Application Note: Determining the Circuit Breaker Size

Revision History

- Version 1.5 November 2023: Footnotes added regarding maximum continuous output for VDE-AR-N 4110 certification
- Version 1.4 May 2022: Reference to circuit breaker ratings for India and Israel added
- Version 1.3 September 2021: Changes in circuit breaker criteria table
- Version 1.2 July 2021: More info added to circuit breaker criteria table

Introduction

Inverters must be protected by over-current protection devices with an exact rating, per model. This document describes how to determine which over-current protection device to use in three phase commercial installations.

NOTE

For Three Phase Inverters with Synergy Technology in India, use only a circuit breaker device. For selecting a circuit breaker, refer to https://www.solaredge.com/sites/default/files/se-determining-the-circuit-breaker-ratings-for-three-phase-inverters-India.pdf

For Three Phase Inverters with Synergy Technology in Israel, use only a circuit breaker device. For selecting a circuit breaker, refer to https://www.solaredge.com/sites/default/files/se-determining-the-circuit-breaker-ratings-for-three-phase-inverters-Israel.pdf

Using Transformers in Commercial Three Phase Inverter Installations

Using transformers in a commercial installation is optional. In most cases a transformer is used to connect the installation to the medium voltage power grid.

For an example of how to connect a transformer on a medium voltage power grid, refer to:

- Medium Voltage Transformer Connection of Commercial Systems, North America
- Medium Voltage Transformer Connection of Commercial Systems

The following figure illustrates a typical transformer and commercial three phase inverter installation topology.

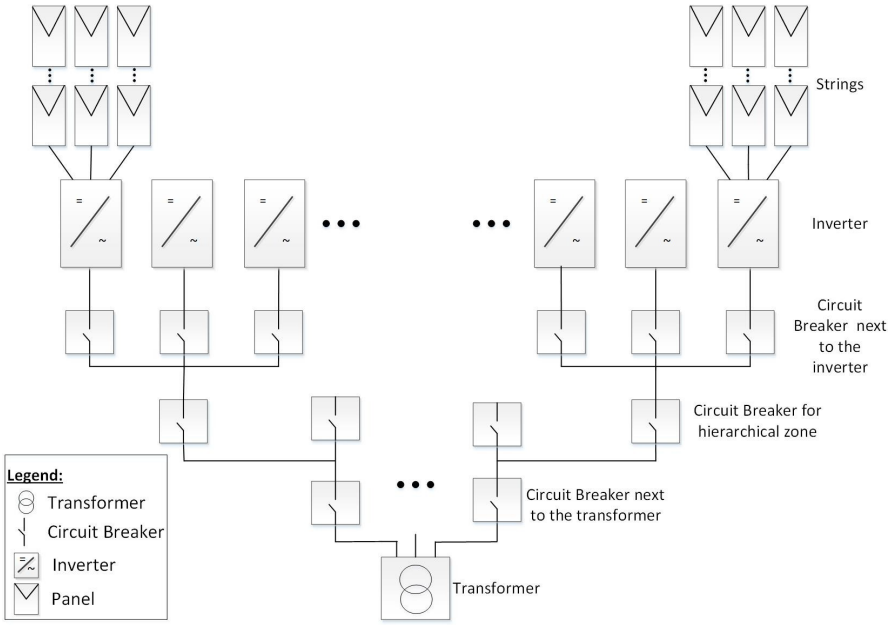

Figure 1: Typical transformer and commercial three phase inverter installation topology

There are many considerations for selecting the suitable transformer and its associated current limiting devices such as circuit breakers and fuses.

The considerations must include at least the following:

- The transformer should be designed for a typical PV system production profile: high daytime loads with no loads at night.
- The current limiting devices should protect the electrical circuits and the inverters from the excess current created by an overload, or a short circuit. If a short circuit or other overcurrent occurs, the current limiting devices should block the current flow to the circuit, thus preventing damage to the electrical circuits and the inverters.

  The circuit breakers and the fuses should comply with the transformer manufacturer recommendations and with the relevant sections in standards such as IEC 60909, IEC 60364, UL 508A and NEC 2017.
  Some manufacturers provide detailed information about the transformer short circuit calculation procedure, and its effect on the selection of circuit breakers and fuses at the different hierarchical levels of the installation topology (see *Figure 1*).
  For an example of a calculation, refer to:

  - Guidelines on the Short Circuit Current Rating for Industrial Control Panels
  - Short-circuit current rating (SCCR) of industrial control panels
- To ensure that the circuit breaker and fuses trip as expected, follow their manufacturers' recommendations, especially with respect to the various de-rating considerations.

