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TECHNICAL MANUAL
OPERATION AND MAINTENANCE INSTRUCTIONS

X-Y PLOTTER, PT-524/TYQ

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SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. This manual contains information necessary to operate and maintain the X-Y Plotter PT-524/TYQ. Section I contains an introduction to the plotter, Section II contains the installation and removal procedures, Section III contains operating procedures, Section IV contains theory of operation and functional diagrams, Section V contains maintenance instructions, and Section VI contains schematic and cabling diagrams. Table 1-1 provides a list of related publications.

Table 1-1. Related Publications

Publication Title	Publication Number
Operation and Maintenance Instructions	T.O. 10M1-7-5-1
Augmented Interpretation-Data Processing Group	TM 11-5895-1029-14
OL-87(V)/TYQ	TM 08045-15/11
Operation and Maintenance Instructions	T.O. 10M1-7-7-1
Auxiliary Interpretation-Data Processing Group	TM 11-5895-1028-14
OL-80(V)/TYQ-11(V)	
Technical Manual Illustrated Parts Breakdown	T.O. 10H4-84
Plotter X-Y	TM 11-5895-1030-24P
PT-524/TYQ	TM 08051A
Test Procedures Manual	T.O. 10-MI-7-9-8-2
TM 11-5895-1021-14-4	
TM 08045-15/4	
Workcards, Periodic Inspection Requirements	T.O. 10M 1-7-9-6WC-1
For Imagery Interpretation Segment	TM 11-5895-1021-14/2
AN/TYQ-11(V) and AN/TYQ-12(V)	TM 08045-15/2

1-3. The X-Y Plotter (figure 1-1), hereafter referred to as the Plotter, is a device capable of graphically charting information. Charting is accomplished by pen movements across a paper surface. Pen movement is controlled by either signals from an external source or manual controls located on the Plotter.

1-4. DESCRIPTION OF EQUIPMENT.

1-5. PHYSICAL DESCRIPTION. The major distinctive features of the Plotter are its two paper spools, the drum, the pen carriage, and the two control panels. Figure 1-2 shows these and other major assemblies with locations. Table 1-2 lists the Plotter components. Table 1-3 lists all equipment required but not supplied. Left and right control panels enable the Plotter operator to control pen and paper movement, scale factor and power application. Indicators are present on the left and right control panels to indicate accumulated plotting time and low paper condition. The two paper spools are cylinders in which paper is wound. Both front and rear spools are 37 inches long and 1.25 inches in diameter. The rear spool is the paper supply spool from which paper originates in the threading path. Paper is wound onto the front spool (takeup roll) at the end of the paper threading path. The drum is a 37.5-inch long, 4.5-inch diameter metal cylinder that rotates for X-axis plotting. Sprockets are located on both ends of

Table 1-2. Plotter Components (Figure 1-2)

Reference Designator	Nomenclature
A1	I/O-Pen Driver PCB
A2	Logic, Drive and Scale Factor PCB
A3	Scale Factor PCB
A4	Encoder Preamplifier PCB
A5	Right Operator Control Panel
A6	Y Limit Switch PCB
A7	+Y Limit Switch PCB
A8	Power Supply
A9	LED Light Source PCB (Rear)
A10	LED Interconnect PCB
A11	Mister Interconnect PCB
A12	LED Light Source PCB (Front)
B1	Front Paper Servo Motor
B2	Rear Paper Servo Motor
B3	X-Axis Servo Motor
B4	Y-Axis Servo Motor
MT1	X-Axis Encoder
MT2	Y-Axis Encoder

Table 1-3. Equipment Required But Not Supplied

Name	Manufacturer	Identifying Number
Plotter Paper	California Computer Products	10438-205-502(14668)
Plotter Pen Kit	California Computer Products	20254-101-000(14668)

the drum to facilitate accurate paper alignment. Sprockets located on the left end of the drum are movable along the axis of the drum. Pen movement (Y-axis) is accomplished by pen carriage movement. The up-down pen placement is also accomplished by the carriage. Table 1-4 lists the physical and electrical characteristics of the Plotter. Other characteristics of the Plotter are dc servomotors, single pen operation, low paper monitor, three-position pen force control, Y-axis limit switches, plot time meter, and Y-axis scale factor adjustment.

1-6. EQUIPMENT INTERFACE. The Plotter interfaces with all external shelter equipment through two cables. These two cables attach to the rear of the Plotter and provide power, data, and control signals. Figure 1-3 illustrates the power and signal inputs and outputs. Power (120 Vac, 3-phase, 400 Hz) is obtained from terminal board six of the shelter and is conducted through the power cable 3W5 to input power connector J301. Eleven individually shielded data lines are within the I/O cable 3W21. These data lines connect the Plotter to XIO-2. Seven of the 11 lines provide the Plotter with information on pen position (up or down), Y-axis movement, X-axis movement, and plot enable. The remaining four data lines of the I/O cable originate from the Plotter and provide information on the carriage overtravel, plotter-on-line, plotter ready and plotter connected.

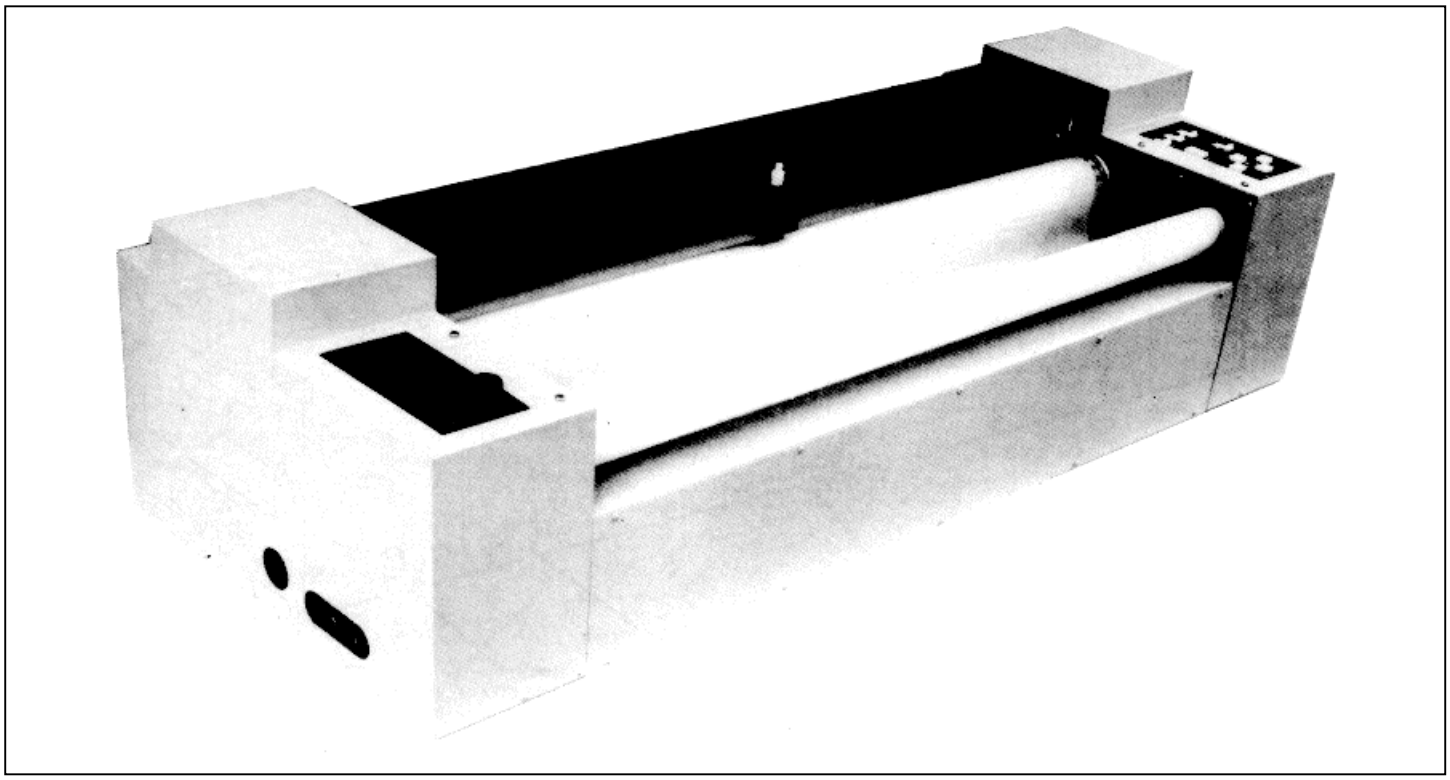
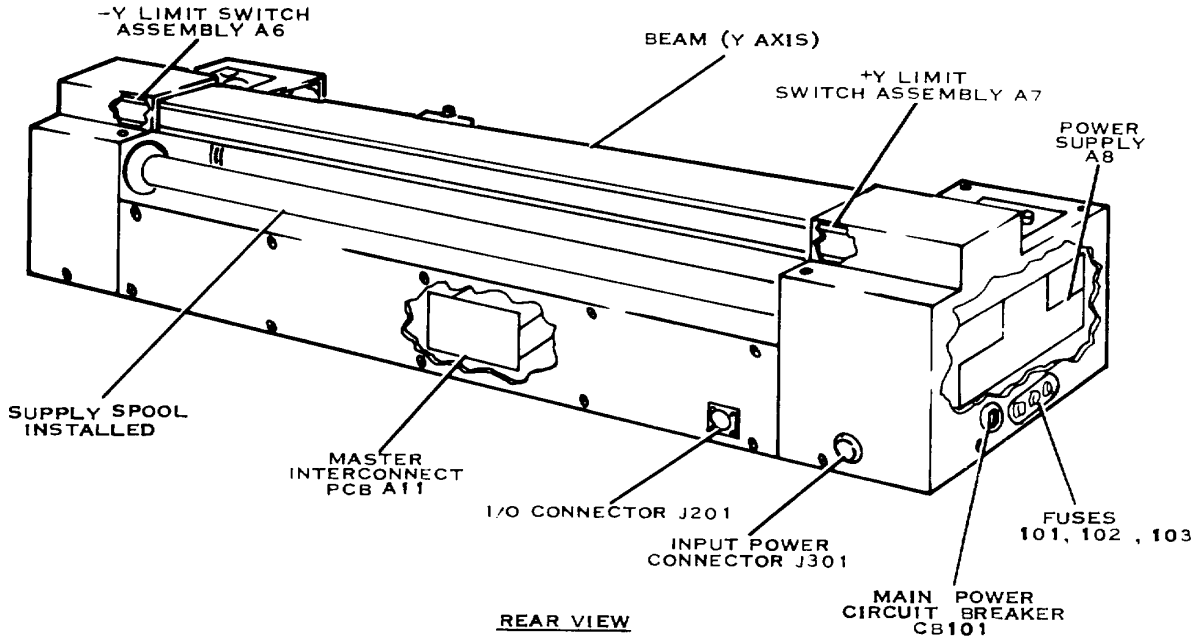


Figure 1-1. X- Y Plotter PT-524/TYQ (Plotter)

Table 1-4. Plotter Physical and Electrical Characteristics

Characteristics	Specification
Resolution	0.005 in. (0.127 mm)
Speed Axial	112.5 mm (4.5 in.) per second
Speed Diagonal	159.1 mm (6.3 in.) per second
Carriage Positional Accuracy	±0.1 mm (±0.004 in.)
Carriage Repeatability	±0.05 mm (±0.002 in.)
Plot Area	86.4 cm (approximately 34 in.) by roll length
Pen Types	Ball point, felt tip, and liquid ink
Plotter Width	130 cm (51 in.)
Plotter Depth	48 cm (18.8 in.)
Plotter Height	31 cm (12.3 in.)
Plotter Weight	46 kg (100 lbs.)
Heat Dissipation	257.8 kg-cal (1023 BTU) per hour
Temperature Environment	250C ±10°C (approximately 780F ±18°F)
Humidity Environment	25 percent to 75 percent relative humidity
Altitude Environment	2285 M (7,500 ft.)
Power Requirement	120 ±12 Vac line to neutral, 3 phase, 400 Hz



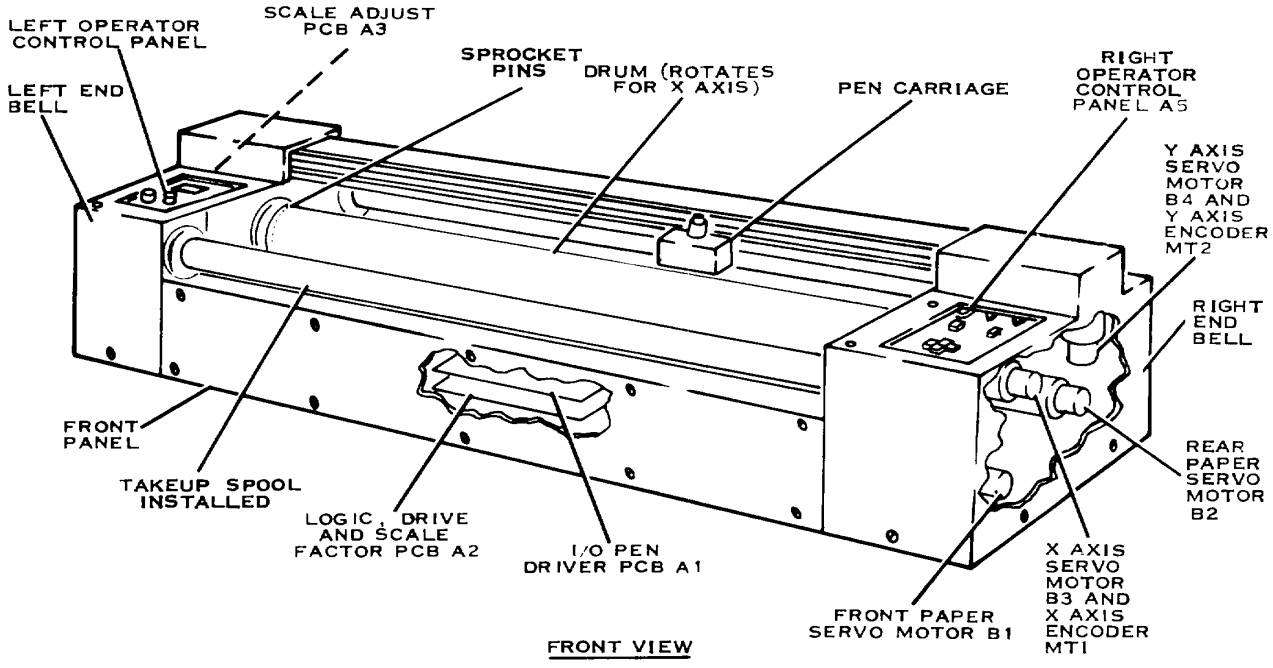


Figure 1-2. Identification of Major Assemblies

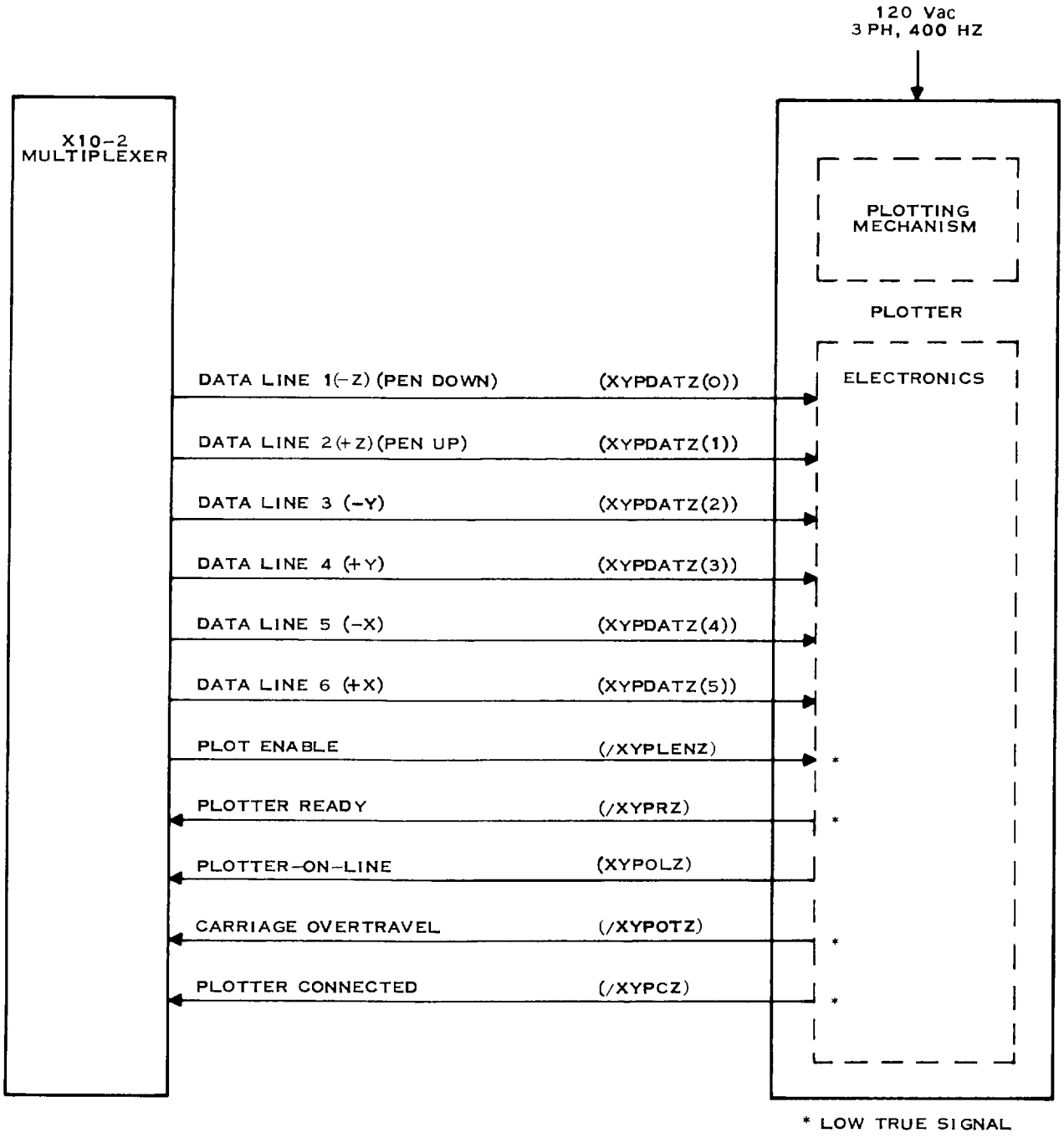


Figure 1-3. Plotter Interface Block Diagram

SECTION II

INSTALLATION AND REMOVAL

2-1. GENERAL.

2-2. This section contains instructions on Plotter installation and removal.

2-3. INSTALLATION. Perform the following steps to install the Plotter into the Auxiliary Automatic Data Processing (AADP) Rack. If the Plotter will he operated below 10,000 feet. the vacuum port must be open. Remove the front panel and pull the vacuum port cover forward to open it. The cover is located on the bottom of the Plotter and to the right of the PCBs.

WARNING

The Plotter weighs 100 pounds and should be lifted by more than one person to prevent injury.

a Lift and place the Plotter onto the mounting adapter.

b. Insert and tighten four mounting screws securing the Plotter to the Plotter Mounting Adapter.

c. Ensure PLOTTER circuit breaker on AADP Rack Power Control Panel is in OFF position.

d. Connect the cables to the back of the Plotter (power cable and I/O cable).

e. Disengage locked mounting slides by depressing the two slide lock retaining knobs at the bottom of the front plate.

f. Slide Plotter completely into the AADP Rack and engage latch handle mechanisms.

CAUTION

Damage to the Plotter can result if the four securing screws located next to the two slide lock releasing knobs are not tightened during transportation of the shelter. These screws should remain loosened during operation to facilitate fast paper replacement.

2-4. REMOVAL. Perform the following steps to remove the Plotter from the AADP Rack.

NOTE

Servicing the Plotter may be accomplished without removing it from the AADP Rack by performing steps a. through c. disengaging the quarter-turn fasteners, and removing the front plate of the Plotter Mounting Adapter.

a. Place Plotter POWER ON/'OFF switch in OFF position.

h. Set the PLOTTER circuit breaker on the AAI)P Rack Power Control Panel to the OFF position.

c. Disengaged latch handle mechanism and pull Plotter forward.

d. Extend unit from AADP Rack ensuring locks do not engage.

e. Disengage two cables from the rear of the Plotter.

f. Loosen and remove four mounting screws securing Plotter to Plotter Mounting Adapter.

g. Lift and remove Plotter from AADP Rack.

SECTION III

OPERATING INSTRUCTIONS

3-1. GENERAL.

3-2. Section III contains information necessary for energizing, operating, and deenergizing the Plotter. Operator checks and adjustments are provided to enable the Plotter operator to ensure that the Plotter is operational. Operating instructions consist of step-by-step instructions for startup, pen assembly and installation, paper loading, operating procedures, shutdown, and paper removal.

3-3. DESCRIPTIONS OF CONTROLS AND INDICATORS.

3-4. Operating controls and indicators are listed in tables 3-1 and 3-2 and are shown in figures 3-1 and 3-2.

Table 3-1. Right Operator Control Panel Controls and Indicators

Control/Indicator	Description	Function	Figure 3-1 Index Number
MANUAL AXIS CONTROL	Four momentary switches A5S5-A5S8	Controls drum rotation to draw line in +X or -X direction. Controls pen carriage movement ih +Y or -Y direction. Active only when PLOT/MANUAL switch is in the MANUAL position and MEDIA PLOT/LOAD switch is in the PLOT position.	1
PEN CONTROL ACTIVATE	Momentary switch A5S1	Raises or lowers pen. Activate only when PLOT/MANUAL switch is in the MANUAL position and MEDIA PLOT/LOAD switch is in the PLOT position.	2
MEDIA PLOT/OVRD	Rocker switch/ indicator A5S4	Overrides low paper switch. When lighted, indicates low paper condition.	3
MEDIA PLOT/LOAD	Rocker switch A5S3	In PLOT position, enables X and Y axis servomotors. Enables supply and takeup motors after a time delay. In LOAD position, allows operator to load paper.	4
MODE PLOT/MANUAL	Rocker switch A5S2	In PLOT position, enables data input circuits to receive input data from computer. Disables controls and resets manual pen control. In MANUAL position, enables manual controls and disables data input circuits.	5
PEN CONTROL FORCE	Rocker switch A5S9	Determines pen holddown force.	6

Table 3-2. Left Operator Control Panel Controls and Indicators

Control/Indicator	Description	Function	Index Number Figure 3-2
PLOT TIME	Four digit indicator	Shows elapsed time in hours.	1
SCALE FACTOR	Thumbwheel switch A3S1	Provides manual compensation for plotting material error.	2

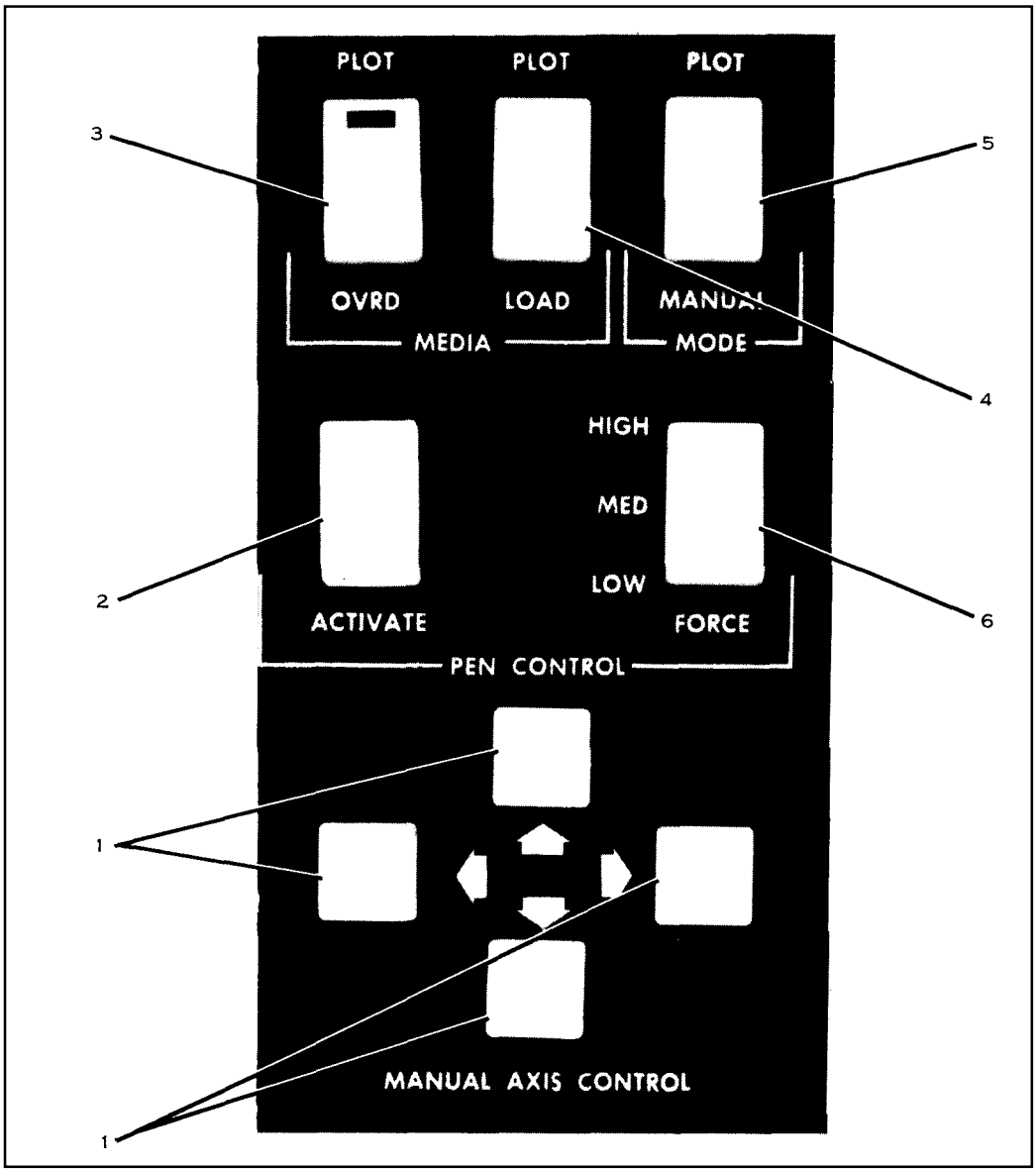


Figure 3-1. Right Operator Control Panel A5

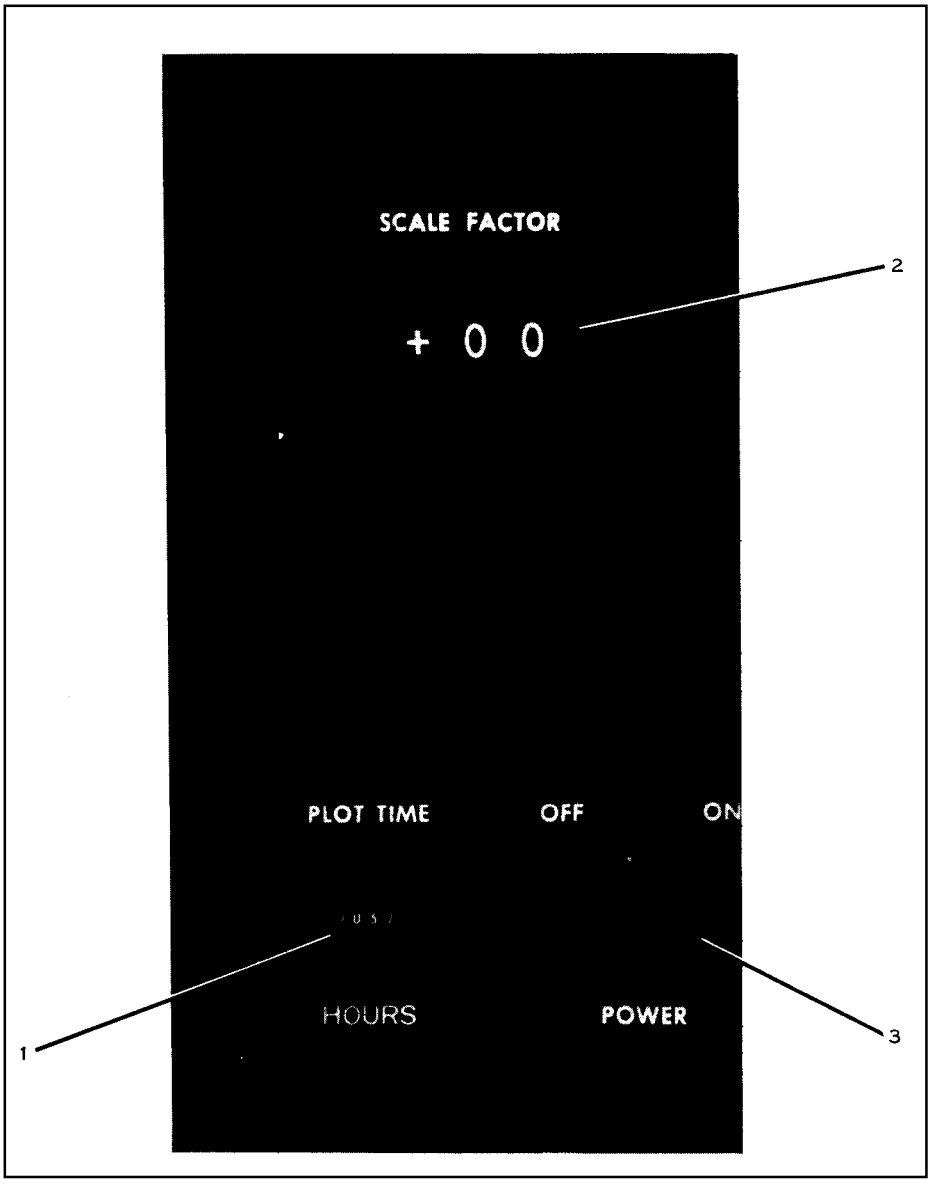


Figure 3-2. Left Operator Control Panel

3-5. STARTUP.

3-6. The following procedures provide instructions for placing the Plotter in a ready-to-operate condition. The procedures should be performed in the order given to prevent damage to the equipment.

a. Place PLOTTER circuit breaker on AADP Power Control Panel to ON position.

b. Place Plotter circuit breaker, located on left side of Plotter, to ON position.

c. Place Plotter POWER ON/OFF switch, located on Left Control Panel, to ON position.

d. If Plotter is loaded with paper and PLOT/LOAD switch is in PLOT position, the paper will stabilize in about 4 seconds. If Plotter is not loaded with paper, follow paper loading procedures outlined in paragraph 3-7.

CAUTION

To prevent possible damage to the drum, never install a pen unless paper is in the Plotter.

e. Locate pen to be used in Plotter. Test proper pen operation by writing on a scrap of paper before inserting pen into carriage. Turn POWER ON/OFF switch to OFF so that pen holder will be in up position. Screw threaded section of pen into pen support hole; finger tighten pen.

f. Set POWER ON/OFF switch to ON.

3-7. PAPER LOADING.

3-8. The following procedures provide step-by-step procedures for paper loading. Refer to figure 1-2 for location of spools and drum.

a. Set PLOT/LOAD switch in LOAD position and POWER ON/OFF switch to OFF.

b. Unscrew pen from pen cartridge.

c. Place empty takeup roll between front drive spool at right end, and front idler spool at left end. Slip key on idler spool into slot on one end of takeup spool by moving roll toward idler spool. Spring-loaded idler will give enough to allow other end of takeup spool to slip onto the front drive spool. The drive spool may have to be turned by hand to align key with slot in takeup spool.

d. Mount and position a supply spool of paper so paper will feed from the bottom of spool toward front of Plotter. The supply spool is mounted (between rear drive spool at right end and rear idler spool at left end) in same manner used to mount takeup spool.

e. Rotate drum by hand until drum screws (figure 3-3) at each end of drum are facing upward. Unroll about 3 feet of paper from rear supply spool.

