Digital Plotter
PM8151

Operating Manual

9499 430 08111
830330

S&I
Scientific & Industrial Equipment Division

PHILIPS

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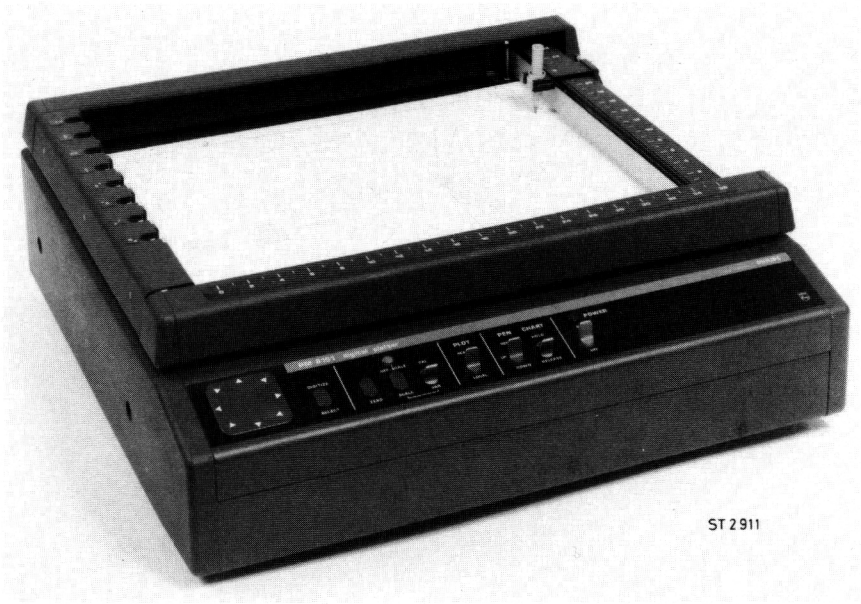

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IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Note: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

Bemerkung: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

Remarques: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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1. INTRODUCTION

The Philips PM 8151 Interactive Digital Plotter is an extremely reliable instrument incorporating microprocessor control of pen movement using ASCII-coded information.
Plotting of graphical data and standard character sets is achieved via plug-in interfaces that enable the plotter to communicate with local minicomputers and terminals in the offline mode, or with remote computers via private or public telephone lines (online).
The plotter facilities can be used by all devices having equipment compatible with the instrument versions:

PM 8151S: incorporating Serial V24 (RS 232C Interface)
PM 8151B: in corporating IEC-625 (I EEE 488) Bus Interface.

A number of interface options are available by simple mechanical switching and connecting operations: these include timesharing and current loop configurations. Regardless of the type of interface in use, the plotter performs four basic functions:

- printing of alphanumeric characters of selectable size,
- vector generation (linear interpolation),
- circular interpolation,
- point digitizing.

By programmable selection of eight pens, multicolour plots are offered with the additional advantage of choice of line thickness. Selection of Rotring Isograph 2000 pens guarantees high-quality drawing action.

The plotting area of the chart table (338 x 280 mm maximum area) is also programmable and is continuously checked by the microprocessor to provide for almost uncontrolled coordinate value transmission. The chart paper, standard DIN A3 format, is held down by electrostatic control.

To extend the plotter's versatility, a number of options are available, which include a programmable paper advance facility with roll chart take-up, a 1k-byte RAM input buffer expansion and a ROM expansion for special character sets. The roll chart option is programmable for incremental
paper advance, thus permitting multiple plots with unattended plotter.

NOTE: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

2. TECHNICAL DATA

This instrument has been designed and tested in accordance with IEC Publication 348 for Class 1 instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

All values mentioned in this description are nominal; those given with tolerances are binding and guaranteed by the manufacturer.

2.1 BASIC INSTRUMENT

2.1.1 Performance Specification

Plotting Area:	Y-axis: 280 mm X-axis: 338 mm (with 8-pen depot)
Chart Paper:	A3(297 x 420 mm) accepted
Accuracy:	0,1% of full-scale
Linearity:	better than ± 0,1%
Repeatability:	± 0,1 mm using same pen ± 0,3 mm with different pens
Line Plotting Speed:	21 cm/s max.
Positioning Speed:	100 cm/s max.
Character Plotting Speed:	2 characters per sec approx. at 2 mm height
Pen Lift:	30 actions per sec.
Control Characteristics:	Z 80 microprocessor
Offscale Data Handling:	Automatic calculation of intercept with mechanical boundary/or currently-defined graphic limits. When onscale data is again received, new intercept is calculated and plotting is resumed.
Resolution:	0,1 mm
Up and Down Scaling:	2 : 1 to 1 : 10
User-defined Offset:	Zero anywhere within the plotting area by front-panel ZERO selection, or programmed over the full plotter range
Number of pens:	up to eight, e.g.: 4 Rotring Isograph ink pens, 4 nylon fibre-tip pens
Paper Hold-down:	Electrostatic
Input Buffer:	800 bytes, expandable to 1800 bytes
Interfaces:	For PM 8151S: Serial Communucation Interface in accordance with: EIA RS 232 C/CCITT V24, can be switched to 20 mA Current Loop passive and to Timesharing (see Section 2.2) For PM 8151B: IEC-bus Interface IEC 625/IEEE 488 (see Section 2.3)

2.1.2 Power Supply

Mains Voltage:	110 V, 220 V, 240 V ± 10%
Mains Frequency:	50-60 Hz
Power Consumption:	30 VA typical

2.1.3 Environmental Characteristics

The environmental characteristics are valid only if the instrument is checked in accordance with the official checking procedures. Details of these procedures and failure criteria are supplied on request by the PHILIPS Organisation in your country, or by N.V. PHILIPS GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND.

Ambient Temperature:	operating: +5°C ... 40°C storage: -25°C ... +65°C
Climatic Category:	class 2 according to VDE 3540 75% relative humidity

WARNING: When an instrument is brought from the cold into a warm environment, condensation may cause a hazardous condition. Therefore, ensure that the earthing requirements are strictly adhered to.

2.1.4 Mechanical Data

Height:	160 mm (6.3 in.)
Width:	456 mm (18.4 in.)
Depth:	452 mm (17.8 in.)
Weight:	13 kg

2.2 CCITT V24 (RS 232C) SERIAL COMMUNICATION INTERFACE (PM 8151S ONLY)

Operating Mode:	Full Duplex, asynchronous
Configurations:	in accordance with EIA RS-232-C/CCITT V24 and 20 mA current loop passive and V24 Timesharing
Baud Rates:	110, 300, 600, 1200, 2400, crystal-controlled, switch selectable
Data Bits:	7 or 8, switch selectable
Stop Bits:	1 or 2, switch selectable
Parity:	EVEN or ODD, switch selectable (No parity check of RCVD data)
Connectors:	MODEM, 25 pin female.

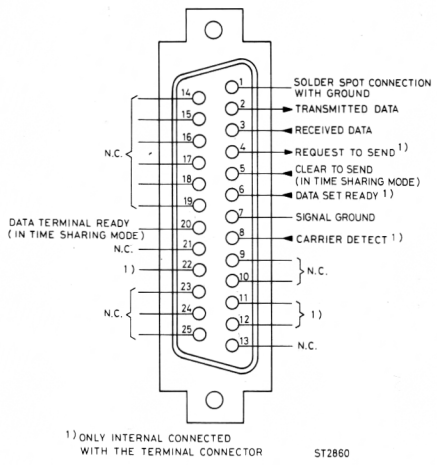


Fig. 2.2.

TERMINAL CONNECTOR, 25-pin female

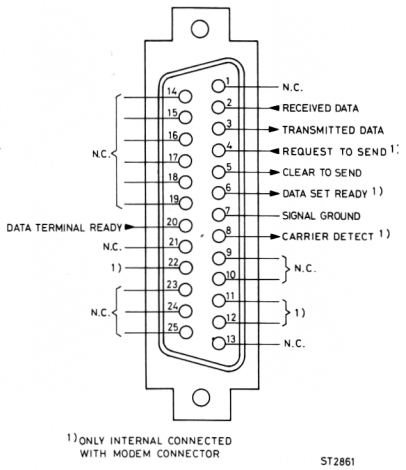


Fig. 2.2.a.

CURRENT LOOP (MODEM), 25-pin female

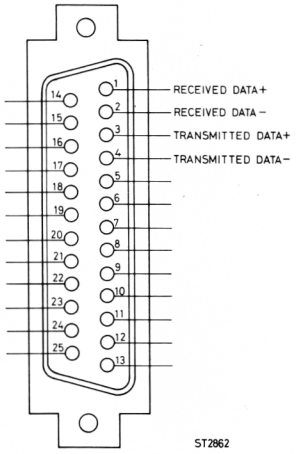


Fig. 2.2.b.

NOTE: The connector pinning is given in non-timesharing operation.

Mechanical: The Serial V24 interface comprises a p.c. board, interconnecting cables and two 25-pin female connectors. (p.c.b. 132 x 148 mm).

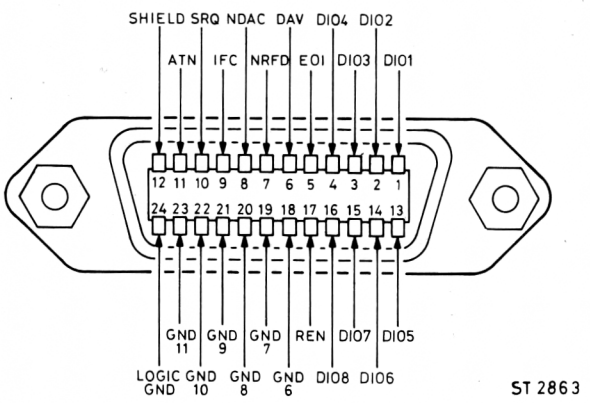
2.3 IEC- 625 BUS INTERFACE (PM 8151B only)

The IEC 625/IEEE 488 interface enables the plotter to be readily integrated into systems using the IEC 625/ IEEE 488 Bus (also referred to as GPIB-, HPIB- and ASCII - Bus).

The IEC-bus interface provides the following functions:

T6:	Basic Talker, serial poll, unadress if MLA
L3:	Basic Listener, Listen-only Mode, unaddress if MTA
SR1:	Complete Service Request capability
RLO:	no Remote/Local capability (see functions of Remote/Local switch)
PP1:	complete Parallel Poll capability or hardware switching selection
PP2:	Parallel Poll with Local Poll Enable
DC1:	Complete Device Clear capability
DT0:	no Device Trigger capability

Switch selectable functions:	Listener - Address = Talker - Address
	Listen-Only mode
	Parallel Poll PP1 or PP2
	Local Poll enable and Parallel Poll
	Response Message
Electrical specifications:	4 bidirectional Bus Transreceivers type 3448 (open collector) employed.
Configurations:	In accordance with IEC 625/IEEE 488
Data Lines:	1 ... 8
Parallel Poll Function:	Switch selectable response on one of eight data lines or from controller via interface.
Listen-only function:	switch selectable
Binary Code:	ASCII (see Section 7.4)
Mechanical:	The IEC-bus interface comprises a printed-circuit board with interconnect connecting cables and two 25-pin female connectors. The dimensions of the p.c. board are 132 mm x 148 mm.
Connectors:	IEEE 488 - 1975,24-pin female and IEC-625,25-pin female



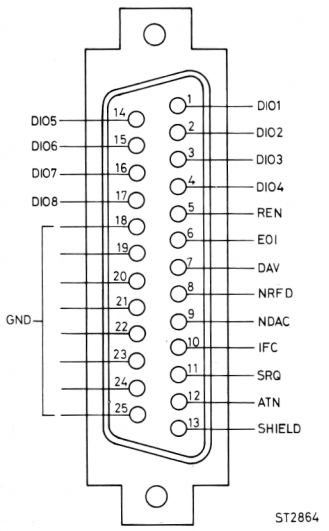


Fig. 2.3.

3. ACCESSORIES

3.1 ACCESSORIES SUPPLIED WITH THE INSTRUMENT

- Operating Manual
- Pad of 50 blank A3 sheets of drawing paper
- Dust cover
- Accessory kit containing:

8 nylon tip disposable pens (2 black, 2 blue, 2 green, 2 red)
1 Rotring Isograph 0.35 mm
1 Digitising sight
1 Rotring adaptor for pens < 0,35 mm (white)
4 Rotring adaptors for pens ⩾ 0,35 mm (red)
1 Fuse T05 B DIN 41571, 0,5 A delayed action
2 Fuses T1 B DIN 41571, 1A delayed action
1 bottle of special Indian ink
1 screwdriver

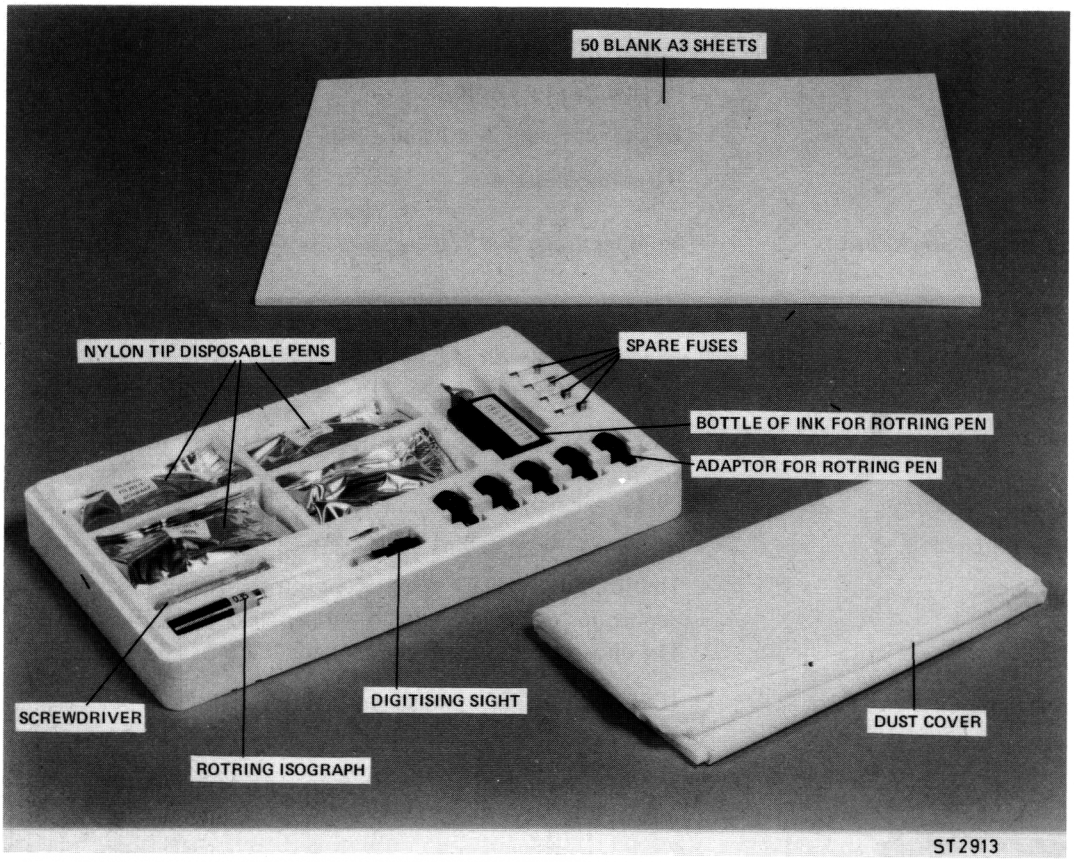


Fig. 3.1.

3.2 CONSUMABLE SPARES

The following typical consumable items can be ordered under the appropriate type numbers.

Pens:	Sets of 10 disposable nylon tip pens: PM 9876 A/01 black PM 9876 B/01 blue PM 9876 G/01 green PM 9876 R/01 red
Chart:	Packs of 5 rolls, each for 60 A3 plots approx PM 9950/02 - blank for use with Chart Advance Unit PM 9886/01

3.3 OPTIONAL ACCESSORIES

For convenience, the details of the optional accessories, are all given in this section of the operating manual.

3.3.1 Programmable Paper Advance Unit PM 9886/01

The unit is styled to fully adapt to the plotter and consists of a paper-supply roll holder and a transport unit. It is supplied with one roll of chart sufficient for 60 A3 format plots approximately.

a) Specification

Direction of Advance:	right to left
Remote Advance:	Programmable in multiples of 10 mm(max. 640 mm with one instruction)
Local Advance:	by multiples of 10 mm
Chart Roll Paper:	Length approx. 25 m Width 297 mm
Velocity of Advance:	30 mm/sec
Accuracy:	± 0.5 mm (non-cumulative)

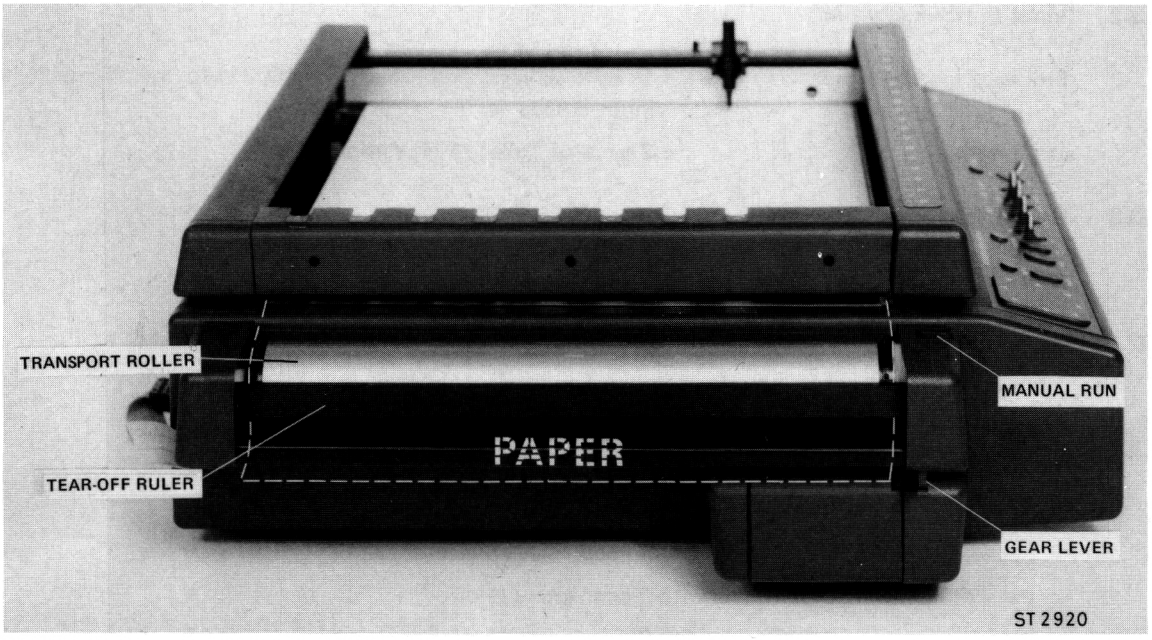


Fig. 3.3.1.

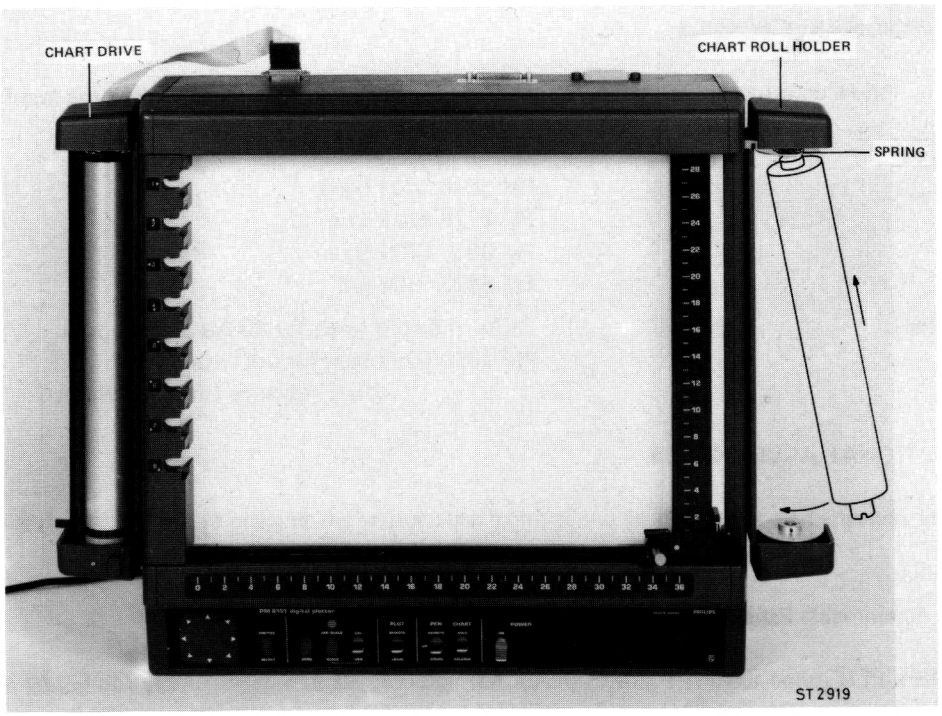


Fig. 3.3.1. a.

b) Paper Roll Fitting

The take-up pin of the flange hub must, in the stationary position, slit open the edge of the paper roll case. The paper roll and the flange are pressed together as shown in Fig. 3.3.1.a. With the gear lever depressed, the paper feeds off and threads between the transport roller and the tear-off ruler (see fig. 3.3.1.).

WARNING: CHART switch on plotter keyboard must always be set to RELEASE position to prevent tearing of paper perforations.

3.3.2 Input Buffer Expansion*

Storage Capacity:	1k byte giving a total capacity of 1800 bytes together with standard input buffer.
Organisation:	2 p.c.s. of 1024 * 4-bit static RAMs

3.3.3 ROM Expansion*

Application:	for special characters
Storage Capacity:	2k byte

* For installation, contact your local Philips Service Organisation

3.3.4 Cables

- PM 9888A/01 V24 cable
- PM 9888B/01 V24 cable with one 25-pole male connector (3 m)
- PM 9280/01 IEC-625 cable with 2 connectors (1 m)
- PM 9281/01 IEC-625 cable with 2 connectors (2 m)
- PM 9282/01 IEC-625 cable with 2 connectors (4 m)
- PM 9283/01 IEC-625/IEEE 488 cable

4. PRINCIPLE OF OPERATION

The PM 8151 plotter can be divided into three functional blocks as shown in Fig. 4., namely:

- the interface
- the microprocessor controlling system
- the recording system

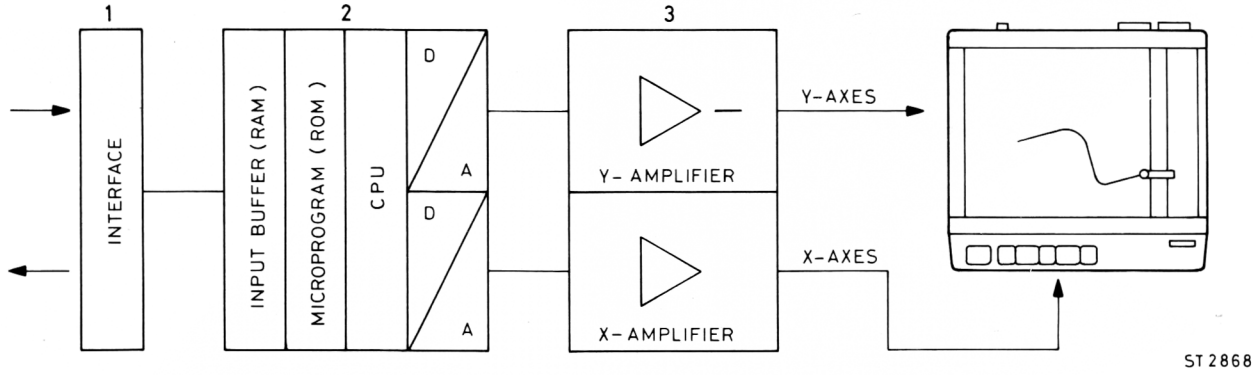


Fig. 4.

4.1 THE INTERFACE

The interface provides the link with external equipment. It handles received and transmitted data and provides the input/output protocol. All received data are prepared in the interface for processing by the microprocessor controlling system and are fed into the RAM area of the input buffer.
The choice of interface is dependent on the mode of operation.

4.2 THE MICROPROCESSOR CONTROLLING SYSTEM

The system of control is built around the Zilog Z 80 microprocessor. The actions of the plotter, both physical and electrical, are controlled by the microprogram permanently stored within 6k bytes of the read-only memory (ROM). This functional block performs all necessary calculations and plotting control actions and provides for the correct start conditions (initialisation).
Instructions to the plotter are temporarily stored in the input buffer (RAM area) and are processed on a First-In, First-Out (FIFO) basis. All points located within the physical area are identified by X and Y coordinate values.
The microprocessor continuously calculates these coordinate pair values in accordance with the desired plotting action (either drawing or positioning) and applies the resulting information to two digital-to-analogue (D/A) converters. The voltage output of these converters provides the input for the analoque XY recording system.
To allow for a resolution of 0.1 mm, 12-bit D/A s are employed.

4.3 THE RECORDING SYSTEM

The recording system is based on the well-known potentiometric principle shown in Fig. 4.3. The voltage outputs generated by the two D/A converters of the controlling system are applied separately to two amplifiers, each driving a d.c. motor that moves the pen along the appropriate axis, X and Y. Ultra high-reliability potentiometers sense the instantaneous position of the pen and complete the feedback loop that comprises the amplifier and motor-drive. When the input voltage of the overall amplifier equals the voltage sensed by the potentiometer slider, the circuit is in equilibrium and pen movement stops.
As a result of the extremely high linearity of this device the overall linearity of the plotter is better than 0.1% of full scale.

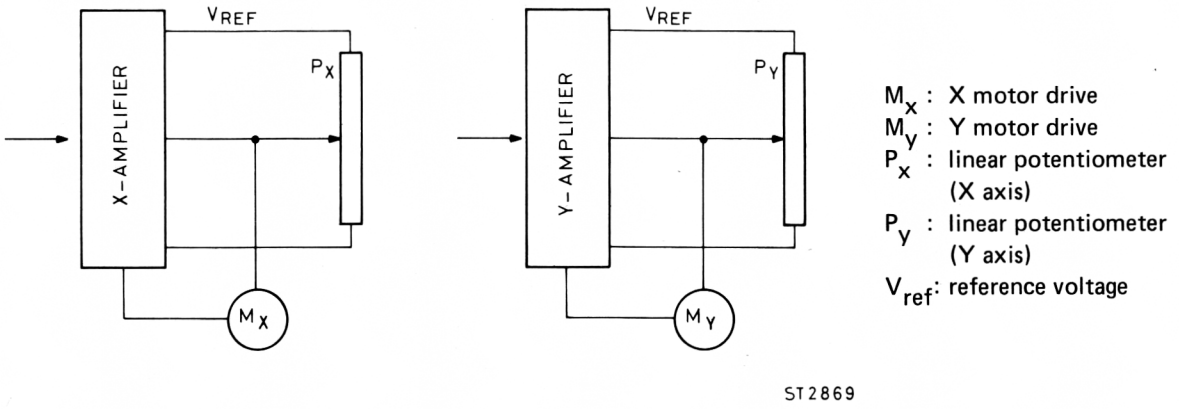


Fig. 4.3. Principle of Potentiometric Recording System

5. INSTALLATION

WARNING: Before any other connection is made, the protective earth terminal shall be connected to a protective conductor (see Section 5.3 Earthing).

5.1 TRANSPORT SECURITY

During transit the measuring carriage is secured to prevent damage. To release on delivery, loosen the locking screw 1 and rotate the locking clip as shown in Fig. 5.1. Tighten the screw afterwards to prevent loss.

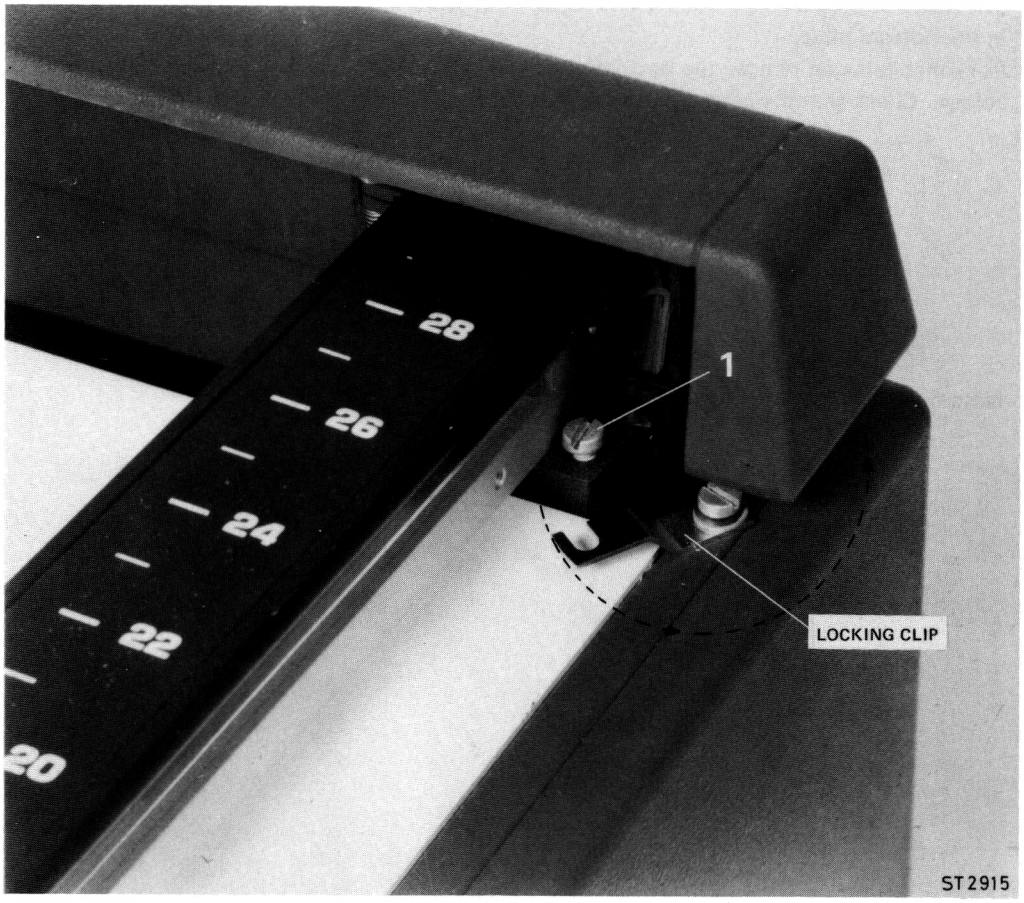


Fig. 5.1. Carriage Locking Device for Transit.

