SERIES 1640/1650

PRINTERS and TERMINALS

PRODUCT DESCRIPTION

90412-01 Rev B   Apr., 1980

DIABLO SYSTEMS, Inc.
A XEROX Company

WARRANTY

Diablo Series 1640/1650 Printers and Terminals are warranted against defects in materials and workmanship for 90 days from the date of shipment. Any questions regarding the warranty should be directed to your Diablo Sales Representative.

All requests for repairs should be directed to the Diablo Service Center in your area. This will assure you the fastest possible service.

UL recognized and listed under File No. E51242
CSA certified as a component under File No. LR2196

PREFACE

Diablo Systems, Incorporated, reserves the right to make changes and/ or improvements to its products without incurring any obligation to incorporate such changes or improvements in units previously sold or shipped.

Diablo publishes descriptive Brochures and Data Sheets, a Product Description Manual, a Maintenance Manual, a Parts Catalog, and a Parts Price List for each product line. In addition, important changes to a product are conveyed to the field in the form of Field Service Aids sent to all product customers of record.

Those changes which alter manual content are covered by publishing an Addenda to the affected manual.

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NOTE: On revised pages of text, a heavy vertical bar in the margin indicates each area of new revision.

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RO PRINTER

KSR TERMINAL

Figure 1-1 SERIES 1640/1650 PRINTERS and TERMINALS

1.1 INTRODUCTION

1.1.1 Description

Diablo has combined the latest in microelectronic technology with its expertise in small, stand alone terminals to produce the Series 1640/-1650 Printers and Terminals. The Series 1640/1650 feature Diablo's field proven HyType II printer mechanism equipped with its Universal Interface circuits. These features allow plug-in operation with serial (RS-232-C, CCITT V.24), 8-bit ASCII parallel, optional Series 2741, or optional current loop data exchange techniques, and/or a keyboard. The 1650 Series produces an output of "word processor" quality which can include two color printing and graphics. A choice of options, such as true proportional spacing and right margin justification, vector plotting and remote diagnostics further expand the versatility of the units.

1.1.2 Features

The units receive data from and transmit data to a host controller or
another remote terminal thru any one of a variety of possible communi-
cations links. See Appendix A.

1.1.2.1 Serial Interface

Both 1640 and 1650 Series may interface with Bell type 103A, 113A, or
212A modems which make them compatible with other asynchronous modems
employing the RS-232-C or CCITT V.24 interface specifications for ser-
ial data input and output. This interface features switch selectable
baud rates of 110, 300, 1200, and option. The user can, thru custom
PROM and the option switch settings, provide for input baud rates of
up to 9600. If an optional rate is not specified in the firmware, the
system will default to a 600 baud rate if the option setting (OFF/OFF)
of the SPEED switches is selected. See subsection 6.4.11.

The units may be optionally configured to communicate thru the serial
interface using IBM 2741 terminal codes and protocol. Interconnecting
cable lengths up to 50 feet (15 m) can be used.

1.1.2.2 Parallel Interface

Either unit may be configured to communicate thru its byte parallel
interface using ASCII codes. This interface provides 8 data lines
and 8 status lines, plus strobes for both input and status output, re-
store, ready, clear, and ground. The interface supports "Buffer Full"
status reporting and features a typical operating speed of 5000 cps.

See subsection 1.1.2.4. When the parallel interface is used for host
system communications the USART Module D55 must be removed from its
socket on the HPRO4 PCB. Removing this module relieves the micro-
processor of that portion of its program load imposed by the USART.
Interconnecting cable lengths up to 25 feet (7.5 m) can be used.

1.1.2.3 Current Loop Interface

Either unit may be optionally configured to communicate thru its
Serial Interface port using either a 20 mA or 60 mA passive or active
current loop interface, in half- or full-duplex mode – strap select-
able. Note that the 20 mA passive full-duplex mode configuration is
standard for this option as supplied by the factory. The speed of the
current loop interface is established by the speed selected for the
serial interface. Interconnecting cable lengths up to 4000 feet (1220
m) can be used.

1.1.2.4 Keyboard Input

Either unit may be optionally configured to communicate thru its Par-
allel Interface using a keyboard. Diablo keyboards are available in
logical bit paired, typewriter paired, ASCII, APL, and various Euro-
pean languages. The terminal output is thru the serial port when

using the keyboard attached to the parallel port, precluding use of
the parallel port for host system communications. See Appendix B.

1.2 GENERAL SPECIFICATIONS

1.2.1 The Print Mechanism (OEM Version)

This is the basic version of both the 1640 and the 1650 Series. It
includes the following:
* For the 1640 Series – Model 1345A HyType II Plastic Wheel
                        Printer.
  For the 1650 Series – Model 1355WP HyType II Metal Wheel
                        Printer.
  The printer is equipped with special Motherboard and HPRO4 Pro-
  cessor Universal Interface PCB's with both serial and parallel
  ports and the following operation control switches.

```
        HPRO4 Switch Definition without Control Panel installed:
          A25-1  Self Test. . . . ON/OFF
          A25-2  Pitch. . . . . . 10/12
          A25-3  DC1/DC3. . . . . ON/OFF
          A25-4  Parity . . . . . ON/OFF
          A25-5  Parity ODD/EVEN  (select)
          A25-6  Duplex . . . . . HALF/FULL
          A25-7  120 Speed )
          A25-8   30 Speed ) Select    (See Table 1-1)
```

* 96 Character Diablo Print Wheel Sort (the 1650 Series system
  uses the 88 Character Xerox Print Wheel Sort in Self-Test mode
  in the absence of the optional Operator Control Panel)
* 256 Byte Buffer
* Self-Test
* Cover Open Switch

TABLE 1-1
BAUD RATE (SPEED) SELECT SWITCH SETTINGS

Speed 30	Speed 120	Baud Rate Selected
OFF	OFF	Option Baud Rate per PROM*
ON	OFF	300 Baud
OFF	ON	1200 Baud
ON	ON	110 Baud (ASCII) 134.5 Baud (2741)

*System defaults to 600 baud if the baud rate is not specified in PROM.
See subsection 6.4.11.

1.2.2 The RO Printer

The basic version of this model includes the Print Mechanism described
above plus the following:
* Internal Power Supply
* The Operator Control Panel and/or a Cover Open Switch.
    Warning: Lack of a cover open switch (either form) will allow
    a printer to possibly resume printing while the operator is
    correcting paper out or replacing the ribbon.
* A Diablo RO Cover Set
* A Friction Feed Platen

Including the Operator Control Panel option adds operating features, and redefines the switches mounted on the HPRO4 PCB.

    HPRO4 Switch Definition with Control Panel installed:
    A25-1   Enhanced 2741. . ON/OFF (if 2741 option is installed)
    A25-2   ETX/ACK. . . . . ON/OFF
    A25-3   DC1/DC3. . . . . ON/OFF
    A25-4   Corr/PTTC. . . . (select) (if 2741 option is installed)
    A25-5,-6,-7, and -8 (not used)

  Operator Control Panel operating features added:
    (The following switches are under the access cover)
    Audible Alarm Signal
    TEST (self) . . . . . . ON/OFF
    APL . . . . ON/OFF (if Alternate Print Wheel Logic
                                    option is installed) 1650 Series
                                    see Table 1-2.
    ANSI/2741 . . . . (select) (if 2741 option is installed)
    AUTO CR . . . . ON/OFF
    PITCH 10/12 . . . . . . (select)
    PROPORTIONAL SPACE. . . ON/OFF (if Word Processing Option is
                                      installed)
    PARITY. . . . . ON/OFF
    PARITY ODD/EVEN . . . . (select)
    DUPLEX. . . . . ON/OFF
    SPEED 120 . . . . ON/OFF
    SPEED 30 . . . . ON/OFF
    PAPER OUT DEFEAT. . . . ON/OFF
    (The following switches and lights are accessible from outside
    the cover)
    POWER . . . . ON/OFF
    SCROLL. . . . . ON/OFF
    AUTO LF . . . . ON/OFF
    Blank) 1640   96) 1650 Series
    Blank) Series   92) Print Wheel Select. See Table 1-2.
    LF. . . . . ON/OFF
    FF. . . . . ON/OFF
    RESET . . . . ON/OFF
    BREAK . . . . ON/OFF
    Error, Mode, and Power On Indicator Lights

TABLE 1-2
SERIES 1650 PRINT WHEEL SELECT SWITCH SETTINGS *

"92"	"96"	APL**	Print Wheel Selected
OFF	OFF	OFF	88 Character Xerox Metal WP
ON	OFF	OFF	92 Character Rank Xerox Metal WP
OFF	ON	OFF	96 Character Rank Xerox Metal WP
ON	ON	OFF	96 Character Diablo Metal WP
X	X	ON	APL Versions of the above

  X = ON or OFF as required to select desired print wheel.
   * = System will default to 96 character Diablo Metal WP Print Wheel
      format without optional Operator Control Panel installed.
  ** = Applicable only if Alternate Print Wheel Logic option is installed.

1.2.3 The KSR Terminal

The basic version of this model includes the Print Mechanism described in subsection 1.2.1 plus the following:

* Internal Power Supply
* The Operator Control Panel with Cover Open Switch
* Keyboard decoding PROM on the HPRO4 PCB.
* A Keyboard
* A Friction Feed Platen
* A Diablo KSR Cover Set

The effect of adding the optional Operator Control Panel is as defined above. Adding the optional keyboard makes available the following, in addition to normal keyboard data entry.

1.2.4 Programmable Functions (ESC sequences)**

Set Horizontal Tab
Clear horizontal tab
Set vertical tab
Clear all tab stops, horizontal and vertical
Graphics on/off
Forward print on/off
Print suppression on (clear with CR)
Set left/right margin
Negative line feed
Print in red/black
Set top/bottom margins
Clear top/bottom margins
Half-line feed
Negative half-line feed
Set top/bottom page margins
Absolute horizontal tab (to position or column)
Absolute vertical tab (to position or line)
Set normal carriage settling time
Set lines per page
Set VMI
Set HMI
Return HMI control to PITCH switch
Underscore each character on/off *
Bold overprint on (clear with CR) *
Shadow printing on (clear with CR) *
Auto line centering *
Increase carriage settling time *
Auto right margin justification *
Proportional spacing on/off *
Horizontal spacing offset selection *
Backspace 1/120" *
Select print wheel spoke, hammer intensity, ribbon advance *
Cancel all WP modes except proportional spacing
HyPlot character change *
HyPlot precision change *

```
HyPlot move *
HyPlot plot *
HyPlot relative move *
HyPlot relative plot *
Run self-test *
Status report *
Remote reset
Auto front feed on/off *
Print print wheel character under ASCII code 20(Hex)
Print print wheel character under ASCII code 7F(Hex)
Clear ESC sequence
Select Print Wheel (88, 92, 96 Diablo, 96 Xerox) ***
```

(clear with CR = clear function with either a remote carriage return code or depression of the Carriage Return key)

```
  * = These items applicable only with special options
 ** = See subsection 3.2 Item 10 for a more detailed list of the
      ESC sequences
*** = Applicable to 1650 Series only
```

1.2.5 Accessories and Options

The Terminal models can be fitted with the following paper and forms handling options:

```
Friction Feed Platen (factory standard item)
Unidirectional Pin Feed Platen
Bidirectional Pin Feed Platen
Bottom Feed
Unidirectional Forms Tractor *
Bidirectional Forms Tractor *
Mechanical Front Feeder *
```

When either RO or KSR model is equipped with the XMEM2 PCB, the following forms handling options may be fitted:

```
HyFeed Sheet Feeder *
Auto Front Feed *
```

* = These items require a Diablo Cover Set, or equivalent.

See subsection 6.3.2 for a more detailed description of these items.

Equipping a unit with the optional XMEM2 PCB further broadens the scope of available operating options to include the following:

```
Current Loop Interface
2048 Bytes of additional buffer
The HyPlot Option, which includes -
    Plot character insertion
    Relative and absolute tabbing
    Relative and absolute plotting
    Plotting precision insertion
```

Word Processor Enhancement, which includes –
        Automatic proportional spacing
        Automatic underscore
        One character size memory backspace to allow centered under-
            scoring in proportional space printing
        Automatic bold overprint
        Automatic shadow printing
        Memory backspace to remove any keyboard action (except a line
            ending function)
        Automatic right margin justification
        Offset selection for computer-generated right margin justifi-
            cation
        Automatic line centering
        selection of spoke, hammer energy and ribbon advance for non-
            standard print wheels
External Diagnostics, either local (keyboard) or remote
(interface), to include
        Local or remote interrogation of machine parameters
        Local or remote initiation of self-test
        Local or remote initiation of machine performance diagnostics
Keyboard programmable "Here Is . . ."
Alternate Print Wheel Logic
2741 Protocol

1.2.6   Performance Specifications

PRINT SPEED, 1640 SERIES
        Up to 40 characters per second typical in 12 pitch mode printing
    an average English text.
PRINT SPEED, 1650 SERIES
        Up to 38 characters per second typical in 12 pitch mode printing
    an average English text.
CHARACTER SET, 1640 SERIES
        96 character Diablo plastic Print Wheel. See Diablo Publication
    No. 90007-XX for print samples of the many type styles available,
    and Appendix C for information on Print Wheel codes.
CHARACTER SET, 1650 SERIES
        1650 Print Mechanism (OEM):
        96 character Diablo Metalized Print Wheels; others (see below)
            under program control
        1650-RO and 1650-KSR with switch (optional Operator Control Panel
            installed) or program controlled selection of:
        88 character Xerox Metalized Print Wheels
        92 character Rar.k Xerox Metalized Print Wheels
        96 character Rank Xerox Metalized Print Wheels
        96 character Diablo Metalized Print Wheels

        Users of Xerox and Diablo metalized print wheels may expect
        a print wheel life in excess of 15,000,000 character impres-
        sions when printing average English text.

    See Diablo Publication No. 90007-XX for print samples of the many
    type styles available, and Appendix C for information on Print
    Wheel codes.

PRINT LINE
13.1 inches (332.74 mm) = 132 columns 10 pitch or 158 columns 12 pitch.

PAPER WIDTH
16-1/2" (419.1 mm) maximum width between side frames, 15-1/2" (393.7 mm) maximum paper width and 14-3/4" (374.65 mm) maximum width between drive holes for optional Forms Tractors.

14-3/8" (365.13 mm) maximum width between drive holes when using a standard width pin feed platen. Standard manifold paper is 14-7/8" (377.83 mm) in width, and 14-3/8" (365.13 mm) between its drive holes.

PAPER THICKNESS
Standard settings (Platen Position Lever) permit single sheet or multiple form paper thickness to .027" (.686 mm). Refer to appropriate Operators Instructions when using optional paper handling equipment.

PAPER FEED
Forward (up) only with standard friction feed platens and/or a unidirectional forms tractor.

Forward (up) and reverse (down) when using bidirectional pin feed platens or a bidirectional forms tractor. Refer to appropriate Operators Instructions when using optional paper handling equipment.

PAPER FEED SPEED
4" (101.6 mm) per second plus 50 msec typical settling delay.

LINE SPACING
48 positions per inch (25.4 mm).

CARRIAGE RETURN
300 msec maximum.

TABULATION
Right or left

COLUMN SPACING
120 positions per inch (25.4 mm)

POWER REQUIREMENTS
Power consumption is less than 250 Watts worst case with the optional Internal Power Supply installed.

Units with the optional Internal Power Supply installed may have it configured to operate with an AC power input between –

90 - 130V / 180 - 260V AC   47-63 Hz

See subsection 2.1.3 for external power supply requirements.

PHYSICAL CHARACTERISTICS
Dimensions - see subsection 2.1.1.
Weight - Approximately 42 pounds (18.9 kg) with Diablo covers and
the optional Diablo Internal Power Supply.

PLATENS
Friction feed
Unidirectional pin feed
Bidirectional pin feed

AUXILLIARY PAPER HANDLING DEVICES
Unidirectional Forms Tractor
Bidirectional Forms Tractor
Bottom Feed
HyFeed Sheet Feeder
Mechanical Front Feed
Auto Front Feed

RIBBONS
Interchangeable cartridge, 1- or 2-color fabric
Interchangeable cartridge, carbon film base multistrike (includes
end of ribbon sensing element). 1640/1650 Series units include a
mating end of ribbon sensor as standard factory equipment).

RIBBON LIFE
Fabric ribbons - 1,000,000 impressions per cartridge
Carbon film base multistrike - 185,000 impressions per cartridge

ENVIRONMENT
Printer ambient temperature with the optional internal power
supply installed.
Storage - -20°F (-29°C) to +135°F (+57°C)
Operating - +45°F (+7°C) to +105°F (+40°C)
Printer ambient relative humidity
Storage - 0 to 90%
Operating - 10 to 95% (without condensation)
Printer ambient altitude
Storage - Sea Level to 25,000 feet (7620 m)
Operating - Sea Level to 10,000 feet (3048 m)

RIBBON LIFT CONSIDERATIONS
Maximum ribbon position change rate = 5 per second.
Maximum duty cycle = 30% (not to exceed 400 sequential ribbon
position changes between rest periods)

CAUTION: Expect a significant temperature rise in and around the
ribbon lift solenoids when operating at the 5 position
changes per second rate. Operations should be limited
to 400 between rest periods, for the 30% duty cycle.
Failure to observe these limits may result in excessive
temperature rise.

1.3   PRINT SPEED MEASUREMENTS

The following paragraphs detail the procedures used for determining
print speed performance.

1.3.1   Performance Criteria

1.   The printer is to be operated in the 12 pitch mode with the test
text printed unidirectionally with carriage return and paper feed
commands at the end of each line of text.

2.   All printing times and/or character counts are to start at column
0 following any RESTORE function, with character counts to include all
characters and spaces.   The combined carriage return and paper feed
motions shall count as one (1) character.   Host system software over-
head is to be excluded from any recorded printing time.   Any host sys-
tem real time clock to be used shall have a resolution no greater than
10 msec in the least significant digit (LSD), and an overall accuracy
of at least +/-.1% +/-1 count in the LSD.

1.3.2   Performance Tests

Two texts shall be used to measure print speed; the Shannon Text, and
the 3A text.

1.   The Shannon Text

The head and in frontal attack on an english writer that the character of this
point is therefore another method for the letters that the time of who ever told
the problem for an unexpected. The head and in frontal attack on an english writer
that the character of this point is therefore another method for the letters that
the time of who ever told the problem for an unexpected. The head and in frontal
attack on an english writer that the character of this point is therefore another
method for the letters that the time of who ever told the problem for an unexpected.

2.   The 3A Text

In the 3A text, a capital A is printed in columns 0, 1, and 2; fol-
lowed by a tab to column 4 where the sequence is repeated.   This se-
quence is repeated a total of 33 times, ending with the carriage
positioned at column 132, for a total character count of 132.

AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA AAA etc......

1.3.3   Print Speeds

1.   The 1640 Series units shall print the Shannon Text as shown in a
maximum time of 14.35 seconds, corresponding to 40 characters per
second.

2.   The 1650 Series units shall print the Shannon Text as shown in a
maximum time of 15.11 seconds, corresponding to 38 characters per
second.

3. The 1640 Series units shall print the 3A text as described in a maximum time of 2.93 seconds, corresponding to 45 characters per second.

4. The 1650 Series units shall print the 3A text as described in a maximum time of 2.94 seconds, corresponding to 45 characters per second.

SECTION 2

INSTALLATION AND OPERATION

2.1 INSTALLATION

2.1.1 Space Requirements

The 1640/1650 Series Print Mechanism is shipped without covers where the user intends to incorporate the unit into his own cabinet. Figure 2-1 provides the external dimensions of the unit, shown with a standard film ribbon cartridge, platen and a cooling fan installed. The user wishing to design his own enclosure may use the dimensions given to ensure adequate clearance around the machine. In those instances where Diablo's optional paper handling devices are to be used, the cover designer should carefully observe the dimensions and profiles of the Diablo Top Cover, shown in Figures 2-2 thru 2-6, to ensure proper fit and operation of the devices.

RO and KSR models are shipped installed in appropriate Diablo cover sets. Figures 2-2 thru 2-6 also provide the external dimensions needed to plan space for these models.
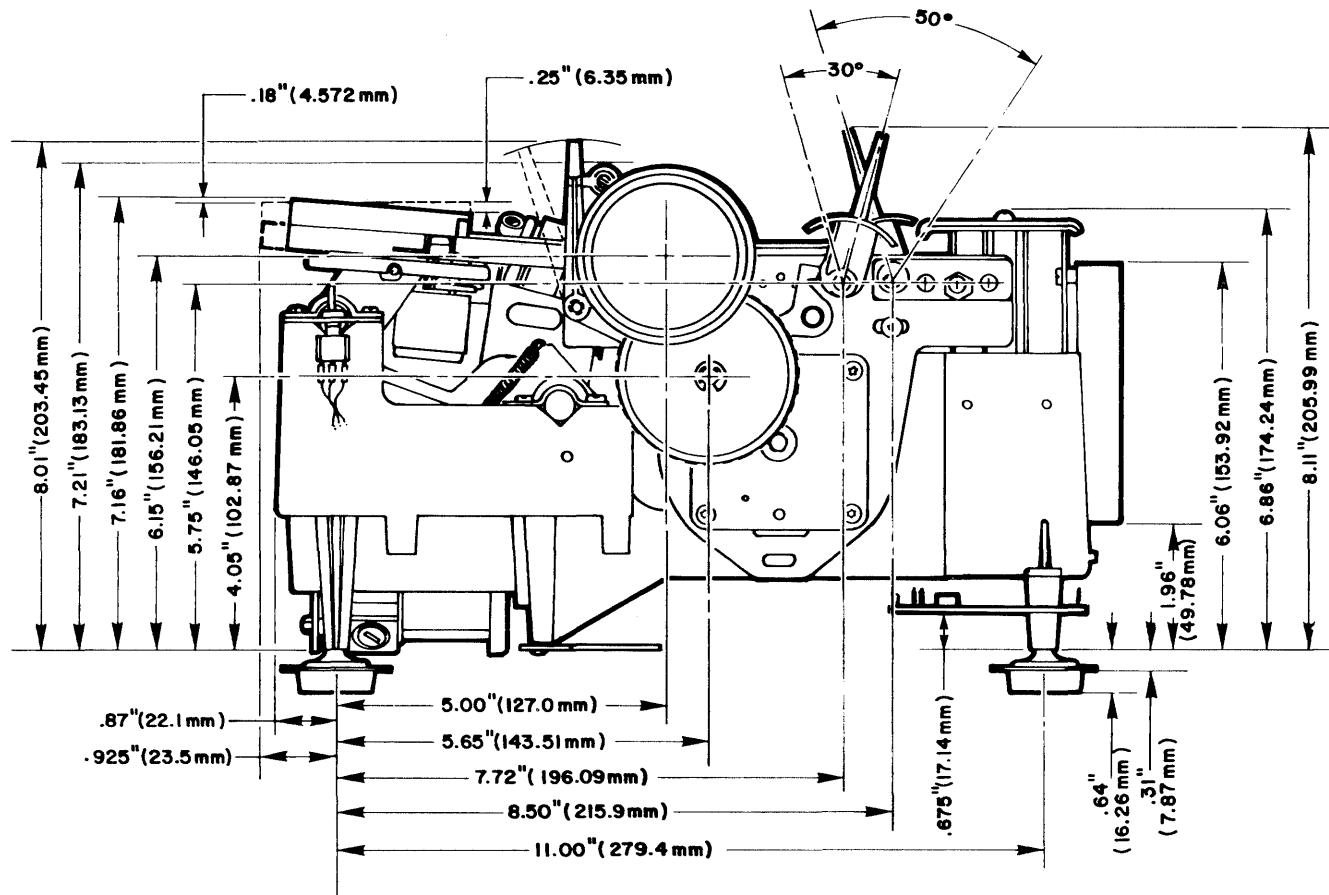
Figure 2-1A   SERIES 1640/1650 EXTERNAL DIMENSIONS
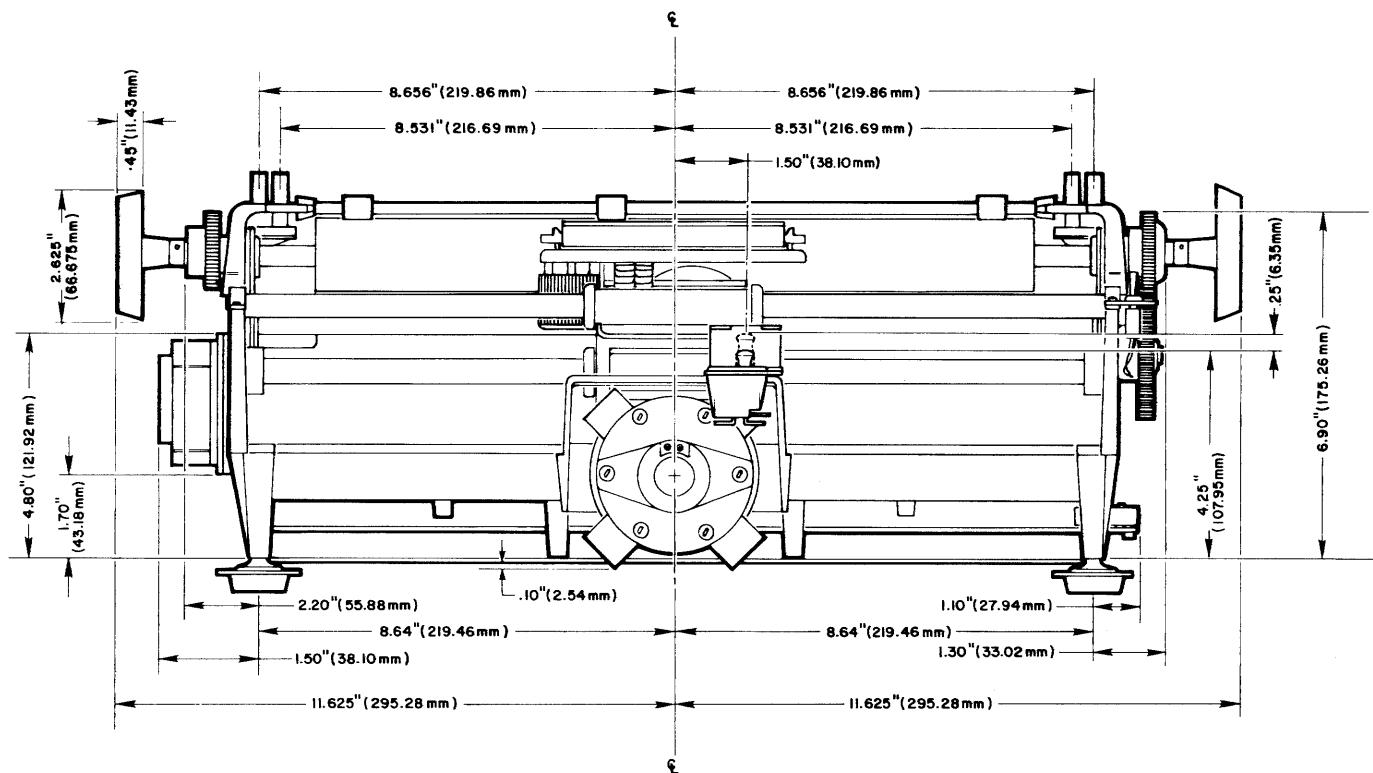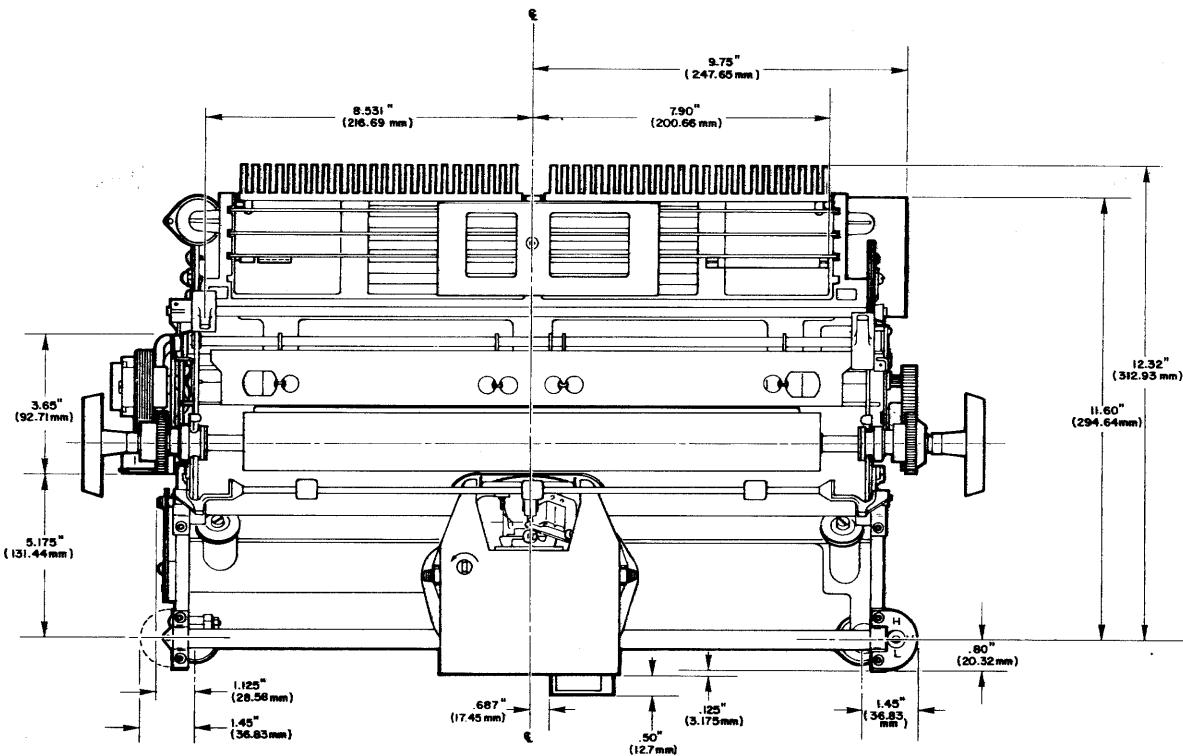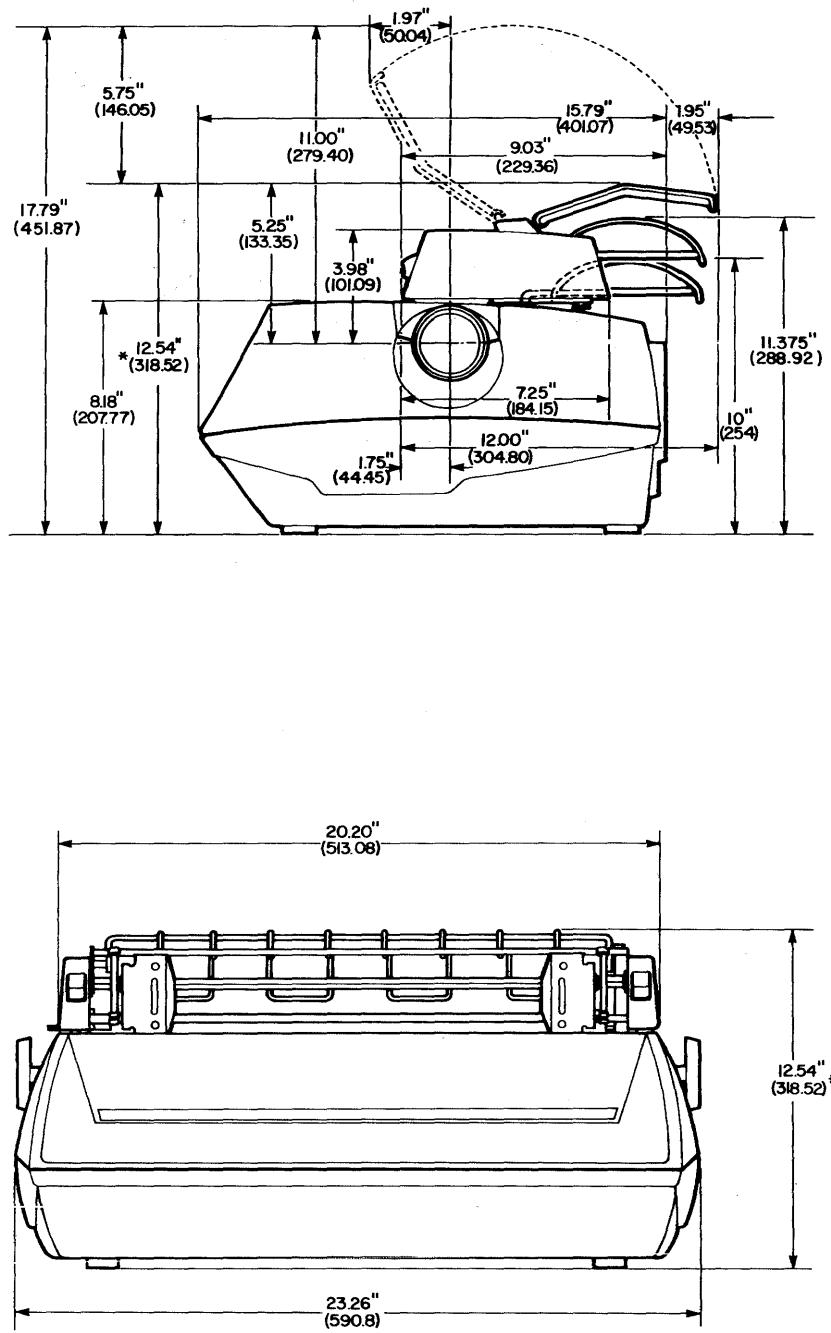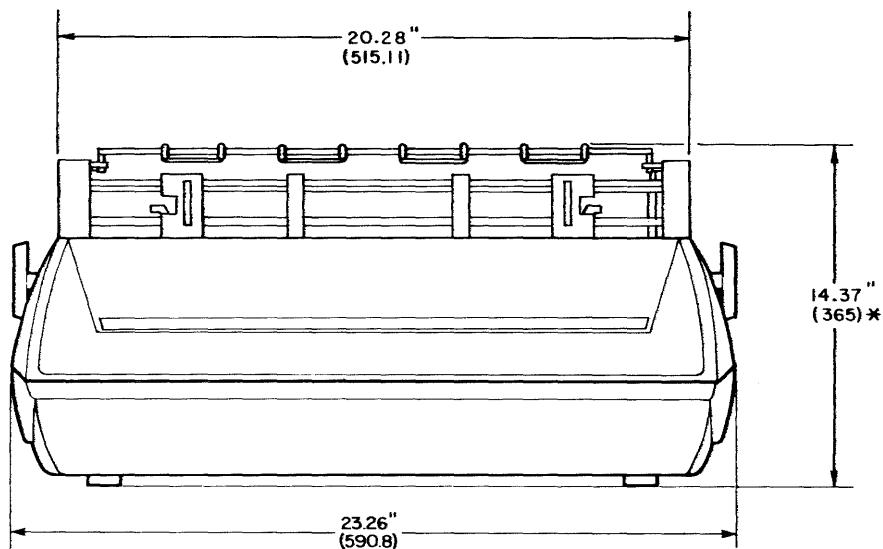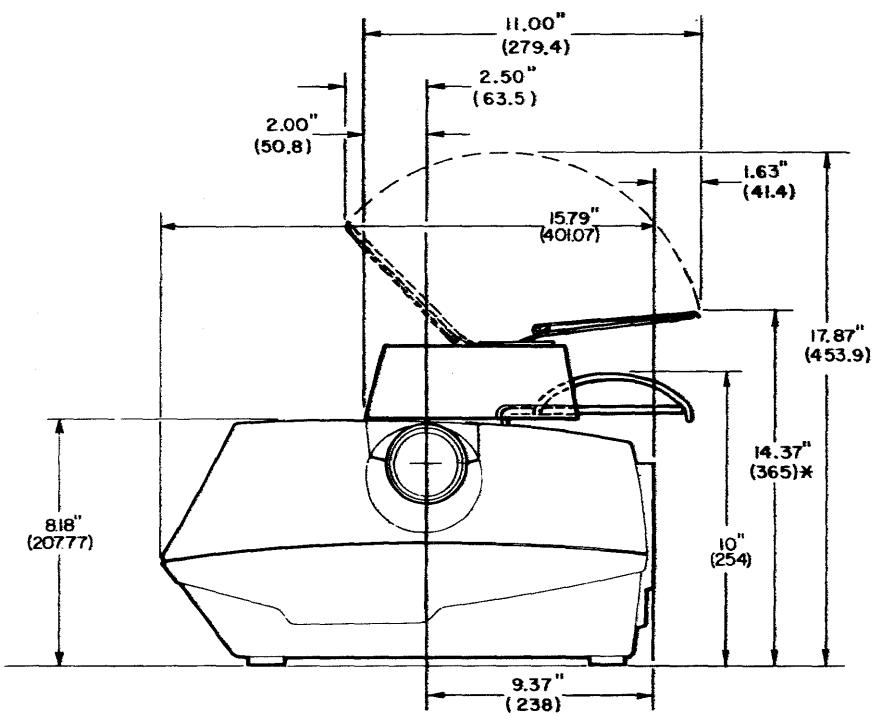
Figure 2-1B   SERIES 1640/1650 EXTERNAL DIMENSIONS
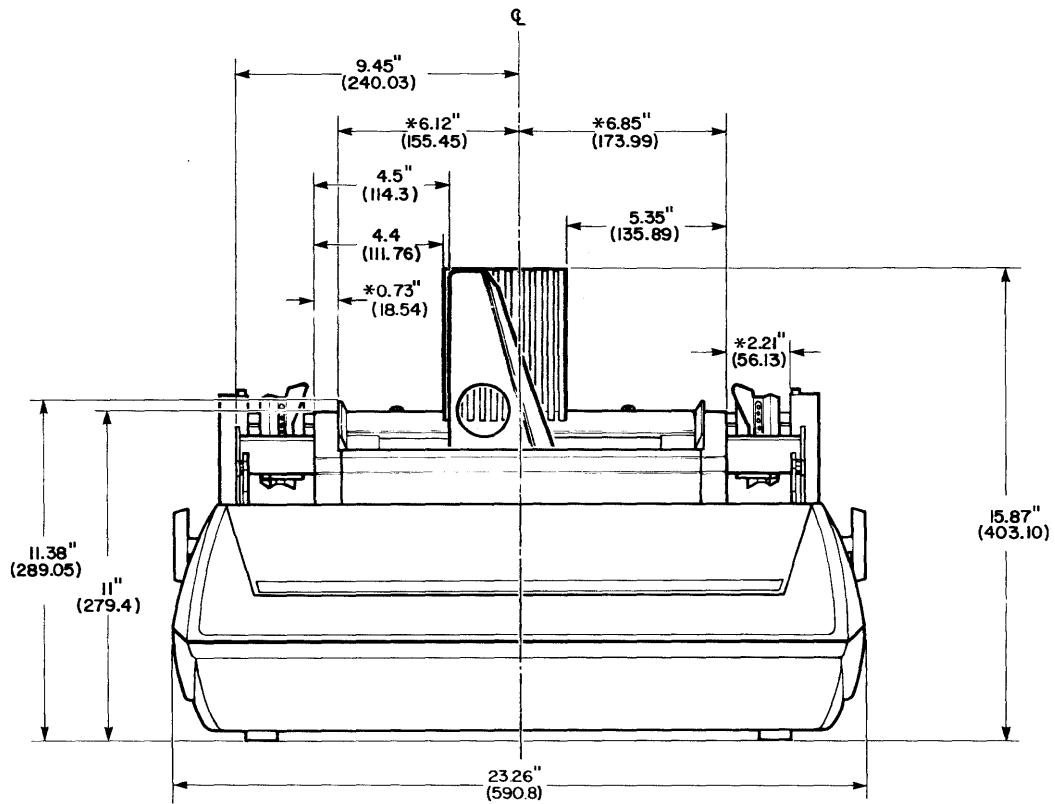
NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
*=ADJUSTABLE

