SERIES 1640/1650

PRINTERS and TERMINALS

MAINTENANCE MANUAL

90413-01 Rev A   Aug., 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 repair 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 change and/or service information is conveyed to the field in the form of manual revisions and addenda, and Field Service Aids sent to all product customers of record. Diablo publications may be requested from your Diablo Sales Representative, or may be ordered from Diablo in the same manner as spare parts. Comments on all Diablo publications or their use are invited. Please use the Comment Form at the back of this manual, or address your comments to:

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                     90413-01 – Second Edition – August, 1980

FCC NOTICE

This equipment generates and uses radio frequency energy and if not installed and used properly, i.e. in strict accordance with the manufacturer's instructions, may cause harmful interference to radio and television reception. It has been tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: a) Reorient the receiving antenna. b) Relocate the equipment with respect to the receiver. c) Move the equipment away from the receiver. d) Plug the equipment into a different outlet so that it and the receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. In addition, an FCC booklet "How To Identify and Resolve Radio-TV Interference Problems" Stock No. 004-000-00345-4 is available from the US Government Printing Office, Washington DC, 20402.

Printed in the USA

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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 key-
board. The 1650 Series produces an output of "word processor" quality
which can include two color printing and graphics. A choice of op-
tions, such as true proportional spacing and right margin justifica-
tion, vector plotting and remote diagnostics further expand the ver-
satility of the units.

1.1.2 Features

The units exchange data and status with a host controller or another remote terminal thru any one of a variety of possible communications links. See Appendix A.

1.1.2.1 Serial Interface

Either unit may be configured to interface with Bell type 103A, 113A, or 212A modems which make them compatible with other asynchronous modem employing the RS-232-C or CCITT V.24 interface specifications for serial data input and output. This interface features switch selectable baud rates and may be optionally configured to communicate 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 and 8 status lines, plus strobes for both input and status output, restore, store, ready, clear, and ground. The interface supports "Buffer Full" status reporting and features a typical operating speed of 5000 cps.

This interface can be used either for parallel communications or to support a keyboard. See subsection 1.1.2.4. Note that when using the parallel interface for host system communications the USART Module D55 should be removed from its socket on the HPRO4 PCB. Removing this module relieves the microprocessor 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 selectable. 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 Parallel Interface using a keyboard. Diablo keyboards are available in logical bit paired, typewriter paired, ASCII, APL, and various European 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 Processor 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
Without Control Panel

Speed	30	120	Baud Rate Selected
	ON	ON	110 (ASCII) 134.5 (2741)
	ON	OFF	300
	OFF	OFF	600
	OFF	ON	1200

1.2.2 The RO Printer

The basic version of this model includes the Print Mechanism described above plus the following:

* Internal Power Supply
* Operator Control Panel and/or a Cover Open Switch.

WARNING :   Lack of a cover open switch will allow a printer to possibly resume printing while the operator is correcting paper out or replacing the ribbon.

* Diablo RO Cover Set
* 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   Baud Rate Selection.  See Table 1-2.
A25-6,7 & 8  Keyboard Mode Selection.  See subsection 1.2.3.
```

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 1-3.
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 1-3.
LF. . . . . . . . . . . ON/OFF
FF. . . . . . . . . . . ON/OFF
RESET . . . . . . . . . ON/OFF
BREAK . . . . . . . . . ON/OFF
Error, Mode, and Power On Indicator Lights
```

TABLE 1-2
BAUD RATE (SPEED) SELECT SWITCH SETTINGS – With Control Panel

HPRO4 SW-5	Speed 30	Select 120	Baud Rate Selected
OFF	ON	ON	110 Baud (ASCII) 134.5 Baud (2741)
OFF	ON	OFF	300 Baud
OFF	OFF	OFF	600 Baud
OFF	OFF	ON	1200 Baud
ON	ON	ON	2000 Baud
ON	ON	OFF	2400 Baud
ON	OFF	OFF	4800 Baud
ON	OFF	ON	9600 Baud

See subsection 2.4.2.2

TABLE 1-3
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.
* = Defaults to Diablo 96 Character print wheel if no
    control panel installed.
** = Requires optional APL Logic.

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. HPRO4 switches A25-6, -7 & -8 may be used to select
             program support for the keyboard installed. See
             Table 1-4.
* A Friction Feed Platen
* A Diablo KSR Cover Set

TABLE 1-4
KEYBOARD MODE SELECTION **

HPRO4 Switch A25-			
-6	-7	-8	Keyboard Mode
OFF	OFF	OFF	(Default *)
ON	OFF	OFF	Typewriter Paired
OFF	ON	OFF	Logical Bit Paired
ON	ON	OFF	APL
OFF	OFF	ON	French AZERTY
ON	OFF	ON	German
OFF	ON	ON	Scandanavian
ON	ON	ON	Norsk

* = Default Mode is the same as Typewriter Paired Mode.
** = Control Panel APL switch will override the HPRO4
     switches when ON.

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 (clear with CR)
    Graphics off

Forward print on
Forward print off (clear with CR)
Print suppression on (clear with CR)
Set left margin
Set right margin
Negative line feed
Print in red
Print in black
Clear top and bottom margins
Half-line feed
Negative half-line feed
Set bottom page margin
Set top page margin
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 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 the print wheel character under ASCII code 20(Hex)
Print the 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
            Automatic carriage return at end of line mode (no CR needed)
            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
> 40 characters per second typical in 12 pitch mode printing an average English text.

PRINT SPEED, 1650 SERIES
> 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 Rank 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 impressions 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 LENGTH
> 11" (279.4mm) US Standard or 12" (304.8mm) European Standard, jumper selectable.

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 standard cartridge, 225,000 impressions per high capacity 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 overhead is to be excluded from any recorded printing time. Any host system 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; followed by a tab to column 4 where the sequence is repeated. This sequence 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 stand-
ard film ribbon cartridge, platen and 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.
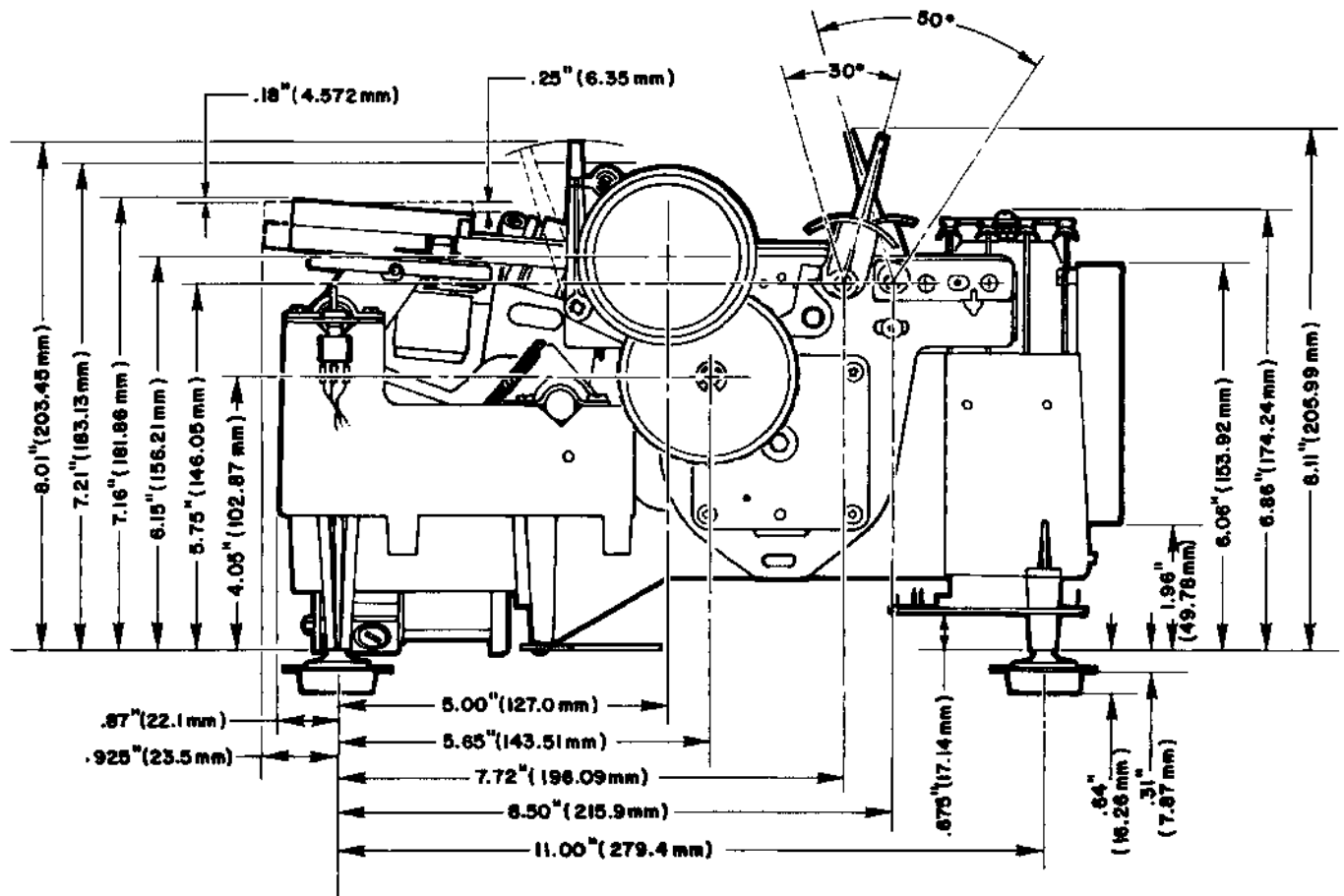
Figure 2-1A   Series 1640/1650 EXTERNAL DIMENSIONS
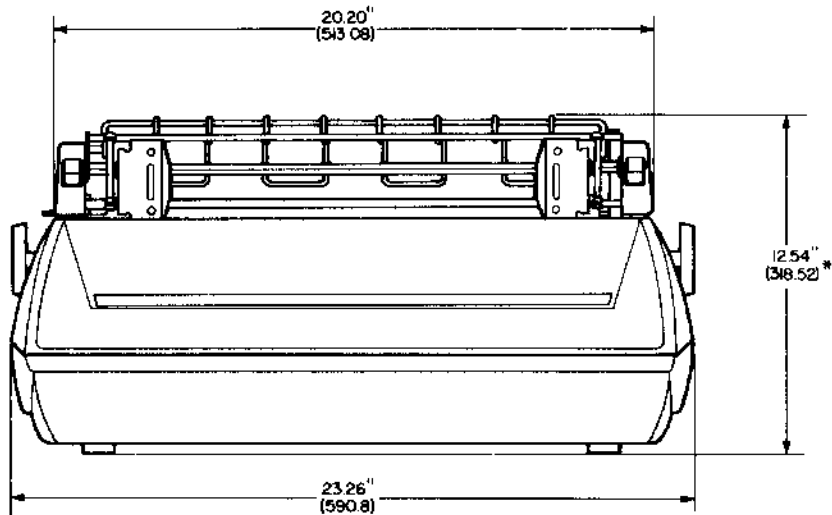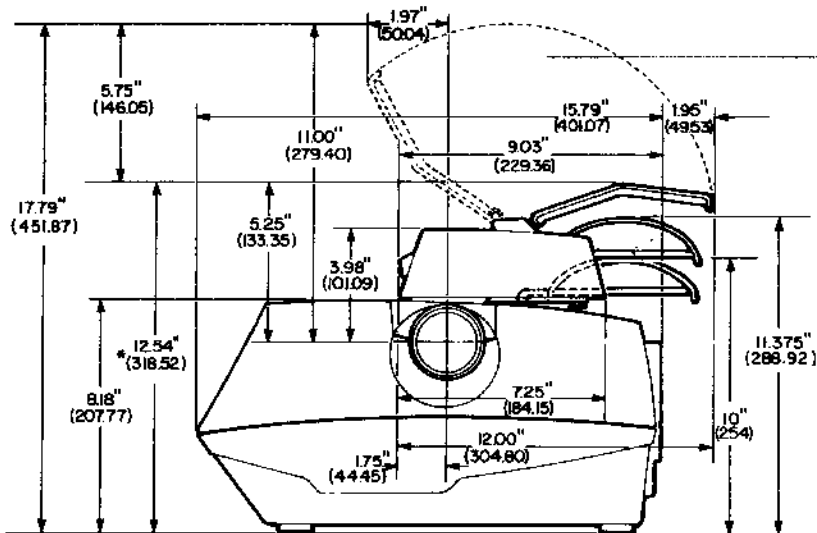
Figure 2-1B SERIES 1640/1650 EXTERNAL DIMENSIONS

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

Figure 2-2   DIABLO UNIDIRECTIONAL FORMS TRACTOR
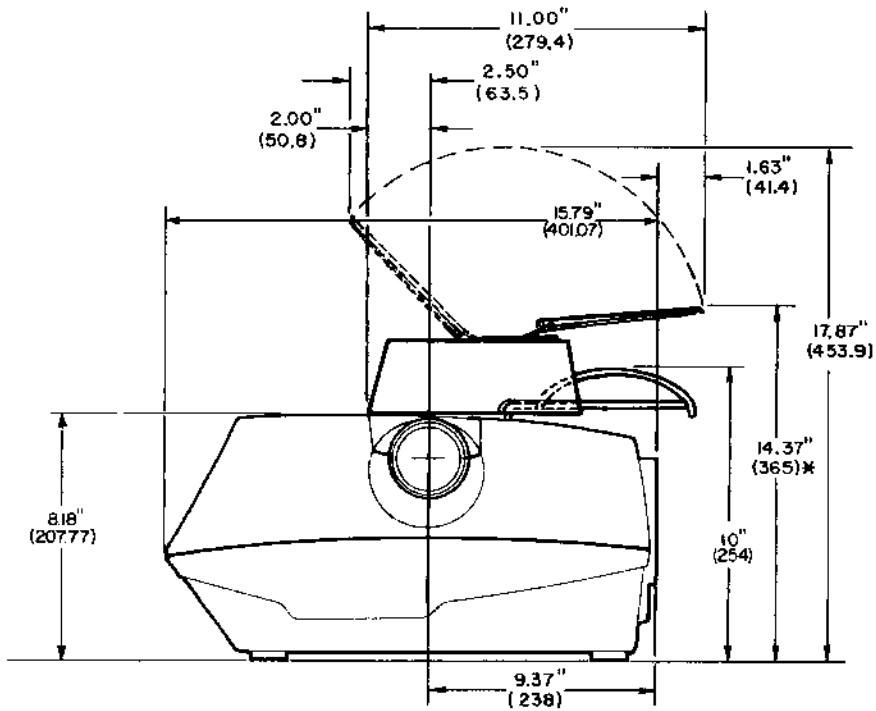
NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
*= ADJUSTABLE

Figure 2-3   DIABLO BIDIRECTIONAL FORMS TRACTOR
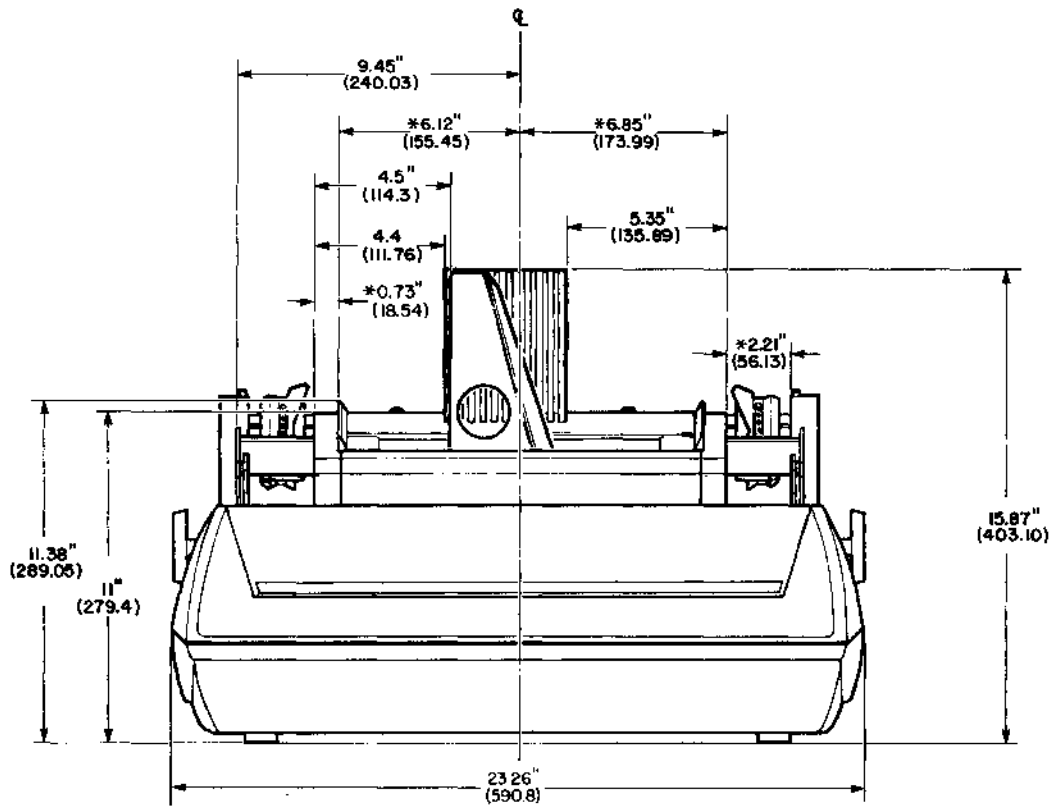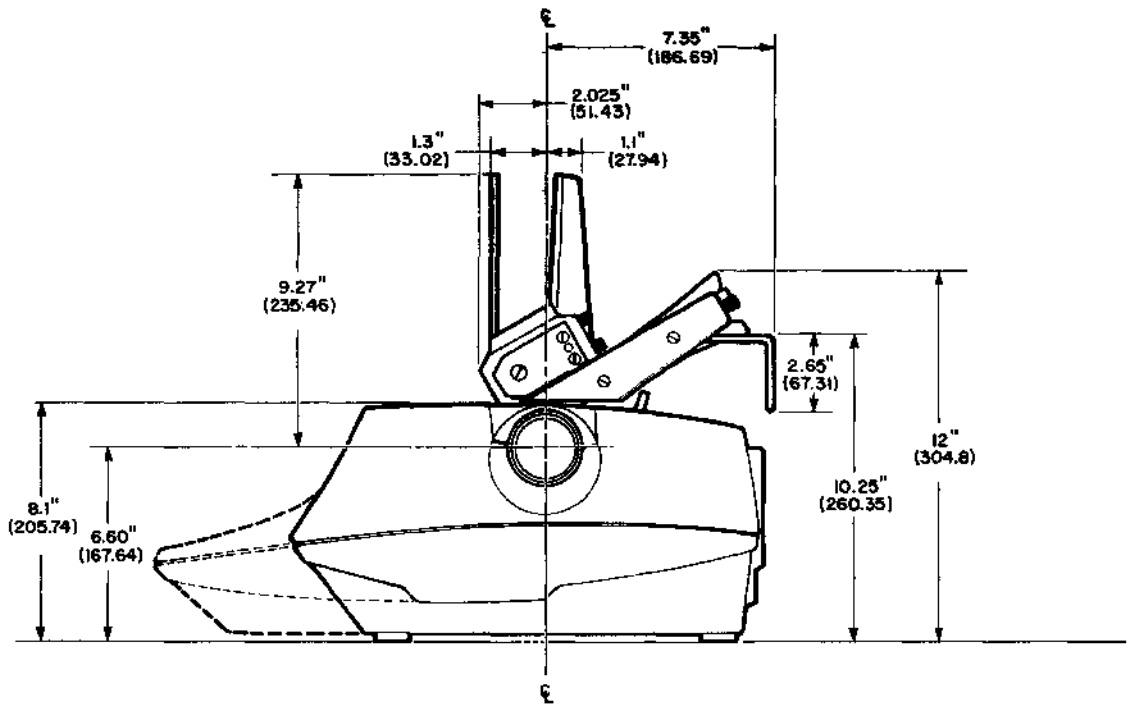
NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
* = ADJUSTABLE

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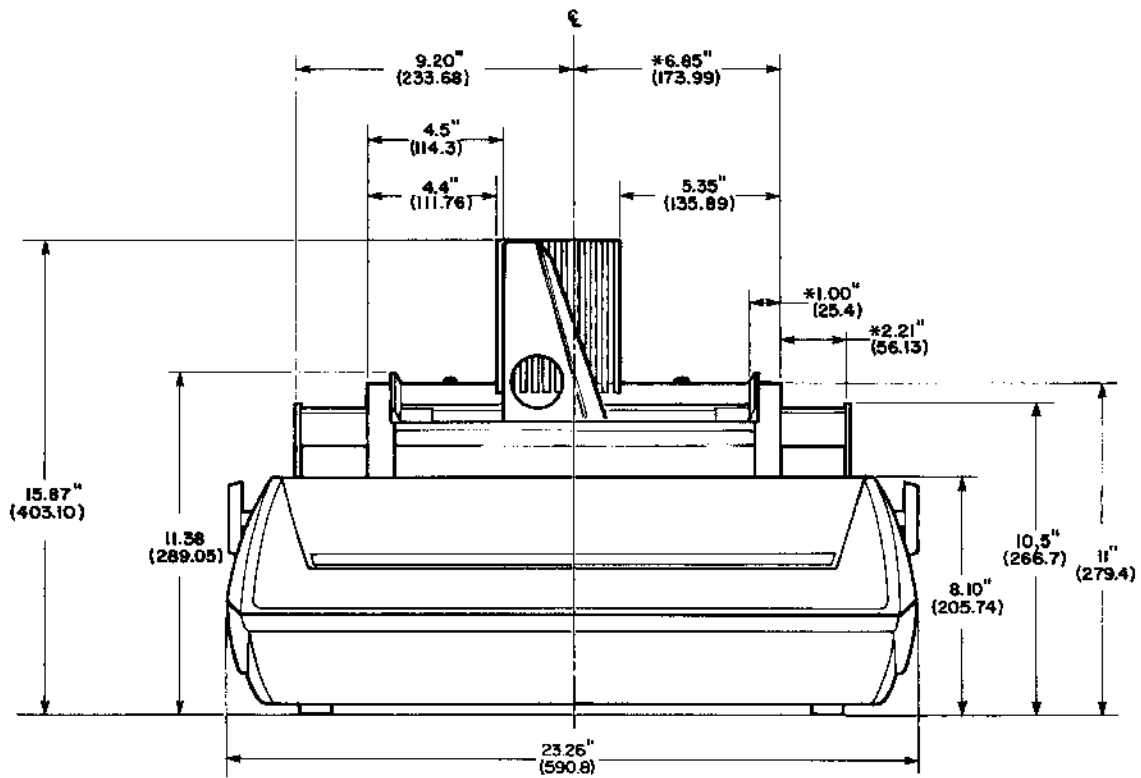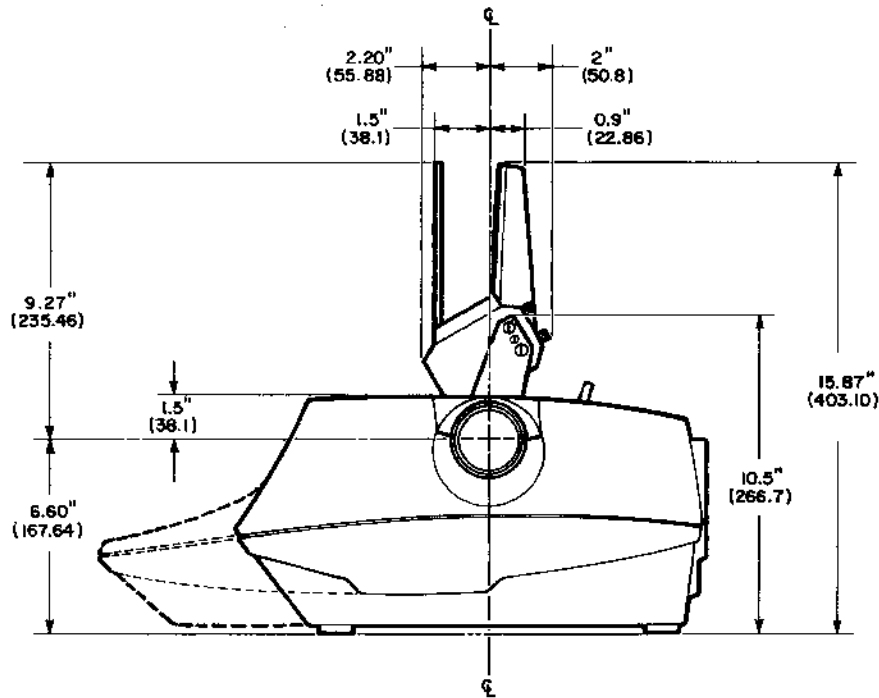
NOTES: ALL DIMENSIONS ARE NOMINAL,
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS
* = ADJUSTABLE

Figure 2-5   MECHANICAL FRONT FEED
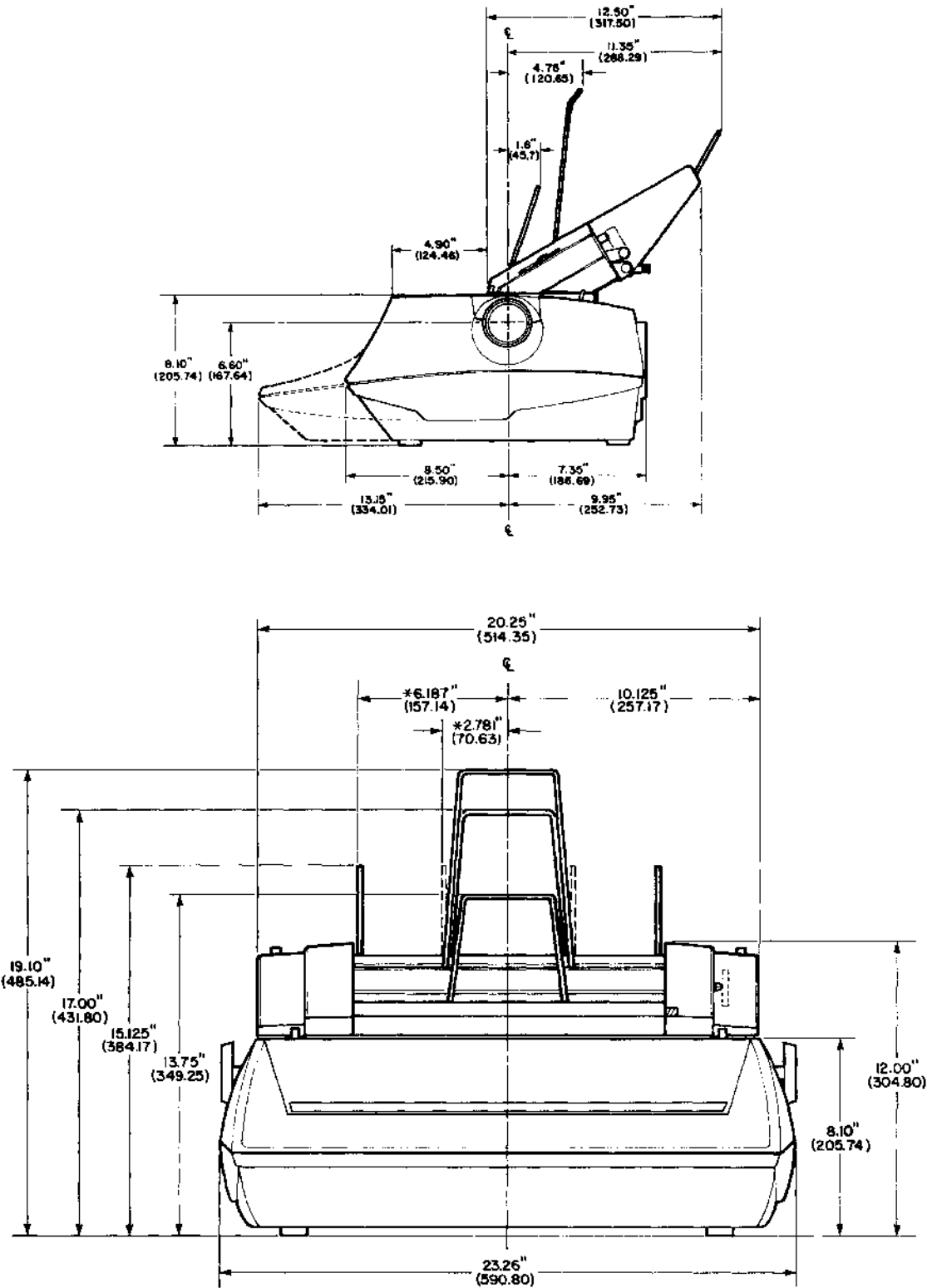
NOTES: ALL DIMENSIONS ARE NOMINAL.
DIMENSIONS SHOWN IN PARENTHESES ARE IN MILLIMETERS.
* = ADJUSTABLE

Figure 2-6   HyFEED SHEET FEEDER

2.1.2 Mounting

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 External Power Supply Requirements

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

NOTE: 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.

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

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

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.

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 (Paper Out)
5		(not used)		22	O	-Status 3 (Auto LF)
6	–	(key)		23	O	-Status 4 (Cover Open)
7	O	-Status 0 (End Of Ribbon)		24	O	-Status 5 (Printer Idle)
8	O	-Clear		25	I	-Restore
9	O	-Character Ready		26		Ground
10	O	-Status 1 (10 Pitch)		27	O	-Status Strobe
11	O	-12V		28		Ground
12	I	-Character Strobe		29	O	-Status 6 (Printer in Check)
13	I	-Data Bit 0		30		Ground
14	I	-Data Bit 7		31	O	-Status 7 (Printer Ready)
15	I	-Data Bit 6		32		Ground
16	I	-Data Bit 1		33		Ground
17	I	-Data Bit 5		34		Ground

Connector pin layout:

```
 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
```

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

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. The appropriate Current Loop I/O cable kit must be ordered separately as follows:

#301608-01	U. S. Standard
#301608-02	European
#301608-03	Honeywell Applications

For Half-Duplex operation - One Twisted Pair of wires;
For Full-Duplex operation - Two Twisted Pairs of wires; minimum 22 AWG. Maximum cable length tested is 4000 feet (1220 m).

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. +RLSD
6. -TxD	13. REC DATA (RCV A)
7. XMIT DATA (RTN)(XMIT A)	14. - RxD

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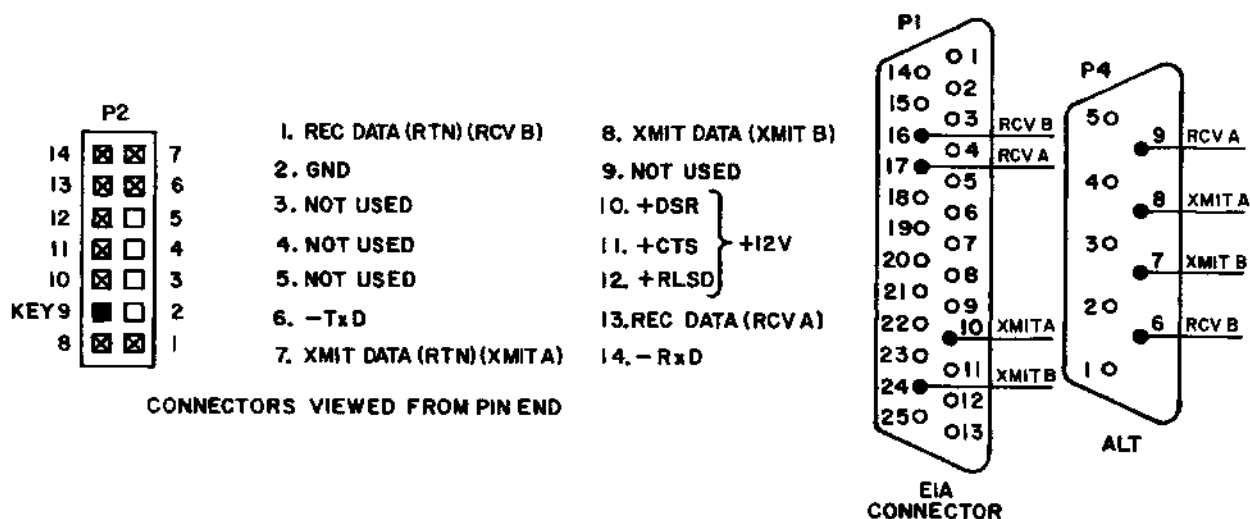
Figure 2-9   CURRENT LOOP I/O CABLE CONNECTOR PIN ASSIGNMENT

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 holding 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 machine 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 installing 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 posi-
tioned, 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 print-
ing on single sheets of paper using cloth ribbons. As the paper thick-
ness increases, as with multiple carbon forms or heavier paper stocks,
the lever is moved one or more detents to the rear. Each detent posi-
tion 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 fol-
lowing 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)
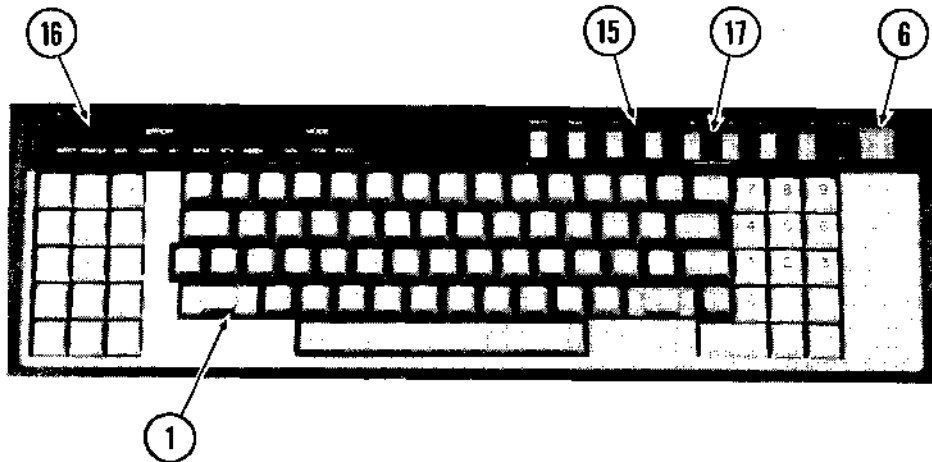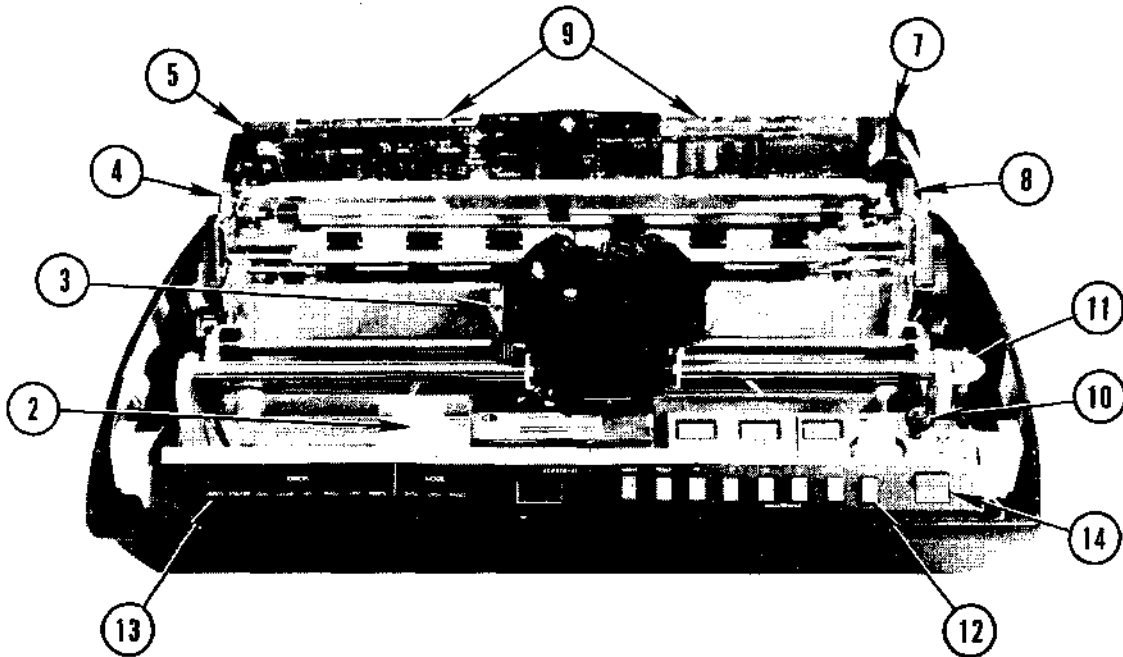
13. Control Panel Indicators (RO Version)
14. Power Switch (RO Version)
15. Control Panel Switches (KSR Version)
16. Control Panel Indicators (KSR Version)
17. Print Wheel Select Switches
    (1650 Series only)

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.

> ○ (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
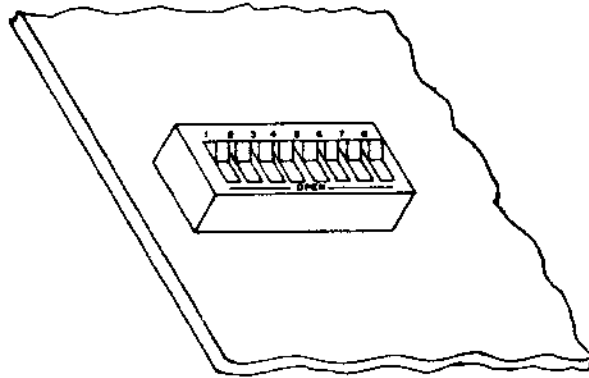
Figure 2-11   HPRO4 CONTROL SWITCH MODULE A25

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 four
   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
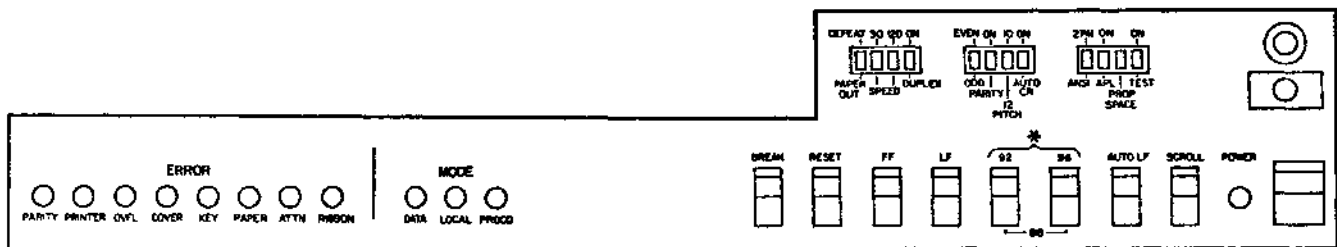
Figure 2-12 OPERATOR CONTROL PANEL

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 enhanced to include all ASCII mode functions.

Switch #2 ETX/ACK ENABLE When this switch is ON, an ACK character will be transmitted whenever an ETX character is encountered 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.

Switch #5 BAUD RATE SELECTION Used in conjunction with Control Panel switches for Baud Rate (Speed) selection. See Table 1-2.

Switches #6 thru #8 KEYBOARD SELECTION Used to enable Table ROM support for the language mode keyboard installed.

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).

Rev A (8/80)

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.

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

<u>Error Lamps</u>   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.

  <u>Mode Lamps</u>   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
              when the WP Enhancement option is installed.
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, 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 period, hyphen, space bar, comma and tab keys. The key assignments in this section do not change with Shift key operation, and are therefore 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.
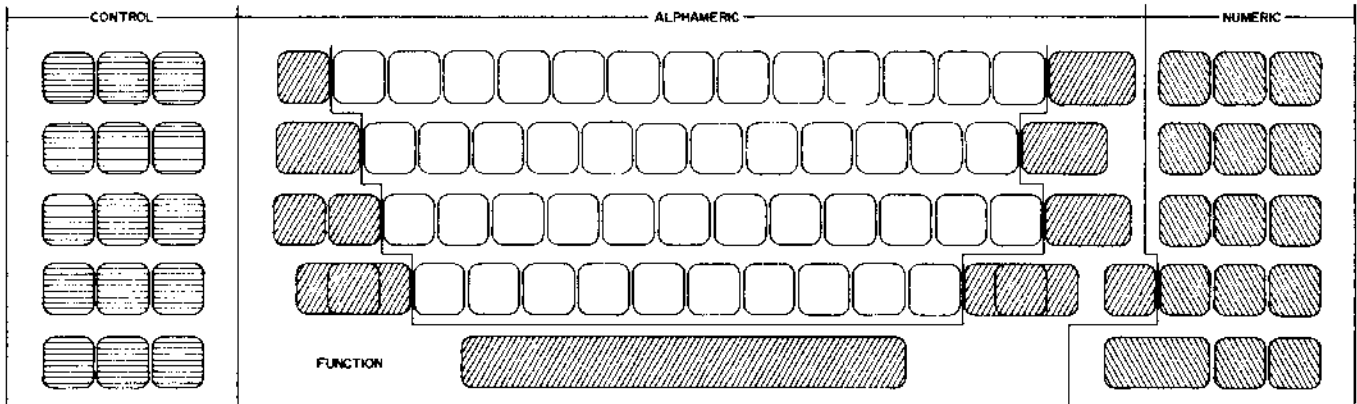
Figure 2-13   DIABLO KEYBOARD SECTIONS
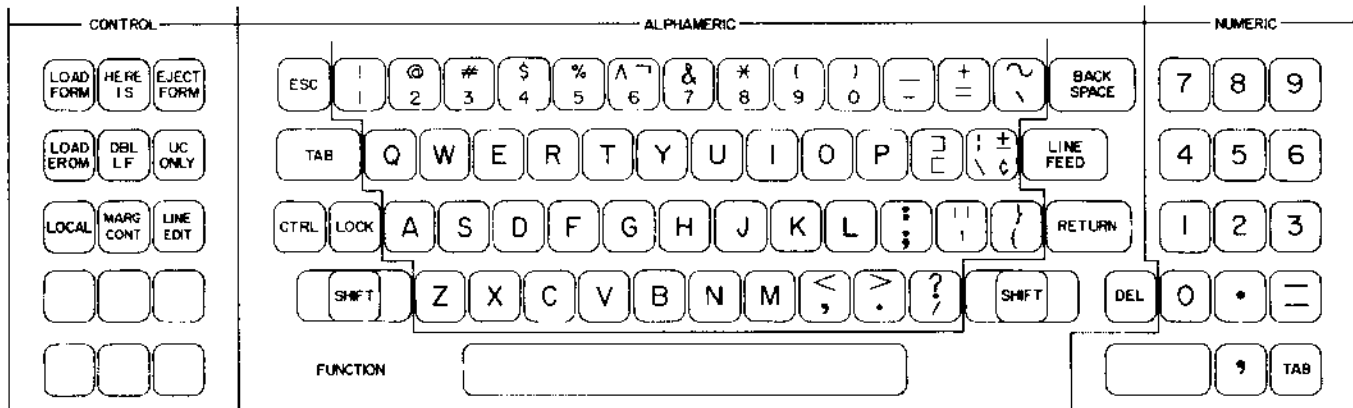
Figure 2-14   STANDARD KEYBOARD ASSIGNMENTS - KSR MODELS
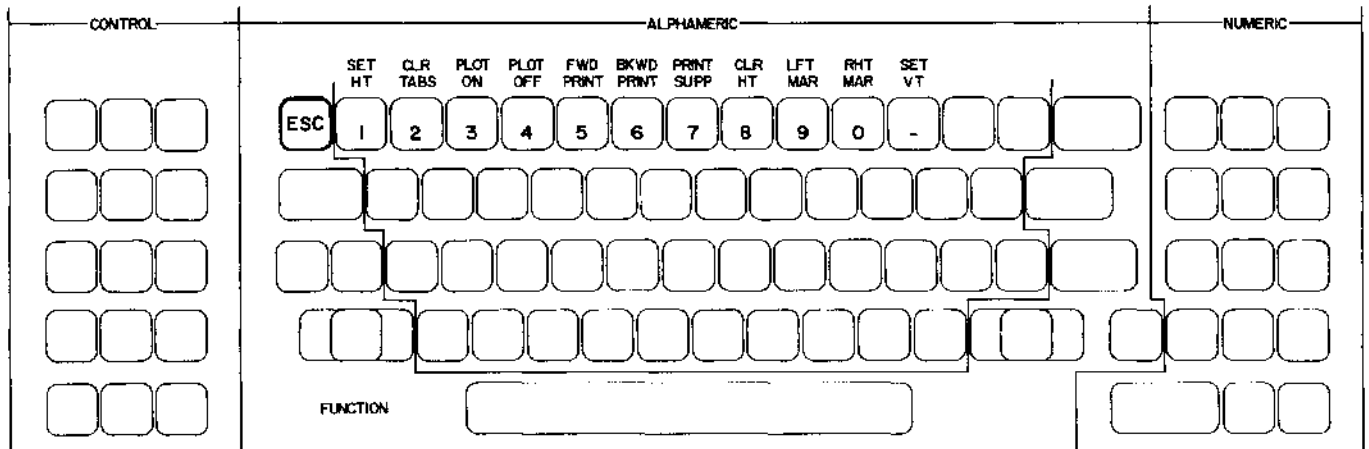
Figure 2-15   ESC MODE KEY ASSIGNMENT
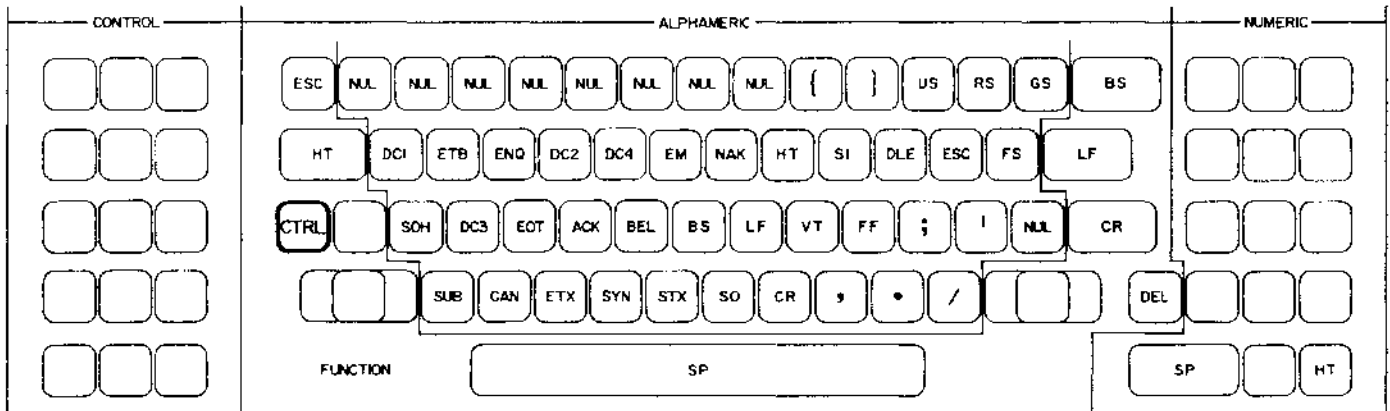
Figure 2-16   CTRL MODE KEY ASSIGNMENT

2.4.4.1   Definition of Terms

ORIGIN: The print head position after a form feed (with no top mar-
gin set) and an absolute horizontal tab to print position 1 (horizon-
tal 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 increments
of 1/120 inch 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 number 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.

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 indixing overrides the PITCH switch function. Control may be restored to the PITCH switch by issuing the ESC S sequence.

*FORM FEED
TO HERE

HORIZONTAL POSITION O-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

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

NEGATIVE HORIZONTAL MOVEMENT NOT POSSIBLE
BEYOND HORIZONTAL POSITION O.

PAGE SIZE

SETABLE
LEFT
RIGHT
MARGINS

*NEXT FORM
FEED TO
HERE

SETABLE BOTTOM 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 × 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 - 11" PAPER

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 except DATA TERMINAL READY, 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.

$$HMI = (ASCII character -1) \times 1/120 inch$$

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 (72 lines with HPRO4 jumper B56 installed for European 12" standard paper) 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 top 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 position, 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 simultaneously 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-2 to determine the (ASCII character) for the ESC sequence. 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:

$$\text{Horizontal Position} = (\text{ASCII character} - 1) \times \text{HMI}$$

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-2 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 auto-
matically 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 in-
crements for space and backspace commands, and in response to tab com-
mands. 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 ter-
minals. 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), exe-
cute 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 (Remote Reset) sequence. This command resets all
the logic circuits except DATA TERMINAL READY status, resets all pro-
gram 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 (11" page size) or 72 (12" page size)
        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. Overrides motion minimalization routine.

3. BS: Backspaces the carriage one print position (HMI) in normal mode, or 1/60 inch in graphics mode. Direction of 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 the "¬" 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 protocol. 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)  Reset 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 (D) 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 (C) code to the interface. The PROCEED lamp goes out,
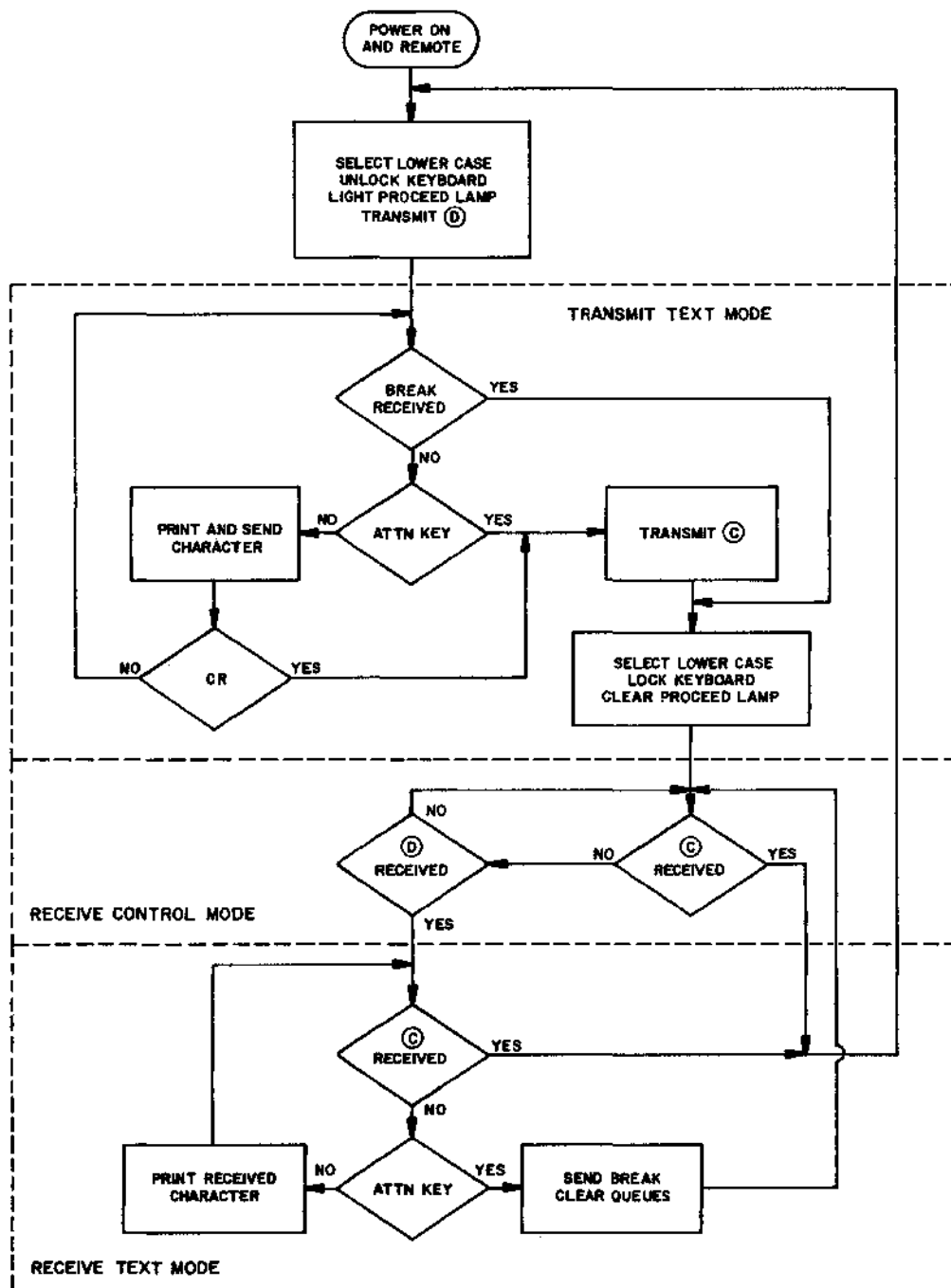
Figure 3-1   2741 LINE CONTROL

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.
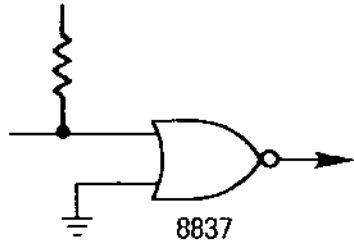
Figure 3-2   INPUT GATES

8837

Figure 3-3   OUTPUT GATES

7417

DATA BIT 0-7

-CHARACTER STROBE

-CHARACTER READY
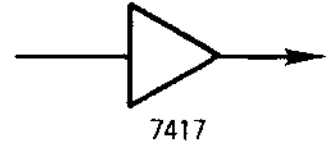
T1 ≥ 200 ηS
T2 ≥ 750 ηS
T3 ≤ 450 ηS
T4 MIN≈60μSEC MAX TIME TO PRINT OR PROCESS AVG= 25 MSEC
T5 ≥ 0 ηS
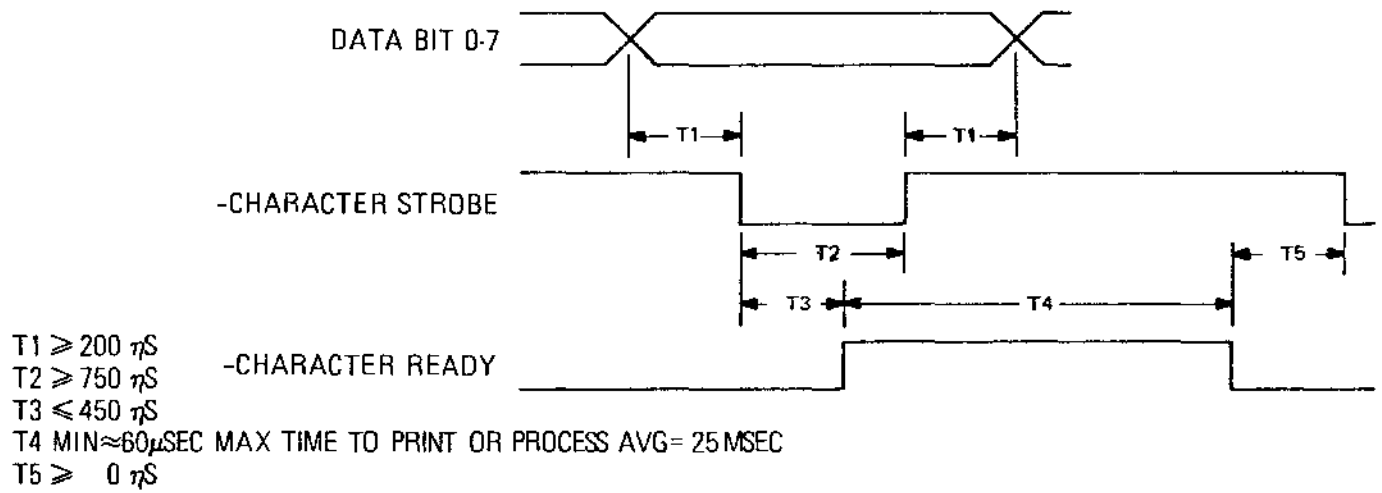
Figure 3-4   DATA TRANSFER TIMING

-RESTORE

-PRINTER READY

-IDLE

T1 ≥ 10μSEC
T2 ≤ 60μSEC
T3 ≤ 1 SEC
T4 ≥ 6 SEC
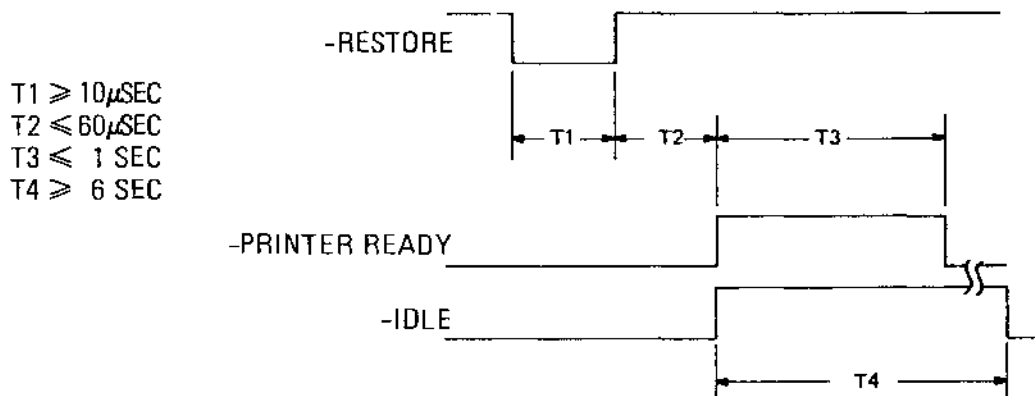
Figure 3-5   RESTORE

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.

