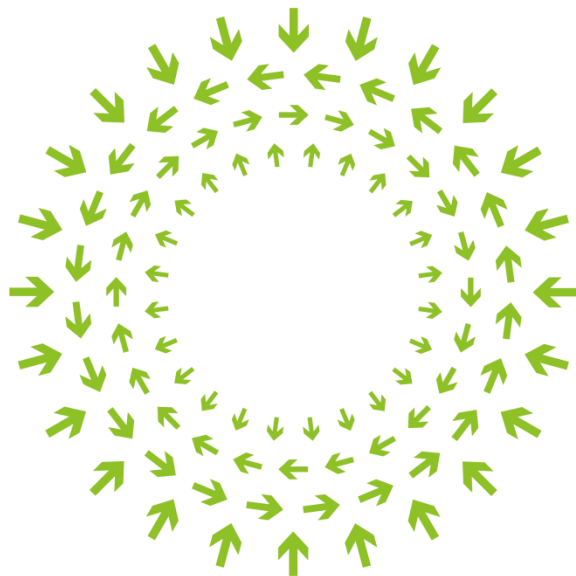




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Compute Project

Tencent Micro-modular Data Center

Revision 0.9

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1. Scope

This standard specifies the technical requirements of all-in-one micro-modular data center, including applicable environment, typical model of micro-module, power supply subsystem, cooling subsystem, structural subsystem, generic cabling subsystem, manage and control subsystem, etc.

2. Terminology and definitions

The following terminologies and definitions apply to this document.

2.1 Integrated micro-modular data center

Abbreviated as micro-module, it is a small rack cluster formed by a certain number of two rows of back-to-back or face-to-face IT racks, uninterruptible power supply, near-end cooling equipment and so on through closed aisle.

By sealing the cold or hot aisle between the two IT racks, a physical environment relatively isolated from the large computer room and other clusters is formed, and independent electrical, cooling, security, monitoring, cabling and even fire protection systems are designed according to the equipment conditions in the rack.

Users only need to provide power, network and the necessary cooling sources to make the data center operational.

The subsystems and components in the micro-module can be prefabricated and tested in the factory. Those components can be put into use after rapid assemble on site.

With little or no physical correlation between multiple micro-modules, users can build on demand to meet the need to modularize and deploy a large-scale data center step by step.

2.2 Closed aisle

An air distribution design method for isolating the aisleway between two rows of opposite or opposite racks from the computer room environment use some special structural components,

Closed aisle is connected with the return air side or the air supply side of the cooling equipment. The cold air flow or hot air flow in the aisle will not be mixed with the air flow in the computer room environment, which can effectively improve the efficiency of air flow utilization.

The way to close the air inlet aisle on the front of the rack is called the closed cold aisle, and the way to close the air outlet aisle on the back of the rack is called the closed hot aisle.

2.3 Near-end air conditioner

The cooling equipment placed close to the IT rack can realize the nearby cooling cycle of the air flow in the IT rack.

2.4 In-Row air conditioner

Cooling equipment placed side by side with IT rack, air supply on the front and air return on the back.

2.5 Top-mounted air conditioner

Cooling equipment placed above the IT rack with air outlet on the front and air return on the back.

The top cooling equipment is equipped with a detachable fan, which can rely on the server fan to drive the air circulation flow without fan drive.

2.6 Cooling distribution unit

When the chilled water type near-end cooling equipment is used, the water supply and water return device of multiple cooling equipment is centrally connected. Through this device, the chilled water supplied to the micro-module can be distributed, and the water supply of the branch can be controlled.

3. Abbreviation

The following abbreviations apply to this document.

3.1 EC

EC is the abbreviation for Electrical Commutation. EC fan refers to the integrated fan of high-performance external rotor motor using electronic commutation technology.

3.2 HVDC

HVDC is the abbreviation for High-Voltage Direct Current, refers to the 240V direct current power supply system.

3.3 IT

IT is the abbreviation for Information Technology. IT rack in this document refers to the rack in which electronic information equipment is placed in the data center.

3.4 LED

LED is the abbreviation for Light Emitting Diode.

3.5 PDU

PDU is the abbreviation for Power Distribution Unit.

3.6 PUE

PUE is the abbreviation for Power Usage Effectiveness. PUE is an indicator for evaluating energy efficiency in data Centers

4. General Requirements

1. Micro-module is a functional rack cluster which can operate relatively independently. There is very little or no physical connection between micro-modules, and there should be an independent security system. Micro-module's operation should not or be affected a little by other micro-modules.

2. The micro-module should operate in the indoor environment, and the micro-module can form a relatively independent environmental system through the closed aisle.
3. Micro-modules should be designed, integrated, and delivered as a stand-alone product.
4. The micro-module shall include the following subsystems: power supply subsystem, cooling subsystem, structural subsystem, generic cabling subsystem, manage and control subsystem, etc.
5. The micro-module should have an independent monitoring system, and all data can be uploaded through the standard interface to the upper tier monitoring system.
6. The inlet air mode of the micro-module IT rack should be the front inlet air and the back outlet air, compatible with the special inlet and outlet air mode of some high-end switches.
7. The micro-module is a frame structure, and itself does not equipped with IT rack. After the construction of the micro-module, according to the needs of users, it racks can be flexibly added, and the IT racks can also be delivered by the micro-module manufacturers as a whole, and the users can deploy the server after rack deployment. Fully integrated rack deployment requires additional rack lifter.

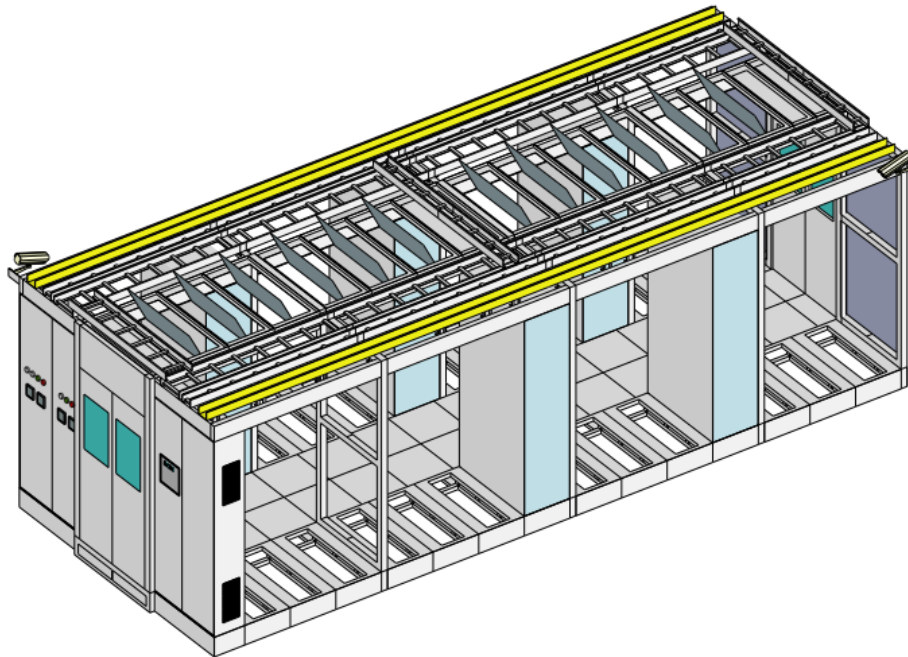


Figure 4-1 Micromodule schematic diagram

5. Applicable Environment

1. The micro-module should be operated in the indoor environment, and the access floor should not be used in the computer room where the micro-module is placed.
2. The indoor environment for which the micro-module is suitable shall meet the following requirements:

