1301 Programmers Manual

Section = Part One

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Part I

I·C·T 1300 SERIES

programmers reference manual

INTRODUCTION

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Introduction

THE 1300-SERIES DATA-PROCESSING SYSTEM 1.1

The 1300-series data-processing system comprises a fast central processor incorporating magnetic core and magnetic drum storage, together with a wide range of peripheral equipment. Peripheral units provide punched-card and paper-tape input, punched-card, paper-tape and printed output, interrogating typewriter facilities and magnetic-tape storage. A summary of the main characteristics of the system is given in Part 6.

COMPUTER STORAGE 1.2

The store of the computer is divided into locations or words. Each word has a fixed size termed the word-length. The term 'word' usually refers to the contents of a location rather than to the location itself.

Each storage location can contain a number which may represent either program or data. There is a numerical code for each instruction which can be given to the computer, and a program consists of these instructions together with any constants which may be referred to by the program. Data are manipulated by the program and may consist of data numbers for calculations or alphabetic information held in coded form.

The word-length is twelve digits. Each digit is recorded in binary code and consists of four bits (i.e. *b*inary dig*its* with value 0 or 1) the '1' bits representing 1, 2, 4 and 8 respectively. By using a combination of bits, it is possible to record any number from 0 to 15 in one decimal digit position.

One word usually represents a 12-digit decimal number and in this instance a single digit lies in the range 0 to 9. The ability to record up to 15 in one position is, however, useful, particularly for holding 10 or 11 as one digit in the pence position when performing arithmetic operations in sterling.

Immediate Access Storage (I.A.S.) 1.2.1

The Immediate Access Storage (I.A.S.) is a magnetic-core store. Data held in I.A.S. are accessible instantly to the program, and program instructions are themselves obeyed from I.A.S.

The basic capacity of I.A.S. is 400 words. Each word is identified by an address which is a number in the range 0 to 399. The capacity of I.A.S. may be increased by units of 400 words up to a standard maximum of 2,000. Hence a particular computer may have 400, 800, 1200, 1600 or 2000 words of I.A.S. with addresses in the range 0 to 1999.

It is also possible for a computer to have, as an alternative unit, a 4,000-word I.A.S. with addresses in the range 0 to 3,999.

Magnetic Drum Storage 1.2.2

The capacity of I.A.S. is augmented by a second level of internal storage in the form of magnetic drums. Whereas any word in I.A.S. is available immediately, any word on the drum must first be transferred to I.A.S. before it is available to the program. The average access time to a word on the drum is in the order of a few milliseconds compared with an effectively zero access time to I.A.S.

A standard drum has 12,000 words of storage. A small computer may be fitted with a 3,000 -word drum or a 6,000-word drum. Alternatively, a computer may have one or more standard drums up to a maximum of eight drums.

The drum is divided along its length into channels each containing 200 words. Each channel is further divided into 20 groups of 10 words each called decades. The decade is the smallest unit of transfer to or from the drum. The largest unit which can be transferred by one instruction is 20 decades or one channel. Data may be transferred to or from the drum either as a complete channel or as a number of consecutive decades. In the latter instance, provided that the decades are consecutive, they need not be confined to one channel or to one drum.

A series of read/write heads along the length of the drum transfers information to and from the drum as it rotates at a constant speed. Transfer is effected when the appropriate decade passes the corresponding read/write head.

Each drum has a further two channels (40 decades) of reserved storage. On the first drum on each machine these channels are used to retain permanently the Initial Orders program and engineers' test routines. Transfers can be made by the program from the reserved channels to I.A.S. but not vice versa.

THE ARITHMETIC UNIT 1.3

The arithmetic unit is that part of the computer where arithmetic calculations are performed. The unit consists basically of three registers A, B and C (Figure 1) that hold information and a Mill which carries out the actual additions and subtractions. (Multiplication is a built-in routine and is carried out in the Mill as a series of additions and subtractions.) Each register is one word length and can therefore hold a number consisting of twelve decimal or sterling digits. Program instructions cause numbers to be transferred from one register to another or to be added, subtracted or multiplied via the Mill.

Register A acts as the link with I.A.S. Every word entering or leaving I.A.S. is transferred via Register A. Hence, besides being used during arithmetical calculations, Register A is also used as follows:

when transferring information between I.A.S. and Registers B or C,
when transferring instructions from I.A.S. to be obeyed,
when transferring information to or from magnetic tape,
when transferring information to or from the magnetic drum,
when performing logical functions involving a word in I.A.S.

