# Cubby

## Three-bay Shelf for Open Rack V2

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# Scope

This document defines the technical specifications for the Cubby three-bay shelf used in Open Compute Project Open Rack V2.

# Contents

# Table of Figures

# Version History

| Version | Author | Comments |
|---|---|---|
| 0.1 | Jason Adrian | Early Version for Internal Review |
| 0.2 | Renee Chu | Mechanical details |
| 0.3 | Jason Adrian | Updated power distribution details |
| 0.4 | Renee Chu & Jason Adrian | External Release |

# 1 Overview

The Cubby design is a new shelf and power distribution design that is fully compatible with Open Rack V1 and forward compatible with Open Rack V2. The objective of the design is to further reduce the cost of the individual nodes and rack infrastructure while at the same time increasing the flexibility of the rack interface to support future designs. This new shelf design, hereafter referred to by its project name Cubby, provides three bays and occupies 2 Open U (96mm).

# 2 License

# 3 Open Source

This design and all design files and specifications shall be provided to the Open Compute Project. The information provided includes:

- Mechanical CAD files
- Design Specification

# 4 Overview and Definition of Terms

In the Open Rack V2 schema, there are two basic building blocks and terms that describe the major components of a disaggregated rack design.

**Shelf** – A mechanical structure that occupies two Open 0U, supports and distributes power to individual storage/compute/etc. sleds.

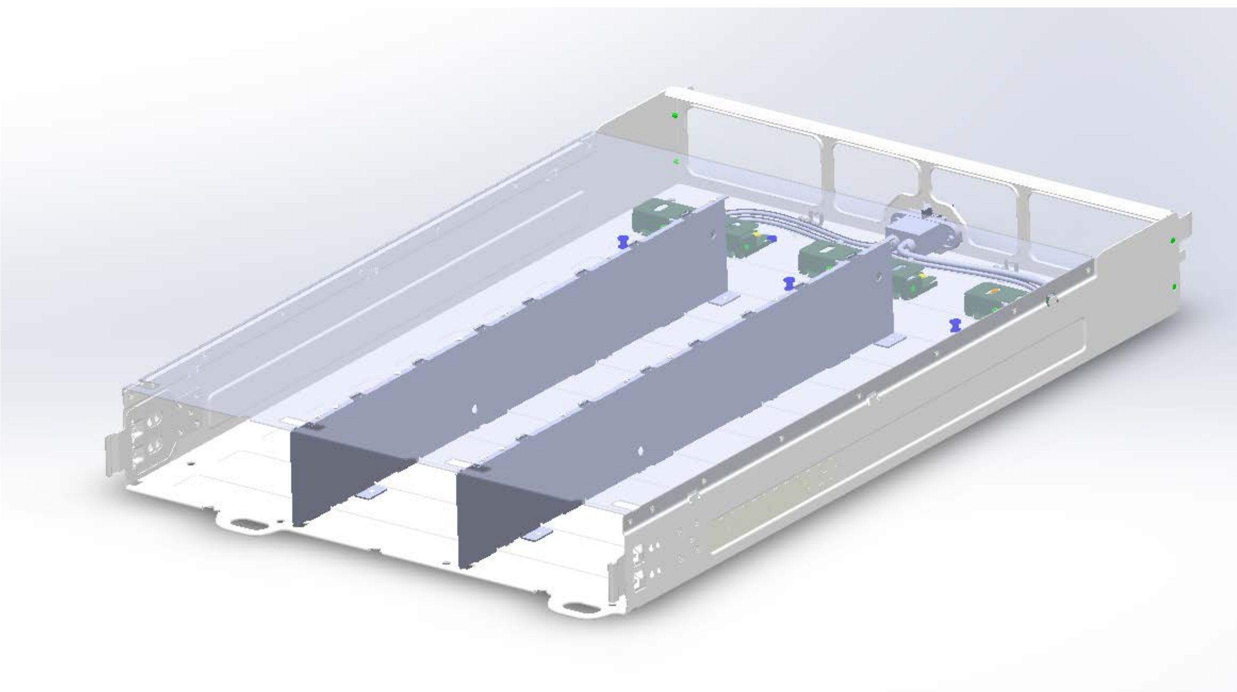


Figure 1: V2 3-bay shelf (Cubby)

