The CMPE 118 Uno32 I/O Board

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Background:

The ChipKit Uno32 module is a single-board computer produced by Digilent, Inc., which integrates a Microchip PIC3 microcontroller (PIC32MX320F128H), FTDI USB to Serial converter, voltage regulation, and 3.3V clamp diodes into a tidy little package. CMPE118 uses the Uno32 platform throughout the lab exercises and final project. The Uno32 is an Arduino compatible module, though we reflash the Arduino firmware to use a custom bootloader that allows us to program the PIC32 directly in C over the USB link.

However, the Uno32 wasn't designed with CMPE118 in mind, so it isn't exactly what we want, so we've designed and manufactured the Uno32 I/O board to get us closer to the ideal we are looking for.

The Uno32 I/O Board has several major functions:

1. Bring out all of the connections from the Uno32 to clearly defined and easily accessible ports with uniform connectors.
2. Provide a wide range of voltage input through an onboard switching regulator (6V to 30V).
3. Provide over-voltage and over-current protection circuitry on all port pins.
4. Provide LED banks for user visual outputs.
5. Provide both local and remote on/off power and reset switches
6. Provide reverse polarity protection
7. Provide fuse protected power distribution for additional circuits.

The data sheet for the ChipKit Uno32 can be found on the Digilentinc.com website at: http://www.digilentinc.com/Products/Detail.cfm?NavPath=2,892,893&Prod=CHIPKIT-UNO32

Using the CMPE118 Uno32 I/O Board:

Using the CMPE118 Uno32 I/O Board should be straightforward. All the connections that will typically be made to the board are located around the edge of the board, and are clearly labeled and logically grouped. At the end of this document is a table which lists each pin on the PORT, along with its associated pins on the PIC32 microcontroller. All ports are clamped with diodes (TL7226) and series resistors to protect them from either overvoltage, undervoltage, or excessive currents.

Digital Input/Output Ports (PORT-X, PORT-Y, and PORT-Z):

Digital input and output ports are located on the three ports on the top of the board. They can be accessed either directly at the bit level through the #defines in the PORTS library, or as a word sized port through the functions contained within the library. Following the convention that microchip uses, the _TRIS registers are used to set output (0) or input (1) for each pin. The _LAT registers are used to write the output, and the _BIT registers to read from the port.

Port X, Y, and Z each have the outer two pins of the connectors grounded at the I/O board.

The pinout of PORT-X, PORT-Y, and PORT-Z are as follows:

PORT	Connection
Pin 1	GND
Pin 2	GND
Pin 3-12	PORT-x 3-12
Pin 13	GND
Pin 14	GND

Digital and Analog Input/Output Ports (PORT-V and PORT-W):
Analog inputs (10bit ADC) are available on PORT-V and PORT-W, and can be set either as Analog or Digital I/O. The Analog pins can be accessed through the AD library, and the digital I/O can be accessed through the PORTS library.

Port V and W each have the outer pins connected to ground, and only have six pins each with the remaining pins connected to ground.

The pinout of PORT-V and PORT-W are as follows:

PORT	Connection
Pin 1	GND
Pin 2	GND
Pin 3-8	PORT-w 3-8
Pin 9	GND
Pin 10	GND
Pin 11	GND
Pin 12	GND
Pin 13	GND
Pin 14	GND

Battery Voltage Monitoring:
The Uno32 I/O Board includes a precision 9:1 voltage divider connected to an ADC pin that is accessible through the AD library.

LED Banks:
The Uno32 I/O Board includes 12 LEDs organized into 3 banks of 4 LEDs each. They are connected to a subset of pins (see table at end) and are accessible through the LED library. The LED CONTROL jumper (JP7) connects the top of each bank of LEDs to the 3.3V rail through a set of current-limiting resistor banks. Leave them open if using them as normal I/O pins

Reset and Remote Reset (SW1 and JP3):
The Uno32 I/O Board includes a reset switch (SW1) as well as a remote reset jumper (JP3). The switch is a momentary contact switch which holds the PIC32 in reset while depressed. The remote switch works by shorting either of the outer pins to the center pin to reset the micro.

