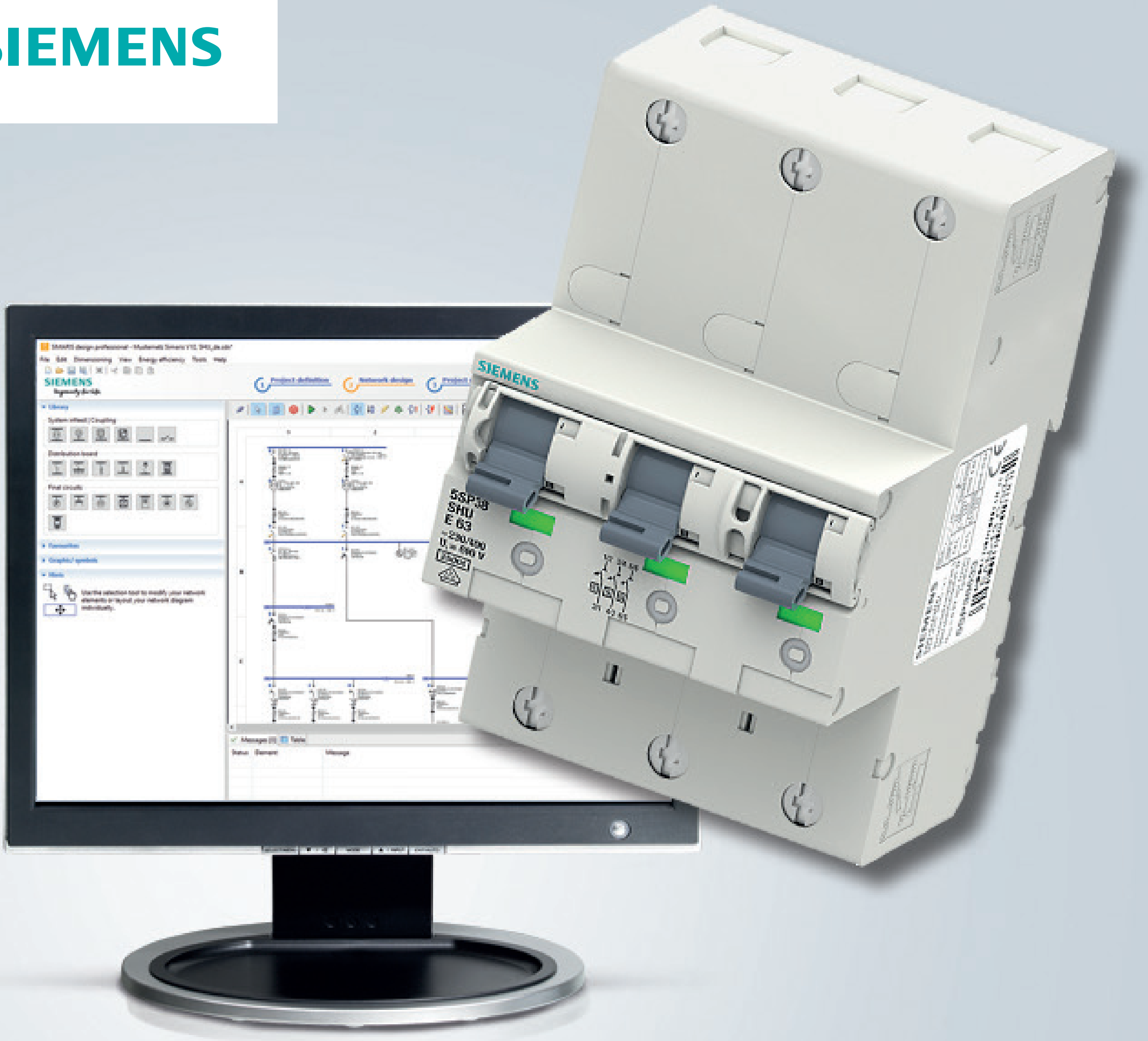
SIEMENS



Totally Integrated Power

Technical Series Edition 4.1

Modelling the Use of Selective Main Miniature Circuit-Breakers without Control Circuit (SHU) in SIMARIS® design

siemens.de/tip-cs

Technical Series Edition 4.1

Modelling the Use of Selective Main Miniature Circuit-Breakers without Control Circuit (SHU) in SIMARIS® design

1. Fields of application for main circuit-breakers and selectivity

A typical field of application for main miniature circuit-breakers is that of a feeder for electricity supplied by the distribution system operator (DSO), i.e. at the service entrance point or in the meter cabinet, and as a group switch to improve selectivity, for example

- in communal facilities and workplaces, IEC 60364-7-718 or DIN VDE 0100 Part 718
- in medical locations IEC 60364-7-710 or DIN VDE 0100 Part 710.

