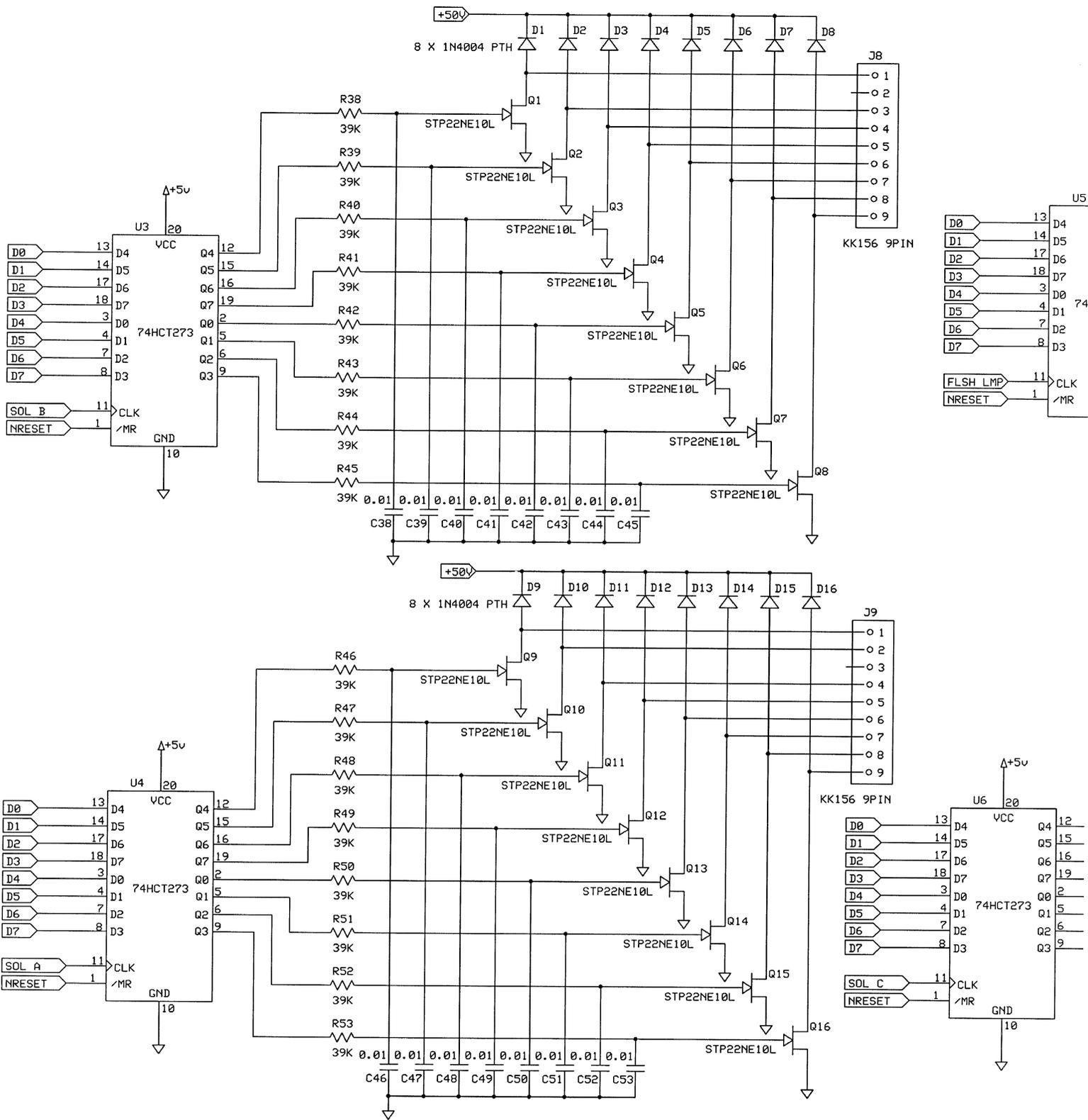
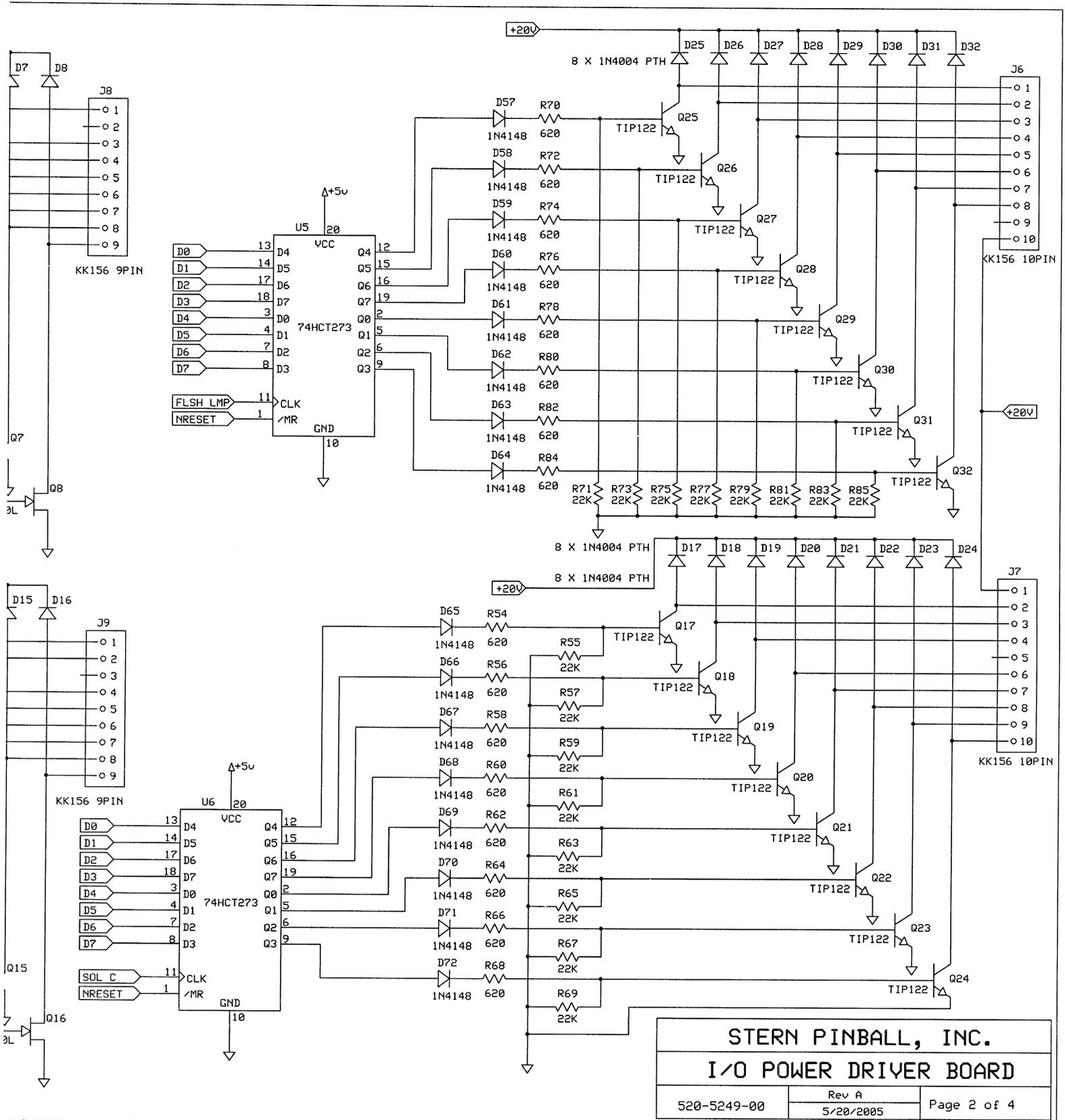


STERN PINBALL, INC.		
I/O POWER DRIVER BOARD		
520-5249-00	Rev A 5/20/2005	Page 1 of 4





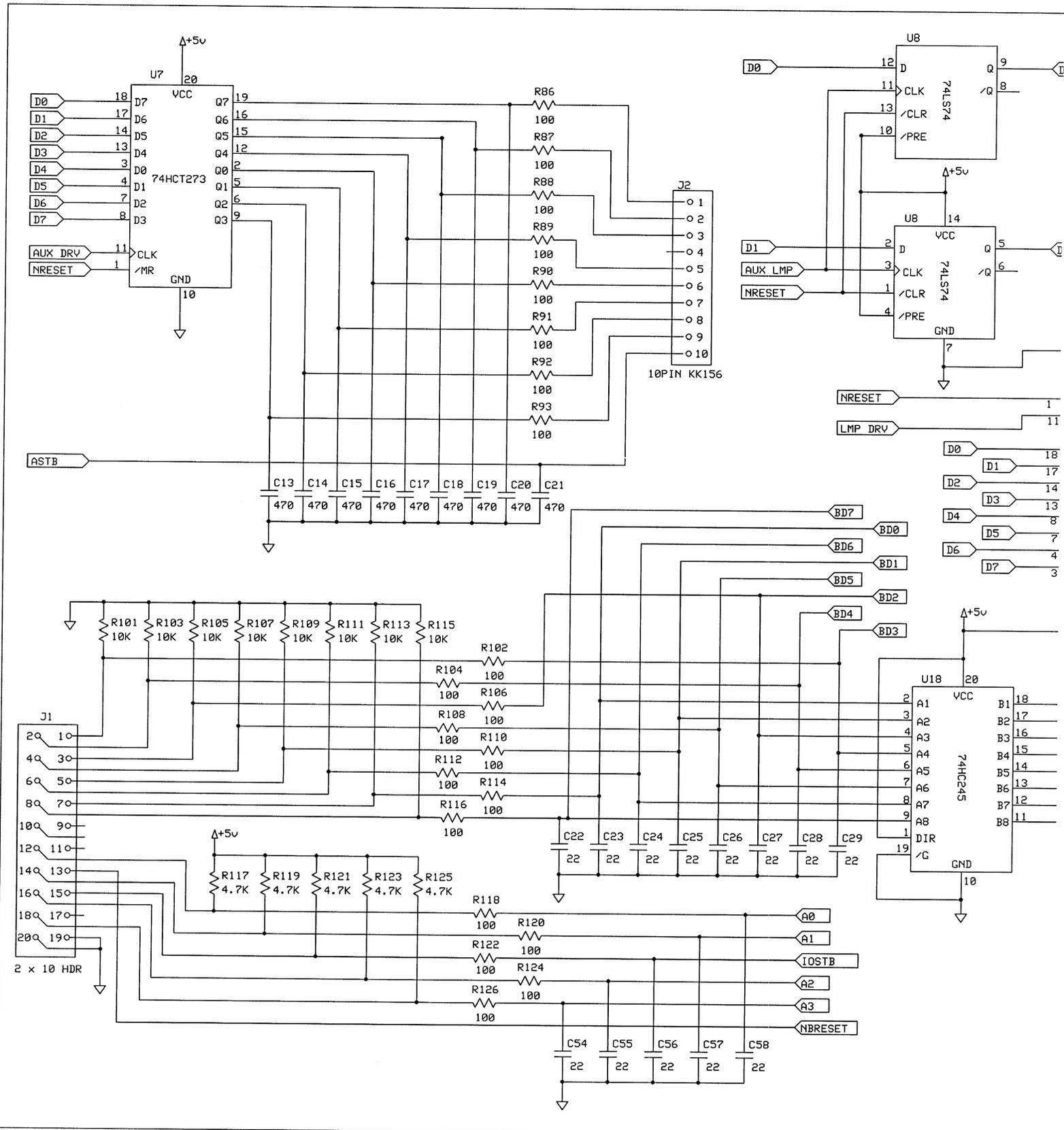
STERN PINBALL, INC.
I/O POWER DRIVER BOARD

