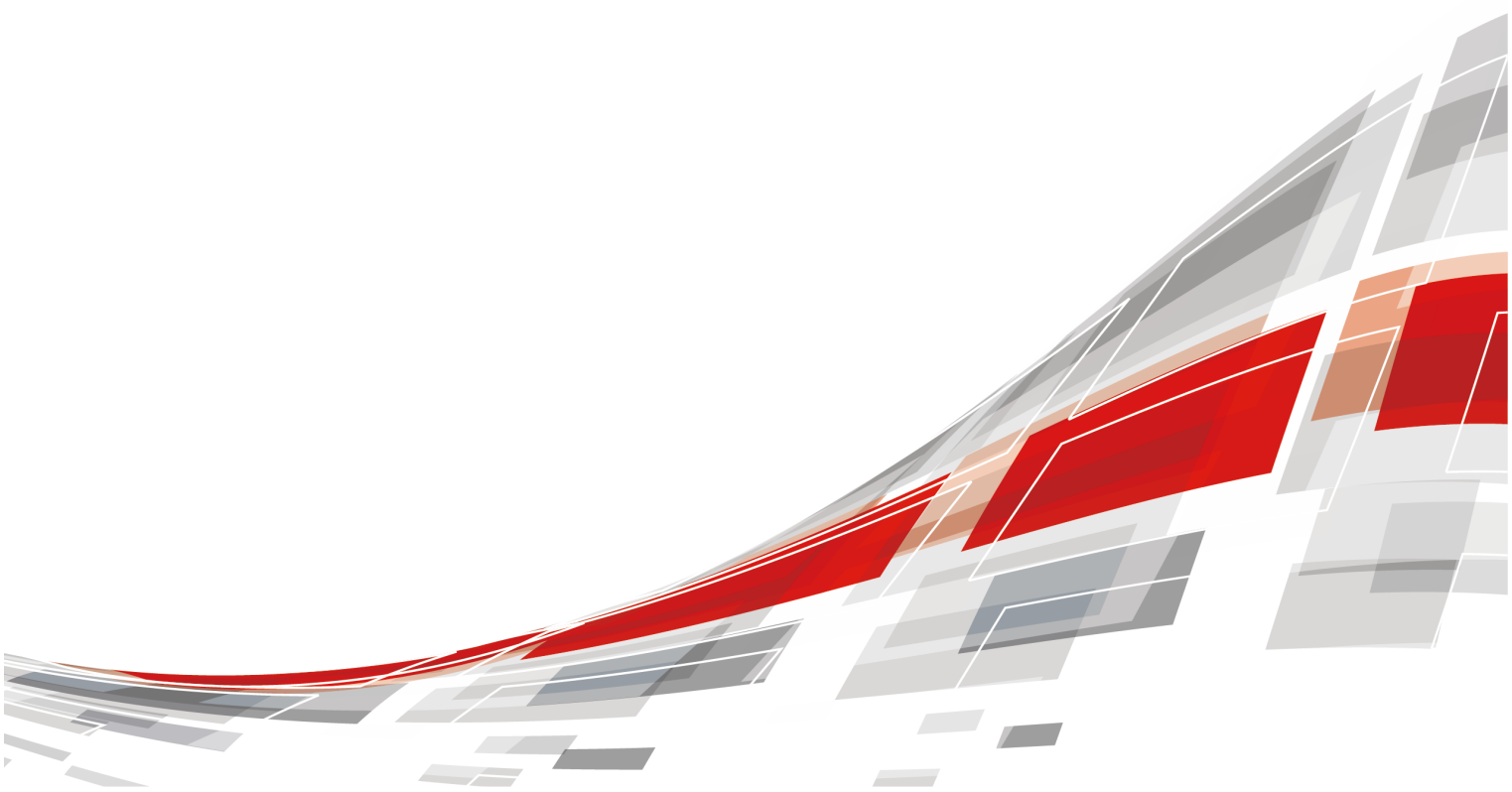
FusionServer G8600 V7 Server

Power Supply Technical White Paper

Issue 02

Date 2023-08-11



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xFusion Digital Technologies Co., Ltd.

Address: 9th Floor, Building 1, Zensun Boya Square, Longzihu Wisdom Island
Zhengdong New District 450046
Zhengzhou, Henan Province
People's Republic of China

Website: https://www.xfusion.com

Contents

1 About This Document

Overview

This document describes the G8600 V7 server in terms of its power supply design, power supply architecture, characteristics in energy efficiency and reliability, and power supply unit (PSU) appearance and performance parameters, so that users can have an in-depth and detailed understanding of power supply of the G8600 V7 server.

Intended Audience

This document is intended for:

- Technical support engineers
- Maintenance 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, could 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, 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.

Symbol	Description
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

Issue	Date	Description
02	2023-08-11	Updated **7.4 Load Distribution Between Inputs A and B**.
01	2023-04-27	This issue is the first official release.

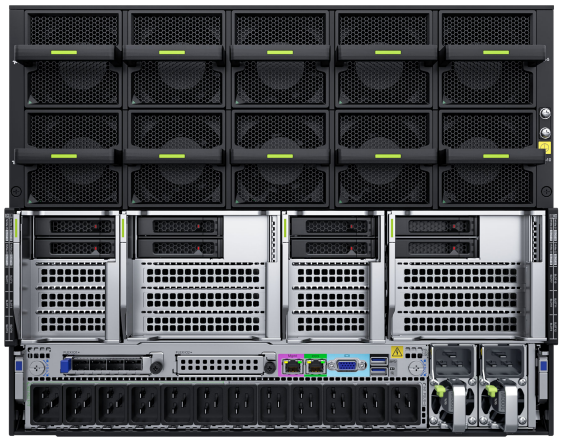
2 Overview

Rapid advancements in applied computing, such as artificial intelligence (AI) and deep learning algorithms, mean growing demand for computing power. The computing performance of servers needs to be improved much faster than that of general-purpose CPUs. A viable solution is heterogeneous computing, which allows for flexible combinations of CPU, GPU, FPGA, and ASIC processors.

xFusion's G8600 V7 server is an 8U GPU server oriented to heterogeneous computing. It supports HGX 8-GPU module.

