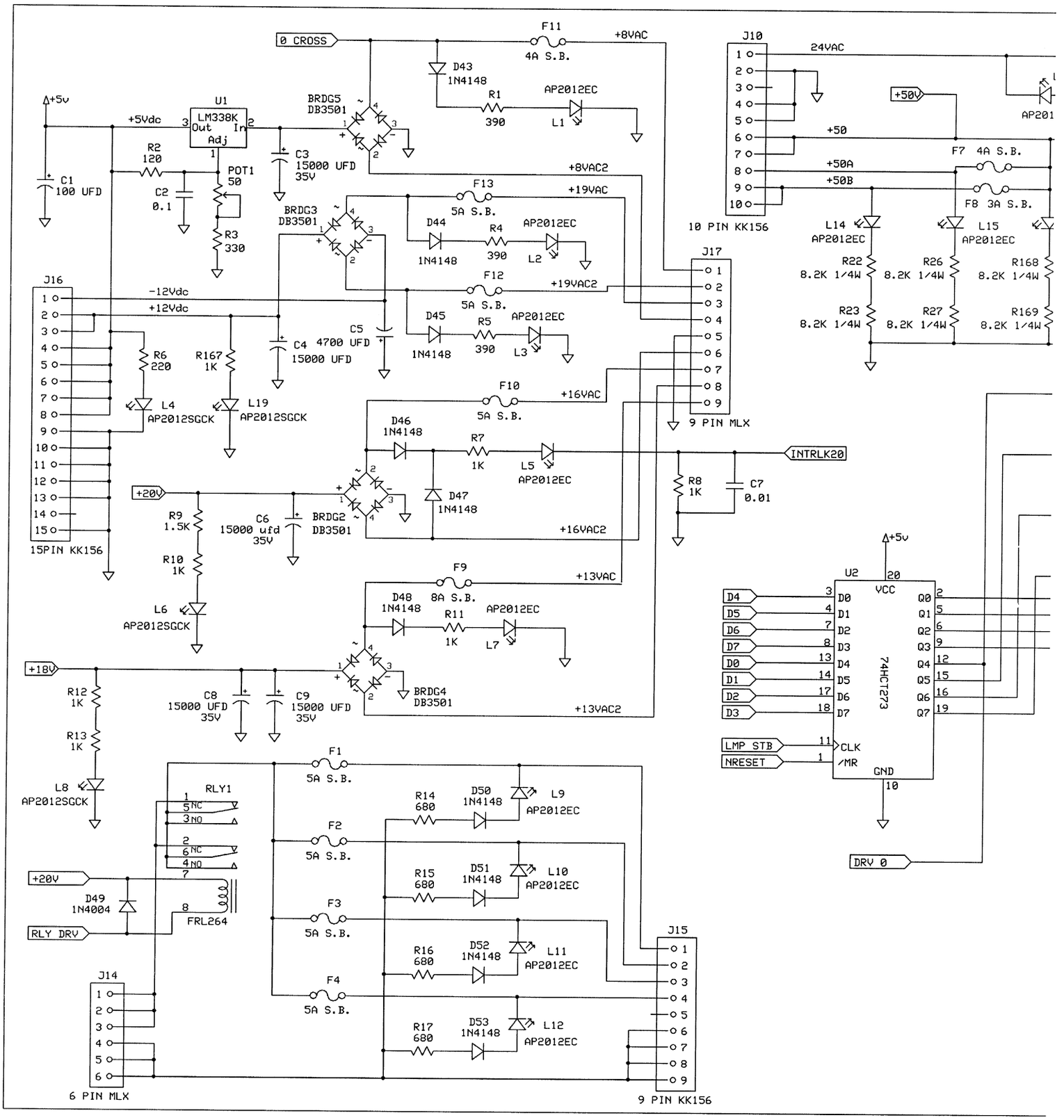
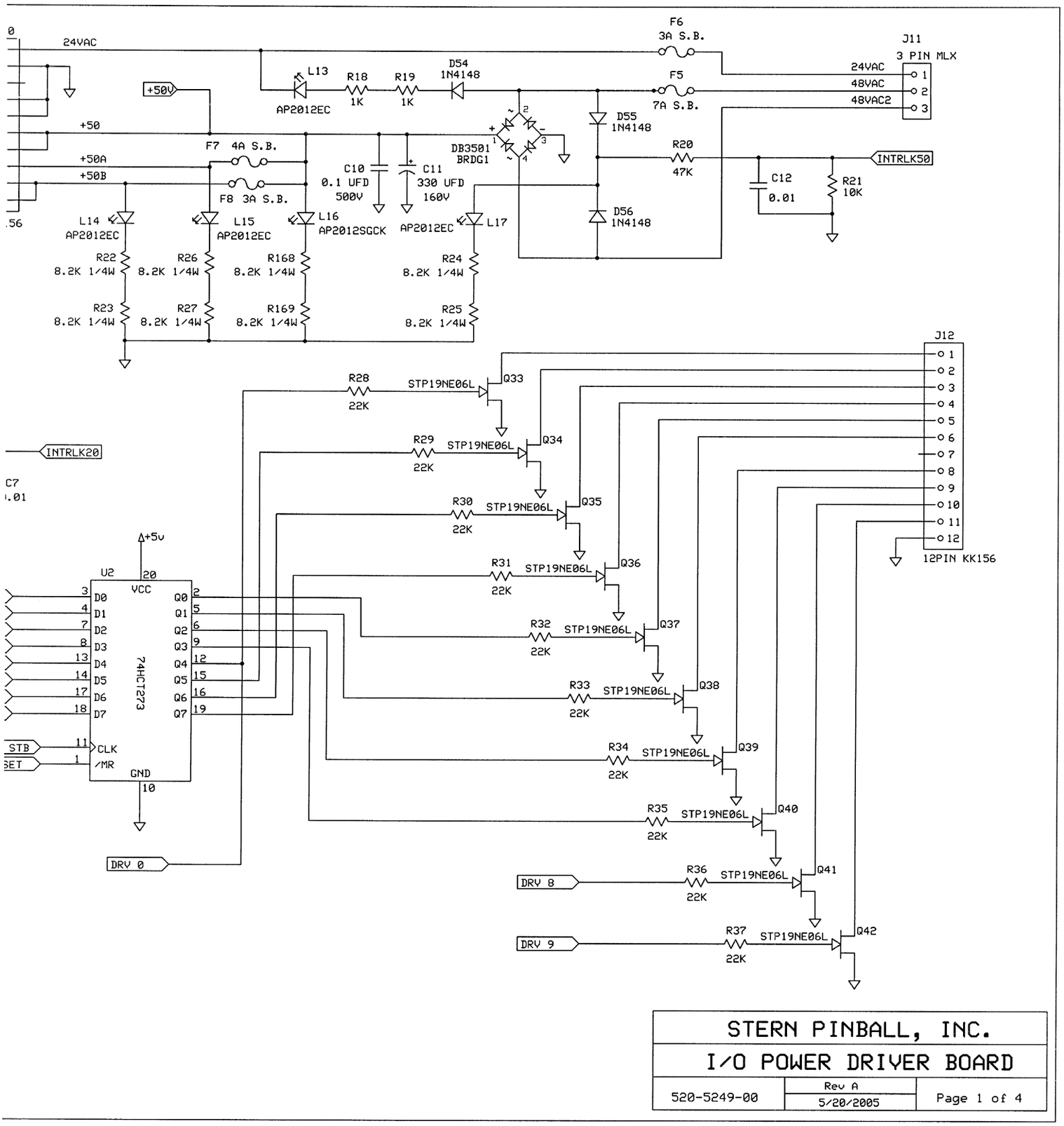
# I/O POWER DRIVER BOARD (S.A.M.) 520-5249-00 (Sheet 1 of 4)






