Camera Lightning Protection and Earthing Engineering Guide

Date **2025-11-21**

Contents

1 Scope

This document describes the lightning protection measures, earthing methods, as well as the lightning protection and earthing requirements for the engineering design and installation of outdoor pole-mounted or wall-mounted cameras and Micro Edge devices. It also specifies the cross-sectional areas, materials, and lengths of the ground cables connected to the cameras and devices, ensuring the lightning protection, electric shock protection, and anti-interference performance of the cameras and devices.

2 Normative References

The following reference documents are indispensable for the application of this document. This document is not subject to any subsequent change (excluding error correction) to or revision of any dated document among the reference documents, provided that the parties to any agreement concluded based on this document are encouraged to consider whether the latest version of such reference documents will be applicable. For an undated reference document, its latest version (including all revisions) applies to this document.

No.	Document No.	Document Name
1	IEC62305-1	Protection against lightning – Part 1: General principles
2	IEC62305-2	Protection against lightning – Part 2: Risk management
3	IEC62305-3	Protection against lightning – Part 3: Physical damage to structures and life hazard
4	IEC62305-4	Protection against lightning – Part 4: Electrical and electronic systems within structures
5	IUT-T K.27	Bonding configurations and earthing inside a telecommunication building
6	GB 50689	Code for design of lightning protection and earthing engineering for telecommunication bureaus (stations)

3 Terms and Acronyms

Earth

Conductive stratum, whose electric potential at any point is usually regarded as zero.

Earthing

The process of connecting the exposed conductive parts of a device or system to other parts of the earthing network or the earthing system.

Equipotential bonding

The process of electrically connecting metalwork and conductive parts, both exposed and extraneous.

Earthing network

A metal conductor that is buried under the ground and directly connected to the ground. A natural earthing network can act as an earthing network that is directly connected to the ground. The natural earthing network can be metal components, metal well casings, reinforced concrete foundations, as well as metal pipes and devices.

Protective earth

The earthing of the metal shell.

Acronym	Full Name
PE	Protective Earth

4 General Requirements

4.1 General Rules

Rule 1: The earthing design should follow the principle of equipotential bonding, that is, a combined grounding method, where the working earthing and protective earthing are connected to a common grounding electrode.

Rule 2: The ground resistance should comply with related regulations of the local country or carrier.

Rule 3: Use the ground cables made of yellow and green plastic insulated copper core wires or those complying with local laws and regulations.

Rule 4: The network box must be installed close to the camera to ensure that the cable between them is as short as possible. In common installation environments, the cable length should not exceed 10 m. In harsh installation environments, the cable length should not exceed 5 m.

Rule 5: Route cables through metal poles (or metal pipes). If the distance is long, bury the cables underground or route them along walls. Do not route cables overhead.

Rule 6: The length of 24 V AC cables should not exceed 30 m, and the length of 12 V DC cables should not exceed 10 m when the voltage drop is within the allowed range.

Rule 7: In outdoor environments, after the 220 V AC power cable is connected to the network box, install and ground a surge protector.

Rule 8: In harsh installation environments, a network port surge protector must be installed in the network box and grounded.

Rule 9: Do not use other devices (such as a network box) as the components for electrical connections of PGND cables.

Rule 10: The metal reinforcing rib of the optical fiber is connected to the ground copper bar through the yellow and green ground cable with a cross-sectional area of at least 4 mm^2.

Rule 11: When connecting cables, wrap at least five layers of insulation tape around the connectors to ensure reliable insulation.

Rule 12: The device must not be grounded by using the downlead of the lightning belt or lightning rod of the building.

Rule 13: A ground cable should be no longer than 30 m and be kept as short as possible. If a ground cable is longer than 30 m, a ground bar should be installed at a place close to the device.

4.2 Principles for Classifying Installation Environments of Cameras and Network Boxes

There are two types of installation environments for cameras and network boxes: common environments and harsh environments, according to whether camera cables are exposed to direct lightning strikes.

Common installation environments refer to environments where camera cables are not exposed to direct lightning strikes, for example, poles on the urban street and walls outside the building.

Harsh installation environments refer to environments where camera cables are exposed to direct lightning strikes, for example, open fields, lakeside, tower-mounted installation, installation on a metal pole on the roof of a building, pole-mounted installation in non-urban/open areas, and installation on lamp poles in urban areas. In such environments, the risk of direct lightning strikes must be considered.

The equipment room is classified as a common installation environment for Micro Edge devices, whereas outdoor cabinets are classified as harsh installation environments.

5 Earthing Solutions for SDCs and Network Boxes

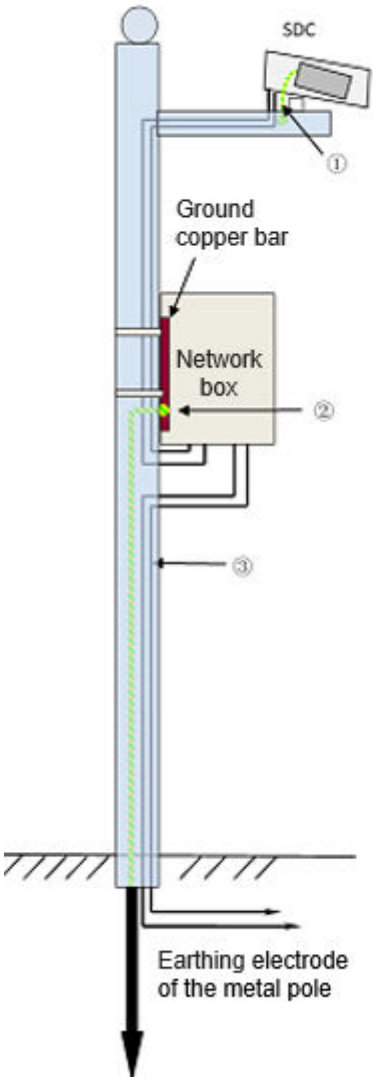
5.1 Earthing Solutions for SDCs and Network Boxes in Common Installation Environments

This section describes the earthing solutions for outdoor SDCs and network boxes in common installation environments, to reduce lightning strike accidents and avoid personal safety accidents. In principle, the earthing of the devices must comply with the standard earthing specifications.

5.1.1 Earthing Through the Earthing Electrode of the Metal Pole

If an SDC is installed on a metal pole that has an earthing electrode, use the earthing electrode of the metal pole for the earthing of the SDC and network box. For example, in most new video security projects, the earthing electrode of a dedicated metal pole is used for earthing.

Figure 5-1 Earthing through the earthing electrode of the metal pole



Note:

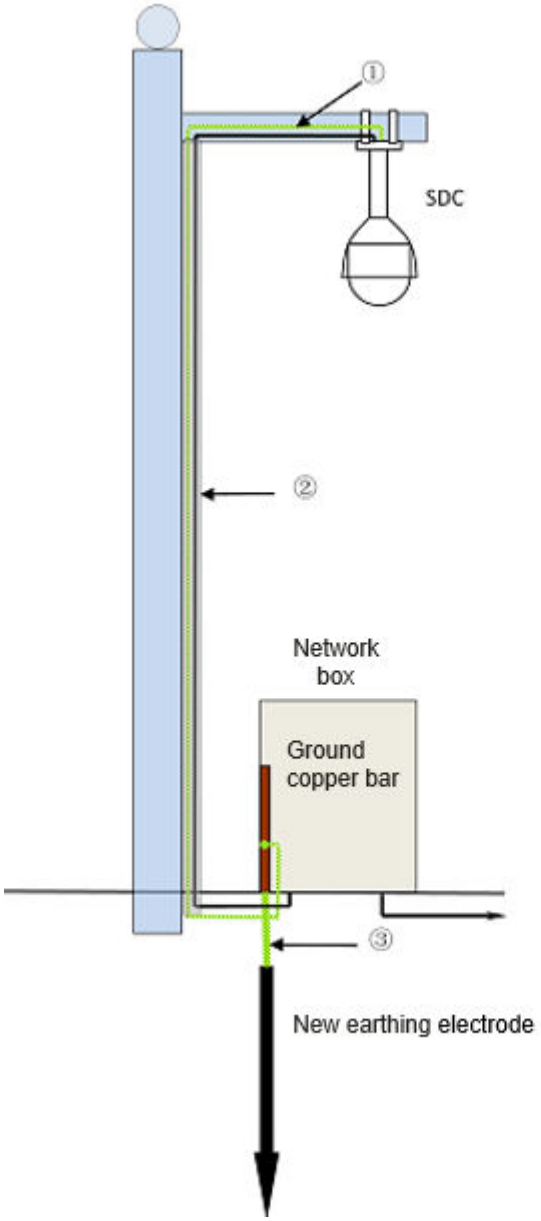
1. The SDC is connected to the metal pole or the ground copper bar in the network box by using a ground cable with a cross-sectional area of at least 4 mm^2. If the SDC ground cable, SDC metal shell, metal support, and metal pole are connected properly, the SDC can also be grounded through metal mechanical parts.
2. The network box can be installed on a pole or on the ground. The ground copper bar in the network box is connected to the earthing electrode of the metal pole by using a ground cable with a cross-sectional area of at least 16 mm^2. When the network box is installed on a pole, if the ground copper bar, network box, and metal pole are connected properly, the ground copper bar can also be grounded through the metal pole.
3. Cables are routed through the metal pole and buried underground. They must not be routed overhead.

4. The protective earth of the grounding device inside the network box is connected to the ground copper bar by using a yellow and green ground cable.