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PRINCIPLES OF OPERATION
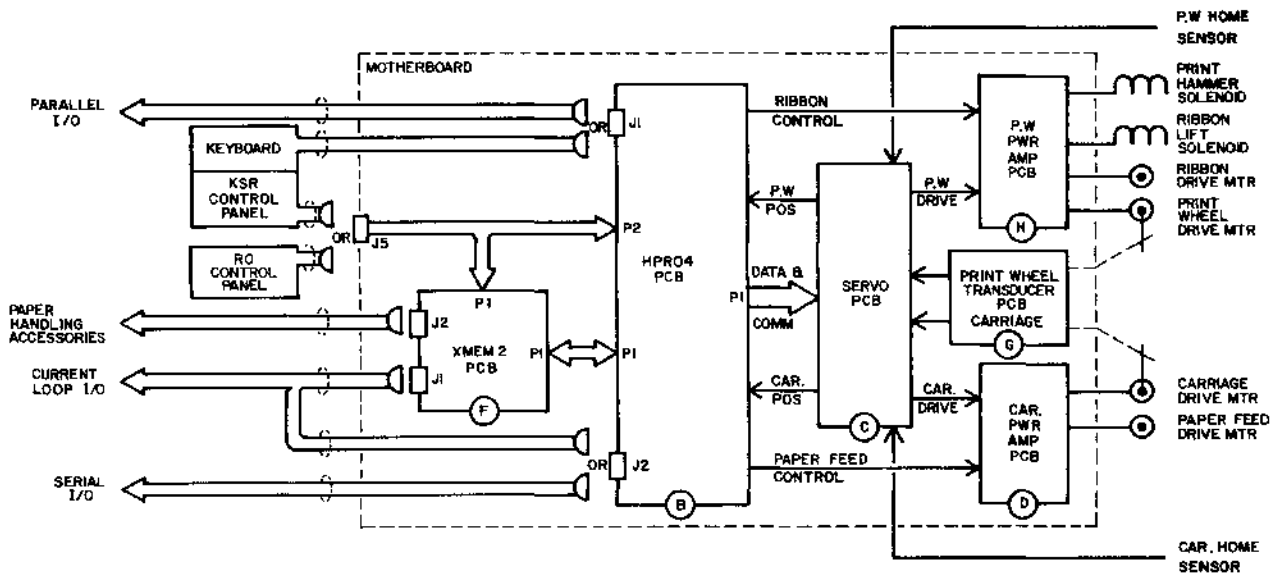
Figure 4-1.   SERIES 1640/1650 BLOCK DIAGRAM

4.1 GENERAL DISCUSSION

The basic configuration of the 1640/1650 Series Printer Mechanism
provides for either an RS-232 Serial or an ASCII Parallel interface;
the interface circuitry resides in firmware on the HPRO4 PCB assembly.
The following options can be added to this basic configuration: a Cur-
rent Loop interface, which connects thru the Serial I/O port; a key-
board, which connects thru the Parallel I/O port; an Operator Control
Panel, which connects to the Motherboard; and a variety of paper han-
dling accessories. As indicated in the block diagram shown in Figure
4-1, the current loop option requires addition of the XMEM2 PCB, and
the keyboard option requires addition of the control panel.

In operation, print commands and data arrive at the interface, and are
gated into the microprocessor circuits on the HPRO4 PCB. Processed
print wheel and carriage commands are sent to the Servo PCB. Feedback
loops, beginning at position transducers on each of the servo motors,
introduce continuously updated true position status to the servo cir-
cuits and to the microprocessor for an ongoing comparison of present
to commanded position. The results of these comparisons are position-
al error signals. These error signals are channeled to the appropri-
ate Power Amplifier PCB where they become servo drive signals for the
print wheel and carriage servo motors.

Processed ribbon commands go directly from the HPRO4 PCB to the ribbon
drive circuits on the Print Wheel Power Amplifier PCB. Processed
paper feed commands go directly to the paper feed drive circuits on
the Carriage Power Amplifier PCB. Both of these are one-way instruc-
tions that do not rely on position status feedback to the logic cir-
cuits for position update.
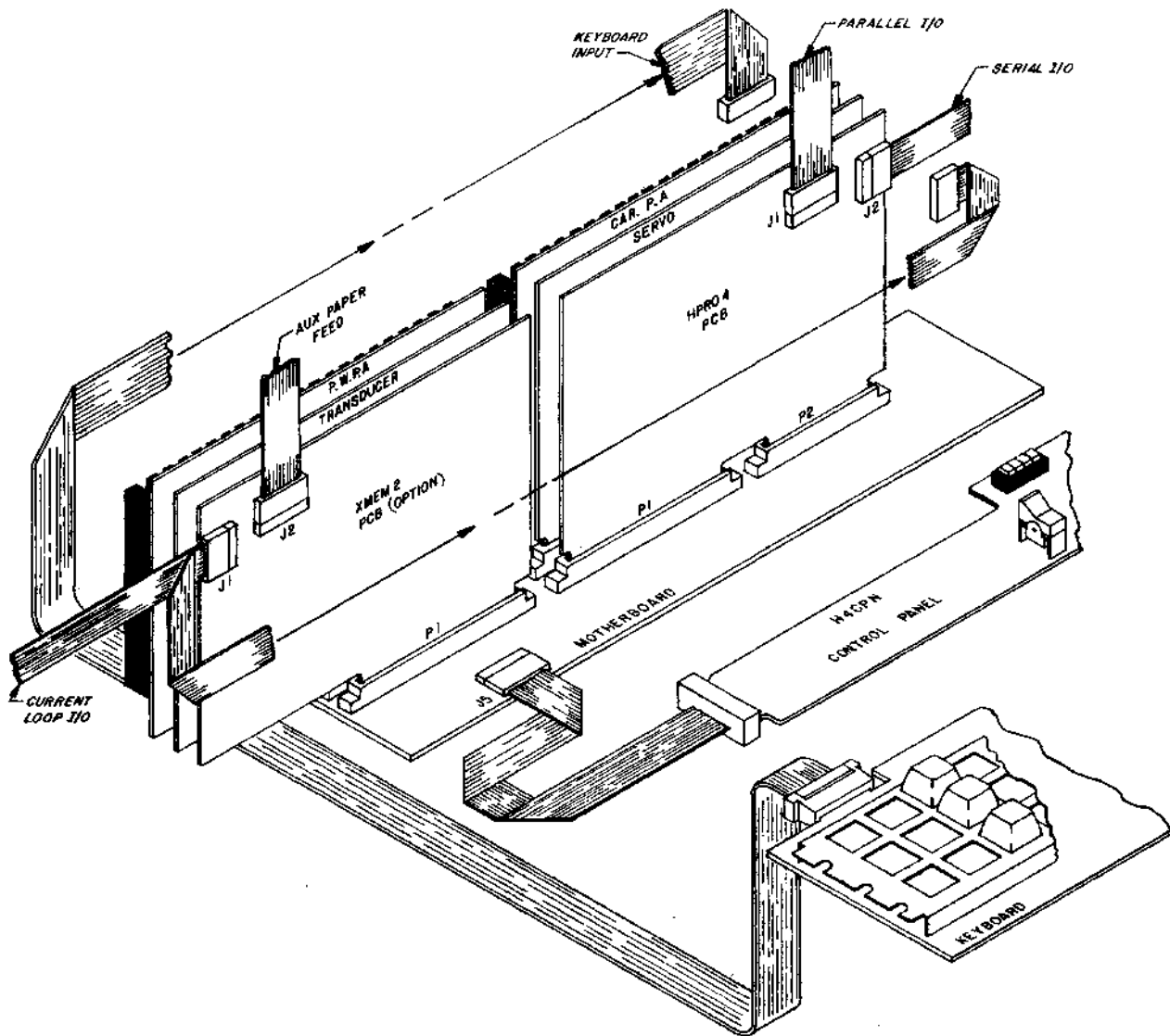
Figure 4-2   SERIES 1640/1650 INTERNAL ARRANGEMENT

TABLE 4-1
MOTHERBOARD CONNECTOR ASSIGNMENT

CONNECTOR		ASSIGNMENT
PCB Edge Connector	A	(not used)
PCB Edge Connector	B	HPRO4 Processor PCB
PCB Edge Connector	B2	HPRO4 Processor PCB
PCB Edge Connector	C	Servo PCB
PCB Edge Connector	D	Carriage Power Amplifier PCB
PCB Edge Connector	E	XMEM2 Extended Memory PCB
PCB Edge Connector	F	XMEM2 Extended Memory PCB
PCB Edge Connector	G	Transducer PCB
PCB Edge Connector	H	P. W. Power Amplifier PCB
Jack J2		Carriage Home Sensor
Jack J3		Impression Control Switch
Jack J4		Carriage Facilities
Jack J5		Control Panel
Terminal T1		Cover Open Switch
Terminal T2		Signal Ground
Terminal T3		Signal Ground
Terminal T4		Paper Feed 1
Terminal T5		Paper Feed 2
Terminal T6		Paper Feed 2
Terminal T7		Paper Feed 1
Terminal T8		Signal Ground
Terminal T9		Paper Out Switch
Terminal T10		(not used)
Terminal T11		-15VS
Terminal T12		+15VS
Terminal T13		Signal Ground
Terminal T14		Analog Ground (Driver Return)
Terminal T15		+5V
Terminal T16		-15VD
Terminal T17		+15VD

All printer functions may be in motion simultaneously except during print hammer fire time. Since the act of imprinting a character mechanically bridges all moving functions, these functions must be at rest prior to energizing the print hammer solenoid. A system of firmware interlock ensures that these preconditions are met before firing of the print hammer is allowed.

The printer's electronic design includes firmware for resetting and initializing carriage and print wheel servos. This program is activated by conditions within the printer, or by command from the controller, and is divided into two parts: Carriage initialization; and Print Wheel initialization. Carriage initialization is performed first. The carriage is commanded to move to the left (reverse) at a low velocity. The Carriage Home Sensor, located under the left end of the front carriage rail, detects the arrival of the carriage at its extreme left position and signals for carriage servo disable. After .1 second, the carriage is commanded to move to the right (forward). After the microprocessor detects carriage movement (signaled by the absence of the Carriage Home signal), it drives the carriage to the right two more increments of 1/120" and stops the carriage. This position is designated as the Carriage Home Position.

Print Wheel initialization is performed after the carriage has been initialized. The print wheel is commanded to rotate clockwise at a velocity corresponding to a move of 15 character "petals". As the print wheel passes the Print Wheel Home position sensor (a vane mounted on the print wheel motor shaft behind the print wheel passes over an inductor mounted on the carriage frame) a voltage pulse is induced in the sensor. When the third pulse is detected, the microprocessor resets its Absolute Print Wheel Counter to zero and stops print wheel movement. In 1640 Series machines, the print wheel will have its #0 petal (standard print wheel lower case w) in the print position. In 1650 Series machines with a 96 character print wheel, the print wheel will have its #0 petal (standard print wheel ¢ character) in the print position. With an 88 or 92 character print wheel in the 1650 Series machine, the print wheel will have its "flag" in the print position. This final print wheel position is designated as Print Wheel Home Position.

The printer will signal successful completion of these two sequential operations, and is ready to accept print commands. Commands arriving at the printer will be processed and executed in the order received, except as noted. The microprocessor logic processes commands in a multiplexed manner, and issues drive signals to the several printer activities as required. The following subsections provide detailed operating descriptions of the printer's logic and drive circuits used in carrying out the commanded print operations. See Section 7 for a description of the conventions used in describing the circuits.

Refer to Figure 4-2 for the location of the several circuit boards, and a representation of the internal layout of the machine.

4.2 MOTHERBOARD PCB, #301390-XX

Refer to Figure 7-1, Schematic Diagram.

The 1640/1650 Series Motherboard PCB assembly is mounted laterally across the bottom rear of the printer's main frame. It supports the edge mounted circuit boards which extend down thru the printer's electronics compartment and plug into its edge connectors from above. The Motherboard also supports a variety of spade lugs and connectors along its edges for interconnecting to remote items such as drive motors and switches, the internal power supply, and the optional control panel. Table 4-1 lists the Motherboard connector assignments. Figure 7-2 includes a layout drawing of the circuit board which locates and identifies the connectors and terminals.

4.3 HPRO4 PROCESSOR UNIVERSAL INTERFACE PCB ASSY, #301410-XX
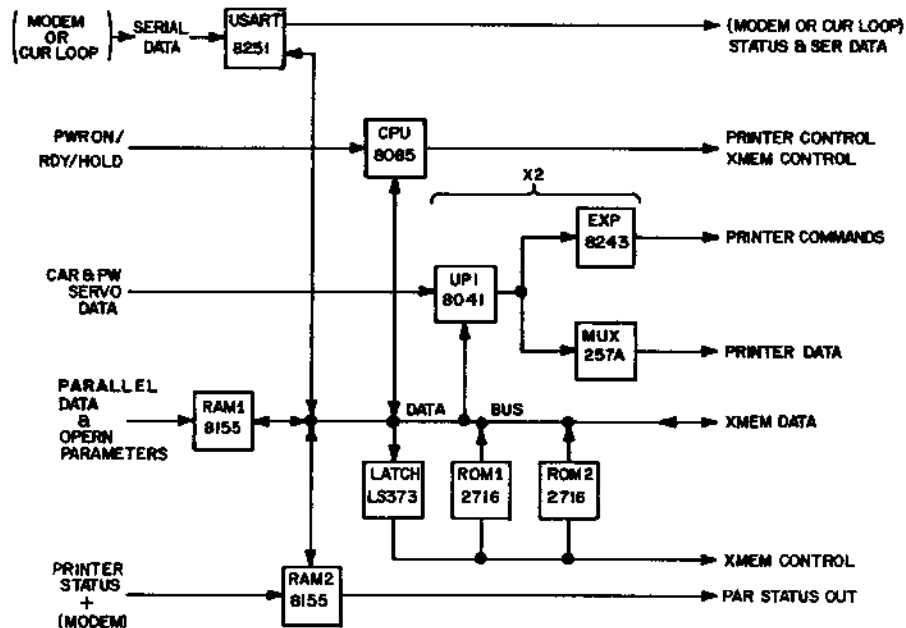
Figure 4-3   HPRO4 BLOCK DIAGRAM

4.3.1 General Information

Refer to Figure 4-3, Block Diagram, and to Figure 7-2, Schematic Diagram, for aid in understanding the circuits on this PCB.

This PCB assembly is supplied in four basic versions. These are:
    #301410-03 for Series 1640 units configured for Serial I/O,
    #301410-04 for Series 1640 units configured for Parallel I/O,
    #301410-05 for Series 1650 units configured for Serial I/O, and
    #301410-06 for Series 1650 units configured for Parallel I/O.

The Serial I/O configurations (-03 and -05) include all the components and modules shown on the schematic diagram. The Parallel I/O configurations (-04 and -06) delete the following:
        Type 8251A USART module D55,
        Type 75150 Driver modules B70 and B71,
        Type 75154 Receiver modules B64 and D64,
        Type 78M12C 12V Regulator module F48, and
        Type 79M12C 12V Regulator module F41.

Removal of the USART (Universal Synchronous Asynchronous Receiver Transmitter) module and its associated components relieves the CPU (Central Processor Unit, or microprocessor) of the program load imposed by the USART, resulting in an improved data throughput.

The design of the HPRO4, as indicated earlier, supports the universal interface concept. The totally configured assembly will operate with commonly used data transfer techniques at speeds up to 9600 Baud. The following discussion relates to this most complex configuration.

4.3.2 Block Level Discussion

Refer to the block diagrams in Figures 4-1 and 4-3, and to the internal machine layout depicted in Figure 4-2.

The HPRO4 PCB Assembly has four connectors: J1, J2, P1 and P2. J1 and J2 are the parallel and serial I/O connectors respectively, and are located on the upper right corner of the assembly face. P1 and P2 are PCB edge connectors for interfacing this PCB assembly with its companion Motherboard PCB assembly described in subsection 4.2.

Data can enter or leave the HPRO4 board via either of two channels, serial or parallel. Each channel can have either of two sources: The serial channel can be either a serial modem input or a current loop interface; The parallel channel source can be either an 8-bit data bus or a keyboard.

Inputs are thru the two RAMs and the USART, depending on the interface mode in use. Printer status and operating parameter inputs from the printer and the optional control panel are also channeled thru the RAMs. A series of switches (module A25) and jumpers establish operating parameters. Under control of the CPU, this information is gated onto the bidirectional data bus along with table data from the ROMs as required, and into the CPU for processing. In the case of carriage, print wheel, ribbon and paper feed commands, the CPU performs only preliminary processing of the data. Processed data is channeled back onto the data bus by the CPU, along with an address, for eventual gating out. Printer command data is sent to a type 8041 Peripheral Interface. Printer status to be transmitted to the host system in serial bit fashion is sent back to the USART for reformatting and transmission, while status to be transmitted in parallel fashion is sent to RAM2. The CPU transmits some printer control information directly to the affected printer control system along with control information from the optional XMEM2 PCB when installed. In addition, the type LS373 transparent Latch transmits 8 lines of control data to the XMEM2 PCB. To complete the extended memory loop, the 8 data bus lines extend off this PCB to the XMEM2 PCB, in effect extending the data handling logic memory found on the HPRO4 PCB.

When receiving partially processed printer commands from the CPU, the Peripheral Interface modules further process the information in terms of the function addressed, and release the results to the type 8243 Expanders and the type 257A Multiplexers. The multiplexer modules switch the data output lines between the two Peripheral Interface

modules. The Expander modules receive address command information on
two 4-line input ports, and expand this information for output on one
4-line output port.

4.3.3 Circuit Discussion

4.3.3.1 Programmable Communications Interface (USART), Module D55

TABLE 4-2
USART SIGNAL DESCRIPTIONS

RxD	Serial data input from the modem (receive).
-RxC	Receive clock signal from the RAM. Times the receiver.
RxRDY	Receiver is ready with a character for the CPU.
TxD	Serial data output to the modem (transmit).
-TxC	Transmit clock signal from the RAM. Times the transmitter.
TxRDY	Transmitter is ready to accept a character from the CPU.
RESET	Reset signal from the CPU to initialize the module.
CLK	System TTL clock input.
C/-D	CPU instruction to read or write a control or a data character.
-RD	CPU instruction to read a data command.
-WR	CPU instruction to write a data or a control command.
-CS	Chip (module) select signal from the CPU.
-DSR	Data Set Ready signal from the modem.
-CTS	A data transmission enable signal.
-RTS	Request To Send a character to the modem.
-DTR	Data Terminal Ready signal to the modem.
DO-7	8-bit parallel bidirectional data bus.
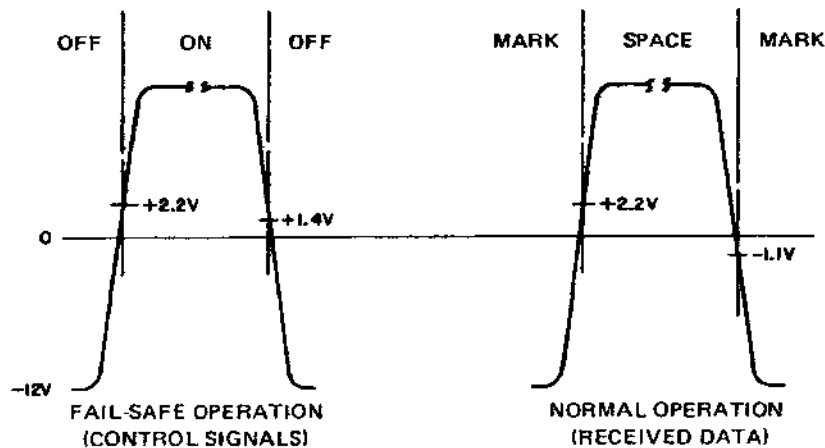
Figure 4-4   INPUT LINE SWITCHING LEVELS

This module translates information for transfer between the serial
format of a serial modem or current loop interface and the parallel
format of the balance of the printer's circuits. It exchanges signals
with the CPU to regulate and synchronize its several receive and
transmit functions.

Table 4-2 lists the various signals involved in the operation of this
module. Figure 4-4 illustrates the interface signal levels, and the
fail-safe features of this facility which provide for data protection
in the event of a modem signal loss.

TABLE 4-3

RAM SIGNAL DESCRIPTIONS

AD0-7 3-state 8-bit bidirectional Address/Data bus. Bus content is designated by the IO/-M signal as either address or data information, and is either written into or read from the chip depending on the state of the -RD and -WR signal lines.

IO/-M CPU instruction to select RAM operating registers (Command, Status, PA, PB and PC) or RAM memory for use in processing information on the AD bus.

-CE Chip (module) Enable signal from the CPU.

ALE Address Latch Enable signal from the CPU. Latches AD0-7, IO/-M and -CE into the RAM.

-RD With -CE causes stored information selected by the IO/-M signal to be read onto the AD bus.

-WR With -CE causes AD bus information to be written into (stored in) RAM as instructed by the IO/-M signal.

PA0-7 General purpose I/O port, with direction controlled by the Command Register:

RAM-1	RAM-2
0-7 = -Data Bits 0-7	0-7 = -Status Bits 0-7**

PB0-7 General purpose I/O port, with direction controlled by the Command Register:

RAM-1	RAM-2
0 = Option Sw 1 (Self-Test)	0 = Clear To Send
1 = Option Sw 2 (10-Pitch)	1 = Carrier Detect
2 = Option Sw 3 (DC1/DC3)	2 = Sec. Data Receive
3 = Option Sw 4 (Parity Enable)	3 = Ring Indicator
4 = Option Sw 5 (Parity Even)	4 = Cover Open
5 = Option Sw 6 (Full-Duplex)	5 = Paper Out
6 = Option Sw 7 (Baud LSB)	6 = Ribbon Out
7 = Option Sw 8 (Baud MSB)	7 = (not used)

PC0-5 I/O, or PA and PB Control:

RAM-1	RAM-2
0 = Keyboard or I/O Interrupt	0 = Sec. Transmit Data
1 = Keyboard or Character Ready	1 = Status Strobe
2 = Keyboard or Character Strobe	2 = (not used)
3 = (not used)	3 = (not used)
4 = (not used)	4 = (not used)
5 = (not used)	5 = (not used)

** = See subsections 3.8.7 and 6.4.9.2.3 for Status definitions.

4.3.3.2 Random Access Memory (RAM), Modules B28 and B45

These modules are 2048-Bit Static RAMs with I/O Ports. They act as data address and command storage facilities for the CPU. RAM-1 supports the ASCII or optional Keyboard parallel input and the operating control switches (B25), while RAM-2 supports printer status output. Associated with RAM-2 are a series of four option jumper locations of which three, B47, B53 and B56 are presently used. Inserting Jumper Plug B47 enables the PCB to be used in Series 1650 machines with the metalized print wheel. Inserting a jumper strap at B53 enables the Model 1650 to use the metalized print wheels and European standard 12" paper. Inserting a jumper strap at B56 enables the Model 1640 to use European standard 12" paper.

CAUTION: Only one jumper strap or plug can be used at one time.

Table 4-3 lists the various signals involved in the operation of these modules. Figures 4-5 and 4-6 illustrate the serial interface signal formats for both ASCII and optional 2741 modes.
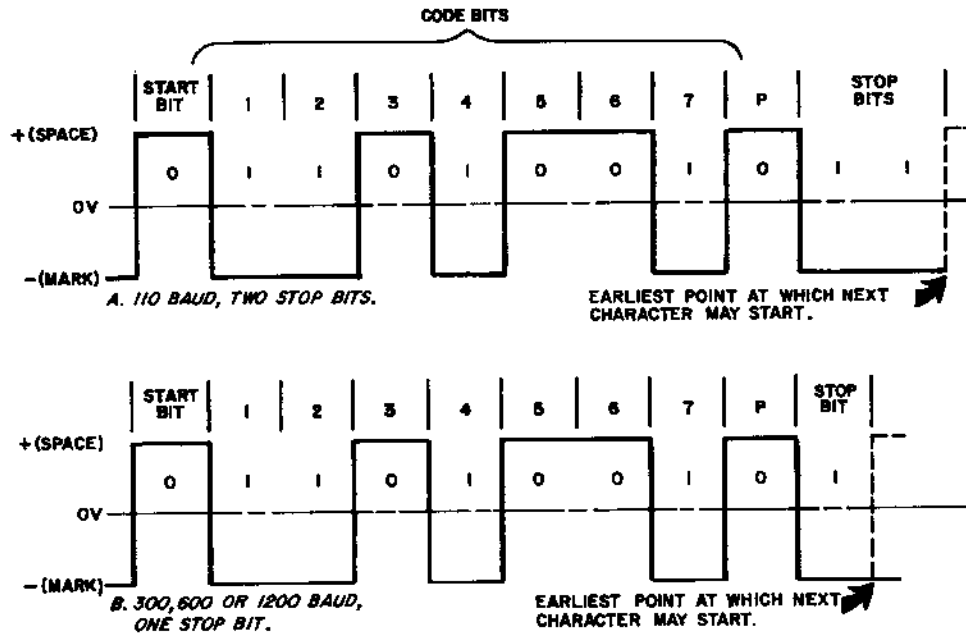
Figure 4-5 ASCII DATA FORMAT ON INTERFACE
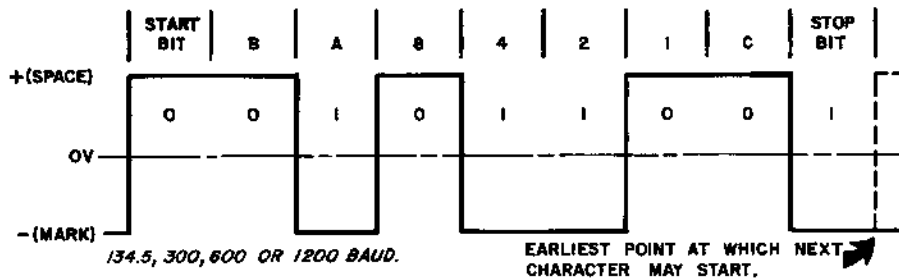
Figure 4-6 2741 OPTION DATA FORMAT ON INTERFACE

4.3.3.3 Central Processor Unit (CPU), Module B37

TABLE 4-4
CPU SIGNAL DESCRIPTIONS

AD0-7	3-state 8-bit bidirectional multiplexed Address/Data bus: LS 8-bits of the memory or I/O address appear during the 1st clock cycle (T state) of a machine cycle. The lines become a data bus during the 2nd and 3rd clock cycles.
A8-15	Address Bus: MS 8-bits of memory address or 8-bits of the I/O address, 3-stated during HOLD and HALT modes and during RESET.
ALE	Address Latch Enable. Enables peripheral modules to receive and latch in addresses from a bus.
IO/-M	An instruction to select either interface or memory for subsequent read or write operations.
-RD	An instruction to read memory or I/O device with the data bus available for data transfer.
-WR	An instruction to write information on the data bus into the selected memory or I/O location.

(continued)

READY Indicates memory or peripheral device is ready to send or to receive data.

HOLD A request from the host controller to use the AD bus.

HLDA Hold Acknowledge, a signal indicating the CPU has received the HOLD request.

INTR A Priority 5 Interrupt Request.

RST 5.5 A Priority 4 Interrupt Request.

RST 6.5 A Priority 3 Interrupt Request.

RST 7.5 A Priority 2 Interrupt Request.
 These requests, if honored by the CPU, cause an internal RESTART of the program counter and may be software masked.

TRAP A Priority 1 nonmaskable RESTART interrupt signal to the CPU program counter.

RESET IN Host System input signal to reset the program counter, HLDA and INT EN flip flop's.

RST OUT CPU signal to the Host System indicating the program counter is being reset.

X1 & X2 Clock inputs from a crystal network to drive the internal clock generator.

CLK OUT System clock output at 2x X1/X2 frequency.

SID Serial Input Data, to be loaded in whenever a "Read Interrupt Mask" (RIM) instruction is executed.

SOD Serial Output Data, set or reset according to a "Set Interrupt Mask" (SIM) instruction.

This module is a Type 8085A2 8-bit N-channel microprocessor, a complete 8-bit parallel central processing unit. This module contains the central processing unit (CPU) and working registers for the entire machine. It controls the input and processing of all commands, supplies operating signals to the several printer functions, and responds to requests from its Host System for printer status information.
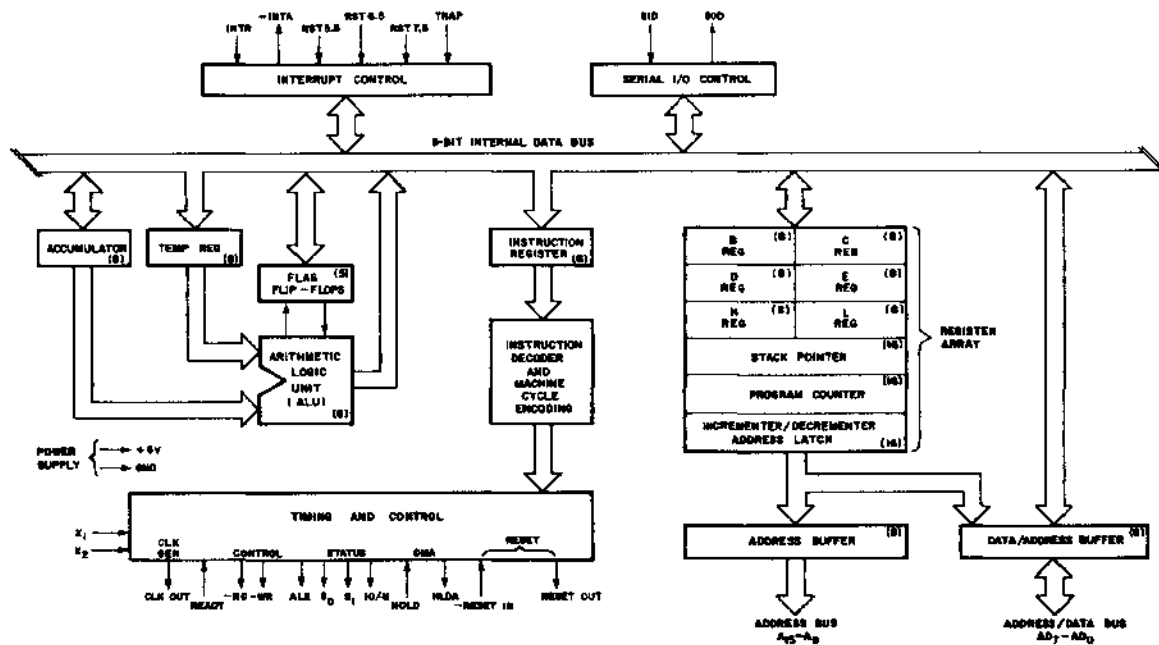
Figure 4-7 CPU (Microprocessor) BLOCK DIAGRAM

Table 4-4 lists the various signals associated with this module, and Figure 4-7 is a block diagram of its circuits.
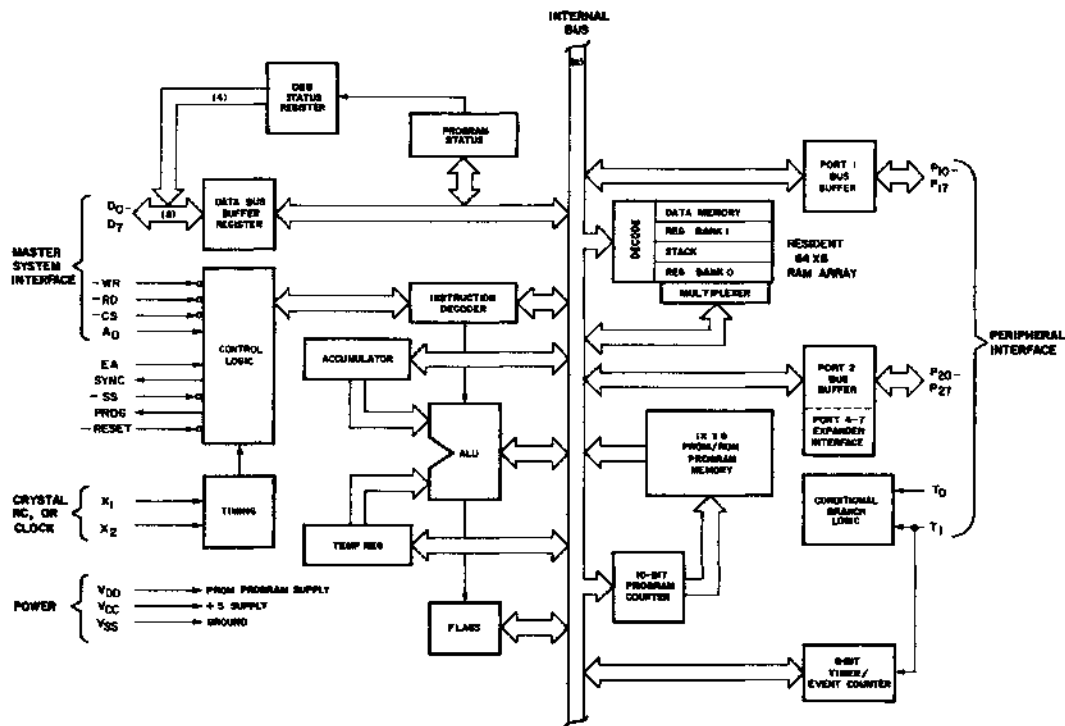
Figure 4-8   UPI BLOCK DIAGRAM

TABLE 4-5
PERIPHERAL INTERFACE SIGNAL DESCRIPTIONS

D0-7	3-state bidirectional data input bus to the Data Bus Buffer.
P10-17	Port 1, an 8-bit bidirectional I/O bus.
P20-27	Port 2, an 8-bit bidirectional I/O bus.
-RD	An I/O read instruction from the CPU to enable it to read the content of this module's Data Bus Buffer or Status Register.
-WR	an I/O write instruction from the CPU to enable data and command words to be written in on the data bus.
-CS	Chip (module) Select signal from the CPU.
A0	Address input signal from the CPU to designate information on the data lines as either data or command information.
T0	System Real Time Clock (RTC1) from the CPU.
T1	Position count signal input from the Carriage Decrement or Print Wheel Increment/Decrement counter circuits.
X1 & X2	System clock from the clock generator.
EA	A test input.
PROG	An Address/Data strobe output to the Expander Modules.
-RST	SOD output signal from the CPU used as a RESET signal in this module.
-SS	Single Step input signal line, held HI to allow modules to run with clock inputs.

These two modules are used for printer control: One for carriage, paper feed and option control; and one for print wheel, ribbon feed and print hammer control. These individually selectable modules read the Address/Data bus when commanded by the CPU, and process this information for presentation to the appropriate printer circuits. These modules also receive increment-decrement counts from the print wheel

4-10   Rev A (8/80)

and carriage transducer feedback circuits for updating the print wheel
and carriage Absolute Position counters.

These modules are 8-bit microcomputers with internal ROM and RAM, two
TTL compatible 8-bit I/O ports, and event counters. Their ability to
process a major portion of the command and data information relieves
the CPU of this load, resulting in increased throughput. Table 4-5
lists the various signals associated with these modules, and Figure
4-8 is a block diagram of the module's circuits.

4.3.3.5 UPI Expander, Modules E4/E25

TABLE 4-6
PERIPHERAL INTERFACE EXPANDER SIGNAL DESCRIPTIONS

PROG	Address/Data input strobe signal from the Peripheral Interface modules. Signal state selects Address/Control or Data.
-CS	Chip (module) Select signal. These inputs are grounded to permanently select the modules.
P20-23	4-bit input port. This port inputs address and control on a HI to LO transition of PROG, and data for the selected output on a LO to HI transition of PROG if a write operation, or data from the selected output if a read operation.
P40-43	-
P50-53	-
P60-63	-
P70-73	- 4-bit bidirectional output ports. These are low impedance latched outputs. Data on P20-23 may be directly written for output here, or it may be ANDed or ORed with previous data.
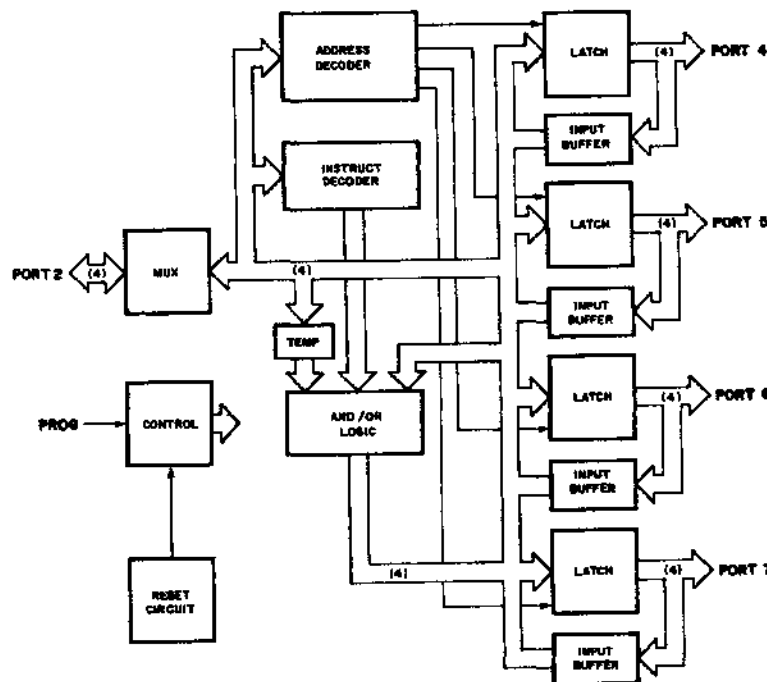
Figure 4-9 UPI EXPANDER BLOCK DIAGRAM

These modules feature one 4-bit input port (Port 2, P20-23) and four
output ports (Port 4, P40-43; Port 5, P50-53; Port 6, P60-63; and Port
7, P70-73). The selected module receives two 4-bit words to transfer

data from the UPI to the printer's circuits. The first word contains
an output port address and an operation code:

P20	P21	Address	P22	P23	Operation
0	0	Port 4	0	0	Read
1	0	Port 5	1	0	Write
0	1	Port 6	0	1	OR and Load (ORLD)
1	1	Port 7	1	1	AND and Load (ANLD)

The outputs for Ports 4-7 are as follows:

Print Wheel (Module E25)

Port 4 (40)= P W FWD (41)= P W REV (42)= P W LIN (43)= HAM FIRE
Port 5 (50 = +/- RIB O/A (51)= +/- RIB O/B (53 & 54 not used)
Port 6 (60)= +Car Vel Stb (61)= Multip. Sel. (62)= +PW Vel Stb
          (63 not used)
Port 7 (70)= -Req Ser En (71)= PW Cntr (72)= +Rib Lift (73) +Rib Hold

Carriage (Module E4)

Port 4 (40)= +CAR FWD (41)=+CAR REV (42)= +CAR LIN (43)=+/-CAR CUSP
Port 5 (50)= +P F A (51)= +P F B (52 & 53 not used)
Port 6 (60)= +OPT 2 (61)= +OPT 3 (62 & 63 not used)
Port 7 (70)= -INH HAM (71 - 73 not used)

Each module has three write modes. Write mode places new data on the
selected port and any old data is lost. ORLD mode OR's the new data
with the old data and writes the result to the selected port. ANLD
mode AND's the new data with the old data and writes the result to the
selected port. Processed data is latched and outputted, and remains
latched until new valid data is received.

Table 4-6 lists the various signals associated with these modules, and
Figure 4-9 is a block diagram of the module's circuits.

4.3.3.6 Multiplexer Modules E13/E19/E46

The Multiplexer consists of two sets of four input lines (A and B),
one set of four output lines (Y), and an input select line. SEL=LO
selects the A inputs, while SEL=HI selects the B inputs. Information
on the selected inputs then appears on the like numbered Y outputs.

Multiplexer E46 uses the IO/-M signal to issue read or write commands
to the affected modules. Multiplexers E13 and E19 are used to select
either print wheel or carriage data for output on the HPRO4's data bus
to the D-A Converter circuit on the Servo PCB.

4.3.3.7 ROM-1, ROM-2, and The Address Latch, Modules E52/E67/E62

The ROM modules E52 and E67 are 16K (2K x 8) erasable PROMs. They
have a static standby mode, and feature fast single address location
programming (single pulse TTL level) as well as compatibility with the
upward memory expansion provided by the optional XMEM2 PCB. These
devices contain the various lookup tables for microprocessor and

printer operation, such as print wheel position and hammer energy, as well as the addresses for the data being processed.

The Address Latch module E62 consists of a series of D flip flops. The flip flops are enabled by the ALE signal from the CPU and receive address information from the A/D bus. The address bits are latched on the FF -Q outputs, to appear on the address bus lines when the module receives the Output Control (OC) signal (HLDA=LO) from the CPU.

4.3.3.8 Carriage and Print Wheel "Swap" Circuits, Module A19

The Printer's carriage and print wheel servo drive motors each include a shaft position transducer. The rotor of each device turns with the rotor of the servo, and in rotating transforms a two-phase sine-wave input into a composite output whose instantaneous value compared to the input is used to develop three square waves called POS A, POS B and EVEN. The HI and LO status of these three signals changes with respect to actual movement of the transducer rotor. Depending on the direction of rotor movement (and thus carriage or print wheel servo motor movement), two of these signals (EVEN and A or B) will be of opposite polarity when the third (B or A) changes polarity. This event occurs only once for each increment of carriage or print wheel movement, and is called a track crossing point. The "Swap" module's circuits receive the three inputs from each source, and provide one count pulse as an output for each track crossing or increment of servo movement. This is equal to 1/120" of carriage travel or 1/2 of 1 "petal" movement for the print wheel. Carriage position is tracked from home position to the right, and its count decrements the Carriage Absolute Counter after being sent to the Carriage UPI module B10 for processing. The print wheel position is tracked in both directions, and its "swap" circuit outputs two pulses of opposite polarity for use in either incrementing or decrementing its Absolute Counter after being sent to the Print Wheel UPI module B19 for processing.

4.4 XMEM2 EXPANDED MEMORY OPTION PCB ASSY, #400664-XX

4.4.1 General Information

Refer to Figure 4-10 and to Figure 7-3 Schematic Diagram.

This assembly has the capability of supporting all of the optional programs described earlier which extend and/or enhance the operation of the Terminal. The available configurations are outlined in Tables 4-7 and 4-8. The operating program options are housed in pluggable ROM modules; memory buffer options are housed in pluggable RAM modules. The "Here Is . ." message option requires installation of the EAROM module. When the Current Loop I/O option is asserted, the additional components and jumpers are installed. The user may, at his option, rewrite basic machine programs and make the RAM and EAROM locations on this assembly available for increased memory or other custom assignments.
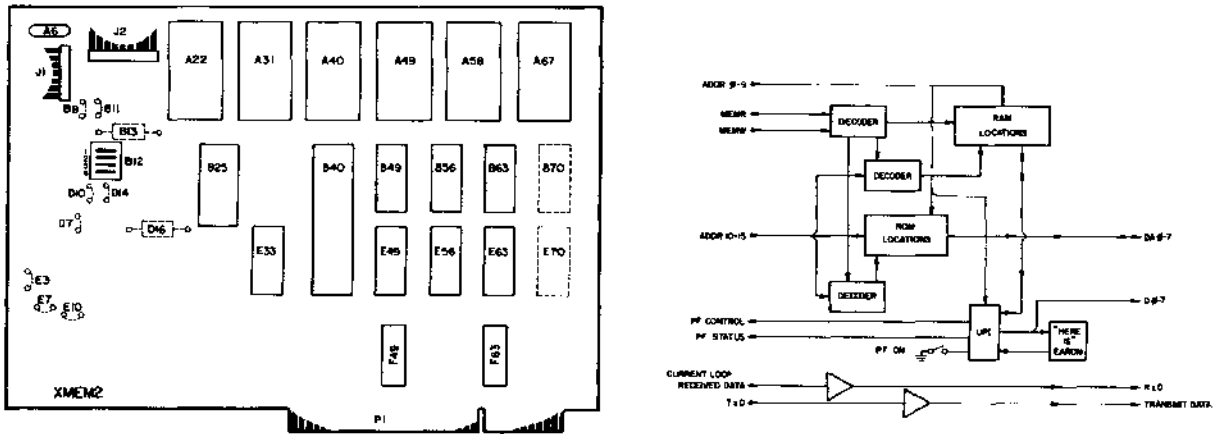
Figure 4-10   XMEM2 PCB LAYOUT AND BLOCK DIAGRAM

TABLE 4-7
RAM/ROM ASSIGNMENT

RAM LOCATIONS	B49/B56	E49/E56	B63/E63	B70/E70
RAM Dedication	1K Expanded Buffer	1K Expanded Buffer	Word Processor Scratch Pad Memory	(Space Avail.)

ROM LOCATIONS	A22	A31/A40	A49/A58	A67
Programs	KSR Keyboard APL Here Is	2741 Mode	Word Processor Mode	HyPlot Paper Feed External Diag.

B25

"Here Is" Message
Storage

4.4.2 Block Level Discussion

As indicated in Tables 4-7 and 4-8, the XMEM2 assembly features versatility of application in expanding the capability of the Terminal. Figure 4-10 illustrates the layout of the assembly and includes the circuit block diagram.

In operation, the ADDR 0-15 and DA 0-7 buses on this assembly connect to and become extensions of similar buses on the HPRO4 PCB thru circuits on the Motherboard. Two connectors located on the upper left corner of the assembly provide an interface for a Current Loop I/O (J1 which is oriented vertically) and Auxilliary Paper Feeder control (J2 which is oriented horizontally). The lower left area of the PCB supports the components associated with the Current Loop I/O and power regulation.

Data handling commands arrive via the system address bus and go to decoder modules for distribution to the appropriate RAM or ROM modules. A read or write definition for each command is channeled thru one decoder to control the operation of the other decoder(s). Decoder outputs then control the operation of the RAM and/or ROM modules.

TABLE 4-8
XMEM2 CONFIGURATIONS

	JUMPERS								DECODERS		RESISTORS				SWITCHES B12			
	A6	B8	B11	D7	D10	D14	E7	E10	F63	F70	B13 200Ω	B13 680Ω	D16 200Ω	D16 680Ω	S1	S2	S3	S4
CURRENT LOOP:																		
20mA Half-Duplex Active				IN		IN						IN		IN				
Passive		IN		IN	IN													
Full-Duplex Active			IN			IN						IN		IN				
Passive		IN				IN												
60mA Half-Duplex Active				IN		IN					IN		IN					
Passive		IN		IN	IN													
Full-Duplex Active			IN			IN					IN		IN					
Passive		IN				IN												
EXPANDED MEMORY:																		
2K Byte EROM							IN		IN									
4K Byte EROM								IN		IN								
"HERE IS" MESSAGE:																		
Write Enable	IN																	
Write Protect	OUT																	
AUX PAPER FEED ENABLE																		ON

4.4.3 Circuit Discussion

4.4.3.1 2 To 4 Line Decoder, Module E33
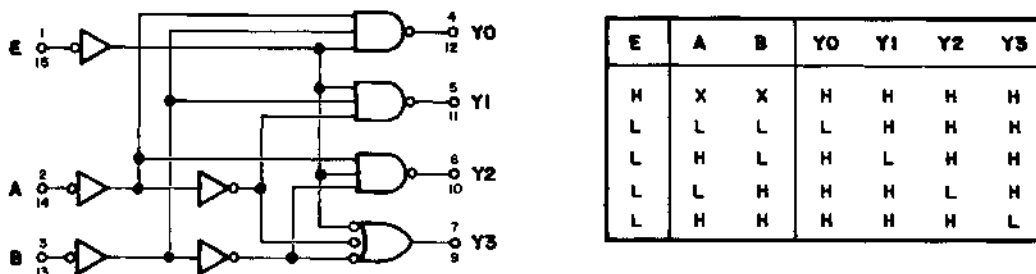
Figure 4-11   2 TO 4 LINE DECODER DIAGRAM AND TRUTH TABLE

This dual decoder module receives commands and issues instructions to other decoder modules downstream. One part receives the read and write command from the CPU on the HPRO4 PCB, the other receives the PPI chip select (enable) instructions from the HPRO4 PCB via the address bus. The read or write select section issues a Write Enable signal to the RAM modules if the accompanying data is to be written in, or an Enable signal to downstream RAM/ROM address decoders. The PPI section enables the PPI to process accompanying instructions when the proper address code is received. Figure 4-11 includes the circuit diagram for one decoder and its truth table.

4.4.3.2 1 Out Of 8 Binary Decoder, Modules F49/F63/F70

A0	1	16	Vcc
A1	2	15	O0
A2	3	14	O1
E1	4	13	O2
E2	5	12	O3
E3	6	11	O4
O7	7	10	O5
GND	8	9	O6

A0-A2 = Address Inputs
E1-E3 = Enable Inputs
O0-O7 = Decoded Outputs

ADDRESS			ENABLE			OUTPUTS							
A0	A1	A2	E1	E2	E3	0	1	2	3	4	5	6	7
L	L	L	L	L	H	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
L	H	L	L	L	H	H	H	L	H	H	H	H	H
H	H	L	L	L	H	H	H	H	L	H	H	H	H
L	L	H	L	L	H	H	H	H	H	L	H	H	H
H	L	H	L	L	H	H	H	H	H	H	L	H	H
L	H	H	L	L	H	H	H	H	H	H	H	L	H
H	H	H	L	L	H	H	H	H	H	H	H	H	L
X	X	X	L	L	L	H	H	H	H	H	H	H	H

Figure 4-12   1 OUT OF 8 BINARY DECODER PIN ASSIGNMENT AND TRUTH TABLE

These modules receive commands both from the HPRO4 Address Bus and the upstream decoder E33. Upon receipt of appropriate signals, the modules will output an enabling signal to the appropriate ROM or RAM modules. Figure 4-12 shows the chip pin assignment and the truth table.

4.4.3.3 Programmable Peripheral Interface (PPI), Module B40

Refer to Figure 4-13.

The block diagram and pin assignments for this module are shown in Figure 4-13. This module performs two functions. First, it receives and processes operating commands and status information for the accessory paper handling equipment, and second, it interfaces with the EAROM module (B25) to record and transmit the "Here Is" message. Its data bus buffer is connected to the data bus on the HPRO4 PCB which carries both "Here Is" and paper feed status information. Port A outputs either commands to the accessory paper feed via the D0-6 bus, or addresses for the "Here Is" text characters to be written into the EAROM. Port B inputs both accessory paper feed and operating switch module (B12) status. The upper four bits of Port C outputs either paper feed commands or EAROM enable commands, while the lower four bits interface the "Here Is" message to the PPI. Note that Switch B12-4 must be ON to enable the passage of paper feed information and that Jumper A6 must be installed on the PCB to enable writing the "Here Is" message into the EAROM. Once the message has been written in, Jumper A6 may be removed. This action serves as a write protect for the message.

PIN CONFIGURATION

Figure 4-13   PROGRAMMABLE PERIPHERAL INTERFACE (PPI)

4.4.3.4   Random Access Memory (RAM), Modules B49/B56/B63/B70/E49/E56/E63/E70

Figure 4-14   RANDOM ACCESS MEMORY (RAM)

These modules are 1024 x 4 bit static RAM. They act as buffer data storage devices for both expanded memory and word processing scratch pad memory. Their I/O connections go to the data bus on the HPRO4 PCB, and their operation is controlled by the HPRO4's CPU via the address bus and the decoder modules discussed earlier. Figure 4-14 includes the RAM block diagram and chip pin assignment.

4.4.3.5 Read Only Memory (ROM), Modules A22/A31/A40/A49/A58/A67

MODE SELECTION

PINS / MODE	-CE/PGM (18)	-OE (20)	Vpp (21)	Vcc (24)	OUTPUTS (9-11,13-17)
READ	VIL	VIL	+5	+5	D OUT
STANDBY	VIH	DON'T CARE	+5	+5	HIGH Z
PROGRAM	PULSED VIL TO VIH	VIH	+25	+5	D IN
PROGRAM VERIFY	VIL	VIL	+25	+5	D OUT
PROGRAM INHIBIT	VIL	VIH	+25	+5	HIGH Z

PIN CONFIGURATION

```
A7  [ 1      24 ] Vcc
A6  [ 2      23 ] A8
A5  [ 3      22 ] A9
A4  [ 4      21 ] Vpp
A3  [ 5  2716 20 ] -OE
A2  [ 6  16K  19 ] A10
A1  [ 7      18 ] -CE
A0  [ 8      17 ] O7
O0  [ 9      16 ] O6
O1  [ 10     15 ] O5
O2  [ 11     14 ] O4
GND [ 12     13 ] O3
```

PIN NAMES

A0 – A10	ADDRESSES
CE/PGM	CHIP ENABLE/PROGRAM
-OE	OUTPUT ENABLE
O0 – O7	OUTPUTS

BLOCK DIAGRAM

Figure 4-15   READ ONLY MEMORY (ROM)

Refer to Figure 4-15 and Table 4-7.

These modules each contain specific portions of the several operating programs offered as options for the 1640/1650 Series Printers and Terminals. Table 4-7 lists the various programs resident in each ROM location. Their output connections are direct to the data bus on the HPRO4 PCB, and their operation is controlled by the HPRO4's CPU via the address bus and the decoder modules discussed earlier. Figure 4-15 includes the ROM functional block diagram and chip pin assignments.

4.4.3.6 Electrically Alterable ROM (EAROM), Module B25

Refer to Figure 4-16.

This module is used to store the "Here Is" message of up to 31 characters. Jumper A6 enables the module's write mode when installed and, with the Here Is ROM installed in position A22, opens the EAROM to receive the "Here Is" message. After the message has been written in, Jumper A6 can be removed to disable the write mode and protect the message. Thereafter, the PPI module B40 can read the message on command and transmit it to the HPRO4 system data bus via Data Lines DA0-7. Figure 4-16 contains the EAROM block diagram, chip pin assignment and a listing of the function of each pin.

4.4.3.7 -30 Volt DC-DC Power Inverter Circuit

Refer to Figures 4-17 and 4-18.

This circuit develops the regulated -30 volt output needed by the EAROM module.

PIN CONFIGURATION

```
Vgg(-30V) ▭ 1        22 ▭ Vss (+5V)
Vdd(-12V) ▭ 2        21 ▭ A5
      A6  ▭ 3        20 ▭ A4
      A7  ▭ 4        19 ▭ A3
      A8  ▭ 5        18 ▭ A2
      A9  ▭ 6        17 ▭ A1
      C0  ▭ 7        16 ▭ A0
      C1  ▭ 8        15 ▭ -CE
  Vgi(GND)▭ 9        14 ▭ -WE
      D3  ▭ 10       13 ▭ D0
      D2  ▭ 11       12 ▭ D1
```
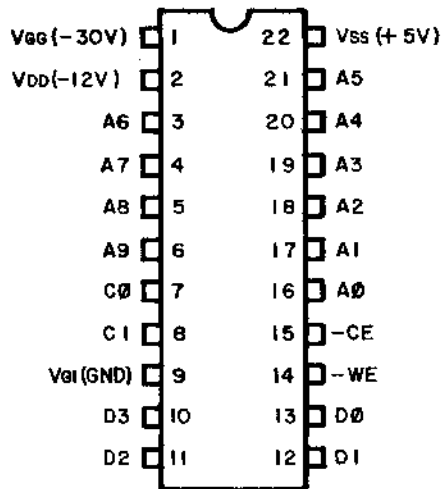
BLOCK DIAGRAM
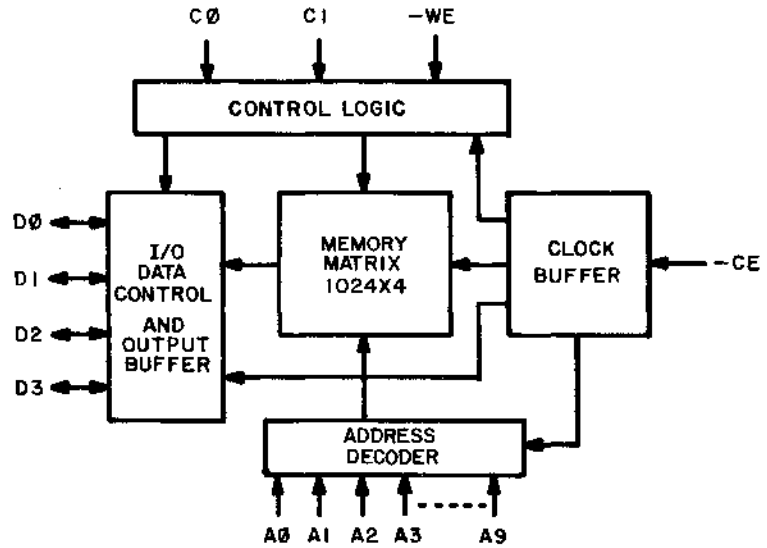
PIN FUNCTIONS

A0-A9	10-Bit Word Address
D0-D3	Data input and output pins
-CE	Chip Enable. Chip selected when -CE is pulsed to logic "0".
C0, C1	Mode Control Inputs

C0	C1	
0	1	Block Erase Mode: erase operation performed on all words.
1	1	Word Erase Mode: stored data is erased at addressed location.
0	0	Read Mode: addressed data read after leading edge of -CE pulse.
1	0	Write Mode: input data written at addressed location.

-WE	Write Enable. Input data read when -WE is pulsed to logic "0".
VSS	Substrate supply. Normally at +5 volts.
VGI	Ground Input
VDD	Power Supply Input. Normally at -12 volts.
VGG	Power Supply Input. Normally at -30 volts.

