



OPEN

Compute Project

Open Rack V3 48V BBU

Rev: 0.5

Revision History

Revision	Date	Description	Author
0.1	2020/03/25	First draft	David Sun
0.2	2020/04/10	Updated thermal, mechanical, compliance and reliability/quality sections	Cheng Chen, Chenyu Xu, Ben Kim, Rommel Mercado
0.3	2020/04/30	<ol style="list-style-type: none">1. Section 4.4 Charger minimum input voltage changed from 47.5V to 48.5V2. Section 8.4 Latch position is on the top side of BBU3. Section 8.5 Corrected input/output connector PN.	David Sun Chenyu Xu

Open Compute Project • Open Rack V3 BBU

0.4	9/29/20	<ol style="list-style-type: none"> 1. 4.3 Change discharger output voltage setting and droop to 48V@0% and 47V@100% load to keep >2V voltage gap with PSU. 2. 4.3 BBU minimum life 4 years->8 years 3. 4.3 Add surge load requirement same as PSU. 4. 4.5 Change BBU output activation and exit thresholds. 5. 4.5 Add BBU/PSU output voltage gap tolerance analysis as attachment. 6. 4.16 Add connector pinout table 	David Sun
0.5	10/07	<ol style="list-style-type: none"> 1. 4.16 Updated connector pinout table 2. 8.1 Mechanical dimensions 3. 8.2 Updated table of LED indicators 4. Added V3 PMC/PSU/Power Shelf specs in Appendix. 	David Sun Chenyu Xu

License (OCP CLA Option)

Contributions to this Specification are made under the terms and conditions set forth in **Open Compute Project Contribution License Agreement ("OCP CLA")** ("Contribution License") by:

[Contributor Name(s) or Company name(s)]

You can review the signed copies of the applicable Contributor License(s) for this Specification on the OCP website at <http://www.opencompute.org/products/specsanddesign>

Usage of this Specification is governed by the terms and conditions set forth in **[select one: Open Web Foundation Final Specification Agreement ("OWFa 1.0"), Open Compute Project Hardware License – Permissive ("OCPHL Permissive"), Open Compute Project Hardware License – Copyleft ("OCPHL Reciprocal")]** ("Specification License").

Open Compute Project • Open Rack V3 BBU

You can review the applicable Specification License(s) executed by the above referenced contributors to this Specification on the OCP website at <http://www.opencompute.org/participate/legal-documents/>

Note: The following clarifications, which distinguish technology licensed in the Contribution License and/or Specification License from those technologies merely referenced (but not licensed), were accepted by the Incubation Committee of the OCP:

[insert “None” or a description of the applicable clarifications].

NOTWITHSTANDING THE FOREGOING LICENSES, THIS SPECIFICATION IS PROVIDED BY OCP "AS IS" AND OCP EXPRESSLY DISCLAIMS ANY WARRANTIES (EXPRESS, IMPLIED, OR OTHERWISE), INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, FITNESS FOR A PARTICULAR PURPOSE, OR TITLE, RELATED TO THE SPECIFICATION. NOTICE IS HEREBY GIVEN, THAT OTHER RIGHTS NOT GRANTED AS SET FORTH ABOVE, INCLUDING WITHOUT LIMITATION, RIGHTS OF THIRD PARTIES WHO DID NOT EXECUTE THE ABOVE LICENSES, MAY BE IMPLICATED BY THE IMPLEMENTATION OF OR COMPLIANCE WITH THIS SPECIFICATION. OCP IS NOT RESPONSIBLE FOR IDENTIFYING RIGHTS FOR WHICH A LICENSE MAY BE REQUIRED IN ORDER TO IMPLEMENT THIS SPECIFICATION. THE ENTIRE RISK AS TO IMPLEMENTING OR OTHERWISE USING THE SPECIFICATION IS ASSUMED BY YOU. IN NO EVENT WILL OCP BE LIABLE TO YOU FOR ANY MONETARY DAMAGES WITH RESPECT TO ANY CLAIMS RELATED TO, OR ARISING OUT OF YOUR USE OF THIS SPECIFICATION, INCLUDING BUT NOT LIMITED TO ANY LIABILITY FOR LOST PROFITS OR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES OF ANY CHARACTER FROM ANY CAUSES OF ACTION OF ANY KIND WITH RESPECT TO THIS SPECIFICATION, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, AND EVEN IF OCP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Table of Contents

License (OCP CLA Option)	2
Table of Contents	3
1. Scope	6
2. Overview	6
3. Acronyms	6
4. Electrical Requirements	7
4.1 BBU operation modes	7
4.2 Battery pack	7
4.3 Discharger	8
4.4 Charger	9
4.5 Transition between Power Shelf and BBU Shelf	10
4.6 SOH test	10
4.7 Variable charging	10
4.8 Periodical Charging Mode	10
	3

Open Compute Project • Open Rack V3 BBU

4.9	Current sharing and redundancy	10
4.10	Redundancy and hot swap	10
4.11	Fuse	11
4.12	Protections	11
4.13	Interoperability	11
4.14	Constant power operation	11
4.15	BBU physical addressing	12
5.	Communication	14
5.1	Monitoring and control	14
5.2	FRUID	15
5.3	In system firmware upgrade	16
5.4	Failure event log	16
6.	Environment	16
6.1	Temperature	16
6.2	Humidity	16
6.3	Altitude	16
6.4	Acoustic Noise	16
6.5	Vibration	16
6.5.1	Operational	16
6.5.2	Non-Operational	17
6.6	Shock	17
6.6.1	Operational	17
6.6.2	Non-Operational	17
6.7	UN compliance	17
7.	Thermal	17
7.1	Thermal Design Requirement - Standby Mode	17
7.2	Thermal Design Requirement - Discharge Mode	18
7.3	Thermal Design Requirement - Charge Mode	18
7.4	Airflow Direction	18
7.5	Fan	18
7.6	Fan Failure	18
7.7	Temperature Sensors	18
7.8	Fan Speed Control	18
7.9	BBU Thermal Monitoring	18
7.10	BBU Exhaust Temperature	19
8.	Mechanical	19
8.1	Physical Dimensions	19
8.2	Indicators/LED	19

Open Compute Project • Open Rack V3 BBU	
8.4 Chassis Interface	21
8.5 Rear Blind mate connector	21
9. Reliability and Quality	22
9.1 Derating Design	22
9.2 Reliability Prediction	22
9.3 Design Failure Mode and Effect Analysis (DFMEA)	22
9.4 Burn-In (BI) and Ongoing Reliability Testing (ORT)	22
9.5 Manufacturing Quality	22
10. Compliance requirements	22
10.1 Safety Standards	22
10.1.1 Component Safety requirements	23
10.2 EMC Requirements	23
10.3 Environmental Compliance	24
10.4 Documentation	24
Appendix 1: Mechanical dimensions of the BBU	24

1. Scope

This document defines the technical specifications for the Open Rack V3 BBU (Battery Backup Unit) used in the Open Compute Project.

