

# Portable Impedance Tomography System

## Mid-Term Status

Ashton Johnson

CPE621 Advanced Embedded Systems  
Electrical and Computer Engineering  
The University of Alabama in Huntsville

# Logistics

## Milestones

### Hardware

☒ Platform Selection (19 SEP)

Cypress PsoC BLE Module

Digilent Zybo (Xilinx Zynq-7000 SoC)

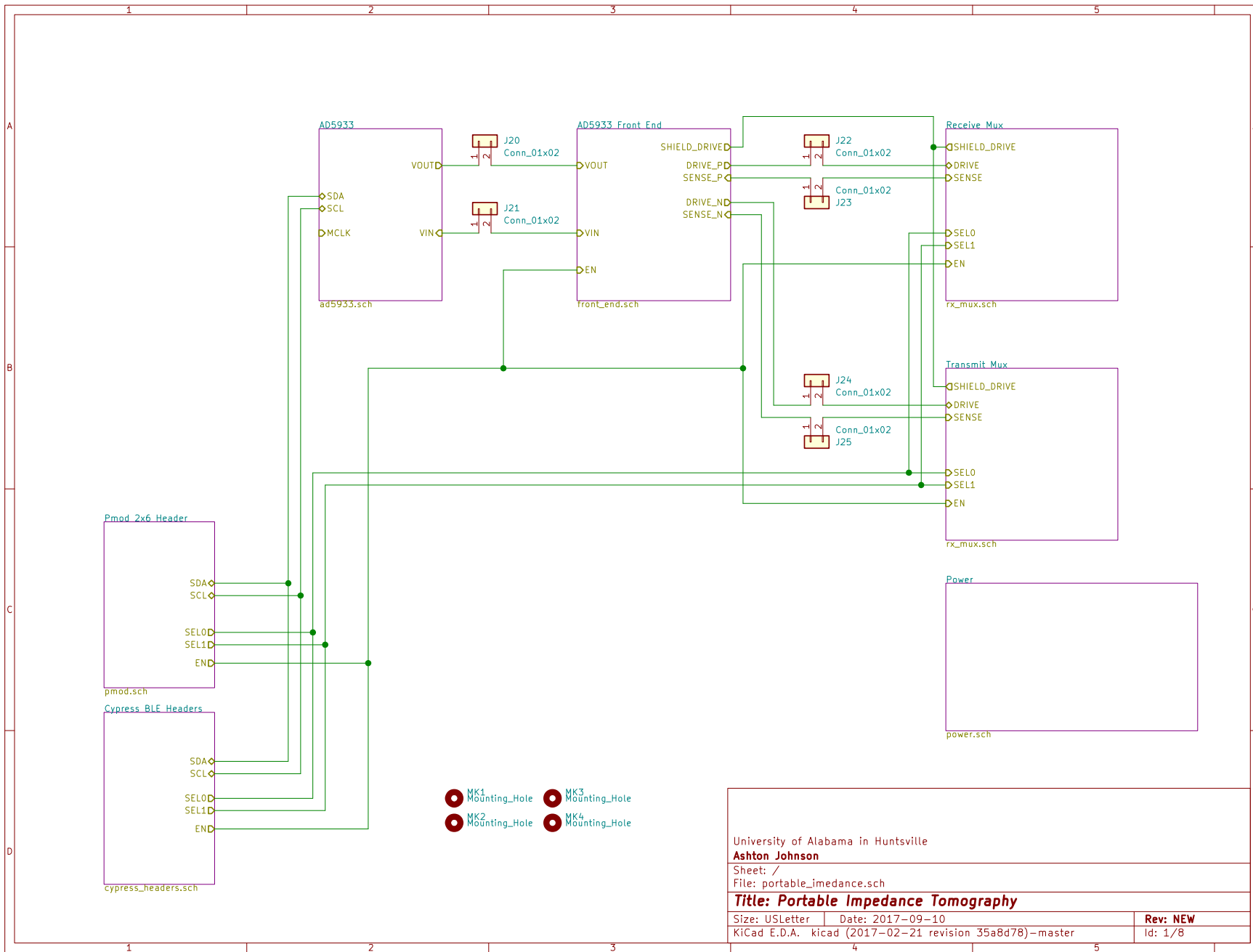
☒ Schematic Design & Layout Complete (26 SEP)

DRC Checks Completed

DFM Checks Completed

☐ PCB Assembly Complete (10 OCT)