Figure 4-16   ELECTRICALLY ALTERABLE ROM (EAROM)

BLOCK DIAGRAM
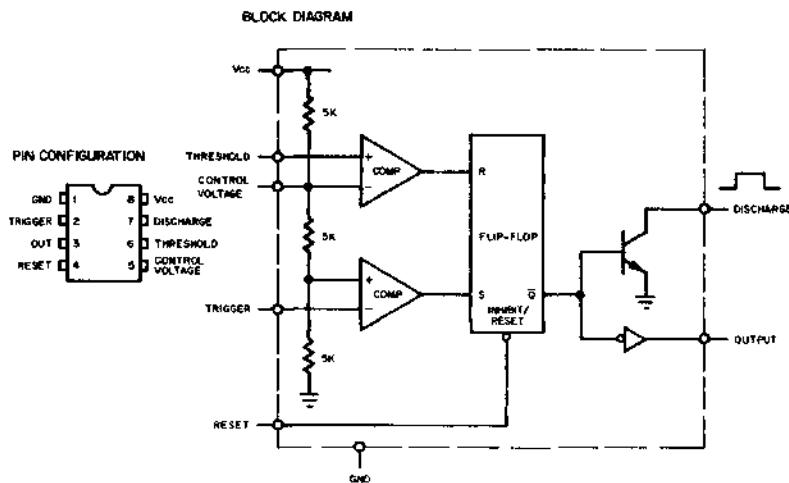
Figure 4-17   TIMER MODULE F10
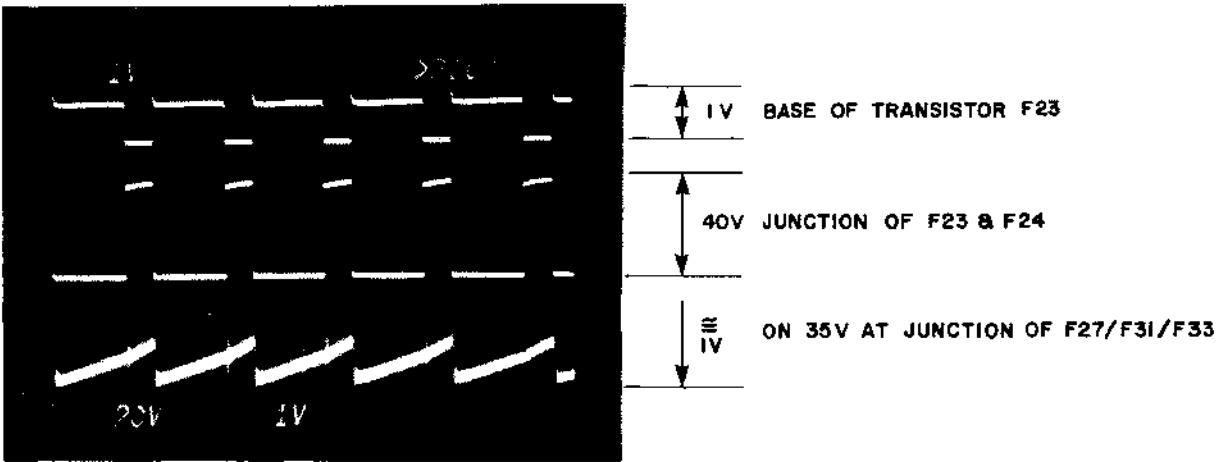
Figure 4-18   -30 VOLT POWER INVERTER WAVEFORMS

This circuit uses a Type 555 Timer module F10 shown in Figure 4-17. This module operates in its astable mode to produce one volt timing pulses on the base of transistor F23 as shown in Figure 4-18.   The operation of Timer F10 is controlled by the circuits and components shown surrounding it in the Schematic Diagram.   DC to DC inversion occurs in the emitter circuit of transistor F23 where an approximately -40 volt pulse is produced thru the action of inductor F24 each time transistor F23 is turned off by the pulses from F10.   This pulse, act-ing thru capacitor F28 and diodes F29 and F31 develop an output level of approximately -35 volts peak at the input of the regulator section. The regulator section filters and regulates the output to a smooth -30 volt level for use by EAROM B25.

4.4.3.8   The Current Loop Interface Circuit

Refer to Table 4-8, and to the Schematic Diagram.

A current loop is an interface circuit which uses current flow <u>yes</u> or <u>no</u> to represent 1's and 0's as compared to the changes in voltage level usually associated with TTL.   The current source for the loop may be located on this PCB (active mode) or in the host system (pas-sive mode).   The circuit may be configured for either 20mA or 60mA current limits, and for either half- or full-duplex operation.   Table 4-8 lists jumper configurations and resistor values to be used to establish the desired operating parameters.   The Terminal may be located up to 4000 ft from its host system.

Current loop data input is passed thru optoisolator module D12 where an LED/phototransistor circuit converts the current ON/OFF serial data to voltage HI/LO serial data.   The voltage data is then channeled thru inverters and gates for presentation to the serial data interface on the HPRO4 PCB as -RxD.   Data to be transmitted arrives at Receiver Module E5 on this PCB from the HPRO4 PCB as -TxD.   E5's output goes to optoisolators B5 and D5, whose outputs control switching transistor D4.   The resultant <u>ON/OFF</u> current flow is then transmitted to the host system.

4.5 TRANSDUCER PCB Assy, #40515-XX

4.5.1 General Information

This PCB contains all the circuits necessary to generate the sine-wave drive for the carriage and print wheel transducer stator windings, to demodulate the resultant phase-modulated carrier signal coming from the two transducer rotor windings, and to produce from each carrier signal three triangular position signals and one linear mode signal each for the carriage and print wheel tachometer circuits on the Servo PCB. Refer to Figure 7-4 Schematic Diagram.

4.5.2 The Sine-wave Drive Generator Circuit

Refer to Figure 4-19 for an illustration of the waveforms discussed below.

Figure 4-19 shows the waveforms generated by modules H24 and H48. These two modules are 4-bit parallel access shift registers which are driven by the 5 mHz -CLOCK A input from Logic #1 PCB, and connect to form a :16 circuit. The outputs are square waves as shown, where the output H48-15=HI is followed one clock cycle later by H48-14=HI, and so forth. When H24-12 goes HI, feedback through H24-11 and thru gate H30-8 drives the output at H48-15 LO. This condition then cascades through the registers again until H24-12 goes LO, when H24-11 will drive H48-15 HI to start the cycle again. These square-wave outputs are connected through inverters, pull-up resistors and load resistors to four output lines - two for carriage circuit use, and two for print wheel circuit use. The inverters act as switches, allowing current to flow through the associated load resistors whenever the inverted output is LO. Seven of the inverter outputs are selected for summation to form each of the four output signals -CAR 1, CAR 3, PW 1 and PW 3. The values of the several load resistors plus a capacitor connected from each output line to their common return line produces a set of two-phased sinusoidal waveforms as shown for both the carriage and the print wheel circuits. These two signals are fed to the stator windings on each position transducer.

4.5.3 The Servo Position Transducer

Each Servo Position Transducer consists of rotor and stator members made up as flat disks with windings laminated on adjacent surfaces. The rotor is mounted on the free end of the servo motor shaft, with the stator mounted over it and fastened to the motor casing. Output signals from the rotor are picked up by means of an axially mounted rotary transformer.

As shown in Figure 4-20, the stator has an eight segment winding, with alternate segments connected together to form two groups of four segments each. The four segments of one group are displaced laterally from the other group by a distance equal to one-half a winding width. This displacement is equal to a 90° phase difference.

The rotor has one symmetrical winding.
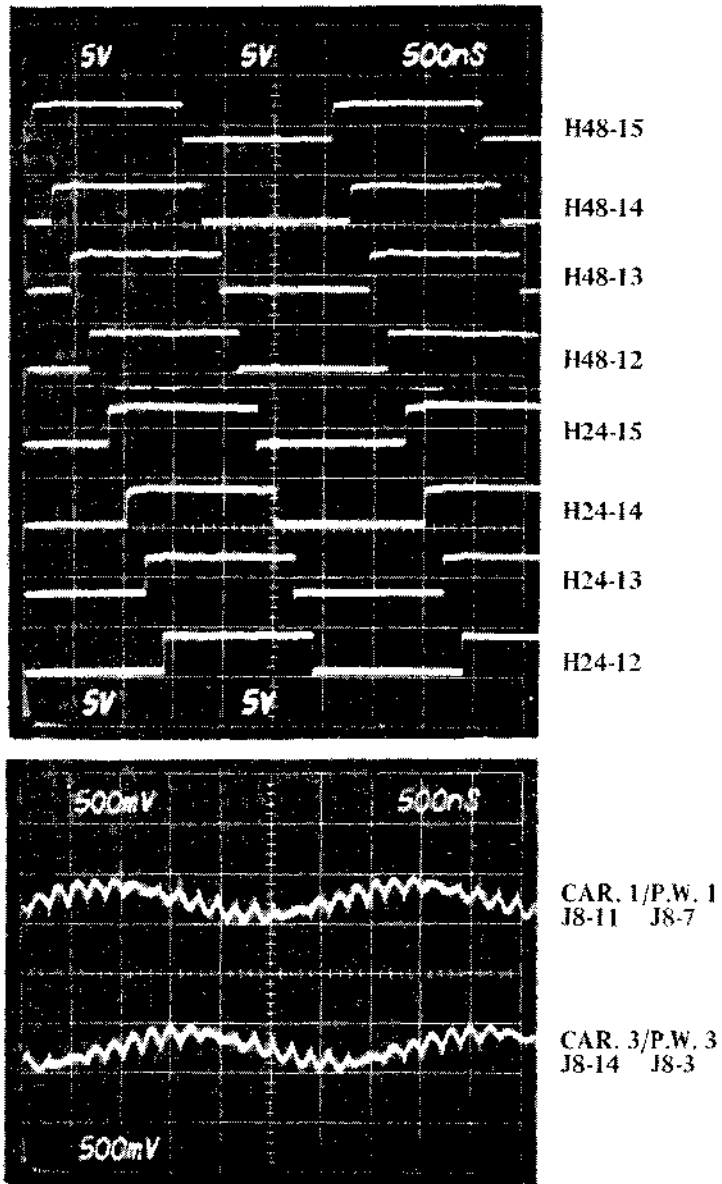
Figure 4-19   SINE-WAVE DRIVE GENERATOR WAVEFORMS
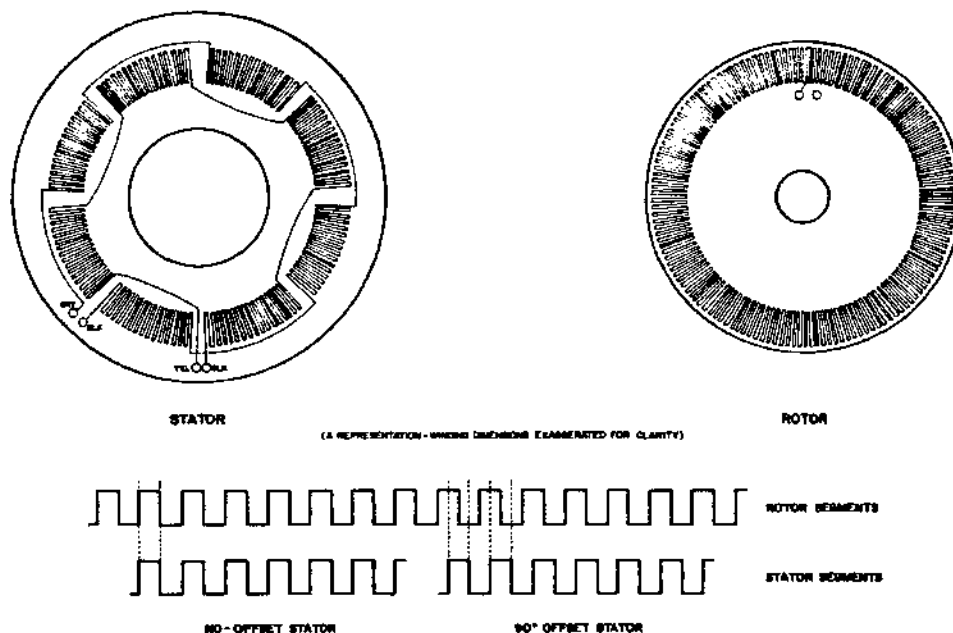
Figure 4-20 SERVO POSITION TRANSDUCER

The two sinusoidal outputs shown in Figure 4-19 are introduced into
the transducer's stator windings. Since all the windings in the
device are nearly 1:1, the only transformation of the inputs is that
the summed output is phase modulated by rotor movement. The phase
modulated output from the transducer is coupled back to a 2-stage RF
Amplifier and a squaring circuit.

4.5.4 The Servo Feedback Amplifier Circuit
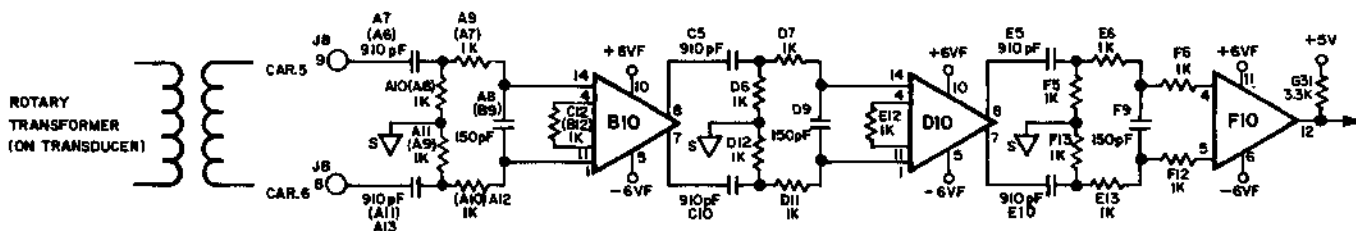
Figure 4-21 SERVO FEEDBACK AMPLIFIER

Figure 4-21 is a partial schematic showing this circuit as seen in the
carriage channel. Since both carriage and print wheel channels are so
nearly alike, the balance of this discussion will follow the carriage
channel only.

Figure 4-22 shows waveforms taken in this circuit. Waveform A is the
phase-modulated servo transducer output, as seen at the input to
the first video amplifier B10-1/-14. Amplifier B10 has an adjusted
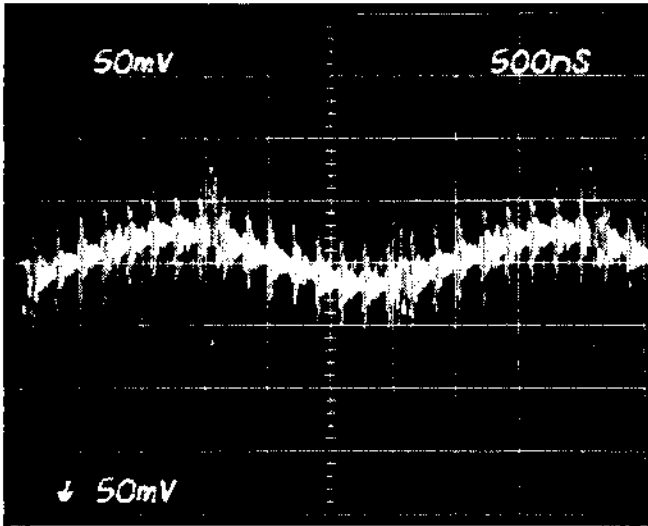
A

1 st VIDEO AMPL. INPUT

BIO−1/14 (BIO−1 INVERTED)
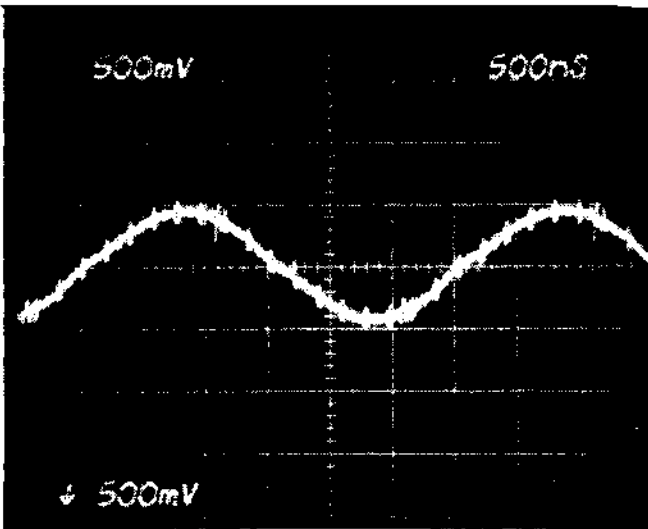
B

1 st VIDEO AMPL. OUTPUT

BIO−7/8 (BIO−7 INVERTED)
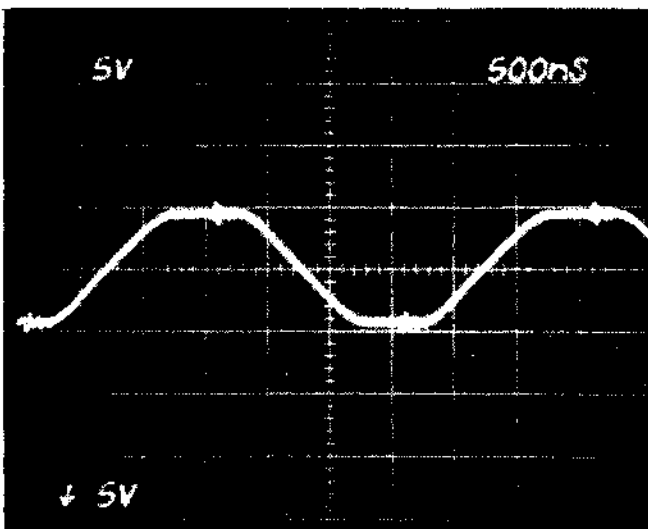
C

2 nd VIDEO AMPL. OUTPUT

DIO−7/8 (DIO−7 INVERTED)

Figure 4-22   SERVO FEEDBACK AMPLIFIER WAVEFORMS

gain of approximately 20. It amplifies and partially filters the in-
put as shown at its output, waveform B, taken at B10-7/-8. The sec-
ond video amplifier D10, also with a gain of approximately 20, further
filters the signal and generates a 10 volt p-p output waveform C
which displays some squaring from saturation limiting. This output,
from D10-7/-8, is applied to a high speed squaring comparator module
F10. F10 is overdriven, and produces a square-wave output.
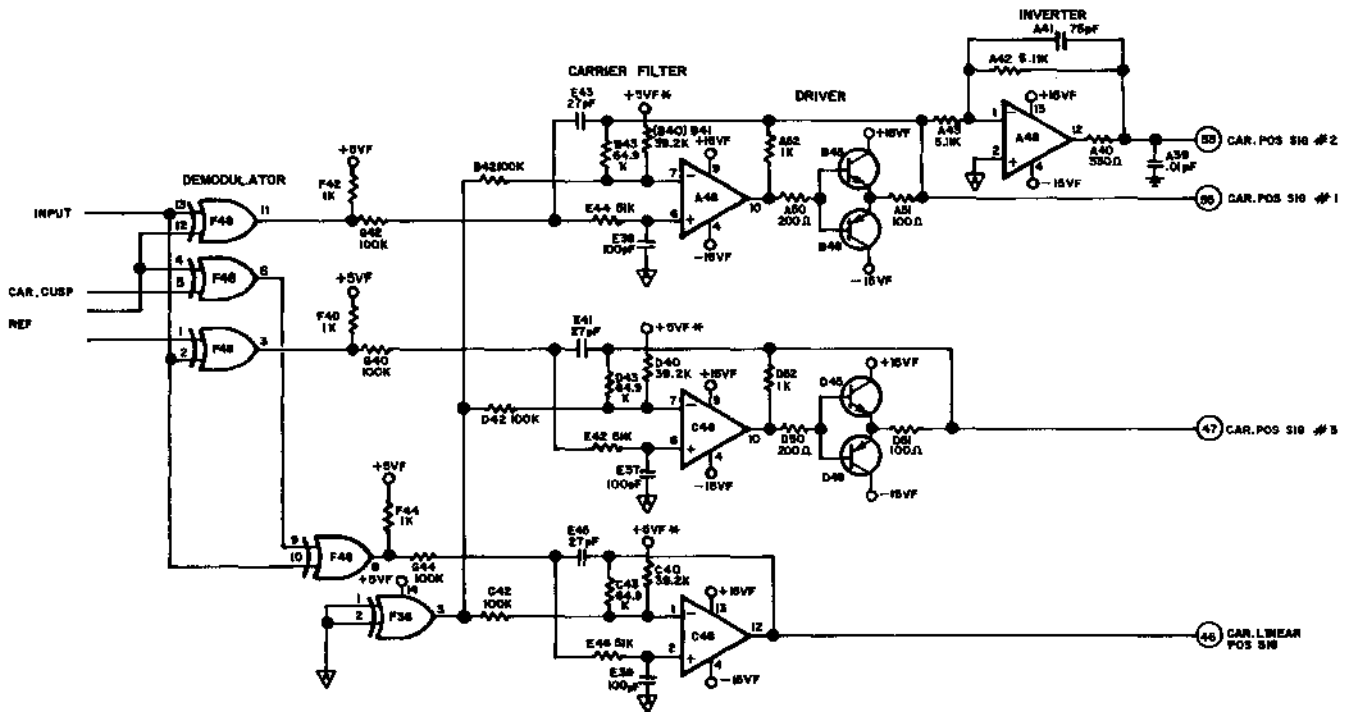
Figure 4-23   SERVO FEEDBACK DEMODULATOR/INTEGRATOR/AMPLIFIER

Figure 4-23 is a partial schematic showing the Servo Feedback Demod-
ulator/Integrator/Amplifier circuit. Figure 4-24 shows waveforms
taken in this circuit.
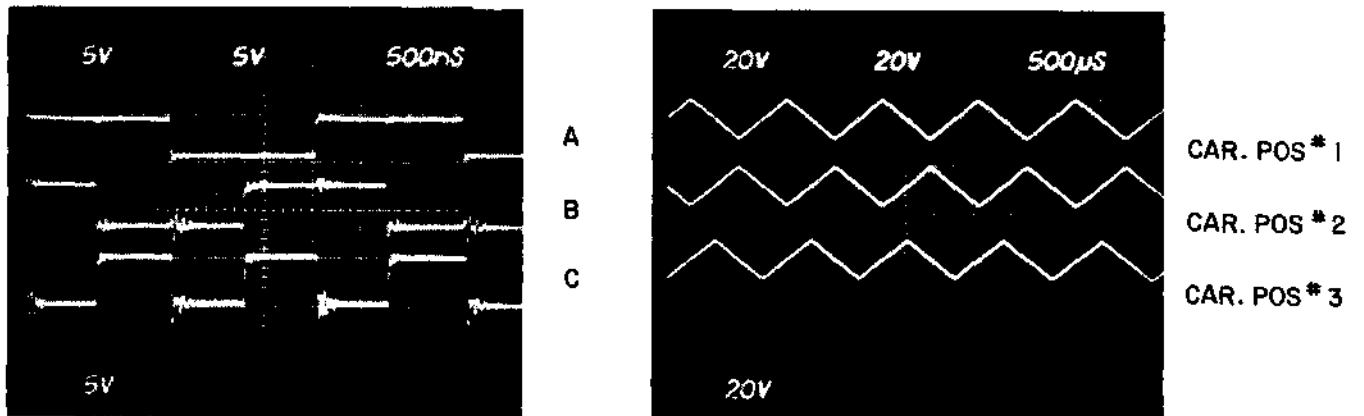
Figure 4-24   SERVO FEEDBACK DEMODULATOR/INTEGRATOR/AMPLIFIER WAVEFORMS

The square-wave output of comparator F10 is inverted and applied to Exclusive OR gates F48-3/-11 as the squared and inverted phase modulated signal from the carriage servo transducer, along with reference square waves from the sine-wave driver generator circuit.

As shown in Figure 4-24, by observing the two inputs to either F48-3 or F48-11 along with the gates' output on a multichannel oscilloscope which is synchronized to the sine-wave drive generator and slowly moving the carriage by hand, the square-wave input from comparator F10 (B) will appear to move with respect to the input on either pin 1 (F48-3) or pin 12 (F48-11) from the sine-wave generator (A). Then, the output (C) from either F48-3 or F48-11 will be a square wave whose relative HI-LO status will vary as the HI-LO states of the two inputs vary with respect to each other.

Figure 4-25   WAVEFORM ANALYSIS

Figure 4-25 illustrates the development of the output waveform (C) from the two input waveforms (A and B), and further shows the sawtooth waveshape developed in the integrating circuits for amplifiers A48-10 and C48-12. The output of A48-10 is then supplied to amplifier A48-12. These three amplifiers produce the waveshapes called CAR POS SIG #1, CAR POS SIG #2, and CAR POS SIG #3. In addition, when the carriage has stopped, the lower circuit shown in Figure 4-23 produces a signal called CAR LINEAR MODE, which is used to detent the servo.

4.6 SERVO PCB ASSY, #40520-XX

4.6.1 General Information

Figure 4-26   SERVO PCB BLOCK DIAGRAM

As shown in Figure 4-26, this circuit follows the HPRO4 Interface in the command response chain, and has four functions. First, it receives strobed processed command data in digital form from the HPRO4 PCB, and converts this digital data input to a voltage level representative of the absolute value of the desired velocity at which the carriage or print wheel is to be moved. Since incoming data are multiplexed, the D-to-A Converter part of the circuit is common, with the print wheel and carriage functions being steered to nearly identical but separate sample and hold circuits. The velocity level output from the sample and hold circuit is then switched in polarity to control direction of movement, and the resultant polarized voltage is presented to a summing amplifier as the velocity command signal. Second, dual tachometer circuits convert incoming analog position signals (XX POS SIG #1, #2 and #3) to a voltage level which represents the actual servo velocity. In addition, these circuits derive a series of three digital position signals (XX POS A, POS B and EVEN). These position signals represent distance moved and are supplied back to the HPRO4 PCB where they are used to generate increment and/or decrement counts for the position memoriesin. Third, the voltage level of velocity is summed with the velocity command signal to develop a 0 to 7 volts maximum SERVO ERROR signal. SERVO ERROR is used on the Power Amplifier PCBs to develop the actual servo motor drive current. Fourth, the D-A Con-

verter output is used to process print hammer energy commands which
are then used to develop the actual print hammer drive current on the
Print Wheel Power Amplifier PCB.

Refer to Figure 7-5 Schematic Diagram.

4.6.2 The D-A Converter Circuit

Figure 4-27 D-A CONVERTER CIRCUIT

This common input stage serves both the carriage and print wheel chan-
nels as well as the print hammer circuit. It consists of 8-bit digi-
tal-to-analog converter module G12, operational amplifier E12-6, buf-
fer/driver transistor E6, and associated circuit components. Figure
4-27 is a partial schematic illustrating this circuit. Converter G12
converts the binary input from the microprocessor to a current. The
amplitude of this current represents either a speed command for car-
riage or print wheel, or a hammer energy command for the print hammer.
The circuit's operating parameters are set by the value of resistors
F9 and F10 in the +5V supply line to G12 pin 14, so that when all di-
gital inputs are HI the output current at pin 4 will be 99.6% of the
reference current of approximately 1 mA on pin 14. When all digital
inputs are LO, the output on pin 4 will be 0 mA. E12-6 is a current-
to-voltage converter, with its instantaneous voltage level stored on
capacitor F5 for reference between updating inputs from the micro-
processor.

4.6.3 The Sample and Hold Circuit

Figure 4-28 illustrates a typical Sample and Hold circuit for either
the carriage or print wheel channel, and shows the basic timing
involved. The circuit consists of an input switching FET, an opera-
tional amplifier A coupled to a buffer/driver transistor Q, and asso-
ciated components.
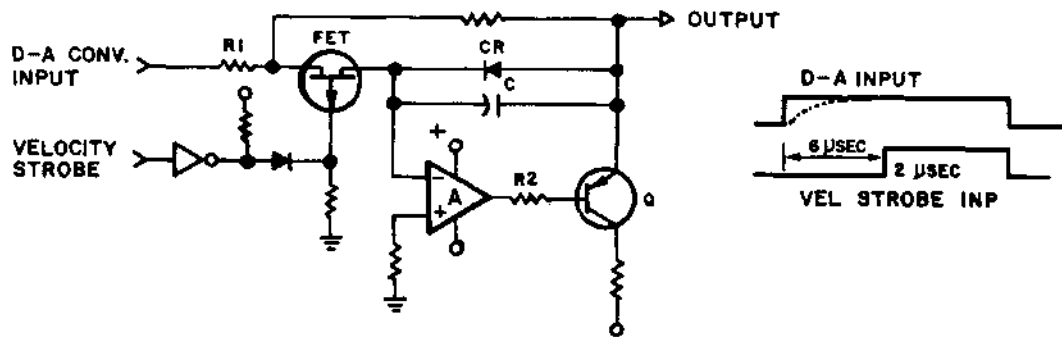
Figure 4-28   TYPICAL SAMPLE AND HOLD CIRCUIT

In operation, the output of the D-A Converter is presented to the switching FET through resistor Rl (D9 in the actual carriage circuit, F23 in the actual print wheel circuit). Approximately 6 usec after the arrival of data on the data bus input to the D-A Converter, the microprocessor on the HPRO4 PCB issues a 2 usec Velocity Strobe pulse through a line receiver network to turn on the FET. When turned on, the FET couples the D-A output voltage to holding capacitor C in the feedback circuit of amplifier A. Capacitor C holds this voltage until the microprocessor again strobes in the D-A output. The microprocessor's cycle rate is so fast that it may update the charge on the capacitor 100-200 times before it actually modifies the data. The microprocessor modifies the D-A input data only when the associated transducer has experienced a track crossing ¼has generated the required pulse(s)¼, which occurs each time the carriage or print wheel has moved a prescribed distance. Amplifier A follows and inverts the charge on capacitor C, to produce a 0-to-negative going voltage which represents the velocity command for the associated servo. Transistor Q buffers the amplifier output, and provides drive current for the circuits following.

4.6.4   Servo Direction Switching Circuits

Refer to Figure 7-5 Schematic Diagram. The output of the nearly identical Carriage and Print Wheel Sample and Hold circuits follow identical paths. One path goes through a 10K resistor to a switching FET, while the other path goes through an inverting operational amplifier to a second switching FET, with the output of both of the FET's tied together. This means that the negative going output of the Sample and Hold circuit is supplied as a negative going voltage to one FET, and as a positive going voltage to the other FET. The gates of these FET's are controlled by inputs from the microprocessor labled FWD and REV through inverters and voltage divider networks. The microprocessor then selects the correct polarity of signal to be presented to the Summation circuit to control ultimate direction of servo movement.

During those times in printer operation when carriage and/or print wheel motion has stopped, and before the hammer fire sequence is complete, the associated servo must be detented to hold its position. To accomplish this, a signal called LINEAR POS SIG is generated in the Transducer circuit and presented to a third switching FET whose output is also tied to the Summation circuit. This FET is A12-7 for the carriage circuit, and A32-15 for the print wheel circuit. The input to the gates of these FET's comes from the HPRO4 PCB through the normal inverter/divider network, and is labeled LINEAR MODE. The associated

servo system is detented by the LINEAR POS SIG being gated to the
summation point, while holding the two associated position switching
FET's are held in their OFF state.

30 msec after the LINEAR POS SIG is gated in following the last posi-
tion command strobe the SERVO DISABLE signal is activated. This turns
off the power amplifier and effectively removes current flow through
the servo while it is at rest. This is called the Float Mode.

In the Print Wheel circuit, the absolute counter is maintained in syn-
chronization with print wheel position at all times, even if the print
wheel is manually moved or should drift. In this way, print wheel
movement in response to the next command can start from wherever the
print wheel happens to be when the command is received.

Carriage position information is not maintained within the printer
circuits. Any carriage drift or noncommanded movement would desyn-
chronize the controller's position information. Any carriage move-
ment, therefore, triggers a response to remove the Float Mode and
drive the carriage back to its last commanded position.

4.6.5 Servo Tachometer Circuits
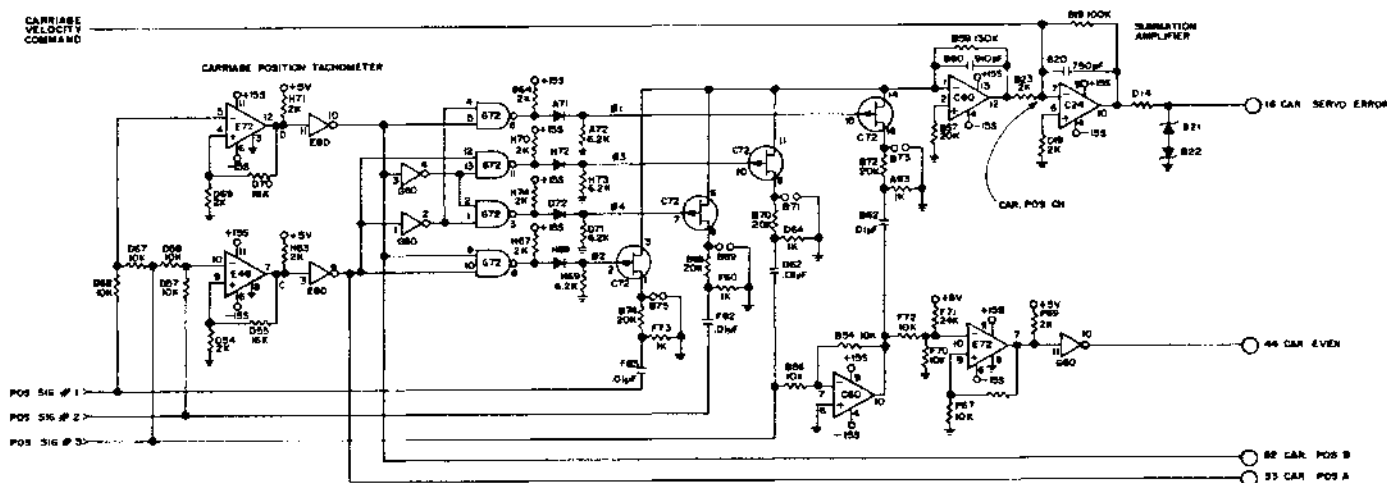
Figure 4-29   CARRIAGE POSITION TACHOMETER CIRCUIT

Figure 4-29 is a partial schematic diagram showing the Carriage Posi-
tion Tachometer and associated circuits. Again, the Print Wheel
circuits are nearly identical, so only the carriage circuit will be
discussed.
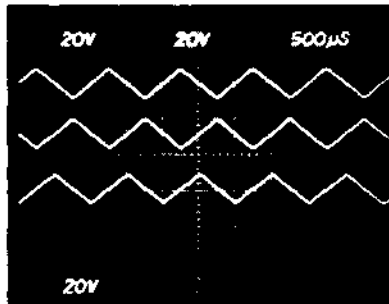
Figure 4-30
CAR. POS TACHOMETER WAVEFORMS
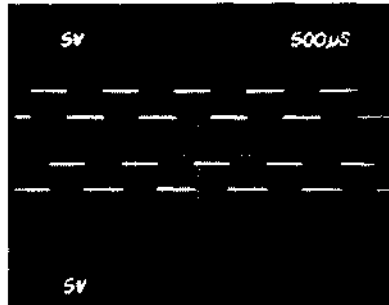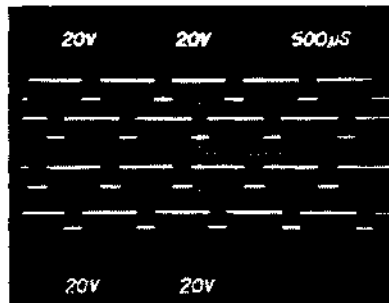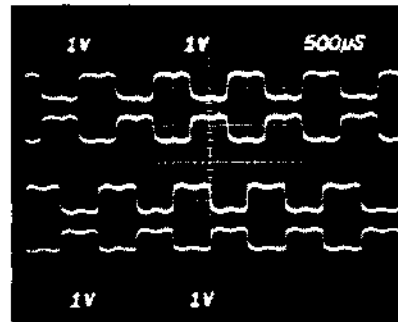
Figure 4-31
CAR. POS FET INPUT WAVEFORMS

Figure 4-30 shows waveforms taken in these circuits.

The transducer on the carriage servo motor is designed so that each complete cycle of the sawtooth waveform inputs represents 1/120 inch (.212 mm) of carriage travel. Thus, while these sawtooth inputs do not vary in amplitude, they DO vary in frequency. This variation (or modulation) follows actual servo speed, with the waveshape itself tracking carriage position.

Refer to Figure 4-30. Modules E48 and E72 are high speed comparators. Their inputs are the sawtooth (or triangular) POS SIG waveforms A, B and C. Their actual outputs are square waves. The duration of these square waves follows the frequency of the sawtooth inputs. They pass through inverters, whose outputs are waveforms D and E from comparators E72 and E48 respectively, and are sent to the HPRO4 PCB as POS A and POS B. POS SIG #3 input is also sent through inverting amplifier C60-10, comparator E72-2, and inverter G60-10 to develop the CAR EVEN signal also supplied to the HPRO4 PCB.

The POS A and B square waves are also channeled through a series of inverters and gates to supply waveforms F, G, H and I. These signals are used to control the feedback FET's C72-2, -7, -10 and -15.

The three POS SIG sawtooth waveforms, plus POS SIG #3 inverted, are supplied to the control FET's through differentiating networks. Figure 4-31 shows the waveforms taken at the capacitor-resistor junction in each network. The control pulse to each FET will turn the FET on to pass either the positive or negative part of the differentiated signal, depending on the direction of servo movement. Since servo velocity is seen here as frequency, the higher or lower the velocity, the higher or lower the level of the differentiated square wave. The voltage level of the outputs of the FET's are applied one at a time to the input (pin 1) of amplifier C60-12 with the combined result representing servo velocity. Amplifier C60-12 inverts the input and presents it to the velocity summation junction (pin 7) of Servo Summation Amplifier C24-10 as negative feedback.

4.6.6 Servo Summation Amplifier Circuit

This amplifier, C24-10 for carriage and C36-12 for print wheel, is the output of the servo velocity command circuit. It is an operational amplifier with a compensating capacitor, and a gain resistor in its feedback loop. The back-to-back 6.2 volt zener diodes in the output, plus their normal voltage drop, provide a bidirectional voltage clamp which limits the amplifier output to +/-7 volts. Since each volt of signal output here produces a fixed value of drive current later on in the servo motor, it is necessary to establish this voltage limit to safeguard the servo motor.

The input to this amplifier is then either the sum of actual velocity and velocity command voltages, or the LINEAR POS signal input and velocity signal which is used to detent the servo motor. The output is a voltage which is directly proportional to the desired amount of servo drive current. This output is labeled SERVO ERROR, and is sent to the associated Power Amplifier circuit.

4.7 CARRIAGE POWER AMPLIFIER PCB ASSY, #40525-XX

4.7.1 General Information

This assembly includes the Carriage Servo Power Amplifier, the Paper Feed Drivers, and the Power Monitor circuits. It is located in Printer Electronics Compartment Slot D, and has a finned heat sink attached to it, to help cool the several drive transistors.

> NOTE: DO NOT stand the Printer on its rear heat sinks. These finned heat sinks are mounted on plug-in circuit boards which can be easily damaged by this practice.

4.7.2 Carriage Power Amplifier Circuit
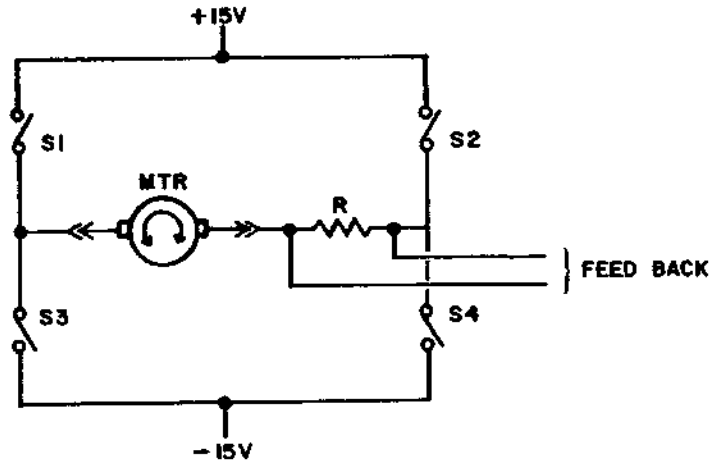
Figure 4-32   CARRIAGE POWER AMPLIFIER SIMPLIFIED DIAGRAM

This circuit supplies and controls current flow to the carriage servo drive motor. It is designed as an H bridge, allowing all current to flow through the motor from supply to supply instead of through circuit ground to avoid circuit noise problems. Figure 4-32 illustrates the basic circuit in simplified form, where certain transistors in the actual circuit are represented as switches. It may be seen that closing switches S1 and S4 will cause current to flow through the motor and resistor R right to left, while closing switches S2 and S3 will cause current flow left to right.

Referring to Figure 7-6 Schematic Diagram and the above will aid in understanding the operation of the circuit itself. Since the amplifier is composed of several similar circuits, only one path will be discussed.

Assume a CAR. SERVO ERROR signal of +1 volt for a commanded motor current of 1 ampere. The output from operational amplifier B55-6 will be low, and this will place a low potential on the base of transistor G58 to disable the Pulse Fwd circuit, and on the emitter of transistor G73. G73 will turn OFF. G73 being OFF turns transistor E70 OFF, which turns transistor E65 ON to turn ON Pulse Rev switching transistor F63.

The error signal is also supplied to amplifier A50-6. Amplifier A50-6 output will be negative with a positive input, which will turn transistor D42 OFF. This will turn transistor D45 OFF and transistor E44 ON to turn ON Drive Rev switching transistor D48.

Referring to Figure 4-32, transistor D48 is shown as switch S2, while transistor F63 is shown as switch S3. Turning these two transistors ON establishes a current path from the +15 volt supply through D48, resistor C53, the drive motor, and F63 to the -15 volt supply.
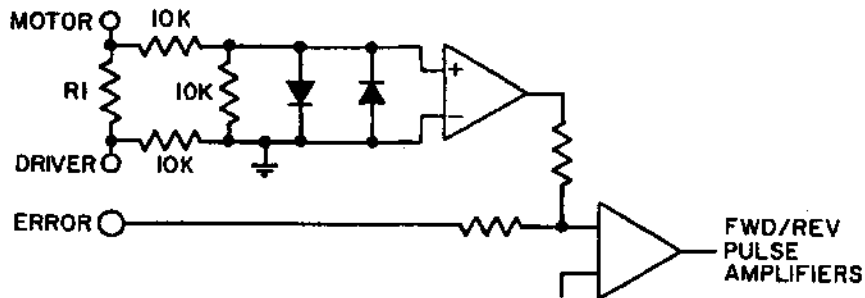
Figure 4-33   CARRIAGE FEEDBACK INSTRUMENTATION CIRCUIT

Figure 4-33 is a simplified schematic diagram of the carriage motor feedback circuit. This circuit includes the .1 Ohm resistor C53 (R1) located in one of the lines to the servo motor, across which is connected a precision balanced 10K Ohm resistor network and difference amplifier B62-10. The value of resistor C53 (R1) is selected for a voltage drop to current ratio of 1 to 10 (.1 volt drop equals 1 ampere of motor current). Difference amplifier B62-10 inverts this voltage, and presents the result to servo error input terminal 2 of amplifier B55-6. The two signals are summed at a ratio of 10 inputs to 1 feedback. It may be seen then that as current through the drive motor approaches the commanded level the output of B55-6 will diminish. When motor current matches command current, the Pulse Rev switch transistor F63 will be turned OFF. This removes motor current which removes feedback voltage and F63 is turned back ON again. The circuit will oscillate in this manner to maintain motor current at the commanded level.

Should the Power Monitor circuit detect an input voltage error, it will generate a -CAR. SERVO disable signal. This signal will turn transistor E77 ON which results in turning OFF Pulse Fwd and Pulse Rev transistors F47 and F63 to disable carriage servo movement.

4.7.3   Power Monitor Circuit
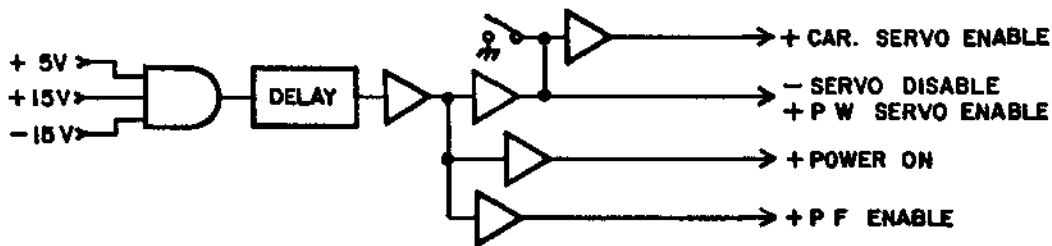
Figure 4-34   POWER MONITOR CIRCUIT BLOCK DIAGRAM

The purpose of this circuit is to inhibit paper feed, print wheel and carriage movement by generating a series of disabling signals anytime one or more of the three supply voltages drops below a level where

component damage might result. These signals also reset all printer program and logic circuits to their initial or zero condition (a re-store sequence).
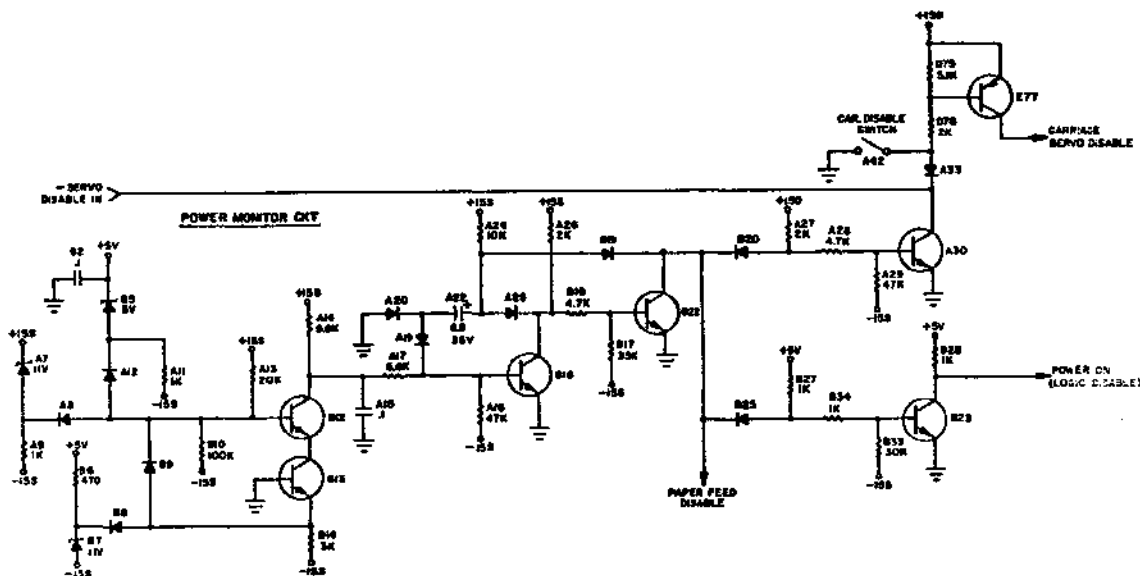
Figure 4-35 POWER MONITOR CIRCUIT

Refer to Figure 4-35. This circuit operates as follows. As power is applied, transistors B12 and B13 are OFF. Three divider networks begin to sample the +5, +15, and -15 volt levels being supplied: zener diode B5 and resistor A11 sample the +5 volt input; zener diode A7 and resistor A9 sample the +15 volt input; and zener diode B7 and resistor B6 sample the -15 volt input. As these voltages approach their appropriate values, diodes A8, A12, B8 and B9 (operating as an AND gate) are reverse biased, and transistors B12 and B13 turn ON. Up to this time transistor B16 had been ON and B22 OFF. When transistors B12 and B13 turn ON, capacitor A22 begins to charge through resistor A24 and the emitter base junction of B16, and transistor B22 is biased OFF. With transistor B22 OFF, transistors A30 and B23 along with two transistors C34 and C36 in the Paper Feed Drive circuit, are biased ON and their outputs are all clamped LO. This condition disables all printer functions as outlined and will continue until capacitor A22 has charged sufficiently to turn transistor B22 ON.

At the end of the delay (approximately 25 msec), transistor B22 is turned ON discharging capacitor A22 and turning transistor B16 OFF. It will also turn OFF transistors A30, B23, C34 and C36, allowing all their outputs to go HI. This removes the circuit disable clamps, starts the program counter on the HPRO4 PCB, and initiates a restore sequence.

Any subsequent interruption in, or depreciation of, any of the three
input voltages monitored will disable the printer by action of this
circuit. Complete restoration of power recycles this circuit, putting
the printer back in operation with a _restore_ sequence.
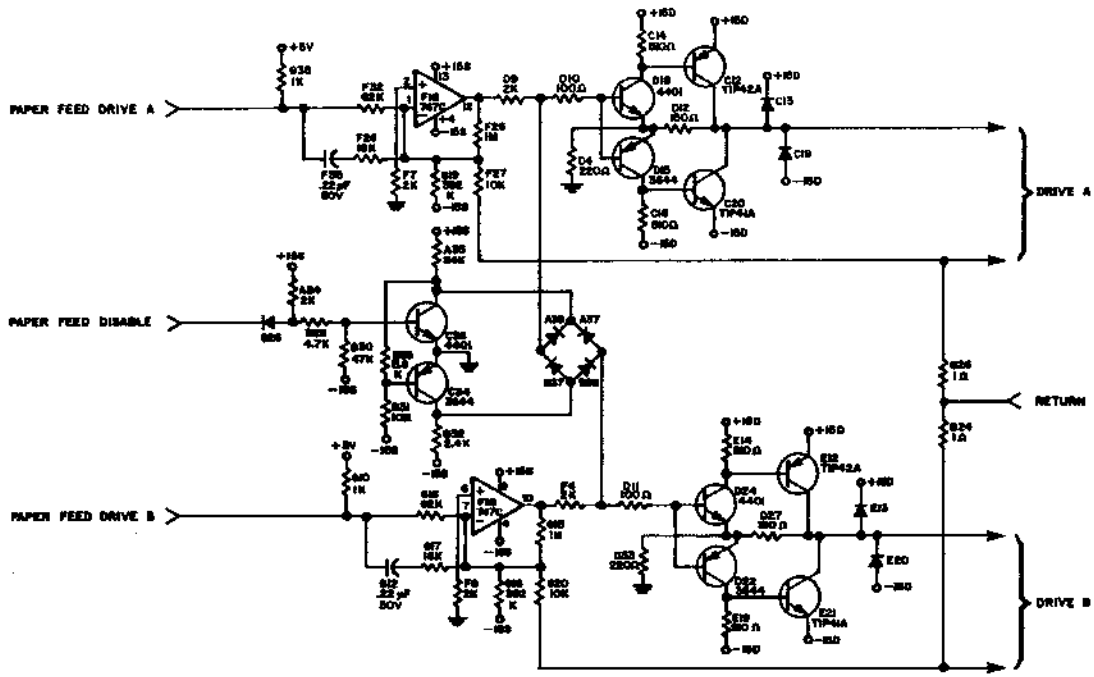
Figure 4-36   PAPER FEED DRIVE CIRCUIT

P F B

DIFF B (GI2 — GI7)

P F A

DIFF A (F28 — F35)

DRIVE B
CURRENT

DETENT CURRENT
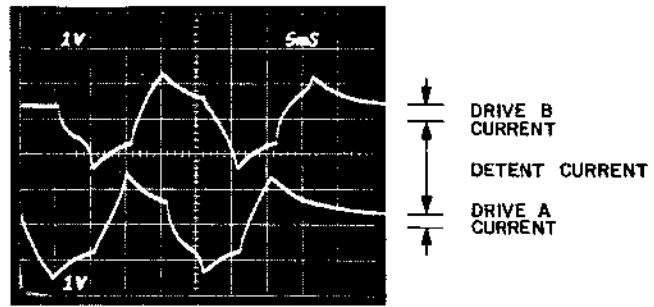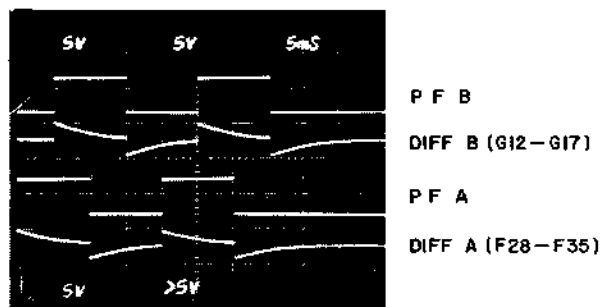
DRIVE A
CURRENT

Figure 4-37   PAPER DRIVE WAVEFORMS

4-36

4.7.4 Paper Feed Drive Circuit

Figure 4-36 is a partial schematic diagram of the Paper Feed Drive circuit. Figure 4-37 shows waveforms taken in the circuit. The circuit consists of two identical channels A and B, each feeding a field winding in the paper feed stepper drive motor. As shown in Figure 4-37, the signals in channel A lead the signals in channel B by 90° This relationship produces clockwise rotation of the stepper motor shaft (as viewed from its shaft end) for upward (forward) paper movement only. Since the A and B channels are identical, only channel B will be discussed here.

In operation, the square-wave PF B input on connector 10 is differentiated by a circuit consisting of capacitor G12, resistor G17 and resistor G20. This network provides a pulse to the input, pin 7, of operational amplifier F18-10 with a duration of approximately 4 to 5 msec. F18-10 squares and amplifies the input, with the result coupled to current amplifiers D22/24 - E12/21. The output drive current waveform (lower half of Figure 4-37) is applied to the B winding of the paper feed stepper drive motor (terminals T5 and T6).

The waveforms shown in Figure 4-37 represent one complete line feed operation. Examination of the waveforms will disclose four level changes for each channel, or a total of eight level changes per line feed. The stepper motor shaft moves 7.5° per level change (A or B) with the A to B 90° phase relationship controlling the direction of movement. Thus each line feed command produces 8 x 7.5°=60° of shaft rotation for a line spacing of six lines per inch.

The paper feed motor is detented electrically at the end of each line feed operation. Again, discussing channel B only, a circuit consisting of resistors G18, G16 and G10 (-15 volts to +5 volts) provides enough output from amplifier F18-10 (about .4 amp motor current) to electrically detent the stepper motor.
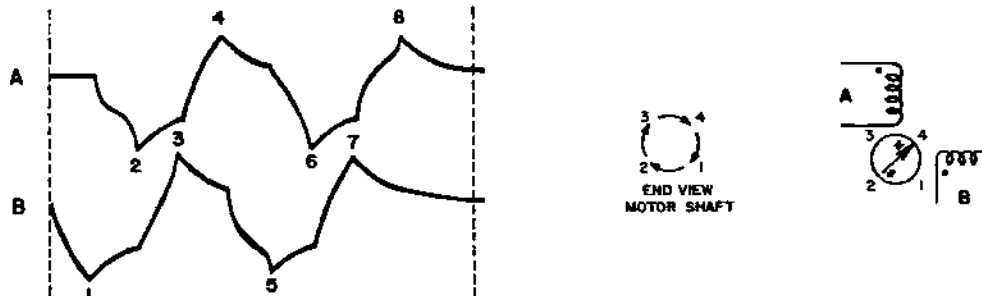
Figure 4-38   TYPICAL STEPPER MOTOR ROTATION

Figure 4-38 illustrates the development of stepper motor rotation from two inputs 90° out of phase with each other. Actually, the paper feed stepper motor's rotor has a magnetic node each 7.5°. This would be difficult to illustrate. It should be noted, therefore, that for clarity the illustration depicts a stepper rotor with magnetic nodes every 90° only.

4.8 PRINT WHEEL POWER AMPLIFIER PCB ASSEMBLIES

4.8.1 #40530-XX, 1640 Series Units

4.8.1.1 General Information

This assembly includes the Print Wheel Servo Power Amplifier, the Ribbon Lift and Ribbon Feed Drivers, the End Of Ribbon sensor amplifier, and the Hammer Energy Control and Driver circuits. It is located in Printer Electronics Compartment Slot H, and has a finned heat sink attached to it, to help cool the several drive transistors.

> NOTE: DO NOT stand the Printer on its rear heatsinks. These
>   finned heat sinks are mounted on plug-in circuit boards
>   which can be easily damaged by this practice.

4.8.1.2 Print Wheel Power Amplifier Circuit

> NOTE: This circuit is nearly identical to the Carriage Power Amp-
>   lifier circuit described in subsection 4.7.

This circuit supplies and controls current flow to the print wheel servo drive motor. It is designed as an H bridge, allowing all current to flow through the motor from supply to supply instead of thru circuit ground to avoid circuit noise problems. Figure 4-32 illustrates the basic circuit in simplified form, where certain transistors in the actual circuit are represented as switches. It may be seen that closing switches S1 and S4 will cause current to flow through the motor and resistor R right to left, while closing switches S2 and S3 will cause current to flow left to right.

Referring to Figure 7-7a Schematic Diagram and the above will aid in understanding the operation of the circuit itself. Since the amplifier is composed of several similar circuits, only one path will be discussed.

Assume a PW SERVO ERROR signal input of +5 volts for a commanded motor current of 1 ampere. The output of operational amplifier A31-6 will be low, and this will place a low potential on the base of transistor H18 and on the emitter of transistor H35. H35 will turn OFF, turning transistor F32 OFF, which turns transistor E30 ON to turn ON Pulse Rev switching transistor G26.

The error signal is also supplied to amplifier A19-6. The output of amplifier A19-6 will be zero volt with a positive input, which will turn transistor C4 OFF. This will turn transistor D5 OFF and transistor E6 ON to turn ON Drive Rev switching transistor C10.

Referring to Figure 4-32, transistor C10 is shown as switch S1, while transistor G26 is shown as switch S4. Turning these two transistors ON establishes a current path from the -15 volt supply through G26, resistor H32, the drive motor, and C10 to the +15 volt supply.

Figure 4-33 is a simplified schematic diagram of the feedback circuit. This circuit includes a 1 ohm resistor H23 located in one of the lines to the servo motor, across which is connected a precision

balanced 10K Ohm resistor network and difference amplifier A45-12. The value of resistor H23 is selected for a voltage drop to current ratio of two-to-one (a 2 volt drop equals 1 ampere of motor current). Difference amplifier A45-12 inverts this voltage and presents the result to the servo error input terminal 2 of amplifier A31-6. The two signals are summed at a ratio of 10 inputs to 1.6 feedback, and it may be seen then that as motor current approaches the commanded level, the output of A31-6 will diminish. When motor current matches command current, the Pulse Rev switch transistor G26 will be turned OFF. This removes motor current, which removes feedback voltage and G26 is turned back ON again. The circuit will oscillate in this manner to maintain motor current at the commanded level.

Should the Power Monitor circuit detect an input voltage error, it will generate a -PW SERVO ENABLE signal. This signal will turn transistor E35 ON, turning OFF Pulse Fwd and Pulse Rev transistors G10 and G26 to disable print wheel movement.