2. Overview

This specification defines the BBU (battery backup unit) that fits into the BBU shelf. The BBU is intended for use in a BBU shelf that is part of the rack for supplying DC power to system loads during AC power outages. 6 BBUs with 5+1 redundancy are included in the BBU shelf.

The BBU operates based on “narrow-range 48V Architecture,” with the output voltage fixed at 48.5V. The BBU module consists of a battery pack and BMS, charger/discharger and other function blocks as shown in Figure 1.

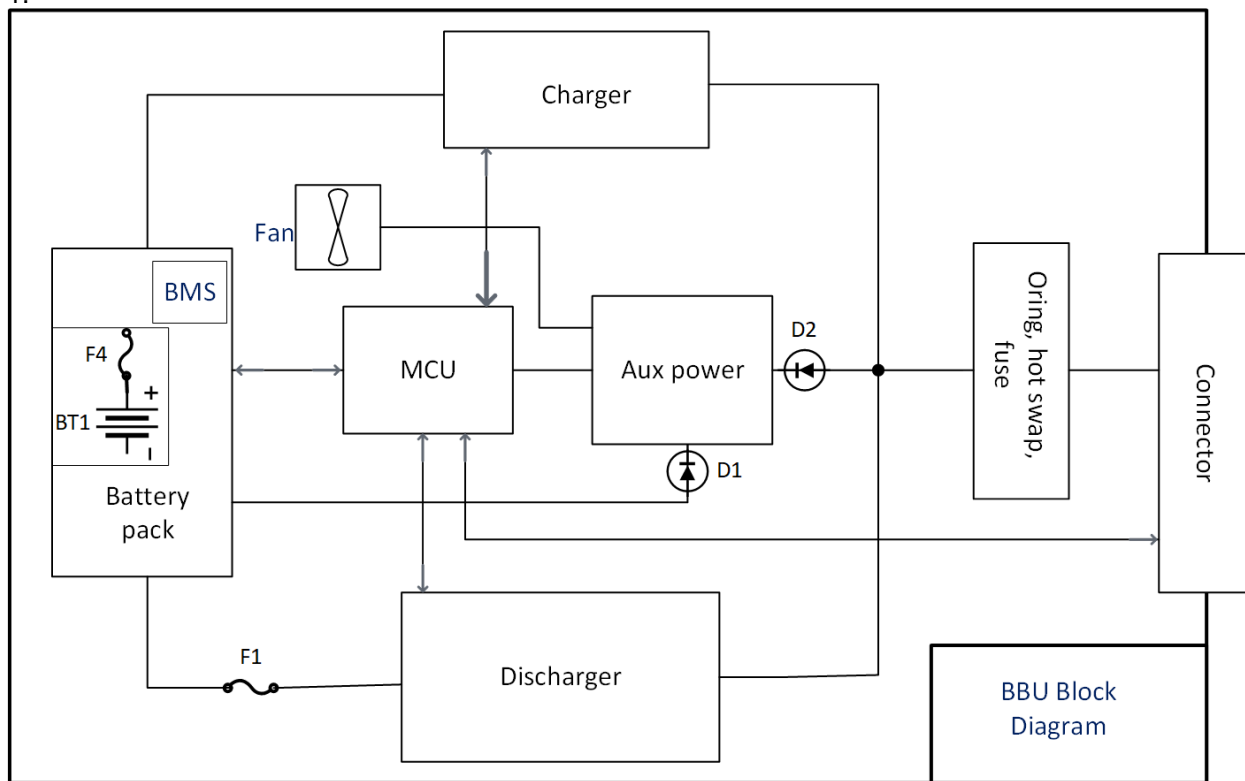


Figure 1

3. Acronyms

BBU: Battery Back Unit
PMC: Power Management Controller
PSU: Power Supply Unit
BMS: Battery Management System
SOH: State of Health
SOC; State of Charge

4. Electrical Requirements

4.1 BBU operation modes

BBU operation mode	Description
Sleep mode	When BBU is in transportation or stock or is not attached to an active busbar, the cell discharge current is minimized for longer storage time. BBU monitoring/reporting is not available in sleep mode. The BBU will wake up and exit sleep mode when the busbar voltage is detected to be above 48V for >20ms (TBD).
Standby mode	The BBU is fully charged and healthy, constantly monitoring busbar voltage to be prepared for a discharge event. The BBU operates in this mode for the vast majority of its lifespan. The BBU's status and parameters are visible on the upstream rack monitor through the communication bus.
Discharge mode	When the busbar voltage drops below 48V(TBD) for >1ms (TBD), BBU discharge mode is activated. The BBU is expected to take over the busbar voltage within 2ms (TBD).
Charge mode	The BBU enables its internal charger to charge up its battery pack when all conditions are met. The charger current can be anywhere from 0A - 5.5A based on the previous depth of discharge of the battery capacity. It also allows the upstream system to override the charge current through the communication bus. There should be a charger timeout control scheme based on the calculated charge current.
Status of health check mode (SOH)	The BBU routinely tests battery pack capacity through forced discharge of the battery pack. The BBU shall perform the SOH test every 90 days to determine the battery's EOL status.
Periodical charge mode (PCM)	Because the BBU battery pack leaks current in standby mode, it needs to be periodically recharged.
Fault mode	In fault mode, the BBU is not allowed to charge/discharge and should be replaced as soon as possible.
System control mode	The BBU shall allow upstream system to control charger/discharger operation through communication bus.

4.2 Battery pack

There is a battery pack installed inside the BBU with a mechanical assembly.

4.2.1 Battery pack capacity

The battery will be able to provide 3KW discharge power for more than 5 minutes over a period of 4 years.

4.2.2 Battery cell type

A Li-ion battery is considered suitable for this high current/power discharge application. The reference battery cell in this spec is 18650 type with the min 1.5Ah, 3.7V nominal, 4.2V max, 30A max continuous discharge current.

4.2.3 Battery pack configuration

Open Compute Project • Open Rack V3 BBU

Based on the reference battery cell type in 3.1.1, the recommended configuration of the battery pack is 12S6P (6 parallel strings of 12 cells in series each string).

