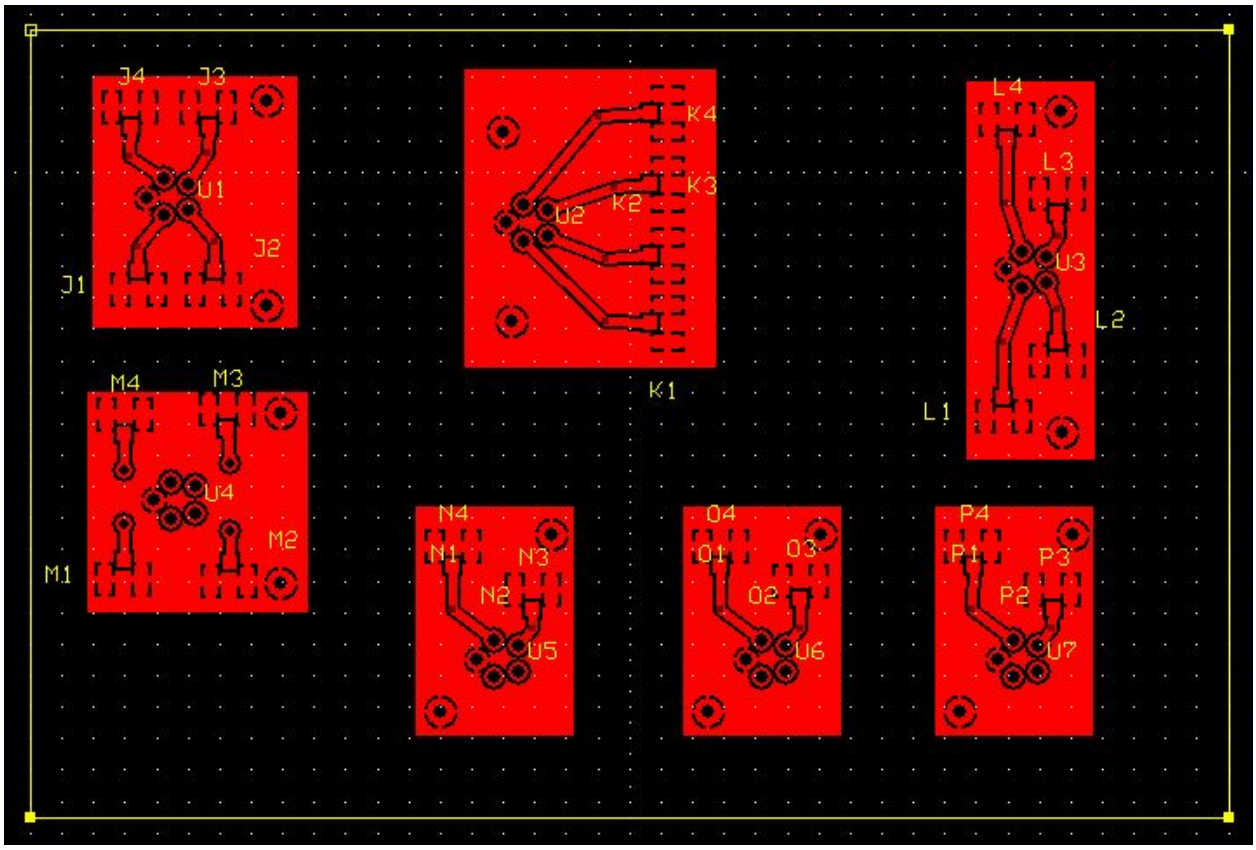
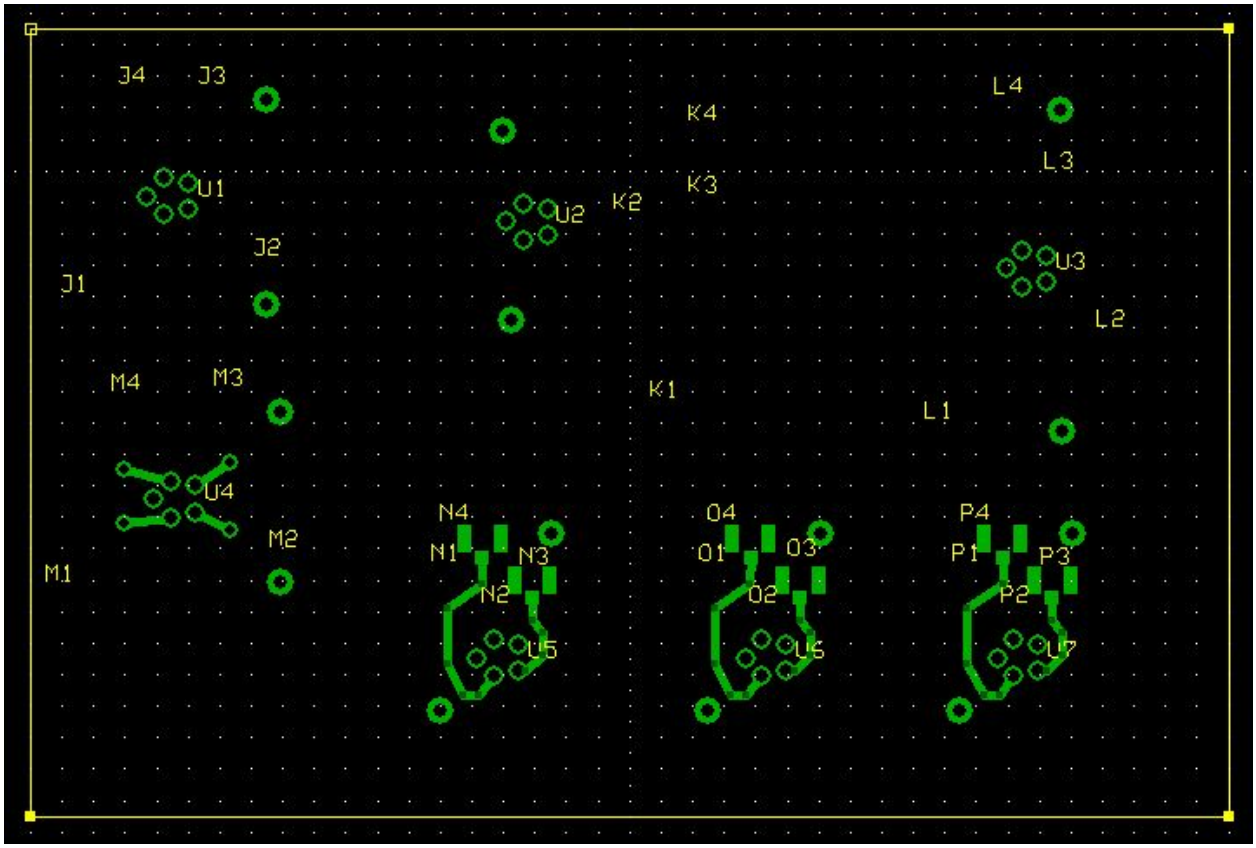
The first thing needed for this project is a PCB design program so that the hardware can be made. Altium is already installed on the computers in the Senior Design Lab but we used ExpressPCB which is a free software that can be installed from: https://www.expresspcb.com/free-cad-software/

