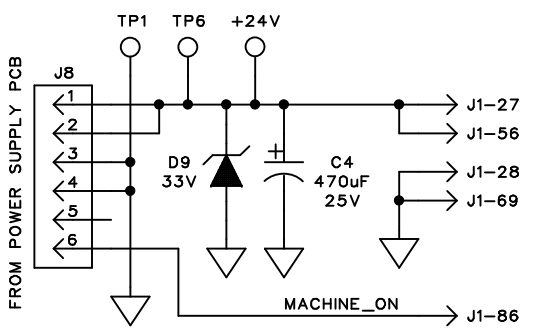
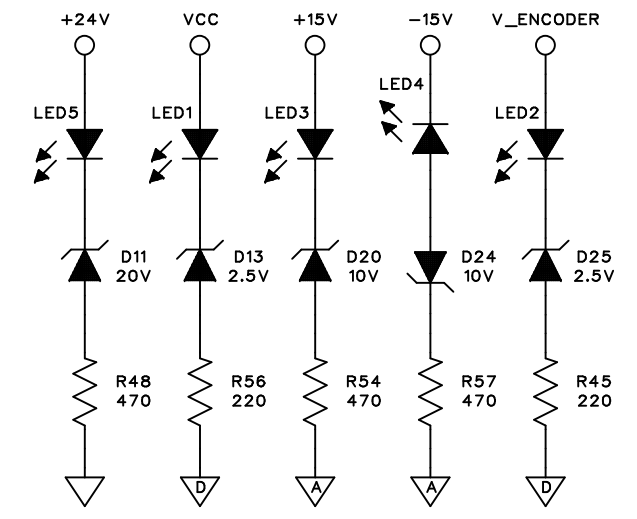
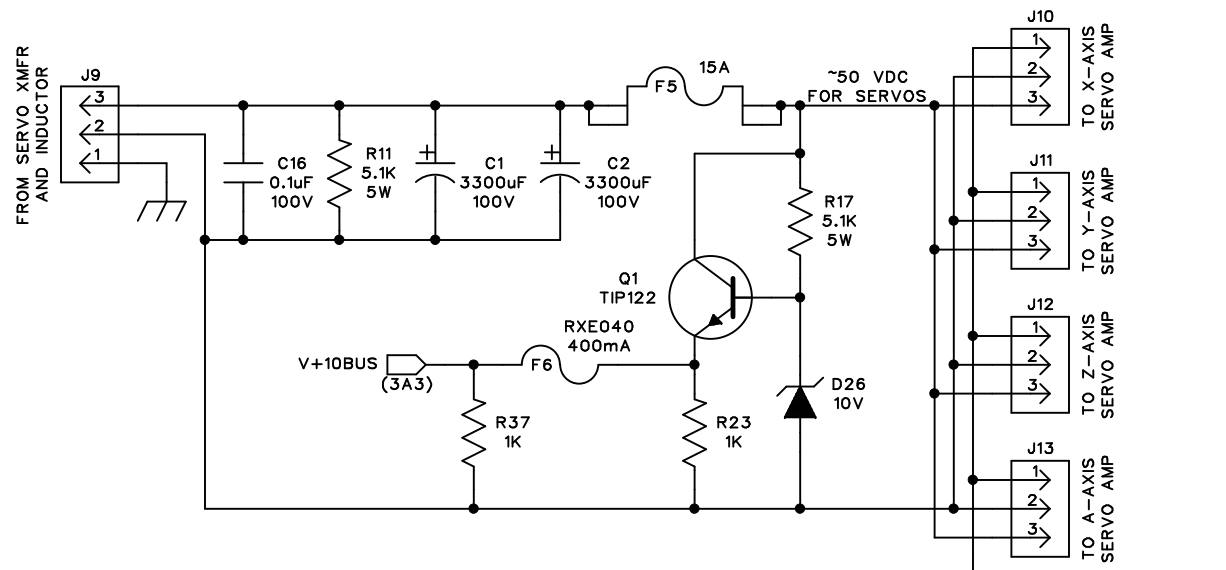
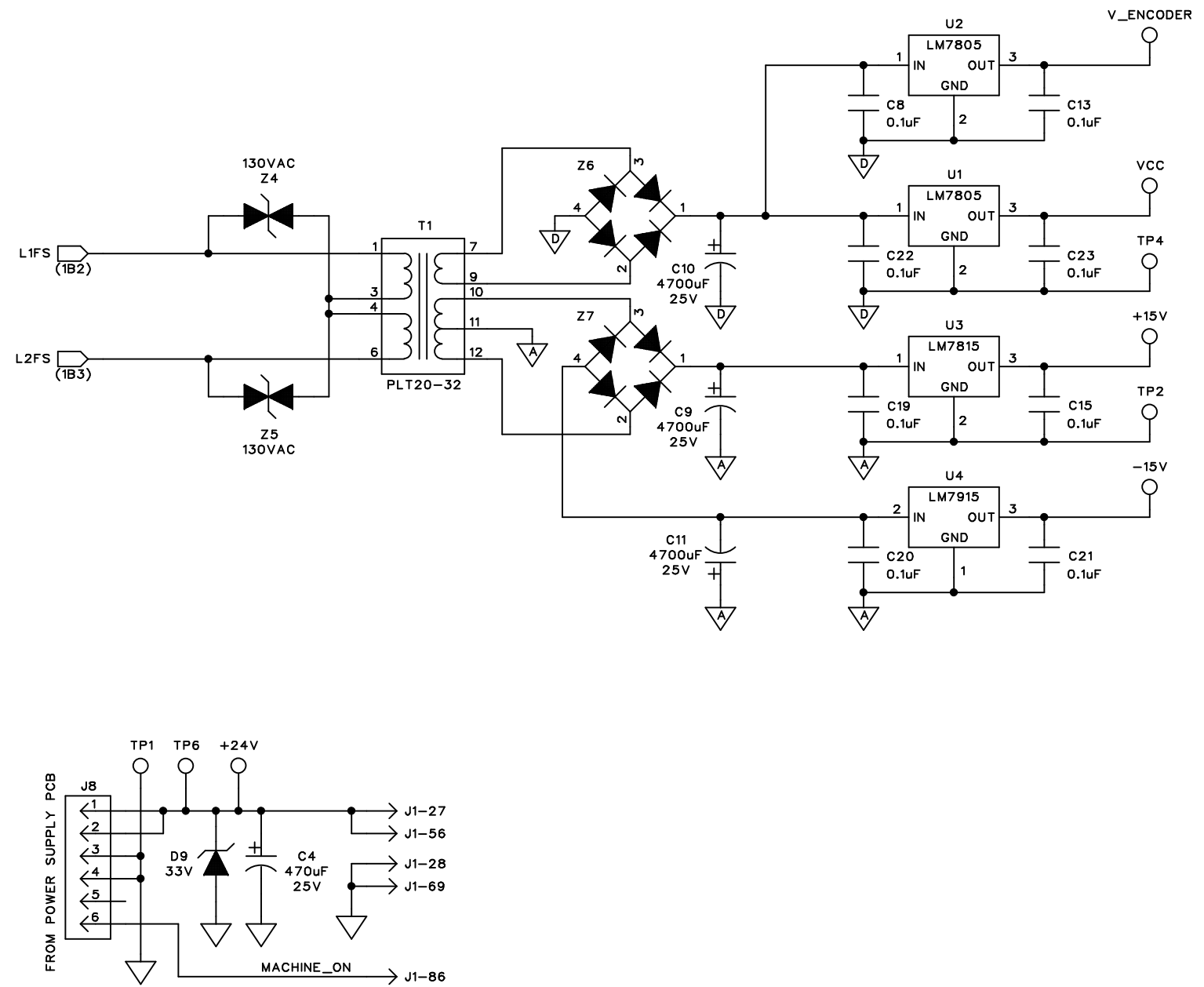


