Sun™ SPOT
eDEMO Technical Datasheet

Rev 8.0

Revision 8 manufactured after October 2010

Sun Labs
October 2010

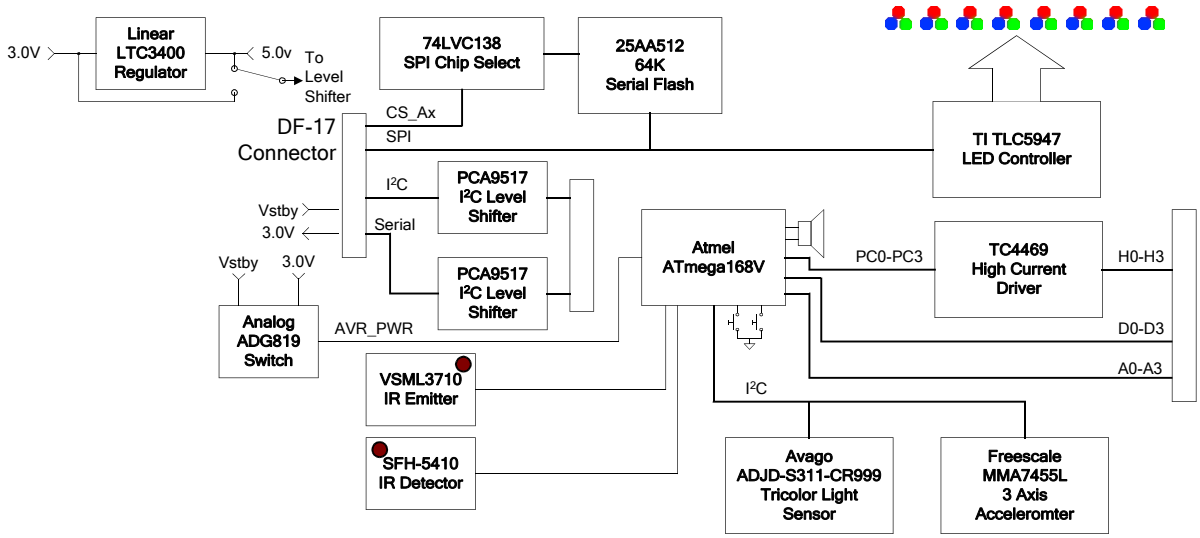
Sun Microsystems, Inc.
16 Network Circle
Santa Clara, CA 94025 USA
Document Revision 1.5.1

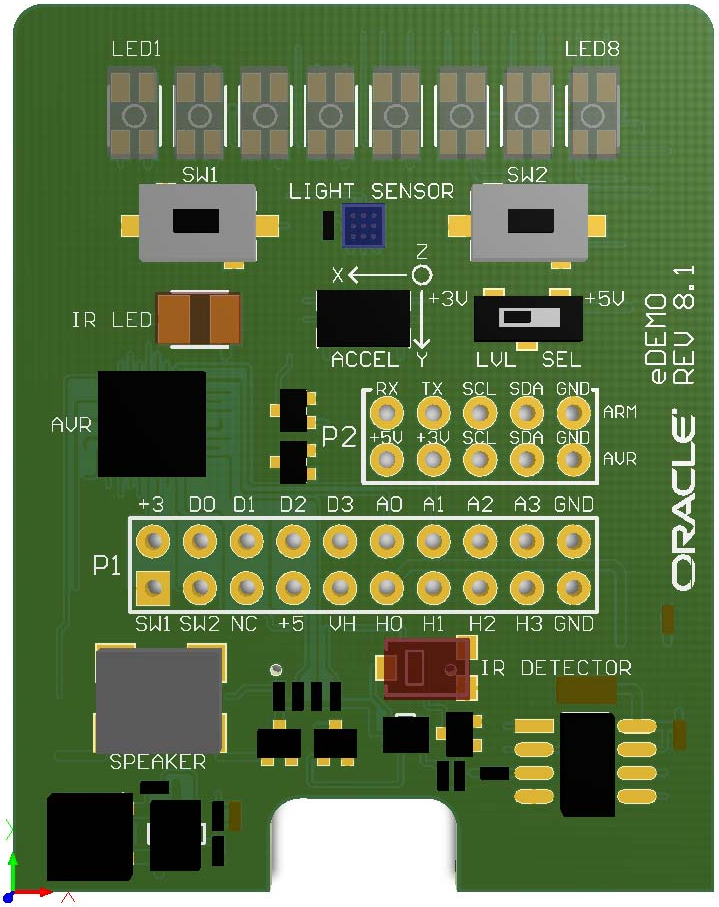
The eDEMO Application Board

Features

- ±2g/±4g/±8g Three Axis Accelerometer (MMA7455L)
- RGB Color Sensor (ADJD-S311-CR999)
- 8 RGB LEDs
- ATmega168V IO processor
    - 4 high current/high voltage outputs (TC4469)
    - 4 General Purpose Input/Outputs
    - 4 Analog Inputs
    - 3V I²C Interface
    - 3V USART
- Infrared Emitter/Detector (VSML3710/SFH 5410)
- Small Speaker (AST7525)
- 2 push buttons
- 512Kbit Serial EEPROM (25AA512)
- 3V/5V USART Interface
- 3V/5V I²C Interface from ARM9