**Sled** – A storage/compute/etc. element that plugs into a shelf design.

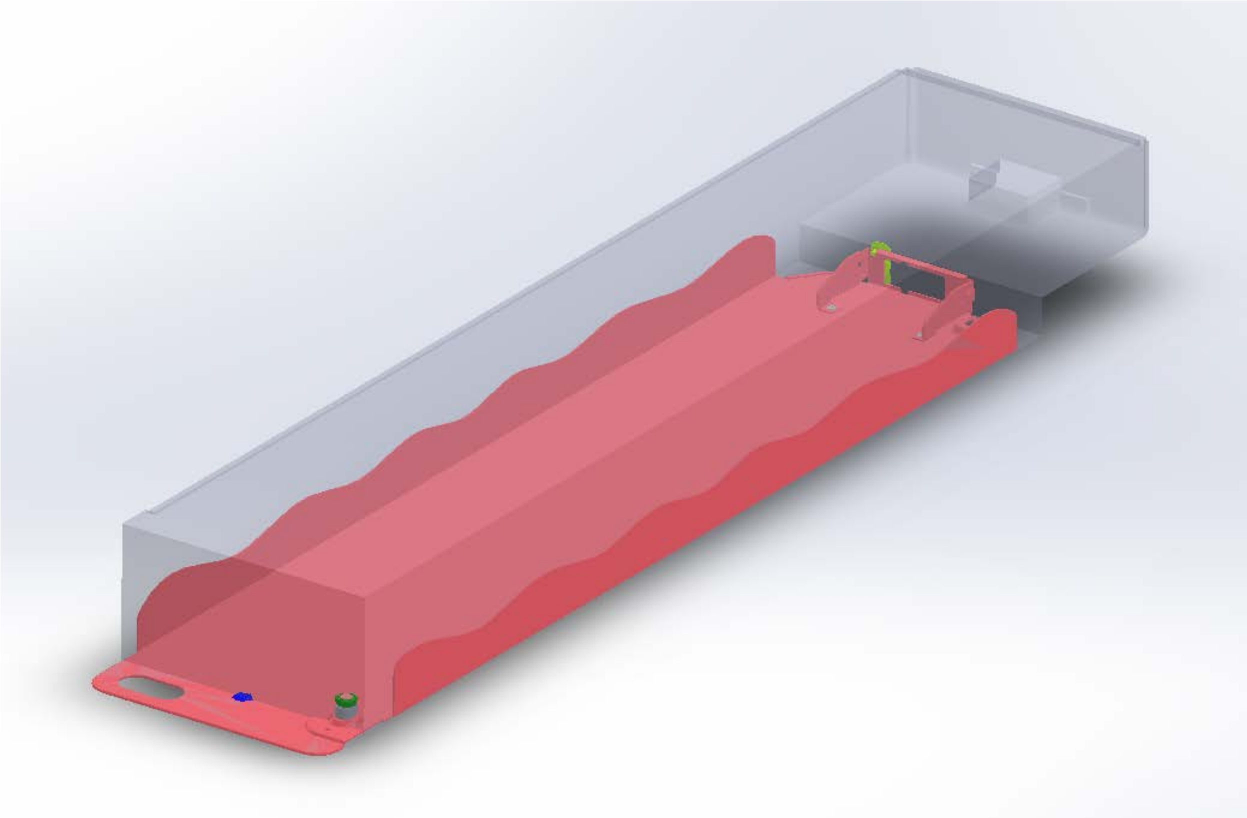


Figure 2: Sled design envelope

Cubby, which is defined in this specification, is a shelf design that occupies 2 Open U in a rack, and distributes power from a single center bus bar to three sled bays. The Open Rack V2 sled design, hereafter referred to as the sled, is a container for nearly any design as long as it meets some basic requirements pertaining to the power connector and the physical dimensions. This specification outlines the requirements . This sled will be the main building block for the V2 Open Rack storage and compute designs. A rendering of a sled plugged into the Cubby shelf is depicted below.

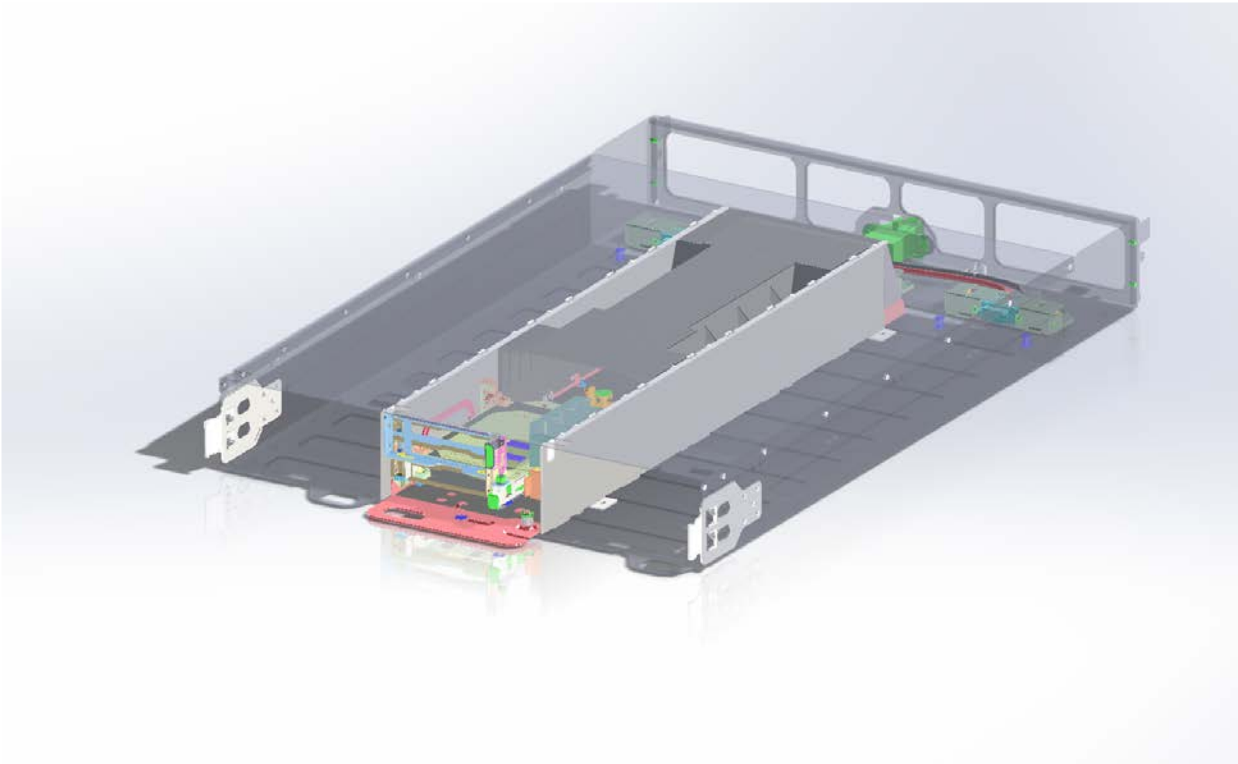


Figure 3: Cubby with a single sled installed

# 5 Mechanical

## 5.1 Mechanical Overview

Cubby consists of a base, two interior partitions, and a top. The three interior bays are receptacles for sleds.

Interior sleds are cold serviceable and blind-mate into power connectors (the part number and locations are specified in the reference drawing below). Three power connectors terminate to a busbar connector that blind-mates to the busbar of Open Rack V2.

Please reference control drawing for details of critical dimensions and control features.

The busbar panel mount cutout must follow the V2 Power Distribution specification (see reference drawing).

## 5.2 Shelf Details

The exterior dimensions of the shelf must be compliant with the OCP Open Rack v2 specification.

Shelves must be compliant to the 3D/2D electronic database.

Shelves must support the node volume and retention features of the general reference sled specification.

Shelves must be compliant to the reference chassis design in the Open Rack Design Guide Specification V2; Locations of the medusa connectors and bus bar clip assemblies will be in compliance with the reference drawing (below).

## 5.3 Sled Requirements

### 5.3.1 Required Sled Features and Dimensions

Sleds must not exceed the keepout volume defined provisioned for sled bays – must be compliant to electronic databases.

Sleds must feature power connectors as specified in Parts 2 and 7 in Section 9 of this document.

Sleds must be compliant to 3D/2D electronic databases for maximum volume and retention features.

### 5.3.2 Sled Retention

In order to retain in Cubby, sleds must include T-standoffs and slots as specified in the general reference sled specification. Secondary catch holes on the roof are required for sleds weighing more than 15kg. Specified plungers with hold-open features for insertion/removal must be implemented as shown in the electronic databases.

Additional holes/ejection systems may be provisioned but are contingent on approval from the purchaser.

### 5.3.3 Weight Rating

Cubby will support sleds weighing up to 20kg per sled bay for a total maximum shelf weight of 60kg.