4.2.4 BMS

The BMS shall include a protection mechanism and logic circuitry to generate and control algorithms and signals used in the BBU.

The BMS shall also include a cell balancing circuit where the cell voltage on all battery cells in a pack are kept within **+/- 1% (TBD or 0.1V)** of each other, i.e. $|V_{max}-V_{in}|<0.1V$. The BMS shall provide system monitoring and control functions through communication bus.

The BMS shall support other functions such as SOH, SOC, PCM, failure events log, remote FW upgrade, etc.

4.3 Discharger

There is a 3KW Discharger in each BBU module. The Discharger characteristics are defined in the table below.

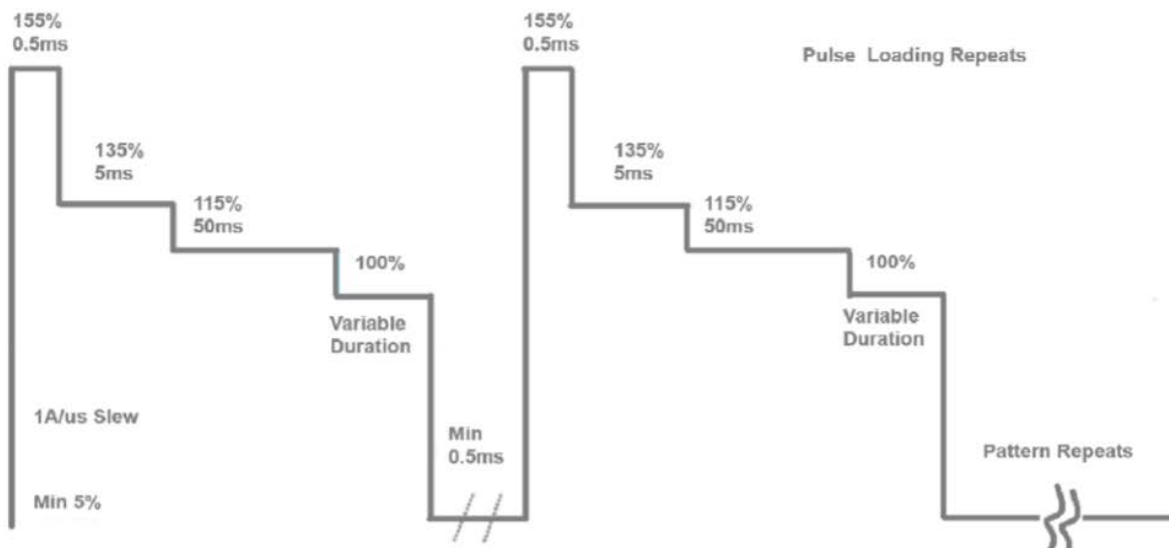
	Min	Typ	Max	Peak	Unit	Note
Input voltage	31.2	-	48.0	-	V	Assuming 12S6P 18650 Li-ion
Input current	-	-	100	TBD	A	
Output voltage setpoint	47.4	47.5	47.6	-	V	@50% load
Output voltage	47.9	48.0	48.1			@0% load
Output voltage	46.9	47.0	47.1			@100% load
Output voltage total regulation	46.0	47.5	49.0	-	V	Including load transient
Output voltage droop		1.0		-	V	Output voltage droop 1.0V(1%) from 0% load to 100% load
Output voltage boost limit for SOH	-	-	51.0	-	V	BBU boost voltage up to discharge energy at 3KW CP mode or max 51V CV mode until <70% SOC
Output current	0	-	62	See Note	A	Peak load profile to follow Power shelf/rectifier spec.
Output power	0	-	3,000	See Note	W	Peak load profile to follow Power shelf/rectifier spec.
Output capacitance	-	-	TBD	-	uF	Follow Power Shelf/Rectifier
Battery backup time	300	-	-	-	seconds	Full power discharge time
BBU life	8	-	-	-	years	Full power discharge time >300s at the end of 4 years
Output ripple voltage	-	-	300	-	mV	Peak to peak
Transient load response	-3%	-	+3%	-	-	60% load step, 1A/us
Startup time	-	-	2		ms	From discharger activation to output

Open Compute Project • Open Rack V3 BBU

						voltage reaches regulation limit
Efficiency	97%(Note)	-	-	-	-	1. Minimum efficiency shall cover max load at full input voltage range. 2. Fuse/Hot swap/Oring shall be included if used.

The BBU shall meet the following surge power requirements.

Surge Power Capability ³ (Average ≤ 3000 W over 10 s)	155% rated power for ≥ 0.5 ms duration 135% rated power for ≥ 5 ms duration 115% rated power for ≥ 50 ms duration
--	--



4.4 Charger

There is a Charger in each BBU to charge up the battery pack. The Charger characteristics are defined in the following table.

	Min	Typ.	Max	Unit	Note
Input voltage	48.5	50	52.5	V	
Input current	0	-	5.5	A	CC/CV mode charge and adjustable CC charge current
Input power	0	-	275	W	
CC mode output current	0	See Note	5	A	The charging current is a variable based on previous discharge level.
CC mode output ripple current	-1%	-	+1%	-	Peak-peak
CV mode output voltage	47.9	48.0	48.1	V	Voltage at no load to 0.5A load

Open Compute Project • Open Rack V3 BBU

CV mode output ripple voltage	-1%	-	+1%	-	Peak-peak at no load to 0.5A load
Efficiency	95%(Note)	-	-	-	Fuse/Hot_swap/Oring shall be included.
Charge time	-	3	-	hours	TBD

4.5 Transition between Power Shelf and BBU Shelf

BBU shall constantly monitor busbar voltage. When the busbar voltage declines to the BBU activation level **47.5V** for >1ms (TBD), the BBU shelf output voltage shall ramp up to provide power to the busbar within <2ms. During the transition, the busbar voltage shall never drop below 46V.

When the BBU shelf detects that the busbar voltage is above **49V** for >200ms (TBD), the BBU shelf exits discharge mode.



Narrow_range_48V_analysis.xlsx

4.6 SOH test

The BBUs inside a BBU Shelf shall perform a SOH test every 90 days to determine the battery's EOL status. A random number is generated in the BBU production line and stored on the EEPROM. This is to be associated permanently within each BBU shipped. After the BBU exits the 'Sleep Mode', a clock timer included in the BBU logic starts to count down the hours in the 'First SoH Timer'. Once the countdown has reached its end, the BBU logic will submit the request of the first battery test (SoH Check) to the system shelf.

Only one BBU inside a BBU Shelf should perform the SOH test at a time. The BBU shall boost its discharger output voltage in order to share a 3KW constant power load or a maximum 51.0V constant voltage load until discharged to <70%SOC during the SOH test.