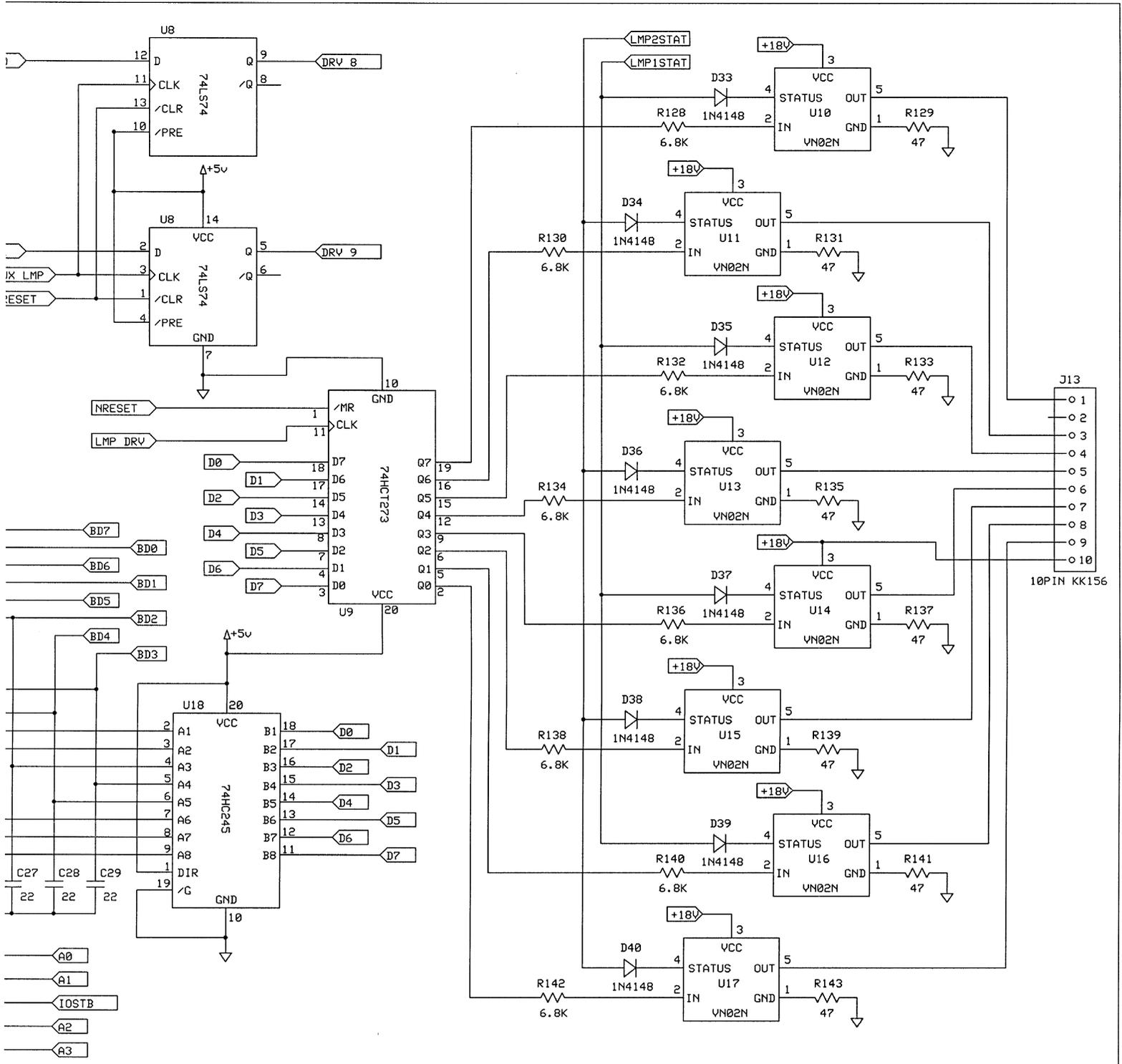
520-5249-00	Rev A 5/20/2005	Page 2 of 4
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Printed Circuit Boards (PCBs)



Section 5, WPT
Page 7

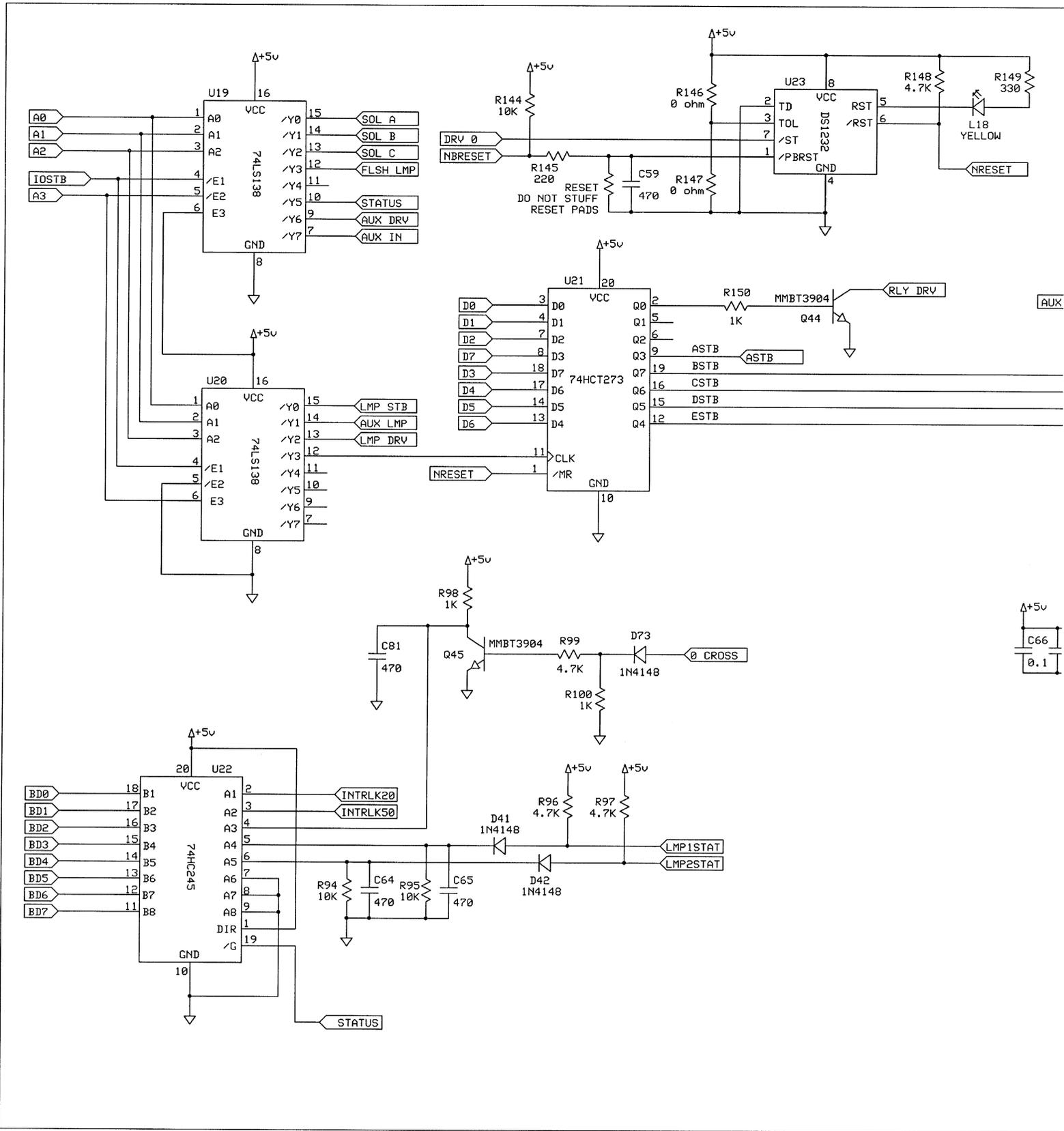


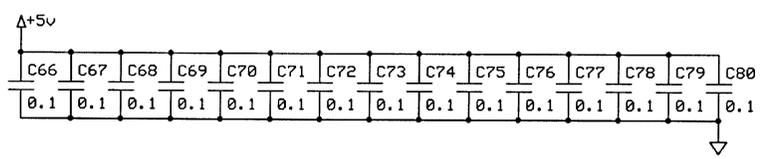
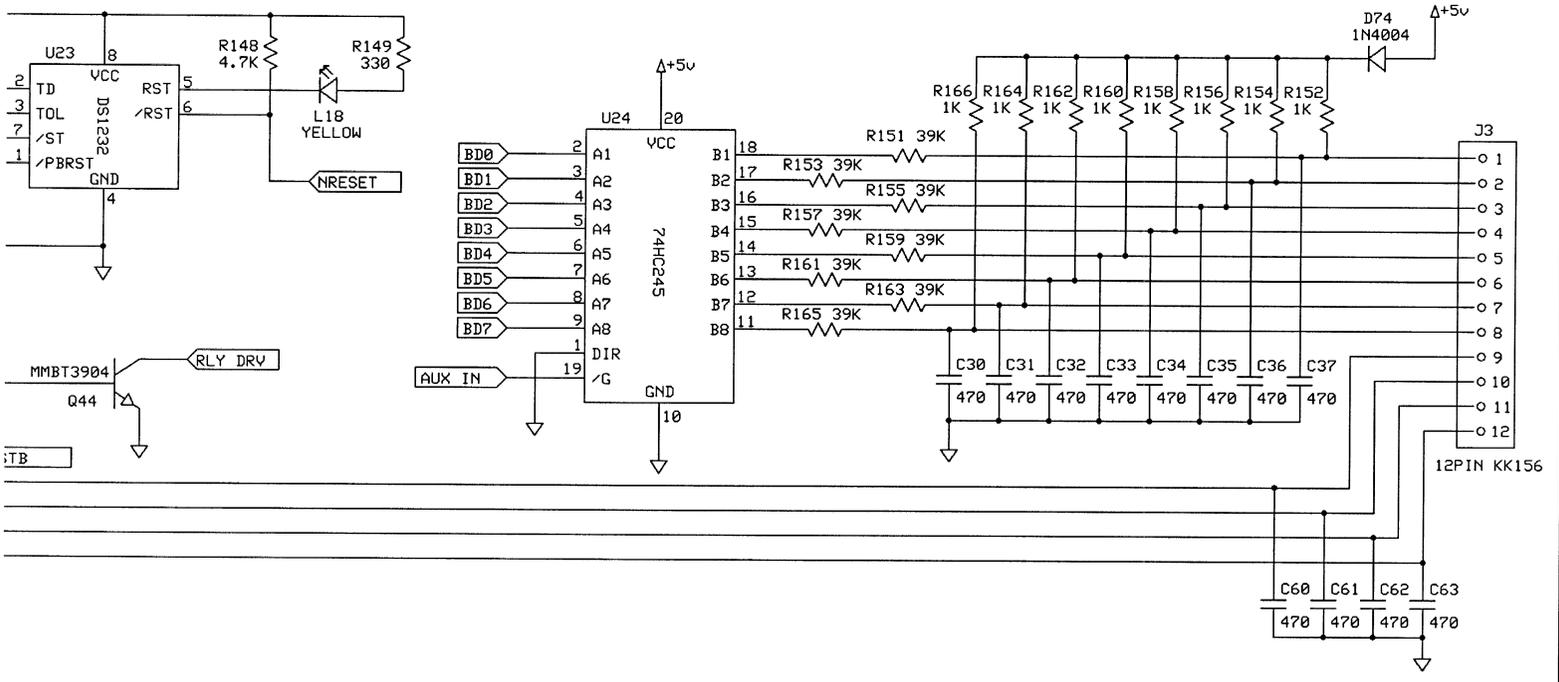


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STERN PINBALL, INC.		
I/O POWER DRIVER BOARD		
520-5249-00	Rev A 5/20/2005	Page 3 of 4