- dry bulb temperature: 10 °C ~ 35 °C
 - relative humidity: 20% ≤ 80%
3. The micro-module supports the push-in deployment of the whole rack, and the computer room and transportation aisle should be barrier-free; the base can also be added under the micro-module to meet the requirements of cabling, drainage etc.
 4. When constructing micro-module, the weight of single rack and the overall weight of micro-module should be considered, which should meet the load-bearing requirements of floor and building.
 5. In the micro-module computer room, an electric cable bridge shall be laid according to the position of the micro-module, the bridge shall be laid to the top of the micro-module distribution rack, the power supply cable shall be laid to the corresponding micro-module position through the bridge, and a suitable length shall be reserved. The micro-module can be connected to the power distribution rack after it is in place.
 6. The cooling source pipe should be laid in the micro-module computer room according to the position of the micro-module, and the interface should be reserved in the corresponding position. the micro-module can be connected after it is in place. Pipeline path selection should be reasonable and safe to avoid occupying transportation and maintenance aisles.
 7. According to the position of the micro-module, the copper cable and optical fiber bridge should be laid in the micro-module computer room, the bridge should be laid to the top of the micro-module control rack, the cable should be laid to the corresponding micro-module position through the bridge, and the appropriate length should be reserved.
 8. If the chilled water type near-end refrigeration equipment is used, the emergency drainage floor drain should also be set up in the computer room, which can be reasonably arranged according to the floor and position of the computer room.
 9. The use of micro-modules should meet the requirements of local fire laws and regulations.
 10. When the altitude of the place where the micromodel is placed exceeds 1000m, the derating is required.

6. Recommendation of Typical Models for Micro-modules

1. 70kW~80kW and 120kW~130kW are recommended for micro-modules based on the IT load capacity.
2. 6.5kW, 8kW, 10kW, 12kW are recommended for load capacity of single rack in micro-module.
3. Recommended number of IT racks in micro-modules is between 10 and 18.
4. When selecting the rack power density level, the number of racks and the total capacity of micro-modules, several typical models listed in Table 1 should be used.

Model	IT Capacity /kw	Single Rack Capacity /kW	IT Rack Number
A	70~80	6.5	12
B	120~130	6.5	18
C	120~130	8	16
D	120~130	10	12
E	120~130	12	10

5. Considering the efficiency of uninterruptible power supply, cooling equipment power, battery charging power and other factors in the micro-module, the total capacity of the micro-module should be calculated and amplified on the basis of IT capacity.
6. The maximum capacity of micro-module should not be too high, and the IT capacity should not exceed 150kW.

Note: According to the characteristics of practical application, the capacity of micro-module can be evaluated based on typical models to achieve better adaptability.

7. A typical model of micro-module data center is as following and reference with micro module R18 parts: a distribution unit, a HVDC unit, three battery units, a cooling capacity distribution unit, five precision air conditioners, a manage and control unit, a set of monitoring components, a set of fire protection components, a set of aisle sealing components, a set of column frame components, a set of base and micro-module internal cable tray, and so on.