| STERN PINBALL, INC. | | |
|---|---|---|
| I/O POWER DRIVER BOARD | | |
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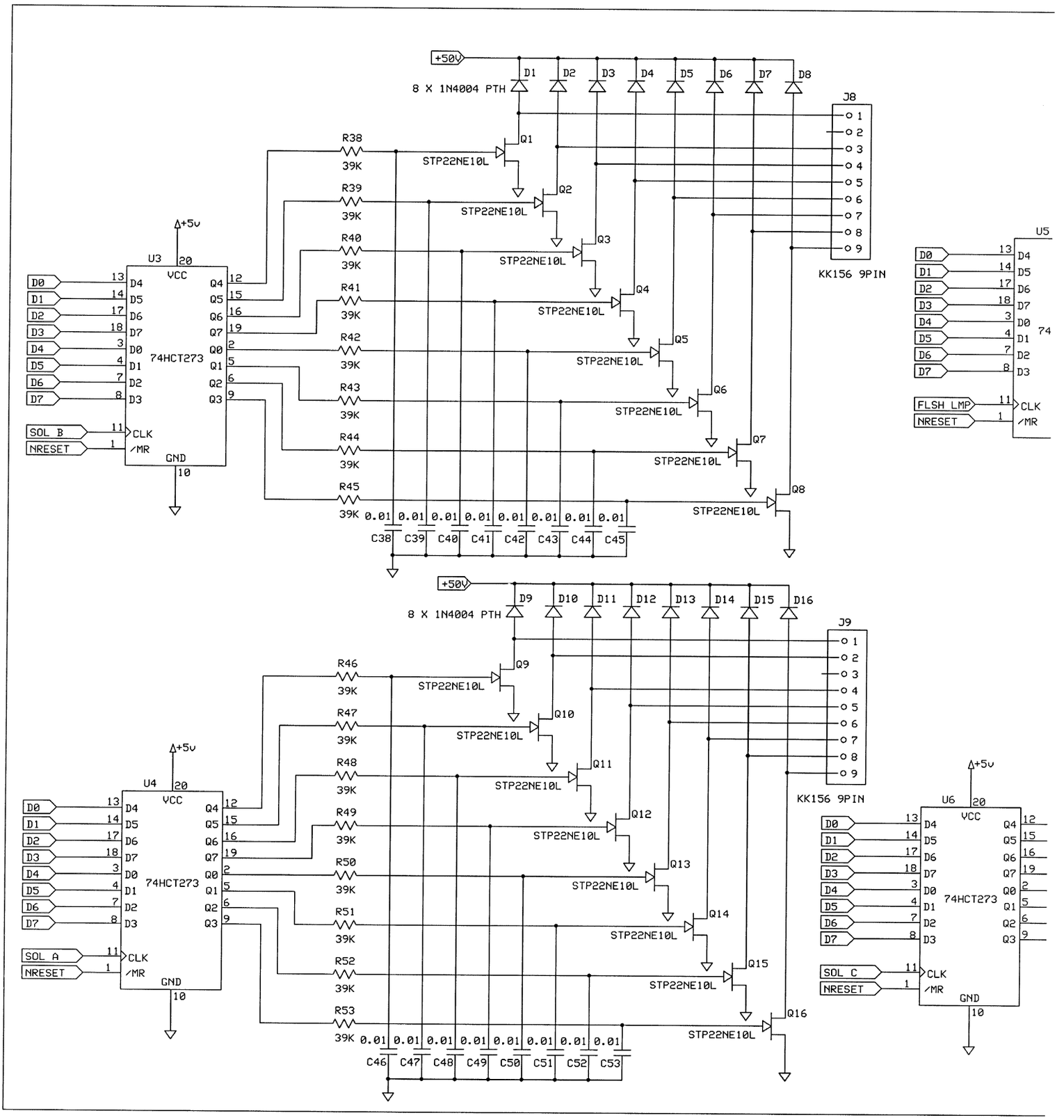
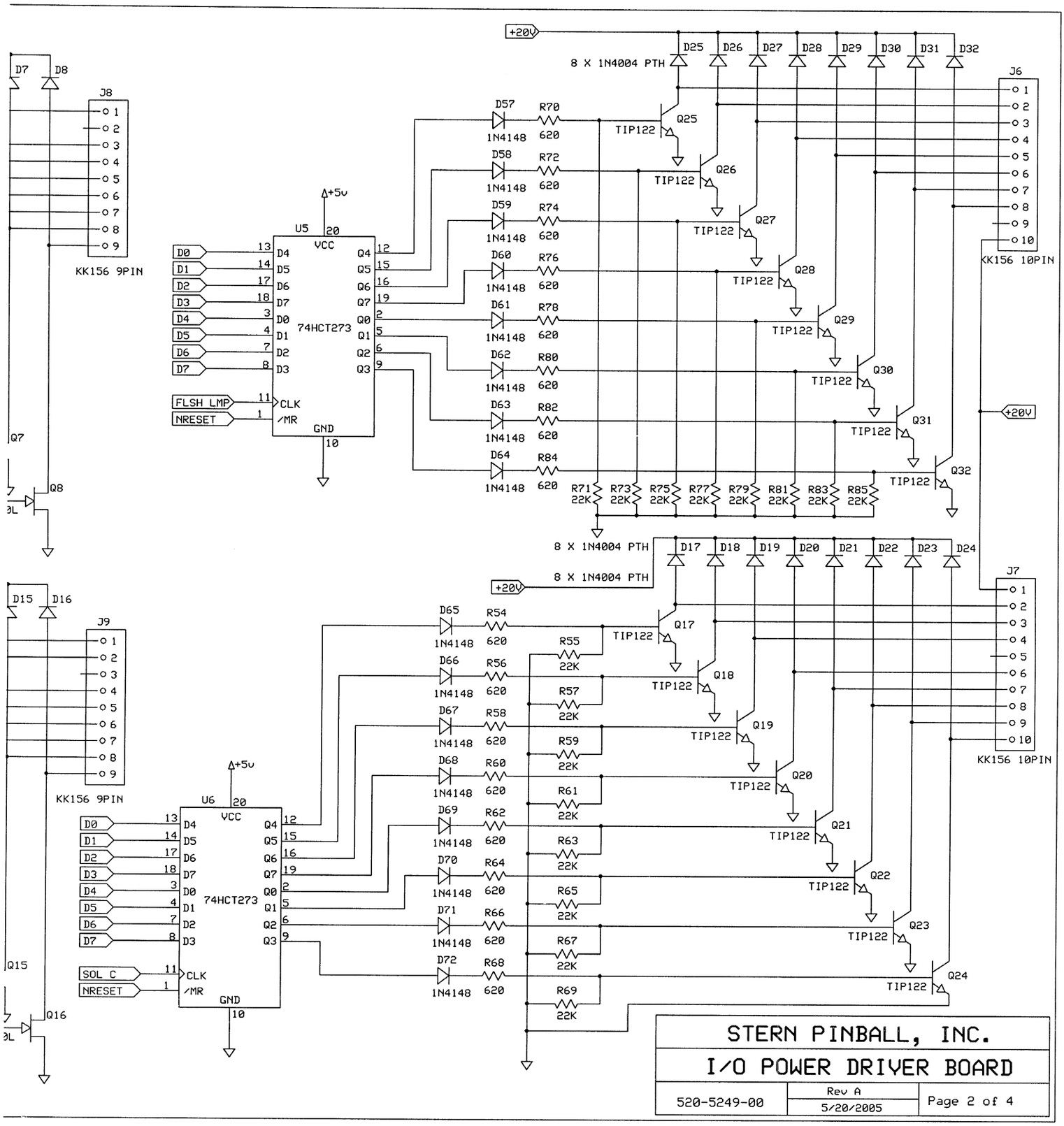





WORLD POKER TOUR

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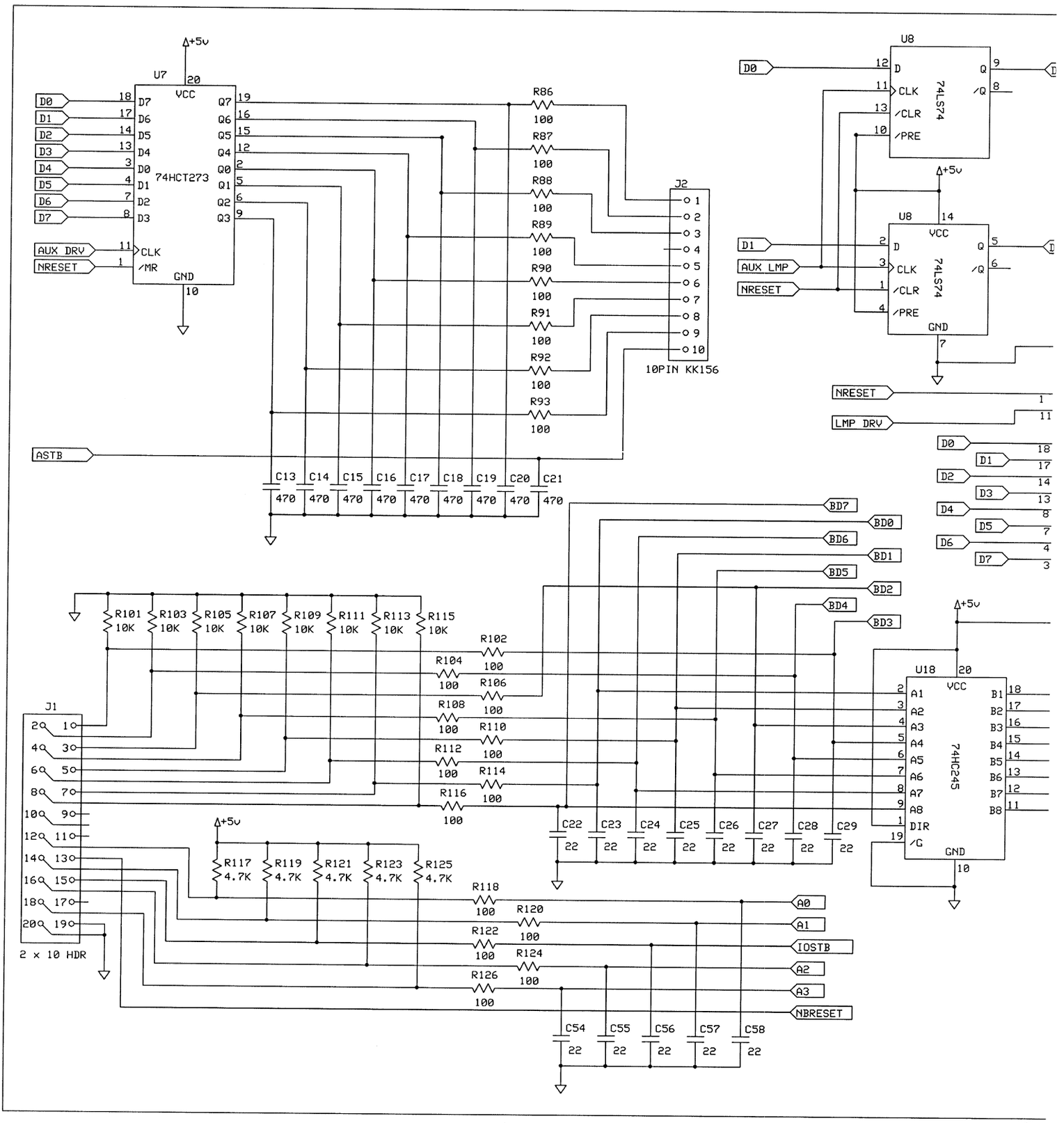
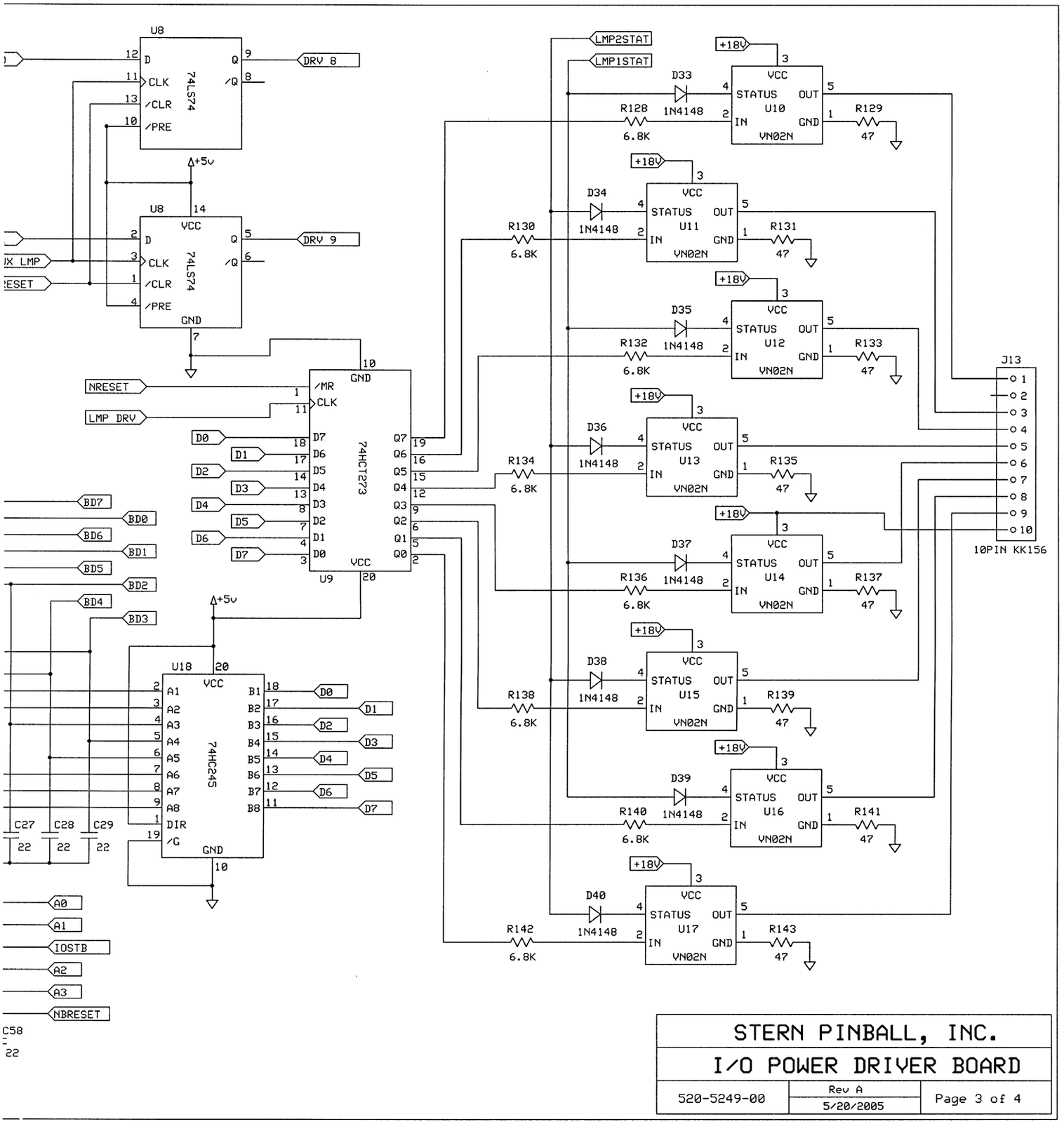

