Radio Shack®

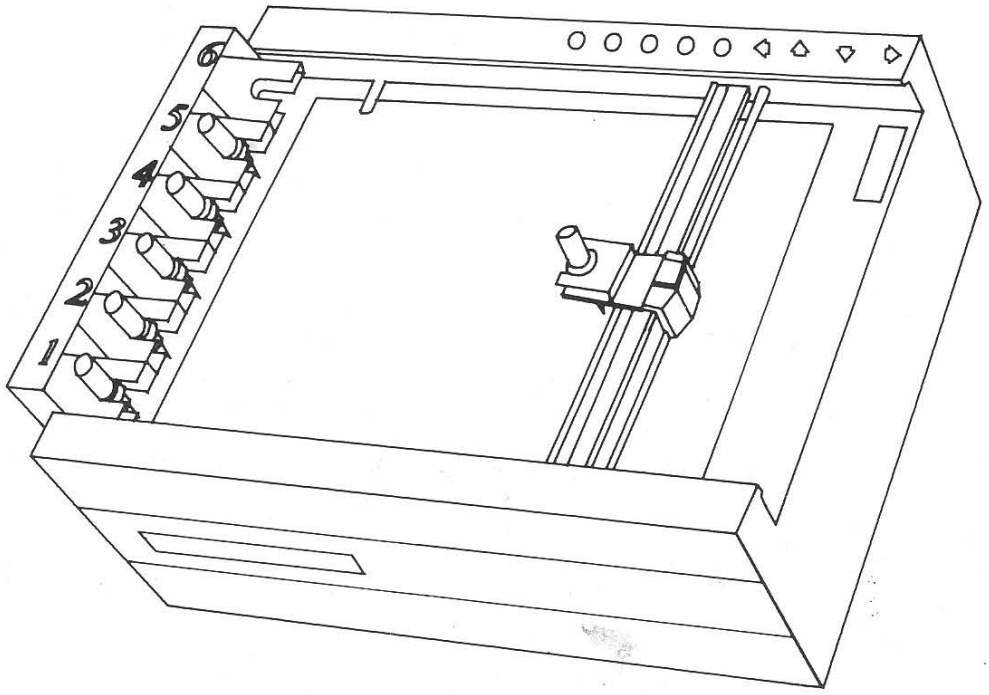
Service Manual

26-1191

TRS-80®

MULTI-PEN PLOTTER

Catalog Number 26-1191



CUSTOM MANUFACTURED FOR RADIO SHACK TC A DIVISION OF TANDY CORPORATION

TABLE OF CONTENTS

INTRODUCTION ii

1/SPECIFICATIONS 1

2/IDENTIFICATION AND FUNCTION OF CONTROLS 3

3/TECHNICAL OVERVIEW 6

- Introduction 6
- Technical Overview 7
- Digital Micro/Plot Software 10

4/SERVICING 12

- Preventive Maintenance 12
- Measurements 13
- Adjustments 15
- Recabling 19
- Removal/Replacement and Part Identification 22
- Troubleshooting 37

5/MASTER PARTS LIST 42

6/DIAGRAMS AND DRAWINGS 47

APPENDIX 55

1/SPECIFICATIONS AND RELATED DETAILS

Physical Dimensions:

Height . . . . . 6 inches (15.2 cm)
Width . . . . . 15 inches (38 cm)
Depth . . . . . 10.5 inches (26.6 cm)
Weight . . . . . 17 pounds (7.7 kg)

Performance:

Speed . . . . . 2.8 inches (7.1 cm) per second
Step Size . . . . . Horizontal .005 inch (.0127 cm)
. . . . . Vertical .005 inch (.0127 cm)
Resolution . . . . . 200 increments per inch

Power Requirements:

Input: 115 VAC +/– 10%. 50/60 Hz, single phase, 50 VA max. (Uses .5 ampere SLO-BLO fuse)

Other Features:

Operating Temperature . . . . . +65° – +95°F (18.3°C – 35°C)
Storage Temperature . . . . . +32° – +160°F (0 – 71.1°C)
Humidity . . . . . Home or Office environment 20 to 80% Relative
Surface Area (Platen) . . . . . 8½ x 11 inch (21.6 x 27.9 cm)
Plot Size . . . . . 7 x 9 ¼ inch (17.78 x 23.50 cm)
Writing Device . . . . . Ball Point Pen or Felt Tip Ink Pen, selectable colors
Noise Level . . . . . Less than 60 Db at 1 M
Reliability . . . . . 1200 hrs MTBF
Preprogrammed Capabilities (firmware routines):

Relative and Absolute coordinate addressing.
Straight line generator with solid or dash line patterns.
Circle generator.
Arc generator.
Character generator.
- 93 ASCII characters
- Four rotations
- Nine sizes

Marker Symbol Generator
- Six fixed markers
- Five sizes

Soft limits
Pen changing routine
Self test

SIGNAL INPUT REQUIREMENTS

Mating Connector DB-25P
EIA RS-232-C Serial Asynchronous

CAUTION: While the serial port conforms to standard RS-232-C Levels, not all standard RS-232-C Signals are brought out; see SIGNAL CONNECTIONS and LEVELS below for details.

Failure to insure proper connection may damage the plotter or other equipment.

Rate . . . . . 2400 baud, fixed
Allowable cable length . . . . . Up to 15 feet
Signal Levels:

(TTL H level diagram)

TTL: "H" Level	2.4 to 5.0 V
"L" Level	0 to .4 V
RS-232 "H" Level	−3 to −25 V
"L" Level	+3 to +25 V

SIGNAL CONNECTIONS AND LEVEL

Pin #	Signal	Signal Level
1	Chassis Ground (power)	
2	Received Data (from TRS-80)	RS-232
3	Transmitted Data (to TRS-80)	RS-232
5	Clear to Send (CTS) from the plotter	TTL
6	Data Set Ready (DSR) from the plotter	TTL
7	Signal Common	
8	Carrier Detect (CD) from the plotter	TTL
22	Ring Indicator (RI) from the plotter	TTL

Pin Connections, Interface Table

PAPER

A smooth, 20 pound, No. 1 (white) sulfite, or better quality paper may be used to produce normal quality graphics.

PEN

Ball point or ink pen of 2.125 inch length x .375 inch diameter with specially designed retaining features are available in various colors.

2/IDENTIFICATION AND FUNCTION OF CONTROLS

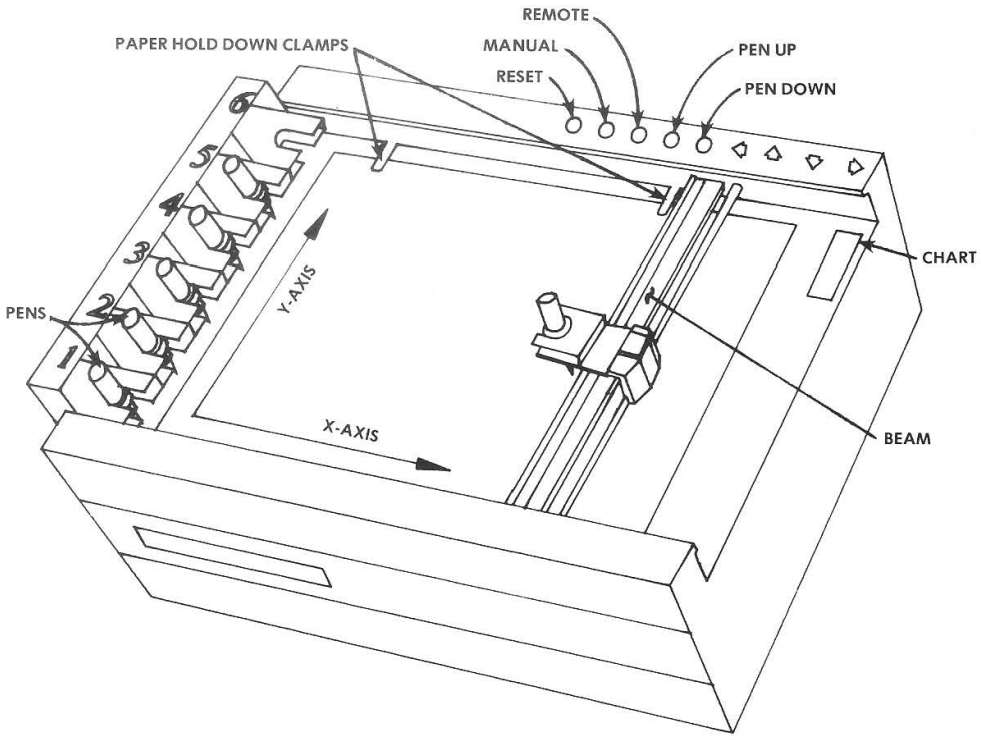


FIGURE 2-1
PLOTTER FRONT VIEW

The principal operator controls mounted on the rear side panel include the following (refer to Figure 2-1):

CHART

Located on the platen, upper right. This slide relieves tension through a mechanical linkage on the paper hold down clamps when pushed to the LOAD position; the paper is secured when the slide is pushed to the HOLD position.

PAPER HOLD DOWN CLAMPS

Located on the platen as illustrated, the paper clamps are mechanically linked to the chart slide. These clamps secure properly positioned chart paper when the chart slide is in the HOLD position.

PEN

The pen is the writing device of the plotter. It is held in place by the pen holder. Its movement is constrained along the beam, or the Y-Axis of the plotter.

BEAM

Provides a support for the pen and pen holder, as well as the means of their movement along the X-Axis of the plotter.

MANUAL

When pressed, allows local control of the plotter. When in the MANUAL mode, PEN UP, PEN DOWN and positioning of the pen in the direction of the arrows is electronically controlled by the operator. MANUAL also disables remote plotting activities.

PEN UP

The pen is raised from the plotting surface through a mechanical linkage by the energy in a spring after the pen solenoid is electrically deactivated by pressing PEN UP.

PEN DOWN

The pen is lowered to the plotting surface through a mechanical linkage after the pen solenoid is electrically activated when pressing PEN DOWN.

LEFT, RIGHT, UP AND DOWN ARROWS

These are touch switches which cause pen and/or beam movement in the indicated direction(s) on the pressed touch switches. Activating voltage is available to these switches when the plotter is in MANUAL.

REMOTE

Turns control of the plotter and plotting activities over to a TRS-80, or other microprocessor.

RESET

Clears all plotter registers and memory; resets the plotter.

CAUTION: AFTER PRESSING RESET, BE SURE PEN IS REMOVED FROM HOLDER AND RETURNED TO THE PEN STABLE.

PEN CHANGER ASSEMBLY

This assembly holds a "stable" of different colored pens. The individual pen holders are identified as "stalls."

The X and Y orientation of the plotter is as illustrated in Figure 2-1.

The remainder of the controls are located on the bottom rear of the plotter (refer to Figure 2-2).

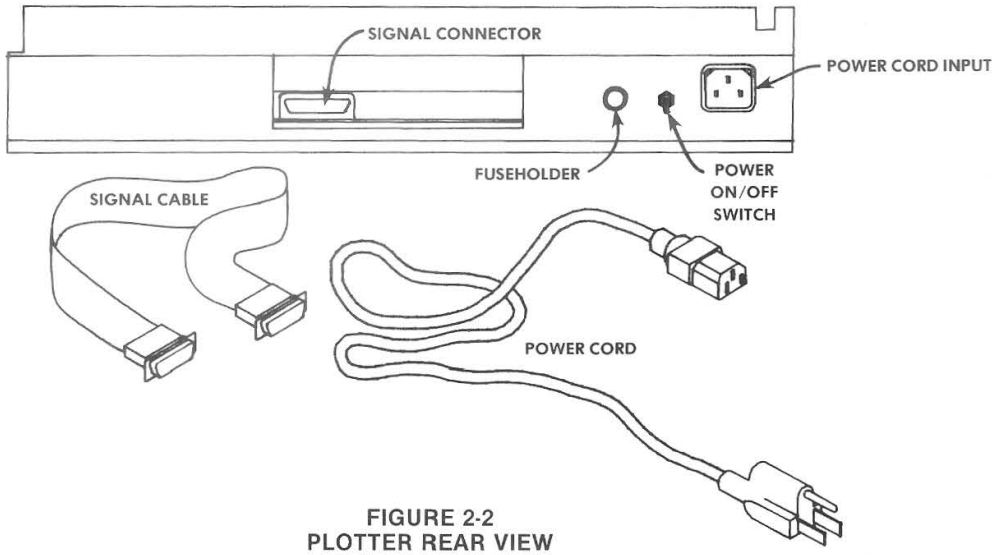


FIGURE 2-2
PLOTTER REAR VIEW

POWER CORD

Provides a means of connecting the plotter to a 115 VAC electrical outlet.

POWER ON/OFF SWITCH

The power interruption device.

FUSEHOLDER

Holds the fuse which is used to protect the plotter from a fire hazard in case of internal circuit or component malfunction.

SIGNAL CONNECTOR

Accepts a series "D" subminiature 25-pin connector (plug) with cable to connect the plotter to a Radio Shack TRS-80 Computer. The signal cables obtainable from Radio Shack are identified below.

Microcomputer	Radio Shack Cable Catalog Number
Model I	26-1145
Model II	26-4403
Model III	26-1408

TABLE 2-1
SIGNAL CABLES

3/TECHNICAL OVERVIEW

INTRODUCTION

The logic and data processing circuitry used in plotters are similar to circuitry used in other electronic devices. The digital plotter is an electromechanical device in which timing has an important role. The stepper motor may be the single unit that a technician does not usually encounter in a daily routine. Consequently, some additional information for its understanding is included.

Exploded line drawings are provided to enable one to readily disassemble the unit. There are usually several different sequences which will give the same result.

The logic board component numbers have been used in the overview for a direct correlation to the schematic diagram. The overview is presented on the basis of the Plotter Logic block diagram, Figure 3-1.

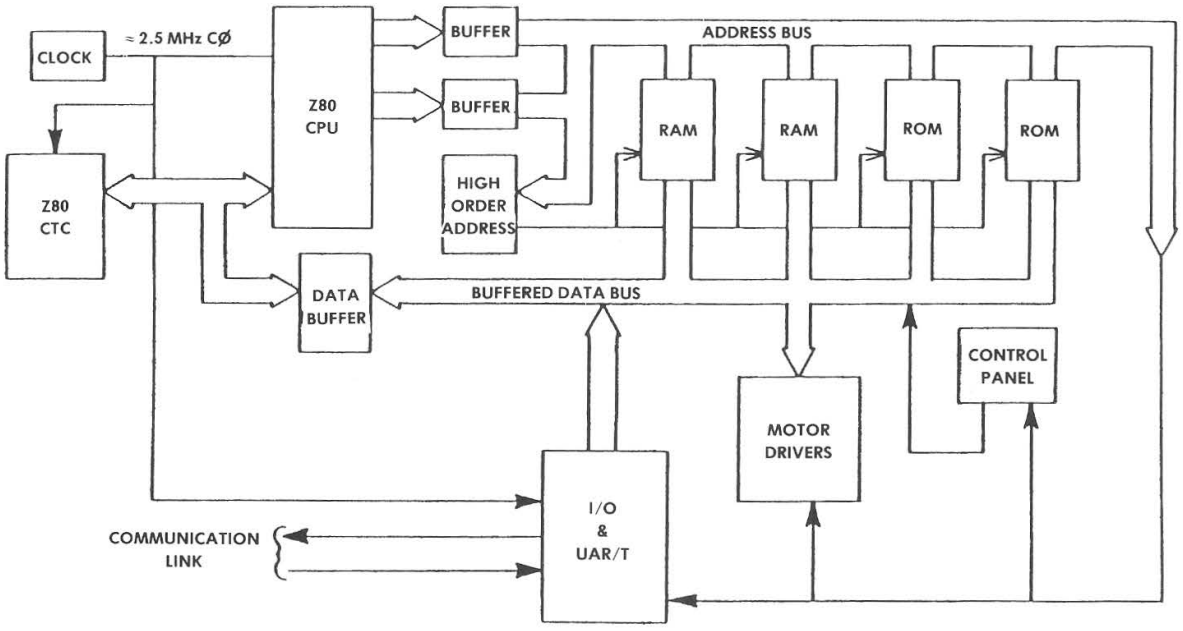


FIGURE 3-1
PLOTTER LOGIC BLOCK DIAGRAM

TECHNICAL OVERVIEW

The TRS-80 Multi-Pen Plotter is microprocessor based. It has on-board intelligence to simplify user operation and reduce host computer software requirements. The logic block diagram below shows the plotter's clock (timing), microprocessor, communications link and universal asynchronous receiver/transmitter (UAR/T) capabilities.

DIGITAL MICRO/PLOT SOFTWARE

While it may be an intelligent device, the plotter must still be provided with commands and data in a specific format to produce desired graphics. The DM/PL commands and other information are included in the Appendix.

POWER SUPPLY

The plotter operates from a three-wire, single-phase alternating current power source. Electrical energy is provided through a 125 VAC three conductor power cord. The personnel protective grounding (earth connected) conductor is separately connected to the plotter frame. The ungrounded (hot) line is fused for protection of the plotter. The source interruption device (on/off switch) breaks the ungrounded (hot) and the grounded (neutral) lines to the plotter. The ground line is not interrupted. An input filter is included in the power circuit to reduce the line conducted high frequency emissions to levels within FCC requirements for a Class B computing device. A complete schematic diagram of the power supply is provided in Figure 3-2.

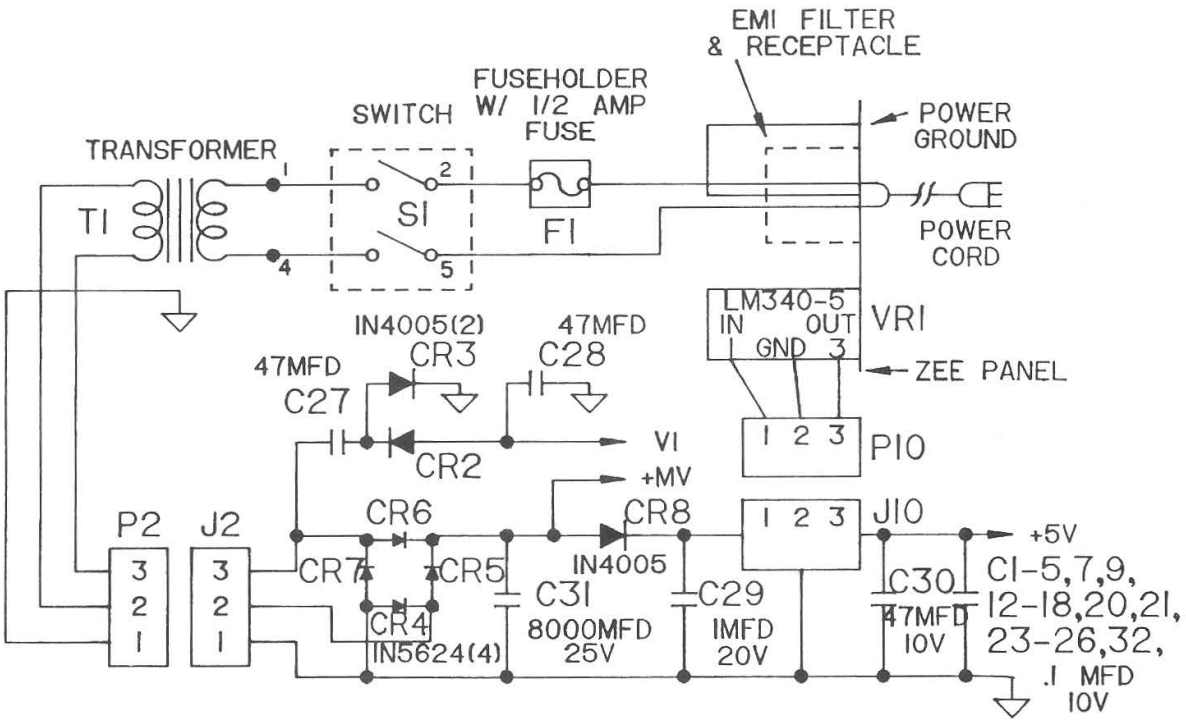


FIGURE 3-2
POWER SUPPLY

It should be noted that the components on the primary side of the transformer are mounted on the Zee frame (DMP-566), the power transformer is mounted on the motor mount (DMP-1) and the rectifier components are mounted on the logic board (DMP-649). The voltage regulator (VRI) is physically mounted on the Zee panel for heat dissipation purposes.