5.1.2 Earthing Through a New Earthing Electrode

If no earthing electrode is available near the SDC, you can create one for earthing. For details, see **Appendix A Requirements for Creating an Earthing Electrode**. This earthing solution is applicable to SDC installation on legacy poles (such as lamp poles, traffic light poles, and utility poles) or external walls.

Figure 5-2 Earthing through a new earthing electrode



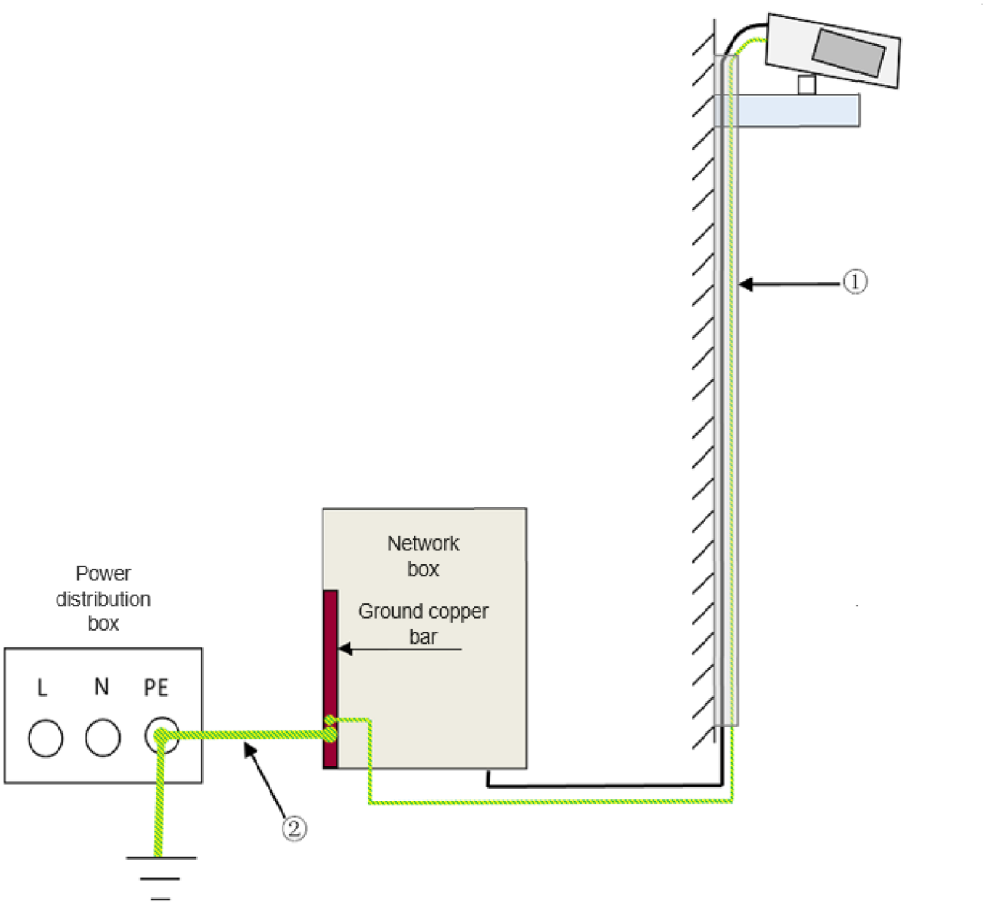
Note:

1. The SDC is connected to the earthing electrode or the ground copper bar in the network box by using a ground cable with a cross-sectional area of at least 4 mm^2.
2. Cables are routed through PVC pipes along the pole (wall) and buried underground. They must not be routed overhead.
3. The ground copper bar is connected to the earthing electrode by using a ground cable with a cross-sectional area of at least 16 mm^2.
4. The protective earth of the grounding device inside the network box is connected to the ground copper bar by using a yellow and green ground cable.

5.1.3 Earthing Through the PE Cable of AC Power Supply

The SDC can also be grounded through the PE cable, provided that the AC distribution PE cable is reliably grounded. If the ground cable is longer than 30 m, you are advised to use a new earthing electrode.

Figure 5-3 Earthing through the PE cable of AC power supply



Note:

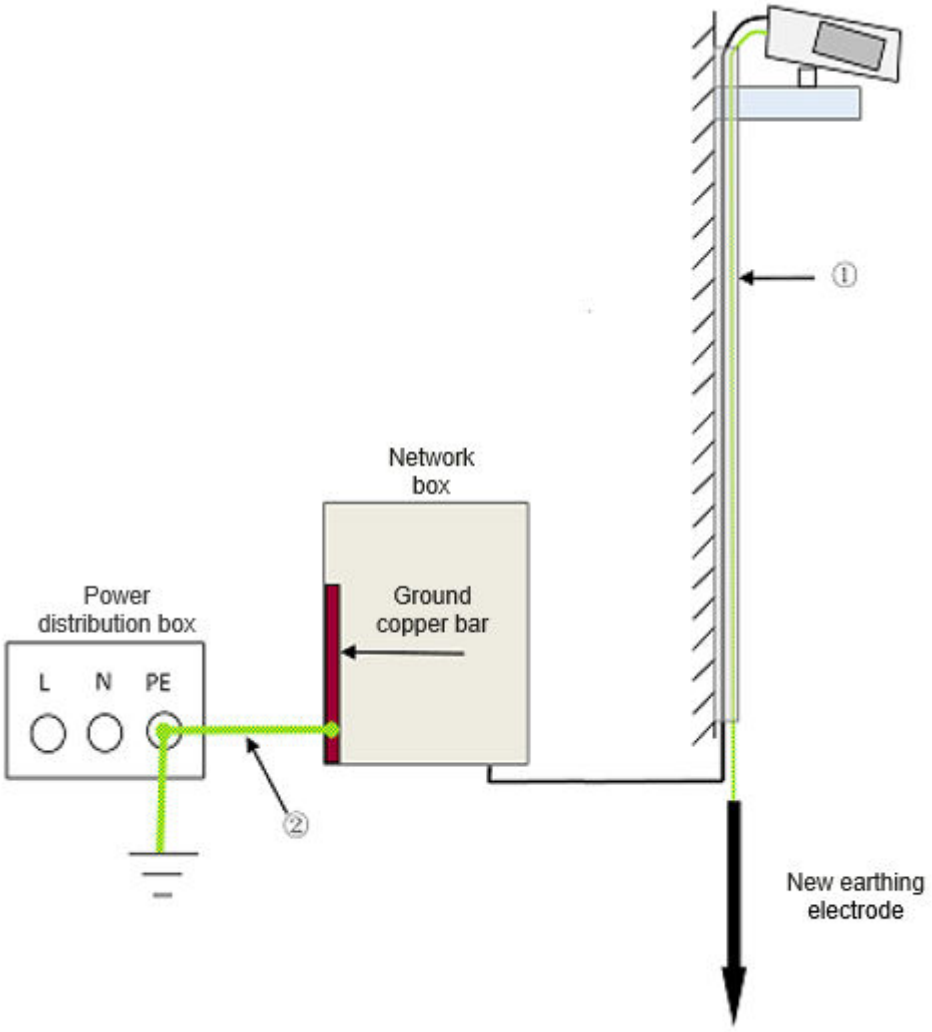
1. The SDC is connected to the PE cable or the ground copper bar in the network box by using a ground cable with a cross-sectional area of at least 4 mm^2. If an SDC uses a floating ground design, the SDC does not need to be grounded.

2. Cables are routed through pipes along the wall (pole). They must not be routed overhead.
3. The ground copper bar is connected to the PE cable in the PDF by using a ground cable with a cross-sectional area of at least 16 mm^2.
4. The protective earth of the grounding device inside the network box is connected to the ground copper bar by using a yellow and green ground cable.

5.1.4 Earthing in Hybrid Mode

If the network box is far from the SDC, connect the SDC and network box to their closest earthing points. The SDC and network box can be grounded according to any of the three methods described in the preceding sections.

Figure 5-4 Earthing in hybrid mode



Note:

1. The SDC is connected to a new earthing electrode by using a ground cable with a cross-sectional area of at least 4 mm^2. If an SDC uses a floating ground design, the SDC does not need to be grounded.

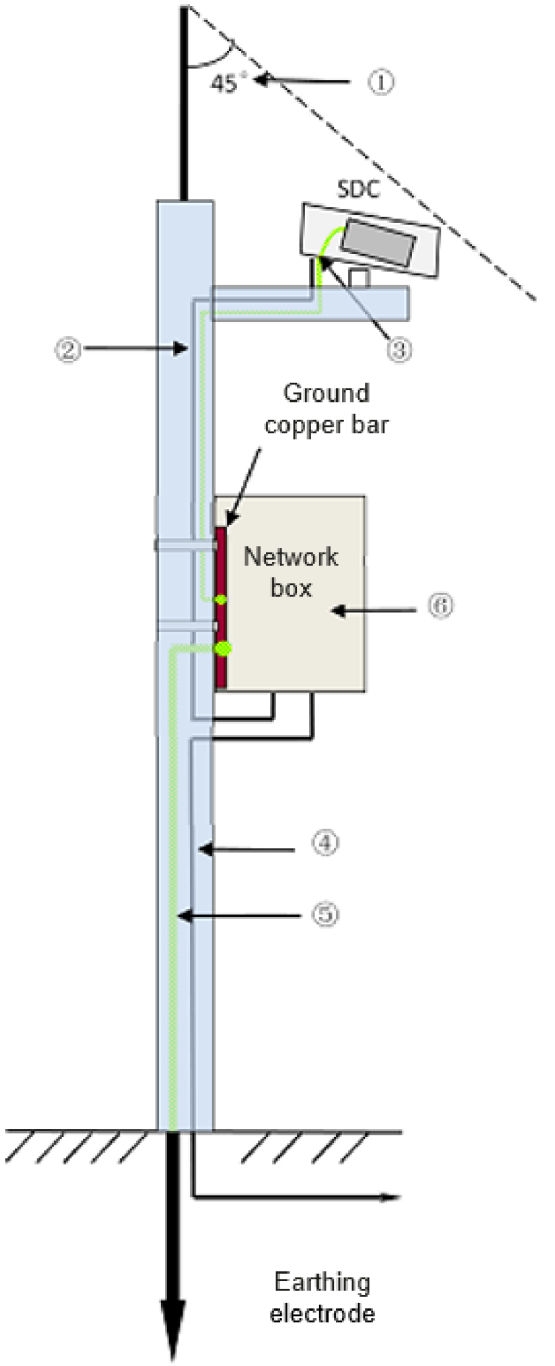
2. Cables are routed through pipes along the wall (pole). They must not be routed overhead.
3. The ground copper bar is connected to the PE cable in the PDF by using a ground cable with a cross-sectional area of at least 16 mm^2.
4. The protective earth of the grounding device inside the network box is connected to the ground copper bar by using a yellow and green ground cable.

