ARTESYN Open Rack V3 Power System

15 kW (N+1) and 9 kW (N+N)

PRODUCT DESCRIPTION

Advanced Energy's Artesyn introduces the Open Rack V3 (ORV3) 3 kW PSU for use in the ORV3 Power System. The PSU is a single-phase AC to DC power supply that operates from nominal input voltages from 200 to 277 Vac and produces 50 V, 60 A (3 kW) DC output. Within the ORV3 1OU Power Shelf, six of the ORV3 PSUs operate in parallel, current sharing mode to produce 15 kW of N+1 redundant power. Power Shelf input(s) are universal 7 pin connector which can be configured as star, delta or single phase. It includes a hot-pluggable Shelf Controller for monitoring and control over Ethernet (DMTF Redfish® compatible) management networks.

The ORV3 Power System features a narrow DC Voltage range to eliminate oversize design and enable high efficiency, fixed ratio downstream DC to DC conversion. The ORV3 Power System is typically used for compute and storage applications which require reliable power and optional battery backup.

AT A GLANCE

Total Power

PSU: 3 kW

Shelf: 18 kW

Input Voltage

PSU: 180 to 305 Vac

Shelf: 346 to 480 Vac 3 phase 5 wire Wye (3ph + N + E)

200 to 277 Vac 3 phase 4 wire Delta (3ph + E)

Output Voltage

50.5 to 51 Vdc

SPECIAL FEATURES

PSU

- Peak efficiency 97.5%
- Efficiency greater than 96.5% for 230 to 277 Vac and 30% to 100% load range
- Active + Droop current sharing
- Hot swappable
- Cooling via internal fan with speed control
- Modbus/PMBus communications
- Interface for monitoring and control
- Black box fault logging

Shelf

- 15 kW at 50 V with N + 1 redundancy or 9 kW at 50 V with N + N redundancy (dual feed shelf)
- Highly accurate droop + active current sharing
- Houses 6 x 3000 W power modules and a removable shelf controller
- Very high efficiency
- Accepts 3 types of input configurations (3P Delta 4 W, 3P Wye 5 W, 3 x of 1P)

EMC/SAFETY

- IEC EN 61000-4-5 CAT A surges
- EN 61000-3-2 Class A harmonics
- CISPR and FCC Part A EMC
- UL 60950
- IEC 60950
- IEC/EN/UL 62368-1
- SEMI F47 Compliance

MODEL NUMBERS

Standard	Input Voltage	Output Voltage	Output Current	Description
700-015234-0100	1 Phase AC, 180 to 305 Vac, 50 to 60 Hz	50 V	60 A	ORV3 PSU
700-015746-0100	3 Phase AC, 200/480 Vac, 50 to 60 Hz	50 V	300 A	1OU-18 kW, ORV3 Power Shelf Single Whip
700-015235-0100	3 Phase AC, 200/480 Vac, 50 to 60 Hz	50 V	300 A	1OU-18 kW, ORV3 Power Shelf Dual Whip
700-015718-0100	-	-	-	Power Monitor Interface (PMI)
700-015798-0000	-	-	-	Shelf Management Controller(PMC)

Options

None

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Stress in excess of those listed in the "Absolute Maximum Ratings" may cause permanent damage to the power supply. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply's reliability.

Table 1. Absolute Maximum Ratings

Parameter	Models	Symbol	Min	Typ	Max	Unit
Input Voltage AC continuous operation	PSU	$V_{IN,DC}$	180	-	305	Vac
Maximum Output Power	PSU Shelf	$P_{O,max}$	- -	- -	3 18	kW kW
Ambient Operating Temperature	All models	T_A	-5	-	45	^{O}C
Storage Temperature	All models	T_{STG}	-40	-	85	^{O}C
Humidity (non–condensing) Operating Non-operating	 All models All models		 10 5	 - -	 90 93	 % %
Altitude Operating Non-operating	 All models All models		 0 0	 - -	 3050 12000	 Meters Meters

ELECTRICAL SPECIFICATIONS

Input Specifications

Table 2. Input Specifications – PSU						
Parameter	**Condition**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Operating Input Voltage, AC	All	$V_{IN,AC}$	180	200/277	305	Vac
Input AC Frequency	All	$f_{IN,AC}$	47	50/60	63	Hz
Input AC Start-up Voltage	All	$V_{IN,AC}$	-	178	-	Vac
Input AC Undervoltage Lockout Voltage	All	$V_{IN,AC}$	-	172	-	Vac
Input Fuse	Phase and return lines UL approved		25	-	-	kA
TON_noBBU	All		1	-	4.5	s
TON_BBU	All		1	-	8.0	s
T-Max_ON_noBBU	All		6	-	7.5	s
T-Max_ON_BBU	All		9.5	-	11.0	s
Startup Surge Current (Inrush)	All	$I_{IN,surge}$	-	-	30	A
Hold Up Time[1]	200 to 277 Vac input 100% Load		-	20	-	ms
Input iTHD	5% to 10% load 10% to 30% load 30% to 100% load	iTHD	- - -	- - -	15 10 5	% % %
Power Factor	10% to 30% load Vin<250V 10% to 30% load Vin>250V 30% to 100% load	PF	0.95 0.90 0.98	- - -	- - -	- - -
Operating Efficiency @ 25°C	Note 2	η	97.5 96.5 96.5 95.5 94.0	- - - - -	- - - - -	% % % % %

Table 3. Input Specifications – Shelf						
Parameter	**Condition**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Input Voltage (3 phase Delta 4 wire)	All	$V_{IN,AC}$	180	200/277	305	Vac
Input Voltage (3 phase Wye 5 wire)	All	$V_{IN,AC}$	360	380/480	528	Vac
Input Voltage (3 x of 1 phase)	All	$V_{IN,AC}$	180	200/277	305	Vac

Note 1 - Refer to PSU-BBU Transition.
Note 2 - At 30% to 100% load, peak 230, 240, 277 Vac input, the minimum efficiency is 97.5%.
At 30% to 100% load, 230, 240, 277 Vac input, the minimum efficiency is 96.5%.
At 30% to 100% load, peak 208Vac input, the minimum efficiency is 96.5%.
At 30% to 100% load, 208Vac input, the minimum efficiency is 95.5%.
At 10% to 30% load, 208 to 277 Vac input, the minimum efficiency is 94%.

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 4. Output Specifications – PSU

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Factory Set Voltage	Half load	V_O	50.625	50.750	50.875	Vdc
Output Current[1]	PSU Shelf	I_O	0 0	- -	60 300	A A
Output Ripple, pk-pk	Compliance will be verified using a 0.1uF capacitor connected locally to the oscilloscope probe tips during this measurement	V_O	-	-	500	mV_{PK-PK}
V_O Dynamic Response Peak Deviation	10% min load 0 to 10 mF output cap. Dynamic load @ 20Hz Slew rate 1A/usec 50% step load 90% step load 140% step load[2]	V_O	 - - -	 - - -	 0.5 1.0 1.5	 V V V
V_O Dynamic Response Settling Time	All	t_s	-	3	-	ms
Regulation and Droop Characteristics	All	V_O	0.375	0.500	0.625	Vdc
Output Rise Time	All		-	60	-	ms
Current Sharing Accuracy	20 to 50% load 50 to 100% load		-5 -2	- -	+5 +2	% %

Note 1 – For surge current capabilities, see Pulse Load Operation on page 17.
Note 2 – Refer to “Allowable peak power step” curve on page 17 for the duration of pulse load.

ELECTRICAL SPECIFICATIONS

System Timing Specifications

Table 5. System Timing Specifications					
Legend	Item	Parameter	Min	Max	Unit
T1	T_power-up_ready	Time for PSU to be power-up ready	1.0	2.5	s
T2	T_random_noBBU	0-2 second initial turn on random delay without BBU discharging	0	2.0	s
T3	TON_noBBU	Time 51Vdc turns on after shelf receives AC input without BBU discharging.	1.0	4.5	s
T4	T_random_BBU	0-5.5 second turn on random delay after BBU discharging	0	5.5	s
T5	TON_BBU	Time 51Vdc turns on after shelf receives AC input with BBU discharging.	1.0	8.0	s
T6	TSYNC	After all PSUs in the shelf are ready to start till when 51Vdc will start	2.0	5.0	ms
T7	T-Max_ON_noBBU	Max PSU turn-on time without BBU in case of sync failure	6.0	7.5	s
T8	T-Max_ON_BBU	Max PSU turn-on time with BBU in case of sync failure	9.5	11.0	s

Random Timer and Synchronization Requirements

Under any conditions of dissipative load, capacitive load, temperature, with or without backup voltage connected to the PSU, max time for PSU to be “power-up ready” after AC voltage starts is 2.5 s.

After “power-up ready”:

- When there is no DC voltage on the bus (first AC turn on) the power shelf will be randomized with 0 to 2 s window to give each power shelf a random turn-on time (six PSU turn-on is synchronized).
- When there is DC voltage on the bus higher than 44 V for 0.1 s (BBU is discharging), the power shelf will be randomized with 0 to 5.5 s window to give each power shelf a random turn-on time (six PSU turn-on is synchronized).

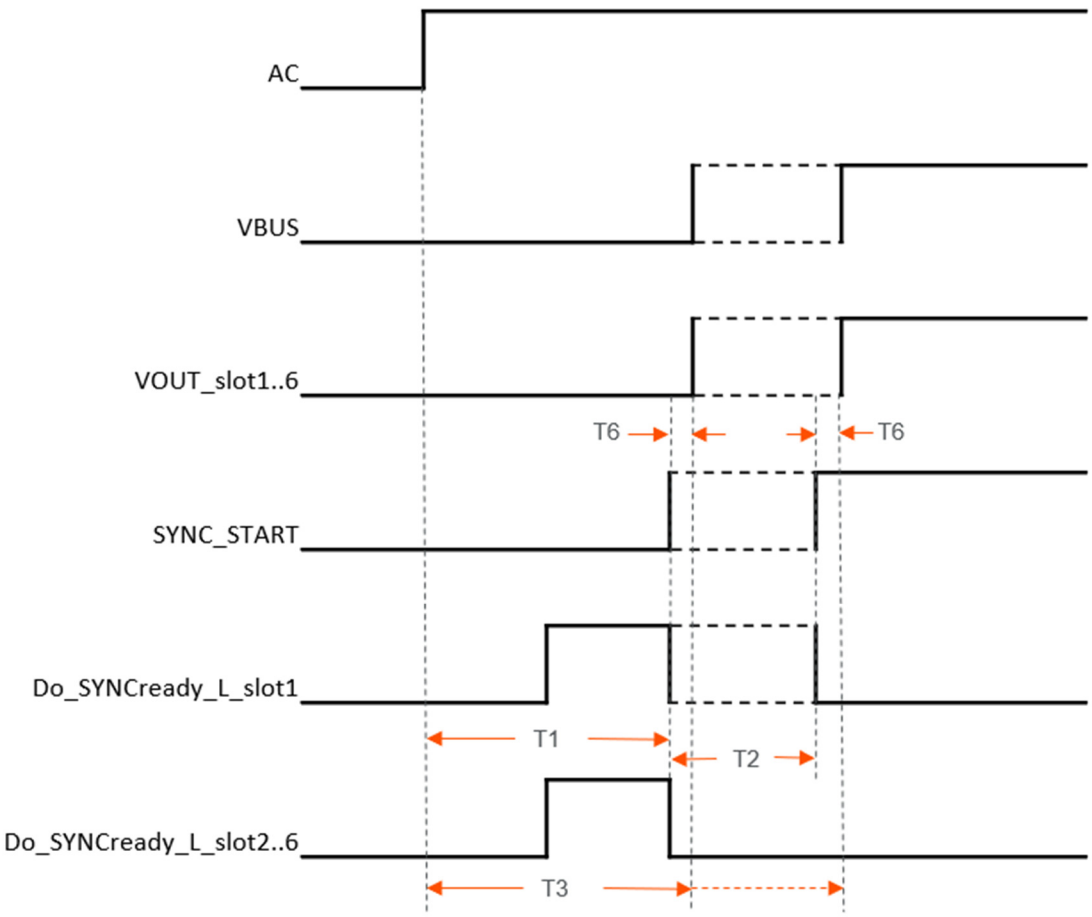
The power shelf will turn on with only 1 PSU inserted into any slot.

Note: The random numbers above will be dynamically generated immediately after each AC recycle, and not generated one time and then stored in the EEPROM for future usages.

ELECTRICAL SPECIFICATIONS

System Timing Diagram

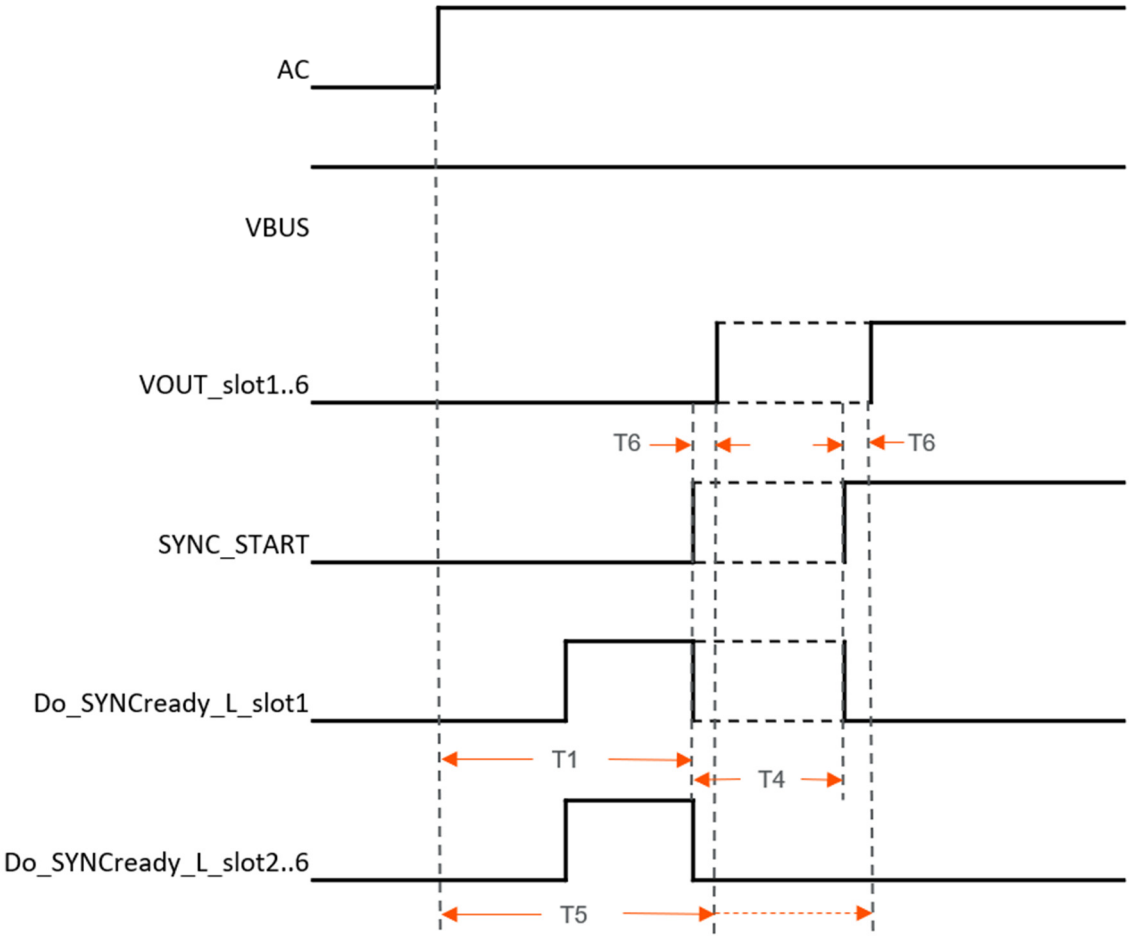
Normal Turn On (no bus)



