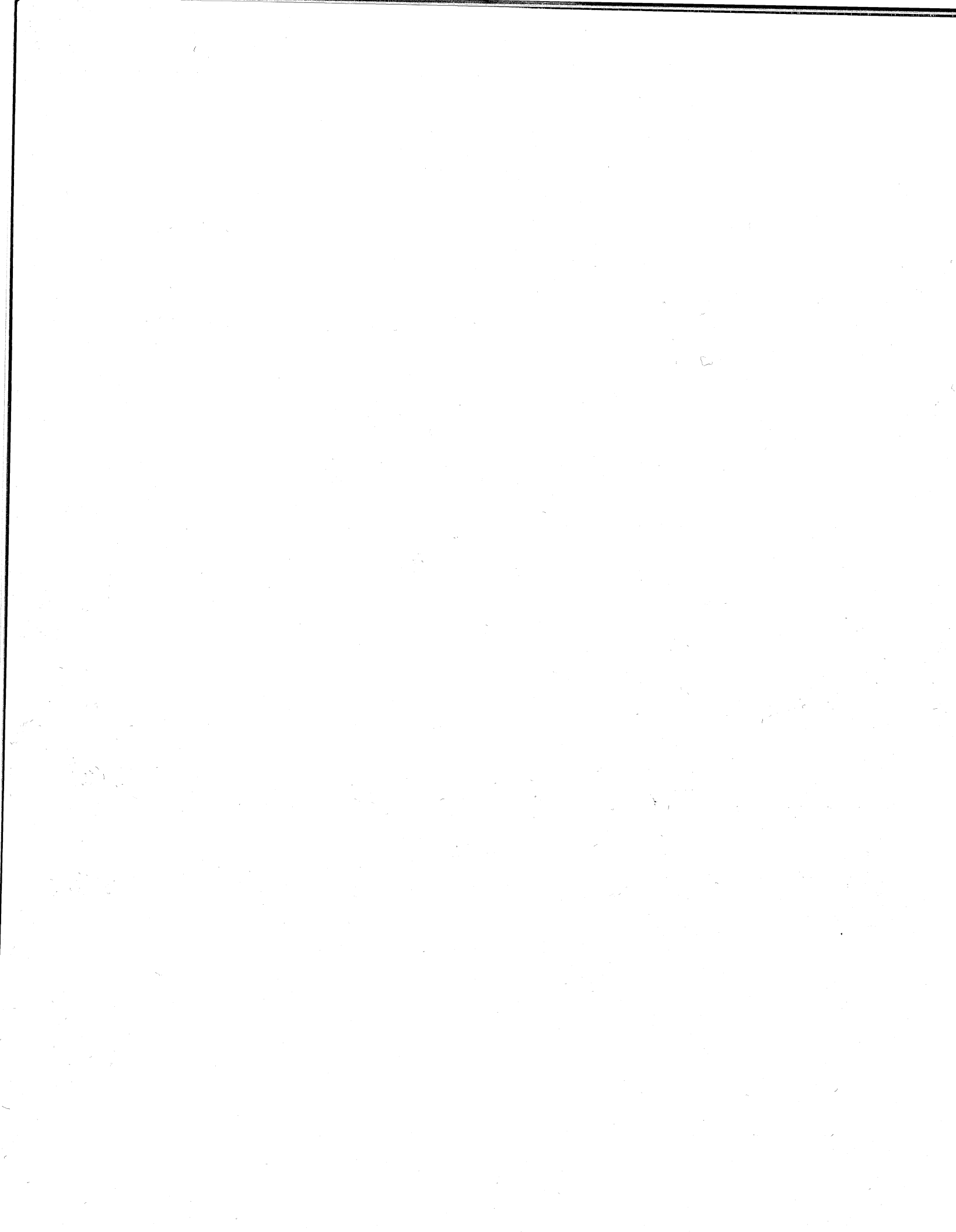


**Technical
Manual
6040-6043
DASHER™ TP1
TERMINAL
PRINTERS**

10, 15, 30, 60 cps

015-000051-03



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Ordering No. 015-000051

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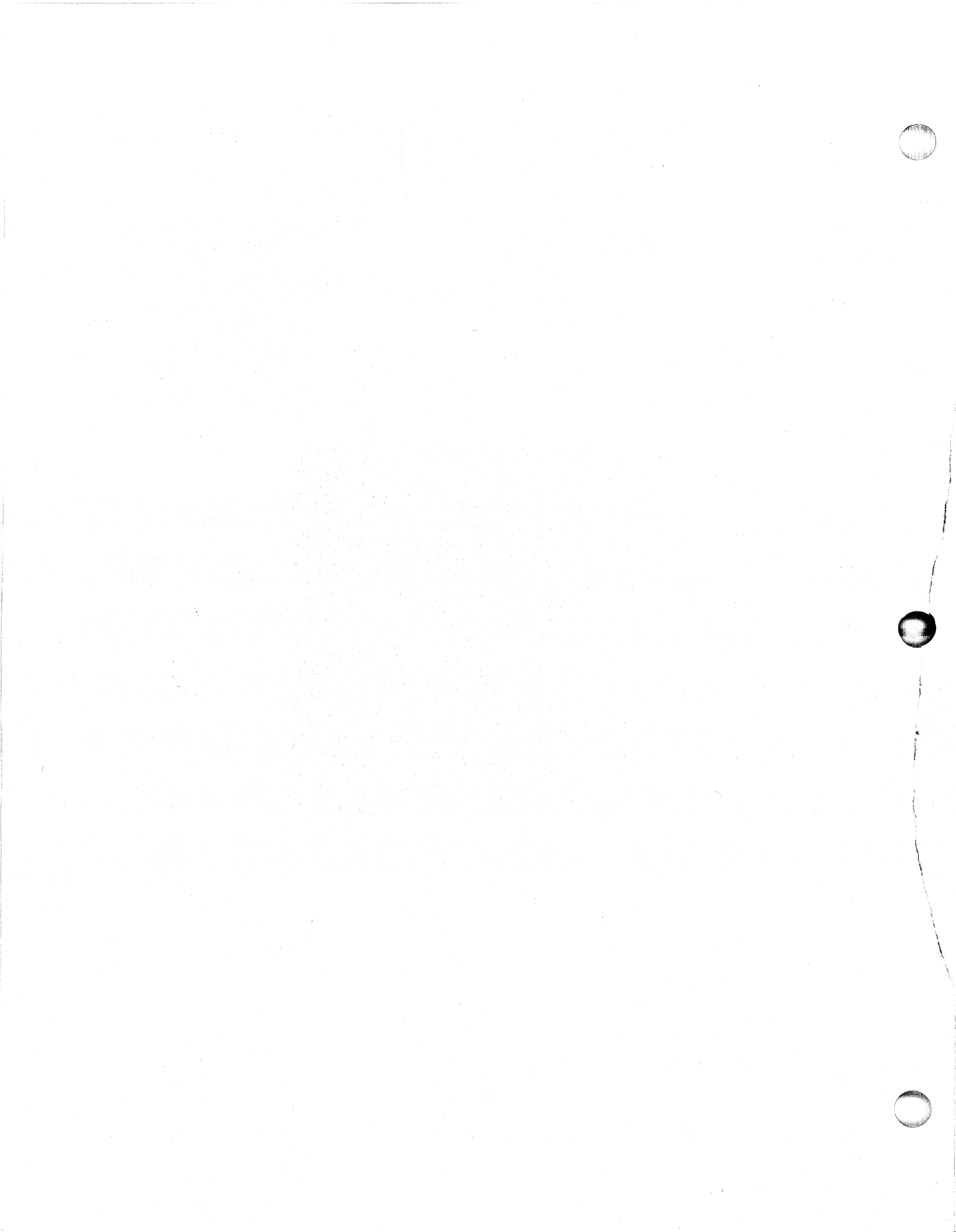
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**6040-6043
DASHER™ TP1
TERMINAL
PRINTERS**
10, 15, 30, 60 cps

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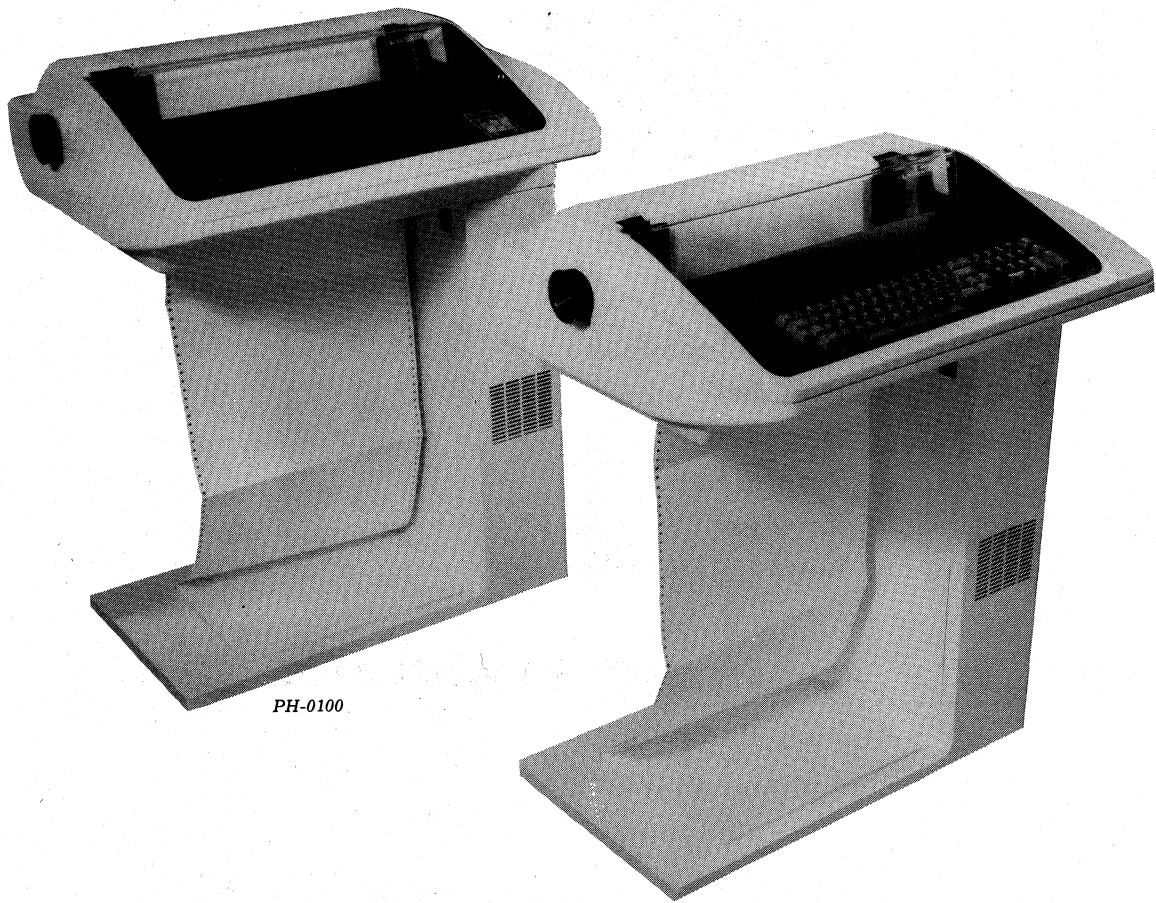
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DASHER TERMINAL PRINTER



PH-0100

SECTION I OVERVIEW

Data General's 6040 or 6042 DASHER™ TP1 terminal printer is a free standing unit with: a 128-ASCII compatible, capacitor-switched keyboard; a 5x7 dot matrix, upper/lower case, serial printer; and integral asynchronous interface to 20ma current loop and EIA RS-232C controllers. The terminal is fully plug compatible with all Data General asynchronous interfaces and some modems; the terminal is entirely upward-compatible with DGC software designed to drive teletypewriters. Models 6041 and 6043 are receive (printer) only models similar to the 6040 and 6042. Character transfer rate is selectable to 30 or 60cps on models 6040 and 6041, and to 10, 15, or 30cps on models 6040 and 6043.

INTRODUCTION

Hard copy data terminals have principal applications where a printed record of the dialogue between a user and the computer system is important, or where low volume report generation does not require higher speed and higher cost output printers. They are particularly useful for computer system maintenance or troubleshooting; most Data General diagnostic and reliability test programs presume that at least one teletypewriter-like terminal be available for user prompts and statistical printouts.

The 6040-6043 terminals are quiet, reliable, replacements for teletypewriter equipment previously offered by DGC for NOVA ECLIPSE and microNOVA computer systems. They combine a high performance, electronic keyboard with a stepper-controlled printer and a paper feed mechanism using a minimum of moving parts. Electronic circuitry is contained on one large printed circuit board.

Model 6042 is the basic teletypewriter replacement, providing true 30cps throughput when used with Data General's standard communications hardware and software. Model 6040 is a speed-enhanced terminal offering 60cps throughput; DGC recommends its use with certain I/O controllers with modem controls to maintain full compatibility with DGC software. General specifications for the terminals are summarized in the table to the right; complete specifications for each model are presented in Appendix A.

SUMMARY OF CHARACTERISTICS

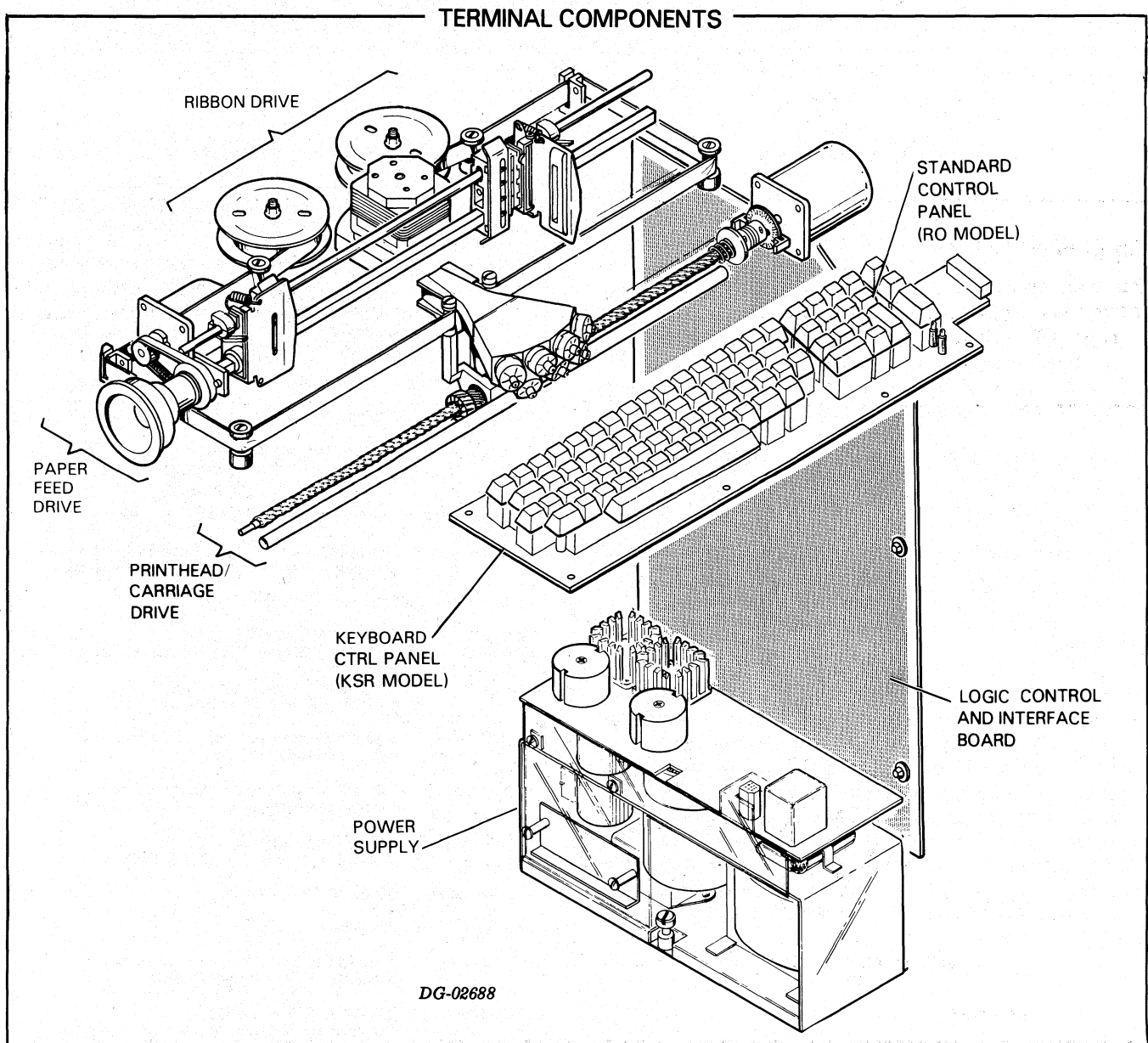
Character Set (Appendix B)	6 Standard ASCII character sets: AMERICAN, FRENCH, GERMAN, SWEDISH, UK, and ASCII/JAPANESE. Lower/upper case character foldover, jumper selectable. An additional 29 symbols can be enabled; these correspond to character codes usually ignored by most terminals; the symbols in this "extended" set of characters are ASCII standard "control" symbols.
Character Style	5 x 7 dot matrix, inclined 10 degrees to the right.
Character Size	Approximately 0.082" (base) 0.107" (height)
Printing Size	10 characters per inch (horizontal) 132 characters per line (maximum) 6 characters per inch (vertical)
Character Buffer	(interface to printhead) 40 characters, FIFO
Keyboard Type	3-level, capacitor-switched, electronically debounced unlimited key-rollover (ordered by falling keystroke)
Keyboard Layout	ANSI standard, typewriter-paired
Printing Speed (Maximum)	6040/6041: 60cps @600 baud 6042/6043: 30cps(normal) 60cps(catch-up) @300 baud
Forms	pin feed forms only (1/2" centers) Minimum - 4" wide; Maximum - 15" wide
Multiple Forms	6-part forms, maximum (top sheet must be paper) 0.025" maximum form pack
Ribbon Type	0.5" x 80yds. mylar or 40yds. ink impregnated fabric multi-pass on each half of ribbon; auto-reversing
Control Codes	015 CR (Carriage Return) 007 BEL (tone) 012 LF (Line Feed) 177 DEL is ignored
Carriage Return	600ms for 132 column return
Line Feed	33ms/line
AC voltages	120V (standard), 100V, 240V, and 220V tolerances: +10% - 15% V, 47Hz-63Hz
Dimensions	33.75" (h), 21" (d), 26.5" (w) all models are free-standing and pedestal-mounted

6040 - 6043 DATA TERMINALS

Each data terminal is an electromechanical device which communicates with the computer system through a device cable. Mechanical and electrical components within the terminal interact to perform terminal functions. The various components may be conveniently grouped into five systems: the printhead/carriage drive, the paper feed drive, the ribbon drive, the keyboard (6040 and 6042 only) and control panel (KSR models) or Control panel only (ROA models), and the control logic and interface board, power supply and cabling system. All are contained in a free-standing enclosure, and their relative locations are shown in the figure below. Each system is shown isolated on the facing page, and a brief functional description of each is included there. More detailed descriptions of the components and their operation may be found in Section

V of this manual. Adjustment and repair procedures for these systems are detailed in the 6040-6043 Field Service Maintenance Manual. (DGC No. 015-000052.)

The enclosure consists of a stamped metal pedestal and an injection molded, two piece housing, whose top cover swings open to expose all mechanical systems. Panels on the sides of the pedestal provide access to the logic board and power supply. The systems are modular in construction and are designed with a minimum of moving parts to minimize wear and maximize service life. The assemblies are easily removed, replaced and adjusted in the field. The drawing below is a left-front view of the terminal, with the top cover open and the five systems emphasized. The drawings on the facing page show each system in the same perspective as below.

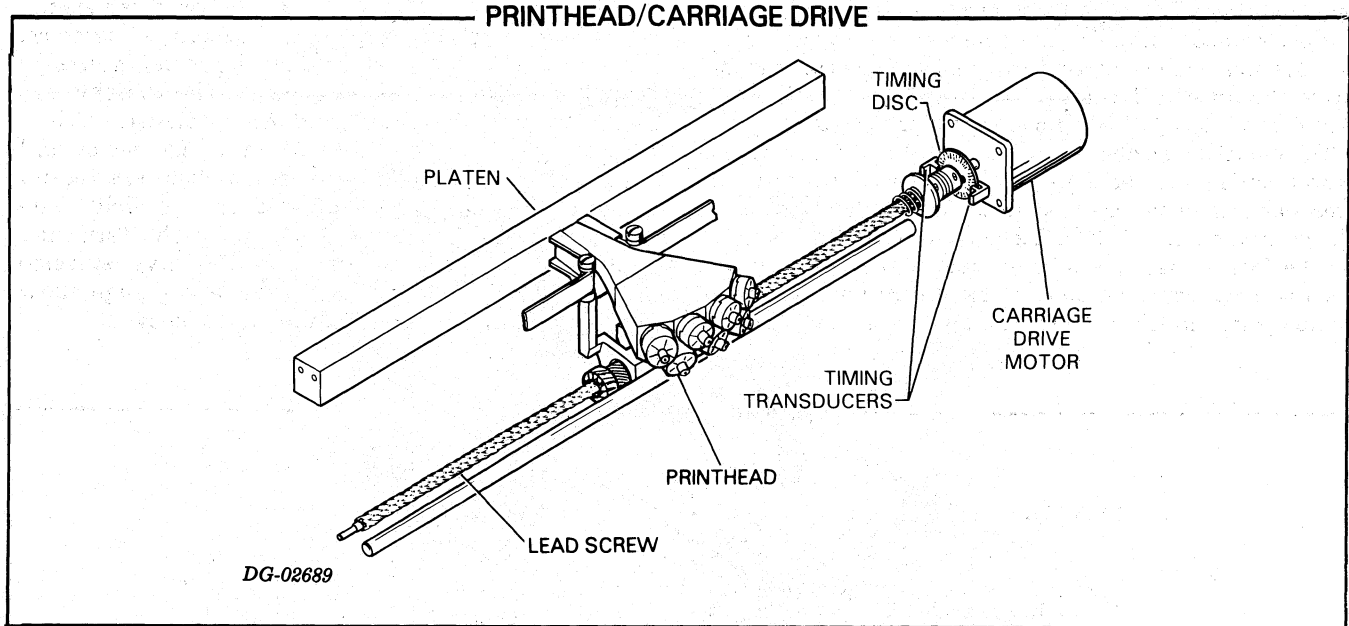


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Printhead/Carriage Drive

An anti-backlash lead screw and a permanent magnet stepping motor move the dot matrix printhead and

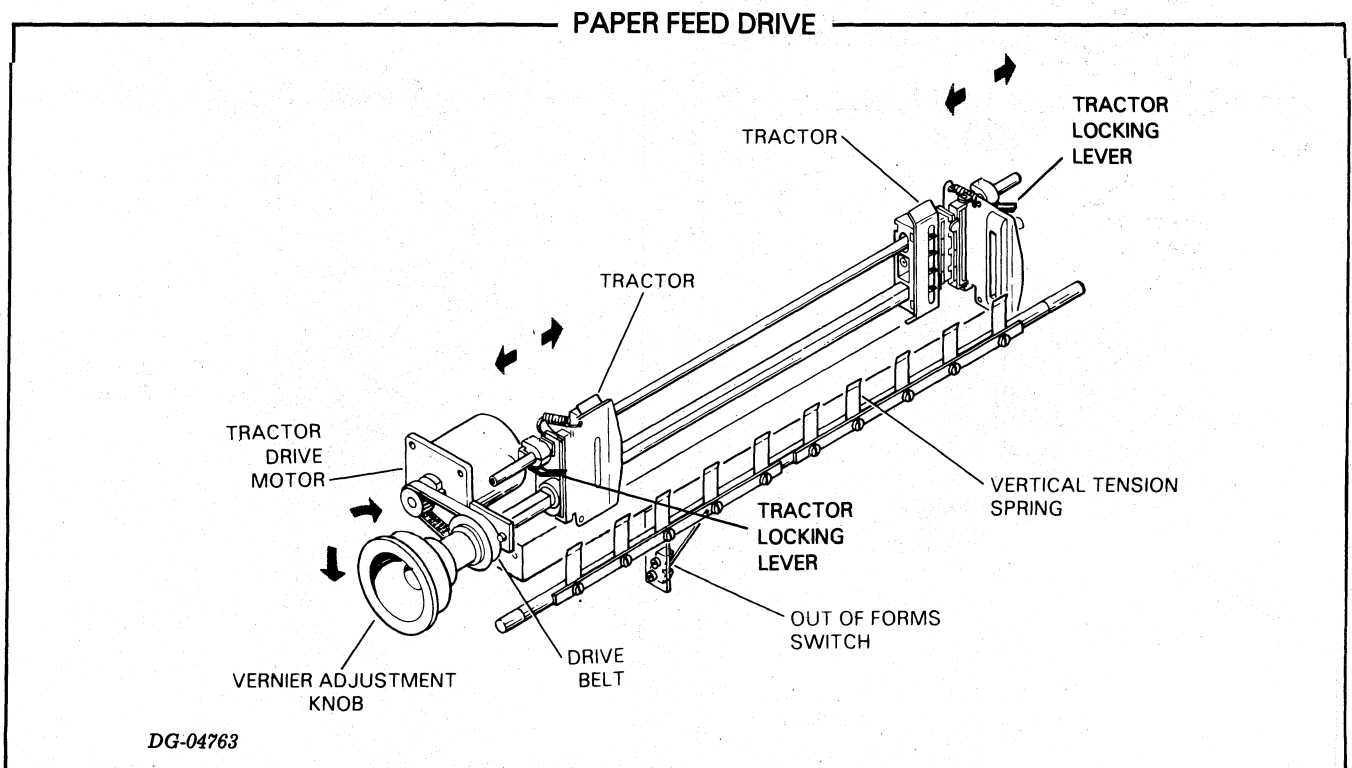
carriage across the platen during carriage returns and printing operations. Signals from the timing transducer also trigger the printhead solenoids when a character is printed.



Paper Feed Drive

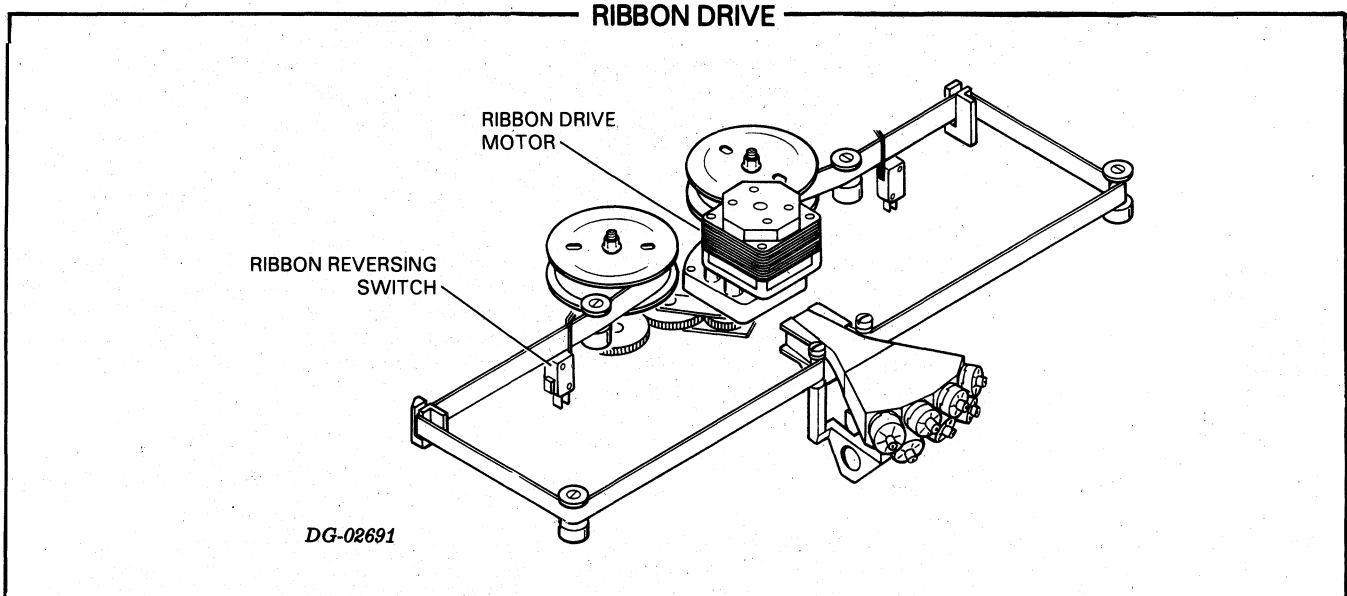
Pin feed tractor assemblies, driven by a stepping motor via a timing belt, advance the paper one line at a time. The tractors are easily adjustable to

accommodate different paper widths; a vernier adjustment knob provides manual paper height control. The form feed option will automatically advance the paper to the top of the next form on forms up to 16.5 inches long.



