⊙ Facit 4510
Serial matrix printer

Technical description

SCOPE OF THE MANUAL

This manual describes briefly the operation of the Facit 4510 Serial Matrix Printer and provides detailed information aimed at assisting the user in setting up the printer and using it from a host computer system.

The information in this manual is intended primarily for the systems programmer and for convenience hexadecimal notation is used. The information is not intended for the local printer operator.

The other documents associated with the technical description are:

Facit 4510 Operator Guide   1103 89 14-00
Facit 4510 Service Instruction   1160 82 22-12/8

CONTENTS

1. INTRODUCTION

The Facit 4510 is a versatile 80-column serial matrix printer. It features:

- 128-character constant pitch alphanumeric font (9 x 9) which gives eight 96-character national character sets.

- 128-character high-resolution/proportional pitch alphanumeric font (9 x 15 (max)) giving eight 96-character national sets.

- 64-character block graphic font (12 x 8).

- Pin graphics mode of operation with 1:1 aspect ratio allowing data source to position dots anywhere on the paper.

- 3 carriage speeds allowing variation in length of each character.

- Optimized bidirectional printing, line-oriented.

- Standard serial and parallel interfaces.

- 2K-word input buffer.

- Handles cut forms and roll paper by friction feed and fan-fold paper by tractor feed, all as standard.

- Comprehensive range of user commands for remotely controlling printer operation.

- Operator's control panel for effective local control of printer operation.
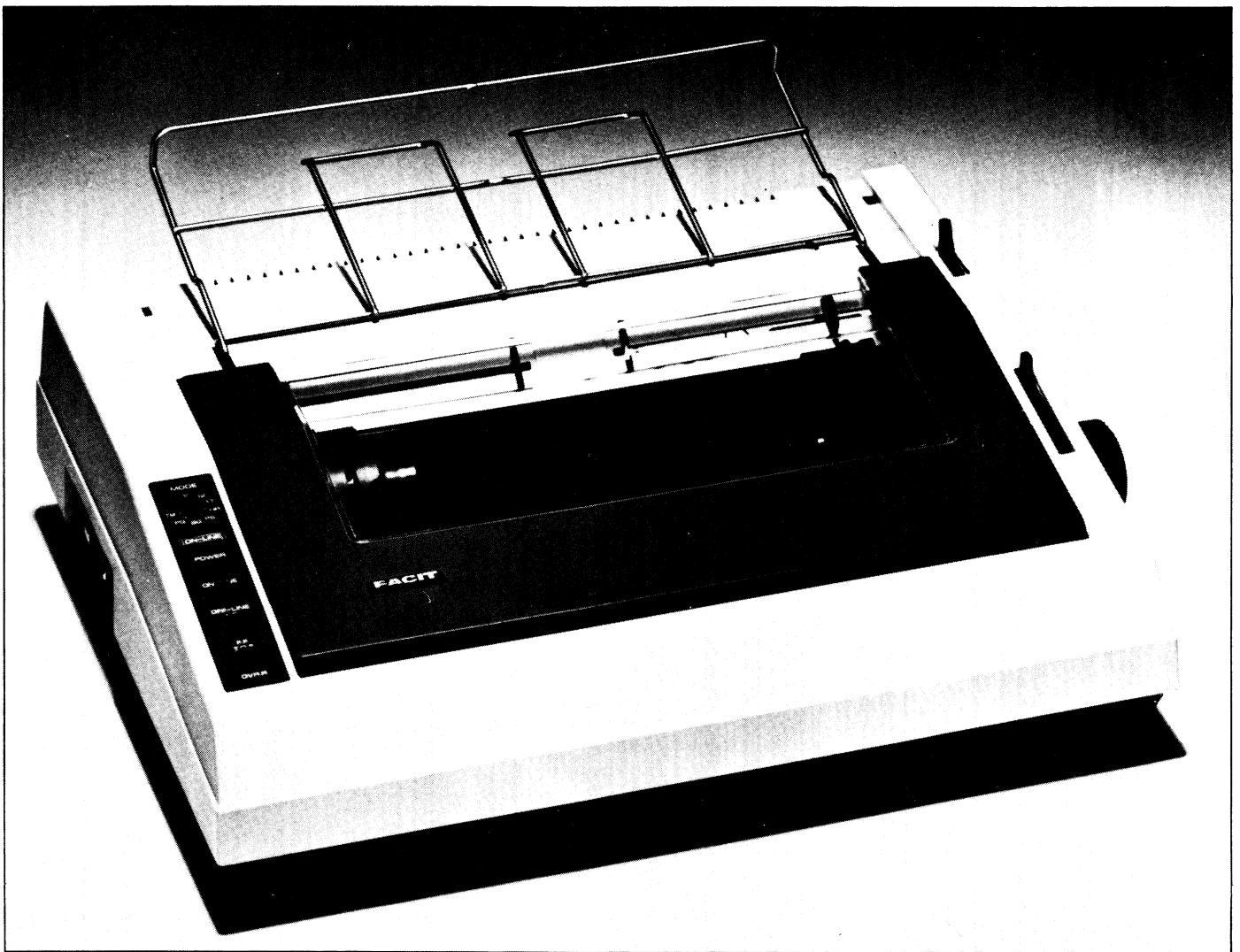
2. DESCRIPTION

2.1 Physical Description

The printer's main components — the Printing and Paper Feed module, the single PCB and the mains transformer are secured directly to the printer base. The printer's top cover fits onto the printer base and is retained by four screws. Incorporated in the top cover are the Operator's Control Panel and a hinged lid which gives access to the paper and the Paper Tractor unit during normal use.

2.1.1 Printing and Paper Feed Module

This module consists of two main permanent parts and one removeable part:

(1)   The print head and carriage assembly which also incorporates the drive for the ribbon cassette. The carriage is mounted on guide bars and is driven from the carriage drive stepping motor by a specially tensioned closed-loop cable. This drive motor is also used to drive the ribbon-cassette. The print head has 9 print-pins and can be easily removed and replaced in the field. Just to the right of the drive motor is a lever which allows adjustment of the head-to-platen distance for optimizing print quality and to simplify paper and ribbon loading.

(2)   The paper feed assembly which is a friction feed device. The platen is driven by the paper feed stepping motor and the friction for paper feeding is applied by sprung pinch rollers under the platen; the platen may be released for tractor feeding and manual alignment by means of the platen release lever. The platen may be removed easily for maintenance and cleaning. Paper is guided round the front of the platen by the paper bail, which has its own release lever at the right hand side. The friction feed assembly will accept individual cut sheets loaded by the operator and roll paper mounted on the removeable paper roll holder.

(3)   The removeable tractor feed unit which simply clips onto the top of the paper feed assembly. A gear wheel on the tractor unit engages with one from the stepping motor to supply drive to the tractor unit. The friction feed must be disengaged by pulling the platen release lever forwards.

Fig. 1 Layout of Printer

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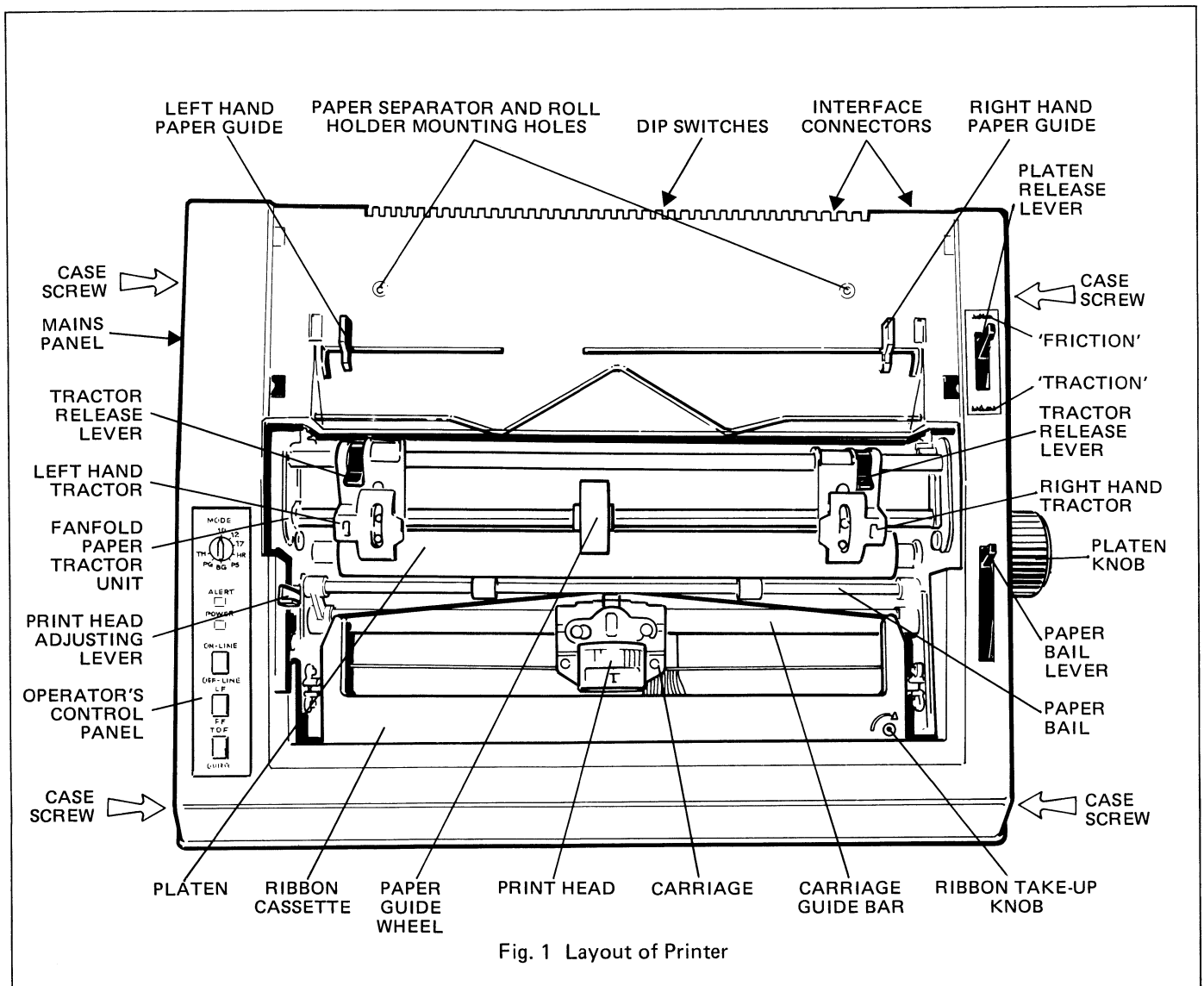
2.1.2 Electronics

All electronic components including rear DIP switches and interface connectors are mounted on a printed circuit board, except for the mains transformer, Mains Panel and Operator's Control Panel. The board is mounted horizontally on the Printer Base and connections are made to remote components (e.g. Control Panel, drive motors and AC power supply) by flying leads which plug onto the board.

The principal functions of the electronics are summarized in fig. 2.

2.2 Functional Description

2.2.1 Overall Operation

When the printer is switched on it will enter the Off-line state and indicate 'Printer Busy' to the data source, (see fig. 3). It will then perform either the power up sequence, or, if the operator held the OVR.R switch down whilst switching on the printer, it will test itself.

In order to print data the operator must set the printer On-line with the ON-LINE switch. The printer will enter the On-line state if there are no faults.

In the On-line state the flow of data to the printer is controlled by the status of the printer's input buffer. When it can accept new data it signals 'Printer Ready' to the data source, but when it can take no further data it signals 'Printer Busy'. In the On-line state the initial mode of printing after power-up is selected by the setting of the MODE rotary switch on the Operator's Control Panel. The modes marked 10, 12, 17, HR, PS and BG are all variations of Character mode (see section 2.2.8). The mode PG is Pin Graphics mode (see section 2.2.9) and TM is Transparency mode (see section 2.2.10). If either Character or Pin Graphics mode is selected, the data source may change between those modes as required (even on one line), but if Transparency mode is selected prior to power-up the printer remains in that mode until switched off and reset by the operator.

In Character and Pin Graphics mode, the printer receives data and commands from the data source and stores them in its input buffer, checking all the time for a valid print command (see section 2.2.12). When one is found the preceding data (from the previous print command to the current one) is processed by the printer in the order received, thus:

(1) In Character mode the printer calculates the least time-consuming combination of printing direction, carriage movement and paper motion for printing the next line. With Block and Pin Graphics this is not necessary since printing is always unidirectional.

(2) All data is printed according to the current printing parameters (i.e. using the current national character set, font, pitch etc., or interpreting the data as pin graphics columns).

(3) All commands are detected and obeyed immediately. This means that any combination of printing possibilities is allowed on a line. Invalid commands are treated as data or ignored.

