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An introduction to the FERRANTI SIRIUS COMPUTER

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The Basic Sirius Computer.

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Ferranti Sirius Computer

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Introduction

Sirius is a small general-purpose digital computer with wide applications in industry, commerce, science and technical education.

It is designed particularly for those establishments and departments which have no need for a large computer installation, but nevertheless require a true computer possessing the essential features of versatility, speed and reliability, associated with ease of maintenance and low capital and running costs. Given appropriate peripheral equipment, it can also be employed on data-logging and a variety of control work.

Sirius is especially easy to use. Numbers and instructions are represented in decimal form and are displayed to the operator in this decimal form on the front panel of the computer. The provision of eight accumulators and a single-level store results in ease of programming with a much smaller number of instructions than are required for other computers of comparable size. For the benefit of those who need to use Sirius from time to time, but who do not need to become full programmers, an automatic coding facility (Autocode) has been provided. The computer normally operates entirely automatically, but the provision of a keyboard similar to that of a desk calculator makes manual operation easy when this is required.

The small size and modest installation and maintenance requirements of Sirius arise from the evolution of new engineering techniques that have been accepted only after lengthy trials, and which give confidence of high operating reliability.

Physical Characteristics

Sirius is compact and may quickly be installed in the average-sized office with little or no preparatory work. The basic computer is in the form of a narrow cabinet standing on the floor along the back of a 6 ft. 6 in. desk. The cabinet is 4 ft. 9 in. high and 6 ft. $9\frac{1}{2}$ in. wide, but only 10 in. deep; a projection occupies part of the knee-hole of the desk. Access doors open to the rear for maintenance.

On the desk are a small control panel and the input paper tape reader. There remains ample space for working papers, and the desk drawers are available for storing programme tapes and documents.

To the right of the computer desk there will be a Teletype punch, mounted on a small cabinet. Adjacent to this will normally be a Tape Editing Set for preparing input tapes by the manual operation of a keyboard and for printing results from the output tape. If the computer is to be used intensively on certain classes of work additional tape-editing equipment will be needed in another room.

Electric power is required from a stable 230-volt 50 c/s 5-amp supply; no special precautions are necessary unless the variations of voltage or frequency are excessive.



A Sirius Computer in use.

Sirius is especially designed so that it may be extended to suit the needs of the user. Additional tape readers can be attached and placed on the desk; additional computer storage units, additional tape punches, and a card reader and punch are supplied in the form of separate free-standing cabinets which may be sited in any convenient position reasonably close to the computer. Magnetic-tape equipments are available.

Functional Characteristics

Sirius operates with strings of ten decimal digits, which are called computer 'words'; they may represent either a number used in the computation or a coded control instruction for the computer to obey.*

Work is put on the computer by breaking down the method of solution into sequences and then into simple steps in each sequence. By reference to the Instruction Code, a list of written instructions is prepared, called a 'programme', any sequence of which may be called into use many times. The programme is typed on a teleprinter to produce a punched paper tape, and this tape can be run through the tape reader for the programme to be put into the computer store whenever necessary; the instructions are then available at very short notice, and are, in fact, obeyed at a rate of up to 4000 a second.

Any sort of a computer word may be put into any part of the single-level store. This is a very flexible facility which is absent on many small computers. It allows the programmer to employ the store to best advantage whatever the nature of the computation.

The special feature of eight accumulators in which arithmetic is carried out greatly simplifies and shortens programmes and speeds their preparation. The contents of

* A 'word' may also have other uses – for instance to represent several short numbers of say two or three digits, or half a double-length number of twenty digits, or five alphabetical characters.

any accumulator may be used to 'modify' the address of an instruction so that repetitive procedures are easily programmed. An accumulator used for modification may also hold a 'counter' for controlling the repetitive process. These comprehensive facilities are among the most important aspects of a computer.

Programming Features The Instruction Code comprises more than 60 different instructions, in a particularly handy form, to cover the operations of addition, subtraction, multiplication, division, decimal shifts up and down, collation, jumps, input, output and so on. It should be noted particularly that the division instruction is built-in, so that division does not have to be programmed as on some machines.

The basic Instruction Code is shown in Appendix 'A'. The Programming Manual gives a full explanation of the instructions, with a liberal use of examples. Programming Courses are offered so that a user's staff may learn the technique quickly and thoroughly from experienced instructors.

In the course of a calculation a number may arise which is outside the permissible range of the computer. If this should occur, an overflow indicator will give warning to the programmer, who includes instructions in the programme to deal with this situation.