ELECTRICAL SPECIFICATIONS

System Timing Diagram

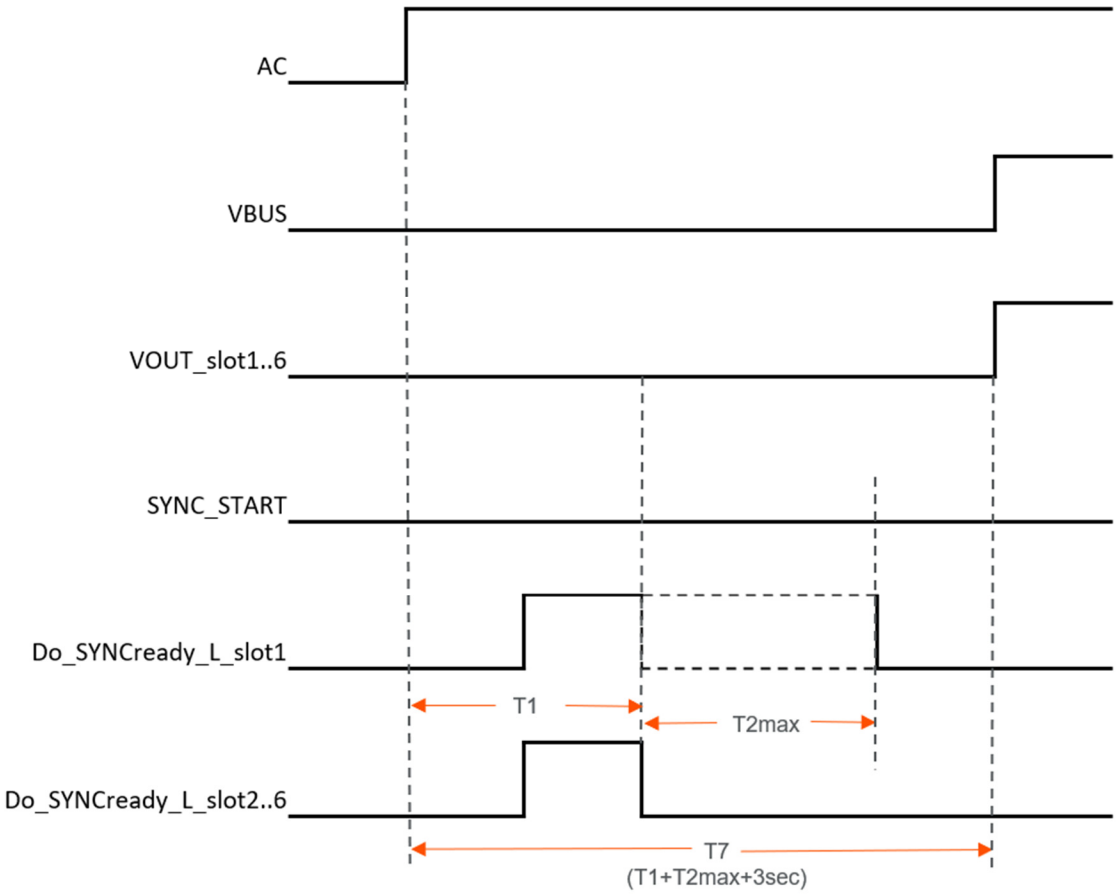
Normal Turn On (with bus)



ELECTRICAL SPECIFICATIONS

System Timing Diagram

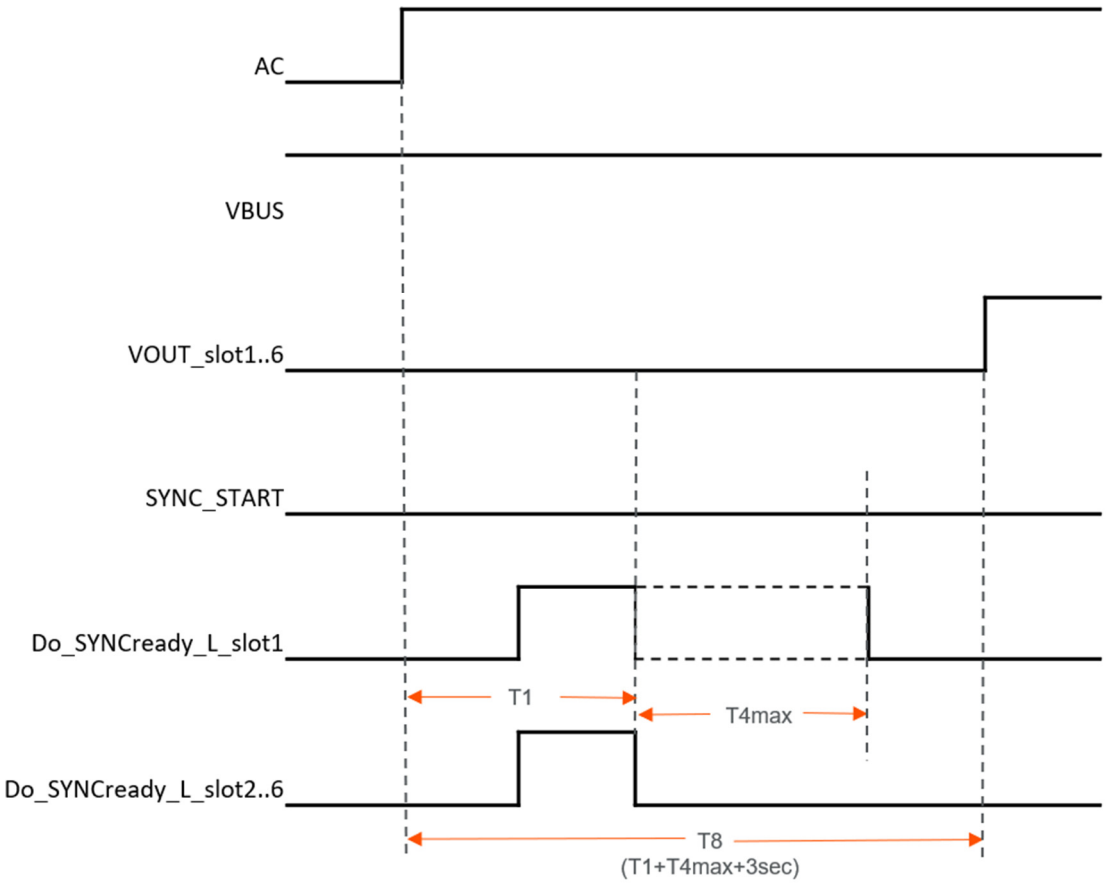
Normal Turn On (no bus, single fault SYNC_START pulled low)



ELECTRICAL SPECIFICATIONS

System Timing Diagram

Normal Turn On (with bus, single fault SYNC_START pulled low)



ELECTRICAL SPECIFICATIONS

Transition And Synchronization Requirements

Start-up (0 V to 51 V) Transition Procedure

Each PSU has a small circuit as shown below and the circuit output (called SYNC_START) of all PSUs are connected together on the power shelf backplane.

1) Each PSU sets its uC Digital output signal (Do_SyncReady_L) to low when the PSU is ready to turn on the output.

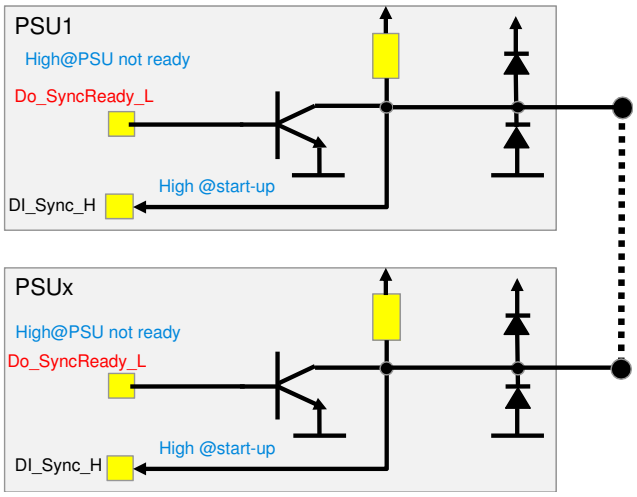
2) Only PSU in SLOT #1 generates random timer and set Do_SyncReady_L to low when ready and random timer is finished.

3) The PSUs will turn on the output when the uC Digital input sync signal (DI_Sync_H) is high.

4) If DI_Sync_H kept stuck low for 3 s more than the max random timer limit (which is 2 s without BBU and 5.5 s with BBU), the PSU will turn on immediately.

5) If PSU1 is not installed or its Do_SyncReady_L stuck low, the other PSUs shall turn on when the DI_Sync_H is high. In this case random timer doesn't exist.

Please refer to section "Pulse Load Operation" on page 17 for the timing and constant current value requirements during the cold startup.



48 V to 51 V Transition Procedure

The same SYNC_START circuit as shown above is used here.

1) When PSU enters 48V output mode, it sets “Do_SyncReady_L” signal to HIGH.

2) If there is no over power or over current condition for 5 s, each PSU sets “Do_SyncReady_L” signal to LOW.

3) If signal “DI_Sync_H” is HIGH (HIGH when all PSUs in parallel ready to adjust), then change constant current level to 120% and adjust output from 48 V to 51 V.

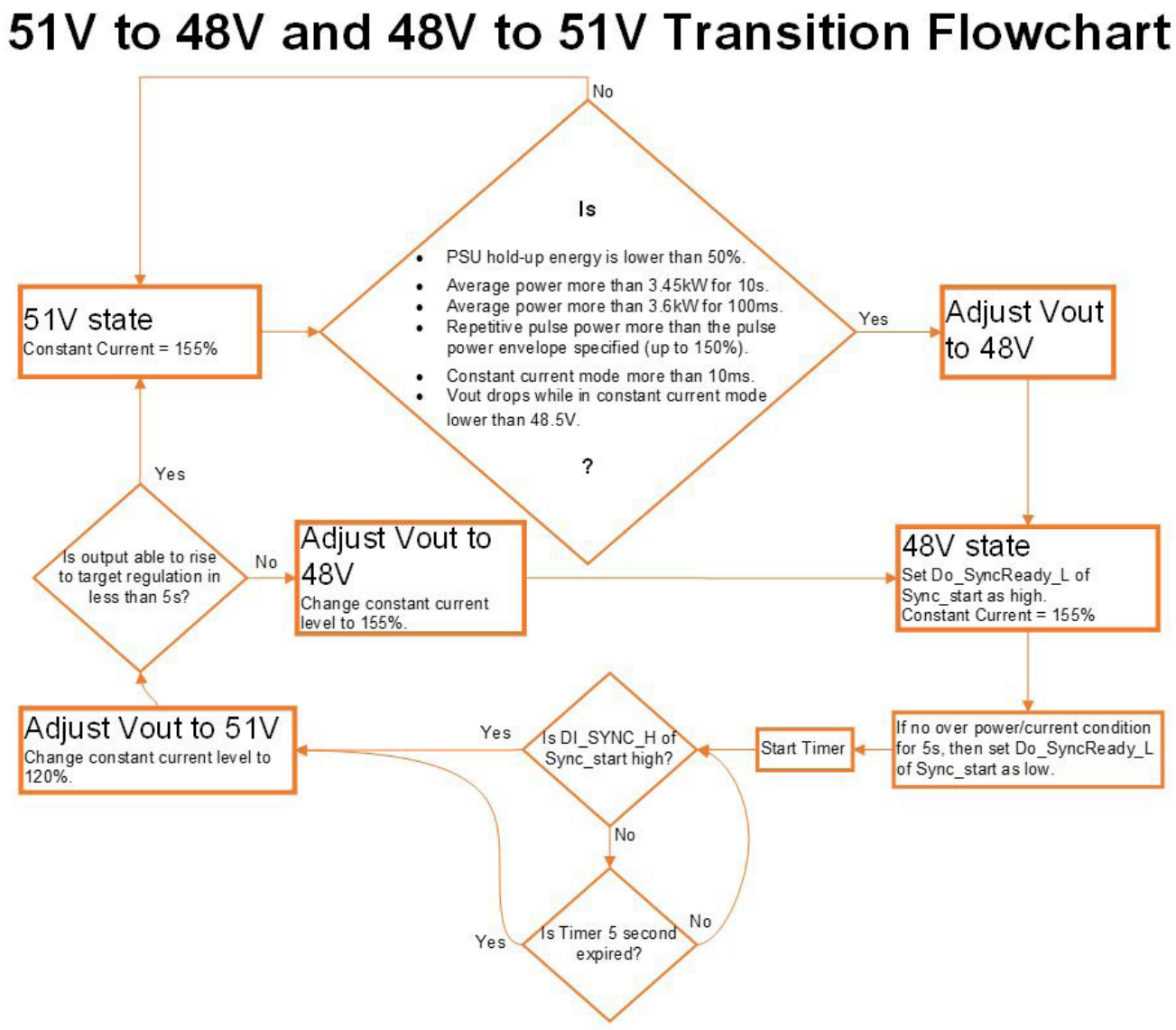
4) If the signal “DI_Sync_H” is stuck LOW for 5 s, the PSU shall adjust its output from 48 V to 51 V.

5) If the PSU output did not reach 51 V in 5 s, then it return to 48 V mode, set constant current level to 155%, and go to step 1.

Refer to diagram below that covers both 48 V to 51 V and 51 V to 48 V transitions.

ELECTRICAL SPECIFICATIONS

Transition And Synchronization Requirements



51 V to 48 V Transition Procedure

This transition and conditions associated with it was explained in section "over power/current protection" on page 20 and section "PSU-BBU transition“ on page 18. No synchronization is needed in this case. Refer to diagram above that covers both 48 V to 51 V and 51 V to 48 V transitions.

ELECTRICAL SPECIFICATIONS

Performance Curves (Single PSU)

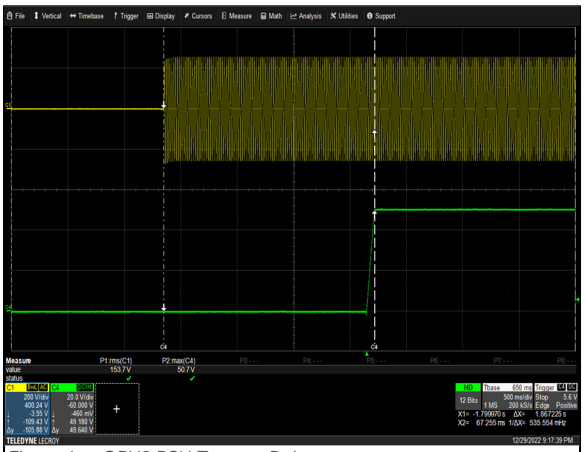


Figure 1: ORV3 PSU Turn-on Delay
Vin = 180Vac (L-N) Io = 60A
Ch 1: V_{IN} Ch 4: Vo

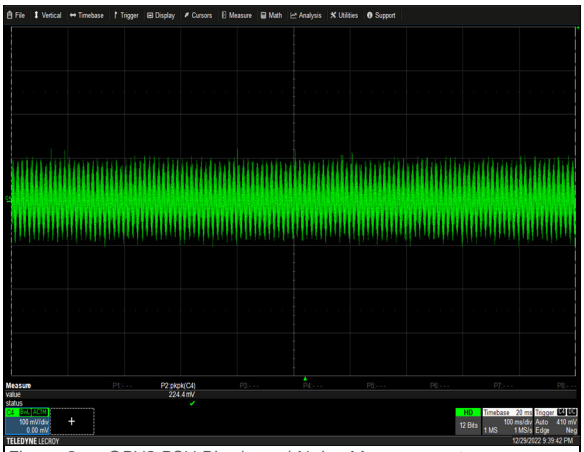


Figure 2: ORV3 PSU Ripple and Noise Measurement
Vin = 180Vac (L-N) Io = 60A
Ch 4: Vo

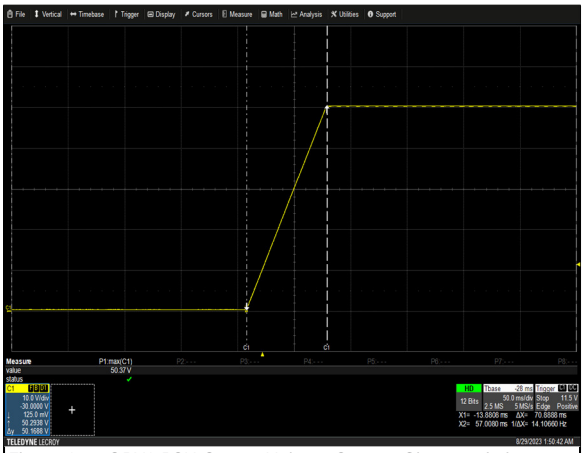


Figure 3: ORV3 PSU Output Voltage Startup Characteristic
Vin = 180Vac (L-N) Io = 60A
Ch 1: Vo

