1301 Initial Orders Manual

Whole Manual

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1301 DATA PROCESSING SYSTEM

INITIAL ORDERS MANUAL

INTERNATIONAL COMPUTERS AND TABULATORS LIMITED

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INTRODUCTION

This manual supersedes all previous information on the subject.

Throughout this manual the abbreviation I.A.S. is used for Immediate Access Store.

Initial Orders comprises 400 words of program stored permanently on the reserved channels of the first drum. It is used as the means of loading all other programs, and "entering" them after input. It also has other facilities, not strictly needed for the input of programs, that are intended to make operation of the computer easier and also to assist the engineer.

Initial Orders is intended to read cards punched in convenient forms and convert the information thus read into the form required by the computer and then store it either on the drum (as described in Sections 1 to 11 inclusive) or in I.A.S (see Section 12). The information on the cards falls into two groups; program instructions (and constants), which are stored in the computer, and "control words", which are used only to give directions to Initial Orders (e.g. where to store part of a program).

In studying this manual it is important to remember that Section 12 is entirely independent of Sections 1 to 11 inclusive, and also to remember that the remarks concerning relative addresses and designations do not apply to the fast-read cards described in Section 8.

Section 1

ORDERS

As written on a programming sheet, a single order is made up of four parts:

D	F	A	R

D is the "designation" of the order with permissible values 0, 4, 8 or 9. It is usual to leave the designation blank when it takes zero value. F is the "function" of the order and consists of two decimal digits. The combination of designation and function specifies the operation to be carried out by the computer when obeying the order. A is the "address" of the order and consists of four decimal digits. R is the "relativiser reference number" of the order and consists of two decimal digits*. When the relativiser reference number specifies the non-existent relativiser zero, it is usual to leave R blank.

Programming sheets are marked with a heavy line under every second order - thus dividing them into order-pairs. Each order-pair is stored in a separate location when the program is input by Initial Orders. Certain orders for the 1301 are double-length and these are written as two single orders comprising an order-pair. A sample program sheet is included in this manual in Appendix 4.

Single orders written on programming sheets occupy nine decimal digits. Inside the computer, however, each order occupies six decimal digits only, so that an order-pair can be stored in a 12-digit word. The reduction from nine digits to six is part of the processing performed by Initial Orders and is accomplished by removing the designation and relativiser reference numbers after using them to adjust the remaining six digits of function and address. The designation is included in the most significant (thousands) digit of the address, by logical OR. The relativiser reference number is used to obtain a previously specified relativiser which is then added to the order, with no carry occurring if the sum exceeds six digits.

Section 2

RELATIVISERS

A relativiser comprises two six-digit numbers, which are held as one twelve-digit number by Initial Orders. It normally represents an I.A.S. address and a drum word address. The purpose of relativisers is to ease the task of writing large programs. After the flow-diagram has been drawn the program is split into blocks and a two-digit reference number is associated with each block of the program (and also with each block of data). Each block is then written and referred to as if it were to be stored in location 0 onwards on the drum and obeyed from location 0 onwards in I.A.S.

When the program is completely written, absolute I.A.S. and drum addresses are assigned to the various blocks. This could not be done initially since the lengths (number of words) of the blocks would be unknown. Using these absolute addresses, the two addresses (I.A.S. and drum) comprising each relativiser used by the program are allocated, and special "control words" are added at the head of the program to set the appropriate relativisers. Then, by virtue of the inclusion of the relativiser reference numbers in the orders of the program, Initial Orders will store the orders in the desired absolute addresses (making allowance for program instructions which require drum decade addresses).

This system obviates the necessity for the programmer to defer address allocation until the detailed form of the program is known and also enables the locations occupied by the program to be changed easily (e.g. at program testing time) since only the values of the relativisers need be changed.

It should be noted that when the address of an order is not that of a storage location (e.g. a shift order) then it should contain the relativiser reference number zero or, as is the normal practice, "R" should be left blank. It is permissible to use different relativiser numbers in the two halves of a double-length instruction.

* See also Section 4 (Item 2) and Section 5.

Section 3

NUMBERS (CONSTANTS)

Numbers to be read by Initial Orders are written on programming sheets as pseudo order-pairs, occupying the 12 digits in the functions and addresses of an order-pair. (It is also permissible to include relativiser reference numbers.) They may also have an extra component consisting of single letter P (plus) or M (minus) which is written in the first designation of the order-pair. Although numbers are not "control words" (since they are stored, not used to direct Initial Orders), the sign letter (P or M) is referred to as a "control designation" since this component is not included in the stored word.

The effect of designation "M" is to decimal-negate a word immediately before storing it. The designation P is redundant, but is retained so that programs already written are not invalidated. It is, however, useful, in that it can be used on program sheets to differentiate between program words and reset constants; it is also used to indicate words which can take any initial value, because they are set by program before use.

Typical constants might be written on program sheets as:

0	P			
			25	
1		28	7500	
2	M			
			273	

and these would be stored in the computer as:

0 0 0 0 0 0 0 0 0 0 2 5

1 2 8 7 5 0 0 0 0 0 0 0

2 9 9 9 9 9 9 9 9 7 2 7

One point connected with numbers is the constant consisting of some value less than the setting of a relativiser. For example suppose it is required to have a constant of one less than the I.A.S. address of relativiser 31. Further suppose that the I.A.S. address of relativiser 31 is set at 240 at the head of the program. The constant on the programming sheet would be written as.

	00	0	
	99	9999	31

and this would be stored in the computer as:

0 0 0 0 0 0 0 0 0 2 3 9.

The zero first order is necessary since Initial Orders inhibits the carry between the two halves of an order-pair.

NOTE:
If a word designated M has relativisers specified, it is converted to absolute form *before* negating.