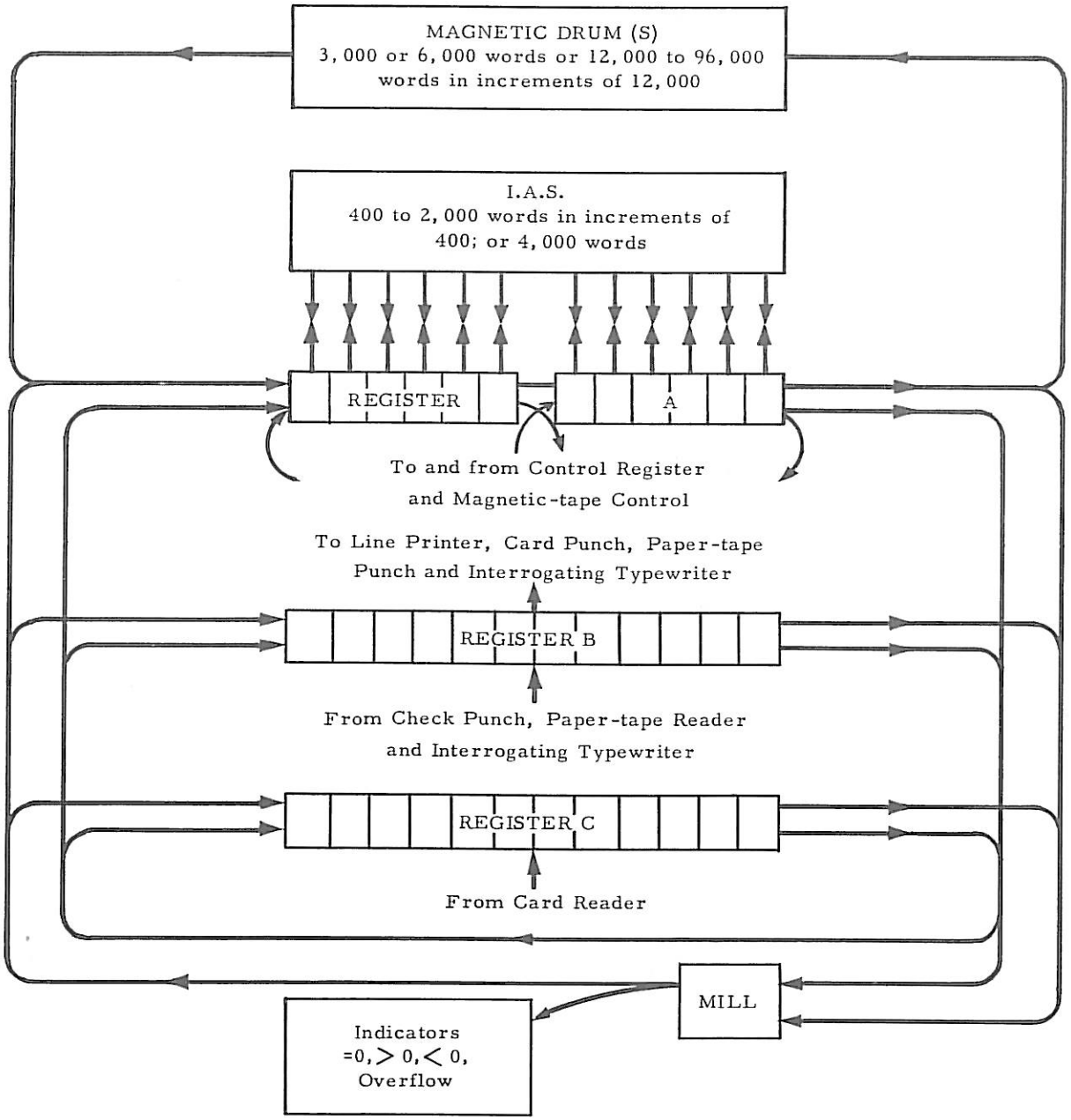


Figure 1: THE ARITHMETIC UNIT

Register B is involved in most arithmetical calculations and is the communicating link between the central processor and all peripheral units with the exception of magnetic-tape units and the card reader. It is also the only register in which numbers may be shifted i.e. displaced to the right or left within the register.

Register C is used during multiplication and for communication with the card reader.

As stated in 'Computer Storage', each digit of a number is represented by four bits. When information passes between a word of I.A.S. and Register A, the transfer takes place along 48 parallel paths, one for each data bit. When information is transferred between the registers and the Mill, the transfer takes place digit by digit, each digit being transferred along four parallel paths.

INDICATORS 1.4

Indicators are provided so that a program may determine whether or not a particular condition has been satisfied. An indicator is in one of two states, set or unset. When the state of an indicator is tested, there are two alternative pieces of program to be obeyed, one for a set condition and the other for an unset condition. If an indicator is tested and found to be set, then the normal sequence of instructions is interrupted and a jump takes place to another part of the program. If the indicator is unset, the next sequential instruction is obeyed.

