

Documentation | EN

SCT7xxx

Busbar split-core current transformers



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1 Foreword

1.1 Notes on the documentation

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The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.

The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

1.2 Safety instructions

Description of instructions

In this documentation the following instructions are used.
These instructions must be read carefully and followed without fail!

DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTICE

Damage to environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.



Tip or pointer

This symbol indicates information that contributes to better understanding.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

WARNING

Intended use

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

⚠ WARNING**Current transformer safety instructions**

- The devices described are intended for installation by qualified electricians and may only be installed in electrical plant rooms or in closed housings. Any other use or the disregard of these application notes will result in the loss of the warranty/guarantee.
- Observe the applicable laws, standards and regulations.
- Observe the state of the art at the time of installation and the rules of technology.
- Observe the operating instructions and take into account the fact that these can only provide general instructions and that these must be observed.
- The devices may only be installed in dry indoor rooms.
- Do not mount the devices on or near highly flammable materials.
- Check the device carefully for transport damage prior to commissioning. The device must not be put into operation if it is mechanically damaged.
- Operation with a higher current than the rated current specified on the name plate can lead to overheating of the current transformer and thus to burns.
- Current transformers which are not directly connected to a load must be short-circuited on the secondary side for safety reasons!

2 Product overview

2.1 Introduction

SCTxxxx | Current transformers for power measurement



Fig. 1: SCT current transformers

The SCT current transformers allow reliable power sensor technology to be implemented directly in the field as an integral part of the PC-based control system. Users can choose between two concepts, which are highly scalable thanks to various designs and performance classes and are thus suitable for any application. The SCT series portfolio is extremely diversified, ranging from the low-cost 3-phase transformer sets for properties and standard industrial transformers for mechanical engineering, through to solutions for test benches with particularly high requirements for accuracy.

The choice of the right product category [► 16] depends on the type of usage:

Whilst the data acquisition can be implemented cost-efficiently and with high measurement accuracy using the ring-type current transformers, particularly in new systems, the split-core current transformers are suitable as an uncomplicated retrofit solution due to the simplicity of their attachment.

The SCT5xxx transformers occupy a special position. These are not intended for energy measurement, but are specially designed for highly accurate detection of differential currents. In addition, unlike the other SCT transformers, they are also suitable for DC currents and thus meet the differential current detection according to the Type B definition. Therefore, AC as well as DC currents up to 100 kHz can be measured by a fluxgate measuring principle.

2.2 Basics current transformers

Basic information on the technology area of current transformers is given in the following. The information is of general nature; so it is imperative to check the extent to which these notes apply to your specific application.

2.2.1 Function and structure

A current transformer is a transformer that converts an input current into a processable current signal at the output. Current transformers are mainly used to transform high currents to directly measurable smaller values in the milliamp or lower amp range. In a classic current transformer, the input current is proportional to the output current. Due to the physical operating principle and the mechanical structure, the current signal is electrically isolated for transmission to the evaluation electronics.

A current transformer basically consists of a small number of windings on the primary side and a larger number of windings on the secondary side. The current being converted flows through the primary side. The windings are usually wound on an alternating magnetic ferrite ring core.

The toroidal or **ring-type CT** is a typical type of transformer. Here, the busbar or current-carrying line is often used as the primary winding which is fed through the ring core of the transformer. Thus, the rail or line constitutes the primary winding with one turn. The secondary winding is located on the ring core. The transformation is determined by the primary to secondary winding ratio. The classic ring-type CT design is shown in the figure on the left below.

Another classic type is the **coil current transformer**. In this type of transformer, the primary winding is a current-carrying wire that is wound around the primary side of the ring core. The number of primary windings is > 1 , but is smaller than the number of secondary windings. This principle is illustrated in the figure on the right below.

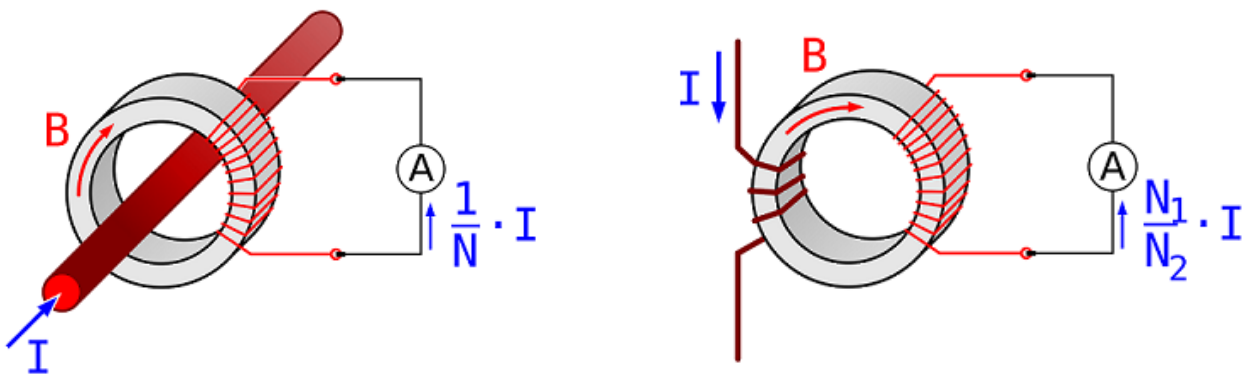


Fig. 2: Left: Principle of a ring-type CT; Right: Principle of a coil current transformer

⚠ WARNING

Dangerous voltages if the secondary side is not connected

The secondary winding must be connected to an ammeter or short-circuited, otherwise high core losses or dangerous voltages may occur on the secondary side.

- Before replacing the measuring electronics in the secondary circuit, the current transformer must therefore be short-circuited at its secondary connections.

● Grounding of secondary terminals

i According to DIN VDE 0141 (01/2000) paragraph 5.3.4, current and voltage transformers for rated voltages from $U_m = 3.6 \text{ kV}$ must be grounded on the secondary side. For low voltages ($U_m \leq 1.2 \text{ kV}$), grounding is not required if the transformer housings do not have any metal surfaces with large contact areas.

Small signal transformers with secondary signal voltage

In small signal transformers, the transformed secondary current of the current transformer is converted into a voltage signal via a low measuring resistance R_M . The input impedance R_V of the connected voltage electronics must be high-resistance and thus ensures a negligible influence on the measuring accuracy.

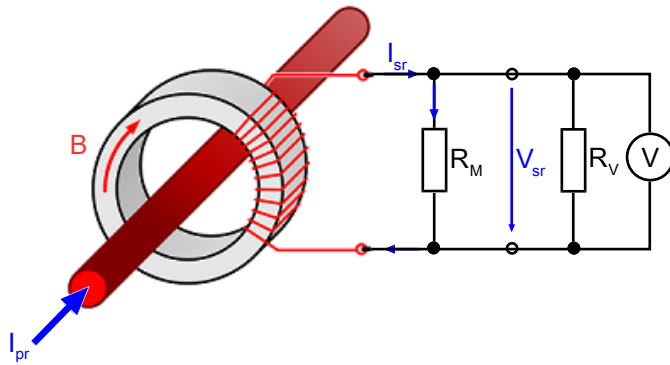


Fig. 3: Principle of a ring-type CT with secondary voltage signal

The low measuring resistance prevents dangerous open-circuit voltages, eliminating the need to short-circuit the secondary connections.

2.2.2 Characteristic values and calculation

In principle, the structure, and thus also the calculation, are the same as those for a normal transformer. The basic relationship between input and output current is given by the ratio of the number of windings (N) on the primary and secondary sides. The transformer ratio is therefore an important parameter for designing a current transformer.

