SECTION 23

AUTO-ALIGN AUTOMATIC CONVERGENCE OPTION

SUB-SECTIONS

ILLUSTRATIONS

SECTION 23

AUTO-ALIGN (Automatic Convergence Option)

23.1 TECHNICAL DESCRIPTION

23.1.1 General Description

AUTO-ALIGN is an optional automatic convergence feature for Electrohome VPF® 40HD, and 80HD series projectors. The system consists of a Locator Assembly, Control Board and Locator Cable. The Locator Assembly, situated on the front of the projector, is the "eye" of the system. It mechanically scans the projected display in each convergence zone while sensing relative positions of each projected color. Sensory information is directed via wire harness to the Control board in the projector card rack. The Control board analyses this data to determine image positioning, then adjusts the vertical and horizontal positions of the red and blue colors until optimum convergence with the green image is achieved.

The AUTO-ALIGN hardware is under the control of software stored in PROM on the Remote Control Board and is run by that board's 80C154 microcontroller. Automatic convergence is performed by the repetition of four fundamental operations: 1) a 'target' is generated at the location in the projected image that is to be converged;
2) the photosensor on the Locator Assembly is pointed at the target using the stepper motors; 3) registration between the color components of the target image is sensed by reading the photosensor; and 4) the color components at the current screen position are moved using the projector's convergence circuitry to register the colors. For off-center points, the Digital Convergence Board provides the correction. For the center, the Remote Control Board generates control voltages that specify the positions of each color raster as a whole. Convergence of the colors must be ensured at the center before converging any other area.

There are 45 convergence points arranged in a 9 X 5 rectangular matrix on the projected raster. Figure 23-1 illustrates the position of each convergence point in relationship to the internal crosshatch video pattern. The position of the red, green and blue component images are independently specified at each of these control points. Positioning between control points is calculated by linear interpolation: horizontally by software and vertically by the Digital Convergence board hardware (in real time).

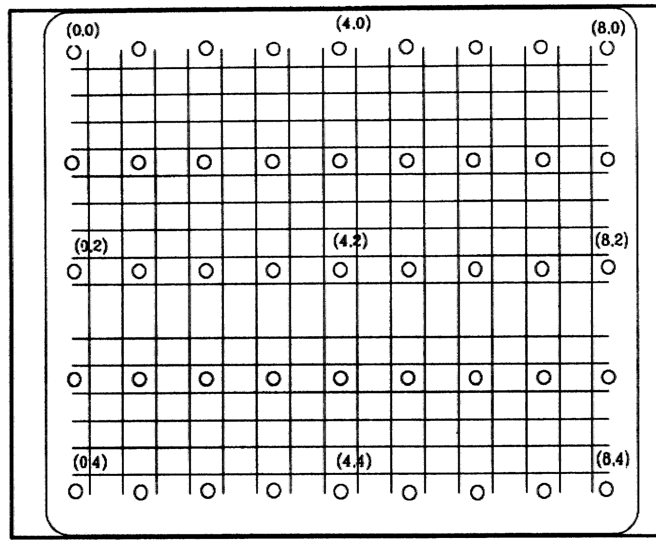

FIGURE 23-1. *Screen Convergence Points*

23.1.2 Hardware Description

23.1.2.1 Locator Assembly

The Locator Assembly consists of a rigid metal casting supporting two stepper motors in an orthogonal-rotation configuration onto which is mounted a lens/sensor component containing an objective (imaging) lens at one end, and a photosensor device at the other end. The motors allow the optical system to be aimed at any arbitrary point on a projection screen in front of the system.

The photosensor is a custom designed quadrant photodiode array. The function of the sensor is to detect (through the objective lens) the position of a target imaged produced by the projector. The sensor size and lens focal length combine to give the assembly a telephoto view of the projected light on the screen. This allows the sensor to accurately determine the position of the image.

23.1.3 Circuit Description

The AUTO-ALIGN electronics is divided between two circuit boards: the AUTO-ALIGN Sensor Board (in the Locator Assembly) and the Control Board (in the projector card rack). The circuits are interconnected by the shielded multi-conductor Locator Cable.

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23.1.3.1 AUTO-ALIGN Sensor Board

The AUTO-ALIGN Sensor Board is mounted at the back end of the lens/sensor component in the Locator Assembly. The photodiode array is mounted at the center of the board on the optical axis of the imaging lens. It is surrounded by surface-mounted amplifier circuitry; one amplifier channel for each quadrant of the sensor.

The board operates on +12V and -12V. It outputs four analog voltages proportional to the amount of light on each of the inner quadrant photodiodes. These signals are sent via the Locator Cable to the Control Board in the projector card rack.

23.1.3.2 AUTO-ALIGN Control Board

The AUTO-ALIGN Control board (in the projector card rack) contains motor control, data acquisition and software recognition circuitry.

