PAC2000S12-B1 PSU

Technical Manual

Issue 1.0

Date 2020-09-30

HUAWEI TECHNOLOGIES CO., LTD.

About This Document

Purpose

This document describes the PAC2000S12-B1 power supply unit (PSU), including its electrical specifications, features, applications, and communication.

The figures provided in this document are for reference only.

Intended Audience

This document is intended for:

- Sales personnel
- Technical support engineers
- System engineers
- Software engineers
- Hardware engineers

Symbol Conventions

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

Symbol	Description
⚠ DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could 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	Supplements the important information in the main text. 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 the changes made in earlier issues.

Issue 1.0 (2020-09-30)

This issue is the first release.

Contents

1 Product Overview

Product Description

The PAC2000S12-B1 supports AC input of 90 V to 264 V and HVDC input of 180 V to 300 V. The PSU provides one output (three output modes: MV12, SV12, and MV6). The rated output power is 2000 W.

The PSU supports hot swap, current sharing, and 1+1, 2+2, or 3+3 parallel connection.

The PSU provides an I2C communication function, and can report information such as the manufacturer, model, and version. It provides a black box and supports online upgrade of primary side and secondary side. The PSU is designed in strict accordance with safety requirements and meets the requirements of information technology equipment safety standards.

Features

- Efficiency: ≥ 94% (T_A = 25°C; V_{in} = 230 V AC; P_{out} = 1000 W; without a fan)
- Depth x Width x Height: 183.0 mm x 68.0 mm x 40.5 mm (7.20 in. x 2.68 in. x 1.59 in.)
- Weight: < 2.0 kg
- Hot swappable
- Controllable fan speed
- Protection against input overvoltage, input undervoltage, PFC overvoltage, output overvoltage, output overcurrent/ short circuit, and overtemperature
- I2C for control, programming, and monitoring
- TUV, CE, NRTL, CCC, BSMI, BIS certification and CB report available
- 80 Plus platinum energy efficiency certification
- IEC 60950-1, UL 60950-1, EN 60950-1, IEC 62368-1, and GB 4943.1 compliant
- RoHS6 compliant
- 2002/95/EC compliant

Model Naming Convention

$\frac{P}{1}\ \frac{AC}{2}\ \frac{2000}{3}\ \frac{S}{4}\ \frac{12}{5} - \frac{B}{6}\ \frac{1}{7}$

1 — Embedded power

2 — AC input

3 — Output power: 2000 W

4 — Single output

5 —Output voltage: 12.30 V DC (MV12, SV12), 7.60 V DC (MV6)

6 — Platinum energy efficiency certification

7 — Identifier

Applications

Servers

2 Electrical Specifications

2.1 Environmental

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Operating temperature (T_A)	5	25	50	°C	• The PSU can start in a –10°C environment. There are no requirements on its performance. • When the ambient temperature is 60°C, the PSU can work with half load.
Storage temperature	–40	25	85	°C	-
Relative humidity	5	-	95	% RH	Non-condensing
Altitude	–60	-	5000	m	• When the module does not work, it can be placed at an altitude of 15,000 m. • When the altitude ranges from 1800 m to 5000 m, high-temperature derating applies and the temperature decreases by 1°C for each additional 220 m.
Atmospheric pressure	61	-	106	kPa	The PSU meets the atmospheric pressure at an altitude of 4000 m.
Low atmospheric pressure	-	-	4000	kPa	Low atmospheric pressure test at 4000 m (acceptance for the rated input voltage of 230 V AC)

2.2 Input

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
AC input voltage range	90	-	264	V	220 V AC single-phase or 110 V AC dual–live wire input
Rated AC input voltage range	100	220	240	V	-
AC input voltage frequency	47	50/60	63	Hz	-
HVDC input voltage range	180	240	300	V	The live wire and neutral wire support reverse connection input.
THDi (MV12)	-	-	-	-	T_A = 25°C, V_{in} = 208 V AC/60 Hz or V_{in} = 230 V AC/50 Hz, < 10% load: There are no requirements on the parameter.
	-	-	20	%	T_A = 25°C, V_{in} = 208 V AC/60 Hz or V_{in} = 230 V AC/50 Hz, 10% load
	-	-	10	%	T_A = 25°C, V_{in} = 208 V AC/60 Hz or V_{in} = 230 V AC/50 Hz, 20% load
	-	-	5	%	T_A = 25°C, V_{in} = 208 V AC/60 Hz or V_{in} = 230 V AC/50 Hz, > 30% load
THDv	-	-	10	%	THDv ≤ 10%: The PSU can work properly.
Power factor (MV12)	0.94	-	-	-	T_A = 25°C, V_{in} = 208 V AC/60 Hz, V_{in} = 230/50Hz, or V_{in} = 240 V AC/60 Hz, 10% load
	0.96	-	-	-	T_A = 25°C, V_{in} = 208 V AC/60 Hz, V_{in} = 230/50Hz, or V_{in} = 240 V AC/60 Hz, 20% load

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
	0.98	-	-	-	T_A = 25°C, V_{in} = 208 V AC/60 Hz, V_{in} = 230/50Hz, or V_{in} = 240 V AC/60 Hz, 50% load
	0.99	-	-	-	T_A = 25°C, V_{in} = 208 V AC/60 Hz, V_{in} = 230/50Hz, or V_{in} = 240 V AC/60 Hz, 100% load
AC input RMS current	-	-	11	A	V_{in} = 220 V AC, rated load
HVDC input current	-	-	10	A	V_{in} = 240 V DC, rated load
AC input DC bias	-	-	50	mA	Rated input voltage, full load range
Inrush current	-	-	30	A	Complies with ETSI 300132-3 and ETSI EN 300 132-3
Standby power	-		1	W	• T_A = 25°C, V_{in} = 115 V/230 V AC or V_{in} = 240 V DC; • The fan is shut down, and the PSU works in deep sleep mode. • The standby PSU does not connect to loads.
	-		8	W	• T_A = 25°C, V_{in} = 115 V/230 V AC or V_{in} = 240 V DC; • The fan rotates at the lowest speed. I_{out} = 0 A • The PSU is the standby PSU in cold standby or active/standby mode. • The standby PSU does not connect to loads.
Harmonic current	-	-	-	-	Meet the test requirements of class A equipment.
Input overcurrent and short circuit protection	-	-	-	-	If an internal fault occurs in the PSU, the upstream C32 circuit breaker cannot trip.

2.3 Output

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Number of outputs	-	-	-	1	-	• The PSU provides one output. There are three output modes: MV12 (V_{out} = 12 V DC), SV12 (V_{out} = 12 V DC), or MV6 (V_{out} = 7.6 V DC)
Output power	MV12	-	-	2000	W	V_{in} = 200–264 V AC or V_{in} = 200–300 V DC
		-	-	1800	W	V_{in} = 180–200 V AC or V_{in} = 180–200 V DC
		-	-	1000	W	V_{in} = 90–180 V AC
	MV6	-	-	60	W	V_{in} = 90–264 V AC or V_{in} = 180–300 V DC
Output voltage setpoint	MV12/ SV12	12.27	12.30	12.33	V	T_A = 25°C, rated input; I_{out} = 3 A
	MV6	7.3	7.6	7.9	V	T_A = 25°C, rated input; I_{out} = 3 A
Output voltage range	MV12/ SV12	11.70	12.30	12.60	V	Full load range
	MV6	6.4	7.6	8.2	V	Full load range
Output current	MV12	3	-	167	A	V_{in} = 200–264 V AC or V_{in} = 200–300 V DC
		3	-	150	A	V_{in} = 180–200 V AC or V_{in} = 180–200 V DC
		3	-	83	A	V_{in} = 90–180 V AC
	SV12	1	-	45	A	-
	MV6	1	-	10	A	-
Source regulation rate	-	–1	-	1	%	-

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Output ripple and noise (peak to peak)	MV12	-	-	120	mV	• The minimum load is 3 A. The ripple probe is connected to a 10 µF capacitor and a 0.1 µF ceramic capacitor in parallel. The oscilloscope has a bandwidth of 20 MHz (full temperature range and full input voltage). • If the output power is less than 1000 W, add the minimum capacitive load: 540 µF capacitor. If the output power is greater than 1000 W, add the minimum capacitive load: 1000 µF capacitor.
	SV12	-	-	360	mV	A 10 µF capacitor and a 0.1 µF ceramic capacitor are connected in parallel at the test end. The oscilloscope bandwidth is 20 MHz, and the minimum capacitive load is a 270 µF capacitor. The minimum load is 1 A.
	MV6	-	-	360	mV	A 10 µF capacitor and a 0.1 µF ceramic capacitor are connected in parallel at the test end. The oscilloscope bandwidth is 20 MHz, and the minimum capacitive load is a 270 µF capacitor. The minimum load is 1 A.

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Dynamic overshoot amplitude	MV12	11.6	-	12.6	V	Current change rate: 0.5 A/μs, T = 10 ms (CCDHT1 = 5 ms; CCDHT2 = 5 ms); load: 25%–50%–25%; 50%–75%–50%. Test with the minimum capacitive load 540 μF capacitor.
		11.4	-	12.8	V	• Current change rate: 0.5 A/μs, T = 10 ms (CCDHT1 = 5 ms; CCDHT2 = 5 ms); load: 50%–100%–50%. The bus voltage is not lower than 11 V, and the time when the bus voltage is lower than 11.4 V does not exceed 100 μs • If the output power is less than 1000 W, add the minimum capacitive load: 540 μF capacitor. If the output power is greater than 1000 W, add the minimum capacitive load: 1000 μF capacitor.

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
		11.4	-	12.8	V	• Current change rate: 2 A/µs, T = 1 ms (CCDHT1 = 0.5 ms; CCDHT2 = 0.5 ms); load: 65%–100%–65%. The bus voltage is not lower than 11 V, and the time when the bus voltage is lower than 11.4 V does not exceed 100 µs • Add the 3000 µF capacitor in the 2+2 backup application scenario (including the 2+0 backup application scenario). The power is 3900 W in 100% load scenarios.
	SV12	11.4	-	12.6	V	Current change rate: 0.5 A/µs, T = 10 ms (CCDHT1 = 5 ms; CCDHT2 = 5 ms); load: 25%–50%–25%, 50%–75%–50%. Test with the minimum capacitive load 270 µF capacitor.
	MV6	6.0	-	8.2	V	Current change rate: 0.5 A/µs, T = 10 ms; load: 5%–100%. Test with the minimum capacitive load 270 µF capacitor.

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Transient impact power overshoot	MV12/ SV12	11.4	-	12.8	V	• Current change rate: 0.5 A/µs; T = 1s–10 ms–1s; load: 65%–130%–65% • The PSU 12 V bus voltage is greater than or equal to 11 V, and the time when the bus voltage is lower than 11.4 V does not exceed 100 µs.
Startup and shutdown overshoot	MV12/ SV12	–5	-	5	%	The PSU can start in a –10°C environment. There are no requirements on its performance.
Temperature coefficient	-	–0.02		0.02	%/°C	Rated output voltage, rated output current, full operating temperature range
Current share imbalance	MV12	–5	-	5	%	50%–100% load (rated load for a single PSU in a parallel system)
		–10	-	10	%	200 W–50% load (rated load for a single PSU in a parallel system)
		-	-	-	%	Load of a single PSU < 200 W
Current share bus voltage	-	5.7	6.0	6.3	V	$I_{MON} = \frac{6}{167} * I_{out}$ • I_{MON}: current share bus voltage • I_{out}: output current • 6/167: proportional coefficient
External capacitance	MV12	540	-	22000	µF	Full voltage, full load, full temperature range, output power greater than 1000 W, minimum capacitive load: 1000 µF capacitor
		1000		22000	µF	
	SV12	270	-	1000	µF	
	MV6	270	-	1000	µF	

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Hot swap	MV12	11.4	-	12.6	V	The system backplane voltage must not exceed the dynamic specification requirements of the PSU. During the hot swap of the MV12/SV12 output, the bus voltage is lower than 11.0 V and greater than or equal to 11.4 V for less than 100 μs.
	MV6	6.0	-	8.2	V	

NOTE

- Specifications are subject to change without notice.
- Short-time output power of MV12: V_{in} = 220 V AC, T_A = 50°C. After the output power of a single PSU is 1100 W, the PSU does not trigger protection within 2 minutes if the output power of the PSU is switched to 2200 W transiently.
- When the PSU output voltage is less than 4 V, ignore the power-off ringback. When the PSU output voltage ranges from 4 V to 9 V, the power-off ringback is less than 300 mV. When the PSU output voltage is greater than 9 V, the power-off ringback is less than 400 mV.
- Active current sharing is used for the parallel system.
- Current sharing imbalance applies only to the normal temperature.
- Requirements for switching the output modes between MV12, SV12, and MV6:
  - PSON12V# is at high level, and the PSU output enters MV6 mode.
  - PSON12V# is at low level, and the PSU output enters MV12 mode.
  - When PSON12V# is at low level, the PSU IP PRESENT# works in the following modes:
    - IP PRESENT# is at high level, and the PSU output maintains MV12 mode.
    - IP PRESENT# is at low level, and the PSU output enters SV12 mode. The indicator blinks greenat 1 Hz.
    - IP PRESENT# signal detection validity time is greater than or equal to 25 ms, and the switching delay time is less than or equal to 200 ms (including the detection time).
- In the parallel system current sharing scenario, fault isolation (except output overvoltage isolation) is performed. The upper threshold of the 12 V output busbar voltage of the PSU is 12.8 V.
- In a parallel system, the upper threshold of the PSU 12 V output busbar voltage is 12.8 V for PSON12V# switching.

