PAH-3000WA PSU

Technical Manual

Issue V1.0

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HUAWEI TECHNOLOGIES CO., LTD.

About This Document

Purpose

This document describes the PAH-3000WA power supply unit (PSU), including its features, electrical specifications, applications, and communication.

The figures provided in this document are for reference only.

Intended Audience

This document is intended for:

- Hardware engineers
- Software engineers
- System engineers
- Technical support engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Calls attention to important information, best practices and tips. NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

Change History

Changes between document issues are cumulative. The latest document issue contains all updates made in previous issues.

Issue 01 (2019-03-25)

This issue is the first official release.

Contents

1 Product Overview

PAH-3000WA 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 is protected against output overcurrent, output overvoltage, and overtemperature. The PSU has a built-in fan for heat dissipation. The fan draws air in from the front and exhausts air from the rear.

The PSU provides a CAN communication connector, which allows it to communicate with and send electronic serial numbers to the host to facilitate monitoring and management.

Features

- Efficiency: peak efficiency of 96%; ≥ 95% (V_{in} = 230 V AC/240V DC/380 V DC; 40%-70% load)
- Depth x Width x Height: 485.0 x 104.8 x 40.8 mm (19.10 x 4.13 x 1.61 in.)
- Weight: < 3.0 kg
- Power grid: 110/220 V AC single-phase, 110 V AC dual-live wire, 240/380 V DC
- Overvoltage, overcurrent, and overtemperature protection
- CAN communication interface for controlling, programming, and monitoring
- CE, UL, and TUV certification and CB report available
- UL62368, EN62368 and IEC62368 compliant
- RoHS6 compliant

Model Naming Convention

P	AH-	3000W	A
1	2	3	4

1 - Embedded power

2 - AC+HVDC input

3 - Output power: 3000 W

4 - Version: A

Applications

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

2 Electrical Specifications

2.1 Environmental

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Ambient temperature (T_A)	-5	-	55	°C	● The ambient temperature refers to the temperature at the air intake vent of the PSU. ● At an ambient temperature of －40°C and input voltage of 190－400 V DC/176－290V AC, the PSU is able to start with rated power of 3000 W. ● All common performance indicators of the PSU must meet the requirements when the PSU works at a temperature ranging from －5°C to +55°C. For details, see **Derating Curves**.
Storage temperature	－40	-	85	°C	-
Relative humidity	5	-	95	% RH	Non-condensing
Altitude	－60	0	5000	m	When the altitude is between 1800 m and 5000 m, the temperature decreases by 1°C for each additional 200 m. The output power can be derated to 80% when the altitude is between 4000 m and 5000 m.

2.2 Input

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
AC input voltage range	90	-	290	V AC	Supports single-phase and dual-live wire. If the input voltage is 318 V AC for a long time (T < 2 h), the PSU does not have to work, but it should not be damaged. When the input voltage is lower than 176 V AC, the PSU power needs to be derated.
Rated AC input voltage range	100	110/220	240	V AC	-
AC input voltage frequency	45	50/60	65	Hz	-
Power factor (T_A = 25°C)	0.99	-	-	-	V_{in} = 208/220/230/240 V AC (50/60 Hz), 100% load
	0.98	-	-	-	V_{in} = 208/220/230/240 V AC (50/60 Hz), 25 – 100% load
	0.9	-	-	-	V_{in} = 208/220/230/240 V AC (50/60 Hz), 10 – 25% load
	0.6	-	-	-	V_{in} = 208/220/230/240 V AC (50/60 Hz), 3 – 10% load
THD	-	-	5	%	T_A = 25°C, V_{in} = 208/220/230/240 V AC (50/60 Hz), THDi ≤ 5%, 50% – 100% load
AC input current	-	-	19	A	● ≤ 16 A, V_{in} = 200 V AC, full load ● ≤ 19 A, V_{in} = 176 V AC, full load ● ≤ 19 A, V_{in} = 90 V AC, 50% load
Standby power	-	-	10	W	output off
	-	-	30	W	output on
Input inrush current	-	-	50	A	T_A = 25°C; V_{in} = 290 V AC; ETSI300132-3 compliant
HVDC input voltage range	188	-	400	V DC	With an HVDC input of 410 V, the PSU is not damaged within 2 hours but may not be working. There is no derating requirement on the PSU.

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Rated HVDC input voltage range	240	270/378	380	V DC	-
DC input current	-	-	18	A	● ≤ 14 A, V_{in} = 240 V DC, full load ● ≤ 18 A, V_{in} = 188 V DC, full load
Input inrush current	-	-	40	A	T_A = 25°C; V_{in} = 400 V DC; ETSI300132-2 compliant

2.3 Output

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Output power	-	-	3000	W	V_{in} = 176 V AC–290 V AC or V_{in} = 188 V DC–400 V DC
	1500	-	-	W	With an input voltage of less than 176 V AC, the PSU power should be derated.
Output voltage range	-	53.5	-	V DC	T_A = 25°C ● 53.5±5 V DC, V_{in} = 270 V DC; 50% load ● 53.5±5 V DC, V_{in} = 378 V DC; 50% load ● 53.5±5 V DC, V_{in} = 220 V AC; 50% load
Regulated voltage precision	-	-	±3	%	Full range of V_{in}, I_{out}, and T_A
Line regulation	-	-	±1	%	V_{out} = 53.5 V DC
Load regulation	-	-	±1	%	V_{out} = 53.5 V DC; I_{out} > 1 A
Current share imbalance	-	-	±5	%	≥ 30% load
Overshoot at turn-on/ turn-off	-	-	±5	%	V_{out} = 53.5 V DC
Dynamic response recovery time	-	-	200	µs	● di/dt = 1 A/µs; response cycle: 4 ms (1:1); load: 25% – 50% – 25%; 50% – 75% – 50%; 75% – 100% – 75%

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Dynamic response overshoot	-	-	2.5	V DC	● di/dt = 0.1 A/μs; response cycle: 4 ms (1:1); load: 10% – 90% – 10%
Temperature coefficient	-	-	±0.02	%/°C	-
External capacitance	-	-	22,000	μF	-
Turn-on output delay	-	-	8	s	Time for the output voltage to rise to 46 V
	-	-	16	s	Time for the output voltage to rise to 90%V_{out}
Output ripple and noise (peak to peak) (Vin ≤ 264 V AC)	-	-	200	mV	V_{in} = 90 – 264 V AC or V_{in} = 188 – 400 V DC Oscilloscope bandwidth: 20 MHz; YD731-2008 compliant Tested with a 0.1 μF ceramic (metalized film) capacitor and a 10μF electrolytic capacitor connected to the output terminal.
			300	mV	T_A = -25°C to -5°C Oscilloscope bandwidth: 20 MHz; YD731-2008 compliant Tested with a 0.1 μF ceramic (metalized film) capacitor and a 10μF electrolytic capacitor connected to the output terminal.
			500	mV	V_{in} = 264 – 290 V AC Oscilloscope bandwidth: 20 MHz; YD731-2008 compliant Tested with a 0.1 μF ceramic (metalized film) capacitor and a 10μF electrolytic capacitor connected to the output terminal.
Output hold-up time	10	-		ms	T_A = 25°C; V_{in} = 220 V AC/240 V DC/380 V DC; V_{out} = 42 V DC; 100% load
	20	-		ms	T_A = 25°C; V_{in} = 220 V AC/240 V DC/380 V DC; V_{out} = 42 V DC; 50% load
Input voltage measurement precision	-	-	±5	V AC	V_{in} = 85 – 300 V AC

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
			±5	V DC	V_{in} = 190 – 400 V DC
Hot swap	-	-	-	-	Supports hot swaps at an interval of 1s.