Ribbon Drive

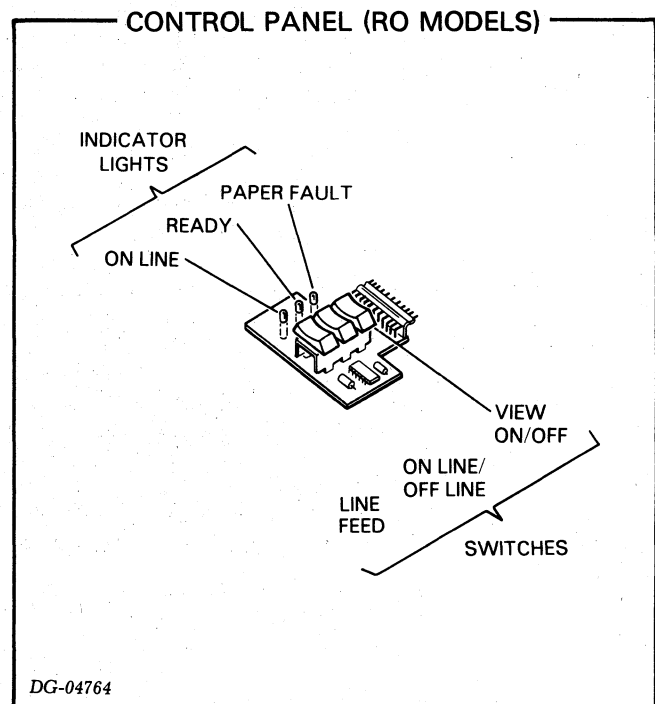
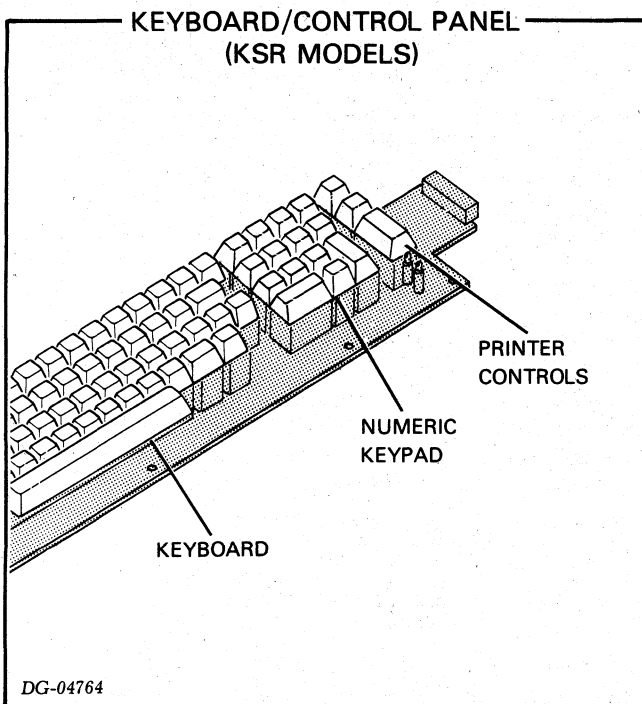
The drive motor winds the ribbon from spool to spool during carriage returns, and couples to the driven spool via a swing arm gear train. Ribbon reversing switches automatically reverse ribbon direction when the supply spool is empty.



Keyboard and Control Panel (KSR Models)

The keyboard may generate all 128 USASCII codes. N-key rollover is standard. The control panel contains switches and indicator lights for operator functions. Numeric keypad incorporates these operator controls and indicator

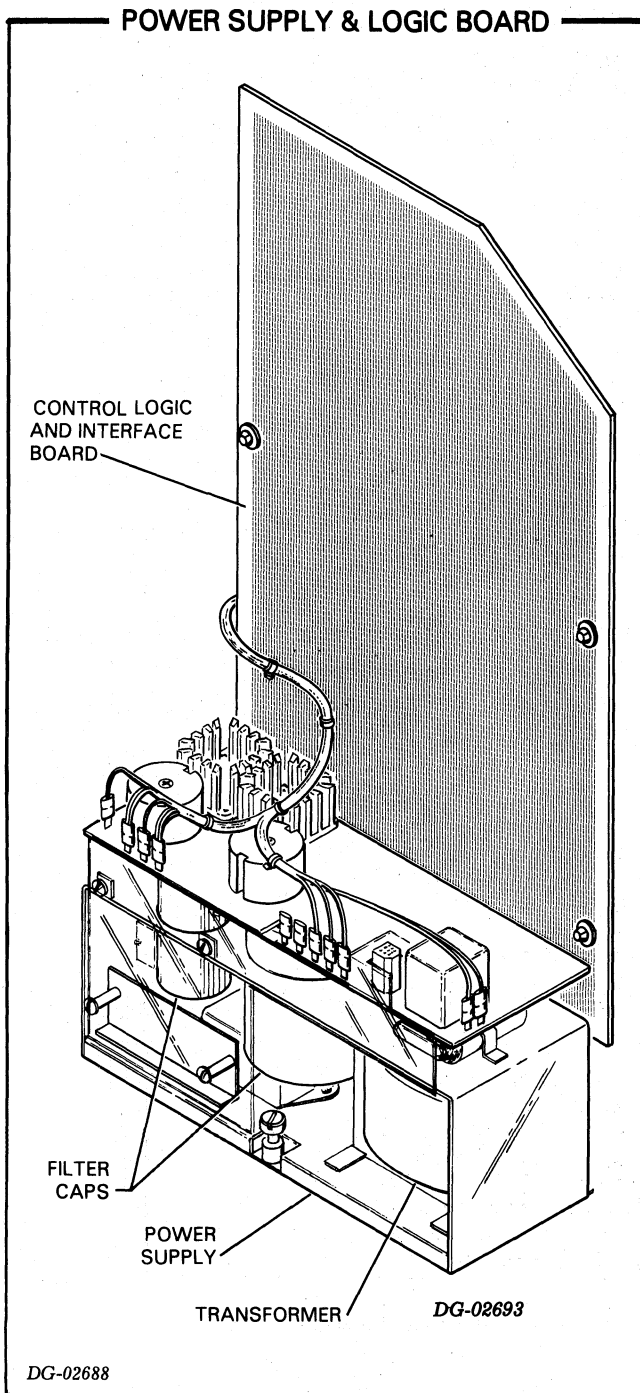
lights with an eleven-key numeric pad. The numeric keypad replaces the standard control panel. The controls for the form feed option are located under the top cover in the right rear corner.



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Logic Board, Power Supply, and Cabling

The interface, decoder, and control circuits are located on one printed circuit board, accessible through a panel on the outer side of the pedestal. The power supply is contained in a sheet metal bracket, accessible through a panel on the inner side of the pedestal. Large power supply components are located inside the bracket, and the remainder of the power supply is contained on a small printed circuit board on top of the bracket. Cables carry control and power signals among the terminal's systems; all connections are made through plugs.



RELATED DOCUMENTS

Engineering Drawings

001-000963 Printer Logic (Board No. 107-000609)
001-000964 Printer Power Supply
001-001007 Printer Control Panel
001-001096 AC Input
001-001124 Printer Busy Signal
001-001301 Printer Logic (Board No. 107-000845)
001-001302 Form Feed PCB Logic
001-001385 Form Feed Logic
001-001386 60cps Conversion
010-000094 Installation Data Sheets DASHER Terminal Printers
016-000338 Power Supply IPL
016-000380 Mechanical IPL
016-000479 IPL 30cps w/Form Feed
016-000498 IPL 60cps w/Form Feed

Manuals

015-000052 6040-6043 Field Service Maintenance Manual
015-000021 Programmer's Reference Manual-Peripherals
015-000031 Interface Designer's Manual

Diagnostics

095-000437 Printer Action Test Tape
096-000437 Printer Action Test Listing



SECTION II INSTALLATION

INTRODUCTION

This section describes the on-site installation of the DASHER terminal printers. Each terminal is a free-standing unit which is connected to the computer system by a 4- or 6- wire device cable and may be used in a variety of applications using one of many Data General asynchronous communications interfaces, such as the line multiplexors, asynchronous interfaces, or the standard teletypewriter controller. Models 6042 and 6043 operate at three different data transmission rates (110, 150, or 300 baud), and with 20mA current loop or EIA RS-232C interfaces. Models 6040 and 6041 operate at two different data transmission rates (300 baud or 600 baud). They are intended primarily for use with EIA interfaces when operating at 600 baud. They can, however, operate with DGC's asynchronous controllers with both current loop and EIA interfaces.*

Installation consists of choosing a site for the terminal, unpacking it, placing it in position, installing the controller interface in the computer system, and connecting the cable. When the terminal is obtained with a complete Data General computer system, the controller will be installed in the system at the factory. However, when the terminal is obtained as an addition to an existing computer system, the customer must interface the terminal to the desired computer system component.

* The 6040 or 6041 is electrically compatible with Data General asynchronous controllers. Timing constraints imposed at 600 baud by some controllers can require that fill characters be inserted by the program.

INSTALLATION DATA SHEETS

Installation details may be found in the installation data sheets included with the equipment. These drawings provide information useful to both the installer and the system designer. The drawings contain information necessary to configure the terminal into a computer system and to install the terminal. They are divided into blocks of data which are presented in the order the information is used. The first blocks describe the system components and tabulate operating specifications. They include such information as space and power requirements.

The remaining data blocks contain information necessary to install the terminal at the installation site. The blocks are arranged in the order of installation, and have captions which are self-explanatory. Data blocks describing most controller installations are not included in the data sheets due to the large variety of possible interfaces. Typical cabling schemes are shown for some specific applications. Electrical interfacing requirements for the printer are listed on the data sheet for 20mA or EIA standard transmission line characteristics; this information is required to properly connect the terminal to the controller used in the system.

PRELIMINARY CHECKOUT

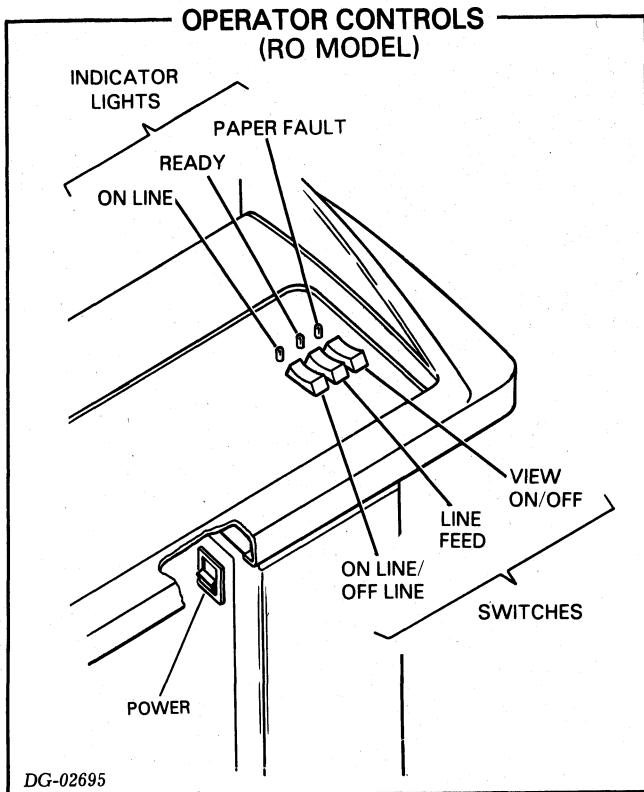
Data General recommends a preliminary checkout of a terminal after it is uncrated, to ensure that the electro-mechanical assemblies and control logic function correctly. Such a checkout procedure is described below. Unpack the terminal and remove the shipping restraints as described in the installation data sheets. Plug the terminal into the ac line supply receptacle and then load paper and ribbon as described in the operator's section of this manual.

There are two parts to the checkout; the first tests the electromechanical functions of the terminal operating off-line from the computer, while the second tests these functions when it is operating on-line with the computer. Most of the tests can be performed only on keyboard-send-receive models. These tests are marked with an "*". (The diagram on the opposite page shows the location of most operator controls.)

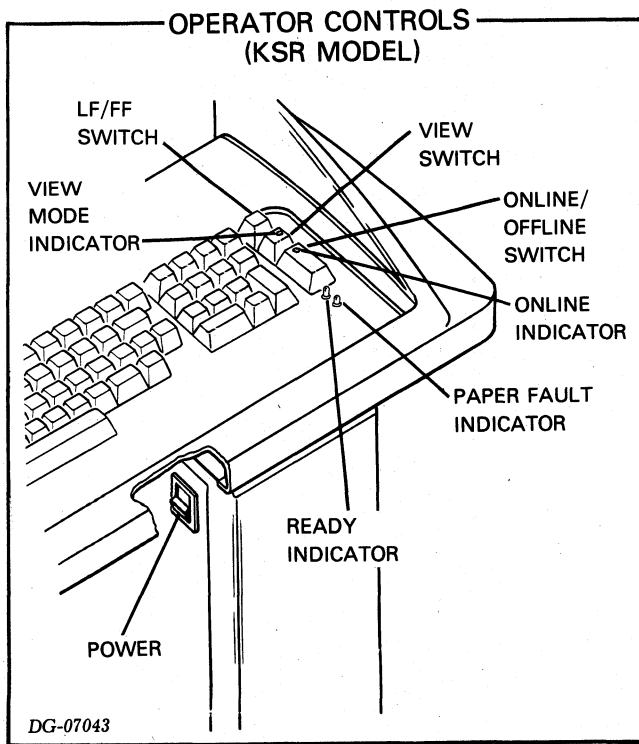
OFF LINE CHECKOUT

Procedure	Expected Result
Set the ON LINE/OFF LINE switch to the OFF LINE position. Turn the POWER switch ON.	The cooling fan spins and the RDY (Ready) light glows. The printhead returns to the column one position.
* Type a line of text, without a carriage return.	The text is printed as typed.
Depress the FEED** switch backward.	The paper advances one line.
*Depress the RETURN (Carriage Return) key.	The printhead moves to the column one position.
* Type more text, followed by a carriage return.	The text is printed as typed, and the printhead returns to the column one position. The paper does not advance.
Depress the FEED** switch backward several times.	The paper advances one line for each depression of the switch.
Hold the FEED* *switch forward.	The paper advances continually while the switch is held.
* Place the VIEW ON/VIEW OFF switch to the VIEW ON position, and type a line of text, pausing at several places to the left of column 126 for at least 1.2 seconds.	The text is printed as typed. At each pause of 1.2 seconds or more, the printhead moves 6 columns to the right of the last character printed.
* Type a full line of text pausing to the right of column 126 for at least 1.2 seconds.	The text is printed as typed. At the pause, the printhead moves 6 columns to the left of the last character printed.
* Place the VIEW ON/VIEW OFF switch to the VIEW OFF position; repeat the preceding step.	The text is printed as typed. The printhead does not move clear of the text during lapses in typing.
* Depress an alphanumeric key and the RPT key simultaneously.	The alphanumeric character is printed repeatedly until either key is released.
Check the form feed option as follows: Advance the paper to the top of the next form. Set the line count thumbwheels to the line count corresponding to the length of the form used. Press and release the TOP INIT pushbutton and press the FEED* *switch forward.	The paper advances to the top of the next form.

** The LF key on the numeric keypad.



This completes the off-line preliminary checkout of the terminal. Proceed to install the terminal in accordance with the installation data sheets. Ensure that the BAUD RATE switch setting agrees with the controller's baud rate. Check on-line operation as follows:



ON LINE CHECKOUT

Procedure	Expected Result
Turn the POWER switch ON. Set the ON LINE/OFF LINE switch to the ON LINE position.	The cooling fan spins and the READY light glows. The printhead returns to the column one position. The ON LINE indicator light glows.
Turn on the computer power, load the following "echo" program into memory locations 0 - 6 via the CPU console switches; then reset and start the computer. (For an RO terminal, use a program which transmits ASCII characters to the terminal.)	No visible result on the terminal. The computer's RUN light glows.
<pre> 063610 ;SKPDN TTI 000777 ;JMP -1 060610 ;DIAC 0,TTI (CODE 10) 063511 ;SKPBZ TTO 000777 ;JMP -1 061111 ;DOAS 0,TTO (CODE 11) 000000 ;JMP 0 </pre>	
Repeat the off-line checkout. The results should be identical.	
Check the form feed option as follows:	
Switch the terminal OFF LINE. Activate the automatic perforation skip-over feature and set the line count thumbwheels to the number of lines corresponding to the length of the form being used.	No visible result on the terminal.
Adjust the paper so the printhead is about 1/2" below the top of the form. Press and release the TOF INIT pushbutton. Switch the terminal ON LINE. Type in several lines of text and press the CTRL and the L keys simultaneously. (For an RO terminal, transmit to the terminal an appropriate number of ASCII printing characters followed by a Form Feed character.)	The text is printed as typed and the paper advances to 1/2" below the top of the next form.
Repeat the above procedure typing in the same number of lines as set by the line count thumbwheels.	The text is printed as typed until the last six lines are reached. The paper advances to 1/2" below the top of the next form and the last six lines are printed.

This completes the preliminary checkout of the terminal. If any expected result is not obtained, check cabling connections, baud rate switch setting, program coding, and input power, and repeat these procedures. If the unit still fails to function correctly, contact the nearest Data General Field Service representative for assistance.



SECTION III

PROGRAMMER'S REFERENCE INFORMATION

INTRODUCTION

This section describes the programming instructions and conventions used with the DASHER terminal printers, models 6040 thru 6043. The 6040 or the 6042 terminal is a self contained, free-standing, keyboard send and receive (KSR) input/output terminal which responds to and transmits serial character codes. The 6041 or the 6043 terminal is a receive-only (RO) printer. All data transfers take place in bit-serial fashion via a 20mA current loop or an EIA interface. Models 6040 and 6041 receive data at baud rates of 300 or 600 bits per second, while models 6042 and 6043 receive data at rates of 110, 150, or 300 bits per second.

The table at right summarizes the programming information for Data General's basic I/O controllers as presented in this section. It can serve as a quick reference guide for the programmer.

Data moves between the terminal and the interface in full duplex transmission mode; that is, the terminal appears as two separate devices when operated on-line. The keyboard is the input device and the printer is the output device. Because they appear as two separate devices, the program must echo each character entered at the keyboard if the characters are to be printed as they are typed.

All the exchanges of data between the keyboard and the computer and between the computer and the printer utilize the ASCII code given in Appendix B. While the keyboard generates the full 128-character ASCII alphanumeric code, the printer responds to a subset of this character code. The characters which the terminals print depends on certain jumper positions located on the main logic board. Subsets of printable characters are defined in Appendix B.

PROGRAMMING SUMMARY

Primary Mnemonic	
Transmitter	TTI
Receiver	TTO
Primary Device Code	
Transmitter	10
Receiver	11
Secondary Mnemonic	
Transmitter	TTI1
Receiver	TTO1
Secondary Device Code	
Transmitter	50
Receiver	51
Priority Mask Bit	
Transmitter	14
Receiver	15
Characters/line	132
Lines/inch	6
Average Transfer Rate (cps, model 6042/43)	30

ACCUMULATOR FORMATS

Read Character (DIA to TTI)



Write Character (DOA to TTO)



S, C, and P FUNCTIONS

- f = S Sets the Busy flag to 1 and the Done flag to 0. No effect on receiver; initiates transmission of character to terminal.
- f = C Sets the Busy flag to 0 and the Done flag to 0. Terminates all data transfers; if issued before transmission is completed, a partial character code will be received at the terminal.
- f = P No effect.

Parity output from the keyboard is selectable to odd, even, or no parity, and must agree with that expected by the program. Installation Data Sheets describe how to select parity. The printer does not test incoming data for parity errors, but the parity (or eighth) bit is required for correct framing.

The horizontal column spacing is ten characters per inch. Vertical lines print with a spacing of six lines per inch. A maximum line length of 132 characters can be printed. The printer will accommodate forms as narrow as 4 inches in width, and up to a maximum of 15 inches in width.

The printer's vertical spacing allows standard 66 line pages to fit on 11 inch fanfolded forms. The terminal does not respond to Form Feed codes (14_8) unless it is equipped with the automatic form feed option. Without this option, the program must issue an appropriate number of Line Feed codes (12_8) to start a new page of printing.

The terminal interfaces to the I/O bus of any NOVA, ECLIPSE, or microNOVA line CPU through the 4007/10 controller, the 4075/78 controller, or a wide variety of asynchronous, serial data controllers.* A description of the programming and sample programs for reading, writing, and echoing characters with a simple I/O controller, such as the 4010, are given as general programming examples. When programming the terminal interfaced with another controller, consult the technical data for the specific controller used.

INSTRUCTIONS

The following instruction definitions and timing information are for the terminal used in conjunction with a DGC 4007/4010 controller.

The controller contains two independent character buffers, an 8-bit Input Buffer and an 8-bit Output Buffer.

The controller's Busy and Done flags are controlled using two of the device control flag commands as follows:

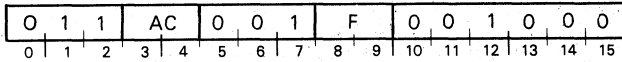
- f = S** Sets the Busy flag to 1, the Done flag to 0. Has no effect on the receiver, initiates the transmission of a character from the output buffer to the terminal.
- f = C** Sets both the Busy and Done flags to 0 and terminates data transfers. A CLEAR command issued during character transmission will cause a partial character code to be sent to the terminal.
- f = P** No effect.

* To operate full software compatibility with its diagnostic programs and operating systems, Data General recommends that, at 600 baud, the model 6040 or 6041 terminal only operates with a controller having modem controls which can test the terminal's Printer Busy flag.

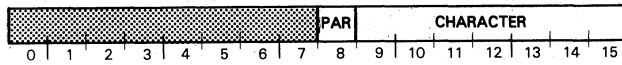
Since the terminal is actually two devices, separate Busy and Done flags are available for input and for output operations.

Read Character

DIA [*f*] *ac*, TTI



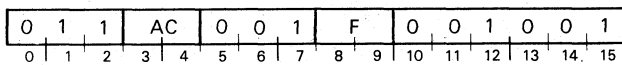
The contents of the receiver buffer are placed in bits 8-15 of the specified accumulator. Bits 0-7 are set to 0. After the transfer, the function specified by F is performed. The format of the specified AC is as follows:



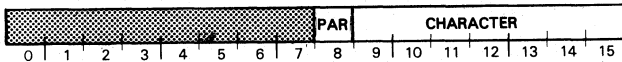
Bits	Name	Contents
0-7	---	Reserved for future use.
8	Parity	The value of the parity determined by the terminal.
9-15	Character	The character most recently received (right-justified).

Write Character

DOA [*f*] *ac*, TTO



Bits 8-15 of the specified accumulator are placed in the transmitter buffer. After the transfer, the function specified by F is performed. The contents of the specified AC remain unchanged. The format of the specified AC is as follows:



Bits	Name	Contents
0-7	---	Reserved for future use.
8	Parity	The value of parity is not tested at the terminal.
9-15	Character	The character to be transmitted (right-justified).

PROGRAMMING

The following discussion assumes that the terminal is interfaced with a Data General Basic I/O Controller in order to explain the I/O programming of the terminal, and therefore contains information specific to that controller. Since the data terminal is actually two separate devices, input and output are discussed separately.

Input

Striking any character key or a combination of CTRL or SHIFT with a character key transmits a serial data burst to the controller. This data burst is assembled into an eight bit parallel word and stored in the controller's input buffer. After the character is assembled in the controller, the Input Busy flag is set to 0, the Input Done flag is set to 1, and a program interrupt request is initiated.

The character can then be read by issuing a READ CHARACTER instruction (DIA). The Input Done flag should then be set to 0 with either a Start or a Clear command. This allows the next character to initiate a program interrupt request when it is fully assembled.

Output

A character is loaded into the output buffer of the controller by issuing a WRITE CHARACTER instruction (DOA). A Start command initiates a parallel to serial conversion and transmits the resulting data burst. While the character is being transmitted serially to the printer, the Output Busy flag is set to 1. Upon completion of the transmission, the Output Busy flag is set to 0 and the Output Done flag is set to 1, thus initiating a program interrupt request.

The 6040 and 6041 terminals return a Terminal Busy flag to the controller via the the EIA signal, DATA TERMINAL READY. This signal can be used by certain controllers to freeze the controller's Output Busy flag and delay transmission of a character to the terminal when the terminal's input buffer is full. In these controllers, the transmission sequence proceeds as follows: The Start command sets the Output Busy flag to 1; when the Terminal Busy flag is 0, the controller initiates the parallel to serial conversion. Upon completion of the transmission, the Output Busy flag is set to 0 and the Output Done flag is set to 1, initiating a program interrupt request.

Each time a character is to be sent to the printer, the controller's output buffer must be reloaded with a WRITE CHARACTER instruction. A sequence of WRITE CHARACTER instructions together with Start commands is used to transmit a multi-character message. The program must allow each character to be transmitted before loading the next character into the output buffer.

TIMING CONSIDERATIONS

Input

After the controller's Input Done flag is set to 1, and before another key strike can destroy the character in the input buffer, the character is available for a READ CHARACTER BUFFER instruction for a time interval determined by the baud rate. The program must respond to the interrupt request and read the character within the time interval indicated in the following table to avoid possible data loss.

PROGRAMMED I/O LATENCY

Baud Rate	Max Allowable Programmed I/O Latency
110	21.59ms
150	15.84ms
300	7.92ms
600	3.95ms

Output

After the controller's Output Done flag is set to 1, the program should provide another character within a time period determined by the baud rate to keep the transmission line operating at its maximum rate.

MAXIMUM RATE TIME LIMITS

Baud Rate	Time Limit
110	9.15ms
150	6.64ms
300	3.33ms
600	1.66ms

Considerations for 600 Baud and Automatic Form Feed

When a terminal operates at 600 baud, the time needed for the printhead to move to column one during a carriage return becomes important. During this non-printing period, the characters received by the terminal may overflow the 40-character input buffer and be lost before the printhead reaches column one and printing begins again. Also, if a terminal is equipped with a form feed option, a similar problem arises. In this case, characters may overflow the buffer while the paper advances to the top of the next form.

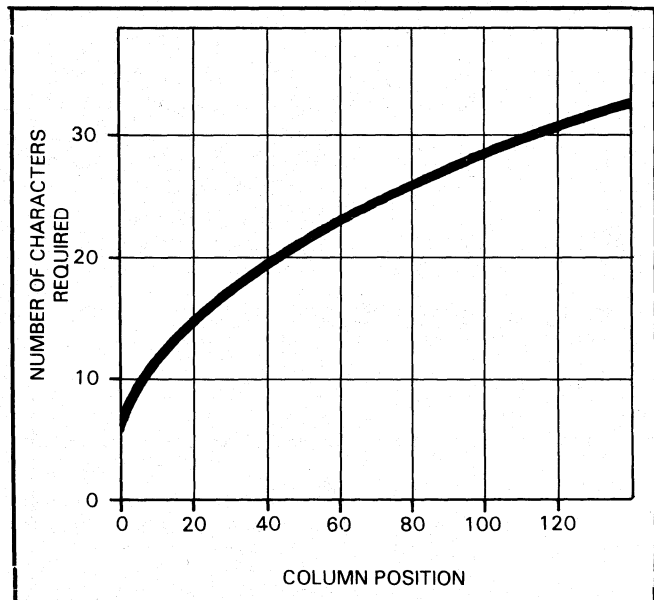
For this reason, the models which can operate at 600 baud generate a Printer Busy flag which is set when the buffer is full. This flag is transmitted as the EIA interface signal, DATA TERMINAL READY. Such a terminal should be connected to controllers which can test this signal and suspend transmission to the terminal while this signal is low.

If a DASHER terminal interfaces to a controller which does not test this signal, it can still operate at 600 baud and/or with the form feed option if the following programming constraint is met:

NOTE *The program must not allow the data transmitted to the terminal to lead the terminal's printing activity by more than 40 characters.*

This constraint can be overcome by padding the data stream transmitted to the terminal with fill characters (e.g., the DEL character), so that the terminal's buffer overflows only with fill characters. The graph below estimates the maximum number of characters transmitted at 600 baud to the terminal during a carriage return of various lengths.

MAXIMUM NUMBER OF CHARACTERS TRANSMITTED TO THE TERMINAL DURING A CARRIAGE RETURN OF VARIOUS LENGTHS



When a Form Feed code (014₈) is received by a terminal with the form feed option activated, the terminal generates:

1. An internal Carriage Return command which moves the printhead to column one;
2. An internal Line Feed command for each line to be skipped to the top of the next form;
3. Another internal Carriage Return command which places the printer in catch-up mode. In this mode, the terminal prints at twice its normal rate to catch-up. When its buffer is empty, the terminal returns to its normal printing speed.