(4) Where the length of data exceeds the physical line length set for the printer, the data is printed on the next line (and subsequent lines, if necessary). This wrapping is handled automatically by the printer.
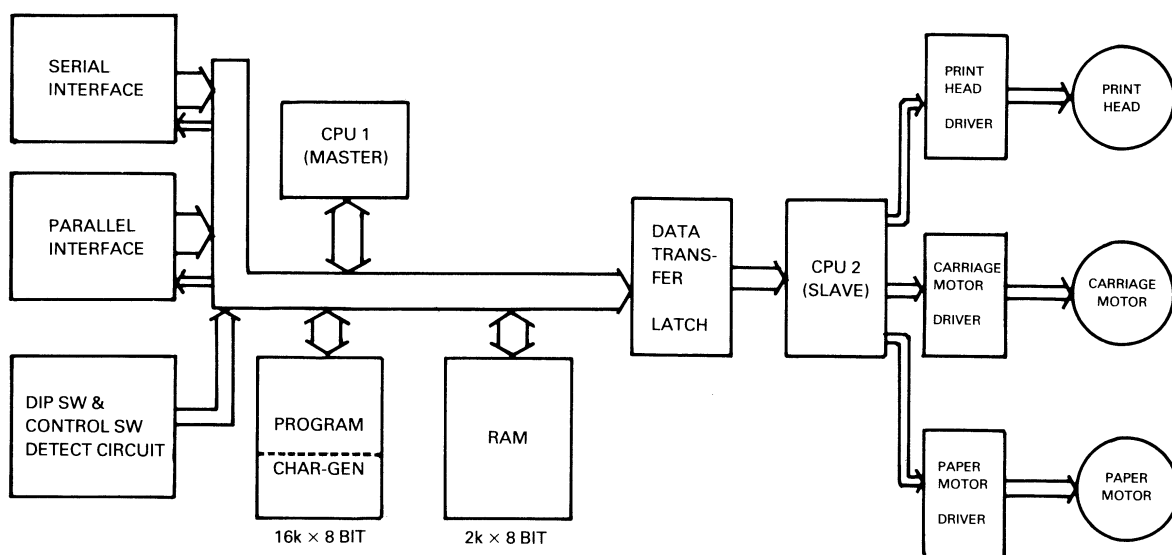
Fig. 2 Functional Block Diagram
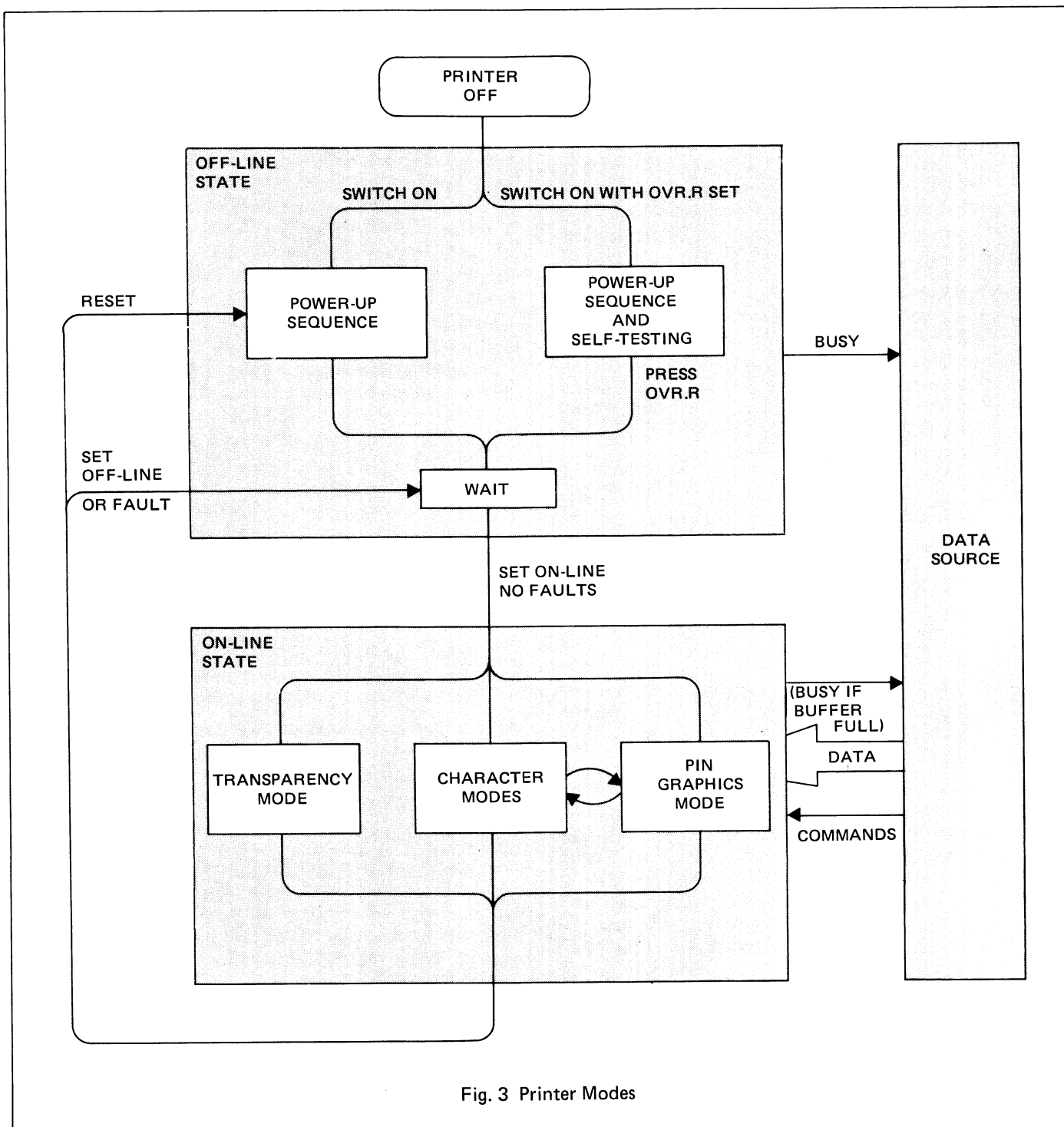
Fig. 3 Printer Modes

The printer will continue in the On-line state until:

(1) The operator sets it into Off-line mode with the OFF-LINE switch.

(2) A fault occurs or paper runs out, when the printer will automatically enter Off-line mode.

(3) The printer is reset to its power-up conditions by the operator or data source.

In Transparency mode, the printer uses only the normal character font for all printing, and treats all incoming codes (even valid commands) as printing data, ignoring all non-printable codes (i.e. control codes) except CR and LF, and ignoring the first character after each ESC code.

The printer will stay On-line in Transparency mode until paper is exhausted (see section 2.2.5) or until it is turned off.

2.2.2 Power-up Sequence

At power-up the printer reads the states of the MODE switch and DIP switches and sets the default values for:

(1) The operating mode: Transparency mode (TM), Pin Graphics mode (PG) or one of the variations of Character mode (normal (10), condensed (12) or compressed (17) standard characters, fixed pitch (HR) or proportional pitch (PS) high resolution characters or standard block graphics characters (BG)).

(2) The national version.

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(3) The I/O interface requirements.

(4) Format details.

Full details of these switches are given in section 9.

On completion of the Power-up sequence the printer waits in the Off-line state until the operator sets the machine On-line.

2.2.3 Self-testing

The Facit 4510 has built-in self-testing facilities which may be initiated by the operator when required. There are three self-testing modes:

(1) Printing self-test. This requires paper to be loaded. The printer is switched on while holding the OVR.R switch depressed until printing starts. The printer's internal logic is tested first (excluding input/output circuits) and if any error (e.g. invalid memory checksum) is found the ERROR/ON LINE LED will flash. If there are no electronic faults the printer will print out a test header:

FACIT 4510 REV: X X X
SW1:X X X X X X X X   SW2:X X X X X X X X

giving the revision number of the program and the current settings of the rear DIP switches. This is then followed by a test print pattern and then the character repertoire is printed continuously. Normal printer operation can be obtained by holding the OVR.R switch down until the current line has been printed and then setting it On-line.

(2) Non-printing self-test. This is identical to the printing self-test (including carriage and paper motion) but the print-pins are not activated, so it is used automatically if paper is not loaded.

(3) Loop-back self-test. This test is identical to the previous self-testing (printing or non-printing being determined by the presence or lack of paper in the printer) but in addition tests the input/output interface. To do this a test connector must be fitted to the serial interface connector so that pins 2 (Data Out) and 3 (Data In) are connected. To initiate this test the operator must hold both the OVR.R and FF switches depressed while switching on. On completion of the test the printer will print out the selected data rate followed by OK if successful and NG if not, e.g.
4800 BPS OK or 4800 BPS NG
The test should be terminated by switching off, removing the test connector and refitting the normal interface connector.

2.2.4 Off-line State

When the printer is Off-line, its status to the data source is 'Busy'. It will still accept data from the host provided there is room in the input buffer. The Off-line state is indicated by the ERROR/ON-LINE indicator being not lit. Entry to the Off-line state caused by the Paper End condition is a special case (see section 2.2.5).

When the printer is Off-line all the controls on the control panel are functional (except during Paper End).

2.2.5 Paper End

When the end of the paper is sensed by the printer it will record all further paper movement and will go to the 'Paper

End' condition when the end of the paper is about 20 mm from the printing position. The 'Paper End' condition sets the printer Off-line (printing ceases at the end of the line) and the ERROR/ON-LINE indicator flashing. In this state the OVR.R and ON-LINE switches have the special functions which allow printing of data in the buffer to be continued before renewing the paper.

(1) **Print Next Line** One more line of text may be printed by depressing and releasing the OVR.R switch. The ERROR/ON-LINE indicator is extinguished while the line is printed (i.e. the printer remains Off-line and hence 'Busy'). This may be repeated until the end of the paper or until the buffer is empty when no further action is possible without replacing the paper.

(2) **Print to End of Paper** If the OVR.R switch is held depressed printing continues until the end of the paper, the buffer is empty or the switch is released. During the printing the ERROR/ON-LINE indicator will be extinguished (the printer will remain Off-line and 'Busy').

(3) **Print to End of Paper with Printer On-line** To allow the printer to accept more data from the source whilst printing, the OVR.R and ON-LINE switches should be held depressed, the ERROR/ON-LINE indicator will light to show that the printer is On-line (and hence capable of accepting data subject to the buffer having sufficient capacity). Printing will be resumed until the end of the paper is reached or the switches are released. The ERROR/ON-LINE lamp will then flash to indicate that the paper must be replaced.

Paper is then loaded as described in the Operator Guide and printing is resumed by pressing the ON-LINE switch. The ERROR/ON-LINE indicator will light to indicate that the printer is On-line.

2.2.6 On-line State

When the printer is On-line (ERROR/ON-LINE lit steadily) it can accept data all the time that there is room in the input buffer, and it will react to all recognised commands sent from the data source in the same order that they were received. When the input buffer becomes full the printer remains On-line but signals 'Busy' to the data source (buffer status is discussed in section 2.2.7).

In the On-line state, only the OFF-LINE switch is operative. All other switches on the control panel are ignored.

2.2.7 Buffer Handling

The printer is fitted with an approximately 2K input buffer which can accept data at line speeds (up to 9600 bps). The printer then extracts and processes the data at printing speed, storing printing data in the 160 byte print buffer.

The capacity of the input buffer at any time controls the Ready/Busy status of the printer; the points at which the status changes are at 140 characters from each end of the buffer, thus:

(1) When the buffer has room for only 140 characters left, Busy is signalled. This allows room for at least one more line of data before the data source must stop transmission.

(2) When the buffer has only 140 characters left in it Ready is signalled. In this 'empty' condition the buffer

still contains approximately one line of characters ready for printing.

2.2.8 Character Mode

Character mode is used for printing characters which are stored in the character generator PROM(s) in the printer. There is a choice of basic, high-resolution and block graphic characters (described more fully in section 4) and national variations of character set can be handled automatically by the printer. The basic set may be printed at any of the 3 available carriage speeds (resolutions) giving normal (10 cpi), condensed (12 cpi) and compressed (nominally 17 cpi) characters. The high resolution set is used only at the slowest character speed (for maximum resolution) but may be used to produce fixed pitch (10 cpi) or proportional pitch (10 to 20 cpi) characters. The basic graphics set can also be printed with three different resolutions to give enlarged (7.5 cpi), standard (9 cpi) and condensed (12.5 cpi).

In Character mode, the user can select which combination of character set and carriage speed (font) is required and then send ASCII codes which are printed in the chosen style. Fonts can be changed as often as the user wishes by sending the appropriate commands. Where particular fonts are often used, they can be assigned the special Shift In and Shift Out commands which allow font changing with minimum command overhead.

When using Character mode, the user has a wide range of carriage and paper motion control functions available on command (see section 6).

2.2.9 Pin Graphics Mode

In Pin Graphics mode the data source has direct control over the upper 7 print-pins in the print head. Each print-pin is associated with one bit of the 7-bit data word transmitted to the printer. A 1 in the word means that the print-pin is activated and a dot is printed; a 0 means no dot. In Pin Graphics mode only a limited set of carriage and paper motion commands are available (see section 7).

2.2.10 Transparency Mode

The printer may be set to act as a conventional "dumb" printer by entering Transparency mode. In this mode it prints only with the basic 9 x 9 character matrix at the fastest carriage speed and responds only to CR and LF commands (all control codes except CR and LF are ignored, and so is the first character after each ESC). Selection of Transparency mode is only possible by the operator before power on (using the rotary switch) and exit can only be made by switching off the printer and resetting the switch.

2.2.11 Minimum-Time-to-Print Algorithm

For lines of text that are to be printed entirely in Character mode, printing is performed bidirectionally and a minimum-time-to-print algorithm is used to calculate the quickest way to print the next line from the position of the carriage when printing of the current line is finished.

2.2.12 Valid Print Commands

The printer will produce printed characters from the data in the input buffer only when a valid print command has been received, when all data up to and including the print command is printed (or obeyed, if command data). Valid print commands are:

(1)   From the host
        Line terminator (CR, LF, VT, FF, soft reset)
        Backspace (BS)
        Local linefeeds
        Carriage speed change

(2)   From the printer (internally)
        Print buffer overflow
        Line overflow (wrapping)

Note that the printed output is always line-oriented and lines are delimited only by line terminators. Intermediate print commands simply cause different parts of the line to be printed out at different times.

3. PAPER HANDLING

The printer is fitted with a friction feed mechanism for handling roll paper and cut sheets, and has a removeable tractor feed unit for fanfold paper. A single lever is used to change from one type of feed to the other.

3.1 Tractor Feed

The printer is supplied with the tractor feed unit in place, but the operator may easily remove and replace the unit whenever required (full details are given in the Operator Guide). The paper tractors may be adjusted to handle paper from 4 inches to 11 inches total width. High positional accuracy of printing can be ensured by feeding paper forwards only.

3.2 Friction Feed

The friction feed mechanism is fitted permanently to the printer. It can accept cut sheets fed in and positioned by the operator or roll paper mounted on a detachable external support.

Paper may be fed forwards or backwards by any amount but where high positional accuracy is required backwards movement should not exceed 12 inches.

When cut sheets are loaded by the operator, the paper may be positioned using the paper advance knob without affecting the VFU.

3.3 Vertical Format Unit (VFU)

The printer incorporates an electronic VFU which allows the user to set the Top of Form position, up to 32 vertical tab stops and the total format length. By default, the printer sets vertical tab stops every 1 inch in a format whose length is set at 8, 8½, 11 or 12 inches by the DIP switches SW1/3 and 4. All vertical formatting is done in increments of 1/6 inch independent of the currently selected line feed size.

The Top of Form position is set as the current paper position at power-up but may be reset by the operator. When the paper has been loaded, it is positioned so that the desired TOF in the paper is aligned with the footline indicator. The SET TOF switch on the control panel is then operated to register this position in the printer.

The default value of format length may be changed by the data source to any value between 1/3 inch and $15\,^2/_3$ inches in 1/6 inch increments.

Vertical tab stops are changed from the data source. The first stop is set relative to the TOF, and all subsequent stops are set relative to the preceding stop. Vertical tab stops are stored in the printer as absolute distances (in 1/6 inch increments) from the TOF (see fig. 4).

Between the forms there is usually a blank zone to ensure that printing does not occur over the perforation on fan fold paper. The data source may specify the size of blank zone (measured backwards from the TOF position) which the printer will always skip when printing. Its size may vary from zero (no skip zone, i.e. continuous printing) up to one line less than the format length (giving a format which consists of just one line of text). The default value for skip zone is set using DIP switches SW 1/6 and 7.

3.4 Horizontal Formatting

Horizontal formatting (absolute positioning) is carried out in increments of one character depending on the font currently in use (in terms of the space character where the high resolution proportional font is in use) for Character mode (see section 6.4) and in terms of the dot resolution in use for Pin Graphics mode (see section 7.2) and Character mode.

The size of the left margin is determined by the operator; paper is loaded with its left hand edge set the required distance from the carriage home position (indicated by 0 on the paper bail ruler). Horizontal tab stops are fixed at 1 inch intervals from the home position.

The size of the right margin (and the position of the point at which text is wrapped) is determined by the data source and is expressed as a distance (in 1/10 inch increments) left of the right margin (40th or 80th column depending on default setting). Thus the data source must ensure that the wrapping point occurs within the width of paper in use.

The carriage is always homed (set to column 0) at the top of each form. If the carriage registration is disturbed at any time (e.g. is moved by the operator) the ERROR lamp will flash and registration can be reset by pressing the OVR.R switch.