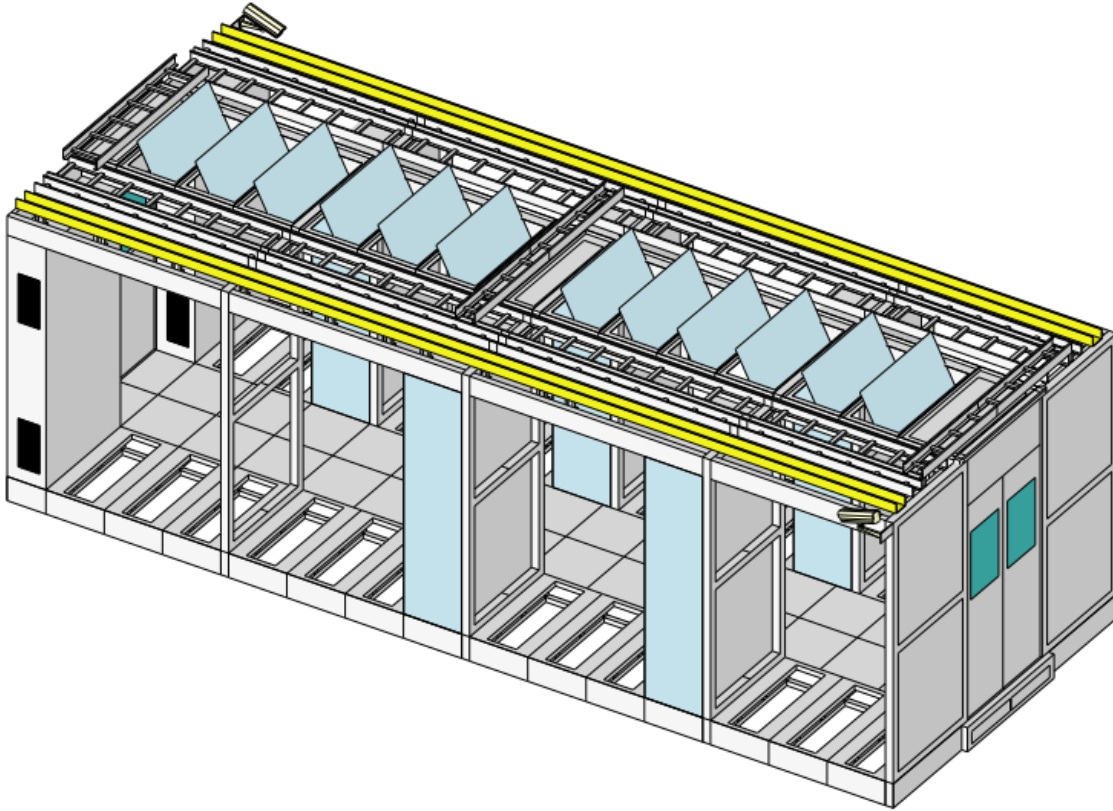


Figure 6-1 Micro-Module R18

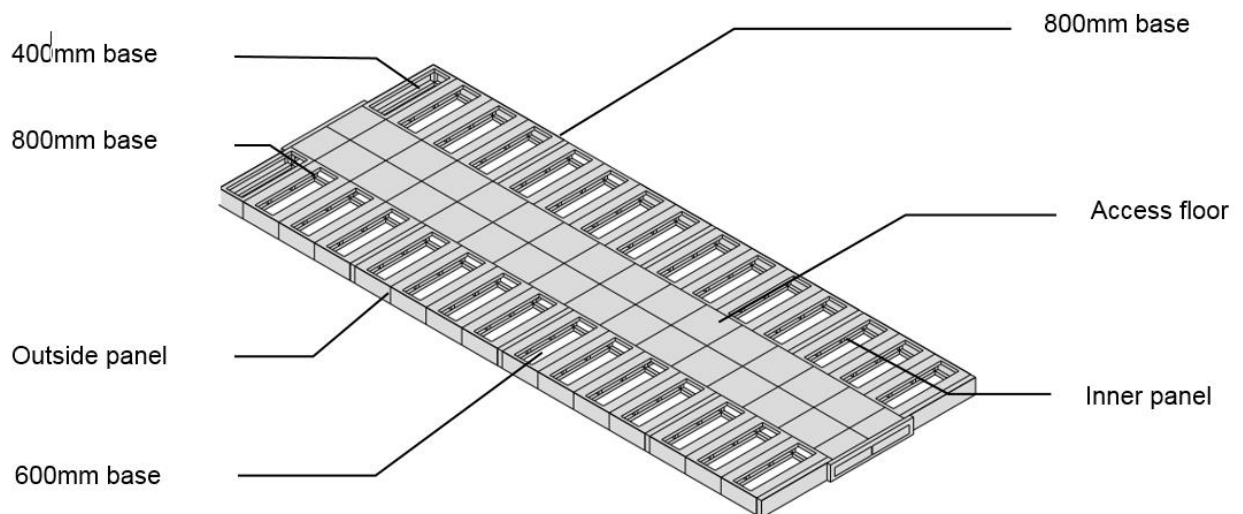


Figure 6-2 Schematic diagram of floor and support of Micromodule R18

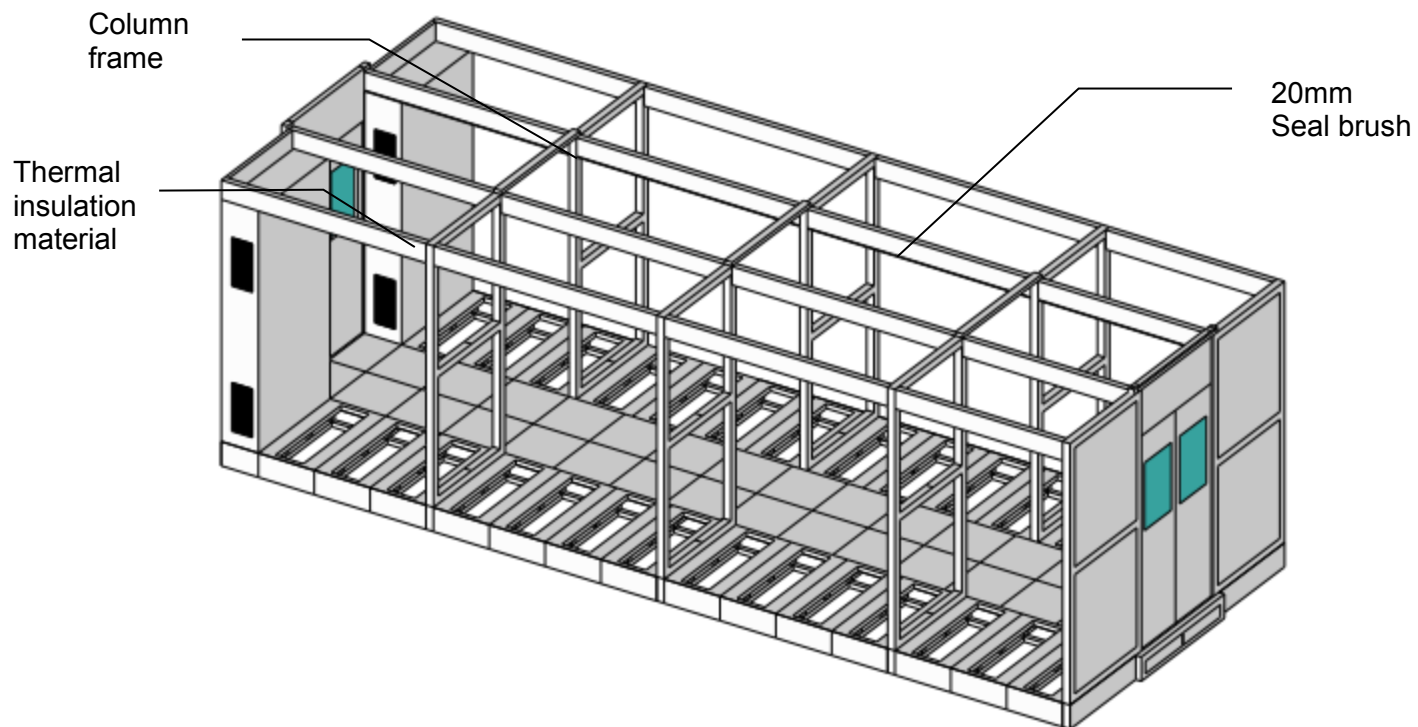


Figure 6-3 Schematic diagram of column and frame of Micromodule R18

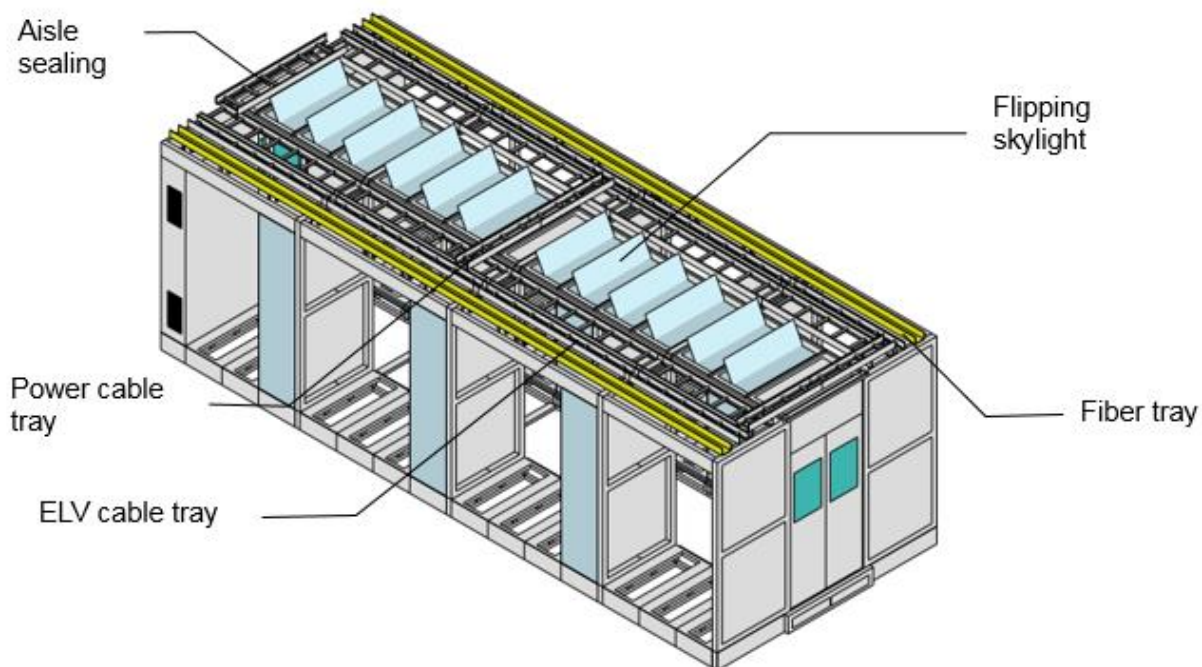


Figure 6-4 Schematic diagram of Aisle sealing component and cable tray of Micromodule R18