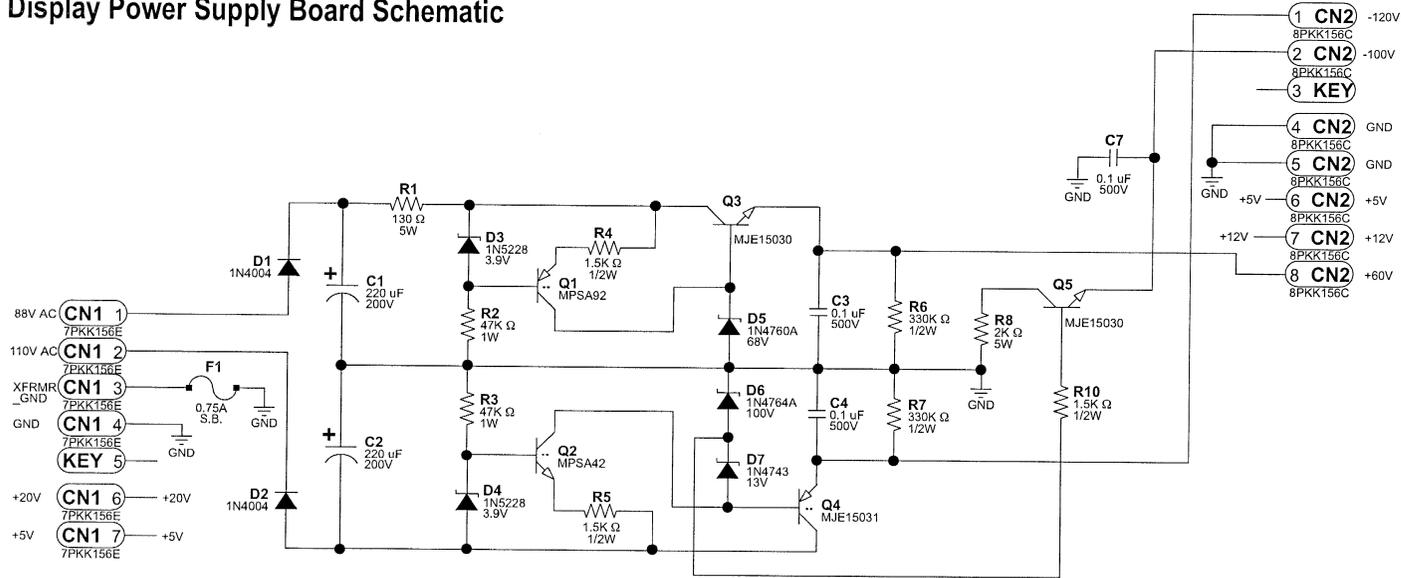




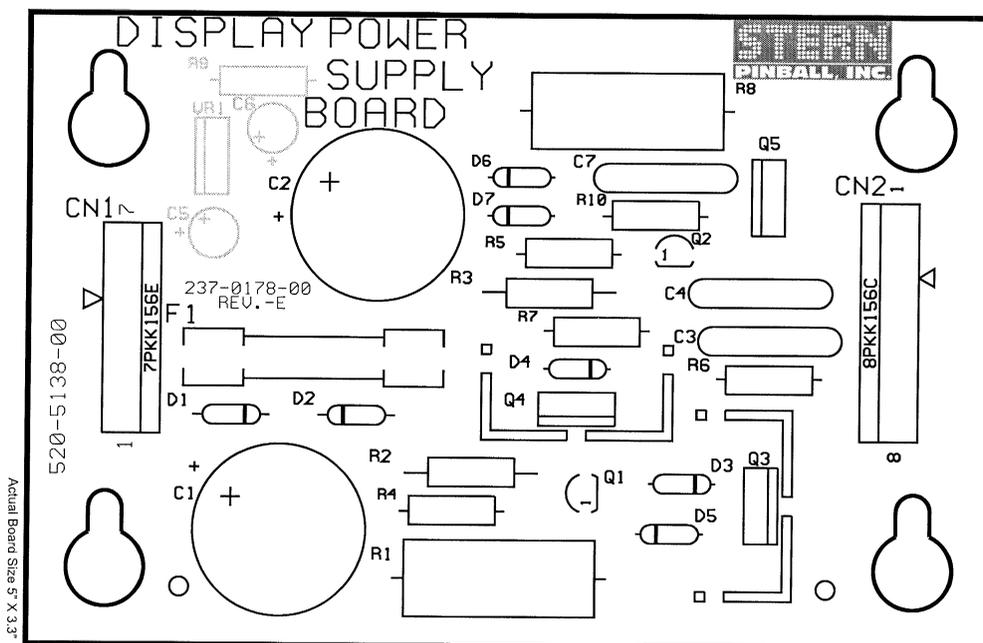
STERN PINBALL, INC.		
I/O POWER DRIVER BOARD		
520-5249-00	Rev A 5/20/2005	Page 4 of 4



Display Power Supply Board Schematic



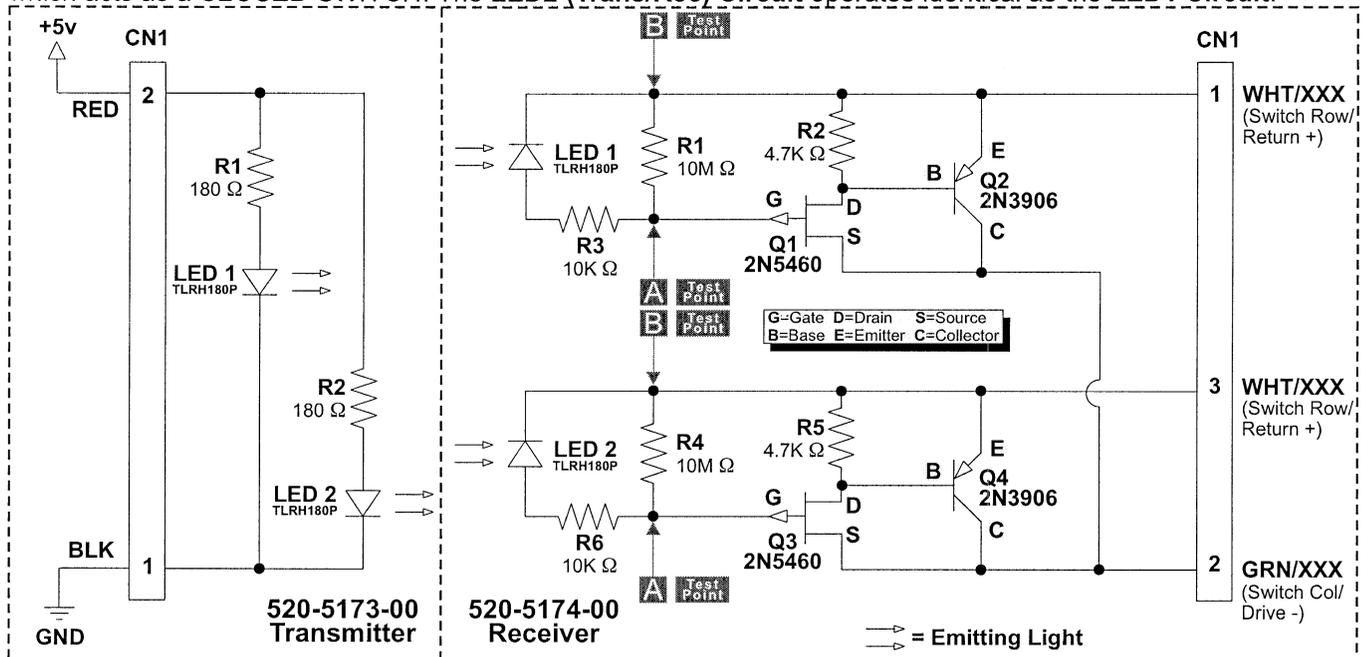
Display Power Supply Board Component Layout & Parts



ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION (NS = Not Stuffed)
01	1	520-5138-00	Display Power Supply Board	Complete PCB Assembly
02	2	125-5044-00	C1, C2	220uF, 200v, Radial Lytic Cap.
03	3	125-5035-00	C3, C4, C7	0.1uF, 500v, Ceramic Disk Cap.
04	1	125-5018-00	(C5, C6: NS)	22uF, 35v, Rad Lytic Cap
05	1	045-5015-07	CN1	7PKK156E (PIN5=KEY)
06	2	045-5015-08	CN2	8PKK156 (PIN3=KEY)
07	2	112-5003-00	D1, D2	1N4004, Diode
	2	112-0053-00	D3, D4	1N5228, 3.9v, Diode
	1	112-0062-00	D5	1N4760A, 68v, Diode
	1	112-0049-00A	D6	1N4764A, 100v, Diode
	1	112-0061-00	D7	1N4743, 13v, Diode
	1	200-5000-17	F1	3/4A (0.75A) S.B. Fuse
	2	205-0004-00	F1	Fuse Clip
	1	110-0100-00	Q1	MPSA92, Transistor
	1	110-0082-00	Q2	MPSA42, Transistor
	2	110-0101-00	Q3, Q5	MJE15030, Transistor
	2	535-5000-11	Q3, Q4	Heatsinks - AAVID #563002
	2	240-5008-00	Q3, Q4	#6-32 KEPS Nut
	2	237-5501-00	Q3, Q4	#6-32 X 3/8" PPH Screw
	1	110-0103-00	Q4	MJE15031, Transistor
	1	121-5061-00	R1	130 Ω 5W Res.
	2	121-5060-00	R2, R3	47K Ω 1W Res.
	3	121-5038-00	R4, R5, R10	1.5K Ω 1/2W Res. (R9: NS)
	2	121-5059-00	R6, R7	330K Ω 1/2W Res.
	1	121-5062-00	R8	2K Ω 5W Res.
	0	124-5003-00	(VR1: NS)	7812CT

Trough Up-Kicker Dual OPTO Boards Theory of Operation & Schematic

As light from the **Transmitter LED1** falls on the **Receiver LED1**, it generates a Positive Bias Voltage (0.7v to 1.5v) which is applied to the **Gate (G)** of **Q1 (Fet 2N5460)** turning **Q1** off. When **Q1** is held off, no current flows through **Q2's (2N3906) Base (B)**. With no *base current*, **Q2** is off and acts as an **OPEN SWITCH**. When the light is interrupted (**BLOCKED**) **R1 (Rec. Bd.)** bleeds the gate voltage off of **Q1** allowing it to conduct, switching **Q2** on, which acts as a **CLOSED SWITCH**. The **LED2 (Trans/Rec) Circuit** operates identical as the **LED1 Circuit**.