$$I_{\text{Off}} = N_1/N_2 * I_{\text{On}}$$

2.2.3 Technical terms of current transformers

Term	Explanation
Primary rated current I_{pr} (alternative symbol I_N)	Value of the rated current on the primary side
Secondary rated current I_{sr}	Value of the rated current on the secondary side
Secondary signal	With low power transformers, a voltage signal in the mV range (e.g. 333 mV) is output using an internal load.
Rated power S_r	Value of apparent power (in [VA]) that the transformer can deliver to the secondary circuit at secondary rated current and rated load
Rated frequency f_R	Value of the rated frequency
Accuracy class	Indication that the measurement deviations are within specified limits under prescribed conditions of use.
Rated insulation level U_m	Maximum voltage; the rms value of the highest phase-to-phase voltage for which a measuring transformer is rated in terms of its insulation. The value of the rated insulation level is specified in 3° increments: <ol style="list-style-type: none"> 1. maximum value of the conductor-to-conductor voltage for which the insulation of the transformers is designed; 2. Value of the rated short-duration power frequency withstand voltage (50 Hz, 1 min), with which the insulation safety of the devices is tested 3. Value of the surge voltage level (this specification is mostly unoccupied here, since according to IEC 61869/1 a specification is only required for transformers with a conductor-to-conductor voltage of > 1.2 kV)
Overcurrent limiting factor (FS)	Ratio of rated limiting current to primary rated current.
Rated continuous thermal current I_{cth}	Value of the continuous current in the primary winding at which the overtemperature does not exceed the value specified in the standard, with the secondary winding loaded with the rated load.
Rated short-time thermal current I_{th}	Value of short-time current for a limited time in the primary winding at which the overtemperature does not exceed the value specified in the standard, with the secondary winding loaded with the rated load.
Rated peak current I_{dyn}	Maximum value of the primary current whose electromagnetic force effect does not cause electrical and mechanical damage to the current transformer with short-circuited secondary winding.
“Open-circuit voltage” of low power current transformers (e.g. SCL transformer with 333 mV secondary signal)	Due to the low measuring resistance, there is no dangerous “open-circuit voltage” with low power transformers. It is therefore not necessary to short-circuit the secondary terminals.
“Open-circuit voltage” of typical current transformers (e.g. SCT transformers with 1 A and 5 A secondary signal)	<p>WARNING Current transformers which are not directly connected to a load must be short-circuited on the secondary side for safety reasons!</p> <p>A current transformer operated open on the secondary side induces very high peak voltage values at its secondary terminals. The magnitudes of these voltages can reach values of up to several kilovolts, depending on the dimensioning of the current transformer, and thus represent a danger to persons and the functional safety of the transformer. For safety reasons, open operation should generally be avoided in order to prevent magnetization of the core iron during secondary open operation.</p>
Grounding of secondary terminals	According to DIN VDE 0141 (01/2000) paragraph 5.3.4, current and voltage transformers for rated voltages from $U_m = 3.6$ kV must be earthed on the secondary side. For low voltage ($U_m \leq 1.2$ kV), grounding is not required if the transformer housings do not have any metal surfaces that can be touched over a large area.

2.2.4 Fluxgate current measurement technology

Principle of the fluxgate current measurement technology

While all SCT transformers except the SCT5xxx are based on the transformer principle described above, the technology of the all-current sensitive differential current transformers is fundamentally different.

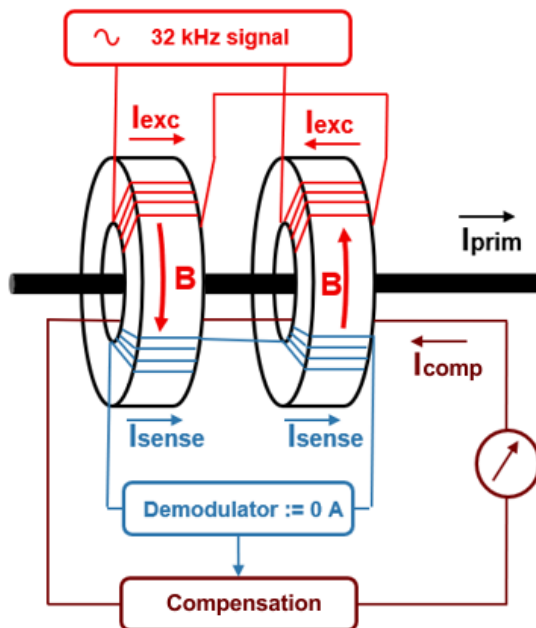


Fig. 4: Principle fluxgate current measurement technology

The measuring principle of the SCT5xxx is based on a differential current measurement of two oppositely excited cores in the transformer. For this purpose, both cores are brought into saturation with an excitation winding (red) with an internally generated 32 kHz signal, whereby the first core is driven in the positive and the second in the negative range of the y-axis. See fig.)

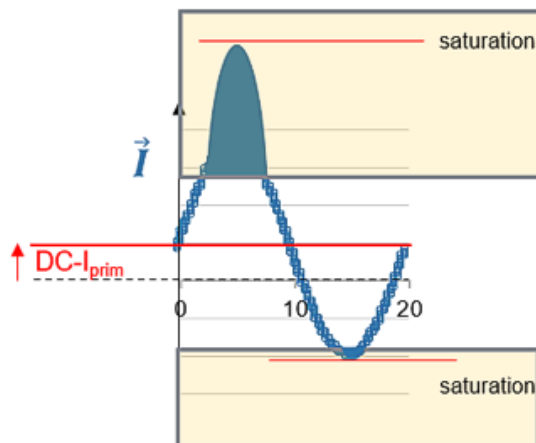


Fig. 5: Characteristics fluxgate current measurement technology

The detection winding now measures the induced current of the excitation winding (blue).

If the measuring current $I_{\text{prim}} = 0$, then 0 A is also measured, as no compensating current is generated for compensation.

If the exhibition current I_{prim} is not equal to 0, a compensating current is generated through both cores, which compensates for the imbalance of the magnetic flux density B in core 1 and core 2. Due to the compensation, I_{sense} is 0 again.

The measured compensating current provides information about the current to be measured I_{prim} .

Together with a fixed excitation frequency, this leads to improved accuracy and stability.

General description of the fluxgate current measurement technology

The SCT series SCT5xxx is used for monitoring differential currents in electrical power supply systems that do not require fast system shutdown. The SCT5xxx type B/B+ can measure DC and AC residual currents at frequencies up to 100 kHz.

This makes this differential current transformer compatible with a wide range of industrial applications, loads and power sources. With its user-selectable settings, this series provides a flexible platform for differential current measurement suitable for any possible application, both at the time of industrial plant design and when expanding with new modern loads operating at DC voltages or high switching frequencies that increase the amount of leakage current in the system.

The SCT5xxx have an analog 4 - 20 mA output, which represents the real-time RMS value (TRMS) of the measured residual current for connection to a PLC, for example. In addition, a potential-free relay output (NO / NC) with a freely selectable residual current limit can be used for warning or even system shutdown if the TRMS residual current measured value has exceeded the preset value. The status of the relay output is replicated on an LED for visual indication on the device itself. A built-in test button and an external test button input are provided for periodic testing of the SCT5xxx according to the applicable product standards.

Notice Only a single 24 Vdc power supply should be provided for the SCT5xxx.

2.3 Product categories – SCTxxxx current transformer

Breakdown of the type designation of the SCT current transformer

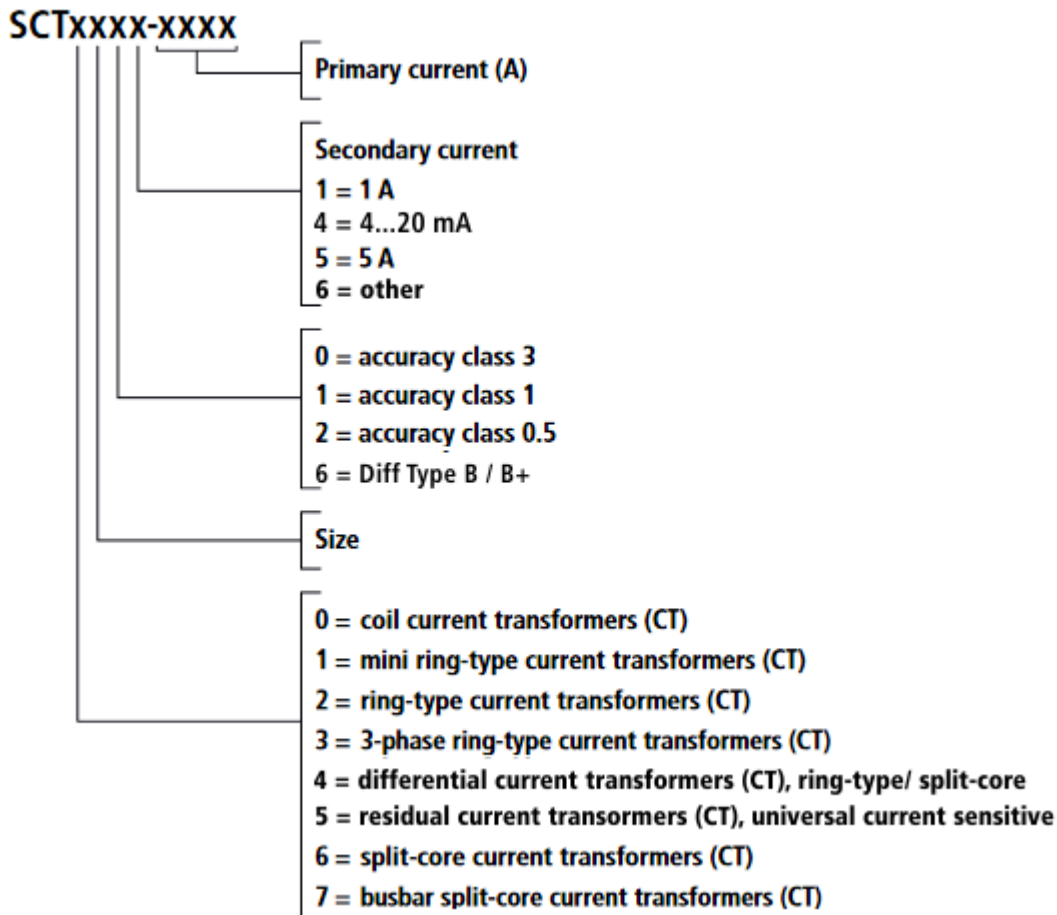


Fig. 6: Designation key of the SCT current transformers

Coil current transformers



Fig. 7: SCT0xxx

In order to guarantee the power transmission, current transformers need a correspondingly large measuring core volume with decreasing primary nominal currents. The dimensions of standard current transformers would quickly hit their limits on the basis of this physical principle. The SCT0xxx coil current transformers with electrical isolation are specially designed for these low primary nominal currents and are used in corresponding applications.