When the power switch (S1) is turned on, AC line power is applied to the primary windings of T1. The secondary windings are connected to a diode bridge rectifier consisting of CR4 through CR7. The output is filtered by capacitor C31 and has a nominal voltage value of 15 volts DC (+ MV). This unregulated voltage is used as a power source for the stepper motors and the pen solenoid. A portion of the unregulated voltage is routed through CR8 to the voltage regulator (VRI) to generate the regulated + 5 volts DC logic rail. Capacitors C20 and C21 through C28 provide a low impedence bypass for undesired radio frequency energy.

Returning to the appropriate sheets (Figure 6-2, 6-3 and 6-4) of the logic board schematic, one observes that connections to the world outside of the plotter are at J-11. These and their levels are given below.

Pin #	Signal	Signal Level
1	Chassis Ground (power)	
2	Transmitted Data (from TRS-80)	RS-232
3	Received Data (TRS-80)	RS-232
5	Clear to Send (CTS) from the plotter	TTL
6	Data Set Ready (DSR) from the plotter	TTL
7	Signal Common	
8	Carrier Detect (CD) from the plotter	TTL
22	Ring Indicator (RI) from the plotter	TTL

INPUT-OUTPUT COMMUNICATIONS

The plotter has eight wire connections between itself and the microprocessor, see Sheet 3 of the LOGIC BOARD schematics (DMP-609). Of these wires, two are used to accomplish virtually all of the communications between these units. The data exchange is conducted in a full duplex communications mode. Serial (RS-232-C interface) bits that are the plot commands and data from the TRS-80 microcomputer are received at pin 2 of connector J11 for use by the plotter. These bits are received at RS-232 voltage levels and then converted to TTL levels by the signal level converter consisting of R13, R14, R15, CR10 and Q10. It should be noted that signal common is not directly tied to chassis (power) ground.

DATA CONVERSION

After converting the serial RS-232 data to TTL levels, the output from Q10 is applied to pin 20 of the UAR/T (U30). The UAR/T functions as a dual output serial-to-parallel data converter. For use in this model of digital plotter, the dual outputs of parallel data are connected together. The serial character input is applied to pin 20 of U30 which is converted to the equivalent eight-bit parallel ASCII output on pins 5 through 12 and pins 26 through 33. When the output is valid, a strobe DAV, pin 19 of U30, goes high. This strobe is fed to pin 23 of U20 which is used to interrupt (alert) the CTC to signify that input data is available for action by the central processing unit (CPU).

MASTER CLOCK

The clock for the plotter is a crystal (Y1) controlled oscillator (U17). Its fundamental (crystal) frequency is 4.9152 MHz which is available at pin 10, U17. The frequency is then divided by the flip-flop circuit, U18, and the resulting 2.4576 MHz is made

available to the CPU (U21) and the CTC (U20) for use by the plotter's computer. The frequency is again divided by a flip-flop U26 whose output is provided to the multiple frequency divider/counter (U27). An output of the multiple frequency divider/counter (pin 3, Q5) is connected to pin 17 and pin 40 of the UAR/T (U30). The frequency at pin 3 of U27 is 38,400 Hz which meets the requirements of the UAR/T for eight-bit data conversion at 2400 baud. These different frequencies are used to synchronize the input data rate, the serial to parallel data conversion, the data processing and the mechanical action of the plotter.

MICROPROCESSOR

The microprocessor (U21) is an eight-bit, single chip (Z80) CPU. It performs all arithmetic operations and calculations within the machine. It is supported by a Z80 CTC (20) which keeps up with system timing and processes interrupts to the CPU. These two chips plus the aforementioned timing circuitry are the heart of the internal computing system. These components and the rest of the system communicate via the two buses (i.e., the address bus and the data bus), as depicted on the block diagram.

INTERRUPTS

The CTC receives the incoming clock signal from the master clock, CØ, and provides timing for the rest of the data processing system. The CTC also processes incoming interrupts and assigns priorities to them. For example, if the CPU is executing the motor timing routine and a data available interrupt is asserted, the CTC will cause the motor timing routine to wait until the data available interrupt has been satisfied. The internal microprocessor operates much faster than the motors, thus interrupts are not apparent to the operator. The interrupts, in order of priority are:

1) data available and

2) motor timing.

CONTROL PANEL

Data can be input to the plotter regardless of control panel status. The incoming data is input to the data buffer in the foreground while control panel operations take place in the background. Buffer size is limited to 256 bytes. The bidirectional buffers (U11) share internal data with the CPU and CTC and act as an output buffer to the rest of the system. If the interrupt is from the I/O, the CPU allows the data to enter. The CPU examines all incoming data and, if valid, enables the proper components to act, accordingly.

The first data the CPU must receive is the plotter select code (;:). All incoming data is scanned, but nothing else happens until the first plotter select command is received.

ADDRESS BUS

The address bus is controlled by the CPU (U21) through some decoding circuitry (U22 and 23). The decoders flag the particular component being addressed. This bus interconnects the memories (U12, 13, 14 and 15) and the I/O decoding circuitry (U2 and 3).

FIRMWARE

Included in the processing system are 1K byte of Random Access Memory (RAM) and 6K bytes of Read Only Memories (ROM). The byte is composed of eight-bits; hence the RAM is composed of U12 (1K x 4), and U13 (1K x 4) and the ROM is composed of U15 (4K x 8) and U16 (2K x 8). The ROMs contain the programming necessary for line generation,

character and symbol generation, and the system operating routines. When commanded, the routine actually looks up the vectors to form the desired symbol and executes the command.

MOTOR DRIVERS AND PEN LIFT

After the data input to the plotter has been processed and the desired graphics/vectors to be plotted have been calculated, the data are strobed out to a latch/driver chip, U16, which turn on the stepper motor driver transistors (Q1-Q8) in the proper sequence to produce the desired X-Y movement of the plotter's pen. The computed information leaves the address decoder (U3) and is gated via U2, U9 and U18 as an output enable to the plotter's pen and stepper motor. The output enable at pin 1, U16, goes low and remains low as data is input and processed one byte at a time. The Darlington transistors are individually switched as determined by CPU to produce the desired graphics. The pen axis (Z-up/down) is similarly controlled by the CPU through U9 and Q9. The motor drivers and the pen solenoid have a time-out (remove power) feature. The Schmitt Retriggerable multivibrator, a one-shot circuit consisting of U8 and its associated RC components, remove power from the pen solenoid and the stepper motors after three seconds duration. This conserves energy and also prevents overheating of the identified circuits in the plotter.

STEPPER MOTORS

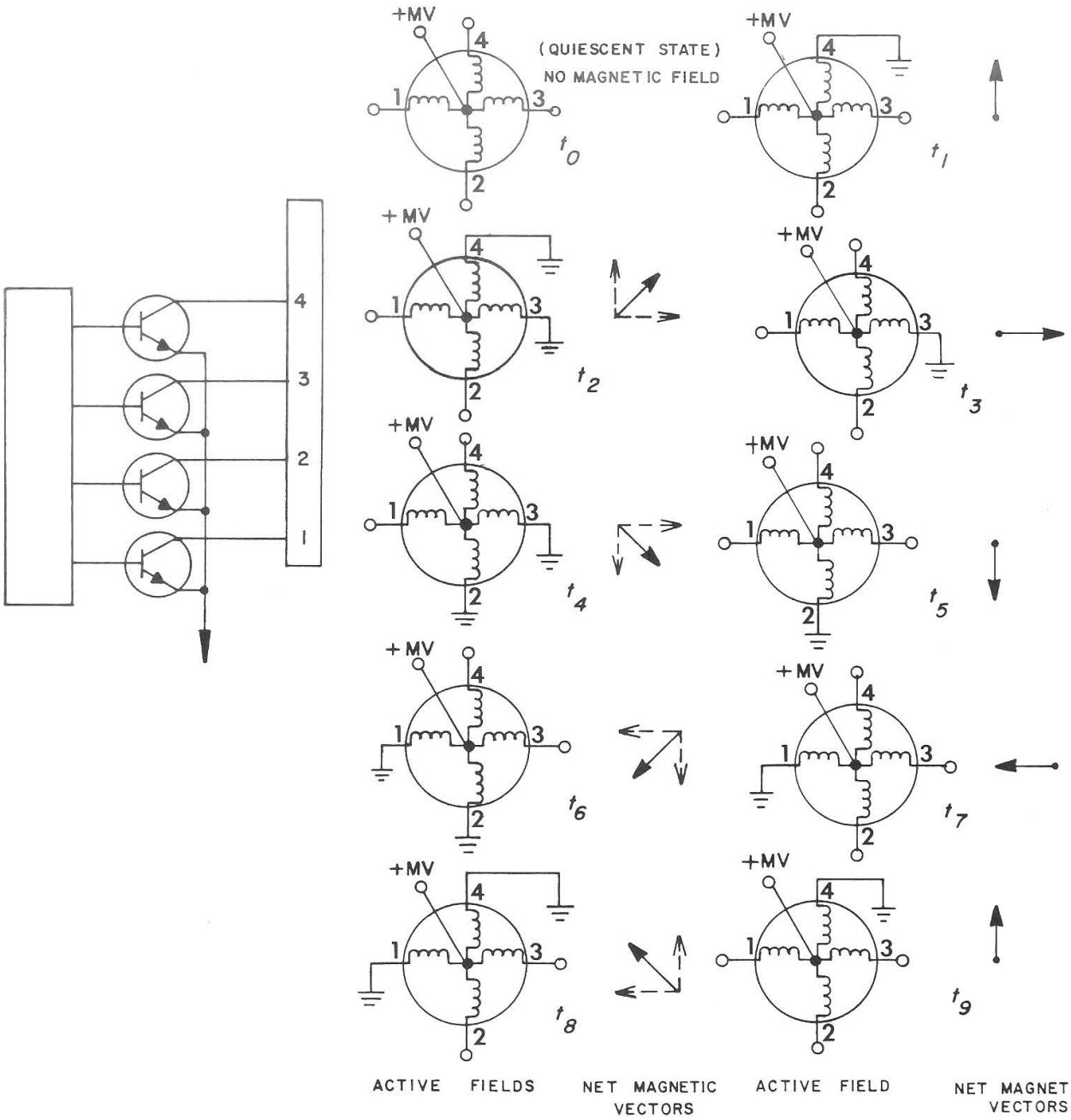
Stepper motors are specifically designed to rotate from pole to pole of sequentially energized field windings. The motor responds precisely to the code from the CPU and rotates in discrete increments (400/revolution) as far and as rapidly as directed with no complicated feedback loop. The computer must, however, continually count the exact number of net steps executed by each stepper motor so that the precise pen location is known at all times.

Operation of this permanent magnet motor consists of the interactions between the magnetic forces generated in the stator windings and the flux in the rotor magnets. If, for example, a pattern of bits was output by the stepper motor driver circuit as shown in Figure 3-3, the rotation of that motor or its shaft, would occur in a clockwise (CW) or counter clockwise (CCW) direction. Also illustrated in the figure, one complete vector field rotation will be accomplished in a sequence of eight steps. For graphics, the stepper motors are designed to rotate in tiny steps in either direction (CW or CCW).

The stepper motor in the TRS-80 Multi-Pen Plotter has 50 poles. With appropriate techniques, the motor is driven at 400 steps per revolution.

DIGITAL MICRO/PLOT SOFTWARE

DIGITAL MICRO/PLOT LANGUAGE (DM/PL) has evolved over time. DM/PL is easily used with computers that are programmed in BASIC, PASCAL, FORTRAN and other high level computer languages. The codes which are used in DM/PL consist of 93 ASCII characters transmitted from the TRS-80 MICROPROCESSOR to the plotter. Plot command instructions consist of a single or dual character(s) or the character(s), followed by additional information. Details related to the plot commands are covered in the RADIO SHACK, TRS-80 MULTI-PEN PLOTTER, OPERATORS MANUAL, catalog number 26-1191.



0	0	0	0	0	0	1	1	1	0	1
0	0	0	0	1	1	1	0	0	0	2
0	0	1	1	1	0	0	0	0	0	3
0	1	1	0	0	0	0	0	1	1	4
t_0	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9	WINDING NO

FIGURE 3-3
STEPPER MOTOR VECTOR FIELD ROTATION

4/SERVICING

WARNING: THESE INSTRUCTIONS ARE INTENDED FOR QUALIFIED SERVICE PERSONNEL ONLY. IF YOU ARE NOT QUALIFIED TO WORK ON THIS EQUIPMENT, DO NOT ATTEMPT TO DO SO.

Servicing is divided into the following major subsections:

1) Preventive Maintenance,
2) Measurements,
3) Adjustments,
4) Recabling or Restringing,
5) Removal/Replacement and Part Identification,
6) Troubleshooting.

The information contained here is for use by a qualified technician who is familiar with repair of electromechanical and/or electronic equipments. It is recommended that personnel become familiar with the plotter through review of the operators manual, the technical overview contained herein and the schematic diagrams, before proceeding to repair the plotter.

PREVENTIVE MAINTENANCE

GENERAL COMMENTS

The plotter has been designed to provide trouble-free operation over prolonged periods without the need for specific preventive maintenance. It does, however, require some care and periodic inspections to insure that all is well and the probability of completing a graphics operations is high.

LUBRICATION

DO NOT OIL OR GREASE any parts, bearings, slides, etc. All parts are either permanently lubricated or low-friction coefficient material. Adding lubricants actually increases friction by providing a trap for dust and contaminants. If a bearing or slide is obviously causing friction, it should be replaced rather than lubricated.

CLEANLINESS

The plotter incorporates several sliding surfaces. These have intentionally been made of stainless steel, highly polished metal and/or plastic such that they are essentially friction free. This, however, does not mean that they will not collect dust. Any dust adhesion, dirt or salt corrosion can adversely influence the plotters performance. Keep it as clean as possible by using the dust cover. If cleaning is necessary, the unit may be wiped clean with a soft lintless cloth using only alcohol, freon, or a mild detergent as the cleaning agent.

INK ON SURFACES

Use a clean cloth dipped in a concentrated solution of soap and water. Squeeze first to avoid excess soap and then lightly scrub affected surface. Second choice is LAVA soap and water (but, be careful as the pumice can scour through the finish). DO NOT use any aerosol cleaners, such as TV contact cleaner, household wall cleaners or anything with a solvent, as these may damage certain components.

PERIODIC INSPECTIONS

These periodic inspections are easily accomplished. Access to the appropriate area may be gained via removal of the right end panel (DMP-134) and both side plates (DMP-523 and 623). The two screws securing the Pen Changer Assembly and the left end panel (DMP-134) to the mainframe SHOULD NOT be loosened. Time intervals are suggested as guides. If it is desired that the plotter be kept in better operating condition, preventive maintenance should be accomplished more frequently.

1) At 200 HOUR intervals:

   The X and Y-Axes drive cables and all pulleys should be checked for wear, strand breakage, binding, frays, etc. The lower section of Pen Carriage Assembly or the beam assembly may be slowly pushed while each pulley and the cable is monitored. If no binding or irregularity is noted, the cables are usually acceptable. Cable tension should also be measured.

2) At 400 HOUR intervals:

   a) The long axis Guide Rod (DMP-50) and Linear Bearing (DMP-302) should be inspected for secureness, wear, binding, corrosion and dust adhesion. If the rod is satisfactory, it should be cleaned with alcohol or freon. If after cleaning, the rod surface is not smooth to the touch and clean in appearance it should be replaced. Lubrication will not smooth out imperfections that would only cause further wear to the bearing.

   b) The travel of the pen solenoid plunger should be monitored while it is electrically actuated several times. If full travel of the plunger is consistently achieved, it is safe to assume no contamination or corrosion has occurred. If the plunger travel is sluggish, it must be removed and cleaned with alcohol or freon.

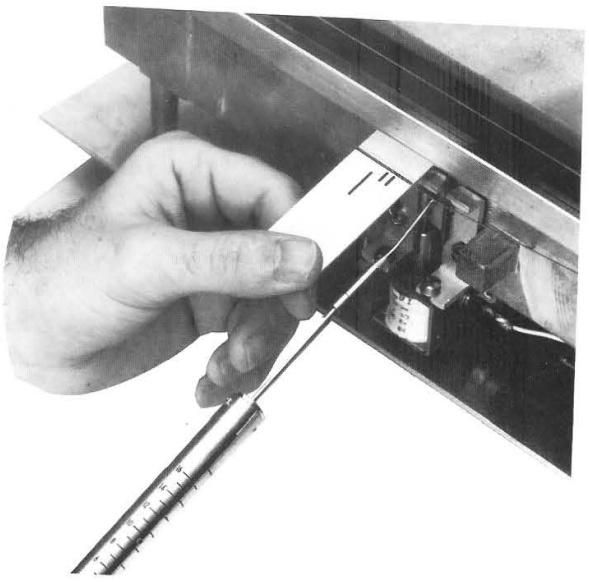
MEASUREMENTS

A standard six inch ruler which has at least 32 equal divisions per inch (General model 633 or equivalent) should be used in taking this measurement. Pen height is measured from the tip of a new pen (properly seated in its carriage) to the plotting surface. The measurement is made in at least five different places on the plotting surface. Measured pen height must be 1/8 inch ± 1/16 inch.

CABLE TENSION

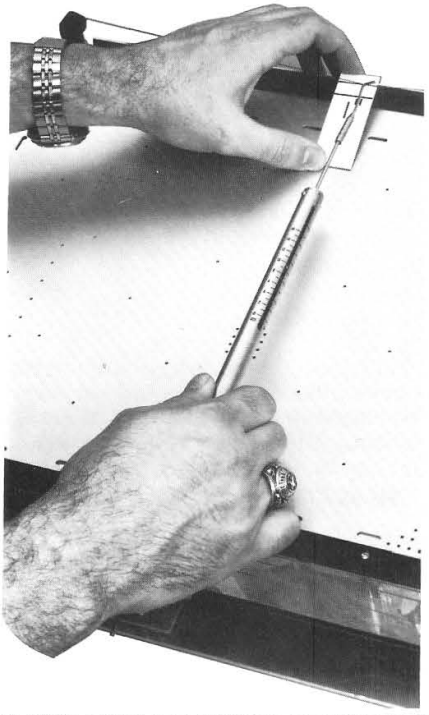
A standard spring scale terminated in a hook capable of measuring force in 1 gram increments (Jonard Tukahoe model GPP-5 or equivalent) should be used in taking spring tension measurements. For each measurement (X or Y-Axis), the beam should be adjacent to the Pen Changer Assembly and the pen carriage should be positioned near the center of the beam.