Figure 2-1 Front view

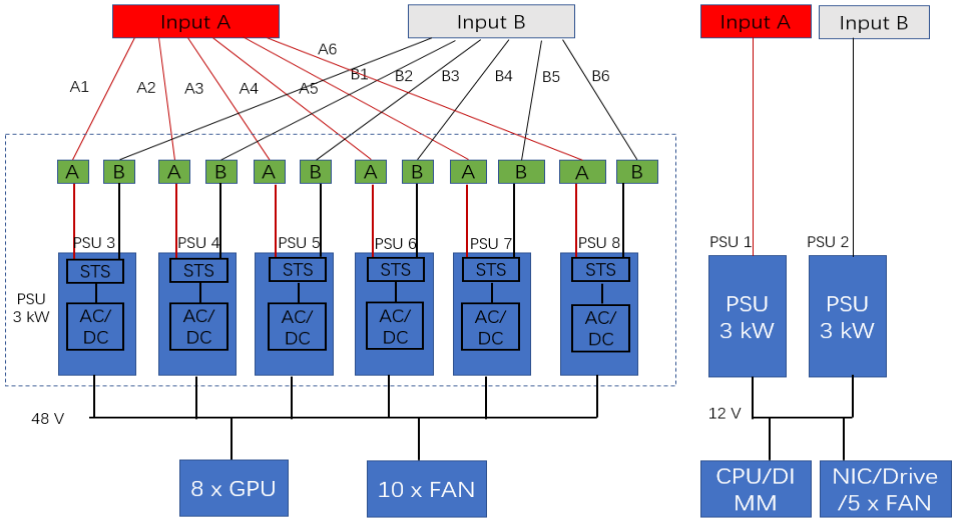
Figure 2-2 Rear view



3 Power Supply Architecture

Power Supply Architecture Overview

Figure 3-1 Power supply architecture of the G8600



Power Supply Architecture Introduction

- **54 V and 12 V dual power supply buses**: The 54 V bus supplies power to the GPU cards and the 54 V fan components that provide heat dissipation for the GPU modules. The 12 V bus supplies power to the CPUs, mainboard, NICs, drives, and 12 V fans that provide heat dissipation for the mainboard.
- **54 V power supply bus**:
  a. The bus is powered by dual-input 3 kW 54 V PSUs (numbered 3 to 8) in N +1 backup mode. Up to 15 kW can be supported by PSUs in 5+1 backup mode.
  b. Each of PSUs 3 to 8 has a dual-input static transfer switch (STS), which connects to two inputs in the equipment room.
  c. When the two inputs in the equipment room are normal, the STS in the PSU connects to one of the inputs and supplies power downsream. If one input is abnormal, the STS automatically switches to another input for power supply. The output is not interrupted (the switching duration is less than 10 ms).

- **12 V power supply bus**: The bus is powered by single-input 12 V PSUs (numbered 1 and 2) in 1+1 backup mode. Up to 3 kW can be supported by the PSUs. You can flexibly select proper PSUs based on the power consumption required by the configuration. **Table 3-1** describes the options.

Table 3-1 Optional PSU list

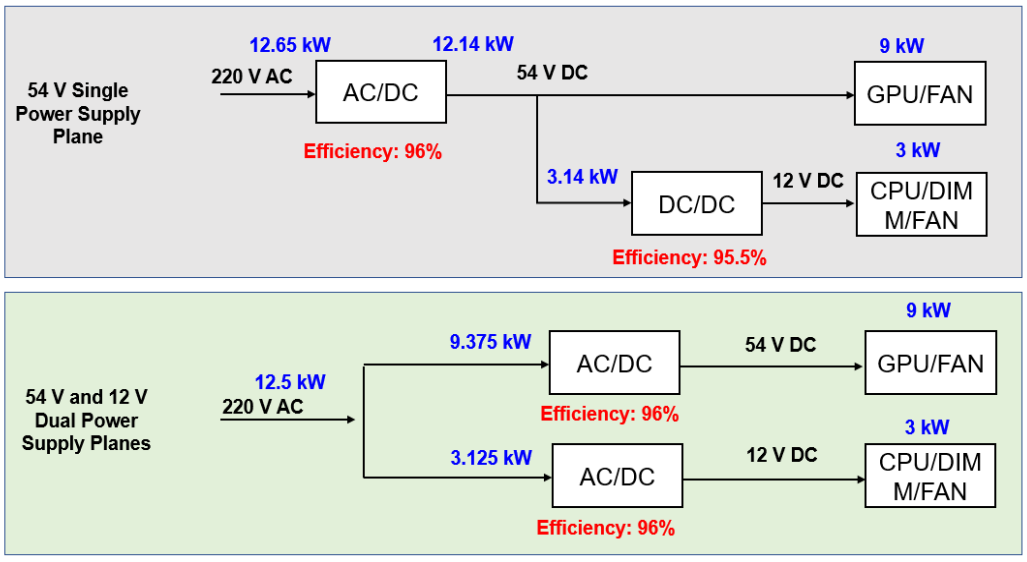
Code	PSU Power	Efficiency
0231Y023	12 V/3000 W	Titanium
0231Y025	12 V/2000 W	Titanium
0231Y019	12 V/2000 W	Platinum

4 Power Supply Architecture Features

4.1 High Energy Efficiency

4.1.1 54 V and 12 V Dual Power Supply Buses

Figure 4-1 Energy efficiency comparison between the single power supply plane and dual power supply planes



As shown in **Figure 4-1**, the 54 V and 12 V dual power supply planes save 150 W energy compared with the 54 V single power supply plane in the case that the server work load is 12 kW.

4.1.2 Dual Inputs of the 54 V PSUs in N+1 Backup Mode

Figure 4-2 Architecture of a single input in N+N backup mode and that of dual inputs in N+1 backup mode

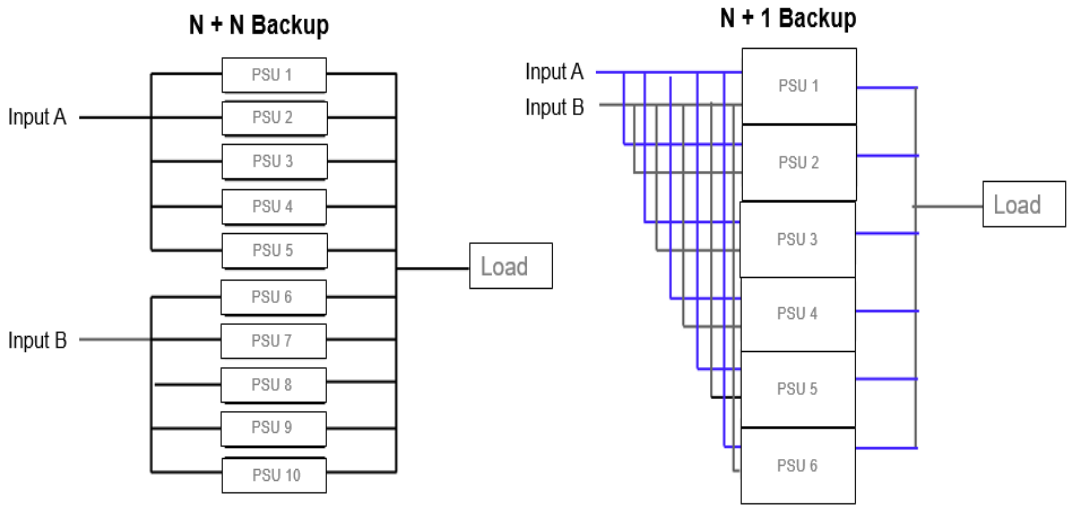
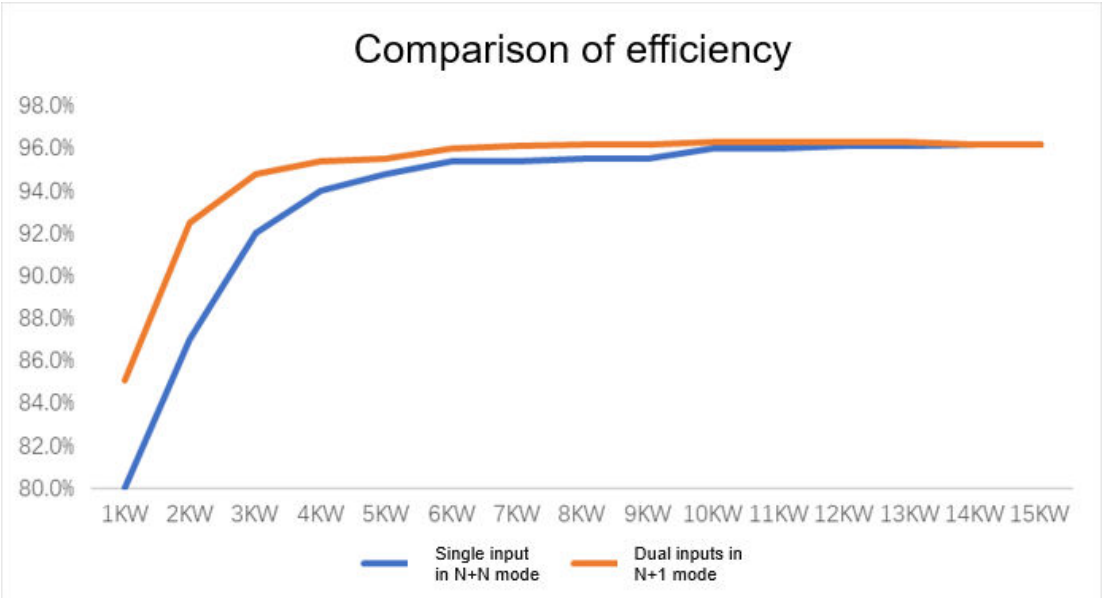


Figure 4-3 PSU efficiency curve



The PSUs have the highest efficiency at 50% load.