4.7 Variable charging

In order to minimize the charger power consumption, the BBU shall calculate and adjust its charging current based on previous depth of discharge. The adjustable charge current can also be overridden by the system through PMC.

4.8 Periodical Charging Mode

Because the BBU battery pack leaks current in standby mode, the battery pack needs to be periodically recharged. It is called the 'Periodical Charging Mode'. The PCM is set between **3.9V** and 4.0V per cell (**46.8V to 48V** of battery pack output voltage). The amount of current leaking from the standby mode battery pack to the BMS, discharger, etc. shall be minimized. If there are no discharge sequences, the BBU should recharge the battery pack no more than once every 10 days.

4.9 Current sharing and redundancy

The BBU shall have a dedicated analog bus for active current sharing. With up to 6 BBUs in a shelf, the current sharing accuracy shall be +/- 3% or better under load > 90% and +/- 5% or better under load > 50%. For loads less than 25% of rated output the share shall be 5% of the full rated output power.

There is 0.5V voltage droop from 0% load to 100% load. The droop voltage shall be programmable 1%-5% of output voltage.

4.10 Redundancy and hot swap

The BBU is hot swappable.

The BBU shall have Oring device on each output for N+1 redundancy for parallel operation and redundancy.

4.11 Fuse

Fuses are necessary to protect against catastrophic failures and safety hazards. For example, fuses should be placed at the following locations: 1) between battery pack and discharger input, 2) on charger input, 3) on Aux converter input, etc. There should be a controlled fuse between the charger and battery pack to protect against charger faults such as OVP. Fuses should be properly rated for maximum operation current and short circuit interrupting current. The status of main fuses shall be monitored and reflected in BBU status registers.

4.12 Protections

The BBU shall protect battery pack, charger and discharger from damage under the following fault conditions

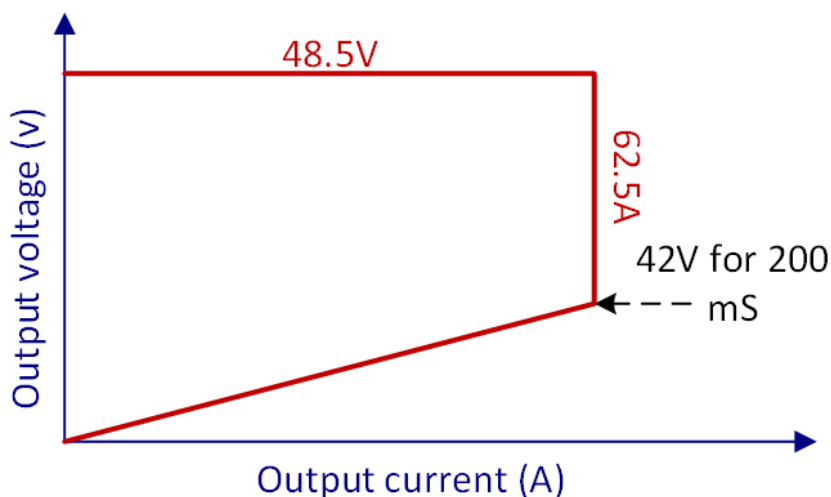
- Battery pack over charge
- Battery pack over discharge
- Over current
- Short circuit
- Over temperature
- Over voltage
- Under voltage
- Other faults

4.13 Interoperability

The BBU modules and shelves from different suppliers shall be interoperable and interchangeable in any mixed configuration.

4.14 Constant power operation

The BBU shall go to constant current operation mode in case it goes over the output power. As a result, the DC output voltage starts to drop. The BBU shuts off if its output voltage is at or lower than 42V for 200mS. If the BBU voltage is lower than 10V (short circuit condition), the BBU shuts off immediately. No component shall be damaged. The protection shall be implemented with a hiccup mode. It tries to restart 5 times (2 second off, 200 ms on) and then locks out.



Open Compute Project • Open Rack V3 BBU

4.15 BBU physical addressing

Four BBU signal pins are used for physical addressing. There are digital signals that should have internal pull up resistors inside the BBU. On the BBU shelf, these pins can be grounded (0) or left open (1) to determine the BBU location as below:

BBU location 1-1 (row-column): 0001

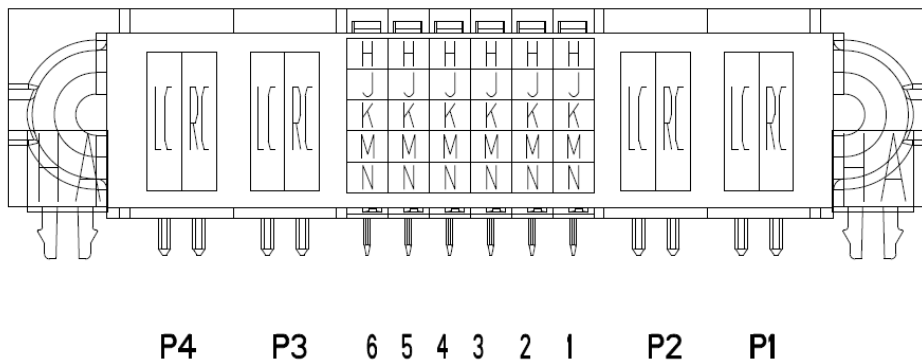
BBU location 1-2: 0010

BBU location 1-3: 0011

BBU location 2-1: 0111

and so on.

4.16 BBU connector pinout



E
D
C
B
A

P1 & P2	48V return
P3 & P4	48V positive
Note: P1, P2 mate first and break last.	