☐ PCB Checkout Complete (24 OCT)



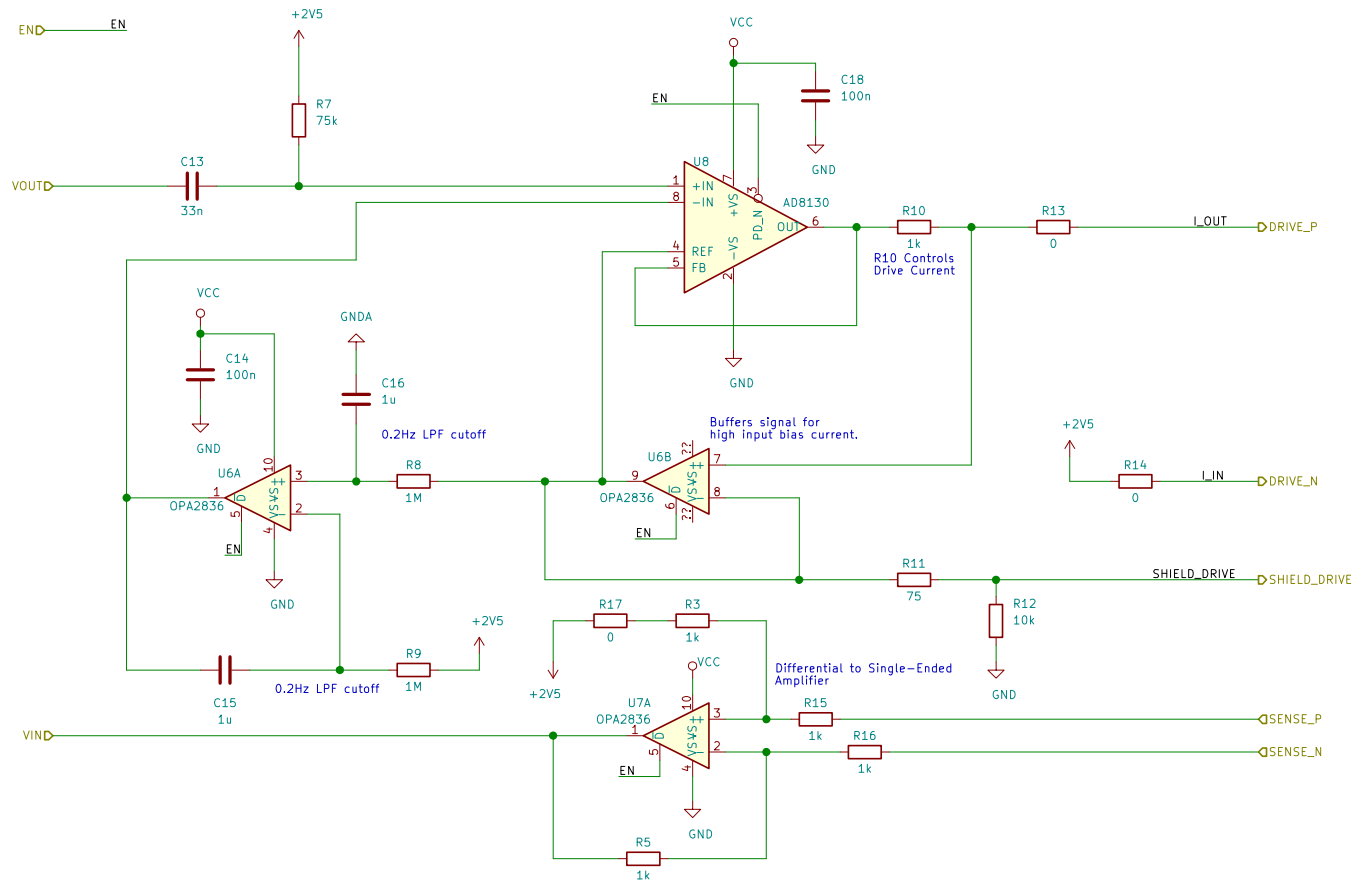
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Sheet: /  
File: portable\_impedance.sch

### Title: Portable Impedance Tomography

Size: USLetter | Date: 2017-09-10  
KiCad E.D.A. | kicad (2017-02-21 revision 35a8d78)-master

Rev: NEW  
Id: 1/8



Design Published in:

R. Harder, A. Diedrich, J. S. Whitfield, M. S. Buchowski, J. B. Pietsch, and F. J. Baudenbacher, "Smart Multi-Frequency Bioelectrical Impedance Spectrometer for BIA and BIVA Applications," IEEE Transactions on Biomedical Circuits and Systems, vol. 10, no. 4, pp. 912-919, Aug. 2016.