Fig. 4 Paper Formatting
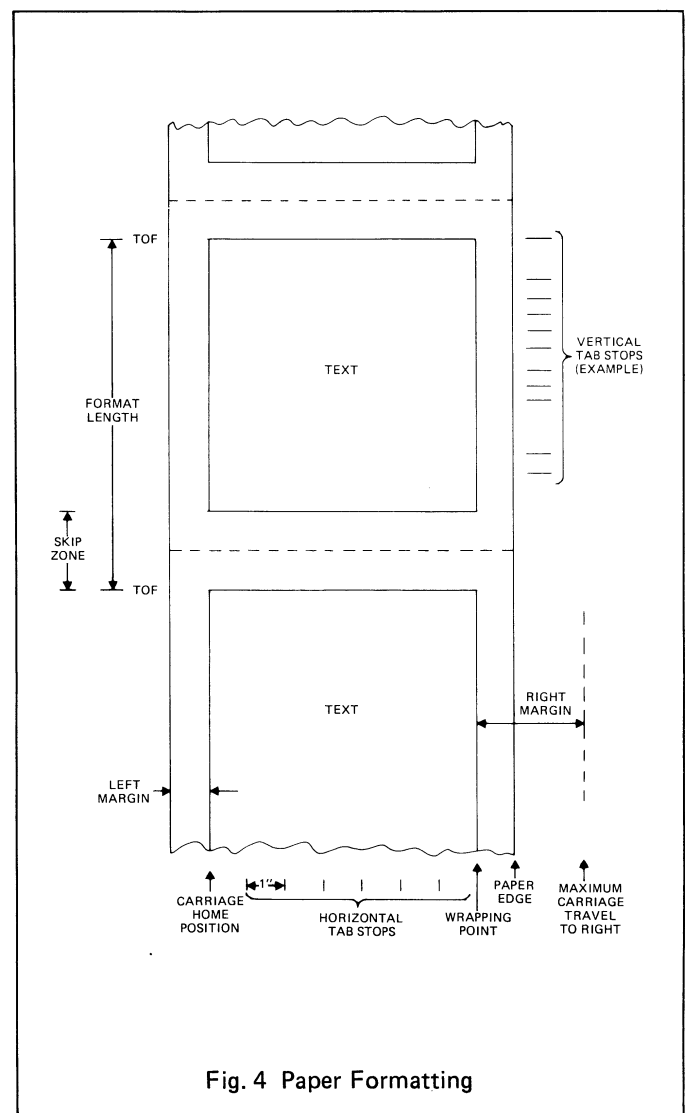
4. CHARACTER MODE

When the printer is in Character mode the data source sends character codes which are buffered by the printer until a complete line of characters is received. The printer then converts each character code into a dot pattern (obtained from the selected character generator PROM) and then prints out the entire line, one dot column at a time, either forwards or backwards depending on the outcome of the minimum-time-to-print calculation (see section 2.2.11).

Factors which influence the final appearance of the printed line are:

(1) The selected character set which determines the types of characters to be printed (see sections 6.1 and 6.3).

(2) The carriage speed. Three speeds are possible for standard and block graphics characters, slower speeds giving narrower characters. Note that changing the carriage speed has little affect on the number of characters printed per second, since the dot printing frequency is virtually constant. High resolution characters are always printed with the lowest carriage speed.

(3) The selected line feed size: at 6 lines per inch lines have a clear space between them, but at 8 lines per inch the bottom of one line touches the top of the next. With block graphics printing the line feed size is fixed at 6 lines per inch to ensure that matrixes touch vertically to allow continuous lines.
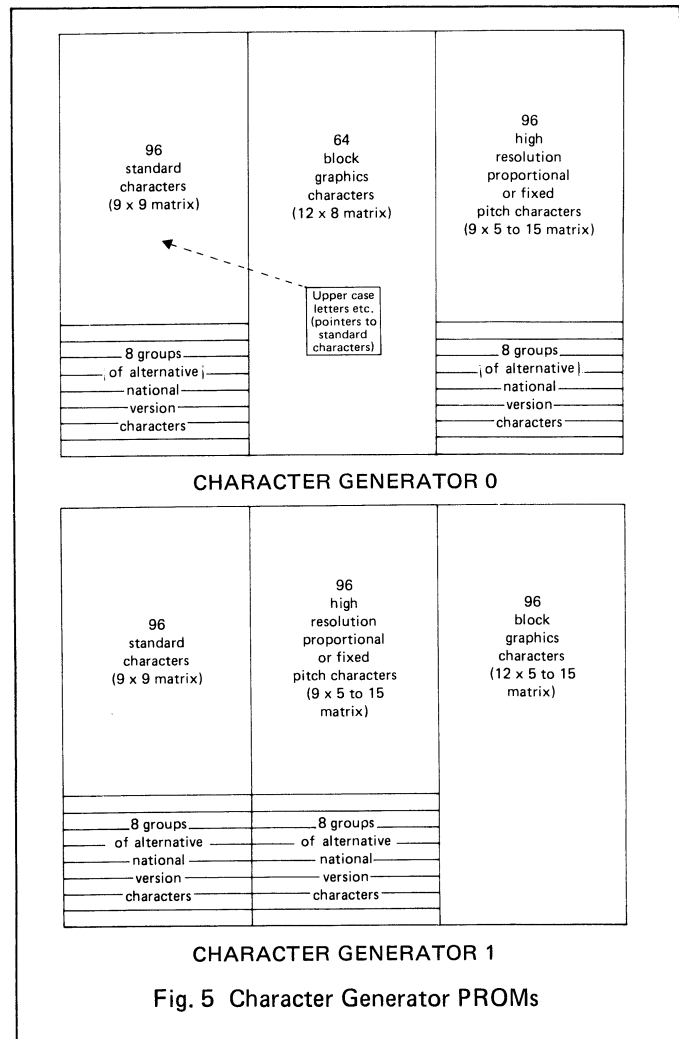
(4) Whether enlarged or underlined characters have been selected (see section 6.4).

(5) Whether constant or proportional character pitch is selected with high resolution characters (see section 6.3).

Although the printer only commences printing when it receives a valid print command (see section 2.2.12) this does not mean that all the preceding data will be printed on one line. The printer takes note of the location of the right hand margin on the paper and wraps the transmitted line of characters onto as many lines on the paper as is necessary. This point is particularly important when using block graphics since unplanned wrapping of graphical data can result in an unintelligible printout.

4.1 Character Generator PROMs

The printer incorporates one character generator PROM as standard (CHGEN 0) and has one optional character generator PROM (CHGEN 1). Each PROM contains 3 character sets as shown in fig. 5.

4.2 Standard Character Matrix (9 x 9)

The 128 standard characters (96 ASCII + national variations) are defined in a 9 x 9 matrix with full-dot resolution vertically and half-dot resolution horizontally (although there must always be at least one blank position between dots horizontally, because although the carriage can be placed at any half-dot position, individual print-hammers cannot print at less than full-dot spacing). The characters are shown in Appendix 1. The characters are printed on a line with 3 half-dot spaces after each character. The vertical separation depends on the currently selected line-feed size; at 6 lpi, the interline spacing is 3 full-dots (see fig. 6a), but at 8 lpi there is no clear space between the 9 x 9 matrixes (see fig. 6b), thus line separation relies entirely on space built into the matrix.

Fig. 5 Character Generator PROMs

Fig. 6 9 x 9 Matrix Interline Spacing
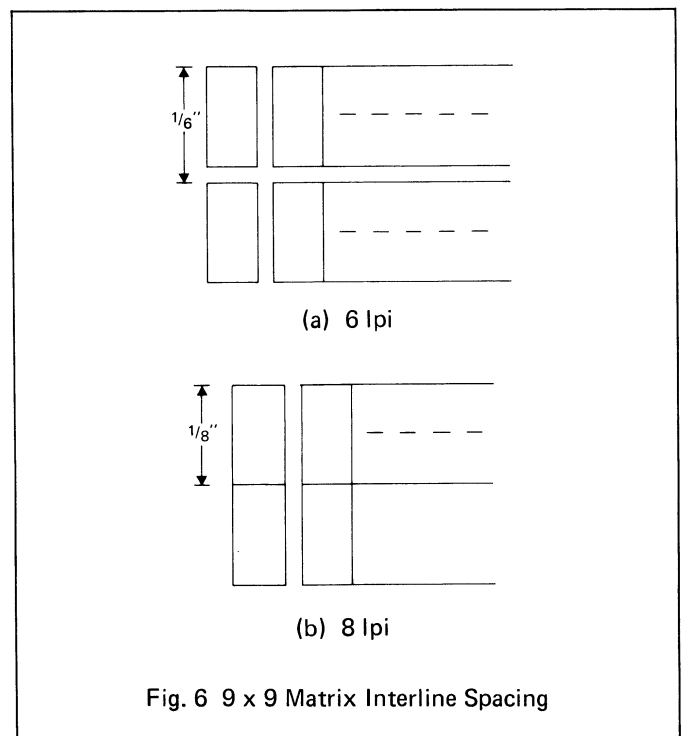
The appearance of the printed character is determined by the carriage speed selected (since the print-hammer frequency is constant). The fastest carriage speed is selected for normal printing, the two slower speeds giving condensed and compressed printing (see figs. 7a, b, c).

Fig. 7 9 x 9 Character Matrix
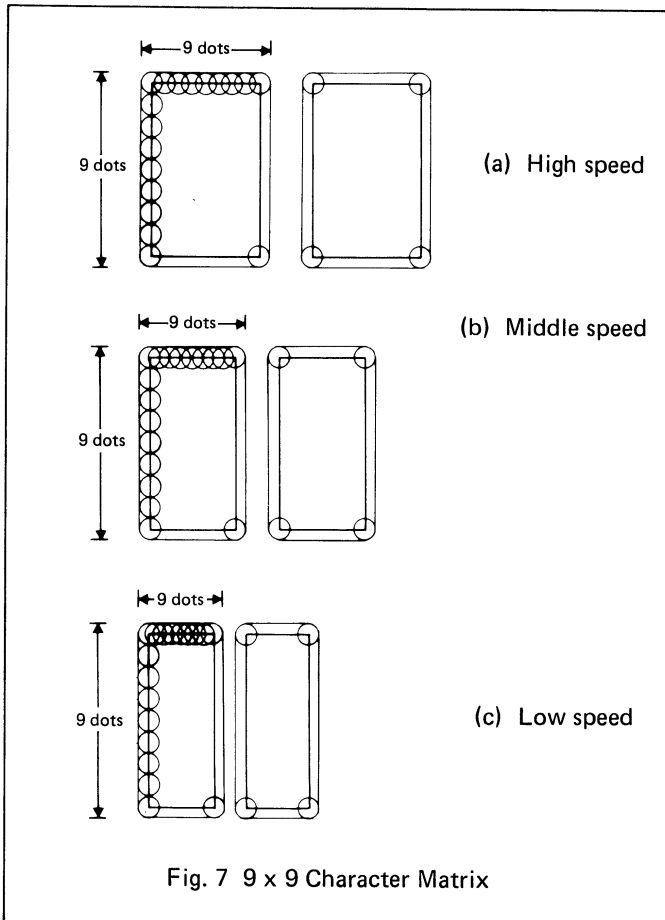
4.3 Standard Block Graphics Character Matrix (12 x 8)

The 64 block graphic characters (see Appendix 2) are defined in a 12 x 8 matrix with full-dot resolution in both directions. The characters are printed on a line with no intercharacter space allowing the production of continuous lines horizontally. Each line of characters is printed in two stages:

(1) The top 8 rows of the line are printed first using the upper 8 print-pins, followed by an 8-dot line feed.

(2) The bottom 4 rows of the line are then printed using the upper 4 print-pins. If there are no dots in these rows, then no carriage movement occurs. Finally there is a 4-dot line feed.

There is no spacing between consecutive lines of graphics characters, thus continuous vertical and sloping lines may be produced, and printing is unidirectional to ensure high accuracy.

Included in the block graphics set is a series of upper case letters and associated symbols (with national variations) which are formed in the same width matrix as the block graphics characters. Use of these characters within graphical constructions, rather than switching to another font, will ensure continued alignment of subsequent block graphics characters.

The carriage speed affects the appearance of the graphics characters. The middle speed is selected as the normal speed since at this speed the character matrix is square (giving an equal dot overlap horizontally and vertically). The faster speed gives enlarged (20% elongated) characters and the slower speed gives condensed characters (fig. 8 shows the appearance of the characters). All the graphical symbols are built up of 4 x 4 dot squares in a 3 x 2 matrix superimposed on the 12 x 8 basic matrix (see fig. 8d).

(a) Enlarged   (b) Standard

(c) Condensed

(d) Example of use of standard block graphics

Fig. 8 Block Graphics Characters (12 x 8 Matrix)
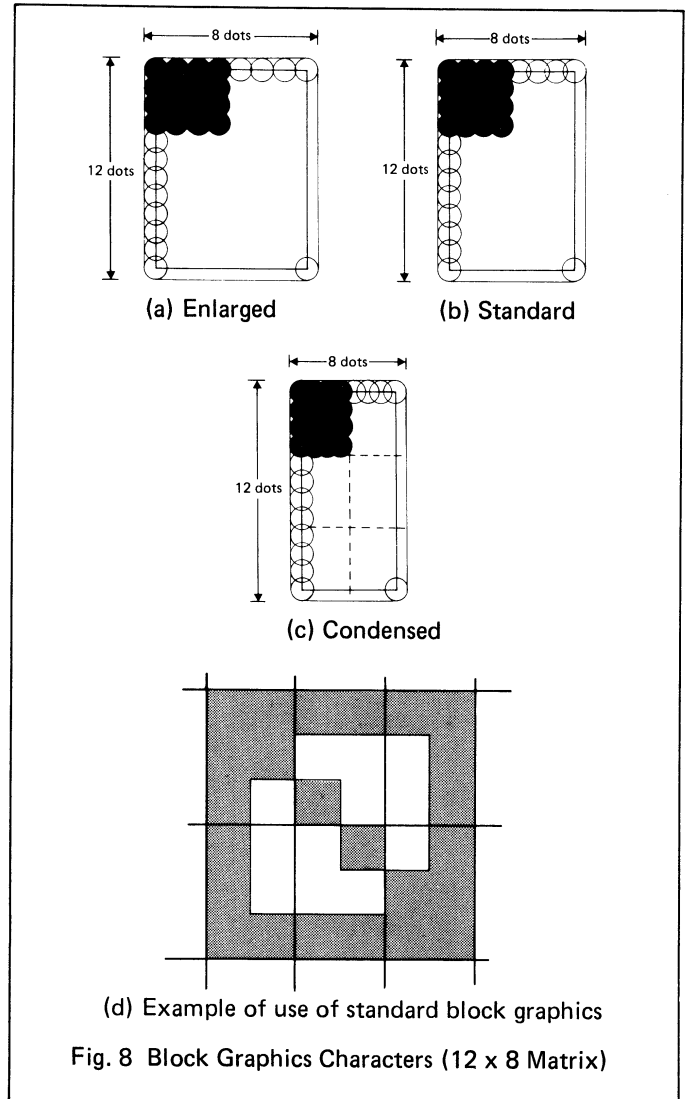
4.4 Standard High Resolution Characters (9 x 5 to 15)

The 128-character high resolution characters (96 ASCII + national variations) are defined in a 9-high matrix whose width varies between 5 and 15 half-dots depending on character width. It may be used in two ways:

(1) To print proportional-pitch characters.

(2) To produce the same high-resolution characters but with fixed pitch.

The high resolution set can only be used at the slowest carriage speed, giving a horizontal printing resolution of 200 dots/inch. Thus characters may be printed with 15 half-dots horizontally having the same proportions as the standard 9 x 9 characters printed on the fastest carriage speed.

