# Lightning Protection Guide
# Business Products

V1.0

## Audience

This guide is intended for network engineers and network administrators that have general electrical knowledge.

## Conventions

This guide introduces lightning protection of Tenda's business products. The symbols that may be found in this document are defined as follows.

| Symbol | Meaning |
|---|---|
| NOTE | This format is used to highlight information of importance or special interest. Ignoring this type of note may result in ineffective configurations, loss of data or damage to device. |
| TIP | This format is used to highlight a procedure that will save time or resources. |

## Revision History

Tenda is constantly searching for ways to improve its products and documentation. The following table indicates any changes that might have been made since the guide was first published.

| Version | Date | Description |
|---|---|---|
| V1.0 | 2022-03-15 | Original publication. |

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# 1 Terminology and basic knowledge for lightning protection

## 1.1 Terminology

| Terminology | Description |
|---|---|
| Lightning stroke | The rapid discharge between thunderclouds, or the rapid discharge of thunderclouds to the earth and ground objects. |
| Direct lightning flash | The rapid discharge that occurs in a thundercloud and a certain point on the ground. |
| Induced lightning flash | Because of thundercloud discharge, induced voltage or induced electromagnetic field is generated, resulting in damage to nearby objects. |
| Lightning overvoltage | Transient overvoltage at certain locations in the system due to specific lightning discharges. |
| Earth | Connect the conductor to "earth" so that it has a potential close to (or instead of) the earth. |
| Air-termination | Including lightning rods, lightning strips (wires), lightning nets, and metal roofing or metal components intended to intercept lightning flashes. |
| Lightning down-conductor | Conductor intended to conduct lightning current from the air-termination to the earth-termination. |
| Earth electrode | For the purpose of connecting with the ground, a conductive part or a group of conductive parts that are in intimate contact with the soil (earth) and provide an electrical connection. |
| Earthing grid | To achieve good grounding, a large area metal grid evolved from the earth electrode. |
| Earthing down-conductor | The connecting conductor from the disconnection or change of the down-conductor to the earth electrode, or the connecting conductor from the grounding conductor, equipotential bonding belt to the earth electrode. |
| Grounding conductor | Protective earth (PE) of the device. |
| Equipotential bonding | Measures for connecting separate metal parts, foreign conductors, power lines, communication lines and other cables directly with connecting conductors or through lightning arresters to reduce the potential difference between them caused by lightning current. |

| | |
|---|---|
| PE | Protective earth. Protective earth of the cabinet and the metal casing of various devices in the cabinet. |
| BGND | DC ground. The grounding of the DC power supply of the cabinet, generally the positive pole of -48V DC is grounded at the power supply cabinet, or RTN can be used. |
| GND | Working ground, the grounding of functional circuits on various devices in the cabinet, is the collective name of the digital ground and analog ground on the single board and the motherboard. |
| Common earthing system | A common earthing system that connects grounding device of the lightning protection system, metal structures of the building, low voltage electrical distribution protection line (PE), equipotential bonding terminal board or strip, equipment protection grounding, shield grounding, ESD grounding and functional grounding. |

## 1.2 Basic knowledge of lightning strokes

### 1.2.1 Damage of lightning strokes

Lightning strokes are one of the serious natural disasters. With the rapid development of modern electronic technology, the degree of integration of electronic equipment is constantly improving. However, the ability of electronic equipment to resist lightning strokes and surge is constantly decreasing, which makes these electronic equipment suffer more damage from overvoltage, especially lightning stroke. The consequence is not only direct damage to the equipment, but more seriously, the interruption of the operation of the entire system, resulting in incalculable economic losses. Therefore, it is crucial to protect devices from lightning strokes.

### 1.2.2 Classification of lightning strokes

Lightning strokes are usually divided into two categories: direct lightning flash and induced lightning flash.

- **Direct lightning flash**

A direct lightning flash is a phenomenon in which the charged cloud layer causes a violent discharge to a certain point on the ground. Its destructive power is very huge. If it cannot be quickly discharged into the ground, it will cause serious damage to objects and buildings in the discharge channel, and even endanger the lives of humans and animals.

- **Induced lightning flash**

The discharge between thunderclouds or between thunder clouds and the ground generates induced voltage on nearby overhead lines, buried lines, metal pipelines, or similar conductors. The induced voltage is transmitted to devices through conductors, resulting in damage to the devices.

