

# ELLIOTT

# 9000

Volume 1: FUNCTIONAL SPECIFICATION  
Part 4: PERIPHERAL EQUIPMENT  
Section 3: DIGITAL PLOTTER DPA 381

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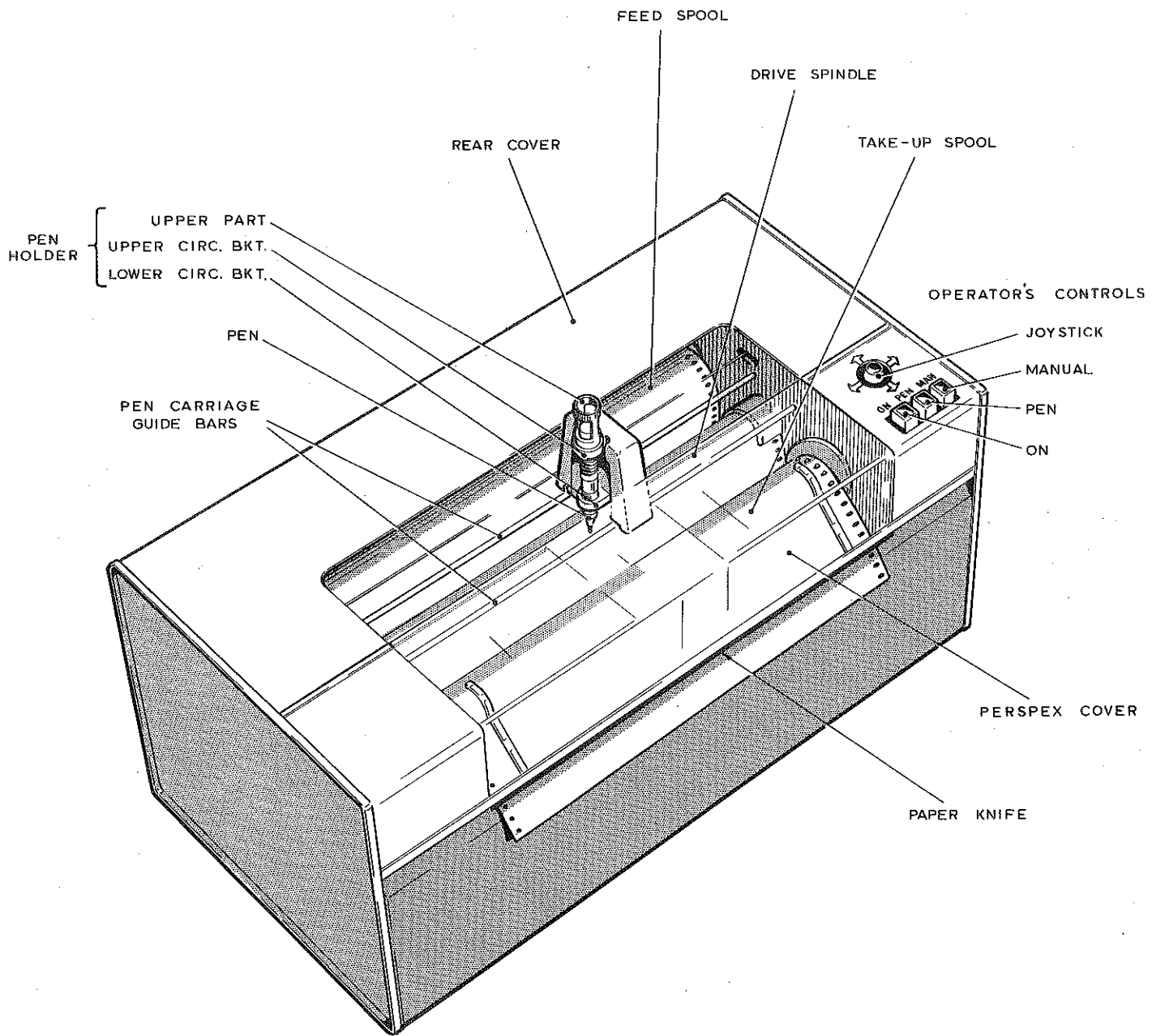


Fig. A

## Chapter 1: INTRODUCTION

### 1.1 General Description

The output data from the 903 computer can be presented in the form of a permanently recorded graph, chart or diagram complete with scale markings, where required. The equipment used to display information in this manner is termed a digital plotter and is shown in Figure A.

The three digital plotter models available for use with the 903 computer are listed in Paragraph 6.2; each is supplied with a specially designed mobile stand. The models are similar and differ only in respect of step size. The user can, therefore, select the model most suited to his requirements.