U7
74HCT273
VCC
GND
+5v
D0
D1
D2
D3
D4
D5
D6
D7
AUX DRV
NRESET
CLK
/MR
R86
R87
R88
R89
R90
R91
R92
R93
100
J2
10PIN KK156
ASTB
C13 C14 C15 C16 C17 C18 C19 C20 C21
470
U8
74LS74
/CLR
/PRE
AUX LMP
NRESET
LMP DRV
BD7
BD6
BD5
BD4
BD3
BD0
BD1
BD2
R101 R103 R105 R107 R109 R111 R113 R115
10K
R102 R104 R106 R108 R110 R112 R114 R116
J1
2 x 10 HDR
U18
74HC245
A1 A2 A3 A4 A5 A6 A7 A8
B1 B2 B3 B4 B5 B6 B7 B8
DIR
/G
C22 C23 C24 C25 C26 C27 C28 C29
22
R117 R119 R121 R123 R125
4.7K
R118 R120 R122 R124 R126
A0
A1
IOSTB
A2
A3
NBRESET
C54 C55 C56 C57 C58

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| I/O POWER DRIVER BOARD | | |
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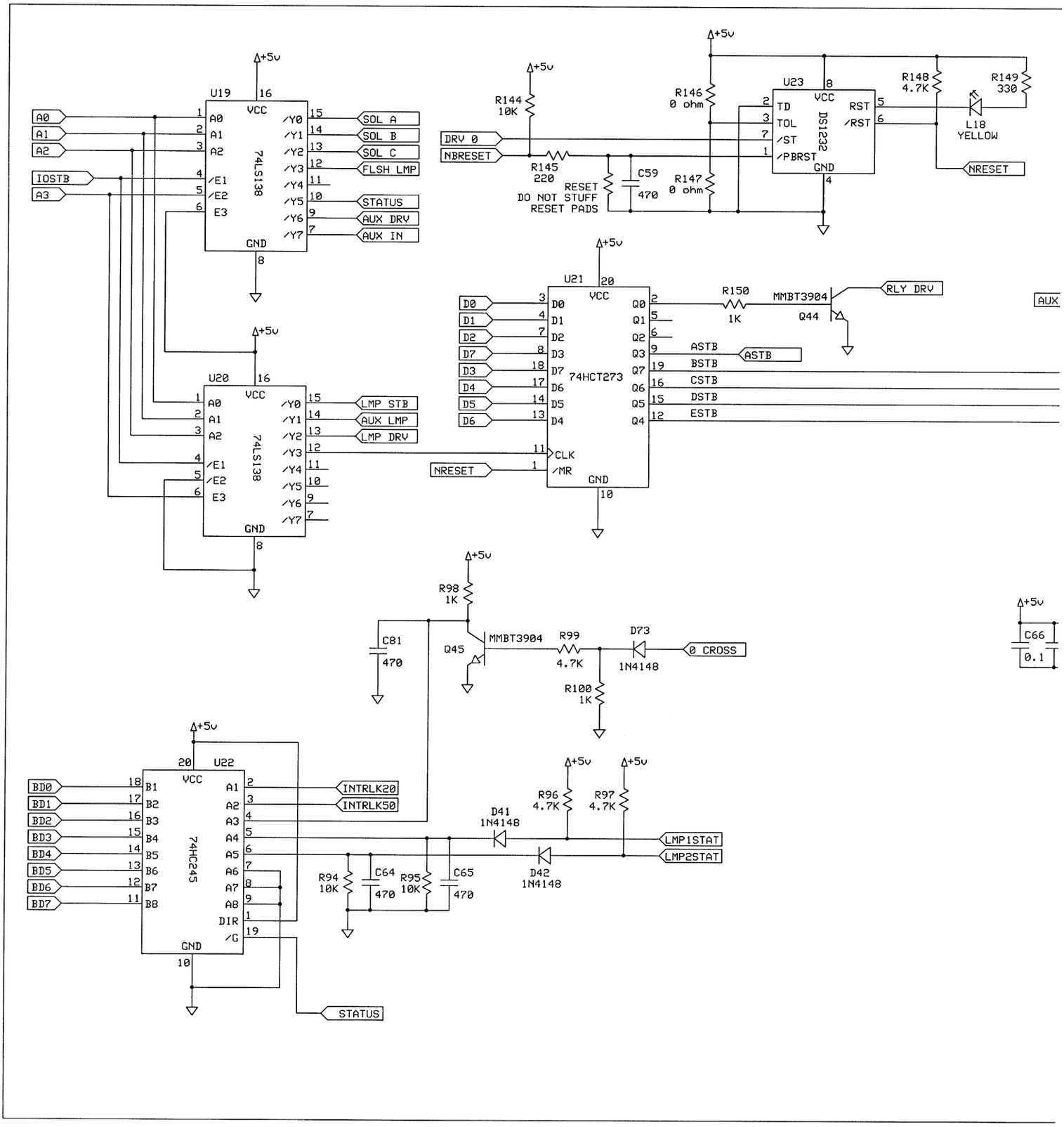
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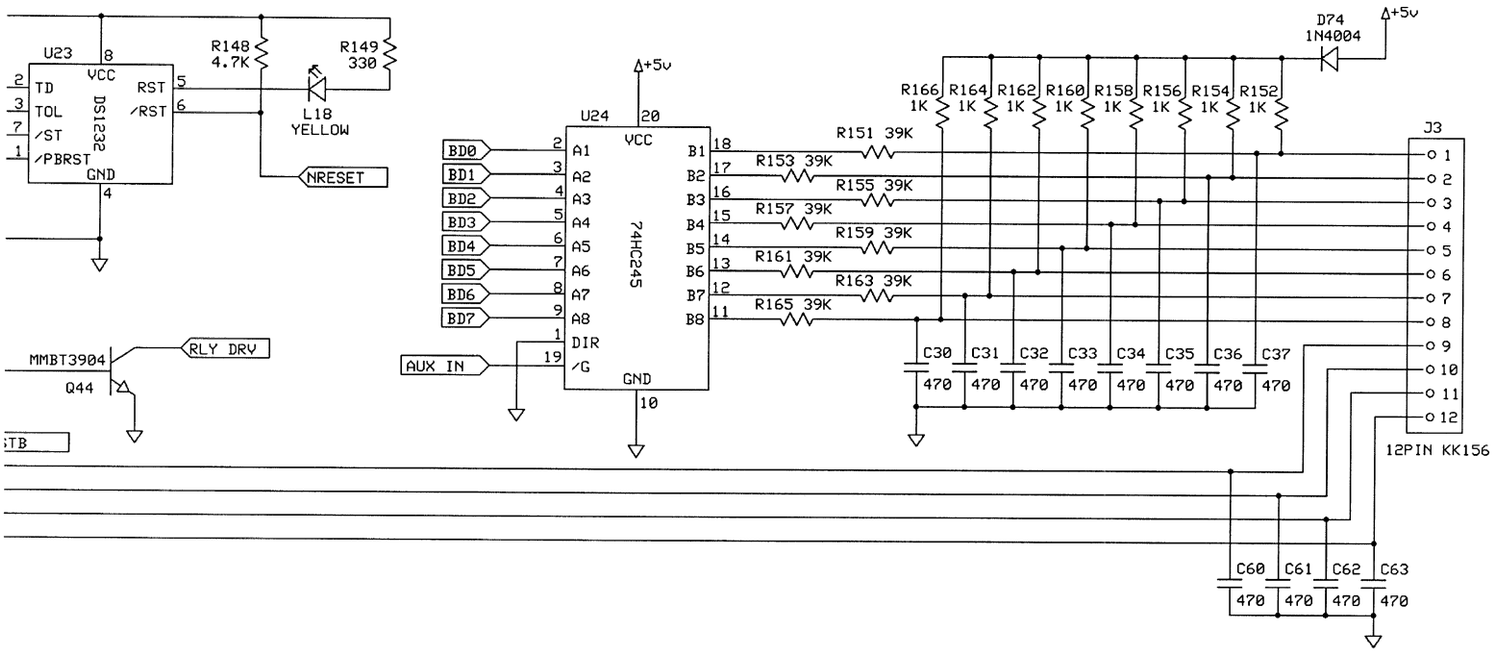
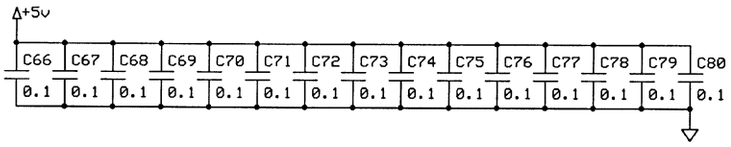
74LS138
A0
A1
A2
IOSTB
A3
/E1
/E2
E3
GND
VCC
/Y0
/Y1
/Y2
/Y3
/Y4
/Y5
/Y6
/Y7
SOL A
SOL B
SOL C
FLSH LMP
STATUS
AUX DRV
AUX IN
+5v
U20
74LS138
LMP STB
AUX LMP
LMP DRV
U21
74HCT273
D0
D1
D2
D7
D3
D4
D5
D6
Q0
Q1
Q2
Q3
Q7
Q6
Q5
Q4
CLK
/MR
NRESET
ASTB
BSTB
CSTB
DSTB
ESTB
R150
1K
MMBT3904
Q44
RLY DRV
AUX
U23
DS1232
TD
TOL
/ST
/PBRST
RST
/RST
R144
10K
R145
220
RESET
DO NOT STUFF
RESET PADS
C59
470
R146
0 ohm
R147
0 ohm
R148
4.7K
R149
330
L18
YELLOW
DRV 0
NBRESET
R98
1K
C81
470
Q45
R99
4.7K
D73
1N4148
0 CROSS
R100
1K
C66
0.1
U22
74HC245
BD0
BD1
BD2
BD3
BD4
BD5
BD6
BD7
B1
B2
B3
B4
B5
B6
B7
B8
A1
A2
A3
A4
A5
A6
A7
A8
DIR
/G
INTRLK20
INTRLK50
R96
4.7K
R97
4.7K
D41
1N4148
D42
1N4148
LMP1STAT
LMP2STAT
R94
10K
C64
470
R95
10K
C65
470