5.2. MAINS SUPPLY AND FUSES

WARNING:
Before inserting the mains plug into the mains socket, ensure that the instrument is set to the local mains voltage.
Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided. The instrument shall be disconnected from all voltage sources when a fuse is to be replaced or when the instrument is to be adapted to a different mains voltage. Fuse replacement should be carried out only by a skilled person who is aware of the danger involved.
The mains voltage of the instrument is set at the factory for 220 V standard as displayed in the small aperture in the bottom plate.
For other voltages, remove the bottom plate and rotate the mains selector switch to display the appropriate voltage. Check that the correct fuses are fitted and refit the bottom plate.

Mains voltage	Rated value of mains fuse	
110 V	1 A	Delayed-action according to IEC 127/DIN 41571
220 V	0,5 A	
240 V	0,5 A	

Note that the right-hand fuseholders are not used.

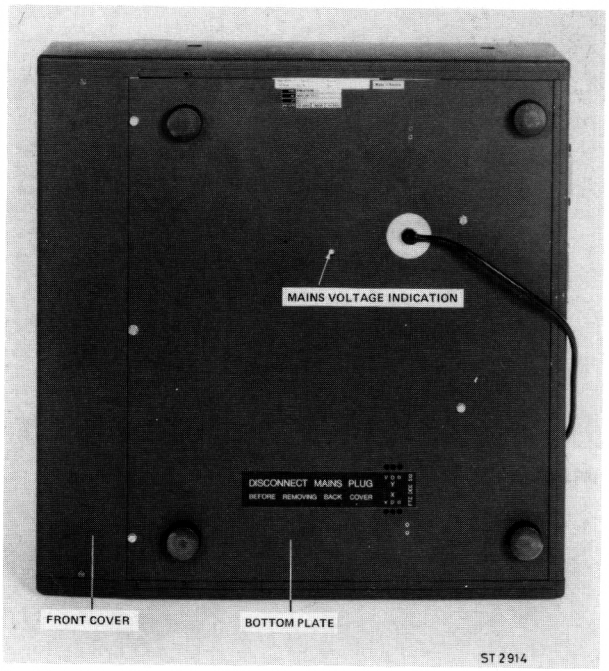


Fig. 5.2.

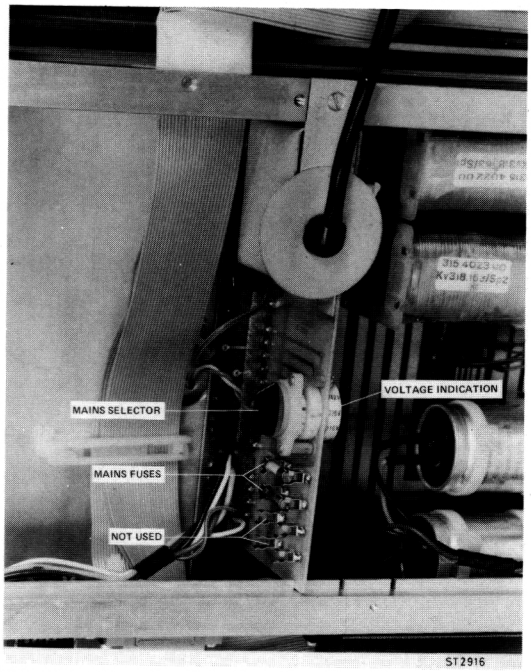


Fig. 5.2.a.

5.3 EARTHING

WARNING: Before switching on, the instrument shall be connected to a protective earth conductor via the three-core mains cable. The mains plug shall only be inserted into a socket outlet provided with an earth contact. The protective action shall not be made ineffective by the use of an extension lead without protective conductor. Replacing the mains plug is at the user's own risk. Any interruption of the protective conductor inside or outside the instrument or disconnection of the protective earth terminals is likely to make the instrument dangerous.

5.4 CCITT V24 (RS 232 C) SERIAL COMMUNICATION INTERFACE (SCI)

The installation procedure for the Serial V24 Interface version PM 8151S will depend upon the type of configuration required, i.e. V24 online, offline or timesharing or current loop passive. These functions are hardware selected, the necessary wiring changes being referred to under the appropriate sections.
The switches located on the front edge of the interface p.c.b. are accessible after removing the instrument front cover (see fig. 5.2. and fig. 5.4.).

The operation of the switches is given in fig. 5.4.b.

WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals, which can be dangerous to life.

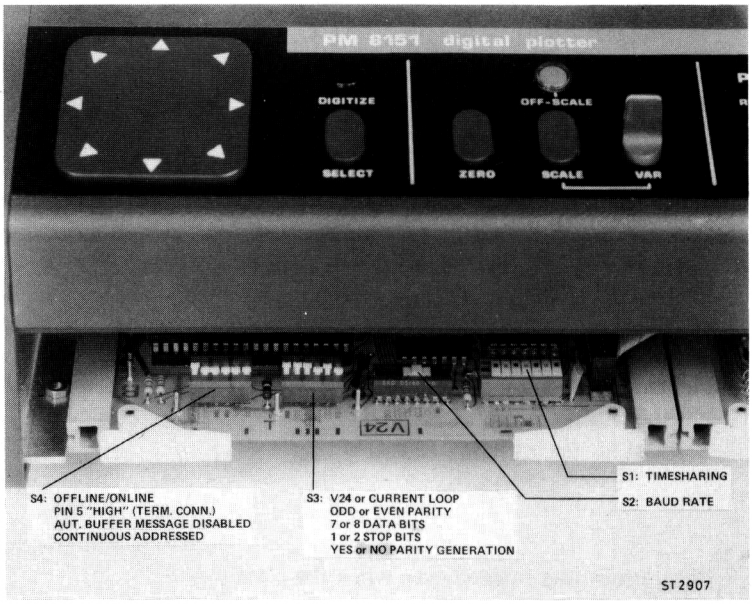


Fig. 5.4.

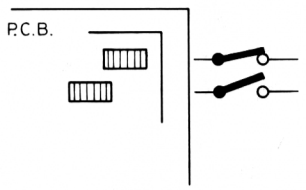


Fig. 5.4.b.

5.4.1 Common Features

Whatever configuration is required, there are some common features for selection during installation:

NOTE: The power must be switched off and on again after changing one of the switch positions.

a) Baud rate is selected for RCVD and Xmitted data with switch S2.

b) Character length is selected with switch S3.

Function	Contract			
No. of data bits	3	7	8	
No. of stop bits	4	1	2	
Parity generation	5	YES	NO	} X mitted
Parity type	2	ODD	EVEN	} characters only

NOTE: If character lenght selected differs from that of RCVD data, LED2 indicates a framing error (see SCI for location).

5.4.2 Special features.

—MODEM/TERMINAL configuration (S4/1).

S4/1 (OFF) closed	If connector pin 20 of the TERMINAL connector is high, (DTR ON) the PM8151 will be initialized in TERMINAL configuration (see 7.3.2 I/O Programming).
	If connector pin 20 of the TERMINAL connector is low, (DTR OFF) the PM8151 will be intialized in MODEM configuration. No device connected to the TERMINAL connector is interpreted as DTR OFF.
S4/1 (OFF) open	The PM8151 will be initialized in TERMINAL configuration independent of DTR at the TERMINAL connector.

—Clear to Send.

S4/2 (5H) closed	Clear to Send via the TERMINAL connector is continuously ON.
S4/2 (5H) open	Clear to Send via the TERMINAL connector is controlled by the input buffer. * Input buffer empty: CTS = ON * Input buffer full: CTS = OFF.

—ROA

S4/4 (ROA) open	Plotter outputs enabled even when the plotter is unaddressed.
S4/4 (ROA) closed	Plotter outputs disabled when the plotter is unaddressed. To avoid unexpected buffer status messages when the plotter is unaddressed, this switch must be closed.

—Buffer status messages.

S4/5 (KAUT) closed	Automatic buffer status messages disabled.
S4/5 (KAUT) open	Automatic buffer status messages enabled.

—Addressing.

S4/6 (DADR) closed	Addressing enabled. Plotter will be turned on and off from a standby status to an operating status and vice versa with the PLOTTER ON instructions (see Section 7.3.2)
S4/6 (DADR) open	Addressing disabled. Plotter is permanently addressed.

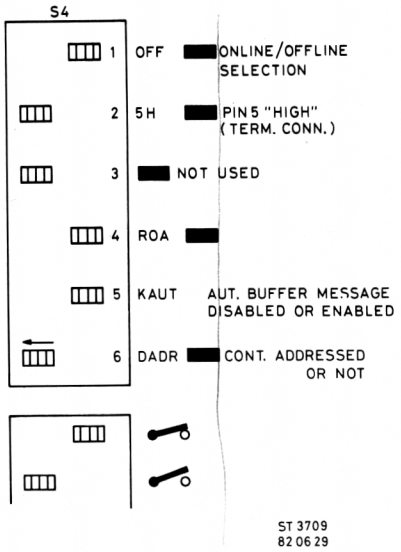


Fig. 5.4.2.

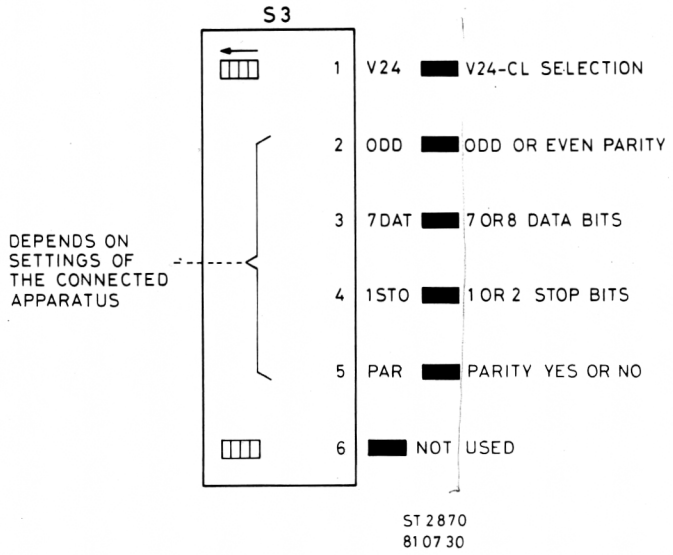


Fig.5.4.3.a.

5.4.3. V24/Current Loop Selection

- Transfer band cable from connector P14 (ONLINE) on p.c.b. to P15 (CL)
- Move switch S3/contact 1 away from the V24 position as shown in Fig. 5.4.3.a. (switch open)
- Connect the controller to the MODEM connector at the rear of the instrument.

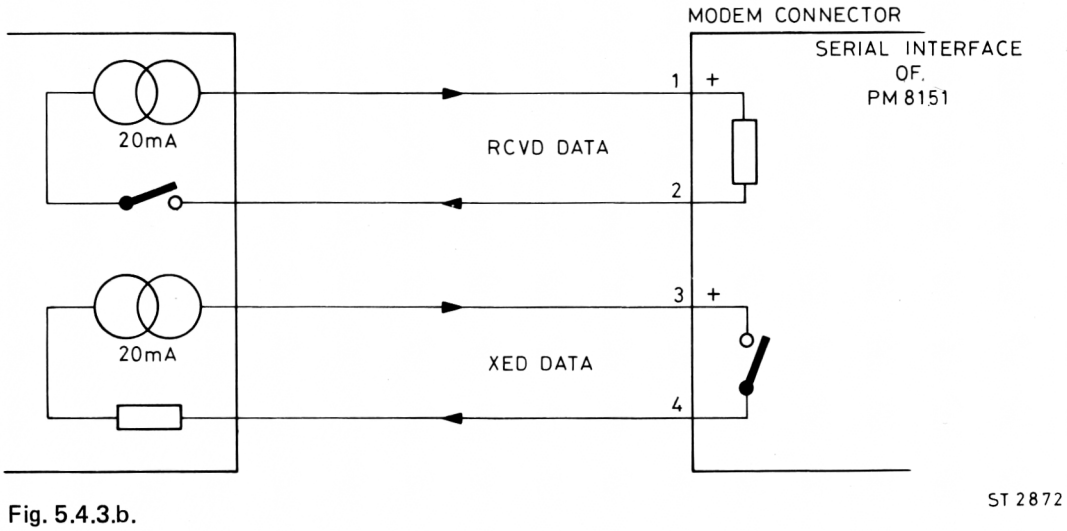


Fig. 5.4.3.b.

As the CL interface of the PM8151 is passive, the driving unit applied to the MODEM rear connector of the plotter must supply the necessary current of 20 mA.

5.4.4 V24 Configurations.

5.4.4.1 General.

The PM8151 is equipped with two 24 pole female connectors, labelled TERMINAL and MODEM. At the TERMINAL connector, another terminal can be connected directly via a cable without crossings. For the pinning see fig. 2.2.a. At the MODEM connector a modem can be connected via a cable without crossings. For the pinning see fig. 2.2. Both connectors are used in Timesharing operation.

5.4.4.2 Standard V24 configuration.

In the figures 5.4.4a to 5.4.4d some examples of V24 connections are given. Before connecting another terminal or modem, please observe the specification and wiring.

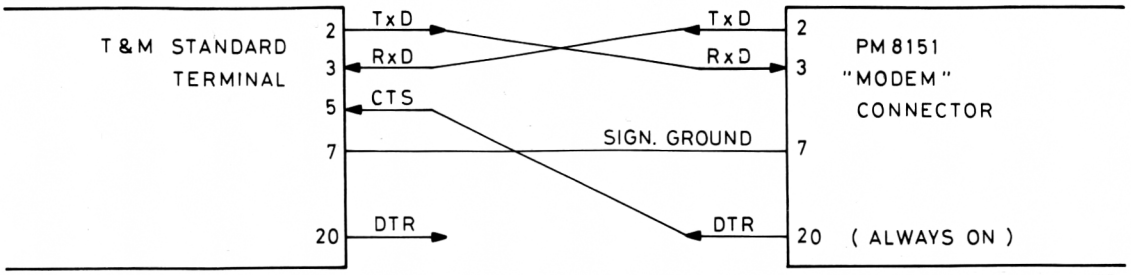


Fig. 5.4.4a

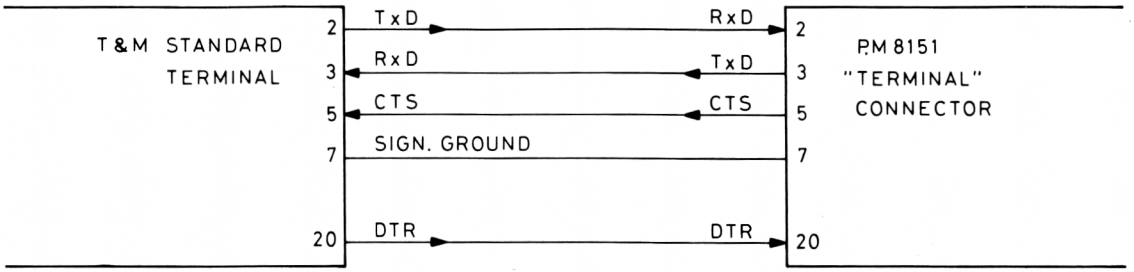


Fig. 5.4.4b

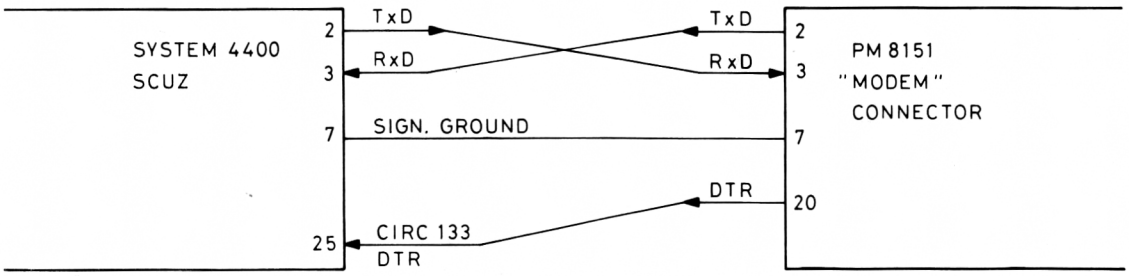


Fig. 5.4.4c

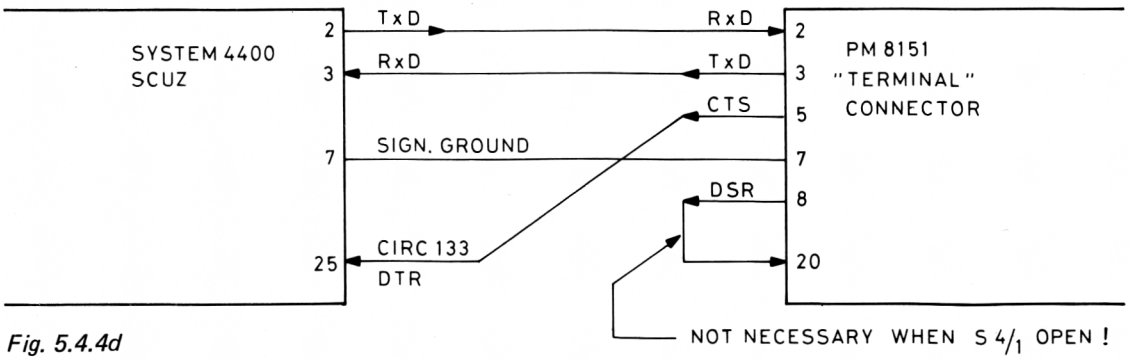


Fig. 5.4.4d

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5.4.4.3. V24 Timesharing Configuration

In a timesharing environment the following conditions are fulfilled:

Plotter

POWER OFF
- MODEM data linked to TERMINAL
- TERMINAL data linked to MODEM

In this situation the plotter acts as a NULL MODEM

POWER ON
- plotter SCI still acts as a NULL MODEM but the MODEM-TERMINAL link is now established electronically instead of galvanically as in the POWER OFF situation. Incoming data are now checked continuously by the microprocessor control.

Instruction

PLOT ON (SOH P)
- On receipt, the datastream is directed to the plotter, all data following the PLOT ON instruction being treated as plot command strings. The TERMINAL is disconnected electronically from the MODEM, the plotter being the only terminal to the MODEM.

PLOT OFF (ETX)
- redirects the datastream to the TERMINAL. Normally part of the datastream preceding the PLOTTER OFF instruction is still in the memory and will be executed by the plotter.

To enable timesharing (normally conforming to CCITT V24) set up the interface as follows:

- set switch S3/contact 1 to V24
- move switch S1 to TS (timesharing) position
- select appropriate baud rate with switch S2
- select character length and parity with S3
- enable addressing with switch S4/contact 6 (i.e. not DADR position; SCI is address enabled by PLOT ON)

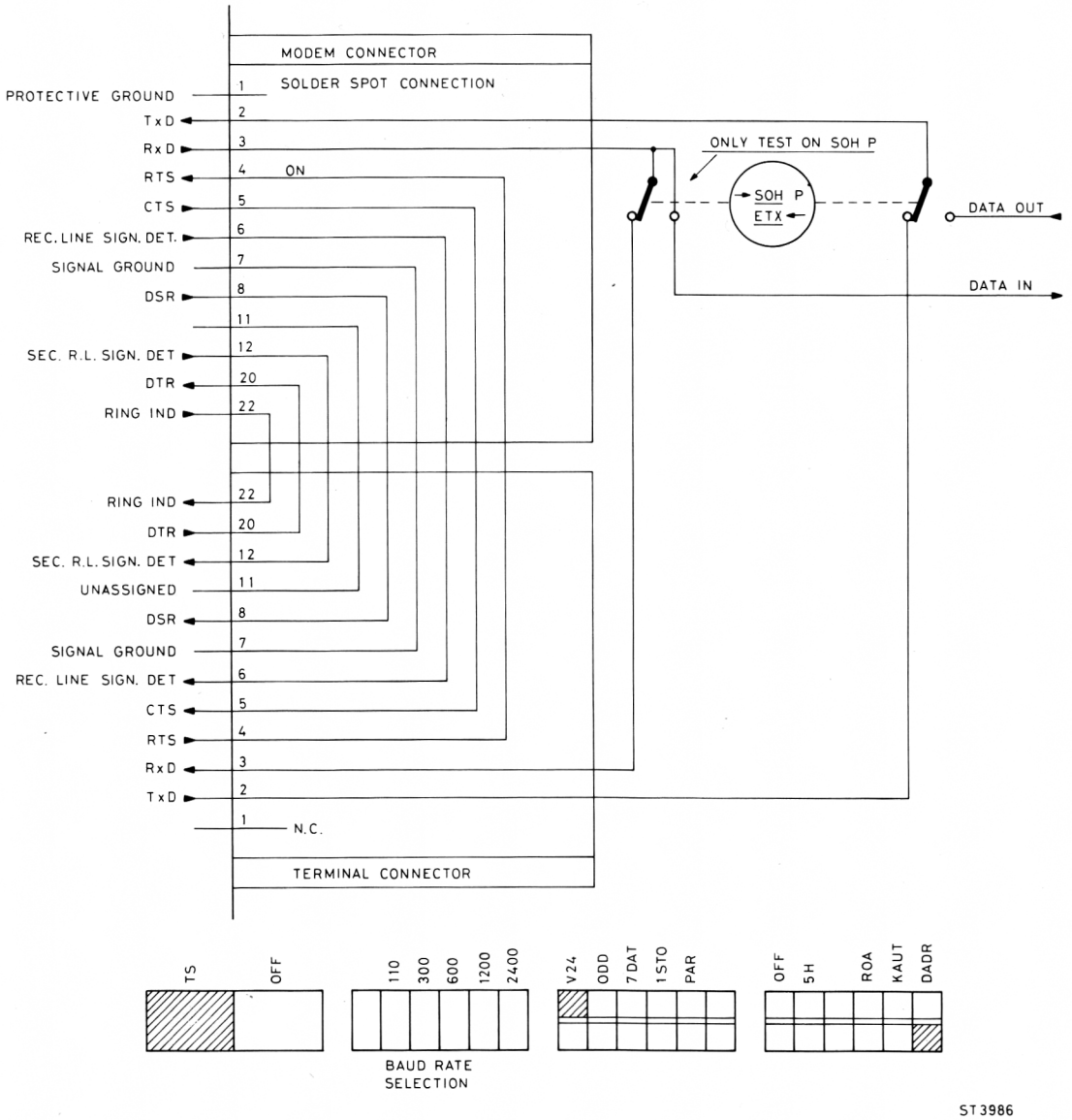


Fig. 5.4.4.e.

NOTES: *Athough the configuration implies timesharing one interface for two data terminal devices, the facility also holds good for non-timesharing applications.*

Only the switches which should be in a fixed position in timesharing operation are given. For the other switches see 5.4.2 and 5.4.3.

5.4.5. The I/O Protocol

The advantage of full TERMINAL and MODEM configuration is offered by two 25-pin connectors at the rear of the plotter.
Similarly, the plotter hardware switching also provides two different I/O Protocols as standard.

During initialisation, the plotter detects an ONLINE or an OFFLINE configuration.

a) Standard TERMINAL Protocol

TERMINAL — if terminal connector pin 20 is at logic 'HIGH' (i.e. Data Terminal Ready)

— also if switch S4/contact 1 is not at OFF position.

NOTE: If the user's program does not provide the instruction SET I/O PARAMETERS or does not alter the parameters BS1E and/or BS1F using this instruction, the microprocessor firmware supplies:

Xon — 11^{DC1} for Buffer Empty (transmit on)

Xoff — 13^{DC3} for Buffer Full (transmit off)

IMPORTANT: The most popular minicomputers, e.g. all PDP 11s, Philips P800 series and Data General Minis, use Xoff and Xon to terminate and/or resume an output. Standard Teletype Handlers can therefore be used to drive the plotter and the user can take full advantage of powerful operating systems such as RT11 or RSX11.

The buffer status messages are applied to both MODEM and TERMINAL rear connectors. XOn and Xoff output characters are formatted due to the initialising process and/or the SET I/O Parameters instruction.

b) Standard MODEM Protocool

MODEM — detected whenever the driving unit is applied to MODEM rear panel connector.

NOTE: Data terminal equipment connected to TERMINAL connector must be removed if it supplies a 'HIGH' (Data Terminal Ready) to pin 20.
Timesharing is always MODEM as interface line 20 is directly connected to MODEM connector pin 20. (See Timesharing, Fig. 5.4

If the user's program does not provide the instruction SET I/O PARAMETERS or does not alter the parameters BS1E and/or BS1F and BS2F, BS2F using this instruction, the plotter supplies the initialising characters, DC1 and DC3.

IMPORTANT: These buffer status messages are applied to both MODEM and TERMINAL rear panel connectors. As the standard buffer messages are output characters of the plotter, they are formatted due to the initialising process and/or according to the optional instruction SET I/O PARAMETERS.

c) Current Loop Applications

As detailed in Section 5.4.3.a, current loop is MODEM with respect to I/O
To run programs using standard TERMINAL protocol in a Current Loop environment (MODEM) the terminal mode can be simulated by moving switch S4/contact 1 from the OFF position.

5.4.6. Installation Flow Charts for SCI

The following installation procedured do not give complete information for all applications. It is therefore essential to use them in conjuction with the foregoing information and the circuit diagram of the SCI, Fig. 5.4.6.