- In the single-input N+N architecture, the maximum load of a PSU is 50%, that is, the PSU cannot work with the optimal efficiency.
- In the dual-input N+1 mode, the maximum load of a single PSU can reach 83%, and the PSU can work with the optimal efficiency.

As shown in **Figure 4-3**, the overall efficiency in the dual-input N+1 mode is higher than that in the single-input N+N mode. The previous figure takes the server with a full load of 15 kW and a typical load of 4 kW as an example. If the 3 kW 5+5 backup

mode is used, the load of a single PSU is 400 W with the efficiency of 94%. If the 3 kW 5+1 backup mode is used, the load of a single PSU is 666 W with the efficiency of 95.4%, improving by 1.4%.

4.2 High Reliability

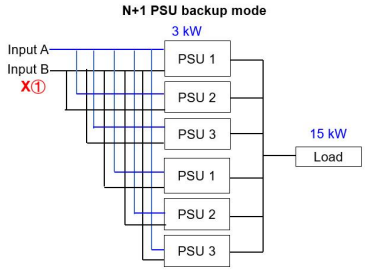
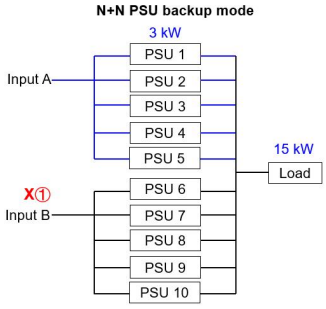
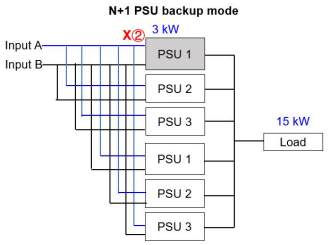
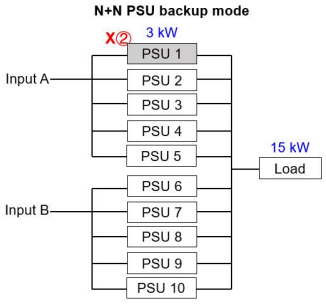
4.2.1 54 V and 12 V Dual Power Supply Buses

The 54 V and 12 V dual power supply planes are more reliable than 54 V single power supply plane:

- The 54 V and 12 V planes are independent from each other. If one plane is faulty, the other plane is not affected.
- If the 54 V single plane is faulty, the device will be directly powered off.

4.2.2 Dual Inputs of the 54 V PSUs in N+1 Backup Mode

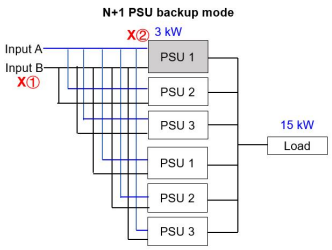
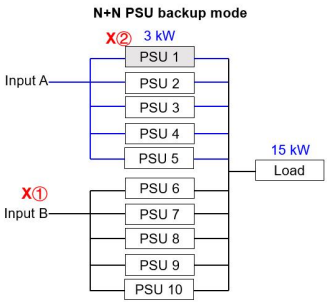
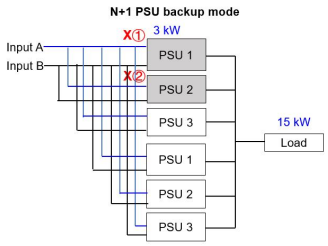
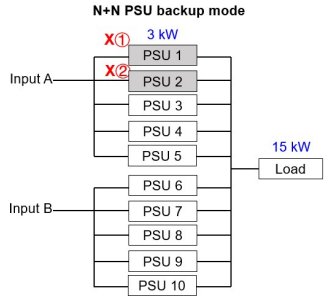
1. **Single-point failure**

<table>
<tr><th>Type</th><th>5+1 Mode</th><th>5+5 Mode</th><th>Comparison</th></tr>
<tr><td rowspan="2">(1) Input power failure</td><td> 
</td><td> 
</td><td rowspan="2">Even</td></tr>
<tr><td>Power supply capability of 18 kW</td><td>Power supply capability of 15 kW</td></tr>
<tr><td rowspan="2">(2) One faulty PSU</td><td> 
</td><td> 
</td><td rowspan="2">Even</td></tr>
<tr><td>Power supply capability of 15 kW</td><td>Power supply capability of 27 kW</td></tr>
</table>

Summary of reliability upon single-point failure: The system is designed based on 15 kW. In the N+N and N+1 modes, no matter one input or one PSU

fails, the power supply for the server is not affected. The reliability in N+N mode and that in N+1 mode are even.

2. **Dual-point failure**

<table>
<tr><th>Type</th><th>5+1 Mode</th><th>5+5 Mode</th><th>Comparison</th></tr>
<tr><td rowspan="2">(1) One faulty input and one faulty PSU</td><td> 
</td><td> 
</td><td rowspan="2">The power supply capacity in 5+1 mode is better. The probability of occurrence is 2,727,792 ppm^2.</td></tr>
<tr><td>Power supply capability of 15 kW</td><td>Power supply capability of 12 kW</td></tr>
<tr><td rowspan="2">(2) Two faulty PSUs</td><td> 
</td><td> 
</td><td rowspan="2">The power supply capacity in 5+1 mode is weaker. The probability of occurrence is 2,396,162 ppm^2.</td></tr>
<tr><td>Power supply capability of 12 kW</td><td>Power supply capability of 24 kW</td></tr>
</table>

Summary of reliability upon dual-point failure: N+1 and N+N modes have their own advantages and disadvantages. If PSUs have a high failure rate, the N+1 mode is less reliable than N+N mode. If the PSU is reliable, the N+1 mode is more reliable than N+N mode. The 54 V PSUs are developed by xFusion. The PSU failure rate is less than 400 ppm. The calculation reveals that the probability of scenario (1) is 2,727,792 ppm^2 and that of scenario (2) is 2,396,162 ppm^2. That is, the probability of weak reliability in the N+1 mode is lower. For details about the calculation formula, see **Scenario Occurrence Probability Detailed Calculation Process**.

Detailed Process of Calculating Scenario Occurrence Probability:

- [Calculation Basis]:

a. The PSU failure rate is 400 ppm. This value is obtained from xFusion's return rate statistics of PSUs. The industry average is around 1000 ppm.

b. The input power failure rate is 228 ppm. This value is calculated based on 12 power failures (once per month) and the recovery 10 minutes after each power failure in the first-tier cities in China (considering scenarios such as abnormal power failure of the mains, power-off of the O&M branch circuits in the equipment room, and tripping of the distribution board circuit breaker). The annual failure rate is 228 ppm: 12 x 10/(24 x 60 x 365) = 228 ppm

- [Calculation Process]:

1. **One fault PSU. The probability of occurrence is 2,727,792 ppm^2.**

   Power failure occurs on input A or B first, and a PSU fails. The probability of occurrence is 910,632 ppm^2.

