Community Specifications

Technical Specifications for Design, Evolution, and Deployment of High-Density Micro-Module Power Distribution Systems

Version 0.8

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Technical Specifications for Design, Evolution, and Deployment of High-Density Micro-Module Power Distribution Systems

1 Scope

1.1 Purpose

In response to the power distribution requirements of AI data centers (AIDCs) with high power density and liquid cooling technologies, this document systematically defines the end micro-module composition and power distribution architecture, and specifies the selection, installation, and delivery requirements for key devices. It is intended to support fast deployment and elastic expansion, improve the safety, compatibility, and maintainability of the power distribution system throughout its lifecycle, and provide technical support for AI infrastructure construction.

1.2 Applicable Scenarios

1. AIDC high-density computing micro-modules that use the liquid cooling technology and have an IT equipment power density of 100–300 kW per cabinet.
2. Micro-module system deployed with standard combined units. The typical configuration consists of four server cabinets and one integrated cabinet (including the network cabinet and bus cabinet). Table 2 lists the power range of a single module.
3. Scenarios where the end power distribution system uses the busway or remote power panel architecture and provides three-phase AC or high-voltage DC power input to the cabinet power shelf.
4. The scenarios include the construction of large-scale AI intelligent computing centers, high-density reconstruction projects of traditional data centers, and computing infrastructure that has clear requirements for fast delivery, elastic scale-out, and high availability.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced documents (including any amendments) applies.

GB/T 16895.6-2014 Low-voltage electrical installations—Part 5-52: Selection and erection of electrical equipment-Wiring systems

GB 50054-2011 Code for design of low voltage electrical installations

GB 50217-2018 Standard for design of cables of electric power engineering

GB 31247-2014 Classification for burning behavior of electric and optical cables

GB 50174-2017 Code for design of data centers

GB/T 7251.1-2023 Low-voltage switchgear and controlgear assemblies—Part 1: General rules

GB/T 7251.2-2023 Power switchgear and controlgear assemblies

GB/T 7251.6-2015 Busbar trunking systems (busways)

GB/T 17215.211-2021 Electricity metering equipment (AC)—General requirements, tests and test conditions

GB/T 17215.321-2021 Static meters for active energy

GB/T 17626 Electromagnetic compatibility—Testing and measurement techniques

GB 50057-2010: Code for design protection of structures against lightning

GB 50343-2012 Technical code for protection against lightning of building electronic information system

GB 50171-2012 Code for construction and acceptance of switchboard outfit complete cubicle and secondary circuit electric equipment installation engineering

GB 50303-2015 Code for acceptance of construction quality of building electrical engineering

GB 50150-2016 Standard for acceptance test of electric equipment

GB/T 14549 Quality of electric energy supply—Harmonics in public supply network

GB/T 12325 Power quality - Deviation of supply voltage

GB/T 4208 Degrees of protection provided by enclosures (IP code)

3 Terms and Definitions

3.1 High-Density Liquid-Cooled Micro-Module

A standard and prefabricated data center infrastructure module that uses the liquid cooling technology, has an IT equipment power density of at least 100 kW per cabinet, and integrates power supply and distribution, cooling, monitoring, and other subsystems.

3.2 Power Shelf

A power distribution unit that connects the remote power panel or tap-off unit to IT equipment and provides power distribution and access interfaces for IT equipment in the cabinet.

3.3 Server Cabinet

A service cabinet used to deploy servers and computing devices in a centralized manner to process and compute data. This document classifies cabinets by power density into 100 kW, 200 kW, and 300 kW levels.

3.4 Network Cabinet

A cabinet used to install network devices such as switches and routers to implement data forwarding and network connection. The typical power of a single cabinet is about 20 kW.

3.5 Bus Cabinet

A dedicated cabinet used to carry high-speed interconnection bus devices and implement low-latency interconnection between compute nodes. The typical power of a single cabinet is about 24 kW.

3.6 Redundancy Architecture

3.6.1 2N Redundancy

It consists of two independent power supply and distribution systems with the same capacity. During normal operation, each system carries part of the load. When either system is out of service, the other system shall be able to carry the entire load and ensure continuous operation of the system.

3.6.2 Distributed Redundancy (DR)

It consists of three or more independent power supply and distribution units. During normal operation, they share the load. When any unit is out of service, the remaining units shall be able to carry the entire load and ensure the continuous operation of the system.

3.7 Busway

The definition of the busway system is in accordance with GB/T 7251.6. The busway system described in this document is a dense plug-in busway system for data centers.

3.8 Busbar Trunking Unit (BTU)

A set of power distribution units consisting of busbar conductors, insulation supports, connecting conductors, enclosures, and fasteners. It is used for power transmission and distribution. BTUs can form a continuous busbar trunking system and can be equipped with or without tap-off devices. This term is derived from GB/T 7251.6.

3.9 Tap-Off Unit

A tap-off unit is a fixed or movable outlet unit that distributes power from the busbar trunking unit. In this document, a tap-off unit mainly refers to a plug-in box installed on a busway to provide power distribution interfaces for loads such as server cabinets and network cabinets. This term is derived from GB/T 7251.6.

3.10 Remote Power Panel (RPP)

A device that supports power distribution and management for cabinets arranged in rows or by function. In this document, an RPP distributes, protects, and monitors power of cabinet rows in a data center. This term is derived from *GB 50174 Code for design of data centers*.

3.11 Prospective Short-Circuit Current

It refers to the root mean square (r.m.s.) value of the short-circuit current that can be provided by the power supply system at the equipment access point when the impedance at the short-circuit point can be ignored. In this document, the prospective short-circuit current is calculated according to the IEC 60909 method. The calculation result is represented by Ik, which indicates the level of the system short-circuit current.

This term is derived from GB/T 5226.1.

3.12 Selectivity

When a fault occurs, only the protection device closest to the fault point takes action to isolate the fault locally.

4 Definition of Micro-Module Data Center

4.1 General Provisions

The micro-module should be planned and designed as a standard basic unit of the data center. It is recommended that the power supply and distribution, cooling, monitoring, and cabling systems be integrated to implement modular deployment and elastic expansion.

The micro-module design should use the forward configuration method, and the load should be matched based on the transformer capacity. In addition, the equipment utilization efficiency should be improved while ensuring system reliability and safe operation.

4.2 Designed Input Conditions

The power supply configuration of the micro-module should be designed based on the following conditions:

1. The standard transformer capacity of 2500 kVA is preferred. A transformer with a smaller capacity is used only when the cooling capacity is limited. The system design should be based on the specified transformer capacity. The power factor of IT loads should be calculated as 0.95.
2. In normal operating conditions, the transformer load rate should be kept within a reasonable range. In a redundant power supply system (such as 2N or DR), the system should be checked based on the worst-case operating conditions when a single power supply unit is out of service. The load rate of the remaining transformers should be controlled within the range of 85% to 95%.
3. The design should be checked based on the actual cooling conditions. If the cooling capacity is limited, the load configuration should be reduced or a transformer with a smaller capacity should be used.

4.3 Micro-Module Combination Principles

The micro-module configuration should be determined based on the transformer capacity, redundancy architecture, and load density. It is recommended that the micro-module be designed by combining cabinets of typical power levels such as 100 kW, 200 kW, and 300 kW. When determining the micro-module scale, the number of server cabinets, network cabinets, and bus cabinets should be properly configured based on the load calculation to ensure that the power supply system capability matches the IT load requirements.

4.4 Redundancy Check Principles

The capacity of the micro-module power supply system should be checked based on the redundancy architecture. In a redundant power supply system such as 2N or DR, the following requirements must be met:

1. When any power supply unit is out of service, the remaining power supply units should be able to carry all critical loads.
2. The redundancy check should meet the transformer load rate control requirements specified in Section 4.2 of this document.
3. The redundancy design should balance reliability and equipment utilization efficiency, and avoid long-term low-load operation.

4.5 Micro-Module Configuration

The micro-module power distribution system uses 1600 kVA and 2500 kVA transformers as the basic capacity units, and supports 100–300 kW load per cabinet. The typical configuration in this document does not consider the long-term capacity expansion. The actual configuration should be determined based on the actual project requirements.

Note: A 1600 kVA unit is available as a new option. The main consideration is that the height of the current liquid cooling overhead layer is limited (about 0.8 m), and the pipe diameter is limited, which reduces the liquid cooling heat dissipation capability and restricts the power supply and distribution capacity. In this case, the utilization of the 2500 kVA transformer may be low. Therefore, the 1600 kVA capacity is added as an adaptation solution.

4.5.1 2N Redundant Power Distribution Micro-Module Configuration

Table 1 Reference configurations of load and power distribution systems

Micro-Module Solution	Row	Power of a Single Server Cabinet (kW)	Number of Server Cabinets in the Module	Integrated Cabinet (kW)	Number of Integrated Cabinets	Input of a Single Server Cabinet	Total Power of a Cabinet Row (kW)	Total Current of a Cabinet Row (A)	Total Power of the Micro-Module (kW)	Number of Modules	Number of Transformers	Transformer Load Rate	
												2500 (kVA)	1600 (kVA)
1	A	100	12	44	3	3+3	1332	2130	1332	1	2	-	88%
2	A	200	6	44	2	6+6	1288	2060	1288	1	2	-	85%
3	A	100	10	44	5	3+3	1108	1772	2220	1	2	93%	-
	B	100	10	44		3+3	1112	1778					
4	A	200	10	44	3	6+6	2132	3410	2132	1	2	90%	-
5	A	300	7	44	2	10+10	2188	3499	2188	1	2	92%	-

Calculation logic:

1. Total power of a micro-module = Power of server cabinets + Power of the integrated cabinet (every four server cabinets correspond to one 20 kW network cabinet and one 24 kW bus cabinet)
2. Single server cabinet input: **3+3** indicates that the input of a single server cabinet is three active and three standby. The meaning of other specifications can be deduced by analogy.
3. Number of integrated cabinets: The value **3** indicates that the micro-module contains three network cabinets and three bus cabinets. The meaning of other specifications can be deduced by analogy.

4.5.2 DR: 3+1 DR Power Distribution Micro-Module Configuration

Table 2 Reference configurations of load and power distribution systems

Micro-Module Solution	Row	Power of a Single Server Cabinet (kW)	Number of Server Cabinets in the Module	Integrated Cabinet (kW)	Number of Integrated Cabinets	Input of a Single Server Cabinet	Total Power of a Cabinet Row (kW)	Total Current of a Cabinet Row (A)	Total Power of the Micro-Module (kW)	Number of Modules	Number of Transformers	Transformer Load Rate	
												2500 (kVA)	1600 (kVA)
1	A	100	12	44	3	3+3	1332	2130	1332	3	4	-	88%
2	A	200	6	44	2	6+6	1288	2060	1288	3	4	-	85%
3	A	100	10	44	5	3+3	1108	1772	2220	3	4	93%	-
	B	100	10	44		3+3	1112	1778					
4	A	200	10	44	3	6+6	2132	3410	2132	3	4	90%	-
5	A	300	7	44	2	10+10	2188	3499	2188	3	4	92%	-

Calculation logic:

1. Power of the integrated cabinet (configuration: every four server cabinets correspond to one 20 kW network cabinet and one 24 kW bus cabinet)

2. Single server cabinet input: **3+3** indicates that the input of a single server cabinet is three active and three standby. The meaning of other specifications can be deduced by analogy.
3. Number of integrated cabinets: The value **3** indicates that the micro-module contains three network cabinets and three bus cabinets. The meaning of other specifications can be deduced by analogy.

5 Micro-Module Terminal Power Distribution System

5.1 General Provisions

1. **Voltage system selection**

   The terminal power distribution system of the micro-module should use 380 V AC or 240 V high-voltage DC as the power supply voltage level. Other voltage systems (such as 800 V DC) can be selected based on the project requirement when mature application conditions are met. After the technical solution is mature and the industry chain is complete, it will be included and iterated in later versions.

2. **Short-circuit current adaptation and transformer impedance selection**

   The design of the power distribution system should verify the expected short-circuit current and meet the short-time withstand requirements of the equipment. A higher impedance level (such as 8%) should be used for the transformer impedance voltage to limit the short-circuit current. When multiple transformers are connected in parallel, the impedance voltage deviation of each transformer should not exceed ±10%.

3. **Adaptation requirements for the power distribution architecture and redundancy mode**

   The terminal power distribution system of the micro-module should use the redundancy power supply architecture such as 2N or DR based on the reliability requirements, investment costs, and O&M conditions.

5.2 Micro-Module End Power Distribution Solution

Table 3 Two typical solutions available for the terminal power distribution system of the micro-module—busway and RPP

Item	Busway Power Distribution System	RPP Power Distribution System
Power distribution mode	Busway+plug-in box	RPP+branch circuit
Load power distribution access mode	Power supply to cabinets through the plug-in box	Circuit breaker circuit of the RPP connected to the cabinet
Expansion mode	Flexible online expansion by adding plug-in boxes	Expansion by adding cabling circuits or expansion cabinets
Power distribution path	Centralized power supply by busway	Power distribution inside the cabinet
Capacity configuration model	Comply with the specifications in Section 4.5.1 or 4.5.2.	Comply with the specifications in Section 4.5.1 or 4.5.2.
Redundancy implementation mode	Multi-busway power distribution system	Multi-RPP power distribution system
O&M mode	Modular unit maintenance	Branch circuit maintenance

Item	Busway Power Distribution System	RPP Power Distribution System
Power distribution system boundary	Start from the outlet terminal of the busway general input unit or the upstream low-voltage power distribution equipment, and end at the input terminal of the power shelf.	Start from the inlet terminal of the RPP, and end at the input terminal of the power shelf.

5.3 Design of the Micro-Module Terminal Power Distribution System

5.3.1 Design of the Busway Power Distribution System

The design of the busway power distribution system described in this section applies to the AC systems.

5.3.1.1 General Provisions

1. The rated voltage of the busbar is 380 V AC, and the rated frequency is 50 Hz. The rated current should be calculated based on the total calculated load of the micro-module, and the bearing capacity should be checked based on the redundancy architecture. In a redundant power supply system, the load requirements in the most unfavorable operating conditions must be met. The busbar capacity should be at least 1.25 times the calculated load.
2. The busway should be selected based on the rated current level and application scenario.
   (a) When the rated current is small (such as 1250 A or lower), small busways are recommended.
   (b) When the rated current is large (such as 1600 A or higher), dense busways are recommended.
3. Short-circuit withstand strength: The rated short-time withstand current of the busway should be greater than or equal to the expected short-circuit current at the installation point, and the withstand time should be greater than or equal to the short-delay action time of the upstream circuit breaker. This ensures that the equipment does not suffer thermal damage or mechanical deformation before the circuit breaker acts.
4. Material and insulation requirements: The busway conductor should be made of T2 copper with high conductivity, and the heat resistance level of the insulation material should not be lower than B (130°C). The enclosure should have good anti-condensation and corrosion resistance performance and be suitable for operation in a liquid cooling environment.
5. Intelligent monitoring design: Busbars and plug-in boxes should have the electrical parameter monitoring function, including voltage, current, power, electric energy, and temperature.
6. Tap-off unit: The rated current of the busway tap-off unit should be configured based on the downstream load requirements. The protective devices in the tap-off unit should be determined based on the load characteristics and meet the requirements of hierarchical protection. The circuit breaker should be configured in 3 × 3P or 4 × 3P mode.
7. Certification requirements: Busbar products should comply with the GB/T 7251 series standards. Products involved in the national mandatory certification catalog should have the corresponding certification.

5.3.1.2 Design of 2N Redundant Busway Power Distribution

1. **Key Design and Implementation Points**
   (a) According to Table 1 "Micro-module load configuration solution" in Section 4.5.1, in the 2N redundancy architecture, when the system is running properly, two power supply systems share the load, and the load rate of a single transformer is about 45% to 50%.

   When any power supply unit is out of service due to a fault, the remaining power supply unit should be able to bear all IT loads to ensure continuous operation of the system. In the most

unfavorable operating conditions, the load rate of a single transformer should be controlled within the range of 85% to 95%. The typical configuration in this document does not consider the long-term capacity expansion. The actual configuration should be determined based on the actual project requirements.

(b) Table 3-1 lists the recommended configurations for the busway rated current and plug-in box circuits (only for server cabinets). Table 3-2 and Table 3-3 list the recommended configurations for power supply circuits of network cabinets and bus cabinets.

Table 3-1 Reference configurations for busways, plug-in boxes, and circuits

Micro-Module Solution	Safe Current of a Single Busway (A)	Maximum Power Supported by a Single Busway (kW)	Busway Current Specifications (A)	Number of Busways	Number of Plug-In Boxes in a Single Busway	Number of Circuits in a Single Plug-In Box	Number of Circuits in a Single Busway	Single-Circuit Power in Faulty Conditions (kW)	Single-Circuit Current in Faulty Conditions (A)	Recommended Circuit Breaker Current (A)
1	2663	1332	3200	1+1	12	3 × 3P	36	33	53	80
2	2575	1288	3200	1+1	9	4 × 3P	36	33	53	80
3	2215	1108	2500	1+1	10	3 × 3P	30	33	53	80
	2223	1112	2500	1+1	10	3 × 3P	30	33	53	80
4	4262	2132	5000	1+1	15	4 × 3P	60	33	53	80
5	4374	2188	5000	1+1	18	4 × 3P	70	30	48	80

Calculation logic:

(1) Number of busways: **1+1** indicates two sets of busways that supply power mutually and independently and back up each other. The rest can be deduced by analogy.

(2) Single-circuit current in fault conditions: maximum current of the remaining busway plug-in boxes when a single busway is faulty. The table only calculates the power supply branches of the server cabinet.

(c) Table 3-2 and Table 3-3 list the configurations for power supply circuits of network cabinets and bus cabinets.

Table 3-2 Reference configurations for network cabinet circuits

Micro-Module Solution	Row	Network Cabinet (kW)	Number of Network Cabinets	Power Input to the Network Cabinet	Total Power Consumption (kW)	Single-Circuit Power in Faulty Conditions (kW)	Single-Circuit Current in Faulty Conditions (A)	Recommended Circuit Breaker Current (A)
1	A	20	3	1+1	60	20	32	50
2	A	20	2	2+2	40	10	16	32
3	A	20	3	1+1	60	20	32	50
	B	20	2	1+1	40	20	32	50
4	A	20	3	2+2	60	10	16	32
5	A	20	2	-	-	-	-	-

Table 3-3 Reference configurations for busway cabinet circuits

Micro-Module Solution	Row	Bus Cabinet (kW)	Number of Bus Cabinets	Power Input to the Bus Cabinet	Total Power Consumption (kW)	Number of Circuits in a Single Busway	Single-Circuit Power in Faulty Conditions (kW)	Single-Circuit Current in Faulty Conditions (A)	Recommended Circuit Breaker Current (A)
1	A	24	3	1+1	72	3	24	38	50
2	A	24	2	2+2	48	4	12	19	32
3	A	24	2	1+1	48	2	24	38	50
	B	24	3	1+1	72	3	24	38	50
4	A	24	3	2+2	72	6	12	19	32
5	A	24	2	-	-	-	-	-	-

5.3.1.3 Design of DR:3+1 Redundant Busway Power Distribution

1. Key Design and Implementation Points

(a) According to Table 2 "Micro-module load configuration solution" in Section 4.5.2, in the DR:3+1 redundancy architecture, when the system is running properly, four power supply systems share the load, and the load rate of a single transformer is about 45% to 50%.

When any power supply unit is out of service due to a fault, the remaining power supply units should be able to bear all IT loads to ensure continuous operation of the system. In the most unfavorable operating conditions, the load rate of a single transformer should be controlled within the range of 85% to 95%. The typical configuration in this document does not consider the long-term capacity expansion. The actual configuration should be determined based on the actual project requirements.

(b) Table 4 lists the recommended configurations for the busway rated current and plug-in box circuits (only for server cabinets). Table 3-2 and Table 3-3 list the configurations for power supply circuits of network cabinets and bus cabinets.

Table 4 Reference configurations for busways, plug-in boxes, and circuits

Micro-Module Solution	Safe Current of a Single Busway (A)	Maximum Power Supported by a Single Busway (kW)	Busway Current Specifications (A)	Number of Busways	Number of Plug-In Boxes in a Single Busway	Number of Circuits in a Single Plug-In Box	Number of Circuits in a Single Busway	Single-Circuit Power in Faulty Conditions (kW)	Single-Circuit Current in Faulty Conditions (A)	Recommended Circuit Breaker Current (A)
1	888	444	1000	3+1	6	3 × 3P	18	22	36	50
2	858	429	1000	3+1	6	3 × 3P	18	22	36	50
3	738	369	800	3+1	5	3 × 3P	15	22	36	50
	741	371	800	3+1	5	3 × 3P	15	22	36	50
4	888	1137	1600	3+1	10	3 × 3P	30	22	36	50
5	912	1166	1600	3+1	12	3 × 3P	35	20	32	50

Calculation logic:

(1) Number of busways: **3+1** indicates that four independent busways are configured for power supply, with three active and one standby.

(2) Single-circuit current in fault conditions: maximum current of the circuits in plug-in boxes of the remaining busways when a busway is faulty. Only the power supply branches of the server cabinet are calculated.

5.3.2 Design of the RPP Power Distribution System

The design of the RPP power distribution system described in this section applies to AC power distribution systems.

5.3.2.1 General Provisions

1. The rated voltage of the RPP is 380 V AC, the rated frequency is 50 Hz, and the power factor is 0.95. The rated current should be calculated based on the total calculated load of the micro-module, and the bearing capacity should be checked based on the redundancy architecture. In a redundant power supply system, the load requirements in the most unfavorable operating conditions must be met. The RPP capacity should be at least 1.25 times the calculated load.

2. Ingress protection (IP) rating requirements: The IP rating of the RPP in the micro-module of the equipment room should be IP30 or higher. Internal energized components must be protected against electric shocks. A safety isolation structure must be installed in the operation area of branch circuits.

3. Short-circuit withstand capability: The rated short-time withstand current and withstand time of the branch busbar in the RPP should be greater than or equal to the expected short-circuit current at the installation point and the short-delay action time of the upstream circuit breaker, respectively. The breaking capacity of protection devices at all levels must meet the requirements of the maximum expected short-circuit current of the system.

4. Material and insulation requirements: The busbar inside the RPP should be made of T2 copper with high conductivity. The conductivity and mechanical strength should meet the requirements for long-term full-load operation. The enclosure should have sufficient mechanical strength and anti-corrosion performance. Internal cabling should meet the requirements for electrical clearance and creepage distance to avoid partial discharge risks.

5. Intelligent monitoring design: The RPP should have the circuit-level electric energy monitoring function. The monitoring content should include parameters such as voltage, current, power, electric energy, power factor, and harmonics.

6. Branch circuit matching: The rated current of the RPP branch circuit should be configured based on the downstream cables and IT load requirements, and should match the rated current of the cabinet power distribution unit (PDU) or power module. The rated value of the protective device for the branch circuit should match the conductor cross-sectional area and load characteristics.

5.3.2.2 Design of 2N Redundant RPP Power Distribution

1. Key design and implementation points

(a) According to Table 1 "Micro-module load configuration solution" in Section 4.5.1, in the 2N redundancy architecture, when the system is running properly, two power supply systems share the load, and the load rate of a single transformer is about 45% to 50%.