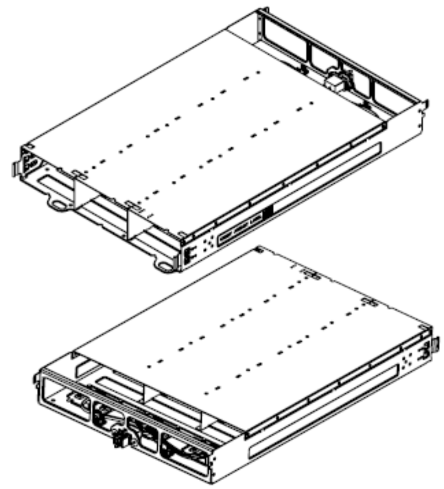
## 5.4 Reference Drawing

**NOTES:**

1. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-2009
2. COMPONENT KEEPIN DIMENSIONS ARE DENOTED AS MAXIMUM
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED
4. ALL COMPONENTS SHALL BE UL 94V-0 RECOGNIZED AND ROHS COMPLIANT
5. CHASSIS MATERIAL: ELECTRO GALVANIZED STEEL
   MATERIAL TYPE: SGCC
   MATERIAL THICKNESS: SEE SHEET 4
   MATERIAL SPECIFICATION:
   ASTM A-591/A 591M ELECTROLYTIC ZINC-COATED, COMMERCIAL STEEL, TYPE B, PHOSPHATE TREATED, CHEMICALLY TREATED DRY -(NO OIL), 42-60 ROCKWEL B OR JIS G3313 SECC, CHROMATE-FREE ANTI-FINGER PRINT TREATED, 42-60 ROCKWELL B, NO OIL. CONDUCTIVITY-SURFACE RESISTANCE <1.0 m-OHM
   MATERIAL MUST BE COMPLIANT WITH ENVIRONMENTAL SPECIFICATION
6. MAXIMUM ASSEMBLY WEIGHT 14KG. DEVIATIONS SUBJECT TO APPROVAL BY FACEBOOK ENGINEERING.
7. ALL CUT/SHARP EDGES WILL BE TREATED FOR OXIDATION PREVENTION. TREATMENT PROCESS WILL BE INCLUDED IN THE QUALIFICATION PROCESS
8. COMPONENTS SHALL BE CLEAN AND FREE FROM FOREGIN MATERIAL. OXIDATION, DIRT, OIL, GREASE AND OTHER CONTAMINANTS ARE NOT ALLOWED.
9. [9] BURR SIDE AS INDICATED
10. [10] COINED EDGES WILL HAVE A CHAMFER DEPTH OF AT LEAST 15% MATERIALTHICKNSS UNELSS OTHERWISE SPECIFIED. BREAKS IN COINING MUST BE APPROVED BY FACEBOOK ENGINEERING
11. EXTERNAL EDGES NOT CONFORMING TO NOTE 10 WILL BE DEBURRED
12. ALL EDGES NOT CONFORMING TO NOTES 10 AND 11 SHALL BE CONDITIONED FOR HANDLING WITH A BURR NO GREATER THAN 10% OF MATERIAL THICKNESS AND SHALL CONFORM TO UL SAFETY SPECIFICATION 1439.
13. NO CARRY WEBS ALONG LINE A
14. RIVET JOINING PATTERN AND PARTITION WALL DESIGN MUST CONFORM TO ELECTRONIC DATABASE.
15. ALL SHOWN DIMENSIONS ARE CRITICAL TO FUNCTION AND WILL BE INCLUDED IN THE QUALIFICATION PROCESS.
16. [16] ALL DIMENSIONS NOT SHOWN MUST COMPLY WITH TOLERANCE TABLE. DIMENSIONS EXCEEDING TOLERANCE LIMIT MUST BE APPROVED BY FACEBOOK ENGINEERING
17. MUST BE COMPLIANT WITH THE FOLLOWING REFERENCE DOCUMENTS:
    i. 06-000060 OPEN RACK V2 DESIGN GUIDE
    ii. ORV2 POWER DISTRIBUTION SPECIFICATION
    iii. CUBBY SELD REFERENCE SPECIFICATION
18. [18] COMPOMENTS MUST COMPLY WITH COMPONENT TABLE (SEE SHEET 2)

REVISIONS

| REV | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|
| 01 | RFQ RELEASE | 10.05.13 | RLCHU |
| 02 | V2 POWER DISTRIBUTION v0.3 | 01.03.14 | RLCHU |
| 03 | INITIAL RELEASE | 11.19.14 | RLCHU |



| FEATURE | TOL± mm/in |
|---|---|
| HOLE TO HOLE | 0.13/.005 |
| HOLE TO BEND | .25/.01 |
| SHEAR EDGE TO BEND | 0.25/.01 |
| BEND TO BEND | 0.40/.016 |
| HOLD TO SHEAR EDGE | 0.25/.01 |
| CS DIAMETER | 0.20/.008 |
| CS FEATURE TO DATUM | 0.10/.004 |
| CS FEATURE TO CS FEATURE | 0.15/.006 |
| CS TO HOLE CONCENTRICITY | 0.15/.006 |
| ANGLES | 0.5° |