4.4.1 Proportional-pitch Characters

Proportional characters are defined in matrixes whose width varies with the width of the character (from 5 to 15 half-dot columns) see fig. 9. Just the body of the character is defined, the columns which would contain no dots (on either side of the character in a fixed width matrix) are not used.
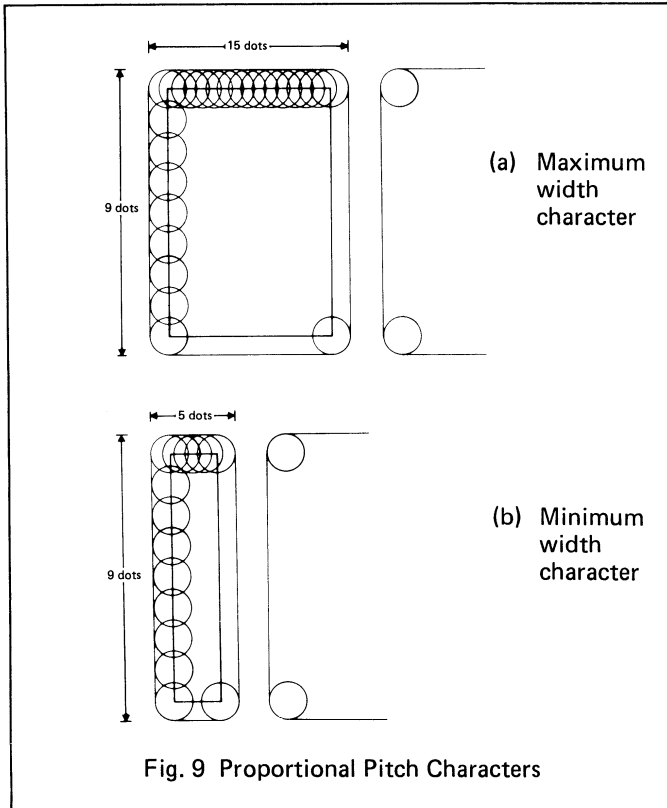
Fig. 9 Proportional Pitch Characters

When the characters are printed, the body is printed and then the carriage is moved by a fixed amount of intercharacter space (5 half-dots) before the next character body is printed. Thus each character body is separated by the constant intercharacter space. The maximum width of character body (15 half-dots) plus space is 1/10 inch and the minimum (5 half-dots) is 1/20 inch, giving between 10 and 20 characters per inch.

4.4.2 Fixed-pitch Characters

The same character bodies as used for proportional-pitch may also be printed to give fixed pitch (1/10 inch) high resolution characters.

4.5 Optional Character Sets

The optional character sets held in PROM CH-GEN 1 conform to the same basic rules as the basic character sets, but enable the user to select alternative fonts (see section 6.1 for commands for changing between character generators).

The optional standard and high resolution characters use the same matrixes as the basic. The block graphics characters may use a matrix which is 12 high and may be fixed between 5 and 15 full-dot columns wide, see fig. 10, (all characters in the graphics set must have the same width, unlike the high resolution set, whose widths may vary). This gives between 12 and 4 cpi for standard (middle carriage speed) block graphics characters. In the optional block graphics character set up to 96 characters may be defined.
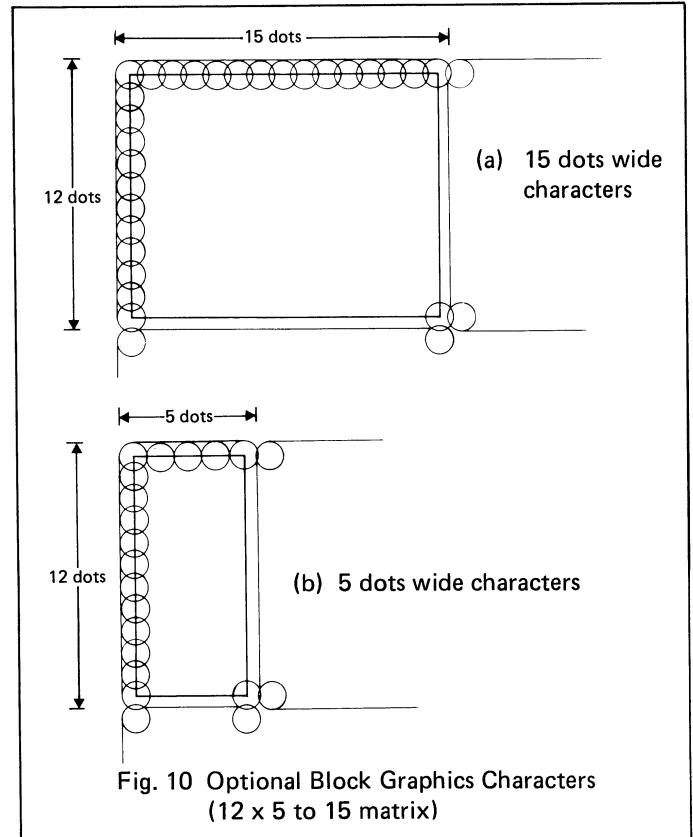
Fig. 10 Optional Block Graphics Characters (12 x 5 to 15 matrix)

4.6 Elongated and Underlined Characters

The data source may specify that all subsequent characters on the line should be printed elongated or underlined (or both see section 6.4) unless an End Elongated/Underlined command is received earlier. Elongation takes place whatever type of character is selected.
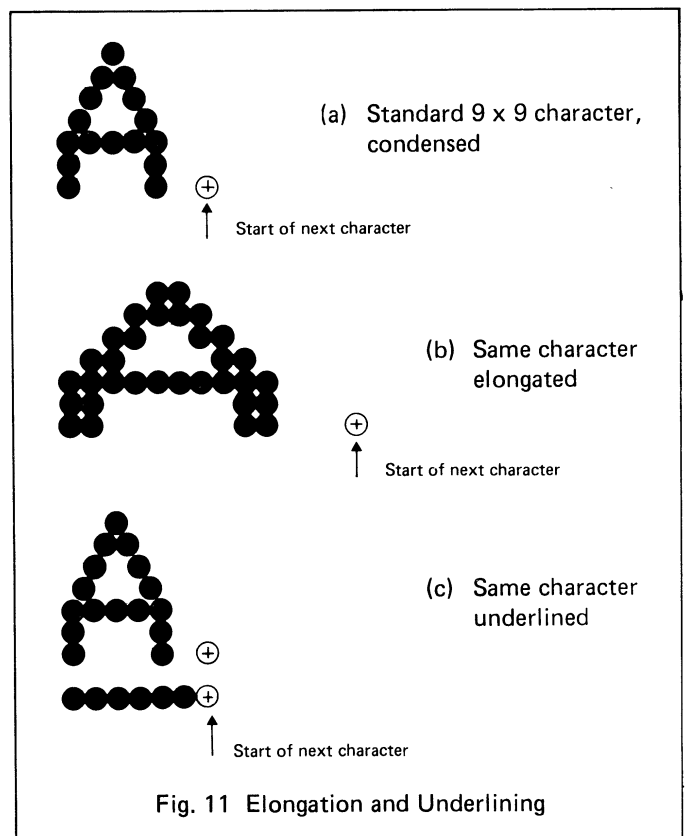
Fig. 11 Elongation and Underlining

4.6.1 Elongation

Elongation of characters involves printing each dot column twice with carriage movement of 1 dot column between each impression, effectively doubling the width of each character. Spaces are also doubled in width. The effect is illustrated in fig. 11b.

4.6.2 Underlining

Underlining is achieved by printing a continuous row of dots with the 9th (bottom) print-pin as shown in fig. 11c. Space characters are underlined but any spaces resulting from tabulation commands (e.g. HT) and any trailing spaces on a line will not be underlined. The underline can be used with block graphics characters but because these are printed in two consecutive rows, a line will result through the middle of the block as well as below it.

4.7 Superimposing

Any characters may be superimposed by sending a Back-space command (Hex 08) between them. Thus for example to produce a slashed 0 (Ø), the data source would send 0, Backspace, / (Hex 30, 08 2F), as shown in fig. 12.

The superimposition is performed mechanically, the first character being printed, the carriage moving back one character space and then the second character being printed. Note that when using the high resolution font with proportional pitch, that the size of the backspace is one space character and thus the second character may not be positioned precisely over the first since the characters have different widths.

4.8 SI/SO Character Sets

The data source can use the SI (Hex 0F) and SO (Hex 0E) codes to shift between two alternative fonts. By default the SI code selects character generator 0 (the most recently used national version and font) and the SO code selects character generator 1 (again the most recently used national version and font), or is ignored if character generator 1 is not fitted.

If two specific combinations of character generator, national version and font are regularly used these can be specified by a special command (Set SI/SO Sequence — see section 6.2) and assigned to the SI and SO codes. Sending the appropriate code then activates the required version of the font.

Where SI and SO codes are assigned particular fonts in this manner, character generators 0 and 1 can still be specified by the full ESC sequence for the Select Character Generator command (see section 6.1).
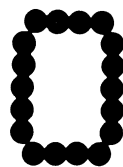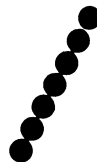
(a) Digit 0   (b) Slash character   (c) Superimposed
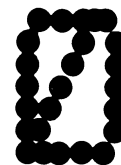
Fig. 12 Superimposing

5. PIN GRAPHICS MODE

In Pin Graphics mode each 7-bit data word received is taken to represent a dot pattern to be printed by the upper 7 pins of the print head unless the SYN code (Hex 16) is received first. The SYN code introduces all Pin Graphics commands; these are described in section 7. Printing may be performed at any of the three carriage speeds giving Normal (60 dots/inch), Medium (72 dots/inch) and High (100 dots/inch) resolution. The use of Medium resolution results in a 1:1 aspect ratio, with 72 dots/inch vertically and horizontally.

As each 7-bit data word is received it is stored in the printer's buffer. On receipt of a valid line terminator the data is printed out. Each data word represents a dot pattern, a logical 1 is a dot and logical 0 no dot. For example, to build up a diagonal line the codes SOH, STX, EOT, BS, DLE, SP and @ would be sent in sequence (Hex 01, 02, 04, 08, 10, 20, 40), see fig. 13.

On completion of a printed line, the paper will be fed by 7/72 inch (7 dot rows) so that the top of the next printed line will touch the bottom of the previous line, allowing continuous vertical graphical representations to be built up.
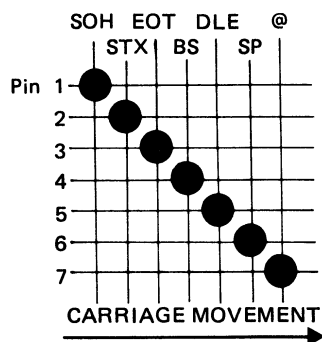
		Bits					
Code	7	6	5	4	3	2	1
SOH	0	0	0	0	0	0	1
STX	0	0	0	0	0	1	0
EOT	0	0	0	0	1	0	0
BS	0	0	0	1	0	0	0
DLE	0	0	1	0	0	0	0
SP	0	1	0	0	0	0	0
@	1	0	0	0	0	0	0

Fig. 13 Pin Graphics Dot Pattern (Example)

6. CHARACTER MODE COMMANDS

The data source may control the operation of the printer remotely by sending commands. The commands obeyed by the printer fall into clearly defined classes:

(1) Parameter selection commands — these "soft switch" commands can be used to change some of the operational parameters of the printer by selecting one of a predefined range of values.

(2) Parameter setting commands — the commands are used to override default values of certain operational parameters in the printer. With these commands the data source enters the new value(s) directly in the command sequence.

(3) Font selection commands — these select the form of characters to be used when printing.

(4) Order commands — these are commands which have a direct, but temporary effect on the printed output (i.e. at most until the current print buffer contents have been printed out).

In the cases of the parameter setting and parameter and font selection commands, the values set remain effective until they are reset by further commands or until the printer is reset or switched on again, when the default values are used.

6.1 Parameter Selection Commands

FUNCTION	MEANING	HEX CODE
SELECT NATIONAL VERSION	These commands are used to select the required national character set as follows:	
	US ASCII	1B 38 40
	Swedish/Finnish	1B 38 41
	Danish/Norwegian	1B 38 42
	German	1B 38 43
	British	1B 38 44
	Italian	1B 38 45
	French/Belgian	1B 38 46
	Spanish	1B 38 47
	The default value is set by DIP switches SW2/6, 7 and 8 (see section 9.2.10).	
SELECT LINE SPACING	The printer may be set to produce 6 or 8 lines per inch using one of the commands:	
	6 lines per inch	1B 34
	8 lines per inch	1B 35
	The default value is set by DIP switch SW1/2 (see section 9.2.2).	
SELECT PIN GRAPHICS RESOLUTION	The data source may select one of three resolutions to be used in Pin Graphics mode:	
	Normal, 60 dots/inch	1B 2E 4E
	Medium, 72 dots/inch	1B 2E 4D
	High, 100 dots/inch	1B 2E 48
	The default value is Medium (72 dots/inch).	
SELECT CHARACTER GENERATOR	Determines whether to use the standard (0) or optional (1) character generator:	
	Character Generator 0	1B 2F 40
	Character Generator 1	1B 2F 41
	The default value is set by DIP switch SW1/1 (see section 9.2.1) but when no optional character generator is fitted, character generator 0 is always selected.	

6.2 Parameter Setting Commands

These commands consist of sequences of codes which include numeric parameters which are entered in relative hexadecimal, i.e. decimal 0 to 94 correspond to Hex 20 to 7E.

These parameters are identified by N. A conversion table to simplify the use of these parameters is given in Appendix 4.

FUNCTION	MEANING	HEX CODE
SET VERTICAL TABS	Sets up to 32 vertical tabs in a form. Each N sets a vertical tab stop at the specified number of increments (1/6 inch) from the previous vertical tab stop. All vertical tab stops must be set at the same time; all previous ones are cleared. The default setting is every 1 inch (6 increments).	$1B\ 31\ (N_1\ N_2\ \text{-}\text{-}\text{-}\ N_{32})\ 7F$
SET FORMAT LENGTH	Sets the total length of a format, N, in increments of 1/6 inch from 1/3 inch (2 increments) to 15-2/3 inches (94 increments). The default length is set to either 8, 8½, 11 or 12 inches by DIP switches SW1/3 and 4.	$1B\ 32\ (N)\ 7F$
SET RIGHT MARGIN	Sets the position of the right hand edge of the text, N, relative to the 80th column in increments of 1/10 inch (i.e. increments of 1 basic column), see fig. 14.	$1B\ 29\ (N)\ 7F$
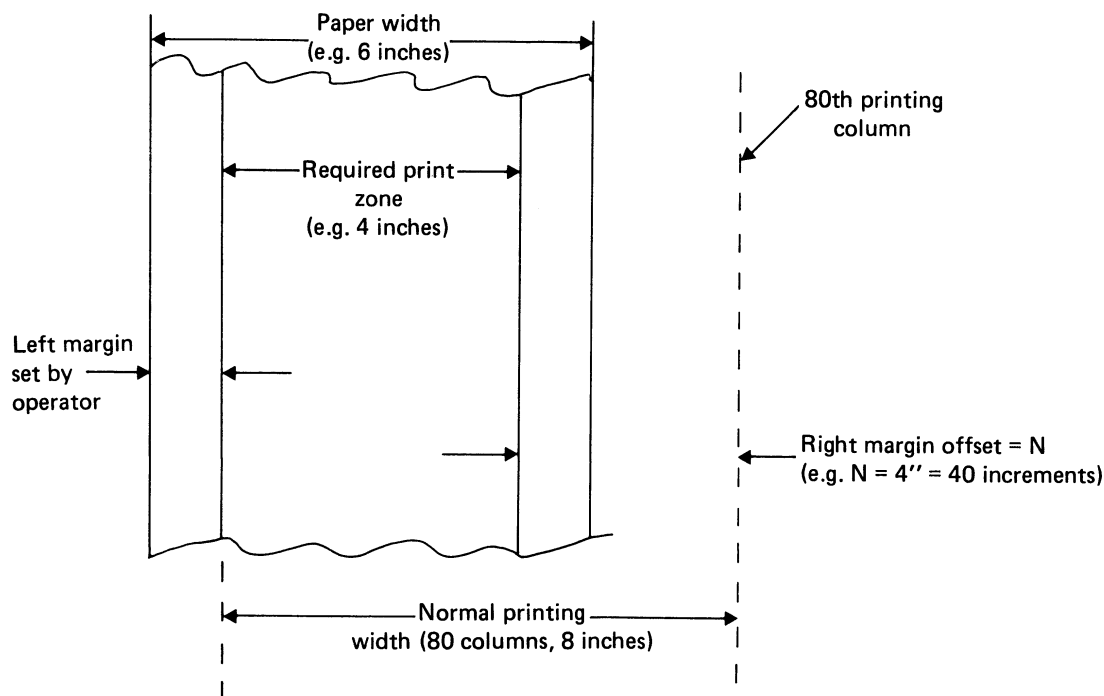
Fig. 14 Setting Right Hand Margin

The value of N may be from 0 to 68 (Hex 20 to Hex 64) giving text widths of 8 inches (80 columns) down to 1.2 inches (12 columns), with a default value of 8 inches or 4 inches (DIP switch SW1/5).