Section 4

CONTROL WORDS

In order to function correctly Initial Orders needs certain data - which is supplied by control words. Initial Orders recognises control words by their first component, the control designation, which is written as a single letter in the first designation of an order-pair. In addition to P and M, Initial Orders will recognise B, C, E, F, R as control designations. Should an alphabetic designation other than these be met, or *any* alphabetic designation be discovered in the second half of a word, Initial Orders will stop the computer.

It should be noted that *any* numeric designation will be accepted in either half of any word and will be treated as described in Section 1.

1 Control Designation R

The function of the control word having control designation R is to set a relativiser. Such control words usually appear at the head of a program. R is written like an order-pair with the I.A.S. address in the first order and the drum word address in the second order. The number of the relativiser to be set is written as the second relativiser reference number of the control word.

Thus:

R		127	
	1	4027	23

is a typical control word which will set relativiser 23 with I.A.S. address 127 and drum address 14027. Note that, in certain circumstances either, or both, values may take up to six digits.

Often it is desired to set a relativiser relative to another relativiser. To do this the number of the master relativiser is written in the first relativiser reference number of the control word. Then the relativiser being set will have the I.A.S. value of the master relativiser added to the specified I.A.S. value to give that which is actually set. Further, the drum-word value (not, as when relativising program words, the decade value) of the master relativiser will be added to the drum-word value specified.

Thus, the pair of control words:

R		110	
		460	52
R		140	52
		1234	30

will set relativiser 52 with I.A.S. address 110 and drum address 460, and relativiser 30 with I.A.S. address 250 and drum address 1694.

It is also possible to set a relativiser with a value less than that of the master relativiser by writing the desired decrease in complementary form in the function and address digits.

Thus, the pair of control words:

R		200	
		750	63
R	99	9943	63
	99	9950	87

will set relativiser 63 with I.A.S. address 200 and drum address 750, and relativiser 87 with I.A.S. address 143 and drum address 700. (Note the inhibition of the carry between the two halves of the word, and also that it is possible to increase the value of one half whilst decreasing the other.)

It must be emphasised, however, that the resultant value* of the relativiser must be positive or zero; otherwise Initial Orders will, when required to refer to that relativiser, infer that it has not been set and stop the computer.

2 Control Designation B

The control word having control designation B is called a "block relativiser". Its function is to inform Initial Orders of where they are to store the block of program (order-pairs and/or numbers) about to be read. It does this by setting the "current address" to the value of the drum word address given in the control word.

Since Initial Orders occupies the I.A.S. while it is being used and, anyhow, most programs are too large to be held completely in I.A.S., any program read by Initial Orders is stored on the drum. As each word is read it is *effectively* stored in the drum word having the "current address". (In fact Initial Orders builds groups of words in I.A.S. before actually storing them on the drum; this is achieved by reading, from the drum, a group of words into I.A.S. and then overwriting appropriate words with information read from cards before returning the group to the drum.) The current address is then increased by one and the next word stored in the same way. Thus, consecutive words of program are stored in consecutive drum locations. However, the current address with its initial value must be set at the head of the program. Further it may be desired to store consecutive blocks of program in non-consecutive blocks of drum storage. A block relativiser will reset the current address to a specified value at any point during the reading of a program pack. The value of the new current address is written in the second half of the control word, and is a drum word address.

Thus:

B			
	1	1386	

is a block relativiser which will set the current address to 11386, i.e. the seventh word of decade 1138.

The main property of the block relativiser is to set the current address, but it also has other properties. Firstly, whenever Initial Orders reads a block relativiser it sets relativiser 2 with the I.A.S. and drum addresses specified in the block relativiser (the I.A.S. address being written as the first address of the order-pair as in an ordinary relativiser). Thus, orders which have addresses of other words in the same block of program as that in which they appear need not quote the actual block number as the relativiser, but may quote relativiser 2, or "B" as is customary, which makes it easier to follow a program on the coding sheets. This is possible because Initial Orders ignores the zone component of all punching in columns representing relativiser numbers. This system makes it unnecessary to associate a relativiser with a block of program which is not referred to by orders in any other block of the program. It also gives rise to the recommended practice of heading all blocks with a block relativiser, even though this may not be needed for resetting the current address (i.e. if the blocks are stored consecutively on the drum).

Secondly, the block relativiser may be used to perform the function of a control word with designation R (i.e. to set a relativiser). This is achieved by including the number of the relativiser in the second relativiser reference number of the block relativiser. Further, the block relativiser may be set relative to a previously set relativiser in exactly the same manner as setting a relative relativiser.

Thus, the pair of control words:

R		75	
		600	62
B		25	62
		120	26

perform the following functions:

* The whole relativiser must be considered as one twelve-digit number for this purpose, i.e. digit 1 may not have a value greater than "4".

(a) Set relativiser 62 with I.A.S. value 75 and drum word value 600

(b) Reset the current address to 720

(c) Set both relativisers 2 and 26 with I.A.S. value 100 and drum word value 720.

The facility to set a block relativiser relative to a master relativiser is extremely useful. For example if every block relativiser is punched as zero (both values) relative to the relativiser bearing the number of the block concerned it will never need to be altered, however many alterations may be made to the actual program. Furthermore supposing the ordinary relativisers concerned have been set relative to each other, as in this example:

R		0	-
		0	10
R		193	10
		193	11
R		18	11
		18	12

(Block 10 is 193 words long)

(Block 11 is 18 words long)

then should an alteration increase the length of, say, block 10 by 5 words, the only change in the relativisers needed would be to make relativiser 11 take addresses 193 + 5 i.e. 198 relative to block 10:

R		0	10
		0	-
R		198	10
		198	11
R		18	11
		18	12

This single alteration, which would be to one of the first few cards of the program pack, would ensure that all blocks after block 10 were repositioned on the drum and in I.A.S. to allow for the extra words in block 10.