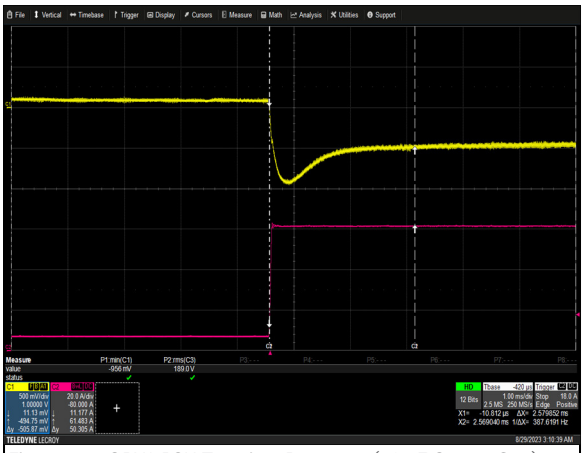


Figure 4: ORV3 PSU Transient Response (10mF Output Cap)
Vin = 200Vac(L-L) Io = 6A to 60A (10% to 100%), 1A/µs
Ch 1: Vo Ch 2: Io

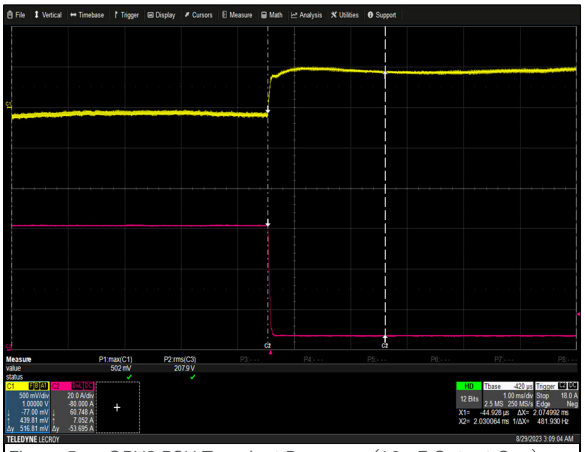


Figure 5: ORV3 PSU Transient Response (10mF Output Cap)
Vin = 200Vac(L-L) Io = 60A to 6A (10% to 100%), 1A/µs
Ch 1: Vo Ch 2: Io

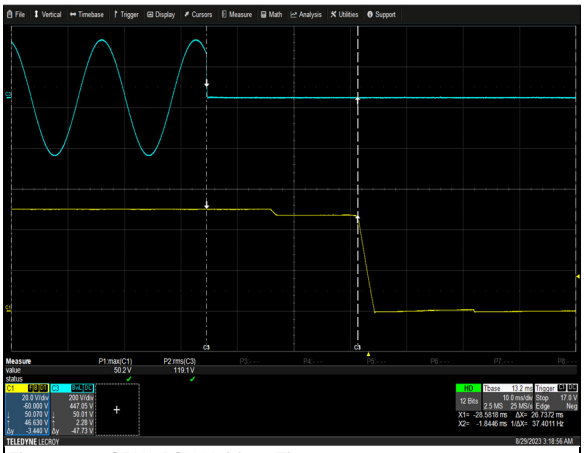


Figure 6: ORV3 PSU Hold-up Time
Vin = 200Vac (L-N) Io = 60A
Ch 1: Vo Ch 3: V_{IN}

ELECTRICAL SPECIFICATIONS

Performance Curves (Shelf)

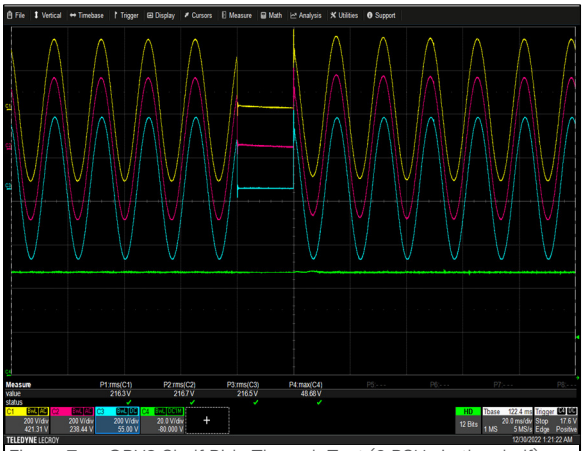


Figure 7: ORV3 Shelf Ride Through Test (6 PSUs in the shelf)
Vin = 230Vac to 0V (20ms) to 230Vac (L-N) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Vo

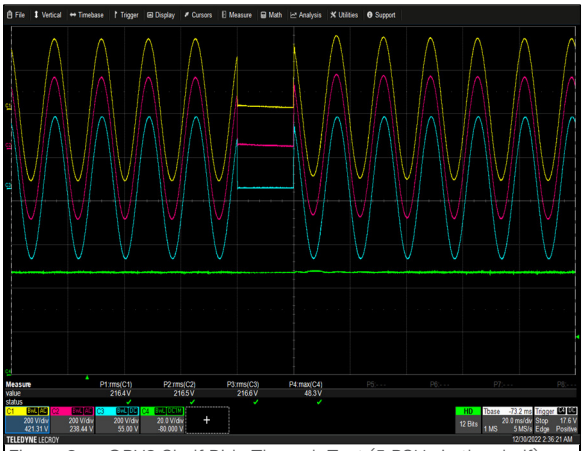


Figure 8: ORV3 Shelf Ride Through Test (5 PSUs in the shelf)
Vin = 230Vac to 0V (20ms) to 230Vac (L-N) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Vo

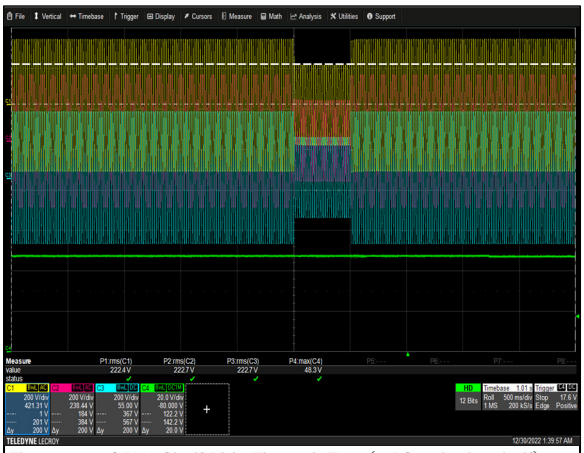


Figure 9: ORV3 Shelf Ride Through Test (6 PSUs in the shelf)
Vin = 230Vac to 140V (500ms) to 230Vac (L-N) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Vo

Figure 10: ORV3 Shelf Ride Through Test (5 PSUs in the shelf)
Vin = 230Vac to 140V (500ms) to 230Vac (L-N) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Vo

Figure 11: ORV3 Shelf Ride Through Test (6 PSUs in the shelf)
Vin = 230Vac to 160V (1s) to 230Vac (L-N) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Vo

Figure 12: ORV3 Shelf Ride Through Test (5 PSUs in the shelf)
Vin = 230Vac to 160V (1s) to 230Vac (L-N) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Vo

ELECTRICAL SPECIFICATIONS

Performance Curves (Shelf)

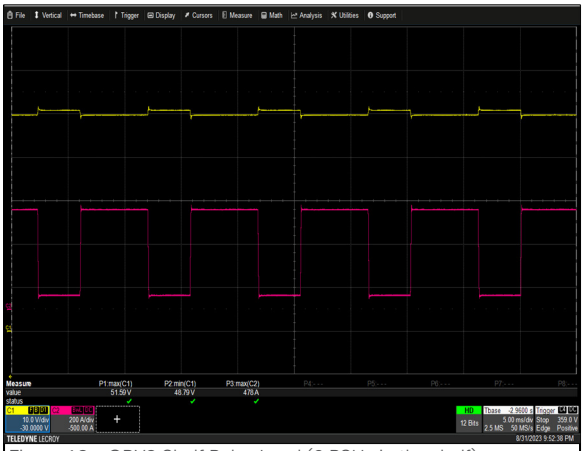


Figure 13: ORV3 Shelf Pulse Load (6 PSUs in the shelf)
Vin = 400Vac(L-L) Io = 60A(3.75ms) to 450A (6ms) repetitive
Ch 1:Vo Ch 2: Io (slew rate: 5A/us)

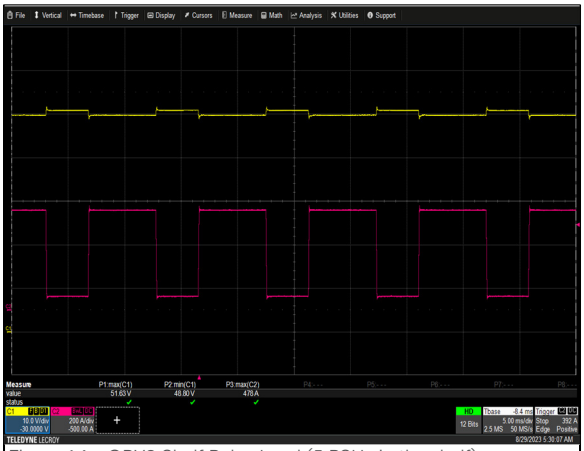


Figure 14: ORV3 Shelf Pulse Load (5 PSUs in the shelf)
Vin = 400Vac(L-L) Io = 60A(3.75ms) to 450A (6ms) repetitive
Ch 1:Vo Ch 2: Io (slew rate: 5A/us)

Figure 15: ORV3 Shelf Pulse Load (6 PSUs in the shelf)
Vin = 400Vac(L-L) Io = 300A to 450A (16ms) single pulse
Ch 1:Vo Ch 2: Io (slew rate: 5A/us)

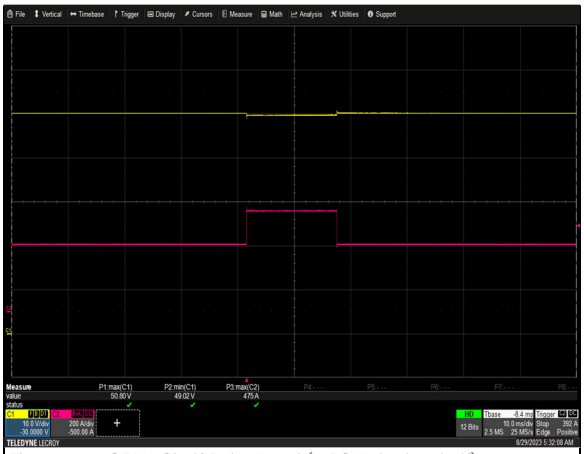


Figure 16: ORV3 Shelf Pulse Load (5 PSUs in the shelf)
Vin = 400Vac(L-L) Io = 300A to 450A (16ms) single pulse
Ch 1:Vo Ch 2: Io (slew rate: 5A/us)

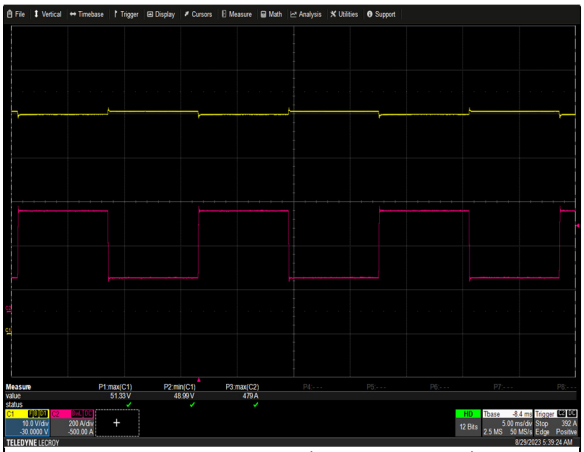


Figure 17: ORV3 Shelf Pulse Load (6 PSUs in the shelf)
Vin = 400Vac(L-L) Io = 150A(8ms) to 450A (8ms) repetitive
Ch 1:Vo Ch 2: Io (slew rate: 5A/us)

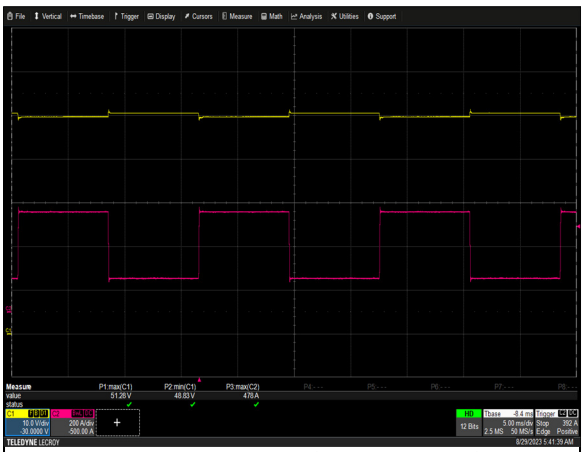


Figure 18: ORV3 Shelf Pulse Load (5 PSUs in the shelf)
Vin = 400Vac(L-L) Io = 150A(8ms) to 450A (8ms) repetitive
Ch 1:Vo Ch 2: Io (slew rate: 5A/us)

ELECTRICAL SPECIFICATIONS

Performance Curves (Shelf)

Figure 19: ORV3 Shelf Inrush Current
Vin = 230Vac(L-N) (3 phases drop for 20ms) Io = 150A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Iin

Figure 20: ORV3 Shelf Inrush Current
Vin = 230Vac(L-N) (3 phases drop for 20ms) Io = 300A
Ch 1: Vin (L1-N) Ch 2: Vin (L2-N) Ch3: Vin (L3-N) Ch4:Iin

Figure 21: ORV3 Shelf Over Power/Current Protection
Vin = 400Vac(L-L) Io = 432A(100ms) to 396A(9.9s) to 40A(1.14s)
Ch 1:Vin Ch 2: Iin Ch3:Vo Ch4:Io

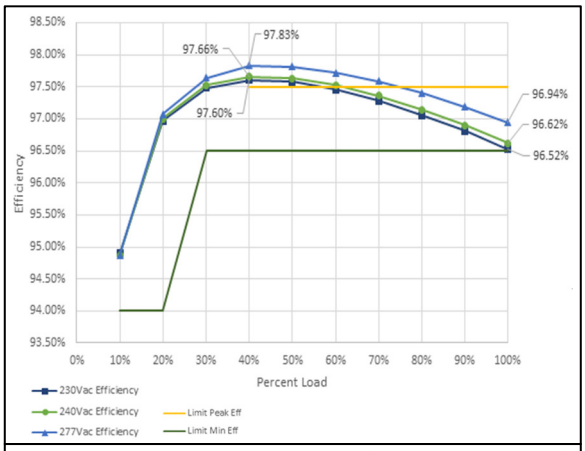


Figure 22: ORV3 PSU Efficiency Curves (with Fan Loss Included)
Vin = 230/240/277Vac
Load: Io = 0% to 100% (% load based on 3000W full load)

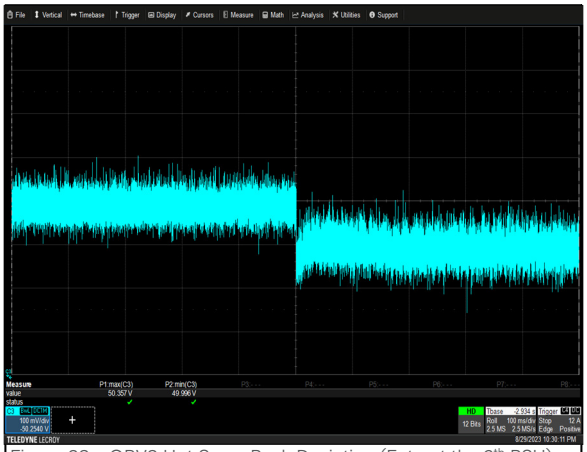


Figure 23: ORV3 Hot Swap Peak Deviation (Extract the 6th PSU)
Vin = 400Vac (L-L) Io = 300A
Ch 3: V_O (100mV/div, 100ms/div)

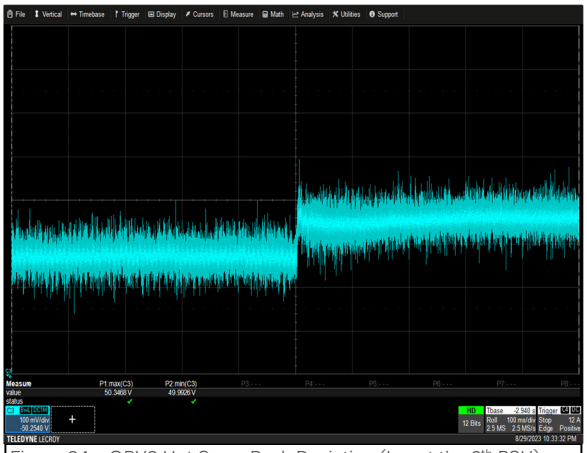
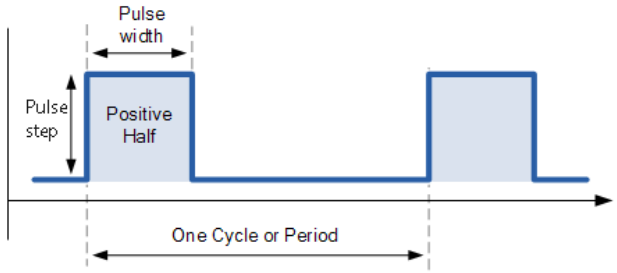


Figure 24: ORV3 Hot Swap Peak Deviation (Insert the 6th PSU)
Vin = 400Vac (L-L) Io = 300A
Ch 4: V_O (100mV/div, 100ms/div)

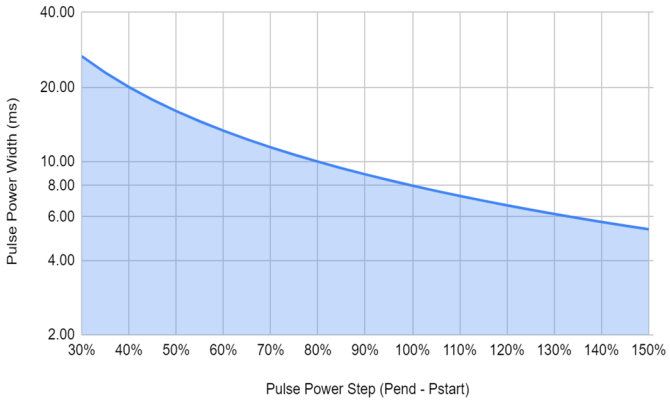
ELECTRICAL SPECIFICATIONS

Pulse Load Operation

PSU voltage will drop by 3 V after its holdup energy is lost by 50% or 30J. Here, 24J or 40% of holdup energy is allocated for pulse power. As the result, PSU will meet the following pulse power envelope shown below without triggering BBU (reducing voltage by 3 V, which happens when holdup energy is reduced by 50%).

