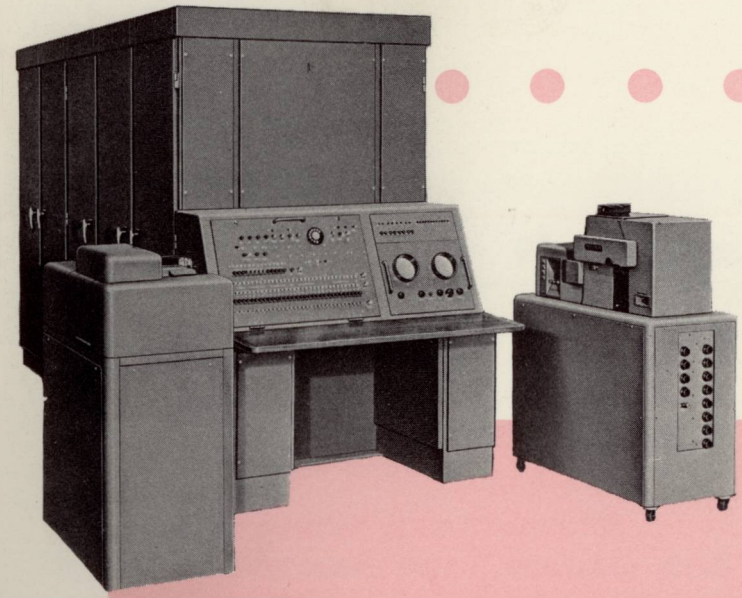

Specification 'DEUCE'

Mark IIA

'ENGLISH ELECTRIC'

Contents

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1.0 INTRODUCTION

The DEUCE, Digital Electronic Universal Computing Engine, was developed by the Nelson Research Laboratories of The English Electric Company. It is based on the ACE Pilot Model which was designed and built at the National Physical Laboratories by a combined team of engineers and mathematicians from the two establishments.

DEUCE Mk. IIA operates in conjunction with an 80-column punched card combined input/output unit, complete with automatic conversion facilities. It is principally intended to be the central unit of a data processing system and it retains its inherent power as a scientific machine.

In certain data processing applications considerable advantage can be gained by increasing the size of the DEUCE high-speed store. DEUCE Mk. IIA therefore provides a 50% greater capacity high-speed store than DEUCE Mk. II whilst retaining all other features. This increase enables programmes and data to be present in rather larger blocks thus making recourse to the backing store less frequent.

As part of an electronic data processing system, DEUCE Mk. IIA is normally fitted with magnetic tape auxiliary storage units. High-speed paper tape input and paper output and a second 80-column punched card input/output unit may be fitted as optional extras.

Most programmes and sub-routines built up over a number of years on the original 32-column punched card operated machines are usable, including powerful interpretative schemes designed to simplify programming.

2.0 GENERAL INFORMATION

DEUCE is a serial machine operating in the binary mode and has a pulse repetition frequency of 1 megacycle. It uses a word length of 32 digits and a word time of 32 microseconds. Multiplication and division times are 2 milliseconds and addition and subtraction 32 microseconds per operation. A further 32 microseconds is required per instruction in order to allow its analysis by the control circuits. Each instruction may effect up to 32 operations. All arithmetic operations are fixed point, although numerous floating point sub-routines are available. One single length accumulator and one double length accumulator are provided and the latter may be used as two single length accumulators.

Three types of storage are available. The high-speed store, immediately associated with the computing circuits, is of the acoustic delay type using mercury delay lines. A large capacity store of longer access time is provided by a magnetic recording drum and information is transferred in blocks between these two systems. The third type of storage is on magnetic tape, which is available as an optional extra.

It is possible to have an input or output operation, a transfer to or from the Magnetic Drum, a transfer to or from the Magnetic Tape, a multiplication or a division and a simple arithmetical or logical operation all occurring simultaneously.

All arithmetic and logical facilities are associated with particular parts of the high-speed store. Instructions specify the transfer of words from a specified source to a specified destination indicating at the same time the location in the high-speed store of the next instruction. The code can be described loosely as '2 + 1 address'. There are 32 sources and 32 destinations. Twenty one of each are direct store addresses and the remainder are associated with the various arithmetic and organisational facilities. Each instruction can transfer up to 32 words between the selected source and destination. A facility for automatic modification of instruction is provided. This has eight modifying registers.