Motor Control Circuitry

The two stepper motors in the Locator Assembly are controlled by identical circuits, each consisting of a micro-step controller IC (U10 and U12) and a motor driver IC (U15 and U16). These IC's are controlled by the 80C154 microprocessor resident on the Remote Control Board. The microprocessor provides U10 with a seven bit value and a sign which are converted to an analog value and a sign at pin 21 and pin 20. Pin 19 is programmed high for slow current decay mode. These three pins are connected directly to U15. The maximum analog output of U10 is set by the reference voltage on pin 1, which is set to 2.75V by shunt regulator U12. The analog input to U15, along with current sense resistor R35, determine the current level in the motor winding. R30 and C32 provide filtering of the feedback signal. The motor drivers are clocked at approximately 28 kHz by the timing circuit of U14. The clock frequency is determined by R14, R16 and C25.

The power for the motor drivers come from switching regulator U18 with associated components L1, R62, R63, R64, R65, D15, D16, D17, C43, C44, C51 and C53. This regulator boosts 5V to 19V. D16, D17 and C52 reduce current surges during power-up by slowing the rise time of the boosted voltage. The output voltage is determined by R62 and R64.

Data Acquisition Circuitry

This circuity conditions the analog signal received from each quadrant of the AUTO-ALIGN sensor module and converts it to digital so that it can be read reliably by the microprocessor. The signals are filtered, amplified (if necessary), clipped (if necessary), clamped and peak detected. The signal from each quadrant is conditioned the same. The following description explains the cuircuitry form quadrant 1.

The signal from quadrant 1 of the sensor, input on PC1-1, is capacitively coupled by C46 to a low pass filter consisting of R43, R53 and C37. R45 and R53 act as a resistor divider to attenuate the signal so that the contrast setting can be increased to give a better video-to-ambient ratio. The output of the filter is fed to pin 3 of op-amp U17 which is used in its non-inverting configuration. The op-amp gain is determined by R46, R47 and Q10. If Q10 is turned ON, the gain is 3.2. If Q10 is turned OFF, the gain is 1.0. Q10 is controlled by the microprocessor. A higher gain is used for the corners of large screens.

The signal then passes through R44 whose purpose is threefold. With C33 it forms a low pass filter. It also limits the current drawn from op-amp U17 when the signal is clipped by D9. And lastly, it helps to stabilize the output of U17 when driving the clamp capacitor C22.

The signal is clipped when it exceeds 5.2V to protect the inputs of the analog to digital convertor (ADC), U1. The ADC will not properly digitize a signal if it is greater than 300mV above the IC's analog supply voltage. To maximize the ADC input range, clipping does not occur at less than the ADC's reference voltage Vref. Since the analog supply voltage and the reference voltage are tied together, the clipping level is in the range of 0mV to 300mV above Vref. The clipping circuitry consists of D9, D1, U7, R4, and R9. R4, R9, and U7 set the anode voltage of schottky diode D1 to 5.0V. The cathode of D1 is then at 4.5V. The signal is clipped to a diode drop above this at 5.2V. The 5.0V at the anode of D1 is also used as the Vcc, Vdd and Vref inputs of the analog to digital convertor U1.

The clamping circuit consists of C22 and JFET Q2. It is microprocessor controlled through flip flop U9. Q2 is turned ON when the gate to source voltage is greater than 0V and turned OFF when the gate to source voltage is greater than a few volts negative. The signal is peak detected through U13 and D6 and held up by capacitor C12. This peak is fed to a 4 channel 12-bit ADC, U1. Channel selection and initiation of the data conversion is microprocessor controlled via data bus lines (D0-D7), address bus lines (A0-A3), and address decoded select lines (SEL6 and SEL7).

Software Recognition Circuitry

The software recognition circuitry allows the projector's system software to recognize the existence of the AUTO-ALIGN Control Board in the projector. It is comprised of a read-only register (U5) with a hard-wired identification code (55H), readable at a specific bus address by the projector's microcontroller.