Power and Remote Power (SW1 and JP1 on lower board):
The Uno32 I/O Board includes a power switch (SW1 on lower board) as well as a remote power jumper (JP3) with three right angle pins. The switch is a side slider switch, labeled ON and OFF which connects the ground line back to the source. The remote switch works by shorting either of the outer pins to the center pin to power the board.

SPI Master/Slave Select Jumper (J2):
The Uno32 I/O Board moves the jumpers to select SPI master or slave from the ChipKit board to the I/O board with exactly the same functionality. Both jumpers should be moved together, and set towards the top of the board for SPI master (normal) or both down for SPI slave. Note that the PORTS and LED libraries both have an SPI_MASTER #defined that should be commented out for SPI slave operation.

Power Regulation and Protection Circuitry:

The Uno32 I/O Board is powered through a connector on the bottom power distribution board, in on connector J1. The connector is reverse polarity protected via a dual N-channel FET that connects the ground line when connected correctly.

Uno32 I/O Board Power Supply Requirements: ***+6V < Vin (J1, pin 1) < +30V***

The input voltage is regulated via a TI TPS5410 switching regulator which provides clean 5V to the clamps and the ChipKit board. The regulated 3.3V power rail for the microcontroller is from the LDO on the ChipKit board itself. The I/O board has its power smoothed via two inductors, one on the power line and one on the ground line. The power distribution board is fused on each half with 3Amp fast blow 2AG fuses.

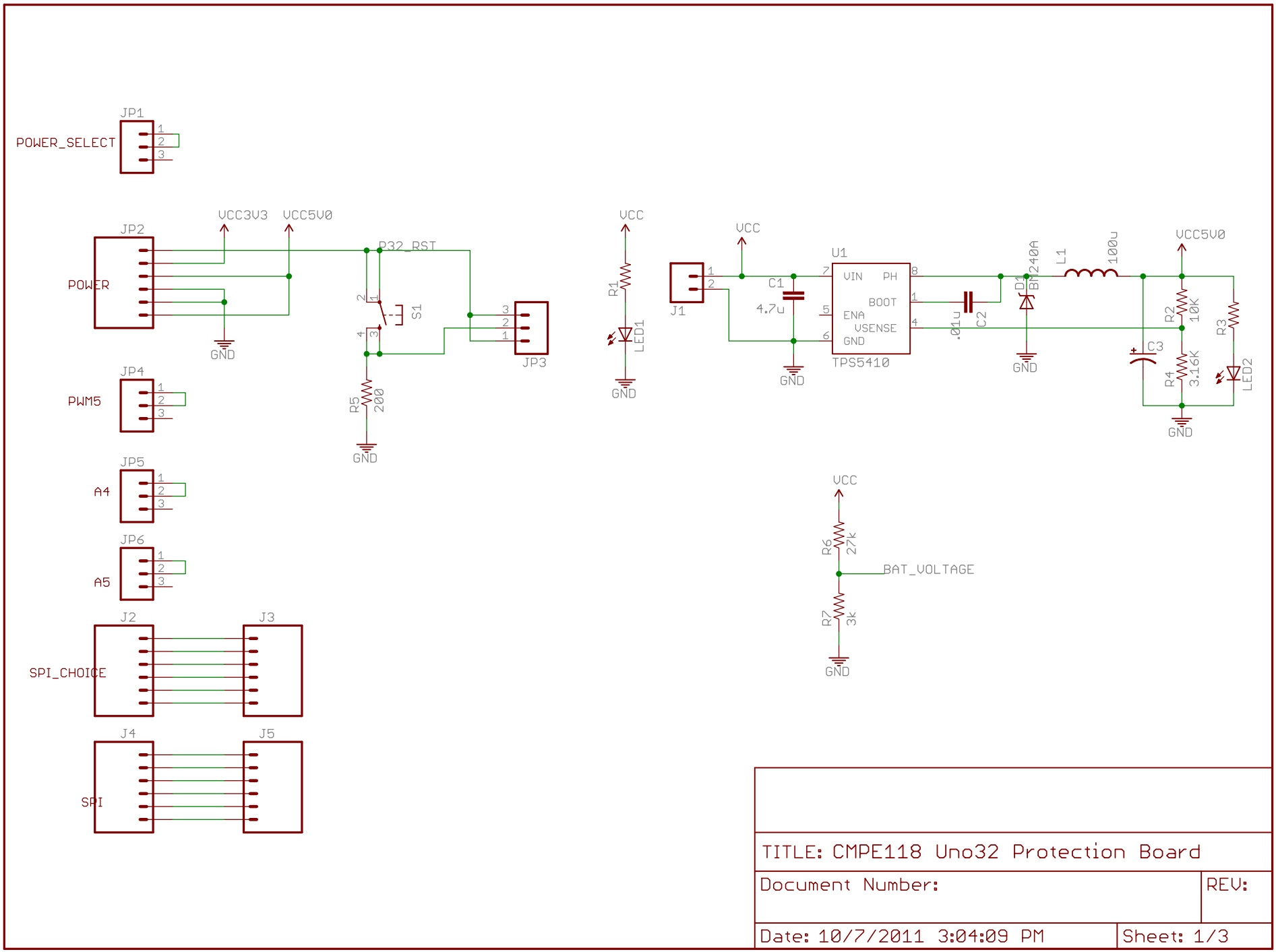
J1	Connection
Pin 1	Power (6V to 30V)
Pin 2	High Current Ground