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|---|---|---|
| I/O POWER DRIVER BOARD | | |
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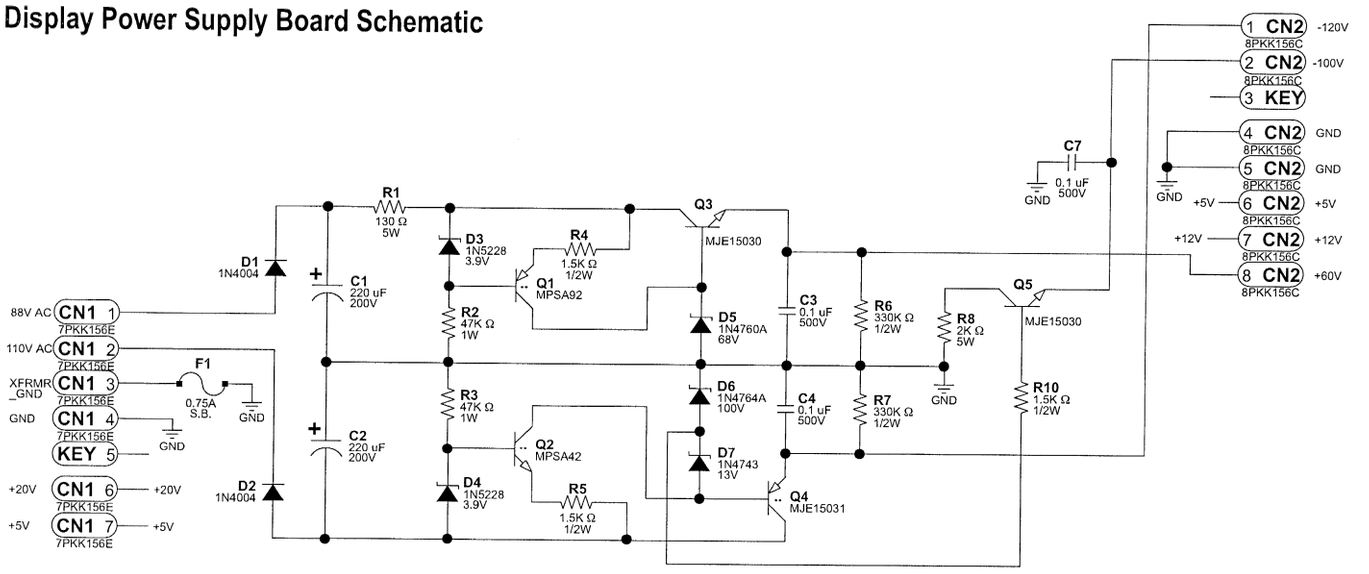
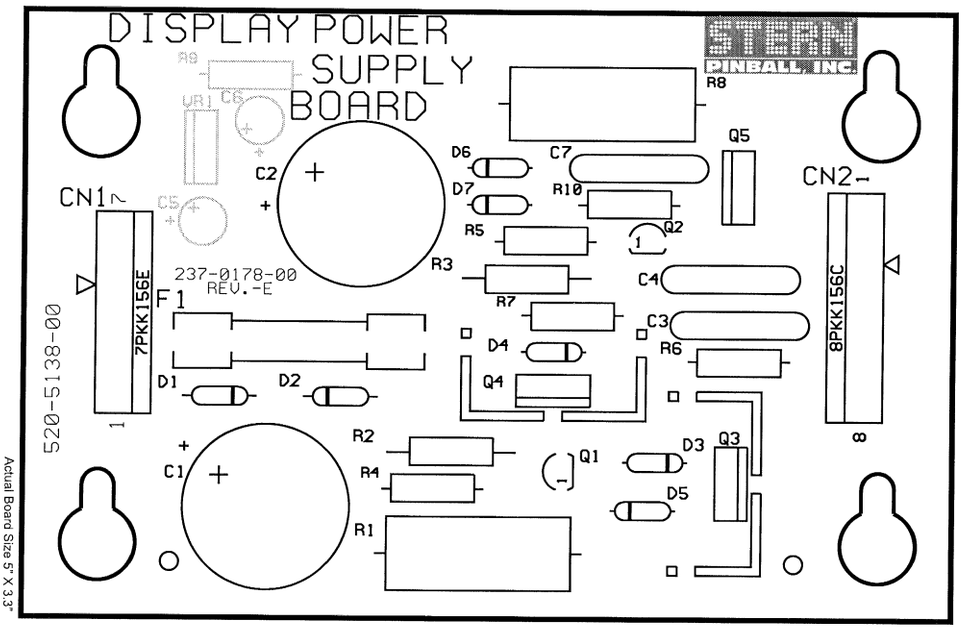
## Display Power Supply Board Schematic



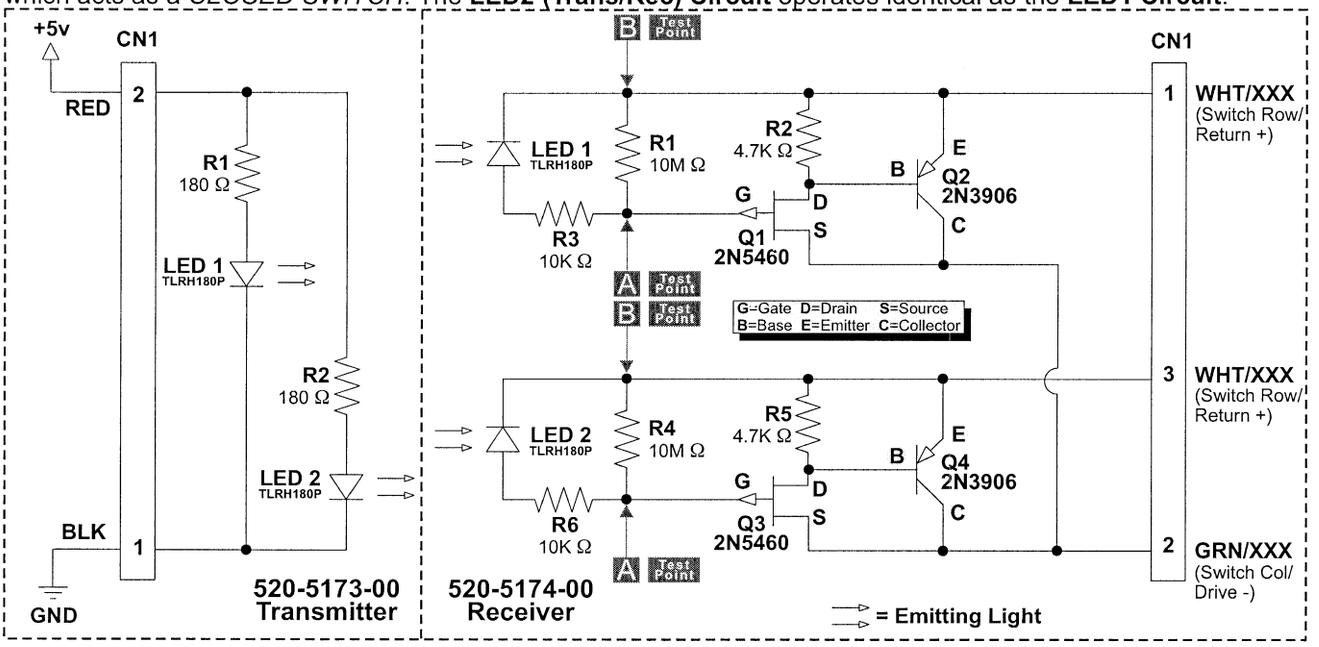

## Display Power Supply Board Component Layout & Parts



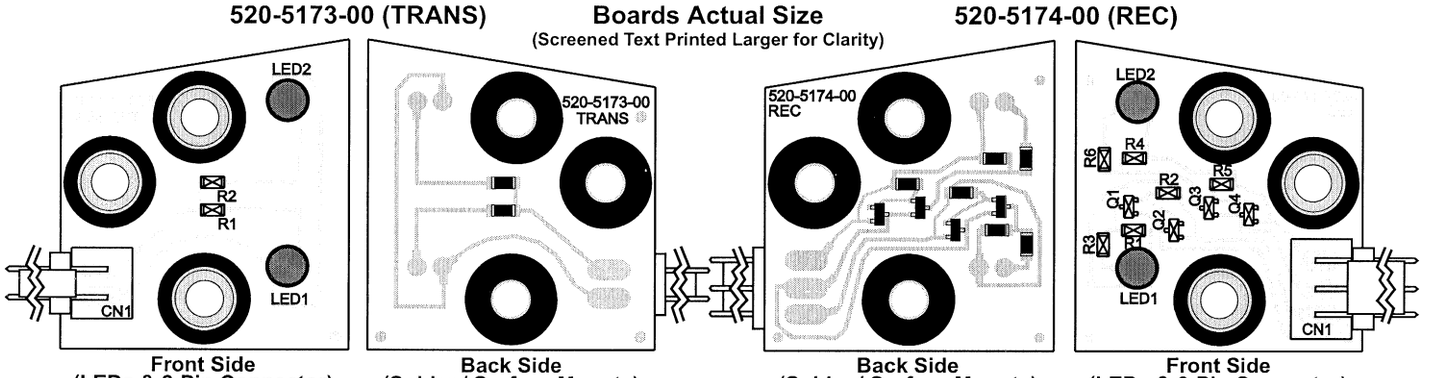

| ITEM | QTY | PART NUMBER | REF-DESIGNATOR | DESCRIPTION (NS = Not Stuffed) |
|---|---|---|---|---|
| — | 1 | **520-5138-00** | **Display Power Supply Board** | **Complete PCB Assembly** |
| 01 | 2 | 125-5044-00 | C1, C2 | 220uF, 200v, Radial Lytic Cap. |
| 02 | 3 | 125-5035-00 | C3, C4, C7 | 0.1uF, 500v, Ceramic Disk Cap. |
| C2 | 1 | 125-5008-00 | (C5, C6: NS) | 22uF, 35v, Rad Lytic Cap |
| 04 | 1 | 045-5015-07 | CN1 | 7PKK156E (PIN5=KEY) |
| 05 | 1 | 045-5015-08 | CN2 | 8PKK156 (PIN3=KEY) |
| 06 | 2 | 112-5003-00 | D1, D2 | 1N4004, Diode |
| 07 | 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

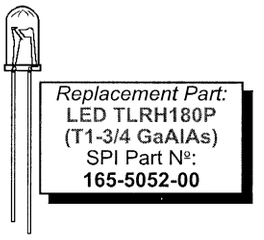
As light from the **Transmitter LED1** falls on the **Receiver LED1**, it generates a Positive Bias Voltage (0.7v to 1.5v) which is applied to the **Gate** (**G**) of **Q1 (Fet 2N5460)** turning **Q1** off. When **Q1** is held off, no current flows through **Q2**'s **(2N3906) Base** (**B**). With no *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




| 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 Nº:
**165-5052-00**

# 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):

Fig. A

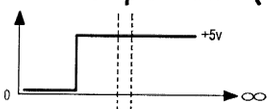
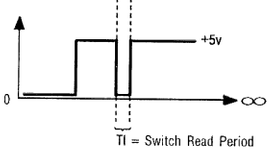



Fig. B




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.

