SECTION 22

WAVEFORM MODULE

SUB-SECTIONS

ILLUSTRATIONS

TABLES

SECTION 22

WAVEFORM MODULE

22.1 TECHNICAL DESCRIPTION

22.1.1 General Description

The Waveform Module forms part of the video circuitry. It's main function is to provide the necessary gain control voltages to the Video Control module. It also provides geometry correction waveform signals to the Keystone, Power Deflection and Bias modules.

22.1.2 Circuit Description

22.1.2.1 Address/Data De-multiplexing

The Waveform module receives data via address and data buses from the Remote Control Module. The data and 8 least-significant address bits use lines AD(0) to AD(7). They are de-multiplexed by IC10 and IC22. The 8 most significant address bits use lines A(8) to A(15) and are latched by IC16, a 74HC373 transparent latch. The latch functions only when enabled; when disabled, it allows the flow of addresses.

The ALE signal from the Remote Control module goes high when the address is valid. This enables latches IC10 and IC16. IC22, a 74HC245 bi-directional buffer, allows data transfer only when RD or WR is low, i.e., when data is present on AD(0) to AD(7).

22.1.2.2 Address Decoding

IC5, a 74HC138, 3-to-8 line decoder, performs address decoding. IC5's binary select inputs A, B and C are tied to A(10), A(11) and A(12) respectively. This divides the 8K byte address space into eight 1K byte spaces. References to addresses in one of these 8 ranges cause the corresponding SEL line to go low for the duration of the RD or WR strobe. Address decoding is summarized in Table 22-1.

22.1.2.3 Programmable Blanking Generation

The Waveform module generates two types of blanking -- vertical blanking (top and bottom) and full screen RGB blanking.

Vertical Blanking.
IC26 (a 74HC74 flip-flop), IC27 (a 74HC688 digital comparator), IC28 and IC34 (74HC373 latches) and IC33 (a 74HC688 digital comparator) generate the vertical blanking waveform. SEL3 and SEL4 enable IC28 and IC34 respectively.

The microprocessor loads IC28 and IC34 with 8-bit values, representing the top and bottom positions of the un-blanked raster. IC20 (a 74HC590 vertical counter) provides an ascending 8-bit count. IC27 and IC33 compare this value to the values in latches IC28 and IC34. The comparators control the state of IC26, producing the desired vertical blanking waveform.

TABLE 22-1. ***Address Decoding***

I/O	ADDRESS	MODULE	FUNCTION
SEL0	6000 TO 63FF	CONVERGENCE	RAM BANK SELECT
SEL1	6400 TO 64FF	VIDEO CONTROL	VIDEO RAM ADDRESSING
SEL2	6800 TO 6BFF	VIDEO CONTROL	MODE CONTROL SIGNALS
SEL3	6C00 TO 6FFF	WAVEFORM	TOP VERTICAL BLANKING
SEL4	7000 TO 73FF	WAVEFORM	BOTTOM VERTICAL BLANKING
SEL5	7400 TO 77FF	WAVEFORM	RGB BLANKING
SEL6	7800 TO 7BFF	SPARE	ACON
SEL7	7C00 TO 7FFF	SPARE	ACON

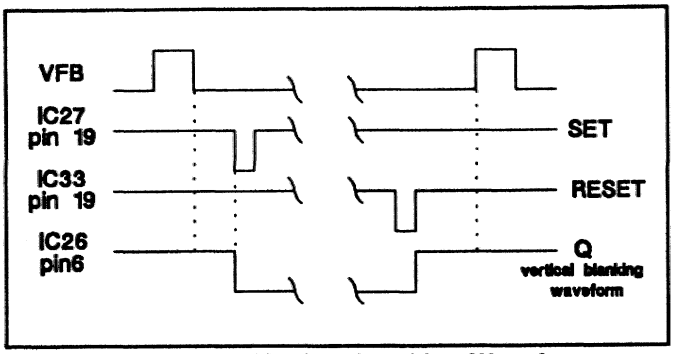

FIGURE 22-1. *Vertical Blanking Waveforms*

RGB Blanking

The red, green and blue drive levels can be blanked individually. SEL5 latches data bits D0, D1 and D2 to IC9 (a 74HC175 quad flip-flop). IC9's outputs are ORed with the composite blanking waveform. The resulting signals feed the A, B and C SELECT lines of IC3 (a 74HC4053 triple 2-input analog multiplexer). A high on SELECT A blanks red, a high on SELECT B blanks green, and a high on SELECT C blanks blue.

22.1.2.4 Drive Level Control

Drive levels derive from the CONTRAST voltage. The CONTRAST voltage is limited to a safe level by the BEAM LIMIT line. Trimpots R1, R2 and R3 adjust the red, green and blue drive levels respectively.

22.1.2.5 Waveform Generation

The Waveform module generates horizontal and vertical rate geometry correction waveforms. Counter IC2 is clocked by HPLLCLK (256 counts per active line) and reset by HRESET (during horizontal retrace). It sends an 8-bit address to IC7 (a 256 x 8 bit PROM, programmed to define a $y=x^2$ parabola) which feeds IC17.

The REVERSE SCAN signal, from the Remote Control module, selects either a normally ascending count from IC2 or a descending count for reverse scan applications.

IC20 (a 74HC590 counter) is clocked by VPLLCLK and reset by VRESET (during vertical retrace). It sends an 8-bit ascending address to IC15 (a TBP28L22 PROM, programmed to define a $y=x^2$ parabola). IC15 feeds IC13 (multiplying digital-to-analog converter) to produce vertical dynamic focus. The address, without data, feeds IC25 (multiplying digital-to-analog converter) to produce keystone (a sawtooth waveform).

22.1.2.6 Dynamic Focus

Trimpot R48 sets the size of the horizontal rate parabola produced by IC17. Trimpot R17 sets the size of the vertical rate parabola produced by IC13. Op-amp IC12 adds the two parabolas together and outputs them as a composite signal -- DYNAMIC FOCUS.

22.1.2.7 Pincushion PCB

The Pincushion PCB is piggyback mounted to the Waveform module via connector. The circuitry consists of a vertical section that provides modulation for top and bottom pincushion and bow centering, and a horizontal section that generates the parabola needed to correct each line for pincushion. See Figure 22-3, *Pincushion Waveform and Function Diagram.*

Vertical Section

The prime functions of the vertical section are:

1) generation of a constant amplitude ramp whose frequency tracks VFB

2) algebraic manipulation of the d.c. control voltages (TOP PIN DC, BOT PIN DC, BOW DC) and the ramp (TOP PIN RAMP, BOT PIN RAMP)

Ramp Generation. IC4B generates a square wave pulse output whose period is equal to that of VFB. The duration of this pulse is fixed at 4 milliseconds from the rising edge of VFB. R24 and C2 form a frequency to voltage converter. They integrate the output of IC4B to provide a voltage proportional to the frequency of VFB.

IC9C and associated components add gain and improve integration. The voltage appearing at pin 8 of IC9C is -1.8 V at 40 Hz and -5.4 V at 120 Hz. R23 carries a current of 11 mA at 40 Hz and 34 mA at 120 Hz. The current charges C14 and generates a constant peak amplitude voltage ramp at pin 7 of IC2B. Q1 discharges C14 during the VFB pulse. C1 AC-couples the ramp and IC2A, with associated circuitry, rectifies it. The precision rectifiers output 2.6V half period ramps. The positive ramp is TOP PIN RAMP. The negative ramp is BOT PIN RAMP. Their respective peaks represent the top and bottom of the image.

Vertical Modulation. Vertical modulation is provided by IC13A, IC13B, IC2D, IC9D, IC1, IC13 and associated components. Vertical modulation is based on the equation:

0.086 x [(BOT PIN RAMP x BOT PIN DC)
+ (BOT PIN RAMP x BOW DC)
- (TOP PIN RAMP x TOP PIN DC)
- (TOP PIN RAMP x BOW DC)
+ (2.6 x BOW DC)]

BOW DC controls the image at center (BOT PIN RAMP = TOP PIN RAMP = 0V). At the top and bottom of the image (TOP PIN RAMP = +2.6V and BOT PIN RAMP = -2.6V) the BOW DC terms cancel. Top and bottom pincushion and center bow are adjusted independent of each other.

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Horizontal Section

The horizontal section is responsible for generating the horizontal ramp and horizontal parabola. The horizontal section operates over the range of 15 KHz to 80 KHz.

Horizontal Ramp. IC4A, IC14 and associated components produce a voltage ramp. The voltage appearing at pin 7 of IC14 is -1V at 15.75 kHz and -3.1V at 50 kHz. R55 carries a current of 56 mA at 15.75KHz and 174 mA at 80KHz. The current charges C34 and generates a 3.4V 0-peak voltage ramp (H.RAMP) at pin 1 of IC14. In a similar manner, a 3.0V 0-peak ramp is generated at pin 8 of IC14. IC11A produces a 600 nanosecond pulse referenced to the falling edge of HFB. See Figure 22-2. The pulse turns on Q3, discharging C32. Resistors R72, R73, R74, R81 and R78 produce a reference voltage proportional to frequency plus a constant (V_{ref}=kf+c). The ramp drives the output of comparator IC16 high when ramp voltage is less than the reference voltage on pin 2 of IC16. The square wave at pin 7 of IC16 can be used to trigger IC11 to output a 600 nanosecond pulse which resets H. RAMP.

H. RAMP is squared after it is applied to the IC15 input. The new ramp is averaged and the result is applied to the offset of the multiplier, resulting in H PAR at pin 14 of IC14.

Modulation. VERT. MODULATION and H PAR are multiplied by IC17, IC9B and associated components. Output voltage is +6V maximum and -6V minimum.