When any power supply unit is out of service due to a fault, the remaining power supply unit should be able to bear all IT loads to ensure continuous operation of the system. In the most unfavorable operating conditions, the load rate of a single transformer should be controlled within the range of 85% to 95%. The typical configuration in this document does not consider

the long-term capacity expansion. The actual configuration should be determined based on the actual project requirements.

(b) Table 5 lists the recommended configurations for the rated current of the RPPs and power distribution circuits (only for server cabinets). Table 3-2 and Table 3-3 list the recommended configurations for power supply circuits of network cabinets and bus cabinets.

Table 5 Reference configurations for the RPPs and circuits

Micro-Module Solution	RPP Safe Current (A)	Maximum Power Supported by a Single RPP (kW)	RPP Current Specifications (A)	Number of RPPs	Number of Circuits in a Single RPP	Single-Circuit Power in Faulty Conditions (kW)	Single-Circuit Current in Faulty Conditions (A)	Recommended Circuit Breaker Current (A)
1	2663	1332	1600	2+2	18	33	53	80
2	2575	1288	1600	2+2	18	33	53	80
3	2215	1088	2500	1+1	30	33	53	80
	2223	1132	2500	1+1	30	33	53	80
4	4262	2132	2500	2+2	30	33	53	80
5	4374	2188	2500	2+2	35	30	48	80

Calculation logic:

(1) Number of RPPs: **1+1** indicates two RPPs that supply power mutually and independently and back up each other. The rest can be deduced by analogy.

(2) Single-circuit current in fault conditions: maximum current of the power distribution circuits in the remaining RPPs when one RPP is faulty. Only the power supply branches of the server cabinet are calculated.

5.3.2.3 Design of DR:3+1 Redundant RPP Power Distribution

1. Key design and implementation points

(a) According to Table 2 "Micro-module load configuration solution" in Section 4.5.2, in the DR:3+1 redundancy architecture, when the system is running properly, four power supply systems share the load, and the load rate of a single transformer is about 45% to 50%.

When any power supply unit is out of service due to a fault, the remaining power supply units should be able to bear all IT loads to ensure continuous operation of the system. In the most unfavorable operating conditions, the load rate of a single transformer should be controlled within the range of 85% to 95%. The typical configuration in this document does not consider the long-term capacity expansion. The actual configuration should be determined based on the actual project requirements.

(b) Table 6 lists the recommended configurations for the rated current of the RPPs and power distribution circuits (only for server cabinets). Table 3-2 and Table 3-3 list the recommended configurations for power supply circuits of network cabinets and bus cabinets.

Table 6 Reference configurations for the RPPs and circuits

Micro-Module Solution	Safe Current of a Single RPP (A)	Maximum Power Supported by a Single RPP (kW)	RPP Current Specifications (A)	Number of RPPs	Number of Circuits in a Single RPP	Single-Circuit Power in Faulty Conditions (kW)	Single-Circuit Current in Faulty Conditions (A)	Recommended Circuit Breaker Current (A)
1	888	444	1000	3+1	18	22	36	50
2	858	429	1000	3+1	18	22	36	50
3	738	369	800	3+1	15	22	36	50
	741	371	800	3+1	15	22	36	50
4	888	1137	1600	3+1	30	22	36	50
5	912	1166	1600	3+1	35	20	32	50

Calculation logic:

(1) Number of RPPs: **3+1** indicates that four independent RPPs are configured for power supply, with three active and one standby.

(2) Single-circuit current in fault conditions: maximum current of the power distribution circuits in the remaining RPPs when one RPP is faulty. Only the power supply branches of the server cabinet are calculated.

5.3.3 Design of Changing the AC Busway Power Distribution System to a DC One

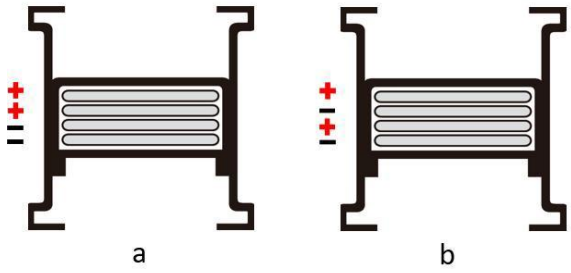
1. General provisions

A DC busway power distribution system should use a proper DC voltage level based on the project requirements. Typical applications include 240 V or 336 V HVDC systems; while higher voltage DC distribution systems (such as 800 V DC, ±400 V DC) can be adopted based on engineering conditions and technical maturity.

2. System configuration requirements

For a system where AC busway application is changed to the DC busway application, the polarity configuration and conductor layout should be properly determined to meet the current-carrying capacity and system reliability requirements. Generally, positive and negative poles of DC busways are arranged as follows: Two conductors in the DC busway are used as the positive pole, and the other two conductors are used as the negative pole, as shown in the following figure.

Figure 1



Common modes of arranging positive and negative poles of DC busways

3. **Current and capacity calculation**

   For details about the rated DC busbar current conversion, see Appendix B.

4. **Short-circuit current check**

   For the DC bus short-circuit fault current criteria, see Appendix C.

5. **Voltage drop check**

   For details about how to calculate the DC bus voltage drop, see Appendix D.

5.4 Connection Between Terminal Power Distribution Interfaces and IT Equipment

As a key power distribution unit that connects the plug-in boxes and IT devices, a power shelf must have input interfaces that meet the requirements of high power density, high reliability, and fast deployment. Based on the current and future development trends of the AIDC architecture, the following four power distribution modes are recommended, and the interface standards and evolution paths are specified:

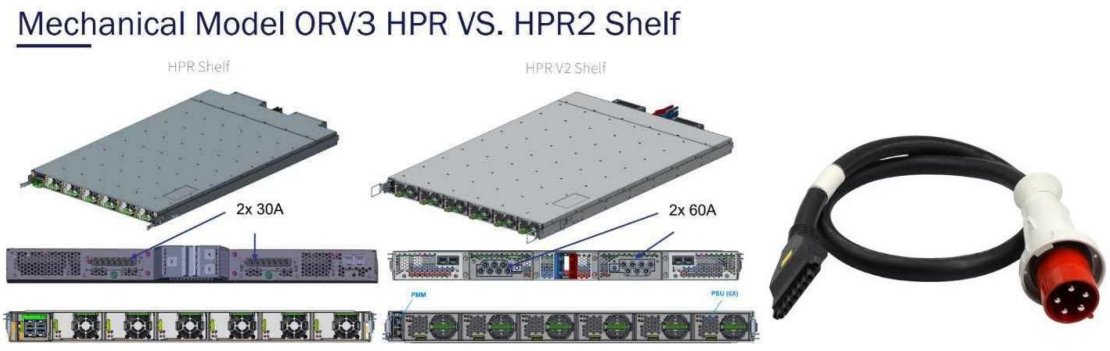
1. **Allocation through intelligent PDUs (transitional solution)**
   (a) This solution is applicable to traditional servers or medium- and low-power density deployment scenarios, and to inventory system reconstruction or hybrid deployment environments.
   (b) The plug-in mode should use the connectors such as C13 and C19 that comply with the IEC standard. The rated current of a single branch circuit should be less than or equal to 20 A.
   (c) Each power shelf should be configured with dual inputs to implement power supply redundancy.

   Note: In high power density or AI server scenarios, plug-in PDUs are not recommended as the main power supply mode.

2. **Direct power supply through high-power power supply interfaces (mainstream solution)**
   (a) This solution is applicable to new high-density data centers and AI computing modules.
   (b) The input end of a power shelf should use standard industrial-grade power supply interfaces and support multiple independent inputs to implement power supply redundancy.
   (c) The interface capability shall meet the high current density requirements, and the interfaces shall have the features of reverse connection prevention and incorrect insertion prevention.

   This mode is used as the mainstream power supply mode for high-density data centers outside China, such as ORV3 HPR (30 A) and HPR2 (60 A) interfaces.

Figure 2



3. **Power supply through the HVDC Side-Car architecture (HPR3 evolution direction)**
   (a) This solution is applicable to ultra-high power density and large-scale AI data centers.

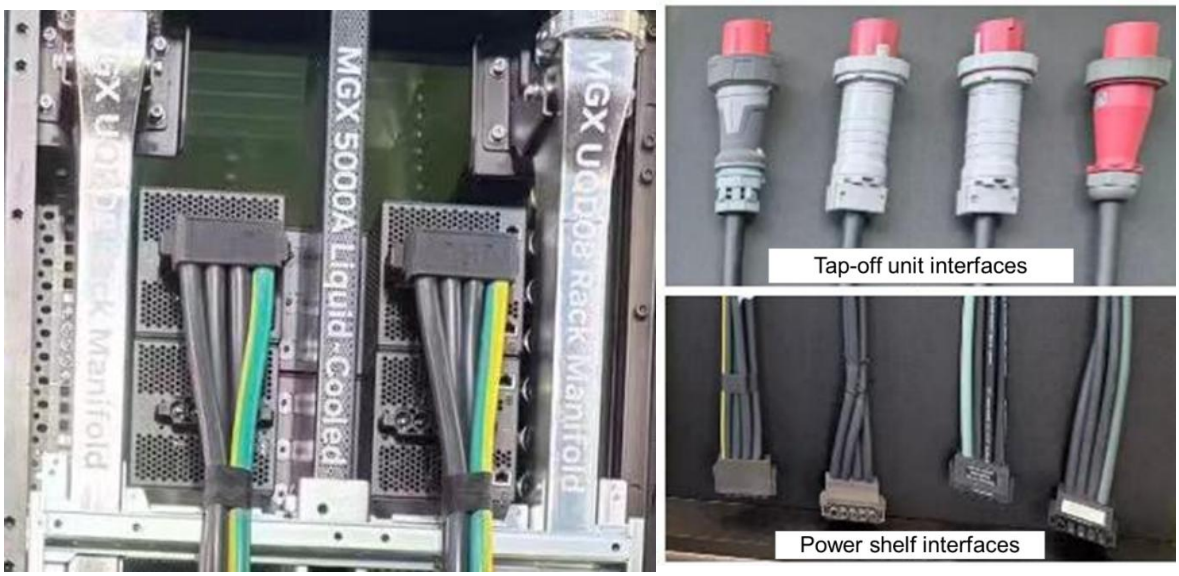
(b) The high-voltage direct current (HVDC) power supply mode is used to decouple the power module from the IT cabinet, forming an independent power unit (Side-Car).

Note: This mode represents the development direction of the power supply architecture of data centers. It is recommended that this mode be implemented gradually based on the project scale and technical conditions.

4. Customization by other server or cabinet manufacturers

For customized cabinet architectures, manufacturer-specific IT power distribution interfaces can be used. However, the compatibility, electrical performance, and reliability verification reports of the interfaces must be provided to ensure that the interfaces match the power distribution system. For example, the power shelf interfaces of the Vera Rubin cabinet support a power distribution current of 100 A, as shown in the following figure.

Figure 3



5. Cable connection method

In the busway and RPP power distribution mode, the power shelves in the cabinet are connected through cables. The cross-sectional area of the cables must comply with the requirements specified in Section 6.9 of this document. For details, see Table 9.

5.5 General Input Design

This section applies to the AC system. The general input design should be determined based on the power distribution mode, rated current, and system protection configuration, and should meet the electrical performance requirements such as short-circuit withstand capability, voltage drop, and temperature rise.

5.5.1 Main Configurations of the General Input Unit

(a) Circuit breaker selection

The general input protective circuit breaker should be selected based on the rated current and protection requirements. The main circuit breaker should meet the temperature rise requirements under the operating current and the short-circuit short-time withstand requirements under the expected short-circuit current at the installation point. If the molded case circuit breaker (MCCB)

cannot meet the short-time withstand current (Icw) requirements under the preceding conditions, an air circuit breaker or other protective circuit breakers that meet the requirements should be used.

The main protective circuit breaker should provide long-time overload (L), short-time short-circuit (S), and instantaneous short-circuit (I) protection functions, and support remote shunt release. The protection setting values should be set based on the current-carrying capacity of the busbar and the characteristics of downstream loads, and meet the requirements for selective coordination.

(b) Protection and backup protection

A level-II surge protective device (SPD) and its dedicated backup protection device should be installed at the general input unit to limit the lightning-induced overvoltage and prevent the impact of SPD failure on the system operation.

(c) Requirements for the general input intelligent monitoring

It is recommended that the general input circuit be configured with a smart electricity meter and a temperature sensor to monitor electrical parameters, harmonics, and switch status and provide overtemperature warnings.

5.5.2 Design of the Busbar General Input Unit

1. Selection of the General Input Form

(a) The design of the busbar general input unit shall comply with the relevant specifications in Section 5.3.1.

(b) The form of the busbar general input unit shall be determined based on the rated current level, installation conditions, and O&M requirements. When the rated current is small (for example, 1250 A or lower), the general input unit is recommended as the start unit of the busbar. When the rated current is large (for example, 1600 A or higher), it is recommended that the busway be directly led out from the upstream power distribution cabinet.

5.5.3 RPP Design

1. Selection of the General Input Form

(a) The RPP design shall comply with the relevant provisions in Section 5.3.2.

(b) The RPP should use cables or busways as inlets. The inlet mode should be determined based on the load scale and onsite layout conditions. The inlet position should be properly set based on the cabinet structure and onsite space layout.

6 Device Selection

6.1 AC Busway Selection

1. According to Clause 1 of Section 5.3.1.1, check key parameters such as the rated voltage, rated current, IP rating, and expected short-circuit current of the busway.

2. The busway type is selected according to Clause 2 of Section 5.3.1.1.

3. Compliance and testing requirements: The product must meet the GB/T 7251.6 standard with a complete type test report provided.

4. Accessory selection requirements: Auxiliary fastening accessories (brackets and fasteners) of the busway must be made of anti-corrosion and anti-rust materials and painted to meet the anti-condensation, anti-corrosion, load-bearing, and installation requirements in a liquid cooling environment.

6.2 DC Busway Selection

1. Product selection: Mature DC busbar products are preferred. If AC busbars are modified for use in DC systems, there must be a description of the applicability under DC conditions and type test reports or third-party test reports.
2. Insulation level: The rated insulation voltage of the busbar must be at least 1500 V.
3. Standards and tests: The product shall comply with the GB/T 7251 series standards and provide type test reports or test reports, including at least the temperature rise, short-time withstand current, dynamic stable current, and insulation performance. The related tests shall cover or be no lower than the design voltage and current levels. Test reports of lower levels cannot be used as a substitute.
4. Certification requirements: Products that belong to the national mandatory certification catalog shall have the CCC certification (or self-declaration). For non-catalog products, type tests or third-party test reports shall be provided.

6.3 Busway Plug-In Requirements

6.3.1 Plug-In Interface Type

(a) Busways should be equipped with standardized plug-in interfaces, which can be of the guide rail (track) type or fixed hole type. The installation position of the plug-in box should be flexibly set based on the layout and power requirements of IT cabinets in the micro-module.

(b) The fixed plug-in interfaces should adopt a standardized and modular design and be universally interchangeable to ensure that the system capacity can be easily expanded and functions can be easily extended throughout the lifecycle. The distance between adjacent connection points should not be too small to ensure heat dissipation and maintenance space.

6.3.2 Hot Swapping Capability

(a) Plug-in boxes should support hot-swapping without load. That is, they can be safely connected to or removed from busways that are continuously energized and running without load current, and the operation should not cause arcs, overvoltage, or interference to adjacent circuits.

(b) The claws of plug-in boxes shall be silver-plated to effectively reduce the contact resistance and ensure long-term conductivity reliability and electrical connection stability.

6.4 Plug-In Box Selection

6.4.1 General Provisions

1. **Structure and material requirements**
   (a) Enclosure material: The enclosure should be made of high-quality cold-rolled steel plates or aluminum alloy to provide sufficient mechanical strength for the installation of high-load and multi-circuit high-current circuit breakers.
   (b) IP rating: The overall IP rating shall not be lower than IP20.
   (c) Visual indication: A power-on indicator can be installed on the exterior of the box to intuitively display the power-on status of the busbar and main circuit of the plug-in box, ensuring safe O&M.
2. **Rated limited short-circuit current (Icc)**

   The short-circuit withstand capability of the plug-in boxes should be checked according to the complete set of equipment. The rated limited short-circuit current (Icc) should comply with the requirements of GB/T 7251.1.

6.4.2 Plug-In Box Circuit Breaker Configurations

(a) Quantity: All 380 V AC output circuits use 3P circuit breakers. The number of plug-in box circuits should be determined based on the space and heat dissipation conditions of a plug-in box.

(b) Dedicated for DC: When the circuit breaker is used in a DC system, consider the DC arc extinguishing characteristics. Preferentially select circuit breakers that are suitable for DC working conditions. The rated voltage, number of poles, and arc extinguishing performance of the circuit breakers must meet the system design requirements.

(c) Circuit matching: The rated current of the output circuit should be calculated based on the power requirements of downstream cables and cabinet PSUs. Based on the calculation result, select circuit breakers, current transformers (CTs), connectors, and cables to ensure that the current-carrying capacity of the entire link matches.

6.4.3 Output Interfaces and Protection Requirements of Plug-In Boxes

(a) The power distribution output interfaces of the plug-in boxes for power distribution to the power shelves or terminal IT equipment should use industrial connectors. All interfaces should have the following features:

  (1) Anti-misinsertion structure;
  (2) The IP rating should be at least IP44.
  (3) Equipped with mechanical latches or rotating locking mechanisms to prevent accidental disconnection;
  (4) Complies with the GB/T 11918.1/2 standard.

(b) Recommended configuration for the AC system (AC 380 V):

  (1) Current level: 32 A, 63 A, and 125 A
  (2) Number of poles and wires: 3P+N+E, which is applicable to three-phase IT loads.

(c) Recommended configuration for the DC system (HVDC 240 V):

  (1) Current level: 63 A and 125 A
  (2) Number of poles and wires: 2P+E (positive pole + negative pole + protective earth). The E pole is used only for protective earth and does not carry working current.
  (3) Polarity marking: The polarity (+ and –) must be clearly marked on the connector to prevent reverse connection.

6.4.4 Intelligent Monitoring

This section applies to the AC power distribution system. A plug-in box shall be equipped with an intelligent power monitoring module and auxiliary sensors, and be capable of collecting and monitoring the following key parameters in real time:

1. Electrical parameters: three-phase voltage, current, active/reactive power, active/reactive energy, power factor, total harmonic distortion (THD), etc.

2. Status signal: reports the switch-on/off status of the circuit breaker and fault tripping alarm signal in real time.

3. Temperature monitoring: real-time monitoring of the temperature at the contact point of the bus conductor and the internal ambient temperature of the plug-in box (optional).

4. Intelligent warning: The system shall provide the function of proactive warning and alarm for abnormal working conditions such as overload, overvoltage, undervoltage, phase missing, and overtemperature (optional).

5. Communications interface: The monitoring module shall be equipped with standard communications interfaces and support the Modbus RTU or Modbus TCP communications protocol to facilitate access to the background monitoring system.

6.4.5 Configuration Calculation of Plug-In Boxes

The number and rated current of plug-in boxes are determined based on the redundancy power distribution solution, power level of a single cabinet, and circuit requirements, as well as the rated voltage and power factor. For details about the configuration parameters, see Table 3 and Table 4.

- **Configuration Example 1 (See Table 3)**

In solution 1, there are 30 circuits in the single busway of row A1. Three 3P circuit breakers are configured for each box, and 10 plug-in boxes are configured for each busway. With the 2N redundancy architecture, 20 plug-in boxes are configured for the two busways in row A1.

6.4.6 Installation of Industrial Socket-Outlets

Industrial connectors are generally fixed or portable when used on plug-in boxes. The number of output circuits can be three or four, depending on the number of power shelves in the cabinet. You can refer to the technical specifications of products from mainstream vendors. For details about the installation modes, see Appendix A.

6.5 RPP Selection

1. According to Section 5.3.2.1, check key parameters such as the rated voltage, rated current, IP rating, and expected short-circuit current of the RPP.
2. The RPP should support combined installation with standard server cabinets or independent installation.
3. Compliance and testing requirements: The product must comply with the GB/T 7251.2 standard, and a complete type test report and CCC self-declaration must be provided.

6.6 Circuit Breaker Selection and Check Requirements

6.6.1 General Requirements

The circuit breaker should be selected based on the load characteristics, conductor current-carrying capacity, and system short-circuit current level, and meet the requirements of protection selectivity and operation safety.

6.6.2 General Selection and Check Methods for Circuit Breakers

1. **Load current calculation**

   Before selecting a circuit breaker, calculate the calculated load current (Ib) of the circuit. For continuous operating loads, the current should be corrected by a factor of at least 1.25. This current can be used as the basis for selecting the rated current of the circuit breaker.

2. **Rated current selection for circuit breakers**

   The rated current (In) of a circuit breaker shall be selected according to the calculated current of the circuit and shall meet the following requirements:

   (a) The rated current of the circuit breaker shall not be less than the calculated current of the circuit, that is, $Ib \leq In$.

   (b) The rated current of the circuit breaker shall match the load characteristics.

3. **Derating check**

   The derating of the rated current of a circuit breaker should be checked based on its actual operating conditions. The derating check should consider the following factors:

(a) Ambient temperature

(b) Temperature rise inside the cabinet

(c) Multi-circuit dense installation

(d) Ventilation and heat dissipation conditions

Under the above conditions, the selection of circuit breakers should be checked based on the temperature correction coefficient and dense installation correction coefficient provided by the manufacturer, and should comply with the actual installation conditions.

When the product technical documents cannot accurately reflect the actual operating conditions, the current-carrying capacity can be supplemented and checked based on test data or engineering experience. For the temperature derating factor, refer to the technical specifications of mainstream vendors in Appendix D.

Note: The rated current of the circuit breaker is the nominal value under standard conditions. In actual operation, the continuous current-carrying capacity may be derated due to factors such as ambient temperature, temperature rise inside the cabinet or box, and dense installation of multiple circuits.

4. Cable selection

The selection of circuit breakers and conductors must meet the comprehensive requirements of the calculated current of the circuit and the current-carrying capacity of the conductors, and comply with the following specifications in Article 6.3.3 of GB 50054:

$$Ib \le In \le Iz$$

$$I_2 \le 1.45\ Iz$$

The overload protection characteristics of the circuit breaker shall be coordinated with the current-carrying capacity of the conductor to ensure that the overload current is cut off before the conductor reaches the allowable temperature rise. On the premise that the preceding requirements are met, the cross-sectional area of the conductor should be properly selected based on the actual load level, operating conditions, and system expansion requirements.

Note: In actual engineering operations, when the actual upper limit of the circuit load current can be controlled not to exceed the load current (Ib) under fault conditions, the conductor current-carrying capacity (Iz) can be selected based on a value not less than the upper limit. However, this configuration depends on the load level and operating conditions and does not have a general design margin. When the load increases or the operating conditions change, the conductor may be overloaded. Therefore, the verification should be performed in specific projects.

5. Calculation and verification of breaking capacity

The selection of the breaking capacity should be based on the power supply capacity, transformer impedance, cable impedance, and system topology, and the expected short-circuit current at the installation point should be determined.

The breaking capacity of a circuit breaker should be verified according to the expected short-circuit current, and the rated ultimate breaking capacity (Icu) should not be lower than the expected short-circuit current (Ik).