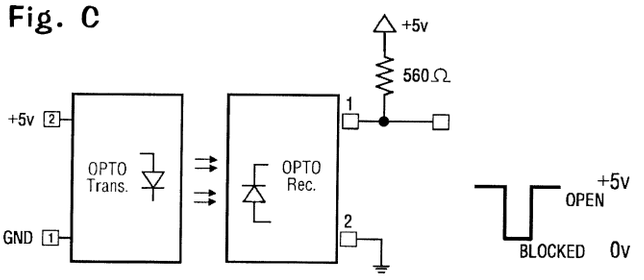
B. **CLOSED OPTO** (Light Blocked) = *SWITCH CLOSED.* Place Scope lead at **Pin-1** of OPTO Rec. Board with Scope Grounded (see Schematic). The Scope should display a **PULSE STREAM** indicating **Q2** has switched "On" as shown in **Fig. B**, Wave Form Diagram. This is your Switch Drive Pulse.

## 3. Bench Test (See Fig. C):

*Please Note: To perform this test you must use a spare 560Ω Pull-Up Resistor, SPI Nº: 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.***

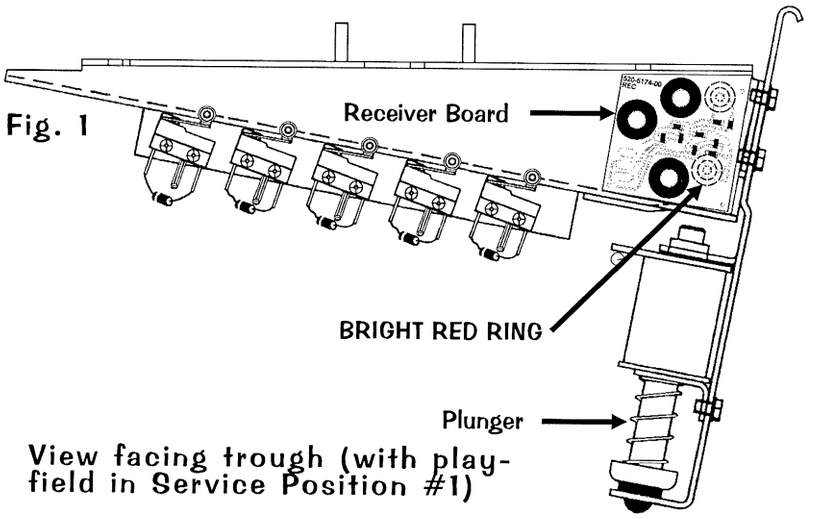
Fig. C




## Trough Dual OPTO Boards Alignment / Test for LED1

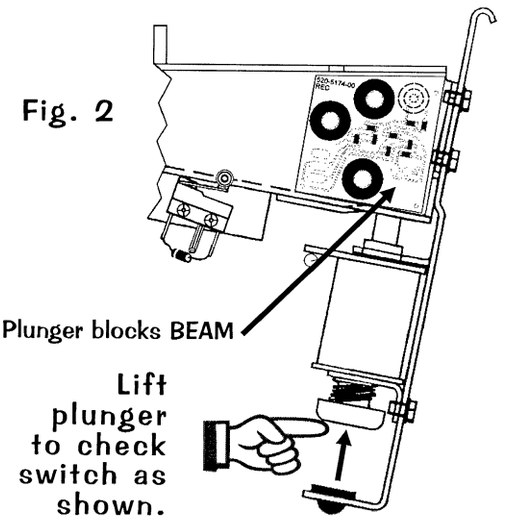
When a working **OPTO** is installed and connected in a game, the transmitter should light *(LED1 lower & LED2 upper)* when the power is switched on. With the playfield in **Service Position #1** *(playfield lifted up in the half-way position resting on the Prop Rod or edge slide support brackets)* and 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. 1

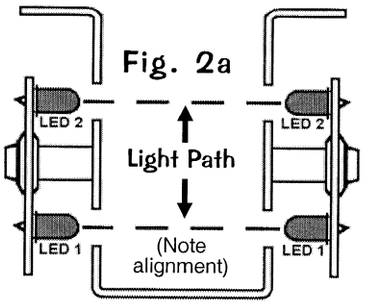


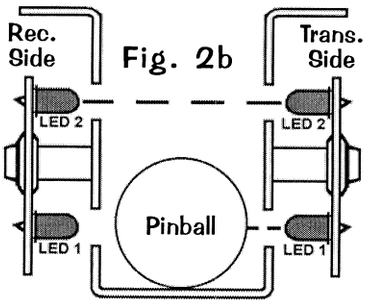

View facing trough (with playfield in Service Position #1)

Fig. 2



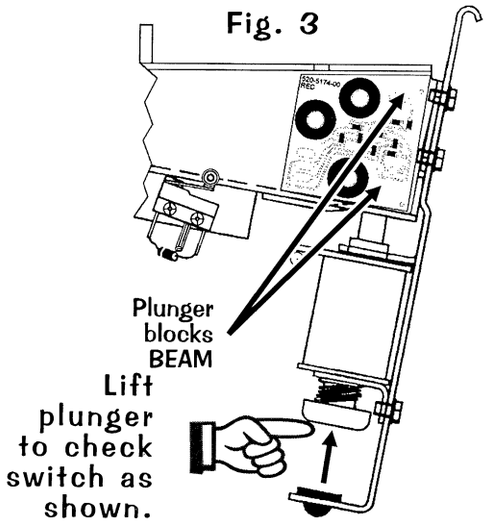
## Sectional view from right (Fig. 2a & 2b)

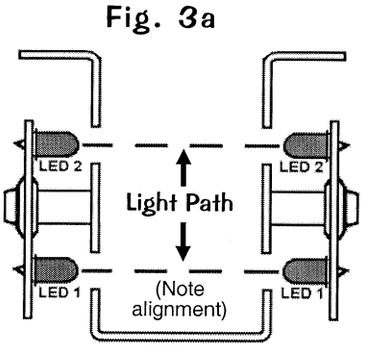


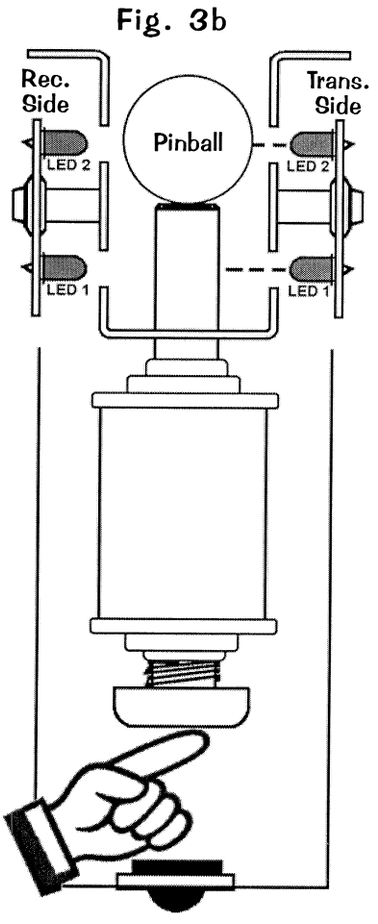




## Trough Dual OPTO Boards Alignment / Test for LED2

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**).*

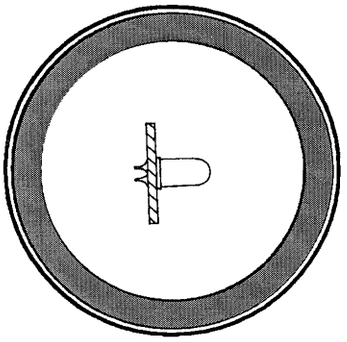


**Fig. 4a**
**Correct Position**

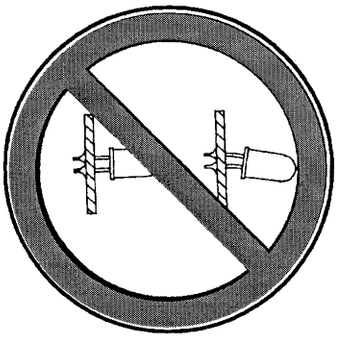
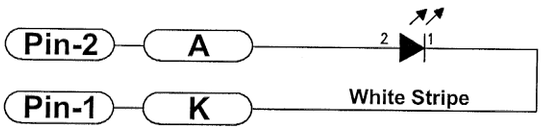
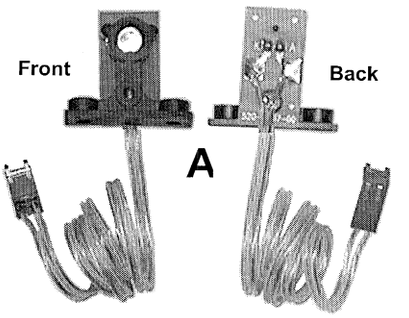