2.4 Efficiency

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Output efficiency	MV12	87	-	-	%	T_A = 25°C, V_{in} = 230 V AC, P_{out} = 200 W, without a fan

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
		91	-	-	%	T_A = 25°C, V_{in} = 230 V AC, P_{out} = 400 W, without a fan
		94	-	-	%	T_A = 25°C, V_{in} = 230 V AC, P_{out} = 1000 W, without a fan
		91	-	-	%	T_A = 25°C, V_{in} = 230 V AC, P_{out} = 2000 W, without a fan
		85	-	-	%	T_A = 25°C, V_{in} = 240 V DC, P_{out} = 200 W, without a fan
		89	-	-	%	T_A = 25°C, V_{in} = 240 V DC, P_{out} = 400 W, without a fan
		92	-	-	%	T_A = 25°C, V_{in} = 240 V DC, P_{out} = 1000 W, without a fan
		89	-	-	%	T_A = 25°C, V_{in} = 240 V DC, P_{out} = 2000 W, without a fan
		87	-	-	%	T_A = 25°C, V_{in} = 115 V AC, P_{out} = 300 W, without a fan
		90	-	-	%	T_A = 25°C, V_{in} = 115 V AC, P_{out} = 500 W, without a fan
		89	-	-	%	T_A = 25°C, V_{in} = 115 V AC, P_{out} = 1000 W, without a fan
	MV6	70	-	-	%	T_A = 25°C, V_{in} = 230 V AC or V_{in} = 240 V DC, I_{out} = 8 A, without a fan

2.5 Protection

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
AC input overvoltage protection threshold	-	280	-	-	V	Self-recovery
AC input overvoltage recovery threshold	-	275	-	-	V	Hysteresis ≥ 5 V
AC input undervoltage protection threshold	-	-	-	85	V	Self-recovery

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
AC input undervoltage recovery threshold	-	-	-	90	V	Hysteresis ≥ 5 V (During recovery, the PSU cannot start in the hysteresis range.)
AC input overcurrent or short circuit protection	-	-	-	-	-	Fast-blow fuse
PFC overvoltage protection	-	-	-	-	-	The PSU 12 V bus capacitor is not damaged due to PFC overvoltage (excluding input overvoltage).
HVDC input overvoltage protection threshold	-	310	-	-	V	Self-recovery
HVDC input overvoltage recovery threshold	-	305	-	-	V	Hysteresis ≥ 5 V
HVDC input undervoltage protection threshold	-	-	-	175	V	Self-recovery
HVDC input undervoltage recovery threshold	-	-	-	180	V	Hysteresis ≥ 5 V
Output overvoltage protection	MV12/ SV12	13	-	15	V	Latch-off mode
	MV6	13	-	15	V	Latch-off mode. In MV6 mode, if the PSU loop is detected to be open, protection is triggered directly without having to reach the MV6 overvoltage protection threshold.
Output overcurrent protection	MV12	110	-	130	%	After a short circuit or overcurrent lasts for at least 100 ms (the overcurrent protection threshold can be set according to the actual situation; the threshold is not required to be within 110%–130% but cannot exceed 130%), the PSU latches off.

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
		130	-	150	%	After a short circuit or overcurrent lasts for at least 4 ms, the PSU latches off.
	SV12	50	-	-	A	After the SV12 contact ground output overcurrent protection is triggered, the PSU enters the MV12 output mode and the green indicator blinks at 1 Hz.
	MV6	11	13	15	A	The PSU enters the MV12 output mode (no need to receive system signals; the indicator blinks at 1 Hz) when overcurrent lasts for 100 ms at least. The output mode can switch back to MV6 after PSON12V# turns from high to low, and then turns from low to high.
Output short circuit protection	MV12	150	-	-	%	After a short circuit or overcurrent lasts for 500 µs at most, the PSU latches off.
	SV12	-	-	-	-	Supported. The PSU latches off.
	MV6	15	-	-	A	The PSU latches off when a short circuit lasts for 500 µs at most.

Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
Overtemperature protection	-	50	-	-	°C	• Overtemperature protection can be triggered and the PSU can shut down the output only when the ambient temperature exceeds 50°C. The recovery temperature must have a hysteresis that is greater than 5°C. • The temperature protection threshold for the air intake vent of the PSU should be greater than 70°C. • If overtemperature occurs in MV12 mode, the output mode is MV6 (even if PSON12V# is low) at system service load. When the internal component temperature recovers to a safe range, the output mode can switch back to MV12 only if PSON12V# is still low. If overtemperature occurs in MV6 mode, the output is shut down. When the internal component temperature recovers to a safe range, the PSU recovers and works in MV6 output mode (even if PSON12V# is low). After recovery, if PSON12V# is still low, the PSU switches to MV12 output mode. The hysteresis

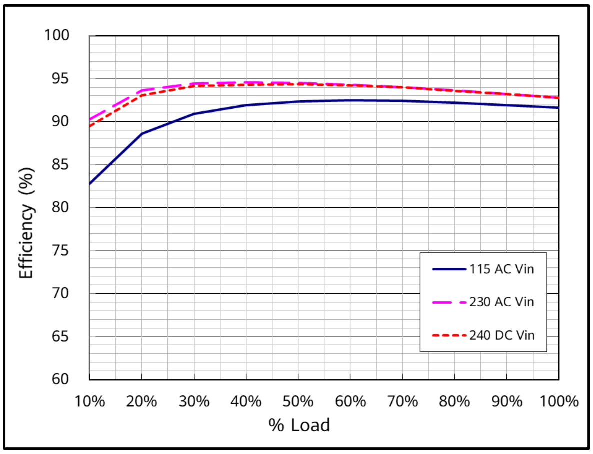
Parameter	Output	Min.	Typ.	Max.	Unit	Notes & Conditions
						between the protection threshold and the recovery threshold is greater than 5°C.

NOTE

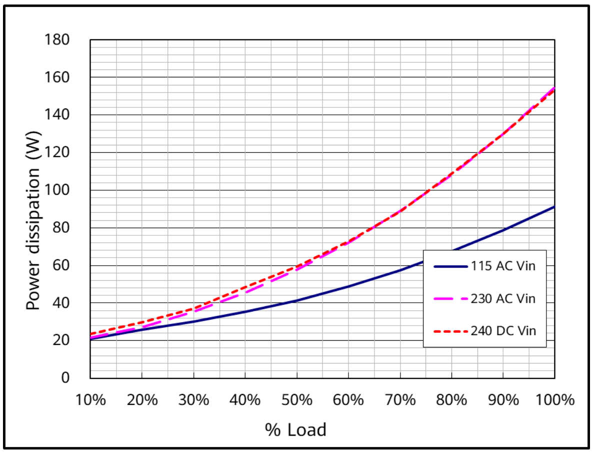
- MV12/MV6/SV12 overvoltage unlock mode (unlocked if any of the following conditions is met):
  - AC input is recovered after being disconnected for 15s. (In a parallel system, if output overcurrent occurs on one PSU, recover the power after the AC input is disconnected. The PSU can be unlocked within 2s.)
  - INSTALLED# changes from low level to high level.
  - PSON12V# changes from high level to low level.
  - IP Present# changes from low level to high level twice within 30s.
  - After PSON12V# changes to high level for more than 500 ms and then changes to low level, the PSU can be unlocked (MV12 output overvoltage).
  - After IP PRESENT# changes to low level for more than 500 ms and then changes to high level, the PSU can be unlocked (SV12 output overvoltage).
- MV12 output overcurrent/short circuit unlock mode (unlocked if any of the following conditions is met):
  - AC input is recovered after being disconnected for 15s. (In a parallel system, if output overcurrent occurs on one PSU, recover the power after the AC input is disconnected. The PSU can be unlocked within 2s.)
  - INSTALLED# changes from low level to high level.
  - PSON12V# changes from high level to low level.
  - IP Present# changes from low level to high level twice within 30s.
  - After PSON12V# changes to high level for more than 500 ms and then changes to low level, the PSU can be unlocked (MV12 output overcurrent).
- SV12 overcurrent/short circuit unlock mode (unlocked if any of the following conditions is met):
  - AC input is recovered after being disconnected for 15s.
  - INSTALLED# changes from low level to high level.
  - If SV12 triggers overcurrent protection but does not cause PSU shutdown, IP PRESENT# changes from low level to high level once to unlock the PSU. If SV12 triggers overcurrent protection and causes PSU shutdown, IP PRESENT# changes from low level to high level twice within 30s.
  - After IP PRESENT# changes to low level for more than 500 ms and then changes to high level, the PSU can be unlocked (SV12 output overcurrent).
- MV6 overcurrent/short circuit unlock mode (unlocked if any of the following conditions is met):
  - AC input is recovered after being disconnected for 15s.
  - INSTALLED# changes from low level to high level.
  - PSON12V# changes from high level to low level.
- After the PSU triggers fault protection, the MCU and I2C in the PSU can work properly.
- If the output exceeds the rated load, the output regulated voltage precision can be ignored.
- When the PSU output mode is switched from MV12 to MV6, all loads connected to MV12 will passively exit before the output voltage drops to 9 V. Then, the PSU only connects to MV6 loads.

3 Characteristic Curves

Conditions: T_A = 25°C unless otherwise specified



Efficiency curve

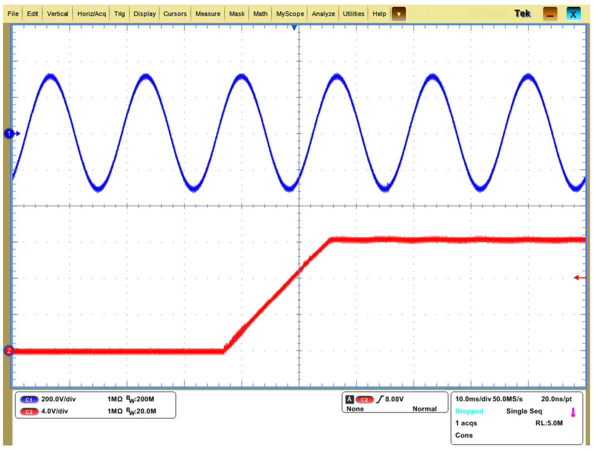


Power dissipation curve

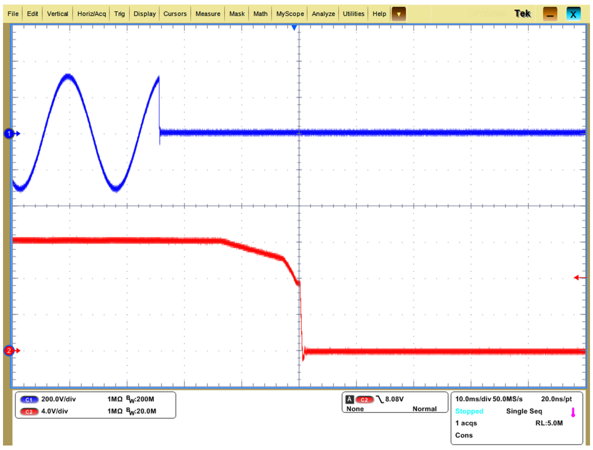
4 Typical Waveforms

4.1 Turn-on/Turn-off

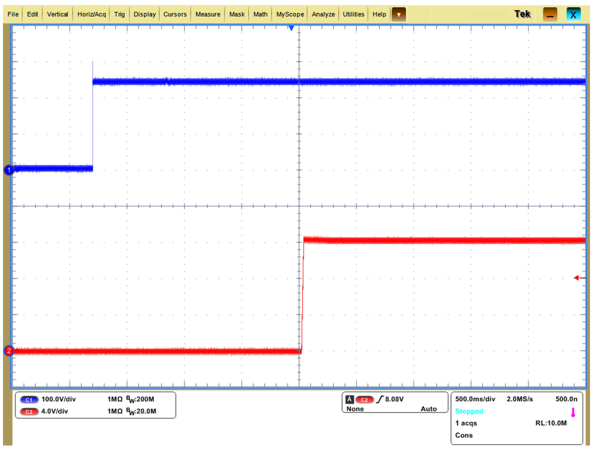
Conditions: T_A = 25°C unless otherwise specified



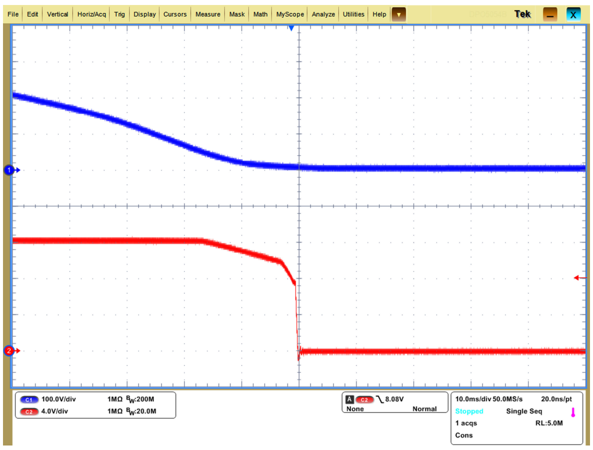
Startup by power-on
(V_{in} = 220 V AC, V_{out} = 12.30 V)



Shutdown by power-off
(V_{in} = 220 V AC, V_{out} = 12.30 V)



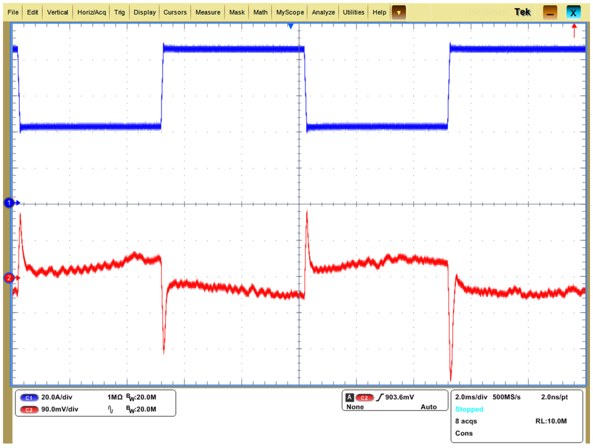
Startup by power-on
(V_{in} = 240 V DC, V_{out} = 12.30 V)