Coil current transformers	
<u>SCT0111</u>	Accuracy class 1, Primary current 0...1 A AC to 0...30 A AC, Secondary current 1 A AC
<u>SCT0121</u>	Accuracy class 0.5, Primary current 0...1 A AC to 0...30 A AC, Secondary current 1 A AC

Mini ring-type current transformer



Fig. 8: SCT1xxx

The SCT1111 mini ring-type current transformer can be positioned on a DIN rail by means of snap-on mounting and is thus suitable for measurements in very tight installation spaces, e.g. directly in the sub-distribution unit. Two current transformers are attached to the DIN rail, while the third current transformer is plugged into the fastened current transformers. The connection is realized via removable picoMAX® connectors, which enables pre-wiring.

Mini ring-type current transformer	
<u>SCT1111</u>	Accuracy class 1, Primary current 0...32 A AC to 0...64 A AC, Secondary current 1 A AC, Max. diameter round conductor 7.6 mm (size 1)

Ring-type current transformer



Fig. 9: SCT2xxx

The SCT2xxx series offers a large selection of ring-type current transformers for primary currents from 60 to 2500 A in six sizes and two accuracy classes. The innovative screwless connection technology for rigid and flexible conductors saves time – ferrules can be dispensed with here.

Ring-type current transformer	
<u>SCT2111</u>	Accuracy class 1, Primary current 0...60 A AC to 0...500 A AC, Secondary current 1 A AC, Max. diameter round conductor 25.7 mm (size 1)
<u>SCT2121</u>	Accuracy class 0.5, Primary current 0...125 A AC to 0...600 A AC, Secondary current 1 A AC, Max. diameter round conductor 25.7 mm (size 1)
<u>SCT2211</u>	Accuracy class 1, Primary current 0...600 A AC / 750 A AC, Secondary current 1 A AC, Max. diameter round conductor 31.8 mm (size 2)
<u>SCT2221</u>	Accuracy class 0.5, Primary current 0...600 A AC / 750 A AC, Secondary current 1 A AC, Max. diameter round conductor 31.8 mm (size 2)
<u>SCT2311</u>	Accuracy class 1, Primary current 0...800 A AC / 1000 A AC, Secondary current 1 A AC, Max. diameter round conductor 43.7 mm (size 3)
<u>SCT2321</u>	Accuracy class 0.5, Primary current 0...800 A AC / 1000 A AC, Secondary current 1 A AC, Max. diameter round conductor 43.7 mm (size 3)
<u>SCT2411</u>	Accuracy class 1, Primary current 0...1250 A AC / 1500 A AC, Secondary current 1 A AC, Max. diameter round conductor 43.7 mm (size 4)
<u>SCT2421</u>	Accuracy class 0.5, Primary current 0...1250 A AC / 1500 A AC, Secondary current 1 A AC, Max. diameter round conductor 43.7 mm (size 4)
<u>SCT2515</u>	Accuracy class 1, Primary current 0...2000 A AC, Secondary current 5 A AC, Max. diameter round conductor 54.7 mm (size 5)
<u>SCT2525</u>	Accuracy class 0.5, Primary current 0...2000 A AC, Secondary current 5 A AC, Max. diameter round conductor 54.7 mm (size 5)
<u>SCT2615</u>	Accuracy class 1, Primary current 0...2500 A AC, Secondary current 5 A AC, Max. diameter round conductor 70 mm (size 6)
<u>SCT2625</u>	Accuracy class 0.5, Primary current 0...2500 A AC, Secondary current 5 A AC, Max. diameter round conductor 70 mm (size 6)

3-phase ring-type current transformers



Fig. 10: SCT3xxx

The compact SCT3xxx 3-phase ring-type current transformers for direct mounting below commonly used power switches measure primary currents from 3 x 50 to 3 x 600 A, with secondary currents of 1 or 5 A. The SCT3xxx series is available throughout in accuracy class 1 and is supplemented by the SCT3121-0125 and SCT3121-0150 current transformers in accuracy class 0.5.

3-phase ring-type current transformers	
<u>SCT3111</u>	Accuracy class 1, Primary current 3 x 0...50 A AC to 3 x 0...150 A AC, Secondary current 1 A AC, Max. diameter round conductor 13.5 mm (size 1)
<u>SCT3121</u>	Accuracy class 0.5, Primary current 3 x 0...125 A AC / 3 x 0...150 A AC, Secondary current 1 A, Max. diameter round conductor 13.5 mm (size 1)
<u>SCT3215</u>	Accuracy class 1, Primary current 3 x 0...100 A AC to 3 x 0...250 A AC, Secondary current 5 A AC, Max. diameter round conductor 18 mm (size 2)
<u>SCT3315</u>	Accuracy class 1, Primary current 3 x 0...250 A AC to 3 x 0...600 A AC, Secondary current 5 A AC, Max. diameter round conductor 22 mm (size 3)

Differential current transformer, type A, differential current measurement

The SCT4xxx differential current transformers were designed for the detection of differential currents (earth fault currents) type A. A differential current measurement can already detect very low residual currents as well as various leakage currents. Continuous monitoring is necessary to be able to separate these from each other. This allows early detection of changes that may be indicative of degenerating insulation. The SCT4xxx differential current transformers thus enable condition-based maintenance and save operators the increased costs of previous blind maintenance intervals.

Ring-type CT for differential current measurement	
<u>SCT4116-0025</u>	Accuracy class 1, Primary rated differential current 20 mA ... 25 A AC, type A Secondary rated differential current: 0.0417 A AC, Max. diameter round conductor 20 mm (size 1)
<u>SCT4216-0025</u>	Accuracy class 1, Primary rated differential current 20 mA ... 25 A AC, type A Secondary rated differential current: 0.0417 A AC, Max. diameter round conductor 35 mm (size 2)
<u>SCT4316-0025</u>	Accuracy class 1, Primary rated differential current 20 mA ... 25 A AC, type A Secondary rated differential current: 0.0417 A AC, Max. diameter round conductor 60 mm (size 3)
<u>SCT4416-0025</u>	Accuracy class 1, Primary rated differential current 20 mA ... 25 A AC, type A Secondary rated differential current: 0.0417 A AC, Max. diameter round conductor 120 mm (size 4)



Fig. 11: SCT41xx, SCT42xx, SCT43xx, SCT44xx

Split-core current transformers for differential current measurement	
<u>SCT4616-0018</u>	Accuracy class 1, Primary rated differential current 20 mA ... 18 A AC, type A Secondary rated differential current: 0.0167 A AC, Max. diameter round conductor 20 mm (size 1)
<u>SCT4716-0018</u>	Accuracy class 1, Primary rated differential current 20 mA ... 18 A AC, type A Secondary rated differential current: 0.0167 A AC, Max. diameter round conductor 50 mm (size 2)
<u>SCT4816-0018</u>	Accuracy class 1, Primary rated differential current 20 mA ... 18 A AC, type A Secondary rated differential current: 0.0167 A AC, Max. diameter round conductor 80 mm (size 3)



Fig. 12: SCT46xx, SCT47xx, SCT48xx

Ring-type CT for differential current measurement



Fig. 13: SCT5xxx

The increasing prevalence of DC loads (e.g., LED lighting, DC motor drives, 48 V DC bus systems, etc.), distributed DC generation (e.g., PV systems, UPS, batteries, etc.), and high-frequency converters (e.g., SMPS, motor drives, etc.) in industrial environments makes it increasingly difficult to reliably measure insulation faults with conventional current transformers designed for AC 50/60 Hz with limited measurement bandwidth.

Differential current transformers of the SCT5xxx series can be used here. Monitoring residual currents with the SCT5xxx in real-time in a power system opens up the possibility of evaluating the condition of the electrical insulation based on the actual measured value, so that the long-term trend of the residual current value can be used for planning maintenance to detect significant deterioration of the insulation.

This means that residual current monitors (SCT5xxx) used in a condition-based monitoring scheme Industrie 4.0-Standards, can detect faults in a timely manner and increase the availability of power supplies or plants at a much lower cost than conventional, expensive, and time-consuming high-voltage insulation testing.

Ring-type CT for differential current measurement

SCT5564	Measuring ranges 400 mA / 2 A, type B / B+, transformer opening 70 mm
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Split-core current transformers

Fig. 14: SCT6xxx

The separable measuring system of the SCT6xxx split-core current transformers enables flexible retrofitting without disconnecting the primary conductor. Due to the minimal installation effort, they are suitable for use in places that are difficult to access or where space is limited. Four sizes are available. Accuracy class 3 is suitable for primary currents from 60 to 150 A, accuracy class 1 for 200 to 1000 A.