The position of the right margin determines the point at which the printer will wrap text. Where printing is being performed at either of the two slower printing speeds, (narrower pitches) if the right margin is set a position which is not an integral number of columns in the selected pitch the printer will wrap so that the printed line is a fraction of a character short (i.e. it will not place any part of a character beyond the right margin).

FUNCTION	MEANING	HEX CODE
SET SPACING INCREMENT	The spacing increment allows the data source to insert a different amount of space into a line of text from that of the standard space character (Hex 20). The user may set this spacing increment at any number, N, of half-dot columns from 0 (default) to 94. The actual size of space produced by the spacing increment will depend on the currently selected carriage speed (but will always have the same ratio with the standard space character). The incremental space is obtained by sending the Spacing Increment command (Hex 18), see section 6.4.	1B 20 (N) 7F
SET SKIP ZONE	The skip zone is the zone at the bottom of a form immediately preceding the next Top of Form position in which printing must not occur. This command sets the size of the zone, N, in increments of 1/6 inch from 0 (continuous printing) to one less than the total format length (see fig. 15). The default skip zone is set by DIP switches SW1/6 and 7 (see section 9.2.5).	1B 2A (N) 7F

Fig. 15 Setting Skip Zone

SET SI/SO SEQUENCE
Where two different types of printing are commonly used on one printer, the user may define the printing requirement for each, just once, and then call up the required type using SI and SO codes (Hex 0F and 0E) (see section 4.8). The user may specify:

(a)   National character set (see section 6.1).

(b)   Font (see section 6.3).

(c)   Character generator (see section 6.1)

in any order in a [command string].

To set the SI sequence: 1B 0F [command string] 7F

To set the SO sequence: 1B 0E [command string] 7F

If no command string has been defined, the corresponding SI or SO command will select character generator 0 or 1 (if fitted) respectively, with the national version and font last used by the printer. For example, to set the SI command to select normal (10 cpi) US ASCII characters from Character Generator 0 and the SO command to select condensed (12 cpi) Spanish characters from Character Generator 1 the two sequences would be:

1B 0F 1B 38 40 1B 2F 40 1B 36   7F and 1B 0E 1B 38 47 1B 2F 41 1B 39 7F
          US ASCII   CG0   10 CPI   SPANISH   CG1   12 CPI

6.3 Font Selection Commands

FUNCTION	MEANING	HEX CODE
SELECT FONT	These commands allow the user to select which font to use from the currently selected character generator, and which carriage speed to use for printing the characters, and to change from Character mode to Pin Graphics mode:	
	Normal (10 cpi)	1B 36 *
	Condensed (12 cpi)	1B 39
	Compressed (17 cpi)	1B 37
	High resolution, constant pitch (10 cpi)	1B 3A
	High resolution, proportional pitch	1B 3B
	Block graphics condensed (12.5 cpi)	1B 3C
	Block graphics normal (9 cpi)	1B 3D
	Block graphics enlarged (7.5 cpi)	1B 3E
	Select pin graphics mode	16
	The national version used is that most recently used by the printer unless changed by a Select National Version command (see section 6.1).	
SHIFT IN (SI)	Sets the printer according to the SI command string (see section 6.2). This command selects character generator 0 if no SI command string has been defined.	0F
SHIFT OUT (SO)	Sets the printer according to the SO command string (see section 6.2). This command selects character generator 1 is no SO command string has been defined.	0E

*The hex code 02 may be used instead of 1B 36 where convenient for compatibility.

6.4 Order Commands

FUNCTION	MEANING	HEX CODE
START ELONGATED	After this command all characters are printed double width. Elongated printing will continue until an End Elongated/Underlined command or a valid line terminator is received.	1E
START UNDERLINED	After this command all characters (including SP) will be automatically underlined. The underlining will continue until an End Elongated/Underlined command or a valid line terminator is received.	1D
END ELONGATED/ UNDERLINED	This terminates elongated and underlined printing.	1F
HORIZONTAL TAB	This command moves the carriage right to the next tab stop position. Tab stops are fixed at 1 inch intervals (i.e. every 10 characters in Normal printing).	09
BACKSPACE	Receipt of this command causes the preceding data to be printed out. The carriage is then moved back (left) to position it over the previous character. More than one Backspace command may be given in succession.	08
SPACING INCREMENT	Moves the carriage by the number of half-dot columns specified by the Set Spacing Increment command (see section 6.2). The spacing increment will be truncated, if necessary, when the line is wrapped.	18
ABSOLUTE CHARACTER POSITION	Moves the carriage right to a position n increments from the left margin $(0 \leqslant n \leqslant 9999)$. The increment is the width of the space character for the currently selected font. If the specified value of n would result in an absolute position to the left of the current position the command is ignored (the carriage remains stationary), and if it would result in a position beyond the right margin the carriage is positioned at the left margin and paper is fed by one line (i.e. the line is wrapped and n truncated).	1B 2B (n) 7F
ABSOLUTE DOT POSITION	Moves the carriage right to a position n full dot columns from the left margin $(0 \leqslant n \leqslant 9999)$, using the currently selected dot resolution. If the specified value of n would result in an absolute position to the left of the current position the command is ignored (the carriage remains stationary), and if it would result in a position beyond the right margin the carriage is positioned at the left margin and the paper is fed by one line (i.e. the line is wrapped and n truncated).	1B 2C (n) 7F
REPEAT DATA	This command is used to print the next character repeatedly n times $(0 \leqslant n \leqslant 9999)$ on one line. Repeating terminates at the end of the line; if n repeats have not been performed the line is wrapped and the carriage stays at the left margin (i.e. n is truncated).	1B 2D (n) 7F

6.4.1 Local Linefeeds

HALF LINE FEED FORWARD	Prints the preceding data and then advances paper by half the currently selected line feed size during printing of a line.	1B 55
FULL LINE FEED FORWARD	Prints the preceding data and then advances paper by the currently selected line feed size during printing of a line.	1B 4E
HALF LINE FEED BACK	Prints the preceding data and then moves the paper back by half the currently selected line feed size during printing of a line.	1B 44
FULL LINE FEED BACK	Prints the preceding data and then moves the paper back by the selected line feed size during printing of a line.	1B 10

FUNCTION	MEANING	HEX CODE

6.4.2 Line Terminators

FUNCTION	MEANING	HEX CODE
CARRIAGE RETURN	The effect of this command depends on the setting of DIP switch SW2/1 (see section 9.2.7). Receipt of this command causes the preceding data to be printed out. On completion of the line the paper may or may not be fed by one line depending on the DIP switch setting.	0D
LINE FEED	On receipt of this command the preceding data is printed. On completion of printing the paper is fed by the currently selected line feed size.	0A
VERTICAL TAB	This command causes the preceding data to be printed. On completion of printing the paper is advanced to the next vertical tab stop; if there are no more vertical tab stops in the format, paper is advanced to the next top of form position. Vertical tab stops are set every 1 inch.	0B
FORM FEED	This command causes the preceding data to be printed. On completion of printing paper is advanced to the next top of form position and the carriage is moved to the left margin.	0C
RESET TO POWER-UP	This command resets the printer to its power-up status (using the default values for all its operational parameters). Note that all the data in the buffer that has been entered before this soft reset command will be processed and printed first, therefore the user must wait for the printing to be completed and the soft reset performed before sending further data.	1B 30

7. PIN GRAPHICS MODE COMMANDS

There is a limited command set for use in Pin Graphics mode. There are two types of command:

(1) Select commands — these are used to exit Pin Graphics mode and specify the font required in Character mode.

(2) Order commands — these commands have a direct, but temporary, effect on the printed output, the effect lasting at most until the next line terminator has been obeyed.

The SYN code (Hex 16) is used as a lead-in code to identify Pin Graphics commands. Any code not preceded by SYN is treated as a printing dot pattern.

7.1 Select Commands

FUNCTION	MEANING	HEX CODE
SELECT FONT	These commands allow the user to change from Pin Graphics mode to the selected Character mode, defining which font to use in Character mode and which carriage speed to use for printing the character.	
	Normal (10 cpi)	16 1B 36 *
	Condensed (12 cpi)	16 1B 39
	Compressed (17 cpi)	16 1B 37
	High resolution, constant pitch	16 1B 3A
	High resolution, proportional pitch	16 1B 3B
	Block graphic, condensed (12.5 cpi)	16 1B 3C
	Block graphic, normal (9 cpi)	16 1B 3D
	Block graphic, enlarged (7.5 cpi)	16 1B 3E

*The hex code sequence 16 02 may be used instead of 16 1B 36 where more convenient for compatibility.

7.2 Order Commands

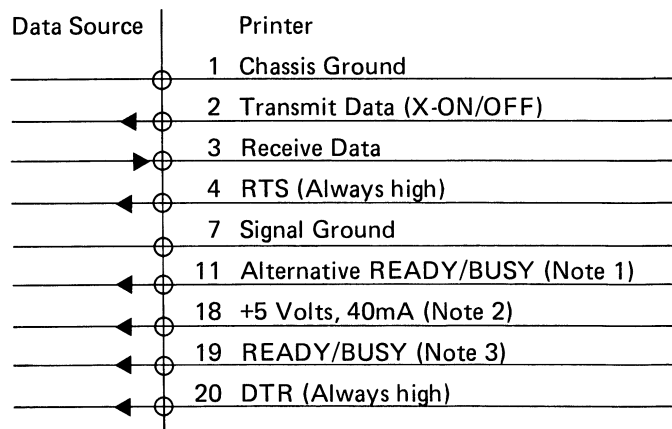| FUNCTION	MEANING	HEX CODE
START ELONGATED	This command causes every dot column to be printed twice with a carriage movement of 1 dot column (at the selected resolution) between each impression. This elongation of dots continues until the End command is given or until the current line is terminated by wrapping or a valid line terminator.	16 1E
END ELONGATED	This terminates elongated printing.	16 1F
ABSOLUTE DOT POSITION	Moves the carriage right to a position n full dot columns from the left margin $(0 \leqslant n \leqslant 9999)$ using the currently selected dot resolution. If the specified value of n would result in an absolute position to the left of the current position the command is ignored (the carriage remains stationary), and if it would result in a position beyond the right margin the carriage is positioned at the left margin and paper is fed by one line (i.e. the line is wrapped and n truncated).	16 1B 2C (n) 7F
REPEAT DATA	This command is used to print the next dot column repeatedly n times $(0 \leqslant n \leqslant 9999)$ on one line. Repeating terminates at the end of the line, and if less than n repeats have been performed the line is wrapped and the carriage stays at the left margin (i.e. n is truncated).	16 1B 2D (n) 7F
CARRIAGE RETURN	The effect of this command depends on the setting of DIP switch SW2/1 (see section 9.2.7). Receipt of this command causes the preceding line of data to be printed out. On completion of the line the carriage is returned to the left margin and paper may or may not be fed by one line (7 dots) depending on the DIP switch setting.	16 0D
LINE FEED	On receipt of this command the preceding line of data is printed. completion of printing the carriage is returned to the left margin and the paper is fed by one 7-dot line.	16 0A
FORM FEED	This command causes the preceding line of data to be printed out. On completion of printing the paper is advanced to the next top of form position and the carriage is moved to the left margin.	16 0C
RESET TO POWER-UP	This command resets the printer to its power-up status (using the default values for all its operational parameters). Note that all the data in the buffer that has been entered before this soft reset command will be processed and printed first, therefore the user must wait for the printing to be completed and the soft reset performed before sending further data.	16 1B 30
PRINT DOTS 2 + 3 + 5	Since the Hex code 16 which is used to introduce all pin graphics commands is the same value as the data word used to print dots 2, 3 and 5 only (from the column of 7 dots), the Hex 16 must be repeated whenever only those dots are to be printed.	16 16

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8. INPUT/OUTPUT INTERFACES

8.1 General

The printer is fitted with a V.24/RS-232-C serial interface and both Centronics and Epson type parallel interfaces. The selection of serial or parallel interface is by DIP switches SW2/3, 4 and 5, and the Centronics or Epson type is selected by a solder bubble (see section 9.4.4). The printer has a choice of protocols for the serial interface (READY/BUSY and X-On/X-OFF) and provides a handshake protocol for the parallel interfaces. The connectors are shown in Fig. 16.

8.2 Serial Interface

The printer has a standard V.24/RS-232-C interface. The transmission rate and data word characteristics are set by DIP switches as described in section 9.2.8 and 9.

8.2.1 Interface Connector

The printer is fitted with a standard 25-pin DB type connector:

Data Source	Printer
	1 Chassis Ground
◀	2 Transmit Data (X-ON/OFF)
▶	3 Receive Data
◀	4 RTS (Always high)
	7 Signal Ground
◀	11 Alternative READY/BUSY (Note 1)
◀	18 +5 Volts, 40mA (Note 2)
◀	19 READY/BUSY (Note 3)
◀	20 DTR (Always high)

Notes: (1) READY/BUSY can be moved from pin 19 to pin 11 by linking a solder bubble (see section 9.4.2).

(2) +5 volts can be supplied on pin 18 by linking a solder bubble (see section 8.2.3 and 9.4.3).

(3) READY = High, BUSY = Low; can be inverted by solder bubble (see section 9.4.1).

8.2.2 Protocols

The status of the printer is determined by the state of the input buffer as described in section 2.2.7. This status is expressed on the interface in two ways:

(1) Using the READY/BUSY protocol which changes the signal level on pin 19 (or alternatively on pin 11). The polarity of this signal may be inverted if desired (see section 9.4).

(2) Using the X-ON/X-OFF protocol which transmits the appropriate codes to the data source via pin 2.

Printer Ready

When the printer is Ready, the level on pin 19 is high. Whenever the printer status changes from Busy to Ready (i.e. whenever there is a low-to-high transition on pin 19) the X-ON code (Hex 11) is sent via pin 2 to the data source.