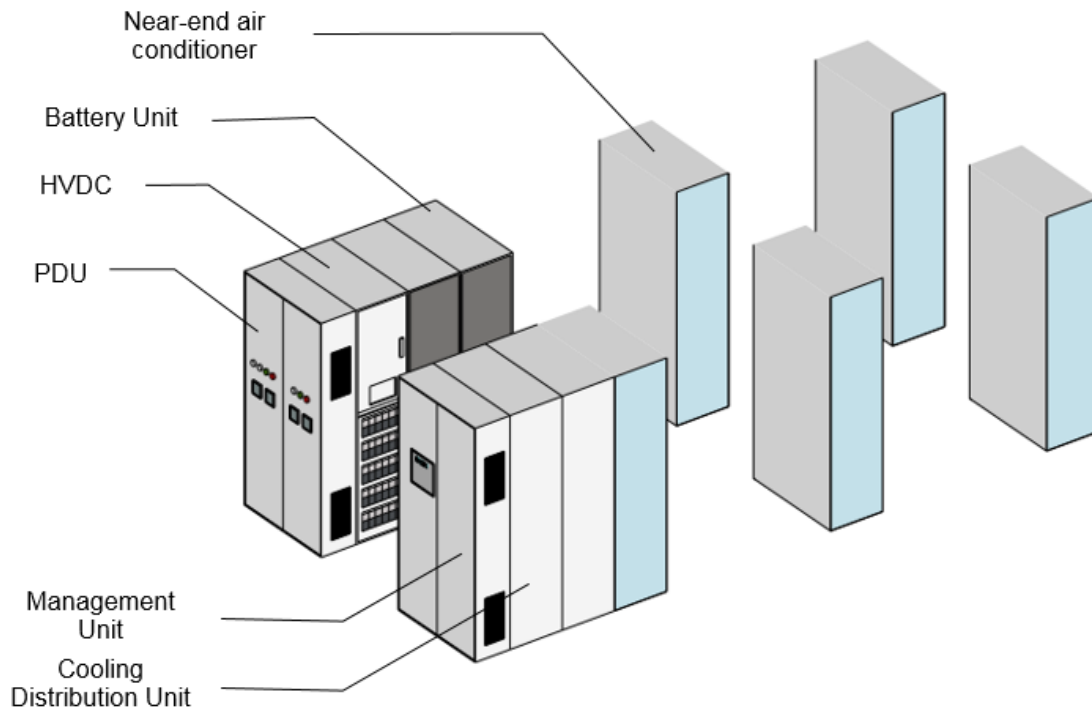


Figure 6-5 Schematic diagram of unit layout of Micromodule R18

P D U	B A T	B A T	H V D C		Rack	Rack	Rack	A/C		Rack	Rack	Rack	A/C		Rack	Rack	Rack
Manage & Control	C D U	B A T	A/C		Rack	Rack	Rack	A/C		Rack	Rack	Rack	A/C		Rack	Rack	Rack

Figure 6-6 Overall layout of Micromodule R18

The overall size of the micro module R18 is 9520mm length, 3600mm width and height not exceeding 3200mm (including 300mm base, cable tray and skylight flip height); the dimensions of the other functional units are as follows:

Functional unit	Width mm	Depth mm	Height mm
HVDC unit	600	1200	2500

Battery unit	800	1200	2500
PDU/Manage & Control	1200	400	2500
A/C unit	600	1200	2500
Cooling distribution unit	800	1200	2500

7. Power Supply Subsystem

1. The micro-module power supply sub system includes micro-module power supply and distribution, lightning protection grounding and static electricity protection, the overall technical requirements should be in accordance with the provisions of related standards.
2. The power load grade of micro-module and the quality of power supply shall conform to the requirements of local requirements.
3. Micro-module 380V low-voltage distribution system can choose to use an independent power distribution rack or busway. Distribution racks are used for power access and related devices in the power distribution system, such as branch distribution breakers, smart meters, surge suppressors, etc., and should not be mixed with other racks. The direction of opening and maintenance should be to the outside of the closed aisle.
4. The micro-module low-voltage distribution system should be equipped with intelligent power collector, surge suppressor and other equipment.

An example of PDU 1200mm (wide) * 400mm (deep) * 2500mm (high) for micromodule as shown below.

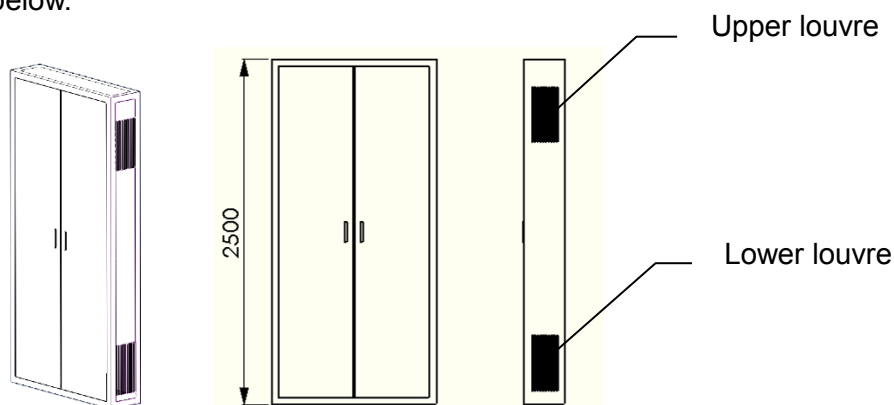


Figure 7-1 Micro-module PDU

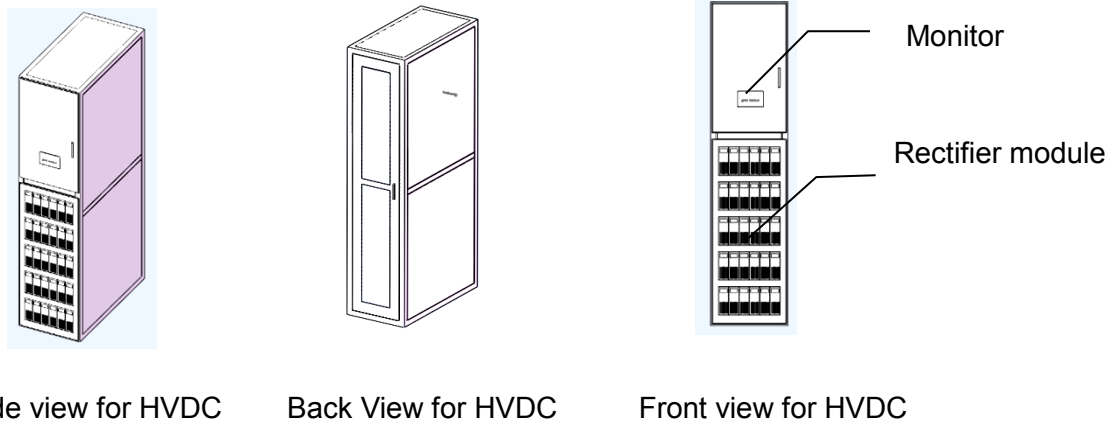


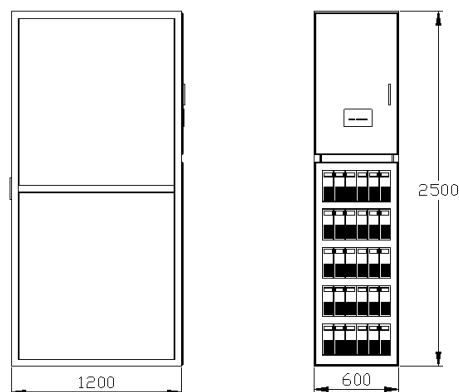
Figure 7-2 Front View for Micro-module PDU

5. The micro-module should support dual power supply access and realize dual power supply mode.
6. The micro-module low-voltage distribution cable shall be arranged at the top of the rack.
7. At least one path of independent uninterruptible power supply system should be configured in the micro-module.