NOTE

Sprocket pins on the left end of the drum are movable.

f. Slide paper between pen carriage and drum. Align sprocket pins on drum into sprocket holes on paper so that holes between registration marks on paper are aligned with drum screws on both ends. See figure 3-3. It is important that paper is aligned correctly to prevent skew.

g. Slip paper under takeup spool and tape center of free end of paper to center of takeup spool.

h. Wrap several turns of paper onto takeup roll by hand. Ensure hole alignment with drum is maintained.

i. Set PLOT/LOAD switch to PLOT position and set POWER ON/OFF switch to ON. Paper should form a stabilizing loop at front and back.

j. Recheck hole alignment with drum sprockets.

k. Select pen, assemble pen, and install pen per paragraph 3-9.

3-9. PEN ASSEMBLY AND INSTALLATION.

3-10. The following procedures provide step-by-step procedures for pen assembly and installation. Three pen types (pressurized ballpoint, liquid ink, or nylon tipped) may be installed in the pen carriage. Refer to figure 3-4.

3-11. PRESSURIZED BALLPOINT PEN ASSEMBLY. Procedures for pressurized ballpoint pen assembly are listed below. Refer to figure 3-4.

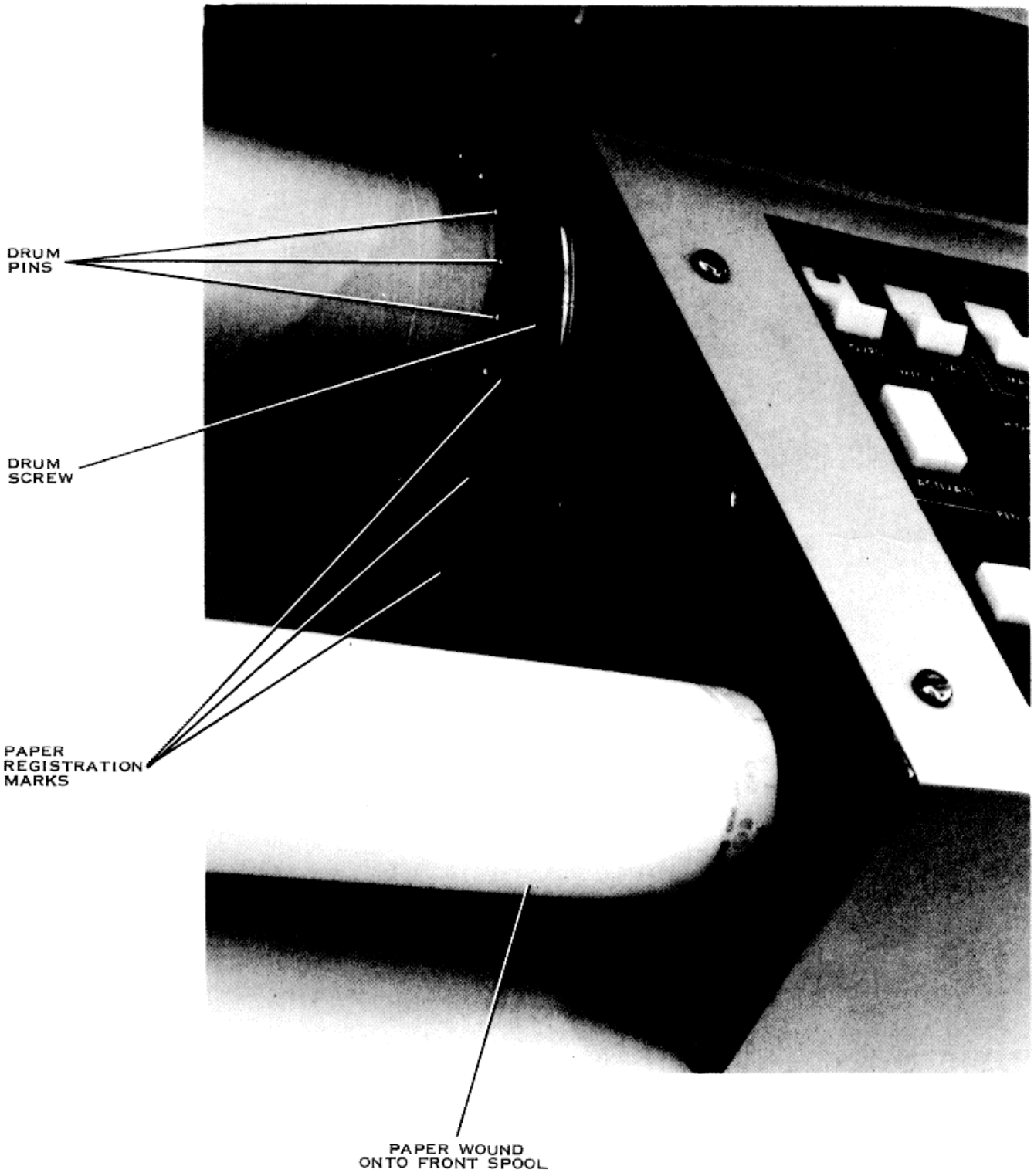


Figure 3-3. paper Alignment positioning

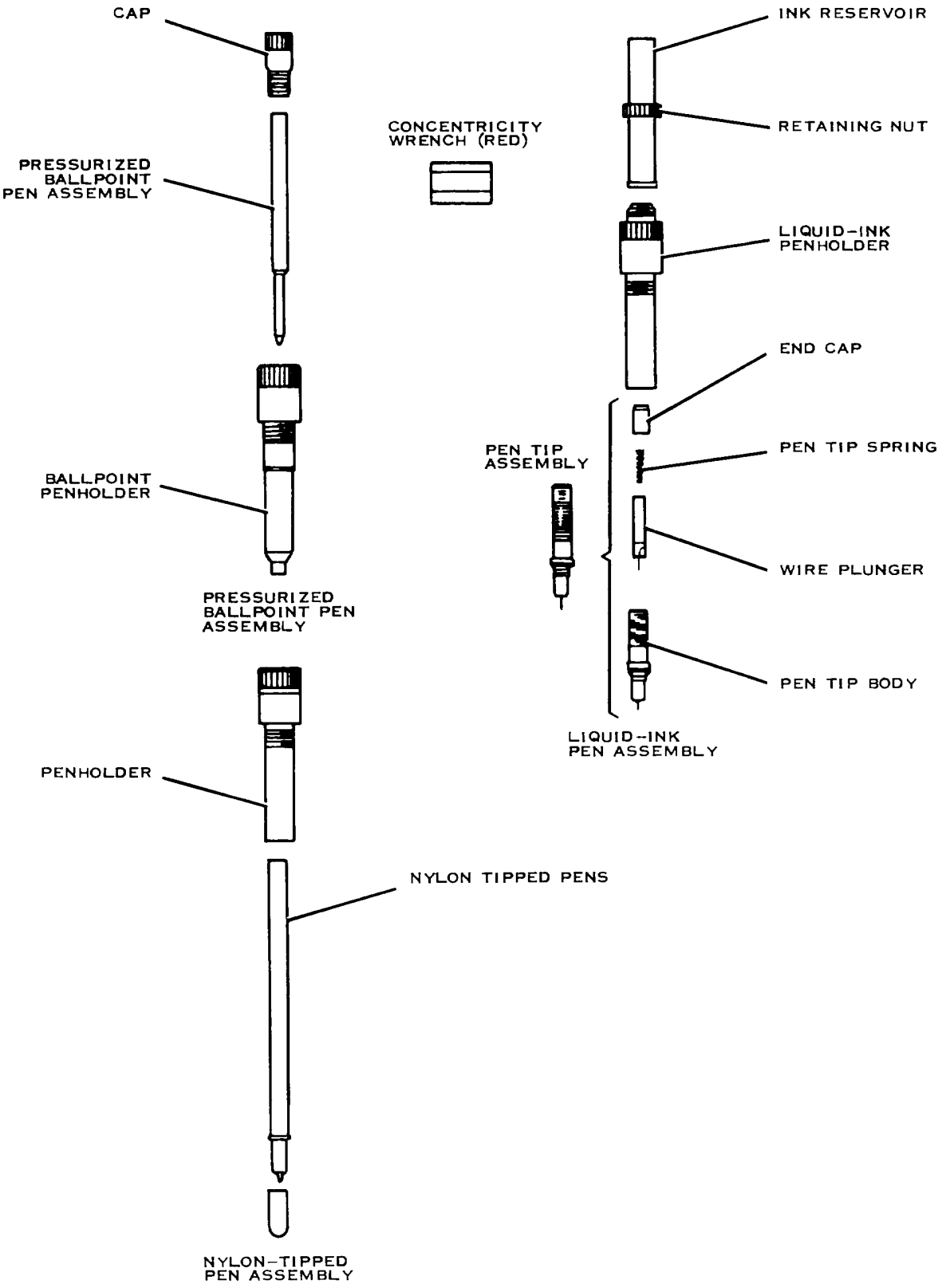


Figure 3-4. Pen Assemblies

a. Select a ballpoint pen cartridge from pen kit. Check that cartridge writes smoothly by writing manually on a piece of plotting material.
b. Select a ballpoint penholder assembly (white colored unit) and unscrew cap from top of unit.
c. Place ballpoint pen cartridge inside penholder, and replace cap.

3-12. NYLON-TIPPED PEN ASSEMBLY. Procedures for nylon tipped pen assembly are listed below. Refer to figure 3-4.

a. Select nylon-tipped pen cartridge from pen kit. Remove tip protector, check that cartridge writes smoothly by manually writing on a piece of plotting material. Replace tip protector.
b. Select a nylon-tipped penholder.
c. Insert cartridge into penholder through bottom, and pull cartridge until shoulder just above tip fits snugly against bottom of penholder.
d. Remove tip protector just before assembly is installed in carriage. Replace tip protector when pen is removed from carriage.

3-13. LIQUID-INK PEN ASSEMBLY. Procedures for liquid-ink pen assembly are listed below. Refer to figure 3-4.

NOTE

Ink in the tip of the pen assembly dries quickly if the pen is not used. Be ready to begin plotting after installing the pen assembly in pen carriage.

a. Before assembling a liquid-ink pen, always check that the parts, especially inside of pen tip, are clean. For a detailed description of pen cleaning, refer to paragraph 5-5.
b. Select a liquid-ink penholder (black colored unit) from pen kit.
c. Determine size of pen tip required for plotting, and select appropriate pen tip assembly.
d. Hold pen tip assembly vertically and shake it to check for freedom-of-plunger movement.
e. Screw pen tip assembly into penholder, but do not tighten it. Place concentricity wrench over pen tip and tighten it, finger-tight only.
f. Determine color and amount of ink required for plotting.
g. Select an ink reservoir and retaining nut from pen kit.
h. Pour ink into reservoir. If a great amount of ink is needed, fill reservoir to approximately 6 mm (1/4-inch) from top.
i. While still holding ink reservoir, tighten retaining nut.
j. Prime pen by shaking it lightly to start flow of ink.
k. Check pen operation by writing manually on a piece of plotting material.

3-14. PEN INSTALLATION. To install pen in carriage, refer to figure 3-4 and proceed as follows.

CAUTION

To prevent possible damage to drum, never install a pen unless plotting material is loaded. Refer to paragraph 3-7 for paper loading procedures.

a. Set POWER switch to OFF position, or ensure that PLOT/LOAD switch is in LOAD position so pen will be in up position when installed.

b. Screw threaded section of the pen into pen support hole. Finger-tighten pen.

3-15. OPERATING PROCEDURES.

3-16. INITIAL OPERATION ADJUSTMENT PROCEDURES. With paper loaded and Plotter properly connected to primary power and I/O lines. operate the Plotter to perform the following adjustments.

a. Paper width adjustment may be accomplished at 3 locations. Refer to figure 3-3. The supply and takeup spools must be adjusted to provide proper tracking. They are adjusted in a similar manner. If the paper is too wide, the edges will be compressed by the spring-loaded idler spools. If the paper is too narrow and a gap exists between the end of the roll and the spool, the paper may skew during operation.

1. To achieve desired fit for takeup roll. grasp roll firmly to prevent rotation and turn black flange of idler spool clockwise (away from the operator) to lengthen distance between spools or counterclockwise to shorten distance between spools. A data punch card (0.008-inch thick) should slip into gap between face of idler pulley and plotting material.

2. Supply roll is adjusted in a manner similar to takeup roll.

3. After supply and takeup spools are adjusted, a third paper width adjustment is accomplished by moving pins on left end of drum. Worn or enlarged sprocket holes in plotting material are an indication of poor paper tracking.

b. Scale factor adjustment is used to compensate for stretched or shrunk gridded plotting material. This affects only Y-axis. In the following procedure, the Plotter controller is required to send data to Plotter to create a pattern of a known size. The Plotter BIT may be used for this purpose. The following steps should be used to adjust scale factor.

1. Set POWER ON/OFF switch to ON position, PLOT/MANUAL switch to PLOT position and PLOT/LOAD switch to PLOT position.

2. With pen loaded, execute the Plotter BIT. Refer to Section V. paragraph 5-11, for instructions on how to initiate Plotter BIT to obtain plot illustrated in figure 5-5.

3. Upon completion of Plotter BIT, measure the distance between two most distant points along the Y-axis, using the paper's grid as a measuring device. Compare the measured distance with the value given in figure 5-5.

4. Calculate scale factor as follows:

$$\text{scale factor} = \frac{\text{measured difference (in inches)}}{0.005}$$

Example: If drawn pattern falls short by 0.1 inch, calculate scale factor as follows:

$$\text{scale factor} = \frac{0.1}{0.005} = 20$$

5. Algebraically add calculated scale factor from step 4 to value already set in the SCALE FACTOR switch. If the line falls short, use a plus sign for the calculated scale factor. If drawn line overshoots, use a minus sign for calculated scale factor.

6. Repeat steps 2 through 5 until error is acceptable.

c. Pen pressure adjustment should be done according to pen type being used and the given pressure in table 3-3. Pressure adjustment is accomplished by using PEN CONTROL FORCE rocker switch located on the right control panel.

Do not use a larger pen force than recommended. Damage to pen, plotting material and drum may result.

Table 3-3. Pen Pressure Adjustment

Pen Type	Pen Force
Ballpoint only	High
Liquid ink (pen size L8)	Medium
Liquid ink (pen size L5 and L6)	Medium or Low
Liquid ink (pen size L2 through L4) and nylon tip	Low

3-17. PLOT MODE OPERATION. To initiate the Plotter in the PLOT mode, proceed as follows:

a. Ensure that supply spool contains enough material for plot, then install spool of plotting material in Plotter. Follow the paper loading procedures given in paragraph 3-7.

b. Ensure that pen contains enough ink; then install the pen in the carriage per paragraph 3-14.

c. Set the PLOT/MANUAL switch in the MANUAL position, PLOT/LOAD switch in PLOT position, and the POWER ON/OFF switch in the ON position.

d. Use the MANUAL AXIS CONTROL buttons to check for freedom of movement of pen carriage, supply spool, and takeup spool. Check pen up and pen down movement by depressing PEN CONTROL ACTIVATE switch. Move pen carriage the length of beam, and rotate drum in both directions for about 20 seconds. When rotating drum, use care to avoid pulling plotting material off takeup spool.

e. Set PLOT/MANUAL switch to PLOT position.

f. Plotter is now ready for remote controlled operation.

3-18. SHUTDOWN.

3-19. The Plotter may be turned off completely by performing the following steps. For maintenance purposes, the plotter circuit breaker, located on the left side of the Plotter, may also be set to the OFF position.

a. Ensure that pen is in the up position by placing PLOT/LOAD switch in LOAD position.

b. Set Plotter POWER ON/OFF switch to OFF position.

3-20. PAPER REMOVAL.

3-21. To remove a spool of plotting material from Plotter, follow the steps in the sequence given.

a. On the Left Operator Control Panel, set POWER ON/OFF switch to the ON position.

b. Set PLOT/MANUAL switch to MANUAL position, set PLOT/LOAD switch in PLOT position, and press PEN ACTIVATE to raise pen from drum surface. Visually check that pen is in raised position.

c. Press +X axis MANUAL AXIS CONTROL button (top button) until all plotting information is on takeup spool. Set the PLOT/LOAD switch to LOAD position or set POWER ON/OFF switch to OFF.

d. Cut the plotting material outside of the area of plot by placing paper over slot behind front surface and running sharp object along slot for entire paper width.

e. Remove takeup spool by pressing left end of the spool against spring-loaded idler spool and lifting right end of the spool clear of drive spool.

f. If supply spool contains enough material for next plot, this material can be started on the takeup spool as described in the paper loading procedures in paragraph 3-7. If supply spool does not contain enough material, remove it in same manner described in step e. for takeup spool.

SECTION IV

THEORY OF OPERATION

4-1. GENERAL.

4-2. This section contains information on the theory of operation of the Plotter. Paragraphs 4-3 through 4-18 contain a discussion explaining the overall electrical and mechanical operation of the Plotter. Paragraphs 4-19 through 4-44 provide detailed discussion supported by diagrams for each of the electrical functional groups. Refer to figure 4-1 for a block diagram of the Plotter system.

4-3. GENERAL DESCRIPTION.

4-4. ELECTRICAL GENERAL DESCRIPTION. The following paragraphs (4-5 through 4-12) contain a general description of the Plotter's electrical functions. Refer to figure 4-1.

4-5. Power Characteristics. The Plotter operates on three-phase, four wire, wye (Y) connected power at 120 volts line-to-neutral, 208 volts line-to-line. The power frequency is 400 Hz. This power is brought to the Plotter through a five-conductor cable with individual conductors for phase 1, phase 2, phase 3, neutral and ground. After passing through a line filter, the power is transformed to a level where it is rectified, filtered, and regulated to several voltage levels. The HOURS meter, fan and POWER switch are all connected in the Power Supply after the line filter and before the transformer. The three phases of the input power are fused at this point by the circuit breaker accessible from the outside of the Plotter on the left end. The voltages output from the Power Supply are at levels of +5 Vdc regulated, ±14 Vdc unregulated and ±15 Vdc regulated. Also included in the Power Supply circuitry is an adjustable circuit that indicates if the voltage is within an acceptable range. The output of this circuit affects XPOLS (to indicate that the Plotter is off-line if the voltage should go out of tolerance).

4-6. Input Signals. There are seven input signals to the Plotter. Six of these signals are data and one is a strobe. Each of the signal lines is shielded with a return line and all are at TTL voltage levels. The data lines (+X, -X, +Y, -Y, pen-up and pen-down) are all positive-going signals and are all latched into the Plotter with the plot enable signal. Table 4-1 and figure 4-2 indicate the direction of pen movement resulting from receipt of one or more signals. Note that is the Plotter receives two directional pulses (one in Y-axis and one in X-axis) simultaneously, a diagonal pen movement will result.

4-7. Output Signals. There are four signal outputs from the Plotter to indicate the current status of the Plotter. The first of these four signals is plotter connected (/XYPCZ), which indicates by a TTL logic 0 (O Vdc) that the Plotter is connected. The second output is plotter on-line (XYPOLZ), which indicates by a TTL logic 1 (+5 Vdc) that the Plotter is on line (paper level is good, power within regulation, and in plot mode). Plotter ready (/XYPRZ) indicates with a TTL logic 0 when the Plotter is ready to accept data. The fourth output signal is a carriage overtravel (/XYPOTZ) signal, which indicates with a TTL logic 0 that the Plotter has reached the end of the limits of travel in the Y-axis.

4-8. Supply and Takeup Spool Servo Circuits. The supply (rear) and takeup (front) spools are rotated by dc motors under the control of a completely analog servosystem. Paper drive servos are used to maintain the isolation loops between the drum and the paper feed spool and the drum and the takeup spool. Light-sensitive transistors (see figure 4-3) in combination with a light source provide the servosystem with information on the location of the paper loop in the pan. Reset, load and standby circuitry affect the paper servo circuitry.

Table 4-1. Pen Movement and Vectors Resulting From Input Data

+X	-X	+Y	-Y	PUP	PDP	Resulting Movement
0	0	0	0	0	0	No movement
0	0	0	0	0	1	Pen down
0	0	0	0	1	0	Penup
0	0	0	1	0	0	270 degree
0	0	1	0	0	0	90 degree
0	I	0	0	0	0	180 degree
1	0	0	0	0	0	0 degree
1	0	1	0	0	0	45degree
1	0	0	1	0	0	315 degree
0	1	1	0	0	0	135 degree
0	1	0	1	0	0	225 degree

NOTE: Resulting movement is 0.005 inch(0.127 mm) long for vertical and horizontal movement, and $2^{1/2}$X0.005 ($2^{1/2}$X 0.127) long for diagonal movement.

4-9. Carriage Limit Switches. +Y and -Y axis limit switches are made with photoelectric devices that have a small opening and will be obstructed when the pen carriage reaches the limits of its travel. The resulting indication caused by the overtravel is sent to the Y-axis servosystem and the carriage overtravel

4-10. Pen Drive Circuitry. The position of the pen (up or down) is affected by input data, PEN (/XPOTS) output line. Refer to figure 1-2 for location of limit switches. CONTROL ACTIVATE, PEN CONTROL FORCE, and PLOT/MANUAL controls. The pen is moved by energizing or deenergizing a solenoid penholder. The pen force circuit applies current specified by the PEN FORCE control when the pen is in the down position. When the pen is sent the command for down. a sequence of two different current values is used to bring it to its down position. Refer to

4-11. Low Paper Sensor. A low paper condition is sensed by a switch arrangement on the supply spool (see figure 4-3). When the switch is closed (low paper condition) a signal is sent to the Right Control paragraph 4-22 for a detailed description of the Pen Amplifier. Panel where the signal may be overridden by the MEDIA PLOT/OVRD control. If the signal is not overridden, the result will be that the plotter online (XPOLS) signal will fall to a logic 0 level to INDICATE THAT THE Plotter is not on line.

4-12. Axis Servosystem. The X-axis signals control the drum servomotor and the Y-axis signals control the carriage servomotor. Since both of these servosystems are essentially the same, only the X-axis will be discussed here. Refer to figure 4-4 when reading this section. The axis servo uses both analog and digital feedback loops. Plot motion commands (input data) are sent to the servo loop by entering the values into the position error register. The plot motion commands tell the system where to move. Along with the plot motion commands. the current position is entered into the position error register (SUM 1). The result of algebraically adding these two values is a digital value indicating how far the system needs to move. This value of how far to move is then algebraically added with a digital velocity feedback signal (SUM 2). The result of this is a value that indicates how far and how fast the system needs to move. This is sent to a digital-to-analog converter (DAC). The positive or negative dc signal outputs of the DAC are applied to a third summing point (SUM 3) along with analog feedback from the drive motor. The feedback from the motor is dual level with the least sensitive setting being used only when

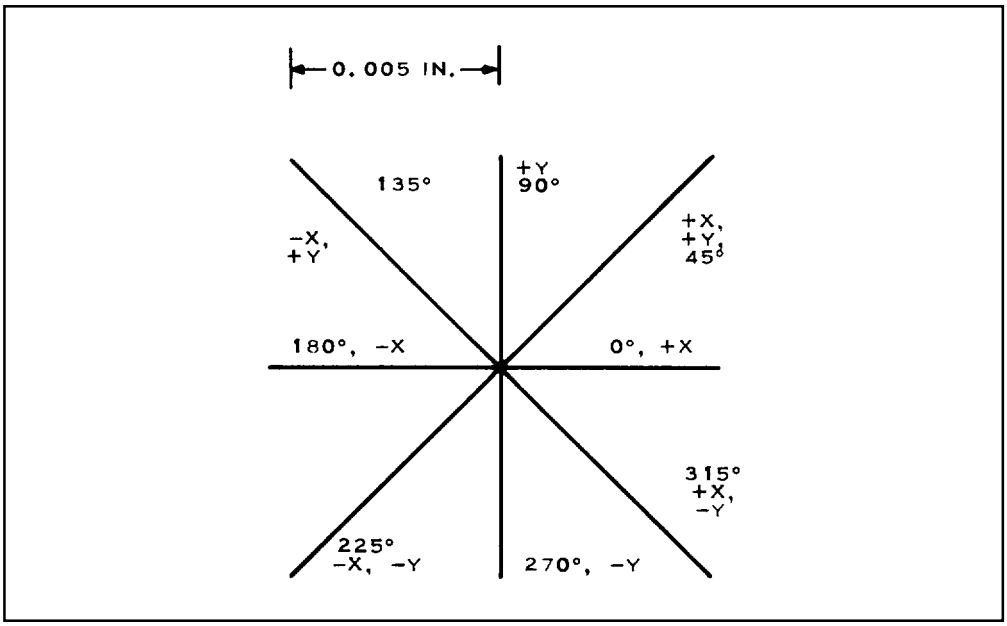


Figure 4-2. Basic Plotter Vectors

the Plotter is in the idle state. The servomotor is mechanically connected to the positional encoder by use of the same shaft. The encoder creates pulses which are processed by the encoder logic to produce the digital positional feedback signals. Thus, the servo loop is completed.

4-13. MECHANICAL GENERAL DESCRIPTION. The following paragraphs give a general description of the Plotter's prominent mechanical devices.

4-14. DC Drive Motors and Encoders. The dc drive motors for the front and back (takeup and supply) paper servosystems are identical to each other. They are driven by corresponding servo sense and power amplifiers. The shafts of the paper supply and takeup drive their respective spool using O-ring belts. The drum drive servo drives the drum gear on the end of its shaft. On the opposite end of the drive motor is the X-axis encoder. The encoder is a photomechanical device and produces two sine-wave voltages (phase A and B) that determine the direction of encoder rotation. The encoder produces the pulses by using a rotating mask (attached to the shaft) to interrupt a light beam between a light source and photosensitive device. The encoder pulses are also used to produce velocity and position data. Refer to paragraph 4-31 for information on Encoder Preamplifier. The carriage drive motor and encoder operate in the same manner as the X-axis except that the motor drives the carriage drive band.

4-15. Drive Band. The drive band is used to transfer motion from the Y-axis servomotor to the carriage. This band is wrapped around a pulley at each end of the beam, and the ends of the band are connected to the carriage. The drive pulley, at the right end of the beam, is connected through a geartrain to the servomotor; the idler pulley, at the left end of the beam, is used to apply tension to the band. The drive band is shown in figure 5-8.

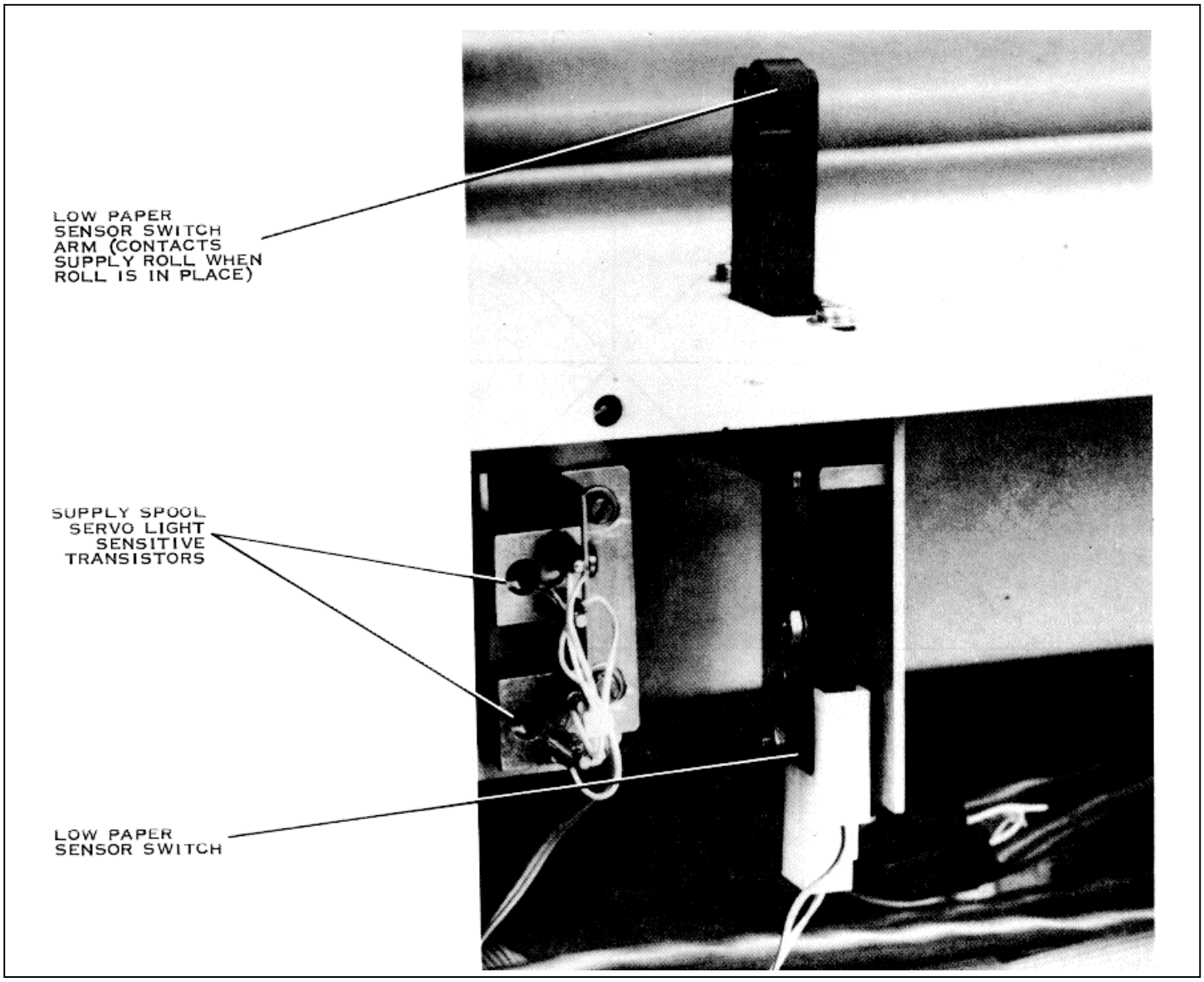


Figure 4-3. Low Paper Sensor Switch and Supply Spool Servo Photodetectors

4-16. Vacuum Fan. The vacuum fan is used to supply a vacuum to the paper pans.

4-17. Pen Carriage. The pen carriage is the device that holds the pen during plotting operations. Pens are inserted into the carriage so as to allow a solenoid to move the pen in a vertical direction (upon receiving a pen-up or pen-down command). An adjustment is provided for pen height.

4-18. Printed Circuit Boards. There are a total of 10 PCB types ill the Plotter. Some of these are fairly complex while others are used for support and interconnection of a device (limit switch PCBs). Table 4-2 indicates the various PCBs and functions.

