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ORV3 Power Shelf Development Update

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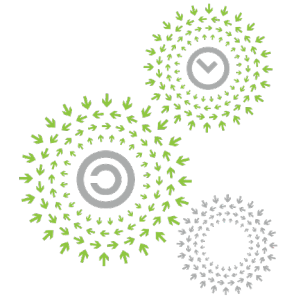
NOVEMBER 9-10, 2021

ORV3 Power Shelf Development Update

Ralf Pieper, R&D Director, Delta Energy Systems
Harry Soin, Senior Director, Advanced Energy
Lam Vu, Director, Lite-on Technologies



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Common ORV3 with PMBus Shelf-Controller (PMC) **by Ralf**

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Rectifier and BBU transition **by Harry**

BBU and Rectifier transition in fault cases
Current sharing between power shelves **by Lam**

Short refresh on ORV3 Spec

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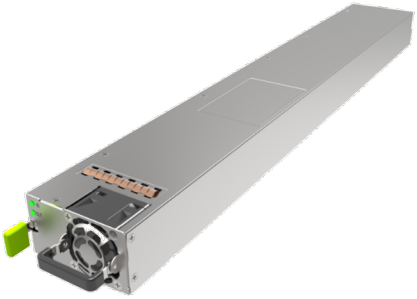


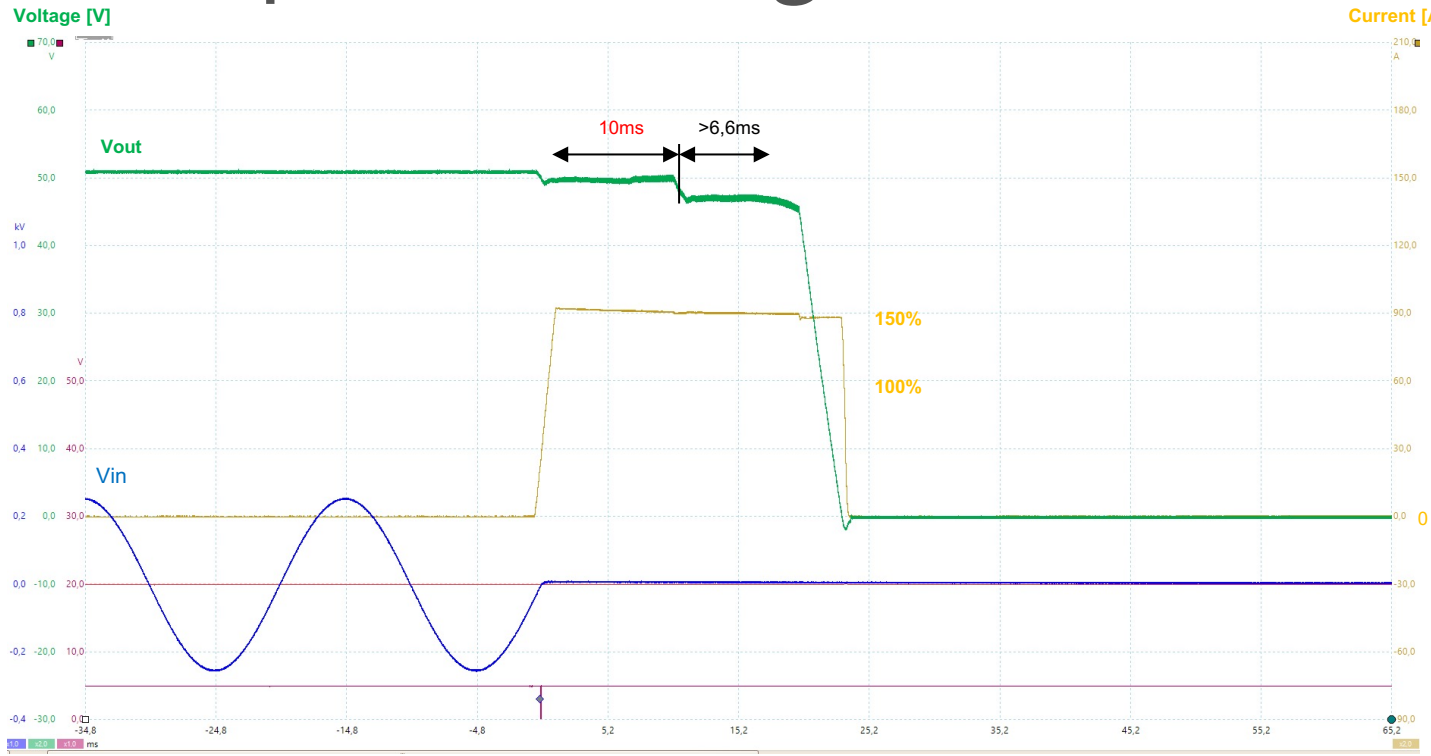
Rectifier:

Input voltage range: 180V-305VAC
Output power: 3000W
Output voltage: 50V @ AC / 48V @ BBU
Output current: 60A
Holdup time: 20ms
Efficiency: 97,5% pk / 96,5% @ full load
Current share: Active + Voltage Droop
Communication: I2C / MOD-Bus
Size: 73mm x 40mm (1RU) x 520mm

Shelf:

6 Slots for PSU + 1 Slot for PMC
Output power: (N+1) = 18000W / 15000W usable
Output voltage: 50V @ AC / 48V @ BBU
Output current: 300A nominal
Output connector: 500A Barklip (BK500)
Communication: Ethernet via PMC
Size: 21“ x 48mm (1OU) x 787mm

Holdup time during overload



„Design 2“ Requirements:

20ms Holdup @ 100%

equals 60J

13,3ms Holdup @ 150%
(9ms + 4ms)

After 10ms Output voltage drops to 48V to wake up Battery Backup Unit.

BBU timing requirement:
1ms for detection
2-3ms for rampup DC/DC
→ Minimum **4ms**