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| A         | INITIAL RELEASE | 5/5/00  |    |

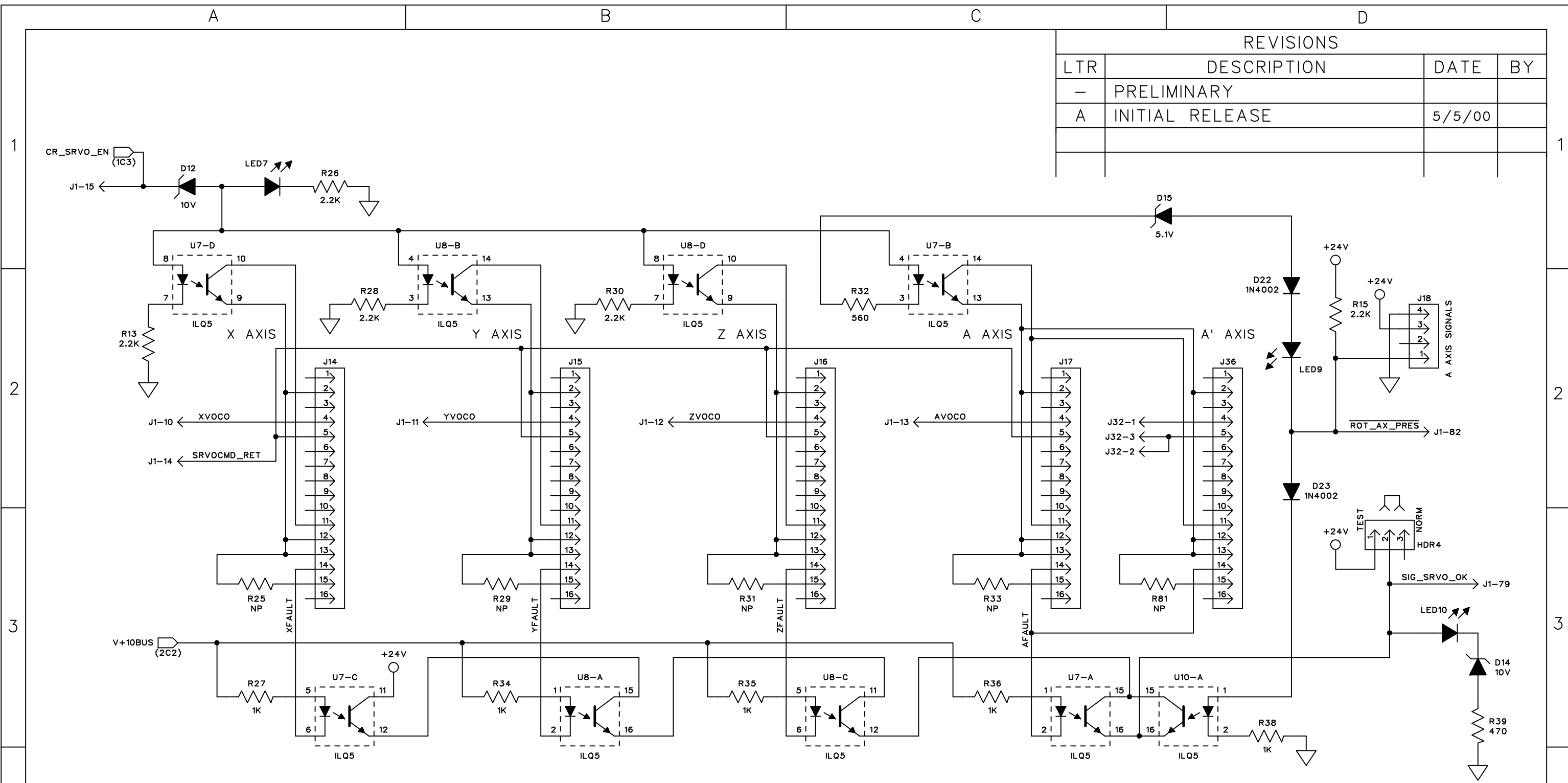
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| LIGHT MACHINES CORPORATION |                |              |                    |
| SCHEMATIC                  |                |              |                    |
| BENCHMAN XT MU/EBO BOARD   |                |              |                    |
| CONTROL RELAYS             |                |              |                    |
| DRAWN                      | D. HUGHES      | DATE         | 12/10/99           |
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| B                          | DRAWING NUMBER | 81-1000-0052 | REV A SHEET 1 of 9 |