4.8.1.3 Ribbon Lift Drive Circuit

This circuit consists of two subcircuits; one for ribbon lift and one for ribbon hold. The ribbon lift portion includes transistors G67 and H59. The RIBBON LIFT signal turns G67 ON to apply a ground potential to the base of H59. H59 turns ON, applying -15 volts to one side of the ribbon lift coil. The opposite side of the coil is tied to +15 volts. The coil is then energized with a potential of 30 volts, to provide maximum power to rapidly lift the ribbon. At the end of the ribbon lift sequence the RIBBON LIFT signal is removed and replaced with the RIBBON HOLD signal. The ribbon hold portion of the circuit includes transistors H67 and H61. The RIBBON HOLD signal turns ON transistor H67 applying a ground potential to the base of H61. H61 turns ON, applying a ground potential to one side of the ribbon lift coil. The coil is then maintained in its energized state (ribbon lifted) with a potential of 15 volts.

4.8.1.4 Ribbon Feed Drive Circuit

> NOTE: This circuit is nearly identical to the Paper Feed circuit described in subsection 4.7.4.

Refer to Figures 4-36, 4-37 and 4-38. The Ribbon Feed Drive circuit consists of two identical channels A and B. Figure 4-36 shows typical input and output waveforms for each channel for ribbon feed motor rotation.

The A and B inputs, 90° out of phase, are presented to type 747 operational amplifiers E74-12/-10 where they are squared and amplified. The output of these amplifiers is coupled to current amplifiers F48/D50 - D43/F45 for channel A, and F64/D64 - D58/E58 for channel B, where the drive for the ribbon feed stepper motor is developed.

The information in Figure 4-38 further illustrates the development of the stepper motor rotation from the two out-of-phase inputs. It should be noted, however, that unlike the paper feed operation, ribbon feed is in one direction only, with the controller providing the information for ribbon feed.

On the Series 1650 Word Processor Printers and Terminals, the ribbon advance stepper motor increments in $30°$ steps rather than $90°$ steps. This aids in achieving true proportional ribbon advance.

4.8.1.5 Hammer Energy Control and Drive Circuit
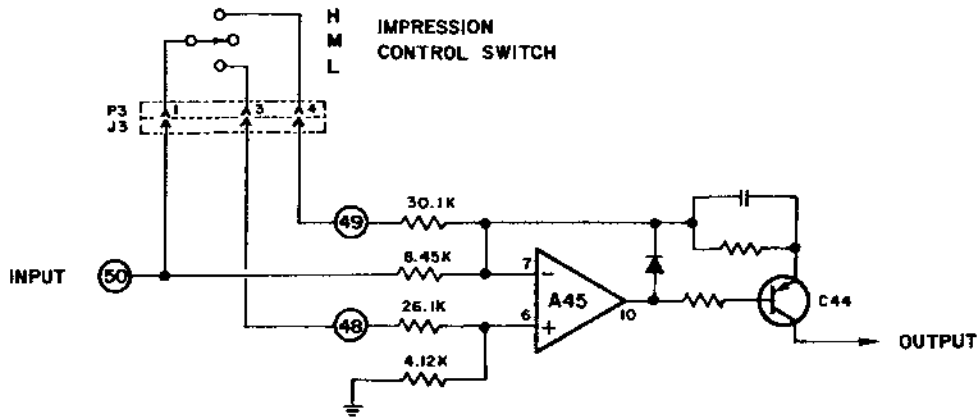
Figure 4-39 HAMMER ENERGY CONTROL CIRCUIT

Refer to Figures 4-39 and 7-7a Schematic Diagram.

Figure 4-39 is a simplified schematic diagram of the Hammer Energy Control circuit. The HAMMER ENERGY CONTROL signal from the D-A Converter on the SERVO PCB is the input to this circuit. This is the signal whose instantaneous level depends on the character to be printed. The normal range of this signal is 0 to +10 volts. Direct Controller access to exercise closer control of this level is discussed in Section 6.

The input is applied to Terminal 50. From this point, it goes through resistor B40 to pin 7 of amplifier A45-10, and to the wiper arm of the Operator's Impression Control Switch. The output of the amplifier is then dependent on the position of this switch, i.e. whether a portion of the input is added to or subtracted from the input.

The +FIRE HAMMER pulse from the HPRO4 PCB turns transistor H50 OFF, to drive the hammer enabling circuits. The hammer fire pulse from H50 is compared with the hammer energy level in comparator A64-7, and also enables transistor C65. C65's output switches driver transistor C73, and also establishes its output level to control the amount of current flowing to the hammer coil.

4.8.2 #40730-XX, 1650 Series Units

This version of the circuit is designed for use in Series 1650 units which make use of the Model 1355WP HyType II Printers. This version is identical to #40530-XX described above, with the exception of R-C networks added to the RIB. Phase A and Phase B input circuits.

Refer to Figure 7-7b Schematic Diagram.

4.9   H4CPN Control Panel PCB Assy, #400568-01

4.9.1   General Information

A single version of the Control Panel PCB Assembly serves in all versions of the optional Control Panel Assembly. Refer to Figure 7-8 Schematic Diagram.

The function of each control panel switch and indicator is described in subsection 2.4.2.2.

4.9.2   Circuit Discussion

4.9.2.1   Programmable Peripheral Interface (PPI), Module U5

PIN NAMES

$D_7 - D_0$	DATA BUS(BI-DIRECTIONAL)
RESET	RESET INPUT
— CS	CHIP SELECT
— RD	READ INPUT
— WR	WRITE INPUT
A_0, A_1	PORT ADDRESS
$PA_7 - PA_0$	PORT A (BIT)
$PB_7 - PB_0$	PORT B (BIT)
$PC_7 - PC_0$	PORT C (BIT)
V_{CC}	+5 VOLTS
GND	Ø VOLTS
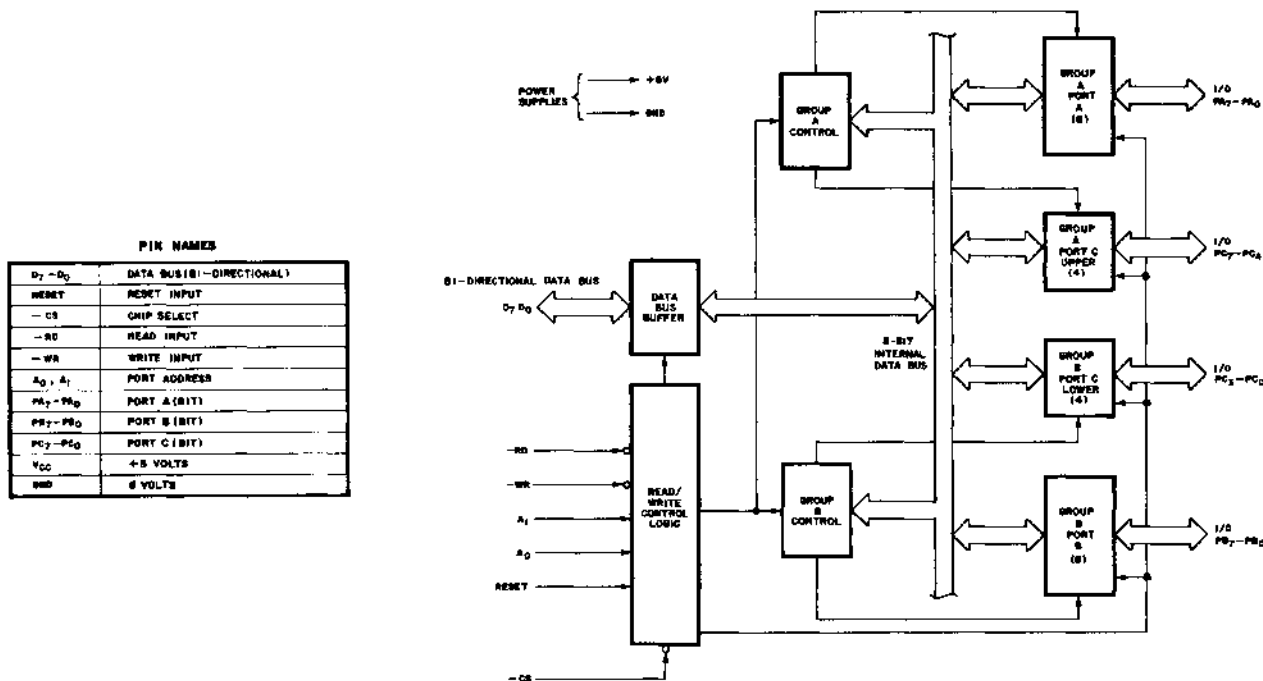
Figure 4-40   PROGRAMMABLE PERIPHERAL INTERFACE

Refer to Figure 4-40 above, and to subsection 4.4.3.3 for a description of this same type module in a similar application.

This module is a Type 8255A general purpose programmable I/O device designed to interface to the microprocessor data bus. It has 24 I/O pins, programmable as two groups of 12 bits each (Group A and Group B). Group A comprises the 8 bits of Port A (PA 0-7) and the upper 4 bits of Port C (PC 4-7). Group B comprises the 8 bits of Port B (PB 0-7) and the lower 4 bits of Port C (PC 0-3).

As used on the 1640/1650 Control Panel PCB Assembly, PA 0-7 and PC 0-3 serve as input ports from 12 of the control panel switches to the data bus, while PB 0-7 and PC 4-7 serve as output ports to the 12 control panel indicators. In the Series 1640/1650 machines, the 8255A in this application is programmed to operate in its basic Input/Output mode.

Table 4-9 lists the basic operating instructions for the 8255A.

TABLE 4-9
8255A BASIC OPERATION

A$_1$	A$_0$	-RD	-WR	-CS	INPUT OPERATION (READ)
0	0	0	1	0	PORT A $\Rightarrow$ DATA BUS
0	1	0	1	0	PORT B $\Rightarrow$ DATA BUS
1	0	0	1	0	PORT C $\Rightarrow$ DATA BUS
					OUTPUT OPERATION (WRITE)
0	0	1	0	0	DATA BUS $\Rightarrow$ PORT A
0	1	1	0	0	DATA BUS $\Rightarrow$ PORT B
1	0	1	0	0	DATA BUS $\Rightarrow$ PORT C
1	1	1	0	0	DATA BUS $\Rightarrow$ CONTROL
					DISABLE FUNCTION
X	X	X	X	1	DATA BUS $\Rightarrow$ 3-STATE
1	1	0	1	0	ILLEGAL CONDITION
X	X	1	1	0	DATA BUS $\Rightarrow$ 3-STATE

4.9.2.2 Other Control Panel PCB Circuits

An additional input port to interface the control panel is provided by 3-State Bus Driver module U6.

I/O port selection is accomplished by the dual 2-line to 4-line decoder module U2. Output 1Y0 from the decoder goes low to enable the 8255A to receive data from the data bus. Output 2Y0 or 2Y1 goes low to enable either the 8255A input ports or the 3-State buffer to read switch status onto the data bus. When reading switch status thru the 8255A, Port A and Port C are read separately to accommodate the 8-bit data bus.

4.10   KEYBOARD PCB ASSEMBLIES

4.10.1   Keyboard PCB Assembly, M, #400716-XX

4.10.1.1   General Information

Refer to Figure 7-9a Schematic Diagram.

The keyboard PCB assembly contains an LSI Scan Encoder that is capable of encoding up to 127 keys by sequentially interrogating each key, and generating a specific code and data ready signal for each key that is operated.

4.10.1.2   Internal Logic Description

4.10.1.2.1   Keyswitch Matrix

The 127 possible keys of the keyboard are arranged in a matrix consisting of 16 row drive outputs and 8 column sense inputs. An operated key will produce a "Key Active" signal when a corresponding matrix intersection is sensed. The signals used to interrogate the key matrix are also used to address an internal ROM which is programmed with a specific code for each key.

4.10.1.2.2 N-Key Rollover Mode

The basic operation of the keyboard is N-Key Rollover mode. This is implemented by storing the state of each key in the prior scan in a 128-bit shift register. By comparing the input and output of the shift register, key actuation and release can be detected for each key regardless of the state of any other key. Thus, by responding to an actuated key on the down-stroke transition, a key code and strobe will be generated for every new key depression, regardless of how many keys are already depressed.

4.10.1.2.3 Strobe Output

Whenever new data is loaded into the output storage latches, a Strobe or "data ready" signal is generated. Only one Strobe signal can be generated per scan cycle. The presence and duration of the Strobe signal is determined by the Strobe Reset input signal.

4.10.1.2.4 Strobe Reset

The Strobe signal is enabled only when the Strobe Reset input is in the high (not reset) state. It is cleared by the Strobe Reset signal going low (reset). The associated data will remain stable until the Strobe Reset signal returns to the high state. The Strobe Reset signal must never go low except in response to a high Strobe signal.

4.10.1.2.5 FIFO Buffer Operation

A two level FIFO (first-in first-out) buffer is also provided on the keyboard. Two sets of latches are loaded alternately to the output drivers in response to the Strobe Reset signal. If new data is generated when both buffers are still waiting for system response (Overrun Condition) the output drivers are forced to an all low state. A new Strobe signal is generated if not already present. When the external electronics acknowledges this Strobe signal, an internal System Reset signal is produced. Thus, any previous data will no longer be accessible, but keys found depressed at the end of the reset sequence will be treated as new key depressions.

4.10.1.2.6 System Reset

A System Reset signal is required to reset all counters and logic to an initial state necessary for subsequent correct operation. After the system reset signal is removed the encoder completes the reset operation in a time lasting between one and two scan cycles. During this time, and the reset time, all key inputs are ignored. Any keys found depressed after this time are treated as new key depressions, even if they were depressed prior to system reset.

4.10.1.3 External Electronics

4.10.1.3.1 Output Codes

The scan encoder will generate an 8-bit binary code to identify the key station location in the given matrix when the key is depressed, and a modified key code when the key is released. This modified key code consists of regeneration of bits D0 thru D6, and the inversion of

TABLE 4-10

KEYSTROKE POSITION CHART

Y	X	KEY No.	DOWNSTROKE 76543210	UPSTROKE 76543210	Y	X	KEY No.	DOWNSTROKE 76543210	UPSTROKE 76543210	Y	X	KEY No.	DOWNSTROKE 76543210	UPSTROKE 76543210
4	2	80	01110111	11110111	2	5	22	00100100	10100100	6	13	70	01010001	11010001
0	2	81	01110100	11110100	2	6	23	00100011	10100011	6	14	71	01010010	11010010
0	3	82	01110101	11110101	2	7	24	00110100	10110100	6	15	72	01010011	11010011
1	0	1	00000101	10000101	2	8	25	00110011	10110011	7	0	89	01000111	11000111
1	1	2	00000110	10000110	2	9	26	00101100	10101100	7	1	90	01000100	11000100
1	2	3	00111101	10111101	2	10	27	00101011	10101011	7	2	91	01000101	11000101
1	3	4	00111110	10111110	2	11	28	00011100	10011100	3	1	49	00111111	10111111
1	4	5	00010101	10010101	2	12	27	00011011	10011011	4	3	50	00111001	10111001
1	5	6	00010110	10010110	2	13	30	00001100	10001100	4	4	51	00010111	10010111
1	6	7	00100101	10100101	2	14	31	00001011	10001011	4	5	52	00010001	10010001
1	7	8	00100110	10100110	5	13	67	01100001	11100001	4	6	53	00100111	10100111
1	8	9	00110101	10110101	5	14	68	01100010	11100010	4	7	54	00100001	10100001
1	9	10	00110110	10110110	5	15	69	01100011	11100011	4	8	55	00110111	10110111
1	10	11	00101101	10101101	6	0	86	01010111	11010111	4	9	56	00110001	10110001
1	11	12	00101110	10101110	6	1	87	01010100	11010100	4	10	57	00101111	10101111
1	12	13	00011101	10011101	6	2	88	01010101	11010101	4	11	58	00101001	10101001
1	13	14	00011110	10011110	3	0	32	00111000	10111000	4	12	59	00011111	10011111
1	14	15	00001101	10001101	3	1	33	00111111	10111111	3	1	60	00111111	10111111
1	15	16	00001110	10001110	3	2	34	00111010	10111010	4	15	62	00001111	10001111
0	13	64	01110001	11110001	3	3	35	00010000	10010000	7	13	73	01000001	11000001
0	14	65	01110010	11110010	3	4	36	00010010	10010010	7	14	74	01000010	11000010
0	15	66	01110011	11110011	3	5	37	00100000	10100000	7	15	75	01000011	11000011
5	0	83	01100111	11100111	3	6	38	00100010	10100010	0	4	92	01111111	11111111
5	1	84	01100100	11100100	3	7	39	00110000	10110000	0	5	93	01111100	11111100
5	2	85	01100101	11100101	3	8	40	00110010	10110010	0	6	94	01111101	11111101
2	0	17	00000011	10000011	3	9	41	00101000	10101000	0	7	95	01111110	11111110
2	1	18	00111100	10111100	3	10	42	00101010	10101010	0	8	63	00011001	10011001
2	2	19	00111011	10111011	3	11	43	00011000	10011000	0	10	77	01111001	11111001
2	3	20	00010100	10010100	3	12	44	00011010	10011010	0	11	78	01111010	11111010
2	4	21	00010011	10010011	3	14	46	00001010	10001010	0	12	79	01111011	11111011

KEY POSITION ⌐ ⌐ POSITION CODE

80	81	82	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	64	65	66
77	74	75		06	3D	3E	15	16	25	26	35	36	2D	2E	1D	1E	0D	0E	71	72	73

83	84	85	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	67	68	69
67	64	65		3C	3B	14	13	24	23	34	33	2C	2B	1C	1B	0C	0B	61	62	63

86	87	88	32	33 (1)(2)	34	35	36	37	38	39	40	41	42	43	44	45	46	70	71	72
57	54	55	38	3F	3A	10	12	20	22	30	32	28	2A	18	1A	08	0A	51	52	53

89	90	91	47	48	49 (1)	50	51	52	53	54	55	56	57	58	59	60 (1)	61	62	73	74	75
47	44	45			3F	39	17	11	27	21	37	31	2F	29	1F	3F		0F	41	42	43

92	93	94	95	63	76	77	78	79
7F	7C	7D	7E	19		79	7A	7B

NOTES:
1. KEYS 33, 49 AND 60 SHARE THE SAME POSITION CODE.
2. KEY 33 IS A MECHANICAL SHIFT LOCK KEY.
3. ALL POSITION CODES ARE IN HEXADECIMAL FORM.

Figure 4-41   KEY POSITION LAYOUT

bit D7. This 8-bit code is a position code assigned to the physical location of a particular key on the keyboard. Figure 4-41 shows the key positions and Table 4-10 gives the position codes generated by each key position. These position codes are inverted and sent to the HPRO4 PCB via its parallel I/O connector. The downstroke position code generated when the key is depressed uses the D7 bit to flag the HPRO4 to repeat the corresponding function or character after a 1/2 second delay (counted by the Real Time Clock). The upstroke position code generated when the key is released inverts the D7 bit of the downstroke position code which in turn causes the HPRO4 to remove the repeat flag for the corresponding function or character.

There are two key positions on the keyboard (48 and 61) which are strapped to produce only the downstroke position code for keyboard diagnostics. These position codes are present at the interface after power-up or system reset sequence.

- POR → |_| ← 20 MSEC
- READY
30 µs   Tc →|←   ← STROBE FOR UPSTROKE
- KYSTB
T_A →|←→|← T_B
DATA
KEY DEP   UPSTROKE
DOWNSTROKE   KEY NOT DETECTED
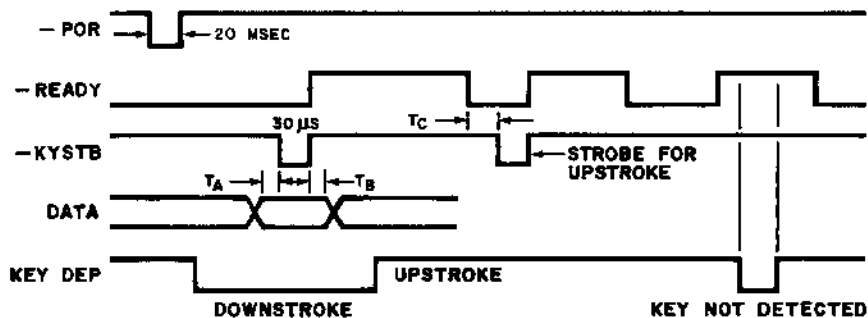
T_A = 5µs MINIMUM: DATA BITS STABLE BEFORE STROBE IS ACTIVE.

T_B = 5µs MINIMUM: DATA BITS STABLE AFTER STROBE GOES HIGH.

T_C = 10µs MINIMUM: READY ACTIVE LOW UNTIL NEW STROBE IS SENT.

NOTE: DATA IS TAKEN DURING 'T_B'.

Figure 4-42   KEYBOARD TIMING DIAGRAM

4.10.1.3.2 Output Strobe Logic

The strobe output signal -KYSTB is generated each time a key is depressed and released. A low (active) state on the -KYSTB output informs the HPRO4 that data is available at the keyboard. In response, the HPRO4 sends a +BUSY=HI to the keyboard. The -KYSTB strobe will go high after the +BUSY input goes LO. As long as -KYSTB and -BUSY are both HI, the scan cycle stops, and any new key depressions are ignored. See Figure 4-42.

4.10.1.3.3 Power On Reset (POR)

The HPRO4 will provide a -POR=LO input signal to the keyboard when power is applied to the terminal. -POR=LO produces a System Reset signal for the encoder. When -POR=HI (inactive), the position codes of the two diagnostic keys and any other keys that are depressed will appear at the interface. The sequence in which these codes arrive at the interface depends upon the location of the keys in the matrix at the time when -POR=HI occurred.

4.10.2 Keyboard PCB Assembly, C, #400716-XX

4.10.2.1 General Information

Refer to Figure 7-9b Schematic Diagram.

The keyboard PCB assembly contains all the electronic circuits needed to sequentially interrogate each key, and to generate a specific code and key strobe signal for each key that is operated.

4.10.2.2 Keyswitch Matrix

The keyswitch used on the keyboard is a linear saturable ferrite core with two preformed wires snapped thru it. One wire, called the drive wire, is periodically driven by a current pulse. The response to the drive pulse is transferred to the second or sense wire thru transformer action. This core module is itself snapped into the switch housing together with a plunger and return spring. A pair of magnets are molded into the plunger, and saturate the core while the plunger is in its up or at rest position. Since the core is saturated, signals on the drive wires are not coupled to the sense wires. As the plunger is depressed, the magnets clear the core to bring it out of saturation and allow the drive signals to be coupled to the sense wires. These signals are then translated into digital pulses.

4.10.2.3 Circuit Description

4.10.2.3.1 The Microprocessor

The 128 key nonprogrammed MOS/LSI microprocessor integrated circuit with external electronics is used for sequential interrogation. This microprocessor can be logically divided into the following sections:

Timing Section. The timing section generates a main clock signal
train which drives the scanning counter and generates clock phases
01, 02 and 03 (02 is used internally only). The scanning counter pro-
vides the address for each key and its position code. The position
code is the address of the keyswitch latched into the output data
latch. 01 is used as the interrogation enable signal. 02 generates
the strobe and loads the data into the data latch. The strobe is
updated one time per depression of a keyswitch. Phase 03 is used in
the external electronics. The input to the timing section (TPC) is a
pulse train of 10 usec square waves.

Count Register Section. The count register section consists of one
binary counter seven bits in length. The first four bits are used to
scan in the "X" direction and the last three bits are used to scan in
the "Y" direction. This counter provides 128 unique position codes,
each of which corresponds to a unique location of the key in the mat-
rix.

Data Section. The output data consists of a seven bit data latch and
a shift register. Each of the seven bits of the counter is latched
into the data latch with 02 if the key is depressed, and with the
signal 01·-CLK if the key is released. A 128 bit shift register is
used to provide past key history to the data latch, to the strobe
section, and to the external amplifier for hysteresis.

Strobe Section. All keys that are detected will enter into the N-key
rollover scheme. During 02, the input shift register is "anded" with
the inverted output of the shift register to detect a down stroke of
the keyswitch which is presently being interrogated, and the strobe is
generated.

4.10.2.3.2 Keyswitch Array

Each keyswitch is assigned to a particular location in the matrix. The
first four lines (A1 - A4) of the microprocessor are gated with 01 to
scan in the "X" direction and the last three lines (A5 - A7) are used
to scan in the "Y" direction. If the keyswitch is depressed, a signal
appears on the sense line, which is amplified and latched into the
keyswitch latch. The detected signal in the keyswitch latch is called
"Shift Register In" (SRIN) and represents a depressed keyswitch in the
matrix location.

4.10.2.3.3 Output Code

The microprocessor will generate a binary code to identify the key
station location in the given matrix when the key is depressed, and a
modified key code when the key is released. This modified key code
consists of regeneration of bits D0 thru D6, and the inversion of bit
D7. The diagnostic positions generate down stroke codes only.

There are two diagnostic positions installed on the keyboard. All
keyboard memories are erased when -POR is LO. When -POR=HI, the diag-
nostic codes and the codes of any depressed keys will appear at the
interface. The sequence in which these codes appear depends upon the
location of the key in the matrix, and on the time of removal of -POR.

4.10.2.3.4 Output Strobe Logic

A strobe signal -KYSTB is generated each time a key is depressed or released (this signal is generated by the microprocessor, gated with 01). The +BUSY signal goes HI after the terminal microprocessor receives the strobe signal. The strobe will go HI after +BUSY=LO. As long as -KYSTB=HI and +BUSY=HI the scan cycle stops, and any new key depressions will be ignored.

4.11 INTERNAL POWER SUPPLY OPTIONS

4.11.1 General Information

CAUTION: *A word of CAUTION for those technicians who may not be familiar with the higher voltage levels found in switching power supplies.*

Experiments have shown that +/-18 volts at .25 Amp can KILL if the conditions are right!

WARNING: *The Internal Power Supplies discussed herein use voltage levels which can be LETHAL!*

4.11.2 Internal Power Supply Assy, B, #26021-XX
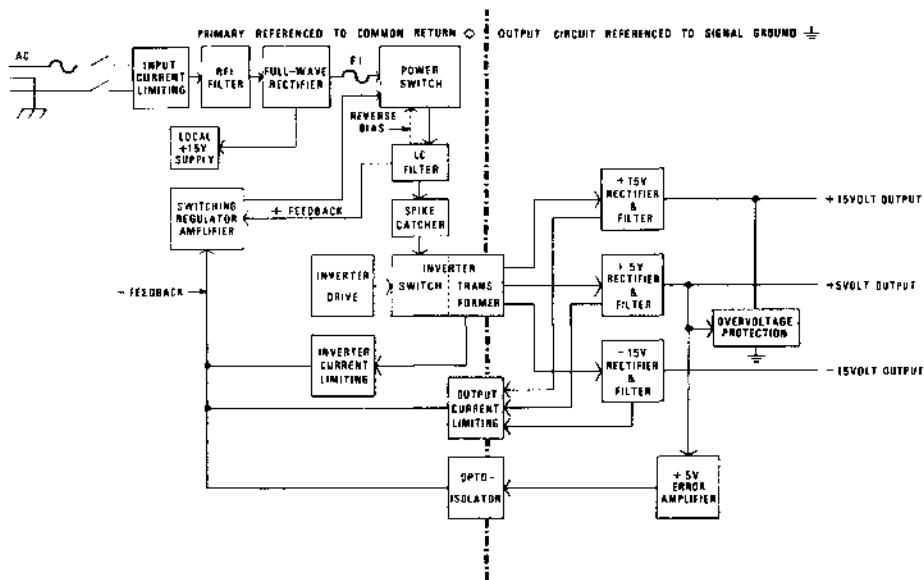
Figure 4-43   INTERNAL POWER SUPPLY BLOCK DIAGRAM, B

Refer to Figure 4-43 above, and to Figure 7-10 Schematic Diagram.

This internal power supply is a direct line switching circuit and operates as follows. The 115/230 volt 50/60 Hz AC input (domestic version) passes thru line transient/surge protection and filtering circuits, and is applied to a full-wave bridge rectifier circuit. The dc output of approximately 100 volts from the rectifier passes fuse F1 and is supplied thru a resistor network to a local +15 volt regulated power supply circuit, and to the high voltage primary power supply circuit.

4.11.2.1 Input Surge Limit and Filter Circuits

When ac power is initially applied, filter capacitor C23 demands a high rate of charging current. To protect the diodes in the recti- fier, thermistor RT1 is inserted in the line. This device has a neg- ative temperature coefficient and initially offers a relatively high resistance value, which then lowers as its internal temperature rises due to current flowing thru it. This sequence limits the charge rate for C23. Eventually, the resistance of RT1 drops to a very low level, where the ac ripple component from the rectifier is sufficient to keep its temperature up and resistance down.

Switching power supplies tend to generate sharp transients, which can be reflected back on to the power line. Line filter capacitors C1, C2 and C3, and RFI filter inductor L1 suppress these transients. L1 is a device with two windings on a common magnetic core. This design develops a higher Q and provides better filtering than two single RF chokes.

4.11.2.2 Full-Wave Bridge Rectifier and Local +15 Volt Supply Circuits

The full-wave bridge rectifier, CR1 thru CR4, converts the line ac voltage to dc. Capacitor C23 provides filtering and storage of the rectified dc. The cathode of C23 defines the primary circuit common return. Note that the rectifier is returned to the primary circuit common return and NOT to signal ground. Fuse F1 protects the bridge diodes in the event of excessive current or a component failure in the primary circuit. The output is applied to both the local +15 volt supply and to power switch Q1.

The local +15 volt circuit furnishes power to the primary circuit. Zener diode VR1 and resistors R12, R13 and R14 provide a reference voltage that is compared to a sampled voltage by transistor Q5. The error signal developed is used to control transistor Q6, the series- pass element, to produce the desired regulation.

4.11.2.3 Power Switch and Switching Regulator Amplifier Circuits

Power transistor Q1, the power switch, is controlled by Type 723 switching regulator amplifier U1, thru a chain of power-boosting tran- sistors. The switching signal generated within U1 at approximately 20 kHz turns the power switch on and off. Regulation is affected by modifying the duty cycle of the switch in response to feedback signals from the +5 volt output. Low output voltage results in increasing "on" time; with high output voltage causing a reduction in "on" time. Modifying the duty cycle raises or lowers the average voltage deliv- ered to the inverter.

The output of U1 is boosted by transistor Q7 to drive complementary Darlington stage Q3. Q3 in turn drives Darlington-connected Q2, the immediate driver stage for power switch Q1. The 20 kHz chopped dc output from the switch is applied to an LC filter for smoothing. The switch output signal is fed back to pin 4 of U1 via inductor L2 and resistors R27 and R17 to maintain self-oscillation. To overcome the effect of charge storage, reverse emitter-base bias is injected into the power switch from a secondary winding on L2. The reverse bias

signal is applied via a network of resistors R2, R3 and R5, capacitor C5, and diode CR5. The phasing of the secondary of L2 causes a pulse of turn-off bias to be applied to both Q1 and Q2 at the termination of the switch "on" period. Turn off of the switch becomes regenerative, and is greatly accelerated.

4.11.2.4 LC Smoothing Filter and Spike Catcher Circuits

The regulated pulsed dc is applied to a filter network made up of inductor L2 and capacitor C10. Diode CR6 maintains output current flow during switch "off" periods by providing a current path to discharge the energy stored in the magnetic field of the inductor during "on" periods. CR6 is reverse-biased when the power switch is "on" to prevent upsetting dc conditions. The smoothed and regulated dc output of the filter is applied to the inverter via a "spike catcher" network.

This network consists of diode CR10, resistors R29 and R48, and capacitor C11. The purpose of this circuit is to suppress large current spikes that can be generated when conduction of the two inverter transistors overlaps. This is not a common occurrence, but can happen during start-up or during recovery from an overload condition. This suppression not only reduces RFI radiation, but also protects the inverter transistors and the power switch transistor. Diode CR10 is polarized to damp production of counter emf in L3 should transients occur in the inverter.

4.11.2.5 The Inverter Circuit

The smoothed dc input is chopped at 20 kHz by the two power transistors Q10 and Q11 conducting alternately. They feed current to the two halves of the primary winding 1-2-3 of the nonsaturating output transformer T1 in opposite directions. Supporting circuitry consists of a saturating transformer T2, diodes CR11 and CR15, resistors R29 and R32, and capacitor C12. The transformer is a self-excited type.

4.11.2.6 DC Output Circuits

Each dc output has its own full-wave center-tapped rectifier and low pass filter. In addition, high-frequency ripple (mostly 40 kHz) is filtered out of the outputs by capacitors C32 and C33. The rectifier for the +15 volt supply is made up of transformer T6, diodes CR17 and CR22, and capacitors C35 and C38. Inductor L4 and capacitor C18 provide filtering. The -15 volt supply uses transformer T5, diodes CR18 and CR21, and capacitors C36 and C37. Filtering is provided by inductor L6 and capacitor C20. The +5 volt supply uses transformer T4, diodes CR19 and CR20, and capacitors C39 and C43. Filtering is provided by L5 and capacitors C19 and C25. R54 is the +5 volt bleeder resistor. Filter capacitors C32 and C33 are discharged when required by bleeder resistor R51.

4.11.2.7 +5 Volt Error Amplifier Circuit

The +5 volt output is sampled by voltage divider resistors R43 and R44, and applied to the noninverting input of Type 723 voltage regulator U2 via resistor R41. The adjustable reference voltage is derived from potentiometer R40 and applied to the inverting input of the

voltage regulator via resistors R39 and R38. The two voltages are compared within U2 and the difference is applied to the optoisolator U3. Only the +5 volt output is adjustable and regulated. The close electromagnetic coupling in the transformer secondary of T1 makes it possible to control all output voltages by controlling any one.

4.11.2.8 Current Limiting and Overvoltage Protection Circuits

The optoisolator U3 consists of a solid-state lamp and a phototransistor. The output of the error amplifier is applied to the lamp, illuminating it in proportion to the error. The optical energy is read by the phototransistor, which has no electrical connection to its base.   The output of the phototransistor is fed back thru resistor R33 to the switching regulator amplifier U1 where the signal is used to modify the duty cycle of the power switch, and thereby regulate the voltage. Since there is no direct electrical connection thru this device, and the phototransistor output is returned to the primary circuit common return, the output circuit is effectively isolated from the primary.

Current flow in each output passes thru a toroidal transformer where it is monitored and fed back to the switching regulator transformer to modify the switch duty cycle. Resistor R58 is connected across a winding of transformer T4 in the +5 volt circuit. Current thru the transformer develops a voltage drop across the resistor. Transistors Q14 and Q15 sense and amplify the voltage drop. In the -15 volt supply, resistor R59 is across the winding of T5, and transistors Q16 and Q17 are the sense amplifiers. In the +15 volt output circuit, the elements are transformer T6, resistor R60, and transistors Q18 and Q19. The collectors of all the transistors are connected to the base of transistor Q13 thru resistor R70. Q13 amplifies the error signal, which can originate in any of the outputs, and applies it to the switching regulator amplifier along with the voltage regulation feedback signal. As current increases, the duty cycle of the switch regulator, and of the power switch, is modified to reduce switch "on" time reducing the average voltage applied to the inverter which limits current thru the inverter transformer. A shorted output will reduce current to a very low level which can be tolerated indefinitely.

Overvoltage protection is provided primarily to protect the loads in the event of failure of the regulating circuit. Silicon controlled rectifier SCR1 is connected across the +15 volt output. The gate of SCR1 monitors the +5 volt output thru zener diode VR2 which has a 5.6 volt breakdown rating. If the +5 volt supply exceeds the zener's breakdown voltage VR2 conducts, placing a direct short across the +15 volt output. In effect, this "crowbars" all outputs because of the close coupling of the inverter transformer secondary. To protect the power supply, the current limiting circuit takes over, reducing the power switch output to a safe level. Once fired, the SCR will continue conducting until power is turned off. When the condition causing the overvoltage is corrected and power reapplied the protect circuit is automatically restored to normal.

4.11.3 Internal Power Supply Assy, U, #301155-XX
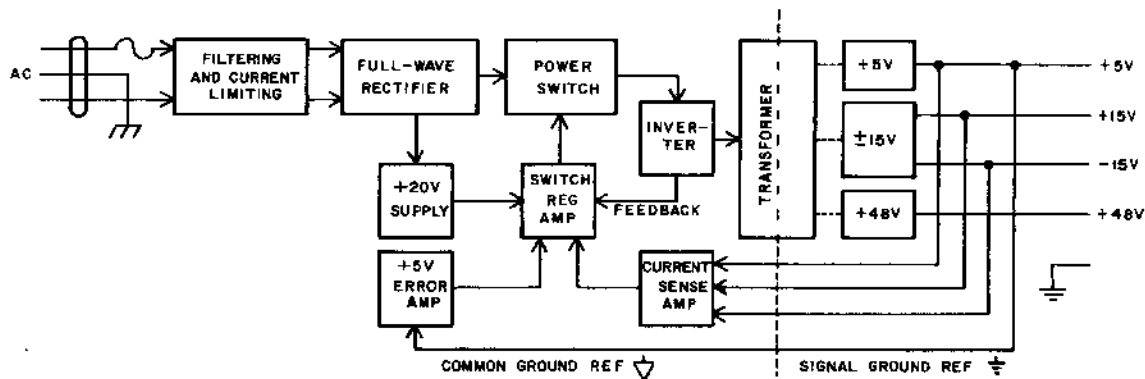
Figure 4-44   INTERNAL POWER SUPPLY BLOCK DIAGRAM, U

4.11.3.1 General Information

Refer to Figure 4-44 and to Figure 7-10b Schematic Diagram.

This optional Internal Power Supply is a direct line switching type. In operation, the ac input is rectified and filtered. It is then applied to an inverter circuit which produces the "ac" needed for transformer action. The secondary windings of the power transformer then produce the several output voltages of +5, +/-15 and +48 volts. The +5 and +/-15 volt outputs are sensed for current flow and the +5 volt supply is sensed for voltage level. These signals are used as feedback to regulation amplifiers which in turn control the power switching transistor.

AC input to this power supply is nominaly 115/230 Volt 60 Hz. Input is acceptable within the following limits:

90-130/180-260 VAC   47-63 Hz

Selection of the input power range is by jumper plug B-1/-2 on the main power supply circuit board.

4.11.3.2 Input Surge Limit and Filter Circuit

The ac input passes a line fuse, a line filter network, and surge protection devices. These devices are located on a separate chassis bolted to the main power supply chassis. The surge protection components prevent destructive inrush current following application of input power. Switching power supplies tend to generate sharp transients which can be reflected back on to the input power line. The line filter on this subassembly, plus capacitors A1, A2 and A3 on the main circuit board are used to suppress these transients.

4.11.3.3 Full Wave Bridge Rectifier and Local +20 Volt Supply

A full wave bridge rectifier (diodes B1 thru B4) converts the line ac input to a pulsating dc which is then smoothed by filter capacitors A5, A25 and C16. Resistors C3, C4 and C7, 20 volt zener diode C2, and

transistor C5 produce a regulated +20 volt dc source for use by the
switching regulator circuits.

4.11.3.4   Power Switch and Switching Regulator Amplifiers

Power switch transistor C35 is controlled by switching regulator amp-
lifier B30 thru a network composed of transistors C9, C21, C23, C30
and their associated components. Regulation amplifier B30 operates to
turn switch C35 on and off to maintain a charge on capacitor B50 which
supplied power to the inverter circuit. Regulation of the supply out-
put is affected by monitoring several outputs (+5 volt and +/-15 volt)
and using the results to modify the power switch transistor's on/off
duty cycle. All three are monitored for current flow, while the +5
volt supply is also monitored for voltage level. The +5 volt level is
adjustable using potentiometer A71 which controls regulation amplifier
A67 which in turn controls amplifier B30 thru opto-isolator B36. Thus
the +5 volt output is used to control the levels of all the outputs
from the supply. Close transformer coupling allows the +/-15 volt
and +48 volt circuits to reflect their condition back to the +5 volt
supply and ultimate power switch operation. Excessive current flow
in any output will be sensed and the action of the power switch cir-
cuit adjusted accordingly. A short circuit failure will cause the
output to be reduced to a minimum level until the problem is correc-
ted.

4.11.3.5   LC Smoothing Filter and Spike Catcher

The regulated pulsed dc output of power switch C35 is applied to a
filter network made up of inductor A40 and capacitor B50. Diode B39
maintains output current flow during switch C35 "off" periods by pro-
viding a discharge path for inductor A40's magnetic field current
stored during "on" periods. Diode B39 is reverse biased during "on"
times. The smoothed and regulated dc output is applied to the inver-
ter circuit via a "spike catcher" network.

The "spike catcher" network consists of inductor A52, resistor A26 and
capacitor B50. This circuit suppresses any large current spikes which
might be generated should conduction of the two inverter transistors
overlap. Diode A55 damps counter emf in inductor A52.

4.11.3.6   The Inverter

The smoothed dc is chopped at a 20 mHz rate by the two transistors C52
and C64 conducting alternately. They feed current to the primary
winding of nonsaturating output transformer B70 supported by saturat-
ing transformer B57 and its associated components.

4.11.3.7   DC Output Circuits

Each of the four dc outputs makes use of a center tap secondary wind-
ing of transformer B70, and a rectifier/filter network. In addition,
the +/-15 volt circuits have noise filters and toroidal current sens-
ing transformers while the +5 volt circuit includes the current trans-
former and a voltage regulator circuit. Current flow in each output
is sensed and the results fed back thru an R-C Diode network to tran-
sistor B12-6 to the switching regulator amplifier B30. The +5 volt

output level is also monitored by overvoltage regulating amplifier
A67. Due to the close transformer coupling mentioned earlier, the +48
volt output does not require monitoring.

Note also that the +48 volt output is not used in this application and
circuit components associated exclusively with it are not installed.

SECTION 5

MAINTENANCE

5.1 GENERAL DISCUSSION

The limited number of moving parts within the Series 1640/1650 printers and terminals simplifies troubleshooting, and minimizes maintenance and repair time.

Replacement of the printer, to shorten downtime in the event of a malfunction, is made practical by the unit's light weight and low cost.

When unit replacement is impractical, subassembly replacement is a ready alternative. The subassemblies recommended as part of a normal spares inventory, are listed in subsection 5.2. These are directly interchangeable, requiring no more than a minor adjustment or two in most cases to complete the installation. Extensive component replacement or mechanical adjustments are normally attempted only in a service depot or factory environment.

5.1.1 Maintenance Requirements

The reduced reliance on mechanical devices decreases normal preventive maintenance to surface cleaning and lubrication, and a visual check of the printer's mechanical features, as outlined in subsection 5.3.3 Cleaning and Inspection. Higher level maintenance and adjustment procedures are discussed in subsection 5.4 Corrective Maintenance.

5.1.2 Maintenance Instructions

The Series 1640/1650 user should study subsection 5.2, compare that information with his existing or intended facilities and capabilities, and determine the maintenance level he intends to sustain. Spares provisioning and test equipment assignment may then be accomplished economically.

5.1.3 Maintenance Precautions

Avoid damage to the 1640/1650. Observe the following precautions during service and maintenance activity:

1. Never remove or install any circuit board, or connect or disconnect any plug or cable while power is on.
2. Applying power to the printer initiates a RESTORE sequence which includes movement of the carriage. Make sure the carriage is free to move LEFT before applying power.
3. DO NOT stand the unit on its rear heat sinks. The finned heat sinks are mounted on plug-in circuit boards which can easily be damaged by this practice.
4. Do not use alcohol to clean the platen or the paper feed rollers. Alcohol hardens rubber, resulting eventually in paper feed problems. Use Fedron Platen Cleaner or its equivalent.

CAUTION: *Fedron Platen Cleaner and similar products are flammable and have a very low flash point!*

5. Do not use platen cleaner to clean plastic parts. These products are usually harmful to plastics, and may cause damage. Clean plastics with alcohol.

6. Print wheels do not need cleaning under normal operating conditions with carbon ribbons. Slight ink buildup is normal when using cloth ribbons, especially with a new ribbon. Such ink deposits are partially returned to the ribbon as its ink supply is used up. Unusually severe operating conditions will make print wheel cleaning necessary more often. When needed, clean the print wheel with either toluene or naphtha.

5.2 MAINTENANCE LEVELS, TOOLS, EQUIPMENT AND SPARES

5.2.1 Levels of Maintenance

Preventive maintenance on Series 1640/1650 units is simple and easily accomplished by the user. Corrective maintenance, however, requires a minimum level of technical expertise and facility in practice, and capability in this area will vary greatly from user to user. Consequently, the maintenance procedures described herein are divided into three categories, or levels. The first level is preventive maintenance and may be accomplished by any user. The second level is corrective maintenance involving on-site exchange of printed circuit boards and subassemblies, and minor adjustments. The third level, also corrective in nature, involves depot and/or factory repair or refurbishment of assemblies and printed circuit boards.

5.2.1.1 Level 1 - Ribbon cartridge and print wheel change; surface cleaning and lubrication; adjustment of print impression and platen position controls; and minor assembly exchanges of platens and paper cradle.

5.2.1.2 Level 2 - Level 1 items, plus unit replacement, PCB exchange, subassembly replacement, and minor adjustment and alignments.

5.2.1.3 Level 3 - Levels 1 and 2, plus major disassembly and refurbishment of subassemblies, and repair of PCB's.

5.2.2 Preventive Maintenance Items - Level 1

The following listed items should be available to persons operating and/or servicing Series 1640/1650 units on a regular basis:

1. Fedron Platen Cleaner, or equivalent
2. Lint Free wipers
3. No. 70655 light oil 1/4oz
4. No. 70654 Polyoil (light white grease) 8cc
5. No. 70825-01 Multipurpose grease, 2oz tube
6. No. 99000-01 Alcohol Pads (91% Isopropyl alcohol) or equivalent
7. Clean, low pressure compressed air (optional)
8. Toluene or Naphtha solvent

CAUTION:
1. *Observe all OSHA safety rules for use of compressed air, including safety goggles.*
2. *Do not use alcohol on rubber items.*

3. *Do not use platen cleaners on plastic items.*
4. *Use platen cleaners and alcohol with care. Alcohol and most platen cleaners are VERY flammable (low flash point, volatile, etc.).*

5.2.3 Corrective Maintenance Items – Levels 1 and 2

The items listed above for Level 1, plus the following, should be available to persons involved in corrective maintenance and/or repair of Series 1640/1650 units at the second level:

1. One set of PC boards
2. One Platen (appropriate type)
3. One Carriage Assembly
4. One Carrier Assembly, complete with paper feed motor
5. One Carriage Drive Motor
6. One Carriage Drive Cable Assembly
7. One Forms Tractor Assembly, if appropriate
8. Assortment of Hand Tools adequate for electronic/mechanical repair, including a T-handle spring tool (Diablo No. 99009) and a long nose self-locking clamp (Hemostat, Diablo No. 16424)
9. TORX Tools –   Driver Bit   #T15   Diablo No. 70826-01
                    Driver Bit   #T9   Diablo No. 70826-02
                    Screwdriver   #T15   Diablo No. 70826-03
                    Screwdriver   #T9   Diablo No. 70826-04
                    Key Wrench   #T15   Diablo No. 70826-05
                    Key Wrench   #T9   Diablo No. 70826-06
10. Connector Extractor, 3M #3438, Diablo No. 70832
11. Print Wheel Adjustment Tools, Diablo No's 40795, 40795-02, 40796, and 301445-01
12. Tensiometer, Electromatic Equipment Co. Model DXX-IKD or equivalent, calibrated for Diablo cable
13. Cable Ties, Diablo No. 10538-01
14. Thermal Compound, Diablo No. 10549

5.2.4 Corrective Maintenance Items – Levels 1, 2 and 3

The items listed above for Levels 1 and 2, plus those listed below should be available to persons involved in corrective maintenance and/or repair of Series 1640/1650 units at the third level:

1. One PCB Extender Assembly, Diablo No. 46095-02
2. One Carriage Motor Extender Cable Assembly, Diablo No. 40667
3. One Transducer Extender Cable Assembly, Diablo No. 40666
4. One Print Wheel Motor with appropriate hub assembly
5. One Paper Feed Motor
6. Oscilloscope, vbw 15 mHz, vds 100 mV/cm, sweep speed 50 ns/cm
7. Model 500 Programmable Tester Assembly, Diablo No. 20900-XX

5.3 PREVENTIVE MAINTENANCE – MAINTENANCE LEVEL 1

5.3.1 Preventive Maintenance Philosophy

The principle of maximum machine availablity governs the preventive maintenance recommendations contained herein. Unless a procedure in-

creases machine availability or enhances operation, it is not recommended. Except for the procedures outlined, no maintenance or adjustment should be performed on a printer that is operating properly.

5.3.2 Preventive Maintenance Procedures

The recommended preventive maintenance is normal cleaning and inspection every 6 months or each 500 hours of operation, whichever occurs first. The machine will require a visual inspection, cleaning, and minimal lubrication at this time. Normal time required for this procedure should not exceed 15 minutes.

5.3.3 Cleaning and Inspection

1. Remove power from the unit. Open and remove covers as required to gain access to the printer mechanisms.
2. Thoroughly inspect the printer for signs of wear and loose or broken hardware. Check the platen for looseness or wobble. Check the carriage system for looseness, wobble, or accumulations of foreign material on the rails which might cause uneven carriage movement. Check the carriage drive cable system carefully for signs of wear.
3. Remove the platen, paper cradle, ribbon cartridge, and print wheel. Inspect these for signs of wear.
4. Clean the printer thoroughly, using alcohol saturated cleaning pads and wipers. Remove accumulations of paper residue, ink, dust, etc., with special atention to carriage rails and pulley grooves. Heavy deposits may be first removed by blowing with compressed air. Be sure to observe all safety precautions when using compressed air.

   NOTE: Use of compressed air is NOT recommended when the printer is located close to other equipment sensitive to dirt and dust.

5. Clean the platen, platen pressure rollers, and paper bail rollers with a good platen cleaner which is noninjurious to rubber products, such as Fedron Platen Cleaner. Do not use alcohol on these items.

5.3.4 Lubrication

Lubricate the various parts of the cleaned and inspected printer according to the following schedule. DO NOT exceed this schedule. Too much lubricant is often worse than none at all.

5.3.4.1 Carriage System

Refer to Figures 5-1 and 5-2.

1. Carriage Rails (A) - Clean these with alcohol pads.
2. Carriage Rail Bearings (B) - Put 4 to 5 drops of light oil on each rail on each side of the carriage, and move the carriage back and forth slowly by hand allowing the oil to saturate the lubrication felts inside each carriage bearing.
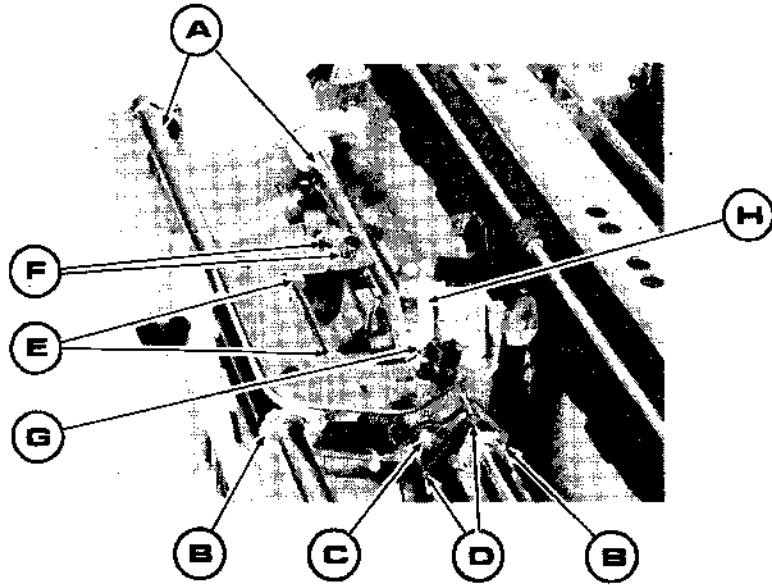
Figure 5-1   CARRIAGE SYSTEM LUBRICATION POINTS
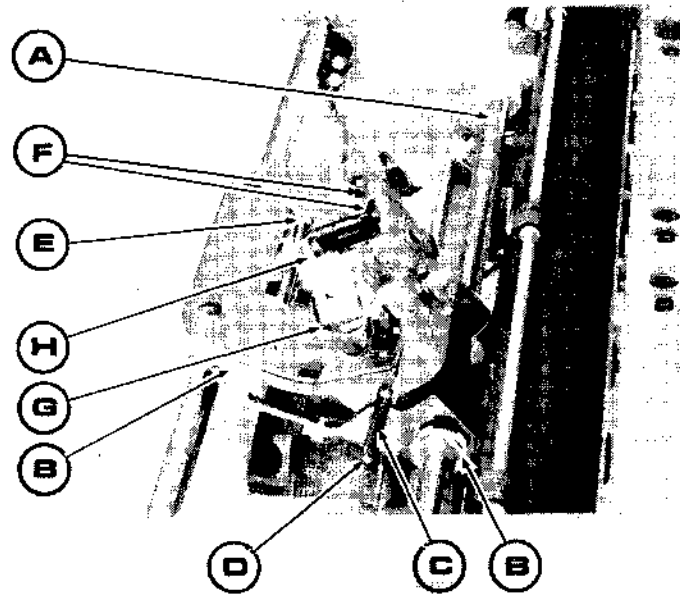
Figure 5-2   CARRIAGE SYSTEM LUBRICATION POINTS

3.   Carriage Pivots (C) - Apply one drop of light oil to the pivot on each side of the carriage frame.

4.   Carriage Pivot Spring Loops (D) - Lightly grease the end loops and posts of the pivot spring on each side of the carriage frame with multipurpose grease.

5.   Ribbon Base Plate Pivots (E) - Saturate the felt washer on each end of the base plate pivot shaft with light oil.

6.   Ribbon Drive System (F) - Apply one drop of light oil to the drive and idler gear shafts, and to the drive key slot.

7. Hammer Armature Pivots (G) - Remove the two rubber cups, and fill the grease chambers with Polyoil. Replace the rubber cups.

8. Print Hammer (H) - DO NOT lubricate this item. If a cloth ribbon is being used make sure the hammer is clean.

5.3.4.2 Carrier System
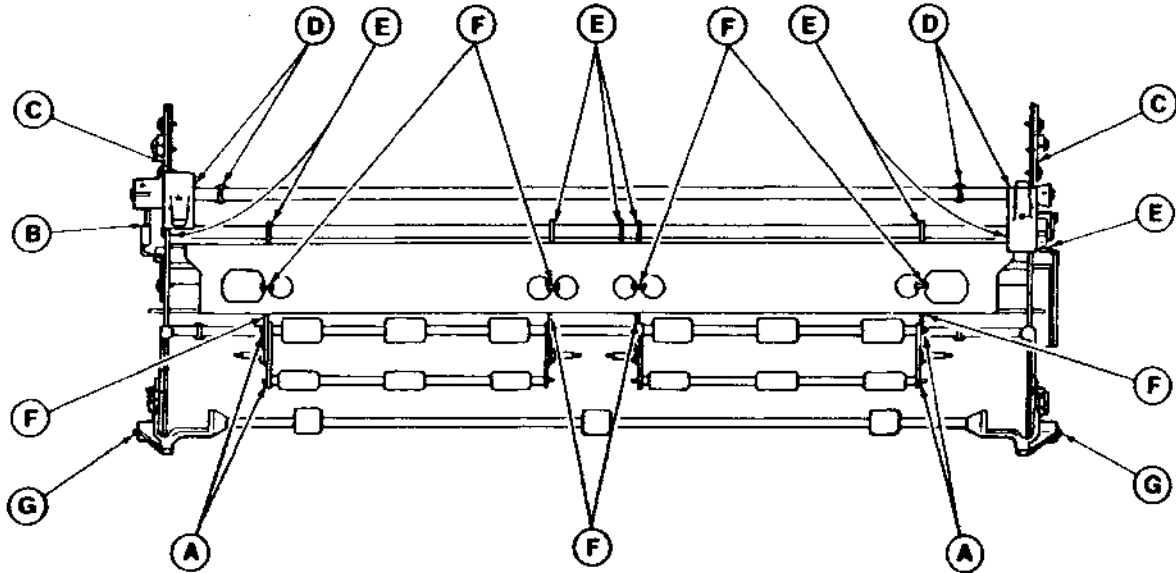
Figure 5-3   CARRIER SYSTEM LUBRICATION POINTS

Refer to Figure 5-3. Lightly grease or apply one drop of oil to the following points with either multipurpose grease or light oil as indicated.

1. Paper Feed Roller Shaft Pins (A) - grease 8 places.
2. Platen Position Lever Detent Plate (B) - grease.
3. Platen Position Slide Plates (Carrier Frame) (C), including exposed slide surfaces (lever moved limit to limit), and all points of contact with pivots, eccentrics, guides, etc. - grease.
4. Platen Position Torque Shaft Ends, Bearing Surfaces, and Spring Loops (D) - grease.
5. Paper Release Tab Ramp and Shaft Pivots (E) - grease.
6. Paper Release Arm Slots and Spring Ends (F) - grease.
7. Paper Bail Pivots (G) - grease.
8. Paper Carrier Pressure Lever Pivots (under) - oil.

5.3.4.3 Platen System

Refer to Figure 5-4.

1. Paper Feed Idler Gear (A) - Inspect the large felt washer behind this gear. If it is becoming white in color, saturate with Polyoil.
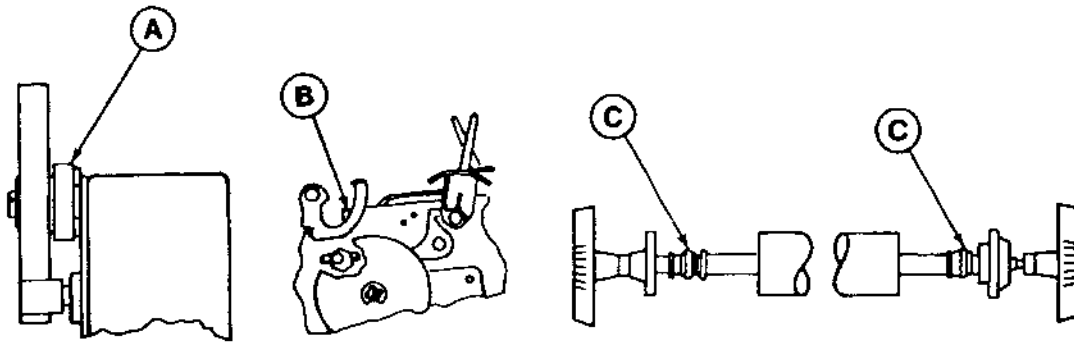
Figure 5-4   PLATEN SYSTEM LUBRICATION POINTS

2. Platen Release Tab Arms (B) - Lightly grease the contact area between these and the carrier frames with multipurpose grease
3. Platen Hubs (C) - Apply one drop of light oil to the bore of the hub at each end of the platen.