**Fig. 4b**
**Incorrect Position**

# Playfield Switches OPTO Transceiver Boards Schematic, Component Layout & Parts



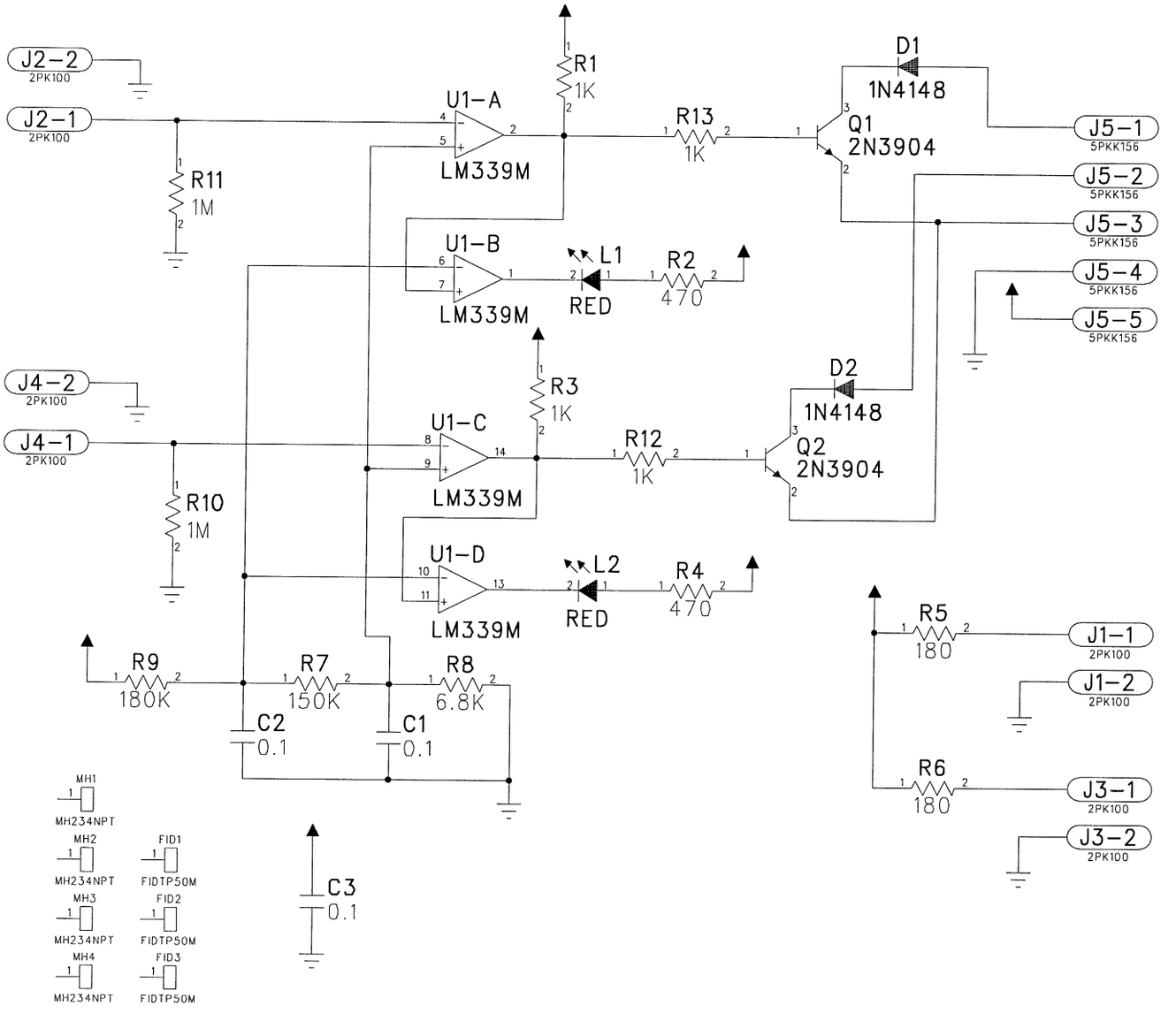

## Mini PCB OPTO 12" Lead (Black Bracket) 500-6775-00



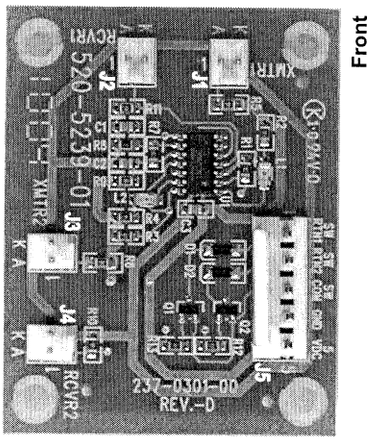

| ITEM | QTY | PART NUMBER | REF-DESIGNATOR | DESCRIPTION |
|---|---|---|---|---|
| A | 8 | **500-6775-00** | | **MINI PCB OPTO ASM WHT / 12" LEAD** |
| — | **1** | 520-5237-00 | | **Mini OPTO Trans. or Rec. Board** |
| 01 | 1 | 545-6092-00 | | |
| 02 | 1 | 237-5909-00 | | |
| **03** | **1** | **165-5052-00** | | |
| 04 | 1 | 601-5023-12 | K, A | |
| 05 | 1 | 045-5020-02 | *Note White Strip to Pin-1* | |

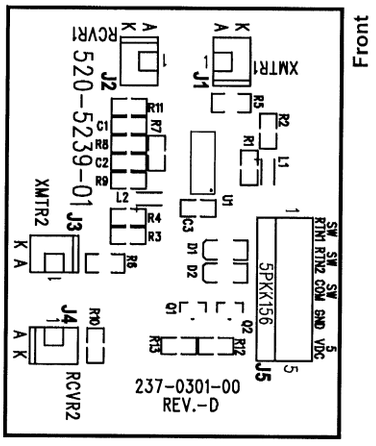
**PCB Assy.** (with all **Items 1-5**)
**PCB Only Plain**
Black Bracket (Plastic) Holder
#4-40 X 1/4 PPH Screw
**LED (Ultra Bright Red)**
12" Speaker Wire (1-Side White Stripe)
2-Pin Cn., .100 **KK Cmp Trm** Molex 08-50-0113

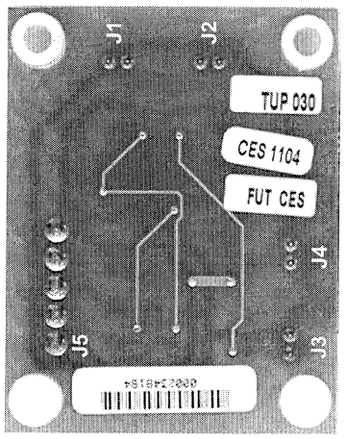
## Playfield OPTO Transmitter / Receiver Amplifier Board Schematic



## Playfield OPTO Transmitter/Receiver Amplifier Board Component Layout & Parts
(for OPTO Switches 52, 54, 56 & 59)



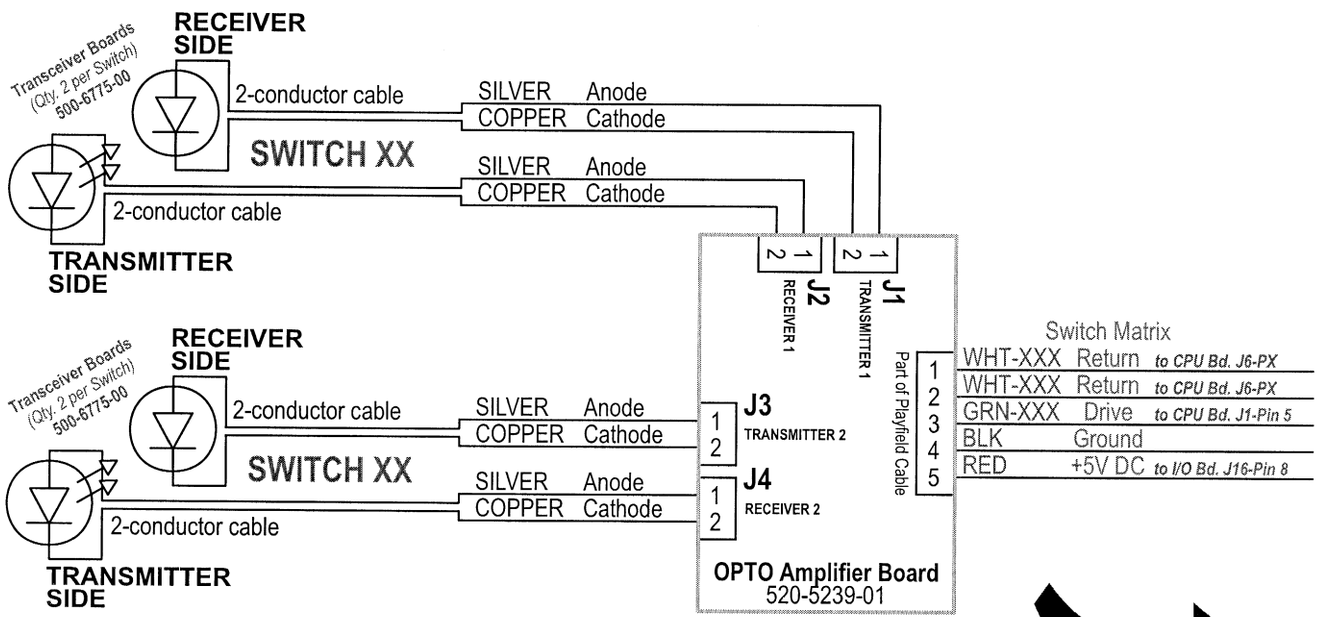




| ITEM | QTY | PART NUMBER | REF-DESIGNATOR |
|---|---|---|---|
| — | **2** | **520-5239-01** | **OPTO Transmitter/Receiver Amplifier Board** |
| 01 | 1 | | R7 |
| 02 | 2 | | R5, R6 |
| 03 | 1 | *If a part is required where a part number is not provided, call Technical Support (see back of cover).* | R9 |
| 04 | 4 | | R1, R3, R12, R13 |
| 05 | 2 | | R10, R11 |
| 06 | 2 | | R2, R4 |
| 07 | 1 | | R8 |
| 08 | 3 | | C1, C2, C3 |
| 09 | 2 | | D1, D2 |
| 10 | 2 | | Q1, Q2 |
| 11 | 1 | | U1 |
| 12 | 4 | Mfg. 22-23-2021 | J1, J2, J3, J4 |
| 13 | 1 | Mfg. 640445-5 | J5 |
| 14 | 2 | Mfg. **APT3216SURC** | L1, L2 |
| 15 | 4 | | n/a |

**DESCRIPTION**

**Complete PCB Assembly**
SMT 150K Ω 1/10W Resistor 805, 5%
SMT 180 Ω 1/10W Resistor 805, 5%
SMT 180K Ω 1/10W Resistor 805, 5%
SMT 1K Ω 1/10W Resistor 805, 5%
SMT 1M Ω 1/10W Resistor 805, 5%
SMT 470 Ω 1/10W Resistor 805, 5%
SMT 6.8K Ω 1/10W Resistor 805, 5%
SMT Cer. .1uF 50v Cap., 10% X7R
1N4148W, Diode, 100v, 350MW
MMST3904, NPN, 40v, .02A
LM339M, Low Power Offset QUA
2-Pin, 0.1 Header (1 Row, VT, Tin)
5-Pin, .156 Header (1 Row, VT, Tin)
LEDD-SMT, Red 1206
**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.*

Rear View of the Backpanel

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

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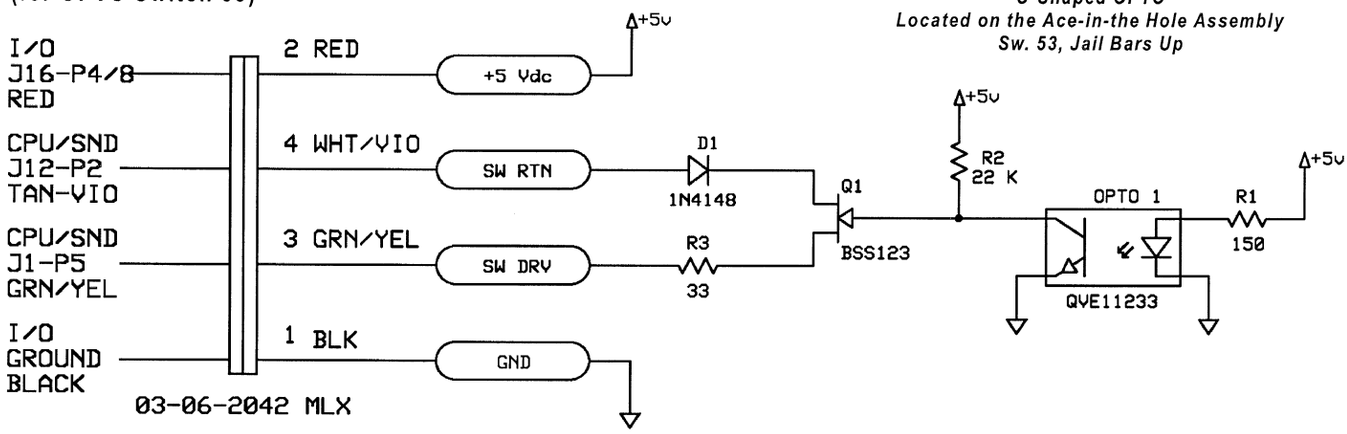
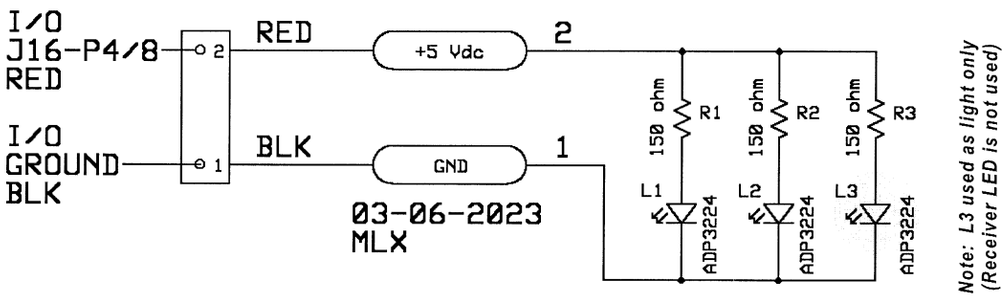
## OPTO Interrupter (520-5251-00) Schematic
(for OPTO Switch 63)