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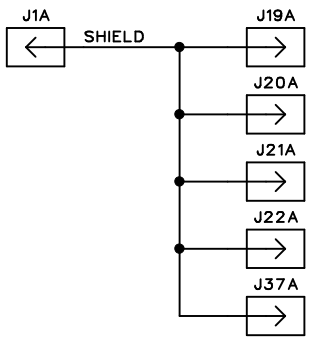
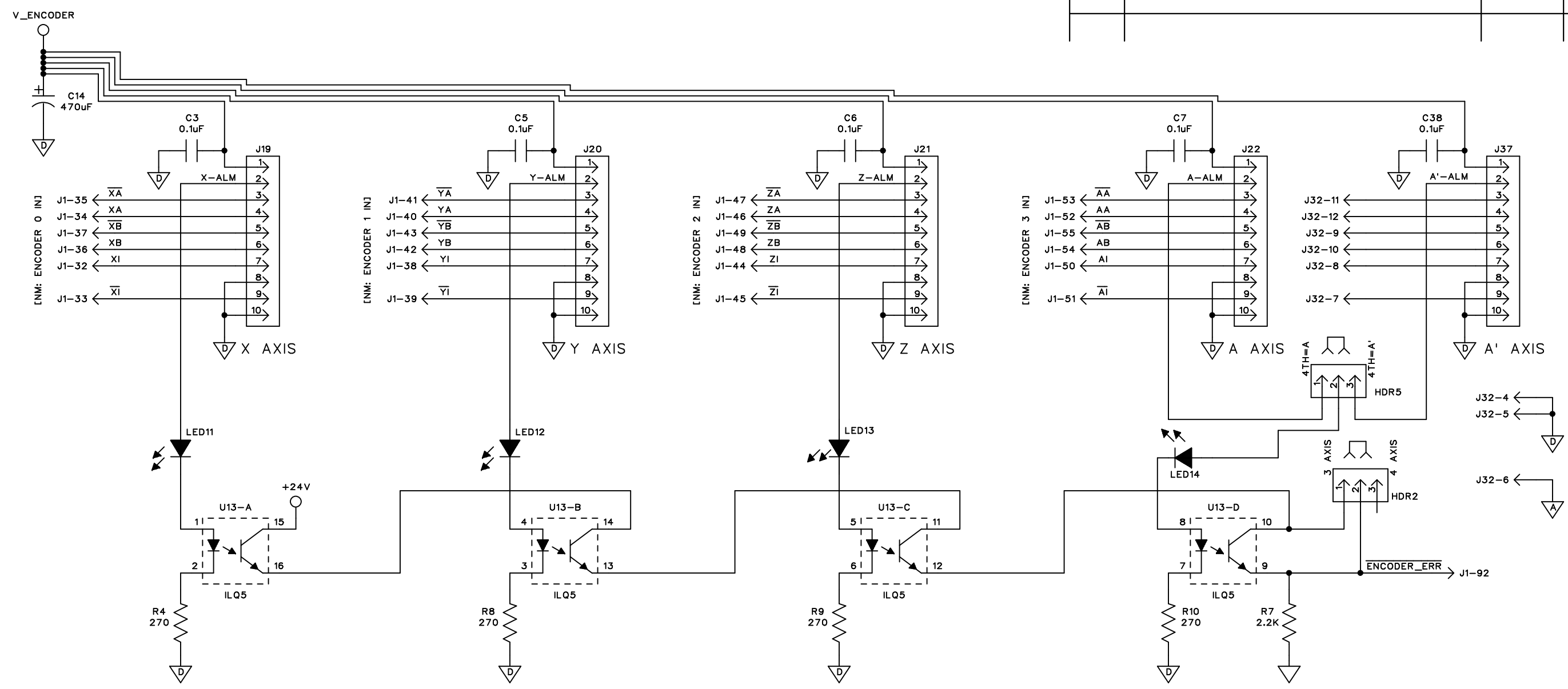
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| POWER SUPPLIES                   |                  |
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| SCHEMATIC                  |                                |
| BENCHMAN XT MU/EBO BOARD   |                                |
| SERVO AMP INTERFACE        |                                |
| DRAWN<br>D. HUGHES         | DATE<br>12/10/99               |
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| SCHEMATIC                      |                  |
| BENCHMAN XT MU/EBO BOARD       |                  |
| AXIS ENCODERS & ALARMS         |                  |
| DRAWN<br>D. HUGHES             | DATE<br>12/10/99 |
| DRAWING NUMBER<br>81-1000-0052 | REV<br>A         |
|                                | SHEET<br>4 of 9  |

