

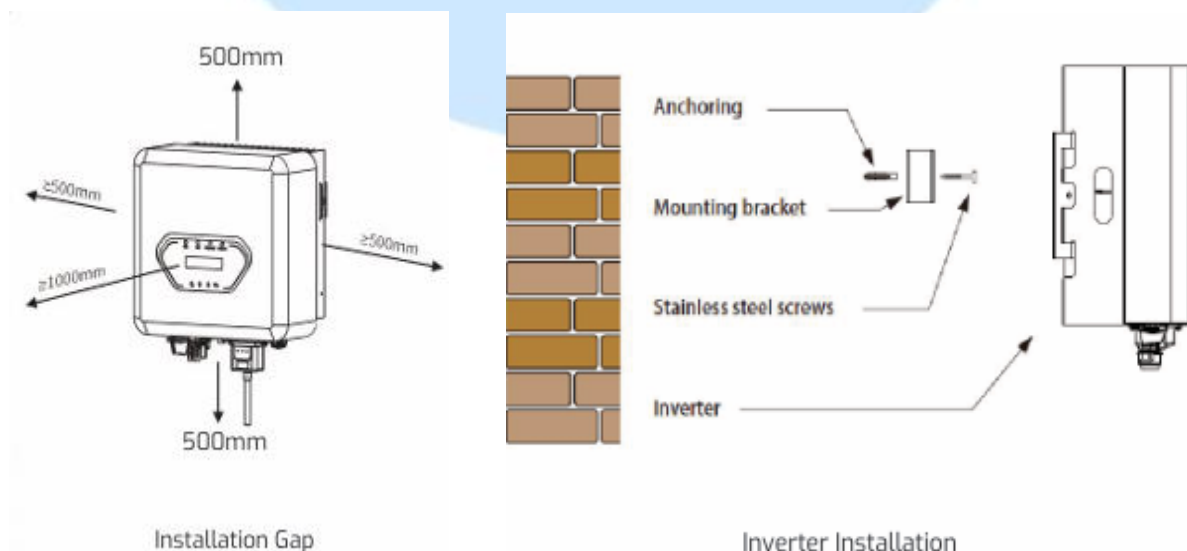
Inverter

Installation Guidelines



General Installation Guidelines

1. **Install both AC Distribution Box (ACDB) and DC Distribution Box (DCDB)** with appropriate protection devices, including **MCB/MCCB, SPD, and DC Fuses**.
2. **Provide a dedicated DC Surge Protection Device (SPD) for each PV string.**
Example: For 3 PV strings connected to 2 MPPTs, install 3 DC SPDs (one per string).
3. **Ensure the open-circuit voltage (Voc) difference between parallel strings connected to the same MPPT does not exceed 5%** to maintain optimal MPPT performance.
4. **Install a protective canopy for outdoor-mounted inverters** to shield the equipment from direct sunlight and rain, thereby minimizing thermal stress and extending service life.
5. **Do not install the inverter in enclosed or poorly ventilated spaces**, such as storage rooms or confined areas. Ensure adequate airflow for efficient heat dissipation.
6. **Use standard colour-coded cables for AC wiring** to ensure safe installation and easy identification.
7. **Maintain adequate clearance between the inverter and AC/DC distribution boxes** to facilitate safe operation, inspection, maintenance, and future servicing.
8. **Select MCBs, SPDs, fuses, and cables based on the inverter's electrical ratings and applicable IEC/IS standards.** Ensure all protection devices are correctly sized for the system.
9. **Maintain a minimum clearance of 500 mm around all sides of the inverter** to provide sufficient ventilation, improve cooling efficiency, and allow easy access for maintenance.



DC Side Protection

DC String Fuses:

Install **DC-rated string fuses** for each PV string to provide protection against reverse current and overcurrent conditions. Select the fuse rating based on the PV module manufacturer's maximum series fuse rating and string current (typically **10–20 A** for most applications). This helps protect both the PV array and the inverter from electrical faults.

DC Circuit Breakers (DC MCB/Isolator):

Install a **DC-rated circuit breaker** with a current rating of at least **$1.25 \times$ the PV string short-circuit current (I_{sc})**. The breaker provides overcurrent protection, safe isolation during maintenance, and protection against short-circuit faults, ensuring reliable and safe system operation.