Furthermore, main miniature circuit-breakers are used in low-voltage distribution boards as group switches for cable and line protection where short-circuit currents greater than 10 kA and less than 25 kA are present.

1.1 Use in DSO applications

In case of a load-side fault (e.g. household socket), the SHU in a distribution system operator (DSO) application enables, besides its pure disconnection function, selective tripping upstream of the service entrance point, so that a disconnection of the service entrance fuse, which would require servicing on part of the DSO, can be avoided.

> Excerpt from the TAB NS Nord / 2012, of the Federal States of Berlin, Brandenburg, Hamburg, Mecklenburg-West Pommerania and Schleswig-Holstein:
>
> ... 6.2.3 Coordination of protective devices
>
> (1) Planners of electrical installations as well as the installation companies shall consider that there is selectivity between the overcurrent protective devices integrated in the customer's installation and those in the main power supply system and the main service fuses.

The requirement of selective tripping is described in the „Technical Supply Conditions" (TAB), published by the distribution system operators in Germany.

An improvement of the selective response requires a certain network configuration, for example use of an SHU in a defined device cascade with upstream LV HRC fuse and downstream miniature circuit-breaker.

These TAB also contain specifications in respect to the above requirement, as shown in Figure 1s SHU.

Figure 1: Example for the distribution system operator specifications regarding the selectivity when using the SHU