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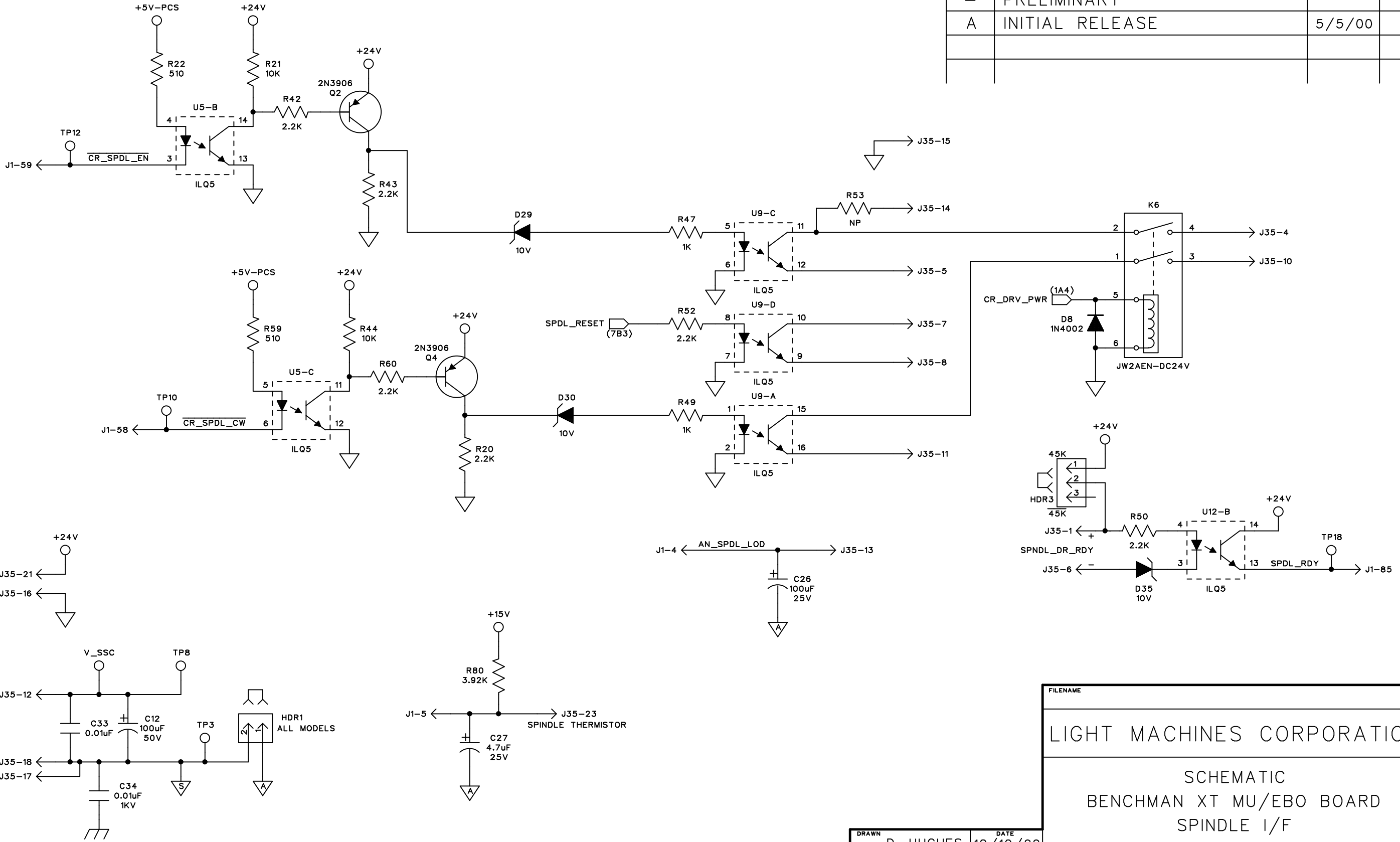
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| SCHEMATIC                      |                  |
| BENCHMAN XT MU/EBO BOARD       |                  |
| SPINDLE I/F                    |                  |
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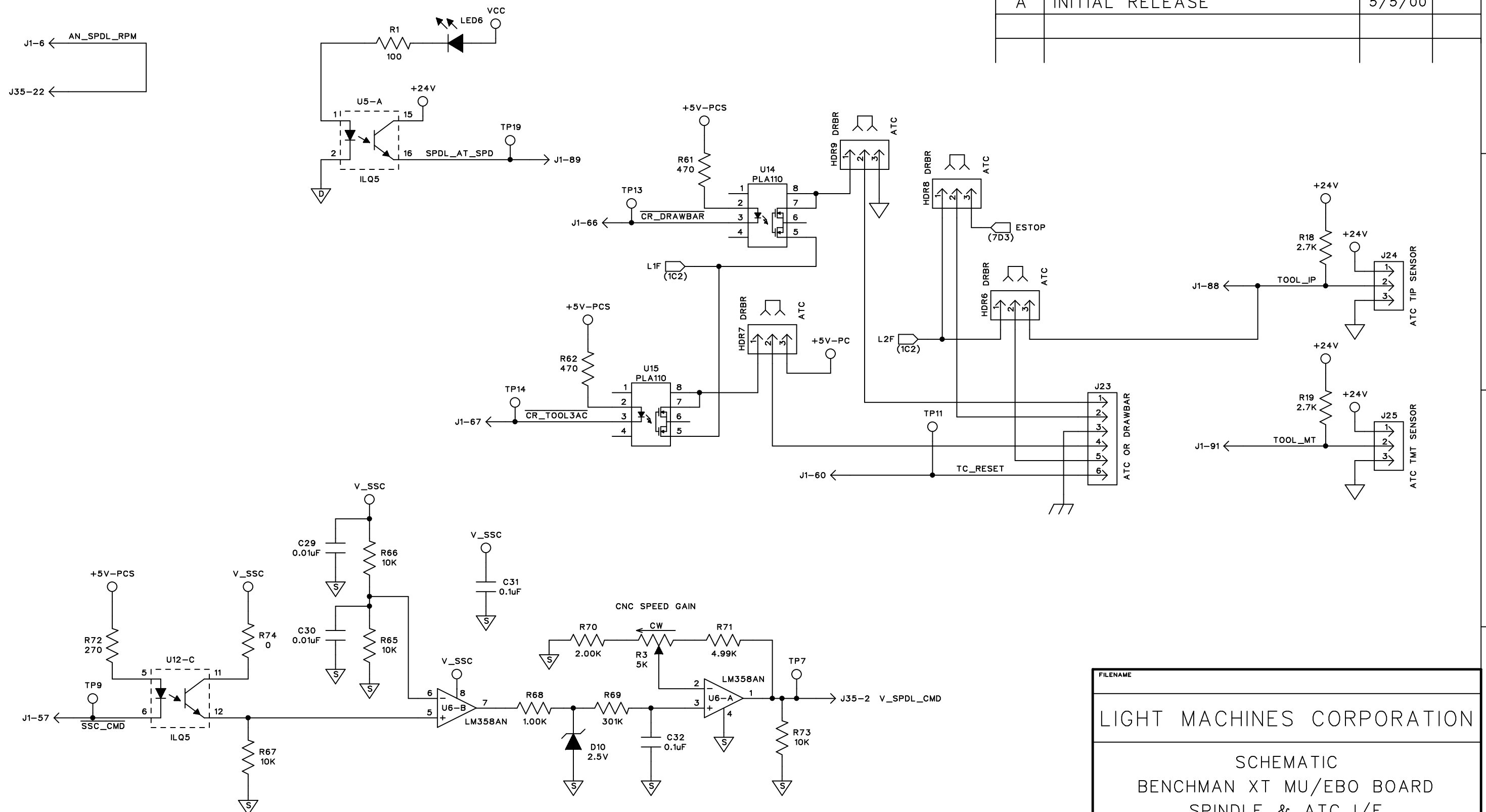
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FILENAME