5.2 Earthing Solutions for SDCs and Network Boxes in Harsh Installation Environments

If an SDC is installed in a harsh environment, you are advised to take the following surge protection measures based on the preceding earthing solutions: 1. Install a lightning rod and mount the SDC within the 45-degree effective protection range of the rod. 2. Place the SDC close to the network box, and connect the SDC and network box to their closest earthing points. 3. If the network box cannot be installed close to the SDC, install a surge protector near the SDC and place the surge protector in a waterproof box.

5.2.1 Installing the SDC Close to the Network Box

Figure 5-5 Installing the SDC close to the network box in harsh environments



Note:

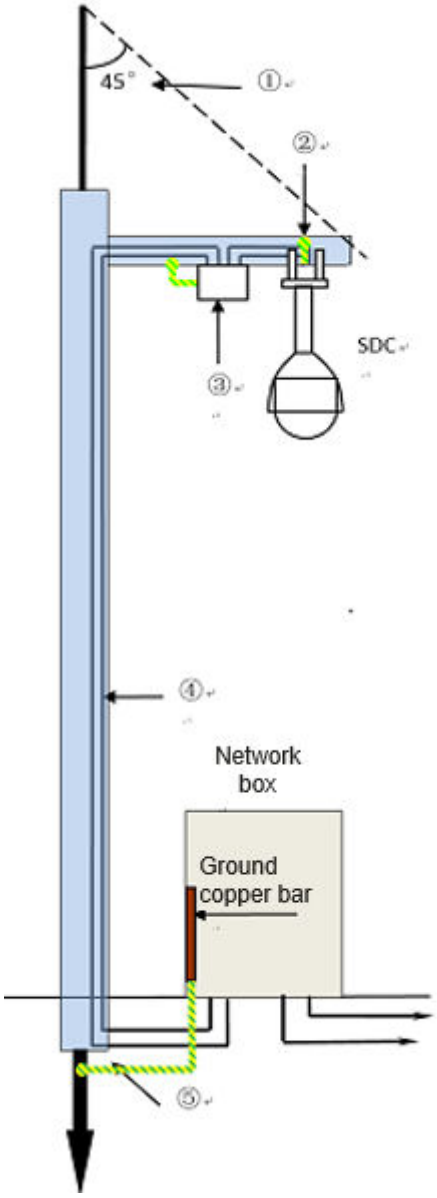
1. The SDC and network box must be within the 45-degree protection range of the lightning rod.
2. The network box is placed close to the SDC, and the cabling distance must be 5 m at most.

3. The SDC is connected to the ground copper bar in the network box by using a ground cable with a cross-sectional area of at least 4 mm^2.
4. Cables are routed along the tower (or through metal poles) and buried underground. They must not be routed overhead.
5. The ground copper bar in the network box is connected to the nearest tower (or metal pole) or directly to the earthing electrode by using a ground cable with a cross-sectional area of at least 16 mm^2.

5.2.2 Installing a Surge Protector on the SDC Side

If the network box cannot be installed close to the SDC, install a surge protector on the SDC side and place the surge protector in a waterproof box. In this solution, all the cables that have been routed from the SDC to the network box must be connected to the surge protector.

Figure 5-6 Installing a surge protector on the SDC side in harsh environments



Note:

1. The SDC and network box must be within the 45-degree protection range of the lightning rod.
2. The SDC is connected to the nearest tower (or metal pole) by using a ground cable with a cross-sectional area of at least 4 mm^2.
3. The power cable and network cable from the SDC are connected to the surge protector near the SDC. The surge protector is connected to the nearest tower (or metal pole) through a ground cable with a cross-sectional area of at least 6 mm^2. The surge protector must be placed in a waterproof box for proper waterproofing. For details about how to install the waterproof box, see the related instructions. Ensure that the cable outlet faces downwards.
4. Cables are routed along the tower (or through metal poles). They must not be routed overhead.
5. The ground copper bar is connected to the earthing electrode by using a ground cable with a cross-sectional area of at least 16 mm^2.

6 Surge Protector Installation Solutions for SDCs and Network Boxes in Outdoor Scenarios

6.1 Surge Protector Installation Solution for Adapter Power Supply

Figure 6-1 Installation solution in harsh environments

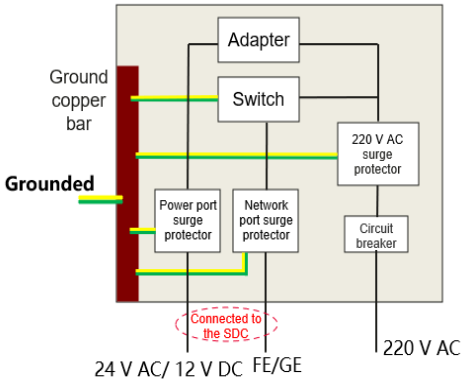


Figure 6-2 Installation solution in common environments

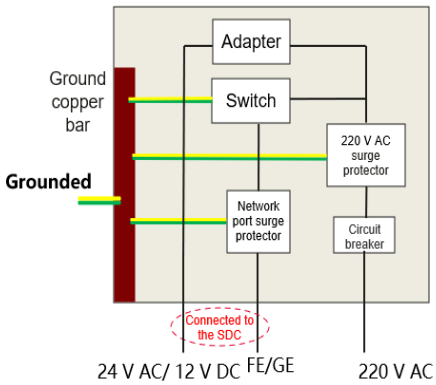
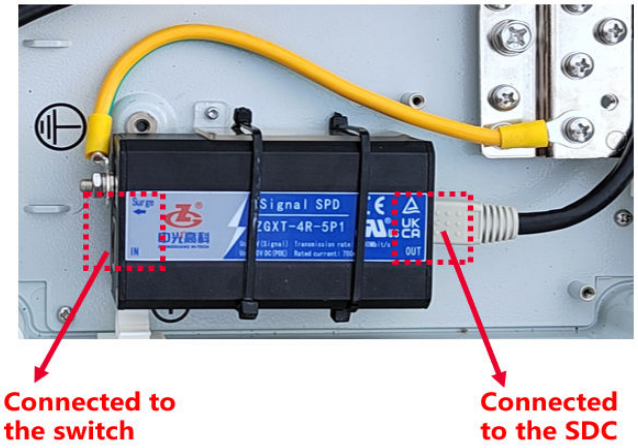


Figure 6-3 Installation directions of a network port surge protector in a network box



Note:

1. The mains cable should be connected to the surge protector after entering the network box to protect the adapter and switch. If the network box is installed indoors and the building has already implemented surge protection for the mains power supply, it is not necessary to install a 220 V AC surge protector in the network box.
2. In common installation environments, you are advised to connect the switch's network cable to a network port surge protector before routing the cable out of the network box.
3. In harsh installation environments, the network box must be installed close to the SDC. If the network box cannot be installed close to the SDC, a surge protector can be installed on the SDC side. For details, see **6.4 Surge Protector Installation Solution When the SDC Is Far Away from the Network Box**.
4. In harsh installation environments, the switch's network cable must be connected to a network port surge protector before being routed out of the network box. When the SDC is installed in a harsh environment and the power cable is longer than 5 m, a power port surge protector must be installed on the adapter output side.
5. The protective earth of the switch is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 4 mm^2. The surge protector is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 6 mm^2. The ground copper bar is grounded by using a ground cable with a cross-sectional area of at least 16 mm^2.
6. In the network box, the IN port of the network port surge protector is connected to the switch's network port through a network cable, and the OUT port is connected to SDC's network port through a network cable. Do not reverse the connections.