Among them, the specific requirements for different Uninterruptible Power supply systems are as following: 240V DC power supply/ 336V DC power supply/The AC Uninterruptible Power supply system.

An 240V DC power supply system is showed as following.





Top view of HVDC Height & width of HVDC

The uninterruptible power supply system of micro-module should be a separate rack.

8. The micro-module should be equipped with an independent battery rack, and an automatic forced exhaust fan should be designed on the battery rack for heat dissipation in the battery rack.
9. The uninterruptible power supply system should have the protection function to prevent the battery from over discharge, the independent maintenance switch, and the single battery condition monitor.

An example of battery unit design is showed as follows.

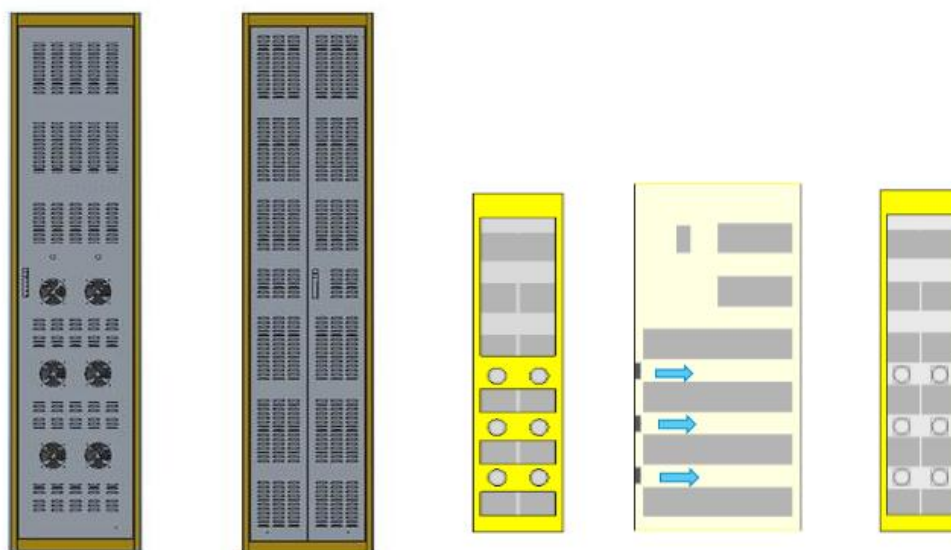


Figure 7-3 Front & back & side view of battery unit

The size of the micro-module R18 battery rack is 800mm (wide) * 1200mm (deep) * 2500mm (high) and placed inside the micro-module. The battery rack is designed as 6 layers, the battery rack switch and battery monitoring server are placed in the upper part, the distance between each layer of the battery pack is not less than 140 mm, and the battery in the same layer should be evenly distributed to ensure smooth ventilation in the battery rack. Battery rack front door equipped with 6 fans. The fan outlet should face the gap between the batteries. the fan has automatic control or manual control, and the automatic function of temperature monitoring is adopted by default. when the temperature in the battery rack is greater than or equal to 27 °C, the fan is turned on, and when the temperature in the battery rack is less than 24 °C, Fan off. Reasonable thermal analysis shall be carried out in the battery rack, and the temperature in the battery rack shall not exceed 25 °C. When the battery rack door is opened and closed, there should be no obvious deformation, and the magnetic suction should be increased on the frame of the battery rack door.

10. IT rack PDU in the micro-module and the distribution cable at the top of the micro-module should be connected by industrial connectors.
11. All types of racks, power modules, near-end cooling equipment and other metal conductors in the micro-module should be connected by equipotential, and there should be no isolated conductor insulated to the ground. The equipotential connection network should be arranged on the structural framework and should be connected to the rack.
12. The external grounding of the micro-module shall be connected to the basic grounding electrode by a copper wire not less than 25mm².

8. Cooling Subsystem

1. The micro-module should use the near end cooling equipment to cool the IT rack, and the horizontal air supply in row air conditioning should be used.

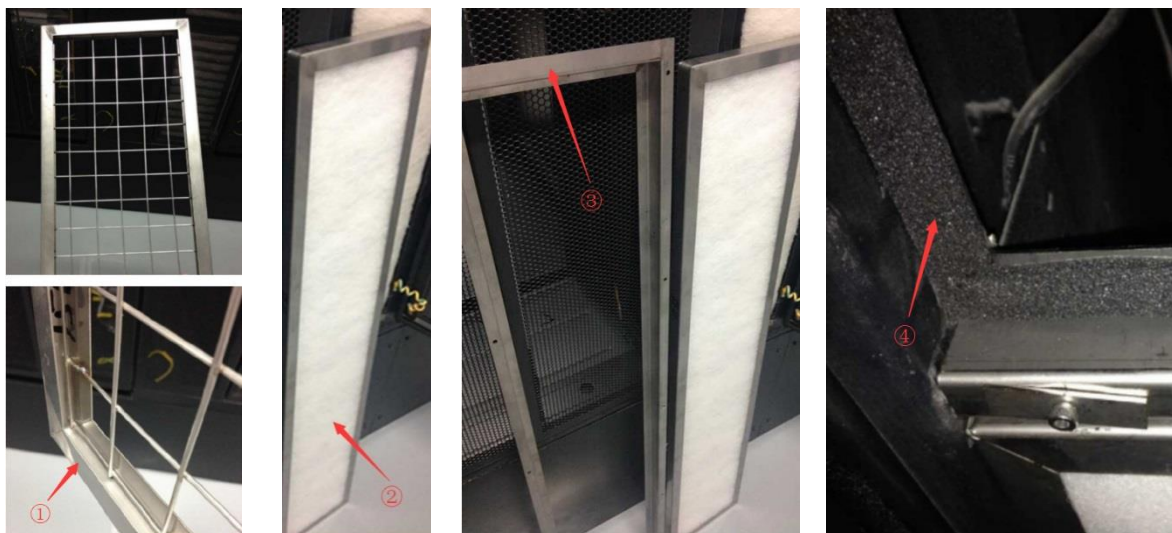
The dimensions of in-row precision air conditioning are 600 mm wide, 1200 mm deep and 2500mm high. Air conditioning front horizontal air supply, back return air.

Each air conditioner is equipped with 2 G4 grade filters. the bottom barbed wire of the filter frame adopts cross structure, the mesh adopts 40mm*40mm structure, and the four sides of the barbed wire need to be fixed with wire. The entire barbed wire needs to be welded from the inside to the filter frame. The wire is made of stainless-steel wire, the filter frame is also made of stainless steel, and the sharp edge of the filter frame should be equipped with plastic protective cover to facilitate the operation when changing the filter cotton.

A sealing strip shall be added at the support of the filter frame and the air conditioning body. The filter frame and the air conditioning body support adopt the push adsorption

sealing mode. The fixation can be carried out by means of upper and lower pressing buckle.

Air conditioning filter screen fixing screws should be hand-screw type for easy installation. The initial resistance of the filter is not more than 50 Pa under the rated air volume, and the rated air volume should be maintained when the 100Pa is reached.