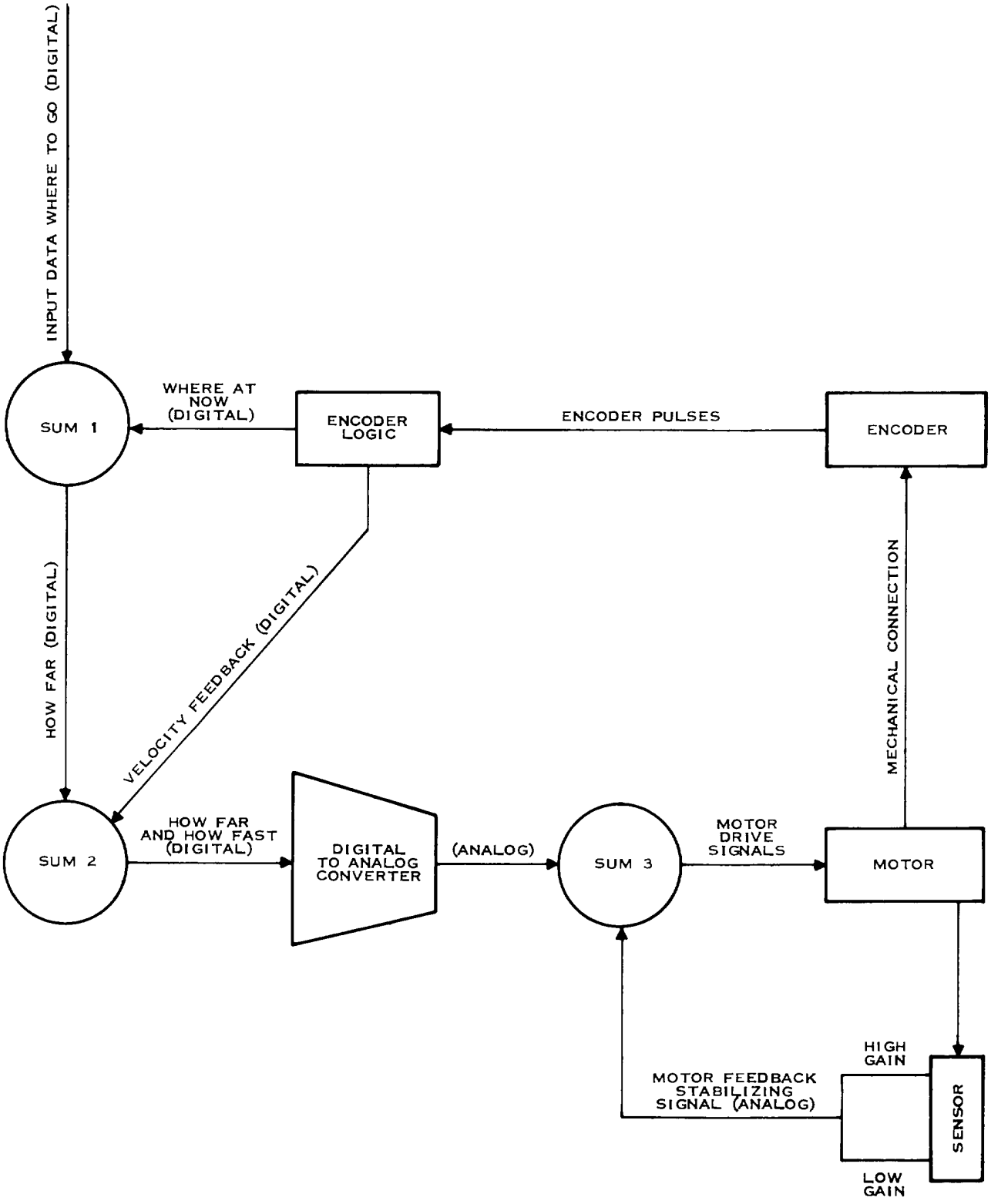


Figure 4-4. Plotter Servosystem Block Diagram

Table 4-2. Printed Circuit Boards and Functions

Name	Quantity	Function
LED Light Source PCB (A9, A12)	2	Location of paper supply and takeup servo LED row, one PCB per paper pan.
LED Interconnect PCB (A10)	2	Small PCB with no components, allows edge connector to wiring hookup.
Right Operator Control Panel PCB (A5)	1	Mounting location for MANUAL AXIS CONTROL, PEN CONTROL ACTIVATE, PLOT/OVRD, PLOT/LOAD, PLOT/MANUAL and PEN FORCE switches and associated circuitry
Scale Factor PCB (A3)	1	Mounting location for SCALE FACTOR switch and associated circuitry.
Master Interconnect PCB (A1)	1	Mother board for I/O-Pen Driver PCB and Logic. Drive and Scale Factor PCB. Mounts behind Plotter front panel (under drum).
I/0-Pen Driver PCB (A1)	1	Contains circuitry for I/O, pen amplifier, paper servoamplifier and low paper sensor.
Logic, Drive and Scale Factor PCB (A2)	1	Contains circuitry for axis drive (X, Y), scale factor logic and encoder logic.
Encoder Preamplifier PCB (A4)	1	Contains circuitry to provide X- and Y-axis encoder signal preamplification.
Limit Switch PCB (A6, A7)	2	Left and Right Limit Switch PCB assemblies are identical except for location of optical switch assembly. No components on PCB except for optical switch.
Power Supply Regulator PCB (A8)	1	Provides circuitry for rectification, filtering, regulation, and level sensing of power supplied to Plotter circuitry.

4-19. DETAILED DESCRIPTION.

4-20. The detailed description of the Plotter explains the electrical functional groups (circuits). These groups are: input/output networks, pen amplifier, paper servoamplifiers, power monitor, axis driver logic (servosystem), scale factor logic, and controls and indicators.

4-21. INPUT/OUTPUT NETWORKS. The circuitry that makes up the input/output network is located on Input/Output Pen Driver PCB Al located behind the front panel and below the drum. Refer to figure 6-2 (sheet 2).] Al PCB is plugged into the Master Interconnect Board (MIB) in the top slot. Further identification of Al PCB can be made by noting that the PCB has six large transistors mounted on the top side. Input pulses that arrive at the I/O driver circuitry are first buffered by U43 and U48. These input pulses must have a pulsewidth greater than 4 microseconds and a rise time of less than 10 microseconds. Source impedance should be 500 ohms or less. The TTL level input pulses are accompanied by an enable (strobe) pulse which latches the input data (+X, -X, +Y. -Y, pen up, and pen down) into flip-flops located on U39, U40, and U29. Figure 4-5 illustrates the input signal timing. Note that the operation of the pen (pen up or pen down) causes an additional delay in the resetting of the plotter ready (/XPRS) to allow for the pen to overcome inertia. Refer to figure 4-6 for a pen current pattern diagram. The latched input data present in U39, IJ40 and U29 is brought to U45 where either

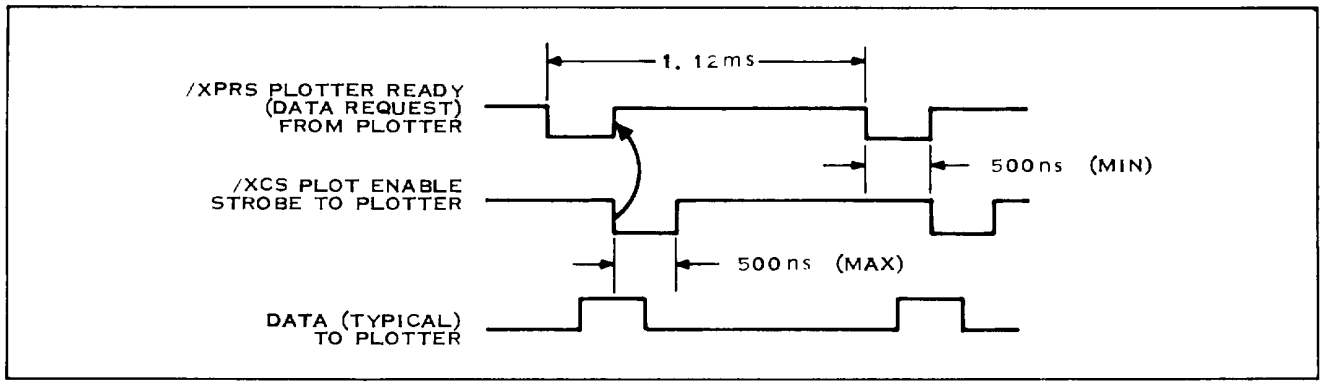


Figure 4-5. Typical Input Signals

this input data or manual commands can be selected for further processing. The selection of manual commands or input data is made at the PLOT/MANUAL switch. After this selection, the +X, -X, +Y and -Y signals arrive at U49 and U50 where they pulse individual 600 microsecond one-shots. The resulting pulses created from the one-shots are sent to the Logic, Drive and Scale Factor PCB. Output signals consist of plotter ready (/XPRS), plotter on line (XPOLS), carriage limit (/XPOTS) and plotter connected (/XPCS). These TTL level output signals indicate the status of the Plotter. Plotter request is created from a MANUAL/PLOT signal, a reset signal and a ready signal. The result is that /XPRS signal goes low to indicate that the Plotter is ready for data. This signal has no maximum time limit. Refer to figure 4-5 for a timing diagram of this signal. Plotter on line is created by Adding the signals of paper OK (POK), power within regulation (PWREG) and a manual indication signal (MANF). The signal goes high to indicate that the three signals are good. Note that this signal is asynchronous to the operation of the Plotter. Carriage overtravel signal goes low to indicate the Y-axis overtravel condition. This signal is derived from circuitry located on the Logic, Drive and Scale Factor PCB. The U79, in combination with U32 and U51, provides squaring and ORing of the signals received from two limit sensors. The resultant signal is asynchronous to the operation of the Plotter. The Plotter connected signal indicates that the Plotter is physically connected when a TTL low level is present. The signal is derived from an inverter in U27, which has its input connected to +5 Vdc.

4-22. PEN AMPLIFIER. Refer to figure 6-2 (sheet 3). The two pen commands, pen up and pen down, are buffered and latched and sent to a flip-flop (U16) which indicates the desired pen position. If the pen is to be put in the down position, the flip-flop in U16 is reset. This sets a line (PSDN) high which initiates a sequence of events to lower the pen. When U2 one-shot receives the high signal from line PSDN, the result is a 2 millisecond output. This 2 millisecond output is encoded with inverting input AND gates present in U1. The resulting binary output (binary 1) of the encoder is used to select the

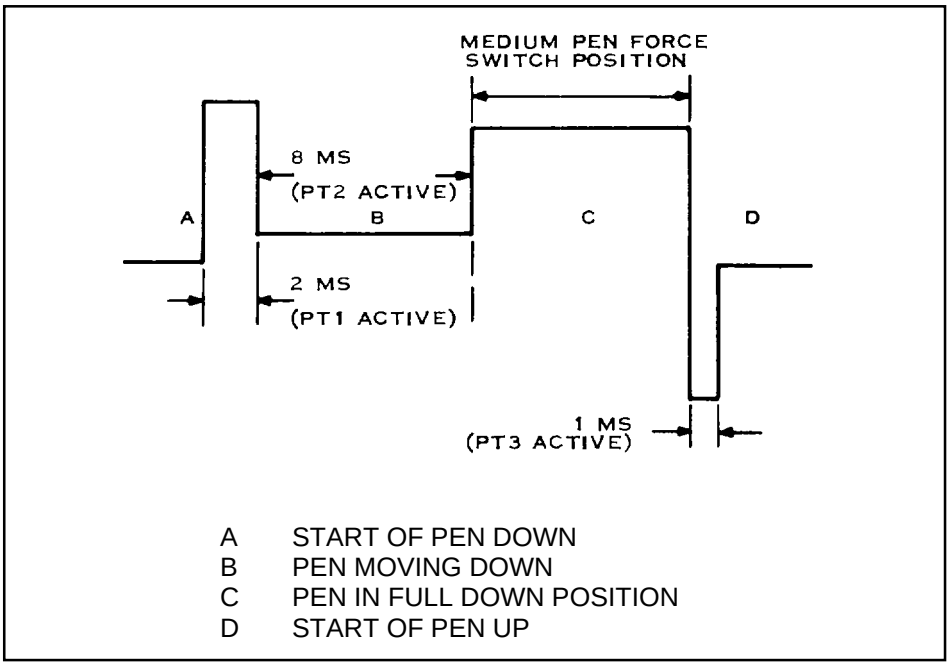


Figure 4-6. Pen Current Pattern

initial pen loading current (set by 180-kilohm resistor R10) from the multiplexer. After U2 one-shot fires, U2 one-shot fires for 8 milliseconds. This produces a binary 2, which selects pin 15 of the multiplexer (U13) and allows the current to be set by a 560-kilohm resistor. Note that this is a reduced current. When U2 one-shot goes back to its high state, the multiplexer selects the current set by the PEN FORCE switch. The PEN FORCE switch has 560-, 510-, and 82-kilohm resistors used to set LOW, MED, and HIGH pen force currents, respectively. When a pen-up command is received at flip-flop U16, the output is reset and PSDN drops to low. This causes U15 one-shot to become active for 1 millisecond. The U15 one-shot selects a binary 3, which directs the multiplexer to allow a negative current set by 100-kilohm resistor R 11. This negative current energizes the coil in the opposite direction and pulls the pen up. Figure 4-6 shows the current pattern for lowering and raising a pen. The output of the multiplexer is amplified using an op-amp (U26) with adjustable gain (potentiometer R15) and balance (potentiometer R18). Amplified signals from the op-amp are then sent through a relay which is used to raise the pen for certain functions (reset). The signal is then used to drive transistors Q1 and Q2. Q3 and Q4 are driven by these to provide positive and negative currents resulting from the applied +14 Vdc.

4-23. PAPER SERVOAMPLIFIERS. The front and rear servosystems for supply and takeup spools are located on the I/O Pen Driver PCB. Refer to figure 6-2 (sheet 7). These two amplifiers are complete separate units with individual inputs (from light sensors) and individual outputs (to servomotors). In the front servoamplifier, input is in an adjustable gain circuit. A potentiometer (R43) is provided to adjust the gain. At this point, the signal passes through a relay which is opened upon reset. The signal is further amplified by U34 and is applied to the final stage of the amplifier. Transistors Q5, Q6, Q9, and Q10 are used to drive the servomotor. The circuitry for the rear servosystem is identical to front circuitry except that part designations are different.

4-24. POWER MONITOR. The circuitry which monitors the power of the Plotter is located on the Power Supply Regulator PCB. Refer to figure 6-6. U5 is used to provide op-amps, which detect when the power is out of tolerance. Resistor voltage dividers with adjustable values supply the op-amp circuitry with input values. Potentiometers R2 and R5 provide adjustability. The output of the circuitry (PWREG) is brought to U31 on the I/O Pen Driver PCB where it is ANDed with two other signals to produce the XPOLS signal.

4-25. AXIS DRIVE CIRCUITRY. The axis drive circuitry is the most complex circuit in the Plotter. Refer to figure 6-3. The axis driver servosystem uses both analog and digital feedback loops. A signal developed across the sense resistor is used to stabilize the gain of the dc amplifier (analog), and the output of the motor-driven encoder and circuitry (digital) is used as position and velocity feedback. The circuitry for the axis driver is located on the Logic, Drive and Scale Factor PCB A2 behind the front panel and under the drum. Refer to figure 4-7 for a block diagram of an axis servosystem. Starting with the error register, which receives plot pulses (manual or input) and negative feedback (encoder position), this discussion will continue until the loop has been completed. Since the X- and Y-axis drive servo circuitry is essentially the same, only the X-axis circuitry will be discussed.

4-26. Error Register. The error register uses the input signals to produce a digital result indicating the required distance to move. Input pulses can either be input data or data created for manual controls. Only the Y-axis has scale factor adjustment circuitry for the input pulses. The error register contains two, 4-bit up/down counters (U33, U40), which create a sign-plus-two's complement number. The most significant bit of the counter output (pin 7 of U33) acts as the sign bit. Polarity of the counter output is the direction the Plotter will be driven. Inputs to the error register are plot motion commands and encoder counts from the scale factor logic. Input signals arriving at the input of the Y-axis error register are first sent through the scale factor circuitry. This scale factor circuitry, even though it is within the servo loop, will be explained at a later point because of its complexity. The plot motion commands are synchronized with the system clock and then are gated with the velocity and the limit switch terms (Y-axis only). The velocity term prohibits plot motion commands and encoder counts from being used at the same time by the error register. The limit switch term prohibits any Plotter movement in the direction of an activated limit switch. The plot motion commands and encoder counts enable the counter, which is then strobed by the Plotter clock. The counter is incremented for plus plot motion commands and plus encoder counts and decremented for minus plot motion commands and minus encoder counts. The counter up/down line (pin 5, U33, and U40) is raised by plus counts. Plus plot motion commands cause the servo to run forward. Forward motion results in minus encoder counts and vice versa. Therefore, encoder counts are negative feedback in the servo. The counter stores the difference between number of steps commanded (plot motion commands) and number of steps moved (encoder counts).

4-27. Adder. The adder (U41 and U34) is a binary adder circuit that takes the algebraic sum of the position and the effective velocity count. The velocity storage register (U25) output is multiplied by four (shift two bit positions to the left at the adder input) before adding. The output is a binary number, which drives the digital-to-analog-converter (DAC) in the servoamplifier. Each binary count is equal to 1/4 ampere of current in the servo loop. Since, at this point, the effective velocity count has been subtracted from the position count, the adder output only has to be large enough to accelerate the Plotter or overcome friction. Sixty-four counts, six bits, are sufficient for this purpose. The sign bit from the adder (pin 10 of U34) has the same definition as for the error register; however, the DAC circuit requires the opposite polarity to give the correct voltage output: therefore, the sign bit is inverted (U32) before driving the DAC.

4-28. Digital-to-Analog Converter. The Plotter uses 8-bit DAC circuit (U60). By driving the most significant input bit with the inverted adder sign bit, a bipolar output is obtained. The output voltage is also inverted. Therefore, when the inverted sign bit is 1, the output is negative voltage: when the bit is

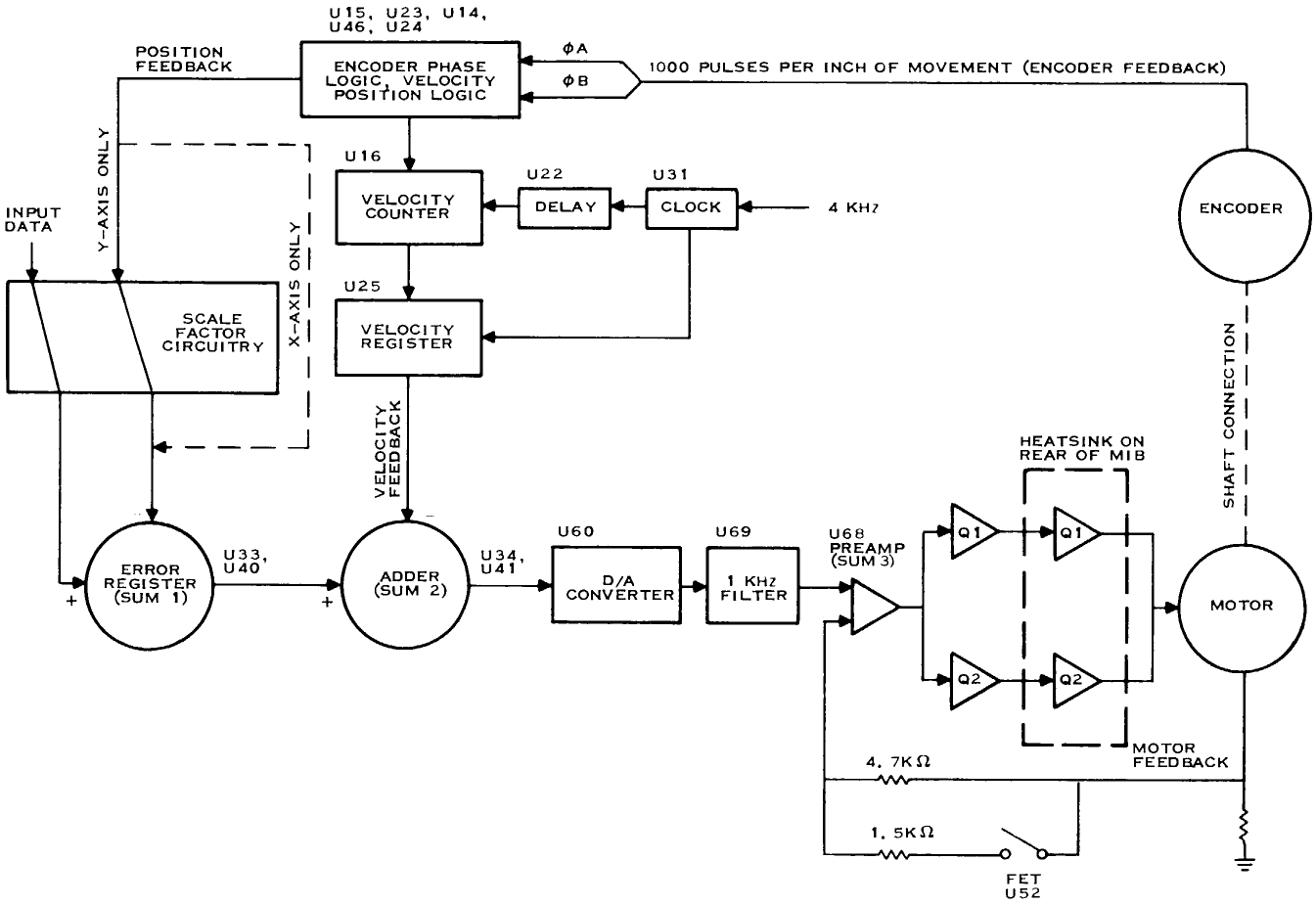


Figure 4-7. Detailed Axis Servosystem Block Diagram

0, the output is positive. Zero voltage out for the zero input is adjusted by an offset voltage potentiometer (R17). The inverted sign bit and the five adder output bits drive the six most significant DAC input positions, the lower two are grounded. The inputs to the DAC are -3 110 (11111 12) to +311o (0111112).

4-29. One KHz Filter. The output of the DAC is routed through a 1 kHz low-pass filter to reject the high frequency square edges of the step-shaped waveform and to remove noise. Gain for the servo circuit is set at this point to produce 1/4 ampere of current per binary bit applied to the DAC.

4-30. Preamplifier-Amplifier. A second amplifier (U68) is used as a summing point for the gain feedback from the drivers. This negative feedback has two levels, one for motors running and a second for motors standing still. The level is changed by the addition of a parallel resistor throughout the analog switch (U52) FET. The analog switch lowers the gain to lower the dither frequency of the Plotter. Mechanical springiness and slight amplifier effects carry the motor past the stopping point, and the resulting encoder pulse moves the error register away from null. Enough current is generated to rotate the motor in the opposite direction, but again, the motor coasts past the stopping point. In effect, the servo loop would oscillate about the zero line of the encoder. This condition, dither, is seen only by the Plotter logic. The mass of the drum and the carriage prevents the dither from being transmitted to the pen I Output of the summing amplifier is routed through relay K to provide the capability of disconnecting the amplifier during power up and power down. This prevents the axis from jumping. Finally, the signal is amplified by one stage of transistors (Q1 and Q2). Q3 and Q4 provide protection from too much current (6 amperes) by shorting the base of the last stage. After the signal leaves the PCB in the form of positive and negative motor commands, it is routed to large heatsinked transistors mounted on the Master Interconnect PCB mounting bracket. These four transistors are the final drivers to the axis servomotors.

4-31. Encoder Preamplifier. The encoder preamplifier is located on the Encoder Preamplifier PCB mounted near the drum motor-encoder. The dual channel optical encoder has an incandescent lamp as a light source and photosensitive devices to create the two-phase, sine-wave shaped outputs. Phase displacement between channels is 90 $\pm$ 45 degrees. Each rotation of the motor shaft causes 1,000 cycles of the signal on each channel. Differential levels on the balanced lines are detected by line receivers U1 and U2. Adjustable gain and bias potentiometers are present for each phase. The resultant signals are routed to the encoder phasing and velocity logic.

4-32. Encoder Phase Logic. Refer to figure 6-3, sheet 3. The logic for determining the phase of the signals is present in the circuitry made up of U24 1-bit shift register (flip-flop), U23 decoder and U15 decoder. U24 creates four signals to represent the two phases (A and B) which are routed to the two decoders. Phase B leads phase A for positive plotting motion and phase A leads phase B for negative plotting motion. The output of the decoder is directed to the velocity counter and to the error register throughout the scale factor logic.

4-33. Velocity Counter and Register. The velocity counter (U16) and velocity register (U25) is located on the Logic, Drive and Scale Factor PCB. Velocity counter U16 receives velocity pulses and counts either up or down according to the output of the encoder phase logic. The count is transferred to the velocity register every 200 microseconds. The output of the storage register is connected to the adder. The X-axis servo loop is completed.

4-34. SCALE FACTOR LOGIC. Scale factor logic for the Y-axis is located on the Logic, Drive and Scale Factor PCB and the Operator Scale Factor PCB. Refer to figure 6-3. Controls for setting the scale factor logic are located on Left Operator Control Panel. Figure 4-8 is a block diagram of the scale factor circuitry. Scale factor logic comprises input and output selectors, a scale counter, and a scale gating circuit. As the pen moves on the Y-axis, incremental steps of motion are added or subtracted. This

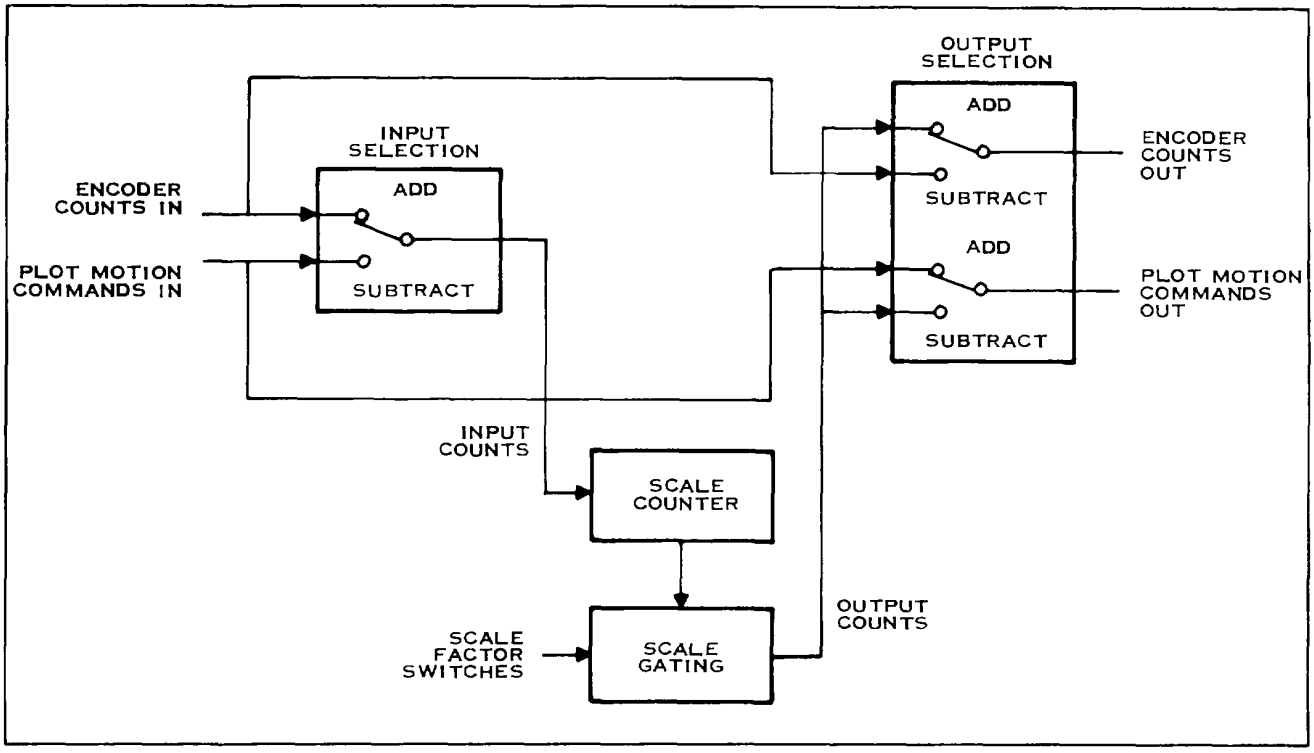


Figure 4-8. Scale Factor Logic Block Diagram

addition or subtraction is in effect for both positive and negative directions. The number of steps to be added or subtracted is determined during the initial adjustment procedures and scale factor calibration. As implemented, the scale factor logic only subtracts counts from a series of incoming pulses. Therefore, to add steps of motion, the logic subtracts encoder counts (causing the pen to move further than commanded). Selection of the signal to be scaled is selected by the + or - switch on the control panel. When the switch is in the open position, steps will be added (encoder counts will be directed to the scale counter). When the switch is closed, steps will be subtracted (plot motion commands will be directed to the scale counter). The scale counter (U26, U8, U27, and U17) is a 14-bit up/down binary counter. The counter is incremented by positive input counts (plus plot motion commands or plus encoder counts) and is decremented by negative input counts (minus plot motion commands or minus encoder counts). The counter will count to 16,383 and then overflow to zero. For the entire Plotter width (Y-axis) of 860 millimeters. the counter will overflow 4.2 times for 68,800 counts. The counter output terms, along with the scaling factor switches, control the scaling function. The scaling function is mechanized by using three integrated circuits, a dual 4-line-to-l-line data selector (U19), an 8-line-to-3-line priority encoder (U18), and an 8-line-to-l-line data selector (U9). Scale factor counter output terms ZYO and /ZY51 are used as the address inputs to U19; data inputs to U19 are at +5 Vdc level and the output of U9, and enabling inputs are the plus and minus input counts to the scale factor circuit. Counter output terms ZY6 through ZYI3 are used as the inputs to U18 and the scale factor switch outputs are used as the inputs to U9. The address inputs to U9 are the encoded counter terms from U18. Counter terms ZYI through ZY5 are NANDed at U35 to become /ZY51, which prevents elimination of counts until at least 63 are received. Terms ZY6 through ZY13, through priority encoder, select the appropriate scale factor switch to be used as data input to U9. After routing through U19, the signals pass through U1 and are sent to the Y-axis error register.

4-35. CONTROLS AND INDICATORS. This subsection provides a detailed explanation of controls and indicators. The individual controls and the circuits they interact with will be examined. Refer to figures 6-4 and 6-7.

4-36. MANUAL AXIS CONTROL Switches. The MANUAL AXIS CONTROL switches consist of four momentary contact single pole, single throw pushbutton switches located on the right control panel. After routing through individual 33-ohm resistors, the signals are pulled up to +5 Vdc by 4.7-kilohm resistors contained in resistor network R33 located on the I/O Pen Drive PCB. The four signals are then latched at U47. Refer to figure 6-2, sheet 5. The signals are then ready to be selected at U45, should the Plotter be in the manual mode. Note that the switches may not produce a signal (low TTL level) unless the PLOT/MANUAL switch is in the MANUAL position.

4-37. PEN CONTROL ACTIVATE Switch. The PEN CONTROL ACTIVATE switch consists of noe momentary contract single pole, single throw pushbutton switch located on the Right Control Panel. When the PLOT/MANUAL switch is in the MANUAL position, the ACTIVATE switch is allowed to ground the K-input of U2 located on the Right Control Panel PCB. The Q-output of the flip-flop is routed to the I/O Pen Driver PCB where it is NANDed with a manual indication signal and pen signal to control the PSDN line which selects pen-up or pen-down position (as discussed in the pen amplifier, paragraph 4-22).

4-38. PEN CONTROL FORCE Switch. The PEN CONTROL FORCE switch is a three position rocker switch with double pole, double throw configuration located on the Right Control Panel. The individual poles of the switch are not directly connected to each other to provide for the three settings. The three resistor combinations of 560. 510. and 82 kilohms provide for the LOW, MED and HIGH pen pressures. The output of the switch is sent to the I/O Pen Driver PCB where it is used to determine the current value sent to the pen solenoid.

4-39. MEDIA PLOT/OVRD Switch. The PLOT/OVRD switch is a single pole, double throw switch with the venter pole connected to ground, and is located on the Right Control Panel. This switch provides the capability of overriding the low paper condition caused by the low paper switch and indicated on PLOT/OVRD switch lamp. When the low paper condition occurs, the low paper resets flip-flop U2 located on the Right Control Panel PCB by connecting pin I of the U2 to a low state. To override the reset (override low condition) the PLOT/OVRD switch is placed in the OVRD position (Switch closed). This causes the low paper switch to conduct a high state to the reset of U2 resulting in continued Plotter operation.

4-40. MEDIA PLOT/LOAD Switch. The MEDIA PLOT/LOAD switch is a single pole, double throw switch with the center pole connected to ground and is located on the Right Control Panel. The switch provides the capability of causing a manual reset condition which will disconnect the front and rear servoamplifiers. This allows for manual manipulation of supply and takeup spools. When the switch is in the LOAD position. TTL low is routed to U9 on the I/O Pen Driver PCB causing its output to opern relay K2 (in the servoamplifier circuit).

4-41. MODE PLOT/MANUAL Switch. The MANUAL/PLOT switch is a single pole, double throw switch with the center pole connected to ground and is located on the Right Control Panel. The switch provides the capability of selecting either manual or input data for plotter control. When the switch is placed in the MANUAL position, the PEN CONTROL ACTIVATE and MANUAL AXIS SWITCHES ARE ENABLES. Also, a low TTL signal is routed out the /MAN line to indicate the manual condition. When the switch is placed in the PLOT position, the pen is reset and the /MAN line goes high (to indicate PLOT mode).