2.4 Efficiency

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Peak efficiency	96	-	-	%	T_A = 25°C, V_{in} = 230V AC/240V DC/380 V DC; For the overlapped load range, calculate the efficiency based on the larger value.
40% – 70% load	95	-	-	%	
70% – 100% load	94	-	-	%	
20% – 40% load	92	-	-	%	

2.5 Protection

AC Input

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Input overvoltage protection threshold	300	-	-	V AC	Hysteresis ≥5 V Self-recovery
Input overvoltage recovery threshold	290	-	-	V AC	
Input undervoltage protection threshold	-	-	85	V AC	Hysteresis ≥5 V Self-recovery
Input undervoltage recovery threshold	-	-	90	V AC	
Input overcurrent	-	-	-	-	The AC input live wire and neutral wire are configured with fuses.
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.
Primary short circuit protection	-	-	-	-	A resistance fuse is configured at the input end to protect the upstream input voltage.

HVDC Input

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Input overvoltage protection threshold	410	-	-	V DC	Self-recovery; hysteresis ≥ 5 V
Input overvoltage recovery threshold	400	-	-	V DC	
Input undervoltage protection threshold	-	-	175	V DC	Self-recovery; hysteresis ≥ 12 V
Input undervoltage recovery threshold	-	-	187	V DC	
Input soft-start protection	-	-	-	-	A soft-start circuit needs to be available for the input, preventing the transient voltage generated during hot swap from damaging the internal circuits. The total capacity of EMI filter capacitors before the soft-start circuit is less than 25 μF to prevent voltage drop when the load power increases.
Input polarity reverse protection	-	-	-	-	The PSU output is normal when the input polarity is reversed.
Primary short circuit protection	-	-	-	-	A 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. The upstream circuit breaker should have a rated current of at least 25 A (C characteristic curve). A short circuit after the fuse must not cause the circuit breaker to trip.

Output Protection

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Output overvoltage protection threshold	57	-	60	V	Latch-off protection mode. The PSU must have output if bus overvoltage occurs. ● The PSU latches off if overvoltage occurs due to an internal fault of the PSU. If overvoltage occurs three times within 5 minutes, the PSU shuts down and then restarts when overvoltage occurs the first and second times and latches off when overvoltage occurs the third time. ● The duration for which the output voltage exceeds 60 V to 62 V must be less than 200 ms. If the output voltage exceeds 62 V, the PSU needs to trigger protection within 50 ms. The maximum output voltage must not exceed 65 V. ● Overvoltage outside the PSU must not cause the PSU to stop working. ● If the PSU is powered off completely (the DSP is powered off completely), the PSU exits from the latch-off state caused by overvoltage.
Output overcurrent protection threshold	110	-	150	%	110% – 150% rated load. The PSU can automatically recover after the fault is rectified. For details, see **PSU Output Curve**.
Overtemperature protection	60	-	-	°C	Self-recovery; hysteresis ≥ 5°C
Output short circuit protection	-	-	-	-	The PSU is not damaged by a long-time short-circuit. The PSU can automatically recover after the fault is rectified. The PSU should be isolated after encountering a short circuit.
Output isolation protection	-	-	-	-	Output fault isolation, supports automatic exit when a fault occurs.

2.6 Switchover Between Two Inputs

Active Input Selection After Power-On

Item	Switchover Condition	Switchover Requirements
Active/Standby input selection after power-on	The host sends a switchover command.	If the power input meets the power supply requirements after the switchover, the PM performs a switchover. If the power input cannot meet the power supply requirements after the switchover, the PM does not perform a switchover. **NOTE** During the switchover, the output voltage cannot be less than 42 V.
	The host does not send a command. Instead, the PM automatically performs a switchover for adaptation.	If both power inputs meet the power supply requirements after the switchover: ● AC+AC: The active input is switched to input A. ● HVDC+HVDC: The active input is switched to input A. ● AC+HVDC: The AC input is the active input, and the HVDC input is the standby input. If only one power input meets the power supply requirements after the switchover: ● AC+AC: The active input is switched to the one that meets the power supply requirements. ● HVDC+HVDC: The active input is switched to the one that meets the power supply requirements. ● AC+HVDC: The active input is switched to the one that meets the power supply requirements. **NOTE** ● For details about the definition of inputs A and B, see the definition of the input terminal in section **7.1 Dimensions** (input A: P1–P3; input B: P4-P6). ● During the switchover, the output voltage cannot be less than 42 V.

Switchover During the Working Process

Item	Switchover Condition	Switchover Requirements
Input power failure	The current input is powered off.	If the other power input meets the power supply requirements after the switchover, the PM performs a switchover. During the switchover, the output voltage cannot be less than 42 V. If the other power input does not meet the power supply requirements after the switchover, the PM does not perform a switchover and allows the output to be powered off.
Input undervoltage	The current input experiences undervoltage.	If the other power input meets the power supply requirements after the switchover, the PM performs a switchover. During the switchover, the output voltage cannot be less than 42 V. If the other power input does not meet the power supply requirements after the switchover, the PM does not perform a switchover and allows the output to be powered off.
Input overvoltage	The current input experiences overvoltage.	If the other power input meets the power supply requirements after the switchover, the PM performs a switchover. During the switchover, the output voltage cannot be less than 42 V. If the other power input does not meet the power supply requirements after the switchover, the PM does not perform a switchover and allows the output to be powered off.

Item	Switchover Condition	Switchover Requirements
Input A recovers.	Input A recovers when input B supplies power.	If input A meets the power supply requirements after the switchover, the PM performs a switchover. During the switchover, the output voltage cannot be less than 42 V. If input A does not meet the power supply requirements after the switchover, the PM does not perform a switchover.
Minimum switchover time	Minimum interval between two switchovers	After each switchover, the next switchover can be performed only after at least 3 seconds. For a switchover requirement raised within the minimum interval, the PM does not perform a switchover and allows the output to be powered off.