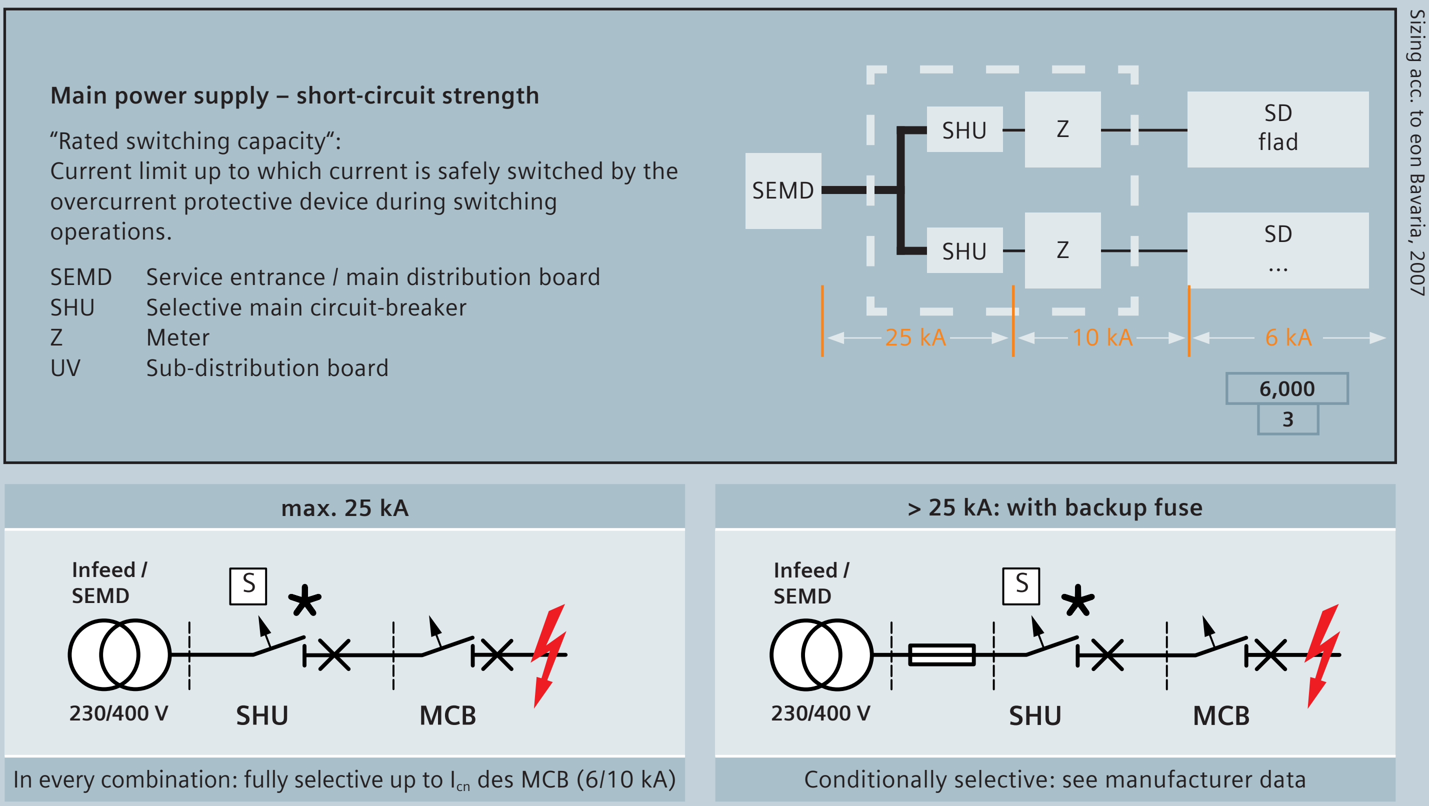


Figure 2: Improving the selective response through the use of SHU

In the DSO context, selectivity specifically means „short circuit selectivity", i.e. the selective response of the protective device chain in the event of a short circuit. The electrical designer has the additional task to ensure selectivity in the overload range by grading the protective device chain appropriately (comparison of characteristic curves: the overload characteristics of the protective devices must not intersect). The tolerance bands of the equipment manufacturers must be considered in this case!

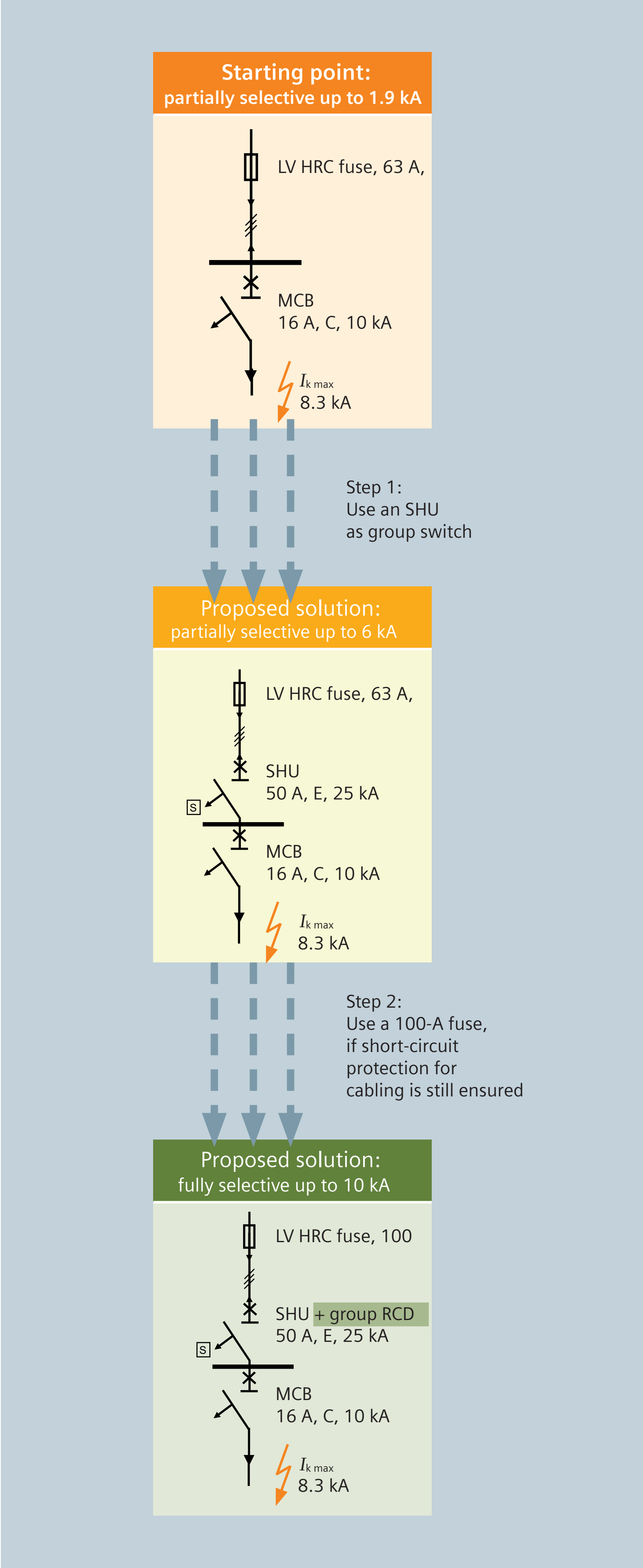
Attention! A combination consisting of LV HRC fuse, SHU, and MCB, with the SHU acting as group switch, is not automatically fully selective! As described in section 1.2, the electrical designer must provide such a proof of selectivity.