Split-core current transformers

<u>SCT6101</u>	Accuracy class 3, Primary current 0...60 A AC to 0...150 A AC, Secondary current 1 A AC, Max. diameter round conductor 18.5 mm (size 1)
<u>SCT6311</u>	Accuracy class 1, Primary current 0...200 A AC / 0...250 A AC, Secondary current 1 A AC, Max. diameter round conductor 18.5 mm (size 3)
<u>SCT6321</u>	Accuracy class 0.5, Primary current 0...200 A AC / 0...250 A AC, Secondary current 1 A AC, Max. diameter round conductor 18.5 mm (size 3)
<u>SCT6411</u>	Accuracy class 1, Primary current 0...300 A AC to 0...500 A AC, Secondary current 1 A AC, Max. diameter round conductor 27.9 mm (size 4)
<u>SCT6421</u>	Accuracy class 0.5, Primary current 0...400 A AC / 0...500 A AC, Secondary current 1 A AC, Max. diameter round conductor 27.9 mm (size 4)
<u>SCT6615</u>	Accuracy class 1, Primary current 0...600 A AC / 0...750 A AC, Secondary current 5 A AC, Max. diameter round conductor 42.4 mm (size 6)
<u>SCT6625</u>	Accuracy class 0.5, Primary current 0...600 A AC / 0...750 A AC, Secondary current 5 A AC, Max. diameter round conductor 42.4 mm (size 6)
<u>SCT6715</u>	Accuracy class 1, Primary current 0...800 A AC / 0...1000 A AC, Secondary current 5 A AC, Max. diameter round conductor 2 x 42.4 mm (size 7)
<u>SCT6725</u>	Accuracy class 0.5, Primary current 0...800 A AC / 0...1000 A AC, Secondary current 5 A AC, Max. diameter round conductor 2 x 42.4 mm (size 7)

Busbar split-core current transformers



Fig. 15: SCT71xx

Like the SCT6xxx series, the SCT7xxx busbar split-core current transformers for primary currents up to 5000 A can be retrofitted to existing systems with no great mounting effort. From 500 A, there is a choice between accuracy class 0.5 and 1 for each primary current. The SCT7105-0100 and SCT7105-200 current transformers support accuracy class 3.

Busbar split-core current transformers	
SCT7105	Accuracy class 3, Primary current 0...100 A AC / 0...200 A AC, Secondary current 5 A AC, Max. diameter round conductor 20 mm (size 1)
SCT7115	Accuracy class 1, Primary current 0...200 A AC / 0...450 A AC, Secondary current 5 A AC, Max. diameter round conductor 20 mm (size 1)
SCT7125	Accuracy class 0.5, Primary current 0...400 A AC, Secondary current 5 A AC, Max. diameter round conductor 20 mm (size 1)
SCT7215	Accuracy class 1, Primary current 0...500 A AC / 0...600 A AC, Secondary current 5 A AC, Max. diameter round conductor 50 mm (size 2)
SCT7225	Accuracy class 0.5, Primary current 0...500 A AC / 0...600 A AC, Secondary current 5 A AC, Max. diameter round conductor 50 mm (size 2)
SCT7315	Accuracy class 1, Primary current 0...750 A AC to 0...1500 A AC, Secondary current 5 A AC, Max. diameter round conductor 80 mm (size 3)
SCT7325	Accuracy class 0.5, Primary current 0...750 A AC to 0...1500 A AC, Secondary current 5 A AC, Max. diameter round conductor 80 mm (size 3)
SCT7415	Accuracy class 1, Primary current 0...1500 A AC to 0...5000 A AC, Secondary current 5 A AC, Max. diameter round conductor 80 mm (size 4)
SCT7425	Accuracy class 0.5, Primary current 0...1500 A AC to 0...5000 A AC, Secondary current 5 A AC, Max. diameter round conductor 80 mm (size 4)

2.4 Notes on the class accuracy of current transformers

Current transformers are divided into classes according to their accuracy. Depending on the product category, Beckhoff current transformers are available in the standard accuracy classes 0.5; 1 and 3. The class designation corresponds to an error curve with regard to current amplitude and angle error. Beckhoff current transformers conform to the IEC 61869 standard.

The accuracy classes of current transformers are related to the rated current. If current transformers are operated with a low current in relation to the rated current, the measuring accuracy decreases. The following tables show the error limits taking into account the rated current values:

Percentage current error ($\pm$) when the operating current is a percentage of the rated current						
I/I_N [%]		5 %	20 %	50 %	100 %	120 %
Accuracy class	0.5	1.5 %	0.75 %	-	0.5 %	0.5 %
	1	3.0 %	1.5 %	-	1.0 %	1.0 %
	3	-	-	3 %	-	3 %

Phase shift/misalignment ($\pm$) with percentage of operating current to rated current											
		Minutes [']					Degrees				
I/I_N [%]		5 %	20 %	50 %	100 %	120 %	5 %	20 %	50 %	100 %	120 %
Accuracy class	0.5	90'	45'	-	30'	30'	1.5°	0.75°	-	0.5°	0.5°
	1	180'	90'	-	60'	60'	3°	1.5°	-	1°	1°
	3	-	-	-	-	-	-	-	-	-	-

The following graph shows the error limits taking into account the rated current values for the accuracy classes.

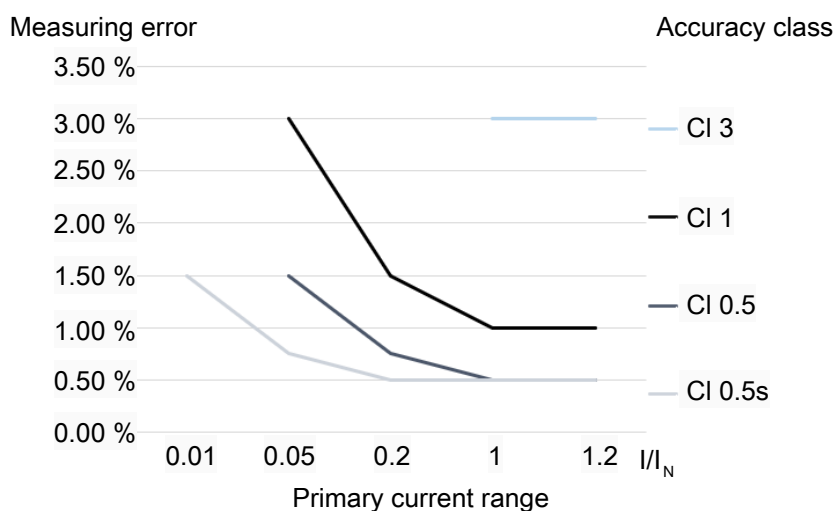


Fig. 16: Characteristic curves accuracy classes/primary current



Transformer load

In order to use the optimum accuracy of the transformer, you must ensure that the cabling between the transformer and the measuring terminal provides a suitable transformer load in your application. This is achieved by using 0.25 to 1.0 times the rated power of the transformer. Additional resistors in the secondary path allow the transformer and measuring terminal to be adapted to each other.

3 Technical data

3.1 SCT71xx | Busbar split-core current transformers, size 1

3.1.1 SCT71xx | General

Primary side	SCT71xx-xxxx
Thermal rated continuous current I_{cth}	$1.0 \cdot I_N$
Rated short-time thermal current I_{th}	$60 \cdot I_N / 1 \text{ s (max. 100 kA)}$
Rated impulse current I_{dyn}	$2.5 \cdot I_{th}$
Rated frequency f_R	50..60 Hz
Secondary side	SCT71xx-xxxx
Secondary rated current I_{sr}	5 A
Overcurrent limiting factor	FS5
Operating conditions	SCT71xx-xxxx
Permissible ambient temperature range during operation	-5...+50°C
Permissible ambient temperature range during storage	-25...+70°C
Permissible relative humidity	5...85%
Operating height	Up to 1000 m
Protection class	IP20
Insulation characteristics	SCT71xx-xxxx
Rated insulation level U_m	0.72/3/- kV
Insulation class	E
Insulation test voltage	3 kV, 1 min, U_{rms} , 50 Hz ($U_m \leq 0.72 \text{ kV}$)
General data	SCT71xx-xxxx
Max. Diameter conductor bushing primary conductor	20 mm x 30 mm
Connection technology secondary	Screw terminals M5x8
Conductor cross section secondary	4 mm ² with ferrule 6 mm ² massive
Size	1
Dimensions (W x H x D)	93 mm x 106 mm x 58 mm
Weight	580 g
Markings, standards and regulations *)	SCT71xx-xxxx
Markings/Approvals	CE, EAC, UKCA
Flame rating	UL 94 V-2
Standards/Regulations	EN 61869-1; EN 61869-2; IEC 61010-1

*) Real applicable approvals/markings see type plate on the side (product marking).