CMPE118 Uno32 I/O Board Connection Table:

PIC32 Pin #	Connector Pin #	chipKIT Pin #	PIC32 Signal	Protection Pin #	Notes
15	J5-16	41	PGC1/AN1/VREF-/CVREF-/CN3/RB1	Battery Voltage	Inaccesible from I/O
14	J7-01	A00/14	C2IN-/AN2/SS1/CN4/RB2	PORTV-3	RC Servo
13	J7-02	A06/20	C2IN+/AN3/CN5/RB3	PORTV-4	RC Servo
12	J7-03	A01/15	C1IN-/AN4/CN6/RB4	PORTV-5	
11	J7-03	A07/21	C1IN+/AN5/CN7/RB5	PORTV-6	
21	J7-05	A02/16	U2CTS/C1OUT/AN8/RB8	PORTV-7	
22	J7-06	A08/22	PMA7/C2OUT/AN9/RB9	PORTV-8	
24	J7-08	A09/23	TDO/PMA12/AN11/RB11	PORTW-3	
23	J7-07	A03/17	TMS/CVREFOUT/PMA13/AN10/RB10	PORTW-4	
28	J7-10	A10/24	TDI/PMA10/AN13/RB13	PORTW-5	
27	J7-09	A04/18	TCK/PMA11/AN12/RB12	PORTW-6	
30	J7-12	A11/25	PMALL/PMA0/AN15/OCFB/CN12/RB15	PORTW-7	RC Servo
29	J7-11	A05/19	PMALH/PMA1/U2RTS/AN14/RB14	PORTW-8	RC Servo
32	J5-14	40	PMA8/U2TX/SCL2/CN18/RF5	PORTX-03	LED_BANK3_2, RC
16	J5-15	42	PGED1/PMA6/AN0/VREF+/CVREF+/CN2/RB0	PORTX-04	LED_BANK3_3, RC
4	J5-11	13	SCK2/PMA5/CN8/RG6	PORTX-05	LED_BANK3_0
31	J5-12	39	PMA9/U2RX/SDA2/CN17/RF4	PORTX-06	LED_BANK3_1
5	J5-09 or J5-07	12	SDI2/PMA5/CN8/RG7	PORTX-07/9	LED_BANK2_2*
35	J5-10	38	U1RTS/BCLK1/SCK1/INT0/RF6	PORTX-08	LED_BANK2_3
6	J5-07 or J5-09	11	SDO2/PMA3/CN10/RG8	PORTX-09/7	LED_BANK2_0*
55	J5-08	37	CN16/RD7	PORTX-10	LED_BANK2_1
52	J5-05	10	PMWR/OC5/IC5/CN13/RD4	PORTX-11	PWM5
54	J5-06	36	CN15/RD6	PORTX-12	LED_BANK1_3
45	J5-04	35	IC4/PMCS1/PMA14/INT4/RD11	PORTY-03	LED_BANK1_2
51	J5-03	9	OC4/RD3	PORTY-04	PWM4, LED_BANK1_1
53	J5-02	34	PMRD/CN14/RD5	PORTY-05	LED_BANK1_0