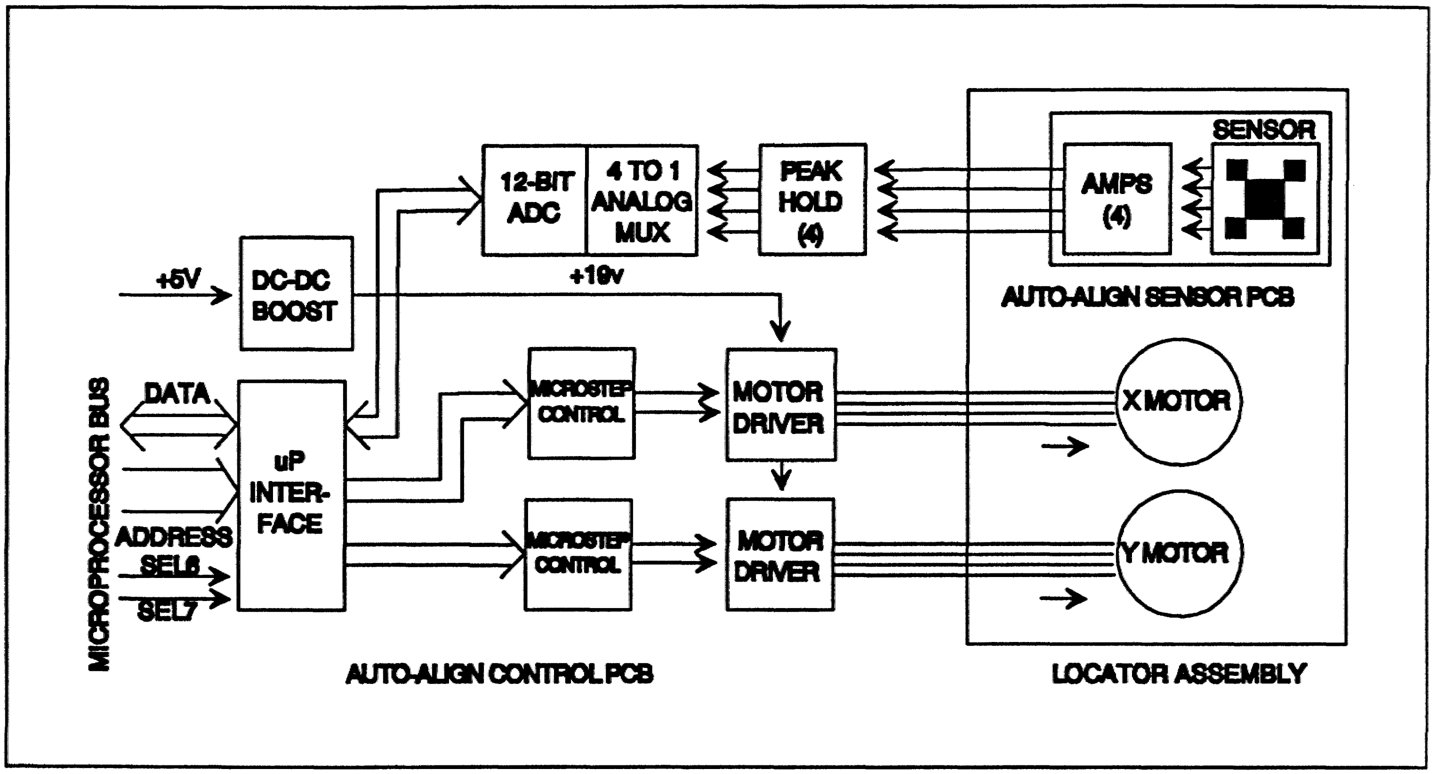


FIGURE 23-2. *AUTO-ALIGN Function Block Diagram*

23.2 SERVICING AND ALIGNMENT

23.2.1 Disassembly and Access

WARNING

STATIC SENSITIVE COMPONENTS
STATIC CONTROLLED WORK STATION REQUIRED

Module Location:
- card rack (Control Board)
- front panel (Locator Assembly)

Tools & Equipment Required:
- Phillips screw driver
- circuit board extractor

23.2.1.1 Control Board Removal

a) Remove the back panel as described in Section 5.

b) Locate the AUTO-ALIGN Control Board in the rear panel card rack. The AUTO-ALIGN Control Board is located in the "SPARE" slot of the Card Rack (refer to Figure 5-8). Using the printed circuit board extractor from the tool pouch, pull the module from the card rack as described in Section 5.2.

23.2.1.2 Locator Assembly Removal

a) Remove the three mounting screws securing the Locator Assembly to the front panel.

b) Gently Slide the Locator Assembly down (away from lens') about 2 inches. Disconnect the Locator Cable from the assembly by removing the two connector screws.

23.2.1.3 Locator Cable Removal

The Locator Cable connects between the P20 connector on the Mother Board and the Locator Assembly. The Locator Cable path is illustrated in Figure E-1 in Appendix E.

a) Remove the AUTO-ALIGN Control Board per step 23.2.1.1 above. In the same way, remove the Convergence module.

b) Remove the upper and lower snap-in type card slides and module shields for the two removed boards.

c) Unplug the Locator Cable at the P20 connector on the Mother Board.

d) Remove the Locator Assembly per step 23.2.1.2 above.

e) Remove the front top cover per Section 5.2.1.

f) From the lens area, pull out both ends of the Locator Cable and remove.

23.2.2 Diagnostics

AUTO-ALIGN's software includes a servicing mode to assist when trying to identify or pinpoint the source of an automatic convergence problem. While in service mode, the service technician can:

1) Auto-converge at any specified convergence point,

2) Record and analyse sensory data for any specified convergence point.

To enter service mode:

a) Call up the CONVERGENCE menu by pressing the **CONV** button on the projector keypad. Select item 4, *AUTO-ALIGN: Auto-Convergence.*

AUTO-ALIGN: AUTO-CONVERGENCE

1. Full Screen
2. Touch Up
3. Center Only (static)
4. Learn Screen
5. Service Tools

Press a number to select

Press HELP for instructions
Press EXIT to return

b) With the AUTO-ALIGN Automatic Convergence menu displayed, press the "*" key. Item 5, *Service Tools* will appear as shown.

c) Select item 5. The screen will display all 45 convergence points. AUTO-ALIGN is now in service mode. Leave service mode at any time by pressing the **EXIT** key on the keypad. Pressing the **HELP** key will display a summary of available functions.