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Sheet: /AD5933 Front End/

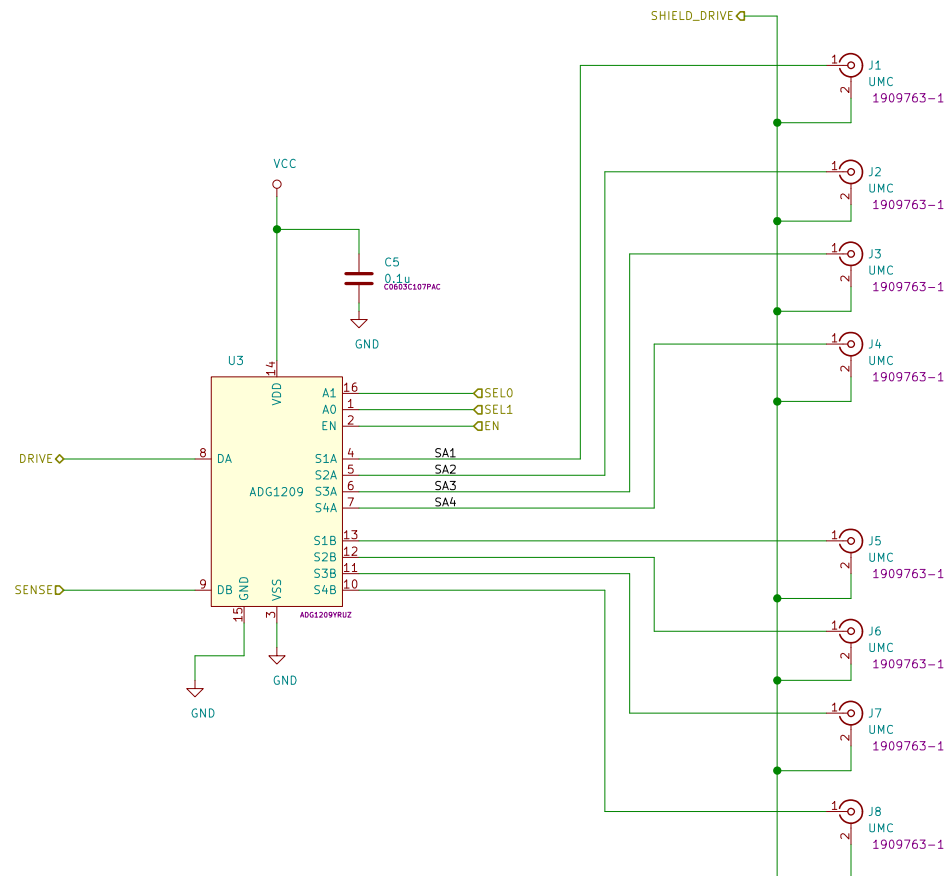
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### Title: Portable Impedance Tomography

Size: A4 | Date: 2017-09-10  
KiCad E.D.A. kicad (2017-02-21 revision 35a8d78)-master

**Rev: NEW**

Id: 5/8



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Sheet: /Receive Mux/

File: rx\_mux.sch

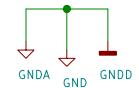
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Size: A4 Date: 2017-09-10

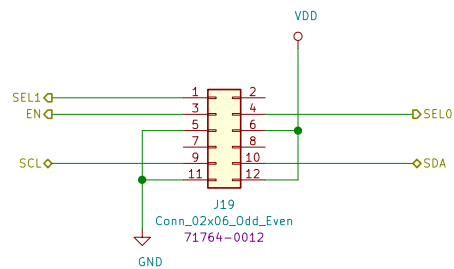
Rev: NEW

KiCad E.D.A. kicad (2017-02-21 revision 35a8d78)-master

Id: 3/8



Id: 4/8



This interface is capable of being mated to any 2x6 PMOD host, but is specifically compatible for the Digilent Zybo MIO PMOD JF connection.