Figure 2-2   DIABLO UNIDIRECTIONAL FORMS TRACTOR

NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
*= ADJUSTABLE

Figure 2-3   DIABLO BIDIRECTIONAL FORMS TRACTOR

NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
*= ADJUSTABLE
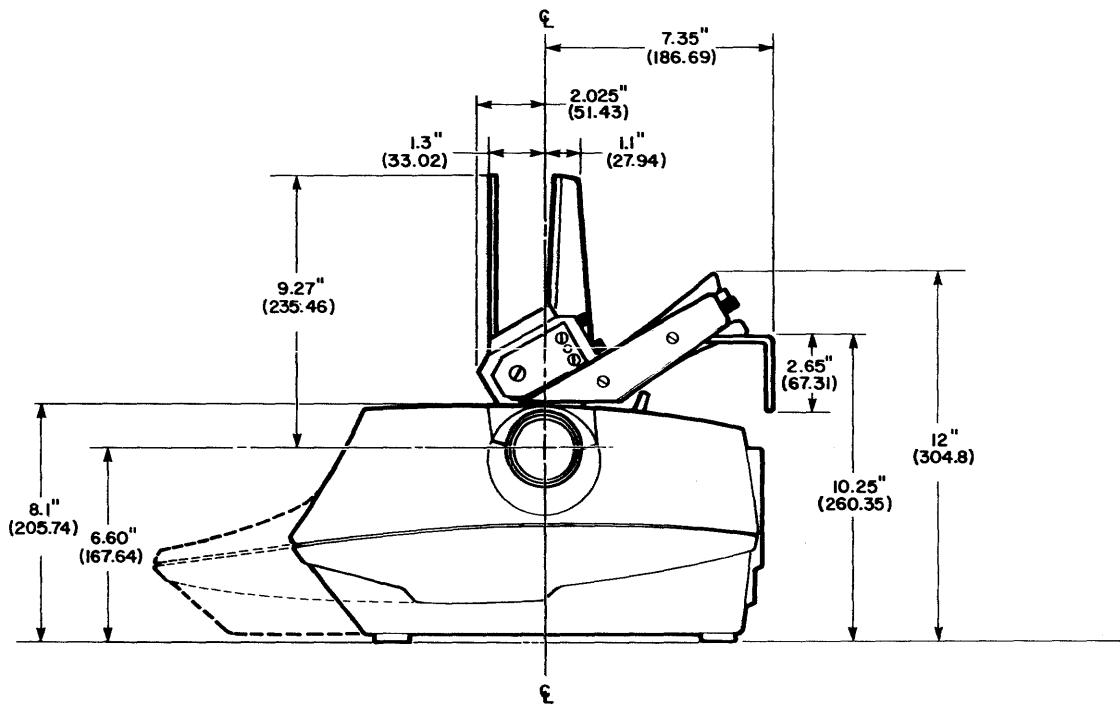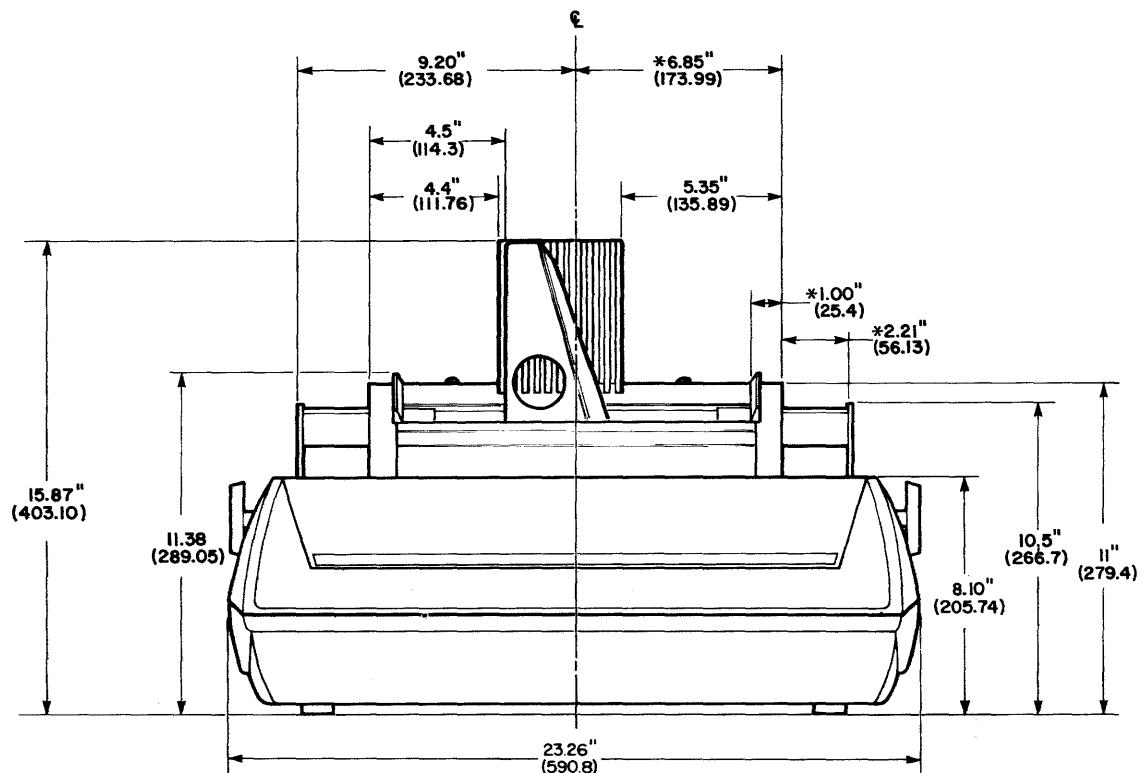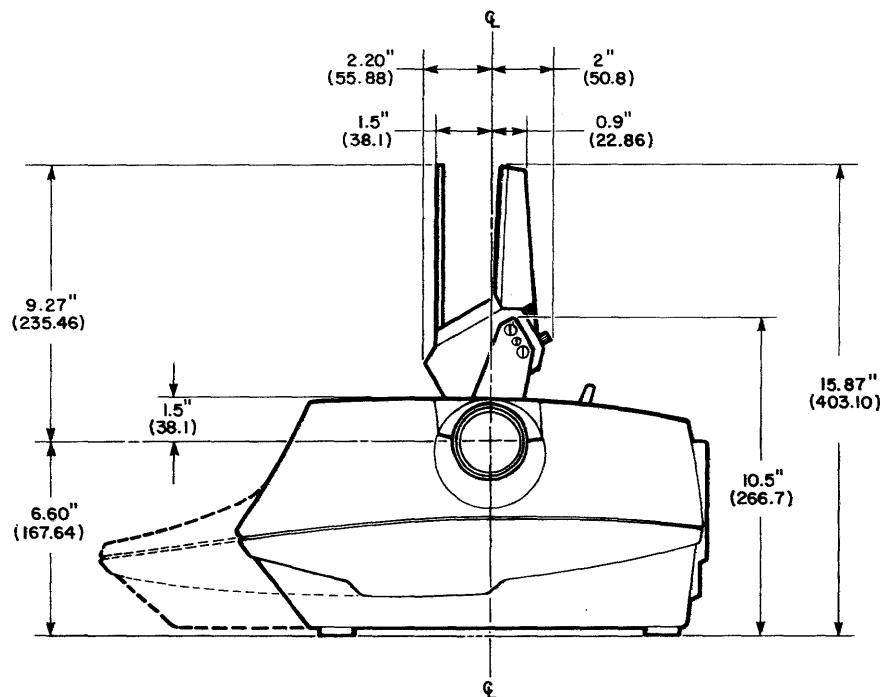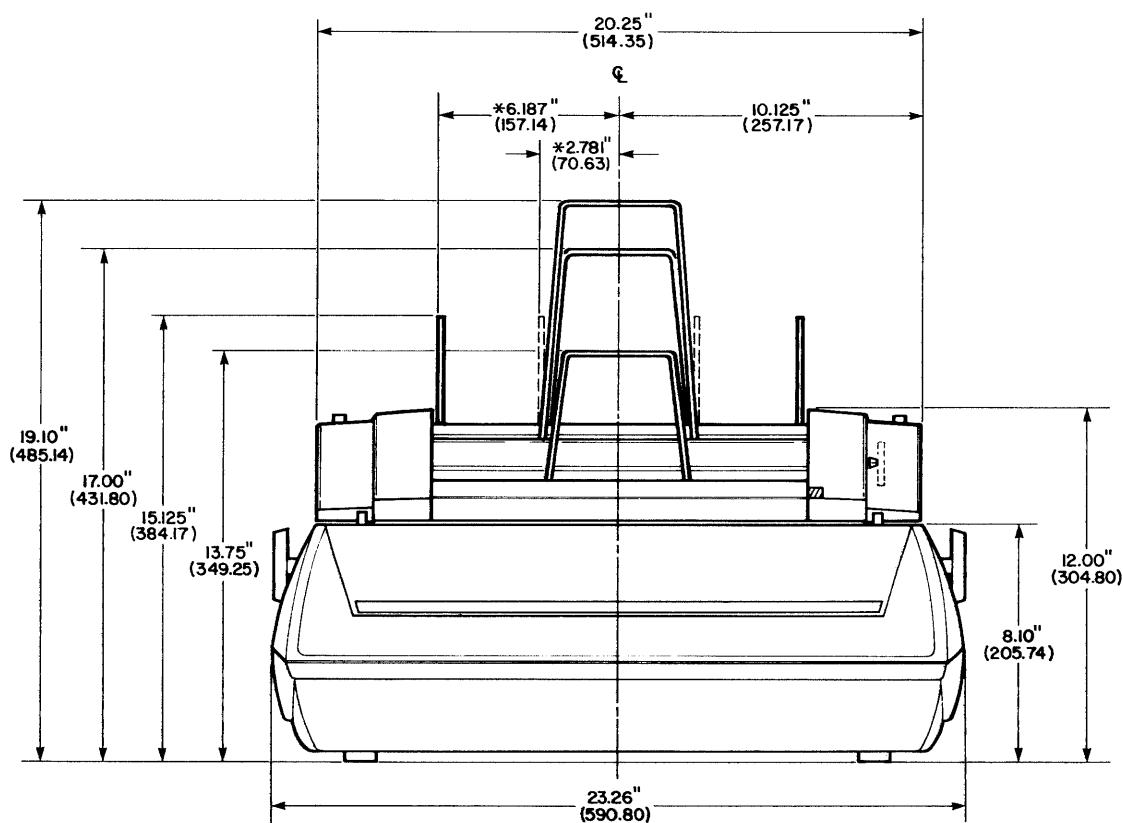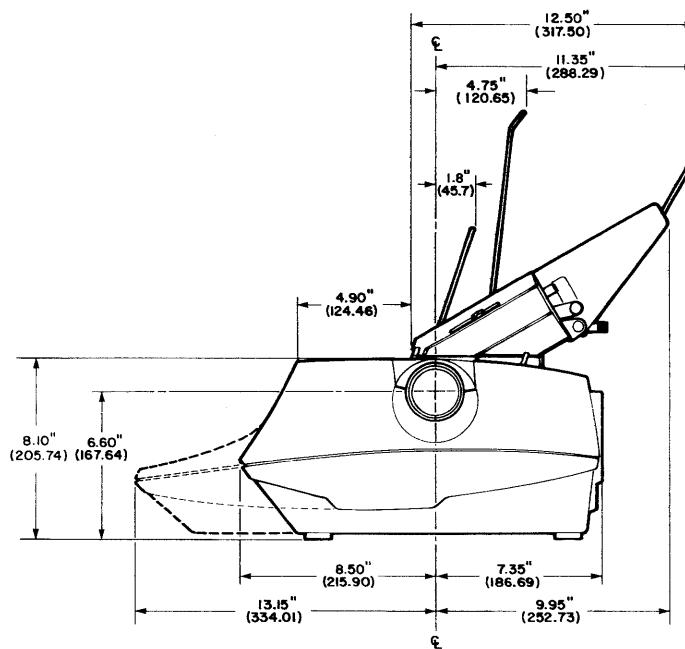
Figure 2-4   AUTO FRONT FEED AND BIDIRECTIONAL FORMS TRACTOR

NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
*= ADJUSTABLE

Figure 2-5   MECHANICAL FRONT FEED

NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
✳= ADJUSTABLE

Figure 2-6   HyFEED SHEET FEEDER

2.1.2 <u>Mounting</u>

Series 1640/1650 Print Mechanisms are supplied with shock mounts. Users are encouraged to use these, or their mounting holes (8-32 thread) when installing the unit in its operating position. The threaded holes used for shipping restraint SHOULD NOT be used for permanent mounting.

RO and KSR models are intended to sit on the rubber shock mounts which extend out below the cover's bottom pan. Those users who require additional restraint in mounting the unit may make use of the shock mount locations, but must make provision for cover restraint when the shock mounts are removed.

2.1.3 <u>External Power Supply Requirements</u>

The following power criteria are included for the user who elects to supply power to the unit from his own external source.

<u>NOTE</u>: Diablo Systems, Inc. assumes no liability for degraded unit operation or damage resulting from improper application of power to the unit from power sources not manufactured or furnished by it.

The power cable must NOT be connected or removed while power is on, or damage to the unit may result. DC power must not be applied to the unit or any of its components by switch or relay closure. Application of power must always begin at 0 volt. If power is to be reapplied after a momentary interruption, such reapplication should be delayed to allow all power levels to decay to 0 volt. Following application (or reapplication) of power, each voltage must rise to 95% of its final level in not less than 6 msec (to limit destructive inrush current) nor more than 200 msec (to prevent capacitor leakage from causing a printer RESET condition) to ensure proper sequencing.

In addition, if an unregulated "bulk" rectifier type power supply is to be used, the minimum output capacitance required to prevent sagging on the +/-15 volt supplies is 51,000 mFd. When a power supply with active regulation is used to provide the +/-15 volts, its output impedance at 20 kHz must be low enough to reduce the noise produced by dynamic load switching to less than +/-.5 volt. The minimum capacitance recommended is 2000 mFd.

POWER REQUIREMENTS

Current Requirements:	Idle	Worst Case
+5V	3 Amps	3 Amps
+15VS	.5 Amp	.5 Amp
-15VS	.25 Amp	.25 Amp
+15VD *	1.5 Amps	4.5 Amps (average) — standard 13 Amps peak for 20 usec duration. 0-25 kHz switching rate
-15VD *	1.5 Amps	4.5 Amps (average) — standard 13 Amps peak for 20 usec duration. 0-25 kHz switching rate

* = In the unit, both +15 and -15 volts DC are distributed
    separately to the high current driver (VD) and the low
    current logic (VS) circuits.

Voltage tolerance of the 15 volt supplies will be +/-5% static
or +/-8% full printing demand. Voltage tolerance of the +5 volt
supply will be +/-2% RMS, +/-3% peak-to-peak.

Power dissipation is less than 250 Watts worst case operation.

POWER SUPPLY SEQUENCING

Power On Sequence:

All DC voltages must rise to within 95% of their final value in
not less than 6 msec, nor more than 200 msec. The last voltage
to reach 95% of its final value must do so no later than 20 msec
after the first voltage to do so. The +/-15 volt supply outputs
must be equal within 1.5 volts at any point in their rise time.

Power Off Sequence:

The +/-15 volt supply outputs shall be equal within 1.5 volts at
any point in their fall time.

2.1.4 Grounding Requirements

For optimum noise immunity, unit Signal Ground (connector T13 on the
Motherboard) and Chassis Ground (printer main frame) should be wired
separately and only tied together within the host system. In those
instances where this is not possible, Signal Ground (T13) is tied to
Chassis Ground with a jumper wire. In addition, care should be taken
to ground cover halves together, and to the printer main frame.

2.2 INTERCONNECTING CABLES

2.2.1 The Power Cable

All versions of the Series 1640/1650 may be equipped with an optional
Internal Power Supply which includes an AC power cable approximately
11 feet (3.4 m) in length. This AC cable should be connected to an
AC source of appropriate voltage level and type, and dedicated to this
service. The source should be capable of carrying the power loads im-
posed by the unit, and should include an adequate safety margin of at
least 50%.

Those installations which use an external power supply will require
an interconnecting DC power cable. The following list summarizes
the minimum requirements for an adequate size 6 foot (1.83 m) power
cable:

Circuit	Motherboard Connector	Conductor Size	Connector
-15V	T11	#14 AWG	#4 Spade Lug
+15V	T12	#14 AWG	#4 Spade Lug
Signal Ground	T13	#14 AWG	#4 Spade Lug
Analog Ground	T14	#10 AWG Flat Braid	#4 Spade Lug
+5V	T15	#14 AWG	#4 Spade Lug

2.2.2 The Serial Interface Cable

All versions of the Series 1640/1650 configured for Serial Data I/O
are shipped with an EIA RS-232-C compatible cable attached, which is
approximately 12' (3.66 m) in length. This cable is terminated on
its free end with a Cannon or Cinch DB-25P connector (or equivalent).
This connector mates with the connector found on most modems.

Figure 2-7 shows the pin arrangement and assignment for the cable
end connector.

NOTE: In those installations where the Serial I/O port is to be used
       with an input direct from the host system rather than thru a
       modem, the user must ensure that the +DATA SET READY input
       (HPRO4 Processor PCB connector J2-8) is held HI (nominal +10
       +/-5 volts) during data input.

2.2.3 The Parallel Interface Cable

All versions of the 1640/1650 Series configured for a parallel ASCII
Data I/O are shipped without an interconnecting cable. Each such unit
will require an I/O cable with the following parameters, to ensure
proper entry of the cable into the unit structure and mating with the
PCB mounted Parallel I/O connector.

    3M type flat cable, 34 conductor, 28 AWG, 3M P/N 3365-34
    3M type socket connector - flat cable, 3M P/N 3414-0000

Maximum tested cable length is 25 feet (approximately 7.6 m).
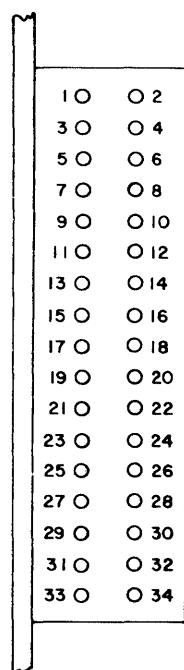
Figure 2-8 shows the pin arrangement and assignment for the PCB con-
nector.

2.2.4 The Current Loop Interface Cable

All versions of the 1640/1650 Series configured for a Current Loop
Data I/O are shipped without an interconnecting cable. Each unit will
require an I/O cable with the following parameters.

```
   14 O    O 1
   15 O    O 2
   16 O    O 3
   17 O    O 4
   18 O    O 5
   19 O    O 6
   20 O    O 7
   21 O    O 8
   22 O    O 9
   23 O    O 10
   24 O    O 11
   25 O    O 12
           O 13
```

PIN		TelCo	CCITT
1	Protective Ground	AA	101
2	Transmitted Data	BA	103
3	Received Data	BB	104
4	Request To Send	CA	105
5	Clear To Send	CB	106
6	Data Set Ready	CC	107
7	Signal Ground	AB	102
8	Carrier Detect	CF	109
9	(not used)		
10	"		
11	"		
12	"		
13	"		
14	"		
15	"		
16	"		
17	"		
18	"		
19	"		
20	Data Terminal Ready	CD	108
21	(not used)		
22	"		
23	"		
24	"		
25	"		

Figure 2-7   SERIAL I/O CABLE CONNECTOR PIN ASSIGNMENT

```
  1 O   O 2
  3 O   O 4
  5 O   O 6
  7 O   O 8
  9 O   O 10
 11 O   O 12
 13 O   O 14
 15 O   O 16
 17 O   O 18
 19 O   O 20
 21 O   O 22
 23 O   O 24
 25 O   O 26
 27 O   O 28
 29 O   O 30
 31 O   O 32
 33 O   O 34
```

PIN	I/O	Signal	PIN	I/O	Signal
1	O	+5V	18	I	–Data Bit 2
2		Ground	19	I	–Data Bit 4
3	O	+5V	20	I	–Data Bit 3
4		Ground	21	O	–Status 2
5		(not used)	22	O	–Status 3
6	–	(key)	23	O	–Status 4
7	O	–Status 0	24	O	–Status 5
8	O	–Clear	25	I	–Restore
9	O	–Character Ready	26		Ground
10	O	–Status 1	27	O	–Status Strobe
11	O	–12V	28		Ground
12	I	–Character Strobe	29	O	–Status 6
13	I	–Data Bit 0	30		Ground
14	I	–Data Bit 7	31	O	–Status 7
15	I	–Data Bit 6	32		Ground
16	I	–Data Bit 1	33		Ground
17	I	–Data Bit 5	34		Ground

Figure 2-8   PARALLEL I/O CABLE CONNECTOR PIN ASSIGNMENT

For Half-Duplex operation - One Twisted Pair of wires;
For Full-Duplex operation - Two Twisted Pairs of wires; minimum
    22 AWG. EIA cable recommended is Diablo P/N 1-904-05. Max-
    imum cable length tested is 4000 feet (1220 m).
EIA cable connector parts (P1, P4 Alternate):
    Body - P1 = Diablo P/N 10936-25   P4 = Diablo P/N 10845-09
    Housing - P1 = Diablo P/N 10947   P4 = Diablo P/N 42602-09
    Contacts - P1 = Diablo P/N 10939-01   (N/A P4)
XMEM2 cable connector parts (P2):
    Body = Diablo P/N 10890-08   Contacts = Diablo P/N 10891-02
HPRO4 cable connector parts (P3):
    Body = Diablo P/N 10890-04   Contacts = Diablo P/N 10891-02
P2-P3 interconnect wires 22 AWG, 21", Diablo P/N 10954-XX.
Figure 2-9 shows pin arrangements and assignments for the cable.

1. REC DATA (RTN) (RCV B)   8. XMIT DATA (XMIT B)
2. GND   9. NOT USED
3. NOT USED   10. +DSR
4. NOT USED   11. +CTS }+12V
5. NOT USED   12. +CRR
6. -TxD   13. REC DATA (RCV A)
7. XMIT DATA (RTN) (XMIT A) 14. -RxD

CONNECTORS VIEWED FROM PIN END
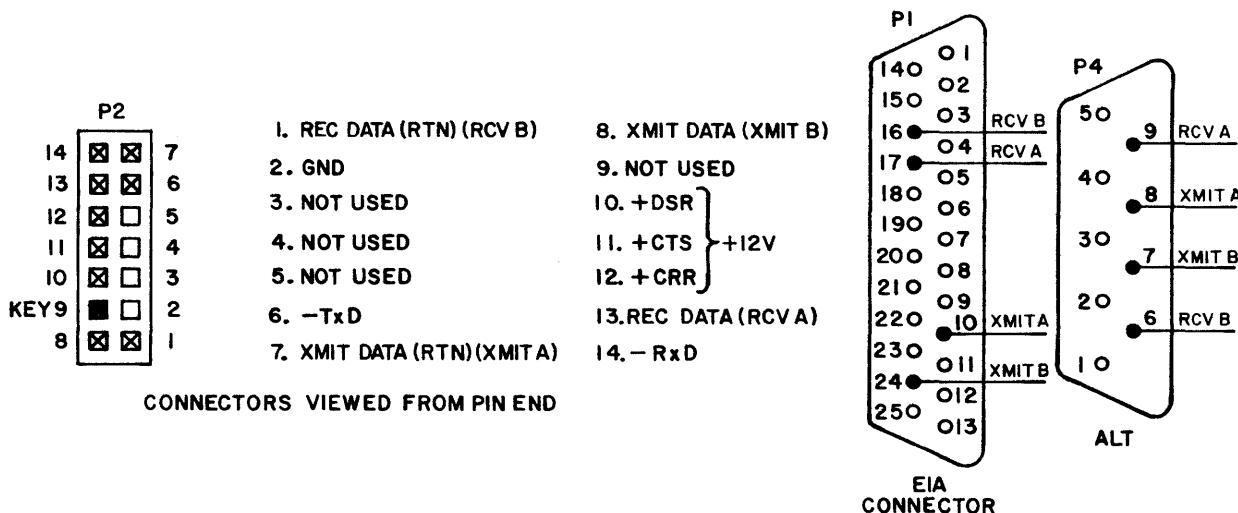
Figure 2-9   CURRENT LOOP I/O CABLE CONNECTOR PIN ASSIGNMENT

2.3 VENTILATION

All versions of the 1640/1650 Series which include the optional Diablo
Internal Power Supply also include a cooling fan. This fan provides
an adequate flow of cooling air around and thru the unit. Care should
be taken to allow adequate clearance around and up thru the unit for
air flow. Diablo cover sets are equipped with a 2" (50.8 mm) high
rack support. This rack aids in maintaining cooling air flow by hold-
ing the paper up away from the vented top surface of the cover.

2.4 OPERATION

2.4.1 General Procedures

Functions to be performed by the operator vary greatly with the ma-
chine version and options being employed. The information in this
subsection describes only those operator duties applicable to the
STANDARD versions of the 1640/1650 Printer Mechanism. These are
loading paper, adjusting for paper thickness, selecting and instal-
ling print wheels and ribbon cartridges, and selecting print hammer

intensity. Operator duties pertaining to other models, selected options and accessories are included with the descriptions of those items.

Refer to Figure 2-10 for the location of the 1640/1650 Series controls and connectors.

NOTE: A small percentage of printers may require printer adjustment to obtain optimum print quality after shipment. This is due to uncontrollable handling and shipping conditions after the units have left the factory. Refer to subsection 5.4 for print quality tests and adjustment procedures.

2.4.1.1 Paper Loading

Loading paper into a machine is accomplished in much the same manner as a standard typewriter. Paper is inserted down behind the platen, the platen rolled by hand to bring the paper under and up in front of the platen. The paper bail, when pulled forward, aids in directing the paper back over the top of the platen to the rear. The right-hand paper release lever may be pulled forward to release roller pressure to aid in proper paper alignment. After the paper is positioned, both the paper bail and paper release lever are returned to their operating positions.
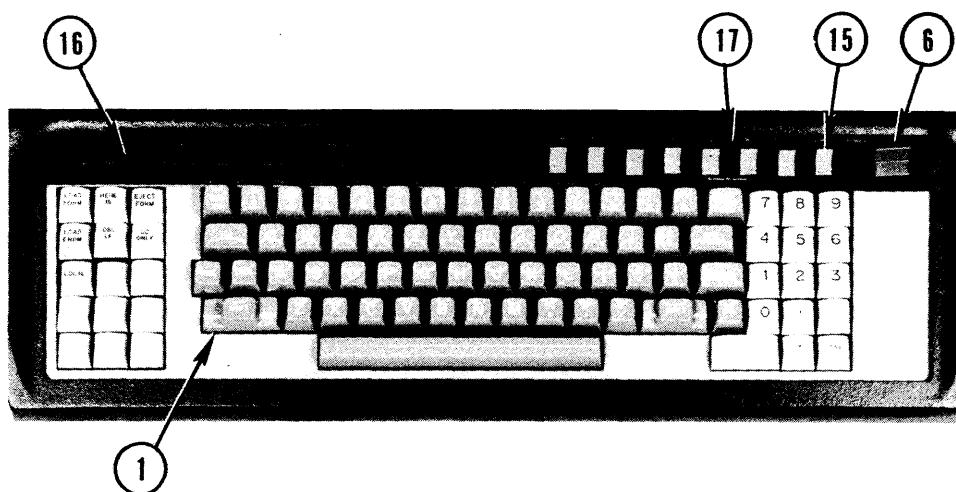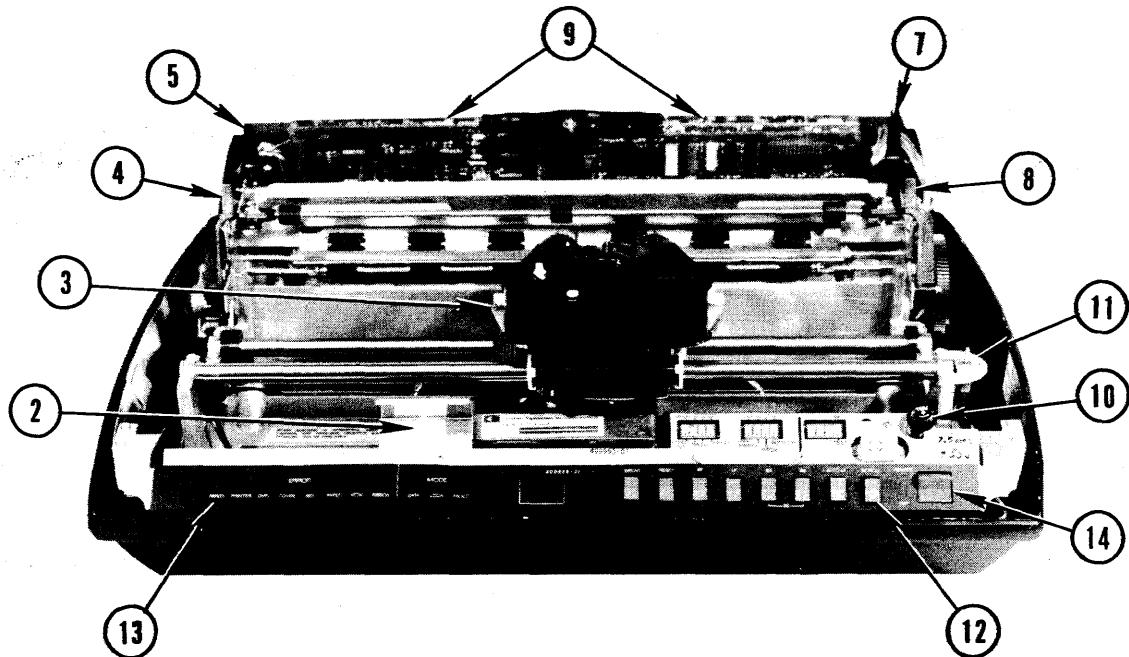
2.4.1.2 Paper Thickness Adjustment

The operator may position the left-hand platen adjust lever for the type of printing to be performed. This lever should be in the first detent position (fully forward, and then back one "notch") for printing on single sheets of paper using cloth ribbons. As the paper thickness increases, as with multiple carbon forms or heavier paper stocks, the lever is moved one or more detents to the rear. Each detent position moves the platen back approximately the thickness of one sheet of 20# bond paper.

The platen adjust lever MUST be in its fully forward position when printing on single sheets of paper using film base carbon ribbons. If this lever is NOT fully forward in this situation it is possible that the ribbon will be damaged.

2.4.1.3 Ribbon Cartridge Replacement

Replacing a Diablo ribbon cartridge is quick and clean. The cartridge is held on its platform atop the print wheel carriage by two latches. Pushing down on both of these latches simultaneously releases the cartridge into the hand for removal. Lift the cartridge straight up to clear the print hammer guide and the ribbon guide posts at the rear of the platform. Installing a new cartridge involves the following simple steps. Each Diablo ribbon cartridge has a small knob on its upper surface for moving the ribbon manually. Use this knob to make sure the exposed portion of the ribbon moves freely, and is tight and straight. Hold the cartridge in one hand with the exposed ribbon toward the platen. Lower the cartridge down past the print hammer guide, engage the ribbon behind the two ribbon guide posts and

1. Keyboard
2. Cover Open Switch
3. Carriage
4. Paper Bail Lever
5. Platen Adjust Lever
6. Power Switch (KSR Version)

7. Paper Release Lever
8. Paper Bail Lever
9. Electronics
10. Fuse
11. Impression Control Switch
12. Control Panel Switches (RO Version)

13. Control Panel Indicators (RO Version)
14. Power Switch (RO Version)
15. Control Panel Switches (KSR Version)
16. Control Panel Indicators (KSR Version)
17. Print Wheel Select Switches
    (1650 Series only)

Figure 2-10   SERIES 1640/1650 CONTROLS AND CONNECTORS

push the cartridge "ears" against the upright card guide. Check that
the exposed ribbon is straight, and located between the card guide
and the print wheel. Push the cartridge down firmly until both latches
have snapped into their latched position to hold the cartridge in
place. Rock the cartridge back and forth on its platform and observe
unobstructed up and down movement of the exposed ribbon. Turn the
cartridge's manual ribbon advance knob again to ensure that the rib-
bon is tight, straight and ready to operate.