To automatically converge or view sensory data of a convergence point, press the **MOV** key on the keypad. The screen will prompt you for the *x* and *y* coordinates of the convergence point. Input each coordinate from the keypad (refer to Figure 23-1). Upon completion, a green "target" will be displayed for the convergence point. The sensor motors will position the sensor to the center of the target, based on data stored in the automatic convergence database. Sensory data currently recorded by the sensors is displayed on the screen.

To converge the selected point:

Press the **CONV** key on the keypad.

Selection of the individual red, green or blue colors for viewing and analysis may be made by pressing the **COLOR** button on the keypad. Repeated presses of the **COLOR** button cycle the colors in the following order:

1. white (all colors)
2. green
3. red
4. blue
5. background (no target)

How to analyse the positional data

AUTO-ALIGN measures the reflected light from a target in each of the four sensor quadrants as illustrated below.

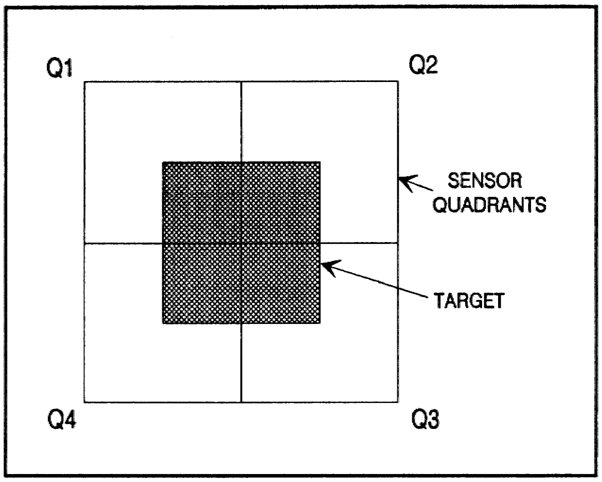


FIGURE 23-3. ***Sensor Quadrants***

Analog values are converted by the analog-to-digital convertor on the AUTO-ALIGN Control Board and displayed in hexadecimal format on the display screen. Calculated positional data based on the above measurements is also displayed. Each data value displayed is described below.

Q1 A hexadecimal value between 000 and FFF representing the amount of reflected light measured in quadrant Q1.

Q2 A hexadecimal value between 000 and FFF representing the amount of reflected light measured in quadrant Q2.

Q3 A hexadecimal value between 000 and FFF representing the amount of reflected light measured in quadrant Q3.

Q4 A hexadecimal value between 000 and FFF representing the amount of reflected light measured in quadrant Q4.

CX A hexadecimal value between -400 and +400 representing the horizontal displacement of the target's centroid relative to the center of the sensor.

CY A hexadecimal value between -400 and +400 representing the vertical placement of the target's centroid relative to the center of the sensor.

MX A hexadecimal value between 000 and C80 representing the displacement of the horizontal motor relative to the home position.

MY A hexadecimal value between 000 and FFF representing the displacement of the vertical motor relative to the home position.

Based on the screen information, it may be possible to pinpoint automatic convergence problems.

Ideally, but impractically, the amount of light measured in each quadrant when the sensor points at a converged target should be identical and constant. As it is not reasonable to expect exact matching, the fact that the displayed values are reasonably close is a good sign. In addition, the values constantly change due to factors such as electrical field noise, magnetic fluctuations, thermal noise and vibration. Changes up to 10 (HEX) are considered normal.

The values CX and CY represent the horizontal and vertical distances, respectively, of an imaged target in a given color from the center of the sensor. For the green color, both CX and CY will normally be less than 80 (Hex). On a converged point, the CX and CY values of the red and blue colors should closely match the corresponding values for the green color.

If the displayed values are not as described above, auto-converge the selected point. If a problem still exists, check other convergence points. If the problem is consistent among other convergence points, reduce the amount of room lighting and try again. If the problem persists, the Locator Assembly or the Control Board may require replacement. Inconsistency amongst different convergence points (or the same point tested at different times) may indicate that the eccentric motor stops are not properly positioned. If this is the case, refer to section 23.2.3, *Alignment and Adjustments*.

Problems at edge points may result from a reflective screen frame. If this is indicated, cover the screen frame surface facing AUTO-ALIGN with a matte black material such as black felt.

If all light measurements are close to 000 or FFF when any of the red, green or blue colors are displayed, the motors may not be placing the sensor at the projected target. This can occur if the setup configuration (Learn Screen) does not match the actual system configuration or the motor drive circuitry is not operating properly. Use the Learn Screen feature as described in the AUTO-ALIGN User's manual and re-converge. If the problem still exists, check the physical position of the lens/sensor component. If it does not appear to be positioned toward the specified convergence point on the display, the motor drive circuitry on the Control Board may be at fault.

23.2.3 Alignment and Adjustments

Adjustment of the eccentric motor end stops is the only service adjustment which may be performed to the AUTO-ALIGN system. This adjustment may be required if AUTO-ALIGN does not accurately or consistently auto-converge at each convergence point. There are two end stops, one at each end of the "stop bar" on the Locator Assembly. Each end stop consists of a rubber grommet with an eccentrically placed center hole. When the motors move to their "home" position, the lens/sensor component butts up against each stop. Rotating the stop changes the physical location of the home position.