*U-Shaped OPTO*
*Located on the Ace-in-the Hole Assembly*
*Sw. 53, Jail Bars Up*



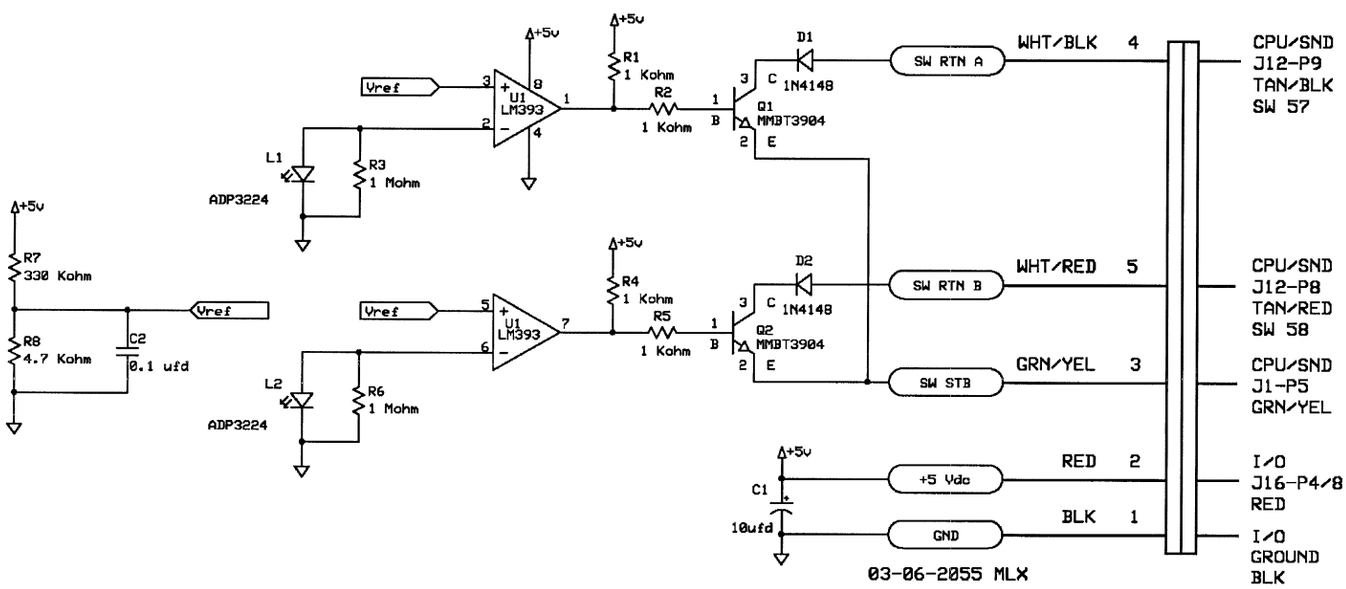

## OPTO Transmitter (520-5247-00) Schematic
(for OPTO Switches 57 [front] & 58 [rear])

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



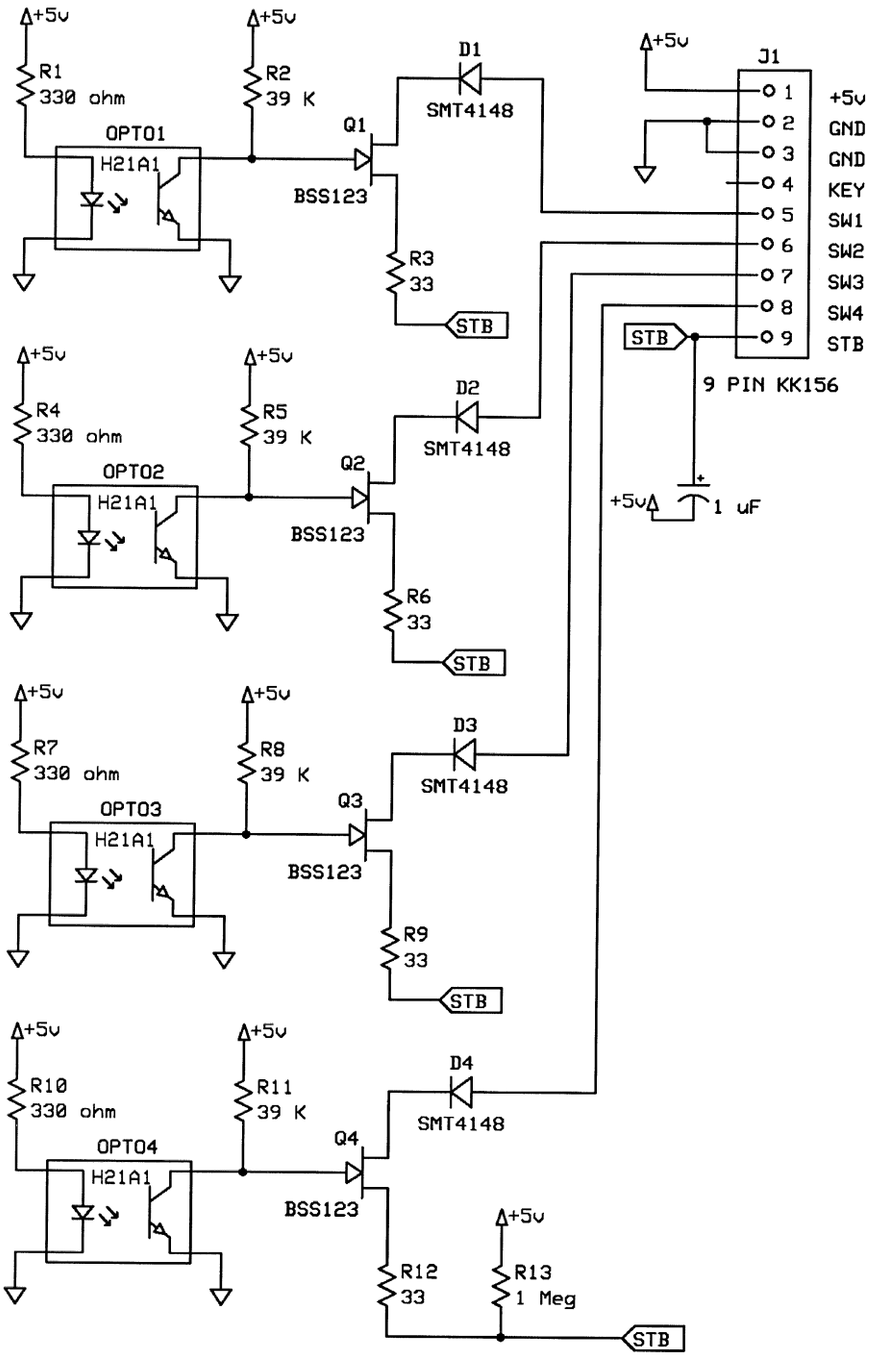

## OPTO Receiver (520-5248-00) Schematic
(for OPTO Switches 57 [front] & 58 [rear])

*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 | | |
| 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 | | |
| 4 | KEY | |
| 5 | WHT-BRN SW 33 | CPU/SND J6-P9 |
| 6 | WHT-RED SW 34 | CPU/SND J6-P8 |
| 7 | WHT-ORG SW 35 | CPU/SND J6-P7 |
| 8 | WHT-YEL SW 36 | CPU/SND J6-P6 |
| 9 | GRN-ORG (DRV) | CPU/SND J1-P4 |

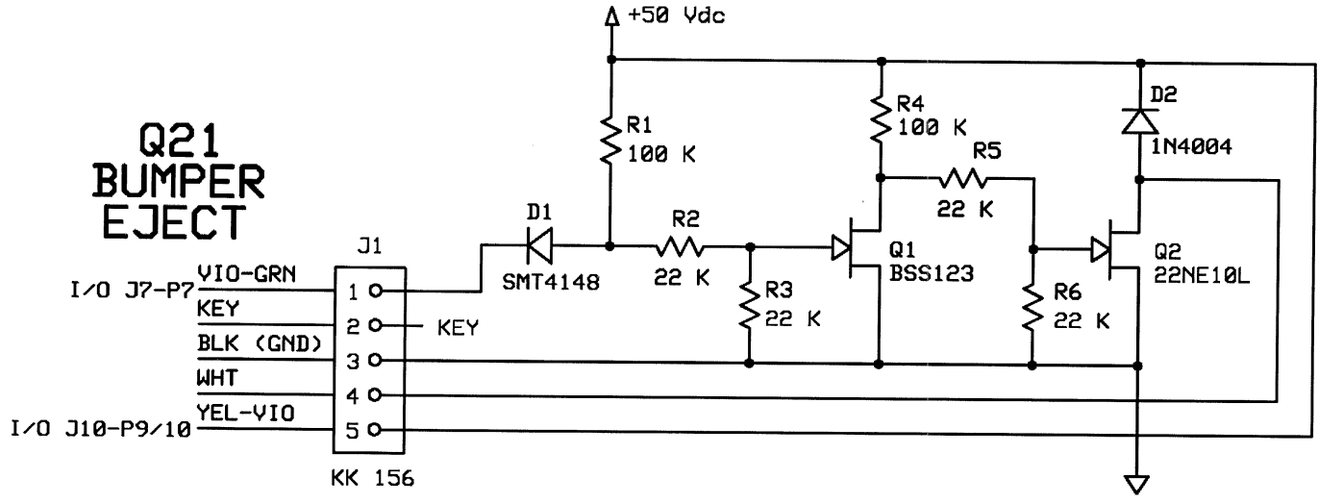
### 4-BANK DROP TARGET (MIDDLE)

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

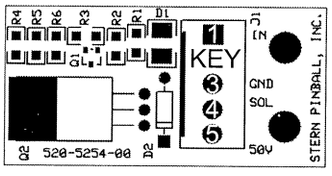
### 4-BANK DROP TARGET (RIGHT)

