PHB3000S53V5-CB
PSU Technical Manual V1.0

AC/DC-DC PSU	90 - 290 V AC/188 - 400 V DC Input	53.5 V DC Output	3000 W Power

NOTE

1. **PHD-3000WA** on the label of the module is the internal model used by the manufacturer.
2. The figures provided in this document are for reference only.

Description

PHB3000S53V5-CB is a high-efficiency PSU that converts AC and HVDC inputs into DC output, which has a wide application range. The PSU has an AC input range of 90 V AC to 290 V AC, HVDC input range of 188 V DC to 400 V DC, and a rated output of 53.5 V DC. It provides CAN communication ports, communicates with and sends the electronic serial numbers to the host to facilitate the monitoring and management. It also supports N+N redundancy. Up to 32 PSUs can be paralleled for redundancy use.

Applications

- Routers/Switches
- Servers/Storages
- Telecommunications equipment
- Advanced workstations

P	HB	3000	S	53V5	-	C	B
1	2	3	4	5		6	7

1 — Embedded Power
2 — Hybrid
3 — Output power: 3000 W
4 — Single output
5 — Output voltage: 53.5 V DC
6 — With case
7 — Blowy fan

Features

- Input voltage range: 90 - 290 V AC, 188 - 400 V DC
- Output power: 3000 W
- Efficiency: The peak point is ≥95.5%; ≥ 94%(230 V AC & 240 V DC & 380 V DC, 40% - 100% load)
- Depth x Width x Height: 485.0 mm x 106.5 mm x 41.0 mm (19.09 in. x 4.19 in. x 1.61 in.)
- Weight: < 3.0 kg
- Hot-plug capable
- Power grid: 110/208/220/230 V AC single-phase, 110 V AC dual-live wire, 240/380 V DC
- With speed-controllable fan
- Support input undervoltage, overvoltage, overcurrent ,reverse polarity protection
- Support output overcurrent, overvoltage, short circuit protection
- Support output fault isolation protection
- Support overtemperature protection
- CAN communication interface for controlling, programming and monitoring
- TUV, UL, CE certification
- Meet RoHS 6 requirement

Electrical Specifications

Conditions: T_A = 25°C (77°F), unless otherwise notes.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
Environmental characteristics					
Operating temperature	-5	-	55	°C	Able to start up with power module at -40°C. For load status of the non-core temperature range from +55°C to +75°C , refer to Figure 6 and 7.
Storage temperature	-40	-	70	°C	-
Relative humidity	5	-	95	%/RH	Non-condensing
Altitude range	0	-	4000	m	If the altitude is between 3000 m and 4000 m, the temperature decrease by 1°C for each additional 200 m.
AC Input characteristics					
AC input voltage range	90	-	290	V AC	With an AC input of 318 V, the PSU is not damaged within two hours but may not be working. With an input voltage of less than 170 V AC, the PSU power should be derated . See Figure 5.
Rated AC input voltage	100	110/220	240	V AC	-
Frequency	47	50/60	63	Hz	-
Power factor	0.99	-	-	-	V_{in} = 208 V AC, 220 V AC, 230 V AC, 240 V AC (50/60 Hz), 100%load
Total Harmonic Distortion(THD)	-	-	5	%	V_{in} = 208 V AC, 220 V AC, 230 V AC, 240 V AC (50/60 Hz), Input source must have THD (V) < 1.1%, 50% - 100% load
Input current	-	-	18.5	A	V_{in} = 176 V AC, rated load
Standby power consumption	-	-	10	W	Output off
	-	-	30	W	Output on
Input inrush current	-	-	50	A	V_{in} = 290 V AC, Meet ETSI300132-3
DC Input characteristics					
DC input voltage range	188	-	400	V DC	With an DC input of 410 V DC, the PSU can withstand work within two hours
Rated DC input voltage	240	240/380	380	V DC	-
Input current	-	-	18.5	A	V_{in} = 188 V DC
Standby power consumption	-	-	10	W	Output off
	-	-	30	W	Output on
Input inrush current	-	-	40	A	V_{in} = 400 V DC, Meet ETSI300132-3

Electrical Specifications

Conditions: T_A = 25°C (77°F), unless otherwise notes.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
Output characteristics					
Output voltage set point	53	53.5	54	V DC	V_{in} = 220 V AC, 240 V DC, 380 V DC; 50% load
Output power	-	-	3000	W	V_{in} = 170 V AC – 290 V AC, 188 V DC - 400 V DC
	1500	-	-	W	With an input voltage of less than 170 V AC, the PSU power should be derated. See Figure 5
Output current	-	56.1		A	-
Line regulation	-1	-	1	%	V_{out} = 53.5 V DC
Load regulation	-1	-	1	%	V_{out} = 53.5 V DC; I_{out} > 1 A
Regulated voltage precision	-1	-	1	%	The whole range of V_{in}, I_{out} and T_A.
Current share unbalance	-5	-	5	%	30% load to 100% load
Overshoot at turn on/turn off	-5	-	5	%	V_{out} = 53.5 V
Dynamic overshoot amplitude Recovery time	 - -	 - -	 2.5 200	 V µs	Current change rate: 1 A/µs Load : 25% - 50% - 25%; 50% - 75% - 50%,75% -100% - 75%, T = 4 ms
Temperature coefficient	-0.02	-	0.02	%/°C	-
External capacitance	-	-	22000	µF	-
Turn on delay time	-	-	8	s	From V_{in} connection to V_{out} = 42 V
	-	-	16	s	From V_{in} connection to 90%V_{out}
Output voltage ripple and noise (peak to peak)	-	-	200	mV	T_A = 15 - 35 °C, Oscilloscope bandwidth: 20 MHz; Meet YD731-2008; 50% load to 100% load; V_{in} ≤ 264 V AC. Tested with a 0.1 µF ceramic (metalized film) capacitor and a 10µF electrolytic capacitor connected to the output terminal.
	-	-	300	mV	T_A = -5 - 15 °C and 35 - 55 °C, Oscilloscope bandwidth: 20 MHz; Meet YD731-2008; 50% load to 100% load; V_{in} ≤ 264 V AC. Tested with a 0.1 µF ceramic (metalized film) capacitor and a 10µF electrolytic capacitor connected to the output terminal.
Hold up time	10	-	-	ms	Time used for the voltage to drop from 53.5 V DC to 44.0 V DC when V_{in} = 240 V DC or 220 V AC, 100% load.
	20	-	-	ms	Time used for the voltage to drop from 53.5 V DC to 44.0 V DC when V_{in} = 240 V DC or 220 V AC, 50% load.