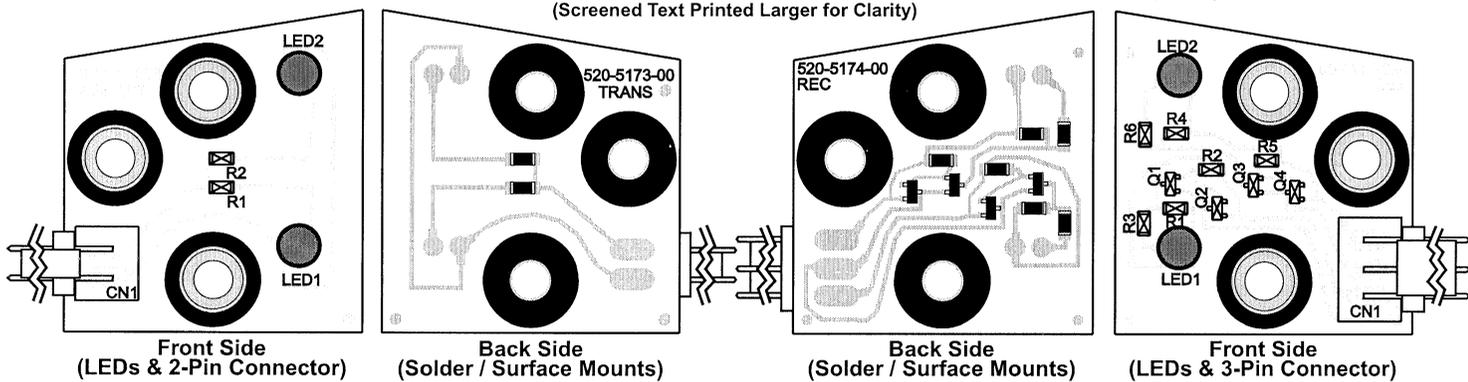
Trough Up-Kicker Dual OPTO Boards Component Layout & Parts

520-5173-00 (TRANS)

Boards Actual Size

520-5174-00 (REC)

(Screened Text Printed Larger for Clarity)



ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
A	1	515-0173-00	Dual-OPTO Trans. Bd. Assy.	PCB Assy. (with all Items 1-5)
—	1	520-5173-00	Dual-OPTO Trans. Board	PCB Assy. (with Items 1-3 only)
01	1	045-5111-02	CN1	2X, .156" Rt. Angle (26-60-5020) Conn.
02	2	165-5052-00	LED1, LED2	LED TLRH180P (Ultra Bright Red)
03	2	121-5067-00	R1, R2	180 Ω 1/8W Chip Res. (CRCW)
04	3	530-5308-02	n/a	OPTO PCB Brass Tube Spacer
05	3	545-5518-00	n/a	OPTO PCB Rubber Grommet
B	1	515-0174-00	Dual-OPTO Rec. Bd. Assy.	PCB Assy. (with all Items 1-9)
—	1	520-5174-00	Dual-OPTO Rec. Board	PCB Assy. (with Items 1-7 only)
01	1	045-5111-03	CN1	3X, .156" Rt. Angle (26-60-5030) Conn.
02	2	165-5052-00	LED 1, LED 2	LED TLRH180P (Ultra Bright Red)
03	2	110-5006-00	Q1, Q3	2N5460, Transistor (P-FET SOT-23)
04	2	110-0086-00	Q2, Q4	2N3906, Transistor
05	2	121-5082-00	R1, R4	10M Ω 1/8W Chip Res. (CRCW)
06	2	121-5083-00	R2, R5	4.7K Ω 1/8W Chip Res. (CRCW)
07	2	121-5011-00	R3, R6	10K Ω 1/8W Chip Res. (CRCW)
08	3	530-5308-02	n/a	OPTO PCB Brass Tube Spacer
09	3	545-5518-00	n/a	OPTO PCB Rubber Grommet



Replacement Part:
LED TLRH180P
(T1-3/4 GaAlAs)
SPI Part N#:
165-5052-00

Printed Circuit
Boards (PCBs)



Section 5, WPT
Page 13

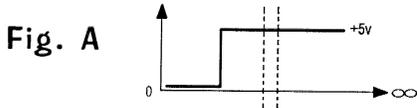
OPTO Troubleshooting

1. Volt Meter Test (indicates normal operating condition):

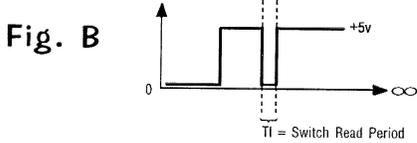
A. **OPEN OPTO** (Light Falling on LED) = **SWITCH OPEN**. Place meter leads across points **A** and **B** on the **LED1 Circuit** (Refer to Schematic Drawing on previous page, 520-5174-00 Receiver Side). It should read approximately 0.8 - 1.2v DC. The **LED2 Circuit** operates the same.

B. **CLOSED OPTO** (Light Blocked) = **SWITCH CLOSED**. Place meter leads across points **A** and **B** on the **LED1 Circuit** (Refer to Schematic Drawing on previous page, 520-5174-00 Receiver Side). It should read approximately 0.0 - 0.1v DC. The **LED2 Circuit** operates the same.

2. Oscilloscope Test (indicates normal operating condition):



A. **OPEN OPTO** (Light Falling on LED) = **SWITCH OPEN**. Place Scope lead at **Pin-1** of OPTO Rec. Board with Scope Grounded (see Schematic). The Scope should display a **STEADY +5v** as shown in **Fig. A**, Wave Form Diagram.



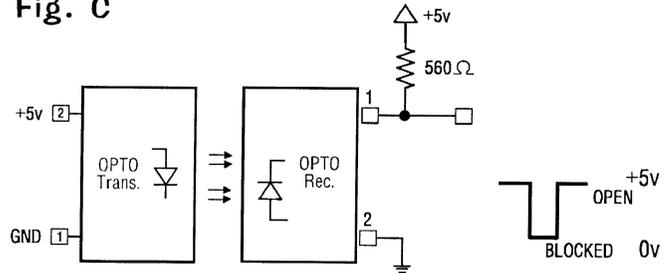
B. **CLOSED OPTO** (Light Blocked) = **SWITCH CLOSED**. Place Scope lead at **Pin-1** of OPTO Rec. Board with Scope Grounded (see Schematic). The Scope should display a **PULSE STREAM** indicating **Q2** has switched "On" as shown in **Fig. B**, Wave Form Diagram. This is your Switch Drive Pulse.

3. Bench Test (See Fig. C):

Please Note: To perform this test you must use a spare 560Ω Pull-Up Resistor, SPI N°: 121-5047-00

Disconnect the **OPTO Transmitter / Receiver Board** from the circuit. Connect one side of a 560Ω Pull-Up Resistor to **Pin-1** of the OPTO Receiver Bd. and the other side of the resistor to a 5v DC source. Connect **Pin-2** to GND. Connect a +5v DC source to **Pin-1** of the Transmitter & GND to **Pin-2**. Align with the Receiver OPTO approx. 3" distance. Using your Volt-Meter or an Oscilloscope, monitor **Pin-1** while **BLOCKING** and **UNBLOCKING** the **BEAM** from the Trans. The output will be approx. +5v DC when the **BEAM IS NOT BLOCKED** and approx. 0v when the **BEAM IS BLOCKED**.

Fig. C



Trough Dual OPTO Boards Alignment / Test for LED1

When a working **OPTO** is installed and connected in a game, the transmitter should light (**LED1 lower & LED2 upper**) when the power is switched on. With the playfield in **Service Position #1** (playfield lifted up in the half-way position resting on the Prop Rod or edge slide support brackets) and the game on, the LED lights should show up as a **BRIGHT RED RINGS** through the back of the Receiver Board around the **Receivers LED1 & LED2** (see **Fig. 1**). Testing only **LED1**: With the game in **Switch Test Mode**, lifting the Trough Plunger with a fingertip should block the **BEAM** and cause the Switch Position to trigger (see **Fig. 2**). View **Fig. 2a & 2b** (on the next page) for a sectional view of the Light Path (note alignment) and what happens as a ball breaks the light beam.

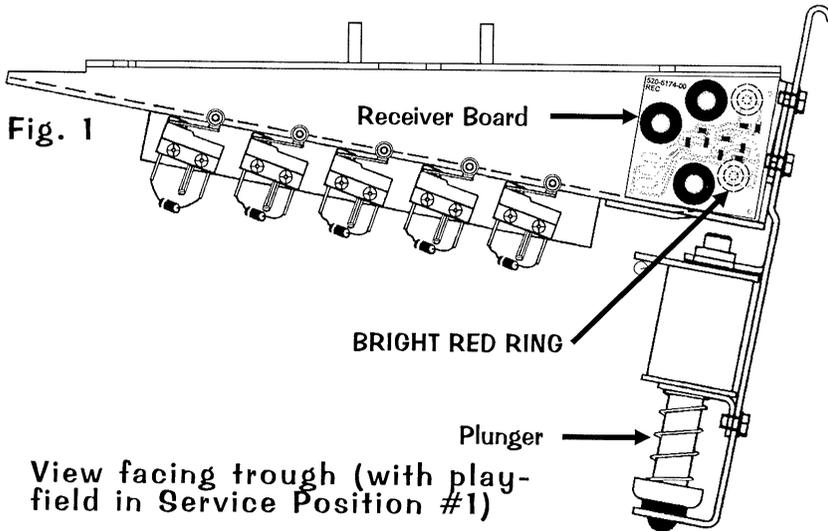
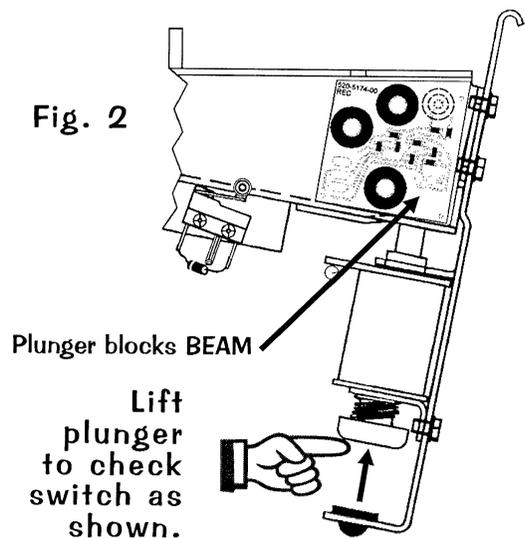
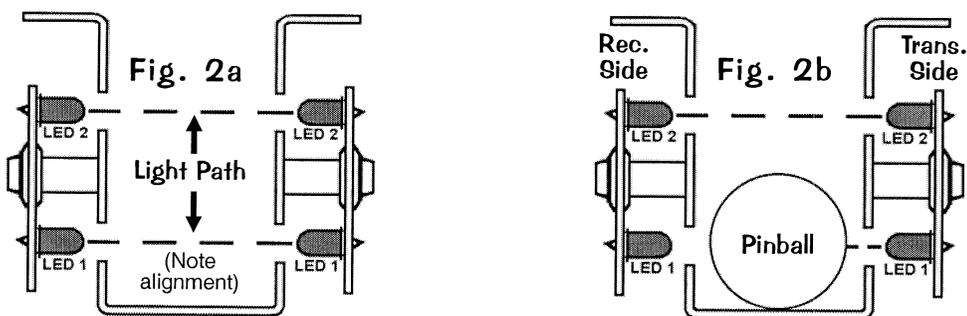


Fig. 2

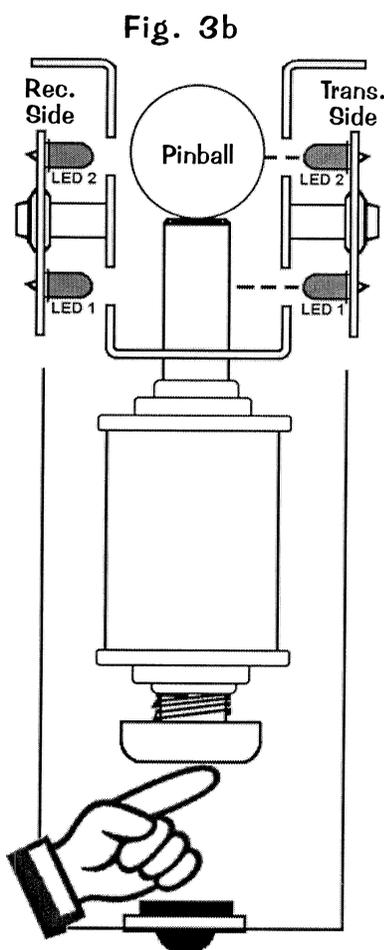
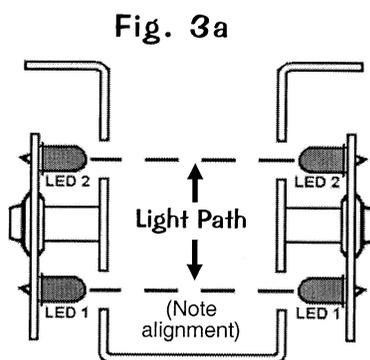
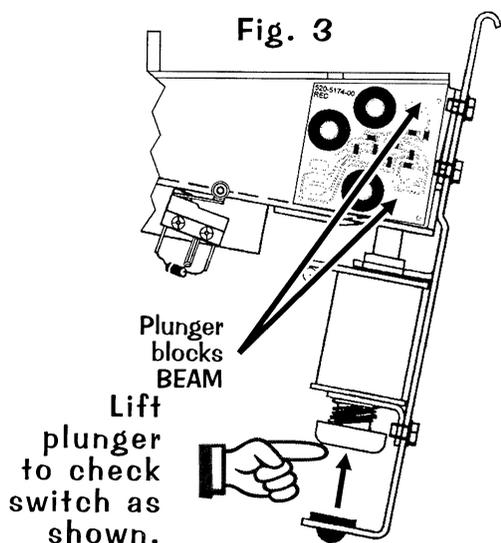


Sectional view from right (Fig. 2a & 2b)



Trough Dual OPTO Boards Alignment / Test for LED2

When a working **OPTO** is installed and connected in a game, the transmitter should light (*LED1 lower & LED2 upper*) when the power is switched on. With the playfield in **Service Position #1** (*playfield lifted up and resting on the Playfield Support Slide Brackets*) and the game on, the LED lights should show up as a **BRIGHT RED RINGS** through the back of the Receiver Board around the **Receivers LED1 & LED2** (see Fig. 1, previous page). Testing only **LED2**: **TO PERFORM THIS TEST, A PINBALL MUST BE IN THE BALL TROUGH**. With the game in **Switch Test Mode**, lifting the Trough Plunger with a finger tip should block the **BEAM** on LED2 and cause the Switch Position to trigger (see Fig. 3). View Fig. 3a & 3b for a sectional view of the Light Path (*note alignment*) and what happens as a "double-stacked" ball scenario breaks the light beam.