Since instructions are coded in binary form they may be stored in the same way as numbers, each instruction occupying one word length. Optimum programming is used to achieve maximum speed of operation. Programme input is in binary form on punched cards and this is regarded as being a simpler and more efficient method than decimal input, although a programming system is available allowing the latter. Comprehensive operating and display facilities are provided, including 'Programme Display' (the punching out of instructions as they are obeyed) and 'Request Stop' (the ability to halt the programme on any given instruction). Fifty selected words of the high-speed store may be displayed simultaneously. Operations may be effected manually and interlocks are provided to ensure correct operation.

3.0 PHYSICAL FORM OF THE COMPUTER

An installation comprises the following units:-

1) 80-column Punched Card Combined Input/Output Unit.
2) Electronic Units, Magnetic Store (Main Assembly).
3) Control Desk.
4) Mercury Delay Line Store in two Thermostatic Enclosures.
5) Power Supply Unit.
6) Voltage Regulator.

This computer will normally be fitted with magnetic tape auxiliary storage. Also it may be fitted with high-speed paper tape input and paper tape output.

3.1 ELECTRONIC UNITS, MAGNETIC STORE

The electronic circuits of the machine are built onto steel chasis mounted in a vertical plane, all valves projecting on one side with other components arranged on the opposite face. Services-approved types of component, conservatively rated, are used throughout.

The chassis are mounted in groups of eight in vertical racks approximately 6 ft. high, 26½ in. wide and 11 in. deep, with screw retaining devices which also serve as locations for the plug and socket connections to the cubicle wiring.

The main assembly consists of thirteen cubicles, arranged in two rows of six and one at one end, with an access corridor 2ft. 8in. wide between the rows. Doors on the outer faces of the cubicles give access to the component side of the chassis, on which the layout has been arranged to permit inspection and servicing of any component without removal of the unit from the cubicle.

Transformers feeding valve heaters and the main power distribution system are mounted above the ceiling of the access corridor.

3.2 CONTROL DESK

The control desk is separated from the main assembly and carries controls for normal operation together with a number of additional controls and indicator lamps for testing of the machine and programmes. Two C.R.T. monitors are provided, one displaying in raster form the contents of all the short delay lines, and the other displaying the information stored in any selected long delay line. The control desk also carries remote controls and overload indicators for the main power supply unit.

4.0 80-COLUMN PUNCHED CARD COMBINED INPUT/OUTPUT

This gives access to all 80 columns of the punched card and may operate synchronously at 100 cards per minute, or independently at 200 cards per minute input and 100 cards per minute output. Automatic conversion of decimal, and translation of alphabetical, coding to 6-bit binary in a buffer store is provided so that the computer need only refer to the input once for each card and computation may proceed concurrently.

Normal 64-column input/output is included, the choice (64/80) being under programme control. Practically all existing 32-column programmes may be used without alteration.

5.0 HIGH SPEED PAPER TAPE INPUT

The High-speed Paper Tape Input will operate at approximately 850 characters per second. It will read either 5-hole or 7-hole paper tape. 8-hole tape can be accepted though 7 holes only will be sensed. Of the 7 holes, one digit will complete parity leaving a 6-bit character to be read into the main store. The use of the paper tape will be independent of the code punched on the tape, the computer being given the task of converting the code to a standard form.

It is possible to convert numbers from decimal to binary at this speed though occasional stopping of the tape may be necessary to store away the converted numbers. Direct Programme input is not possible although large programmes could be read in from paper tape by a special card programme.

6.0 PAPER TAPE OUTPUT

The reliable paper tape equipment currently available provides an output rate of 30 characters per second, i.e. 210 binary digits per second with 7-hole punching facility. It can be fitted where required and would be mainly useful for producing paper tape for such other equipments as wind tunnels and machine tool controls. The output is Programme controlled.

7.0 STORAGE

The built-in storage facility of DEUCE Mk. IIA other than that provided by magnetic tape units, provides a total of 8,818 words of 32 digits each. This facility is made up as follows:-

19 mercury delay lines of 32 words each - average random access time 496 microseconds.

3 short mercury delay lines of two words each - average random access time 16 microseconds.

4 short mercury delay lines of one word each - average random access time immediate.

2 short mercury delay lines of four words each - average random access time 48 microseconds.

A Magnetic Drum of 8,192 words recorded on 256 tracks - practical average access time 20 milliseconds.

