paper tensioning device.

(ii) The print barrel is in the 'Open' position, or not severely clamped.

(iii) The power supply has failed

(iv) Ribbon jammed

(v) Engineers' switches on (these are situated inside the printer).

(vi) Ribbon run away.

(vii) Paper run away (after nominal 2 seconds delay).

(viii) Motor jammed.

Installation Details

Approximate Plan Dimensions	4'6" front x 3'6" side. The paper tray projects from the back of the printer by 2' 3".
Approximate Weight	1000 lbs
Power Supply	440 V.A.C. 3 phase
Heat Dissipation	2.5 Kw.

4.5.8 I.C.T. 582 Card Punch

General Description

This machine punches 80-column cards with rectangular holes at the rate of 100 cards per minute. The cards are fed broadside on, face down with the 10 edge leading, thus punching one row at a time. The card track comprises card hopper, punching station, check reading station and stacker which are all one card cycle apart. The card capacities of the hopper and stacker are approximately 700 and 800 cards respectively.

Punching

Punching is carried out by a single row of 80 punch knives which punch each of the 12 rows in turn. There are no restrictions on the number of holes which may be punched in any one card. To maintain a maximum punching speed of 100 cards per minute, each card punch transfer must be initiated within 40 ms, of completion of punching the previous card. If the punch is allowed to stop between punch cycles it will take 66 ms. to restart.

The punch may be used off line as a gang punch.

Punch Checking

Checking is carried out by a single row of 80 check brushes which sense each row in turn. The punching in each row of the card is treated as an 80-bit serial number. These numbers are accumulated in a 128-bit adder loop as each of the 12 index points of the card passes. On completion of the card passage the sum formed is compared with a similar sum of data sent to the punch station. If there is a disagreement the card is offset in the stacker by about 3/8 inch, and the monitor program entered. The check of the punching and the offsetting of the card is carried out by hardware. There is no way of causing an offset card by program.

Code Interpretation

Any given code can be punched by filling the code buffer with the appropriate internal representation. However, there is a limitation on the number of characters at one index point (see Section 4.5.5).

One character in the buffer is translated into a character in one column of the card. Overpunching, split columns and undisciplined punching of any type designed to increase the capacity of a card by punching 2 unrelated figures in the same column will, therefore, require the conversion of the two figures to one character by program.

Controls and Lights

The display panel carries the following controls and indicators.

ENGAGE	Push Button and Indicator
DISENGAGE	Push Button and Indicator
POWER ON/OFF	Push Button and Indicator

RUN BUTTON	)	These Buttons are only effective when the machine is disengaged. Pressing the 'Run' Button has the effect of making the machine cycle continuously.
STOP BUTTON	)	

CARD WRECK or CARD MISFEED	Indicator
HOPPER EMPTY	Indicator
STACKER FULL	Indicator
BUSY	Indicator

Operating Procedure

The following is a list of conditions which result in monitor action (see Section 5.5.3, page 1) and the restart action necessary to correct sequence of cards.

a) Cards low or operators requirements.

b) Disabled.

In the event of a) or b) the fail interrupt occurs when a new transfer is initiated. To restart it is necessary to repeat this transfer.

c) Buffer Overflow.

d) Current Address Parity Pail.

These interrupts occur during transfer from the core store to the buffer, and to restart it is necessary to repeat the transfer.

e) Failure of Read Check.

This is a failure at the read station on the punch.

The card will be offset automatically, and to restart it will be necessary to output the failing card, and the following card (which was being punched at the time of the read check failure). Both the offset card and the following card should be removed.

f) Checksum failure

This is a failure in the control unit. i.e. in the buffer store.

When this occurs and the transfer abandoned, the card passing under the read check station will probably fail and be offset. It is necessary to repunch the failing card and the previous card. The monitor program will reset the standard code.

A plugboard is provided on this machine. This provides the normal facilities of a gang punch, when the machine is run detached from the computer. There are four groups of 980 positions on the board:-

Computer Outlet	Punch Magnets
Computer Input	Brushes

The Computer Outlet and Input positions provide a link with the punch control. The Punch Magnet and Brush positions provide a link with the punching and checking stations of the punch. The 80 individual computer outlets are normally plugged to the corresponding punch magnets and the computer inputs to the brushes. The facilities of the plugboard can, however, be used to provide format control or to ignore columns, etc.

Installation Details

Approximate plan dimensions	4’0” front x 2’0” side
Weight	504 lbs.
Approx. dimensions of Electronics Cabinet	1’6” front - 2’0” side, spaced 6” from side of 582.
Weight of Cabinet	150 lbs.
Power Supply	230 V.A.C. Single phase
Total Heat Dissipation	1 Kw.