Electrical Specifications

Conditions: T_A = 25°C (77°F), unless otherwise notes.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
Detected precision					
Input voltage detected precision	-5	-	5	V AC	V_{in} = 85 - 300 V AC
	-5	-	5	V DC	V_{in} = 188 - 410 V DC
Temperature detected precision	-5	-	5	℃	T_A = -33℃ to +75℃ (-27.4°F to 167°F)
Output current detected precision	-1	-	1	A	50%-100% load
Efficiency					
Peak point efficiency	95.5	-	-	%	V_{in} = 230 V AC, 240 V DC, 380 V DC; For the overlapped load range, calculate the efficiency based on the larger value.
40%-100% load	94.0	-	-	%	
20%-100% load	92.0	-	-	%	
Protection characteristics					
AC input overvoltage protection Protection threshold Recovery threshold	 300 290	 - -	 310 300	 V AC V AC	Hysteresis ≥ 5 V; Self-recovery
AC input undervoltage protection Protection threshold Recovery threshold	 70 -	 - -	 85 90	 V AC V AC	Hysteresis ≥ 5 V; Self-recovery
AC input overcurrent protection	-	-	-	-	The AC input live wire and neutral wire are configured with fuses.
AC input soft startup protection	-	-	-	-	A soft startup circuit is configured for the AC input, preventing the transient current caused by hot swaps from damaging the internal circuits.
AC primary short circuit protection	-	-	-	-	A resistance fuse is configured at the input end to protect the upstream input voltage.
DC input overvoltage protection Protection threshold Recovery threshold	 410 400	 - -	 - -	 V DC V DC	Hysteresis ≥ 5 V; Self-recovery
DC input undervoltage protection Protection threshold Recovery threshold	 168 182	 - -	 175 187	 V DC V DC	Hysteresis ≥ 12 V; Self-recovery
DC input soft startup protection	-	-	-	-	A slow startup circuit is configured for the DC input, preventing the transient current caused by hot swaps from damaging the internal circuits.

Electrical Specifications

Conditions: T_A = 25°C (77°F), unless otherwise notes.

Parameter	Min.	Typ.	Max.	Units	Notes & Conditions
Protection characteristics					
DC input reverse polarity protection	-	-	-	-	When the input polarities are reversed, the PSU is not damaged but has no outputs with all three indicators off.
DC primary short circuit protection	-	-	-	-	A resistance fuse is configured at the input end to protect the upstream input voltage. Internal input short circuits in one PSU do not affect the normal operating of other PSUs.
Output overvoltage protection	57	-	60	V	Latch off
Output overcurrent protection	60	-	70	A	See Figure 29
Output short circuit protection	-	-	-	-	Self-recovery
Overtemperature protection	60	-	-	°C	Self-recovery
Output fault isolation protection	-	-	-	-	Output fault isolation, supports automatic exits in case of faults.
Reliability characteristics					
Mean time between failures (MTBF)	-	250,000	-	hours	Rated Input; 100% load;
Emission					
Acoustic noise	-	-	60	dBA	V_{in} = 220 V AC, 240 V DC, 380 V DC, 100%load, T_A = 27°C (80.6°F)

Specifications are subject to change without notice.

Characteristic Curves

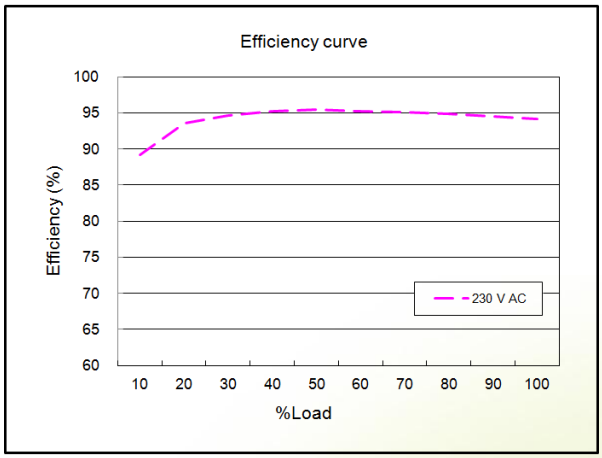

Figure 1: Efficiency
(T_A = 25°C [77°F], V_{in} = 230 V AC)

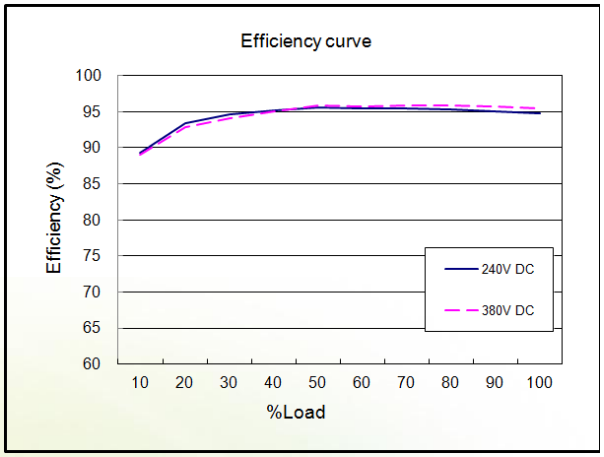

Figure 2: Efficiency
(T_A = 25°C [77°F], V_{in} = 240 V DC, 380 V DC)

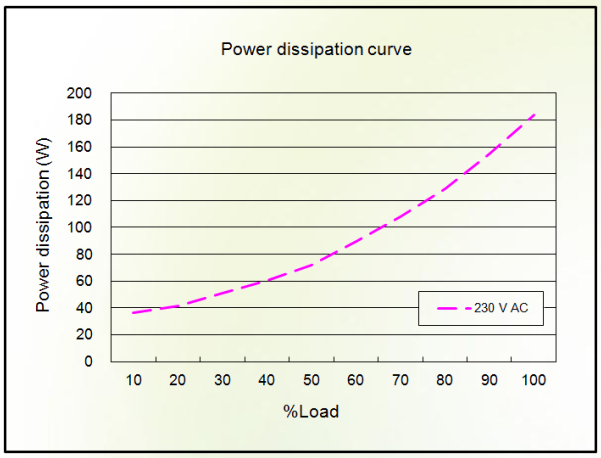

Figure 3: Power dissipation curve
(T_A = 25°C [77°F], V_{in} = 230 V AC)

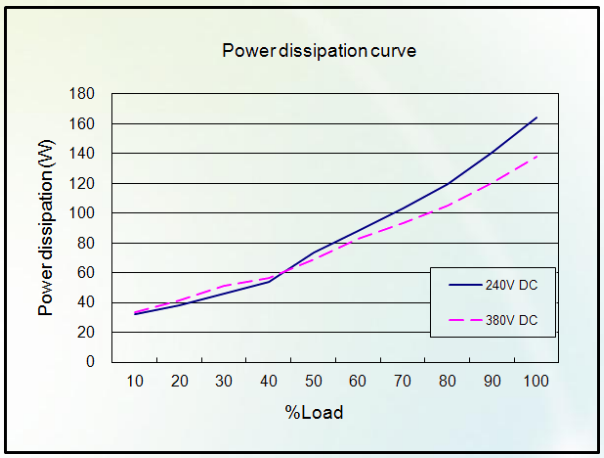

Figure 4: Power dissipation curve
(T_A = 25°C [77°F], V_{in} = 240 V DC, 380 V DC)