Pin number	Signal Name	Type	Function	Pull up/down @BBU	Pull up/down @shelf	Corresponding PMC to shelf edge connector signal name and pin number
A1	RS485+	I/O	Modbus communication			RS485 A_0/1/2/3/4/5 (B18/B19/B20/B21/B22/B23)
A2	RS485-	I/O	Modbus communication			RS485 B_0/1/2/3/4/5 (A19/A20/A21/A22/A23/A24)
A3	A0	Input	BBU Address 0	10K	Ground/open	N/A
A4	A1	Input	BBU Address 1	10K	Ground/open	N/A
A5	A2	Input	BBU Address 2	10K	Ground/open	N/A
A6	A3	Input	BBU Address 3	10K	Ground/open	N/A

Open Compute Project • Open Rack V3 BBU

B1	SGND					GND (B2/A9/B15/B31/A34)
B2	N/A					N/A
B3	PSKILL (short pin length)	Input	Quick shut down output to mitigate hot unplug arcing.	10K pull-ups to 3.3V	10 Ohm to ground	N/A
B4	N/A					
B5	BBU_ALERT_L	Output	Logic "Low"= BBU not Ready Logic "High"= BBU Ready Ready indicates that BBU can support discharge.			ALERT_0_N(A3) ALERT_1_N(B3) ALERT_2_N(A4) ALERT_3_N(B4) ALERT_4_N(A5) ALERT_5_N(B5)
B6	SGND					Same as BBU "B1"
C1	SDA	I/O	I2C data (I2C maybe removed)	TBD	TBD	N/A
C2	CLK	Input	I2C clock (I2C maybe removed)	TBD	TBD	N/A
C3	SGND					Same as BBU "B1"
C4	N/A					
C5	N/A					
C6	BBU_ISHARE	Analog	Active current sharing bus			ISHARE(A32)
D1	N/A					
D2	48V_Sense+	Analog	Remote sense +			N/A
D3	48V_sense-	Analog	Remote sense -			N/A
D4	BBU reset	Input	Logic "Low"= BBU output enable. Logic "Low to High"= BBU reset. Reset means BBU output turns off and on including MCU reset.	TBD		RESET_0/1/2/3/4/5(B9/A10/B10/A11/B11/A12)
D5	N/A					
D6	BKP_RED_L	Output	Logic "Low"= BBU shelf redundancy lost (i.e. one or more BBU failed) Logic "High"= BBU shelf redundancy OK (i.e. all 6 BBUs are OK)	10KOhm to 3.3V (Value TBD)		BKP(B16)
E1	VOUT_SEL	Input	Logic "Low"= Set Output is 48V Logic "High"=Set Output is 50V	pull down resistor 10k to SGND, Default Output is 48V		VOUT_SEL(A33)
E2	PLS_L	Output	Power loss siren. Logic low: AC has lost for ≥XX seconds (e.g. 45s for V2. It is configurable by Modbus command.) Logic high: AC is OK or lost <xxs(configurable).			PLS(A16)

Open Compute Project • Open Rack V3 BBU

E3	SYNC_START	Input	Synchronizing turn on main output. (reserved feature).	TBD	TBD	SYNC_START(B32)
E4	RS485_Addr2	Input	TBD			RS485_Addr2(A18)
E5	RS485_Addr1	Input	TBD			RS485_Addr1(B17)
E6	RS485_Addr0	Input	TBD			RS485_Addr0(A17)

5. Communication

The BBUs shall communicate with the PMC through single SMBUS. Please refer to PMC Spec for details. The software interface shall be operational when the BBU shelf is not in sleep mode. The BBU communication interface shall provide the following features.

5.1 Monitoring and control

BBU shall provide registers for the system to monitor and control BBU operation. Here is an example of a typical BBU register map.

Register name	Hex Address	R/RW	Description
BBU_MFR_MODEL		R	
BBU_MFR_DATE		R	
BBU_FB part#		R	
BBU_HW Revision		R	
BBU_FW Revision		R	
BBU_MFR_SERIAL		R	
BBU_ManufacturerName		R	
BBU_BatteryMode		R/W	
BBU_BatteryStatus		R	
BBU_Cell_Voltage1		R	
BBU_Cell_Voltage2		R	
BBU_Cell_Voltage3		R	
BBU_Cell_Voltage4		R	
BBU_Cell_Voltage5		R	
BBU_Cell_Voltage6		R	
BBU_Cell_Voltage7		R	
BBU_Cell_Voltage8		R	
BBU_Cell_Voltage9		R	
BBU_Cell_Voltage10		R	
BBU_Cell_Voltage11		R	
BBU_Cell_Voltage12		R	
BBU_Temp1		R	

Open Compute Project • Open Rack V3 BBU

BBU_Temp2		R	
BBU_Temp3		R	
BBU_Temp4		R	
BBU_RelativeStateofCharge		R	
BBU_AbsoluteStateofCharge		R	
BBU_BatteryVoltage		R	
BBU_BatteryCurrent		R	
BBU_AverageCurrent		R	
BBU_RemainnigCapacity		R	
BBU_FullChargeCapacity		R	
BBU_RunTimetoEmpty		R	
BBU_AverageTimetoEmpty		R	
BBU_ChargingCurrent		R	
BBU_ChargingVoltage		R	
BBU_CycleCount		R	
BBU_DesignCapacity		R	
BBU_Design Voltage		R	
BBU_AtRate		R	
BBU_AtRateTimetoFull		R	
BBU_AtRateTimetoEmpty		R	
BBU_AtRate OK		R	
BBU_MaxError		R	
SoH results		R	
BBU Signal Status (FB Status)		R	
Fan Speed		R/W	
Charge Voltage Target		R/W	
BBU_I_(Charge_Target)		R/W	
BBU_Charger_Current		R/W	
Programmable BBU charge time out coefficient		R/W	

5.2 FRUID

The BBU logic includes a non-volatile memory (EEPROM or Flash) used to store permanent data. The following information is to be added in the said memory in addition to the vendor specific data:

- Manufacture Name
- Manufacturer Model
- Facebook Part Number
- FW revision

Open Compute Project • Open Rack V3 BBU

- Build Revision: EVT, DVT, PVT
- Manufacture Date
- End of Life status
- Battery test results
- Random Number for SoH test

5.3 In system firmware upgrade

The interface shall allow the user to re-flash firmware on the device. Firmware upgrades shall result in no power interruption on the shelf level (the unit being upgraded can go offline.) Upgrades should be done one BBU at a time. Firmware upgrade time shall be less than 2 minutes per BBU.

The flash/EEPROM shall keep a working copy of the firmware on the BMS at all times. In the event of a firmware update failure, the BBU can be recovered with a previously stored version of the firmware.

5.4 Failure event log

The BBU shall provide a failure event log triggered by all failure conditions. The failure event log data shall be stored on a flash/EEPROM.

6. Environment

6.1 Temperature

- Operational: 0°C to +40°C
- Long term standby mode ambient is +15°C to +35°C
- Non-operational: -20°C to +60°C

6.2 Humidity

- Operational: 10-90% RH non-condensing
- Non-operational: 5-93% RH non-condensing

6.3 Altitude

- Operational: 0-3000m
- Non-operational: 0-12000m

6.4 Acoustic Noise

- ≤ 55 dBA at maximum operation point

6.5 Vibration

6.5.1 Operational

Equipment must satisfy .17G vertical z-axis: .12G horizontal x- and y- axes swept from 5-500-5 Hz, 5 sweeps in all, at 1 octave/min. Reference spec (IEC 60068-2-6 Test Fc). Equipment shall be running diagnostic test while sweep is going on.