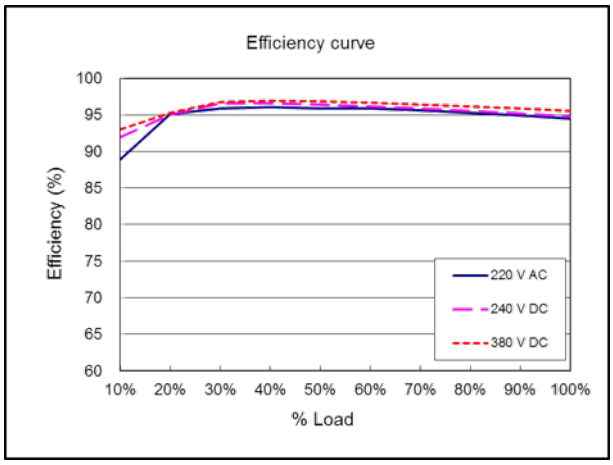
NOTE

The default input priority for the PM is as follows: AC in the high-power segment > HVDC > AC in the low-power segment

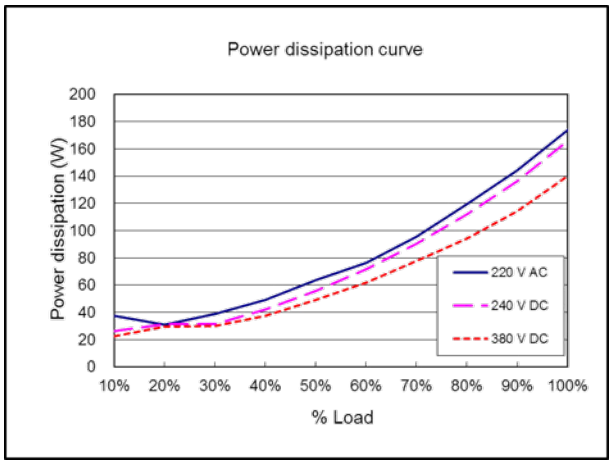
3 Characteristic Curves

Efficiency and Power Dissipation Curves

Conditions: T_A = 25°C unless otherwise specified

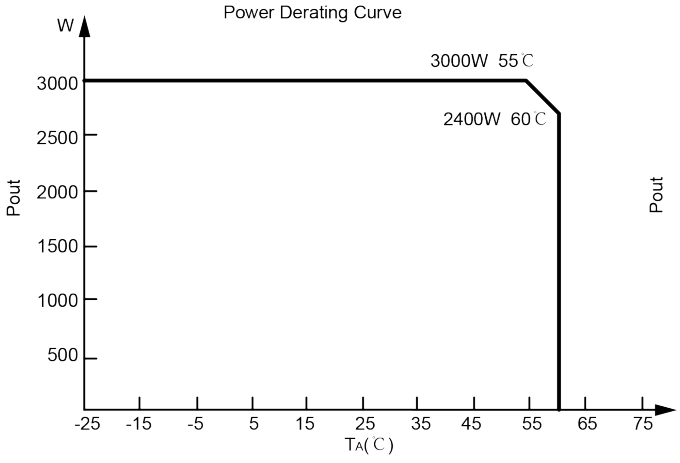


Efficiency curve

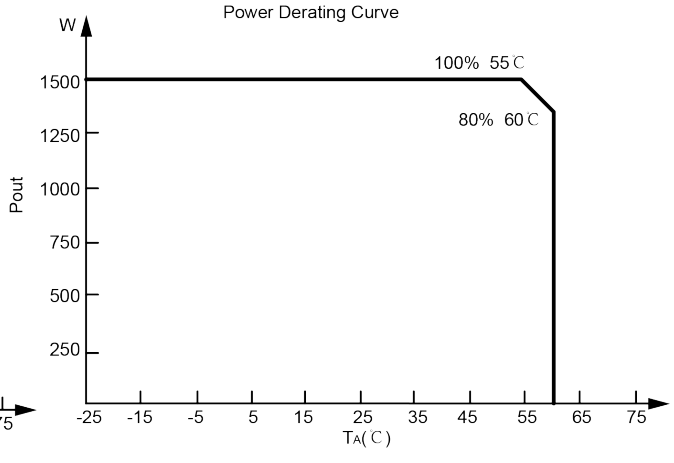


Power dissipation curve

Derating Curves

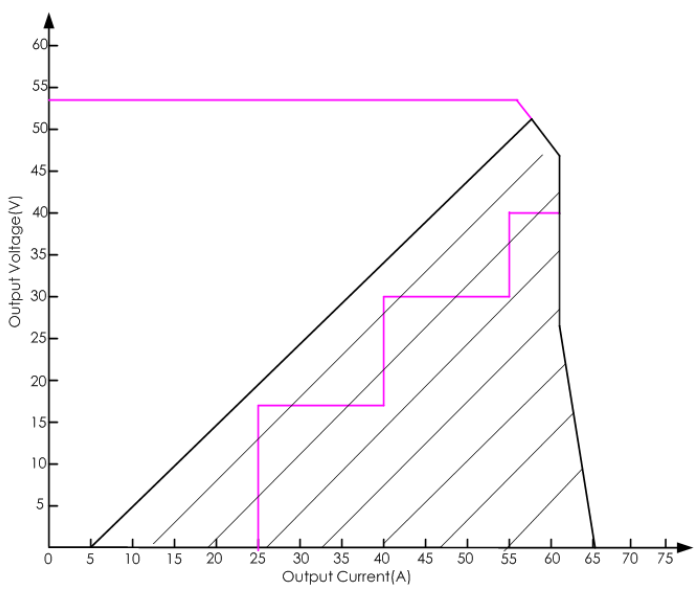


V_{in} > 176 V AC



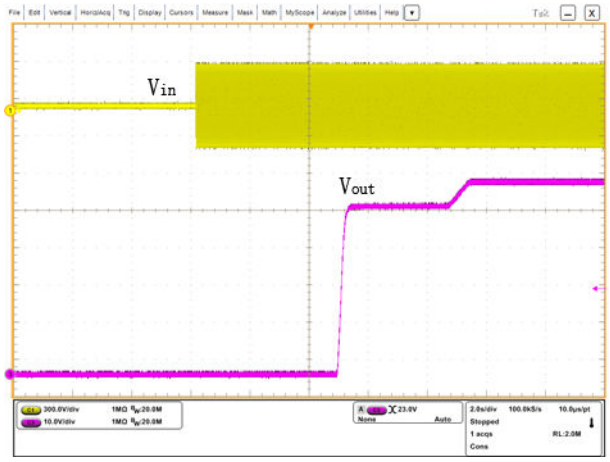
V_{in} < 176 V AC

PSU Output Curve



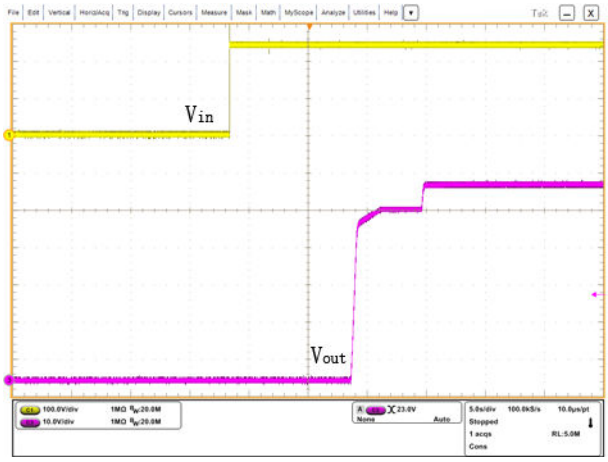
4 Typical Waveforms

4.1 Turn-on/Turn-off