SCT71xx dimensions, size 1

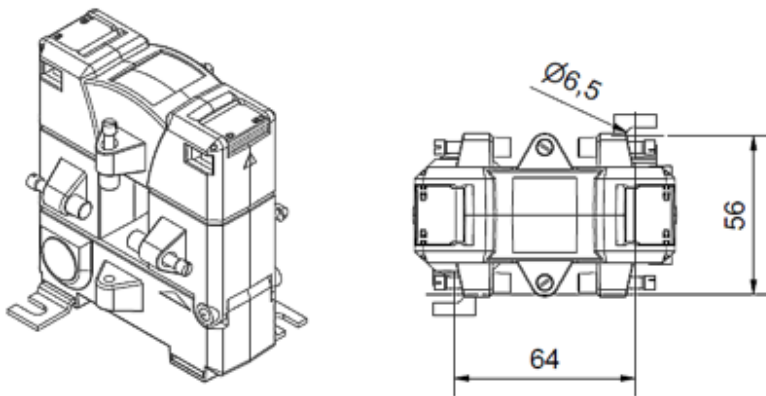


Fig. 17: Isometric view, top view; all dimensions in mm

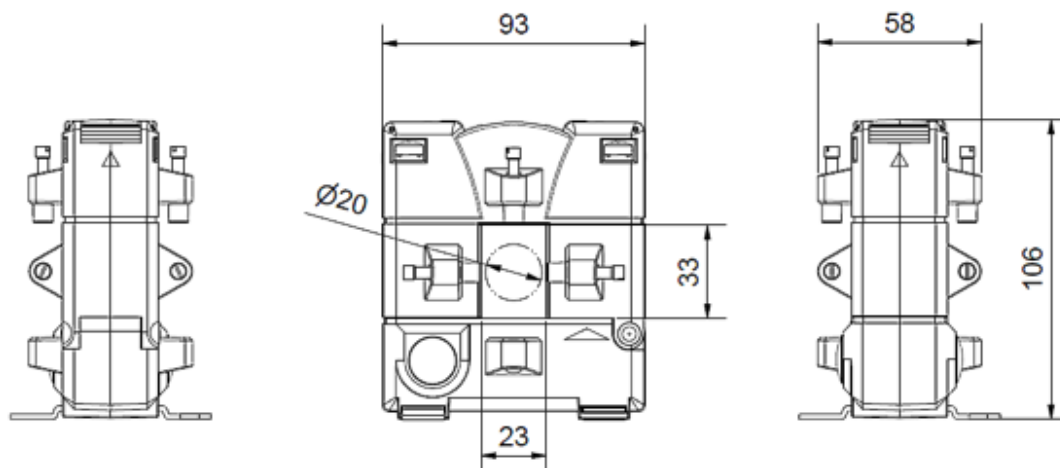


Fig. 18: Right side view, front view, left side view; all dimensions in mm

3.1.2 SCT7105 | Busbar split-core current transformer for primary currents 0...100 A AC / 0...200 A AC, accuracy class 3, size 1

Technical data	SCT7105-xxxx
Accuracy class	3
Primary current	0...100 A AC / 0...200 A AC
Secondary current	5 A AC

Versions	
SCT7105-0100	ratio 100/5, rated power 1.25 VA
SCT7105-0200	ratio 200/5, rated power 2.5 VA

3.1.3 SCT7115 | Busbar split-core current transformer for primary current 0...250 A AC / 0...400 A AC, accuracy class 1, size 1

Technical data	SCT7115-xxxx
Accuracy class	1
Primary current	0...200 A AC / 0...400 A AC
Secondary current	5 A AC

Versions	
SCT7115-0250	ratio 250/5, rated power 1.5 VA
SCT7115-0400	ratio 400/5, rated power 5 VA

3.1.4 SCT7125 | Busbar split-core current transformer for primary current 0...400 A AC, accuracy class 0.5, size 1

Technical data		SCT7125-xxxx
Accuracy class		0.5
Primary current		0...400 A AC
Secondary current		5 A AC
Versions		
SCT7125-0400		ratio 400/5, rated power 1.0 VA

3.2 SCT72xx | Busbar split-core current transformers, size 2

3.2.1 SCT72xx | General

Primary side	SCT72xx-xxxx
Thermal rated continuous current I_{cth}	$1.0 \cdot I_N$
Rated short-time thermal current I_{th}	$60 \cdot I_N / 1 \text{ s}$ (max. 100 kA)
Rated impulse current I_{dyn}	$2.5 \cdot I_{th}$
Rated frequency f_R	50..60 Hz
Secondary side	SCT72xx-xxxx
Secondary rated current I_{sr}	5 A
Overcurrent limiting factor	FS5
Operating conditions	SCT72xx-xxxx
Permissible ambient temperature range during operation	-5...+50°C
Permissible ambient temperature range during storage	-25...+70°C
Permissible relative humidity	5...85%
Operating height	Up to 1000 m
Protection class	IP20
Insulation characteristics	SCT72xx-xxxx
Rated insulation level U_m	0.72/3/- kV
Insulation class	E
Insulation test voltage	3 kV, 1 min, U_{rms} , 50 Hz ($U_m \leq 0.72 \text{ kV}$)
General data	SCT72xx-xxxx
Max. Diameter conductor bushing primary conductor	50 mm x 80 mm
Connection technology secondary	Screw terminals M5x8
Conductor cross section secondary	4 mm ² with ferrule 6 mm ² massive
Size	2
Dimensions (W x H x D)	125 mm x 158 mm x 58 mm
Weight	990 g
Markings, standards and regulations *)	SCT72xx-xxxx
Markings/Approvals	CE, EAC, UKCA
Flame rating	UL 94 V-2
Standards/Regulations	EN 61869-1; EN 61869-2; IEC 61010-1

*) Real applicable approvals/markings see type plate on the side (product marking).

SCT72xx dimensions, size 2

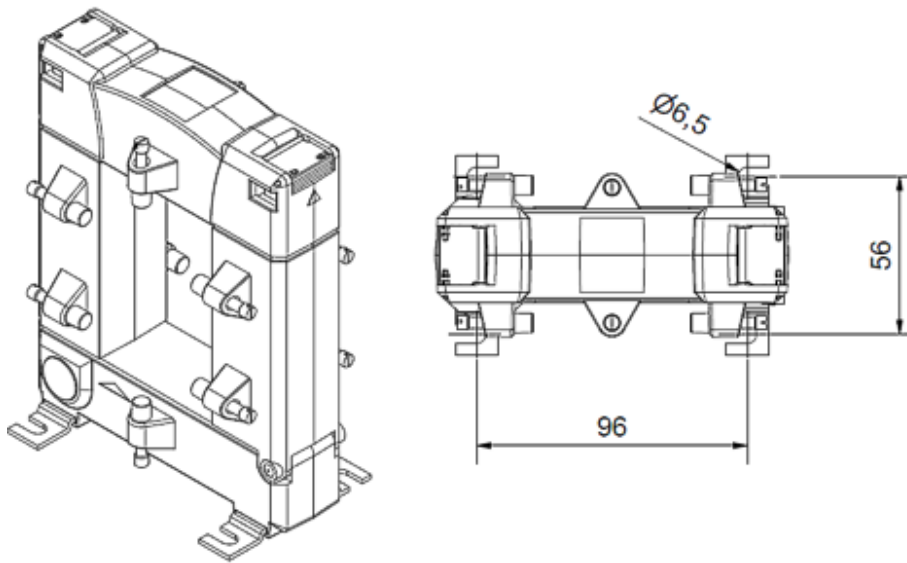


Fig. 19: Isometric view, top view; all dimensions in mm

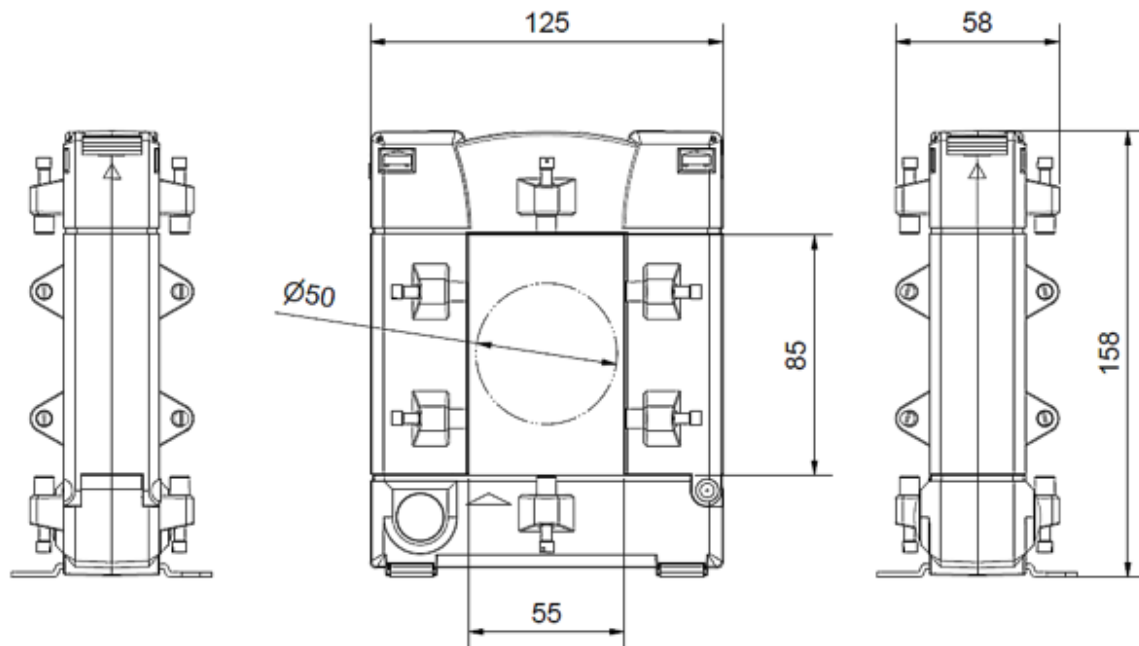


Fig. 20: Right side view, front view, left side view; all dimensions in mm

3.2.2 SCT7215 | Busbar split-core current transformer for primary currents 0...500 A AC / 0...600 A AC, accuracy class 1, size 2