Following the great success of the Library Service provided for other Ferranti computers, programming routines which are commonly needed for Sirius are being thoroughly developed by Ferranti staff and will be made available in the form of programme tapes and specifications for their employment. Thus the user will have the great advantage of being able to concentrate on the master programme specific to his problem, drawing on the library for routines which are in common use. The library will also include complete programmes for the solution of common problems, using standard forms for the supply of data and presentation of results.

A simplified means of using the computer has been developed, so that in a day or two anyone may learn to put work on Sirius with little or no help from a trained programmer. The notation is identical with that of the well-tried and popular Autocode for the Pegasus computer; in fact Pegasus Autocode programmes are acceptable by Sirius with very little alteration. The Autocode has also proved its worth to trained programmers because, although there is necessarily some sacrifice in the speed of the computer, the preparation and the development of a programme are so much quicker that there is a considerable overall saving in the time needed to obtain the results.

Input, Output and Checking The basic Sirius computer is supplied with one Ferranti TR5 punched paper tape reader for input, and one Teletype tape punch for output. Extra input/output equipment may be added, as described below.

The new fast transistorised tape reader, TR5, operates photo-electrically at speeds up to 300 characters per second. A character may be either a number, a letter, or a symbol, represented by a pattern of up to five holes across the paper tape. The character code is the same as for Pegasus and Mercury, the representation of decimal figures being self-checking.

When a written programme is converted to punched paper tape on a teleprinter, a typewritten version is produced automatically for proof-reading. For programmes which are to be used frequently, the standard input routine provides the facility of a

available for the use of continuous pre-printed stationery on both machines. For those applications where the output is required in graphical form, special plotters are obtainable to plot a family of curves automatically from the output tape.

The input and output facilities which are available are extensive, and they allow a wide variety of peripheral devices to be attached. Every Sirius computer is fitted with two input and two output channels, and to each of these may be attached a 5-way switch-box so as to provide ten input and ten output channels under control of the programme with instantaneous switching. Each channel operates on the new standard Ferranti system so that peripheral equipment which is developed for other computers may be used with Sirius. Such equipment will include additional tape readers and punches, direct-coupled Creed 75 teleprinters, Creed 3000 tape punches (operating at 300 characters per second), Magnetic Products Ltd. magnetic-tape equipment providing simple character-by-character reading and writing, 7-channel paper tape readers and punches, and, for data-logging and process-control, a wide variety of specialist equipment as described in Section 9.

The punched card equipment for use with Sirius is the Bull PRD Reproducer, which comprises both a reader and an independent punch for 80-column cards, working at a rate of 120 cards per minute. Cards of Bull, Hollerith or I.B.M. type can be used. The PRD has check reading stations on both the reader and the punch. The control electronics are housed in a cabinet the same size as a 3000-word additional store cabinet for Sirius.

When cards are used 50-word buffer stores are provided, and also buffer transfer instructions. Disciplined and undisciplined buffers are both available to the programmer. With disciplined cards each column is represented as two Sirius decimal digits, one for the upper curtate and one for the lower curtate. Thus, with ordinary decimal punching, programmed conversion is unnecessary. All the 160 possible digits from one card can be held in the first 20 Sirius words of a 50-word buffer. With undisciplined cards each column is held as half a Sirius word with each hole separately represented. Thus it is possible for any code to be deciphered by programme or for any form of binary punching to be dealt with.

Storage

The basic Sirius computer is provided with 1000 words of storage, all of which are parity checked and available for use by the programmer for any purpose, as indicated in the foregoing paragraphs. The first 200 words will normally be allocated to the standard routines for input, monitor, and output; but they may be over-written when the programme and data have been read in if this space is required during the computation. There is a special facility for restoring these routines if required at a later stage when the space becomes available again. By this means, and by 'packing' techniques facilitated by the 'collate' instructions, the greatest possible use may be made of the whole of the store.

If further storage is needed, it can be provided in free-standing cabinets without structural alteration to the basic computer. Every such cabinet is capable of holding 3000 words, but it is only necessary to insert as many plug-in packages of 100 words as are required. Additions may be made at any time, either filling up a cabinet or adding an extra cabinet. The maximum is three cabinets, providing a total store of 10,000 words. The extra storage is available to the programmer in exactly the same way as the basic store of 1000 words.



The Sirius Displays and the Keyboard.

Speed of Operation

The Sirius computer is nearly twice as fast as any other existing computer at its price, both as regards speeds of input and output and speeds of computation.