Printer Busy

When the printer is Busy, the level on pin 19 is low. When the high-to-low transition occurs the printer sends an X-OFF code (Hex 13) via pin 2.

After the input buffer has filled to its Busy level (<140 characters capacity), all subsequent characters received from the host result in the transmission of another X-OFF until the buffer capacity reaches its READY level.

8.2.3 Current Loop Interface

The V.24/RS-232-C interface can be converted to a 20mA current loop interface using the optional Facit 5165 Current Loop Adapter. This adapter plugs into the serial interface connector and takes its power supply from the printer via pin 18. For this purpose pin 18 must be linked to the +5V supply line in the printer by the appropriate solder bubble; details of this connection are given in section 9.4. The current loop lines then connect directly to the adapter.

CENTRONICS TYPE
PARALLEL CONNECTOR

V.24 SERIAL
INTERFACE CONNECTOR
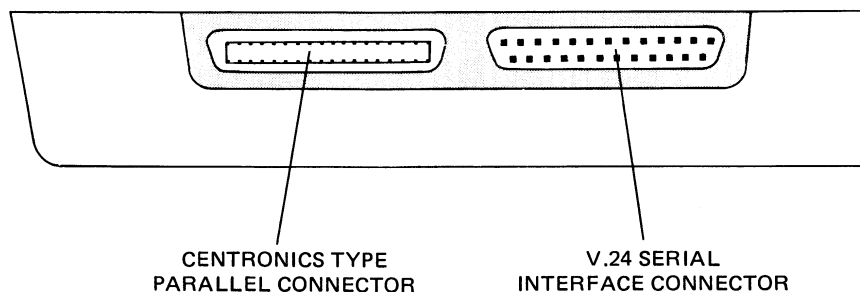
Fig. 16 I/O Interface Connectors

8.3 Parallel Interface

The printer as supplied has a solder bubble linked to select the standard Centronics type parallel interface. The Epson type interface can be selected by changing the link as described in section 9.4.4.

The printer accepts 8-bit parallel ASCII data from the data source. Bit 8 (most significant bit) is ignored. Data is transferred on a handshaking basis where the printer controls the data flow by indicating its internal status to the data source.

8.3.1 Timing Diagram — Printer Ready

Centronics type

Epson type

Fig. 17 Timing — Printer Ready (Centronics and Epson)
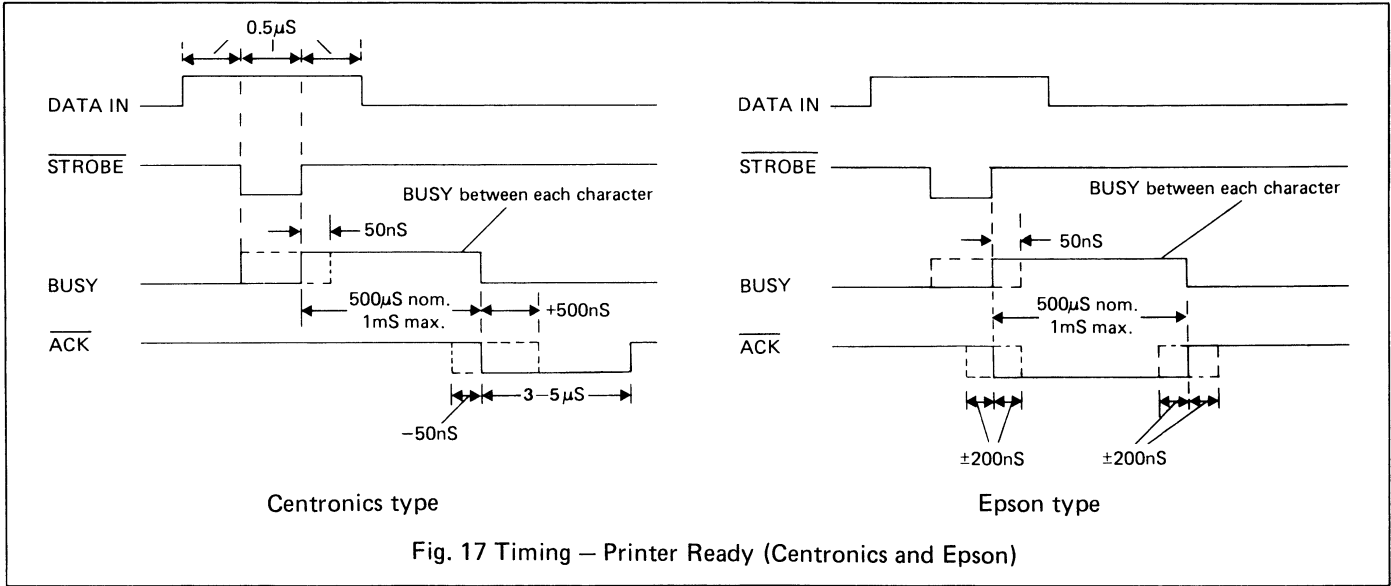
8.3.2 Timing Diagram — Printer Busy

Centronics type

Epson type

Fig. 18 Timing — Printer Busy (Input Buffer Full)
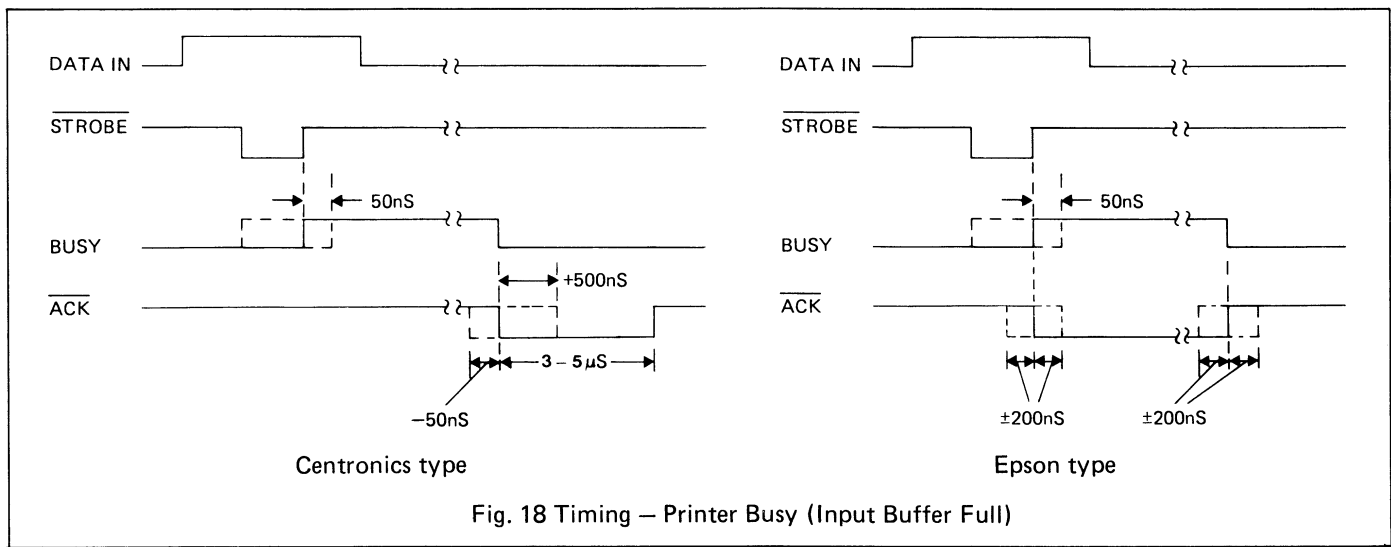
8.3.3 Interface Connector

The printer is fitted with a standard 36-pin Centronics type connector:

Notes: (1) High indicates Paper End.

(2) Can be reset to power-up condition by data source setting this line low.

Data Source		Printer
	1	Data Strobe
	2 to 8	Input Data 1 to 7
	9	Input Data 8 (Ignored)
	10	Acknowledge
	11	Busy
	12	Paper End (Note 1)
	13	Select (High when On-line)
	17	Chassis Ground
	18	+5V, 40mA
	19—30	Signal Ground
	31	Reset (Note 2)
	32	Fault (low when Paper End or Off-line)

9. CONTROLS AND INDICATORS

9.1 Operator's Control Panel

The Operator's Control Panel is shown in fig. 19. The functions of its switches and LEDs are described below.

9.1.1 MODE Switch

The MODE switch sets the default operating mode of the printer. The switch is sensed only after Power-up or a Reset command. The operating mode may subsequently be changed by command from the host, or by the operator switching off, changing the switch and switching on again. The switch settings are explained in the table below.

Setting	Meaning
10 12 17	Characters from the normal font printed at fast, medium and slow carriage speeds to give normal (10 cpi), condensed (12 cpi) and compressed (17 cpi) characters.
HR	Characters from the high resolution font printed with fixed pitch (10 cpi).
PS	Characters from the high resolution font printed with proportional pitch (10 to 20 cpi).
BG	Standard block graphics font (printed at 1:1 aspect ratio).
PG	Pin Graphics mode (medium resolution, 1:1 aspect ratio).
TM	Transparency mode.

9.1.2 ERROR/ON LINE Indicator

This red LED is unlit when the printer is Off-line and there are no faults. When the printer is On-line, the lamp is lit steadily.

When the lamp is flashing it indicates one of two conditions.

(a) That the end of the paper has occurred (see section 2.2.5).

(b) If not Paper End then either an internal fault has occurred or the print head has been disturbed. Press the OVR.R switch; the print head position will be reset. If the lamp continues flashing then the cause is an internal fault.

9.1.3 POWER ON Indicator

This red LED lights whenever the printer is switched on.

9.1.4 ON LINE/OFF LINE Switch

Depressing the upper half of this switch sets the printer On-line providing there are no faults (the ERROR/ON-LINE indicator lights to indicate the On-line state). Depressing the lower half of the switch when the printer is On-line changes the status to Off-line (ERROR/ON-LINE indicator extinguished). The switch is also used in conjunction with the OVR.R switch (see section 9.1.6).

9.1.5 LF/FF Switch

This is a two function switch which is biassed to the central (off) position. It is only effective when the printer is Off-line.

If the upper half of the switch is pressed and released, a single line feed will occur. If the switch is held depressed for more than ¼ second, the printer will perform repeated line feeds until the switch is released.

If the lower half of the switch is depressed a single form feed will occur.

9.1.6 TOF/OVR.R Switch

This rocker switch is biassed to the central (off) position. The upper half of the switch (TOF) is depressed when the printer is Off-line to register the current paper position as a new Top of Form, overriding any previous TOF position.

The bottom half of the switch (OVR.R) has a number of functions related to the Paper End condition (see section 2.2.5).

(1) Momentary depression of the switch after Paper End will result in the next line of text in the buffer being printed.
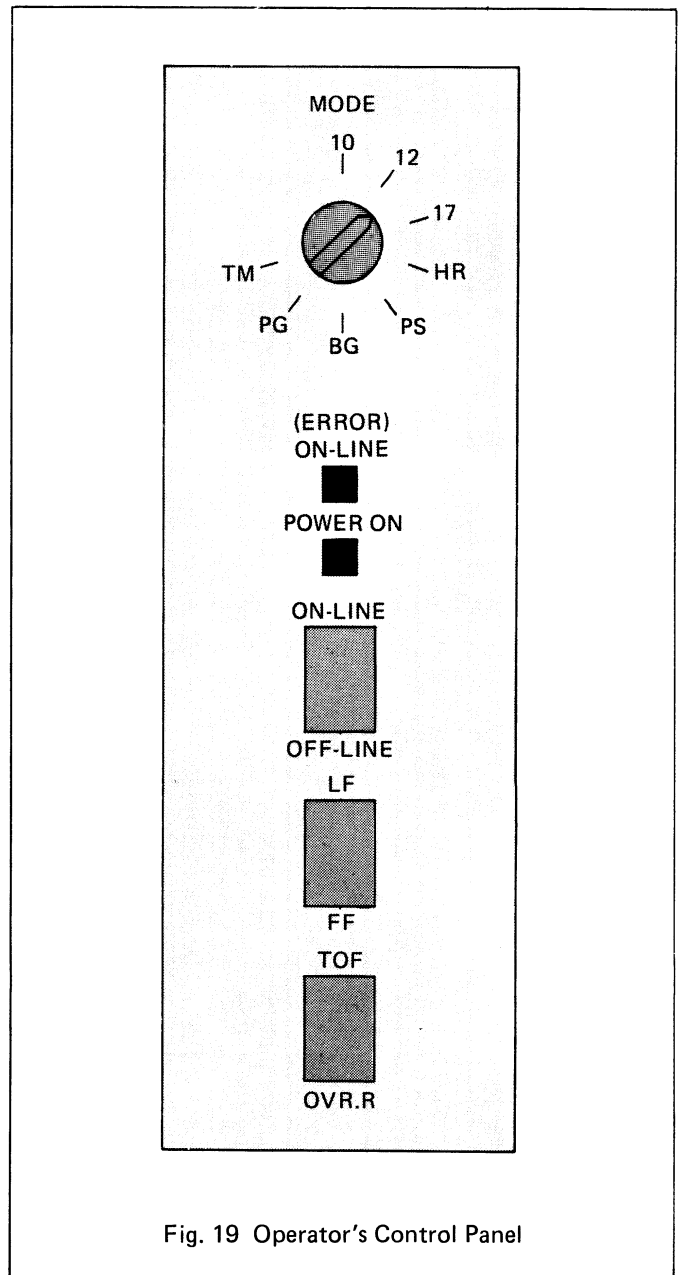

Fig. 19 Operator's Control Panel

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(2) If the switch is held depressed printing will continue to the end of the paper (or until the buffer becomes empty). The printer will automatically stop at the physical end of the paper.

(3) If the ON-LINE switch and the OVR.R switch are both held depressed, the printer will print to the end of the paper and will also accept more data into the buffer from the data source (printer On-line).

The switch is also used to initiate self-testing of the printer (see section 2.2.3). If it is held depressed while the printer is switched on, self-testing will begin and continue until the switch is depressed again.

9.2 Rear DIP Switches

The two DIP switches SW1 and SW2 are shown in fig. 20. These switches set the default values for the printer's operational parameters.

9.2.1 Select Character Generator (SW1/1)

When the switch is set to 0, character generator 0 is selected, when set to 1, character generator 1 is selected.

9.2.2 Line Spacing (SW1/2)

The number of lines printed per inch is set by this switch; setting it to 0 selects 6 lines/inch and 1 selects 8 lines/inch.

9.2.3 Format Length (SW1/3 and 4)

The user may select one of four format lengths (form feed sizes) with these switches, as shown in the table below.

SW1/3	SW1/4	Format length
1	0	8 inches
0	1	8½ inches
1	1	11 inches
0	0	12 inches

9.2.4 Line Length (SW1/5)

This switch is used to select an 80 column (0) or 40 column (1) line length.

9.2.5 Skip zone size (SW1/6 and 7)

There are four alternative sizes of skip zone that may be selected according to the table below. The skip zone is the area on which no printing can take place immediately preceding the top of form position; it is included in the format length.

SW1/6	SW1/7	Skip zone size
0	0	0
0	1	½ inch
1	0	1 inch
1	1	1½ inch

9.2.6 Hex 5C Character (SW1/8)

When this switch is set to 0, the printer will print the character defined in the chosen national version of the current font for code Hex 5C. When the switch is set to 1, the printer will print a 'yen' sign (¥) on receipt of Hex 5C, regardless of the national version selected.