Data is recorded on the plotter, in response to computer instructions (see Paragraph 3.1). This is done by means of a pen which can move horizontally across a paper plotting surface which itself can move at right angles to the pen. The pen may move to the left or the right and the paper may move either forwards or backwards. Thus, a single increment on the paper can, by a combination of these movements, be in any one of eight directions. A continuous trace can thus be drawn as a series of correctly positioned increments; 18,000 such increments are made per minute. The pen can also be lifted from the paper when necessary.

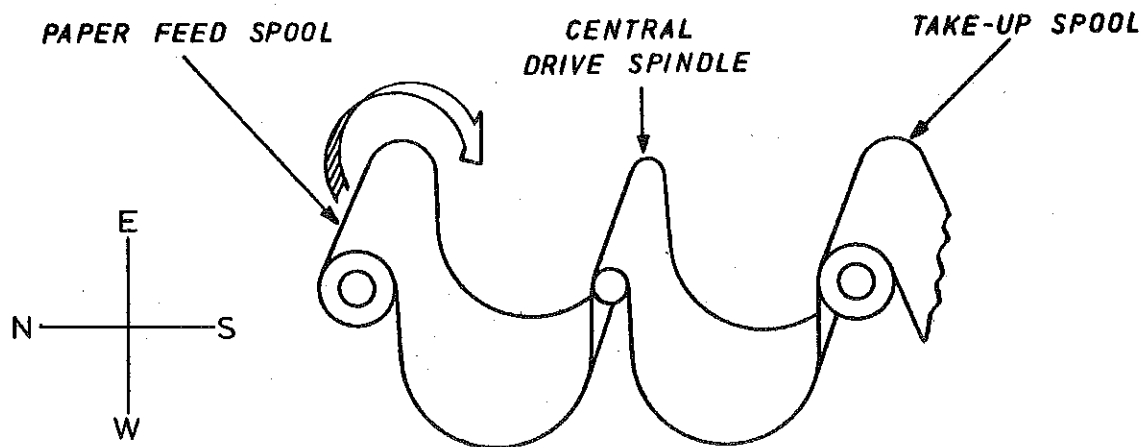


Figure B. MOVEMENT OF PAPER ACROSS DRIVE SPINDLE

Holes at the edge of the paper engage on sprockets on the central drive spindle and the pen carriage moves along tracks parallel to the spindle axis. Movement of paper between the spools, across the drive spindle, is shown in Figure B.

#### 1.2 Connection to a 903 System

The digital plotter may be connected direct to the peripheral sockets or via the 903 peripheral multiplexer. The plotter power cable must also be connected to a suitable mains outlet (see Paragraph 6.4).

## Chapter 2: DESCRIPTION OF THE DEVICE

### 2.1 Drive Spindle and Pen Carriage

The movements of the drive spindle and pen carriage are controlled by geared stepping motors capable of being stepped in either direction. Spindle and carriage steps can occur either separately or together, so making it possible to move from one point to any one of eight others in a single movement. The pen is raised or lowered by means of a solenoid mechanism in the pen housing.

For ease of reference, map conventions have been adopted; that is, lines resulting from movement of the pen carriage to the right or the left are referred to as a movement East (-Y) or West (+Y) respectively and similarly, lines resulting from spindle movements are North (+X) or South (-X).

### 2.2 Plotting Paper

The paper used with the digital plotter is in the form of 160 ft (48.8 m) rolls. It is loaded on the paper feed spool at the rear of the plotter. The paper has holes punched, in both margins, which fit the sprockets on the drive spindle and the take-up spool. The pitch of the sprockets is different for each model and hence the paper used is different (see Paragraph 6.2) For paper required, see Section 3.4.3 of the 903 Manual.

The main drive to the paper is through the central drive spindle, the paper being held firmly in contact with the spindle by the action of a fan, mounted below it, which sucks the paper downwards. The paper is maintained in a loop on each side of the spindle due to the suction created by the fan. The size of these loops is automatically maintained between two limits by means of photoelectric detectors which govern the motion of both the paper feed spool and the take-up spool.

The normal arrangement is for the paper to be fed by the take-up spool out of the slot in the front (South) of the plotter. Alternatively, the paper may be collected on the take-up spool. In the latter case the normal sprocketed take-up spool must be replaced by an unsprocketed one.

### 2.3 Pen Unit

The pen units for the plotter are readily interchangeable. The standard nib sizes are 0.2 mm and 0.4 mm but nib sizes of 0.3 mm, 0.5 mm, 0.6 mm, 0.8 mm and 1.2 mm are also available. The available ink colours are black, green and red.