44	J5-01	8	IC3/PMCS2/PMA15/INT3/RD10	PORTY-06	RC Servo
3	J6-16	33	PMD7/RE7	PORTY-07	RC Servo
43	J6-15	7	IC2/U1CTS/INT2/RD9	PORTY-08	
2	J6-14	32	PMD6/RE6	PORTY-09	
50	J6-13	6	OC3/RD2	PORTY-10	PWM3
1	J6-12	31	PMD5/RE5	PORTY-11	
49	J6-11	5	OC2/RD1	PORTY-12	PWM2
64	J6-10	30	PMD4/RE4	PORTZ-03	
59	J6-09	4	RF1	PORTZ-04	
63	J6-08	29	PMD3/RE3	PORTZ-05	
46	J6-07	3	OC1/RD0	PORTZ-06	PWM1
62	J6-06	28	PMD2/RE2	PORTZ-07	
42	J6-05	2	IC1/RTCC/INT1/RD8	PORTZ-08	RC Servo
61	J6-04	27	PMD1/RE1	PORTZ-09	RC Servo
33	J6-03	1	U1TX/SDO1/RF3	PORTZ-10	
60	J6-02	26	PMD0/RE0	PORTZ-11	
34	J6-01	0	U1RX/SDI1/RF2	PORTZ-12	