6.2 Surge Protector Installation Solution for 220 V AC Mains Supply

Figure 6-4 Surge protector installation solution for 220 V AC mains supply

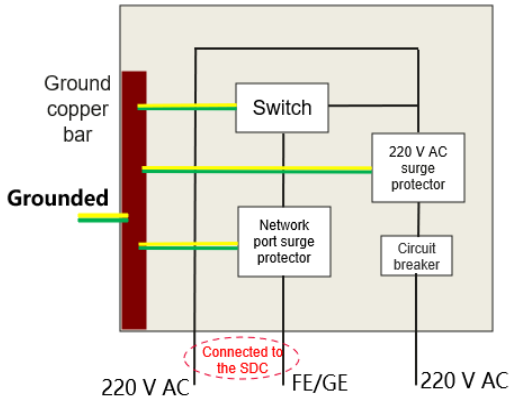
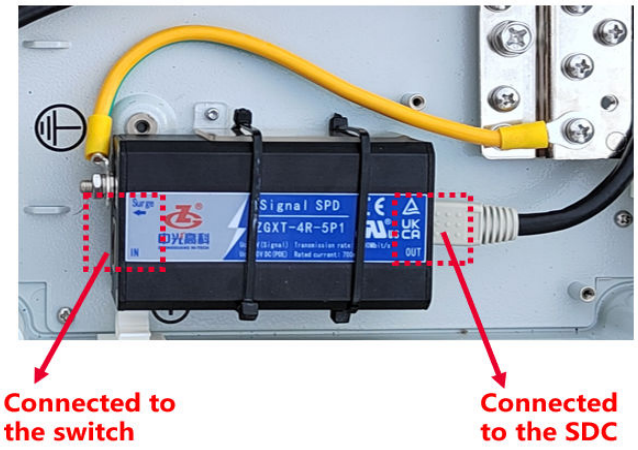


Figure 6-5 Installation directions of a network port surge protector in a network box



Note:

1. The 220 V mains cable should be connected to the surge protector after entering the network box. It is recommended that a 3–5 m power cable be connected between the surge protector and the protected SDC for effective decoupling. If the network box is installed indoors and the building has already implemented surge protection for the mains power supply, it is not necessary to install a 220 V AC surge protector in the network box.
2. The network box should be placed as close as possible to the SDC. In common installation environments, a distance of no more than 10 meters is recommended, while in harsh installation environments, the distance should not exceed 5 meters.
3. In harsh installation environments, the switch's network cable should be connected to a network port surge protector before being routed out of the

network box. In common installation environments, if the network cable length does not exceed 10 m and is routed entirely through metal poles (pipes), no network port surge protector is required. In this case, the metal poles (pipes) must be properly grounded.

4. The protective earth of the switch is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 4 mm^2. The surge protector is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 6 mm^2. The ground copper bar is grounded by using a ground cable with a cross-sectional area of at least 16 mm^2.
5. In the network box, the IN port of the network port surge protector is connected to the switch's network port through a network cable, and its OUT port is connected to SDC's network port through a network cable. Do not reverse the connections.

6.3 Surge Protector Installation Solution for PoE Power Supply

Figure 6-6 Installation solution when the switch does not support PoE

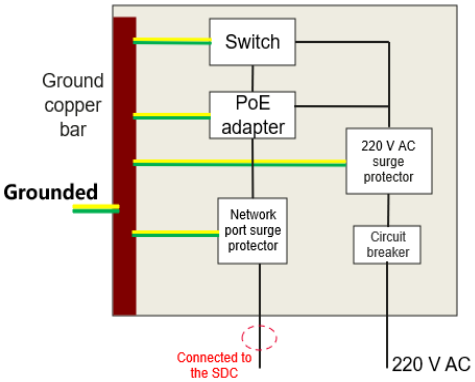


Figure 6-7 Installation solution when the switch supports PoE

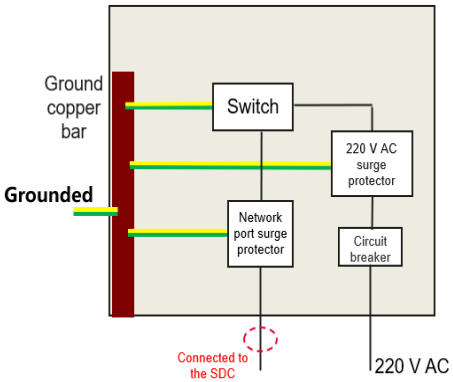
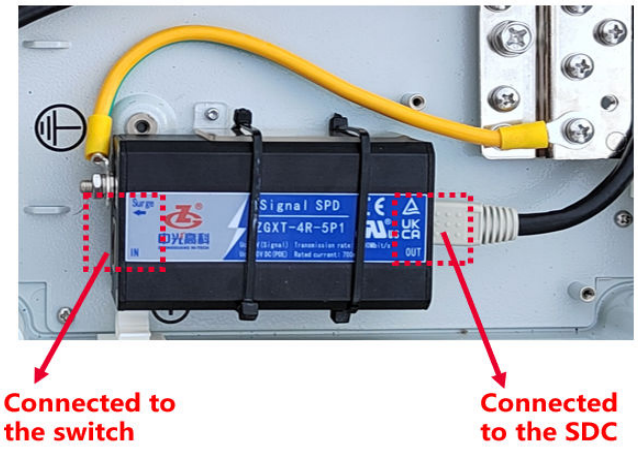


Figure 6-8 Installation directions of a network port surge protector in a network box



Note:

1. The 220 V mains cable should be connected to the surge protector after entering the network box. If the network box is installed indoors and the building has already implemented surge protection for the mains power supply, it is not necessary to install a 220 V AC surge protector in the network box.
2. In common installation environments, you are advised to connect the PoE network cable to a network port surge protector before routing the cable out of the network box. In harsh installation environments, the network cable should be connected to a network port surge protector before being routed out of the network box. The surge protector must not be installed between the switch and the PoE adapter.
3. In harsh installation environments, the network box must be installed close to the SDC. If the network box cannot be installed close to the SDC, a surge protector can be installed on the SDC side. For details, see **6.4 Surge Protector Installation Solution When the SDC Is Far Away from the Network Box**.
4. The protective earth of the switch is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 4 mm^2. The surge protector is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 6 mm^2. The ground copper bar is grounded by using a ground cable with a cross-sectional area of at least 16 mm^2.
5. In the network box, the IN port of the network port surge protector is connected to the switch's network port through a network cable, and its OUT port is connected to SDC's network port through a network cable. Do not reverse the connections.

6.4 Surge Protector Installation Solution When the SDC Is Far Away from the Network Box

If the cable between the SDC and the network box is longer than 10 m, a surge protector should be installed close to the SDC and placed in a waterproof box.

Figure 6-9 Installing a surge protector in a waterproof box close to the SDC

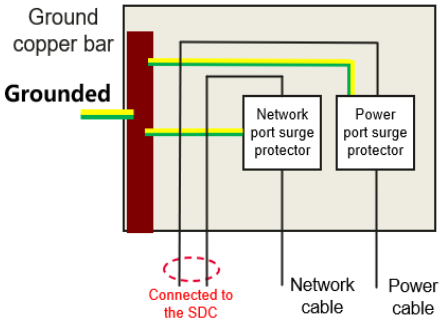
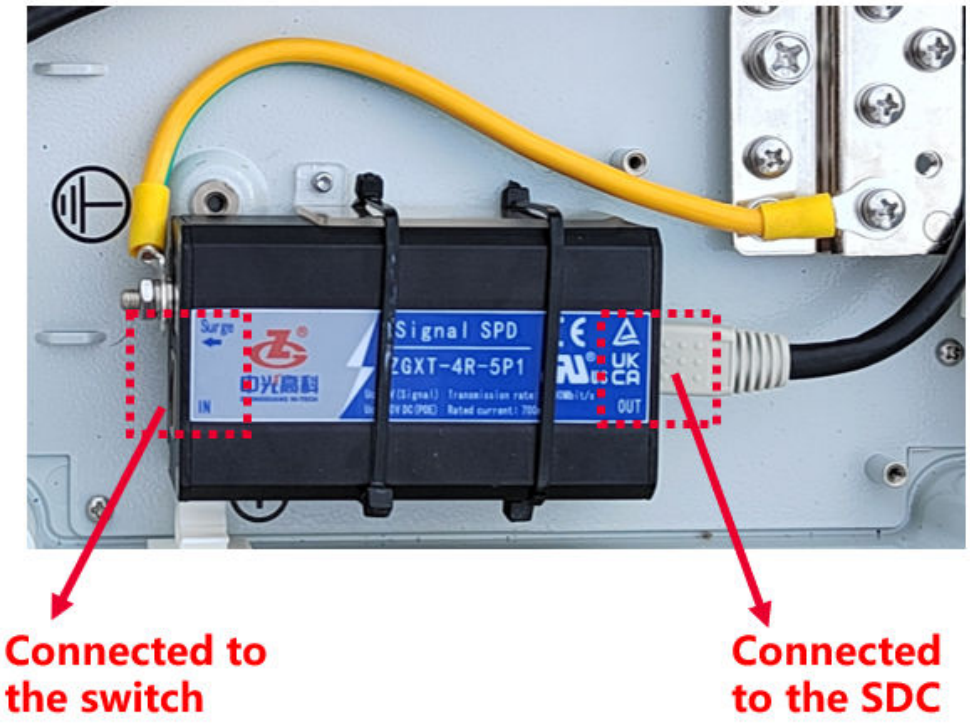


Figure 6-10 Waterproof box installation illustration

Figure 6-11 Installation mode of the network port surge protector in the waterproof box close to the SDC



Note:

1. Select an appropriate power port surge protector based on the actual power voltage and ground the surge protector.
2. The surge protector is connected to the ground copper bar by using a ground cable with a cross-sectional area of at least 6 mm^2. The ground copper bar is grounded by using a ground cable with a cross-sectional area of at least 16 mm^2.
3. In the waterproof box, the IN port of the network port surge protector is connected to the switch's network port through a network cable, and its OUT port is connected to SDC's network port through a network cable. Do not reverse the connections.