   P1 = C_2^1 x 228 ppm x (1 – 228 ppm) = 456 ppm --- Power failure occurs on any one of the two inputs.

   P2 = C_5^1 x 400 ppm x (1 – 400 ppm)^4 = 1997 ppm --- Any one of the five PSUs is faulty.

   Failure rate = P1 x P2 = 456 x 1997 = 910,632 ppm^2.

   A PSU fails first, and power failure occurs on input A or B. The probability of occurrence is 1,817,160 ppm^2.

   P1 = C_{10}^1 x 400 ppm x (1 – 400 ppm)^9 = 3985 ppm --- Any one of the ten PSUs is faulty.

   P2 = C_2^1 x 228 ppm x (1 – 228 ppm) = 456 ppm --- Power failure occurs on any one of the two inputs.

   Failure rate = P1 x P2 = 456 x 1997 = 1,817,160 ppm^2

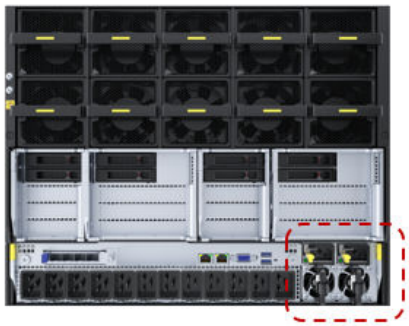
   Total failure rate = 1,817,160 ppm^2 + 910,632 ppm^2 = 2,727,792 ppm^2

2. **Two PSUs fail. The probability of occurrence is 2,396,162 ppm^2.**

   The total failure rate = C_6^2 x 400 ppm^2 x (1 – 400 ppm) ^{4} = 2,396,162 ppm^2 --- Any two of the six PSUs are faulty.

5 Introduction to the PSU

54 V PSUs



12 V PSUs

5.1 54 V PSU

Figure 5-1 54 V PSU 1

Figure 5-2 54 V PSU 2

5.1.1 54 V PSU Specifications

The maximum output power provided by the PSU varies depending on the input voltage and ambient temperature, as shown in **Table 5-1**. During PSU configuration, power distribution must be performed based on the maximum power consumption of the device to reserve sufficient power for the system.

NOTE

- The maximum power consumption varies with configurations. For details about how to calculate the power consumption, see the **Power Calculator**.
- If the PSU is used between 1800 m (5905.51 ft) and 5000 m (16,404.20 ft), the maximum temperature decreases by 1°C (1.8°F) for every increase of 220 m (721.78 ft).

Table 5-1 PSU output parameters

Input Parameter	Output Characteristic	Energy Efficiency Level
220 V to 240 V AC	54 V/3000 W	80 PLUS Titanium
240 V DC	54 V/3000 W	
200 V to 220 V AC/6.5 A	54 V/2500 W	
100 V to 127 V AC/12.5 A	54 V/1500 W	
● The output power consumption of the PSU varies depending on the input voltage of the PSU and the maximum ambient temperature of the chassis. ● The maximum output power is 1500 W when the input power cable is 10 A within the input range from 100 V AC to 127 V AC.		

Table 5-2 PSU input parameters

Item	Unit	Minimum Value	Typical Value	Maximum Value	Remarks
Range of the AC input voltage	V AC	90	/	264	-
Range of the 240 HVDC input voltage	V DC	180	240	320	-
THDi (tested at room temperature)	%	/	/	/	Not required in case of the load below 5%.
		/	/	20	5% to 10% load
		/	/	10	20% load; iTHD linearity is reduced from 20% to 10% with 10% to 20% load.
		/	/	5	30% load and above; iTHD linearity is reduced from 10% to 5% with 20% to 30% load.
Power factor (tested at room temperature)	/	0.94	/	/	10% load
	/	0.97	/	/	20% load

Item	Unit	Minimum Value	Typical Value	Maximum Value	Remarks
	/	0.99	/	/	50% load
	/	0.99	/	/	100% load
Input inrush current	A	/	/	30	-
AC input system	/	/	Single-phase AC input and dual-live wire input	/	-
One input of AC and another input of 240 HVDC	-	Supported			-

5.1.2 Built-in STS of the 54 V PSU

The STS dual-input switch is integrated in the 54 V PSU, with the switchover time less than 10 ms. The power output is not interrupted during the input switch. The input can be totally switched more than 20,000 times, which is highly reliable.

Table 5-3 Dual-input switch logic

Input voltage of Port A	Input voltage of Port B	Switch Action
Normal	Normal	Switch to the default input port for operation. The default input port can be set. If a new default input port is not set, the default input port of the PSU is used.
Abnormal	Normal	Switch to input port for operation.
Normal	Abnormal	Switch to input port for operation.
Abnormal	Abnormal	Not required.

5.2 12 V PSU

Figure 5-3 12 V PSU

The maximum output power provided by the PSU varies depending on the input voltage and ambient temperature, as shown in **Table 5-4**. During PSU configuration, power distribution must be performed based on the maximum power consumption of the device to reserve sufficient power for the system.

NOTE

- The maximum power consumption varies with configurations. To calculate the power consumption, use the **Power Calculator**.
- If the PSU is used between 1800 m (5905.51 ft) and 5000 m (16,404.20 ft), the maximum temperature decreases by 1°C (1.8°F) for every increase of 220 m (721.78 ft).

Table 5-4 PSU output parameters

Input Parameter	Output Characteristic	Energy Efficiency Level
220 V to 240 V AC	12 V/3000 W	80 PLUS Titanium
240 V DC	12 V/3000 W	
200 V to 220 V AC	12 V/2500 W	
100 V to 127 V AC	12 V/1300 W	

Input Parameter	Output Characteristic	Energy Efficiency Level
NOTE ● The output power consumption of the PSU varies depending on the input voltage of the PSU and the maximum ambient temperature of the chassis. ● The maximum output power is 1300 W when the input power cable is 10 A within the input range from 100 V AC to 127 V AC.		

Table 5-5 PSU input parameters

Item	Unit	Minimum Value	Typical Value	Maximum Value	Remarks
Range of the AC input voltage	V AC	90	/	264	-
Range of the 240 HVDC input voltage	V DC	180	240	300	-
THDi (tested in MV12 mode)	%	/	/	/	Not required in case of the load below 10%.
		/	/	20	10% to 20% load (including 10%)
		/	/	10	20% to 30% load (including 20%)
		/	/	5	30% load and above
Power factor (tested in MV12 mode)	/	0.99	/	/	100% load
	/	0.98	/	/	50% load
	/	0.96	/	/	20% load
	/	0.94	/	/	10% load

Item	Unit	Minimum Value	Typical Value	Maximum Value	Remarks
Input inrush current	A	/	/	30	-
AC input system	Single-phase three-wire input, that is, 220 V AC single-phase input is supported. 110 V AC dual-live-wire input is supported. The L and N wires must be connected with a circuit breaker in series in use.				
One input of AC and another input of 240 HVDC	Supported				

6 PSU Certification

Table 6-1 lists the certification that the G8600 V7 PSU has passed.