The second Carriage Return command has no effect during 600 baud operation as there is no catch-mode at this speed. Since the first Carriage Return command moves the printhead while the Line Feed commands advance the paper, the time needed for the printhead to move overlaps the time needed for the paper to advance. It takes approximately 175msec to complete a carriage return from column 10; and an additional 3.5msec for each column beyond column 10. It takes approximately 33msec for the paper to advance one line (execute one Line Feed command). The table below estimates the maximum number of characters which are transmitted at different baud rates to the terminal during the execution of a form feed from column 132.

MAXIMUM NUMBER OF CHARACTERS TRANSMITTED TO THE TERMINAL DURING A FORM FEED FROM COLUMN 132.

LINES SKIPPED	NUMBER OF CHARACTERS TRANSMITTED			
	600 BAUD	300 BAUD	150 BAUD	110 BAUD
6 (1")	35	19	10	6
18 (3")	36	19	10	6
21 (3.5")	42	21	11	7
24 (4")	48	24	12	8
33 (5.5")	66	33	17	11
36 (6")	72	36	18	12
42 (7")	84	42	21	14
48 (8")	96	48	24	16
51 (8.5")	102	51	26	17
66 (11")	132	66	33	22
72 (12")	144	72	36	24
84 (14")	167	84	42	28
99 (16.5")	197	99	50	32

DG-04838

PROGRAMMING EXAMPLES

The following examples show how characters are passed between the computer, the printer, and the keyboard when interfaced with a Basic I/O Controller such as the 4010. The first example reads a character from the keyboard and the second example prints a character on the terminal.

EXAMPLE 1

Read a character from the keyboard

```
SKPDN  TTI      ;Character buffer loaded yet?
JMP     -1      ;No
DIAC    1,TTI   ;Read character and clear the Done flag
```

EXAMPLE 2

Print a character

```
SKPBZ  TTO      ;terminal printer free?
JMP     -1      ;No, try again
DOAS   1,TTO    ;Print character
```

The subroutine shown in example 3 and called by a JUMP TO SUBROUTINE instruction JSR TTYRD, illustrates both reading and echoing characters on the terminal, with the printer's interrupts disabled. It uses ACO to store the character.

EXAMPLE 3

Subroutine to read and echo characters (interrupts disabled)

```
TTYRD:  SKPDN  TTI      ;Has character been typed?
        JMP     -1      ;No, then wait
        DIAC   0,TTI   ;Yes, then read char, clear done
        SKPBZ  TTO      ;Is TTO ready?
        JMP     -1      ;No, Then wait
        DOAS   0,TTO   ;Yes, Then echo character
```

Peripherals are usually programmed using the program interrupt facility. This technique is necessary to avoid continually checking the condition of the device status flags. The program interrupt facility frees the processor to execute other tasks or to service other peripheral devices during the time the data terminal completes an operation or when it does not require processor intervention. The routine shown in example 4 will read a line and echo it on the printer using the interrupt priority structure. It will read characters into a buffer beginning at location 1000₈. It is terminated by either a carriage return or a line overflow. Line overflow is determined by the value of MAXLL, the maximum line length.

EXAMPLE 4

Read a line using interrupts

```
      .LOC 0
      0          ;PC goes here on interrupt
      IHAND      ;Address of interrupt handler
      .LOC 400

START: LDA 1,BUFFR ;Set up buffer pointer in
      STA 1,23    ;auto-increment location 23
      LDA 1,MAXLL ;Get maximum line length
      STA 1,CNTR  ;Initialize line overflow counter
      SUBZL 1,1   ;Set AC1 = 1
      DOBS 1,CPU  ;Maskout TTO, turn on interrupts
      ---
      ---        ;Program can do useful things
      ---        ;while line is being read

HANG:  LDA 0,CBTR ;When need full line to continue,
      MOV 0,0,SZR ;Hang up here until
      JMP -.2     ;reading is all done

      ---
      ---
      ---
      ---
      ---
      ---

BUFFR: 777       ;Buffer begins at location 1000
MAXLL: 204       ;Maximum - 132 chars per line
CNTR:  0         ;Line overflow counter

      ---
      ---
      ---
      ---
      ---
      ---

IHAND: SKPDN TTI  ;Make sure TTI interrupted
      HALT      ;Error--another device interrupted
      STA 0,SAVO ;Save AC's that will be used
      STA 1,SAV1
      DIAC 0,TTI ;Read character and clear Done
      STA 0,@23 ;Store character in buffer
      SKPBZ TTO ;Make sure TTO not busy
      JMP -.1
      DOAS 0,TTO ;Echo character
      LDA 1,CR  ;End of line?
      SUB 0,1,SZR
      JMP .+4   ;No
      SUBC 0,0 ;Yes, clear ACO, preserve Carry
      STA 0,CNTR ;Zero out cntr to signal line done
      JMP .+3
      Dsz CNTR  ;If not a new line, decrement CNTR
      JMP OUT  ;Line not yet done, go dismiss
      LDA 0,TTMSK ;Line is done
      MSKO 0    ;Maskout TTI/TTO to inhibit further
      ;input

OUT:   LDA 0,SAVO ;Restore accumulators
      LDA 1,SAV1
      INTEN
      JMP @0     ;Return to interrupted program

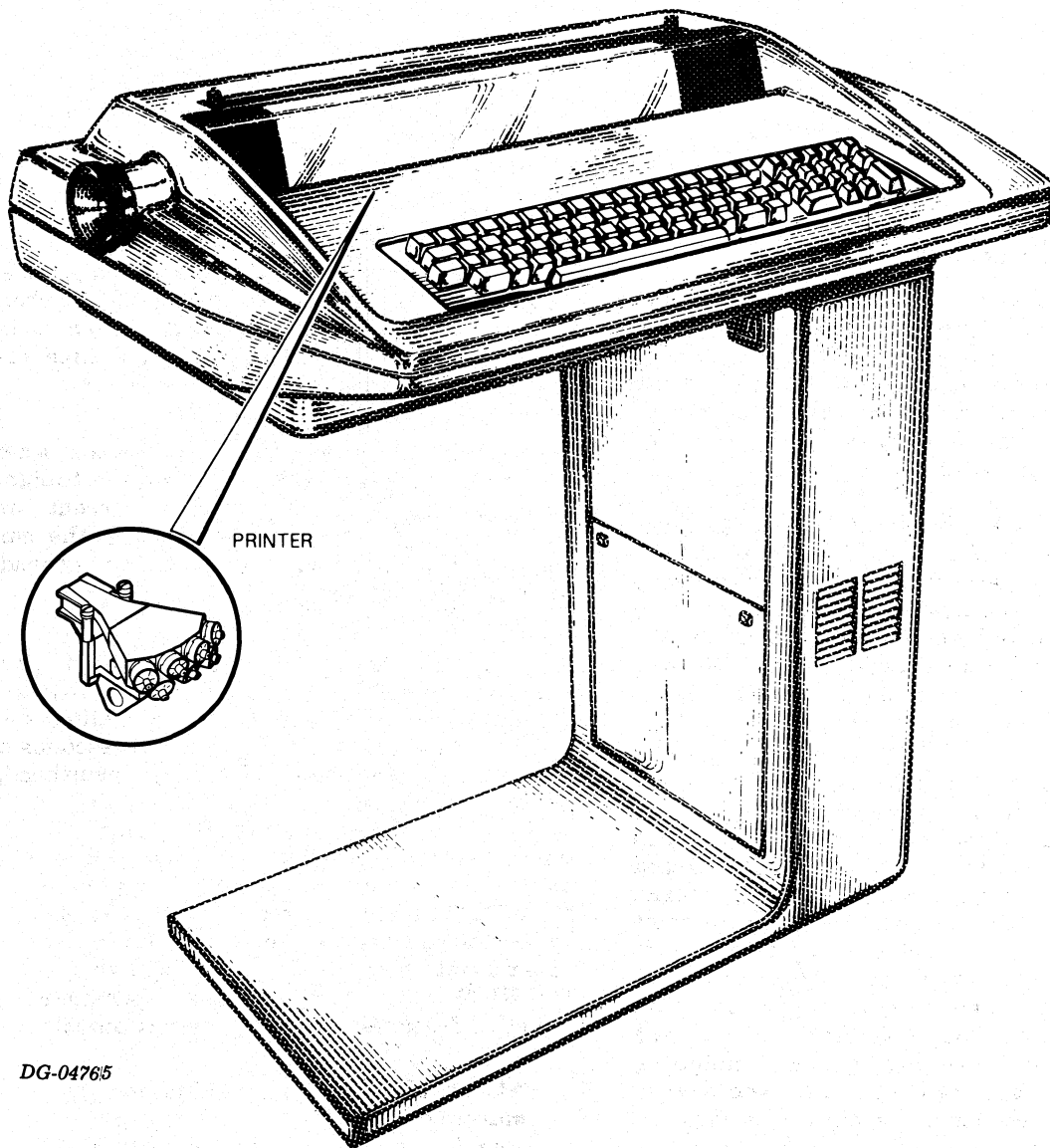
SAVO:  0
SAV1:  0
CR:    015
TTMSK: 3
```



III

Data General Corporation (DGC) has prepared this manual for use by DGC personnel and customers as a guide to the proper installation, operation, and maintenance of DGC equipment and software. The drawings and specifications contained herein are the property of DGC and shall neither be reproduced in whole or in part without DGC's prior written approval nor be implied to grant any license to make, use, or sell equipment manufactured in accordance herewith.

DASHER TERMINAL PRINTER



DG-04765

SECTION IV OPERATING CONTROLS AND PROCEDURES

INTRODUCTION

This section describes the operator controls on the 6040-6043 DASHER terminal printers, and the procedures required to operate these units. A brief description of the terminal and its operation is given to familiarize the operator with the unit. Maintenance is not included in this section; the reader is referred to Section V for these procedures.

Data General's 6040-6043 DASHER terminal printers (*the model 6040 or 6042 is pictured to the left*) are multiple baud rate data terminals which produce 132-column hard copy output on industry standard, pin-feed paper. Models 6040 and 6042 are full duplex send/receive units with keyboards. Models 6041 and 6043 are receive-only terminals, and have no keyboard.

All models print 124 distinct 5x7 dot matrix characters, available in six distinct character sets that provide the basic alphabet with numbers plus common usage symbols for applications in the United States and five other regions throughout the world. (*See Appendix B.*) A terminal can be set up to print 124 characters of the 128 ASCII character set or it may be restricted to printing one of two character subsets by field-installed hardware jumpers. One jumper configuration (64 characters) limits the printer to upper case characters, numbers, punctuation marks, the space character, and certain symbols such as parentheses, and square brackets. In this configuration, the terminal performs "character foldover:" it converts lower case character codes (plus six other codes) to the upper case equivalent before printing. (*See Appendix B for details.*) In the second configuration (95 characters), foldover is disabled and the terminal prints lower case characters and six other characters in addition to the basic teletypewriter set.

A 60 key, three level typewriter paired keyboard is an integral part of the 6040/6042 terminal, and provides data entry to the computer system. All 128 ASCII characters may be generated from the keyboard. A numeric keypad with an eleven-key numeric pad and three operator controls is also included on the keyboard.

An audible "carriage-right" tone sounds when the printhead reaches character position 126, to signal the operator that the end of the current line is approaching. If data is entered after the carriage contacts the right hand stop, the printhead will overprint the characters.

A "view print" feature is standard on all models, and moves the printhead clear of the printed text to allow the operator to view the text, including the last character printed. When a lapse of 1.2 seconds occurs during data transmission to the printhead, the printhead automatically moves six character positions to the right, giving a view of the last character printed. When data transmission resumes, the printhead returns to the character position following the last character printed. This operation takes place during both on- and off-line operation; the "view print" feature may be disabled with the VIEW ON/VIEW OFF switch on the operator's control panel, as described under "Operator Controls".

NOTE *When the printhead is near the right margin and after the "carriage-right" tone has sounded (approximately character position 126), the printhead moves six character positions to the left after a 1.2 second lapse in data transmission.*

An automatic form feed option allows the operator to select a form length from 0.167 to 16.5 inches. The terminal will automatically advance the paper to the top of the next form in response to the local line feed switch pressed to the continuous feed position or a Form Feed code (014₈). If the automatic perforation skip-over feature is enabled, the paper automatically advances one inch (6 lines) between forms.

When upper case characters only are selected, the print mechanism will translate any lower-case alpha code to its upper case equivalent. Lower case alpha characters are not printed with this choice of characters. When upper/lower case is selected, all alpha characters print without translation; in the final mode. Standard ASCII symbols are printed to represent control codes (except CR, BEL, LF & DEL) received by the terminal.

KEYBOARD (Models 6040, 6042)

The keyboard contains 60 keys which may be used singly or in combination to generate all 128 ASCII character codes. The character codes are 3-digit octal numbers ranging from 000₈ to 177₈ inclusive. A unique character is assigned to each octal number, in accordance with the ASCII coding scheme. Appendix B lists all 128 ASCII codes in octal and hexadecimal notation, together with the character or symbol assigned to each code.

Keypop legends vary slightly among terminal options, corresponding to variations in the printed characters. ASCII code is used on all models. Each export model may be selected to print one of the three subsets of ASCII characters.

The keyboard operates on-line or off-line with the computer, as selected by a switch on the control panel described under "Operator Controls". When the terminal is off-line, a character code generated at the keyboard is transmitted directly to the printhead and the character is printed if the character set contains that character. The character code is not transferred to the computer, and the printer functions somewhat like a standard typewriter. When the terminal is on-line, the character code generated at the keyboard is transferred to the controller for processing. If the computer contains an "echo" program, it transfers the character code back to the printer and the character is printed, provided the selected set in the printer contains that character. When the terminal operates with an "echo" program, the sequence of events is as follows:

1. The character code is transferred from the keyboard to the computer system.
2. The code is returned to the printer, where it is decoded by the printhead logic.
3. The printhead prints the character (if the character is contained in the printable subset of characters).

With the appropriate software, the echo sequence is completed so fast that the character is printed almost immediately. The time delay is nearly imperceptible, and the printer appears to function as a standard typewriter.

There are 11 function keys on the keyboard, in addition to the alpha-numeric keys. Two of these function keys, SHIFT and ALPHA LOCK, perform functions as they do on a standard typewriter when the terminal operates off-line or when it operates on-line and the computer contains an echo program. Two more of these keys, RETURN and RPT, perform typewriter-like functions when the terminal is off-line or operating under an echo program. An additional four function keys, TAB, BS, ESC, and DEL, generate special control characters whose functions are defined by the computer program. The remaining two function keys, CTRL and BRK, are used for special functions as described in the table to the right. Operation of the function keys is described to the right.

SHIFT and any alpha-numeric key - Generates upper case character code for the alpha-numeric key depressed.

ALPHA LOCK and any alpha key - Generates upper case character code for the alpha key depressed. Numeric characters are not affected. The ALPHA LOCK function remains asserted until the ALPHA LOCK key is depressed again. An indicator light on the SHIFT key glows when this function is asserted.

RETURN (Carriage Return) - The printhead returns to the leftmost character position. The paper does not advance.

LF (Line Feed) - The paper advances one line.

RPT (Repeat) and any key - Repeatedly generates the character code for the depressed key. Stops when one or both keys are released.

TAB - Generates character code 011₈. No effect unless the 124-character set is selected. In this case the special control code symbol \Rightarrow is printed. The computer program may define a tab function during on-line operation, by inserting a number of spaces.

BS (Backspace) - Generates the character code 010₈. No effect unless the 124-character set is selected. In this case, the special control code symbol \uparrow is printed. The computer program may define a function during on-line operation. The printhead cannot move back to the last character position.

CTRL (Control) and any of 31 alpha-numeric keys - Generates the control code corresponding to the alpha-numeric key depressed. The mnemonic, octal code, and printing symbol for each control character is given in Appendix B.

ESC (Escape) - Generates the control code 033₈. No effect unless the 124-character set is selected. In this case, the special control code symbol \ominus is printed. The computer program may define a function during on-line operation.

BRK (Break) - While this key is depressed, the transmission line is kept in a spacing state preventing any other key-entered coded from being transmitted. No ASCII code is generated by this key.

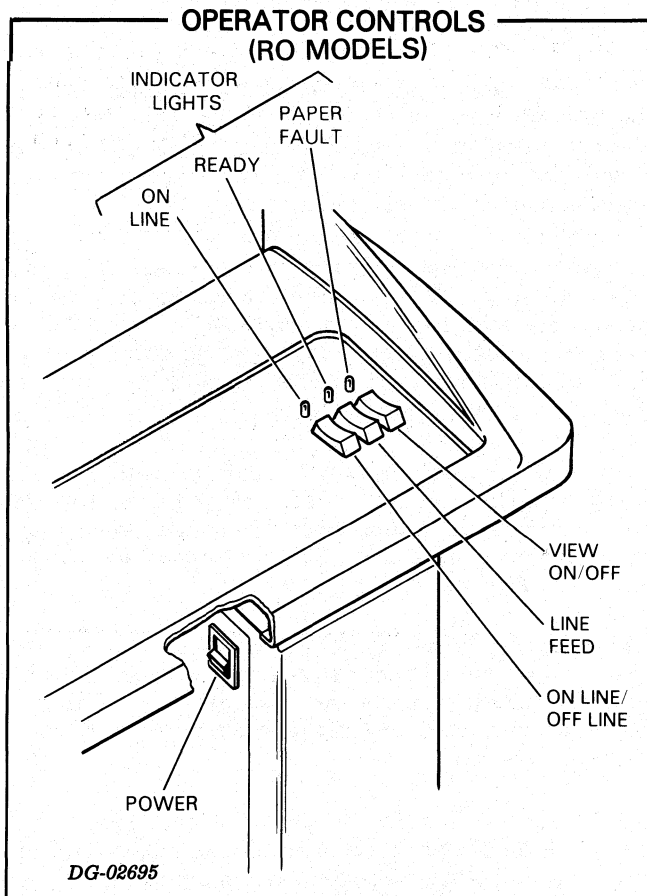
DEL (Delete) - Generates the control code 177₈. No effect during off-line operation. The computer program may define a function during on-line operation.

OPERATOR CONTROLS

POWER Switch

A two-position switch is located on the inner side of the pedestal, and turns line power on or off to the power supply. Operation is as follows:

Position	Function
ON (Up)	The power supply is turned on, the fan runs, the RDY (Ready) light glows, and the printhead returns to the column one position.
OFF (Down)	The power supply, fan, and the RDY light are turned off.



ON LINE/OFF LINE Switch and Indicator Light

A two-position rocker switch and an ON LINE indicator light are located on the standard control panel. The switch is used to place the terminal on- or off-line with the computer, and the light displays the selected state. Operation is as follows:

Position	Function
ON LINE	The printer is placed on-line with the computer. The ON LINE indicator light glows.
OFF LINE	The terminal is off-line from the computer. Information entered at the keyboard is printed, but not transmitted to the computer. The ON LINE indicator light is off. Do NOT change this switch setting when the printer is receiving data from the computer, or data may be lost.

On terminals equipped with a keyboard, this switch is replaced with an alternate action key on the keypad. The ON LINE indicator light is located on this key.

LINE FEED Switch

A three-position rocker switch located on the control panel (RO models) is used to advance the paper. Depressing this switch backwards toward the rear of the terminal advances the paper one line each time the switch is pressed. Pressing (and holding) the switch forward toward the front of the terminal causes the paper to feed continuously. The FEED switch operates when the terminal is on- or off-line with the computer.

On terminals equipped with a keyboard, this switch is replaced with the alternate action LF/FF key on the keypad. Depressing this key for less than 2 seconds advances the paper one line; depressing it for 2 seconds or longer activates the form feed feature (if installed) or feeds the paper continuously if form feed is not present.

VIEW ON/VIEW OFF Switch

A two-position rocker switch is located on the standard control panel, and disables the automatic view feature. Operation is as follows:

Position	Function
VIEW ON	The automatic view feature functions normally.
VIEW OFF	The automatic view feature is disabled; the printhead will not move clear of the print during lapses in data transmission.

On terminals equipped with the keyboard, this switch is replaced with an alternate action key on the keypad. The VIEW ON indicator light is located on this key.

READY and PAPER FAULT Indicator Lights

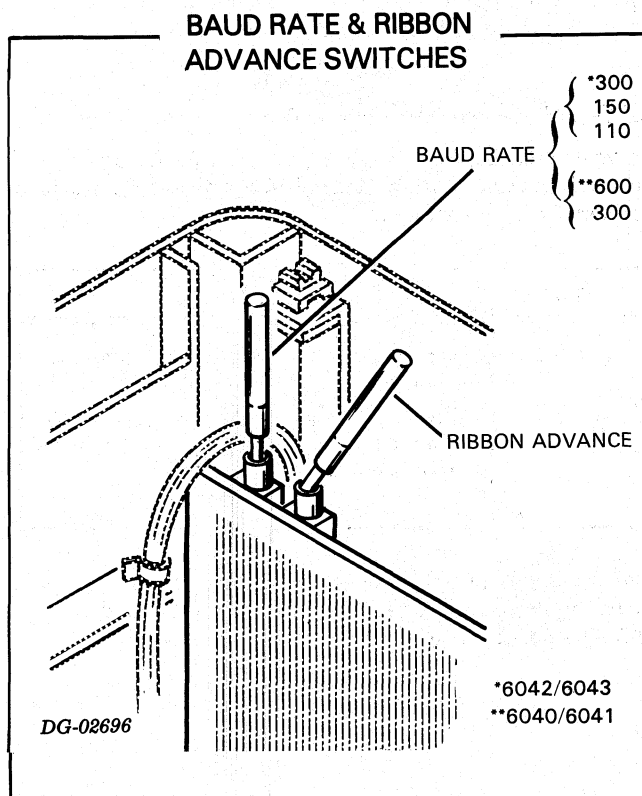
These indicator lights indicate status information as follows:

Indicator	Meaning When Glowing
RDY (Ready)	No faults or interlocks are set to disable operation. The terminal operates normally.
PAPER FAULT	The terminal has no more paper available. The current line will be printed up to an including the next carriage return, and the printer will stop. Data transmitted after this point will be lost. On terminals equipped with the form feed option, this light also glows if there is a line count error.

RIBBON ADVANCE, BAUD RATE Switches

A toggle switch labelled RIBBON ADVANCE is located under the top cover on the right-hand side as shown, and is used to wind the ribbon onto the spool, in the direction that the ribbon last moved. This function is always enabled, whether or not the terminal is on line.

A toggle switch labelled BAUD RATE is located under the top cover on the right-hand side as shown, and is used to select one of two or three baud rates for the device. The selected baud rate **MUST** agree with the controller's baud rate. Change this switch setting only when the terminal is off-line (ON LINE indicator light off).



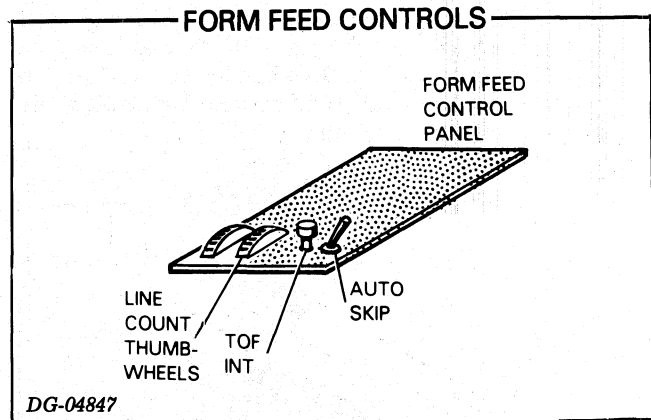
Automatic Form Feed Controls

There are three controls for the automatic form feed option: the Line Count thumbwheels, the TOF INIT pushbutton, and the SKIP DISABLE switch. These switches are located under the top cover in the right rear corner just in front of the BAUD RATE and RIBBON ADVANCE switches. These controls should be set only when the terminal is off-line; they should be reset for each different form length used.

The two Line Count thumbwheels each have ten digit positions. These switches should be set to the number of lines corresponding to the length of the form being used. Form lengths from 0.167" (1 line) to 16.5" (99 lines) can be selected.

The TOF INIT pushbutton is for initializing the line counters. Whenever the Line Count thumbwheels are changed, the line counters must be initialized by pushing and releasing this pushbutton.

The SKIP DISABLE switch is a two-position toggle switch for disabling the automatic performance skip-over feature. When this feature is functioning, the last 6 lines of a form are automatically skipped and printing continues on the top of the next form.



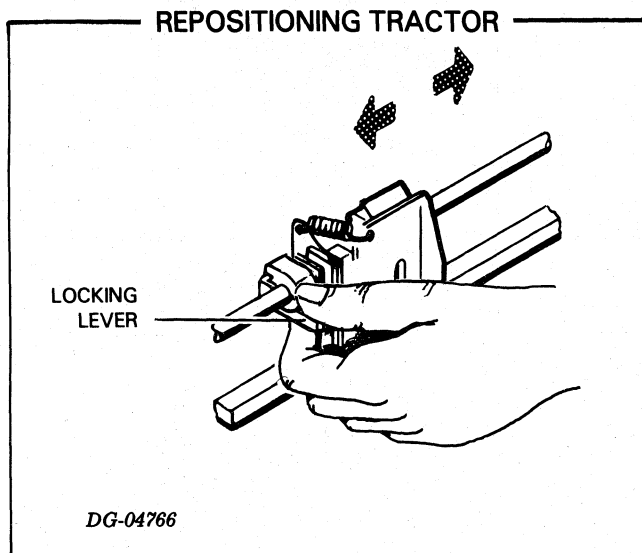
OPERATING PROCEDURES

Loading Paper

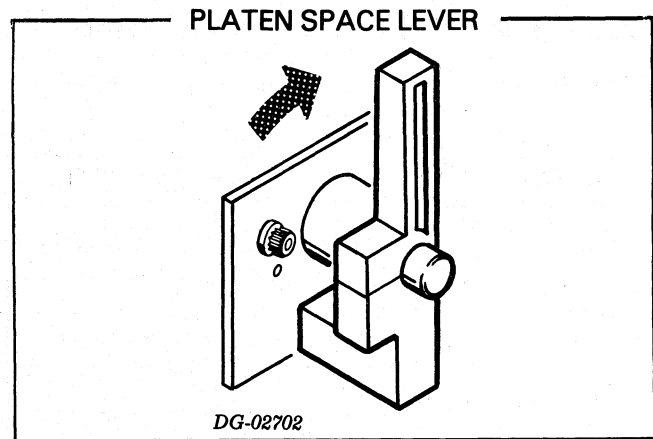
The 6040-6043 terminals use industry standard pin-feed paper, single or multiple form (up to six-part forms), of any width between 4" and 15". A platen space lever may be set for single or multiple form, and the pin-feed tractors are easily adjustable to the desired paper width. The tractors may be moved to locate the paper at any desired platen position, allowing flexibility in locating the left margin. Typically, the paper is placed at the extreme left-hand position, and the left margin is at the column one ("carriage home") position. However, a programmer may choose to place the left margin to the right of the column one position, and the paper may be moved to accommodate such a shift.

Load the paper as follows:

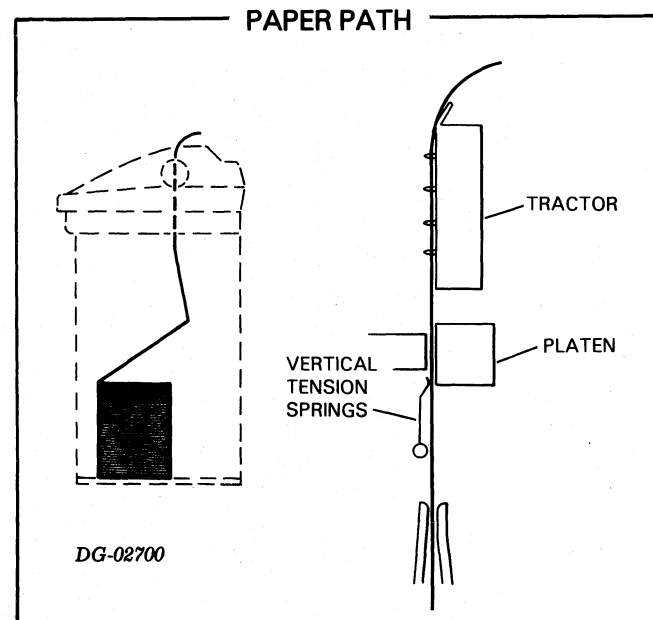
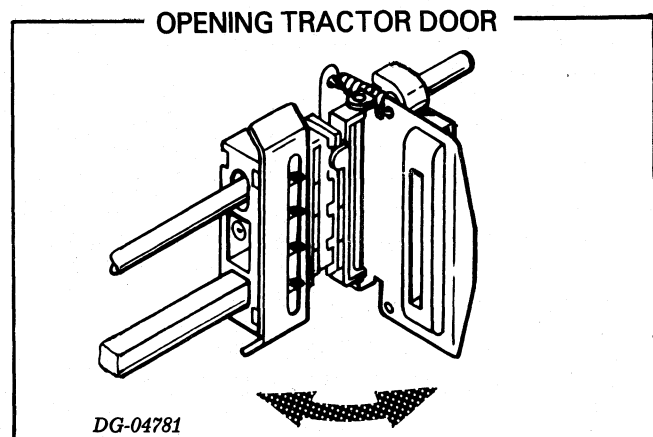
- Switch the terminal OFF LINE.
- Swing the top cover up until it latches open.
- Place the left-hand tractor at the position required for the desired left margin. The tractor may be moved by releasing the locking lever, moving the tractor to the desired position, and tightening the lever as shown in the figure.