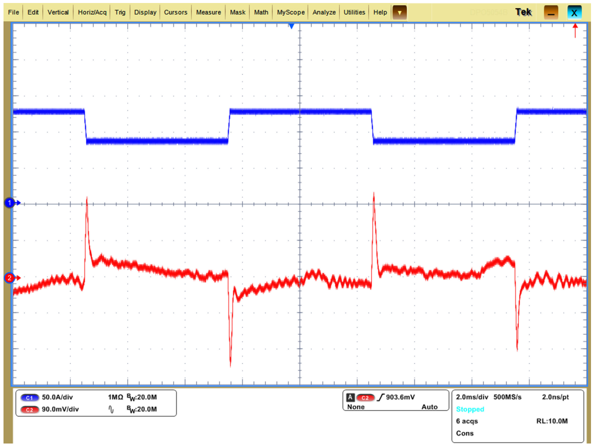
Shutdown by power-off
(V_{in} = 240 V DC, V_{out} = 12.30 V)

4.2 Output Voltage Dynamic Response

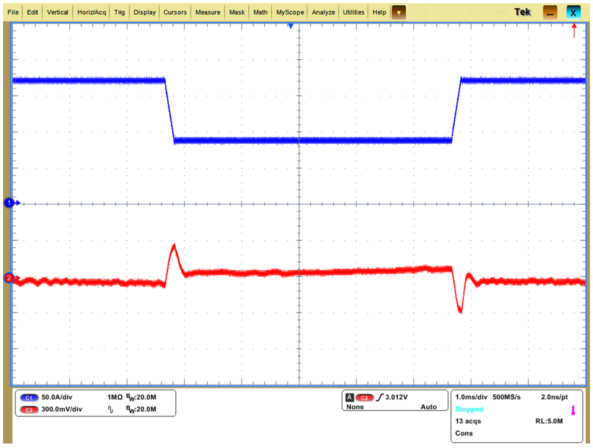
Conditions: T_A = 25°C unless otherwise specified



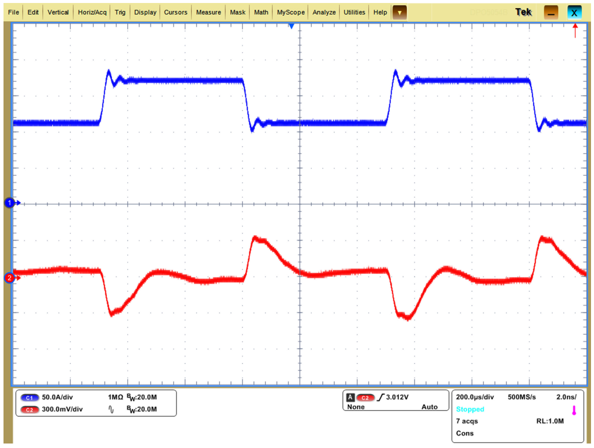
Output voltage dynamic response
(V_{in} = 220 V AC; load: 25%–50%–25%;
0.5 A/μs; T = 10 ms; MV12)



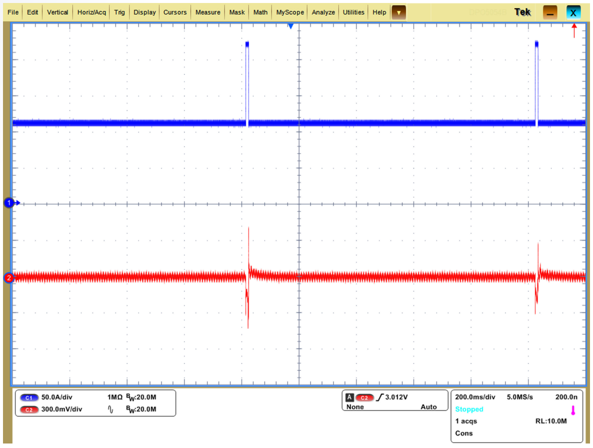
Output voltage dynamic response
(V_{in} = 220 V AC; load: 75%–50%–75%;
0.5 A/μs; T = 10 ms; MV12)



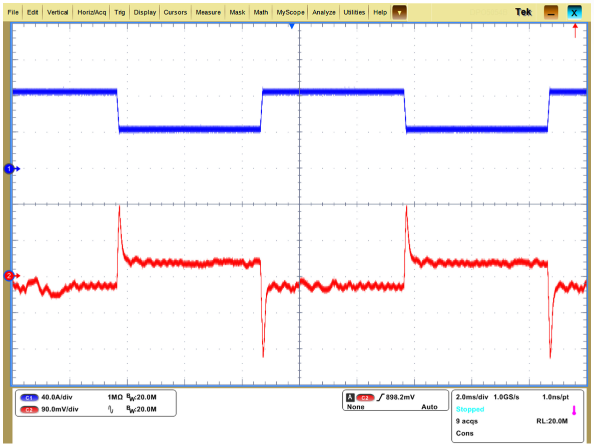
Output voltage dynamic response
(V_{in} = 220 V AC; load: 100%–50%–100%;
0.5 A/μs; T = 10 ms; MV12)



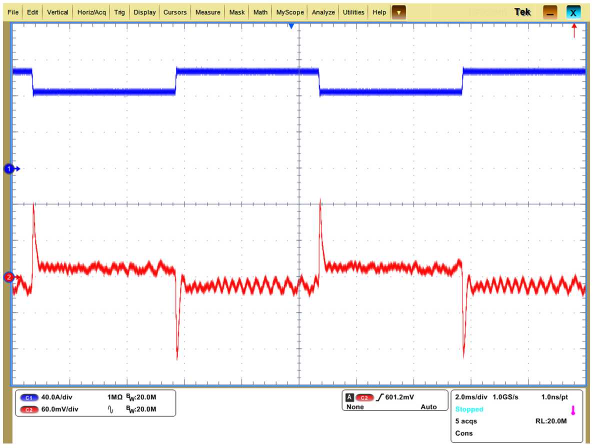
Output voltage dynamic response
(V_{in} = 220 V AC; load: 65%–100%–65%;
2.0 A/μs; T = 1 ms; MV12)



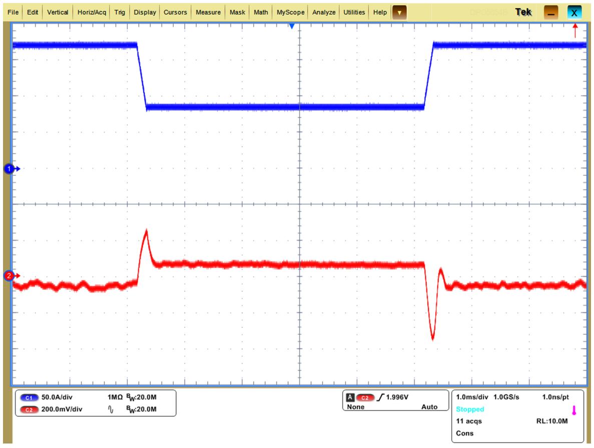
Output voltage dynamic response
(V_{in} = 220 V AC; load: 50%–75%–50%;
0.5 A/μs; MV12)



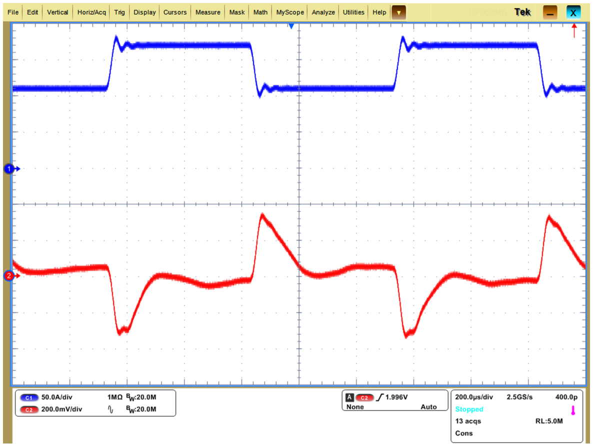
Output voltage dynamic response
(V_{in} = 240 V DC; load: 25%–50%–25%;
0.5 A/μs; T = 10 ms; MV12)

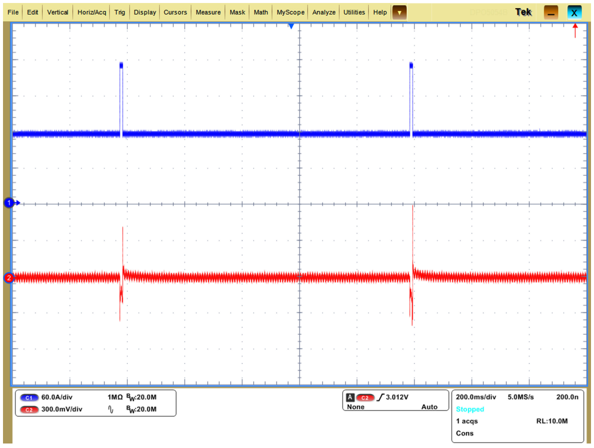


Output voltage dynamic response
(V_{in} = 240 V DC; load: 75%–50%–75%;
0.5 A/μs; T = 10 ms; MV12)



Output voltage dynamic response
(V_{in} = 240 V DC; load: 100%–50%–100%;
0.5 A/μs; T = 10 ms; MV12)



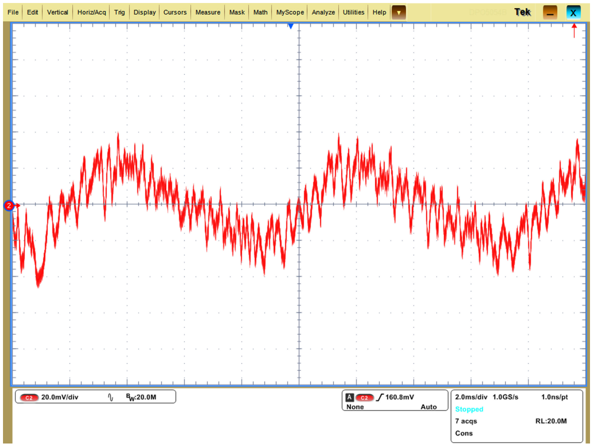


Output voltage dynamic response
(V_{in} = 240 V DC; load: 65%–100%–65%; 2.0 A/μs; T = 1 ms; MV12)

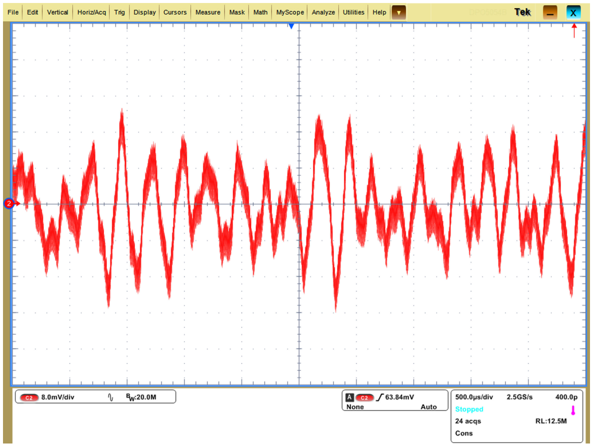
Output voltage dynamic response
(V_{in} = 240 V DC; load: 50%–75%–50%; 0.5 A/μs; MV12)

4.3 Output Voltage Ripple

Conditions: T_A = 25°C unless otherwise specified



Output voltage ripple
(V_{in} = 220 V AC; 100% load; MV12)



Output voltage ripple
(V_{in} = 240 V DC; 100% load; MV12)

5 Energy Saving Feature

5.1 Active/Standby (Hot Standby) Power Supply

If PSUs work in parallel, the PSU with an output setting voltage of 12.3 V is the active PSU and the PSU with an output setting voltage of 12.05 V is the standby PSU.

- Only hot standby is supported for MV12 output.
- If PS_CONTROL (CEh) bit 7 is set to 1, the output voltage of the standby PSU is set to 12.05 V by VOUT_COMMAND (21h).

Table 5-1 Active/Standby power supply characteristics

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
12 V output voltage of the standby PSU	-	12.05	-	V	T_A = 25°C
No-load power consumption of the standby PSU	-	-	8	W	1+1 active/standby power supply scenario: For the active/standby power supply with rated input (115 V AC/230 V AC/240 V DC; AC+AC, AC+HVDC, HVDC+HVDC), the input power consumption of each standby PSU is lower than 8 W (the standby PSU does not connect to loads).
	-	-	8	W	2+2 active/standby power supply scenarios (AC+AC, AC+HVDC, or HVDC +HVDC): The input power consumption of each standby PSU is less than 8 W (the standby PSU does not connect to loads).

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Busbar voltage in fault mode	11.4	-	-	V	In 1+1 active/standby power supply scenarios (AC +AC, AC+HVDC, or HVDC +HVDC), the PSU output voltage is greater than 11.4 V, the PSU 12 V bus voltage is greater than or equal to 11 V, and the time when the bus voltage is lower than 11.4 V does not exceed 100 μs, in the case of removal/insertion, power-off, or faults (input power failure, input cable removal or insertion, input undervoltage, input overvoltage, fan fault, overtemperature, or output slow overvoltage) of any power supply. **Note:** In a 1+1 parallel system, if the total load is less than 70% of a single PSU, one PSU restarts due to overvoltage. In this case, the PSU output voltage is greater than 11.4 V, the PSU 12 V bus voltage is greater than or equal to 11 V, and the time when the bus voltage is lower than 11.4 V does not exceed 100 μs.