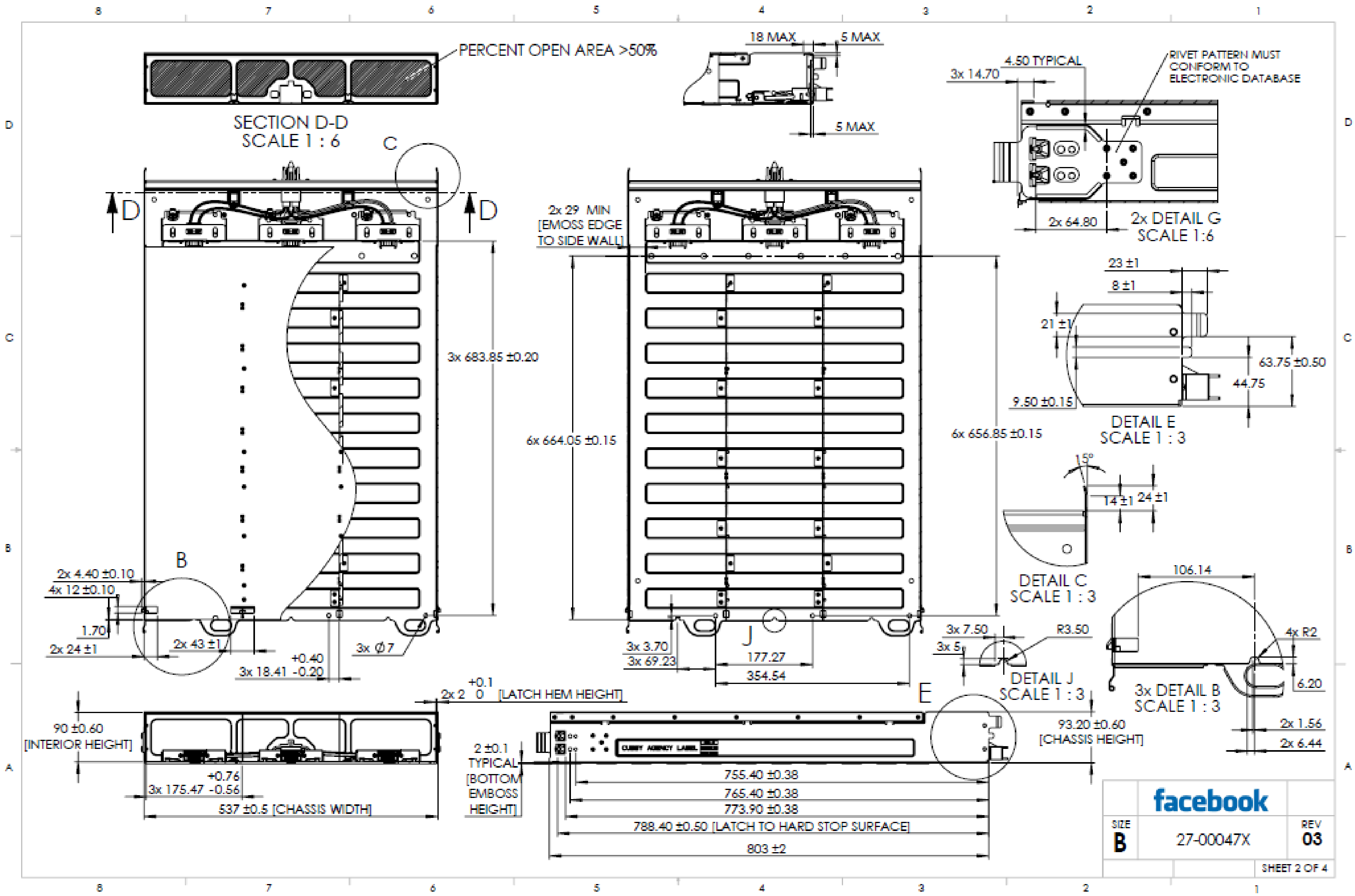
| | NAME | DATE |
|---|---|---|
| DRAWN | RLCHU | 19NOV14 |
| CHECKED | SMILLS | 20NOV14 |
| ENG APPR. | RLCHU | 20NOV14 |