Block Diagram





eDemo Board Top View

Signal Description

J1 – Hirose DF17 Bottom Header

Pin	Signal Name	Signal Type	Description
1,2	V_EXT	Power	Not Connected
3	MISO	Output	SPI MISO Slave Data Output from Atmega to ARM
4	USB_HOST_P	Bidirectional	Not Connected
5	SCLK	Input	SPI SCLK (Clock) Input to Atmega
6	USB_HOST_N	Bidirectional	Not Connected
7	MOSI	Input	SPI MOSI Slave Data input from ARM to Atmega
8	I2C_CLK	Input	I2C SCK (Clock) to 3V/5V Level Shifter
9	EXT_INn	Open Drain Output	External Interrupt (Active low)

Pin	Signal Name	Signal Type	Description
10	I2C_DATA	Bidirectional	I2C SDA (Data) to 3V/5V Level Shifter
11	CS_A0	Input	SPI Address A0. Address range 0 to 7. Must be stable prior to BD_SELx.
12	VSTBY	Power	+3V at 35ma output power from the SPOT (always on)
13	CS_A1	Input	SPI Address A1. Address range 0 to 7. Must be stable prior to BD_SELx.
14	TXD	Output	ARM UART (TXD0) to Level Shifter
15	CS_A2	Input	SPI Address A2. Address range 0 to 7. Must be stable prior to BD_SELx.
16	RXD	Input	ARM UART (RXD0) to Level Shifter
17	BD_SEL1n	Input	Board Select
18	VCC	Power	+3V at 400mA output power from the SPOT (on when running, pulled to 0V during deep sleep)
19	BD_SEL2n	Output	Not Used (goes to BD_SEL1n when top connector present on application board)
20	P19	Multifunction	Unused (test pad)
21	P22	Multifunction	GPIO Signal PA19 to LED_BLANK on LED controller
22	P21	Multifunction	Unused
23	P24	Multifunction	GPIO Signal PA16 to LED_XLAT on LED Controller
24	P23	Multifunction	Unused
25	P26	Multifunction	Unused
26	P25	Multifunction	Unused
27	P28	Multifunction	Unused
28	P27	Multifunction	GPI Signal PA17 to Hi_PWR_EN (Active High) to switch AVR_VCC from Vsbty to Vcc
29,30	GND	Power	Ground - Return for Power

Pin numbers are for the Hirose DF17 interboard connector for the eDEMO board. The pin numbering for the signals is mirrored from the main board to the bottom mating connector of the application board.

P1 – External Signal Pads

Pin Number	Signal Name	Signal Type	Description
1	SW1	I/O	Actively pulled high, as output it indicates state of SW1, as input it can simulate SW1 button press (Open Drain only)
2	VCC	Power	+3V power from the SPOT main board.
3	SW2	I/O	Actively pulled high, as output it indicates state of SW2, as input it can simulate SW2 button press (Open Drain only)
4	D0	Bidirectional	3V logic general purpose I/O pin or USART RXD Input
5	NC	NA	No Connection
6	D1	Bidirectional	3V logic general purpose I/O pin or USART TXD Output
7	+5V	Power	5V at 100ma from eDemo board switcher
8	D2	Bidirectional	3V logic general purpose I/O pin
9	VH	Power	Power input for H0-H3 high current high voltage output. Must be connected for H0-H3 to work
10	D3	Bidirectional	3V logic general purpose I/O pin
11	H0	Output	4.5V to 18V at 100ma max high voltage high current digital output
12	A0	Analog In	Analog input to 10 bit A/D converter. Voltage input from 0 to 3V
13	H1	Output	4.5V to 18V at 100ma max high voltage high current digital output
14	A1	Analog In	Analog input to 10 bit A/D converter. Voltage input from 0 to 3V
15	H2	Output	4.5V to 18V at 100ma max high voltage high current digital output
16	A2	Analog In	Analog input to 10 bit A/D converter. Voltage input from 0 to 3V
17	H3	Output	4.5V to 18V at 100ma max high voltage high current digital output
18	A3	Analog In	Analog input to 10 bit A/D converter. Voltage input from 0 to 3V
19,20	Ground	Power	Ground Return

P2 – External Signal Pads

Pin Number	Signal Name	Property	Description
1	+5V	Power	+5V at 100ma from eDemo board boost switcher
2	RXD	Input	3V or 5V Level shifted ARM USART (Serial) RXD0. Level selected by switch SW3
3	+3V	Power	+3V power from main board
4	TXD	Output	3V or 5V Level shifted ARM USART (Serial) TXD0. Level selected by switch SW3
5	AVR SCL	Output	3V I2C (TWI) serial clock SCL from eDemo Atmega168
6	ARM SCL	Output	3V or 5V Level Shifted ARM I2C (TWI) serial clock from ARM. Level selected by switch SW3
7	AVR SDA	Bidirectional	3V I2C (TWI) serial data SDA from eDemo Atmega168
8	ARM SDA	Bidirectional	3V or 5V Level Shifted ARM I2C (TWI) serial data from ARM. Level selected by switch SW3
9,10	Ground	Power	Ground Return

Theory of Operation

The supplied eDemo board is a single example of the class of application boards which may be connected to the eSPOT main board. Any eSPOT application boards must be able to:

- Connect to the eSPOT main board with a Hirose DF17-30 connector
- Act as an SPI slave in communication with the eSPOT main board
- Contain SPI flash memory for storing configuration information

Communication from the main board to any application board is done through the SPI channel. Individual SPI channels are addressable using CS_A0, CS_A1 and CS_A2 address lines and selected using BD_SEL1 (active low). Application boards can have an optional DF17-30 pass through connector on top for double stacked application boards. The BD_SEL2 line on the bottom DF17-30 becomes BD_SEL1 on the top DF17-30. BD_SEL1 will then select the board nearest the main board and BD_SEL2 will select the top most board. If there is no top connector, BD_SEL2 can be used to double the number of SPI channels.