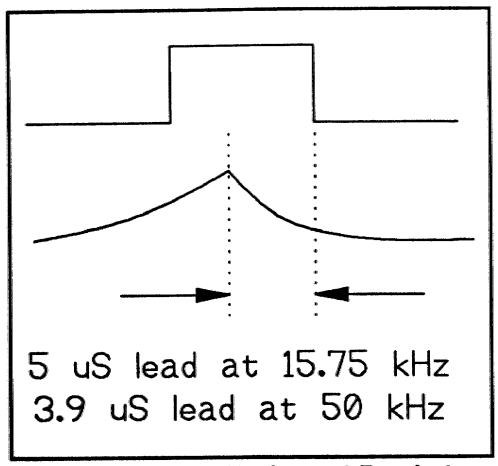

FIGURE 22-2. ***Horizontal Parabola***

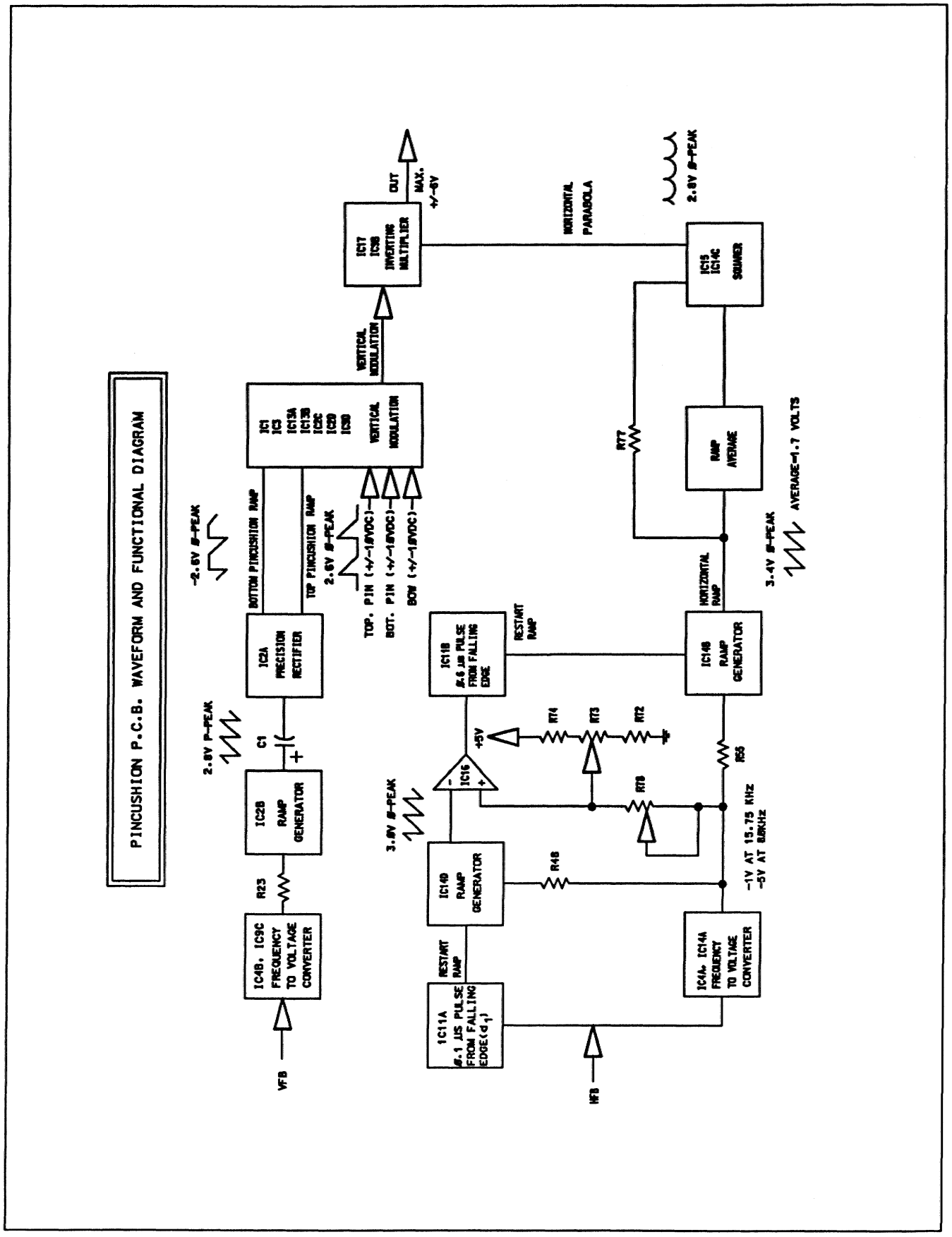

FIGURE 22-3. *Pincushion Waveform and Function Diagram*

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22.2 SERVICING AND ALIGNMENT

22.2.1 Disassembly and Access

CAUTION

STATIC SENSITIVE COMPONENTS
STATIC CONTROLLED WORK STATION REQUIRED

Module Location:
▸ rear panel card rack

Tools & Equipment Required:
▸ Phillips screw driver

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

b) Locate the Waveform Module in the rear panel card rack. Using the printed circuit board extractor from the tool pouch, pull the module from the card rack as described in Section 5.

NOTE: To remove the Pincushion PCB from the Waveform PCB, refer to Figure 22-4.

22.2.2 Alignment

This section contains full set-up procedures for the Waveform Module.

NOTE: Optical and electronic focusing must be performed before this procedure.

Reference Figure 22-4.

Tools & Equipment Required:
- printed circuit board extractor
- extender board, Vidikron Part # A-03-230330-01P
- fine tip slot screwdriver
- oscilloscope
- video source (15.7 KHz horizontal, 45.0 Hz vertical)

STEP 1 - Remove projector top covers

STEP 2 - Remove Waveform Module

a) Pull the module out of its slot. Insert the extender board into the Waveform module slot. Connect the Waveform module to the extender board.

STEP 3 - Horizontal Dynamic Focus

a) Press # on the keypad. This produces a crosshatch pattern on the screen.

b) Connect the oscilloscope to TP6 on the Bias module.

c) Adjust R48 until a 250V horizontal parabola is produced.

STEP 4 - Vertical Dynamic Focus

a) Press # on the keypad. Adjust R17 until a 360 V p-p parabola is produced (250V horizontal plus 110V vertical components).

STEP 5 - Verify Dynamic Focus

a) Electrically de-focus the projector until the crosshatch lines are thick. Observe the thickness of a horizontal line across center and a vertical line across center. The horizontal line should be equal thickness from left through center to right. If it is not, adjust R48.

b) The vertical line should be equal thickness from top through center to bottom. If it is not, adjust R17.

STEP 6 - Keystone Offset

a) Connect an oscilloscope probe to row B, pin 14 on the extender board (KEY WFM). Press KEY on the keypad. Press the U or D arrow key until KEY WFM is zero.

b) Adjust R61 until KEY WFM reads 0 volts.

STEP 7 - Keystone Amplitude

a) Connect the video source to the projector. Set source horizontal rate to 15.7 KHz and vertical rate to 45.0 Hz.

b) Press KEY on the keypad. Press the U key for maximum keystone.

c) Adjust R51 until either a) distortion or jitter appears on the image, or b) image sides appear straight when the projection angle is 15°.

