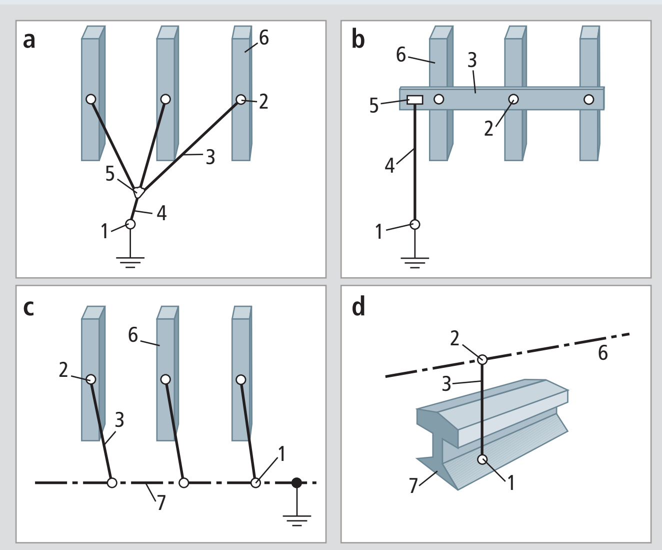
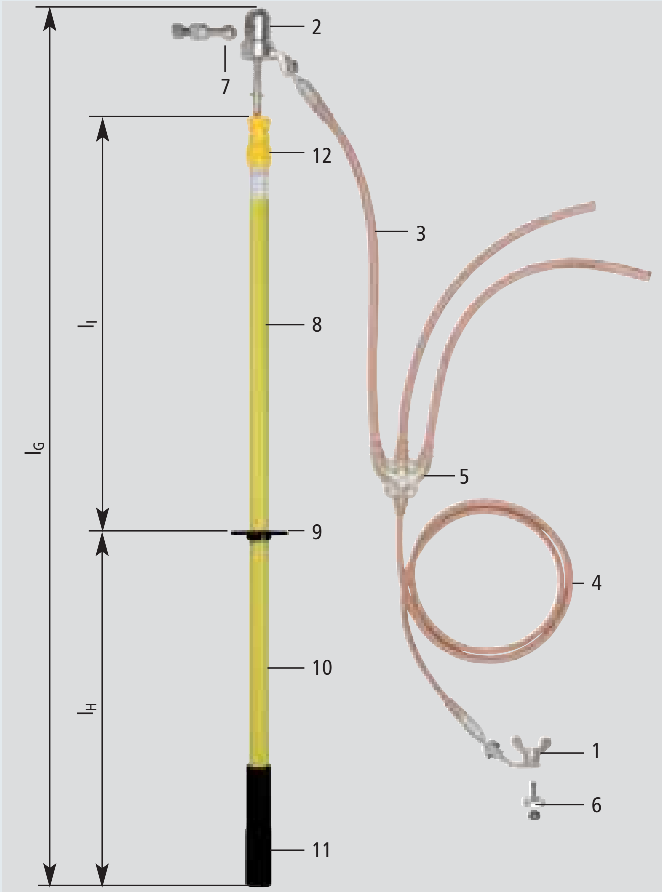
# EARTHING AND SHORT-CIRCUITING DEVICES