2.4.1.4 Print Wheel Replacement

Replacing a Diablo print wheel is fast and simple. The ribbon car-
tridge is first removed, as instructed above. The inner carriage
assembly then tilts forward away from the platen to expose the print
wheel. The print wheel is held on the motor shaft hub by friction,
and is easily pulled free by grasping its rubber hub and pulling while
rocking it gently.

Install a print wheel by lightly pushing it onto the print wheel
shaft hub. Make sure the alignment slot in the wheel is properly
aligned with the alignment tab protruding from the shaft hub. Push
the wheel firmly and fully onto the shaft hub. Tilt the inner car-
riage assembly back into its operating position, and reinstall the
ribbon cartridge.

NOTE: In Series 1650 units equipped with the optional Operator Con-
trol Panel, care should be taken to ensure that the control panel
Print Wheel Select switches are set correctly when changing print
wheels.

2.4.1.5 Print Intensity Adjustment

All versions of the 1640/1650 Series include an impression control
switch. This switch provides three levels, or steps, of print inten-
sity (print hammer energy) to accommodate print wheel font variations
as well as multiple copy printing. The switch positions are as de-
scribed below.

        O (for High)   = Used for heavy printing on multiple forms
        o (for Medium)   = Used for most normal work
        . (for Low)   = Used for light printing to extend the life of
                            the more delicate lightfaced type fonts, such
                            as MANIFOLD 10 (as compared to a medium- or
                            bold-faced type font such as COURIER 10).

2.4.1.6 Top Paper Out Switch

All applicable versions of the 1640/1650 Series include a switch that
senses the end of the paper nearing the active print line location.
This switch is disabled during normal operations when the paper re-
lease lever is farthest back. When in use with optional paper hand-
ling equipment, this switch senses the end of the paper and signals
printer logic for appropriate action in accordance with the operating
parameters of the unit.

2.4.1.7 End Of Ribbon Sensor

All versions of the 1640/1650 Series include a sensor which detects
the nearly empty condition of film base carbon ribbon cartridges.
This sensor signals printer logic for appropriate action in accordance
with the operating parameters of the unit. The sensor is nonopera-
tional with cloth type ribbon cartridges.

2.4.1.8 Cover Open Switch

This switch is mounted on the front part of the printer's main frame.
It is activated by the position of the Top Access Cover, and signals
printer logic anytime the access cover is not fully in place or has
been removed. Printer logic can then respond in accordance with the
unit's operating parameters.

2.4.1.9 Internal Switches
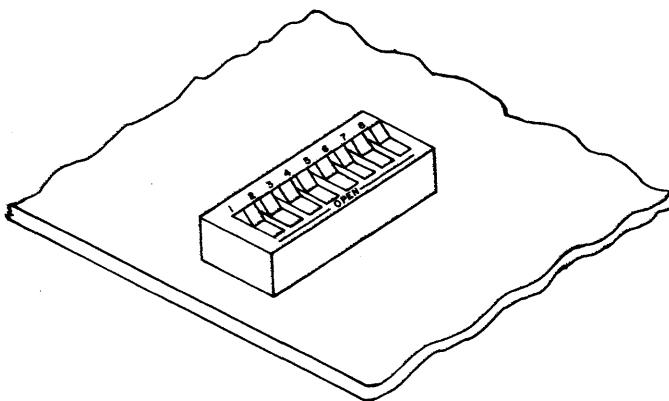
Figure 2-11   HPRO4 CONTROL SWITCH MODULE A25

All versions of the 1640/1650 Series include a group of operating
control switches mounted on the HPRO4 Processor PCB, as mentioned in
subsections 1.2.1 and 1.2.2. These switches are normally accessible
only to a Service Technician. The operator should, however, be aware
of their setting and effect on the operation of the unit.

Refer to Figure 2-11 for aid in identifying these switches as they
appear on the PCB.

HPRO4 switch definitions when the Operator Control Panel is NOT in-
stalled:

> Switch #1 SELF-TEST If this switch is ON when power is applied,
> the unit will perform a preprogrammed self-test routine which in-
> cludes a RAM test, a ROM test, a keyboard test (when applicable),
> and a printer test. Each passage of the test routine begins with
> a printed message "selftest" followed in a few moments by printed
> lines of reports on the test results. If an error is detected,
> the system will stop and printout a failure notice calling the
> operators attention to the area of failure. If the optional Op-
> erator Control Panel is installed, all error indicators will
> glow. If no errors are detected, the test will recycle continu-

ously until the SELF-TEST switch is turned OFF. A typical print-
out of error free test results using a 96 character Diablo metal
print wheel is shown below. The bottom line of the self-test
printout is comprised of characters addressed by ASCII codes 20-
(Hex) up thru 7F(Hex). See Appendix A-1. In all cases, the
first code (20-Hex) produces a space character in the first
print position. Using any of the metal print wheels, the last
print position contains a "?" character in place of the character
normally addressed by ASCII code 7F(Hex) (see Appendices C-2, C-3
and C-4). When using a plastic print wheel, the last print posi-
tion contains the character addressed by ASCII code 7F(Hex) (see
Appendix C-1).

```
self test!
ramok
romok
key
 !"#$%&´()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~?
```

Switch #2 PITCH This switch controls the number of columns in
the print line, and thereby the letter spacing of the printout.
The switch is ON for 10 Pitch (or 10 characters per inch), and
OFF for 12 Pitch (or 12 characters per inch). The setting of
this switch is sensed only during a power on or controller in-
itiated remote RESET routine. This switch is not functional in
the self-test mode (self-test printout is 12 pitch).

Switch #3 DC1/DC3 ENABLE If this switch is ON, a DC3 code will
be transmitted thru the interface if printing is attempted when-
ever any of the following conditions are present: a) Buffer
Nearly Full *; b) Cover Open; c) Paper Out; d) Ribbon Out; or
e) Printer in CHECK (assuming appropriate options are asserted).
Once a DC3 code is transmitted, a DC1 code will be transmitted
when the buffer has been nearly emptied *, and/or the item(s)
b) thru e) causing the alarm have been corrected and a RESET
routine initiated.

* = These signals indicate buffer content within 64 characters
    of being full or empty.

Switch #4 PARITY ENABLE This switch enables parity checking
and parity transmission when ON.

Switch #5 PARITY SELECT Used in conjunction with the Parity
Enable switch, this switch selects either ODD (space) counting
when ON, or EVEN (mark) counting when OFF.

Switch #6 DUPLEX This switch selects half-duplex operation
when OFF, or full-duplex operation when ON, in ASCII mode only.

Switch #7 120 SPEED)
Switch #8 30 SPEED ∫ These two switches are used to select the
speed at which data will be received and transmitted. See Table
1-1.

2.4.2   The RO Printer

2.4.2.1   General Operating Procedures

All general points of operation outlined above in subsection 2.4.1
also apply to this model in its STANDARD configuration. In addition,
this model includes the Diablo RO Cover Set, and the Operator Control
Panel with its Cover Open Switch installation.

2.4.2.2   Operator Control Panel

*BLANK SWITCHES SERIES 1640 ONLY
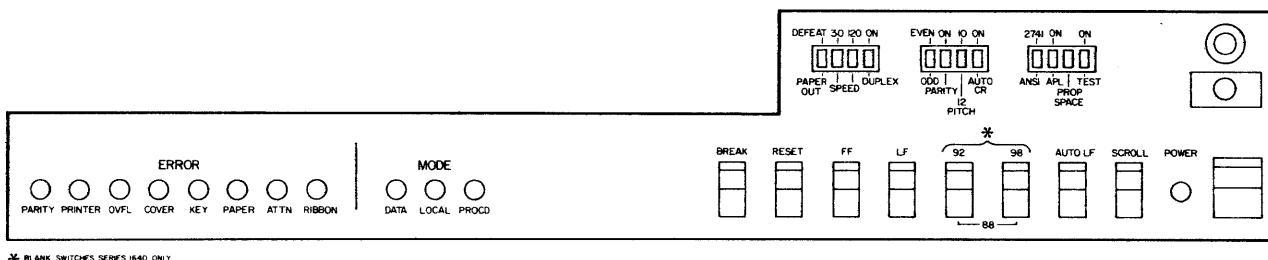
Figure 2-12   OPERATOR CONTROL PANEL

Installation of this control panel redefines the 8 control switches
located on the HPRO4 PCB, as discussed in subsection 2.4.1.9, and
adds a number of operating features.

HPRO4 Switch Definition WITH the Control Panel installed:

>   Switch #1   ENHANCED 2741   This switch is ignored unless the 2741
>   option is installed. When this switch is OFF, the 2741 mode of
>   operation is identical to IBM. When ON, the 2741 mode is en-
>   hanced to include all ASCII mode functions.
>
>   Switch #2   ETX/ACK ENABLE   When this switch is ON, an ACK char-
>   acter will be transmitted whenever an ETX character is encount-
>   ered in the print buffer. ETX characters are not printed. When
>   the switch is OFF, ETX's are ignored.
>
>   Switch #3   DC1/DC3 ENABLE   (same as subsection 2.4.1.9)
>
>   Switch #4   CORRESPONDENCE   This switch is ignored in the ASCII
>   mode, or when the 2741 option has not been installed. When used
>   in the 2741 mode, this switch selects unit operation in either
>   IBM Correspondence (ON) or IBM PTTC/EBCD (OFF) codes.
>
>   Switches #5 thru #8 are ignored.

The Control Panel switches and features are as follows:

>   POWER   This switch controls AC power to the unit.
>
>   TEST   This switch performs the same function as the internal
>   Self-Test switch (see subsection 2.4.1.9).
>
>   PROP SPACE   This switch overrides the PITCH switch. It controls

character spacing based on the proportional size of the
next character to be printed along with that of the char-
acter just printed. This switch is ignored when the WP
Enhancement option has not been installed.

APL   When ON, this switch enables character codes for an APL
        version of the selected print wheel, or other alternate
        print wheel logic coded into an option PROM.

ANSI/2741 This switch is ignored unless the 2741 option has been
        installed. The setting of this switch is sensed at power
        on only. It establishes the unit to operate with either
        standard ASCII (ANSI) character codes or IBM 2741 codes
        and line protocol.

AUTO CR When this switch is ON, the unit will automatically do
        a carriage return when horizontal movement is attempted
        beyond the farthest right column (or farthest left in the
        backward print mode), and the alarm will sound.

PITCH 10/12 This switch performs the same function as the in-
        ternal Pitch Switch.

PARITY   This switch performs the same function as the internal
        Parity Enable Switch.

PARITY ODD/EVEN This switch performs the same function as the
        internal Parity Select Switch.

DUPLEX   This switch performs the same function as the internal
        Duplex Switch.

SPEED 120)
SPEED 30) These two switches perform the same functions as
        the two internal Speed Switches.

PAPER OUT/DEFEAT When this switch is ON the Paper Out switch
        signal will be ignored.

SCROLL When this switch is ON the following paper feed activity
        is added to the normal routine. Approximately 1/2 second
        after the last character is printed the paper will be ad-
        vanced so that the print line may be easily seen. When
        the next character is received, the paper is moved back
        down and realigned with the print line before the charac-
        ter is printed. Note that this switch should be OFF when
        inserting paper and setting Top Of Form. If it was ON
        when paper was inserted it should be switched OFF. Key-
        board installations may operate any key that will return
        the paper to normal position before setting Top Of Form.

AUTO LF When this switch is ON with the unit in the ASCII mode,
        a line feed will be performed with each carriage return
        (CR) command. This switch is ignored in the 2741 mode.

96 } 1640 Series machines – these two switches are unlabeled
92 } and ignored. 1650 Series machines – these two switches
are used to select the character sort to match the print
wheel in use. See Table 1-2.

LF The paper is immediately advanced one line when this momen-
tary action switch is pressed. Holding this switch down
will cause repeated line feed operations.

FF This momentary action switch causes a form feed operation to
the next Top Of Form position without transmitting a form
feed code.

RESET This momentary action switch clears all error lamps and
initiates a printer RESTORE sequence if the printer was
in CHECK.

BREAK In the ASCII mode, this momentary action switch causes a
break (250 msec space) to be transmitted. Its operation
in the 2741 mode depends on current machine operating
status.

Audio Alarm This device buzzes for short periods of 1/4 to 1/2
second to signal various error or operating conditions.

Error Lamps These lamps glow to indicate machine disfunction:

  *PRINTER - The printer is in CHECK and printing was attempted.
  *COVER   - The cover is open and printing was attempted.
  *PAPER   - The printer is out of paper and printing was
              attempted.
  *RIBBON   - A ribbon out condition exists and printing was
              attempted.
  PARITY   - Incoming parity, framing, or overrun error sensed.
  ATTN   - A framing error was sensed with a NUL character (all
              zeros) indicating that a "break" was received. The
              print and send buffers will be cleared. This lamp
              also glows while the unit is in the LINE EDIT mode.
  *OVFL   - Data has been received with the print buffer full.
  KEY   - Keyboard entry was attempted while the keyboard was
              locked **, or an undefined key was pressed.

* = These errors cause a "break" to be transmitted when in Remote
     mode if DC1/DC3 is not selected.

** = See subsection 3.3.2.2 for an explanation of this keyboard
     feature.

  Mode Lamps These lamps glow to indicate Terminal mode of
              operation as follows:

  LOCAL   - Glows when the Terminal is in the local (keyboard)
            mode. This lamp is operative only in those units
            which have the keyboard installed.
  DATA   - Blinks as characters are received or transmitted
            in the remote modes. Normally glows in local mode.

POWER   - Glows when AC power is applied to the Terminal.
                PROCEED - Glows in remote ASCII mode when The DSR (Data Set
                           Ready) signal is active (HI), or in remote 2741 mode
                           when the DSR signal is active (HI) and the keyboard
                           is unlocked.

2.4.3   The KSR Terminal

2.4.3.1   General Operating Procedures

All points of operation outlined for the RO models apply to this model
in its STANDARD configuration. This model includes a Diablo KSR Cover
Set, Operator Control Panel, and a Diablo keyboard.

2.4.3.2   The Diablo Keyboard

The STANDARD Diablo Keyboard is as shown in Figure 2-13. It supports
ASCII, IBM Correspondence, or IBM PTTC/EBCD data interchange modes,
and APL versions of these three. It consists of three sections; the
left-hand "control" section, the center "alphameric" section, and the
right-hand 10-key pad "numeric" section. Note that the normal ASCII
mode is standard, with all others being optional.

Figure 2-14 illustrates the standard key assignments for the 1640/1650
Series Keyboard. Following is a description of the function of the
special keys found in each section of this keyboard.

THE CONTROL SECTION: This section contains 15 keys; six are alter-
nate action, three are momentary action, and six are not presently
used.

          LOCAL   - This alternate action key selects the LOCAL op-
                        erating mode when DOWN, and the REMOTE operating
                        mode when UP.
          UC ONLY   - This alternate action key converts all lowercase
                         alphabet characters to their uppercase equivalents
                         when DOWN. Received characters are not affected
          DBL LF   - This alternate action key converts all line feed
                         commands to double line feed commands when DOWN.
          LOAD FORM)- These two momentary action keys are used to man-
          EJECT FORM)   ually control the operation of the Auto Front Feed
                        forms handling accessory described in subsection
                        6.3.1.4.
          LOAD EROM   - This alternate action key enables keyboard entry
                        of the "Here Is . . ." message when the XMEM2
                        PCB with appropriate options has been installed.
          MARG CONT   - When activated (DOWN), this alternate action key
                        enables the sounding of the alarm when the printer
                        is 5 normal character spaces from the right margin,
                        and initiates an auto line feed and carriage return.
          LINE EDIT   - When activated (DOWN), this alternate action key
                        allows the current print line to be verified and
                        corrected before it is transmitted. The ATTN lamp
                        will glow and the alarm will sound if the memory
                        buffer is not empty, and keyboard data will be re-
                        jected. A carriage return (CR), line feed (LF) or

line edit key action will clear the buffer. The DEL key is used to erase characters. A CR or LF command will allow the stored data to be transmitted.

HERE IS   - This momentary action key initiates the transmission of a special message of up to 31 characters over the communications link with the Terminal in the remote ASCII mode and if the appropriate option has been installed.

THE ALPHAMERIC SECTION: This section contains 47 keys in typewriter paired configuration, and 11 function and control keys. Some keys in this section have different functions, represent different characters, or are undefined depending on the mode of operation. This is because the ASCII, IBM Correspondence, and IBM PTTC/EBCD character sets do not completely overlap. The KEY error lamp will glow and the alarm will sound for 1/4 second anytime an undefined key in any mode is struck.

ESC   - This is a control key. Once pressed, its signal redefines certain keys in the alphameric section for the next one or two characters. The affected keys in the top row are shown in Figure 2-15 and are listed below. Other affected keys are discussed in appropriate subsections following.

```
ESC 1 = SET HT (set Horizontal Tab)
 "  2 = CLR TABS (Clear all Horizontal and Vertical Tabs)
 "  3 = PLOT ON (set Graphics mode ON)
 "  4 = PLOT OFF (clear Graphics mode)
 "  5 = FWD PRINT (clear Backward Print mode)
 "  6 = BKWD PRINT (set Backward Print mode)
 "  7 = PRINT SUPP (set Print Suppression mode)
 "  8 = CLR HT (Clear individual Horizontal Tab)
 "  9 = LEFT MAR (set Left Margin)
 "  0 = RIGHT MAR (set Right Margin)
 "  - = SET VT (set Vertical Tab)
```

CTRL   - This is also a control key. When it is held down while pressing other keys, special control characters such as HT, VT, FF, etc. are generated. The affected keys are shown in Figure 2-16 and listed below. Note that the key legends depicted are for the standard 47-key typewriter paired keyboard.

```
CTRL ESC = Escape mode
 "   1  = NUL (no effect)
 "   2  = NUL      "
 "   3  = NUL      "
 "   4  = NUL      "
 "   5  = NUL      "
 "   6  = NUL      "
 "   7  = NUL      "
 "   8  = NUL      "
 "   9  = Left Brace Code
 "   0  = Right Brace Code
 "   -  = US code
 "   =  = RS code
 "   `  = GS code
```

```
"    Backspace = BS code
"    Tab = HT code
"     q   = DC1 code
"     w   = ETB code
"     e   = ENQ code
"     r   = DC2 code
"     t   = DC4 code
"     y   = EM code
"     u   = NAK code
"     i   = HT code
"     o   = SI code
"     p   = DLE code
"     [   = ESC code
"     \   = FS code
"    Line Feed = LF code
"     a   = SOH code
"     s   = DC3 code
"     d   = EOT code
"     f   = ACK code
"     g   = BEL code
"     h   = BS code
"     j   = LF code
"     k   = VT code
"     l   = FF code
"     ;   = ; code
"     '   = ' code
"     }   = NUL (no effect)
"    Return Key = CR code
"     z   = SUB code
"     x   = CAN code
"     c   = ETX code
"     v   = SYN code
"     b   = STX code
"     n   = SO code
"     m   = CR code
"     ,   = , code
"     .   = . code
"     /   = / code
"    Del = DEL code
"    Space Bar = SP code
"    Space Key in Numeric Section = SP code
CTRL Tab Key in Numeric Section = HT code

DEL  This key is ignored by the unit in remote, and prints a
     "?" in LOCAL mode (1650), or "¬" in LOCAL mode (1640).
```

THE NUMERIC SECTION: This section is to the right of the Alphameric
section, as shown in Figure 2-14. It contains a 10 key pad with per-
iod, hyphen, space bar, comma and tab keys. The key assignments in
this section do not change with Shift key operation, and are there-
fore useful in place of their alphameric counterparts while the 1650
is in the shifted or CTRL modes.

2.4.4 Printing Format

Printing format is dependent upon three main factors; horizontal character spacing, vertical line spacing, and number of lines per page. Each of these factors can be independently controlled. An "index" is used to define the specific motion desired for both horizontal character spacing and vertical line spacing. Any point on a page can be defined in terms of a "horizontal position" and a "vertical position". The number of lines per page can easily be changed when necessary.
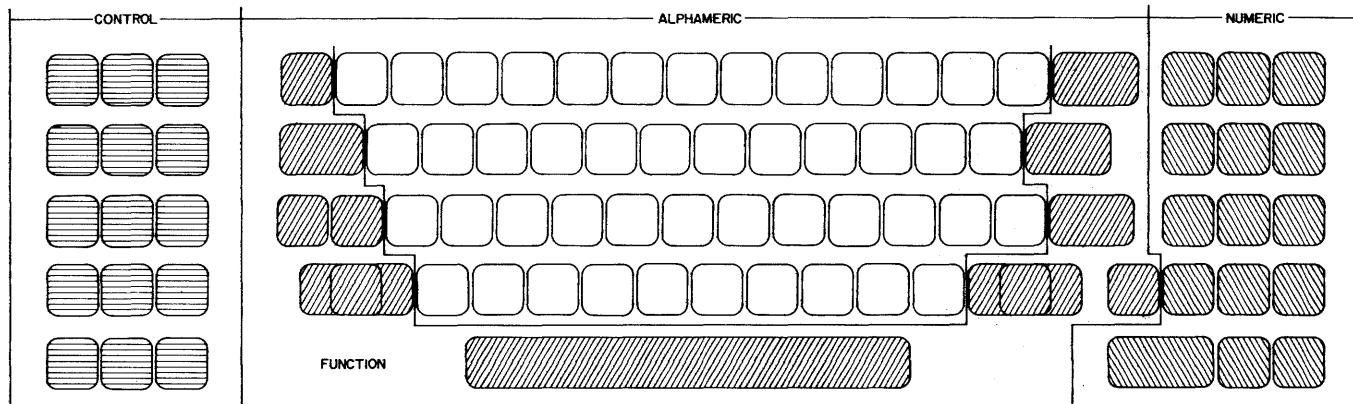
Figure 2-13 DIABLO KEYBOARD SECTIONS
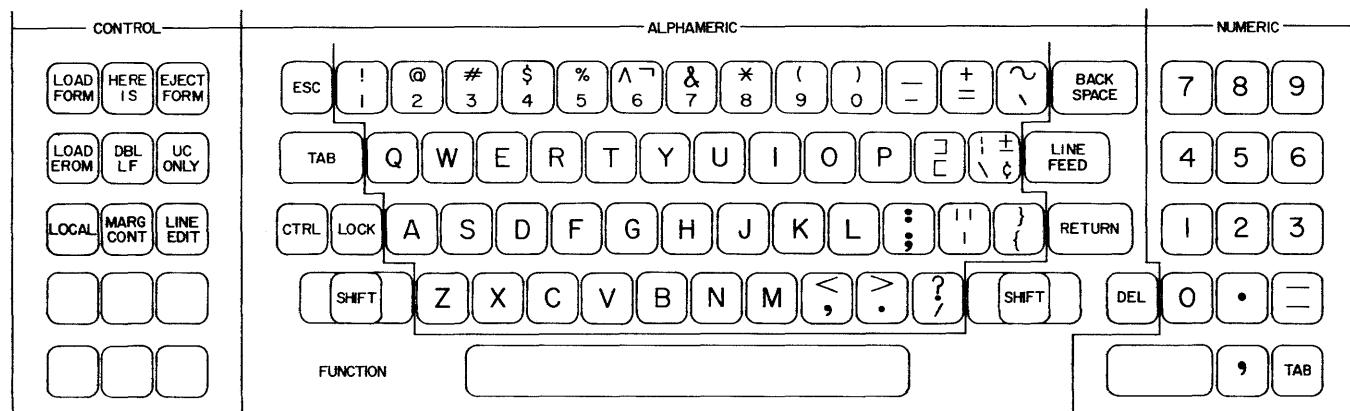
Figure 2-14 STANDARD KEYBOARD ASSIGNMENTS – KSR MODELS

SET HT   CLR TABS   PLOT ON   PLOT OFF   FWD PRINT   BKWD PRINT   PRINT SUPP   CLR HT   LFT MAR   RHT MAR   SET VT

ESC | 2   3   4   5   6   7   8   9   0   -

FUNCTION
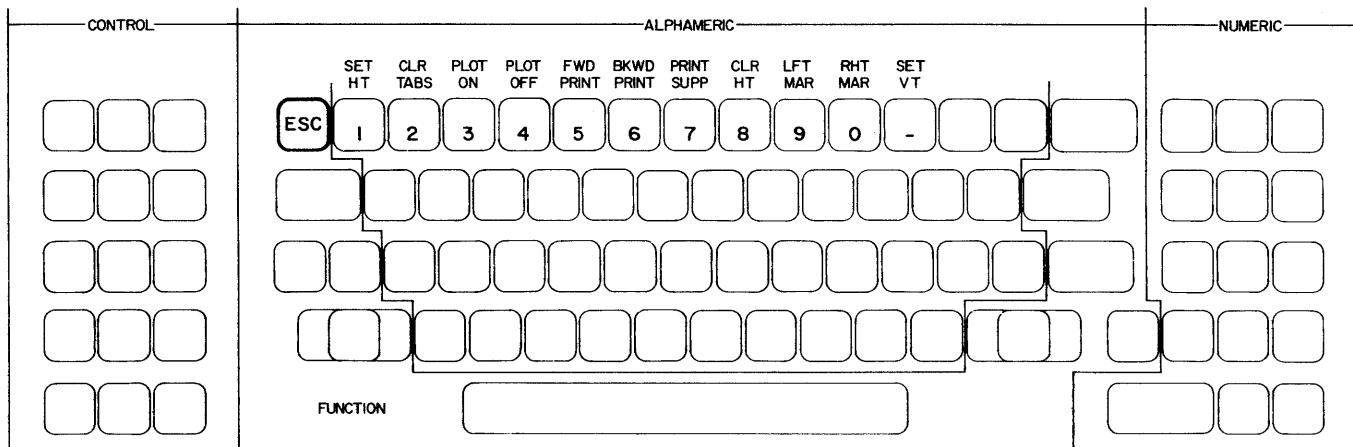
Figure 2-15   ESC MODE KEY ASSIGNMENT

CONTROL ─────── ALPHAMERIC ─────── NUMERIC

ESC   NUL   NUL   NUL   NUL   NUL   NUL   NUL   NUL   {   }   US   RS   GS   BS

HT   DCI   ETB   ENQ   DC2   DC4   EM   NAK   HT   SI   DLE   ESC   FS   LF

CTRL   SOH   DC3   EOT   ACK   BEL   BS   LF   VT   FF   ;   I   NUL   CR

SUB   CAN   ETX   SYN   STX   SO   CR   ,   .   /   DEL

FUNCTION   SP   SP   HT
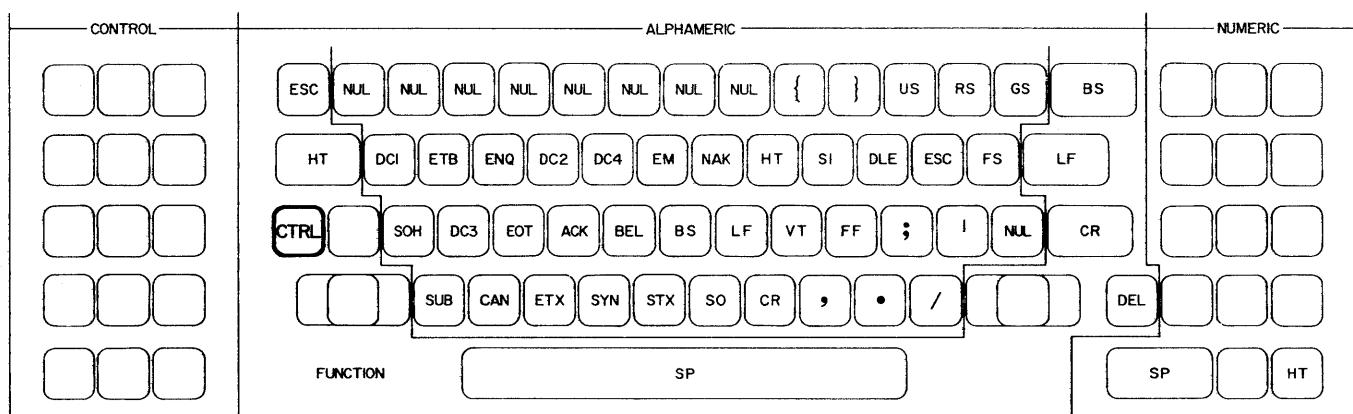
Figure 2-16   CTRL MODE KEY ASSIGNMENT

2.4.4.1   Definition of Terms

ORIGIN: The position of the print head after a form feed (with no top margin set) and an absolute horizontal tab to print position 1 (horizontal position 0).   The first print position on the first line of a page.

HORIZONTAL MOTION INDEX (HMI): The distance that the carriage moves
after printing a character (or when spacing). This distance is in
multiples of 1/120 inch. Minimum HMI is 0, maximum is 125.

VERTICAL MOTION INDEX (VMI): The distance that the paper (platen)
moves for each line feed, negative line feed, etc. This distance is
in multiples of 1/48 inch. Minimum VMI is 0, maximum is 125. When
VMI = 0 no paper movement occurs.

ABSOLUTE HORIZONTAL POSITION: The horizontal distance, in 1/120
inch increments, between the print head position and the origin.
Minimum absolute horizontal position is 0, maximum is 1572 (13.1" x
120).

ABSOLUTE VERTICAL POSITION: The vertical distance, in 1/48 inch
increments, between the current print line and the first line on
the page (the origin). Minimum absolute vertical position is 0,
maximum is 15,750 (125 x 126 lines per page).

PRINT POSITION: The horizontal area capable of being occupied by
a single printed character. This is similar to a print "column" on
a line printer except that it is variable. That is, the number of
print positions per line is dependent on the HMI. The minimum num-
ber of print positions per line is 13 when HMI=125, the maximum is
1572 when HMI=1. The print position farthest left is position 1.
Print position may be calculated as follows:

$$\text{Print Position} = \frac{\text{Horizontal Position}}{\text{HMI}} + 1$$

LINE: The vertical distance capable of being occupied by a row of
printed characters. The height of the line is equal to VMI. Line
number may be calculated as follows:
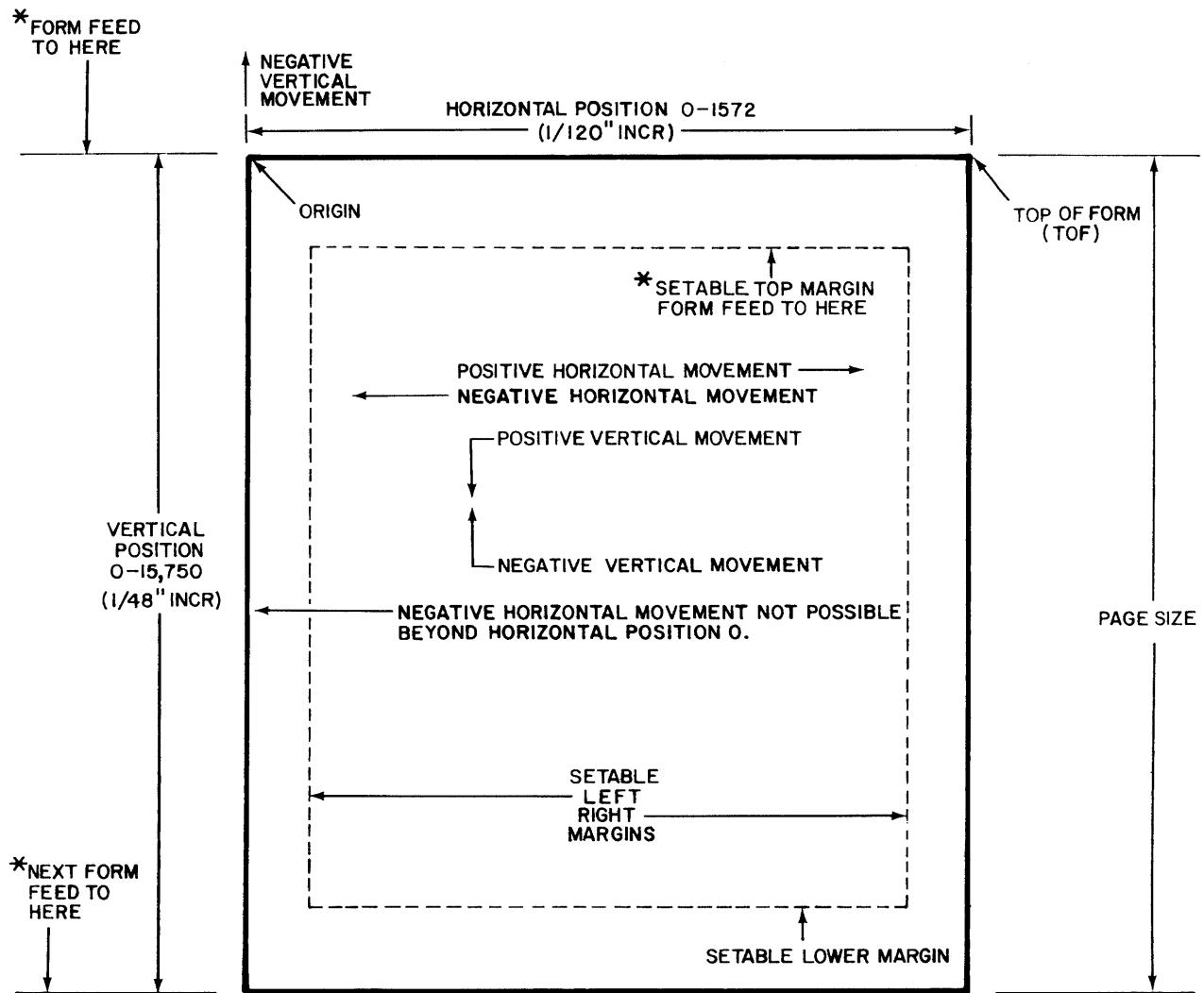
$$\text{Line Number} = \frac{\text{Vertical Position}}{\text{VMI}} + 1$$

LINES PER PAGE: The actual number of print lines per page of paper.
Lines per page can be set to any number from 1 thru 126.

Figure 2-17 illustrates some of the points just described, as applied
to a simple page layout.

2.4.4.2 Standard Formats

Either of two standard formats can be selected via the PITCH switch on
the Operator Control Panel. These formats are summarized in Table
2-1.

*FORM FEED TO HERE

NEGATIVE VERTICAL MOVEMENT

HORIZONTAL POSITION 0-1572 (1/120" INCR)

ORIGIN

TOP OF FORM (TOF)

*SETABLE TOP MARGIN FORM FEED TO HERE

POSITIVE HORIZONTAL MOVEMENT ⟶
⟵ NEGATIVE HORIZONTAL MOVEMENT

POSITIVE VERTICAL MOVEMENT

NEGATIVE VERTICAL MOVEMENT

NEGATIVE HORIZONTAL MOVEMENT NOT POSSIBLE BEYOND HORIZONTAL POSITION 0.