If the use of a conventional MCB (= miniature circuit-breaker) is compared to that of a combination of SHU and MCB, improvements of selective response can be found as shown in Figure 2, for example.

For example, if downstream of the transformer an LV HRC fuse rated 63 A is used in combination with an SHU rated 50 A and further downstream a miniature circuit-breaker with a rated current of 16 A and a rated current breaking capacity of 10 kA, the selectivity limit is 6 kA.

If a 100-A LV HRC fuse is line-side connected, as shown in step 2 of Figure 2, this combination is selective up to the rated breaking capacity of the MCB.

Specifications for this combination and many other combination varieties are listed in the product catalogue titled „SHU 5SP3 main miniature circuit breakers - Reliable personnel and line protection and optimal plant availability" (E86060-K8280-E191-A1-7600). This catalogue is only available as PDF file and can be found on the web pages of our SENTRON devices. For your convenience, this PDF is attached to this edition of the Technical Series.



1.2 Use of the SHU for cable and line protection

In order to be able to use an SHU as a group switch upstream of a group of conventional miniature circuit-breakers, the selectivity of this switching device combination must be demonstrated. An SHU can now be selected for cable and line protection. Owing to the fact that the SHU is additionally considered in the overload range, SIMARIS design allows a complete selectivity evaluation to be performed for an SHU in combination with cable routes and downstream MCBs in infrastructure networks with higher short-circuit levels.

The requirements placed on SHUs are described in VDE 0641-21. According to this standard, an SHU cannot be compared to conventional circuit-breakers or miniature circuit-breakers with regard to its electrical characteristics.

Figure 3 presents a compilation of the different scenarios. Firstly, an SHU is used as a group switch in an LVMD without cables (on the right) and secondly, feeder protection by SHU is calculated for a cable route of 20m (on the left). The corresponding demo file for SIMARIS design 10 is attached to this edition of the Technical Series.

This example demonstrates that the combination of LV HRC fuse + SHU + MCB results in a very good selectivity response in case of faults downstream of the MCB. If the fault, however, is located immediately downstream of the SHU, this device usually shows a very bad selectivity response. This means the optimal location of the SHU is where a short circuit between SHU and MCB can be ruled out.