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
	11.0	-	-	V	In 2+2 active/standby power supply scenarios (AC +AC, AC+HVDC, or HVDC +HVDC), when the following faults occur, the PSU output voltage is greater than 11.4 V, and the PSU 12 V bus voltage is greater than or equal to 11 V and the time when the bus voltage is lower than 11.4 V does not exceed 100 µs. 1. One power input fails (2+2 backup, one power input for two PSUs). 2. One PSU becomes faulty (such as input undervoltage, input overvoltage, fan fault, overtemperature, and output overvoltage). **Note:** The 12 V output of parallel PSUs is equipped with 1500 µF capacitors.
Time for switching to HVDC in the case of intermittent AC disconnection (MV12 mode)	8	-	-	ms	Active: AC; standby: HVDC; PSU load: 70%; valid HVDC input current: ≤ 1 A within 20 ms
	16	-	-	ms	Active: AC; standby: HVDC; PSU load: 35%; valid HVDC input current: ≤ 1 A within 20 ms
	30	-	-	ms	Active: AC; standby: HVDC; PSU load: 20%; valid HVDC input current: ≤ 1 A within 20 ms
	40	-	-	ms	Active: AC; standby: HVDC; PSU load: 10%; valid HVDC input current: ≤ 1 A within 20 ms

NOTE

1. 1+1 scenarios (input voltage of the active PSU: 220 V/50 Hz; input voltage of the standby PSU: 230 V/50 Hz): When the total load of the system is less than or equal to 80% of the rated load of a single PSU, the standby PSU does not connect to loads in the steady state. When the total load of the system ranges from 80% to 100%, the load ratio of the active and standby PSUs does not exceed 6:1 in the steady state. The total load of the system ranges from 80% to 100%. If an active/standby switchover occurs, the PSU output voltage dip can occur in microseconds (less than 11.4 V/100 µs and greater than 11 V). The upper limit of the PSU output voltage cannot exceed 13.3 V.

   2+2 scenarios (input voltage of the active PSU: 220 V/50 Hz; input voltage of the standby PSU: 230 V/50 Hz): When the total load of the system is less than or equal to 160% of the rated load of a single PSU, the standby PSU does not connect to loads in the steady state. When the total load of the system ranges from 160% to 200%, the load ratio of the active and standby PSUs does not exceed 6:1 in the steady state. The total load of the system ranges from 180% to 200%. If an active/standby switchover occurs, the PSU output voltage dip can occur in microseconds (less than 11.4 V/100 µs and greater than 11 V). The upper limit of the PSU output voltage cannot exceed 13.3 V.
2. A software interface is provided for the system to query whether the PSU supports the N+R active/standby feature.
   - When bit 14 of 0xCE is 1, N+R is supported.
   - When bit 14 of 0xCE is 0, N+R is not supported.
3. After a PSU enters the standby mode, it can exit the mode in any of the following cases:
   1. The system clears bit 7 of PS_CONTROL (CEh) of the standby PSU.
   2. The MCU of the standby PSU restarts.
   3. The communication of the standby PSU is faulty.
   4. The load of the standby PSU exceeds 50% of the rated load of a single PSU.
   5. The load of the active PSU exceeds 100% of the rated load of a single PSU.
4. When the active PSU is faulty (except for PSU hot swap and output ORing-FET short circuit) or in 1+1 active/standby scenarios with the total load greater than 100%, or in 2+2 active/standby scenarios with the total load greater than 160%, the system needs to wake up the standby PSU in a timely manner (false wakeup is allowed) to ensure that the 12 V bus voltage of the system is greater than or equal to 11.4 V (the 12 V bus voltage of the system is greater than or equal to 11 V, and the time when the bus voltage is lower than 11.4 V is less than 100 µs).
5. The standby PSU experiences input current overshoot during active/standby switchover: When the total load rate is greater than or equal to 90% of the load of a single PSU, the valid AC input current of the PSU is 20 ms@170% x I_{max} or 100 ms@130% x I_{max}. When the total load rate is between 50% and 90%, the valid AC input current of the PSU is 20 ms@150% x I_{max} or 100 ms@130% x I_{max} (input voltage of the active PSU: 220 V AC/50 Hz; input voltage of the standby PSU: 230 V AC/50 Hz).
6. Standby PSU restart: The standby PSU is restarted after the input power is off. If the DSP is not powered off, record the standby PSU status. After the standby PSU is restarted, it works with the voltage of the standby PSU.
7. After the program is updated on the standby PSU, the standby PSU is removed, the power communication fault is rectified, or the power module of the standby PSU is replaced, the active/standby information of the standby PSU is initialized (the active PSU is restored by default), and the system resets the active/standby information.
8. No single fault should cause the PSU to exceed the output overvoltage threshold (except for output overvoltage).
9. Isolation function (except for short circuits): If output overvoltage, output overcurrent, or output short circuit occurs, the faulty PSU can shut down the output. If a PSU fails, it must be isolated reliably. When a single PSU fails, the system bus voltage must be greater than or equal to 11.4 V during voltage overshoot (excluding internal short circuits and overvoltage) or dip. When the load is greater than 80%, the system bus voltage is greater than or equal to 11 V and the time when the bus voltage is lower than 11.4 V is less than 100 µs.

5.2 Deep Sleep Function

The PSU enters deep sleep mode if bit B of PS_CONTROL (CEh) is set to 1.

NOTE

When PSUs are connected in parallel, if one PSU enters deep sleep mode and the system communicates with it, the primary side information including input voltage, current, and power is reported as 0, and secondary side information is reported based on the actual situation (except that the output voltage and current are reported as 0).

The deep sleep function is available in both MV12 and MV6 modes. In deep sleep mode:

1. The PSU input power is less than 1.0 W.
2. The main power circuit of the PSU is shut down and MV12/SV12 has no output.
3. The PFC is shut down.
4. The fan obtains power from the 12 V bus of the PSU.
5. The PSU supports the intelligent control function through the 12 V bus.
6. The system can control all PSUs to restore output online.

When PSUs are connected in parallel, the PSU can enter deep sleep mode if all of the following conditions are met:

1. The system sets PS_CONTROL (CEh) bit B of the PSU in deep sleep mode to 1.
2. EFUSEV is less than or equal to 0.8 V.

The PSU can restore output if any of the following conditions is not met:

1. The bus voltage is less than 5.7 V.
2. The deep sleep control register is cleared.
3. EFUSEV is greater than 1.0 V.

5.3 Cold Standby Energy Saving

In the 1+1 application scenario, the PSU (MV12) supports cold standby energy saving mode.

The PSU enters cold standby mode if the following conditions are met.

1. One PSU is set to be the active unit by running the D0h 0x01 command (The Smart_ON# signal is at high level).
2. The other PSU is set to be the standby unit by running the D0h 0x02/0x03/0x04 command and the Smart_ON# signal is detected to be at high level. This PSU enters cold standby mode.
3. The total system load is less than 70% of the rated load of a single PSU.

The standby PSU exits from cold standby mode if any of the following conditions is met:

- The system sends the D0h 0x00 command.
- The standby PSU restarts.

- The communication of the standby PSU is faulty.
- The active PSU MV12/SV12 experiences a fault, such as input power failure, input undervoltage, input overvoltage, output overvoltage, output overcurrent, overtemperature, fan fault, and output undervoltage (the output voltage is lower than 11.8 V), which causes the Smart_ON# signal to be at low level.
- Both the PSON12V# and INSTALLED# signals are becomes high level from low level.
- The load power is greater than the upper power limit in cold standby mode.

The active PSU exits from cold standby mode if any of the following conditions is met:

- The system sends the D0h 0x00 command.
- The MCU of the active PSU restarts.
- The communication of the active PSU is faulty.
- The active PSU MV12 experiences a fault, such as input power failure, input undervoltage, input overvoltage, output overvoltage, output overcurrent, overtemperature, fan fault, and output undervoltage (the output voltage is lower than 11.8 V), which causes the Smart_ON# signal to be at low level.
- Both the PSON12V# and INSTALLED# signals are becomes high level from low level.

Table 5-2 Loss of the standby PSU in cold standby mode

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Standby PSU loss	-	-	8	W	Input power consumption of each standby PSU in 1+1 scenarios (AC+AC, AC +HVDC, HVDC+HVDC) when the standby PSU is not connected to loads

6 Hot Swap Requirements

Hot swapping is the process of inserting the PSU to and extracting the PSU from a power system. The PSU should meet hot-swapping specifications.

The PSU can be hot swapped by the following methods:

1. PSU hot swap without AC power applied

   NOTE

   The PSU does not work before the insertion or extraction.

   a. Extraction: The AC power is disconnected from the PSU before the PSU is extracted from the system.
   b. Insertion: The PSU is inserted into the system without power applied. Then, power is applied after the insertion.
2. PSU hot swap through the management system
   a. Extraction: The management system removes the PSU by turning off the PSON12#.
   b. Insertion: After a PSU is inserted into the system, the management system queries the INSTALL# of the PSU and then turns on the PSON12# to turn on the PSU.
3. PSU hot swap with AC power applied
   a. Extraction: The PSU is removed from the system with power on.
   b. Insertion: The PSU starts to work immediately after it is inserted into the system.

7 Internal Cooling Fan

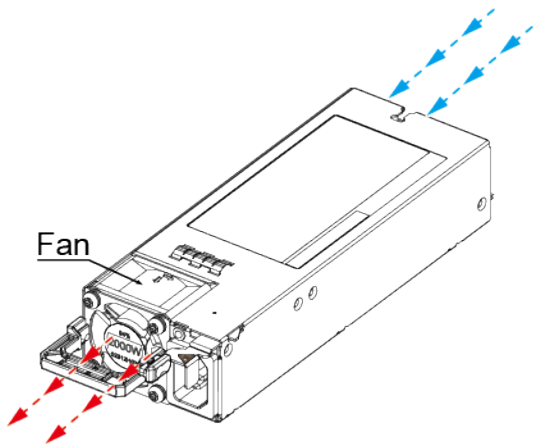
The PSU uses the extraction mode for heat dissipation. The air blows in from the rear and blows out from the front.

The fan meets the following requirements:

1. In MV6 working mode, the PSU works at the lowest rotational speed, and overtemperature protection should not be triggered.
2. In MV12 working mode, the PSU works at the required rotational speed, and overtemperature protection should not be triggered.
3. The fan cannot stop rotating in the case of reverse power supply of the PSU.
4. The fan works at full speed before the PSU triggers overtemperature protection.

The PSU supplies power to the internal fans. It contains a fan speed control circuit to vary the fan speed. **Figure 7-1** shows the details about the air channel.

Figure 7-1 Air channel

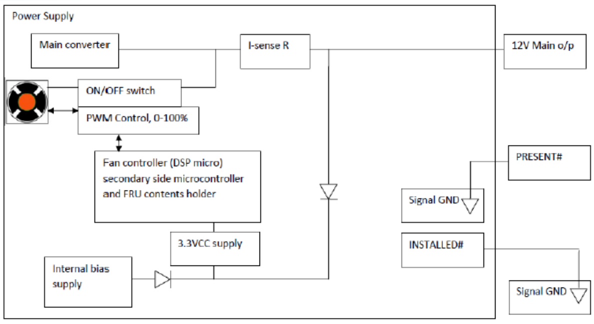


Power Supply to the Fan

1. If the fan is powered by the output busbar, PSU swap, fan startup and shutdown, and fan faults should not cause the system busbar to drop out of the regulated voltage precision.
2. The fan should be isolated if a fault occurs.
3. The system sends a command to clear the fault so that the fan can work again.
4. The system can deliver a command to turn off the fan.

Figure 7-2 shows the fan power supply circuit.

Figure 7-2 Fan power supply circuit



Fan Protection

1. When PSUs work in parallel, if a fan and its power supply circuits are short-circuited or open-circuited, the 12 V/6 V power of the system backplane cannot exceed the normal dynamic voltage change limit (the output voltage of the MV12 is greater than 11.4 V, and the time when the MV12 is lower than 11.4 V is less than 100 µs; the MV6 output voltage is greater than 6 V). The normal operation of the system is not affected.
2. When the fan fault detection board detects a fan or fan circuit fault and the fault lasts for over 20s, it reports a fault.

   NOTE

   Long-time fan operation ages the internal bearing, which prolongs fan startup time. The fan is considered to be faulty only when it does not reach the specified rotational speed after more than 10s.)
3. The fan fault can be rectified.

8 Parallel Operation

Current Share Design Requirements

1. The current imbalance of the MV12 main output is ±5% (50%–100% load).
2. When the PSU starts in parallel mode, the total startup load is less than the rated load of one PSU.
3. In backup mode (1+1, 2+2, 3+3), if one PSU works in MV6 mode and the other PSU works in MV12 mode, the PSUs should not affect each other and should work properly.
4. When PSUs of the same model are inserted, if the I-MON# signals of two PSUs are directly connected, the PSU running and current share function should not be affected.
5. Current sharing imbalance applies only to the normal temperature.
6. The AC input voltage, frequency, and phase asynchronization should not affect the parallel system output performance (requiring current sharing and output stability).