- Place a box of pin-feed paper under the terminal just behind the platen position, as shown in the figure.
- Move the platen space lever to the widest (rear-most) position. This provides the spacing necessary to slide the paper into place, with no interference from the printhead or the leaf spring.



- Swing open the tractor doors, as shown in the figure. The right-hand tractor may need to be moved to a different position if a different width paper is used. This is most readily performed with the paper in position on the left-hand tractor pins, as described in the next step.

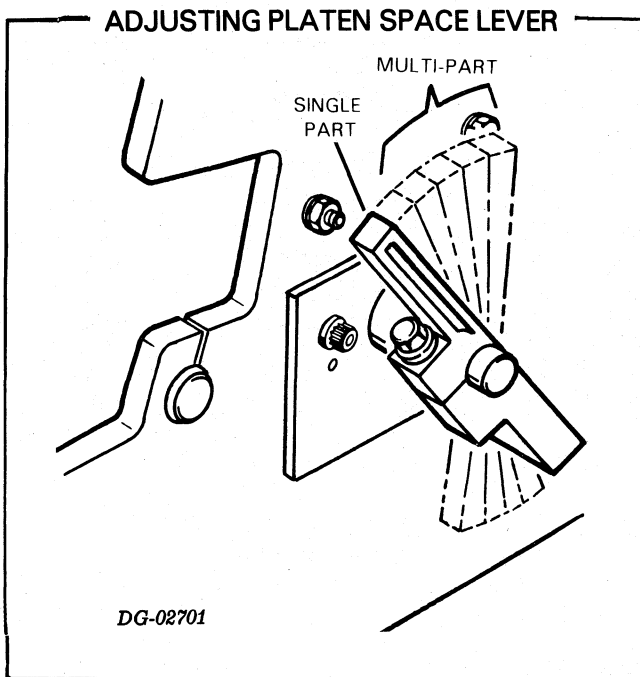


- Thread the leading edge of the paper through the bottom of the printer, under the leaf spring and onto the left-hand tractor pins. Reposition the right-hand tractor as necessary, after locating the feed holes on the tractor pins.

CAUTION *Ensure that corresponding holes are engaged, so that the top of the paper is horizontal, or the paper will jam and tear.*

- Move the right-hand tractor slightly to the right to put a light horizontal tension on the paper. Be sure that the feed holes are not deformed by this tension, or the paper may tear and/or jam in the tractor.
- Close the tractor doors, and recheck that the edge of the paper is parallel to the platen.
- Move the platen space lever to the desired detent position for the form thickness used: forward for single paper, detents 2 through 6 for multi-part forms (up to six-part maximum).

NOTE *The numbering of the detent positions corresponds approximately to the number of the forms. However, form thickness varies among suppliers; adjust the platen space lever experimentally to obtain the desired print contrast.*



- Adjust the paper to the desired vertical position using the FEED switch (LF switch on the numeric keypad). Make fine adjustments manually by pulling out the paper feed vernier knob and rotating it.

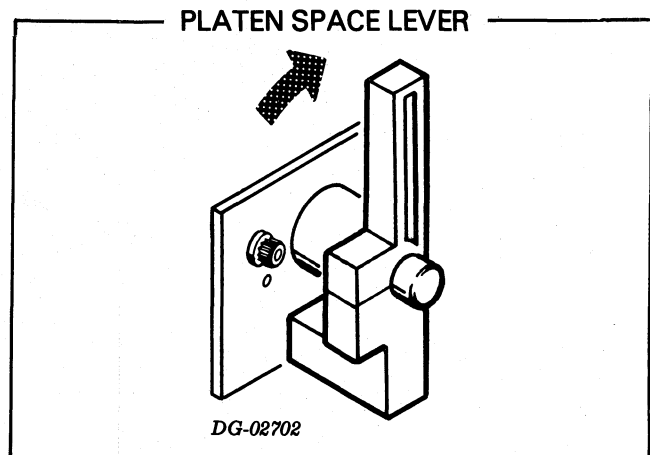
- If the terminal is equipped with the form feed option, check the Line Count thumbwheels on the form feed control panel to make sure that they are set to the correct line count for the length of form being used.
- Close the top cover while feeding the paper through the large slot on the cover.
- Switch the terminal ON LINE.

Changing the Ribbon

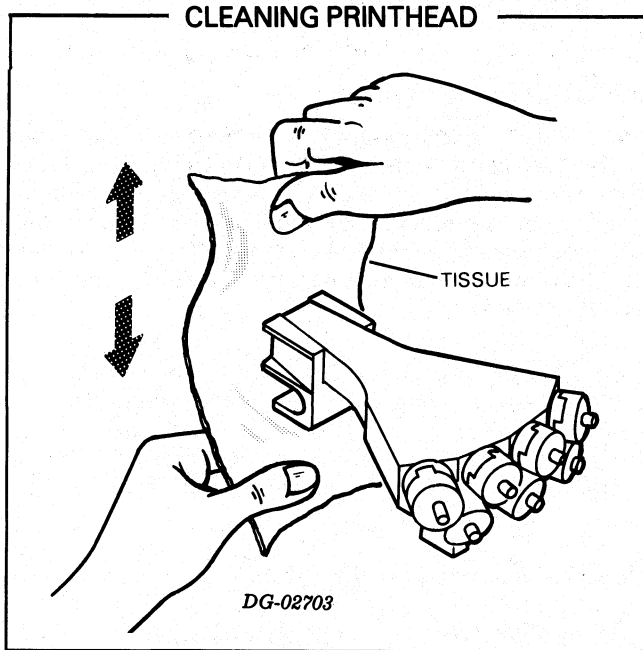
The printhead uses the upper half of the ribbon when printing. When the ink is exhausted on the first half, wind the ribbon, remove it, and replace it upside down to use the second half of the ribbon. When this half is exhausted, replace the ribbon. The procedures for both operations are nearly identical, and are described below.

NOTE *If the printhead is dirty, clean it while the ribbon is being replaced or inverted. This will maintain print clarity and extend printhead service. The cleaning procedure is included in the step-by-step procedure below.*

- Switch the terminal OFF LINE.
- Swing the top cover up until it latches open.
- Rewind the ribbon using the Ribbon Advance toggle switch. (This step is not necessary, but it does help prevent the ribbon from dangling between spools when the ribbon is removed.)
- Move the platen away from the printhead by moving the platen space lever to the rearmost position, as shown on the figure.
- If the top of the paper is above the tractors, swing open the tractors and remove the paper from the terminal.



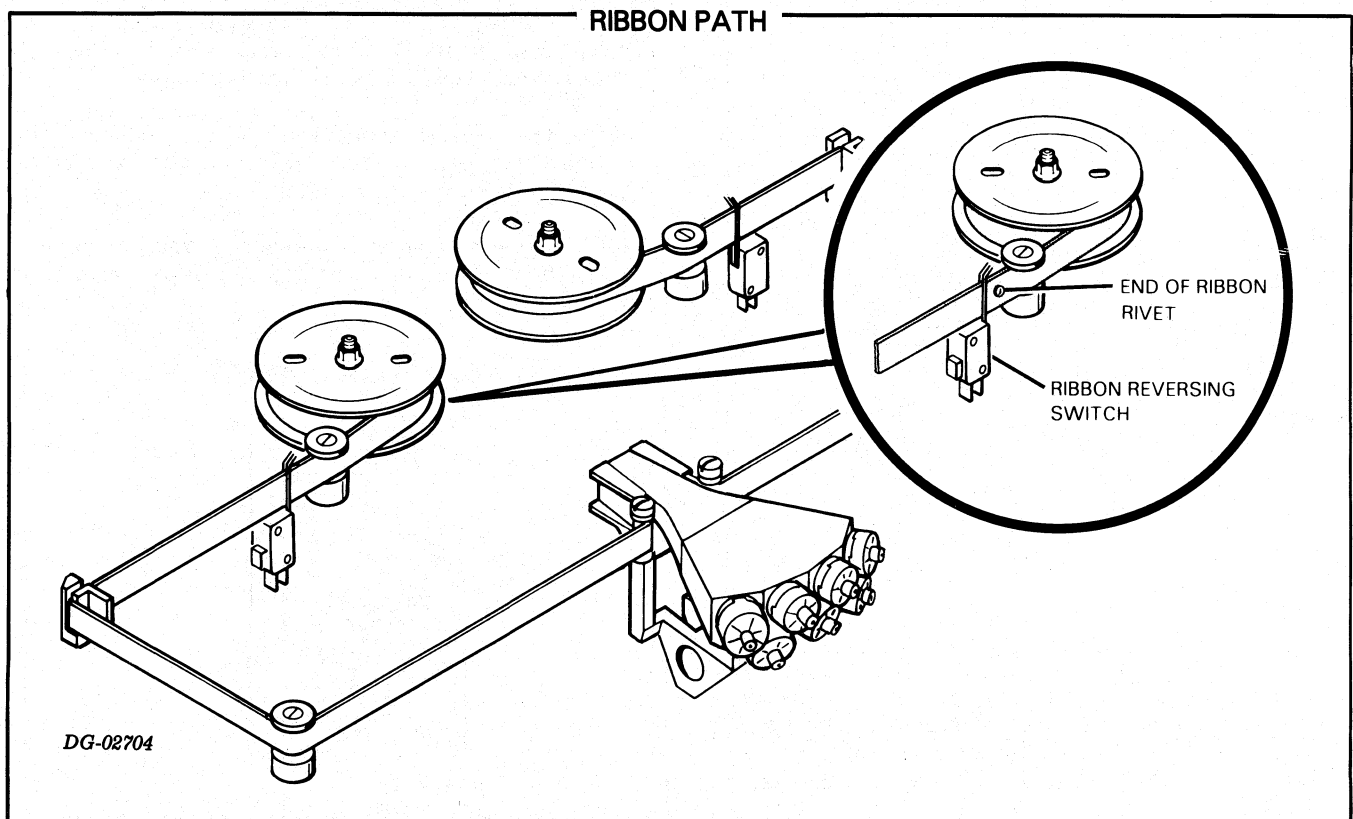
- Lift the ribbon spools off their spindles and remove the ribbon from its various guides.
- If the printhead is dirty, wipe it with a folded lint-free tissue as shown. Repeat with clean tissues until the face is clean. Also wipe the platen with a clean tissue.



- Place the full spool of new (or inverted) ribbon on one of the ribbon spindles. Two pins on the spool holder should engage with holes in the spool.
- Unwind some ribbon from the full spool, thread the ribbon through the ribbon guides and switches, and place the empty spool on the other spindle. The correct ribbon path is shown in the illustration, and must be followed exactly. The ribbon path is also marked on the terminal.

NOTE There is an "end-of-ribbon" rivet near the end of the ribbon; this rivet **MUST** be between the empty spool and the ribbon reversing switch, as shown. Otherwise, the rivet will jam in the rear ribbon guide when the ribbon moves.

- Apply a slight tension to the ribbon by taking up any slack with the empty spool.
- If necessary, replace the paper and set the platen space lever to the appropriate position for the desired print contrast.
- Recheck the ribbon path, and close the top cover.
- Switch the terminal ON LINE.



OPERATOR PRECAUTIONS

Take care that foreign objects such as paper clips or thumbtacks do not fall into the printer mechanism. If an object does fall into the mechanism, turn the POWER switch to OFF, unplug the power cord from the wall outlet, and retrieve the object.

The paper used should conform to the specifications given in Appendix A. In particular, form crimps must be tab-type only; metal fasteners or glue spots should not be used or the print mechanism may be damaged.

Do not use the keyboard area as a tray for coffee cups, ash trays, food, etc.

Keep the to cover closed except when changing the ribbon or the paper.

Support the paper on the top cover when separating forms, to prevent damaging the pin-feed holes which could cause paper jamming.

Ensure that the paper feeds over the top and back of the terminal.

Clean the terminal using a lint-free tissue; if necessary, use a mild detergent sparingly.

SECTION V THEORY OF OPERATION

INTRODUCTION

This section describes the operating principals of key assemblies and electromechanical subsystems in the 6040-6043 DASHER terminal printers. They are designed in a series of subsystems organized around well defined primitives or functional operations; the segments of this section are largely organized around these same operations, hence most segments describe a complete functional subsystem. Information is presented in summary form with the aid of block diagrams, flow charts, and generalized timing diagrams.

BLOCK DIAGRAM OF THE DATA TERMINAL

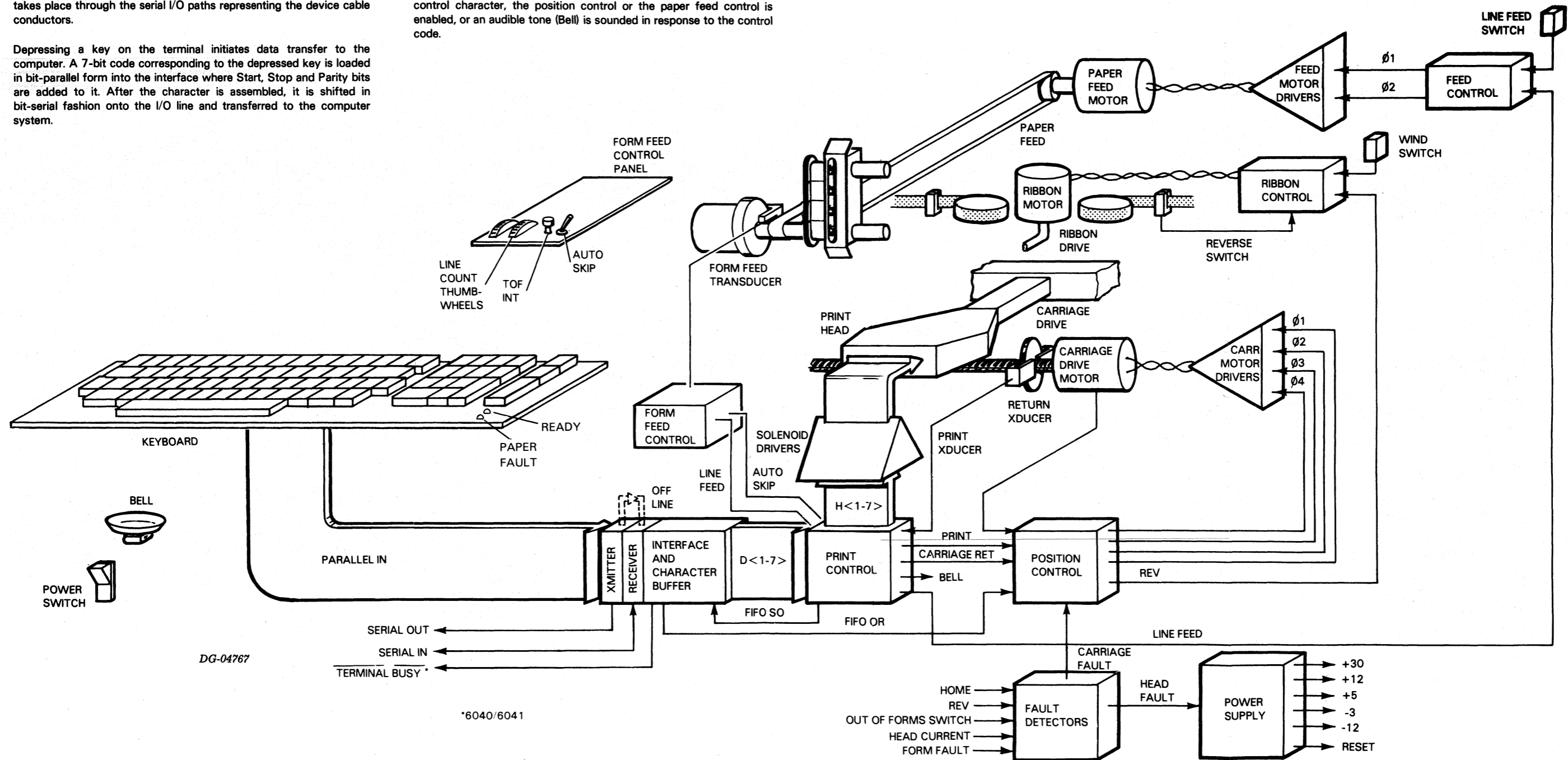
The block diagram on the next page shows the principal components plus the control and data paths of the DASHER terminal printers. Data and most command signals which are TTL levels, and whose circuits generally employ standard digital IC's are shown as single line or bussed paths with signal names. Control paths that employ non-TTL digital signals (e.g. stepping motor pulses) are shown as twisted-pair or two wire paths.

DASHER TERMINAL PRINTER ORGANIZATIONAL DIAGRAM

DATA GENERAL'S DASHER TERMINAL PRINTERS are organized as shown in this diagram. When the 6040 or 4042 terminal is on-line, it appears as two separate devices to the computer system. The input (to computer) section consists of the keyboard and interface transmitter; the output (from computer) section consists of the interface receiver, the character buffer and the printer system. The 6041 and 6043 receive-only terminals consist only of the output section of this diagram. All data transfer with the computer system takes place through the serial I/O paths representing the device cable conductors.

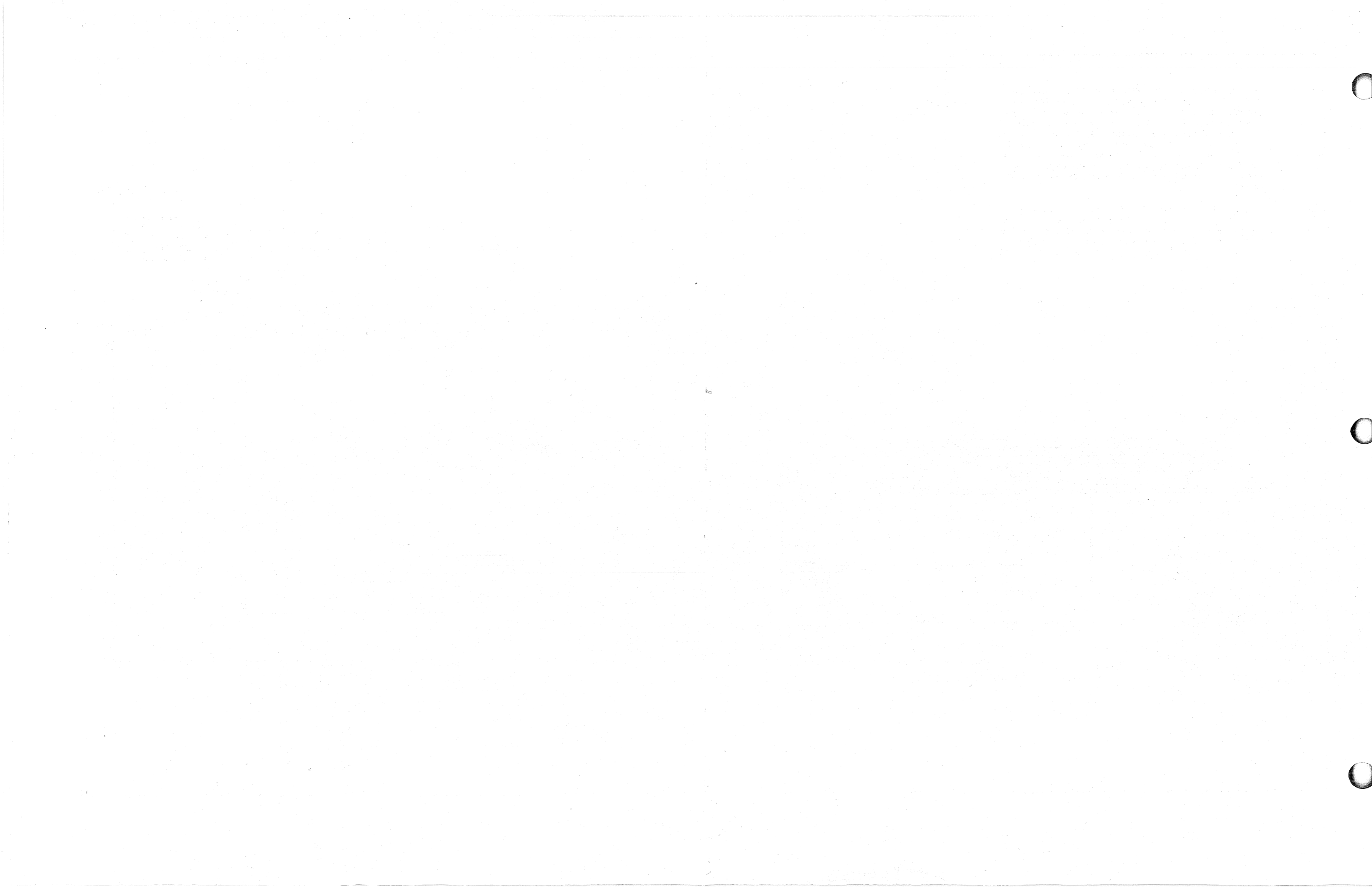
Depressing a key on the terminal initiates data transfer to the computer. A 7-bit code corresponding to the depressed key is loaded in bit-parallel form into the interface where Start, Stop and Parity bits are added to it. After the character is assembled, it is shifted in bit-serial fashion onto the I/O line and transferred to the computer system.

A bit-serial data burst containing a character from the computer system is shifted into parallel form as it enters the interface; when a stop bit is detected, the character is moved in bit-parallel fashion into the character buffer and then transferred to the character generator. The action taken by the printer system depends on the character code. If the code represents a printable character, the applicable printhead solenoids as well as the printhead position control are activated and the character is printed slice-by-slice. If the code is a control character, the position control or the paper feed control is enabled, or an audible tone (Bell) is sounded in response to the control code.



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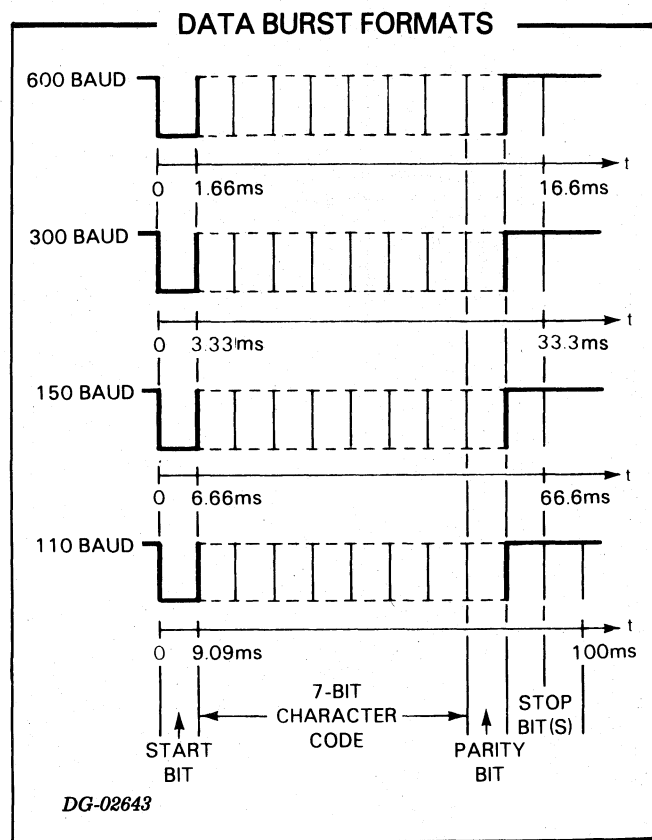
*6040/6041



INTERFACE AND CHARACTER BUFFER

The interface and character buffer transmits, receives, and stores data, interacting with the controller to pass characters among the controller, the printer, and the keyboard. The interface and character buffer operates in two modes: on-line and off-line. On-line, data passes via a 20mA current loop or an EIA interface from the controller through the character buffer to the printer, and from the keyboard to the controller. Off-line, data passes from the keyboard through the character buffer to the printer. The interface and character buffer consists of a universal asynchronous Receiver/Transmitter (UART), a 40 character First-In-First-Out (FIFO) buffer, and a timing circuit to establish the baud rate. In the 6040 and 6041 terminals, there is a Terminal Busy flag which sends the status of the FIFO buffer to the controller via an EIA interface.

The data transferred between the terminal and the controller is formatted as shown in the following diagram. These asynchronous data bursts consist of a start bit, a 7-bit ASCII character code, a parity bit, and one or two stop bits depending on the baud rate selected.



Receiver Transmitter (UART)

The UART is a 40 pin large scale integrated (LSI) circuit containing both a receiver and a transmitter which operate independently of each other. The receiver receives serial data bursts and converts them into 7-bit parallel characters which are loaded into the FIFO buffer. The transmitter receives 7-bit parallel character codes from the keyboard and converts them into serial data bursts. The timing of the data transfer rate is established by a clock running at 16 times the desired baud rate. The times 16 (X16) clock is common to the receiver and the transmitter; the input and the output baud rates are always equal.

When the terminal operates on-line, the receiver input is the serial data bursts from the interface and the transmitter output is the serial data bursts to the interface. Off-line, the receiver input is the transmitter output.

The receiver begins data reception when a start bit is received and verified. After verification of a start pulse the input level is sampled every 16 clock pulses and each sampled bit is loaded into the receiver shift register. Detection of the stop bit terminates the reception. The stop bit loads the contents of the shift register into the output data register. After the data register is loaded, the signal DATA AVAILABLE asserts, indicating that the character is available to the FIFO buffer.

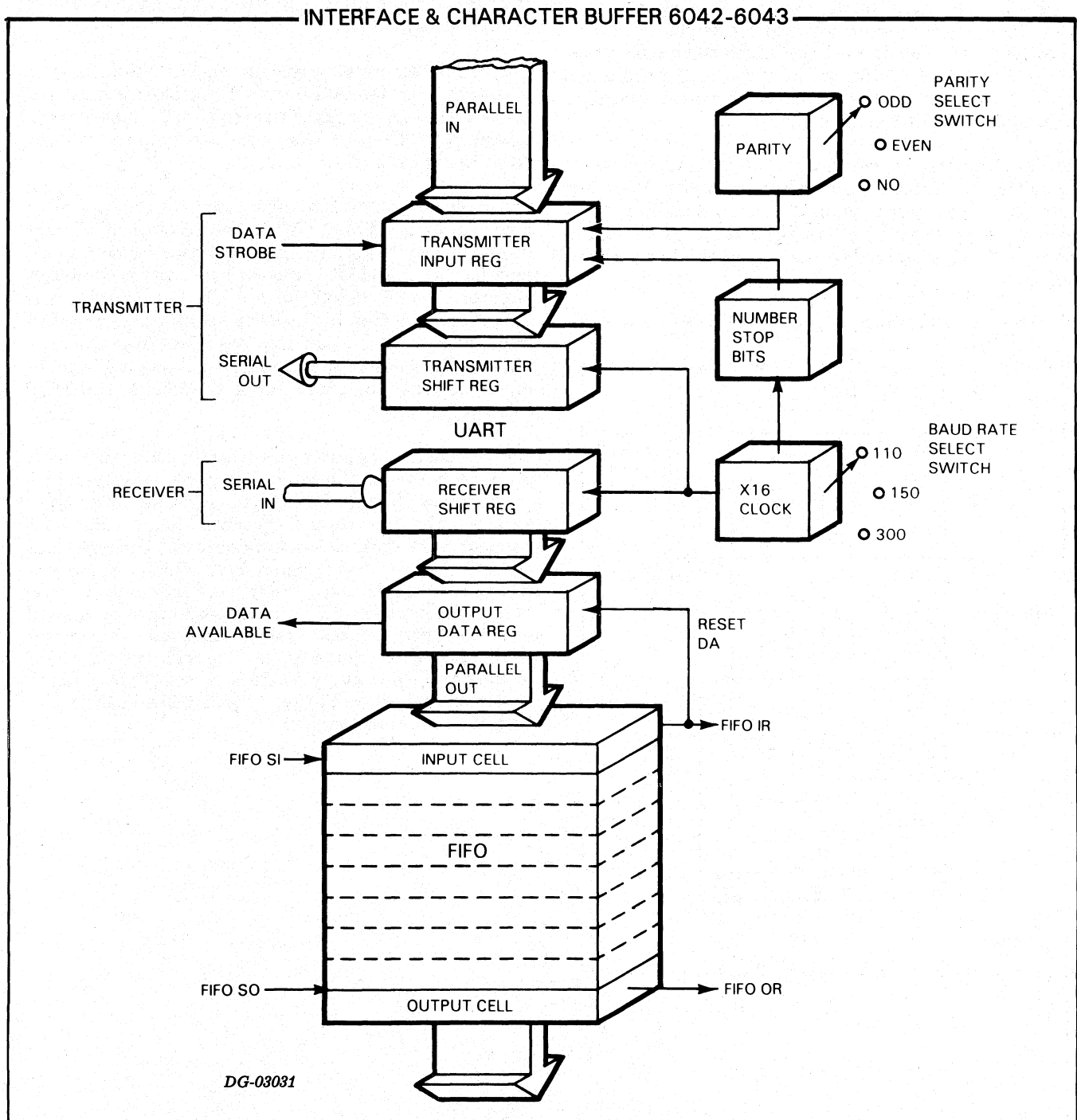
The transmitter input register is parallel loaded with a character from the keyboard upon detection of a data strobe pulse. The keyboard generates DATA STROBE pulse on each keystroke. When the RPT (Repeat) and another key are depressed the keyboard asserts the low level signal RPT, which causes the interface logic to repeatedly generate data strobe pulses. Start, stop, and parity bits and the contents of the input register are loaded into the transmitter shift register for transmission. The register shifts a bit to the output line every 16 clock pulses. Transmission is terminated when the last stop bit has been on the output line for one bit time.