LIGHT MACHINES CORPORATION

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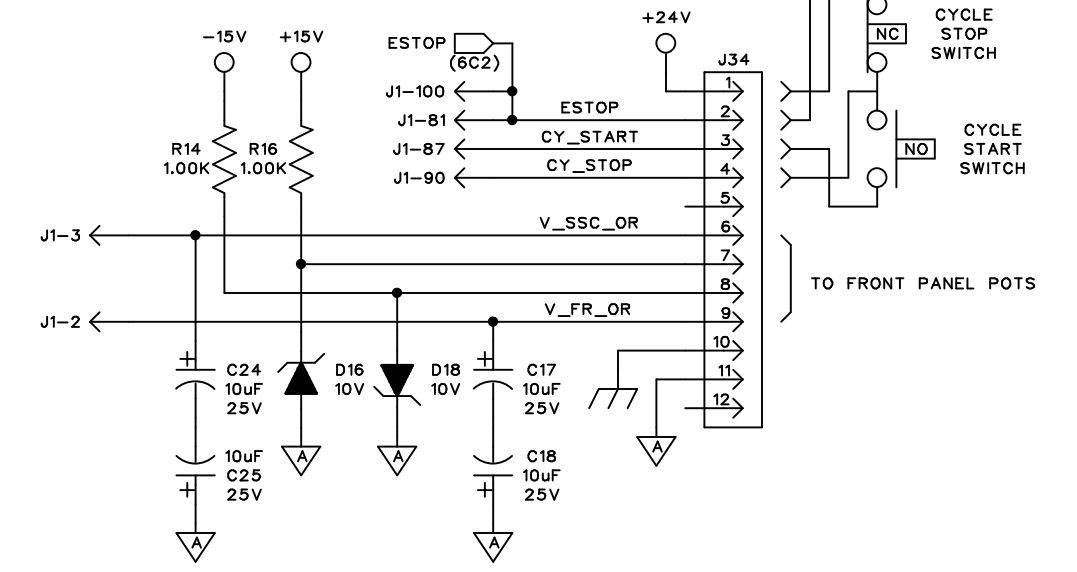
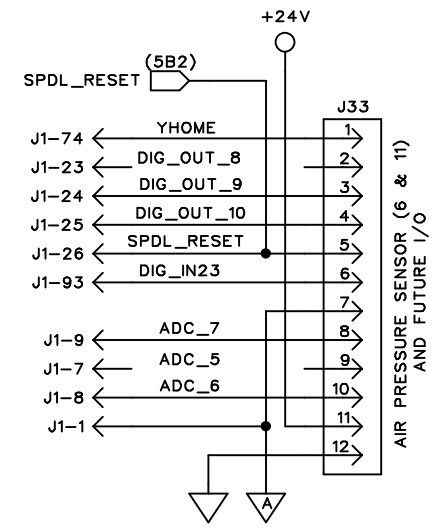
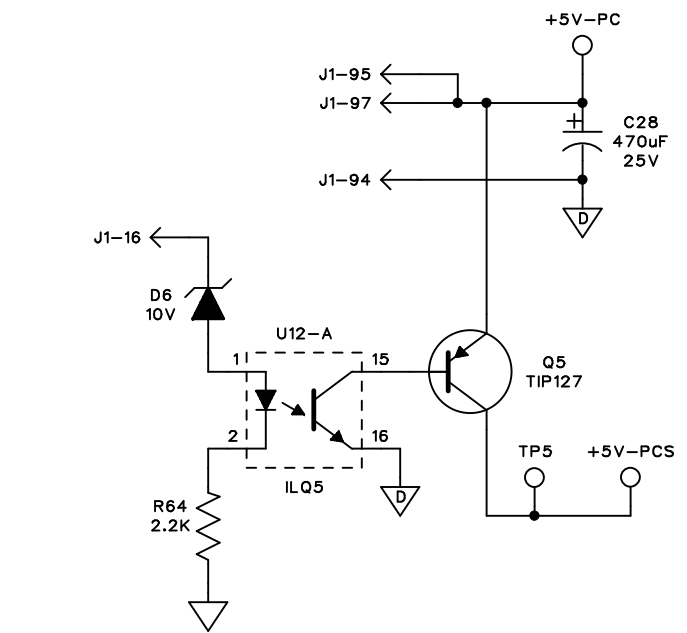
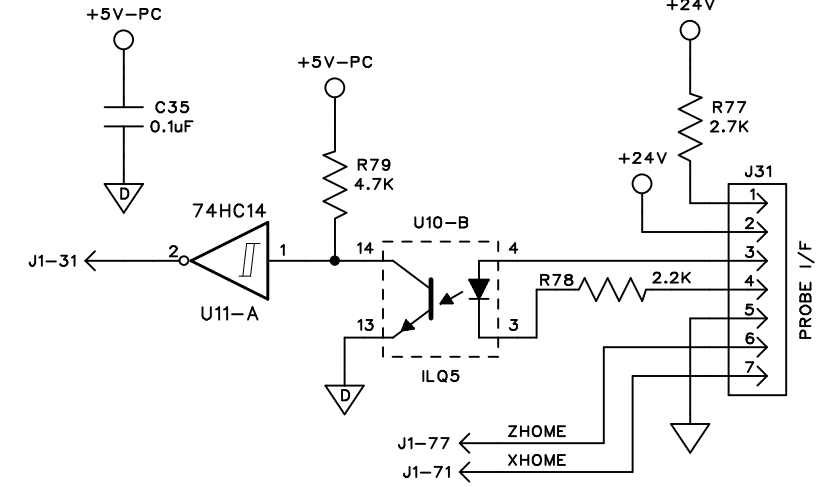
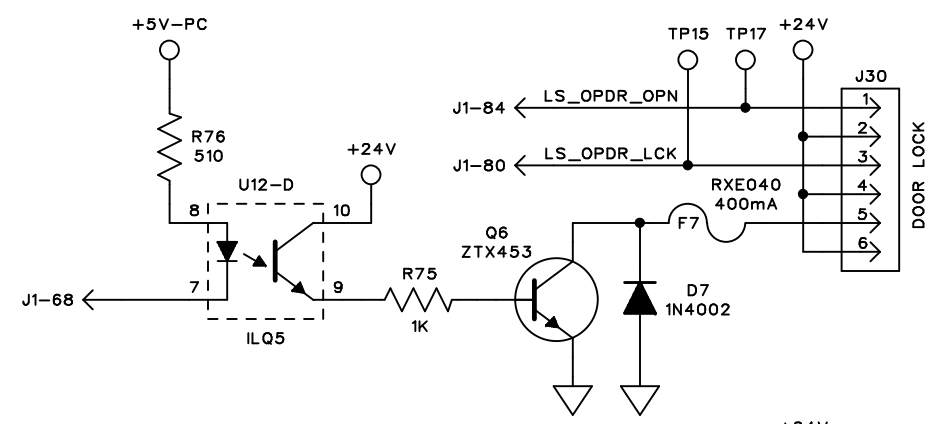
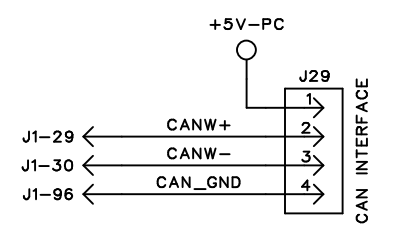
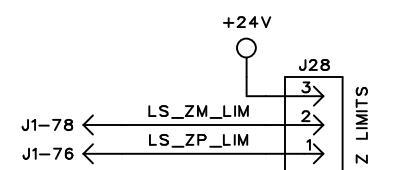
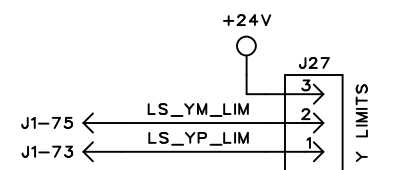
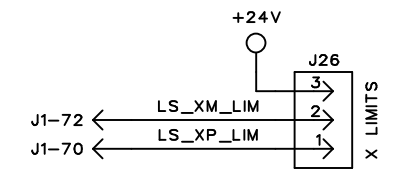
BENCHMAN XT MU/EBO BOARD