VERTICAL POSITION 0-15,750 (1/48" INCR)

PAGE SIZE

SETABLE LEFT RIGHT MARGINS

*NEXT FORM FEED TO HERE

SETABLE LOWER MARGIN

Width of Print Position	=	Horizontal Motion Index (HMI) and is variable from 0 to 125 (1/120") increments.
Print Position Number	=	$\dfrac{\text{Horizontal Position}}{\text{HMI}} + 1 =$ Horizontal Tab Position. Tab Positions limited to first 160 Print Positions.
Height of Line	=	Vertical Motion Index (VMI) and is variable from 0 to 125 (1/48") increments.
Line Number	=	$\dfrac{\text{Vertical Position}}{\text{VMI}} + 1 =$ Vertical Tab Position. Total number of lines can be specified from 1 to 126.
Page Size	=	Number of lines x VMI.

* If a top margin is set, the Form Feed will advance beyond the Top of Form to the top margin.

Note: *Movement* arrows depict carriage movement relative to paper and not actual paper movement direction.

Figure 2-17   PAGE LAYOUT and PRINTING FORMAT

TABLE 2-1
STANDARD PRINTING FORMATS

PITCH Switch	Horizontal Spacing			Vertical Spacing		
	Char/in.	Char/line	HMI	Lines/in.	Lines/page	VMI
10	10	132	12	6	66	8
12	12	158	10	6	66	8

Whenever the PITCH switch is repositioned and an optional format has not been selected, the values listed in the table for the new position are used for horizontal and vertical spacing, and for lines per page.

Additional formats can be obtained by changing the HMI, VMI, or Lines Per Page. Such variable indexing overrides the PITCH switch function. Control may be restored to the PITCH switch by issuing the ESC S sequence.

2.4.4.3 Optional Formats (Variable Indexing)

Any of the three format factors can be altered by utilizing special escape (ESC) sequences. The ESC CR P (remote RESET) sequence may also be used here to cancel all optional format factors and return the Terminal to the format selected by the PITCH switch. Refer to subsection 3.2 for a detailed listing of all ESC sequences.

Execution of any of these sequences does not immediately alter horizontal or vertical position. It does, however, change subsequent operations by redefining the variable format factors. It is recommended that a Form Feed (FF) and an Absolute Tab (see subsection 2.4.4.10) to location 0 be performed prior to changing any format factors.

2.4.4.4 Variable HMI

The standard HMI can be altered in ASCII mode by executing the 3-character sequence ESC US (ASCII character), where the binary value of the selected ASCII character is one (1) greater than the number of 1/120 inch increments the carriage will move after printing a character or when spacing.

HMI = (ASCII character -1) x 1/120 inch

NUL and DEL characters cannot be used, therefore the minimum HMI is 0 increments, and the maximum is 125 increments. See Appendix D-1 to determine the ASCII character for the ESC sequence. An ESC S sequence will return control of HMI to the PITCH switch.

2.4.4.5 Variable VMI

The standard VMI can be altered in ASCII mode by executing the 3-character sequence ESC RS (ASCII character), where the binary value of the ASCII character is one (1) greater than the number of 1/48 inch increments the paper is to move for each line feed, negative line feed, etc. Minimum VMI is 0, maximum is 125. See Appendix D-1 to determine the (ASCII character) for the ESC sequence.

$$VMI = (ASCII\ character - 1) \times 1/48\ inch$$

2.4.4.6 Lines Per Page

Lines per page is automatically set at 66 when the unit is initialized (restored on power up). The number of lines per page can be altered in ASCII mode by executing a 3-character sequence ESC FF (ASCII character) where the binary value of the ASCII character is equal to the number of lines per page desired. The minimum number of lines per page is 1, the maximum number is 126.

The following two formulas can be used to compute the desired number of lines per page:

    * Lines Per Page = Number of Lines Per Inch x Page Size in Inches

$$* \text{ Number of Lines Per Inch} = \frac{48}{VMI}$$

Once the desired number of lines per page is known, use the information in Appendix D-2 to determine the (ASCII character) for the ESC sequence.

2.4.4.7 Forward/Backward Printing

All versions of the 1640/1650 Series are capable of printing forward (left to right) or backward (right to left) with equal ease. Backward printing is enabled by the sequence ESC 6, initiated either from the keyboard in local mode or thru the communications link in remote mode. The unit returns to normal forward printing upon receipt of either an ESC 5 sequence or a carriage return (CR) command.

During forward printing each character printed causes incremental carriage movement to the right. During backward printing, this motion is reversed with the carriage moving to the left. Note also that print data must be received by the unit logic in 'reverse order', and that the action resulting from the space and backspace commands is also reversed.

2.4.4.8 Print Suppression

Print suppression is initiated by the sequence ESC 7, and cancelled by a carriage return (CR) command. While this feature is enabled, all printable characters are replaced by spaces. Escape sequences and control characters are not affected.

2.4.4.9 Margin Placement

Horizontal Margins: Both left and right margins can be adjusted by positioning the carriage to the desired print position, and then entering an ESC 9 or 0 (LEFT MAR or RIGHT MAR) sequence. Altering the left margin causes the carriage to return to the new print position setting following a carriage return (CR) command. Altering the right margin causes the audible alarm to sound for 1/2 second when typing continues beyond the new margin setting in the local mode.

The carriage can be moved to the left beyond the left margin by using either Absolute Horizontal Tab or Backspacing, when the margin is set at some print position other than 1.

A power on or a remote RESET operation will clear adjusted margins to print positions 0 and 1572.

Vertical Margins: Both top and bottom vertical margins can be adjusted by first placing the paper in the top of form position, then moving the paper up with a series of LINE FEED operations to reach the desired top margin position. This "Top Margin" is then set by executing an ESC T sequence. Advancing the paper with LINE FEED operations to the desired "Bottom Margin" position, and then executing an ESC L sequence sets the bottom margin. The bottom margin must always be set below the upper margin, and both must be within the page size boundaries.

Top and bottom margins are reset to the top of form and bottom of page locations whenever page size is altered, or a remote RESET is received. They are also reset (or initialized) on power up, or upon receipt of a remote ESC C command in (ASCII) or (UC) PRE C command in 2741.

2.4.4.10 Tabbing

Two methods of tabbing are available for both horizontal and vertical motion. One method, called "Normal Tab", is similar to the traditional system used on typewriters in that tab stops are set at predetermined positions. The carriage or paper then moves to these positions sequentially on command. The second method is termed "Absolute Tab". This method is unique in that it does not require prior setting of tab stops. The carriage or paper is positioned directly to any one of 126 possible positions either horizontally or vertically from any other position. In the case of vertical tabbing, the paper should be moved "forward only", unless the unit is equipped with optional bidirectional paper handling accessories.

Both methods of tabbing provide horizontal and vertical positioning to standard print positions or lines. This makes it possible to print data out in any format desired without prior editing thru utilization of variable indexing. The method of tabbing to be used is specified by the character sequence used. The Horizontal Tab (HT) character or Vertical Tab (VT) character alone executes a Normal Tab operation. An ESC HT or ESC VT sequence, plus an ASCII character executes an Absolute Tab.

Normal Horizontal Tab: Horizontal tab stops can be set at any print position up to position 160 by positioning the carriage to the desired print position and executing an ESC SET HT sequence. Keeping in mind that tab stops can only be set at the first 160 print positions, the formula for determining a tab position is:

$$\text{Horizontal Tab Position (1-160)} = \frac{\text{Horizontal Position}}{\text{HMI}} + 1$$

A keyboard TAB command automatically causes the carriage to move to
the next sequential tab stop. Should a TAB move be commanded with no
tab stop having been set to the right of the present carriage posi-
tion, the carriage will not move and the alarm will sound. Individual
horizontal tab stops can be cleared by first positioning the carriage
to that print position and then executing an ESC 8 (CLR HT) sequence.
All tab stops,both horizontal and vertical can be cleared simultane-
ously by executing an ESC 2 (CLR TABS) sequence.

Absolute Horizontal Tab: In this mode the carriage can be positioned
directly to any of the first 126 print positions without the need for
prior setting of tab stops. Also, Absolute Tab Stops are not retained
in memory and each stop must be commanded each time it is to be used.
The command sequence for this is ESC HT (ASCII character), where the
value of the (ASCII character) indicates the print position desired.
See Appendix D-3 to determine the (ASCII character) for the ESC se-
quence. The farthest left print position is considered to be binary
location 1. The horizontal position at the completion of an Absolute
Tab operation is computed as follows:

Horizontal Position = (ASCII character - 1) x HMI

Normal Vertical Tab: Vertical tabs are set with reference to the Top
Of Form position. This position, the first print line on the page,
is reached by a keyboard FORM FEED command, followed by a manual
adjustment of the paper location vertically to locate the paper in
proper position. Vertical tab stops may then be set at any other
line on the page by first moving the paper to the desired line by
means of a series of LINE FEED commands, and then executing an ESC
SET VT sequence. This is repeated for each desired tab stop. The
location of the vertical tab stop is defined as follows:

$$\text{Vertical Tab Position} = \frac{\text{Vertical Position}}{\text{VMI}} + 1$$

Once vertical tab stops are set, subsequent VT commands will cause
the paper to be indexed upward to the next sequential vertical tab
stop. If there are no more stops set between present print line and
the end of the form, the paper will not move and the audible alarm
will sound. Individual vertical tab stops cannot be cleared as can
the horizontal tab stops. All tab stops, horizontal AND vertical are
cleared simultaneously by executing the ESC 2 (CLR TABS) sequence.

Absolute Vertical Tab: In this mode the paper can be moved to any of
the 126 possible lines on the page. Absolute Vertical Tab is ini-
tiated by executing the sequence ESC VT (ASCII character) where the
value of the (ASCII character) chosen determines the number of the
line to be reached. See Appendix D-3 to determine the (ASCII char-
acter) for the ESC sequence. NUL and DEL are not used. The top
print line on the page is assigned the binary value of 1, with each
succeeding line down the page assigned the next higher number. Note
that it is possible to tab beyond the end of the page if the total
page line number is less than the maximum 126. The actual amount of
paper movement is determined by a) the paper position before VT exe-

cution, b) the ASCII character used, and c) the Vertical Motion Index (VMI). The ultimate position reached is determined as follows:

$$\text{Vertical Position} = (\text{ASCII character} - 1) \times \text{VMI}$$

2.4.4.11 Line Feed

A LINE FEED command from the keyboard will cause the paper to be moved up one line (one VMI). A line feed will be accomplished automatically as a result of a Carriage Return operation when the AUTO LF switch is ON.

2.4.4.12 Form Feed

A FORM FEED command from the keyboard will cause the paper to be moved up to the first line of the next page, or to the top margin line if one has been set.

2.4.4.13 Graphics

An ESC 3 sequence received by the 1640/1650 Series issued either thru the keyboard or remotely will place the unit in the graphics mode. A carriage return command or an ESC 4 sequence will return the unit to normal operation. While in the graphics mode, carriage movement is not tied to character printing. Carriage movement is in 1/60 inch increments for space and backspace commands, and in response to tab commands. Also in the graphics mode paper feed movement in response to line feed commands is in 1/48 inch increments, while vertical tab, form feed, top of form and margin commands remain unchanged.

2.4.4.14 Two-Color Printing

Red/Black ribbon control is standard in all Diablo printers and terminals. Two-color printing can be achieved by installing a Diablo two-color ribbon cartridge. The mechanism initializes to print in the primary color (black). To print in the alternate color (red), execute an ESC A sequence. To return to the primary color, execute an ESC B sequence or a RESTORE sequence.

2.4.4.15 RESTORE (Initialization)

The 1640/1650 Series may be restored (or initialized) by executing an ESC CR P 3-character sequence. This command resets all the logic circuits, resets all program counters to zero, and sets the unit to operate as follows:

    Normal print mode
    Forward print mode
    Print suppression OFF
    Print in primary color (black)
    HMI defined by PITCH switch
    VMI set to 8 (6 lines per inch)
    Lines/page set to 66 (page size of 528 x 1/48" = 11")
    All tabs cleared
    All margins cleared (horizontal to 0 and 1572 x 1/120")
                        (vertical to 0 and 528 x 1/48")

Send and print buffers cleared
Vertical position cleared to 0
Carriage moved to Horizontal Position 0
Print Wheel moved to home position

SECTION 3

INTERFACE

3.1 GENERAL INFORMATION

The KSR Terminal has three modes of operation; Local, Remote ASCII, and optional Remote 2741. These modes are switch selectable by the operator. In the Local mode with the LOCAL key latched DOWN, the Terminal operates as a typewriter and cannot receive or transmit data. In either the Remote ASCII or Remote 2741 mode, the Terminal transmits and receives data thru a communications link, or interface. This section deals with that interface.

3.2 REMOTE ASCII (ANSI) MODE

(LOCAL switch UP, ANSI/2741 switch to ANSI)

In this mode, the Terminal responds to the control codes specified in EIA Standard RS-232-C, August, 1969. Codes can be generated and used internally using the keyboard. Codes can also be transmitted to and/or received from the interface for use by the connected system or the Terminal. In either condition, the codes are in addition to the ASCII character data transmitted and/or received.

The following list summarizes the control codes:

1. ACK: Transmitted over the communications link when an ETX is encountered in the print buffer. See "ETX" below.

2. BEL: Sounds the audible alarm (buzzer) for 1/2 second. Updates all summarized motion.

3. BS: Backspaces the carriage one print position (HMI) in normal mode, or 1/60 inch in graphics mode. Direction or movement reverses in the backward print mode.

4. CR: Causes a carriage return. If AUTO LF key is latched DOWN, also causes a line feed operation.

5. DC1: This signal can only follow a DC3 signal. When enabled by the DC1/DC3 ENABLE switch on the HPRO4 PCB being set to ON, this signal is transmitted whenever the print buffer is within 64 characters of being empty, following the transmittal of a DC3 signal.

6. DC3: When enabled by the DC1/DC3 ENABLE switch on the HPRO4 PCB being set to ON, this signal is transmitted whenever the print buffer is within 64 characters of being full.

> NOTE: The DC1/DC3 protocol is an alternative to the ETX/ACK protocol. The purpose is to prevent buffer overflow and loss of data while maintaining a high throughput.

7. DEL: This signal is ignored by the 1640/1650 Series in all remote modes. In the local mode, this signal will cause the "?" character (1650) or " ¬ " character (1640) to be printed.

8. ENQ: Receipt of this signal initiates the automatic answer-back sequence "Here Is . ." if that option is installed.

9. ETX: This remotely generated signal is included at the end of a data string transmitted to the unit at a rate faster than the unit can print. The data string should be long enough to fill the print buffer. Upon finding the ETX in the buffer, the unit will immediately transmit an ACK signal to notify the sending system to send another data string. The ETX/ACK feature is enabled by the ETX/ACK ENABLE switch on the HPRO4 PCB being set to ON.

> NOTE: The ETX/ACK protocol is an alternative to the DC1/DC3 proto-col. The purpose is to free the sending system from having to monitor the progress of the unit as it prints out the content of the print buffer.

10. ESC: This code is always received as the first character of a 2- or 3-character command sequence. ESC initializes the unit's logic to receive the characters next following, and preceding a CR, as commands and not print data. The following list summarizes the ESC command sequences:

Characters			Description of Command
(1)	(2)	(3)	
ESC	0		Set Right Margin
ESC	1		Set Horizontal Tab Stop at Current Carriage (print) Position
ESC	2		Clear ALL Horizontal and Vertical Tab Stops
ESC	3		Graphics Mode ON (clear with CR)
ESC	4		Graphics Mode OFF
ESC	5		Forward Print Mode ON
ESC	6		Backward Print Mode ON (clear with CR)
ESC	7		Print Suppression ON (clear with CR)
ESC	8		Clear Individual Horizontal Tab Stop at Current Carriage (print) Position
ESC	9		Set Left Margin
ESC	HT	(n)	Initiate Absolute Horizontal Tab to Position (n)
ESC	LF		Perform Negative Line Feed
ESC	VT	(n)	Initiate Absolute Vertical Tab to Line (n)
ESC	FF	(n)	Set Lines Per Page to (n)
ESC	–		Set Vertical Tab stop at Current Paper Position
ESC	CR	P	Initiate Remote RESTORE (reset)
ESC	SYN	(n)	Select Print Wheel Size (1650 Series only)

Where bits 5 and 6 of (n) are defined by the following:

Bit 5	Bit 6	Print Wheel
0	0	Diablo 96
0	1	Rank Xerox 92
1	0	Rank Xerox 96
1	1	Xerox 88

See ASCII Code Chart in Appendix A for specific codes.

(continued)

```
ESC  RS  (n)    Set Vertical Motion Index (VMI) to (n-1)
ESC  US  (n)    Set Horizontal Motion Index (HMI) to (n-1)
ESC  S          Set Horizontal Motion Index (HMI) by Pitch
                Switch
ESC  A          Print in Secondary Color (red)
ESC  B          Print in Primary Color (black)
ESC  C          Clear Top and Bottom Margins
ESC  N          Normal Carriage Settling Time
ESC  D          Perform Negative Half-Line Feed
ESC  U          Perform Half-Line Feed
ESC  L          Set Lower Page Margin at Current Paper Posi-
                tion
ESC  T          Set Top Page Margin at Current Paper Posi-
                tion
ESC  Y          Print the Print Wheel Character under ASCII
                code 20(Hex)
ESC  Z          Print the Print Wheel Character under ASCII
                code 7F(Hex)
ESC FF SOH ESC LF FF ESC FF (n) Set Top of Form
```

(n = binary value of selected ASCII character. See Appendix D)

11. **FF:** Initiates form feed to the top of the next form (or page), or to the top margin on the next form or page if one is set.

12. **HT:** Initiates movement of the carriage to the next previously set Horizontal Tab Stop.

13. **LF:** Initiates movement of the paper up one line (one VMI). Movement changes to 1/48" per command in the Graphics mode, or two line feed operations if Double Line Feed is selected.

14. **NUL:** This signal is ignored by the 1640/1650 Series in all modes.

15. **SP:** Initiates movement of the carriage one print position (HMI) in normal mode.

16. **VT:** Initiates movement of the paper up to the next previously set Vertical Tab Stop.

NOTE: The ASCII codes outlined above also apply to Model 1640/1650 KSR Terminals in the local mode (LOCAL key latched DOWN).

3.3 REMOTE 2741 MODE (Option)

(LOCAL key UP, ANSI/2741 switch to 2741)

In this optional mode, the Terminal will respond to the IBM 2741 codes and protocol specified in "2740/2741 Communication Terminal Original Equipment Manufacturer's Information, GA27-3002-0", and "IBM Maintenance Library, 2740/2741 Theory of Operation, XY27-0013-4, January, 1973", both by IBM Corporation. These codes can be generated and used internally. The codes may also be transmitted to and received from a remote system. In either case, these codes are in addition to the PTTC/EBCD or Correspondence character data transmitted and received.

3.3.1 Control Codes

The following list summarizes the 2741 mode control codes:

1. BS: Backspaces the carriage one print position.

2. BY: Places the Terminal in the Print Inhibit (print suppression) Mode.

3. EOA: End Of Address code Ⓓ , (IBM 8-2-1 code).
          Prints "#" in PTTC/EBCD, or a "9" in CORRESpondence.

4. EOT: End Of Transmission code Ⓒ , (IBM C-8-4-2-1 code).

5. HT: Initiates movement of the carriage to the next previously set Horizontal Tab Stop.

6. LC: Places the Terminal in the Lowercase mode.

7. LF: Initiates movement of the paper up one or two lines according to the setting of the DOUBLE LINE FEED key.

8. NL: Initiates a simultaneous carriage return and line feed operation. The line feed portion responds to the setting of the DOUBLE LINE FEED key.

9. RES: Ends Print Inhibit (print suppression) mode.

10. SP: Initiates movement of the carriage one print position.

11. UC: Places the Terminal in the Uppercase mode.

3.3.2 2741 Mode Interface Line Control

In this mode, with the ANSI/2741 switch set to 2741, Interface Line Control becomes effective with power on and the LOCAL key released to its UP (remote) position.

3.3.2.1 Initialization

On power up, the Terminal is initialized in a control-receive state and automatically shifted to lowercase (if necessary). Following this the Terminal goes into the communicate-transmit state.

On switch over from local to remote mode, the Terminal goes immediately into the communicate-transmit state.

3.3.2.2 Transmit/Receive Interchange

In the 2741 mode, the unit operates in HALF-DUPLEX only, and ignores the setting of the DUPLEX/ON switch. In this configuration, the Terminal cannot receive and transmit simultaneously. The following discussion describes the code interchange by which the unit and its correspondent notify each other of their respective transmit/receive states.

Upon entering the communicate-transmit state, the Terminal transmits a ⓓ code to the interface, the PROCEED lamp glows, and the keyboard "unlocks". The operator may now key in any desired requests and/or text.

Transmission by the Terminal is ended by the operator activating either the BREAK switch or striking the (carriage) RETURN key. With this action, the Terminal reverts to the control-receive state and transmits a ⓒ code to the interface. The PROCEED lamp goes out,
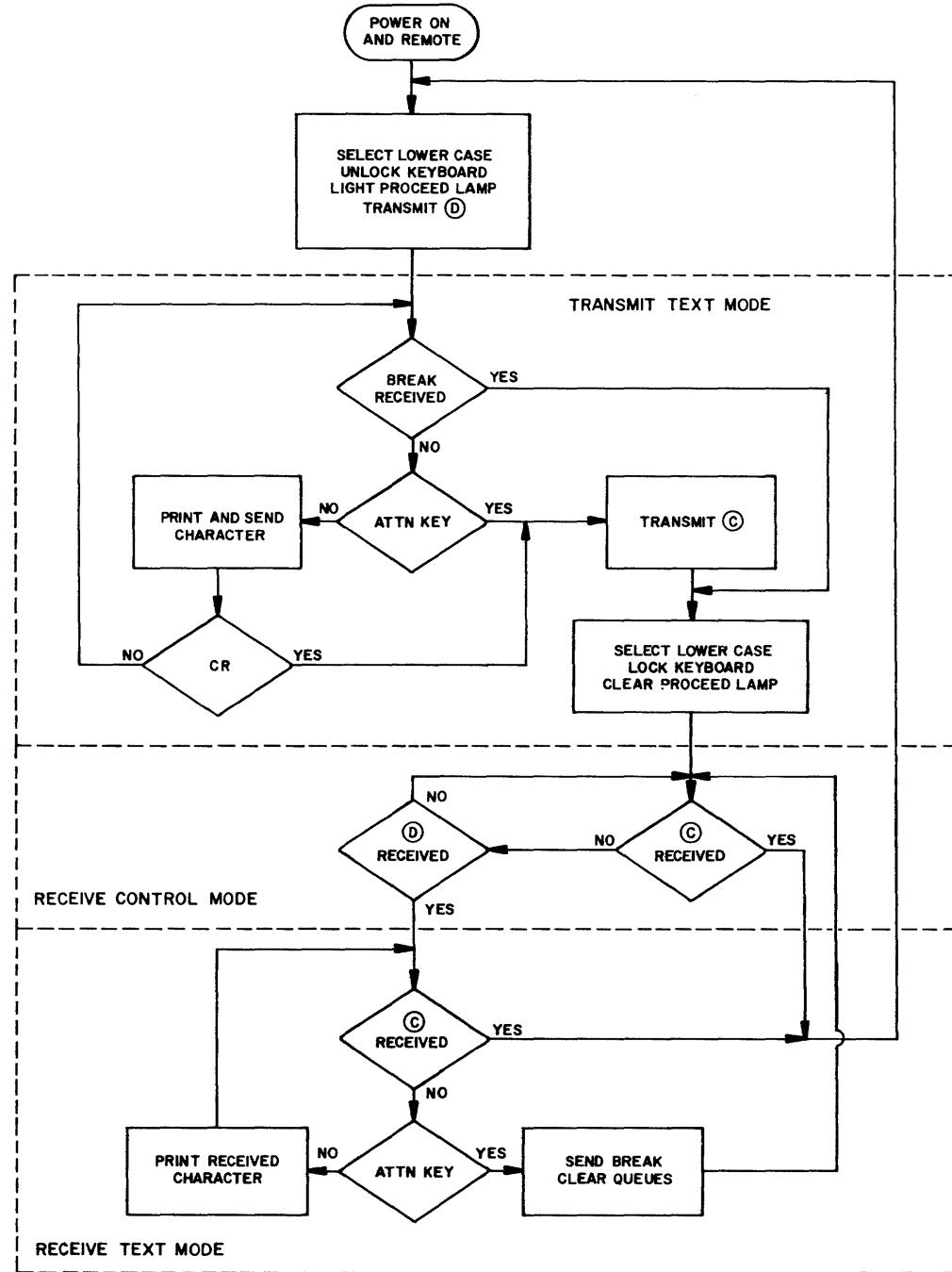
Figure 3-1   2741 LINE CONTROL

the DATA lamp glows, and the keyboard "locks up" to prevent attempts
to make keyboard entries while the Terminal is receiving information
from the interface. Attempted keyboard entries will cause the alarm
to sound and the KEY lamp to glow for 1/4 second.

Upon completion of its transmission, the correspondent system trans-
mits a Ⓒ code to the Terminal. Upon receipt of the Ⓒ code,
the Terminal switches back to the communicate-transmit state, the
keyboard is "unlocked", the Ⓓ code is transmitted, the DATA lamp
goes out, and the PROCEED lamp glows.

3.3.2.3 Interrupt

Receive Interrupt: This feature allows the operator to request that
the correspondent system stop sending data, and is activated by press-
ing the BREAK switch. This causes the Terminal to transmit a 250 ms
continuous space signal. The correspondent system may or may not
honor this request, but if it does, it stops transmission and sends
the Ⓒ code. The Terminal responds by entering the communicate-
transmit state, transmitting the Ⓓ code, and unlocking the key-
board.

Transmit Interrupt: This feature allows the correspondent system to
interrupt Terminal transmission by transmitting a continuous space
signal whose length is set by the system in increments of one char-
acter time and must be a minimum of one character time. Reception
of this signal causes the Terminal to switch to the control-receive
state. The ATTN lamp glows and the alarm sounds for 1/4 second.

Note that any data printed on a line during which an interrupt occurs
may not be correct. For this reason, the interrupt should be con-
sidered a terminating condition that voids the entire line.

3.4 INPUT/OUTPUT GATES

3.4.1 Input Gates

The input impedance inside the unit is 1k. The circuit is as shown
in Figure 3-2.

3.4.2 Output Gates

The open collector circuit shown in Figure 3-3 is used to drive the
output lines to the interface. In order to maintain impedance match-
ing, collector resistance of 150 Ohms is recommended within the con-
troller.

3.5 DATA TRANSFER TIMING

Figure 3-4 illustrates the signal timing relationships for the trans-
fer of data into the 1640/1650 Series through the parallel data input
lines.

3.6 RESTORE TIMING

Figure 3-5 illustrates the timing relationship for the RESTORE
command.

8837
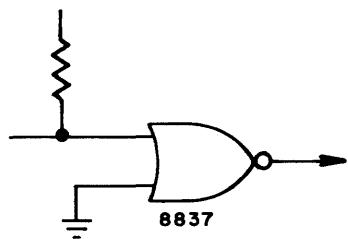
Figure 3-2   INPUT GATES

7417

Figure 3-3   OUTPUT GATES

DATA BIT 0—7

—CHARACTER STROBE
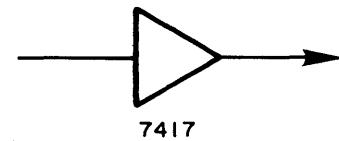
T1 ≧ 200 NS   —CHARACTER READY
T2 ≧ 750 NS
T3 ≦ 450 NS
T4 MIN≈60μSEC TYP≈200μSEC MAX TIME TO PRINT OR PROCESS AVG = 25 MSEC
T5 ≧ 0 NS
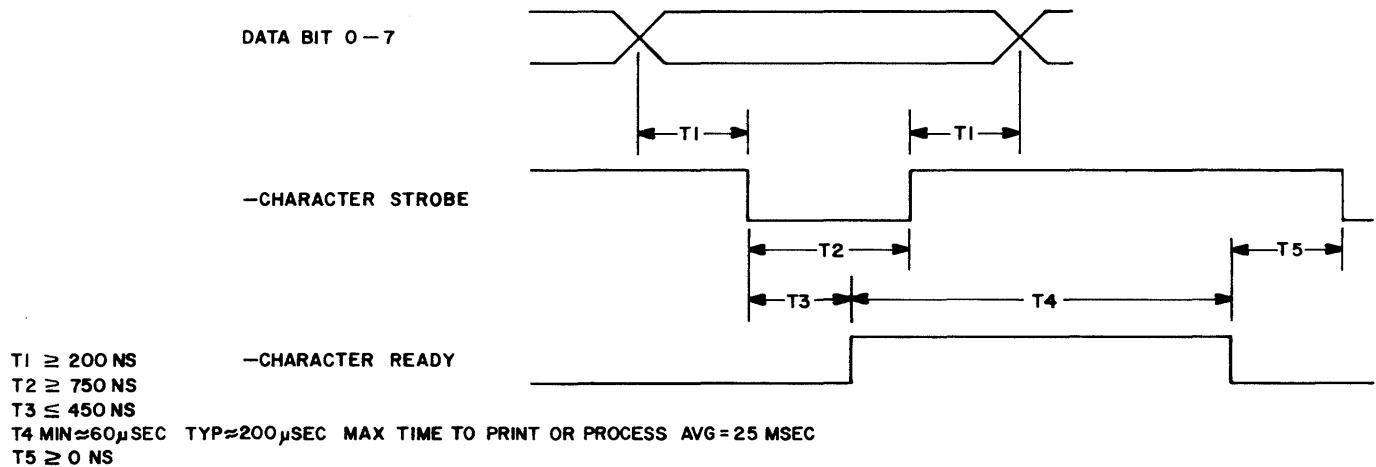
Figure 3-4   DATA TRANSFER TIMING

—RESTORE

T1 ≧ 10μSEC
T2 ≦ 60μSEC
T3 ≦ 1 SEC
T4 ≦ 6 SEC

—PRINTER READY

—IDLE
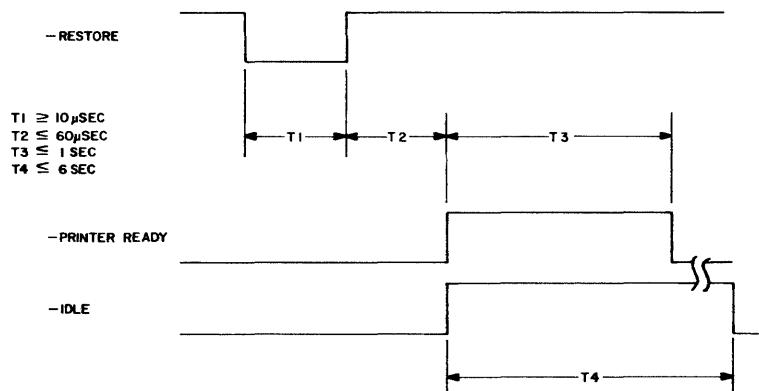
Figure 3-5   RESTORE

3.7 DIAL UP

The Dial Up feature allows the 1640/1650 Series to be connected to a common carrier switched network. An appropriate modem is required. To establish connection with a correspondent system, the operator places the modem in its "talk" mode, dials the telephone number of the correspondent in the conventional manner, listens for an answer tone, then places the modem in its "data" mode. Connection is terminated either by switching the modem to its "talk" mode, or by turning off the power to the unit or the modem.

3.8 I/O SIGNALS - PARALLEL ASCII

3.8.1 -Character Strobe

This active LO signal transfers a character from the data lines to the printer. Characters should not be sent to the printer if the -Character Ready signal is HI.

3.8.2 -Character Ready

This active LO signal indicates the printer is ready to accept another character on the data lines. This signal works with the -Character Strobe signal.

3.8.3 -Restore

This active LO signal causes the printer to perform a RESTORE sequence. The sequence consists of moving the carriage to the extreme left margin (column 0), restoring the print wheel to its "home" position, and clearing all previous data format information (such as tab settings). This signal should not be used as a carriage return. Completion of the sequence is indicated by the -Printer Ready signal going from HI to LO.

3.8.4 -Clear

This active LO signal is generated by the printer any time it is clearing its internal logic. This action is short of the RESTORE sequence, and is intended for clearing keyboard logic and should not be used by printer controllers.

3.8.5 -Data Bits 0-7

When the keyboard is not used, these eight (8) active LO signals specify the character being sent to the printer. The character is gated and latched into printer logic by the -Character Strobe signal. The character is in the ASCII format and represents commands to the printer as well as data to be printed. The Most Significant Bit (MSB) will be ignored.

3.8.6 -Status Strobe

This active LO signal is used to send diagnostic status from the printer to the controller upon request.

3.8.7 —Status Bits 0-7

These eight (8) active LO signals define the status of the printer. During normal operation, the real-time status information available when strobed is as follows:

Bit 0 = End Of Ribbon   Bit 4 = Cover Open
Bit 1 = 10 Pitch   Bit 5 = Printer Idle
Bit 2 = Paper Out   Bit 6 = Printer in Check
Bit 3 = Auto Line Feed   Bit 7 = Printer Ready

See subsection 6.4.9.2.3 for information on the availability of additional status information.

3.9 I/O SIGNALS - SERIAL RS-232-C

3.9.1 EIA Interface Signals

Protective Ground   Clear To Send
Transmitted Data   Data Set Ready
Received Data   Signal Ground
Request To Send   Carrier Detect
Data Terminal Ready (see 3.9.2)

3.9.2 Printer Ready Signal

Printer Ready is a signal which is available as a replacement for Data Terminal Ready. This signal will be inactive (false) with one or more of the following conditions present:

Local Mode   End Of Ribbon
Cover Open   Printer In Check
Paper Out   Printer Buffer Nearly Full

Except for "Local Mode", Printer Ready False will be generated only when printing is attempted when the condition is present. Printer Ready will return to active (true) status when buffer becomes nearly empty and/or all other conditions have been corrected.

To implement the optional Printer Ready Signal, move the black wire from Pin 3 to Pin 2 of the 12-pin connector on the HPRO4 end of the Serial I/O cable as follows. Lightly depress the hold-in tab thru the small hole at pin 3 of the connector, so the pin can be pulled out of the connector body. Being sure the tab is bent outward, reinsert the pin into the connector body at pin 2, and verify that it is securely locked in place. In a similar manner, move any wire found in the pin 2 position to the pin 3 position.

See Figure 7-11 Schematic Diagrams of Miscellaneous Cable Assemblies.

SECTION 4

PRINCIPLES OF OPERATION

4.1 GENERAL INFORMATION

The Diablo Series 1640/1650 machines are produced in three configurations; the basic mechanism, the RO version, and the KSR version. Each of these configurations can then be expanded by the addition of one or more options which include expanded memory, operator control panel, keyboard, cover sets, and paper handling accessories.

In its simplest form, the basic mechanism includes a modified Model 1345A HyType II printer for the 1640 Series or a Model 1355WP HyType II printer for the 1650 Series, with a Universal Interface circuit board configured for both serial and ASCII parallel data interchange.

In its most complex form, the 1640- or 1650-KSR Terminal expands this to include a control panel, a keyboard, a cover set, expanded memory circuits with enhanced 2741 and word processing capability, plus the capability to interface with either serial or current loop systems. Note that the keyboard utilizes the ASCII parallel I/O port.

4.2 UNIVERSAL INTERFACE

The Universal Interface circuits perform a wide variety of tasks.

First, the actual interface must adapt the input/output signal levels to the TTL logic levels used inside the unit. The Serial Interface facility can accept the EIA Standard voltage swings of as much as +/- 25 volts (typically 15 volts maximum), and provides signals in the range of +/-7 to 12 volts to the modem.