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Character Buffer (FIFO)

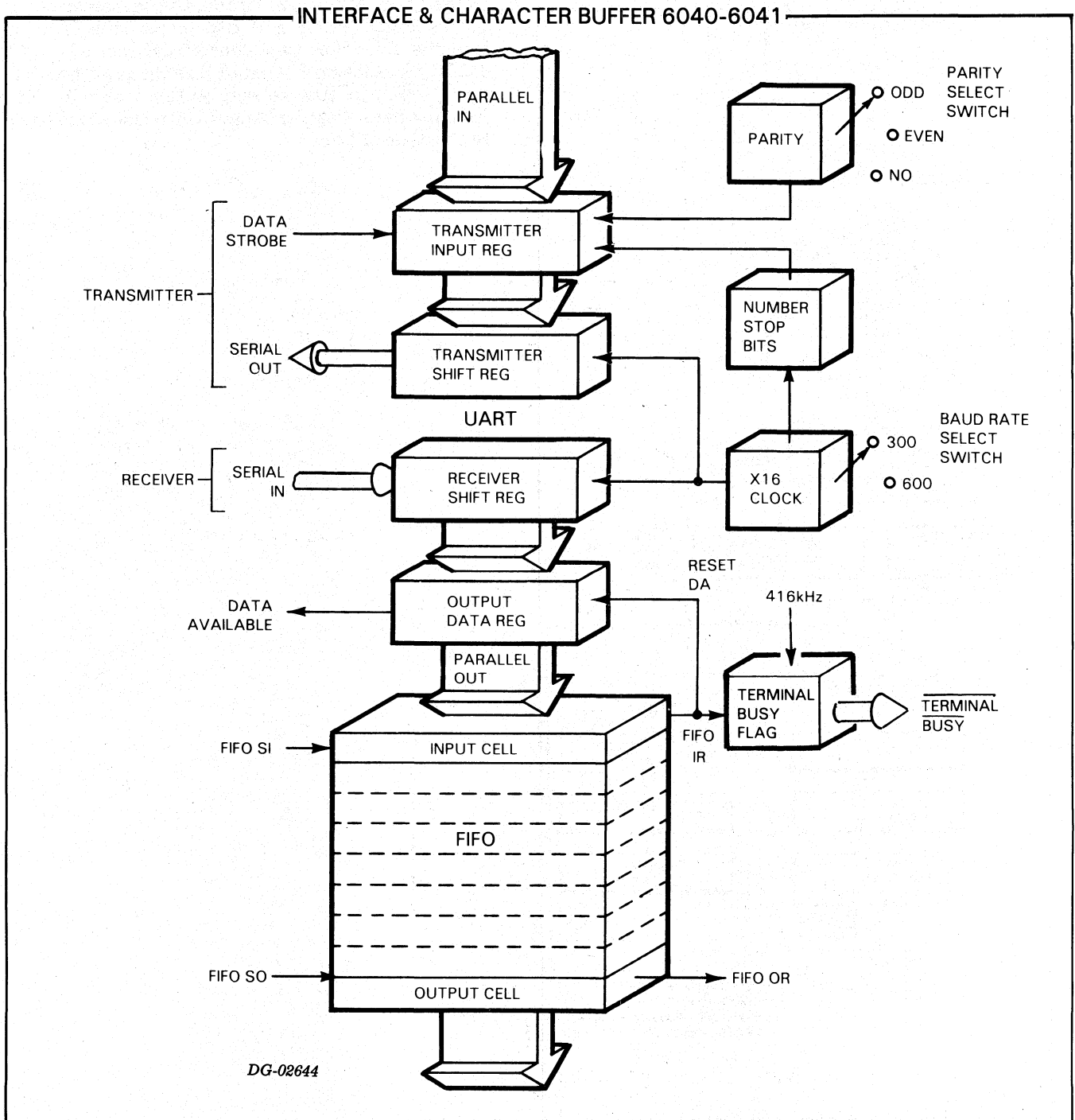
The character buffer is a 28 pin integrated circuit that can stack up to 40 character codes in an ordered (FIFO) queue. Characters leave the buffer in the order that they arrive; the first character into the buffer is the first character out of the buffer. The FIFO buffers the flow of characters between the input interface and the character printer when certain control sequences (e.g. Carriage Return) briefly suspend the operation of the printhead.

A character is shifted into the input cell of the FIFO buffer by the FIFO shift-in signal, FIFO SI. After the character is loaded into the input cell, the character shifts down through the buffer, toward the FIFO's output cell, to the first empty cell closest to the output. While the character is in the FIFO's input cell, the input ready signal, FIFO IR, goes false, indicating the input cell is occupied and not ready to receive another character. When the character falls out of the input cell and into the FIFO stack, FIFO IR is asserted. If

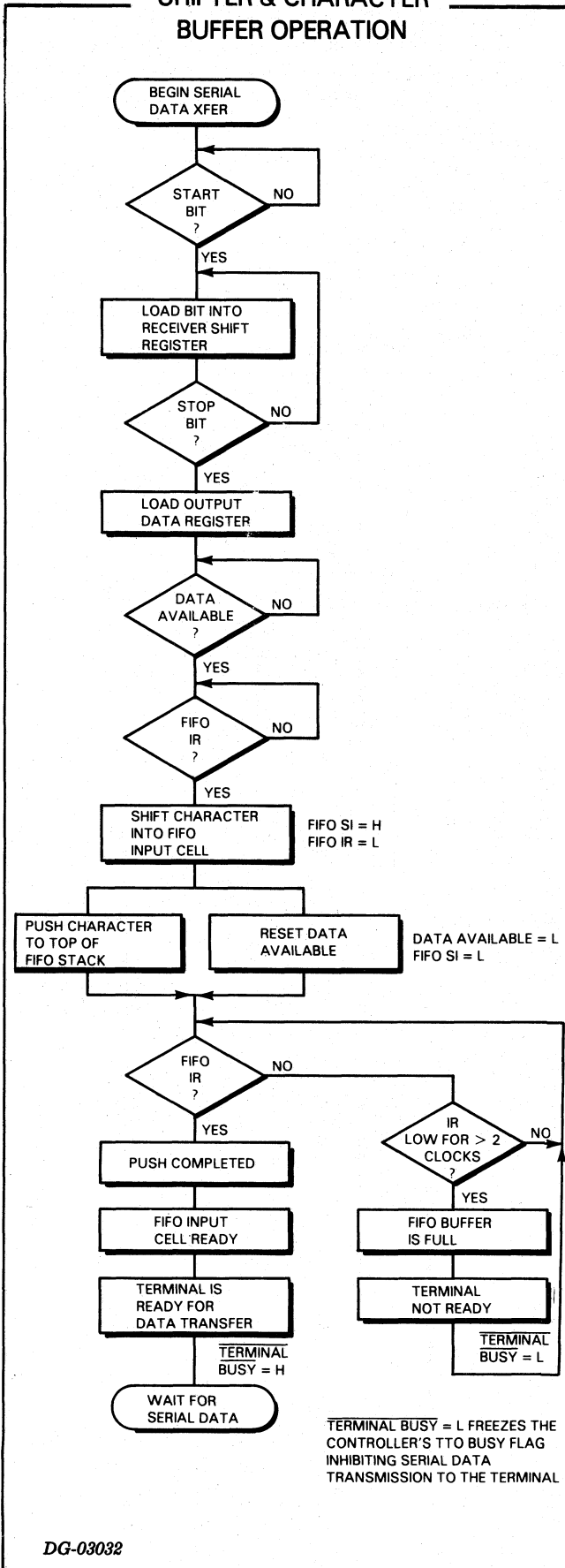


the FIFO buffer is empty, a character received at the input essentially falls through to the output cell. If the buffer contains a character, the received character stacks up on top of the previously received character. Successive characters stack up on top of the former ones in the order that they arrive. Characters shift out of the buffer from the bottom of the stack. When a character shifts out of the output cell all characters in the buffer shift down one cell toward the output. The shifting of characters out of the output cell is controlled by the FIFO shift-out signal, FIFO SO.

The buffer informs the position control of its status with the FIFO output ready signal, FIFO OR. When the buffer is empty, this signal is low; when the buffer contains characters, FIFO OR is high. The position control uses this information for catch-up mode operation.



SHIFTER & CHARACTER BUFFER OPERATION



Terminal Busy Flag

The 6040 and 6041 terminals contain a Terminal Busy flag which informs the controller of the FIFO's status. Controllers intended for use with these terminals at 600 baud test the Terminal Busy flag before transmitting each character, and suspend the data transmission if the Terminal Busy flag is set to 1.

The Terminal Busy flag monitors the signal FIFO IR. As each character is loaded into the FIFO's input cell, FIFO IR is forced false. After the character moves from the input cell and falls into the FIFO stack, FIFO IR returns true. If the FIFO is full, the character remains in the input buffer and FIFO IR remains false. If it remains false for two consecutive periods of the 416MHz clock, the Terminal Busy flag is set to 1. The signal TERMINAL BUSY is sent to the controller via an EIA interface. The Terminal Busy flag is set to 0 when FIFO IR returns true.

CHARACTER PRINTER

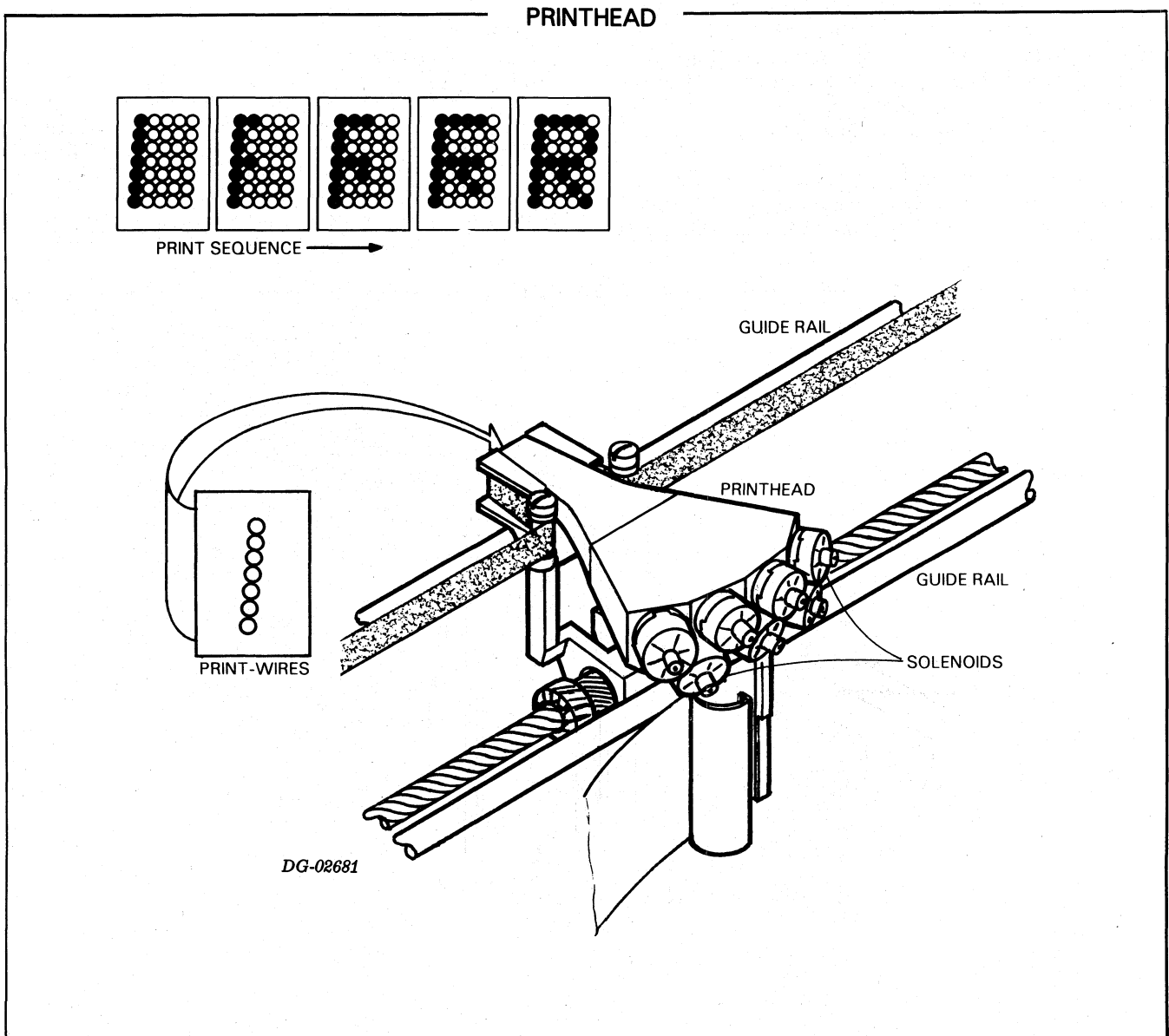
The character printer consists of a dot matrix printhead and related mechanism, a character generator, and solenoid drivers. It receives character codes from the FIFO buffer, selects those codes that represent printable characters and prints them on the paper. Certain groups of character codes are designated as printable or non-printable according to the configuration of selection jumpers on the printed circuit board.

Printhead/Carriage Assembly

The printhead/carriage assembly consists of a dot matrix printhead mounted on a carriage, and positioned in front of an adjustable platen. This assembly prints hard copy on paper forms. The dot

matrix printhead contains seven print-wires and an actuating solenoid for each wire. The wires are set in a straight line, angled at 10 degrees to the vertical; they print one slice of a 5-slice-wide character at one time. Some or all of the actuating solenoids may be energized simultaneously, depending on the character to be printed. A leaf spring on each wire holds the wire retracted; when the solenoid is activated, the wire is driven toward the paper and prints a dot through the ribbon. After the solenoid is de-energized, the spring returns the wire to the retracted position. The figure shows the dot matrix for the character R, and emphasizes the slices which comprise it.

The carriage travels on guide rails parallel to the platen, and slides on bushings. Electrical signals to the printhead solenoids are carried from the logic board by a ribbon cable clamped to a plug on the printhead.



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Print Controller

The print controller receives data from the character buffer, generates a 5X7 matrix for printable character codes, and fires the appropriate pin solenoids to construct the character image on the paper form. If the character decoded is a carriage return, the print controller activates the printhead positioner which moves the printhead to the home position so that the next character printed will be aligned with the column one position. A dual clocking scheme allows the printer to operate in a 'catch-up mode', printing characters at twice the normal printing speed at the beginning of each line.

The print controller incorporates a 128x7x9 column scan ROM character generator which contains a 5X7 matrix representation of each of the printable ASCII character codes and a decoder which defines which characters are printable, non-printable, and control characters. The inputs to the character generator ROM are a 7-bit ASCII character code as the character address and a 3 bit column address. The output from the ROM is one 7 row column of the the character matrix corresponding to the current address on the input column address lines.

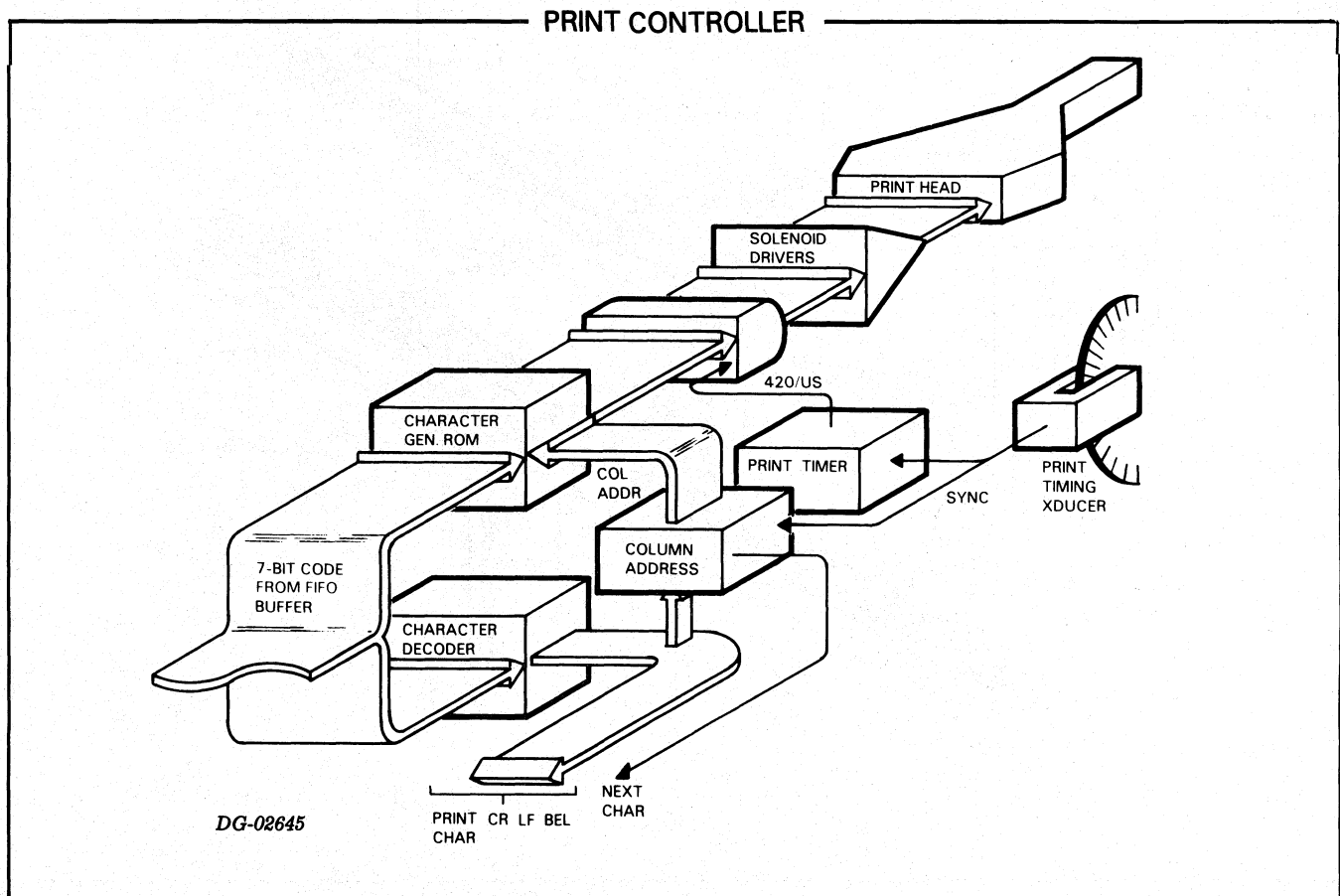
The action of the character decoder is controlled by the position of decoder jumpers on the main printed circuit board. For all jumper positions, Carriage

Return, Line Feed, and BEL are control characters that is, no corresponding matrix is addressed in the ROM and no print sequence is initiated. For some jumper positions, Form Feed is also a control character. The appropriate control function is executed by the terminal and the next character is decoded. Non-printable characters are the control characters and DEL for all jumper combinations, plus the octal codes 000 through 037, when the 64-character or 95-character subset is enabled. No print sequence is initiated by non-printable characters; they are effectively ignored by the terminal and the next character in the buffer is decoded. The decoder also performs lower case to upper case alphabetic translations (foldover) when the 64-character subset is enabled.

Jumper positions to select various functions are tabulated in the installation data sheets.

Solenoid Drivers

The solenoid drivers are transistor amplifiers which switch +30vdc to the printhead pin solenoids, energizing the solenoids, and causing the printhead pins to impact the paper form. The drivers are gated by a 420 microsecond timer synchronized to the printhead positioner by the print timing transducer.



PRINthead POSITIONER

The printhead positioner moves the carriage forward. It also moves the carriage backward in response to Carriage Return codes, and to Form Feed codes on terminals equipped with the form feed option. When the VIEW feature is enabled, the positioner moves the printhead away from the most recently printed characters so they can be seen. The positioner consists of a drive mechanism and a position controller.

Carriage Drive

The carriage drive system consists of a carriage drive motor, a lead screw and coupling, a timing disc and timing transducers, a 'carriage home' transducer, and carriage guide rails. The system moves the carriage across the platen, and provides electrical signals used to position the printhead during carriage returns and printing operations.

The lead screw is a threaded stainless steel rod which engages a threaded split nut in the carriage. Backlash is eliminated by a spring which compresses the nut on the screw threads. Two ball bearings support the lead screw, and it is coupled directly to the carriage drive motor with a flexible sleeve which is secured by clamp screws.

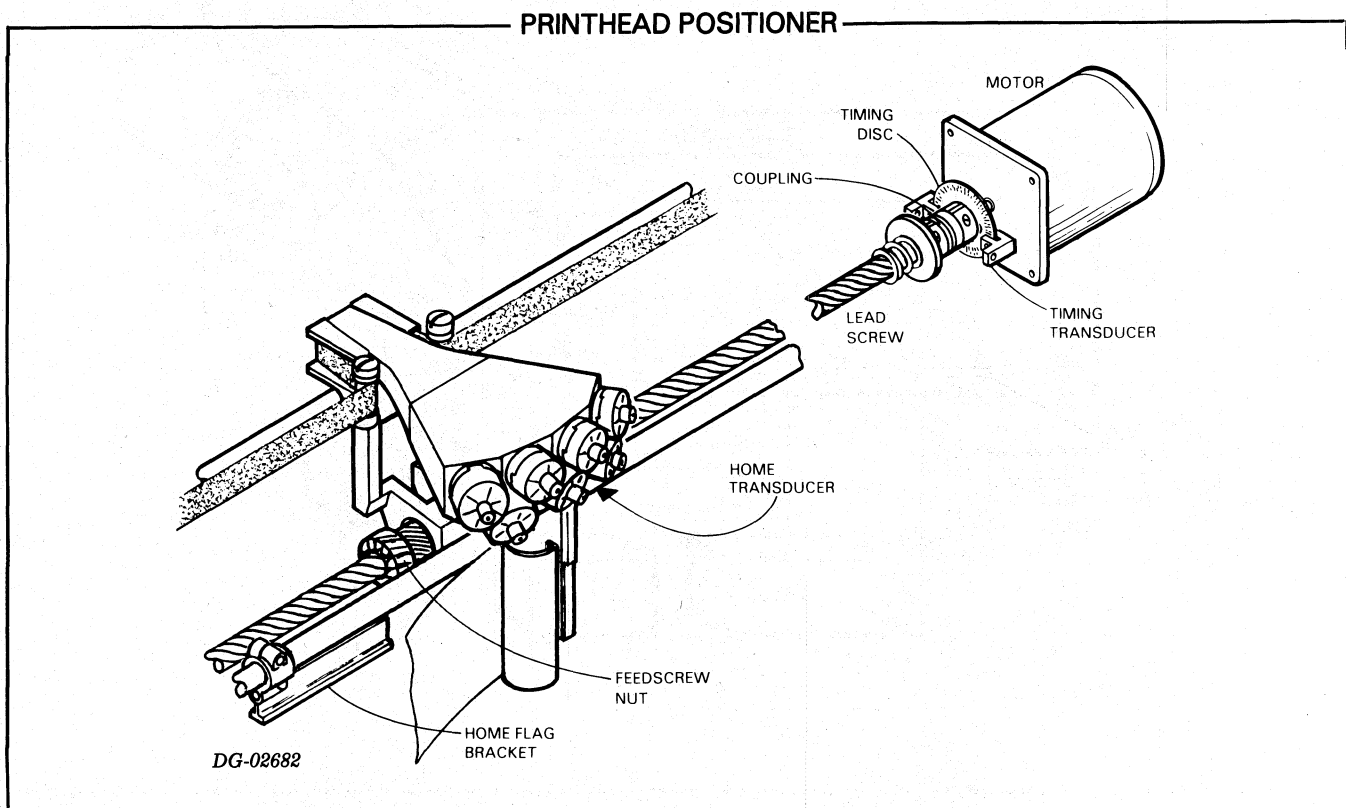
The carriage drive motor is a permanent magnet stepping motor, which is driven by a stepper control. The stepper control runs in open loop mode during

print operations and during short line (less than 10 characters) carriage returns. During longer carriage returns, the stepper control operates in closed loop (feedback) mode and uses timing signals from the timing transducers. These signals are used by the stepper system to control the carriage speed during these carriage returns.

A slotted disc is clamped to the right end of the motor shaft and rotates between two photoelectric transducers which are secured to a fixed bracket. As the disc rotates, the slots chop light beams which generate signals from the transducers. The signals from the print timing transducer are used to time the printhead solenoids when printing and, in conjunction with signals from the home flag transducer, to position the printhead at the column one position at the completion of a carriage return. The reversing transducer signals are used to control the carriage speed during long carriage returns.

The home flag transducer is a photoelectric element fixed to the printhead. A fixed bracket at the home (column one position) carriage position activates the transducer when the carriage passes it; the signals are used to decelerate the carriage drive motor and to reposition the printhead at the home position.

The carriage guide rails are stainless steel rods, fixed in position, and parallel to the platen. The platen is mounted on adjusting cams, so that printhead to platen spacing may be adjusted by moving the platen.



Position Controller

An understanding of the actions of the position controller depends on some familiarity with the operation of the stepping motor and the arrangement of the print timing and carriage return timing transducers. These are introduced separately below. The operation of the controller is then presented for three sequences: printing, carriage return, and VIEW.

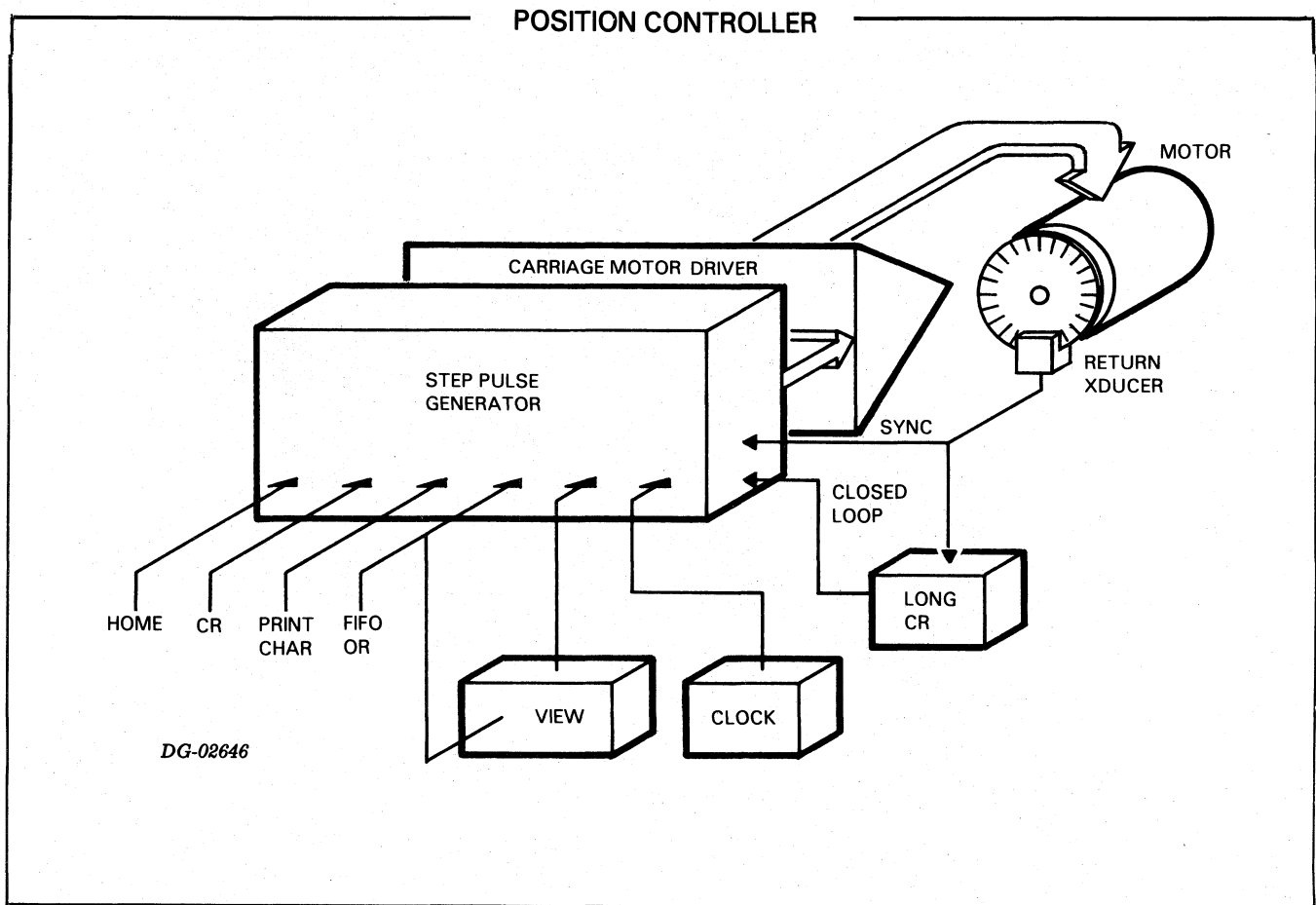
Carriage Drive Motor

The carriage drive motor is a bi-directional stepping motor which advances six 5 steps in the forward direction for each character printed. During carriage returns it steps in the reverse direction until the print head passes the home position.