The final end adjustment of each end stop can be critical to assure repeatable and reliable positioning of the Locator Assembly stepper motors. To adjust the eccentric end stops, follow the procedure below.

a) Enter servicing mode.

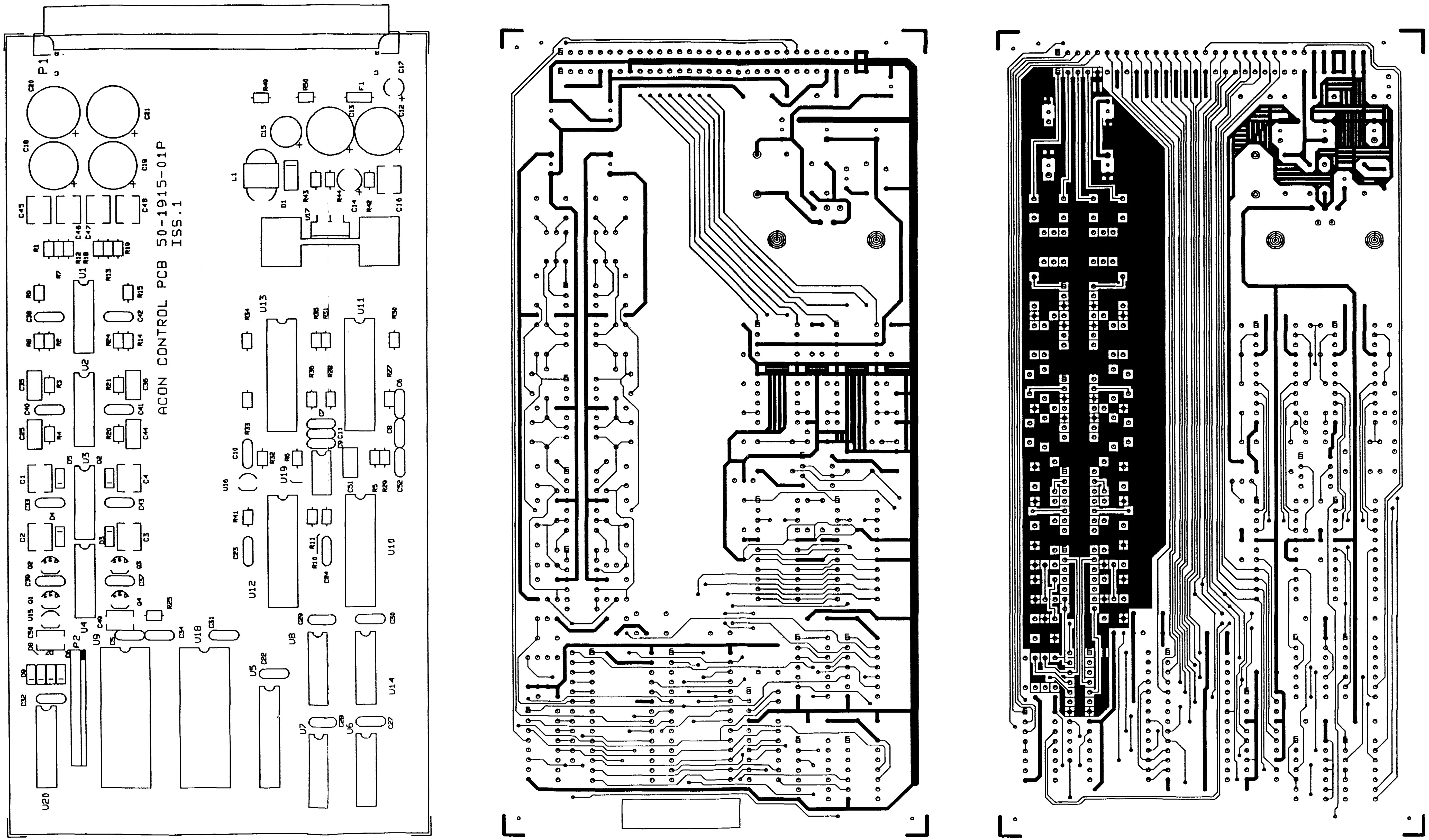
b) Press the **RESET** key on the projector keypad. This sets the motors to their home position.

c) Select one of the convergence points using the **MOV** command.

d) Record the CX and CY coordinate values.

e) Repeat b) to d) above (selecting the same convergence point). If either the CX or CY coordinate values are significantly different than the first readings, slightly rotate the appropriate end stop grommet. Repeat b) to e) until the readings are reasonably close between measurements.

Note: The upper grommet affects the vertical positioning and the lower grommet affects the horizontal positioning.