It should be noted, at this point, that should Initial Orders read any words of program (other than B, E or R control words) before it has read at least one Block Relativiser it will stop the computer.

3 Control Designation C

Sometimes it is essential to have several consecutive words of a program initially set to zero. Rather than having to write (and punch) many consecutive words on the program sheets with zero, we may achieve this by means of a single control word having designation C. In such a word the number of consecutive words to be loaded as zero must be quoted in the function and address digits of the first half (Initial Orders will ignore all other digits of a "C" control word). This process is exactly equivalent to writing several words each containing zero as is clear from the following example:

	B		0	75
			0	-
0		37	55	B
		68	83	90
1	4	01	0	10
	4	00	0	76
2 to 56	C		55	
57	M			
			61	
58			'5'5'5'5	

which is sufficient to load 59 words.

NOTE:

A count of zero in a "C" control word is not acceptable to Initial Orders and will cause an "invalid designation" error stop (see Section 11).

4 Control Designation F

The use of this designation is described fully in Section 8.

5 Control Designation E

Initial Orders must be informed that the last word of a program has been read, and of the action to be taken. This information is supplied by the "entry word" which is a control word having designation E. All programs must be terminated with an entry word (for apart from making no attempt to enter the program if the entry word is omitted, Initial Orders may fail to store some of the program). On recognising the entry word, Initial Orders ceases reading cards and prepares to enter the program. To do this certain data are needed and these are supplied by the entry word. Since program can only be obeyed from I.A.S., but Initial Orders stores all program on the drum, the first part of the program must be transferred into the I.A.S. This transfer is performed by Initial Orders and the drum locations from which the transfer takes place are specified in the second half of the entry word, which is written as if it were the second half of a drum transfer instruction, i.e. the function digits contain the number of decades to be transferred and the address digits contain the *drum decade address* of the first of the decades to be transferred. Using this information Initial Orders obeys a drum-transfer instruction bringing the specified area of drum storage into *I.A.S. location 0 onwards.* Initial Orders also constructs a jump instruction to enter the program at a location which is specified in the first address of the entry word. Before this jump instruction is obeyed Initial Orders stop the computer (with 111111 showing in CR3). This stop allows the external conditions required by the program to be set up (Manual Indicators etc.). When the start button is pressed (to restart the computer)

the jump instruction constructed by Initial Orders is obeyed and the program is entered.

Thus:

E		25	
	07	314	

is an entry word informing Initial Orders that all the program has been read and causing drum words 3140 to 3209 to be transferred into I.A.S. locations 0 to 69. Then, when the start button is pressed following the stopping of the computer, the program will be entered at I.A.S. location 25.

On recognising the entry word Initial Orders makes two checks on its format before instigating the entry procedure. Firstly, it checks that the number of decades specified is positive (i.e. non-zero) and does not exceed 20. Secondly, it checks that the entry point lies within the area of I.A.S. to be filled with program from the drum. If either of these checks fails then Initial Orders stops the computer.

It is permissible to use relativisers in the entry word, in a manner analogous to relativising a drum-transfer instruction.

Thus, the entry word in the combination of control words:

R		16	
		0	76
B		0	
		640	
E		7	76
	05	2	B

will cause drum locations 660 to 709 to be transferred to I.A.S. locations 0 to 49, and the program to be entered at I.A.S. location 23. However, generally speaking, it is advisable to use absolute addresses in an "E" control word, to punch it in a separate card and to make that card number one of a separate block (a good system is to make it card one of block 999). This will enable a program, once stored on the drum, to be used several times, merely by re-reading this one card (or a duplicate of it) under Initial Orders on each occasion.

It should be noted that although Initial Orders brings the first part of the program into I.A.S. from the drum it does not arrange to bring any other part of the program into I.A.S; this must be done by the program itself.

If a "4" is punched in the second digit of the function columns of the first half of an "E" word, Initial Orders will attempt to read the first part of the subject program from reserved storage (where a choice exists for the address specified).

Section 5

PUNCHING OF PROGRAM CARDS

Programs to be read by Initial Orders are punched on standard 80-column cards. Columns 1 to 16 do not contain any program or any information for Initial Orders, and are not read by Initial Orders. These columns are reserved for special usage (editing, filing etc.) by the programmer or organisation. The remaining columns (17 to 80) are normally used to hold three words of program and a sequence number. The sequence number consists of a "block number" which remains constant on cards holding a block of program, a "card number" which increases sequentially through a block starting at *one* for the first card of each block, and an "end of block" signal, which must appear in the last card of each block. The sequence number may also contain an extra digit, the "suffix", which allows the insertion of cards in a block without invalidating the existing sequencing information. When the suffix is present the block and card numbers are the same as those on the previous card with the suffix increased by 1. The suffix, if present, is punched in columns 18 of the card, the block number in column 19-21, the card number in columns 22-26 and the "end of block" signal in column 17. The end of block signal may be any punching which will produce a non-zero numeric component, but the following conventions are suggested: Last card of a block - X; Last card of a sub-routine - Y; Last card of a complete program - Z. The maximum number of suffixed cards permissible at any one point is fifteen, standard 1301 punching being used when the suffix number exceeds 9 (e.g. 8 + 5 for 13).

Full details of the system of sequence checking mentioned above are given in Section 7.