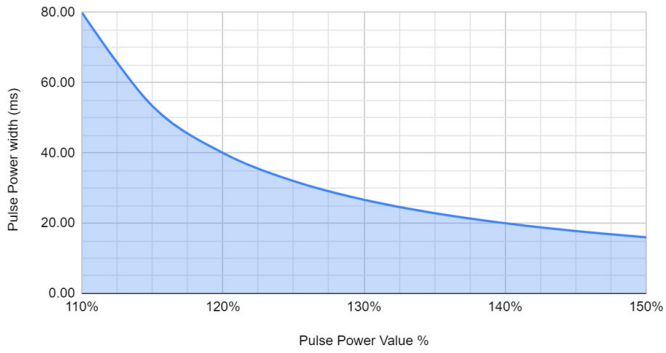


Allowable peak power step



In order to meet the pulse power requirements as the graph above, the DC to DC converter will meet the following absolute pulse power requirement as shown below. This graph comes from the worst case of Pstart as 100%.

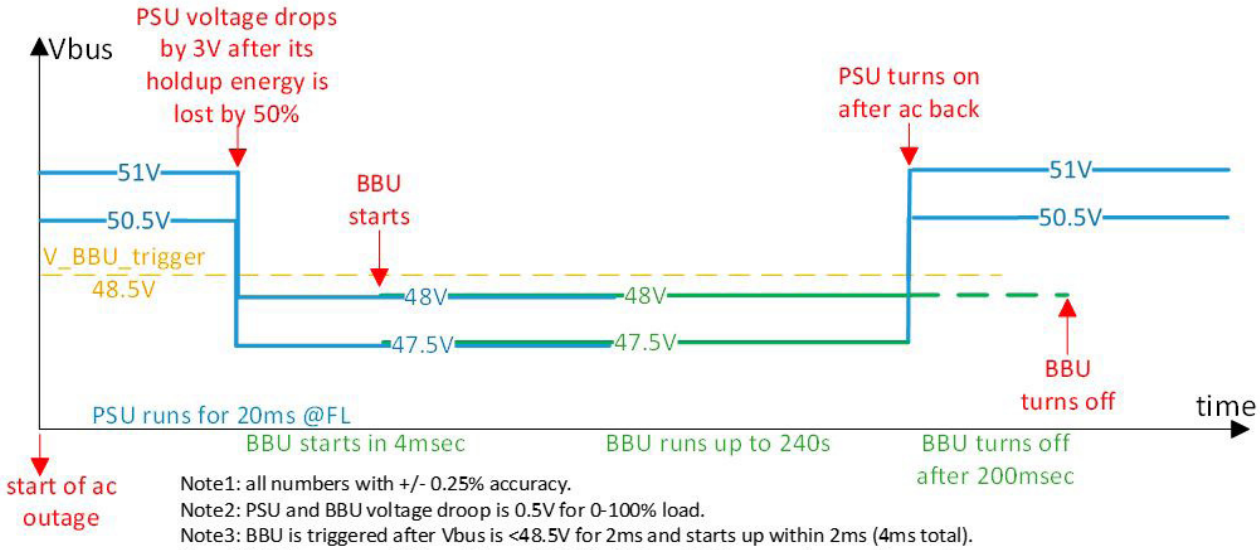
DC-DC converter pulse power requirement



ELECTRICAL SPECIFICATIONS

PSU-BBU Transition

Graph below shows the PSU requirement to transition to BBU in case of AC outage. PSU voltage will drop by 3 V after its holdup energy is lost by 50% or 30 J.



Note1: all numbers with +/- 0.25% accuracy.
Note2: PSU and BBU voltage droop is 0.5V for 0-100% load.
Note3: BBU is triggered after Vbus is <48.5V for 2ms and starts up within 2ms (4ms total).
Note4: if BBU current <0.1A and Vbus >48.5V for 200ms, BBU goes to the stand by mode.
Note5: PSU hold-up energy is 60J for loads up to 150%.
Note6: PSU 3V drop should occur after its hold-up energy is lost by 50%. This can be done by setting a proper trigger value on the PSU PFC bulk voltage.
Note7: PSU 3V drop fall time is 1ms (3V/ms.)

Per the scheme above, for the worst case that AC outage and pulse power happens at the same time (and pulse power remains constantly), PSU will transition to BBU seamlessly as calculated in the table below.

Load Power	Holdup Time (ms)	Time Before 3 V Drop (ms)	Remaining Time After 3 V Drop (ms)
100%	20.00	10.0	9.0
110%	18.18	9.1	8.1
120%	16.67	8.3	7.3
130%	15.38	7.7	6.7
140%	14.29	7.1	6.1
150%	13.33	6.7	5.7

In case that AC voltage is available, but constant overload of up to 150% happens, PSUs will drop voltage by 3 V per the scheme above and share power with BBUs. PSUs will retry to sync together and increase the voltage once every 5 s.

ELECTRICAL SPECIFICATIONS

Protection Function Specifications

Input Over-Current Protection

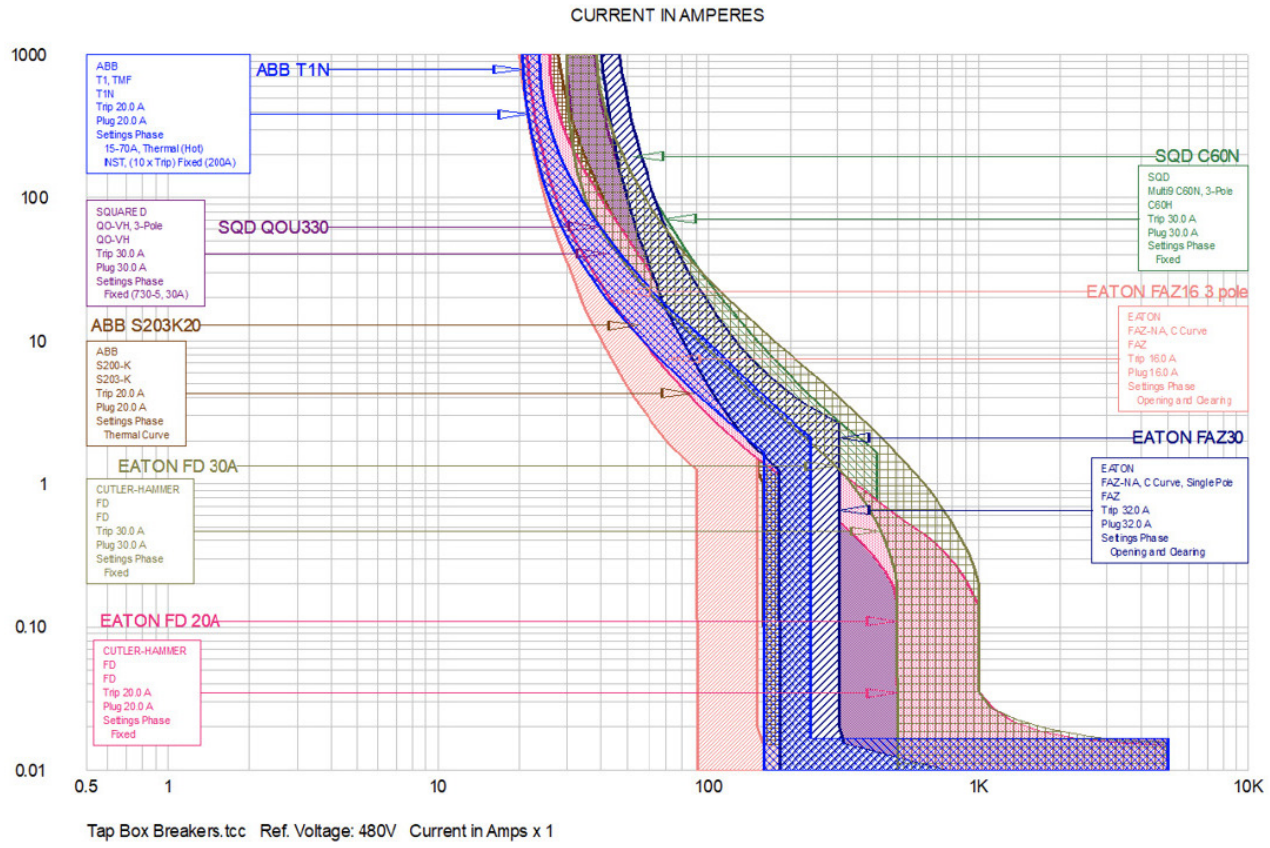
The PSU incorporate primary fusing on both phase and return lines for input over-current protection to meet product safety requirements. Fuses are selected to prevent nuisance trips. AC inrush current will not cause the fuse to blow under any conditions. No PSU operating condition will cause the fuse to blow unless a component in the PSU has failed. This includes DC output overload and short-circuit conditions. Fuse is approved by UL for an interrupt rating of at least 25 kA for 10 ms..

PSU fuse is in coordination with Datacenter Tapbox breaker curve as given below.

NEC breakers are 20 A and 30 A (two AC feeds go to the power shelf – one PSU per input AC phase feed).

IEC breaker is normally 32 A (one AC feed goes to the power shelf – two PSUs per input AC phase feed).

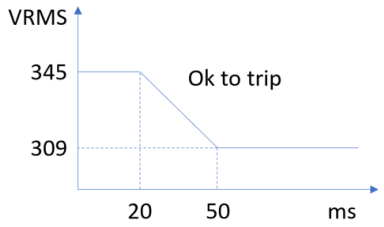
(Ignore 16 A breaker)



ELECTRICAL SPECIFICATIONS

Input Over Voltage and Under Voltage Protection

The rectifier contain protection circuitry such that application of an input voltage below the minimum specified in section "Input Specification" on page 4 will not cause any damage to the rectifier and “softly shuts down” while operating. The rectifier will “softly shut down” if the input voltage is over 345 V for 20 ms or 309 V for 50 ms as shown in the graph below.



Output Over Voltage Protection (OVP)

The PSU will shut down for DC output voltage exceeding 52.5 V and the reacting time will not exceed 200 ms. DC output voltage will never exceed 54 V (fast OVP).

Over Power/Current Protection

If a PSU is overloaded higher than the values listed below, it will “softly shut down”, meaning reduce its voltage by 3 V and wait for 6 ms (to give enough time for BBU to take over and then turn off output.). If overload is still there, PSU will shut down. After an overload fault or in case of 3 V drop if there is no overload, PSUs will retry to sync together and turn on once every 5 s.

- Average power more than 3.45 kW for 10 s.
- Average power more than 3.6 kW for 100 ms.
- Repetitive pulse power more than the pulse power envelope specified (up to 150% load).

Constant Current mode will be triggered at 155% load. Output reduce voltage by 3 V if any of the conditions below are met:

- Constant current mode dwell for 10 ms.
- Output droops < 48.5 V due to constant current mode.

Output Short-circuit Protection

The PSU includes short-circuit protection to protect the rectifier and attached load in the case of an output short-circuit or other output overload condition.

If the PSU voltage is lower than 10 V (short circuit condition), the rectifier shuts off immediately. No component damage. The protection will be implemented with a hiccup mode. it tries to restart 5 times every 5 s and then locks out. PSUs will sync using sync_start after shut down to power up together.

Over Temperature Protection (OTP)

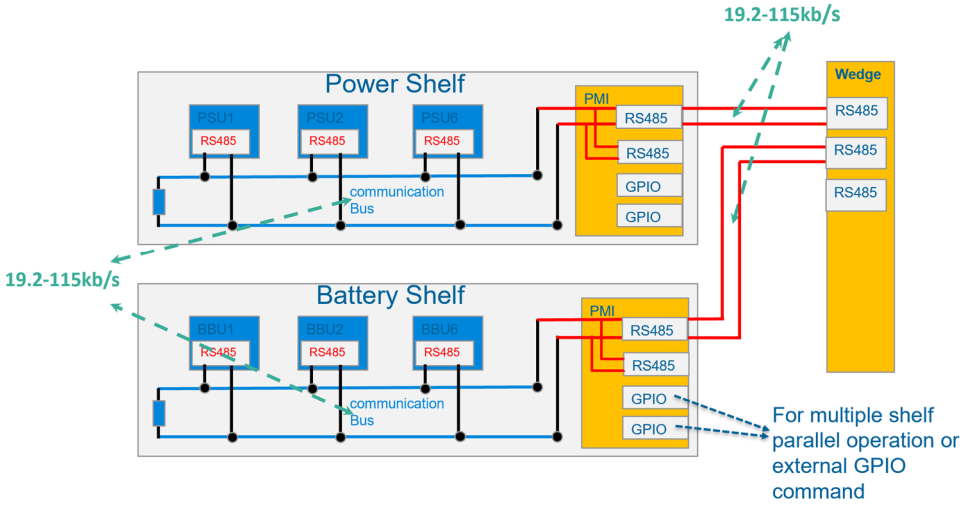
The PSU employ over temperature protection for both ambient over temperature and internal thermal temperature to protect the rectifier. The rectifier will “softly shut down” under over temperature condition and recover after certain period after the over temperature condition is removed.