Tension in the X-Axis cable is measured at the underside of the platen. Using the Long Guide Rod (DMP-50) and the platen center screw as a reference for cable connection, pull cable toward rod (outward) with the spring scale. Take the reading when the inner side of the rod, center screw and pulled cable are aligned. Reading for X-Axis tension should be 12 oz. ± 1 oz.



X-AXIS CABLE TENSION ADJUSTMENT

Tension in the Y-axis cable is measured at the upperside of the platen. Using the edge of the platen, and the platen center screw as a reference for cable connection, pull cable to center of plotter with the spring scale. Take the reading when edge of platen, center screw and pulled cable are aligned. Reading for the Y-Axis tension should be 9 oz. ± 1 oz.



Y-AXIS CABLE TENSION ADJUSTMENT

ADJUSTMENTS

The plotter has been carefully and completely aligned at the factory for optimum performance. It should normally not require any adjustments for an extended period of time. It should be noted that even though measurements taken in the field may not be within those values contained in this manual, the plotter can still produce satisfactory graphics. DO NOT, under this circumstance, make any adjustment to the plotter. There should be no reason to adjust a good plotter only to meet a specified value. At the factory, good plotter performance is achieved through the "tweaking" of a combination of static and dynamic mechanical and electrical parameters. These are rarely exclusively independent of each other.

PEN PRESSURE ADJUSTMENT

Complete adjustment is made with the exposed set screw on the pen holder. See Figure 4-1. Pressure is increased by turning the screw in a clockwise direction. At maximum speed, pen skipping may occur. This can be corrected by increasing the pen pressure.

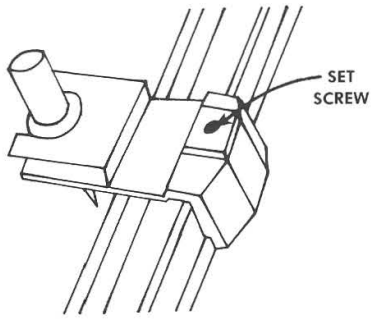


FIGURE 4-1
PEN PRESSURE ADJUSTMENT

For the next seven adjustments, access to the appropriate area may be gained by removing the right end panel (DMP-134) and the front (DMP-523) and rear (DMP-623) side plates. The Pen Changer (DMP-596) Assembly and the two screws securing the changer and left end panel (DMP-134) to the mainframe SHOULD NOT be loosened.

PEN/CHART COINCIDENCE (X-AXIS) ADJUSTMENT

1) A clean chart* should be placed and held on the platen.

2) Remove appropriate enclosures.

3) VERY CAREFULLY push or pull Long Guide Rod (DMP-50) laterally in plane parallel to platen at Pen Changer Assembly end.

4) Cause the pen to draw a horizontal line which must be parallel with line(s) on chart paper. (This is a trial and error adjustment). Repeat steps (3) and (4) until desired accuracy is achieved.

BEAM/CHART COINCIDENCE (Y-AXIS) ADJUSTMENT

1) Place a clean chart* on the platen and hold.

2) Remove appropriate enclosures.

* rectangular graph paper

3) Position and secure beam approximately 1½ inches to the right of the platen center screw.

4) With long shaft Phillips head screwdriver, loosen screw on cable clamp (100-172) on carriage guide block.

5) Reposition beam, using edge of guide rod as reference, to be coincident with vertical line on chart and tighten screw on cable clamp.

6) Cause the pen to draw a vertical line, which must be parallel with line(s) on chart paper. (This is a trial and error adjustment). Repeat steps (5) and (6) until desired accuracy is achieved.

PEN HEIGHT ADJUSTMENT

Refer to Figure 4-2, BEAM/SOLENOID ADJUSTMENT.

1) Remove the appropriate enclosures.

2) VERY CAREFULLY bend the beam/solenoid linkage arm with needle nose pliers until the proper clearance is achieved. (This is a trial and error procedure.)

3) After this adjustment is completed, remove the pen from the carriage.

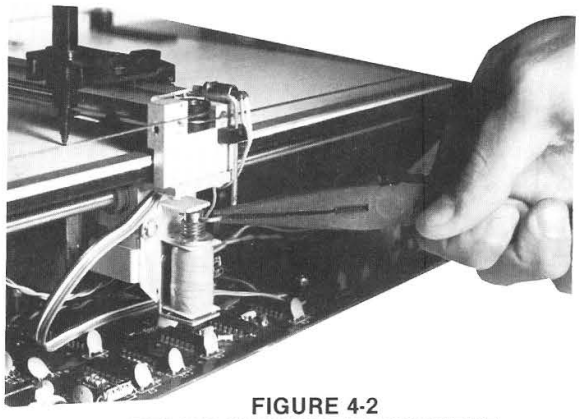


FIGURE 4-2
BEAM/SOLENOID ADJUSTMENT

– X LIMIT ADJUSTMENT

NOTE: The – X Limit Switch must be adjusted if the pen carriage fails to enter the stall far enough to fully grasp the pen or if the carriage continues to drive forward after contact with the pen in the stall.

1) Remove the appropriate enclosures.

2) Place plotter in its normal operating position, with six pens in the stable.

3) Locate the Limit Switch (see Figure 4-3) and the contacting metal tab.

4) VERY CAREFULLY bend the metal tab which pushes against the – X Limit Switch to the direction that will remedy the problem. (This is a trial and error adjustment.)

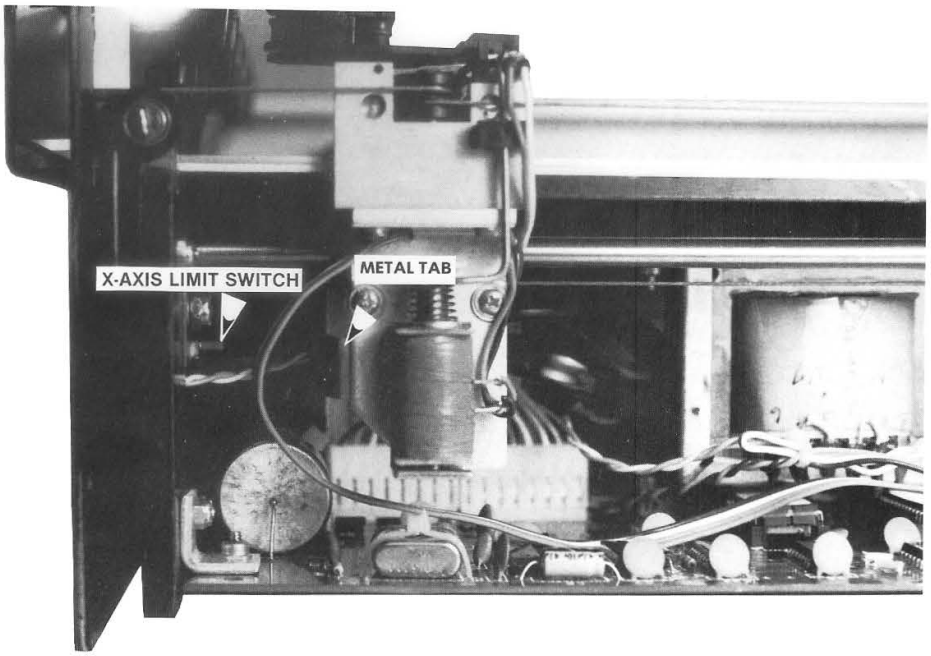


FIGURE 4-3
– X LIMIT SWITCH ADJUSTMENT

5) Run SELF TEST to determine if problem is solved.

Readjust Limit Switch if necessary.

– Y LIMIT ADJUSTMENT

NOTE: The – Y Limit Switch must be adjusted if the pen carriage fails to properly center itself as it enters or exits a pen stall.

1) Remove the appropriate enclosures.

2) Place plotter in its normal operating position with six pens in the stable.

3) Locate the Limit Switch (see Figure 4-4).

4) VERY CAREFULLY bend the switch metal mounting bracket with needle nose pliers until the carriage enters and exits the stall properly (This is a trial and error adjustment).

5) Run SELF TEST to determine if problem is solved.

Readjust Limit Switch if necessary.

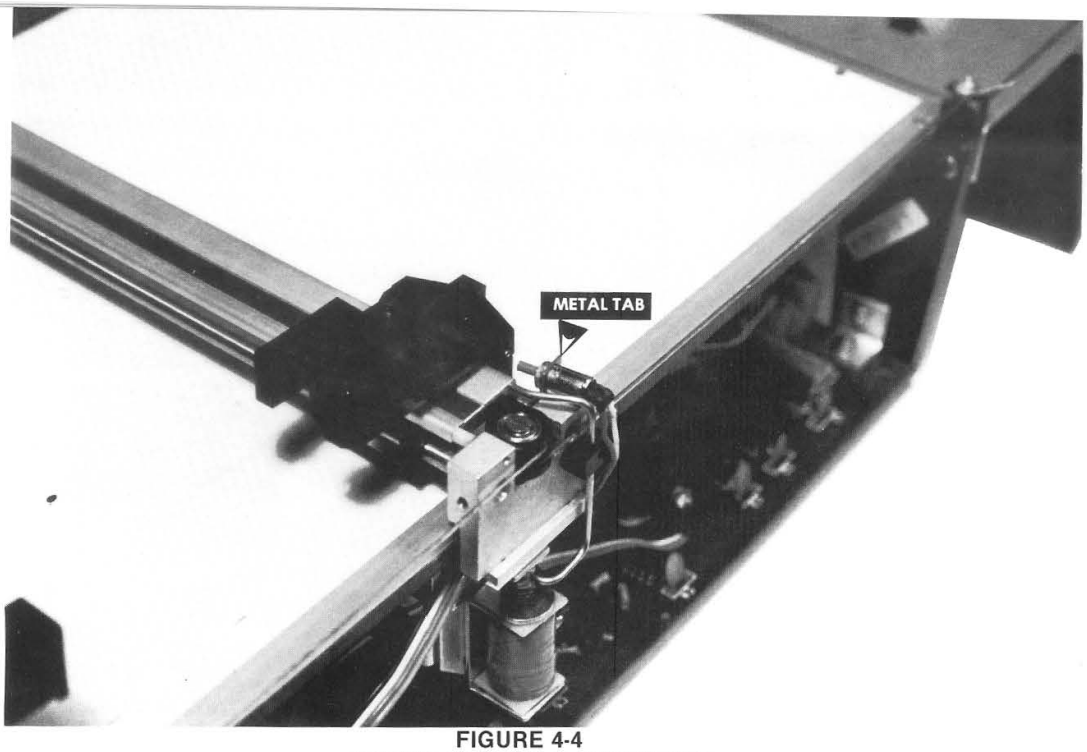


FIGURE 4-4
– Y LIMIT SWITCH ADJUSTMENT

CABLE TENSION ADJUSTMENT

X-AXIS (BEAM)

1) The beam should be positioned near the Pen Changer Assembly.
2) The pen carriage should be centered on the beam.
3) Loosen the Phillips head screws on pulley mount assembly (DMP-702) and move in appropriate direction (i.e., against cable to increase, away from cable to decrease) to achieve desired tension.
4) Tighten bracket and measure tension (This is a trial and error procedure). Repeat steps 3 and 4 until the required tension is achieved.

NOTE: If additional tension is needed, the DMP-700 pulley mount assembly may be used in the procedure.

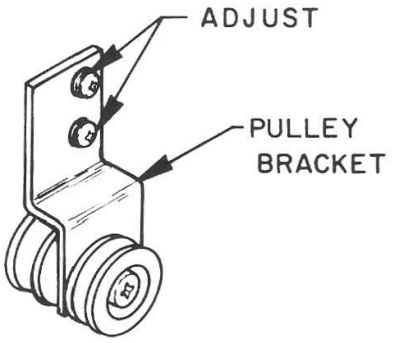


FIGURE 4-5
X-AXIS BEAM TENSION ADJUST

Y-AXIS (PEN)

1) The beam should be positioned near the Pen Changer Assembly.

2) The pen carriage should be centered on the beam.

3) Tighten or loosen in small amounts, the Phillips head screw on the anchor post to achieve required tension. Grasping the free end of the cable with pliers is helpful while performing this adjustment. It also prevents the cable from losing its proper routing on the plotter.

4) Measure tension. (This is a trial and error procedure.) Repeat steps 3 and 4 until the required tension is achieved. After adjusting, move beam gently back to the extreme right and verify that the cable DOES NOT contact the moving beam end.

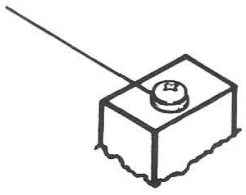


FIGURE 4-6
Y-AXIS PEN TENSION ADJUST

RECABLING OR RESTRINGING

For either of the recabling procedures, the entire Case Assembly should be removed. Adequate work space should be available. The rotation directions, clockwise (CW) and counter clockwise (CCW), are from the viewer who is looking at the pulley.

RESTRINGING THE X AXIS (BEAM)

Refer to Figure 4-7.

1) Remove Case Assembly.

2) Remove all old cable from unit and set pulley mount assemblies (DMP-702 and 700) to slightly less than the center of travel for CABLE TENSION adjustment later; beam should be free.

Now refer to specific items, Figure 4-7.

3) Fasten one end of the cable (7 foot length) securely under the screw head and washer (Item 1).

4) Run the cable up through slot (Item 2) on the drive pulley.

5) Run cable CCW over pulley (Item 3).

6) Run cable CW over pulley (Item 4).

7) Run cable CW over pulley (Item 6).

8) Run cable CCW over pulley (Item 7).

9) Run cable CCW over pulley (Item 8).

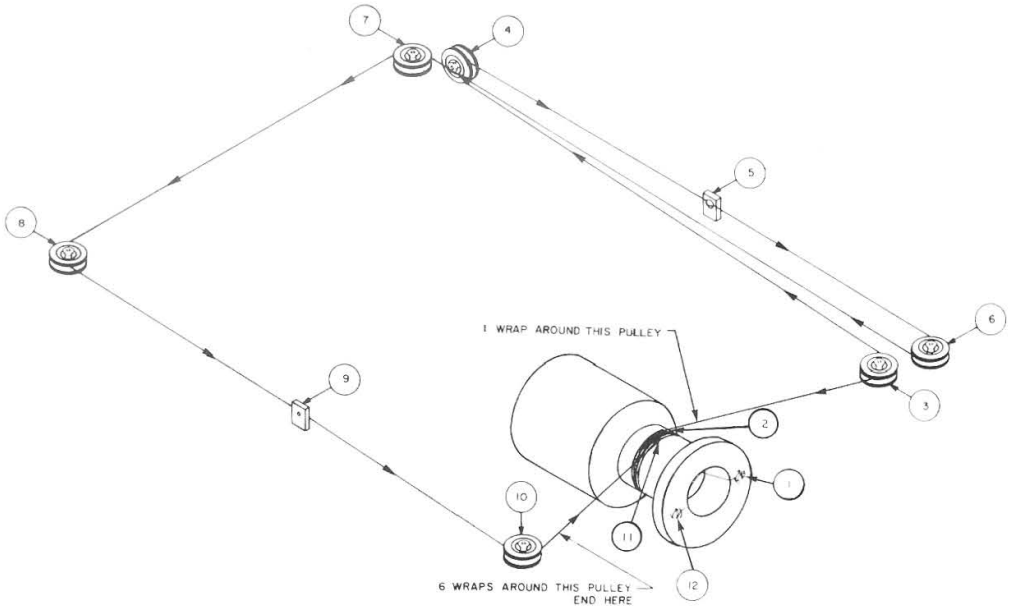


FIGURE 4-7
X-AXIS STRINGING

10) Run cable CCW over pulley (Item 10.)

11) Now, while holding cable taut, rotate drive pulley 5 complete turns CCW; then secure drive pulley. Cable take-up action, moving inward, should wrap the cable 5 times around drive pulley. There should be no overwraps or space between adjacent wraps.

12) Now insert end of cable from Item 10 through slot (Item 2) and fasten under screw head and washer (Item 12). The cable should be taut (no slack, kinks or overwraps).

13) Adjust cable to required tension; see note below.

NOTE: Tension for new cable should be on high side of tension (12 to 14 oz.) requirement as use will cause slight stretching with resultant reduction in tension.

14) Position the Beam Assembly in the mechanical center of its travel.

15) Run the cable through the slots (under the washer and screw) on the cable clamp (Item 5) that is attached to the carriage guide block and the cable clamp, (Item 9) on the carriage beam block (tighten screws).

16) Adjust cable to required tension.

17) Turn the pulley (Item 11) CW, the cable should track toward outer edge of the drive pulley. Turn the pulley (Item 11) CCW, the cable should track toward the inner edge of the drive pulley.

18) Check X-Axis movement of the beam to be sure it tracks the whole length of the chart. If not, reposition pulley shaft (Item 11).

19) Stringing for the X-Axis is complete.

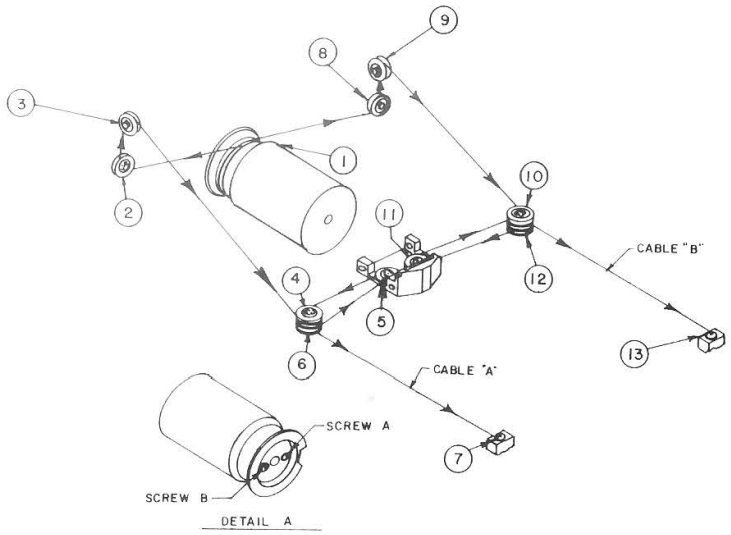


FIGURE 4-8
Y-AXIS STRINGING

RESTRINGING THE Y AXIS (PEN)

Reference Figure 4-8.

1) Remove Case Assembly.

2) Remove Pen Holder Assembly.

3) Remove – Y Limit Switch Bracket (DMP-84), Limit Switch (MS-372) from beam plus Lift Rod Guide (100-138) and Lift Rod (100-138) from Pen Lift Beam (100-127). This will provide access to the pulleys in the Pen Carriage (100-176).

4) Remove all "Y" Axis (pen) cables. (Two cables are used for the Y-Axis).