The three words of program are punched into the card in columns 27-80 as a direct translation from the program sheet, each digit giving rise to one column on the card. The first word of each triplet is punched in columns 27-44, the second in columns 45-62, and the third in columns 63-80. Zeros or blank digits on the programming sheets may be punched as either zeros or left as blank columns on the card - but it should be noted that if a complete field consists of 18 blank columns then Initial Orders will ignore

that field. Hence, if it is required to input a zero in the program either a P must be punched as the control designation or at least one zero punched in the word. Considering the first word punched on the card (columns 27-44), the first designation is punched in column 27, the first function in columns 28 and 29, the first address in columns 30-33 and the first relativiser reference number in columns 34 and 35. This format is repeated for the second half of the word in columns 36 to 44 inclusive.

NOTES

1 Except in the "designation" columns (27, 36 etc.) Initial Orders ignores the zone component of any punching. Hence it is possible to use the convention of writing "B" instead of "2" in the relativiser.

2 Card forms are shown pictorially in Appendix 3

3 The punching of "fast read" cards is described in Section 8.

Section 6

READING OF PROGRAM CARDS

The passage of a card past the reading station of the 1301 Card Reader is initiated by a computer order. As a column passes the reading station the information is read from it by a photo-electric sensing device. Later the column passes the checking station and the information is again read from it and compared with the information read when the column passed the reading station. Failure to agree between the two readings of the same column causes a signal to be sent to the computer which, when detected by Initial Orders. causes the program to divert the card to the reject stacker and to stop the computer. If mischeck occurs it is unnecessary to restart the input from the beginning; the rejected card (or its substitute) is replaced at the bottom of the hopper and the start button is pressed to continue the input. Once Initial Orders has read columns 17-80 of the card it proceeds to process the information read from the card immediately, ignoring the contents of columns 1-16. By starting processing as soon as all relevant columns have been read, not waiting until the whole card is read, the rate at which program cards can be read, processed and stored is considerably increased.

Section 7

SEQUENCE CHECK

The first processing carried out by Initial Orders for each card is the application of the sequence check. This is a check on the sequence number (columns 17-26) and may be passed:

1 If no other card has yet been read, or if the last card read contained an end of block signal. This card must be number one, suffix 0 of some block.

or

2 Provided that the previous card had no end of block signal; if the suffix number is zero; the block number the same as, and the card number one greater than, that in the previous card. (This is the normal condition.)

or

3 If condition 2 is satisfied except that the card number is the same as, and the suffix number is one greater than, that in the previous card, *and* Manual Indicator 22 is set. This shows that the card has been inserted and is correctly positioned in the block. (The facility to insert extra cards by means of the suffix number should not be used, except during program testing, as it weakens the sequence check very considerably.)

Provided that one of these criteria is satisifed the sequence check is passed. If a sequence failure occurs, Initial Orders diverts the card to the reject stacker and stops the computer. It is usually possible to continue input

after a sequence failure, i.e. by putting the cards into correct order and restarting the computer.

In certain cases it will not be found possible to restart in this manner. Under such circumstances, no attempt must be made to carry on by reading again some cards which have been accepted by Initial Orders already nor by going back to the start of the last block as this may cause program to be wrongly stored, particularly because a relativiser may become wrongly set (and the "card count" and "hash total" would be wrong).

The success of the sequence check is not an absolute indication that all the cards of a program pack have been read. If an inserted card or a whole block of cards were omitted from the pack this omission would not be shown up by the sequence check, which merely verifies that the cards which are read are in the correct order. For this reason there is an extra facility incorporated in Initial Orders which comes into force when the entry word is met. When the computer is stopped prior to entering the program, Initial Orders displays numbers in registers A and B.

In register A will be found the number of cards which have been read.

In register B will be found the "hash total" of columns 9-80 of the cards. This is built up by summing the information read from each group of six columns (zones in digits 1-6, numerics in 7-12 *with* a carry over into the zones). The contents of columns 1-8 are *not* included in this total.

Thus, prior to actually starting a program, a visual check on accuracy of input is available. Any card diverted to the reject stacker, due to misreading or a sequence error, is not included in the displayed totals.

Once the sequence check has been passed, Initial Orders processes the three words read from the card. Relativisers are set and words are built up and stored on the drum at the appropriate addresses until the entry word is met, when the first block of program is brought down into I.A.S. When the computer is re-started after the Entry Stop, the program is entered.

Section 8

FAST READ

The function of the control word having designation F will now be considered. It has been seen how each word to be stored by Initial Orders consists of 18 digits on the programming sheet (and 18 columns on the card) but is reduced to 12 digits by Initial Orders for storing within the computer. The reduced form of the word, however, is not unreadable, especially if the program has been written using absolute addresses (no relativiser reference numbers), and is more convenient for reading numbers. Further, if words were punched in the card occupying only 12 columns per word, it would be possible to have more words per card and thus speed up the input of information. To enable Initial Orders to read "12-column words" is the function of the control word having control designation F; with this facility there are effectively two sets of Initial Orders, one of which is a subroutine of the other.

When cards are punched in this way there are five words on each card, plus a sequence number consisting of a 3-digit card number and an end of block signal. As there are no columns allocated for block or suffix numbers these are always treated as zero when performing sequence check on fast-read cards, and as the card number is limited to three digits its most-significant digit may take any value from 0 to 15 (using the standard 1301 punching code for digits greater than 9). The end of block signal is punched in column 17, and the card number in columns 18-20. The remaining 60 columns (21-80) contain the five 12-column words with no inter-word gaps (the first word is punched in columns 21-32, the second in columns 33-44 etc.). Each word is punched exactly as it is to appear inside the computer, with designations included in the thousands digits of the address, negative numbers in complementary form, and all addresses absolute. Initial Orders then do no processing of the words, merely reading and storing them in the form that they appear. It should be noted that if a word consists of 12 blank columns it is not ignored (as in an 18-column word) but stored as zero.