V24 INSTALLATION PROCEDURE

1 Is the serial Interface of the driving unit V24 or RS–232–C? Asynchronous?

If it is not refer to CURRENT LOOP INSTALLATION PROCEDURE

Note:

Data Terminal Equipment	MODEM (Data Comm. Equipment)
Xmits on pin 2	Xmits on pin 3
RCVs on pin 3	RVC on pin 2

2 Does driving facility show Terminal configuration? (Xmitted and RCVD data on pins 2 and 3 resp.)

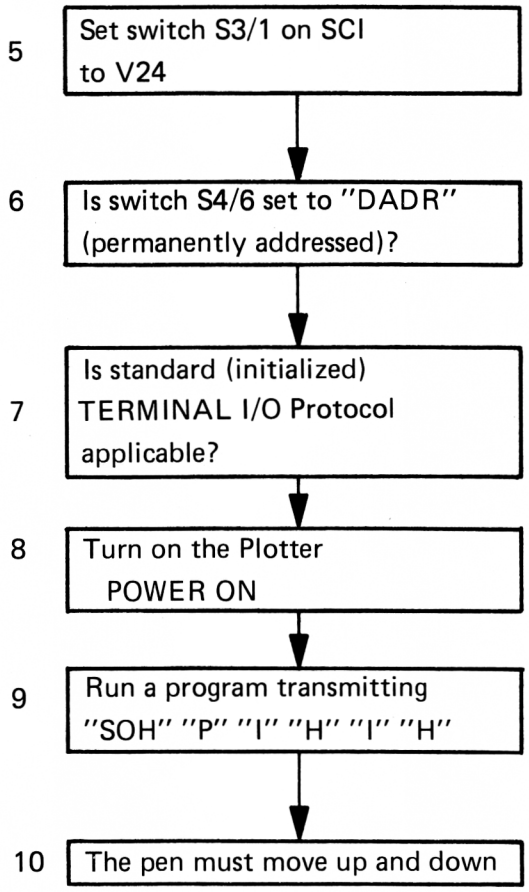
If it does not it is a MODEM to the Plotter. Refer to MODEM INSTALLATION PROCEDURE

3 Switch Plotter off
Connect driving unit to the Plotter Terminal Connector

4 Set Transmission parameters identical on both serial interfaces (driving unit and Plotter) i.e. baudrate, number of Databits, Stopbits and Parity

(see next page)

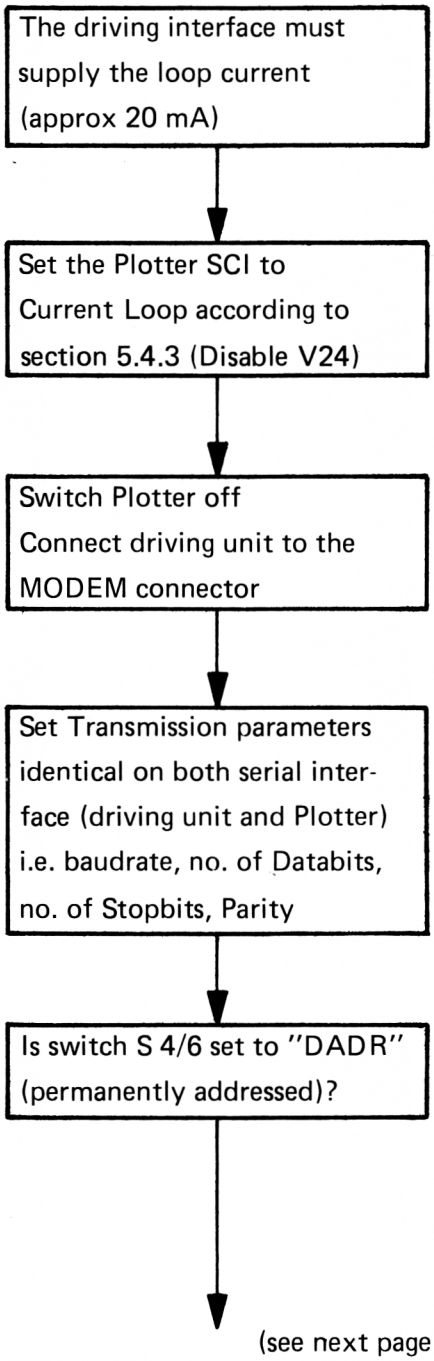
V24 INSTALLATION PROCEDURE (Cont'd)



If "DADR" is disabled the first Plotter instruction must be PLOTTER ON

If other parameters are desired an instruction SET I/O PARAMETERS must be provided

CURRENT LOOP INSTALLATION PROCEDURE



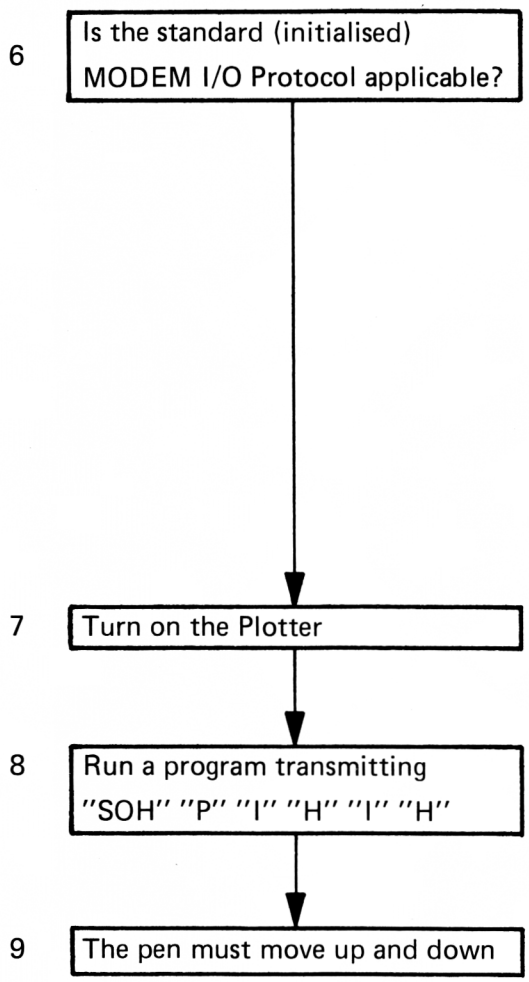
Note:

The Serial Comm. Interface
receives data on pins 1 and 2 (+ on pin 1)
it Xmits data on pins 3 and 4 (+ on pin 3)

If "DADR" is disabled the first Plotter instruction must be PLOTTER ON

(see next page)

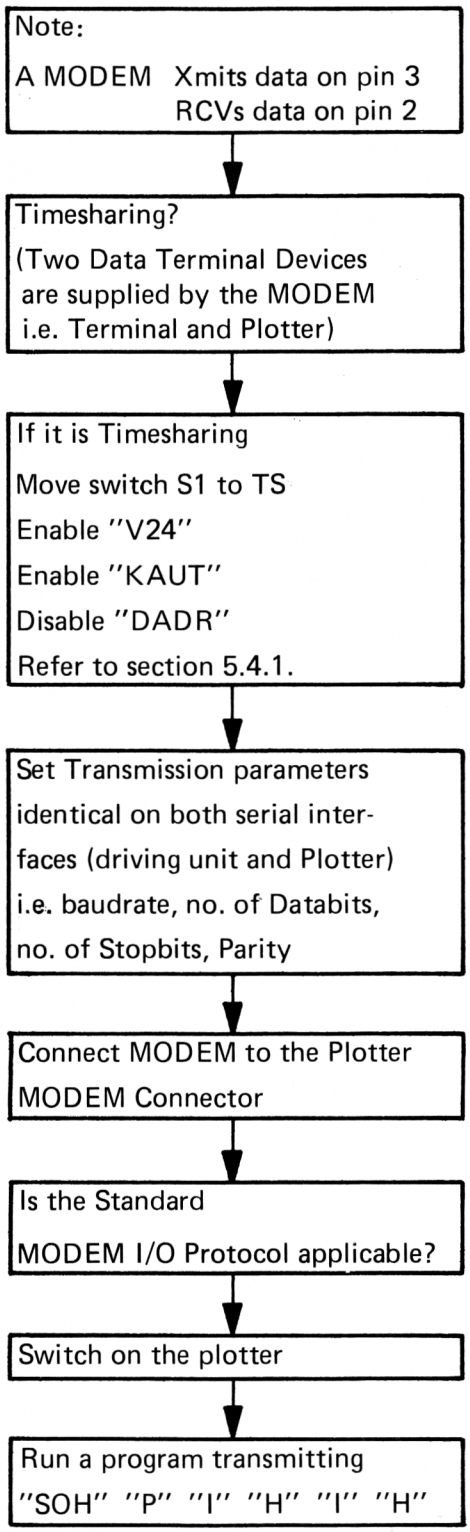
CURRENT LOOP INSTALLATION PROCEDURE (Cont'd)



Is the standard (initialized) TERMINAL Protocol desired. if so disable switch S4/contact 1 labeled "OFF".

If neither standard MODEM nor standard TERMINAL is desired provide an instruction SET I/O PARAMETERS Refer to section 7.3.2

MODEM INSTALLATION PROCEDURE



SERIAL INTERFACE

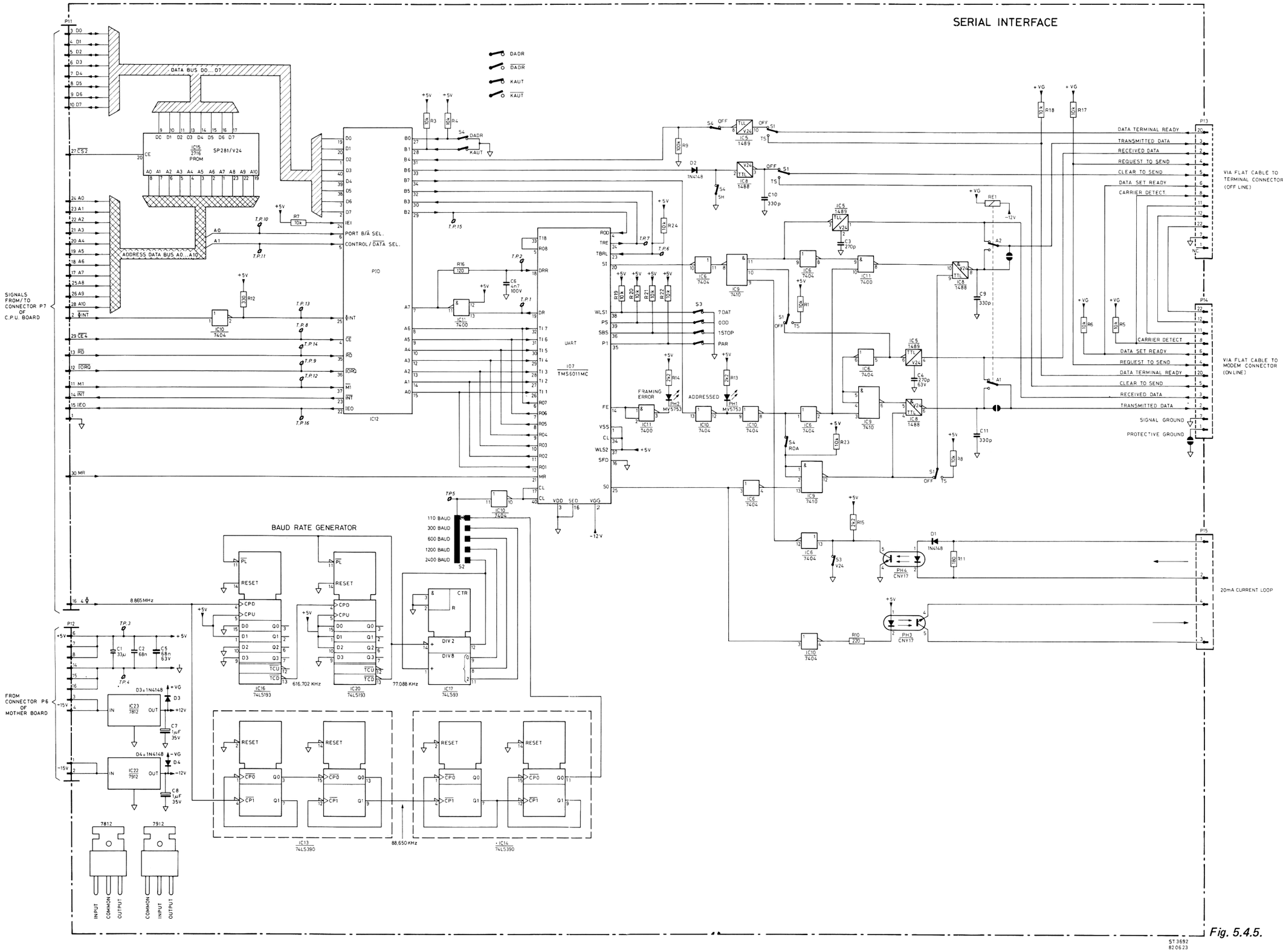


Fig. 5.4.5.

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5.5 IEC-BUS INTERFACE

The installation of the IEC 625/IEEE 488 interface enables the plotter to communicate with a computer via the IEC-bus. The p.c. board is connected internally via two flat cables to the IEC and IEEE sockets at the rear of the instrument. A large number of parameters can be programmed via the IEC-bus and a number of DIL switches provide further options to give a high level of operational flexibility.

5.5.1 Hardware Switching

The hardware switching is achieved by two DIL 6-way switches, S1 and S2, located at the front edge of the IEC interface board. These switches are accessible by removing the instrument front panel as shown in Fig. 5.5.1.

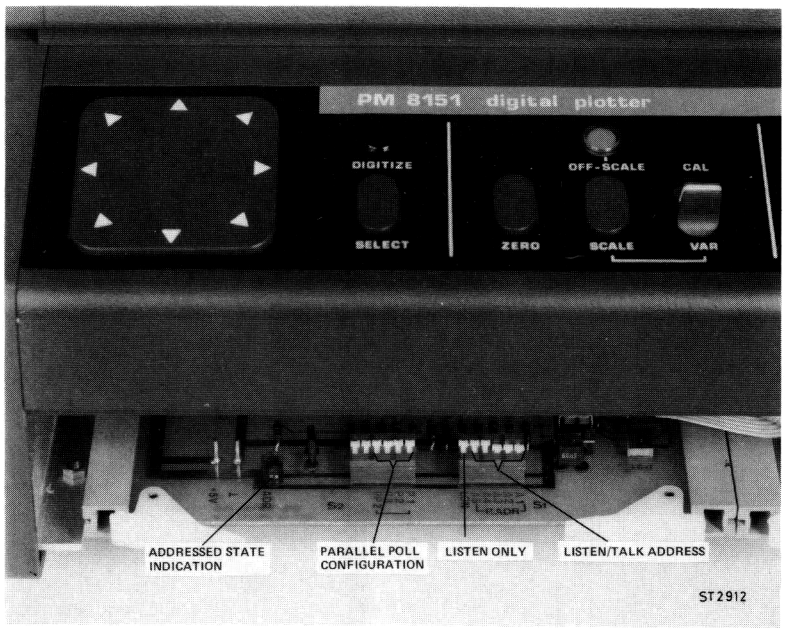


Fig. 5.5.1.

WARNING: The opening of covers or removal of part, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals, which can be dangerous to life.

A light-emitting diode (LED) indicates when the plotter is addressed.
After power-up, during the initialisation procedure the DIL switches are sensed that select the Addressing and Parallel Poll configuration. This enables the interface to respond correctly to interface messages and plotter commands received via the IEC-bus.

The switch positions are allocated as follows:

Switch S1 positions: — selects Address and Addressing mode of plotter

A1	2^0	Address selection for both listener and talker
A2	2^1	
A3	2^2	
A4	2^3	
A5	2^4	
		(logic 1 = switch closed)
A6	LON	Listener Only mode when closed (i.e. disables A1 to A5)

Example:

Switch S1 positions	5	4	3	2	1
Settings	0	1	0	0	1

= Address 9 (refer to table, page 96)

Switch S2 positions:

— selects parallel poll configuration of plotter

P1 2^0
P2 2^1
P3 2^2

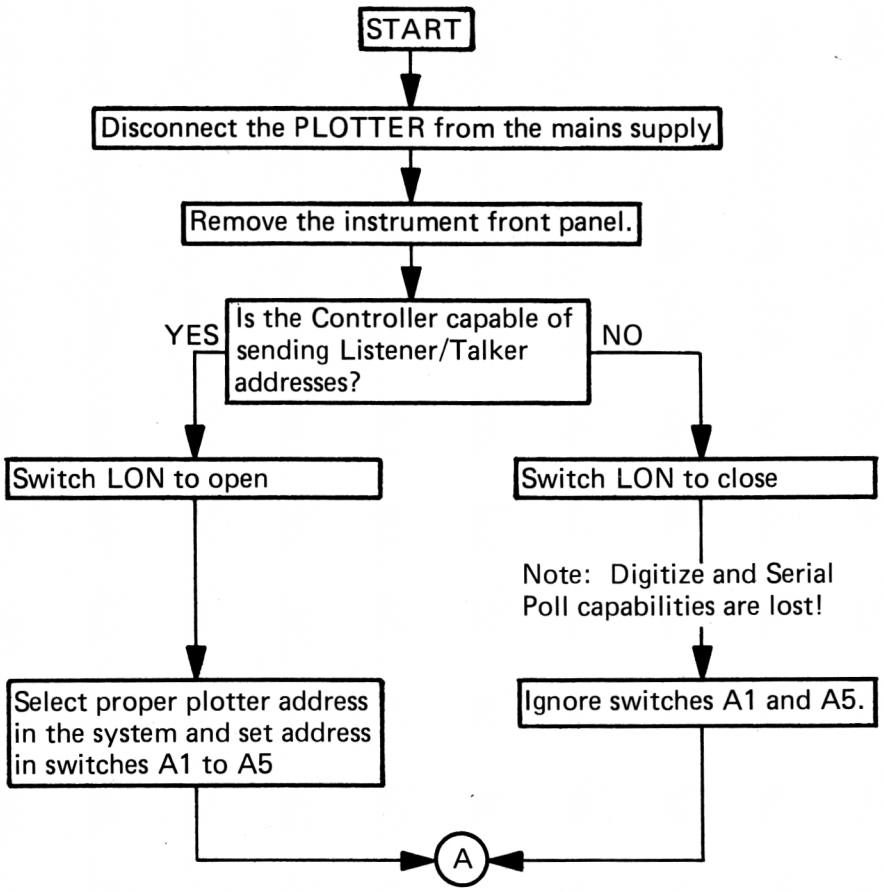
} Enabled in PP2 mode and select PPR message, (Parallel Poll Response) (logic 1 = switch closed)

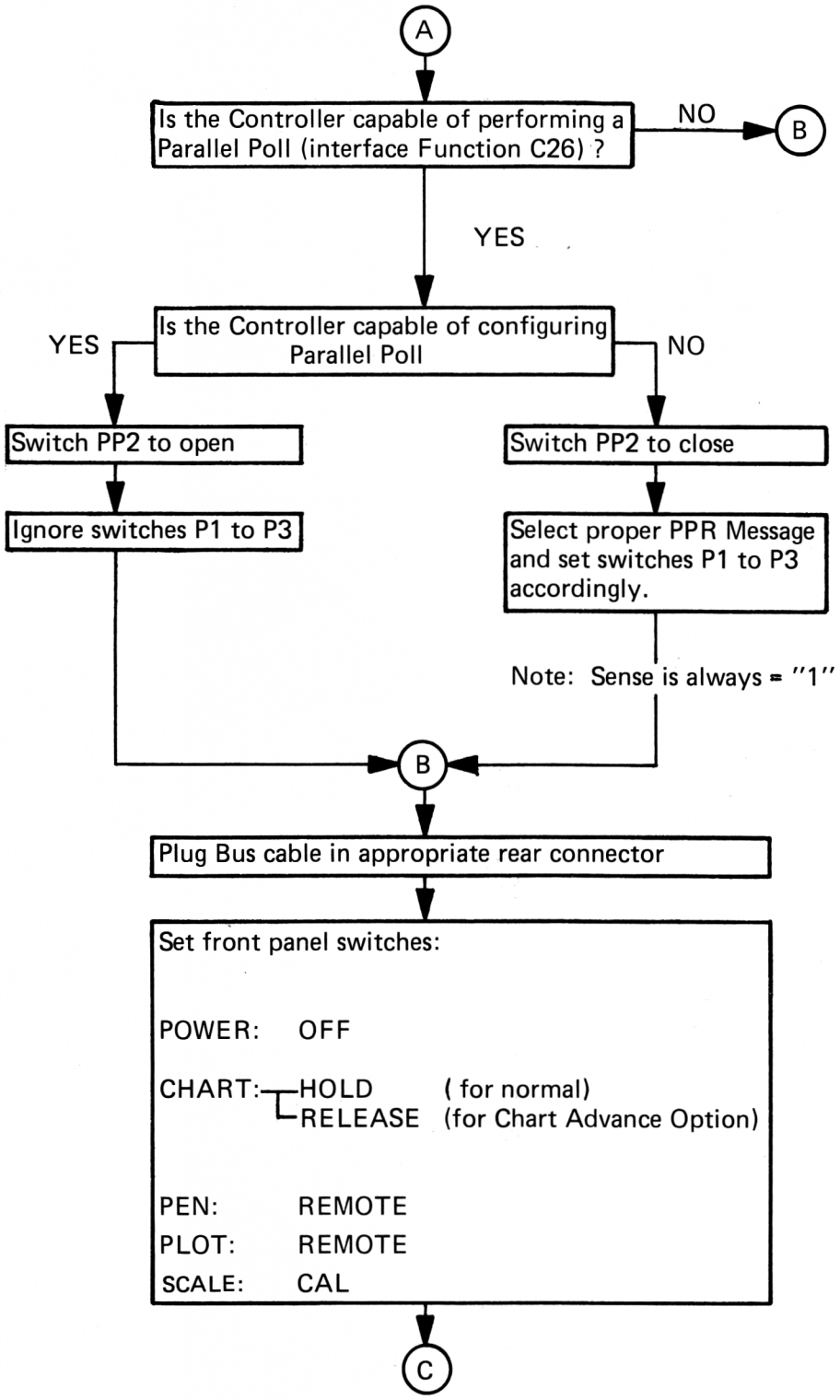
PP2 selects PP2 mode when closed (PP1 mode when open) and parallel poll of the controller is overruled by hardware position of P1, P2, P3.

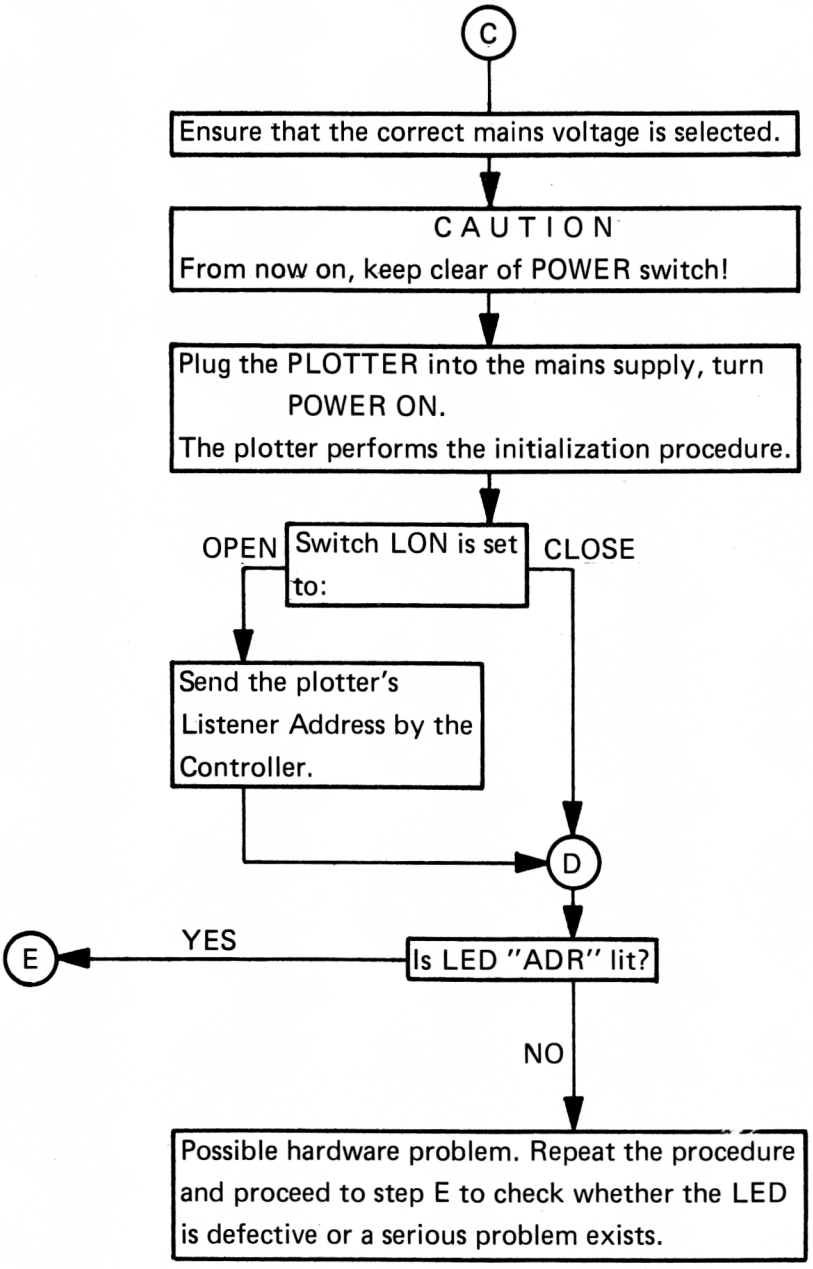
(See Section 7.4.3)

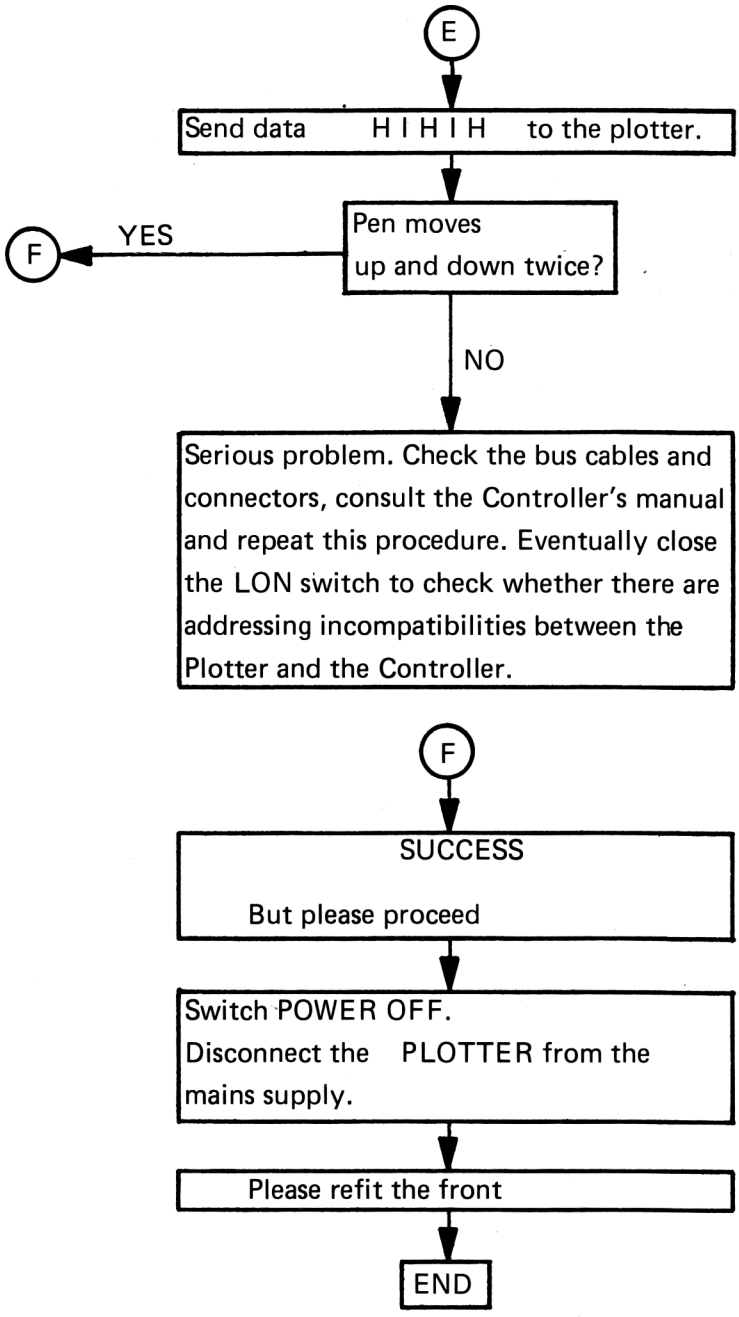
5.5.2 Installation Flow Charts for IEC-bus Interface

The installation procedure for the IEC 625/IEEE 488 interface is fairly simple. The following flow chart is given to assist the first-time user.




A
Is the Controller capable of performing a Parallel Poll (interface Function C26) ?
NO
B
YES
Is the Controller capable of configuring Parallel Poll
YES
NO
Switch PP2 to open
Switch PP2 to close
Ignore switches P1 to P3
Select proper PPR Message and set switches P1 to P3 accordingly.
Note: Sense is always = "1"
B
Plug Bus cable in appropriate rear connector
Set front panel switches:
POWER: OFF
CHART: HOLD (for normal)
RELEASE (for Chart Advance Option)
PEN: REMOTE
PLOT: REMOTE
SCALE: CAL
C


C
Ensure that the correct mains voltage is selected.
CAUTION
From now on, keep clear of POWER switch!
Plug the PLOTTER into the mains supply, turn POWER ON.
The plotter performs the initialization procedure.
OPEN
Switch LON is set to:
CLOSE
Send the plotter's Listener Address by the Controller.
D
E
YES
Is LED "ADR" lit?
NO
Possible hardware problem. Repeat the procedure and proceed to step E to check whether the LED is defective or a serious problem exists.


E
Send data H I H I H to the plotter.
Pen moves
up and down twice?
YES
F
NO
Serious problem. Check the bus cables and connectors, consult the Controller's manual and repeat this procedure. Eventually close the LON switch to check whether there are addressing incompatibilities between the Plotter and the Controller.
F
SUCCESS
But please proceed
Switch POWER OFF.
Disconnect the PLOTTER from the mains supply.
Please refit the front
END

IEC 625/IEEE 488 INTERFACE

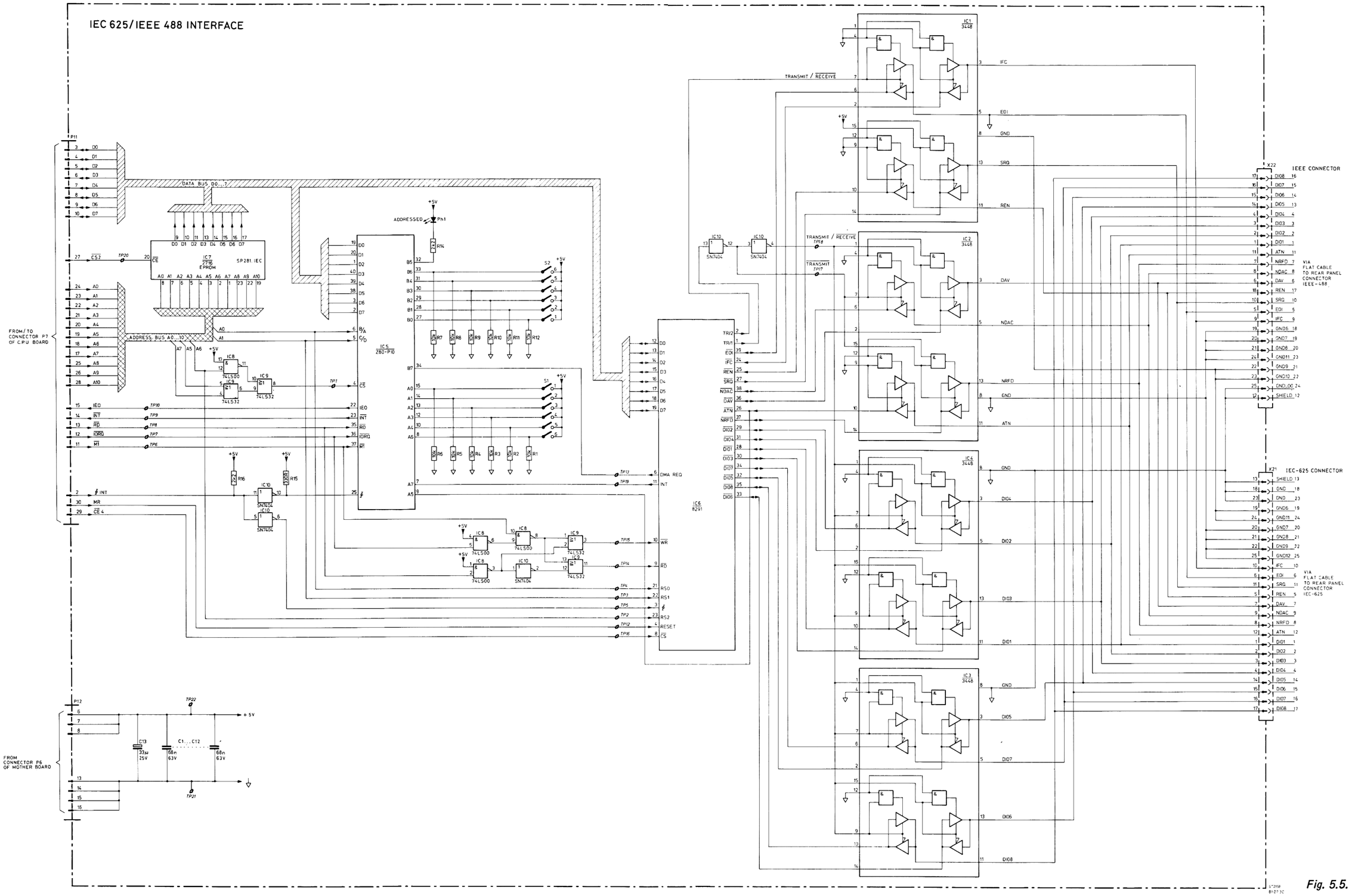


Fig. 5.5.