facebook

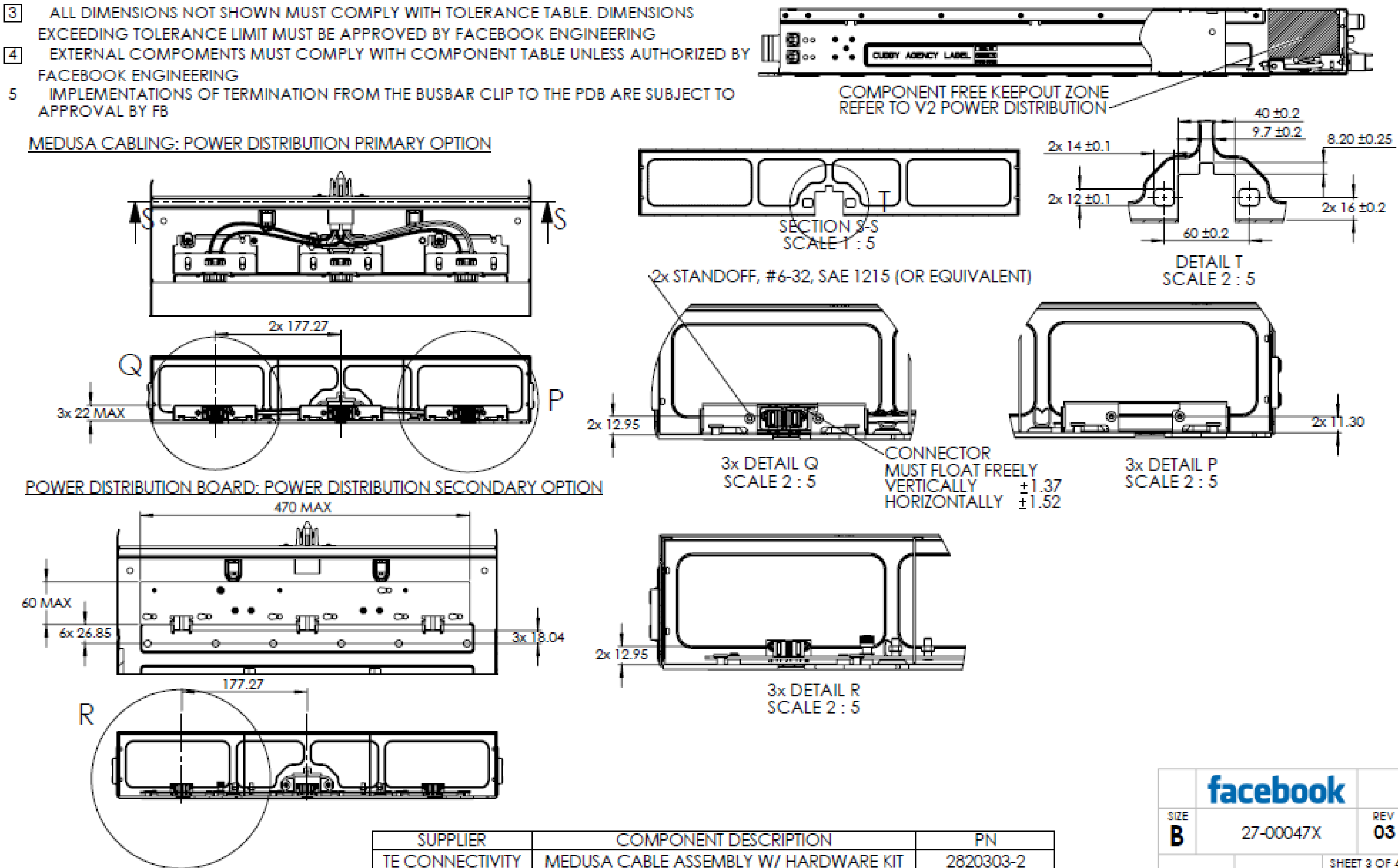
TITLE: CUBBY SPECIFICATION

SIZE: B | 27-00047X | REV: 03

SCALE 1:6 | WEIGHT: | SHEET 1 OF 4


PERCENT OPEN AREA >50%
SECTION D-D
SCALE 1 : 6
18 MAX
5 MAX
5 MAX
4.50 TYPICAL
3x 14.70
RIVET PATTERN MUST CONFORM TO ELECTRONIC DATABASE
2x 64.80
2x DETAIL G
SCALE 1:6
2x 29 MIN [EMOSS EDGE TO SIDE WALL]
3x 683.85 ±0.20
6x 664.05 ±0.15
6x 656.85 ±0.15
23 ±1
8 ±1
21 ±1
63.75 ±0.50
44.75
9.50 ±0.15
DETAIL E
SCALE 1 : 3
15°
14 ±1
24 ±1
DETAIL C
SCALE 1 : 3
106.14
4x R2
6.20
3x DETAIL B
SCALE 1 : 3
2x 1.56
2x 6.44
2x 4.40 ±0.10
4x 12 ±0.10
1.70
2x 24 ±1
2x 43 ±1
3x 18.41 +0.40 -0.20
3x Ø7
3x 3.70
3x 69.23
177.27
354.54
3x 7.50
3x 5
R3.50
DETAIL J
SCALE 1 : 3
2x 2 +0.1 0 [LATCH HEM HEIGHT]
90 ±0.60 [INTERIOR HEIGHT]
3x 175.47 +0.76 -0.56
537 ±0.5 [CHASSIS WIDTH]
2 ±0.1 TYPICAL [BOTTOM EMBOSS HEIGHT]
93.20 ±0.60 [CHASSIS HEIGHT]
755.40 ±0.38
765.40 ±0.38
773.90 ±0.38
788.40 ±0.50 [LATCH TO HARD STOP SURFACE]
803 ±2
facebook
SIZE
B
27-00047X
REV
03
SHEET 2 OF 4

NOTES:
1 INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-2009
2 ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED
3 ALL DIMENSIONS NOT SHOWN MUST COMPLY WITH TOLERANCE TABLE. DIMENSIONS EXCEEDING TOLERANCE LIMIT MUST BE APPROVED BY FACEBOOK ENGINEERING
4 EXTERNAL COMPOMENTS MUST COMPLY WITH COMPONENT TABLE UNLESS AUTHORIZED BY FACEBOOK ENGINEERING
5 IMPLEMENTATIONS OF TERMINATION FROM THE BUSBAR CLIP TO THE PDB ARE SUBJECT TO APPROVAL BY FB




| SUPPLIER | COMPONENT DESCRIPTION | PN |
|---|---|---|
| TE CONNECTIVITY | MEDUSA CABLE ASSEMBLY W/ HARDWARE KIT | 2820303-2 |

# 6 Power Delivery

## 6.1 Power Requirements

One of the goals of Cubby is to reduce the overall cost of power distribution. In the current Open Rack V1, each sled has a busbar clip assembly. Additionally, each of the three sled bays has its own bus-bar zone. In Open Rack V2 and Cubby, the goal is to move to a single bus bar. Cubby will provide the power distribution to the three sleds. The power delivery solution must be able to deliver 400W to each sled simultaneously, across the operating voltage range of 11.8V to 13.2V. A summary of these requirements are shown below:

- **Voltage range**: 11.8V-13.2V
- **Minimum Lifetime Insertion cycles**:
  - **Bus Bar**: 30 Cycles
  - **Sled to Shelf connector**: 100 Cycles
- **Power Requirements**:
  - **Bus Bar**: 1200W
  - **Sled Connector**: 400W

# 7 Power Distribution and Connectors

There are two options considered for implementing the power delivery subsystem. One option is to use a fixed PCB for power distribution. The other option uses a cabled approach. The cabled approach is the main focus for this design, but a fixed PCB may be considered for future designs. Both options must stay within the keep-in volume as shown in the V2 Power Distribution specification.

Open Rack V2 will support heavy sled designs, up to 20kg, and will require some float in the power connector system to the sled. The float for the blind-mate connection is provided on both the sled power cable assembly as well as the Cubby cable assembly via panel mount connectors. The FCI Power Blade Plus/TE Multi Beam XLE panel mount connectors offer +/- 1.52mm of float in the X- and Y-axis. This float is required for blind mating during insertion as well as shock and vibration.

## 7.1 Power Connector System

Most sleds will implement a slide-to-lock panel mount power connector to mount to the structure of the sled with a cabled connection to the PCB. This cabled approach allows sled designs ranging from max length to as short as desired. To adapt legacy boards, or other devices, an interposer can be used to adapt from a rigid PCB mount power connector to the panel mount. The image below is an example of using a removable cabled approach to a sled (left), a pressfit connector with cable tail for low cost (middle), and an interposer example to retrofit to legacy designs (right). The images also depict a side-band GPIO signaling cable, but this is reserved for future use and is not implemented in the first design.

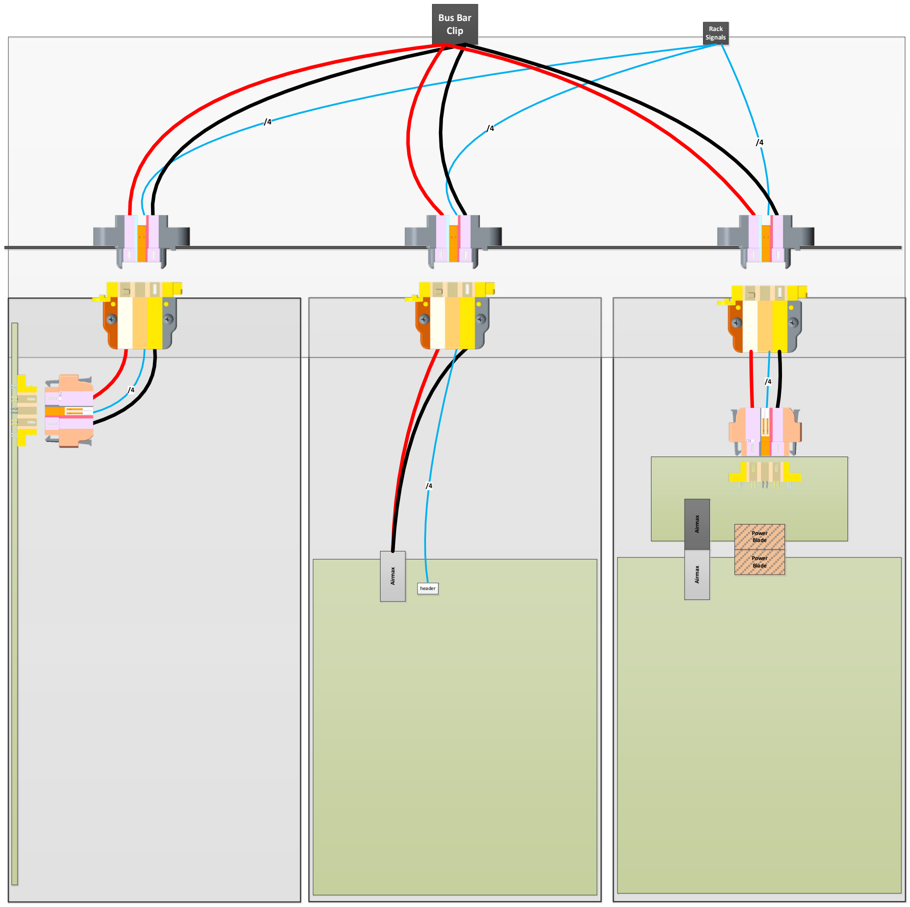



Figure 4 - Sled options

The connector selected for this application is a panel mount floating connector from FCI's Power Blade Plus and Tyco's Multi Beam XLE product family, in a 1P, 8S, 1P configuration. The images below show all possible connectors for the power solution. Vendor part numbers appear in the table below. The mounting details and recommended panel cutouts can be found in the Tyco and FCI datasheets. It is important to note that sleds should use the #2 connector to interface to the fully cabled Cubby design, but further connection to the PCB is at the discretion of the designer.