CMPE118 Uno32 I/O Board and Power Distribution Board Schematics: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JP2
POWER
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VCC5V0
GND
P32_RST
S1
JP3
R5
200
JP4
PWM5
JP5
A4
JP6
A5
J2
J3
SPI_CHOICE
J4
J5
SPI
VCC
R1
LED1
GND
J1
C1
4.7u
U1
VIN
PH
BOOT
ENA
VSENSE
GND
TPS5410
.01u
C2
D1
BAT240A
L1
100u
VCC5V0
R2
10K
R3
C3
R4
3.16K
LED2
R6
27k
BAT_VOLTAGE
R7
3k
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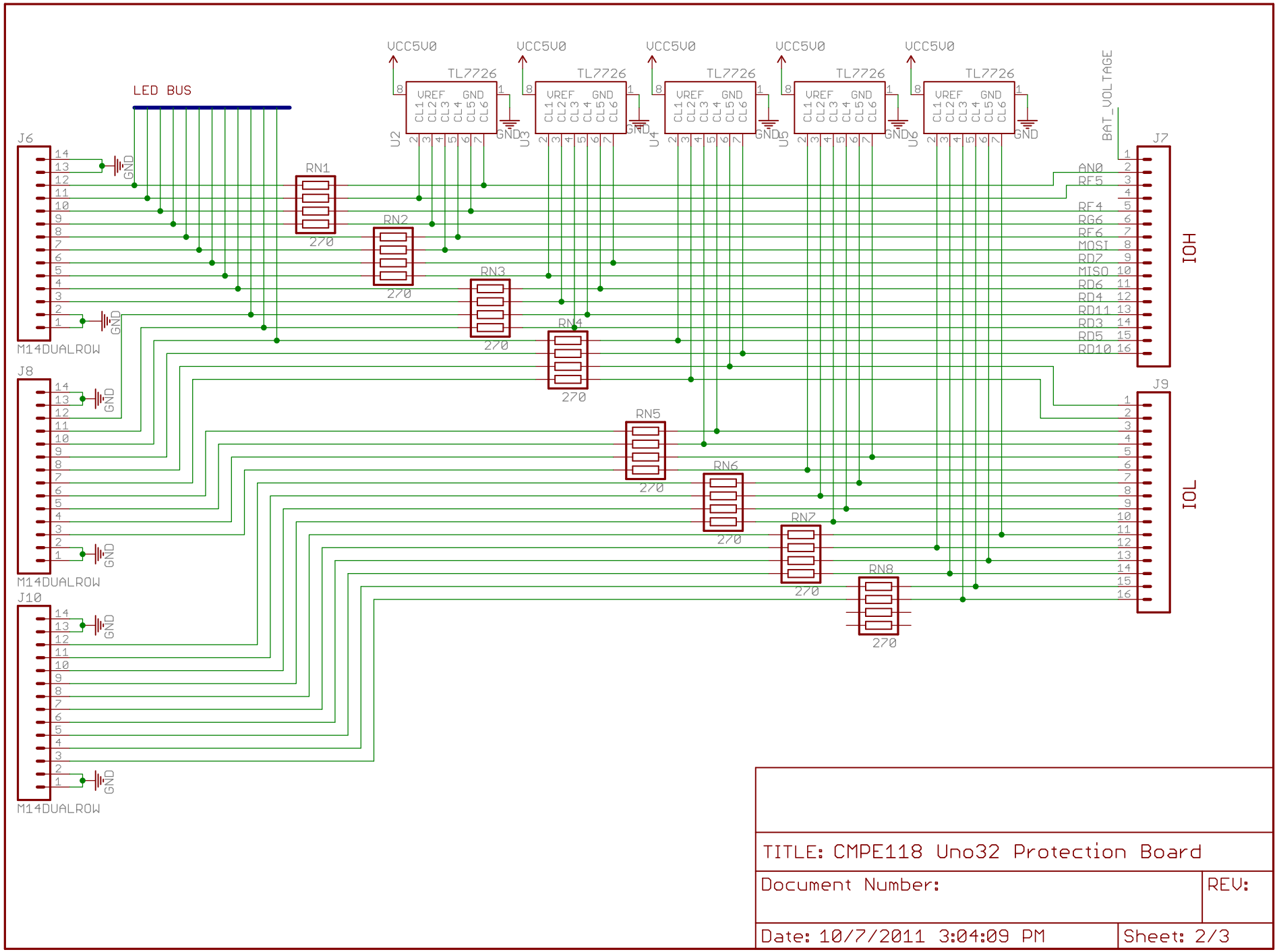