Automatic Indicators 1.4.1

Automatic indicators serve as a communicating link between the computer and the program. These indicators are set, and in some cases unset, automatically by conditions arising in the computer or in the peripheral units. Automatic indicators associated with the Mill may be used to test whether a number is positive, negative or zero. There is also an overflow indicator that is set if an arithmetic operation gives a result which carries into the most-significant digit position. This is a warning to the programmer that subsequent arithmetic operations might produce a result that will be too large to be held in one location.

Indicators are automatically set if a transfer error occurs during transfer to or from I.A.S. or the drum, thus by programming an indicator test and an error routine the error can be detected by program and possibly corrected without manual intervention. The peripheral equipment is not synchronized with the computer and it is by testing the relevant indicators that a program determines when a unit is ready for use, before obeying instructions to control it.

There is also an automatic indicator that is permanently set enabling the program to jump unconditionally to another section of the program if this is necessary.

Programmed Indicators 1.4.2

Programmed indicators are entirely under program control and are set, unset, and tested by program. Where two pieces of program are largely similar, the programmer should be able

to combine them into one program using indicators to differentiate between the two cases where necessary.

Manual Indicators 1.4.3

Manual indicators enable operator action to affect the running of a program. These indicators are set and unset by manual controls (switches) on the console display panel. For example, a program might be written so that if a manual indicator is set, a complete table of results is printed, whereas if the indicator is unset, only a summary is printed. The choice is effected by the program testing an indicator to determine the switch setting.

INSTRUCTIONS 1.5

There is a range of permissible instructions which can be given to the computer. Each instruction has its own code number and the instructions are combined to form a coded program. Control may be transferred to a word of program stored anywhere in I.A.S.

A coded instruction is usually six digits in length and two instructions are normally held in one location. Some instructions (termed double-length instructions) are twelve digits in length and occupy a whole word.

The form and effects of the various instructions are described in Parts 2 and 3 and a summary is given in Part 6 of this manual. The following paragraphs form a guide to the different types of instruction available.

Transfer instructions enable information to be transferred between Registers A, B, C and I.A.S. or from Register C to Register B. When the transfer is to or from I.A.S., the particular I.A.S. word is specified as part of the instruction. There is also an instruction for transferring a group of consecutive words from one area of I.A.S. to another. The first words of the source and destination areas are specified in the instruction.

Arithmetic instructions cause decimal or sterling arithmetic to be performed, usually between Register B and a word of I.A.S. The I.A.S. word is specified in the instruction.

Logical instructions enable the programmer to store information in individual bits or digits of a word or to examine individual bits or digits of a word. Logical operations take place between Register B and a specified word of I.A.S.

Shift instructions cause the contents of Register B to be displaced in the register. The number of positions to be shifted is specified in the instruction.

Indicator-test instructions cause a jump to another part of the program if the indicator is set. If the indicator is unset, the next sequential instruction is obeyed. The indicator number and the I.A.S. word to which the jump is to be made if the test is successful are specified in the instruction. Programmed indicators are also set and unset by program instructions.

Magnetic drum instructions permit decades to be transferred from the drum to the I.A.S. and vice versa. The drum decade address and the I.A.S. location address at which the transfer is to commence are specified together with the number of decades to be transferred. All drum transfer instructions are double-length.

Peripheral instructions are used for controlling each of the peripheral units. Instructions to write to and read from magnetic tape are double-length. The I.A.S. word at which the transfer is to begin and the tape-unit address are both specified in the instruction.

THE CONTROL REGISTERS 1.6

There are three control registers: CR1, CR2 and CR3. Each is six digits in length and capable of holding one single-length instruction.

When a word of program is to be obeyed it is transferred from I.A.S. via Register A to CR1 and CR2. An instruction is actually obeyed from CR1. After the first instruction has been obeyed from CR1, the contents of the registers are shifted and the second instruction is moved from CR2 into CR1 to be obeyed.

The operation of the control registers is such that instructions are obeyed automatically in the same sequential order as they appear in I.A.S. When the two instructions in one word have been obeyed, the next word is automatically transferred through Register A to the control registers. The only instruction which causes this sequence to be broken is a successful indicator test.

The detailed operation of the control registers is described in Part 2.

MAGNETIC TAPE 1.7

Magnetic-tape units can be linked to the computer, and program instructions are available for reading from and writing to magnetic tape. By means of one instruction a block of consecutive words can be transferred from I.A.S. to tape or vice versa, the transfer being effected via Register A. There is no limit to the size of a block other than the size of I.A.S. and the remaining usable length of tape. Extra bits are automatically stored on the tape for checking purposes and transfer errors are detected during writing or reading. Magnetic tape has the advantage that reels of tape can be removed easily from the computer and the information on them preserved for future processing. Full details of the magnetic-tape systems and given in Part 3.

One - inch Tape System 1.7.1

This system comprises units recording information on one-inch wide magnetic tape. From one to eight units can be attached to the computer and each unit can be allocated an address in the range 1 to 8 by means of an eight-position switch. It is possible to read from one unit and write to another unit simultaneously.