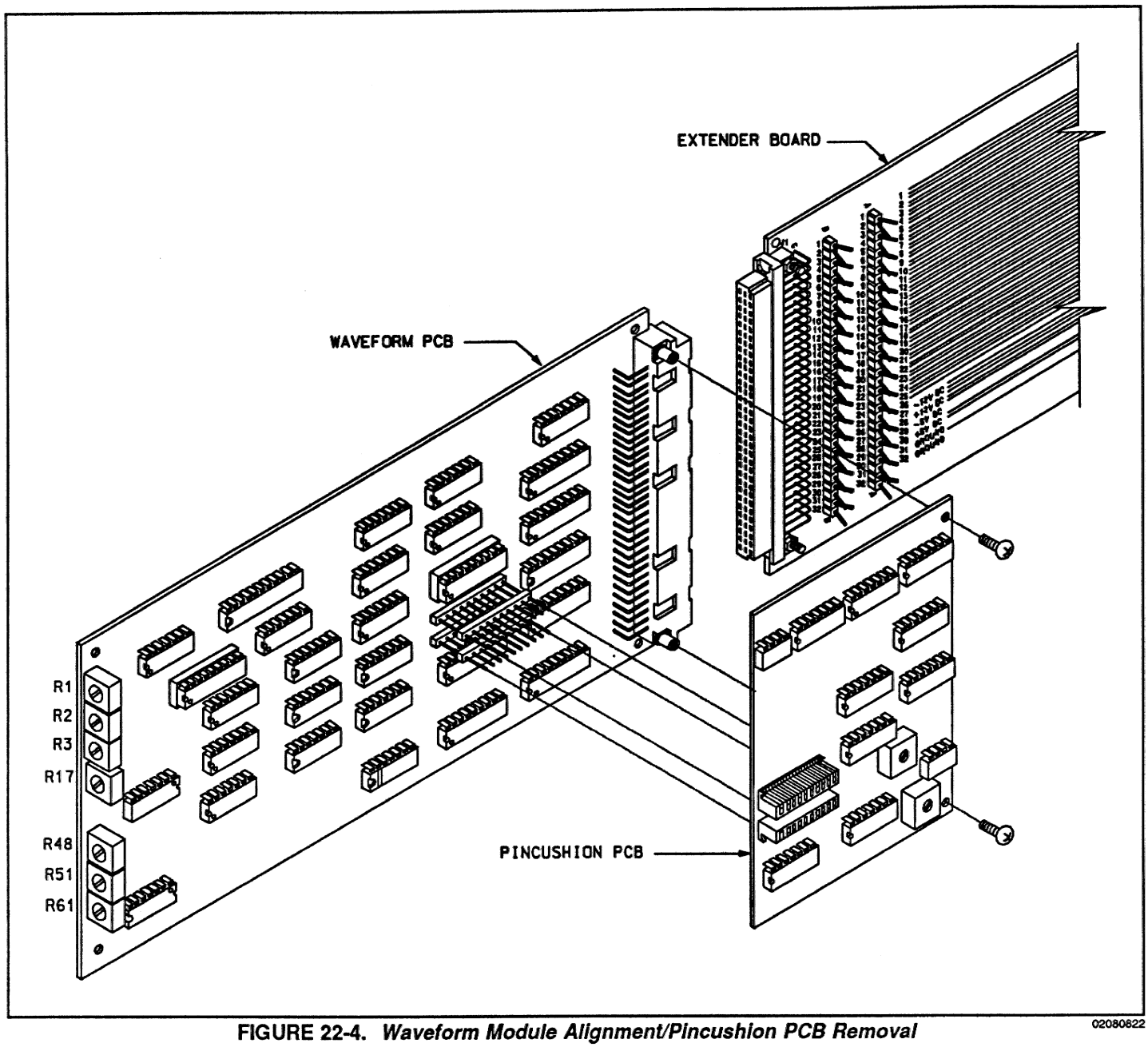

FIGURE 22-4. *Waveform Module Alignment/Pincushion PCB Removal*

22.3 COMPONENT LAYOUT AND SCHEMATICS

Refer to the following pages for component layouts and schematics of the Waveform module.

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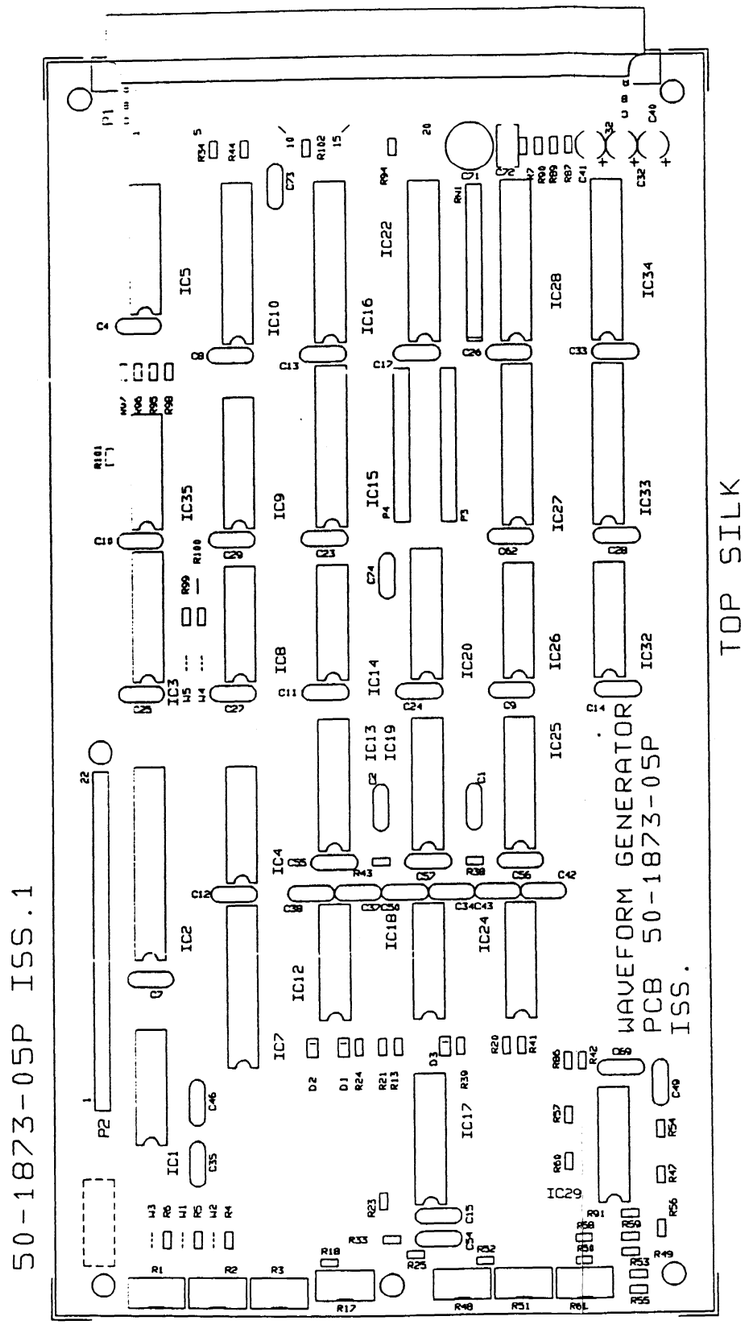
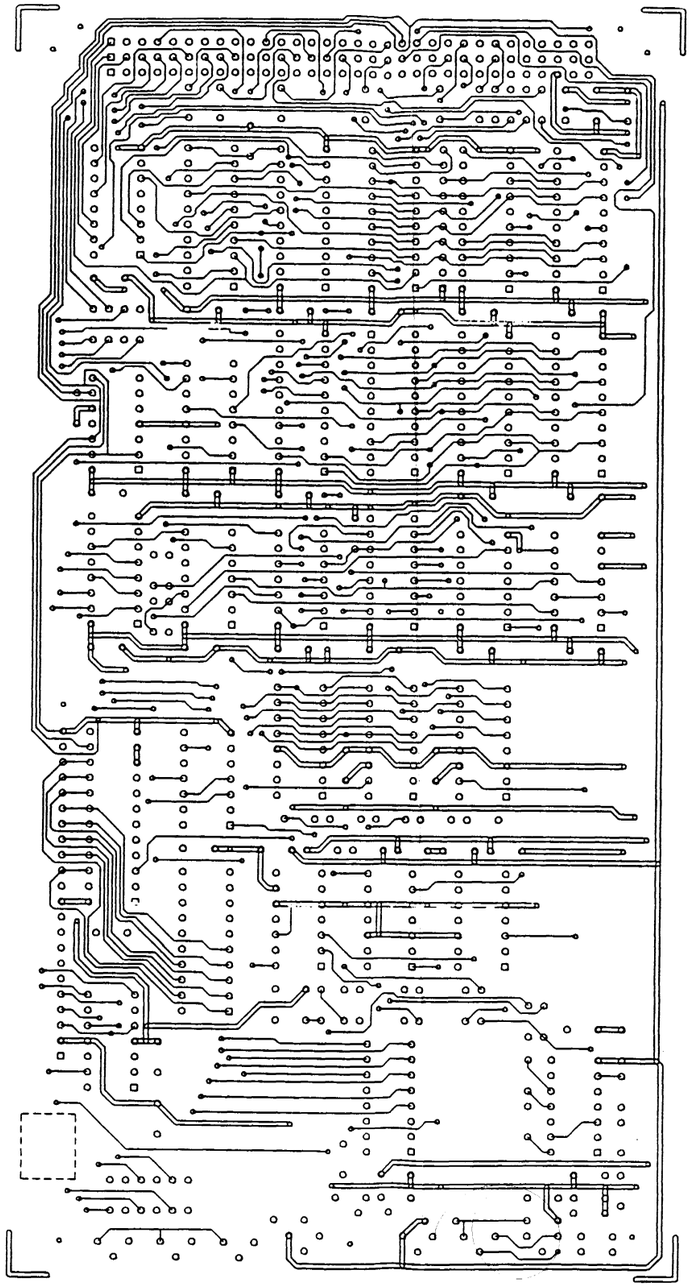
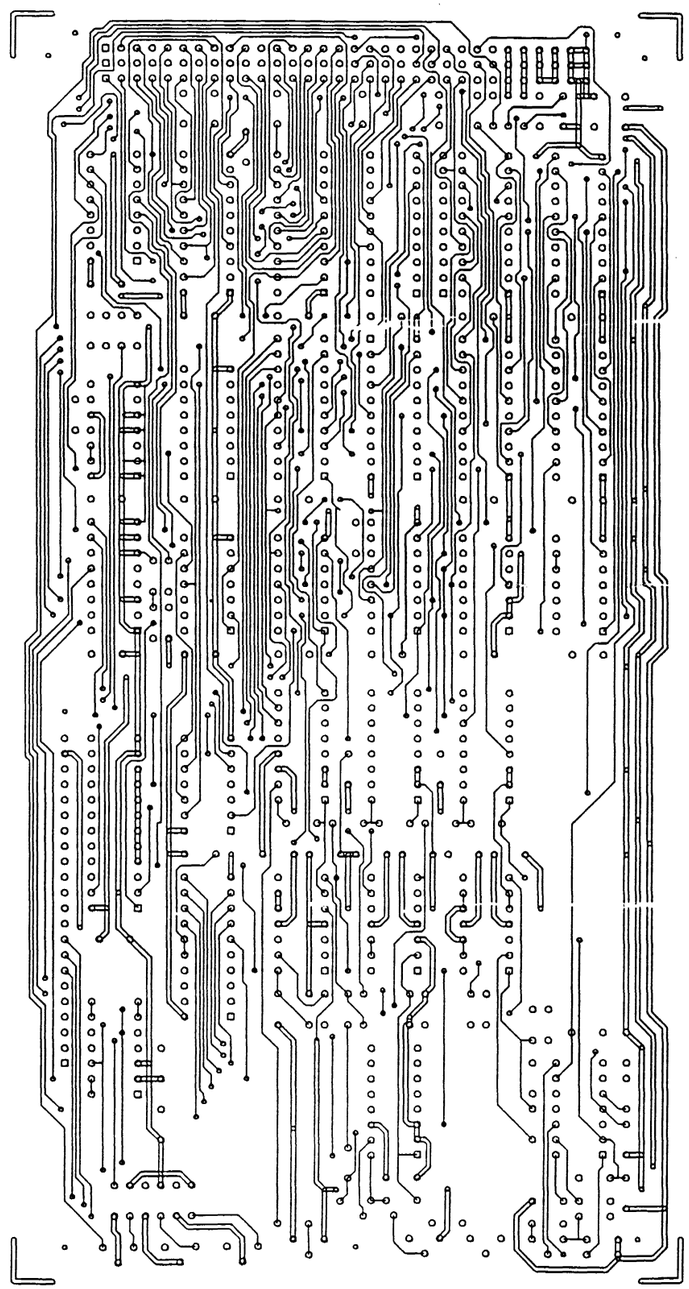