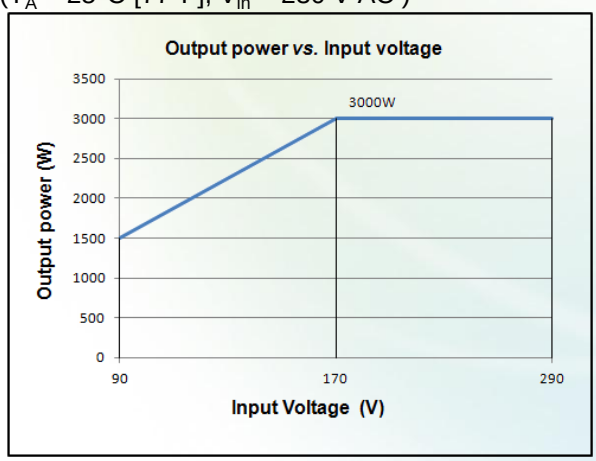

Figure 5: Output power *vs.* Input voltage

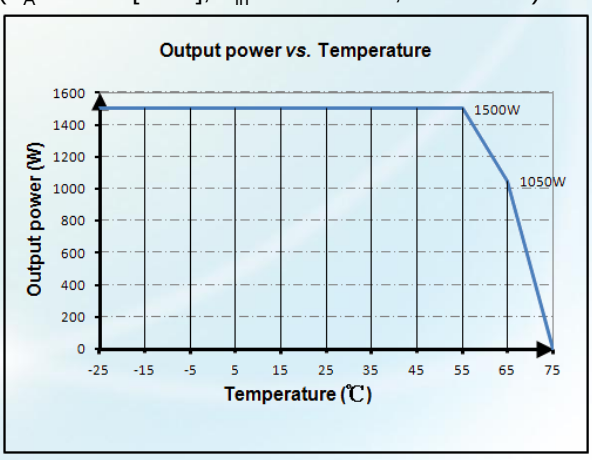

Figure 6: Output power *vs.* Temperature
(V_{in} = 90 - 170 V AC)

Characteristic Curves

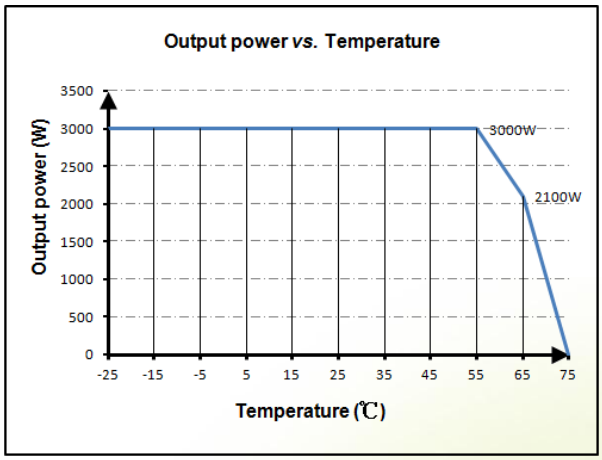

Figure 7: Output power *vs.* Temperature
(V_{in} = 170 - 290 V AC, V_{in} = 188 - 400 V DC)

Control Signal

Enable

The analog signal Enable is an input signal to enable/disable the 53.5 V DC output. The logic of Enable is as following:

Enable	53.5 V output
High level	Off
Low level (< 0.8 V)	On

The configuration diagram of Enable is shown in Figure 8:

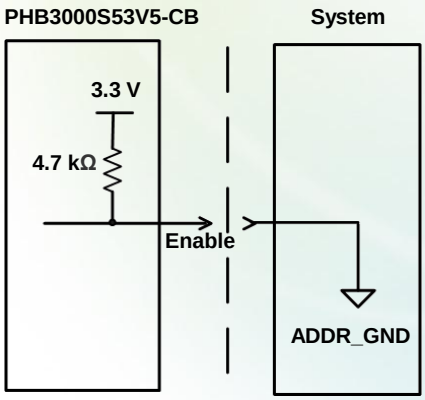

Figure 8: Configuration diagram of Enable

Present

This signal indicates that the PSU is in position. It connects to the GND inside the PSU and has a impedance equal to 200 ohm to the GND. The configuration diagram of Present is shown in Figure 9:

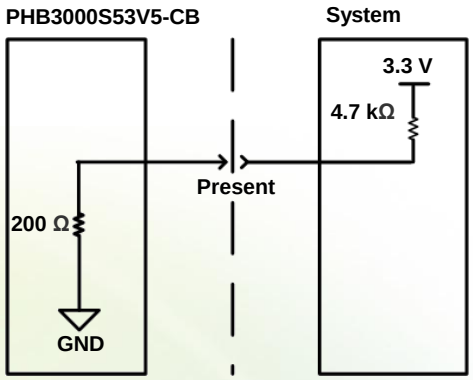

Figure 9: Configuration diagram of Present

The logic of Present is as following:

Present	Connect to the system
Low level	Yes
High level	No

On/Off 1, On/Off 2

The low active signal On/Off 1 and On/Off 2 are input signal to enable/disable the 53.5 V DC output. On/Off 1 and On/Off 2 can control the PSU output in separate or combined mode with connecting to a mechanical switch.
The logic of On/Off 1 and On/Off 2 are as following:

On/Off 1, On/Off 2	53.5 V output
Low level	On
High level	Off

Control Signal

The configuration diagram of On/Off (common ground mode) is as following:

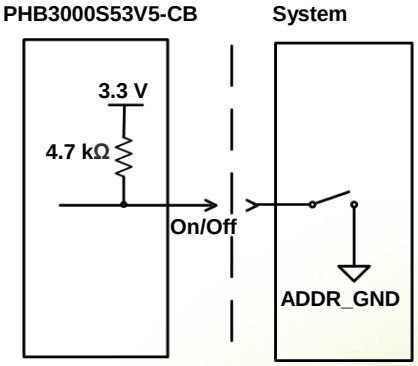

Figure 10: Configuration diagram of On/Off (common ground mode) signal

On/Off 1 and On/Off 2 combination methods and control results:

On/Off 1 level	On/Off 2 level	Output voltage
Low level	Low level	On
Low level	High level	On
High level	Low level	On
High level	High level	Off

On/Off 3, On/Off 4

The low active signal On/Off 3 and On/Off 4 are input signal to enable/disable the 53.5 V DC output. On/Off 3 and On/Off 4 can control the PSU output in separate or combined mode with connecting to a mechanical switch.