4.5.9 Anelex Type 4-1000 Printer

General Description

This machine is a line at a time printer capable of a speed of up to 1000 lines per minute. In front of the paper is a continuously rotating print barrel, which carries a complete character set for every print position along the line, behind the paper is a row of hammers, one for every print position, which are actuated individually to strike the paper against the associated print wheel when the appropriate character is passing the hammer. The paper is stationary while printing occurs and is moved by tractors between lines of print. Format control is entirely by computer program.

<u>Printing</u>

The print barrel has 120 print positions, spaced 10 to the inch, each with 60 characters. The 60 characters are distributed round the print barrel on a 64-character pitch.

<u>Paper Feed</u>

Between lines of print the paper is moved by tractors. One set of tractors is positioned before the print station, and one set after the print station. There are two ways of initiating paper movement, Newline and Paper Throw, both of which move the paper at the same speed. The newline character causes the paper to move the number of lines specified by the character following the newline character. In the case of Paper Throw the stationery is moved to a pre-set position on a form. The machine is equipped with a vertical format tape reader. This reads a paper loop, cut to the same number of characters as the number of lines on the form being printed, and the loop moves in synchronism with the stationery. The loop has 8 channels numbered 0-7 along which hole's are punched as required. The effect of Paper Throw is to move the paper until the next hole is detected in the channel whose address is indicated by the three least significant bits of the character following the Paper Throw character. By convention, Channel 0 is reserved for indicating 'Top of the Form', but there is no restriction on the use of channels (for further details see section 4.5.3). It is recommended that only channel 0 should be used and this should be 'Top of Form'; positions on the form then being so many lines from 'Top of Form'.

A printing cycle can be divided into two parts, printing and paper movement. The printing barrel revolves continuously at 1000 r.p.m. (one revolution takes 60 ms. on high or 90 ms, on low). Printing time depends on the mode of printing.

Mode 21 prints an alpha-numeric line asynchronously. Printing commences wherever the print barrel happens to be and the barrel rotates nearly one and a quarter times during a single cycle and line feed. The single spaced printing speed is 800 lines per minute.

Mode 22 prints a line synchronously, the character set being limited to the first 48 characters on the print wheel. The barrel rotates exactly once per single print cycle and single line feed, the latter occurring while the 16 unused character positions are passing the hammers. A cycle may only start at the beginning of the character set, and there may be up to 59 ms, waiting time after a throw. The single-spaced printing speed is 1000 lines per minute.

The paper movement times are given by the following formula:

15 + (n-1) 6.67 m.secs. where n is the number of lines

i.e. 1 line - 15 ms. 2 lines - 23 ms. 3 lines - 28 ms.

In either mode, the lockout of the data buffer is lifted and an interrupt occurs as the paper movement starts. This allows at least 15 ms. for the data buffer to be refilled while paper movement takes place. If the data is proffered to the buffer at intervals of less than approximately 35 ms. printing will occur at maximum speed. Printing speed can be reduced by a manual switch to 2/3 normal speed when extra good quality printing is required.

<u>Paper Details</u>

The paper must be sprocket fed and interleaved. The maximum overall width of stationery is 19 inches, the margins at this width being 3½ inches on either side of the 12 inch printing area. The minimum width is 4 inches overall. The tractors are adjustable to any width between these extremes.

One original plus 5 copies are obtainable with suitable stationery.

The original copy is obtained using a broad inked ribbon, which moves between two mandrels located above and below the printing position. The 5 copies are obtained using high speed carbon between the copies, the carbon moves with the stationery,

<u>Character Set</u>

There is one character set available on the Anelex (Standard). This is as follows, in the sequence in which the characters are arranged on the print wheel.

0 ½ 1 - 2 + 3 . 4 £ 5 & 6 (7) 8 * 9 / 10 11 A B C D E F G H

I J K L M N O P Q R S T U V W X Y Z : ' [ ] < > = _ | ? , %

The code buffer is filled with the internal representation of these characters separated by erase characters, (i.e. 0 Er ½ Er 1 Er .... , Er % Er). It should be carefully noted that it is only possible to use 59 characters of the 60 mentioned at any time, and that this is a limitation enforced by 5 characters of 64 character values available having special interpretation, i.e. 0,2,3,4,63. As an example, if the character "½" was not required the first word of the code table would read 16.63.0.63.17.63.30.63 where 16, 17 and 30 are the standard internal values for 0,1 and - respectively. Binary zero, i.e. Space, set in the character "½" index point will cause no printing of this character (for further explanation see Section 4.5.4).

The standard code table set by the Monitor program does not use the character underline, and if this character is required by the object program, the code will have to be set by the object program and reset when restart action is required as the Monitor program has reset the standard code (e.g. in the event of a checksum failure, see Section 5.5.3, page 1).