4-42. POWER ON/OFF Switch. The POWER ON/OFF switch (figure 6-6) on the Plotter is a triple pole, double throw rotary switch located on the Left Control Panel. In the ON position, the switch conducts phase A, phase B, and phase C, to the primary of the transformer. When the POWER ON/OFF switch is in the OFF position, the three phases are disconnected from the primary of the transformer.

4-43. SCALE FACTOR Switch. The SCALE FACTOR adjustment switch is composed of three individual thumbwheel switches. On the polarity thumbwheel, the + position opens the single pole, double throw switch. The - position of the polarity thumbwheel brings low (TTL) the input of inverter pin 9 of U1 located on the Scale Factor PCB. The resultant high output of the inverter is routed to the other circuitry on the Scale Factor PCB. The other two thumbwheel switches are BCD encoded four pole switches. These two numerical switches output 4 bits each of BCD data to BCD-to-binary integrated circuits U6 and U10. The binary output is routed to magnitude comparators U16 and U13. The other signals being compared against these are created by switch S2 with associated pullup resistors. Switch S2 is used to initially calibrate the Plotter. The result is sent to 4-bit true/complement, high/low elements UI 1, U12, U14, and U15. These four elements determine the true/complement result of switch S2 created and thumbwheel created data which is added together by U8 and U9. The final result of this addition is buffered by UI and U5 and sent to the Y-axis scale factor logic on the Logic Drive and Scale Factor PCB.

4-44. PLOT TIME Indicator. This 4-digit indicator meters the time that the power is applied to the Plotter. It is attached to phase A and neutral immediately after the POWER switch.

SECTION V
MAINTENANCE

5-1. GENERAL.

5-2. This section contains information necessary for performing preventive and corrective maintenance. Maintenance controls and indicators used in checkout, troubleshooting, and adjustment .are listed. Checkout procedures consist of sequences used to verify performance of the Plotter. Troubleshooting procedures are outlined where fault isolation diagnostic troubleshooting procedures leave off. Thus, only manual and Power Supply troubleshooting procedures are given. Alignment/adjustment and removal/replacement procedures are provided in step-by-step form.

5-3. PREVENTIVE MAINTENANCE.

5-4. Preventive maintenance procedures pertaining to the Plotter, including Plotter cleaning, inspection, and lubrication, are provided in Workcards, Periodic Inspection Requirements for Imagery Interpretation Segment AN/TYQ-II(V) and AN/TYQ-12(V) with publication numbers of T.O. O1M 1-7-9-6WC-1, TM 11-5895-1021-14/2, and TM 08045-15/2. Pen cleaning procedures are given below because of the many times they need to be cleaned.

5-5. Cleaning procedures consist of methods of cleaning the pen block and pens. Pen and pen block cleaning should be done after each plotting cycle before accumulated ink dries. Never allow components or holders to stand for extended periods of time before cleaning.

NOTE

Turn POWER ON/OFF switch to OFF position and unscrew pen.

a. Pen block cleaning procedures are as follows:
   1. Remove pen block cover (two screws).
   2. Interior surfaces of pen block should be cleaned with a brush and solvent supplied in pen kit.
   3. Pen block should be gently wiped with lint-free shop cloth.
   4. Replace pen block cover and two screws.

b. Ballpoint and nylon-tip pens should be cleaned by wiping exterior surfaces with lint-free shop cloth and solvent.

c. Liquid ink pens should be cleaned thoroughly at the end of each plotting cycle.
   1. Disassemble pen assembly and place components in cleaner supplied in pen kit. Allow to soak for at least one-half hour.
   2. Wipe components with lint-free shop cloth and blow out reservoir with syringe from pen kit.
   3. Insert a brush in pen holder assembly to remove remaining ink.
   4. Remove end cap from pen assembly. Be careful not to lose pen tip spring.
   5. Remove wire plunger. Clean components with cleaner and wipe all parts except for inside of pen tip body.
   6. Blow air through pen tip body to ensure open tip.

Table 5-1. Test Equipment Required, But Not Supplied, For Maintenance

Nomenclature	Use
Oscilloscope, Tektronix 465	Used to monitor and measure voltages and frequency of waveforms.
Digital Multimeter, Fluke 8000A	Used to measure voltages and resistances.
Multimeter, Triplett 630-NS	Used in adjustment of servosystem.
Fixture adapter, Calcomp PN 14393-204-000	Used to adapt fixture to carriage during beam alignment procedure.
Fixture, Calcomp PN 11398-211-011	Used during beam alignment procedure.
Extender pcb, Calcomp PN 20890-502-000	Used to extend PCB for access to test and adjustment points.
100 nonpunched data punch cards	Used in paper width and pen height adjustment.
Ruler, General Hardware Mfg. Co. Inc. (73792) PN CF2445	Used during scale factor calibration adjustment procedure.

7. Reassemble pen tip assembly and set asside to dry.

8. Reassemble complete pen assembly and check for pen tip wear. Worn tips will not perform satisfactorily.

5-6. CORRECTIVE MAINTENANCE.

5-7. Corrective maintenance of the Plotter consists of checkout, troubleshooting, adjustment, removal, and replacement procedures. Corrective maintenance can be performed with the Plotter installed in the Shelter. Table 5-1 lists test equipment required for maintenance.

5-8. MAINTENANCE CONTROLS AND INDICATORS. Left and right control panel controls and indicators used in maintenance are described and illustrated in section III. Figures 5-1, 5-2, 5-3, and 5-4 and tables 5-2, 5-3, 5-4, 5-5 show the test and adjustment points on the I/O-Pen Driver PCB: Logic, Drive and Scale Factor PCB; Encoder Preamplifier PCB: and Power Supply Regulator PCB, respectively.

5-9. CHECKOUT. Checkout consists of verifying Plotter operation in both manual and plot modes. Four types of checkouts are listed: manual checkout, Built-In Test (BIT) checkout, Fault Isolation Diagnostic (FID) checkout, and Plotter Power Supply checkout. The manual and Power Supply checkouts have related troubleshooting procedures.

5-10. Plotter Manual Checkout. Manual checkout procedures are listed in table 5-6. The manual checkout may be performed without BIT or FID software.

5-11. Plotter BIT Test Checkout. A quick go/no-go checkout of the Plotter can be performed by operating the Plotter BIT test. The BIT test is executed at the Indicator Control Group (QRU) Keyboard and Video Indicator. The following procedures outline steps required to run the Plotter BIT.

a. Press computer DISK LOAD switch. Computer DATA indicators should flash and DISK RECOVERY message should be displayed on QRU Video Indicator.

b. Press QRU Keyboard EXIT key.

c. Press QRU Keyboard STATUS key. A BIT selection list should appear on the QRU Video Indicator.

d. On the QRU keyboard, type the numeric that appears next to the Plotter BIT on the selection list. Press XMIT on QRU Keyboard to initiate Plotter BIT.

e. Follow instructions that appear on QRU Video Indicator. Pen is automatically positioned about inch from right end of drum.

f. Upon completion of the Plotter BIT, a manual comparison of the plotted pattern and the given pattern (figure 5-5) should be made. If the generated Plotter BIT output is not acceptable, perform the Plotter FID to further isolate the problem.

Table 5-2. A 1 1/0 and Pen Driver PCB Test and Adjustment Points

Figure 5-1 Index No.	Part Value or Color	Voltage	Location in Circuit
R52	50 kilohm		Rear paper servoamplifier gain
R43	50 kilohm		Front paper servoamplifier gain
R36	5 kilohm		U7 data rate adjust
R29	2 kilohm		U6 data rate adjust
R15	1 kilohm		Pen force amplifier gain
R18	10 kilohm		U26 Balance-pen force amplifier
TP1	White	+2.5 Vdc	Bias for op-amps in U32 and U48
TP2	Gray		Pen return
TP3	Violet	Gnd	Ground-PM
TP4	Green		PRSC/
TP5	Orange		256 kHz clock from U7
TP6	Brown		4 kHz clock
TP7	White		Gain front servo
TP8	Gray		Gain rear servo
TP9	Black	Gnd	P2101
TP10	Black	Gnd	P2102
TP11	Yellow	+5 Vdc	P2102
TP12	Red	+15 Vdc	P2101
TP13	Blue	-15 Vdc	P2101
TP14	Violet	+15 Vdc	P2102-AA38
TP15	Green	+15 Vdc	P2102-BB38
TP16	Orange	-15 Vdc	P2102-AA40
TP17	Brown	-15 Vdc	PP2102-BB40

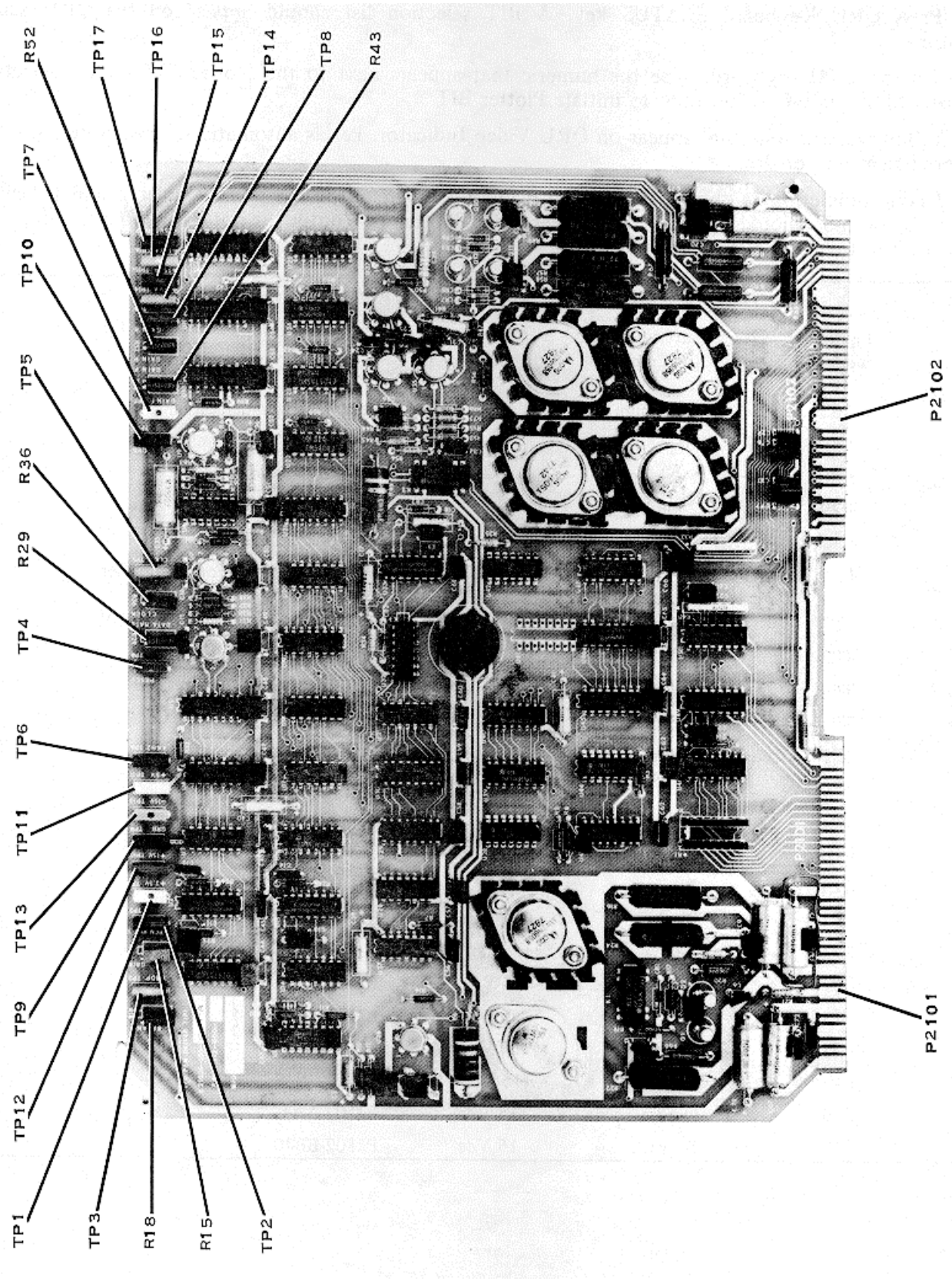


Figure 5-1. A1 I/O Pen Driver PCB Test and Adjustment Points

Table 5-3. A2 Logic, Drive and Scale Factor PCB Test and Adjustment Points

Figure 5-2 Index No.	Part Value or Color	Voltage	Location in Circuit
R17	2 kilohm		X-zero (X-axis servoamplifier)
R25	20 kilohm		X-gain (X-axis servoamplifier)
R18	2 kilohm		Y-zero (Y-axis servoamplifier)
R22	20 kilohm		Y-gain (Y-axis servoamplifier)
TP1	Brown		Y ϕ B (after buffer U63)
TP2	Red		Y ϕ A (after buffer U55)
TP3	Orange		X ϕ B (after buffer U59)
TP4	Yellow		X ϕ A (after buffer U67)
TP5	Green	Gnd	P2201, P2202
TP6	Blue	+5 Vdc	P2201, P2202
TP7	Violet		Y-axis U49 FET input
TP8	Gray		X-axis U52 FET input

5-12. Plotter FID Test Checkout. The Plotter Fault Isolation Diagnostic (FID) tests the Plotter operation in both manual and plot mode. If an error is encountered during the test, an error message is displayed on the QRU Video Indicator, indicating what Plotter PCB or group of PCBs is defective. Complete instructions for operating the Plotter FID are listed in the Test Procedures Manual T.O. 10-M 1-7-9-8-2.

5-13. Plotter Power Supply Checkout. Plotter Power Supply checkout is provided because the Plotter FID does not check the operation of or troubleshoot the Power Supply. Turn Plotter POWER to ON. With a DVM, measure the voltages at indicated test points and compare measured and given values. Table 5-7 lists the Power Supply checkout procedure. Use figure 5-4 for locating test points on the Power Supply and Regulator. The Power Supply is located under the left end housing. If the given values are not obtained, perform Power Supply troubleshooting procedures outlined in paragraph 5-14.

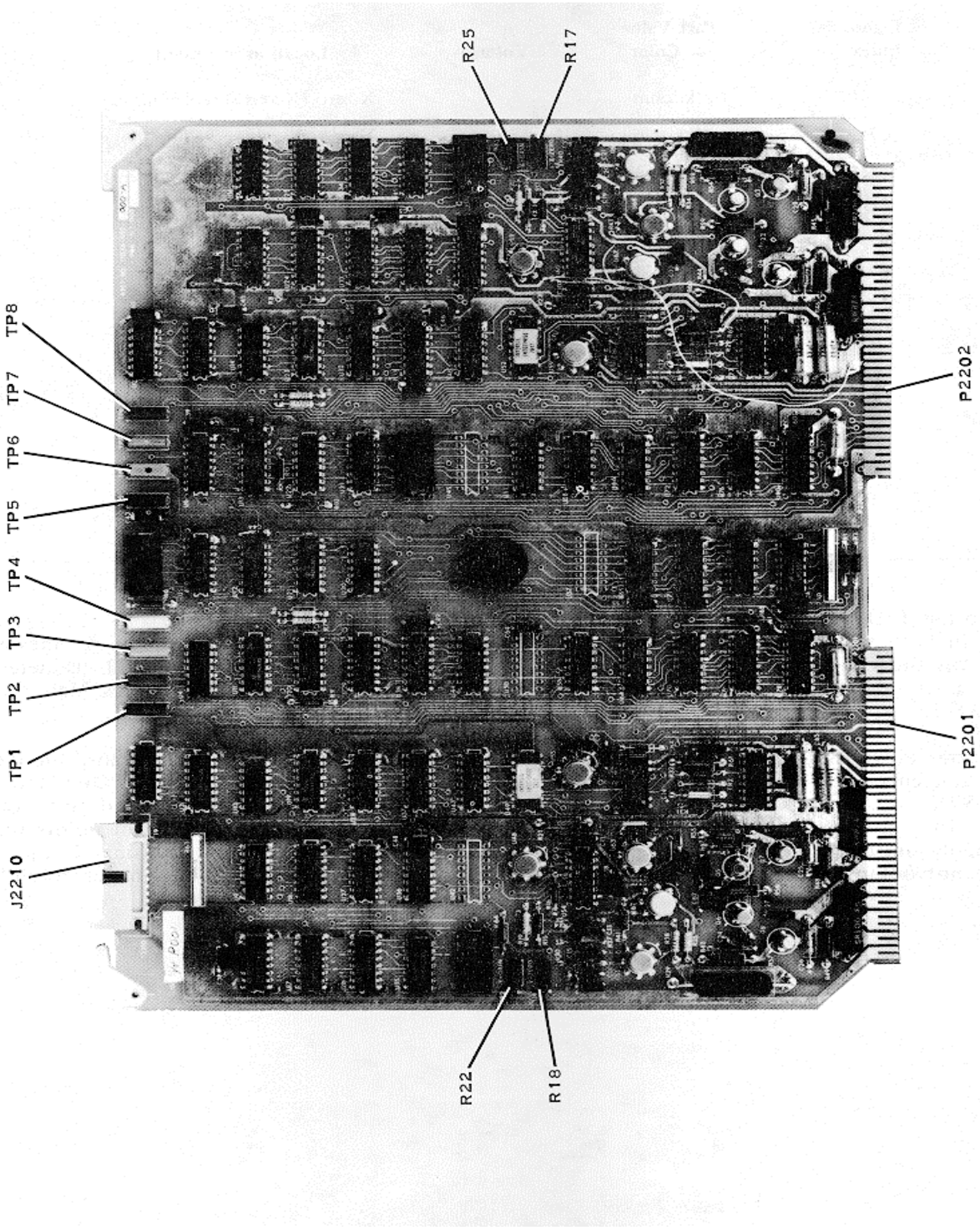


Figure 5-2. A2 Logic, Drive and Scale Factor PCB Test and Adjustment Points

Table 5-4. A4 Encoder Preamplifier PCB Test and Adjustment Points

Figure 5-3 Index No.	Part Value or Color	Voltage	Location in Circuit
R17	100 kilohm		GAIN-X ϕ A
R18	100 kilohm		GAIN-X ϕ B
R6	50 kilohm		BIAS-X ϕ A
R8	50 kilohm		BIAS-X ϕ B
R10	50 kilohm		BIAS-Y ϕ A
R12	50 kilohm		BIAS-Y ϕ B
R19	100 kilohm		GAIN-Y ϕ A
R20	100 kilohm		GAIN-Y ϕ B
TP1	Brown		X encoder ϕ A
TP2	Red		X encoder ϕ B
TP3	Orange		Y encoder ϕ A
TP4	Yellow		Y encoder ϕ B
TP5	Green		X amplified encoder ϕ A
TP6	Blue		X amplified encoder ϕ B
TP7	Violet		Y amplified encoder ϕ A
TP8	Gray		Y amplified encoder ϕ B
TP9	Black	Gnd	Ground-J6020, J6010

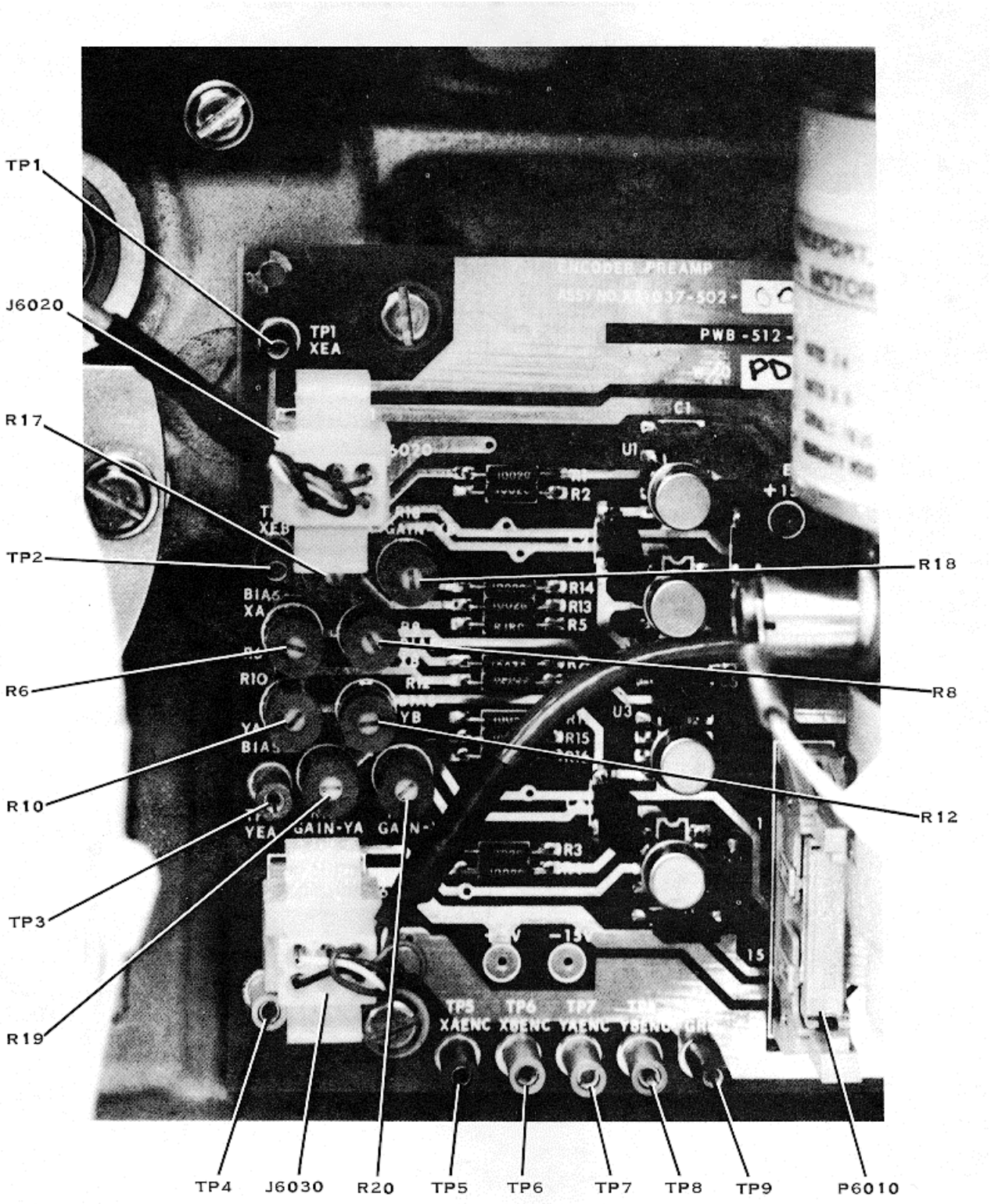


Figure 5-3. A4 Encoder Preamplifier PCB Test and Adjustment Points

Table 5-5. A8 Power Supply and Regulator Test and Adjustment Points

Figure 5-3 Index No.	Part Value or Color	Voltage	Location in Circuit
F1	3 A		18AC1 Transformer Secondary
F2	3 A		18AC2 Transformer Secondary
F3	3 A		18AC3 Transformer Secondary
F4	5 A		9AC1 Transformer Secondary
F5	S A		9AC2 Transformer Secondary
F6	5 A		9AC3 Transformer Secondary
F101	6 A		11AC1 Transformer Secondary
F102	6 A		11AC2 Transformer Secondary
F103	6 A		11AC3 Transformer Secondary
CB101	3 A		3-phase circuit breaker before power switch
R2	500 ohm		Power supply high limit set
R5	500 ohm		Power supply low limit set
TP1		Gnd	9ACN (Transformer Secondary)
TP2			B input of U1 (+15 V regulator)
TP3			Case of U2 (-15 V regulator)
TP4			18AC1 (after Fl)
TP5			18AC2 (after F2)
TP6			18AC3 (after F3)
TP7			9AC1 (after F4)
TP8			9AC2 (after F5)
TP9			9AC3 (after F6)
TP10		+9 Vdc	B input of U3
TP11		+5 Vdc	+5V1 at 1.5 amperes from regulator
TP12		+5 Vdc	+5V2 at 1.5 amperes from regulator
TP13		Gnd-PM	14 Return
TP14		-14 Vdc	-14 Vdc at 1.5 amperes from regulator
TP15		+14 Vdc	+14 Vdc at 1.5 amperes from regulator
TP16			PWREG power within regulation
TP17		+15 Vdc	+15 Vdc at 0.2 ampere from regulator
TP18		-15 Vdc	-15 Vdc at 0.2 ampere from regulator
TP19		Gnd	Ground of regulator
TP20			High limit detector positive input.
TP21			Low limit detector positive input.

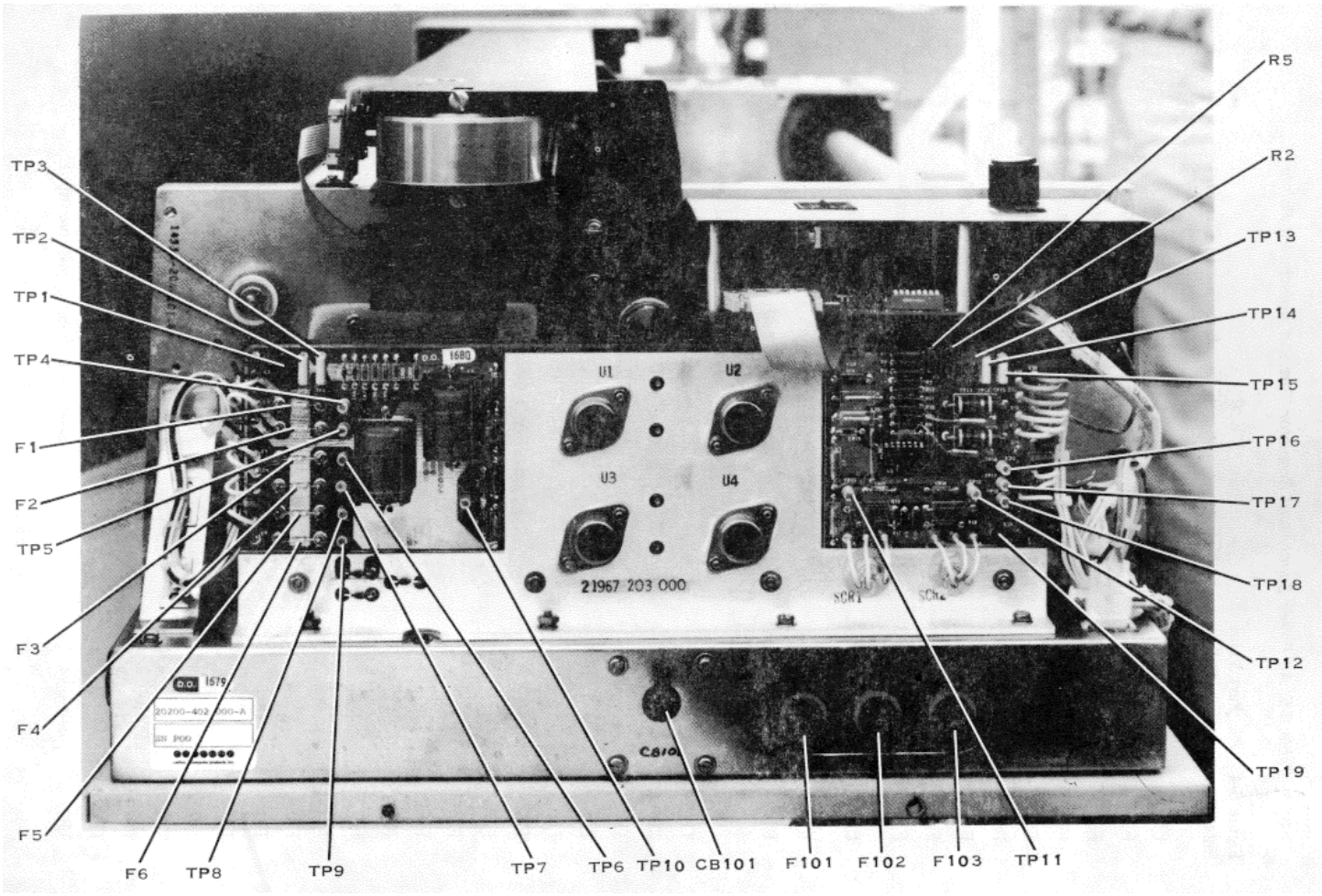


Figure 5-4. A8 Power Supply and regulator PCB Test and Adjustment Points

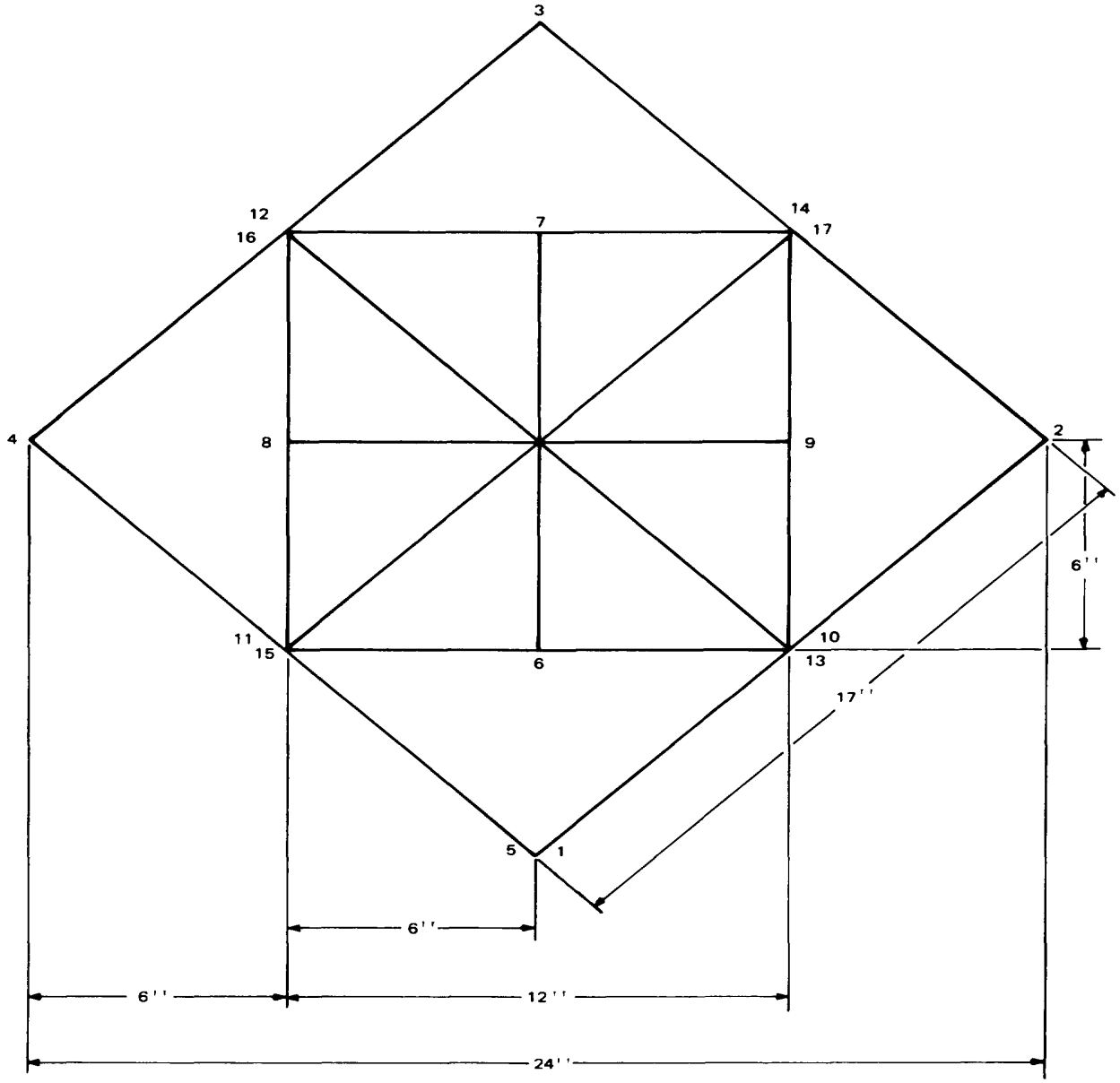


Figure 5-5. Plotter BIT Output

Table 5-6. Manual Checkout Procedures

Step	Procedure	Minimum Performance Standard	Troubleshooting Reference Table 5-8
1	Set MAIN POWER CIRCUIT BREAKER to ON. Remove paper from plotter per paragraph 3-20. Set PLOT/MANUAL switch to MANUAL, set PLOT/LOAD switch to PLOT, and set POWER switch to ON position.	Fan motor will operate, paper loop detector lights will be on, both paper spools will rotate After 4-8 seconds if paper is not loaded.	1
2	Set PLOT/LOAD switch to LOAD.	Paper spools will stop rotating.	2
3	Set PLOT/LOAD switch to PLOT.	Paper stools will again rotate, after 3 seconds.	2
4	Interrupt front light sensor.	Front spool will reverse direction.	3
5	Interrupt rear light sensor.	Rear spool will reverse direction.	3
6	Set PLOT/LOAD switch to LOAD.	Paper spools will stop rotating within 4 seconds. Verify free movement of drum and carriage.	4
7	Install paper in plotter per paragraph 3-7. Set PLOT/LOAD Switch to PLOT position.	Front and rear paper loops should stabilize within 8 to 10 seconds.	5
8	Place PLOT/MANUAL switch in MANUAL position. Press +X (↑) pushbutton.	Paper should move from rear to front paper spool (supply to takeup).	6
9	Press --X (↓) pushbutton.	Paper should move from front to rear paper spool (takeup to supply).	6
10	Press +Y (←) pushbutton.	Carriage should move toward the left end of beam.	6
11	Press ----Y (→) pushbutton.	Carriage should move toward the right end of beam.	6
12	Install a pen in the carriage. Adjust pen force according to table 3-3. Lower the pen by using PEN ACTIVATE switch.	Pen should lower to drum surface.	7

Table 5-7. Power Supply Checkout Procedures

Step	Procedure	Minimum Performance Standard	Troubleshooting Reference Table 5-9
1	Measure ac voltages at TP4, TP5, and TP6 with DVM using TP1 as ground.	DVM should indicate 18 ± 2 Vac.	1
2	Measure ac voltage at TP7, TP8, and TP9 with DVM using TP1 as ground.	DVM should indicate 9 ±1 Vac.	2
3	Measure dc voltage at TP10 with DVM using TP1 as ground.	DVM should indicate +9 +1.5 Vdc.	3, 2
4	Measure dc voltage at TP11 and TP12 with DVM using TP1 as ground.	DVM should indicate +5 +0.5 Vdc.	4, 3, 2
5	Measure dc voltage at TP14 with DVM using TP13 as ground.	DVM should indicate -14 +1.5 Vdc.	5
6	Measure dc voltage at TP15 with DVM using TP13 as ground.	DVM should indicate +14 +1.5 Vdc.	5
7	Measure dc voltage at TP16 with DVM using TPI9 as ground.	DVM should indicate 0.0 ± 0.5 Vdc.	8, 7, 6, 4, 3, 2, 1
8	Measure dc voltage at TP18 with DVM using TP19 as ground.	DVM should indicate -15 ± 1.5 Vdc.	7, 1
9	Measure dc voltage at TP17 with DVM using TP19 as ground.	DVM should indicate +15 +1.5 Vdc.	6, 1

5-14. TROUBLESHOOTING. Troubleshooting the Plotter consists of performing the Plotter FIDs and manually troubleshooting the Power Supply section. Instructions for performing the FID are listed in Test Procedures Manual, T.O. I0-M1-7-9-8-2. Table 5-8, which relates back to manual checkout procedures listed in table 5-6, is provided to diagnose problems encountered during manual checkout. Table 5-9, which relates back to Power Supply checkout procedures listed in table 5-7, is provided to diagnose problems encountered during Power Supply checkout.