Component Layout



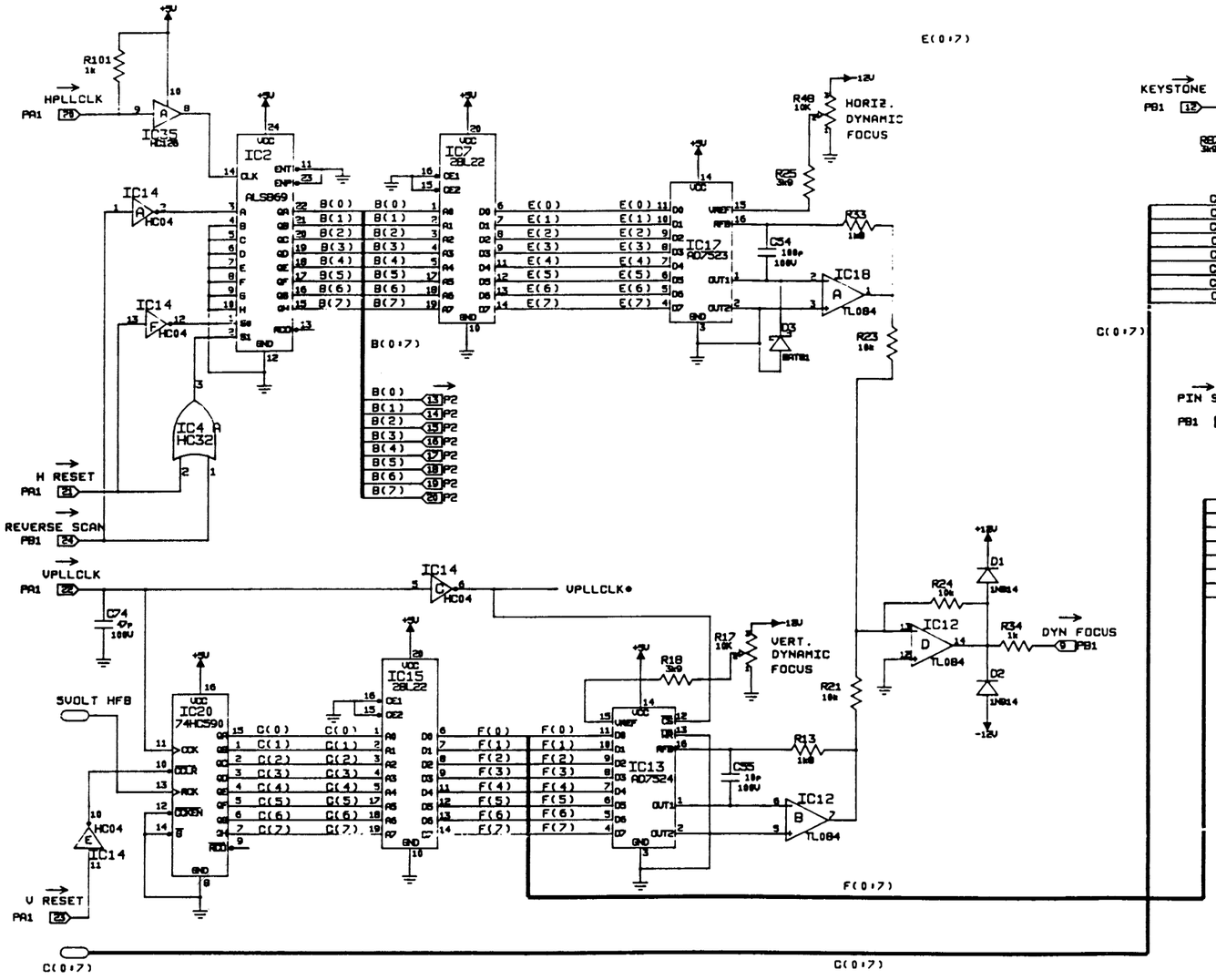
Solder Side
(Viewed from Component Side)

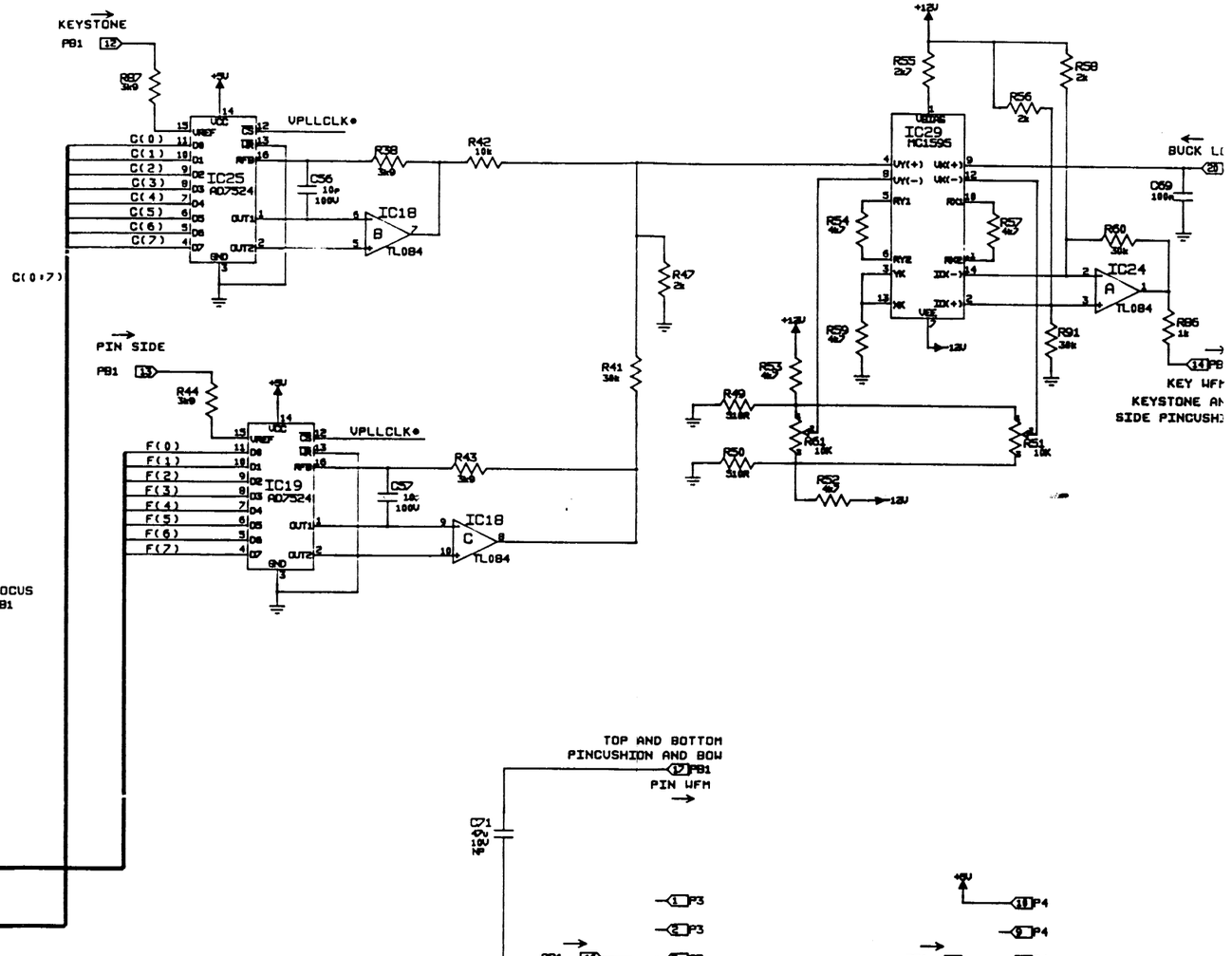


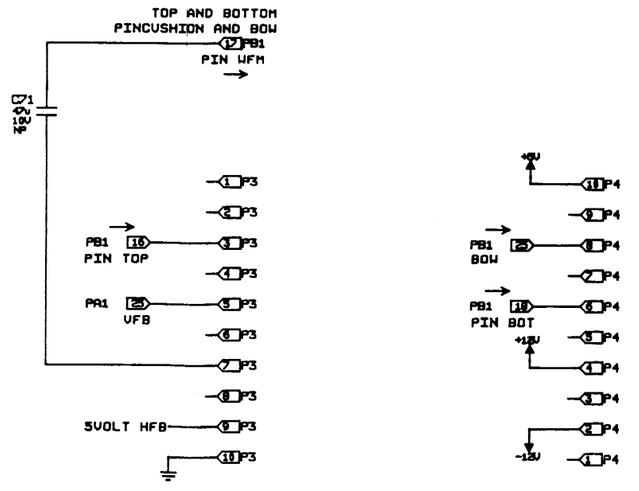
Component Side

FIGURE 22-5. *Waveform Module Component Layout*

54-7598-01P







IMPLICIT POWER CONNECTIONS							
IC#	NAME	PIN#	POWER		PIN#	POWER	
IC1	TL084	4		+12V	11		-12V
IC4	74HC32	14	VCC	+5V	7		GND
IC8	74HC32	14	VCC	+5V	7		GND
IC12	TL084	4		+12V	11		-12V
IC14	74HC04	14	VCC	+5V	7		GND
IC18	TL084	4		+12V	11		-12V
IC24	TL084	4		+12V	11		-12V
IC26	74HC74	14	VCC	+5V	7		GND
IC32	74HC08	14	VCC	+5V	7		GND