SPINDLE & ATC I/F

|          |           |      |          |
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| DRAWN    | D. HUGHES | DATE | 12/10/99 |
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| DRAWING NUMBER | 81-1000-0052 | REV | A | SHEET | 6 of 9 |
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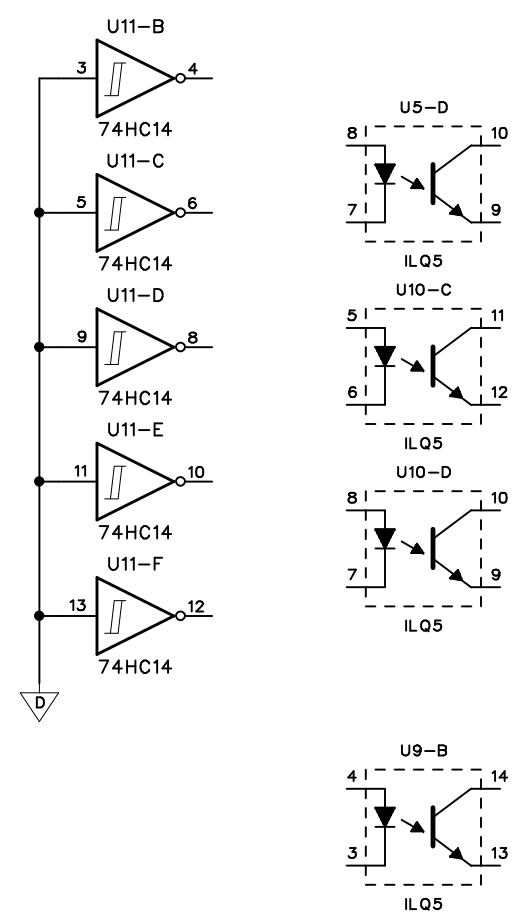
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| LIGHT MACHINES CORPORATION |          |                |           |
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| BENCHMAN XT MU/EBO BOARD   |          |                |           |
| I/O - USER I/F             |          |                |           |
| DRAWN                      | DATE     | DRAWING NUMBER | REV SHEET |
| D. HUGHES                  | 12/10/99 | 81-1000-0052   | A 7 of 9  |

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### HEADER CONFIGURATION MATRIX

|      | 5K/7.5K<br>DRAWBAR<br>W/ 4TH AXIS | 5K/7.5K<br>DRAWBAR<br>W/O 4TH AXIS | 5K/7.5K<br>ATC<br>W/ 4TH AXIS | 5K/7.5K<br>ATC<br>W/O 4TH AXIS | 45K<br>DRAWBAR<br>W/ 4TH AXIS | 45K<br>DRAWBAR<br>W/O 4TH AXIS | 45K<br>ATC<br>W/ 4TH AXIS | 45K<br>ATC<br>W/O 4TH AXIS |
|------|-----------------------------------|------------------------------------|-------------------------------|--------------------------------|-------------------------------|--------------------------------|---------------------------|----------------------------|
| HDR1 | 1-2                               | 1-2                                | 1-2                           | 1-2                            | 1-2                           | 1-2                            | 1-2                       | 1-2                        |
| HDR2 | 2-3                               | 1-2                                | 2-3                           | 1-2                            | 2-3                           | 1-2                            | 2-3                       | 1-2                        |
| HDR3 | 2-3                               | 2-3                                | 2-3                           | 2-3                            | 1-2                           | 1-2                            | 1-2                       | 1-2                        |
| HDR4 | 2-3                               | 2-3                                | 2-3                           | 2-3                            | 2-3                           | 2-3                            | 2-3                       | 2-3                        |
| HDR5 | 2-3                               | 1-2                                | 2-3                           | 1-2                            | 1-2                           | 1-2                            | 1-2                       | 1-2                        |
| HDR6 | 1-2                               | 1-2                                | 2-3                           | 2-3                            | 1-2                           | 1-2                            | 2-3                       | 2-3                        |
| HDR7 | 1-2                               | 1-2                                | 2-3                           | 2-3                            | 1-2                           | 1-2                            | 2-3                       | 2-3                        |
| HDR8 | 1-2                               | 1-2                                | 2-3                           | 2-3                            | 1-2                           | 1-2                            | 2-3                       | 2-3                        |
| HDR9 | 1-2                               | 1-2                                | 2-3                           | 2-3                            | 1-2                           | 1-2                            | 2-3                       | 2-3                        |