AC Side Protection

AC Circuit Breaker (MCB/MCCB)

Install a suitably rated **Miniature Circuit Breaker (MCB)** or **Molded Case Circuit Breaker (MCCB)** on the AC output side of the inverter to provide protection against overloads, short circuits, and electrical faults.

The protective device shall be rated at **$1.25 \times$ the inverter's rated AC output current** to accommodate continuous operation and temporary overload conditions.

Example:

For a **5-kW single-phase inverter** with a rated output current of **21.7 A**, a **25 A AC MCB/MCCB** is recommended.

AC Isolator

Install an **AC isolator** between the inverter and the utility grid to enable safe electrical isolation during maintenance and servicing. The isolator shall have a current rating of **at least $1.25 \times$ the inverter's rated AC output current** and be suitable for the system voltage.

AC Cable Selection

Select AC output cables based on the inverter's rated output current, installation conditions, and cable length to ensure safe operation and minimize voltage drop.

Rated Output Current	Recommended Copper Cable Size
Up to 20 A	4 mm ²
20 A – 40 A	6 mm ²
Above 40 A	10 mm ² or larger

For cable runs exceeding **15 m**, increase the cable cross-sectional area to limit the **voltage drop to less than 1%**, in accordance with applicable electrical standards.

Inverter Protective Earthing

The inverter chassis shall be securely connected to the building's **protective earthing system** using a **minimum 6 mm² copper conductor**.

Proper earthing protects personnel and equipment against electric shock, leakage currents, and fault conditions while ensuring reliable inverter operation.

Earthing Requirements:

- Use a minimum **6 mm² copper earth conductor**.
- Ensure all earthing connections are secure and corrosion-resistant.
- Maintain an **earth resistance of less than 5 Ω** (or as required by local electrical regulations).
- Verify earth continuity before commissioning the system.

Surge Protection Devices (SPD)

A **two-column comparison table** is the most professional format for an installation manual.



Parameter	DC Surge Protection Device (SPD)	AC Surge Protection Device (SPD)
Installation Location	Installed between the PV array and the inverter .	Installed between the inverter AC output and the utility grid .
Purpose	Protects the inverter and PV system from high-voltage surges caused by lightning strikes or switching transients on the DC side.	Protects the inverter and connected equipment from voltage surges originating from the utility grid or external switching events.
Recommended Type	Type II SPD for standard installations. Type I+II SPD is recommended in areas with frequent lightning activity.	Type II SPD for standard AC installations. Type I+II SPD is recommended where lightning protection is required.
Voltage Rating	Select an SPD with a voltage rating matching the inverter's maximum DC input voltage (e.g., 1000 V_{DC} or 1500 V_{DC}).	Select an SPD with a voltage rating matching the system voltage (e.g., 230 V_{ac} for single-phase or 400 V_{ac} for three-phase systems).
Selection Criteria	Ensure the SPD is compatible with the PV system voltage and complies with applicable IEC/IS standards.	Ensure the SPD is suitable for the system voltage, fault level, and expected surge current in accordance with applicable IEC/IS standards.

Single Phase on-grid Inverter (1kW to 3kW)

Component	Specification
AC Output Cable	2.5 mm ² – 4 mm ² Copper Cable
DC Input Cable	2.5 mm ² Copper Cable
DC Cable Voltage Rating	1000 V DC (1500 V _{DC} where applicable)
AC Side MCB	16 A – 20 A MCB (Single-Phase)
DC Side MCB	16 A – 20 A DC MCB (Per PV String)
AC Surge Protection Device (SPD)	Type II SPD, 230 V _{ac}
DC Surge Protection Device (SPD)	Type II SPD, 1000 V _{DC} (1500 V DC where applicable)
DC String Fuse	10 A – 16 A DC Fuse (Selected based on PV string current)
DC Fuse Voltage Rating	1000 V _{DC} (1500 V _{DC} where applicable)

Notes

- All protection devices shall comply with the applicable **IEC/IS standards**.
- Cable selection shall be based on **current carrying capacity, installation method, ambient temperature, and permissible voltage drop**.
- The DC fuse rating shall not exceed the **maximum series fuse rating specified by the PV module manufacturer**.
- Verify that all components are compatible with the inverter's electrical ratings before commissioning.