Technical data	SCT7215-xxxx
Accuracy class	1
Primary current	0...500 A AC / 0...600 A AC
Secondary current	5 A AC

Versions	
SCT7215-0500	ratio 500/5, rated power 5.0 VA
SCT7215-0600	ratio 600/5, rated power 5.0 VA

3.2.3 SCT7225 | Busbar split-core current transformer for primary currents 0...500 A AC / 0...600 A AC, accuracy class 0.5, size 2

Technical data	SCT7225-xxxx
Accuracy class	0.5
Primary current	0...500 A AC / 0...600 A AC
Secondary current	5 A AC

Versions	
SCT7225-0500	ratio 500/5, rated power 2.5 VA
SCT7225-0600	ratio 600/5, rated power 2.5 VA

3.3 SCT73xx | Busbar split-core current transformers, size 3

3.3.1 SCT73xx | General

Primary side	SCT73xx-xxxx
Thermal rated continuous current I_{cth}	$1.0 \cdot I_N$
Rated short-time thermal current I_{th}	$60 \cdot I_N/1 \text{ s}$ (max. 100 kA)
Rated impulse current I_{dyn}	$2.5 \cdot I_{th}$
Rated frequency f_R	50..60 Hz
Secondary side	SCT73xx-xxxx
Secondary rated current I_{sr}	5 A
Overcurrent limiting factor	FS15
Operating conditions	SCT73xx-xxxx
Permissible ambient temperature range during operation	-5...+50°C
Permissible ambient temperature range during storage	-25...+70°C
Permissible relative humidity	5...85%
Operating height	Up to 1000 m
Protection class	IP20
Insulation characteristics	SCT73xx-xxxx
Rated insulation level U_m	0.72/3/- kV
Insulation class	E
Insulation test voltage	3 kV, 1 min, U_{rms} , 50 Hz ($U_m \leq 0.72 \text{ kV}$)
General data	SCT73xx-xxxx
Max. Diameter conductor bushing primary conductor	80 mm x 120 mm
Connection technology secondary	Screw terminals M5x8
Conductor cross section secondary	4 mm ² with ferrule 6 mm ² massive
Size	3
Dimensions (W x H x D)	155 mm x 198 mm x 58 mm
Weight	1300 g
Markings, standards and regulations *)	SCT73xx-xxxx
Markings/Approvals	CE, EAC, UKCA
Flame rating	UL 94 V-2
Standards/Regulations	EN 61869-1; EN 61869-2; IEC 61010-1

*) Real applicable approvals/markings see type plate on the side (product marking).

SCT73xx dimensions, size 3

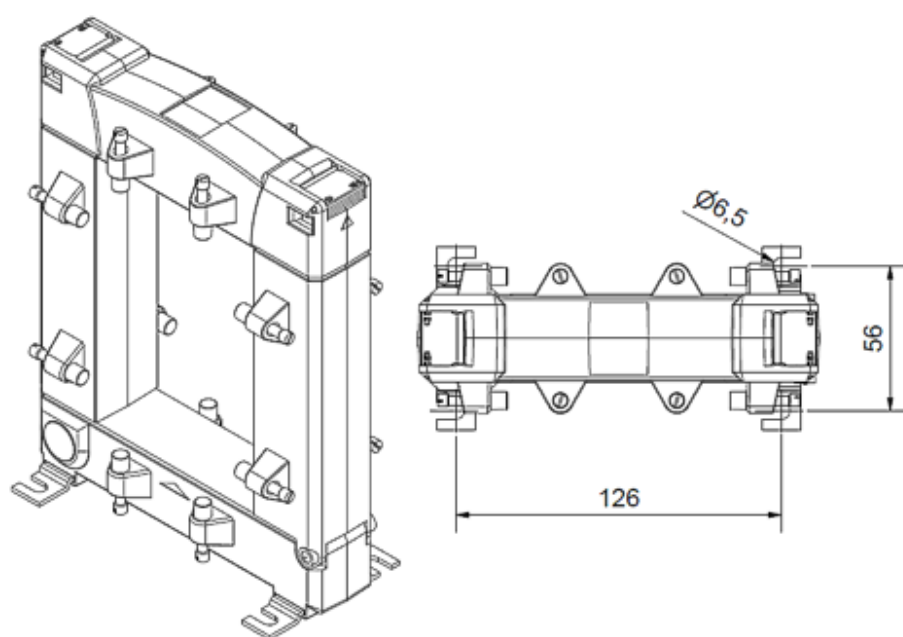


Fig. 21: Isometric view, top view; all dimensions in mm

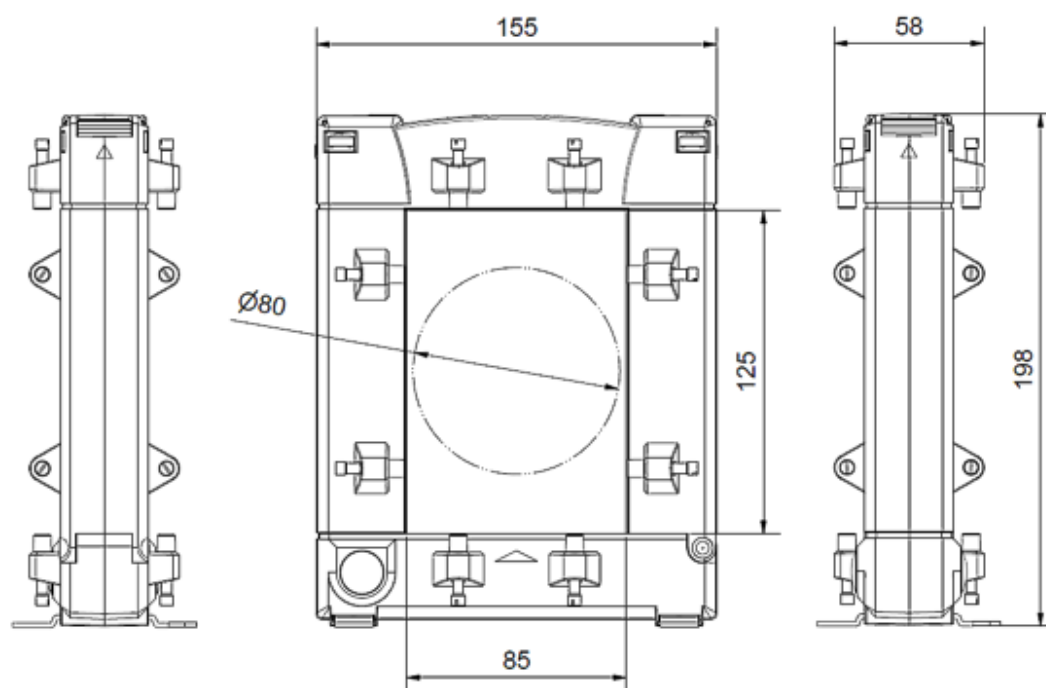


Fig. 22: Right side view, front view, left side view; all dimensions in mm

3.3.2 SCT7315 | Busbar split-core current transformer for primary currents 0...750 A AC to 0...1500 A AC, accuracy class 1, size 3

Technical data	SCT7315-xxxx
Accuracy class	1
Primary current	0...750 A AC to 0...1500 A AC
Secondary current	5 A AC

Versions	
SCT7315-0750	ratio 750/5, rated power 5 VA
SCT7315-1000	ratio 1000/5, rated power 10 VA
SCT7315-1500	ratio 1500/5, rated power 15 VA

3.3.3 SCT7325 | Busbar split-core current transformer for primary currents 0...750 A AC to 0...1500 A AC, accuracy class 0.5, size 3

Technical data		SCT7325-xxxx
Accuracy class		0.5
Primary current		0...750 A AC to 0...1500 A AC
Secondary current		5 A AC

Versions	
SCT7325-0750	ratio 750/5, rated power 2.5 VA
SCT7325-1000	ratio 1000/5, rated power 5 VA
SCT7325-1500	ratio 1500/5, rated power 7.5 VA