VCSEL Schematic:

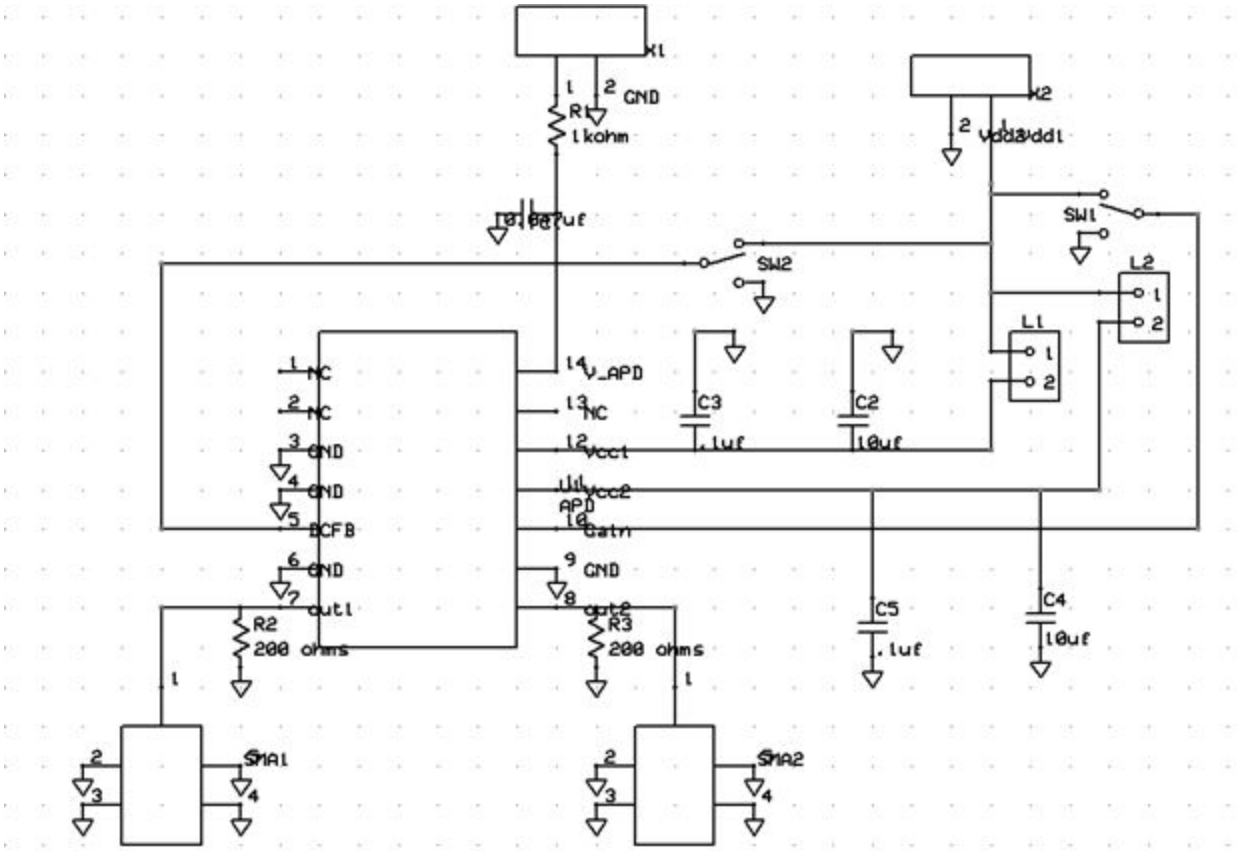
There are several different VCSEL PCB designs. All of them have four RF inputs which use MMX connectors. These four inputs connect to four of the pins on the VCSEL, these separate inputs are used for the four different wavelengths. The top pin of the VCSEL is just connected to ground.