① Filter frame; ② Filter; ③ Filter frame fix structure; ④ Sealing strip

Precision air conditioning internals reserve in and out of the water connection pipe, the interface requirements for threaded connection, pipe connection under the floor.

The rated air volume of precision air conditioning is not less than $9000 \text{ m}^3 \times \text{h}$, and the power consumption of fan is not higher than that of 1.5kW.

The precision air conditioning can support the chilled water supply temperature range of 7 to 20 °C, and the inlet / outlet temperature of the frozen water is 15 / 21 °C when the rated air volume. The return air dry / wet bulb temperature is 37 / 21.5 °C (relative humidity 25%), the apparent cooling capacity is not less than 40 kW and the water resistance is not more than 100kPa when the outlet air dry bulb temperature is not higher than 22 °C.

The precision air conditioning surface cooler adopts copper tube aluminum fin type, and the fin adopts hydrophilic window opening, which is located on the suction side of the fan. The precision air conditioning adopts the adjustable speed fan of EC technology, the fan is evenly distributed at the air outlet, the fan speed can be automatically adjusted according to the return air or air supply temperature, and the manual speed regulation mode is

supported at the same time; the air outlet has a safety shield and is easy to disassemble, Do not affect the maintenance of the fan.

Precision air conditioning needs to be equipped with an independent controller to support multi-line display, which can display unit status, inlet and outlet air temperature, fan speed percentage, inlet and outlet water temperature and other parameters.

Precision air conditioning supports RS485 or TCP/IP communication protocols, The important parameters of the unit (including, but not limited to, inlet and outlet air temperature and humidity, unit power supply state, unit operation status, fan status, alarm, etc.) can be uploaded to the micro-module or background centralized monitoring system.

When the micro-module receives the fire action signal, the precision air conditioning in the module must stop automatically immediately.

Precision air conditioning using metal material, need to carry out anticorrosion spraying, color appearance should be same with IT rack. It is necessary to do heat preservation and sealing inside the unit to avoid water leakage, air leakage and other faults.

2. If the chilled water type near-end cooling equipment is used, an independent cooling distribution unit should be configured in each micro-module, which is used to distribute chilled water to multiple near-end cooling equipment.

Separate valves should be provided on the supply and return pipes corresponding to each near-end cooling equipment on the cooling distribution unit; the water pipes connecting the near-end cooling equipment should be aluminum plastic pipes with quick joints.

- a) The cooling capacity distribution unit is mainly composed of the main inlet pipe, the main outlet pipe, the ball valve, the flange and the support. Its function is to distribute the chilled water supplied to the micro-module to each precision air conditioning, and the ball valve can be used to shut down and maintain each water supply and effluent.
- b) The distribution unit is provided with an inlet and outlet distribution main pipe. The micro-module R18 has six branch pipes (1 standby) in each main pipe for the distribution of influent and effluent. Two ball valves are installed on each branch pipe, the upper ball valve is normally open and only closed during maintenance, and the lower ball valve is normally switched on and off, which is used to close the waterway during maintenance. The water distribution unit allows maintenance on both sides of the front and rear.
- c) The frame size of the cooling capacity distribution unit is 600 mm wide, 1200 mm deep and 2500 mm high. the overall size and appearance are consistent with the rack. The front and rear doors of the distribution unit do not leave any through holes and should have a certain sealing property in order to prevent pipeline leakage and splash into the module.
- d) The main water supply pipe and outlet pipe are copper pipes with inner diameter not less than 80mm. Welding flanges are reserved at the end of the pipe. The bottom of the distribution unit does NOT have the bottom cover and lands on the support structure directly. It is used to connect the chilled water main pipe and the air

conditioning branch pipe of the room on the spot, and the flange and ball valve position should be convenient for the field to take over and the later maintenance.

- e) Both the main pipe and the branch pipe should have independent and reliable support to avoid the fracture of the pipeline or the leakage of the interface.
 - f) The inlet and outlet pipes, ball valves and flanges of the cooling capacity distribution unit shall be well insulated. All devices except ball valve wrenches should not be naked after connection is completed. The thickness of insulated cotton should not be less than 20mm. Insulation cotton requires the use of flame-retardant materials, flame retardant grade up to V0.
 - g) The pipeline design requires that the water resistance should be reduced as much as possible under the premise of meeting the requirements of use and maintenance. the total water resistance of the micro-module should not exceed 150kPa.
 - h) The pressure of pipeline system is not less than 1600kPa.
- 3. Each micro-module should be equipped with multiple near-end cooling equipment and form $N \geq X$ redundancy ($N \geq X \geq 1$), which should be in full operation hot standby mode.
 - 4. The near-end cooling equipment should be flexibly adjusted according to the heating position of the equipment in the micro-module to avoid hot spots.
 - 5. Cooling equipment can adopt a variety of control methods, it is appropriate to control the cold aisle side temperature to ensure that the inlet air temperature of IT equipment meets the recommended range of ASHRAE.
 - 6. The EC fan with non-polar speed regulation should be used in the near end cooling equipment. the safety protection net should be designed in front of the EC fan, and it should be convenient for front disassembly and maintenance.
 - 7. The near-end cooling equipment in the micro-module should have an intelligent communication interface, which can upload the monitoring data to the micro-module monitoring system.
 - 8. The near-end cooling equipment should have inter-communication functions, which can realize group control.
 - 9. The near-end cooling equipment should be able to drain water by gravity, the equipment should be equipped with a leakage detection device, and the installation of drainage pumps can be considered according to the layout position.
 - 10. The selection of near-end cooling equipment should be calculated with: the cooling source supply, return water temperature, the environment condition.
 - 11. The near end cooling equipment in the micro-module should consider reserving the necessary installation space and maintenance space, and the filter and other consumables should be easy to replace.

9. Structure Subsystem

9.1 Closed aisle components

1. The cold aisle or hot aisle between the two rows of racks of the micro-module should be closed to form a relatively sealed environmental space.
2. The closed aisle frame material should be made of high strength material, which can reliably support the top skylight and other components. The frame surface is sprayed with anticorrosive coating.
3. The closed aisle should adopt an independent frame structure, can be built independently, is not fixed with the IT rack and other functional racks, and can be sealed with seals or brushes at the joints with other racks. After installation, if there is an obvious air short path or air leakage point between the rack bodies or between the rack body and the closed aisle components, the appropriate sealing material should be used for sealing.
4. The height dimensions reserved for all kinds of racks in the micro-module should be 2100mm, 2300mm, 2500mm, the width size should be 600mm, the depth size should be 1200mm, and the appropriate allowance should be reserved in the height and width size.

Racks of different heights should approach the above recommended heights by individually adapting height adjustment accessories, thereby reducing the specifications of closed aisle components.

5. The skylight should be automatically flipped or dropped at the top of the closed aisle of the micro-module, and the skylight should be made of transparent, fire-proof and explosion-proof materials. the skylight can be linked with the fire control system to realize the automatic opening in case of emergency, and at the same time, the manual opening function can be realized. The skylight should not block the normal opening of the rack door after flipping or falling.
6. The width in the closed aisle should not be less than 1.2m.
7. The outer flat door should be used on both sides of the closed aisle of the micro-module, the transparent observation window should be on the door, and the toughened glass should be used as the material. The width of the door should not be less than 1m and the height should not be less than 2m.
8. The installation position of monitoring camera, smoke detection, temperature sensing and other devices should be reserved at the top of the closed aisle of micro-module. the number of cameras should not be less than 2 and should be placed opposite to each other on both sides of the aisle.
9. The top of the micro-module closed aisle should reserve the entrance for the fire pipe access, and the reserved hole should be kept sealed when not in use.
10. The micro-module shall have at least one AC 220V/50Hz maintenance plug socket and the breaker shall not be less than 10A.
11. All racks can be provided with a base under which the upper and lower water pipes can be laid down. if a base is set, consideration should be given to facilitating the handling,

loading and fixation of the rack, and the same height of access floor should be laid in the closed aisle at the same time for easy maintenance.