7 Surge Protection and Earthing Solutions for Micro Edge Products

7.1 Solution for a PoE NVR/IVS Device Directly Connected to an Outdoor Camera

Figure 7-1 Surge protection and earthing solution for an NVR/IVS device directly connected to an outdoor camera

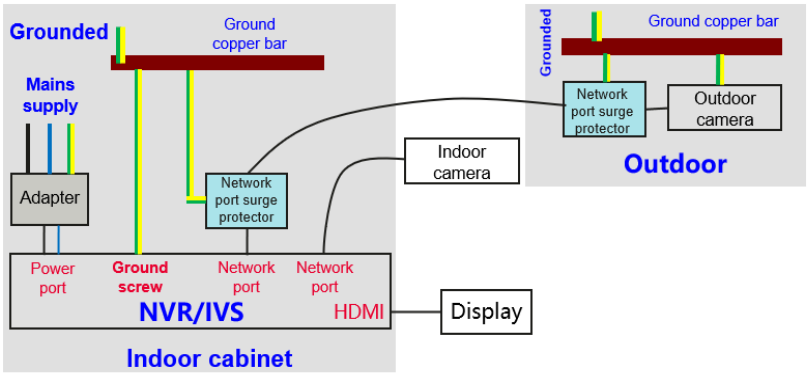
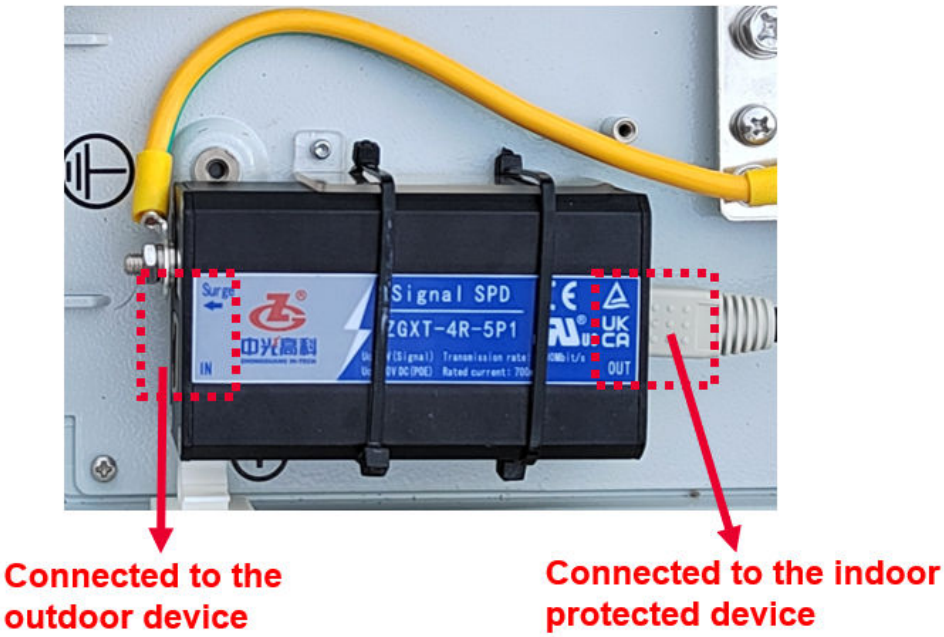


Figure 7-2 Installation directions of a network port surge protector



Note:

1. The NVR/IVS device is connected to the nearest ground copper bar through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw. If the device is installed in a cabinet, it should be connected to the nearest ground copper bar of the cabinet.
2. For the NVR/IVS device directly connected to the outdoor camera, a network port surge protector must be installed at the NVR/IVS network port connected to the outdoor camera. The surge protector must be connected to the ground copper bar through a ground cable with a cross-sectional area of at least 6 mm^2.
3. The ground copper bar is grounded by using a ground cable with a cross-sectional area of at least 16 mm^2. The ground impedance is less than or equal to 10 ohms.
4. The OUT port of the network port surge protector is connected to the indoor protected device through a network cable, and the IN port is connected to the outdoor device. Do not reverse the connections.

7.2 Solution for a Non-PoE NVR/IVS Device Connected to a Switch

Figure 7-3 Surge protection and earthing solution for an NVR/IVS device connected to an indoor switch

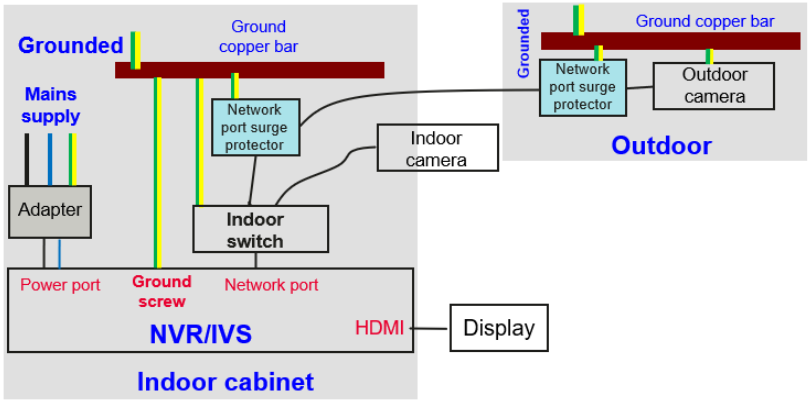


Figure 7-4 Surge protection and earthing solution for an NVR/IVS device connected to an outdoor switch

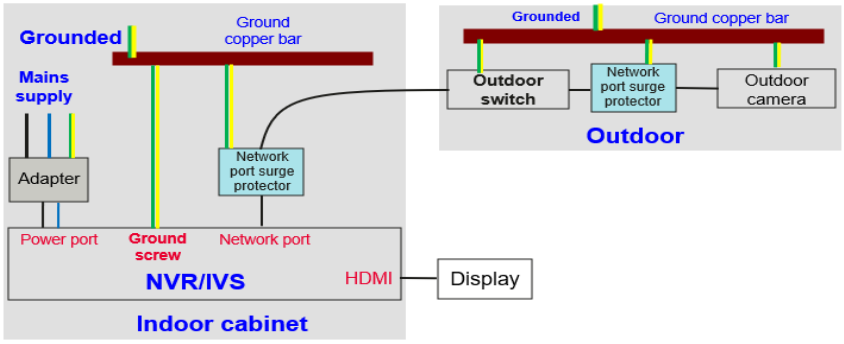
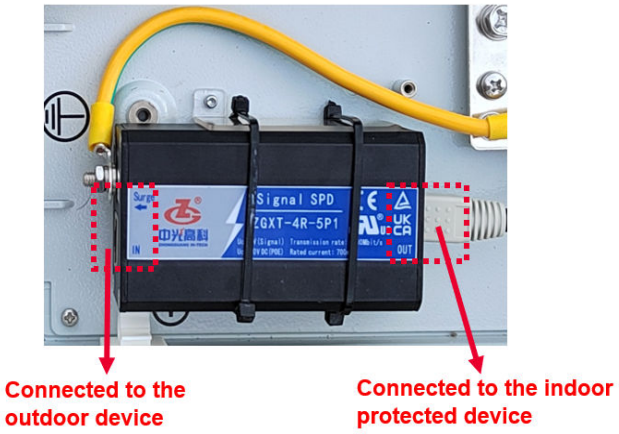


Figure 7-5 Installation directions of a network port surge protector



Note:

1. The NVR/IVS device is connected to the nearest ground copper bar through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw. If the device is installed in a cabinet, it should be connected to the nearest ground copper bar of the cabinet.
2. The switch is connected to the nearest ground copper bar through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw. If the switch is installed in a cabinet, it should be connected to the nearest ground copper bar of the cabinet.
3. If the switch directly connects to an outdoor camera, a network port surge protector must be installed at the NVR/IVS network port connected to the switch. The surge protector must be connected to the ground copper bar through a ground cable with a cross-sectional area of at least 6 mm^2.
4. If the NVR/IVS device directly connects to an outdoor camera, a network port surge protector must be installed at the NVR/IVS network port connected to the outdoor camera. The surge protector must be connected to the ground copper bar through a ground cable with a cross-sectional area of at least 6 mm^2.
5. The ground copper bar is grounded by using a ground cable with a cross-sectional area of at least 16 mm^2. The ground impedance is less than or equal to 10 ohms.
6. The OUT port of the network port surge protector is connected to the indoor protected device through a network cable, and the IN port is connected to the outdoor device. Do not reverse the connections.

7.3 Solution for a Non-PoE NVR/IVS Device Powered by 220 V AC and Connected to a Switch

Figure 7-6 Surge protection and earthing solution for an NVR/IVS device powered by 220 V AC and connected to an indoor switch

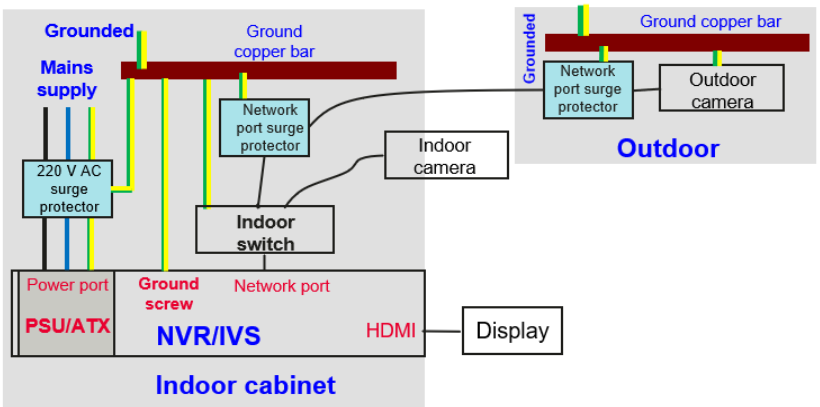


Figure 7-7 Surge protection and earthing solution for an NVR/IVS device powered by 220 V AC and connected to an outdoor switch