Open Compute Project • Open Rack V3 BBU

6.5.2 Non-Operational

Packaged unit must satisfy ASTM D 4169 Level 2 Schedule E using 60min Truck then 120 min Air Power Spectrum
Unpackaged unit, attached to a shaker using product's mounting points, must survive 3 hours random vibration per the following PSD Break Points.

Frequency	<u>G²/Hz</u>
1	.00004
4	.00675
8	.00759
15	.0273
17.5	.0102
26	.148
34	.000355
122	.000006

Grms = .92

Table 5: Vibration Spectrum

6.6 Shock

6.6.1 Operational

Equipment must satisfy 10 +/- shocks, 3.5G, 11 msec half-sine, in the x-y- and z- axes. Ref spec (IEC 60068-2-27 Test Ea). Equipment shall be running diagnostic test during shock events.

6.6.2 Non-Operational

Packaged unit must satisfy ASTM D4169 Schedule A Level 2, 6 impacts, before and after shipping vibe with the last impact at twice the height on the most typical surface to be dropped on.

Unpackaged unit, attached to a test machine using product's mounting points, must survive 3 +/- Shocks, 7.5 G, 19 msec half sine, in the vertical axis only

6.7 UN compliance

The BBU shall meet shock, vibration and drop requirements specified in UN38.3, UN3480/81 (transportation safety test requirements) and safety certification requirement.

6.8 Rack level shock and vibration

The BBU and shelf shall be able meet Facebook rack level shock and vibration requirements.

7. Thermal

7.1 Thermal Design Requirement - Standby Mode

The thermal design of BBU should be able to keep cell temperatures low enough in the long term standby mode regarding lifetime and EOL capacity requirements, given the long time standby mode environment condition defined above. The design should be optimized that the airflow and fan power consumption in standby mode is minimized.

Open Compute Project • Open Rack V3 BBU

7.2 Thermal Design Requirement - Discharge Mode

The thermal design of BBU should be able to support discharge mode operation with the cells at EOL, for at least 5mins, with max output power and worst case operational environment condition defined above.

7.3 Thermal Design Requirement - Charge Mode

The thermal design of BBU should be able to support charge mode operation at the worst case operational condition defined above. It should also be able to accelerate the cooldown of cells after discharge, and enable recharge within 30mins in the worst case condition. The FSC should be designed to control airflow and fan power consumption based on actual cooling needs.

7.4 Airflow Direction

The BBU shall provide an air intake from the front side and exhaust to the rear side to allow front to rear forced convection cooling. The air removal device (fan) should be able to maintain the airflow direction and sufficient airflow rate for cooling with up to 0.05InH₂O extra back pressure behind the BBU.

7.5 Fan

Mounting of the fan must meet any vibration and acoustic criteria and will not violate any physical constraints outlined. The fan shall be included within the BBU enclosure.

7.6 Fan Failure

If a fan fails, the BBU must indicate the failure with a signal that will be reported via SW as well as an LED indicator on the front panel. The BBU shall shut down at fan failure if there is no redundant fan.

7.7 Temperature Sensors

The temperature sensors shall be chosen to meet the monitoring requirements and the accuracy for the sensing is within a +/- 2.0C tolerance. The temperatures of inlet air, exhaust air, hottest cell(s) and other hotspots should be reported.

7.8 Fan Speed Control

The fan speed control should be a combination of multiple control tables (linear or PID) based on inlet temperature, hottest cell temperature, rectifier hotspot temperature(s) and operation mode. It should be tuned properly to support cooling needs of all operation conditions, maintain appropriate thermal margins, reduce unnecessary consumption of airflow rate and fan power, and minimize fan speed oscillation.

7.9 BBU Thermal Monitoring

Each BBU shall provide the following parameters via the defined communication protocol. The following thermal parameters must be available for each rectifier and labeled accordingly:

- Inlet temperature
- Exhaust temperature
- Cell temperature sensors, maybe multiple sensors to capture hottest cells
- Fan speed reading (include all fan/rotor speeds if more than 1 rotor), percent is acceptable as long as full speed rpm is provided at some point.
- Hotspot temperatures on the rectifier
- Fan fail signals
- Component overheat signal

Open Compute Project • Open Rack V3 BBU

7.10 BBU Exhaust Temperature

Maximum BBU exhaust air temp shall not exceed 70C at back pressure between -0.05 to 0.05" H2O. While BBU is plugged in, the BBU fan(s) shall still function properly even at low/Standby load (FSC should increase fan speed if needed to overcome the high back pressure).

8. Mechanical

8.1 Physical Dimensions

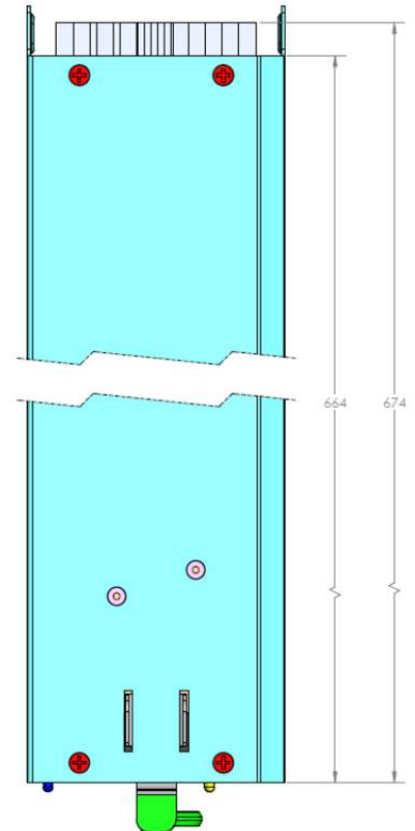
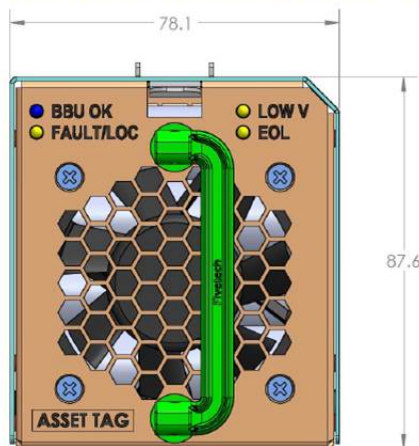
BBU Module Dimensions

Slight dimension change

Width x Height x Depth

Old: 78.35mm x 88.1mm x 656mm

New: 78.1mm x 87.6mm x 664mm (674mm if connector included)




Updated mechanical drawing to be released will include critical dimensions of the connector location and placement, connector protector, keying feature, LED locations, handles, etc.