Earthing and short-circuiting at the work location is a vital part of the five safety rules. Earthing and short-circuiting ensure the protection of personnel from dangerous voltages that may be caused by induced voltages, atmospheric surges or accidental reconnection of the supply voltage.
Isolation from supply voltages must be verified immediately before installing portable earthing and short-circuiting devices at the installation point.
When connecting the earthing and short-circuiting device, the earthing cable must be connected to the earthing system first in order to discharge any residual potential or induced voltages.
**Portable earthing and short-circuiting devices** according to IEC/EN 61230 (DIN VDE 0683 Part 100) are hand-hold devices used to approach the connecting points of electrical parts of an installation for earthing and short-circuiting purposes and to connect them to the connecting points. These devices are applied without restricted guidance e.g. guide slots, sockets, guide rails.
The device consists of an earthing and short-circuiting device (E+S devices) and an earthing rod.
The purpose of **earthing and short-circuiting devices** is to earth and short-circuit electrical circuits. It consists of an earthing device and a short-circuiting device.
The **earthing device** connects the earthing system to a short-circuiting device or to the equipment to be earthed (**Figures a to d**). It consists of a connecting component (**1**) and earthing cable (**4**).
The **short-circuiting device** connects the phase conductors that have to be short-circuited (**6**). It consists of connecting components (**2**), short-circuiting cables or short-circuiting busbars (**3**) and connecting pieces, if required (**5**).
The **short-circuiting bar** is a rigid short-circuiting device.
**Connecting pieces** connect the short-circuiting cables to each other and to the earthing cable or the short-circuiting bar to the earthing cable.
**Connecting components** connect the earthing and short-circuiting cables or bars to the earthing system and parts of the installation either directly or via connecting links such as cable lugs or, if required, connecting points.




a 3-pole unit with short-circuiting cables and earthing cable
b 3-pole unit with short-circuiting bar and earthing cable
c Single-pole unit with short-circuiting cables
d Single-pole unit with short-circuiting cable for earthing railways

1 Connecting component to earthing system
2 Connecting component to conductor
3 Earthing and short-circuiting cable or earthing busbar
4 Earthing cable
5 Connecting piece
6 Phase conductor
7 Earthing system (earthing busbar, rail)




Portable earthing and short-circuiting device

1 Connecting component to earthing system
2 Connecting component to conductor
3 Short-circuiting cable
4 Earthing cable
5 Connecting piece
6 Connecting point to earthing system
7 Connecting point to conductor
8 Insulating part with length $l_I$
9 Handguard
10 Handle with length $l_H$
11 Sealing unit with plug-in
12 Coupling

**Connecting points** are points in the installation, to which coupling are connected earthing and short-circuiting devices (e.g. cables, bars, fixed ball points, cylinder bolts, brackets etc.). Maximum short-circuit strength can be achieved by connecting the ball head cap of the earthing and short-circuiting device to fixed ball points.

Two types of ball head caps are available:
– Ball head cap, rigid
– Ball head cap, adjustable (4 x 90°)

The adjustable ball head cap allows the user to position the earthing and short-circuiting device in the most favourable operating position by adjusting the ball head cap, even if the fixed ball points are unfavourably located. Using angled fixed ball points is therefore mostly unnecessary.


Ball head cap, rigid


Ball head cap, adjustable (4 x 90°)

# Earthing and Short-circuiting Devices



## EARTHING AND SHORT-CIRCUITING DEVICES

An **earthing rod** is a hand-held insulating rod for approaching the connecting components of earthing and short-circuiting devices to parts of electrical installations for earthing and short-circuiting purposes. It consists of an insulating part, black ring, handle and coupling for a connecting component. Earthing rods are selected according to the **weight** of the respective earthing and short-circuiting devices (See specification: "max. load on operating head in kg").

The **insulating part** is the part of the earthing rod between the black ring and the end of the earthing rod in the direction of the connecting component. It ensures that the user maintains a safe distance and provides sufficient insulation. The insulating part $l_I$ must have a minimum length of 500 mm.

A complete device for earthing and short-circuiting device according to EN/IEC 61230 (DIN VDE 0683 Part 100) includes e.g.

1 Fixed point / Fixed ball point
2 Single-pole or three-pole earthing and short-circuiting device or short-circuiting bar
3 Fixed earthing point
4 Earthing rod

**Earthing and short-circuiting devices** as well as the fixed ball and earthing points must be rated to withstand the **short-circuit current conditions** expected on site.

The required cable cross section depends on the maximum short-circuit current ($I_k$ in A) and the maximum short-circuit time ($T_k$ in s).

**Remark:**

In the event of a short-circuit, the short-circuit current will flow through the short-circuiting device. However, this is different for earthing devices as they do not conduct short-circuit currents and can therefore be rated for lower values.