The control word with control designation F is a single-length control word, and no punching appears in the second half. When Initial Orders recognises the control designation F it sets a 6-digit counter equal to the number represented by the first function and address digits. This is the number of 12-column words which are to be read from the cards following that containing the F control word. Having set this counter the following words on the card are ignored, and Initial Orders reads and stores 12-column words, starting on the next card. Each word is stored in the current address, and the first word is stored in the current address left over from the previous block relativiser. Often an F control word is immediately preceded by a block relativiser. The block relativiser must not be punched following the F control word since it would then be ignored. When the specified number of 12-column words have been read and stored, the excess (if any) on the last card containing 12-column words is ignored and the main section of Initial Orders re-entered to continue reading cards having up to three words punched in each of them. A control word to fast-read 0 words is treated as an invalid designation (see Section 11) and the computer is stopped.

Section 9

OPERATING AIDS

Various facilities are provided in Initial Orders to make the operation of the 1301 computer both simple and reliable. These can be divided into two categories; those which are always carried out and those which are only carried out if signalled by the operator (usually by setting a manual indicator before entering Initial Orders).

1 Compulsory Aids

Before actually reading cards and storing any program the following actions are performed by Initial Orders:

(a) Provided the computer concerned is fitted with the standard (Type 660) printer, Sprag One is dropped; if the printer motors are not running it will engage when the motors are next started. On other types of printer the equivalent starting condition of paper movement will be brought about by Initial Orders.

(b) All locations of I.A.S. which are not actually used by Initial Orders are loaded with a distinctive pattern (a word in which all digits are equal to 14); this is mainly to clear "switch on" conditions in the I.A.S., but is also useful during program testing. (The I.A.S. words so loaded are 400-1929 inclusive.)

After loading the subject program on the drum, but before reaching the "E" stop, all program indicators are unset.

The above are the only conditions which may be assumed to exist at the start of the subject program. Any other conditions noticed are side effects of the coding of Initial Orders which may only exist on computers of identical specification and are likely to be altered without warning.

2 Optional Aids

These can be sub-divided into two groups - those which concern program loading, and those which provide facilities in Initial Orders alternative to program loading.

(a) FACILITIES APPLICABLE TO PROGRAM LOADING

If M.I.20 is set before Initial Orders is entered the whole of the normal drum storage will be filled with labelled stops before program loading commences. These stops take the form 110076; 0xxxxx, where X is the drum word address concerned.

If M.I.21 is set before Initial Orders is entered, the whole of the normal drum storage will be filled with zeros before program loading commences.

If M.I.22 is set during the use of Initial Orders to load a program, cards inserted into an existing sequence (using the suffix facility) will be accepted. For full details see Section 7.

(b) FACILITIES ALTERNATIVE TO PROGRAM LOADING

M.I.29 provides the facility to load program into I.A.S. only (see Section 12) and takes precedence over *all* other Manual Indicators.

M.I.25 when set causes Initial Orders to jump to an area of the program which contains no fixed instructions. The purpose of this is to enable the user to provide direct access to programs required frequently, provided that such programs are stored permanently (or semi-permanently) on the drum at some predetermined position. To make use of this facility the user must insert suitable instructions in that part of Initial Orders which appears on the second reserved channel of the first drum and appears in I.A.S. at words 232 to 249 inclusive (sheets 17 and 18 of X/18/00). Any manual indicators other than 29 may be used in conjunction with 25 to select desired routines. Alteration of the contents of these words of Initial Orders must only be carried out in conjunction with the engineer responsible for the computer concerned as several engineers' program packs must be altered to correspond.

M.I.24 is used to give the engineer certain test facilities and does not concern the normal user, except that it must always be left unset.

M.I.28 when set, will cause Initial Orders to move the paper on the printer such a distance that it may be detached without the covers being opened.

M.I.26 and 27 are used to cause Initial Orders to enter routine X/18/02 for printing the contents of the I.A.S. or selected channels of the Drum, or a Magnetic Tape. Routine X/18/02 must have previously been loaded on the drum as follows:

(i) a single-drum computer, on channels 1160 and 1180.

(ii) a multi-drum computer, on *reserved* channels 1200 and 1300.

NOTE:
Channel 1160 or reserved channel 1300 will only be used for X/18/02 on a magnetic tape installation.

The master relativiser of the I.A.S./Drum section of X/18/02 must have I.A.S. value 230, giving entry point 307 for this purpose, but the channel used for dumping the contents of I.A.S. 200-399 is not dependent on Initial Orders and can be varied at will (see specification X/18/02). The addresses quoted above cannot be altered as these facilities are essential for engineering purposes.

Section 10

OPERATION OF INITIAL ORDERS

With the Auto/Manual switch at "manual" the Initial Orders button is pressed, setting the control register as follows:

CR1 870200

CR2 000000

CR3 004200.

(In fact certain extra bits may be set in digits 4 and 5 of CR1, but these are of no consequence.)

According to requirements the appropriate Manual Indicator(s) are set and cards, if any, are loaded in the card reader.

The computer is then started and Initial Orders either reads the program or carries out the operating aid specified.

On the control panel of the computer is a switch which, if set, causes the computer to stop whenever a parity failure occurs; this should be set when Initial Orders is being used.

Section 11

ERROR CONDITIONS

If Initial Orders detects an unacceptable condition it stops the computer with an indicative stop, and sometimes a display in register B. The various error stops are as follows (the reference being the display in CR3):

110001 SEQUENCE ERROR

A card does not conform with the sequence rules. (Offending card is rejected.)

110002 CARD MISREAD (Indicator 38 set)

(Offending card is rejected.)

110003 CARD MISTIMED (Indicator 37 set)

(Offending card is rejected.)