### 1.2.3 Lightning strokes on network devices

There are usually three ways for lightning strokes to intrude on network device:

– A direct lightning stroke is diverted to the earth directly through an air-termi nation system, which rises potential around the earthing grid. Overvoltage is drawn to the devices along the grounding cables, damaging the devices.
– When the lightning current is led into the ground through the lightning down conductor, high current rate change causes a strong magnetic field in the vicinity of the down conductor. Overvoltage is induced on the surrounding devices.
– When the power lines or communication lines in and out of a building or an equipment room are hit by a lightning stroke, overvoltage and overcurrent run into the devices along the lines and damage the devices.

## 1.2.4 Lightning protection

The electronic information system in a building shall adopt measures including external and internal lightning protection systems for comprehensive protection.

### ■ External lightning protection system

The external lightning protection system mainly protects the building against direct lightning strokes. The system contains an air-termination system, down-conductor system, and earthing arrangement.

### ■ Internal lightning protection system

The internal lightning protection system mainly reduces and prevents the electromagnetic (EM) effects of overcurrent caused by lightning strokes. The system contains an equipotential bonding system, common grounding system, shielding system, correct cable routing, and lightning arrester.

The comprehensive lightning protection system is shown in the figure below.

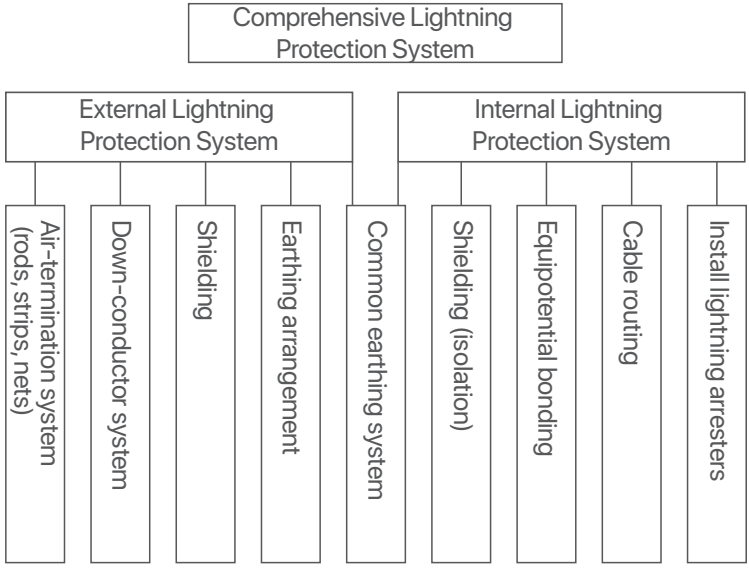


**Figure1-1 Comprehensive lightning protection system**

# 2 Lightning protection guide of devices

The lightning protection of the devices belongs to the category of internal lightning protection. For the application environment of general communication devices, the damage of induced lightning strokes is mainly prevented from the following three aspects: grounding, cable routing, and equipotential bonding.

## 2.1 Grounding

Grounding is not only a measure to release the overvoltage and overcurrent induced by lightning strokes as soon as possible, but also a necessary measure to ensure personal safety.

### 2.1.1 General grounding requirements

To quickly discharge overvoltage and overcurrent caused by lightning strokes or other reasons, ground all the uncharged metal components of the device. Uncharged metal components include grounding terminals on the device, metal sheaths or shields on outdoor cables, and signal lightning arresters on cables. When AC power is used, you can use the PE wire to ground the device. When DC power is used, ground the positive electrode of the -48V DC power source (or the negative pole of the 24V DC power source) at the DC power outlet on the power distribution cabinet.

The lightning protection grounding should be designed based on the principle of voltage balance and equal potential, that is, the combined grounding method of a group of grounding bodies is used for working grounding and protective grounding (including shielding grounding and lightning protection grounding of patch panels).