Component Layout

Solder Side
(Viewed from Component Side)

Component Side

FIGURE 23-4. *AUTO-ALIGN Control Board Component Layout*

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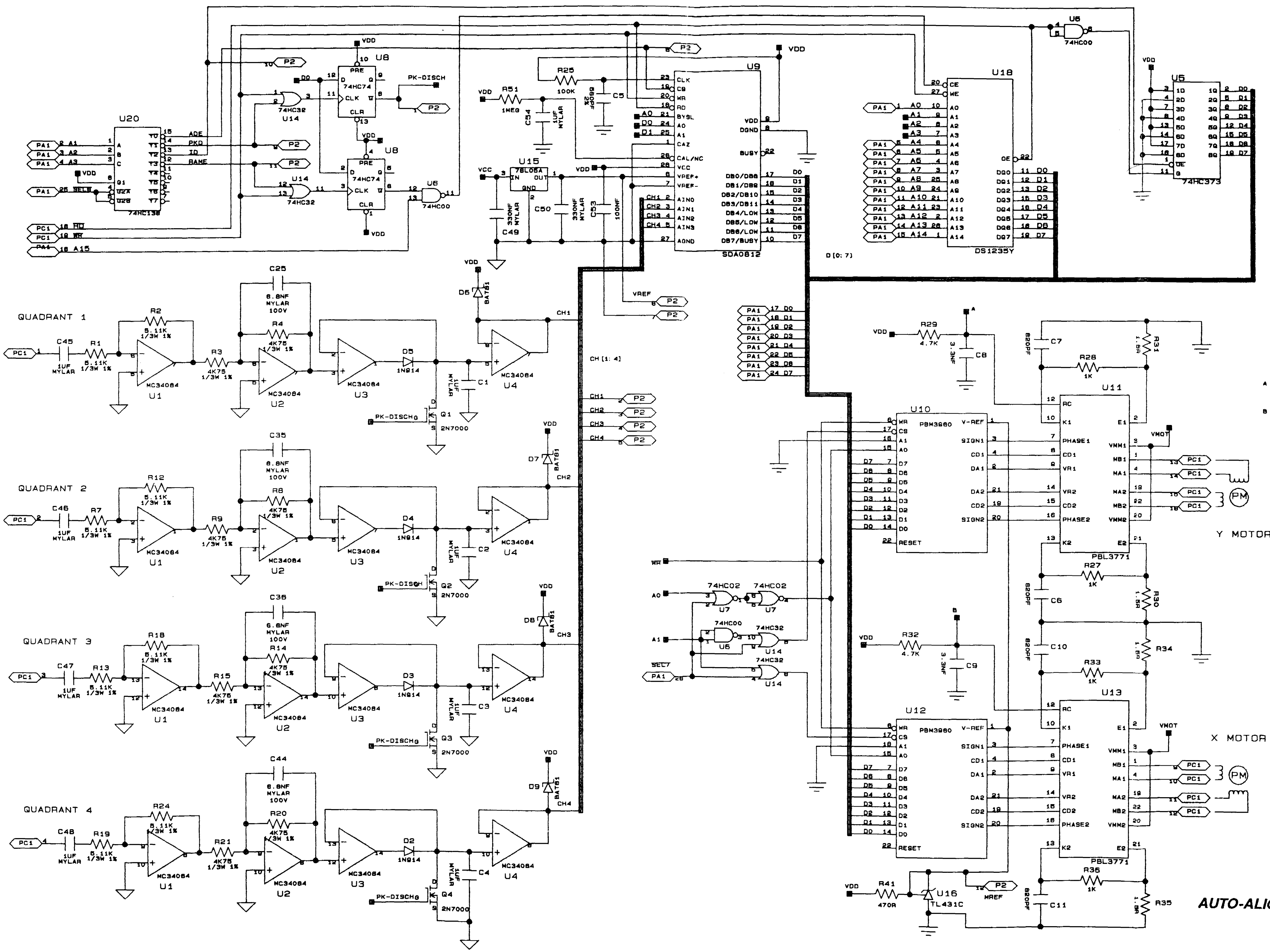

NOTES:

1) U8 IS RESERVED FOR FUTURE USE.

2) R8 AND R6 MAY OR MAY NOT BE USED.

FIGURE 23-5.

AUTO-ALIGN Control Board Schematic (Sheet 1 of 2)