5) Position beam in center of plotter and secure pen carriage on beam at rear side of plotter.

6) Secure drive pulley with pin or rod in set screw holes stopped by mainframe at about 10 o'clock position.

7) Fasten one end of Cable A securely under head and washer of Screw A (see detail A).

8) Run Cable A CW over center of drive pulley (Item 1) such that wrap travel will be to the center of the plotter (¾ of a wrap will be on drive pulley.)

9) With cable taut run CCW around pulley (Item 2).

10) Run cable CW of the top of pulley (Item 3).

11) Run cable CCW around top pulley, on beam (Item 4).

12) Run cable CCW ½ wrap, on first pulley on pen carriage (Item 5).

13) Run cable CCW, ¼ wrap on bottom pulley (Item 6).

14) Terminate Cable A by fastening in CCW direction under screw head washer that is attached to the mainframe (Item 7). Cable A should be taut.

15) Hold pen carriage and beam and remove securing device.

16) Remove pin from drive pulley.

17) Rotate drive pulley CCW while holding pen carriage to maintain cable taut as the Pen Assembly is pulled to the front side plate.

18) Secure drive pulley to maintain cable tension.

19) Fasten one end of Cable B securely under head and washer of Screw B (see detail A).

20) Run Cable B CCW over center of drive pulley (Item 1) such that wrap travel will be away from plotter (about ½ of a wrap will be on drive pulley).

21) With Cable B taut, run CW around pulley (Item 8).

22) Run CCW over the top of pulley (Item 9).

23) Run CW around top pulley (Item 10).

24) Run CW around second pulley in Pen Carriage Assembly (Item 11).

25) Run CW around bottom pulley (Item 12).

26) Terminate Cable B by fastening in CW direction under screw head and washer that is attached to mainframe (Item 13).

27) Adjust cable to required tension; see note below.

NOTE: Tension for a NEW cable should be on the high side (11 to 13 oz.) of the tension requirements as use will cause slight stretching with resulting reduction.

ALSO NOTE: The plotter has performed satisfactorily after only one defective cable was replaced. Therefore, it is unnecessary to replace both cables if only one is defective.

28) Check Y-Axis movement of the pen carriage and be sure it tracks the whole length of the chart. If it doesn't, reposition the pulley shaft (Item 1).

29) Stringing of the Y-Axis is complete.

REMOVAL/REPLACEMENT AND PART IDENTIFICATION

TRS-80 MULTI-PEN PLOTTER major assemblies are identified as follows:

A. Pen Changer Assembly DMP-800

B. Plotter Case Assembly DMP-612

C. Mainframe Assembly DMP-801

D. Beam Assembly DMP-802

E. Stepper Motor Assembly DMP-803

F. Transformer Assembly DMP-805

G. Power Panel Assembly DMP-804

H. Logic Board Assembly DMP-628

The foregoing are illustrated in Figure 4-9.

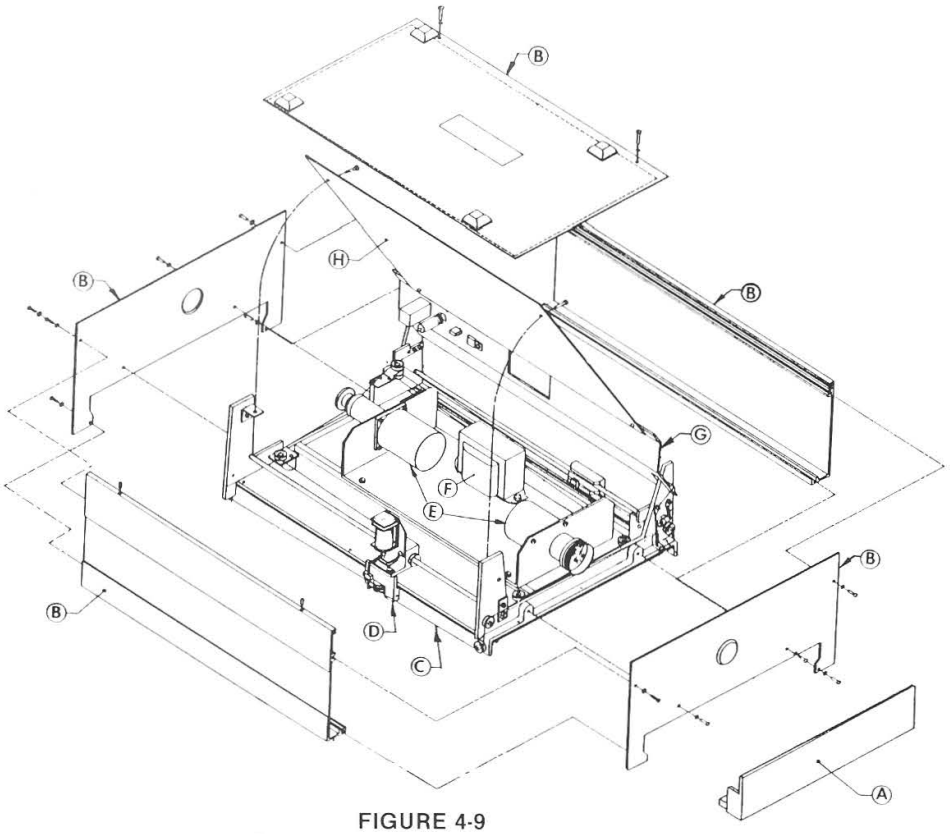


FIGURE 4-9
DMP-3T MAJOR ASSEMBLIES
DMP-596

A. PEN CHANGER ASSEMBLY DMP-800 (See Figure 4-10)

Reference Number	MFGR P/N	Description	Radio Shack P/N
A1	DMP-387	Pivot Rod	
A2	DMP-600	Stable	
A3	DMP-657	Stable Bracket	
A4	HR29-90	Pen Stall	
A5	DMP-602	Decal	
(Location Shown) A6	Bulk Hardware	Truarc Retaining Pins	

TABLE 4-1

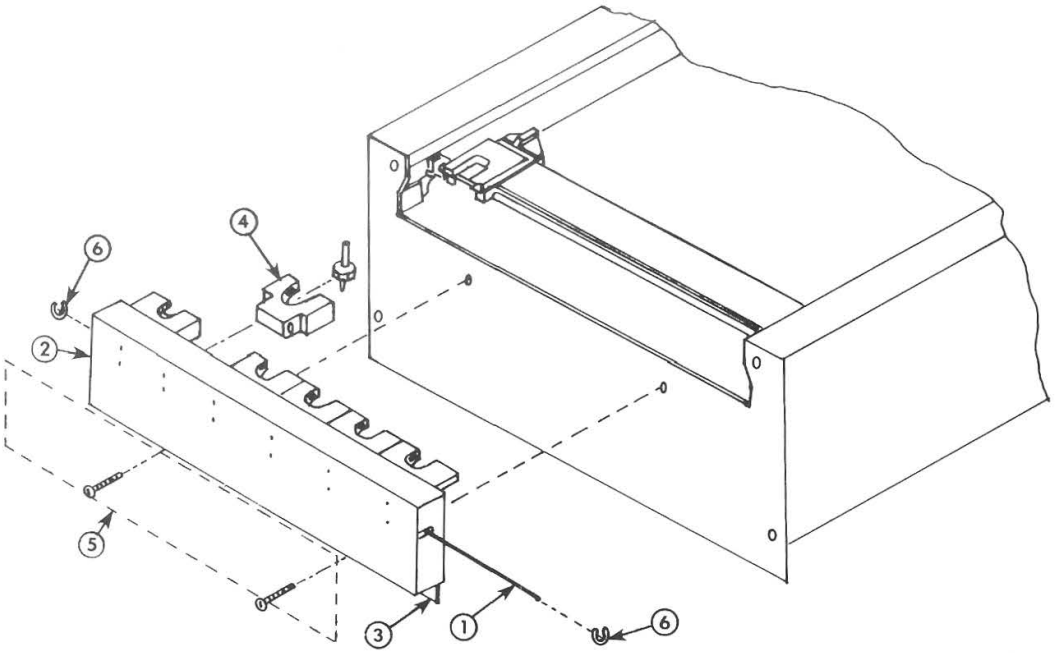


FIGURE 4-10
PEN CHANGER ASSEMBLY

FUNCTION

The Pen Changer Assembly serves as a repository for different colored pens which are used to provide colored graphics.

REMOVAL/REPLACEMENT

TOOLS REQUIRED — Phillips Screwdriver, TRUARC Assembly Pliers

1) Remove the Pen Changer Assembly from the plotter.

2) Remove TRUARC retainer from the pivot rod.

3) Pull pivot rod a sufficient distance out of the stable to remove the defective pen stall.

PRECAUTIONS ON REPLACEMENT

Mount one stall at a time on stall pivot rod.

Last stall must be hand-held while pivot rod is pushed through hole in stall. Pressure must then be applied to end opposite of pivot rod while applying TRUARC retaining ring thereon.

ADJUSTMENT DURING ASSEMBLY

After assembly, the replaced stall may require adjustment of the two bristol set screws in order that the stall has sufficient vertical movement such that the pen is appropriately replaced/removed each time the carriage enters the stall. (This is a trial and error adjustment in the field).

B. PLOTTER CASE ASSEMBLY DMP-612 (See Figure 4-11)

Reference Number	MFGR P/N	Description	Radio Shack P/N
B1	DMP-133	Panel, End, Left	
B2	DMP-134	Panel, End, Right	
B3	DMP-523	Plate (Mod. DMP-524) Side, Narrow (Rear)	
B4	DMP-623	Plate (Mod. 100-168) Side, Wide (Front)	
B5	DMP-137	Cover, Bottom	
B6	MR-618	Foot	
B7	DMP-530	Sound Dampener - Bottom	
B8	DMP-528	Sound Dampener - Front and Rear Plate(s)	
B9	DMP-529	Sound Dampener - Front	
B10	DMP-531	Sound Dampener - Right Side	
B11	DMP-525	Sound Dampener - Lt. Side	
B12	DMP-290	Switch, Escutcheon	
B13	DMP-622	Label - Tandy (not shown)	
B14	DMP-627	Assy., Cable - Keyboard (not shown)	
B15	DMP-603	Label, Blank	

TABLE 4-2

FUNCTIONS

The Plotter Case Assembly is the outer enclosure for plotter; it denies operator access to the hazardous voltages which are inside the unit and provides protection for the mechanical assemblies, cable, pulleys and electrical components. The enclosures also contain undesired electromagnetic energy within the unit.

REMOVAL/REPLACEMENT

TOOLS REQUIRED — Phillips Screwdriver, Bristol splined set screw wrench

1) Remove Pen Changer Assembly (see major Assembly A).
2) Remove bottom cover after taking set screws out of wide side plate.
3) Remove end panels.
4) Disconnect plug P7 from J7.

PRECAUTIONS

1) Remove the rear side panel cautiously in order to avoid seizure of or damage to the switch escutcheon cable.
2) The front edge of the bottom cover must be properly fitted into the appropriate recess in the front (wide) side plate in order that set screws make metal to metal contact for RFI grounding purposes.

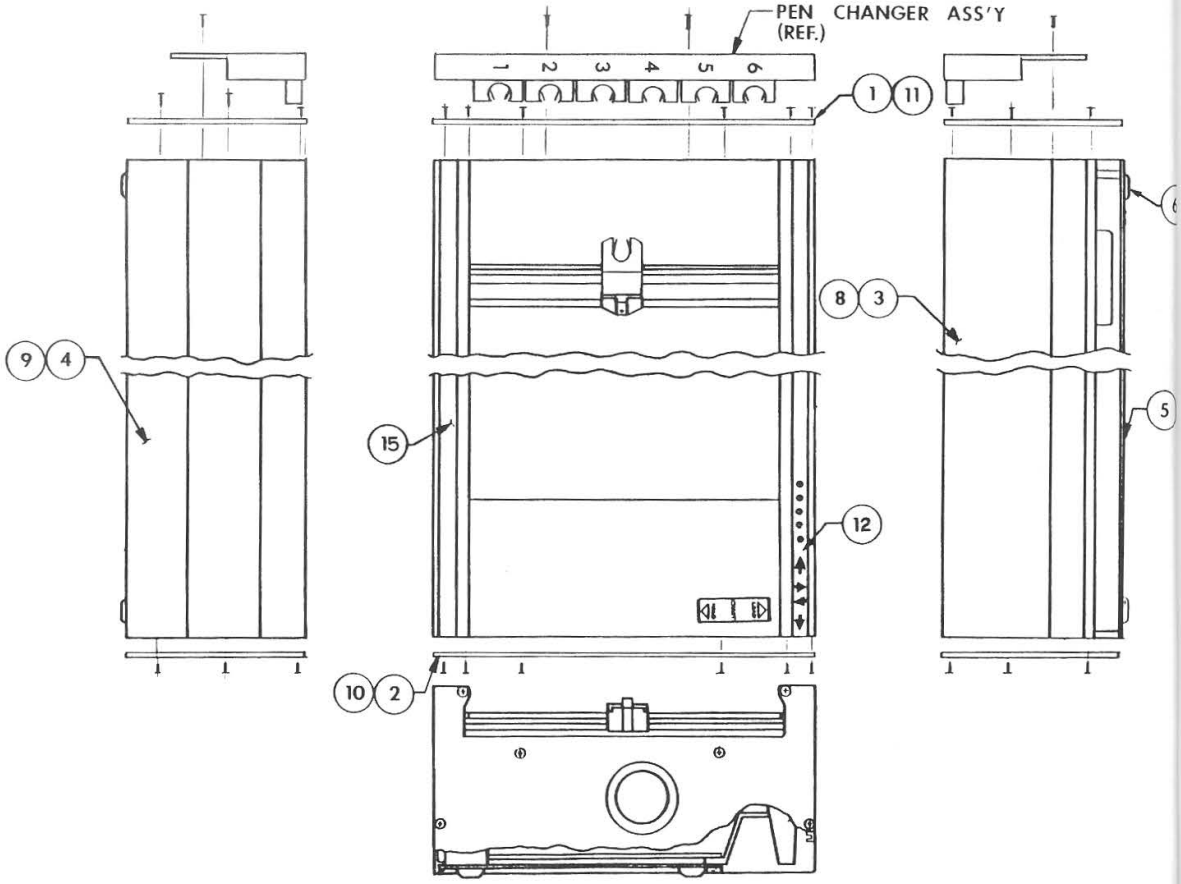


FIGURE 4-11
DMP-612 CASE ASSEMBLY

C. MAINFRAME ASSEMBLY DMP-801 (See Figure 4-12)

Reference Number	MFGR P/N	Description	Radio Shack P/N
C1	100-147	Frame, Molded	
C2	DMP-664	Platen, Tandy	
C3	100-150	Guide (MOD 100-162), Paper	
C4	100-182	Pin, Retainer Mount	
C5	100-143	Stop, Zee Panel	
C6	DMP-50	Rod, Guide Long Axis	
C7	DMP-74	Pen Bar, Spring Loaded	
C8	100-133	Plate, Shaft Locating	
C9	DMP-710	Assy., Pulley	
C10	DMP-701	Assy., Pulley Bracket	
C11	DMP-700	Assy., Pulley Mount	
C12	DMP-702	Assy., Pulley Bracket	
C13	MS-661	Switch, Pushbutton	
C14	6550-90	Spring, Roller	
C15	MC-1386	Cable, Cycle Flex	
C16	100-171	Angle, PCB Retainer	
C17	100-186	Slide, Molded	
C18	100-492	Assy., Bar & Paper Retainer	
C19	100-353	Assy., Paper Retainer	
C20	100-188	Bar, Lift	
C21	100-131	Button, Slide	
C22	MS-180	Spring, Lee #E1-012-B4	
C23	DMP-185	Bracket, Limit SW X-Axis	
C24	DMP-186	Bracket, SW, Actuator	
C25	DMP-615	Paper Stop (clips on pen stable)	

TABLE 4-3

FUNCTION

The Mainframe Assembly serves as the basic structure for the plotter. The plotting surface is mounted on the mainframe.

REMOVAL/REPLACEMENT

NOTE: For access to most of the components and subassemblies mounted on the mainframe, remove the right end panel plus the front and rear side plates. This will retain the Pen Changer Assembly mounted to the mainframe and, therefore, not require unneeded adjustments.

Restringing and complete removal of the beam will require full removal of the Case Assembly.

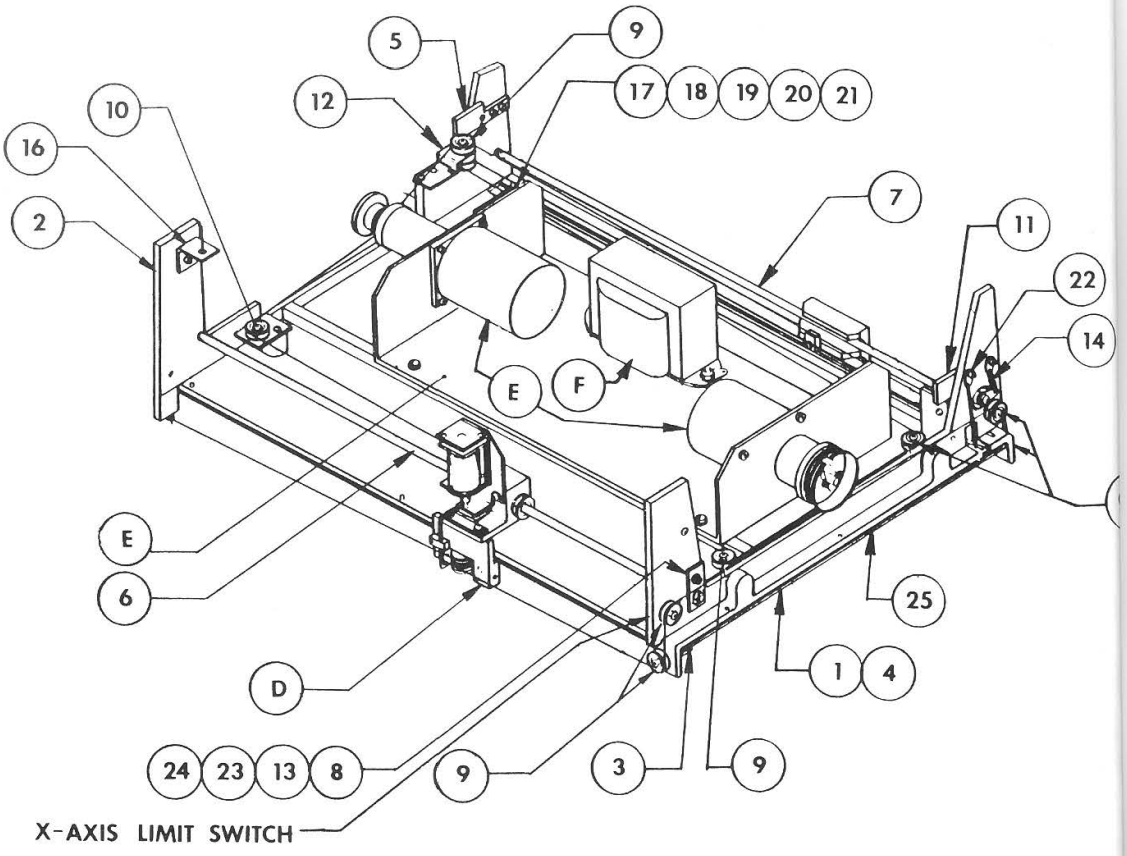


FIGURE 4-12
MAINFRAME ASSEMBLY DMP-611

D. BEAM ASSEMBLY DMP-802 (See Figure 4-13)

Reference Number	MFGR P/N	Description	Radio Shack P/N
D2	100-124	Carriage Guide Block	
D3	100-176	Pen Carriage	
D4	100-129	Guide Rod	
D5	100-141	Flat Cable Clamp	
D6	100-174	Carriage Beam Block	
D7	100-172	Cable Clamp	
D8	100-135	Nut Plate	
D9	100-183	Pen Pressure Spacer	
D10	HR29-100	Pen Holder Assy.	
D11	HR29-93	Spring	
D12	100-127	Pen Lift Beam	
D13	100-175	Beam Guide Mount	
D14	DMP-75	Beam Spacer	
D15	DMP-711	Beam Pulley	
D16	DMP-302	Linear Bearing	
D17	2000-192	Pen Pressure Spring	
D18	DMP-710	Pulley	
D19	100-139	Solenoid Mount	
D20	100-122	Solenoid Modified	
D21	DMP-689	Lift Rod Guide	
D22	100-138	Lift Rod	
D23	DMP-51	Solenoid Spring	
D24	DMP-201	Solenoid Cable Assy.	
D26	MC-1453	2-Pin Connector	
D27	DMP-184	Limit Switch Bracket	
D28	MS-661	Switch and Wire	
D29	100-277	Pen Lift Decal	
D30		Roll Pin, 3/8	
D31	DMP-527	Sound Deadener Beam	

TABLE 4-4

FUNCTION

The Beam Assembly is constrained to move along the X-Axis of the mainframe and also provides the means for movement of the pen along a Y-Axis. It also provides movement of the pen (up or down) along the Z-Axis.