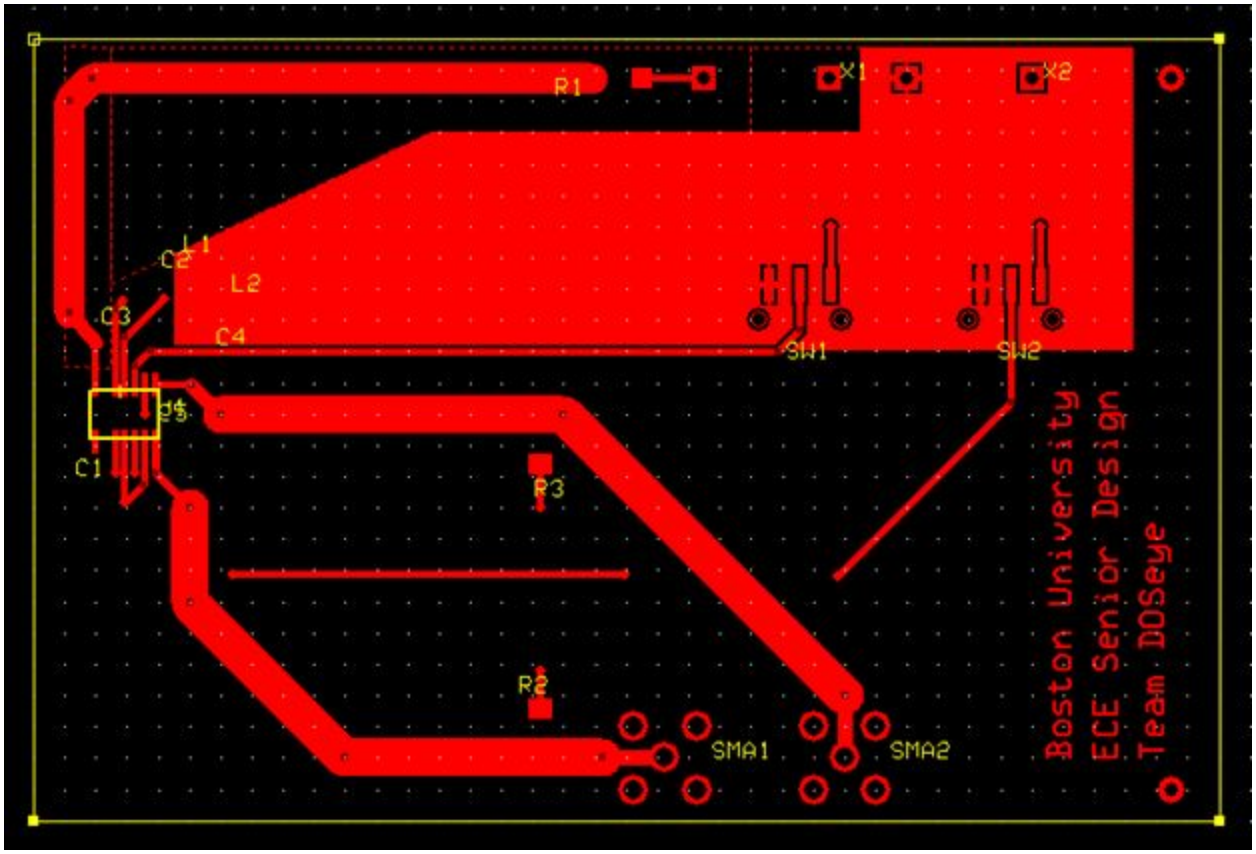




APD Schematic:

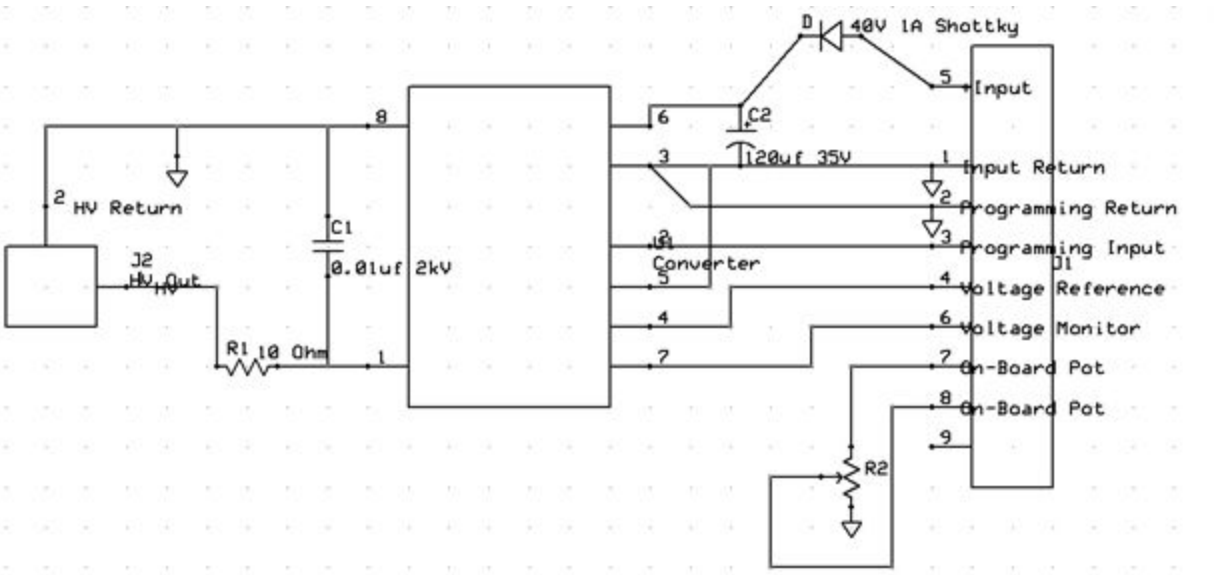
The PCB design software ExpressPCB was used to design the board. Factors such as simplicity, ease of use, depth of the individual parts (to keep the APD flush with the surface), soldering ability, and size were considered in the design process. In addition, we tried to take into account the characteristic impedance of the traces themselves, and thus made the traces for the high voltage connection and the RF outputs much larger. The traces for the outputs are approximately 120 mils wide to match the SMA connectors' impedance of 50 ohms. Once the board arrived, we soldered the parts on by hand, with the exception of the APD itself. For the APD, we had the EDF solder it on for us, due to its incredibly small contact points.

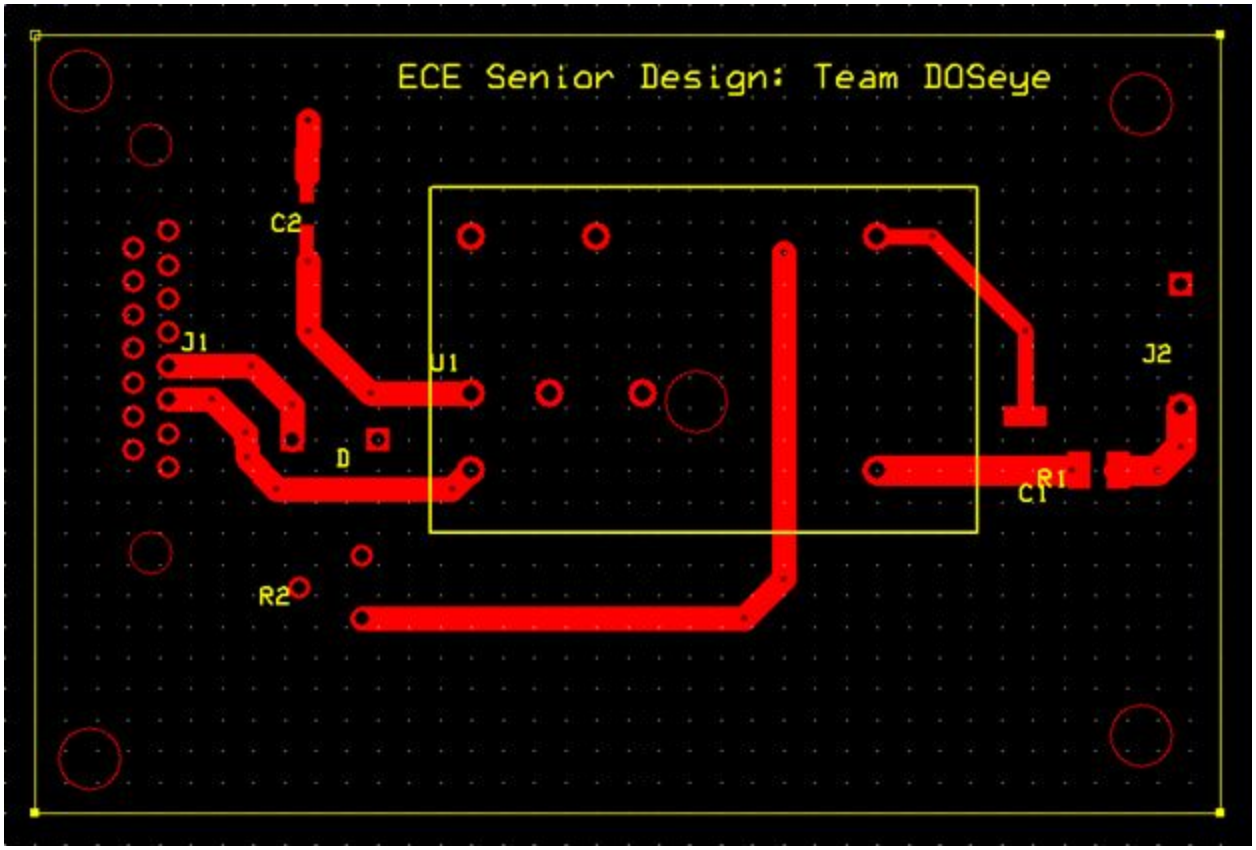

X1
X2
R1
1kohm
GND
Vdd3/Vdd1
SW1
SW2
L1
L2
C1
.1uf
C2
10uf
C3
.1uf
C4
10uf
C5
.1uf
NC
NC
GND
GND
BCFB
GND
outl
V_APD
NC
Vcct
Vcc2
APD
Gatn
GND
gate
R2
200 ohms
R3
200 ohms
SMA1
SMA2