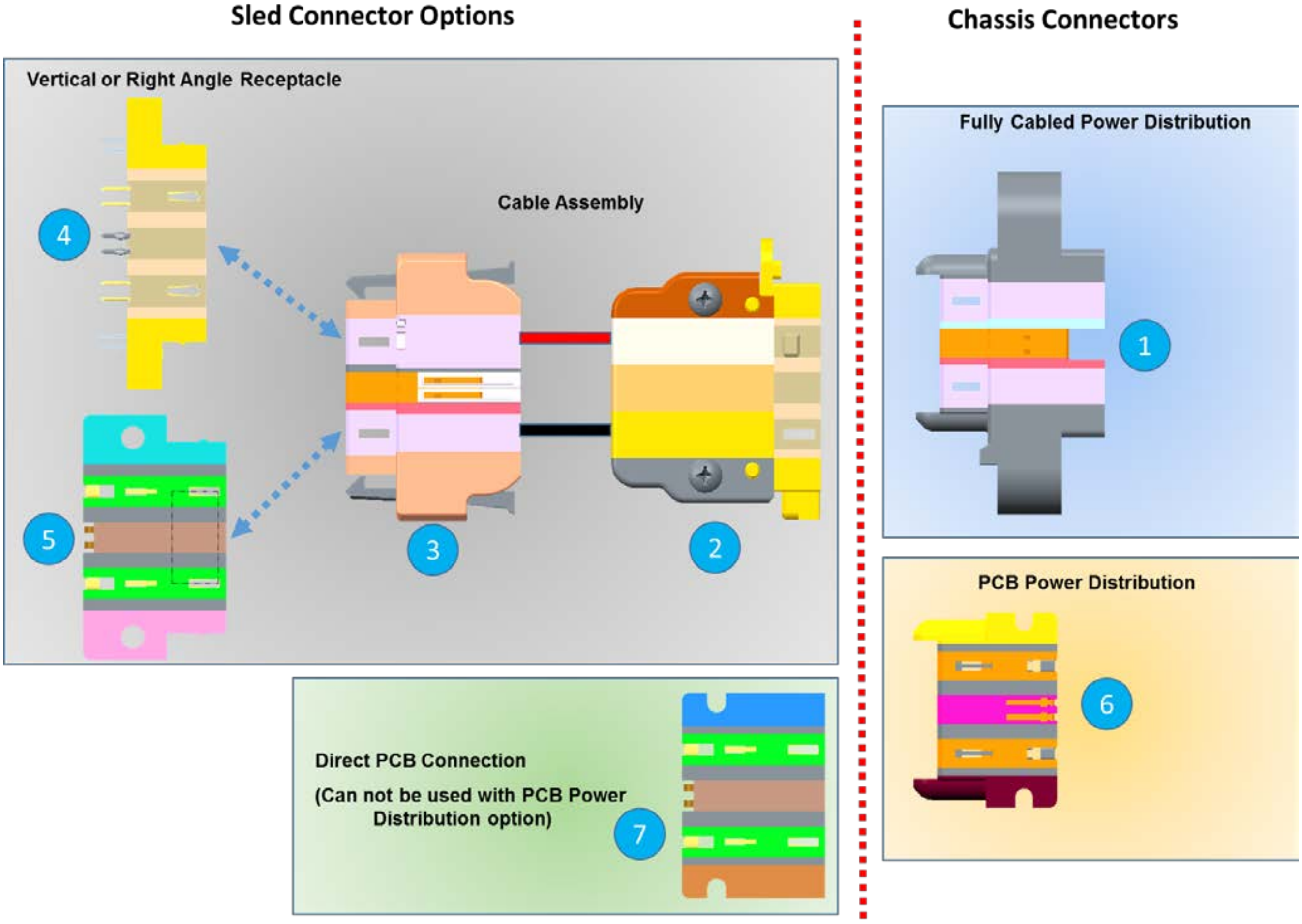



Figure 5 - Connector Options

Table 1: Connector Part Numbers

| | TE | FCI |
|---|---|---|
| 1 | 1-1892903-2 | TBD |
| 2 | 1-1892933-1 | |
| 3 | 1-1892820-1 | |
| 4 | 6450824-5 | |
| 5 | 6450844-2 | |
| 6 | 2-6450880-8 | |
| 7 | 3-6450840-6 | |

## 7.2 Rack GPIO signaling

The Cubby design has the capability to implement GPIO cabling to a power shelf or other external entity with minor modifications, but is not implemented in the current design.

## 7.3 Fully Cabled Assembly Option

The primary design implementation for the power delivery subsystem for Open Rack V2 is to create a busbar clip assembly that breaks out into three cable assemblies. These connectors are panel mounted to the Cubby chassis as shown below. This solution forgoes the PCB, and is therefore optimized for power only delivery. The cable assembly does provide for the low speed rack GPIO, which breaks out into a separate connector housing. If future designs require components inside the chassis, a power distribution PCB, described later in this specification, is more appropriate.

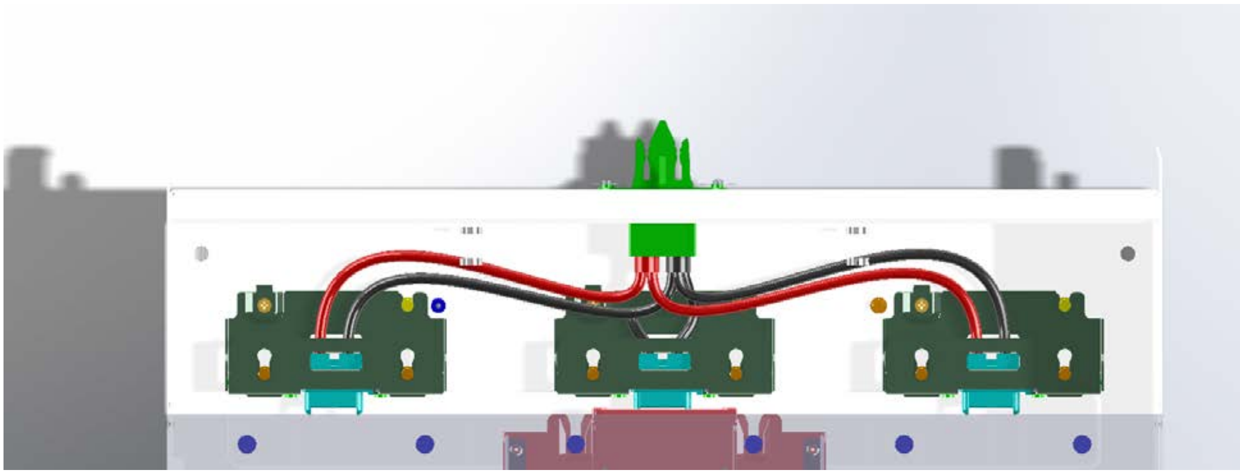


*Figure 6: Cable assembly*

The cable assembly is comprised of the bus bar clip connector, three panel mount connectors, and eight AWG wires for the power lines. The cable assemblies have several sources, with part numbers referenced below:

TE: 280303-2

2nd source TBD

## 7.4 Power PDB option

The power delivery subsystem can be accomplished using a small power distribution board (PDB) with a bus bar clip assembly that terminates to the PCB using a pressfit, soldered, or lug-style connector. The three right angle sled power connectors should be placed per the mechanical section (please see the reference drawing above).

The connector style for the sled has two primary sources, FCI's Power Blade Plus and Tyco's Multi Beam XLE. The configuration for this connector is 1P, 8S, 1P. An example of this connector style, of the right angle type to be mounted on the PDB, is shown below.

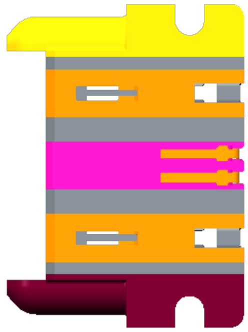


*Figure 7: Right Angle Multi Beam XLE/ Power Blade Plus*

The proposed power distribution board is a 6-layer, 85mil thick PCB. The four internal power planes are 2 oz. copper, and the top/bottom layers are 1.5 oz.

<PCB Stackup Image coming soon>

<PDB FRONT EDGE DETERMINED BY CONNECTOR PINS>

The power distribution board, in addition to distributing the 12.5V power, will also provision for some rack GPIO signals as described in previous sections. The connection to the exterior of Cubby can be via a cable assembly as shown below, or by making an L shaped PCB.

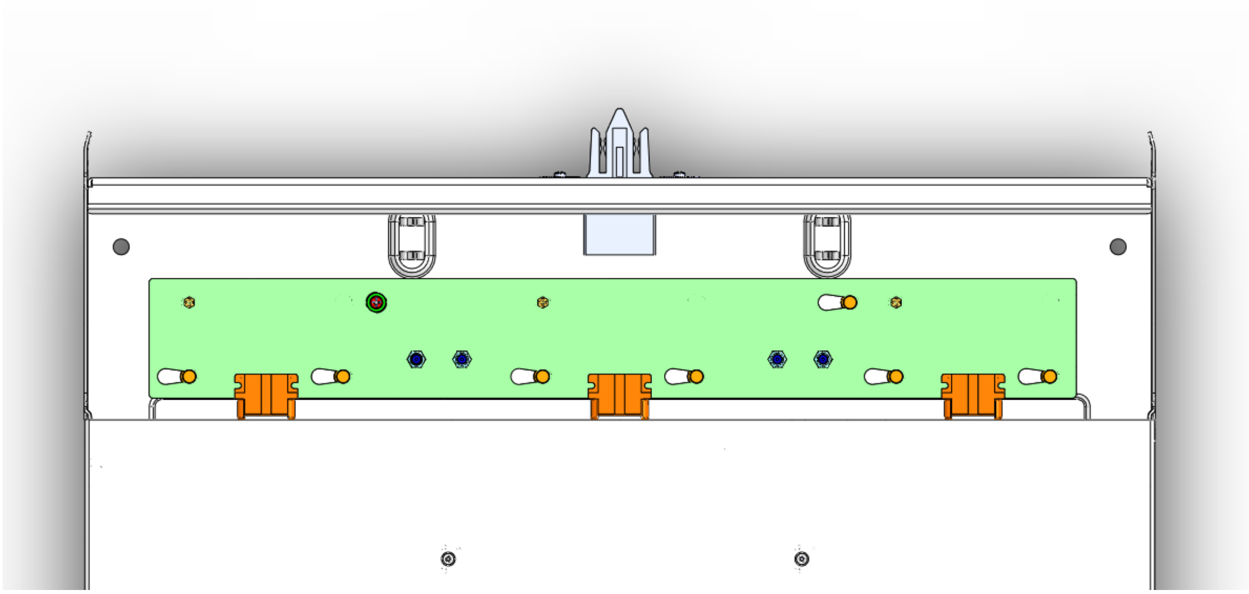


Figure 8: PDB with connectors

## 7.5 Enclosure to sled cables

The easiest way to create an IT sled that plugs into Cubby is to use a cable assembly. One end would be a panel mount connector that latches into the sled's sheet metal support (right), and the other end would feature a squeeze-to-release locking mechanism (center). This allows easy detachment from the PCB to allow service and easy assembly. For the PCB side connector, vertical and right angle options are available (left).

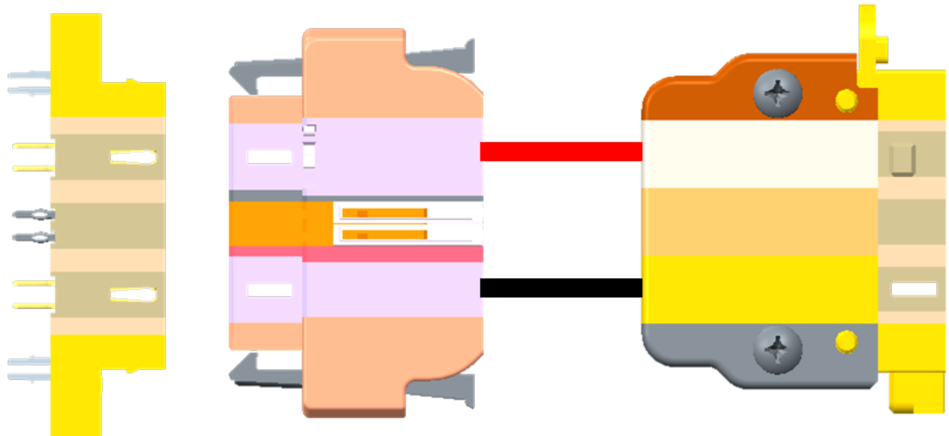


Figure 9: Connectors for cabled implementation

## 7.6 Open Rack V1 design Compatibility

Some designs for the Open Rack V1 can be converted for use in the Open Rack V2. For example, a compute sled can be reused by using an interposer PCB to adapt the current PCB mount connector to the new connector type. Some examples of existing connectors that are easily adapted are the Power Blade and Airmax power connectors.