I M P O R T A N T

If replacement of **LED** is required, insure that is **mounted correctly before and after soldering** (See Fig. 4a / 4b).

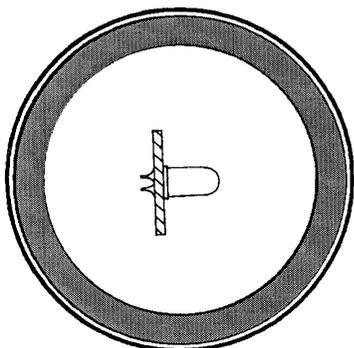


Fig. 4a
Correct Position

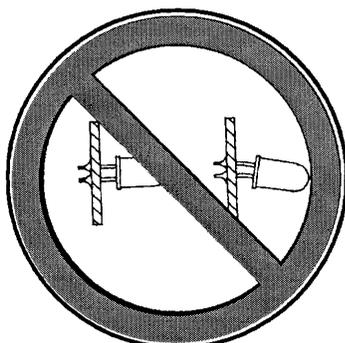
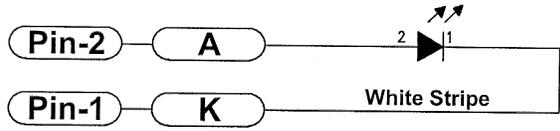
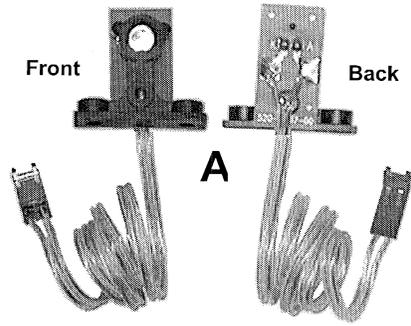


Fig. 4b
Incorrect Position

Playfield Switches OPTO Transceiver Boards Schematic, Component Layout & Parts

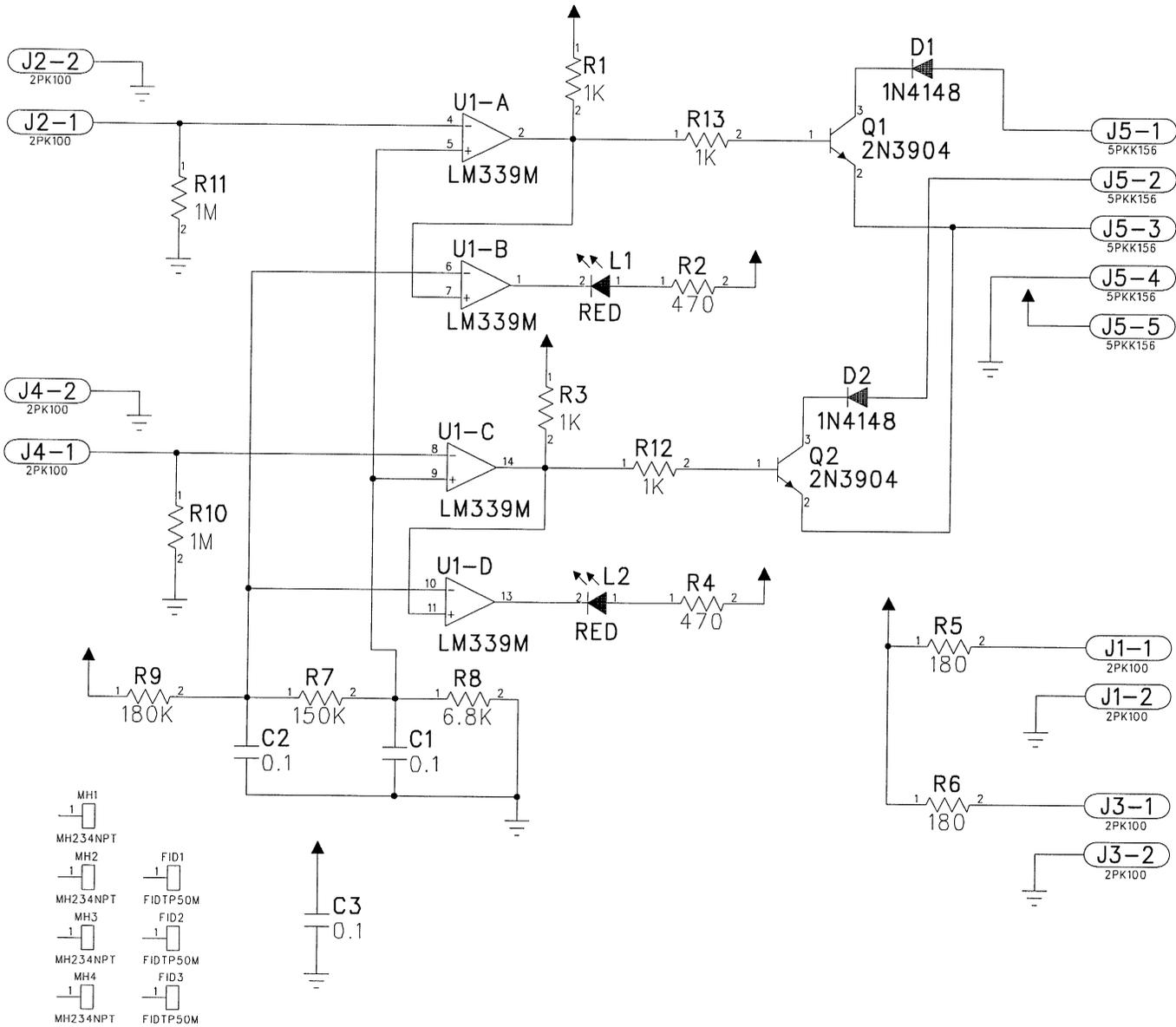


**Mini PCB
OPTO 12" Lead
(Black Bracket)
500-6775-00**



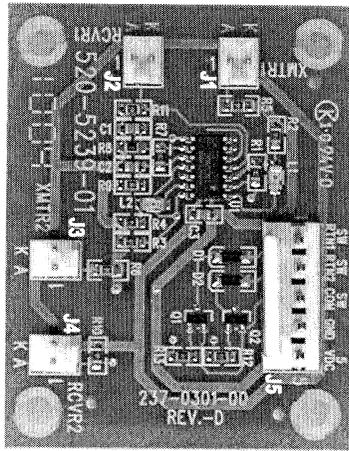
ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
A	8	500-6775-00	MINI PCB OPTO ASM WHT / 12" LEAD	PCB Assy. (with all Items 1-5) PCB Only Plain Black Bracket (Plastic) Holder #4-40 X 1/4 PPH Screw LED (Ultra Bright Red) 12" Speaker Wire (1-Side White Stripe) 2-Pin Cn., .100 KK Cmp Trm Molex 08-50-0113
01	1	520-5237-00	Mini OPTO Trans. or Rec. Board	
02	1	545-6092-00		
03	1	237-5909-00		
04	1	165-5052-00		
05	1	601-5023-12	K, A	
		045-5020-02	Note White Strip to Pin-1	

Playfield OPTO Transmitter / Receiver Amplifier Board Schematic

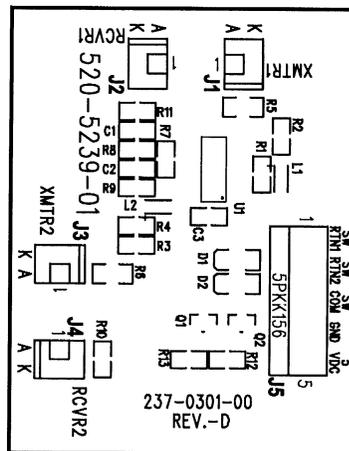


Playfield OPTO Transmitter/Receiver Amplifier Board Component Layout & Parts

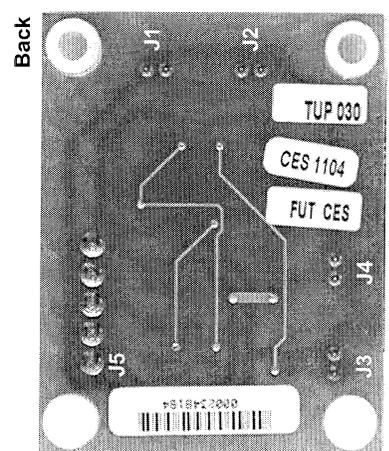
(for OPTO Switches 52, 54, 56 & 59)