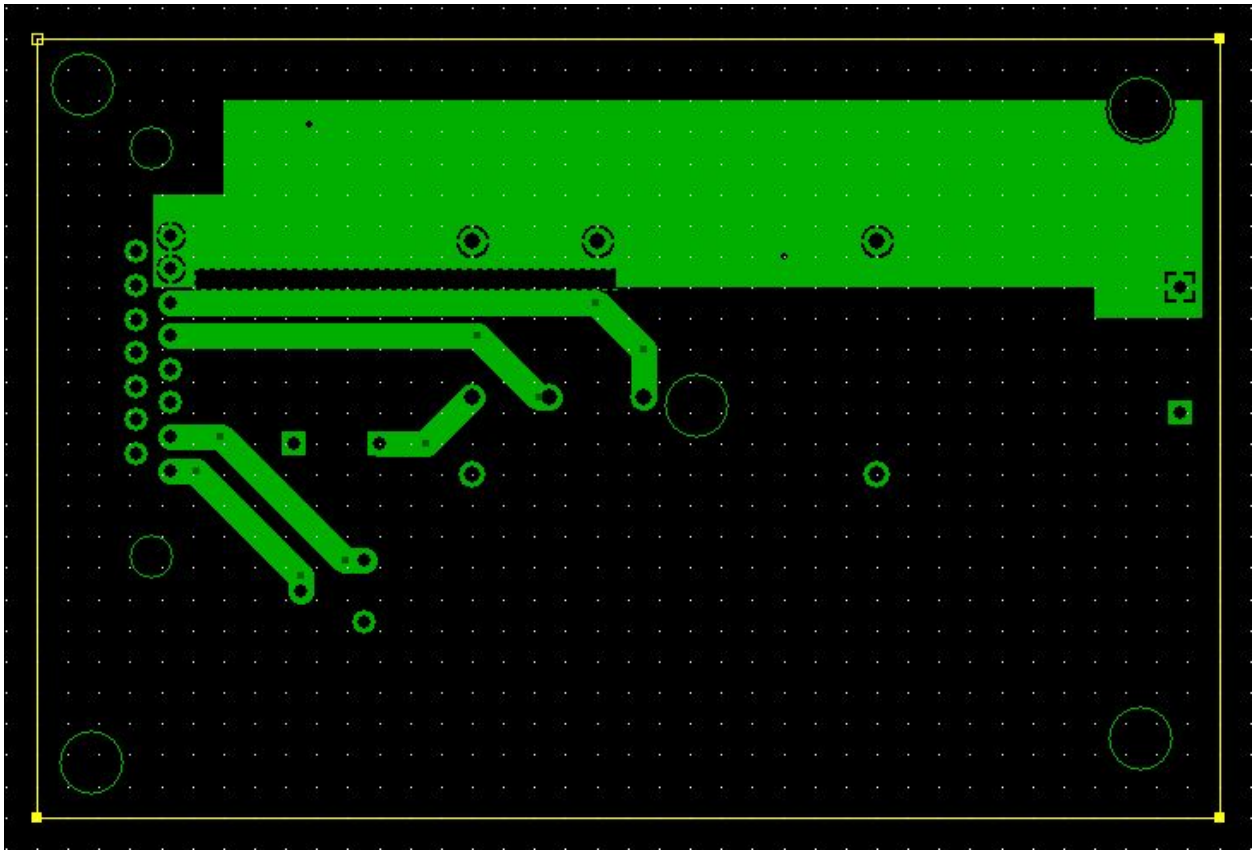

R1
X1
X2
L1
C2
L2
C3
C4
SW1
SW2
C1
R3
R2
SMA1
SMA2
Boston University
ECE Senior Design
Team DOSeye

Voltage Converter Schematic:

Referring to the diagram below for the high voltage converter PCB, input pin 5 should be connected to the 12V DC output from the AC to DC converter. Input Pins 4 and 7 should be connected to the output of the 5V DC to DC converter. Input Pins 3, 6, and 8 should all be connected together, while Input Pins 1 and 2 should be grounded. Additionally, the inputs for both the 3.3V DC to DC converter and the 5 V DC to DC converter should be connected to the 12V output of the AC to DC converter. Finally, the output of the 3.3V DC to DC converter should be connected to the low voltage input of the APD PCB.