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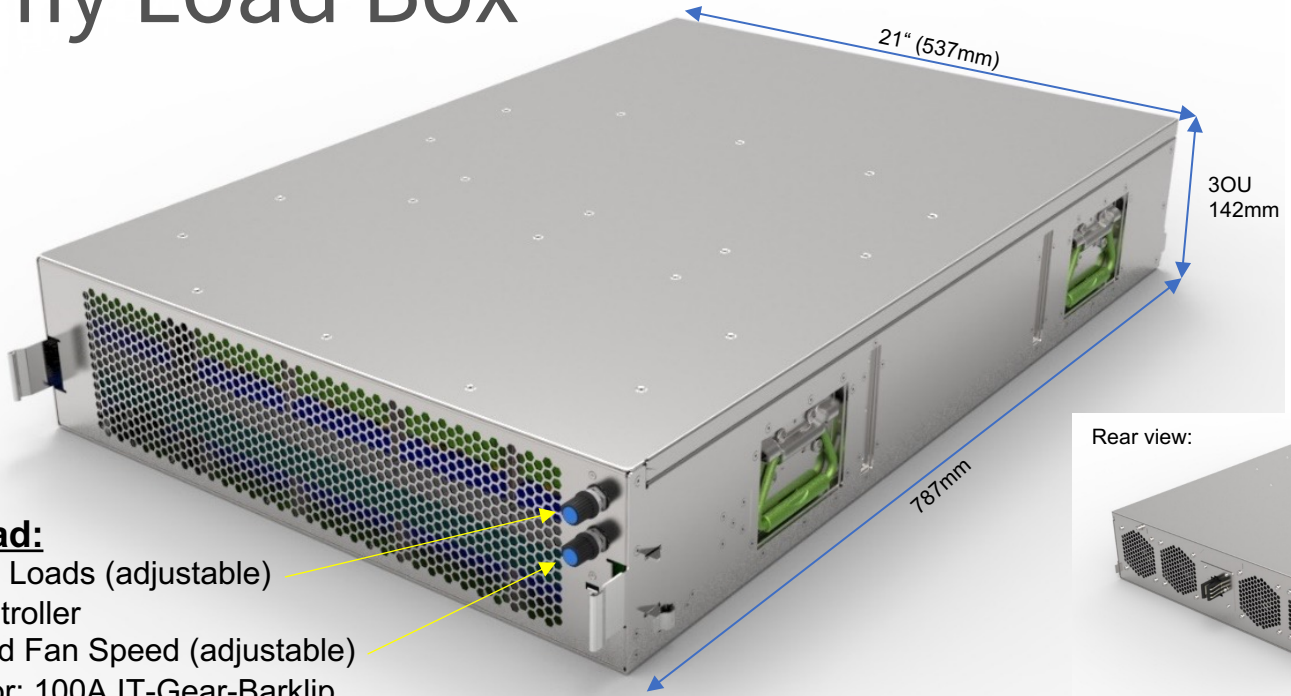
Dummy Load Box



Rear view:

Dummy Load:

8 x 500W TTV Loads (adjustable)
Hot Swap Controller
MCU controlled Fan Speed (adjustable)
Input connector: 100A IT-Gear-Barklip
Communication: N/A
Size: 21“ x 142mm (3OU) x 787mm

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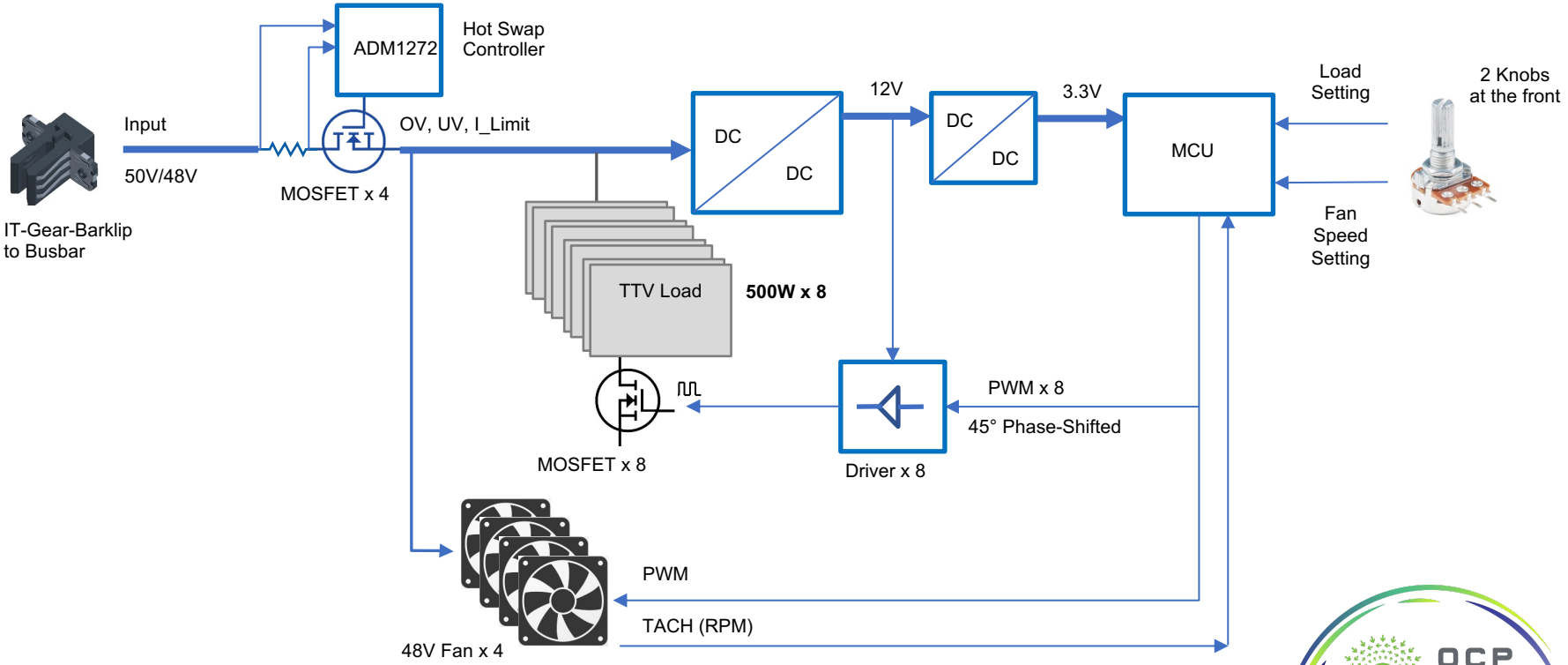
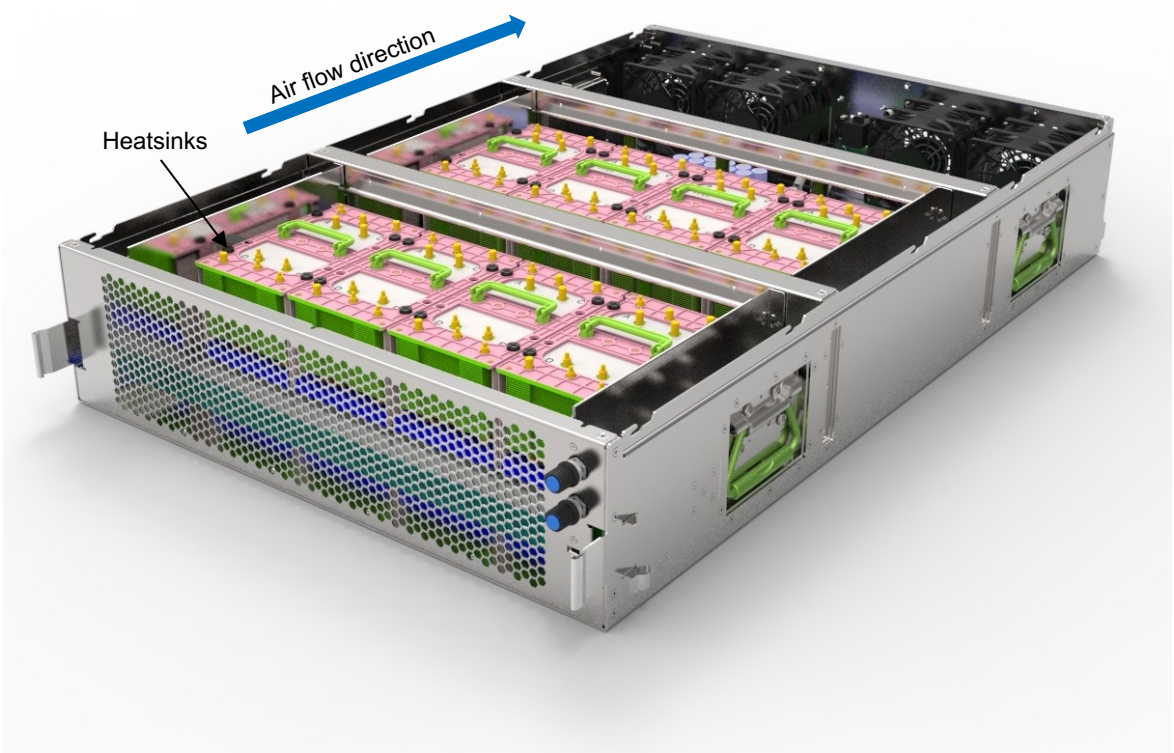
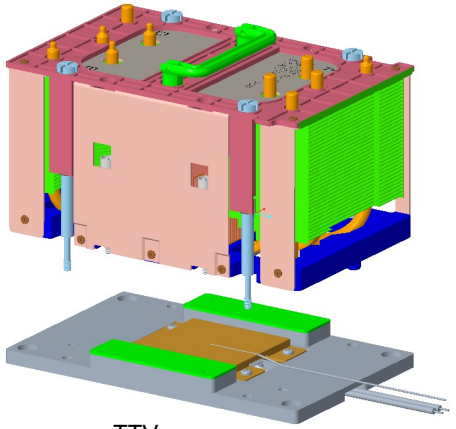
Dummy Load Box