All application boards have a serial EEPROM memory for storing configuration information. On the eDEMO board this is the Microchip 25AA512 SPI EEPROM 64K x 8 and is enabled when CS_A2-CS_A0 = '111' and BD_SEL asserted. This memory can be written to and read from the ARM9.

BD_SEL 1	CS_A2	CS_A1	CS_A0	Function
1	X	X	X	No Operation
0	1	1	1	Select configuration memory
0	1	1	0	User
0	1	0	1	User
0	1	0	0	User
0	0	1	1	User
0	0	1	0	User
0	0	0	1	Select Atmega168 RESET (Program mode)
0	0	0	0	Select Atmega168 Slave SPI

I/O Connector

The P1 I/O connector is designed for a 20-pin through-hole 0.1” center header. The header contains four bidirectional I/O, four high-current high-voltage outputs, four analog inputs, two pushbutton and power. Vcc is 3V from the SPOT while it is running. 5V is from the eDEMO board boost regulator while the SPOT is running.

The four bidirectional I/O D0-D3 are 3V logic from the on-board Atmega 168. D0 is Port D bit 0 or alternately UART Receive Data. D1 is Port D bit 1 or alternately UART Transmit Data. D2 is Port D bit 4 and D3 is Port D bit 5. These ports can be on during deep-sleep and can be used to wake up the ARM9. If the port is not used, it should be configured as an input with the pullup disabled (by setting it's output bit to '0') to minimize current draw. Do not exceed 10ma sink current from the D0-D3 outputs.

The four outputs from Port C bit 0 to bit 3 drive a high-current high-voltage buffer to H0 – H3. For these outputs to work, a power supply must be provided from 4.5V to 18V to pin VH with sufficient current. Each output can source-sink a maximum of 300mA or 500mA total for the four outputs. VH can be connected to the 5.0V output on the header; however the total output current is limited to 100mA maximum.

The four analog inputs measure 0V to 3V with 10 bit resolution using the Analog to Digital converter inside the Atmega168. The voltage reference is 3V either from the Vcc switcher or standby LDO, the same supply that powers the Atmega168.

The conversion function is:

$$ADC = \frac{V_{in} \cdot 1024}{3\ V}$$

or

$$V_{in} = \frac{3V \cdot ADC}{1024}$$

Where 3V is Vref, ADC is integer 16-bit value read from the ADC and Vin is the input voltage. The ADC conversion time is about 200µs although the SPI transaction and Java overhead can increase that to 3ms. The analog A0 to A3 maps to Port A PC2/ADC2, PC3/ADC3, ADC6, and ADC7. Note that A2 and A3 can only be analog inputs, A0 and A1 can be configured to be digital I/O or analog input.

Accelerometer

Near the center of the board is a Freescale MMA7455 3-axis digital output accelerometer with three sensitivity ranges: ±2G, ±4G and ±8G. It has built-in temperature compensation and signal conditioning. The accelerometer communicates with the Atmega168 using the I^2C bus at 100Kbps, and has provisions to interrupt the AVR (such as freefall detection) using its

INT1output.

The low current consumption of MMA7455 (400uA typical) allows it to be enabled during deep-sleep and wake the Atmega processor when acceleration along any one of the axis exceeds a preset threshold.

The maximum sample rate of the MMA7455 is 250Hz with a 125Hz bandwidth filter.

Lignt Sensor

Above the acceleromter is the Avago ADJD-S311-CR999, a RGB digital color sensor. It has a self contained 10-bit ADC for Red-Green-Blue-Clear sensors. The light sensor communicates as a slave device with the Atmega168 over the I^2C bus at 100Kbps. The slave address is 0xE8 write and 0xE9 reading. (least significant bit is read/write bit, 7 bit address is 0x74)

The light sensor can be placed into sleep from the Atmega168 pulling Port D bit 7 low. The light sensor consumes 2uA during sleep and can be powered during deep sleep.

RGB LEDs

Along the top of the eDEMO board is a row of eight tricolor (red-green-blue) LEDs (LED1-LED8). These LEDs are driven by the TLC5947 24-channel LED driver. The driver is configured and loaded by the ARM's SPI bus. Each LED has a 12-bit intensity value which uses PWM to control the current sink for the LED. When all of the configuration and intensity information has been serially shifted into the driver, the “LED_XLAT” signal is strobed to load the data into the driver.

Push Buttons

Below the LEDs are two tactile momentary SPST normally open push buttons, SW1 and SW2. These are scanned by the Atmega168 processor and can report the state of each push button to the ARM9 over the SPI bus. The push buttons are pulled up to the AVR's power supply (+3V, either V_{CC} or V_{STBY}), and are connected to the AVR's PB0 and PB1 pins. Pushing a button pulls the signal on PB0 or PB1 to ground. The push button signals also go to connector P1 pin 1 (SW1) and P1 pin 3 (SW2) through 1K ohm resistors. P1-1 and P1-3 can be wired to external switches which operate in parallel with SW1 and SW2. They may also be used to monitor the logic state of each switch.

IR Transmitter/Receiver

The eDEMO board has an on-board IR transmitter and receiver. The system is designed to operate at 940 nm and is compatible with most IR remote controllers.

The IR receiver is composed of several elements consisting of a photodiode, preamp, automatic gain control, bandpass filter and demodulator. Most IR controllers generate a modulated signal using a 38KHz carrier. The receiver takes the modulated signal from an IR source, decodes it and outputs a serial data stream. The output is connected to pin PB0 on the AVR. This pin is shared with SW1. Software automatically detects whether the switch is

being pressed or a data stream is present.