The sheet metal material shall be steel, pre-plated hot-dip zinc coated, with 1mm of thickness.









The BBU mechanical chassis is composed by a base and a cover assembled using flathead screws: no rivets are allowed (the BBU must be able to be opened by using a screwdriver).

8.2 Indicators/LED

The front of the BBU shall display the following LEDs, single color or bicolor.

Silkscreen	Display	Color	Meaning
BBU OK		Solid Blue	BBU ready

Open Compute Project • Open Rack V3 BBU

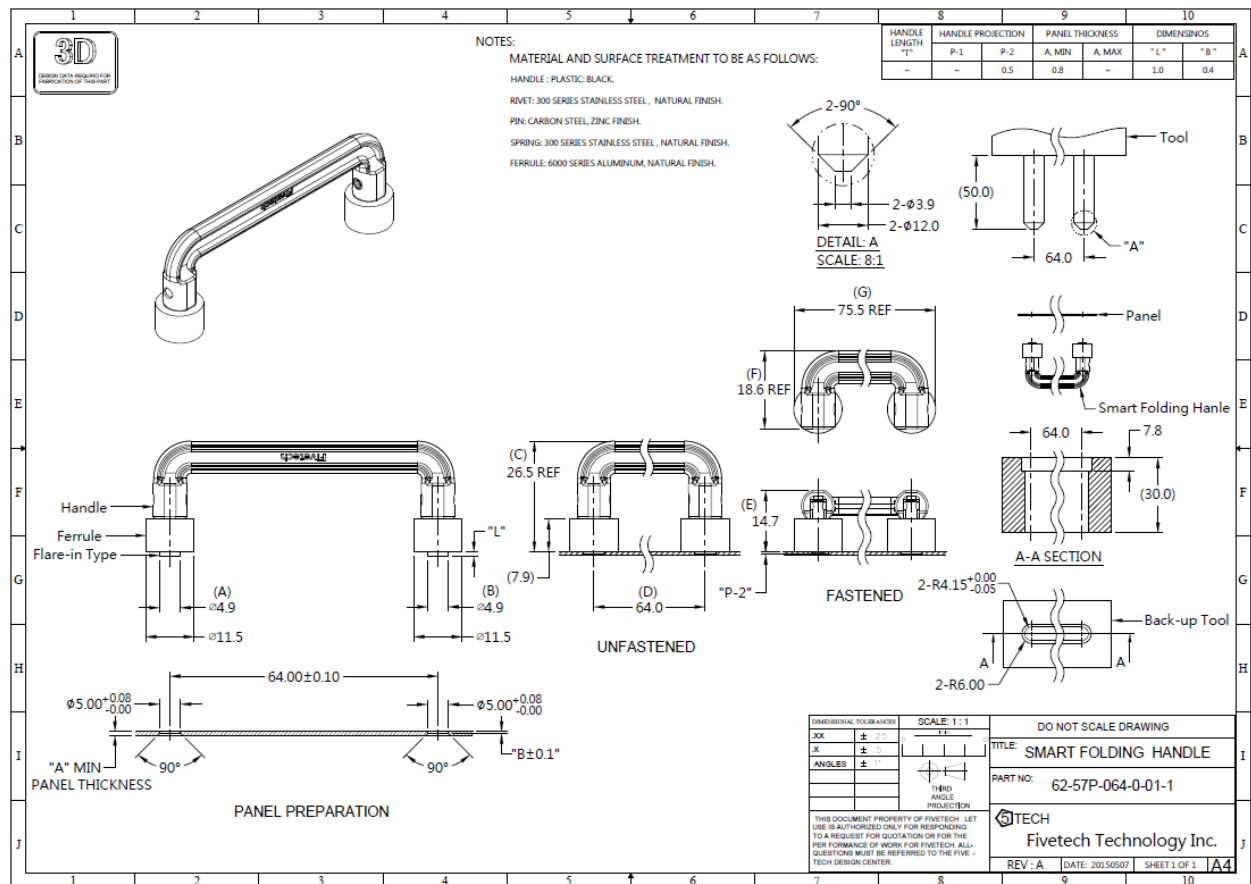
		Blinking Blue @0.5s on/0.5s off	BBU charging/FW upgrade
		Off	Default
Low V/EOL		Solid Amber	BBU low Capacity*/EOL*
		Blinking Amber @0.5s on/0.5s off	BBU discharging
		Off	Default
FAULT/LOC		Solid Amber	Permanent fault (Replacement required)
		Blinking Red @0.5s on/0.5s off	Recoverable temporary fault/Locate
		Off	Default

* BBU capacity is too low to support a fully rated discharge cycle.

8.3 Latch & Handle

A latch and handle are required for BBU removal. The latch shall be attached in the location shown, to interface with the cutout in the chassis. The latch and/or handle designs may vary, but the latch must be Pantone 375C (green). Please note that the BBU will be heavy and the handle should be sturdy enough to carry the entire weight of the BBU.

Open Compute Project • Open Rack V3 BBU



8.4 Chassis Interface

The handle of the BBU may not protrude from the front surface of the BBU by more than 25mm. The latch shall be located on the top side of the BBU and interface with a rectangular hole in the chassis wall (please refer to the 3D drawing for latch location on the BBU). They should only lock into place when a good electrical contact is made on the rear blind mate connectors. This scheme will allow a quick installation of the BBU in the tray, and without the need of using a screwdriver. The front face where the handle is attached should have perforated holes to allow airflow for the fan(s). Spring finger gaskets should be installed on all four sides to ensure solid EMI containment.

8.5 Rear Blind mate connector

The rear blind mate connector of the BBU shall be Amphenol 10127401-03h1510 or equivalent. This is a R/A PLUG PwrBlade ULTRA HD connector with 4 high power pins, 30 signal pins. Please refer to the drawing for more details.

The connector position within the BBU is fixed in x, y, and z direction according to the 3D drawing. This cannot be altered due to mix-and-match requirements for the BBUs into the shelf.
 (Add connector drawing)

Open Compute Project • Open Rack V3 BBU

9. Reliability and Quality

9.1 Derating Design

A comprehensive stress analysis and derating design shall be performed for the BBU. The stress analysis shall include electrical, thermal, and mechanical stresses with actual measurements. The components in the BBU design(excluding battery) shall be properly derated and to meet the derating guideline as specified in IPC-9592B "Requirements for Power Conversion Devices for the Computer and Telecommunication Industries", Appendix A.