5-15. ADJUSTMENT AND ALIGNMENT. Adjustment and alignment procedures consist of measuring, verifying and adjusting circuits located on various Plotter PCBs. Adjustment procedures are provided for I/O-Pen Driver PCB, Encoder Preamplifier PCB, axis servos, pen height, carriage limit switches, beam alignment, and scale factor calibration.

Table 5-8. Manual Troubleshooting Procedures

Step	Manual Checkout Table 5-6 Reference	Trouble	Probable Cause	Remedy
1	1	Fan motor not operating, paper loop detectors not lighted, spools not rotating (paper not loaded).	Power Supply malfunction	Refer to Power Supply checkout (table 5-7) and troubleshooting procedures (table 5-9).
2	2, 3	Spools do not stop after PLOT LOAD switch is placed in LOAD or spools do not rotate after PLOT/LOAD switch is placed in PLOT.	Paper servosystem (supply and takeup) malfunctioning	Adjust R43 and R52 as indicated In paragraph 5-16. If trouble persists. replace and adjust (paragraph 5-16) new I/O-Pen Driver PCB (A1).
3	4, 5	Interrupting light to paper loop sensors does not reverse their direction and rotation.	Paper servos (supply and takeup) malfunctioning.	Adjust R43 and R52 as indicated in paragraph 5-16 If trouble persilts. replace and adjust (paragraph 5-16) new I/O-Pen Driver PCB (A1).
4	6	Drum or carriage not disabled after PLOT,/LOAD switch is placed in LOAD position.	PLOT/LOAD function malfunction.	Replace and adjust (paragraph 5-16) new I/O-Pen Driver PCB (A1) if trouble persists, replace Right Operator Control Panel (A5).
5	7	Front and back paper loops not stabilized after PLOT LOAD switch is placed in LOAD position.	Paper servosystem (supply and takeup) malfunctioning	Adjust R43 and R52 as indicated in paragraph 5-16. If trouble persists. replace and adjust (paragraph 5-16) new I/O-Pen Driver PCB (A1).
6	8, 9, 10	Drum and,/or carriage fail to respond to manual move commands.	Axis servosystem malfunction.	(1) If both axes inoperative: Adjust R36 and R29 as indicated In paragraph 5-16. If trouble persists, replace and adjust (paragraph 5-16) new I/O -Pen Driver (A1). If trouble persists, replace Right Control Panel (A5). (2) If one axis Inoperative Adjust R17 and R25 for X-axis. R18 and R22 for Y-axis, as indicated in paragraph 5-1X. Adjust R17. RIX, R6. and R8 for X-axis. R10, R12. R19. and R20 for Y-axis as indicated In paragraph 5-17. If trouble persists, remove back panel of Plotter. check and replace detective transistors (Q1. Q'2, Q3, Q4) on heatsink attached to NMIB. Q1 and 02, the two right-most. are for the X-axis and Q3 and Q4. the two left-most, are for the Y-axis. If trouble persists. Replace and adjust (paragraph 5-1 8) new Logic Drive and Scale Factor PCB (A'). If trouble persists. replace and adjust (paragraph

Table 5-8. Manual Troubleshooting Procedures (Continued)

Step	Manual Checkout Table 5-6 Reference	Trouble	Probable Cause	Remedy
6 (cont.)				5-17) new Encoder Preamplifier PCB (A4). If trouble persists, replace Right Control Panel (A5). If trouble persists, remove and replace motor-encoder as indicated in paragraph 5-31.
7	12	Pen fails to move when PEN ACTIVATE switch is pressed (PLOT/MANUAL) in MANUAL position.	Pen driver circuitry malfunctioning.	Perform pen height adjustment in paragraph 5-19. Adjust R15 and R18 as indicated in paragraph 5-16. If trouble persists, replace and adjust (paragraph 5-16) new I/O-Pen Driver PCB (A1).

Table 5-9. Power Supply Troubleshooting Procedures

Step	Power Supply Checkout Reference	Trouble	Probable Cause	Remedy
		NOTE		
		Access to transformer. rectifier assembly, and line filter mounting screws may be gained by following Power Supply removal and replacement procedures in paragraph 5-33.		
1	1	Improper voltage level at TP4 TP5 or TP6.	Fuse F1, F2 or F3 is open	Replace fuses as needed.
			Transformer T101 secondary defective.	Replace transformer.
			Line filter FL1 defective.	Replace line filter. Line filter is located under Power Supply chassis under transformer.
2	2	Improper voltage level at TP7, TP8, or TP9.	Fuse F4, F5 or F6 is open. Transformer T101 secondary defective.	Replace fuses as needed. Replace transformer.
-3	3	Improper voltage level at TP10.	CR1, CR2 or CR3 Is defective.	Check and replace if defective.
4	4	Improper voltage level at TP11 or TP1.	U3, U4, R15, R16, R17, R18, CR13, CR14, SCR or SCR2 Is defective.	Check and replace associated defective components.
5	5, 6	Improper voltage level at TP14 or TP15.	R8, R10. (103, C104 or DA1 is defective.	Check and replace defective components.
		F101. F102 or F103 is open	Check and replace as needed. (blown).	
			Rectifier assembly (AC1, AC, AC3) is defective.	Replace rectifier assembly. Rectifier assembly is located under Power Supply chassis near J1050.
			Transformer T101 secondary defective.	Replace transformer.
6	9	Improper voltage level at TP17.	CR11, CR15, U1 or C12 is defective.	Check and replace defective component.
7	8	Improper voltage level at TP18.	CR15, U2 or R19 is defective.	Check and replace defective component.
8		Improper voltage level at TP16.	US, R1, R2, R3, R4, R5, R6, R9, R1., RI2, R13, R14 or C13 is defective.	Check and replace defective component.

5-16. I/O and Pen Driver PCB Adjustment. Adjustment procedures are provided for the I/O and Pen Driver PCB. Figure 5-1 illustrates the location of adjustment and test points referred to in this paragraph. The I/O and Pen Driver PCB is located under the drum and behind the front panel. The I/O Pen Driver PCB may be attached to the extender board for easier access. If required readings cannot be obtained, refer to related troubleshooting procedures.

a. Place POWER ON/OFF switch in ON position. Remove paper from Plotter. Remove front panel.

b. With DVM (+) probe attached to TP7 and DVM (-) attached to TP3, adjust R43 to obtain a reading of 9 ± 0.25 Vdc. Adjust when front sensors are fully illuminated.

c. With DVM (+) probe attached to TP8 and DVM (-) attached to TP3, adjust R52 to obtain a reading of 9 ± 0.25 Vdc. Adjust when rear sensors are fully illuminated.

d. With oscilloscope probe attached to TP6 and oscilloscope ground attached to TP3, adjust R36 to obtain a reading of 4 kHz ± 100 Hz.

e. With oscilloscope probe attached to TP4 and oscilloscope ground attached to TP3, adjust R29 to obtain a reading of 900 ± 100 Hz.

f. Replace paper in Plotter, place PLOT/LOAD in PLOT, and attach DVM probe to TP2 and attach DVM ground to TP3. With PEN FORCE in LOW position, lower the pen. Adjust R15 for 0.0192 Vdc. Verify that the voltage at MEDIUM and HIGH PEN FORCE positions is 0.0202 and 0.139 Vdc, respectively.

g. Attach DVM probe to TP2 and attach DVM ground to TP3. With no pen selected, adjust R18 for 0 Vdc.

5-17. Encoder Preamplifier PCB Adjustment. Adjustment procedures for the Encoder Preamplifier PCB are provided below. The oscilloscope ac ground should be floating when making these adjustments. Figure 5-3 illustrates the location of test and adjustment points referred to in this paragraph. The Encoder Preamplifier PCB is located behind right end housing. If required reading cannot be obtained, refer to related troubleshooting procedures.

CAUTION

Remove power to Encoder Preamplifier PCB by placing POWER ON/OFF switch in OFF position before disconnecting or connecting encoders (J6020 or J6030).

a. Place PLOT/LOAD switch in LOAD position and PLOT/MANUAL switch to MANUAL.

b. Attach oscilloscope probe to TP5 and attach oscilloscope ground to TP9. Adjust R17 while encoder is connected and moved by hand to obtain 2-volt peak-to-peak signal ± 0.1 Vac).

c. Disconnect J6020. Attach oscilloscope probe to TP5 and oscilloscope ground to TP9. Adjust R6 for 0 +0.1 Vdc. Reconnect J6020.

d. Attach oscilloscope probe to TP6 and attach oscilloscope ground to TP9. Adjust R18 while encoder is connected and moved by hand to obtain 2-volt peak-to-peak signal (± 0.1 Vac).

e. Disconnect J6020. Attach oscilloscope probe to TP6 and oscilloscope ground to TP9. Adjust R8 for 0±0.1 Vdc. Reconnect J6020.

f. Attach oscilloscope probe to TP7 and attach oscilloscope ground to TP9. Adjust R19 while encoder is connected and moved by hand to obtain 2-volt peak-to-peak signal (± 0.1 Vac).

g. Disconnect J6030. Attach oscilloscope probe to TP7 and attach oscilloscope ground to TP9. Adjust R10 for 0 ± 0.1 Vdc. Reconnect J6030.

h. Attach oscilloscope probe to TP8 and attach oscilloscope ground to TP9. Adjust R20 while encoder is connected and moved by hand to obtain 2-volt peak-to-peak signal (+0.1 Vac).

i. Disconnect J6030. Attach oscilloscope probe to TP8 and attach oscilloscope ground to TP9. Adjust R12 for 0 ± 0.1 Vdc. Reconnect J6030.

5-18. Axis Servo Adjustment. The axis servo adjustment procedure uses the zero and gain potentiometers located on the Logic, Drive and Scale Factor PCB. Plugging the Logic, Drive and Scale Factor PCB into the extender PCB will allow easier access to the potentiometers. The procedure consists of substituting an ammeter (Triplett model 630NS) for a servomotor.

a. Ensure that the Plotter POWER ON/OFF switch is in the OFF position.

b. Remove the right end bell, left end bell, and front panel and disconnect the X-servomotor leads J6120 from terminal A and J6110 from terminal B. If adjustment is for the Y-axis. disconnect the Y-servomotor leads J6220 from terminal A and J6210 from terminal B.

c. For the X-adjustment, connect J6 110 and J6 120 to the ammeter terminals. For the Y-axis, use J(210 and J6220.

CAUTION

When an axis servomotor is replaced by an ammeter, do not turn the drum or move the pen carriage by hand. The movement will generate encoder feedback, which may damage components and give erroneous adjustment results as well as damage the meter. To correct the condition, momentarily turn the Plotter POWER switch to the OFF position or place the PLOT/LOAD switch in the LOAD position.

d. Set PLOT/LOAD switch in the PLOT position, PLOT/MANUAL to MANUAL and turn Plotter POWER ON/OFF switch to ON position.

e. Ensure that the ammeter is nulled (+0.025 ampere). If the ammeter is not nulled, adjust the zero potentiometer R 17 (for the X-axis) or R18 (for the Y-axis) found on the logic drive and scale factor PCB. If necessary, the board may be removed, inserted in extender board (table 5-1) and reinserted.

NOTE

In the following steps, a plot motion command of one polarity is used to increase the circuit output, and a plot motion command of the opposite polarity is used (in lieu of negative feedback from encoder) to reduce the output back to zero.

CAUTION

Avoid exposing the driver transistors to prolonged high current. If overheating occurs, turn the Plotter POWER switch to OFF position and allow transistors to cool. Damage to ammeter may also result from improper polarity connection or improper current scale. Check polarity and scale before making measurement.

f. The servo low-gain adjustment is as follows:

1. When checking the X-axis gain, tap the positive plot motion command switch once. If the servomotor is connected, the tap would normally produce a 0.005-inch movement on the +X-axis.
2. Verify that the ammeter movement indicates 0.50 +0.05 ampere.
3. If necessary, adjust gain potentiometer R25 (for X-axis) or R22 (for Y-axis).

g. The servo high-gain adjustment is as follows:

1. Turn Plotter POWER ON/OFF switch to the OFF position.
2. Using a jumper wire, route +5 Vdc from TP 1 of Power Supply Regulator PCB to TP8 (for X-axis) or TP7 (for Y-axis).
3. Adjust current meter to 12-ampere current scale and turn the Plotter POWER switch to the ON position.
4. Tap the positive plot motion command switch once.
5. Adjust R25 (for X-axis) or R22 (for Y-axis) so that a reading of 2.25 +0.05 amperes is obtained. Make the adjustment quickly to avoid transistor overheating.
6. Turn the Plotter POWER ON/OFF switch to the OFF position.
7. Remove jumper from the Power Supply and reconnect motor leads.
8. Replace right end bell, left end bell, and front panel.

5-19. Pen Height Adjustment. The following steps outline the procedure for adjusting the pen. Refer to figure 5-6.

a. Remove Plotter power by setting POWER ON/OFF switch to OFF position.
b. Remove paper from Plotter (refer to paragraph 3-20). Ensure POWER switch is in OFF position.
c. Stack two data punch cards on drum. Pile the cards two thick. A data punch card is 0.008-inch thick.
d. Slide carriage over cards.
e. If the pen marks on the cards, the pen is too low. To raise the pen, turn the adjustment screw above the pen clockwise. When the pen has been raised high enough not to write on two cards, place three cards on the drum. The pen should write smoothly on three cards. If it does not, lower the pen by turning the adjustment screw counterclockwise. When the pen fails to write on two cards but writes on three cards, the adjustment is complete.

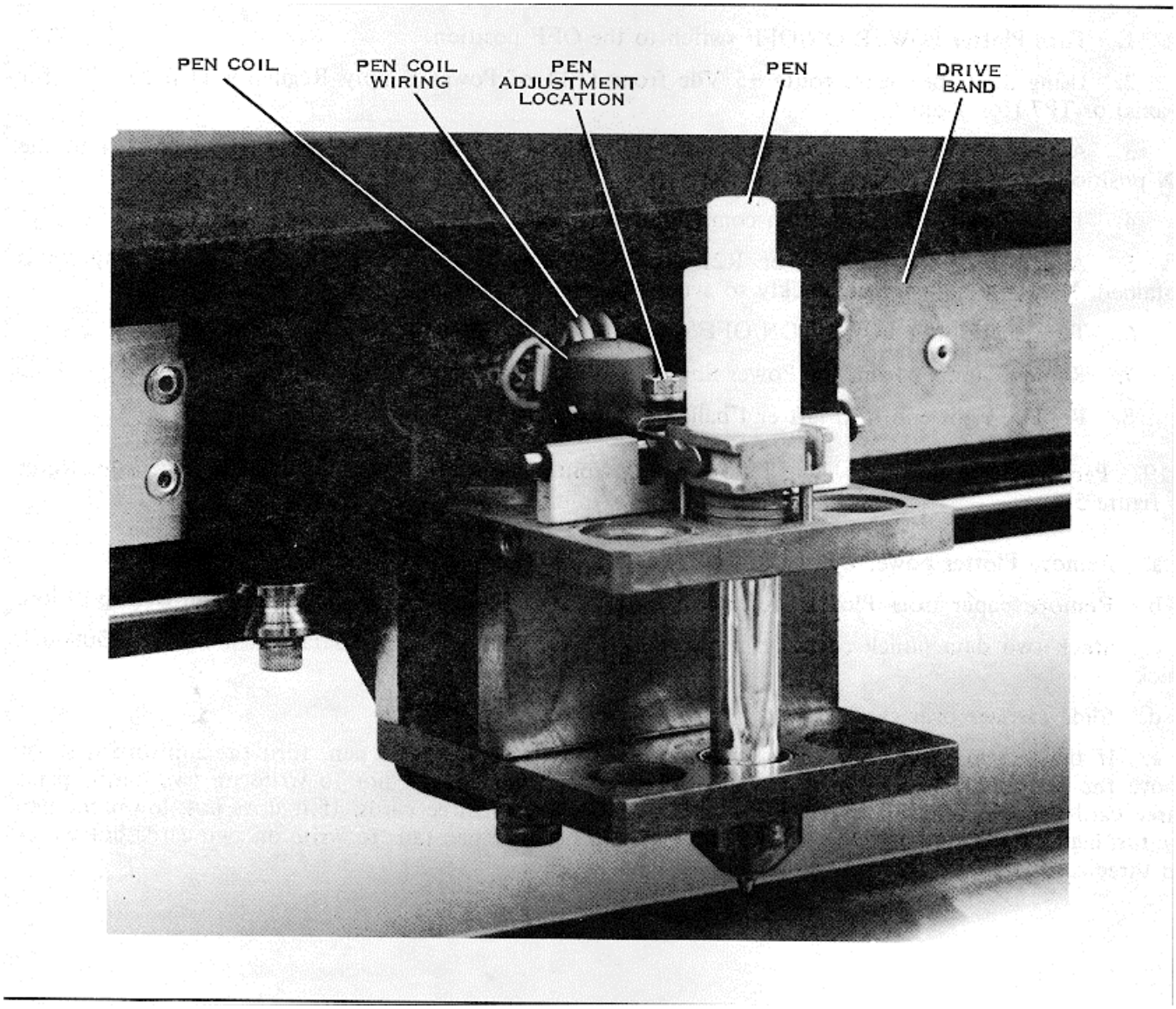


Figure 5-6. Pen carriage Assembly

5-20. Carriage Limit Switch Adjustment. The following steps outline the procedure for adjusting the Carriage Limit Switches of the Y-axis. The two limit switches are located on the rear end positions of the beam.

a. The carriage rear bracket is moved whenever the carriage is removed or a carriage height adjustment is made. Adjustment of Carriage Limit Switches should be checked after either event.

b. Remove both end housings after extracting screws holding them in place.

c. Move the carriage by hand to each end of the beam and observe how the ends of the rear carriage bracket fit into the switches.

d. If the rear carriage bracket touches the limit switch, the limit switch may be adjusted by loosening screws holding it in place. The rear carriage bracket may be adjusted by loosening screws holding it in place.

e. Replace end housings and fasten with screws.

5-21. Beam Alignment. The following steps outline the procedure for aligning the beam.

a. Remove the drum (refer to paragraph 5-24).

b. Remove pen block. It is held in place by two socket-head cap screws.

c. Install fixture adapter to carriage using two socket-head cap screws. Position adapter against carriage face similar to pen block installation.

d. Replace drum.

e. Check fixture to ensure dial faces are set to zero when the contact tips are depressed flush to their surfaces.

f. Install fixture to adapter, making sure the fixture rests on the adapter pads before tightening thumbscrew. See figure 5-7.

g. Check beam and carriage height by examining indications read from fixture top indicator. Dimensions should be 0.150 ± 0.004 inch at extreme ends of plotting area on drum.

h. To adjust dimension of previous step, loosen carriage spring and move carriage up or down to improve reading. If enough adjustment is not available, remove shims under guide bearing to achieve the required dimension of beam carriage height. See figure 5-7.

i. Check beam-locating indicator (side indicator). Dimension should be 0.137 +0.004 inch at the extreme ends of the plotting area on the drum. See figure 5-7.

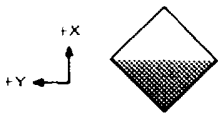
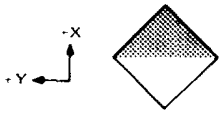
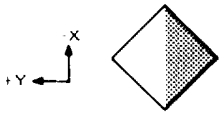
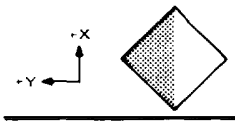
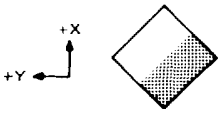
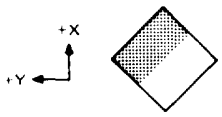
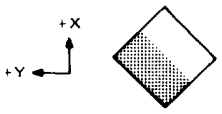
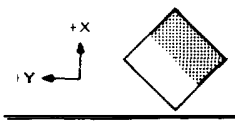
j. To adjust dimension of previous step, loosen beam holddown bolts and slide the beam back or forth to improve indicator reading. The beam holddown bolts are located on each end of the beam. The beam holddown bolts may be identified by noting the recessed area around the bolt.

k. Fully tighten the beam holddown bolts.

l. Remove the alignment tool and install the pen block.

m. Check beam alignment with a liquid ink plot of the rotated chinese trivet (Maintenance Test Language, verb PLP). The plot is required to check for shading resulting from improper alignment. The plot is to be done at both sides of the plotting area. If shading is present, the beam, carriage, or beam and carriage need readjusting indicated by the shading. Refer to table 5-10.

Table 5-10. Beam and Carriage Adjustment Using Rotated Chinese Trivet

Shading Of Rotated Chinese Trivet *	Required Adjustment **
	The carriage bearings on the left side need a shim added.
	The carriage bearings on the right side need a shim added.
	Move the beam toward the rear of the plotter.
	Move the beam toward the front of the plotter.
	The carriage bearings on the left side need a shim added and the beam should be moved toward the rear of the plotter.
	The carriage bearings on the right side need a shim added and the beam should be moved toward the front of the plotter.
	The carriage bearings on the left side need a shim added and the beam should be moved toward the front of the plotter.
	The carriage bearings on the right side need a shim added and the beam should be moved toward the rear of the plotter.

* Note that the shading is the result of wider lines being drawn on one side of the pattern.

** Left and right sides are viewed from the front of the Plotter.

5-22. Scale Factor Calibration Adjustment. Scale factor calibration need only be performed after the drive band, idler pulley, drive pulley, ring gear or beam has been replaced. Switch S2 (programmable switch), located on the Scale Factor PCB, is used to perform this initial calibration. This calibration should not be confused with scale factor adjustment performed with the thumbwheel switch S1 located on Left Control Panel. Note the following affects only the Y-axis. The following steps describe how to set the scale factor calibration.

a. Prepare the Plotter for plot mode operation as described in paragraph 3-17.

b. Set thumbwheel scale factor switches located on left Control Panel to +00.

c. Set scale factor calibration switch S2 (located on Operator Scale Factor PCB A3) contacts 1 through 8 to ON position.

d. Initiate the Plotter BIT as described in paragraph 5-11 to draw pattern shown in figure 5-5.

e. Measure the plotted BIT pattern along the Y-axis with the ruler listed in table 5-1. When measured from the extreme points of the outside diagonal shape, the distance should be 24 ± 0.01 inches. If the measured distance of step

d. is not 24 ± 0.01 inches, the scale factor calibration adjustment S2 located on Operator Scale Factor PCB should be adjusted.

f. If the figure needs to be made larger along the Y-axis, place switch S2 rocker (contact) 1 in the ON position. If the figure needs to be made smaller along the Y-axis, place switch S2 rocker (contact) I in the OFF position. Switch S2 rockers are numbered on top of the switch.

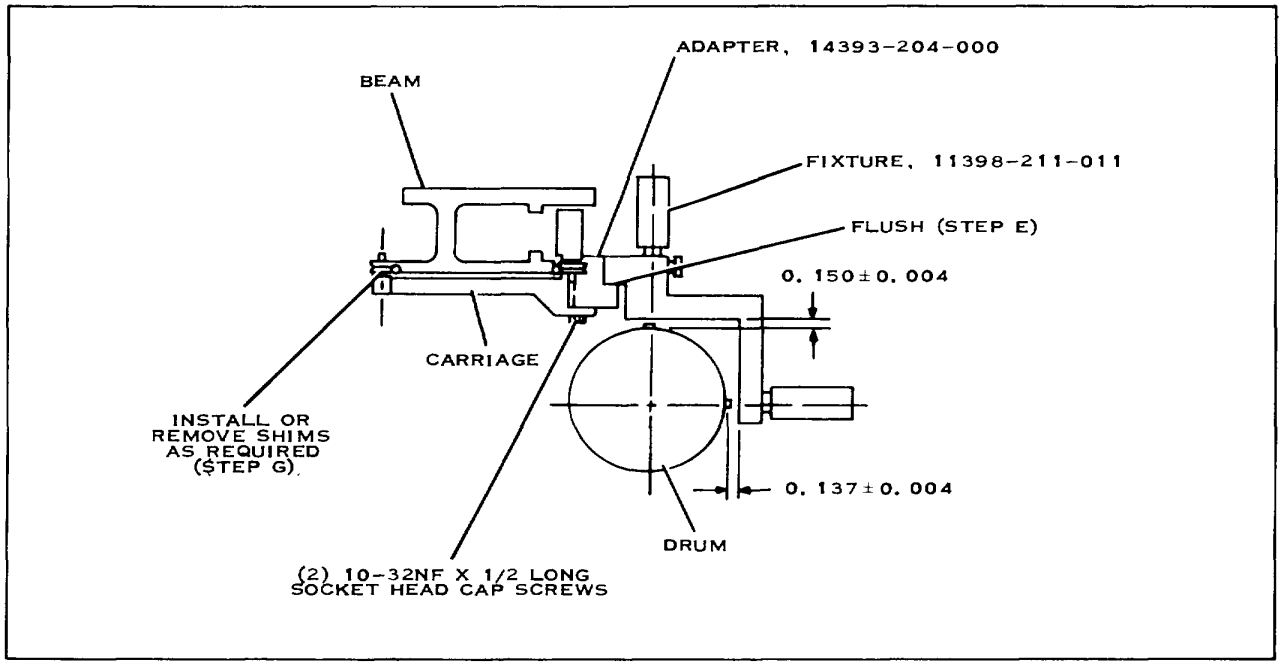


Figure 5-7. Beam Alignment

g. To determine the remaining switch settings of S2, perform the following calculation:

$$\frac{\text{Difference between plotted figure and } 24 \pm 0.01 \text{ inches}}{0.005} = \text{Calibration Switch S2 setting (Increments)}$$

Example: =

$$\frac{\text{Difference is 0.1 inch}}{0.005} = \text{S2 setting of 20 increments}$$

h. Switch S rockers have the following increment values:

CONTACT NUMBER	INCREMENT VALUE
2	1
3	2
4	4
5	8
6	16
7	32
8	64

Set the rockers of S2 to the OFF position so the total value of the rockers set to the OFF position corresponds to the desired increment value (determined in step f.). Example: The desired number of increments equals 20, so the S' contacts of 4 and 6 (with values of 4 and 16) should be set to the OFF.

i. Initiate the Plotter BIT to ensure the proper setting of S2. Repeat steps d. through g. if the plotted figure is not correct in dimension for the Y-axis.

5-23. REMOVAL AND REPLACEMENT. Removal and replacement procedures are given for drum, beam, dri\fs20 e band, drive pulley, ring gear, pulley shaft, band idler pulley, pen block, carriage and carriage cable. motor encoders, feed and takeup motors and belts, and Power Supply A8. In all cases. examine carefully the placement of components during removal to ensure proper replacement. Figure 1-2 shows the location of Plotter parts.

5-24. Drum Removal and Replacement.

a. Removal is as follows:
   1. Place Plotter POWER ON'OFF in OFF position.
   2. Remove pen from pen block.
   3. Push the carriage to the extreme right end of beam.

4. Push the drum against the spring-loaded shaft at the left end to disengage the gears at the right end. The drum need not be turned to disengage the gears.

CAUTION

Do not allow drum to come in contact with pen block.

5. Pull the right end of the drum forward and up, and pull the left end of the drum free of the bearing shaft. Lift the drum out of the Plotter.

b. Replacement is in reverse order of removal.

5-25. Beam Removal and Replacement.

a. Removal is as follows:
   1. Remove both end bells. They are held on by five screws.
   2. Remove carriage and carriage cable (see paragraph 5-30).
   3. Disconnect the Y-axis servomotor cables.
   4. Disconnect and remove beam from plothead. Two bolts hold the beam on the plothead. The bolts may be identified by the recessed areas around them.

b. Replacement is as follows:
   1. Install the beam on the plothead and tighten the holddown bolts just snug.
   2. Install the carriage cable and carriage.
   3. Align the beam as instructed in beam alignment procedures, paragraph 5-21.

5-26. Drive Band Removal and Replacement.

a. Removal is as follows:

WARNING

Do not attempt to remove or replace drive band while power is connected to the Plotter. Personal injury could result from accidental application of power to the motor drive circuits.

1. Remove drum per paragraph 5-24.
2. Remove both end bells.
3. Remove pen block from carriage by removing two screws on each side (underneath) the pen block.
4. Move carriage to extreme left end of beam.
5. Loosen drive band adjustment screws at left end of beam assembly. Refer to figure 5-8 for screw location. Do not loosen any screw completely the first time; turn each screw one-half turn at a time.