The logic of On/Off 3 and On/Off 4 are as following:

On/Off 3, On/Off 4	53.5 V output
Low level	On
High level	Off

On/Off 3 and On/Off 4 combination methods and control results:

On/Off 3 level	On/Off 4 level	Output voltage
Low level	Low level	On
Low level	High level	On
High level	Low level	On
High level	High level	Off

The configuration diagram of On/Off (isolation mode) is as following:

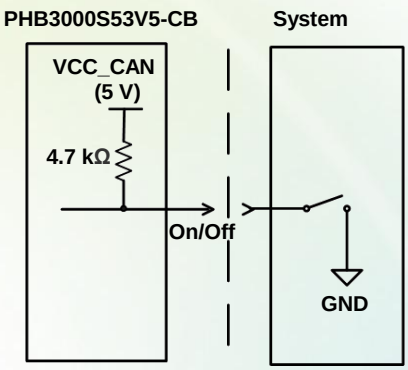

Figure 11: Configuration diagram of On/Off (isolation mode) signal

Typical Waveforms

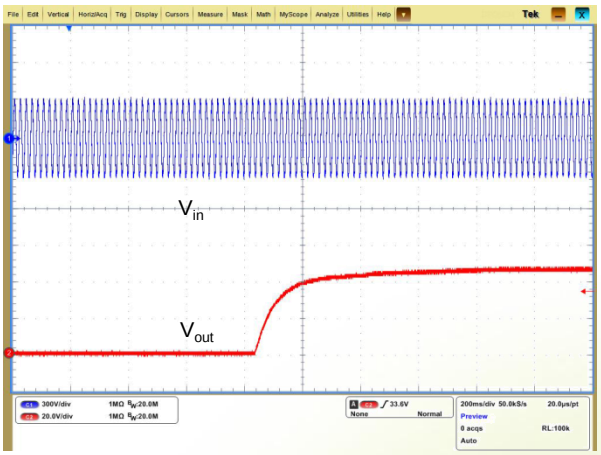

Figure 12: Turn-On AC line (100% load, 220 V AC, 200 ms/div)

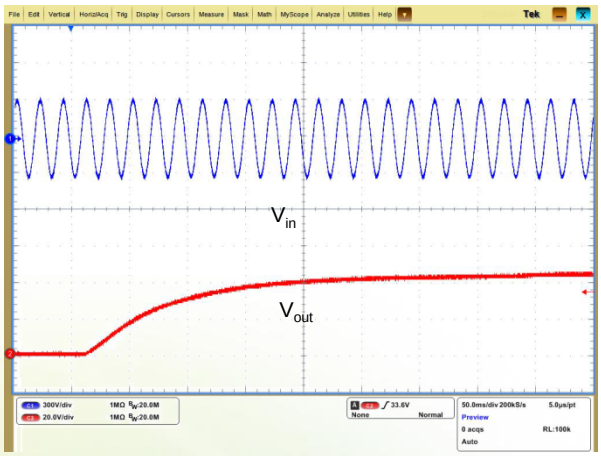

Figure 13: Turn-On AC line (100% load, 220 V AC, 50 ms/div))

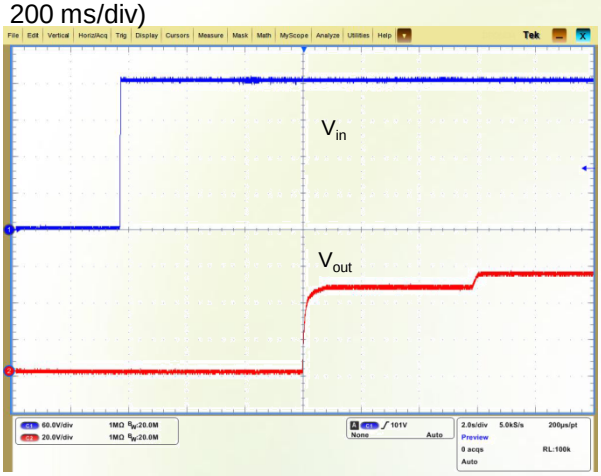

Figure 14: Turn-On DC line (100% load, 240 V DC, 2s/div)

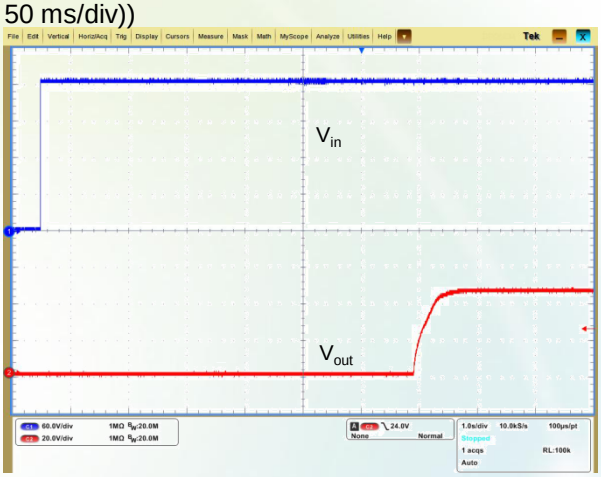

Figure 15: Turn-On DC line (100% load, 240 V DC, 1s/div)

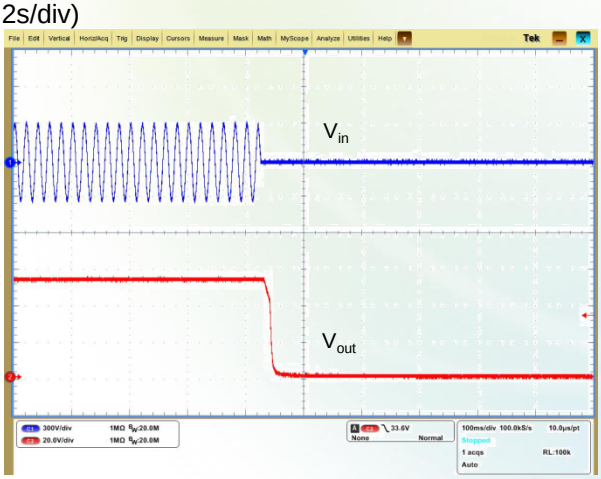

Figure 16: Turn-Off AC line (100% load, 220 V AC, 100 ms/div)

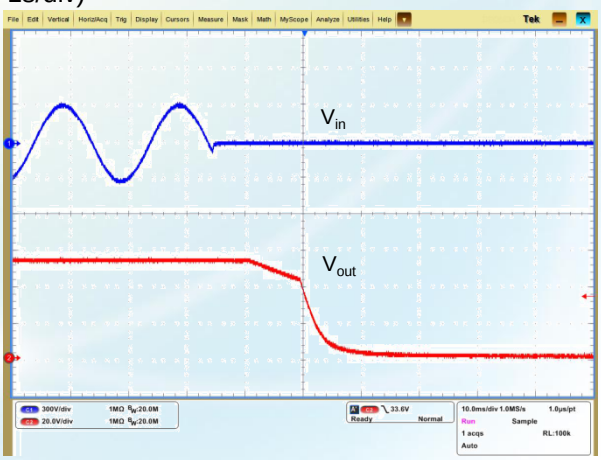

Figure 17: Turn-Off AC line (100% load, 220 V AC, 10 ms/div)