Figure 4-1 illustrates the signal levels involved with the Serial Interface, and shows the fail-safe features of this facility. This feature provides for data protection should the modem lose power or become disconnected.

Figure 4-2 illustrates the signal levels and data format for the ASCII Serial Interface. The illustration shows the minimum spacing for both 10- and 11-bit characters. Data output from the Terminal is via the Serial Interface when the keyboard is installed, and is asynchronous due to the large variation in character spacing.

Figure 4-3 illustrates an idealized representation of the data format found when the 2741 mode has been asserted. It differs from ASCII in that there are only six data bits with the MSB (most significant bit) first, only one stop bit, and with parity always odd.

Second, the Universal Interface processes incoming information and provides control signals to the carriage and print wheel drive circuits, and paper movement commands to the paper drive circuits.

Third, the Universal Interface processes data and transmits printer status information thru the appropriate output port.
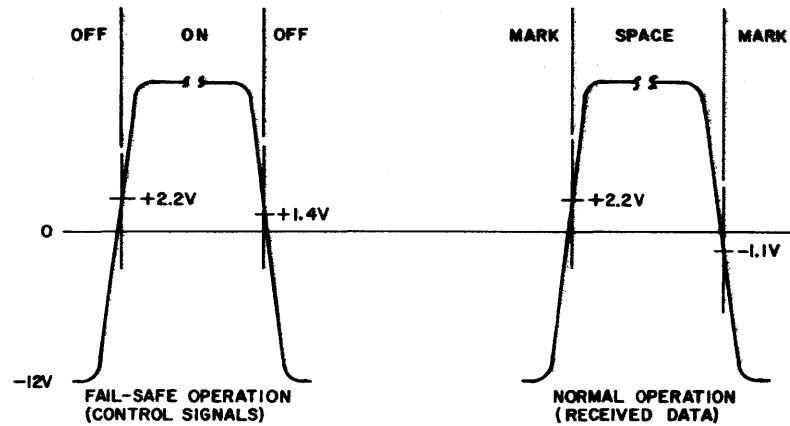
Figure 4-1 INPUT LINE SWITCHING LEVELS
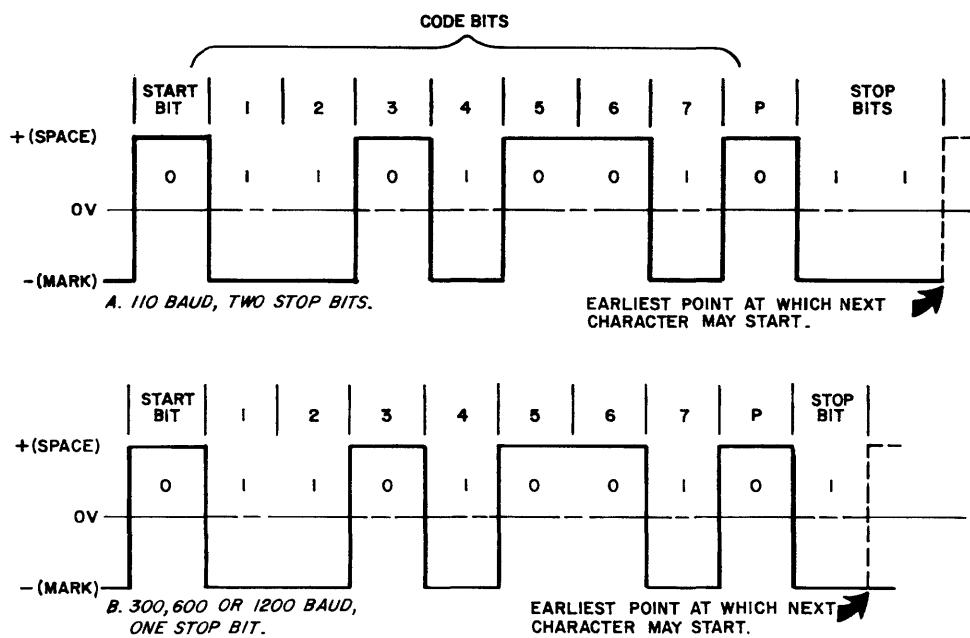
Figure 4-2 DATA FORMAT ON INTERFACE (ASCII)
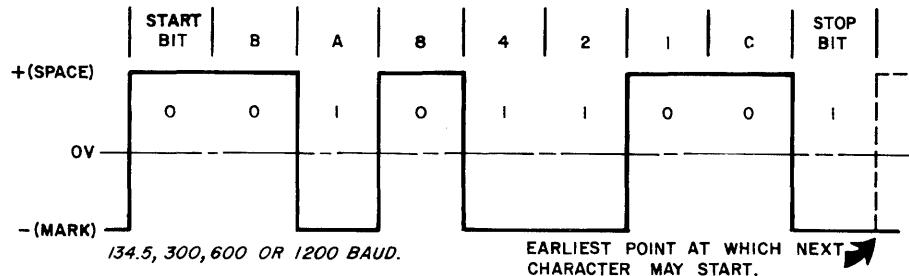
Figure 4-3 DATA FORMAT ON INTERFACE (2741)

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4.3 THE PRINTER

A modified version* of the Diablo Model 1345A HyType II Printer forms the base of the 1640 Series. This serial inpact printer makes use of the processed output of the Universal Interface to position its carriage and print wheel, move paper, and to manipulate its ribbon and fire its print hammer to produce a high quality printout of the data received.

A modified version* of the Diablo Model 1355WP HyType II Printer forms the base of the 1650 Series. This serial impact printer makes use of the processed output of the Universal Interface to position its carriage and print wheel, move paper, and to manipulate its ribbon and fire its print hammer to produce the commanded printout in word processor quality.

* = Basic printer modifications include, but are not limited to; a different Motherboard, and the HPRO4 Processor PCB which replaces both the Logic I and Logic II PCB's.

SECTION 5

MAINTENANCE

5.1 GENERAL INFORMATION

The Diablo Series 1640/1650 units are designed to greatly reduce
maintenance and repair. Unique electronic control systems require
less than 20% of the mechanical assemblies usually found in machines
of this type. The mechanical subsystems found in these units require
a minimum of moving parts. This plus electronic components utilized
well below their design limits has produced a unit with superior ser-
vice characteristics.

5.2 PREVENTIVE MAINTENANCE

The recommended preventive maintenance is normal cleaning and inspec-
tion every 6 months or each 500 hours of power on operation. The
machine will require cleaning and minimal lubrication at this time.
Normal time for this preventive maintenance should not exceed 15
minutes.

5.3 MAINTENANCE PHILOSOPHY

A 3-level maintenance philosophy is recommended for the 1640/1650
Series.

5.3.1 Level One

Ribbon cartridge and print wheel change; surface cleaning and lubri-
cation; adjustment of print impression and platen position controls;
and minor assembly exchange of platens and paper cradle make up this
level of maintenance.

5.3.2 Level Two

Due to the design of the 1640/1650 Series, machine subassembly and/or
printed circuit board exchange is recommended for on-site failures.
This level of maintenance also includes Level One items, plus unit
replacement, and minor adjustments and alignments.

Spares on hand to support this level of maintenance activity should
include at least one complete set of PCB's, subasemblies, and such
miscellaneous components as recommended in the detailed maintence
documentation.

5.3.3 Level Three

This is a Repair Depot and/or in-plant maintenance level, for the
repair and/or refurbishment of assemblies, subassemblies, and PCB's.

SECTION 6

APPENDICES

6.1 GENERAL INFORMATION

This section describes the supplies, accessories and optional features currently available for each version of the 1640/1650 Series.

6.2 SUPPLIES

Refer to Diablo Publication No. 90007-XX Diablo Printer Supplies Catalog for a complete listing of all ribbons and print wheels currently available for use with the 1640/1650 Series.

6.3 ACCESSORIES

6.3.1 Paper Handling Accessories

The following paper handling accessories are applicable to certain versions of the 1640/1650 Series. For additional information on these items consult the Series 1640/1650 Parts Catalog, Diablo Publication No. 90414-XX and/or your Diablo Sales Representative. Where applicable, appropriate installation and operating instructions for these items are included in the 1640/1650 Series Operating Manuals, Diablo Publication No's 90405-XX (1650) and 90415-XX (1640).

Note that all of these accessories except platens require a Diablo or equivalent cover set.

6.3.1.1 Platens

1. **Friction Feed Platen** This platen is very similar to the rubber surfaced platens found in typewriters.

2. **Pin Feed Platen** This platen features a set of cam operated paper feed pins on each end of the roller. This rubber surfaced platen is available in several lengths from the factory.

3. **Bidirectional Pin Feed Platen** This platen features a set of dual cam operated paper feed pins on each end of the roller. The dual cam feature allows paper to be moved backward (down) as well as forward (up) without jamming. This platen is available in either of two lengths for 14.875" (377.83 mm) or 15" (381 mm) paper.

6.3.1.2 Forms Tractors

1. **Unidirectional Forms Tractor** This unit mounts on top of the printer cover where it engages the platen shaft for alignment and drive. It requires use of a friction feed platen. It is adjustable to any paper width from 2-3/4" (69.85 mm) to 14-1/2" (368.3 mm) maximum as measured between the pin feed drive holes.

2. **Bidirectional Forms Tractor** This unit mounts on top of the printer cover where it engages the platen shaft for alignment and drive. It requires use of a friction feed platen. It is adjustable to any paper

width from 2-3/4" (69.85 mm) to 14-1/2" (368.3 mm) maximum as measured
between the pin feed drive holes. It also features both upper and
lower pin feed paper drives to enable feeding paper in either direc-
tion.

NOTE: Installation of the optional Forms Tractor Sound Cover will re-
       duce maximum allowable paper width by 1/2" (12.7 mm) when used
       with the "thumb screw" version of the Forms Tractor.

6.3.1.3 Bottom Feed

All versions of the 1640/1650 Series can be configured to allow feed-
ing of continuous (manifold) forms up thru the bottom of the mecha-
nism. This feature requires use of either a Pin Feed Platen or Forms
Tractor Accessory.

6.3.1.4 Sheet Feeders

1. Mechanical Front Feed Refer to Figure 2-3b, and to Diablo Publi-
cation No. 90421-XX Mechanical Front Feed Operation and Maintenance.
This unit mounts on top of the printer cover. It engages the platen
shaft for alignment, and is driven by a special gear mounted at the
left end of the required friction feed platen roller. It feeds multi-
part forms, and single sheets of up to 48 lb ledger stock into the
printer, one item at a time. The inserted item extends down into a
special bottom chute and out under the printer to allow printing with-
in 1" of the top and at the very bottom before being ejected out the
top. This accessory preempts use of the bottom feed option, and re-
quires that the carriage be centered for each paper insertion.

2. Auto Front Feed Refer to Figure 2-3a, and to Diablo Publication
No. 90422-XX Auto Front Feed Operation and Maintenance. This acces-
sory consists of the Auto Front Feed unit, a special bidirectional
forms tractor, interconnecting wiring, and the HyPlot, Feeder and
Diagnostics option installed on the optional XMEM2 PCB. The resulting
system feeds multipart forms, and single sheets of up to 48 lb ledger
stock in much the same manner as the Mechanical Front Feeder.

This unit operates independently of the 1640/1650's paper drive sys-
tem. It can be used in conjunction with continuous form (manifold)
paper, with both auto feed and form feed controlled separately by the
host system. An optional optical line finder version allows the feed-
er to sense a position marker preprinted in the left hand margin and
automatically feed the form to a preset start position. Switch B12-4
on the XMEM2 PCB must be ON for this option.

The 1640/1650 enters the Front Feed Mode upon receipt of an ESC I se-
quence, and exits the mode upon receipt of either an ESC K sequence or
a carriage return (CR) command. The ESC K sequence returns the 1640/
1650 to its normal print mode as soon as the feeder has processed the
last command character sent to it. Although this implies a possible
departure from front feed mode during a command string, to return la-
ter for completion, this practice is not recommended. If the last
command character sent initiated front feeder motion, the feeder's
program will not recognize the exit sequence until the motion has been
completed. Conversely, no motion commands will be honored when enter-

ing front feed mode while the 1640/1650 is printing until the last character entered has been printed. Exit from the front feed mode via a carriage return (CR) will always await completion of any front feed command sequence in process.

Upon entering front feed mode, the 1640/1650 will recognize ONLY the following Front Feed Mode commands *:

```
A    - Step Forward (up) (144 steps per inch)
B    - Step Reverse (down) (144 steps per inch)
C    - Line Feed Forward (per Line Space setting)
          - or -
LF   - Line Feed Forward (per Line Space setting)
D    - Automatic Insert.  Unit will automatically insert a
       form approximately 1 second after the form is placed
       in the input tray.
E    - Line Feed Reverse (per Line Space setting)
F    - Find Last Line (Optical Line Finder option)
G    - Subscript (8 steps)
H    - Superscript (8 steps)
I    - Vertical Tab, associated with the optional Optical
       Line Finder.
Jn   - Go (n) Lines Forward (000 - 170)
Kn   - Go (n) Lines Reverse (000 - 170)
Ln   - Go To Line (n) (001 - 255)
Mn   - Go (n) Steps Forward (000 - 999)
Nn   - Go (n) Steps Reverse (000 - 999)
O    - Insert Paper **
P    - Eject Paper Forward (up)
Q    - Eject Paper Reverse (down)
Rnnn - Set Format ***
Sn   - Set Line Spacing (001 - 127) Defaults to 6/inch
T    - Self Test
U    - Automatic Optical Line Finder insert (same as code "D"
       above except uses Optical Line Finder option).
V    - Reset
```

(n = a 3 digit number as indicated)

* - Undefined characters received will be rejected and reported to the 1640/1650 as a PAPER OUT error. This will also cause the feeder to abort its current command but not exit the mode.

** - NOTE: The carriage MUST be centered on the sheet or form before paper insertion is attempted. The carriage card guide aids in proper control of the bottom edge of the sheet during the feed operation.

Upon receipt of the INSERT PAPER command (ASCII O), the feeder will direct the 1640/1650 to move the carriage to center position before executing the command. Upon completion of the command, the feeder will direct the 1640/1650 to return the carriage to its former position.

If the printer should go into CHECK trying to center the carriage, the PRINTER and PAPER lamps will glow and action will stop to prevent a paper jam.

If the printing format has been set (SET FORMAT ASCII Rnnn) the paper
will be positioned appropriately. If printing format has not been
set, the paper will be positioned for printing to start at a point
approximately 1" from the top edge. Note that as a sheet or form is
inserted the feeder automatically jogs the form to align it before
beginning the feed. This helps alleviate feed problems due to verti-
cal misalignment.

*** — SET FORMAT (ASCII Rnnn) = 000 000 001 as stored in memory upon
power on. The first three digits (000-170) control the upper margin.
The second three digits (000-170) control the lower margin. The third
three digits (001-255, nominal 090) are used with the optional Optical
Line Finder, and describe the distance the paper or form must be fed
after the Optical Line Finder senses a preprinted position marker.

SPECIAL FUNCTION KEYS: The Diablo keyboard includes two keys which
are for forms control. They are LOAD FORM and EJECT FORM, and are
located in the left-hand Control section. The LOAD FORM key will
imitate the ASCII O command described above for the insertion of
paper. The EJECT FORM key will imitate the ASCII P command for the
ejection of paper forward (up). These keys are valid only during
printer and/or front feed idle times. They will be ignored if they
are pressed during execution of a command string in Front Feed Mode,
and the KEY error lamp will glow. These keys will abort any unfin-
ished Front Feed command(s) stored by a carriage return (CR) command
if pressed while the 1640/1650 is not currently in the Front Feed
Mode.

3. HyFeed Sheet Feeder Refer to Figure 2-6, and to Diablo Publica-
tion No. 90420-XX HyFeed Sheet Feeder Operating and Maintenance. This
unit mounts on top of the printer cover and engages the platen shaft
for alignment and drive. It draws power from either the 1640/1650 or
an optional external power supply. The unit permits storing, automa-
tic feeding, and retaining of up to 200 sheets of 20 lb paper. Print-
ing is possible from the extreme top to the extreme bottom of the
page, or automatic positioning to a "top margin" starting point. This
unit uses the friction feed platen, and requires that the 1640/1650 be
configured with the XMEM2 PCB and appropriate options, or fitted with
the HyFeed Interface Kit. Note that the carriage must be centered
during each form feed (page transition).

6.3.2 Cover Sets

Diablo Cover Sets are available for both RO and KSR versions of the
1640/1650, configured for either regular or optional bottom feed. In
addition, the RO style may also be ordered for use with or without the
optional Operator Control Panel.

6.4 OPTIONS

The 1640/1650 may be configured with a series of hardware and firmware
options which significantly increase its flexibility, capacity, and
capability for special purpose application. These are as follows:
    Keyboard
    Operator Control Panel
    Expanded Memory PCB Assembly

```
     Internal Power Supply
     Current Loop Interface
     Word Processing Enhancements
     2741 Option Mode/Enhancements
     HyPlot, Feeder, Diagnostics
     Expanded Buffer
     Keyboard Programmable "Here Is . ."
     Baud Rate Option Mode
```

6.4.1 Diablo Keyboard

This assembly is optional with the Model 1640/1650 Printer Mechanisms,
and standard with the Model 1640/1650-KSR Terminals. It is not appli-
cable to the Model 1640/1650-RO Printers. The standard keyboard is
discussed in subsection 2.4.3.2. Additional information on foreign
language, APL, IBM 2741 Correspondence, and IBM 2741 PTTC/EBCD key-
boards will be found in Appendix B.

6.4.2 Operator Control Panel

This assembly is optional for use with the Model 1640/1650 Printer
Mechanism. It is standard with Model 1640/1650-RO Printers and Model
1640/1650-KSR Terminals. Refer to subsection 2.4.2.2.

6.4.3 XMEM2 Expanded Memory PCB Assembly

This assembly is optional with all versions of the 1640/1650 Series.
It is required for implementation of the Current Loop Interface op-
tion, the 2741 Mode options, and the Word Processor options. It is
also required for addition of the controllable accessory paper han-
dling units, for HyPlot, for external diagnostics,for expanding unit
memory, and for the "Here Is" EAROM.

6.4.4 Internal Power Supply

This unit mounts inside the printer's main frame, and includes a cool-
ing fan which mounts on the left-hand end of the frame, as shown in
Figure 2-1. This power supply meets all the electrical power needs
for the 1640/1650, and plugs directly into the Motherboard for distri-
bution of power to the various circuits. AC input power options are
90-130V/180-260V, 47-63 Hz, with power controllable either from the
host system or the optional Operator Control Panel.

6.4.5 Current Loop Interface

The Current Loop Interface option is described in subsection 1.1.2.3.
This option consists of components added to the XMEM2 PCB and a cus-
tomer supplied interconnecting cable (see subsection 2.2.4) installed
between the current loop output on the XMEM2 PCB and the serial input
on the HPRO4 Universal Interface PCB. Jumpers and resistors (user
supplied) are used on the XMEM2 PCB to select 20ma or 60ma/passive or
active/half- or full-duplex operation as described in subsection 4.4
of the Series 1640/1650 Maintenance Manual #90413-XX. The speed of
the current loop interface is established by the speed selected for
the Serial Interface, as described in subsection 1.1.2.1.

6.4.6   Word Processing Enhancements

The 1650 Word Processing Enhancements option consists of a number of features that make the development of word processing software much simpler. This option consists of components added to the XMEM2 PCB. Some features of this option require the Operator Control Panel or a keyboard, while others require memory storage while being performed. Those which require memory are:

Line Edit	Auto Line Center
Auto Justify	Auto Underscore

6.4.6.1   Proportional Space Printing

Use of Proportional Space (PS) print wheels on the 1640/1650 is eased by this feature of the Word Processing Enhancements option. A table of PS unit values is retained in the memory of the 1640/1650. These PS unit values represent one-half of the width required by each proportionally spaced character. The letter "V", for example, has a PS value of 6, which is half of the 12/120" spacing a "V" requires. Carriage movement is calculated by adding the PS unit value of the character just printed to the PS unit value of the character about to be printed. Thus, if the character "i" is to follow a "V", the carriage must move 9/120" before printing the "i". This is the sum of the PS unit values of the "i" (3) and the "V" (6). Tables of PS unit values for most standard characters on both metal and plastic print wheels are contained in Appendix E. Note from the Tables that the PS unit values for many characters on the metal print wheels differ from those on the plastic print wheels.

Proportionally spaced printing requires use of a Proportional Space print wheel. See Diablo Publication No. 90007-XX Diablo Printer Supplies Catalog.

When the Operator Control Panel is installed in a 1640/1650, one of the switches under the access cover (PROP SPACE, second from the right) is used by the operator when a PS print wheel is installed (switch ON) or removed (switch OFF).

In the absence of the Operator Control Panel, proportionally spaced printing can be enabled by supplying the sequence ESC P to the 1640/1650 thru its communications interface. Proportionally spaced printing can also be turned off in this same manner using the sequence ESC Q. These commands can also be used with units equipped with the control panel. In this case, remote PS commands override the setting of the PROP SPACE switch. Control can be returned to the switch by issuing (ESC S).

Proportionally spaced printing is not affected by the execution of the ESC X sequence which turns off all other Word Processing Enhancement Option functions.

There are times when certain data is to be printed nonproportionally spaced, even though a PS print wheel is being used in the 1640/1650. For example, the display from a Video Terminal is to be printed to illustrate a document; if it is printed proportionally spaced, the

columnar alignment of the information would be lost. Issue the ESC Q
sequence to exit proportional space printing, then execute an ESC US
DLE sequence to set the Horizontal Motion Index (HMI) to 15; this is
adequate to print all characters on the PS print wheel without any
characters touching. When the nonproportionally spaced printing has
been completed, revert to normal HMI by executing the ESC S sequence,
and return to proportionally space printing by executing the ESC P se-
quence.

Note that all numeric characters have the same PS unit value (5).
This allows numeric data to be printed aligned in columnar form with-
out having to turn off proportional space printing. The starting
position of the columns can be established by setting a tab at that
position, and tabbing to it, or by using the absolute horizontal tab
to move to the starting position (see subsection 2.4.4.10). Be sure
that HMI has the same value prior to each movement to the beginning
of the column, if you are altering the value of HMI during the print-
ing of each line, to be sure that the starting position does not
change.

Proportionally spaced printing can be accomplished without using the
Word Processing Enhancements Option by controlling carriage movement
under software control. Maintain a table of PS unit values for each
character to be printed; scan the line of characters and calculate the
HMI value that is required to move the carriage for each character
based on the character preceding it; send the data to the 1640/1650
in the sequence:

    ESC US (ASCII character for HMI) (character to be printed)

for each character that is to be printed. Note that four characters
are sent to the 1640/1650 for each that is printed. To drive the
1640/1650 at rated speed (maximum of 40 cps) a communication link of
over 1600 Baud is required (40 cps x 10 bits per byte x 4 transmitted
characters per printed character).

6.4.6.2 Offset Selection (Auto Prop. Spacing)

The normal way to change character spacing is to adjust HMI. However,
for proportionally spaced printing, HMI is ignored and table values
are used. Thus, to add or subtract a constant to each table size,
the sequence ESC DC1(byte) should be used. The value of the "byte"
character is added to each table size value, or HMI if it is control-
ling size, as well as to the space character. This continues until
another ESC DC1(byte) sequence is received, or until offset is cleared
by a carriage return (CR) or the sequence ESC X.

The byte character is defined as follows:

    Bits 1-6   Size of offset   (64 units maximum) (one unit = 1/120")
    Bit   7   Sign of offset   (1 = negative)

If a negative offset (smaller character size) is desired, bit 7 should
be set. If the resulting character size is zero or less, no carriage
movement will occur. Note that because NUL and DEL cannot pass thru
the serial receiver, positive offset values range from 1 thru 64, neg-
ative values range from 0 thru 63. Refer to Appendix A-1.

6.4.6.3 Auto Underscore

Automatic underscoring is initiated by the sequence ESC E. The present carriage position is stored in memory as the start location. When the end position is reached, the carriage will return to the start location and underscore the area between it and the end position. The printed underscore characters will overlap and the ribbon advance will increase to prevent fading.

The end position is defined as the carriage position when one of the following events occur.

    ESC R - The underscoring will occur and the 1640/1650 will exit
              the Auto Underscore mode.
    CR   - The underscoring will occur and the start location set
              equal to the left margin.
    LF   - The underscoring will occur and the start location set
              equal to the present carriage position.

No underscoring will occur if the area between the start and end locations is not positive or if the sequence ESC X is received. Auto Underscore is cancelled by either sequence ESC R or ESC X.

6.4.6.4 Bold Overprint

Bold overprint is initiated by the sequence ESC O. Subsequent printable characters are struck twice with no intervening carriage motion. The normal ribbon advance occurs between character strikes. A carriage return (CR) or either of the sequences ESC & or ESC X will cause the 1640/1650 to exit the bold overprint mode.

    NOTE: Bold Overprint and Shadow Print are mutually exclusive
            modes.

6.4.6.5 Shadow Print

Shadow print is initiated by the sequence ESC W. Subsequent printable characters are struck twice with 1/120" of carriage movement and normal ribbon advance between character strikes. This does not change the HMI or table size value for that character. Increased carriage settling time may provide improved Shadow Print quality on some units. A carriage return (CR) or either of the sequences ESC & or ESC X will cause the 1640/1650 to exit the shadow print mode.

6.4.6.6 Carriage Settling Time

The carriage settling time can be increased to 20 msec by issuing the sequence ESC %. This provides more time for mechanical vibrations to damp out before printing to improve print quality, at a small sacrifice in print speed. The sequence ESC N will restore the normal carriage settling time.

6.4.6.7 Half-Unit Backspace

The sequence ESC BS will produce a 1/120" backspace movement of the carriage.

6.4.6.8 Program Mode

Program mode provides user control of spoke position, hammer energy, and ribbon advance. This allows the use of special print wheels without modifications to the 1640/1650. In Program Mode, two characters are sent for each character to be printed. The first character selects the print wheel spoke, the second establishes the hammer energy and ribbon advance. See Appendix E for a table of Hammer Energy and Ribbon Advance units.

Spacing is controlled by HMI plus offset. If the 1640/1650 is in proportional space mode, spacing is controlled by the ribbon advance (move RA, print, move RA) plus offset.

Program mode is initiated by the sequence ESC SO M. It is turned off by either the control character SI or the sequence ESC X. If the sequence for Auto Justify or for Auto Center is received, the 1640/1650 will exit program mode and enter the requested mode.

> NOTE: MARG CONT and LINE EDIT keys do not function in Program
> Mode.

6.4.6.8.1 Spoke Position Data (first character)

The first character received is tested to determine if it is a control character or a spoke position character. If it is a control character, the normal processing of control characters will occur. If it is not a control character, it is assumed to be a spoke position character (the second character will not be tested for control character parameters). The non-control first character (the one to be printed) is selected in terms of the electrical equivalent of its physical print wheel position as follows:

Electrical Spoke Position number (per Appendix C) + 32 = n

where n is the decimal value of the ASCII character to be sent (see Appendix A Figure A-1). Note that only spokes 1 thru 94 can be distinguished from control characters. However, spokes 0 and 95 can be accessed by an ESC Y or ESC Z sequence respectively, followed by the second and third characters.

6.4.6.8.2 Hammer Energy/Ribbon Advance Data (second character)

The second character contains 4 bits (0-3) for ribbon advance and 3 bits (4-6) for hammer energy. This provides 16 different size ribbon advances (0 to 15 steps) and 8 different hammer energy levels (0 to 7). The hammer energy level definitions are as follows:

        Level 0 - Select spoke 0, do not fire hammer
        Level 1 - Lowest hammer energy
        Level 2 - Low hammer energy
        Level 3 - High hammer energy
        Level 4 - Highest hammer energy
        Level 5 - Above Level 4 (maximum hammer energy)
        Level 6 - Hammer energy between Levels 1 and 2
        Level 7 - Hammer energy between Levels 3 and 4

Caution should be exercised when using Level 5, as it will cause higher than normal print wheel wear. Refer to Appendix C and E for more information.

6.4.6.9 Cancel Word Processing Options

The sequence ESC X will cancel the following Word Processing modes:

Auto Underscore   Bold Overprint
Shadow Print   Program Mode
Offset Selection   Auto Justify
       Auto Center

Proportional space mode and increased carriage settling time are not cancelled by ESC X.

6.4.6.10 Auto Center

Auto line centering is initiated by the sequence ESC =. Subsequent data is stored in a memory buffer until a carriage return (CR) or a line feed (LF) command is received. The data is then printed centered between the margins and the 1640/1650 exits the auto center mode. Auto Center allows the line to extend beyond the left and right margins. If Auto Justify was enabled when Auto Center was entered, Auto Center will have precedence for that line only. The sequence ESC X will clear Auto Center without performing any printing.

6.4.6.11 Auto Justify

Automatic margin justification is initiated by the sequence ESC M. Subsequent data is stored in a memory buffer until a carriage return (CR) or a line feed (LF) command is received. The data is then printed justified between the left and right margins. Auto Justify remains enabled until the sequence ESC X is received. The 1640/1650 then exits the mode without performing any printing.

Auto Justify functions in fixed pitch or proportional space mode. Up to 256 data characters may be included in a line; additional characters cause the OVERFLOW lamp to glow, and data is destroyed. Note that all communication protocols still function normally. If the LINE EDIT key is on, data from the keyboard will also be printed as it is stored.

Auto Justify begins its justification calculations from the position of the first printable character after the carriage return (CR), line feed (LF), or ESC M sequence. This allows unjustified leading spaces or tabs and allows partial line justification. Auto Justify calculates the number of 1/120" offset units needed to fill out or to condense the line so that it will fit exactly between the first printable character and the right margin. The offset units are then applied, first to the word spaces, and then to the character spaces after the word spaces reach 150% of their normal size. If the offset added to the character spaces exceeds 7 units, the line is printed unjustified. Offset units are added from left to right on odd lines and from right to left on even lines.

6.4.6.12 Line Edit

Line edit mode is selected by the LINE EDIT key in the keyboard control section. Line editing is a means of verifying and correcting data before it is transmitted. Line edit mode prints and stores keyboard data as it is entered without transmitting the data. While the line data is in the buffer, depressing the DEL key will erase the last character and backspace the carriage, thus allowing for corrections. When a carriage return (CR) or line feed (LF) character is entered, the stored data will be transmitted. This transmitted data will also be printed after a local carriage return-line feed has been performed. LINE EDIT key transitions always clear the print buffer. Release of the key also causes a local carriage return-line feed.

Data may be received while in the Line Edit mode only when the buffer has no keyboard data entered. If the memory buffer is not empty, received data will be rejected, the ATTENTION lamp will glow, and the alarm will sound. Only the following keyboard entries will empty the buffer; carriage return (CR), line feed (LF), or transitions of the LINE EDIT key.

NOTE: The control panel FF and LF switches are treated as keyboard data when the LINE EDIT key is on and keyboard data has been entered. Using the BREAK switch may disrupt LINE EDIT data.

6.4.6.13 Margin Control

Margin control mode is selected by the MARG CONT key in the keyboard control section. Margin control is a means of increasing typing throughput by providing automatic carriage returns at appropriate line endings. A carriage return and line feed are provided on the first space or hyphen after entering a "hot zone" of five characters before the right margin, when the "AUTO CR" switch is on. The alarm will sound when the "hot zone" is entered instead of when the right margin is crossed. If in remote, the carriage return and line feed are transmitted. Auto Line Feed and Double Line Feed functions remain the same as with a normal carriage return. The carriage return provided by Margin Control does not clear Bold or Shadow Print modes. It will cause Auto Underscore to operate the same as it does for a normal CR command.

6.4.7 2741 Option Mode/Enhancements

2741 mode operation is an optional feature. Because of the nature of its communications requirements, this option is described in Interface subsection 3.3. 2741 Enhancement is a switch selectable feature which adds to normal 2741 operation. It expands the 2741 mode, as described in subsection 3.3, to include all ASCII functions when the HPRO4's ENHANCED 2741 switch is set to ON. The following control codes then become effective:

1.   BS: Backspaces the carriage one print position (HMI) in the normal mode, 1/60" in the graphics mode. Direction of carriage movement reverses in the backward print mode.

2.   BY: Places the 1640/1650 in the print inhibit (suppression) mode. (cleared by RES)

3. DEL: This signal is ignored by the 1640/1650 in all remote modes. It can be used as a buffer or 'sluff' character. In the LOCAL mode, the DEL character will cause printing of the print wheel character under ASCII code 7F(Hex).

4. EOA: End Of Address code Ⓓ . See subsection 3.3.1.

5. EOT: End Of Transmission code Ⓒ . See subsection 3.3.1.

6. HT: Initiates movement of the carriage to the next previously set Horizontal Tab Stop.

7. LC: Places the 1640/1650 in the Lowercase mode.

8. LF: Initiates movement of the paper up one or two lines according to the setting of the DBL LF key. The movement is changed to one or two increments of 1/48" each in graphics mode.

9. NL: Initiates a simultaneous carriage return and line feed operation. The line feed portion responds to the setting of the DBL LF key.

10. PF: Causes the alarm to sound for 1/4 second.

11. PRE: This code is always received as the first character of a 2- or 3-character command sequence. PRE initializes the 1650 logic in the Enhanced 2741 Mode to receive the next 2 or 3 characters preceding a CR as a command and not as print data. The following list summarizes the PRE command sequences:

Command Characters (1) (2) (3)	Command Description
PRE 0	Set Right Margin
PRE 1	Set Horizontal Tab Stop at current carriage (print) position
PRE 2	Clear all Horizontal and Vertical Tab Stops
PRE 3	Graphics Mode ON
PRE 4	Graphics Mode OFF (clear also with NL)
PRE 5	Forward Print ON
PRE 6	Backward Print ON (clear with NL)
PRE 7	Print Suppression ON (clear with NL)
PRE 8	Clear individual Horizontal Tab Stop at current carriage (print) position
PRE 9	Set Left Margin
PRE HT (n)	Initiate Absolute Horizontal Tab to print position $(2n + 1)$
PRE UN1	Perform negative line feed
PRE UN2 (n)	Initiate Absolute Vertical Tab to line $(2n + 1)$
PRE UN3 (n)	Set Lines Per Page = $(2n)$
PRE — (hyphen)	Set Vertical Tab Stop at current paper position

```
        PRE   SYN   (n)           Select Print Wheel Size if no control
                                  panel installed
                                  Where bits 5 and 6 of (n) are defined
                                  by the following:
                                  Bit 5   Bit 6   Print Wheel
                                    0       0     Diablo 96
                                    0       1     Rank Xerox 92
                                    1       0     Rank Xerox 96
                                    1       1     Xerox 88
                                  See ASCII Code Chart in Appendix A for
                                  specific codes.
  PRE   PN    (n)                 Set Horizontal Motion Index (HMI) to (n)
  PRE   S                         Set HMI to PITCH switch
  PRE   A                         Print in secondary color (red)
  PRE   B                         Print in primary color (black)
  PRE   C                         Clear Upper and Lower Margins
  PRE   N                         Normal Settling Time
  PRE   D                         Perform Negative Half-line Feed
  PRE   U                         Perform Half-line Feed
  PRE   L                         Set Lower Page Margin at current paper
                                  position
  PRE   T                         Set Upper Page Margin at current paper
                                  position
  PRE   Y                         Print the print wheel character under
                                  ASCII code 20(Hex)
  PRE   Z                         Print the print wheel character under
                                  ASCII code 7F(Hex)
  PRE   LF                        Form Feed to Top of (next) Form
  PRE   NL    (n)                 Initiate Remote RESTORE (reset)
```

12. RES: Ends print inhibit (suppression) mode when initiated by a BY code.

13. SP: Initiates movement of the carriage one print position in normal mode, one 1/60" increment in graphics mode. Direction of movement reverses in backward print mode.