6. MANUAL OPERATION

6.1. CONTROLS AND CONNECTORS

6.1.1. Keyboard Controls and Indicators (figure 6.1.1.)

ITEM	DESCRIPTION	FUNCTION
1	Pen Positioning/Select switch	manually selects pen and/or moves the pen when digitising or to define ZERO and SCALE
2	SELECT/DIGITIZE button	used to select a pen, to set ZERO and SCALE and to check digitised points
3 4	ZERO button SCALE button	used with the positioning control and SELECT button to define the origin and units in the User Coordinate System (UCS)
5	CAL/VAR switch	used to run programs with calibrated or variable scale(latter defined manually on front panel)
6	DIGITIZE indicator	When ON and remote/locale switch to remote, user is requested to direct the digitising sight to the desired point. Flashing indicator with the remote/local switch to LOCAL, user is requested to press SCALE or ZERO or the Pen Select
7	OFF-SCALE indicator	when ON, indicates that an attempt has been made to access a point outside the currently-defined graphic limits or outside the physical plotting area.
8	PLOT switch	on REMOTE, plotter is program controlled. on LOCAL, the local functions are enabled, i.e. Select ZERO and request ZERO Select SCALE and request SCALE Exchange of pens
9	PEN switch	manual or remote (programmed) pen control is enabled. In UP or DOWN position, the programmed pen status is overridden.
10	CHART switch	activates the electrostatic paper hold-down facility.
11	POWER switch	connects mains supply to plotter
12	POWER ON indicator	indicates power supply connected, 5V supply present and CPU fitted.

6.1.2. Miscellaneous Connectors and Indicators

PM 8151S: – MODEM : 25 – pin connector on rear panel for online configurations.
– TERMINAL : 25 – pin rear-panel connector for offline configurations.

PM 8151B – IEC 625 rear-panel connector
– IEEE 488 rear-panel connector

PM 8151 (both types):
– CHART ADVANCE rear-panel socket for connecting automatic chart advance facility PM 9886/01.

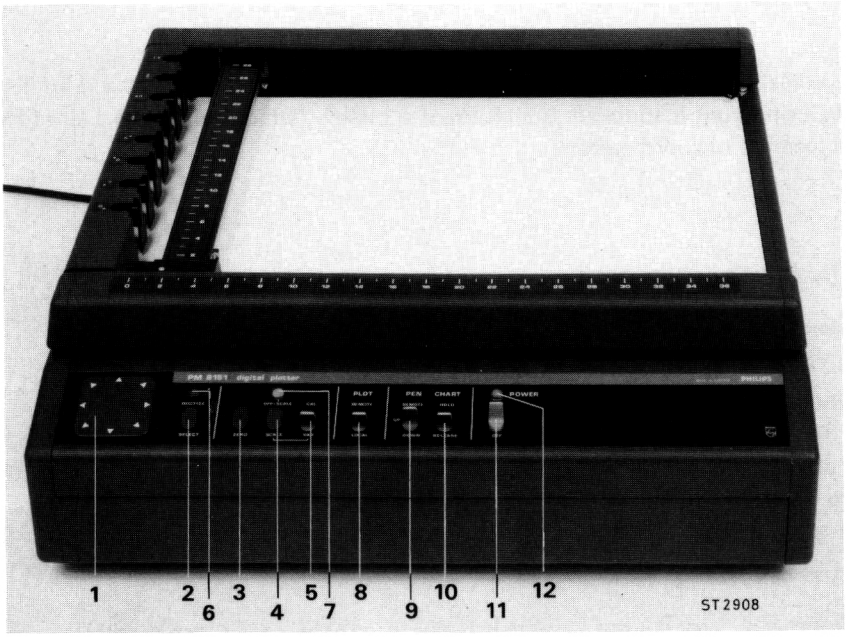


Fig. 6.1.1. Keyboard Controls and Indicators.

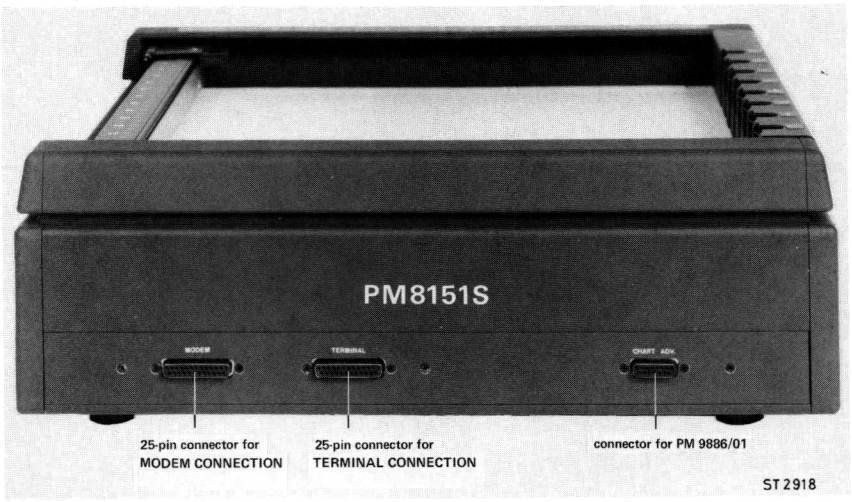


Fig. 6.1.2.

Fig. 6.1.2.a.

6.2. PENS

Two types of pen are available for use in the plotter, namely, disposable nylon-tip pens and refillable Rotring pens. In addition, a digitising sight is supplied as a standard accessory, which consists of a lens fitted in a pen holder to enable visual location of coordinates.

6.2.1. Nylon-fibre Tip Pens

These pens are useful for multi-coloured traces.

WARNING: To prevent drying out, ensure that the plastic push-on caps are replaced after use.

6.2.2. Rotring Isograph/KOH-I-NOR pens

These pens provide a choice of thickness and give high precision drawing action. Adaptors for fitting Rotring Isograph 2000 pens are standard accessories.
The adaptor must be screwed tightly on to the pen. Use the white adaptor for pens smaller than 0.35 mm.

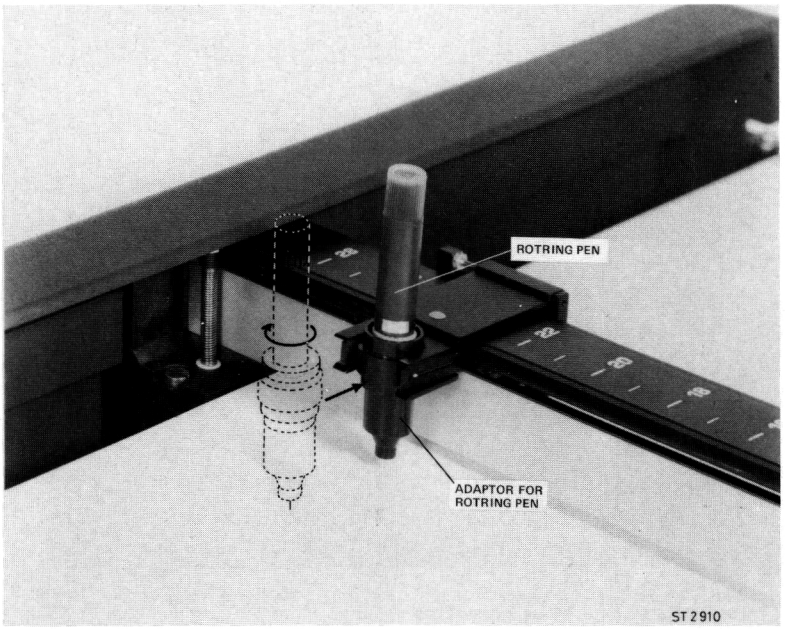


Figure 6.2.2.

Pen stores 1 to 4 should preferably be used for Rotring pens as they are protected against drying out. It is necessary to lift the level of the pen when using these stores.

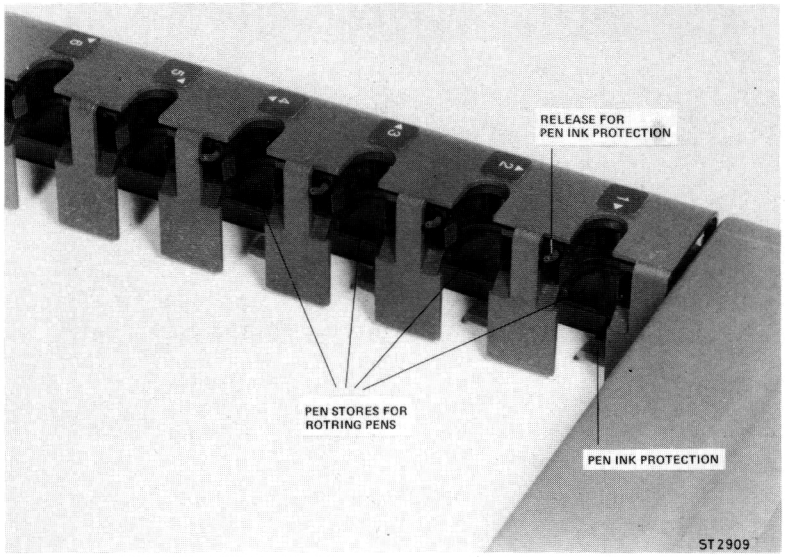


Figure 6.2.2.a.

6.2.3. Pen Level Adjustment

If distance A between the pen tip and the paper support plate differs from 1 mm, then:
- slacken the locking nut
- adjust the fixing piece of the lift-magnet pivot to correct distance by means of the adjusting screw.

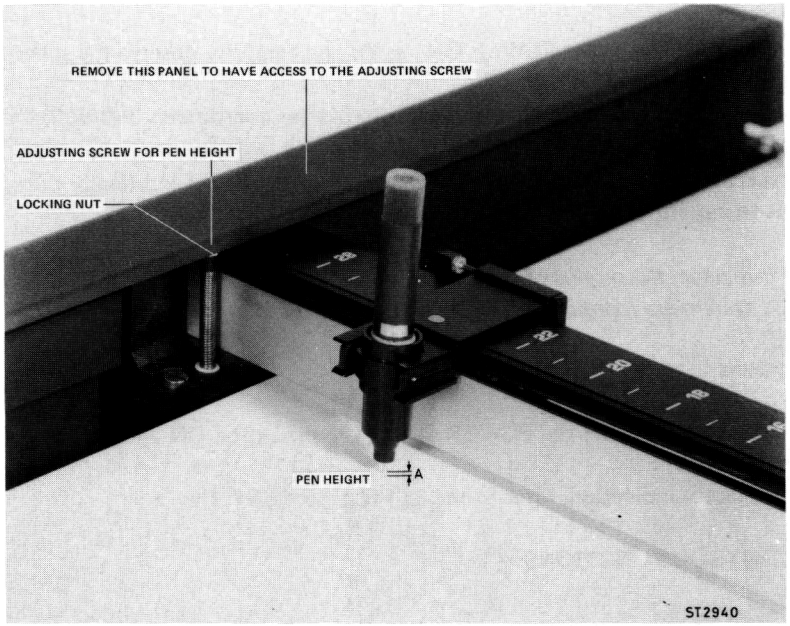


Fig. 6.2.3.

6.2.4. Pen Carriage Disabling

Certain actions are easier with the pen carriage disabled. If the plotter is on a program, the carriage can more easily be shifted across the chart table in this way without loss of data.

To disable the carriage:
- set PLOT switch to LOCAL and **then** CHART switch to RELEASE.

6.3. PAPER

Blank A3 sheets of drawing paper are supplied as standard accessories. Alternatively, paper rolls may be used by incorporating the PM9886/01 option (see section 3.3.1).
To fit the chart paper:
- disable the pen carriage to facilitate movement (PLOT switch to LOCAL and then CHART switch to release)
- move pen carriage to some convenient position and fit the paper
- put CHART switch to HOLD and gently smooth the paper as necessary
- put PLOT switch to REMOTE.

WARNING: KEEP HANDS CLEAR OF THE CHART TABLE – carriage moves quickly to the position held prior to the last switch LOCAL action.

NOTE: If the plotter is set to use the programmable paper advance option, the CHART switch must be permanently on RELEASE to allow paper movement.

To remove graph sheets:
- put CHART switch to RELEASE (preferably before POWER OFF to ensure rapid electrostatic discharge)
- gently withdraw the paper, disabling the pen carriage if necessary.

WARNING: Any inadvertent writing on the chart table (i.e. without paper) should be removed as soon as possible with a damp cloth (water or alcohol).

6.4. SWITCHING ON

Before switching on, ensure that the provisions for earthing and mains adjustment outlined in section 5. INSTALLATION have been rigorously adhered to.

6.4.1. Initialisation Procedure

- Switch on the plotter at the POWER ON switch and carefully observe the succeeding pen carriage movements.
- Check that the pen moves extremely rapidly to plotter coordinates 300/500, the first point of initialisation
- then check that it moves to a point between pen stores 1 and 2 and finally brings pen 1 from the store and directs it to a point (the origin) at the lower left of the chart table.

NOTE: At this stage, the origins of the plotter coordinate (PC) system and the user coordinate (US) system are identical (see sections 6.5 and 7.1.2.).

6.4.2. Initial Indications

Normally, after POWER ON, the POWER lamp (12) should be ON and the OFFSCALE (7) and DIGITIZE (6) lamps should be OFF.
In the event of faulty indication, refer to the Self-test (section 8.1).

6.5. MANUAL CONTROL FUNCTIONS

6.5.1. General

The manual control functions permit the characteristics of a plot to be changed locally without passing data to a control computer.
Therefore, the PLOT switch must be at LOCAL for these facilities.

NOTE: *When in LOCAL mode, the plotter still acts as a peripheral device to the driving unit. It can be switched to LOCAL at any time without loss of data if correctly controlled. See section 7. Programming.*

Two important plotting requirements are to scale a plot or to produce an offset. Before considering the operating procedures for these actions the basic principles are discussed.

6.5.2. Zero

a) To check or select Origin:
press ZERO
pen should move to lower left of chart table for plotter coordinates origin

b) To set Origin of UCS:
- switch to LOCAL
- direct pen or digitizing sight to point intended for user's zero.
- press SELECT
- press ZERO

For accurate offsets, use OFFSET instruction instead of locally shifting the Origin. Also necessary for shifts in excess of 3380 X-units and/or 2800 Y-units.
Offsetting may be usefully applied to shift offscale portions of a plot on to the chart table without editing the plot file.

c) To check the manual offset:

- switch to CAL
- press SCALE
- check that pen moves rapidly to a position 18 cm to the right and 14 cm up from the UC origin
  if this point is outside the mechanical boundaries, check that the OFFSCALE light is ON
- press ZERO
- check that pen returns to the manually defined Origin
- switch to VAR
- press ZERO
- check that the pen does not move

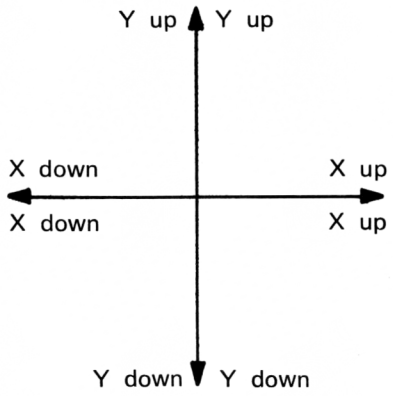
a) Offset

Offsets can be produced locally and/or by programming; each overrides the other, as required. A user-defined offset is achieved by shifting the origin (ZERO) of the plotter coordinate (PC) system that is located at the lower left of the chart to a new position (user coordinate UC system) as selected. This offsets the whole of the plotting area (effectively pushes the whole plotting area by its lower left-hand corner). See section 6.5.2. ZERO.

b) Scaling

Scaling is a local keyboard function. It permits upscaling and downscaling with respect to the calibrated scale, mirror-image plots and rotated printing plane (used for negative image plots and transparencies). A new scale can be selected by moving the pen to a new position before the SELECT SCALE operations. Note that in dowscaling, the smallest possible writing increment in the X and Y directions is 0.1 mm.

NOTE: *Y upscaling occurs in the top half of the chart area; X upscaling occurs in the right-hand half. Y downscaling occurs in the lower half of the chart area and X downscaling in the left-hand half. The diagrammatic representation is shown below:*



The calibrated scale (CAL) is 1 unit = 0.1 mm. As the total area represents 3600/2800 units, the Scaling Points lies at 1800/1400 units. However, because of the area occupied by the pen changer, the physical X limit is reduced to 3380 units.
The user-defined scale (VAR) is set by assigning different values to this Scaling Point (i.e. adopting a different centre-point and hence a different origin-to-centre-point vector length).
The distances of this Scaling Point from the Y and X axes of the UC system in calibrated units divided by 1800 and 1400 respectively give the scale unit of the UC system; i.e.

$$\text{X scale units} = \frac{\text{X distance}}{1800} \text{ or } X_{dist.} = X_{sc.} \times 1800$$

$$\text{and Y scale units} = \frac{\text{Y distance}}{1400} \text{ or } Y_{dist.} = Y_{sc.} \times 1400$$

6.5.3. Scale (First set the ORIGIN to 0/0)

a) To check Calibrated Scale:
- move format switch to CAL
- press SCALE button
- check that pen moves to a point 18 cm to the right and 14 cm up (Scaling Point for Cal. scale units)

b) To check Variable Scale:
- move format switch to VAR
- press SCALE button
- check that pen moves to a point 12.2 cm to the right and 9.89 cm up. (Downscaling factor of $\sqrt{2}$, the initialised VAR. Scaling Point)

c) To set the Variable Scale:
- switch to LOCAL
- move pen to desired Scaling Point on chart with the Pen Positioning/Select switch
- move format switch to VAR
- press SELECT
- press SCALE

d) Examples of Scaling:

Example 1. Consider a variable scale of 1 unit = 0.05 mm is required
- switch to LOCAL and press ZERO to ensure origing of UCS is at lower left.

Substituting 0.05 for scale units in the following we have:
X distance = 0.05 x 1400 = 70 mm
X distance = 0.05 x 1800 = 90 mm (see 6.5.1.b)
- move format switch to VAR
- move pen 9 cm to the right and 7 cm up
- press SELECT
- press SCALE

With this new Scaling Point the scale units are now set to 0.05 mm.

Example 2. Consider scale units X: 0.15 mm, Y : 0.2 mm are required:
- switch to LOCAL and press ZERO to verify the user's origin (now at lower left)

Substituting required scale units, we have:

X distance = 0.15 x 1800 = 270 mm
Y distance = 0.2 x 1400 = 280 mm
- move format switch to VAR
- move pen 27 cm to the right and 28 cm up (upper boundary)
- press SELECT
- press SCALE

Example 3. Consider mirror image of Example 1. is required, where:
Y scale = 0.05 mm and X scale now = –0.05 mm

Y coordinate distance = 0.05 x 1400 = 7cm (as before)
Now the X coordinate distance = 0.05 x 1800 = –9cm (using the lower right as origin)

- move format switch to VAR
- move the pen to the lower right corner
- press SELECT
- press ZERO (Origin is 3380/0)
- direct pen 9 cm to the **left** and 7 cm up
- press SELECT
- press SCALE

e) Notes on Variable Scaling

- Following POWER ON, the calibrated scale is initialised to 0.1 mm for both axes.
- The variable scale is initialised to 0.07 mm, i.e. a reduction factor of $\sqrt{2}$
- If both Origin and Scale of a plot program need to be set locally, preferably set the Origing first.

f) Program-assisted Variable Scaling

Where plots are printed on blank paper, the foregoing method becomes laborious, especially when accurate up or down-scaling is required.
If X and Y units are to be scaled by the same factor, the following program-assisted procedure may be usefully adopted.

Let X and Y be the Plotter Coordinates of the desired Scaling Point.

- Perform a MOVE ABSOLUTE to the position 3380/2800 (upper right) with calibrated format.
- Perform a MOVE RELATIVE by –X/–Y. (where X and Y are the plotter coordinates of the desired Scaling Point).
- Switch to LOCAL
- Press SELECT and then ZERO
- Press SCALE and note that the OFFSCALE lamp is ON.
- Move format switch to VAR
- Press SELECT and then SCALE
- Direct the pen to the lower left using the Pen Positioning switch.
- Press SELECT and then ZERO.

6.5.4. Remote/Local

The positions of the PLOT switch permit the plotter to be either controlled from the plotter keyboard (LOCAL) or program-controlled (REMOTE) from a remote position. In position LOCAL the input buffer can still be accessed by the controller.
Local control has been described in the foregoing (see section 6.5.1. and subsequent sections).
Remote programming is described in section 7. Programming Instructions.

6.5.5. Pen Lift

REMOTE:	In the REMOTE position, the pen up/pen down instructions are programmable.
UP/DOWN	The local keyboard UP/DOWN positions control the pen lift movement and override the programmed pen status.

6.5.6. Chart Hold/Release

In the HOLD position, the switch provides for electrostatic hold-down of the chart paper. The graph sheets can be removed by switching to the RELEASE position. To remove the electrostatic charge quickly, switch to RELEASE before POWER OFF.

NOTE: *For the Programmable Paper Advance option, the CHART switch must be permanently to RELEASE.*

6.5.7. Pen Positioning (Carriage Movement)

The Pen Positioning 8-position switch enables carriage movement in eight different directions as indicated by the arrows, by manual operation of the switch.

6.5.8. Pen Selection

The Pen Positioning/Pen Select switch can be used for pen selection after pressing the SELECT pushbutton. The adjacent indicator lamp should then flash, whereupon the arrow indication that corresponds to the desired pen should be pressed.
The carriage should then deposite the pen in use to its depot, select the desired pen and transport it to the point held before the pen exchange.

7. PROGRAMMING INSTRUCTIONS

The PM8151 plotter is programmed with ASCII characters, or transmits these characters in a similar way to other terminal equipment.

7.1. GENERAL INFROMATION

7.1.1. Scope

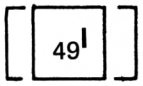
This part of the operating manual gives an introduction to the programming of the PM8151 including the the available options.
Instructions that relate specifically to a particular interface are dealt with later under the appropriate interface description.
The Instruction Summary for basic instruments is therefore valid for all types of interfaces and gives examples for effective programming.

7.1.2. Definitions

TERM	DEFINITION
Current position of pen	Always corresponds to programmed positions. Corresponding point can either be inside plotter area or off-scale, therefore, not necessarily identical to actual pen position.
Actual position of pen	Always corresponds to physical position within the mechanical boundaries of plotting system and/or within the currently defined graphic limits.
Plotter coordinates (PC)	A system of coordinates having its Origin fixed to the lower left corner of the plotter. The scale unit is 0.1 mm. Corresponding to the mechanical boundaries coordinates are restricted to: X coordinate: 0 to 3380 Y coordinate: 0 to 2800
User coordinates (UC)	A system of coordinates with Origin and scale units defined by the user (LOCAL functions), dependent on selected ZERO and SCALE. Range of values restricted by microprocessor to $-32768 \leqslant x \leqslant +32767$
Command Strings	In simple cases consists of one ASCII character (one byte) that defines the type of instruction (one byte instruction). More advanced plotting and computing actions require more bytes. The complete instruction is then made up of an ASCII-character that defines the type of instruction, followed by additional characters representing parameters. Thus the command string has a length of at least two bytes (a two-or-more byte instruction).

7.1.3. Notations

To accurately describe the syntax of the instruction, the following notations are used:

	Instruction with hexa-decimal equivalent of ASCII-character (column and row) defining the type (refer to table, page 51)
	Optional instruction any or all syntactic items between these brackets may be omitted.
	Numerical value for X is optional
(a) = n	The parameter a has been initialised to the numeric value n. (see section 7.1.4e)
<a> = n	The default numeric value for the parameter a is n. (see section 7.1.4e)
"A"	ASCII-character A

7.1.4. Instruction Features

a) Instruction

To avoid confusion, the ASCII-character defining the entire instructions is always shown within a square together with its hexa-decimal equivalent.
Dependent on the type of instruction, the microprocessor may request additional values to assign to some parameters.

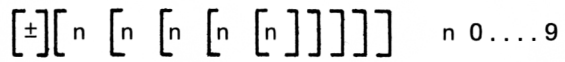
b) Command string delimiters

As there is no need to terminate a command string with a special delimiter (following instruction acts as such), they can be concentrated, thus avoiding redundancy.
In addition to auto-delimiting, command string terminations can also be carried out by the ASCII characters, ". ", "; " and by "CR" (CARRIAGE RETURN). This is useful, for example, at the end of a plot program where the parameter list is incomplete and no instruction follows.

NOTE: Succesive numeric values must be separated by an ASCII space or comma

c) Format of numeric values

The microprocessor accepts numeric values as coordinates and/or parameters. These numeric values are integers with up to five digits, optionally preceded by a sign. The range of numbers is from –32768 to 32767 for valid numeric values.
According to the notations and the above description the format of numeric values is



Some examples of valid numeric values:
–10
+450
–0005
1300

				b7→	0	0	0	0	1	1	1	1
				b6→	0	0	1	1	0	0	1	1
				b5→	0	1	0	1	0	1	0	1
b4↓	b3↓	b2↓	b1↓	column / row	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	\	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENG	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	A	LF	SUB	*	:	J	Z	j	z
1	0	1	1	B	VT	ESC	+	;	K	[	k	{
1	1	0	0	C	FF	FS	,	<	L	\	l	|
1	1	0	1	D	CR	GS	-	=	M	]	m	}
1	1	1	0	E	SO	RS	.	>	N	^	n	~
1	1	1	1	F	SI	US	/	?	O	_	o	DEL

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Fig. 7.1.3.

d) Separating numeric values

Successive numeric values must be separated by an ASCII space (hexa-decimal 20) or comma (2C). Although this procedure is necessary within a parameter list of a command string, for simplicity no blancs are used in the syntax of the instructions. Polarity signs also act as separating characters for numeric values thus allowing blanks to be omitted.

Example: The following command strings for plot circle are identical.

O 1 0 0 0 3 0 9 0
O 1 0 0 0 + 3 0 + 9 0

e) Parameters and default values

Instructions with a command string of more than one byte consist of an ASCII-character defining the Instruction and a number of ASCII-characters following representing numeric values for parameters.

After POWER ON, all parameters of all instructions are initialised to specific numeric values as detailed in section 7.2. These initialised values are then replaced by the new ones and remain in memory until replaced by a further transmission. This remaining value is called default value.
To simplify programming, some or even all of the parameters can be omitted. In this event, default values are assigned to all the parameters – usually the last values transmitted or the initialised values. For details, see appropriate instructions.

NOTE: *Defaulting is only applicable from left to right in a list of parameters. Therefore, it is not allowed to omit the first (second) parameter in an instruction requiring two (three) numeric values.*

7.2. INSTRUCTION SUMMARY FOR BASIC INSTRUMENT

7.2.1. General Information

This section provides all the programming information for correctly setting up the command strings.
The plotter responses are described in detail and examples are given of valid command strings together with the resulting plotter action where appropriate.
The instructions have been classified into groups for ease of reference. Each group is preceded by a brief introduction giving fundamental plotting features as required.

7.2.2. Pen Group

There are three pen instructions that are programmable:

- **PEN DOWN**
- **PEN UP**
- **SELECT PEN**

In addition, an automatic pen lift facility prevents ink bleeding in the event of long intervals between instructions (more than 10 seconds). The microprocessor keeps track of the pen status prior to automatic pen up and continues drawing correctly on receipt of new plot instructions.

a) PEN DOWN

Syntax: 49 I

Purpose: The instruction **PEN DOWN** is used to lower the pen at the current position.

Description: Immediately following the receipt of the ASCII-character "I", the pen is lowered. If it has been up. Otherwise no action occurs.

NOTES: *1) An explicit* **PEN DOWN** *must precede the Instructions for*

PLOT RELATIVE
PLOT ABSOLUTE
PLOT CIRCLE (ARC)

2) "PEN DOWN" is stored in the microprocessor RAM at the pen status location

3) The pen status and the contents of the pen status location are altered to "PEN UP" due to
- an explicit instruction **PEN UP**
- the instruction **CHARACTER PLOT ENABLE**

b) PEN UP

Syntax: 48 H

Purpose: The instruction **PEN UP** is used to lift the pen at the current postion.