The addition or subtraction of numbers in the multiple accumulators occupies 240 microseconds including modification of the address. Instructions which involve reference to the store require a total of 4 milliseconds. Both multiplication and division take from 4 to 16 milliseconds, with an average of about 8 milliseconds. Analysis of existing programmes has shown that only about 10% of instruction require reference to the store and that about 5% are for multiplication or division. Thus about 1000 instructions in a programme would be obeyed in 1 second.

It is not possible to give an exact comparison between the speeds of Sirius and Pegasus, as this will depend on the nature of the programme. As an example, the solution of 27 simultaneous linear equations takes 3 minutes on Pegasus and 6 minutes on Sirius. In applications where input and output predominate over computation, the speed of Sirius will closely approach that of Pegasus. The Autocode will run twice as fast on Sirius as on Pegasus.

Teaching Sirius has excellent facilities for teaching, as it may be made to operate at any speed, **Facilities** to stop at any desired point in the programme, and to display the contents of any accumulator or any 'word' in the store in the form of decimal digits. It may also be operated manually for demonstration purposes, or to correct a programming error.

> One of the two numerical displays on the front of the computer cabinet always shows the instruction which has just been obeyed. On the other display may be selected the contents of any accumulator. Thus it is easy to demonstrate the effect of each instruction, the accumulation of numbers, the effect of modifiers, the movement of counters, jump instructions - in fact all the basic essentials of computer work - on the readily-understood decimal displays.

> There is a switch to determine whether the computer will operate automatically at full speed or will only obey one instruction each time a button is depressed, and there is a rotary knob whereby any intermediate speed may be selected.

> Apart from 'Wait' instructions which may be written into the programme, the handkeys on the desk may be set to cause the computer to wait at any chosen point in the programme. The handkeys may also be used for the display of any word in the store, to alter any word in the store or an accumulator, or to operate the computer manually.

> It is believed that these instructional facilities are of the greatest importance for imparting a rapid understanding of the basic characteristics of a computer, and for giving early familiarity and confidence to a programmer.

Data-Logging and Process-Control

Sirius can be used for data-logging and process-control and the computer itself needs no alteration in order to be able to perform such functions.

The computer must have access to digital and analogue information from a large number of sources and this data will be fed into the computer via the input channels, which are fitted with scanners as necessary. Digital data, perhaps derived from handset dials, relays and switches, is acceptable in either packed or unpacked form in the same way as data from a standard input device. Analogue inputs require conversion into digital form before the machine can accept them. Economic reasons usually prevent an analogue-to-digital converter being attached to each input and it is necessary to have some form of switching mechanism prior to the converter so that a large number of inputs can be converted, in turn, by the one device. Various methods of input selection can be provided, the most appropriate method for a particular application being determined by the sizes of analogue signals to be selected, and the speed required. It is sufficient to say that a large number of signals, which may be of the order of volts, milliamps or millivolts, can be selected and converted quickly and accurately. The selector may scan the inputs in a fixed order or it may be controlled by the computer so that inputs can be called for in any sequence demanded by the programme.

The normal output channels on Sirius are sufficient for any data-logging/alarmmonitoring requirements. A direct coupled teleprinter, paper tape and alpha-numeric displays should satisfy most logging demands. In addition, if the machine is to be used for control work, analogue outputs can be produced by means of a digital-toanalogue converter or converters, and digital control signals can be produced to operate selectors, relays, etc. A number of suitable input/output devices have already been developed.



REAR VIEW OF SIRIUS. The delay line trays are at the bottom of the centre compartment and the accumulator packages are on the fourth shelf up at the extreme left.

It will thus be seen that Sirius is suitable for data-logging and process-control applications and, since the computer itself does not need to be altered to do this type of work, it can still be used at any other time as a general-purpose computer.

Installation and Maintenance Sirius is easily transportable and, as mentioned above, it requires only a moderate amount of space and a normal power supply at 230 volts, 50 c/s, and 5 amps., free from excessive fluctuations. The small amount of heat generated by the basic computer does not call for special arrangements for room ventilation.

Inside the computer, the logical and storage elements are mounted on plug-in 'packages' and, if a fault should develop in one of these, it is quickly replaced and the computer put back into service.

When Sirius is run on a daily basis, it will be normal to start with test programmes, occupying about $\frac{1}{4}$ hour, to prove that it is in full working order. Periodically the computer and the mechanical equipment incorporated in the input and output channels should be tested more exhaustively and adjusted, and any discarded packages should be repaired by an expert.