14. UC: Places the 1640/1650 in the Uppercase mode.

15. UN2: Initiates movement of the paper up to the next previously set Vertical Tab Stop.

16. UN3: Initiates Form Feed to the top of the next form, or to the upper margin if one is set.

NOTE: (n) = 2741 character whose decimal value is equal to the decimal position, number of lines, or increments. See Appendix D-4.

6.4.8 HyPlot, Feeder, Diagnostics

This firmware supports HyPlot Vector Plotting, the Diablo Auto Front Feed and HyFeed paper handling accessories and External (remote) Diagnostics.

6.4.8.1 HyPlot Vector Plotting

The 1640/1650 HyPlot Vector Plotting option provides the capability to produce graphs and other vector designs in a manner considerably faster than the standard graphics mode. The vector plotting commands closely resemble those employed by various graphics plotters, which results in the higher speed.

In the HyPlot mode, the printing position may be moved thru a combination of carriage moves (X) and/or paper feed moves (Y) using the smallest increments available. These moves are possible between any two print positions on a currently defined page using a command of no more than six bytes. Any ASCII character may be used as the plot character, or the system allowed to default to use of the period (.). Plot resolution may be varied over a wide range to accommodate either high throughput or high density plotting using either absolute or relative vectors.

The HyPlot commands are:

ESC G	Enter HYPLOT ABSOLUTE mode. All vectors are interpreted as absolute locations. Draw all vectors except the first, which is a move only.
ESC G BEL	Same as ESC G except all vectors are to be drawn, including the first.
ESC V	Same as ESC G except all vectors include a sign byte and are treated as RELATIVE coordinates.
ESC V BEL	Same as ESC G BEL except that all vectors include a sign byte and are treated as relative coordinates
ESC . character	Change plot character to "character". Space = no print but execute plotting motion; ESC Y = Print Wheel character under ASCII code 20(Hex); ESC Z = Print Wheel character under ASCII code 7F(Hex).
ESC , h v	"h" refers to horizontal resolution in increments of 1/120". Default value = 2. "v" refers to vertical resolution in increments of 1/48". Default value = 1. If both horizontal and vertical resolution = 0 then only the starting and ending points of a vector will be plotted. Both "h" and "v" may assume values between 0 and 31. Refer to Table D-2, the portion "SPACE" thru "?", where "SPACE"=0 and "?"=31.
ESC A	Ribbon down, print in red.
ESC B	Ribbon up, print in black.
ESC 4 (or CR)	Exit HyPlot mode.

A HyPlot vector consists of one to six ASCII characters in the following sequence:

1	SIGN	-	Needed only in relative mode
2	HIY	-	5 most significant bits of Y coordinate
3	XLOY	-	2 least significant bits of both X and Y coordinates
4	LOY	-	5 intermediate bits of Y
5	HIX	-	5 most significant bits of X coordinate
6	LOX	-	5 intermediate bits of X

A vector may contain less than six bytes if some of them are unchanged from the previous vector, or if the absolute mode is selected.

Table 6-1 illustrates the format of the data in vector bytes, while Table 6-2 illustrates the bytes required to change the various fields of data.

Table 6-1
VECTOR DATA FORMAT

BYTE	ASCII CHARACTER						
	7	6	5	4	3	2	1
SIGN	0	1	x	x	x	Y NEG	X NEG
HIY	0	1	5 MSBs of Y				
XLOY	1	1	0	2 LSBs of Y		2 LSBs of X	
LOY	1	1	5 Intermediate bits of Y				
HIX	0	1	5 MSBs of X				
LOX	1	0	5 Intermediate bits of X				

Table 6-2
DATA BYTE CHANGE REQUIREMENTS – ABSOLUTE MODE ONLY

CHANGED BYTE	BYTES THAT MUST BE SENT				
	HIY	XLOY	LOY	HIX	LOX
HIY	•				•
XLOY		•	•		•
LOY			•		•
HIX			•	•	•
LOX					•
RETRANSMIT PREVIOUS VECTOR –					•

NOTES:
1. A HYPLOT vector consists of one to six ASCII characters which must always be in the sequence stated.
2. The SIGN character must always be sent in RELATIVE mode.
3. The SIGN character must NOT be sent in ABSOLUTE mode.
4. If the 5 intermediate bits of Y (LOY) are all ones (I), the sequence ESC Z should be used to prevent ASCII DEL from being used as a data byte.
5. 1640/1650 HYPLOT is not designed to operate with 2741 protocol.
6. Refer to Table 6-1. "x" = don't care.
7. Refer to Table 6-1. Negative movement if 1, positive if 0.
8. Vector plot origin is located at vector "SP ' ' SP @".
9. In relative mode, Table 6-2 is invalid; all bytes must be resent.

6.4.8.2 Paper Feeder Options

This portion of the firmware supports the operation of the accessory paper feed equipment described in subsection 6.3.1.4.

6.4.8.3 External (Remote) Diagnostics

The remote diagnostics option allows the interrogation of machine parameters and status, and the initiation of a self test sequence to be performed thru both the serial and parallel interfaces.

6.4.8.3.1 Diagnostic Commands

The following diagnostic commands are included in this option:

```
ESC SUB I        Initialize the printer
ESC SUB 1        Request status word 1
ESC SUB 2        Request status word 2
ESC SUB 3        Request status word 3
ESC SUB 4        Request status word 4
ESC SUB 5        Request status word 5
ESC SUB 6        Request status word 6
ESC SUB SO       Perform selt-test
ESC SUB U        Enter user (programmable) test mode
ESC SUB W (n)    Enter wrap-around (echo) test mode
ESC SUB X        Exit test mode
DEL              Error correct backspace (user test mode only)
STX              Print buffer once (user test mode only)
SOH              Print buffer repeatedly (user test mode only)
```

6.4.8.3.2 Interface Protocol

Status information is not supplied to the interface of any keyboard equipped Series 1640/1650 while it is in the LOCAL mode. All diagnostic commands are processed immediately when received and are not queued. This means all status reported will be the status present at the time the command was received. Only the low 7 bits (bits 0 thru 6) of a status byte are significant. Their equivalent value may range from 0 to 127. The MSB (bit 7) will be a PARITY bit on the serial interface and PRINTER READY on the parallel interface. The one exception is in WRAP-AROUND mode, where the MSB (bit 7) sent thru the parallel interface will be that received from the host computer.

Serial Interface

All commands that generate a response from the 1640/1650 will send back a status byte to the host computer preceded by a STX character when sent thru the serial interface. The rules for ETX/ACK and DC1/DC3 protocols are applicable and should be used for sending status requests to the 1640/1650.
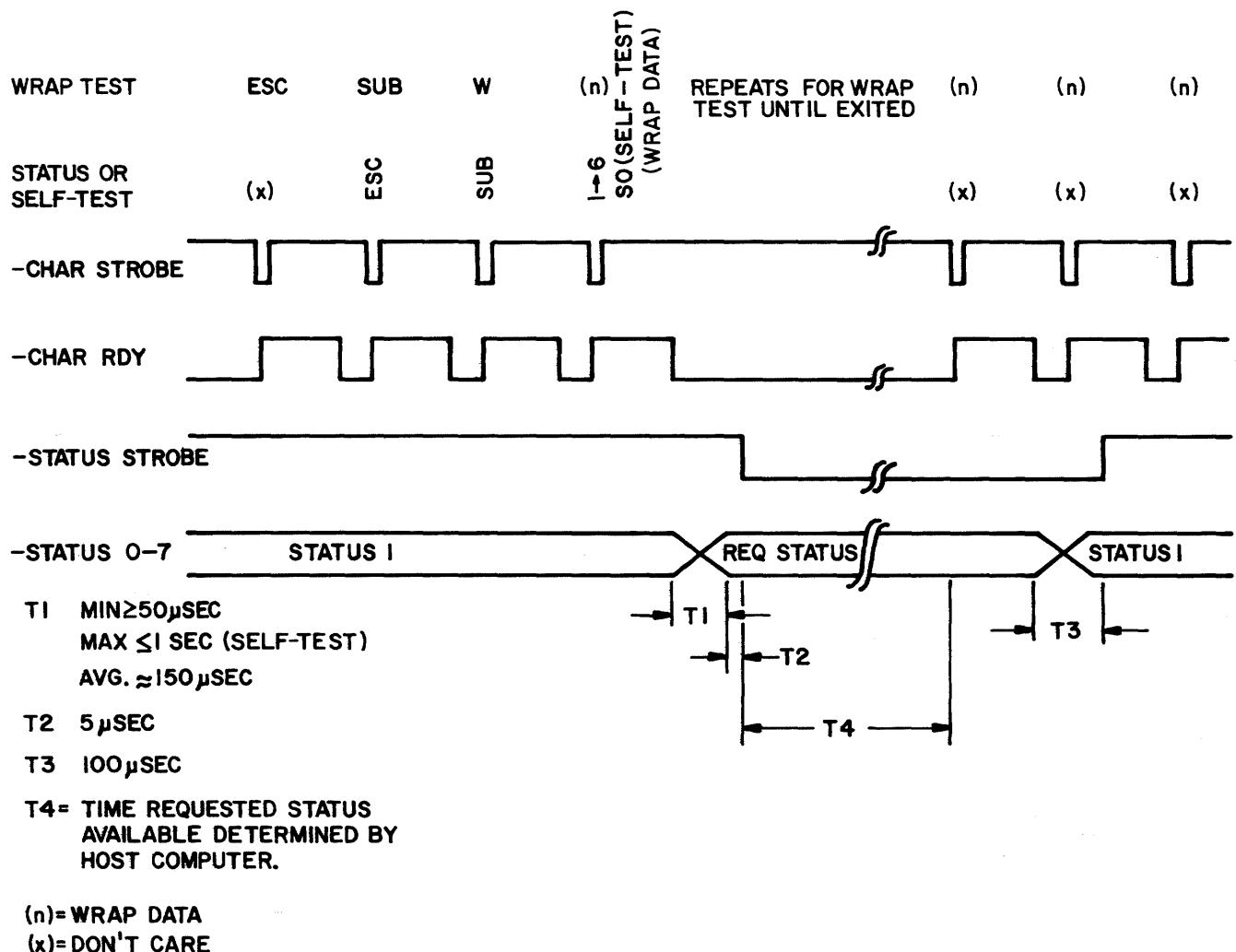
Parallel Interface

Parallel interface timing for a status request is shown in Figure 6-1. The status will always be sent thru the parallel interface with a corresponding status strobe. The requested status is available at the

leading edge of the status strobe and will remain on the interface until another character is accepted from the host computer, indicating that the status has been received by the host system. Any status on the interface from the time the third character of the sequence is sent until the leading edge of -STATUS STROBE is received should be ignored. The parallel interface will always default to a STATUS 1 condition after power up, a printer initialize sequence, or within 100 usec of accepting another character thru the interface (-CHAR RDY = LO after receipt of a character). At this time -STATUS STROBE will go HI (false) to indicate that the default status is now on the interface bus.

6.4.8.3.3 Diagnostic Command Definitions

ESC SUB I This command will cause the 1640/1650 to unconditionally execute an initialize sequence regardless of any error conditions that may exist within the printer. Unlike the corresponding sequence ESC CR P, this command is executed immediately when received. The 1640/1650 will default to the conditions that exist at power up. This command should be preceded by a nonprinting character to cause the 1640/1650 to abort any multiple character sequence in progress.

Figure 6-1

PARALLEL INTERFACE RESPONSE TO STATUS REQUEST, SELF-TEST and WRAP TEST

ESC SUB 1   This command will cause the 1640/1650 to send STATUS 1 to
the interface.   The bit definitions for STATUS 1 are:

0	End Of Ribbon	4	Cover Open Switch
1	10 Pitch	5	Printer Idle (no motion and
2	Paper Out Switch		queue empty)
3	Auto Line Feed Switch (0 if	6	Printer in Check
	no panel)	7	**Parity Bit or Printer Rdy**

ESC SUB 2   This command will cause the 1640/1650 to send STATUS 2 thru
the interface.   The bit definitions for STATUS 2 are:

0	Control Panel Option	4	Always 0
1	Diablo Keyboard Option	5	Always 0
2	Plastic Print Wheel Mode	6	Always 0
3	Serial Interface Option	7	**Parity Bit or Printer Rdy**

ESC SUB 3   This command will cause the 1640/1650 to send STATUS 3 thru
the interface.   The bit definitions for STATUS 3 are:

0	Enhanced 2741 Switch	(always 0 if no panel)
1	ETX/ACK Enable Switch	(always 1 if no panel)
2	DC1/DC3 Enable Switch	
3	Correspondence Switch	(always 0 if no panel)
4	92 Character Switch (not used on 1640)	(set by ESC sequence if no panel)
5	96 Character Switch (not used on 1640)	(set by ESC sequence if no panel)
6	Scroll Switch	(always 0 if no panel)
7	**Parity Bit or Printer Rdy**	

ESC SUB 4   This command will cause the 1640/1650 to send STATUS 4 thru
the interface.   The bit definitions for STATUS 4 are:

0	Full-Duplex Switch	
1	Proportional Space Switch	(always 0 if no panel)
2	APL Mode Switch	(always 0 if no panel)
3	ASCII Mode Switch	(always 0 if no panel)
4	Auto Carriage Return Switch	(always 0 if no panel)
5	Paper Out Defeat Switch	(always 0 if no panel)
6	Always 0	
7	**Parity Bit or Printer Rdy**	

ESC SUB 5   This command will cause the 1640/1650 to send STATUS 5 thru
the interface.   The bit definitions for STATUS 5 are:

0	Attention (break) received	4	Print Buffer Overflow
1	Print Wheel in check	5	Always 0
2	Carriage in Check	6	Parity Error
3	Always 0	7	**Parity Bit or Printer Rdy**

<u>ESC SUB 6</u> This command will cause the 1640/1650 to send STATUS 6 thru the interface. This status byte is valid ONLY if the Diablo Keyboard (KSR) option is installed, otherwise this byte will always be 0. The bit definitions are:

    0   Shift Key
    1   Line Edit Key   (always 0 if WP option not installed)
    2   Margin Control Key   (always 0 if WP option not installed)
    3   Upper Case Only Key
    4   Double Line Feed Key
    5   Load EROM Key
    6   Always 0
    7   **Parity Bit or Printer Rdy**

<u>ESC SUB SO</u> This command will cause the 1640/1650 to execute a self-test sequence. The test executed consists of the RAM test and ROM checksum portions only of the basic self-test routine and a control panel I/O port test routine. No indication of test pass or failure is printed. The checksum portion of this test will wait for all printer motion to stop before proceeding. Therefore, this command sequence should not be sent while the 1640/1650 is busy. At the end of the self-test a status byte will be sent to the host computer. The bit definitions are:

    0   Basic ROM Checksum Error   (first 4k - HPRO4)
    1   Print Wheel 8041 ROM Checksum Error
    2   Carriage 8041 ROM Checksum Error
    3   Option ROM Checksum Error (next 12k - KSR or XMEM2)
                            Bit 4 5
    4   RAM Error (encoded) 0 0 = No error
    5   RAM Error (encoded) 0 1 = HPRO4 - scratch RAM
                                 1 0 = HPRO4 - Print queue
                                 1 1 = XMEM2 - Print queue
    6   Control Panel Error   (always 0 if no panel)
    7   **Parity Bit or Printer Rdy**

<u>ESC SUB U</u> This command will cause the 1640/1650 to enter the USER (programmable) test mode. In this mode the user may enter any command sequence whose length is no more than 5 characters when within 5 characters of the end of the buffer. The 1640/1650 may then be commanded to execute the buffer either once or repeatedly. All standard and optional ESC sequences are valid except REMOTE DIAGNOSTIC commands. Any REMOTE DIAGNOSTIC commands in the buffer will be ignored. Both ETX/ACK and DC1/DC3 protocols will function normally when entering data into the buffer. During buffer execution an ACK will be sent thru the serial interface for each ETX encountered in the buffer, if enabled. DC1/DC3 will not function during buffer execution. USER test mode may be exited by issuing either ESC SUB X or ESC SUB I sequence. All other incoming commands will be ignored during buffer execution.

<u>ESC SUB W (n)</u> This command will cause the 1640/1650 to enter the WRAP-AROUND (echo) test mode. In this mode the 1640/1650 will send back to the host computer each byte (n) that it receives, using the same protocol as status commands. The echoing starts with the first byte following the ESC SUB W sequence. The byte sent via the parallel

interface will be 8 bits wide. The MSB (bit 7) will be what was received and not -PRINTER RDY. The 1640/1650 will automatically exit WRAP-AROUND mode when in LOCAL mode. WRAP-AROUND mode may be exited by issuing either ESC SUB X or ESC SUB I sequence. The ESC SUB X sequence will be echoed back to the host computer.

ESC SUB X This command will cause the 1640/1650 to exit both WRAP-AROUND and USER test modes immediately. When in USER test mode, the 1640/1650 will finish the execution of the buffer if in progress when the ESC SUB X was received, and will simultaneously accept new data from the interface.

DEL The DEL or RUB OUT character is used for error correction when entering data into the buffer in USER test mode. The buffer pointer will be backed up one and the previous character echoed on the printer for each DEL received. All control characters except SPACE, BACKSPACE, CARRIAGE RETURN and LINE FEED will be echoed as the uppercase ASCII equivalent preceded by an exclamation mark(!). An ESCAPE character will be echoed as a dollar sign ($). The DEL character is ignored during an ESCAPE sequence to prevent invalid ESC sequences. If the incoming data is faster than the speed of the print mechanism, the entire RUBOUT and ECHO sequence will be transparent.

STX The STX character will cause the content of the print buffer to be executed one time only, when in USER test mode. If the buffer is being executed repeatedly (SOH character), receiving an STX character will cause the 1640/1650 to return to single cycle execution mode at the end of the buffer. The SOH and STX characters may still be used as the third character of a three character sequence in USER test mode. They will not cause the buffer to be executed when included within a valid ESCAPE sequence. Data may no longer be entered into or deleted from the buffer after receiving an SOH or STX execution character without first exiting and then reentering USER test mode.

SOH The SOH character will cause the content of the print buffer to be executed repeatedly. The 1640/1650 will continue buffer execution until being returned to single cycle execution mode (STX character), or exiting USER test mode (ESC SUB X or ESC SUB I).

6.4.9 Expanded Buffer

Normal 1640/1650 firmware includes a 256 character buffer memory (RAM) on the HPRO4 Universal Interface PCB. The Expanded Buffer option provides an additional 2048 character buffer (for a total of 2304 characters) in 4 RAMs plugged into sockets on the XMEM2 PCB assembly. 1640/1650 logic will automatically access the additional storage.

6.4.10 Keyboard Programmable "Here Is. ."

The Keyboard Programmable "Here Is . ." option provides the user of the Model 1640/1650-KSR Terminals with a way to store a "Here Is . ." response message of up to 31 characters in nonvolatile memory, and have it transmitted to a host system either on receipt of an ENQ request message, or by depressing the HERE IS key located in the keyboard Control section.

The programming of the "Here Is" message is a Local mode function. It is accomplished by depressing the LOAD EROM key down to its latched position, keying in the Here Is message, and then releasing the LOAD EROM key. Note that jumper A6 must be installed on the XMEM2 PCB prior to keying in the Here Is message. If the jumper is removed, the recorded message is protected and cannot be altered without first re-installing the jumper.

6.4.11 Baud Rate Option Mode

The 1640 and 1650 provide standard baud rates from 110 to 1200 thru switch selection. In addition there is an option baud rate capability that can be implemented by OEM users of these printers. The option baud rate allows the substitution of one baud rate, selected from Table 6-3, for the standard 600 baud.

This option baud rate is implemented by modifying the contents of 3 bytes in the Keyboard/APL/Option Baud Rate firmware ROM and copying the ROM with the revisions to an EPROM. The locations that change are identified in the table, with the new values for each possible option baud rate. All location addresses and values are given in hexideci-mal, and the ROM addresses are relative to 0.

Note that the APL/Option Baud Rate ROM is standard in the 1640KSR and 1650KSR, but is optional in the RO versions.

The 7FB byte must be 00 to enable the option baud rate. The 7FD byte is set for the selected option baud rate. There are 6 different ver-sions of the APL/Option Baud Rate firmware ROM depending on which key-board is being used. The 7FF byte varies according to keyboard type supported by the ROM, as this is the checksum byte that provides the "ROMOK" message from Self-Test.

The only byte that must be changed for 9600 baud is the 7FB byte. All APL/Option Baud Rate ROM's are preprogrammed for 9600 baud but are disabled.

Table 6-3
OPTION BAUD RATE TABLE

Baud Rate	7FB	7FD	7FF					
			Standard TWP	Logical Bit Paired	German	French Azerty	Scandanavian	Norsk
1800	00	57	B4	8B	5E	98	0B	A0
2000	00	4E	BD	94	67	A1	14	A9
2400	00	41	CA	A1	74	AE	21	B6
4800	00	21	EA	C1	94	CE	41	D6
7200	00	16	F5	CC	9F	D9	4C	E1
9600	00	10	FB	D2	A5	DF	52	E7

NOTE: The 7FB byte is the only one that must be changed for 9600 baud.

Coding Systems

A-1 ASCII Code

The ASCII Coding System is based on the American National Standard Code for Information Interchange, Standard No. X3.4-1977 of the American National Standards Institute, Inc.

Bits	$b_7 \rightarrow$	0	0	0	0	1	1	1	1
	$b_6 \rightarrow$	0	0	1	1	0	0	1	1
	$b_5 \rightarrow$	0	1	0	1	0	1	0	1
$b_4\, b_3\, b_2\, b_1$ COLUMN→ ↓ROW↓		0	1	2	3	4	5	6	7
0 0 0 0	0	NUL	DLE	SP	0	@	P	`	p
0 0 0 1	1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0	2	STX	DC2	"	2	B	R	b	r
0 0 1 1	3	ETX	DC3	#	3	C	S	c	s
0 1 0 0	4	EOT	DC4	$	4	D	T	d	t
0 1 0 1	5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0	6	ACK	SYN	&	6	F	V	f	v
0 1 1 1	7	BEL	ETB	'	7	G	W	g	w
1 0 0 0	8	BS	CAN	(	8	H	X	h	x
1 0 0 1	9	HT	EM	)	9	I	Y	i	y
1 0 1 0	10	LF	SUB	*	:	J	Z	j	z
1 0 1 1	11	VT	ESC	+	;	K	[	k	{
1 1 0 0	12	FF	FS	,	<	L	\	l	¦
1 1 0 1	13	CR	GS	-	=	M	]	m	}
1 1 1 0	14	SO	RS	.	>	N	^	n	~
1 1 1 1	15	SI	US	/	?	O	__	o	DEL

All characters in these two columns and SP (Space) are nonprinting. DEL (Delete) does not print in Remote mode. However, when DEL is entered on keyboard in Local mode, it prints the print wheel character addressed by ASCII code 7F (HEX) on a 1640 or 3F (HEX) on a 1650. (This character is also printed in place of characters received with parity or framing error.) When UPPERCASE ONLY is used, shaded lowercase characters (columns 6 & 7) from keyboard are converted to their uppercase equivalents (columns 4 & 5) before being printed or transmitted.

Figure A-1 ASCII CODE CHART

A-2 2741 Codes

There are two different 2741 coding systems that can be used by the 1640/1650: Correspondence code and PTTC/EBCD code. (Either of these coding systems may be used with or without the 2741 Enhancement features.) These two systems normally employ both uppercase and lowercase printable characters, as well as special symbols and control characters. If the APL option is used along with an APL printwheel, however, the uppercase alphabetic characters take the place of the lowercase characters, and the codes normally used for uppercase characters are used to represent the special APL characters. Figures A-2a thru A-2d list the specific bit configuration of each character in the 2741 coding systems.

Lower Case	N/A	| Bit Number (Internal Data Bus HPR03) |						Upper Case
		D A 0 / B	D A 1 / A	D A 2 / 8	D A 3 / 4	D A 4 / 2	D A 5 / 1	
IBM:	C	B	A	8	4	2	1	
.	C	B				2		·
;	C	B	A		4	2	1	:
,		B	A		4	2	1	,
'	C	B			4			"
!		B						]
=		B	A			2		+
-		B	A	8		2	1	:
/		B	A	8				?
1							1	+
2						2		@
3	C					2	1	#
4				8				$
5					4			%
6	C				4	2		[
7	C				4		1	&
8					4	2	1	*
9 (EOA, Ⓓ)				8		2	1	(
0	C			8			1	)
a	C	B			4	2	1	A
b	C		A	8		2	1	B
c	C		A		4	2	1	C
d			A		4		1	D
e	C		A		4			E
f	C	B	A			2	1	F
g		B	A				1	G
h			A	8			1	H
i		B			4	2		I
j	C	B	A					J
k			A		4	2		K
l	C		A	8				L
m	C	B					1	M
n	C		A			2		N
o	C	B		8				O
p		B	A		4			P
q	C	B	A		4	2		Q
r		B			4		1	R
s		B		8			1	S
t			A					T
u			A			2	1	U
v		B				2	1	V
w	C	B		8		2	1	W
x	C		A				1	X
y	C	B	A	8			1	Y
z	C			8		2		Z

Non-Printing Codes

Lower Case	N/A	B	A	8	4	2	1	Upper Case
SP	C							Space
HT		B	A	8	4		1	Horizontal Tab
BS	C	B		8	4	2		Backspace
NL	C	B		8	4		1	New Line
LF	C		A	8	4		1	Line Feed
PN	C			8	4			Punch On
BY			A	8	4			Bypass
RES		B		8	4			Restore
PF	C	B	A	8	4			Punch Off
RS				8	4		1	Reader Stop
EOB	C		A	8	4	2		End of Block
EOT (Ⓒ)	C			8	4	2	1	End of Transmission
PRE			A	8	4	2	1	Prefix
IL		B		8	4	2	1	Idle
UC				8	4	2		Upper Case
LC		B	A	8	4	2		Lower Case
DEL	C	B	A	8	4	2	1	Delete
UN1			A	8		2		Unspecified
UN2		B		8		2		Unspecified
UN3	C	B	A	8		2		Unspecified

Figure A-2a   IBM CORRESPONDENCE CODE

	Bit Number							
Internal Data Bus (HPR03)	N/A	DA0	DA1	DA2	DA3	DA4	DA5	
IBM	C	B	A	8	4	2	1	
Lower Case								**Upper Case**
.		B	A	8		2	1	⌐
,	C		A	8		2	1	¦
# (EOA, Ⓓ)				8		2	1	"
$	C	B		8		2	1	!
&	C	B	A					+
-		B						
/	C		A				1	?
@			A					¢
1							1	=
2						2		<
3	C					2	1	;
4					4			:
5	C				4		1	%
6	C				4	2		'
7					4	2	1	>
8				8				*
9	C			8			1	(
0	C			8		2		)
a		B	A				1	A
b		B	A			2		B
c	C	B	A			2	1	C
d		B	A		4			D
e	C	B	A		4		1	E
f	C	B	A		4	2		F
g		B	A		4	2	1	G
h		B	A	8				H
i	C	B	A	8			1	I
j	C	B					1	J
k	C	B				2		K
l		B				2	1	L
m	C	B			4			M
n		B			4		1	N
o		B			4	2		O
p	C	B			4	2	1	P
q	C	B		8				Q
r		B		8			1	R
s	C		A			2		S
t			A			2	1	T
u	C		A		4			U
v			A		4		1	V
w			A		4	2		W
x	C		A		4	2	1	X
y	C		A	8				Y
z			A	8			1	Z
Non-Printing Codes								
SP	C							Space
HT		B	A	8	4		1	Horizontal Tab
BS	C	B		8	4	2		Backspace
NL	C	B		8	4		1	New Line
LF	C		A	8	4		1	Line Feed
PN	C			8	4			Punch On
BY			A	8	4			Bypass
RES		B		8	4			Restore
PF	C	B	A	8	4			Punch Off
RS				8	4		1	Reader Stop
EOB	C		A	8	4	2		End of Block
EOT (Ⓒ)	C			8	4	2	1	End of Transmission
PRE			A	8	4	2	1	Prefix
IL		B		8	4	2	1	Idle
UC				8	4	2		Upper Case
LC		B	A	8	4	2		Lower Case
DEL	C	B	A	8	4	2	1	Delete
UN1			A	8		2		Unspecified
UN2		B		8		2		Unspecified
UN3	C	B	A	8		2		Unspecified

Figure A-2b   IBM PTTC/EBCD CODE

Figure A-2c table:

Lower Case	N/A (C)	B	A	8	4	2	1	Upper Case
.	C	B				2		:
[	C	B	A		4		1	(
,		B	A		4	2	1	;
]		B			4			)
←		B						→
×		B	A			2		÷
+		B	A	8		2	1	−
/		B	A	8				\
1							1	¨
2						2		—
3	C					2	1	<
4				8				≤
5					4			=
6	C				4	2		≥
7	C				4		1	>
8					4	2	1	≠
9 (EOA,Ⓓ)				8		2	1	∨
0	C			8			1	∧
A	C	B			4	2	1	∝
B	C		A	8		2	1	⊥
C	C		A		4	2	1	∩
D			A		4		1	∟
E	C		A		4			∈
F	C	B	A			2	1	_
G		B	A				1	∇
H			A	8			1	Δ
I		B			4	2		ι
J	C	B	A					○
K			A		4	2		'
L	C		A	8				▯
M	C	B					1		
N	C		A			2		⊤
O	C	B		8				○
P		B	A		4			*
Q	C	B	A		4	2		?
R		B			4		1	ρ
S		B		8			1	⌈
T			A					∼
U			A			2	1	↓
V		B				2	1	∪
W	C	B		8		2	1	ω
X	C		A				1	⊃
Y	C	B	A	8			1	↑
Z	C			8		2		⊂
Non-Printing Codes								
SP	C							Space
HT		B	A	8	4		1	Horizontal Tab
BS	C	B		8	4	2		Backspace
NL	C	B		8	4		1	New Line
LF	C		A	8	4		1	Line Feed
PN	C			8	4			Punch On
BY			A	8	4			Bypass
RES		B		8	4			Restore
PF	C	B	A	8	4			Punch Off
RS				8	4		1	Reader Stop
EOB	C		A	8	4	2		End of Block
EOT (Ⓒ)	C			8	4	2	1	End of Transmission
PRE			A	8	4	2	1	Prefix
IL		B		8	4	2	1	Idle
UC				8	4	2		Upper Case
LC		B	A	8	4	2		Lower Case
DEL	C	B	A	8	4	2	1	Delete
UN1			A	8		2		Unspecified
UN2		B		8		2		Unspecified
UN3	C	B	A	8		2		Unspecified

Bit Number

Internal Data Bus (HPR03): N/A | DA0 DA1 DA2 DA3 DA4 DA5

IBM: C | B A 8 4 2 1

Figure A-2c   IBM CORRESPONDENCE CODE (APL)

Lower Case	N/A	\[DA0\] B	\[DA1\] A	\[DA2\] 8	\[DA3\] 4	\[DA4\] 2	\[DA5\] 1	Upper Case
. (IBM: C)		B	A	8		2	1	:
,	C		A	8		2	1	;
] (EOA, ⓓ)				8		2	1	)
[	C	B		8		2	1	(
×	C	B	A					÷
+		B						−
/	C		A				1	\
←			A					→
1							1	¨
2						2		¯
3	C					2	1	<
4					4			≤
5	C				4		1	=
6	C				4	2		≥
7					4	2	1	>
8				8				≠
9	C			8			1	∨
0	C			8		2		∧
A		B	A				1	∝
B		B	A			2		⊥
C	C	B	A			2	1	∩
D		B	A		4			L
E	C	B	A		4		1	ε
F	C	B	A		4	2		‾
G		B	A		4	2	1	∇
H		B	A	8				Δ
I	C	B	A	8			1	ι
J	C	B					1	○
K	C	B				2		'
L		B				2	1	□
M	C	B			4			|
N		B			4		1	⊤
O		B			4	2		○
P	C	B			4	2	1	*
Q	C	B		8				?
R		B		8			1	ρ
S	C		A			2		⌈
T			A			2	1	~
U	C		A		4			↓
V			A		4		1	∪
W			A		4	2		ω
X	C		A		4	2	1	⊃
Y	C		A	8				↑
Z			A	8			1	⊂

				Non-Printing Codes				
SP	C							Space
HT		B	A	8	4		1	Horizontal Tab
BS	C	B		8	4	2		Backspace
NL	C	B		8	4		1	New Line
LF	C		A	8	4		1	Line Feed
PN	C			8	4			Punch On
BY			A	8	4			Bypass
RES		B		8	4			Restore
PF	C	B	A	8	4			Punch Off
RS				8	4		1	Reader Stop
EOB	C		A	8	4	2		End of Block
EOT (ⓒ)	C			8	4	2	1	End of Transmission
PRE			A	8	4	2	1	Prefix
IL		B		8	4	2	1	Idle
UC				8	4	2		Upper Case
LC		B	A	8	4	2		Lower Case
DEL	C	B	A	8	4	2	1	Delete
UN1			A	8		2		Unspecified
UN2		B		8		2		Unspecified
UN3	C	B	A	8		2		Unspecified

Figure A-2d   IBM PTTC/EBCD CODE (APL)

APPENDIX   B

KEYBOARDS

Two different English language keyboards are available, a 47-key Type-
writer paired array and a 47-key Logic Bit paired array. Several
foreign language keyboards and an APL keyboard (all 47-key) are also
available. All keyboards can be used in ASCII Mode or in any of the
2741 Mode variations. However, some combinations of keyboards/coding
systems can be confusing at first glance. For example, on the key-
board, the character in uppercase above the digit 6 is the circum-
flex (¢) in the ASCII Mode, but prints the logical NOT (¬) in PTTC/
EBCD, and prints nothing at all in Correspondence Mode. To lessen
this confusion, several different illustrations of the standard 47-key
keyboard are presented in Figure B-1. Note that these illustrations
do not show the keyboard as it actually appears to the operator. In-
stead, they show the characters printed and/or transmitted in the re-
spective operating mode, regardless of the engraving actually on the
keytops.

Note also in the 2741 keyboard charts that occasionally two different
characters will be listed as having the same code. For example, in
the 2741 (PTTC/EBCD) Code chart, in the "Shifted" column, both the
dollar sign and the exclamation point are shown as producing the code
"35". This is because some characters that are normally considered
lowercase characters in 2741 code can only be produced in the "shift-
ed" mode. When this occurs, an LC code is automatically transmitted
before the code for the lowercase character. Then, when a subsequent
uppercase character is printed, a UC code is automatically transmitted
before the uppercase character's code is sent.

Starting in Figure B-2, each of the 47-key keyboards is shown. The
format of the APL keyboard is slightly different to show the engrav-
ing on the front of the keytops. These legends depict the different
characters printed when a "standard" print wheel is used in place of
an APL print wheel.

Accompanying each of the 47-key keyboard drawings is a table listing
the characters and codes produced by each of the keys. Bear in mind
that the characters listed in the tables will be printed only if the
appropriate print wheel is installed.

Typewriter paired keyboards are designed to closely follow the format
and operation of a standard office typewriter. These keyboards offer
ease of operation by non-terminal trained operators. Typewriter
paired keyboards transmit a discrete ASCII code for all keys in both
the shifted and unshifted mode.

Logic Bit paired keyboards can have a much wider variety of key
assignments, and can follow the format and operation of other data
entry equipment such as teletype terminals. The appropriate keytops
on Diablo's Logic Bit paired keyboards include engravings for these
special assignments, including CTRL characters. Logic Bit paired key-
board circuts delete the high order bit when transmitting a special or
CTRL character, but transmit a discrete ASCII code for all other char-
acters in both shifted and unshifted modes.