Information is recorded on the tape along 16 tracks, the 16 bit-positions across the tape making one frame. The bits in one frame form two decimal digits of four bits each, the remaining eight bits being used for checking purposes. The checking system is such that single-bit errors are precisely detected and are automatically corrected on reading. One word is held on the tape in six frames.

The packing density on the tape is 300 frames (i.e. 600 digits) to the inch and the tape moves past the read/write heads at a speed of 150 inches a second. Information is thus transferred at 90,000 digits a second (90 kc/s). The maximum length of tape on each spool is 3,600 feet.

Half - inch Tape System 1.7.2

This system comprises units recording information on half-inch wide magnetic tape. From one to eight units may be attached to the computer and each unit can be allocated an address in the range 1 to 8 by means of an eight-position switch. It is possible to read from one unit and write to another unit simultaneously.

Information is recorded along the tape in ten tracks, the ten bit-positions across the tape making one frame. The bits in one frame form one decimal digit of four bits, the remaining six bits being used for checking purposes. The checking system is such that single-bit errors are precisely detected and are automatically corrected on reading. One word occupies twelve frames.

The packing density on the tape is 300 digits to the inch and the tape moves past the read/write heads at a speed of 75 inches a second. The transfer rate is therefore 22,500 digits a second ($22\frac{1}{2}$ kc/s). The maximum length of tape on each spool is 3,600 feet.

Quarter - inch Tape System 1.7.3

Four, six or eight units can be attached to the computer, each unit having a fixed address in the range 1 to 8. It is possible to read from one unit and write to another unit simultaneously.

The tape width is a quarter of an inch. Information is recorded by different digits being represented by different distances between signals on the tape. Information is recorded over the whole width of the tape and the value of a digit is determined by the time taken for a tape length to pass the read/write heads. For reading purposes the tape is divided into two tracks and reading may take place from either track. Extra information is held on the tape at the end of a block for checking purposes.

As the digit values are recorded by a length of tape, the packing density depends on the value of the data recorded. Assuming random distribution, the packing density is approximately 440 digits to the inch and the tape moves past the read/write heads at a speed of $37\frac{1}{2}$ inches a second. The transfer rate is therefore 16,500 digits a second (nominally 16 kc/s). The maximum length of tape on each spool is 1,800 feet.

INPUT AND OUTPUT EQUIPMENT 1.8

Input equipment provides the means of reading information into the computer and may consist of a card reader, a paper-tape reader and an interrogating typewriter, the last also being an output unit.

Information is presented to the card and paper-tape readers (in coded form) as holes punched in cards or paper tape and the readers convert this information into computer code.

The interrogating typewriter converts information typed on the keyboard directly into computer code. This information, together with the reply are then reproduced in plain language by the computer on the print unit of the typewriter.

Output equipment provides the means of obtaining the results of data processing and may consist of a card punch, a paper-tape punch and a line printer. The results may be printed in plain language or be produced (in coded form) as holes punched in cards or paper tape.

Full details of input and output equipment are given in Part 3.

The Card Reader 1.8.1

The card reader reads into the computer information punched on 80-column rectangular hole cards. The information is punched in code with one numeric or alphabetic character to a column. The characters are read into Register C, six columns at a time, and are then stored by program in I.A.S. Each character is represented in the computer by two digits termed the zone and numeric components.

The cards are read column by column, first by a reading station and then by a check-reading station. The two readings are automatically compared and an error indicator is set if they do not agree.

Two types of card reader are available, one reading up to 600 cards a minute and the other up to 300 cards a minute.

The Card Punch 1.8.2

The card punch punches information received from the computer into 80-column cards. The information is transmitted to the punch via Register B and the cards are punched row by row starting at the top of the card. When a card has been punched, the information is read back into the computer and compared by program with the original punch data.

The card punch operates at a maximum speed of 100 cards a minute.

The Line Printer 1.8.3

The line printer prints information received from the computer via Register B. The information is printed, one line at a time, on continuous stationery.

Printing is accomplished by activating print hammers which strike the paper and a carbon ribbon against a print barrel which rotates at a constant speed. All available characters (i.e. letters of the alphabet, numerals and special symbols) are embossed around the print barrel for each print position so that axial lines of similar characters are displayed on the surface of the barrel. Each character may be printed in any position along the line and spaces may be programmed.

As each line of characters on the barrel comes opposite the hammers the computer sends an impulse for each print position at which that character is to be printed. An indicator is set if a timing error arises.

Vertical line spaces can also be achieved by program instructions. The line printer may be one of the following types:

(a) 120 print positions, with a maximum speed of 600 lines a minute,
(b) 120 print positions, with a maximum speed of 300 lines a minute,
(c) 80 print positions, with a maximum speed of 300 lines a minute.