Typical Waveforms

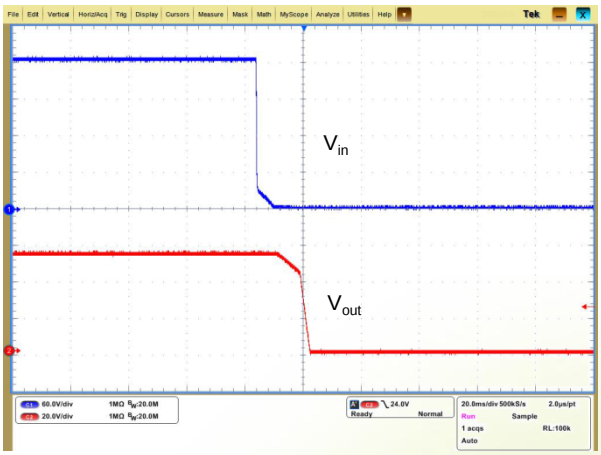

Figure 18: Turn-Off DC line (100% load 240 V DC, 20 ms/div)

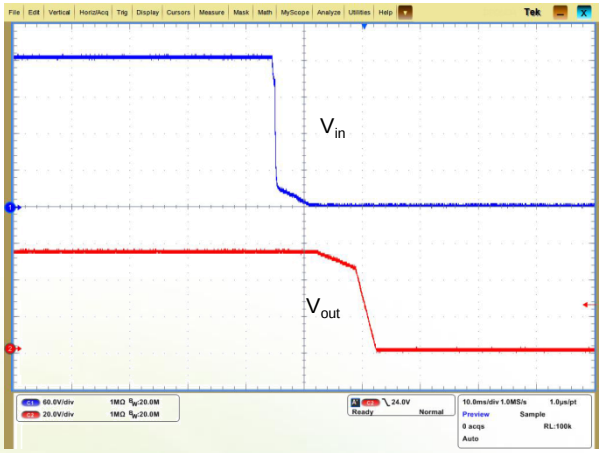

Figure 19: Turn-Off DC line (100% load 240 V DC, 10 ms/div)

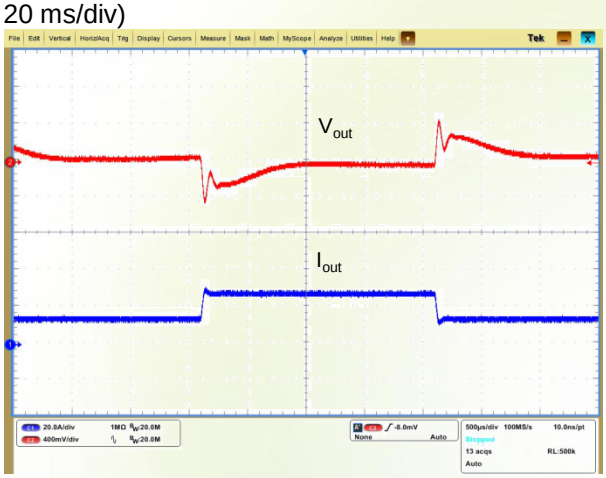

Figure 20: Output voltage dynamic response (load: 25%-50%-25%, 220 VAC, di/dt = 1 A/μs)

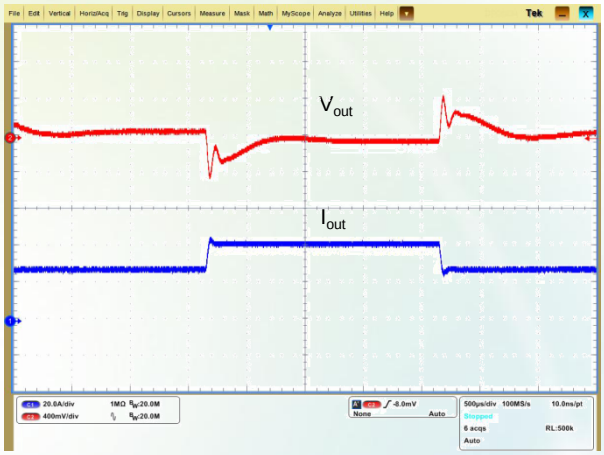

Figure 21: Output voltage dynamic response (load: 50%-75%-50%, 220 V AC, di/dt = 1 A/μs)

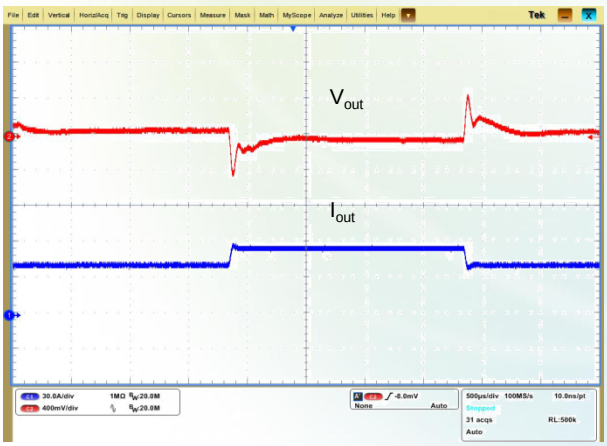

Figure 22: Output voltage dynamic response (load: 75%-100%-75%, 220 V AC, di/dt = 1 A/μs)

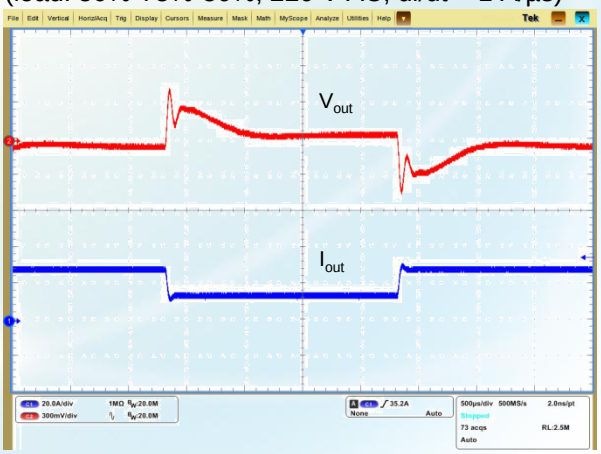

Figure 23: Output voltage dynamic response (load: 25%-50%-25%, 240 V DC, di/dt = 1 A/μs)

Typical Waveforms

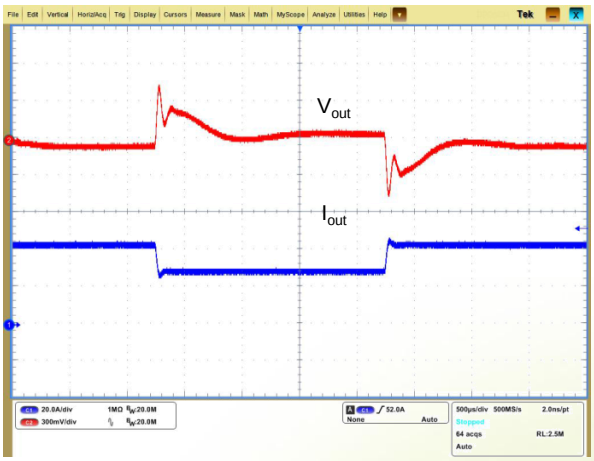

Figure 24: Output voltage dynamic response (load: 50%-75%-50%, 240 V DC, di/dt = 1 A/μs)