REMOVAL/REPLACEMENT

TOOLS REQUIRED —

Remove Plotter Case Assembly.

NOTE: After the Plotter Case Assembly has been removed nearly all of the components are exposed. Except for the cable or an associated bearing, it is easy to remove or replace a specific component or make a required adjustment. If replacement of the guide rods, Pen Carriage Assembly, pen carriage block, pen guide mount, linear bushing or carriage beam block are necessary, then recabling will also be required. Continue the removal/replacement as follows:

1) Push the beam to the right end of the mainframe.

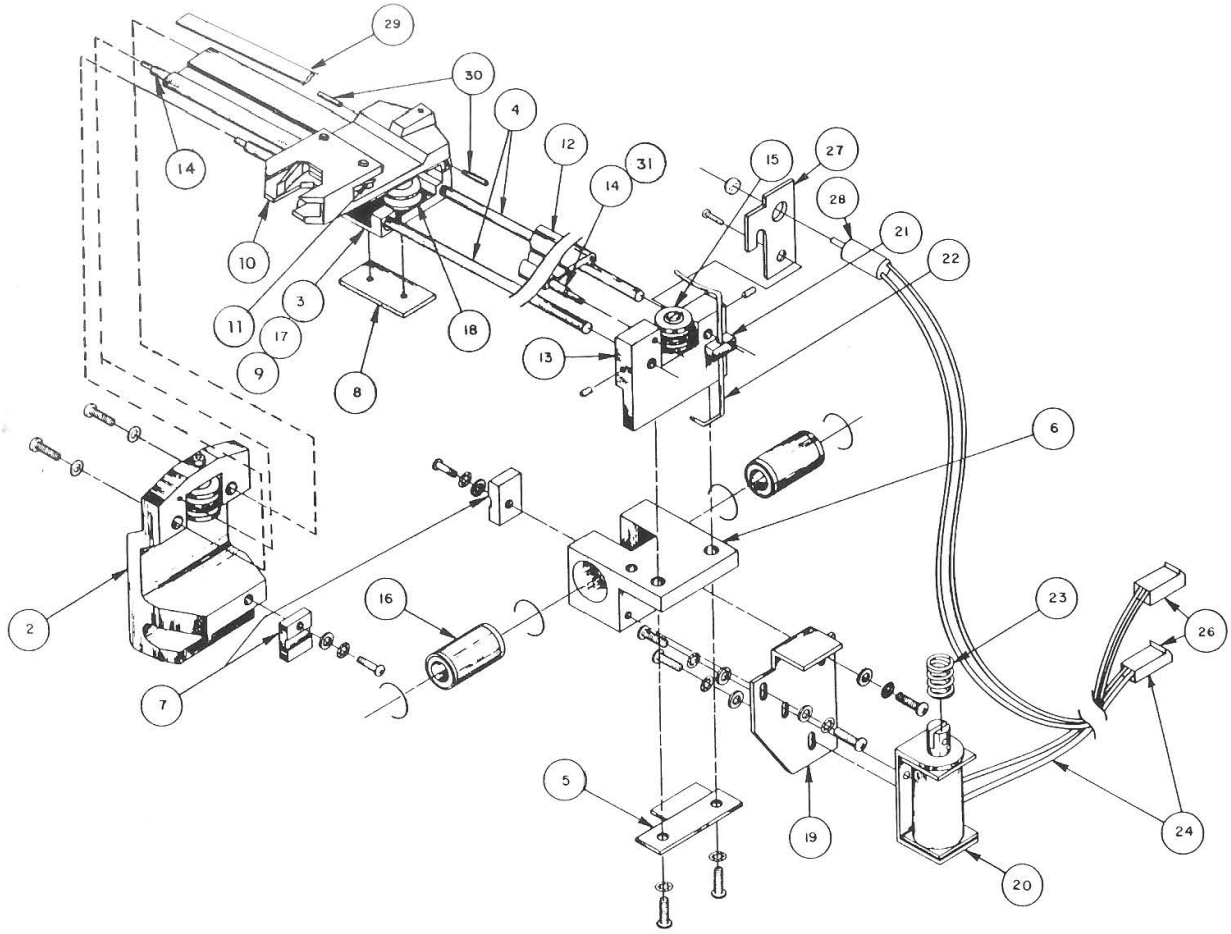


FIGURE 4-13
DMP-634 BEAM ASSEMBLY

2) Pull the rod guide, long axis (DMP-50), from the opposite end until the beam carriage block (100-124) is free.

3) Loosen Phillip head screws on cable clamps to free cable from the Beam Assembly.

4) Remove one Phillip head screw and loosen the other on the lower portion of beam block. Twist relay mounting bracket to provide adequate clearance and very carefully lift assembly and remove from plotter.

5) Remove both Y-Axis cables from plotter.

6) Remove/replace defective component.

E. STEPPER MOTOR ASSEMBLY DMP-803 (See Figure 4-14)

Reference Number	MFGR P/N	Description	Radio Shack P/N
E1	DMP-1	Mount, Motor	
E2	MM-83	Motor, Stepper	
E3	DMP-305	Pulley, Beam (X) Axis	
E4	DMP-304	Pulley, Pen (Y) Axis	
E5	MC-1454	Conn. 8 Pin Female, 22 AWG	

TABLE 4-5

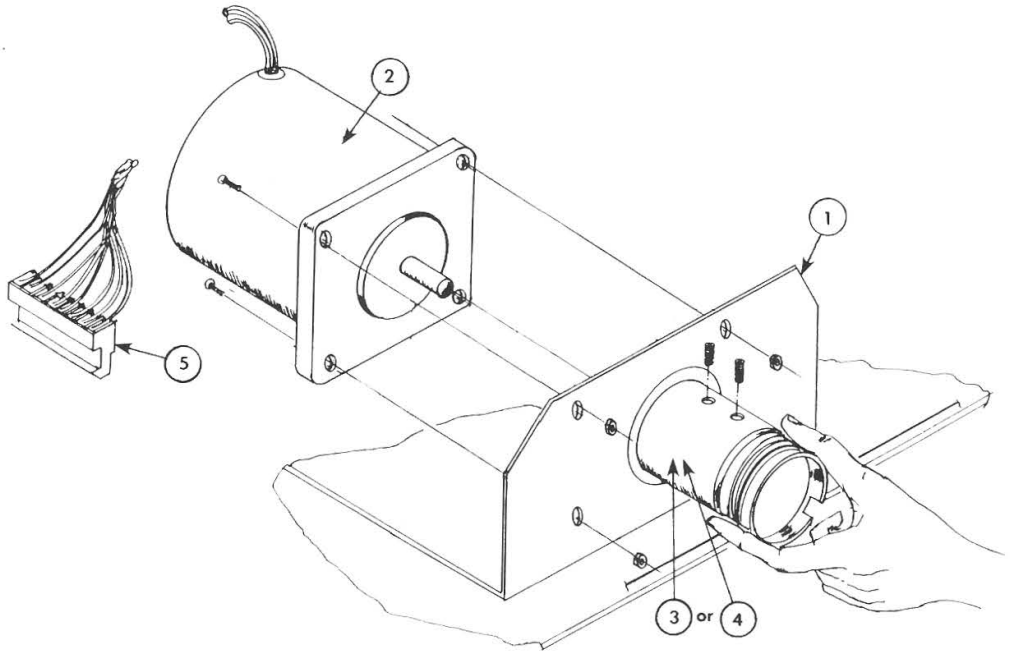


FIGURE 4-14
STEPPER MOTOR ASSEMBLY

FUNCTION

Provides the means that cause the controlled displacement of the beam and pen (X and Y-Axes).

REMOVAL/REPLACEMENT

TOOLS REQUIRED — Phillips head screwdriver, Bristol splined set screw wrench

1) Center pen or beam and also center beam on plotter.
2) Loosen set screws in pulley.
3) Remove motor retaining screws and replace defective stepper motor.

PRECAUTIONS (on Removal/Replacement of Stepper Motor):

1) The pulley must be secured or held in place so that the cable (string) does not unravel or is otherwise displaced.
2) When mating pulley to stepper motor shaft, the original spacing between pulley and flange should be maintained.
3) Manually displace pen or beam, as appropriate to the extreme ends, to insure the cable does not overwrap on the pulley.

F. TRANSFORMER ASSEMBLY DMP-805 (See Figure 4-15)

Reference Number	MFGR P/N	Description	Radio Shack P/N
F1	DMP-1	Motor Mount	
F2	MC-1455	Connector, 3 Pin Female	
F3	MT-147	Transformer, Power	

TABLE 4-6

FUNCTION

Reduce A.C. input voltage so it can be converted to low voltage direct current for use in the plotter.

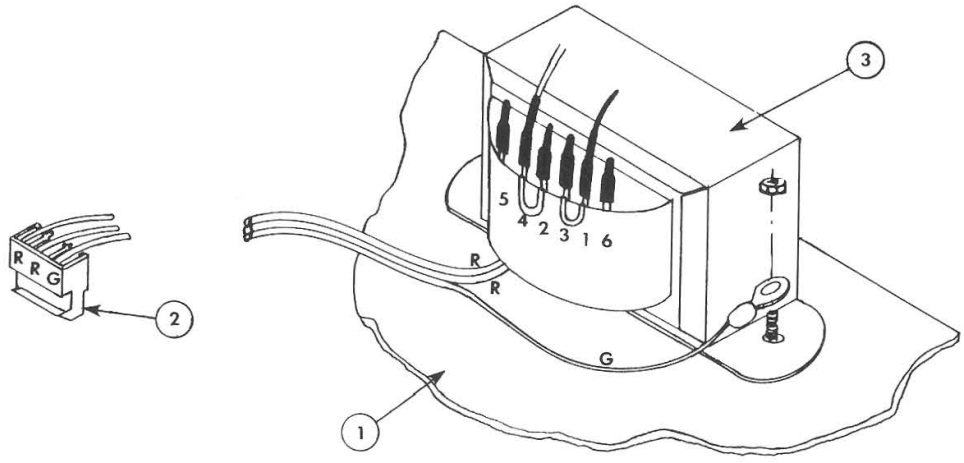


FIGURE 4-15
TRANSFORMER ASSEMBLY

G. POWER PANEL ASSEMBLY DMP-804 (See Figure 4-16)

Reference Number	MFGR P/N	Description	Radio Shack P/N
G1	DMP-566	Panel, Zee	
G2	DMP-618	Label, Zee Panel	
G3	DMP-670	Label, Fuse Spec.	
G4	MF-31	Fuse ½ AMP SLO BLO	
G5	MF-83	Fuseholder, (Low Profile)	
G6	MC-1445	AC Line Filter	
G7	MF-84	Fuse Carrier, 3AG	
G8	MS-640	Switch, Toggle	
G9	MW-578	Washer, Shoulder	
G10	MW-440	Washer, Insulating MICA	
G11	DMP-488	Assy., Voltage Regulator	
Not shown	MC-1184	Power Cord	

TABLE 4-7

NOTE: Each of the above components can be removed/replaced after the Zee panel assembly is rotated outward from the plotters frame, i.e., you don't need to remove it from the mainframe for component removal/replacement. If the Zee panel must be replaced, then continue.

REMOVAL/REPLACEMENT

TOOLS REQUIRED — Flat Screwdriver

1) PLOTTER'S CASE MUST BE REMOVED.
2) With plotter resting on right end, very carefully apply downward force on rear right leg (narrow) of plotter frame while pulling Zee panel away from leg. Hinge pin should come out of retaining hole.
3) At opposite end of Zee panel, insert flat blade screwdriver between outer edge of cut-out and plotter frame (chassis).
4) While holding plotter, rotate screwdriver VERY CAREFULLY CW to free hinge pin from its retaining hole.

H. LOGIC BOARD ASSEMBLY DMP-628 (See Figure 4-17)

Reference Number	MFGR P/N	Description	Radio Shack P/N
H1	DMP-631	Board, Logic Plotter	
H2	MS-155	Socket	
H3	MS-156	Socket, 40 pin D/P	
H4	MS-488	Socket, 18 pin Burndy	
H5	MS-523	Socket, 28 pin IC	
HC1,2,3,4,5,7,9, 12,13,14,15, 16,17,18,20, 21,23,24,25,26 & 32	MC-448	Cap. .1Mfd. 10V cer.	

TABLE 4-8

TABLE 4-8 cont'd.

Reference Number	MFGR P/N	Description	Radio Shack P/N
HC6,29	MC-535	Cap. 1Mfd. 35V 10% Tant	
HC8,27,30	MC-1355	Cap. 47Mfd. 10V Tant	
HC10,11	MC-395	Cap. 30Pfd. 1000V 20% Cer.	
HC19,33,37,38	MC-579	Cap. .01Mfd. 1000V Cer.	
HC22	MC-542	Cap. 10Mfd. 35V Lytic	
HC27,28	MC-1235	Cap. 47Mfd. 20V Tant	
HC31	MC-1225	Cap. 8500Mfd. 25V	
HCR1,2,3,8,9,10, 13,20	MD-25	Diode IN4005	
HCR4,5,6,7	MD-126	Diode IN5624	
HJ2	MC-1457	Conn, 3 pin Male	
HJ5	MC-1458	Conn, 2 pin Male	
HJ7	MC-1459	Conn, 12 pin Male	
HJ9	MC-1456	Conn, 8 pin Male	
HJ10	MC-1069	Conn, 3 pin right angle	
HJ11	MC-1677	Conn, 25 pin right angle	
HQ1—9	MQ-75	Transistor MJE-800 + L54Z	
HQ10	MQ-28	Transistor MPS-6531	
HQ11	MQ-29	Transistor MPS-6534	
HR1	MR-819	Res. 20016 5% ¼WCF	
HR2	MR-310	Res. 10016 5% ¼WCF	
HR3	MR-170	Res. 390 ohm 5% ¼WCF	
HR4,5,6,9	MR-972	Res. 470 ohm 5% ¼WCF	
HR7,18	MR-470	Res. 10K 5% ¼WCF	
HR8	MR-107	Res. 220 ohm 5% 1/3WCF	
HR10	MR-823	Res. 100 ohm 5% ¼WCF	
HR11,13,16,19,20	MR-963	Res. 1K 5% ¼WCF	
HR12,17	MR-979	Res. 4.7K 5% ¼WCF	
HR14,15,21	MR-1183	Res. 3K 5% ¼WCF	
HR22,23	MR-10	Res. 47 ohm 5% ½WCC	
HU1,10,28	MW-551	I.C. MC14503BCPD	
HU2,4,6,7	MW-497	I.C. 74LS32	
HU3	MW-356	I.C. 74LS42NS	
HU5	MW-342	I.C. 74LS00N/B +	
HU8	MW-349	I.C. 74LS123N/B +	
HU9	MW-354	I.C. 74LS02N/B +	
HU11	MW-414	I.C. 74LS245N	
HU12,13	MW-479	I.C. MM2114N-L	
HU14	MW-701	I.C. ROM2732	
HU15	MW-700	I.C. ROM2716-T8	
HU16	MW-549	I.C. 74LS374	
HU17	MW-351	I.C. 74LS04N/B +	
HU18,26	MW-348	I.C. 74LS74N/B +	
HU19	MW-344	I.C. 74LS14N/B +	
HU20	MW-474	I.C. Z80CTC	
HU21	MW-387	I.C. Z80CPU	
HU22,23	MW-427	I.C. 74LS244N	
HU24	MW-343	Res. Network - 470 ohm	
HU25	MW-568	Res. Network 10K	
HU27	MW-243	I.C. CD4040 BC PR	
HU29	MW-322	Res. Network 10K	
HU30	MW-433	I.C. AYA-1014A	
HY1	MC-1354	Crystal, JAN 4.9152 MHz	