110007 This stop is due to a misfeed (wreck or card jam) and is not a true error stop (see Appendix 2).

110010 UNSET RELATIVISER

(a) An attempt to refer to a relativiser, the settings of which have not been specified (or the I.A.S. value has been specified as a negative number).

(b) An attempt to refer to a relativiser with reference number greater than 99 (usually double punching in card).

In both cases the reference number of the offending relativiser will be found in digits 8 and 9 of register B.

110011 SETTING A RELATIVISER GREATER THAN 99

Similar to case (b) of 110010 stop but when setting a relativiser. (Offending relativiser reference number in digits 4, 5 and 6 of register B.)

110012 NO BLOCK RELATIVISER

Met if a program word (as distinct from a control word) is read before B control word has been found.

110013 INVALID E WORD

If an entry word is read which does not conform the following conditions:

(a) The number of decades must be more than 0 but less than 21.

(b) The entry point must lie within the area to be loaded from the drum (e.g. if five decades are specified, the entry point must be in the range 0 to 49, absolute address).

The number of decades specified will be found in digits 4 and 5 of register B.

110014 INVALID DESIGNATION

(a) A non-numeric designation in the second half of any word.

(b) A non-numeric designation, other than B, C, E, F, M, P or R, in the first half of a word.

(c) A "C" or "F" control word with count specified as zero (usually due to punching count in wrong half of word).

110026 I.A.S. PARITY CHECK FAILURE

This stop will only be met if the computer is restarted after a compulsory stop due to I.A.S. parity error.

110027 DRUM PARITY CHECK FAILURE

This stop will only be met when the computer has been restarted after a complsory stop due to Drum parity error during a transfer which Initial Orders is unable to repeat.

Restarting after an Error Stop

STOPS 110001, 110002, 110003, 110007.

Deal with offending card, returning it to the hopper if appropriate, then restart the computer.

STOPS 110010, 110011, 110012, 110013, 110014

If the computer is restarted after any of these stops similar types of error *may* be detected (some errors may pass unnoticed as a side effect of the first one) but the program will be wrongly stored, as these stops are due entirely to programming mistakes.

STOPS 110026, 110027

If the computer is restarted it will immediately stop again with the same display. Initial Orders must be started again with all cards already read returned to the bottom of the feed hopper.

Section 12

INPUT OF PROGRAMS TO I.A.S. ONLY

This facility is primarily intended for engineers test routines but is of use to programmers in certain cases.

1 Mode of Use

Programs to be read in this manner must be written in absolute form and are punched five words to a card in exactly the form in which they are to appear in the computer.

The five words are punched in the following columns:

Word 1	columns 15-26	These must be consecutive words of I.A.S. (blank fields being read as zero)
Word 2	27-38	
Word 3	39-50	
Word 4	51-62	
Word 5	63-74	

Columns 75 and 76 are punched 4 and 2 respectively, and the absolute address of the *fifth* word is punched in columns 77-80 inclusive.

To the program cards must be added:-

(a) A leader card containing the following:-

Word 1 The lowest I.A.S. location to be loaded by this pack.

Word 2 The pair of orders which are to cause entry to the subject program (including stop, if desired).

Word 3 The decimal sum of all words to be loaded.

Word 4 The number of *consecutive* words to be loaded.

Word 5 The number of program cards in the pack (including leader and trailer cards).

Columns 75-80 420371

(b) A trailer card with columns 75-80 punched 004395.

2 Restrictions on Programs to be Loaded in This Mode

I.A.S. 360-399 cannot be loaded with program.

Each program loaded must occupy an unbroken sequence of I.A.S. locations (otherwise the check total will not agree).

3 Mode of Operation

Initial Orders is entered with M.I.29 set and, provided that the two checks described below are satisified, the Entry Order pair punched in the leader card will be obeyed as soon as the program has been loaded.

4 Error Conditions

On reading the trailer card Initial Orders makes the following checks on accuracy of input:

(a) The number of cards read since the last leader card, including both the leader and trailer cards, must agree with the number punched in the leader card.

If this check is not satisified the computer will be stopped with CR3 = 080001.

(b) If Check (a) is satisfied, Initial Orders sums the number of words specified, starting from the first word specified, and checks that the total thus obtained agrees with the total punched in the leader card.

If this check is not satisfied the computer will be stopped with CR3 = 090001. Register A will display the check sum read from the leader card and register B the check sum actually obtained.

A restart after either of the above error stops will cause Initial Orders to read the next card, which should be the leader card of the pack (after correction if appropriate).

The only other possible error stop is 110027 (drum parity error in reading down Initial Orders).

5 Operating Aids

When a program is first written it is usual to omit the "check sum" from the leader card, punching it only when the program is proved. This will cause an 09 stop to be met, but if M.I.29 is then unset and the computer restarted the entry jump order pair will be obeyed as if the check sum was correct.

NOTE:

This aid must *not* be used once the program is proved, as this section of Initial Orders makes no use of the card-reader error indicators, relying only on the two checks described above.

6 General and Engineers Facilities

In addition to the above means of input it is possible to load a "broken program if it is punched as two or more programs, the entry jump order pair of all parts save the last being punched as an unconditional jump to 379 (which will cause Initial Orders to read the next sub-program).

Engineers have the ability to read their programs from cards using the card punch checking brushes, but this mode is subject to further severe restrictions and is not described here. If Initial Orders is entered with a special pack of cards in the card reader and M.I.24 set (alone) a simple test of the card reader photo-electric cells is carried out.