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| LIGHT MACHINES CORPORATION                              |                  |
| SCHEMATIC<br>BENCHMAN XT MU/EBO BOARD<br>NOTES / SPARES |                  |
| DRAWN<br>D. HUGHES                                      | DATE<br>12/10/99 |
| DRAWING NUMBER<br>B 81-1000-0052                        | REV<br>A         |
|   | SHEET<br>8 of 9  |

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| DRAWN    | D. HUGHES | DATE | 12/10/99 |
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| A   | INITIAL RELEASE | 5/5/00 |    |

| CONNECTOR PIN | NEXTMOVE SIGNAL | SIGNAL NAME        | SCHEMATIC LOCATION | CONNECTOR PIN | NEXTMOVE SIGNAL | SIGNAL NAME | SCHEMATIC LOCATION |
|---------------|-----------------|--------------------|--------------------|---------------|-----------------|-------------|--------------------|
| J1-1          | ANA COMMON      | ANA_GND            | 7D2                | J1-51         | AI              | AI          | 4C2                |
| J1-2          | ANA IN 0        | V_FR_OR            | 7C3                | J1-52         | AA              | AA          | 4C2                |
| J1-3          | ANA IN 1        | V_SSC_OR           | 7C3                | J1-53         | AA              | AA          | 4C2                |
| J1-4          | ANA IN 2        | AN_SPDL_LOD        | 5C3                | J1-54         | AB              | AB          | 4C2                |
| J1-5          | ANA IN 3        | SPINDLE THERMISTOR | 5B4                | J1-55         | AB              | AB          | 4C2                |
| J1-6          | ANA IN 4        | AN_SPDL_RPM        | 6A1                | J1-56         | USER V+         | +24V        | 2A4                |
| J1-7          | ANA IN 5        | ADC_5              | 7D2                | J1-57         | PULSE 0         | SSC_CMD     | 6A4                |
| J1-8          | ANA IN 6        | ADC_6              | 7D2                | J1-58         | DIRECTION 0     | CR_SPDL_CW  | 5A3                |
| J1-9          | ANA IN 7        | ADC_7              | 7D2                | J1-59         | BOOST 0         | CR_SPDL_EN  | 5A1                |
| J1-10         | ANA OUT 0       | XVOCO              | 3A2                | J1-60         | PULSE 1         | TC_RESET    | 6C3                |
| J1-11         | ANA OUT 1       | YVOCO              | 3A2                | J1-61         | DIRECTION 1     | CR_TOOL1    | 6C3                |
| J1-12         | ANA OUT 2       | ZVOCO              | 3B2                | J1-62         | BOOST 1         | CR_TOOL0    | 6C3                |
| J1-13         | ANA OUT 3       | AVOCO              | 3C2                | J1-63         | PULSE 2         | NOT USED    | N/A                |
| J1-14         | ANA COMMON      | SRVOCMD_RET        | 3A2                | J1-64         | DIRECTION 2     | NOT USED    | N/A                |
| J1-15         | DIG OUT 0       | CR_SRVO_EN         | 3A1                | J1-65         | BOOST 2         | NOT USED    | N/A                |
| J1-16         | DIG OUT 1       | +5V-SWITCH_CTL     | 7A4                | J1-66         | PULSE 3         | CR_DRAWBAR  | 6B2                |
| J1-17         | DIG OUT 2       | CR_LIGHT           | 1A2                | J1-67         | DIRECTION 3     | CR_TOOL3AC  | 6B2                |
| J1-18         | DIG OUT 3       | NOT USED           | N/A                | J1-68         | BOOST 3         | DOOR_LOCK   | 7B1                |
| J1-19         | DIG OUT 4       | NOT USED           | N/A                | J1-69         | USER GND        | GND         | 2A4                |
| J1-20         | DIG OUT 5       | CR_COOLANT         | 1A1                | J1-70         | DIG IN 0        | LS_XP_LIM   | 7A1                |
| J1-21         | DIG OUT 6       | CR_VISE            | 1B2                | J1-71         | DIG IN 1        | NOT USED    | N/A                |
| J1-22         | DIG OUT 7       | NOT USED           | N/A                | J1-72         | DIG IN 2        | LS_XM_LIM   | 7A1                |
| J1-23         | DIG OUT 8       | DIG_OUT_8          | 7D1                | J1-73         | DIG IN 3        | LS_YP_LIM   | 7A1                |
| J1-24         | DIG OUT 9       | DIG_OUT_9          | 7D2                | J1-74         | DIG IN 4        | NOT USED    | N/A                |
| J1-25         | DIG OUT 10      | DIG_OUT_10         | 7D2                | J1-75         | DIG IN 5        | LS_YM_LIM   | 7A1                |
| J1-26         | DIG OUT 11      | SPDL_RESET         | 7B2                | J1-76         | DIG IN 6        | LS_ZP_LIM   | 7A2                |
| J1-27         | USER V+         | +24V               | 2A3                | J1-77         | DIG IN 7        | NOT USED    | N/A                |
| J1-28         | USER GND        | GND                | 2A4                | J1-78         | DIG IN 8        | LS_ZM_LIM   | 7A2                |
| J1-29         | CAN W+          | CANW+              | 7A2                | J1-79         | DIG IN 9        | SIG_SRVO_OK | 3D3                |
| J1-30         | CAN W-          | CANW-              | 7A2                | J1-80         | DIG IN 10       | LS_OPDR_LCK | 7B1                |
| J1-31         | EXT INT         | ???                | ???                | J1-81         | DIG IN 11       | ESTOP       | 7D3                |
| J1-32         | XI              | XI                 | 4A2                | J1-82         | DIG IN 12       | ROT_AX_PRES | 3D2                |
| J1-33         | XI              | XI                 | 4A2                | J1-83         | DIG IN 13       | KEYLOCK     | 1B4                |
| J1-34         | XA              | XA                 | 4A2                | J1-84         | DIG IN 14       | LS_OPDR_OPN | 7B1                |
| J1-35         | XA              | XA                 | 4A2                | J1-85         | DIG IN 15       | SPDL_RDY    | 5D3                |
| J1-36         | XB              | XB                 | 4A2                | J1-86         | DIG IN 16       | MACHINE_ON  | 2A4                |
| J1-37         | XB              | XB                 | 4A2                | J1-87         | DIG IN 17       | CY_START    | 7D3                |
| J1-38         | YI              | YI                 | 4B2                | J1-88         | DIG IN 18       | TOOL_IP     | 6D2                |
| J1-39         | YI              | YI                 | 4B2                | J1-89         | DIG IN 19       | SPDL_AT_SPD | 6B2                |
| J1-40         | YA              | YA                 | 4B2                | J1-90         | DIG IN 20       | CY_STOP     | 7D3                |
| J1-41         | YA              | YA                 | 4B2                | J1-91         | DIG IN 21       | TOOL_MT     | 6D3                |
| J1-42         | YB              | YB                 | 4B2                | J1-92         | DIG IN 22       | ENCODER_ERR | 4D3                |
| J1-43         | YB              | YB                 | 4B2                | J1-93         | DIG IN 23       | NOT USED    | N/A                |
| J1-44         | ZI              | ZI                 | 4B2                | J1-94         | PC COMMON       | DIG_GND     | 7A3                |
| J1-45         | ZI              | ZI                 | 4B2                | J1-95         | +5V             | +5V-PC      | 7A3                |
| J1-46         | ZA              | ZA                 | 4B2                | J1-96         | PC COMMON       | CAN_GND     | 7A2                |
| J1-47         | ZA              | ZA                 | 4B2                | J1-97         | +5V             | +5V-PC      | 7A3                |
| J1-48         | ZB              | ZB                 | 4B2                | J1-98         | RELAY COM       | CR_DRV_PWR  | 1A3                |
| J1-49         | ZB              | ZB                 | 4B2                | J1-99         | RELAY NC        | NOT USED    | N/A                |
| J1-50         | AI              | AI                 | 4C2                | J1-100        | RELAY NO        | ESTOP       | 7D3                |