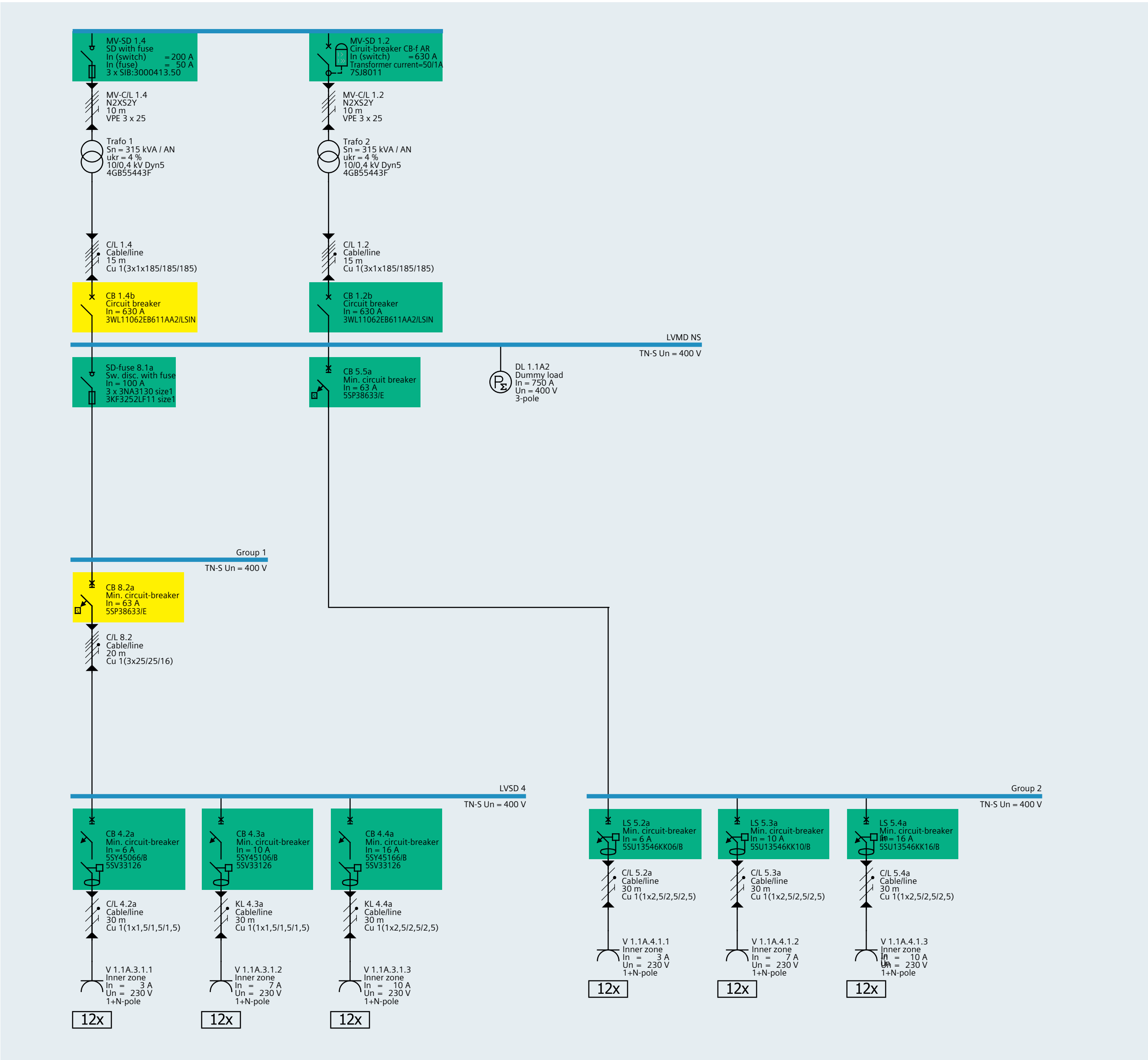


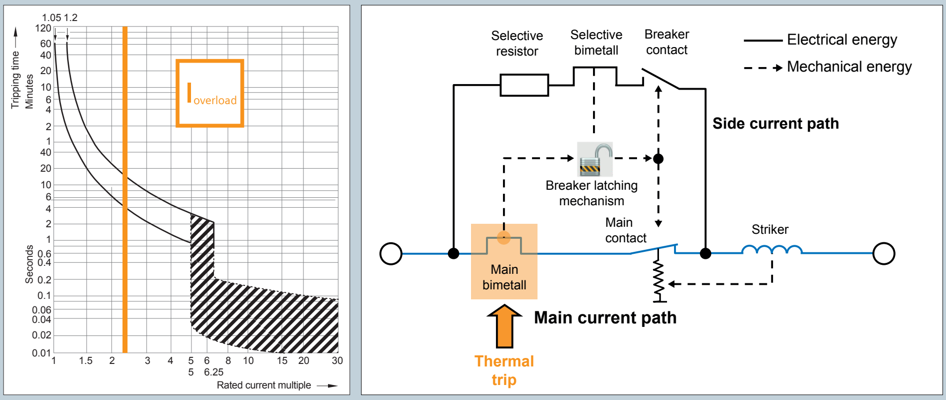
Figure 3: Selectivity evaluation for SHU in SIMARIS design 10 (left, as outgoing feeder to a sub-distribution board and right, as group switch upstream of miniature circuit-breakers; e.g. using MCBs in the range of low-voltage main distribution)

1.3 Functioning principle of the SHU

When overloaded, the thermal trip will be triggered by a bimetal as shown in Fig. 4, so that the contact latching mechanism will be unlatched and the main contact opened. This protects the whole installation including the meter unit against overload. In case of a short circuit, a magnetic system with armature or striker pin ensures quick opening of the main contact Initially, the contact latching mechanism will remain locked then (see Fig. 5). If the downstream protective device does not break the fault current, or if the fault current exceeds the MCB switching capacity (max. 25 kA), the short circuit will initially stay. But then, the selective bimetal responds with a time lag and unlatches the contact latching mechanism, so that the device finally goes into OFF position, as illustrated in Fig. 6.