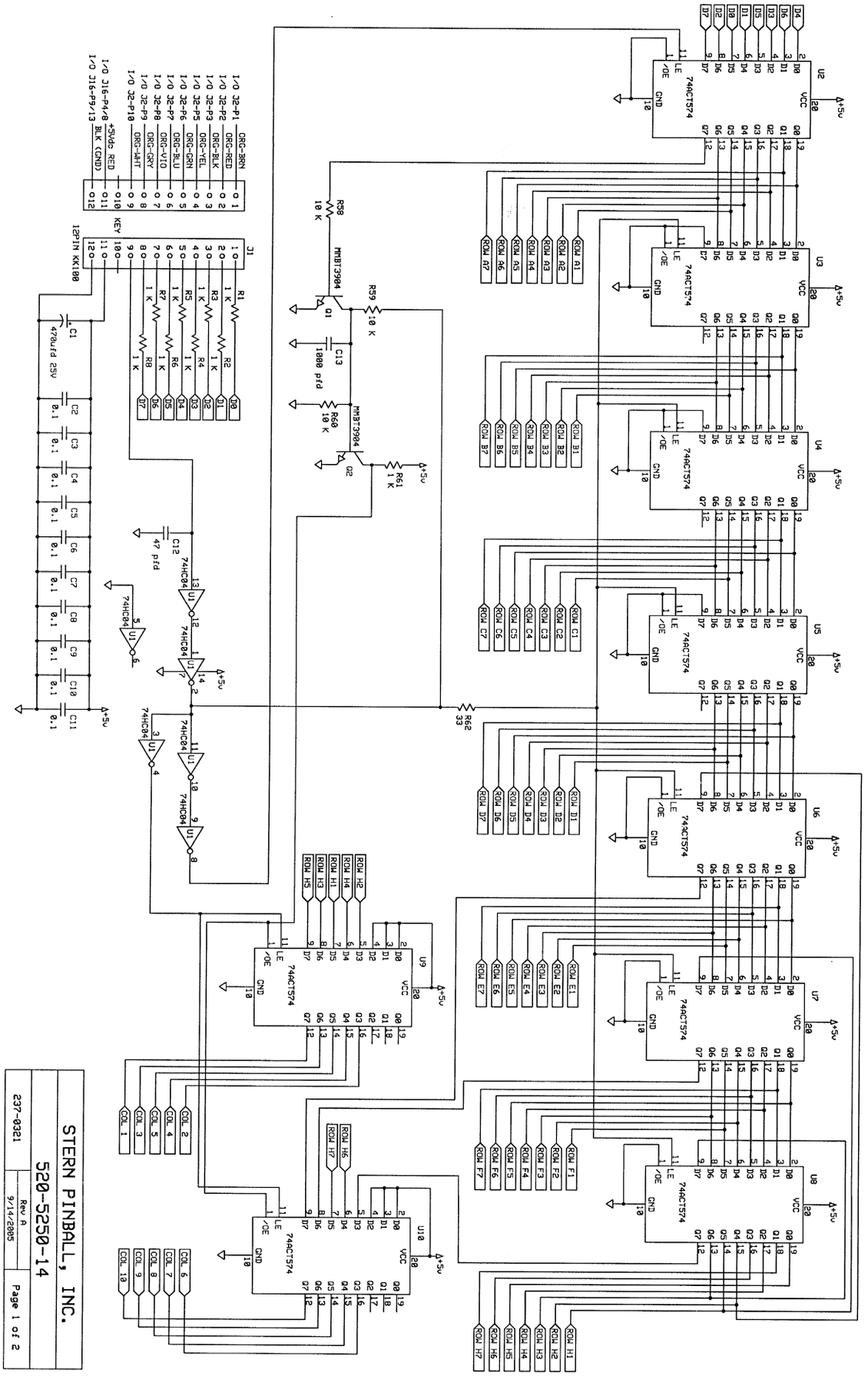
| | | |
|---|---|---|
| 1 | RED +5 Vdc | I/O J16-P4/8 |
| 2 | BLK GND | I/O J16-9/13 |
| 3 | | |
| 4 | KEY | |
| 5 | WHT-VIO SW 7 | CPU/SND J6-P2 |
| 6 | WHT-BLU SW 6 | CPU/SND J6-P3 |
| 7 | WHT-GRN SW 5 | CPU/SND J6-P5 |
| 8 | WHT-YEL SW 4 | CPU/SND J6-P6 |
| 9 | GRN-BRN (DRV) | CPU/SND J1-P1 |

## 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))



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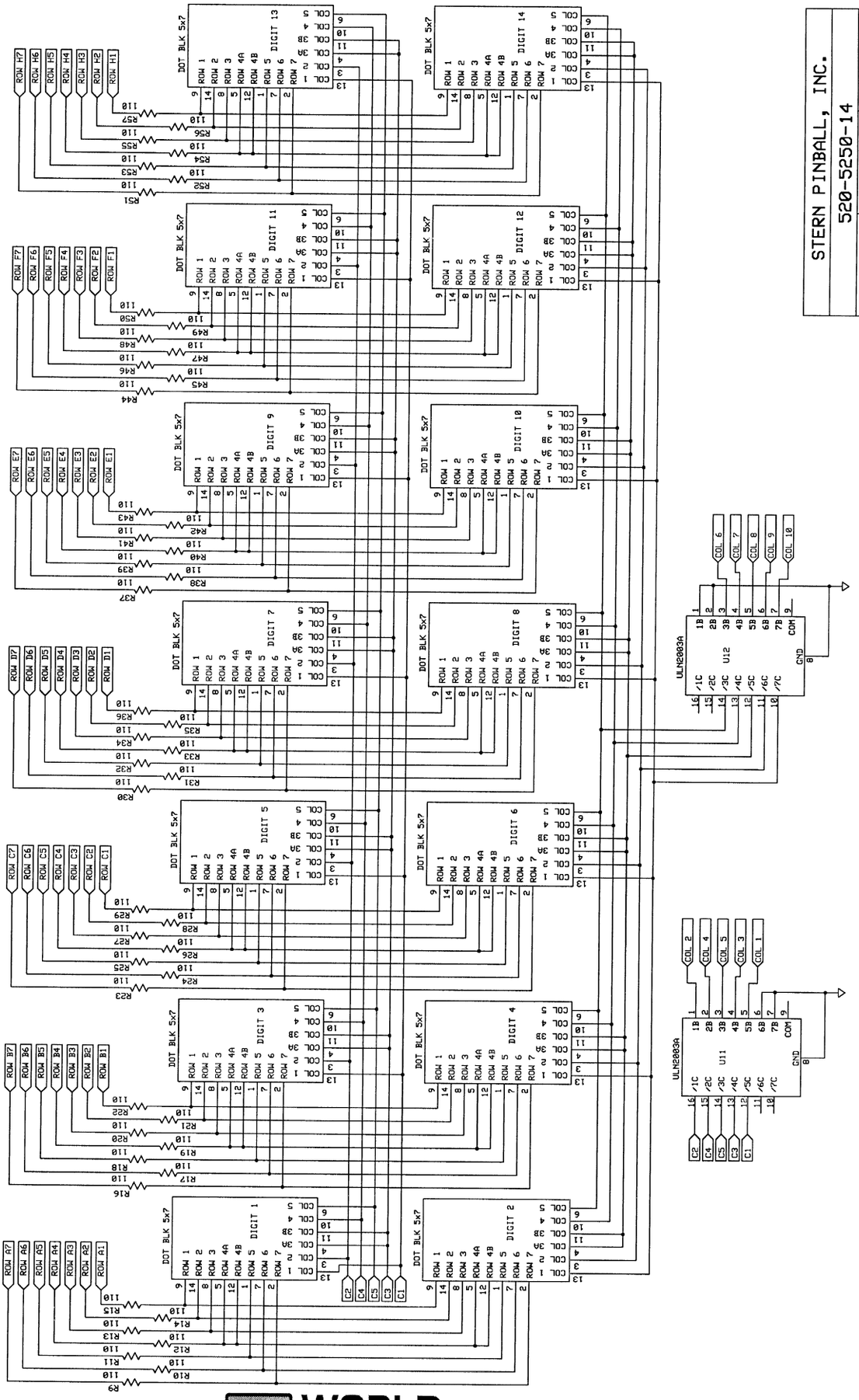
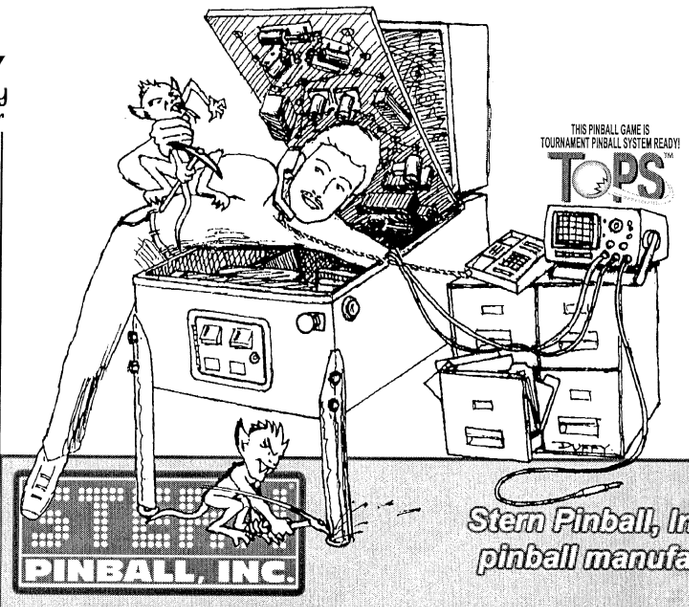

STERN PINBALL, INC.
520-5250-14
Rev A
9/14/2005
237-0321
Page 2 of 2
DOT BLK 5x7
DIGIT 13
DIGIT 14
DIGIT 11
DIGIT 12
DIGIT 9
DIGIT 10
DIGIT 7
DIGIT 8
DIGIT 5
DIGIT 6
DIGIT 3
DIGIT 4
DIGIT 1
DIGIT 2
ROW 1
ROW 2
ROW 3
ROW 4A
ROW 4B
ROW 5
ROW 6
ROW 7
COL 1
COL 2
COL 3
COL 4
COL 5
COL 6
COL 7
COL 8
COL 9
COL 10
ROW H7
ROW H6
ROW H5
ROW H4
ROW H3
ROW H2
ROW H1
ROW F7
ROW F6
ROW F5
ROW F4
ROW F3
ROW F2
ROW F1
ROW E7
ROW E6
ROW E5
ROW E4
ROW E3
ROW E2
ROW E1
ROW D7
ROW D6
ROW D5
ROW D4
ROW D3
ROW D2
ROW D1
ROW C7
ROW C6
ROW C5
ROW C4
ROW C3
ROW C2
ROW C1
ROW B7
ROW B6
ROW B5
ROW B4
ROW B3
ROW B2
ROW B1
ROW A7
ROW A6
ROW A5
ROW A4
ROW A3
ROW A2
ROW A1
ULN2003A
U12
U11
COM
GND
C2
C4
C5
C3
C1

▼ U.S. ▼
Customary
Inch Ruler

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2020 Janice Avenue
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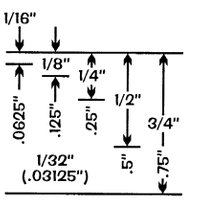
### Metric Conversion




**1" = 2.54 cm *or* 25.4 mm**
**1 cm = .3937"**
**1 mm = .03937"**

*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"**

# 1-800-5KICK3RS

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