6. Protection coordination check

Protection coordination check should be performed during circuit breaker selection to meet the requirements for hierarchical protection and selectivity. When a fault occurs, the protective device closest to the fault point shall be preferentially operated.

6.6.3 Selection and Configuration Requirements for General Input Circuit Breakers

1. The general circuit breaker referred to in this document is a circuit breaker installed at the power input of the terminal power distribution system, including the cable inlet circuit breaker installed in the general input unit, power distribution cabinet, or RPP. The circuit breaker can be a three-pole or four-pole one.

2. Breaking capacity:

(a) The breaking capacity of the general input circuit breaker shall be verified in accordance with Section 6.6.2.

(b) When the breaking capacity of the circuit breaker cannot cover the expected short-circuit current, the following measures can be taken:

- Select a circuit breaker with current limiting characteristics.
- Increase the transformer impedance or adjust the system impedance.

(c) The breaking capacity and related parameters of the circuit breaker shall be verified based on the type test report or certification documents of the product. For details, see the technical specifications of mainstream vendors in Appendix C (Informative).

3. Rated current:

The rated current of the main circuit breaker at the busway general input or RPP shall comply with the relevant provisions in 6.6.2.

4. DC system:

In the DC power distribution system, when the short-circuit current is limited or the fault current rise rate is low, the circuit breaker with a lower short-circuit protection setting multiplier should be selected. When selecting a circuit breaker, the breaking capacity and arc extinguishing performance of the circuit breaker under DC conditions shall be verified.

If necessary, the parameters such as the circuit breaker's making capacity (Icm) shall be verified based on the system characteristics.

Note: In a DC system, the short-circuit current may not reach the threshold for traditional overcurrent protection due to the current limiting of the power supply or the system impedance. As a result, the protection device may fail to operate or the operation may be delayed.

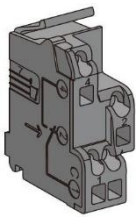
5. Operating environment:

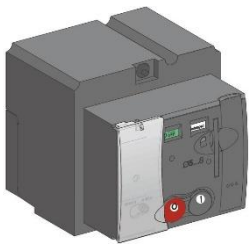
The general input unit is small in size and has limited heat dissipation conditions. Therefore, the rated current of the circuit breaker should be derated and verified according to the manufacturer's technical documents. You can refer to the technical specifications of mainstream vendors. For details about the derating factor, see Appendix B.

6. Accessory configuration:

When the switch-on/off status or fault tripping signal needs to be monitored, auxiliary contacts can be configured. When remote operation is required, an electric operating mechanism can be configured.

Figure 4





Auxiliary contact Electric operating mechanism

6.6.4 Selection of Circuit Breakers for Plug-In Boxes and RPP Branches

This section describes how to select circuit breakers for plug-in boxes and RPP branches in an AC power distribution system.

1. **Standards Compliance**

   The circuit breakers shall comply with the relevant standards of GB/T 10963.1, GB/T 14048.1, or GB/T 14048.2.

2. **Number of poles and rated current of circuit breakers**

   The rated current (In) of the circuit breaker shall be determined in accordance with the provisions in Section 6.6.2 and checked based on the installation ambient temperature and multi-circuit dense routing conditions. The related derating factor shall be determined based on the technical documents provided by the equipment manufacturer. For details, see the technical specifications of products from mainstream vendors in Appendix D (Informative).

3. **Protection functions**

   The circuit breaker should provide long-time overload and short-circuit protection. Its protection characteristics should comply with the requirements in Section 6.6.2 and be coordinated with the upstream and downstream protection devices.

4. **Breaking capacity and selectivity**

   The breaking capacity and selectivity of circuit breakers shall be checked according to section 6.6.2.

   When the breaking capacity of a branch circuit breaker is limited and cannot cover the expected short-circuit current at the installation point, the upstream circuit breaker shall be used to clear the short-circuit current through the system protection configuration. In addition, the setting of protection parameters and optimization of system configuration shall be performed to reduce over-level tripping.

5. **Tripping Characteristic Curve**

   Generally, the C-type tripping characteristic is preferred. The instantaneous tripping current range of the circuit breaker shall comply with relevant product standards.

6. **Temperature Rise and Wiring**

   (a) The temperature rise of the circuit breaker wiring terminals shall meet the requirements of the applicable product standards:

   - For circuit breakers complying with the GB/T 10963 standard, the temperature rise shall not exceed 60 K.
   - For circuit breakers complying with the GB/T 14048 standard, the temperature rise shall not exceed 70 K.

   (b) Circuit breakers shall use wiring terminals and connection methods that are suitable for their rated currents to ensure reliable connections and prevent overheating caused by poor contact.

7. **(Optional) Accessory Configuration**

   For key high-density cabinet circuits, auxiliary contacts should be configured for the branch circuit breakers to monitor the switch-on/off status and fault tripping signal. If remote operation is required, an electric operating mechanism can be configured.

8. **Configuration of the Tap-Off Unit and Circuit Breakers in the RPP**

Table 7 Recommended configurations of circuit breakers in the plug-in box

Plug-In Box Specifications (IP30)			Selection of 3P Circuit Breaker (Un = 380–415 V), GB/T 14048.2								
Single Circuit Imax (A)	Number of Circuits in a Single Plug-In Box	Circuit Breaker In (A)	Cable Selection (mm2)	Breaking Curve	iC65HI Icu = 15 kA	iC65M Icu = 25 kA	iC65F Icu = 36KA	iC65E Icu = 50 kA	C120H Icu = 10 kA	C120L, Icu = 15 kA	Box Heat Dissipation
27–32	≤ 4	50	≥ 6	C	A92HIC350	A92MC350	A92FC350	A92EC350			With heat dissipation holes
33–38	≤ 4	50	≥ 10	C	A92HIC350	A92MC350	A92FC350	A92EC350	-	-	
39–42	≤ 4	63	≥ 16	C	A92HIC363	A92MC363	A92FC363	A92EC363			
43–63	≤ 4	80	≥ 25	C	-	-	-	-	A96HC380	A95LC380	

Note: The numbers of the Schneider Electric products are used as examples. The conductor cross-sectional area in the table is recommended when the general design conditions are met. In specific operating conditions, the selection can be optimized according to the relevant provisions in Section 6.5.2 of the Specifications.

Table 8 Recommended configurations of circuit breakers in the RPP

RPP Specifications (IP30)		Selection of 3P Circuit Breaker (Un = 380–415 V), GB/T 14048.2								
Single Circuit Imax (A)	Circuit Breaker In (A)	Cable Selection (mm2)	Breaking Curve	iC65HI Icu = 15 kA	iC65M Icu = 25 kA	iC65F Icu = 36KA	iC65E Icu = 50 kA	C120H Icu = 10 kA	C120L, Icu = 15 kA	Heat Dissipation Inside the Cabinet
27–32	50	≥ 6	C	A92HIC350	A92MC350	A92FC350	A92EC350			Forced air cooling
33–38	50	≥ 10	C	A92HIC350	A92MC350	A92FC350	A92EC350	-	-	
39–42	63	≥ 16	C	A92HIC363	A92MC363	A92FC363	A92EC363			
43–63	80	≥ 25	C	-	-	-	-	A96HC380	A95LC380	

Note: The numbers of the Schneider Electric products are used as examples. The conductor cross-sectional area in the table is recommended when the general design conditions are met. In specific operating conditions, the selection can be optimized according to the relevant provisions in Section 6.5.2 of the Specifications.

6.7 Intelligent Meter Selection

This section applies to AC power distribution systems.

1. Function requirements

An AC smart meter should be able to measure three-phase and single-phase electrical parameters, such as voltage, current, power, and energy. It should also support harmonic monitoring, exception alarms, and remote data access, and be able to connect to the DCIM system.

2. **The power metering precision of the RPP and general input unit should be at least 0.5S level.**
3. **Installation mode:**
   - The intelligent meter of the general input unit should use a panel display.
   - The power meter of the plug-in box should be installed in the DIN track mode.
   - The RPP should use a centralized multi-circuit precision power distribution monitoring device to implement unified monitoring and centralized management of multiple circuits.

Figure 5



Digital display



DIN meter



Multi-circuit precision power distribution monitoring device

4. **Communication protocol: The mainstream industrial communication protocols such as Modbus RTU and Modbus TCP should be supported.**
5. The meter should have good electromagnetic interference resistance and meet the requirements of GB/T 17626 series electromagnetic compatibility standards. A surge protection device should be configured for the communications interfaces to adapt to the strong electromagnetic environment and lightning protection requirements of the equipment room.

6.8 Micro-Module Surge Protection Devices

To protect the electrical system and sensitive electronic devices from lightning overvoltage and switching overvoltage, the power distribution system of the data center shall be equipped with surge protection devices (SPDs) and effective protection should be provided for the end power distribution loop.

SPDs shall be configured according to the hierarchical configuration principle and coordinated with each other. The configuration shall comply with the relevant provisions of the *Code for design protection of structures against lightning* (GB 50057) and the *Technical code for protection against lightning of building electronic information system* (GB 50343).

For details about the selection, see the technical specifications of mainstream vendors in Appendix E.

6.9 Industrial Connector Selection

This section applies to AC power distribution systems.

1. The power distribution output interfaces of a plug-in box for the power shelf and end devices shall use industrial socket-outlets that comply with GB/T 11918 series standards (parts 1 and 2) to ensure performance and dimensional interchangeability.
2. The power distribution output interfaces of the plug-in box can use straight fixed, angled fixed, or portable industrial connectors and plugs. In the standard equipment room environment, fixed socket-outlets are preferred. The IP rating of the socket-outlets should be at least IP44. In high-density or special environments, the IP rating should be increased to IP67 according to the actual working conditions.

Figure 6



Straight fixed socket-outlet | Angled fixed socket-outlet | Portable socket-outlet | Plug

3. Product selection and verification:

   For common products, mainstream industrial connector series that comply with the preceding standards (such as Schneider IPS and MENNEKES TYP series) can be used to ensure product quality and system compatibility. After connectors are installed on products (such as tap-off units), they should be checked as part of the entire set of equipment. The focus should be on verifying their ability to withstand the electric force and thermal effects under short-circuit current conditions to ensure that they are not damaged or cause secondary accidents in the event of a short circuit.

4. Current level: The rated current should be 32 A, 63 A, or 125 A, depending on the load.

5. Pole configuration:

   The number of poles of the connector should be consistent with the wiring mode of the power distribution system.

   - For a three-phase system, a 3P+N+PE (five-pole) connector is recommended.
   - For a single-phase circuit, a 2P+PE (three-pole) connector is recommended.

6.10 Cable Selection and Application Requirements

1. Power distribution cables should be cross-linked polyethylene (XLPE) insulated and flame-retardant power cables (such as Z-YJY and Z-YJYR). The flame spread rating (A/B/C) and whether to use a low smoke zero halogen (WDZ) sheath should be determined based on the fire compartmentation requirements of the equipment room and the project requirements. The selection and routing of cables should comply with relevant national standards, such as GB 50217 and GB 31247.

2. The cross-sectional area of a cable should be selected based on the requirements for current-carrying capacity, voltage drop, and short-circuit thermal stability. When cables are routed in multiple circuits, the current-carrying capacity should be corrected according to the specified standards. The design can be preliminarily estimated based on the common derating factor.

   The following table lists the current-carrying capacity at an ambient temperature of 40°C. The actual current-carrying capacity should be verified based on the actual cable routing mode, number of circuits, and installation conditions. If necessary, the current-carrying capacity should be determined based on the manufacturer's data or calculation results.

Table 9

Cross-Linked Polyethylene (XLPE) Flexible Cable					
Cross-Sectional Area (mm^2)	Number of Circuits	Cable Trough/Cable Tray in the Equipment Room		Air, Above the Cold Aisle	
		Two-Core	Three-Core	Two-Core	Three-Core
4	3	**29**	**27**	36	32
	4	**29**	**27**	36	32
6	3	**37**	**34**	46	41
	4	**37**	**34**	46	41
10	3	**50**	**48**	64	56
	4	**50**	**48**	64	56
16	3	**68**	**64**	86	75
	4	**68**	**64**	86	75
25	3	**88**	**81**	108	95
	4	**88**	**81**	108	95

- The current-carrying capacity is obtained from Table C.52.1 in Appendix C of GB/T 16895.6-2014. The derating factor is obtained from Table C.52.3 in Appendix C, which is 0.8.
- The values in bold are the recommended current-carrying capacities. The derating factor for multiple circuits is obtained from Table C.52.3 in Appendix C of the cable standard GB/T 16895.6-2014, which is 0.8.
- Circuit configuration: For three-phase AC circuits, use five-core cables (3P+N+E). For single-phase AC circuits, use three-core cables (1P+N+E).

  For DC circuits, use two-core (positive and negative) or three-core (positive, negative, and E) cables. Use yellow and green cables for grounding. Do not mix cables. The number of cores in Table 9 refers to the main live conductors in the cable.
- Users can select low smoke and zero halogen products as required.

7 Installation and Deployment

7.1 Installation Requirements

1. Waterproof measures (such as sealing or drip loops) should be taken for the cable inlet and outlet interfaces of electrical equipment (busways, plug-in boxes, and RPPs) to prevent condensate water or accumulated water from entering the equipment.
2. In a liquid cooling environment, a busway system should be designed to prevent condensation. Measures should be taken to prevent condensate water from accumulating on the busway surface or entering the busway. It is recommended that accumulated water be drained in a timely manner through structural diversion.

3. The drainage design of the busway system should specify the drainage path. Condensate water or seepage water should not directly drip onto cabinets or electrical equipment. If necessary, diversion, shielding, or collection measures should be taken to implement directional drainage.
4. The busway should be installed above pipes (such as liquid cooling pipes) that have a risk of liquid leakage. The installation should be staggered, and the layout should be considered in conjunction with the operation and leakage risks of the liquid cooling system. A sufficient O&M space must be reserved between the busway and pipes. The horizontal and vertical clearances should be at least 0.6 m. The layout of busways and pipes should not rely solely on spatial positioning to mitigate risks. It should also consider the impact of water leakage from pipes and condensate water to avoid direct impact on electrical equipment.

7.2 Busbar, Cable Tray, and Cable Installation and Routing

1. Before installation, check the appearance to ensure that there is no deformation, damage, and insulation layer damage, and that all accessories are complete.
2. The layout of cable trays or power distribution busbars should not block the air circulation path of the air conditioner.
3. Installation space requirements for busways and cable trays:

   The installation space for busbars, cable trays, and cables should be reserved based on engineering experience values (see the following table) and should be checked based on the equipment dimensions, O&M requirements, and actual layout. If the space is insufficient to meet the preceding reference values, evaluate the temperature rise and O&M conditions to ensure safe operation of the system.

Table 10

Area	Recommended Value in the Vertical Direction
Busbar → Top plate	At least 200 mm
Between cable tray layers	At least 300 mm
Top of the cabinet → Bottom of the cable tray	At least 200 mm
Cable tray width	600 mm or 800 mm
Number of cable trays	No more than four layers

4. The minimum distance between copper cables and power cables or power distribution busways in the cabling system of the main equipment room shall be determined based on the cabinet capacity and cable protection mode, and shall comply with the requirements specified in the following table (Table 10.2.17 in the revised draft for comment of GB 50174).

Table 11

Cabinet Capacity (kVA)	Routing relationship between copper cables and power cables	Routing relationship between copper cables and power distribution busways	Minimum Spacing (mm)
> 5	Copper cables are laid in parallel with power cables.	-	600

Cabinet Capacity (kVA)	Routing relationship between copper cables and power cables	Routing relationship between copper cables and power distribution busways	Minimum Spacing (mm)
	One of them is routed in a metal cable trough or steel pipe, or shielded copper cables are used.	Copper cables are laid in parallel with the power distribution busways.	300
	Both cables are routed in metal cable troughs or steel pipes, or shielded copper cables are used.	Copper cables are routed in metal cable troughs or steel pipes, or shielded copper cables are used.	150

5. Busbar Installation

(a) To ensure application security and facilitate future maintenance, busbars should be installed on the top of cabinets.

(b) Busbars installed on the top of cabinets can be arranged horizontally or vertically. The arrangement mode should be adapted based on the space conditions.

- Horizontal layout is applicable to scenarios where the height space on the top of the cabinet is limited but the depth space of the cabinet is sufficient.
- Vertical layout is applicable to scenarios where the height space on the top of the cabinet is sufficient but the depth space of the cabinet is limited.

(c) For a single high-power cabinet (the number of power module circuits is less than or equal to 10), a maximum of two to four plug-in boxes are configured. To avoid the blocking and space interference caused by the front and rear plug-in boxes when they are horizontally arranged, it is recommended that the cabinet busways be vertically arranged. Refer to the technical specifications of products from mainstream vendors, such as Schneider Electric Busway. When the vertical layout is used, the following space and installation requirements must be met:

- Installation and operation space: Sufficient clearance must be reserved between the busways and plug-in boxes and the cabinet enclosure and cable trays to facilitate the installation of plug-in boxes and routine operation and maintenance by O&M personnel. For details, see Table 21.
- Load-bearing and fixing requirements: If a plug-in box is configured with multiple circuit breakers, has a large number of external cables, and has a heavy weight, load-bearing arms or load-bearing supports can be added during installation to enhance the load-bearing capacity and structural stability of the cabinet.
- For vertically arranged busways, sufficient maintenance space must be reserved between the top of the busway and the suspended ceiling, and between the plug-in box and the top of the cabinet below. The net distance must be at least 200 mm to ensure that the installation, maintenance, and replacement of the busway and plug-in box are not restricted.
- For multiple groups of busways arranged horizontally, the net distance between two adjacent groups of busways should be at least 300 mm to reserve space for operation and O&M.

6. For details about how to hoist busways, see Appendix D.

8 Test Verification and Acceptance

8.1 Check Items Before Power-On

Table 12

Test Acceptance Category	Core Test Item	Test Object	Check Method	Key Test Requirement	Qualification Criteria
Installation foundation and compliance verification	Busbar installation check	Terminal power distribution busbars	Visual inspection	There is no cold source pipe or water dripping risk above the device.	There is no cold source or water risk.
	Conductor check	Busbar conductors	Visual inspection and wiping	The conductor has no burr, oxidation, or dirt.	The surface is clean and free of defects.
	Phase sequence check	Busway system	Phase sequence tester	The phase sequence is correct.	The ABC sequence is correct.
	PE grounding check	Busbars and cabinets	Visual inspection	The PE is correctly connected.	The grounding is continuous and reliable.
	Mechanical fastening	Busbar connection bolts	Torque wrench	Tighten according to the manufacturer's torque requirements.	Deviation ≤ ±5%
	Cabinet check	RPPs	Visual inspection	The cabinet is clean and labels are complete.	Installation requirements are met.
	Connection check	Plug-in boxes	Perform visual inspection and manual check.	The connection is correct and the locking is reliable.	There is no loosening.
	Cable layout	Cables and cable trays	Visual inspection	Cable routing complies with specifications and sealing is complete.	There is no non-compliant layout.
	Grounding continuity test	Grounding system	Ground resistance test	Grounding circuit continuity	≤ 1 Ω or as designed

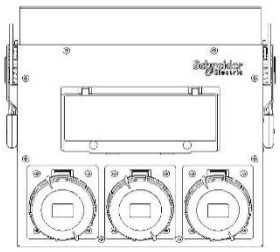
Test Acceptance Category	Core Test Item	Test Object	Check Method	Key Test Requirement	Qualification Criteria
Capacity and load verification	Full-load testing	RPPs	Loading and thermal imaging	Load for 2 hours based on the designed capacity.	No tripping occurs.
	Temperature rise test (main circuit)	Busbar and RPP terminals	Infrared thermal imaging	Full load operation	Temperature rise ≤ 70 K
	Branch test (RPP)	Branch circuit breakers and terminals of the RPPs	Loading and thermal imaging	Load for 2 hours based on the designed capacity.	The temperature rise meets the requirements specified in Item 6 of Section 6.5.2.1, and no tripping occurs.
	Branch test (plug-in boxes)	Output circuits of the plug-in boxes	Loading and thermal imaging	Load for 2 hours based on the designed capacity.	The temperature rise meets the requirements specified in Item 6 of Section 6.5.2.1, and no tripping occurs.
	Insulation resistance test	Conductor	Megohmmeter	1000 V test	≥ 5mΩ
	Withstand voltage test	Cabinet insulation system	Withstand voltage tester	2200 V 60s	There is no breakdown.
	Harmonic test	Busbars	Power quality analyzer	Full-load testing	Voltage harmonics < 5% (GB/T 14549); current < 10%
	Neutral-ground voltage	PDU output terminal	Multimeter	Full-load measurement	< 2 V
	Temperature rise scanning	Busbar/Terminal	Infrared thermal imaging	Key parts are scanned.	There is no abnormal hot spot.
Protection and monitoring	CT	Current transformer	Current injection	The transformer ratio and polarity are verified.	Compliant to standards.
	Secondary injection test	Circuit breaker protection	Injection test	Overcurrent/Short circuit is simulated.	The action is correct.

Test Acceptance Category	Core Test Item	Test Object	Check Method	Key Test Requirement	Qualification Criteria
	Monitoring joint commissioning	Monitoring system	Signal comparison	Data is consistent.	When the meter uses the 0.5S level, the 0.5S level requirements of GB/T 17215 are implemented for electric energy metering.
Operating functions	Load switching test	Multi-circuit	Switching test	On-load switching	No service interruption occurs.
	Joint communication commissioning	System	Communication test	The communication is normal.	No fault is found.
Grounding for surge protection	SPD check	SPD device	Visual inspection	The model and installation are correct.	The design requirements are met.