Front



Front

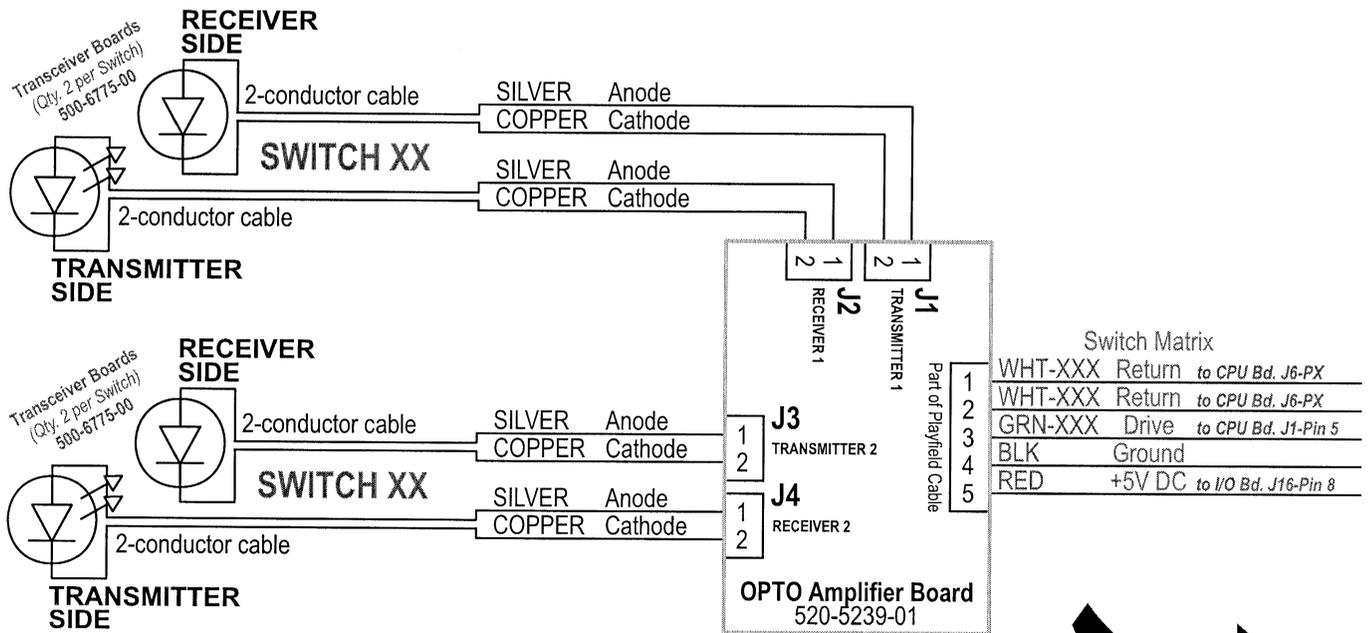


Back

ITEM	QTY	PART NUMBER	REF-DESIGNATOR	DESCRIPTION
1	2	520-5239-01	OPTO Transmitter/Receiver Amplifier Board	Complete PCB Assembly
01	1		R7	SMT 150K Ω 1/10W Resistor 805, 5%
02	2		R5, R6	SMT 180 Ω 1/10W Resistor 805, 5%
03	1	<i>If a part is required where a part number is not provided, call Technical Support (see back of cover).</i>	R9	SMT 180K Ω 1/10W Resistor 805, 5%
04	4		R1, R3, R12, R13	SMT 1K Ω 1/10W Resistor 805, 5%
05	2		R10, R11	SMT 1M Ω 1/10W Resistor 805, 5%
06	2		R2, R4	SMT 470 Ω 1/10W Resistor 805, 5%
07	1		R8	SMT 6.8K Ω 1/10W Resistor 805, 5%
08	3		C1, C2, C3	SMT Cer. .1uF 50v Cap., 10% X7R
09	2		D1, D2	1N4148W, Diode, 100v, 350MW
10	2		Q1, Q2	MMST3904, NPN, 40v, .02A
11	1		U1	LM339M, Low Power Offset QUA
12	4	Mfg. 22-23-2021	J1, J2, J3, J4	2-Pin, 0.1 Header (1 Row, VT, Tin)
13	1	Mfg. 640445-5	J5	5-Pin, .156 Header (1 Row, VT, Tin)
14	2	Mfg. APT3216SURC	L1, L2	LEDD-SMT, Red 1206
15	4		n/a	Spacer (Nylon), .153" ID X 9/32" OD X 3/8"

Playfield OPTO Transmitter/Receiver Amplifier Board Wiring (General)

(for OPTO Switches 52, 54, 56 & 59)



For details on Board Wiring Configuration for Boards 1 & 2, see opposite page.

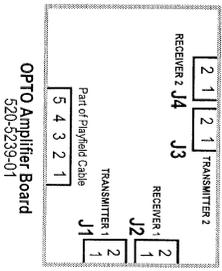
Printed Circuit Boards (PCBs)



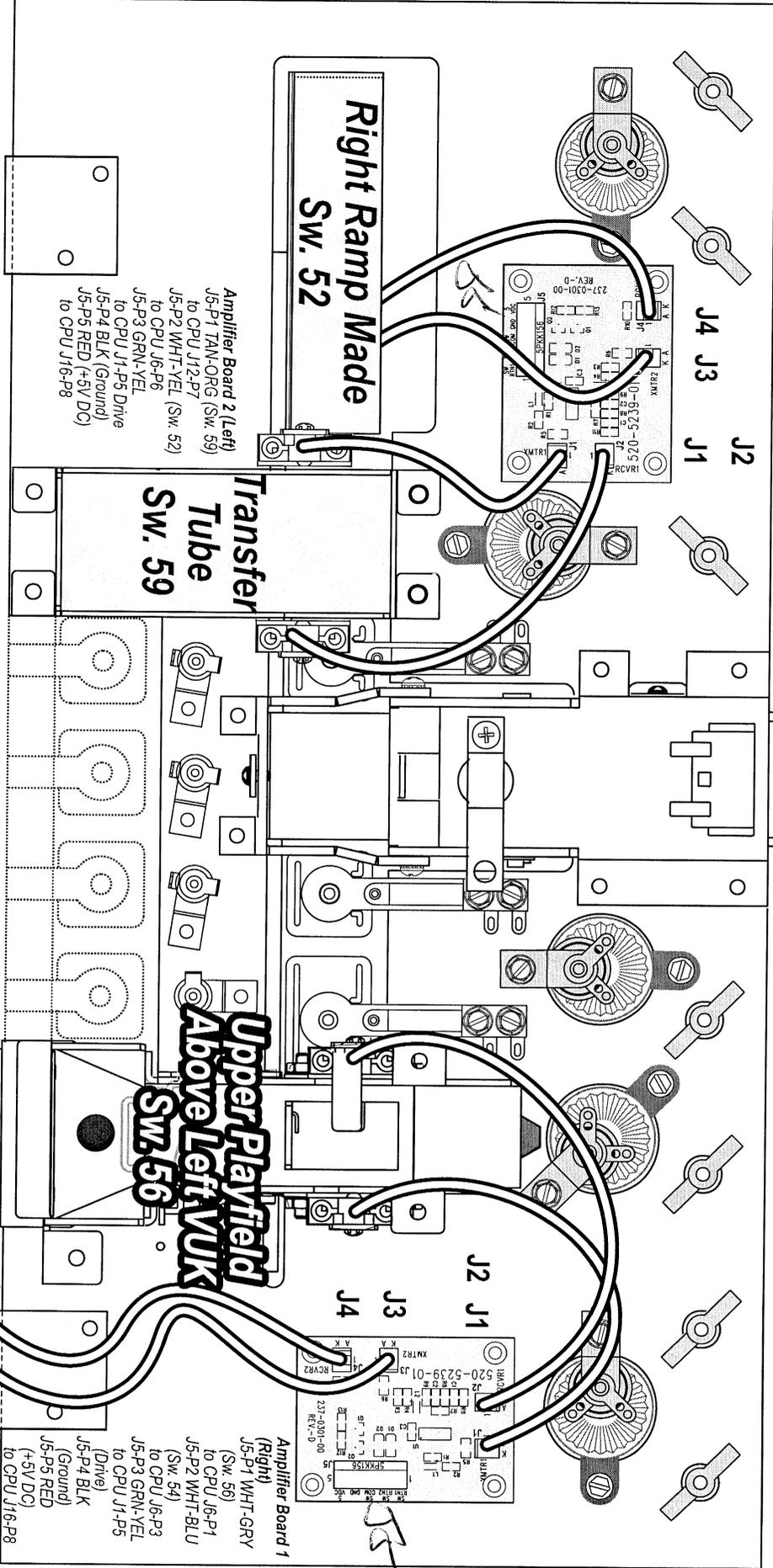
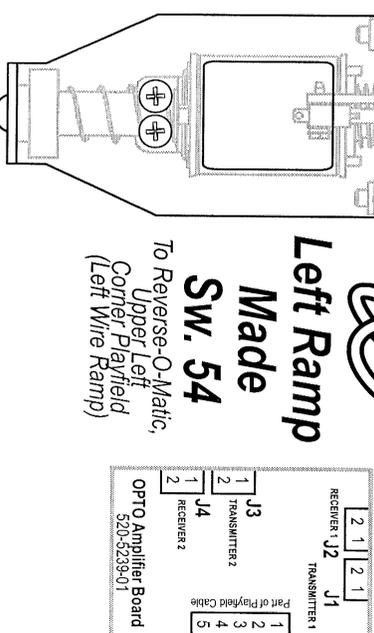
Section 5, WPT
Page 17

Rear View of the Backpanel

Mini PCB OPTOs (500-6775-00) to OPTO Trans/Rec Amplifier Board Wiring Configuration for Boards 1 & 2



Rear View of the Backpanel



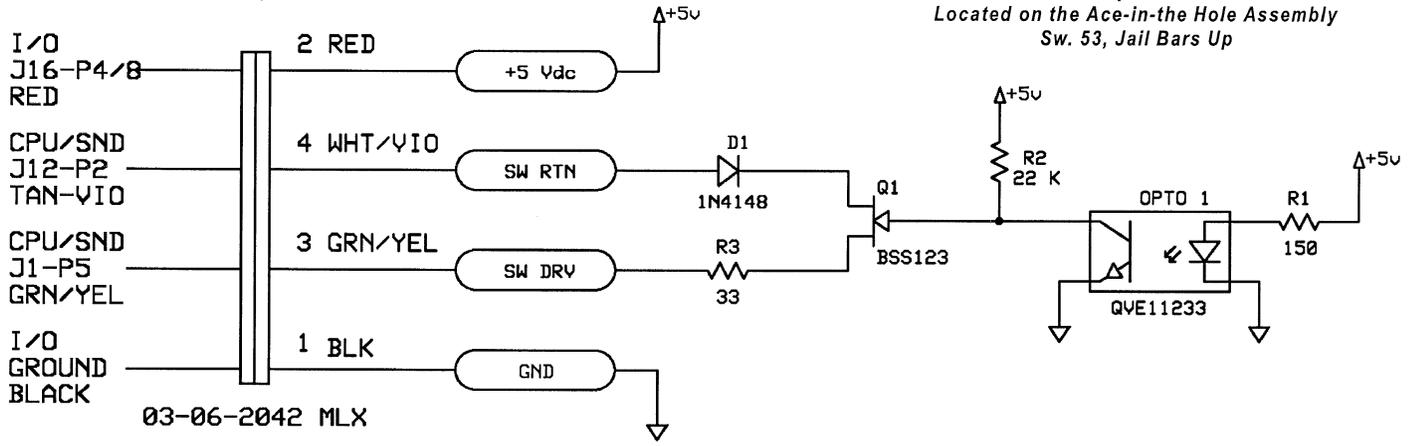
Amplifier Board 2 (Left)

Amplifier Board 1 (Right)



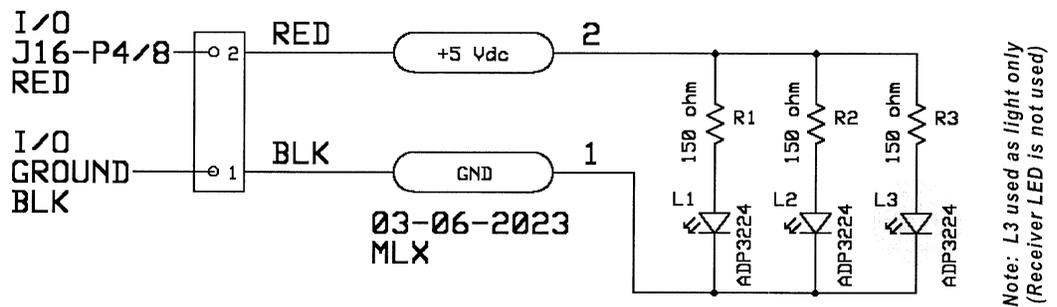
Printed Circuit Boards (PCBs)

OPTO Interrupter (520-5251-00) Schematic
(for OPTO Switch 63)