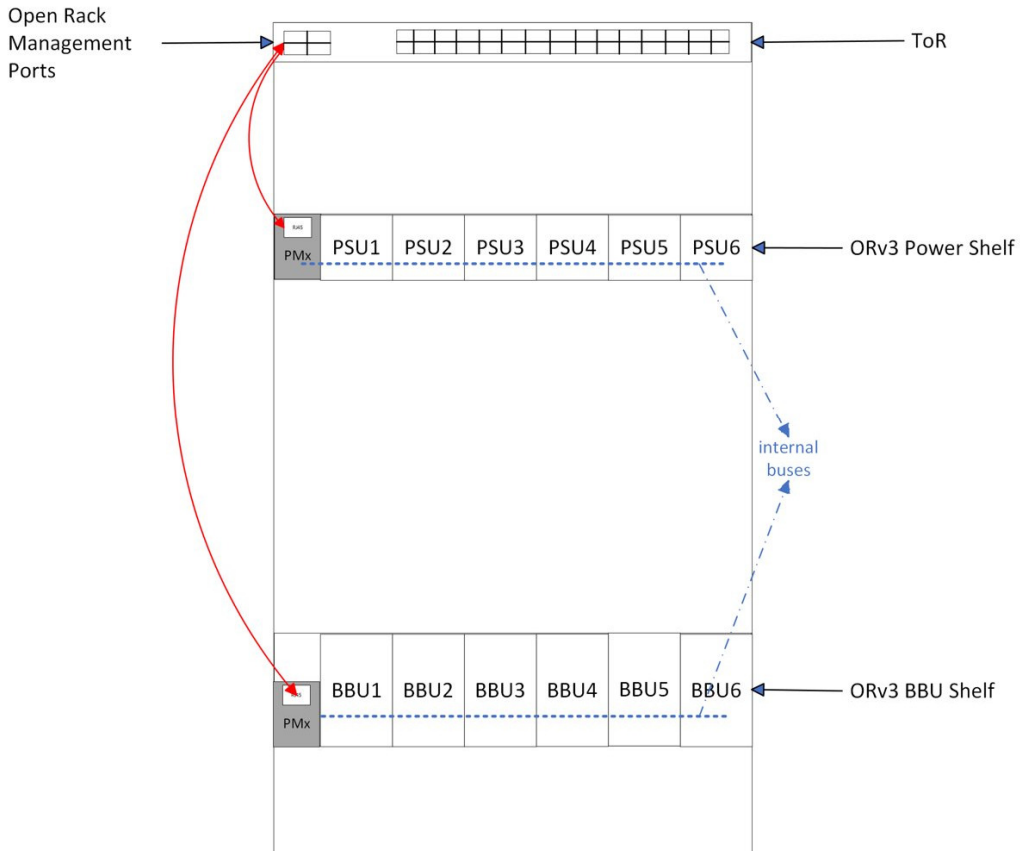
The OTP circuit incorporate built in hysteresis such that the power supply does not oscillate on and off due to temperature recovering condition. The OTP event will be reported as a fault condition.

MONITORING & CONTROL INTERFACE

PMI Overview

PMI is an extension module, which brings Modbus of the PSUs/BBUs directly out for upstream communication. PMI sits on ORV3 Power and Battery Shelves. On one end, it has communication with the PSUs or BBUs – through sliver straddle connector. On the other end, it interacts with centralized system through the use of RJ45 connectors. Please refer to page 32 for RJ45 connectors location and pinout definitions. Please refer to "ARTESYN ORV3 PMI" datasheet for more details of PMI module.





MONITORING & CONTROL INTERFACE

PMC Overview

The Power shelf includes a slot for a shelf management controller (PMC) to monitor and control various power supply parameters (The slot is the same one for PMI module). The PMC is connected to rack management controller or facility level monitoring through a monitoring & control interface.

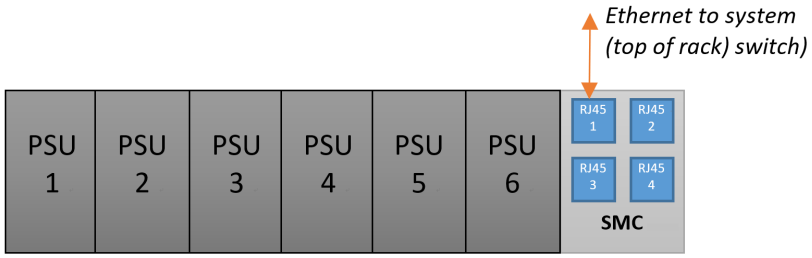
The PMC is a hot-pluggable controller that monitors and facilitates the power supply units through a 10/100/1000 MB base Ethernet port and can be connected directly to the rack switch.

The PMC communicates with PSUs in the shelf through the backplane connector. The front connector provides one Ethernet port and one RS232 port for debugging.

If the PMC fails or is not provided, the power system is able to operate normally. The PMC is powered from the 48 V bus directly.

Power Shelf Deployment

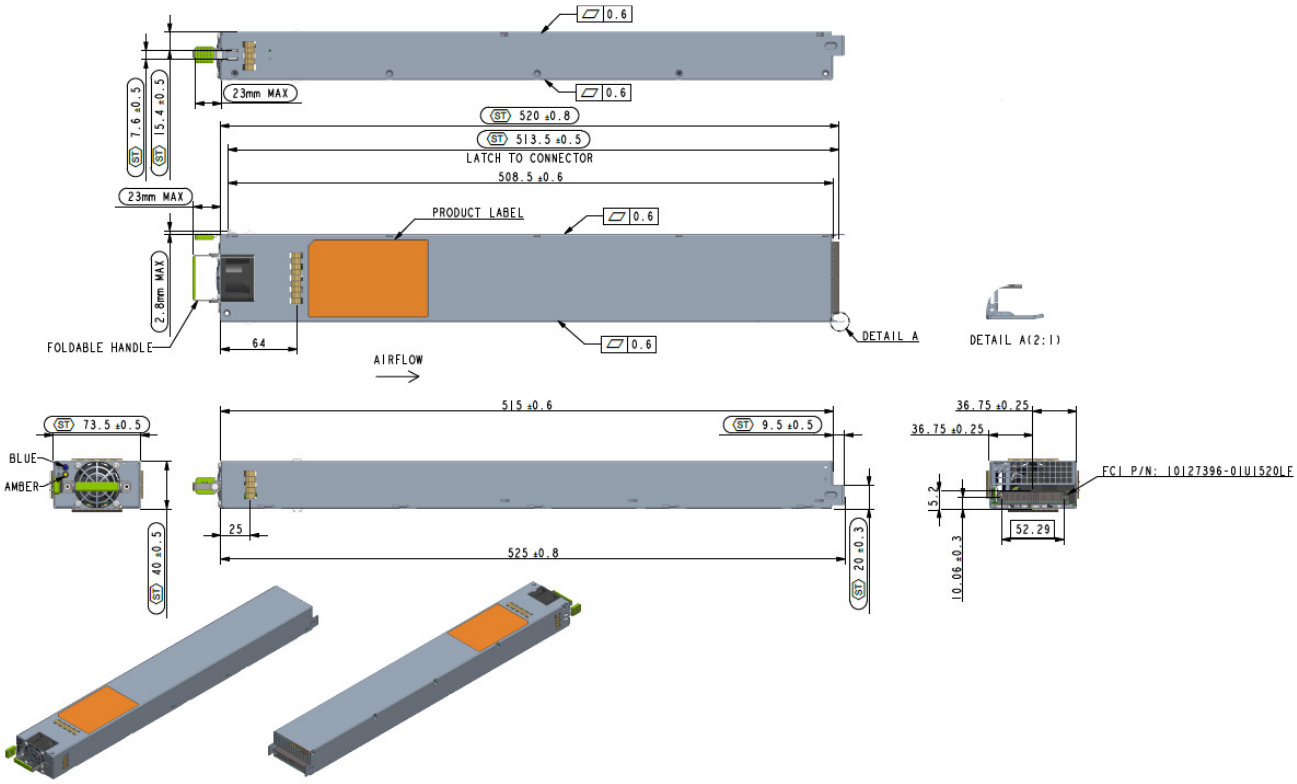
The PMC is connected via Ethernet to a switch (normally the top of rack controller/switch) and up to 6 PSUs are monitored. See page 34 for PMC connectors.



MECHANICAL SPECIFICATIONS – PSU

Mechanical Drawing (unit: mm)

ORV3 PSU (PN: 700-015234-0100)



MECHANICAL SPECIFICATIONS – PSU

Connector Definitions

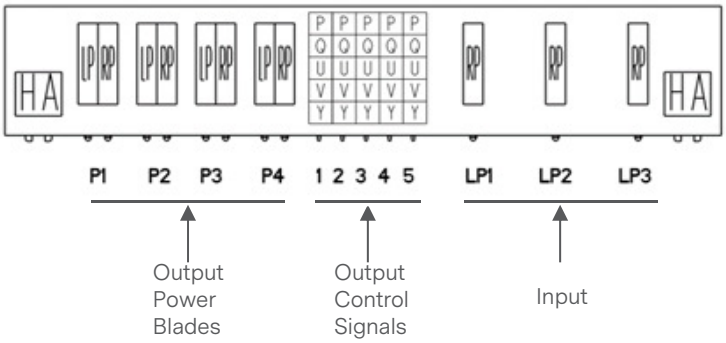
Input Connector

LP1	–	Earth
LP2	–	AC phase
LP3	–	AC phase

Output Connector – Power Blades

P1 & P2	–	48 V output positive
P3 & P4	–	48 V output return

PSU Connector Pinout



Output Connector – Control Signals

Pin	Name	Type	Bus	Description
P1	PSU_A0	Input		Address 0 – PSU ID A0, Internal pull up 10 k to 3.3 V.
P2	PSU_A1	Input		Address 1 – PSU ID A1, Internal pull up 10 k to 3.3 V.
P3	PSU_A2	Input		Address 2 – PSU ID A2, Internal pull up 10 k to 3.3 V.
P4	PSU_A3	Input		Address 3 – PSU ID A3, Internal pull up 10 k to 3.3 V.
P5	Spare			
Q1	Ground	Ground		
Q2	Alert	Output/ Active Low	Individual	Logic "Low“ = Fault or Warning, Logic "High“ = OK. Internal pull up 10 k to 3.3 V PSU Alert.
Q3	Reset_Latch_ Fault	Input/ Active high	Individual	Logic "high" for 1 to 2 s = clear faults and start PSU to operate if not working due to a fault. Internal pull down 10k resistor. Will be enabled by SW.
Q4	RS485_addr0	Input	Share bus	Rack address pin. Internal pull up 100 k to 3.3 V.
Q5	RS485_addr1	Input	Share bus	Rack address pin. Internal pull up 100 k to 3.3 V.
U1	RS485_addr2	Input	Share bus	Rack address pin. Internal pull up 100 k to 3.3 V.
U2	BKP	Output/ Active Low	Share bus	No pull up or pull down, Open collector output. All PSUs Ored together.
U3	PSKILL (Short Pin)	Input/ Active High		Logic "Low“ = Output Turn on, Logic "High“ = Output Turn off. Quick shut down Output, mitigate hot unplug arcing. Internal pull up 10 k to 3.3 V.
U4	RS485A	BI	Share bus	
U5	RS485B	BI	Share bus	
V1	Ground	Ground		
V2	I2C_SDA	BI	Share bus	I2C Data
V3	I2C_SCL	BI	Share bus	I2C Clock
V4	Ground	Ground	Share bus	I2C ground
V5	PLS (power loss siren)	Output/ Active low	Share bus	Logic "Low"= Input is not OK for 45Sec, Logic "High"= Input is OK. No pull up or pull down, Open collector output. All PSUs Ored together.
Y1	ISHARE	Analog	Share bus	Main output current share bus.
Y2	SYNC_STOP			Synchronizing turn off main output. Internal pull up 10k to 3.3V
Y3	SYNC_START	BI	Share bus	Synchronizing turn-on main output Internal pull up 10 k to 3.3 V.
Y4	VOUT_SEL	Input	Share bus	Logic "Low“ = Set Output 48 V, Logic "High“ = Set Output 51 V. Internal pull up 10 k to 3.3 V, Default Output is 51 V.
Y5	Ground	Ground		

Note: P3, P4 (48 V return), and LP1 (Earth) connect first. U3 (PSKILL) is short pin.

MECHANICAL SPECIFICATIONS – PSU

Mating Connector – PSU

Table 6. Mating Connector for ORV3 PSU		
Connector	Mating Connector	Description
FCI: 10127396-01U1520LF (PwrBlade ULTRA HD)	FCI: 1027400-01U1520LF (PwrBlade ULTRA HD)	I/O Connector

LED Indicator Definitions – PSU

The PSU has a single blue and single amber LED mounted near the PSU handle for accessibility. Following are power supply LED states:

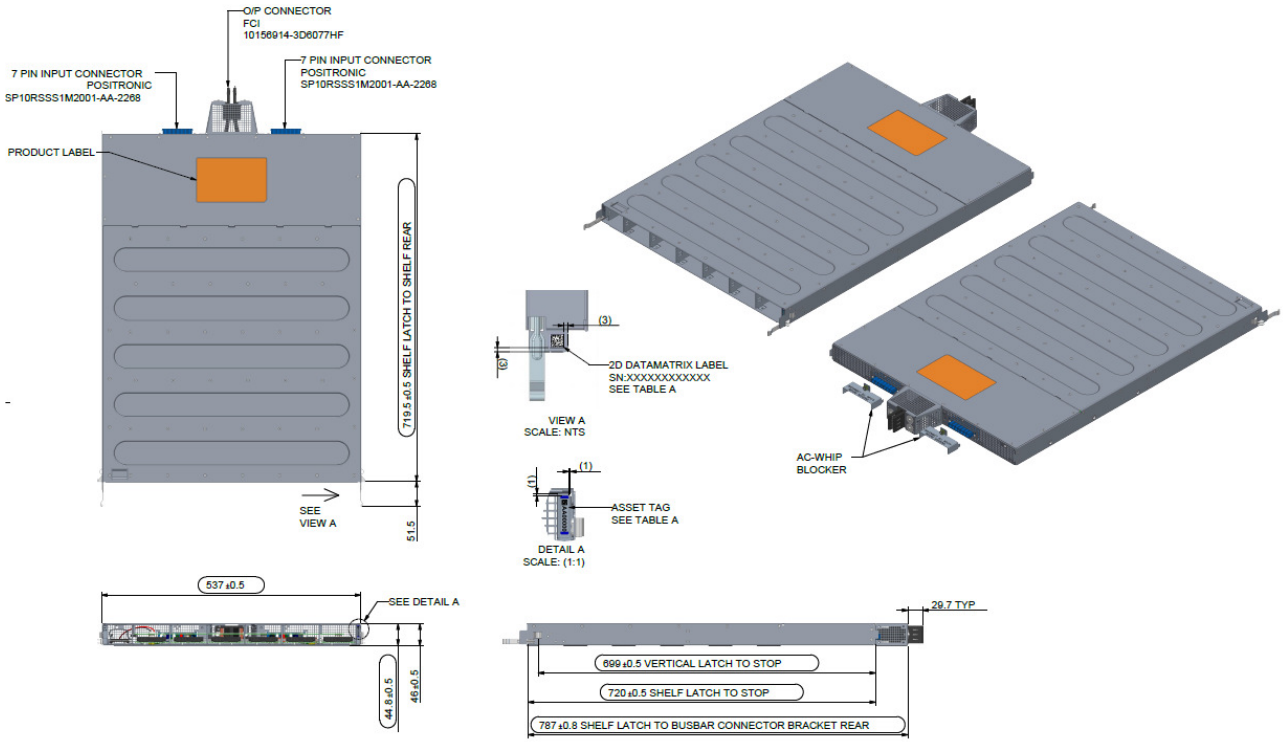
Table 7. LED Indicator Definitions – PSU		
LED	Status	Description
Blue LED	Blinking Blue	Sync Start State, PSU is ready to turn on its output and awaiting the sync start signal
	Solid Blue	DC output is on and available
	Off	DC output is off
Amber LED	Blinking Amber	Bootloading
	Solid Amber	Primary/Secondary/Fan/bootloading failure, and/or loss of DC output (refer to PSU PMBus registers for specific failures)
	Off	fault NOT present/condition 1 and 2 are false

Note 1 – Toggling AC input power will reset the solid/blinking amber fault light but will come up again if faults re-occur.
Note 2 – Only one of the 3 conditions per LED will be applied at all time.