D
40V 1A Shottky
C2
120uf 35V
8
6
3
2
HV Return
C1
0.01uf 2kV
J2
HV Out
R1 10 Ohm
1
Converter
5
4
7
5
Input
1
Input Return
2
Programming Return
3
Programming Input
4
Voltage Reference
6
Voltage Monitor
7
On-Board Pot
8
On-Board Pot
9
R2
J1


ECE Senior Design: Team DOSeye
C2
J1
U1
D
R2
J2
R1
C1



Bill of Materials:

Project Costs for Production of Beta Version (Next Unit after Prototype)				
Item	Quantity	Description	Unit Cost	Extended Cost
1	3	VCSEL PCB		$70.93
2		Voltage Converter Parts		$191.15
3	25	0.1 uF Capacitors		$8.95
4		APD Parts		$14.44
5		APD Switches		$11.74
6		Voltage PCB		$90.93
7		APD PCB		$90.93
8		High Voltage Converter		$202.00
			Beta Version-Total Cost	$681.07

SMA connectors were ordered from Pasternack, all other components were ordered from Digi-Key

C3216X7T2J473K160AC

TDK Item Description : C3216X7T2J473KT****

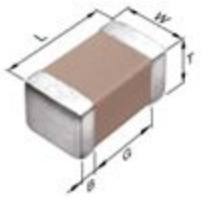
Characterization Sheet (Multilayer Ceramic Chip Capacitors)

Application & Main Feature

Commercial Grade (Mid Voltage (100 to 630V))

Series

C3216 [EIA CC1206]



Dimensions

L	3.20mm +/-0.2mm
W	1.60mm +/-0.2mm
T	1.60mm +/-0.2mm
B	0.20mm Min.
G	1.00mm Min.

Temperature Characteristic
X7T (-55 to 125 degC +22,-33%)

Rated Voltage
2J (630Vdc)

Capacitance
47nF

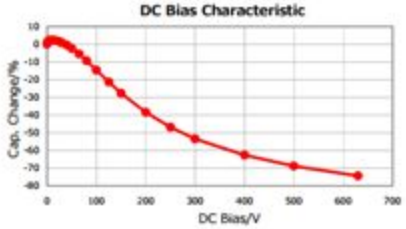
Capacitance Tolerance
K (+/-10%)

Dissipation Factor
2.5% Max.

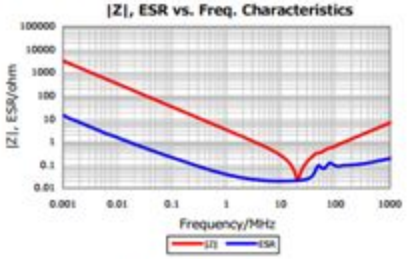
Insulation Resistance
10Gohm Min.

AEC-Q200
Not Applicable

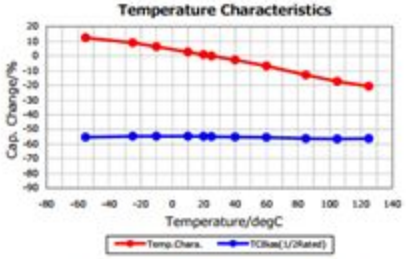
DC Bias Characteristic



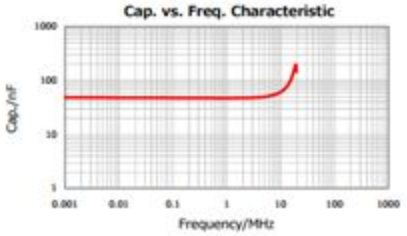
|Z|, ESR vs. Freq. Characteristics



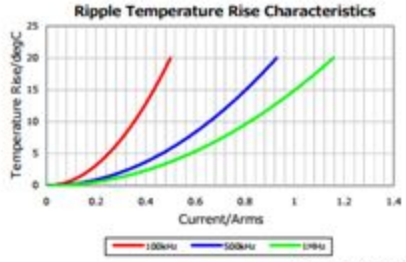
Temperature Characteristics



Cap. vs. Freq. Characteristic



Ripple Temperature Rise Characteristics



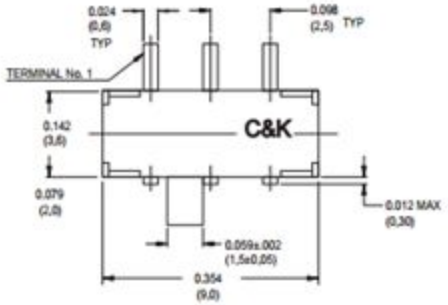
TDK

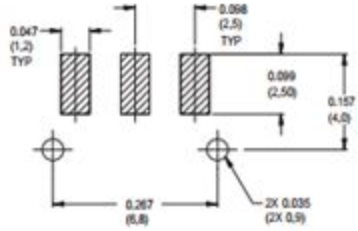
All specifications are subject to change without notice.