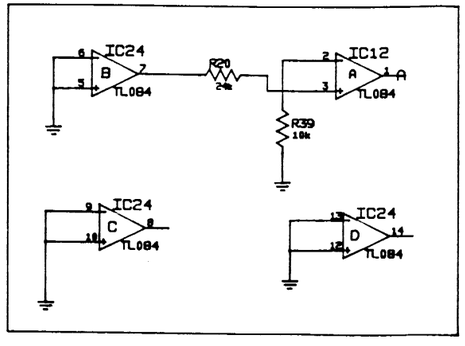
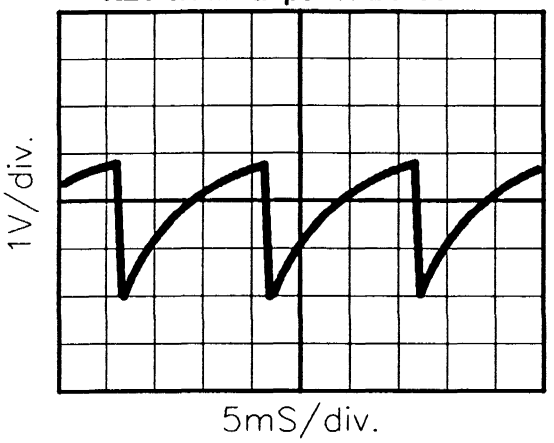


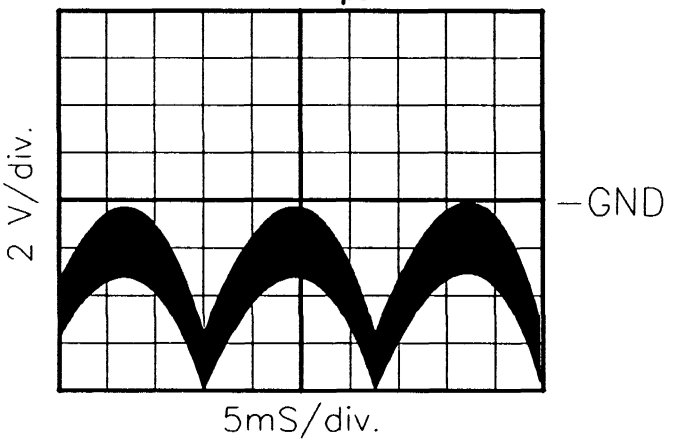
FIGURE 22-6. *Waveform Module Schematic (1 of 2)*
00-270001-01P

SCHEMATIC REFERENCE

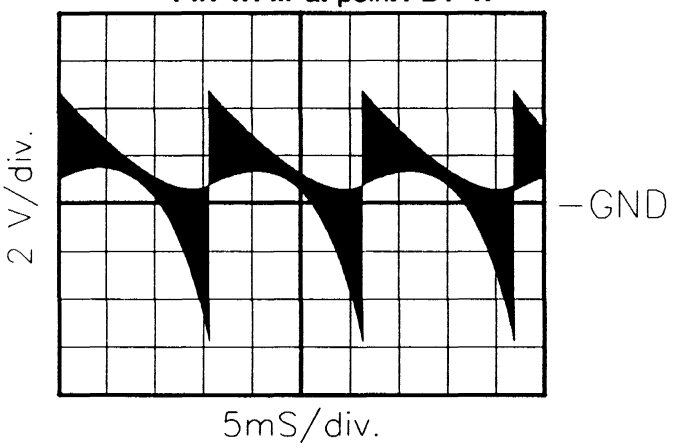
KEY WFM at point **PB1<14**



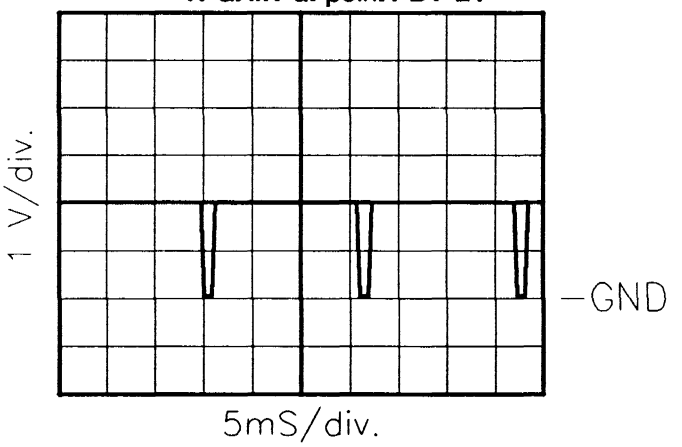
KEY WFM at point **PB1<14**



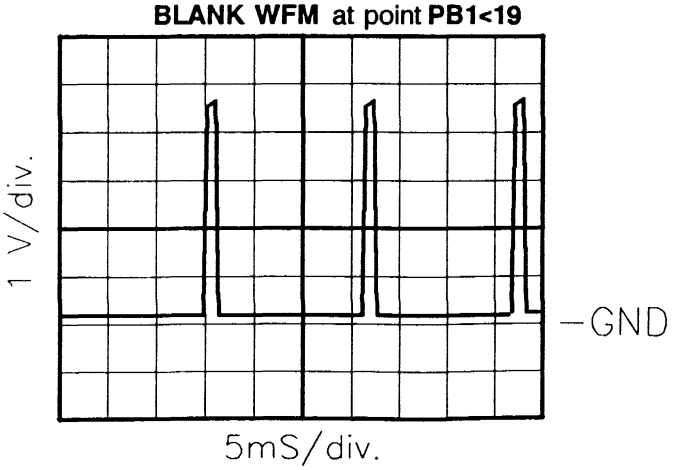
PIN WFM at point **PB1<17**



R GAIN at point **PB1<21**



BLANK WFM at point **PB1<19**



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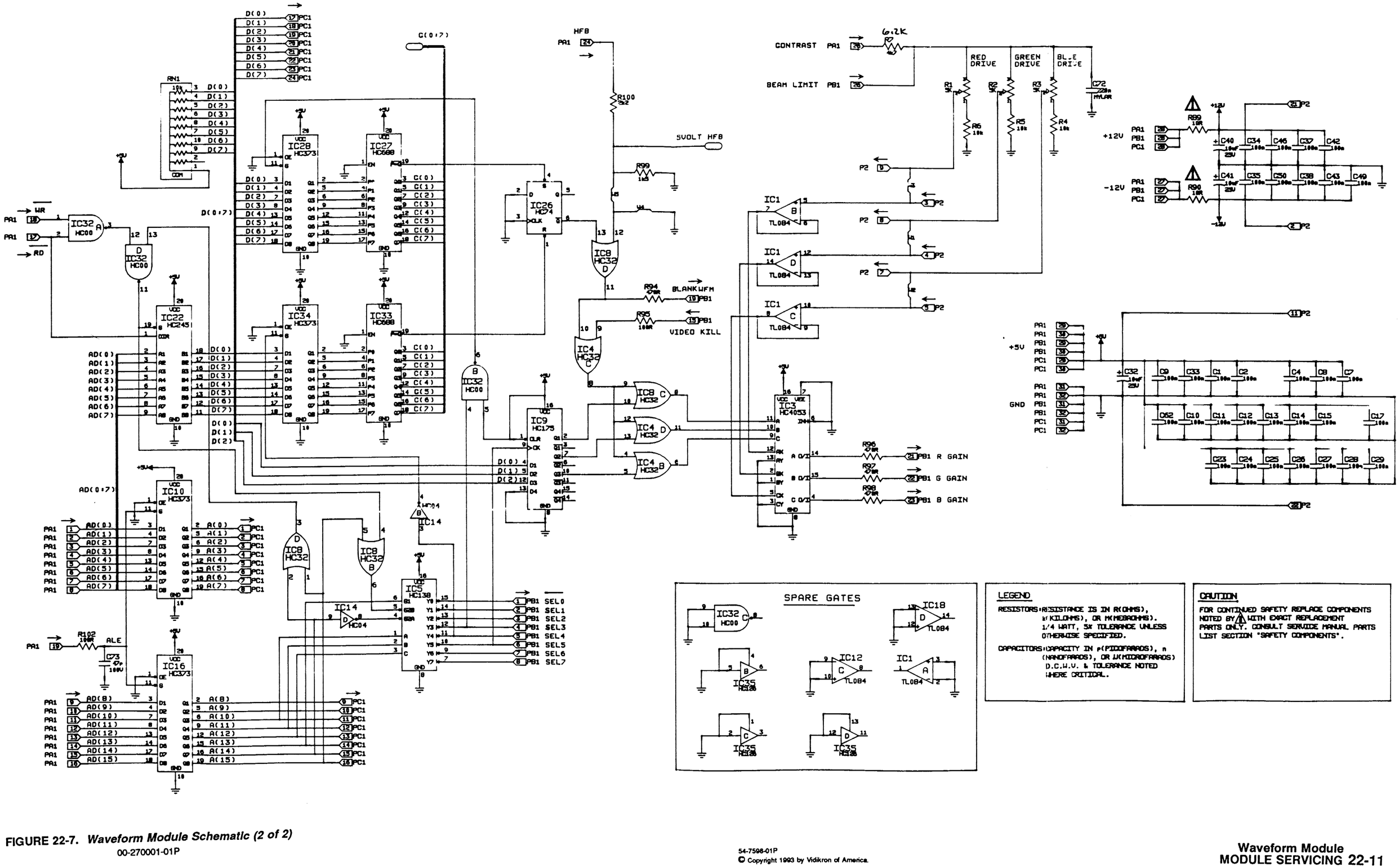
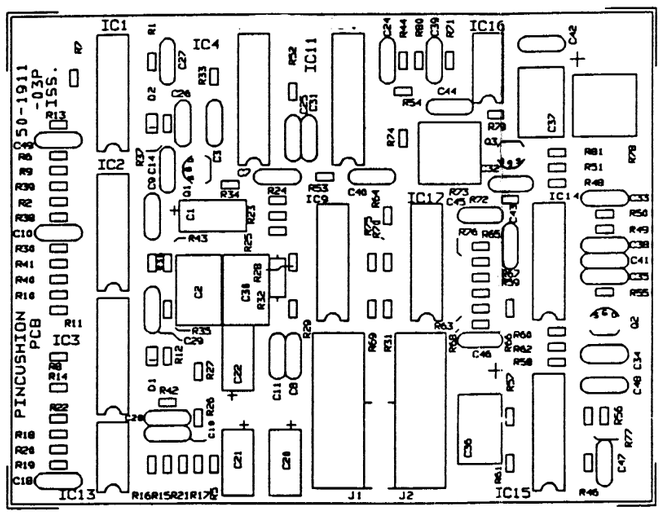
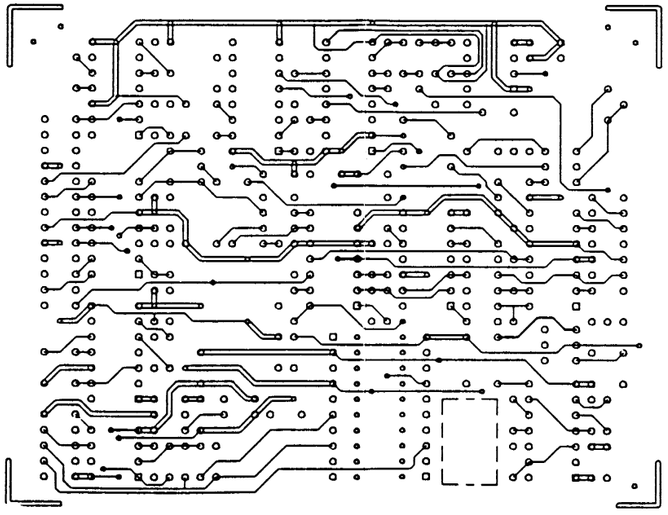