MECHANICAL SPECIFICATIONS – SHELF

Mechanical Drawing (unit: mm)

ORV3 Power Shelf Dual Whip (PN: 700-015235-0100)

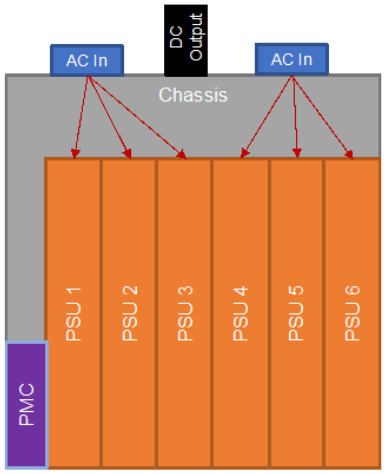


MECHANICAL SPECIFICATIONS – SHELF

Power Shelf Option

Power Shelf Option 1 – 6 x 3 kW PSU with dual cord (2 x 20 A NEC breaker upstream) – 700-015235-0100

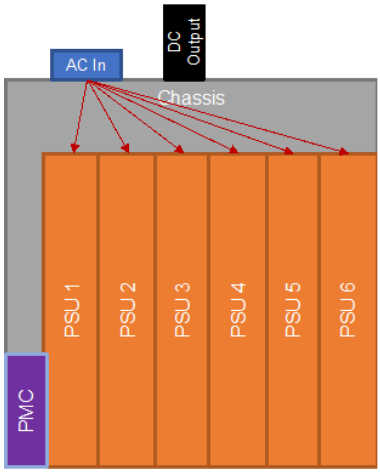
1OU shelf with two AC power input
6 x 3 kW PSU slots
Output power: 15 kW with N + 1 and dual cords or 9 kW N + N
Direct connect to tap-boxes/facility – no intermediate PDU



TOP VIEW

Power Shelf Option 2 – 6 x 3 kW PSU with single cord (32 A IEC breaker upstream) – 700-015746-0100

1OU shelf with one AC power input
6 x 3 kW PSU slots
Output power: 15 kW with N + 1 and single cord
Direct connect to tap-box/facility – no intermediate PDU



TOP VIEW

MECHANICAL SPECIFICATIONS – SHELF

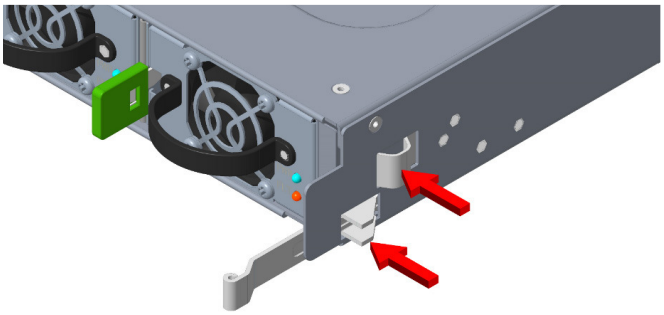
ORV3 Rack Mounting Features

ORV3 power shelves are designed for front mounting into ORV3 racks on OU pitch rails (please refer to the ORV3 specifications on more details for the design of these). The design of the 48 V output connector allows it to be placed in any location in the rack.

Rack mounting features are of particular importance in the power shelf design since they assist in constraining the power shelf in X, Y, and Z directions and promote solid electrical contact with the 48 V busbar.

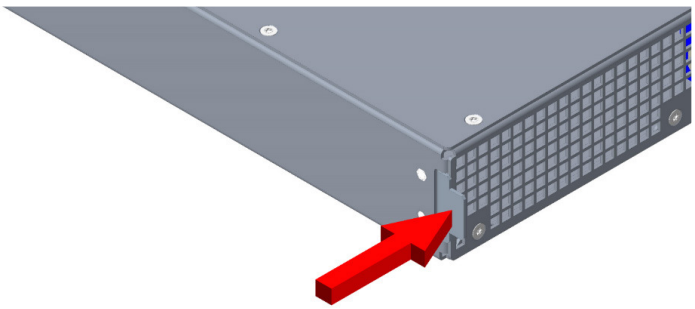
Front Latch & Bumper

Please refer to the mechanical CAD for the locations of the front latch and bumper. Note that these serve separate functions and should not be a single part.



Rear Stop

Please refer to the mechanical CAD for the geometry of the rear stop. This is required to interface properly with the ORV3 rack

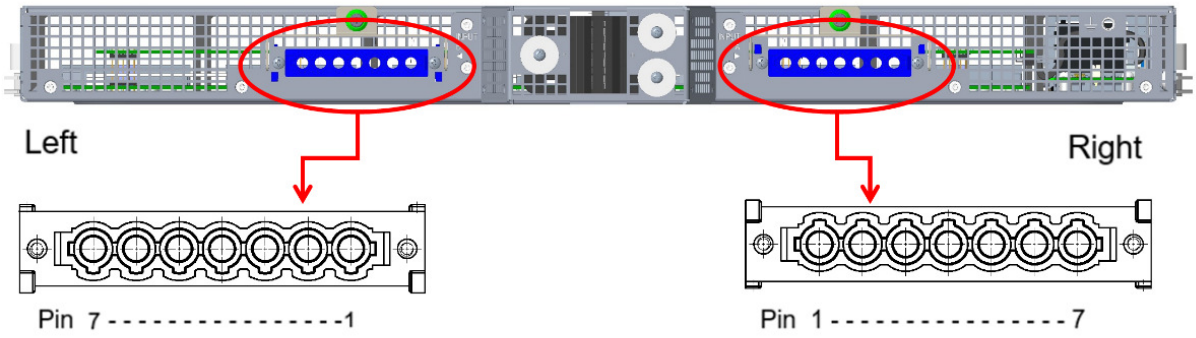


MECHANICAL SPECIFICATIONS – SHELF

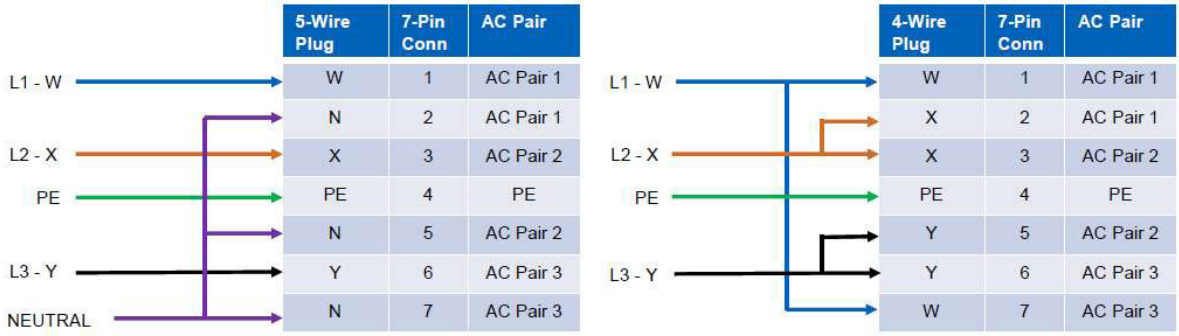
Connector Definitions

AC Input Connector

The power shelf has either one or two AC input connectors right only in the case of the single whip shelf (PN: 700-015746-0100), or left and right in the case of the dual whip shelf (PN: 700-015235-0100).

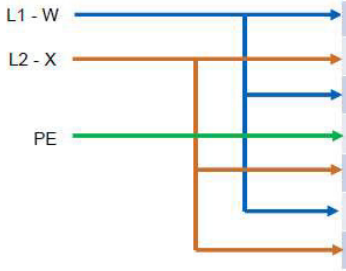


AC Input Connector Wiring



5-Wire Plug	7-Pin Conn	AC Pair
W	1	AC Pair 1
N	2	AC Pair 1
X	3	AC Pair 2
PE	4	PE
N	5	AC Pair 2
Y	6	AC Pair 3
N	7	AC Pair 3

4-Wire Plug	7-Pin Conn	AC Pair
W	1	AC Pair 1
X	2	AC Pair 1
X	3	AC Pair 2
PE	4	PE
Y	5	AC Pair 2
Y	6	AC Pair 3
W	7	AC Pair 3



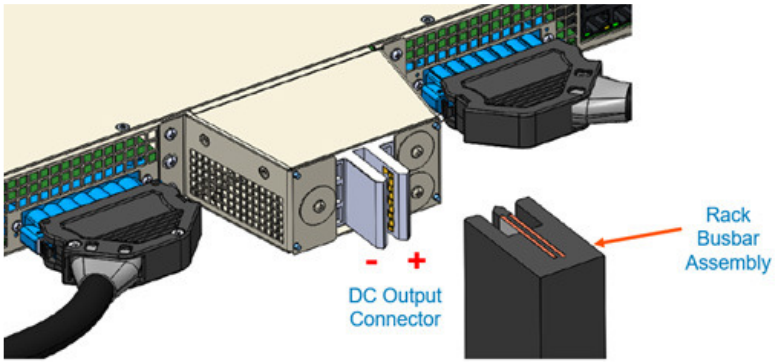
2-Wire Plug	7-Pin Conn	AC Pair
W	1	AC Pair 1
X	2	AC Pair 1
W	3	AC Pair 2
PE	4	PE
X	5	AC Pair 2
W	6	AC Pair 3
X	7	AC Pair 3

MECHANICAL SPECIFICATIONS – SHELF

DC Output Connector

The shelf DC output connector is a floating blind mate connector that mates with ORV3 busbars in an ORV3 rack. This gives the flexibility for:

- Placing power and battery shelves any desirable location on the rack
- Increasing power and energy by adding more power and/or battery shelves in the rack



Power Supply Connector

The shelf contains the 6 blind mate mating connectors for the 6 ORV3 PSUs. Amphenol 10127400-01U1520LF or equivalent. This is a R/A receptacle, PwrBlade ULTRA HD connector with 3 low power pins, 25 signal pins, and 4 high power pins.

PSUs plug into the power shelf directly, and they are hot swappable while the rack is powered. Please refer to page 24 for pinout details.

PMC/PMI Connector

The shelf contains a blind mate mating connector for PMC or PMI module. The PMC or PMI module plugs into the power shelf directly, and is hot swappable while the rack is powered. Please refer to “ARTESYN ORV3 PMI” or “ARTESYN ORV3 PMC” datasheet for pinout details.

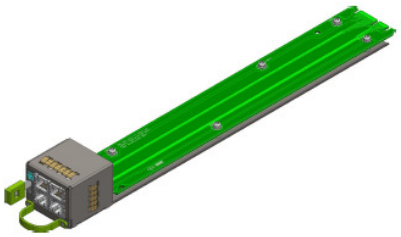
Mating Connector

Table 8. Mating Connector for ORV3 Shelf

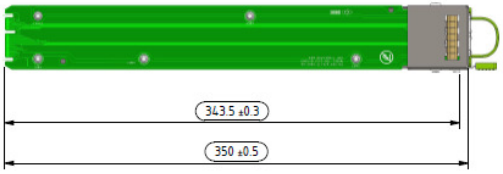
Device	Connector	Mating Connector
Shelf	Input Connector: POSITRONIC SP10RSSS48RM220A1-AA-2269 SP10RSSS48M220A1-AA-2269	POSITRONIC SP10RSSS1F0W01/AA-2268
	Output Connector: FCI BarKlip BK500 Cable 10156914-3D6077HF	ORV3 Busbars

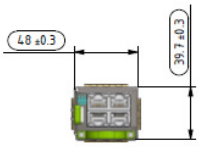
MECHANICAL SPECIFICATIONS – PMI

Mechanical Drawing (unit: mm)



3D VIEW



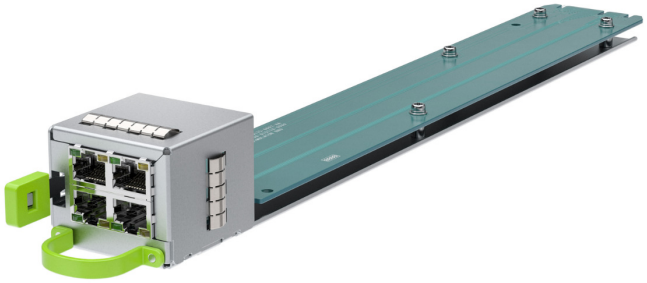


RJ45 P/N: 2041376-4 (TE CONNECTIVITY),
RJSAE-J384-04 (AMPHENOL)

MECHANICAL SPECIFICATIONS – PMI

Connector Definitions

The PMI contain four RJ45 connectors located on the bulkhead of the assembly. The pinouts of the four connectors are shown below. Looking from the front, Top left RJ45 is #1, Top right is #2, bottom left is #3, bottom right is #4.



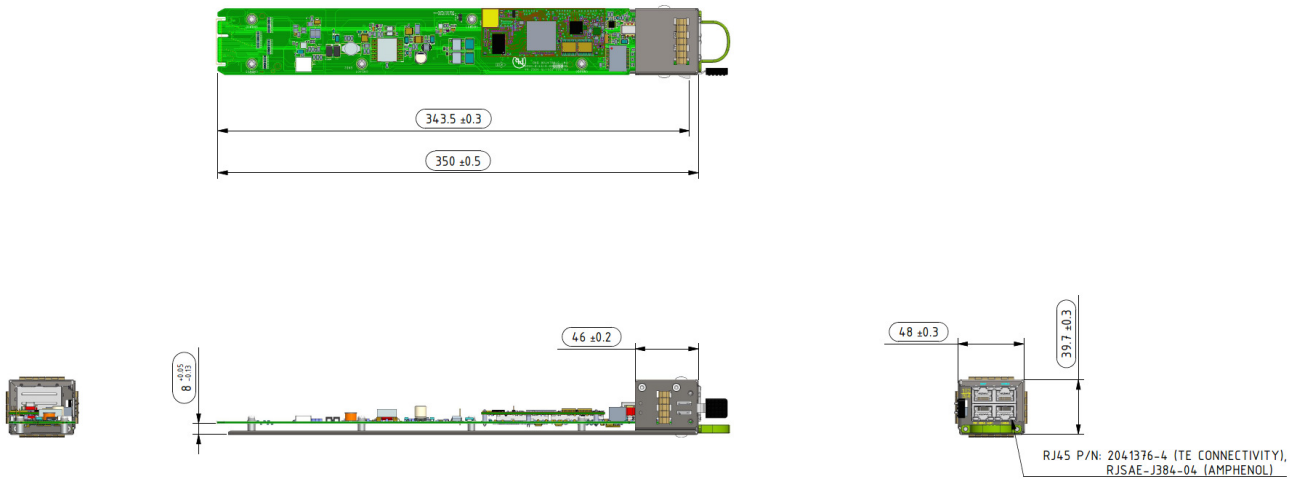
RJ45 #1		
Pin	Wire color	Function
1	White/Orange	GND
2	Orange	PLS (PSU/BBU Power Loss Siren)
3	White/Green	BKP
4	Blue	RS485A
5	White/Blue	RS485B
6	Green	RS485_Addr2
7	White/Brown	RS485_Addr1
8	Brown	RS485_Addr0

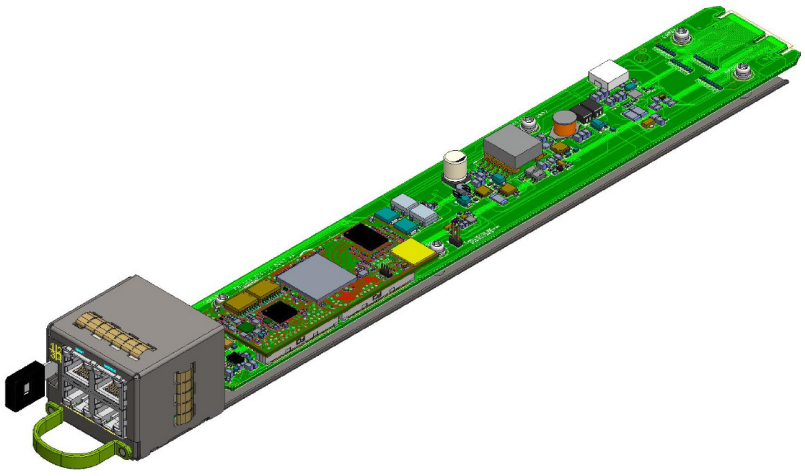
RJ45 #2		
Pin	Wire color	Function
1	White/Orange	GND
2	Orange	PLS (PSU/BBU Power Loss Siren)
3	White/Green	BKP
4	Blue	RS485A
5	White/Blue	RS485B
6	Green	GND
7	White/Brown	RS485_Addr1
8	Brown	RS485_Addr0

RJ45 #3 & 4		
Pin	Wire color	Function
1	White/Orange	ISHARE
2	Orange	GND
3	White/Green	SYNC_START_L
4	Blue	VOUT_SEL
5	White/Blue	SYNC_STOP_L
6	Green	RSVD
7	White/Brown	CAN_H
8	Brown	CAN_L

MECHANICAL SPECIFICATIONS – PMC

Mechanical Drawing (unit: mm)



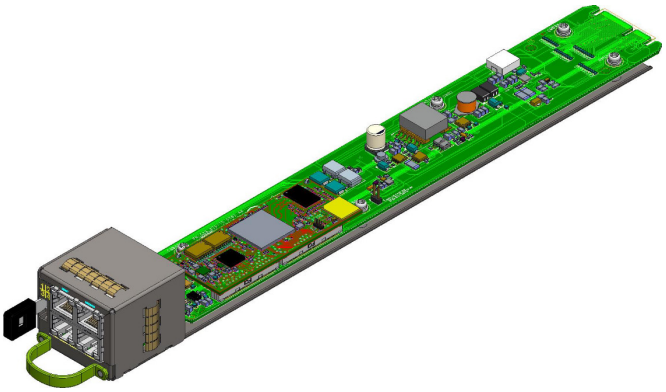


3D VIEW

MECHANICAL SPECIFICATIONS – PMC

Connector Definitions

The PMC contain four RJ45 connectors located on the bulkhead of the assembly. The pinouts of the four connectors are shown below. Looking from the front, Top left RJ45 is #1, Top right is #2, bottom left is #3, bottom right is #4.