The Paper - tape Reader 1.8.4

One or two paper-tape readers may be fitted to the computer. The paper-tape reader reads information punched in code on five, six, seven or eight tracks, the number of tracks being manually selected by a switch.

Information is read into Register B and then stored in I.A.S. by program. Each character is represented in Register B by two digits; the zone and numeric components.

In the case of 7- or 8-track paper tape, one track is reserved for a check bit. In these cases an automatic check is carried out on reading and an indicator is set if there is an error.

The feeding spool can hold up to 300 feet of paper tape and the reader operates at a maximum speed of 1,000 characters a second.

The Paper - tape Punch 1.8.5

The paper-tape punch punches information into 5-, 6-, 7- or 8-track paper tape, the number of tracks being selected by an engineer's adjustment. A character is punched from its zone and numeric components held in Register B. On 7- and 8-track tape, a check bit is automatically generated and punched in the track reserved for that purpose. The punched character is then check-read at a special sensing station and an indicator is set if an error is detected. There is no such check when punching takes place on 5- or 6-track tape.

The feeding spool can hold up to 800 feet of blank tape and up to 300 characters a second can be punched.

The Interrogating Typewriter 1.8.6

The interrogating typewriter can be used to request information which is readily accessible to the program but which is not normally required as printed output and is therefore not printed by the line printer.

The typewriter is used as an input and an output unit. A message entered on the keyboard is read by program into Register B and is typed (in red) on the typewriter. Acting on the message the program causes the reply to be transferred from Register B to the print unit of the typewriter. This information is typed in black.

All keyboard characters are available for both type-in and type-out. Each character is represented in Register B by its zone and numeric component.

The typewriter prints one character at a time and operates at up to ten characters a second.

THE COMPUTER CONSOLE 1.9

The computer console is a panel containing the switches necessary for operating the computer, and various lamps which indicate conditions within the computer. In addition, each peripheral unit has its own Switch and Indicator panel.

Some of the information which may be displayed on the console is as follows:

the contents of Registers A, B and C,
the contents of the control registers CR1, CR2, and CR3,
the state of programmed indicators,
the state of the transfer error indicators.

It is also possible to set numbers in Registers A, B and C and the control registers manually.

Instructions for operating the computer and the uses of the switches and indicators are contained in the Operators' Reference Manual. Charts of the various switch and indicator panels are shown in Part 6 of this manual.

CHECKING FACILITIES 1.10

The checking facilities associated with the input and output units and magnetic-tape units have already been mentioned. Facilities are also provided for detecting errors in transfers to and from I.A.S. and the magnetic drum.

A word in I.A.S. contains 48 data bits and two extra bits for checking purposes only. These bits are generated immediately before a transfer to I.A.S. and are used for checking purposes when the word is subsequently transferred from I.A.S. If the check fails an error indicator is set.

A word on the drum contains twelve data digits and an extra digit for checking purposes only. This digit is generated immediately before a transfer to the drum and is used for checking purposes when the word is subsequently transferred from the drum. If the check fails an error indicator is set.

The I.A.S. and drum checking systems are described in more detail in Part 2.

ADDRESSING 1.11

A single-length six-digit instruction is composed of two parts, a two-digit function code and a four-digit address part.

The function code number specifies a particular computer operation (e.g. multiply); the address part usually specifies the location of the information on which it is required to perform that operation. The address is usually the location of a word in I.A.S.

For example, one available function is "add the contents of Register B to a word of I.A.S. and store the result in the I.A.S. location from which the word originated". When it is desired to perform this operation the six-digit instruction contains the two-digit code number for the operation and the four-digit address of the I.A.S. word.

The I.A.S. word specified in the address part of an instruction may be program or data. In an indicator test instruction for example, the address is the program word to which the jump is to be made if the test is successful, whereas for an arithmetic instruction, the address is that of a data word.

When an indicator test instruction is used, a jump to another word of program causes the first instruction in that word to be obeyed. It is not possible to program a jump to a single-length instruction held as the second half of a word.

Drum transfer instructions are double-length and a drum decade address is specified as well as an I.A.S. address.

PROGRAM SHEETS 1.12

A program is written as a sequence of coded instructions, and this is done using the printed form shown in Figure 2.

This form is completed as follows:

C The number of the card within the block, numbering the first card, 1.

I The relative address of a word in the block, starting at zero. The word itself contains two single-length instructions (occupying columns D, F, A and R) separated on the program sheet by a broken line. A double-length instruction occupies both halves of a word and must not appear as the second half of one word and the first half of the next.

1300 SERIES PROGRAM SHEET	JOB	BLOCK No.
		SHEET No. /
	PROGRAMMER:-	/ /

C	I	D	F	A	R		NARRATIVE

Figure 2: A PROGRAM SHEET

D Designation column. Instructions to set, unset or test indicators contain a designation in this column as part of the instruction.

F Contains the first part of the instruction, that is, the two-digit function-code number, or the indicator number in the case of an indicator instruction.