SUMMARY OF CONTROL WORDS

Control Designation	Format of Control Word: First Half D	F	A	R	Second Half D	F	A	R	Action taken by Initial Orders
B	B	00	iiii	xx		0d	dddd	yy	Both addresses relativised by relativiser X. Current address set to resulting drum address. Both relativisers 2(b) and Y set, with the resulting address.
C	C	nn	nnnn						Zeroises N words starting at current address, increasing the latter by "N".
E	E	0q	0iii	xx		nn	dddd	yy	Transfers N decades from drum decade D relativised by relativiser Y to *I.A.S.* 0 onwards. Enters program at *I.A.S.* location I relativised by relativiser X. Q should be zero, unless reserved store is required, when it should be 4.
F	F	nn	nnnn						Enters subroutine of Initials Orders to read N 12-column words starting on the next card.
R	R	ii	iiii	xx		dd	dddd	yy	Both addresses are relativised by relativiser X and relativiser Y is set with the results.

NOTE: Designations M & P do not indicate control words (see Section 4)

OPERATORS WORKING SHEET

1 The instructions to "bring down and enter" I.O. are obtained by pressing I.O. button, with computer at manual.

2 The Optional Parity Stop Switch *must* be set to stop on all parity errors.

STOPS (as displayed in CR3)

Note: "R" indicates card rejected.

110001 R	Sequence error
110002 R	Mischeck (IND. 38)
110003 R	Mistime (IND. 37)
110007	Misfeed
110010	Unset relativiser (see digits 8 and 9 of B)
110011	Setting a relativiser> 99 (see digits 4-6 of B)
110012	No "B" relativiser yet set
110013	Invalid "E" word (No. of decades in digits 4 and 5 of B)
110014	Invalid designation (Including C-O and F-O)
110026	I.A.S. parity error
110027	Drum parity error (Non repeatable transfer)
110030	End of paper throw
110031 to 110034 inclusive	Stops in print-out program (X/18/02)
110040 to 110049 inclusive	Error stops in Engineers Stored Tests
110077	Standard stop (Drum Word No. in CR1)
111111	Entry stop (subject program ready)
080001	Card count error } Only when reading into
090001	Check sum error } I.A.S. (M.I. 29)

MANUAL INDICATORS

(effects of setting *before* starting)

29	Load program in I.A.S. only (Engineers etc.)
29 and 25	Ditto, using punch check brushes
25	Special (unique) users' facilities
24	Special engineering tests
28	Throw paper clear, for detaching
26 and/or 27	Enter (pre-stored) program X/18/02 for I.A.S./Drum/Tape print-out
20	Write numbered stops on drum before reading program cards
21	Write zeros on drum before reading program cards
22	Permit "suffixed" cards in sequence

The above list is in the order that I.O. refers to the manual indicators (thus M.I. 29 overrides all other M.I.).

Indicators to be set by the operators must be shown on the operating instructions in full.

PROCEDURE FOR RESTARTING AFTER ERROR STOPS ETC.

1, 2 or 3	Place rejected card in bottom of feed hopper and restart.
10 to 14 inclusive	Not possible to input program correctly, but if computer restarted further errors of a similar nature can be detected.
26 or 27	Not possible to continue (but if met before any cards read "try again" as may be due to switch on condition on or previous program being badly written).

Parity Error Stops

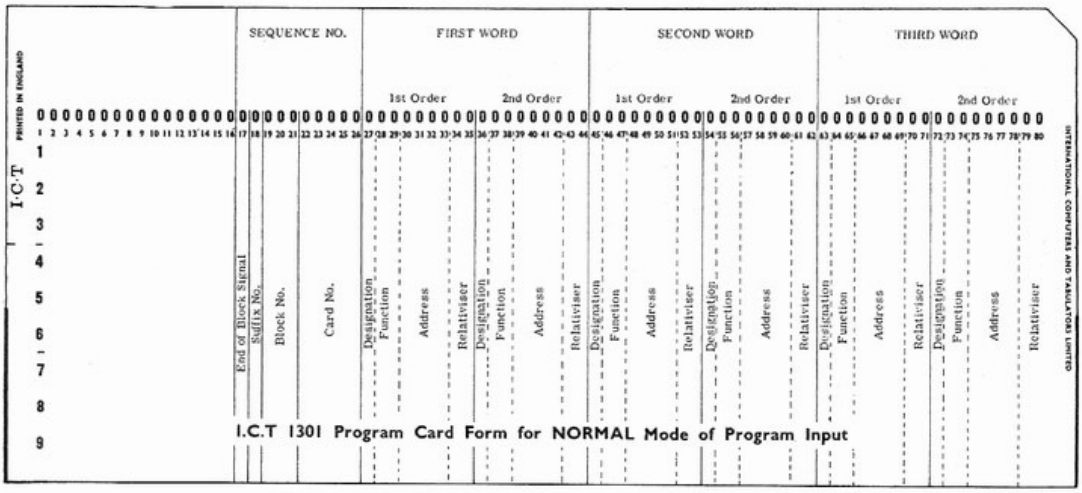
I.A.S.	Initial orders must be re-entered from "scratch" (if computer is restarted a 26 stop will be met)
DRUM	Log details and restart when I.O. will attempt to repeat offending transfer. If the transfer is one which I.O. cannot repeat (e.g. having overwritten the transfer order) a 27 stop will then be met.

MISFEEDS Do not stop computer, but set M.I. 29, then clear card reader, reset it, (when the computer will be found to be stopped with CR3 = 110007), unset M.I. 29 and restart.