Description: Immediately following the receipt of the ASCII-character "H" the pen is lifted if it has been down. Otherwise no action occurs.

NOTES: *1) An explicit* **PEN UP** *must precede the instructions for*

MOVE ABSOLUTE
MOVE RELATIVE
MOVE CIRCLE

2) **PEN UP** is stored in the microprocessor RAM at the pen status location

3) The pen status and the contents of the pen status location are altered to Pen Down due to
- an explicit instruction **PEN DOWN**

c) SELECT PEN

Syntax: [46F] [n]

n . . . integer numbers 0 . . . 8 defining the pen depot

(n) −1
<n> = 0

Purpose: One of 8 pens is fetched from the Programmable Pen Select Depot (PPSD).

Description: The **SELECT PEN** is executed on receipt of the next byte following this instruction.
The pen is lifted at the current postion if it has been down.
The pen in use is returned to its appropriate depot
The new pen relating to no. n is fetched and directed to the positon prior to this instruction.

NOTES: *1 F0 acts as a pen deposit.*

2 If n relates to the pen in current use no action occurs.

Programming example: With the byte string of the example each pen of the depot is fetched. The last instruction (command string F 0) puts back pen no. 8 so that the pen depot stores all 8 pens.

Example: F2F3F4F5F6F7F8F0

NOTE: *Pen 1 has initially been fetched from the depot due to Power On (initialising process)*

7.2.3. Vector Group

a) General

All drafting plotter actions, regardless of complexity, are made up of linear interpolations; i.e. vector generations. These are the result of movements with pen down as distinct from positioning movements with pen up. An exeption is incremental plotting with pen up.
If it is remembered that all accessible coordinate pairs correspond to the corners of 3380 * 2800 squares then the problem of generating a straight line from the current pen position X_c/Y_c to a final point X_f/Y_f is reduced to incrementing (or decrementing either the X or Y coordinates or both as shown in fig. 7.2.3.
Because of the fairly low bandwidth of the system and D/A conversion, the staircase function is smoothed out as shown by the solid line.

For vector generation:

- the pen is lowered, straight line plotting commences with an accelerating phase, continues with constant velocity, and ends with a retarding phase.
- The time of execution depends upon the vector length
- Vector generation is performed by incrementing the X and/or Y coordinate values by single units until the end point is reached.

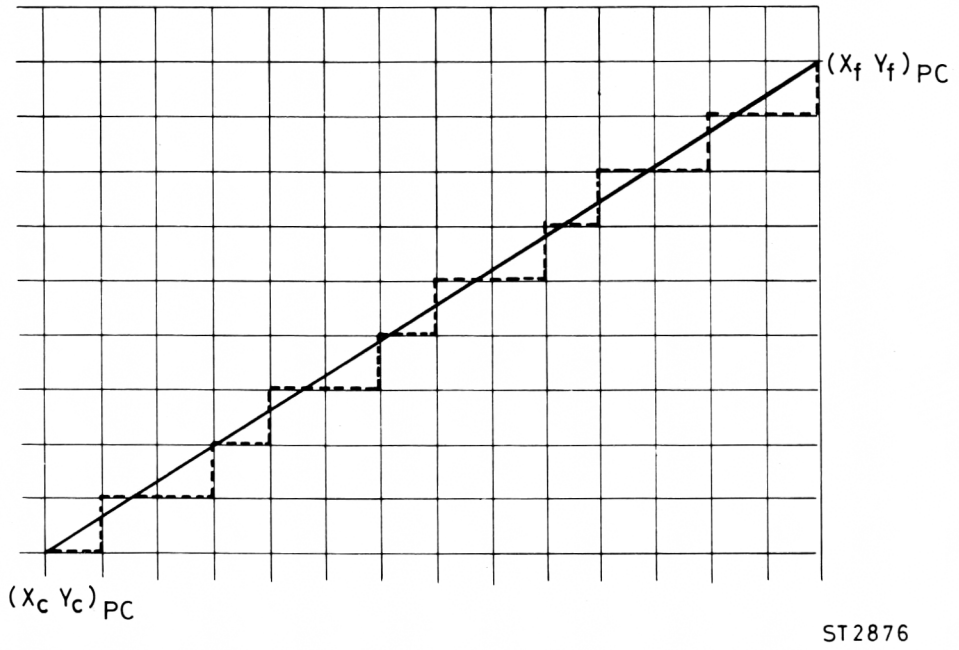


Fig. 7.2.3. Vector generation

Before any positioning or plotting action can take place, the plotter must be instructed to store numeric values as coordinates (absolute or relative) for further treatment by the instruction:

RECEIVE COORDINATES

Syntax: [x] [2F/] y or x [2F/] [y] alternatively

x = x– coordinate; any valid numeric value
y = y– coordinate; any valid numeric value

Description: On receipt of the byte following this instruction the numeric values are stored in the microprocessor memory. No plotting action is started. The instructions **PLOT ABSOLUTE PLOT RELATIVE MOVE ABSOLUTE** and **MOVE RELATIVE** access the entire memory locations and the corresponding plotting action is performed.

NOTES: *Numeric values for x-and y-coordinates remain in memory until alteration by a new* **RECEIVE COORDINATES**

b) POSITIONING

During a plot program, it is often necessary to direct the pen to some point without any drawing action (i.e. in the pen up mode) to arrive at the starting point of the drawing or part of it. Two positioning actions are possible, enabled by the instructions **MOVE ABSOLUTE** and **MOVE RELATIVE.** Both absolute and relative coordinates refer to the UC system.

MOVE ABSOLUTE

Syntax: [48H] 4BK

Purspose: Pen is directed to a point at maximum possible speed without following a straight line as the microprocessor gives only the end-point coordinates.

Description: Immediately following the instruction MOVE ABSOLUTE the pen is directed to a point with absolute coordinates X, Y as defined with the last instruction RECEIVED COORDINATES. No vector is generated as pen is lifted.

NOTES: *The optional instruction* [H] *can be omitted if the last instruction has been* **PEN UP.**

The optional instruction [H] *can further be omitted if* **MOVE ABSOLUTE** *is preceded by one of the instructions:*

CHARACTER PLOT DISABLE
INCREMENT MODE DISABLE

MOVE RELATIVE

Syntax: [[48H]] [4AJ]

Purpose: The pen is directed to a point relative to the current postion speed, without following a straight line as the microprocessor gives only the end-point coordinates

Description: Immediately following the instruction **MOVE RELATIVE** the pen is directed to a point with final coordinates (X_f, Y_f) with the maximum possible speed.

No Vector is generated as the pen is lifted.

The final positon (X_f, Y_f) is

$$\left.\begin{aligned} X_f &= X_c + X \\ Y_f &= Y_c + Y \end{aligned}\right\} \quad (X_c, Y_c) \text{ is current position}$$

with X and Y as defined by the last instruction **RECEIVE COORDINATES**

NOTES: *The optional instruction* [48H] *can be omitted if the last instruction has been* **PEN UP.**

The optional instruction [48H] *can further be omitted if* **MOVE RELATIVE** *is preceded by the instruction* **CHARACTER PLOT DISABLE**

c) PLOTTING

Two instructions are used for plotting depending on whether the pen is to be directed to a defined position on the chart **PLOT ABSOLUTE** or to a position relative to the current pen postion **PLOT RELATIVE.**

PLOT ABSOLUTE

Syntax: 

Purpose: Drawing straight lines.

Description: Immediately following the instruction **PLOT ABSOLUTE** the pen is moved to the point with absolute coordinates (X, Y) as defined by the last **RECEIVE COORDINATES** instruction.

A straight line is drawn starting at the current position (X_c, Y_c) (Vector generation)

NOTES: *Although treated as one instruction* **PLOT ABSOLUTE** *is composed of two instructions:*

for PEN DOWN
and

for ABSOLUTE

The syntax notation declares the instruction **I** as optional because there is no need for an immediate succession of **I** and **K**. Thus these can be separated by an unlimited number of other plot instructions – except **PEN UP.**
(see section 7.1.3. Notations).

Examples for valid instruction sequences:

INSTRUCTION INSTRUCTION INSTRUCTION


is equivalent to

INSTRUCTION INSTRUCTION INSTRUCTION


PLOT RELATIVE

Syntax: [49^I] 4A^J

Purpose: Drawing straight lines.

Description: Immediately following the instruction **PLOT RELATIVE** a straight line is drawn from the current position (X_c, Y_c) to the final position (X_f, Y_f)

The final position (X_f, Y_f) is

$$\left.\begin{aligned} Xf &= X_c + X \\ Y_f &= Y_c + Y \end{aligned}\right\} \quad (X_c, Y_c) \text{ is current postion}$$

with (X, Y) as difined by the last instruction **RECEIVE COORDINATES.**

NOTES: *Although treated as one instruction* **PLOT RELATIVE** *is composed of two instructions:*

49^I *for PEN DOWN*

4A^J *for RELATIVE*

The syntax notation declares the instruction 49^I as optional because there is no need for an immediate succession of **I** and **J**. Thus these can be separated by an unlimited number of other plot instructions – except **PEN UP** and a further exception as noted below.

Examples for valid instruction sequences:

49^I **INSTRUCTION INSTRUCTION INSTRUCTION** 4A^J

is equivalent to

INSTRUCTION INSTRUCTION INSTRUCTION 49^I 4A^J

Programming Example: This example for positioning and plotting uses the instructions MOVE ABSOLUTE, MOVE RELATIVE, and PLOT ABSOLUTE PLOT RELATIVE.

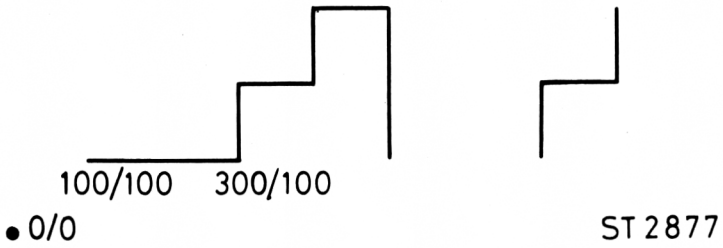


Figure 7.2.3a Example of Positioning and Plotting

The drawing of the above figure is produced with the following string of 75 bytes:
100/100HK 300/100 IK0/100J 100/0J0/100J 100/0J0/–200J 200/0HJ0/100IJ100/0J0/100J

Explanation:

MOVE ABSOLUTE	100/100HK	– pen moves to absolute positon 100/100
PLOT ABSOLUTE	300/100IK	– pen down, plots line to position 300/100
PLOT ~~ABSOLUTE~~ REL	0/100J	– pen plots line 100 Y – units to 300/200
PLOT ~~ABSOLUTE~~ REL	100/0J	– pen plots line 100 X – units to 400/200
PLOT ABSOLUTE	0/100J	– pen plots line 100 Y – units to 400/300
PLOT ABSOLUTE	100/0J	– pen plots line 100 X – units to 500/300
PLOT ABSOLUTE	0/–200J	– pen plots line –200 Y – units to 500/100
MOVE ABSOLUTE	200/0HJ	– pen up, moves 200 X – units to 700/100
PLOT ABSOLUTE	0/100IJ	– pen down, plots line 100 Y – units to 700/200
PLOT ABSOLUTE	100/0J	– pen plots, line 100 X – units to 800/200
PLOT ABSOLUTE	0/100J	– pen plots line 100Y – units to 800/300

DEFINE LINE TYPE

Various types of dashed lines of a programmable length can be selected, the LINE TYPE instruction being effective for circles and line plotting only.

Syntax:  [n [l]]

n . . . 0, 1, 2, 3, 4

l . . . any valid numeric value up to 255

(n) = 0 <n> = 0

(l) = 2 <l> = last l

Purpose: Selection of line type and shape

Description: The instruction defines the line type and shape for all lines performed by the instructions

PLOT ABSOLUTE

PLOT RELATIVE

PLOT CIRCLE

VERIFY WINDOW

The parameter n defines the line type and is restricted to the number 0 . . . 4

n = 0	normal drawing
n = 1	dotted line
n = 2	dashed line
n = 3	dashed dashed line
n = 4	dashed dotted line

The parameter l defines the length of a Basic Line Element.

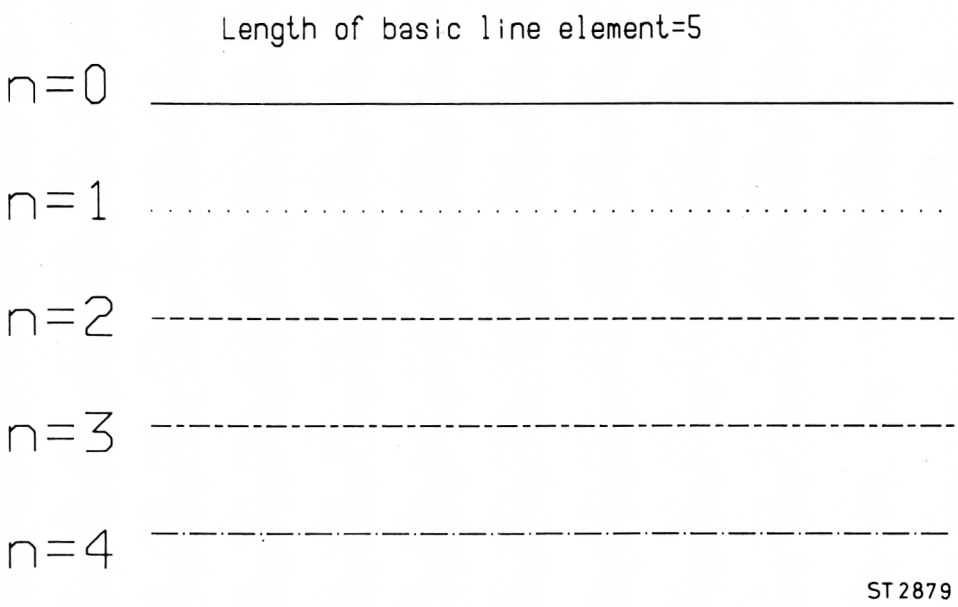
NOTES: *The instruction* **DEFINE LINE TYPE** *does not act upon the execution of the following instructions*

X-AXIS
Y-AXIS
CHARACTER PLOT ENABLE
SPECIAL CHARACTER PLOT ENABLE
PLOT POINT MARK
INCREMENTAL PLOT ENABLE

These instructions reset the LINE TYPE to the initial value.

Programming examples:

The figures show straight lines (Vectors) with a length of 15 cm with different line types. (Fig. 7.2.3b.)



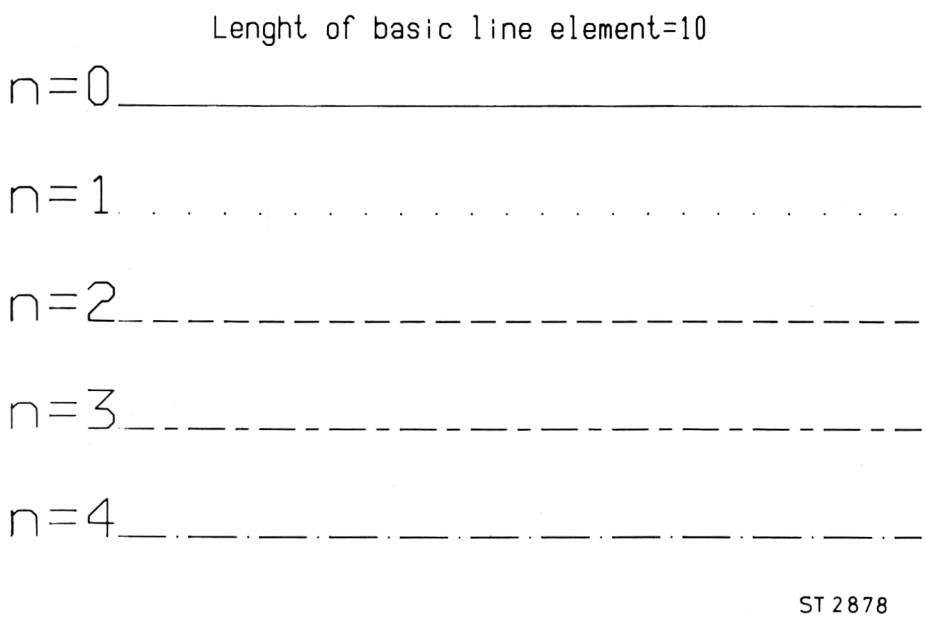


Fig. 7.2.3.b.

7.2.4 Alphanumerics

The alphanumerics feature provides for the printing of text on the plot without the need for software-supported character generation by a controlling computer. The firmware character generator offers five standard-character sets.

All printing characters, both upper and lower case, are plotted in accordance with the character-set currently defined, the character changes being as listed in the difference table above. The complete standard ASCII character set is given in fig. 7.2.4.
Program control also allows the characteristics of alphanumerics to be modified by two instructions:

- one instruction sets the height and width (independently programmable up to 15 cm) and the printing plane,
- the other instruction sets the character slant to 90° or 75°.

The alphanumeric feature is based on vector generation and the character size and printing plane are affected by the selected scale.

The character shape is predetermined by a 7x7 matrix that also provides for character spacing (see fig. 7.2.4.b.). Note that the matrix area embraces the letter together with its required spacing but lower extenders (e.g. lower-case 'j') are offset by two units.

The plotter not only accepts printing characters, but also responds to some control characters to facilitate formatting of text on the plot. These are listed overleaf.

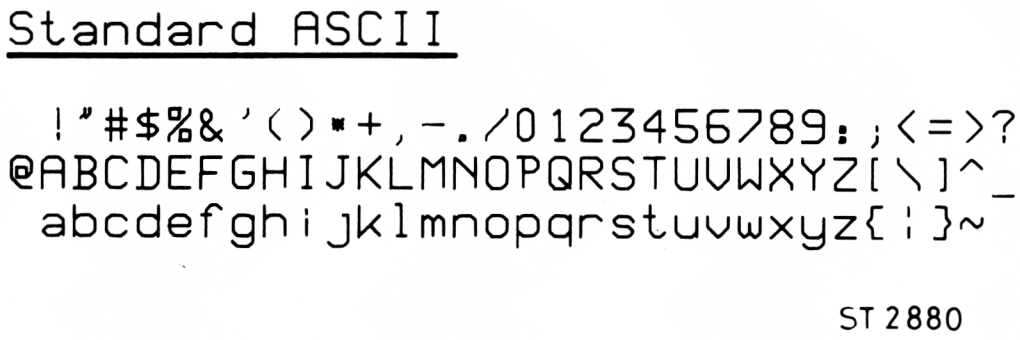


Fig. 7.2.4. Standard ASCII character set

Set	Character value (hex)	5B	5C	5D	7B	7C	7D
0	Standard ASCII	[	\	]	{	¦	}
1	German	Ä	Ö	Ü	ä	ö	ü
2	Spanish	¡	Ñ	¿	{	¦	}
3	Swedish,Finnish	Ä	Ö	Å	ä	ö	å
4	Danish,Norwegian	Æ	Ø	Å	æ	ø	å

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Fig. 7.2.4.a. Character sets

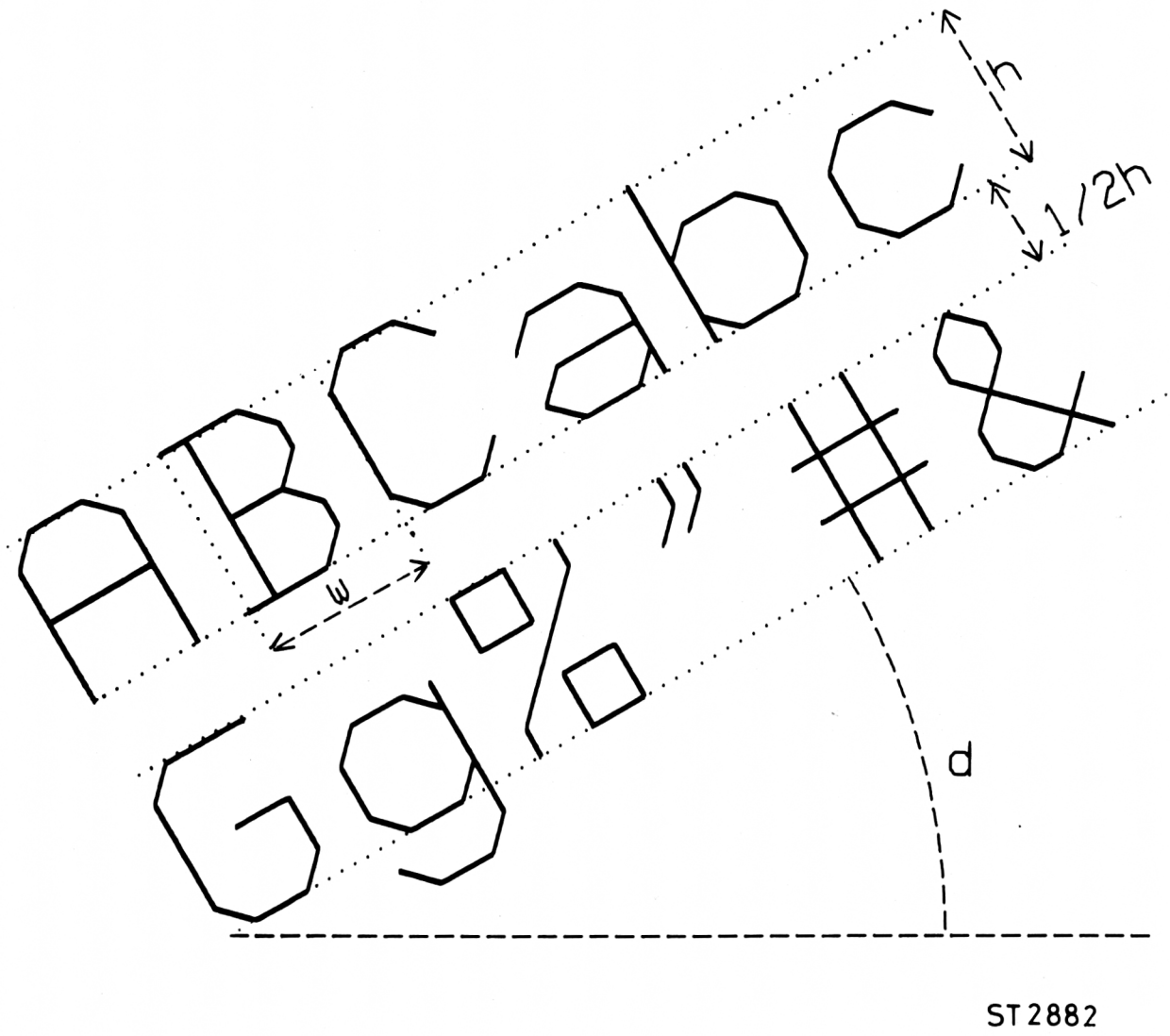


Fig. 7.2.4.b. Character size, width and printing plane

Accepted ASCII character functions (see table, page 96)

Character received (+ hexadecimal equivalent)	**PLOTTERs function**
Printing ASCII characters	All printing characters of columns 2, 3, 4, 5, 6, 7 are plotted. These include upper and lower case characters.
08 BS Backspace	The pen cariage is moved back — according to the writing direction set — by one character from the current pen position.
09 HT Horizontal Tab	The pen is forced ahead or back a programmable number of character width with respect to the left margin.
0A LF Line Feed	Line Feed acts as "Carriage Return" plus "Line Feed". The pen is moved back to the left margin and one line down.
0B VT Vertical Tab	The pen carriage is moved up or down a programmable number of line spaces with respect to the upper margin.
20 SP	Space advances the pen carriage by one character width.

DEFINE SIZE DIRECTION

Syntax: 5A Z [h [d [w]]]

height h ... in multiples of 0.6 with no systematic error

direction d ... from horizontal, any valid numeric value 0 ... 360 (degrees)

width w ... in multiples of 0,6 with no systematic error

(h) = 72 <h> = last h

(d) = 0 <d> = last d

(w) = 72 <w> = last w

Purpose: Selection of height, angle of rotation and width for character plotting.

Description: The instruction **DEFINE SIZE DIRECTION** defines the character height, the character width and the angle of rotation of all printing characters.

DEFINE SIZE DIRECTION also defines the unit spacing distance for horizontal and vertical tabulation (HT and VT)

DEFINE SIZE DIRECTION Similarily defines the unit separation for Line feed and Back Space

DEFINE SIZE DIRECTION Simultaneously transforms the size of Point Marks.

Notes: The instruction **DEFINE SIZE DIRECTION** may precede or follow the instruction **DEFINE CHARACTER FONT** and or **DEFINE CHARACTER SLANT**

Though the instruction **PLOT POINT MARK** does not belong to the character plot group for instructions it is nevertheless affected by the instruction **DEFINE SIZE DIRECTION**

SYSTEMATIC ERRORS OF SOME STANDARD SIZES

DIN size (h) programmed [mm]	deviation [mm]
1,8	0
2,0	+ 0,2
2,5	+ 0,1
3,0	0
3,5	− 0,1
4,0	− 0,2
5,0	+ 0,2
6,0	0
7,0	− 0,2
8,0	+ 0,2
10,0	− 0,2
12,0	0
14,0	+ 0,2
16,0	− 0,2
20,0	+ 0,2

Size = (m x 0,6 + n x 0,1) [mm]	n	deviation [mm]
	0	0
	1	+ 0,1
	2	+ 0,2
m	3	− 0,3
	4	− 0,2
	5	− 0,1
	6	0

m . . . Integer number

For example: A height of 7 mm is equivalent to:
(m) (n)

11 x 0,6 + 4 x 0,1

from the table opposite we see that n = 4 gives a deviation of −0,2 mm.

DEFINE CHARACTER SLANT

Syntax: 25 % [n]

n ... 0 or 1

(n) = 0 <n> = 0

Purpose: Character plot with slanted characters

Description: The instruction **DEFINE CHARACTER SLANT** advises the microprocessor to plot all Standard Characters at 90° or slanted at 75°.

n = 0 normal character plotting at 90°

n = 1 character plotting at 75°

Notes: The instruction **DEFINE CHARACTER SLANT** may precede or follow the instructions **DEFINE SIZE DIRECTION** and/or **DEFINE CHARACTER FONT**

DEFINE CHARACTER SLANT also influences the execution of the instruction **PLOT POINT MARK** though the latter does not belong to the character plot group of instructions.

DEFINE CHARACTER SET

Syntax: 35 # [n]

n 0 ... 4

(n) = 0 <n> = 0

Purpose: One of the standard sets of characters for character plotting is selected

Description: The standard character set contains characters of 5 different fonts.
The instruction **DEFINE CHARACTER SET** opens one of these fonts

The sets available are:

n = 0 Standard ASCII
n = 1 German
n = 2 Spanish
n = 3 Swedish, Finnish
n = 4 Danish, Norwegian

The standard ASCII character set includes all characters of the ASCII table columns 02 to 07 including "Space" and with the exception of "Delete" (177).

The character sets German, Spanish, Swedish, – Finnish and Danish, – Norwegian differ from Standard ASCII at 6 addresses, see fig. 7.2.4.a.

CHARACTER PLOT ENABLE

Syntax: 42 B

Purpose: The plotter enters character plotting

Description: The instruction **CHARACTER PLOT ENABLE** causes the microprocessor to treat all ASCII - characters following "B" as data.

Text is written onto the chart as defined by the instructions
DEFINE CHARACTER SIZE DIRECTION

DEFINE CHARACTER FONT

DEFINE CHARACTER SLANT

The instruction enables the plotter to execute character plotting of all printing characters resident in 5 fonts.

Furthermore the controlling instructions

HT (HORIZONTALLY TABULATE)

VT (VERTICALLY TABULATE)

LF (NEXT LINE inclusive a carriage return)

are accepted and executed

Notes: As a consequence of **CHARACTER PLOT ENABLE** the pen status and the contents of the pen status location is altered to "pen up" on termination of character plotting.

CHARACTER PLOT ENABLE implicitly changes the line type to n = 0 (continuous line)

The previous line type is not resumed following the termination of character plotting.

NEXT LINE

Syntax: 0A LF

Purpose: Character plotting proceeds on the next line

Description: The instruction **NEXT LINE** moves the pen to the left margin of the text and one line down

The line separation is 1.5 times the height of the character as defined by the instruction
DEFINE SIZE DIRECTION

The left margin of the text is identical to the current pen position prior to the instruction
CHARACTER PLOT ENABLE

Notes: The instruction **NEXT LINE** is restricted to the character plotting.

HORIZONTALLY TABULATE

Syntax: 09 HT [n]

n ... any valid numeric value

Purpose: Horizontal formatting of text

Description: On receipt of the byte following the command string the plotter proceeds character plotting n characters from the left margin of the text.

n can be specified to be positive or negative.

If $n > 0$ the pen is shifted to the right of the left margin.

If $n < 0$ the pen is shifted to left of the left margin.

Notes: The instruction **HORIZONTALLY TABULATE** is restricted to the character plotting.

VERTICALLY TABULATE

Syntax: 0B VT [n]

n ... any valid numeric value

Purpose: Vertical formatting of text

Description: On receipt of the byte following this instruction character plotting proceeds n lines from the upper margin.

n can be positive or negative

If $n > 0$ vertical Tabulation is executed downwards

If $n < 0$ vertical Tabulation is performed upwards

Notes: The instruction **VERTICALLY TABULATION** is restricted to character plotting.