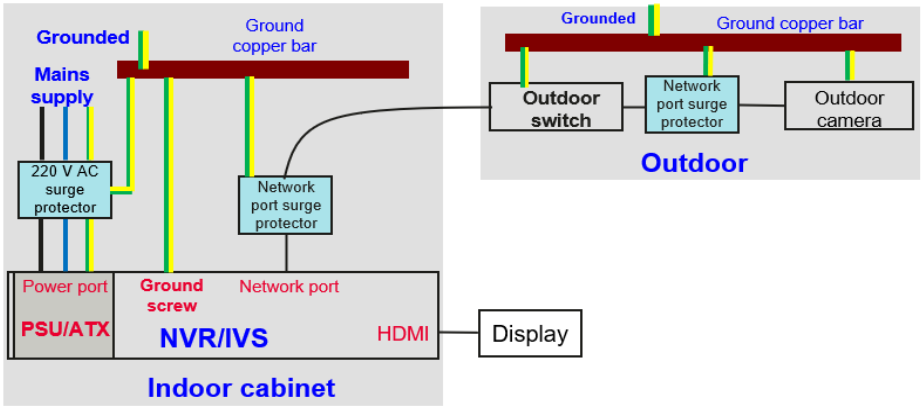
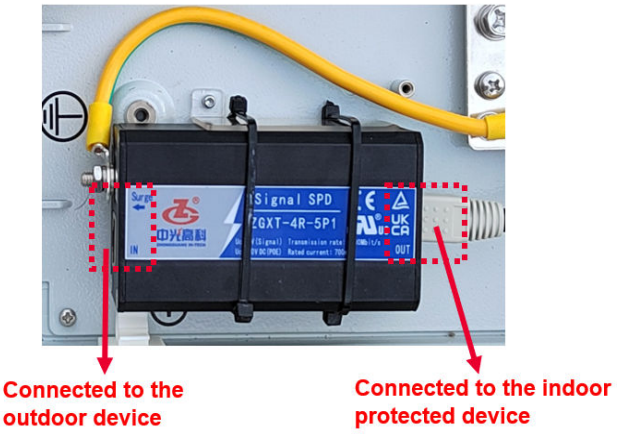


Figure 7-8 Installation directions of a network port surge protector



Note: (mainly for the NVR/IVS device with 8 or 16 disk trays)

1. The NVR/IVS device is connected to the nearest ground copper bar through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw. If the device is installed in a cabinet, it should be connected to the nearest ground copper bar of the cabinet.
2. A 220 V AC surge protector must be installed at the power port, and is connected to the ground copper bar through a ground cable with a cross-sectional area of at least 6 mm^2. If the cabinet has already implemented surge protection for the 220 V AC power supply, the 220 V AC surge protector is not required for the NVR/IVS device.
3. The switch is connected to the ground copper bar through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw. If the switch is installed in a cabinet, it should be connected to the nearest ground copper bar of the cabinet.
4. If the switch is installed in an indoor cabinet and directly connected to an outdoor camera, a network port surge protector must be installed at the switch's network port connected to the outdoor camera. In addition, the surge protector is connected to the ground copper bar through a ground cable with a cross-sectional area of at least 6 mm^2.

5. If the switch is installed in an outdoor cabinet, a network port surge protector must be installed at the NVR/IVS network port connected to the switch. The surge protector must be connected to the ground copper bar through a ground cable with a cross-sectional area of at least 6 mm^2.
6. The ground copper bar is reliably grounded by using a ground cable with a cross-sectional area of at least 16 mm^2. The ground impedance is less than or equal to 10 ohms.
7. The OUT port of the network port surge protector is connected to the indoor protected device through a network cable, and the IN port is connected to the outdoor device. Do not reverse the connections.

7.4 Solution for an Outdoor Device (Such as the ITS800)

Figure 7-9 Surge protection and earthing solution for an outdoor Micro Edge device

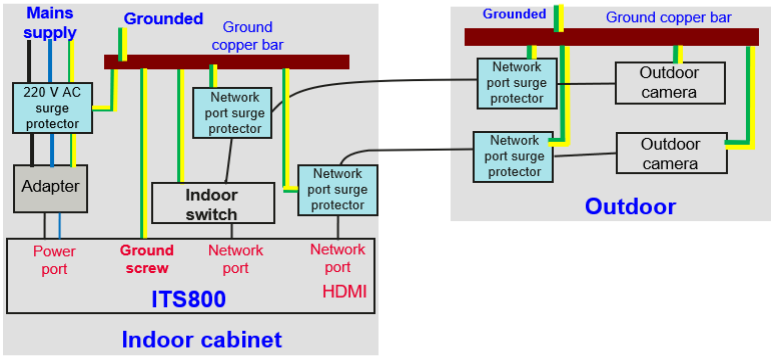
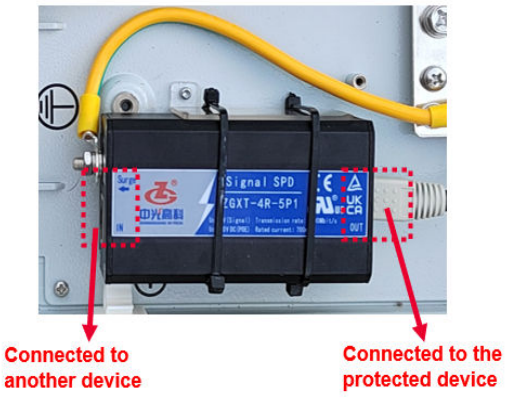


Figure 7-10 Installation directions of a network port surge protector



Note:

1. The ITS800 is connected to the nearest ground copper bar of the cabinet through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw.

2. The switch is connected to the nearest ground copper bar of the cabinet through a ground cable with a cross-sectional area of at least 4 mm^2 from the ground screw.
3. The power adapter must be connected to a 220 V AC surge protector, and the surge protector is connected to the ground copper bar of the cabinet through a ground cable with a cross-sectional area of at least 6 mm^2. If the cabinet has already implemented surge protection for the 220 V AC power supply, the 220 V AC surge protector is not required for the ITS800.
4. A network port surge protector must be installed at the ITS800's network port that is directly connected to an outdoor switch or camera. A network port surge protector is installed at each network port, and is connected to the ground copper bar of the cabinet through a ground cable with a cross-sectional area of at least 6 mm^2.
5. The ground copper bar of the cabinet is reliably grounded through a ground cable with a cross-sectional area of at least 16 mm^2. The ground impedance is less than or equal to 10 ohms.
6. The OUT port of the network port surge protector is connected to the protected device through a network cable, and the IN port is connected to another device. Do not reverse the connections.

8 Acceptance Checklist for Surge Protection and Earthing

After site installation is complete, accept surge protection and earthing items against this checklist.

No.	Information Category	Self-check Item	Self-check Result
1	Pole-mounted installation	A lightning rod is installed on the pole.	
2		Installation positions of the lightning rod and camera: The camera is within the protection range of the lightning rod (45° downtilt range of the lightning rod).	
3		Earthing of site poles: The ground resistance is less than or equal to 10 ohms for a metal pole or concrete pole.	
4	Camera information	The camera and the surge protector in the network box are grounded together. The impedance between them is less than or equal to 4 ohms.	
5	Camera ground cable	The camera ground point or pigtail ground cable is reliably grounded.	
6		The camera ground cable should be as short as possible and grounded nearby.	
7		Cross-sectional area of the ground cable: ≥ 4 mm^2 in a network box; ≥ 16 mm^2 out of a network box	
8		The color of the ground cable complies with the Chinese national standard (yellow-green).	

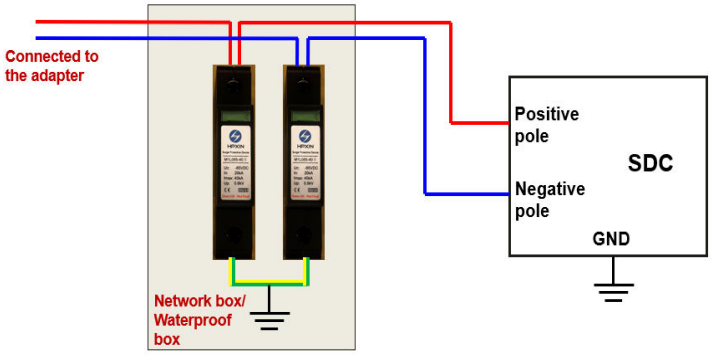
No.	Information Category	Self-check Item	Self-check Result
9	Surge protector	The surge protector installed in the network box or cabinet complies with **Table 2 Surge protector specifications**.	
10		The surge protector is reliably grounded (usually by using the ground copper bar in the pole-mounted box).	
11		The surge protector is correctly installed, without being damaged or reversely connected.	
12	Earthing of the network box/ cabinet	A ground copper bar is required in both the network box and the cabinet.	
13		The network box and the devices inside the cabinet are connected to the ground copper bar through ground cables.	
14		The ground copper bars of the network box and cabinet are reliably connected to the ground through ground cables.	
15	Cables	Cables are intact without damage or breakage.	
16	Micro Edge device	The Micro Edge device in the cabinet is reliably grounded, and the impedance between them is less than or equal to 4 ohms.	
17		The ground cable of the Micro Edge device should be as short as possible and the device is grounded nearby.	
18		The cross-sectional area of the ground cable of the Micro Edge device is greater than or equal to 4 mm^2.	
19		The color of the ground cable complies with the Chinese national standard (yellow-green).	