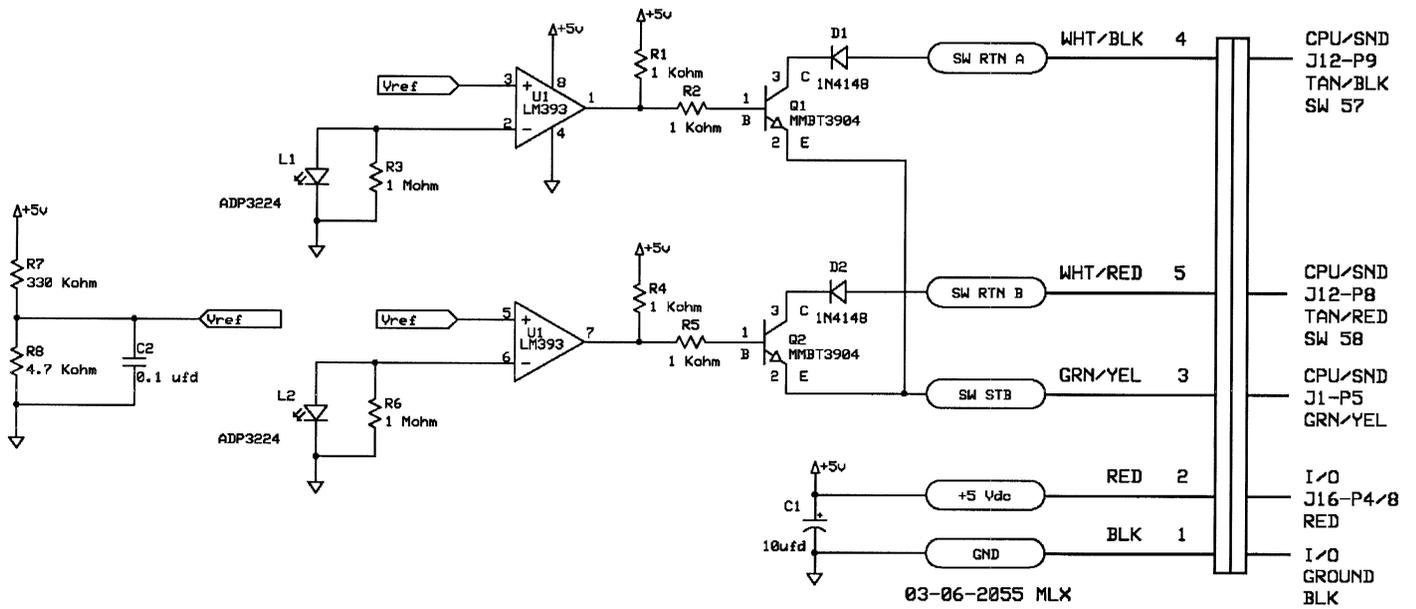
OPTO Transmitter (520-5247-00) Schematic
(for OPTO Switches 57 [front] & 58 [rear])

OPTO PCB (Top)
Located on the Ace-in-the Hole Assembly
Sw. 57, Jail Bars Bash, Sw. 58 Jail Bars Rest



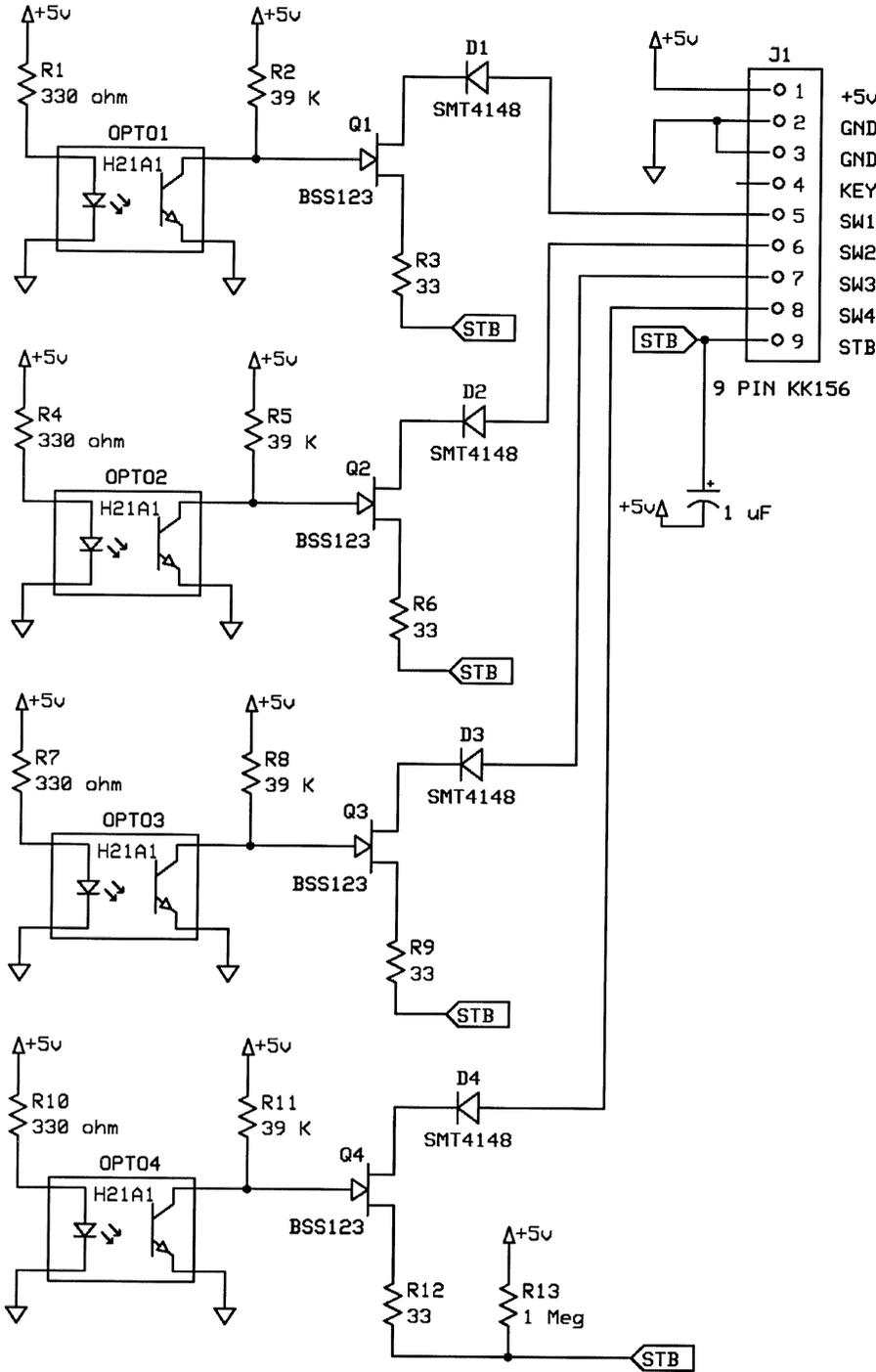
OPTO Receiver (520-5248-00) Schematic
(for OPTO Switches 57 [front] & 58 [rear])

OPTO PCB (Bottom)
Located on the Jail/Mouse Trap Assembly



OPTO Interrupter (520-5252-04) Schematic
 (for OPTO Switches 4-7, 10-13 & 33-40))

U-Shaped X4 OPTO
 Located on the 4-Bank Middle Assembly,
 4-Bank Right Assembly & 8-Bank Left Assembly
 (8-Banks require 2X Boards)



PLAYFIELD HARNESSES

8-BANK DROP TARGET (LEFT)

1	RED +5 Vdc	I/O J16-P4/8
2	BLK GND	I/O J16-9/13
3	GND	
4	KEY	
5	WHT-GRN SW 37	CPU/SND J6-P5
6	WHT-BLU SW 38	CPU/SND J6-P3
7	WHT-VIO SW 39	CPU/SND J6-P2
8	WHT-GRY SW 40	CPU/SND J6-P1
9	GRN-ORG (DRV)	CPU/SND J1-P4

1	RED +5 Vdc	I/O J16-P4/8
2	BLK GND	I/O J16-9/13
3	KEY	
4	WHT-BRN SW 33	CPU/SND J6-P9
5	WHT-RED SW 34	CPU/SND J6-P8
6	WHT-ORG SW 35	CPU/SND J6-P7
7	WHT-YEL SW 36	CPU/SND J6-P6
8	GRN-ORG (DRV)	CPU/SND J1-P4

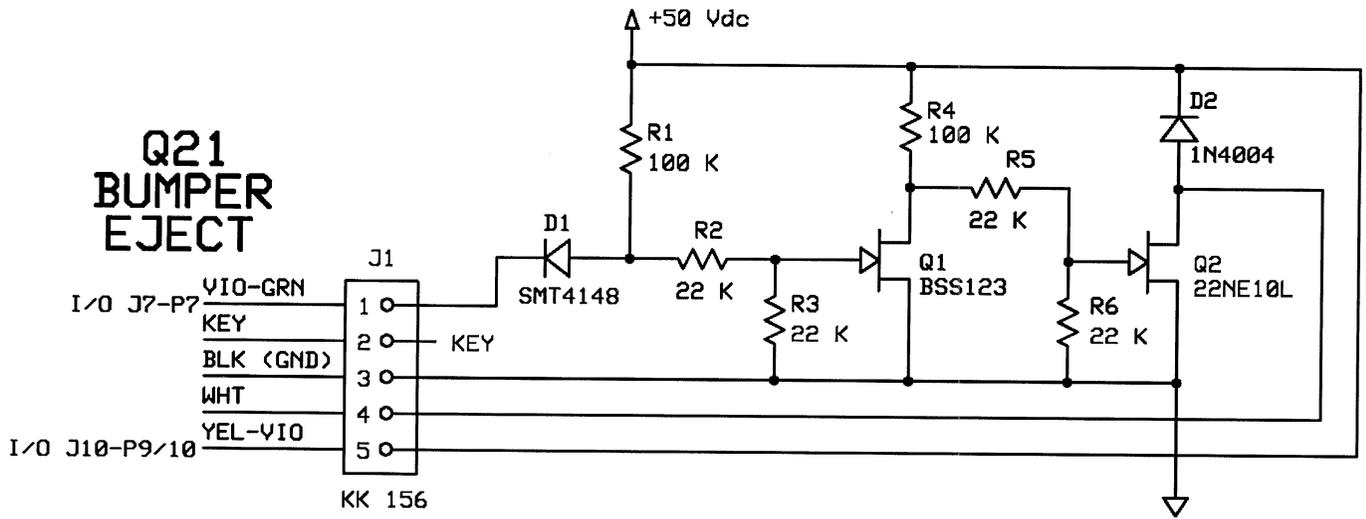
4-BANK DROP TARGET (MIDDLE)

1	RED +5 Vdc	I/O J16-P4/8
2	BLK GND	I/O J16-9/13
3	KEY	
4	TAN-RED SW 10	CPU/SND J12-P8
5	TAN-ORG SW 11	CPU/SND J12-P7
6	TAN-YEL SW 12	CPU/SND J12-P6
7	TAN-GRN SW 13	CPU/SND J12-P4
8	GRN-BRN (DRV)	CPU/SND J1-P1

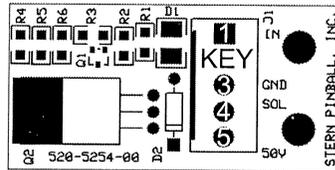
4-BANK DROP TARGET (RIGHT)