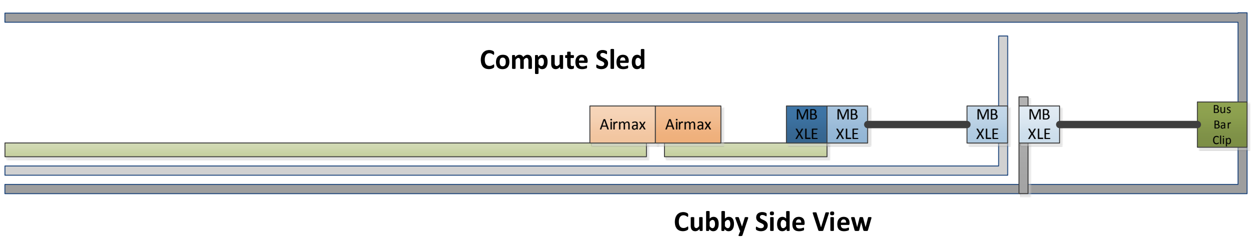



Figure 10 - V1 w/interposer

Another option is to create a pressfit assembly compatible with the existing connector footprint. This solution simplifies the number of connectors and reduces the overall cost. An example of this appears below.

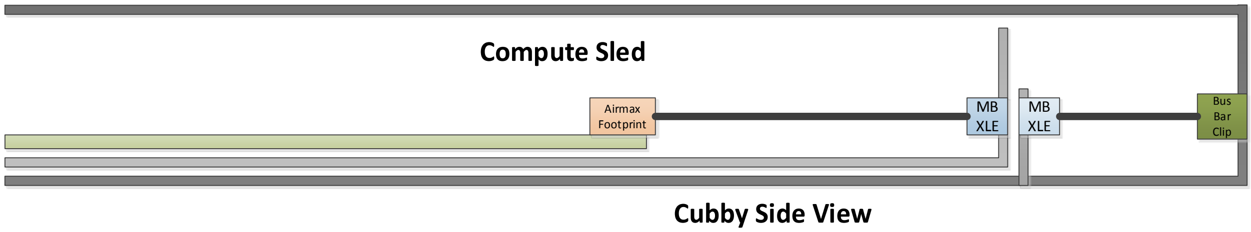



Figure 11 - V1 retrofit

# 8 Shock and Vibration Requirements

| | Operating | Non-Operating |
|---|---|---|
| **Vibration** | 0.5g acceleration, 1.5mm amplitude, 5 to 500 Hz, 10 sweeps at 1 octave/minute per each of the three axes (one sweep is 5 to 500 to 5 Hz) | 1g acceleration, 3mm amplitude, 5 to 500 Hz, 10 sweeps at 1 octave/minute per each of the three axes (one sweep is 5 to 500 to 5 Hz) |
| **Shock** | 6g, half-sine 11mS, 5 shocks per each of the three axes. | 12g, half-sine 11mS, 10 shocks per each of the three axes. |

# 9 Reliability and Quality

## 9.1 Specification Compliance

Vendors must ensure that the Cubby design meets these specifications as a stand-alone unit and while functioning in a complete server system. The vendor is ultimately responsible for assuring that the production Cubby design conforms to this specification with no deviations. The vendor shall exceed the quality standards demonstrated during the pilot build (PVT) while the design is in mass production.

## 9.2 Failure Analysis

Vendors shall perform failure analysis on defective units, which are returned to the vendor. Feedback shall be provided with a corrective action plan within two weeks from the date, which the units were received at the vendor’s facility.

## 9.3 Warranty

The Vendor shall warrant the design against defects and workmanship for a period of two years from the date of initial deployment. The warranty must be fully transferable to any end user.

## 9.4 Quality Control

Below is a list of manufacturing requirements to ensure ongoing product quality:

- Incoming product must have less than 0.1% rejections
- Cpk values will exceed 1.33 (Pilot Build & Production)
- Vendors will implement a quality control procedure during Production, by sampling assemblies at random from the production line and running full test to prove ongoing compliance to the requirements.

## 9.5 Change Authorization and Revision Control

After the design is released to mass production, no design changes, AVL changes, manufacturing process or materials changes are allowed without prior written authorization. The Approved Vendor List (AVL) is defined by the list of components specified in the Bill Of Materials (BOM).

Any request for changes must be submitted with proper documentation showing details of the changes, and reason for the changes. This includes changes affecting form, fit, function, safety, or serviceability of the product. Major changes in the product (or in the manufacturing process) will require re-qualification and/or re-certification. A new set of first article samples may be required to complete the Engineering Change Order (ECO) process. Any modifications after approval shall phase-in during production without causing any delays or shift of the current production schedule. Vendors shall provide enough advance notice to prevent any discontinuation of production.

All changes beginning with the pilot run must go through a formal ECO process. The revision number (on the PDB label) will increment accordingly. Revision Control: copies of all ECOs affecting the product will be provided for approval.

# 10 Deliverables

## 10.1 Documentation

The vendor shall supply the following documentation:

- Theory of Operation
- Block Diagram
- Schematics for EVT, DVT and PVT (Cadence and PDF files)
- Mechanical Component Placement EVT, DVT and PVT (DXF and PDF files)
- Mechanical design files (Step files - and sldasm/sldprt if available)
- Tolerance Analysis reports
- Board Layout EVT, DVT and PVT (Cadence and Gerber RS-274)
- BOM ordered per reference designators
- BOM ordered per components (including AVL)
- BOM in Facebook defined format, whose definition is provided in separate file.
- Board design support documents:
    - Power Topology
- Functional Test report
- De-rating Report (worst conditions)
- Temperature Test report (with indication of critical de-ratings, if any)
- MTBF data and report, including calculation

- Qualification test plan
- Reliability test plan

## 10.2 Mass Production First Article Samples

Prior to final project release and mass production, the vendor will submit the following samples and documentation:

- All the pertinent documentation described in Section 8.1 and any other documents and reports, necessary to release the product to mass production.
- Pilot samples which are built in the allocated facility for mass production.
- A full Specification Compliance matrix
- A full Test/Validation report
- Production line final test 'PASS' tickets
- Samples which have passed the production burn-in process
- Samples shipped using the approved for production-shipping box described in Section 9.

# 11 Shipping

The shelf assemblies shall be shipped using custom packaging containing the maximum number of assemblies in each package. The quality of the packing assembly will be such that the assemblies will not get damaged during transportation. The units shall arrive in optimum condition and will be suitable for immediate use. ASTM D6055-96, D880-92, D6179-07 for the shipping box shall be conducted by the vendor and submitted for audit and approval.