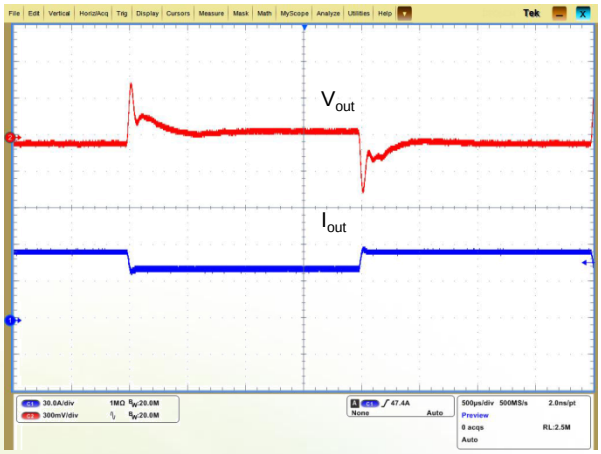

Figure 25: Output voltage dynamic response (load: 75%-100%-75%, 240 V DC, di/dt = 1 A/μs)

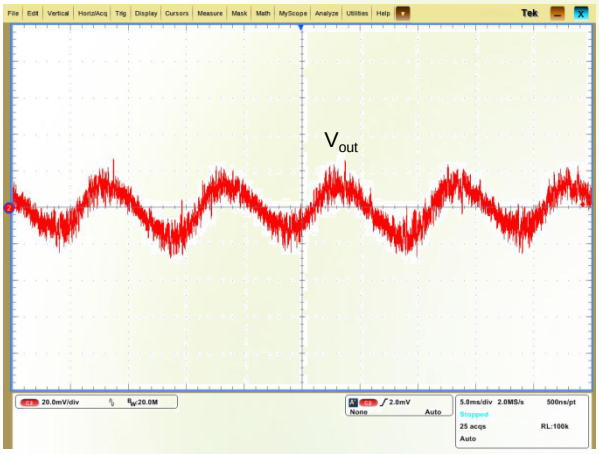

Figure 26: Output voltage ripple and noise (V_{in} = 220 V AC, I_{out} = 56.1 A)

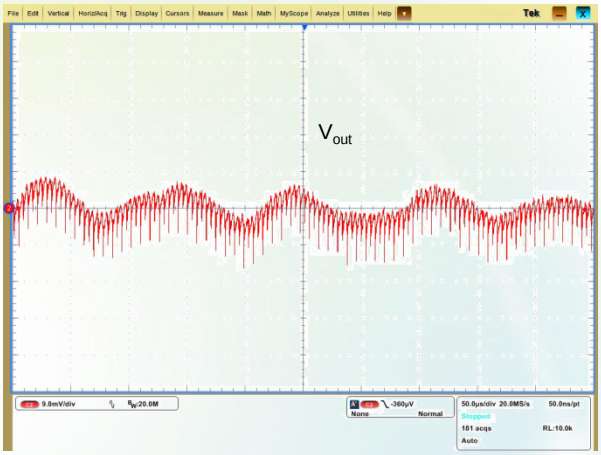

Figure 27: Output voltage ripple and noise (V_{in} = 240 V DC, I_{out} = 56.1 A)

Internal Cooling Fans

Power supply will power for the internal fans. It contains fan speed control circuits to vary the fan speed. Figure 28 shows the detail about the wind tunnel.

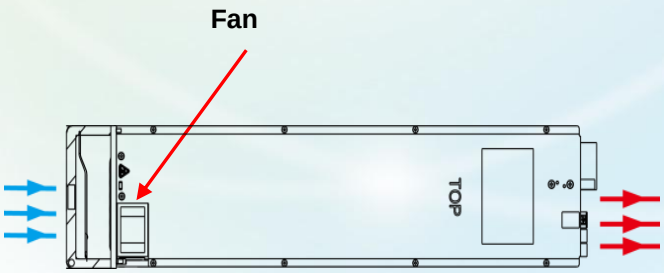

Figure 28: Wind tunnel

Load Sharing

Up to 32 PHB3000S53V5-CBs can be paralleled for redundant configurations. The current sharing is implemented over CAN communication.

Protection Characteristic

Input Overvoltage Protection

The PSU will shut down after the input voltage exceeds the input overvoltage protection threshold for shutdown. The PSU will start to work again after the input voltage reaches the input overvoltage recovery threshold for startup.

Input Undervoltage Protection

The PSU will shut down after the input voltage drops below the undervoltage protection threshold for shutdown. The PSU will start to work again after the input voltage reaches the input undervoltage recovery threshold for startup.

Input Reverse Polarity Protection

With HVDC inputs, when the input polarities are reversed, the PSU is not damaged but has no outputs with all three indicators off.

Output Overvoltage Protection

If the PSU experiences overvoltage due to an internal fault for three times within 5 minutes, the PSU locks out; for less than three times, it shuts down and restarts. You need to power off the PSU to make it exit the locking mode. If the output voltage exceeds 60 V, the PSU triggers protection within 200 ms. If the output voltage exceeds 62 V, the PSU triggers protection within 50 ms. The upper threshold of the output voltage is 65 V. External overvoltage will not affect the normal operating of the PSU.

Output Overcurrent Protection

When the output current exceeds the output overcurrent protection threshold, the PSU will enter current limit status, see figure 29. Within the 10 seconds of short circuit, the current should not exceed the maximum output current. If the short circuit persists more than 10s, the PSU triggers a protection with a time cycle of 16s, that is, it works for 6s and shuts down for 10s.

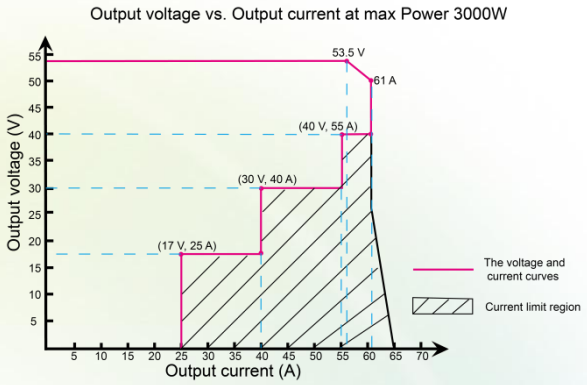

Figure 29: Output voltage *vs.* Output current at max Power 3000 W

Output Short Circuit Protection

The PSU is not damaged even with long-term short circuits and can recover automatically. The internal short circuit in the PSU does not affect the bus voltage. Within the 10 seconds of short circuit, the current should not exceed the maximum output current. If the short circuit persists more than 10s, the PSU triggers a protection with a time cycle of 16s, that is, it works for 6s and shuts down for 10s.