Sheet: 1/3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TL7726
VREF GND
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U2
U3
U4
U5
U6
GND
BAT_VOLTAGE
J6
J7
J8
J9
J10
M14DUALROW
RN1
RN2
RN3
RN4
RN5
RN6
RN7
RN8
270
AN0
RF5
RF4
RG6
RF6
MOSI
RD7
MISO
RD6
RD4
RD11
RD3
RD5
RD10
IOH
IOL
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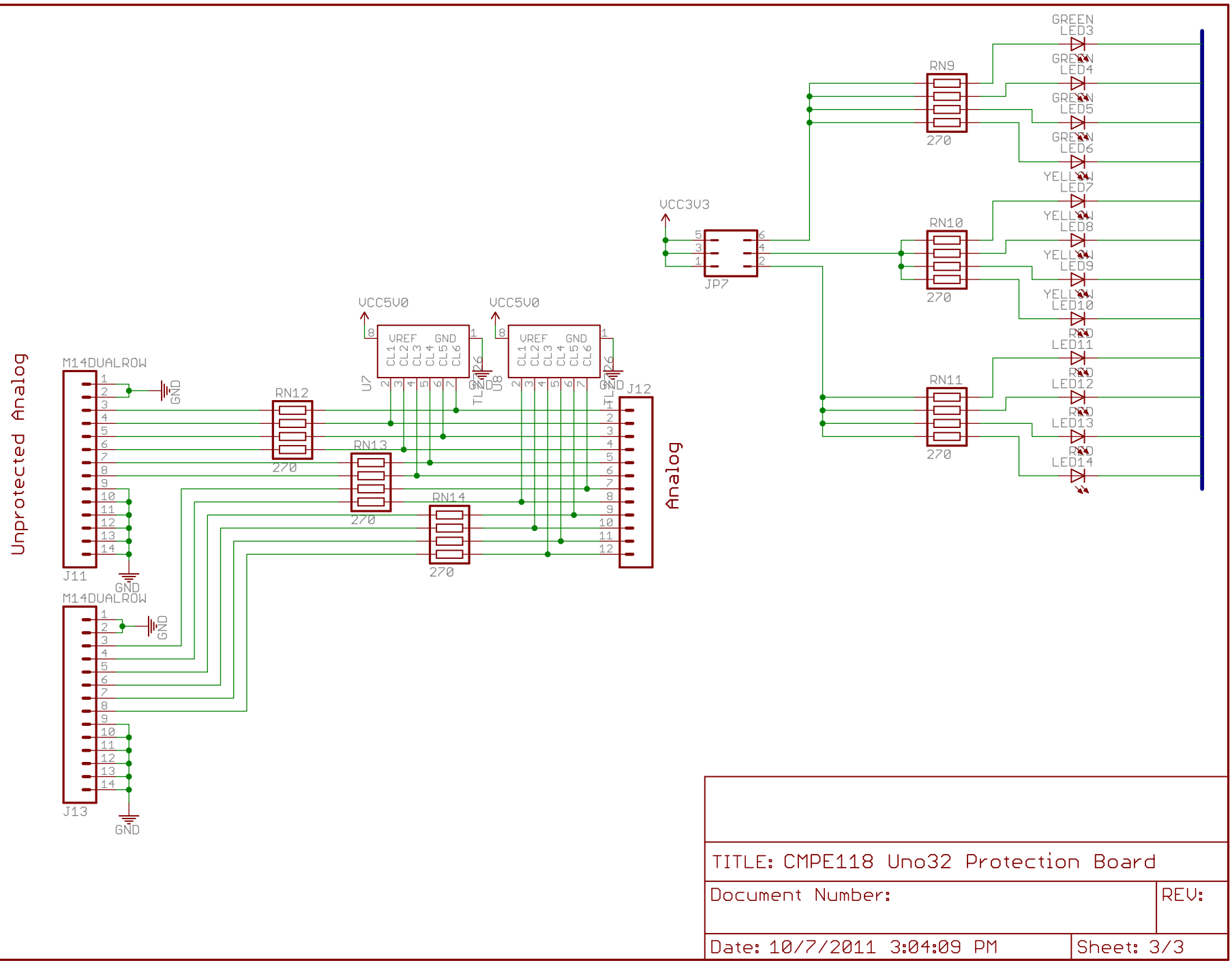
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J11
J13
GND
RN12
RN13
RN14
270
VCC5V0
VREF
GND
U7
U8
TLV2544