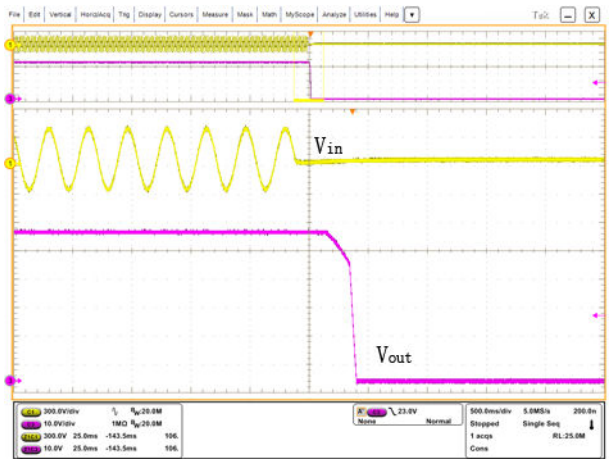
Turn-on for AC input

(T_A = 25°C, V_{in} = 220 V AC, V_{out} = 53.5 V, 100% load)



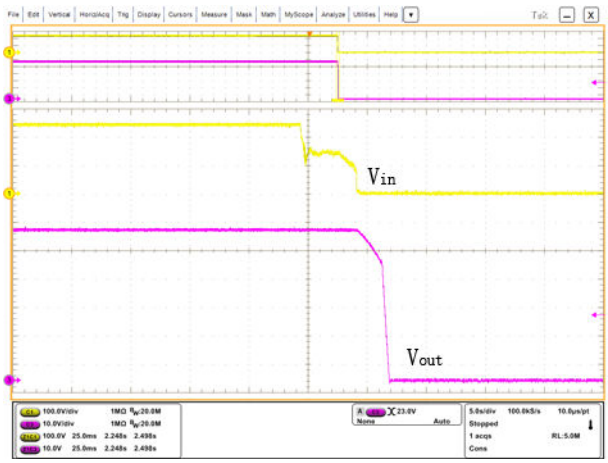
Turn-on for HVDC input

(T_A = 25°C, V_{in} = 240 V DC, V_{out} = 53.5 V, 100% load)



Turn-off for AC input

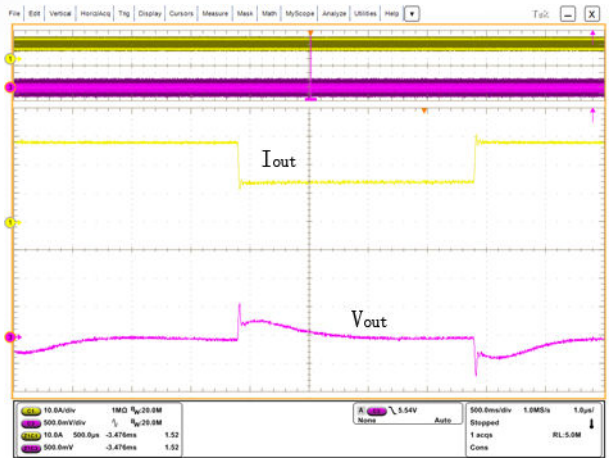
(T_A = 25°C, V_{in} = 220 V AC, V_{out} = 53.5 V, 100% load)



Turn-off for HVDC input

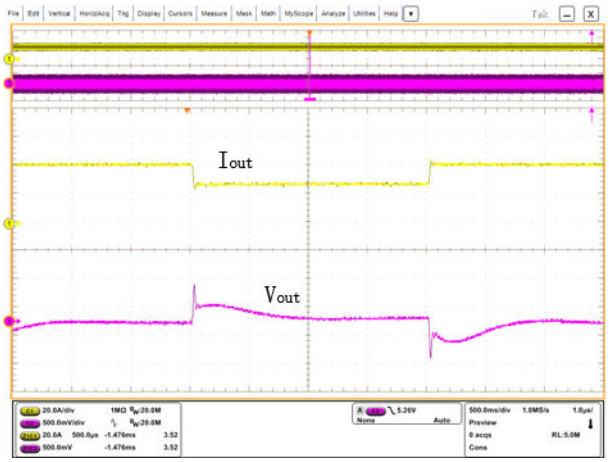
(T_A = 25°C, V_{in} = 240 V DC, V_{out} = 53.5 V, 100% load)

4.2 Output Voltage Dynamic Response



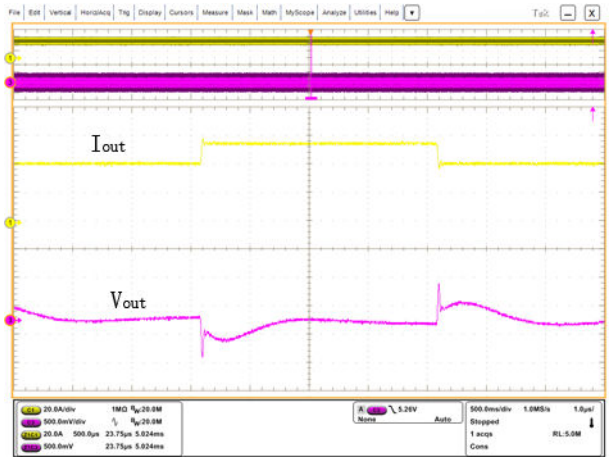
Output voltage dynamic response

(T_A = 25°C, V_{in} = 220 V AC, Load: 25% ⇔ 50% ⇔ 25%, di/dt = 1 A/μs)