9 Control Functions

9.1 Turn-on/Turn-off Timing

Figure 9-1 Turn-on/Turn-off timing

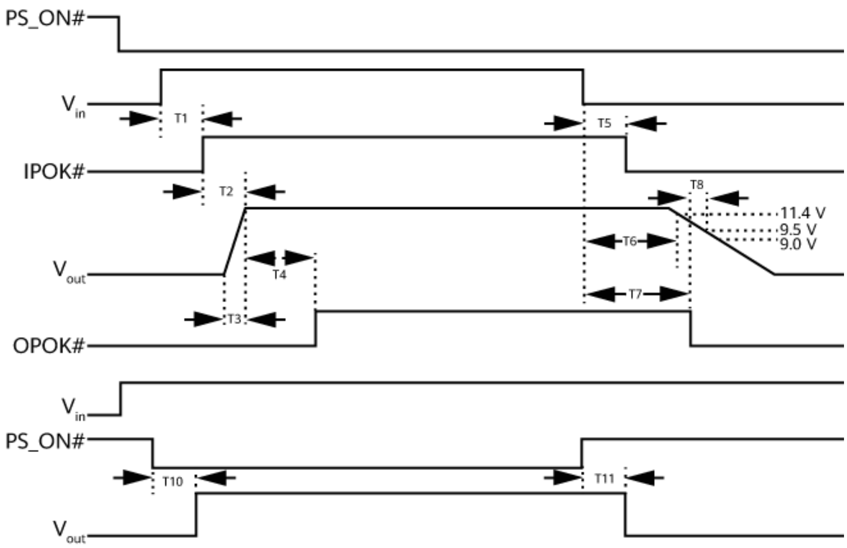


Table 9-1 Turn-on/turn-off timing definitions

Symbol	Description	Minimum Value	Maximum Value	Unit
T1	Time from AC/DC input to when IPOK# becomes high level	/	2000	ms
T2	Time from when IPOK# becomes high level to when MV12 outputs to 11.4 V (PSON# at low level)	/	500	ms
T3	Time for MV6 output to increase from 10% to 90%	5	25	ms
	Time for MV12 output to increase from 10% to 90%	5	25	ms

Symbol	Description	Minimum Value	Maximum Value	Unit
T4	Delay time for OPOK# to take effect (from the time when MV6/MV12 increases to 90% to when OPOK# becomes high level)	50	100	ms
T5	IPOK# failure delay time (from input power failure to IPOK# being at low level, not including circuit breaker power failure)	/	4	ms
T6	Output hold-up time (from input power failure during normal running to 11 V output, 80% load, DIP feature)	10	/	ms
T7	OPOK# hold-up time: time from AC power failure to when OPOK# becomes low level (80% load)	10	/	ms
	Time from when the AC power fails to when OPOK# becomes low level (40% load)	20	/	ms
	Time from when the AC power fails to when OPOK# becomes low level (25% load)	30	/	ms
	Time from when the AC power fails to when OPOK# becomes low level (12.5% load)	40	/	ms
T8	Time from when OPOK# falls to 1.43 V to when the 12 V bus voltage drops to 9.5 V	200	/	μs
T9	Output hold-up time (from low IPOK# to when the output drops to 5.7 V after input power failure during normal running. When the output voltage is lower than 9.2 V, the output power is 15 W. T6 is considered and power failure logs are recorded.)	300	/	ms
T10	Delay when the PSON# signal switches from MV6 to MV12 (from low level to 11.4 V output)	80	200	ms
	The MV6 output overcurrent protection or MV12 output overtemperature protection fault is rectified, and the MV6 output voltage increases to 11 V.	2.1	3.3	s
T11	Time for MV12 to decrease to MV6; 24 W loads connected	80	200	ms

NOTE

1. In case of input outage, if the load power is greater than 50%, the PSU needs 10–120 ms to set the IIC alarm position to 1; if the load power is less than or equal to 50%, the PSU needs 20–120 ms to set the IIC alarm position to 1.
2. The PSU supports the requirement of storing NVDIMM.
   1. T8 scenario: There is a time requirement for input power failure, input overvoltage, input undervoltage, fan fault, and overtemperature. There is no time requirement on the OPOK# alarm caused by output overcurrent, output short circuit, output overvoltage, or output short circuit. In the case of input power failure, undervoltage, or overvoltage, OPOK# is not allowed to rebound after dropping.
   2. The PSU can report an OPOK# fault in advance for predictable PSU faults (such as input power failure, input overvoltage, input undervoltage, fan fault, overtemperature, and output undervoltage). In this case, the requirement that the output power must be less than 11.4 V does not have to be met.
3. T1 and T2 tests can be performed only after the auxiliary power supply is powered off.
4. T3 must meet the minimum load requirements.
5. The PSON# signal is valid when the PSON# high level is detected for 25 ms or longer.

9.2 ORing-FET

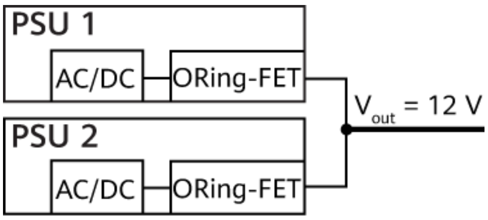
PSU side: An ORing-FET failure isolation circuit needs to be added inside the PSU MV12 output. In the parallel scenario (1+1, 2+2, 3+3 backup), if one PSU is faulty, it needs to exit automatically to prevent the 12 V bus of the PSU from being abnormal.

System side:

Capacitance on the 12 V input side: The equivalent capacitance must be greater than the minimum capacitive load (540 µF x N) of PSUs (N indicates the number of PSUs configured in the system, and the output power of a single PSU is less than 1000 W) or 1000 µF x N (N indicates the number of PSUs configured in the system, and the output power of a single PSU is greater than 1000 W), and less than the maximum capacitive load 8000 µF of the PSUs.

12 V load: greater than the minimum load 3 A of the PSU and less than the rated load of the PSU

Figure 9-2 ORing-FET circuit



9.3 PSON12V#

The PSON12V# signal is an on/off signal that controls the PSU MV12 output remotely. If the PSON12V# signal is at low level, the PSU enters MV12 output mode. If the PSON12V# is at high level, the PSU enters MV6 output mode. **Figure 9-3** shows the interconnect diagram of the PSON12V# signal. PSON# is at high level for 25 ms or longer and is valid.

Figure 9-3 Interconnect diagram of the PSON12V signal

Table 9-2 PSON12V# signal characteristics

Signal Characteristics	
Signal type:PSU on/off signal	PSU side: This signal is pulled up to 3.3 V auxiliary power supply inside the PSU by a 4.7-kilohm resistor. System side: This signal is output by CPLD over the drive circuit and pulled up to 3.3 V by a 10.0-kilohm resistor.
PSON12V# = Low	MV12 output mode
PSON12V# = High/Left open	MV6 output mode

Table 9-3 PSON12V# output

PSON12V# Output	**Min.**	**Max.**
Low level voltage	0 V	0.8 V
High level voltage	2.000 V	3.465 V
Source current, PSON12V# = Low	-	1 mA
Signal rise and fall time	-	100 μs

9.4 PRESENT#

The PRESENT# signal is used by the system to detect whether the PSU is present.

Table 9-4 PRESENT# signal characteristics

Signal Characteristics	
Signal type	PSU side: The PSU interior is directly grounded. System side: This signal is pulled up to 3.3 V by a 4.7-kilohm resistor and output to the system CPLD over a series resistor.
PRESENT# = Low	The PSU is present.
PRESENT# = High	The PSU is removed from the system.

9.5 INSTALLED#

The INSTALLED# signal is used by the PSU to determine whether it has been inserted into the system.

Table 9-5 INSTALLED# signal characteristics

Signal Characteristics	
Signal type: The PSU determines whether it has been inserted into the system.	PSU side: This signal is pulled up to 3.3 V auxiliary power supply inside the PSU by a 4.7-kilohm resistor. System side: This signal is grounded directly.
INSTALLED# = Low	The PSU is inserted into the system.
INSTALLED# = High	The PSU is not inserted into the system.

Table 9-6 INSTALLED# output

INSTALLED# Output	Min.	Max.
Low level voltage	0 V	0.8 V
High level voltage	2.000 V	3.465 V
Input sink current, INSTALLED# = Low	-	4 mA
Signal rise and fall time	-	100 µs

9.6 OPOK#

The OPOK# signal is used to detect whether the PSU MV12 output is normal. **Figure 9-4** shows the interconnect diagram of the OPOK# signal.

Figure 9-4 Interconnect diagram of the OPOK# signal

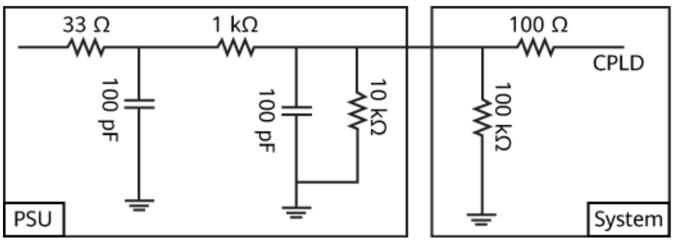


Table 9-7 OPOK# signal characteristics

Signal Characteristics	
Signal type: Detects whether the PSU MV12 output is normal.	PSU side: OD gate; the signal is pulled up to 3.3 V auxiliary power supply inside the PSU by a 1-kilohm (reference value) resistor or the DSP outputs the signal directly through a series resistor. System side: This signal is pulled down to GND through a 100-kilohm (reference value) resistor. A 100-ohm (reference value) series resistor is connected to the system CPLD.
OPOK# = High	The MV12 output is normal.
OPOK# = Low	The MV12 output is abnormal.

Table 9-8 OPOK# output

OPOK# Output	Min.	Max.
Low level voltage	0 V	0.6 V
High level voltage	2.200 V	3.465 V
Source current, OPOK# = Low	-	4 mA
Source current, OPOK# = High	-	4 mA
Signal rise and fall time	-	200 µs

NOTE

1. If the INSTALLED# signal is at high level, then the OPOK# signal is at low level.
2. In MV12 mode:
   1. V_{out} > 11.5 V, OPOK# is at high level
   2. V_{out} < 11.4 V, OPOK# is at low level
   3. The time from when OPOK# drops to 1.43 V to when the PSU 12 V bus voltage drops to 9.5 V is greater than 100 µs. (Input power failure, input overvoltage/undervoltage, fan fault, overtemperature, and output undervoltage should meet the requirements. There is no requirement for output overcurrent, output short circuit, and output overvoltage.)
3. In MV6 mode:
   1. V_{out} > 5.9 V, OPOK# is at high level
   2. V_{out} < 5.8 V, OPOK# is at low level
4. In case of input power failure, input overvoltage, input undervoltage, fan fault, overtemperature protection, and output undervoltage, the PSU can report the OPOK# fault.
5. After the PSU input is powered off, OPOK# is at low level. Before the PSU input recovers, OPOK# cannot be at high level.

9.7 IPOK#

The IPOK# signal is used to detect whether the PSU input is normal. **Figure 9-5** shows the interconnect diagram of the IPOK# signal.

Figure 9-5 Interconnect diagram of the IPOK# signal

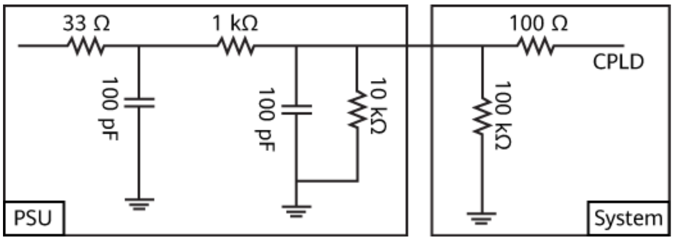


Table 9-9 IPOK# signal characteristics

Signal Characteristics	
Signal type: Output signal from the PSU	PSU side: The PSU directly outputs signals through RC filtering. System side: This signal is pulled down to GND through a 100-kilohm (reference value) resistor. A 100-ohm (reference value) series resistor is connected to the system CPLD.
IPOK# = High	The input is normal. (90 V AC < V_{in} < 264 V AC; 180 V DC < V_{in} < 300 V DC)
IPOK# = Low	The input is abnormal (after input undervoltage protection or input overvoltage protection).

Table 9-10 IPOK# output

IPOK# Output	Min.	Max.
Low level voltage	0 V	0.6 V
High level voltage	2.200 V	3.465 V
Source current, IPOK# = Low	-	4 mA
Source current, IPOK# = High	-	4 mA
Signal rise and fall time	-	200 µs

9.8 IPOK LINK#

The IPOK LINK# signal is delivered by the system to the PSU, which indicates that the system has at least one PSU present with normal input.

Table 9-11 IPOK LINK# signal characteristics

Signal Characteristics	
Signal type: Output signal from the PSU	PSU side: This signal is pulled up to 3.3 V auxiliary power supply inside the PSU by a 2.49-kilohm resistor. System side: This signal is output by CPLD over the drive circuit and pulled up to 3.3 V by a 4.7-kilohm resistor.
IPOK LINK# = High	The input of the standby PSU is normal.
IPOK LINK# = Low	The input of the standby PSU is abnormal.

Table 9-12 IPOK LINK# output

IPOK LINK# Output	Min.	Max.
Low level voltage	0 V	0.6 V
High level voltage	2.200 V	3.465 V
Source current, IPOK LINK# = Low	-	4 mA
Source current, IPOK LINK# = High	-	4 mA
Signal rise and fall time	-	200 µs

9.9 CYC_PWR#

The CYC_PWR# signal is used by the system to make the PSU shut down or restore MV12 output.

- The signal is valid if the CYC_PWR# signal is at low level for 100–150 ms. The PSU is shut down after the delay time (configurable), and then starts after the restart time (configurable).
- The CYC_PWR# signal is valid after the OPOK# signal becomes high level.
- The CYC_PWR# signal is invalid if both the OPOK# and CYC_PWR# signals are low level.
- The signal is invalid if the CYC_PWR# signal is at low level for less than 100 ms.
- The CYC_PWR# signal is invalid when a PSU is during delay shutdown or restarting.