When using Mode 22, the restricted character set starts at 0 (zero) and ends at Z.

Controls and Indicators

The printer display carries the following controls and indicators:

ENGAGE	Push Button and Indicator	
DISENGAGE	Push Button and Indicator	
PAPER LOW	Indicator	Shows that the weight of the paper left has reached a minimum. The number of sheets will vary according to the weight of paper being used, and the number of copies. If the printer is disengaged when the Paper Low lamp is lit it is impossible to engage the printer.
RUN OUT	Push Button and Indicator	The indicator shows a white light when the printer is able. If it is not white the printer cannot be used. The push button when pressed will cause the paper to run out until either Channel 0 (the Top of Form) is found or the button is released. When the button is released to stop the run out, it may stop half way between lines of print and the next two lines output will be very close together. The correct operation of this button is to press, hold and wait for the paper to stop. If the Anelex is engaged when the Run Out button pressed, it will disengage, but it may do so after paper movement has started.

In addition there is an emergency stop button, which should only be used in an emergency.

A program using pre-printed stationery should include a chapter which prints lines for helping the operator to align the paper.

In addition to the control panel there are some switches and controls which are mainly for use by engineers, but some reference should be made. These are as follows:

HIGH/LOW MOTOR SPEED	This is a switch on one side of the Anelex, and controls the barrel speed, and consequently the printing speed. In the high position maximum speeds are obtained. This is mainly for use when several copies are required. When the motor speed is changed, re-phasing is necessary.
PHASING	This controls the timing of the trigger to the hammer devices relative to the instantaneous barrel position to allow for different thicknesses of paper, or multiple copies, and the two barrel speeds.
PAPER TENSION	This is a knob which increases or decreases the lateral tensioning of the paper (increase by a clockwise turn).
PENETRATION	This controls the depth of print to allow for the thickness of paper and the number of copies being printed. It consists of an indicator and a handle. If this is incorrectly set, printing can take place, but no printing will actually occur.
FORM POSITIONING	This is used to position the top of form while printing is taking place. The position can be lined up or down by a maximum of 2½ lines

Operating Procedure

The following condition results in monitor action:

LOW PAPER	This condition occurs when the weight of paper reaches a minimum, or the paper has torn, or is incorrectly loaded. (See Section 5.5.3 for other conditions).

Installation Details

The approximate dimensions of the control pedestal and printer unit are

Width	58 inches
Depth	30.5 inches
Height	55.25 inches
Approx. weight	1100 lbs.

The two power supplies are single phase A.C. at 50 c.p.s, and 240 volts ± 15 per cent, one is raw and the other filtered. The total power consumption of the printer pedestal is 2 KVA approximately.

4.5.10 <u>Anelex Series 5 Description</u>.

This gives some of the differences between it and the Anelex 4 (see 4.5.9)

1. Printing Speed 1000 lines per minute full character set
1250 " " " part " "

2. Manual Controls

Panel at Front - Top Left

ENGAGE	DISENGAGED
TEST PRINT	*
RUN OUT	TRACTOR INDEX
*	*
*	*
NO PAPER	PAPER WARNING
YOKE OPEN	ALARM STATUS

Panel at Rear - Top Right

ENGAGE
DISENGAGE
RUN-OUT

* Shows the button is not used

<u>SWITCHES</u>

ENGAGE Button which is green when pressed and engages the printer so that printing may commence.

TEST PRINT Button which is yellow when pressed and produces a continuous printout of a selectable test character in all print positions.

RUN OUT Button which is white when pressed and causes a paper throw until a hole is detected in channel 0 of the format loop.

DISENGAGED Button which flashes red when pressed and disengages the printer so no further printing can occur. It remains unlit after being pressed.

TRACTOR-INDEX Button which is white when pressed and causes the line feed operation to feed 1 line every time the button is pressed.

POWER ON	Button which is green when the power is switched on by pressing this button
POWER OFF	Button which is red when the power is switched off by pressing it.

INDICATORS

NO PAPER	Amber light lit by the action of two photo-electric sensing devices which detect loss of paper tension at the paper tractors i.e. paper breakage or tearing
YOKE OPEN	Red light which lights when the print hammer mechanism is removed from its normal position in order to load paper or maintain the printer.
PAPER WARNING	Amber light which lights when the last sheet of paper is drawn clear of the paper dispenser.
ALARM STATUS	Red light which when lit indicates a printers fault.

Paper Installation and Adjustment Controls

These controls are only accessible when the front cover of the printer is lifted to load paper or to make any adjustments to the mechanism.