Follow these guidelines to select and route a grounding cable:

- Use a yellow-green plastic insulated copper wire.
- The recommended cross-sectional area is greater than or equal to 6mm².
- The length of the grounding cable does not exceed 30 m. If the connection distance is greater than 30 m, rearrange the grounding strips to reduce the length of the grounding cable.
- Do not lay a grounding cable and a signal cable in parallel or entangle them.
- Do not add a connector, switch, or fuse to a grounding cable.
- The connection points at both ends of the grounding cable should ensure good electrical contact.
- Anti-corrosion treatment (plating or coating) must be performed on the connection points.

## 2.1.2 Grounding methods

There are three main grounding methods for lightning protection of devices: using a grounding strip, a grounding conductor buried in the earth ground, or a PE wire of the power cord. The grounding effect for these methods is in descending order.

NOTE

In addition to the normal grounding of the device grounding terminal, you should also pay attention to the following conditions:

– If the cable connected to the device needs to be routed outdoors, ground the metal sheath or shield of the outdoor part reliably.
– If a signal lightning arrester is installed on the device cable, the signal lightning arrester must be properly grounded.

### Grounding the device by using a grounding strip

If a grounding strip is available at the installation site, refer to the following steps to perform grounding installation.

**Step 1** Attach one end of the grounding cable to a grounding post on the grounding strip in the equipment room.

**Step 2** Attach the other end of the grounding cable to the device grounding terminal, and fasten the fixing screw.

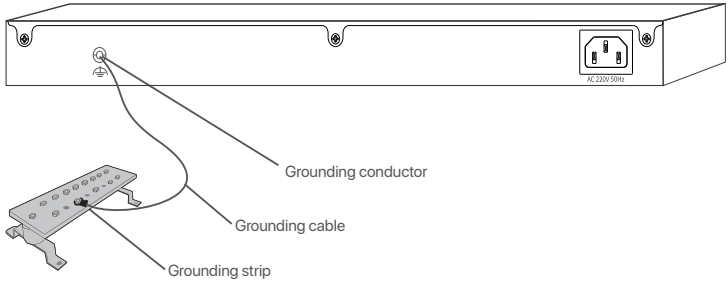


**Figure 2-1 Grounding with a grounding strip in the equipment room**

NOTE

The grounding cable of the device should be connected to the engineering grounding of the equipment room. The grounding of the fire hose and the lightning rod of the building are not correct grounding.

## Grounding the device with a grounding conductor buried in the earth ground

If the installation site does not have grounding strips, but there is mud nearby, and the grounding conductor is allowed to be buried, refer to the following steps to perform grounding.

**Step 1** Hammer a 0.5 m or longer angle iron or steel tube (the cross-sectional area of the angle iron is ≥ 50 × 50 × 5 mm, the wall thickness of the steel tube is ≥ 3.5 mm, the material is galvanized steel) into the earth ground to serve as a grounding conductor.

**Step 2** Weld one end of the grounding cable to the angel iron (or steel tube) and treat the joint for corrosion protection (electroplating or coating).

**Step 3** Attach the other end of the grounding cable to the device grounding terminal.

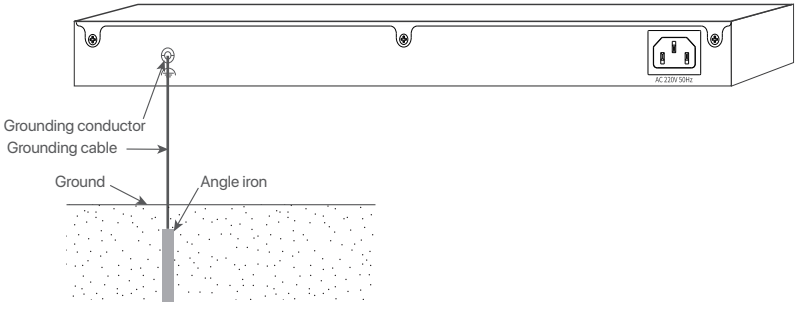


**Figure 2-2 Grounding when the grounding conductor is allowed to be buried near the equipment room**

## Grounding the device by using a PE wire of the power cord

If the installation site does not have grounding strips, and the grounding conductor is not allowed to be buried, directly ground the device through the PE wire of the power cord. Make sure the following requirements are met:

– The power cable of the device adopts a three-core and grounding cable.
– The protective grounding cable of the AC power supply is securely connected to the ground in the power distribution room or on the AC transformer side.

