# Introduction

This PCB serves as a breakout board for the Beaglebone, a power passthrough to the IO PCBs, CAN Circuitry and a generic LED indicator circuit. The PCB is known as the Device Under Test (DUT).

# Estimated Time

2 Hours per board

# Prerequisites

Attend the Badgerloop Soldering and PCB workshop or receive approval from an electrical lead. Some experience with solder paste dispensing or hand soldering SMD components is required.

# Required Equipment

* P4\_LV\_Processor\_002\_REVA PCBs (Qty up to 6) (DUT)
* Soldering iron
* Solder Paste
* Soldering Oven
* Solder
* Side cutters (snips)
* PCB BOM – SEE BOM FILE
* Microscope / Magnifying Glass / Calipers (optional)

# Visual Inspection

A simple visual inspection of the DUT includes:

1. Board thickness Design \_\_\_\_\_\_ Measured: \_\_\_\_\_
2. Board dimensions Design \_\_\_\_\_\_ Measured: \_\_\_\_\_
3. Warpage: Verified \_\_\_\_\_
4. Short circuit, bridge, open circuit, voids Verified \_\_\_\_\_
5. Surface quality (scratches, scrapes, burrs, etc.) Verified \_\_\_\_\_
6. Holes and Vias hole drilled, plating present Verified \_\_\_\_\_
7. Add a serial number to the DUT with permanent marker. Boards should be numbered with this format: <Abbreviated Name>-<Number>-<Revision> for example the first board would be labeled PBB-001-A for Processor BeagleBone, 001-006 for the unique identifier and A for the revision.

# Fit Check

1. Place the processor PCB into the LV and HV module boxes and secure the 4-40 screws.
2. Connect the power PCB
3. Connect the LV\_IO and HV\_IO PCBs
4. Place the assembled module into the 3D Printed case and secure the 4-40 screws.

# Soldering

## SMD Soldering

1. Apply solder paste to all populated SMD pads
   1. Note, if a component won’t be populated for whatever reason, do not apply solder paste. Bake boards soon after placement.
2. Place all SMD resistors (R1-R9, R16, R28-R31), capacitors (C1 – C7) LEDs (LED1-6), Diodes (D1-D2) and ICs (U1, U3-U6)
   1. I find it helpful to have a printout of the schematic and mark off when a component is placed on the board. This prevents DNP (Do Not Place) components from getting populated.
   2. **Do not populate R10-R15, R17-27**
   3. **U2 is 0.1” headers. Do not put solder paste on through holes.**
3. Bake boards following instructions for the specific oven.

### Soldering Inspection 1

1. Verify there are no shorts between adjacent solder joints. Using a magnifying glass or microscope is useful. Adjacent pins on the controllers need to be inspected carefully
2. Verify all solder joints have the appropriate amount of solder.
3. Heat up any un-melted solder paste with an iron if necessary.
4. Touch up any solder joints with an iron if necessary. Use hot air if you are trained with that tool.

## Through Hole Soldering

1. Insert the screw terminals U2 and solder one pin on each component. Ensure that the component is flush to the PCB. Reheat the solder joint and adjust the component if it is not flush. Then solder the other pins.
2. Insert the 0.1” headers in P1-P13 and solder. Ensure that the component is flush to the PCB. Reheat the solder joint and adjust the component if it is not flush. Then solder the other pins.
3. Insert J1 flush to the PCB. Solder one pin and ensure that the bottom of the connector touches the top of the PCB. Reheat the joint and slide the connector as necessary. It is critical that this component is flush. Then solder the rest of the pins.
4. Repeat for J2 and J3
5. Populate P1

### Soldering Inspection 2

1. Repeat the same steps as soldering Inspection 1

## Assembly

1. Connect the beaglebone black to the U2 0.1” headers.

# Testing

## Electrical Testing

### Continuity / Short Circuit Testing

1. Using a digital multimeter set to continuity mode, verify there are no shorts between pins. It’s useful to be on “beep mode”.
   1. My strategy is to hold the red multimeter lead on pin one, then contact all other pins. Then move the red multimeter lead to pin 2, then contact all other pins.
   2. Verified \_\_\_\_\_

### Processor Operation

#### BeagleBone Power

1. Connect the beaglebone to the network via Ethernet
2. Using a current limited power supply, connect power directly to P2.
3. Enable the power supply
4. Verify network connection with the beaglebone and verify any status indicator LEDs

### CAN Testing

1. Work with the controls team to develop a test procedure
2. Suggested approaches are to have two processor PCBs connected by a short CAN Cable through J1 and verify messages can be sent over the bus.
   1. If you’re having problems, check that you have proper 120 Ohm termination resistors on the ends of the bus.
   2. If a node is terminating, populated P1

### IO Expander Testing

1. Work with the controls team to develop a test procedure
2. Suggested approaches are to verify the device is receiving power, the use a logic analyzer on the I2C Breakout Header to verify signals are properly transmitting.

## Integration Testing

Integration testing involves testing the interfaces between the DUT and any other PCB, connector and mechanical enclosure the DUT will nominally interact with.

1. Verify the PCB mounts properly in the enclosure. Verified \_\_\_\_\_

## Thermal and Vacuum Testing

1. As time allows, perform thermal and vacuum testing. This test could be combined with current sense amplification testing. Use a thermal camera, focusing on the FETs and shunt resistors