5.3.4.4 Lubrication of Optional Items

Optional platen styles require only the lubrication of their hubs as outlined above. The pin feed sections of the pin feed styles are internally self-lubricating and do not require user attention. The optional Diablo Forms Tractors likewise do not require lubrication. Lubrication of the optional Forms Handling units is covered in their individual maintenance publications.

5.4 CORRECTIVE MAINTENANCE - MAINTENANCE LEVEL 2

5.4.1 Corrective Maintenance Philosophy

Corrective maintenance or repair may be divided into two periods - warranty and postwarranty. As long as the warranty remains in force, maintenance by the user should normally be limited to Level 1 Preventive Maintenance procedures. Diablo Customer Service should be contacted for assistance with more serious problems.

NOTE: *The Diablo warranty is null and void when any Level 2 procedure has been unsuccessfully attempted. All time and material required to restore the printer to working order will be billed at prevailing rates. No adjustments should be attempted unless equipment malfunction indicates a specific need.*

Beyond the warranty period, only the user's capabilities and desires need govern the point at which Diablo technical assistance would be requested.

5.4.2 Series 1640/1650 Service Tests

5.4.2.1 Trouble Shooting The Series 1640/1650

The trouble shooting information included here is intended as an aid

PRINTER MECHANISM RESTORE SEQUENCE

INIT RESTORE SEQ

CARRIAGE MOVES LEFT ? — N → IS POWER AVAILABLE ? — N → CHECK/TROUBLE-SHOOT/REPAIR POWER SUPPLY

CARRIAGE MOVES RIGHT ? — N → CARRIAGE BLOCKED MECHANICALLY — N → GO TO PROBABILITY SEQUENCE

CLEAR BLOCKAGE AND RETEST

CARRIAGE MOVES RIGHT CONTINUOUSLY ? — Y → CHECK/TROUBLESHOOT/REPAIR CARRIAGE HOME SENSOR → FAULT CLEARS — N → GO TO PROBABILITY SEQUENCE

PRINT WHEEL ROTATES ? — N → GO TO PROBABILITY SEQUENCE

RETURN UNIT TO SERVICE

PRINT WHEEL STOPS AT HOME ? — N → CHECK HOME SENSOR FLAG ADJUSTMENT CHECK HOME SENSOR OUTPUT

UNIT HAS PERFORMED RESTORE. RECHECK SYMPTOMS AND RESTART

SENSOR ADJUSTMENT OK ? — Y → GO TO PROBABILITY SEQUENCE

REPAIR AS RE-QUIRED. RETURN UNIT TO SERVICE

✳ 1345A
1355HS } = "E"
1355WP = FLAG

PRINTER MECHANISM
TROUBLE SHOOTING FLOW CHART

START

CAN OPERATOR DEFINE FAULT ? — N → CAN OPERATOR SHOW EVIDENCE OF FAULT ? — N → GO TO INTERMITTENT FAULT INSTRUCTIONS

Y

CAN FAULT BE DUPLICATED ? — N

Y

CAN FAULT BE ISOLATED TO PRINTER ? — N → CAN FAULT BE ISOLATED TO EXTERNAL DEVICES ? — Y → TROUBLE SHOOT AND REPAIR EXTERNAL DEVICE

Y

N

ISOLATE PRINTER

CAN PRINTER COMPLETE RESTORE SEQUENCE ? — N → GO TO RESTORE SEQUENCE

Y

CAN FAULT BE ISOLATED TO MECH OR ELECTR PROB ? — N

Y

MECHANICAL FAULT ? — N → GO TO PROBABILITY SEQUENCE

Y

REPAIR/ADJUST/ REPLACE AS NECESSARY

FAULT CLEARS ? — N → CALL FOR ASSISTANCE

Y

RETURN UNIT TO SERVICE

PRINTER MECHANISM
PROBABILITY SEQUENCE

REPLACE MOST LIKELY PCB & TEST (SEE PROBABILITY CHART)

DID FAULT CLEAR?

INSERT ORIGINAL PCB & RETEST

Y

N

REPLACE NEXT MOST LIKELY PCB & TEST (SEE PROBABILITY CHART)

DOES FAULT FOLLOW PCB ASSY?

Y → REPLACE DEFECTIVE ASSY, TEST, AND RETURN UNIT TO SERVICE

N

DID FAULT CLEAR?

Y

N

HAVE ALL PCB ASSYS BEEN TRIED?

Y

N

1. REMOVE ALL PCB'S
2. INSPECT & CLEAN
   A. PCB CONNECTORS
   B. WIRING HARNESSES
   C. MOTHERBOARD
   D. PRINTER FRAME
   E. DRIVE SYSTEMS
   F. DRIVE MOTORS

3. INSPECT & CLEAN PCB EDGE CONNECT-ORS WITH NON-ABRASIVE CLEANER.

DID FAULT CLEAR?

N → REPLACE UNIT AND/OR CALL FOR ASSISTANCE

Y

RETURN UNIT TO SERVICE

INTERMITTENT FAULT INSTRUCTIONS

NOTE: Some faults are by nature difficult to isolate and/or define. The following steps may help in isolating intermittent faults.

1. Electrical Noise - Look for evidence of excessive static discharge, line voltage fluctuations, "brownout" conditions which exceed specified operating limits, poor/improper machine grounding, dirty/loose electrical connections and EMI/RFI conditions. Eliminate or isolate the unit from such defects.

2. Debris/Contamination - Close physical examination of the unit may disclose shorts/opens/wire damage caused by debris (staples, paper clips, etc.) or contaminants (liquid spills, paper or environmental dust, etc.). Keep the unit clean.

3. Mechanical Interference - Look for binding or rubbing of moving parts. Listen for any unexpected noise which might help identify mechanical interference. Clean and lubricate the unit per specification.

4. As a general rule, remove all PCB's and clean their edge connectors with a non-abrasive cleaner. Disconnect, inspect, and reseat all electrical connectors. Clean the unit thoroughly and run any exercise routines which might help isolate the fault.

5. If all else fails, call for assistance. In some cases, replacement of major unit subassemblies, or the entire unit, may prove to be more economical than attempting to isolate particularly difficult problems.

PROBABILITY CHART

NOTE: 1 = Most likely, 2 = Next most likely, etc.

A - Carriage Motion Problem

1. HPRO4 PCB
2. Carriage Power Amp PCB
3. Servo PCB
4. Transducer PCB
5. Connectors
6. Carriage Motor
7. Power Supply

B - Print Motion Problem

1. HPRO4 PCB
2. Print Wheel Power Amp PCB
3. Servo PCB
4. Transducer PCB
5. Carriage Assembly
6. Connectors
7. Power Supply

C - Ribbon Lift/Advance Problem

1. Print Wheel Power Amp PCB
2. HPRO4 PCB
3. Connectors
4. Carriage Assembly
5. Power Supply

D - Print Hammer Problem

1. Print Wheel Power Amp PCB
2. Carriage (hammer) Assy
3. HPRO4 PCB
4. Connectors
5. Servo PCB
6. Power Supply

E - Paper Feed Problem

1. Carriage Power Amp PCB
2. HPRO4 PCB
3. Connectors
4. Power Supply

to rapid isolation and correction of faults within the printer. This information is not intended as a substitute for qualified technical support.

The information on operational quality testing and service adjustments which follows is included to assist a qualified technician in the rapid servicing and/or repair of the printer. The tests and adjustments given should be performed in the sequence outlined, even though only one or two of them may be used in any one service situation. This recommendation is made to reduce the time lost in rechecking adjustments made in previous steps. Note also that all checks, adjustments and/or alignments are to be made with the printer either in its operating position or on a work bench resting on its shock mounts. These procedures should not be attempted with the printer mounted on its shipping base.

5.4.2.2 Print Quality

Proper assessment of print quality requires that the print samples used for evaluation be obtained under standardized conditions. Therefore, tests should be made with a new print wheel and a multistrike ribbon, on a good grade of standard bond paper, with the impression control switch set on medium (M) (see subsection 2.4.1.5).

1.   Print a full line of "H's".

H   H   H   H   H

(a)   (b)   (c)   (d)   (e)

2.   Compare the test results with the above illustration.
     Item (a) -Impressions similar to this with uniform density
                and good edge definition indicate proper printer
                adjustment. A gradual change in density
                (lighter or darker) from one end to the other in-
                dicates a PLATEN TO PRINT WHEEL adjustment may be
                required.
     Item (b) -Impressions similar to this indicate PLATEN HEIGHT
                adjustment for platen too low may be required.
     Item (c) -Impressions similar to this indicate PLATEN HEIGHT
                adjustment for platen too high may be required.
     Items (d)-Impressions similar to these indicate that a PRINT
       and (e) WHEEL TO HAMMER adjustment may be required.

5.4.2.3 Print Quality Adjustments

This subsection describes Adjustment Tools # 40795, 40795-02, 40796 and 301445-01, and describes their use in performing printer adjustments as follows:
          * Platen to Print Wheel
          * Print Wheel to Hammer
          * Card Guide Position
          * Ribbon Height
          * Carriage Home
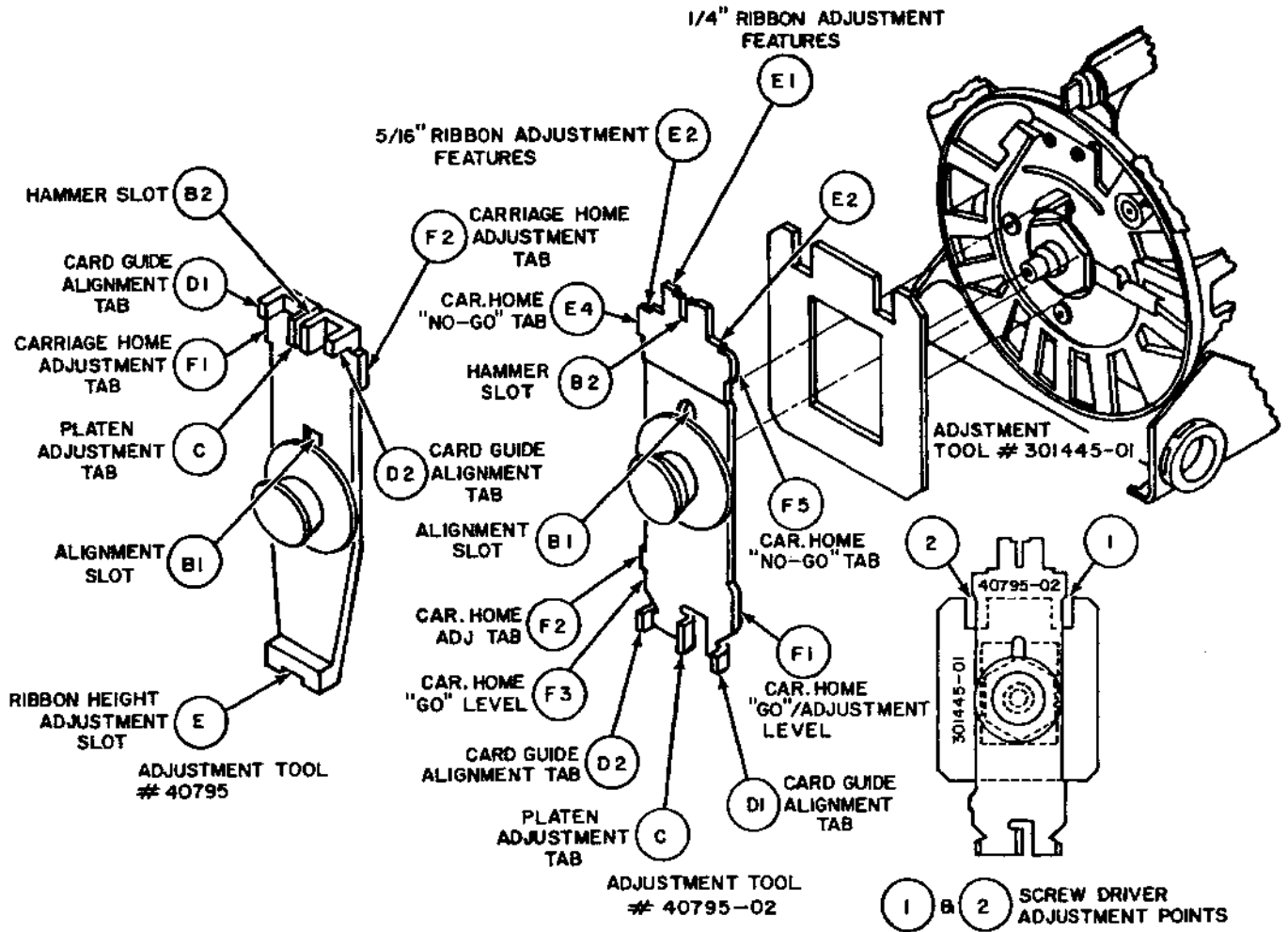
Figure 5-5   ADJUSTMENT TOOLS

Figure 5-5 identifies the several features of these tools by letter-number designators. In the procedures which call for the use of one of these tools, the features to be used are identified by these designators.

5.4.2.4   Conditions of Test and Alignment

1.   Power - Power is to be applied to the printer only when specified while making adjustments. It is used to electrically detent the print wheel and carriage servo motors, to hold the ribbon lift plate in operating position, and for cycling the printer through a RESTORE sequence when required.

2.   Platen - Platen-Carrier adjustments are to be made using a platen whose surface is in good condition and free from wear or defects.

3. Ribbon - Ribbon adjustments are to be made using a carbon ribbon cartridge.

4. Controls - The Platen Position Lever is to be brought fully forward for Platen-Carrier to Print Wheel adjustments.

5. Precautions - Always remove the Adjustment Tool(s) from the Print Wheel motor shaft before initiating a RESTORE sequence, to prevent damage to the printer. Also, always ensure that the tool is properly seated prior to making any measurements.

5.4.3 Paper Carrier System - Replacement and/or Adjustment Procedures

The following procedures detail the removal, replacement and adjustment of the paper carrier system subassemblies.

5.4.3.1 Paper Carrier Subassembly Removal

1. Remove the printer's covers, if any, and disconnect the printer completely (make sure power is off first). Remove the printer from its mounting, and place it on a sturdy work bench or table.
2. Remove and store the ribbon cartridge, print wheel, platen and paper cradle.
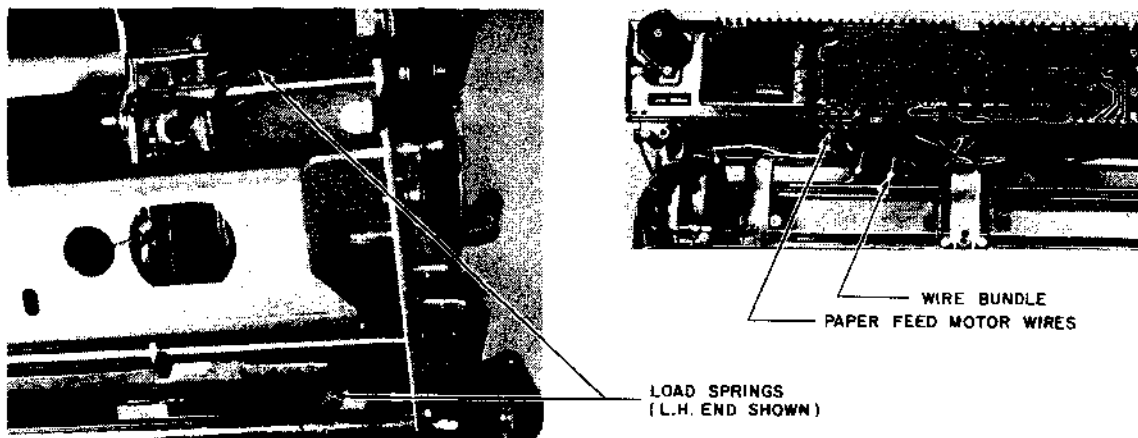
Figure 5-6   CARRIER SYSTEM REMOVAL - A

3. Dismount the Cover Open switch and bracket, if installed. Stand the printer up on the front end of its main frame. Use the T-Handle Spring Hook #99009 to disengage the 4 Carrier System load springs from the printer's main frame (2 long springs in front and 2 shorter springs in the rear). Open the wire bundle and disconnect the 4 paper feed motor wires from the Motherboard PCB. Refer to Figure 5-6.
4. Return the printer to its upright position. Remove the E ring and the paper feed idler gear. Locate and remove the 2 carrier assembly load springs, one on each end of the assembly mounted between the inboard end of a stud on the rear of the carrier assembly and the inboard end of a stud on the main frame.

Store the springs, gear and the E ring in a safe place.
Refer to Figure 5-7.

IDLER
"E" RING
FRONT ECCENTRIC
(L.H. END SHOWN)
(TOP P.O. SW. BAIL SHAFT HOLE)
REAR SUPPORT
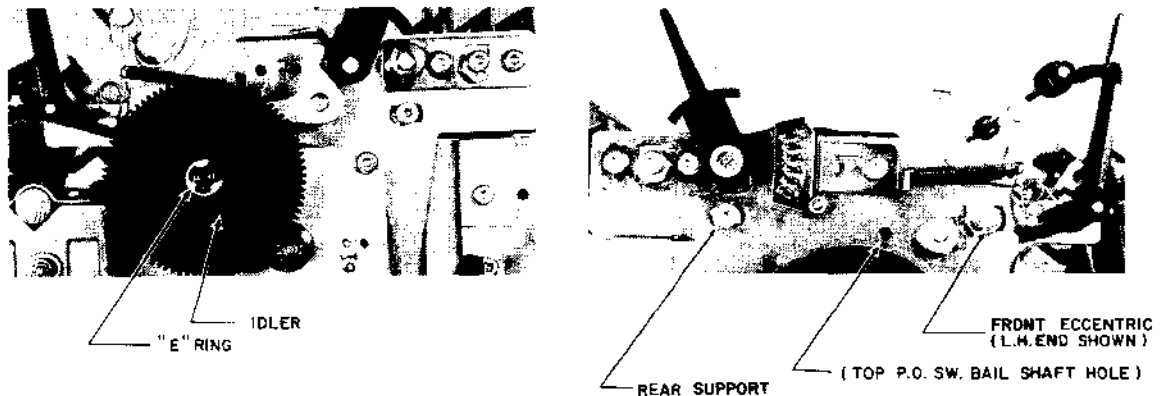
Figure 5-7   CARRIER SYSTEM REMOVAL - B

5. Remove the left- and right-hand front Carrier Subassembly height
    adjustment eccentrics using a 1/4" wrench or nut driver. Remove
    the left- and right-hand Carrier Subassembly support screws and
    shoulder spacers, using a TORX T15 screwdriver. Store these items
    in a safe place. Refer to Figure 5-7.
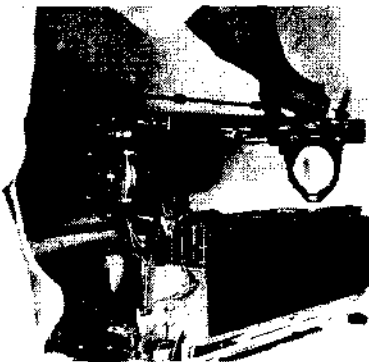
Figure 5-8   CARRIER SYSTEM REMOVAL - C

6. Carefully lift the Carrier Subassembly, which includes the paper
    feed drive motor), free of the printer's main frame as shown in
    Figure 5-8. Be sure the motor's wires are free and not caught in
    the wire bundle.

5.4.3.2 Paper Feed Motor Removal and Replacement

NOTE: This part of the procedure can be used without removing the
         Carrier Subassembly.

1. If the Carrier Subassembly is not to be removed;
        a) Remove the printer's covers, if any, and disconnect the
        printer completely (make sure power is off first). Move

the printer to a sturdy work bench or table.
b) Remove the platen and paper cradle, and dismount the Cover
Open switch and bracket if installed.
c) Referring to Figure 5-7, remove the E ring and idler gear.
d) Stand the printer on the end of its main frame, open the
wire bundle and disconnect the four paper feed motor wires
from the Motherboard PCB. Return the printer to its up-
right position.
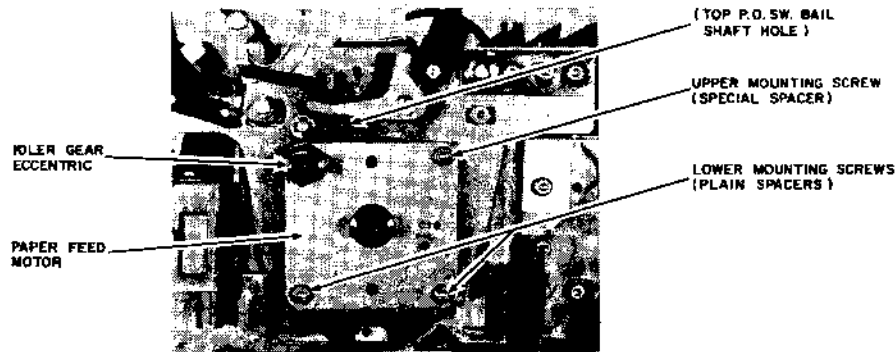
Figure 5-9   PAPER FEED MOTOR REMOVAL

2. Using a TORX T15 screwdriver, remove the three 8-32 x 3/4" screws
    holding the paper feed motor to the right-hand Carrier side frame
    as follows. Remove the two bottom screws first, and retrieve
    their spacers from between the motor flange and carrier frame.
    Remove the upper right-hand (as you view it) screw last, and re-
    trieve its shoulder spacer from behind the motor flange. This
    shoulder spacer prevents motor side movement. Refer to Figure
    5-9.
3. Tilt the motor down and out of the Carrier side frame, and gently
    pull its connecting wires free from the wire bundle inside the
    printer.
4. Using an 11/32" open end wrench and a blade screwdriver, remove
    the paper feed idler gear mounting stud eccentric, nut and two
    washers from the paper feed motor's upper left-hand flange hole.
    Refer to Figure 5-9.
5. Transfer the items removed in Step 4 above to the replacement
    motor exactly as they were arranged on the removed motor (upper
    left flange hole, nut and washers to the rear side). Thread the
    nut on finger tight only; it will be tightened down later in the
    adjustment prodecure.
6. Carefully insert the replacement paper feed motor's connecting
    wires into the opening in the right-hand Carrier side frame, and
    tilt the motor into position in the frame opening.
7. Orient the paper feed motor with the idler gear eccentric stud
    upper left as shown in Figure 5-9. Insert the special shoulder
    spacer (removed last in Step 2) behind the motor's upper
    right flange, with its shoulder extending into the hole in the
    flange. Loosely thread one of the 8-32 x 3/4" screws into the
    Carrier side frame through the motor flange and spacer.

8. Place spacers behind and insert 8-32 x 3/4" screws (removed _first_ in Step 2) through the two bottom motor mounting holes and finger tighten only. Now tighten the first screw (Step 7) until snug, but not so tight as to restrict lateral movement of the motor.

This completes the installation of the paper feed motor _only_ on a Carrier Subassembly. If this was a motor replacement only (did not involve Paper Carrier removal) skip to subsection 5.4.3.3 - Step 6 for the remaining steps to reconnect the motor electrically.

5.4.3.3 Paper Carrier Subassembly Installation Procedure

1. Clean all Carrier Subassembly bearing surfaces on the printer's main frame of old grease, etc. Reapply a light coating of multi-purpose grease to these points on both ends of the printer's main frame. Refer to Figure 5-10.
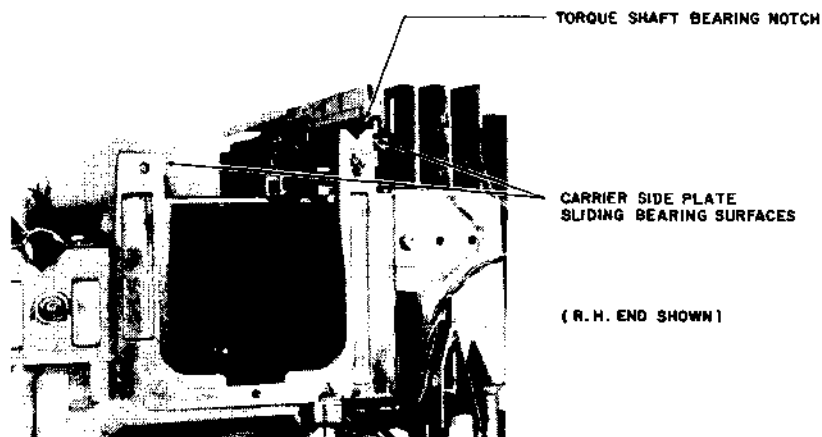
Figure 5-10   CARRIER SYSTEM REPLACEMENT

2. Carefully lower the Carrier Subassembly into position on the printer's main frame. Refer to Figure 5-8.
3. Insert the left- and right-hand rear Carrier Subassembly shoulder spacers and support screws removed in subsection 5.4.3.1 - Step 5, using a TORX T15 screwdriver. Make sure the spacer shoulders pass into the slots in the Carrier side frame, and tighten the screws down firmly, but DO NOT overtighten and strip the threads from the holes in the printer's main frame casting.
4. Insert the left- and right-hand front Carrier Subassembly height adjustment eccentrics removed in subsection 5.4.3.1 - Step 5 using a 1/4" wrench or nutdriver. Make sure the shoulders of the eccentrics pass into the slots on the Carrier side frames, and thread the screws in enough to retain the eccentrics snugly in the slots, but do not tighten. The eccentrics should be positioned so their lobes point toward the rear of the machine.
5. Stand the printer on the front end of its main frame. Use the T-Handle Spring Hook #99009 to hookup the loose ends of the four Carrier Subassembly load springs to the main frame, making use of the holes provided. Subsection 5.4.3.1 - Step 3 detailed the unhooking of these springs.

6. Arrange the four wires from the paper feed motor into the wire bundle running along the edge of the Motherboard PCB, and connect them to the push-on terminals on the Motherboard PCB as follows: Gray wire to terminal T4; Black wire to terminal T5; Yellow wire to terminal T6; and the Red wire to terminal T7. Secure the wire bundle with plastic cable ties or equivalent. Return the printer to its normal position.

This completes the installation of the Carrier Subassembly and Paper Feed Motor. The following subsection 5.4.3.4 details the adjustment of the Paper Carrier System for proper operation, and includes the Paper Feed gear train.

5.4.3.4 Paper Carrier System Adjustments
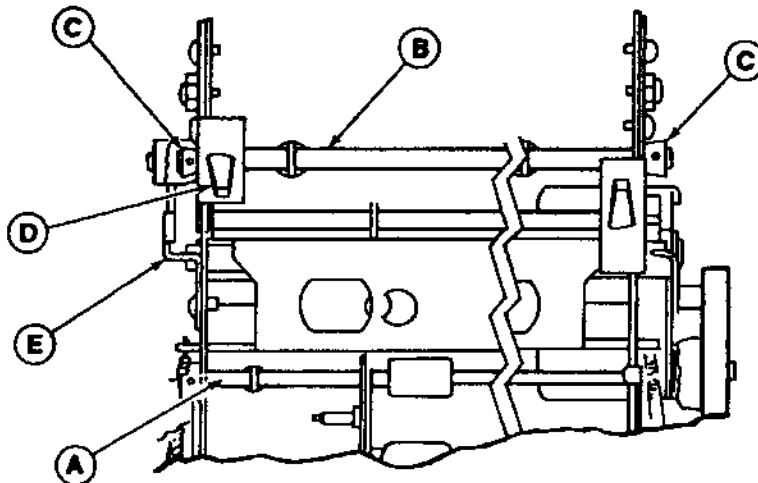
Figure 5-11 CARRIER ASSEMBLY ADJUSTMENTS

1. Carrier Assembly Adjustments. Refer to Figure 5-11.

    Carrier Assembly Bias Shaft (A). Check for axial movement of .002", +.000" - .001". Adjust the collar at (A) as required to achieve this dimension.

    Platen Position Torque Shaft (B). Check that the set screws in the eccentric collars (C) at each end of this shaft are aligned vertically with each other when the Platen Position Lever (D) is fully forward, and that the shaft end play is .002", +.000" -.001". Adjust the collars to achieve these end play dimensions. Failure of the collars to align vertically as described indicates a twisted Torque Shaft, which will affect platen alignment throughout the range of the Platen Position Lever.

    Platen Position Lever (D). Move the lever back and forth. A positive detenting force must be felt for all positions. Adjust the detent plate (E) as necessary to achieve an even detenting action. The Carrier Subassembly must move equally at both ends within +/-.003" in increments of .005" +/-.002" between detent positions.

2. Paper Feed Adjustments
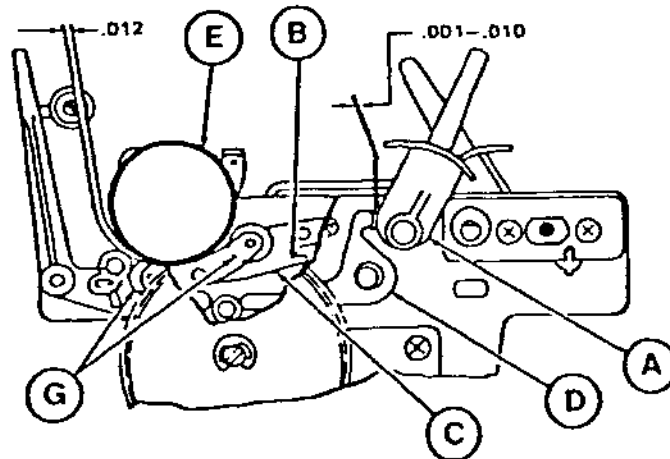
Figure 5-12   PAPER FEED ADJUSTMENTS

Refer to Figure 5-12.

   With the Paper Release Lever (A) fully forward, the Paper Feed
   Rollers (G) must clear the Platen (E) by at least .08". The
   system is adjusted as follows to achieve this:

      * Insert 4 sheets of standard form paper (.012") and move
        the Paper Release Lever (A) fully rearward.
      * Ensure that the Torque Shaft Arm Tab (B) is touching
        the lower edge of the Feed Roller Support Arm slots (C).
      * Remove the 4 sheets of paper and reinsert 1 sheet. Ensure
        that the Paper Release Actuator (D) clears the ramp on the
        Paper Release Lever (A) by .001" to .010". Loosen the ac-
        tuator's set screw and adjust the actuator to achieve this
        dimension. Retighten the set screw.
      * Remove the sheet of paper. Insert a 1" wide strip of
        paper, or a .004" shim, between the platen (E) and each of
        the front paper feed rollers (G), and check that both pla-
        ten and rollers rotate when the strip (or shim) is pulled
        free. Repeat for all rear paper feed rollers (G). If
        rotation does not occur, the Torque Shaft Arm Tab (B) has
        been pushed down too low, and the Paper Release Actuator
        (D) should be readjusted.

   3. Paper Feed Adjustment

   Refer to Figure 5-13.

   With paper feed motor drive gear (A) locked, the platen drive
   gear (B) must have .002" maximum play. Adjust the system as
   follows to achieve this, beginning with the platen removed:

      * Loosen the Paper Feed Motor mounting screws (D).
      * Rotate the Paper Feed Idler Gear Eccentric (E) COUNTER-
        CLOCKWISE only until a minimum backlash is obtained with
        no binding effect when the idler gear (C) is rotated a
        full 360° (clockwise rotation of the eccentric could pre-
        vent proper installation of the platen).
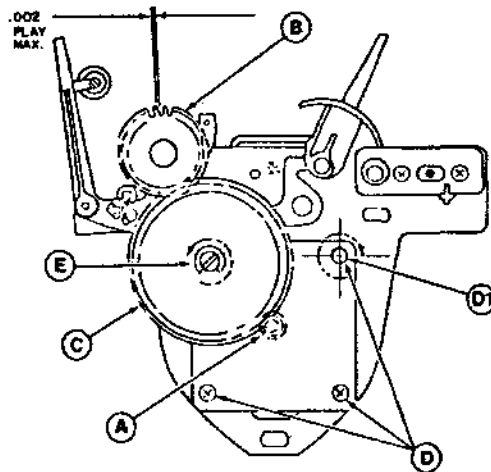
Figure 5-13   PAPER FEED DRIVE ADJUSTMENTS

* Install the platen. Rotate the Paper Feed Motor clock-
  wise about mounting screw (D1) to remove backlash between
  the platen drive gear (B) and the idler gear (C). Tighten
  all screws.

4.   Platen Knob Adjustment

Figure 5-14

PLATEN KNOB END PLAY ADJUSTMENT
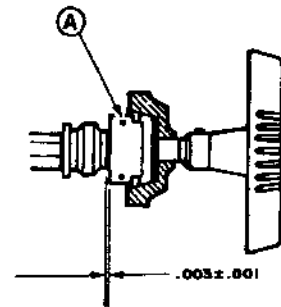
Refer to Figure 5-14.

* Check for Platen Knob end play of .003", +/-.001", as
  shown. To adjust for this dimension, loosen the set screws
  in the platen gear hub and reposition the hub on its shaft.
  Retighten the set screws.

5.4.4 Carriage Systems - Replacement and/or Adjustment Procedures

The following procedures detail the removal and replacement, and/or
adjustment of the Carriage Subassembly.

5.4.4.1 Carriage Subassembly Removal

   1.   Remove the printer's covers and accessories, if any, and dis-
        connect the printer completely (make sure power is off). Re-
        move the printer from its mounting, and place it on a sturdy
        work bench or table.

2.   Remove and store the ribbon cartridge and print wheel.
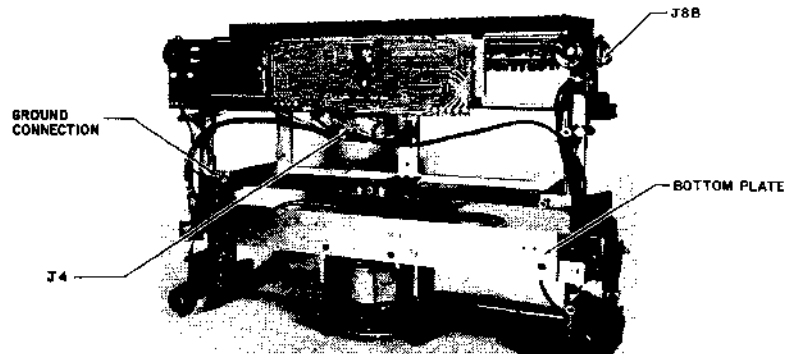
Figure 5-15   PREPARE CARRIAGE CABLES FOR REMOVAL

Refer to Figure 5-15.
3.   Stand the printer up on the front end of its main frame.
     Open the left-hand (as you view it) wire bundle, and unplug
     the sheathed print wheel drive cable connector P4 at Mother-
     board PCB connector J4. Separate this cable from the wire
     bundle for later removal. Also disconnect the black ground
     wire, which is a part of this cable, where it is fastened to
     the main frame near the end of the cable's shield spring.
4.   Open the right-hand (as you view it) wire bundle. Locate the
     sheathed cable extending from connector J8B on the Transducer
     PCB (Slot G) to the Carriage through the smaller cable shield
     spring. Unplug this cable at the PCB, and prepare it for
     later removal from the printer with the carriage.

     NOTE: If the optional Bottom Feed Paper Chute is installed,
           skip to Step 6b.

5.   Return the printer to its normal position near the front edge
     of the work surface.
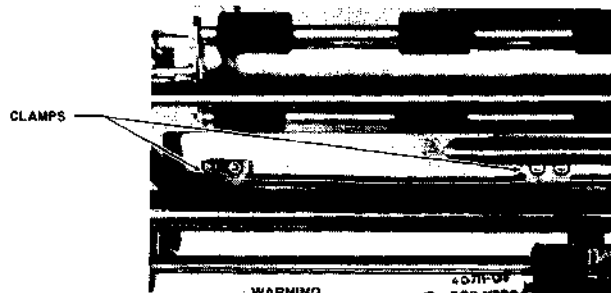
Figure 5-16   CABLE CLAMP REMOVAL

6a. Using the TORX T15 screwdriver, reach down behind the left end of the rear carriage rail and unscrew the four 6-32 x 1/2" screws holding the white plastic spring cable clamps to the bottom plate, as shown in Figure 5-16. Retrieve and store these screws. Reach down behind the right end of the rear rail and remove the large spring cable shield from the two spring clips holding it to the bottom plate.

6b. This step applies only to those printers with the optional bottom feed paper chute installed. Refer to Figure 5-15.
    * Use the TORX T15 screwdriver to remove the four 8-32 x .625" screws which fasten the bottom plate to the printer's main frame.
    # Move this plate away from the frame far enough to release the large spring cable shield from the two spring clips, and to gain access to the four 6-32 x 1/2" screws used to clamp the small spring cable shield to the bottom plate. Remove these screws using the TORX T15 screwdriver.*
    # Return the printer to its normal position near the front edge of the work surface, and proceed to Step 7.

    *Service Note: If the printer being worked on has other wire bundles fastened to the bottom plate with snap-in metal spring clips, remove these clips and replace them with cable ties.

A   B
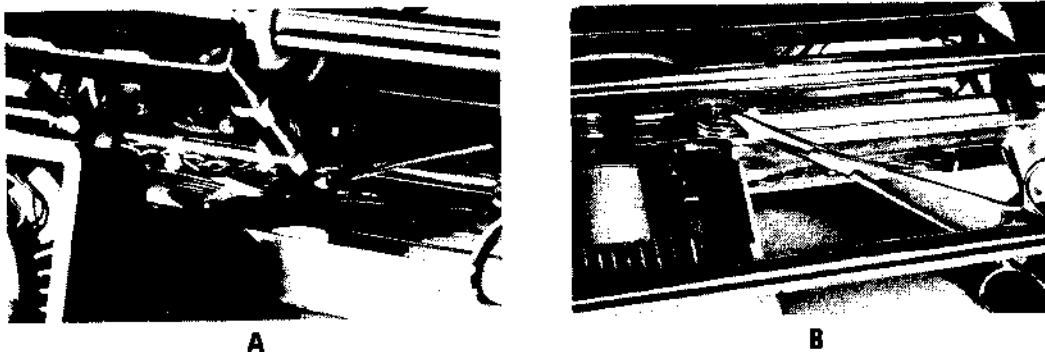
Figure 5-17   DISCONNECTING THE CARRIAGE DRIVE CABLE

Refer to Figure 5-17.

7. Position the carriage slightly to the right of center as shown in Figure 5-17(A), to gain access along the right side of the carriage servo motor to the mounting screw for the carriage drive cable pulley. Install the hemostat clamp on the pulley as shown (use a piece of heavy paper between pulley and clamp jaws to protect the pulley flanges). This prevents the pulley from moving or flipping over and releasing the drive cables. Refer especially to Figure 5-17(B). Note that the clamp is installed to trap the upper forward right-hand cable segment between its jaws as it is clamped to the pulley. Make sure this has been done, and that the clamp is secure before proceeding.

Use the TORX T15 screwdriver to reach up beside the carriage
motor and remove the pulley mounting screw. Make sure the
pulley is free from the carriage frame, and gently move the
carriage to the left to clear the pulley. Retrieve the spa-
cer from the top of the pulley, and note that the spacer has
a shoulder which extends down into the center of the pulley
when properly assembled. Store the spacer and pulley mount-
ing screw. DO NOT remove the hemostat clamp from the pulley!

RAIL
CLAMPS

RAIL
CLAMPS

IMPRESSION
CONTROL
SWITCH
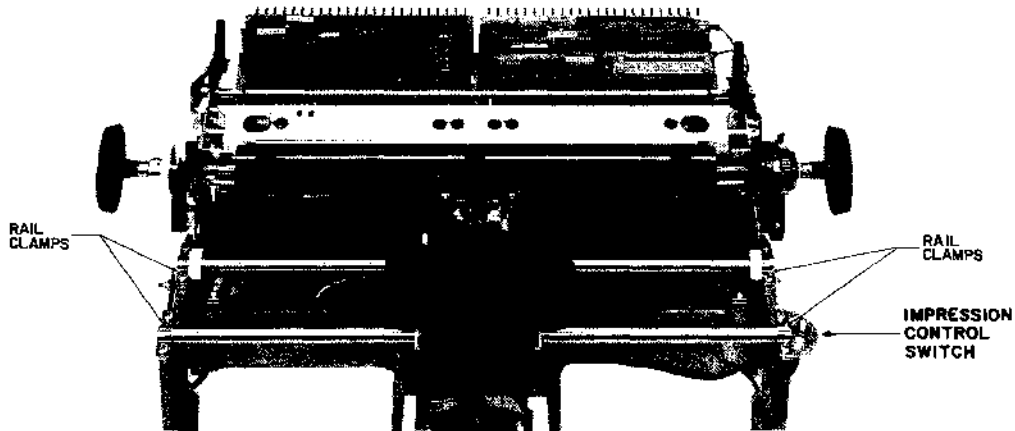
Figure 5-18   CARRIAGE RAIL CLAMPS

Refer to Figure 5-18.
8.   Using the TORX T15 screwdriver, remove the eight 8-32 x .625"
      carriage rail clamp screws and clamps, and dismount the im-
      pression control switch if present. Store the loose items.
      Grasp the carriage and rails in one hand and carefully lift
      the assembly up and out of the printer's main frame while
      guiding the two spring shielded cables and their connectors
      clear of the printer structure.
9.   Lay the carriage and rail assembly on a clean flat surface.
      Slide the front rail sideways out of the front carriage bear-
      ing sleeve and put it aside in a safe place. Slide the heavy
      rubber bumper washers off the ends of the rear rail. Note
      that there are two (2) heavy rubber washers on the left end,
      and only one (1) on the right end of the rear rail. Remove
      and store these washers. Finally, carefully slide the rear
      rail sideways out of the rear carriage bearing sleeve, and
      place with the front rail.

This completes the removal of the Carriage Subassembly.

5.4.4.2 Carriage Subassembly Replacement

Replacement Carriage Subassemblies are complete, aligned and func-
tionally tested at the factory. They are ready for installation and
operation as received, and usually require only a minor readjustment
or two for print quality after installation.

1.   Carefully remove the white felt washers from their plastic
      bag (shipped with each carriage subassembly), and saturate
      4 of them (there are usually 1 or 2 extra) with light oil.

2. Unless replacement of the carriage drive cable is to be included at this time, remove the drive pulley and spacer from the underside of the replacement carriage.

3. Retrieve the carriage rails from their storage place, and thoroughly clean them with alcohol. After cleaning, check both rails for straightness and surface defects. Replace any rail which is bent or defaced.
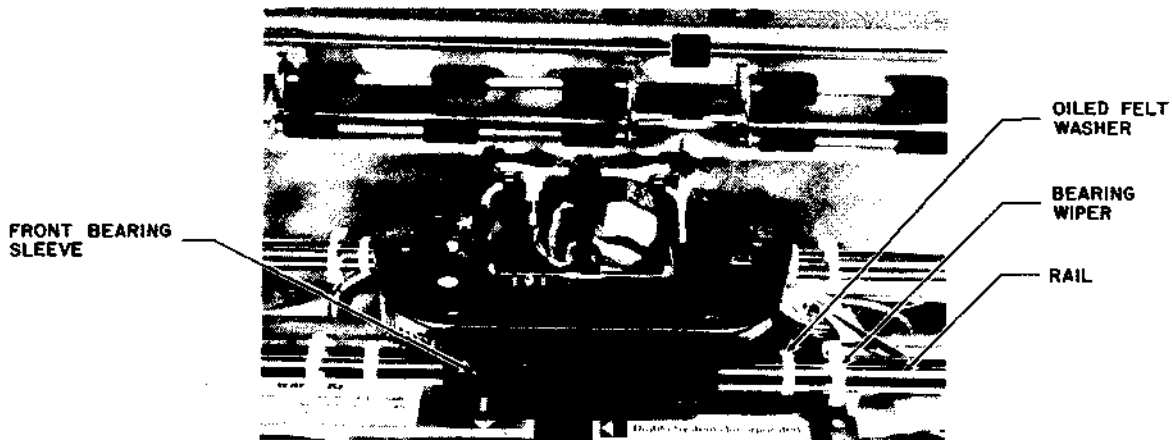
Figure 5-19   CARRIAGE AND RAIL REASSEMBLY

Refer to Figure 5-19.

4. Slide the cleaned and inspected carriage rails through the front and rear carriage bearing sleeves.

5. Gently slide an oil saturated felt washer over each end of both rails (CAREFUL! These washers are easily damaged), followed by a white plastic bearing wiper. Push the washers into their bearing sleeves with the bearing wipers, and snap the wipers into position on the ends of the bearing sleeves.

6. Install the heavy rubber bumper washers on the rear carriage rail, two on the left end, and one on the right end.

7. Gently lower the carriage subassembly and rails down onto the printer's main frame with the rail ends nested in the frame notches. Move the rails until even on each end, and reinstall the rail clamps, and the impression control switch (if present.

8. Hold the two spring shielded cables up out of the way, and gently slide the carriage back and forth as far as it will go. Carriage movement must be smooth and even, with no evidence of binding or roughness.

> CAUTION: DO NOT slide the carriage hard to the left as this may damage the carriage home sensor (mounted on the main frame) with the sensor flag (mounted on the underside of the carriage).

9. Place the spacer on top of the carriage drive pulley, shoulder extending down into the center of the pulley. Position the carriage over the clamped pulley, and insert the mounting

screw. The spacer and screw were removed in subsection
5.4.4.1 Step 7. Tighten the screw down firmly with the TORX
T15 screwdriver, and carefully remove the Hemostat Clamp.

NOTE: If the optional bottom feed paper chute is installed
skip to Step 11b below.

10.   Arrange the small (transducer) spring shielded cable from the
right side of the carriage down inside the printer's main
frame behind the carriage drive cable, and back to the left
along the center of the bottom plate. Extend its free end
out of the bottom of the printer to the left. Position the
first plastic clamp over the threaded screw hole farthest
left in the bottom plate, with its holes to the rear. Thread
in two 6-32 x 1/2" screws, place the spring shield in the
clamp with about 1/8" of the spring extending to the left be-
yond the clamp, and with the loop of the spring as straight
as possible vertically. Tighten down the two clamp screws
using a TORX T15 screwdriver. Move the second plastic clamp
into position, holes to the rear, just left of center on the
bottom plate over the two threaded holes provided; insert two
more 6-32 x 1/2" screws and tighten them down.

11a.   Arrange the large (print wheel) spring shielded cable from
the left side of the carriage down inside the printer's main
frame behind the smaller spring shielded cable just installed
and along the rear edge of the bottom plate. Extend its free
end out the bottom of the printer to the right. Position the
spring as straight as possible vertically, with the end of
the shield spring about 1/8" beyond the spring clip mounted
farthest right on the bottom plate, and push the spring back
under the clip. Push the body of the spring shield under the
second spring clip located just to the right of center on the
bottom plate.

11b.   This step applies only to those printers with the optional
bottom feed paper chute installed.
        # Position the bottom plate behind the carriage, in the area
          of the platen, with its spring clips (for the large cable)
          to the right on top.
        # Loop the small (transducer) spring shielded cable from the
          right side of the carriage back around to the left, and
          position its plastic clamps over the screw holes left of
          center and near the left end of the bottom plate. Thread
          in the 6-32 x 1/2" screws to hold the clamps in place, but
          do not tighten them.
        # Loop the large (print wheel driver) spring shielded cable
          from the left side of the carriage back around to the right
          over the smaller spring shielded cable, and snap it into
          the two spring clips right of center and near the right end
          of the bottom plate.
        # Stand the printer up on the front edge of its main frame.
          Work the bottom plate, with cables attached, back through
          the main frame. Move the plate into position and fasten it
          down with the four 8-32 x .625" screws removed in Step 6b
          of subsection 5.4.4.1, using the TORX T15 screwdriver.
          Secure the carriage drive motor wire bundles to the plate
          with cable ties.

12.   Stand the printer up on the front end of its main frame. Arrange the two sheathed cables into the wire bundles from which their counterparts were removed in Steps 3 and 4, subsection 5.4.4.1, and plug them in; Transducer Cable (smaller) to connector J8B on the Transducer PCB (Slot G); and the Print Wheel Drive Cable (larger) to connector J4 on the Motherboard PCB. Secure the two wire bundles with cable ties. Return the printer to it's normal position.

This completes the removal and replacement of the Carriage Subassembly

5.4.4.3 Paper Carrier System To Carriage System Adjustments

The following procedures detail the adjustment of the movable Paper Carrier Subassembly (platen) to the essentially fixed Carriage Subassembly (print wheel). The adjustments included are platen horizontal movement (platen to print wheel), and platen vertical movement (platen height). The objective of these adjustments is to align the platen with the carriage and its print wheel everywhere on its path of movement along fixed rails, to achieve print quality. Note that adjustment of either of the platen movements affects the other. When adjustment is made to one, the other should be checked to ensure a quality of printout within the limits specified.

The checks and adjustments are to be performed with the printer connected to an exerciser or tester, and a power supply.

1. Platen To Print Wheel Adjustment
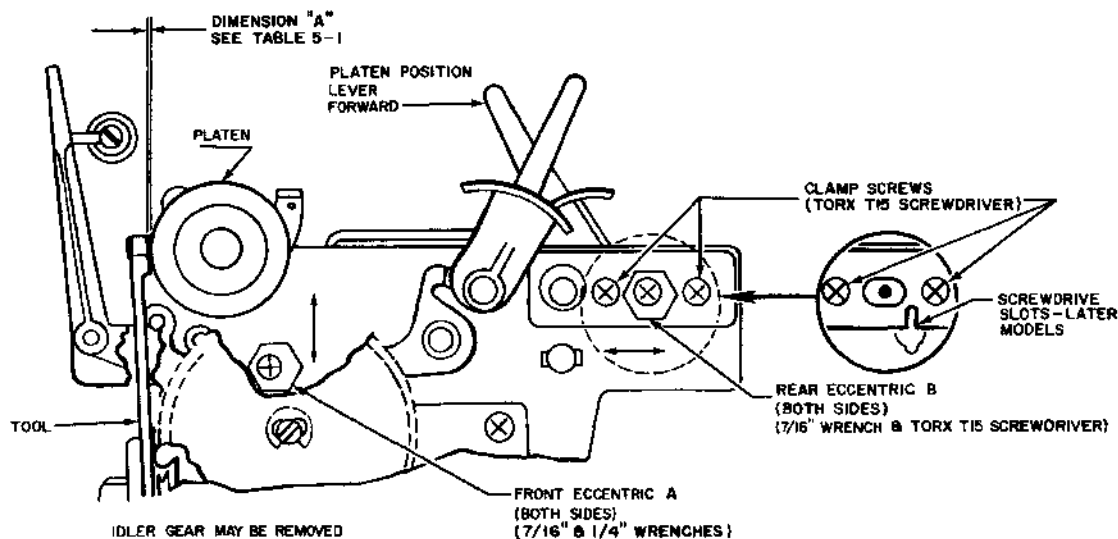
Figure 5-20   PLATEN TO PRINT WHEEL ADJUSTMENT POINTS

Refer to Figures 5-5 and 5-20, and to subsections 5.4.2.2 and 5.4.2.3.

Make sure power is OFF to the printer. Remove the ribbon cartridge and print wheel.

\# Loosen the two 3/16" hex head (or slotted pan head) card guide
mounting screws on the carriage, and lower the card guide as
far as it will go. Tilt the print wheel motor forward.

\# Install Adjustment Tool #40795, or #40795-02 (and #301445-01
as required), on the print wheel motor hub. Make sure the
alignment slot (B1) in the tool properly engages the align-
ment tab on the print wheel motor hub, and that the tool is
fully seated on the hub.

\# Tilt the print wheel motor and tool back into operating position
and verify that the card guide alignment tabs (D1 and D2) on
the adjustment tool clear the top edge of the card guide.

\# Use 1/4" and 7/16" wrenches to adjust the front (platen height)
eccentrics (A) on each side of the printer so that the eccen-
tric lobes are aligned toward the rear of the printer and are
centered in their slots in the carrier side frames. Retight-
en the 1/4" hex head eccentric clamp screws.

\# Loosen the two rear eccentric clamp screws on each side of the
printer, using a TORX T15 screwdriver. Use the T15 screw-
driver and a 7/16" wrench to adjust the rear (platen posi-
tion) eccentric (B) on each side of the printer so that the
eccentric lobes are aligned upward, and are centered in their
slots in the carrier horizontal adjust plate. Note that on
later assemblies the eccentric (B) has been eliminated and
replaced with a screwdriver slot - use a blade screwdriver
to align the two halves of the slot on these units.

\# Make sure the Platen Position Torque Shaft eccentrics are
adjusted per subsection 5.4.3.4, and move the Platen Position
Lever fully forward.

TABLE 5-1
PLATEN TO PRINT WHEEL CLEARANCES

Model	1640	1650
Dimension "A"	.001"—.009"	.005"—.010"

$\approx \pm 170°$

PLATEN POSITION
ECCENTRIC
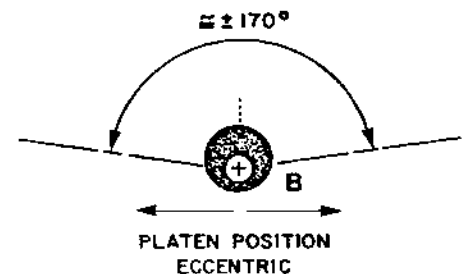
Figure 5-21
PLATEN POSITION ECCENTRICS
ADJUSTMENT LIMITS

\# Refer to Table 5-1. Move the carriage from one end of its trav-
el to the other end. Stop the carriage at each end and,
using flexible (plastic) thickness gauges, check the clear-
ance between the platen surface and the tool's platen adjust-
ment tab(s) (C) per the dimensions listed in Table 5-1 for
the model printer being serviced.

\# Adjust the rear (platen position) eccentric (B), or slot on each
side as necessary to achieve a platen horizontal position
adjustment within the tolerances specified in Table 5-1.
Figure 5-21 depicts the approximate limits of adjustment for
these eccentrics.

NOTE: The platen height adjustment must be checked following
platen position adjustment, and vice versa.

2. Card Guide Height and Position Adjustment
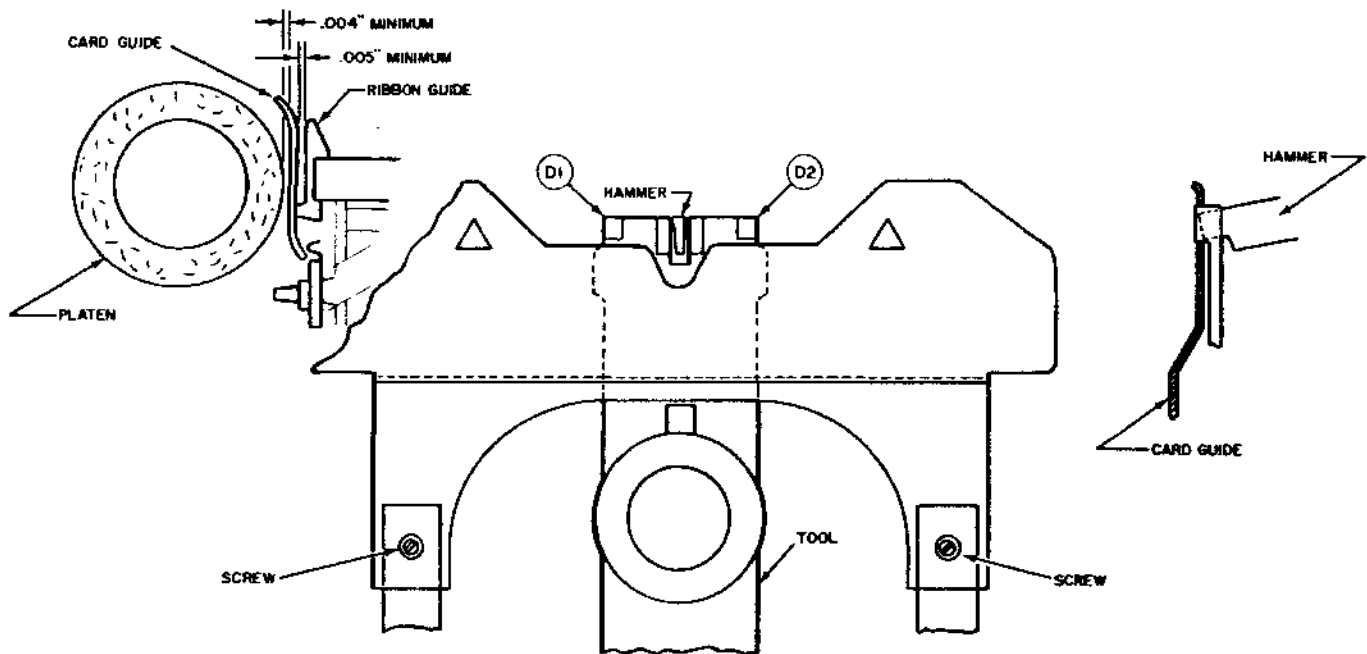
Figure 5-22   CARD GUIDE ADJUSTMENTS

⌗ If not done in the previous procedure, loosen the two 3/16" hex head card guide mounting screws (slotted screws in older models), and move the card guide down.

⌗ Make sure the Adjustment Tool is firmly seated on the print wheel motor shaft hub. Rotate the tool until features D1/D2 are at the top.

Tool #40795   - Push the Print Hammer into the tool's hammer slot B2 and hold it there. Raise the card guide gently, until its top edge contacts the undersides of tool tabs D1 and D2 with EQUAL pressure. Release the hammer and while holding the card guide in contact with the tool tabs tighten the two card guide mounting screws.

Tool #40795-02 - Raise the card guide until its top edge contacts the undersides of tool tabs D1 and D2. Gently move the tool slightly from side to side until the guide rests against the tabs with EQUAL pressure. Hold the card guide firmly in this position and tighten the two card guide mounting screws.