A Contains the second part of the instruction, that is, the four-digit address.

R Contains the relativizer reference number for the address. (If the address in Column A is that of a word in the same block then this column usually contains the letter 'B'.)

Narrative Used by the programmer for explanatory notes.

Constants are written on the program sheet as pseudo-instructions. A negative constant (not sterling) has 'M' written in Column D of the first half of the word and a positive constant may have 'P' written in this position though the 'P' is not essential.

RELATIVE ADDRESSING I.13

When a program is being written it is convenient to split the program into sections which can be written more or less independently of one another, possibly by different programmers.

When a program is run, I.A.S. and drum are used to store the various sections of program and the necessary data. It is not usually possible to hold all of this information in I.A.S. at once and instructions must be included in the program to bring into I.A.S. the sections of program and data as they are required.

In writing a program, frequent references are made (in the address parts of instructions) to other words of I.A.S. and to words on the drum. These words may be data or program, in either the same section or another section of the program. During the early stages of writing a program it will not be possible to ascertain the exact I.A.S. location of each word because the lengths of the various sections of program are not known. To overcome this difficulty, a system of relative addressing is used.

The program and data are divided, as stated above, into sections, which are termed *blocks* The words in each block are numbered in sequence, the first word being numbered zero. This sequence number is the relative address, i.e. it is not the actual address in storage but is the address *relative* to the first word of the block. (The actual address of a word in I.A.S. or on the drum is termed its absolute address.)

When a word of program (say, for example, word 3 of a block) refers in the address part of its instruction to another word (say, word 8) in the same block then the address part of word 3 will contain relative address 8 followed by the letter B denoting that word 8 is in the same block as word 3.

The blocks are given reference numbers termed *Relativizer Reference Numbers* (usually abbreviated to R.R.N.) and these numbers are used by the computer to convert relative addresses into absolute addresses.

For identification purposes, each program or data block is also given a block number and it

is usual to make this the same as the R.R.N. A word in a block would then be addressed by its relative address within the block and the block number, e.g. word 10 of block 15.

When the lengths of the various blocks are known it is possible to allocate storage in I.A.S. and on the drum. After this has been done, control words are written which set the I.A.S. and drum address for the first word of each block.

Each block is headed by a control word called its *block relativizer*. As the block is read into the computer, the block relativizer is used to convert into absolute addresses those addresses that refer to other words in the same block.

For each Relativizer Reference Number, there is another control word which sets the starting address for that relativizer in I.A.S. and on the drum. As the blocks are read into the computer the relativizer setting is used to replace by absolute addresses any address relative to that R.R.N.

Example If a program instruction has in its address part the I.A.S. address 'word 5 of block 16' and the R.R.N. for block 16 is set to a starting address of 150 then the absolute address referred to in the instruction is word 155.

The use of relativizers is fully described in the Initial Orders Manual.

The conversion of relative to absolute addresses takes place as the program is read into the computer. Before the program is obeyed, all addresses are absolute.

PROGRAM CARDS 1.14

When a program has been written on program sheets, the program is punched in code into program cards. The information in Columns I and Narrative is for the programmer's use only and is not punched. The block number and card number are punched into the cards so that a check can be carried out that the cards are in the correct sequence. The information in Columns D, F, A and R occupies nine columns on the card.

Three program words (i.e. six single-length instructions) are punched in each card and the columns are allocated as shown in Figure 3. Column 18 can be used as an extension to the card number when it is necessary to insert cards between sequentially numbered cards. Column 17 is used for a special marker on the last card of each block. This is used as an extra check that the cards are in correct sequence. Columns 1 to 16 are not allocated and are available for program reference purposes.

INSTRUCTIONS WITHIN THE COMPUTER 1.15

A single-length instruction occupies nine digit positions on a program sheet and nine corresponding columns of a program card. During read-in the instruction is condensed to six-digit form within the computer. This is achieved as follows:

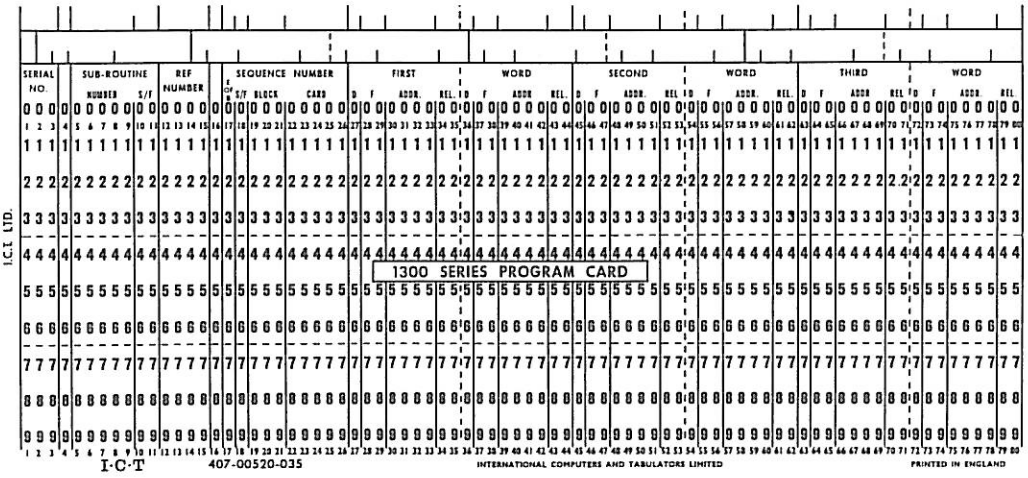


Figure 3: A PROGRAM CARD

The R.R.N. is used to convert the instruction address to absolute form. Where the M control designation occurs the correct negative constant is formed. An indicator-test, set, or unset designation is recorded in the six-digit instruction by adding it to the most-significant position of the address.

Example An unconditional jump (test of indicator 00) to word 16 of block 32 is written on the program sheet as:

D	F	A	R
4	00	0016	32

If R.R.N. 32 has an I.A.S. setting of 23, the instruction is held in the computer as 004039.

Two instructions are held in the computer in one twelve-digit word as follows:

Digit Positions	1 2	3 4 5 6	7 8	9 10 11 12
Instruction	FUNCTION	ADDRESS	FUNCTION	ADDRESS
	First Instruction		Second Instruction	

INITIAL ORDERS I.16

Initial Orders is a special program which enables other programs to be read into the computer. It reads the cards, stores the program instructions on the drum and then transfers a specified portion of the program to I.A.S.

Initial Orders is stored permanently on the reserved channel of the drum. A special button on the console causes Initial Orders to be transferred to I.A.S. ready to be obeyed when the Start button is pressed.

The input to Initial Orders is a pack of program cards. This pack contains program, constants and control words. The control words provide information for Initial Orders but are not stored in the computer program. A sequence check is carried out to ensure that the cards are in correct order.

Blocks of program are read by Initial Orders and within each block the words are stored in sequential locations on the drum. The drum address for the first word of each block is given by the block relativizer control word.

Initial Orders sets relativizers from control words read in for each R.R.N. and uses these relativizer settings to convert relative addresses into absolute addresses. Set, unset, or test designations are also added into the most-significant digit of the address.

If the card columns for a word are all blank, then that word is ignored. Provided that a zero constant has at least one zero punched, the P designation for a positive constant is not necessary. An M designation causes Initial Orders to store the constant in negative form.

It is permissible for addresses to be punched in absolute form so that Column R will be blank. Relative addresses should, however, be used since this saves programming and testing time. In particular, if relative addresses are used, storage re-allocation can be easily achieved if necessary by changing only the control words. Initial Orders and control words are described in more detail in Part 4.

As an instruction in absolute form is only six digits long, five words can be punched on a card instead of three. Cards punched in absolute form are called fast-read cards and are acceptable to Initial Orders. When a program has been fully tested the program pack can then be converted from ordinary program cards to fast-read cards, giving a smaller pack and faster read-in time. Full details of all Initial Orders facilities are given in the Initial Orders Manual.

NUMBERS WITHIN THE COMPUTER 1.17

One word of storage can hold a number consisting of twelve decimal or sterling digits. For arithmetic purposes, the most-significant digit is called the sign digit. Negative numbers are held as a complement of ten (or corresponding sterling complement) and the sign digit is therefore normally zero for a positive number and nine for a negative number.

The sterling positions in a word can be varied by program. Assuming that pence are in the least -significant digit position, the following examples show how numbers are represented in the computer.

Numbers Represented	Representation in Computer											
	1	2	3	4	5	6	7	8	9	10	11	12
365	0	0	0	0	0	0	0	0	0	3	6	5
£987.16.9	0	0	0	0	0	0	9	8	7	1	6	9
-6921	9	9	9	9	9	9	9	9	3	0	7	9
-£123456.19.2	9	9	9	8	7	6	5	4	3	0	0	10

Positive and negative constants entered by Initial Orders are held in the form shown. Initial Orders cannot accept sterling constants with an M designation. Such constants must be converted into sterling complements and then entered as if positive.

ALPHABETIC CHARACTERS WITHIN THE COMPUTER 1.18

Alphabetic characters are held in the computer in coded form. Each character is represented by two digits (called the zone and numeric components) and it is therefore possible to hold up to six alphabetic characters in one twelve-digit word of storage.

All characters punched on cards or paper tape are read into the computer with a zone and numeric component. For a numeric character, the zone component is always one, and the numeric component is equal to the number itself. The zone component is usually discarded (by program) for data numbers and the twelve digits of a word are used to hold only the numeric components of the data numbers. The zone component is re-generated before a data number is punched or printed.