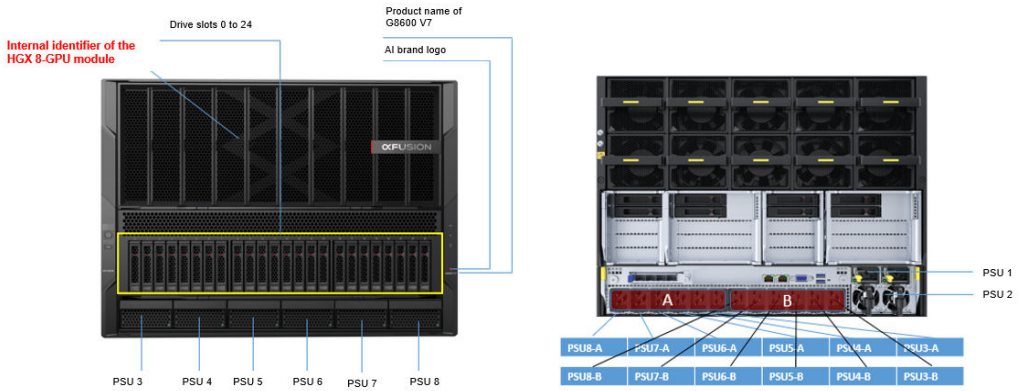
Table 6-1 Certification

Country/ Region	Certification	Standard
Global	80 PLUS	• 80 PLUS Titanium

7 PSU Deployment Guide

7.1 Server PSU Slots

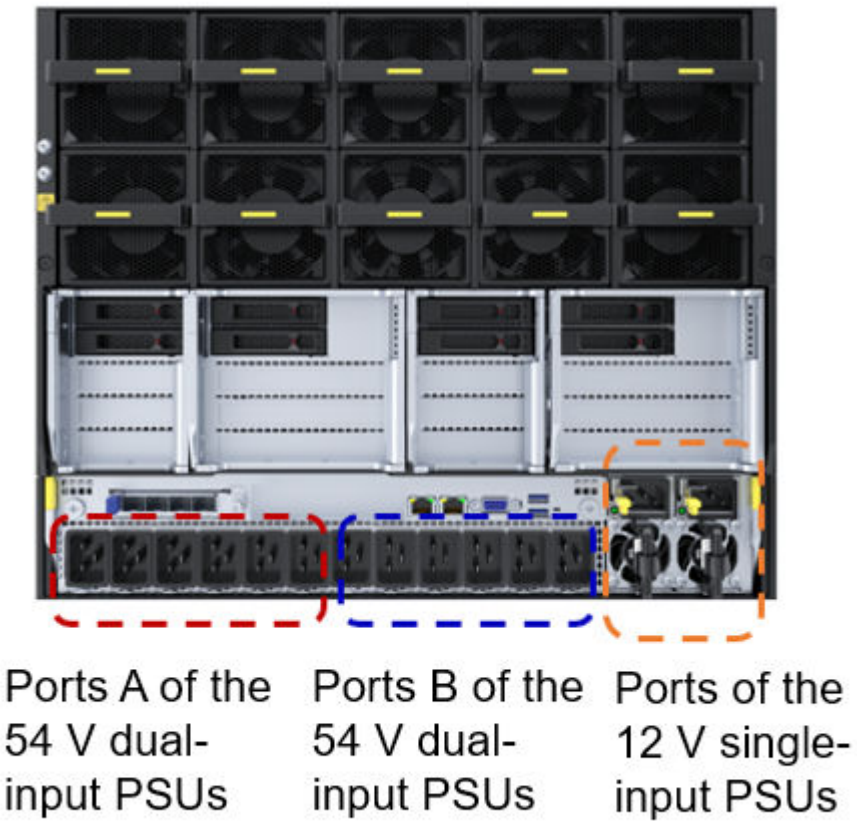
Figure 7-1 PSU slot numbers

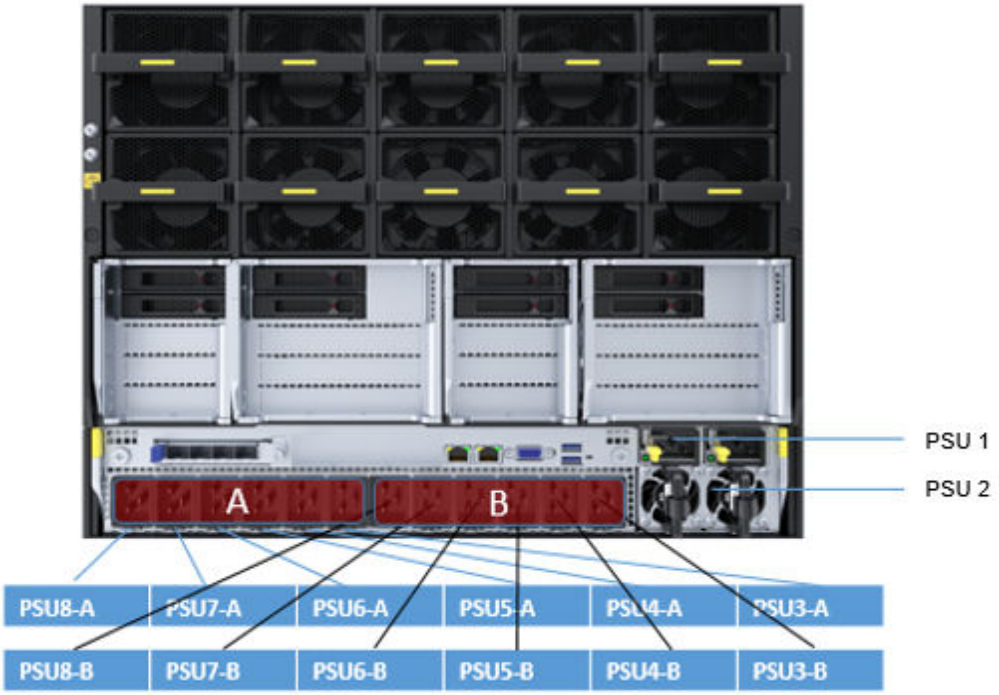


As shown in **Figure 7-1**, the six PSU slots in the front view are for the 54 V dual-input PSUs, which are named PSU 3, PSU 4, PSU 5, PSU 6, PSU 7, and PSU 8 from left to right and are inserted and removed from the front of the server. The two PSU slots on the right in the rear view are for the 12 V single-input PSUs, which are PSU 1 and PSU 2 from left to right and can be removed and inserted from the rear of the server.

7.2 Power Input Ports of the Server

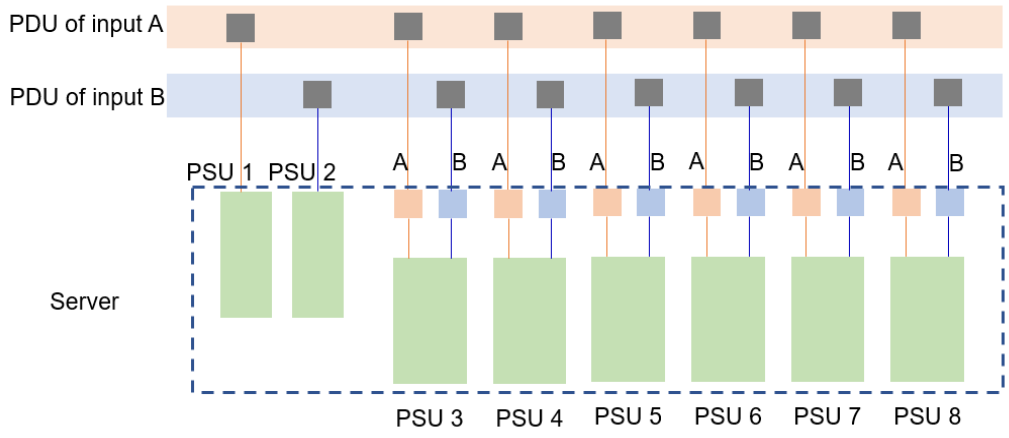
Figure 7-2 Power input ports of the server





7.3 Power Cable Connection

Figure 7-3 Power Cable Connection



As shown in **Figure 7-3**, power input port A for PSU 1 and PSUs 3 to 8 are connected to the PDU of input A, and power input port B for PSU 2 and PSUs 3 to 8 are connected to the PDU of input B.