PENETRATION	These controls are located at either end of the printer yoke mechanism. They allow fine adjustment of the print density over the full width of the barrel. The knobs are independent of each other. Clockwise rotation of either increases the hammer pressure, and anti clockwise rotation decreases the pressure.
CLOSE-OPEN	These are two spring loaded switches on either side of the printer yoke mechanism. They are both spring loaded to return to a central position. When both are pressed down the printer yoke mechanism is automatically wound away from the paper. When both are pressed up the printer yoke mechanism is automatically wound back to its normal position. If only one is pressed then no movement of the yoke will occur. Similarly movement of the yoke will cease if both are being pressed and pressure is then taken off either one. The YOKE OPEN indicator lights when both are pressed and goes out automatically when the yoke is wound back to its normal printing position.
FORM-TENSION	This adjusts the tension of the paper. Clockwise rotation increases the tension, anti-clockwise rotation decreases the tension.
FORM-POSITION	This knob permits fine vertical adjustments to be made to the alignment of the paper. Anti clockwise rotation raises the form position, clockwise rotation lowers the form position.

3. Physical Details

Height	52 - 57 inches
Length	40 inches
Width	30¼ inches
Weight	1000 lbs.
Power Input	250 volts, 50 cycle, single phase.

4. Vertical format loop

The vertical format feeding is effected by means of a loop of paper read by means of a photo electric reader. The loop is made from a strip provided by Anelex. It is punched by users according to their needs.

The loop has 12 channels numbered 1 - 12, only 1-8 are used on ORION and these correspond to paper throw channels 0-7 respectively.

4.5.11 Orion 2 Differences

The information in this section refers in general to both Orion 1 and Orion 2. Described here are the differences to be noted when reading the subsections for Orion 2. These differences arise in some cases because the transfers are extracoded (see 4.1)

Section 4.5.

The printers available on Orion 2 are the unbuffered Anelex Series 4, the buffered Anelex Series 4, and the buffered Anelex Series 5.

Section 4.5.1 Because of the extracode, the code buffer for card punch can be filled even if the peripheral is busy or disengaged. Mode 22 for the punch does in fact leave the code buffer untouched.

Unbuffered Anelex is as for Orion 1.

Section 4.5.3. Newline NL facility.

For all types of Anelex printers whenever "Top of Form" position is reached, paper movement will stop; (i.e. the sentence, on 4.5 page 3 "If the number......... completed" will have substituted "greater than 1")

For buffered Anelexes, no more than 55 lines should be fed.
(NL 56 ≡ PT 0, NL 63 ≡ PT 7)

Section 4.5.3. Paper Throw (PT)

For buffered Anelex. This as described in the section, i.e. PT 0 causes throw to "Top of Form". 8 positions PT 0 to PT 7 are available.

Section 4.5.5. This is not applicable to Orion 2.

Section 4.5.6. Punching a card in binary does not cause the code buffer to be touched, and so it need not be refilled.

4.7 Magnetic Tape Decks

4.7.1 General

One inch tape is used. There are 16 tracks across the width, 12 being used for information. Maximum length for a tape is 3,600 ft. Tapes move at 120 ins/sec. Time taken to run through a reel of 3,600 ft. at full speed is 6 minutes and rewinding tapes 3 minutes.

Ampex TM2 decks read and write tapes in low density and are available on both Orion 1 and Orion 2.

Potter MT120 decks read and write tapes in low density and are available on Orion 2 only.

Potter MT 120X decks read and write tapes in both high and low density and are available on Orion 2 only.

Density.

Low density. Packing density is 375 bits per inch along the tape (instantaneous transfer rate of 90 K c/s). Long gap is 1.6 ins and short gap 1.2 ins. approx.

High density. Packing density is 833 bits per inch along the tape (instantaneous transfer rate of 200 K c/s). Long gap is 1.6 ins and short gap 0.5 ins. approx.

Orion 1

Up to 9 Ampex TM2 decks can be fitted associated with 1 or 2 control units. An exchange allows a path between any deck and any control unit.

Orion 2

For High System
The exchange system allows for interconnection between the Potter MT120X decks and the tape control units. Each exchange rack can make the connections between any of a group of up to 10 decks, and up to two tape control units. A second exchange may also be connected to the pair of tape control units and then up to 10 more decks can be fitted.

For low System
Up to 20 Ampex TM2 or Potter MT120 decks can be fitted to a pair of control units and up to 3 pairs of control units can be fitted.

4.7.2 Layout of Information

There are sixteen tracks across the width of the tape which are used as follows:-

1	Block markers
2 - 4	Information
5	Clock for 2 - 8
6 - 8	Information
9 - 11	Information
12	Clock for 9 - 15
13 - 15	Information
16	Spare

Each computer word is written as four 12-bit stripes with the most significant part of the word first. The check-sum is a 24-bit, end-around-carry sum of the information in the block and is written at the end of the block as two extra stripes.