Digilent PMOD Spec  
[https://reference.digilentinc.com/\\_media/reference/pmod/digilent-pmod-interface-specification.pdf](https://reference.digilentinc.com/_media/reference/pmod/digilent-pmod-interface-specification.pdf)

Zybo MIO PMOD JF Pinout (Table 16.1) :  
<https://reference.digilentinc.com/reference/programmable-logic/zybo-z7/reference-manual>

Zynq MIO Signal Routing (Table 2-4):  
[https://www.xilinx.com/support/documentation/user\\_guides/ug585-Zynq-7000-TRM.pdf](https://www.xilinx.com/support/documentation/user_guides/ug585-Zynq-7000-TRM.pdf)

Sheet: /Pmod 2x6 Header/  
 File: pmod.sch

**Title:**

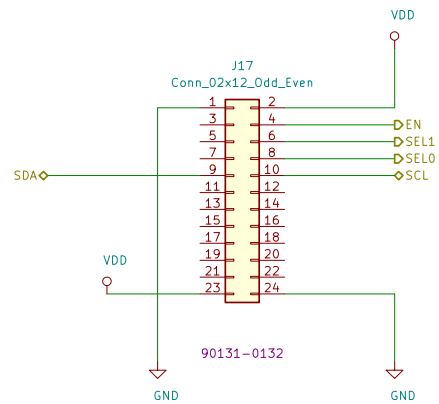
Size: A4

Date:

KiCad E.D.A. kicad (2017-02-21 revision 35a8d78)-master

**Rev:**

Id: 8/8



Cypress BLE Module Kit:  
<http://www.cypress.com/file/140711/download>  
 See Table 4 for pinout of CY8C4247LQI-BL483  
<http://www.cypress.com/file/137466/download>

Sheet: /Cypress BLE Headers/  
 File: cypress\_headers.sch

**Title:**

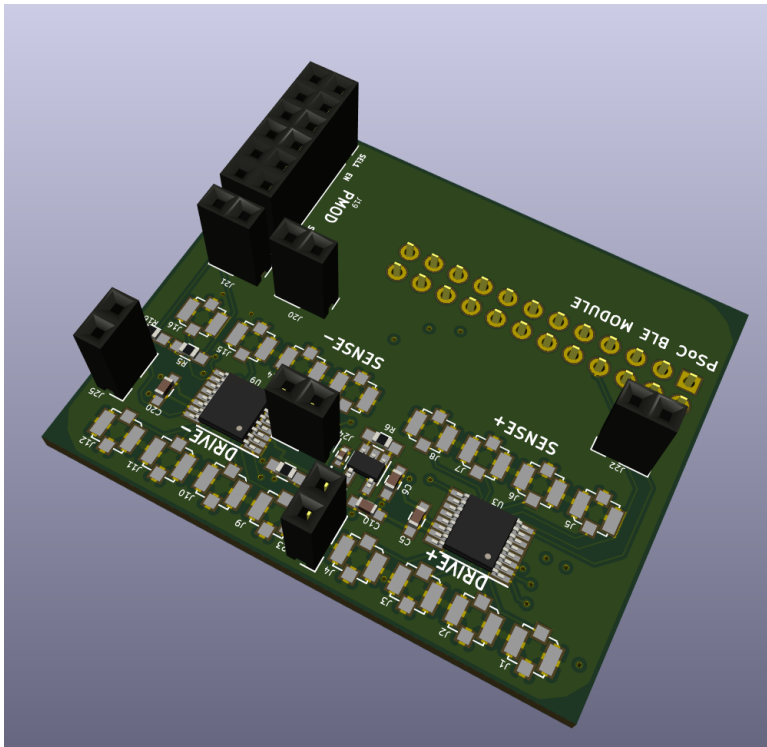
Size: A Date: KiCad E.D.A. kicad (2017-02-21 revision 35a8d78)-master