NOTE

Transformer procurement, installation, maintenance, and support are the responsibility of the installer. Damage to the inverter due to incorrect transformer installation, or use of a transformer that is incompatible with the SolarEdge system will render the SolarEdge warranty invalid.

Determining the Size of an Inverter Circuit Breaker

This section explains how to determine the rate of a circuit breaker next to an inverter. For an example of an inverter with a circuit breaker next to it see *Figure 1*.

Ensure you have the following parameters before determining the circuit breaker size:

- The inverter's maximum continuous output current appears in the data-sheet.
- Factor for the installation's country. This factor is dictated by regulation, applicable standards or common practice and is usually 1.25.

→ To determine the size of an inverter circuit breaker:

1. Multiply the inverter's maximum continuous output current by the factor.
   For example, 40A x 1.25= 50A
2. Round up the rated size, as calculated in step 1, to the closest standard circuit breaker size. See Circuit Breaker Criteria table below for standard sizes suitable for SolarEdge three phase inverters.

NOTE

If the result has a decimal fraction smaller than 0.5 round it down.

3. To ensure that the selected circuit breaker trips as expected, at minimum consider the following:
   - The circuit breaker rated Voltage and current.
   - Temperature de-rating due to both close proximity of other circuit breakers and the effect of ambient temperature on the distribution board.
   - De-rating due to permanent load.

If the de-rated current of the selected circuit breaker is lower than the maximum output current of the inverter, consider selecting a circuit breaker that is designed for a higher rated current, or reducing the temperature de-rating effect by increasing the distance between adjacent circuit breakers.

NOTE

- Make sure to select cables that are suitable for the environmental conditions, operating Voltage, current and the selected circuit breaker.
- Three or four pole circuit breakers are required. It is recommended to use a four pole circuit breaker when applicable.
- Calculate and verify that the circuit breaker can withstand the expected fault current.

  Only use a circuit breaker with tripping characteristic B or C.

Circuit Breaker Specifications

These tables describe criteria for circuit breakers in three phase inverters and three phase inverters with Synergy Technology. For details about selecting circuit breaker, see the Inverter datasheet.

North America 208L

Inverter	Maximum continuous output current (per phase)	Recommended circuit breaker
Three Phase Inverter		
SE14.4KU	40A	50A
SE17.3KUS	48.25A	63A
Three Phase Inverter with Synergy Technology		
SE43.2KUS	120A	150A
SE50KUS	139.5A	175A

North America 480 L-L

Inverter	Maximum continuous output current (per phase)	Recommended circuit breaker
Three Phase Inverter		
SE30KUS	36.25A	50A
SE33.3KUS	40A	50A
SE40KUS	48.25A	63A
Three Phase Inverter with Synergy Technology		
SE66.6KUS	80A	100A
SE80KUS	96.5A	125A
SE100KUS	120A	150A
SE120KUS	145A	200A

EUROPE AND APAC 380/400 L-L

Inverter	Maximum continuous output current (per phase)	Recommended circuit breaker
Three Phase Inverter		
SE12.5K	20A	25A
SE15KUS	23AA	32A
SE16KUS	25.5A	32A
SE17K	26A	32A
SE25K	36.25A[(1)]	50A
SE27.6K	40A	50A
SE30K	43.5A[(2)]	63A
SE33.3K	48.25A	63A
Three Phase Inverter with Synergy Technology		
SE50K	76A	100A
SE55.5K	80A	100A
SE66.6K	96.5A	125A
SE57K	120A	150A
SE82.8K	120A	150A
SE90K	130.5A[(3)]	175A
SE100K	145A	200A

[(1)] For countries that comply with VDE-AR-N 4110 certification, the maximum continuous output current (per phase) is 40A. For details, see the inverter datasheet.

[(2)] For countries that comply with VDE-AR-N 4110 certification, the maximum continuous output current (per phase) is 48.25A. For details, see the inverter datasheet.

[(3)] For countries that comply with VDE-AR-N 4110 certification, the maximum continuous output current (per phase) is 145A. For details, see the inverter datasheet.

EUROPE AND APAC 480 L-L

Inverter	Maximum continuous output current (per phase)	Recommended circuit breaker
Three Phase Inverter		
SE33.3K	40A	50A
SE40KS	48.25A	63A
Three Phase Inverter with Synergy Technology		
SE66.6K	80A	100A
SE80KS	96.5A	125A
SE100K	120A	150A
SE120K	145A	200A