At each end of each block, separated by a small distance from the information, there is a block marker which consists of 12 one bits in the block marker track, which is otherwise clear.

Each block of information on a reel of magnetic tape has a block address, or serial number, which is written in the information tracks opposite the leading block marker. It is written automatically at the time the rest of the block is written.

When a 140/142 compound instruction reading or writing on a magnetic tape deck is obeyed, the bottom 7 bits of the k-bits of the deck specify a core store register called the Block Address Register (this is in the region 64 onwards). If the transfer is forwards, the top half of this register is copied to the bottom half and one is added to the top half. If the transfer is backwards, one is subtracted from the top half and this is then copied to the bottom half. In either case, the bottom half contains the block address of the block being operated upon, and the top half the address of the next block forwards after the transfer is completed.

Block 0

At the front of the tape is the leader block known as Block 0. What is logically Block 0 consists of 3 physical blocks. Block 0 is always written in low density both on low and high density installations. On an Ampex deck, Block 0 is written about 20 feet from the buckle. On a Potter deck about 15 feet are required for threading and loading purposes and Block 0 will be about 5 feet from the reflective sticker.

(i) Firstly, here is a one word block with Block Address 8189 (sometimes known as Block -2). The word is positive and contains the serial-number of the tape in the bottom half. The nominal length of the tape in hundreds of feet is stored in D18 to D23 of this word.

(ii) Then follows a 10-word block with Block Address 8190 (sometimes known as Block -1). The first word contains the date in D1 to D23, the write permit bit (D0) and the date control bit (D24). D25 is the TB (tape bit) and is 0 if the rest of the information on the tape is in low density and is 1 if in high density (see 4.7.3). D33 to D47 give the number of pre-addressed blocks, usually zero. The second to ninth words are the document name of the tape. The 150/41 etc. is used to give OMP information for these nine words. The last word contains the “position” of the last written non-sequential block in the modifier half.

(iii) Following the above block after a short gap is a one word block containing zero of Block Address 0. This block can be read but not re-written by object programs.

Non-sequential Block

At the end of the tape, there should be a non-sequentially addressed block which is used as an end of tape marker. The 150/43 instruction (see 5.3.43) causes a non-sequential block to be written. OMP writes such a block if the physical end of tape is encountered during writing (see 4.7.6.3.1). This non-sequential block is a one word block, containing zero and the address is 8191 unless that would be sequential when 8190 is used instead.

4.7.3 High Density Installations - Orion 2

The high density tape system on Orion 2 is capable of both reading and writing high density tapes (833 bits per inch i.e. 200 K c/s) and low density tapes (90 K c/s).

Reading

When a reading transfer is initiated the density of the tape is recognised by the hardware and the transfer proceeds as expected.

Writing

When a writing transfer is initiated, the extracode uses a bit (the ECB extracode bit) which is set by OMP to decide whether to write in high or low density. (0 for low, 1 for high.)

It is assumed that a job will normally write tapes in high density, and no changes to existing jobs are necessary. It is possible that because of a stand-by arrangement with a low density installation a job will want to treat the high density installation as if it were low, i.e. with no changes to existing jobs, tapes are written in low density. An ENGINEER (see 5.7.4.9) bit (7th from l.s. end) is looked at when a job is accepted and the job classed as a high or low job. When this bit is 0 the job is classed as high; D51 of Word 5 of the job's directory is the H bit of the job and is 1 for a high job. (If the ENG bit is 1 then the job is low and D31 is 0.) The ACCD message is followed by vertical bar and then H or L to indicate high or low job. DIRENT prints H if the job is high only. The H bit remains unchanged throughout the run of the job.

It is possible that a high job will require to write a tape in low density. This is done by writing a 150/41 or 150/44 instruction and setting D25 in word 0 in the core to 1 - this is known as the CB (core bit).

In Block 0, D25 of word 0 is known as the TB (tape bit) and this bit is 1 if the information on the rest of the tape is high density or was produced by a high job etc., and is 0 if in low. Block 0 printing (see 5.3.41 and 5.8.4.2) and from PER directive (see 5.7.4.7) will print an H (after the Date) when TB is 1.

In some cases a tape will not be allocated, e.g. if on a low density installation Block 0 information is such that TB is high, and date not reached or writing inhibited, (i.e. the information is needed) then the tape will not be given to a job.

When a tape is reserved for a job, then the ECB and TB are set as follows:

(i) deck not isolated and date reached, (i.e. tape to be over-written) then EOB is set as H bit of program and the TB (bit on the tape) set as H bit of program.

(ii) deck isolated, or date not reached (i.e. information on tape is needed) then

(a) if the job is high, ECB is set as TB now on the tape and TB left unaltered,

(b) if the job is low, ECB is set as low whatever TB is and TB left unaltered.