The zone component is retained throughout all stages of data processing for alphabetic information or mixed alphabetic and numeric information.

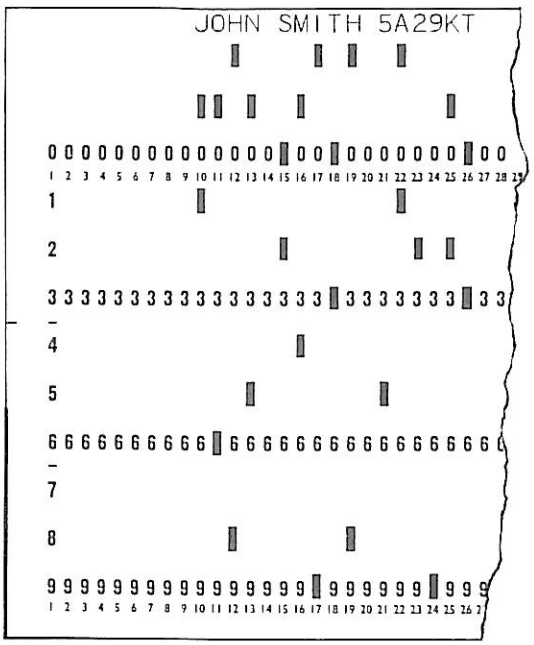
When information is read from cards, six characters are read at a time, the zone components being held in the six most-significant digits of the register and the numeric components being held in the six least-significant digits. The characters are then normally stored as consecutive words in I.A.S.

The standard card punching code together with the zone and numeric components recorded in the computer are given in the table below.

Card Numeric Punching and Computer Numeric Component	Over-Card punching				
		10	11	0	1
	Computer Zone Component				
	1	2	3	4	5
10	10				
11	11				
0	0				
1	1	A	J	&	
2	2	B	K	S	%
3	3	C	L	T	¼
4	4	D	M	U	-
5	5	E	N	V	/
6	6	F	O	W	½
7	7	G	P	X	.
8	8	H	Q	Y	@
9	9	I	R	Z	¾

Example

On Card :-



Might be held in I.A.S. as :

Location 100	0	3	3	2	3	0	0	1	6	8	5	0	(JOHN)
Location 101	4	3	2	4	2	0	2	4	9	3	8	0	(SMITH)
Location 102	1	2	1	1	3	4	5	1	2	9	2	3	(5A29KT)
	Zone						Numeric						

THE SUBROUTINE LIBRARY 1.19

Certain sections of program are common to a variety of tasks. Economies may be effected in programming and testing time if these programs (subroutines) once written are preserved for future use. A library of these subroutines for the 1300-series is maintained by International Computers and Tabulators Limited.

The subroutines may be incorporated into a program using the relative addressing system. An index is maintained of all available routines and a specification sheet for each subroutine gives full instructions on how the subroutine can be used.

General purpose subroutines are termed 'software' since they can be used without programming effort but are not built into the 'hardware' of the computer. General subroutines are available for control of all input and output units and magnetic-tape units.

Besides subroutines which can be included in programs, certain complete routines are available for which the user need supply only data to provide the required result.

The available facilities are described in more detail in Part 5.

1300 - SERIES SYSTEM CONFIGURATIONS

1.20

The 1300-series Computer Systems can be considered in two sections: the Basic System, and those units which can be added to increase the capacity and scope of the system.

	1300	1301
Basic System		
Central Processor with		
Card Reader	80 column, 300 cards a minute	80 column, 600 cards a minute
Card Punch	80 column, 100 cards a minute	80 column, 100 cards a minute
Printer	80 position, 300 lines a minute	120 position, 600 lines a minute
I.A.S.	400 words	400 words
Drum	3,000 words	12,000 words
Additive Capacity		
Printer	Replacement by 120-position printer.	
I.A.S.	Up to four additional 400-word units	Up to four additional 400-word units or one replacement unit of 4,000 words
Drum	May be increased to 6,000 words or 12,000 words. Further 12,000-word drums can then be added up to a total of eight drums.	Additional 12,000-word drums up to a total of eight drums
Alternative Feature		
Card Reader	40 col., 600 cards a minute	40 col., 600 cards a minute
Additional Features (1300 and 1301)		
Magnetic-tape:	Quarter-inch (16 kc/s), 4, 6 or 8 units on a machine **or** half-inch ($22\frac{1}{2}$ kc/s), up to 8 units on a machine **or** one-inch (90 kc/s) up to 8 units on a machine	
Paper-tape Readers:	5-, 6-, 7- or 8-track, 1,000 characters a second, 1 or 2 a machine	
Paper-tape Punch:	5-, 6-, 7- or 8-track, 300 characters a second, 1 a machine	
Typewriter input/output	120 positions, 10 characters a second, 1 a machine	