9.2.7 New Line Effector (SW2/1)

When the switch is set to 0, an LF code causes a new line, and the CR code acts only as a line terminator. When the switch is set to 1 either CR or LR will cause a new line.

9.2.8 Word Length (SW2/2)

When this switch is set to 0, the word length (on the serial interface) is set to 7 bits (receive and transmit) and when set to 1 it is set to 8 bits.

9.2.9 Interface/Baud Rate (SW2/3 to 5)

The transmit and receive speed are set to the same value using these switches as shown in the table. Any of these switch settings selects the serial interface (see section 8.2).

Baud Rate		SW2/3	SW2/4	SW2/5
110*		0	0	0
300		0	0	1
600		0	1	0
1200	Serial Interface	0	1	1
2400		1	0	0
4800		1	0	1
9600		1	1	0
Parallel Interface		1	1	1

*At 110 Baud 2 stop bits are automatically supplied.

If all three switches are set to 1 then the parallel interface is selected (see section 8.3).

OFF = OPEN = 0

DIP SWITCH
SW2

Fig. 20 Rear DIP Switches (viewed from rear)
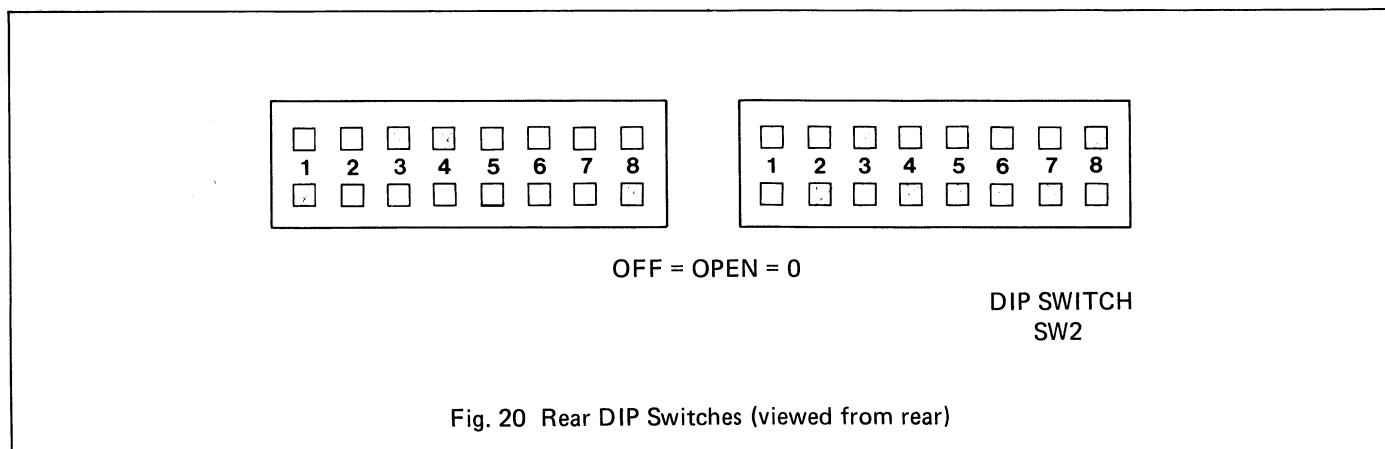
9.2.10 National Character Set (SW2/6 to 8)

These switches are used to select the required national character set according to the following:

National Set	SW2		
	6	7	8
US	0	0	0
Swedish/Finnish	0	0	1
Danish/Norwegian	0	1	0
German	0	1	1
British	1	0	0
Italian	1	0	1
French/Belgian	1	1	0
Spanish	1	1	1

Fig. 21 Mains Panel

9.3 Mains Panel

The mains panel is shown in fig. 21.

9.3.1 On/Off Switch

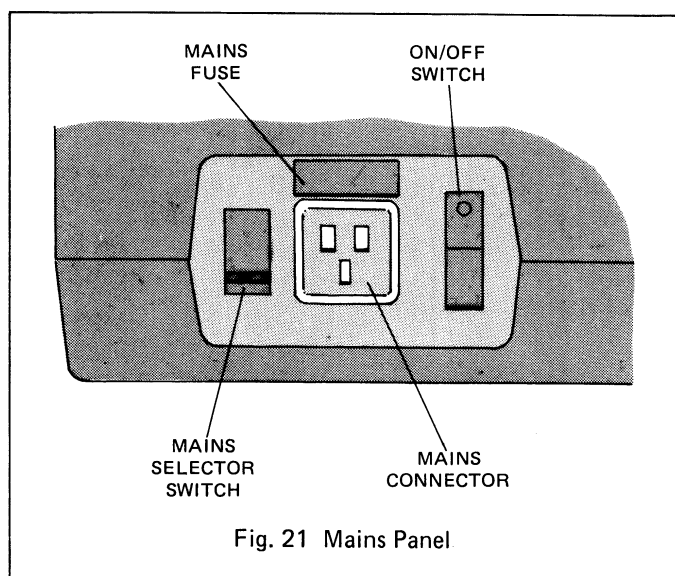The top half of the On/Off switch is depressed to switch the printer on and the bottom half is depressed to switch the printer off.

9.3.2 Mains Selector Switch

There are two versions of the printer, one for 220/240V mains and the other for 100/120V mains. In both cases the voltage selector switch is used to select which of the two voltages are used. Setting the switch to its upper position selects the higher voltage (240V or 120V); setting the switch to its lower position selects the lower voltage (220V or 100V).

9.3.3 Mains Fuse

The mains fuse is mounted above the mains connector. The fuse is extracted by pulling out the fuse holder after first removing the mains cable. The holder contains a spare fuse as well as the operating fuse. The fuse ratings are 1A for 220/240V operation and 2A for 100/120V operation. The fuses are both slow blow types.

9.4 Printed Circuit Board

The printer's printed circuit board contains a number of items which the user may need to change, solder bubbles, fuses and the optional character generator. Their locations are shown in fig. 22. Obtaining access to the board is described in section 11.5.

9.4.1 READY/BUSY Level Solder Bubble (SB1)

The printer is supplied with SB1-A linked by solder bubble giving READY = High and BUSY = Low. The user may invert
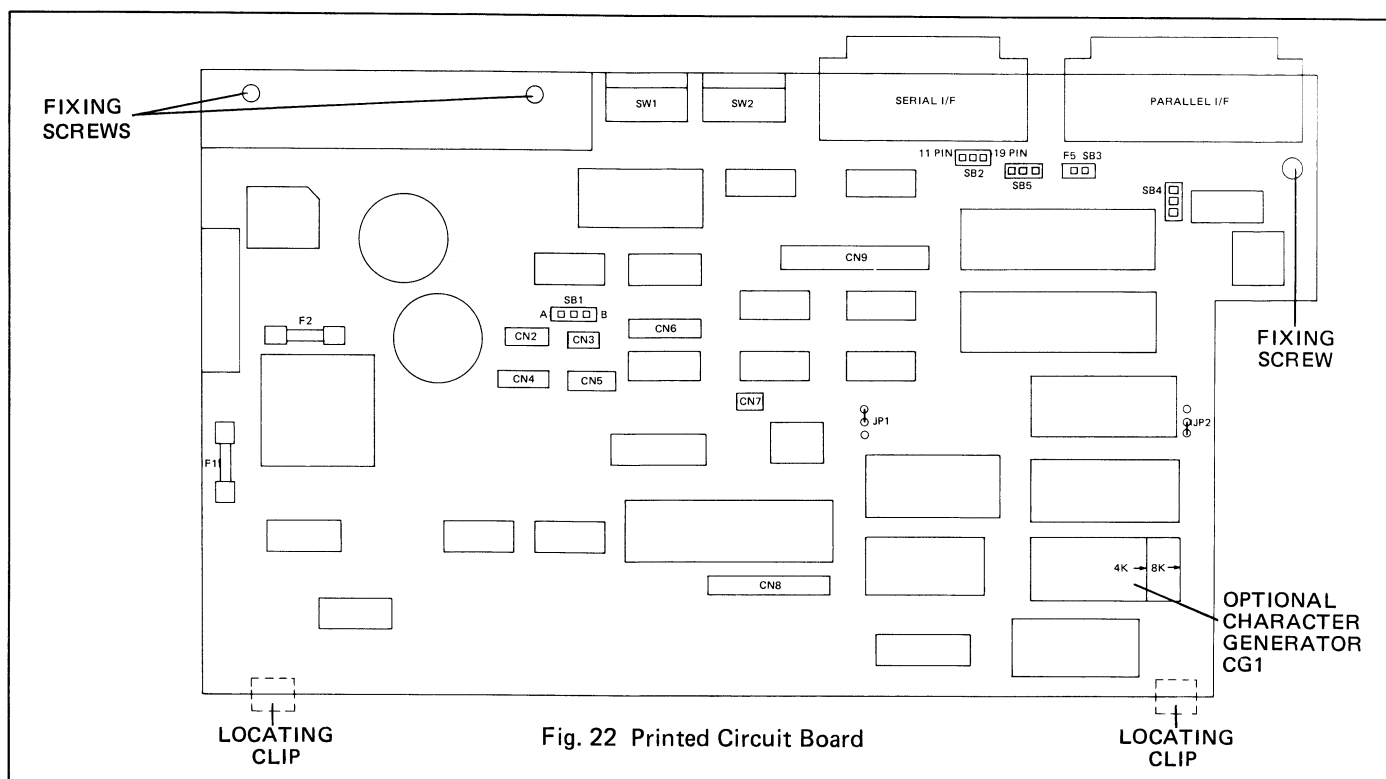

Fig. 22 Printed Circuit Board

this by breaking the solder link to SB1-A and linking the central pad to SB1-B instead.

Function	Level	
	SB1-A linked	SB1-B linked
READY	High	Low
BUSY	Low	High

9.4.2 READY/BUSY Pin Solder Bubble (SB2)

This solder bubble is used to select the pin on the serial interface connector which is used to signal READY/BUSY. When the printer is supplied, SB2—19 PIN is linked by solder bubble. The user may alternatively use pin 11 by breaking the link to SB2—19 PIN and linking the central pad to SB2—11 PIN.

9.4.3 Pin 18 +5V Solder Bubble (SB3)

When the printer is supplied, pin 18 on the serial interface connector is open circuit. If the user wishes to use the Facit 5165 Current Loop Adapter (see section 8.2.3) then the printer can be configured to supply the required +5V on pin 18 by linking solder bubble SB3.

9.4.4 CENTRONICS/EPSON Timing Solder Bubble (SB4)

This solder bubble is used to set the parallel interface timing to comply with either the Centronics or the Epson standard. The printer is supplied with Centronics timing selected: SB4—B is linked by a solder bubble. The user may select Epson timing by breaking the SB4—B link and linking the central pad to SB4—A.

9.4.5 OFF/ON-LINE Power Up Solder Bubble (SB5)

This solder bubble selects whether the printer goes to the Off-line state when mains power is switched on. The printer is supplied with Off-line selected at power up; SB5—A is linked by a solder bubble. The user may select On-line at power up by breaking the SB5—A link and linking the central pad to SB5—B.

9.4.6 Low Voltage Fuses (F1 and F2)

The output from the printer's internal power supply unit is protected by two 3A slow-blow fuses F1 and F2.

9.4.7 Optional Character Generator (CG1)

The optional character generator CG1 may be supplied in a 4K or 8K PROM. The 8K PROM completely fills the socket. The 4K PROM is shorter than the 8K version and the right hand side of the socket (nearest the edge of the board) is unused when the 4K PROM is inserted.

10. SPECIFICATION

PRINTER PERFORMANCE

Print speed:	120 cps bidirectional
Line length:	8 inch (max) (80 columns at 10 cpi)
Throughput:	55 lpm (80 printed columns, 10 cpi)

Horizontal resolution,
character mode:

	at 11.9 ips:	1/120 inch
	at 9.6 ips:	1/144 inch
	at 7.1 ips:	1/200 inch

Horizontal resolution,
pin graphics mode:

	at 11.9 ips:	1/60 inch
	at 9.6 ips:	1/72 inch
	at 7.1 ips:	1/100 inch

Vertical resolution:	72 dots/inch

Line spacing,

character mode:	1/6 inch or 1/8 inch (user selectable)
block graphics mode:	1/6 inch
pin graphics mode:	7/72 inch

CHARACTER FORMATION

Std. char. matrix:	9 x 9	
Std. char. pitch	normal:	10 cpi
	condensed:	12 cpi
	compressed:	17 cpi
Character set:	96 characters, with 8 national variations	
Block graphic matrix:	12 x 8	
Block graphic pitch,	enlarged:	7.5 cpi
	standard:	9 cpi
	condensed:	12.5 cpi
Character set:	64 block characters	
High resolution matrix:	9 x 5 to 15 (character dependent)	
High resolution pitch,	proportional:	10 to 20 cpi
	fixed:	10 cpi
Character set:	96 characters, with 8 national variations	
Optional extra character generator:	96 normal, 96 block graphic and 96 high resolution characters (user definable)	

PAPER

Paper width	Min:	4 inches (edge to edge)
	Max:	11 inches (edge to edge)
Paper thickness	Original plus 3 copies (max total thickness — 0.33 mm)	
Paper feed	Tractor (detachable) and friction feed	
Paper roll	Inner dia:	25 mm ± 1 mm
	Outer dia:	127 mm max.
	Width:	8½" max. (with shaft supplied)

FORMAT DETAILS

Vertical format control

Length of forms	Default length Switch select: 8, 8.5, 11, 12 inches By software commands: Any number of lines up to 94
Vertical tabs	Default value: Every 1 inch By software commands: Max 32
Skip zone	Default value Switch select: 0, 0.5, 1, 1.5 inch By software commands: Any number of lines up to form length minus 1 line
Vertical format commands	Line feed, Vertical tab, Form feed, Local line feeds

Horizontal format control

Horizontal tabs	Every 1 inch

RIBBON

Type	Cassette with endless loop
Life	4 million characters

INPUT BUFFER

Capacity	2K

INTERFACES

Serial	V.24/RS-232-C (110 — 9600 bps)
Parallel	Centronics type
Current loop	Prepared for Facit 5165 I-loop adapter
Protocol	Ready/Busy and X-ON/X-OFF
Self test	Non-printing, printing and loop-back self test

POWER SUPPLY

Voltage:	100/120V (US version) 220/240V (European version) all ± 10%
Frequency:	48—62 Hz
Consumption:	50W printing
Fuse:	Slow-blow European size 220/240V—1A, 100/120V—2A

DIMENSIONS

Width:	430 mm
Height:	150 mm
Depth:	340 mm
Weight:	9 Kg

11. INSTALLATION AND MAINTENANCE

11.1 Installation

The printer should be installed on a secure, level surface with sufficient room for access to the controls and for the paper supply in use. Remove the internal transit protection (black corrugated plastic tube) from the carriage guide bar as follows:

(1) Ensure that the slit along the tube is at the bottom.

(2) Grasping the tube at the end by the print head, pull firmly and steadily up and away from the print head.

(3) Retain the tube for use in subsequent transit operations.

Set the mains selector switch for local supply voltage (see section 9.3.2).

Fit the ribbon cassette as described in the Operator Guide.

16 DIP switches at the rear of the printer let the user configure the printer for specific requirements. These are factory set to the Off position and must be reset if required, before power-up (see section 9.2).