Figure 4: SHU tripping through the main bimetal in case of overload

Overload

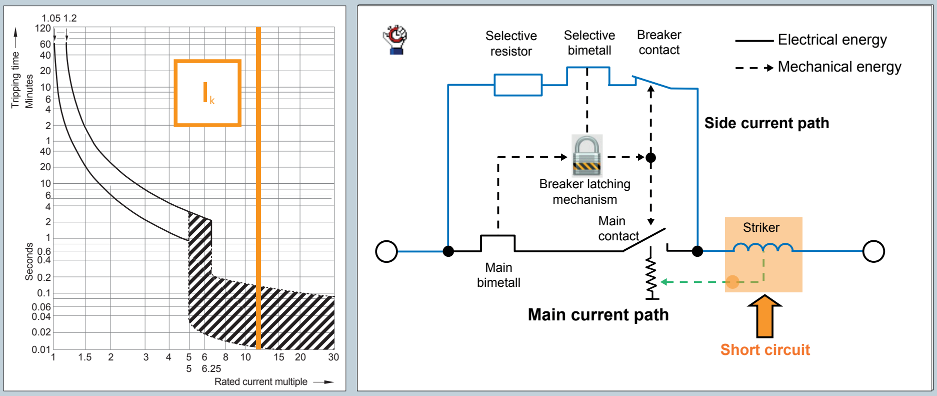


In case of overload, the thermal trip is effected by the bimetal. The contact latching mechanism is unlatched and opens the main contact.

-> Installation (+meter unit) protected against overload

Figure 5: Regular SHU trip effected by the striker in case of short circuit

Short circuit



In case of a short circuit, a magnetic system with armature or striker ensures quick opening of the main contact.
But the contact latching mechanism will remain locked!
When the main contact opens, the NO contact simultaneously closes and thus energizes the side current path.

-> The short-circuit current is limited by the SHU.

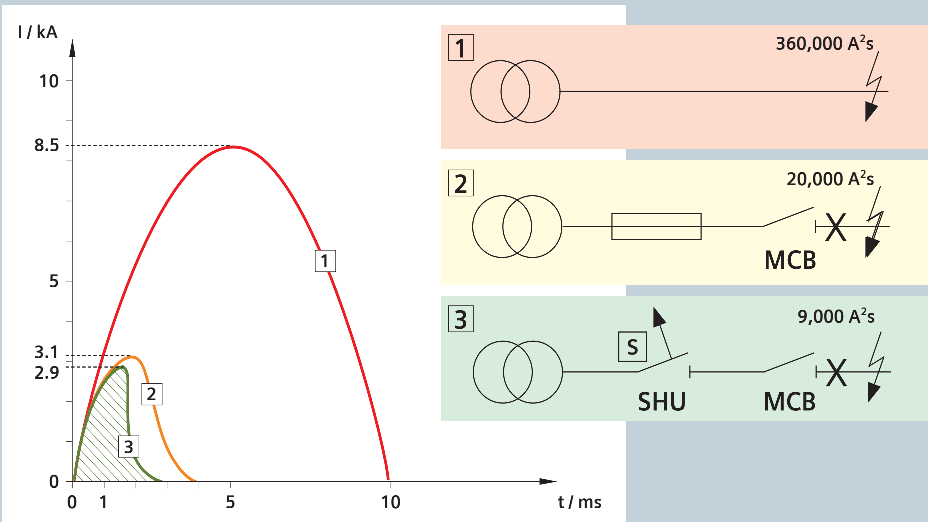
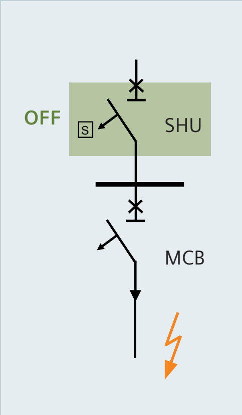
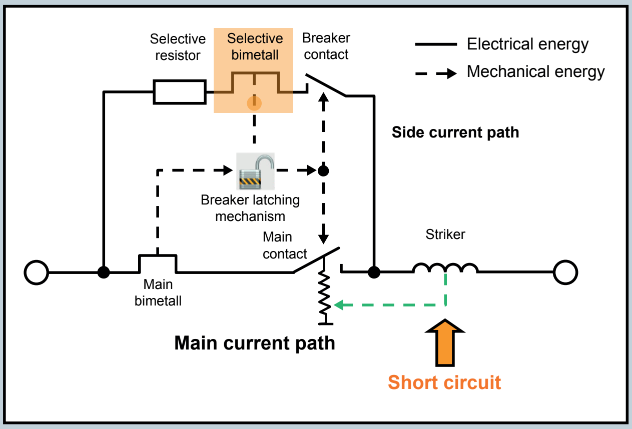