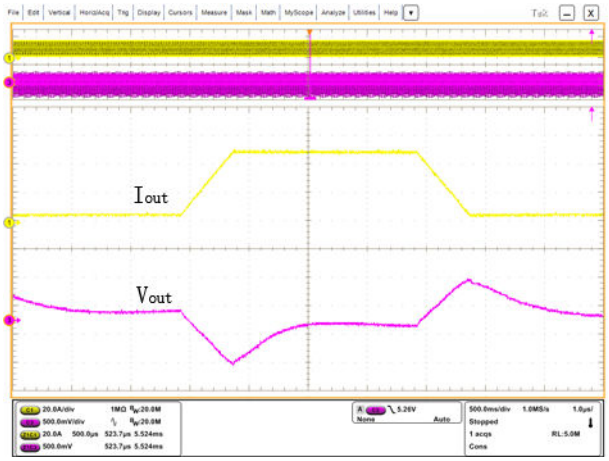
Output voltage dynamic response

(T_A = 25°C, V_{in} = 220 V AC, Load: 50% ⇔ 75% ⇔ 50%, di/dt = 1 A/μs)



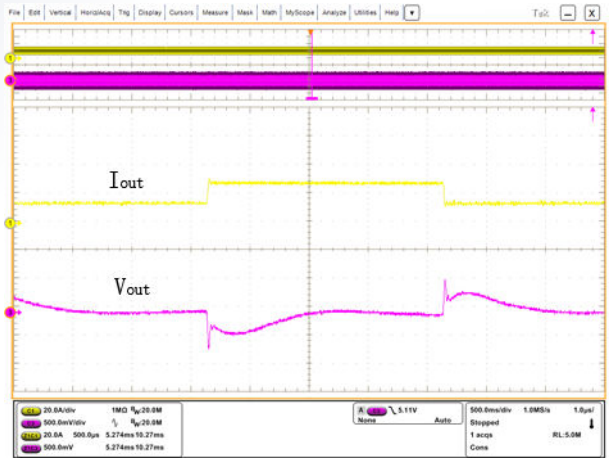
Output voltage dynamic response

(T_A = 25°C, V_{in} = 220 V AC, Load: 75% ⇔ 100% ⇔ 75%, di/dt = 1 A/μs)



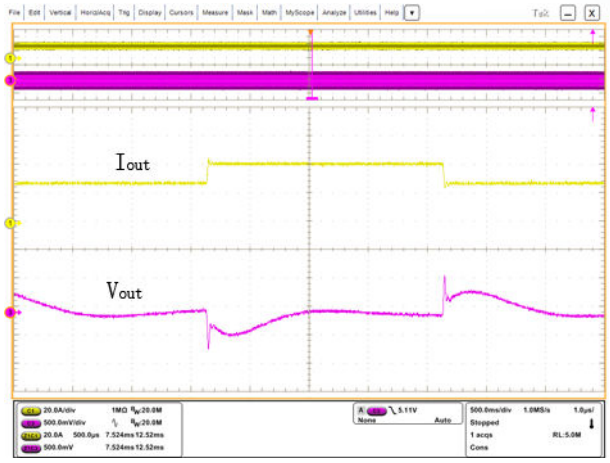
Output voltage dynamic response

(T_A = 25°C, V_{in} = 220 V AC, Load: 10% ⇔ 90% ⇔ 10%, di/dt = 0.1 A/μs)



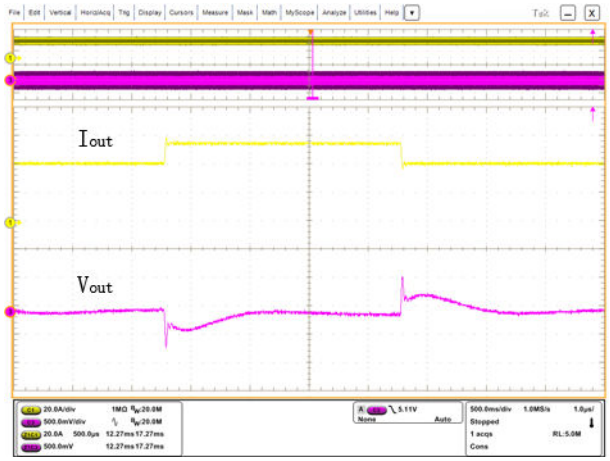
Output voltage dynamic response

(T_A = 25°C, V_{in} = 240 V DC, Load: 25% - 50% - 25%, di/dt = 1 A/μs)



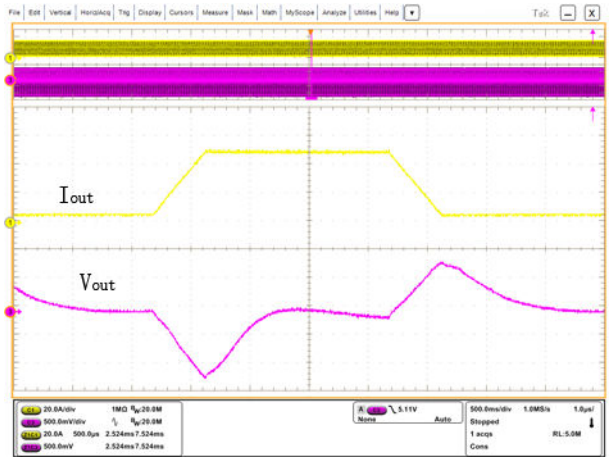
Output voltage dynamic response

(T_A = 25°C, V_{in} = 240 V DC, Load: 50% - 75% - 50%, di/dt = 1 A/μs)



Output voltage dynamic response

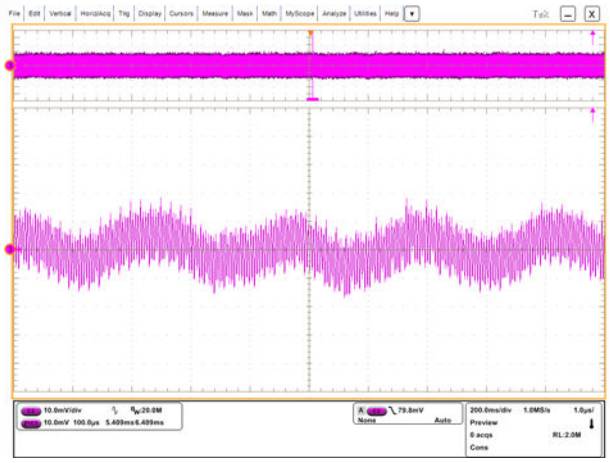
(T_A = 25°C, V_{in} = 240 V DC, Load: 75% - 100% - 75%, di/dt = 1 A/μs)



Output voltage dynamic response

(T_A = 25°C, V_{in} = 240 V AC, Load: 10% - 90% - 10%, di/dt = 0.1 A/μs)

4.3 Output Voltage Ripple



T_A = 25°C, V_{in} = 240 V DC, V_{out} = 53.5 V, 100% load

5 Parallel Operation

Current Share Design Requirements

1. When the load is light, the current share imbalance increases and a PSU may have no output. In this scenario, the alarm indicating abnormal output needs to be masked for the PSU.

   NOTE

   At above 10% of rated load, each PSU must have output.