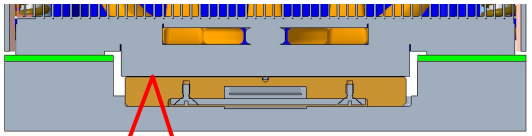
Dummy Load Box



Heatsink



TTV
(Thermal Test
Vehicle)



0.12 mm Gap
for thermal
grease

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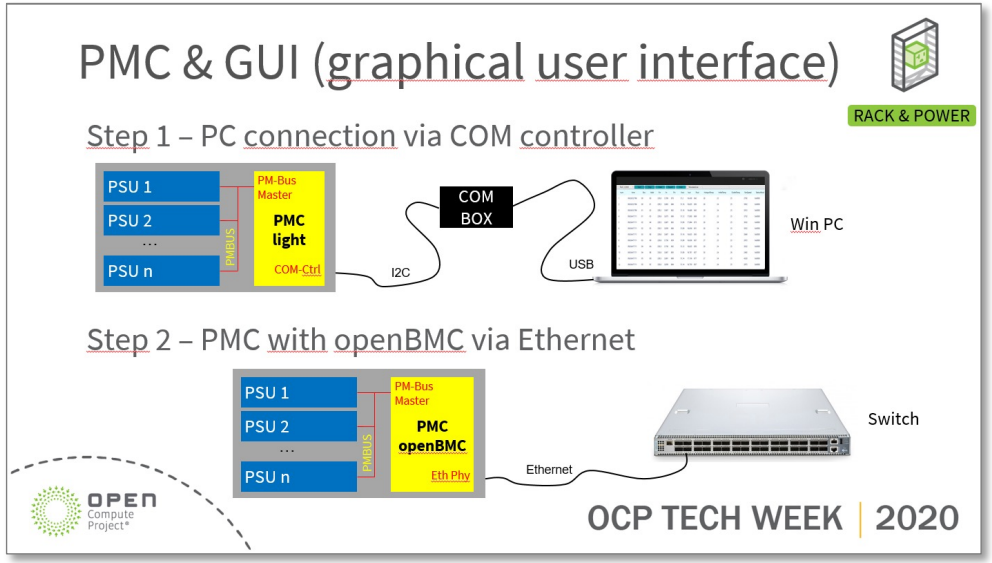
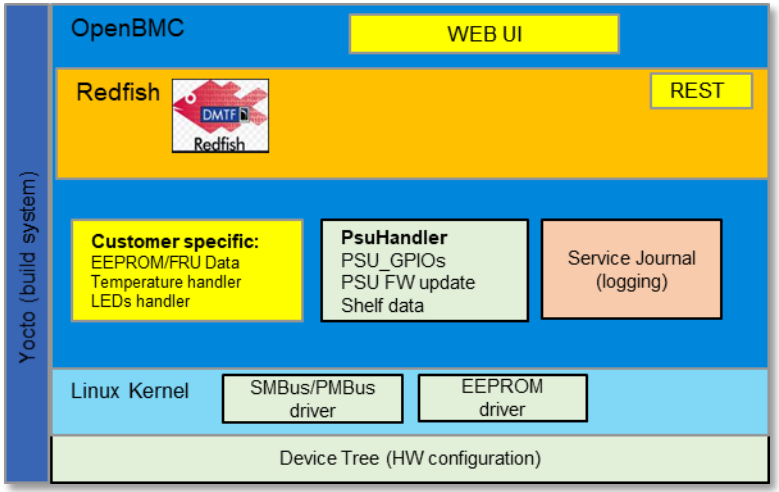
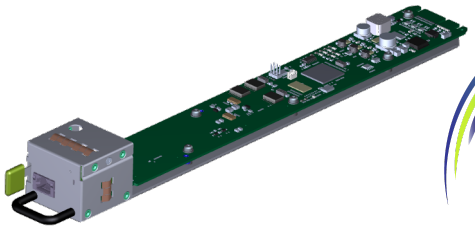
PMC