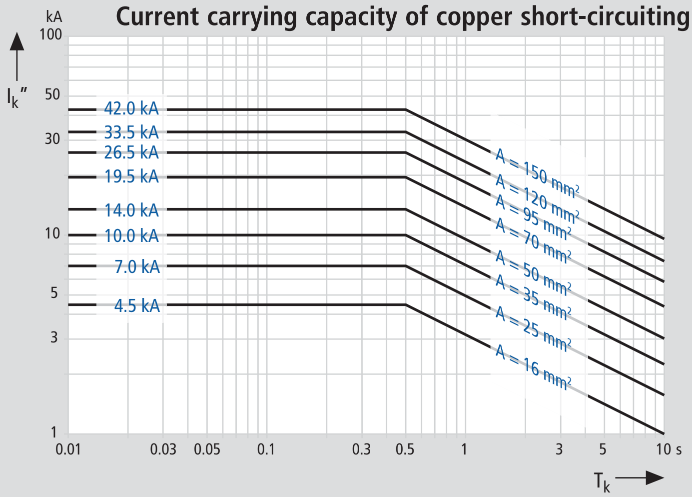
**Cable cross section:**

For short-circuiting cables of our three-pole earthing and short-circuiting devices with cross sections of 50 mm² and higher, **the cross section of the earthing cable** can be reduced according to the following table.

| Cable cross section: | **Short-circuiting cable** | **Earthing cable** |
|---|---|---|
| | 25 mm² | 25 mm² |
| | 35 mm² | 35 mm² |
| | 50 mm² | 25 mm² |
| | 70 mm² | 35 mm² |
| | 95 mm² | 35 mm² |
| | 120 mm² | 50 mm² |
| | 150 mm² | 50 mm² |

These earthing and short-circuiting devices with reduced earthing cable cross sections can be used for all types of installations with **compensated systems** (no solidly earthed systems, i.e. with impedance neutral earthing). For installations with **solid earthing**, earthing and short-circuiting cables must have equal cross sections (available on request).

### Current carrying capacity of copper short-circuiting cables for use in a.c. and three-phase installations




Initial cable temperature 20° C
Final cable temperature 250° C

$\boxed{A = 5.07\ I_k"\ \sqrt{T_k}}$ for $T_k \geq 0.5$ s

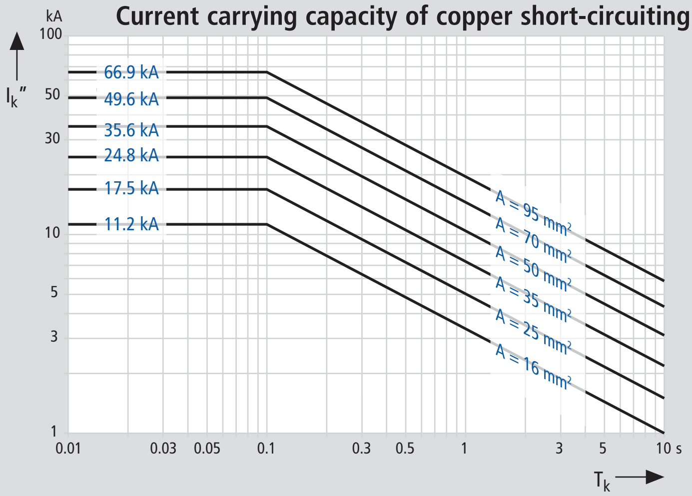
where

A Cable cross section in mm²

$I_k$" Maximum initial short-circuit alternating current in kA according to DIN VDE 0102

$T_k$ Short-circuit time in s

### Current carrying capacity of copper short-circuiting cables for use in d.c. installations




Initial cable temperature 20° C
Final cable temperature 250° C

$\boxed{A = 5.07\ I_k"\ \sqrt{T_k}}$ for $T_k \geq 0.08$ s

where

A Cable cross section in mm²

$I_k$" Maximum initial short-circuit alternating current in kA according to DIN VDE 0102