The manual positioning of the pen prior to on-line operation is effected by use of the Joystick Control (see Paragraph 5.4).

#### 2.4 Run-Off

No facility is provided to prevent the pens from running-off the paper in either the "East" or "West" directions. Care must be taken to prevent such excessive travel.

#### 2.5 Accuracy

A plot is repeatable to within  $\pm 2$  step sizes when the sum of the reversals of both pen and roller movement is  $5 \times 10^4$ .

The dimensional accuracy of the step size is within  $\pm 2.0\%$ .

## Chapter 3: FUNCTIONS

### 3.1 Instructions

There are two instructions used to transfer data from the computer to the digital plotter.

#### (1) 14 4864, Block Transfer

This instruction causes  $x$  18-bit words to be transferred to the plotter from store locations  $y$  to  $y + x - 1$  (where  $y$  is the contents of the accumulator and  $x$  is the contents of the Q-Register). The plotter responds to the six least significant bits of each word which are treated as one data character (see Paragraph 3.2).

#### (2) 15 4864, Single Transfer

This instruction causes a single 18-bit word to be transferred from the accumulator to the plotter. The plotter responds to the six least significant bits of the word which are treated as one data character (see Paragraph 3.2).

The time taken to transfer a word is approximately  $35 \mu\text{s}$  (i.e.  $25 \mu\text{s}$  instruction time +  $10 \mu\text{s}$  device response time). The plotter will be busy for 3.3 ms after receiving a move pen instruction or move roller instruction, and for 20 ms after a raise (or lower) pen instruction.

### 3.2 Data Characters

Each movement performed by the plotter is defined by a 6-bit character. The significance of each character which results in a defined action by the plotter, is given below.

Character	Action
00 00 01	Move East (-Y)
00 00 10	Move West (+Y)
00 01 00	Move North (+X)
00 10 00	Move South (-X)
01 00 00	Raise Pen
10 00 00	Lower Pen

Move East and Move West actions are the result of pen carriage movements; Move North and Move South are the result of spindle movements.



Movements in directions other than those given above may be produced by combining certain of the above characters. This results in the plotter actions given below.

Character	Action
00 01 01	Move North-East
00 10 01	Move South-East
00 01 10	Move North-West
00 10 10	Move South-West

The actions specified in the two tables above are defined by standard data characters. All other actions due to non-standard data characters are undefined and must be avoided. Examples of these are given below.

Character	Action
00 00 00	No Action, but the plotter becomes busy for a maximum of 3.3 ms.
00 00 11	Move East and West; the position of the pen at the conclusion of the instruction cannot be defined. No damage to the plotter will result.
01 00 01	Move East and Raise Pen; both commands are obeyed but the line drawn is undefined. The plotter becomes busy for 20 ms.

If a raise pen or lower pen action is specified when the pen is already in the position called for, no damage to the plotter will result. The plotter will, however, become busy for 20 ms.

### 3.3 Illustration of Plotter Operation

For the purposes of illustration, a method by which the plotter can be made to draw 'A3' is shown. It is assumed that the pen is initially raised at the left foot of the 'A' and is also left raised after drawing the '3' (ready for drawing the next character).

A total of 18 store locations (S to S+17, say) should be set up with three plotter instructions packed into each location (except S+17). The data characters in each location are as shown below.

Location	Character 1	Character 2	Character 3
S	10 00 00	00 01 00	00 01 00
S+1	00 01 00	00 01 00	00 01 00
S+2	00 01 00	00 01 01	00 00 01
S+3	00 00 01	00 10 01	00 10 00
S+4	00 10 00	00 10 00	00 00 10
S+5	00 00 10	00 00 10	00 00 10
S+6	00 00 01	00 00 01	00 00 01
S+7	00 00 01	00 10 00	00 10 00
S+8	00 10 00	01 00 00	00 01 01
S+9	00 01 01	10 00 00	00 10 00
S+10	00 10 01	00 00 01	00 00 01
S+11	00 01 01	00 01 00	00 01 00
S+12	00 01 10	00 00 10	00 00 01
S+13	00 01 01	00 01 00	00 01 10
S+14	00 00 10	00 00 10	00 10 01
S+15	01 00 00	00 10 01	00 10 01
S+16	00 10 01	00 10 01	00 10 01
S+17	00 10 01		

The programmer should then arrange a loop which successively fetches into the least significant six bits of the accumulator each of the 6-bit instruction characters, beginning with character 1, and output them to the plotter. This will draw the character A3, as shown in Figure C.