Now if a 150/41 or 44 is obeyed then

(i) if the job is high - D25 of Word 0 in the Core (CB) is inverted and ECB is re-set to this and the new ECB bit ORed into the TB, giving a new setting of TB. (Thus if D25 = 0 ECB will be 1, whereas if D25 = 1 then ECB will be 0, i.e. write in low.)

(ii) if the job is low, then ECB and TB will be left unaltered whatever D25 is.

Note that on a low density installation (machine) TB will be set low (i.e. = 0) whatever D25 in the core is.

If a 150/40 is obeyed on a high density installation then TB will be inverted, so that D25 in Word 0 in the core will be 0 for high and 1 for low density.

Note that on a low density installation, 150/40 will produce 0 in D25 of Word 0 in the core, whatever the TB bit is.

Block 0 is always written in low density whether written on a low or high installation.

4.7.5 Checking

The following checks are performed on the accuracy of tape transfers.

(a) During reading:

A 24 bit check sum is formed, with end-around-carry from the information read off the tape and is compared with that on the tape.

The information read must be preceded and followed by a block marker.

The block address is checked.

(b) During writing:

All the above checks are performed and in addition the check sum on tape is compared with that which was written. When reading back during a writing transfer the sensitivity and performance of the reading circuits are deliberately reduced. If the checks are satisfied with this reduced performance, there should be no failure due to misreading during a normal "read" operation with the circuits returned to full performance.

Failure of any of these checks causes a failure interruption of the computer. This can also happen due to a transfer finishing with one sensing post already on the conducting trailer or at the end of a rewind and when the engage button on the deck is pressed.

4.7.6 OMP action on magnetic tape interrupts

4.7.6.1 ENGAGE Button

Pressing the engage button on a deck causes an interruption and hence entry into OMP.

(i) Idle Tape Deck

In this case OMP looks for and reads Block 0 (see 4.7.2). If Block 0 is correct, then the information in it is stored on to OMP's drum working space, and any job which is halted awaiting document is switched on; the job requesting this document (or scratch tape) can then be allocated this deck. The tape is in the load position (i.e. engaged and ready to read Block 1 forwards).

If Block 0 read is not of the expected layout, then a message is output to the Flexowriter, e.g.

ORION MTB   NONSTAND TAPE

If no Block can be found, then the message is

ORION MTC   NEW   TAPE

In either case the operator must type either SERIALNO directive (see 5.7.4.6 and 4.7.6.2.1.3) or the UNLOAD directive (see 5.7.4.3 and 4.7.6.2.1.5).

If a peripheral incident occurs while OMP is reading Block 0, the tape is rewound and the reading of Block 0 repeated.

(ii) Allocated Deck

If the engage button is pressed on a deck which has been allocated to a job then this is treated as the peripheral incident DECK FAIL (see 5.5 and 4.7.6.2.2).

4.7.6.2 Deck Interrupt

4.7.6.2.1 End of Rewind

Rewind causes an interruption. OMP then carries out several operations which are sub-divided as follows.

4.7.6.2.1.1 Block 0 to be written

If since Block 0 was last written, information is given to OMP asking it to re-write Block 0, it stores this on the drum and sets a to be written marker. When the tape has been rewound, OMP looks at this marker and then writes this information on the tape and then clears the marker. Such information for example may be given with a 150/41 instruction (Re-Write Block 0) or a 150/43 instruction (the position of the last written non-sequential block is stored in Block 0) or if during a writing transfer, the first sensing post is encountered OMP writes a non-sequential block, or from SERIALNO, VOIDDATE directives. When Block 0 is actually written onto the tape, a message is printed on the Flexowriter.

MTg serial number (Date) (NSn) (PAm) (Ll)
(document name)

The printing of the items in brackets is optional; only those which have been changed, since Block 0 was last written are printed (see 5.3.41).

If the deck is isolated when OMP attempts to re-write Block 0, here OMP disengages the deck and asks the operator to permit writing e.g

MTA PERMIT WRITING

When this is done and the deck engaged the re-writing of Block 0 is done.

If a peripheral incident occurs then the tape is rewound and the writing attempted again.

In general, rewind is initiated as part of the terminating action after a deck has been relinquished (i.e. this rewind is for an idle deck) and in general the action then is to completely rewind the tape, disengage the deck and ask the operator to unload the deck (see 4.7.6.2.1.5).

4.7.6.2.1.2

An object program may obey 140/142 Mode 14 instruction-pair to rewind the tape. This causes an interruption which is correctly interpreted by OMP. In this case the deck is allocated to the job and so OMP having re-written Block 0 if necessary, then positions the tape ready to read Block 1 forwards (i.e. in the load position) the program having continued.