$T_k$ Short-circuit time in s

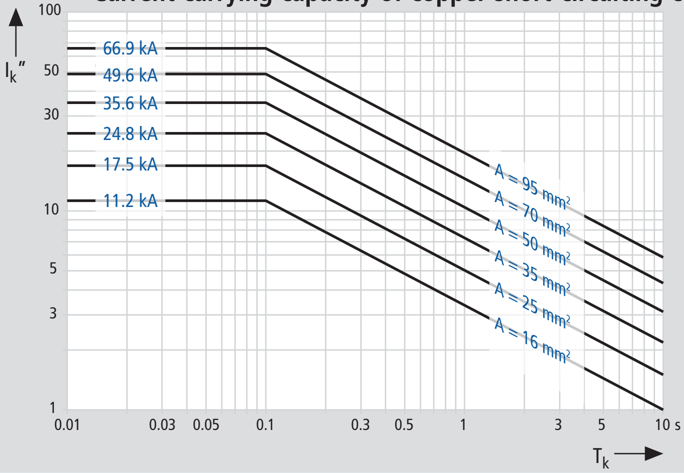
# EARTHING AND SHORT-CIRCUITING DEVICES

The **current carrying capacity** of the short-circuiting cable and the short-circuiting bar depends on the material, the cross section (A) and the short-circuit time ($T_k$).
Calculations were based on the most critical case, i.e. an off-generator short circuit ($\mu = 1$) and are maximum d.c. component ($\chi = 1.8$) with $I_k$" being the maximum initial short-circuit current, which, according to DIN VDE 0102, is equal to the permanent short-circuit current, $I_k$ and the breaking current $I_a$:

$$I_k" = I_k = I_a$$

The diagrams or the table help to determine the required cable or busbar cross sections of short-circuiting devices according to the short-circuit current and the short-circuit time for an installation.

## Current carrying capacity of copper short-circuiting cables for use on overhead contact lines of electrical railways




Initial cable temperature 20° C
Final cable temperature 400° C

$\boxed{A = 4.1\, I_k" \sqrt{T_k}}$ for $T_k \geq 0.12$ s

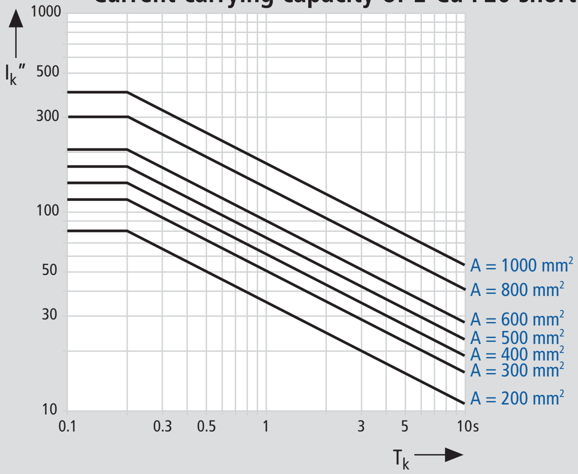
where

A Cable cross section in mm²

$I_k$" Maximum initial short-circuit alternating current in kA according to DIN VDE 0102

$T_k$ Short-circuit time in s

## Current carrying capacity of E-Cu F20 short-circuiting busbars




Initial cable temperature 20° C
Final cable temperature 250° C

$\boxed{A = 5.54\, I_k" \sqrt{T_k}}$ for $T_k \geq 0.2$ s

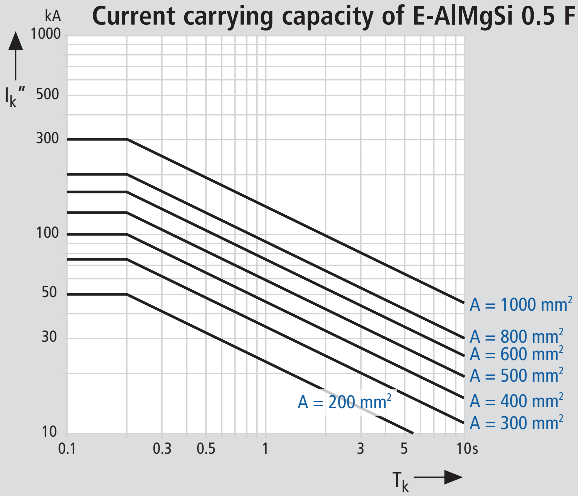
where

A Cable cross section in mm²

$I_k$" Maximum initial short-circuit alternating current in kA according to DIN VDE 0102