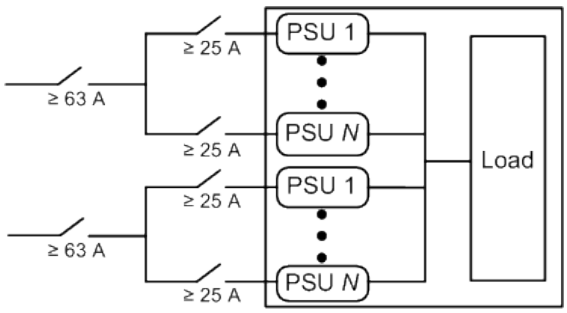
2. Dynamic response of PSU requires that load: 25% – 50% – 25% and 50% – 75% – 50%, di/dt = 1 A/μs. Output overshoot is less than 5% rated V_{out}.
3. Output voltage adjustment range of the current sharing circuit on the PSU: ±1.2 V.
4. PSUs share current through CAN communication. The PSUs that share current must communicate with each other properly and share the output.
5. Current sharing is supported when the PAH-3000WA is used with the PHD-3000WA.

Safety Precautions

You are advised to provide two power inputs for the system. PSU configuration in N+N mode is preferred.

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

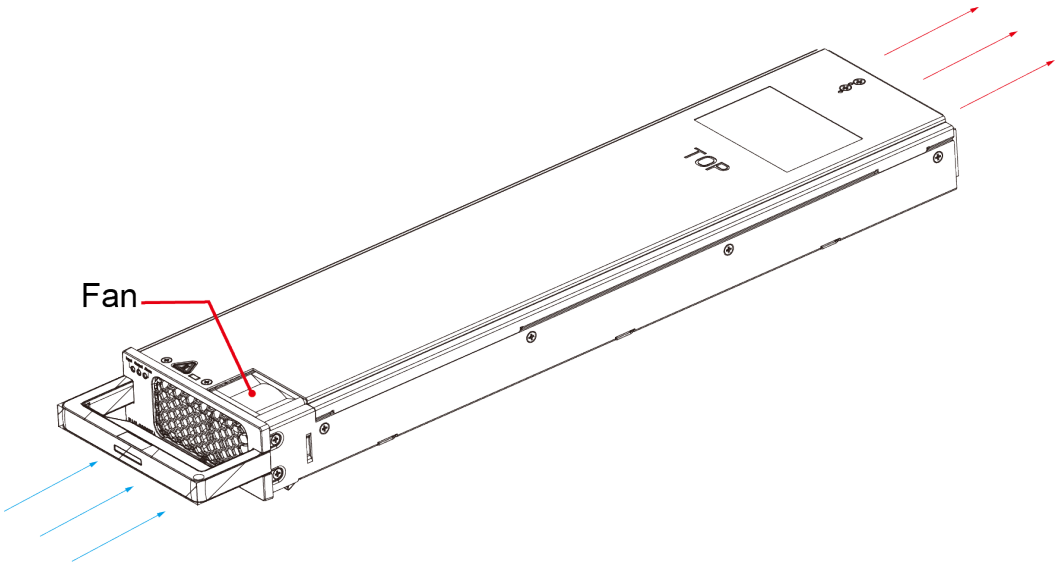
Figure 5-1 Application scenario



6 Internal Cooling Fan

The PSU supplies power to the internal fan. It contains fan speed control circuits to vary the fan speed.

Figure 6-1 Air channel

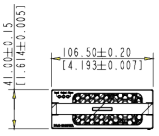


7 Product Structure

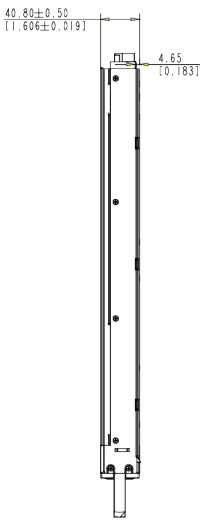
7.1 Dimensions

Unit of measurement: mm (in.)

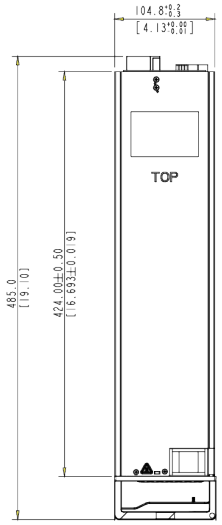
Dimensions (D x W x H): 485.0 x 104.8 x 40.8 mm (19.10 x 4.13 x 1.606 in.)