Table 9-13 CYC_PWR# signal characteristics

Signal Characteristics	
Signal type: Shuts down or restores MV12 output.	PSU side: This signal is pulled up to 3.3 V auxiliary power supply inside the PSU by a 2.49-kilohm resistor. System side: This signal is output by CPLD over the drive circuit and pulled up to 3.3 V by a 4.7-kilohm resistor.
CYC_PWR# = High	The PSU has no action.
CYC_PWR# = Low	The PSU enters power supply cycle power mode.

Table 9-14 CYC_PWR# output

CYC_PWR# Output	Min.	Max.
Low level voltage	0 V	0.8 V
High level voltage	2.000 V	3.465 V
Source current, CYC_PWR# = Low	-	4 mA
Source current, CYC_PWR# = High	-	4 mA
Signal rise and fall time	-	200 µs

9.10 I_MON#

This signal is an MV12 output current share signal. The system backplane directly connects the I-MON signals of all PSUs together.

9.11 IP PRESENT#

IP PRESENT# is an active-low signal that controls the SV12 switch of the PSU. After IP PRESENT is valid, the PSU enters the SV12 output state. The designed overcurrent protection threshold is greater than or equal to 50 A in this case. When the IP PRESENT# signal is at high level, the PSU maintains the MV12 output mode.

PSU side: This signal is pulled up to the 3.3 V auxiliary power supply inside the PSU. The reference value for the pull-up resistor is 4.75 kilohms.

System side: CPLD is output over the drive circuit and pulled up to 3.3 V. The reference value for the pull-up resistor is 4.7 kilohms.

Table 9-15 IP PRESENT# signal characteristics

Signal Characteristics	
IP PRESENT# = High	MV12 output mode
IP PRESENT# = Low	SV12 output mode

Table 9-16 IP PRESENT# output

IP PRESENT# Output	Min.	Max.
Low level voltage	0 V	0.6 V
High level voltage	2.000 V	3.465 V
Source current, IP PRESENT# = Low		4 mA
Source current, IP PRESENT# = High		4 mA
Signal rise and fall time		200 µs

9.12 PS_INTERRUPT#

The PS_INTERRUPT# signal indicates PSU I2C alarm interruption.

Table 9-17 PS_INTERRUPT# signal characteristics

Signal Characteristics	
Signal type: I2C alarm interruption signal	PSU side: OD gate output. There is no pull-up on the PSU side, or the DSP directly outputs the signal through a series resistor. System side: After the signal is pulled up to 3.3 V, it is sent to the system reversely through the MOSFET.
PS_INTERRUPT# = High	PSU normal
PS_INTERRUPT# = Low	PSU alarm

9.13 EFUSEV

The system samples the input current of the main service load branch (12 V), converts the current to a linear voltage analog signal, and sends the signal to the EFUSEV pin of the PSU.

Table 9-18 EFUSEV signal characteristics

Signal Characteristics	
Signal type	PSU side: Sent to the PSU DSP by a 100-ohm series resistor. System side: ● If this function is enabled, the system sends the voltage analog signal of the main service circuit to the PSU, or CPLD outputs this signal over the drive circuit and this signal is pulled up to 3.3 V level by a 4.7-kilohm resistor. ● If this function is disabled, this signal is pulled up to 3.3 V level by a 4.7-kilohm resistor.
EFUSEV = High	Disables deep sleep and automatic PFC shutdown.
EFUSEV = Low	Enables deep sleep and automatic PFC shutdown.

Table 9-19 EFUSEV output

EFUSEV Output	Minimum	Maximum
Low level voltage	0 V	0.8 V
High level voltage	1.000 V	3.465 V

9.14 SMART_ON#

The SMART_ON signal is used to wake up a cold-standby PSU (low level by default).

1. Active PSU setting: The system sends the D0h 0x01 command to the active PSU, the SMART_ON signal of the active PSU changes to high level, and then the PSU enters cold standby mode.
2. Standby PSU setting: The system sends the D0h 0x02/0x03/0x04 command to the standby PSU, and then the standby PSU disconnects the DC/DC circuit.
3. Standby PSU wake-up: If the active PSU is faulty and the SMART_ON signal changes to low level, the standby PSU starts working.

NOTE

Other PSUs must work properly when different models of PSUs are inserted.

Table 9-20 SMART_ON# signal characteristics

Signal Characteristics	
Signal type: Cold-standby PSU wake-up signal	The SMART_ON# signals of all PSUs are connected together.

Signal Characteristics	
SMART_ON# = High	The PSU enters cold standby mode.
SMART_ON# = Low	The PSU exits from cold standby mode.

Table 9-21 SMART_ON# output

SMART_ON# Output	Min.	Max.
Low level voltage	0 V	0.8 V
High level voltage	2.0 V	3.6 V

10 Communication

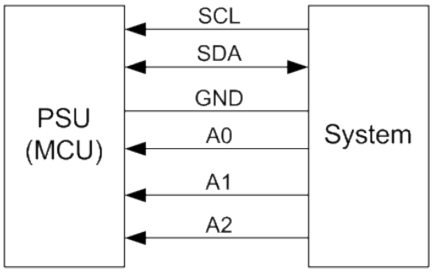
10.1 Physical Link Layer Protocol

10.1.1 I2C Signal

The PSU includes a main control unit (MCU) used for monitoring, and a 256-byte internal EEPROM used for storing fault records. The PSU can use the internal EEPROM in the MCU to store fault records. The system sends commands to the MCU over the I2C bus to read fault records from the PSU.

Figure 10-1 shows the I2C interface communication diagram.

Figure 10-1 I2C interface



SCL and SDA are the serial clock signal and serial data signal of I2C respectively.

PSU Side	System Side
• SCL and SDA are pulled up to 3.3 V level by a 20-kilohm resistor. • The MCU is powered by the auxiliary power supply of the PSU or the busbar at the system side. • When power is supplied from the system side, there should be a fuse or an overcurrent/short-circuit protection circuit. • Capacitors on the SCL and SDA circuit are no more than 66 pF.	SCL and SDA are pulled up to 3.3 V level by a 3-kilohm to 10-kilohm equivalent resistor.

10.1.2 I2C Address

Addresses A2, A1, and A0 are allocated to a PSU.

PSU side:

- A2, A1, and A0 must be pulled up to the internal voltage source through a 10-kilohm (reference value) resistor. The voltage source must be the voltage source that supplies power to the secondary MCU. The voltage source is supplied by the internal auxiliary power source, which is generated by the PSU and system-side 12 V bus at the same time.
- When power is supplied from the system side, the fuse or overcurrent/short-circuit protection circuit must be used.

System side:

If this signal is connected to GND through a 300-ohm resistor, the address bit is 0. If this signal is left open, the address bit is 1.

The I2C address of the PSU from high to low is A2, A1, and A0. See **Table 10-1** for details.

Table 10-1 I2C address

PSU A2/A1/A0	0/0/0	0/0/1	0/1/0	0/1/1	1/0/0	1/0/1	1/1/0	1/1/1
MCU	0xB0	0xB2	0xB4	0xB6	0xB8	0xBA	0xBC	0xBE

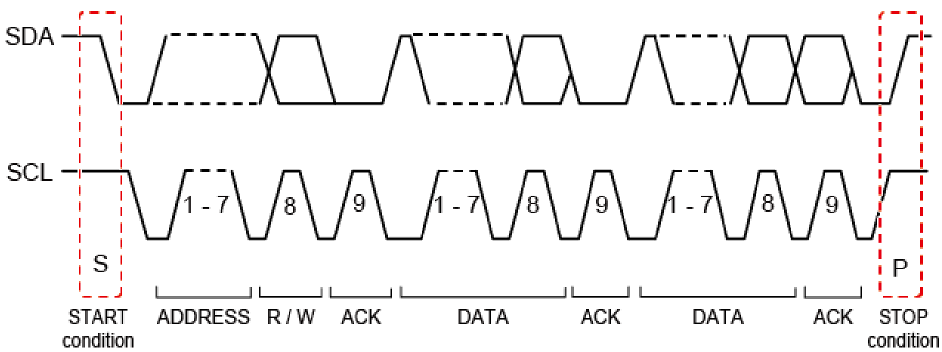
10.2 Data Link Layer Protocol

The link layer uses the PMBus V1.2 protocol and complies with *PMBus_Specification_Part_I_Rev_1-2_20100906* and *PMBus_Specification_Part_II_Rev_1-2_20100906*.

10.2.1 Data Transmission Mode

The I2C transmission standard is used. Data transmission rate is 100 kbps. The timing definition of lower-layer signals, such as START, STOP, R/W, ADDRESS, ACK/NACK, bus arbitration, clock synchronization, and clock extension (except bus timeout) complies with PSMI. **Figure 10-2** shows the I2C data transmission mode.

Figure 10-2 I2C data transmission mode



10.2.2 I2C Bus Timeout

The I2C program of the PSU is reset to 0 if the PSU detects that the SCL or SDA data line is held low for more than 300 ms.

10.3 Network Layer Protocol

10.3.1 Addressing Mode of a Slave Device

The module serves as a slave device. The address is identified by the hardware and allocated statically. The master device accesses each slave device by addressing according to the slave device address determined by the hardware.

10.3.2 Data Packet Verification Mode

To ensure data integrity and accuracy during communication, the PSU uses the 8-bit CRC checksum mechanism.

The last byte of each sent and received signal is the CRC code of this signal.

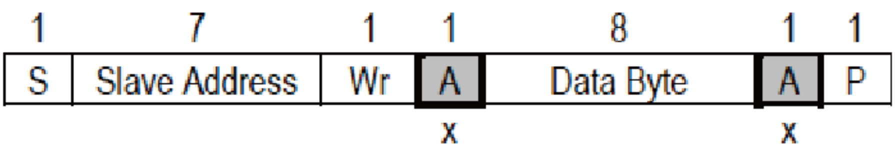
- When the master device sends data to a slave device, PEC (CRC) contains the address byte, read/write bit, command byte, and multiple pieces of data to be sent.
- The master device obtains data from a slave device: PEC (CRC) sent by the slave device contains the address bytes obtained by the slave device, read/write bits, command codes, and data bytes sent by the slave device.

10.3.3 CRC Generation Rules

The generator polynomial is $x^8 + x^2 + x^1 + 1$, and the CRC code is 100000111.

10.3.4 Data Transmission

PMBus communication supports 10 data formats in total. All data formats adopt PEC verification.



S: Start Condition
Sr: Repeated start condition
Rd: Read (bit value of 1)
Wr: Write (bit value of 0)
x: Shown under a field indicates that field is required to have the value of 'x'
A: Acknowledge (this bit position may be '0' for an ACK or '1' for a NACK)
P: Stop condition
PEC: Packet Error Code
...: Continuation of protocol

Master-to-Slave

Slave-to-Master

1. Send Byte command and response

1	7	1	1	8	1	8	1	1
S	Slave Address	Wr	A	Data Byte	A	PEC	A	P

2. Receive Byte command and response

1	7	1	1	8	1	8	1	1
S	Slave Address	Rd	A	Data Byte	A	PEC	A	P
							1	

3. Write Byte command and response

1	7	1	1	8	1	8	1	8	1	1
S	Slave Address	Wr	A	Command Code	A	Data Byte	A	PEC	A	P

4. Write Word command and response

1	7	1	1	8	1	8	1	8	1	
S	Slave Address	Wr	A	Command Code	A	Data Byte Low	A	Data Byte High	A	...

8	1	1
PEC	A	P

5. Read Byte command and response

1	7	1	1	8	1	1	7	1	1	8	1	
S	Slave Address	Wr	A	Command Code	A	S	Slave Address	Rd	A	Data Byte	A	...

8	1	1
PEC	A	P
	1	

6. Read Word command and response

1	7	1	1	8	1	1	7	1	1	8	1	
S	Slave Address	Wr	A	Command Code	A	S	Slave Address	Rd	A	Data Byte Low	A	...

8	1	8	1	1
Data Byte High	A	PEC	A	P
			1	

7. Process Call command and response

1	7	1	1	8	1	8	1	8	1	
S	Slave Address	Wr	A	Command Code	A	Data Byte Low	A	Data Byte High	A	...

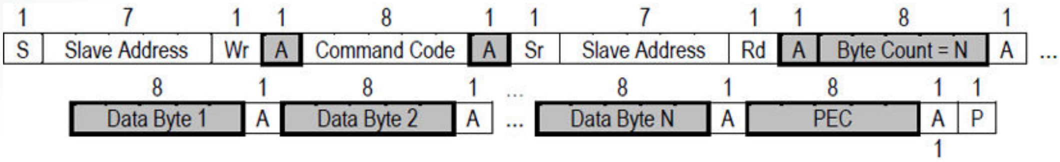
1	7	1	1	8	1	8	1	8	1	1
Sr	Slave Address	Rd	A	Data Byte Low	A	Data Byte HIgh	A	PEC	A	P
									1	

8. Block Write command and response

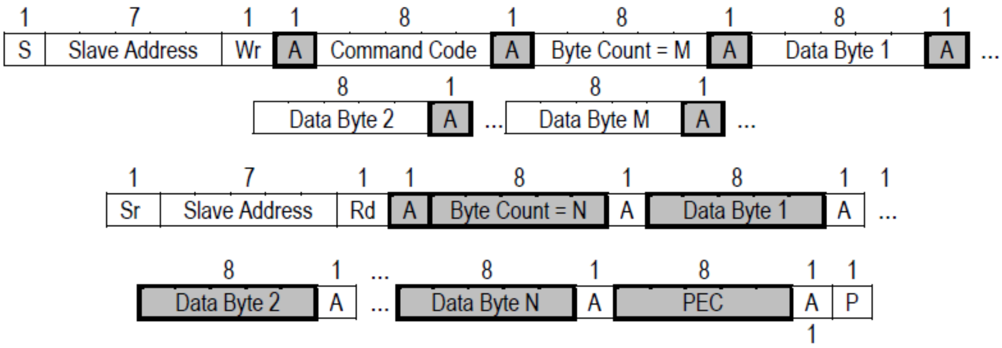
1	7	1	1	8	1	8	1	8	1	
S	Slave Address	Wr	A	Command Code	A	Byte Count = N	A	Data Byte 1	A	...