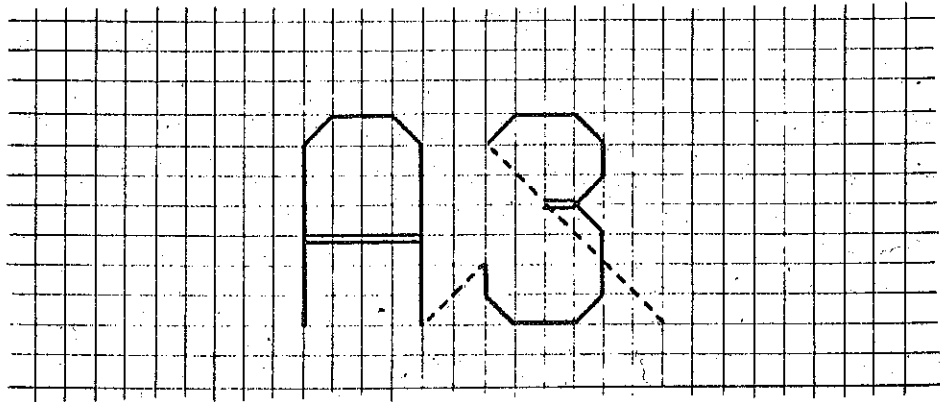
### 3.4 Interface Lines

#### 3.4.1 RESET

This line is not used by the plotter.

#### 3.4.2 INTERRUPT

This line is not used by the plotter.



----- *Movements made with pen raised.*  
==== *Lines duplicated by movements in both directions.*

Figure C. A3 DRAWING SEQUENCE

## Chapter 4: SPEED AND PERFORMANCE

Pen Raise/Lower Time	20 ms max.
After Move Pen Instruction busy for	3.3 ms
Instruction Time	25 $\mu$ s
Device Response Time	10 $\mu$ s
Plotter Speed	Auto: 18,000 steps per minute
	Manual: 120 or 12,000 steps per minute.

## Chapter 5: OPERATOR CONTROLS AND INDICATORS

### 5.1 Location

The digital plotter controls and indicators, intended for use by the operator, are fitted on the top right-hand side of the equipment.

### 5.2 ON Button

This push-button switches the plotter on or off. When switched on, the green lamp in the button is lit.

### 5.3 MAN Button

This push-button transfers the plotter from Auto to Manual operation, or vice versa. When in Manual, the yellow lamp in the button is lit and the plotter is off-line. Data instructions to the plotter will be held up.

### 5.4 Joystick Control

This is a two level control capable of being displaced in any one of eight lateral positions. It is used to position the pen at the desired starting point on the paper before on-line operation.

Displacing the Joystick causes the pen to move (or appear to move in the case of N-S displacements) in the direction of the displacement at a step rate of two increments per second. If the Joystick is simultaneously depressed the step rate increases to 200 increments per second.

Manipulation of this control has no effect unless the plotter is in Manual.

### 5.5 PEN Button

This push-button is used to raise or lower the pen. Depressing the button raises the pen if it was in the down position, or vice versa. The pen is always in the raised position when the plotter is first switched on.

Manipulation of this control has no effect unless the plotter is in Manual.

## Chapter 6: PHYSICAL FEATURES AND REQUIREMENTS

### 6.1 Introduction

Physical details, environmental conditions and power supplies for the digital plotter are given in this chapter.

### 6.2 Physical Characteristics

The physical characteristics and essential differences between the different models of digital plotter are summarised in the table overleaf.

### 6.3 Environmental Conditions

The digital plotter has been designed to be used in a normal office environment where the following conditions are assumed to apply:-

Temperature	10 °C to 30 °C (50 °F to 86 °F).
Relative Humidity	20% to 95% without condensation. Outside the range 40% R. H. to 60% R. H. the quality of the plot will deteriorate however, due to changes in the characteristics of the paper and ink.

No specific dust control is required other than reasonable standards of cleanliness.

The plotting paper should be stored, for at least one week before use, under the temperature and humidity conditions specified. The paper should always be kept in clean air conditions.

Under these conditions external environmental control is not normally required.

### 6.4 Power Supplies

The equipment operates from a single-phase mains supply of:-  
230 volts  $\pm$  10% at 50 c/s  $\pm$  2%.

The power consumption of the equipment is 0.2 KVA.

Model No.	Step Size cm. in	Chart Width (nominal) cm in	Plotting Width		Weight		Height		Depth		Width	
			cm	in	kg	lb	cm	in	cm	in	cm	in
141	.005	14	-	13.375	20	45	36	14	32	12.5	62	24.5
			-	-								
341	.01	34	34	-	33*	73*	105.5*	41.5*				
142	.01	14	-	13.375								

\* These dimensions refer to the complete unit including its stand.