Rev: Id: 7/8

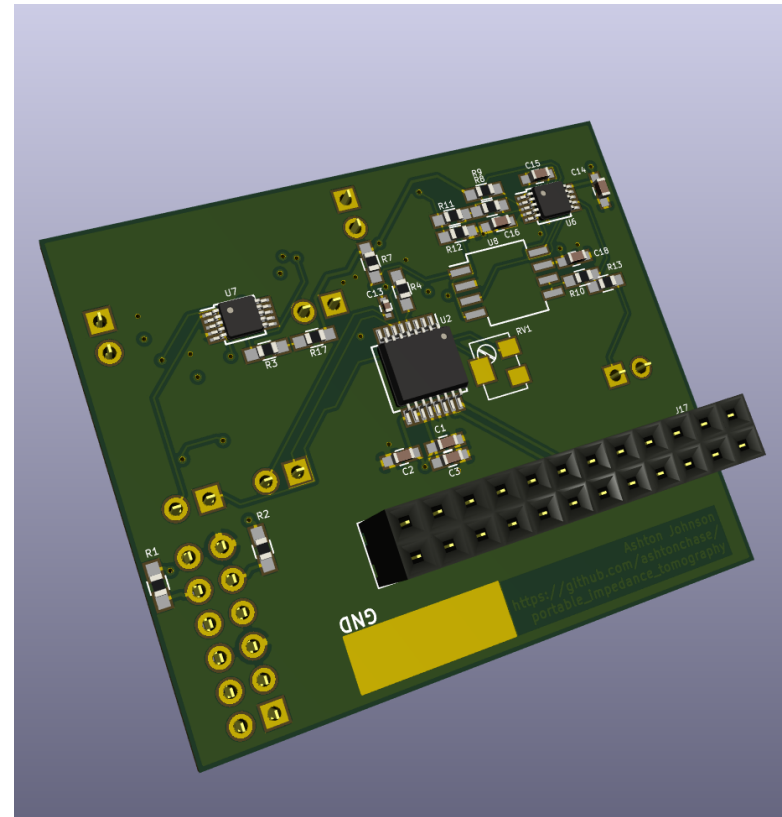


# PCBA 3D View

Top View



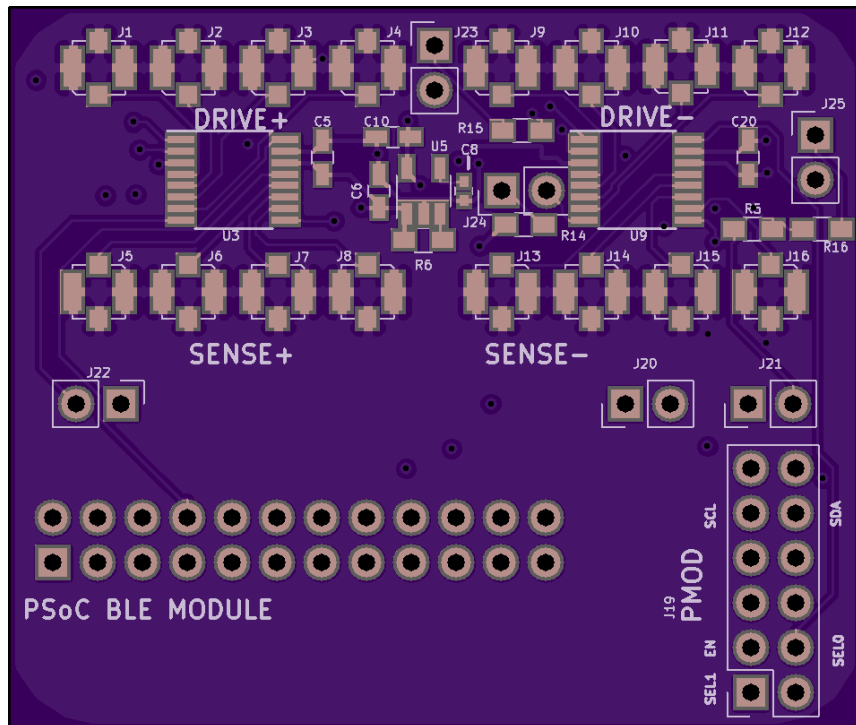
Bottom View



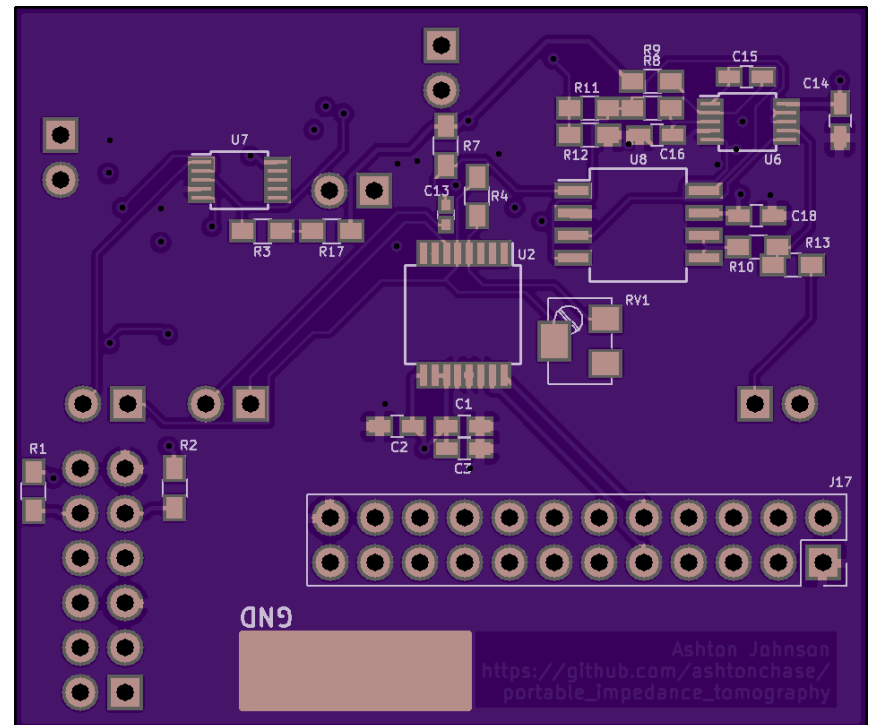
# PCBA OSH Park Order

\$30.80 for 3

Top View



Bottom View



# Software Development

- Driver Development
  - Hardware Independent Driver
  - Hardware Abstraction Layer (HAL)
    - Peripheral access accomplished by binding functions at runtime.

# Software Development

## High Level Functions (ad5933.h)

uint8\_t        ad5933\_Init (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_PerformFrequencySweep (ad5933\_deviceConfig \*config, uint32\_t startFreq, uint32\_t incrementFreq, uint16\_t  
numOfIncrements, uint16\_t \*realArray, uint16\_t \*imagArray)

uint8\_t        ad5933\_ConvertFreq (ad5933\_deviceConfig \*config, uint32\_t desiredFreq, uint8\_t \*freqMsb, uint8\_t \*freqMid, uint8\_t  
\*freqLsb)

uint8\_t        ad5933\_SetStartFreq (ad5933\_deviceConfig \*config, uint32\_t desiredFreq)  
uint8\_t        ad5933\_SetIncrFreq (ad5933\_deviceConfig \*config, uint32\_t desiredFreq)  
uint8\_t        ad5933\_SetIncrCount (ad5933\_deviceConfig \*config, uint16\_t incrNum)  
uint8\_t        ad5933\_SetSettleTime (ad5933\_deviceConfig \*config, uint16\_t cycles, uint8\_t factor)  
uint8\_t        ad5933\_GetStatus (ad5933\_deviceConfig \*config, uint8\_t \*result)  
uint8\_t        ad9533\_WaitForValidTemp (ad5933\_deviceConfig \*config)  
uint8\_t        ad9533\_WaitForValidImpedance (ad5933\_deviceConfig \*config)  