A Surge Protector Installation Guide

A.1 24 V AC/48 V DC Power Surge Protectors

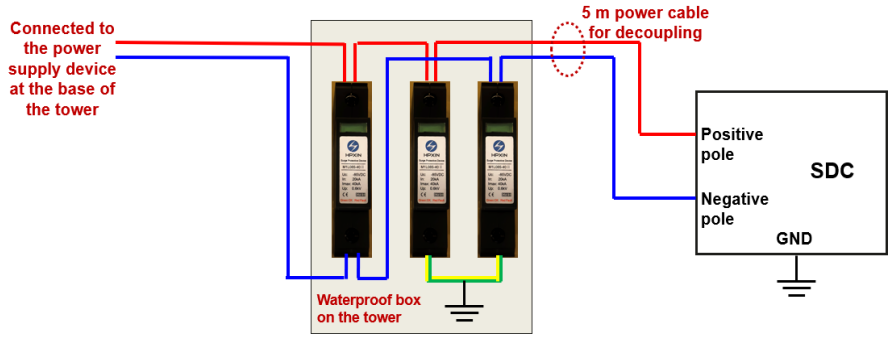
Power surge protectors must be installed for cameras in harsh environments. If the 24 V AC/48 V DC power surge protector is used, install the surge protector according to the following figure in all scenarios (excluding the tower-mounted scenario). If the network box is installed close to the surge protector, install the surge protector in the network box. If the network box cannot be installed close to the SDC, install a surge protector on the SDC side. In this case, install the surge protector in a waterproof box close to the SDC. Note that both the surge protector and earthing-model SDC must be grounded.

Figure A-1 Installation specifications for the 24 V AC/48 V DC power surge protector in all scenarios (excluding the tower-mounted scenario)



When a camera is installed on a tower, a power surge protector must be installed. The following figure shows the surge protector installation specifications in the tower-mounted scenario. In this case, install the surge protector in the waterproof box close to the SDC on the tower. It is recommended that a 5 m power cable be connected between the surge protector and the protected SDC for effective decoupling. Both the surge protector and the SDC must be grounded.

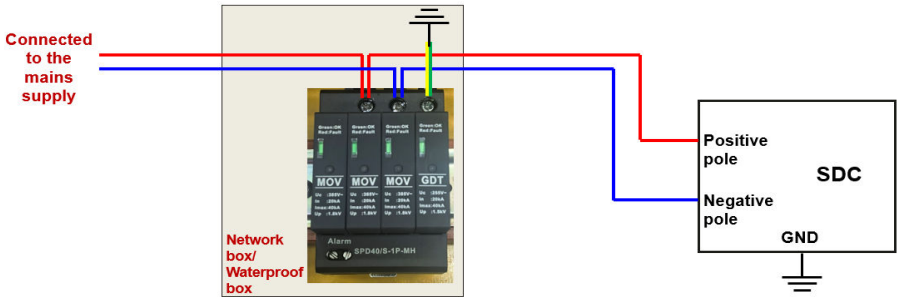
Figure A-2 Installation specifications for the 24 V AC/48 V DC power surge protector in the tower-mounted scenario



A.2 220 V AC Power Surge Protectors

In outdoor scenarios, a surge protector must be installed for the SDC powered by 220 V AC. The following figure shows the installation specifications for the 220 V AC power surge protector. The surge protector must be placed in a network box or waterproof box and close to the SDC. Both the surge protector and the SDC must be grounded.

Figure A-3 Installation specifications for the 220 V AC power surge protector



A.3 Network Port Surge Protectors

In common environments, it is recommended that a network port surge protector be installed for the SDC. In harsh environments, a network port surge protector must be installed for the SDC. The following figure shows the installation specifications for the network port surge protector. To protect the SDC, connect the OUT port of the network port surge protector to the SDC. If the network box is installed close to the surge protector, install the surge protector in the network box. If the network box cannot be installed close to the SDC, install a surge protector on the SDC side. In this case, install the surge protector in a waterproof box close to the SDC. Note that both the network port surge protector and earthing-model SDC must be grounded.

Figure A-4 Installation specifications for the network port surge protector

CAUTION

Note that the OUT port of the network port surge protector must be connected to the protected device, and the surge protector must be grounded. Do not reverse the connections.

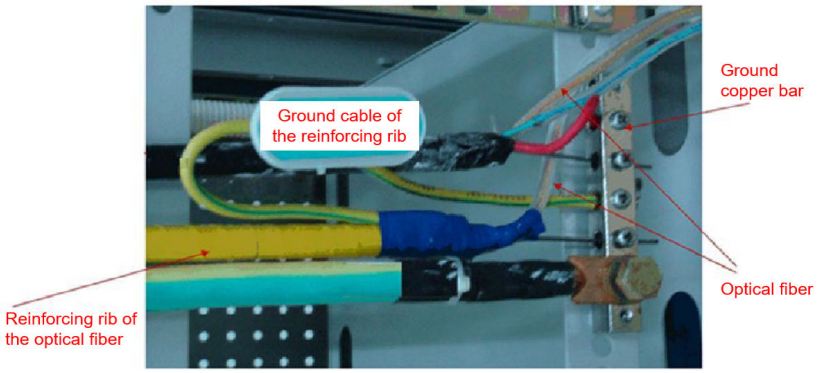
B Requirements for Creating an Earthing Electrode

Bury an angle steel or a steel pipe not shorter than 2.5 m directly underground, with a vertical distance of at least 0.7 m between the upper end of the angle steel or steel pipe and the ground. The cross-sectional area of the angle steel should be at least 50 x 50 mm^2, and the thickness of the steel pipe should be at least 3.5 mm. The material should be galvanized steel. The yellow-green PGND cable of the device should be welded with the angle steel. The surface of the welding point should be coated with antirust paint. The cross-sectional area of the PGND cable must be at least 16 mm^2, and the PGND cable should be as short as possible. Do not wind the cable.

C Earthing Requirements for the Reinforcing Rib of an Optical Fiber

If an armored optical fiber is used, the reinforcing rib of the optical fiber must be grounded. Connect the reinforcing rib of the optical fiber to a ground cable with a cross-sectional area of at least 4 mm^2, wrap the cable with insulation tape, and connect the ground cable to the ground bar, as shown in **Figure 1 Earthing through the reinforcing rib of an optical fiber**.

Figure C-1 Earthing through the reinforcing rib of an optical fiber



D Requirements for Selecting Power Adapters and Surge Protectors

You are advised to use the power adapters and surge protectors in the camera accessory library of the company. Products from other companies must meet the following specifications:

The surge protection specifications for adapter input ports must be greater than or equal to those specified in **Table 1 Surge protection specifications for adapter input ports**.

Table D-1 Surge protection specifications for adapter input ports

Type	Specification
12 V DC power adapter	Differential mode: 2.5 kV (wire to wire), 1.2/50 μs, 2 ohms Common mode: 4 kV (wire to ground), 1.2/50 μs, 12 ohms Isolated: 4 kV (input to output), 1.2/50 μs, 12 ohms
24 V AC power adapter	Horizontal: 6 kV (wire to wire), 1.2/50 μs, 2 ohms Vertical: 6 kV (dual-wire to ground), 1.2/50 μs, 2 ohms Isolated: 6 kV (input to output), 1.2/50 μs, 12 ohms

Note:

1. Do not use an adapter that connects the PE cable of AC power supply to the output ground as a 12 V DC adapter.
2. The horizontal and vertical surge test methods are defined in ITU-T K.44.
3. The Micro Edge device must be used only with the original adapter. Do not use other adapters.

The surge protection specifications of the surge protector must be greater than or equal to those specified in **Table 2 Surge protector specifications**.

Table D-2 Surge protector specifications

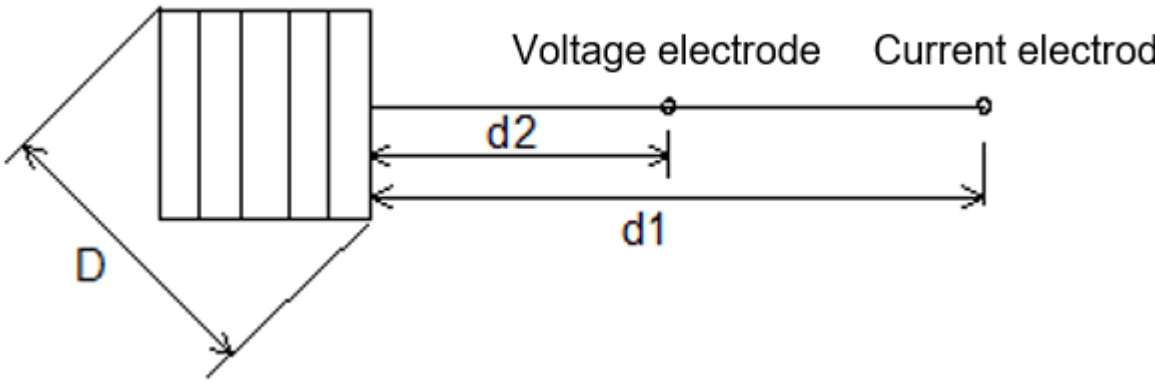
Port	Specification	Scenario
220 V AC 110 V AC	Differential mode: 10 kA (wire to wire), 8/20 μs Common mode: 10 kA (single-wire to ground), 8/20 μs	Common installation environment
	Differential mode: 20 kA (wire to wire), 8/20 μs Common mode: 20 kA (single-wire to ground), 8/20 μs	Harsh installation environment
24 V AC	Differential mode: 10 kA (wire to wire), 8/20 μs Common mode: 20 kA (dual-wire to ground), 8/20 μs	Harsh installation environment
PoE/ network port	Surge: Differential mode: 1.5 kV (differential wire pair), 10/700 μs, 15 ohms + 25 ohms/wire Differential mode: 1.5 kV (–48 V to RTN), 10/700 μs, 15 ohms + 25 ohms/wire Common mode: 6 kV (8-wire to ground), 10/700 μs, 15 ohms + 25 ohms/wire Surge current: Differential mode: 250 A (–48 V to RTN), 8/20 μs Common mode: 3 kA/8-wire, 8/20 μs	Common installation environment
	Surge: Differential mode: 1.5 kV (differential wire pair), 10/700 μs, 15 ohms + 25 ohms/wire Differential mode: 1.5 kV (–48 V to RTN), 10/700 μs, 15 ohms + 25 ohms/wire Common mode: 6 kV (8-wire to ground), 10/700 μs, 15 ohms + 25 ohms/wire Surge current: Differential mode: 250 A (–48 V to RTN), 8/20 μs Common mode: 6 kA/8-wire, 8/20 μs	Harsh installation environment

Note: In addition to complying with the preceding specifications, a surge protector also needs to comply with the specifications listed in **Table 2 Surge protector specifications** in joint tests with the protected devices.