⌗ Using a .005" plastic shim, check for no-drag shim clearance between the card guide and the ribbon guide posts on both sides of the carriage. Normally this dimension is set by the

depth of the ribbon guide post tabs. Shim drag indicates the card guide has become tilted, in which case its support arms should be gently reformed to achieve proper ribbon post clearance.

\# Using the .005" plastic shim, check for no-drag clearance between the card guide and the platen along the full length of the platen.

NOTE: If the printing task involves bidirectional feeding of perforated multipart forms where the perforations must cross the writing line in reverse, an optional card guide #40550-02 must be used. In this event the following adjustment tolerances apply.

Print Line Base to Card Guide Cutout Base = .000" to .010"
Card Guide to Platen = .004"
Card Guide to Ribbon Post remains = .005"

3. Ribbon Height Adjustment
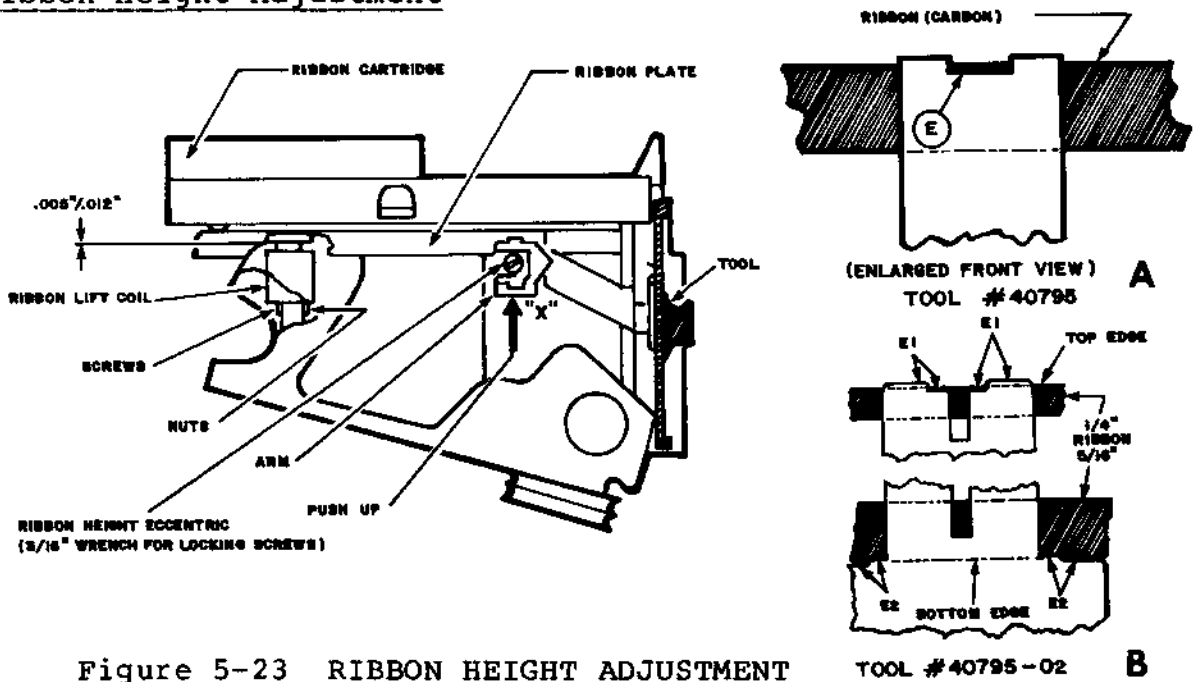
Figure 5-23   RIBBON HEIGHT ADJUSTMENT

Adjustment Tool #40795 - 1/4" Ribbons ONLY. Refer to Figure 5-23 (A).

\# Remove the ribbon cartridge and print wheel (if installed). Install the #40795 Adjustment Tool on the print wheel motor shaft hub, and rotate the tool to bring the ribbon height adjustment feature (E) to the top.

\# Tilt the print wheel motor into operating position, and install a multistrike carbon film ribbon cartridge.

\# Push up on the carriage ribbon base plate tab "X" so the TOP EDGE of the exposed ribbon is brought near the top of the tool. The top edge of the ribbon should be visible within the slot, as shown in Figure 5-23(A). Adjust the ribbon height eccentric as required to achieve this objective.

\# Remove the cartridge and tool. Replace the print wheel and the operating ribbon cartridge removed in the first step above.

Adjustment Tool #40795-02 - 1/4" OR 5/16" Ribbons. Refer to
Figure 5-23(B).

Remove the ribbon cartridge and print wheel (if installed).
   Install the #40795-02 Adjustment Tool on the print wheel
   motor shaft hub, and rotate the tool to bring its hammer
   adjustment slot feature (B2) to the top.
Tilt the print wheel motor into operating position, and install
   a multistrike carbon film ribbon cartridge.
Push up on the carriage ribbon base plate tab "X" so that the
   tab (or grommet) is held against the carriage ribbon height
   eccentric.
Check the position of the exposed portion of the ribbon for pro-
   per height adjustment as follows:
   1/4" Ribbons -The TOP edge of the ribbon must appear be-
                 tween the high and low planes of tool features
                 (E1).
   5/16" Ribbons -The BOTTOM edge of the ribbon must appear be-
                 tween the high and low planes of tool features
                 (E2).
Adjust the ribbon height eccentric as required to achieve proper
   ribbon height.
The adjustment procedure for ribbon lift is as follows:
Remove the ribbon cartridge. Place a .005" plastic shim between
   the ribbon lift coil laminations and the ribbon base plate
   pole piece. Push up on the ribbon base plate tab (X) so that
   the ribbon height tab (or grommet) is firmly against the ec-
   centric. Energize the ribbon lift coils with 12-15V dc and
   insure that the laminations are firmly and equally seated
   against the pole piece. Loosen the 3/16" coil mounting
   screws and adjust the position of the coils with respect to
   the pole piece as required to achieve these goals. Retighten
   the mounting screws and remove the shim.
Recheck the ribbon height adjustment as outlined above. Re-
   adjust as required, then recheck the coil adjustment.

4. <u>Platen To Print Wheel Adjustment - Platen Height</u>
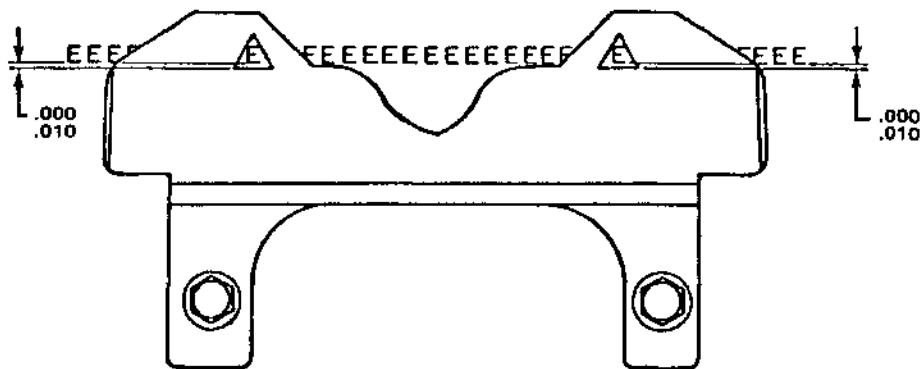
<u>Figure 5-24</u> <u>CARD GUIDE ALIGNMENT</u>
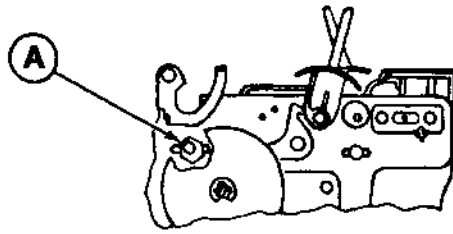
Figure 5-25   PLATEN HEIGHT ECCENTRICS

PLATEN
HEIGHT
ECCENTRIC

A

$\cong \pm 170°$
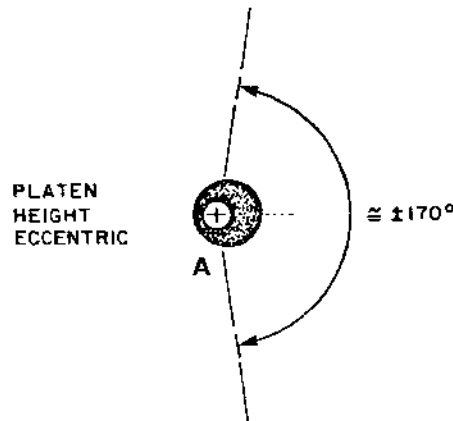
Figure 5-26
PLATEN HEIGHT ECCENTRICS
ADJUSTMENT LIMITS

Refer to Figures 5-20 and 5-24, and to subsection 5.4.2.2.
\# Connect the printer to a tester and apply power. Allow the
   printer to complete its RESTORE sequence.
\# Insert a sheet of wide (14-3/8") paper, and command the print-
   out of a full line of E's.
\# Refer to Figure 5-24. Check the alignment of the card guide.
   As shown, the bottom lines of the printed E's must be even
   with the bottom edges of the triangular openings (A1) in the
   card guide (A) within .000" to .010" as shown. Make minor
   adjustments to the card guide height as required to achieve
   proper card guide positioning. See NOTE in subsection
   5.4.4.3 step 2.
Refer to Figures 5-25 and 5-26, and to subsection 5.4.2.2.
\# Command the printout of a full line of H's. Inspect the print-
   out against the examples in subsection 5.4.2.2. Use 1/4" and
   7/16" wrenches to adjust the platen height eccentrics (A),
   one end at a time, to achieve an even printout top to bottom
   on each character. Print a full line of H's after each ad-
   justment to check results.

NOTE: The platen position adjustment must be checked following a
       platen height adjustment and vice versa.

5.4.4.4 Carriage Home Adjustment
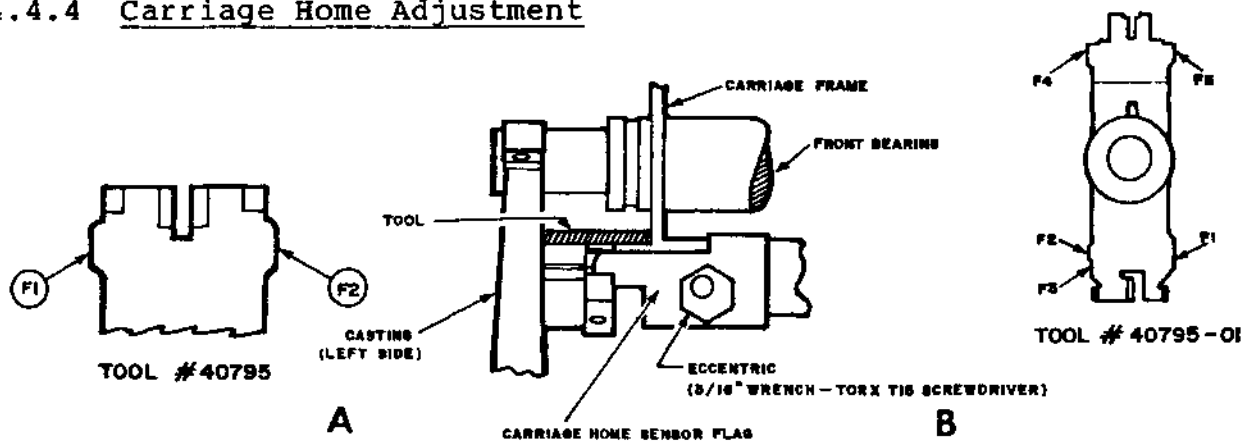
Figure 5-27   CARRIAGE HOME ADJUSTMENT

Refer to Figure 5-27, and to subsection 5.4.2.3.
Adjustment Tool #40795
Apply power to the printer and allow the printer to complete its
   RESTORE sequence. Verify that the carriage has been left in
   its home position.
Insert the Adjustment Tool between the left side of the print-
   er's main frame casting and the carriage frame just above the
   carriage home sensor, as shown in Figure 5-27(A). Check for
   a cumulative clearance of no more than .017" between the
   tool's carriage home alignment tab features F1/F2 and the
   printer assemblies.
If the carriage home position is not within allowable limits
   following RESTORE, adjust the carriage home sensor flag ec-
   centric, located on the bottom left front of the carriage
   frame, using a 5/16" wrench and a TORX T15 screwdriver. The
   eccentric is adjusted to move the sensor flag LEFT for not
   enough clearance, and RIGHT for too much clearance.
Move the carriage right manually and recycle the printer through
   the RESTORE sequence after each small movement of the eccen-
   tric to check results. Tighten the eccentric clamp screw
   securely when the adjustment has been completed.

Adjustment Tool #40795-02.
Apply power to the printer and allow the printer to complete its
   RESTORE sequence. Verify that the carriage has been left in
   its home position.
Insert the Adjustment Tool between the left side of the printer
   main frame casting and the carriage frame, just above the
   carriage home sensor, as shown in Figure 5-27(B). Using tool
   features F1 through F5, check for proper passage of the tool
   as follows:
        Features F4/F5 SHOULD NOT pass (no-go)
        Features F1/F3 SHOULD pass (go)
If carriage home position following RESTORE is not within these
   limits (i.e. F4/F5 passes, or F1/F3 will not pass), adjust
   the carriage home sensor flag eccentric, located on the bot-
   tom left front of the carriage frame, as follows. Use tool
   features F1/F2 as a gauge between carriage and main frame as

before, and a 5/16" wrench and a TORX T15 screwdriver to move
the eccentric. Adjust the eccentric to move the sensor flag
LEFT for not enough clearance, or RIGHT for too much clear-
ance.
Remove the tool, move the carriage to the right manually, re-
cycle the printer through a RESTORE sequence, and recheck
tool clearance after each small movement of the eccentric.
Tighten the eccentric clamp screw securely when the adjust-
ment has been completed.

5.4.4.5 Print Wheel To Hammer Alignment
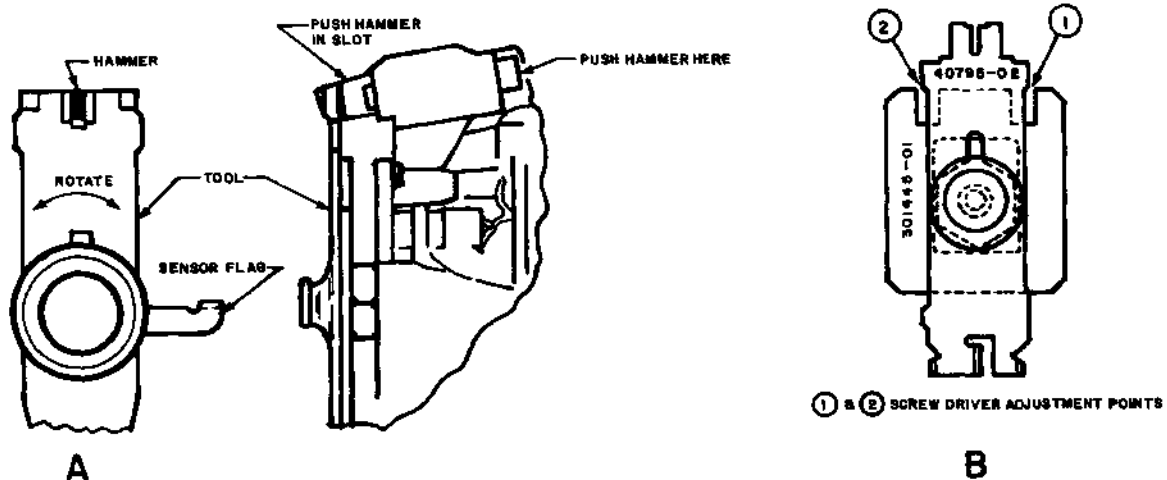
Figure 5-28   PRINT WHEEL TO HAMMER ALIGNMENT

Refer to Figure 5-28, and to subsection 5.4.2.3.
Apply power to the printer and allow the printer to complete its
RESTORE sequence. Remove paper, the ribbon cartridge and the
print wheel.
As shown, install Adjustment Tool #301445-01 over the nut on the
front of the print wheel hub. Install Adjustment Tool #40795
-02 firmly on the print wheel motor shaft hub and ensure
that it is properly seated with its alignment slot (B1) en-
gaged over the tab on the hub's alignment plate.
Rotate the alignment tool to bring its hammer slot (B2) in front
of the print hammer, and then block the carriage home sen-
sor's light path (by inserting a piece of dark paper into its
slot) to detent the print wheel motor.
Manually push the print hammer gently toward the alignment tool
until its face enters the tool's hammer slot (B2). If the
hammer face slides easily into the slot without contacting
the sides of the slot, Print Wheel To Hammer alignment is
correct. If the hammer contacts the sides of the slot or
will not enter the slot at all, continue with this procedure.
Place the tip of a blade screwdriver in either of points 1 or 2.
The screwdriver may then be twisted to move the alignment
plate in relation to the print wheel hub to achieve proper
alignment.

CAUTION: Carriages with the mechanical print wheel hub DO NOT require use of any
adhesive.

5.4.4.6 Print Wheel Home Adjustment
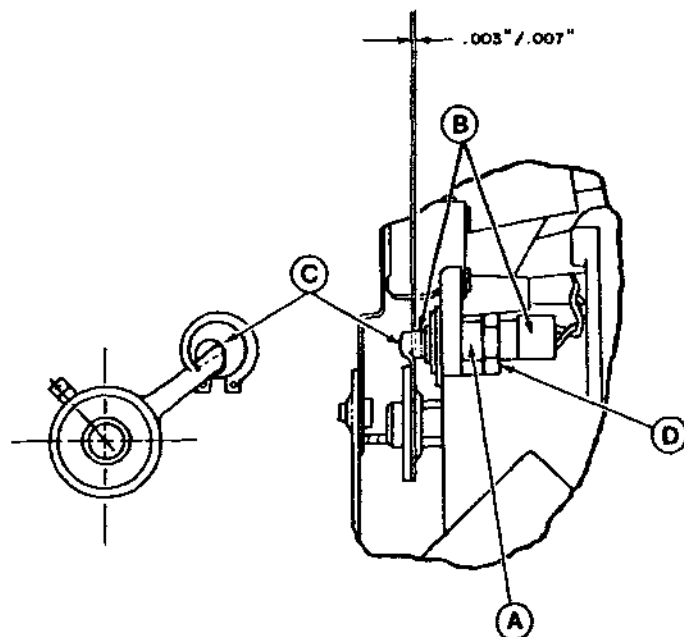
Figure 5-29   PRINT WHEEL "HOME" ALIGNMENT

The printer's print wheel logic includes a safety feature called re-try. This feature helps, during the RESTORE sequence, to ensure that the microprocessor has the right count in its absolute counter for print wheel position. The print wheel is allowed to stop only at those points where the +PW EVEN is HI which occurs only once per print wheel or petal position. If the print wheel fails to stop in a position where +PW EVEN=HI, the microprocessor will reissue the print wheel portion of the RESTORE sequence. The print wheel restore sequence will retry stopping the print wheel in a proper position. If the microprocessor is unable to obtain the correct condition after 8 consecutive attempts (retries), it will issue a CHECK command to stop the printer. This situation normally indicates that a print wheel home adjustment is needed.

Remove the ribbon cartridge, and tilt the print wheel motor for-
    ward away from the platen.
Initiate a RESTORE sequence. Verify that the correct home char-
    acter has been positioned squarely in front of the print ham-
    mer. Home characters for the various models are:
        Series 1640 = w
        Series 1650 = 90° flag notch with 88 and 92 char-
                         acter print wheels
                    = ¢ with 96 character USA TITAN 10 print
                      wheel (print wheel spoke posision 0)

If the home character is displaced less than one character width, per-
form a print wheel to hammer alignment per subsection 5.4.4.5.

If the home character is displaced one full character position, per-
form the print wheel home adjustment procedure.

If the home character is displaced more than one full character posi-
tion, perform both the print wheel alignment and the home position
alignment procedures. In this event, perform the wheel alignment
first.

　　　Print Wheel Home Alignment
　　　Refer to Figure 5-29.
　　　# Use a 7/16" open end wrench to adjust the home sensor eccentric
　　　　　(A) as follows. Move the eccentric slightly in either di-
　　　　　rection, and RESTORE the printer. Continue adjusting the
　　　　　eccentric in that direction, a little at a time, until the
　　　　　print wheel spins (8 revolutions) and the printer goes into
　　　　　its CHECK mode. Note this eccentric position.
　　　# Move the eccentric in the opposite direction in the same manner
　　　　　until the printer goes into CHECK again. Note this eccentric
　　　　　position.
　　　# The two extremes noted above may be as much as 180° apart.
　　　　　Adjust the eccentric to the approximate midpoint between
　　　　　these two extremes.
　　　# If the print wheel spins continuously (8 revolutions), the sen-
　　　　　sor (B) may be located too far from the print wheel home sen-
　　　　　sor flag (C). Loosen nut (D) and rotate the sensor clockwise
　　　　　until the print wheel stops. Use a plastic shim to verify
　　　　　.003" to .007" clearance between the surface of the sensor
　　　　　and the edge of the flag. Retighten nut (D).
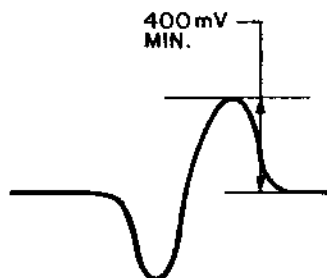
Figure 5-30
PRINT WHEEL HOME SENSOR WAVEFORM

　　　#The electrical signal out of the sensor should be at least 400mV
　　　　　peak. Figure 5-30 illustrates this signal, as seen at the
　　　　　input to the Print Wheel Home Sensor amplifier on the SERVO
　　　　　PCB.

5.4.4.7 Hammer Adjustment

　　　Refer to Figures 5-31 and 5-32.
　　　# Remove power from the printer. Remove ribbon cartridge and any
　　　　　paper. Move the platen position lever fully forward. Verify
　　　　　that the platen is in good condition and free of surface de-
　　　　　fects. If this is to be an adjustment for high print quality,
　　　　　installation of a new platen (even temporarily) should be
　　　　　entertained.

(1640) .042" to .048"
(1650) .073" to .083"

(1640) .073" to .083"
(1650) .086" to .091"
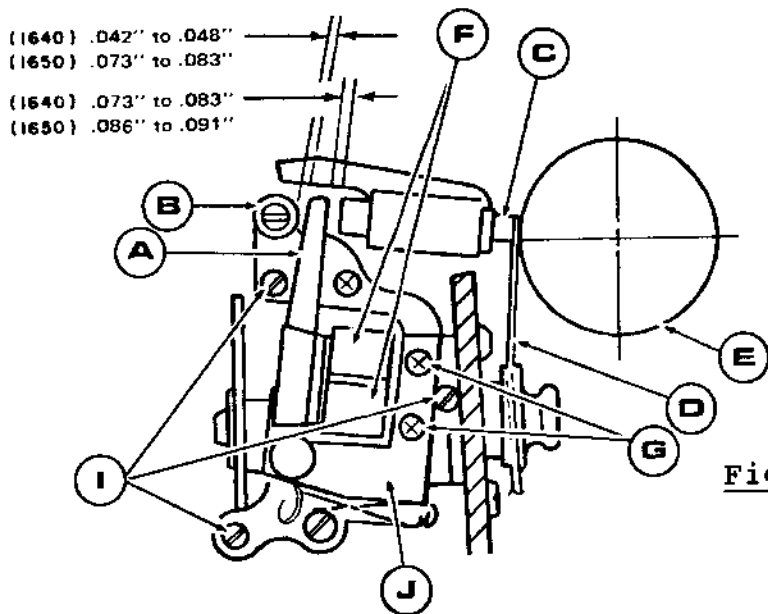
Figure 5-31   HAMMER ADJUSTMENTS

.068 DIA

.078 DIA

.045 DIA

TOOL # 40796

H1
H2
H3

A

HANG THIS PORTION OVER THE HAMMER GUIDE.

INSERT THIS PORTION BETWEEN THE HAMMER ARMATURE AND HAMMER COIL.

FINE ADJUSTMENT SHIM

2.0

B
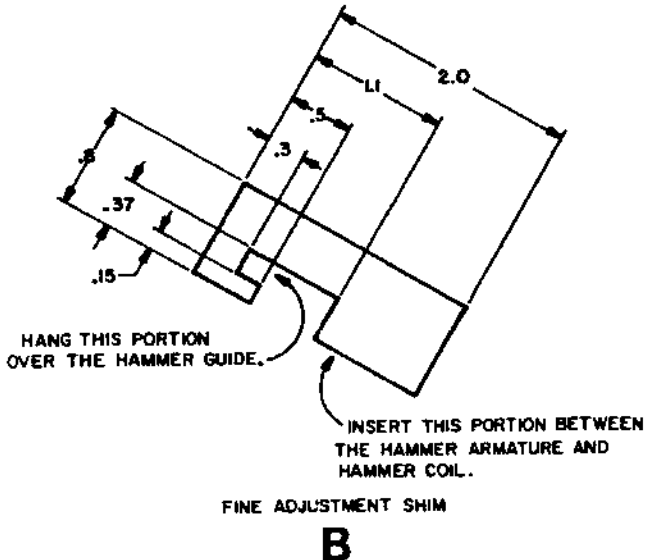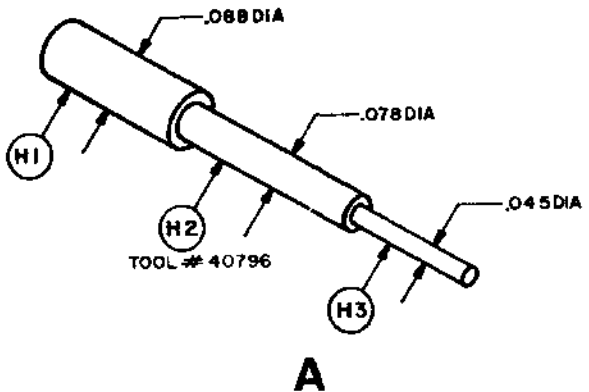
Figure 5-32   HAMMER ADJUSTMENT TOOL #40796 and SHIM

\# Hold the hammer armature (A) against the hammer coils (F), and check for no gap between them. Insert Adjustment Tool #40796 between the armature (A) and the armature stop eccentric (B) as follows:

        Series 1640 - use part H3
        Series 1650 - use part H2

Adjust the eccentric (B) as necessary for a <u>very light</u> resistance to passage of the tool when slid along the side of the armature past the eccentric.

\# Rotate the print wheel manually to place one of the larger characters (M,W,E, etc.) in front of the print hammer. If this is to be an adjustment for high quality use of a new print wheel (even temporarily) should be entertained. Insert Adjustment Tool #40796 between the armature (A) and the anvil end of the print hammer (C) as follows:

        Series 1640 - use part H2
        Series 1650 - use part H1

With the tool in place, lightly press in on the armature (A)
until it stops against the hammer coils (F). This will drive
the print hammer (C) in to nestle the selected print wheel
petal (D) lightly against the platen (E). Gently rock the
print wheel slightly back and forth, and verify that the pet-
al can move with a <u>very light drag</u>. Repeat this check while
rotating the platen and moving the carriage each time until
the entire printing surface condition has been checked. Ad-
just the hammer armature assembly to achieve these goals as
follows:

  Series 1640 - Adjust the print hammer coils (F)
  to achieve best hammer to platen dimensions by
  loosening screws (G) and moving the coils and the
  armature. Retighten screws (G).

  Series 1650 - Adjust the print hammer armature
  assembly (J) to achieve best hammer to platen
  dimensions by loosening screws (I) and moving
  the assembly. Retighten screws (I).

<u>NOTE:</u> It may be necessary to slightly readjust the carrier
  system <u>platen to print wheel</u> dimension to achieve the
  conditions specified above. Refer to subsection
  5.4.4.3.

<u>Print Quality Fine Adjustment Hint</u>
  Refer to Figure 5-32(B). To fine adjust the print quality,
  a .005" plastic shim, as shown in Figure 5-32(B), may be
  placed between the hammer armature and hammer coil. The
  shim will decrease hammer energy significantly. This will
  in turn amplify nonuniform print density for easy adjustment.

  The fine adjustment shim may be cut from .005" plastic shim
  stock (Diablo P/N 41144-07 or equivalent) using the pattern
  shown. In addition, always use a multistrike carbon film
  ribbon for print quality adjustments.

5.4.5 <u>Carriage Drive System - Replacement and/or Adjustment</u>
   <u>Procedures</u>

This subsection outlines the replacement and adjustment of the car-
riage drive system, which includes the carriage servo motor and the
carriage drive cable.

5.4.5.1 Carriage Drive Cable Removal

 # Disconnect the carriage drive pulley and remove the carriage
  rail clamps, as described in Steps 7 and 8 of subsection
  5.4.4.1. Do not disturb the spring shielded interconnecting
  cables.

 # Raise the carriage and rails up together, and carefully lay them
  back on top of the printer. Do not slide the rails out of
  the carriage sleeve bearings.

 # Refer to Figure 5-33. Use a TORX T15 screwdriver to loosen the
  mounting screw and release the drive cable tension leaf
  spring, located on the left-hand side of the printer's main
  frame. This will release tension on the carriage drive
  cables.
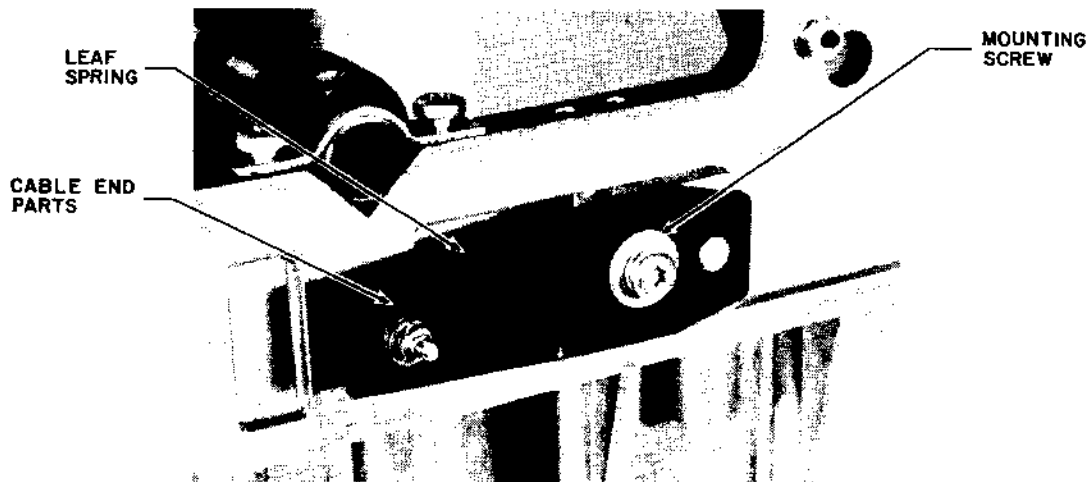
Figure 5-33   DRIVE CABLE TENSION SPRING

\# Remove the hemostat, retrieve the carriage drive pulley, and un-
   thread the two drive cable sections. Note that the ball end
   of the left-hand cable is trapped between the servo motor's
   drive capstan and the printer's main frame. Release the ball
   end from its groove in the capstan, and extend the cable down
   below the lower part of the capstan and to the right to free
   it for removal.
\# If the carriage servo motor is not to be removed, skip to sub-
   section 5.4.5.3.

5.4.5.2   Carriage Servo Motor Replacement
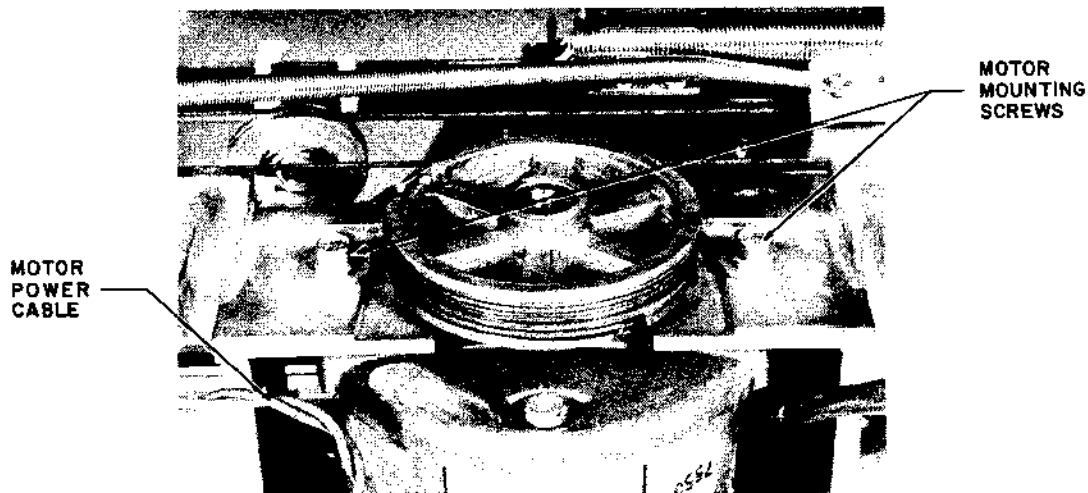
Figure 5-34   CARRIAGE SERVO MOTOR MOUNTING SCREWS

To remove the motor:
\# Temporarily return the carriage and its rails to the operating
   position, and install the rail clamps and screws - with the
   screws threaded in finger tight only.

Stand the printer up on the front end of its main frame, remove
  the four 8-32 screws holding the bottom plate in place, using
  a TORX T15 screwdriver. Move the plate back out of the way.
Cut the cable ties to open the wire bundles, unplug and release
  the servo motor's transducer and power cables. Note their
  arrangement for later reassembly.
Using a 1/4" wrench, remove the two 8-32 hex head thread forming
  screws and #8 flat washers holding the motor to the printer's
  main frame, and remove the motor and its attached cables.
  Note the orientation of motor and cables for reassembly.

To replace the motor:
On the replacement carriage servo motor, lightly coat those sur-
  faces which will contact the printer's main frame with ther-
  mal compound.
Orient the motor with its drive capstan up, and its 2-wire power
  cable to the left (as you view it) as observed above during
  removal, and move it into position in the main frame.
Use a 1/4" wrench to replace the two 8-32 hex head thread form-
  ing screws and #8 flat washers, to hold the motor in place.
  Start the screws, then pull the motor as far toward you as
  possible (toward the bottom of the printer), and tighten
  the screws down firmly.
Arrange the two cables into their respective positions and se-
  cure the wire bundles with cable ties. Plug the cables into
  their PCB connections.

NOTE: If the bottom plate retains the metal clips used to secure
      the two carriage motor cables, remove and discard these
      clips. Replace the clips with cable ties.

Move the bottom plate back into position, and replace the four
  8-32 screws to hold it in position.
Return the printer to its normal position.

5.4.5.3 Carriage Drive Cable Replacement
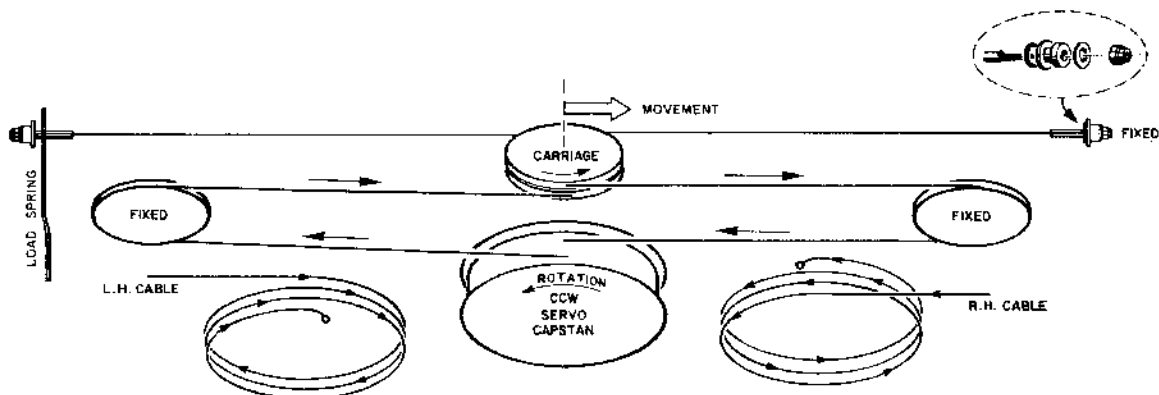
Figure 5-35 CARRIAGE CABLE DRIVE SYSTEM SCHEMATIC

Refer to Figure 5-35.
Study the arrangement of the cable drive system depicted in the
  illustration.

\# Assemble an "O" ring, cable hub, #6 lock washer and 5-40 locknut
on the end of one of the replacement carriage drive cables.
Screw the nut onto the cable shank far enough to allow a
thread or two to show on the free side of the nut. Hold the
cable shank securely with a wrench while driving the nut on,
to avoid twisting the cable.
\# Insert the ball end of this cable through the cable hole in the
right-hand end of the printer's main frame. Engage the cable
end ball in the notch on the outside rim (away from you) of
the servo motor's capstan.
\# Hold slight tension on the cable, and turn the capstan counter-
clockwise (as you view it) to wind on almost all of the cable
(slightly more than 4 turns).
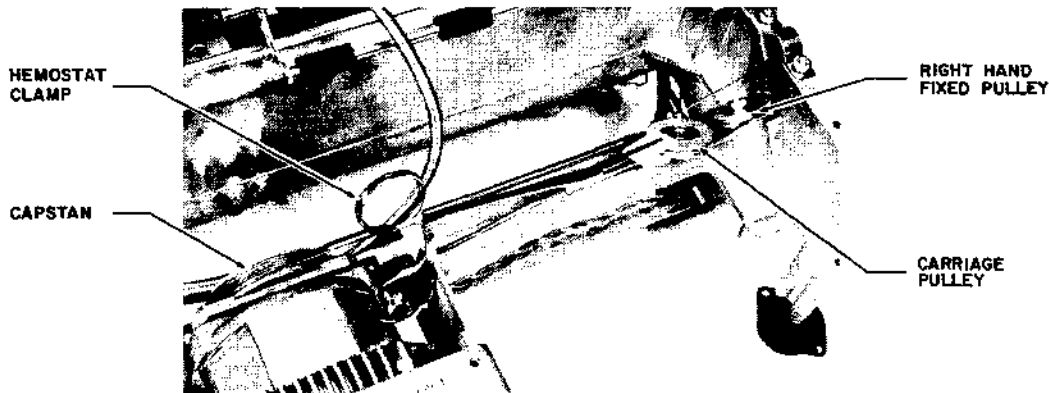
Figure 5-36   RIGHT-HAND CARRIAGE DRIVE CABLE INSTALLATION

Refer to Figure 5-36.
\# From the capstan, arrange the cable back to the right around the
right-hand fixed pulley clockwise (bottom rear to top front),
and back to the left and clockwise (front to back) around the
carriage pulley, with this cable in the carriage pulley's top
groove. It will be necessary to allow the capstan to rotate
slightly.
\# Protect the carriage pulley with heavy paper, and grasp it with
the hemostat clamp as shown in Figure 5-36. Hook the hemo-
stat clamp's lower finger ring over the main frame servo
motor shield as shown, where the motor's magnetism will help
to hold it in position. Rotate the capstan counterclockwise
to keep a slight tension on the cable, and to locate the
notch on the capstan's inside rim (toward you) as near the
top (as you view it) as possible.
\# Work the ball end of the second replacement cable down beside
the capstan (either side) and back up between the capstan and
the main frame. Engage the ball in the rim notch.
\# Arrange the cable back from the capstan to the left around the
left-hand fixed pulley counterclockwise (bottom rear to top
front), and back to the right. Carefully insert the cable
end under the carriage pulley front to back then back to
the left engaging the cable in the carriage pulley's bottom

groove. Stretch the cable to the left and thread its free
end out through the cable hole in the left-hand side of the
printer's main frame.
Assemble the following items on the free end of this second
cable shank as it protrudes out beyond the side of the frame,
in the order listed in Figure 5-37. Put the locknut on
on finger tight only and avoid twisting the cable.

CABLE END ———
"O" RING ———
CABLE HUB ———
6 LOCKWASHER ———
5-40 LOCKNUT ———
LEAF SPRING
MOUNTING
SCREW PARTS
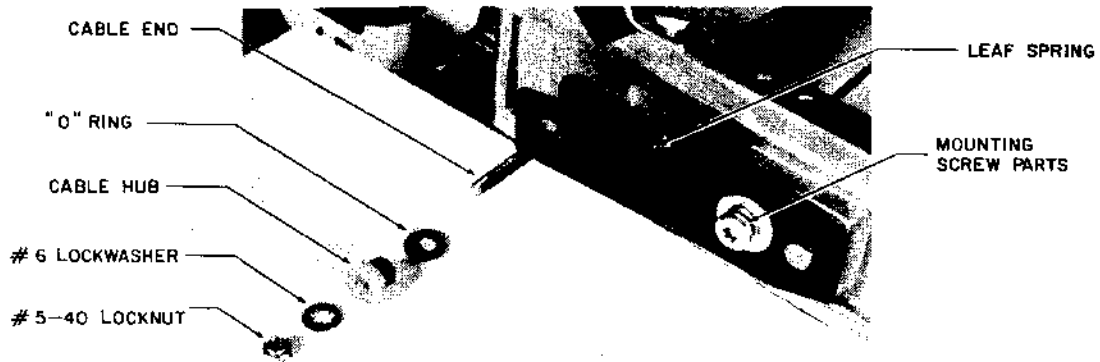
Figure 5-37   CARRIAGE DRIVE CABLE TENSION SPRING ASSEMBLY

Refer to Figure 5-37.
Assemble the 8-32 x .625" screw, #8 flat washer, and #8 lock
washer. Insert the screw through the leaf spring and into
the main frame as shown. Use a TORX T15 screwdriver to
tighten down on the screw enough to apply a light spring
tension to the cables.
Insert the small end of the TORX screwdriver down through the
hub of the carriage pulley (to prevent the pulley from flip-
ping over which would release the two cables) and carefully
release the hemostat clamp.
Hold the TORX handle upright, and gently rotate the servo motor
drive capstan clockwise to move the carriage pulley left, to
a position just to the right of the carriage servo drive
motor, where the pulley hub is accessible up through the bot-
tom of the printer alongside the motor. Install the hemostat
clamp (with heavy paper protector for the pulley) as shown in
Figure 5-17(B), and remove the TORX screwdriver.
Reinstall the carriage and rails and attach the drive cable
pulley as outlined in subsection 5.4.4.2, Steps 7, 8 and 9.

5.4.5.4 Carriage Drive Cable Adjustment

Refer to Figure 5-38.
With the carriage positioned against the left-hand mechanical
stop, check the cable tension midway along the exposed cable
for the force necessary to distort the cable as shown.

NOTE: If the Tensiometer, listed as part of the recommended tools
in subsection 5.2.3, is not used, the dimensions between the
force points shown must be carefully followed.

Adjust cable tension by tightening or loosening the cable ten-
sion nut (B).
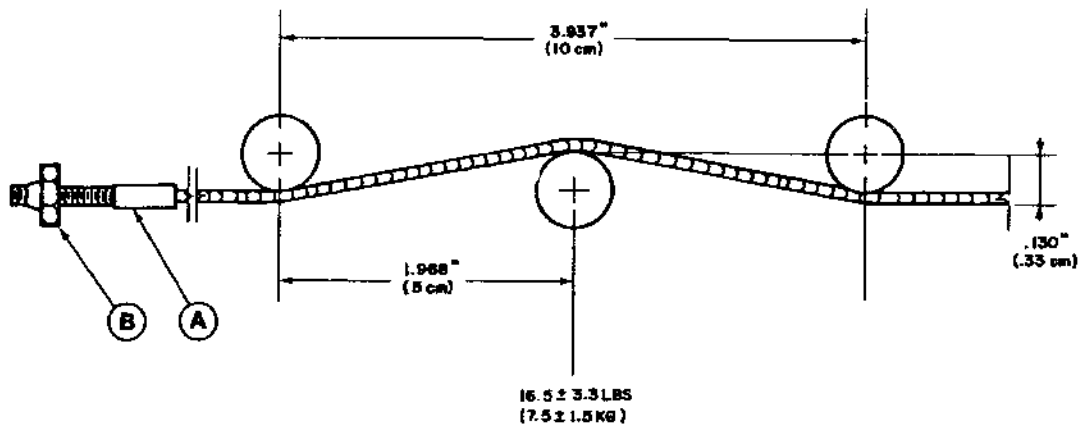
Figure 5-38   CARRIAGE DRIVE CABLE ADJUSTMENT

\# After adjusting the nut (B), move the carriage back and forth
'   several times to redistribute cable tension, and check again.
Readjust as necessary to achieve the conditions shown. Use
bonding adhesive (subsection 5.2.2, Item 7) on the locknuts
on the ends of both cables after adjustment has been com-
pleted.

5.4.6   Motherboard Replacement

1.   Remove power and disconnect the printer completely.

2.   Move the printer to a sturdy work bench or table. Remove any
covers.

3.   Remove the PCB clamp. Disconnect and remove all the plug-in PC
boards. Remove the ribbon cartridge.

4.   Stand the printer up on the front end of its main frame, with
the bottom facing front.

5.   Disconnect all interconnecting wires and cables going to the
Motherboard.

6.   Remove the top left-hand (as you view it) shock mount, if in-
stalled.

7.   Use a TORX T15 screwdriver to remove the 8-32 screws holding the
Motherboard to the main frame - three on the left-hand and (as you
view it), for the power plug supports, and six along the bottom. Re-
move the Motherboard assembly.

8.   Reverse the first seven steps to install a Motherboard.

5.4.7 Top Paper Out Switch Adjustment

Refer to Figure 5-39.

1. Remove the platen, and move the paper release lever fully rearward.

2. Manually hold the paper out bail (A) back toward the rear as far as it will go with <u>both</u> bail arms resting against the carrier assembly main frame.

3. Loosen and reset the bail hub setscrews (B) to remove any tension and/or twisting forces.

4. Still holding the bail back, rotate the disable lever assembly (E) to bring its extended tab into light contact with the top surface of the paper release actuator arm (F). Adjust the disable assembly laterally on the shaft end for a maximum clearance of .005" between its hub (G) and the carrier side frame. Tighten the disable assembly's setscrew.

5. Loosen the paper out switch (or switch bracket) mounting screws (D) and adjust the location of the switch (C) so that the switch actuator arm, being pushed back by the paper bail, clears the switch body and the paper bail also clears the switch body. Tighten the mounting screws.

6. Install the platen, and bring the paper release lever fully forward. The paper out bail should move forward to contact the platen squarely along its length within .015", and should not be bowed vertically more than .030". Reform the bail as necessary to achieve these goals.

7. Check that the paper out switch opens when the paper out bail <u>approaches</u> to within .035" of the platen. If the switch opens when the bail is more than this distance from the platen, reform its actuator arm to place the switchover point within the limit specified.
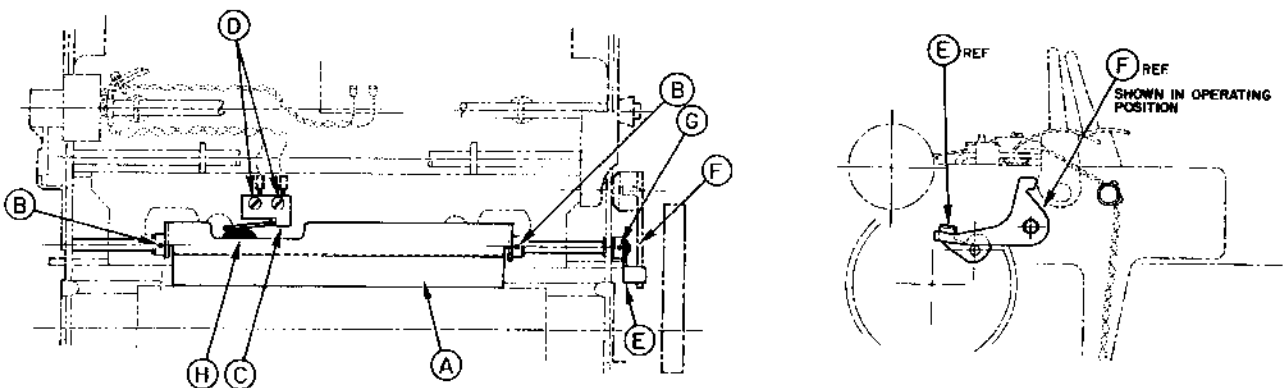
Figure 5-39 TOP PAPER OUT SWITCH AND BAIL LOCATIONS

5.4.8 Cover Open Switch Adjustment

Units without a control panel have the Cover Open Switch mounted on
the printer's main frame casting. These units require both adjust-
ment steps listed below.

Units with a control panel have the Cover Open Switch mounted directly
on the control panel. These units require only adjustment step #2
listed below.

1. Refer to Figure 5-40.
    Lower the access lid. Adjust the switch laterally so that the
actuator's tab strikes the switch plunger squarely. Open the lid
and tighten the switch mounting screws firmly.
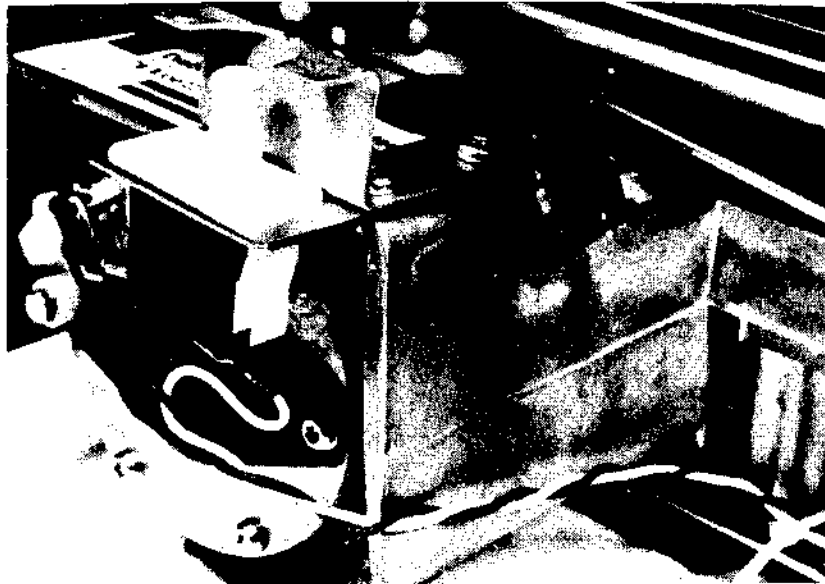
Figure 5-40   COVER OPEN SWITCH (Frame Mounted)

2. Refer to Figure 5-41.
    The cover open switch must switch over (close) at or before the
point where the access lid snaps free from any one of its spring re-
tainer clips, and must switch back (open) before the access lid is
fully seated in its closed position. Also, the actuator must not
drive the switch plunger all the way into the switch body. Adjust
the actuator up or down as necessary to achieve these goals, and
tighten the two mounting screws down firmly.
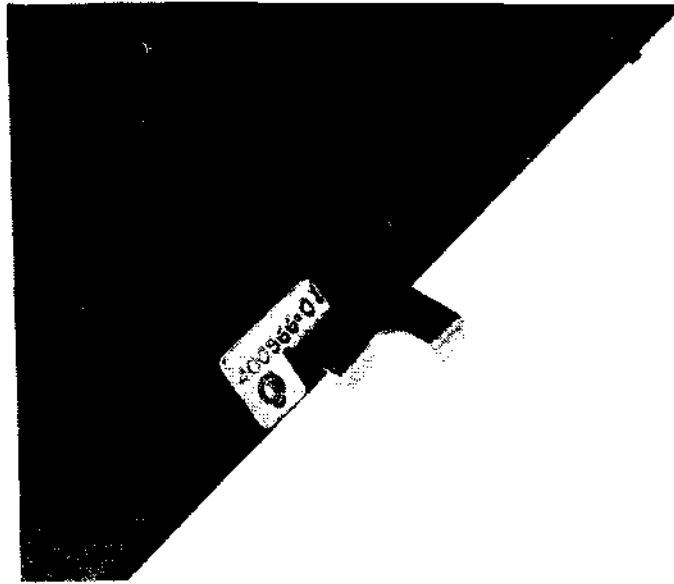
Figure 5-41   COVER OPEN SWITCH ACTUATOR

5.4.9   Control Panel - Removal, Installation and Adjustment

5.4.9.1   Removal/Installation

For installation, reverse the following removal procedure.

1. Disconnect the unit from its power source.

2. Remove the access cover, platen skirts, platen and top cover.

3. Remove the keyboard mask by pulling up on front of mask until it pops free; then lift mask from machine.

4. Remove the four control panel mounting screws. Flip the control panel over and disconnect the edge connector (P1) and the ac lines at the power switch and at the fuse.

5. Lift the control panel off the machine.

5.4.9.2   Adjustment

The only adjustment on the control panel is a volume control adjustment for the audible alarm.

1. Remove the access cover from the unit.

2. With a small screwdriver, turn the adjusting potentiometer until the desired volume is obtained. The potentiometer is accessible through a hole in the right side of the control panel near the buzzer. To sound the audible alarm after each adjustment, operate the RESET key and then attempt to print a character. The alarm will sound for a cover open error.

5.4.10 Keyboard - Removal, Installation and Adjustment

5.4.10.1 Removal

1. Unplug the terminal's power cord from the ac outlet.

2. Remove the access cover, platen skirts, platen and top cover.

3. Remove the keyboard mask by lifting up on the front of the mask until it pops loose. Then lift the entire mask off the keyboard.

4. Disconnect the keyboard edge connector at the left end of the keyboard.

5. Remove the four keyboard mounting screws from the keyboard mounting brackets.

6. Lift out the keyboard and set it safely aside.

5.4.10.2 Installation

1. Position the new keyboard in place on the mounting brackets. Start all four mounting screws. Position the keyboard in its approximate final position and tighten one screw on each end.

2. Attach the keyboard cable plug to the keyboard.

3. Set the keyboard mask in place and push down on the front of the mask until it snaps into position.

WARNING

When the terminal is connected to a power source, line voltage is present at the POWER switch terminals. To avoid a dangerous shock when power is applied and the top cover is removed, keep fingers away from the POWER switch terminals.

4. Apply power and test the keyboard in the following manner: Temporarily install the platen and a sheet of paper; then pull the cover open switch to its override position (all the way up), depress the RESET key, and enter characters from the keyboard. If the keyboard operates properly, turn off power and remove the platen from the terminal.

5. Carefully install the top cover in place, while checking for proper clearance between the keytops and the cutout in the keyboard mask.

6. Install the platen and platen skirts. Retest operation of the terminal.

5.4.10.3 Keyswitch Replacement

After the keyboard has been removed, individual keyswitches can be replaced using a soldering iron and long needle-nose pliers.

CAUTION

When removing the press-to-latch keyswitch modules, be certain that the key is in its released or up position to avoid damaging the module.

1. Remove the keytop from the module being replaced by lifting or prying upward with a padded tool. Also remove the keytops from the modules on either side of the one to be replaced. In some cases it may be necessary to remove additional adjacent keytops to provide adequate work space.

2. Unsolder the four module terminals from the circuit board. Use a solder removal tool to remove all solder from the pin holes in the circuit board.

3. Using the needle-nose pliers, gently squeeze the retaining spring tabs on the module and pull it straight out.

4. Install the replacement module. Before snapping it into place, make sure it is oriented properly and that all four pins are through the circuit board.

5. Solder the new switch terminals, using 60/40 rosin core solder and a 750°F soldering iron with a 1/8" chisel tip.

CAUTION

Never hold the soldering iron to the module pins for more than four seconds.

6. The solder joints may be cleaned with mild solvent, but be careful to avoid getting solvent on the switch modules or keytops.

7. Reinstall the keytops. Make sure they are installed on the right key, and that the legends are properly oriented.

5.4.10.4 Keyboard Adjustment

The only keyboard adjustment is the positioning of the keyboard for proper fit within the keyboard cutout of the top cover. This is accomplished by trial and error positioning of the keyboard, and is normally required only when the keyboard has been removed or when a different top cover is installed.

5.4.11 Bottom Feed Paper Chute Option - Adjustments

1. The following adjustments must be correct before adjusting the Bottom Feed Paper Chute:
   # Platen Position
   # Paper Feed
   # Card Guide

Refer to Figure 5-42.

2. Move the Paper Release and Platen Position levers fully forward. Make sure all paper chute screws are loose, except those for the paper out switch and the front chute bottom bracket (Figure 5-42 Item A).
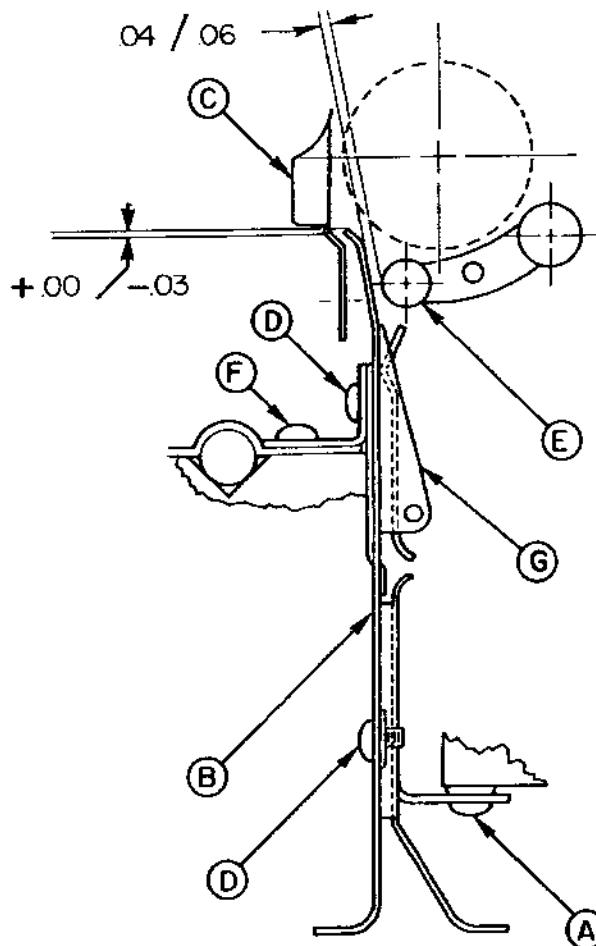
Figure 5-42   BOTTOM FEED PAPER CHUTE ADJUSTMENTS

3. Adjust the front paper chute (B) up or down to achieve the location shown level within +.00/-.03" with the top 45° bend of the card guide (C) the entire length of the carriage travel. Tighten screws (D) on each end.