Appendix A Industrial Connectors on Plug-In Boxes

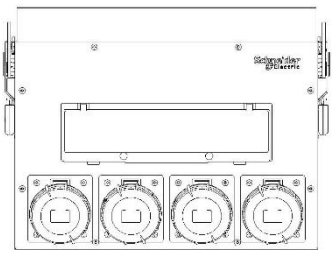
1. Schneider I-LINE TRACK busbar (rated current: 250–1200 A) plug-in box

Figure 7



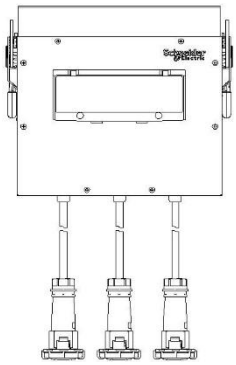
Three outputs – fixed industrial connector

Figure 8



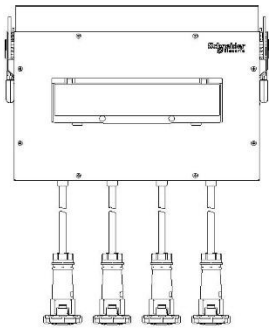
Four outputs – fixed industrial connector

Figure 9



Three outputs – portable industrial connector

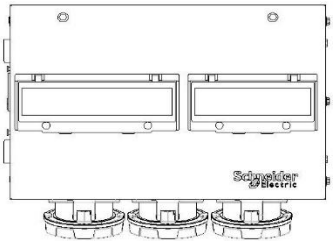
Figure 10



Four outputs – portable industrial connector

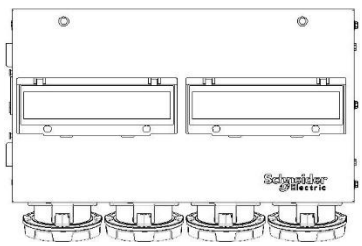
2. Schneider I-LINE H dense busway connector box

Figure 11



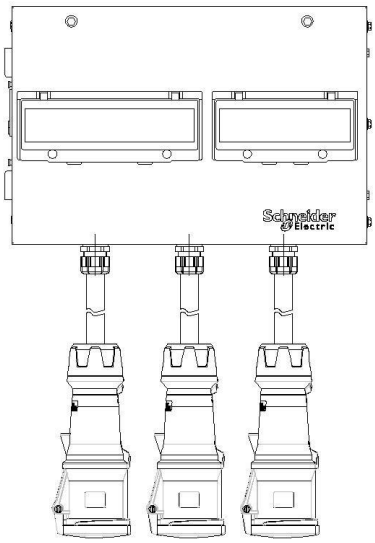
Three outputs – fixed industrial connector

Figure 12



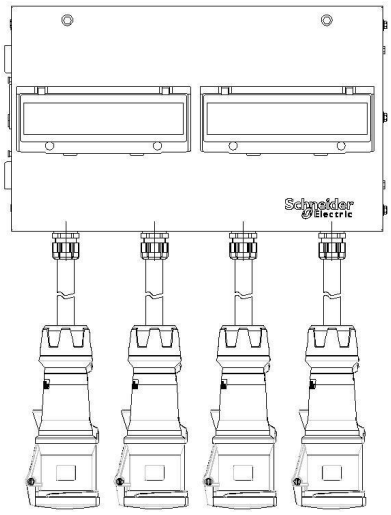
Four outputs – fixed industrial connector

Figure 13



Three outputs – portable industrial connector

Figure 14



Four outputs – portable industrial connector

Appendix B Selection of Common Circuit Breaker Breaking Capacity for General Input Protection

1. Relationship between Icu and Ics of the rated current of Schneider NS series AC circuit breakers under different power distribution voltages

Table 13

Compact Circuit Breaker					NS630b			NS800			NS1000			NS1250		NS1600	
Number of poles					3,4			3,4			3,4			3,4		3,4	
Control	Manual		Toggle handle		•			•			•			•		•	
			Direct or extended rotary handle		•			•			•			•		•	
	Electrical				•			•			•			•		•	
Circuit breaker type					N	H	L	N	H	L	N	H	L	N	H	N	H
Connection	Fixed		Front connection		•	•	•	•	•	•	•	•	•	•	•	•	•
			Bare cable front connection		•	•	•	•	•	•	•	•	•	•	•	•	•
	Withdrawable type (cradle-based)		Rear connection		•	•	•	•	•	•	•	•	•	•	•	•	•
The electrical performance complies with IEC 60947-2 and EN 60947-2.																	
Rated current (A)		In	50℃		630			800			1000			1250		1600	
			65℃ (1)		630			800			1000			1250		1510	
Rated insulation voltage (V)		Ui			1000			1000			1000			1000		1000	
Rated impulse withstand voltage (kV)		Uimp			8			8			8			8		8	
Rated operating voltage (V)		Ue	AC	50/60Hz	690			690			690			690		690	
Circuit breaker type					N	H	L	N	H	L	N	H	L	N	H	N	H
Ultimate breaking capacity (kA, RMS)	Manual	Icu	AC	220V/240V	85	85	150	85	85	150	85	85	150	85	85	85	85
			50/60Hz	380/415V	50	70	150	50	70	150	50	70	150	50	70	50	70
				440V	50	65	130	50	65	130	50	65	130	50	65	50	65
				500V/525V	40	50	100	40	50	100	40	50	100	40	50	40	50
				660/690V	30	42	-	30	42	-	30	42	-	30	42	30	42
		Ics	AC	220V/240V	50	50	150	50	50	150	50	50	150	50	50	37	37
			50/60Hz	380/415V	50	50	150	50	50	150	50	50	150	50	50	37	37
				440V	50	50	130	50	50	130	50	50	130	50	50	37	37
				500V/525V	40	40	100	40	40	100	40	40	100	40	40	30	30
				660/690V	30	30	-	30	30	-	30	30	-	30	30	22	22
	Electrical	Icu	AC	220V/240V	50	70	150	50	70	150	50	70	150	50	70	50	70
			50/60Hz	380/415V	50	70	150	50	70	150	50	70	150	50	70	50	70
				440V	50	65	130	50	65	130	50	65	130	50	65	50	65
				500V/525V	40	50	100	40	50	100	40	50	100	40	50	40	50
				660/690V	30	42	-	30	42	-	30	42	-	30	42	30	42
		Ics	AC	220V/240V	37	37	150	37	37	150	37	37	150	37	37	37	37
			50/60Hz	380/415V	37	37	150	37	37	150	37	37	150	37	37	37	37
				440V	37	37	130	37	37	130	37	37	130	37	37	37	37
				500V/525V	30	30	100	30	30	100	30	30	100	30	30	30	30
				660/690V	22	22	-	22	22	-	22	22	-	22	22	22	22



2. Schneider Masterpact MT series air circuit breaker



Within the rated breaking capacity range, the rated operating breaking capacity (Ics) of the Schneider Masterpact MT series air circuit breaker is usually equal to the rated ultimate breaking capacity (Icu), that is, Ics = 100% Icu.



For circuit breakers with different breaking levels (such as N, H, H2, H3, and L1), the rated breaking capacity (such as 50 kA, 65 kA, 100 kA, and 150 kA) is the corresponding Icu value, which is also the Ics value.



Appendix C Impact of Ambient Temperature on the Circuit Breaker of the General Input Unit

1. Class A circuit breaker

- Applicable series: Compact NSX series
- Specifications: rated current of the frame rating (In) ≤ 630 A
- Derating reference: See Table 14.

Table 14

Correction coefficient table for thermal-magnetic TM-D and TM-GNSX, used to determine the setting value or tripping time at In													
Rated Current (In, A)	**10℃**	**15℃**	**20℃**	**25℃**	**30℃**	**35℃**	**40℃**	**45℃**	**50℃**	**55℃**	**60℃**	**65℃**	**70℃**
400	1.14	1.12	1.1	1.07	1.05	1.03	1	0.98	0.95	0.92	0.89	0.87	0.84
500	1.12	1.1	1.1	1.08	1.06	1.04	1	0.98	0.96	0.94	0.91	0.89	0.87
600	1.12	1.1	1.08	1.06	1.04	1.02	1	0.98	0.96	0.93	0.91	0.89	0.86
630	1.13	1.11	1.09	1.07	1.05	1.02	1	0.98	0.95	0.93	0.9	0.87	0.85

2. Class B circuit breaker

- Applicable series: Compact NS series
- Specifications: 630 A < rated current of the frame rating (In) ≤ 1600 A
- Derating reference: See Table 15.

Table 15

Compact NS630b-1600A

The maximum rated current values listed in the following table depend on the ambient temperature.

Type	Fixed Circuit Breaker - Front Mounting						
Connection Temperature Ti (1)	40℃	45℃	50℃	55℃	60℃	65℃	70℃
NS630bN/H	630	630	630	630	630	630	630
NS800N/H	800	800	800	800	800	800	800
NS1000N/H	1000	1000	1000	1000	1000	1000	1000
NS1250N/H	1250	1250	1250	1250	1250	1240	1090
NS1600N/H	1600	1600	1560	1510	1470	1420	1360

(1) Ti: temperature around the circuit breaker and its connectors

Appendix D Temperature Derating and Dense Installation Derating Coefficients for Miniature Circuit Breakers

1. The actual current-carrying capacity of Schneider's iC65N/H series miniature circuit breakers varies with the ambient temperature and the applicable standards (GB/T 10963.1 and GB/T 14048.2). For details about the derating characteristics and coefficients, see Table 16 to Table 18. For circuit breakers from other vendors, you need to query the derating coefficient table of the corresponding series. Mixed use is not allowed.

Table 16

Temperature derating coefficient

iC65L, iC65L MA

Temperature (°C)	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Rated Current (A)																						
1	1.34	1.32	1.30	1.28	1.26	1.25	1.23	1.21	1.19	1.17	1.15	1.13	1.11	1.09	1.07	1.05	1.02	1.00	0.98	0.95	0.93	0.90
2	2.60	2.57	2.54	2.50	2.47	2.44	2.41	2.37	2.34	2.30	2.27	2.23	2.19	2.16	2.12	2.08	2.04	2.00	1.96	1.92	1.87	1.83
4	4.97	4.92	4.87	4.81	4.76	4.71	4.65	4.60	4.54	4.48	4.43	4.37	4.31	4.25	4.19	4.13	4.06	4.00	3.94	3.87	3.80	3.74
6	8.51	8.38	8.25	8.12	7.99	7.85	7.71	7.58	7.43	7.29	7.14	6.99	6.83	6.67	6.51	6.35	6.18	6.00	5.82	5.63	5.44	5.24
10	13.05	12.89	12.73	12.57	12.40	12.23	12.06	11.89	11.72	11.54	11.36	11.17	10.99	10.80	10.60	10.41	10.20	10.00	9.79	9.58	9.36	9.13
16	21.93	21.63	21.32	21.01	20.69	20.37	20.04	19.71	19.37	19.03	18.67	18.32	17.95	17.58	17.20	16.81	16.41	16.00	15.58	15.15	14.70	14.24
20	27.46	27.08	26.70	26.30	25.90	25.50	25.09	24.67	24.24	23.81	23.37	22.92	22.46	21.99	21.51	21.02	20.52	20.00	19.47	18.93	18.36	17.78
25	33.34	32.91	32.47	32.03	31.58	31.12	30.66	30.19	29.71	29.23	28.73	28.23	27.72	27.20	26.66	26.12	25.57	25.00	24.42	23.82	23.21	22.59
32	42.99	42.43	41.85	41.27	40.68	40.08	39.47	38.85	38.22	37.58	36.93	36.26	35.59	34.90	34.20	33.48	32.75	32.00	31.23	30.44	29.64	28.80
40	53.81	53.10	52.37	51.64	50.90	50.15	49.38	48.60	47.81	47.01	46.19	45.36	44.51	43.65	42.76	41.86	40.94	40.00	39.03	38.04	37.03	35.98
50	69.06	68.08	67.10	66.10	65.08	64.05	63.00	61.93	60.84	59.73	58.61	57.46	56.28	55.08	53.86	52.60	51.32	50.00	48.65	47.25	45.81	44.33
63	87.27	86.03	84.78	83.50	82.21	80.89	79.56	78.20	76.81	75.40	73.97	72.50	71.01	69.48	67.92	66.32	64.68	63.00	61.27	59.50	57.66	55.77

Table 17

iC65N/H and iC65H DT/iC65L DT, complying with GB/T 14048.2 IEC/EN 60947-2

Temperature (°C)	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Rated Current (A)																						
1	1.52	1.50	1.47	1.44	1.42	1.39	1.36	1.33	1.30	1.27	1.24	1.21	1.18	1.14	1.11	1.07	1.04	1	0.96	0.92	0.88	0.83
2	2.78	2.74	2.70	2.66	2.61	2.57	2.53	2.49	2.44	2.40	2.35	2.30	2.26	2.21	2.16	2.11	2.05	2	1.94	1.89	1.83	1.77
3	4.09	4.04	3.98	3.92	3.86	3.80	3.74	3.68	3.62	3.56	3.49	3.43	3.36	3.29	3.22	3.15	3.08	3	2.92	2.84	2.76	2.68
4	5.43	5.35	5.28	5.20	5.13	5.05	4.97	4.89	4.81	4.73	4.64	4.56	4.47	4.38	4.29	4.19	4.10	4	3.90	3.80	3.69	3.58
6	8.72	8.58	8.44	8.30	8.16	8.02	7.87	7.72	7.56	7.41	7.24	7.08	6.91	6.74	6.56	6.38	6.19	6	5.80	5.59	5.38	5.16
8	11.83	11.64	11.45	11.25	11.05	10.85	10.64	10.43	10.21	9.99	9.76	9.53	9.29	9.05	8.80	8.54	8.27	8	7.72	7.42	7.11	6.79
10	13.46	13.29	13.10	12.92	12.73	12.54	12.35	12.16	11.96	11.76	11.55	11.34	11.13	10.91	10.69	10.47	10.24	10	9.76	9.51	9.26	8.99
13	17.94	17.69	17.43	17.17	16.91	16.64	16.37	16.09	15.81	15.52	15.23	14.93	14.63	14.32	14.00	13.67	13.34	13	12.65	12.29	11.92	11.53
16	22.08	21.77	21.45	21.13	20.81	20.48	20.14	19.80	19.46	19.10	18.74	18.38	18.00	17.62	17.23	16.83	16.42	16	15.57	15.13	14.67	14.20
20	27.42	27.04	26.65	26.26	25.86	25.46	25.05	24.64	24.21	23.78	23.34	22.89	22.44	21.97	21.50	21.01	20.51	20	19.48	18.94	18.38	17.81
25	34.22	33.75	33.27	32.79	32.29	31.79	31.28	30.76	30.24	29.70	29.15	28.60	28.03	27.45	26.86	26.25	25.63	25	24.35	23.68	22.99	22.28
32	43.52	42.93	42.33	41.72	41.10	40.48	39.84	39.19	38.53	37.86	37.18	36.49	35.78	35.05	34.32	33.56	32.79	32	31.19	30.36	29.50	28.62
40	53.35	52.66	51.96	51.25	50.53	49.80	49.06	48.30	47.54	46.76	45.97	45.16	44.35	43.51	42.66	41.79	40.91	40	39.07	38.12	37.15	36.15
50	65.67	64.85	64.03	63.19	62.34	61.48	60.60	59.72	58.82	57.91	56.98	56.03	55.07	54.10	53.10	52.09	51.06	50	48.92	47.82	46.69	45.54
63	85.65	84.49	83.31	82.11	80.89	79.66	78.41	77.13	75.84	74.52	73.18	71.81	70.42	69.00	67.55	66.07	64.55	63	61.41	59.77	58.09	56.36
80	105.48	104.15	102.81	101.45	100.07	98.67	97.25	95.81	94.35	92.86	91.35	89.82	88.26	86.67	85.05	83.40	81.72	80	78.24	76.45	74.61	72.72

Table 18

C120H.LBC, D curve, complying with GB/T 10963.1 IEC/EN 60898-1

Temperature (°C)	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Rated Current (A)																					
63	78.64	77.46	76.26	75.04	73.80	72.53	71.25	69.94	68.61	67.25	65.87	64.45	63.00	61.52	60.00	58.44	56.84	55.19	53.49	51.94	49.92
80	98.41	97.01	95.59	94.15	92.68	91.19	89.68	88.14	86.57	84.98	83.35	81.69	80.00	78.27	76.50	74.69	72.84	70.93	68.98	66.96	64.89
100	124.46	122.61	120.73	118.82	116.87	114.90	112.89	110.85	108.77	106.64	104.47	102.26	100.00	97.69	95.32	92.89	90.39	87.82	85.18	82.45	79.63
125	157.02	154.61	152.16	149.66	147.13	144.55	141.92	139.24	136.51	133.73	130.88	127.98	125.00	121.95	118.83	115.62	112.31	108.91	105.40	101.77	98.00

C120H/L, complying with GB/T 14048.2 IEC/EN 60947-2

Temperature (°C)	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
Rated Current (A)																							
80 (1P)	102.71	101.48	100.24	98.97	97.68	96.36	95.03	93.66	92.27	90.85	89.40	87.92	86.40	84.85	83.26	81.63	80	78.22	76.44	74.60	72.70	70.73	68.69
80 (2P)	105.32	103.99	102.65	101.28	99.89	98.47	97.03	95.56	94.07	92.54	90.98	89.39	87.76	86.09	84.38	82.63	80	78.98	77.08	75.11	73.08	70.97	68.79
80 (3P)	105.32	103.99	102.65	101.28	99.89	98.47	97.03	95.56	94.07	92.54	90.98	89.39	87.76	86.09	84.38	82.63	80	78.98	77.08	75.11	73.08	70.97	68.79
80 (4P)	105.32	103.99	102.65	101.28	99.89	98.47	97.03	95.56	94.07	92.54	90.98	89.39	87.76	86.09	84.38	82.63	80	78.98	77.08	75.11	73.08	70.97	68.79
100 (1P)	124.38	123.03	121.66	120.28	118.87	117.44	115.98	114.50	113.00	111.46	109.90	108.31	106.69	105.04	103.35	101.62	100	98.04	96.19	94.29	92.33	90.32	88.25
100 (2P)	147.31	144.82	142.28	139.69	137.05	134.36	131.62	128.81	125.94	123.01	120.00	116.92	113.75	110.49	107.12	103.65	100	96.33	92.45	88.39	84.14	79.67	74.92
100 (3P)	141.43	139.25	137.02	134.76	132.46	130.11	127.72	125.27	122.78	120.23	117.63	114.95	112.22	109.41	106.52	103.54	100	97.30	94.01	90.60	87.04	83.32	79.41
100 (4P)	141.43	139.25	137.02	134.76	132.46	130.11	127.72	125.27	122.78	120.23	117.63	114.95	112.22	109.41	106.52	103.54	100	97.30	94.01	90.60	87.04	83.32	79.41
125 (1P)	175.14	172.50	169.81	167.08	164.30	161.46	158.57	155.63	152.62	149.54	146.40	143.17	139.87	136.48	133.00	129.41	125	121.89	117.93	113.82	109.55	105.08	100.40
125 (2P)	170.40	167.96	165.48	162.96	160.40	157.80	155.15	152.46	149.72	146.93	144.09	141.19	138.22	135.20	132.10	128.93	125	122.34	118.91	115.38	111.73	107.97	104.06
125 (3P)	170.40	167.96	165.48	162.96	160.40	157.80	155.15	152.46	149.72	146.93	144.09	141.19	138.22	135.20	132.10	128.93	125	122.34	118.91	115.38	111.73	107.97	104.06
125 (4P)	170.40	167.96	165.48	162.96	160.40	157.80	155.15	152.46	149.72	146.93	144.09	141.19	138.22	135.20	132.10	128.93	125	122.34	118.91	115.38	111.73	107.97	104.06

2. Derating factor for dense installation

Table 19

Derating factor for dense installation of iC65s63A circuit breakers

Number of Installed Products	Derating Factor
1	1.00
2	0.93
3	0.88
4	0.86
5	0.85
6	0.84
7	0.82
8	0.82
≥ 9	0.81

Appendix E Surge Protection for Terminal Power Distribution

1. Determine the lightning protection level of the electronic information system in a building.

Table 20

Lightning Protection Level	Building Type
A	• Electronic information systems of national computing centers, national communications hubs, special- and first-class financial facilities, large- and medium-sized airports, national and provincial radio and television centers, hub ports, railway hub stations, and important public utilities such as water, electricity, and heat in provincial cities • Level-1 security protection units, such as closed-circuit television (CCTV) surveillance and alarm systems for national cultural relics and archives • Electronic medical equipment in level-3 hospitals
B	• Electronic information systems in medium-sized computing centers, level-2 financial facilities, medium-sized communication hubs, mobile communication base stations, large stadiums (venues), small airports, large ports, and large railway stations • Level-2 security protection units, such as CCTV surveillance and alarm systems for provincial cultural relics and archives • Electronic information systems in radar stations and microwave stations, and highway surveillance and toll collection systems • Electronic medical equipment in level-2 hospitals; • Electronic information systems in five-star and higher-star hotels
C	• Electronic information systems in level-3 financial facilities and small communication hubs • Large- and medium-sized cable TV systems • Electronic information systems in four-star and lower-star hotels
D	Electronic information equipment for general use that requires protection, except for the preceding levels A, B, and C

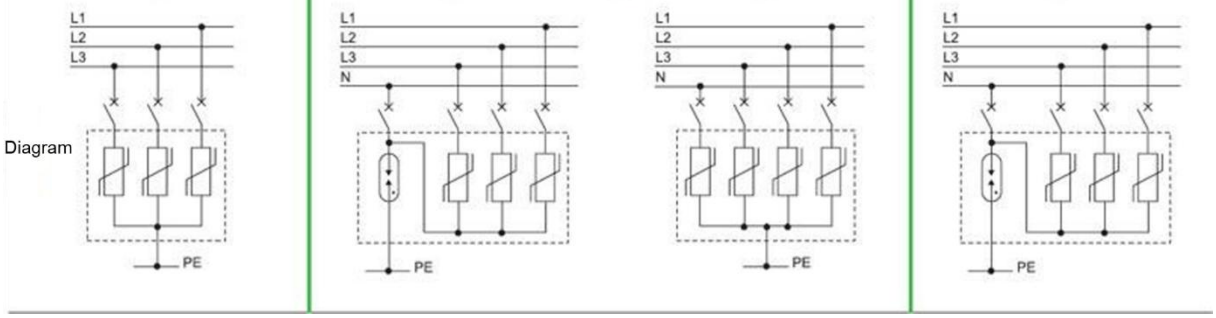
2. Select the specifications of an SPD according to the lightning protection level of the electronic information system in a building and the lightning protection zone where the SPD is installed.