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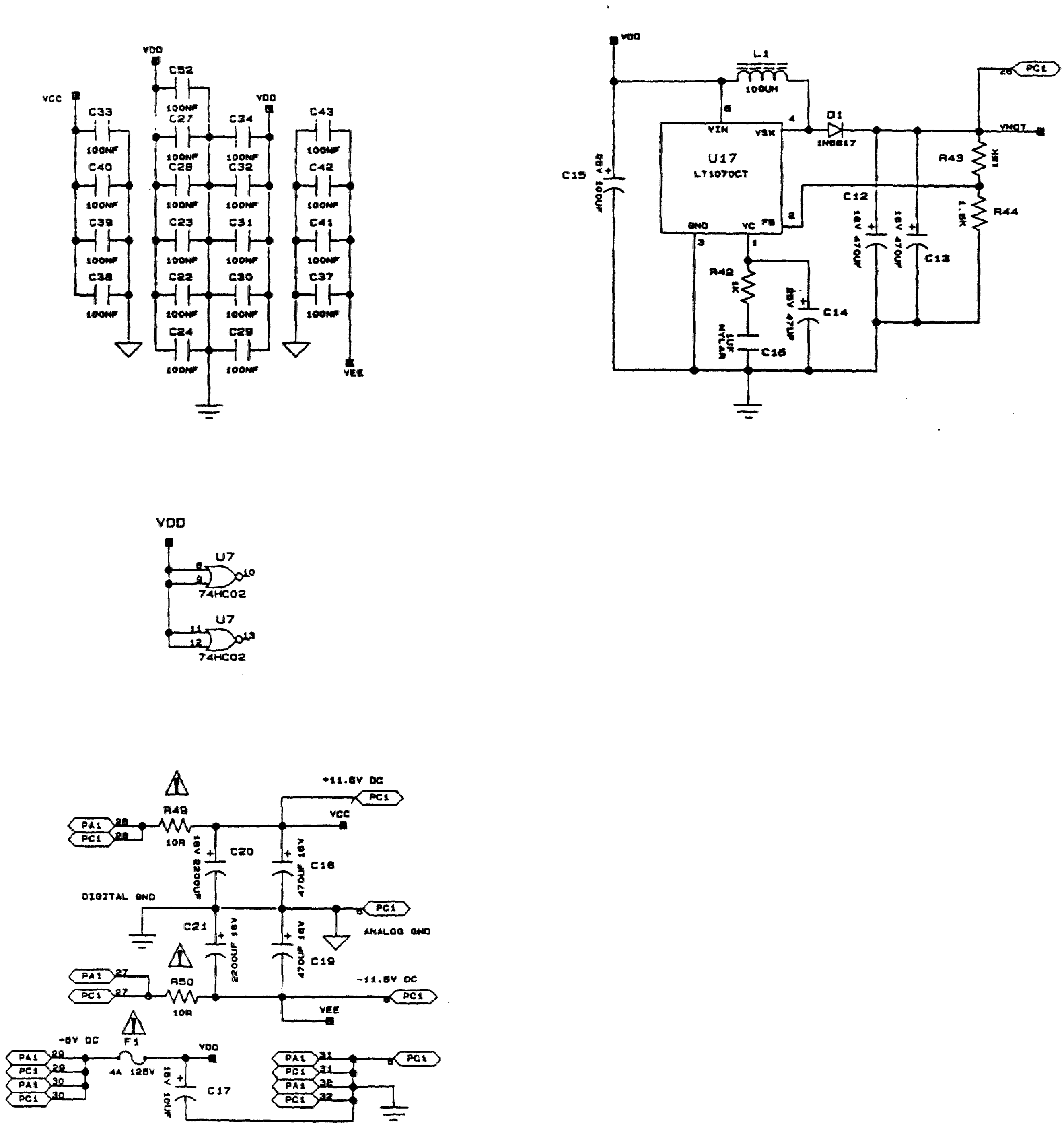

FIGURE 24–6.
ACON Control Board Schematic (Sheet 2 of 2)

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AUTO-ALIGN (Automatic Convergence Option)
MODULE SERVICING 23-11

23.4 PARTS LIST

⚠ - CRITICAL SAFETY COMPONENT
(REPLACE WITH IDENTICAL PART)

Item Ref.	Part No.	Description
Integrated Circuits		
U1	IC-14-A03042-01P	SDA0812, 12-bit A/D converter
U2	IC-14-A04010-01P	74HC373, H-CMOS transparent octal latch
U3	IC-14-A04045-01P	74HC138, demultiplexer
U4	IC-14-A04001-01P	74HC00, quad 2-input NAND gate
U5,U9	IC-14-A04007-01P	74HC74, H-CMOS dual flip-flop
U6	IC-14-A04005-01P	74HC32, quad 2-input OR gate
U7,U12	IC-14-002833-01P	TL431C, precision shunt regulator
U8,U13,U17	IC-14-002164-01P	MC34084, op amp
U10,U11	IC-14-A03043-01P	PBM3960, dual D/A converter
U14	IC-14-A04069-01P	TLC555C, CMOS digital timer
U15,U16	IC-14-A03044-01P	PBL3771, precision stepper motor drive
U18	IC-14-002847-01P	LT1070CT, regulator, high eff. switch
Transistors and Diodes		
Q1	TR-14-000873-82P	2N3906, PNP, small signal
Q2,Q3,Q6,Q7	TR-14-000720-13P	TIS74, FET, 30V, 0.05A, 0.36W
Q4,Q8-Q11	TR-14-A00705-01P	2N7000, TMOS, 60V, 0.2A, 4W
D1,D8,D9,D10,D13,D14, D16,D17	D-14-000513-01P	1N914, diode, 0.075A, 75V
D2-D7,D11,D12	D-14-000513-13P	BAS45, diode, low leakage
D15	D-14-000533-03P	1N5819, rectifier, shottky, 40V, 1A
Capacitors		
C1,C2,C5,C6,C8,C9, C11,C14,C19-C21,C29, C39,C42	C-89-000032-03P	100 nF, 50V, 20%, ceramic, multi layer
C4	C-88-171053-12P	1 • F, 50V, mylar
C7,C52,C54	C-84-80HD04-01P	10 • F, 25V, electolytic
C10,C12,C13,C15, C37,C38,C40,C41	C-89-000032-09P	4.7 nF, 50V, 20% Z5U, ceramic, multi layer
C22,C23,C27,C28	C-89-000033-02P	1.0 nF, 50V, 1%, ceramic, multi layer
C24,C26,C30,C32,C3	C-86-682151-02P	820 pF, 100V, Y5P
C25	C-89-000033-05P	3.9 nF, 1%, NPO, ceramic, multi layer
C31	C-84-000210-05P	47 • F, 10V, non-polar mini, electolytic
C43,C44,C51	C-49-000020-02P	470 µF, 25V, low ESR electrolytic
C45,C48	C-44-447103-06P	470 µF, 16V, electrolytic
C46,C47,C49,C50	C-88-172240-12P	220 nF, 63V, 10%, mylar
C53	C-84-210145-01P	10 µF, 16V, electolytic