Figure 6: Delayed SHU trip effected by the selective bimetal in case of a short circuit





The downstream protective device does not break the fault current, or the fault current exceeds the MCB switching capacity (max. 25 kA).
If the short circuit continues to be present, the selective bimetal will respond within a certain time delay and unlatches the contact latching mechanism.
The switch goes into a (final) OFF position.

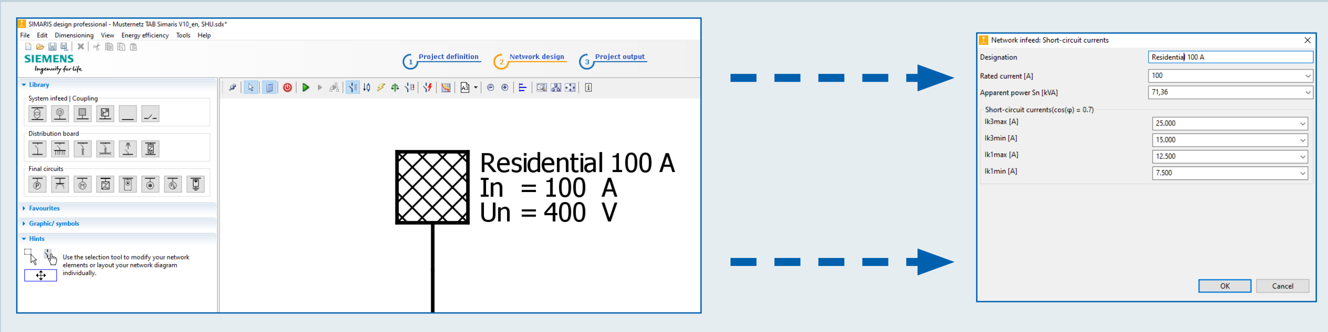
-> The SHU acts as backup protection and independently breaks the fault current.

2. How to Apply SHUs conforming to TAB and How to Map SHU Use in SIMARIS

For the purpose of modelling the use of an SHU in a power distribution network conforming to the Technical Supply Conditions (TAB), you must first select a "neutral system feed-in" as power source in SIMARIS design in order to be able to map DSO requirements concerning the short-circuit currents to be expected at the point of supply.

For information about the short-circuit currents to be expected, please refer to the TAB (see the following excerpt from the TAB NS Nord) or request information from the DSO.

Figure 7: Feed-in specification in SIMARIS design to map the short-circuit currents to be expected at the point of supply.



Excerpt from the TAB NS Nord / 2012, of the Federal States of Berlin, Brandenburg, Hamburg, Mecklenburg-West Pommerania and Schleswig-Holstein:

6.2.3 Coordination of protective devices

In case of a meshed operation of the low-voltage grid (e.g. in Berlin), the installing engineer shall consider the resulting peak short-circuit currents (curve maximum of a sinusoidal half-wave) when selecting equipment:

Service entrance	Peak short circuit current [kA]
max. 250 A	25
2 x 250 A*)	40
3 x 250 A*)	53
4 x 250 A*)	65