The IR transmitter is a simple IR LED. Modulation is performed by the AVR. When the LED is on it has a radiant power of approximately 20mW. The control signal for the IR LED is connected to PB1 on the AVR. This pin is shared with SW2. Software automatically determines whether PB1 should be configured as an output for controlling the IR LED, or configured as an input for sensing the status of SW2. The IR LED can be manually turned on by pressing SW2.

IR Receiver
Typical Current – 1.3mA
Carrier Frequency - 38KHz

IR LED
Viewing Angle – 60 deg
Current – 82.5mA
Radiant Power – 20mW

Mechanical

eDemo board dimensions: 1.50” wide x 1.90” length x 0.28” depth
eDemo board weight: 8g

Operating Characteristics

Absolute Maximum Ratings

Voltage on any input pin -0.1V to 3.5V
Voltage on H0-H3 20V
Voltage on Analog Inputs 3.5V
Operating Temperature (Board only) -30°C to 85°C

DC Characteristics

Symbol	Description	Condition	Min	Typ	Max	Units
V_{ext}	External Voltage		4.2	5.0	5.5	V
I_{ext}	External Current	V_{ext} = 5.0V			100	mA
I_{CC}	eDEMO current from main board.	V_{CC} = 3.0V			250	mA
V_{+5V}	5V output from eDEMO at P1-7	V_{+5V} = +5.0V			100	mA
V_H	H0-H3 high level voltage		4.5		18	V
V_{OL}	Output low level voltage (except for H0-H3)	I_{OL} = 6ma	-	-	0.5	V
V_{OH}	Output high level voltage (except for H0-H3)	I_{OH} = 10ma	2.3	-	-	V
V_{OL}	Output low level voltage for H0-H3	I_{OL} = 0 to 8ma	-	-	0.15	V
V_{OH}	Output high level voltage for H0-H3	I_{OH} = 0 to 8ma	V_H-0.025	-	-	V
I_H	H0-H3 output current sink/source	Single output All outputs			300 500	mA mA
V_{IL}	Input low level voltage	All inputs	-0.5	-	0.9	V
V_{IH}	Input high level voltage		1.8	-	2.5	V
V_{ANA}	Input voltage range		0.0		3.0	V

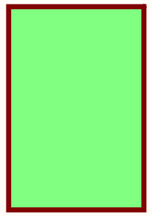
AC Characteristics

Module	Min	Nom	Max	Units
Atmega168 SPI		500		Kbps
Atmega168 I^2C (TWI)		100		Kbps
USART	7	9600	500000	Baud
IR Detector Carrier		38		KHz
Accelerometer (read all axis)		3		ms
Accelerometer Sample Rate (slow)		125		Hz
Accelerometer Sample Rate (fast)		250		Hz
Light Sensor (read RGBC)		100		Hz