FRONT VIEW

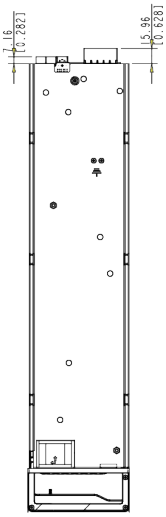


RIGHT VIEW

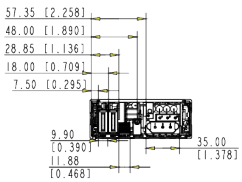


TOP VIEW

LEFT VIEW



BOTTOM VIEW



BACK VIEW

7.2 Connectors

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

Figure 7-1 Rear panel

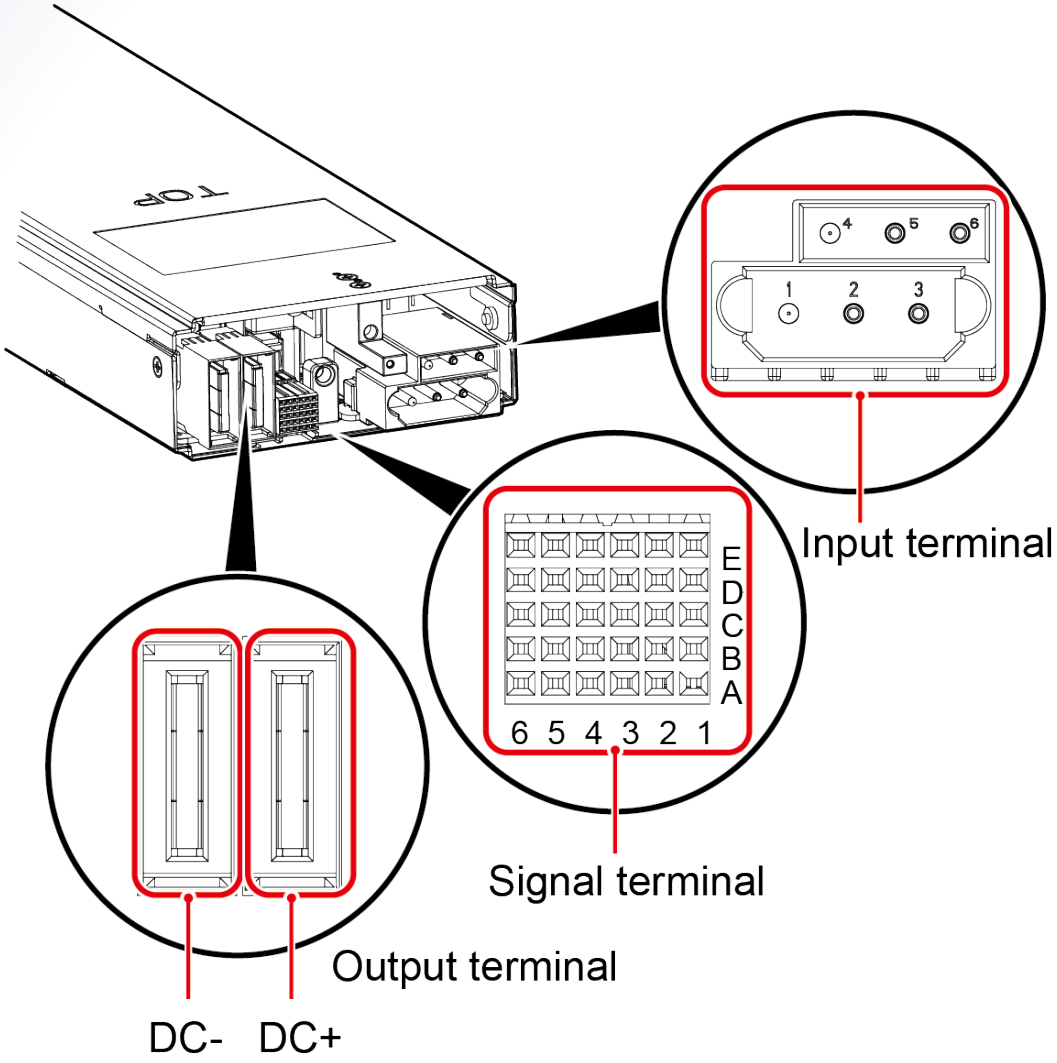


Table 7-1 Input connector pin definitions

Pin	Name	Description
P1 and P4	PE	PE
P2 and P5	L/HVDC-	AC input: live wire; HVDC-
P3 and P6	N/HVDC+	AC input: neutral wire; HVDC+

Table 7-2 Communications connector pin definitions

Pin	Name	Description
A1	ON/OFF3	Control the PSU output with connecting to a mechanical switch.
A2	ON/OFF2	Control the PSU output with connecting to a mechanical switch.
A4	Ishare+	Current sharing signal +
A5	Ishare-	Current sharing signal -
A6	ADDR3	Address 3 Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. The address depends on whether the backplane is pulled down to ADDR_GND.
B1	Present	Presence signal PSU presence signal pin that is pulled down to GND through a 200 Ω resistor inside the PSU. The backplane (PMU/CMU) is pulled up to 3.3 V. The PMU/CMU determines whether the PSU is present by detecting the level of this pin.
B2	GND	Signal isolation GND Connected to the CAN signal GND through a resistor inside the PSU. The backplane is short-circuited to the system GND. The GND pin is referenced to the backplane GND signal.
B4	ON/OFF1	Control the PSU output with connecting to a mechanical switch.
B5	ON/OFF0	Control the PSU output with connecting to a mechanical switch.
B6	ADDR2	Address 2 Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. The address depends on whether the backplane is pulled down to ADDR_GND.
C5	ADDR5	Address 5 Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. The address depends on whether the backplane is pulled down to ADDR_GND.

Pin	Name	Description
C6	ADDR1	Address 1 Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. The address depends on whether the backplane is pulled down to ADDR_GND.
D1	CAN_L_1	CAN low, channel 1 Communications signal pin that is short-circuited to CAN_L_1 of another PSU.
D3	CAN_L_0	CAN low, channel 0 Communications signal pin that is short-circuited to CAN_L_0 of another PSU.
D5	ADDR4	Address 4 Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. The address depends on whether the backplane is pulled down to ADDR_GND.
D6	ADDR0	Address 0 Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. The address depends on whether the backplane is pulled down to ADDR_GND.
E1	CAN_H_1	CAN high, channel 1 Communications signal pin that is short-circuited to CAN_H_1 of another PSU.
E3	CAN_H_0	CAN high, channel 0 Communications signal pin that is short-circuited to CAN_H_0 of another PSU.
E5	ENABLE	Output enable Pulled up to 3.3 V through a 4.7 kΩ resistor inside the PSU. When this pin is in low level state, the output is enabled. When this pin is in high level state, the output is disabled. This pin is pulled down to ADDR_GND during system application.
E6	ADDR_GND	Address ground Address signal ground pin that connects to 48V- (48V output ground) through a resistor inside the PSU.

Pin	Name	Description
A3, B3, C1, C2, C3, C4, D2, D4, E2 and E4	Reserved	-

8 Communication

Dual CAN communication is adopted. The dual CAN buses are isolated from the main output.

The baud rate is 1000 kbit/s, and the dual CAN buses provide mutual backup. A faulty CAN bus has no impact on the other one.

8.1 Communication Functions

The PAH-3000WA PSU supports monitoring and alarming functions.

Monitoring

- PSU status
- Input voltage
- Input power
- Output power
- PSU presence
- Fan speed

Fault Detection and Alarming

- Fan fault
- Overtemperature
- Output overvoltage
- Input undervoltage
- Input overvoltage
- Output current limiting
- EEPROM fault
- Communication failure between the primary and secondary sides
- Input power failure

8.2 Data Format

Definition

Table 8-1 Frame format

29 bits	8 bytes
CAN ID	Data field

Table 8-2 CAN ID definition

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command ID and message ID (8 bits)								M/S	Reserved, filled with 1						CNT

28	27	26	25	24	23	22	21	20	19	18	17	16
Protocol type number (6 bits)						Slave node address (7 bits)						

NOTE

CNT: The value 1 indicates data except the last frame for batch processing and 0 indicates the last frame of data for batch processing.

Slot number (hardware address): 0–31, depends on the slot; used for the communication between the PSU and the host.

M/S: The value 1 indicates a query or configuration message from the master and 0 indicates a reply from the slave.

Command ID and message ID:

- 0x80 - Byte-based control command with customized content
- 0x81 - Byte-based configuration command with customized content
- 0x82 - Byte-based query command with customized content
- 0x40 - Command for querying PSU inherent information
- 0x50 - Command for querying batch inherent information

Slave node address (software address): used during PSU loading for current share and ID information interaction between PSUs.

Table 8-3 Data field definition

4 bits	12 bits	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error type	Signal ID	Signal content					

NOTE

Error type:

- 0000 - No error, normal response
- 0001 - Incorrect parameters
- 0010 - Invalid command
- 0011 - Address identification in progress
- 0100 - E-label not written
- 0101 - Hardware fault in E-label reading
- 0110 - PSU loading interrupted

For details about the signal ID and signal content, see **8.3 Communication Commands**.