9.2 Reliability Prediction

A reliability prediction shall be performed for the BBU (excluding battery) using Telcordia SR-332 Issue 2 Method I, Case I (Part Count). The BBU(exclude battery) shall have a minimum MTBF= 1,000,000 hrs at 30C, 100% load per IPC-9592B.

9.3 Design Failure Mode and Effect Analysis (DFMEA)

A comprehensive DFMEA shall be performed for the BBU. The DFMEA report shall include a list of critical components, risk areas, and corrective actions taken.

9.4 Burn-In (BI) and Ongoing Reliability Testing (ORT)

TBD

9.5 Manufacturing Quality

It is required to meet the quality process requirements as specified in IPC-9592B, Section 6 ("Quality Process"), which include PFMEA, statistical process control (SPC), corrective action process, yield control, materials traceability, product change notice (PCN), qualification of change, etc.

10. Compliance requirements

The BBU shall be designed for compliance to allow worldwide deployment. Additionally, the manufacturer is fully responsible for:

- ensuring the complete compliance of the BBU shelf in the environment it is intended to function (as described by the Rack Spec)
- maintaining and updating the BBU shelf safety reports to current requirements and all new released requirements.
- all design and recertification costs required to update the BBU to meet the new requirements.
- Meeting EMC requirements
- Meeting Safety requirements

The manufacturer is responsible for obtaining the safety certifications specified below.

10.1 Safety Standards

The product is to be designed to comply with the latest edition, revision, and amendment of the following standards. The product shall be designed such that the end user could obtain the safety certifications: UL 62368-1, IEC 62368-1 and EN 62368-1; hazard-based performance standard for Audio video, IT & Communication Technology Equipment

Open Compute Project • Open Rack V3 BBU

The manufacturer shall obtain the following safety certifications for the BBU shelf as applicable. Only requirements that absolutely rely on or are affected by the system may be left to the system level evaluation [i.e. minimize Conditions of Acceptability]. Below are common requirements for North America and Europe. For other countries, different certifications may be required:

- UL or an equivalent NRTL for the US with follow-up service (e.g. UL or CSA).
- CB Certificate and test report issued by CSA, UL, VDE, TUV or DEMKO
- CE Marking for EU
- UL1973 (Recog) cRUus
- IEC62133
- 62368-1 (UL/IEC)
- UN38.3

10.1.1 Component Safety requirements

Following are the safety requirements for major components:

- All Fans shall have the minimum certifications: UL and TUV or VDE.
- All current limiting devices shall have UL and TUV or VDE certifications and shall be suitable rated for the application where the device in its application complies with IEC/UL 62368-1.
- All printed wiring boards shall be rated UL94V-0 and be sourced from a UL approved printed wiring board manufacturer.
- All connectors shall be UL recognized and have a UL flame rating of UL94V-0.
- All wiring harnesses shall be sourced from a UL approved wiring harness manufacturer. SELV Cable to be rated minimum 80V, 130C.
- Product safety label must be printed on UL approved label stock and printer ribbon. Alternatively, labels can be purchased from a UL approved label manufacturer.
- The product must be marked with the correct regulatory markings to support the certifications that are specified in this document.
- Battery cell shall comply with applicable safety standards.

10.2 EMC Requirements

The BBU shall meet the following requirements in the latest edition of standards when operating under typical load conditions and with all ports fully loaded;

The BBU integrated into the shelf is called the component BBU. Manufacturer shall provide the proof of compliance for the component BBU that are required for spare parts shipment. The component BBU shall not contribute any noncompliant conditions to the end-use product.

If at any time it is found that a supplier's component BBU causes the end-use product to fail emissions and/or immunity testing, the supplier will be instructed to investigate and resolve the problem.

The BBU shelf shall have minimum 6dB margin from the Class A limit for the radiated and conducted emissions.

Depending on the system manufacturer's design goals and business needs, more margin may be required when it is integrated into the final end system.

The following EMC Standards (the latest version) are applicable to the product.

- FCC /ICES-003
- CISPR 32/EN55032
- CISPR 35/EN55035 - Immunity
- EN61000-3-2 - Harmonics
- EN61000-3-3 - Voltage Flicker
- VCCI
- KN 32 and KN35

Each individual basic standard for immunity test has the following minimum passing requirement. Higher level of passing criteria may be applied depending on the system manufacturer's design goals and business needs.

Open Compute Project • Open Rack V3 BBU

- EN61000-4-2 Electrostatic Discharge Immunity
 - Contact discharge: >4kV
 - Air discharge: >8kV
- EN61000-4-3 Radiated Immunity
 - > 3V/m
- EN61000-4-4 Electrical Fast Transient Immunity
 - AC Power Line: >1kV
 - Signal Line: >0.5kV
- EN61000-4-5 Surge
 - AC Power Line: >1kV (Line-to-line), >2kV (Line-to-earth)
 - Signal Port: >1kV
- EN61000-4-6 Immunity to Conducted Disturbances
 - DC Power Line: > 3Vrms
- EN61000-4-8 Power Frequency Magnetic Field Immunity, when applicable
 - > 1A/m
- EN61000-4-11 Voltage dip and sag

10.3 Environmental Compliance

The BBU shelf (including all components inside) shall comply with the following minimum environmental requirement and manufacturer shall provide full material disclosure, Declaration of Conformity and technical documentations to demonstrate compliance. The system manufacture may have additional requirements depending on its design goals and business needs.

- RoHS Directive (2011/65/EU and 2015/863/EU); aims to reduce the environmental impact of EEE by restricting the use of certain substances during manufacture
- REACH Regulation (EC) No 1907/2006; registration with the European Chemicals Agency (ECHA), evaluation, authorization and restriction of chemicals.
- Halogen Free: IEC 61249-2-21, Definition of Halogen Free, 900ppm for Br or Cl, or 1500ppm combined
- US SEC conflict mineral regulation to source mineral materials from socially responsible countries, if applicable
- Waste Electrical and Electronic Equipment (“WEEE”) Directive (2012/19/EU) if applicable; aims to reduce the environmental impact of EEE by restricting the use of certain substances during manufacture

10.4 Documentation

The manufacturer shall provide reproducible copies of all pertinent documentation relating to the following:

- Product Information
- Schematics, PCB layout artwork and bill of material including key component specifications at each design phase
- Functional test report at each design phase
- Applicable compliance reports, certifications and declaration of conformance.
- Other applicable certificates required by the system manufacturer.

11. Appendix

11.1 V3 PMC specification



ORV3 Power
Monitoring (PMC and

11.2 V3 PSU specification

11.3 V3 Power shelf specification