3.4 SCT74xx | Busbar split-core current transformers, size 4

3.4.1 SCT74xx | General

Primary side	SCT74xx-xxxx
Thermal rated continuous current I_{cth}	$1.0 \cdot I_N$
Rated short-time thermal current I_{th}	$60 \cdot I_N/1 \text{ s}$ (max. 100 kA)
Rated impulse current I_{dyn}	$2.5 \cdot I_{th}$
Rated frequency f_R	50..60 Hz
Secondary side	SCT74xx-xxxx
Secondary rated current I_{sr}	5 A
Overcurrent limiting factor	FS15
Operating conditions	SCT74xx-xxxx
Permissible ambient temperature range during operation	-5...+50°C
Permissible ambient temperature range during storage	-25...+70°C
Permissible relative humidity	5...85%
Operating height	Up to 1000 m
Protection class	IP20
Insulation characteristics	SCT74xx-xxxx
Rated insulation level U_m	0.72/3/- kV
Insulation class	E
Insulation test voltage	3 kV, 1 min, U_{rms} , 50 Hz ($U_m \leq 0.72 \text{ kV}$)
General data	SCT74xx-xxxx
Max. Diameter conductor bushing primary conductor	80 mm x 160 mm
Connection technology secondary	Screw terminals M5x8
Conductor cross section secondary	4 mm ² with ferrule 6 mm ² massive
Size	4
Dimensions (W x H x D)	195 mm x 243 mm x 64 mm
Weight	3335 g
Markings, standards and regulations *)	SCT74xx-xxxx
Markings/Approvals	CE, EAC, UKCA
Flame rating	UL 94 V-2
Standards/Regulations	EN 61869-1; EN 61869-2; IEC 61010-1

*) Real applicable approvals/markings see type plate on the side (product marking).

SCT74xx dimensions, size 4

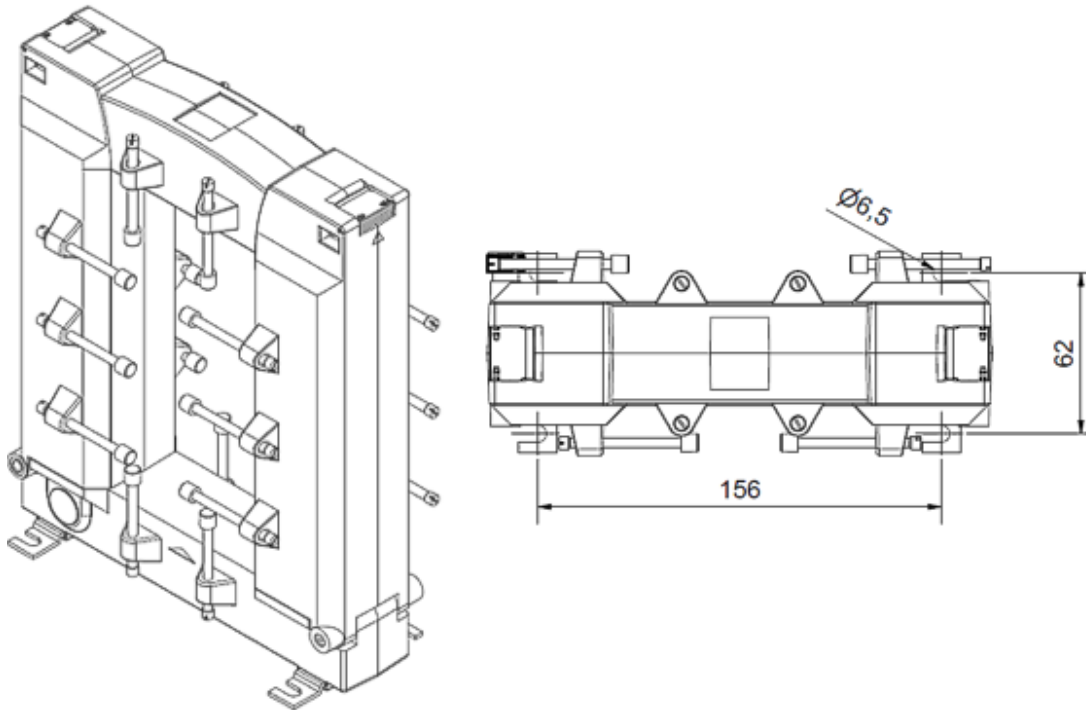


Fig. 23: Isometric view, top view; all dimensions in mm

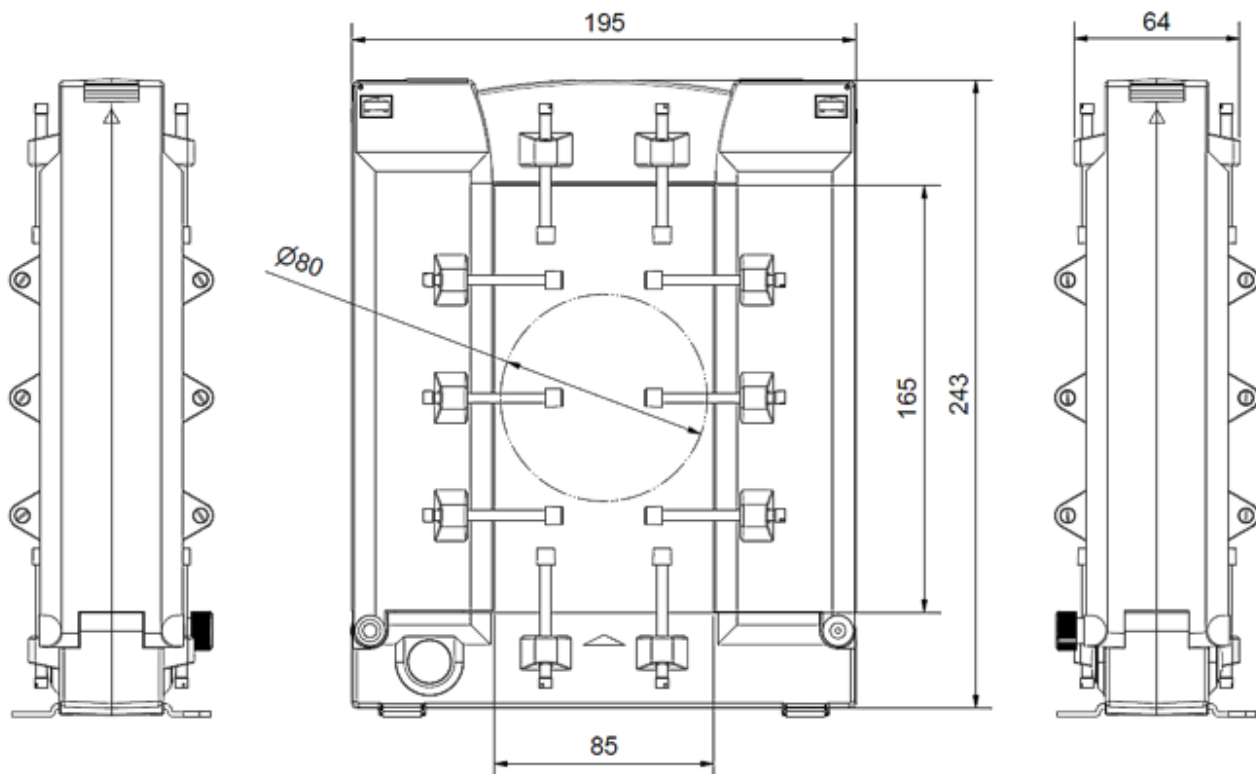


Fig. 24: Right side view, front view, left side view; all dimensions in mm

3.4.2 SCT7415 | Busbar split-core current transformer for primary currents 0...1500 A AC to 0...5000 A AC, accuracy class 1, size 4

Technical data	SCT7415-xxxx
Accuracy class	1
Primary current	0...1500 A AC to 0...5000 A AC
Secondary current	5 A AC

Versions	
SCT7415-1500	ratio 1500/5, rated power 15 VA
SCT7415-2000	ratio 2000/5, rated power 15 VA
SCT7415-2500	ratio 2500/5, rated power 15 VA
SCT7415-3000	ratio 3000/5, rated power 30 VA
SCT7415-4000	ratio 4000/5, rated power 30 VA
SCT7415-5000	ratio 5000/5, rated power 30 VA

3.4.3 SCT7425 | Busbar split-core current transformer for primary currents 0...1500 A AC to 0...5000 A AC, accuracy class 0.5, size 4

Technical data	SCT7425-xxxx
Accuracy class	0.5
Primary current	0...1500 A AC to 0...5000 A AC
Secondary current	5 A AC

Versions	
SCT7425-1500	ratio 1500/5, rated power 15 VA
SCT7425-2000	ratio 2000/5, rated power 15 VA
SCT7425-2500	ratio 2500/5, rated power 15 VA
SCT7425-3000	ratio 3000/5, rated power 15 VA
SCT7425-4000	ratio 4000/5, rated power 30 VA
SCT7425-5000	ratio 5000/5, rated power 30 VA

4 Commissioning

4.1 Installation

DANGER

Open transformer circuits lead to electric shock and arc flashover!

Disregarding this will result in death, physical injury or considerable damage to property!

- Never open the secondary circuit of the current transformer under load.
- Short-circuit the secondary current terminals of the current transformer before removing the device.

WARNING

Hazardous voltage can lead to electric shock and burns!