Table 21

Protection Level	Boundary Between LPZ0 and LPZ1		Boundary Between LPZ1 and LPZ2	Boundary of the Subsequent Protection Zone
	Main Distribution Box		Sub-distribution Box	Ports of the Plug-In Box in the Equipment Room and Electronic Information Devices That Require Special Protection
	10/350 μs	8/20 μs	8/20 μs	8/20 μs
	I_{imp} (kA)	In (kA)	In (kA)	In (kA)
A	≥ 20	≥ 80	≥ 40	5
	iPRD1 20r/iPRD1 20	Contact us	iPRU 80r/iPRU 80	iPRU 10r/iPRU 10
	iPRF1 12.5 r/12.5 (optional according to GB50057)			
B	≥ 15	≥ 60	≥ 30	≥ 5
	iPRD1 15r/iPRD1 15	iPRU 120r/iPRU 120	iPRU 65r/iPRU 65	iPRU 10r/iPRU 10
	iPRF1 12.5 r/12.5 (optional according to GB50057)			
C	≥ 12.5	≥ 50	≥ 20	≥ 3
	iPRF1 12.5r/iPRF1 12.5	iPRU 100r/iPRU 100	iPRU 40r/iPRU 40	iPRU 10r/iPRU 10
D	≥ 12.5	≥ 50	≥ 10	≥ 3
	iPRF1 12.5r/iPRF1 12.5	iPRU 100r/iPRU 100	iPRU 20r/iPRU 20	iPRU 10r/iPRU 10

3. Select the number of poles for the SPD based on the grounding system.

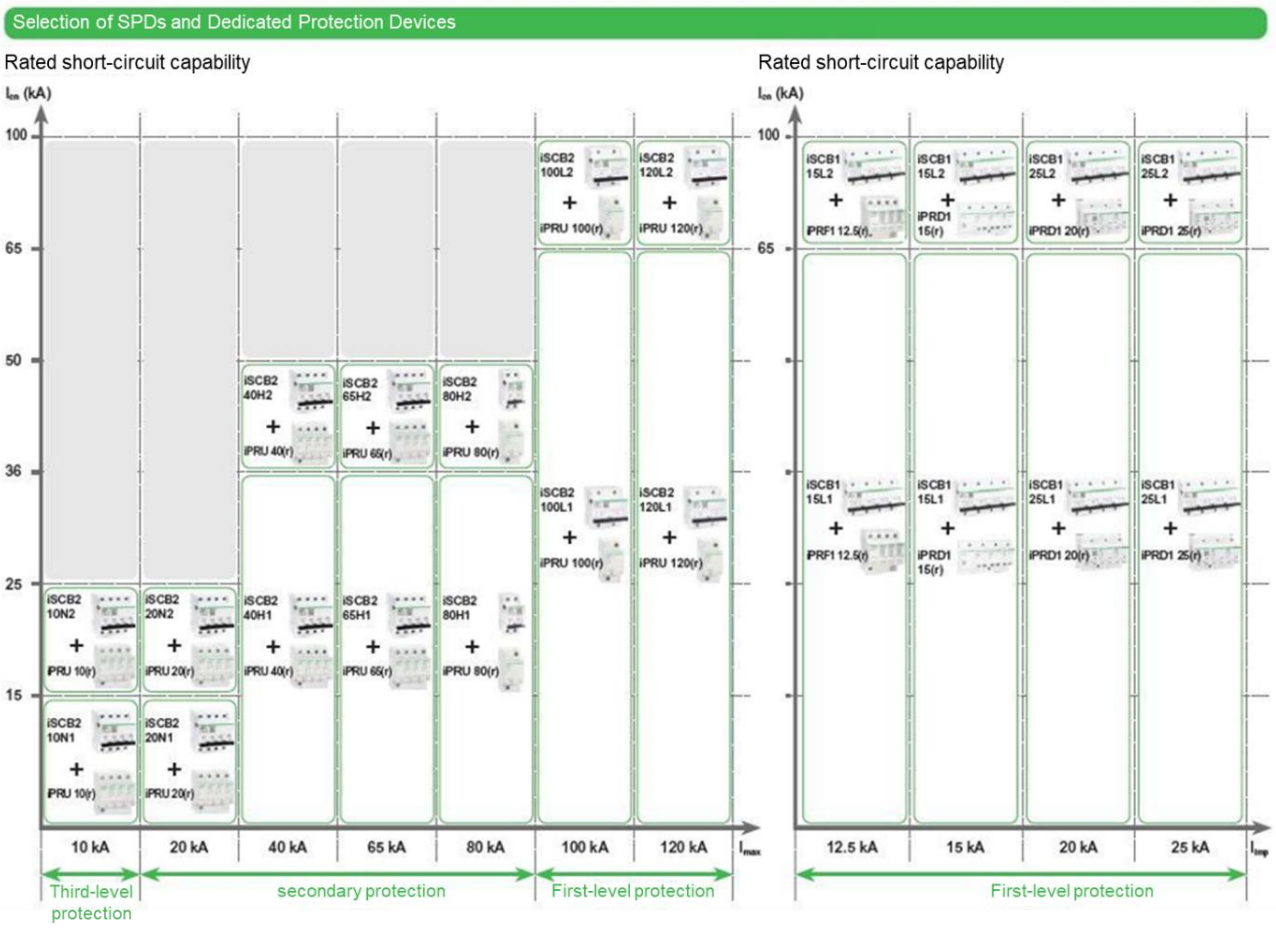
Table 22

TN-C		TN-S				TT	
Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase	Single-phase	Three-phase
1P	3P	1P+N	3P+N	2P	4P	1P+N	3P+N
Diagram							

4. Typical solutions for the combined application of surge protection and backup circuit breakers

(1) Solution 1: SPD+backup protection device. In this solution, the SPD and backup protective device are two independent devices. The selection and coordination of the devices should be based on the verification or recommended combination solution of the manufacturer (see the following table).

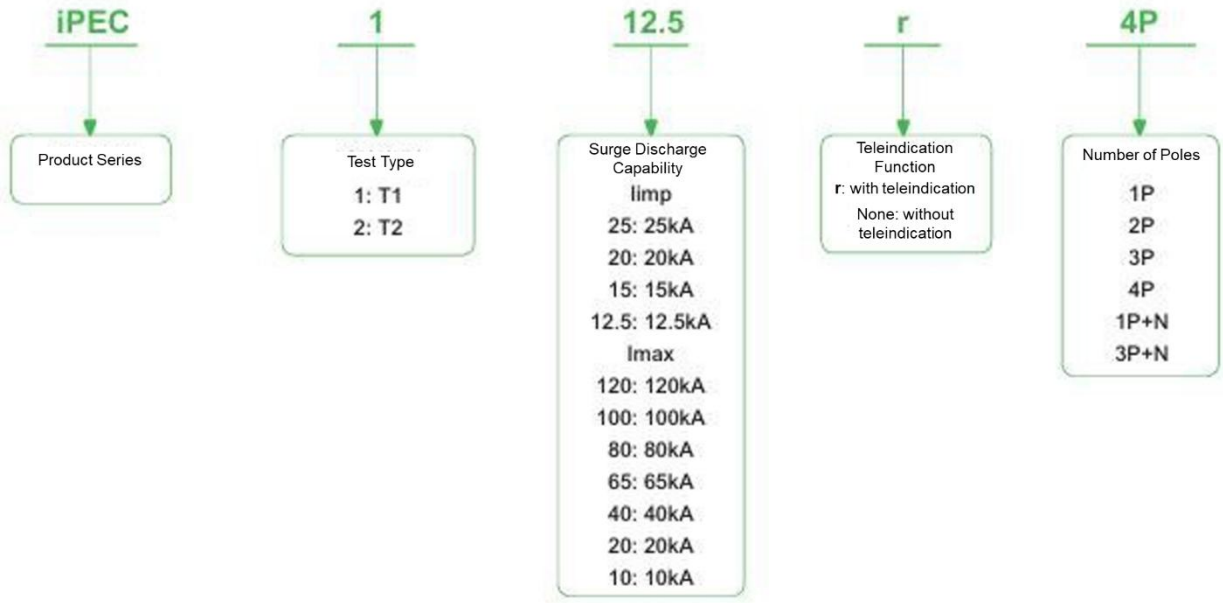
Table 23



(a) A backup protection device for the SPD shall be installed on the SPD installation line and should meet the following requirements:

- It can withstand the impulse current (Iimp/In) passing through the SPD without maloperation.
- When the SPD is deteriorated or short-circuited, the fault current can be quickly cut off.
- The backup protection device shall be a circuit breaker that matches the SPD or is certified by the manufacturer. Do not use a protection device that has not been verified to work with the SPD.
- The backup protective device for the SPD shall effectively protect each pole, and the number of poles shall be consistent with that of the SPD. For example, a 3P+N SPD should be equipped with a 4P protection device to ensure that faults at each pole can be reliably rectified.

(2) Solution 2: Schneider iPEC series SPDs. The surge protector and backup protection switch are designed and manufactured as a whole, which features better protection, more convenience, smaller size, and higher cost-effectiveness. The following figure shows the selection method.



Appendix F Rated Current Conversion for AC Busways Used in DC Power Distribution

(Informative)

1. Based on the principle of constant thermal effect (AC dissipation power Pac = DC dissipation power Pdc), when a standard 3Ø-4W AC busway is used as a DC busway, the DC carried by a single conductor is calculated using the following formula:

∵ Power dissipated in the form of heat energy in AC mode: $Pac = 3 \times R \times Iac^2$

Power dissipated by four conductors in DC mode: $Pdc = 4 \times R \times Idc^2$

- R = Conductor resistance (The impact of skin effect is not considered here.)
- Iac = Effective current of the conductor
- Idc = DC current

∴ When a normal 3Ø-4W AC busway is used as a DC busway, the current carried by each conductor is:

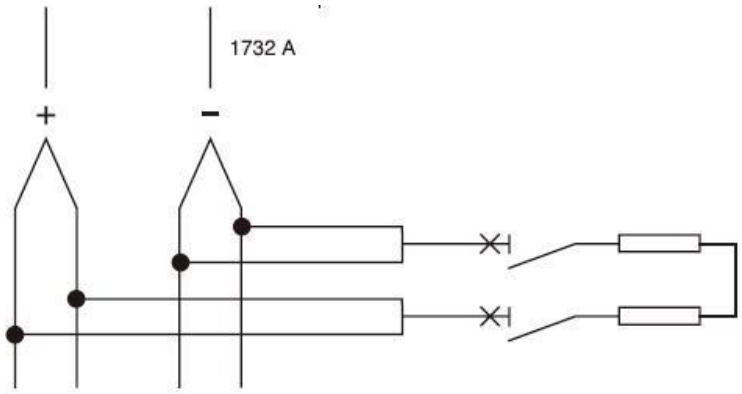
$$Idc = (\sqrt{3}/2) \times Iac$$

2. Single power supply:

Two conductors are connected in parallel for the positive pole, and two conductors are connected in parallel for the negative pole. The total rated current of the DC busway is calculated as follows:

For example, for a 1000 A AC busway with four busbars, the four-pole busway has four busbars. Two busbars are connected in parallel as the positive pole, and the other two busbars are connected in parallel as the negative pole.

$$Idc = 2 \times (\sqrt{3}/2) \times Iac = \sqrt{3} \times 1000 = 1732\ A$$

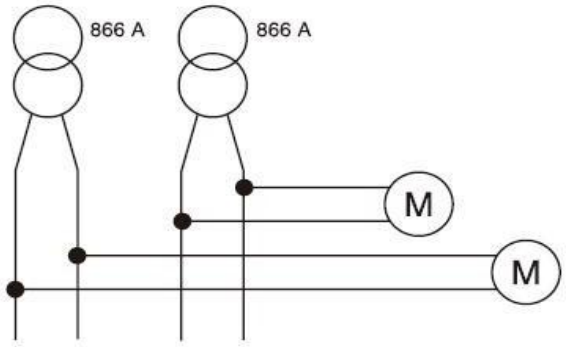


3. Dual power supplies:

One conductor is used for the positive pole and one conductor is used for the negative pole. Two independent DC circuits are implemented in the same busway. The rated current of each circuit is calculated as follows:

For example, if a 1000 A AC busway with four parallel busbars has two circuits, the DC of each circuit is calculated as follows:

$$Idc = (\sqrt{3}/2) \times Iac = (\sqrt{3}/2) \times 1000 = 866\ A$$



4. Selection table for 4-pole AC/DC busways:

Table 24

Rated Current of AC Busways (A)	Rated DC of Single Power Supply (A)	Rated DC of Single Circuits of Dual Power Supplies (A)
250	433	217
400	693	346
630	1091	546
800	1386	693
1000	1732	866
1250	2165	1082
1350	2338	1169
1600	2771	1385
2000	3464	1732
2500	4330	2165
3200	5542	2771
4000	6928	3464
5000	8660	4330
6300	10911	5456

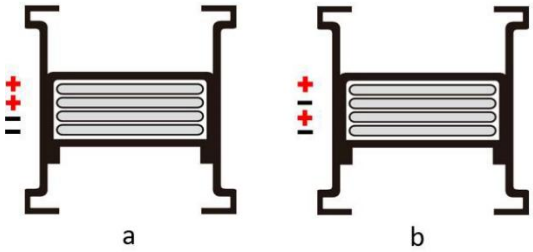
Appendix G Short-Circuit Fault Current Conversion for AC Busways Used in DC Power Distribution

(Informative)

1. Conversion of short-circuit fault current when the AC busways are used for DC power distribution

(a) Table 25 lists the rated values for the three-phase four-wire system and the equivalent two-conductor circuit (two-pole) operation mode.

(b) The preceding short-circuit currents are based on the three-phase four-wire busways arranged in the polarity mode shown in Figure a. When the recommended polarity arrangement shown in Figure b is used, the temperature rise can be reduced and the short-circuit bearing capacity can be improved.



Common modes of arranging positive and negative poles of DC busways

(c) For a DC system, the equivalent electrodynamic force is generated only when the DC fault current reaches the peak current corresponding to the effective value of the AC symmetrical short-circuit current.

(d) The peak factor of the short-circuit current is determined by the X/R (ratio of inductive reactance to resistance) of the system. When the X/R ratio is low, the DC offset component is small. The short-circuit current can be considered as the superposition of the AC component and the attenuated DC component. The peak value is generally ($\sqrt{2}$ + Δ) times the effective value, usually ranging from 1.4 to 1.6 times. In engineering calculation, to simplify calculation and introduce a safety margin, the peak short-circuit current can be taken as not less than 1.5 times the effective value.

Table 25

Nameplate Rating (A)		Maximum Symmetrical Fault Current (kA, RMS)	Maximum DC Busway Fault Current (kA)
3Ø-4W	2-Pole		
800	1380	50	75
1000	1730	50	75
1200	2075	50	75
1350	2330	50	75
1600	2760	65	98
2000	3460	80	120
2500	4320	100	150
3200	5540	120	180
4000	6920	150	225

Appendix H DC Busway Voltage Drop Calculation

(Informative)

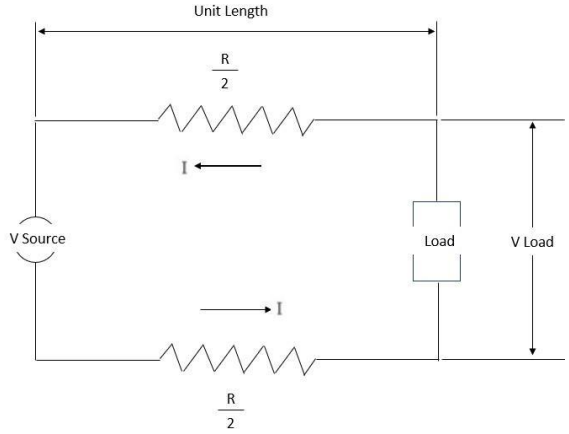
The voltage drop of the DC busway needs to be calculated for both the **forward (positive)** and **return (negative)** circuits. The total voltage drop is calculated as follows:

$$VDrop = I \times R$$

- **I** is the DC operating current.
- **R** is the total resistance per unit length of the busway (including the positive and negative poles). You can use the actual AC resistance value (**R20**) measured by the manufacturer or calculate the resistance based on the copper conductor resistivity (ρ20 = 0.0172 Ω · mm2/m).

Example:

For a DC busbar, if the 3Ø-4W busway has only one power supply, L1 and L2 are connected in parallel as the positive pole, and L3 and N are connected in parallel as the negative pole. In this case, the conductor area of each path is doubled. This reduces the resistance per unit length to half of the released value, as shown in the following figure.



According to the Kirchhoff's voltage law (KVL):

$$(I \times R/2) + (I \times R/2) + VLoad - Vsource = 0$$

Therefore, the DC voltage drop is

$$VDrop = Vsource - VLoad = (I \times R/2) + (I \times R/2) = IR$$

R – The **R20** value in the sample of the busway manufacturer can be optionally used for estimation.

Example: The following table lists the resistance parameters of the Schneider I-LIINE H series.

Table 26

Rated Current		A	400	630	800	1000	1250	1600	2000	2500	3200	4000	5000	6300
Rated Operating Voltage		V	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Rated Current		A	400	630	800	1000	1250	1600	2000	2500	3200	4000	5000	6300
Rated Insulation Voltage		V	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Frequency		Hz	50	50	50	50	50	50	50	50	50	50	50	50
Enclosure IP Rating		IP66/65/55/54												
Rated Transient Withstand Current (Icw)		kA	30	30	30	50	50	80	80	80	120	120	120	150
Rated Peak Short-Circuit Current (Ipk)		kA	63	63	63	105	105	176	176	176	264	264	264	330
Conductor Resistance														
Resistor (R20)		mΩ/m	0.130	0.098	0.076	0.063	0.044	0.034	0.027	0.020	0.015	0.013	0.009	0.008

Method 1: Use the measured value R20 in the sample provided by the busway manufacturer to calculate the voltage drop per meter of the 1000 A busway.

VDrop = (1000 × 0.063/2 × 10^{-3}) + (1000 × 0.063/2 × 10^{-3}) = 0.063 V

Note: The values in Table 2 are the measured R20 values using AC power. This calculation result is affected by the **skin effect and proximity effect**.

Method 2: Calculate the voltage drop per unit length of 1 meter of the 1000 A busway based on the known actual resistivity ρ_{20} of the copper conductor in the busway.

Assume that ρ_{20} = 0.0172 Ω · mm2/m, R20 = ρ_{20} × L / S, S = 272 mm2 (the cross-sectional area of a single copper bar is known),

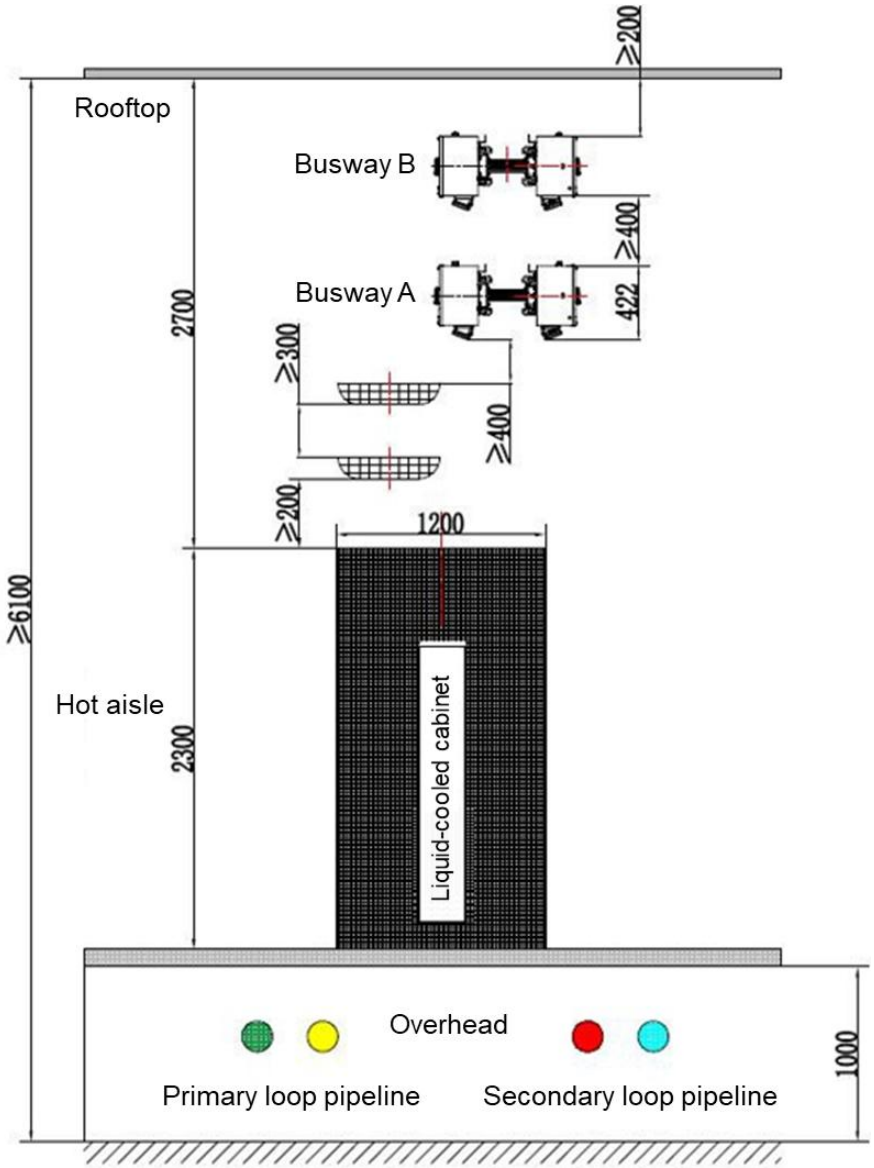
VDrop = 1000 × (0.0172/(272 × 2)) + 1000 × (0.0172/(272 × 2)) ≈ 0.0632 V

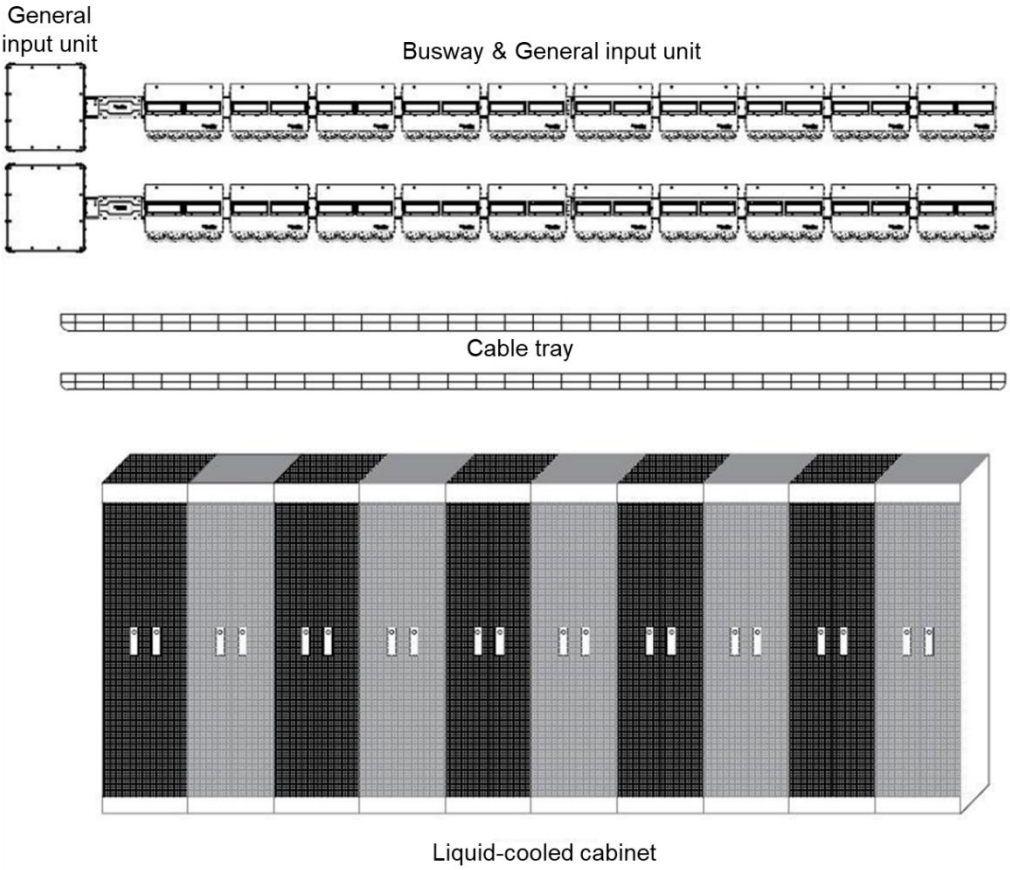
Note: The value is almost the same as that calculated in example a. The reason why the forward and return paths are calculated separately in the preceding formula is to help you understand the essence of the DC voltage drop of the busway.