The Magnetic Drum rotates at 6,510 r.p.m. carries 256 tracks of 32 words each and is fitted with a block of 16 reading heads and a block of 16 writing heads. If the track to be read from or written onto does not lie beneath a head of the appropriate block then it is necessary to order a shift of that block to a suitable position. In all instances this shift takes 35 milliseconds (average).

Once the head-block is aligned a transfer may be ordered and 15 milliseconds later 32 words will have been transferred between the selected track and the buffer store, for which one delay line of the high-speed store is used. A track is not affected by the reading operation.

During either the shifting or the transfer computing may proceed freely provided that the Magnetic Drum facilities are not referred to. An interlock is provided to safeguard against this, holding up the programme if necessary until the Drum operation has been safely executed.

7.1 MERCURY DELAY LINE STORE AND THERMOSTATIC ENCLOSURE

The 19 long mercury delay lines are enclosed in two separate thermostatically controlled chambers, which are maintained at a temperature of

45°C. ± 0.5°. The three short lines of 2 words each and two short lines of 4 words each are housed in a thermostatically controlled enclosure within the main cubicle assembly. The 4 short lines of 1 word each are also mounted in the main frame assembly and temperature control is unnecessary.

8.0 MAGNETIC TAPE AUXILIARY STORAGE

Further auxiliary storage can be supplied utilising magnetic tape units. The magnetic tape units used with DEUCE are of the twin transporter type. Up to 4 twin-tape transporters can be accommodated on the standard 'DEUCE' equipment. This number may be extended by the use of additional equipment within the computer. A significant feature of this magnetic tape system is a facility for varying the block length.

Max. length of Tapes	-	2,400 ft. each.
Speed	-	100 inches/second.
Recording	-	80 characters/inch.
Single Direction		
Block length	-	Variable in steps of 10 characters.

Automatic Two-way Parity Checking.

9.0 INSTALLATION

9-1 POWER SUPPLIES

The power supplies for the complete equipment are mounted in three additional cubicles which form one unit and include full protection against overload, mains failure etc. This unit may be remotely installed and controlled. Indication of operation is provided.

A voltage regulator is provided between the main supply and the power unit to ensure satisfactory operation of the equipment within normal mains input voltage variations.

The main power supply unit is designed to be fed direct from a 400/440 volt, 50 - 60 c.p.s., 3-phase with neutral, supply. To meet continental requirements however a suitable transformer will be provided.

The power supply unit is fitted with an additional interlocked contactor for starting the fans of the ventilating system. The Power required by the fans is not included in the following figures.

9.2 POWER CONSUMPTION

	Stabilised		Unstabilised
DEUCE Mk. IIA without Magnetic Tape	13.4 kVA	+	0.3 kVA
DEUCE Mk. IIA with Magnetic Tape (2 Twin Transporters)	16.4 kVA	+	8.3 kVA

Unstabilised supply - 4 kVA extra for each additional twin tape transporter.

9.3 VENTILATION

A large proportion of the energy supplied to the machine appears as heat in the main cubicle assembly and a forced cooling system is required to remove this heat from the equipment.

The filtered cooling air should be supplied to the machine by a centrifugal fan via under-floor or overhead ducts and the heated air extracted from the top of the machine by an axial flow exhaust fan.

The inlet fan should be capable of supplying 2,500 cubic feet per minute against a static pressure of 0.5 inches water gauge for bottom entry and 1.7 inches water gauge for top entry. Manual or automatic control of the air flow should be provided down to 1,000 c.f.m. to allow for seasonal variations of ambient temperature.

10.0 DIMENSIONS OF EQUIPMENT

		LENGTH	BREADTH	HEIGHT	WEIGHT
Main Assembly	-	14' 11"	5' 0"	7' 5½"	50 cwt.
80 Column Punched Card Input/Output Unit	-	4' 5"	2' 1"	4' 2"	12 cwt.
Control Desk	-	3' 5½"	5' 0"	4' 2½"	6 cwt.
Mercury Delay Line Store (2)	-	3' 1"diam.		3' 4"	3 cwt. each
Power Supply Unit	-	6' 0"	2' 2"	6' 3"	24 cwt.
Voltage Regulator	-	2' 7"	1'10"	3'10"	9 cwt.
Twin Tape Transporter	-	4' 0"	3' 0"	5' 6"	11 cwt.

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THE ENGLISH ELECTRIC COMPANY LIMITED

CONTROL AND ELECTRONICS DEPARTMENT

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