CHARACTER PLOT DISABLE

Syntax: 0D CR

Purpose: Termination of character plotting

Description: The instruction **CHARACTER PLOT DISABLE** causes the microprocessor to terminate character plotting. ASCII-characters following "CR" are treated as instructions again.

Notes: **CHARACTER PLOT DISABLE** does not alter the parameters for character plotting. Thus size, width, angle of rotation, slant and character font remain in memory.

CHARACTER PLOT DISABLE also terminates special character plotting.

After termination of character plotting by the instruction **CHARACTER PLOT DISABLE** the pen is lifted and the contents of the pen status location is also altered to "pen up".

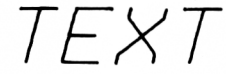
PROGRAMMING EXAMPLES OF CHARACTER PLOTTING (SEE FIG' 7.2.4.c.)

For ease of reference, the ASCII codes used in these examples are again defined:

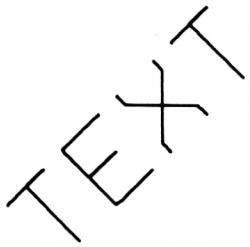
B	Character Plot Enable
"CR"	Character plot Disable (Carriage Return key)
%1	Slant (angle 75°)
Z	Define Size Direction
"LF"	Line Feed (also Carriage Return)
"HT"	Horizontal Tabulate
"VT"	Vertical Tabulate

EXAMPLE 1
Byte string;BTEXT'CR'

EXAMPLE 2
Byte string;%1BTEXT'CR'



EXAMPLE 3
Byte string;Z100 45 100 BTEXT'CR'



EXAMPLE 4
Byte string;Z60 040 BTEXT'LF'12345'HT'6 'BS'12345'LF''HT'12 'BS'
12345'LF''HT'18 'BS'12345'LF'12345'VT'7 'BS'12345
'VT'9 'BS'12345'CR'

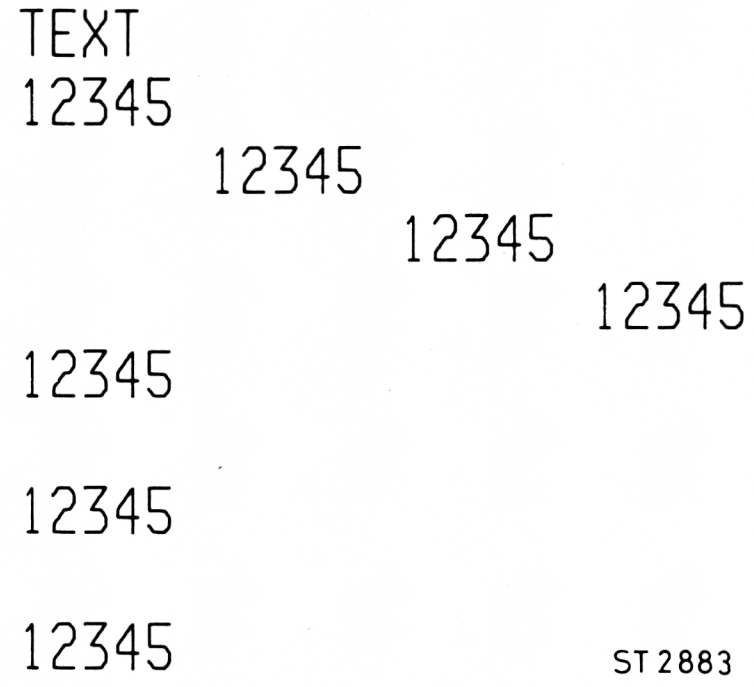


fig. 7.2.4.c.

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7.2.5. Point Mark Plotting

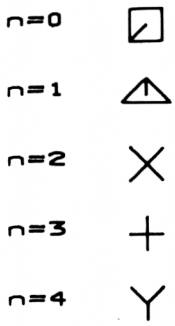
PLOT POINT MARK

Syntax: 4DM [n]

n . . . 0, 1, 2, 3, 4

Purpose: Drawing of marks

Description: On execution of the instruction **PLOT POINT MARK** one of 5 marks (special graphic characters) is drawn.
The current pen postion is the centre of the entire point mark
Shape of point marks



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The pen is lowered implicitly in order to draw.

NOTES: *The contents of the pen status location is not altered by the instruction. Thus the pen status following the execution of the* **PLOT POINT MARK** *instruction is identical to the pen status prior to the instruction.*

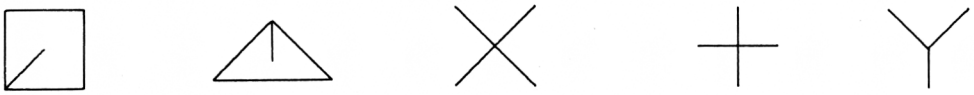
Though the microprocessor controlling system actually treats point marks as text, there is no need to enable Character Plotting.

Because Point Mark Plotting is treated similarily to text, point marks are subject to all transformations valid for character plotting. Thus point marks are of programmable "height", "width", "angle of rotation" and "slant".

PROGRAMMING EXAMPLES OF POINT MARK PLOTTING

Example1. Point Marks with defining parameters as initialised.
Byte string: M0 400/0JM1 JM2JM3JM4 plots:

Example 2. Point Marks with the size defined by the instruction DEFINE SIZE DIRECTION
Byte string: Z200 0 200M0 400/0JM1JM2 JM3 JM4



Example 3. Point Marks rotated and slanted in the same manner as text.
Byte string: Z50 45 50 M0 400/0JM1JZ50 0 50% 1M2JM3JM4

(rotated) (rotated) (slanted) (slanted)

7.2.6. Offset and Window

a) Offscale Data handling

If the application software does not keep track of the current pen position, an attempt is often made to direct the pen to a point outside the physical plotting area. Tracking the current pen position in the host computer program could be most uneconomic, particularly for highly intelligent plotting functions such as circle and arc generation, axes and alphanumerics are extensively used. Consequently, the plotter provides for perfect offscale data handling that obviates the necessity for tracking the current pen position, thus avoiding misleading results and unwanted portions of the plot.

b) Offscale coordinate pairs

These are defined by:

- points outside the physical plotting area
- points outside the currently-defined graphic limits as set by the WINDOW instruction even if they are within the plotting area.

NOTE: It is immaterial whether all the coordinates directly result from transmitted point coordinates (UC) or from internal calculations when intelligent functions are performed.

Some typical cases are listed below (also see fig. 7.2.6.):

- the desired plotting action leads to an end-point outside the physical boundaries or out of the currently-defined graphic limits.
- plotting action starts from a point outside to an end-point inside the physical plotting area or inside the window.
- plotting starts and ends outside with part of the plotter's movement within the limits.
- starting and end points are out of window and no intermediate points are on scale.
- starting and end points are inside the window with part of the plot outside.

The microprocessor continuously tracks the current pen positon (position due to command string execution) and therefore all possible combinations of offscale plotting hardware without any interference.

Whenever a plotting leads to offscale data points the pen is lifted automatically (if down) at the intercept with the mechanical boundary or graphic limit. As soon as on scale data points are reached again plotting is resumed correctly with the pen status as programmed.

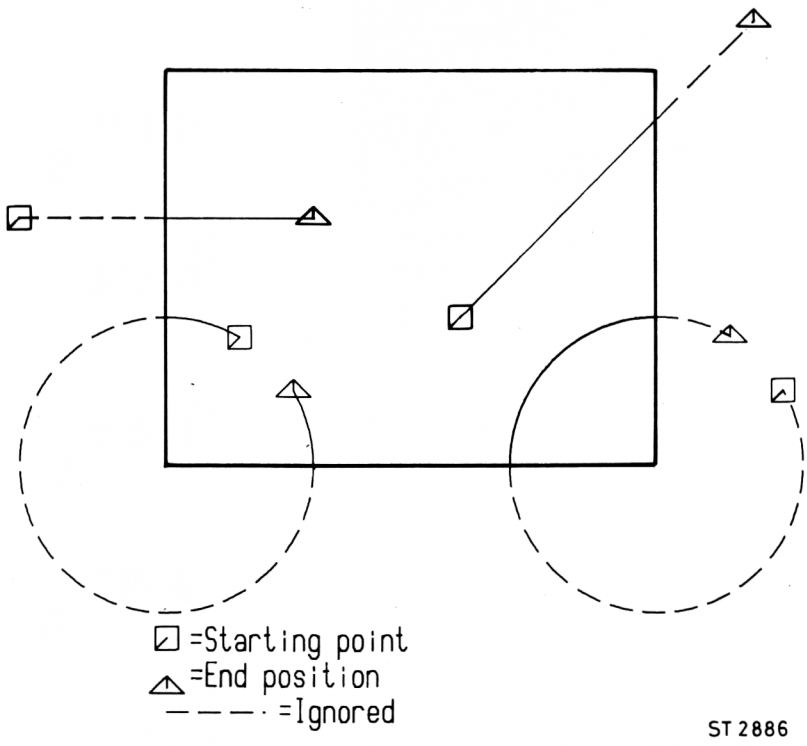


Fig. 7.2.6.

DEFINE WINDOW

Syntax: [57W] Xmin Xmax Ymin Ymax

(Xmin) =0 (Ymin) = 0
(Xmax) = 3380 (Ymax) = 2800

Xmin, Ymin and Xmax, Ymax to be specified with PC

Purpose: To set the graphic limits for window plotting

Description: The instruction **DEFINE WINDOW** sets the graphic limits as a rectangular area with the dimensions (Xmax – Xmin) and (Ymax – Ymin)
The lower left corner of this rectangular area is located at Xmin, Ymin.

DEFINE WINDOW instructs the microprocessor to treat all coordinates with
X < Xmin and X >Xmax

Y < Ymin and Y >Ymax

as "Off scale data"

NOTES:

1 *Xmin, Ymin, Xmax, Ymax must be specified with Plotter coordinates (PC) (multiplies of 0.1 mm with zero at lower left)*

2 *Because window is specified with PC the size and the location of the window is not altered by the local funcitons "SCALE" or "ZERO".*

VERIFY WINDOW

Syntax: [56V]

Purpose: Drawing of a frame according to the graphic limits (see programming example)

Description: An execution of the instruction **VERIFY WINDOW** the pen is lifted at the current position and moved to the postion Xmin, Ymin as defined by the instruction **DEFINE WINDOW**

The pen is implicitly lowered at this point and a rectangular frame is drawn with dimensions according to the **DEFINE WINDOW** instruction.

Following the termination of the frame the pen is lifted again and redirected to the point prior of the **VERIFY WINDOW** instruction.

The frame encloses the drawing area currently defined. All points outside are treated as Off Scale Data.

NOTES: *Following* **VERIFY WINDOW** *the pen status and the contents of the pen status location is implicitly changed to "Pen Up"*

PROGRAMMING EXAMPLE OF WINDOW PLOTTING

In this example the window has been set to Xmin 600 Xmax 1200 Ymin 800 Ymax 1800 and the following byte string has been sent to the Plotter.

Byte string: W600 1200 800 1800H900/1300KI
O200 O300 O400 O500 O600 O700
V

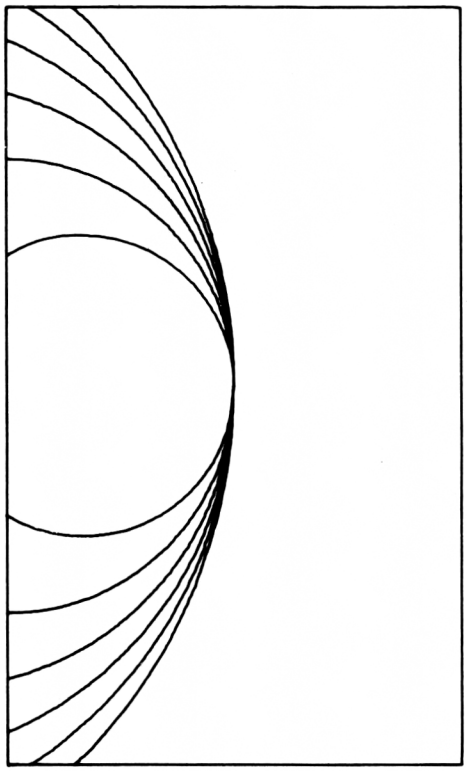


Fig. 7.2.6.a.

OFFSET

Syntax: 4E**N** [x y]

X, Y any valid numeric value

(X Y) =0,0

<n> =0,0

X Y . . . Plotter coordinates

Purpose: Transformation of plotter coordinates (see programming example)

Description: The instruction **OFFSET** shifts the plotter coordinates by an amount as specified by the parameters X and Y.

Offscale data can be shifted into the drawing area by inserting the **OFFSET** instruction.

OFFSET PLOTTING

In this example circles are drawn. First the Plotter is instructed to move the pen out of the window shown. Then the instruction PLOT CIRCLE is transmitted(Radius 3 cm).
Then all Y-coordinates are shifted by 2 cm using the instruction OFFSET. With this method the circle with 2 cm radius is shifted into the window partially if a new instruction PLOT CIRCLE is transmitted (Radius 3 cm)

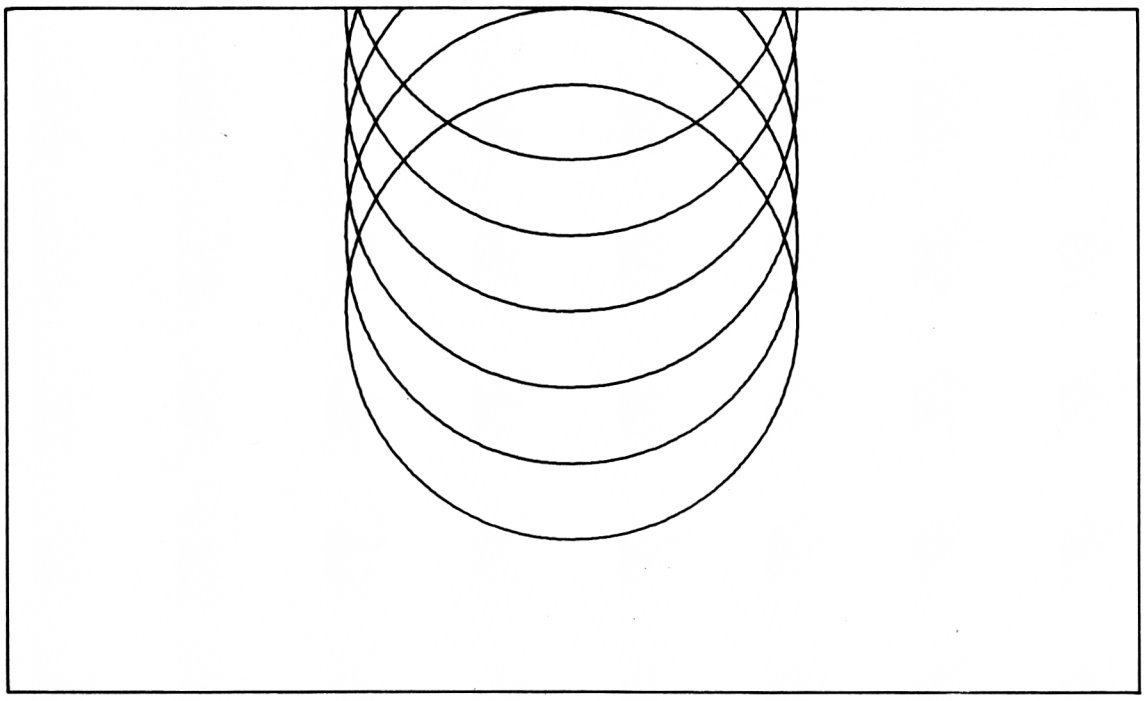


Fig. 7.2.6.b.

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The byte string was:
W300 1800 700 1600
V
1350/1900HKIO300 N0–200IO300 N0–300 IO300
N0–400 IO300 N0–500 IO300 N0–500 IO300
N0 –700 IO300 "(CR)"

NOTE: The first circle was completely outside the window shown

7.2.7. Circles and Axes

PLOT CIRCLE

Syntax: [49 I] 4F O R [a [b]]

R . . . any valid numeric value

a . . . any valid numeric value

b . . . any valid numeric value

(a) = 0 , (b) = 360

Purpose: Drawing of circles and arcs

Description: On execution of the instrumention **PLOT CIRCLE** an arc or a circle is drawn starting at the current pen position.

R . . is the radius of the circle (arc)

a . . is the starting angle of the circle (arc)

b . . is the final angle of the circle (arc)

A circle is drawn, if no values for parameters a, b, have been specified or if (a – b) = 360 or a = b.

The position of the centre of the circle (arc) is defined by the radius R (and the starting angle).

Starting angle and final angle are referred to horizontal. If R has been specified as a positive numeric value the circle (arc) will be drawn counter - clockwise (ccw)

If R has been specified as a negative integer value the circle (arc) will be drawn clockwise (cw).

NOTES: *Although treated as one instruction* **PLOT CIRCLE** *is composed of two instructions* **"I"** *for* **PEN DOWN** *and* **"O"** *for* **PLOT CIRCLE**

The syntax declares the instruction **PEN DOWN** *(ASCII – character "I") as optinal because there is no need for an immediate succession of "I" and "O" in a plot program. Thus these characters (instructions) can be seperated by an unlimited number of other plot instructions – with the exception of* **PEN UP**

Circular interpolation instruction **PLOT CIRCLE**

The firmware routine provides for arc and circle generation with programmable radius (and starting and final angle). With the pen up a circular move is performed (the vector generation: not accessed in this case). Circles and arcs are drawn with the currently defined Line Type.

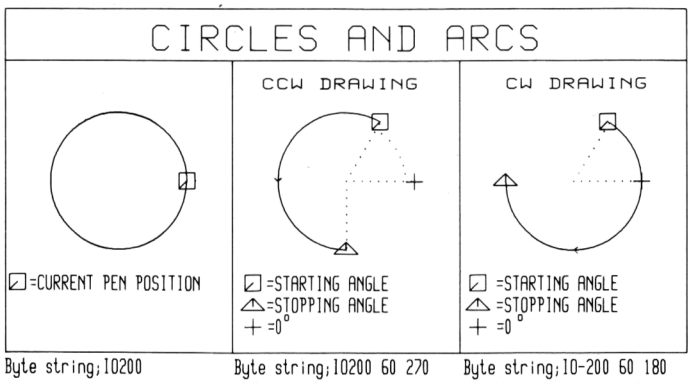


Fig. 7.2.7.

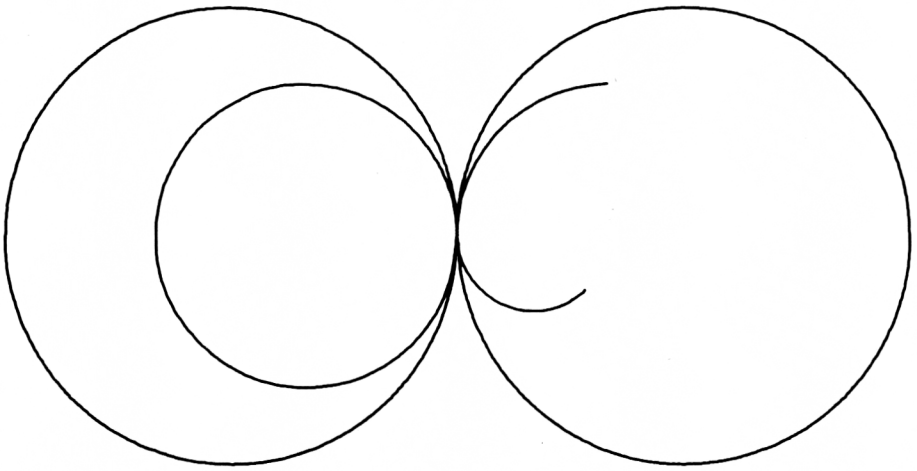
PROGRAMMING EXAMPLE OF CIRCULAR PLOTTING

The figure shown is performed with the plotter using command strings of the instructions **PLOT CIRCLE, RECEIVE COORDINATES, MOVE ABSOLUTE** and **PLOT RELATIVE** observe the spaces.

Example
(59 bytes)

The byte string plotted performs the following action

- Move Absolute to 1400/800
- Circle with R = 3 cm ccw
- Circle with R = 2 cm ccw
- Circle with R = 3 cm ccw
- Arc with R = 2 cm cw, staring at 180° final angle 90°
- Move Absolute to print according to the last instruction Receive Coordinates
- Arc with R = 1 cm, staring at 180°, final angle 315°, ccw
- Pen up



```
Byte string;1400/800HK1030002000-300 180 180
            0-200 180 90HK10100 180 315H
```

Fig. 7.2.7.a.

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X – AXIS

Syntax: $\boxed{{}_{58}X}$ [I [d [t_1 [t_2]]]]

I, d, t_1, t_2 . . . any valid numeric value

(I)	=	3000	<I>	=	last I
(d)	=	100	<d>	=	last d
(t_1)	=	12	<t_1>	=	last t_1
(t_2)	=	–12	<t_2>	=	last t_2

Description:

On receipt of the byte following the instruction X – AXIS the pen is lowered at the current position and an X – AXIS is drawn. The shape of the axis is completely programmable with the help of the parameter list. See programming example at the end of this section.

Description of parameters
I . . . defines the length of the X – Axis

d . . . defines the distance between the tickmarks
d > 0 the X – Axis is drawn from left to right.
d < 0 the X – Axis is drawn from right to left

t_1 . . . length of "first" tickmark
$t_1 > 0$ the first tickmark is drawn up
$t_1 < 0$ the first tickmark is drawn down

t_2 . . . length of "second" tickmark
$t_2 > 0$ the second tickmark is drawn up
$t_2 < 0$ the second tickmark is drawn down

NOTES:

1 *In order to avoid two traces on the same line t_1 and t_2 should show different signs or either t_1 or t_2 should be zero.*

2 *After termination of the instruction* **X – AXIS** *the pen status and the contents of the pen status location is altered to "Pen Up"*

3 *The instruction* **DEFINE LINE TYPE** *does not act upon the instruction* **X – AXIS**

4 *Following the execution of* **X – AXIS** *the line type is altered to line type 0 (continuous line)*

Y – AXIS

Syntax: $\boxed{_{59}Y}[I\ [d\ [t_1\ [t_2\ ]]]]$

I, d, t_1 t_2 . . . . any valid numeric value

(I) = 2000 < I > = last I

(d) = 100 < d > = last d

(t_1) = 12 < t_1 > = last t_1

(t_2) = –12 < t_2 > = last t_2

Purpose: Drawing on Y – AXIS

Description: On receipt of the byte following the instruction **Y – AXIS** the pen is lowered at the current position and an Y – Axis is drawn. The shape of the axis is completely programmable with the help of the parameter list. See programming example at end of section.

Description of parameters

I . . . . . defines the length of the Y – Axis

d. . . . . defines the distance between the tickmarks

d > 0 the Y – Axis is drawn upwards

d < 0 the Y – Axis is drawn downwards

t_1. . . . . length of "first" tickmark

$t_1 > 0$ the first tickmark is drawn to the right

$t_1 < 0$ the first tickmark is drawn to the left

t_2 . . . . . length of "second" tickmark

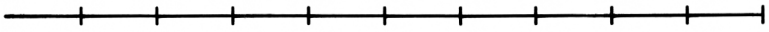
$t_2 > 0$ the second tickmark is drawn to the right

$t_2 < 0$ the second tickmark is drawn to the left

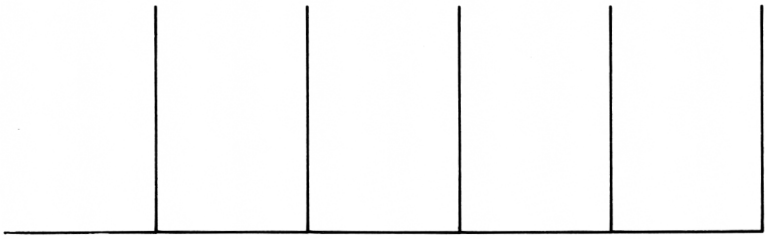
NOTES:

1. *In order to avoid two traces on the same line t_1 and t_2 should show different signs or either t_1 or t_2 should be zero.*
2. *After termination of the instruction* **Y – AXIS** *the pen status and the contents of the pen status location is altered to "Pen Up".*
3. *The instruction* **DEFINE LINE TYPE** *does not act upon the instruction* **Y – AXIS**
4. *Following the execution of* **Y – AXIS** *the line type is altered to line type 0 (continuous line)*

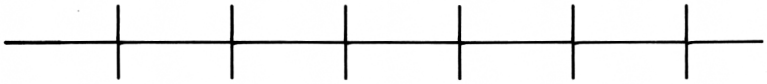
Programming examples of axes and grids using the instructions x-axis and y-axis



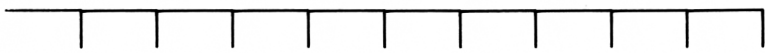
Byte string; X1000 100



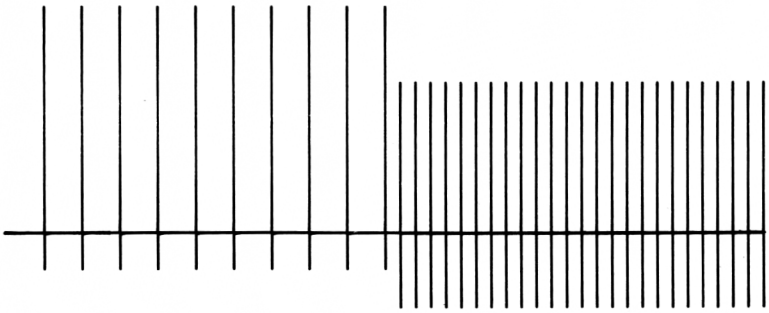
Byte string; X1000 200 300 0



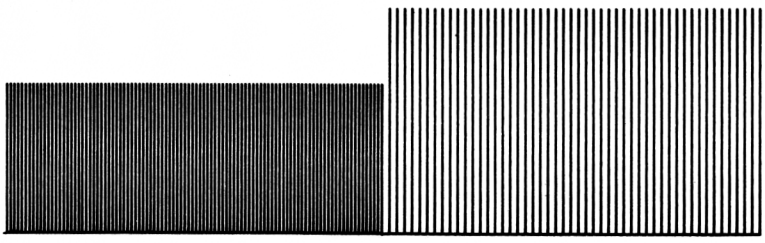
Byte string; X1000 150 50 -50



Byte string; X1000 100 -50 0



Byte string; X500 50 300 -50 X500 20 200 -100



Byte string; X500 5 200 0 X500 10 300 0

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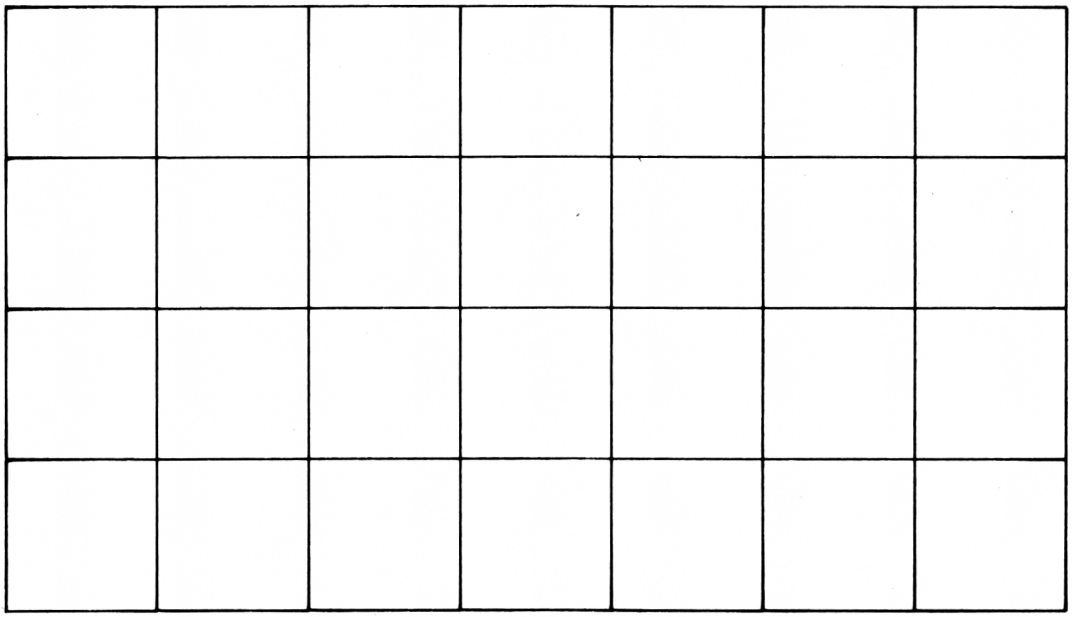
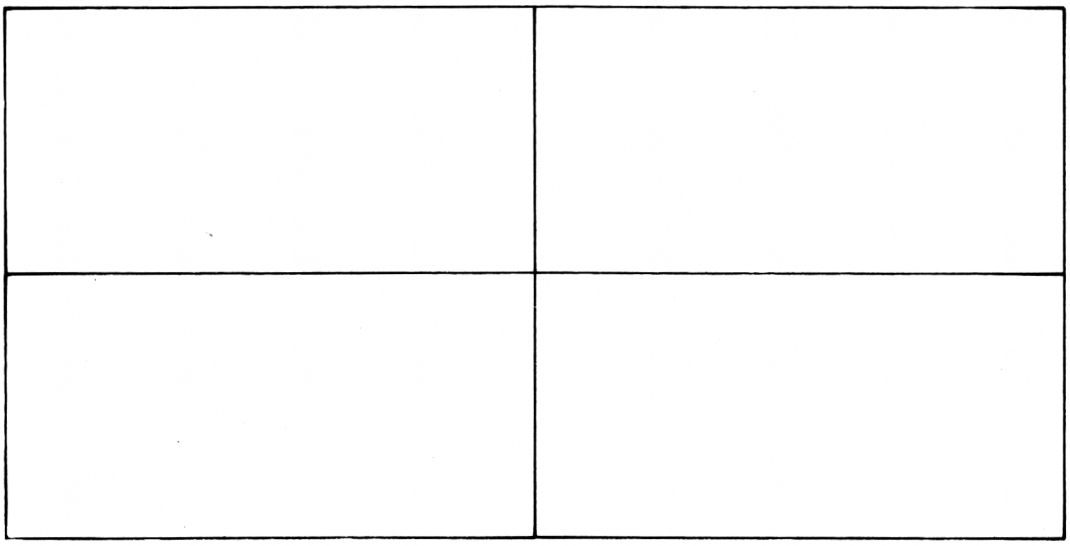
Fig. 7.2.7b.