eDEMO

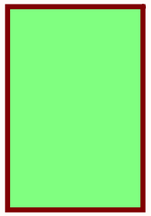
Rev 8.1.3

AVR / Serial Flash



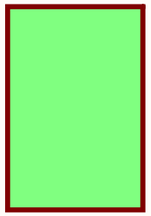
AVR_Flash.SchDoc

Accelerometer



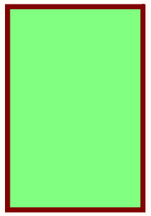
Accelerometer.SchDoc

LEDs



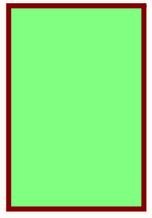
LEDS.SchDoc

Power Supply



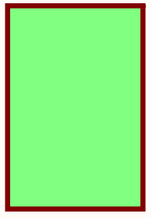
Power_Supply.SchDoc

I2C



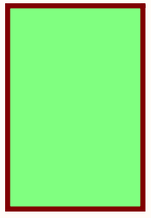
I2C.SchDoc

Light Sensor



Light_Sensor.SchDoc

I/O



IO.SchDoc

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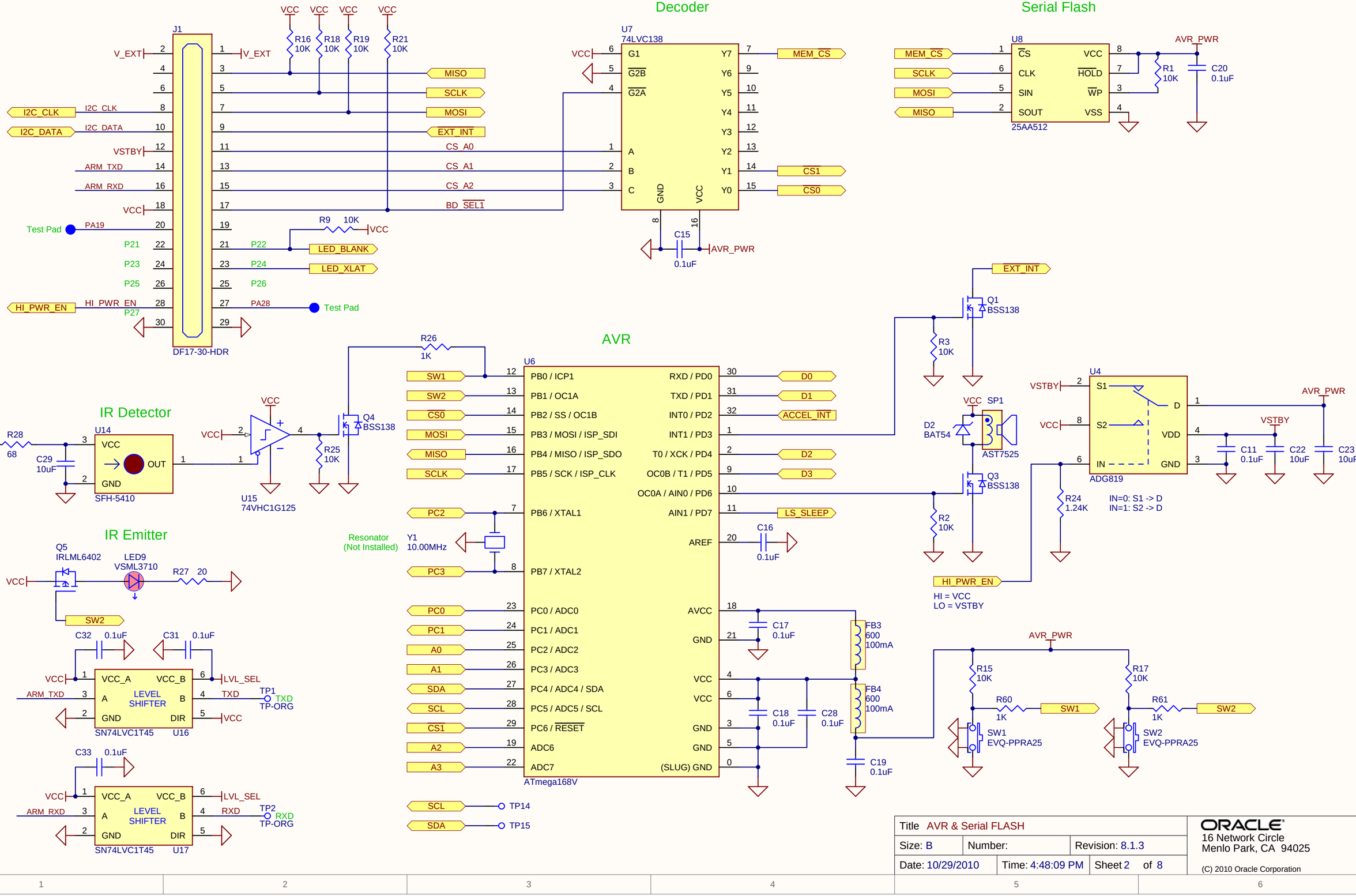

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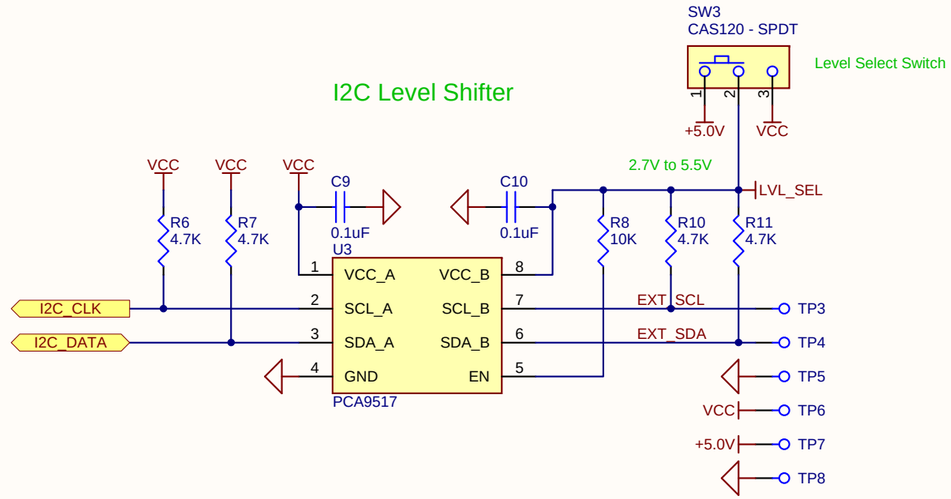

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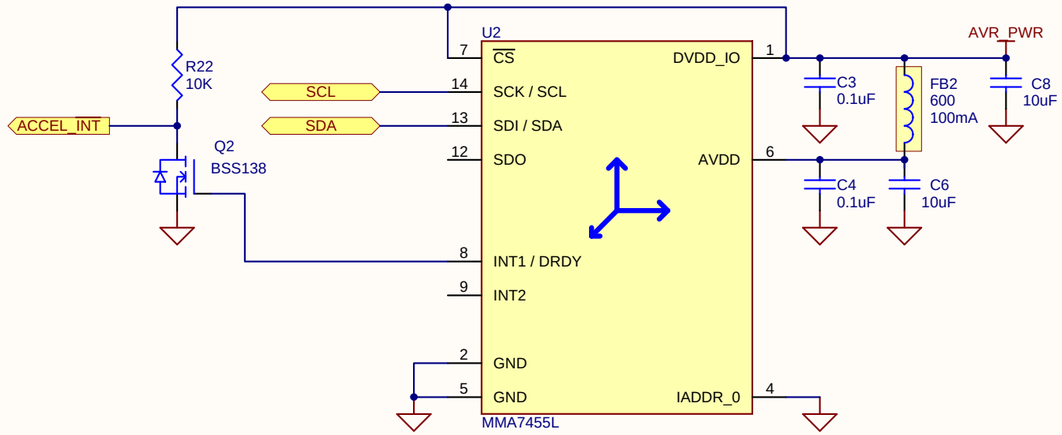
3-Axis Accelerometer