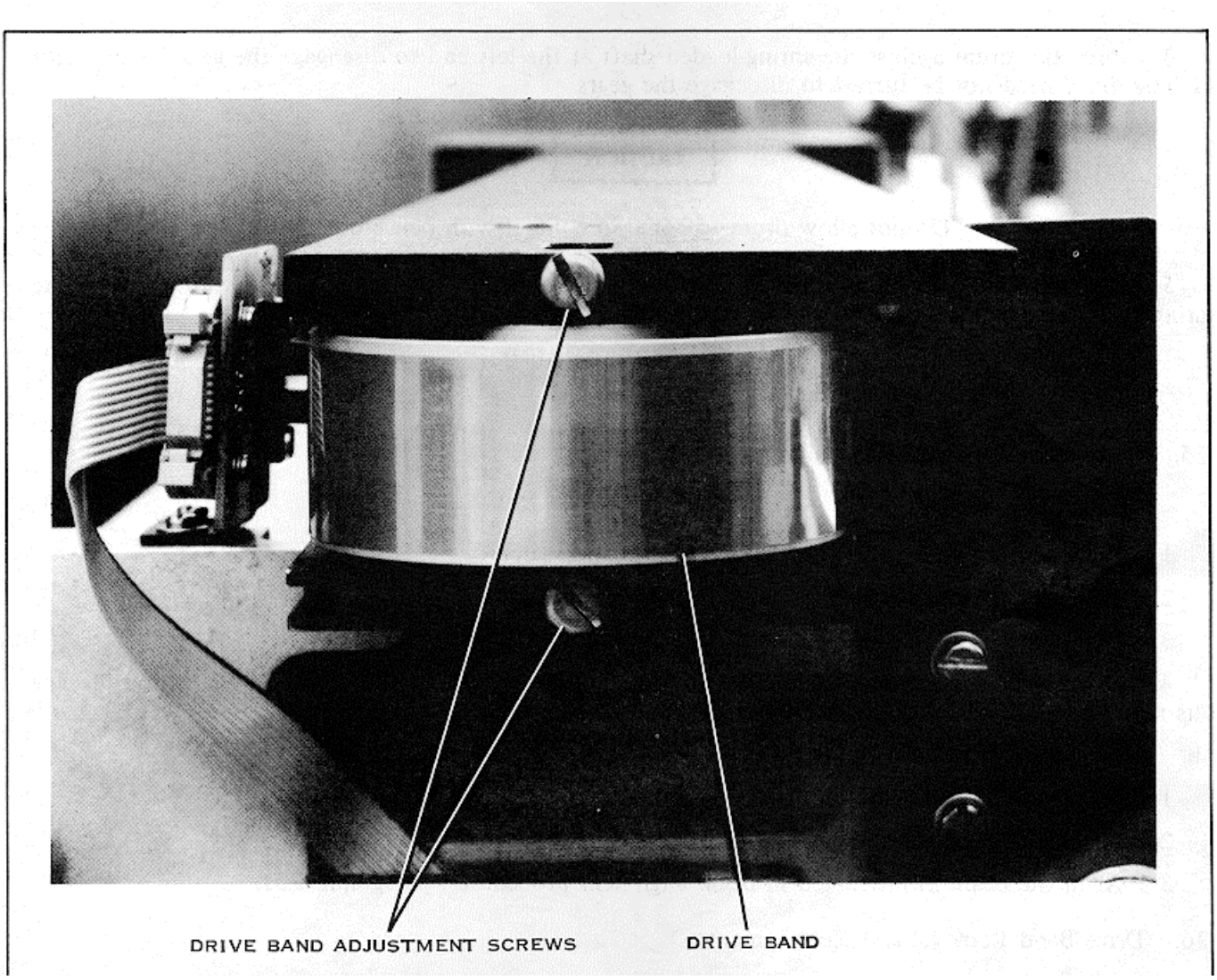


Figure 5-8. Drive Band Adjustment Screw Locations

6. Unhook band from left end of carriage b) pressing it Into cutout portion of beam channel. Move carriage away from end of band.

7. Move carriage to extreme right end of beam.
8. Remove the band from carriage In same manner as left end.

b. Replacement is as follows
1. Thread band around pulleys at each end.
2. Move carriage to each end and hook band on screwheads at back of carriage front plate.
3. Firmly tighten pulley until hand is, tight. Tighten adjustment screws hand tight

4. Using a screwdriver, further tighten each screw 2½/2 turns. Turn each screw 1/2 turn at a time during tightening.
5. Check Plotter for proper operation.

5-27. Drive Pulley, Ring Gear, and Shaft Removal and Replacement.

a. Removal is as follows:
1. Remove drive band from right end of beam (see paragraph 5-26).
2. Remove the Y-axis servomotor (see paragraph 5-31). Remove the three screws holding the motor mounting plate on. The motor may be set aside if the encoder connector is removed.

NOTE

Whenever the motor or encoder connectors are removed, they should be marked as to where they go. Major problems can result from reversing the connectors.

3. Remove motor support assembly by removing the two Allen bolts from the bottom and the two hex bolts from the top.
4. By removing the screw in the shaft, the pulley, ring gear (held on by four screws), and the shaft may be removed.
5. When replacing, be sure that the same number of plain washers are used between the snap ring on the pulley shaft and the drive pulley assembly.

NOTE

Shims are used to adjust the distance between the pulley and the motor support plate.

b. Replacement is as follows:
1. Replace all parts in reverse order and then align the drive band.
2. Ensure that when the motor is replaced, the screws are put in loosely and the motor shaft is moved against the ring gear. The play of the screws will allow this.
3. Place the Plotter POWER switch in the ON position. Using the manual controls, move the carriage across the beam. Move the motor until it is meshed, with no backlash after stopping.

5-28. Band Idler Pulley Removal and Replacement.

a. Removal is as follows:
1. Remove the drive band from the left end of the beam (see paragraph 5-26).
2. Remove the band adjustment screws (see figure 5-8).
3. Push pulley shaft through the beam.
4. Remove idler pulley assembly or pulley shaft.

b. Replacement is as follows:
1. When replacing the pulley, make sure it is shimmed to 0.002-inch minimum, 0.01 2-inch maximum. Replace the idler pulley in reverse order from removal.

2. Apply a light coat of seal grease to the screw threads and reinstall the adjustment screws.
3. Reconnect the drive band and perform alignment on the band.
4. Check Plotter operation.

5-29. Pen Block Removal and Replacement.

a. Removal is as follows:
1. Remove power from Plotter.
2. Remove drum and pen (see paragraph 5-24).
3. Remove two no. 10 Allen screws located on the base of the pen block.
4. Disconnect the coil wiring and lift the pen block off its platform.

b. Replacement is as follows:
1. Replace all parts in reverse order of removal. Hold pen block tight when replacing Allen screws so pen block is not twisted.

5-30. Carriage and Carriage Cable Removal and Replacement.

a. Removal is as follows:
1. Place the Plotter POWER ON/OFF switch in the OFF position.
2. Remove the drive band (see paragraph 5-26).
3. Move the carriage to the left end of the beam over the channel relief.
4. Remove the wedge fastened to the beam by two Allen screws.
5. Remove the carriage rear bearing bracket from the rear of the carriage, and pull the carriage from the beam. The bracket is held in place by two screws.
6. Carefully peel the cable from the double-sided pressure-sensitive tape.
7. Gently pull the cable through and out of the beam.

b. Replacement is as follows:
1. Replacement is in reverse order from removal. Ensure that the carriage bearings are seated on the guide rails before tightening the rear bracket screws.

5-31. Motor-Encoder Removal and Replacement.

a. Removal is as follows: (refer to figure 5-9 for location of motors and encoders.)
1. Disconnect motor and encoder cables.
2. Remove the screws that attach the motor support to the motor.

b. Replacement is as follows:
1. Replacement is in reverse order of removal for the motor. Adjust gear mesh by following steps 2 through 5.
2. Tighten the mounting screws just enough to hold the assembly in place, but so that the assembly can be moved about the pivot point.

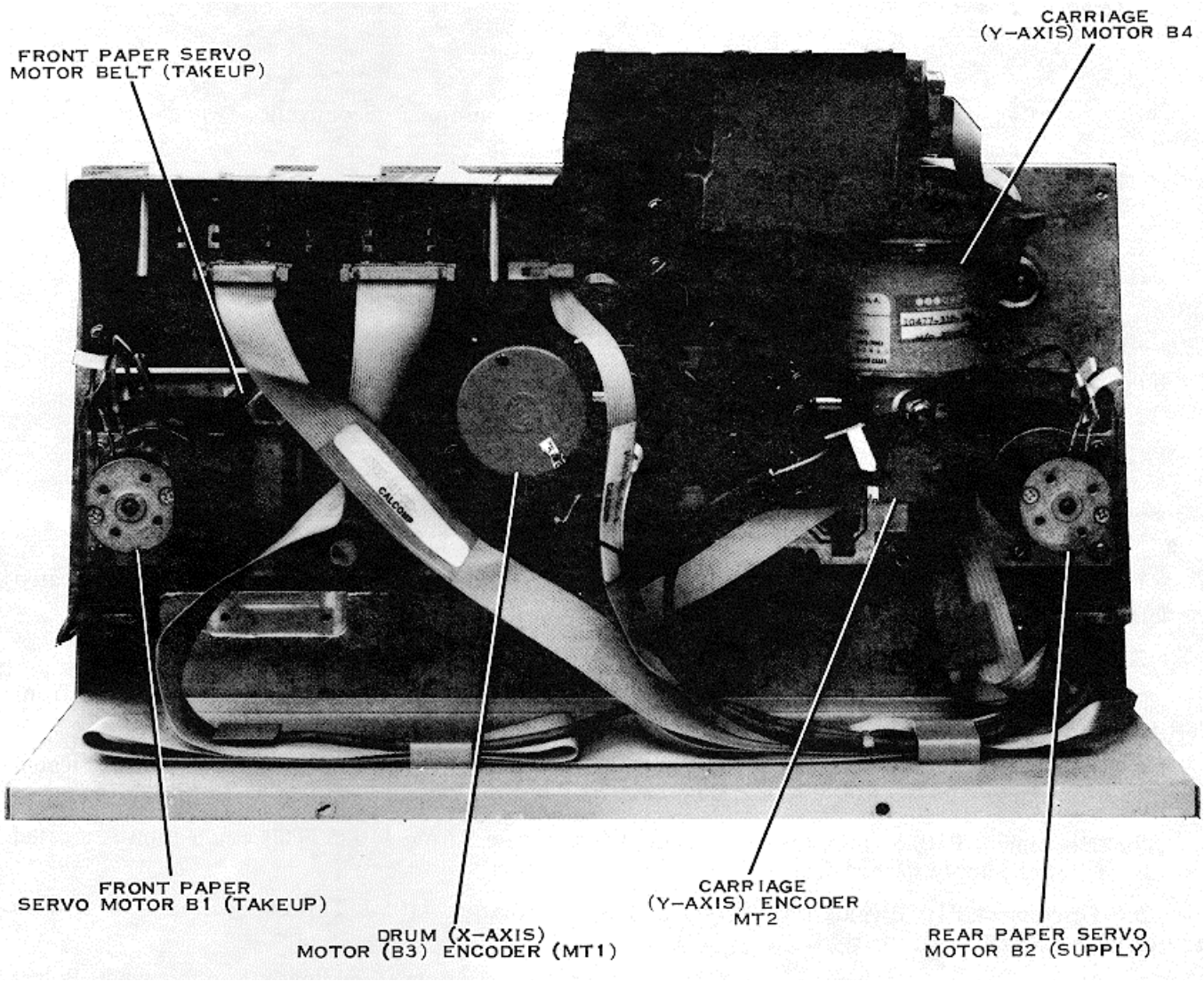


Figure 5-9. Motor and Encoder Locations

3. Rotate the assembly on the pivot to mesh the gears. Check tightness of the mesh by rotating the drum back and forth and moving the carriage the length of the beam. Backlash can be checked by applying power to the Plotter and rocking the drum or carriage (driven gear) against the motor (drive gear). Power will cause the motor to lock in place. The entire circumference of the driven gear can be checked in this manner by applying power, checking, turning POWER ON/OFF switch to OFF, rotating the driven gear a small amount, and turning POWER ON/OFF switch to ON again.
4. When mesh is adjusted properly, tighten the mounting screws.
5. Check Plotter operation.

5-32. Feed and Takeup Motor and Belts Removal and Replacement.

a. Removal is as follows:

NOTE

Examine and label cable connection point. Improper reconnection will cause motor to malfunction.

1. Disconnect the motor cables (spade lugs).
2. Loosen the screws fastening the motor mounting plate to the Plotter chassis.
3. Slide the belts over the end of the pulley. There are two belts per pulley.

b. Replacement is as follows:
1. Place the belts over the end of the pulley. Ensure that the belts are not twisted.
2. Reconnect the motor cable. Ensure the cables are connected to the correct pins.

5-33. Power Supply Assembly (A8) Removal and Replacement.

a. Removal is as follows:
1. Remove power from Plotter by disconnecting cable from input power connector J301 (located on left rear of Plotter).
2. Remove left end housing.
3. Disconnect P2010 (plug on cable from MIB PCB) from J1010. Connection is located near front left lower corner of Plotter.
4. Disconnect P3030 (plug on cable from POWER switch) from J1030. This connection is located on top of Power Supply nearest front.
5. Disconnect P3025 (plug on cable from HOURS meter) from J1025. This connection is located on top of Power Supply nearest front.
6. Disconnect P1050 (plug on cable from fan motor) from J1050. This connection is located on top of Power Supply nearest front.
7. Remove two 8-32 slotted-head setscrews with attached nut from Power Supply panel. Power Supply panel is plate located to right of transformer when viewed from front. The top rear setscrew is located near top middle of transformer. The top right setscrew is located near top front corner of Power Supply panel.
8. Remove two 8-32 pan-head screws from Power Supply panel. Bottom rear screw is located near the lower rear corner of transformer. Bottom front screw is located near the center front of Power Supply panel.
9. Power Supply assembly A8 may then be removed.

b. Replacement is as follows'
1. Replace two 8-32 pan-head screws in locations indicated in step 8 of removal procedures.
2. Replace two setscrews with attached nuts in locations indicated in step 7 of removal procedures.

3. Reconnect cables indicated in steps 3 through 6 of removal procedures.
4. Replace left end housing.
5. Reconnect input power cable.

SECTION VI
DIAGRAMS

6-1. GENERAL.

6-2. Section VI provides cabling and schematic diagrams (figures 6-1 through 6-8) of the Plotter. Schematic diagrams are given for the Plotter interconnecting wiring diagram, I/O Pen Driver PCB (A1), Logic Drive and Scale Factor PCB (A2), and Master Interconnect (MIB) PCB (A11). Individual PCB terminations may be determined by examination of PCB schematics.

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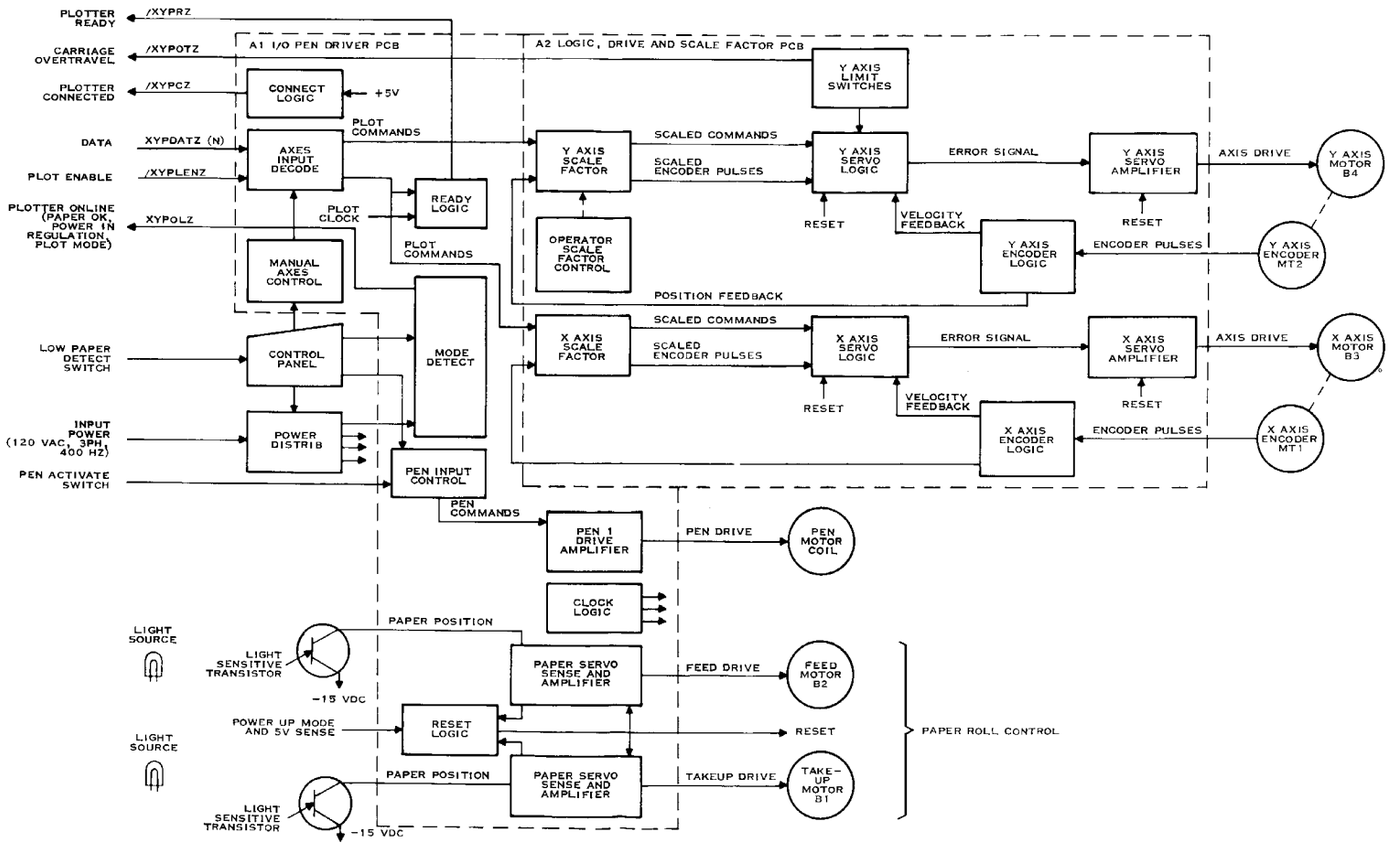

Figure 4-1. Plotter System Block Diagram

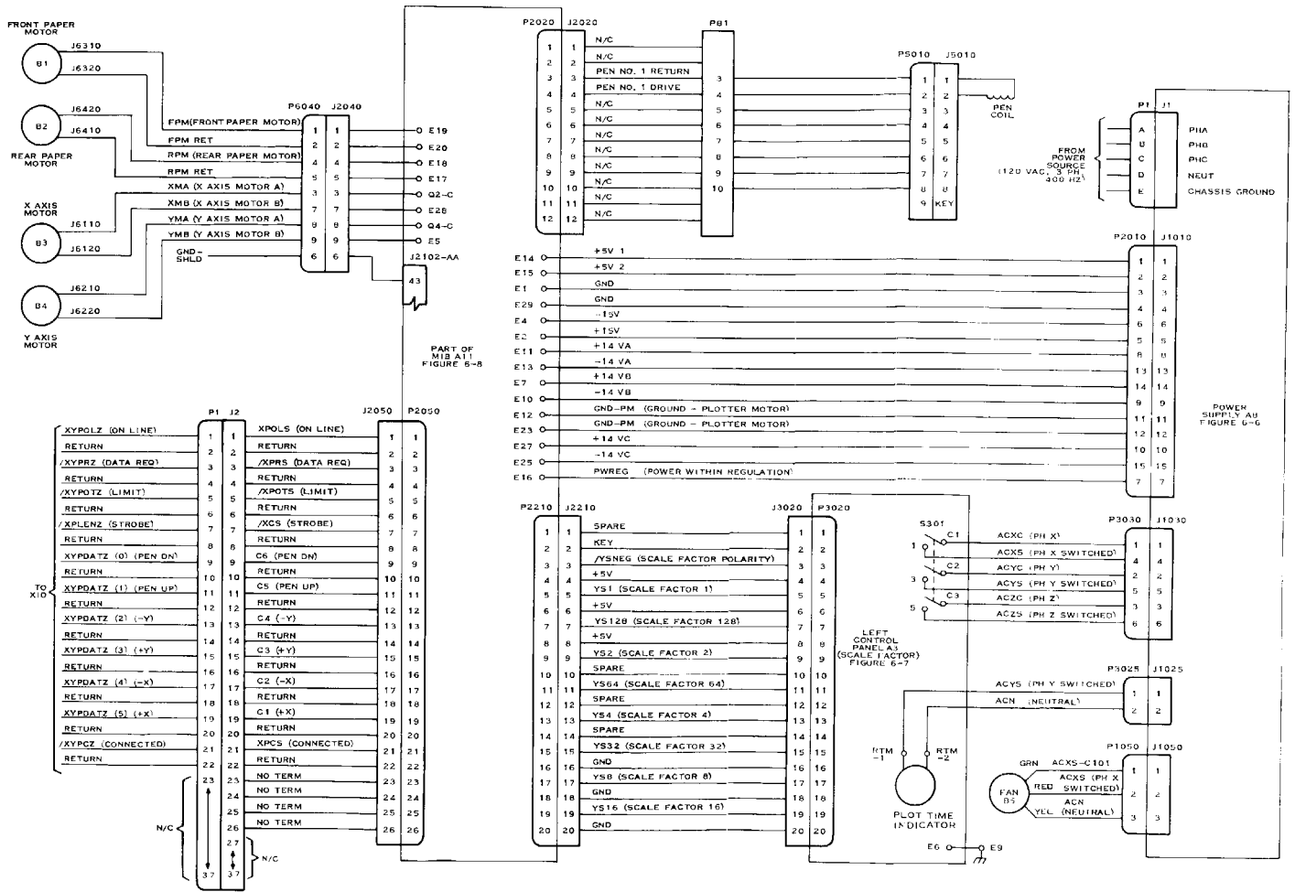

Figure 6-1. Cabling Diagram (Sheet 1 of 2)

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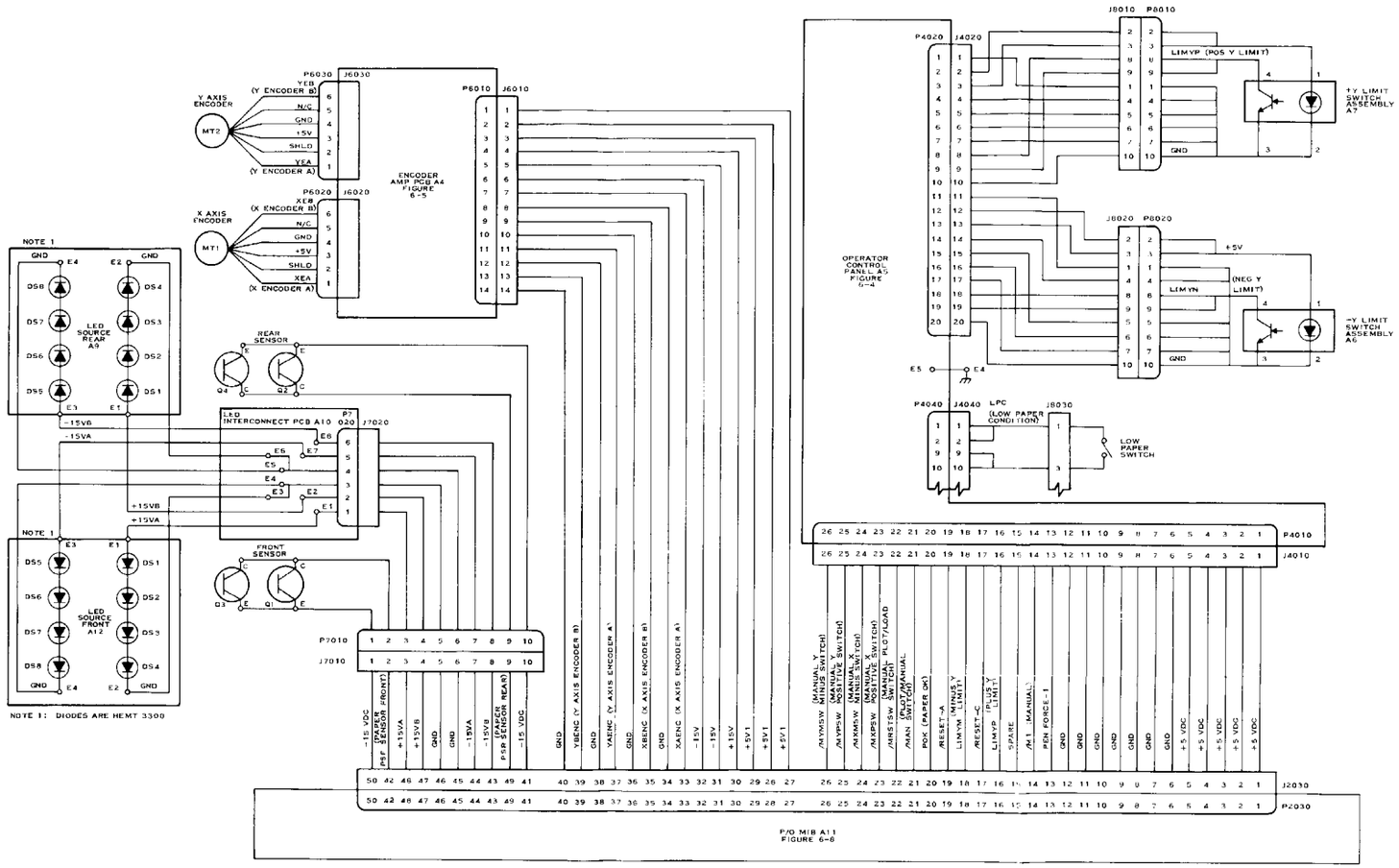
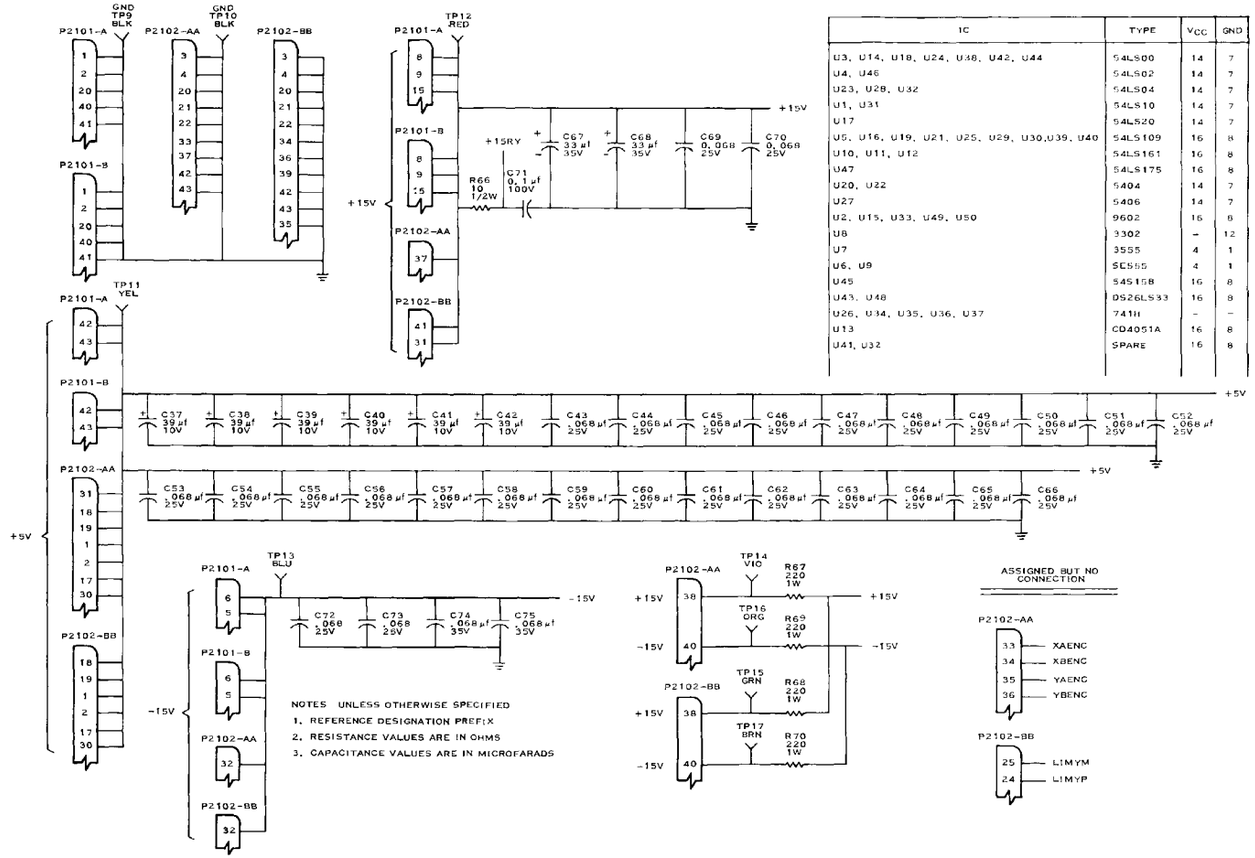


Figure 6-1. Cabling Diagram (Sheet 2 of 2)



IC	TYPE	V_{CC}	GND
U3, U14, U18, U24, U38, U42, U44	54LS00	14	7
U4, U46	54LS02	14	7
U23, U28, U32	54LS04	14	7
U1, U31	54LS10	14	7
U17	54LS20	14	7
U5, U16, U19, U21, U25, U29, U30,U39, U40	54LS109	16	8
U10, U11, U12	54LS161	16	8
U47	54LS175	16	8
U20, U22	5404	14	7
U27	5406	14	7
U2, U15, U33, U49, U50	9602	16	8
U8	3302	–	12
U7	3555	4	1
U6, U9	SE555	4	1
U45	54S158	16	8
U43, U48	DS26LS33	16	8
U26, U34, U35, U36, U37	7411	–	–
U13	CD4051A	16	8
U41, U32	SPARE	16	8

Figure 6-2. Input/Output Pen Driver Pcb A1 Schematic Diagram (Sheet 1 of 7)

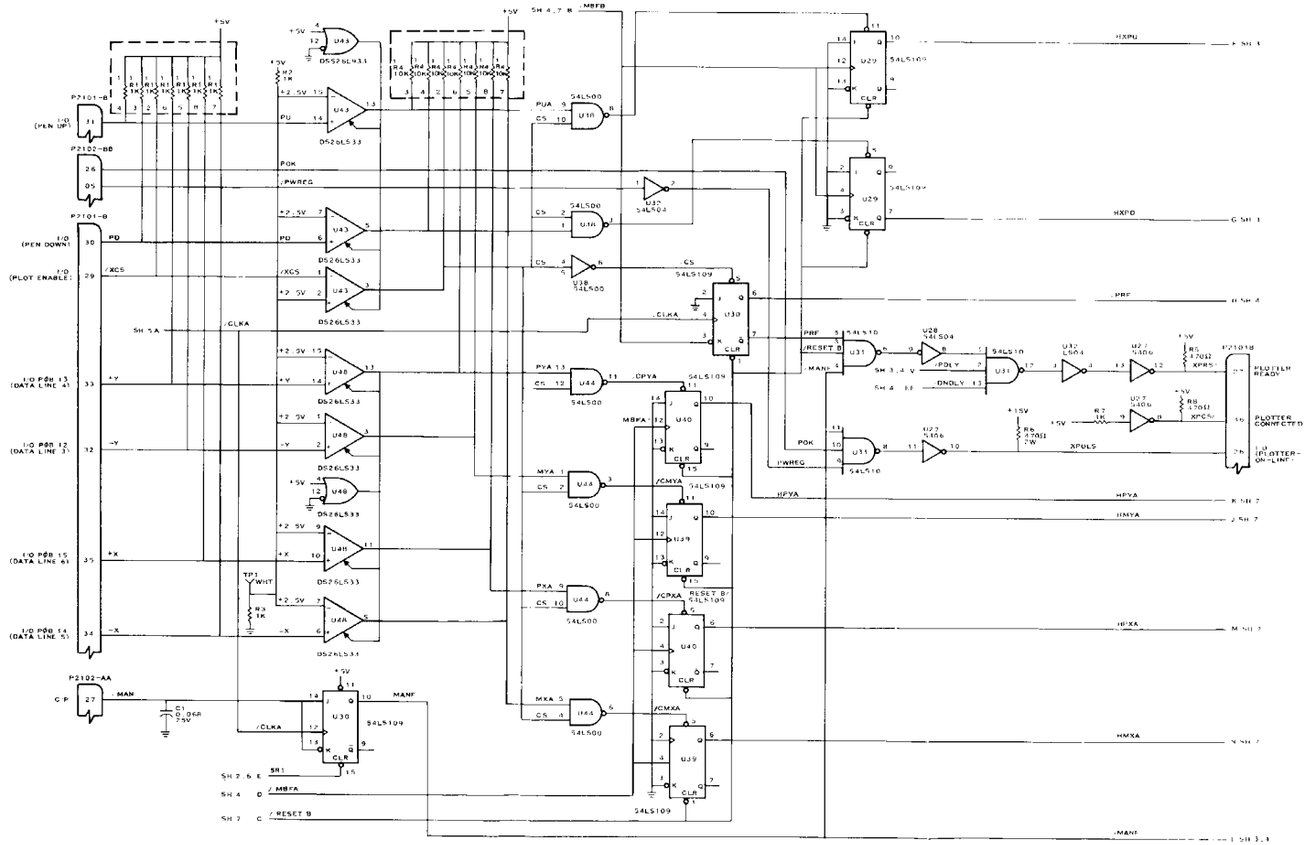


Figure 6-2. Input/Output Pen Driver Pcb A1 Schematic Diagram (Sheet 2 of 7)