7.4 Load Distribution Between Inputs A and B

7.4.1 Web Setting Interface for the Load Distribution Between Inputs A and B

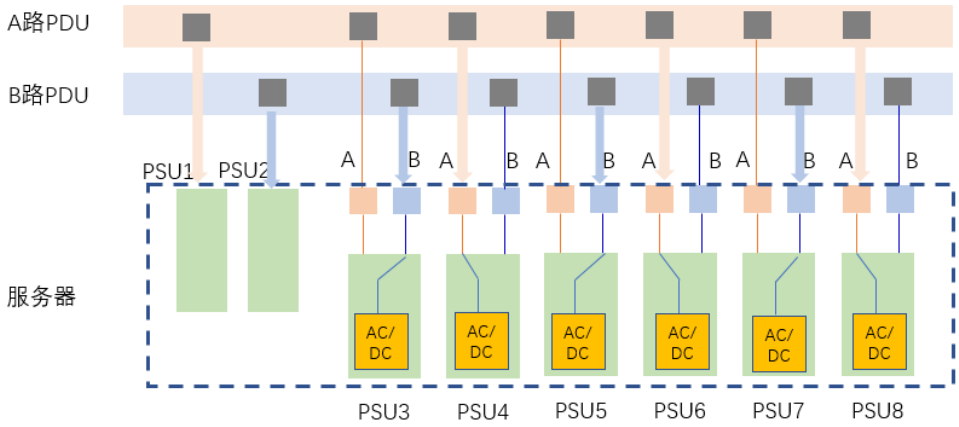
Load distribution between inputs A and B can be specified on the iBMC WebUI. The default value of the distribution configuration is **Balancing between A and B**. This value can also be set to **A active and B standby** or **B active and A standby**.

Figure 7-4 Load balancing mode of inputs A and B on iBMC WebUI

7.4.2 Balancing Between A and B

When six PSUs are configured, the default mode Balancing between A and B is used. **Figure 7-5** depicts this mode. In other cases, change the mode based on the site requirements.

Figure 7-5 Diagram of balancing between A and B

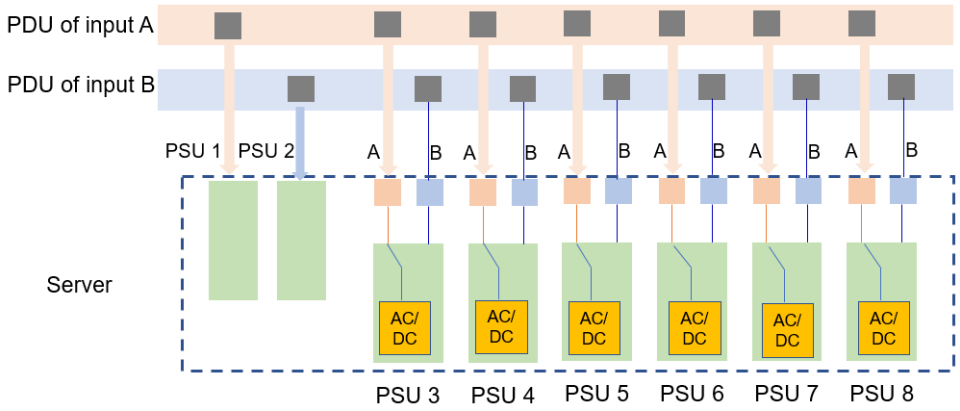


In this mode, the 54 V dual-input PSUs obtain power from PDU A and PDU B. Therefore, inputs A and B has the same load.

Remarks:

1. This function is enabled only when the number of valid 54 V dual-input PSUs is even. To use this function, set the 54 V dual-input PSUs to an even number. That is, the number of valid PSUs in slots 3 to 8 must be even.
2. When the number of the 54 V dual-input PSUs is odd, the **Balancing Between A and B** mode does not take effect, and the PSUs work in active/standby mode.
3. The 12 V single-input PSUs are not affected. PSU 1 obtains power from PDU A and PSU 2 obtains power from PDU B.

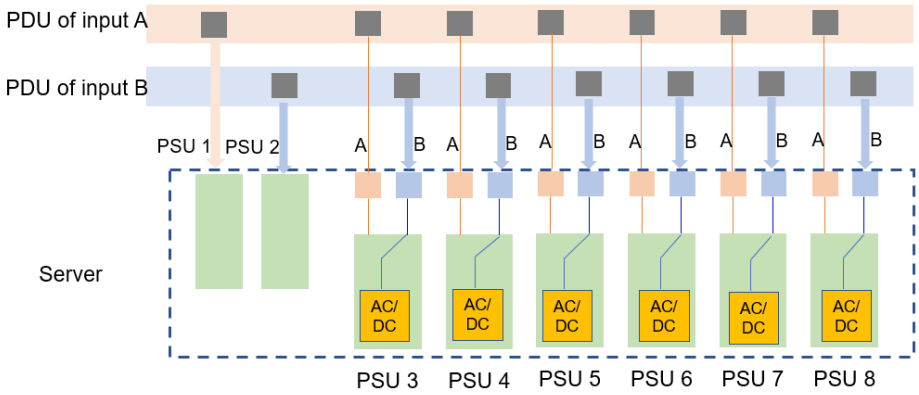
7.4.3 A Active and B Standby



In this mode, the 54 V dual-input PSUs obtain power from PDU A.

Remarks: The 12 V single-input PSUs are not affected. PSU 1 obtains power from PDU A and PSU 2 obtains power from PDU B.