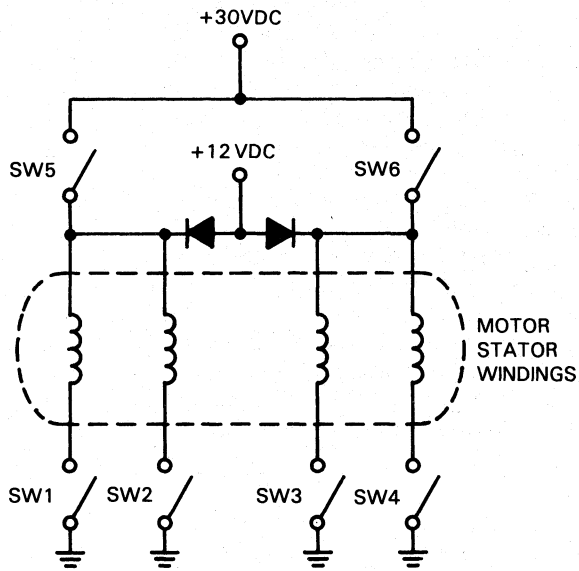
The permanent magnet rotor step motor is driven by four rectangular wave pulses whose phase relationship determines the direction of motion. The motor rotates one 5° step for each step pulse received. During printing, the carriage drive stepping motor rotates six steps each time a print sequence is initiated by the decoding of a printable character.

When the motor is driven by a periodic train of step pulses, it operates as a synchronous motor. The injection of an additional pulse to the pulse train driving step pulse generator accelerates the motor; the position of the additional pulse with respect to the other step pulses determines whether the acceleration is positive or negative. During carriage returns, the carriage drive stepping motor is driven by a step pulse train and decelerated by an additional pulse as the printhead crosses the home position. Stepping motors require settling time outs whenever they are caused to stop or change direction so that oscillations of the motor shaft will dampen out. If a stepping motor receives a step pulse while the motor shaft is oscillating, the resulting direction of motion is unspecified.

The current through the step motor windings is controlled by the carriage motor drivers, transistor switches toggled by the step pulse generator. These transistor switches are depicted in the step motor diagram as the switches 1 through 6. Switches 1 through 4 control the phasing of the current in the motor windings, determining the direction of rotation. Switches 5 and 6 momentarily apply +30vdc to the motor to decrease the rise time of the current in the windings which are otherwise powered by the +12vdc supply.

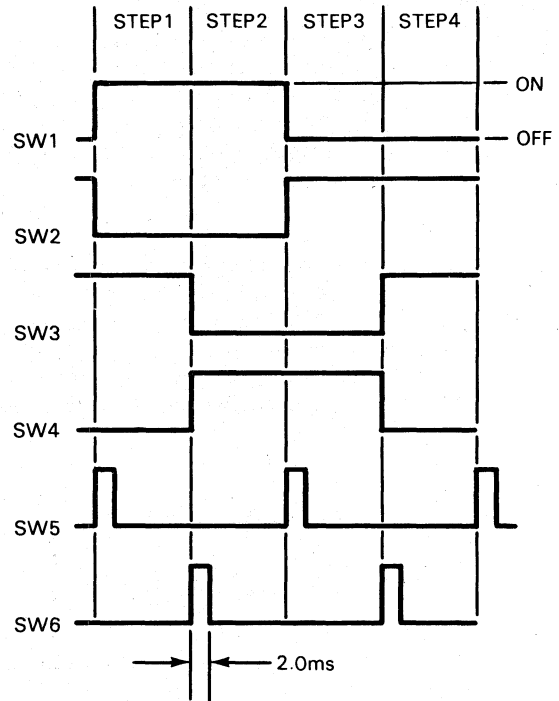


STEP MOTOR

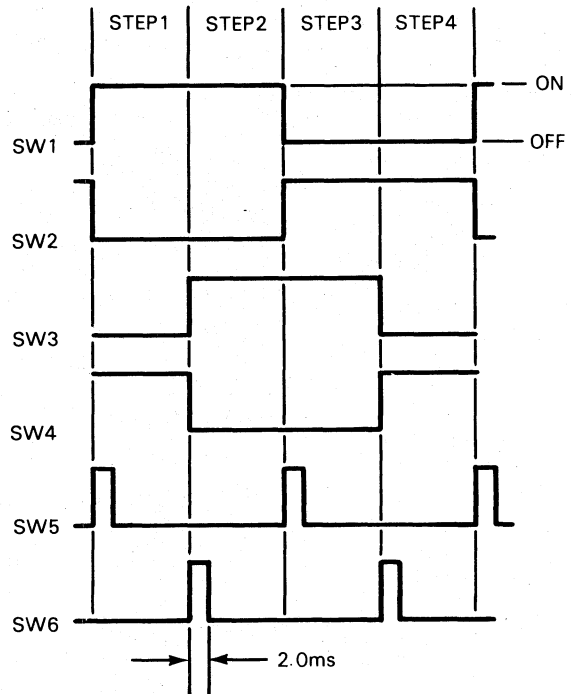


The carriage drive step motor moves in incremental steps of 5°. The phasing of the current through the stator windings determine the direction of motion.

DG-02647



FORWARD STEPPING TIMING DIAGRAM



REVERSE STEPPING TIMING DIAGRAM

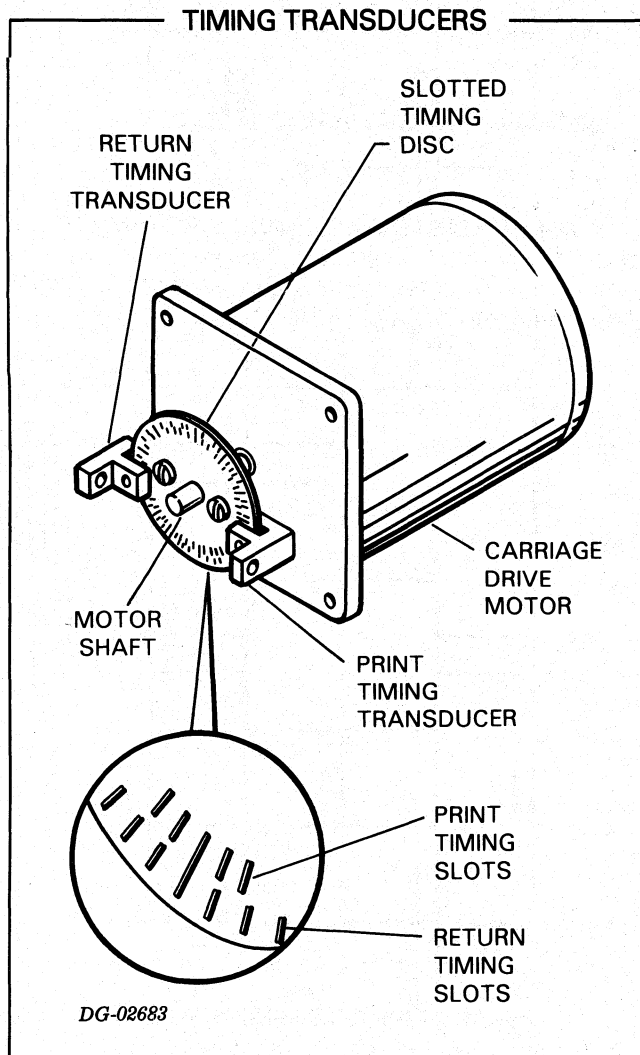
The timing diagrams show the phase relationships for a 4 step sequence in both the forward and reverse directions.

DG-02648

Timing Transducers

The timing transducer assembly consists of two optical switches and a slotted timing disc attached to the carriage drive step motor. The slots on the timing disc are aligned with the light paths of the optical switches and as the timing disc rotates with the carriage control step motor the light path is repeatedly broken.

The timing transducers perform two functions; one optical transducer, the print timing transducer, synchronizes the character column printing to the position of the printhead, and the other optical transducer, the return timing transducer, generates the step pulses which move the carriage drive motor during carriage returns.



There are two sets of timing slots on the disk, the outer set is aligned with the return timing/optical switch and the inner set is aligned with the column timing optical switch. Pulses from the return timing transducer generate the carriage drive motor step pulses to drive the motor in a closed loop mode for maximum speed during long carriage returns. The motor is accelerated from a standstill by logic generated step pulses; once in motion, the transducer generated pulses complete the carriage return. The column timing slots are arranged in groups of five. The five slots correspond to the five columns of the character matrix. The separation between the groups creates the inter-character spacing. Pulses from the column timing transducer gate the printhead pin solenoids allowing the selected pins to fire and increment the character generator ROM address to the next column.

Print Sequence

A print sequence begins when the print controller decodes a printable character. The carriage drive motor is set into motion by a 6 step pulse sequence. The first column of the character matrix is on the output lines of the character generator ROM which are connected to gates enabled by the print timing transducer. When the print timing pulse is detected the gates are enabled, the printhead solenoids energize, and the print pins impact the paper forming one column of the character matrix. The column address is incremented and the next column of the character matrix is placed on the output lines of the ROM. After the fifth column is printed a pulse is generated which resets the column address to zero. The next character is shifted out of the FIFO buffer and decoded and the sequence repeats.

When the terminal is receiving characters at baud rates of 110, 150, or 300, the print sequence goes to completion at twice its normal printing speed in order to maintain true data throughput of 10, 15 and 30 cps (respectively). By printing the characters at twice the normal rate, the terminal can print any characters which may have accumulated during previous carriage return, form feed, or View mode operations (all of which briefly suspend character printing). Characters received during any of these operations accumulate in the FIFO buffer. Double speed operation, or catch-up mode, is initiated at the end of each carriage return and continues as long as more than one character remains in the buffer. The step motor pulse generator continually polls the status of the FIFO buffer to determine if it is empty or contains characters. If the buffer contains characters at the beginning of a new line, the carriage drive motor is stepped at the double rate and continues at this speed until the buffer is empty. When the position control has caught up with the FIFO buffer, the print sequence returns to its normal speed.

Carriage Return Sequence

The carriage return sequence is initiated when the print controller decodes a carriage return character or an internal carriage return is generated by the form feed logic. The step motor is set into motion in the reverse direction initially by logic generated step pulses. Printing is disabled and the next character is shifted to the output of the FIFO buffer. After the initial acceleration of the step motor the return timing transducer pulses are brought into a closed loop control configuration in which each pulse received generates the next motor step pulse. The step motor runs in this slew speed, closed loop mode until the home transducer detects the column one position.

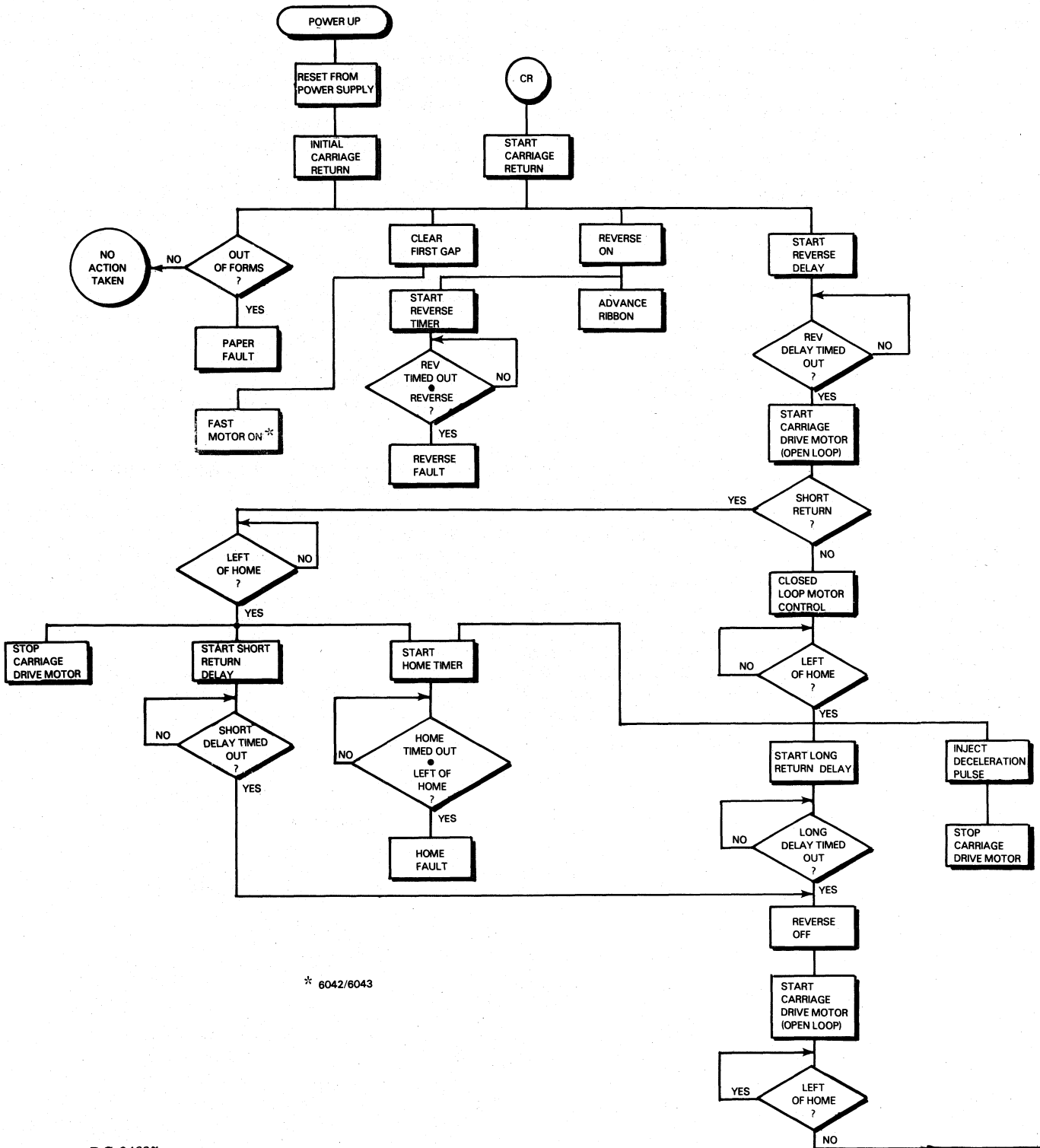
When the printhead reaches home it overshoots, decelerates, and returns to the home position. In order to decelerate the carriage drive step motor, one out-of-phase step pulse is injected into the step motor drive pulse train. As the motor decelerates the printhead engages the spring at the end of the feed screw and stops. The source of the motor drive pulses is switched from the closed loop return timing transducer pulses to the logic generated pulses. After a settling delay, the motor steps in the forward direction toward the home position.

Short line carriage returns are executed when the printhead is 9 columns or less to the right of the home position. During a short line carriage return the logic generated step pulses drive the carriage drive step motor in the reverse direction in the open loop mode only. Upon detection of home the motor stops and then, after a settling delay, steps in the forward direction toward the home position.

Before reaching the home position from the left, during either a long or a short line carriage return, the position control polls the status of the FIFO buffer. If the buffer is empty, the motor stops upon reaching home. If the buffer contains characters, the catch-up mode is initiated, the motor does not stop, and the first character is printed as the printhead crosses first character position.

When a Form Feed character is decoded in a terminal equipped with the form feed option, an internal Carriage Return command is generated. This command moves the printhead to home position. Simultaneously, the terminal generates an appropriate number of Line Feed commands to advance the paper to the top of the next form. After these Line Feed commands have been executed, the terminal generates a second internal Carriage Return command which places the printer in catch-up mode if any characters have accumulated in the FIFO buffer.

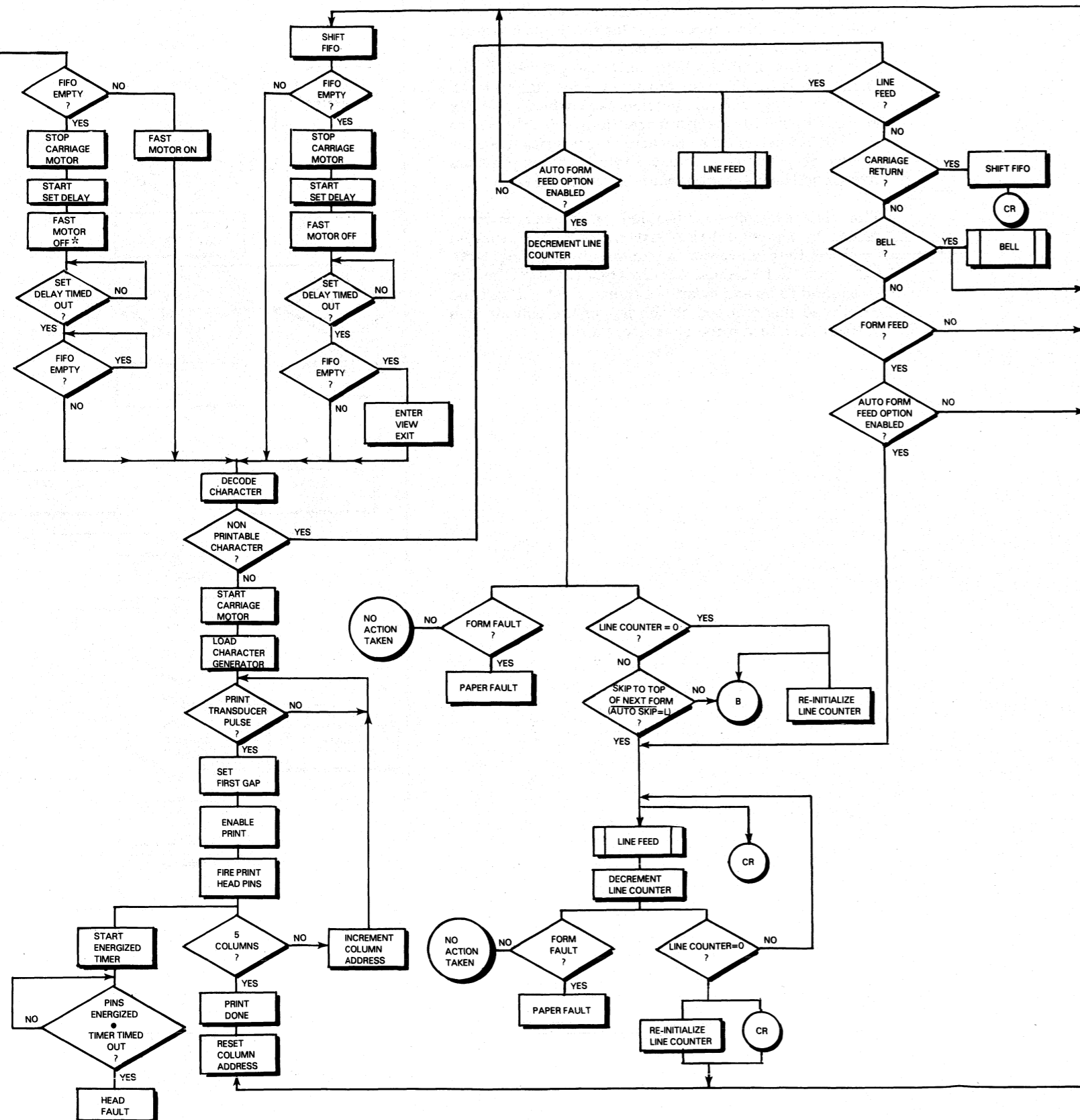
An initial carriage return moves the printhead to the home position during the power-up sequence. The power supply begins the initial return by momentarily switching into a Reset mode when the power is turned on. The initial return is a short line carriage return, that is, the carriage drive motor steps under open loop control. The completion of the initial return illuminates the Ready light.



* 6042/6043

DG-04827

DASHER FLOW CHART

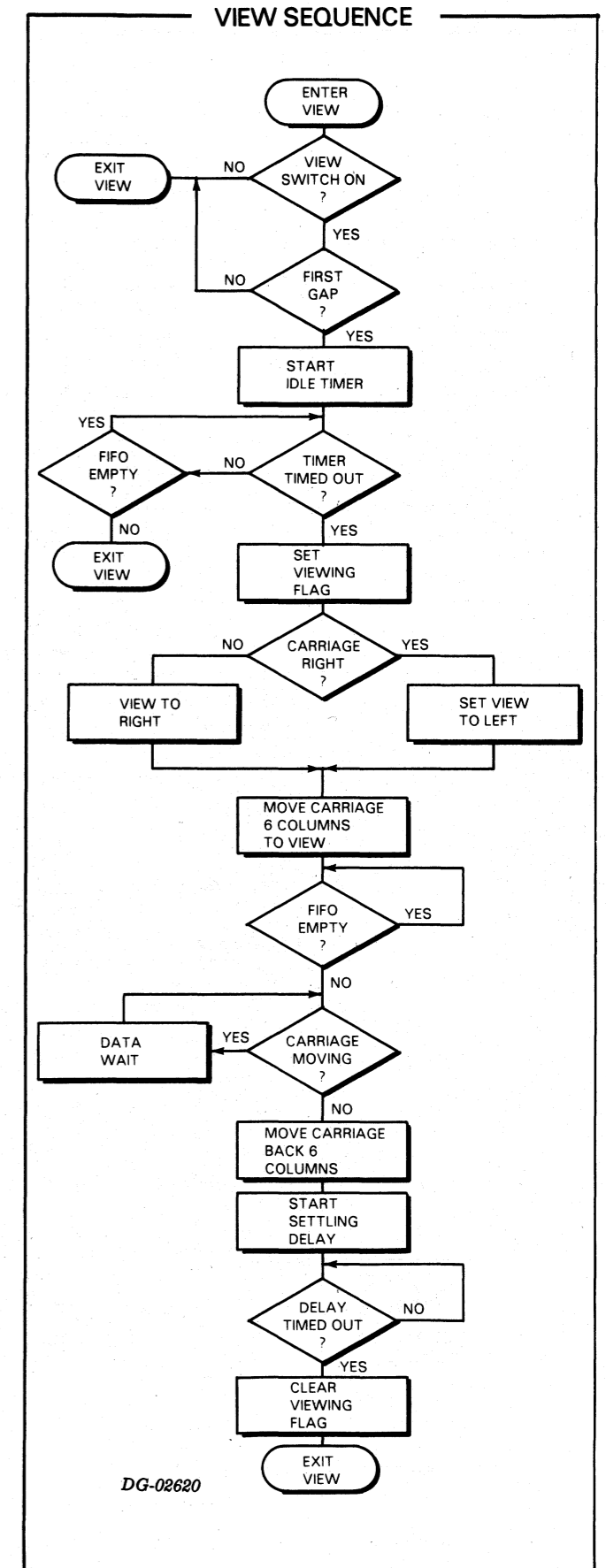


V

View Sequence

During lapses in data reception of more than 1.2 seconds, the position controller begins a view sequence and moves the printhead 6 columns to the right to permit viewing of the last character printed. If the printhead is to the right of the carriage right switch (approximately column position 126) when the view mode is initiated, the printhead moves 6 columns to the left. Reception of a character terminates the view mode; the printhead returns to its previous position, stops, and the print sequence is allowed to begin.

The view sequence is disabled after each carriage return by the signal **FIRST GAP** which is not asserted until the first character is printed on that line. **FIRST GAP**, when not asserted means that the FIFO buffer was found to be empty after a carriage return and the printhead has stopped to the left of the column one position (the first inter-character gap).



DG-02620

PAPER FEED SYSTEM

The paper feed system moves paper upward 1/6 of an inch when a Line Feed character is received (on line operation) or when the local Line Feed switch is pressed rearward. The system moves the paper upward continuously while the Line Feed switch is held in the single feed position. In terminals with the form feed option, the system moves the paper to the top of the next form when a Form Feed character is received (on line operation) or when the local Line Feed switch is the continuous feed position. If the automatic perforation skip-over feature is activated, the system also automatically advances the paper one inch (six lines) between forms. The system contains a feed mechanism and a paper feed control.

Paper Feed Mechanism

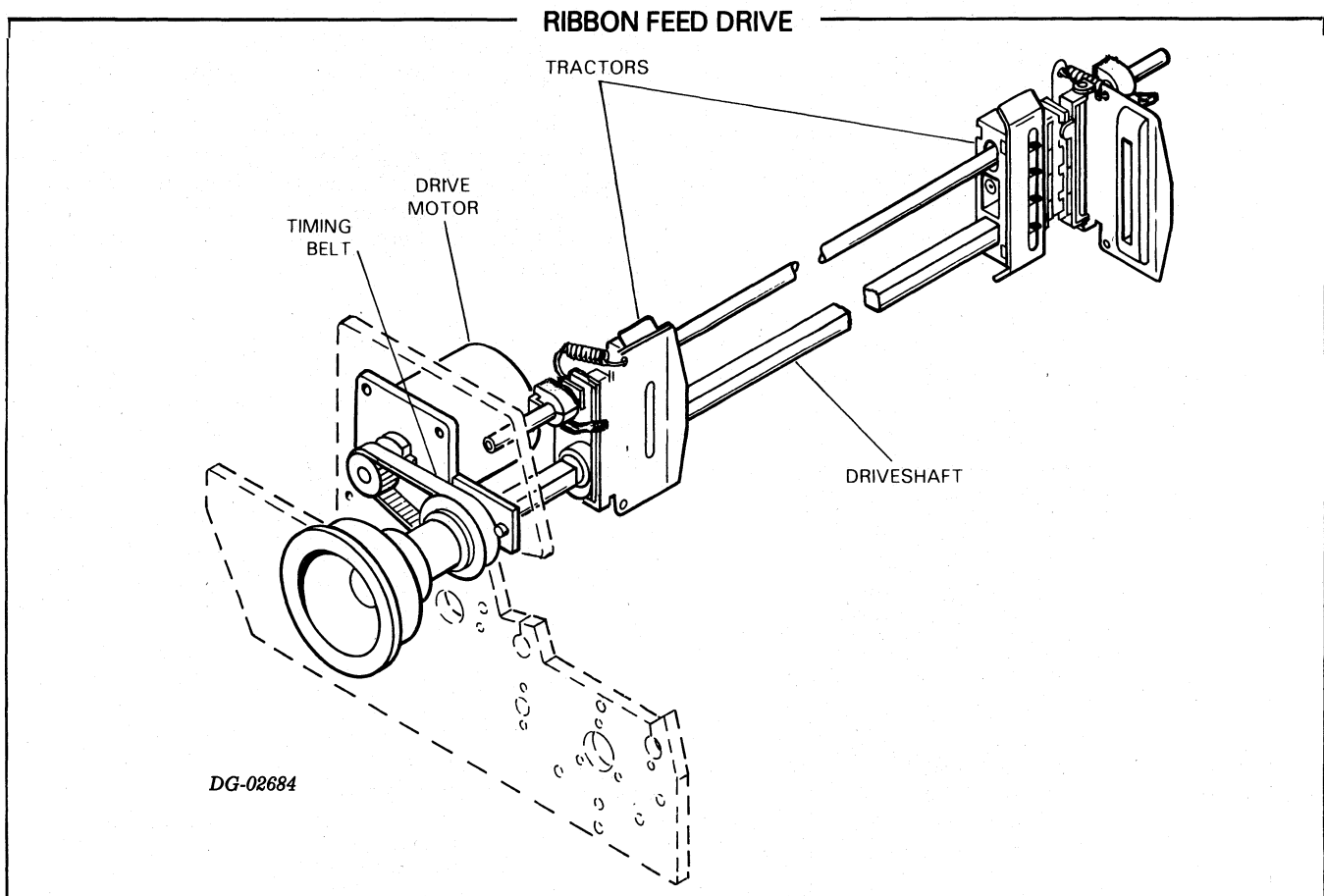
The paper feed drive consists of pin-feed tractors, a tractor drive motor, and a drive belt. This assembly advances the paper form across the platen in increments of one line.