RJ45 #1 – Ethernet (10/100/1000MB Base-T) and Power over Ethernet (PoE)

Please note this will also require external magnetics on the carrier as they are not included in the RJ45 2x2 block as they're not needed for the other connections.

This pinout is Power over Ethernet "mode B" (PoE on pins 4, 5, 7, 8), ideally it would be possible to support "mode A" (PoE on pins 1, 2, 3, 6) either as part of a single hardware solution or as hardware configuration.

Pin	Wire Color	Signal	I/O	Function
1	White/Orange	TRD_D1+	I/O	Bi-directional Data +
2	Orange	TRD_D1-	I/O	Bi-directional Data -
3	White/Green	TRD_D2+	I/O	Bi-directional Data +
4	Blue	TRD_D3+	I/O	Bi-directional Data + / PoE DC +
5	White/Blue	TRD_D3-	I/O	Bi-directional Data - / PoE DC +
6	Green	TRD_D2-	I/O	Bi-directional Data -
7	White/Brown	TRD_D4+	I/O	Bi-directional Data + / PoE DC -
8	Brown	TRD_D4-	I/O	Bi-directional Data - / PoE DC -

MECHANICAL SPECIFICATIONS – PMC

RJ45 #2 – Modbus Shelf Master (For Internal Use)

Pin	Wire Color	Signal	I/O	Function
1	White/Orange	GND	I	(For Internal Use)
2	Orange	PLS	O	This is a pass through from the PSUs for alerts.
3	White/Green	BKP	O	This is a pass through from the PSUs for alerts.
4	Blue	RS485A	I/O	(For Internal Use)
5	White/Blue	RS485B	I/O	(For Internal Use)
6	Green	RS485_Addr2	O	(For Internal Use)
7	White/Brown	RS485_Addr1	O	(For Internal Use)
8	Brown	RS485_Addr0	O	(For Internal Use)

RJ45 #3 –RS232 Debug

This pinout provides a serial debug connection to the command line of the PMC.

Pin	Wire Color	Signal	I/O	Function
1	White/Orange	GND	-	GND
2	Orange	DEBUG_RX	I/O	Debug receive data
3	White/Green	-	-	(For Internal Use)
4	Blue	-	-	(For Internal Use)
5	White/Blue	-	-	(For Internal Use)
6	Green	DEBUG_TX	I/O	-
7	White/Brown	CAN_H	I/O	(For Internal Use)
8	Brown	CAN_L	I/O	(For Internal Use)

RJ45 #4 – CAN and Signals (For Internal Use)

This pinout provides a serial debug connection to the command line of the PMC, useful to recover the PMC if network is not available. Other signals are reserved for future use.

Pin	Wire Color	Signal	I/O	Function
1	White/Orange	ISHARE	A	(For Internal Use)
2	Orange	GND	-	(For Internal Use)
3	White/Green	SYNC_START_L	I/O	(For Internal Use)
4	Blue	VOUT_SEL	O	(For Internal Use)
5	White/Blue	SYNC_STOP_L	I/O	(For Internal Use)
6	Green	RSVD	-	(For Internal Use)
7	White/Brown	CAN_H	I/O	(For Internal Use)
8	Brown	CAN_L	I/O	(For Internal Use)

MECHANICAL SPECIFICATIONS

Weight

ORV3 PSU weight is 2.21 kg.

ORV3 Power Shelf (Single Whip or Dual Whip) weight is 11.57 kg.

PMI weight is 0.27 kg.

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

The ORV3 power system is designed to meet the following EMC immunity specifications.

Table 9. Environmental Specifications

Document	Description
Class A of EN55032 and FCC CFR 47 Part 15 Subpart B	Conducted and Radiated EMI Limits
EN61000-4-2	Electromagnetic Compatibility (EMC) – Testing and measurement techniques – Electrostatic discharge immunity test: 11.2 KV air, 5.6 KV contact discharge. Performance – Criteria A
EN61000-4-3	Electromagnetic Compatibility (EMC) – Testing and measurement techniques – Radiated, radio–frequency, electromagnetic field immunity test: 3 V/m. Performance – Criteria A
EN61000-4-4	Electromagnetic Compatibility (EMC) – Testing and measurement techniques – Electrical fast transient/burst immunity test: >1 KV for AC power line. >0.5 kV for signal line. Performance – Criteria A
EN61000-4-5	Electromagnetic Compatibility (EMC) – Testing and measurement techniques – Surge test: >4 KV common mode and >2 KV differential mode for AC power line. Signal port: >1 kV. Performance – Criteria A
EN61000-4-6	Electromagnetic Compatibility (EMC) – Testing and measurement techniques – Conducted Immunity 3 Vrms. Performance – Criteria A.
EN61000-4-8	Power frequency magnetic field immunity, when applicable, >1 A/m
IEC61000-4-11	Voltage dip and sag

Notes: Performance Criteria as defined by EN300386.
Performance Criteria A: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below specified performance level during intended use of operation.
Performance Criteria B: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below specified performance level during intended use of operation. Degradation of performance is allowed during the exposure to an electromagnetic phenomenon but no change of actual operating state is allowed.
Performance Criteria C: Temporary loss of function is allowed, provided the function is self–recoverable or can be restored by the operation of the controls.

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The ORV3 power system is designed to meet the following safety standards.

Table 10. Safety Standards for ORV3 Power System

Standard	Agency	Description
UL 60950	UL	US Requirements
IEC 60950	IEC	International Requirements
IEC/EN/UL 62368-1	UL	International Requirements
CB	TUV	European Requirements
CE Marking	CE	European Requirements

ENVIRONMENTAL SPECIFICATIONS

EMI Emissions

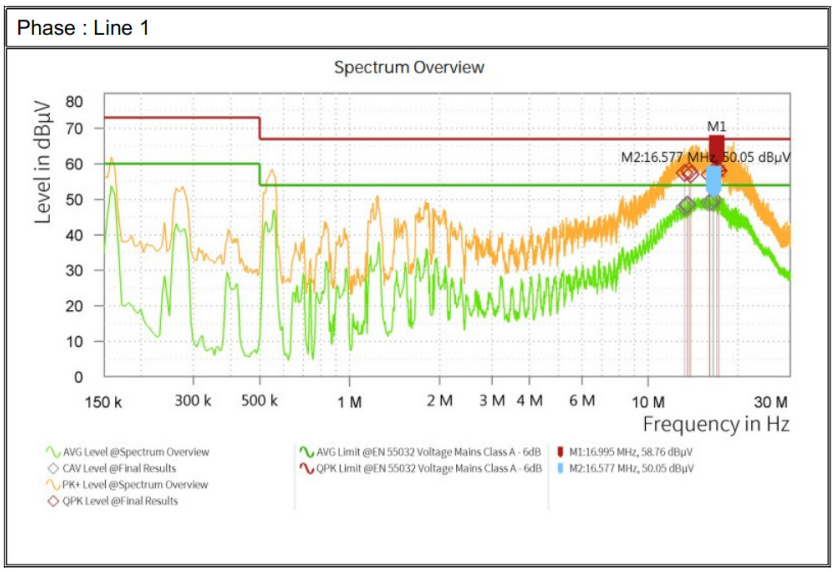
The ORV3 power system has been designed to comply with the Class A limits of EMI requirements of FCC CFR 47 Part 15 Subpart B and the limits specified in CISPR22 / EN55032, with 6dB margin.

Conducted Emissions

The applicable standard for conducted emissions is EN55032 (FCC Part 15). Conducted noise can appear as both differential mode and common mode noise currents. Differential mode noise is measured between the two input lines, with the major components occurring at the supply fundamental switching frequency and its harmonics. Common mode noise, a contributor to both radiated emissions and input conducted emissions, is measured between the input lines and system ground and can be broadband in nature.

The ORV3 power system has EMI filters to ensure the system conducted EMI levels comply with EN55032 (FCC Part 15) Class A limits. The EMI measurements are performed with resistive loads at maximum rated loading.

Sample of EN55032 Conducted EMI Measurement at 230Vac (L-N) (3Phase 5 wire).



Conducted EMI emissions specifications of the ORV3 power system:

Parameter	Model	Symbol	Min	Typ	Max	Unit
FCC Part 15, class A	All	Margin	6	–	–	dB
CISPR 32 (EN55032), class A	All	Margin	6	–	–	dB

Radiated Emissions

Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. The shielding effect provided by the system enclosure may bring the EMI level from Class A to Class B. It is thus recommended that radiated EMI be evaluated in a system environment. The applicable standard is EN55032 Class A (FCC Part 15). Testing DC-DC converters as a stand-alone component to the exact requirements of EN55032 can be difficult because the standard calls for 1m lead to be attached to the input and outputs and aligned such as to maximize the disturbance. In such a set-up, it is possible to form a perfect dipole antenna that very few DC-DC converters could pass. However, the standard also states that an attempt will be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample.

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature

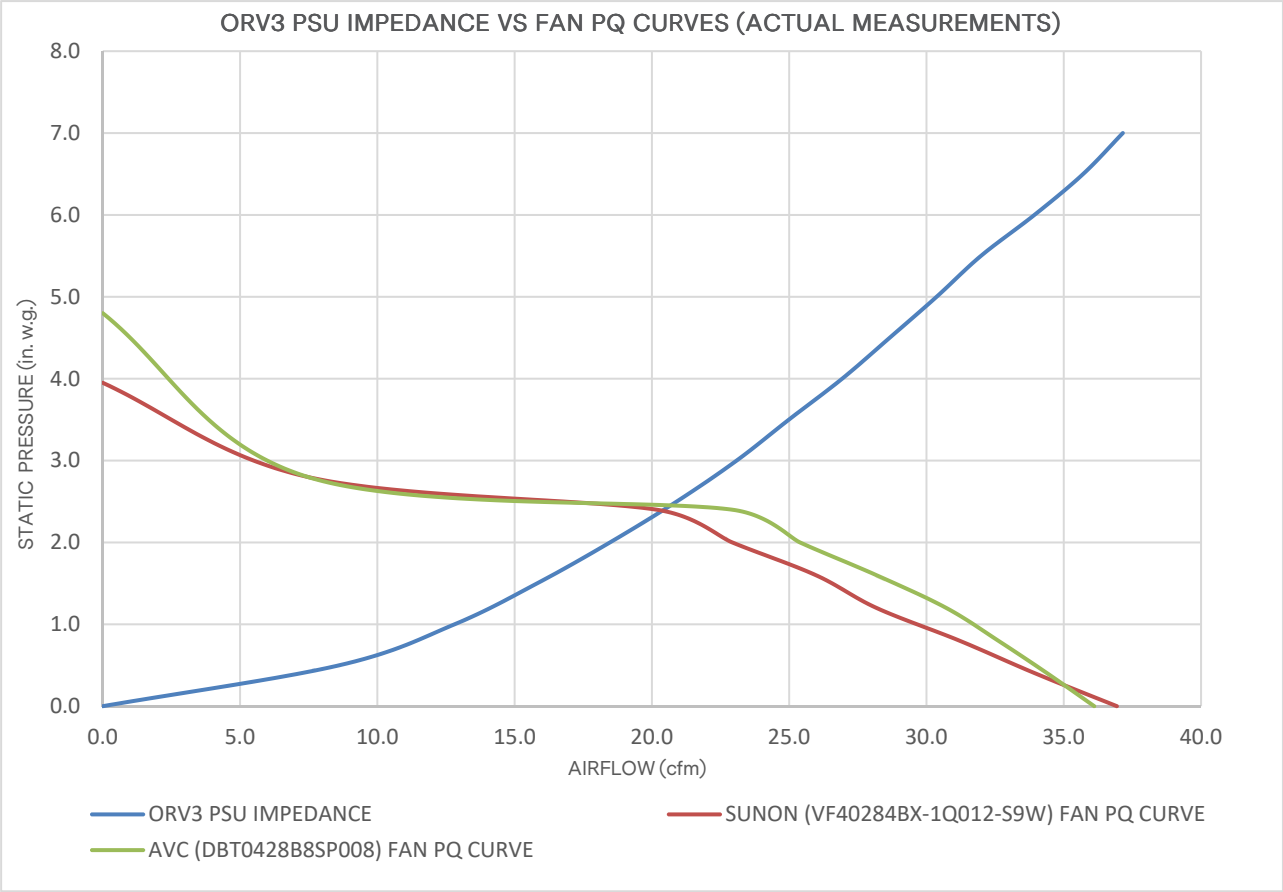
The ORV3 power systems starts and operates with full rated power at an ambient temperature from -5^{O}C to 45^{O}C.

Storage and Shipping Temperature

The ORV3 power systems can be stored at temperatures between -40^{O}C and +70^{O}C. It can be shipped at temperatures between -55^{O}C and +85^{O}C (short-term storage).

Fan Cooling

Fan was sized to support operation across environmental and loading envelopes, with an adequate operating range (speed) to achieve requirements outlined in this document. The fan have adequate overhead to accommodate back-pressure resulting from shelf design, rack-level accessories and data center operation. In general, head room to overcome a back-pressure of ≥ 0.3 inches of water. When the rectifier is plugged in, the fan stays operational irrespective of load and will maintain front-to-back airflow direction (overcome potential back-pressure). Mounting of the fan meets any vibration and acoustic criteria and does not violate any physical constraints outlined.



ENVIRONMENTAL SPECIFICATIONS

Altitude

The ORV3 power systems can operate with no de-ratings at altitudes of up to 3050 m (10,000 feet).

Humidity

The ORV3 power systems can operate within specifications and stored in a relative humidity from 5% to 93% non-condensing.

Vibration and Shock (Non-packaged)

The ORV3 power systems (power shelf with PSUs and PMI/PMC module inside) meet vibration and shock test per EN 60068-2-6 and 60068-2-27, respectively, for both non-operating and operating condition, with the specifications listed below.

During operating vibration and shock tests, the PSU will exhibit full compliance to the specification without any electrical discontinuities.

During the non-operating tests, no damages of any kinds (included physical damages) should occur and they should not corrupt the functionalities of the PSU per the specifications.

Non-Operating Vibration

Excitation Mode	Sinusoidal
Amplitude	1g
Frequency Range	5 to 500 Hz 5 to 9 Hz: 6 mm peak to peak 9 to 500 Hz: 1 g
Frequency Change Rate	1 octave/min
Duration	10 sweep cycles for each direction (2 hours 13 minutes)
Test Direction	3 mutually perpendicular axis
Test Temperature	Room temperature
Electrical Work	None

Operating Vibration

Excitation Mode	Sinusoidal
Amplitude	0.5g
Frequency Range	5 to 500 Hz 5 to 9 Hz: 6 mm peak to peak 9 to 500 Hz: 1 g
Frequency Change Rate	1 octave/min
Duration	10 sweep cycles for each direction (2 hours 13 minutes)
Test Direction	3 mutually perpendicular axis
Test Temperature	Room temperature
Electrical Work	Power supply in operation

ENVIRONMENTAL SPECIFICATIONS

Non-Operating Shock

Shock Pulse	Half sinusoidal
Shock Duration	11ms
Shock Amplitude	12g
Test Directions	6 directions
Number of Shocks	60 (10 per each direction)
Test Temperature	Room temperature
Electrical Work	None

Operating Shock

Shock Pulse	Half sinusoidal
Shock Duration	11ms
Shock Amplitude	6g
Test Directions	6 directions
Number of Shocks	30 (5 per each direction)
Test Temperature	Room temperature
Electrical Work	Power supply in operation

Package Vibration, Drop and Compression

The power shelves (without PSUs) in their shipping package meet the following requirements:

Package Vibration	1.146 g, 2 to 200 to 2 Hz, all three axes, random vibe	ISTA 3E 06-06
Package Drop	8 inch drop	ISTA 3E 06-06
Package Compression	Maximum compression loading on a bulk pack	ASTM D 642-94

COMMUNICATION SPECIFICATIONS

Communication Overview

The PSU can communicate on PMBus (up to 100 kbps) and Modbus (up to 115 kbps). At default, Modbus is active and PMBus is hardware only. Contact Advanced Energy to switch to PMBus communication.

The software interface is operational when the AC is present or when the DC output bus is powered up by other power sources.