TEST POINT / LED FUNCTIONALITY

|                               |                    |
|-------------------------------|--------------------|
| TP1: GND                      | LED1: VCC          |
| TP2: ANA_GND                  | LED2: V_ENCODER    |
| TP3: GND_SSC                  | LED3: +15V         |
| TP4: DIG_GND                  | LED4: -15V         |
| TP5: +5V-PCS (REF TO DIG_GND) | LED5: +24V         |
| TP6: +24V (REF TO GND)        | LED6: SPDL_AT_SPD  |
| TP7: V_SPDL_CMD               | LED7: CR_SRVO_EN   |
| TP8: V_SSC (REF TO GND_SSC)   | LED8: CR_DRV_PWR   |
| TP9: SSC_CMD                  | LED9: ROT_AX_PRES  |
| TP10: CR_SPDL_CW              | LED10: SIG_SRVO_OK |
| TP11: TC_RESET                | LED11: X-ALM       |
| TP12: CR_SPDL_EN              | LED12: Y-ALM       |
| TP13: CR_DRAWBAR              | LED13: Z-ALM       |
| TP14: CR_TOOL3AC              | LED14: A-ALM       |
| TP15: LS_OPDR_LCK             |                    |
| TP16: KEYLOCK                 |                    |
| TP17: LS_OPDR_OPN             |                    |
| TP18: SPDL_RDY                |                    |
| TP19: SPDL_ST_SPD             |                    |

| CONNECTOR PIN | SIGNAL NAME   | SCHEMATIC LOCATION | EMS CONNECTOR | ELECTROCRAFT CONNECTOR |
|---------------|---------------|--------------------|---------------|------------------------|
| J35-1         | SPNDL_DR_RDY+ | 5D3                | N/C           | 42                     |
| J35-2         | V_SPDL_CMD    | 6C4                | N/C           | 13                     |
| J35-3         |               |                    | N/C           | N/C                    |
| J35-4         | C2            | 5D2                | 1             | 26                     |
| J35-5         | E2            | 5C2                | 11            | 20                     |
| J35-6         | SPNDL_DR_RDY- | 5D3                | 10            | 13                     |
| J35-7         | C3            | 5C2                | 4             | 26                     |
| J35-8         | E3            | 5C2                | 11            | 21                     |
| J35-9         |               |                    | N/C           | N/C                    |
| J35-10        | C4            | 5D2                | 2             | 26                     |
| J35-11        | E4            | 5C3                | 11            | 32                     |
| J35-12        | V_SSC         | 5A4                | 15            | N/C                    |
| J35-13        | AN_SPDL_LOD   | 5C3                | 23            | 31                     |
| J35-14        | R_C2          | 5C2                | 22            | N/C                    |
| J35-15        | ANA_GND       | 5C1                | THERMISTOR    | N/C                    |
| J35-16        | GND           | 5A3                | 11            | 13                     |
| J35-17        |               | 5C4                | 18            | N/C                    |
| J35-18        | GND_SSC       | 5A4                | 17            | 28                     |
| J35-19        |               |                    | N/C           | N/C                    |
| J35-20        |               |                    | N/C           | N/C                    |
| J35-21        | +24V          | 5A3                | 20            | 26                     |
| J35-22        | AN_SPDL_RPM   | 6A1                | 21            | N/C                    |
| J35-23        |               | 5B4                | THERMISTOR    | N/C                    |
| J35-24        |               |                    | N/C           | N/C                    |
| J35-25        |               |                    | N/C           | N/C                    |
| J35-26        |               |                    | N/C           | N/C                    |

5K/7.5K RPM SPINDLE USES ELECTROCRAFT SPINDLE CONTROL  
 45K RPM SPINDLE USES EMS SPEED CONTROL

|  |                                |
|--|--------------------------------|
| FILENAME   |                                |
| LIGHT MACHINES CORPORATION                           |                                |
| SCHEMATIC NOTES<br>BENCHMAN XT MU/EBO BOARD<br>NOTES |                                |
| DRAWN<br>D. HUGHES                                   | DATE<br>12/10/99               |
| APPROVED<br>B  | DRAWING NUMBER<br>81-1000-0052 |
| REV<br>A   | SHEET<br>9 of 9                |

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