*) Parallel feed-in to busbar

6.2.4 Short-circuit strength

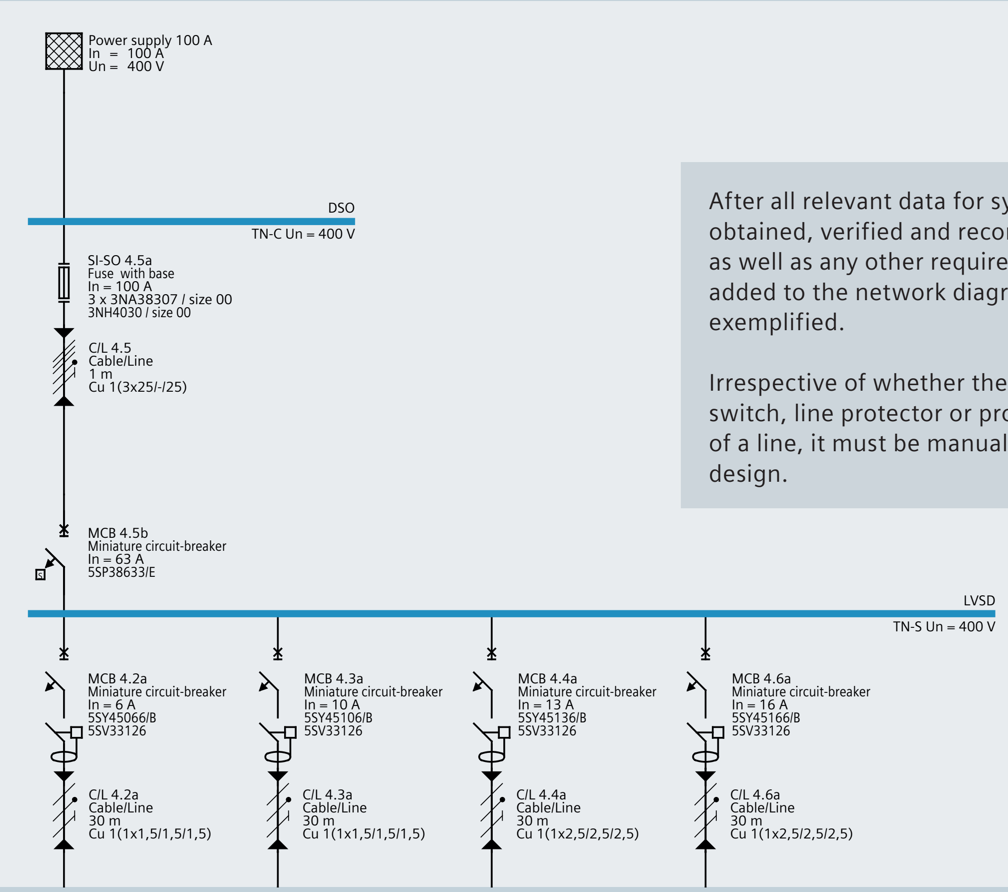
(1) The electrical designer or installing engineer shall rate the electrical installations beyond the point of supply (service entrance box) at least for the following prospective fault currents*:

- 25 kA for the main power supply system from the point of supply of the transmission system operator down to the last overcurrent protection device line-side of the E-meter.
- 10 kA for equipment between the last overcurrent protection device upstream of the E-meter and the distribution board.

(2) The line-side overcurrent protection device for the E-meter, which is installed to allow direct measurements, may have a current rating of max. 100 A. It must show at least the same current-limiting characteristics as SH switches** or fuses in operational class gG, all of them rated for 100 A.

* Prospective fault currents are unlimited continuous short-circuit currents
** SH switch = General main circuit-breaker

Figure 8: Example for modelling SHU application in power distribution networks with SIMARIS design



After all relevant data for system feed-in was obtained, verified and recorded, this feed-in system as well as any other required network component are added to the network diagram in SIMARIS design as exemplified.

Irrespective of whether the SHU is used as group switch, line protector or protection device at the end of a line, it must be manually selected in SIMARIS design.

SIMARIS® design:
Network calculation and short-circuit current calculation

Using the SIMARIS design software, you will perform network calculations including short-circuit current calculations based on real products with a minimum of input – from the medium voltage level to the power consumers. In addition, the software calculates the load flow and voltage drop and returns an energy report.

www.siemens.com/simaris

Published by
Siemens AG

Smart Infrastructure
Distribution Systems

Mozartstr. 31 c
D-91052 Erlangen
Germany

For the U.S. published by
Siemens Industry Inc.

100 Technology Drive
Alpharetta, GA 30005
United States

10/20 • Subject to change without notice and errors excepted.

E-Mail: consultant-support.tip@siemens.com