The software provide below functions:

Fault conditions:

- Last power failure event
- PSU failure

Read:

- Voltage in
- Current in
- Voltage out
- Current out
- Temperatures
- Fan speeds
- Power out
- Power in
- Position
- Serial Number
- Manufacturer part number
- Hardware revision
- Firmware revision

Write:

- Clear faults

Upgrades:

- Upgrade firmware image (s)

Firmware Upgrade

The interface allow the user to re-flash firmware on the device. Firmware upgrade result in no power interruption on the shelf level (the unit being upgrade can go offline). Upgrades can be done one PSU at a time.

The PSU FW maintain regulation on the output during Send, Install and Verification of the new FW, and only require a soft reset (that may reset the output for a short period in a few seconds).

PSU output voltage interruption due to FW upgrade will be less than 10 s.

COMMUNICATION SPECIFICATIONS

Reporting Accuracy

Accurate reporting of input power (power factor, input current, input current harmonics and voltage) and output power (output current and voltage) readings will be reported via communication system at all rated voltage.

The accuracy will be maintained across the operating temperature range and between 200 Vac and 305 Vac.

Table 11. Communication Reporting Accuracy

Parameter	Loading	Reporting Accuracy
AC Input Power	<10%	±25W
	10% to 20%	±5%
	20% to 100%	±3%
AC Input Current	<10%	±0.5A
	10% to 20%	±2%
	20% to 100%	±1%
AC Input Current iTHD (Error difference not %)	<10%	±10%
	10% to 20%	±2%
	20% to 100%	±1%
Power Factor (Error difference not %)	<10%	±0.1
	10% to 20%	±0.025
	20% to 100%	±0.01
AC Input Voltage	0 to 100%	±1%
Output Voltage	0 to 100%	±0.5%
Output Current	10% to 20%	±10%
	20% to 50%	±5%
	50% to 100%	±1%
Output Power	<10%	±25W
	10% to 20%	±4%
	20% to 100%	±2%

COMMUNICATION SPECIFICATIONS

Black Box Function

The black box function store key important data to be used when a fault occurs.

- Store data in memory and can withstand several read/write cycles.
- PSU can store failure data before the PSU turns off/fails even in catastrophic failure events both on primary and secondary side. Hold up time of the black box microcontroller can store all the information and then shutdown.
- Last 4 events stored in memory.
- AC input current, AC input voltage, input power, power factor, iTHD, DC output voltage, DC output current.
- Temperature readings, fan speed, input voltage, output voltage, bulk voltage, various error codes from all the different converters (OTP, OVP, OCP, UVP), and warnings.
- BBU signals at time of failure (fail, charge_enable, BBU voltage, etc).
- Total run time of PSU.
- Run time since last turn on.
- Real time stamping.
- Number of AC power cycles.
- Number of AC outages (can be determined by going into backup without counting the battery test conditions).

Power supply event data is saved to the black box for the following events.

Any events that caused the main output to shut down:

- Main output over voltage fault
- Main output under voltage fault
- Main output over current fault
- Main output short circuit fault
- Fan failure
- Over temperature fault

Any events that caused the AC input to be bad:

- AC input under voltage fault
- AC input over voltage fault
- AC input out of range frequency fault

Contact Advanced Energy for more details about the black box function.

COMMUNICATION SPECIFICATIONS

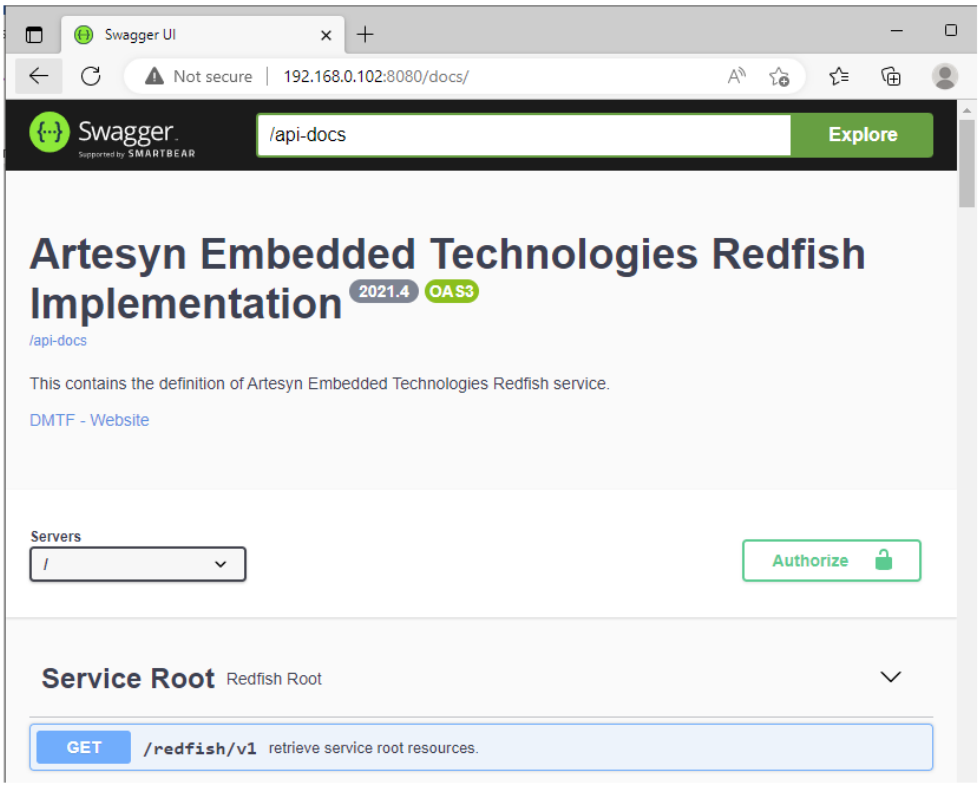
PMC Boot and Software / Firmware Update

Update via RedFish

The PMC software allow update of all images in the system via the RedFish Update Service. These images include, but not limited to:

- uBoot images and other code in SPI flash
- Kernel and filesystem in eMMC
- PSU firmware images

It is possible to download the new image while maintaining full functionality of the shelf. It is permissible to reboot into the newly downloaded image - i.e. no 'live' update required.



Update via Command Line / Debug

It is possible to update all the same images via command line over the SSH or debug UART connection.

Firmware Rollback

After updating the PMC firmware, it must be possible to rollback to the previous version easily, without downloading more images. This should be done automatically if the new images fail to boot. It must also be possible to trigger this rollback manually. Ideally via Redfish but certainly via the command line.

More details please refer to application note "AN10371 - ORV3 - PMC and PSU Update Guide Using Redfish (090223)". (Contact Advanced Energy technical support for the application note).

COMMUNICATION SPECIFICATIONS

Device Addressing

The ORV3 power system will respond to supported commands on the Modbus that are addressed according to PSU_A2, PSU_A1, PSU_A0, RS485_addr2, RS485_addr1, RS485_addr0 pins of PSU output connector (refer to page 24 for PSU output connector details).

Address pins are held HIGH by default via pulled up to internal 3.3 V supply. To set the address as “0”, the corresponding address line needs be pulled down to logic ground level. Modbus address range from 0xC0 (11000000b) to 0xFF (11111111b).

Fixed		Address Pins					
		RS485_addr2	RS485_addr1	RS485_addr0	PSU_A2	PSU_A1	PSU_A0
1	1	X	X	X	X	X	X

Note: X = 0 or 1.

Serial Configuration

Parameter	Settings
Data Rate	19200 to 115200 19200 (default)
Data Bits	8
Parity	Even
Stop Bits	1

CRC Checking

The PSU includes an error-checking field that is based on a Cyclical Redundancy Checking (CRC) method performed on the message contents. Details please refer to “MODBUS over Serial Line Specification and Implementation Guide” V1.02 document section 2.5.1.2 CRC Checking.

Error Handling

The PSU will report MODBUS error codes if the request command is invalid. Details please refer to “MODBUS over Serial Line Specification and Implementation Guide” V1.02 document section 7 MODBUS Exception Responses.

COMMUNICATION SPECIFICATIONS

ORV3 power system supported Modbus Registers which can be read by either Read Holding Register (function code 03h) or Read Input Register (function code 04h), and can be write by Write Single Register (function code 06h) or Write Multiple Registers (function code 10h).

Command Code	Command Name	Default Value	Access Type	Data Size in word	Data Format	Description
00h	PSU part#	"00-000000"	R	8	ASCII	
08h	PSU_MFR_MODEL	"700-015234-XXXX"	R	8	ASCII	
10h	PSU_MFR_DATE		R	8	ASCII	Format: "WW/YYYY"
18h	PSU_MFR_SERIAL		R	16	ASCII	Format: "WWYYP1V3AELXXXXX"
28h	PSU_Workorder #	"XXXXXXXX"	R	4	ASCII	
2Ch	PSU_HW Revision		R	4	ASCII	Format: "ZZZ"
30h	PSU_FW Revision		R	4	ASCII	Format: "0000"
34h	TOTAL_UP_TIME		R	2	Decimal	Seconds
36h	TIME_SINCE_LAST_ON		R	2	Decimal	Seconds
38h	AC_Power_Cycle_Counter		R	1	Decimal	
39h	AC_Outage_counter		R	1	Decimal	
3Ch	General Alarm Signal Register		R	1	Bitmapped	
High Byte	b3 - Fan Alarm					A bit is set in Fan alarm register (Bit 8 of 0x3F)
	b2 - Temp Alarm					Alarm set at shutdown temp (0x3F)
	b1 - Main Converter Fail					A bit is set in DCDC alarm register (0x3E)
	b0 - PFC Converter Fail					A bit is set in PFC alarm register (0x3D)
Low Byte	b3 - Communication					A bit is set in Communication alarm register (0x40)
	b2 - Temperature					A bit is set in Temperature alarm register (0x3F)
	b1 - DCDC					A bit is set in DCDC alarm register (0x3E)
	b0 - PFC					A bit is set in PFC alarm register (0x3D)
3Dh	PFC Alarm Status Register		R	1	Bitmapped	
High Byte	b3 - PFC_Fail					Bulk Voltage > 517.5V for 160us or No Bulk Voltage Detected
	b2 - Input relay off					
	b1 - Bulk ok					Bulk Voltage < 425V for 1ms
	b0 - AC_OK					
Low Byte	b5 - AC_FREQ_GOOD_HIGH					AC frequency > 66Hz for 500ms
	b4 - AC_FREQ_GOOD_LOW					AC frequency < 44Hz for 500ms
	b1 - AC_OVP					AC Input > 315Vac for 250ms
	b0 - AC_UVP					AC Input < 172Vac for 15ms

COMMUNICATION SPECIFICATIONS

ORV3 power system supported Modbus Registers which can be read by either Read Holding Register (function code 03h) or Read Input Register (function code 04h), and can be write by Write Single Register (function code 06h) or Write Multiple Registers (function code 10h).

Command Code	Command Name	Default Value	Access Type	Data Size in word	Data Format	Description
3Eh	DCDC Alarm Status Register		R	1	Bitmapped	
High Byte	b2 - Oring Fail					ORing Temp triggered
Low Byte	b3 - MAIN_SCKT					Vout < 30V and Iout > 30A for 37us Retry after 2s, max 5 times
	b2 - MAIN_OCP/OPP					Pout > 3300W for 10s
	b1 - MAIN_OVP					Vout > 52.5V for 15ms LATCH
	b0 - MAIN_UVP					Vout < 44V for 200ms
3Fh	Temperature Alarm Status Register		R	1	Bitmapped	
High Byte	b0 - Fan Failure					Fan Speed < 500rpm for 5s
Low Byte	b5 - PFC temp alarm					PFC FET 2 and 1 PFC Temp > 110 degC for 500ms
	b4 - LLC temp alarm					Bridge and Buck LLC Temp > 110 degC for 500ms
	b3 - Sync temp alarm					SYNC Temp > 110 degC for 500ms
	b2 - Oring temp alarm					ORing Temp > 110 degC for 500ms
	b1 - Inlet temp alarm					Inlet Temp > 60 degC for 500ms
	b0 - Outlet temp alarm					Outlet Temp > 85 degC for 500ms
40h	Communication Alarm Status Register		R	1	Bitmapped	
High Byte	b0 - Modbus active					No comms for 30s
Low Byte	b1 - Secondary – Logic MCU Fault					
	b0 - Primary – Secondary MCU Fault					
43h	PSU RPM fan0		R	1	Decimal	
44h	PSU RPM fan1		R	1	Decimal	No Fan 1, default 0
45h	PSU_Temp0 - Inlet		R	1	2's comp+sign N=7	
46h	PSU_Temp1 - Outlet		R	1	2's comp+sign N=7	
47h	PSU_Max_Temp		R	1	2's comp+sign N=7	

COMMUNICATION SPECIFICATIONS

ORV3 power system supported Modbus Registers which can be read by either Read Holding Register (function code 03h) or Read Input Register (function code 04h), and can be write by Write Single Register (function code 06h) or Write Multiple Registers (function code 10h).

Command Code	Command Name	Default Value	Access Type	Data Size in word	Data Format	Description
48h	PSU_Min_Temp		R	1	2's comp+sign N=7	
49h	PSU_Position_number		R	2	Decimal	Based on the Modbus Address
4Bh	CRC_error_counter		R	2	Decimal	Increment if Modbus CRC computed is incorrect
4Dh	Timeout_error_counter		R	2	Decimal	Increment if no Modbus communication for 30s.
4Fh	PSU_Output Voltage		R	1	2's comp+sign N=10	
50h	PSU_Output Current		R	1	2's comp+sign N=6	
51h	I_share current value		R	1	2's comp+sign N=6	
52h	PSU_Output Power		R	1	2's comp+sign N=3	
53h	PSU_Bulk Cap Voltage		R	1	2's comp+sign N=6	
54h	PSU_Input Frequency AC		R	1	2's comp+sign N=0	
55h	PSU iTHD		R	1	2's comp+sign N=9	Percentage format (%)
56h	PSU Power Factor		R	1	2's comp+sign N=9	Decimal format (0.00)
57h	PSU_Input Power		R	1	2's comp+sign N=3	
58h	PSU_Input Voltage AC		R	1	2's comp+sign N=6	
59h	PSU_Input Current AC		R	1	2's comp+sign N=10	
5Ah	PSU_Fault_Counter		R	1	Unsigned 16 bit	Increment when there is a fault
5Ch	Power_Cycle Unix Time	Default: 0	R/W	2	Decimal	
5Eh	PSU_setting register		R/W	1	Bitmapped	
5Fh	Communication baud rate	Default: 1 (19200)	R/W	1	Hex	Default: 1 (19200) Range: 1 (19200), 2 (38400), 3 (57600), 4 (115200)
60h	Fan Duty Cycle Override		R/W	1		Default: 0% Range: 0 to 100%
61h	LED Override		R/W	1	Bitmapped	
Low Byte	b6 - Amber LED					0 = off (default) 1 = on
	b5 - Blue LED					0 = off (default) 1 = on
	b0 - LED Override					0 = disabled (default) 1 = enabled

COMMUNICATION SPECIFICATIONS

ORV3 power system supported Modbus Registers which can be read by either Read Holding Register (function code 03h) or Read Input Register (function code 04h), and can be write by Write Single Register (function code 06h) or Write Multiple Registers (function code 10h).

Command Code	Command Name	Default Value	Access Type	Data Size in word	Data Format	Description
62h	Real Date/Time		R/W	2		Unix Format
64h	Configurable PLS Timing	45 sec	R/W	1		Range: 1 to 300 s
65h	Vin_min	180 Vac	R/W	1	2's comp+sign N=6	Range: 180 to 250 Vac
66h	Vin_max	305 Vac	R/W	1	2's comp+sign N=6	Range: 250 to 305 Vac
67h	Vout_setpoint_H	51 V	R/W	1	2's comp+sign N=10	Range: 50.75 to 51.25 V
68h	Vout_setpoint_L	48V	R/W	1	2's comp+sign N=10	Range: 47.75 to 48.25 V
69h	Vout_change_timer		R/W	1		Second
6Ah	PSU FBL FW Revision		R	4	ASCII	Format: "01.00.00"
6Eh	For AEI Use		R			

RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.0	08.30.2023	First issue	E. Wang

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

PRECISION | POWER | PERFORMANCE | TRUST

For international contact information,
visit advancedenergy.com.

powersales@aei.com (Sales Support)
productsupport.ep@aei.com (Technical Support)
+1 888 412 7832