J12
Analog
VCC3V3
JP7
RN9
RN10
RN11
GREEN LED3
GREEN LED4
GREEN LED5
GREEN LED6
YELLOW LED7
YELLOW LED8
YELLOW LED9
YELLOW LED10
RED LED11
RED LED12
RED LED13
RED LED14
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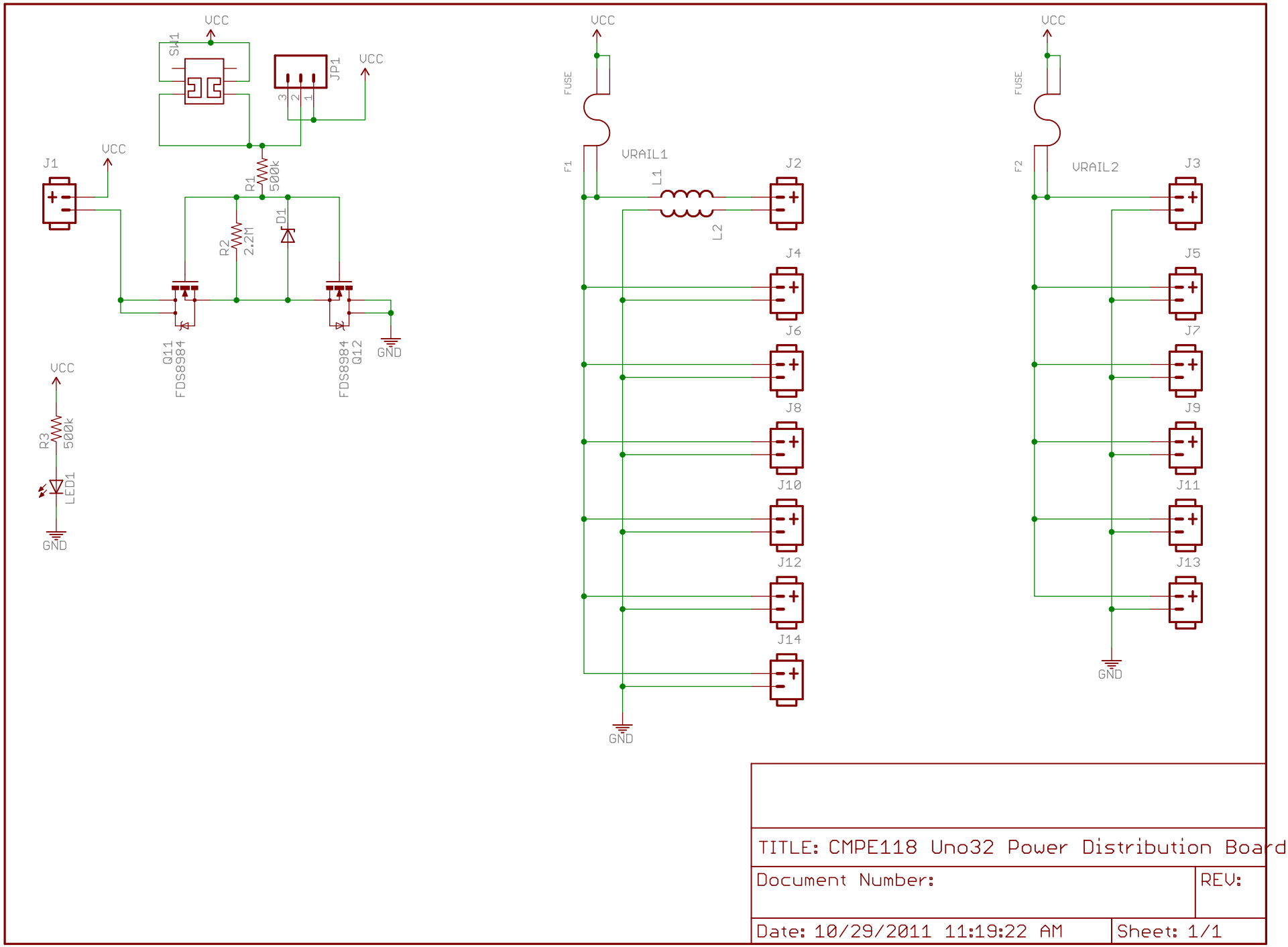
VCC
SW1
JP1
3
2
1
J1
R1
500k
R2
2.2M
D1
Q11
FDS8984
Q12
FDS8984
GND
R3
500k
LED1
FUSE
F1
VRAIL1
L1
L2
J2
J4
J6
J8
J10
J12
J14
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J3
J5
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