NOT USED
NOT USED
NOT USED
NOT USED

ON
OFF

1 2 3 4 5 6 7 8

2741 CORRESPONDENCE (ON)
PTTC/EBCD (OFF)
DCI/DC3 ENABLE
ETX/ACK ENABLE
ENHANCED 2741

DEFEAT 30 120 ON   EVEN ON 10 ON   2741 ON ON

PAPER SPEED DUPLEX   ODD AUTO   ANSI APL TEST
OUT   PARITY CR   PROP
                        12   SPACE
                       PITCH

ERROR   MODE

PARITY PRINTER OVFL COVER KEY PAPER ATTN RIBBON   DATA LOCAL PROCD

BREAK RESET FF LF 92 98 AUTO LF SCROLL POWER
                          88

* BLANK SWITCHES SERIES 1640 ONLY

80	81	82
LOAD FORM	HERE IS	EJECT FORM

83	84	85
LOAD EROM	DBL LF	UC ONLY

86	87	88
LOCAL	MARG CONT	LINE EDIT

89	90	91

92	93	94

CODE SET HT CLR TABS PLOT ON PLOT OFF FWD PRINT BKWD PRINT PRINT SUPP CLR HT LFT MAR RHT MAR SET VT
2   3   4   5   6   7   8   9   10   11   12   13   14   15   16

ESC !1 @2 #3 $4 %5 ∧¬6 &7 *8 (9)0 —- += ~\ BACK SPACE

ESC 18 NUL 19 NUL 20 NUL 21 NUL 22 NUL 23 NUL 24 NUL 25 NUL 26 {27 }28 US 29 RS 30 GS 31 BS

64	65	66
7	8	9

TAB Q W E R T Y U I O P] \ LINE FEED

32 HT 33 DCI 34 ETB 35 ENQ 36 DC2 37 DC4 38 EM 39 NAK 40 HT 41 SI 42 DLE 43 ESC 44 FS 45 LF 46

67	68	69
4	5	6

CTRL LOCK A S D F G H J K L :; '" }{ RETURN

49 SOH 50 DC3 51 EOT 52 ACK 53 BEL 54 BS 55 LF 56 VT 57 FF 58 } 59 ' 60 CR 62

70	71	72
1	2	3

SHIFT Z X C V B N M <, >. ?/ SHIFT DEL

SUB CAN ETX SYN STX 63 SO CR , . /

NUL 60

DEL 77

73	74	75
0	•	=

SP

78	79
,	TAB

SP   HT

NOTES: CONTROL CODES AND SPECIAL SYMBOLS REFERENCED
BELOW KEYTOPS IDENTIFY "CTRL" MODE OUTPUT.
THESE LEGENDS ARE NOT ENGRAVED ON KEYTOPS.

Figure B-1a

47-KEY TYPEWRITER PAIRED ASCII KEYBOARD
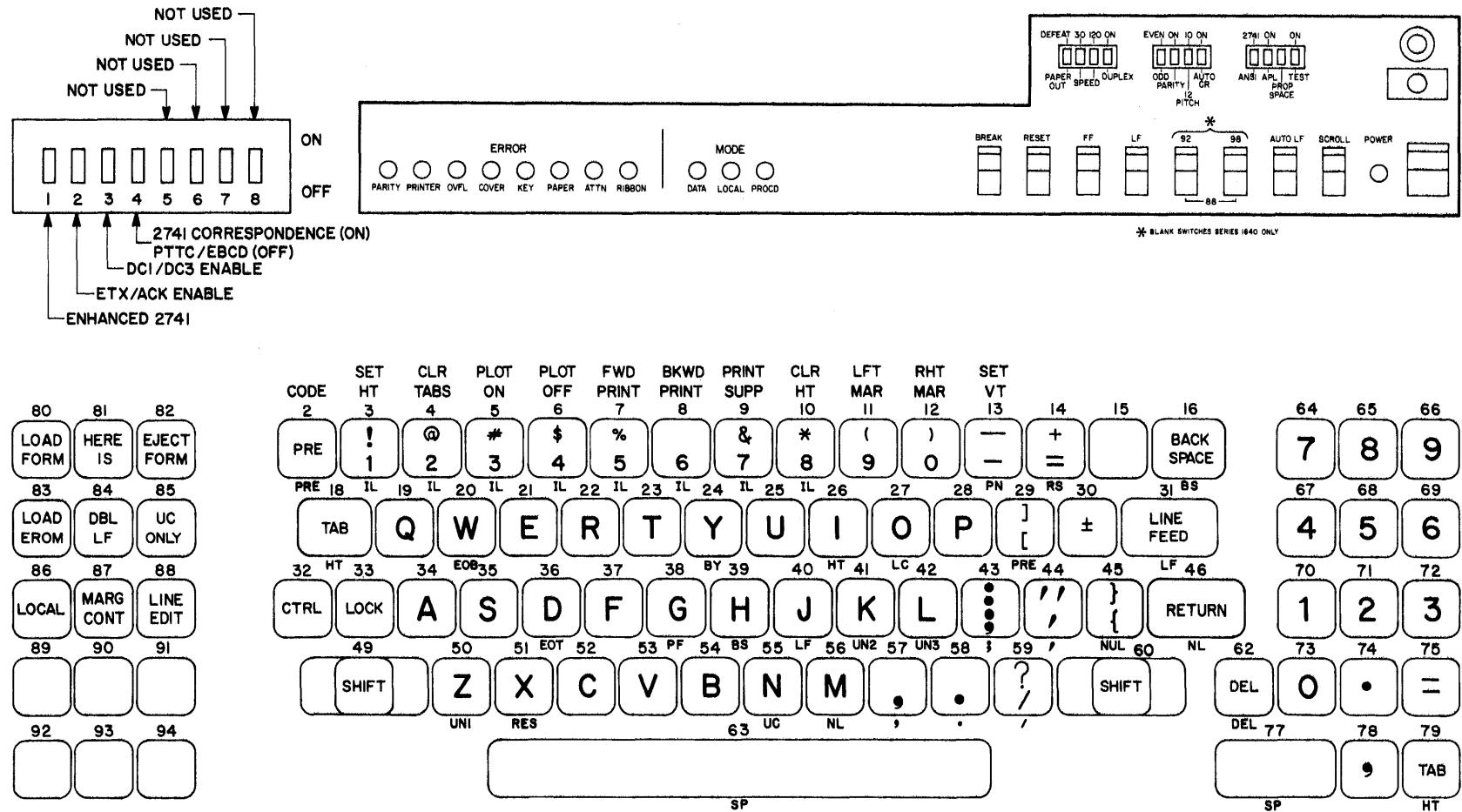
Key Position	Unshifted Characters ASCII	APL	Unshifted Hexadecimal Code	Shifted Characters ASCII	APL	Shifted Hexadecimal Code	Control Characters ASCII	APL	Control Hexadecimal Code
1									
2¹	ESC		1B	ESC		1B	ESC		1B
3	1		31	!		21	NUL		00
4	2		32	@	—	40	NUL		00
5	3		33	#	<	23	NUL		00
6	4		34	$	≤	24	NUL		00
7	5		35	%	=	25	NUL		00
8	6		36	^	≥	5E	NUL		00
9	7		37	&	>	26	NUL		00
10	8		38	*	≠	2A	NUL		00
11	9		39	(	∨	28	{		7B
12	0		30	)	∧	29	}		7D
13	−	+	2D	_	-	5F	US		1F
14	=	×	3D	+	÷	2B	RS		1E
15	`	◇	60	~	$	7E	GS		1D
16	BS		08	BS		08	BS		08
17									
18	HT		09	HT		09	HT		09
19	q	Q	71	Q	?	51	DC1		11
20	w	W	77	W	ω	57	ETB		17
21	e	E	65	E	ε	45	ENQ		05
22	r	R	72	R	ρ	52	DC2		12
23	t	T	74	T	~	54	DC4		14
24	y	Y	79	Y	↑	59	EM		19
25	u	U	75	U	↓	55	NAK		15
26	i	I	69	I	ι	49	HT		09
27	o	O	6F	O	○	4F	SI		0F
28	p	P	70	P	*	50	DLE		10
29	[	←	5B	]	→	5D(3E)	ESC		1B
30	\	⊢	5C(7C)	|	⊣	7C(5C)	FS		1C
31	LF		0A	LF		0A	LF		0A
32	CTRL			CTRL			CTRL		
33	LOCK			LOCK			LOCK		
34	a	A	61	A	∝	41	SOH		01
35	s	S	73	S	⌈	53	DC3		13
36	d	D	64	D	⌊	44	EOT		04
37	f	F	66	F	_	46	ACK		06
38	g	G	67	G	∇	47	BEL		07
39	h	H	68	H	∆	48	BS		08
40	j	J	6A	J	°	4A	LF		0A
41	k	K	6B	K	'	4B	VT		0B
42	l	L	6C	L	⎕	4C	FF		0C
43	;	[	3B	:	(	3A	;	[	3B
44	'	]	27(7F)³	"	)	22	'	]	27
45	{		7B(7D)	}		7D(7B)	NUL		00
46	CR		0D	CR		0D	CR		0D
47									
48									
49	SHIFT			(SHIFT)			(SHIFT)		
50	z	Z	7A	Z	⊂	5A	SUB		1A
51	x	X	78	X	⊃	58	CAN		18
52	c	C	63	C	∩	43	ETX		03
53	v	V	76	V	∪	56	SYN		16
54	b	B	62	B	⊥	42	STX		02
55	n	N	6E	N	⊤	4E	SO		0E
56	m	M	6D	M	|	4D	CR		0D
57	,		2C	<	;	3C	,		2C
58	.		2E	>	:	3E(27)	.		2E
59	/		2F	?	\	3F	/		2F
60	SHIFT			(SHIFT)			(SHIFT)		
61									
62	DEL/¬²		7F³(5D)	DEL		7F	DEL		7F
63	SP		20³	SP		20	SP		20
64	7		37	7		37	7		37
65	8		38	8		38	8		38
66	9		39	9		39	9		39
67	4		34	4		34	4		34
68	5		35	5		35	5		35
69	6		36	6		36	6		36
70	1		31	1		31	1		31
71	2		32	2		32	2		32
72	3		33	3		33	3		33
73	0		30	0		30	0		30
74	.		2E	.		2E	.		2E
75	−	+	2D	−	+	2D	−	+	2D
76									
77	SP		20	SP		20	SP		20
78	,		2C	,		2C	,		2C
79	HT		09	HT		09	HT		09

1 — Non-Repeat Key   2 — Printed Character in LOCAL Mode (1640)   3 — Characters at 20 and 7F are accessed by an ESC Y or ESC Z routine.

NOT USED
NOT USED
NOT USED
NOT USED

ON

OFF

1 2 3 4 5 6 7 8

2741 CORRESPONDENCE (ON)
PTTC/EBCD (OFF)
DCI/DC3 ENABLE
ETX/ACK ENABLE
ENHANCED 2741

DEFEAT 30 120 ON   EVEN ON 10 ON   2741 ON   ON

PAPER   DUPLEX   ODD   AUTO   ANSI APL   TEST
OUT SPEED   PARITY   CR   PROP
                    12   SPACE
                   PITCH

ERROR   MODE

PARITY PRINTER OVFL COVER KEY PAPER ATTN RIBBON   DATA LOCAL PROCD

BREAK RESET FF LF   92   98   AUTO LF SCROLL POWER

88

* BLANK SWITCHES SERIES 1640 ONLY

80	81	82
LOAD FORM	HERE IS	EJECT FORM

83	84	85
LOAD EROM	DBL LF	UC ONLY

86	87	88
LOCAL	MARG CONT	LINE EDIT

89	90	91

92	93	94

CODE 2   SET HT 3   CLR TABS 4   PLOT ON 5   PLOT OFF 6   FWD PRINT 7   BKWD PRINT 8   PRINT SUPP 9   CLR HT 10   LFT MAR 11   RHT MAR 12   SET VT 13   14   15   16

PRE   ! 1   @ 2   # 3 $ 4   % 5   6   & 7   * 8   (9   ) 0   — -   + =   BACK SPACE

PRE 18   IL 19   IL 20   IL 21   IL 22   IL 23   IL 24   IL 25   IL 26   27   28   PN 29   RS 30   31 BS

TAB   Q   W   E   R   T   Y   U   I   O   P   ] [±   LINE FEED

32   HT 33   34   EOB 35   36   37   38   BY 39   40   HT 41   LC 42   43   PRE 44   45   LF 46

CTRL   LOCK   A   S   D   F   G   H   J   K   L   :   ' '   } {   RETURN

49   50   51   EOT 52   53   PF 54   BS 55   LF 56   UN2 57   UN3 58   59   NUL 60   NL

SHIFT   Z   X   C   V   B   N   M   ,   .   ? /   SHIFT

UNI   RES   63   UC   NL   ,   .   /

SP

64	65	66
7	8	9

67	68	69
4	5	6

70	71	72
1	2	3

62	73	74	75
DEL	0	.	=

DEL 77	78	79
	,	TAB

SP   HT

NOTES: 1. CONTROL CODES AND SPECIAL SYMBOLS REFERENCED BELOW KEYTOPS IDENTIFY
          "CTRL" MODE OUTPUTS, AVAILABLE IN 2741 ENHANCED MODE ONLY.
          THESE LEGENDS ARE NOT ENGRAVED ON KEYTOPS.

       2. CHARACTER AND FUNCTIONS IN SHADED AREAS AVAILABLE IN 2741 ENHANCED
          MODE ONLY.

       3. "PRE" CHARACTER IS TRANSMITTED IN 2741 ENHANCED MODE ONLY.

Figure B-1b

47-KEY TYPEWRITER PAIRED 2741 CORRESPONDENCE KEYBOARD

Key Position	Unshifted Character STD	Unshifted Character APL	Unshifted Hex STD	Unshifted Hex APL	Shifted Character STD	Shifted Character APL	Shifted Hex STD	Shifted Hex APL	Control Character STD	Control Character APL	Control Hex Code
1											
2*	PRE		3E		PRE		3E		PRE		3E
3	1		20		!	¨	01	20	IL		3D
4	2		10		@	¯		10	IL		3D
5	3		30		#	<		30	IL		3D
6	4		04		$	≤		04	IL		3D
7	5		08		%	=		08	IL		3D
8	6		18		N/U	≥		18	IL		3D
9	7		28		&	>		28	IL		3D
10	8		38		*	≠		38	IL		3D
11	9		34		(	∨		34	Not Used		
12	0		24		)	∧		24	Not Used		
13	−	+	37			−		37	PN		0C
14	=	×	13		∓	÷		13	RS		2C
15	Not Used				Not Used				Not Used		
16	BS		1D		BS		1D		BS		1D
17											
18	HT		2F		HT		2F		HT		2F
19	q	Q	1B		Q	?	1B		Not Used		
20	w	W	35		W	ω	35		EOB		1E
21	e	E	0A		E	∈	0A		Not Used		
22	r	R	29		R	ρ	29		Not Used		
23	t	T	02		T	∼	02		Not Used		
24	y	Y	27		Y	↑	27		BY		0E
25	u	U	32		U	↓	32		Not Used		
26	i	I	19		I	ι	19		HT		2F
27	o	O	05		O	○	05		LC		1F
28	p	P	0B		P	*	0B		Not Used		
29	[	←	18	01	]	→		01	PRE		3E
30	Not Used				±	N/U	20		Not Used		
31	LF		2E		LF		2E		LF		2E
32	CTRL				CTRL				(CTRL)		
33	LOCK				LOCK				(LOCK)		
34	a	A	39		A	⍺	39		Not Used		
35	s	S	25		S	⌈	25		Not Used		
36	d	D	2A		D	⌊	2A		EOT		3C
37	f	F	33		F	_	33		Not Used		
38	g	G	23		G	∇	23		PF		0F
39	h	H	26		H	∆	26		BS		1D
40	j	J	03		J	∘	03		LF		2E
41	k	K	1A		K	'	1A		UN2		15
42	l	L	06		L	⎕	06		UN3		17
43	;	[	2B		:	(	2B		;	[	2B
44	'	]	09		"	)	09		'	]	09
45	Not Used				Not Used				Not Used		
46	NL		2D		NL		2D		NL		2D
47											
48											
49	SHIFT				(SHIFT)				(SHIFT)		
50	z	Z	14		Z	⊂	14		UN1		16
51	x	X	22		X	⊃	22		RES		0D
52	c	C	3A		C	∩	3A		Not Used		
53	v	V	31		V	∪	31		Not Used		
54	b	B	36		B	⊥	36		Not Used		
55	n	N	12		N	⊤	12		UC		1C
56	m	M	21		M			21		NL		2D
57	,		3B		N/U	;		3B	,		3B
58	.		11		N/U	:		11	.		11
59	/		07		?	\	07		/		07
60	SHIFT				(SHIFT)				(SHIFT)		
61											
62	DEL		3F		DEL		3F		DEL		3F
63	SP		00		SP		00		SP		00
64	7		28		7		28		7		28
65	8		38		8		38		8		38
66	9		34		9		34		9		34
67	4		04		4		04		4		04
68	5		08		5		08		5		08
69	6		18		6		18		6		18
70	1		20		1		20		1		20
71	2		10		2		10		2		10
72	3		30		3		30		3		30
73	0		24		0		24		0		24
74	.		11		.		11		.		11
75	−	+	37		−	+	37		−	+	37
76											
77	SP		00		SP		00		SP		00
78	,		3B		,		3B		,		3B
79	HT		2F		HT		2F		HT		2F

*Non-repeat key   Characters and functions in shaded area available in Enhanced Mode only.

NOT USED
NOT USED
NOT USED
NOT USED

ON

OFF

1 2 3 4 5 6 7 8

2741 CORRESPONDENCE (ON)
PTTC/EBCD (OFF)
DCI/DC3 ENABLE
ETX/ACK ENABLE
ENHANCED 2741

DEFEAT 30 120 ON   EVEN ON 10 ON   2741 ON   ON

PAPER SPEED DUPLEX   ODD | AUTO   ANSI APL | TEST
OUT   PARITY | CR   PROP
          12   SPACE
         PITCH

ERROR   MODE

PARITY PRINTER OVFL COVER KEY PAPER ATTN RIBBON   DATA LOCAL PROCD

BREAK RESET   FF   LF   92   98   AUTO LF SCROLL POWER

—88—

* BLANK SWITCHES SERIES 1640 ONLY

80 81 82
LOAD | HERE | EJECT
FORM | IS | FORM

83 84 85
LOAD | DBL | UC
EROM | LF | ONLY

86 87 88
LOCAL | MARG | LINE
        CONT | EDIT

89 90 91

92 93 94

CODE 2

SET HT 3   CLR TABS 4   PLOT ON 5   PLOT OFF 6   FWD PRINT 7   BKWD PRINT 8   PRINT SUPP 9   CLR HT 10   LFT MAR 11   RHT MAR 12   SET HT 13   14   15   16   64   65   66

PRE   ! 1   @ 2   # 3 $ 4   % 5   ¬ 6   & 7   * 8   (9   ) 0   — -   + =   BACK SPACE   7 8 9

PRE 18 IL 19 IL 20 IL 21 IL 22 IL 23 IL 24 IL 25 IL 26   27   28 PN 29 RS 30   31 BS   67 68 69

TAB   Q W E R T Y U I O P   ¦ ¢   LINE FEED   4 5 6

32 HT 33   34 EOB 35   36   37   38 BY 39   40 HT 41 LC 42   43 PRE 44   45   LF 46   70 71 72

CTRL LOCK   A S D F G H J K L   : .   " '   } {   RETURN   1 2 3

49   50   51 EOT 52   53 PF 54 BS 55 LF 56 UN2 57 UN3 58 $ 59 '   NUL 60   NL 62   73 74 75

SHIFT   Z X C V B N M   < ,   > .   ? /   SHIFT   DEL   0 • =

UNI   RES   63 UC   NL   ,   .   /   DEL 77   78 79

SP   SP   HT

NOTES: 1. CONTROL CODES AND SPECIAL SYMBOLS REFERENCED BELOW KEYTOPS IDENTIFY "CTRL" MODE OUTPUTS, AVAILABLE IN 2741 ENHANCED MODE ONLY. THESE LEGENDS ARE NOT ENGRAVED ON KEYTOPS.

2. CHARACTER AND FUNCTIONS IN SHADED AREAS AVAILABLE IN 2741 ENHANCED MODE ONLY.

3. "PRE" CHARACTER IS TRANSMITTED IN 2741 ENHANCED MODE ONLY.

Figure B-1c

47-KEY TYPEWRITER PAIRED 2741 PTTC/EBCD KEYBOARD
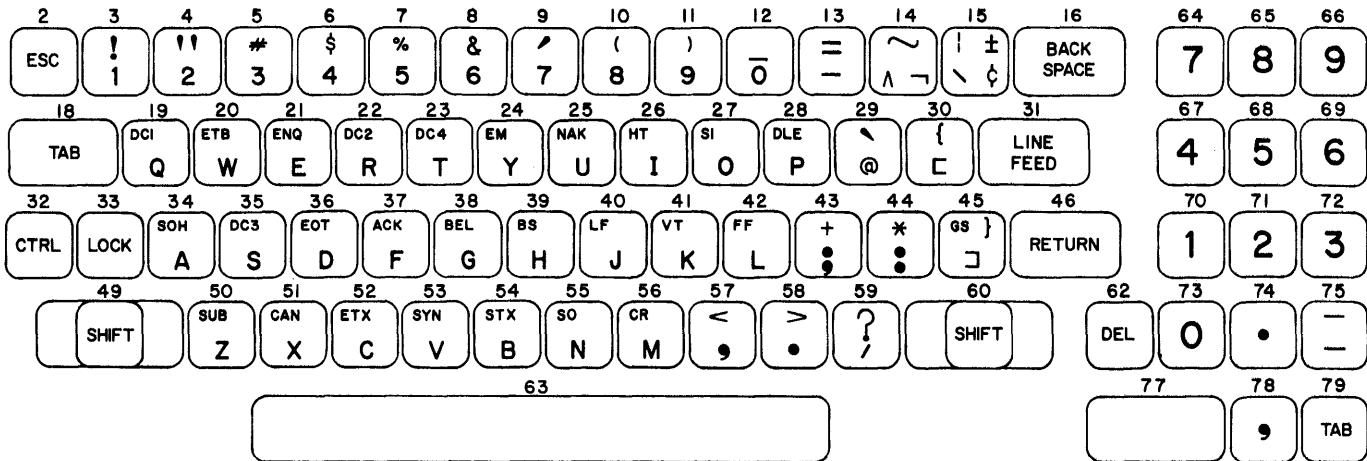
| Key Position	Unshifted Character STD	APL	Unshifted Hex STD	APL	Shifted Character STD	APL	Shifted Hex STD	APL	Control Character STD	APL	Control Hex STD	APL
1												
2*	PRE		3E		PRE		3E		PRE		3E	
3	1		20		!	¨	35	20	IL		3D	
4	2		10		@	‾	02	10	IL		3D	
5	3		30		#	<	34	30	IL		3D	
6	4		08		$	≤	35	08	IL		3D	
7	5		28		%	=	37	28	IL		3D	
8	6		18		¬	≥	37	18	IL		3D	
9	7		38		&	>	03	28	IL		3D	
10	8		04		*	≠	04		IL		3D	
11	9		24		(	∨	24		Not Used			
12	0		14		)	∧	14		Not Used			
13	–	+	01		‾	–	01		PN		0C	
14	=	×	20	03	‾+	÷	03		RS		2C	
15	Not Used				Not Used				Not Used			
16	BS		1D		BS		1D		BS		1D	
17												
18	HT		2F		HT		2F		HT		2F	
19	q	Q	05		Q	?	05		Not Used			
20	w	W	1A		W	ω	1A		EOB		1E	
21	e	E	2B		E	ε	2B		Not Used			
22	r	R	25		R	ρ	25		Not Used			
23	t	T	32		T	~	32		Not Used			
24	y	Y	06		Y	↑	06		BY		0E	
25	u	U	0A		U	↓	0A		Not Used			
26	i	I	27		I	ι	27		HT		2F	
27	o	O	19		O	○	19		LC		1F	
28	p	P	39		P	*	39		Not Used			
29	N/U	←		02	N/U	→		02	PRE		3E	
30	¢	N/U	02				N/U	36		Not Used			
31	LF		2E		LF		2E		LF		2E	
32	CTRL				CTRL				(CTRL)			
33	LOCK				LOCK				(LOCK)			
34	a	A	23		A	∝	23		Not Used			
35	s	S	12		S	⌈	12		Not Used			
36	d	D	0B		D	⌊	0B		EOT		3C	
37	f	F	1B		F	_	1B		Not Used			
38	g	G	3B		G	∇	3B		PF		0F	
39	h	H	07		H	∆	07		BS		1D	
40	j	J	21		J	○	21		LF		2E	
41	k	K	11		K	'	11		UN2		15	
42	l	L	31		L	☐	31		UN3		17	
43	;	[	30	35	:	(	08	35	:	[	30	35
44	'	]	18	34	"	)		34	'	]	18	34
45	Not Used				Not Used				Not Used			
46	NL		2D		NL		2D		NL		2D	
47												
48												
49	SHIFT				(SHIFT)				(SHIFT)			
50	z	Z	26		Z	⊂	26		UN1		16	
51	x	X	3A		X	⊃	3A		RES		0D	
52	c	C	33		C	∩	33		Not Used			
53	v	V	2A		V	∪	2A		Not Used			
54	b	B	13		B	⊥	13		Not Used			
55	n	N	29		N	⊤	29		UC		1C	
56	m	M	09		M			09		NL		2D	
57	,		36		<	;	10	36	,		36	
58	.		37		>	:	38	37	.		37	
59	/		22		?	\	22		/		22	
60	SHIFT				(SHIFT)				(SHIFT)			
61												
62	DEL		3F		DEL		3F		DEL		3F	
63	SP		00		SP		00		SP		00	
64	7		38		7		38		7		38	
65	8		04		8		04		8		04	
66	9		24		9		24		9		24	
67	4		08		4		08		4		08	
68	5		28		5		28		5		28	
69	6		18		6		18		6		18	
70	1		20		1		20		1		20	
71	2		10		2		10		2		10	
72	3		30		3		30		3		30	
73	0		14		0		14		0		14	
74	.		37		.		37		.		37	
75	–	+	01		–	+	01		–	+	01	
76												
77	SP		00		SP		00		SP		00	
78	,		36		,		36		,		36	
79	HT		2F		HT		2F		HT		2F	

*Non-repeat key Characters and functions in shaded area available in Enhanced Mode only.
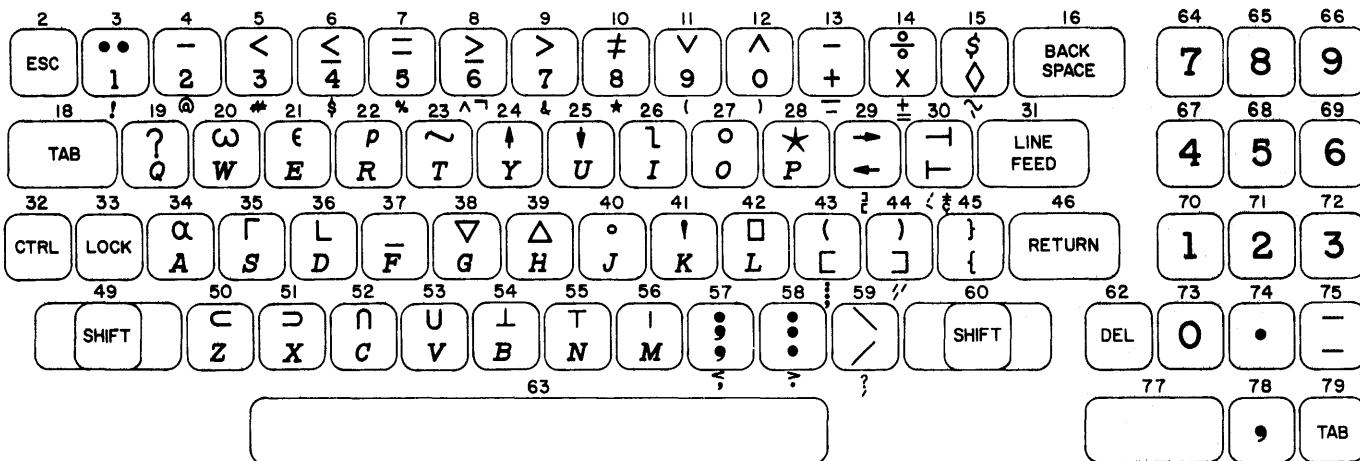
Keys 83-88 are latching keys.
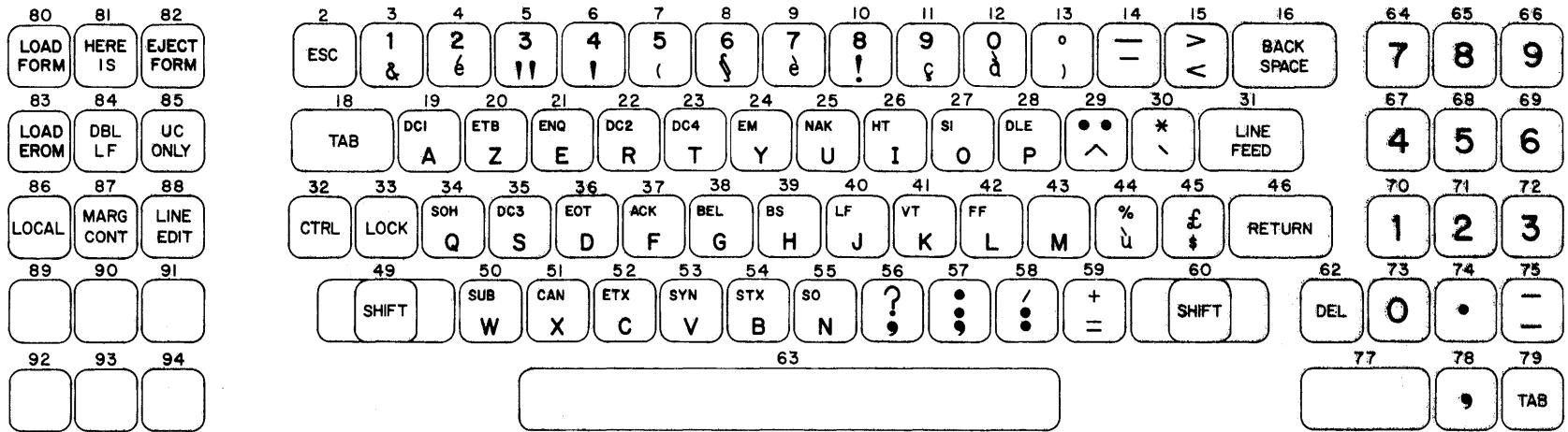
Figure B-2   47-KEY LOGICAL BIT PAIRED KEYBOARD
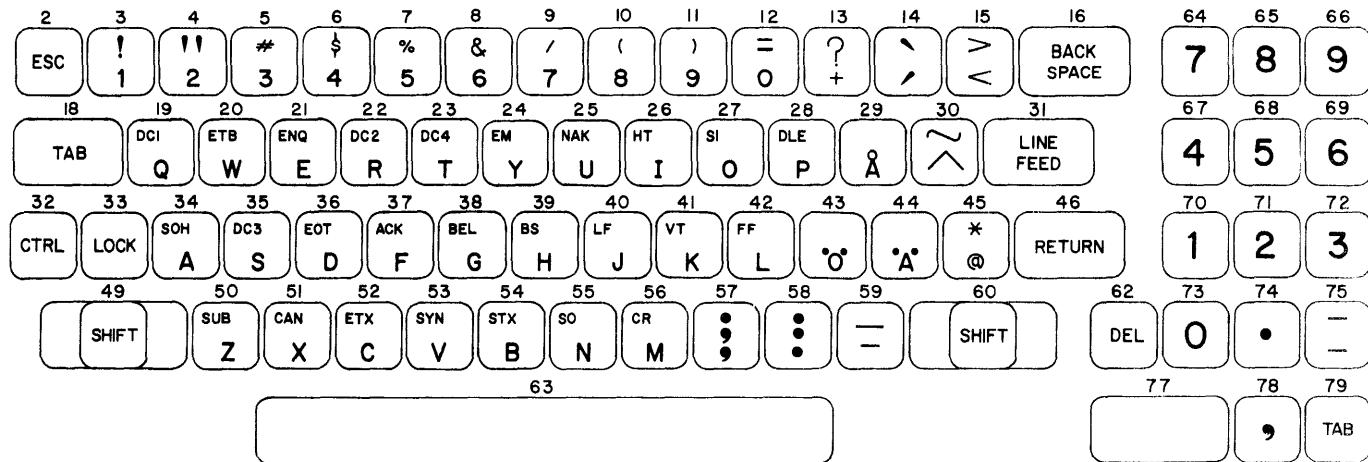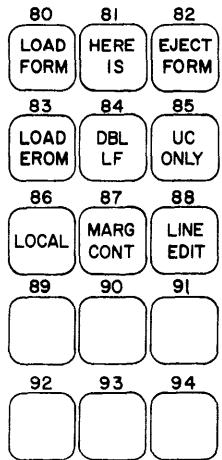
Keys 83-88 are latching keys.

Figure B-3   47-KEY APL KEYBOARD

Keys 83-88 are latching keys.
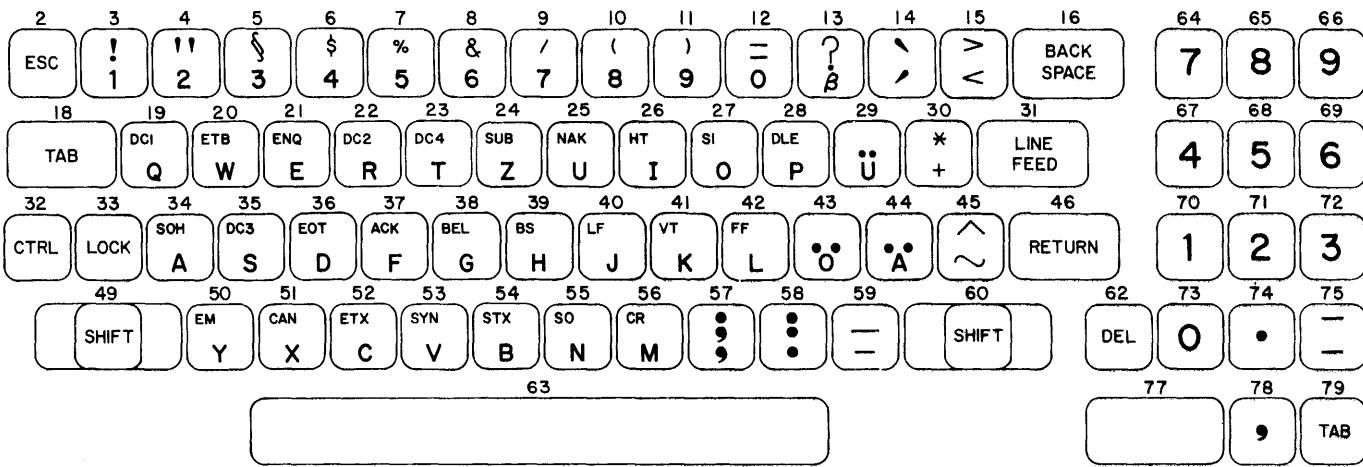
Figure B-4   47-KEY FRENCH AZERTY KEYBOARD

80	81	82
LOAD FORM	HERE IS	EJECT FORM
83	**84**	**85**
LOAD EROM	DBL LF	UC ONLY
86	87	88
LOCAL	MARG CONT	LINE EDIT
89	90	91
92	93	94

Keyboard layout:

Row 1: 2 ESC | 3 ! 1 | 4 " 2 | 5 # 3 | 6 $ 4 | 7 % 5 | 8 & 6 | 9 / 7 | 10 (8 | 11) 9 | 12 = 0 | 13 ? + | 14 ` ´ | 15 > < | 16 BACK SPACE

Numeric: 64 7 | 65 8 | 66 9

Row 2: 18 TAB | 19 DCI Q | 20 ETB W | 21 ENQ E | 22 DC2 R | 23 DC4 T | 24 EM Y | 25 NAK U | 26 HT I | 27 SI O | 28 DLE P | 29 Å | 30 ~ | 31 LINE FEED

Numeric: 67 4 | 68 5 | 69 6

Row 3: 32 CTRL | 33 LOCK | 34 SOH A | 35 DC3 S | 36 EOT D | 37 ACK F | 38 BEL G | 39 BS H | 40 LF J | 41 VT K | 42 FF L | 43 °Ö° | 44 °Ä° | 45 * @ | 46 RETURN

Numeric: 70 1 | 71 2 | 72 3

Row 4: 49 SHIFT | 50 SUB Z | 51 CAN X | 52 ETX C | 53 SYN V | 54 STX B | 55 SO N | 56 CR M | 57 ; : | 58 . : | 59 — | 60 SHIFT

62 DEL | 73 0 | 74 • | 75 —

Row 5: 63 (space bar)

77 | 78 , | 79 TAB

Keys 83-88 are latching keys.