8	1	...	8	1	8	1	1
Data Byte 2	A	...	Data Byte N	A	PEC	A	P

9. Block Read command and response



10. Block Read – Block Write Process Call command and response



10.4 Application Layer Protocol

NOTE

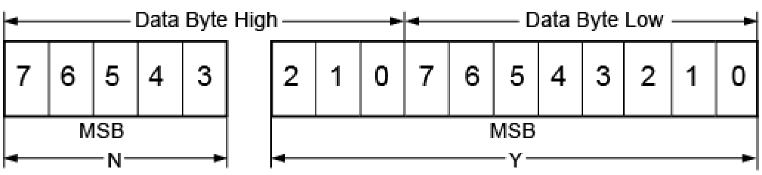
- The PSU alarm is not latched. If a PSU is faulty, an alarm is reported. After the PSU fault is rectified, the alarm is automatically cleared.
- If the PSU is faulty, the system sends CLEAR_FAULTS to clear the alarm. If the alarm persists, the PSU continues to report the alarm.
- The FAULT alarm and the WARNING alarm are mutually exclusive.

10.4.1 Data Format

Linear 11 Data Format

The linear data format consists of two parts, with an 11-bit binary signed mantissa (two's complement) and a 5-bit binary signed exponent (two's complement), as shown in the following figure.

Figure 10-3 Linear 11 data format



The relationship between N, Y, and actual value X is given by the following equation:

$$X = Y \times 2^N$$

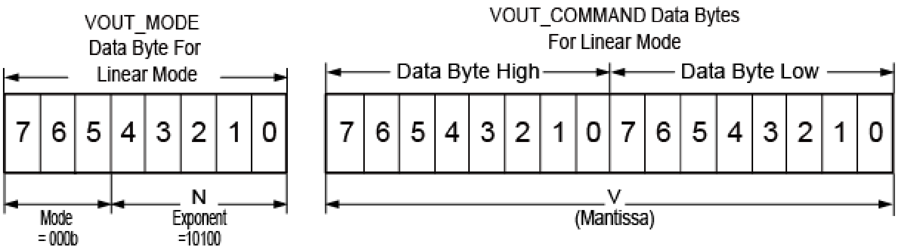
Where:

- Y is the 11-bit, binary signed mantissa (two's complement).
- N is the 5-bit, binary signed exponent (two's complement).

Linear 16 Data Format

The linear data format consists of two parts, with a 16-bit binary unsigned mantissa and a 5-bit binary signed exponent (two's complement), as shown in the following figure.

Figure 10-4 Linear 16 data format



The output voltage is calculated as follows:

$$Voltage = V \times 2^N$$

Where:

- Voltage is the output voltage value.
- V is the 16-bit unsigned integer.
- N is the 5-bit signed integer (two's complement). N = –12

10.4.2 Commands

Hex Code	Command Name	Read/Write	Data Format
0x01	PMBUS_CMD_OPERATION	Read/Write BYTE	HEX
0x03	PMBUS_CMD_CLEAR_FAULTS	Write BYTE	HEX
0x20	PMBUS_CMD_VOUT_MODE	Read BYTE	HEX
0x21	PMBUS_CMD_VOUT_CTRL	Read/Write WORD	LINEAR 16
0x31	PMBUS_CMD_RATED_POUT	Read WORD	LINEAR 11
0x3A	PMBUS_CMD_FAN_CONFIG	Read/Write BYTE	HEX
0x3B	PMBUS_CMD_FAN_COMMAND	Read/Write WORD	HEX
0x78	PMBUS_CMD_STATUS_BYTE	Read/Write BYTE	HEX
0x79	PMBUS_CMD_STATUS_WORD	Read/Write WORD	HEX
0x7A	PMBUS_CMD_STATUS_VOUT	Read/Write BYTE	HEX

Hex Code	Command Name	Read/Write	Data Format
0x7B	PMBUS_CMD_STATUS_IOUT	Read/Write BYTE	HEX
0x7C	PMBUS_CMD_STATUS_INPUT	Read/Write BYTE	HEX
0x7D	PMBUS_CMD_STATUS_TEMP	Read/Write BYTE	HEX
0x7E	PMBUS_CMD_STATUS_CML	Read/Write BYTE	HEX
0x80	PMBUS_CMD_STATUS_MFR_SPECIFIC	Read/Write BYTE	HEX
0x81	PMBUS_CMD_STATUS_FANS	Read/Write BYTE	HEX
0x88	PMBUS_CMD_READ_VIN	Read WORD	LINEAR 11
0x89	PMBUS_CMD_READ_IIN	Read WORD	LINEAR 11
0x8B	PMBUS_CMD_READ_VOUT	Read WORD	LINEAR 16
0x8C	PMBUS_CMD_READ_IOUT	Read WORD	LINEAR 11
0x8D	PMBUS_CMD_READ_TEMPERATURE_1	Read WORD	LINEAR 11
0x8E	PMBUS_CMD_READ_TEMPERATURE_2	Read WORD	LINEAR 11
0x8F	PMBUS_CMD_READ_TEMPERATURE_3	Read WORD	LINEAR 11
0x90	PMBUS_CMD_READ_FAN_SPEED	Read WORD	DEC
0x95	PMBUS_CMD_READ_FREQUENCY	Read WORD	LINEAR 11
0x96	PMBUS_CMD_READ_POUT	Read WORD	LINEAR 11
0x97	PMBUS_CMD_READ_PIN	Read WORD	LINEAR 11
0x98	PMBUS_CMD_PMBUS_REVISION	Read BYTE	DEC
0x99	PMBUS_CMD_MFR_ID	Read BLOCK	ASCII
0x9A	PMBUS_CMD_MFR_MODEL	Read/Write BLOCK	ASCII
0x9B	PMBUS_CMD_HARD_VERSION	Read BLOCK	ASCII
0x9D	PMBUS_CMD_MFR_DATE	Read/Write BLOCK	ASCII
0x9E	PMBUS_CMD_MFR_SERIAL	Read/Write BLOCK	ASCII
0xBD	PMBUS_CMD_E_LABLE_LENGTH	Read/Write BLOCK	HEX
0xBE	PMBUS_CMD_E_LABLE_INDEX	Read/Write WORD	DEC
0xBF	PMBUS_CMD_E_LABLE_CONTENT	Read/Write BLOCK	ASCII
0xC0	PMBUS_CMD_POWER_CYCLE_TIME	Read/Write WORD	DEC
0xC6	PMBUS_CMD_WARNING_COUNT1	Read/Write WORD	DEC
0xC7	PMBUS_CMD_WARNING_COUNT2	Read/Write WORD	DEC

Hex Code	Command Name	Read/Write	Data Format
0xC8	PMBUS_CMD_WARNING_COUNT3	Read/Write WORD	DEC
0xCC	PMBUS_CMD_MAX_VIN	Read/Write WORD	LINEAR 11
0xCD	PMBUS_CMD_MAX_IIN	Read/Write WORD	LINEAR 11
0xCE	PMBUS_CMD_PS_CONTROL	Read/Write WORD	HEX
0xCF	PMBUS_CMD_READ_POWER_TYPE	Read WORD	HEX
0xD0	PMBUS_CMD_SMART_ON_CONFIG	Read/Write BYTE	HEX
0xD4	PMBUS_CMD_SET_PSALERT	Read/Write BYTE	HEX
0xD6	PMBUS_CMD_MAX_PIN	Read/Write WORD	LINEAR 11
0xD7	PMBUS_CMD_MAX_POUT	Read/Write WORD	LINEAR 11
0xD8	PMBUS_CMD_MAX_TEMP_MONITOR	Read/Write WORD	LINEAR 11
0xDB	PMBUS_CMD_MAX_12V_IOUT	Read/Write WORD	LINEAR 11
0xDE	PMBUS_CMD_READ_PART_NUMBER	Read/Write BLOCK	ASCII
0xDF	PMBUS_CMD_READ_INPUT_TYPE	Read WORD	HEX
0xE0	PMBUS_CMD_WRITE_EVENT_INDEX	Write BYTE	DEC
0xE0	PMBUS_CMD_READ_EVENT_LOG	Read BLOCK	HEX
0xE1	PMBUS_CMD_WRITE_EVENT_LOG	Write WORD	HEX
0xE4	PMBUS_CMD_DCDC_SOFT_VER	Read WORD	HEX
0xE7	PMBUS_CMD_PFC_SOFT_VER	Read WORD	HEX
0xED	PMBUS_CMD_LED_CTRL	Read/Write BYTE	HEX
0xEE	PMBUS_CMD_LOAD_SHARE_SCALE	Read/Write BYTE	DEC
0xF9	PMBUS_CMD_READ_TEMPERATURE_4	Read WORD	LINEAR 11
0xFA	PMBUS_CMD_UPDATE_TIME	Write BLOCK	TIME
0xFB	PMBUS_CMD_LOAD_PARAM	Read BLOCK	HEX
0xFC	PMBUS_CMD_LOAD_START	Read/Write WORD	HEX
0xFD	PMBUS_CMD_LOAD_DATA	Write BLOCK	HEX

Command Description

PMBUS_CMD_OPERATION: remote startup and shutdown

- 0x80: The PSU is enabled.
- 0x00: The PSU is reset.
- 0x40: The PSU soft-closes the mains output. The PSOK# time sequence meets the requirements.

NOTE

- When the MCU is powered on again or the PSU is removed from the system, the default value 0x80 is restored.
- Other data is not responded.
- By default, the PSU is shut down 1s after the reset, and is started 10s after being shut down.

PMBUS_CMD_FAN_CONFIG: fan configuration

- Bit 7: whether position 1 has a fan
  - 0: Position 1 has no fan. 1: Position 1 has a fan.
- Bit 6: format of the fan speed adjustment command
  - 0: duty cycle, 1: RPM
- Bits 5–4: The rotational speed is measured by pulse.
- Bit 3: whether position 2 has a fan
  - 0: Position 2 has no fan. 1: Position 2 has a fan.
- Bit 2: format of the fan speed adjustment command
  - 0: duty cycle, 1: RPM
- Bits 1–0: The rotational speed is measured by pulse.

PMBUS_CMD_POWER_CYCLE_TIME: shutdown delay time

- Bits F–8: PSU shutdown delay time
- Bits 7–0: PSU shutdown time

NOTE

- By default, the PSU is shut down after a delay of 1s, and is started 10s after being shut down.
- The OPERATION# signal can be used. When the active PSU sends the 0x00 reset command, the PSU is reset based on the set time.
- The CYC_PWR# signal can be used. When the active PSU sets the CYC_PWR# signal low for 100–150 ms, the PSU is reset based on the set time.

PMBUS_CMD_READ_POWER_TYPE: PSU types

- 0: AC
- 1: 48 V DC
- 2: HVDC
- 3: AC&240 HVDC
- 4: AC&240HVDC&380HVDC

NOTE

Currently, the PSU always reports 3, that is, AC&240HVDC.

PMBUS_CMD_SMART_ON_CONFIG: cold standby configuration command

- 0x00: standard backup mode
- 0x01: cold standby active mode
- 0x02: standby PSU 1 in cold standby mode
- 0x03: standby PSU 2 in cold standby mode
- 0x04: standby PSU 3 in cold standby mode

PMBUS_CMD_SET_PSALERT: forcible alarm command

- Write 0x20 to forcibly interrupt the signal alarm.
- Write 0x00 to clear the software control and restore the PSU normal control.
- Writing other values is invalid.

PMBUS_CMD_READ_INPUT_TYPE: input voltage type

- 0: no input or input voltage abnormal
- 1: AC input
- 2: HVDC
- 3: low-voltage DC

PMBUS_CMD_LED_CTRL: LED indicator control

- Bit 7: 1 indicates active PSU control (the indicator is valid), and 0 indicates PSU automatic control.
  - Bit 1: 1 indicates that the orange LED indicator is on, and 0 indicates that it is off.
  - Bit 0: 1 indicates that the green LED indicator is on, and 0 indicates that it is off.

NOTE

If bit 0 and bit 1 are written to 1 at the same time, the command is invalid.

10.4.3 Online Upgrade

Both the primary and secondary sides of the PSU support online upgrade.

10.4.4 Black Box Function

The PSU has 440-byte space for storing fault logs. The PSU provides a read channel for external systems by the Read Event Log command.

10.4.4.1 Runtime Counter

The PSU needs to calculate the total runtime. The total runtime is the sum of the time when the PSU works properly (OPOK signal is normal), is presented in the unit of seconds, and occupies four bytes.

10.4.4.2 Event Log

The PSU maintains a circular event log of the last ten records. Before saving the event log, the PSU shall set the event update flag in the event log to 1. Each event shall start with an event number followed by a 4-byte runtime (measured in minutes). The total runtime must be updated before the log is saved.