Overtemperature Protection

The power supply is protected against over temperature conditions caused by overload, loss of fan cooling or excessively high ambient temperature. When the ambient temperature exceeds 60°C, the overtemperature protection is triggered and the PSU output is derating. When the ambient temperature returns to normal, the PSU automatically recovers.

Mechanical Dimension

Unit of measurement: mm (in.) Tolerances: x.x ± 0.5 mm [x.xx± 0.02 in.]

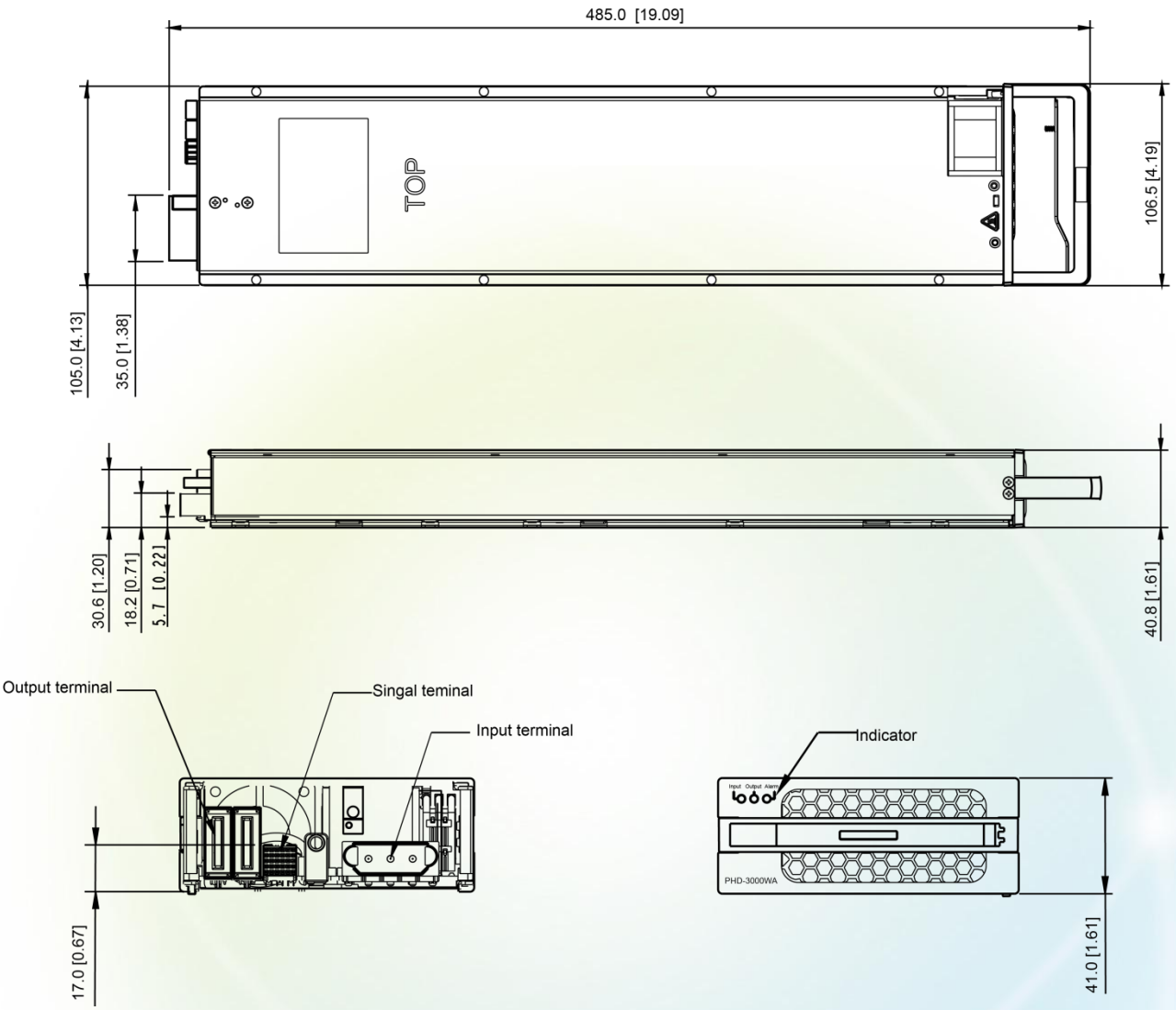

Figure 30: Mechanical dimension

Interface Description

The output connector connects the power as well as the signal to the system or the power backplane board.

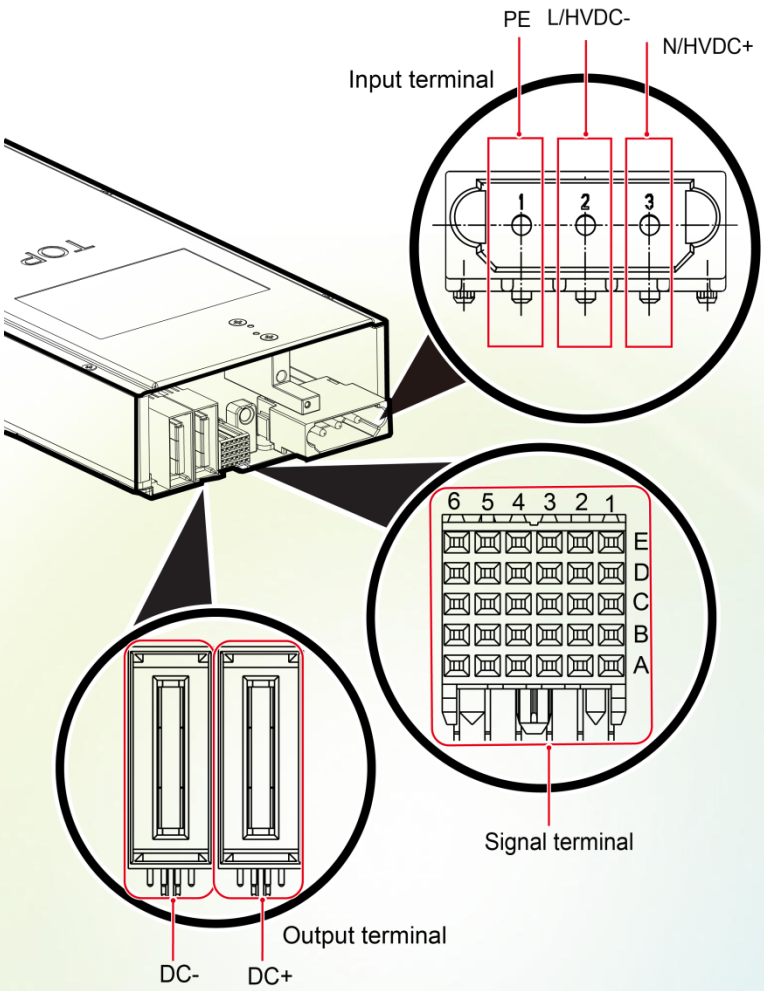

Figure 31: Rear panel

Terminal type	Manufacturer	Part number
Input terminal	China Aviation Optical-Electrical Technology Co., LTD	CZ36E-3T
	Suzhou Huazhan Space Appliance Co., LTD	SJ019-3PZWH1
Output terminal	MOLEX	755561500
Signal terminal	CHIEF LAND ELECTRONIC Co., LTD	091A01-8A00A