7.4.4 B Active and A Standby

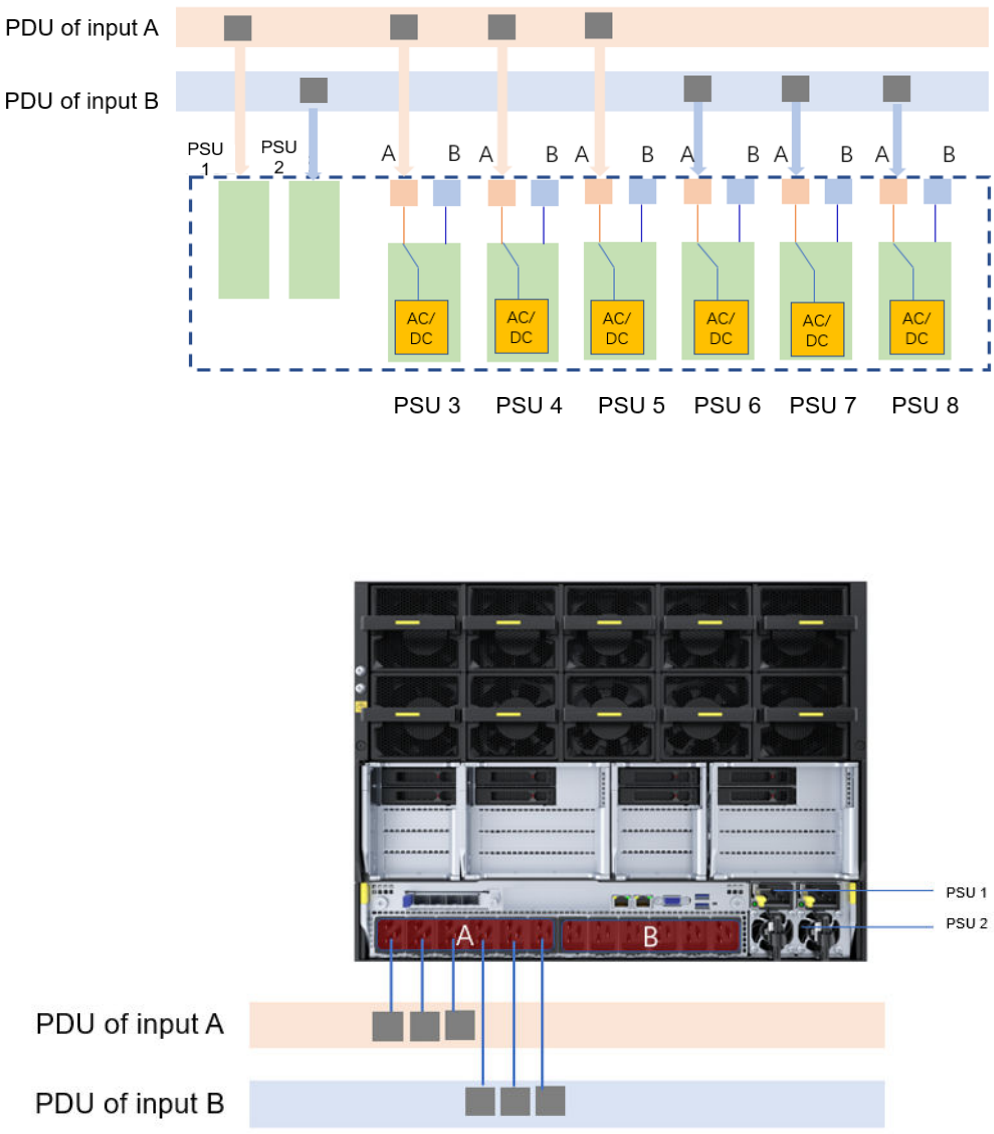


In this mode, the 54 V dual-input PSUs obtain power from PDU B.

Remarks: The 12 V single-input PSUs are not affected. PSU 1 obtains power from PDU A and PSU 2 obtains power from PDU B.

7.5 Compatible with Single Input in N+N Mode

Figure 7-6 Diagram of single input in N+N mode



The 54 V dual-input PSUs are also compatible with single input in N+N mode. As shown in **Figure 7-6**, the dual-input PSUs 3 to 8 use only input ports As which connect to the corresponding PDUs of inputs A and B. Input port B of each PSU does not need to be connected.

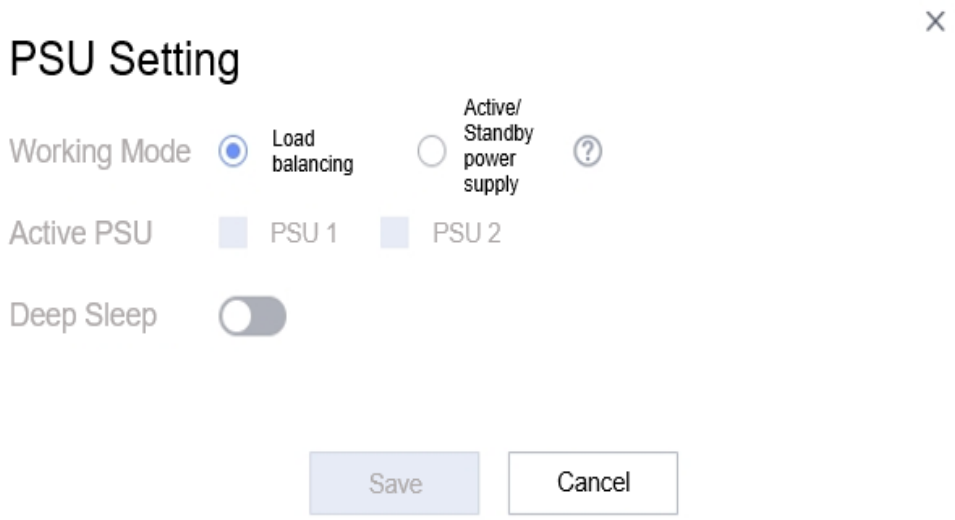
NOTE

For 54 V single-input PSUs in N+N mode, the maximum number of N is 3 (3+3 backup mode with 9 kW) because a maximum of six 54 V PSUs can be installed. If the power of some PSUs exceed 9 kW, the single input in N+N mode cannot be used.

7.6 Setting the PSU Backup Modes

7.6.1 Settings Load Balancing and Active/Standby Modes for the 12 V Single-Input PSUs

Figure 7-7 Setting the backup mode of the 12 V PSUs



Load balancing and **Active/Standby power supply** for PSU 1 and PSU 2 can be set on the web interface. **Load balancing** indicates that PSU 1 and PSU 2 each carry 50% load. To set to the active/standby power supply mode, select **Active/ Standby power supply** and select **PSU 1** or **PSU 2** as the active PSU. The active PSU carries 100% load, and the standby PSU does not carry load.

7.6.2 Setting Backup Modes for the 54 V Dual-Input PSUs

Figure 7-8 Setting the 54 V PSU backup mode 1

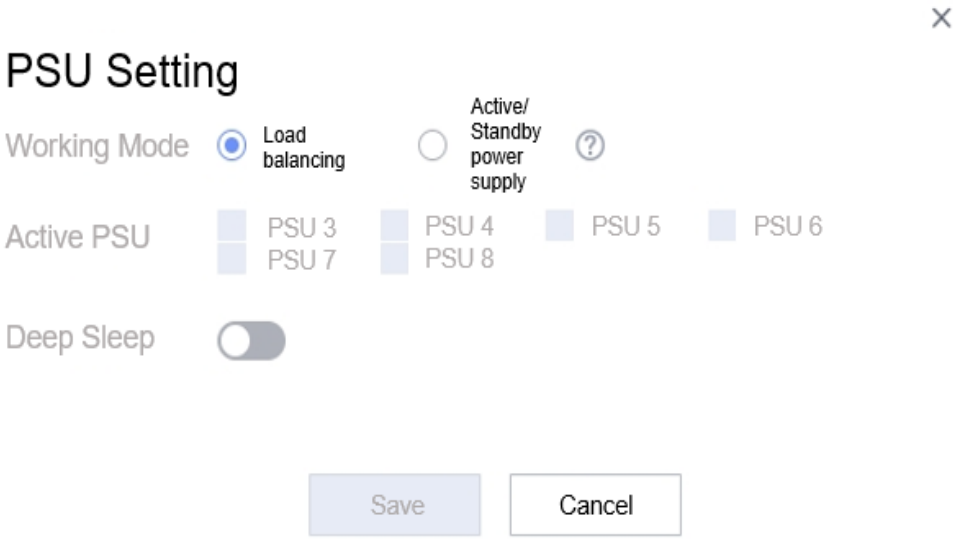
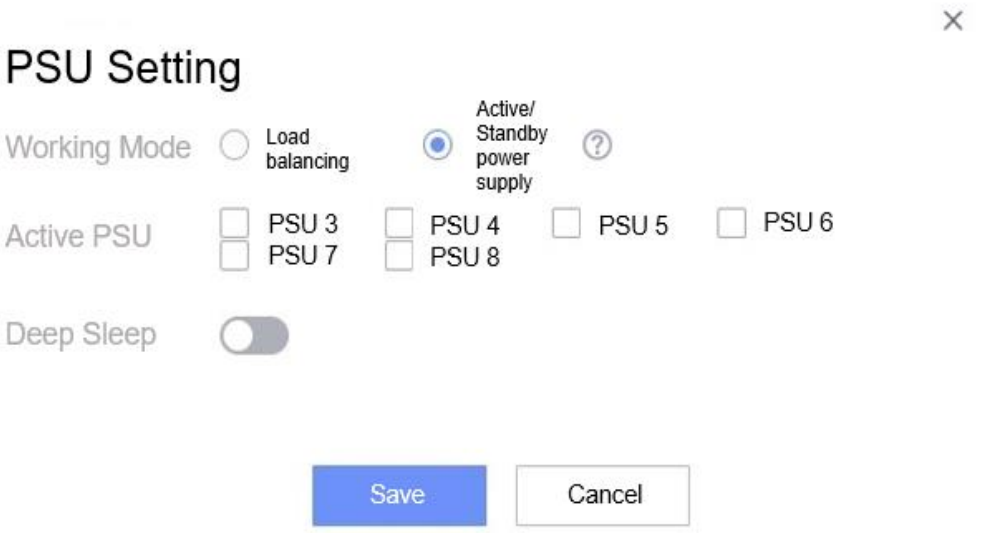