January 4, 2016

JS Series
Sub-Miniature Slide Switches

RIGHT ANGLE SURFACE MOUNT

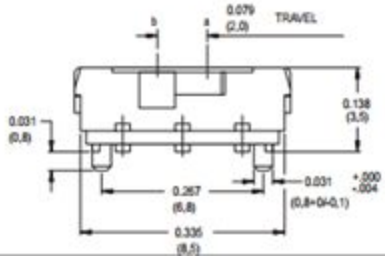


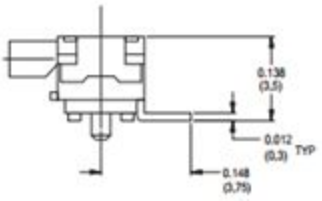


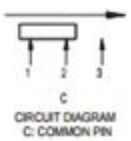
Part Number
JS102011SAQN
SPDT

Shown in position a

Available in tape & reel only, see page I-59







Shown in position b

Slide

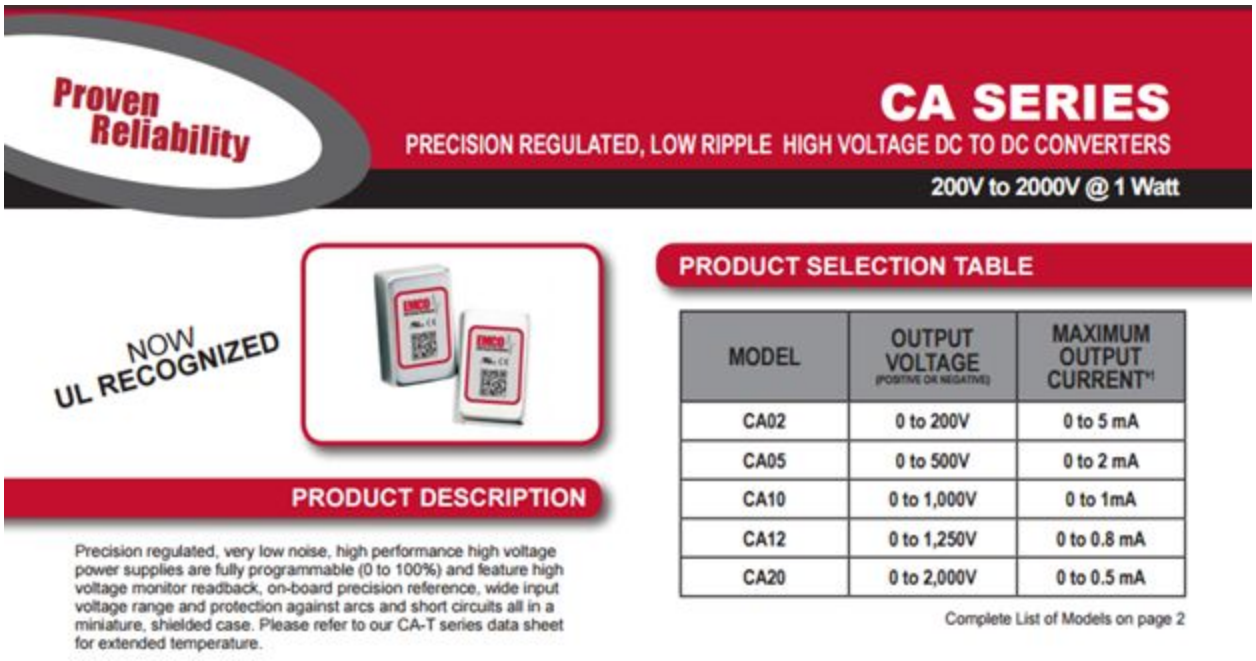
Components used for APD PCB:

200 ohm resistors (used 1206 size, digikey #541-200ECT-ND)
BLM18PG221SN1D Ferrite Bead
1kOhm Resistor, used size 1206, digikey #311-1.00KFRCT-ND
10uF capacitor, used 1206 size, digikey #311-1376-1-ND
0.1uF capacitor, used 1206 size, digikey #399-1249-1-ND

Components used for High Voltage PCB:

10 ohm resistor digi-key #P16861CT-ND
1N5819 Schottky Diode
1kOhm Potentiometer, digikey part #3310Y-001-103L-ND
120uF electrolytic capacitor, digikey #P18961CT-ND
10000pF capacitor, used size 1812, digikey #399-10477-1-ND

Power Requirements:



ELECTRICAL SPECIFICATIONS[*2] CA02 - CA20 (200V to 2000V)

OUTPUT VOLTAGE	MODEL	MAXIMUM OUTPUT CURRENT[*1]	RIPPLE P-P FULL-LOAD[*3]	REGULATION		FREQUENCY[*3]
				LOAD 0 TO 100%[*3]	LINE 11.5 TO 15.5V[*3]	
12 VDC INPUT MODELS						
0 to +200V	CA02P	0 to 5 mA	<0.01 %	<0.05 %	<0.01 %	80 - 180 kHz
0 to -200V	CA02N	0 to 5 mA	<0.01 %	<0.05%	<0.01%	80 - 230 kHz
0 to +500V	CA05P	0 to 2 mA	<0.01 %	<0.01 %	<0.01%	200 - 400 kHz
0 to -500V	CA05N	0 to 2 mA	<0.01 %	<0.01 %	<0.01 %	100 - 250 kHz
0 to +1,000V	CA10P	0 to 1 mA	<0.001 %	<0.005 %	<0.001 %	80 - 250 kHz
0 to -1,000V	CA10N	0 to 1mA	<0.001 %	<0.005 %	<0.001 %	100 - 250 kHz
0 to +1,250V	CA12P	0 to 0.8 mA	<0.0005 %	<0.005 %	<0.001 %	80 - 250 kHz
0 to -1,250V	CA12N	0 to 0.8 mA	<0.0005 %	<0.005 %	<0.001 %	80 - 250 kHz
0 to +2,000V	CA20P	0 to 0.5 mA	<0.001 %	<0.01 %	<0.01 %	80 - 250 kHz
0 to -2,000V	CA20N	0 to 0.5 mA	<0.001 %	<0.01 %	<0.01 %	100 - 250 kHz