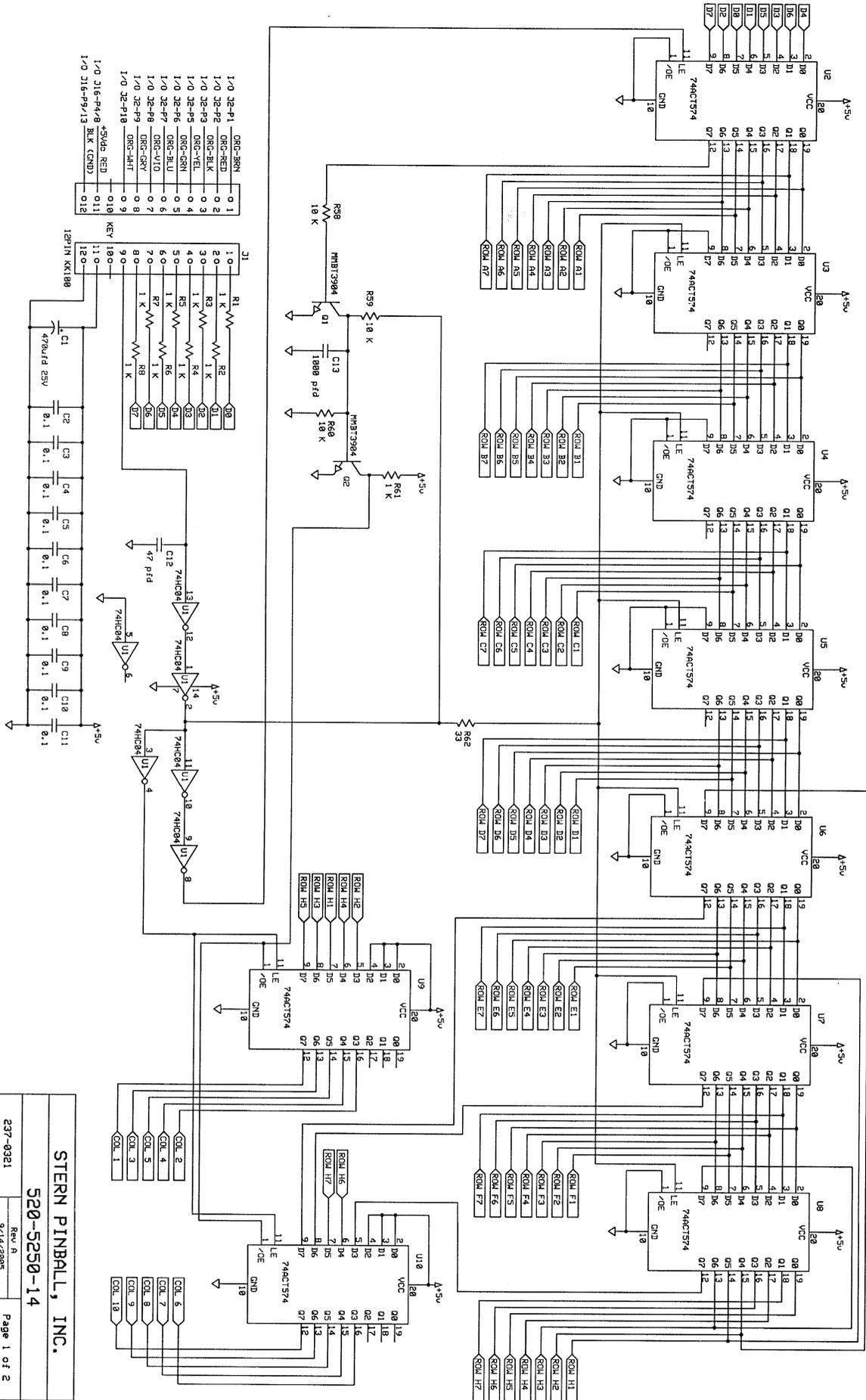
1	RED +5 Vdc	I/O J16-P4/8
2	BLK GND	I/O J16-9/13
3	KEY	
4	WHT-VIO SW 7	CPU/SND J6-P2
5	WHT-BLU SW 6	CPU/SND J6-P3
6	WHT-GRN SW 5	CPU/SND J6-P5
7	WHT-YEL SW 4	CPU/SND J6-P6
8	GRN-BRN (DRV)	CPU/SND J1-P1

Q21 50V Step-Up Driver Board Schematic
 (for Coil #21 Bumper Eject)

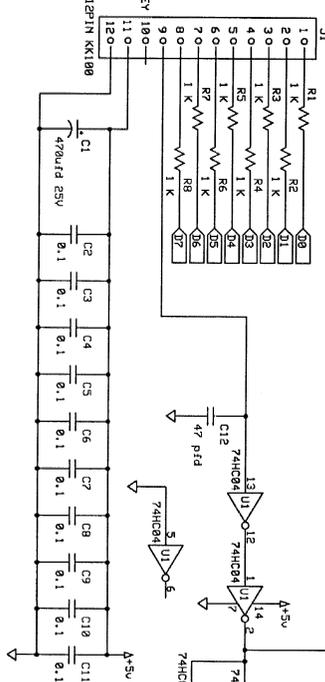


Q21 50V Step-Up Driver Board (520-5254-00) Component Layout
 (for Coil #21 Bumper Eject)



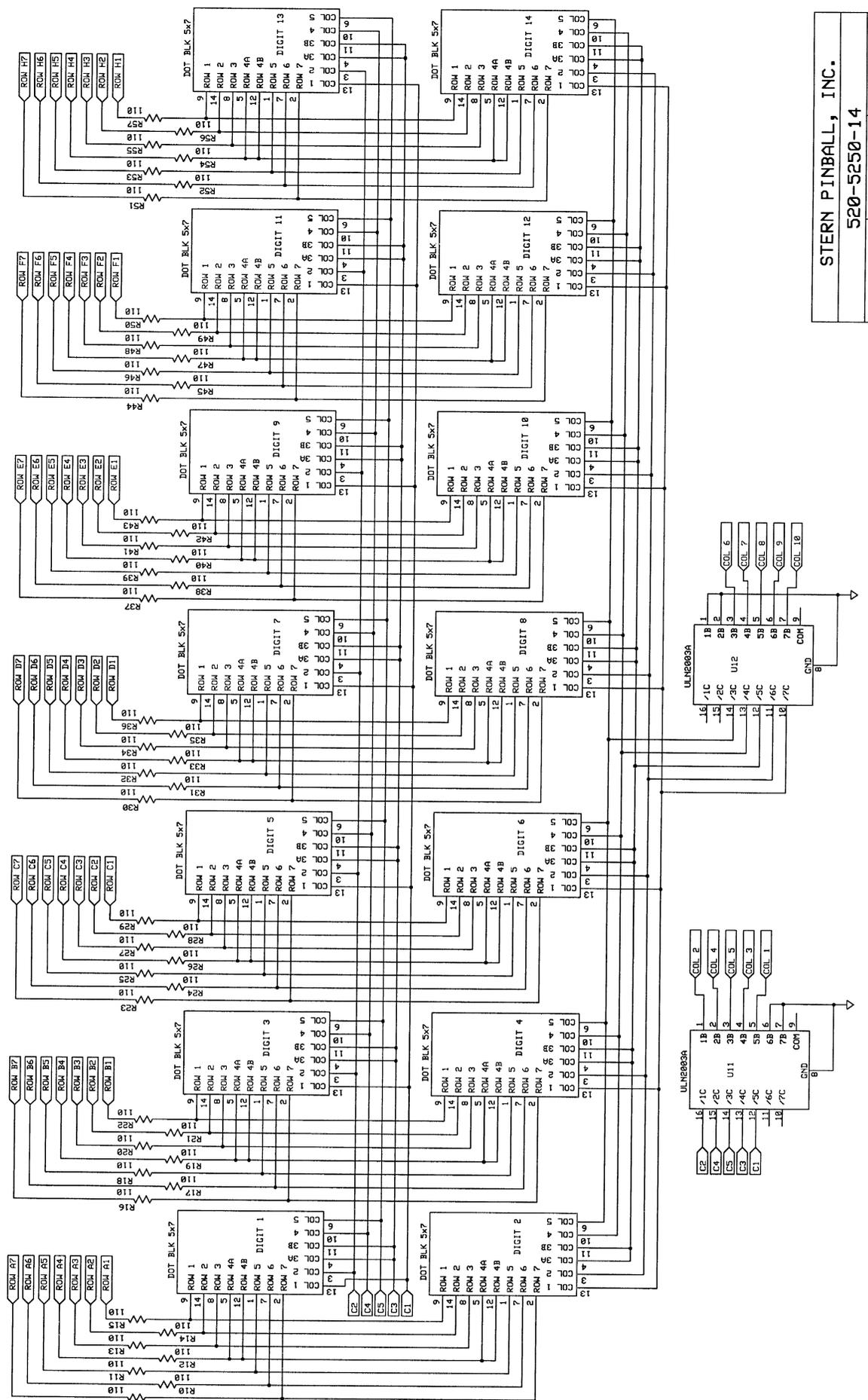


1/0 3E-P1	ORC-BRN	0 1
1/0 3E-P2	ORC-RED	0 2
1/0 3E-P3	ORC-BLK	0 3
1/0 3E-P4	ORC-YEL	0 4
1/0 3E-P5	ORC-GRN	0 5
1/0 3E-P6	ORC-BLU	0 6
1/0 3E-P7	ORC-VIO	0 7
1/0 3E-P8	ORC-GRY	0 8
1/0 3E-P9	ORC-WHT	0 9
1/0 3E-P10	ORC-GRY	0 8
1/0 3E-P11	ORC-GRY	0 8
1/0 3E-P12	ORC-GRY	0 8

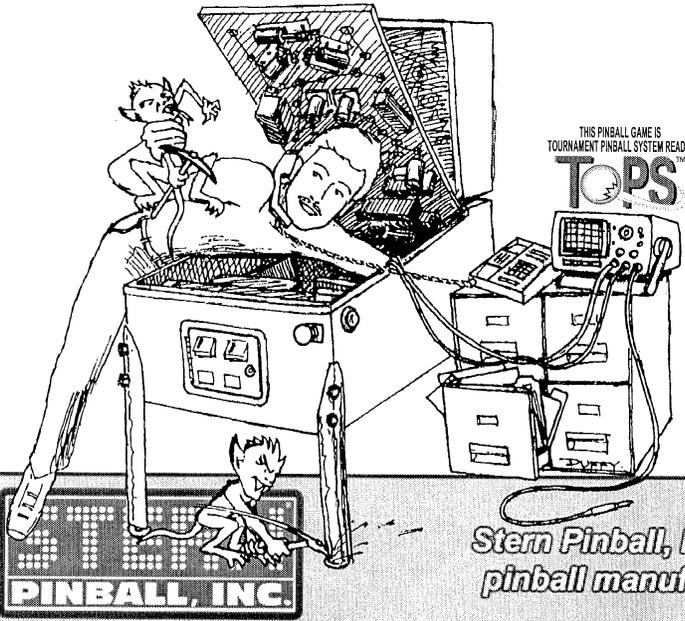
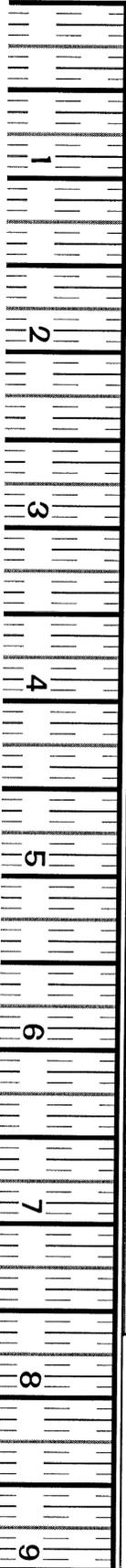


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9/14/2005
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Customary
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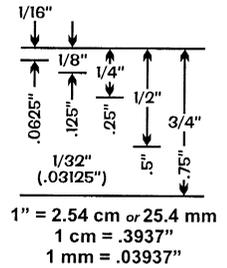
Technical Support & Parts Sales

2002, 2003 (2-Disc Set) & 2004 (2-Disc Set) CD-Roms are now available! *Click year for more info!*

We at STERN Pinball continuously strive to provide our distributors, operators, and game owners with the best technical support possible. We, therefore, have provided you with the service options listed below. If your game requires parts and/or service, please contact your nearest STERN Pinball distributor (See our [Distribution List](#)). For any additional assistance, contact our technical service staff at 1-800-KICKERS (1-800-542-5377) or by e-mail at parts.service@sternpinball.com.



Metric Conversion



If your STERN Pinball is in need of repair, please contact your nearest [STERN Distributor](#).

Pinball Game Parts

Offering Service Game Manual excerpts:
Parts Identification & Location, Drawings for Major Assemblies & Ramps and Appendixes A-J (*updated with each game*)

Coinage Cards

Detailing the Country Setting, Pricing Scheme and Dip Switch Setting

Service Bulletins

Detailing Technical Information, Tips, FYIs, Notices and Updates

Schematics, Theory of Operation and Troubleshooting Tips

Drawings on the White Star Board System™

ROM Code Library

Offering game code for all Data East®, Sega™ and STERN® Pinballs (*EPROM Programmer required*)

Tricks & Tips

1st Time Pinball Set-Up / Prev. Maintenance

For metric, multiply the inch value by the metric value:

example: 5" X 2.54 cm = 12.7 cm or 127 mm

For US, multiply the metric value by the inch value:

example: 13 cm X .3937" = 5.1181"

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Radio Shack Component Catalogue

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This Game Service Manual and all other documents relating to this product, playfield components, features, rules, programming and operation are subject to change without notice (Service Bulletins, if applicable, available through our website).