Appendix I Typical Installation of Busways Above the Cabinet

■ **Schneider I-LINE H dense large busway (2N power distribution architecture)**

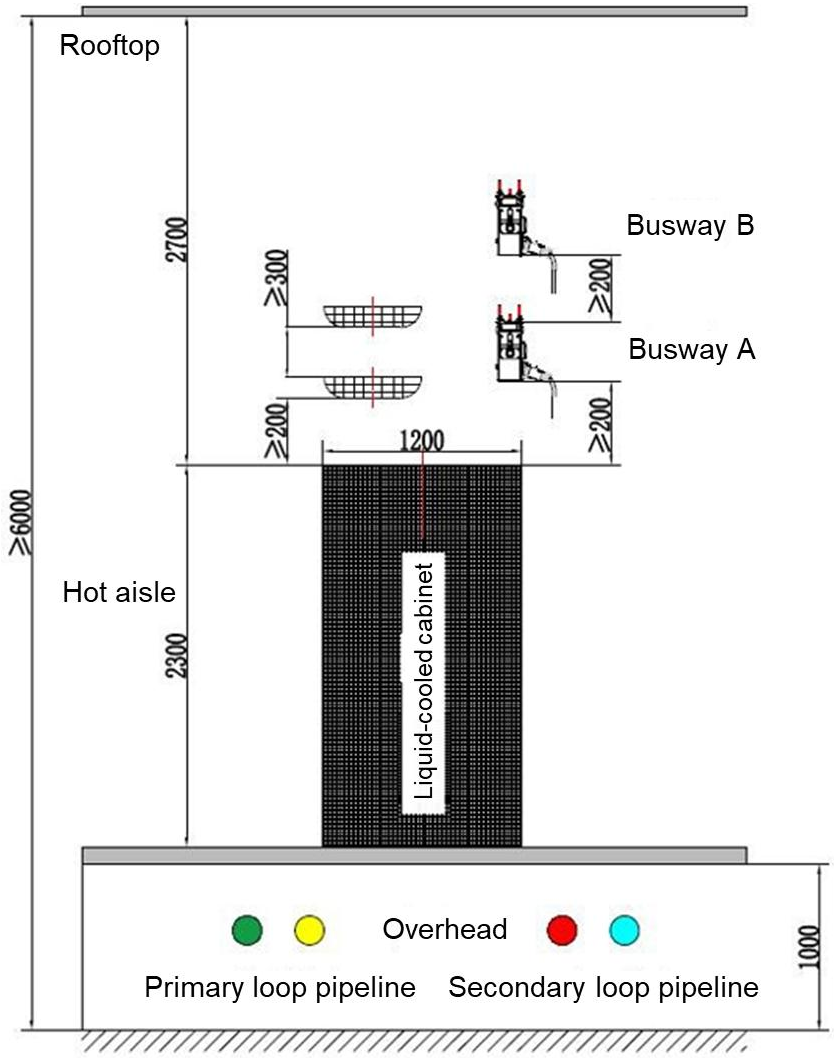
Figure 15

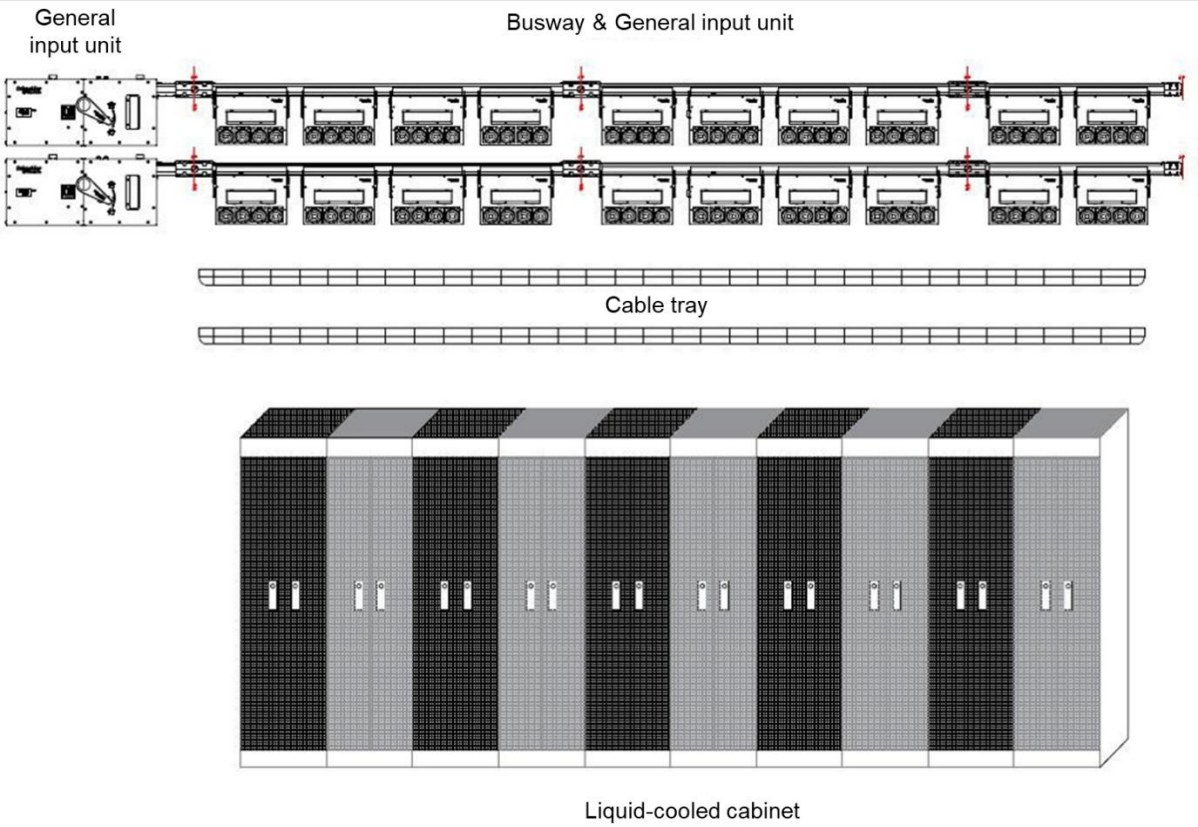



General
input unit
Busway & General input unit
Cable tray
Liquid-cooled cabinet

■ **Schneider I-LINE TRACK miniature busway (2N power distribution architecture)**

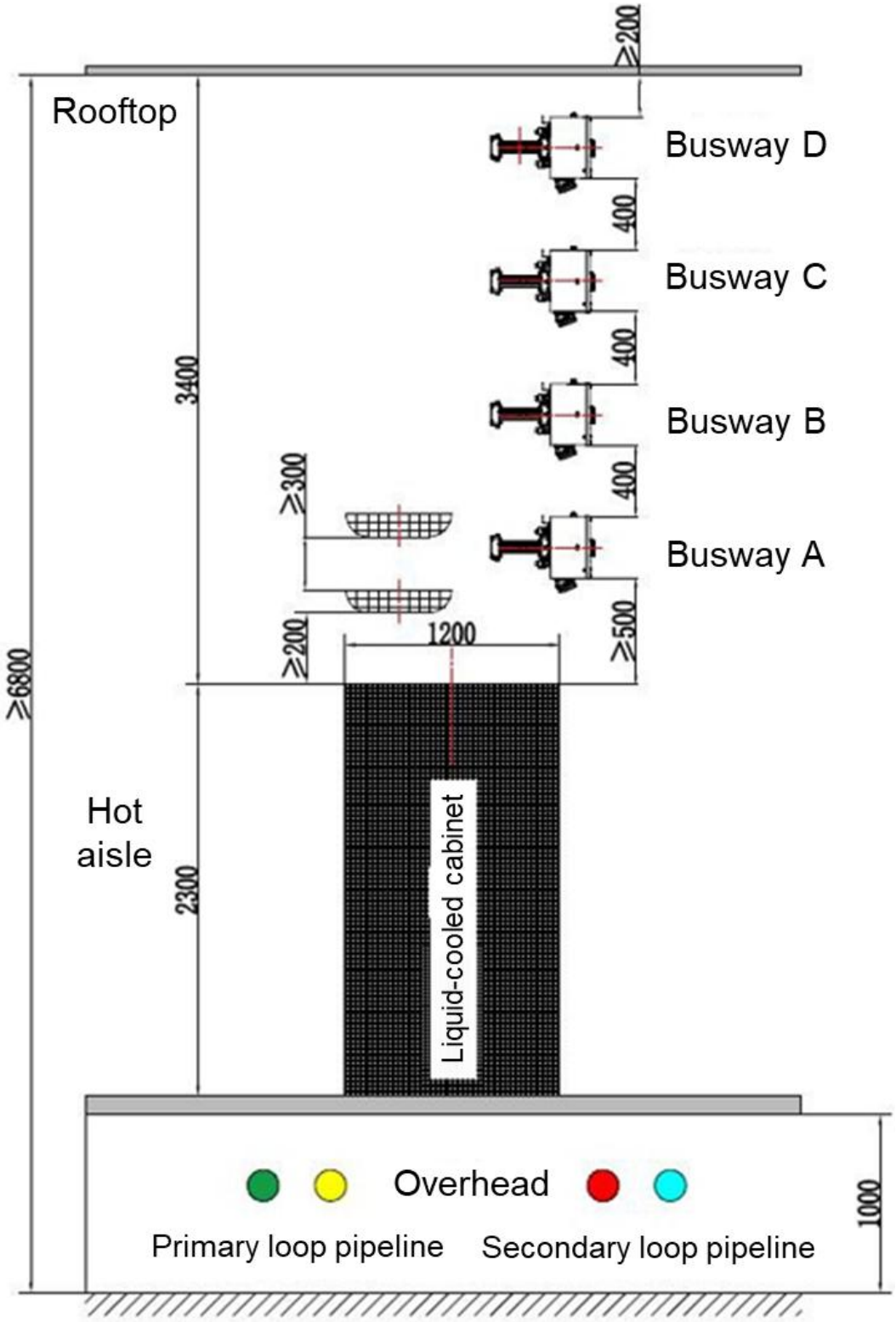
Figure 16

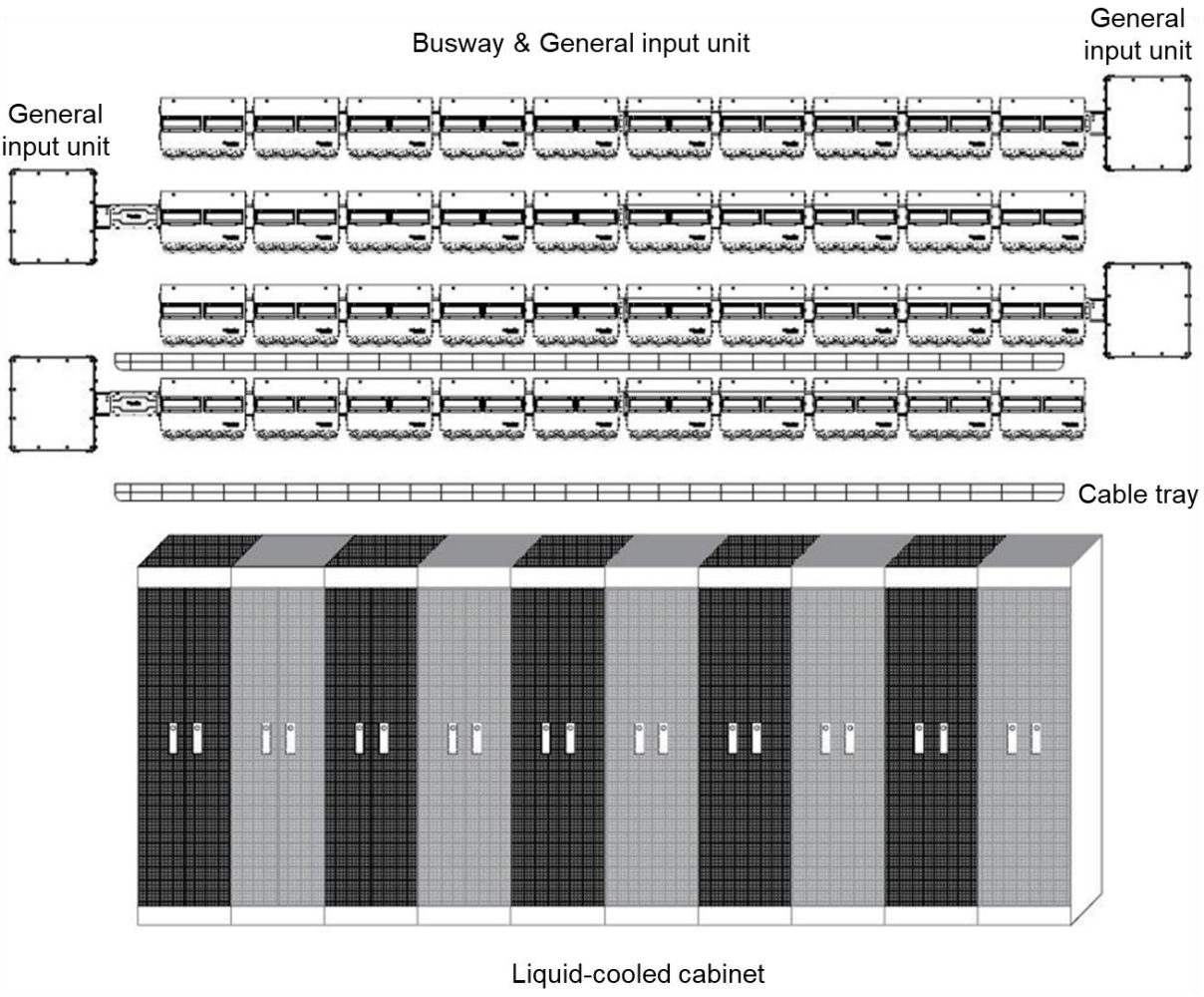



General input unit
Busway & General input unit
Cable tray
Liquid-cooled cabinet

- **Schneider I-LINE H dense large busway (DR: 3+1 power distribution architecture, suspended ceiling solution A)**

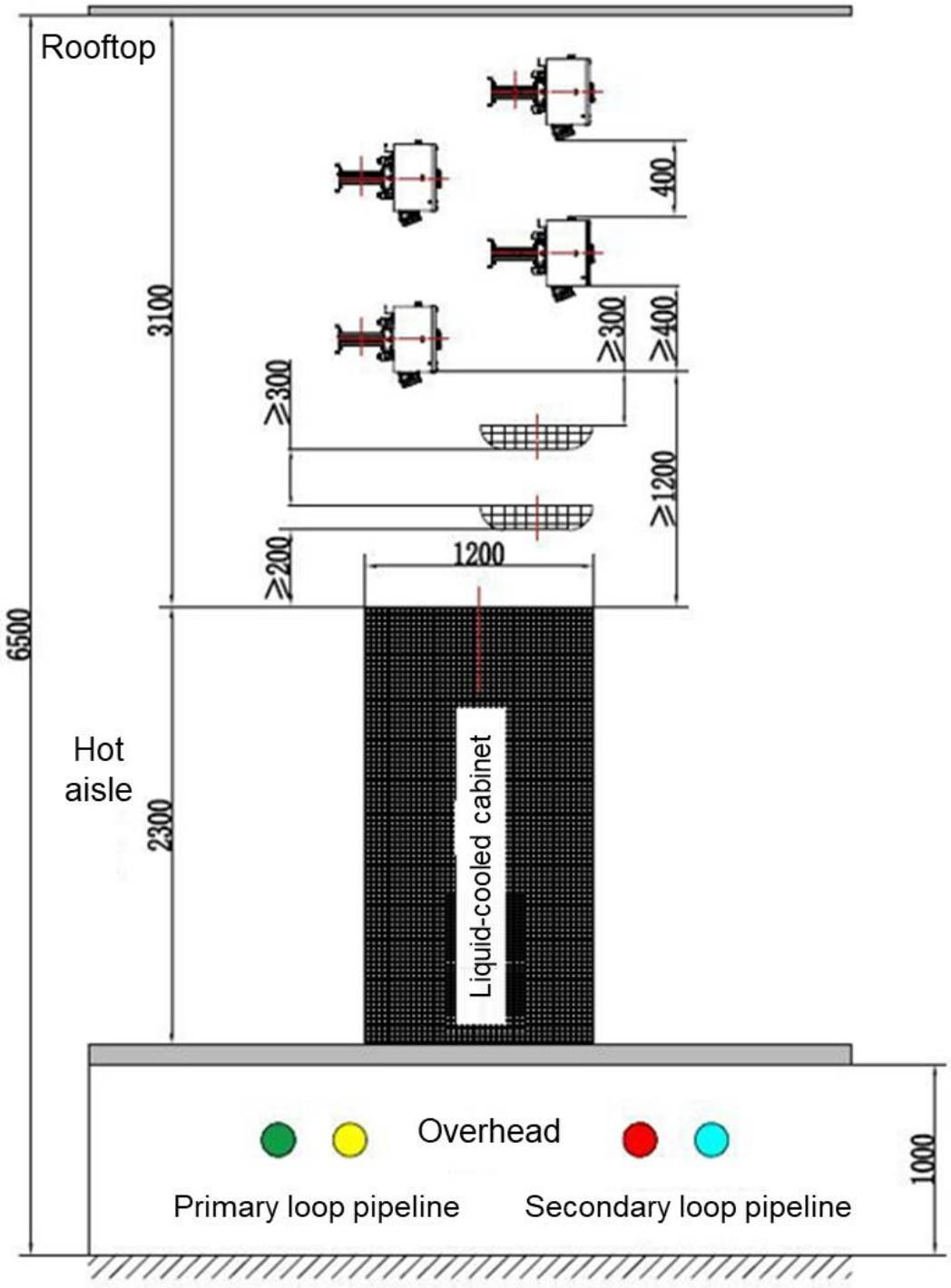
Figure 17

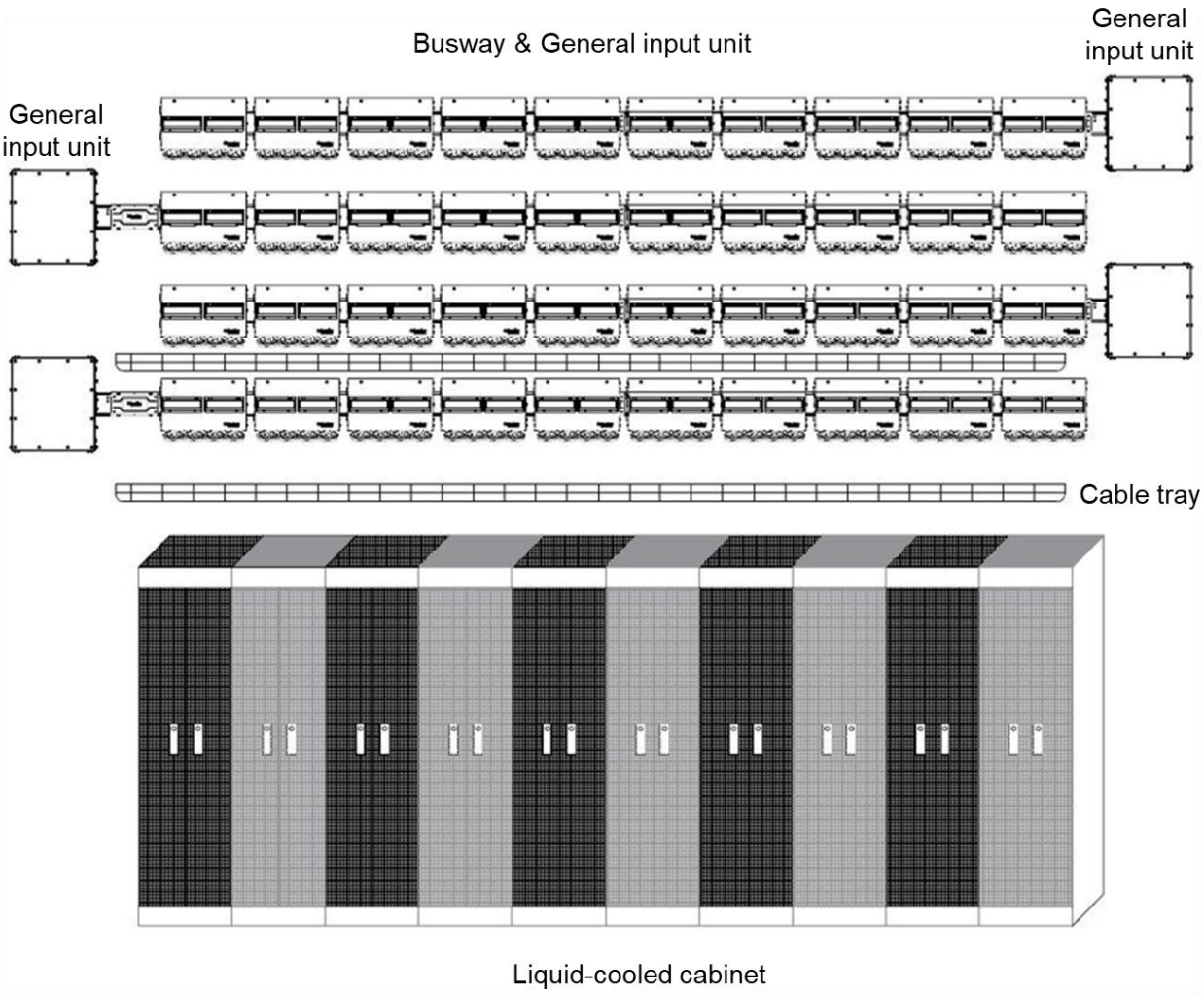



Busway & General input unit
General input unit
General input unit
Cable tray
Liquid-cooled cabinet

- **Schneider I-LINE H dense large busway (DR: 3+1 power distribution architecture, suspended ceiling solution B)**