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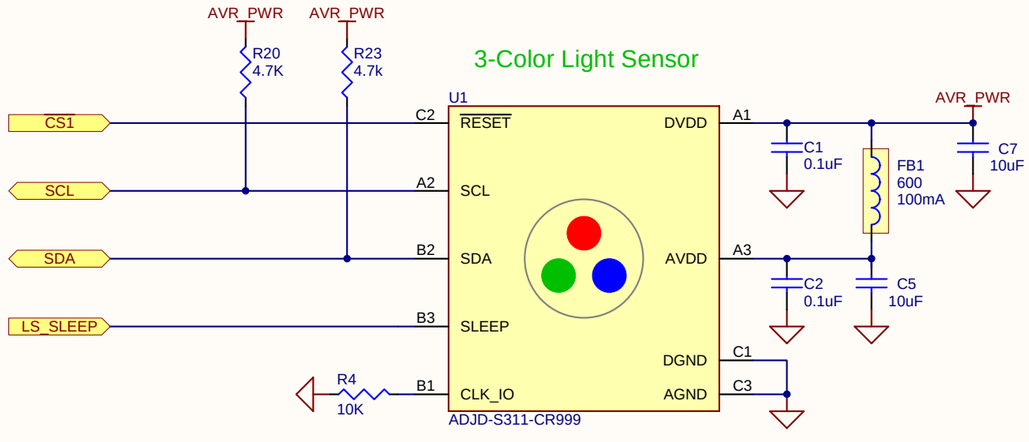

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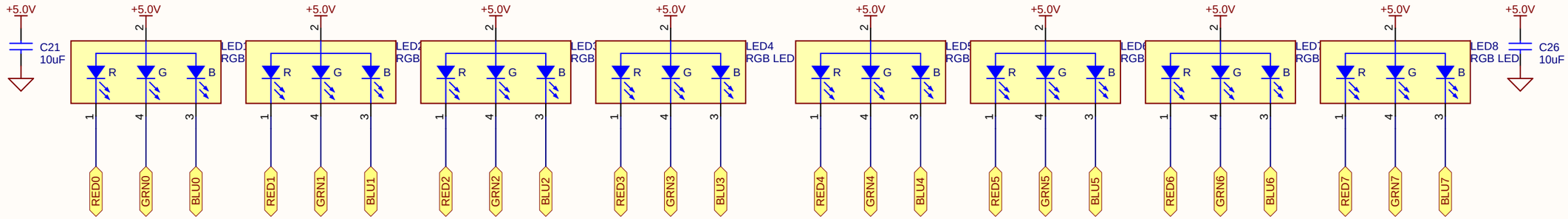

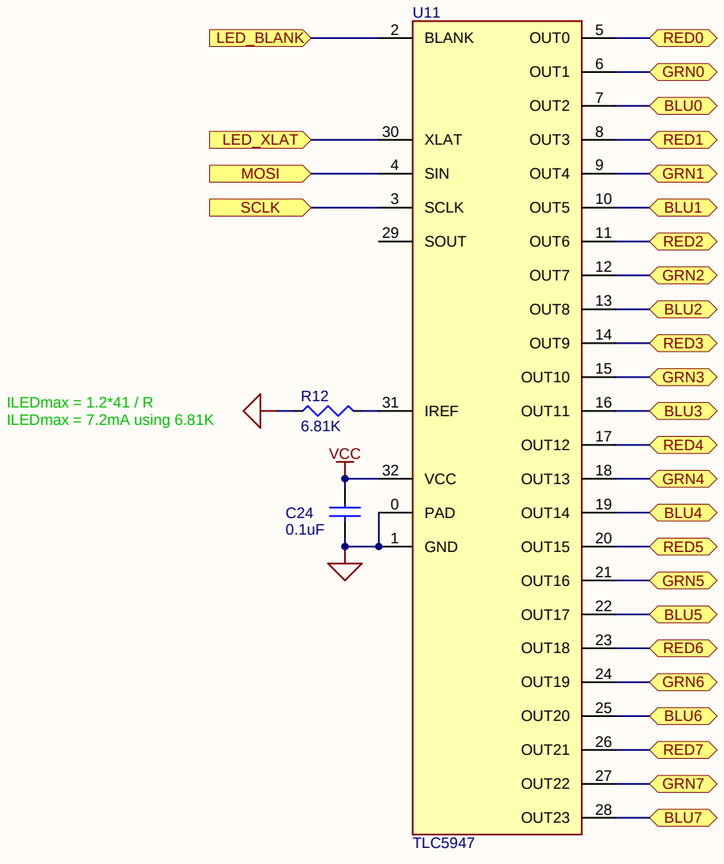

Title LEDs			ORACLE 16 Network Circle Menlo Park, CA 94025
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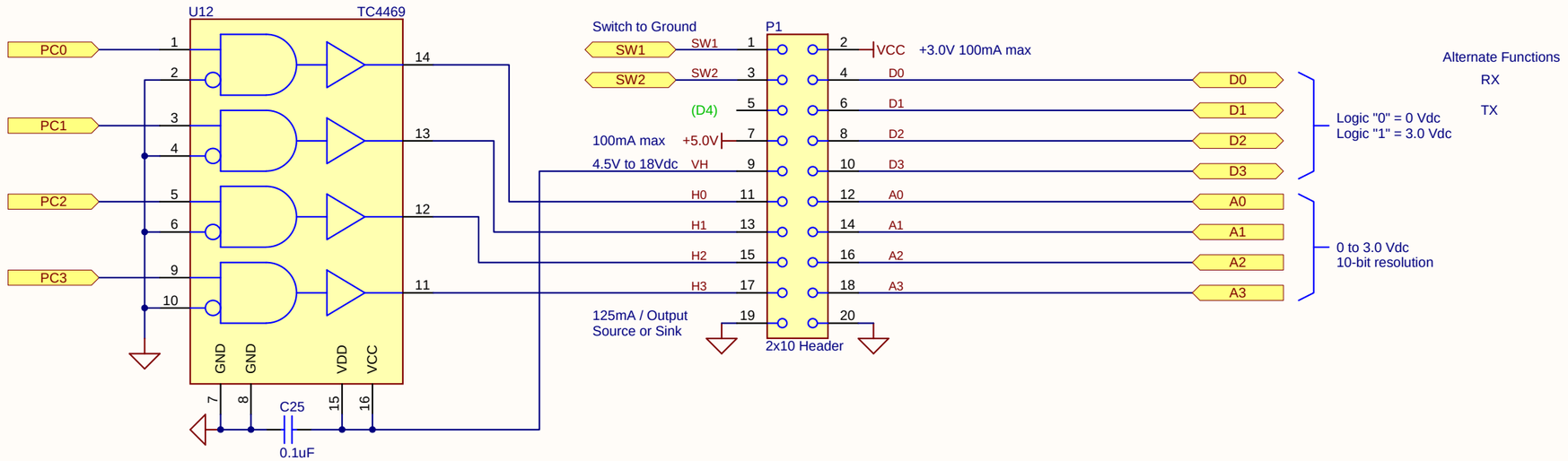
Date: 10/29/2010	Time: 4:48:09 PM	Sheet 6 of 8	