4. Adjust the clearance between the front pressure rollers (E) and the upper surface of the paper chute (B) for .05" +/-.01". Tighten screws (F) on each end.

5. Adjust the paper bail (G) as necessary so that its "dimples" contact the front paper chute evenly at both ends, and tighten the setscrews in its hubs.

6. Adjust the paper out switch to reset .025" to .040" before the paper bail dimples touch the front chute (B).

7. Check for bail minimum movement of .100" beyond tangent point of the dimples on the chute and on the bail. Reform the switch arm and readjust the switch as required.

NOTE: The bail must move freely.

5.4.12   Internal Power Supply - Removal and Installation

The procedures given here are referenced to a Model 1640/1650 RO terminal with control panel. For other configurations some obvious minor variations will be necessary during the preliminary removal steps and final installation steps.

5.4.12.1   Removal

1. Remove the access cover, ribbon cartridge, print wheel, platen skirts, platen, paper cradle and top cover.

2. Remove 4 screws holding the control panel to the bottom cover.

3. Disconnect the PCB edge connector from the left end of the control panel. Disconnect all wires from the Power switch and Cover Open switch after noting their positions for reassembly reference. Remove the control panel.

4. Disconnect the green ground wire from inside front edge of the bottom cover.

5. Remove the bottom cover.

6. Stand the printer up on the front end of its main frame for access to the bottom.

7. From top side of printer, remove 4 screws holding the power supply assembly to the printer main frame. (See Figure 5-43.)

8. Carefully work the power supply assembly out the bottom of the printer, and place it alongside the printer as shown in Figure 5-44.

9. Disconnect the DC power cable, AC power cable and fan motor power cable from terminal block TB1 on the power supply circuit board. The power supply is now completely free.

MOUNTING SCREWS
(4 PLACES)

Figure 5-43   POWER SUPPLY MOUNTING SCREWS
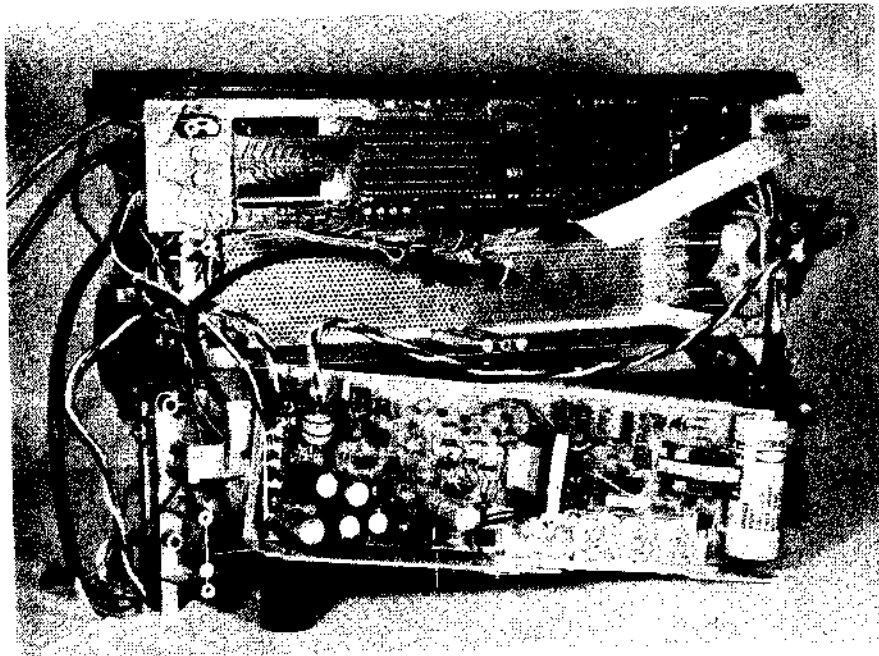
Figure 5-44   POWER SUPPLY REMOVAL/INSTALLATION

5.4.12.2 Installation

1. Position power supply alongside printer, with TB1 at left end as shown in Figure 5-44. Connect the DC power cable, AC power cable and fan motor power cable to terminal block TB1 according to the wiring diagram in Figure 5-45.

```
+5V   1  ⊘ White  ─────┐          AC to  9  ⊘ White  ─────┐
GND   2  ⊘ Black  ─────┤          fan    8  ⊘ Black  ─────┤
GND   3  ⊘ Black  ─────┤                 7  ⊘                   AC from PWR
+15V  4  ⊘ Red    ─────┤                 6  ⊘                        switch
-15V  5  ⊘ Brown  ─────┤          -15V   5  ⊘ Brown  ─────┐
      6  ⊘                        +15V   4  ⊘ Red    ─────┤
      7  ⊘          DC to printer  GND    3  ⊘ Black  ─────┤
AC to 8  ⊘ Black  ─┐              GND    2  ⊘ Black  ─────┤
fan   9  ⊘ White  ─┘              +5V    1  ⊘ White  ─────┘
                                                     DC to printer
      AC from PWR switch

"B" Supply                        "U" Supply
26021-XX                          30115S-XX
```
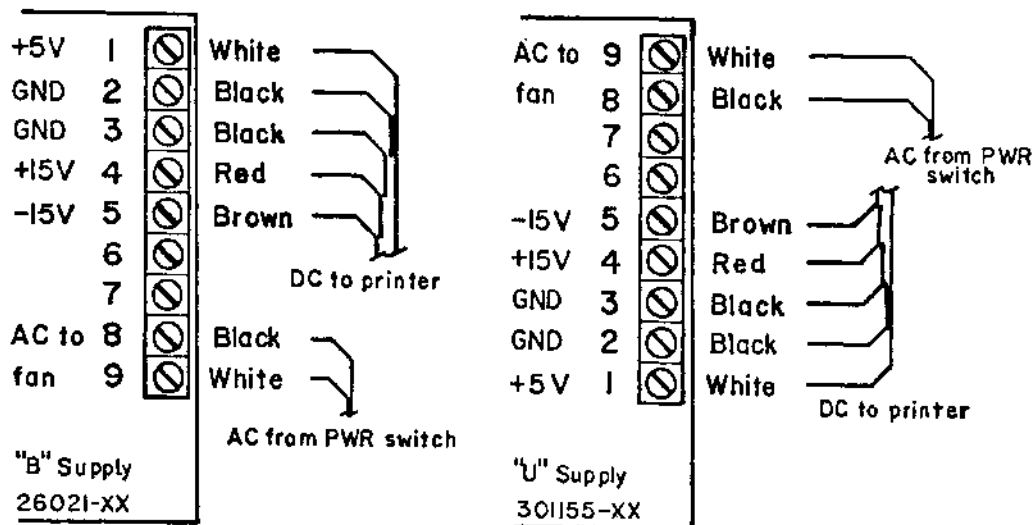
Figure 5-45   TB1 WIRING DIAGRAM

2. Place the metal screen into position at the top of the power supply compartment in the main frame, and align its screw holes with the holes in the main frame. (See Figure 5-44.)

3. Carefully work the power supply into its compartment in the main frame, with its interconnecting cables extending to the left. Fasten the power supply into place with four 6-32 x .500" screws which pass through the main frame, through the metal screen and into the threaded holes in the frame of the power supply.

4. Tuck the fan motor power cable up between the power supply and main frame to hold it out of the way. Check that all connectors along the edge of the Motherboard are fully seated.

5. Arrange all cables along the bottom side of the printer so that they will not be pinched when the printer is returned to its upright position.

6. Install the printer mechanism into the bottom cover.

7. Connect the green ground wire from the printer frame to the front edge of the bottom cover.

8. Connect the wires to the appropriate terminals of the Power switch and Cover Open switch on the control panel. Connect the PCB edge connector to the left end of the control panel.

9. Mount the control panel onto the bottom cover.

10. Install the paper cradle, top cover, platen, platen skirts, print wheel, ribbon cartridge and access cover.

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.

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 direction.

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 2-5, 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 2-4, 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 vertical 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 unfinished 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 Publication 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, automatic feeding, and retaining of up to 200 sheets of 20 lb paper. Printing 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

Rev A (8/80)

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 applicable 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 keyboards 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 option, the 2741 Mode options, and the Word Processor options. It is also required for addition of the controllable accessory paper handling 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 cooling 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 distribution 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 customer 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. These jumpers and resistors are described in subsection 4.4 of this manual. 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 spaced printing by executing the ESC P
sequence.

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 proportional 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 0-5 Size of offset (64 units maximum) (one unit = 1/120")
    Bit   6   Sign of offset (1 = negative)

If a negative offset (smaller character size) is desired, bit 6 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 noncontrol 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 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 if the WP Enhancement option is installed. 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			Command Description
(1)	(2)	(3)	
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 nor-
         mal 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 deci-
       mal 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) Diag-
nostics.

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-1, 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					•

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 present.

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.

T1 MIN ≥ 50μSEC
    MAX ≤ I SEC (SELF-TEST)
    AVG. ≈ 150μSEC

T2 5μSEC

T3 100μSEC

T4 = TIME REQUESTED STATUS
     AVAILABLE DETERMINED BY
     HOST COMPUTER.
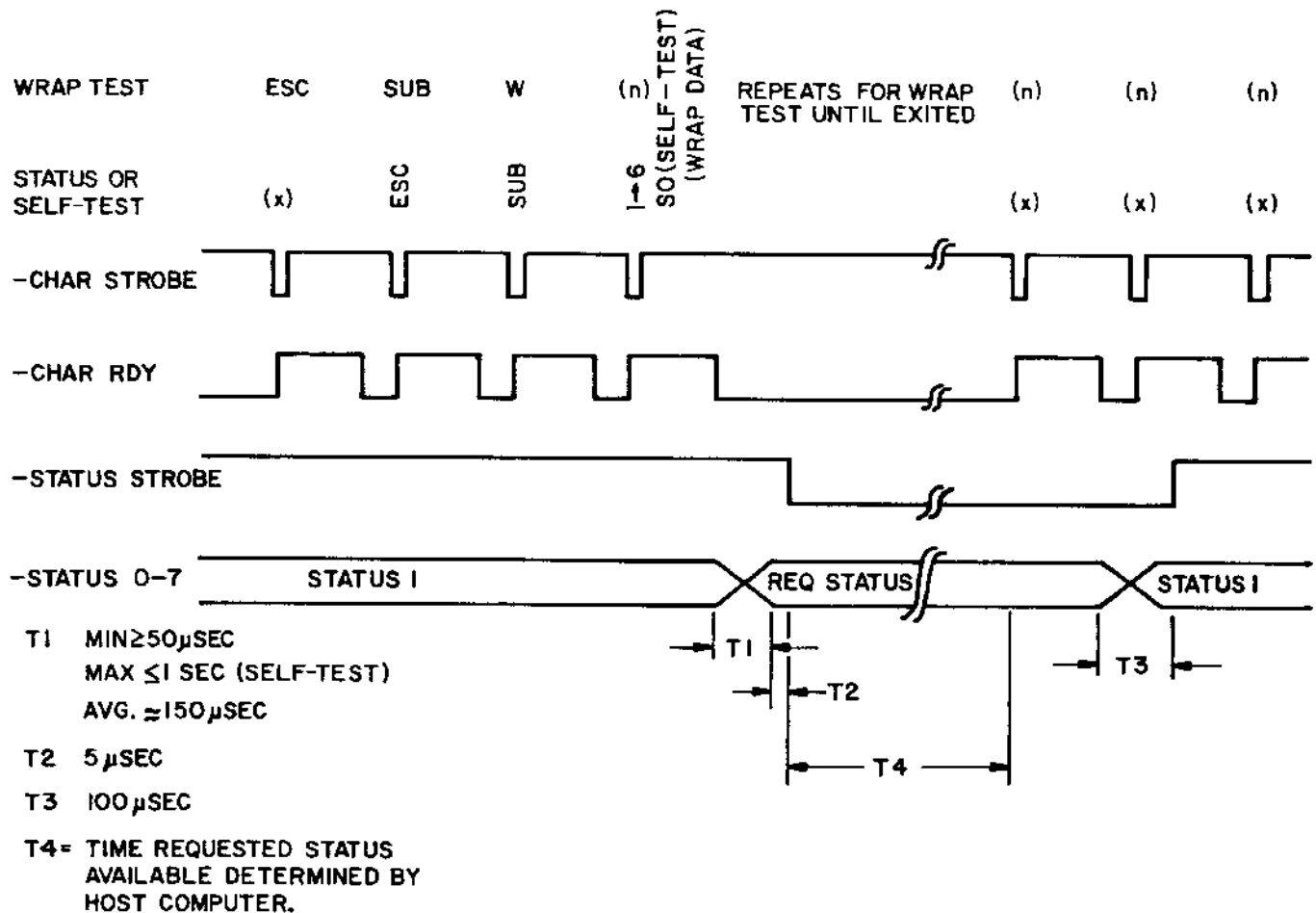
(n) = WRAP DATA
(x) = DON'T CARE

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**

ESC SUB 6 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   Uppercase Only Key
    4   Double Line Feed Key
    5   Load EROM Key
    6   Always 0
    7   **Parity Bit or Printer Rdy**

ESC SUB SO 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**

ESC SUB 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.

ESC SUB W (n) 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.

.

DIAGRAM ZONE COORDINATES

COMPONENT IDENTIFIER and PCB LOCATION CODE

DEVICE TYPE NO.

SPECIAL VOLTAGE CONNECTION

COMMON VOLTAGE CONNECTIONS

INTERFACE CONNECTOR

TWISTED PAIR SHIELDED

SLIP-ON PCB CONNECTORS

CIRCUIT CONTINUED FROM PAGE INDICATED

CIRCUIT CONTINUED ON PAGE INDICATED

PLUG TYPE PCB CONNECTOR

CABLE DIAGRAM PAGE NO.

TEST POINT

ALTERNATE PCB EDGE CONNECTORS

IDENTICAL COMPONENTS MULTIPLE PCB LOCATIONS

OUTPUT IC PIN NO

SPECIAL CIRCUIT GROUND

SIGNAL POLARITY INDICATES ACTIVE LEVEL

OPTIONAL-FOR CLARITY WHEN NEEDED

DEVICE PIN NUMBER

DEVICE REFERENCE DESIGNATOR

DRAWING ZONE WHERE DESTINATION SYMBOL IS LOCATED (INCLUDED ONLY IF DRAWING IS ZONED)

SHEET NUMBER

+DATA STROBE

FIG 7-0 DRIVE PCB ASSEMBLY, STD

44055-XX Rev A

DIAGRAM PAGE NO. WHERE APPL

ALTERNATE DIAGRAM TITLE SCHEMES

Diablo Systems Incorporated

Figure 7-0
Logic Drawing
Notation

TITLE
PCB ASSY DRIVE

44055-XX
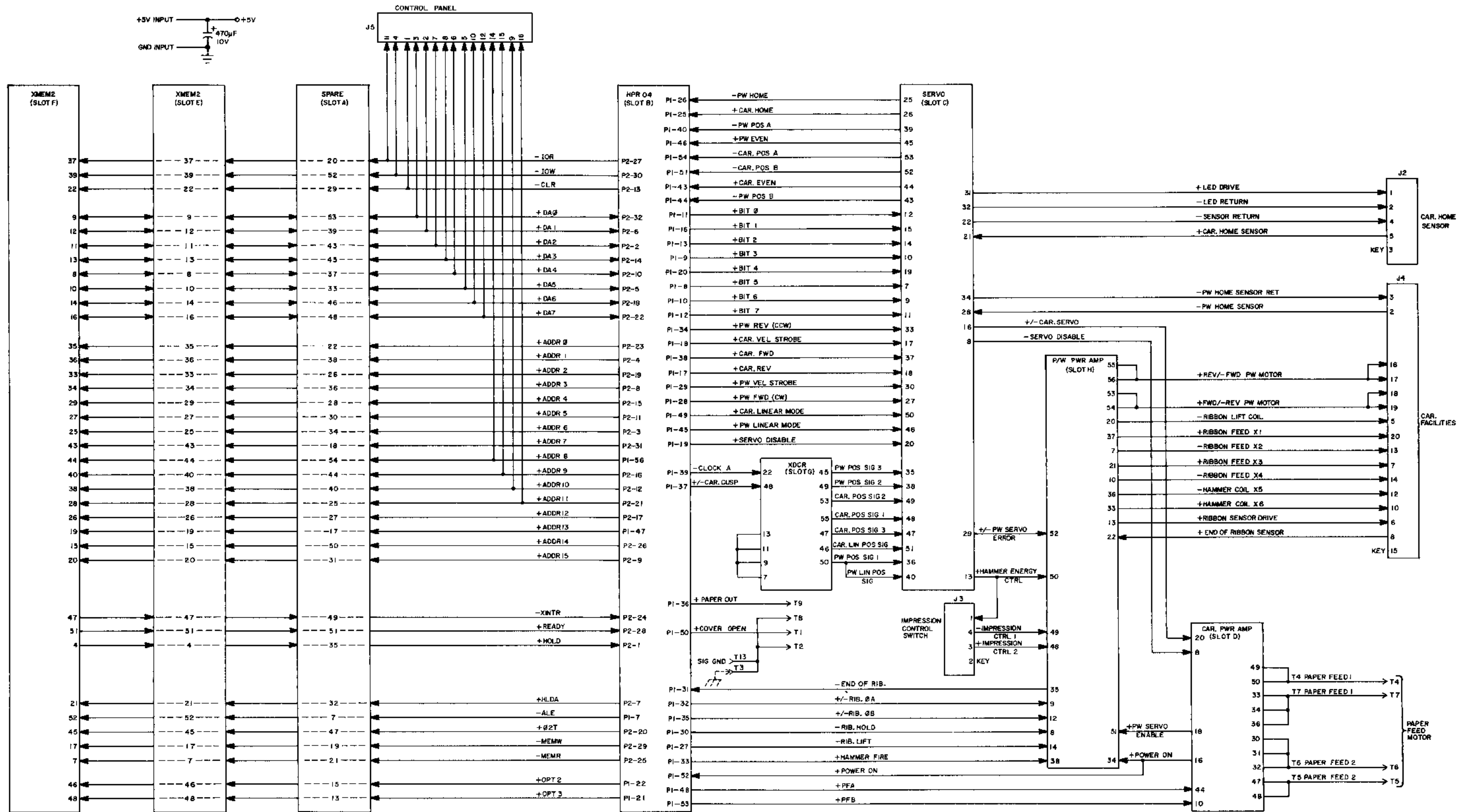
Figure 7-1
Motherboard PCB Assy
#301390-XX   Rev D

Figure 7-1 Motherboard PCB Assy
            #301390-XX   Rev D

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

 A   A3961   01   As released
 B   B1048   01   Documentation change only
 C   B1072   02   Allow use of -02 etch. New layout to relieve signal
                   problems
 D   B1592   02   Document change only. Change tab bend angle callout.

SOLID STATE COMPONENTS USED:

        (No solid state components listed)
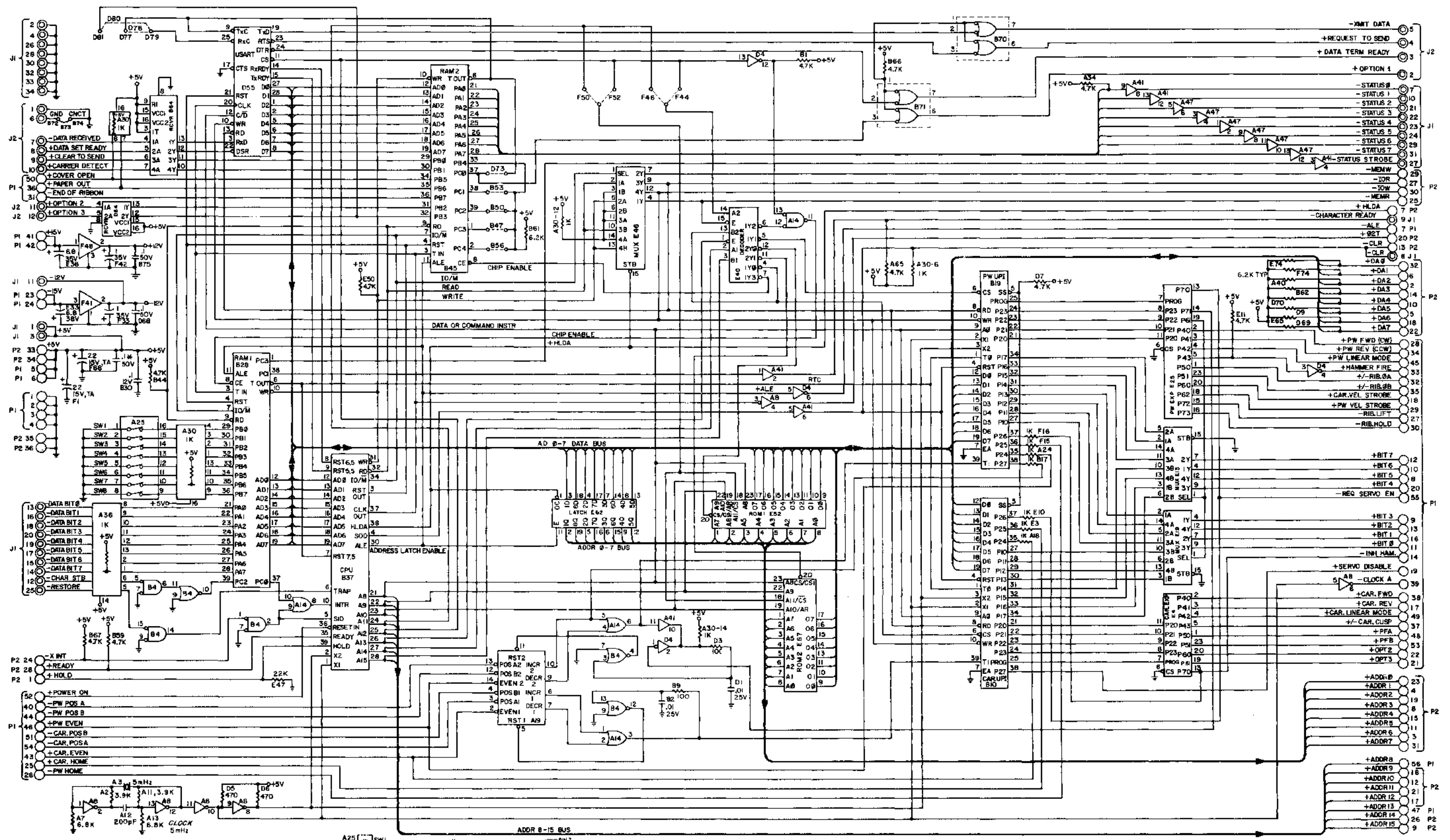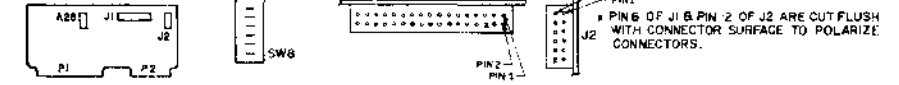
Figure 7-2
HPRO4 Processor PCB Assy
#301410-XX   Rev H

Figure 7-2   HPRO4 Processor PCB Assy
           #301410-XX   Rev H

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

A   A3963   02   As released for configurations -03 thru -08
B   B1048   02   Add HS UPI's, Switch A25 designations, -02
                    ROM changes, and option kits
C   B1095   02   Rev B program. Change pull up resistors to
                    6.2K to raise thresholds.
D   B1145   02   Release -97 configuration - masked ROMs
E   B1207   03   Allow use of -03 etch with pluggable LSI's
F   B1787   03   Document change only. Program change to aleviate a
                    noise problem.
G   B1946   03   New base program includes numerous internal "house
                    keeping" changes; new Auto CR action, enables switch
                    A25-5 for baud rate selection, jumper selection of
                    12" (european) paper length, etc.
H   B2093   03   Replace oscillator circuit resistors A2/A11 with 3.9K
                    and A7/A13 with 6.8K to eliminate a power on reset
                    problem.

SOLID STATE COMPONENTS USED:

IC's   100176-02   B37
        100236-02   B10   (carriage)
        100310-01   B10   (masked carriage)
        100237-02   B19   (P W)
        100311-01   B19   (masked PW)
        100234-02   E52   (EROM-1 program)
        100319-01   E52   (32K ROM basic program)
        100235-02   E67   (EROM-2 program)
        8155   B28,B45
        8243   E4,E25
        7404   A8
        74LS05   D4
        74LS32   A14
        74LS139   E40
        74LS257   E13,E19,E46
        74LS373   E62
        8837   B4
        13235-03   A19
        Resistor Pack, 1K   A30,A36
        7417   A41,A47
        8251A   D55
        75150P   B70,B71
        75154   B64,D64
        78M12C   +12V   F48
        79M12C   -12V   F41

Diodes   (No components listed)
Transistors   (No components listed)

TABLE 1		
Switch Dedication without Cont Pnl	Switch A25	Switch Dedication with Cont Pnl
Self Test	#1	Enhanced 2741
10 Pitch	#2	ETX/ACK Enable
DC1/DC3 Enable	#3	DC1/DC3 Enable
Parity Enable	#4	Correspondence
Even Parity	#5	Baud Rate Select See Table 2
Full Duplex	#6	Keyboard) See
120) Baud Rate) See	#7	Mode } Table
30) Select }Table 3	#8	Select } 4

TABLE 2			
HPRO4 SW5	Control Panel Speed Select 30	120	Baud Rate Selected
OFF	ON	ON	110 Baud (ASCII) 134.5 Baud (2741)
OFF	ON	OFF	300 Baud
OFF	OFF	OFF	600 Baud
OFF	OFF	ON	1200 Baud
ON	ON	ON	2000 Baud
ON	ON	OFF	2400 Baud
ON	OFF	OFF	4800 Baud
ON	OFF	ON	9600 Baud

TABLE 3		
HPRO4 SW7 120	SW8 30	Baud Rate Selected
ON	ON	110 (ASCII) 134.5 (2741)
OFF	ON	300
OFF	OFF	600
ON	OFF	1200

TABLE 4			
HPRO4 Switch A25 -6	-7	-8	Keyboard Mode
OFF	OFF	OFF	(Default to Typ Pr)
ON	OFF	OFF	Typewriter Paired
OFF	ON	OFF	Logical Bit Paired
ON	ON	OFF	APL
OFF	OFF	ON	French AZERTY
ON	OFF	ON	German
OFF	ON	ON	Scandanavian
ON	ON	ON	Norsk

JUMPER	OPTIONS
B47	Enable Metal Print Wheel, Series 1650
B50	N/A
B53	Enable Metal Print Wheel/12" Paper Length, Series 1650
B56	Enable 12" Paper Length, Series 1640
B73	RS-232-C Protective Ground
D73/D80	Synchronous System
D78	Asynchronous System
F46/F52	2 K ROMs
F44/F50	4 K ROMs
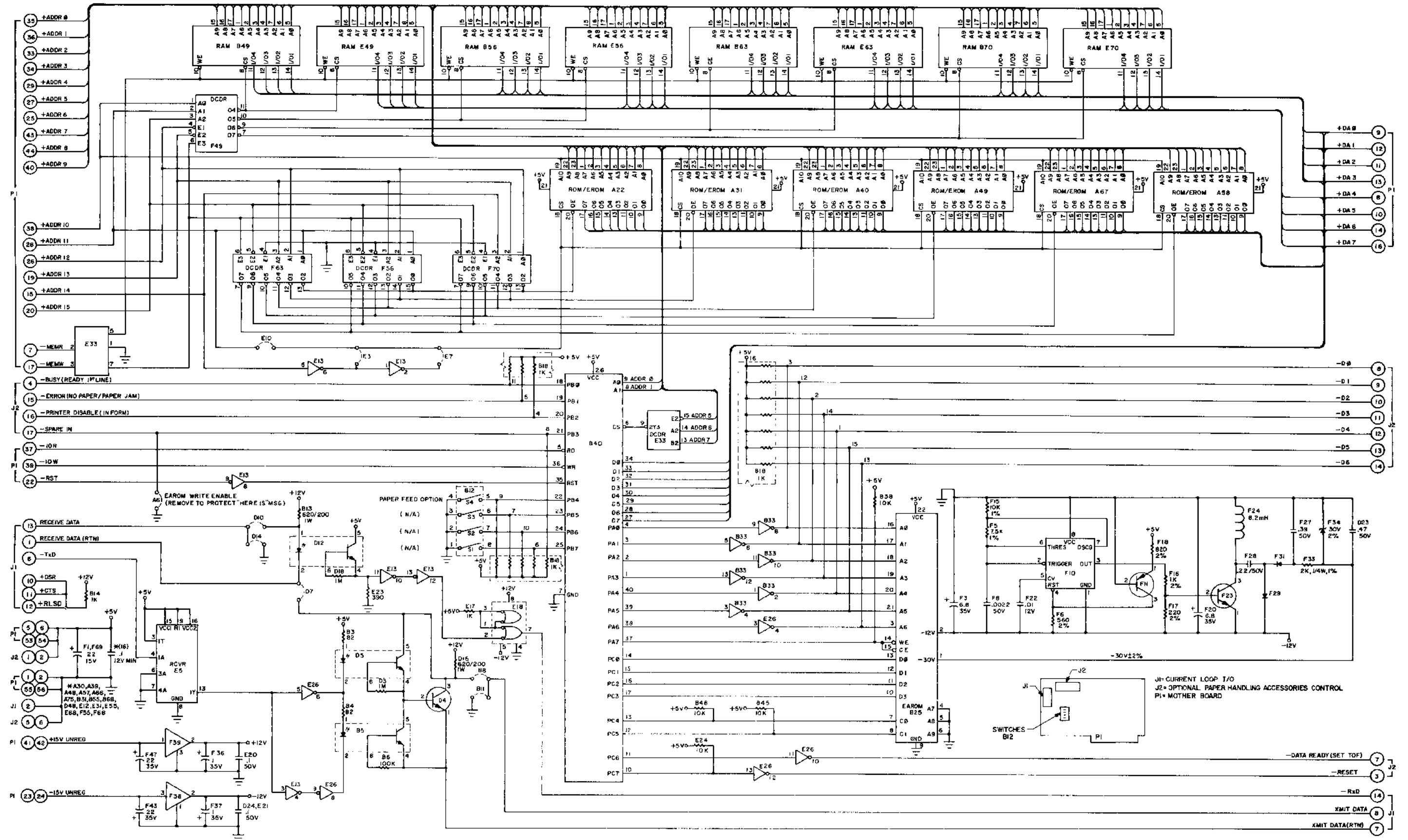
Figure 7-3
XMEM2 Expanded Memory PCB Assy
#400664-XX   Rev C

Figure 7-3 XMEM2 Expanded Memory PCB Assy
            #400664-XX   Rev C

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

 A   B1046   01   B/M as released
 B   B1071   01   Documentation changes only
 C   B1139   01   Release options programs

SOLID STATE COMPONENTS USED:

IC's   400598-01   A22
         100248-01   B25
         400710-01   A67
         100249-02   B49,B56,E49,E56
         7405   B33,E26
         74LS14   E13
         74LS138   F49,F63
         74LS139   E33
         75150P   E18
         75154   E5
         TIL 117   B5,D5,D12
         8255A   B40
         555   F10
         10213-12 -12V   F38
         42391-12 +12V   F39
         Resistor Pack 1K   B18

Diodes   1N4454   F29,F31
         1N5256 Zener, 30V   F34

Transistors
         2N3644   F11
         2N2219A   D4,F23
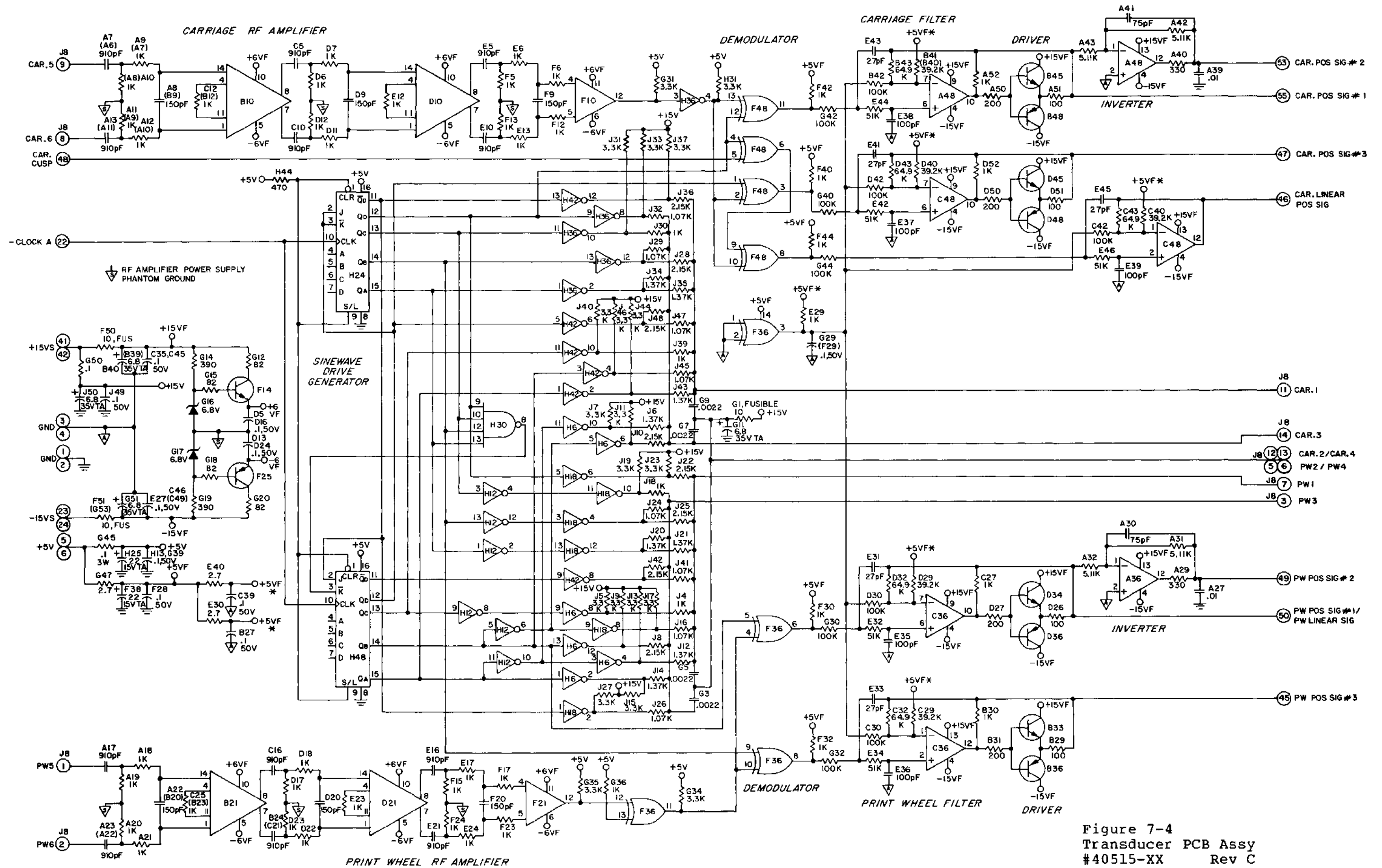
Figure 7-4
Transducer PCB Assy
#40515-XX   Rev C

Figure 7-4   Transducer PCB Assy
             #40515-04   Rev C

REVISION HISTORY:

REV   ECO#   ETCH   CONFIGURATION

  A   A1720   03   As Released to 1640/1650 Series
  B   B1163   03   Documentation changes only
  A   B1470   03   Release -04 (ESD) version
  B   B1761   03   Replace connectors J8A and J8B with single connector
                    J8. Renumber affected pin outs
  C   B2092   04   Release -04 etch. New layout to accommodate auto
                    component insertion. New locator codes only - no
                    circuit or value changes. Old codes shown in par-
                    enthesis.

SOLID STATE COMPONENTS USED:

IC's   7404   H12
          7420   H30
          7406   H6,H18,H36,H42
          74195   H24,H48
          7486 (ICEX)   F36,F48
          72747   A36,A48,C36,C48
          733   B10,B21,D10,D21
          LM319N   F10,F21

Diodes   1N4763A Zener 6.8V   G16,G17

Transistors
          2N5320   F14
          2N5322   F25
          2N4401   B33,B45,D34,D45
          PN3644   B36,B48,D36,D48
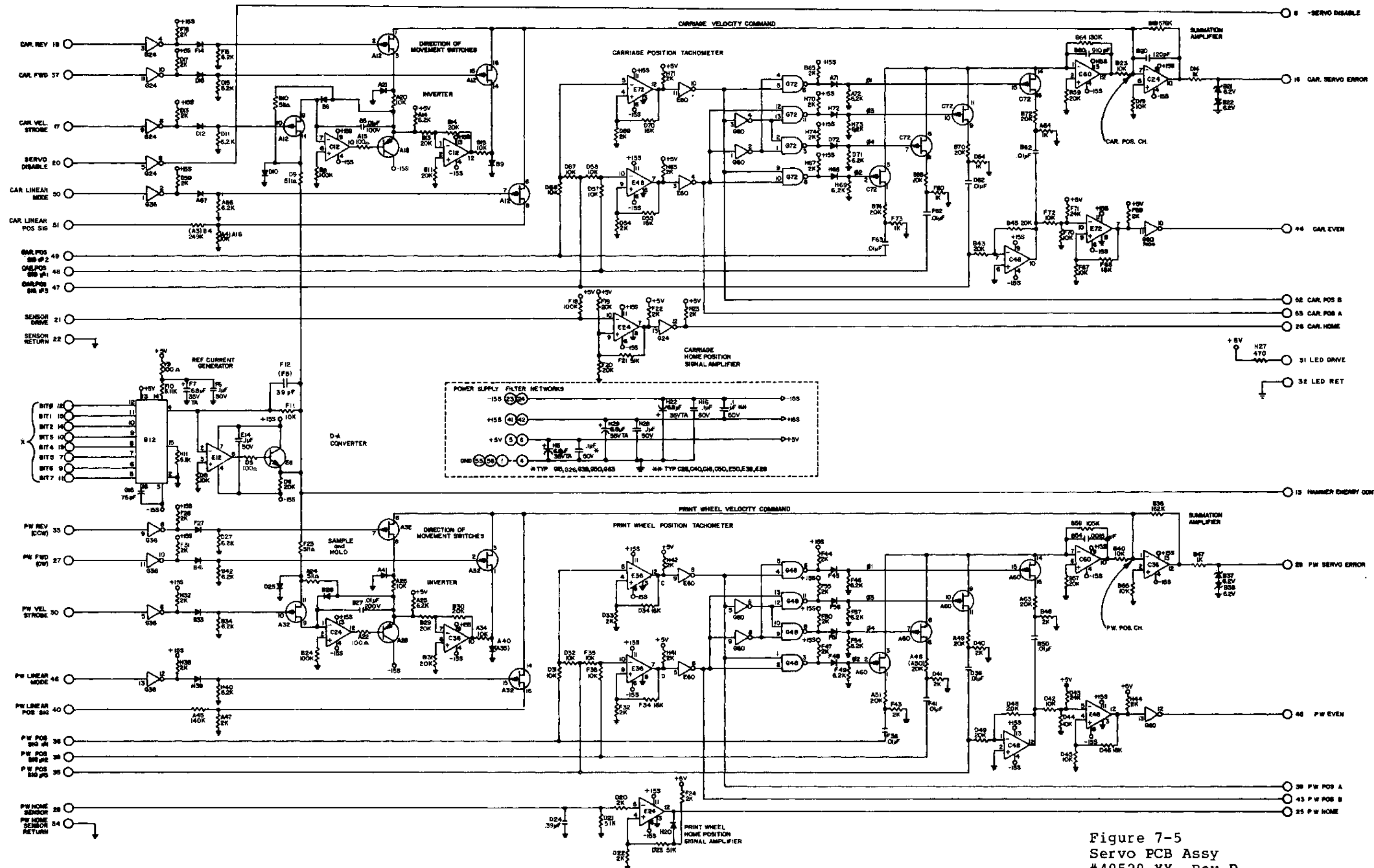
Figure 7-5
Servo PCB Assy
#40520-XX Rev P

Figure 7-5 Servo PCB Assy
         #40520-04 Rev P

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

 N A1504   05   As released to 1640/1650 Series
 P B2092   06   Release -06 etch. New layout to accommodate auto
                  insertion of components. New locator codes only -
                  no circuit or value changes. Old codes shown in
                  parenthesis.

SOLID STATE COMPONENTS USED:

IC's   7404   E60,G60
        7406   G24,G36
        7426   G48,G72
        1741   E12
        747 C   C12,C24,C36,C48
        8041   A12,A32,A60,C72
        1408L-6   G12
        LM319N   E24,E36,E48,E72
        747 C (low offset) C60

Diodes 1N5234B Zener 6.2V B21,B22,B37,B38
        1N4454   A21,A35,A41,A67,A71,B6,B9,B26,B33,B41,
                          D10,D12,D16,D25,D72,F14,F27,F45,F48,F51,
                          F56,H20,H39,H68,H72

Transistors
        2N4401   E6
        PN3644   A18,A28
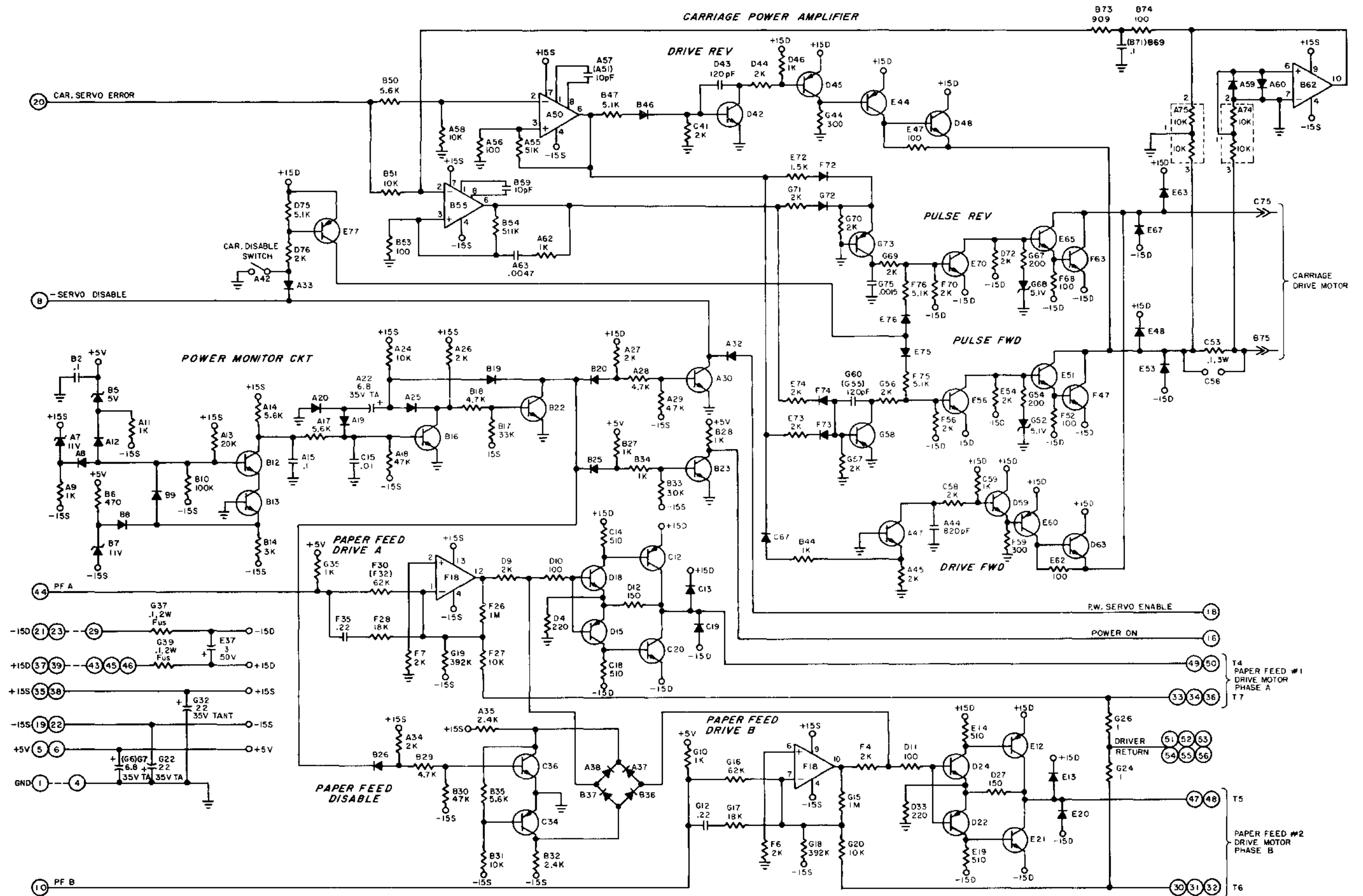
Figure 7-6
Car. Power Amp PCB Assy
#40525-XX   Rev C

Figure 7-6 Carriage Power Amplifier PCB Assy
          #40525-10   Rev C

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

 C   A3966   07   As released for 1640/1650 series
 D   B1613   07   Replace Instrumentation Resistor Module A70 with two
                   resistor modules, both at A70.
 A   B1308   07   Release ESD version as -09 configuration
 B   B1422   07   Add ESD insulator
 A   B1325   08   Release -08 etch as -10 configuration. Add capaci-
                   tors A51 and B59 at op amps A50 and B55. Replace
                   instrumentation resistor modules with Resistor Packs
                   A74 and A75.
 B   B1615   08   Documentation change only.
 C   B2152   09   Release -09 etch. New layout to accommodate auto
                   component insertion. New locator codes only - no
                   circuit or value changes. Old codes shown in par-
                   enthesis.

SOLID STATE COMPONENTS USED:

IC's   747 C   B62,F18
          748   A50,B55
          Resistor Pack 10K   A74,A75

Diodes   1N4733 Zener 5V   B5
          100138-01 Zener 11V   A7,B7
          1N5231B Zener 5.1V   G52,G68
          1N4454   A8,A12,A19,A20,A25,A32,A33.A37,A38,
                                A59,A60,B8,B9,B19,B20,B25,B26,B36,B37,
                                B46,C67,E75,E76,F72,F73,F74,G72
          1N4002   C13,C19,E13,E20
          1N5807   E48,E63
          1N5415   E53,E67

Transistors
          PN3644   C34,D15,D22,D45,D59,E77,G58,G73
          2N4401   A30,A47,B12,B13,B16,B22,B23,C36,D18,D24,
                                D42,E56,E70
          2N5320   E51,E65
          2N5322   E44,E60
          2N6103   D48,D63,F47,F63
          TIP41A   C20,E21
          TIP42A   C12,E12
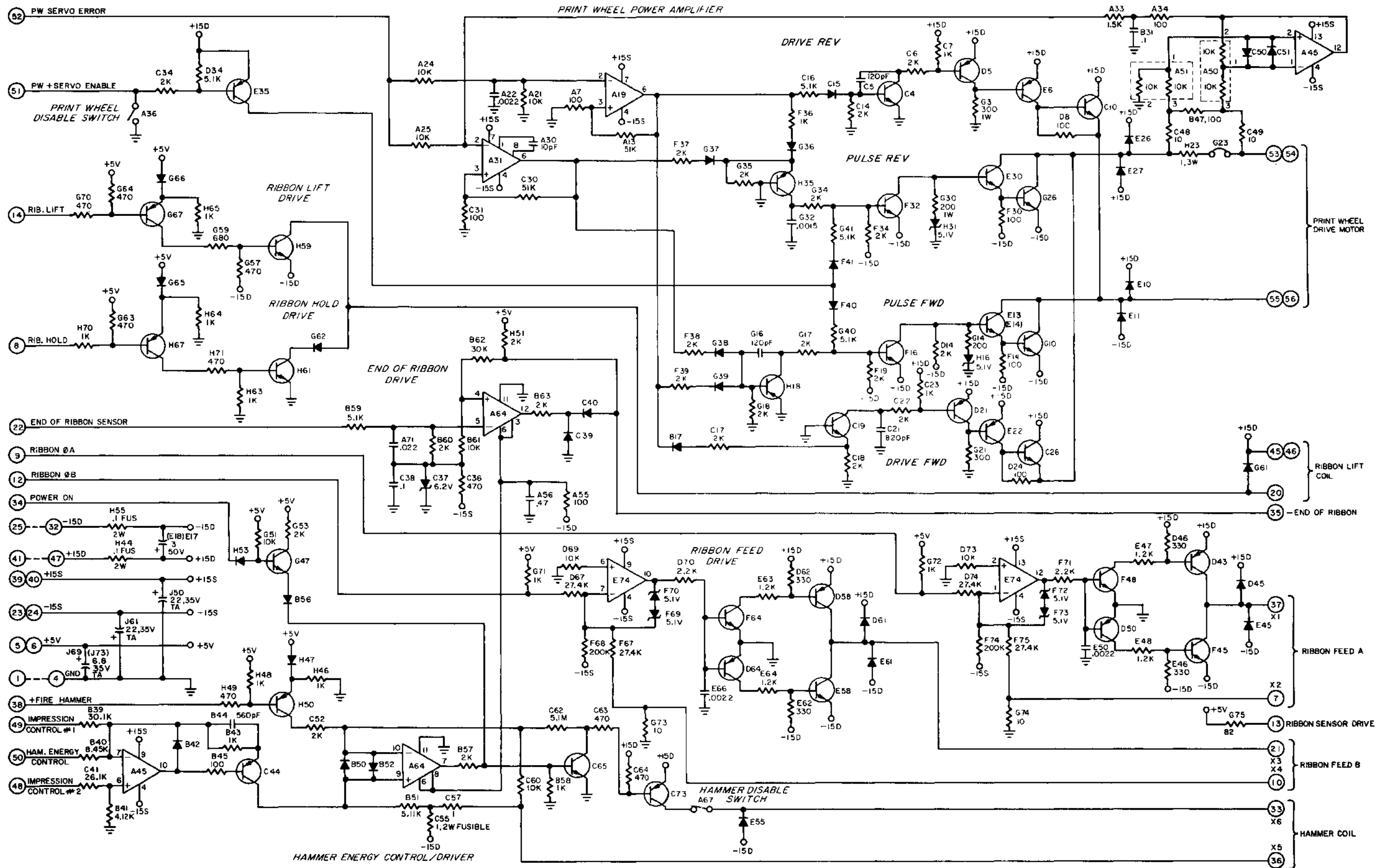
Figure 7-7a
P W Power Amp PCB Assy, 1640
#40530-XX   Rev B

Figure 7-7a Print Wheel Power Amplifier PCB Assy, 1640 Series
              #40530-10   Rev B

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

 C   A3966   06   As released for 1640 Series
 D   B1613   06   Replace resistor pack A53 with two resistor packs
                   at A53.
 A   B1308   06   Release -09 configuration as ESD version.
 B   B1422   06   Add ESD insulator
 A   B1325   08   Release -08 etch as -10 configuration. Add capacitor
                   A30 at op amp A31. Replace instrumentation resistor
                   pack A53 with two packs at A50 and A51.
 B   B2152   09   Release -09 etch. New layout to accommodate auto
                   component insertion. New locator codes only - no
                   circuit or value changes. Old codes shown in par-
                   enthesis.

SOLID STATE COMPONENTS USED:

IC's   747 C   A45,E74
        748   A19,A31
        LM319N   A64
        Resistor Pack 10K   A50,A51

Diodes 1N4454   B17,B42,B50,B52,B56,C15,C39,C40,C50,C51,
                             F40,F41,G36,G37,G38,G39,G65,G66,H47,H53
        1N4002   D45,D61,E45,E55,E61,G61,G62
        1N5231B Zener 5.1V   F69,F70,F72,F73,H16,H31
        1N5415   E10,E11,E26,E27
        1M6.2ZS2 Zener 6.2V C37

Transistors
        PN3644   C44,D5,D21,D43,D50,D58,D64,E35,G67,H18,
                             H35,H50,H67
        2N4401   C4,C19,C65,E58,F16,F32,F45,F48,F64,
                             G47,H61
        2N5322   E6,E22
        2N5320   E14,E30,H59
        2N6103   C10,C26,G10,G26
        TIP125   C73
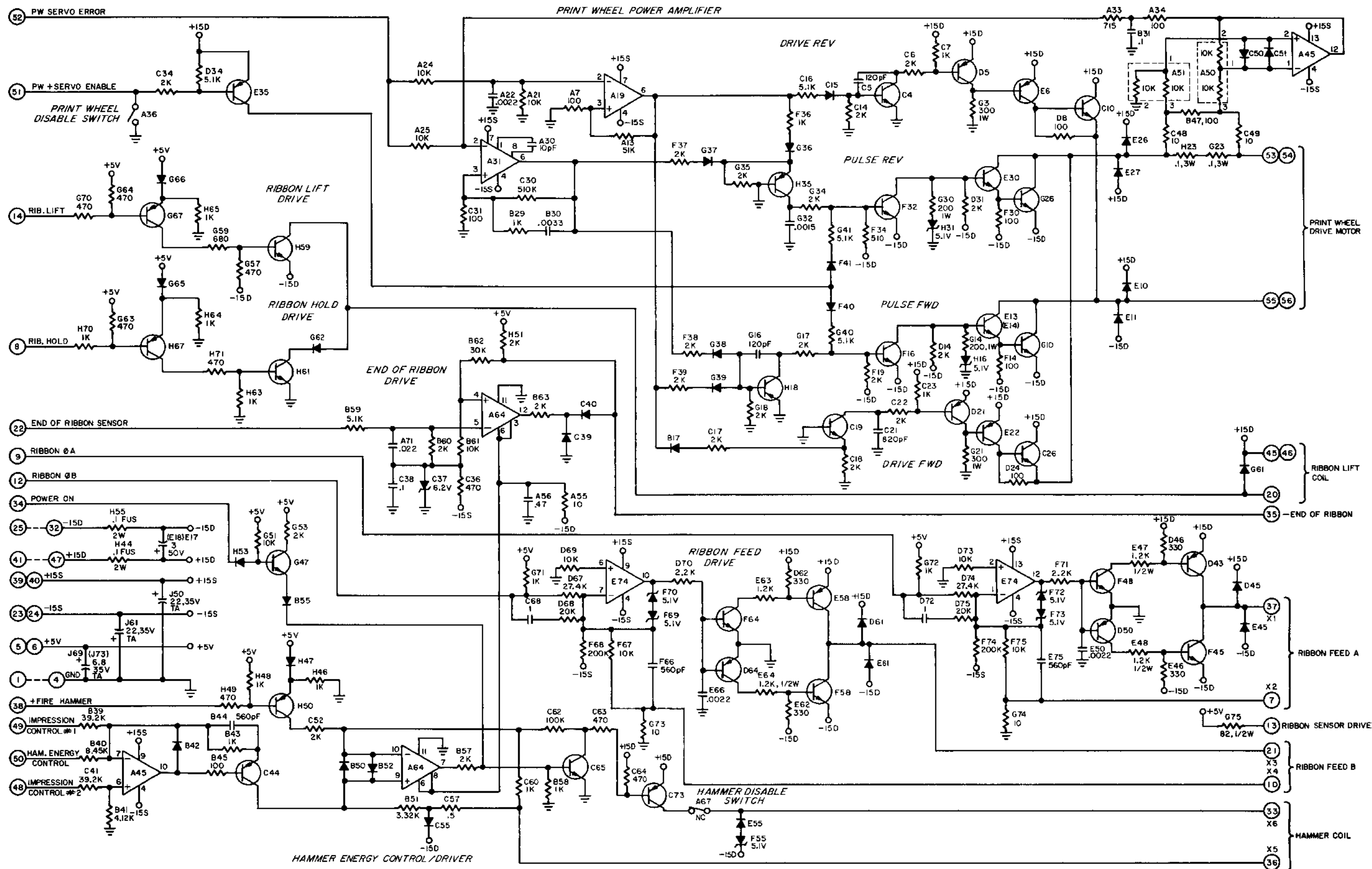
Figure 7-7b
P W Power Amp PCB Assy, 1650
#40730-XX   Rev B

REVISION HISTORY:

REV	ECO#	ETCH	CONFIGURATION
C	A3966	03	As released for 1650 Series
D	B1613	03	Replace resistor pack A53 with two resistor packs at A53.
A	B1308	03	Release -09 configuration as ESD version
B	B1422	03	Add ESD insulator
A	B1325	04	Release -04 etch as -10 configuration. Add capacitor A30 at op amp A31. Replace resistor pack A53 with two resistor packs at A50 and A51.
B	B2152	05	Release -05 etch. New layout to accommodate auto component insertion. New locator codes only - no circuit or value changes. Old codes shown in parenthesis.