$T_k$ Short-circuit time in s

## Current carrying capacity of E-AlMgSi 0.5 F17 short-circuiting busbars




Initial cable temperature 20° C
Final cable temperature 250° C

$\boxed{A = 8.79\, I_k" \sqrt{T_k}}$ for $T_k \geq 0.2$ s

where

A Cable cross section in mm²

$I_k$" Maximum initial short-circuit alternating current in kA according to DIN VDE 0102

$T_k$ Short-circuit time in s

## Calculation example:

Known: Mains breaking capacity $S_a$
Short-circuit time $T_k$

Unknown: Required cable or bar cross section A.

The calculation is based on an off-generator short-circuit.

Three-phase current $$I_k" = I_k = I_a = \frac{S_a}{\sqrt{3} \bullet U_N}$$

Single-phase a.c. current $$I_k" = I_k = I_a = \frac{S_a}{U_N}$$

$I_k$", the required cable or bar cross section can now be calculated with the value of the above equation or can be taken from the diagrams. The permissible short-circuit current of an earthing and short-circuting device expressed by indicating the cross-section of the short-circuiting cables or bars.

## Notes:

- Earthing and short-circuiting devices can only be loaded once with the permissible short-circuit currents depending on the short-circuit time.
- Short-circuiting cables of multi-pole earthing and short-circuiting devices must have equal cross sections.
- Cable lengths of earthing and short-circuiting devices should be as short as possible, as the cables move violently during a short-circuit. They should be at least 120% of the distance between two termination points.
- When connecting earthing and short-circuiting devices in parallel with cables for achieving certain total cable cross sections, the following conditions must be fulfilled:
  1. Identical cable lengths and cross sections,
  2. Identical connection parts and termination points,
  3. Installing the devices directly next to each other, with parallel arrangement of cables,
  4. The loading capacity per lead must be reduced to 75% of the loading capacity of the cable cross-section.

  Remark:
  If it is ensured that earthing and short-circuiting devices connected in parallel are loaded with short-circuit currents only once (no interruption of the short circuit), the devices may be exposed to the full load. Generally, this applies to installations for nominal voltages above 110 kV.

## Table:

Cable cross section of the earthing and short-circuiting device depending on the maximum short-circuit $I_k$ and maximum short-circuit time $T_k$.

| Cross section of the copper cable | Max. permissible short-circuit current $I_k$ at a duration of | | | | |
|---|---|---|---|---|---|
| | 10 s | 5 s | 2 s | 1 s | ≤ 0.5 s |
| 16 mm² | 1 000 A | 1 400 A | 2 200 A | **3 200 A** | 4 500 A |
| 25 mm² | 1 600 A | 2 200 A | 3 500 A | **4 900 A** | 7 000 A |
| 35 mm² | 2 200 A | 3 100 A | 4 900 A | **6 900 A** | 10 000 A |
| 50 mm² | 3 100 A | 4 400 A | 7 000 A | **9 900 A** | 14 000 A |
| 70 mm² | 4 400 A | 6 200 A | 9 800 A | **13 800 A** | 19 500 A |
| 95 mm² | 5 900 A | 8 400 A | 13 200 A | **18 700 A** | 26 500 A |
| 120 mm² | 7 500 A | 10 600 A | 16 700 A | **23 700 A** | 33 500 A |
| 150 mm² | 9 400 A | 13 200 A | 20 900 A | **29 600 A** | 42 000 A |
| | | | | **our catalogue data** | |