Last year: Step 1 with PMC-Light + I2C-Box + Laptop GUI



This year: **Step 2**
PMC with openBMC & Redfish implementation





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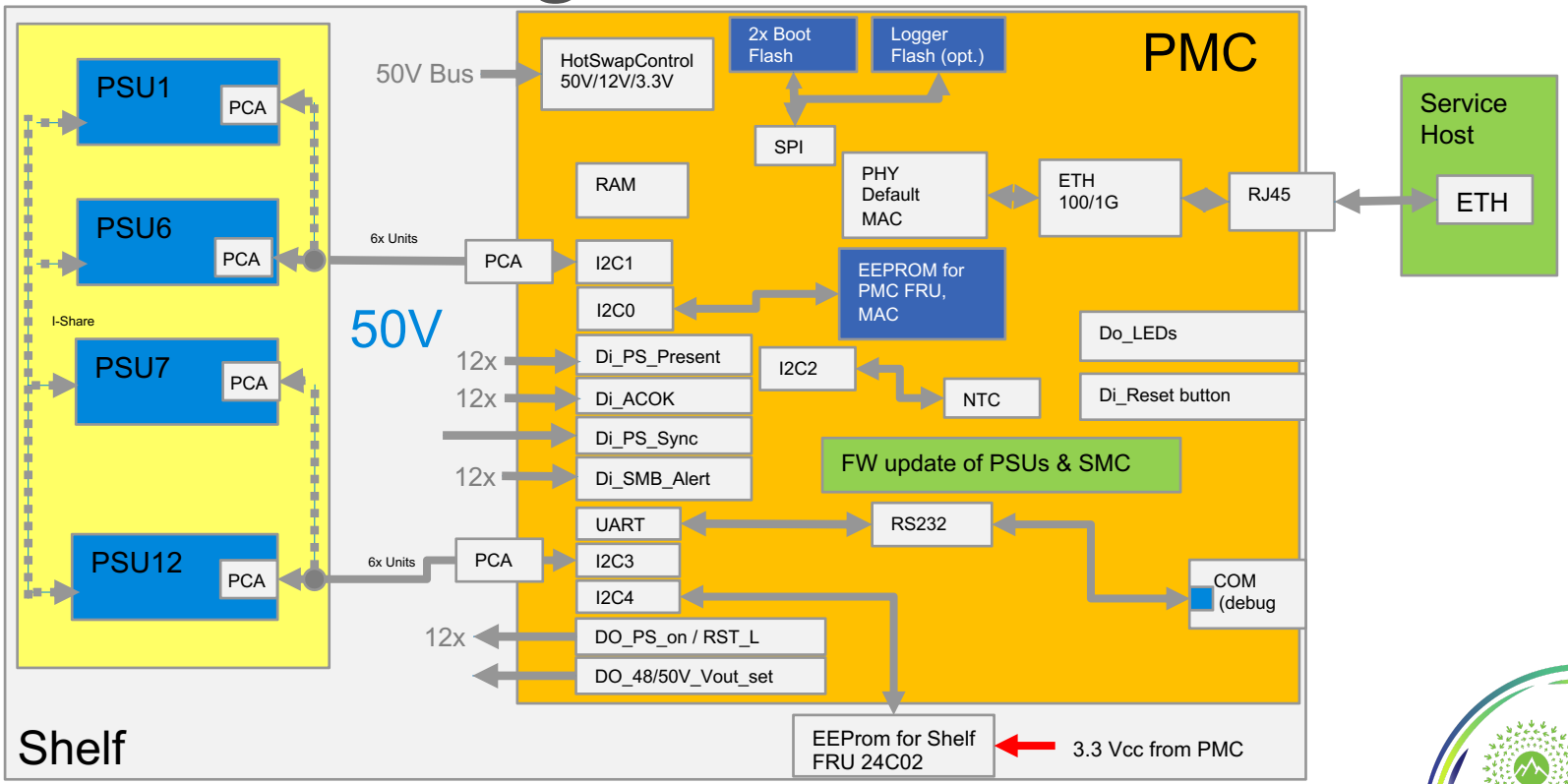
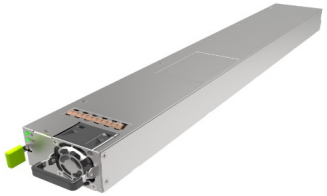
PMC Block diagram



For more information & Prototypes

ORV3 1OU
Power Shelf



ORV3 3000W
Power Supply

ORV3 2OU
Power Shelf

ORV3 5000W
Power Supply

Dummy Load

Contact: ralf.pieper@deltaww.com

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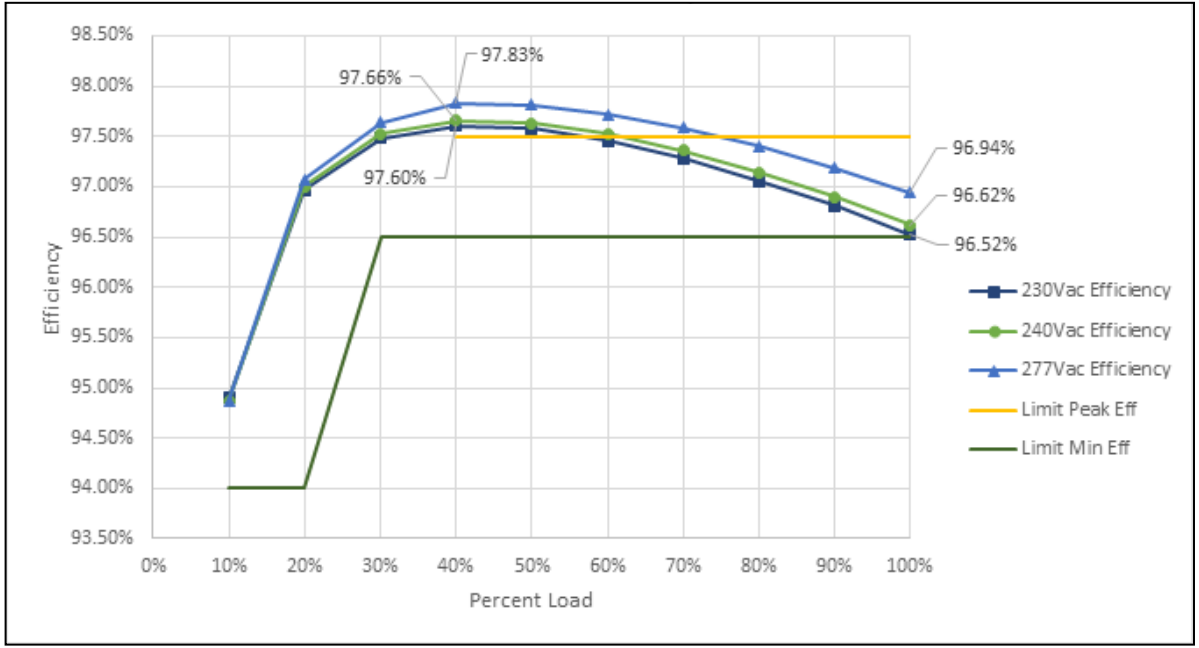
ORV3 3KW Measured Efficiency



AC	Peak Efficiency	Full Load
277VAC	97.83%	96.94%
240VAC	97.66%	96.62%
230VAC	97.60%	96.52%

*** % Load based on 3000W full load; Efficiency measured with fan loss included**
*** Efficiency measured on PSU that can meet 20msec hold-up on all load conditions**

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ORV3 3KW iTHD and PF Measurement Data

iTHD

Load	iTHD@240 VAC	iTHD@277 VAC	Limit
5%	22.271	35.713	15%
10%	4.709	9.712	15%
15%	3.571	4.026	10%
20%	3.196	3.315	10%
30%	2.789	2.781	5%
40%	2.631	2.671	5%
100%	2.269	2.148	5%

PF

Load	PF@ 240VAC	PF@ 277VAC	Limit
5%	0.7843	0.6876	--
10%	0.9495	0.9105	0.95
15%	0.9764	0.9566	0.95
20%	0.9861	0.9741	0.95
30%	0.9936	0.9876	0.98
40%	0.9965	0.9932	0.98
100%	0.9992	0.9987	0.98

iTHD and PF improvement is work in progress to meet the specs

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ORV3 Rectifier to BBU Transitions Definitions

For the load to transition or share from rectifier to BBU seamlessly, rectifier regulation would drop by 3V and maintain that level at minimum 4msec to trigger BBU to turn on and time to share.