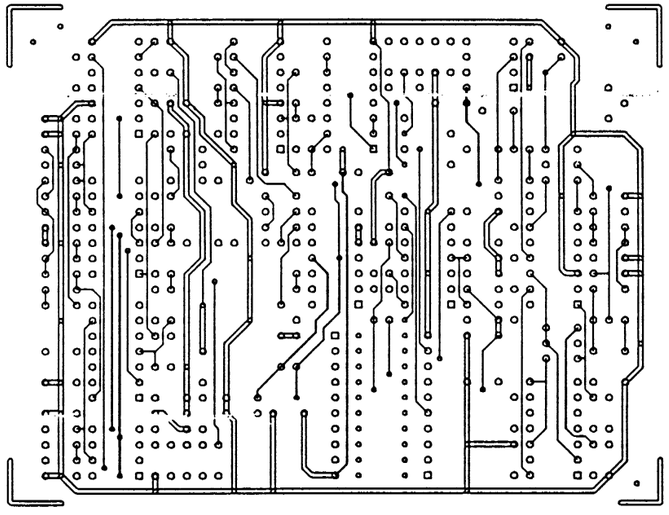
FIGURE 22-7. *Waveform Module Schematic (2 of 2)*
00-270001-01P



Component Layout



Solder Side
(Viewed from Component Side)



Component Side

FIGURE 22-8.
Pincushion PCB Component Layout

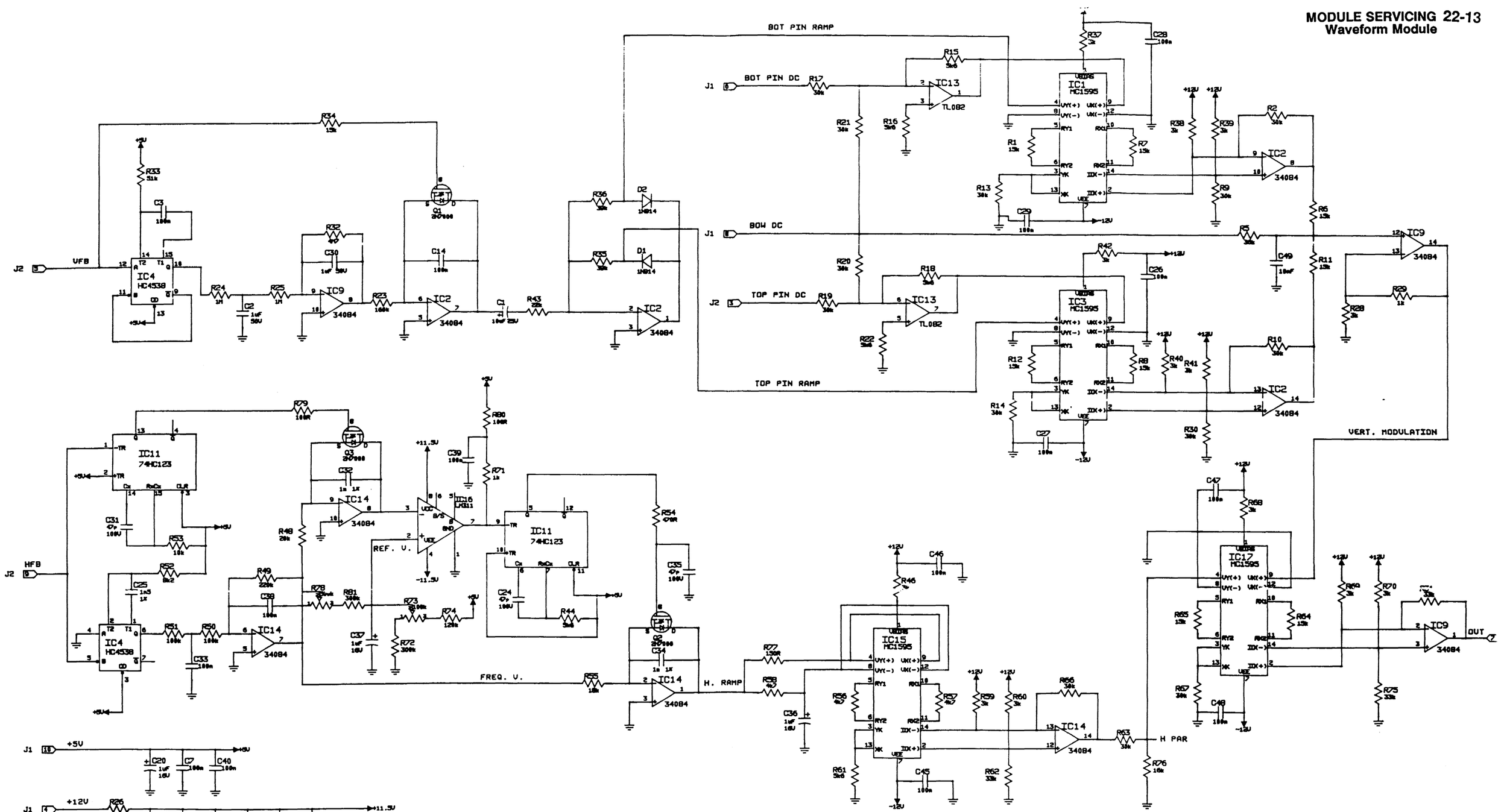
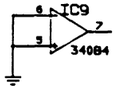


FIGURE 12-9.
Pincushion PCB Schematic

SPARE GATES ETC.



LEGEND

RESISTORS: RESISTANCE IS IN R(OHMS), k(KILOHMS), OR M(MEGAOHMS). 1/2 WATT, 5% TOLERANCE UNLESS OTHERWISE SPECIFIED.

CAPACITORS: CAPACITY IN p(PICOFARADS), n(NANOFARADS), OR μ(MICROFARADS) D.C.W.V. & TOLERANCE NOTED WHERE CRITICAL.