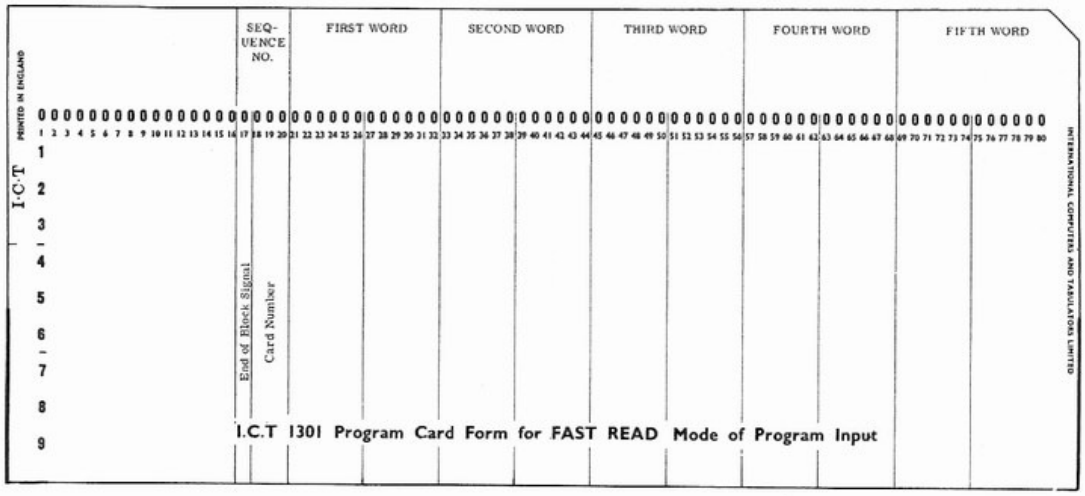
'E' STOP 111111 I.O. has read the subject program and stored it on the drum, has brought the first part of it into I.A.S. word O onwards and is ready to enter it (indicators 10-19 will all be unset). The number of cards read *correctly* (i.e. not rejected) is in register A and the "hash" total of their contents in register B.

CARD FORMS

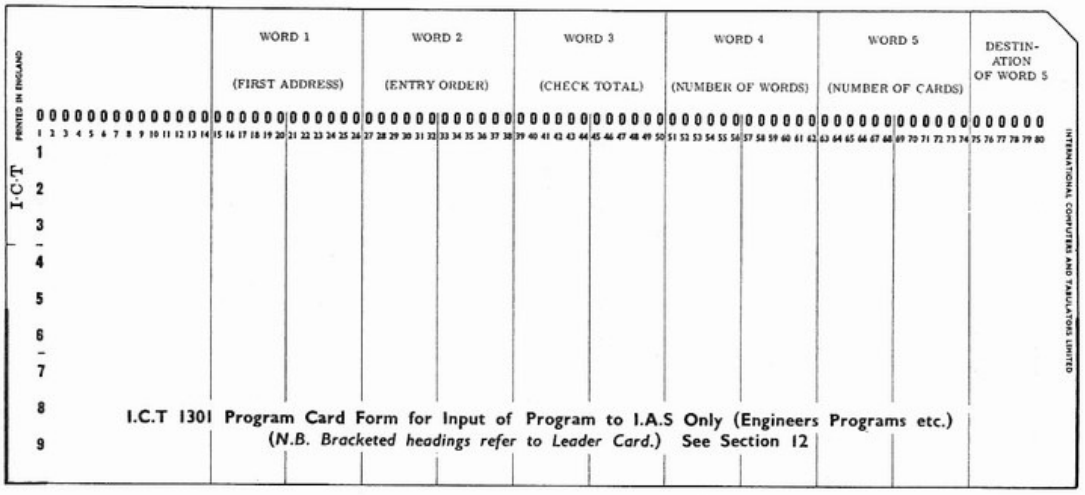
(not actual size)



I.C.T 1301 Program Card Form for NORMAL Mode of Program Input



I.C.T 1301 Program Card Form for FAST READ Mode of Program Input



I.C.T 1301 Program Card Form for Input of Program to I.A.S Only (Engineers Programs etc.)
(*N.B. Bracketed headings refer to Leader Card.*) See Section 12

1301 PROGRAM SHEET	JOB:-	BLOCK No.
		SHEET No.
	PROGRAMMER:-	/ /

C	I	D	F	A	R		NARRATIVE

FORM 1/1666/2 (11.62)

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PROGRAM SHEET AND CONVENTIONS USED IN THE PREPARATION OF PROGRAMS

The following remarks outline the conventions adopted by I.C.T staff when writing programs. They are intended to assist all concerned, but are not *requirements* for Intial Orders.

1 On the program sheet opposite it will be noticed that there is room for sixteen words (order pairs), but as program cards contain either three or five words, it is convenient to leave one word space unused on each program sheet and this is normally the *first* word space of each sheet.

2 Block relativisers are normally punched on a separate card from actual program words; the block relativiser for a block can appear in the first word space of the first sheet of the block, and still leave room for fifteen words of program. One exception to this policy is when a block relativiser is immediately followed by an "F" control word, when the two control words are often punched in one card.

3 Entry control words are usually punched in a separate card for the reasons given in Section 4 Item 5.

4 The characters normally used for "End of Block" markers in cards are
"X" in last card of most blocks
"Y" in last card of library subroutines
"Z" in last card of a complete program.

GLOSSARY OF TERMS USED IN THIS MANUAL

Block Relativiser A control word which indicates where, on the drum, the immediately following words of program are to be stored.

Control Word An item occupying one of the 18-column fields of a program card. A control word provides Initial Orders with information relevant to the storing of program but is not itself stored on the drum.

Current Address The drum word address at which the next program word read will be stored.

Entry The transfer of control from Initial Orders to the subject program.

Fast Read The facility to input tables of constants and similar items at a higher speed, and using fewer cards, than normal, relative-addressed program words.

Order Pair Two single instructions stored within the computer as one 12-digit word.

Relativiser A key which enables Initial Orders to calculate the actual (absolute) addresses involved in a program.

Subject Program The program being stored in the computer by Initial Orders.