The tractor feed unit is supplied already fitted to the printer. If friction feed is required the tractor feed unit should be removed (see Facit 4510 Operator Guide). A paper roll holder and paper support/separator are supplied with the printer and one or the other should be fitted to the printer to suit the type of paper in use (again see the Operator Guide for details).

Connect the printer to the mains supply and to the host and switch on the printer. The print head should move to the home position (position 0 on the paper bail ruler). All that is necessary now for normal operation is loading of appropriate paper and setting the printer On-line.

11.2 Regular Maintenance

The printer should be switched off and disconnected from the mains supply before performing any maintenance activities.

A maintenance kit is provided with the printer, consisting of two brushes and a bottle of oil. The oil is to lubricate the carriage where it slides on the guide bar only. No other parts should be oiled.

The following maintenance schedule is based on intermittent daily use and may be modified according to actual usage and the operating environment.

11.2.1 Monthly

(1) Carefully clean off any accumulation of ink particles from around the print head nose (see section 11.3 for access) using the brushes supplied. Adjust print head-to-platen distance to optimise printing (see Operator Guide).

(2) Clean out the printer's interior to remove paper debris, paper clips, staples etc.

(3) Check platen for damage or wear (see section 11.6).

(4) Check for free movement of the carriage across the full width of travel in both directions (see section 11.2.2).

11.2.2 Yearly

After 50 million characters have been printed, or yearly (whichever comes first), oil the carriage guide bar as follows:

(1) Remove the ribbon cassette.

(2) Move the carriage to one side and clean the guide bar with a tissue. Move the carriage to the other side and repeat the cleaning exercise.

(3) Apply one or two drops of oil to the guide bar at the side of the carriage and move the carriage across and back a few times to distribute the oil evenly (add more oil sparingly if necessary). Do not use excessive amounts of oil.

(4) Replace the ribbon cassette.

Note: This operation should be repeated imediately before any long-term storage of the printer.

11.2.3 As Necessary

The printer case may be cleaned with a damp cloth (using a mild detergent solution).

The print head may be easily replaced by the user (see section 11.3).

11.3 Print Head Replacement

After extended periods of use (in excess of two years in a typical environment) where excessive print head wear has occurred, the print head may be simply exchanged by the user as follows:

(1) Switch off the printer and disconnect from the mains supply.

(2) Remove the ribbon cassette and move the print head to the centre of the carriage for ease of handling.

(3) Remove the print head spring clip by simultaneously pressing down and pushing away the right hand edge (see fig. 23). When this is free the clip may be lifted off by locating the large hole at the left hand side

Fig. 23 Removal of Print Head
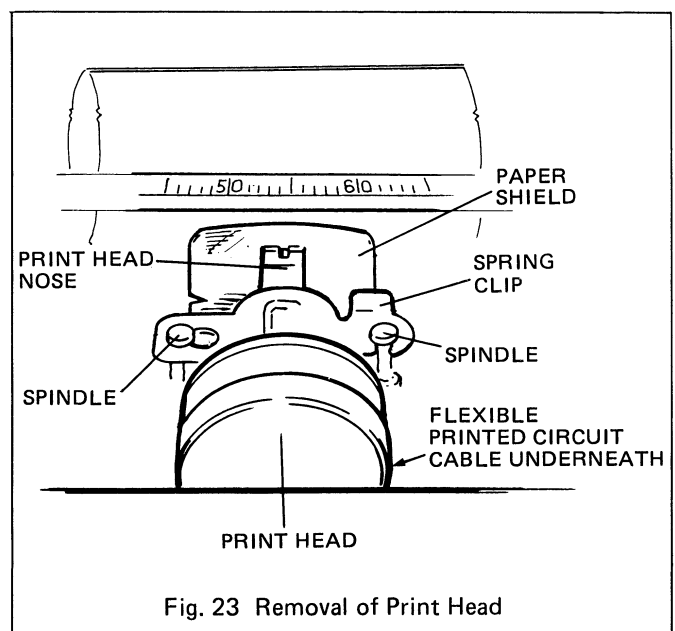
over the spindle and lifting up while keeping the clip horizontal.

(4) Lift up the print head carefully; it is still connected to the printer by a flexible printed circuit cable and connector. These may be disconnected by pulling the cable firmly from the bottom of the print head.

(5) Plug the cable into the new print head and fit the print head onto the carriage, locating it by means of the two spigots on the carriage which engage with holes in the print head.

(6) Refit the spring retaining clip while holding the print head in position.

(7) Refit the ribbon cassette and switch on the printer.

11.4 Removal of Cover

(1) Switch off the printer and disconnect it from the mains supply.

(2) Pull off the platen knob at the right of the printer.

(3) Remove the four cross-head screws in the printer base (2 at each side).

(4) Lift off the cover, swinging it backwards to allow for the connections to the control panel. The control panel connections may be unplugged from the printed circuit board (connector CN9) see fig. 22.

11.5 Removal of Printed Circuit Board

The printed circuit board needs to be removed from the printer for the following operations:

(1) Changing of solder bubbles (see section 9.4.1, 2 and 3).

(2) Checking/replacement of low voltage fuses (see section 9.4.4).

(3) Installation of optional Character Generator CG1 (see section 9.4.5).

To remove the printed circuit board:

(1) Remove the printer's cover as described in section 11.4 (disconnect CN9).

(2) Disconnect any interface connectors.

(3) Remove the three retaining screws (locations shown in fig. 22).

(4) Unplug connectors CN1 to CN7 from the printed circuit board, pull the board gently out and unplug connector CN8.

(5) Lift the board out from the printer.

To refit the printed circuit board.

(1) Lay the board in the printer.

(2) Plug in connector CN8 (flexible printed circuit cable) first and then connectors CN1 to CN9 (each plug will fit in only one socket).

(3) Carefully push the printed circuit board in under the platen assembly so that the edge of the board fits into the two white plastic support clips.

(4) Refit the three screws in the locations shown in fig. 22.

(5) Plug in connector CN9 (from the control panel) and refit the cover.

(6) Reconnect the interface connector.

11.6 Removal of Platen

The platen may be removed for cleaning or replacement as follows:

(1) Remove the cover and print head (see sections 11.4 and 11.3).

(2) The platen is retained by spring clips fixed to the platen shaft at each side of the platen roller. If each clip is moved inwards the corresponding end of the platen may be lifted out of the printer. Full details of platen removal and replacement are given in the Service Instruction.

APPENDIX 1
STANDARD CHARACTERS

HEX CODE	2	3	4	5	6	7
0	SP	0		P		p
1	!	1	A	Q	a	q
2	"	2	B	R	b	r
3		3	C	S	c	s
4	$	4	D	T	d	t
5	%	5	E	U	e	u
6	&	6	F	V	f	v
7	'	7	G	W	g	w
8	(	8	H	X	h	x
9	)	9	I	Y	i	y
A	*	:	J	Z	j	z
B	+	;	K		k	
C	,	<	L		l	
D	–	=	M		m	
E	.	>	N		n	
F	/	?	O	_	o	DEL

The shaded areas indicate characters which are subject to national variation. These are listed below.

National Variations

Nation	Hex Code										
	23	40	5B	5C	5D	5E	60	7B	7C	7D	7E
US	#	@	[	\	]	^	`	{	|	}	~
Swedish/Finnish	#	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
Danish/Norwegian	#	É	Æ	Ø	Å	Ü	é	æ	ø	å	ü
German	#	§	Ä	Ö	Ü	^	`	ä	ö	ü	ß
British	£	@	[	\	]	^	`	{	|	}	—
Italian	£	@	°	§	é	^	ù	à	ò	è	ì
French/Belgian	£	à	°	ç	§	^	`	é	ù	è	..
Spanish	£	§	¡	Ñ	¿	^	`	°	ñ	ç	~

APPENDIX 2
BLOCK GRAPHICS CHARACTERS

HEX CODE	2 KEY	2 CHAR	3 KEY	3 CHAR	4 KEY	4 CHAR	5 KEY	5 CHAR	6 KEY	6 CHAR	7 KEY	7 CHAR
0	Space		0		@*	@*	P	P	_*		p	
1	!		1		A	A	Q	Q	a		q	
2	"		2		B	B	R	R	b		r	
3	#*		3		C	C	S	S	c		s	
4	$		4		D	D	T	T	d		t	
5	%		5		E	E	U	U	e		u	
6	&		6		F	F	V	V	f		v	
7	'		7		G	G	W	W	g		w	
8	(		8		H	H	X	X	h		x	
9	)		9		I	I	Y	Y	i		y	
A	*		:		J	J	Z	Z	j		z	
B	+		;		K	K	[*	[*	k		{*	
C	,		<		L	L	*	*	l		|*	
D	–		=		M	M	]*	]*	m		}*	
E	.		>		N	N	^*	^*	n		~*	
F	/		?		O	O	_	_	o		DEL	

*Subject to national variation, see Appendix 1.

APPENDIX 3

SUMMARY OF COMMANDS

CHARACTER MODE

COMMAND	HEX CODE	ASCII KEY SEQUENCE
SELECT NATIONAL VERSION – U.S.	1B 38 40	ESC 8 @ *
SWEDISH/FINNISH	1B 38 41	ESC 8 A
DANISH/NORWEGIAN	1B 38 42	ESC 8 B
GERMAN	1B 38 43	ESC 8 C
BRITISH	1B 38 44	ESC 8 D
ITALIAN	1B 38 45	ESC 8 E
FRENCH/BELGIAN	1B 38 46	ESC 8 F
SPANISH	1B 38 47	ESC 8 G
SELECT LINE SPACING – 6 lpi	1B 34	ESC 4
8 lpi	1B 35	ESC 5
SELECT PIN GRAPHICS RESOLUTION – 60 d/i	1B 2E 4E	ESC . N
72 d/i	1B 2E 4D	ESC . M
100 d/i	1B 2E 48	ESC . H
SELECT CHARACTER GENERATOR – 0	1B 2F 40	ESC / @ *
1	1B 2F 41	ESC / A
SET VERTICAL TABS	1B 31 (N_1 .. N_{32}) 7F	ESC 1 (N_1 .. N_{32}) DEL
SET FORMAT LENGTH	1B 32 (N) 7F	ESC 2 (N) DEL
SET RIGHT MARGIN	1B 29 (N) 7F	ESC) (N) DEL
SET SKIP ZONE	1B 2A (N) 7F	ESC * (N) DEL
SET SPACING INCREMENT	1B 20 (N) 7F	ESC SP (N) DEL
SET SI SEQUENCE	1B 0F [string] 7F	ESC [CTRL+O] [string] DEL
SET SO SEQUENCE	1B 0E [string] 7F	ESC [CTRL+N] [string] DEL
SELECT FONT – NORMAL	1B 36 (or 02)	ESC 6 or [CTRL+B]
CONDENSED	1B 39	ESC 9
COMPRESSED	1B 37	ESC 7
HIGH RESOLUTION – CONSTANT	1B 3A	ESC :
PROPORTIONAL	1B 3B	ESC ;
BLOCK GRAPHICS – CONDENSED	1B 3C	ESC <
NORMAL	1B 3D	ESC =
ENLARGED	1B 3E	ESC >
PIN GRAPHICS	16	[CTRL+V]
SHIFT IN	0F	[CTRL+O]
SHIFT OUT	0E	[CTRL+N]
START ELONGATED	1E	[CTRL+^] *
START UNDERLINED	1D	[CTRL+]] *
END ELONGATED/UNDERLINED	1F	[CTRL+_]
HORIZONTAL TAB	09	[CTRL+I]
BACKSPACE	08	[CTRL+H]

COMMAND	HEX CODE	ASCII KEY SEQUENCE
SPACING INCREMENT	18	[CTRL+X]
ABSOLUTE CHARACTER POSITION	1B 2B (n) 7F	ESC + (n) DEL
ABSOLUTE DOT POSITION	1B 2C (n) 7F	ESC , (n) DEL
REPEAT DATA	1B 2D (n) 7F	ESC - (n) DEL
HALF LINE FEED FORWARD	1B 55	ESC U
FULL LINE FEED FORWARD	1B 4E	ESC N
HALF LINE FEED BACK	1B 44	ESC D
FULL LINE FEED BACK	1B 10	ESC [CTRL+P]
CARRIAGE RETURN	0D	[CTRL+M]
LINE FEED	0A	[CTRL+J]
VERTICAL TAB	0B	[CTRL+K]
FORM FEED	0C	[CTRL+L]
RESET TO POWER UP	1B 30	ESC Ø

*Subject to national variation (see Appendix 1)

PIN GRAPHICS MODE

COMMAND	HEX CODE	ASCII KEY SEQUENCE
SELECT FONT – NORMAL CONDENSED COMPRESSED HIGH RESOLUTION – CONSTANT PROPORTIONAL BLOCK GRAPHICS – CONDENSED NORMAL ENLARGED	16 1B 36 (or 16 02) 16 1B 39 16 1B 37 16 1B 3A 16 1B 3B 16 1B 3C 16 1B 3D 16 1B 3E	[CTRL+V] ESC 6 ([C+V][C+B]) [CTRL+V] ESC 9 [CTRL+V] ESC 7 [CTRL+V] ESC : [CTRL+V] ESC ; [CTRL+V] ESC < [CTRL+V] ESC = [CTRL+V] ESC >
START ELONGATED END ELONGATED	16 1E 16 1F	[CTRL+V] [CTRL+^]* [CTRL+V] [CTRL+–]*
ABSOLUTE DOT POSITION	16 1B 2C (n) 7F	[CTRL+V] ESC , (n) DEL
REPEAT DATA	16 1B 2D (n) 7F	[CTRL+V] ESC – (n) DEL
CARRIAGE RETURN	16 0D	[CTRL+V] [CTRL+M]
LINE FEED	16 0A	[CTRL+V] [CTRL+J]
FORM FEED	16 0C	[CTRL+V] [CTRL+L]
RESET TO POWER UP	16 1B 30	[CTRL+V] ESC Ø
PRINT DOTS 2+3+5	16 16	[CTRL+V] [CTRL+V]

* Subject to national variation (see Appendix 1)

APPENDIX 4
RELATIVE HEX CONVERSION TABLE

Decimal Value	Hex Code	Decimal Value	Hex Code	Decimal Value	Hex Code	Decimal Value	Hex Code	Decimal Value	Hex Code	Decimal Value	Hex Code
0	20	16	30	32	40	48	50	64	60	80	70
1	21	17	31	33	41	49	51	65	61	81	71
2	22	18	32	34	42	50	52	66	62	82	72
3	23	19	33	35	43	51	53	67	63	83	73
4	24	20	34	36	44	52	54	68	64	84	74
5	25	21	35	37	45	53	55	69	65	85	75
6	26	22	36	38	46	54	56	70	66	86	76
7	27	23	37	39	47	55	57	71	67	87	77
8	28	24	38	40	48	56	58	72	68	88	78
9	29	25	39	41	49	57	59	73	69	89	79
10	2A	26	3A	42	4A	58	5A	74	6A	90	7A
11	2B	27	3B	43	4B	59	5B	75	6B	91	7B
12	2C	28	3C	44	4C	60	5C	76	6C	92	7C
13	2D	29	3D	45	4D	61	5D	77	6D	93	7D
14	2E	30	3E	46	4E	62	5E	78	6E	94	7E
15	2F	31	3F	47	4F	63	5F	79	6F		

Facit 4510
Serial matrix printer

FACIT
DATA
PRODUCTS