An example of closed aisle components is showed as follows.

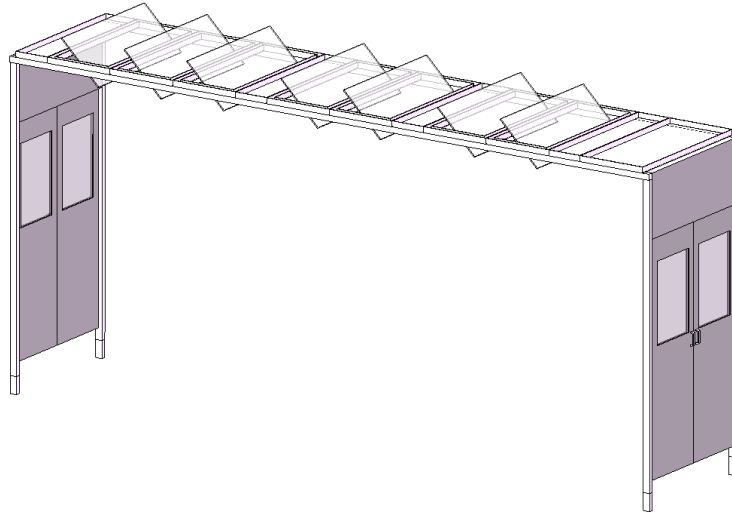


Figure 9-1 The Closed aisle components

The width of the cold aisle is 1200 mm, the height of the highest point of the roof from the floor of the cold aisle is not more than 2900 mm, and the height of the lowest point from the floor of the cold aisle is not less than 2500mm

The closed aisle assembly includes slide rail door on both sides of the aisle (including access control system), roof frame and brush, flip skylight, lighting and so on. the height of the door is 2200 mm and the width of the door column is 60mm (along the long side of the module). Cold aisle components (doors, ceilings, etc.) should be thermal insulation design, sheet metal doors in the middle of the addition of thermal insulation materials, ceiling partition back paste insulation materials, each rack should use sealing strips for gap plugging.

The closed aisle frame material is thick cold rolled plate, the surface anticorrosion spraying treatment, the color is black gray, is consistent with the rack color. The top of the frame and rack is bolted, the overall structure of the frame is beautiful and firm, long-term use should not appear deformation, bending and other fault.

9.2 Racks

1. All kinds of racks in the closed aisle should be consistent in shape and size, and there should be no obvious air flow short path point and air leakage point in the structural design.
2. For the micro-module with access control, the IT rack inside the closed aisle can drop the rack door.

3. Battery racks, uninterrupted power racks, distribution racks and other distribution equipment racks with heat dissipation needs in the micro-module shall consider the design of ventilation holes on the rack body, The selection of the position and size of the ventilation hole should be able to realize the natural flow of air flow in the rack to achieve the purpose of heat dissipation with the help of the pressure difference between inside and outside the aisle. Or the forced cooling can be carried out by increasing the forced exhaust fan and independent cooling equipment.
4. If the rack does not have heat dissipation requirement in the micro-module, the rack front and rear rack doors should be designed as non-perforated rack doors.
5. The rack in the micro-module shall have the function of being anchored together.
6. The detailed technical requirements of IT rack and functional rack in micro-module should be determined according to the actual demand.

10. Generic Cabling Subsystem

1. Micro-module cabling should meet the relevant requirements.
2. The power cable, copper cable, optical fiber and ELV cable of the micro-module shall be arranged at the top of the rack.
3. The top of the micro-module should design independent power cable tray, optical fiber tray, ELV cable (including signal, copper cable) tray, and reserve enough maintenance and heat dissipation space between the cable tray. If the micro-module adopts the overhead air conditioning mode, the wire frame position should avoid hindering the air conditioning in and out of the air.
4. The top cable tray of the micro-module should be able to cover all racks and meet the requirements of cable cross-aisle, and all cables inside the micro-module should be arranged through the top of cable tray on the micro-module.
5. The micro-module shall reserve the inlet of the power cable at the top of the strong distribution rack and reserve the distribution cable and the weak cable outlet of each rack at the same time. The micro-module shall reserve the outlet of the weak current, optical fiber, copper cable and other cables at the top of the weak current control rack.
6. There should be enough space at the inlet and outlet to avoid excessive concentration of the cable. sheet metal at the edge of the wire hole should be protected from cutting the cable and should be blocked by a brush. Cable fixtures should be designed near the wire hole.

11. Manage and Control Subsystem

11.1 General description of Management and Control Subsystem

The management and control subsystem of the micro-module should include monitoring system, lighting, security, fire protection and other equipment.

1. The control system shall be powered by the uninterruptible power supply system of the micro-module.
2. The micro-module shall be configured with a separate management and control rack for the placement of the relevant control equipment and display panel, which shall be a large screen industrial control display screen. The direction of opening and maintenance of the control rack and the display panel should be outside the closed aisle, which is convenient for users to inspect and maintain the control system.
3. The micro-module management and control subsystem shall have an intuitive and friendly man-machine interface. It is appropriate to display the important parameters such as micro-module capacity information, environmental parameters, PUE value, alarm information, power supply and distribution system status, near-end cooling equipment operation status and so on in real time on the home page of the management and control interface.
4. The management and control subsystem architecture of the micro-module should adopt the architecture in figure 1, which can add and subtract the equipment according to the actual needs.