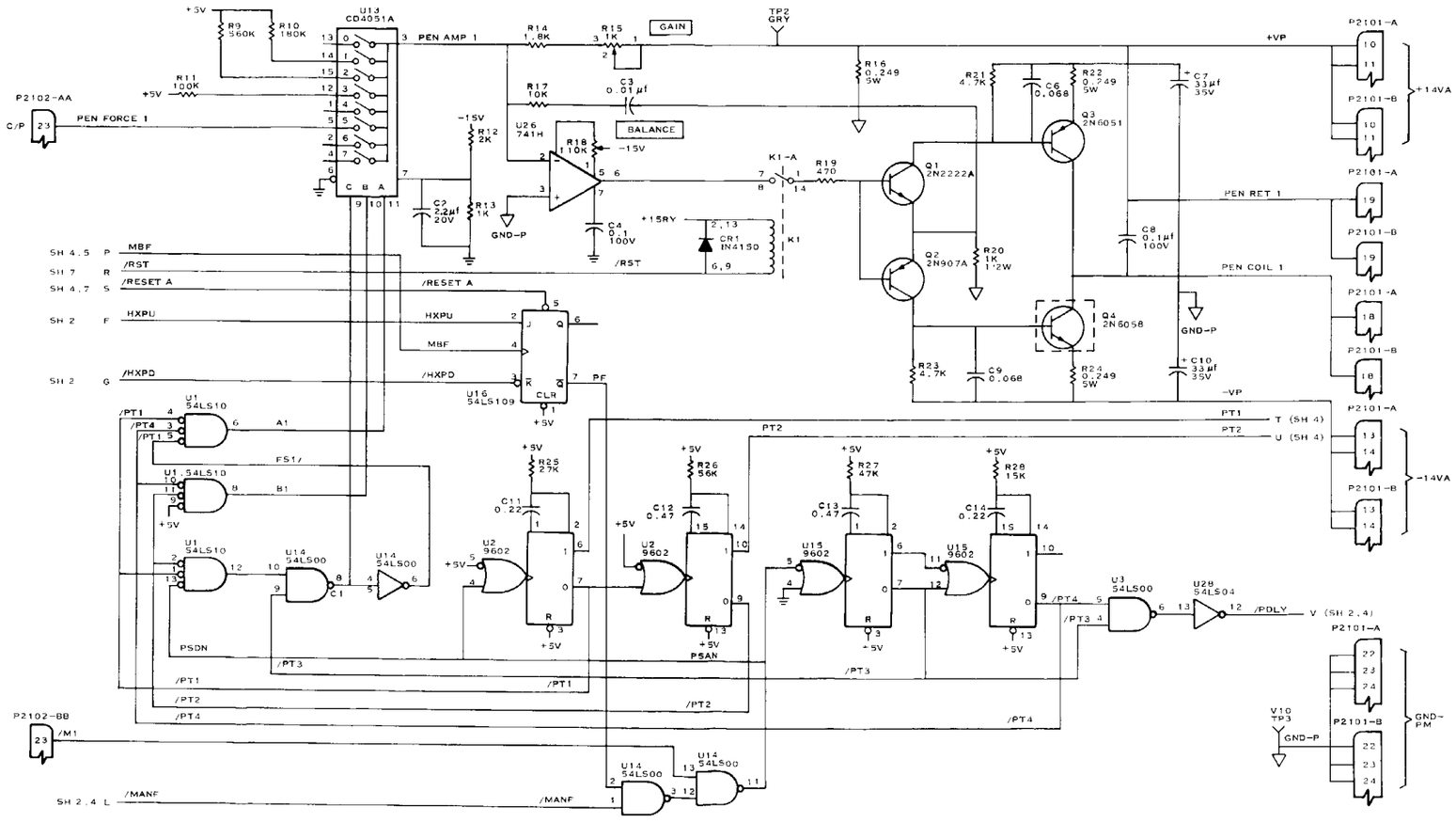


Figure 6-2. Input/Output Pen Driver Pcb A1 Schematic Diagram (Sheet 3 of 7)

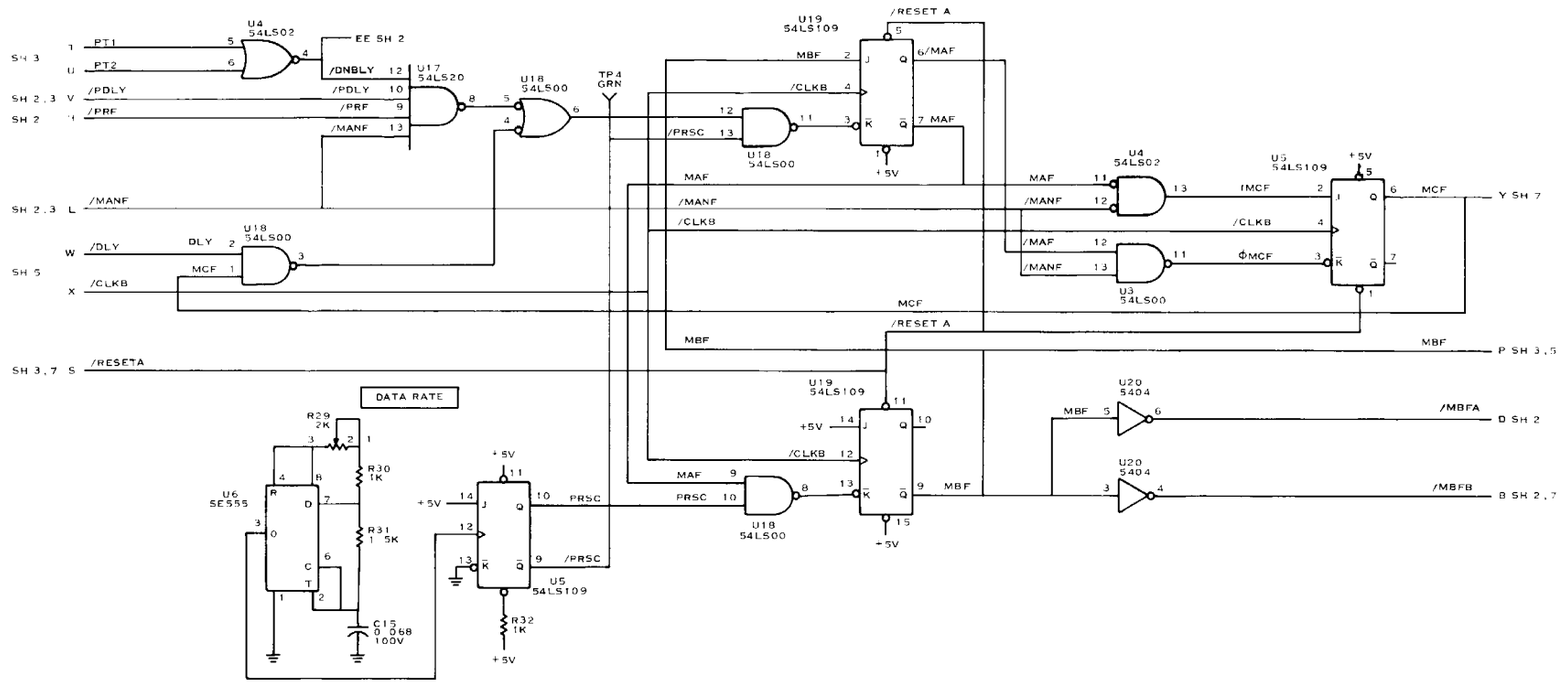


Figure 6-2. Input/Output Pen Driver Pcb A1
Schematic Diagram (Sheet 4 of 7)

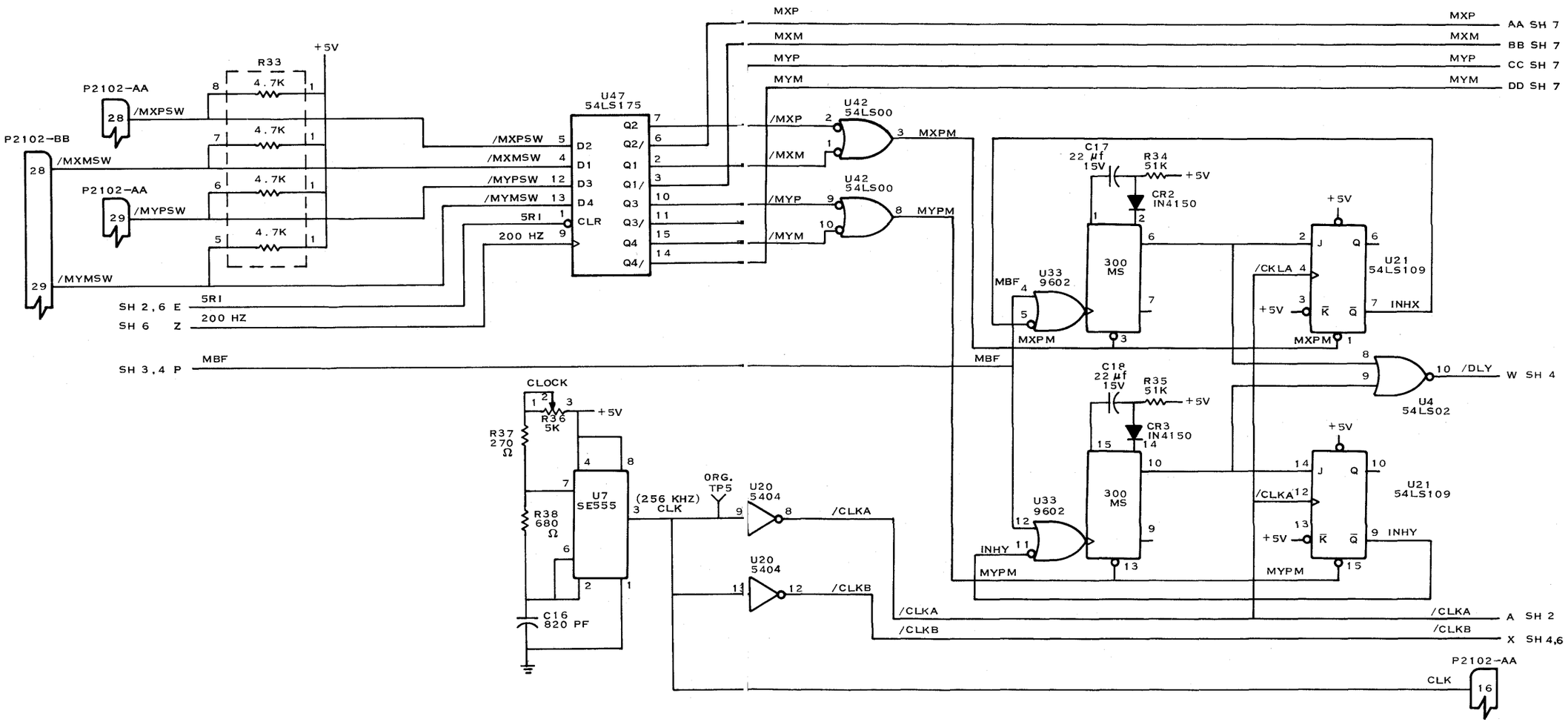


Figure 6-2. Input/Output Pen Driver Pcb A1
Schematic Diagram (Sheet 5 of 7)

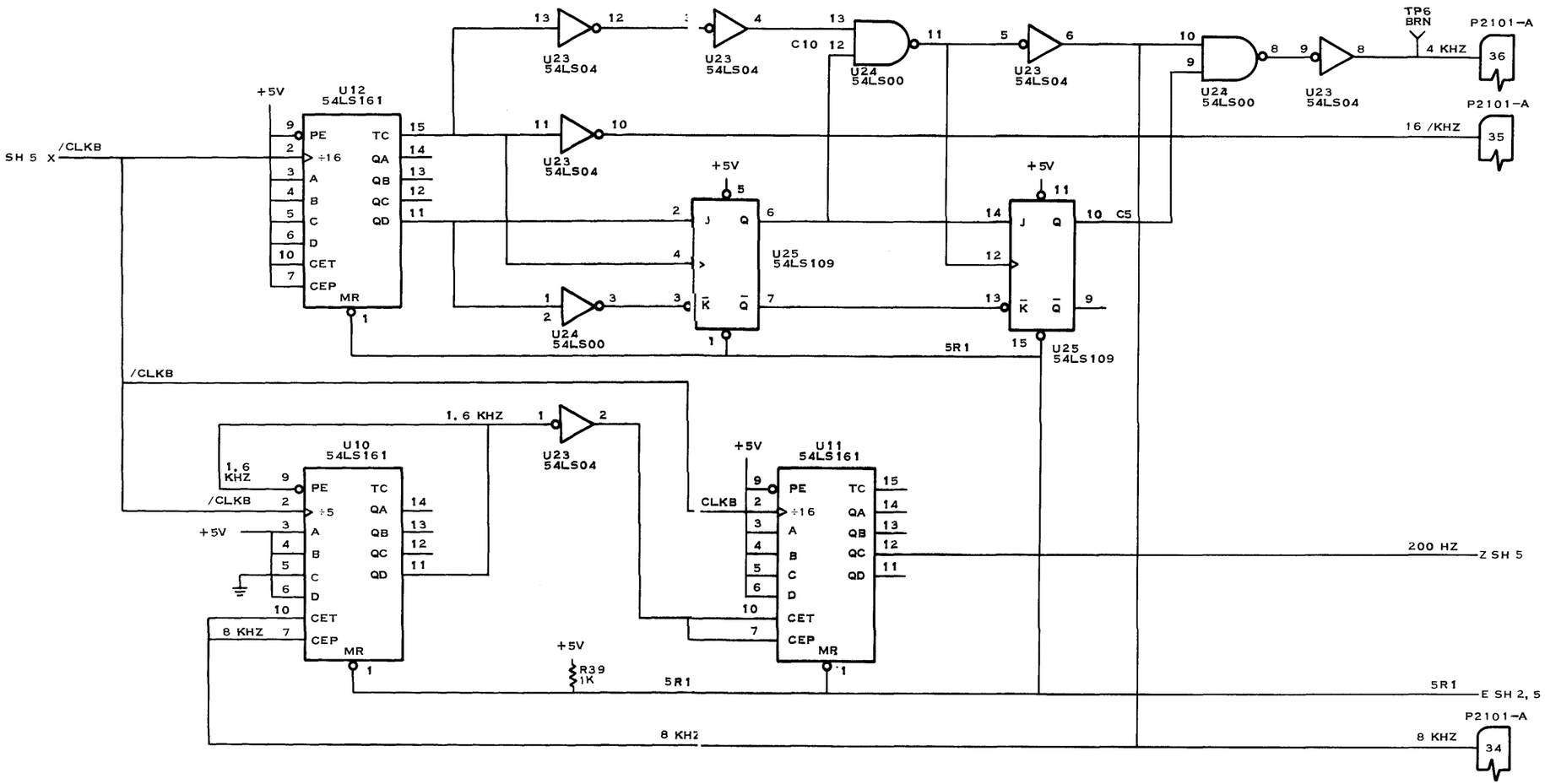


Figure 6-2. Input/Output Pen Driver Pcb A1
Schematic Diagram (Sheet 6 of 7)

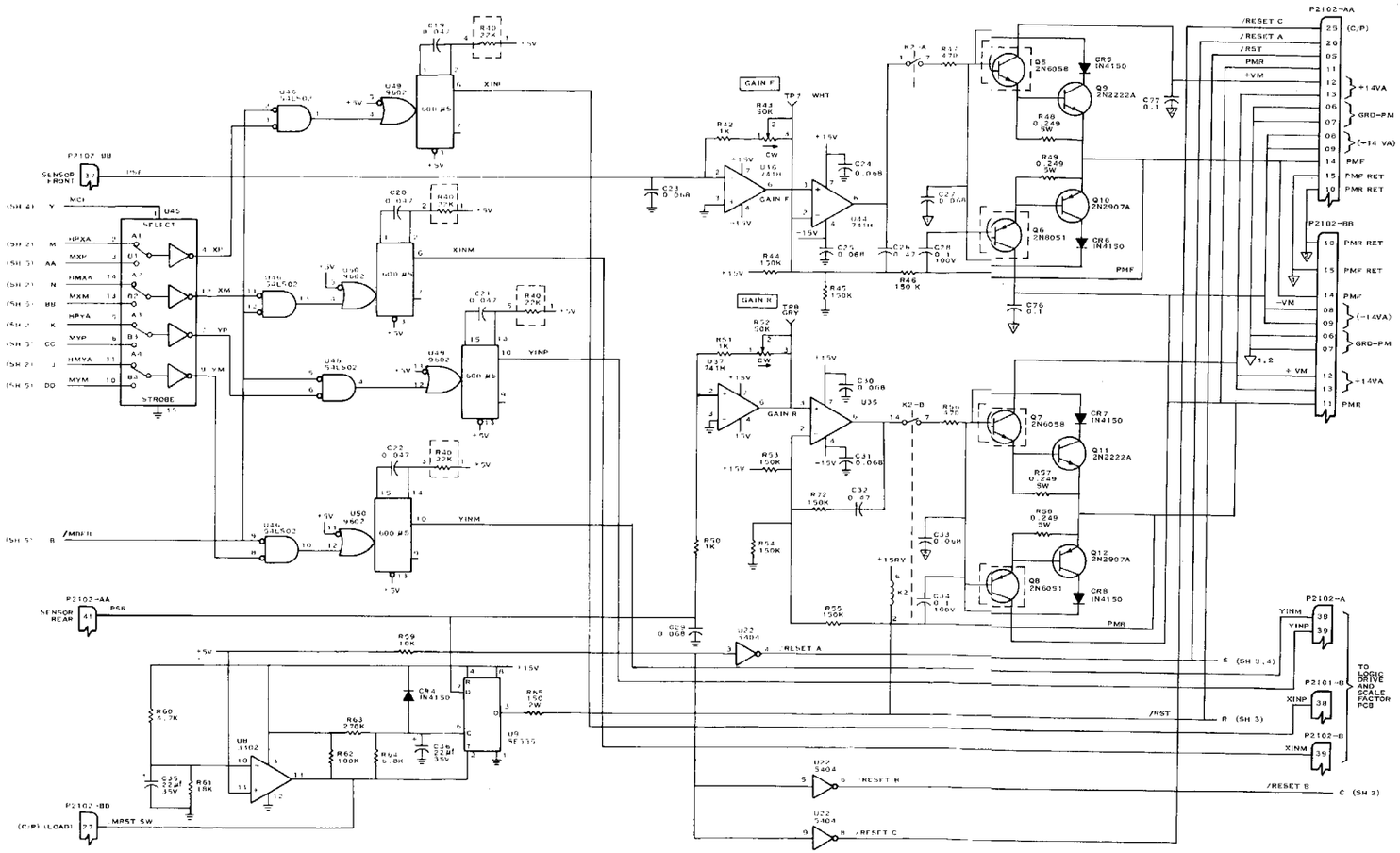


Figure 6-2. Input/Output Pen Driver Pcb A1 Schematic Diagram (Sheet 7 of 7)

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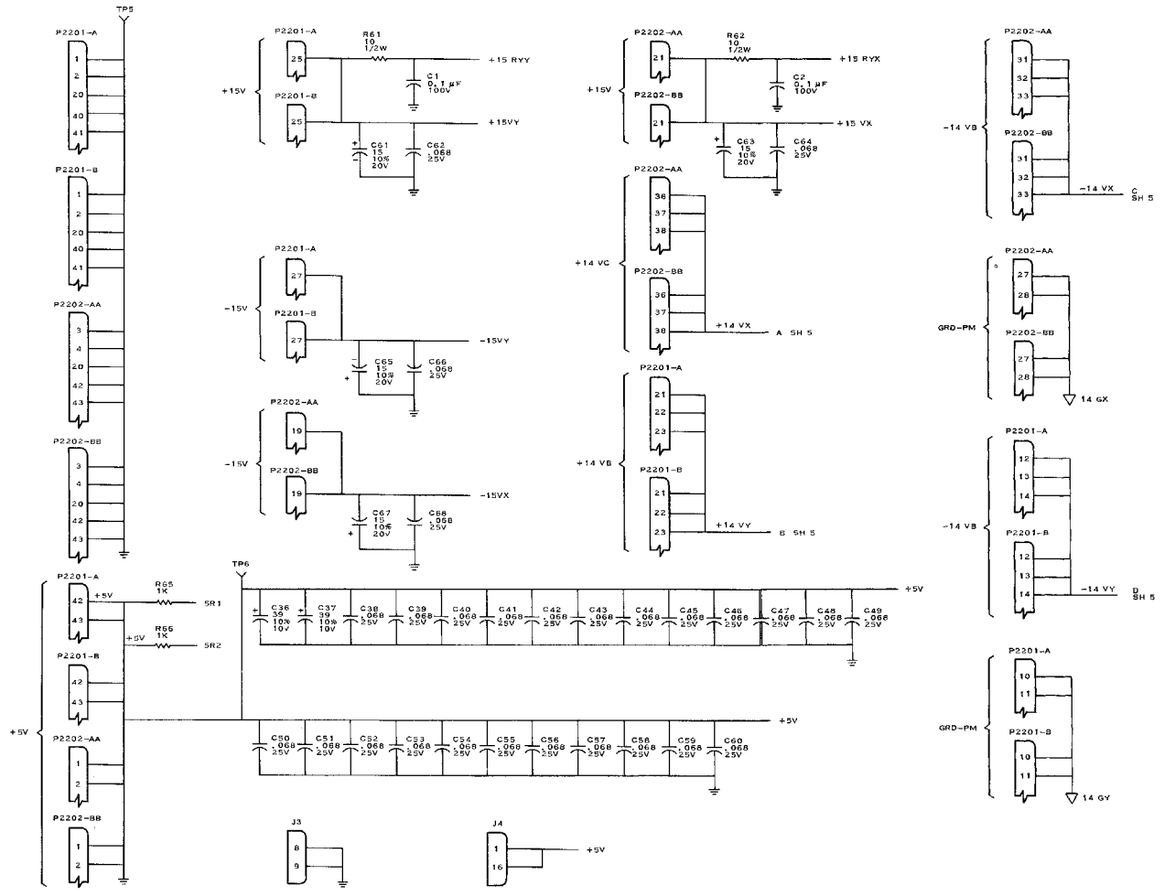

IC	TYPE	V_{CC}	GND
U2, U32, U36, U39, U75	54LS00	14	7
U4, U10, U13, U47, U71	54LS04	14	7
U64, U66, U78, U80	54LS10	14	7
U12, U14, U65-	54LS20	14	7
U35	54LS30	14	7
U11, U15, U21, U23	54LS42	16	8
U5, U31, U70, U72, U74, U76	54LS109	16	8
U18	54LS148	16	8
U9	54LS151	16	8
U19	54LS153	16	8
U1, U3	54LS157	16	8
U6, U7, U25, U28, U56, U58	54LS161	16	8
U20, U24	54LS175	16	8
U8, U16, U17, U26, U27, U29, U33	54LS191	16	8
U38, U40, U44			
U34, U37, U41, U43	54LS283	16	8
U79	3302	3	12
U51	5406	14	7
U30	5440	14	7
U22, U73, U77	9602	16	8

NOTES: UNLESS OTHERWISE SPECIFIED
1. REFERENCE DESIGNATION PREFIX
2. RESISTANCE VALUES ARE IN OHMS
3. CAPACITANCE VALUES ARE IN PICOFARADS

Figure 6-3. Logic, Drive and Scale Factor PCB A2 Schematic Diagram (Sheet 1of 2)

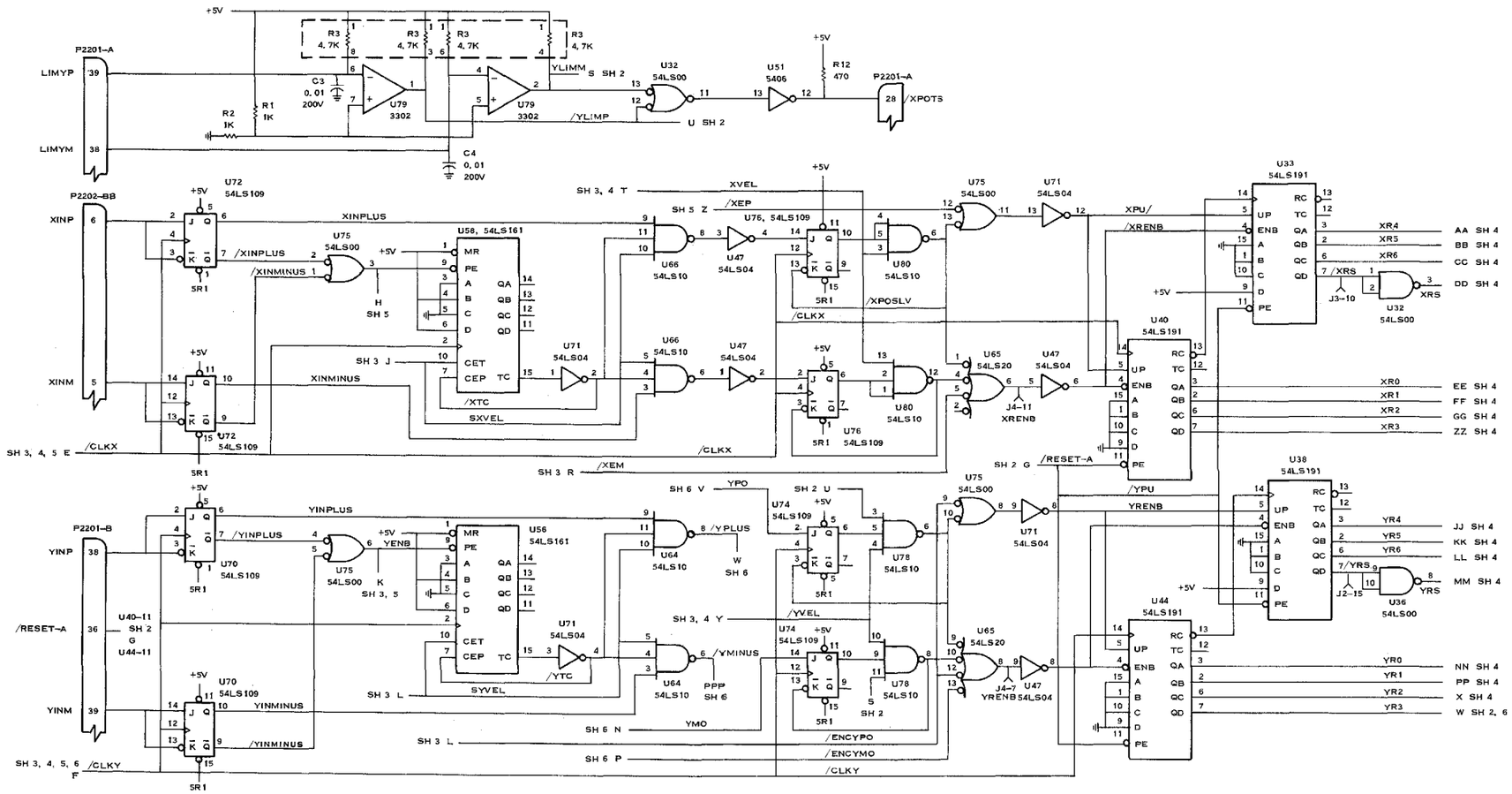

Figure 6-3. Logic, Drive and Scale Factor Pcb A2 Schematic Diagram (Sheet 2 of 6)

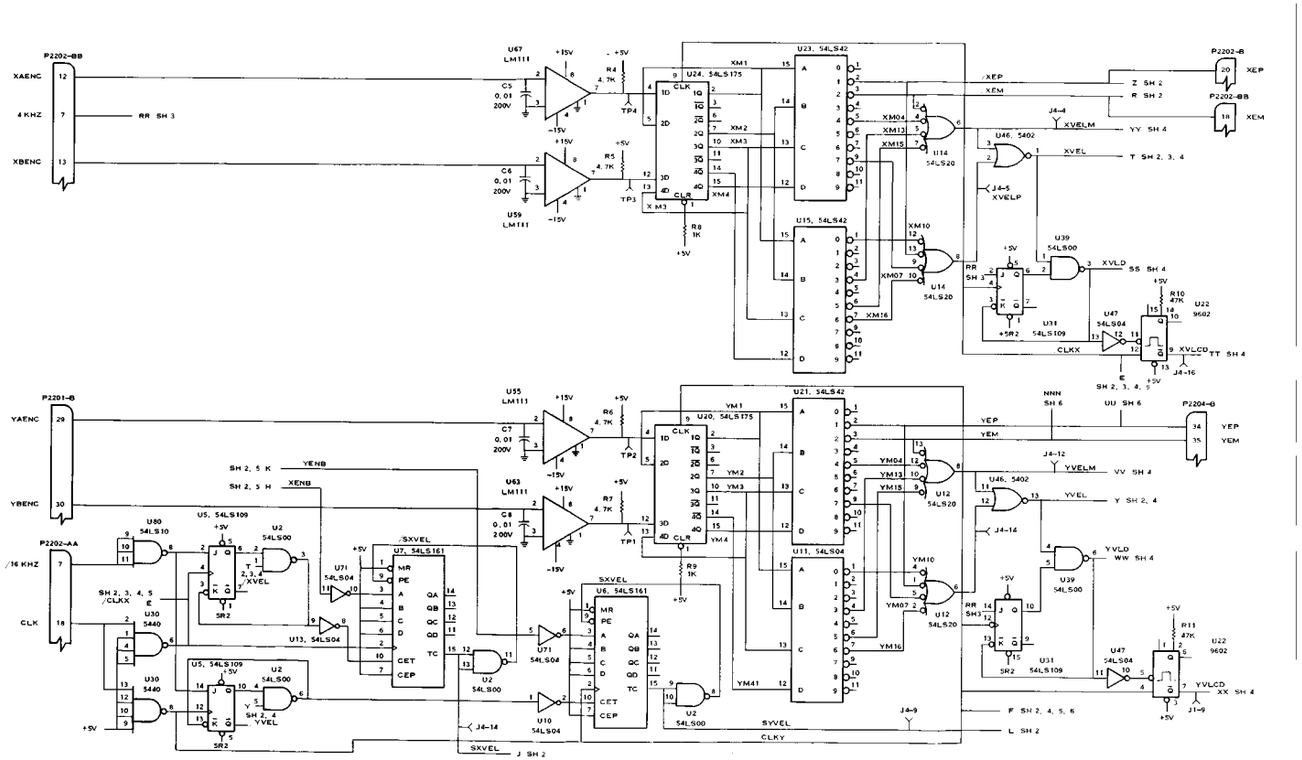

Figure 6-3. Logic, Drive and Scale Factor Pcb A2 Schematic Diagram (Sheet 3 of 6)