There are two main conditions for rectifier to adjust from 51V to 48V:

Condition 1: During AC loss conditions

- Output will adjust if 66.6% of bulk energy is depleted

Condition 2: Over power/current conditions:

- Average power more than 3.3kW for 10s
- Average power more than 3.6kW for 100ms
- Repetitive pulse power more than the pulse power envelope specified (up to 150% load)
- Single pulse power more than holdup time at the overload condition (up to 150% load)

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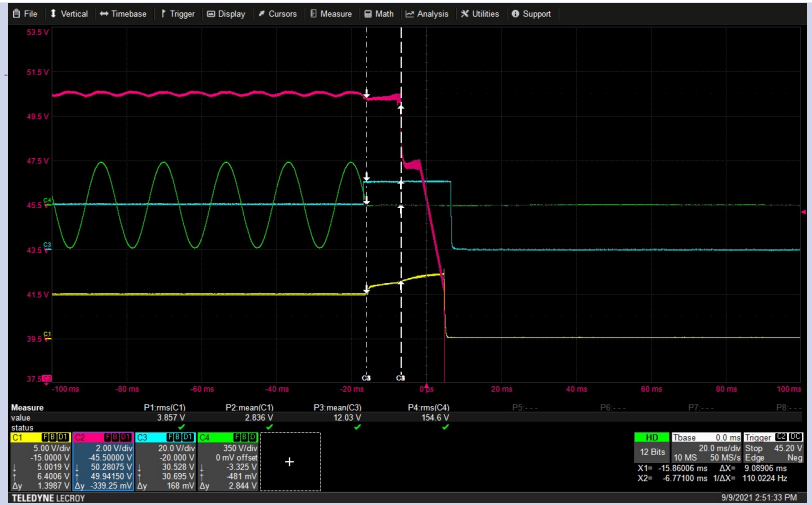
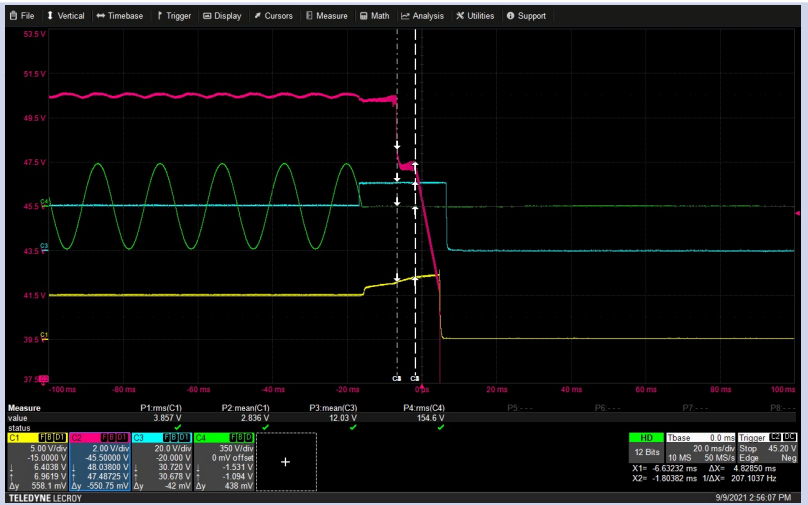
ORV3 Rectifier adjusts from 51V to 48V – AC Loss @100% load

AC loss (100% load); time before drop – 11.6msec	AC loss (100% load); remaining time @48V – 13.9msec
	
CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC	CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC

ORV3 Rectifier adjusts from 51V to 48V – AC Loss @150% load

AC loss (150% load); time before drop – 9msec	AC loss (150% load); remaining time @48V – 4.8msec
	
CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC	CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC

ORV3 Rectifier adjusts from 51V to 48V – Output Over Power (Average Overload)

3.6KW average power overload for 100msec (100% - 140% dynamic load) Recovers back to 51V after 10sec	3.3kW average power overload for 10sec (100% - 120% dynamic load) Recovers back to 51V after 10sec
	
CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC	CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC

ORV3 Rectifier adjusts from 51V to 48V – Output Over Power (Repetitive/Envelope Pulse Overload)

10-110% Step Load (Adjusts to 48V after the step load exceeds specified pulse power envelope; shuts down after persistent overload then recovers after 10sec)

CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC

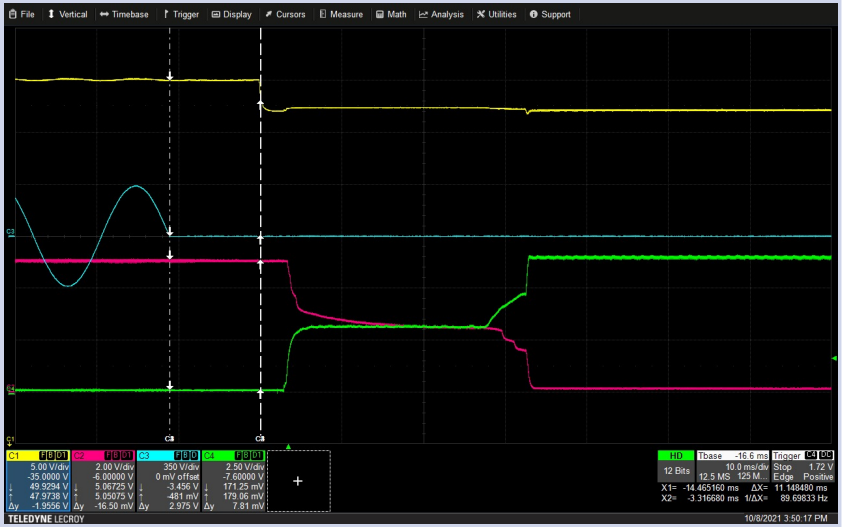
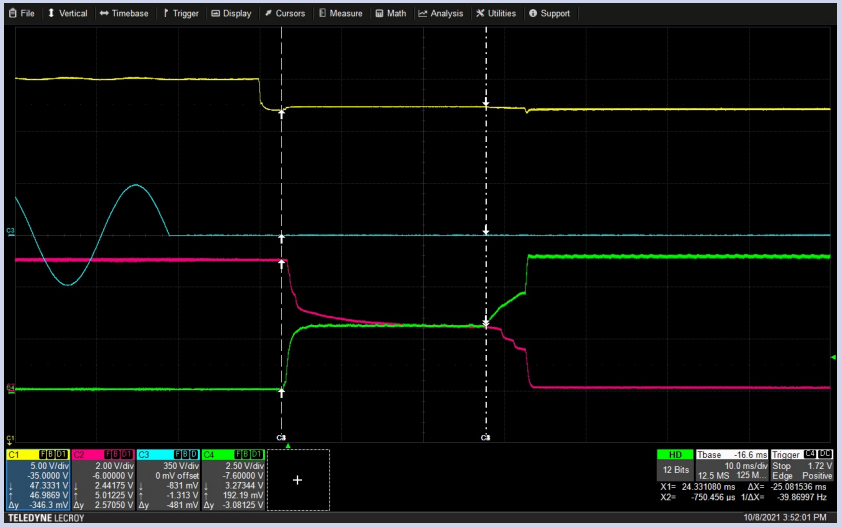
10-110% Step Load (Short step load pulse exceeds specified pulse power envelope, no shutdown after reducing load <5msec, stays at 48V for 10sec before recovering back to 51V)

CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC

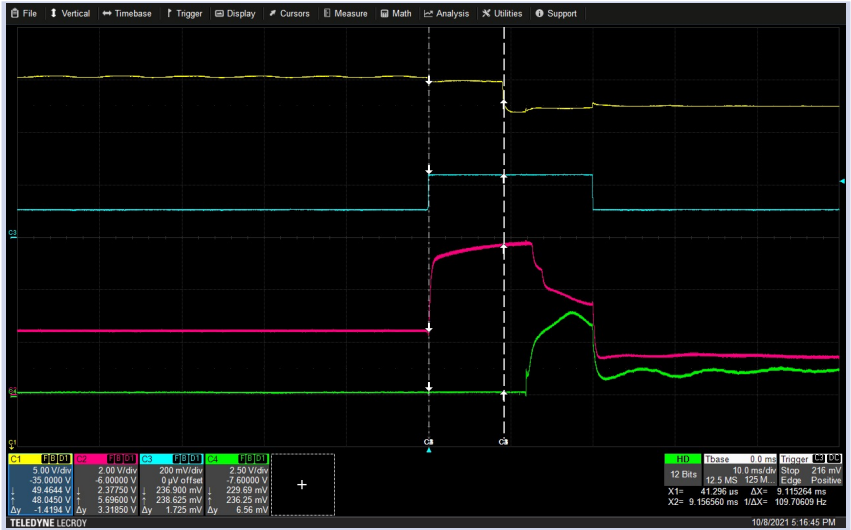
ORV3 Rectifier adjusts from 51V to 48V – Output Over Power (Single pulse overload)

100-110% Step load (load exceeds the hold up time for the overload condition adjusts output to 48V then shuts down after a persistent overload then recovers after 10sec)	100-110% Step load (load exceeds the hold up time for the overload condition adjusts output to 48V and reduce load to maintain output at 48V before recovering back to 51V after 10sec)
	
CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC	CH1:Ishare; CH2:Vout; CH3: Iout; CH4:AC

ORV3 Rectifier to BBU transition – AC Loss

1PSU: 1BBU 100% load @ AC loss; time before drop 11msec	Time remaining for share between PSU and BBU is 25msec
	
CH1:Vout; CH2:PSU Ishare; CH3: AC; CH4:BBU Ishare	CH1:Vout; CH2:PSU Ishare; CH3: AC; CH4:BBU Ishare

ORV3 Rectifier to BBU Transition – Overload

1PSU: 1BBU Single envelope pulse overload 50% - 115%; PSU adjusted to share load with BBU	Load share between PSU and BBU for 10sec after adjust then PSU adjusted back to 51V
	
CH1:Vout; CH2:PSU Ishare; CH3:Iout ; CH4:BBU Ishare	CH1:Vout; CH2:PSU Ishare; CH3:Iout ; CH4:BBU Ishare

For more information, please contact: **Harry.Soin@aei.com**

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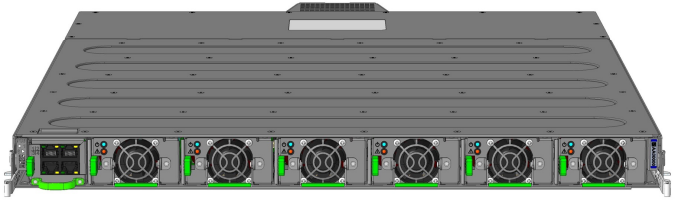
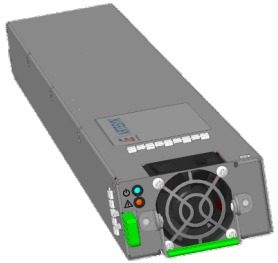
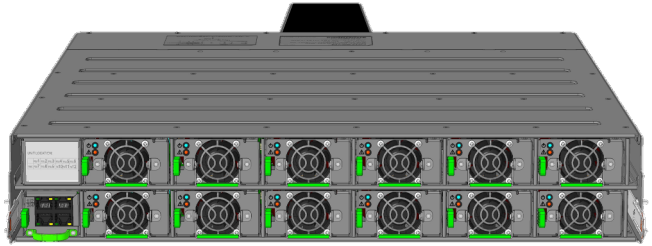


ORV3 1OU Power Shelf



3-5kW Power Supplies

ORV3 2OU Power Shelf



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For more Information & Prototypes

Please contact: Harry.Soin@aei.com

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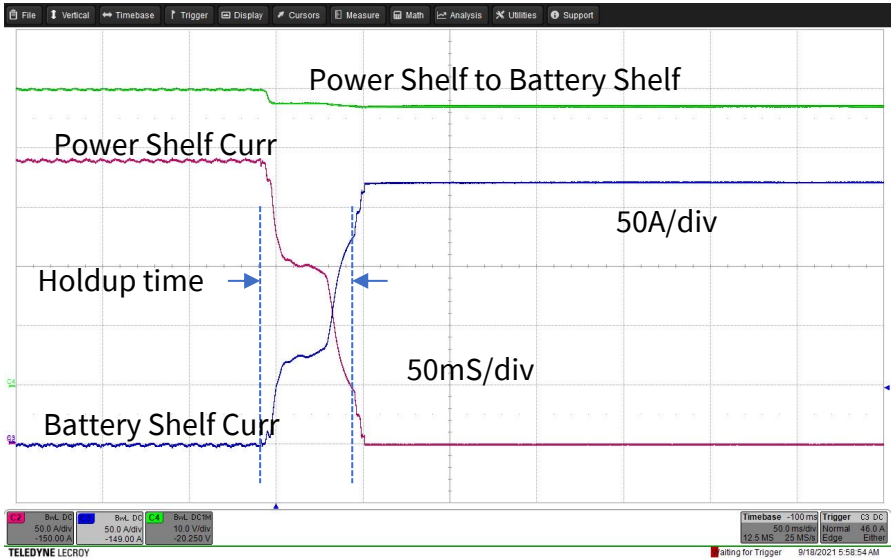
ORV3 Rectifier to BBU Transitions in Fault Cases

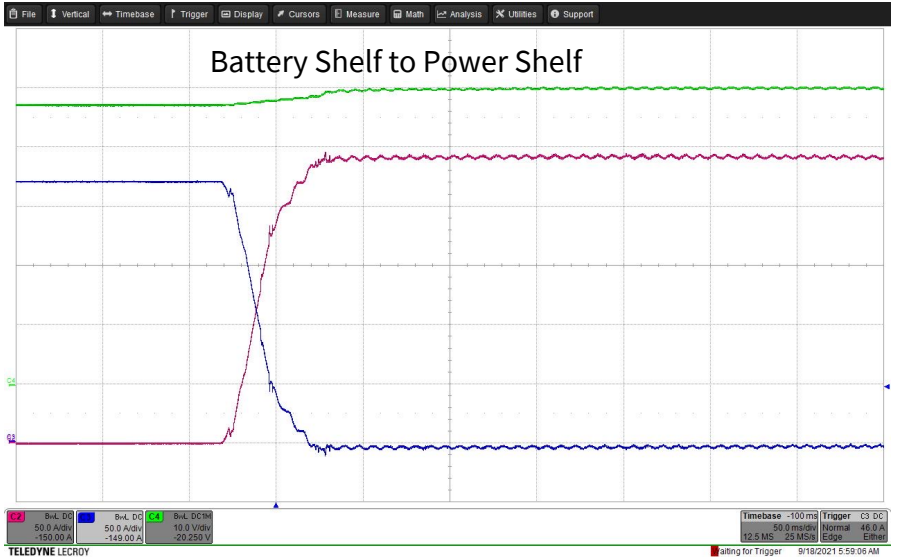
Transition between PSU to Battery backup is facilitated by PSU lowering its output voltage into the output voltage range of BBU.