uint8\_t        ad9533\_WaitForSweepComplete (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_ReadRealResult (ad5933\_deviceConfig \*config, int16\_t \*real)  
uint8\_t        ad5933\_ReadImagResult (ad5933\_deviceConfig \*config, int16\_t \*imag)  
uint8\_t        ad5933\_InitWithStartFreq (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_StartSweep (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_IncrementFreq (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_RepeatFreq (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_MeasureTemp (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_PowerDown (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_Standby (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_Stop (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_SetPGAx1 (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_SetPGAx5 (ad5933\_deviceConfig \*config)  
uint8\_t        ad5933\_SetVoutRange (ad5933\_deviceConfig \*config, uint8\_t range)

# Software Development

## High Level Functions (hal/iic\_hal.h)

```
void          lic_Init (const lic_ConfigType *Config)
uint8_t       lic_RxByte (const uint8_t addr, const uint8_t reg, uint8_t *rxValue)
uint8_t       lic_TxByte (const uint8_t addr, const uint8_t reg, const uint8_t txValue)
void          lic_RegisterWrite (lic_RegisterType Register, uint32_t RegisterData)
uint32_t      lic_RegisterRead (lic_RegisterType Register)
```

- These functions must implemented for each target
  - Current design targets Cypress PsoC BLE

# Logistics cont.

## Milestones

### Software

- ☒ Driver Development
- ☐ Device Specific Code
- ☐ Android Application Code