The tractor unit is composed of two tractor mechanisms mounted on a driveshaft and a guide rail. Each mechanism has a rubber belt with molded pins

to engage the paper form. Four pins engage each edge of the form to provide driving force and prevent paper tearing. A spring-loaded door on each mechanism holds the form against the pins. Both tractor mechanisms are adjustable along the guide rail to accommodate various form widths and margins; each mechanism is secured in position with a knob which clamps to the guide rail. The driveshaft is square in cross-section to mechanically synchronize the tractor pins.

The tractor drive motor is a permanent magnet stepping motor which is connected to the driveshaft via a timing belt. Four motor pulses advance the paper one line.

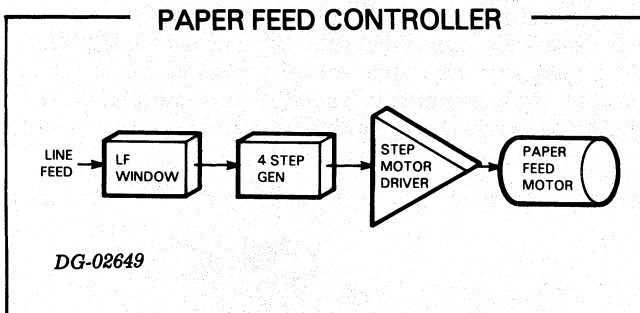
In terminals equipped with the form feed option, a form feed transducer monitors the action of the paper feed motor. This transducer consists of an optical switch and a slotted disc attached to the tractor drive gear on left end of the driveshaft. The slots on the disc are aligned with the light path of the optical switch and the disc rotates with the tractor drive motor. Each time the tractor drive advances the paper one line, the light path is broken and a signal is sent to the form feed logic. The form feed logic uses this signal to check that the paper actually does advance when a Line Feed command is issued. If the paper does not advance when it should, a line count error occurs.



Paper Feed Controller

The paper feed control is an open loop system which generates four step pulses for each single line advance. It responds to octal code 012 (the Line Feed command) and the local Line Feed switch. In terminals equipped with the form feed option, the octal code 014 (the Form Feed command) also affects the paper feed. When a Form Feed command is decoded, the terminal generates the appropriate number of Line Feed commands to advance the paper to the top of the next form.

When the character decoder detects a Line Feed command or when the local Line Feed switch is pressed to the continuous Feed position, the paper feed control starts a timer which enables the step pulse generator. It generates four step pulses, amplifies them, and applies them to the paper feed stepping motor. The motor advances four 15° steps moving the paper form 1/6 of an inch upward. When the Line Feed switch is pressed forward, the control generates a continuous stream of pulses to drive the motor.



RIBBON FEED

The ribbon feed moves the ribbon only during carriage return sequences, and reverses the direction of ribbon feed when an end-of-ribbon rivet actuates a ribbon-reverse switch. The system consists of a drive mechanism and a controller.

Ribbon Drive

The ribbon drive consists of two spool seats, a swing-arm gear train, a drive motor, two ribbon reversing switches, and a ribbon wind switch. The spool seats are hub and shaft assemblies which hold the ribbon spools; each seat is preloaded with a friction washer to maintain correct ribbon tension. The ribbon motor drives one of the ribbon seats (and its spool) through the swing-arm gear train. The arm swings from one ribbon seat to the other as the motor rotation reverses.

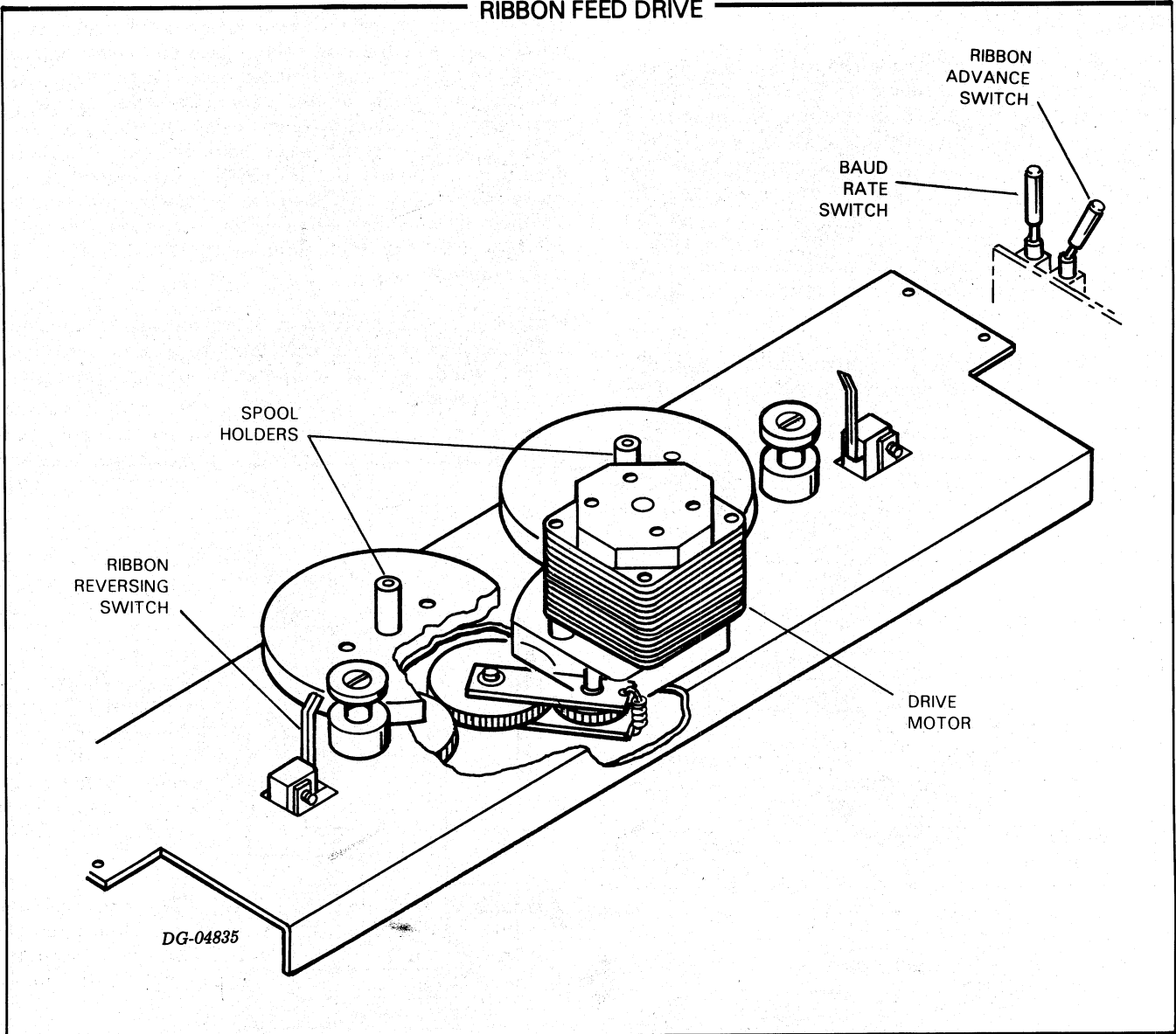
The ribbon drive motor is an ac induction motor which is activated during carriage returns, and is coupled to the ribbon spools through the gear train described above.

Two ribbon reversing switches reverse the direction of ribbon motion when either switch senses the end of the ribbon (i.e. supply spool nearly empty). The ribbon passes through both switches, and a rivet near the end of the ribbon mechanically triggers the switch. The switches may be operated manually to reverse ribbon direction when rewinding the ribbon or when printing.

The ribbon advance switch is an operator control used to wind the ribbon. This switch is enabled when the terminal is on or off-line, and is used when changing the ribbon or when performing maintenance procedures.

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RIBBON FEED DRIVE



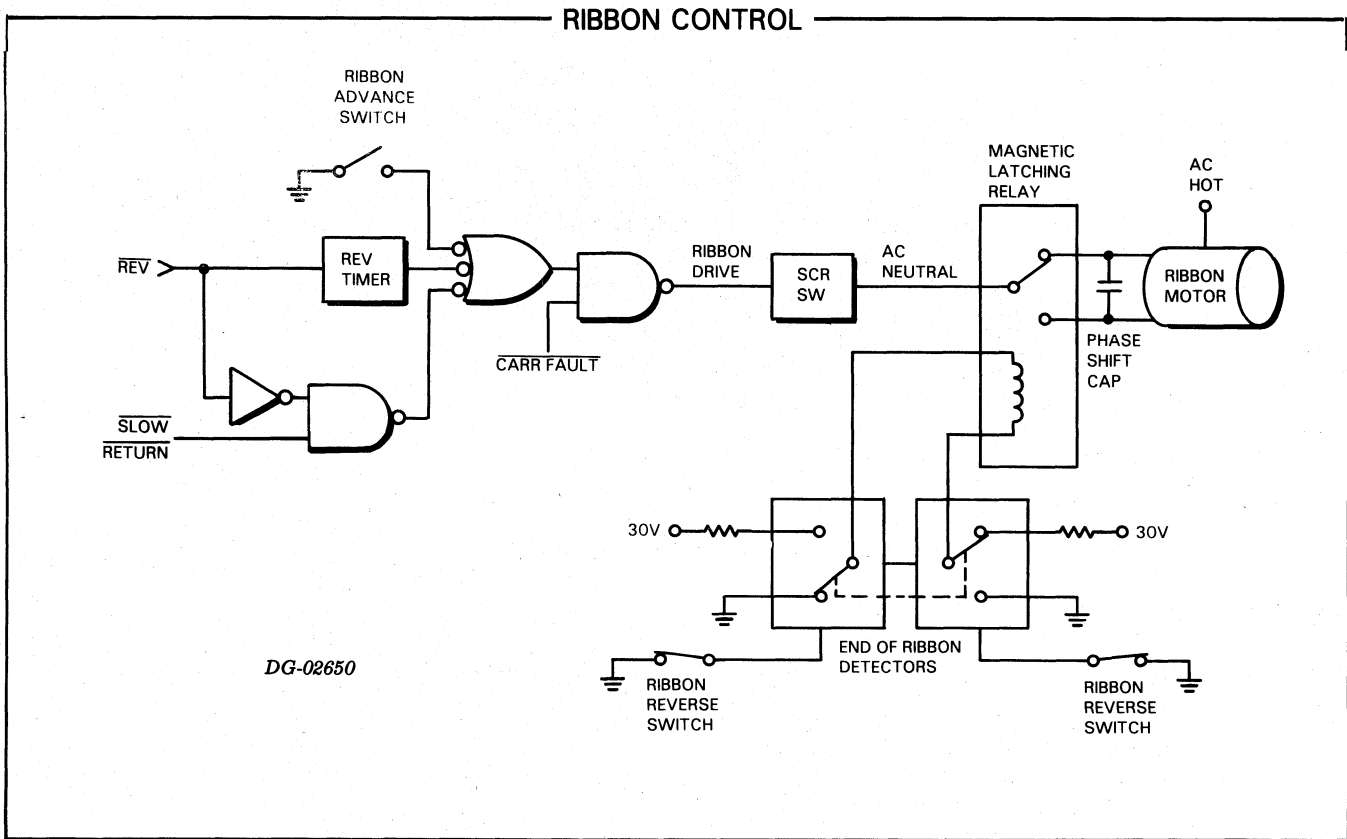
Ribbon Control

The ribbon control advances the ribbon during the carriage return time interval on lines longer than 9 characters or for 65ms on shorter lines. At the start of a carriage return the carriage control asserts the signal **REV** informing the ribbon control that the printhead is moving in the reverse direction; the ribbon control then starts a 200ms timer. Either the output of the timer, the **REV** signal, or the ribbon advance switch in the closed position activates the SCR switch which supplies an ac return to the ribbon motor.

The direction of the motor is controlled by a magnetic latching relay and a phase shift capacitor located on

the power supply printed circuit board. The relay is a double-pole self holding relay; once the relay coil is energized by a voltage of either polarity, the contacts remain closed until the coil is energized by a voltage of the opposite polarity. The relay then switches, latching against the other contacts. The end-of-ribbon detectors, activated by the ribbon reverse switches, energize the relay coil. The relay contacts select which winding of the ribbon drive motor receives the leading voltage phase angle, determining the direction of motor motion.

Motion of the ribbon drive motor is defeated by either a Home fault or a Reverse fault to avoid continuous ribbon winding if a malfunction occurs during a carriage return.



POWER SUPPLY

The terminal's power supply produces regulated outputs of -3vdc, -12vdc, +12vdc, +30vdc, and +5vdc given an input voltage of 100vac, 120vac, 220vac, or 240vac within a frequency range of 47 to 63 Hz. In addition to the DC voltage outputs, a RESET signal is also generated by the power supply to initialize the logic during the power-up sequence and to protect the circuitry against faults. Three techniques of regulation are employed in the data terminal's power supply: shunt regulation for the -3vdc section, fixed voltage regulation for the -12vdc section, and pulse width modulated (PWM) switching regulation for the +30vdc, +12vdc, and the +5vdc sections. The output voltages and their current ratings are summarized in the following table.

POWER SUPPLY OUTPUT VOLTAGES

VOLTAGE	CURRENT	TYPE OF REGULATION	WHERE USED
+12Vdc	3.5A	PWM	STEPPING MOTORS, CHARACTER GENERATOR
-12Vdc	50 mA	FIXED VOLTAGE	UART,FIFO KEYBOARD
+30Vdc	3.5A	PWM	STEPPING MOTORS, PRINthead
+5Vdc	3.A	PWM	LOGIC
-3Vdc	20mA	SHUNT	CHARACTER GENERATOR

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The type of regulaton used in the -3vdc section is a zener diode shunt. The output of a fullwave bridge rectifier, connected to the line transformer's secondary winding, is filtered by a capacitor and impressed across a zener diode. The zener diode maintains a constant voltage across its terminals, within certain current limitations, and thereby regulates the output voltage.

The type of regulation used in the -12vdc section is a monolithic fixed voltage regulator. The output of the fullwave bridge rectifier, connected to the transformer's secondary winding, is filtered by a capacitor and sent to a -12vdc fixed voltage regulator. A compensation capacitor is connected to the regulator's output to improve transient response.

The type of regulation used in the +30vdc, +12vdc, and the +5vdc sections is pulse width modulated (PWM) switching regulation. Switching regulators are a highly efficient and accurate means of regulating output voltages from changes due to line and load variations. Regulation is accomplished by changing the duty cycle (the on-time divided by the period) of a fixed-period switched dc voltage to compensate for changes in either the input or output voltage. The output voltage to a constant load is proportional to the duty cycle, increasing the duty cycle increases the output voltage; decreasing the duty cycle decreases the output voltage.

In addition to the regulating circuits, the power supply contains circuits for over voltage protection, under voltage protection, and over current protection. These protection circuits safeguard the power supply components against short circuits to the output voltages and extreme changes in the input line voltage.

POWER SUPPLY AC INPUTS

LINE VOLTAGE (\pm V)	CURRENT DRAW	FREQUENCY
100V + 10V -15V	2.5Amps	47 - 63Hz
120V + 12V -18V	2.2Amps	
240V + 22V -33V	1.2Amps	

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PWM REGULATED DC OUTPUT VOLTAGES

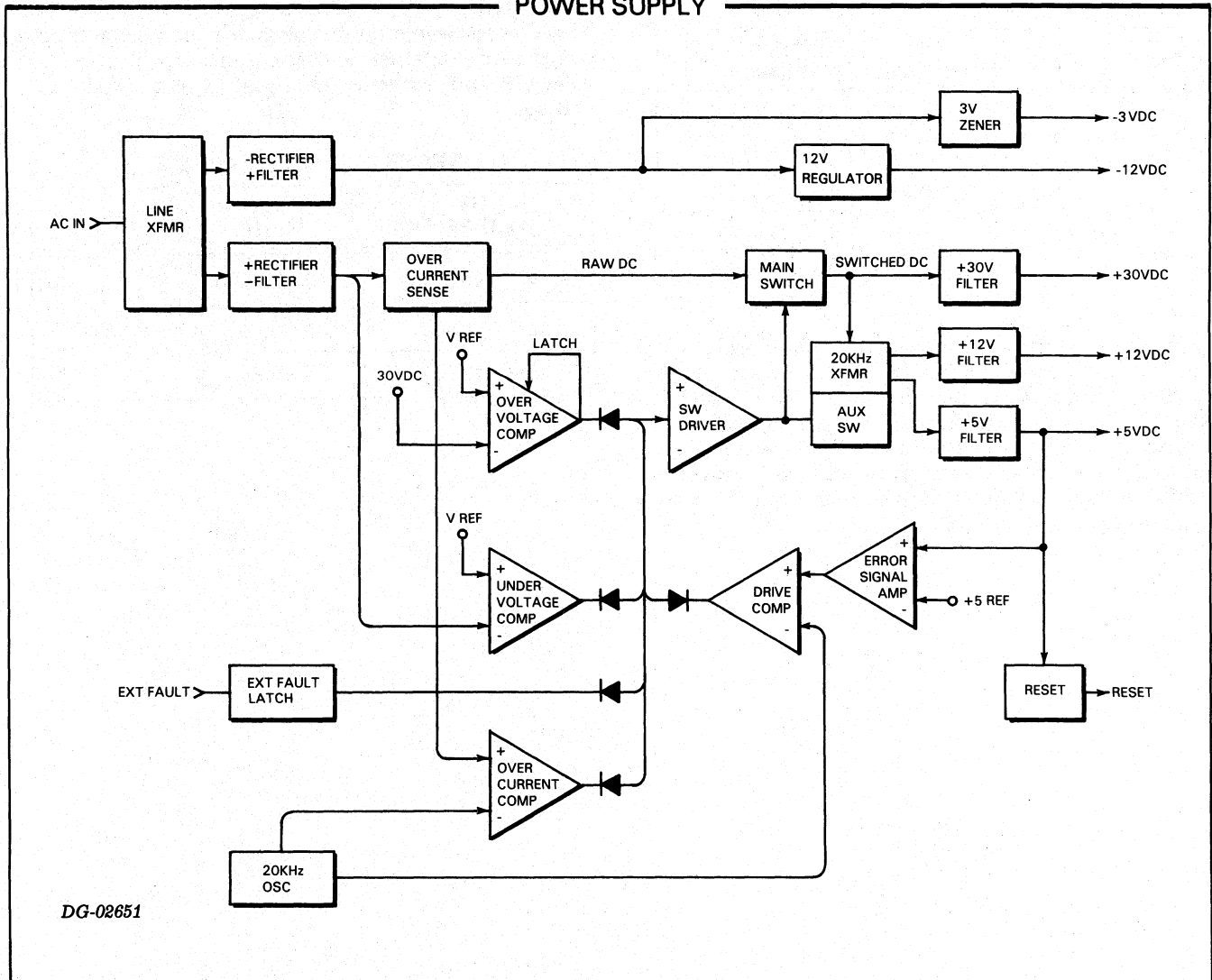
VOLTAGE	LINE REGULATION	LOAD REGULATION	RIPPLE	NOISE*	OVERSHOOT**	POWER FAIL RIDE THROUGH	OVER CURRENT	OVER VOLTAGE
+5V±1%	±2%	N/A	50mVp-p	≤20mV	100mV ≤1.5mS RECOVERY TIME	≥40mS DROPOUT FROM NOMINAL LINE	POWER FOLDBACK FOR ≥10A TOTAL CURRENT THROUGH MAIN SWITCH	LATCH INHIBIT FOR 30Vdc ≥36V OR 5Vdc ≥6.0V
+12V±10%	±2%	±7%	100mVp-p	≤40mV	300mV ≤2.5mS RECOVERY TIME			
+30V±10%	±2%	±7%	100mVp-p	≤50mV	250mV ≤2.5mS RECOVERY TIME			

*NOISE MEASURED AT MAIN PCB

**OVERSHOOT MEASURED USING 1 AMP STEP LOAD

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POWER SUPPLY



DG-02651

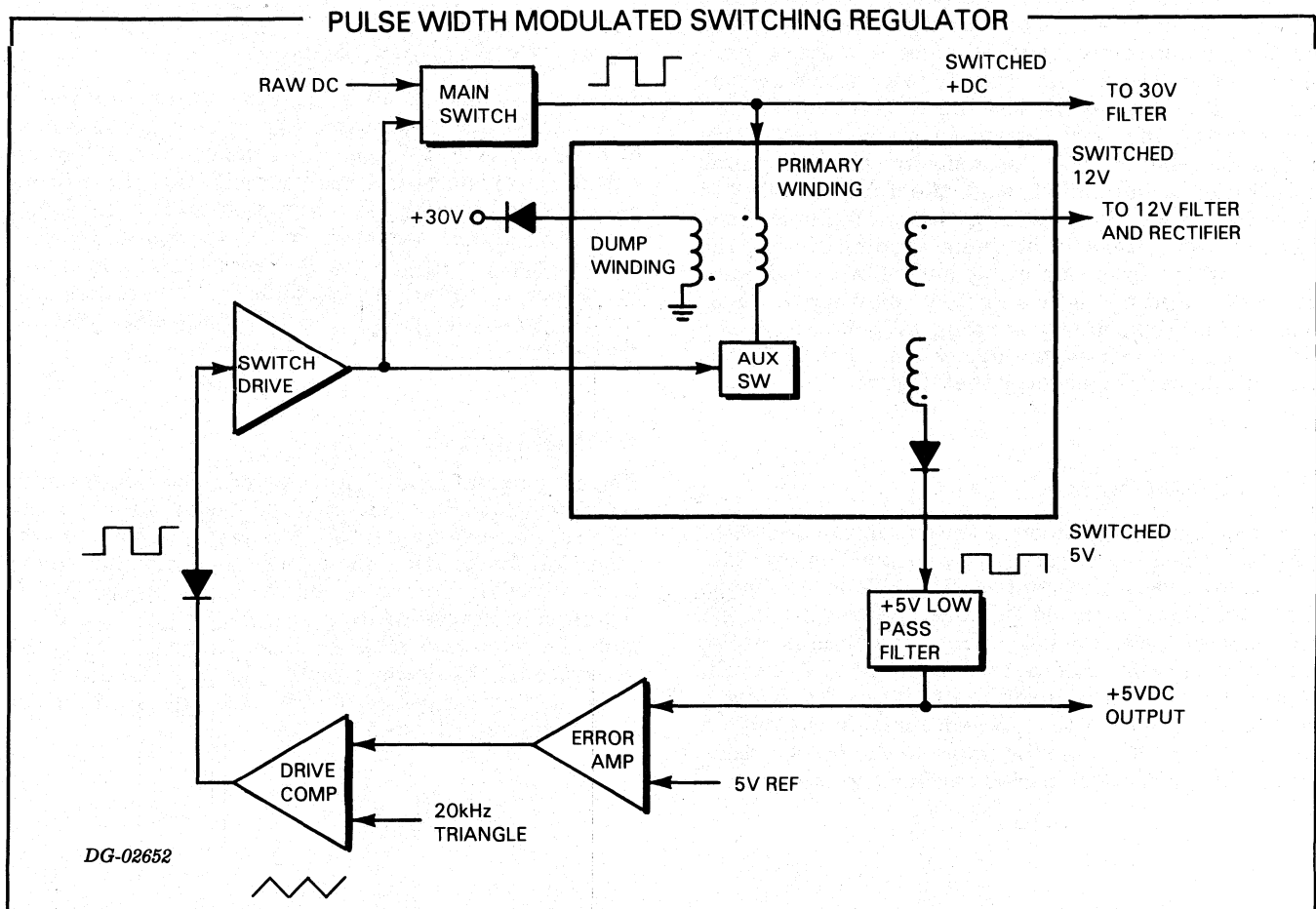
Pulse Width Modulated Switching Regulators

The PWM switching regulator of the power supply is depicted in the function block diagram below. The regulator is a closed loop feedback system whose error signal is the difference between the filtered +5vdc output and a 5 volt reference obtained from a 1% 5 volt zener diode. All three output voltages derive from the same source, the switched 30 volts, and are proportionally related to each other by the turns ratio of the 20kHz transformer. By using only the +5vdc output in the feedback loop, line regulation is obtained for all voltages since changes in the line voltage are linearly reflected to the output voltages in corresponding proportions. Correcting the +5vdc output from a change due to a line variation also corrects the +12vdc and the +30vdc outputs. The +5vdc output is both line and load regulated; changes in the +5vdc due to load variations are sensed in the feedback loop and compensated for.

Located in the lower left of the block diagram is the 20kHz oscillator. The oscillator supplies two outputs, a rectangular waveform which resets the over current comparator and a triangular waveform which switches the drive comparator and fixes the switching period at 50 microseconds.

The function blocks involved in the feedback control loop are the error signal amplifier, the drive comparator, the switch driver, the main switch, the auxiliary switch and 20kHz transformer, and the +5 volt filter. The error signal amplifier is an operational amplifier whose output is proportional to the difference between the 5 volt reference applied to the non-inverting input and the filtered +5vdc output applied to the inverting input. This error signal is the non-inverting input to the drive comparator, an op amp connected in a uni-polar supply, open loop gain configuration. The inverting input to the drive comparator is the triangular output from the 20kHz oscillator. Whenever the voltage of the triangle wave is less than that of the error signal, the op amp is driven into positive saturation and the output equals $V+$ which is +24vdc. As the triangle ramps up, it eventually becomes greater than the voltage level of the error signal; when this happens, the drive comparator op amp is driven into negative saturation and the output goes to $V-$ which is ground.

The drive comparator switches between saturation states creating a rectangular output with a 50 microsecond period. The pulse width or duty cycle is determined by the level of the error signal. This variable pulse width rectangular waveform is coupled through the switch driver and controls the main



switch which chops the RAW DC. The output of the main switch, SWITCHED DC, has a duty cycle which varies between 50% and 67% keeping its average dc value at 30 volts.

The SWITCHED DC is coupled across a transformer whose turns ratio steps down the voltage. The switched 5 volts is rectified and passed through the +5v low-pass filter which averages the waveform into a +5vdc level. The +5vdc is applied to the inverting input of the error amp, completing the loop. The duty cycle of the SWITCHED DC varies in order to keep the +5vdc output equal to the reference voltage.

Another winding on the 20kHz transformer and two similar low-pass filters produce the +12vdc and +30vdc outputs. The SWITCHED DC from the main switch is averaged by a low-pass filter to produce the +30vdc output. The 12 volt winding of the 20kHz transformer steps down and couples the SWITCHED DC waveform to a rectifier. This rectified switched 12 volts is averaged by a low-pass filter to produce the +12vdc output.

The fourth winding of the 20kHz transformer is the dump winding. The dump winding and the auxiliary switch regulate the current flow in the transformer. No net DC current can be allowed to flow through the transformer primary winding or the transformer will quickly saturate creating extremely high currents when the switch is on. The auxiliary switch is driven by the switch driver and supplies a current path through the transformer primary to ground when the main switch applies the RAW DC to the transformer. When the switch driver opens the main and auxiliary switches, the energy stored in the magnetic inductance is shunted through the dump winding to the +30vdc supply, resetting the transformer core. The induced voltage in the dump winding inhibits the switch driver from operating until the transformer primary winding is completely discharged. This insures that the primary winding will not saturate by inhibiting the next switching cycle until the primary winding gives up the energy that it stored.

Over Current Protect

The over current protection circuit limits the total output current by lowering the output voltage. The over current sense determines if the RAW DC current to the main switch exceeds 10 amps. If an over current condition exists at the beginning of a switching cycle, the over current comparator inhibits the switch, terminating the on time of the SWITCHED DC waveform for the remainder of that period, limiting the output current. The 20kHz oscillator resets the over current comparator after each period causing the comparator

to check for an over current condition during each switching cycle. If the instantaneous current to switch exceeds 10 amps during several consecutive cycles the output voltages drop to near zero as the average duty cycle approaches zero.

Over Voltage Protect

The over voltage comparator compares the +30vdc output with a reference voltage and latches up, inhibiting the switch, when the +30vdc exceeds 36 volts. Unlike the over current comparator which resumes normal operation when the current returns to its rated value, the over voltage fault is non-recoverable. Once an over voltage fault is encountered the power supply is inoperable until the voltage has returned to its normal value and the terminal is shut down and powered up again.

Under Voltage Protect

The under voltage protection circuit inhibits the switching operation when the RAW DC voltage is less than 26 volts. Under normal operating conditions the under voltage protect disables the power supply during its power up sequence. This fault interlock clears itself when the voltage increases to 26 volts.