The following table describes the signal terminal definitions:

Pin	Definition	Function
A1	ON/OFF3	Control the PSU output with connecting to a mechanical switch.
A2	ON/OFF4	Control the PSU output with connecting to a mechanical switch.
A3	NC	-
A4	Ishare +	Current share bus+ (ports to reserve)
A5	Ishare -	Current share bus- (ports to reserve)
A6	ADDR3	Address 3
B1	Present	Detect whether the DC power module securely connects to the system backplane
B2	GND	Shorted to ground inside the power supply and CAN signals.
B3	NC	-
B4	ON/OFF2	Control the PSU output with connecting to a mechanical switch.
B5	ON/OFF1	Control the PSU output with connecting to a mechanical switch.
B6	ADDR2	Address 2
C1, C2, C3, C4	NC	-
C5	ADDR5	Address 5
C6	ADDR1	Address 1
D1	CAN_L_1	Channel 1 CANL
D2, D4	NC	-
D3	CAN_L_0	Channel 0 CANL
D5	ADDR4	Address 4
D6	ADDR0	Address 0
E1	CAN_H_1	Channel 1 CANH
E2, E4	NC	-
E3	CAN_H_0	Channel 0 CANH
E5	ENABLE	Enable output
E6	ADDR_GND	Address GND

Indicator And Alarm

LED	Condition	Description
Input LED (Green)	Steady On	Input normal
	Blinking	Input undervoltage, input overvoltage
	Steady Off	No input
Output LED (Green)	Steady On	Output normal
	Steady Off	No output, output voltage less than 44 V
Alarm LED (Red)	Steady Off	PSU normal
	Steady On	Fan faults, severe current imbalance, shutdown due to overtemperature, output overvoltage protection, an internal fault of the PSU

Monitor And Communication

The PSU communicates with the monitoring module over CAN. The two CAN ports on the PSU are designed isolated. An internal 5 V DC power supply is supplied for the CAN ports.

The PHB3000S53V5-CB develops the following monitoring & communication functions and faults detection functions**:**

Monitoring & communication functions:

- Input voltage, Input current, Input power
- Output voltage, Output current, Output power
- PSU state
- PSU present signal
- ON/Off (Power on/off, System shutdown delay)
- Indicator
- Electronic label
- Fan speed
- Address zone
- Fan fault

Faults detection functions:

- Reports alarms for input under/overvoltage
- Reports alarms for input disconnection
- Reports alarms for output overvoltage
- Reports alarms for output overcurrent, and short circuits
- Reports alarms for overtemperature
- Reports alarms for fan faults

For more monitoring and communication information, please refer to ***Appendix A CMU Command***.

Safety Precautions

You are advised to provide two power inputs for the system. Power configuration in N+N mode is preferred. The following figure shows the power configuration in 3+3 mode.

- Configure a circuit breaker (with a rated current not less than 25 A) for each PSU.
- The rated current of the upstream circuit breaker for each power input is recommended to be not less than 63 A.
- The PSU should be properly grounded. Otherwise, it will be damaged due to a lightning strike.

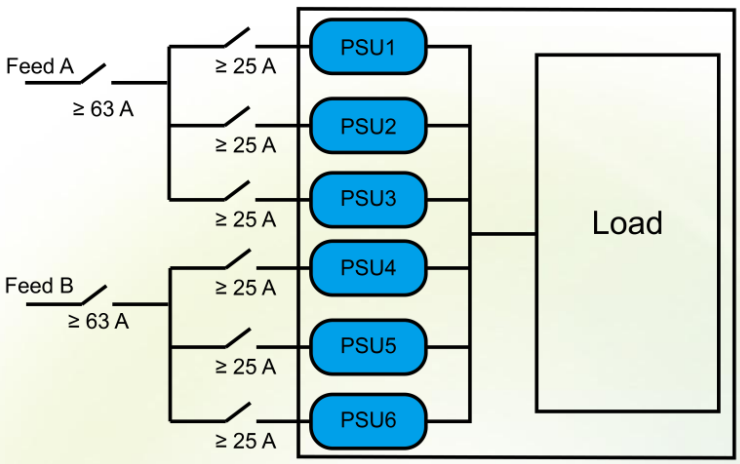

Figure 32: Application configuration in system

Appendix A CMU Command

Command (hex)	Transaction Type	Data format	Description
Control commands			
0x0001	Read word	4Bytes	Module types characteristic data
0x0002	Read/Write word	6Bytes	Serial number
0x0003	Read/Write word	6Bytes	Bar code 1
0x0004	Read/Write word	6Bytes	Bar code 2
0x0005	Read word	2Bytes	Hardware version number
		2Bytes	DCDC Software version number
		2Bytes	PFC Software version number
0x012F	Read word	1Bytes	Input voltage type
0x0136	Write word	1Bytes	Shut down DCDC output
		4Bytes	Set startup delay time
0x0170	Read word	4Bytes	Input power
0x0171	Read word	4Bytes	AC input frequency
0x0172	Read word	4Bytes	Input current
0x0173	Read word	4Bytes	DC output power
0x0174	Read word	4Bytes	Real-time efficiency
0x0175	Read word	4Bytes	DC input voltage measured value
0x0176	Read word	4Bytes	Actual output current limit
0x0177	Read word	4Bytes	Actual output power limit
0x0178	Read word	2Bytes	AC phase No.
		4Bytes	AC/HVDC input voltage
0x017F	Read word	4Bytes	Internal temperature
0x0180	Read word	4Bytes	Air intake vent temperature
0x0181	Read word	4Bytes	Actual output current
0x0182	Read word	4Bytes	Displayed output current
0x0183	Read word	4Bytes	The current alarm / status
0x0187	Read word	2Bytes	Module calculates the duty cycle
		2Bytes	Fans effective duty
		2Bytes	Wind speed query
0x0188	Read word	2Bytes	module rated current
0x019E	Read word	4Bytes	module rated power
0x019F	Read word	4Bytes	Maximum output power reporting
0x0201	Read/Write word	6Bytes	Communication state

Appendix A CMU Command

Command (hex)	Transaction Type	Data format	Description
Control commands			
0x0202	Read word	4Bytes	Heartbeat
0x0203	Read word	6Bytes	External switch status
0x0204	Read/Write word	4Bytes	Heartbeat wake-up time
0x0205	Write word	4Bytes	External switch Delay
0x0220	Read word	4Bytes	Read SD5K software version
0x030E	Read word	4Bytes	Read SD5K running time
0x0388	Read word	4Bytes	Read the last power failure alarm of the SD5K

HUAWEI TECHNOLOGIES CO., LTD.
Huawei Industrial Base Bantian Longgang
Shenzhen 518129
People's Republic of China
www.huawei.com