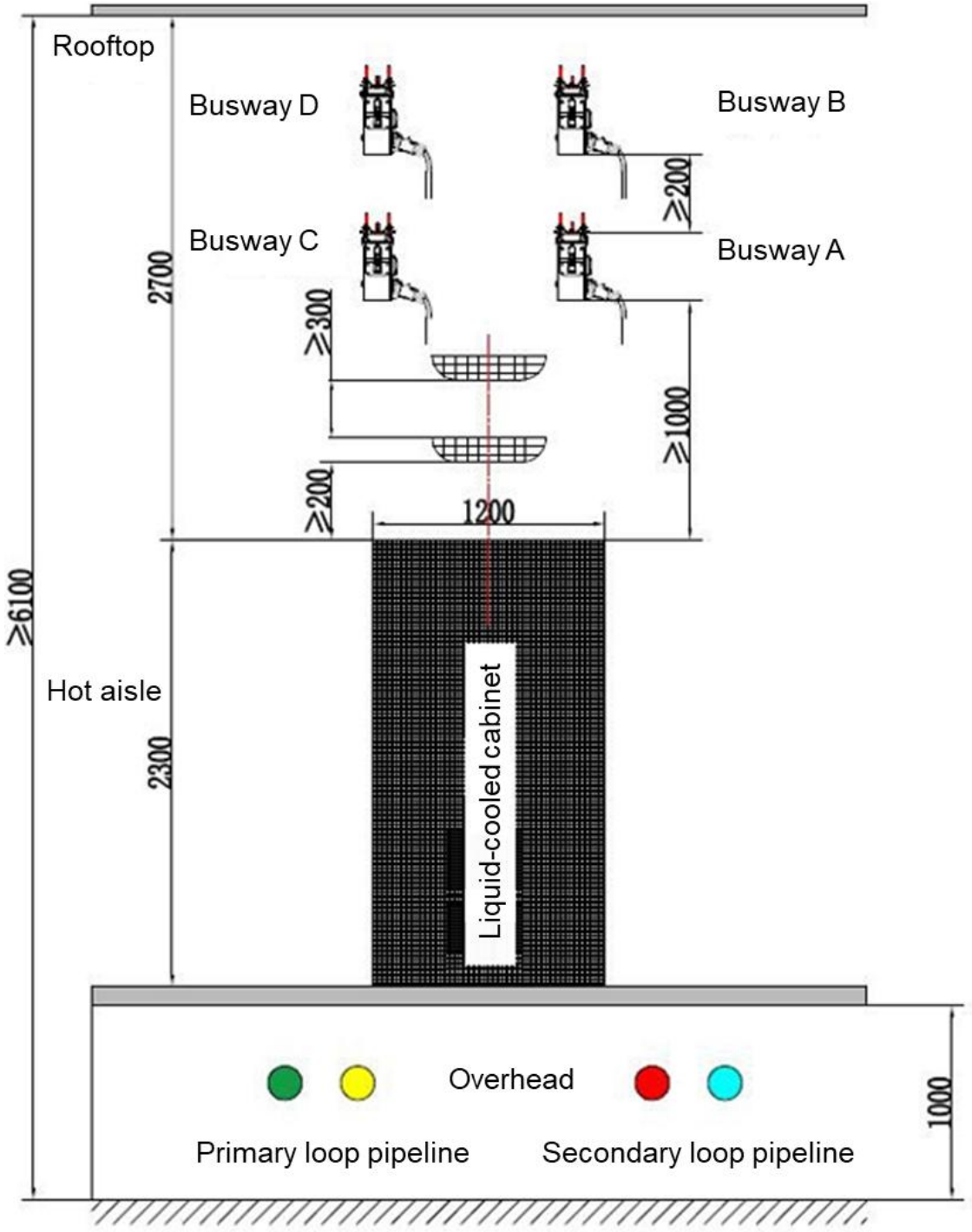
Figure 18

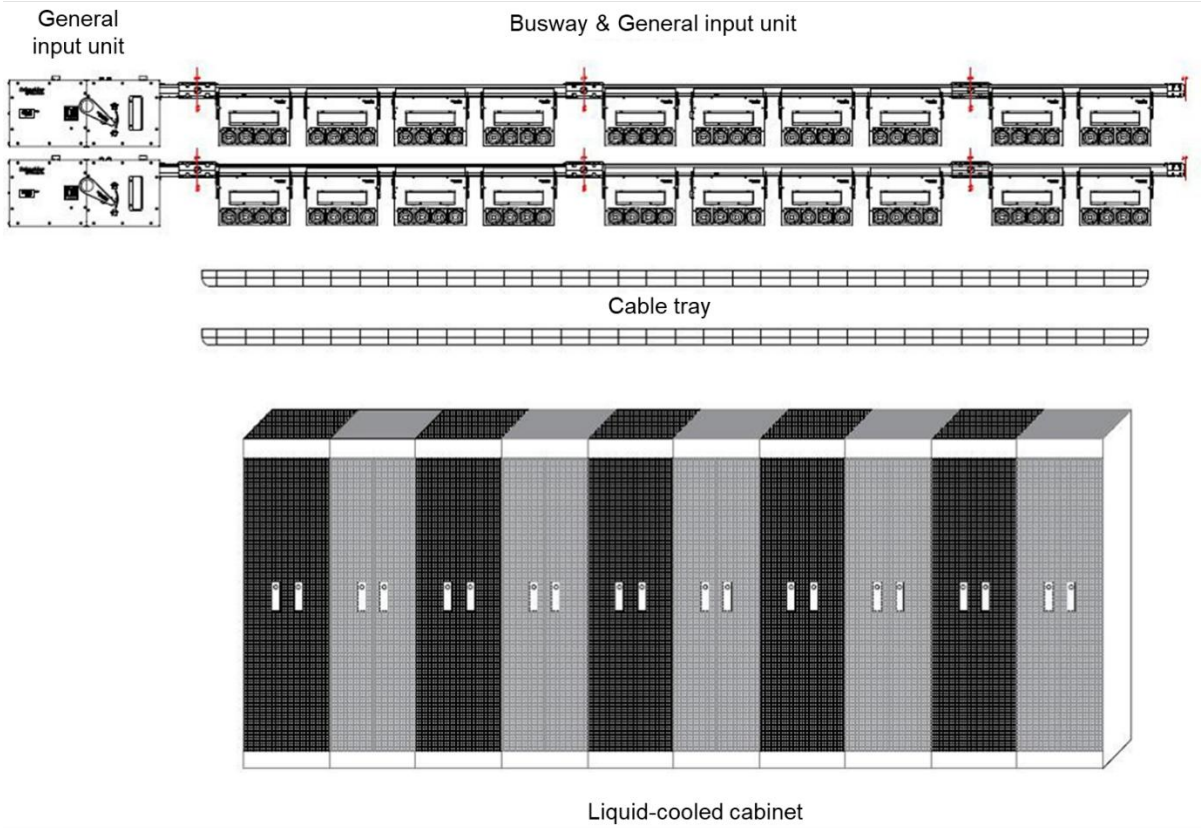



Busway & General input unit
General input unit
General input unit
Cable tray
Liquid-cooled cabinet

- **Schneider I-LINE TRACK miniature busway (DR: 3+1 power distribution architecture, suspended ceiling solution A)**

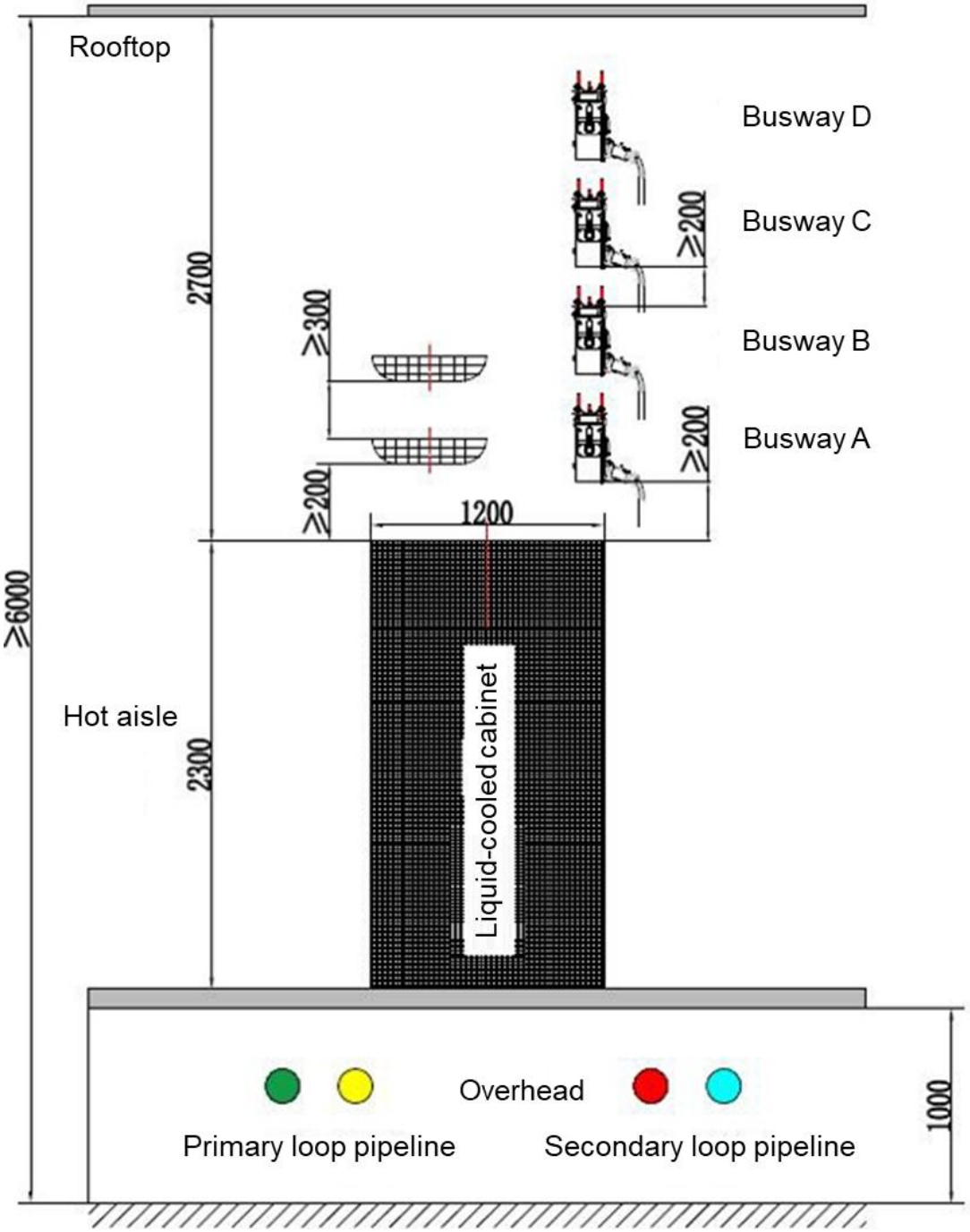
Figure 19

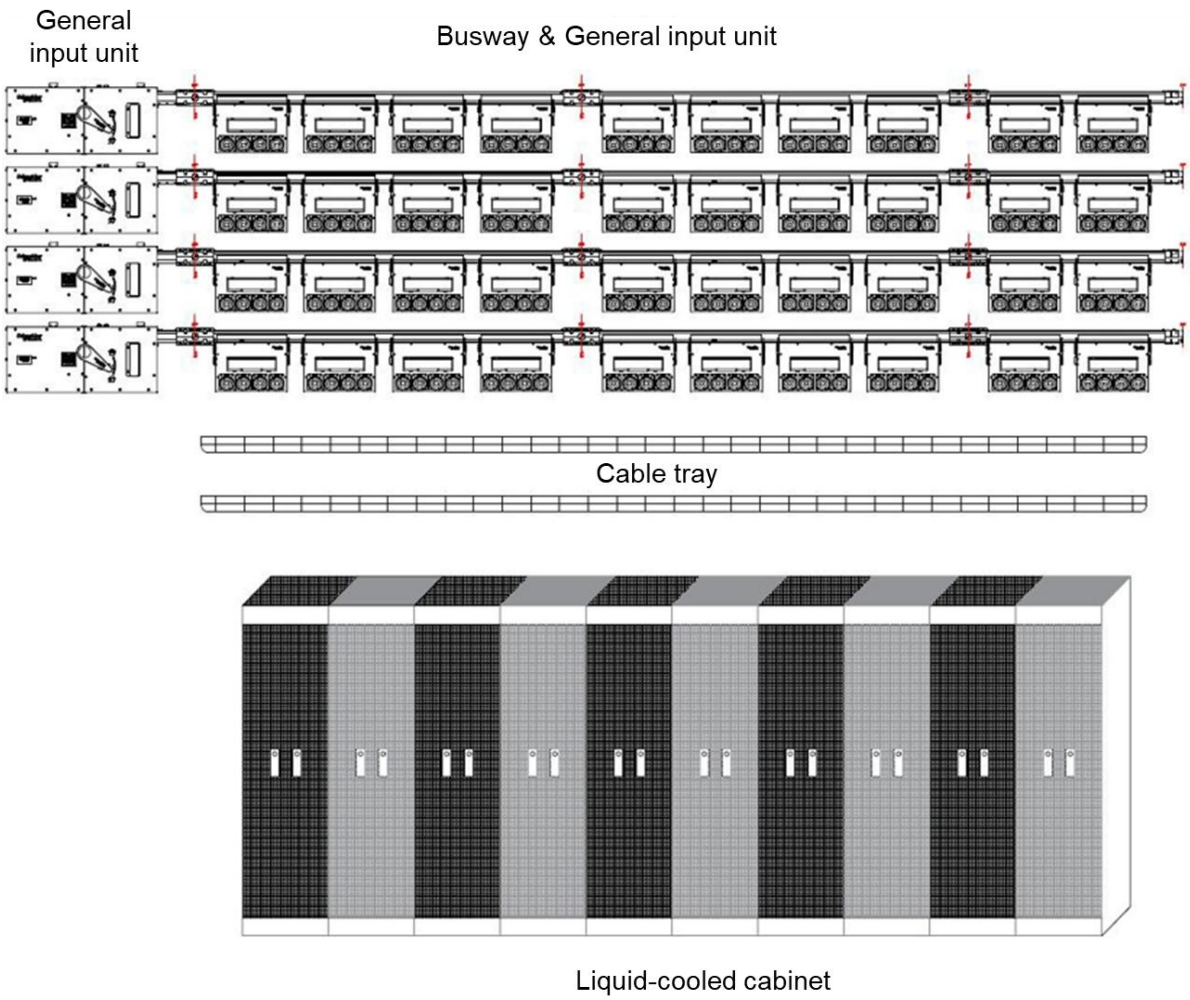



General
input unit
Busway & General input unit
Cable tray
Liquid-cooled cabinet

- **Schneider I-LINE TRACK miniature busway (DR: 3+1 power distribution architecture, suspended ceiling solution B)**

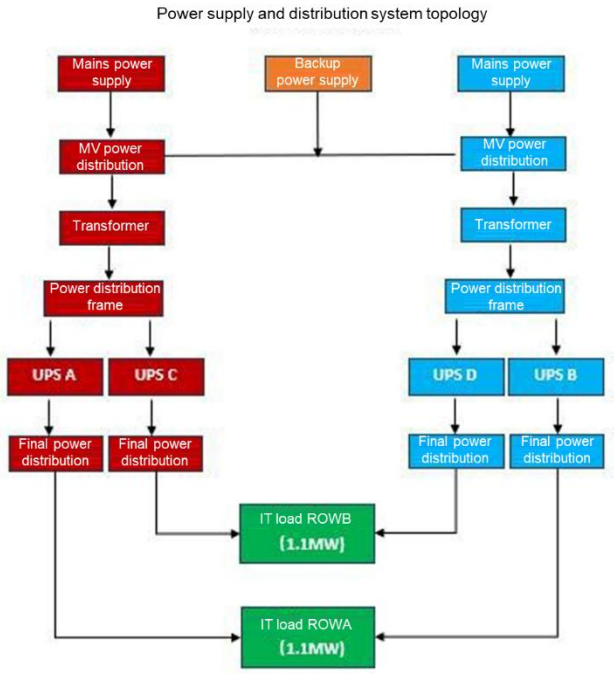
Figure 20




General input unit
Busway & General input unit
Cable tray
Liquid-cooled cabinet

Appendix J Reference Design for 2N Redundant Power Distribution in the Micro-Module

1. 2N RPP power distribution solution



In this reference design, IT loads are powered by two independent 2.5 MVA power supply links, forming a 2N redundant power supply architecture. In normal working conditions, the two sets of RPPs in each A1 & A2 row are redundant to each other and each carries about 50% of the load. When either power supply link fails (N-1 working condition), the other power supply link can independently bear all IT loads, ensuring continuous operation of the system. In addition, a diesel generator is configured as the backup power supply to improve the overall power supply reliability.

Each power supply link contains a 2500 kVA transformer, which supplies power to downstream devices through the power distribution cabinet and RPP. Each row of cabinets is configured with two 2500 A RPPs to provide dual power supplies. The maximum load of a single row of modules is about 2220 kW. When a single power supply fails, the load rate of a single transformer is about 93%, which meets the equipment operation requirements. The RPP and its protection devices are designed for high-power-density loads. They can adapt to the deployment of AI servers with a power of about 100 kW per cabinet, meeting the overall power consumption requirements of server cabinets, network devices, and bus devices in the module.

The downstream power distribution uses a hierarchical structure. A single RPP supplies power to loads through the power distribution circuits corresponding to the server cabinet, network cabinet, and bus cabinet. The server cabinet uses the 3+3 dual power supply mode, and each power supply is configured with an 80 A/3P circuit breaker. The network cabinet and bus cabinet use the 1+1 dual power supply mode, and each power supply is configured with a 50 A/3P circuit breaker. Hierarchical protection and proper configuration are implemented to achieve 2N redundancy power supply for IT loads from the power source to the terminal.

2. Micro-module configuration

- Power distribution system: three-phase AC 380 V/50 Hz, cosφ = 0.95

Item	Specifications	Quantity	Remarks
Power supply architecture	2N dual independent redundancy		RPP solution, with A and B completely independent
Transformer apparent power	2500 kVA	2	A total of 2 (in 1+1 redundancy mode)
Server cabinet	100 kW	20	Two rows of cabinets, 10 cabinets per row
Network cabinet	20 kW	5	One network cabinet for every four server cabinets
Bus cabinet	24 kW	5	One bus cabinet for every four server cabinets
Cable inlet for a single server cabinet	6 circuits (3+3)	-	Three active and three standby power shelves for cable inlet circuit.

3. Transformer configuration and capacity calculation

■ Total load power of the micro-module

Load Type	Quantity	Single-Unit Power	Subtotal Power
Server cabinet	20	100 kW	2000 kW
Network cabinet	5	20 kW	100 kW
Bus cabinet	5	24 kW	120 kW
Total load power of the module (P)	—	—	2200 kW

■ **Load rate calculation for a single transformer**

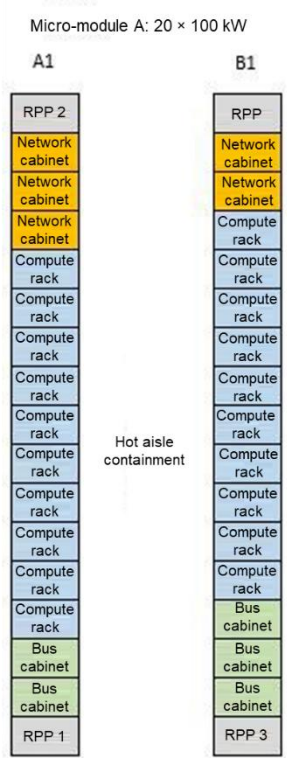
Assume that a single transformer carries the full load of 2200 kW in the case of a single circuit failure.

$$\text{Load rate} = \frac{P}{Sn \; X \cos\varphi} = \frac{2200}{2500 \; X \; 0.95} \approx 93\%$$

4. Calculation of the rated current of an RPP

4.1. The micro-module consists of 20 server cabinets, five network cabinets, and five bus cabinets, which are arranged in two rows: A1 and A2.

Operating Condition	Operation Description
Normal operation	The two sets of RPPs in rows A1 and A2 each bear 50% of the load.
Fault condition of either busbar	If either of the two sets of RPPs in row A1 and A2 is out of service, the other set carries the full load.



A1: 10 server cabinets
2 network cabinets
3 bus cabinets
RPP: 2 × 2500 A

A2: 10 server cabinets
3 network cabinets
2 bus cabinets
RPP: 2 × 2500 A

■ Load calculation table for row A1 (when the RPP A or B is faulty):

Step	Calculation Item	Calculation Formula	Calculation Process	Result
1	Total load power	$P_1 = P_{Server\ cabinet} + P_{Network\ cabinet} + P_{Bus\ cabinet}$	$P_1 = 10 \times 100 + 3 \times 20 + 2 \times 24$	$P_1 = 1108$ kW
2	Maximum operating current	$I_1 = P_1 \times 1000/(\sqrt{3} \times Ue \times \cos\varphi)$	$I_1 = 1108 \times 10^3/(\sqrt{3} \times 380 \times 0.95)$	$I_1 \approx 1772$ A
3	Safe current	$I_{Safe} = I_1 \times 1.25$	$I_{Safe} = 1772 \times 1.25$	$I_{Safe} = 2215$ A

■ Load calculation table for row A2 (when the RPP C or D is faulty):

Step	Calculation Item	Calculation Formula	Calculation Process	Result
1	Total load power	$P_2 = P_{Server\ cabinet} + P_{Network\ cabinet} + P_{Bus\ cabinet}$	$P_2 = 10 \times 100 + 2 \times 20 + 3 \times 24$	$P_2 = 1112$ kW
2	Maximum operating current	$I_2 = P_2 \times 1000/(\sqrt{3} \times Ue \times \cos\varphi)$	$I_2 = 1112 \times 10^3/(\sqrt{3} \times 380 \times 0.95)$	$I_2 \approx 1778$ A
3	Safe redundant current	$I_{Safe} = I_2 \times 1.25$	$I_{Safe} = 1778 \times 1.25$	$I_{Safe} = 2223$ A

5. RPP and main circuit breaker selection

5.1. Model selection

If either circuit A or B is faulty and the other circuit is fully loaded, the current level of the RPP is determined by the fault current limit multiplied by 1.25.

Item	A1	A2
Maximum operating current	1772 A	1778 A
1.25 times safe redundant current	2215 A	2223 A
RPP rated current	2500 A	2500 A
Main circuit breaker selection	2500 A/3P ACB circuit breaker	2500 A/3P ACB circuit breaker
Current setting	Ir = 2200	Ir = 2200

5.2. Basic RPP Configuration

Item	RPP Technical Specifications
Rated insulation voltage	1000 V
Rated frequency	50 Hz
Rated current	2500 A
IP rating	IP30
Structure	Front-mounted circuit breaker with top cable inlet
Circuit configuration	Circuit with rear outlet and forced air cooling, meeting the 3+3 dual power supply requirements of server cabinets

6. RPP power distribution

6.1. Server cabinet power distribution

- Calculation of the rated current of the circuit breaker for the server cabinet

Item	Calculated Value	Note
Total power of a single-row server cabinet	1000 kW	10 × 100 kW
Maximum power supported by a single RPP	1000 kW	Either circuit A or B is faulty.
Number of circuits in a single RPP	30 circuits	10 cabinets × 3 circuits
Power per circuit	1000 ÷ 30 ≈ 33.33 kW	Maximum power supported by a single RPP/Number of circuits
Calculated current for a single faulty circuit	≈ 53.3 A	$I = 33.33 \times 10^3/\sqrt{3} \times 380 \times 0.95$
× 1.25 safety factor	53.3 × 1.25 = 66.6 A	
Switch selection	80 A/3P	Consider the derating due to

		ambient temperature.

■ Circuit configuration for the server cabinet RPP

No.	Circuit No.	Number of Circuits	Power Supply RPP	Server Cabinet No.	Circuit Breaker Specifications and Quantity
1	A1-AP-01~10	30	RPP A	A1 rows 1–10	3 × 80 A/3P
2	A1-BP-01~10	30	RPP B	A1 rows 1–10	3 × 80 A/3P
3	A2-CP-01~10	30	RPP C	A2 rows 1–10	3 × 80 A/3P
4	A2-DP-01~10	30	RPP D	A2 rows 1–10	3 × 80 A/3P

6.2. Network cabinet and bus cabinet power distribution

■ Rated current calculation for circuit breakers of the network cabinet and bus cabinet in the RPP

No.	Item	Network cabinet	Bus cabinet	Note
1	Rated power per device	20 kW	24 kW	
2	Rated operating current	≈ 32 A	≈ 38 A	
3	1.25 times the safe redundant current	≈ 40 A	≈ 48 A	
4	Recommended circuit breaker selection	50 A/3P	50 A/3P	Consider the derating due to ambient temperature.