Single Phase on-grid inverter (4kW to 6kW)

Component	Specification
AC Output Cable	4 mm ² Copper Cable
DC Input Cable	4 mm ² Copper Cable
DC Cable Voltage Rating	1000 V _{DC} (1500 V _{DC} where applicable)
AC Side MCB	32 A MCB (Type B or Type C tripping characteristic)
DC Side MCB	32 A DC MCB
AC Surge Protection Device (SPD)	Type II SPD, 230 Vac
DC Surge Protection Device (SPD)	Type II SPD, 1000 V DC (1500 V _{DC} where applicable)
DC String Fuse	16 A – 20 A DC Fuse (Selected based on PV string current)
DC Fuse Voltage Rating	1000 V DC (1500 V _{DC} where applicable)

Notes

- Use protection devices that comply with applicable **IEC/IS standards**.
- Select cable sizes based on **current carrying capacity, installation conditions, cable length, and permissible voltage drop**.
- The DC fuse rating shall not exceed the **maximum series fuse rating specified by the PV module manufacturer**.
- Ensure all protection devices are compatible with the inverter's rated electrical specifications before commissioning.

Three-Phase on-grid Inverter (5kW to 10kW)

Component	Specification
AC Output Cable	6 mm ² – 10 mm ² Copper Cable (Select based on inverter output current and cable length)
DC Input Cable	4 mm ² – 6 mm ² Copper Cable (Based on PV string configuration)
DC Cable Voltage Rating	1000 V DC (1500 V _{DC} where applicable)
AC Side MCB	32 A – 40 A MCB (Three-Phase)
DC Side MCB	20 A – 32 A DC MCB (Selected based on inverter DC input current)
AC Surge Protection Device (SPD)	Type II SPD, 400 Vac (Three-Phase)
DC Surge Protection Device (SPD)	Type II SPD, 1000 V _{DC} (1500 V _{DC} where applicable)
DC String Fuse	Select based on the PV string current and the PV module manufacturer's maximum series fuse rating (typically 15 A–20 A for most applications)
DC Fuse Voltage Rating	1000 V _{DC} (1500 V _{DC} where applicable)

Notes

- Select cable sizes based on **current carrying capacity, installation method, ambient temperature, cable length, and permissible voltage drop**.
- All protective devices shall comply with the applicable **IEC/IS standards**.
- The **DC MCB, DC fuse, and SPD ratings** shall be selected according to the inverter's maximum DC input specifications and the PV module manufacturer's recommendations.
- Ensure all protection devices are compatible with the inverter's electrical ratings before commissioning.

Note: Rather than specifying a fixed **32–40 A DC fuse per string**, it is more accurate to size the DC string fuse based on the **PV module manufacturer's maximum series fuse rating and the string short-circuit current (I_{sc})**. This follows IEC 62548 and industry best practices.

Three phase on-grid inverter (10–15 kW Inverter)

Component	Specification
AC Output Cable	6 mm ² – 10 mm ² Copper Cable (Select based on inverter output current and cable length)
AC Current Capacity	Sized according to the inverter's rated output current (typically 21.7 A – 43.5 A)
DC Input Cable	4 mm ² – 6 mm ² Copper Cable (Based on PV string configuration)
DC Cable Voltage Rating	1000 V DC (1500 V DC where applicable)
AC Side MCB	32 A – 40 A MCB per phase
DC Side MCB	20 A – 32 A DC MCB (Selected based on inverter DC input current)
AC Surge Protection Device (SPD)	Type II SPD, 400 Vac (Three-Phase)
DC Surge Protection Device (SPD)	Type II SPD, 1000 V _{DC} (1500 V _{DC} where applicable)
DC String Fuse	Select based on the PV string current and the PV module manufacturer's maximum series fuse rating (typically 15 A–20 A for most applications)
DC Fuse Voltage Rating	1000 V _{DC} (1500 V _{DC} where applicable)

Notes

- Select cable sizes based on the **rated output current, installation method, ambient temperature, cable length, and permissible voltage drop**.
- AC and DC protection devices shall comply with the applicable **IEC/IS standards**.
- The **DC MCB, DC fuse, and SPD** shall be selected according to the inverter's maximum DC input specifications and the PV module manufacturer's recommendations.
- For cable runs exceeding **15 m**, increase the cable size to maintain a **maximum voltage drop of less than 1%**.
- Verify that all protection devices and cables are compatible with the inverter's electrical ratings before commissioning.