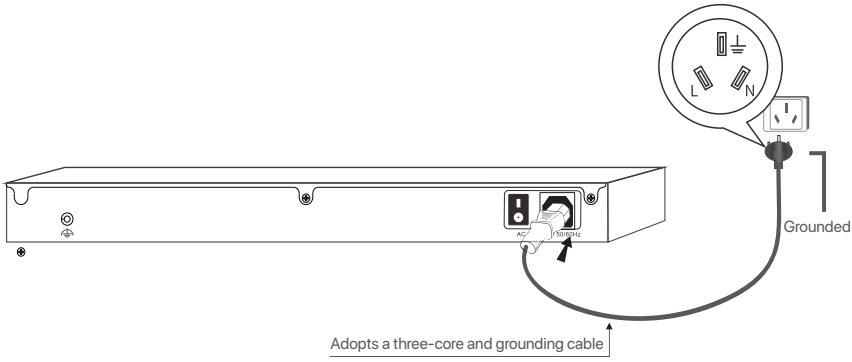


**Figure 2-3 Grounding through an PE wire**

TIP

The above diagram illustrates the application example and principle of grounding through the PE wire of the power cord. The power cord plug and actual power outlet included in the package might vary in different countries or regions.

## 2.2 Cable routing

Cable routing (communication cables, power cables) can effectively reduce the lightning damage rate of devices.

### 2.2.1 General cable routing requirements

Cables may be routed indoors or outdoors depending on the location of the connected network devices, and the related routing requirements are also different.

NOTE

– To minimize damage caused by induced lightning strokes, route communication cables indoors whenever possible.
– Ethernet cables are indoor communication cables. Do not route the cables overhead or over the eaves outdoors.

## Indoor cable routing

For indoor cable routing, the following routing requirements must be followed:

– Route different types of cables separately to avoid bundling cables of different types.
– It is recommended to bind the cables with cable ties every 100 mm to strengthen the combing and fixing.

## Outdoor cable routing

If a cable cannot be routed completely indoors, and the outdoor cable routing must be performed, the following routing requirements must be followed:

– Lay the outdoor part of the cable underground (from underground to the room).
– If part of the cable cannot be laid underground but is routed overhead, feed the cable through a metal tube 15 m before leading it indoors. Ground the two ends of the metal pipe reliably and install a power or signal lightning arrester for the target interface on the device.
– If you use a shielded cable, make sure the shielding layer makes good contact with the device metal cover at the connection point and install a power or signal lightning arrester for the target interface.
– If you connect outdoor cables without any protection to the device, install a power or signal lightning arrester for the target interface.
– When routing optical fibers, the cables must be flat and neatly bundled. The optical fibers must not be stretched or bundled too tightly.

## 2.2.2 Cable installation methods

Before connecting cables, plan the length of the cables to ensure suitable cable length during the cable connection.

After all cables are connected, block up the free space of cable outlet holes in time to prevent rodents.

## Routing power cables

Connect one end of a power cable to the device and the other end to the power strip or lightning protection outlet. Fold the excess part of the power cable into an S-shape and attach it to the inside panel of the cabinet. Keep power cables a minimum of 20 cm away from other cables.

## Routing signal cables

Install and bundle outdoor and indoor signal cables separately and route them from different outlets on the cabinet to user terminals or cascaded devices.

### Routing fibers

After the optical fiber is led out from the fiber port, the optical fiber directly connected to the photoelectric converter can be wound and hung on the inside panel of the cabinet. The optical fiber cascaded with other devices should be led out through a PVC pipe. Do not pull and stretch the fibers.

NOTE

An optical fiber is not conductive and does not induce and transmit overvoltage. However, an optical fiber with reinforcing metal stiffener is very easy to induce and transmit lightning overvoltage, which must be properly handled. Therefore, it is recommended that users perform grounding protection at the entrance end of the optical fiber.

### Routing grounding cables

Connect one end of a grounding cable to the grounding terminal on the device and the other end to the grounding strip. Keep the grounding cable a minimum of 20 cm away from other cables such as communication cables.

## 2.3 Equipotential bonding

Equipotential bonding of device can reduce the potential difference between various metal components and the system in the space requiring lightning protection, thereby effectively avoiding the overvoltage phenomenon of the system due to factors such as lightning strokes.