■ Circuit configurations for the network cabinet and bus cabinet

No.	Item	A1	A2	Total	Unit	Remarks
1	Number of network cabinets	3	2	5	Cabinet	Rated power of a single unit: 20 kW
2	Number of bus cabinets	2	3	5	Cabinet	Rated power of a single unit: 24 kW
3	Total number of cabinets	5	5	10	Cabinet	
4	Total number of circuits	5+5	5+5	20	Circuit	Sharing the same RPP with the IT circuits

7. List of key devices

Device Name	Specifications	Model selection
RPP	2500 A	Calculate based on Section 5.1.
Cable inlet switch of the RPP general input unit	2500 A/3P ACB	Full load in fault conditions

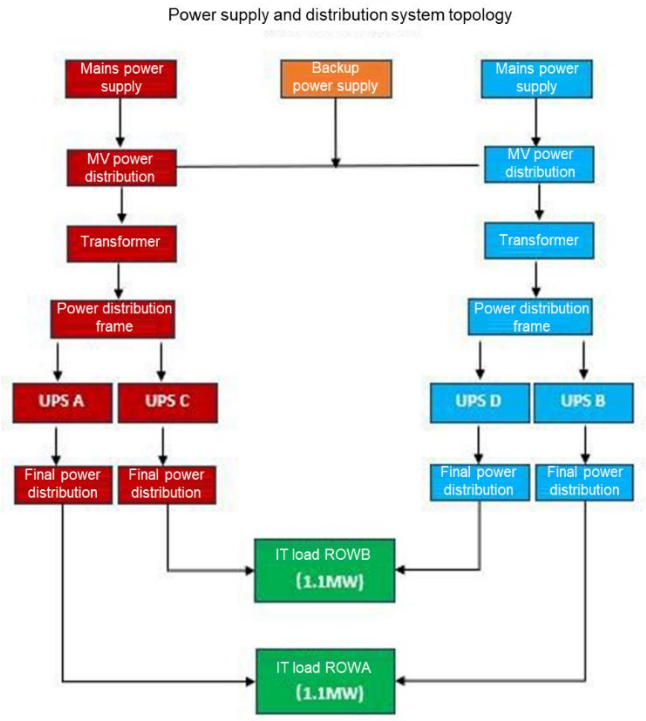
Device Name	Specifications	Model selection
Branch outlet switch of the server cabinet	80 A/3P	Calculate based on Section 6.1.1.
Branch cable outlet switch of the network cabinet	50 A/3P	Calculate based on Section 6.2.1.
Branch cable outlet switch of the bus cabinet	50 A/3P	Calculate based on Section 6.2.1.
Power distribution cables for the server cabinet	3 × 25 mm²	Meet the current-carrying capacity of a single circuit.
Power distribution cables of the network and bus cabinets	3 × 16 mm²	Meet the current-carrying capacity of a single circuit.
Industrial socket-outlet (optional)	63 A (3P+N+PE)	Meet the current-carrying capacity of a single circuit.

8. Design summary

The micro-module uses the 2N dual independent RPP cabinet redundancy architecture. The total calculated load of the micro-module is 2200 kW, including 20 server cabinets, five network cabinets, and five bus cabinets. The calculation is performed completely based on the N-1 fault conditions, and the safety factor of 1.25 is uniformly used. The system runs at 50% load in normal conditions and is redundant and reliable in fault conditions.

Appendix K Reference Design for 2N Busway Redundant Power Distribution in the Micro-Module

1. 2N busway power distribution solution



In this reference design, IT loads are powered by two independent 2.5 MVA power supply links, forming a 2N redundant power supply architecture. In normal working conditions, the two sets of busway power supply circuits corresponding to rows A1 and A2 are redundant to each other and each carry about 50% of the load. When either power supply link fails (N-1 working condition), the other power supply link can independently carry all IT loads, ensuring continuous operation of the system. In addition, a diesel generator is configured as the backup power supply to improve the overall power supply reliability.

Each power supply link contains a 2500 kVA transformer, which distributes power to downstream devices through the power distribution cabinet and busway system. Each row of cabinets is connected to two busways to implement dual power supplies. The maximum load of a single row of modules is about 2220 kW. When a single power supply fails, the load rate of the corresponding power supply link is about 93%, which meets the equipment operation requirements. The busway system and auxiliary protection devices are designed for high-power-density loads. They can adapt to the deployment of AI servers with a power of about 100 kW per cabinet, meeting the overall power consumption requirements of server cabinets, network devices, and bus devices in the module.

The downstream power distribution uses a hierarchical structure. The busway supplies power to the server cabinet, network cabinet, and bus cabinet through plug-in boxes. The server cabinet uses the 3+3 dual power supply mode, and each power supply is configured with an 80 A/3P circuit breaker. The network cabinet and bus cabinet use the 1+1 dual power supply mode, and each power supply is configured with a 50 A/3P circuit breaker. Hierarchical protection and proper configuration are implemented to achieve 2N redundancy power supply for IT loads from the power source to the terminal.

2. Micro-module configuration

- Power distribution system: three-phase AC 380 V/50 Hz, cosφ = 0.95

Item	Specifications	Quantity	Remarks
Power supply architecture	2N dual independent redundancy		Busway solution, with A and B completely independent
Transformer apparent power	2500 kVA	2	2 (in 1+1 redundancy mode)
Server cabinet	100 kW	20	Two rows of cabinets, 10 cabinets per row
Network cabinet	20 kW	5	One network cabinet for every four server cabinets
Bus cabinet	24 kW	5	One bus cabinet for every four server cabinets
Cable inlet for a single	6 circuits (3+3)	-	Three active and three standby power shelves for

Item	Specifications	Quantity	Remarks
server cabinet			cable inlet circuit.

3. Transformer configuration and capacity calculation

■ Total load power of the micro-module

Load Type	Quantity	Single-Unit Power	Subtotal Power
Server cabinet	20	100 kW	2000 kW
Network cabinet	5	20 kW	100 kW
Bus cabinet	5	24 kW	120 kW
Total load power of the module (P)	—	—	2200 kW

■ Load rate calculation for a single transformer

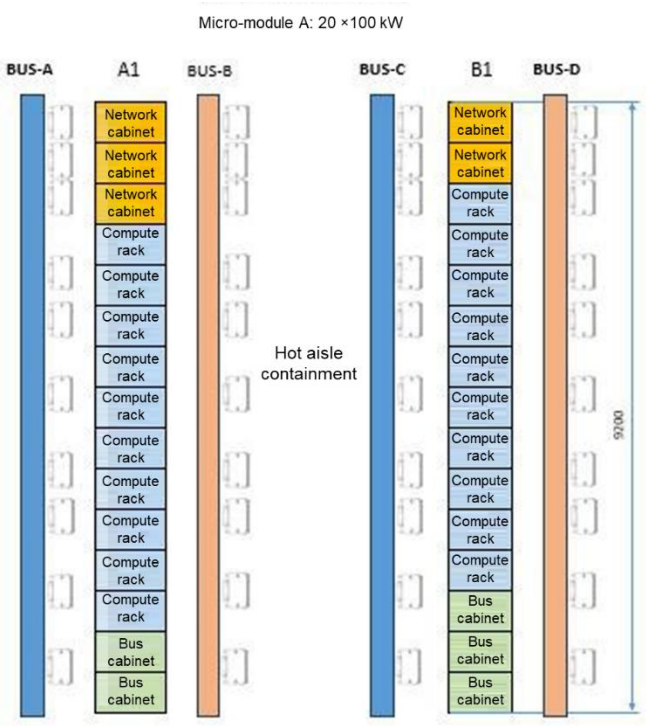
Assume that a single transformer carries the full load of 2200 kW in the case of a single circuit failure.

$$\text{Load rate} = \frac{P}{Sn \times \cos\varphi} = \frac{2200}{2500 \times 0.95} \approx 93\%$$

4. Busway rated current calculation

4.1. The micro-module consists of 20 server cabinets, five network cabinets, and five bus cabinets, which are arranged in two rows: A1 and A2.

Operating Condition	Operation Description
Normal operation	The two sets of busbars in row A1 & A2 each bear 50% of the load.
Fault condition of either path	If either of the two sets of busbars in row A1 & A2 is out of service, the other set carries the full load.



A1: 10 server cabinets
2 network cabinets
3 bus cabinets
RPP: 2 × 2500 A

A2: 10 server cabinets
3 network cabinets
2 bus cabinets
RPP: 2 × 2500 A

■ Load calculation table for row A1 (when the busway A or B is faulty):

Step	Calculation Item	Calculation Formula	Calculation Process	Result
1	Total load power	$P_1 = P_{Server\ cabinet} + P_{Network\ cabinet} + P_{Bus\ cabinet}$	$P_1 = 10 \times 100 + 3 \times 20 + 2 \times 24$	$P_1 = 1108$ kW
2	Maximum operating current	$I_1 = P_1 \times 1000/(\sqrt{3} \times Ue \times \cos\varphi)$	$I_1 = 1108 \times 10^3/(\sqrt{3} \times 380 \times 0.95)$	$I_1 \approx 1772$ A
3	Safe current	$I_{Safe} = I_1 \times 1.25$	$I_{Safe} = 1772 \times 1.25$	$I_{Safe} = 2215$ A

■ Load calculation table for row A2 (when the busway C or D is faulty):

Step	Calculation Item	Calculation Formula	Calculation Process	Result
1	Total load power	$P_2 = P_{Server\ cabinet} + P_{Network\ cabinet} + P_{Bus\ cabinet}$	$P_2 = 10 \times 100 + 2 \times 20 + 3 \times 24$	$P_2 = 1112$ kW
2	Maximum operating current	$I_2 = P_2 \times 1000/(\sqrt{3} \times Ue \times \cos\varphi)$	$I_2 = 1112 \times 10^3/(\sqrt{3} \times 380 \times 0.95)$	$I_2 \approx 1778$ A
3	Safe redundant current	$I_{Safe} = I_2 \times 1.25$	$I_{Safe} = 1778 \times 1.25$	$I_{Safe} = 2223$ A

5. Busway and main circuit breaker selection

5.1. Model selection

If either circuit A or B is faulty and the other circuit is fully loaded, the bus current level is determined by the fault current limit multiplied by 1.25.

Item	A1	A2
Maximum operating current	1772 A	1778 A
× 1.25 Safe redundant current	2215 A	2223 A
Rated current of the busway	2500 A	2500 A
Main circuit breaker selection	2500 A/3P ACB circuit breaker	2500 A/3P ACB circuit breaker
Current setting	Ir = 2200	Ir = 2200

5.2. Basic configurations of busways

Item	Technical Specifications of Busways
Rated insulation voltage	1000 V
Rated frequency	50 Hz
Rated current	2500 A
IP rating	IP54
Structure	Dense (with drainage holes)
Tap-off unit configuration	IP30 plug-in boxes, meeting the 3+3 dual power supply requirements of server cabinets

6. Branch Unit Power Distribution

6.1. Server cabinet power distribution

- Calculation of the rated current of the circuit breakers in the plug-in boxes of the server cabinet

Item	Calculated Value	Note
Total power of a single-row server cabinet	1000 kW	10 × 100 kW
Maximum power supported by a single busway	1000 kW	Either circuit A or B is faulty.
Number of circuits in a single busway	30 circuits	10 cabinets × 3 circuits
Power per circuit	1000 ÷ 30 ≈ 33.33 kW	Maximum power carried by a single busway/Number of circuits in a single

Item	Calculated Value	Note
		busway
Calculated current for a single faulty circuit	≈ 53.3 A	$I = 33.33 \times 10^3 / \sqrt{3} \times 380 \times 0.95$
× 1.25 safety factor	53.3 × 1.25 = 66.6 A	
Switch selection for the plug-in box	80 A/3P	The circuit breaker capacity needs to be increased to 80 A.

- Configurations of the server cabinet plug-in boxes

No.	Plug-In Box No.	Number of Plug-In Boxes	Power Supply Busbar	Server Cabinet No.	Circuit Breaker Specifications and Quantity
1	A1-AP-01~10	10	Busway A	A1 rows 1–10	3 × 80 A/3P
2	A1-BP-01~10	10	Busway B	A1 rows 1–10	3 × 80 A/3P
3	A2-CP-01~10	10	Busway C	A2 rows 1–10	3 × 80 A/3P
4	A2-DP-01~10	10	Busway D	A2 rows 1–10	3 × 80 A/3P

6.2. Network cabinet and bus cabinet power distribution

- Calculation of the rated current of the circuit breakers for the plug boxes in the network cabinet and bus cabinet

No.	Item	Network cabinet	Bus cabinet
1	Rated power per device	20 kW	24 kW
2	Rated operating current	≈ 32 A	≈ 38 A
3	1.25 times the safe redundant current	≈ 40 A	≈ 48 A
4	Recommended circuit breaker selection	50 A/3P	50 A/3P

- Configurations of the plug-in boxes in the network cabinet and busway cabinet

No.	Item	A1	A2	Total	Unit	Remarks
1	Number of network cabinets	3	2	5	Cabinet	Rated power of a single unit: 20 kW
2	Number of bus cabinets	2	3	5	Cabinet	Rated power of a single unit: 24 kW

No.	Item	A1	A2	Total	Unit	Remarks
3	Total number of cabinets	5	5	10	Cabinet	1+1 active/standby power supply is used.
4	Total number of circuits	5+5	5+5	20	Circuit	Two busway power supplies
5	Network cabinet plug-in box	1+1	1+1	4	Box	3 × 50 A per box in row A1; 2 × 50 A per box in row A2
6	Busway cabinet plug-in box	1+1	1+1	4	Box	2 × 50 A per box in row A1; 3 × 50 A per box in row A2
5	Total number of plug-in boxes	4	4	8	Cabinet	

7. List of key devices

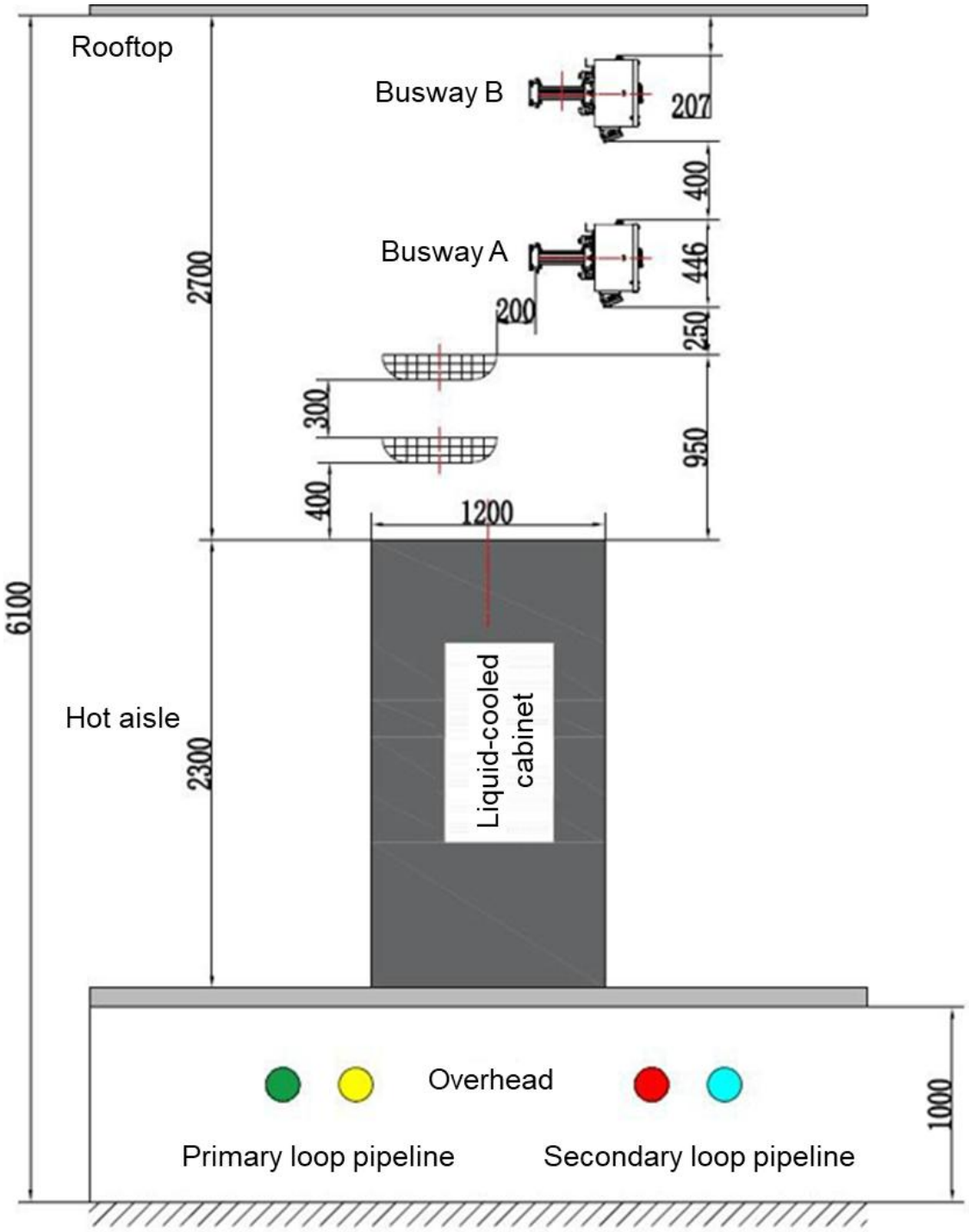
Device Name	Specifications	Model selection
Busway	2500 A	Calculate based on Section 5.1.
General input switch of the busbar	2500 A/3P ACB	Full load in fault conditions
Branch outlet switch of the server cabinet	80 A/3P	Calculate based on Section 6.1.
Branch cable outlet switch of the network and bus cabinets	50 A/3P	Calculate based on Section 6.2.
Power distribution cables for the server cabinet	3 ×25 mm²	Meet the current-carrying capacity of a single circuit.
Power distribution cables of the network and bus cabinets	3 × 16 mm²	Meet the current-carrying capacity of a single circuit.
Industrial socket-outlets (for IT cabinets, network, and bus)	63 A (3P+N+PE)	Meet the current-carrying capacity of a single circuit.

8. Design summary

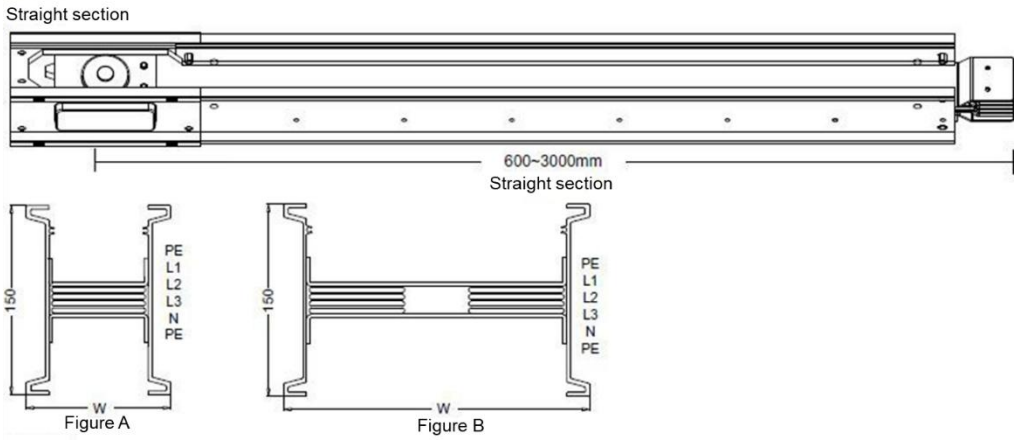
The micro-module uses the 2N dual independent busway redundancy architecture. The total calculated load of the micro-module is 2200 kW, including 20 server cabinets, five network cabinets, and five bus cabinets. The calculation is performed completely based on the N-1 fault conditions, and the safety factor of 1.25 is uniformly used. The system runs at 50% load in normal conditions and is redundant and reliable in fault conditions.

9. Busway layout and reference dimensions of plug-in boxes

- The following figure shows the side view of a row of cabinets based on the technical specifications of mainstream vendors, such as the I-LINE H busway series.



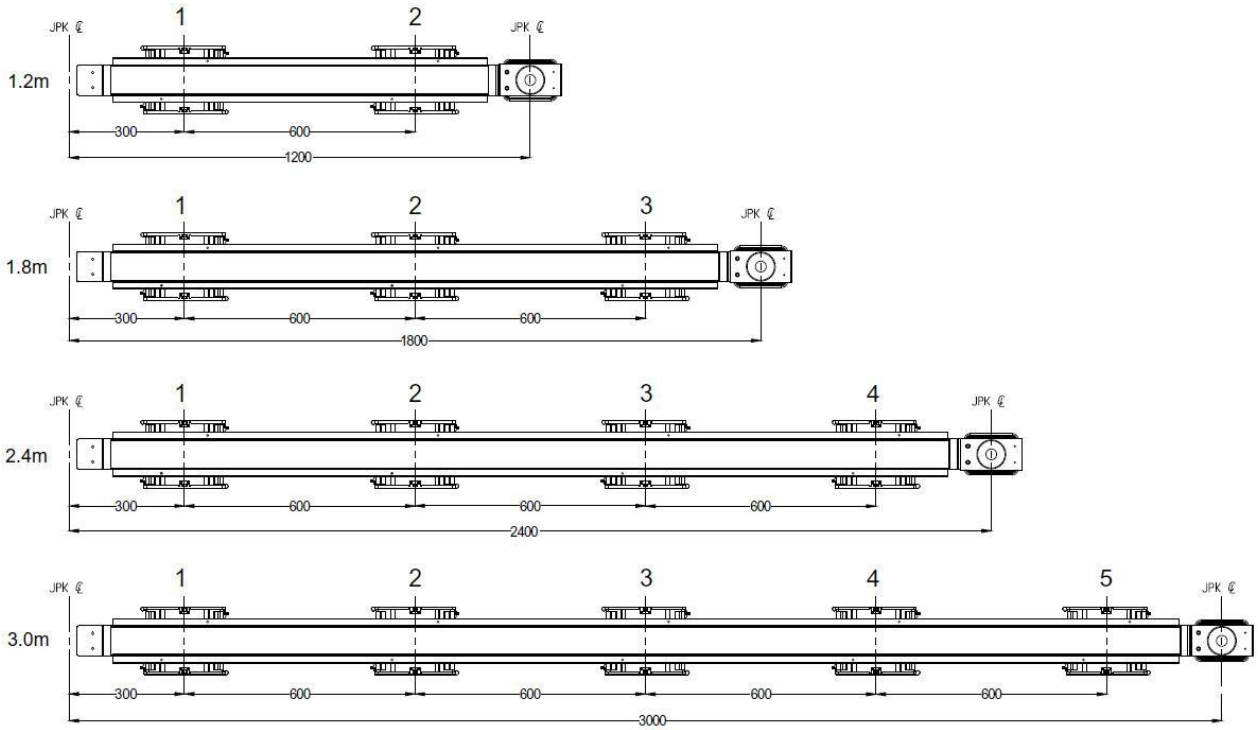
- The following figure shows the dimensions (L × W × H) of the busway.



Dimensions

Rated current (A)	W (mm)	Straight section (kg/m) 3L+N+PE	3L+PE	Figure
400A	99	9.5	8.4	A
630A	99	11.3	9.8	A
800A	99	13.4	11.3	A
1000A	115	15.9	13.3	A
1250A	144	20.5	16.9	A
1600A	176	25.6	20.8	A
2000A	218	32.3	26.0	A
2500A	270	40.5	32.3	A
3200A	378	50.4	40.2	B
4000A	466	64.3	51.0	B
5000A	574	81.5	64.3	B

- The number of plug-in interfaces and spacing are shown in the following figure.



- Plug-in box configuration: 3–4 × 80 A 3P per box. The dimensions are shown in the following figure.