The shutdown event, input voltage, input current, output voltage, output current, temperature, fan speed, maximum input voltage, maximum output current, PS control, and other information will be stored in the fault record register. The no-output faults caused by insertion or extraction with power on, PSU output command (OPERATION), and CYC_PWR delivered by the system will not be stored in the PSU fault record. Faults including input power failure, input overvoltage, input undervoltage, output overvoltage, output overcurrent/short-circuit, overtemperature, fan fault, and PSU damage will be stored. If a new fault is the same as the latest record in the event log, this fault will not be stored. That is, two consecutive same faults cannot exist in the fault record.

A generated event is saved only when it is different from the last event record. The runtime counter shall be updated every time an event occurs regardless of whether the event is written into the event log. When there are more than 10 events, the 11 event shall overwrite the 1st event, the 12 event shall overwrite the 2nd event, and so on.

10.4.4.3 Format of Reading Logs

- Write Byte Index(0-10)

1	7	1	1	8	1	8	1	8	1	1
S	Slave Address	Wr	A	Command Code	A	Data Byte	A	PEC	A	P

- Read Block(N=40)

1	7	1	1	8	1	1	7	1	1	8	1	
S	Slave Address	Wr	A	Command Code	A	Sr	Slave Address	Rd	A	Byte Count = N	A	...

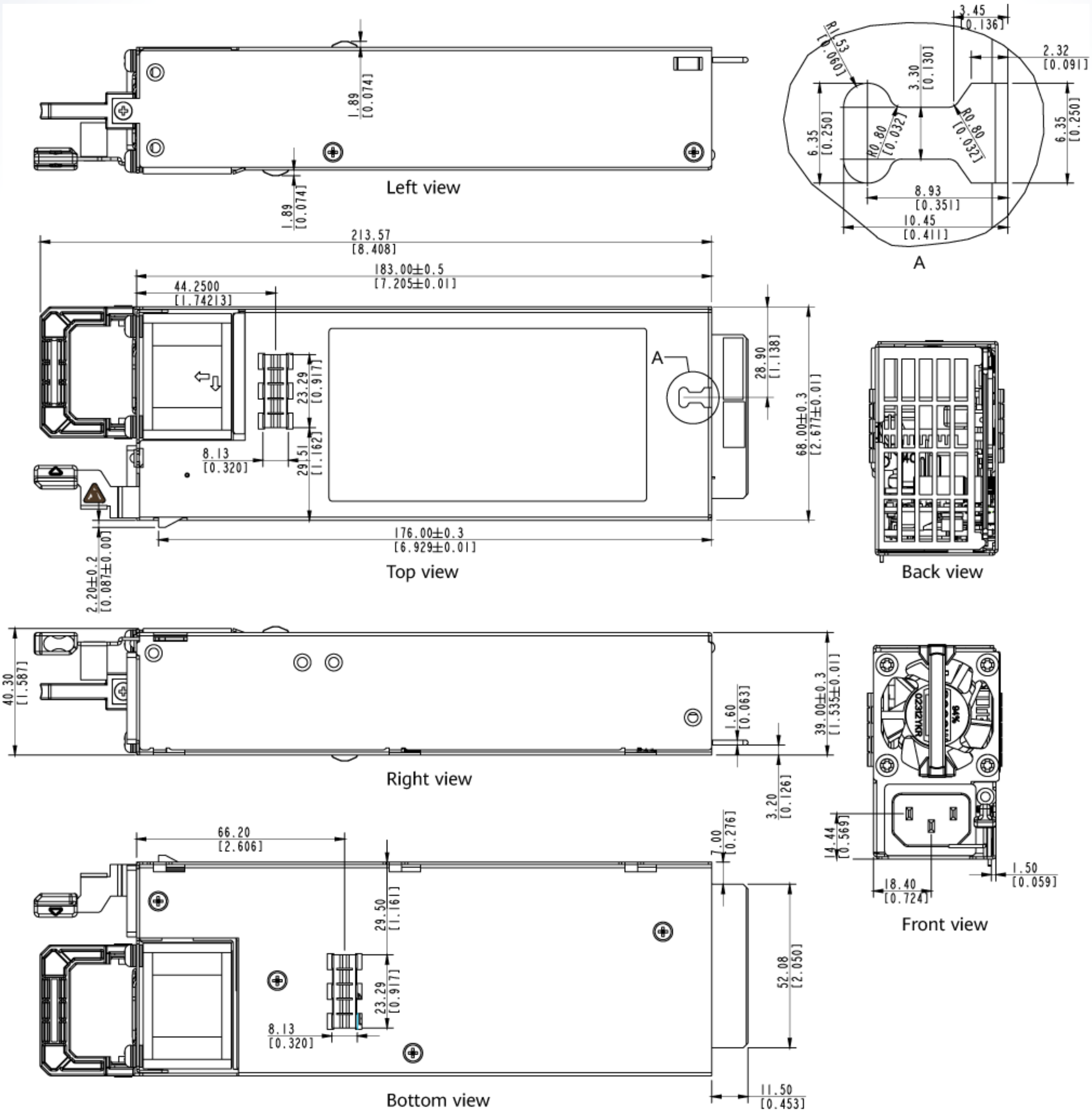
8	1	8	1	...	8	1	8	1	1
Data Byte 1	A	Data Byte 2	A	...	Data Byte N	A	PEC	A	P
								1	

11 Mechanical Overview

11.1 Dimensions

Unit of measurement: mm (in.)

Dimensions (D x W x H): 183.0 mm x 68.0 mm x 40.3 mm (7.20 in. x 2.68 in. x 1.59 in.)


Left view
1.89 [0.074]
1.89 [0.074]
3.45 [0.136]
2.32 [0.091]
R1.53 [0.060]
3.30 [0.130]
6.35 [0.250]
R0.80 [0.032]
R0.80 [0.032]
6.35 [0.250]
8.93 [0.351]
10.45 [0.411]
A
213.57 [8.408]
183.00±0.5 [7.205±0.01]
44.2500 [1.74213]
A
23.29 [0.917]
28.90 [1.138]
68.00±0.3 [2.677±0.01]
8.13 [0.320]
29.51 [1.162]
176.00±0.3 [6.929±0.01]
2.20±0.2 [0.087±0.008]
Top view
Back view
40.30 [1.587]
1.60 [0.063]
39.00±0.3 [1.535±0.01]
3.20 [0.126]
Right view
66.20 [2.606]
7.00 [0.276]
29.50 [1.161]
23.29 [0.917]
8.13 [0.320]
52.08 [2.050]
11.50 [0.453]
Bottom view
14.44 [0.569]
18.40 [0.724]
1.50 [0.059]
Front view

11.2 Output Connector

Figure 11-1 Output connector (top view)

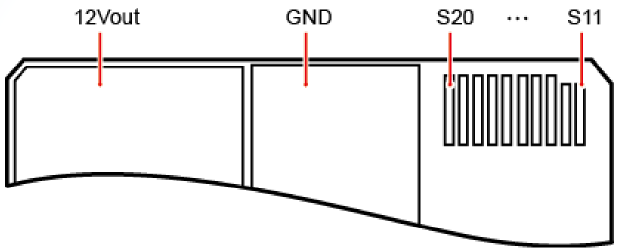


Figure 11-2 Output connector (bottom view)

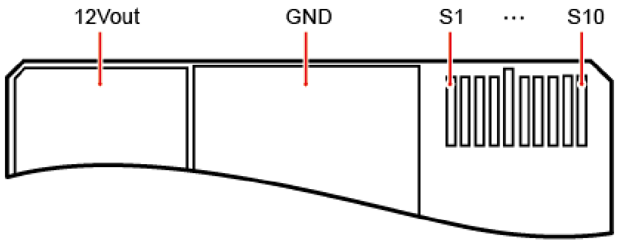


Table 11-1 Output connector definition

PIN#	Signal	Description
S20	PS_OPOK	Signal indicating normal main output
S19	PS_IPOK	Signal indicating normal input
S18	IPOK Link	Signal indicating normal redundant PSU input
S17	SMART_ON	Cold-standby PSU wake-up signal
S16	SHLFBB_SF1	Reserved
S15	INSTALLED54#	Reserved
S14	IP Present	SV12 switch control signal
S13	PSON12V#	MV12 remote on/off control signal
S12	INSTALLED#	PSU installation signal
S11	PRESENT#	PSU presence signal
S10	I-MON	Current share signal
S9	EFUSEV	System E-Fuse voltage

PIN#	Signal	Description
S8	CYC_PWR#	Power supply cycle power
S7	PS_INTR#	PSU alarm interruption signal
S6	SDA	I2C data
S5	I2C Sig GND	I2C signal ground
S4	SCL	I2C clock
S3	ADD2	Address 2
S2	ADD1	Address 1
S1	ADD0	Address 0

11.3 LED Indicator

Indicator	Color	Status	Description
Power status indicator	Orange and green	Steady green	The input and MV12 output are normal.
		Blinking green at 1 Hz	• The input is normal. The MV12 output is shut down via the INSTALLED# signal. • The input is normal and the PSU enters MV6 mode because the PSON12V# signal is at high level. After the PSU enters MV12 mode due to overcurrent in MV6, the indicator blinks at 1 Hz. • Input overvoltage, input undervoltage • Standby PSU in cold standby mode • The PSU enters deep sleep mode. • In low power mode, the PSON12V# and IP PRESENT signals are at low level and the PSU enters SV12 mode. After the PSU enters MV12 mode due to overcurrent in SV12 mode, the indicator blinks at 1 Hz.
		Steady orange	The input is normal. There is no output due to overtemperature protection, output overcurrent, short circuit, or overvoltage protection, or component failure (excluding failure of all components).
		Off	No input
		Blinking green at 4 Hz	Online loading abnormal

NOTE

1. For normal startup, the green indicator should be on and should not blink. For normal power-off, the power indicator should be off.
2. The position of the LED indicator should meet the ESD requirements.
3. The indicator uses the Φ3 mm bi-color indicator.
4. When the indicator is controlled by the main control unit, the indicator status depends on the main control unit command.

A EMC Specifications

Parameter	Conditions	Criterion
Conducted emission (CE)	Class A, 6 dB	EN 55032
Radiated emission (RE)	Class A, 6 dB	EN 55032
	Class A, 6 dB, 30 MHz to 1 GHz	FCC Part15
Electrostatic discharge (ESD)	Contact: ±6 kV, air: ±8 kV	IEC 61000-4-2, criterion B
	Contact: ±8 kV, air: ±15 kV	IEC 61000-4-2, criterion C
Electrical fast transient	±2 kV	IEC 61000-4-4, criterion B
Radiated susceptibility (RS)	10 V/m, 80 MHz to 6 GHz	IEC 61000-4-3, criterion A
Conducted susceptibility (CS)	10 V, 150 kHz to 80 MHz	IEC 61000-4-6, criterion A
Power magnetic susceptibility (PMS)	30 A/m	IEC 61000-4-8:2001, criterion A
Surge	AC input surge: Differential mode: ±2.5 kV for L to N (1.2/50 µs, 2 ohms) Common mode: ±2.5 kV for L to PE, N to PE, and L and N to PE (1.2/50 µs, 12 ohms)	IEC 61000-4-5, criterion B
	HVDC input surge: Differential mode: ±2 kV for P to N (1.2/50 µs, 2 ohms) Common mode: ±2 kV for P to PE, N to PE, and P and N to PE (1.2/50 µs, 12 ohms)	IEC 61000-4-5, criterion B
Dip (AC)	Dip to 0% UT, hold-up time: 10 ms (80% load of a single PSU)	IEC 61000-4-11, criterion A
	Dip to 0% UT, hold-up time: 20 ms (40% load of a single PSU)	IEC 61000-4-11, criterion A

Parameter	Conditions	Criterion
	Dip to 70% UT, hold-up time: 500 ms	IEC 61000-4-11, criterion B
	Dip to 0% UT, hold-up time: 5000 ms	IEC 61000-4-11, criterion C
Dip (HVDC)	Dip to 40% UT Hold-up time: 1 ms/3 ms/10 ms/30 ms/100 ms/300 ms/1000 ms	IEC 61000-4-11, criterion B
	Dip to 70% UT Hold-up time: 1 ms/3 ms/10 ms/30 ms/100 ms/300 ms/1000 ms	IEC 61000-4-11, criterion B
	Dip to 0% UT Hold-up time: 1 ms/3 ms/10 ms/30 ms/100 ms/300 ms/1000 ms	IEC 61000-4-11, criterion B
	Dip to 80% UT Hold-up time: 100 ms/300 ms/1000 ms/3000 ms/10000 ms	IEC 61000-4-11, criterion A
	Dip to 120% UT Hold-up time: 100 ms/300 ms/1000 ms/3000 ms/10000 ms	IEC 61000-4-11, criterion A

B Product Safety Testing

Dielectric Strength Testing

Test Item	Minimum Test Voltage	Test Duration	Leakage Current	Expected Result
Input and PE	2500 V DC	1 minute	≤ 10 mA	No breakdown or arcing
	1500 V AC	1 minute	≤ 10 mA	No breakdown or arcing
Output and PE	SGND of the 12 V output and the PE are short-circuited inside the PSU.			

NOTE

1. Input to output must meet the reinforced insulation requirements after the output ground is disconnected from the PE.
2. Input to output: 4242 V DC, 1 minute, 10 mA; complies with IEC 62368-1.

Ground Continuity Testing

Test Item	Maximum Test Voltage	Test Current	Maximum Resistance	Test Duration
PE input and shell	12 V	25 A	0.1 ohm	Until the readings are stable.

NOTE

This test item is applicable only to power supply devices with metal shells or L-shaped supports that are connected to the PE.

C Reliability

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Mean time between failures (MTBF)	-	500,000	-	Hours	Telcordia SR332; V_{in} = 230 V AC/240 V DC; Rate load; T_A = 25°C

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