Transmit Mode

Table 8-4 1-byte signal

Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0	1-byte variable	0			

Table 8-5 2-byte signal

Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
2-byte variable		0			

Table 8-6 4-byte signal

Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0		4-byte variable			

Table 8-7 2-byte + 4-byte signal

Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
2-byte variable		4-byte variable			

Table 8-8 Signal consisting of two 2-byte values

Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
2-byte variable		2-byte variable			

Table 8-9 Signal consisting of three 2-byte values

Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
2-byte variable		2-byte variable		2-byte variable	

8.3 Communication Commands

Command	Description	Data Type	R/W	Remarks
0x0001	Module type feature data	IV	R	The data mapping to commands 0x0001 to 0x0006 can be read in batches only by using 0x0050.
0x0002	Serial number	IV	W/R	The equipment mode is required.

Command	Description	Data Type	R/W	Remarks
0x0003	Barcode content 1	IV	W/R	Barcode 1 and barcode 2 need to be written together. They cannot be written separately. The equipment mode is required.
0x0004	Barcode content 2	IV		
0x0005	Software and hardware version numbers	VII/VII/VII	R	-
0x0008	Host time serving	II	W	-
0x010E	Total runtime	II	W/R	0x010E is used to read the total runtime of the PSU. 0x0040 can also be used to read data including the total runtime.
0x012F	Input voltage type	V	R	-
0x0136	Disable DC/DC output	A: V B: II	W	One-time effective In the test of a single PSU, because no heartbeat is available, the SD5000 enables the heartbeat loss wake-up time to start the PSU.
0x0170	Input power	I	R	0x0170 is used to read the input power. 0x0040 can also be used to read data including the input power.
0x0171	AC input frequency	I	R	0x0171 is used to read the AC input frequency. 0x0040 can also be used to read data including the AC input frequency.
0x0172	Input current	I	R	0x0172 is used to read the input current. 0x0040 can also be used to read data including the input current.

Command	Description	Data Type	R/W	Remarks
0x0173	DC output power	I	R	0x0173 is used to read the DC output power. 0x0040 can also be used to read data including the DC output power.
0x0174	Real-time efficiency	I	R	0x0174 is used to read the real-time efficiency. 0x0040 can also be used to read data including the real-time efficiency.
0x0175	Measured DC output voltage	I	R	0x0175 is used to read the measured DC output voltage. 0x0040 can also be used to read data including the measured DC output voltage.
0x0176	Actual output current limiting point	I	R	0x0176 is used to read the actual output current limiting point. 0x0040 can also be used to read data including the actual output current limiting point.
0x0177	Actual output power limiting point	I	R	-
0x0178	AC phase number and AC/HVDC input voltage	VII/I	R	0x0178 is used to read the AC phase number and AC/HVDC input voltage. 0x0040 can also be used to read data including the AC/HVDC input voltage.
0x017F	Internal temperature	I	R	0x017F is used to read the internal temperature. 0x0040 can also be used to read data including the internal temperature.
0x0180	Ambient temperature at the air intake vent	I	R	0x0040 is used to read the data including the ambient temperature at the air intake vent.

Command	Description	Data Type	R/W	Remarks
0x0181	Actual output current	I	R	The filter depth is different. The displayed value has a deeper filter. 0x0181 is used to read the actual output current.
0x0182	Displayed output current	I	R	0x0182 is used to read the displayed output current. 0x0040 can also be used to read data including the displayed output current.
0x0183	Active alarm/status	III	R	0x0040 is used to read the data.
0x0187	Fan speed query and control	1: VI (Bytes 2 – 3) 2: VI (Bytes 4 – 5) 3: VII (Bytes 6 – 7)	R	1. Control duty cycle, IQ10 2. Actual duty cycle, IQ10 3. Actual rotational speed, IQ0
0x0188	PSU rated current	VII	R	-
0x019E	PSU rated power	I	R	3000 W is returned for a voltage greater than or equal to 176 V AC, and 1500 W is returned for a voltage below 176 V AC, with hysteresis considered.
0x019F	Maximum output power reporting	I	R	Output voltage x Current limiting point The software has been modified to limit the maximum output power within the range of 0 – 3000 W.
0x0201	Communications status	IV	R	If no error occurs, no data is returned.
0x0202	Heartbeat	/	R	A heartbeat response has the same as content as the received request.
0x0203	External switch status	IV	R	-
0x0204	Heartbeat wakeup time	II	W/R	-

Command	Description	Data Type	R/W	Remarks
0x0205	External switch response delay (unit: s)	II	W	-
0x0220	Software version of the SD5000	II	R	0x0220 is used to read the software version of the SD5000.
0x030E	SD5000 runtime (unit: hour)	II	R	0x030E is used to read the SD5000 runtime. The SD5000 runtime is determined based on the supply voltage of the SD5000. If the PSU is removed and then inserted back immediately, the runtime will not be reset as long as the SD5000 is not powered off.
0x0388	Alarm and system time for last outage of the SD5000	III/II	R	0x0388 is used to read the alarm and system time for the last outage of the SD5000.

NOTE

Data type description:

- I: 4-byte fixed point number (IQ10)
- II: 4-byte integer (IQ0)
- III: 4-byte value defined by bit
- IV: 6-byte value defined by bit
- V: 1-byte integer
- VI: 2-byte fixed point number (IQ10)
- VII: 2-byte integer (IQ0)

A Safety

A.1 Reliability Requirements

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Mean time between failures (MTBF)	-	250,000	-	Hours	Telcordia SR332; rated input, 100% load; T_A = 25°C

A.2 Safety Requirements

Dielectric Strength Testing

Test Item	Condition	Safety Requirements
Input to output	V_{in} = 3000 V AC (50 Hz)	EN 62368/UL 62368 compliant
Input to ground	V_{in} = 1500 V AC (50 Hz)	EN 62368/UL 62368 compliant
Output to shell	V_{in} = 500 V AC (50 Hz)	EN 62368/UL 62368 compliant
Between two inputs	V_{in} = 1500 V AC (50 Hz)	
Insulation resistance	≥ 10 MΩ; V_{in} = 500 V DC; relative humidity < 90%, non-condensing; normal atmospheric pressure	-

A.3 EMC Requirements

Parameter	Conditions	Criterion
Conducted emission (CE)	Class A, 6 dB margin	EN55032
Radiated emission (RE)	Class A, 6 dB margin	EN55032
Surge	Differential mode: ±2 kV (2 Ω) Common mode: ±4 kV (12 Ω)	IEC61000-4-5, criterion B

Parameter	Conditions	Criterion
Electrical fast transient	±2 kV	IEC61000-4-4, level 3, criterion B
Dip	-	EN300132-3-1
Electrostatic discharge (ESD)	Contact: ±8 kV, air: ±15 kV	IEC61000-4-2, criterion B
Conducted susceptibility (CS)	10 V	IEC61000-4-6, level 3, criterion A
Radiated susceptibility (RS)	10 V/m	IEC61000-4-3, level 3, criterion A

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