SOLID STATE COMPONENTS USED:

IC's	747 C	A45,E74
	748	A19,A31
	LM319N	A64
	Resistor Pack 10K	A53

Diodes	1N4454	B17,B42,B50,B52,B55,C15,C39,C40,C50,C51, F40,F41,G36,G37,G38,G39,G65,G66,H47,H53
	1N4002	C55,D45,D61,E45,E55,E61,G61,G62
	1N5231B Zener 5.1V	F69,F70,F72,F73,H16,H31
	1N5415	E10,E11,E26,E27
	1N5234B Zener 6.2V	C37
	1N5338A Zener 5.1V	F55

Transistors	PN3644	C44,D5,D21,D43,D50,D64,E35,E58,G67,H18, H35,H50,H67
	2N4401	C4,C19,C65,F16,F32,F45,F48,F58,F64,G47, H61
	2N5322	E6,E22
	2N5320	E14,E30,H59
	2N6103	C10,C26,G10,G26
	TIP125	C73
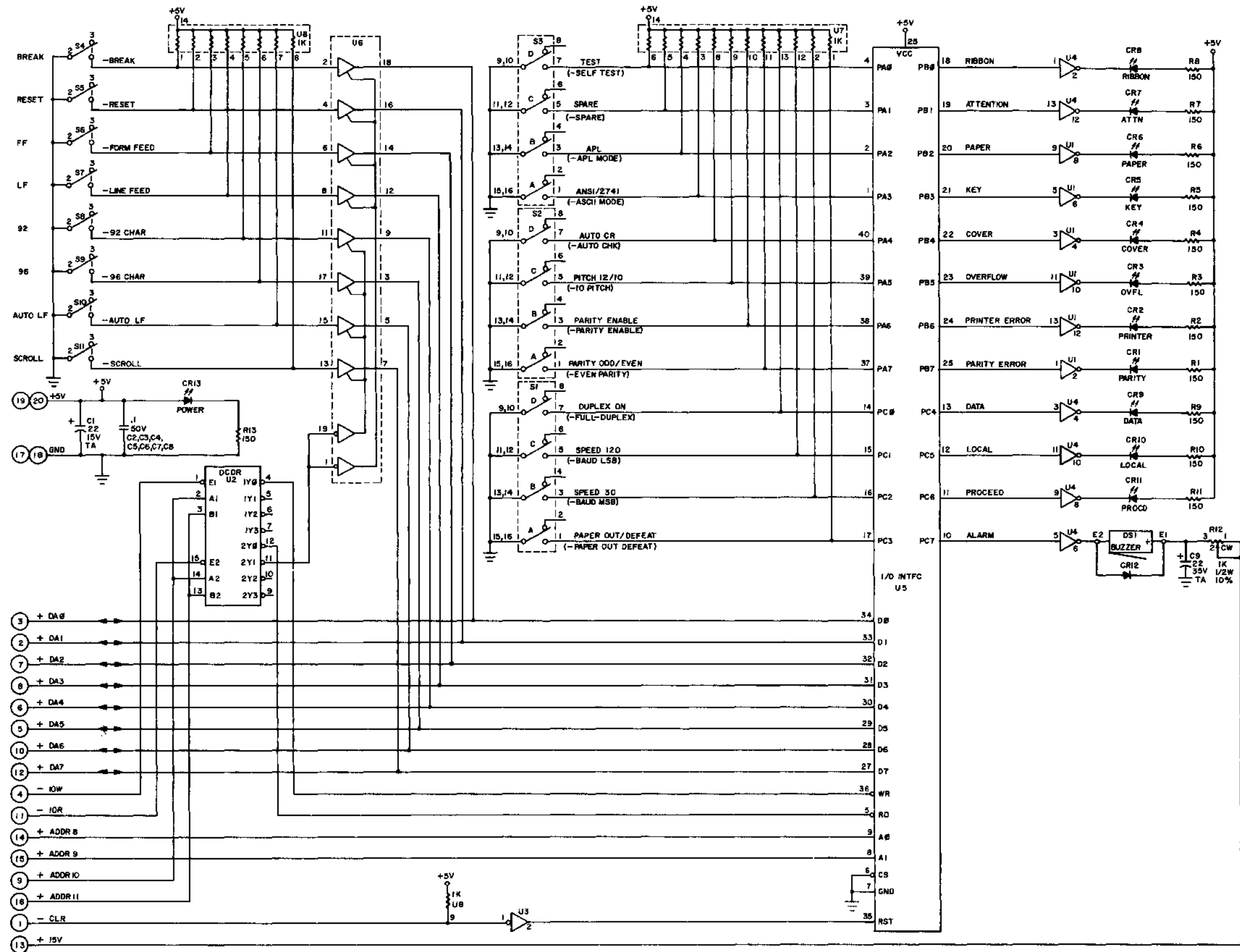
Figure 7-8
H4CPN Control Panel PCB Assy
#400568-01   Rev B

Figure 7-8   H4CPN Control Panel PCB Assy
             #400568-01   Rev B

REVISION HISTORY:

REV   ECO#   ETCH   CONFIGURATION

 A   A4208   01   As released
 B   B1856   01   Document change only.

SOLID STATE COMPONENTS USED:

IC's   74LS04   U3
         7416   U1,U4
         74LS139   U2
         74LS244   U6
         8255A   U5
         Resistor Pack 1K   U7,U8

Diodes   42222-XX   CR11
         1N4454   CR12

Transistors   (No components listed)
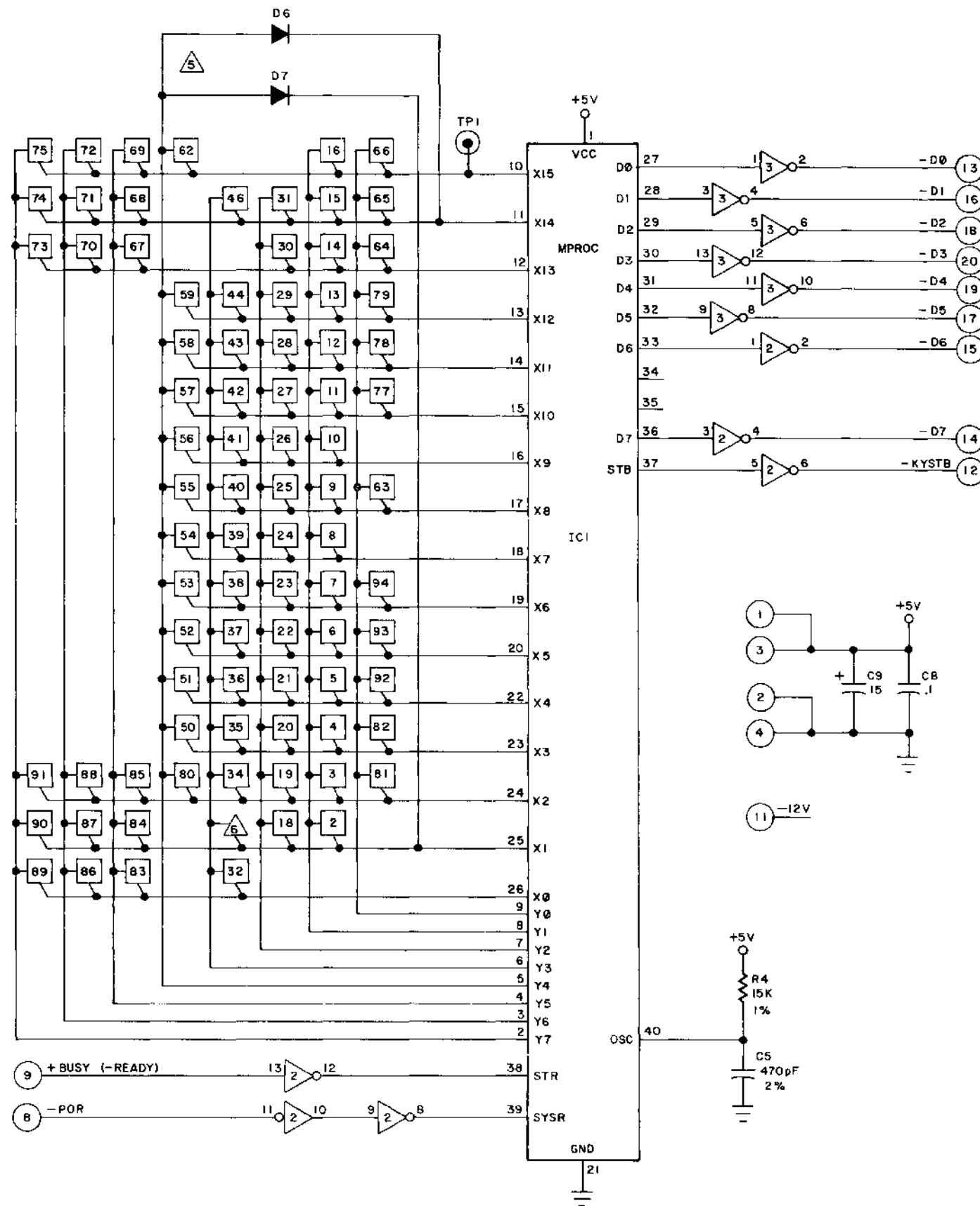
NOTES: UNLESS OTHERWISE SPECIFIED,
1. ALL RESISTANCES SPECIFIED IN OHMS.
2. ALL RESISTORS ARE 1/4 WATT, ±5%.
3. ALL CAPACITANCE SPECIFIED IN MICROFARADS.
4. +5V TO PIN 14 OF 14-PIN IC, GND TO PIN 7;
   +5V TO PIN 16 OF 16-PIN IC, GND TO PIN 8.
⚠5 DIODES 6 AND 7 ARE INSTALLED ON KEYBOARD
   BY THE MANUFACTURER FOR DIAGNOSTIC CODE
   CHECKS OF STATIONS 48 AND 61.
⚠6 SECRETARY SHIFT STATIONS 33, 49, AND 60
   ARE LOCATED HERE.

Figure 7-9a
Keyboard PCB Assy, M
#400285-01   Rev A

Figure 7-9a Keyboard PCB Assy, M
#400285-01   Rev A

REVISION HISTORY:

REV ECO#   ETCH   CONFIGURATION

 A   A4008   --   As released

         (This entire assembly is installed as a single part)
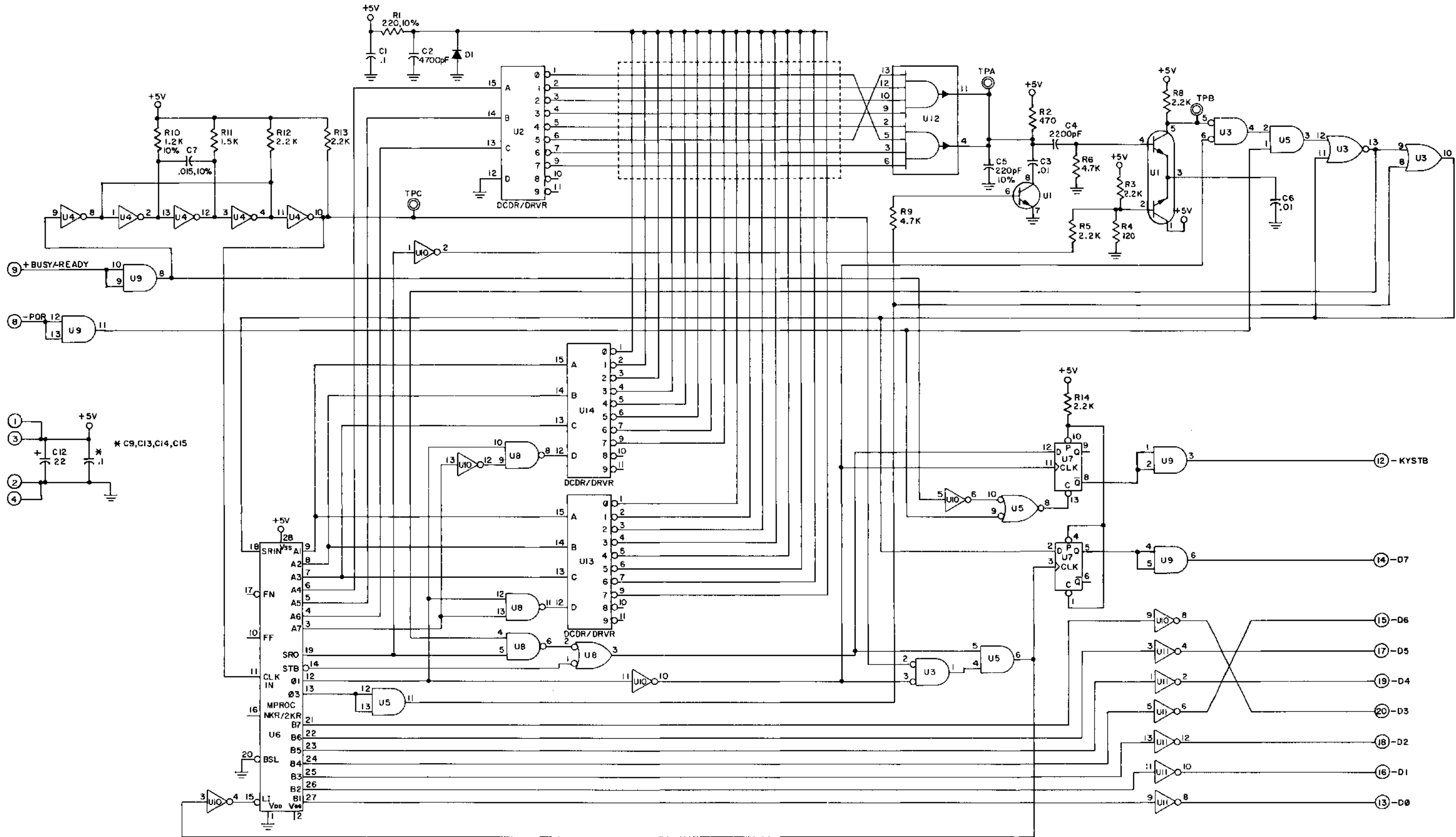
Figure 7-9b
Keyboard PCB Assy, C
#301658-01   Rev B

Figure 7-9b Keyboard PCB Assy, C
             #301658-01   Rev B

REVISION HISTORY:

REV ECO#   ETCH CONFIGURATION

 A   B1103   --   As released
 B   B2145   --   Update schematic to match keyboard as built.

      (This entire assembly is installed as a single part)
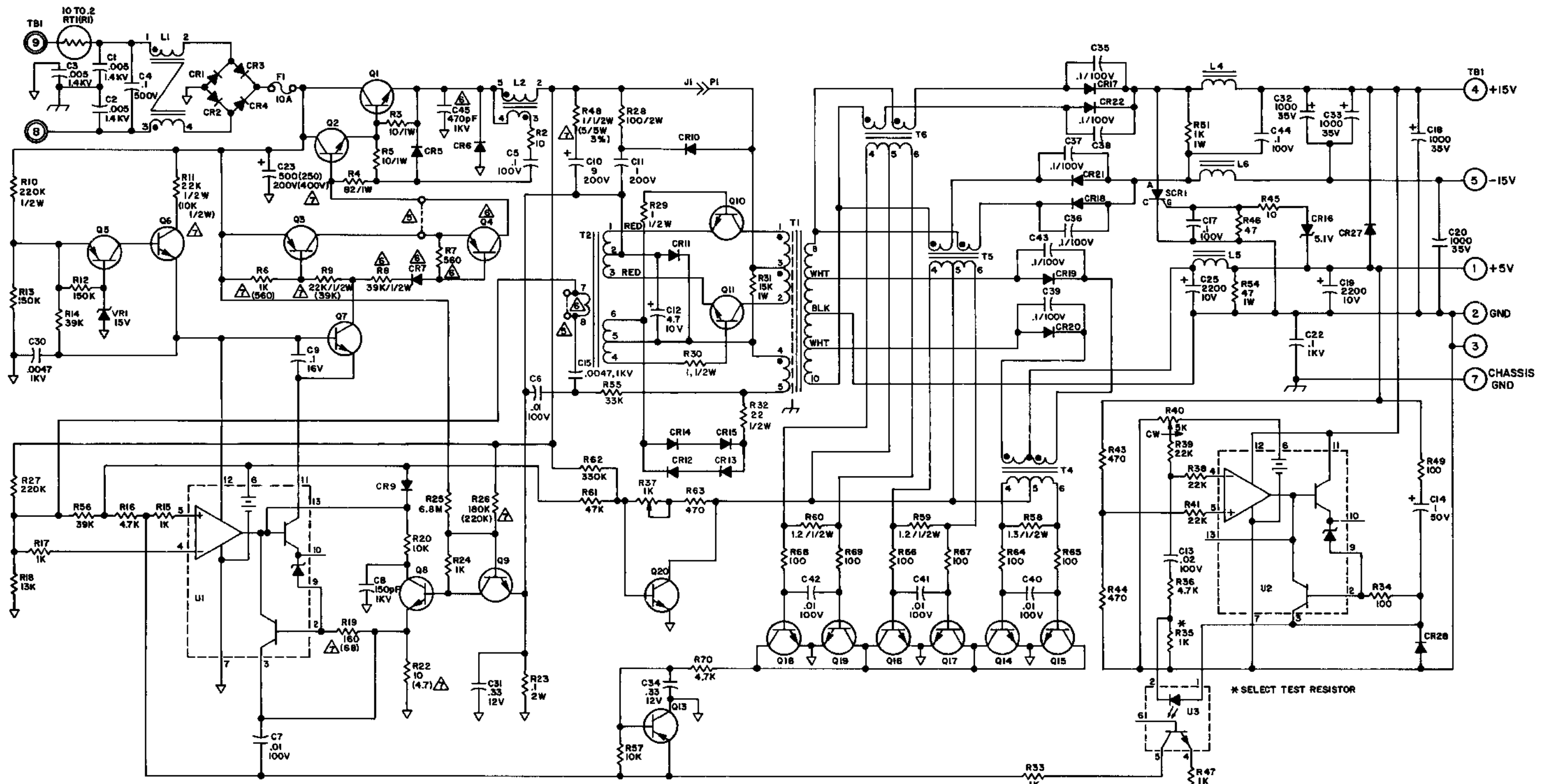
NOTES:(UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTANCES SPECIFIED IN OHMS.
2. ALL RESISTORS ARE 1/4 WATT,±5%.
3. ALL CAPACITANCE SPECIFIED IN MICROFARADS.
4. ⏚ DENOTES PRIMARY CIRCUIT COMMON RETURN.

⚠ INSTALL JUMPER FOR 115V(-01) OPERATION ONLY.

⚠ INSTALL COMPONENTS FOR 220V(-02) OPERATION ONLY.

⚠ USE COMPONENT VALUES IN PARENTHESES FOR 220V(-02) OPERATION ONLY.

Figure 7-10a
Internal Power Supply Assy, B
#26021-XX   Rev D

Figure 7-10a Internal Power Supply Assy, B
               #26021-XX   Rev D

REVISION HISTORY:

REV ECO# ETCH CONFIGURATION

 D A4251 (NA) As released for 1640/1650 Series

SOLID STATE COMPONENTS USED:

IC's   723C   (115V)   V1,V2
         723C   (230V)   A1,A2
         MCT-2E   (115V)   V3
         MCT-2E   (230V)   A3

Diodes   C122F-1   SCR1
         MR502   (115V)   CR1,CR2,CR3,CR4
         MR504   (230V)   CR1,CR2,CR3,CR4
         MR820   CR17,CR18,CR21,CR22
         MR852   (115V)   CR6
         MR824   (230V)   CR6
         S1F2   (115V)   CR7,CR10
         S1F2   (230V)   CR7
         SR3142   CR19,CR20
         1N965 Zener 15V (115V) VR1
         1N965 Zener 15V (230V) CR8
         1N4001   CR11,CR27
         1N4148   CR5,CR9,CR12,CR13,CR14,CR15,CR28
         1N751 Zener 5.1V (115V) VR2
         1N751 Zener 5.1V (230V) CR16

Transistors
         MPS-U60   Q3,Q4
         MPS-5172   Q8,Q9,Q14,Q15,Q16,Q17,Q18,Q19,Q20
         SJ7280 (matched pair) Q10/Q11
         SJ7280   (115V)   Q1
         2N6545   (230V)   Q1
         TIP-47   (115V)   Q2
         TIP-49   (230V)   Q2,Q6
         MPSA43   (115V)   Q6,Q7
         2N3439   (230V)   Q7
         2N4126   Q5,Q13
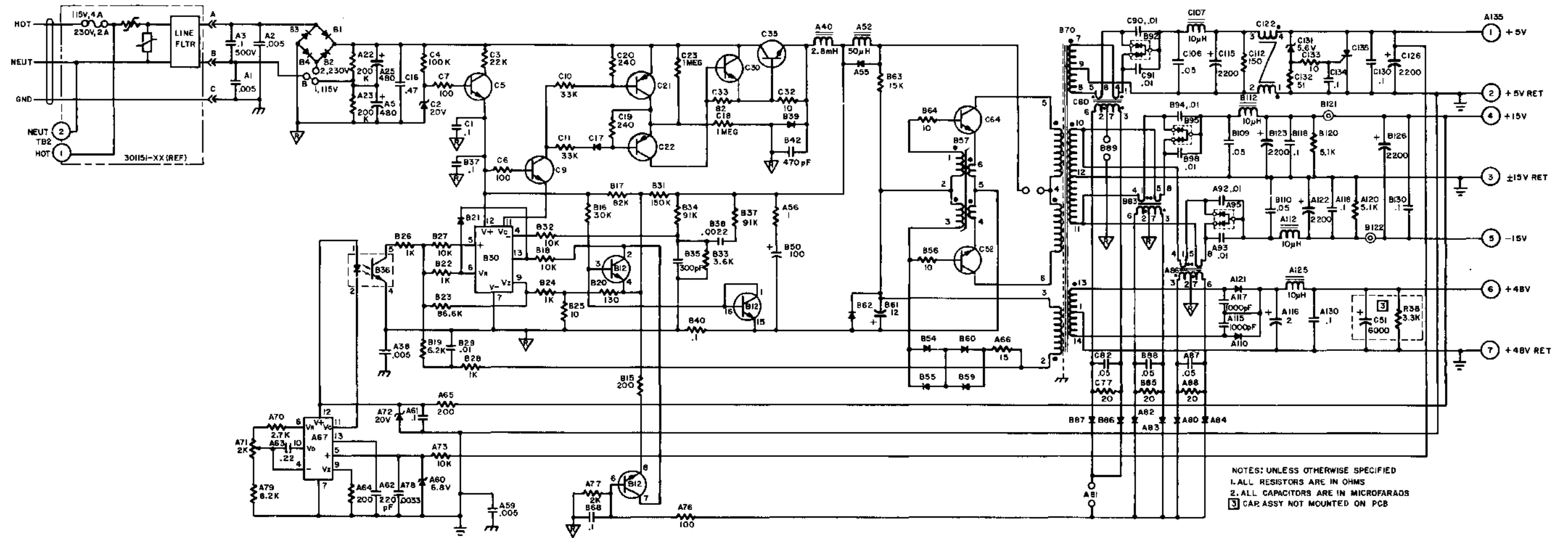
Figure 7-10b
Internal Power Supply Assy, U
#301155-XX   Rev D

Figure 7-10b Internal Power Supply Assy, U
              #301155-XX   Rev D

REVISION HISTORY:

REV. ECO# ETCH CONFIGURATION

A B1179 -- As released.
B B1312 -- New PCB layout and other changes for VDE approval.
C B1683 -- Documentation changes only.
D B2241 -- New PCB layout. Add 91K resistor B37 and .0022 mFd
              capacitor B38, and several mechanical changes.

SOLID STATE COMPONENTS USED:

IC's   723   A67,B30
        TIL-116   B36

Diodes MR506   B1,B2,B3,B4
        MR822   A110,A121
        MR854   A55,B39
        100098-01 Zener 20V A72,C2
        100099-01 Zener 5.6V C131
        R711XA   A95
        R711X   B95
        3020T   B92
        10329 Zener 6.8V   A60
        1N4454   A80,A82,A83,A84,B21,B54,B55,B59,B60
                           B62,B86,B87
        1N4936   C17

Transistors
        MPSA93   C21,C22
        100106-01   B12
        TIP49   C5,C9,C30
        2N6308   C35,C52,C64
        2N6401   C135

PI

14○	○1
15○	○2
16●	○3 RED
17●	○4 WHT
18○	○5
19○	○6
20○	○7
21○	○8
22○	●10 GRN
23○	○11 ORN
24●	○12
25○	○13

P2

14	⊠	⊠	7
13	⊠	⊠	6
12	⊠	☐	5
11	⊠	☐	4
10	⊠	☐	3
KEY9	■	☐	2
8	⊠	⊠	1

ALL 22 AWG

CURRENT LOOP CABLE
400017—01

P3

KEY12	■	☐	6
11	☐	⊠	5 BLK
10	⊠	☐	4
9	⊠	☐	3
8	⊠	☐	2
7	⊠	☐	1

YEL
BLU
BRN
GRA

AC FAN CABLE
23856—00

BLK,18AWG
WHT,18AWG
L
T

TABULATION		
DASH NO.	L	T
-00	21"	F
-01	6"	F
-02	6"	M

18AWG
4"
GRN
BLK
WHT
140"

115V AC PWR CABLE
400015—01

DC POWER CABLE
26097—01

T15 T13 T11
T14 T12
MB

TBI	ALL 16AWG		MB
1	WHT	+5V	T15
2	BLK	GND	T14
3	BLK	GND	T13
4	RED	+15V	T12
5	BRN	-15V	T11

TBI
1 2 3 4 5 6 7 8 9

18AWG
4"
GRN/YEL
BRN
BLU
140"

230VAC PWR CABLE
400016—01

Figure 7-11
Miscellaneous Cable Assys

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	$b_7 \rightarrow$ $b_6 \rightarrow$ $b_5 \rightarrow$	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 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 fea-
tures.) These two systems normally employ both uppercase and lower-
case 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 char-
acters 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.

		Bit Number						
Internal Data Bus	N/A	DA0	DA1	DA2	DA3	DA4	DA5	
IBM	C	B	A	8	4	2	1	
Lower Case								Upper Case
.	C	B				2		.
;	C	B	A		4		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	A		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						
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

Internal Data Bus (Lower Case)	N/A	B	A	8	4	2	1	Upper Case
IBM	C	B	A	8	4	2	1	
.		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

	N/A	B	A	8	4	2	1	
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

Internal Data Bus	N/A	Bit Number						Upper Case
		D A 0	D A 1	D A 2	D A 3	D A 4	D A 5	
IBM	C	B	A	8	4	2	1	
Lower Case								**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	L
E	C		A		4			ε
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

Figure A-2c   IBM CORRESPONDENCE CODE (APL)

	Bit Number						
Internal Data Bus	N/A	D A0	D A1	D A2	D A3	D A4	D A5
IBM	C	B	A	8	4	2	1

Lower Case	N/A	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, ⑩)				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	∆
I		B			4	2		⍳
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

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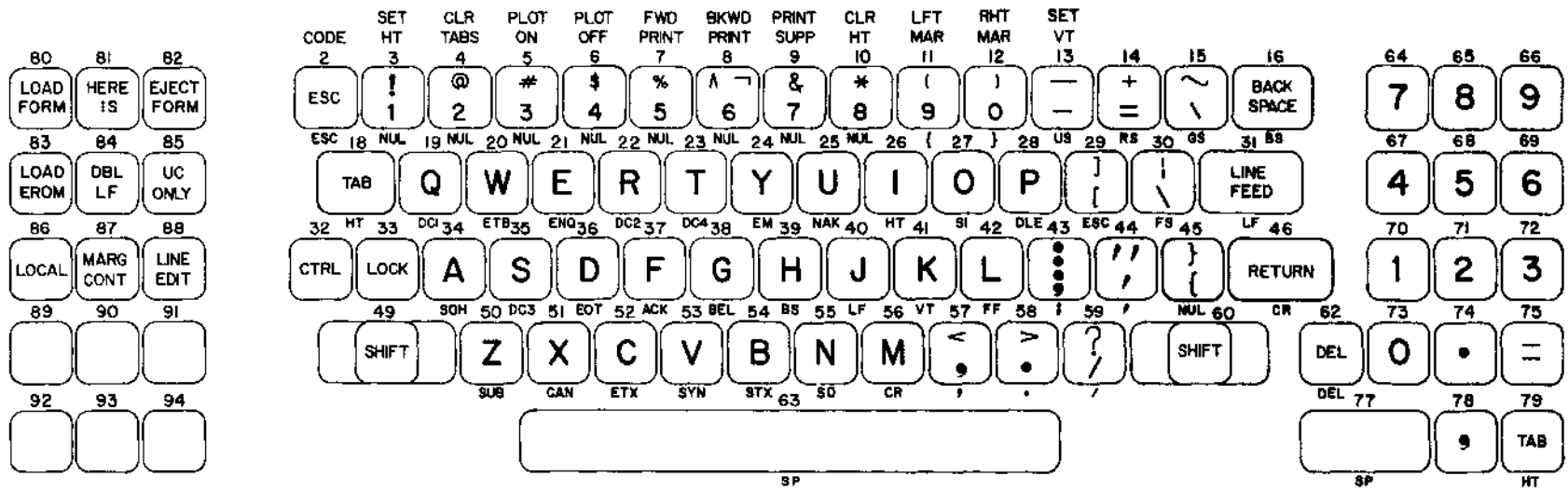
NOTES:
CONTROL CODES AND SPECIAL SYMBOLS REFERENCED
BELOW KEYTOPS IDENTIFY "CTRL" MODE OUTPUT.
THESE LEGENDS ARE NOT ENGRAVED ON KEYTOPS.

Figure B-1a

47-KEY TYPEWRITER PAIRED ASCII KEYBOARD

47-Key Typewriter Pairing Keyboard ASCII/APL Mode for Plastic (or Metalized) Print Wheels

Key Position	Unshifted Characters ASCII	Unshifted Characters APL	Unshifted Hexadecimal Code	Shifted Characters ASCII	Shifted Characters APL	Shifted Hexadecimal Code	Control Characters ASCII	Control Characters APL	Control Hexadecimal Code
1									
2[1]	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	Δ	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]		7F[3](5D)	DEL		7F	DEL		7F
63	SP		20[3]	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.
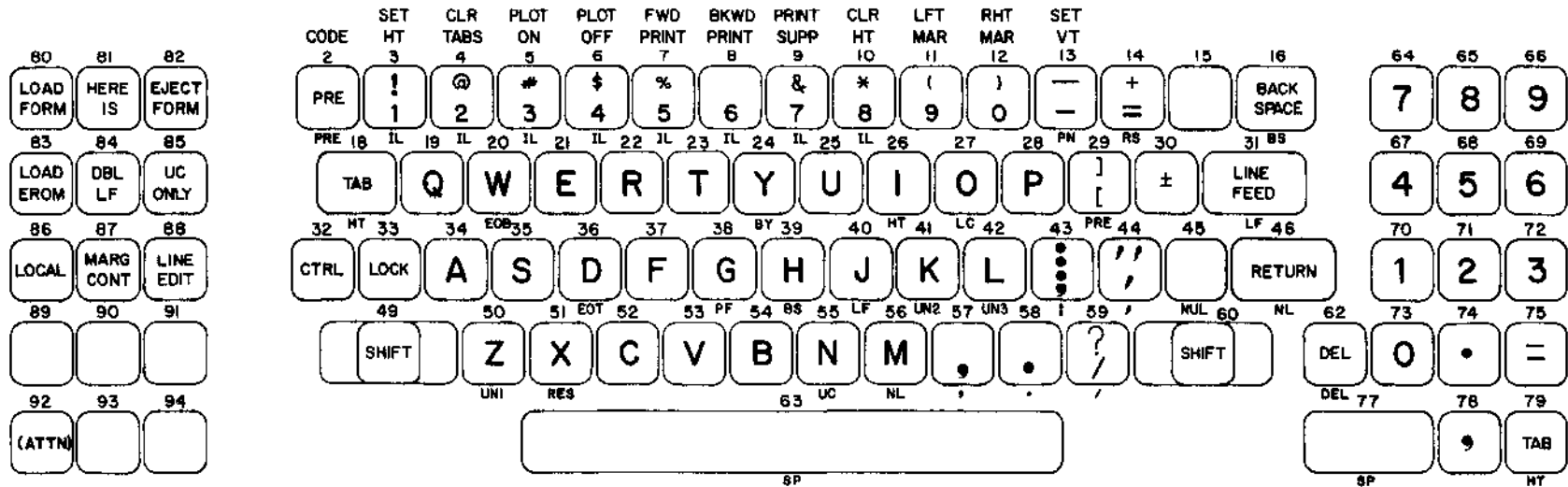
NOTES : 1. CONTROL CODES AND SPECIAL SYMBOLS REFERENCED BELOW KEYTOPS IDENTIFY
"CTRL" MODE OUTPUT, AVAILABLE IN 2741 ENHANCED MODE ONLY.
THESE LEGENDS ARE NOT ENGRAVED ON KEYTOPS.

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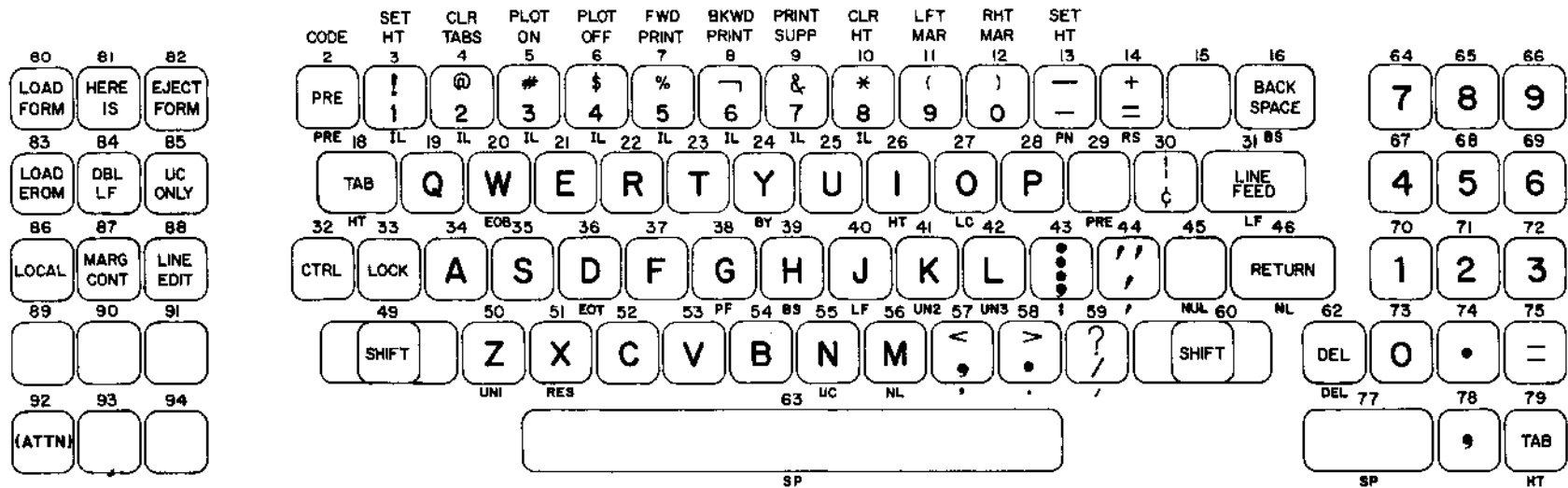
NOTES : 1. CONTROL CODES AND SPECIAL SYMBOLS REFERENCED BELOW KEYTOPS IDENTIFY "CTRL" MODE OUTPUTS, AVAILABLE IN 2741 ENHANCED MODE ONLY. THESE LEGENDS ARE NOT ENGRAVED ON KEYTOPS.

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	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 STD	Control Hex 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		%	=		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	α		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.
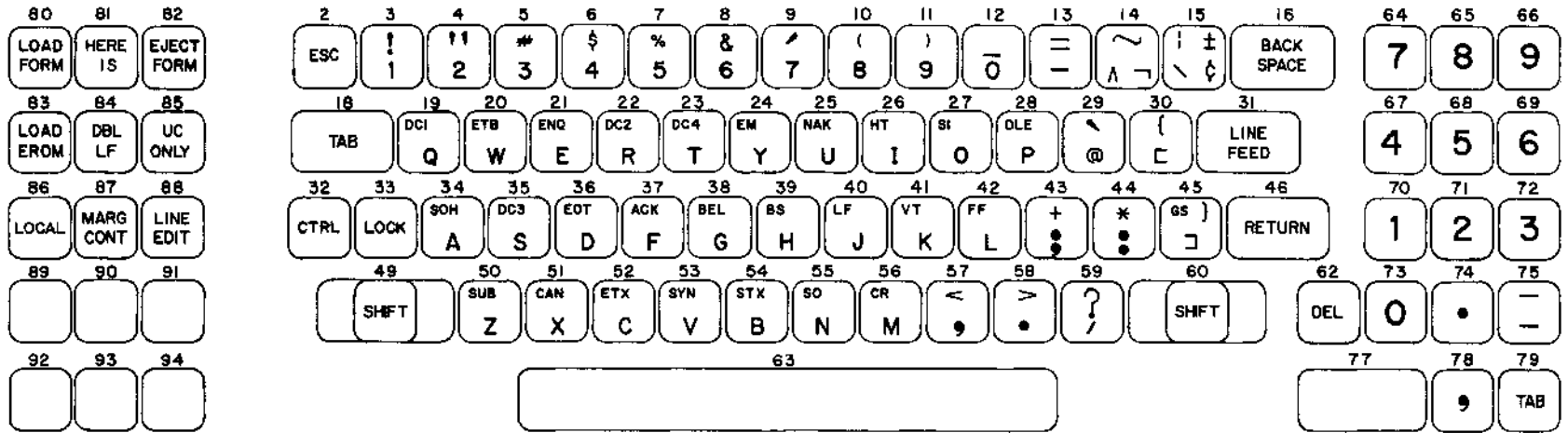
Keys 83-88 are latching keys.

Figure B-2   47-KEY LOGICAL BIT PAIRING KEYBOARD
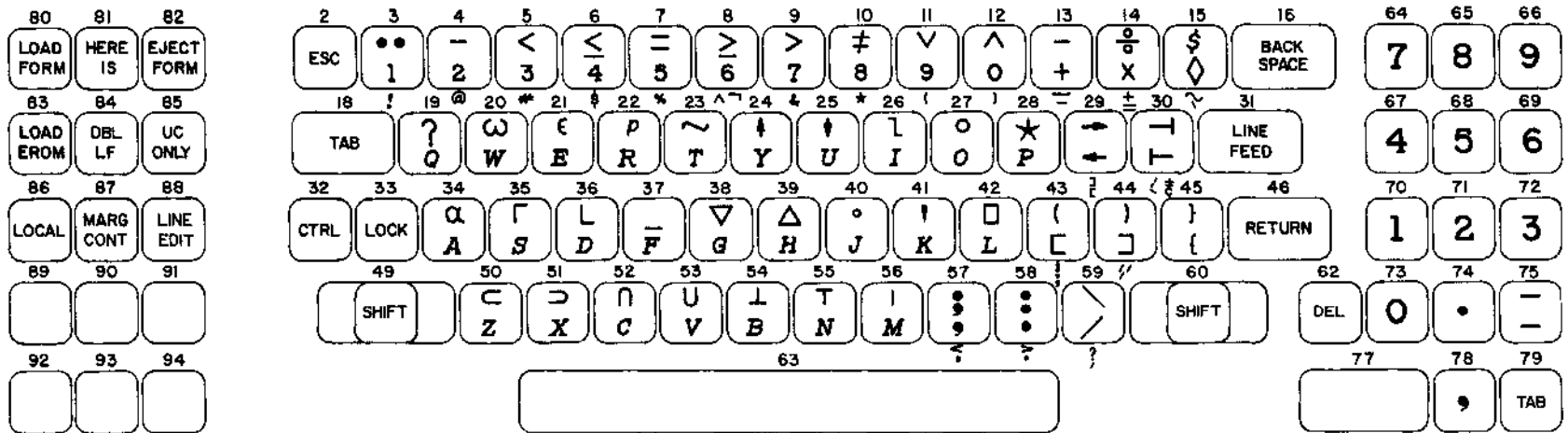
Keys 83-88 are latching keys.

Figure B-3   47-KEY APL KEYBOARD
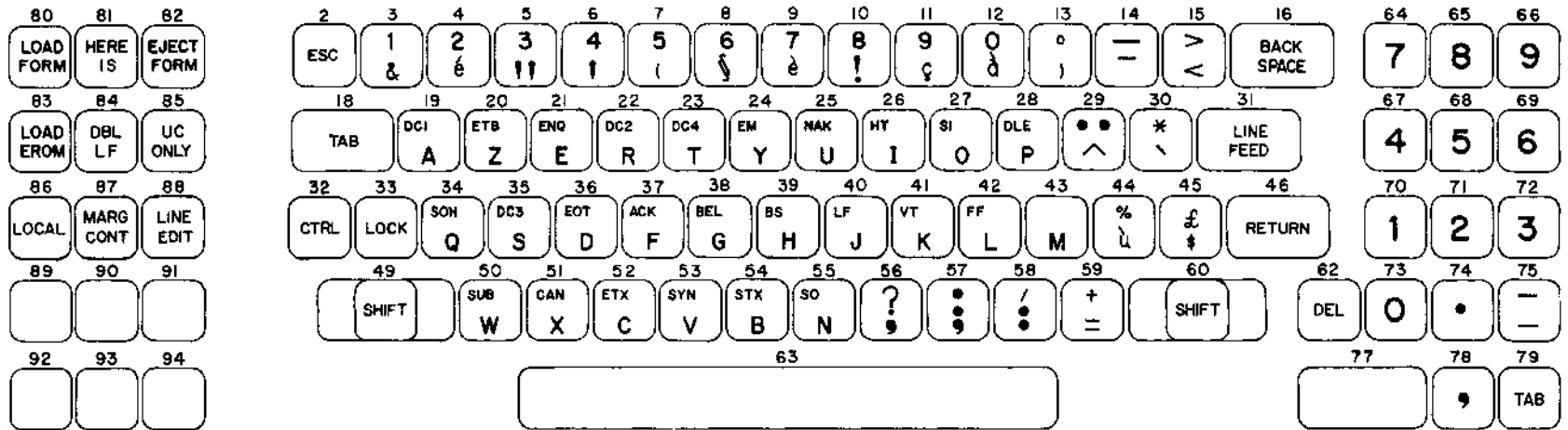
Keys 83-88 are latching keys.

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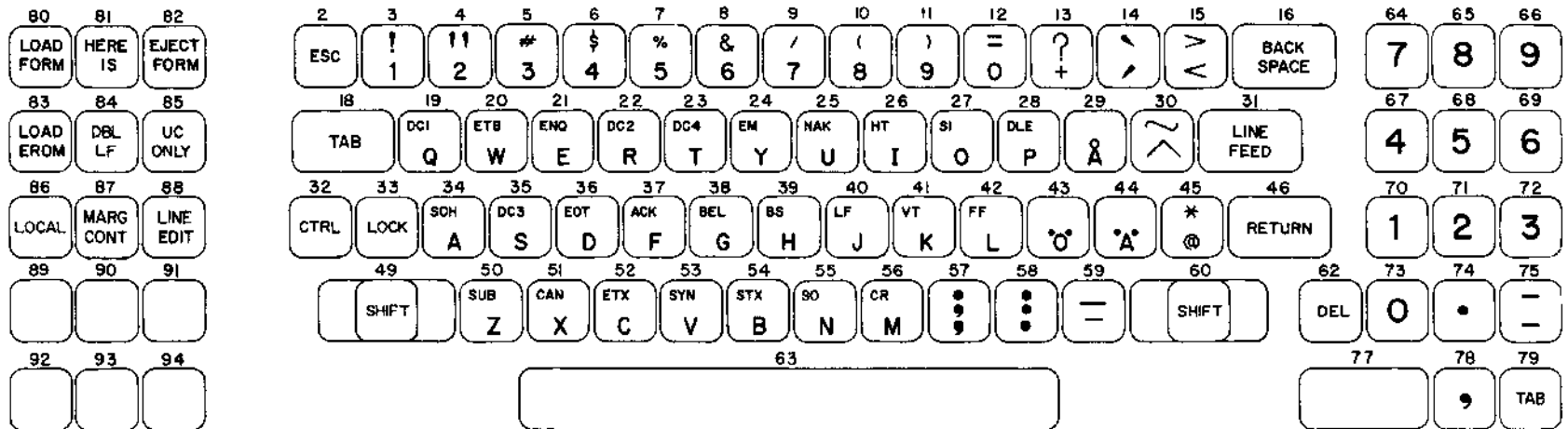
Keys 83-88 are latching keys.

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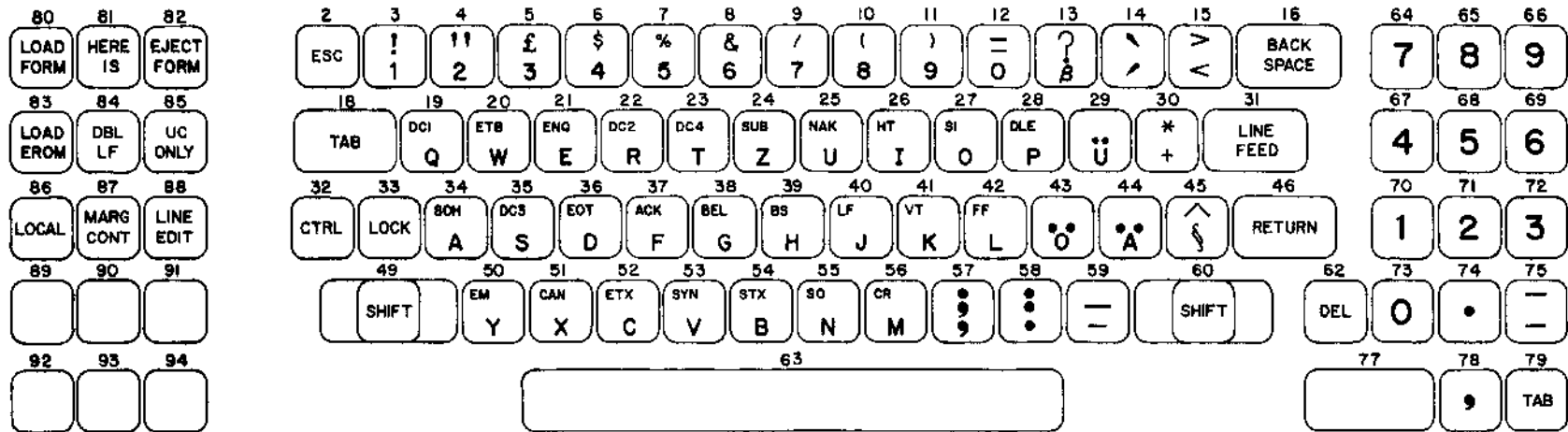
Keys 83-88 are latching keys.

Figure B-6   47-KEY GERMAN KEYBOARD

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
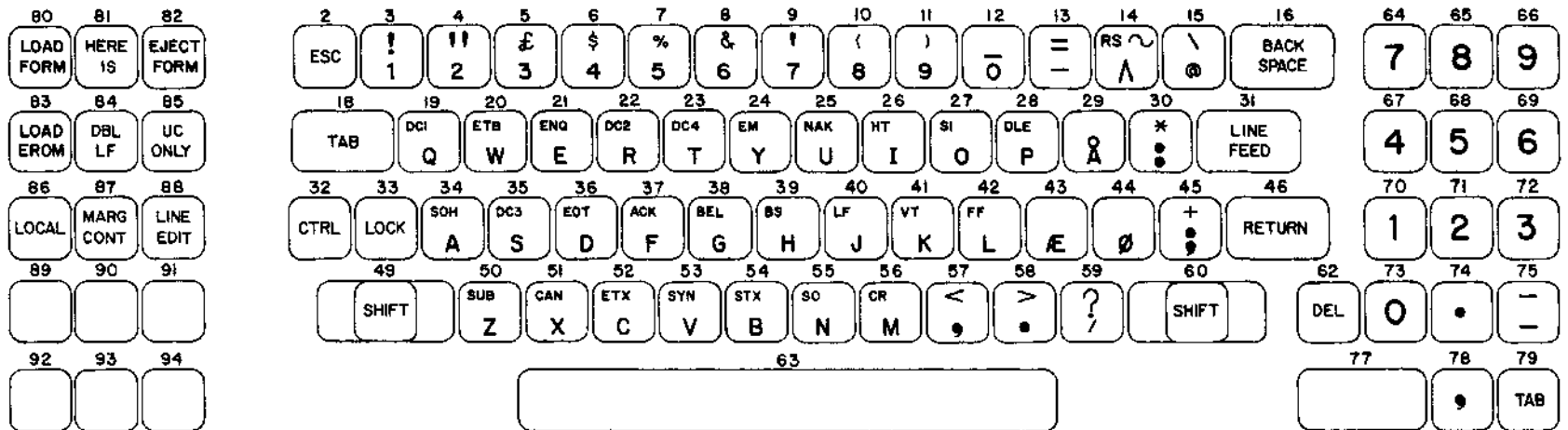
Keys 83-88 are latching keys.

Figure B-7   47-KEY NORSK KEYBOARD

PRINT WHEEL CODE CHARTS
(Typical)

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	¢ 2|94 /3	0 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 /4	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

INTERPRETATION:

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

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

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	0	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	0|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|61	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			

INTERPRETATION:

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

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 (Metal, Rank Xerox). Character assignment table.

b4	b3	b2	b1						
0	0	0	0	¢ (5,91,3)	0 (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 (19,78,4)	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 (20,69,4)	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 (67,9,3)	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)	⅔ (3,93,4)	k (69,27,3)	. (80,16,1)
1	1	0	0	, (41,55,1)	¼ (81,15,4)	L (20,76,3)	£ (4,92,4)	l (42,53,2)	
1	1	0	1	– (35,61,1)	= (9,87,2)	M (38,58,4)	⅓ (93,3,4)	m (48,48,4)	
1	1	1	0	. (39,57,1)	½ (73,23,4)	N (24,72,4)	¾ (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)	

(Each cell: character (electrical position, spoke position, recommended energy level). Column header bits b7 b6 b5 read across: 00 1, 01 0, 10 0, 10 1, 11 0, 11 1.)

INTERPRETATION:

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

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)

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	¢ 0 0	0 86 10 /4	@ 75 21 /4	P 10 86 /4	` 95 I /I	p 67 29 /4
0	0	0	1	I 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	T̄ 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 64 /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

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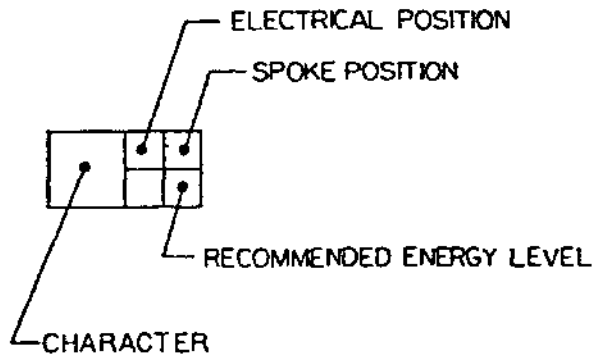
- ELECTRICAL POSITION
- SPOKE POSITION
- RECOMMENDED ENERGY LEVEL
- CHARACTER

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 [NOT REFLECT AESTHETICS OF INDIVIDUA TYPE STYLES.
4. ELECTRICAL POSITION IS PRINTWHEEL SP POSITION AS VIEWED FROM THE CHARAC SIDE OF THE PRINTWHEEL.

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

b4	b3	b2	b1	(MSB) 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 / 6 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)
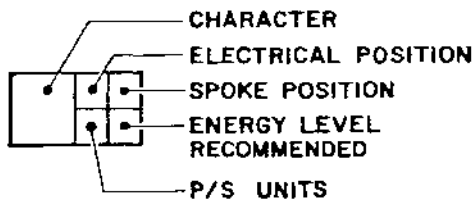
Legend box:
- CHARACTER
- ELECTRICAL POSITION
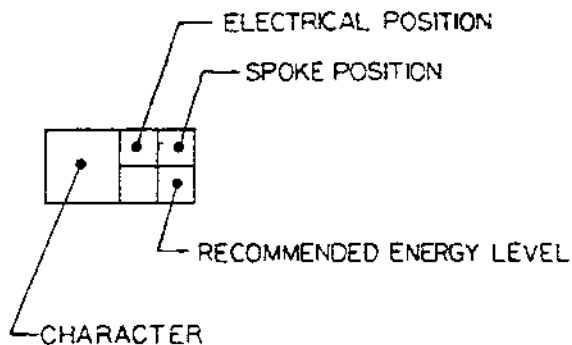- SPOKE POSITION
- ENERGY LEVEL RECOMMENDED
- P/S UNITS

NOTES:

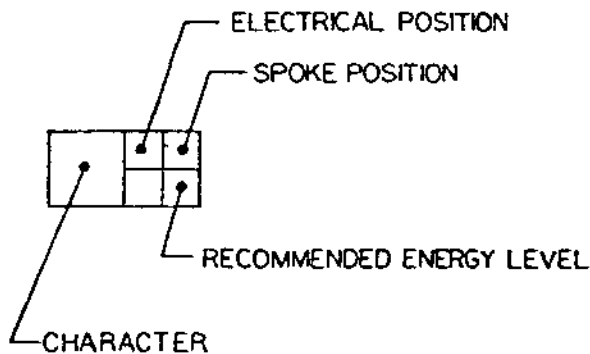1. USE ENERGY SWITCH POSITION M FOR NORMAL USE, FOR MULTISTACK.

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-1 and -2 to find the third character (n) for ASCII coding, and Table D-3 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-2 gives a listing of decimal values for ASCII characters.

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

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Table D-2
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	(SP)	57	9	82	R	107	k
8	CTRL H (BS)	33	!	58	:	83	S	108	l
9	CTRL I TAB	34	"	59	;	84	T	109	m
10	CTRL J (LF)	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 (CR)	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	~

DECIMAL VALUES FOR 2741 CHARACTERS

2741 Correspondence Code

LOWER CASE

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

UPPER CASE

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

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

UPPER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9
0	SP	→	~	∘	≤	○	⎕	\	=	)
1	∈	*	PN	RES	BY	PF	¯	:	T	+
2	⊂	UN2	UN1	UN3	≥	⍳	'	?	UC	BS
3	EOB	LC	¨	⍸	⊃	▽	∧	⌈	↑	↓
4	>	⍴	⌊	(	RS	NL	LF	HT	<	U
5	↓	_	∨	⍵	⊥	-	≠	α	∩	;
6	EOT	IL	PRE	DEL						

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
1	u	d	PN	RES	BY	PF	2	k	s	b
2	o	UN2	UN1	UN3	6	o	w	f	UC	BS
3	EOB	LC	I	j	/	a	9	r	z	1
4	5	n	v	e	RS	NL	LF	HT	3	1
5	t	c	#	$	,	.	7	p	x	g
6	EOT	IL	PRE	DEL						

UPPER CASE

TENS \ UNITS	0	1	2	3	4	5	6	7	8	9
0	SP	_	¢	+	*	Q	Y	H	:	M
1	U	D	PN	RES	BY	PF	<	X	S	B
2	)	UN2	UN1	UN3	'	O	W	F	UC	BS
3	EOB	LC	=	J	?	A	(	R	Z	I
4	%	N	V	E	RS	NL	LF	HT	;	L
5	T	C	"	!			¬	>	P	X	G
6	EOT	IL	PRE	DEL						

2741 PTTC/EBCD Code (APL)

LOWER CASE

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

UPPER CASE

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

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

LOGIC DIAGRAMS AND LOGIC SYMBOL CONVENTIONS

7.1 GENERAL DISCUSSION

Diablo Systems logic diagrams emphasize the functions performed by the logic elements rather than the kinds of devices used. For example, a NAND gate may appear on a Diablo diagram as either a positive logic AND function with the output inverted (NAND), or as a negative logic OR function with the inputs inverted (NOR). This practice runs contrary to some logic drawing standards which require the use of the NAND symbol for both functions, but aids field service personnel in troubleshooting and system design engineers in understanding the principles of operation of the design.

This functional approach to logic symbology is basic to the logic documentation conventions employed by Diablo Systems. The conventions that govern logic symbology, signal nomenclature, and other drawing standards that may help the reader interpret Diablo logic diagrans, are discussed in the following paragraphs.

7.2 LOGIC SYMBOLOGY

The logic function symbols used in Diablo Systems logic diagrams conform closely to those set forth in MIL-STD-806 or ANSI Y32.14-1973. Small scale integration (SSI) circuits are represented by their function symbol. Medium scale (MSI) and large scale (LSI) integration devices, such as shift registers, RAMs, ROMs, CPUs, etc., are represented by rectangles with function labels. Since both positive and negative logic conventions can appear in a single diagram, the unfilled circle negation symbol specified by MIL-STD-806 or ANSI Y32.14-1973 is used to distinguish between LO true and HI true signals.

Usually, all logic symbols are drawn with inputs on the left and outputs on the right. Some device symbols, such as flip flops, show inputs and other external connections on the top and bottom of the symbol for clarity. Also, the drawings themselves are usually drawn with major signal flows from left to right, top to bottom. However drawing layout restrictions occasionally require the reverse of this, in that some symbols be drawn with a vertical orientation.

Figure 7-0 is a sample diagram, drawn to include examples of most if not all of the drawing conventions used. Note that in some cases two "grid coordinate" systems are used. One, shown on the perimeter of the diagram, is useful in locating a portion of a circuit or a particular component on the diagram itself, and has no other meaning. The other involves the component identifiers, such as "Resistor H35". The identifier is a "grid coordinate" code for locating that component on its printed circuit board (PCB). Further, textual reference to a device, such as a flip-flop, will usually further identify the device by its major output terminal. In the case of flip-flops, the "Q" output is usually used, i.e. FF B25-9.

7.3 LOGIC DEVICES

The following pages illustrate the make-up of the logic devices used
in these machines, and are in addition to those discussed several
places in the text. They include pertinent information such as truth
tables where possible.

(Device illustrations not complete at time of printing)

7.4 SCHEMATIC DIAGRAMS

The schematic diagrams which follow the logic device illustrations
represent the latest versions of the several PCB circuits in current
production at the time of printing this manual. Listed on the back of
each diagram will be found its revision history plus a listing of the
solid state components used in the circuit and their identifier codes.

Schematic Diagram Applicability Chart

#301390-XX	Motherboard	-01	Model 1650
		-02	Model 1640
#301410-XX	HPRO4 Processor	-03	Model 1640-01
		-04	Model 1640-02
		-05	Model 1650-01
		-06	Model 1650-02
#400664-XX	XMEM2 Exp. Mem.	-98	All Models
#40515-XX	Transducer	-04	All Models
#40520-XX	Servo	-04	All Models
#40525-XX	Car. Power Amp.	-10	All Models
#40530-XX	P. W. Power Amp.	-10	Model 1640
#40730-XX	P. W. Power Amp.	-10	Model 1650
#400568-XX	H4CPN Control Panel	-01	All Models
#400285-XX	Diablo Keyboard	-01	All KSR Models
#301658-XX	Cortron Keyboard	-01	All KSR Models
#26021-XX	Int. Power Sup., B		All Models
#301155-XX	Int. Power Sup., U		All Models

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