Byte string;X1400 200 800 0KY800 200 1400 0



Byte string;X1400 700 700 0KY700 350 1400 0

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Fig. 7.2.7C.

7.2.8. Incremental Plotting

Although incremental plotting accesses the vector generator, it is treated separately to avoid confusion.
Incremental plotting is an additional feature that allows the pen to be raised or lowered in the same manner as an incremental plotter.
The major differences to positioning and to vector plotting are:

- Incremental moves are restricted to eight different directions,
- Regardless of the pen status all incremental movements follow a straight line.
- The user does not define the end-point by numeric values for a coordinate pair, but encodes the length and direction of the incremental movement by a one byte ASCII character.

INCREMENT ENABLE

Syntax:

$_{44}$D	for small sizes (0 – 7)
$_{54}$T	for big sizes (8 – 15)

Purpose:

The plotter enters the incremental mode of operations to enable plotting or movement from the current pen position to a point, the direction and distance of which is defined by an ASCII character.

Description:

The instructions **INCREMENT ENABLE** cause the microprocessor to treat all following ASCII characters as codes for an incremental plot or for an incremental plot or for an incremental move.

Incremental plotting is performed if the pen is down, incremental movement if it is up.

Incremental plotting and movement is restricted to 8 directions (0 . . . 7) and 16 sizes (0 . . . 15)

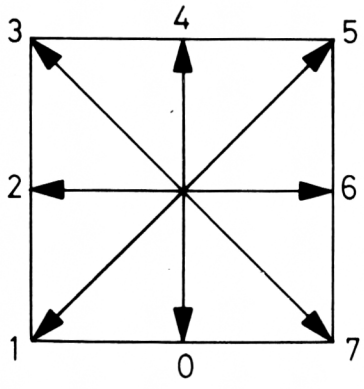
The length of an increment is

(size no + 1) * 0.1 mm	group 1 : sizes 0 – 15
(size no + 1) * √ 2 * 0.1 mm	group 2 : sizes 0 – 15

The mathematical relation ASCII character to size and direction can be written as:

Decimal equivalent of ASCII = 32 + size no + 8 * direction

Coding of directions
Allowed directions are coded as follows



The relation ASCII character to size and direction of the increments can also be seen in the table "Coding of incremental bytes".

TABLE

Coding of incremental bytes

	SIZE	SIZE	DIRECTION ↓ 0	← 2	↑ 4	→ 6	
			02	03	04	05	COLUMN
GROUP1	8	0	SP	0	@	P	
	9	1	!	1	A	Q	
	10	2	"	2	B	R	
	11	3	#	3	C	S	
	12	4	$	4	D	T	
	13	5	%	5	E	U	
	14	6	&	6	F	V	
	15	7	'	7	G	W	
GROUP2	8	0	(	8	H	X	
	9	1	)	9	I	Y	
	10	2	*	:	J	Z	
	11	3	+	;	K	[	
	12	4	,	<	L	\	
	13	5	-	=	M	]	
	14	6	.	>	N	^	
	15	7	/	?	O	_	
			↙ 1	↖ 3	↗ 5	↘ 7	
			DIRECTION				

Fig. 7.2.8.

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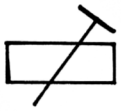
NOTES: *Incremental mode operation does not alter the pen status.*
The incremental byte string must be opened by either the instruction

44 D	*or*	54 T	*and closed by the instruction*	0D CR

Programming example of incremental plotting
The byte string of this example performs the plotting of the symbol for the adjustable resistance. It is assumed that the pen is down. The drawing starts at the current position.



Example of incremental plotting.

In this example increments with size 15 have been used. Thus the incremental step size is 1.6 mm for group 1 and 1.6 x $\sqrt{2}$ for group 2.

The byte string to perform the above symbol was,

GGGGGWWWWWWWWWWWWOOOO? ? ←←←←? ? ////////////OOOOOOOOO
WWWWWWWW''''77777777777777777777

7.2.9. Digitizing

The plotter has the facility to transmit an output of the host computer giving information on the coordinates of the current and/or actual pen position, this facility is known as digitizing and is performed using the digitizing sight. Two different forms of digitizing are available and the instructions to the plotter are DIGITIZE INTERACTIVELY and DIGITIZE IMMEDIATELY.

DIGITIZE INTERACTIVELY

Syntax: 3F?

Purpose: Point digitizing with user interaction

Description: Immediately following the receipt of the instruction **DIGITIZE INTERACTIVELY** the green light "Digitize" goes on (On the keyboard of the plotter).

The user is requested to move the digitize sight (or the pen) to the desired point.

Depressing the button **"SELECT"** causes the microprocessor to transmit the point coordinates of the actual position.

The numeric values transmitted to the computer represent Plotter Coordinates The first value applies to the X-coordinate the second value is the Y-coordinate.
Format of X, Y coordinate values:
1 blank
5 digits for X
1 blank to seperate X and Y
5 digits for Y
"CR" "LF" (see note, page 87)

NOTES: *Numeric values are transmitted without a sign because Plotter coordinates are always positive due to the definition.*
Thus the maximum possible X value is 3380 and 2800 for the Y value.

DIGITIZE IMMEDIATELY

Syntax: 21!

Purpose: Point digitizing without user interaction

Description: Immediately following the receipt of the instruction **DIGITIZE IMMEDIATELY** the microprocessor transmits the point coordinates of the current position.

The current position can be actual – corresponding to the physical position of the pen – or virtual – corresponding to the desired pen position (outside the mechanical boundaries or outside the currently defined window).

The numeric values transmitted to the computer represent user coordinates.
The first value applies to the X-coordinates.
The second value applies to the Y-coordinates.

Format of X, Y coordinates values:
1 blank or – sign
5 digits for X
1 blank or – sign to separate X and Y
5 digits for Y
"CR" "LF"

NOTE: *The end characters "CR" and "LF" are the initialised output terminators and can be changed, when using the V24/RS232C interface, by the instruction SET I/O PARAMETERS.*

In the case of the IEC625/IEEE488 interface, the output terminators are always "CR" and "LF" simultaneously with the second terminator the END message is transmitted.

7.2.10. Options

CHART ADVANCE

Syntax: $_{55}$U n

n . . . 1,2, . . . 64

Note that CHART HOLD must be released to permit chart advance.

Purpose: Paper advance by multiplies of 1 cm

Description: On receipt of the byte following the instruction **CHART ADVANCE** the pen is lifted if it was down and the paper is shifted to the left by n centimetres. The pen status is unaffected.

SPECIAL CHARACTER PLOT ENABLE

Syntax: $_{52}$R

Purpose: Plotting user specified characters

Description: The instruction **SPECIAL CHARACTER PLOT ENABLE** causes the microprocessor to treat all ASCII character following "R" as data.

The correspondence ASCII character — special character is user defined.

Text is written onto the chart as defined by the instructions
DEFINE SIZE DIRECTION
DEFINE CHARACTER SLANT

NOTES: *As a consequence of* **CHARACTER PLOT ENABLE** *the pen status and the contents of the pen status location is altered to "pen up" on termination of character plotting.*

CHARACTER PLOT ENABLE *implicitely changes the line type to n = 0 (continuous line)*

The previous line type is not resumed following the termination of character plotting.

Special character plotting is disabled by the instruction **CHARACTER PLOT DISABLE**

7.3. INSTRUCTIONS FOR THE V24 SERIAL COMMUNICATION INTERFACE

7.3.1. General Information

The Serial Communication interface has excellent hardware and software flexibility to allow for a wide variety of general-purpose applications. As input/output programming largely depends on the hardware configuration of the interface the user is advised to study section 5.4. dealing with the hardware information.

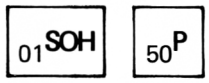
The instructions for this type of interface refer to the following I/0 software features:

- Plotter ON (Addressing)
- Plotter OFF (Cancelling of Address)
- Input buffer control programming
- Formatting of transmitted (X-mitted) data
- Response to received (RCVD) data.

7.3.2. I/O Programming Instructions

The instructions given in this part of the Operating Manual use the same notations as the programming instructions in section 7.2.
At the end of each instruction, examples are given to clarify the use of these command strings and to illustrate effective programming.

PLOTTER ON

Syntax: 

Purpose: To turn the Plotter on logically (Enable command string execution)

Description: If the switch S4/contact 6 labeled "DADR" on the SCI is disabled **PLOTTER ON** instructs the plotter to execute all valid command strings following this instruction.
(Read "DADR" as "permanently addressed")
If the switch S4/contact 6 is enabled the instruction
PLOTTER ON is not effective and does not cause any interference.

NOTES: *Whenever addressing of the plotter with* **PLOTTER ON** *is desired this instruction must precede any other plotter instruction including the instructions outlined in this section.*

Example: Consider the byte string as typed below to be sent to the Plotter with Serial Communication Interface. Switch S4/contact 6 is disabled.

Byte String:
1500/1400KIO 500
"SOH" P
1000/1000KIO300H0/0K

As there is no preceding **PLOTTER ON** instruction, the first line of this byte string is not executed. Thus the pen does not move to position (1500, 1400) and no circle with a radius of 5 cm is drawn.

The bytes in the second line turn the Plotter on and the byte string in Line 3 of this example is executed. The pen moves to position (1000/1000) then a circle with a radius of 3 cm is performed and finally the pen is directed to the origin.

PLOTTER OFF

Syntax:

03 ETX

Purpose: To turn off the Plotter logically

Description: If the switch S4/contact 6 marked "DADR" on SCI is disabled and command string execution has been enabled by **PLOTTER ON** the instruction **PLOTTER OFF** suspends the execution of subsequent plotter instructions.

Any sequence of ASCII characters making up valid command strings following the instruction **PLOTTER ON** and preceding the instruction **PLOTTER OFF** is processed and executed.

Example: Consider the following configuration:
The Plotter is equipped with a serial interface set to Current loop. The switch S4/contact 6 is disabled.

The Plotter is electrically in series with some other terminal (e.g. VDU). It is intended that one interface within the driving unit (it must be current loop active) should support both terminal devices – the Plotter and the Video Display Unit (VDU).

The hardware configuration is outlined in the figure below

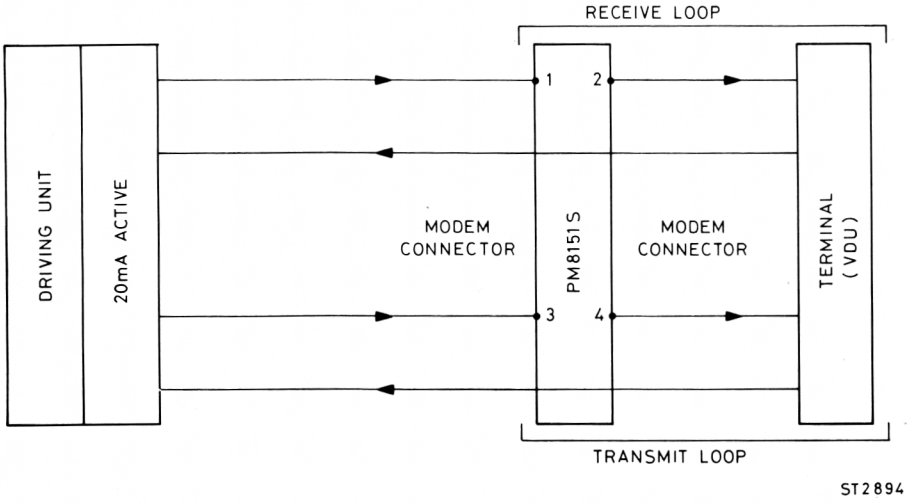


Fig. 7.2.8.a.

Two data terminal devices sharing one interface of driving system (20mA current loop active).

The byte string as listed is sent from the driving unit.

TWO DATA TERMINAL DEVICES SHARE ONE INTERFACE
"SOH" P IHIH
"ETX"
XKXK

Explanation: The Plotter and the terminal receive the same byte string. But the Plotter ignores the first line of the string, executes the second line performing PEN DOWN, PEN UP, PEN UP, PEN DOWN and again ignores the bytes of the 4th line (no X - axes are drawn).
The terminal prints all printing ASCII characters of the above string.

REQUEST BUFFER STATUS

Syntax: Programmable

Purpose: To get Plotter output on buffer filling state on request

Description: The syntax of the instruction **REQUEST BUFFER STATUS** is programmed with the instruction **SET I/O PARAMETERS**

If no instruction **SET I/O PARAMETERS** has been included in the users program, information on the buffer status is obtained by performing the instruction **REQUEST BUFFER STATUS** with

11 DC1

Thus if a different character is desired to perform the instruction **REQUEST BUFFER STATUS** it must be programmed by **SET I/O PARAMETERS.**

On receipt of the instruction **REQUEST BUFFER STATUS** the Plotter X mitts the Buffer Status Character on request as defined by the parameters BS2F of the instruction **SET I/O PARAMETERS. Please refer to the following pages.**

NOTES: *If the Plotter has been initialised in an offline configuration it ignores the instruction* **REQUEST BUFFER STATUS.**

The plotter detects the offline configuration if lead 20 "Data terminal Ready" on the offline connector is high.

It also detects offline configuration if the switch S4/contact 1 marked "OFF" has been disabled. This is independent of the voltage level present on lead 20.

Due to this behaviour it is possible to record the plot data of an "on line" program, (using the instruction **REQUEST BUFFER STATUS)** *and to run it in an offline configuration. This is particularily valuable in the case of a* **SET I/O PARAMETERS** *instruction not allowing the standard (default) device control characters (i.e. DC_1 and DC_3) for X on and X off.*

SET I/O PARAMETERS

Syntax: 26& List of 9 optional parameters

List of parameters in consecutive order

1	BUFR	Request Buffer Status	
2	TRIG	Output Trigger Character	
3	TURN	Turn Around Delay	
4	OUTT2	2nd Output Terminator	
5	OUTT1	1st Output Terminator	
6	BS1E	Buffer Empty Status Character	with automatic buffer status
7	BS1F	Buffer Full Status Character	message enable
8	BS2E	Buffer Empty Status Character	on request
9	BS2F	Buffer Full Status Character	

The parameters BUFR, TRIG, and OUTT2, OUTT1, BS1E, BS1F, BS2E, BS2F must be specified as the **decimal** equivalent of the ASCII characters desired. (see table page108)

The parameter TURN must be specified as an integer number and represents milliseconds of delay. The possible delay is restriced to $0 \leqslant \tau \leqslant 255$ [m sec]
Decimal equivalent 0 disables the entire character and the Turn Around Delay is 0 [m sec] (Decimal 0 does not define the ASCII character "NUL")

Initialised values (decimal equivalent and milliseconds resp.)

Parameter	Meaning	Configuration	
		MODEM	TERMINAL
BUFR	Request Buffer Status Character	$_{17}$DC1	NONE
TRIG	Output Trigger Character	NONE	NONE
TURN	Turn Around Delay	10	10
OUTT2	2nd Output Terminator	$_{10}$LF	$_{10}$LF
OUTT1	1st Output Terminator	$_{13}$CR	$_{13}$CR
BS1E	Automatic Buffer Status Character; Buffer empty	$_{13}$CR	$_{17}$DC1
BS1F	Automatic Buffer Status Character; Buffer full	$_{26}$SUB	$_{19}$DC3
BS2E	Buffer Status Character on request; Buffer empty	$_{01}$SOH	$_{01}$SOH *Note: BUFR = 0*
BS2F	Buffer Status Character on request; Buffer full	$_{26}$SUB	$_{26}$SUB

The initialised values of parameters depend on the configuration of switches S4/contact 5 labelled "KAUT" (read: Automatic Buffer Status Message disabled) and S4/contact 1 (labled "OFF") and on the voltage level of pin 20 ("Data Terminal Ready")

If switch S4/contact 1 labelled "OFF" has been disabled the Terminal parameters are initialised independent of the voltage at pin 20 ("Data Terminal Ready") of the TERMINAL connector.

If switch S4/contact 1 labelled "OFF" has been disabled the Terminal parameters are initialised independent of the voltage at pin 20 ("Data Terminal Ready") of the TERMINAL connector.

Purpose:

To define the input Buffer control charcter, Buffer Status messaged and I/O formatting.

Description:

The instruction **SET I/O PARAMETERS** defines a variety of ASCII characters for plotter input and output. Plotter output data (X mitted data) can be coordinates and/or Buffer status messages.

Plotter input data are instructions and command strings as described in section 7.2. and in this section of the Manual. The latter do not act on the drafting itself but only influence the data transfer between the driving unit and the Plotter.

Description of Parameters:

Request Buffer Status Character (BUFR)
This parameter defines the ASCII character to be used as an input buffer status request. On receipt of this ASCII character the Plotter transmits the ASCII characters defined by the parameters BS2E and BS2F for "Buffer empty" and/or "Buffer full" respectively. BUFR = 0 is equivalent to buffer request not possible.

Output Trigger Character (TRIG)
The instructions **DIGITIZE IMMEDIATELY** and **REQUEST BUFFER STATUS** request plotter output.

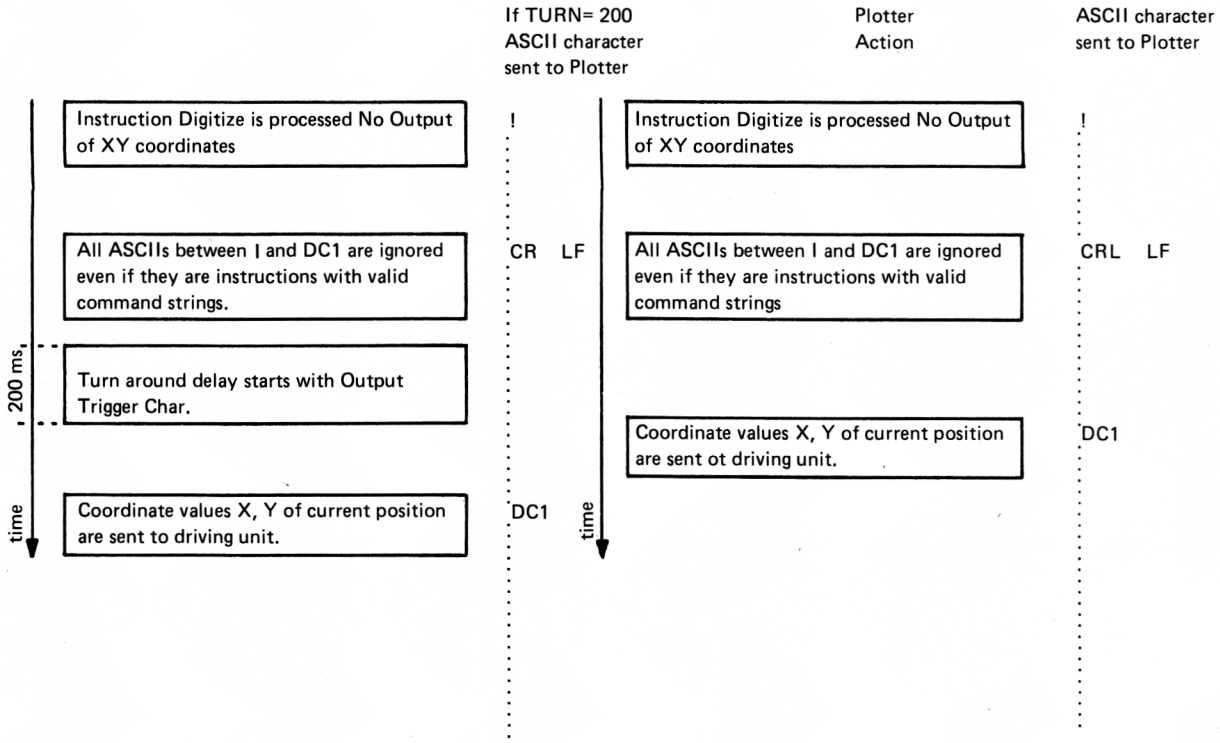
If an Output Trigger Character has been specified by **SET I/O PARAMETERS** the plotter performs the required operation on receipt of this trigger character. The output is forced by this character and enabled by the entire instruction.

The characters following the output instruction and preceding the trigger character are ignored.

The output may be delayed with respect to the Trigger Character by the Turn Around Delay if the parameter TURN has been defined (TURN ≠ 0.)
Refer to the decription of this parameter.

Example:

Assume DC1 has been defined as the Output Trigger Character by the instruction **SET I/O PARAMETERS** and TURN = 0.
The schematic will clarify the situation.



Output Terminators (OUTT2 and OUTT1)

With these parameters two ASCII characters are defined that follow plotter output in order to terminate it. OUTT1 is the first output terminator, OUTT2 is the 2nd terminator (e.g. "CR" "LF")

"Buffer Empty" Status Character (BS1E)
"Buffer Full" Status Character (BS1F)
Automatic messages

These parameters define the ASCII characters associated with the buffer status "FULL" and "EMPTY" if automatic buffer status characters are hardware enabled.

The switch S4/contact 5 on the SCI PC-board must be disabled in this case.
The automatic buffer status messages are also suppressed (by software) if BS1E and BS1F has been specified to 0.

NOTE: The Output Terminators as defined by OUTT1 and OUTT2 will follow the message character.

"Buffer Empty" Status Character (BS2E)
"Buffer Full" Status Character (BS2F)
Requested messages

The only difference to BS1E and BS1F is that these characters are outputted on request only. The Output Terminators OUTT1 and OUTT2 are added.

NOTES: The ASCII character for "Buffer Empty" is sent after the Turn Around Delay is over. Turn Around Delay starts with the Trigger Character if specified. The output terminators are added immediately following the character (without delay).

The ASCII character for "Buffer Full" is sent after the Turn Around Delay is over. The output terminators are added at the moment the buffer underflows again. Thus delay results with a duration strongly dependent on the plot program.

Example: & 17 86 250 66 65 0 0 67 68

Buffer status is requested with $_{11}$ **DC1**

Output Trigger Character is V

Turn Around Delay is 250 milliseconds.

Each output is terminated with A followed by B.

Automatic Buffer Status messages are disabled.

On request with DC1 the plotter sends CAB for
"Buffer Empty" and DAB for "Buffer Full".

7.4. INSTRUCTIONS FOR THE IEC-BUS INTERFACE

7.4.1. General information

The IEC-bus interface permits parallel communication between standard instruments in a system to allow for automatic monitoring of a processor for multi-function measurements. Flexibility is achieved by a combination of both hardware and software facilities. The user is therefore advised to study section 5.5. dealing with the hardware aspects of the IEC-bus interface.

Note that the plotter is designed as a computer output device and not as a data logger for a simple instrumentation system. Therefore, mainly some data formatting and/or processing capability of the system controller is required. Consequently, direct connection to data sources, e.g. digital multimeters, is not possible because of data format incompatibilities.

All plotter commands listed in chapter 7.2 and 7.4.3 are acceptable if the plotter is addressed as listener. The END interface message is ignored when receiving commands.

The FULL and EMPTY state of the input buffer automatically controls the Acceptor Handshake. As many controllers will generate a Handshake time–out if the Handshake is hold to long, the use of Service Request for buffer control is advised.

After a digitize command (?or !) and when addressed as Talker, the plotter sends the coordinates as defined previously. Terminator 1 is alsways "CR" and Terminator 2 is always "LF". The END message is transmitted together with Terminator 2.

Serial and Parallel Poll are carried out as defined in IEC 625/IEEE 488, the mask being set by I/O programming instructions.

BITS						ATN=1		ATN=1		ATN=1		ATN=1		ATN=1		ATN=1		ATN=1		ATN=1
			b7→	0			0			0		0		1		1		1		1	
			b6→	0			0			1	MLA MY LISTEN ADDRESS	1	MLA	0	MTA MY TALK ADDRESS	0	MTA	1	MSA	1	MSA
			b5→	0			1			0		1		0		1		0		1	
b4	b3	b2	b1	column→ row↓	0		1		2		3		4		5		6		7	
0	0	0	0	0	NUL		DLE		SP	0	0	16	@	0	P	16	`	NOT USED IN PM8151	p	NOT USED IN PM8151
0	0	0	1	1	SOH	GTL	DC1	LLO	!	1	1	17	A	1	Q	17	a		q	
0	0	1	0	2	STX		DC2		"	2	2	18	B	2	R	18	b		r	
0	0	1	1	3	ETX		DC3		#	3	3	19	C	3	S	19	c		s	
0	1	0	0	4	EOT	SDC	DC4	DCL	$	4	4	20	D	4	T	20	d		t	
0	1	0	1	5	ENQ	PPC	NAK	PPU	%	5	5	21	E	5	U	21	e		u	
0	1	1	0	6	ACK		SYN		&	6	6	22	F	6	V	22	f		v	
0	1	1	1	7	BEL		ETB		'	7	7	23	G	7	W	23	g		w	
1	0	0	0	8	BS		CAN	SPE	(	8	8	24	H	8	X	24	h		x	
1	0	0	1	9	HT		EM	SPD	)	9	9	25	I	9	Y	25	i		y	
1	0	1	0	10	LF		SUB		*	10	:	26	J	10	Z	26	j		z	
1	0	1	1	11	VT		ESC		+	11	;	27	K	11	[	27	k		{	
1	1	0	0	12	FF		FS		,	12	<	28	L	12	\	28	l		|	
1	1	0	1	13	CR		GS		-	13	=	29	M	13	]	29	m		}	
1	1	1	0	14	SO		RS		.	14	>	30	N	14	^	30	n		~	
1	1	1	1	15	SI		US		/	15	?	UNL	O	15	_	UNT	o		DEL	

MNEMONIC	FUNCTION
GTL	GO TO LOCAL
LLO	LOCAL LOCKOUT
SDC	SELECTED DEVICE CLEAR
DCL	DEVICE CLEAR
SPE	SERIAL POLL ENABLE
SPD	SERIAL POLL DISABLE
UNL	UNLISTEN
UNT	UNTALK
PPU	PARALLEL POLL UNCONFIGURE
PPC	PARALLEL POLL CONFIGURE

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Fig. 7.4.1.

7.4.2 Interface Function Repertoire

(in accordance with IEC 625/IEEE 488)

Interface Function	Symbol	Ident.	Explanation
Source Handshake	SH	SH1	
Acceptor Handshake	AH	AH1	
Talker Function	T	T6	(not extended)
Listener Function	L	L3	(not extended) only hardware switchable mode.
Service Request	SR	SR1	The PM 8151B is capable of sending a Service Request.
Device Clear	DC	DC1	Plotter has carried out actual command and has stopped. Buffer cleared of initial values.
Parallel Poll	PP	PP1 or PP2	Hardware switchable

7.4.3 Programming instructions

Input/output programming enables the plotter to send and receive data and provides the following facilities:

- Addressing (Listener and Talker)
- Plotter status control via serial poll and/or parallel poll
- Stopping plotter action and clearing the interface.

At the end of each instruction, examples are given to clarify the use of the particular command string and to show effective programming.

LISTENER ADDRESS

Syntax: Controller function as defined by IEC 625/IEEE 488 - requires Controller Interface Functions C1 and C28.
Alternatively, local function by switch selection.

Purpose: To enable the PLOTTER to receive command strings.

Description: If switch S1 contact no 6 labelled "LON" is closed, the plotter is permanently enabled as Listener, the address switches and addressing by the Controller being ignored.

If the switch is open, the plotter address can be selected by the address switches labelled "A1" and "A5" (see Section 5.5.1)

When the plotter is addressed as Listener, the LED labelled "ADR" is lit and data on the bus are interpreted as plotter commands.

Notes:

1) Addressing of the plotter as Listener **must precede** any plotter commands. Once addressed as I istener, the plotter will begin the Acceptor Handshake.
2) Unaddressing is accomplished by the Interface Messages "Unlisten" or "Interface Clear" or the plotter's Talk Address (not possible in Listen-Only-Mode).

3) It is strongly recommended to unaddress the plotter when other data transfers on the bus will take place in order to avoid random plotting and slowing down the Handshake when the buffer enters the FULL state.

4) Switching the plotter to "LOCAL" by the front panel switch. PLOT **does not** stop the interface acting as Listener!

5) The use of the Listen-Only-Mode should be avoided because of the effects described above and because the Talker function is permanently disabled, effectively inhibiting the Digitize and Serial Poll capabilities.

6) The switches "LON" and "A1" to "A5" must be set properly **before** the plotter is powered up, as they are sensed by the Microcomputer in the initialization procedure only.

Example:

Assume that the address switches have been set to address 1 (i.e. "A1" is closed, and "A2" to "A5" are open). The plotter can be addressed by the Controller (i.e. Switch LON is open), and has been powered up immediately before the plotter commands are set out:

```
1500/1400KIO500
LAD 1
1000/1000KIO300H0/0K
UNL
300/700IK
```

The first line of this example is not accepted by the plotter. Line two puts the plotter into the Listener Addressed State, and now the next line is executed, resulting in plotting a circle and then returning to the origin of the UC system. The fourth line disables the plotter: thus the fifth line is not accepted.