E Measurement Methods of Ground Resistance

Figure E-1 shows the electrode arrangement. In the preceding figure, d1 indicates the distance between the current electrode and the edge of the earthing network, and D indicates the maximum diagonal length of the earthing network. Ensure that d1 is 4x to 5x of D. Generally, the distance d2 between the voltage electrode and the edge of the earthing network is about 50% to 60% of d1. During the measurement, move the voltage electrode three times along the connection line between the earthing network and the current electrode. Each move is about 5% of d1. If the resistance values obtained in the three movements are similar, the ground resistance is normal.

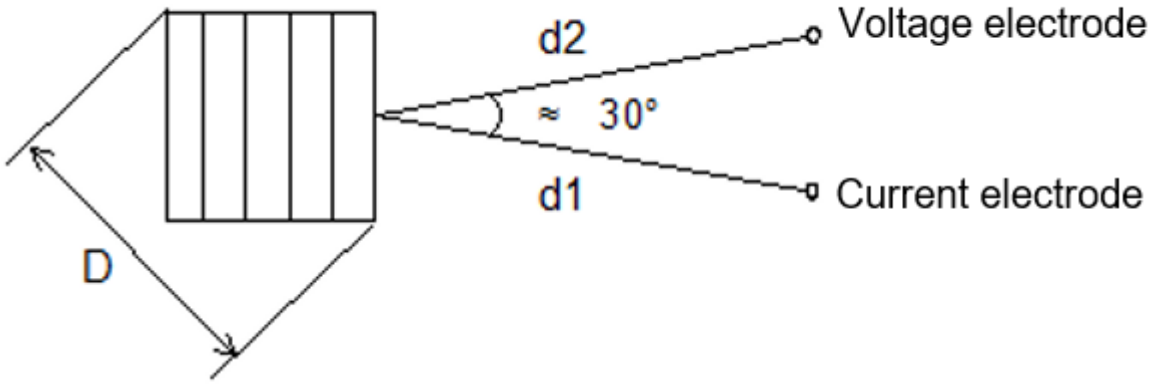
Figure E-1 Layout of measurement electrodes



In an area of well-proportioned soil resistivity, d1 can be 2x of D, and d2 can be as long as D. In an area of poor-proportioned soil resistivity, d1 can be 3x of D, and d2 can be 1.7x of D.

The voltage electrode and the current electrode can also be distributed in triangle mode, as shown in Figure E-2. Generally, d2 = d1 ≥ 2x of D, and the included angle is about 30 degrees.

Figure E-2 Diagram of a triangular layout



Precautions:

The voltage electrode and current electrode must be deployed vertically with circuits or underground mental pipes.

Do not measure the ground resistance when the ground is wet after raining.

If the AC ammeter-voltmeter method is used, the electrodes should be arranged in the manner shown in **Figure E-2**.

F Cross-Sectional Area Selection for PGND Cables

This appendix describes the method of selecting cross-sectional areas of PGND cables for device protection, which is cited from the *IEC 60950 Information Technology Equipment Safety*.

Table F-1 Cross-sectional area selection for PGND cables

Rated Current A	Minimum Conductor Size	
	Nominal Cross-Sectional Area mm^2	AWG or kcmil Cross-Sectional Area (Unit: mm^2)
XXX6	0.75[1)]	18 [0.8]
> 6–XXX10	(0.75)[2)] 1.00	16 [1.3]
> 10–XXX13	(1.0)[3)] 1.25	16 [1.3]
> 13–XXX16	(1.0)[3)] 1.5	14 [2]
> 16–XXX25	2.5	12 [3]
> 25–XXX32	4	10 [5]
> 32–XXX40	6	8 [8]
> 40–XXX63	10	6 [13]
> 63–XXX80	16	4 [21]
> 80–XXX100	25	2 [33]
> 100–XXX125	35	1 [42]
> 125–XXX160	50	0 [53]
> 160–XXX190	70	000 [85]
> 190–XXX230	95	0000 [107]

> 230–XXX260	120	250 kcmil [126]
> 260–XXX300	150	300 kcmil [152]
> 300–XXX340	185	400 kcmil [202]
> 340–XXX400	240	500 kcmil [253]
> 400–XXX460	300	600 kcmil [304]
The AWG and kcmil dimensions are for reference only. The related cross-sectional area in brackets is the valid number after rounding. AWG refers to American Wire Gauge, and cmil refers to circular mil. One cmil is equal to the area of a circle with a diameter of 1 mil (one-thousandth of an inch). These terms are usually used in North America to indicate the size of the conductor.		

G Design Principles of Three-Level Surge Protection

Level-1 Surge Protection

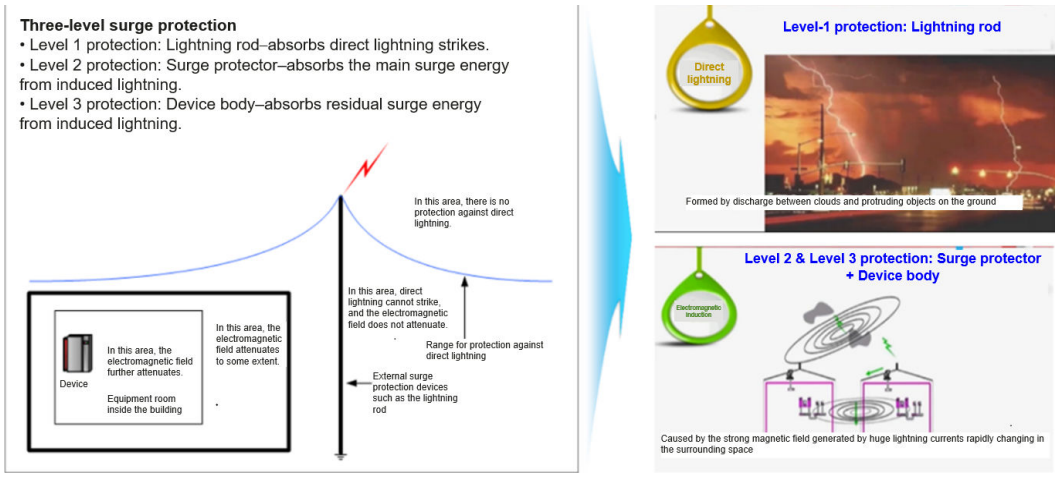
A direct lightning strike is the phenomenon of a direct discharge of cloud charges. It is characterized by extremely high lightning energy, with voltages ranging from tens of thousands to several million volts and currents from tens to hundreds of kiloamperes at the discharge moment. Buildings are equipped with pointed devices such as lightning rods, wires, or belts to attract charges from electrified clouds toward the vicinity of the lightning rods or wires. Then, the lightning is guided by point discharge into the well-grounded lightning receptor and safely discharged into the ground. In this way, buildings within the protection range of lightning rods are safeguarded from damage, electrical equipment is protected against the effects of direct lightning strikes, and human casualties are prevented.

Level-2 Surge Protection

Principle of induced lightning: 1. When a direct lightning strike discharges to a ground object, a rapidly varying strong magnetic field is generated nearby. By the law of electromagnetic induction, a high voltage is induced on conductors close to the strike point. 2. When a charged thundercloud drifts above a cable, an equal amount of opposite-polarity charge is induced on the cable. After the thundercloud moves away or discharges between cloud layers, the bound charges on the cable are released, resulting in an induced surge voltage. Level-2 surge protection is mainly implemented by using a surge protector to absorb induced lightning energy. When an induced lightning strike occurs on the power supply line of the device, the surge protector on the line operates to provide a low-impedance discharge path to ground for the lightning energy. After the main portion of the lightning energy is released through the surge protector, the residual voltage on the line is significantly reduced.

Level-3 Surge Protection

When a lightning strike occurs, the surge protector on the line discharges the lightning energy to the ground. If the residual voltage on the line is still high, internal components such as varistors and gas discharge tubes operate to form a low-impedance discharge path under proper earthing conditions, thereby protecting the internal devices of the equipment.


Three-level surge protection
• Level 1 protection: Lightning rod–absorbs direct lightning strikes.
• Level 2 protection: Surge protector–absorbs the main surge energy from induced lightning.
• Level 3 protection: Device body–absorbs residual surge energy from induced lightning.
In this area, there is no protection against direct lightning.
In this area, direct lightning cannot strike, and the electromagnetic field does not attenuate.
Range for protection against direct lightning
External surge protection devices such as the lightning rod
In this area, the electromagnetic field attenuates to some extent.
In this area, the electromagnetic field further attenuates.
Device
Equipment room inside the building
Level-1 protection: Lightning rod
Direct lightning
Formed by discharge between clouds and protruding objects on the ground
Level 2 & Level 3 protection: Surge protector + Device body
Electromagnetic induction
Caused by the strong magnetic field generated by huge lightning currents rapidly changing in the surrounding space