IMPLICIT POWER CONNECTIONS

IC#	NAME	PIN#	POWER	PIN#	POWER
2	MC34084	4	+11.5V	11	-11.5V
4	74HC4538	16	+5V	8	GND
9	MC34084	4	+11.5V	11	-11.5V
11	74HC123	16	+5V	8	GND
13	TL082	8	+11.5V	4	-11.5V
14	MC34084	4	+11.5V	11	-11.5V

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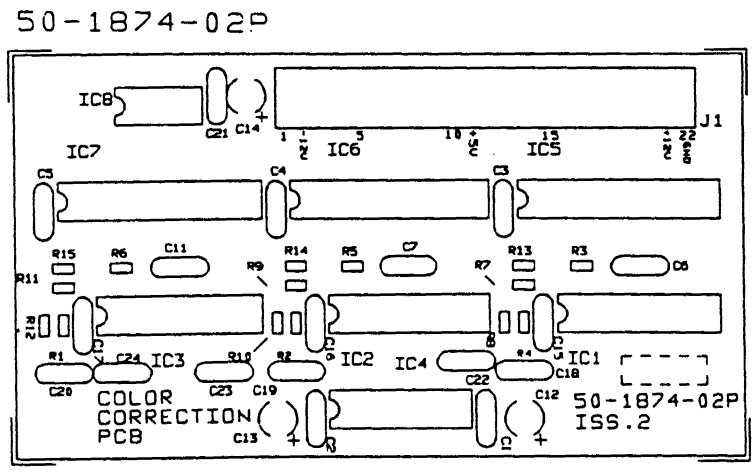
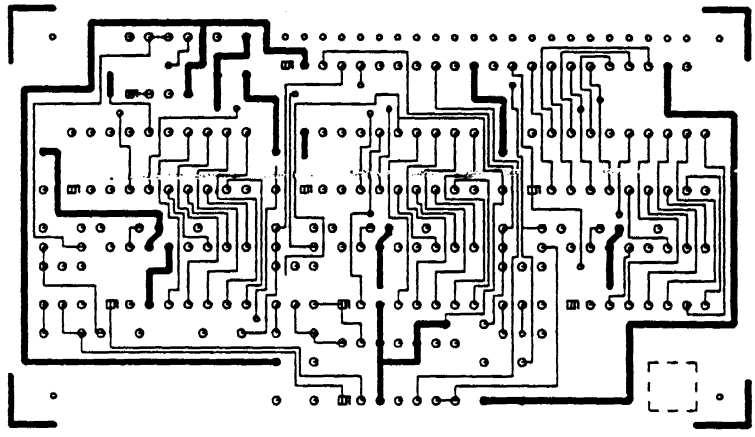
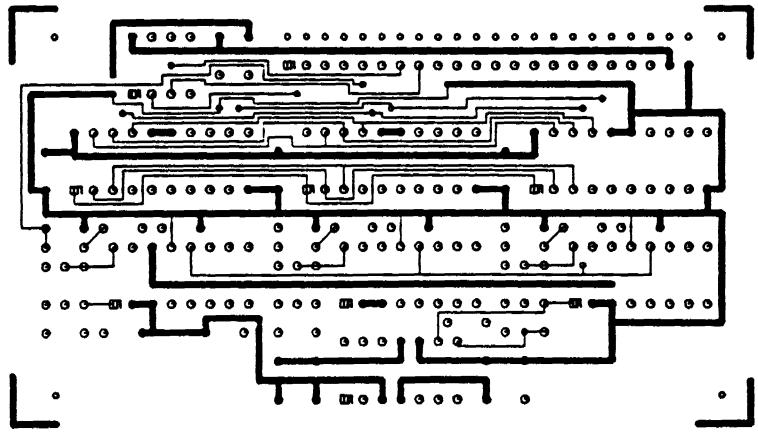


Component Layout



Solder Side
(Viewed from Component Side)



Component Side

FIGURE 12–10.
Color Correction PCB Component Layout

22.4 PARTS LIST

⚠ - CRITICAL SAFETY COMPONENT
(REPLACE WITH IDENTICAL PART)

22.4.1 Waveform PCB Assembly

Item Ref.	Part No.	Description
Integrated Circuits		
IC1,IC12,IC18,IC24	14-002104-01P	TL084CN, quad biFET linear op amp
IC2	14-004686-02P	74ALS869, 8 bit up/down counter
IC3	14-A04052-01P	74HC4053, triple 2-input analog multiplexer
IC4,IC8	14-A04005-01P	74HC32, quad 2-input OR gate
IC5	14-A04045-01P	74HC138, demultiplexer
IC7,IC15	14-A05039-01P	28L22, 256 x 8 bit fast bi-polar PROM
IC9	14-A04031-01P	74HC175, quad flip-flop
IC10,IC16,IC28,IC34	14-A04010-01P	74HC373, H-CMOS transparent octal latch
IC13,IC19,IC25	14-A03031-01P	AD7524, 8 bit multiplying DAC
IC14	14-A04003-01P	74HC04, H-CMOS hex inverter
IC17	14-A03032-01P	AD7523, 8 bit CMOS multiplying DAC
IC20	14-A04067-01P	74HC590, 8 bit binary counter
IC22	14-A04042-01P	74HC245, octal bus transceiver
IC26	14-A04007-01P	74HC74, H-CMOS dual flip-flop
IC27,IC33	14-A04053-01P	74HC688, 8 bit digital comparator
IC29	14-002095-01P	MC1595L, linear arithmetic 4-quad multiplexer
IC32	14-A04001-01P	74HC00, quad 2-input NAND gate
IC35	14-A04077-01P	74HC126, tri-state non-inverting buffer
Transistors & Diodes		
D1,D2	14-000513-01P	1N914, diode, 0.075A, 75V
D3	14-000533-01P	BAT81, Schottky barrier diode
Capacitors		
C1,C2,C4,C7-C15, C17,C23-C29,C33-C35, C37,C38,C42,C43,C46, C49,C50,C62,C69	89-000032-03P	100 nF, 50V, 20%, ceramic, multi layer
C32,C40,C41	84-710003-02P	10 OF, 25V, "super mini", electolytic
C54	86-610134-04P	100 pF, 100V, NPO, ceramic
C55-C57	86-610031-04P	10 pF, ceramic
C71	84-000210-05P	47 OF, 10V, non-polar mini, electolytic
C72	88-172240-12P	220 nF, 63V, 10%, mylar
C73,C74	86-647033-04P	47 pF, 100V, NPO, ceramic
Resistors		
R1-R3	41-000344-39P	5K, carbon trim pot
R4-R6,R21,R23,R24, R39,R42	80-110025-11P	10K, 1/2W, 5%, metal film
R7,R52-R54,R57,R59	80-147015-11P	4.7K, 1/2W, 5%, metal film
R13,R33	80-118015-11P	1.8K, 1/2W, 5%, metal film
R17,R48,R51,R61	41-000344-40P	10K, carbon trim pot
R18,R25,R38,R43,R44, R87	80-139015-11P	3.9K, 1/2W, 5%, metal film
R20	80-124025-11P	24K, 1/2W, 5%, metal film
R34,R86,R101	80-110015-11P	1K, 1/2W, 5%, metal film
R41,R60,R91	80-130025-11P	30K, 1/2W, 5%, metal film
R47,R56,R58	80-120015-11P	2K, 1/2W, 5%, metal film

22.4 PARTS LIST (cont.)

⚠ - CRITICAL SAFETY COMPONENT
(REPLACE WITH IDENTICAL PART)

22.4.1 Waveform PCB Assembly (cont.)

	Item Ref.	Part No.	Description
	Resistors (cont.)		
	R49,R50	80-151005-11P	510R, 1/2W, 5%, metal film
	R55	80-127015-11P	2.7K, 1/2W, 5%, metal film
⚠	**R89,R90**	**80-110095-11P**	**10R, 1/2W, 5%, metal film**
	R94,R96-R98	80-147005-11P	470R, 1/2W, 5%, metal film
	R95,R102	80-110005-11P	100R, 1/2W, 5%, metal film
	R99	80-115015-11P	1.5K, 1/2W, 5%, metal film
	R100	80-122015-11P	2.2K, 1/2W, 5%, metal film
	RN1	43-000053-02P	10K, 10 pin, resistor network

22.4.2 Pincushion PCB Assembly (supplied as part of Waveform module)

Integrated Circuits		
IC1,IC3,IC15,IC17	14-002095-01P	MC1595L, linear arithmetic 4-quad multiplexer
IC2,IC9,IC14	14-002164-01P	MC34084, op amp
IC4	14-A04041-01P	MM14538B, CMOS, precision dual monostable
IC11	14-A04062-01P	74HC123, dual monostable multivibrator
IC13	14-002813-09P	TL082BC, linear op amp
IC16	14-002165-01P	ML311, bi-polar digital voltage comparator
Transistors and Diodes		
Q1-Q3	14-A00705-01P	2N7000, TMOS, 60V, 0.2A, 4W
D1,D2	14-000513-01P	1N914, diode, 0.075A, 75V
Capacitors		
C1,C21,C22	84-410004-01P	10 ΩF, 25V, electolytic
C2,C30	88-171053-12P	1 ΩF, 50V, mylar
C3,C7-C11,C14,C18 C19,C26-C29,C33, C38-C48,C50	89-000032-03P	100 nF, 50V, 20%, ceramic, multi layer
C20,C36,C37	84-410506-01P	1 ΩF, 50V, electolytic
C24,C31,C35	86-647033-04P	47 pF, 100V, NPO, ceramic
C25	89-000033-04P	1.5 nF, 1%, 50V, NPO, ceramic, multi layer
C32,C34	89-000033-02P	1.0 nF, 50V, 1%, ceramic, multi layer
C49	89-000032-04P	10 nF, 50V, 20%, ceramic, multi layer

22.4 PARTS LIST (cont.)

⚠ - CRITICAL SAFETY COMPONENT
(REPLACE WITH IDENTICAL PART)