Figure B-5   47-KEY SCANDINAVIAN KEYBOARD
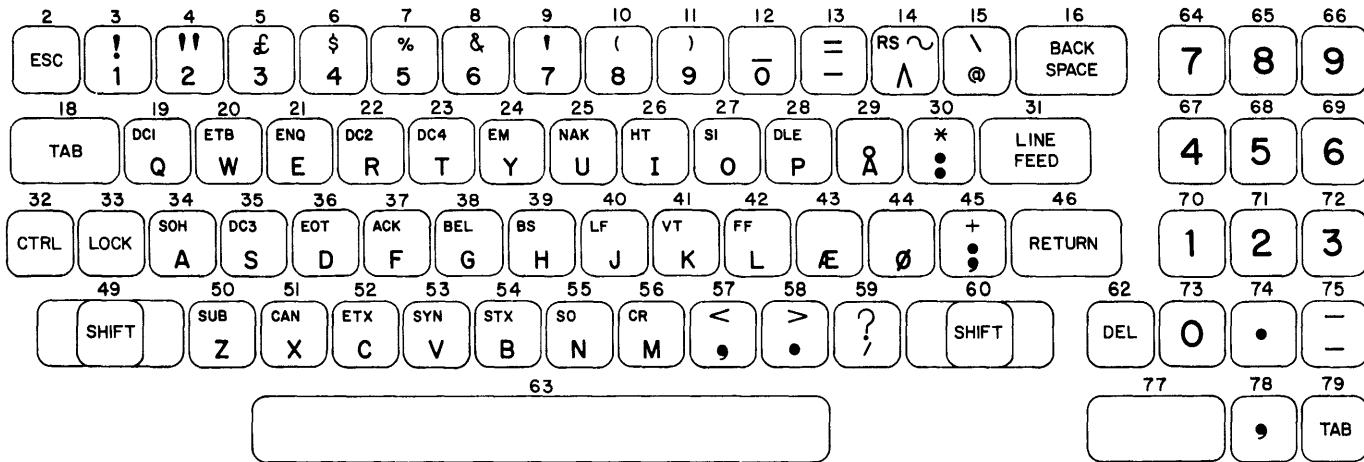
Keys 83-88 are latching keys.

Figure B-6   47-KEY GERMAN KEYBOARD

Keys 83-88 are latching keys.
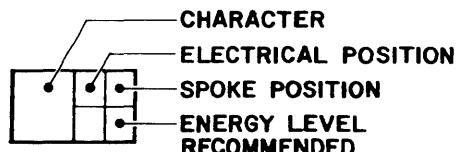
Figure B-7   47-KEY NORSK KEYBOARD

(

PRINT WHEEL CODE CHARTS
(Typical)

b7 (MSB)				0	0	1	1	1	1
b6				1	1	0	0	1	1
b5				0	1	0	1	0	1
b4	**b3**	**b2**	**b1**						
0	0	0	0	¢ 2 94 / 3	O 37 59 / 3	@ 62 34 / 4	P 26 70 / 4	` 56 40 / 1	p 90 6 / 4
0	0	0	1	! 68 28 / 2	1 33 63 / 2	A 11 85 / 3	Q 27 69 / 4	a 84 12 / 2	q 92 4 / 4
0	0	1	0	" 70 26 / 2	2 34 62 / 3	B 8 88 / 4	R 13 83 / 4	b 78 18 / 4	r 81 15 / 2
0	0	1	1	# 46 50 / 3	3 35 61 / 2	C 10 86 / 3	S 14 82 / 3	c 79 17 / 2	s 88 8 / 3
0	1	0	0	$ 44 52 / 4	4 36 60 / 3	D 22 74 / 4	T 16 80 / 3	d 76 20 / 3	t 86 10 / 2
0	1	0	1	% 47 49 / 3	5 38 58 / 3	E 15 81 / 4	U 23 73 / 4	e 83 13 / 2	u 91 5 / 3
0	1	1	0	& 69 27 / 3	6 39 57 / 3	F 9 87 / 4	V 30 66 / 4	f 89 7 / 3	v 73 23 / 2
0	1	1	1	' 54 42 / 1	7 40 56 / 2	G 24 72 / 4	W 4 92 / 4	g 74 22 / 4	w 0 0 / 3
1	0	0	0	(60 36 / 2	8 41 55 / 3	H 17 79 / 4	X 32 64 / 4	h 87 9 / 3	x 75 21 / 3
1	0	0	1	) 58 38 / 2	9 42 54 / 3	I 20 76 / 2	Y 25 71 / 4	i 85 11 / 2	y 94 2 / 4
1	0	1	0	* 61 35 / 3	: 12 84 / 1	J 29 67 / 3	Z 7 89 / 3	j 72 24 / 3	z 95 1 / 3
1	0	1	1	+ 45 51 / 2	; 31 65 / 2	K 28 68 / 4	[53 43 / 2	k 93 3 / 3	{ 49 47 / 2
1	1	0	0	, 3 93 / 1	< 57 39 / 2	L 21 75 / 4	\ 63 33 / 2	l 77 19 / 2	¦ 59 37 / 2
1	1	0	1	— 43 53 / 1	= 48 48 / 3	M 6 90 / 4	] 51 45 / 2	m 71 25 / 4	} 67 29 / 2
1	1	1	0	. 5 91 / 1	> 50 46 / 2	N 19 77 / 4	^ 64 32 / 1	n 82 14 / 3	~ 52 44 / 1
1	1	1	1	/ 66 30 / 2	? 65 31 / 2	O 18 78 / 3	_ 55 41 / 2	o 80 16 / 3	¬ 1 95 / 1

CHARACTER
ELECTRICAL POSITION
SPOKE POSITION
ENERGY LEVEL RECOMMENDED

NOTES:
1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK.
2. ▰ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

Figure C-1   96 CHARACTER PRINT WHEEL – PLASTIC

Figure C-2 describes an 88 CHARACTER PRINT WHEEL – METAL. Each cell format is: **CHARACTER** — ELECTRICAL POSITION / SPOKE POSITION / ENERGY LEVEL RECOMMENDED.

b4	b3	b2	b1	b7=0 b6=1 b5=0	b7=0 b6=1 b5=1	b7=1 b6=0 b5=0	b7=1 b6=0 b5=1	b7=1 b6=1 b5=0	b7=1 b6=1 b5=1
0	0	0	0	¢ 5/91/3	O 86/10/4	@ 75/21/4	P 10/86/4	, 78/18/1	p 67/29/4
0	0	0	1	! 37/59/2	1 82/14/2	A 18/78/4	Q 52/44/4	a 59/37/3	q 72/24/4
0	0	1	0	" 33/63/2	2 83/13/3	B 8/88/4	R 28/68/4	b 68/28/3	r 55/41/2
0	0	1	1	# 92/4/4	3 84/12/3	C 36/60/3	S 14/82/4	c 62/34/3	s 51/45/3
0	1	0	0	$ 7/89/4	4 85/11/3	D 32/64/4	T 19/77/3	d 60/36/3	t 53/43/3
0	1	0	1	% 79/17/4	5 87/9/3	E 16/80/4	U 34/62/4	e 58/38/3	u 63/33/3
0	1	1	0	& 77/19/4	6 88/8/3	F 22/74/4	V 12/84/4	f 45/51/3	v 64/32/3
0	1	1	1	' 23/73/1	7 89/7/3	G 40/56/4	W 42/54/4	g 65/31/4	w 54/42/3
1	0	0	0	(76/20/2	8 90/6/4	H 26/70/4	X 50/46/4	h 61/35/3	x 70/26/3
1	0	0	1	) 74/22/2	9 91/5/3	I 25/71/3	Y 44/52/4	i 47/49/2	y 66/30/3
1	0	1	0	* 15/81/3	: 29/67/2	J 21/75/3	Z 6/90/3	j 49/47/3	z 71/25/3
1	0	1	1	+ 11/85/2	; 27/69/2	K 46/50/4		k 69/27/3	. 80/16/1
1	1	0	0	, 41/55/1	¼ 81/15/4	L 20/76/3		l 43/53/2	
1	1	0	1	– 35/61/1	= 9/87/2	M 38/58/4		m 48/48/4	
1	1	1	0	. 39/57/1	½ 73/23/4	N 24/72/4		n 57/39/3	
1	1	1	1	/ 31/65/2	? 17/79/2	O 30/66/4	— 13/83/1	o 56/40/3	
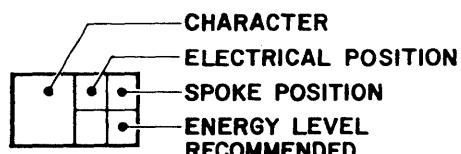
Legend:
- CHARACTER
- ELECTRICAL POSITION
- SPOKE POSITION
- ENERGY LEVEL RECOMMENDED

NOTES:
1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK.
2. ▨ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

Figure C-2   88 CHARACTER PRINT WHEEL – METAL

Figure C-3 — 92 Character Print Wheel table. Each cell shows the character, its two electrical positions (top) and recommended energy level (bottom).

b4	b3	b2	b1	b7=0 b6=1 b5=0	b7=0 b6=1 b5=1	b7=1 b6=0 b5=0	b7=1 b6=0 b5=1	b7=1 b6=1 b5=0	b7=1 b6=1 b5=1
0	0	0	0	¢ 5/91 · 3	O 86/10 · 4	@ 75/21 · 4	P 10/86 · 4	, 78/18 · 1	p 67/29 · 4
0	0	0	1	! 37/59 · 2	1 82/14 · 2	A 18/78 · 4	Q 52/44 · 4	a 59/37 · 3	q 72/24 · 4
0	0	1	0	" 33/63 · 2	2 83/13 · 3	B 8/88 · 4	R 28/68 · 4	b 68/28 · 3	r 55/41 · 2
0	0	1	1	# 92/4 · 4	3 84/12 · 3	C 36/60 · 3	S 14/82 · 4	c 62/34 · 3	s 51/45 · 3
0	1	0	0	$ 7/89 · 4	4 85/11 · 3	D 32/64 · 4	T 19/77 · 3	d 60/36 · 3	t 53/43 · 3
0	1	0	1	% 79/17 · 4	5 87/9 · 3	E 16/80 · 4	U 34/62 · 4	e 58/38 · 3	u 63/33 · 3
0	1	1	0	& 77/19 · 4	6 88/8 · 3	F 22/74 · 4	V 12/84 · 4	f 45/51 · 3	v 64/32 · 3
0	1	1	1	' 23/73 · 1	7 89/7 · 3	G 40/56 · 4	W 42/54 · 4	g 65/31 · 4	w 54/42 · 3
1	0	0	0	(76/20 · 2	8 90/6 · 4	H 26/70 · 4	X 50/46 · 4	h 61/35 · 3	x 70/26 · 3
1	0	0	1	) 74/22 · 2	9 91/5 · 3	I 25/71 · 3	Y 44/52 · 4	i 47/49 · 2	y 66/30 · 3
1	0	1	0	* 15/81 · 3	: 29/67 · 2	J 21/75 · 3	Z 6/90 · 3	j 49/47 · 3	z 71/25 · 3
1	0	1	1	+ 11/85 · 2	; 27/69 · 2	K 46/50 · 4	2/3 3/93 · 4	k 69/27 · 3	. 80/16 · 1
1	1	0	0	, 41/55 · 1	1/4 81/15 · 4	L 20/76 · 3	£ 4/92 · 4	l 43/53 · 2	
1	1	0	1	− 35/61 · 1	= 9/87 · 2	M 38/58 · 4	1/3 93/3 · 4	m 48/48 · 4	
1	1	1	0	. 39/57 · 1	1/2 73/23 · 4	N 24/72 · 4	3/4 94/2 · 4	n 57/39 · 3	
1	1	1	1	/ 31/65 · 2	? 17/79 · 2	O 30/66 · 4	— 13/83 · 1	o 56/40 · 3	

Legend:
- CHARACTER
- ELECTRICAL POSITION
- SPOKE POSITION
- ENERGY LEVEL RECOMMENDED

NOTES:
1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK.
2. ▥ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

Figure C-3   92 CHARACTER PRINT WHEEL — METAL
(Rank Xerox)

96 CHARACTER PRINT WHEEL — METAL (Diablo)

Each cell shows: character, electrical position / spoke position / energy level recommended.

b4	b3	b2	b1	b7b6b5 = 010	011	100	101	110	111
0	0	0	0	¢ 0/0/3	O 86/10/4	@ 75/21/4	P 10/86/4	` 95/1/1	p 67/29/4
0	0	0	1	! 37/59/2	1 82/14/2	A 18/78/4	Q 52/44/4	a 59/37/3	q 72/24/4
0	0	1	0	" 33/63/2	2 83/13/3	B 8/88/4	R 28/68/4	b 68/28/3	r 55/41/2
0	0	1	1	# 92/4/4	3 84/12/3	C 36/60/3	S 14/82/4	c 62/34/3	s 51/45/3
0	1	0	0	$ 7/89/4	4 85/11/3	D 32/64/4	T 19/77/3	d 60/36/3	t 53/43/3
0	1	0	1	% 79/17/4	5 87/9/3	E 16/80/4	U 34/62/4	e 58/38/3	u 63/33/3
0	1	1	0	& 77/19/4	6 88/8/3	F 22/74/4	V 12/84/4	f 45/51/3	v 64/32/3
0	1	1	1	' 39/57/1	7 89/7/3	G 40/56/4	W 42/54/4	g 65/31/4	w 54/42/3
1	0	0	0	(76/20/2	8 90/6/4	H 26/70/4	X 50/46/4	h 61/35/3	x 70/26/3
1	0	0	1	) 74/22/2	9 91/4/3	I 25/71/3	Y 44/52/4	i 47/49/2	y 66/30/3
1	0	1	0	* 15/81/3	: 29/67/2	J 21/75/3	Z 6/90/3	j 49/47/3	z 71/25/3
1	0	1	1	+ 11/85/2	; 27/69/2	K 46/50/4	[81/15/2	k 69/27/3	{ 4/92/2
1	1	0	0	, 78/18/1	< 41/55/2	L 20/76/3	\ 3/93/2	l 43/53/2	| 73/23/2
1	1	0	1	– 35/61/1	= 9/87/2	M 38/58/4	] 1/95/2	m 48/48/4	} 93/3/2
1	1	1	0	. 80/16/1	> 5/91/2	N 24/72/4	^ 2/94/1	n 57/39/3	~ 94/2/1
1	1	1	1	/ 31/65/2	? 17/79/2	O 30/66/4	_ 13/83/1	o 56/40/3	' 23/73/1

Legend:
- CHARACTER
- ELECTRICAL POSITION
- SPOKE POSITION
- ENERGY LEVEL RECOMMENDED

NOTES:
1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK,
2. ▱ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

Figure C-4   96 CHARACTER PRINT WHEEL – METAL
(Diablo)

Figure C-5 — 96 Character Print Wheel (Rank Xerox). Chart: character with electrical position / spoke position (top pair) and energy level / P/S units (bottom pair).

b4 b3 b2 b1	b7=0 b6=1 b5=0	b7=0 b6=1 b5=1	b7=1 b6=0 b5=0	b7=1 b6=0 b5=1	b7=1 b6=1 b5=0	b7=1 b6=1 b5=1
0 0 0 0	**[** 5 91 / 5 2	**O** 86 10 / 5 4	**@** 75 21 / 8 4	**P** 10 86 / 6 4	**,** 78 18 / 3 1	**p** 67 29 / 5 4
0 0 0 1	**!** 37 59 / 3 2	**1** 82 14 / 5 2	**A** 18 78 / 7 4	**Q** 52 44 / 7 4	**a** 59 37 / 5 3	**q** 72 24 / 5 4
0 0 1 0	**"** 33 63 / 4 2	**2** 83 13 / 5 3	**B** 8 88 / 6 4	**R** 28 68 / 7 4	**b** 68 28 / 5 3	**r** 55 41 / 4 2
0 0 1 1	**μ** 92 4 / 6 3	**3** 84 12 / 5 3	**C** 36 60 / 7 3	**S** 14 82 / 5 4	**c** 62 34 / 5 3	**s** 51 45 / 4 3
0 1 0 0	**$** 7 89 / 5 4	**4** 85 11 / 5 3	**D** 32 64 / 7 4	**T** 19 77 / 6 3	**d** 60 36 / 5 3	**t** 53 43 / 4 3
0 1 0 1	**%** 79 17 / 8 4	**5** 87 9 / 5 3	**E** 16 80 / 6 4	**U** 34 62 / 7 4	**e** 58 38 / 5 3	**u** 63 33 / 5 3
0 1 1 0	**&** 77 19 / 7 4	**6** 88 8 / 5 3	**F** 22 74 / 6 4	**V** 12 84 / 6 4	**f** 45 51 / 4 3	**v** 64 32 / 5 3
0 1 1 1	**'** 23 73 / 2 1	**7** 89 7 / 5 3	**G** 40 56 / 7 4	**W** 42 54 / 8 4	**g** 65 31 / 5 4	**w** 54 42 / 7 3
1 0 0 0	**(** 76 20 / 3 2	**8** 90 6 / 5 4	**H** 26 70 / 7 4	**X** 50 46 / 7 4	**h** 61 35 / 5 3	**x** 70 26 / 5 3
1 0 0 1	**)** 74 22 / 3 2	**9** 91 5 / 5 3	**I** 25 71 / 3 3	**Y** 44 52 / 7 4	**i** 47 49 / 3 2	**y** 66 30 / 5 3
1 0 1 0	***** 15 81 / 5 3	**:** 29 67 / 3 2	**J** 21 75 / 5 3	**Z** 6 90 / 6 3	**j** 49 47 / 3 3	**z** 71 25 / 5 3
1 0 1 1	**+** 11 85 / 5 2	**;** 27 69 / 3 2	**K** 46 50 / 7 4	**]** 3 93 / 6 4	**k** 69 27 / 5 3	**.** 80 16 / 3 1
1 1 0 0	**,** 41 55 / 3 1	**¼** 81 15 / 6 4	**L** 20 76 / 6 3	**£** 4 92 / 5 4	**l** 43 53 / 3 2	**<** 1 95 / 6 2
1 1 0 1	**−** 35 61 / 4 1	**=** 9 87 / 5 2	**M** 38 58 / 8 4	**°** 93 3 / 5 1	**m** 48 48 / 8 4	**2** 2 94 / 5 2
1 1 1 0	**.** 39 57 / 3 1	**½** 73 23 / 6 4	**N** 24 72 / 7 4	**¾** 94 2 / 6 4	**n** 57 39 / 5 3	**>** 95 1 / 6 2
1 1 1 1	**/** 31 65 / 4 2	**?** 17 79 / 5 2	**O** 30 66 / 7 4	**—** 13 83 / 5 1	**o** 56 40 / 5 3	**3** 0 0 / 5 2

Legend:
- CHARACTER
- ELECTRICAL POSITION
- SPOKE POSITION
- ENERGY LEVEL RECOMMENDED
- P/S UNITS

NOTES:
1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK.
2. ▨ DESIGNATES RECOMMENDED LEVEL THAT DEVIATES FROM A STD HYTYPE II PRINTER.
3. CHARACTERS SHOWN ON THIS DRAWING DO NOT REFLECT AESTHETICS OF INDIVIDUAL TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SPOKE POSITION AS VIEWED FROM THE CHARACTER SIDE OF THE PRINTWHEEL.

**Figure C-5 96 CHARACTER PRINT WHEEL — METAL**
(Rank Xerox)

APPENDIX D

DECIMAL VALUE TABLES

The Decimal Value Tables are used to determine the third character to use in 3-character sequences for setting format factors and for absolute tabbing. Setting HMI is covered in subsection 2.4.4.4; setting VMI is covered in subsection 2.4.4.5; lines per page is covered in subsection 2.4.4.6; Absolute Horizontal and Absolute Vertical Tabs in subsection 2.4.4.10. The following list summarizes the possible code sequences; use Tables D-2, -3 and -4 to find the third character (n) for ASCII coding, and Table D-5 for 2741 coding:

	ASCII	2741
Set HMI	ESC US (n)	PRE PN (n)
Set VMI	ESC RS (n)	PRE RS (n)
Lines Per Page	ESC FF (n)	PRE UN3 (n)
Absolute Horizontal Tab	ESC HT (n)	PRE HT (n)
Absolute Vertical Tab	ESC VT (n)	PRE UN2 (n)

Table D-1 gives a listing of decimal values for ASCII characters.

Table D-1
DECIMAL VALUES OF ASCII CHARACTERS

		Units									
		0	1	2	3	4	5	6	7	8	9
	0		SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT
	10	LF	VT	FF	CR	SO	SI	DLE	DC1	DC2	DC3
	20	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS
T	30	RS	US	SP	!	"	#	$	%	&	'
	40	(	)	*	+	,	−	.	/	0	1
e	50	2	3	4	5	6	7	8	9	:	;
	60	<	=	>	?	@	A	B	C	D	E
n	70	F	G	H	I	J	K	L	M	N	O
	80	P	Q	R	S	T	U	V	W	X	Y
s	90	Z	[	\	]	∧	_	`	a	b	c
	100	d	e	f	g	h	i	j	k	l	m
	110	n	o	p	q	r	s	t	u	v	w
	120	x	y	z	{			}	~			

Table D-2
ASCII VALUES FOR ESC SEQUENCES
Set HMI
Set VMI

HMI/VMI	ASCII Character	HMI/VMI	ASCII Character	HMI/VMI	ASCII Character	HMI/VMI	ASCII Character	HMI/VMI	ASCII Character
0	CTRL A (SOH)	26	CTRL [ESC	51	4	76	M	101	f
1	CTRL B (STX)	27	CTRL \ (FS)	52	5	77	N	102	g
2	CTRL C (ETX)	28	CTRL ` (GS)	53	6	78	O	103	h
3	CTRL D (EOT)	29	CTRL = (RS)	54	7	79	P	104	i
4	CTRL E (ENQ)	30	CTRL − (US)	55	8	80	Q	105	j
5	CTRL F (ACK)	31	SPACE	56	9	81	R	106	k
6	CTRL G (BEL)	32	!	57	:	82	S	107	l
7	CTRL H BACKSPACE	33	"	58	;	83	T	108	m
8	CTRL I TAB	34	#	59	<	84	U	109	n
9	CTRL J LINEFEED	35	$	60	=	85	V	110	o
10	CTRL K (VT)	36	%	61	>	86	W	111	p
11	CTRL L (FF)	37	&	62	?	87	X	112	q
12	CTRL M RETURN	38	'	63	@	88	Y	113	r
13	CTRL N (SO)	39	(	64	A	89	Z	114	s
14	CTRL O (SI)	40	)	65	B	90	]	115	t
15	CTRL P (DLE)	41	*	66	C	91	\	116	u
16	CTRL Q (DC1)	42	+	67	D	92	]	117	v
17	CTRL R (DC2)	43	,	68	E	93	^	118	w
18	CTRL S (DC3)	44	−	69	F	94	—	119	x
19	CTRL T (DC4)	45	.	70	G	95	`	120	y
20	CTRL U (NAK)	46	/	71	H	96	a	121	z
21	CTRL V (SYN)	47	0	72	I	97	b	122	{
22	CTRL W (ETB)	48	1	73	J	98	c	123	¦
23	CTRL X (CAN)	49	2	74	K	99	d	124	}
24	CTRL Y (EM)	50	3	75	L	100	e	125	~
25	CTRL Z (SUB)								

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Table D-3
ASCII VALUES FOR ESC SEQUENCES
Set Lines/Page
Set Absolute Horizontal Tab
Set Absolute Vertical Tab

Lines or Position	ASCII Character	Lines or Position	ASCII Character	Lines or Position	ASCII Character	Lines or Position	ASCII Character	Lines or Position	ASCII Character
1	CTRL A (SOH)	26	CTRL Z (SUB)	51	3	76	L	101	e
2	CTRL B (STX)	27	CTRL [ESC	52	4	77	M	102	f
3	CTRL C (ETX)	28	CTRL \ (FS)	53	5	78	N	103	g
4	CTRL D (EOT)	29	CTRL ` (GS)	54	6	79	O	104	h
5	CTRL E (ENQ)	30	CTRL = (RS)	55	7	80	P	105	i
6	CTRL F (ACK)	31	CTRL — (US)	56	8	81	Q	106	j
7	CTRL G (BEL)	32	SPACE	57	9	82	R	107	k
8	CTRL H BACKSPACE	33	!	58	:	83	S	108	l
9	CTRL I TAB	34	"	59	;	84	T	109	m
10	CTRL J LINEFEED	35	#	60	<	85	U	110	n
11	CTRL K (VT)	36	$	61	=	86	V	111	o
12	CTRL L (FF)	37	%	62	>	87	W	112	p
13	CTRL M RETURN	38	&	63	?	88	X	113	q
14	CTRL N (SO)	39	'	64	@	89	Y	114	r
15	CTRL O (SI)	40	(	65	A	90	Z	115	s
16	CTRL P (DLE)	41	)	66	B	91	[	116	t
17	CTRL Q (DC1)	42	*	67	C	92	\	117	u
18	CTRL R (DC2)	43	+	68	D	93	]	118	v
19	CTRL S (DC3)	44	,	69	E	94	^	119	w
20	CTRL T (DC4)	45	-	70	F	95	—	120	x
21	CTRL U (NAK)	46	.	71	G	96	`	121	y
22	CTRL V (SYN)	47	/	72	H	97	a	122	z
23	CTRL W (ETB)	48	0	73	I	98	b	123	{
24	CTRL X (CAN)	49	1	74	J	99	c	124	¦
25	CTRL Y (EM)	50	2	75	K	100	d	125	}
								126	~

2741 Correspondence Code

LOWER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	!	t	j	4	o	l	/	5	'	0
1	e	p	PN	RES	BY	PF	2	.	n	=	1
2	z	UN2	UN1	UN3	6	i	k	q	UC	BS	2
3	EOB	LC	1	m	x	g	0	s	h	y	3
4	7	r	d	;	RS	NL	LF	HT	3	v	4
5	u	f	9	w	b	-	8	a	c	,	5
6	EOT	IL	PRE	DEL							6

UPPER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	]	T	J	$	O	L	?	%	"	0
1	E	P	PN	RES	BY	PF	@	.	N	+	1
2	Z	UN2	UN1	UN3	[	I	K	Q	UC	BS	2
3	EOB	LC	±	M	X	G	)	S	H	Y	3
4	&	R	D	:	RS	NL	LF	HT	#	V	4
5	U	F	(	W	B	_	*	A	C	,	5
6	EOT	IL	PRE	DEL							6

032-004

2741 Correspondence Code (APL)

LOWER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	←	T	J	4	O	L	/	5	]	0
1	E	P	PN	RES	BY	PF	2	.	N	×	1
2	Z	UN2	UN1	UN3	6	I	K	Q	UC	BS	2
3	EOB	LC	1	M	X	G	0	S	H	Y	3
4	7	R	D	[	RS	NL	LF	HT	3	V	4
5	U	F	9	W	B	+	8	A	C	,	5
6	EOT	IL	PRE	DEL							6

UPPER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	→	~	°	≤	O	□	\	=	)	0
1	∈	*	PN	RES	BY	PF	‾	:	T	÷	1
2	⊂	UN2	UN1	UN3	≥	⍳	'	?	UC	BS	2
3	EOB	LC	¨	│	⊃	∇	∧	⌈	∆	↑	3
4	>	⍴	L	(	RS	NL	LF	HT	<	U	4
5	↓	_	∨	ω	⊥	-	≠	α	∩	;	5
6	EOT	IL	PRE	DEL							6

032-005

2741 PTTC/EBCD Code

LOWER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	-	@	&	8	q	y	h	4	m	0
1	u	d	PN	RES	BY	PF	2	k	s	b	1
2	o	UN2	UN1	UN3	6	o	w	f	UC	BS	2
3	EOB	LC	1	j	/	a	9	r	z	i	3
4	5	n	v	e	RS	NL	LF	HT	3	l	4
5	t	c	#	$	,	.	7	p	x	g	5
6	EOT	IL	PRE	DEL							6

UPPER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	-	¢	+	*	Q	Y	H	:	M	0
1	U	D	PN	RES	BY	PF	<	K	S	B	1
2	)	UN2	UN1	UN3	!	O	W	F	UC	BS	2
3	EOB	LC	=	J	?	A	(	R	Z	I	3
4	%	N	V	E	RS	NL	LF	HT	;	L	4
5	T	C	"	!			¬	>	P	X	G	5
6	EOT	IL	PRE	DEL							6

032-006

2741 PTTC/EBCD Code (APL)

LOWER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	+	←	×	8	Q	Y	H	4	M	0
1	U	D	PN	RES	BY	PF	2	K	S	B	1
2	O	UN2	UN1	UN3	6	O	W	F	UC	BS	2
3	EOB	LC	1	J	/	A	9	R	Z	I	3
4	5	N	V	E	RS	NL	LF	HT	3	L	4
5	T	C	]	[	,	.	7	P	X	G	5
6	EOT	IL	PRE	DEL							6

UPPER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9	
0	SP	-	→	÷	≠	?	↑	∆	≤	│	0
1	↓	L	PN	RES	BY	PF	‾	'	⌈	⊥	1
2	∧	UN2	UN1	UN3	≥	O	ω	_	UC	BS	2
3	EOB	LC	¨	°	\	α	∨	ρ	⊂	⍳	3
4	=	T	U	∈	RS	NL	LF	HT	<	□	4
5	~	∩	)	(	;	:	>	*	⊃	∇	5
6	EOT	IL	PRE	DEL							6

032-007

Table E-1
CHARACTER PROPORTIONAL SPACE UNITS - METAL PRINT WHEELS

PW POSITION	CHARACTER	PS UNIT		PW POSITION	CHARACTER	PS UNIT		PW POSITION	CHARACTER	PS UNIT		PW POSITION	CHARACTER	PS UNIT
1	( ])	(3)		25	I	3		49	j	3		73	½	6
2	(⌢)	(5)		26	H	7		50	X	7		74	)	3
3	⅔ (\ )	6 (5)		27	;	3		51	s	4		75	@	8
4	£ (⟨)	5 (3)		28	R	7		52	Q	7		76	(	3
5	¢ (⟩)	5		29	:	3		53	t	4		77	&	7
6	Z	6		30	O	7		54	w	7		78	,	3
7	$	5		31	/	4		55	r	4		79	%	8
8	B	6		32	D	7		56	o	5		80	.	3
9	=	5		33	"	4		57	n	5		81	¼	6
10	P	6		34	U	7		58	e	5		82	1	5
11	+	5		35	–	4		59	a	5		83	2	5
12	V	6		36	C	7		60	d	5		84	3	5
13	_	5		37	!	3		61	h	5		85	4	5
14	S	5		38	M	8		62	c	5		86	0	5
15	*	5		39	.	3		63	u	5		87	5	5
16	E	6		40	G	7		64	v	5		88	6	5
17	?	5		41	,	3		65	g	5		89	7	5
18	A	7		42	W	8		66	y	5		90	8	5
19	T	6		43	I	3		67	p	5		91	9	5
20	L	6		44	Y	7		68	b	5		92	#	6
21	J	5		45	f	4		69	k	5		93	⅓ (})	6 (3)
22	F	6		46	K	7		70	x	5		94	¾ (~)	6 (5)
23	'	2		47	i	3		71	z	5		95	(`)	(5)
24	N	7		48	m	8		72	q	5		0 (HOME)	(¢)	(5)

NOTES:
1. Units = 1/120 inch (.212mm) carriage movement.
2. Characters and PS unit values listed in this table represent 88-character "Titan 10", 92-character "Titan 10" (UK), and 96-character "Titan 10" print wheels. Parentheses ( ) are used where characters and/or PS units of the 96-character wheel differ from those of the 88 and 92-character wheels. PW POSITION utilization is 5 thru 92 for 88-character wheels, 3 thru 94 for 92-character wheels, and 1 thru 0 for 96-character wheels.

Table E-2
CHARACTER PROPORTIONAL SPACE UNITS – PLASTIC PRINT WHEEL

PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT	PW POSITION	CHARACTER	PS UNIT
1	¬	4	25	Y	6	49	{	3	73	v	5
2	¢	5	26	P	5	50	>	5	74	g	5
3	,	3	27	Q	6	51	]	4	75	x	5
4	W	7	28	K	6	52	~	5	76	d	5
5	.	3	29	J	4	53	[	4	77	l	3
6	M	7	30	V	6	54	'	2	78	b	5
7	Z	5	31	;	3	55	–	6	79	c	5
8	B	5	32	X	6	56	\	5	80	o	5
9	F	5	33	1	5	57	<	5	81	r	4
10	C	6	34	2	5	58	)	3	82	n	5
11	A	6	35	3	5	59	¦	2	83	e	5
12	:	3	36	4	5	60	(	3	84	a	5
13	R	6	37	0	5	61	*	4	85	i	3
14	S	5	38	5	5	62	@	7	86	t	4
15	E	5	39	6	5	63	\	4	87	h	5
16	T	5	40	7	5	64	^	5	88	s	4
17	H	6	41	8	5	65	?	5	89	f	4
18	O	6	42	9	5	66	/	4	90	p	5
19	N	6	43	–	5	67	}	3	91	u	5
20	I	3	44	$	5	68	!	3	92	q	5
21	L	5	45	+	5	69	&	6	93	k	5
22	D	6	46	#	5	70	"	4	94	y	5
23	U	6	47	%	5	71	m	7	95	z	5
24	G	6	48	=	5	72	j	2	0	w	7

NOTES:
1. Units = 1/120 inch (.212mm) carriage movement.
2. Characters and PS unit values listed in this table represent a 96 character plastic print wheel.

Table E-3
PRINT WHEEL PROGRAM MODE - CHARACTERS FOR HAMMER ENERGY AND RIBBON ADVANCE

HAMMER ENERGY	RIBBON ADVANCE 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	' US
2	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	Q	R	S	T	U	V	W	X	Y	Z	[	/	]	^	—
6	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	q	r	s	t	u	v	w	x	y	z	{	¦·	}	~	DEL

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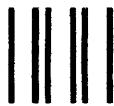
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