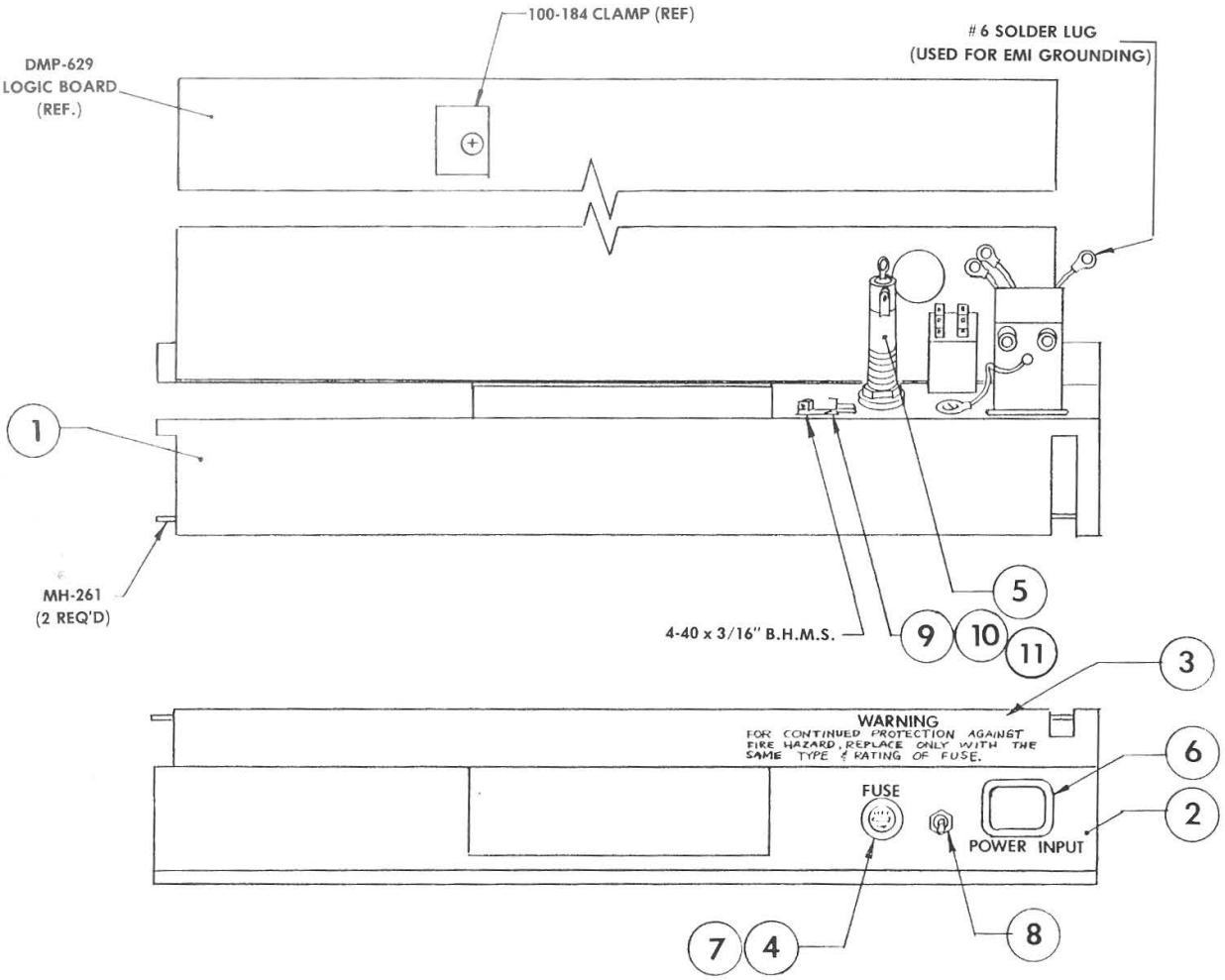


FIGURE 4-16
POWER PANEL ASSEMBLY DMP-617

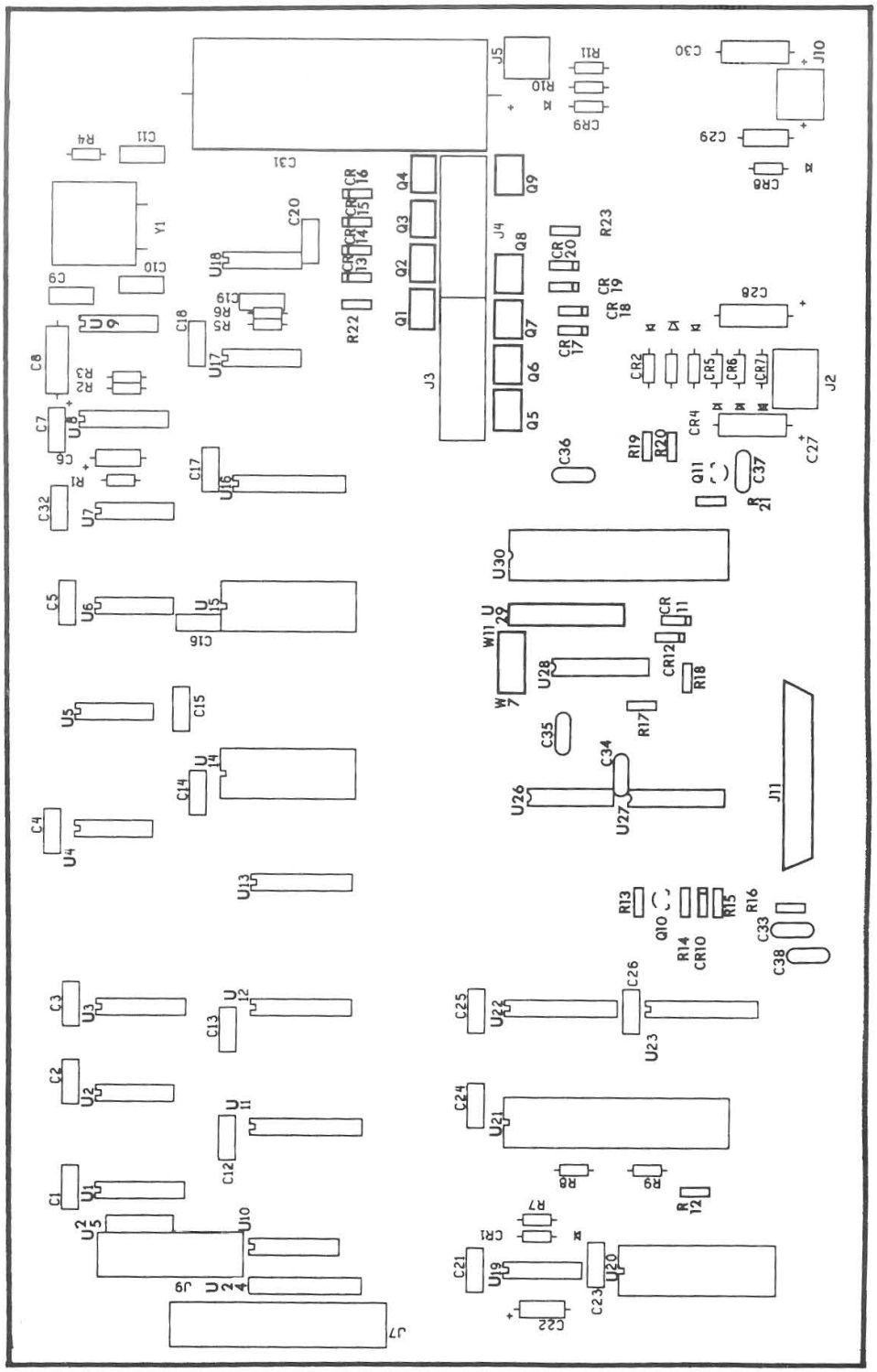


FIGURE 4-17
DMP-629 LOGIC BOARD

FUNCTION

Provides the electronic circuitry for the plotter.

REMOVAL/REPLACEMENT

TOOLS REQUIRED — Phillips head screwdriver, flat blade screwdriver, Bristol splined set screw wrench.

1) Remove bottom cover.

2) Remove PCB retaining screws.

3) Disconnect cables; remove PCB.

TROUBLESHOOTING

CIRCUIT BOARD AND REPAIR

The circuit boards in the plotter are of the "plated-through-hole" variety. The proper method must be used to replace parts or the boards will be damaged, resulting in poor reliability.

USE A SMALL SOLDERING IRON — Excessive heat will lift the circuit foil off the board. Always use a small iron (less than 50 watts) with the tip properly tinned.

CLEAN HOLE WITH A WOOD OBJECT — After removing a component, clean the hole with a toothpick or a sharp wooden stick. DO NOT use a metal pointed object. This might damage the plating in the hole and result in intermittent operation of the plotter.

REPLACING VOLTAGE REGULATOR — Silicon grease should be applied evenly to both sides of the insulators when replacing the regulator on the Zee panel.

EPROM HANDLING — EPROM inputs are susceptible to damage by high voltage and static charges. Particular care should be exercised when handling EPROMS where static charges can build up.

NOTE: Before attempting to troubleshoot the plotter, make certain that the problem is not caused by improper data source switch settings, broken wires, loose connectors, or incorrect input. Check and insure that the proper power is available at the wall outlet, that the power cord is properly mated and the fuse is not blown.

MECHANICAL CONSIDERATIONS

Since many symptoms can be caused by either mechanical or electrical failures, it is wise to first isolate those causes. It is believed that about 80% of the plotter problems are attributable to mechanical malfunctions. For quick fault isolation, the following table (Table 4-9) is provided for guidance in Mechanical troubleshooting.

SYMPTOM	TROUBLE	REMEDY
1. Pen won't write.	a. Element bad or out of ink.	a. Manually check and replace.
	b. Insufficient pressure.	b. Adjust - See Pen Pressure Adjustment, page 15.
	c. Possible binding solenoid mechanism.	c. Check solenoid.
2. Pen UP/DOWN inoperative.	a. Faulty solenoid.	a. Check continuity and/or pressure of solenoid power when the pen is activated down.
	b. Faulty drive circuit.	
3. Ragged trace.	a. Pen element improperly installed.	a. Manually check.
	b. Improper axis cable tension.	b. See Cable Tension Adjustment, page 18.
	c. Loose set screws in X or Y-Axes.	c. Check and tighten screws if necessary.
4. Beam or pen carriage does not traverse the entire plotting surface.	a. Axis stringing improper.	a. Restring axis, See Recabling or Restringing, page 19.

TABLE 4-9
MECHANICAL TROUBLESHOOTING GUIDE

In event the cause of the difficulty is not located, the mechanical troubleshooting possibility should be continued through observing the performance of a suspected defective component. As appropriate, check the following before proceeding to the electrical/electronics troubleshooting section for the problem.

1) Connectors are generally a source of the problem.

2) Control panel switches and the solenoid.

3) Excessive dirt or other contaminant accumulations.

4) Cable conditions and tension.

5) Observe cable track on bearings under dynamic conditions — these should run true, no deviations or wobbles.

6) Manually move the Y-Axis (pen carriage from limit to limit. While moving, listen for abnormal sounds and feel for sluggishness or seizures during the carriage travel, or at its limits. Do the same for the X-Axis (Beam). Repair or adjust as necessary.

7) Install pens in Pen Changer Assembly and run self test. Observe that pen change operations are smooth and the pen traces are of good quality — i.e., no smears, pen skipping, no loss of axis motion, or origin or other imperfections that may be cured mechanically.

ELECTRICAL/ELECTRONIC TROUBLESHOOTING

ACCESS FOR TROUBLESHOOTING

Access to most components or the printed circuit board and other points within the plotter can be gained via removal of the bottom cover and the two retaining screws on the Logic Board. The Logic Board will now swing outward from the plotter providing adequate work area. The internal cable connections to the printed circuit board are given in Figure 4-18.

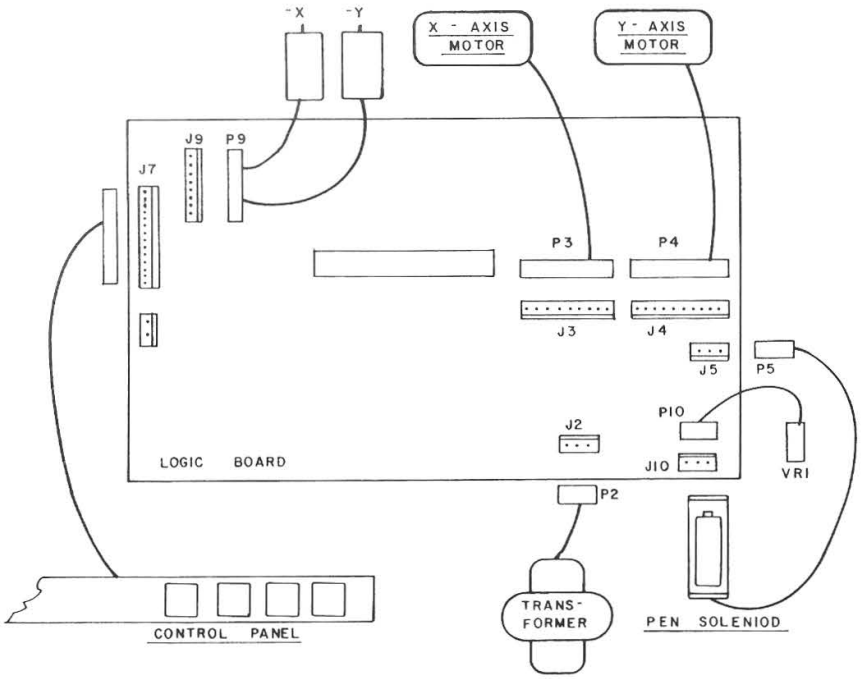


FIGURE 4-18
INTERNAL CABLE CONNECTIONS

The Electrical Troubleshooting Guide (Table 4-10) should be used before resorting to conventional troubleshooting techniques.

CONVENTIONAL TECHNIQUES

Conventional troubleshooting techniques can be used by trained service personnel. With a good digital VOM and an oscilloscope (Phillips Model 3225 or equivalent) and the schematic wiring diagrams, most problems can be isolated down to the component level. The following are included for consideration:

1) CONTINUAL FUSE BLOWING — The most likely area to cause the fuse to blow is the power supply, which is shown in the wiring diagram section of this book. In reference to that schematic, the power supply consists of transformer T1, diode bridge rectifier CR4 thru CR7, capacitors C27, C28 and C31, also diodes CR3 and 8.

SYMPTOM	REMEDY
1. Plotter completely inactive, with power switch on.	a. Check A.C. power. b. Check fuse. Replace blown fuse once. If fuse blows again, refer to 1) Continual Fuse Blowing, page 39. c. Check power switch electrically. d. Check power cord for broken wires or damaged prongs. e. Check transformer output. f. Check +5VDC.
2. Both axes dead; pen operation OK.	a. P3 and P4 disconnected. b. Logic Board defective.
3. One axis dead or intermitting.	a. Check limit switch. b. Interchange stepper motor connectors (P4 and P3). c. Defective drive transistor. d. U16 heat sensitive. e. Logic Board defective.
4. Pen inoperative.	a. Check (connect) P5. b. Check pen solenoid. c. Check pen enable. d. Logic Board defective.
5. No plot function (remote) runs in self test.	a. Check for proper baud rate. b. Check connector J11. c. Check crystal oscillator pin 10, U17. d. Check pin 2, J11. e. Logic Board defective.
6. No self test.	a. Check X and −X position switches. b. Check +5VDC. c. Check EPROM data lines. d. Check RAM data lines. e. Logic Board defective.

TABLE 4-10
ELECTRICAL TROUBLESHOOTING GUIDE

To start, turn the plotter on and measure the voltage across C31. The nominal voltage is 15 volts. If the voltage is less than 10 volts or the fuse blows again, turn the plotter off. Disconnect P3 and P4 and turn the plotter on. If the power stays up (the fuse does not blow), replace P3 and P4 one at a time until the motor which blows the fuse is located. Check the motor winding resistance (each winding should be about 20 ohms), the motor drive transistors Q1-8 and the diodes CR13-20.

2) PEN CIRCUITS — Make sure the circuits are receiving power and that + mV (about + 15 volts) is present at J5, pin 2. If + mV is OK, check Q9 and IC9.

3) RS-232-C SERIAL INPUT — Be sure that the RS-232-C RECD DATA J11 pin 2 is within specifications. (A "1", voltage between − 3V to − 25 DC or a "0", voltage from + 3 and + 25 VDC). If this is correct (by oscilloscope observation), check the output of Q10 for a pulse train (a TTL level should be apparent).

The next check should be for the presence of data at the input of U30 (pins 4, 18, 20, 23). If data is present and correct then U30 is probably defective. If the data is incorrect then check oscillator's output at pin 11 of U18. It should be nearly a square wave of 4.9152 MHz. If the oscillator frequency is correct, then the probable fault lies in U17 or U18 and the process of isolating the fault must be continued.

5/MASTER PARTS LIST

MECHANICAL

A — PEN CHANGER ASSEMBLY DMP-800

Reference Number	MFGR P/N	Description	Radio Shack P/N
A6	Bulk Hardware	TRUARC Retaining Pin	
A2	DMP-600	Stable	
A3	DMP-657	Stable Bracket	
A1	DMP-387	Pivot Rod	
A5	DMP-602	Decal	
A4	HR29-90	Pen Stall	

B — PLOTTER CASE ASSEMBLY DMP-612

Reference Number	MFGR P/N	Description	Radio Shack P/N
B1	DMP-133	Panel, End, Left	
B2	DMP-134	Panel, End, Right	
B3	DMP-523	Plate (Mod. DMP-524) Side, Narrow (Rear)	
B4	DMP-623	Plate (Mod. 100-168) side, wide (front)	
B5	DMP-137	Cover, Bottom	
B6	MR-618	Foot	
B7	DMP-530	Sound Dampener - Bottom	
B8	DMP-528	Sound Dampener - Front & Rear Plate	
B9	DMP-529	Sound Dampener - Front	
B10	DMP-531	Sound Dampener - Rt. Side	
B11	DMP-525	Sound Dampener - Lt. Side	
B12	DMP-290	Switch, Escutcheon	
B13	DMP-622	Label - Tandy	
B14	DMP-627	Assy., Cable - Keyboard	
B15	DMP-603	Label, Dampener	

C — MAINFRAME ASSEMBLY DMP-801

Reference Number	MFGR P/N	Description	Radio Shack P/N
C1	100-147	Frame, Molded	
C2	DMP-664	Platen, Tandy	
C3	100-150	Guide (Mod. 100-162), Paper	
C4	100-182	Pin, Retainer Mount	
C5	100-143	Stop, Z Panel	
C6	DMP-50	Rod, Guide Long Axis	
C7	DMP-74	Pen Bar, Spring Loaded	
C8	100-133	Plate, Shaft Locating	
C9	DMP-710	Assy., Pulley	
C10	DMP-701	Assy., Pulley Bracket	
C11	DMP-700	Assy., Pulley Mount	
C12	DMP-702	Assy., Pulley Bracket	
C14	6550-90	Spring, Roller	
C15	MC-1386	Cable, Cycle Flex	
C16	100-171	Angle, PCB Retainer	
C17	100-186	Slide, Molded	
C18	100-492	Assy., Bar & Paper Retainer	
C19	100-353	Assy., Paper Retainer	
C20	100-188	Bar, Lift	
C21	100-131	Button Slide	
C22	MS-180	Spring, Lee #E1-012-B4	
C23	DMP-185	Bracket, Limit SW X-Axis	
C24	DMP-186	Bracket, SW, Actuator	
C25	DMP-615	Paper Stop	

D — BEAM ASSEMBLY DMP-802

Reference Number	MFGR P/N	Description	Radio Shack P/N
D2	100-124	Carriage Guide Block	
D3	100-176	Pen Carriage	
D4	100-129	Guide Rod	
D5	100-141	Flat Cable Clamp	
D6	100-174	Carriage Beam Block	
D7	100-172	Cable Clamp	
D8	100-135	Nut Plate	
D9	100-183	Pen Pressure Spacer	
D10	HR29-100	Pen Holder Assy.	
D11	HR29-93	Spring	
D12	100-127	Pen Lift Beam	
D13	100-175	Beam Guide Mount	
D14	DMP-75	Beam Spacer	
D15	DMP-711	Beam Pulley	
D16	DMP-302	Linear Bearing	
D17	2000-192	Pen Pressure Spring	
D18	DMP-710	Pulley	
D19	100-139	Solenoid Mount	
D21	DMP-689	Lift Rod Guide	
D22	100-138	Lift Rod	
D23	DMP-51	Solenoid Spring	
D24	DMP-201	Solenoid Cable Assy.	
D27	DMP-184	Limit Switch Bracket	
D29	100-277	Pen Lift Decal	
D30	Bulk Hardware	Roll Pin, 3/8 inch	
D31	DMP-527	Sound Deadener, Beam	