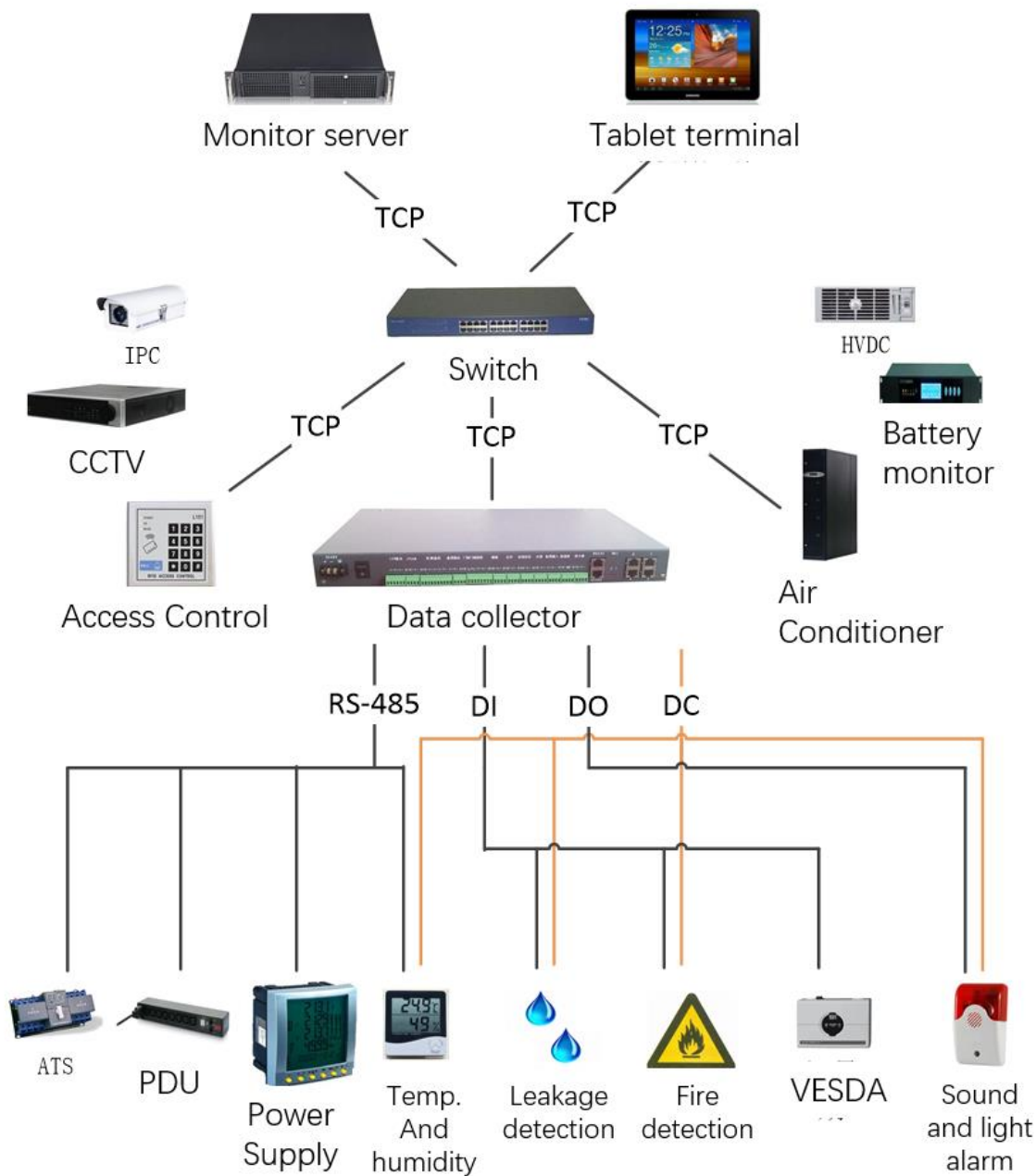


Figure 11-1 Management and Control architecture

11.2 Description of Monitoring System

1. Equipment suitable for monitoring system in micro-module: smart meter, automatic transfer switch, power distribution rack, uninterruptible power supply system, battery monitor, near-end cooling equipment, temperature and humidity sensor inside and outside the aisle, leakage detection sensor, the pressure difference sensor inside and outside the closed aisle, the inlet and outlet water pressure difference sensor and the temperature sensor, the very early smoke detector, the firefighting equipment, the access control equipment, the video equipment and so on.

2. Two video surveillance cameras should be installed in the micro-module aisle, and an appropriate number of cameras can be installed externally according to the demand. video storage can be selected locally or uploaded according to the actual demand, and the storage time should not be less than 60 days.
3. Leakage detection rope should be arranged around the ground of the micro-module to monitor the surface water immersion under the micro-module.
4. Smart electric meter should monitor the contents: micro-module power, IT total load voltage, current, quantity and other parameters.
5. The automatic transfer switch should monitor the main and standby circuit voltage, frequency, the status of the main and standby switch and other parameters.
6. The distribution rack should monitor the parameters such as input phase / line voltage, input phase / line current, each AC branch circuit breaker state, each DC branch current, each DC branch circuit breaker state etc.
7. DC uninterruptible power supply system should monitor system voltage, total load, battery status, AC input voltage, AC input current, AC input frequency, rectifier module output voltage, rectifier module output current,
8. DC output voltage, DC output current, undervoltage protection circuit breaker state and so on.
9. The battery monitor should monitor the contents: single battery voltage, battery total voltage, charge-discharge current, residual discharge time, battery surface temperature, internal resistance and so on.
10. The AC uninterruptible power supply system should monitor the contents: ac input line voltage, AC input phase voltage, frequency, output voltage, output current, total battery voltage, bypass voltage, uniform floating charge state, bypass circuit breaker state and so on.
11. The near end cooling equipment should monitor the contents: supply air temperature and humidity, return air temperature and humidity, start and stop state, fan state, compressor state, filter state, all kinds of alarm information, water valve state, inlet temperature, inlet water pressure difference and so on.
12. Environmental and firefighting equipment should monitor the contents: IT rack front and back the inlet and outlet air temperature and humidity, closed aisle internal and external pressure difference, leakage detection, smoke detection, temperature detection, very early smoke detector state, etc.
13. Monitor the software and hardware modules of the monitoring system itself, the running status of the network, alarm information and so on.
14. The micro-module monitoring system should be able to display all kinds of alarm and reminder information in the micro-module equipment accurately and in real time on the display panel, and the important alarm can emit acousto-optic alarm.

It is advisable to set up a red alarm light obviously outside the micro-module.

11.3 Requirement of Monitoring System

1. The micro-module monitoring system should provide performance guarantee for the continuity of the normal operation of the modular data center. The system software should be functionally fully operational convenience, availability, reliability.
2. The micro-module monitoring system shall meet the requirements of YD/T 1104, GB 50348, GB 50174 and other related specifications.
3. The micro-module monitoring system should be open and should provide standard open protocol interfaces such as Modbus, SNMP, HTTP and so on.
4. The design of the micro-module hardware system should adopt reliable electrical isolation to ensure that the software and hardware of the system can not affect the safety of the operation of the monitored object under any circumstances.
5. The abnormal operation of one of the lower systems in the micro-module monitoring system should not affect the normal operation of other systems in the monitoring system.
6. The micro-module monitoring system should be able to automatically detect the faults of each monitoring module, sensor faults and whether the communication between each intelligent device and the monitoring system and between the monitoring subsystems is normal. Once a communication failure (including the hardware failure of the system itself) is found, the system should be able to send an alarm message.
7. The data accuracy of the micro-module monitoring system should be as follows:
temperature accuracy is ± 1 °C, relative humidity accuracy is $\pm 5\%$, current, voltage and power accuracy is $\pm 1\%$.
8. The micro-module monitoring system should be able to provide a northbound communication interface based on a common protocol. The micro-module monitoring system should be able to classify the alarm information, have the ability to process the alarm in parallel, and deal with the alarm event according to the level.
9. Multi-level password Protection function should be set up in micro-module Monitoring system

11.4 Requirement of Lighting, Security, Fire protection System

1. Independent lighting should be designed at the top of the closed aisle of the micro-module, energy-saving LED light source should be used, and the overall technical requirements should conform to the relevant provisions of GB 50174.
2. The micro-module should be equipped with access control equipment, the aisle door can use single or double open electric control lock or electromagnetic lock, the door opening

switch should be installed inside and outside the door, and the emergency door opening switch should be installed in the obvious position of the door.

3. A very early smoke detector should be installed in the micro-module, and the detector acquisition device should be installed in a position to ensure that the equipment can quickly and accurately sense the smoke produced in the early stage of the fire.
4. Independent smoke and temperature detectors can be installed in the closed aisle according to the actual needs in the micro-module.