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23.4 PARTS LIST (cont.)

⚠ - CRITICAL SAFETY COMPONENT
(REPLACE WITH IDENTICAL PART)

	Item Ref.	Part No.	Description
	Resistors		
	R1,R8,R13,R40,R43, R46,R49	R-80-110025-11P	10K, 1/2W, 5%, metal film
	R2	R-80-110045-11P	1M, 1/2W, 5%, metal film
	R3	R-80-110035-11P	100K, 1/2W, 5%, metal film
	R4,R9,R20,R53,R55, R58,R60	R-80-147015-11P	4.7K, 1/2W, 5%, metal film
	R5,R21,R62	R-80-182005-11P	820R, 1/2W, 5%, metal film
	R6,R10,R11,R14,R15, R24-R27	R-80-147005-11P	470R, 1/2W, 5%, metal film
	R7,R12,R29-R32,R38, R39,R44,R51,R65	R-80-110015-11P	1K, 1/2W, 5%, metal film
	R16,R28,R64	R-80-112025-11P	12K, 1/2W, 5%, metal film
	R18	R-80-122095-11P	22R, 1/2W, 5%, metal film
	R22,R33,R41,R42,R47, R48,R52,R54,R59,R61	R-80-122025-11P	22K, 1/2W, 5%, metal film
	R34-R37	R-80-115085-11P	1.5R, 1/2W, 5%, metal film
	R63	R-80-133015-11P	3.3K, 1/2W, 5%, metal film
⚠	**R66,R67**	**R-80-110095-11P**	**10R, 1/2W, 5%, metal film**
	Coils and Transformers		
	L1	L-21-001459-01P	100 μH choke
	Miscellaneous		
⚠	**F1**	**F-27-000034-05P**	**fuse, 3A, 125V, mini**

23.5 SYSTEM SPECIFICATIONS

23.5.1 Functional

Projector Models .... VPF 40HD/80HD
Screen Sizes .... 5' to 25'
Screen Types .... flat, curved and rear
Convergence Zones .... 9 horizontal by 5 vertical
Convergence Accuracy .... .05% of screen width
Ambient Light Rejection .... up to 5 foot-lamberts at screen surface
Convergence Time (typical) .... <3 minutes

Operating Power (from projector)
+5V .... +5 VDC @ 1.5A
+12V .... +12 VDC @ 150mA
-12V .... -12 VDC @ 100mA

Operating Environment
Temperature .... 32 to 95°F (0 to 35°C)
Humidity .... 0 to 90% NC
Altitude .... 0 to 10,000 ft (0 to 3000m)

Storage Environment
Temperature .... -22 to 149°F (-30 to 65°C)
Humidity .... 0 to 90% NC

23.5.2 Mechanical/Electrical

Control Board

Data Acquisition Circuits
Number of channels 4
A/D Conversion Accuracy .... 12 bits
Input Voltage Range .... 0 to +5V
Gain Matching between Channels .... ±5%

Motor Control Circuitry
Number of Driver Circuits 2
Control Method .... micro-stepping
Output Current/Phase .... 650mA maximum
Drive method .... switch-mode constant current

Locator Assembly

Imaging System
Lens type .... single acrylic plano-convex
Sensor type .... photodiode array
Lens Aperture .... 47mm (1.85")
Focal Length .... 53mm (2.1")
Focus .... fixed
Quadrant Sensor Field of View .... 3°x3°

Lens/Sensor Component
Degrees of Freedom .... 2, rotational, orthogonal
Motive Force .... stepper motors, direct drive
Configuration
Motor A .... azimuth, driving optical system
Motor B .... altitude, driving motor A assembly
Sweep Angles
Motor A .... 80° minimum
Motor B .... 120° minimum

Motor Specifications
Type .... hybrid stepper
Step Angle .... 0.9° (400s/r)
Drive .... 2 phase, bipolar
Phase Voltage (typical) 14VDC
Current/Phase .... 300mA maximum
Resistance/Phase .... 20 ohms
Inductance/Phase 5mH

Size .... 13x15x10cm (5x6x4")

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NOTES