4.7.6.2.1.3

After a SERIALNO directive (see 5.7.4.6) the tape is erased forward and Block 0 as described in 4.7.2 is written with the name block of all 1's. The tape name stored on the drum is set to be all zeros and the "to be written" marker is set and the tape rewound, so this Block 0 is written and then the tape is left in a load position so that a job requesting a scratch tape can be allocated this deck.

4.7.6.2.1.4

Peripheral incidents while reading or writing Block 0 cause OMP to repeat the operation which was being attempted.

4.7.6.2.1.5

In general, at the end of rewind on an idle deck, having written Block 0 if necessary, OMP asks the operator to unload the tape. The tape is rewound, the deck disengaged and a message printed on the Flexowriter e.g.

ORION MTg UNLOAD Serial-number ERn

ERn is printed if the number of errors (eg reading and writing failures) that have occurred since the tape was last loaded, is non-zero.

4.7.6.2.1.6

If the deck is isolated when OMP actually tries to write Block 0, the permit writing message is output (see 4.7.6.2.1.1).

4.7.6.2.2 Other Deck Interrupts

These can occur for example as a result of a failure of the Servos or due to manual intervention (ie. switching deck to standby or opening the door). These, if the transfer is abandoned, produce DECK FAIL action (see 5.5 and 5.5.4).

4.7.6.3 FIRST SENSING POST

When a transfer to or from a magnetic tape ends with either conducting end on the first sensing post an interrupt occurs.

4.7.6.3.1 Writing

The transfer is writing information to the tape when the first sensing post comes up. The writing of the block is completed and if successful, OMP then writes the non-sequential block and then reads backwards over the non-sequential block. The message may be printed on the Flexowriter eg.

Jobname MTC END OF TAPE

If no restart for Code 5 (see 5.5 and 5.5.4) has been specified, then OMP suspends the job and SUSPD is printed between the geographical name and the incident message.

4.7.6.3.2 Failure on Writing Last Block

In this case if the writing of the last block fails (e.g there is a check sum failure) then in this case OMP overwrites the incorrectly written last block with the non-sequential block and reads backwards over this block. If a Code 6 restart has been specified it is entered, otherwise the job is suspended. The message on the Flexowriter in this case is

Jobname MTB LAST FAIL

The restart if any will be responsible for writing the block of information not on the tape onto the next reel of tape.

4.7.6.3.3 Reading

The transfer is reading information when the first sensing post comes up. In this case no action takes place and the block is read. The next block will be the non-sequential block - if this is read then end of tape incident action will occur (see 4.7.6.4.2 (ii))

4.7.6.4 BLOCK ADDRESS FAILURE

4.7.6.4.1 Writing

When writing information, the block address is automatically written which is checked by the read heads. Block address failures when writing are treated as writing check failures (see 4.7.6.6.2). OMP may repeat the transfer several times.

4.7.6.4.2 Reading

When reading information, the block addresses are checked for being in sequential order. If not there is an interruption. Block address failures, unless "end of tape" are treated as reading failures.

(i) Trying to read "Block -1" (end of tape marker)

A program is allowed to read the one word block whose block address is 0. Another backwards read will cause a failure which OMP recognises as END OF TAPE incident. The tape is rewound and moved forward to the load position and the program's Code 5 restart, if any, is entered, otherwise the job is suspended.

(ii) Trying to read the Non-Sequential Block (end of tape marker)

In Block 0 is recorded the position of the last written non-sequential block. If the block address failure is because this block is being read forwards, OMP reads this block backwards checking that its block address is 8191 (or 8190 as appropriate). If so the Block Address Register is reset to its correct value (see 4.7.2 and 5.3.42) and END OF TAPE incident recognised. The program's Code 5 restart, if any is entered. If on reading backwards there is a block address failure (i.e. this is not the non-sequential block) then the original read is repeated.

If the programmer has specified a Code 8 (first fail) restart, OMP enters it (see 4.7.6.6.1).

(iii) If no Code 8 has been specified; OMP then tries to read this block successfully, treating it as a read fail (see 4.7.6.6.3) and tries to position the tape correctly. If the tape cannot be positioned correctly for example, etc. then DECK FAIL incident is given.

4.7.6.5 WRONG MODE WRITING

4.7.6.5.1 Trying to Write after Reading backwards

A 140/142 attempting this operation is illegal but OMP interprets this and carries out this for the object programmer (i.e. OMP reads backwards over the next block, then reads this block forwards and then writes). No message is printed and if a Code 4 restart has been specified, it will never be entered.

If the writing instruction is after reading block 0 backwards, then the tape is rewound and then moved forwards to the load position and END OF TAPE incident action occurs.