High-Current Driver



Title I/O			ORACLE 16 Network Circle Menlo Park, CA 94025
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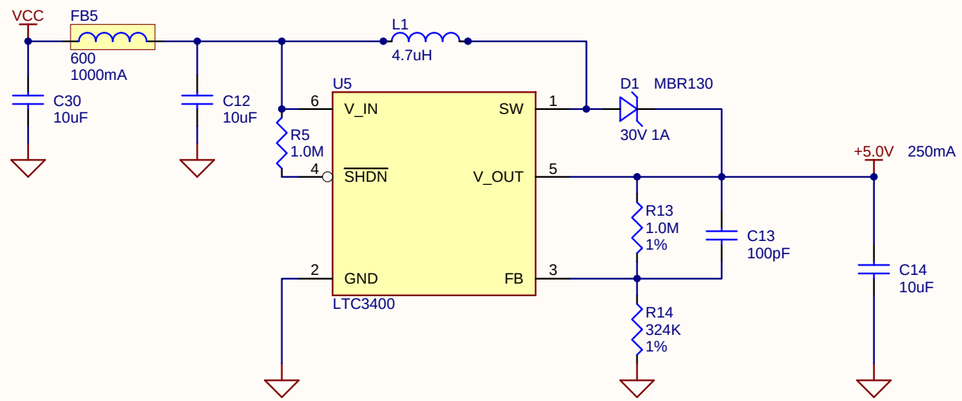
Date: 10/29/2010	Time: 4:48:09 PM	Sheet 7 of 8	

5V DC/DC Converter



FID1 FID1 Fiducial

FID2 FID2 Fiducial

FID3 FID3 Fiducial

FID4 FID4 Fiducial

LOGO1
ORACLE
PCB LOGO

Title Power Supply			
Size: B	Number:	Revision: 8.1.3	
Date: 10/29/2010	Time: 4:48:09 PM	Sheet 8 of 8	

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16 Network Circle
Menlo Park, CA 94025

eDEMO
ASSEMBLY TOP
Rev 8.1.2

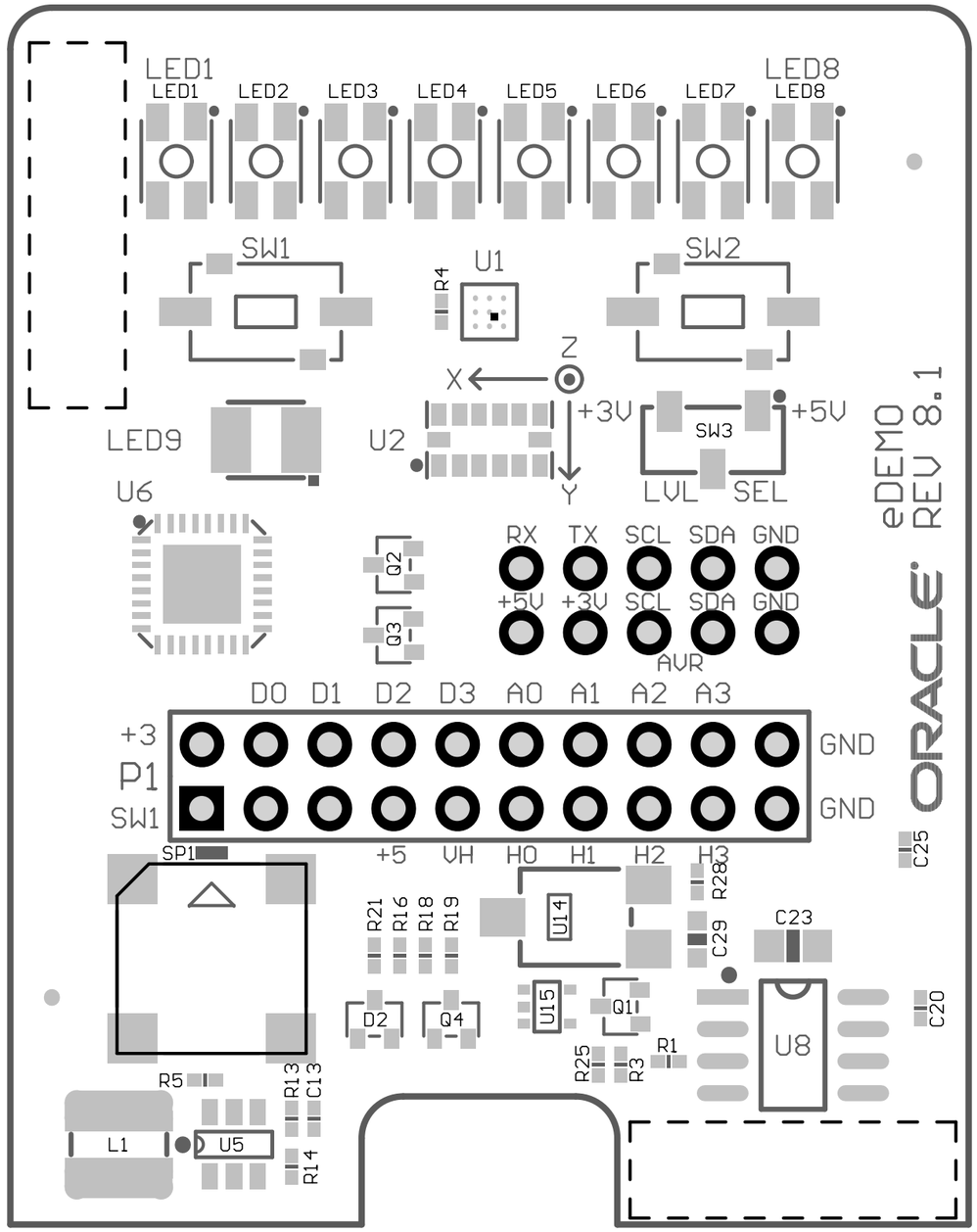
Assembly Notes:

Use RoHS-6 compliant assembly process
(Lead-Free)

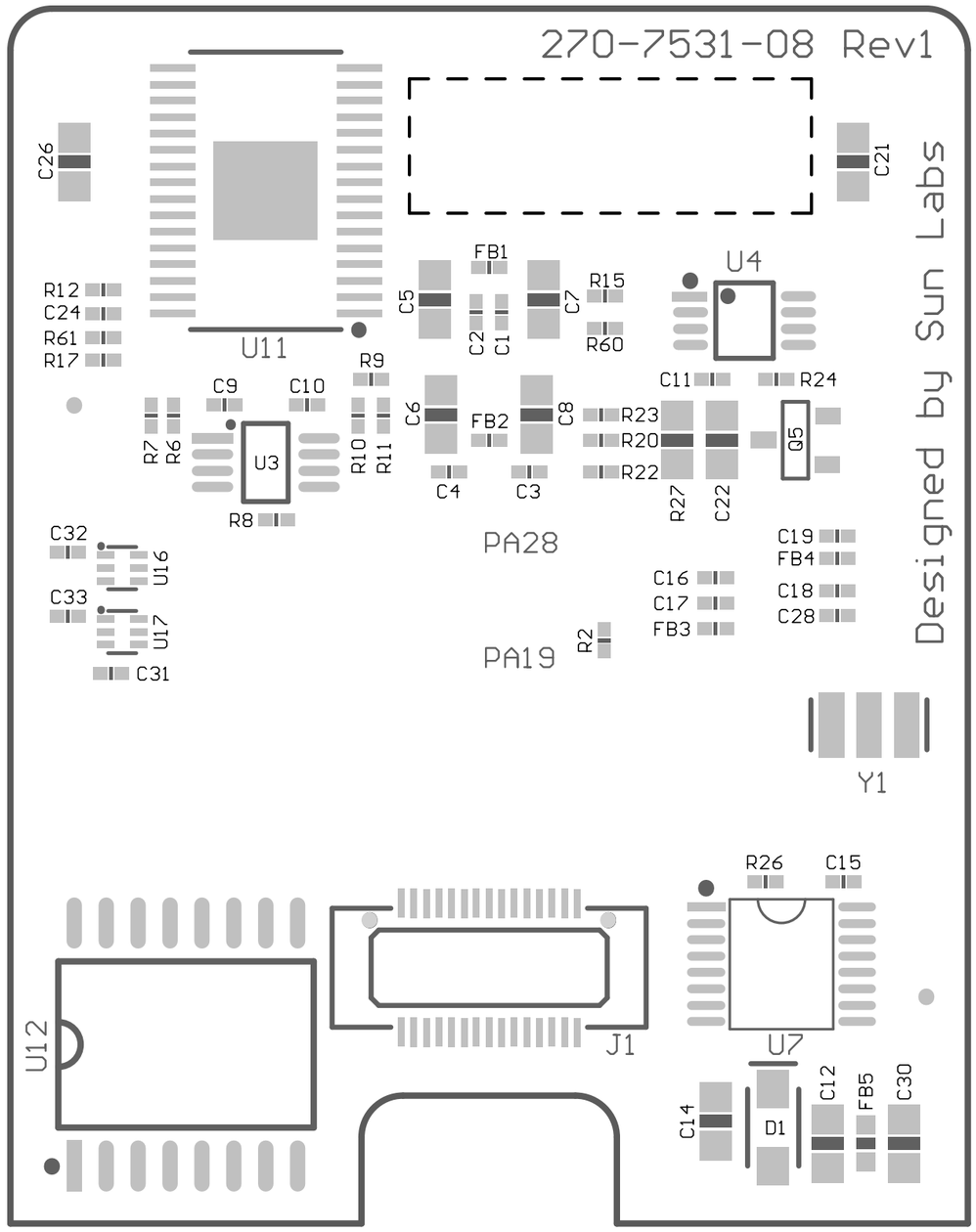
Wash board to remove flux
Bake after washing to dry

Do not put QC stamp markings
over test-points or connector pads

Label Locations - Top Side:
Dotted Areas



eDEMO
ASSEMBLY BOTTOM
REV 8.1.2



Label Locations - Bottom Side:
U11, U12 or dotted area