Whenever PSU is about to shutdown, it will bring its output voltage down 3V to allow BBU a chance to support load.

- Line loss: reduce output by 3V during holdup time. Holdup time varies linearly with load level.
- Overload:
  - Situation: one input phase is lost, 4 remaining PSUs supply 15kW load and go into overload condition
  - Maintain output until overload accumulation reaches shutdown timings
  - Output voltage is reduced by 3V and continues for the next 10mS to allow BBU to pick up the load
- Overtemperature: drop output voltage 3V for 20mS before shutdown

Power Transition Between ORV3 PSU Power Shelf and BBS Line Loss





Power Shelf drops output 3V to trigger Battery shelf to start providing power

Power shelf and battery shelf share current by droop mode during transition time

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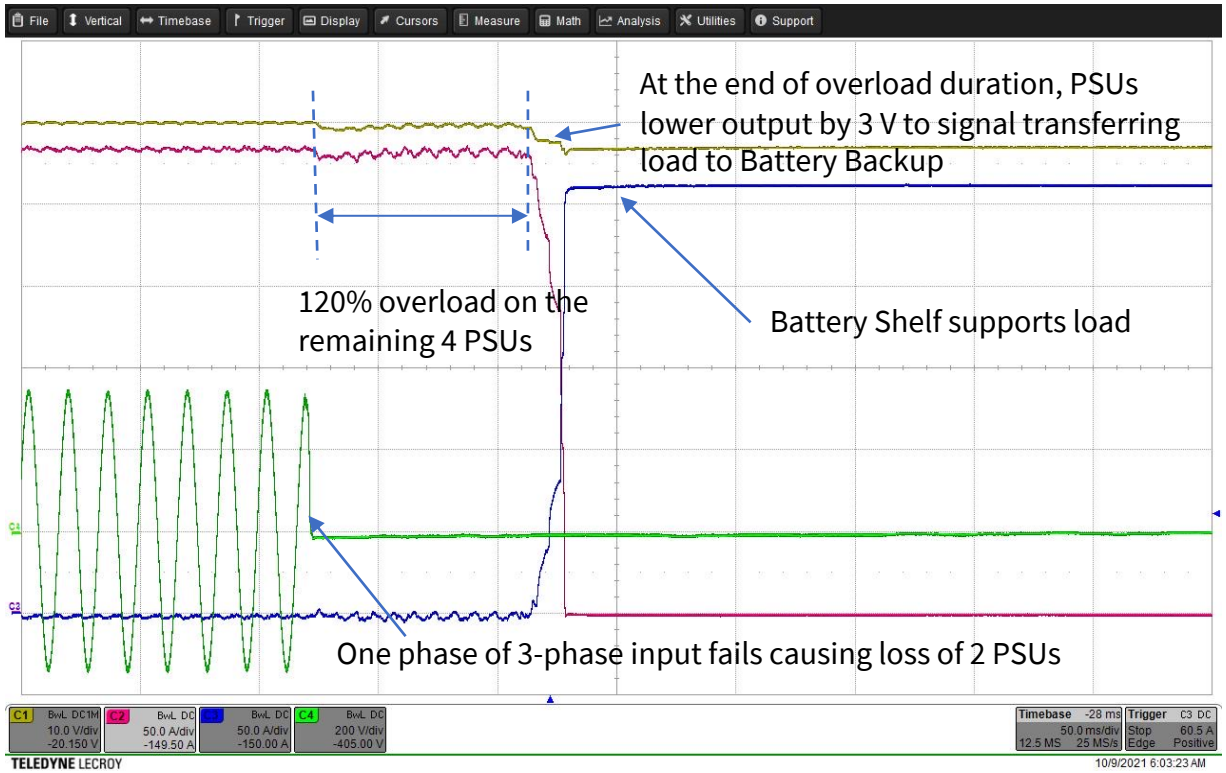
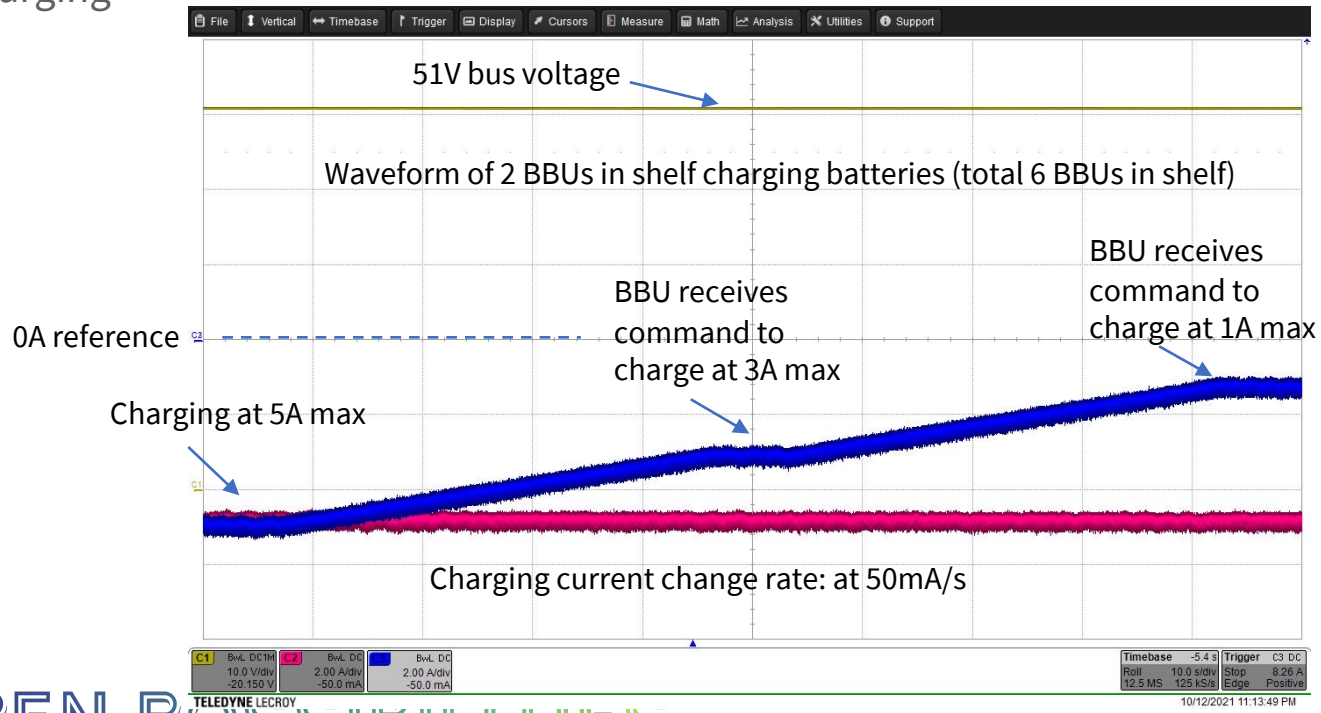
ORV3 Rectifier to BBU Transitions in Fault Cases