22.4.2 Pincushion PCB Assembly (cont.)

Item Ref.	Part No.	Description
Resistors		
R1,R6-R8,R11,R12,R34, R64,R65	80-115025-11P	15K, 1/2W, 5%, metal film
R2,R9,R10,R13,R14, R17,R19-R21,R30,R63, R66,R67	80-130025-11P	30K, 1/2W, 5%, metal film
R5	80-136025-11P	36K, 1/2W, 5%, metal film
R15,R16,R18,R22,R44, R61	80-156015-11P	5.6K, 1/2W, 5%, metal film
R23	80-116035-11P	160K, 1/2W, 5%, metal film
R24,R25	80-110045-11P	1M, 1/2W, 5%, metal film
R26,R27	80-110095-11P	10R, 1/2W, 5%, metal film
R28,R37-R42,R46,R59, R60,R68-R70	80-130015-11P	3K, 1/2W, 5%, metal film
R29,R71	80-110015-11P	1K, 1/2W, 5%, metal film
R31,R62,R75	80-133025-11P	33K, 1/2W, 5%, metal film
R32	40-124755-31P	4.7M, 1/4W, 5%, metal film
R33	80-151025-11P	51K, 1/2W, 5%, metal film
R35,R36	80-139025-11P	39K, 1/2W, 5%, metal film
R43	80-122025-11P	22K, 1/2W, 5%, metal film
R48	80-120025-11P	20K, 1/2W, 5%, metal film
R49	80-122035-11P	220K, 1/2W, 5%, metal film
R50,R51	80-110035-11P	100K, 1/2W, 5%, metal film
R52	80-182015-11P	8.2K, 1/2W, 5%, metal film
R53	80-110025-11P	10K, 1/2W, 5%, metal film
R54	80-147005-11P	470R, 1/2W, 5%, metal film
R55	80-118025-11P	18K, 1/2W, 5%, metal film
R56-R58	80-147015-11P	4.7K, 1/2W, 5%, metal film
R72,R81	80-130035-11P	300K, 1/2W, 5%, metal film
R73	41-000344-14P	100K, carbon trim pot.
R74	80-112035-11P	120K, 1/2W, 5%, metal film
R76	80-116025-11P	16K, 1/2W, 5%, metal film
R77	80-115005-11P	150R, 1/2W, 5%, metal film
R78	41-000344-17P	500K, carbon trim pot.
R79,R80	80-110005-11P	100R, 1/2W, 5%, metal film

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22.5 SPECIFICATIONS

Connector P1, Row A:

NOTE: pins 1 through 7 are multiplexed data/ lower byte address bus

Pin 1 ..... digital in/output, **AD(0)** LSB
Pin 2 ..... digital in/output, **AD(1)**
Pin 3 ..... digital in/output, **AD(2)**
Pin 4 ..... digital in/output, **AD(3)**
Pin 5 ..... digital in/output, **AD(4)**
Pin 6 ..... digital in/output, **AD(5)**
Pin 7 ..... digital in/output, **AD(6)**
Pin 8 ..... digital in/output, **AD(7)** MSB
NOTE: pins 9 through 16 are the upper byte address bus

Pin 9 ..... digital input, **AD(8)** LSB
Pin 10 ..... digital input, **AD(9)**
Pin 11 ..... digital input, **AD(10)**
Pin 12 ..... digital input, **AD(11)**
Pin 13 ..... digital input, **AD(12)**
Pin 14 ..... digital input, **AD(13)**
Pin 15 ..... digital input, **AD(14)**
Pin 16 ..... digital input, **AD(15)** MSB

Pin 17 ..... digital input, $\overline{\textbf{RD}}$
NOTE: read signal from Remote Control module

Pin 18 ..... digital input, $\overline{\textbf{WR}}$
NOTE: write signal from Remote Control module

Pin 19 ..... digital input, **ALE**
NOTE: address latch enable from Remote Control module

Pin 20 ..... digital input, **HPLLCLK**
signal level ..... 0 to 5V
NOTE: see Convergence module

Pin 21 ..... digital input, **H RESET**
signal level ..... 0 to 5V
NOTE: see Convergence module

Pin 22 ..... digital input, **VPLLCLK**
signal level ..... 0 to 5V
NOTE: see Convergence module

Pin 23 ..... digital input, **V RESET**
signal level ..... 0 to 5V
NOTE: see Convergence module

Pin 24 ..... digital input, **HFB**
signal level ..... 0 to 12V
NOTE: see Power Deflection module

Pin 25 ..... digital input, **VFB**
signal level ..... 0 to 5V
NOTE: see Power Deflection module

Pin 26 ..... *analog input*, **CONTRAST**
signal level ..... 0 to 10 VDC
NOTE: DC control voltage from Remote Control module

Pin 27 ..... -12V power supply -12 VDC
current ..... 130mA max

Pin 28 ..... +12V power supply +12 VDC
current ..... 100mA max

Pin 29 ..... +5V power supply +5 VDC
current ..... 400 Ma max

Pin 30 ..... connected to Pin 29 +5 VDC

Pin 31 ..... ground **GND**

Pin 32 ..... connected to Pin 31 **GND**

Connector P1, Row B:

NOTE: pins 1 through 8 are active low, address-decoded I/O select strobes

Pin 1 ..... digital output, $\overline{\textbf{SEL0}}$

Pin 2 ..... digital output, $\overline{\textbf{SEL1}}$

Pin 3 ..... digital output, $\overline{\textbf{SEL2}}$

Pin 4 ..... digital output, $\overline{\textbf{SEL3}}$

Pin 5 ..... digital output, $\overline{\textbf{SEL4}}$

Pin 6 ..... digital output, $\overline{\textbf{SEL5}}$

Pin 7 ..... digital output, $\overline{\textbf{SEL6}}$

Pin 8 ..... digital output, $\overline{\textbf{SEL7}}$

Pin 9 ..... analog output, **DYN FOCUS**
composite parabola ..... 10V p-p min
vertical parabola ..... 0 to 4V p-p
horizontal parabola ..... 0 to 4V p-p

Pin 12 ..... analog input, **KEYSTONE**
DC keystone control ..... -10 to 10 VDC

Connector P1, Row B (cont.):

Pin 13 ..... analog input, **PIN SIDE**
DC side pincushion control .....-10 to 10 VDC

Pin 14 ..... analog output, **KEY WFM**
NOTE: vertical sawtooth multiplied by parabola
vertical sawtooth (without parabola) ..... 0 to 4V p-p
vertical parabola (without sawtooth) ..... 0 to 4V p-p

Pin 15 ..... digital input, **VIDEO KILL**
signal level ..... 0 to 5V

Pin 16 ..... digital input, **PIN TOP**
top pincushion control .....-10 to 10 VDC

Pin 17 ..... analog output, **PIN WFM**
NOTES: All waveforms are AC-coupled. Top/bottom pincushion & bow parabolic waveforms are symmetric

constant amplitude
(BOW=10,PIN TOP=-10,PIN BOT=-10)
signal level ..... 0 to 7V p-p

constant amplitude
(BOW=-10,PIN TOP=10,PIN BOT=10)
signal level ..... 0 to 7V p-p

linearly decreasing to center at middle of scan
(BOW=0,PIN TOP=10,PIN BOT=0)
signal level ..... 0 to 7V p-p ±10%

linearly decreasing to center at middle of scan
(BOW=0,PIN TOP=-10,PIN BOT=0)
signal level ..... 0 to 7V p-p ±10%

linearly increasing from center at middle of scan
(BOW=0,PIN TOP=0,PIN BOT=10)
signal level ..... 0 to 7V p-p ±10%

linearly increasing from center at middle of scan
(BOW=0,PIN TOP=0,PIN BOT=-10)
signal level ..... 0 to 5V p-p ±10%

Pin 18 ..... analog input, **PIN BOT**
bottom pincushion control -10 to 10 VDC

Pin 19 ..... digital output, **BLANK WFM**
composite blanking pulse ..... 0 to 5V ±10%
horizontal pulse width ..... 2 Os min.

Pin 20 ..... analog input, **BUCK LOW**
NOTE: DC voltage proportional to BUCK OUT, see Keystone module

NOTE: measurements for Pins 21, 22 & 23 are made with CONTRAST = 10V; R1, R2 & R3 adjusted to maximum.

Pin 21 ..... analog output, **R GAIN**
signal level ..... 0 to 5V

Pin 22 ..... analog output, **G GAIN**
signal level ..... 0 to 5V

Pin 23 ..... analog output, **B GAIN**
signal level ..... 0 to 5V

Pin 24 ..... digital input, **REV SCAN**
signal level ..... 0 to 5V ±10%
NOTE: high reverses horizontal scan

Pin 25 ..... analog input, **BOW**
DC bow control .....-10 to 10 VDC

Pin 26 ..... analog input, **BEAM LIMIT**
NOTE: clamp line, see Bias module

Connector P1, Row C:

NOTE: pins 1 to 9 are the lower byte of address bus
Pin 1 ..... digital output, **A(0)**
Pin 2 ..... digital output, **A(1)**
Pin 3 ..... digital output, **A(2)**
Pin 4 ..... digital output, **A(3)**
Pin 5 ..... digital output, **A(4)**
Pin 6 ..... digital output, **A(5)**
Pin 7 ..... digital output, **A(6)**
Pin 8 ..... digital output, **A(7)**
Pin 9 ..... digital output, **A(8)**

NOTE: pins 10 to 16 are the upper byte of address bus
Pin 10 ..... digital output, **A(9)**
Pin 11 ..... digital output, **A(10)**
Pin 12 ..... digital output, **A(11)**
Pin 13 ..... digital output, **A(12)**
Pin 14 ..... digital output, **A(13)**
Pin 15 ..... digital output, **A(14)**
Pin 16 ..... digital output, **A(15)**

NOTE: pins 17 through 24 are the data bus
Pin 17 ..... output, **D(0)**
Pin 18 ..... digital output, **D(1)**
Pin 19 ..... digital output, **D(2)**
Pin 20 ..... digital output, **D(3)**
Pin 21 ..... digital output, **D(4)**
Pin 22 ..... digital output, **D(5)**
Pin 23 ..... digital output, **D(6)**
Pin 24 ..... digital output, **D(7)**

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