4.7.6.5.2

Attempting to write on an isolated deck can occur as a result of a 140/142 pair in which case 1 is subtracted from the top half of the Block Address Register, or as a result of a 150/41, 150/44 or 150/43 instruction. If a Code 3 restart has been specified, it is entered otherwise the job is suspended. The message on the Flexowriter is

Jobname MTX WRITE INHIBIT

4.7.6.6 CHECKSUM FAILURES

Any checksum failure or block address failure not covered by 4.7.6.4 is considered to be due to a tape imperfection and will cause 1 to be added to the error count which is output when the tape is unloaded.

4.7.6.6.1 First Fail (Code 8)

If the program which initiated the transfer has set a restart for Code 8 (first fail) then OMP will enter it. The tape is not re-positioned. The message on the Flexowriter is

Jobname MTX FAIL

4.7.6.6.2 Writing

If no Code 8 restart has been specified then any checksum or block address failure causes OMP to try to write the block further along the tape, erasing the incorrect block(s), unless the tape is at this point pre-addressed in which case the writing takes place on the same part of the tape. OMP attempts the re-writing 6 times and on the 6th failure the program's Code 2 restart is entered, otherwise the original transfer is repeated and the job suspended. The message on the Flexowriter is

Jobname MTX WRITE FAIL

4.7.6.6.3 Reading

If no Code 8 has been specified, then any checksum failures or block address failures other than those described in 4.7.6.4.2. cause OMP to read the block in the opposite direction. The number of failures of the transfer is then counted and on the 6th failure the program's Code 1 restart is entered with the tape repositioned ready to read the failing block, otherwise the original transfer is repeated and the job suspended. The message on the Flexowriter is

Jobname MTX READ FAIL

Note that if the tape cannot be re-positioned or for other reasons the failure is not the above, then DECK FAIL incident occurs.

4.7.7 The deck and operation

On the Ampex TM2 tape transport the two spools are placed one above the other, the lower one being the take-up spool. The read and write heads, which are 0.39 inches apart, are in between the spools, as are the drive capstans. On either side are the boxes for holding loops of tape. Next to each spool there is a guide post for the tape which is made of two pieces of metal which can be connected electrically by a conducting section of tape spliced at either end. The upper of these two sensing posts also has a clamp which can hold the tape in position. When the tape is in the “rewind” position the upper spool is full and a short conducting leader spliced to the tape ends in a buckle just above the clamping post. The lower spool has a long conducting leader attached to it which threads the mechanism and buckles to the tape on the upper spool.

When a tape has to be loaded, onto a deck the procedure is as follows:

(1) Open the door - this will automatically disengage the deck.

(2) Clamp the tape at the upper clamping post.

(3) Unbuckle the top spool from the leader and remove it.

(4) Place new reel on the top position and buckle it to the leader.

(5) Unclamp the tape and close the door.

(6) Press the engage button, causing a Monitor Routine Interruption.

4.7.9 Programming techniques

Since the magnetic tape is not preaddressed, when a writing operation is performed, the writing takes place on the following part of the tape without reference to proceeding operations or to what is already on the tape where the writing is to take place. Thus, since the block being written may be of different length to that which it is overwriting, a partially erased block can be left on the tape after the block just written. This can happen even when the blocks are of the same number of words due to variations in the speed of the tape, so that apart from the use of preaddressed tapes (see below) each writing operation must be regarded as destroying everything on the tape beyond the point at which the writing is done.

When a read backwards operation is finished the tape stops in such a position that the writing head is somewhere in the middle of the block just read, so that a writing operation would leave the beginning of that block unerased.

Because the above considerations magnetic tape programs should be written to operate on tape in one of the modes described below.

(a) "File Updating" Mode

In this mode of operation no attempt at overwriting can be made and the write-short-gap mode can be used throughout. A tape used in this way is written only once and then can be read as often as required, usually with the deck isolated. Alterations to the information are done by copying it on to a now tape, incorporating any amendments. This will be the most common method of using tape, particularly in file updating where it is important to keep the input copy unaltered.

(b) "Expanding file" Mode

In this mode of operation a tape may be rewritten from a certain point onwards thus preserving all information before this. When first writing such a tape the write-long-gap mode should be used at any point from which overwriting may subsequently take place. The most usual application of this technique involves two decks which between them contain one file of information which is usually of fixed length blocks. The first part of the information is stored in sequence on one tape and the rest is stored in inverse sequence on the other, the whole file being processed by reading backwards on one tape and writing on the other doing any alterations, insertions or deletions as required.

(c) "PSEUDO-PRE-ADDRESSED" Tape Mode

In this mode of operation overwriting of individual blocks in the tape can be done but only tapes prepared by a special program, WRITE/PREADD/TAPES can be used. Also all operations on the tape should performed by the appropriate Library Subroutine for using these tapes.