Figure 7-9 Setting the 54 V PSU backup mode 2



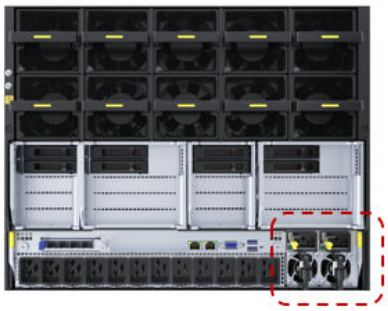
Load balancing and **Active/Standby power supply** for PSUs 3 to 8 can be set on the web interface. If **Load balancing** is selected, PSUs 3 to 8 carry the load evenly. To set to active/standby power supply, select **Active/Standby power supply** and select PSUs as the active PSUs to implement different backup modes. The backup modes can be set to N+1, N+N, or N+M.

- N+1: *N* PSUs are selected and one PSU is not selected, indicating that the PSU not selected is standby.

- N+N: Half of PSUs are selected, indicating that the other half of PSUs are standby.
- N+M: At least two to half of the total PSUs are not selected. For example, four of the six PSUs are selected, indicating the 4+2 backup mode.

8 Japan Low-Voltage Area Application Guide

54 V PSUs



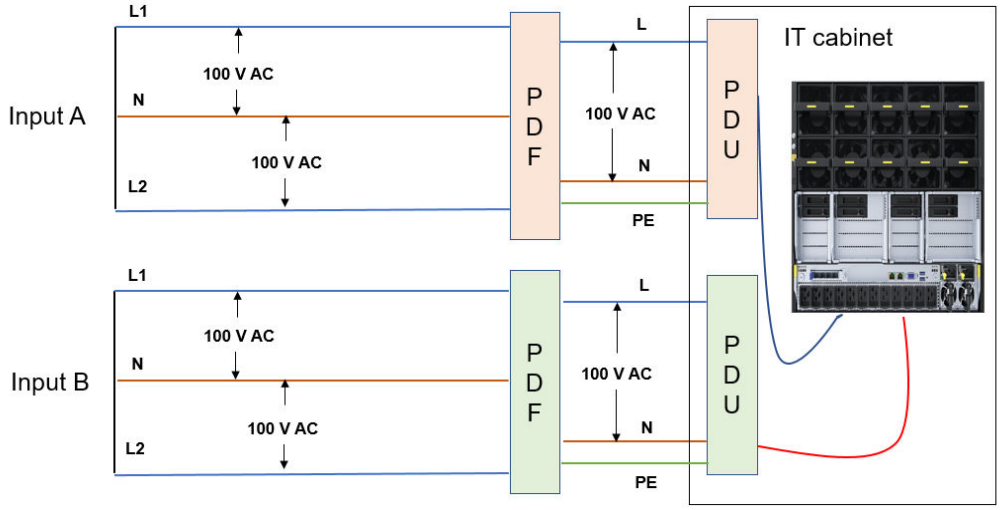
12 V PSUs

The input ports of the 54 V and 12 V 3 kW PSUs on the G8600 server are standard 16 A C20 ports. In low-voltage areas with 100 V AC input, the PSU output needs to be derated because the input power cannot meet the requirement of 3 kW full output power.

-	Input Parameter	Output Characteristic	Dual-Live Wire Is Supported or Not
54 V PSU	100 V to 127 V AC	54 V/1500 W	Supported
12 V PSU	100 V to 127 V AC	12 V/1300 W	Supported

8.1 Conventional 100 V AC Phase Voltage Application Guide

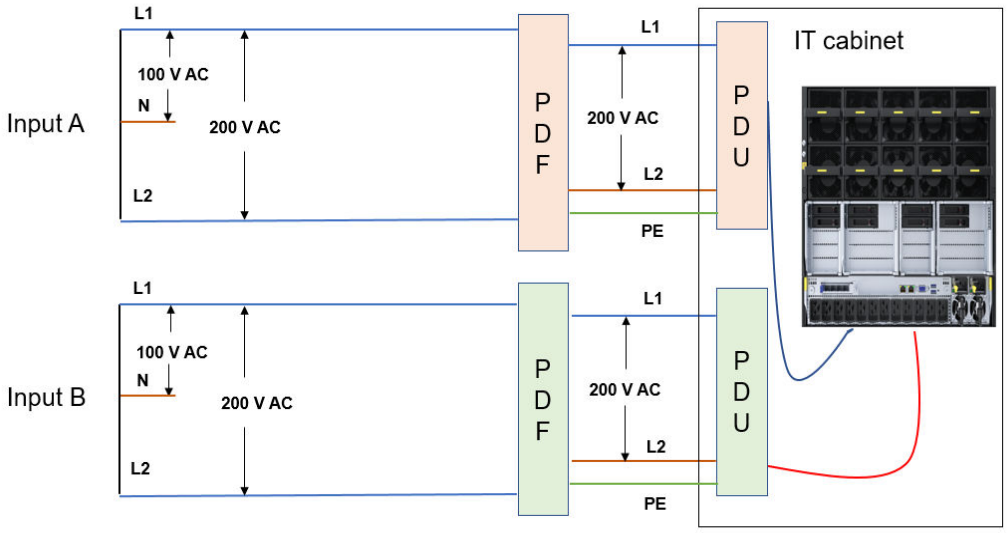
Figure 8-1 Single-live wire application



As shown in **Figure 8-1**, the conventional power supply in low-voltage areas provides the 100 V AC voltage to live wires and the neutral wire of input A. In this case, the loading capability of the 54 V PSUs is 1500 W and that of the 12 V PSUs is 1300 W. Therefore, in this scenario, the power of the server should be: 1500 W x Number of the configured 54 V PSUs + 1300 W. Power capping needs to be implemented based on the input voltage and the number of the configured PSUs to ensure that the OS is not powered off due to insufficient loading capability of the PSUs.

8.2 Dual-Live Wire Application Guide

Figure 8-2 Dual-live wire application



As shown in **Figure 8-2**, dual live wires are used for power supply. Since each input to the power distribution frames (PDFs) has 100 V AC line-to-neutral voltage and 200 V AC line-to-line voltage, the PDFs provide 200 V AC power to the PDUs and then to the PSUs. In this case, the loading capability of the 54 V PSUs is 3000 W and that of the 12 V PSUs is 3000 W. Therefore, the dual-live wires can greatly improve the server configuration.