BBU Charging Power Allocation

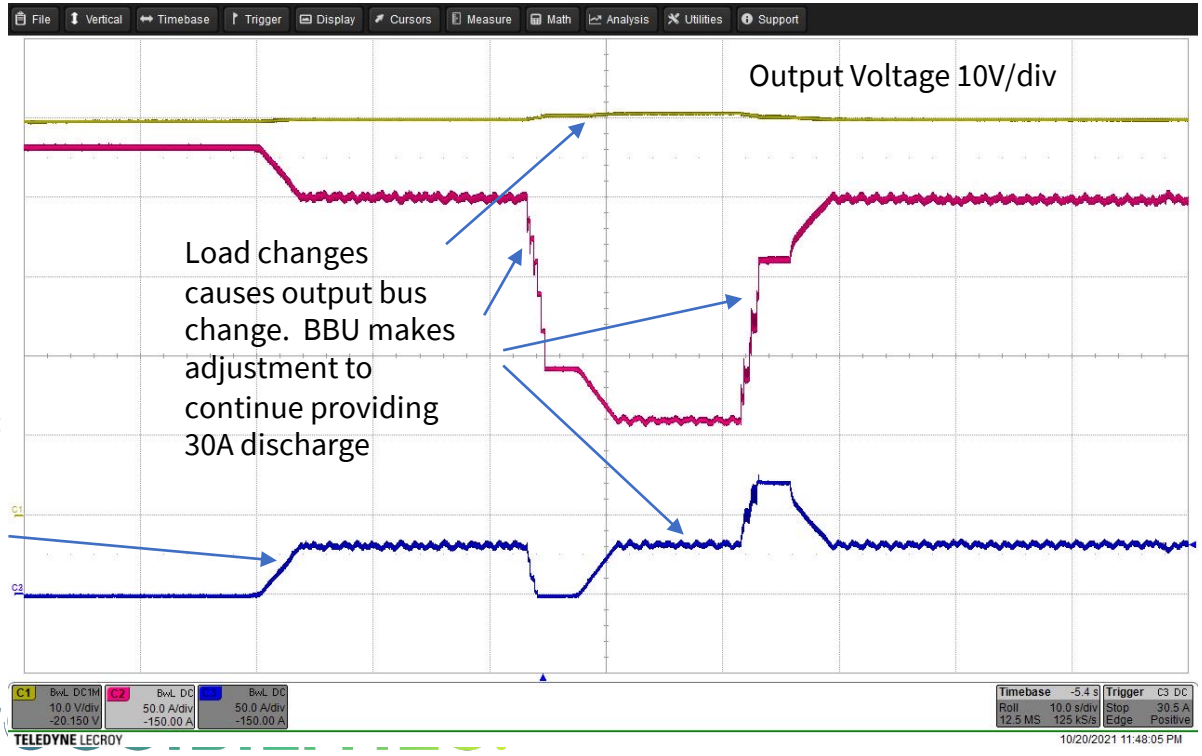
BBU has programmable max charging current to apportion power between load and battery charging



BBU SOH Testing with Constant Current Discharge

BBU can discharge at constant current during SOH test for precise measurement of battery health status

Start SOH testing: BBU raises its output voltage to provide constant 30A to load



More Power in a Rack: Current Sharing Between Power Shelves

Power shelves can share current via both droop and active share bus method to increase power of a rack. Active current share bus can be access thru front analog RJ45 connector.

Accuracy between PSUs in different shelves is better than 2%

Current Sharing with Droop and Active Current Sharing Signal												
	PSU_1		PSU_2		PSU_3		PSU_4		PSU_5		PSU_6	
	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2
120A	10.41	10.11	10.80	10.61	10.52	10.31	10.27	10.82	10.55	10.66	10.39	10.39
240A	20.42	20.18	20.93	20.80	20.78	20.50	20.20	20.84	20.80	20.33	20.58	20.44
360A	30.38	30.02	30.73	30.66	31.16	30.84	30.15	30.64	30.71	30.16	30.83	30.42
480A	40.50	40.14	40.38	40.39	41.13	40.65	40.03	40.89	40.42	40.19	40.64	40.08
600A	50.69	50.46	50.28	50.28	51.00	50.66	50.39	50.94	49.45	50.00	50.61	50.24
720A	60.45	60.29	59.95	60.23	61.07	60.83	60.37	60.85	59.64	59.66	60.94	60.41

More Power in a Rack: Current Sharing Between Power Shelves

Without active current share signal, two power shelves can share thru droop with more error between two shelves.

Current Sharing with Droop Only												
	PSU_1		PSU_2		PSU_3		PSU_4		PSU_5		PSU_6	
	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2	shelf 1	shelf 2
120A	9.31	11.56	9.35	12.27	9.79	8.19	8.33	11.73	8.18	11.61	7.87	11.27
240A	18.79	21.47	19.37	21.99	19.79	18.27	18.06	21.59	18.72	21.46	17.61	21.22
360A	28.91	31.53	29.25	31.97	30.36	28.68	27.79	31.72	28.42	31.40	27.96	31.61
480A	38.77	41.39	38.58	41.56	40.20	38.73	37.61	41.89	37.91	41.19	37.58	41.51
600A	48.42	51.46	48.09	51.40	49.79	48.80	47.45	52.30	47.76	51.46	47.22	51.46
720A	58.13	61.24	57.61	61.14	59.87	58.98	57.03	62.52	57.34	61.25	56.54	62.02

For more information & Prototypes

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Contact: sam.ye@liteon.com

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Call to Action

RACK & POWER

- Get in touch with us to receive latest information about the ORV3 power shelves
- Start testing the ORV3 Power Shelves by yourself! Samples / Prototypes are available!
- Give feedback of your findings to help improving the project in future

Thank you!

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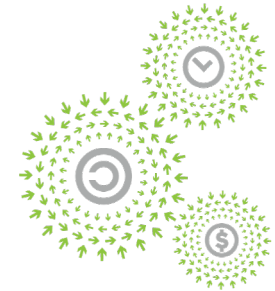
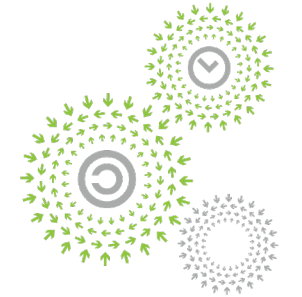
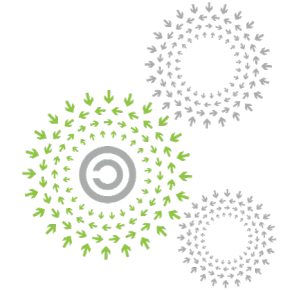
Open Discussion

Please use one of these membership logos to designate your company's membership level.







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