Reset (+5vdc Under Voltage)

Because the action of TTL logic is indeterminate when the 5 volt Vcc supply drops below the tolerance of a logic 1, the +5 volt sense monitors the +5vdc output and generates a RESET signal when the +5vdc output falls below 4 volts. The RESET signal stops the operation of the terminal, but does not affect the power supply. Reset is part of the normal power up sequence; it initializes portions of the terminal's control logic and starts the initial carriage return sequence.

External Fault

The external fault latch is triggered by the HEAD FAULT signal from the Fault Detector. A Head fault indicates that current has been flowing through the print head solenoids for greater than 1ms. The external fault latch inhibits the switch driver, causing the PWM regulated voltages to drop to zero volts. The Head fault is non-recoverable; once a Head fault is encountered the power supply is inoperable until the Head fault interlock is cleared and the terminal is shut down and powered up again.

FAULT DETECTORS

The terminal is protected by a system of fault interlocks which halt the operation of the terminal in the event of a component malfunction or an unsafe condition. Several of these faults incorporate fault indicator lights to facilitate troubleshooting. There are six fault conditions; a summary of these faults follows.

Fault	Caused by
Over Voltage Fault	Power supply positive regulated output voltages have risen above maximum tolerance.
Head Fault	Print head pin solenoid energized for greater than safe time limit.
Home Fault	Print head remains to the left of home position.
Reverse Fault	Print head continually driven in reverse direction.
Paper Fault	Terminal is running out of paper forms.
Reset	Power supply +5vdc output is less than 4 volts.

Some of the faults affect the power supply while others affect the terminal's control logic. The Over Voltage fault and the Head fault inhibit the PWM switching regulator causing the terminal to completely power down. Both the Home and Reverse faults inhibit the carriage control motor step pulses, halting any print head motion. The Reset condition disables the sequencing logic and idles the terminal without affecting the power supply, and the Paper fault stops the terminal from printing.

The data terminal is equipped with five fault indicator lights in order to determine which of the faults halted the terminal's operation. Two of the indicator lights are located on the operator's control panel: the Ready light and the Paper Fault light. The three remaining indicator lights are located on the main printed circuit board as shown in the diagram: the Power OK light, the Reverse Fault light, and the Home Fault light.

The Ready light goes off whenever any fault exists, warning the operator that the terminal is no longer operable. The Power OK light, when on, indicates that the power supply is operating normally. When off, the Power OK light indicates that the power supply is in a Reset condition or that the power supply is disabled. The other lights are related to the faults in the following manner: the Home Fault glowing indicates a Home fault, the Reverse Fault glowing indicates a Reverse fault, and the Paper Fault light glowing indicates a Paper fault.

Over Voltage Fault

An over voltage fault occurs when the +30vdc regulated output from the power supply increases above 36 volts. The over voltage protect circuit compares the +30vdc with a reference and latches up, inhibiting the PWM switching regulator. All the positive voltages drop to zero causing a complete shut down of the terminal and all indicator lights are off.

Head Fault

A head fault occurs when current flows in any print head solenoid for more than 1ms in order to protect the solenoids from overheating and becoming damaged. Whenever current flows through a print head solenoid, a timer is started; if the solenoid is energized after the timer times out, a fault signal is sent to the power supply which activates a latch and inhibits the PWM switching regulator. All positive voltages drop to zero causing a complete shut down of the terminal and all indicator lights are off.

Home Fault

A home fault occurs when the print head remains to the left of the home position for more than approximately one second, or when a home transducer or a circuit failure erroneously indicates that the print head is to the left of home. The home transducer generates a HOME signal when the print head moves behind the home position and starts a timer; if HOME is asserted when the timer times out, the carriage control motor step generator is disabled halting the carriage control motor, and illuminating the Home Fault light.

Reverse Fault

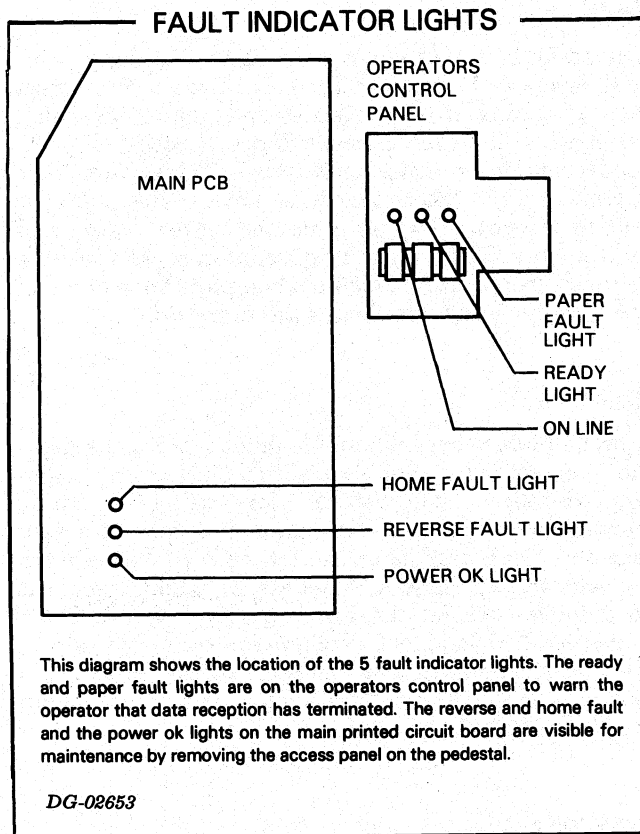
A reverse fault occurs when the carriage control step motor is driven in the reverse direction for more than two second. Whenever the carriage control motor is stepped in the reverse direction the signal REV is asserted and a timer is started; if REV is present when the timer times out, the carriage control motor step generator is disabled halting the carriage control motor, and illuminating the Reverse Fault light. The terminal remains in the reverse fault condition until the POWER switch has been toggled.

Paper Fault

A paper fault occurs when the terminal runs out of paper forms. A switch located in the paper path senses the absence of paper in the paper path. If after a carriage return there are no paper forms in the paper path, the terminal is inhibited from further printing and the Paper Fault light is illuminated. In terminals equipped with the form feed option, a paper fault also occurs when there is a line count error.

Reset

A reset fault occurs when the +5vdc regulated output from the power supply drops to less than 4 volts. Reset disables the carriage control and return sequencing logic and the print head solenoid drivers, stopping all terminal control functions. During Reset the Power OK light is off.



FAULT LIGHT SUMMARY TABLE

CONDITION	LIGHT				
	READY	PAPER FAULT	POWER OK	REV FAULT	HOME FAULT
NORMAL OPERATION	ON	OFF	ON	OFF	OFF
OUT-OF-FORMS / LINE COUNT ERROR	OFF	ON	ON	OFF	OFF
RESET	OFF	OFF	OFF	OFF	OFF
REVERSE FAULT	OFF	OFF	ON	ON	OFF
HOME FAULT	OFF	OFF	ON	OFF	ON
HEAD FAULT	OFF	OFF	OFF	OFF	OFF
OVER VOLTAGE FAULT	OFF	OFF	OFF	OFF	OFF

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SECTION VI OPERATOR MAINTENANCE

INTRODUCTION

This section describes operator maintenance procedures recommended for Data General's 6040-6043 DASHER terminal printers. Maintenance consists of periodically cleaning the mechanical assemblies.

NOTE *Do not lubricate any parts. The terminal requires no lubrication, and lubricants tend to accumulate dust and dirt, which will seriously degrade performance.*

Perform maintenance procedures according to the following schedule:

EVERY MONTH

Clean the printhead guide rails, the platen, and the tractor mechanism as follows:

Materials Required:

Phillips screwdriver
Lint-free tissues
91% isopropyl alcohol
Vacuum cleaner with non-conducting nozzle

- Turn the POWER switch to OFF. Unplug the power cord from the line supply outlet.
- Lift up the top cover until it latches open.
- Remove the print shield by removing the four screws holding it in place.
- Remove the paper from the terminal. Leave the platen in the rearmost position.
- Remove the ribbon from the platen area. Slacken the ribbon sufficiently and lift it off the printhead and guides to expose the platen.

VI

- Use a lint-free tissue to wipe the carriage rails and lead screw. If necessary, *dampen* the tissue with 91% isopropyl alcohol. The lead screw may be rotated manually to move the carriage assembly.

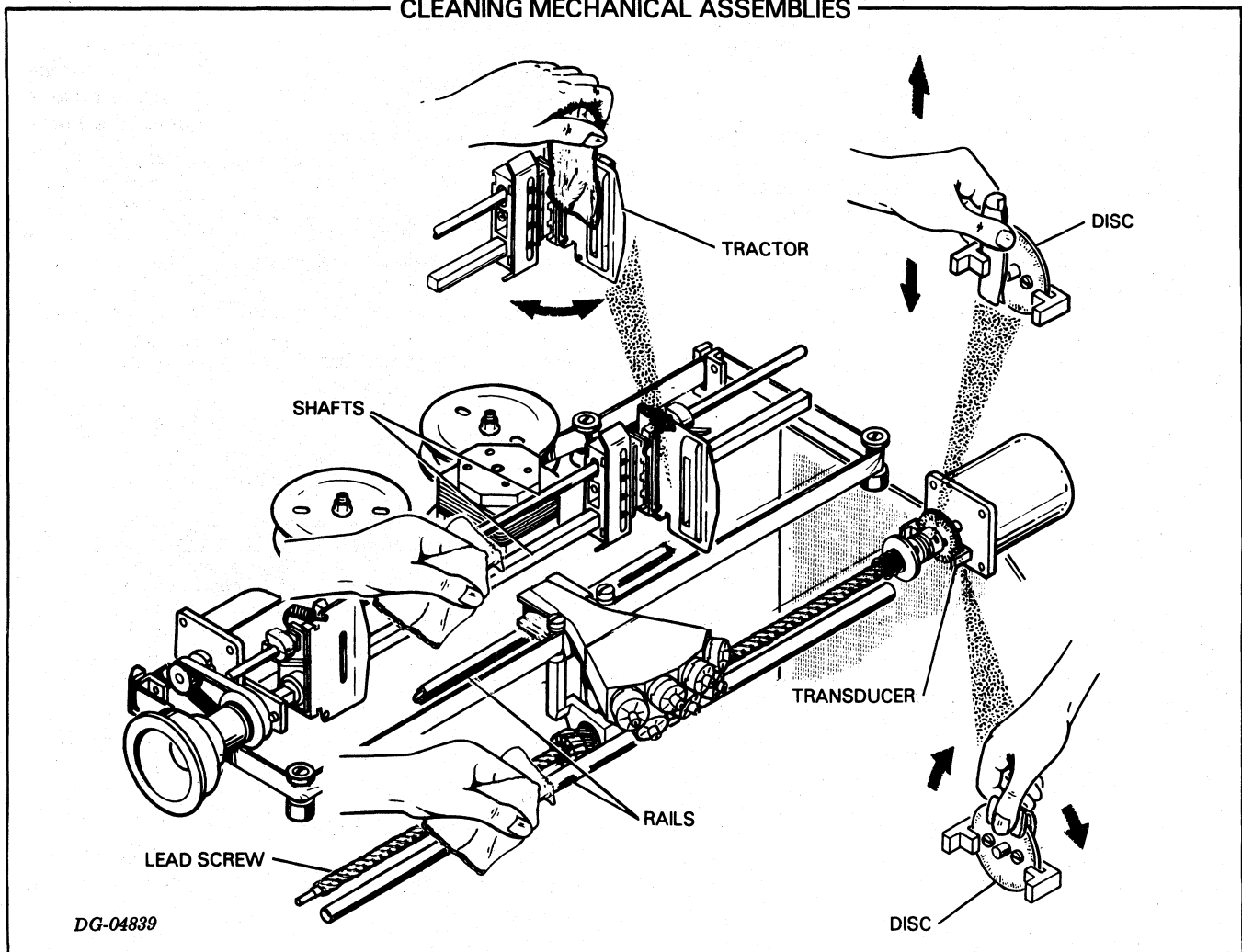
CAUTION *DO NOT attempt to move the print carriage by pushing on the printhead or carriage assembly.*

- Wipe the platen with a tissue. If the tissue is dampened with alcohol, ensure that the ribbon remains dry.
- Wipe the tractor support shaft and drive shaft with a tissue. Clean any paper dust from the tractor assemblies.
- Vacuum clean all debris and paper dust from the carriage cavity, using a non-conducting nozzle.

CAUTION *Special care should be taken not to touch the slotted disc(s) and transducers while vacuuming.*

- Thread the ribbon through its guides and around the printhead; take up any slack by rotating the idler spool. Be sure the ribbon follows the path outlined on a label located atop the mechanism.
- Replace the paper as described in Section IV of this manual. Be sure to adjust the platen space lever to give the desired print darkness for the form thickness used.
- Replace the print shield. Release the top cover latch and close the cover.
- Clean the outside of the terminal with a cloth dampened with a mild cleaning solution. Take care that no liquid enters into the keyboard, standard control panel (or numeric keypad), or carriage cavity.
- Plug the power cord into the line supply outlet and turn the POWER switch to ON.

CLEANING MECHANICAL ASSEMBLIES



APPENDIX A TECHNICAL SPECIFICATIONS

MODEL 6042/6043

General

Maximum Throughput	30 characters/sec
Print Type	5 x 7 dot matrix 0.107in x 0.082in (nom.)
Character Sets	France Germany Japan Sweden United Kingdom United States
Character Subsets	95-character (standard) ●●●● 124-character (field selectable) 64-character (field selectable)
Printhead Drive	Lead screw, permanent magnet stepping motor with open loop mode (while printing) and closed loop feedback control (carriage returns) Maximum carriage return time: 600ms Maximum slew speed: 2200 steps/sec (nom)
Print Technique	Impact through ribbon 7-wire, solenoid-actuated printhead
Solenoid Drive	Pulse Width: 420 μ sec (nom.) ●●●●● Actuating Voltage: 30Vdc Solenoid Current: 2.3Adc (max.)
Ribbon	0.5in wide, commercial spool mounted multi-pass, ink impregnated fabric: 40yds mylar: 80yds
Ribbon Drive	Spool to spool during carriage return ac induction motor with swing-arm gear train Auto-reverse at ribbon end Ribbon speed: 4.97 - 2.84 ips Drive motor output speed: 60rpm Spool rotation speed: 30rpm
Paper Forms	Pin-feed, fan-fold, 1 to 6 part paper maximum forms pack 0.025in Hole spacing: 0.5in centers (nom.) Forms weight: 12lb paper 8lb carbon Form crimps: Tab type only

Paper Feed	Pin-feed tractors driven by permanent magnet stepping motor and timing belt Feed drive rate 4-15deg steps Tractor adjustment range: 4in to 15in Vertical line spacing: 0.167in (nom.) Time for single line feed: 33ms (nom.) Continuous feed rate: 4.8ips (nom.)
------------	---

Electrical

Interface	Plug compatible with DGC 20mA current loop and DGC standard EIA voltage interfaces 110, 150, 300 Baud only
Input Power	100, 120 220 240Vac (nominal) 47-63Hz
Power Dissipation	200 Watts (682 BTU/hr)
Power Cable	6ft

Mechanical

Dimensions	33.75in(h) 21in(d) 26.5in(w)
Weight	60lbs (27Kg)

Environmental

Temperature Ranges	Operating: 50degF--104degF (10degC--40degC) Storage/Shipping: -40degF--140degF (-40degC--60degC)
Humidity Ranges	Operating: 10%--90% (non condensing) Storage/Shipping 5%--95% (non condensing)
Maximum Altitude	50,000ft

APPENDIX A (Continued)

MODEL 6040/6041

General

Data Rate (Transfer)	60 characters/sec
Print Type	5 x 7 dot matrix 0.107in x 0.082in (nom.)
Character Sets	France Germany Japan Sweden United Kingdom United States
Character Subsets	95-character (standard) ●●●● 124-character (field selectable) 64-character (field selectable)
Printhead Drive	Lead screw, permanent magnet stepping motor with open loop mode (while printing) and closed loop feedback control (carriage returns) Maximum carriage return time: 600ms Maximum slew speed: 2200 steps/sec (nom)
Print Technique	Impact through ribbon 7-wire, solenoid-actuated printhead
Solenoid Drive	Pulse Width: 420 μsec (nom.) ●●●●● Actuating Voltage: 30Vdc Solenoid Current: 2.3Adc (max.)
Ribbon	0.5in wide, commercial spool mounted multi-pass, ink impregnated fabric: 40yds mylar: 80yds
Ribbon Drive	Spool to spool during carriage return ac induction motor with swing-arm gear train Auto-reverse at ribbon end Ribbon speed: 4.97 - 2.84 ips Drive motor output speed: 60rpm Spool rotation speed: 30rpm
Paper Forms	Pin-feed, fan-fold, 1 to 6 part paper maximum forms pack 0.025in Hole spacing: 0.5in centers (nom.) Forms weight: 12lb paper 8lb carbon Form crimps: Tab type only
Paper Feed	Pin-feed tractors driven by permanent magnet stepping motor and timing belt Feed drive rate 4-15deg steps Tractor adjustment range: 4in to 15in Vertical line spacing: 0.167in (nom.) Time for single line feed: 33ms (nom.) Continuous feed rate: 4.8ips (nom.)

Electrical

Interface	Plug compatible with DGC 20mA current loop and DGC standard EIA voltage interfaces at 300 Baud; Modified 4010 controller (or equiv) recommended for 600 baud operation
Input Power	100, 120 220 240Vac (nominal) 47-63Hz
Power Dissipation	200 Watts (682 BTU/hr)
Power Cable	6ft

Mechanical

Dimensions	33.75in(h) 21in(d) 26.5in(w)
Weight	60lbs (27Kg)

Environmental

Temperature Ranges	Operating: 50degF--104degF (10degC--40degC) Storage/Shipping: -40degF--140degF (-40degC--60degC)
Humidity Ranges	Operating: 10%--90% (non condensing) Storage/Shipping 5%--95% (non condensing)
Maximum Altitude	50,000ft

APPENDIX B CHARACTER SETS

INTRODUCTION

There are six 124-symbol character sets available with the 6040-6043 DASHER terminal printers. They correspond to standard usage ASCII code specifications in six countries: France, Germany, Japan, Sweden, United Kingdom, and United States. Each character set is shown in its entirety in charts on the pages that follow. All sets are similar to the United States-usage character set; characters variations in each export character set are highlighted in the charts for quick comparison.

The 6040-6043 terminals can print symbols for 124 of the 128 unique, 7-bit ASCII codes. The Delete character code, 177₈, is unconditionally ignored by the terminal, and no character is printed for character codes 007₈, 012₈, and 015₈; each of these codes is interpreted by the terminal as a control code, and initiates a specific function at the terminal. (The control functions are audible tone, *Bell*, line feed and carriage return.)

Jumpers positions on the terminal's main logic board allow the terminal to print all 124 characters, or they can be used to alter the action of the terminal's character generator and cause the terminal to ignore certain codes and/or to perform lower-to-upper-case character foldover. (Consult the Installation Data Sheets for 6040-6043 terminals: *DGC no. 010-000094*.)

Two character *subsets* may be selected with the jumpers: one restricts the printable character set to 95 symbols, the other restricts it to 64 symbols and enables character foldover.

When the full 124-symbol set is enabled, the terminal prints ASCII specified symbols for 29 character codes

NON PRINTING CONTROL CODES IN 95- and 64-CHARACTER SUBSETS

All character codes are 7-bit, Octal			
000	010	020	030
001	011	021	031
002	012*	022	032
003	013	023	033
004	014	024	034
005	015*	025	035
006	016	026	036
007*	017	027	037
			177

*designates control character

commonly known as ASCII control characters. The symbols that are printed for these 29 codes do not resemble alpha and numeric symbols or punctuation symbols.

95-Character Subset

The 95-character subset includes upper and lower case alpha characters, a blank or space character, punctuation marks, numerals, and certain symbols. The table on the left, below, lists the 30 character codes that are unconditionally ignored by the terminal when the 95-character subset is selected. (The same 30 codes are also ignored when the 64-character subset is selected.)

64-Character Subset

The 64-character subset includes upper case alpha characters, the blank or space character, punctuation marks, numerals and somewhat fewer additional symbols than the 95-character set. Additionally, 31 character codes are translated (character foldover) by the character generator. The translation affects principally lower case alpha character codes, converting them to upper case codes of the same letter before printing. Codes for five symbols are also converted to "upper case" equivalents.

Character foldover is accomplished by forcing a zero into bit 2 (from the left) of a 7-bit character code. For example, the following character code conversion, $141_8 \rightarrow 101_8$ causes this alpha character foldover: a \rightarrow A.

The table on the right, below, lists the 31 character codes translated in the terminal; the character code is shown before and after foldover.

CHARACTER FOLDOVER IN 64-CHARACTER SUBSETS

All character codes are 7-bit, Octal		
140→100	152→112	165→125
141→101	153→113	166→126
142→102	154→114	167→127
143→103	155→115	170→130
144→104	156→116	171→131
145→105	157→117	172→132
146→106	160→120	173→133
147→107	161→121	174→134
150→110	162→122	175→135
151→111	163→123	176→136
	164→124	

ASCII CHARACTER SETS

7-BIT OCTAL CODE	NAME OR MNEMONIC	SYMBOL PRINTED OR TERMINAL ACTION			TRANSMIT BY PRESSING KEY(S)	
		124-SET	95-SET	64-SET	KEYBOARD	NUMERIC KEYPAD
000	NUL	□			CTRL O	
001	SOH	␣			CTRL A	
002	STX	␣			CTRL B	
003	ETX	␣			CTRL C	
004	EOT	␣			CTRL D	
005	ENQ	␣			CTRL E	
006	ACK	␣			CTRL F	
007	BEL	␣			CTRL G	
010	BS	↵			CTRL H●BS●SHIFT BS●CTRL BS	
011	HT	→			CTRL I●TAB●SHIFT TAB●CTRL TAB	
012	LF	␣			CTRL J●LF●SHIFT LF●CTRL LF	
013	VT	␣			CTRL K	
014	FF *	␣			CTRL L	
015	CR	␣			CTRL M●RETURN●SHIFT RETURN●CTRL RETURN	
016	SO	⊗			CTRL N	
017	SI	⊙			CTRL O	
020	DLE	⊖			CTRL P	
021	DC1	⊕			CTRL Q	
022	DC2	⊗			CTRL R	
023	DC3	⊙			CTRL S	
024	DC4	⊖			CTRL T	
025	NAK	⊕			CTRL U	
026	SYN	␣			CTRL V	
027	ETB	␣			CTRL W	
030	CAN	␣			CTRL X	
031	EM	␣			CTRL Y	
032	SUB	␣			CTRL Z	
033	ESC	⊖			CTRL [●ESC●SHIFT ESC●CTRL ESC	
034	FS	⊖			CTRL \	
035	GS	⊖			CTRL }	
036	RS	⊖			CTRL '	
037	US	⊖			CTRL -	
040	SP	Blank Space			Space Bar	

●SEPARATES KEY COMBINATIONS

*ON TERMINALS WITH THE FORM FEED OPTION, THIS CODE ADVANCES THE PAPER TO THE TOP OF THE NEXT FORM.

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ASCII CHARACTER SETS (Continued)

7-BIT OCTAL CODE	NAME OR MNEMONIC	SYMBOL PRINTED OR TERMINAL ACTION			TRANSMIT BY PRESSING KEY(S)	
		124-SET	95-SET	64-SET	KEYBOARD	NUMERIC KEYPAD
041	Exclamation Mark	!	!	!	SHIFT !	
042	Quotation Marks	"	"	"	SHIFT "	
043	Number Sign	#	#	#	SHIFT #	
044	Dollar Sign	\$	\$	\$	SHIFT \$	
045	Percent	%	%	%	SHIFT %	
046	Ampersand	&	&	&	SHIFT &	
047	Apostrophe	'	'	'	'●CTRL'	
050	Opening Parenthesis	(((SHIFT (
051	Closing Parenthesis)))	SHIFT)	
052	Asterisk	*	*	*	SHIFT *	
053	Plus	+	+	+	SHIFT +	
054	Comma	,	,	,	,●CTRL,	
055	Hyphen (Minus)	-	-	-	-	
056	Period (Decimal Point)	.	.	.	●CTRL.	
057	Slash	/	/	/	/●CTRL/	
060	Zero	0	0	0		
061	One	1	1	1	1●CTRL 1	1
062	Two	2	2	2	2●CTRL 2	2
063	Three	3	3	3	3●CTRL 3	3
064	Four	4	4	4	4●CTRL 4	4
065	Five	5	5	5	5●CTRL 5	5
066	Six	6	6	6	6●CTRL 6	6
067	Seven	7	7	7	7●CTRL 7	7
070	Eight	8	8	8	8●CTRL 8	8
071	Nine	9	9	9	9●CTRL 9	9
072	Colon	:	:	:	SHIFT:	
073	Semicolon	;	;	;	;●CTRL;	
074	Less Than	<	<	<	SHIFT <	
075	Equals	=	=	=	=	
076	Greater Than	>	>	>	SHIFT >	
077	Question Mark	?	?	?	SHIFT ?	
100	Commercial At	@	@	@	SHIFT @	
101	A	A	A	A	SHIFT A	
102	B	B	B	B	SHIFT B	
103	C	C	C	C	SHIFT C	
104	D	D	D	D	SHIFT D	
105	E	E	E	E	SHIFT E	
106	F	F	F	F	SHIFT F	
107	G	G	G	G	SHIFT G	
110	H	H	H	H	SHIFT H	
111	I	I	I	I	SHIFT I	
112	J	J	J	J	SHIFT J	
113	K	K	K	K	SHIFT K	
114	L	L	L	L	SHIFT L	
115	M	M	M	M	SHIFT M	
116	N	N	N	N	SHIFT N	
117	O	O	O	O	SHIFT O	
120	P	P	P	P	SHIFT P	

●SEPARATES KEY COMBINATIONS

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ASCII CHARACTER SETS (Continued)

7-BIT OCTAL CODE	NAME OR MNEMONIC	SYMBOL PRINTED OR TERMINAL ACTION			TRANSMIT BY PRESSING KEY(S)	
		124-SET	95-SET	64-SET	KEYBOARD	NUMERIC KEYPAD
121	Q	Q	Q	Q	SHIFT Q	
122	R	R	R	R	SHIFT R	
123	S	S	S	S	SHIFT S	
124	T	T	T	T	SHIFT T	
125	U	U	U	U	SHIFT U	
126	V	V	V	V	SHIFT V	
127	W	W	W	W	SHIFT W	
130	X	X	X	X	SHIFT X	
131	Y	Y	Y	Y	SHIFT Y	
132	Z	Z	Z	Z	SHIFT Z	
133	Opening Bracket	[[[[
134	Back Slash	\	\	\	\	
135	Closing Bracket]]]	SHIFT]	
136	Circumflex	^	^	^	SHIFT ^	
137	Underline	_	_	_	SHIFT _	
140	Accent Grave	`	`	@	`	
141	a	a	a	A	A	
142	b	b	b	B	B	
143	c	c	c	C	C	
144	d	d	d	D	D	
145	e	e	e	E	E	
146	f	f	f	F	F	
147	g	g	g	G	G	
150	h	h	h	H	H	
151	i	i	i	I	I	
152	j	j	j	J	J	
153	k	k	k	K	K	
154	l	l	l	L	L	
155	m	m	m	M	M	
156	n	n	n	N	N	
157	o	o	o	O	O	
160	p	p	p	P	P	
161	q	q	q	Q	Q	
162	r	r	r	R	R	
163	s	s	s	S	S	
164	t	t	t	T	T	
165	u	u	u	U	U	
166	v	v	v	V	V	
167	w	w	w	W	W	
170	x	x	x	X	X	
171	y	y	y	Y	Y	
172	z	z	z	Z	Z	
173	Opening Brace	{	{	{	{	
174	Double Bars				SHIFT	
175	Closing Brace	}	}	}	SHIFT }	
176	Tilde	~	~	^	SHIFT ~	
177	DEL				DEL • SHIFT DEL • CTRL DEL	

•SEPARATES KEY COMBINATIONS

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INTERNATIONAL FONTS

Each international font consists of a unique character generator ROM plus the appropriate keycaps which replace the standard U.S. characters for the same code. The following table shows the special symbols printed for each international font and the U.S. symbols which they replace.

FONT	OCTAL CODE											
	043	044	100	133	134	135	136	140	173	174	175	176
FRENCH	f		à	°	9	ƒ			é	ù	è	
GERMAN	f		ƒ	Ä	Ö	Ü			ä	ö	ü	ß
JAPANESE					¥							—
SWEDISH		⌘	É	Ä	Ö	Å	Ü	é	ä	ö	å	ü
UNITED KINGDOM	f			?			↑					
UNITED STATES	#	\$	@	[\]	^	`				~

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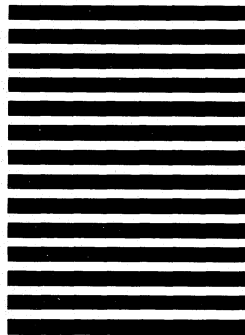
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