Three phase on-grid Inverter (18kW-25kW)

Component	Specification
AC Output Cable	10 mm ² – 16 mm ² Copper Cable (Select based on inverter output current and cable length)
DC Input Cable	4 mm ² – 6 mm ² Copper Cable (Based on PV string configuration)
DC Cable Voltage Rating	1000 V _{DC} (1500 V DC where applicable)
AC Side MCB	40 A – 63 A MCB per phase
DC Side MCB	32 A – 40 A DC MCB (Selected based on inverter DC input current)
AC Surge Protection Device (SPD)	Type II SPD, 400 Vac (Three-Phase)
DC Surge Protection Device (SPD)	Type II SPD, 1000 V DC (1500 V _{DC} where applicable)
DC String Fuse	Select based on the PV string current and the PV module manufacturer's maximum series fuse rating (typically 15 A–20 A for most applications)
DC Fuse Voltage Rating	1000 V _{DC} (1500 V _{DC} where applicable)

Notes

- Select cable sizes based on the **inverter's rated output current, installation method, ambient temperature, cable length, and allowable voltage drop.**
- All protective devices shall comply with applicable **IEC/IS standards** and local electrical regulations.
- The **DC MCB, DC fuse, and SPD** shall be selected according to the inverter's maximum DC input specifications and the PV module manufacturer's recommendations.
- For cable runs exceeding **15 m**, increase the cable cross-sectional area to maintain a **maximum voltage drop of less than 1%.**
- Verify the compatibility of all cables and protection devices with the inverter's electrical ratings before system commissioning.

Three phase On-grid inverter (30kW-50 kW)

Component	Specification
AC Output Cable	16 mm ² – 25 mm ² Copper Cable (Select based on inverter output current and cable length)
DC Input Cable	4 mm ² – 6 mm ² Copper Cable (Based on PV string configuration)
DC Cable Voltage Rating	1000 V DC (1500 V DC where applicable)
AC Side MCB	63 A – 100 A MCB per phase (Type C or Type D tripping characteristic)
DC Side MCB	40 A – 63 A DC MCB (Selected based on inverter DC input current)
AC Surge Protection Device (SPD)	Type II SPD, 400 V AC (Three-Phase)
DC Surge Protection Device (SPD)	Type II SPD, 1000 V DC (1500 V _{DC} where applicable)
DC String Fuse	Select based on the PV string current and the PV module manufacturer's maximum series fuse rating (typically 15 A–20 A for most applications)
DC Fuse Voltage Rating	1000 V _{DC} (1500 V _{DC} where applicable)

Notes

- Select AC and DC cable sizes based on the **inverter's rated current, installation method, ambient temperature, cable length, and allowable voltage drop**.
- All MCBs, SPDs, DC fuses, and associated protection devices shall comply with the applicable **IEC/IS standards** and local electrical regulations.
- The **DC MCB, DC fuse, and SPD** shall be selected in accordance with the inverter's maximum DC input specifications and the PV module manufacturer's recommendations.
- For cable runs exceeding **15 m**, increase the cable cross-sectional area to maintain a **maximum voltage drop of less than 1%**.
- Verify the compatibility of all cables and protection devices with the inverter's electrical ratings before commissioning the system.

Technical Note: For 30–50 kW three-phase inverters, the **DC string fuse rating should not be selected solely based on inverter capacity**. It must be determined by the **PV string short-circuit current (Isc)** and the **maximum series fuse rating specified by the PV module manufacturer**, in accordance with **IEC 62548** and industry best practices. This ensures proper protection of the PV strings while avoiding oversized fuses.