	INPUT CURRENT			
	CA02-CA12		CA20	
VIN	NO-LOAD	FULL-LOAD	NO-LOAD	FULL-LOAD
5 VDC	< 65mA	<420mA	<155 mA	<550 mA
12 VDC	<80 mA	<220 mA	<100 mA	<220 mA

(used model CA02 with the 12VDC input)

CUI INC®

SERIES: SWI24-SC | **DESCRIPTION:** AC-DC POWER SUPPLY

FEATURES
- 24 W power
- universal input (90~264 Vac)
- single regulated 12~24 Vdc output
- short circuit, over current, and over voltage protections
- UL 60950 & UL 1310 safety approvals
- level VI efficiency

RoHS c UL us FC LPS

MODEL	output voltage (Vdc)	output current max (A)	output power max (W)	ripple and noise[1] max (mVp-p)	efficiency level
SWI24-12-N-SC	12	2	24	120	VI
SWI24-15-N-SC	15	1.6	24	150	VI
SWI24-24-N-SC	24	1	24	240	VI

Notes: 1. At full load, nominal input, 20 MHz bandwidth oscilloscope, each output terminated with 0.1 µF multilayer ceramic and 10 µF low ESR electrolytic capacitors.

(Used model SWI24-12-N-SC)

Features

- Efficiency up to 96%, no need for heatsinks!
- Build-in Diode Protection Circuit
- Low Profie (LxWxH= 11.5 x 8.5 x 17.5mm)
- Continuous Short Circuit Protection
- RoHS compliant
- IEC/EN-60950 Certified

Switching Regulator

RECOM
DC/DC Converter

R-78W-0.5

0.5 AMP SIP3 Single Output

3 YEAR WARRANTY

Description

The R-78W series offers wired 0.5A switching regulators which are ideally suited to offer a stable voltage supply without the need for a PCB for applications like high power LED lighting, battery powered systems, cooling systems, or fans. Due to the high efficiencies of up to 96% there is no need for a heat sink. The compact modules feature fully protected outputs and draw only 1mA under no load conditions.

Selection Guide

Part Number	Input Voltage Range (VDC)	Output Voltage (VDC)	Output Current (mA)	Efficiency @ min. Vin (%)	Max. Capacitive Load [1] (µF)
R-78W3.3-0.5	6.5 - 32	3.3	500	88	220
R-78W5.0-0.5	6.5 - 32	5.0	500	93	220
R-78W9.0-0.5	11 - 32	9.0	500	95	220
R-78W12-0.5	15 - 32	12.0	500	96	220

Notes:
Note1: 6800µF with <1sec start-up time

IEC-60950-1 Certified
EN-60950-1 Certified

Specifications (measured at T_A= 25°C, full load, nominal input voltage and after warm-up)

BASIC CHARACTERISTICS				
Parameter	Condition	Min.	Typ.	Max.
Input Voltage Range		6.5VDC	24VDC	32VDC
Output Current [2]		6mA		500mA
Quiescent Current	0% Load		5mA	7mA
Internal Operating Frequency		280kHz	330kHz	380kHz
Efficiency	see Selection Guide			
Internal Power Dissipation				0.4W
Output Ripple and Noise	20MHz BW limited		50mVp-p	75mVp-p

Notes:
Note2: Operation under no load will not damage the device, however they may not meet all specifications. A minimum load of 6mA is recommended.

(Used one converter with an output of 3.3V for the low-voltage supply and a 5V output converter for a reference voltage for the high-voltage converter)

The APD circuit board can be plugged into a standard wall outlet for power via the voltage converters and wall adapter. The VCSEL circuit board must be connected to the RF switch and the current controller in the lab.

Power Sequence

Plug the Voltage Converter into a wall outlet and flip the switch to turn on the power. For the VCSEL power, it must be connected to the RF switch and the current controller in the lab.

Feature	Specification
Housing	
Size	128 mm x 78 mm x 90 mm
Source-Detector Separation	10 mm
High Voltage Converter	
Input Voltage	120 V AC
Output Voltages	3.3 V DC, 150-210 V DC (variable)
APD Board	
Average Operating Voltage - APD	170 V DC
Max Voltage - APD	200 V DC
Average Current - APD	0.4 mA
Operating Voltage - Board	3.3 V DC
Current - Board	240 mA
VCSEL Board	
Current	Laser 1 (660nm) - 10 mA
	Laser 2 (680nm) - 5 mA
	Laser 3 (775nm) - 15 mA
	Laser 4 (795nm) - 10 mA
Power	6 dB for all lasers

Probe	
Average Drift over 1 hour	2%
Average Accuracy	55% error
Useable Bandwidth (SNR > 20dB)	50 - 450 MHz