Accordingly, for the United Kingdom, Ferranti Ltd. offer to install and commission the computer, to maintain an engineer on site for two months to ensure its initial good running and to instruct the purchaser's staff in the daily test routines; also to undertake visits each fortnight thereafter for the next ten months to carry out comprehensive checks and adjustment, to provide an on-call maintenance service, and to provide all necessary spare parts. Arrangements can be made to continue this maintenance after the first year, as required. Customers who wish their own engineers to be responsible for the computer after the initial period may send them to the factory for training.

Conclusion

Large computer installations require justification by the number and volume of major tasks which they are to fulfil. Sirius is a true computer which offers considerable speed, power and flexibility at a modest outlay where the work load is not so great.

In the Ferranti tradition Sirius is engineered for reliability and convenience in its use, and is so designed that the size of the store may be extended whenever the need may arise. This offers a great opportunity for the economical introduction and development of modern computer techniques.



SIRIUS COMPONENTS. A delay line tray with cover removed and front and back of a neuron package.

Appendix A Siriu

Sirius Basic Instruction Code





N is a main store address or a constant F is a function from the table shown below A and B are accumulators n, a, b are the contents of N, A, B respectively a' is the contents of A after the operation OVR is the overflow indicator.

In all instructions up to 69, b is added to N before the instruction is obeyed. **This is the basic instruction code, and only includes the commonly used functions.** The full code is given in List CS.244 'Sirius Programming Manual'.

$\begin{array}{rrrr} 00 & a' = a + (N - 0) \\ 01 & a' = a - (N - 0) \\ 02 & a' = -a - (N - 0) \\ 03 & a' = -a - (N - 0) \\ 04 & a' = N + b \end{array}$	b) b) - b) - b)	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	10a = (N - b) 10a = (N - b) -10a = (N - b) -10a - (N - b) 10a = M.S.D. of (N - b)
$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$10a = 10^{4}(N = b)$ $10a = 10^{4}(N + b)$ $10a = 10^{4}(N + b)$ $10a = 10^{4}(N = b)$ $10a = M.S.D. \text{ of } 10^{4}(N = b)$
$ \begin{array}{rcl} 10 & a' = a + n \\ 11 & a' = a - n \\ 12 & a' = -a - n \\ 13 & a' = -a + n \\ 14 & a' = n \end{array} $		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$ \begin{array}{l} 0a = n \\ 10a = n \\ -10a = n \\ -10a = n \\ 0a = M.S.D. \text{ of } n \end{array} $
40 $a' = (a = 5)/10$ Arithmetical Shift down (Rounded)44 $a' = a/10$ Arithmetical Shift down (Unrounded)45 $a = (a + 5)/10 + L.S.D.$ of N (Rounded)49 $a' = a/10 + L.S.D.$ of N			
50Dummy51Jump to N if N52Jump to N if a53Jump to N if G54Jump to N if a	4.S.D. of $a \neq 0$ = 0 <i>WR</i> set < 0 Instructions 53 and	 55 Jump 56 Jump 57 Jump 58 Jump 59 Jump 58 clear the 0 	to N unconditionally to N if M.S.D. of $a = 0$ to N if $a = 0$ to N if $a = 0$ to N if $a = 0$ VR
$ \begin{array}{lll} 60 & a' = a \\ 64 & n' = 0 \\ 66 & a' = a \& N \\ 68 & a' = a \& 10^{e}N \\ 69 & a' = x_{v} \text{ and jun} \\ 99 & \text{Wait} \end{array} $	np to N	$\begin{array}{ll} 70 & x'_{s} = \\ & \text{dividu} \\ 71 & a' = \\ 72 & (\text{TAP}) \\ 73 & (\text{TAP}) \\ 79 & (a, x_{s}) \end{array}$	quotient, $a'' = remainder, on ng (a, x_n) by b. UnsignedTAPEE) = aE) = a and a'' = TAPEb' = b' = x_s$

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Appendix B Technical Details of Sirius

Basic binary digit frequency	§ megacycle per second.
Number system	Decimal, fixed point. Each decimal digit is represented by 4 binary digits.
Mode	Serial.
Word length	10 decimal digits, each of 4 bits.
Word time	80 microseconds.
Instruction code	Multiple accumulator, single address instructions with modification of address.
Store	Single-level on 50-word delay lines using torsional propagation. 1000 words in basic machine, all available to the programmer.
Checking	Parity bit stored with every word.
Input	Paper tape with self-checking code for decimal digits at up to 300 ch/sec. 2 input channels available.
Output	Paper tape with self-checking code for decimal digits at 60 ch/sec. 2 output channels available.
Extensions	Additional input and output channels. Extra storage up to a total of 10,000 words. Punched card input and output at 120 cards per minute. Magnetic-tape available.

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