E — STEPPER MOTOR ASSEMBLY DMP-803

Reference Number	MFGR P/N	Description	Radio Shack P/N
E1	DMP-1	Mount, Motor	
E3	DMP-305	Pulley, Beam (X-Axis)	
E4	DMP-304	Pulley, Pen (Y-Axis)	

G — POWER PANEL ASSEMBLY DMP-804

Reference Number	MFGR P/N	Description	Radio Shack P/N
G1	DMP-566	Panel, Zee	
G2	DMP-618	Label, Zee Panel	
G3	DMP-670	Label, Fuse Specification	
G9	MW-578	Washer, Shoulder	
G10	MW-440	Washer, Insulating Mica	

ELECTRICAL

C — MAINFRAME ASSEMBLY DMP-801

Reference Number	MFGR P/N	Description	Radio Shack P/N
C13	MS-661	Switch, Pushbutton	

D — BEAM ASSEMBLY DMP-802

Reference Number	MFGR P/N	Description	Radio Shack P/N
D20	100-122	Solenoid, Modified	
D26	MC-1453	Connector, 2 pin	
D28	MS-661	Switch, Pushbutton	

E — STEPPER MOTOR ASSEMBLY DMP-803

Reference Number	MFGR P/N	Description	Radio Shack P/N
E2	MM-83	Motor, Stepper	
E5	MC-1454	Connector, 8 pin Female, 22 AWG	

F — TRANSFORMER ASSEMBLY DMP-805

Reference Number	MFGR P/N	Description	Radio Shack P/N
F2	MC-1455	Connector, 3 Pin Female	
F3	MT-147	Transformer, Power	

G — POWER PANEL ASSEMBLY DMP-804

Reference Number	MFGR P/N	Description	Radio Shack P/N
G4	MF-31	Fuse, ½ AMP 3AG SLO-BLO	
G5	MF-83	Fuse Holder (Low Profile)	
G6	MC-1445	Filter, Line AC	
G7	MF-84	Fuse Carrier, 3AG	
G8	MS-640	Switch, Toggle (Power)	
G11	DMP—488	Assy., Voltage Regulator	
—	MC-1184	Cord, Power	

H — LOGIC BOARD ASSEMBLY DMP-628

Reference Number	MFGR P/N	Description	Radio Shack P/N
H1	DMP-631	Board, Logic Plotter	
H2	MS-155	Socket	
H3	MS-156	Socket, 40 pin D/P	
H4	MS-488	Socket, 18 pin Brundy	
H5	MS-523	Socket, 28 pin IC	
HC1,2,3,4, 5,7,9,12, 13,14,15 16,17,18, 20,21,23, 24,25,26 & 32	MC-448	Cap., .1Mfd. 10V cer.	
HC6,29	MC-535	Cap. 1Mfd. 35V 10% Tant.	
HC8,27,30	MC-1355	Cap. 47Mfd. 10V Tant.	
HC10,11	MC-395	Cap. 30Pfd. 1000V 20% Cer.	
HC19,33, 37,38	MC-579	Cap. .001Mfd. 1000V Cer.	
HC22	MC-542	Cap. 10Mfd. 35V lytic	
HC27,28	MC-1235	Cap. 47Mfd. 20V Tant.	
HC31	MC-1225	Cap. 8500Mfd. 25V	
HC34,35,36	MC-229	Cap. .01Mfd. 200V Cer.	
HCR1,2,3,8, 9,10,13,20	MD-25	Diode IN4005	
CR4,5,6,7	MD-126	Diode IN5624	
HJ2	MC-1457	Conn., 3 Pin Male	
HJ5	MC-1458	Conn., 2 Pin Male	
HJ7	MC-1459	Conn., 12 Pin Male	
HJ9	MC-1456	Conn., 8 Pin Male	
HJ10	MC-1069	Conn., 3 Pin Rt. Angle	

H — LOGIC BOARD ASSEMBLY DMP-628 (cont'd.)

Reference Number	MFGR P/N	Description	Radio Shack P/N
HJ11	MC-1677	Conn., 25 Pin Rt. Angle	
HQ1—9	MQ-75	Transistor MJE-800 + L54Z	
HQ10	MQ-28	Transistor MPS-6531	
HQ11	MQ-29	Transistor MPS—6534	
HR1	MR-819	Res., 20016 5% ¼WCF	
HR2	MR-310	Res., 10016 5% ¼WCF	
HR3	MR-170	Res., 390 ohm 5% ¼WCF	
HR4,5,6,9	MR-972	Res., 470 ohm 5% ¼WCF	
HR7,18	MR-470	Res., 10K 5% ¼WCF	
HR8	MR-107	Res., 200 ohm 5% 1/3WCF	
HR10	MR-823	Res., 100 ohm 5% ¼WCF	
HR11,13,16, 19,20	MR-963	Res., 1K 5% ¼WCF	
HR12,17	MR-979	Res., 4.7K 5% ¼WCF	
HR14,15,21	MR-1183	Res., 3K 5% ¼WCF	
HR22,23	MR-10	Res., 47 ohm 5% ½WCC	
HU1,10,28	MW-551	I.C. MC14503BCPD	
HU2,4,6,7	MW-497	I.C. 74LS32	
HU3	MW-356	I.C. 74LS42NS	
HU5	MW-342	I.C. 74LS00N/B +	
HU8	MW-349	I.C. 74LS123N/B +	
HU9	MW-354	I.C. 74LS02N/B +	
HU11	MW-414	I.C. 74LS245N	
HU12,13	MW-479	I.C. MM2114N-L	
HU14	MW-701	I.C. ROM2732	
HU15	MW-700	I.C. ROM2716-T8	
HU16	MW-549	I.C. 74LS374	
HU17	MW-351	I.C. 74LS04N/B +	
HU18,26	MW-348	I.C. 74LS74N/B +	
HU19	MW-344	I.C. 74LS14N/B +	
HU20	MW-474	I.C. Z80CTC	
HU21	MW-387	I.C. Z80CPU	
HU22,23	MW-427	I.C. 74LS244N	
HU24	MW-343	Res. Network - 470 ohm	
HU25	MW-568	Res. Network 10K	
HU27	MW-243	I.C. CD4040 BC PR	
HU29	MW-322	Res. Network 10K	
HU30	MW-433	I.C. AYA - 1014A	
HY1	MC-1354	Crystal, Jan 4.9152 MHz	

6/DIAGRAMS AND DRAWINGS

FIGURE NO.	DESCRIPTION
6-1	Power Supply
6-2	Logic Board Schematic, Sheet 1 of 3
6-3	Logic Board Schematic, Sheet 2 of 3
6-4	Logic Board Schematic, Sheet 3 of 3
6-5	DMP-629 Logic Board, Component Side
6-6	DMP-629 Logic Board, Solder Side
6-7	Mainframe Assembly of DMP-3T (TRS-80)

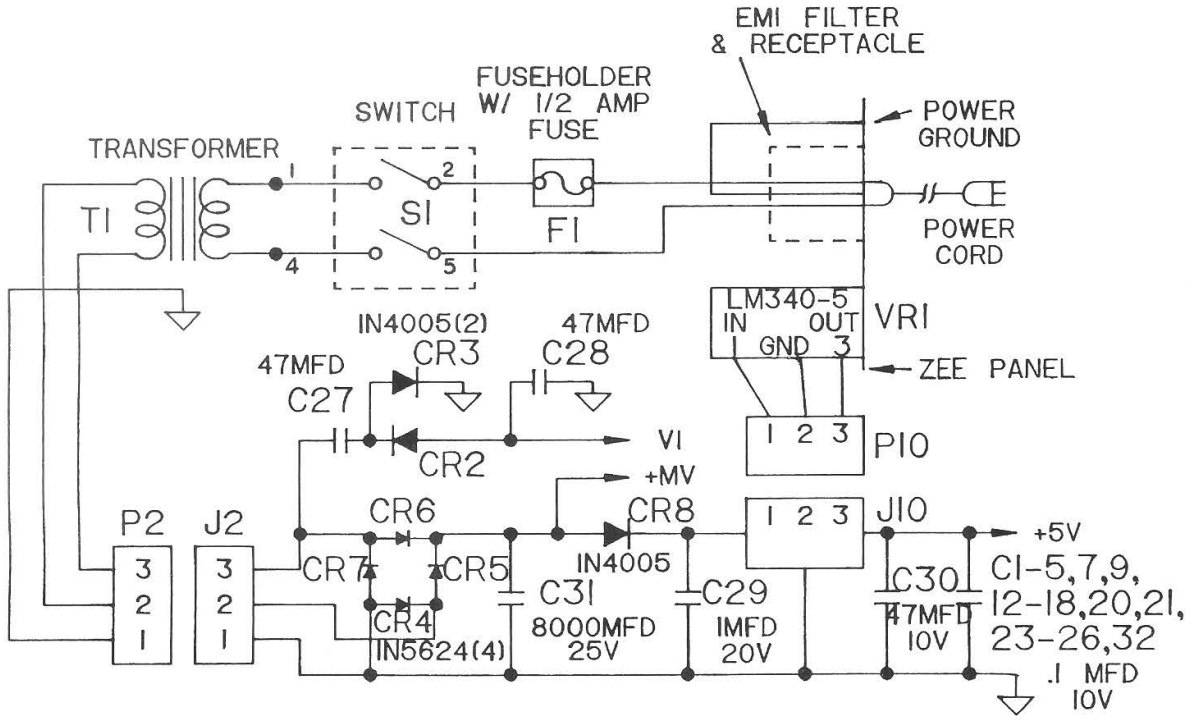


FIGURE 6-1
POWER SUPPLY

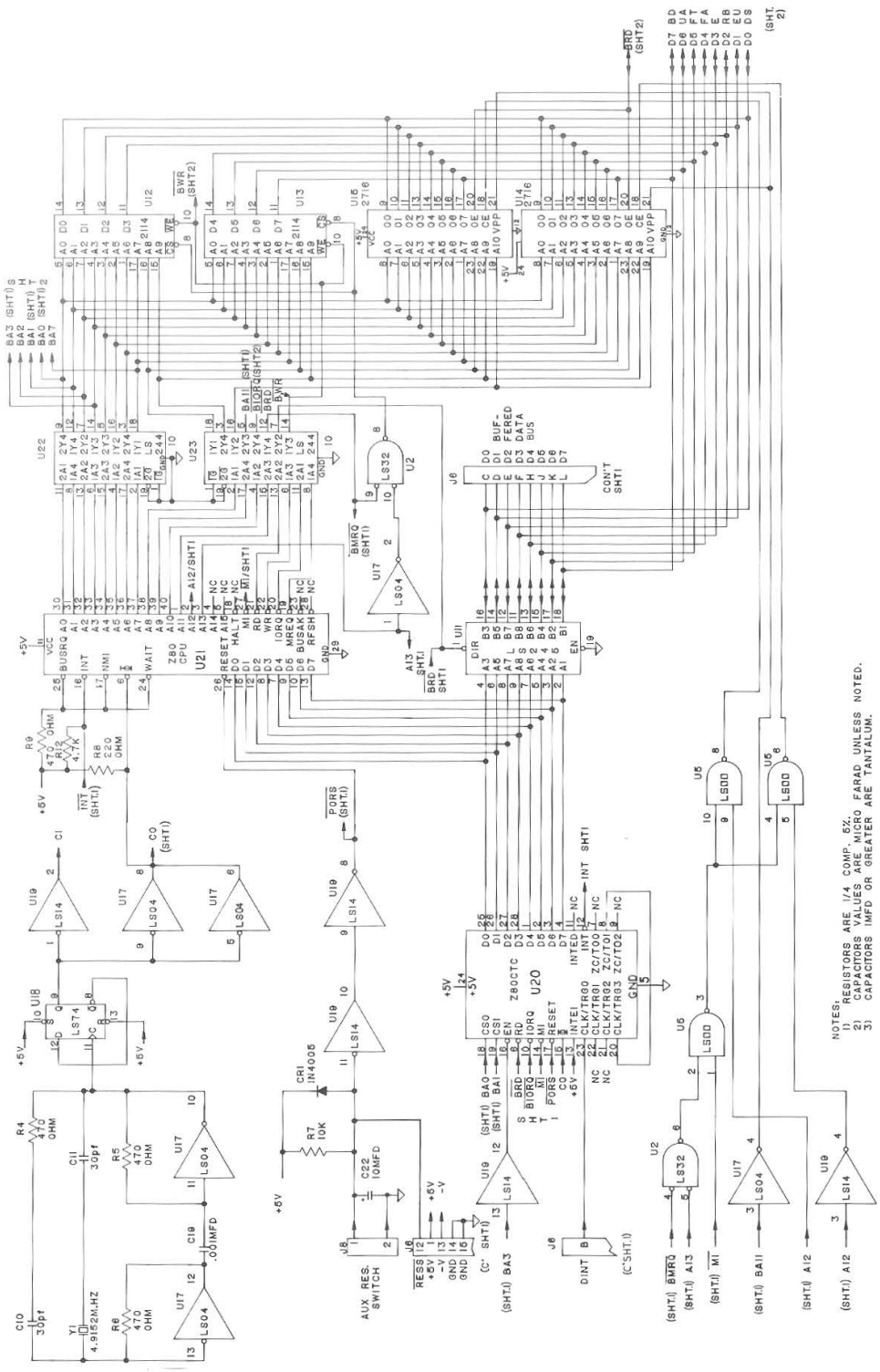


FIGURE 6-2
LOGIC BOARD SCHEMATIC (DMP-3T)
(Sheet 1 of 3)

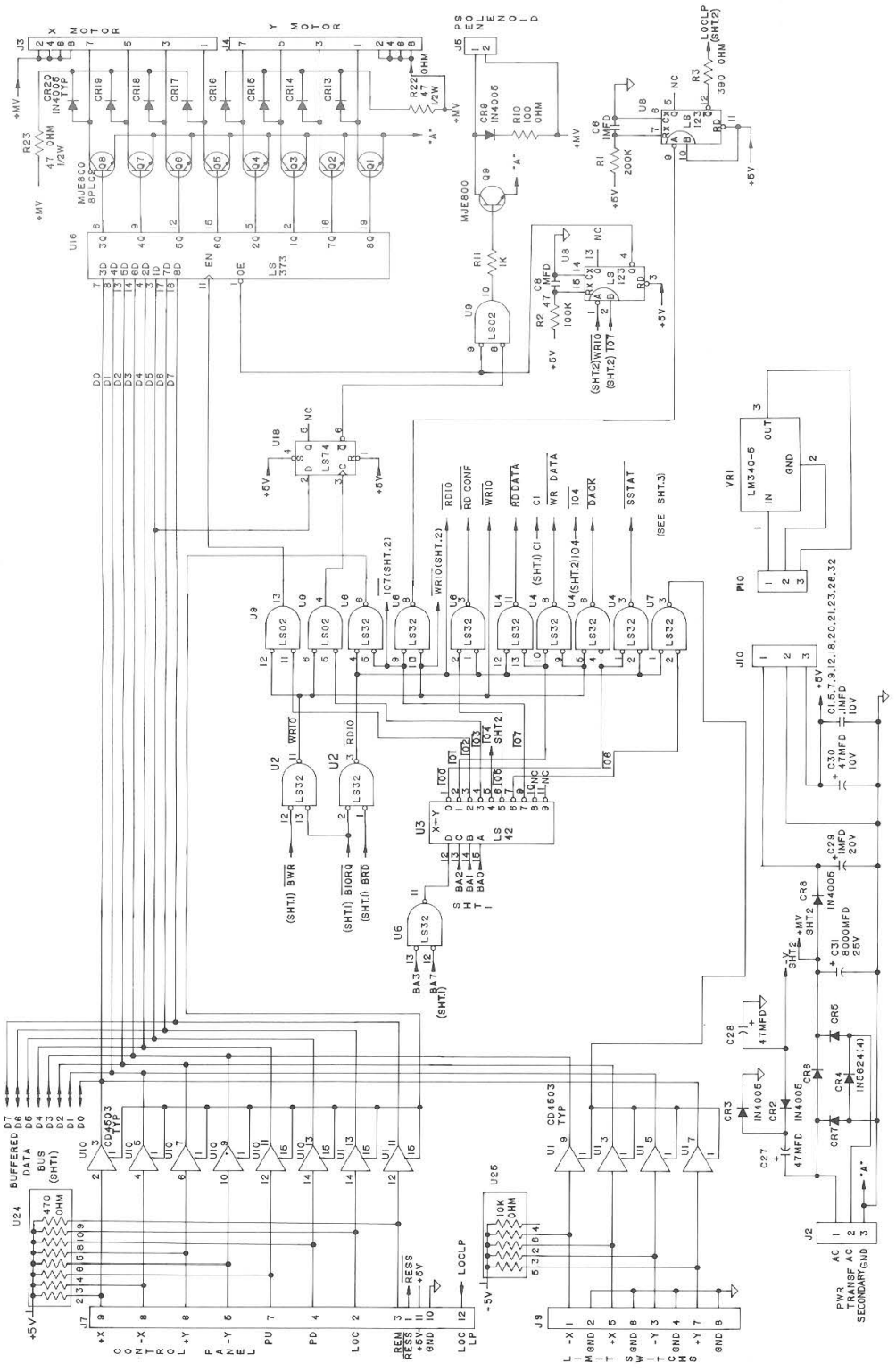


FIGURE 6-3
LOGIC BOARD SCHEMATIC (DMP-3T)
(Sheet 2 of 3)