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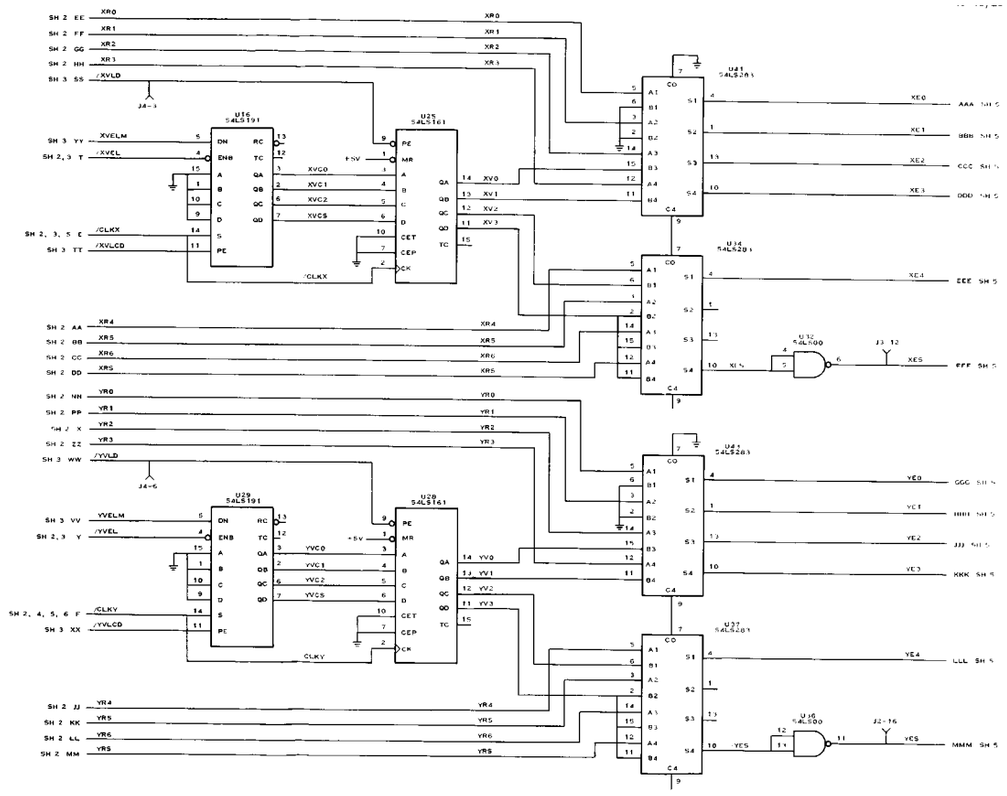

Figure 6-3. Logic, Drive and Scale Factor Pcb A2 Schematic Diagram (Sheet 4 of 6)

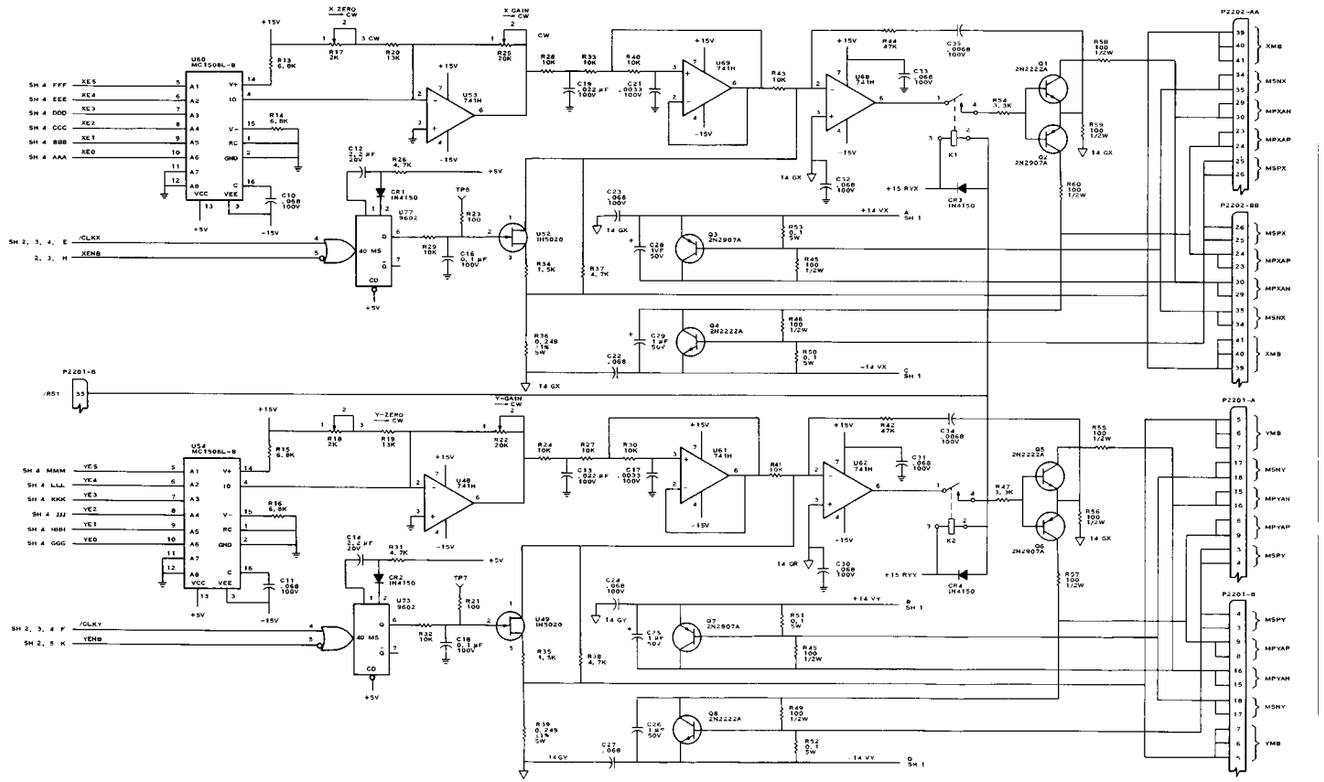

Figure 6-3. Logic, Drive and Scale Factor Pcb A2 Schematic Diagram (Sheet 5 of 6)

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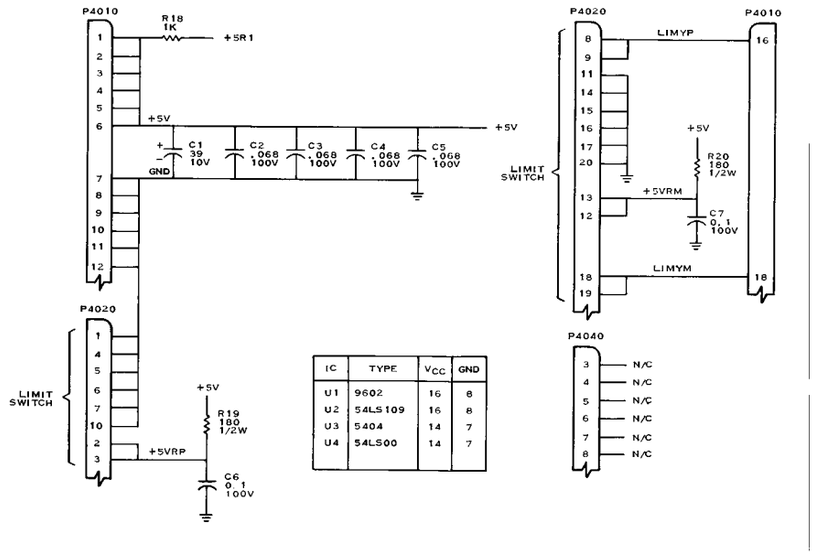

Figure 6-4. Right Control Panel Pcb A5 Schematic Diagram (Sheet 1 of 2)

6-33/(6-34 blank)

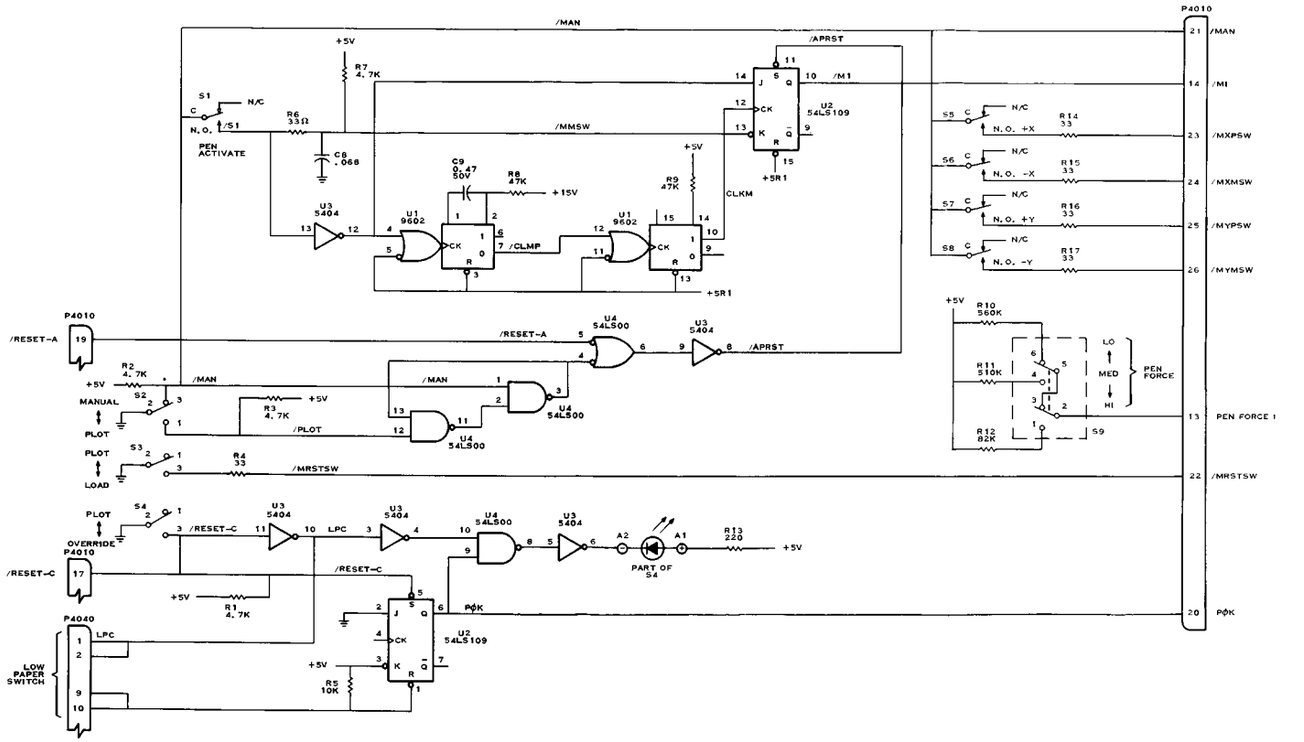

Figure 6-4. Right Control Panel Pcb A5 Schematic Diagram (Sheet 2 of 2)

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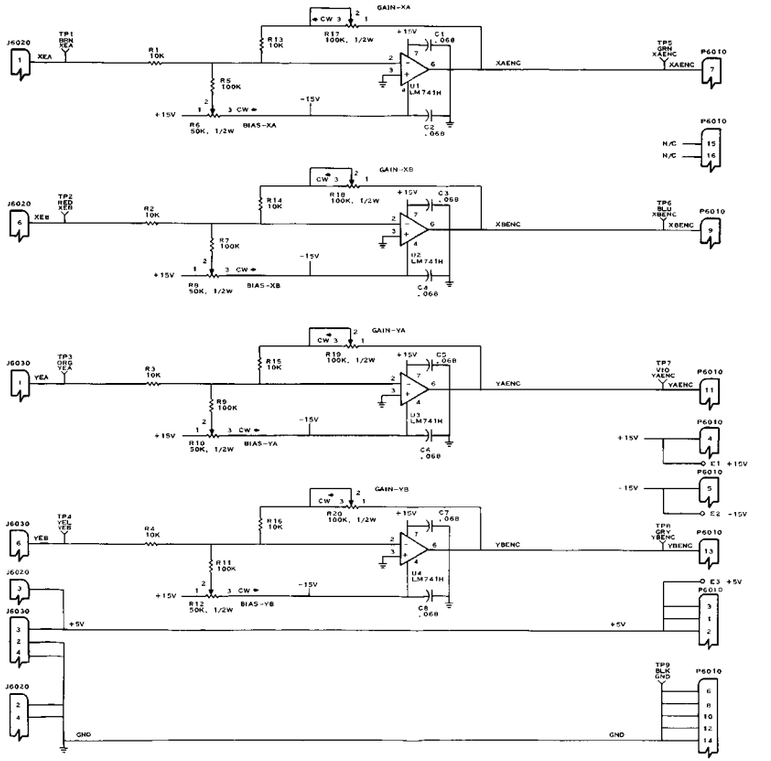

Figure 6-5. Encoder Preamplifier Pcb A4 Schematic Diagram

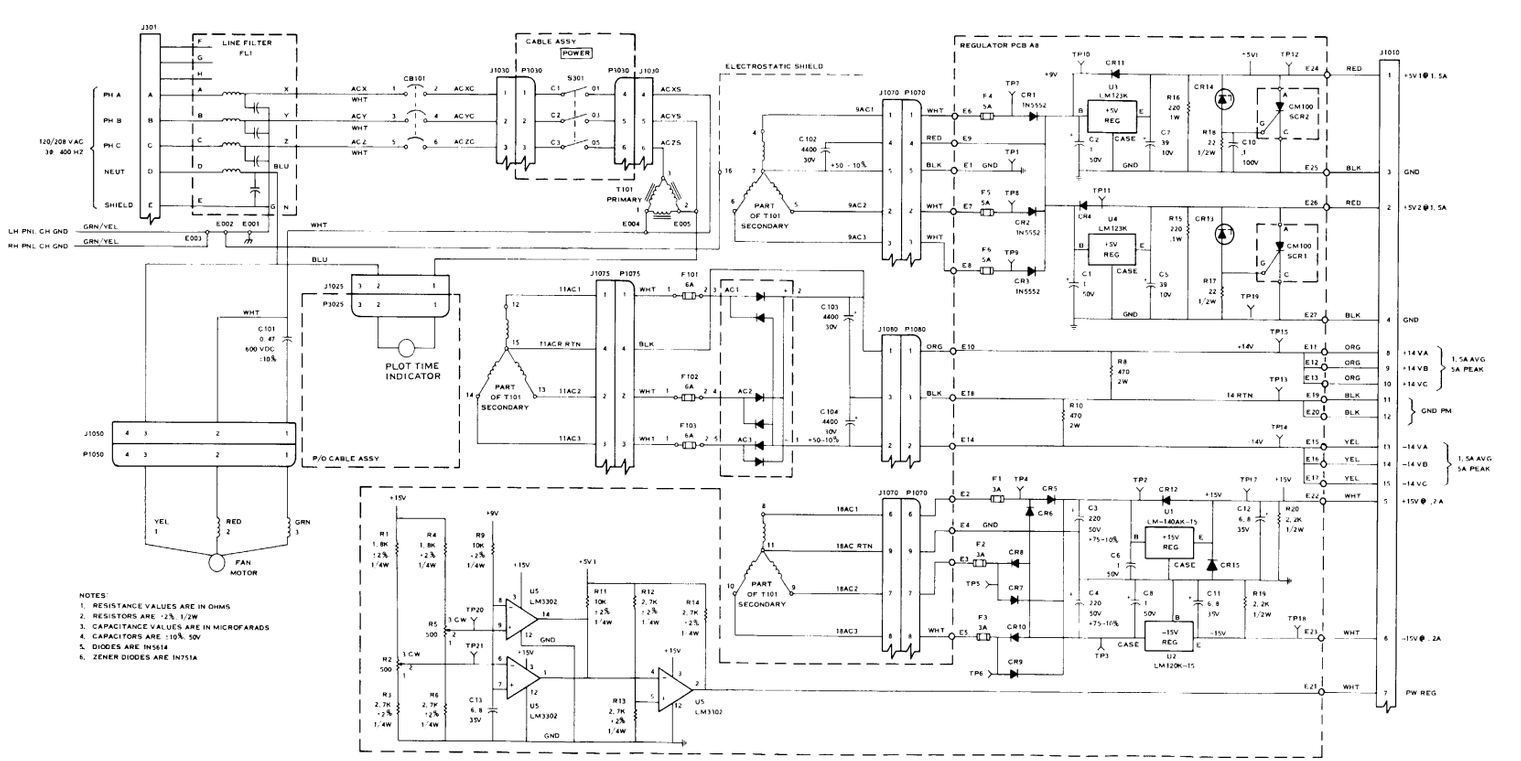

Figure 6-6. Power Supply and Regulator Pcb A8 Schematic Diagram

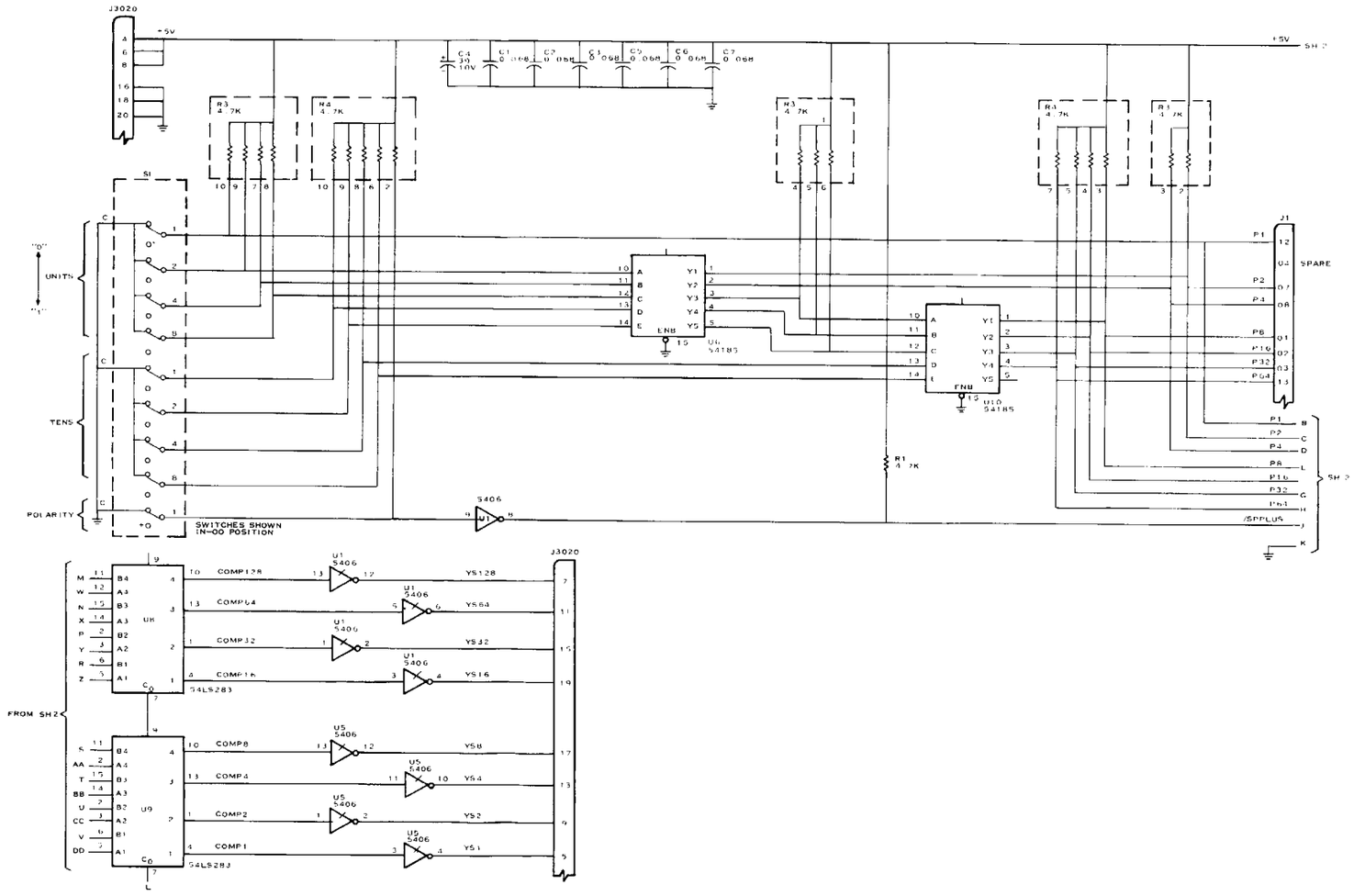

Figure 6-7. Operator Scale Factor Pcb A3 Schematic Diagram (Sheet 1 of 2)

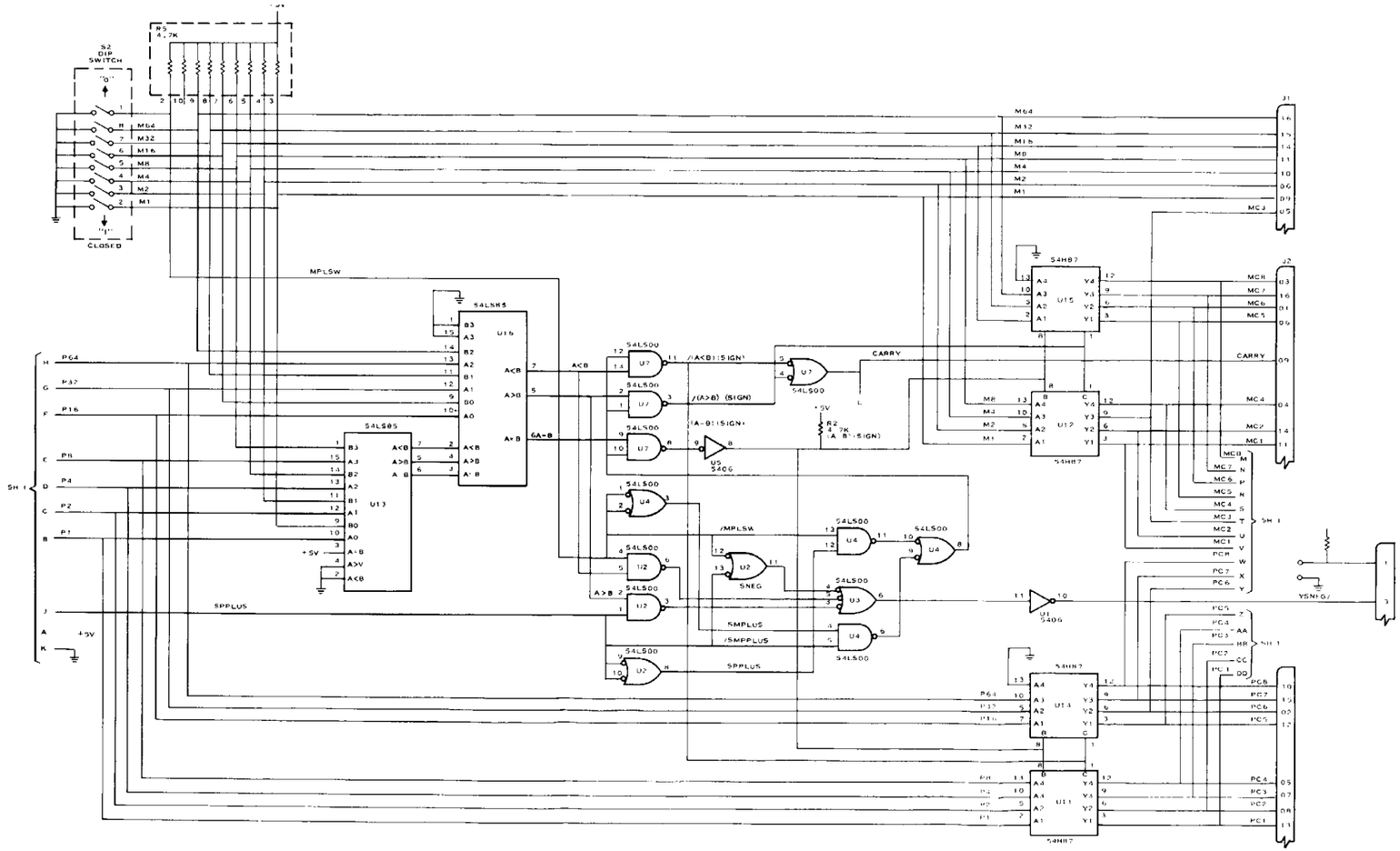

Figure 6-7. Operator Scale Factor Pcb A3 Schematic Diagram (Sheet 2 of 2)

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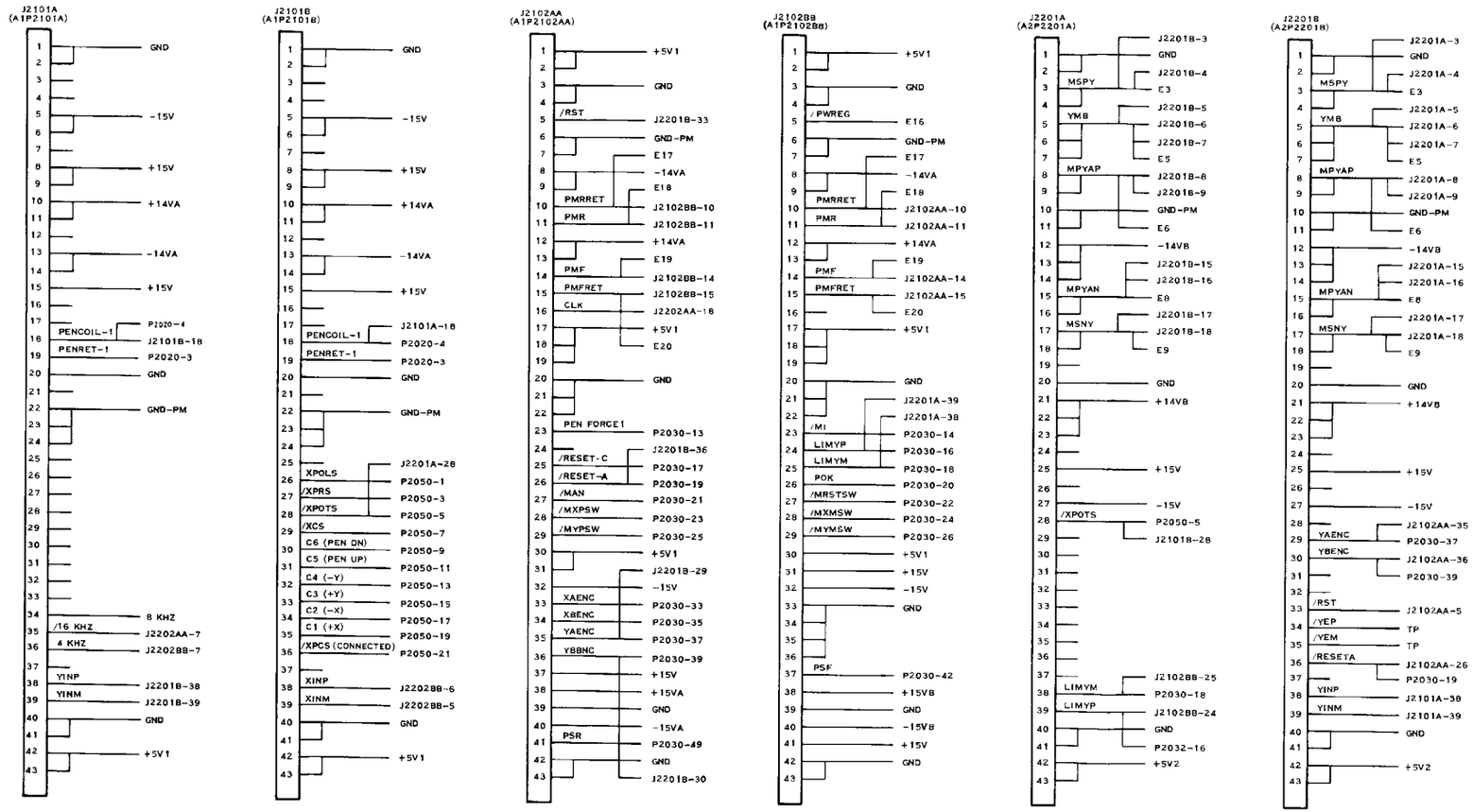

Figure 6-8. MIB Pcb A11 Schematic Diagram (Sheet 1 of 2)

6-45/(6-46 blank)

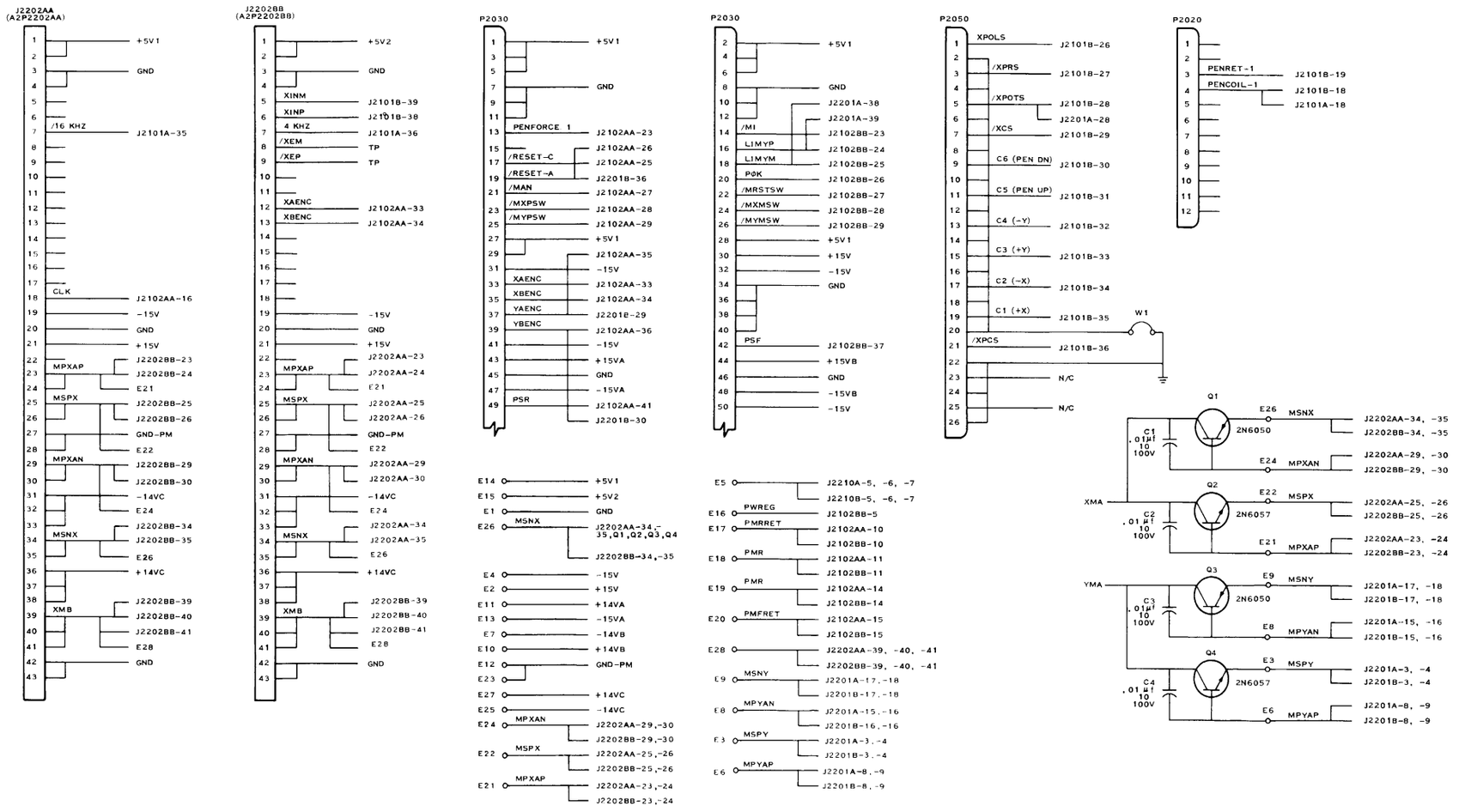

Figure 6-8. MIB Pcb A11 Schematic Diagram (Sheet 2 of2)

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