Note that if the string is sent when the front panel switch PLOT is at LOCAL, the command is executed as soon as the switch is put back to REMOTE - the interface is unaffected by this switch!

TALKER ADDRESS

Syntax:

Controller function as defined by IEEE 488/IEC 625 - requires Controller Interface Functions C1 and C28.

Purpose:

Enables the PLOTTER to send coordinate data in response to a Digitize command or to send the status byte in a Serial Poll (see SERIAL POLL).

Discription:

If the switch labelled "LON" is open, the plotter address can be selected by the address switches "A1" to "A5".
(see Section 5.5.1).

When the plotter is addressed as Talker, the LED labelled "ADR" is lit and data will be sent to the bus by Source Handshake, when available internally.

If the switch labelled "LON" is closed (i.e. Listen-Only-Mode), no Talker Addresses will be accepted, effectively inhibiting the Digitize and Serial Poll capabilities.

Notes:

1) Coordinate data must not be inputted (i.e. Addressing the plotter as Talker) before a Digitize Command has been sent out. In general, this will lead to unpredictable data output by the plotter, and possibly a "bus hangup" if the Controller cannot process the data.
2) The status byte is always available in a Serial Poll.
3) Unaddressing is accomplished by the Interface Messages "Untalk" or "Interface Clear" or the plotter's Listen Address or another device's Address at any time.
4) There is no queue for coordinate data within the plotter. Thus a sequence of Digitize commands without permitting the plotter to talk will result in loss of all data except the most recent .
5) The switches "LON" and "A1" to "A5" must be set properly **before** the plotter is powered up, as they are sensed by the microcomputer in the initialization procedure only.
6) It is strongly recommended to keep to the command sequence outlined in the following example, which is both the simplest and logically correct. Deviations from this command sequence may lead to "bus hangup" or unpredictable results.

Example:

Assume that the address switches have been set to address 1 (i.e. "A1" is closed and "A2" to "A5" are open). The plotter can be addressed by the Controller (i.e. switch LON is open) and has been powered up immediately before the plotter command string is sent out.

.
.
.

LAD 1

.
.
. any number of plotter commands
.

2000/2000HK !

TAD 1

LAD 1 (or **UNT** or **TADX** as required)

.
.
.

The plotter is first addressed as Listener in order to receive plotter commands. Finally, the plotter moves to UC 2000/2000 and processes the Immediate Digitize command (!), preparing to send the coordinate pair.

Then the plotter is addressed as Talker. This may happen while the plotter is still executing previous commands without ill effects.

When:

- the coordinate data are ready and
- the plotter is addressed as Talker
- any Listener on the bus starts Acceptor Handshake, and transmits the coordinate data on the bus in the format:

{"SP" / –} 99999 {"SP" / –} 99999 "CR" "LF" + EOI

X–coo., 5 digits

Y–coo., 5 digits

"SP" is space for positive integers

– is minus for negative integers.

Note:

It is the task of the listening device to accept and process the coordinate data properly!

Finally, the plotter is unaddressed as Talker, which stops the output of the plotter immediately, whether or not it has arrived at the natural end. Do not attempt to resume outputting by readdressing the plotter as Talker, as this may result in unpredictable results! The correct solution is to repeat the whole sequence as outlined in this example.

SERVICE REQUEST MASK

Syntax:

53**S** [n]

n ... 0, 1, 2, ... 63

(n) = 0

<n> = 0

Purpose:

To set mask for Service Request, which indicates a special condition of the plotter.

Description:

Each bit set in the mask to 1 enables the corresponding status register bit (see SERIAL POLL) to generate the Interface Message SRQ.

S without parameter resets the mask to zero and cancels the SRQ.
In all other cases, SRQ is reset by a SERIAL POLL.

Notes:

1) To process SRQ, Controller Interface Function C4 is required.
2) WARNING: A "race condition" exists, if the "Buffer Empty" bit is selected (e.g. S16) and the Controller responds to SRQ by interrupt. While plotter commands are output, which are quickly executed (including S16 self!), at the end of each plotter command the buffer becomes empty for short time. This causes the SRQ message to be asserted while further commands are still being transmitted over the bus. Therefore, the Controller **should not** respond too quickly to SRQ.

Examples:

1) S 20
   enables the conditions
   – Buffer Empty
     and/or
   – Data available
   to cause on SRQ Message.
2) S
   disables all conditions and cancels the SRQ without a Serial Poll Sequence.

SERIAL POLL

Syntax: Controller Function as defined by IEC 625/IEEE 488 - requires Controller Interface Functions C1 and C28.

Purpose: To read the status register of the plotter and clear SRQ if set.

Description:

The plotter status register is made up as follows:

Bit No	Decimal value if set	Contents	Explanation
7	128	0	
6	64	RQS	Requested Service Message. Set if SRQ has been given by the plotter.
5	32	FO	Format Overflow. Set if the Plotter is in OFFSCALE position
4	16	BE	Buffer Empty. Set if input buffer is empty.
3	8	BH	Buffer High. Set when input buffer exceed 600 bytes.
2	4	DA	Data Available. Set when output data is available. Reset when the END message is sent.
1	2	BL	Buffer Low. Set when input buffer drop below 100 bytes.
0	1	0	

Notes:

1) A Serial Poll may be made whether SRQ is given or not. In any case, the Serial Poll returns the contents of the status register and clears the SRQ in the devices polled.

   For smoother operation, the Controllers response to SRQ may often be replaced by performing a Serial Poll periodically and checking the RQS-bits of the devices polled.

2) Serial Poll requires the plotter to be addressed as Talker and is therefore not available when the switch "LON" is closed (i.e. Listen-Only-Mode).

Example: A typical Serial Poll sequence is given. The implementation is largely dependent on the features of the Controller, which are outside the scope of this manual.

UNL (Unlisten)

SPE (Serial Poll Enable)

TAD1 (Talker Address for plotter)

(Controller accepts status byte)

[**TAD X**]
[.]
[.]
[.]
[.]

} eventually further Talker Addresses follow.

UNT (Untalk)

PARALLEL POLL MASK

Syntax: 50P [n]

n ... 0, 1, 2, ... 63

(n) = 0

<n> = 0

Purpose: To set mask for Parallel Poll Response

Description: Each bit set in the mask to "1" enables the corresponding status register bit (see SERIAL POLL) to generate the Local Message "ist" (individual status bit).

P without parameter resets the mask to zero, thereby cancelling the "ist" message.

Note: As only one bit can be transmitted by Parallel Poll (see PARALLEL POLL), the mask should normally be set to enable only one of the Status register bits.

Example: P4
enables the condition Data Available to be checked by Parallel Poll.

PARALLEL POLL – REMOTE CONFIGURATION

Syntax: Controller Function as defined by IEC 625/IEEE 488 - requires Controller interface Functions C1 and C26.

Purpose: To configure the plotter's Parallel Poll Response.

Description: The Controller configures by Interface Messages, how the plotter sends its "ist" (individual status bit) to the bus as Parallel Poll Response.

Notes:

1) The generation of the "ist" is programmed via the PARALLEL POLL MASK.
2) The switch "PP2" must be open to enable remote configuration. This is sensed in the initialization procedure.

Examples:

1) A typical Parallel Poll Configuration sequence is given. The implementation is largely dependent on the features of the Controller, which are outside the scope of this manual.

LAD1	(Listen **A**ddress for plotter)
PPC	(Parallel Poll Configure)
PPE1 0	(Parallel Poll Enable, Sense = 1, PPR on DIO1)
UNL	(Unlisten)

2) To unconfigure (i.e. to disable the Parallel Poll Response), the Controller sends:

PPU	(Parallel Poll Unconfigure)

which is directed to all devices on the bus.

PARALLEL POLL – LOCAL CONFIGURATION

Syntax: Switch selection on the interface p.c.b. (see Section 5.5.1)

Purpose: Local Parallel Poll Enable and PPR configuration.

Description: Used alternatively to remote configuration. The switch "PP2" must be closed, the switches labelled "P1" to "P3" are used to select one of the bus data lines (see PARALLEL POLL).
The Sense bit is always "1".

Notes:

1) Local Parallel Poll Configuration disables remote configuration.
2) The switches are sensed in the initialization procedure only.
3) The generation of the "ist" is programmed via the Parallel Poll Mask.

PARALLEL POLL

Syntax:

Controller Function as defined by IEC 625/IEEE 488 - requires Controller Interface Functions C1 and C26.

Purpose:

To sense the Parallel Poll Responses of the plotter and other bus devices, 1 bit per device.

Description:

The Controller initiates the Parallel Poll by sending the interface messages ATN and IDY simultaneously. The plotter responds immediately without Handshake by sending the appropriate PPR message:

- The message is selected by the bits received in the most recent PPE command or by local switch selection.

P3	P2	P1	Message	DIO line
0	0	0	PPR1	DIO1
0	0	1	PPR2	DIO2
0	1	0	PPR3	DIO3
0	1	1	PPR4	DIO4
1	0	0	PPR5	DIO5
1	0	1	PPR6	DIO6
1	1	0	PPR7	DIO7
1	1	1	PPR8	DIO8

- The PPR message selected is sent true if, and only if the "ist" (individual status - selected by the PARALLEL POLL MASK) is equal to the value of the Sense bit (received as part of the most recent PPE command or equal to 1 in PP2-Mode).

Appropriate reading of the DIO lines and processing of the information is left to the Controller.

Notes:

1) Parallel Poll can be executed, when:
   - the PARALLEL POLL MASK has been selected,
   - the Parallel Poll is configured either by interface messages (REMOTE CONFIGURATION) or by local switch selection (LOCAL CONFIGURATION).
2) Usually, "true" messages are interpreted by the Controller as "1". If this is so and the Sense bit is also set "1", the bit as received by the Controller will be the logical OR of all Status register bits selected by the PARALLEL POLL MASK. A Sense bit of "0" will complement the result.
3) The execution of Parallel Poll does not need Talker Addresses. Thus, Parallel Polling is also possible in Listen-Only-Mode.

DEVICE CLEAR

Syntax: Controller Function as defined by IEC 625/ IEEE 488 - requires Controller Interface Functions C1 and C28.

Purpose: To stop plotter actions.

Description: Terminates current plotter action, clears the input buffer, PEN UP. The addressing state of the plotter is not altered, digitize coordinates will be preserved.

Note: Device clear affects all devices on the bus.

Example: Select a lengthy job, e.g.

LAD1

400/0HK B [all ASCII characters]

DCL (while characters are being plotted)

The action will stop almost immediately. The plotter is ready to receive further plot commands.

SELECTED DEVICE CLEAR

Syntax: Controller Function as defined by IEC 625/IEEE 488 - requires Controller Interface Functions C1 and C28.

Purpose: To stop plotter actions.

Description: See DEVICE CLEAR.

Note: Selected Device Clear affects the plotter only, if addressed as Listener.

Example: Same as outlined in DEVICE CLEAR, except that **DCL** is replaced by **SDC.**

INTERFACE CLEAR

Syntax: Controller Function as defined by IEC 625/IEEE 488 - requires Controller Interface Function C2.

Purpose: To reset all IEC 625/IEEE 488 interface functions on the bus.
Does not reset the individual device functions.

Description: Initializes only the IEC 625/IEEE 488 Interface of the plotter:

- the plotter is unaddressed if not in Listen-Only-Mode,
- the plot commands still present in the plotter's input buffer will continue to be processed.

Example: Select a lengthy job, e.g.:

LAD1

400/0HK B(all ASCII characters)

IFC (while characters are being plotted)

The action will continue and the LED labelled "ADR" will be extinguished.

8. CHECKING CORRECT OPERATION

8.1 SELF TEST

After switch-on a simple self test can be carried out using the three display lamps on the plotter keyboard and checking the following actions during the initialisation.

- First the pen moves to the plotter coordinates 300/500.
- Then the pen moves to a point between pen-depot 1 and 2.
- Subsequently the pen of pen-depot 1 is fetched.
- The pen moves to the origin at the lower left-hand corner (plotter coordinates 0/0) and stops.

Normally after switch-on the POWER lamp should be on, and the OFF SCALE and DIGITIZE lamps should be off.

FAULT CONDITIONS

a) POWER lamp off;
   - no mains supply
   - 5V supply defective
   - lamp defective
   - bad connection of c.p.u. board

b) OFF SCALE lamp on;
   - memory fault on CPU

c) DIGITIZE lamp on;
   - defective connection between interface and CPU
   - interface not selected

8.2 TEST PROGRAMS

Three test programs can be started at the front panel when the switch on the cpu board is set to label test. Proceed as follows to change the position of this switch:

Disconnect the plotter from the mains. Remove the bottom plate just beneeth the front panel.

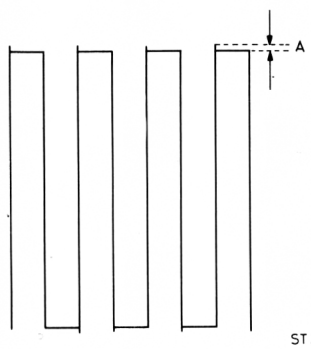
WARNING: The opening of covers or removal of parts, except those to which access can be gained be hand is likely to expose live parts and accessible terminals, which can be dangerous to life.

Connect the Plotter to the mains and Turn Power ON.
Move the Dual in Line Switch on the CPU printed Circuit board to the Label TEST.
Chart in position HOLD, SCALE in position CAL, and PLOT in position REMOTE.

8.2.1 Test program for Y damping

With this program the overshoot of the Y-amplifier can be checked.

- Depress the "SELECT" key
  As long as the key is depressed the plotter will continue drawing as given in the next figure.



The overshoot (A) should be ⩽ 0,3 mm.

Fig. 8.2.1. ST2896

8.2.2 Test program for X damping

With this program the overshoot of the X amplifier can be checked.

– Depress the "ZERO" key

As long as the "ZERO" is depressed the plotter will continue the drawing as given in the next figure.
Check the overshoot (A), this should be ⩽ 0,3 mm.

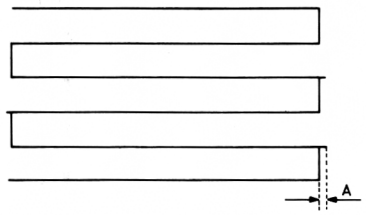


Fig. 8.2.2.

8.2.3 Testprogram for hysteresis check

For this check it is necessary to use a pen with a thickness of 0,3 mm.

– Press the "SCALE" key once.

The plotter will draw a test diagram (fig. 8.2.3.) to check the hysteresis.
No gap may be visible between the two lines (forward and reverse).

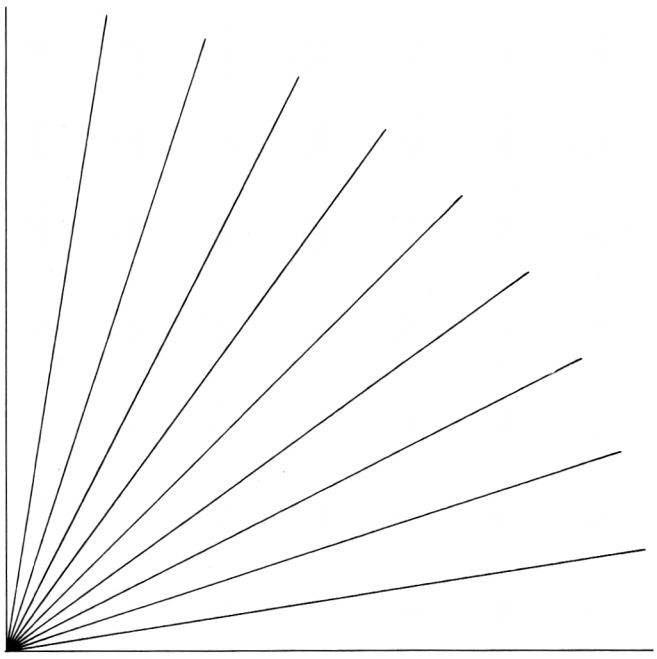


Fig. 8.2.3.

Note: When the charthold switch is set to RELEASE, the plotter moves continuously between 0/0 and 3380/2800 and backwards.

ASCII Character Codes

ASCII Char.	EQUIVALENT FORMS				ASCII Char.	EQUIVALENT FORMS				ASCII Char.	EQUIVALENT FORMS				ASCII Char.	EQUIVALENT FORMS			
	Binary	Octal	Dec	Hex.		Binary	Octal	Dec	Hex.		Binary	Octal	Dec	Hex.		Binary	Octal	Dec	Hex.
NULL	00000000	000	0	0	space	00100000	040	32	20	@	01000000	100	64	40	'	01100000	140	96	60
SOH	00000001	001	1	0	!	00100001	041	33	21	A	01000001	101	65	41	a	01100001	141	97	61
STX	00000010	002	2	0	"	00100010	042	34	22	B	01000010	102	66	47	b	01100010	142	98	62
ETX	00000011	003	3	0	#	00100011	043	35	23	C	01000011	103	67	43	c	01100011	143	99	63
EOT	00000100	004	4	0	$	00100100	044	36	24	D	01000100	104	68	44	d	01100100	144	100	64
ENQ	00000101	005	5	0	%	00100101	045	37	25	E	01000101	105	69	45	e	01100101	145	101	65
ACK	00000110	006	6	0	&	00100110	046	38	26	F	01000110	106	70	46	f	01100110	146	102	66
BELL	00000111	007	7	0	'	00100111	047	39	27	G	01000111	107	71	47	g	01100111	147	103	67
BS	00001000	010	8	0	(	00101000	050	40	28	H	01001000	110	72	48	h	01101000	150	104	68
HTAB	00001001	011	9	0	)	00101001	051	41	29	I	01001001	111	73	49	i	01101001	151	105	69
LF	00001010	012	10	0	*	00101010	052	42	2A	J	01001010	112	74	4A	j	01101010	152	106	6A
VTAB	00001011	013	11	0	+	00101011	053	43	2B	K	01001011	113	75	4B	k	01101011	153	107	6B
FF	00001100	014	12	0	,	00101100	054	44	2C	L	01001100	114	76	4C	l	01101100	154	108	6C
CR	00001101	015	13	0	—	00101101	055	45	2D	M	01001101	115	77	4D	m	01101101	155	109	6D
SO	00001110	016	14	0	.	00101110	056	46	2E	N	01001110	116	78	4E	n	01101110	156	110	6E
SI	00001111	017	15	0	/	00101111	057	47	2F	O	01001111	117	79	4F	o	01101111	157	111	6F
DLE	00010000	020	16	10	∅	00110000	060	48	30	P	01010000	120	80	50	p	01110000	160	112	70
DC_1	00010001	021	17	11	1	00110001	061	49	31	Q	01010001	121	81	51	q	01110001	161	113	71
DC_2	00010010	022	18	12	2	00110010	062	50	32	R	01010010	122	82	52	r	01110010	162	114	72
DC_3	00010011	023	19	13	3	00110011	063	51	33	S	01010011	123	83	53	s	01110011	163	115	73
DC_4	00010100	024	20	14	4	00110100	064	52	34	T	01010100	124	84	54	t	01110100	164	116	74
NAK	00010101	025	21	15	5	00110101	065	53	35	U	01010101	125	85	55	u	01110101	165	117	75
SYNC	00010110	026	22	16	6	00110110	066	54	36	V	01010110	126	86	56	v	01110110	166	118	76
ETB	00010111	270	23	17	7	00110111	067	55	37	W	01010111	127	87	57	w	01110111	167	119	77
CAN	00011000	030	24	18	8	00111000	070	56	38	X	01011000	130	88	58	x	01111000	170	120	78
EM	00011001	031	25	19	9	00111001	071	57	39	Y	01011001	131	89	59	y	01111001	171	121	79
SUB	00011010	032	26	1A	:	00111010	072	58	3A	Z	01011010	132	90	5A	z	01111010	172	122	7A
ESC	00011011	033	27	1B	;	00111011	073	59	3B	[	01011011	133	91	5B	{	01111011	173	123	7B
FS	00011100	034	28	1C	<	00111100	074	60	3C	\	01011100	134	92	5C	¦	01111100	174	124	7C
GS	00011101	035	29	1D	=	00111101	075	61	3D	]	01111101	135	93	5D	}	01111101	175	125	7D
RS	00011110	036	30	1E	>	00111110	076	62	3E	^	01011110	136	94	5E	~	01111110	176	126	7E
US	00011111	037	31	1F	?	00111111	077	63	3F	—	01011111	137	95	5F	DEL	01111111	177	127	7F

9. MAINTENANCE

The maintenance requirements of the PM 8151 have been reduced to the cleaning of the instrument.
Cleaning the frame: Dirt or ink on the text plates can be removed by means of a wet cloth, then wipe it dry with a clean cloth.
Cleaning the chart table: Very persistent dried stains on the chart table can be removed with alcohol, after which it must be dried with a clean cloth.

Positive feedback

Now you are the user of a Philips test and measuring instrument. We trust that it will give you many years of faithful service. But we would like you to realize one thing: we can only supply the best in T & M equipment with **your** help, user.

We need to know what you have found to be the strong and weak points of this instrument; and we would be very interested to hear about any unusual or elegant applications you have devised for it. Some of this information can be passed on to our design and development departments; and some may be fed back to other users via our bimonthly publication **T & M News.**

May we therefore suggest that you fill in the reply card alongside and send it back to us right now. That way, you'll be helping to provide the positive feedback we need to help you!

All contributions that are published will be paid for at current rates; while as an inducement for you to fill in the reply card, we are offering a free subscription to T & M News or a free copy of Part I of our Digital Instrument Course to all who reply.

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Meßgeräte müssen sich in der Praxis bewähren und die in sie gesteckten Erwartungen erfüllen; auch bei Ihnen, dem Besitzer eines Geräts aus der Serie der Philips Test- und Meßgeräte. Wir aber können T & M-Geräte nur zu Ihrer vollen Zufriedenheit herstellen, wenn wir alle Ihre Wünsche kennen.

Deshalb interessiert uns Ihre Meinung über die guten und weniger guten Eigenschaften dieses Gerätes. Außerdem suchen wir Erfahrungen über ungewöhnliche oder neue Anwendungsmöglichkeiten. Vielleicht können Sie unseren Entwicklungs- und Konstruktionsabteilungen einen guten Wink geben; vielleicht können wir Ihre Erfahrungen aber auch in unserer Publikation **Info-dienst** (nur in Deutschland) veröffentlichen, damit auch andere Anwender davon profitieren können.

Deshalb möchten wir Sie bitten, die anhängende Antwortkarte auszufüllen und an uns zurückzusenden. Damit helfen Sie uns, und wir können Ihnen helfen!

Alle veröffentlichten Beiträge werden dem üblichen Tariff entsprechend honoriert. Als Dank für das Ausfüllen der Antwortkarte bieten wir Ihnen ein Freiabonnenment auf Info-dienst (nur in Deutschland) oder ein kostenloses Exemplar von Teil I von unserem Kursus Digital Instrument.

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Nous avons besoin de savoir quels en sont les points forts et les points faibles que vous avez découverts et nous serions très intéressés d'apprendre quelles applications inhabituelles ou élégantes vous lui avez trouvé. Certains de ces renseignements peuvent être transmis utilement à nos bureaux d'études; certains autres peuvent être communiqués à d'autres utilisateurs par l'intermédiaire de notre publication **T & M Informations** (édition française seulement en France).

C'est pourquoi nous vous serions reconnaissants de remplir la carte-réponse à côté et de nous la renvoyer. De cette façon, vous contriburez à nous fournir le "feedback" dont nous avons besoin pour mieux vous servir!

Toutes les réponses publiées seront payées conformément aux tarifs en vigueur; pour vous inciter à remplir la carte-réponse, nous offrons un abonnement gratuit à T & M Informations ou un exemplaire gratuit de la première partie de notre cours sur les instruments numériques à tous ceux qui répondront.

Details of user: **Persönliche Angaben:** **Expéditeur:**

Company/
Firma/Société .....
Department/
Abteilung/Service .....
Street/Straße/Rue .....
Box/Postfach/Boîte Postale .....
City/Stadt/Ville .....
Country/Land/Pays .....
Name/Name/Nom .....
Phone/Telefon/Numéro de téléphone .....

Details of instruments: **Gerätedaten:** **Instrument:**

Name/Name/
Désignation .....
Type number/Typennummer/
Numéro de type .....
Serial number/Serienummer/
Numéro de série .....
Date purchased/Kaufdatum/
Date d'achat .....

What are the main applications for which you use this instrument?
Wofür verwenden Sie dieses Gerät hauptsächlich?
Quelles sont les principales utilisations auxquelles vous affectez cet instrument?

.....
.....

Please, list what you consider to be the **strong points** and the **weak points** of the instrument.
Zählen Sie bitte auf, was Ihrer Meinung nach die **guten Seiten** und was die **schwachen Stellen** dieses Geräts sind.
Veuillez énumérer ce que vous considérez être les **points forts** et les **points faibles** de l'instrument.

.....
.....
.....

Do you have any queries about the use of this instrument? If so, what?
Haben Sie irgendwelche Fragen über die Anwendung dieses Geräts? Wenn ja, welche?
Avez-vous des questions à poser sur l'emploi de l'instrument? Si oui, lesquelles?

.....
.....
.....

I have devised an interesting application for this instrument.
- ☐ I enclose a brief description (up to about 500 words) of this application
- ☐ Please send a representative to collect information about the application

Ich habe einen interessanten Verwendungszweck für dieses Gerät gefunden.
- ☐ Eine kurze Beschreibung hiervon (max. ca. 500 Wörter) erhalten Sie anliegend.
- ☐ Senden Sie bitte jemanden, der sich an Ort und Stelle über den Verwendungszweck informieren kann.

J'ai trouvé une application intéressante pour cet instrument
- ☐ Je joins une brève description (500 mots environ au maximum) de cette application.
- ☐ Veuillez envoyer un représentant à qui nous donnerons des renseignements sur l'application.

- ☐ I would like to receive **T & M News** regularly.
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Test and Measuring Instruments Department
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T & M News is your feedback unit

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One special series that was brought out in supplements to T & M News is our Digital Instrument Course (Part I: Basic binary theory and logic circuits; Part II: Digital counters and timers; Part III: Digital voltmeters and multimeters; Part IV: IEC Bus Interface), which proved so popular with readers that each part of the course has been issued in booklet form.

Info-dienst für Ihren Erfahrungsaustausch

Info-dienst (nur in Deutschland) ist eine Publikation der Philips GmbH Unternehmensbereich für Elektronik für Wissenschaft und Industrie für die jetzigen Besitzer und potentiellen Kunden von Philips T & M-Geräten. Dieses Blatt strebt einen effektieven Informationsaustausch auf dem T & M-Gebiet zwischen Hersteller und Anwender sowie **umgekehrt an.**
Neben diesen **Info-dienst** geben wir auch die **T & M Reports** heraus (nur in englischer Sprache), in denen (im allgemeinen längere) Artikel mehr spezieller bzw. theoretischer Art als Ergänzung zu den Informationen in **Info-dienst** stehen. Diese Reports, an denen in allgemeinen nur Spezialisten interessiert sind, werden an eine begrenzte Anwendergruppe verteilt. Jeder, der daran interessiert ist, kann sie auf Anfrage erhalten.
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P.O. Box 62; Ramna, Dacca; tel. 283332

België/Belgique: Philips and MBLE associates,
Philips Scientific and Industrial Equipment Division;
80 Rue des Deux Gares; 1070 Bruxelles,
tel. (2) 523.00.00

Bolivia: Industrias Bolivianas Philips S.A.,
Cajón Postal 2964. La Paz;
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Brasil: Philips Do Brasil Ltda,
Avenida 9 de Julho 5229; Caixa Postal 8681;
CEP 01407 - Sao Paulo (S.P.);
tel. 2825722
Service Centre:
Sistemas Profissionais
Rua Amador Bueno, 474,
Caixa Postal 3159 - S. Amaro
CEP 04752 - Sto Amara (S.P.);
tel. (11) 2476522

Canada: Philips Test and Measuring Instruments Inc.,
6 Leswyn Road,
Toronto (Ontario) M6A-1K2;
tel. (416) 789-7188

Chile: Philips Chiléna S.A.,
Division Professional, Avda. Santa Maria 0760;
Casilla Postal 2687, Santiago de Chile; tel. 770038

Colombia: Industrias Philips de Columbia S.A.,
Calle 13 no. 51–39, Apartado Aereo 4282,
Bogota; tel. 2600600

Danmark: Philips Elektronik-Systemer A/S,
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Unternehmensbereich Elektronik für
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Ecuador: Philips Ecuador S.A.,
Casilla 343, Quito; tel. 239080

Egypt: Resident Delegate Office of Philips Industries,
5 Sherif Street, Corner Eloui. P.O. Box 1687, Cairo;
tel. 754118/754259/754077.

Eire: Philips Electrical (Ireland) Ltd.
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Ethiopia: Philips Ethiopia (Priv. Ltd. Co.),
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Finland: See Suomi

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Greece: See Hellas

Hellas: Philips S.A. Hellénique,
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S&I Equipment, Shivsagar Estate,
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tel. 662281/5

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Island: Heimilisteaki SF, Saetún 8, Reykjavik;
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Scientific and Industrial Equipment Division;
Horlor Street, P.O. Box 2097,
Naenae, Wellington; tel. 678639

Nigeria: Associated Electronic Products (Nigeria) Ltd.,
Ikorodu Road, P.O.B. 1921, Lagos; tel. 900160/61

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Kirimoto Bldg. 11-2,
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