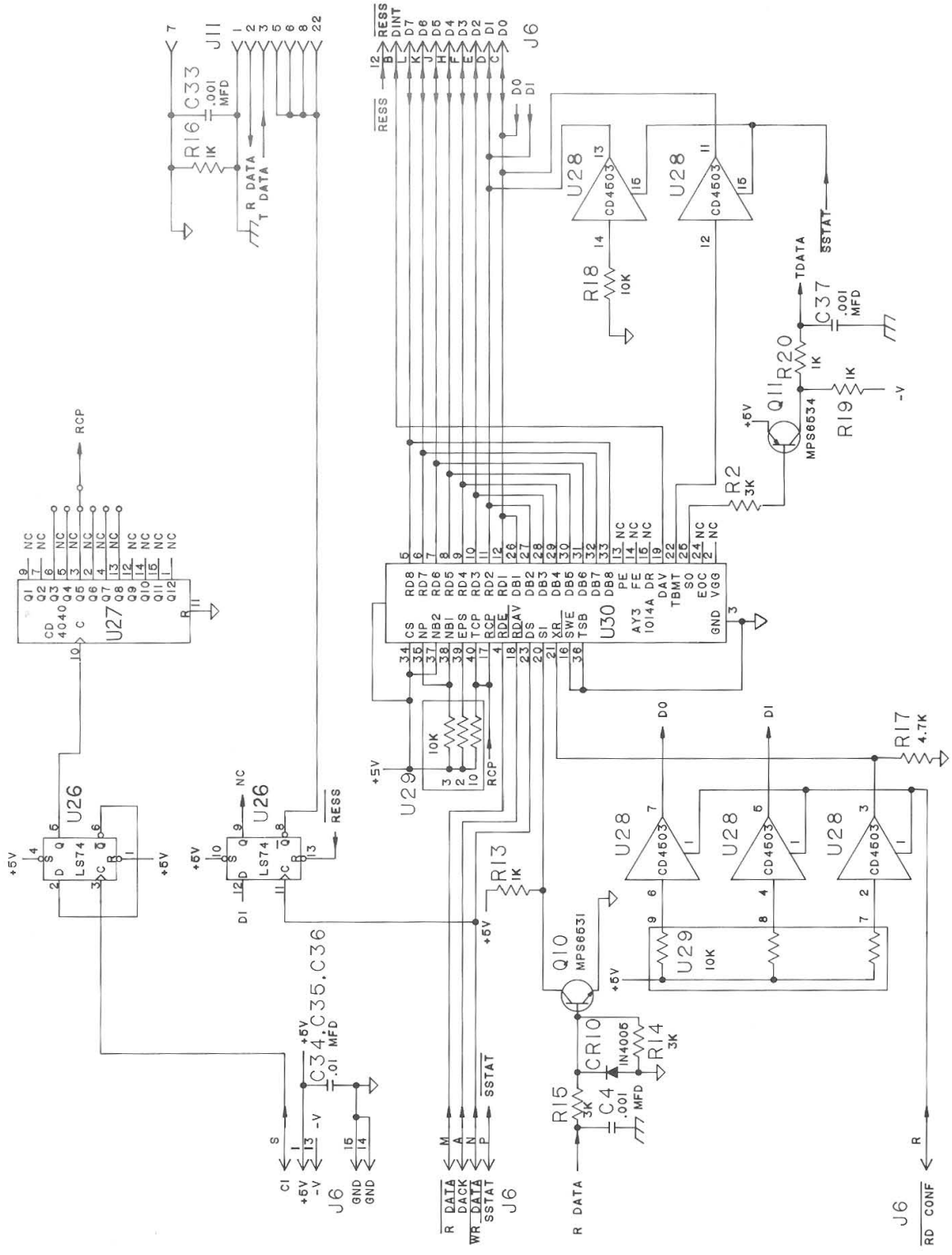


FIGURE 6-4
LOGIC BOARD SCHEMATIC (DMP-3T)
(Sheet 3 of 3)

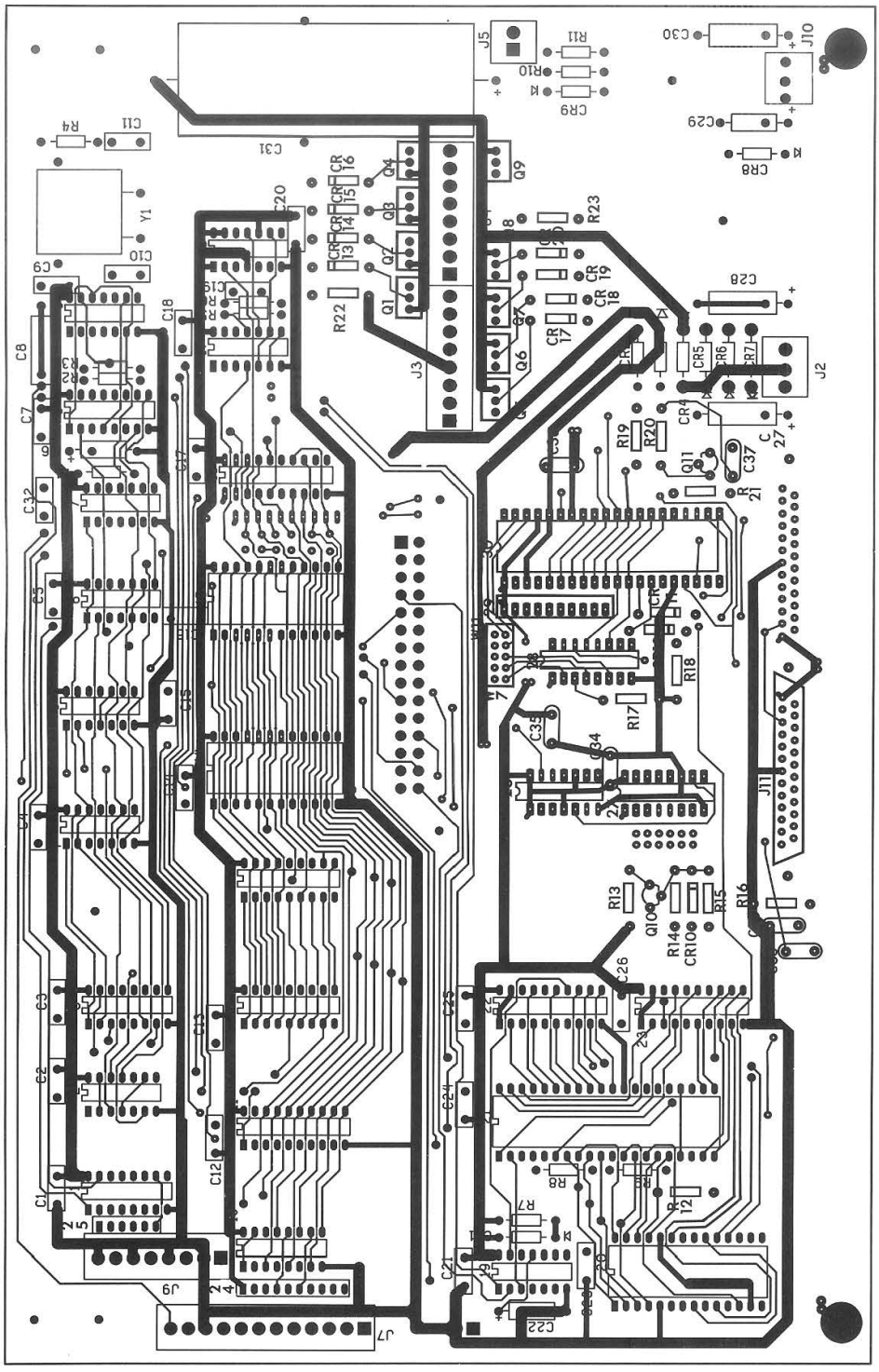


FIGURE 6-5
DMP-628 LOGIC BOARD SCHEMATIC
Component Side

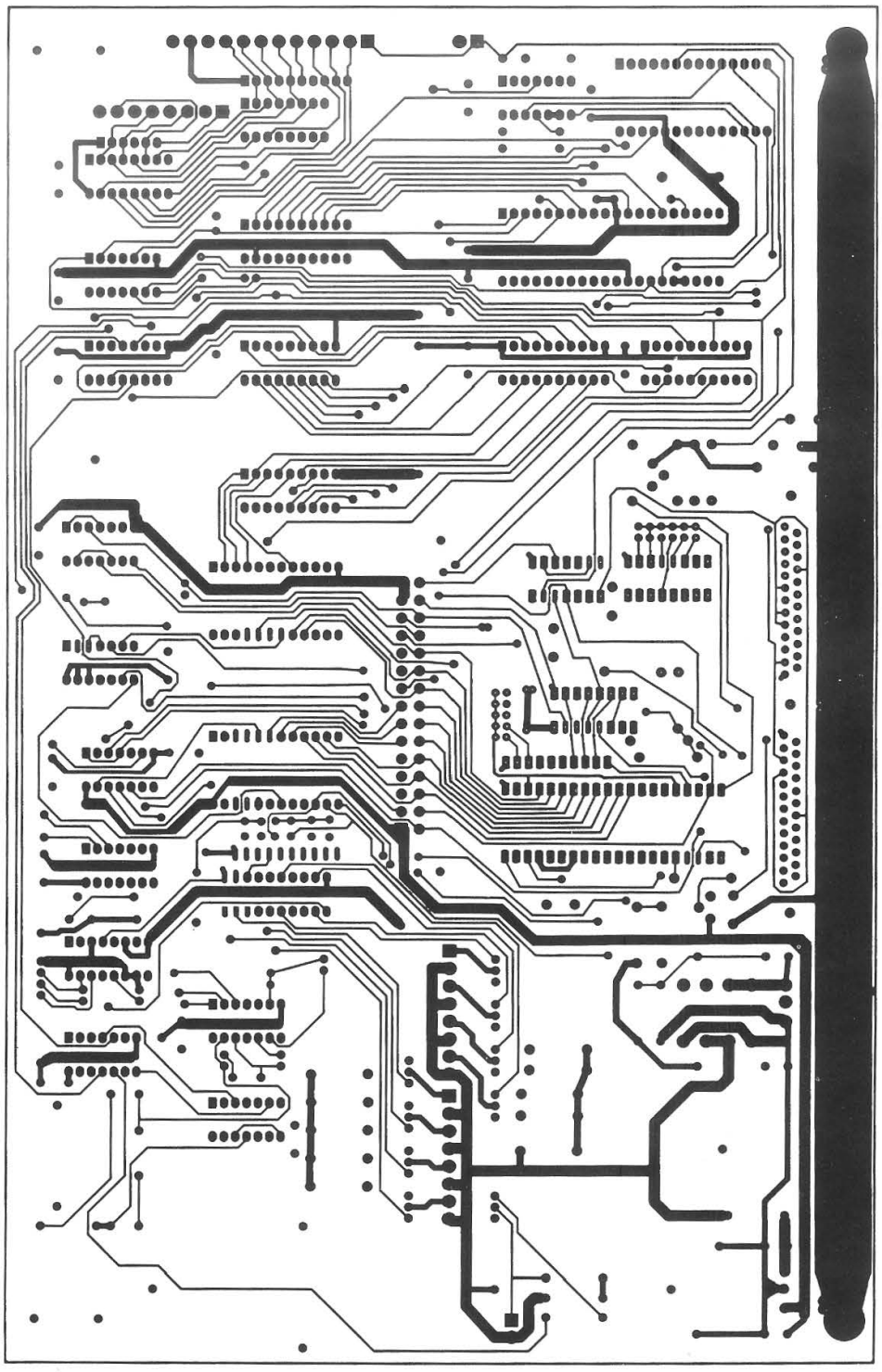


FIGURE 6-6
DMP-628 LOGIC BOARD SCHEMATIC
Solder Side

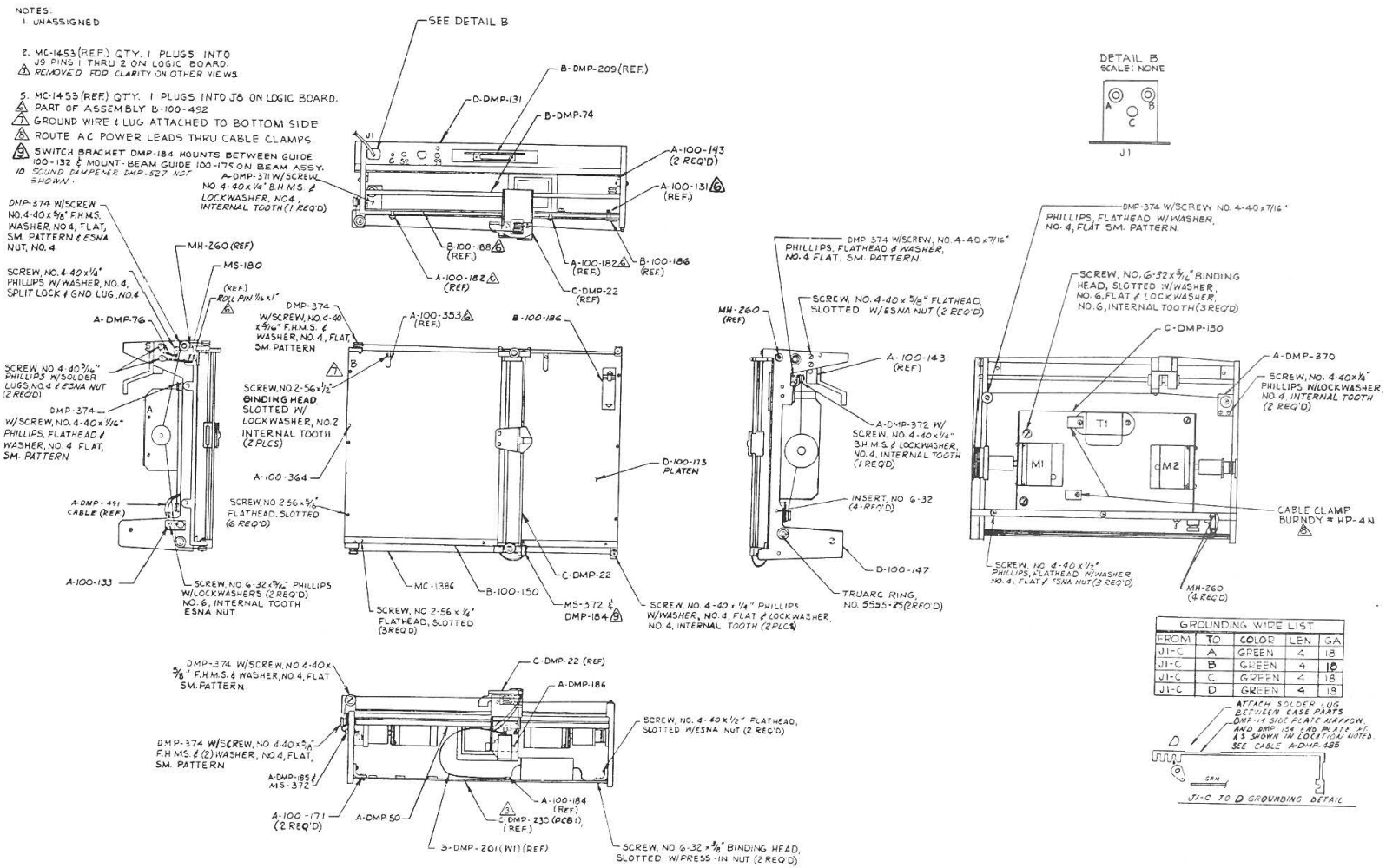


FIGURE 6-7
MAINFRAME ASSEMBLY (DMP-3T)

APPENDIX/COMMANDS, ASCII CHARACTERS AND MARKER SYMBOLS

GENERAL

All COMMANDS, ASCII CHARACTERS and MARKER symbols are listed in this appendix. For specific details, consult the appropriate section of the OPERATOR'S MANUAL, Catalog No. 26-1191.

PLOTTER COMMANDS

All of the PLOTTER COMMANDS are included in Figure A.1.

ASCII CHARACTERS

The 93 ASCII CHARACTERS with their respective codes in decimal, hexadecimal and octal are given in Figure A.2. The character coded heights and coded rotations are provided in Figures A.4 and A.3, respectively.

MARKER SYMBOLS

The coded MARKER SYMBOLS and their coded sizes are given in Figures A.5 and A.6, respectively.

Function	Command Code	Notes
Plotter Select	;:	Computer selects plotter; plotter ignores everything until a ;: is received.
Plotter Deselect	@	Plotter select turned off.
Reset	Z	Plotter software reset.
Self Test	T	Plotter draws test pattern.
Pen DN	D	Pen lowered to plotting surface.
Pen UP	U	Pen is raised.
New Pen	P	Plotter directed to select new pen; choice of 6 different colors.
Home, Position	H	Pen raised, displaced to HOME position, lower left corner of plotting surface. Origin is reset.
Origin	O	Routine identifies current pen position as origin.
Line Types	L	Selects type of line to be drawn; choice of 9 dash line patterns.
Absolute Pen Addressing	A xxxx,yyyy	Pen moves to next position with respect to last origin.
Relative Pen Addressing	R xxxx,yyyy	Similar to A except PEN moves to next position with respect to current position.
Coordinates, Pen Movement	xxxx,yyyy	Pen is moved to specified X and Y coordinates, then the next instruction is executed.
Character Plotting	S	Draws string of characters, selection of 4 angles and 9 heights; choice of 93 characters.
Marker Plotting	M	Draws marker of selected size and type; choice of 5 sizes and 6 types.
Circle Plotting	CC, xxxx,yyyy	Pen currently on point which is circumference of circle whose center is specified X and Y coordinates relative to point.
Arc Plotting	CA, xxxx,yyyy, Arc	Pen currently on point of arc of specified +/– degrees whose center is specified X and Y coordinates relative to point.
X co-ordinate (xxxx) or Y co-ordinate (yyyy) is number from 0 to +/– 32767; degrees is number from 0 to 360.		

FIGURE A.1
PLOTTER COMMANDS

ASCII CHARACTER SET TABLE											
Dec	Hex	Oct	Char	Dec	Hex	Oct	Char	Dec	Hex	Oct	Char
32	20	40	blank	63	3F	77	?	96	60	140	^
33	21	41	!	64	40	100	@	97	61	141	a
34	22	42	"	65	41	101	A	98	62	142	b
35	23	43	#	66	42	102	B	99	63	142	c
36	24	44	$	67	43	103	C	100	64	144	d
37	25	45	%	68	44	104	D	101	65	145	e
38	26	46	&	69	45	105	E	102	66	146	f
39	27	47	'	70	46	106	F	103	67	147	g
40	28	50	(	71	47	107	G	104	68	150	h
41	29	51	)	72	48	110	H	105	69	151	i
42	2A	52	*	73	49	111	I	106	6A	152	j
43	2B	53	+	74	4A	112	J	107	6B	153	k
44	2C	54	,	75	4B	113	K	108	6C	154	l
45	2D	55	–	76	4C	114	L	109	6D	155	m
46	2E	56	.	77	4D	115	M	110	6E	156	n
47	2F	57	/	78	4E	116	N	111	6F	157	o
48	30	60	0	79	4F	117	O	112	70	160	p
49	31	61	1	80	50	120	P	113	71	161	q
50	32	62	2	81	51	121	Q	114	72	162	r
51	33	63	3	82	52	122	R	115	73	163	s
52	34	64	4	83	53	123	S	116	74	164	t
53	35	65	5	84	54	124	T	117	75	165	u
54	36	66	6	85	55	125	U	118	76	166	v
55	37	67	7	86	56	126	V	119	77	167	w
56	38	70	8	87	57	127	W	120	78	170	x
57	39	71	9	88	58	130	X	121	79	171	y
58	3A	72	:	89	59	131	Y	122	7A	172	z
59	3B	73	;	90	5A	132	Z	123	7B	173	{
60	3C	74	<	91	5B	133	[	124	7C	174	▯
61	3D	75	=	92	5C	134	\	125	7D	175	}
62	3E	76	>	93	5D	135	]	126	7E	176	~

FIGURE A.2
ASCII CHARACTER SET

CODE #	ROTATION
1	none
2	90 degrees
3	180 degrees
4	270 degrees

FIGURE A.3
ASCII CODE/ROTATION

CODE #	HEIGHT (inches)
1	.070 inch
2	.105 inch
3	.14 inch
4	.21 inch
5	.28 inch
6	.42 inch
7	.56 inch
8	.85 inch
9	1.12 inch

FIGURE A.4
ASCII CODE/HEIGHT

CODE #	MARKER
0	+
1	x
2	(square)
3	(hexagon)
4	(triangle)
5	(bracketed X)

FIGURE A.5
MARKER CODE/SYMBOL

CODE #	MARKER SIZE
1	.07 inch
2	.14 inch
3	.28 inch
4	.56 inch
5	1.12 inch

FIGURE A.6
SYMBOL CODE/SIZE