### 2.3.1 General equipotential bonding requirements

Equipotential bonding is required for multiple devices in the same network. The following examples should ensure equipotential bonding: interconnection equipment, metal sheath of cables, PE wires of the power cord, installation of metal structures.

TIP

- Use yellow-green cables with a minimum cross-sectional area of 6mm² for equipotential bonding.
- Use cables for equipotential bonding as short as possible.
- Prepare a grounding strip (ring) to act as the bonding bar.

## 2.3.2 Equipotential bonding method

Connect the devices as shown in Figure 2-4 for equipotential bonding. After you finish the connection, use a multimeter to test each connection point to ensure good contact and low resistance.

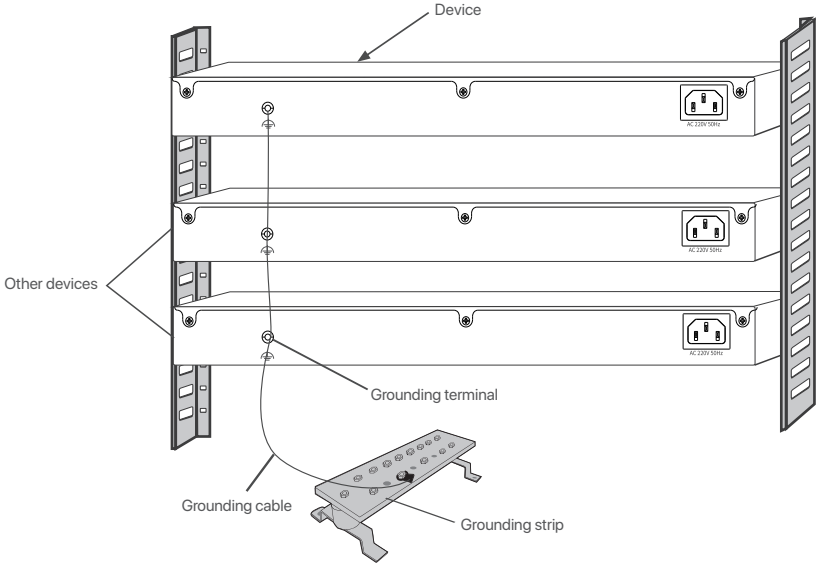


**Figure 2-4 Equipotential bonding connection**

# 3 Installing lightning arresters

This chapter mainly introduces the use of power lightning arresters and signal lightning arresters.

## 3.1 Using a power lightning arrester

The power lightning arrester can provide surge protection for the power system. If an AC power cord is routed from outdoors, connect the AC power cord to a power lightning arrester before leading it to the AC power port on the device.

TIP

– The power lightning arrester is not provided with the device. Prepare it yourself as required.
– Before using a power lightning arrester, read the manual provided with it carefully, install and use it in strict accordance with the requirements.

## 3.2 Using a signal lightning arrester

The signal lightning arrester can protect the Ethernet communication cable interface (using RJ45 connector). If a network cable is routed from outdoors, connect it to a signal lightning arrester before leading it to the target port on the device. This will protect the device from possible damage caused by lightning strokes.

TIP

– The signal lightning arrester is not provided with the device. Prepare it yourself as required.
– Before using the signal lightning arrester, read the manual provided with it carefully, install and use it in strict accordance with the requirements.

The general installation diagram of the signal lightning arrester is as follows.

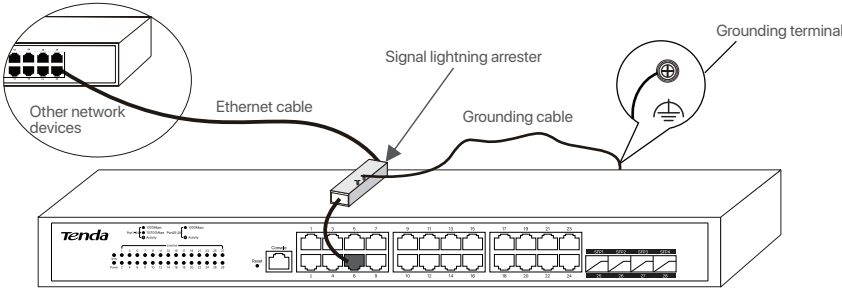


**Figure 3-1 connecting a signal lightning arrester**

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