- Make sure that the details on the name plate and in the "Technical data" correspond to the operating parameters of the system.
- Switch the system off before commencing with the installation!

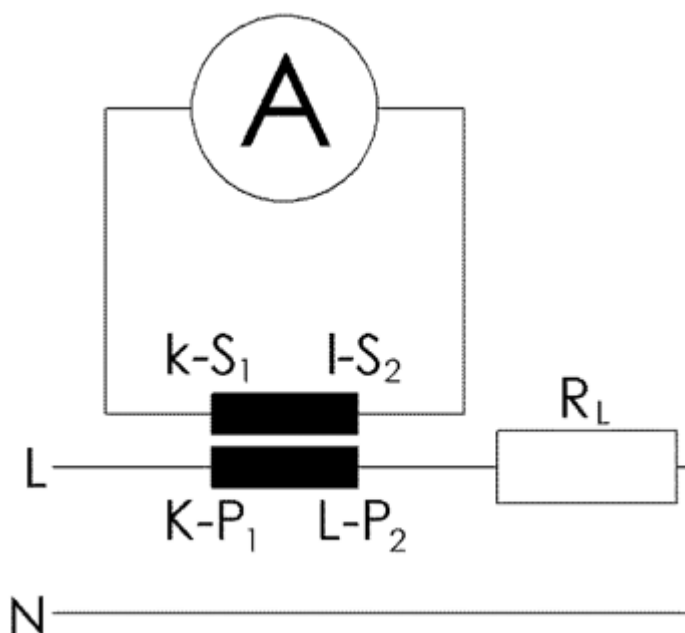
WARNING

Induction of high voltages into the secondary circuit!

- If the secondary circuit of the current transformer is not under load (open), high voltages are induced on its secondary terminals. The voltage values occurring there represent a danger to persons and the functional safety of the current transformer.
- "Open operation", i.e. operation of the current transformer without secondary wiring, must be avoided at all costs.

- Make sure that the working environment is safe during assembly, maintenance and installation work. Interrupt the power supply of the primary conductor and secure against being switched on again inadvertently.
- Open the current transformer and fasten it to the primary conductor with the help of the fixing clasps included in the scope of delivery.
P1 points towards the current source, P2 towards the consumer.
The arrow on the name plate shows the direction of the energy flow.
Caution: Do not close the current transformer yet – high voltages could occur on the secondary connections!
Caution: Make sure that the cut surfaces of the separated core are clean. Avoid hand contact (sweat)!
- Connect the secondary conductors of the current transformer to the measuring device (ammeter, meter, etc.). Observe the operating instructions for the measuring device when doing this.
- Check whether the current transformer is mounted correctly and the secondary conductors are connected correctly.
- Close the current transformer – press together until the closure engages.
- If necessary, switch on the power supply to the primary conductor again.

Measuring circuit

Fig. 25: Measuring circuit - **SCT7xxx** transformer

Assembly notes

Fig. 26: Buttons to open the **SCT7xxx**

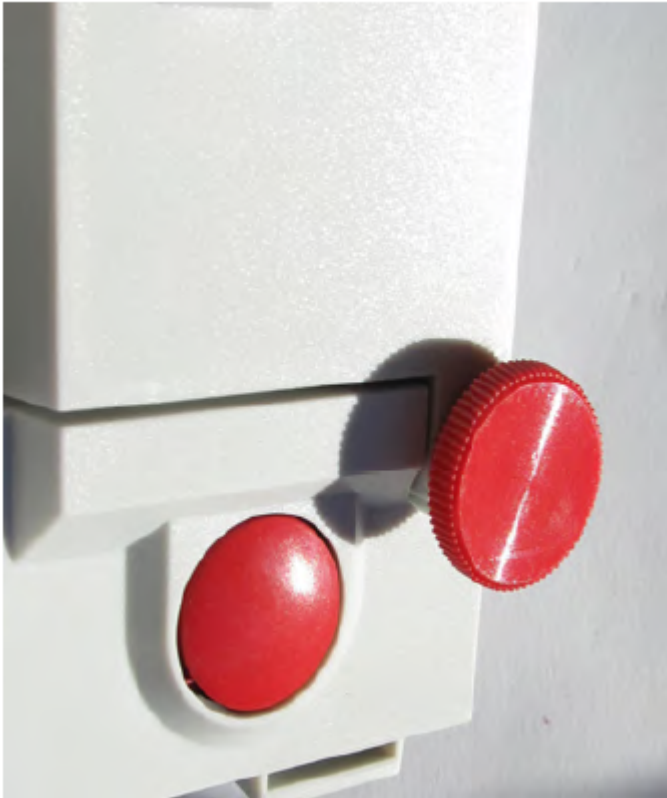


Fig. 27: Knurled screw of the **SCT74xx**

4.2 Maintenance and inspection

Maintenance and inspection

- Check whether the secondary conductors are firmly connected to the current transformer and to the measuring device.
- Open circuit: Current transformers must be short-circuited as long as no tapping occurs!
Note the danger warnings [► 42] in the chapter "Installation [► 42]"!
- Check whether the current transformer is connected correctly.
- Remove coarse dirt from the current transformer housing.
Contact with moisture, in particular with the core, must be avoided at all costs.

4.3 Troubleshooting

In the case of errors, e.g. unexpected or incorrect values, inverse power:

- Check the settings of the measuring device on the basis of its operating instructions.
- Check whether the current transformer is mounted on the intended conductor in the direction of the energy flow.
- Check the connection of the current transformers and the corresponding voltage tap-off if the active and/or reactive power does not correspond to the expected values; if necessary, one phase has been reversed.
- Check whether the current transformer is connected correctly.
- Check the power requirement of the conductors and measuring devices connected to the current transformer. It must not exceed the rated power of the current transformer (see name plate).
- If the above points do not solve the problem:
Check whether there is dust or other dirt between the two parts of the core. If so, clean the surfaces carefully with a lint-free cloth.
- Avoid hand contact (sweat)!

5 Application example

5.1 Power measurement at a machine

⚠ WARNING

WARNING: Risk of electric shock!

Bring the Bus Terminal system into a safe, voltage-free state before starting mounting, disassembly or wiring of the Bus Terminals!

NOTICE

Attention! Risk of device damage!

Avoid confusing the current and voltage circuit during connection, since the direct connection of mains voltage to the terminal points for the current transformers (typical input resistance 100 mΩ) would destroy the power measurement terminal!

EL3443

- The voltage is measured via connections L1, L2, L3 and N.
- The current is measured via three current transformers (e.g. from the Beckhoff SCT series) and the connections I_{L1} , I_{L2} , I_{L3} and I_N (star point of the current transformers).

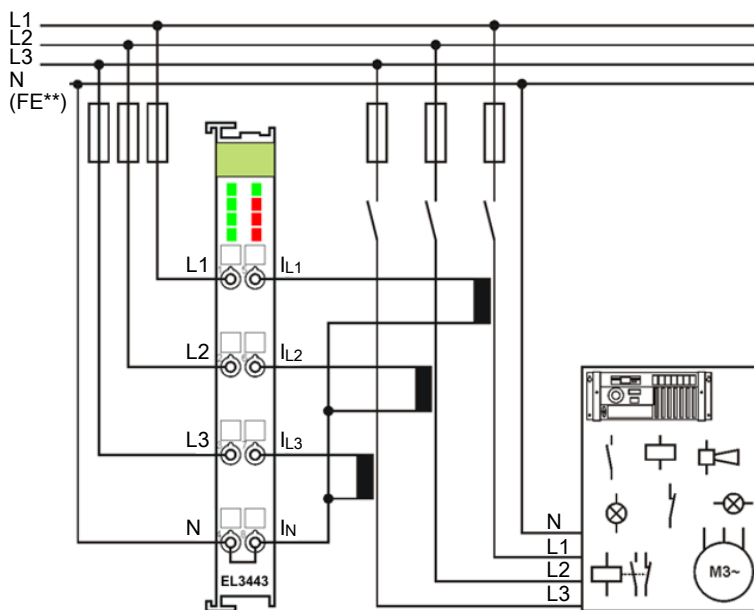


Fig. 28: EL3443, power measurement at a machine

● Fuse protection of the terminal

The voltage measurement inputs L1 - L3 are high-impedance; a minimum measurement current flows. The fuses to the connection points L1 - L3 are therefore only to be designed according to the connection cross-section.

For the current measurement inputs I_{L1} - I_{L2} , the fuse protection must be adapted according to the device to be measured.

The secondary currents of the transformers are not fused, see figure.

● **) FE as star point for 3-phase systems without neutral line

Depending on the current transformers used, FE must be connected as star point in 3-phase systems without neutral line as shown in Fig. "EL3443, power measurement at a machine".

Observe the regulations of the manufacturer of the current transformers!

i Negative power values

If negative power values are measured on a circuit, please check whether the associated current transformer circuit is connected correctly.

EL3453

- The voltage is measured via connections L1, L2, L3 and N.
- The current is measured via 4 current transformers (e.g. from the Beckhoff SCT series) and the connections I_{L1} , I_{L2} , I_{L3} and I_N (star point of the current transformers).

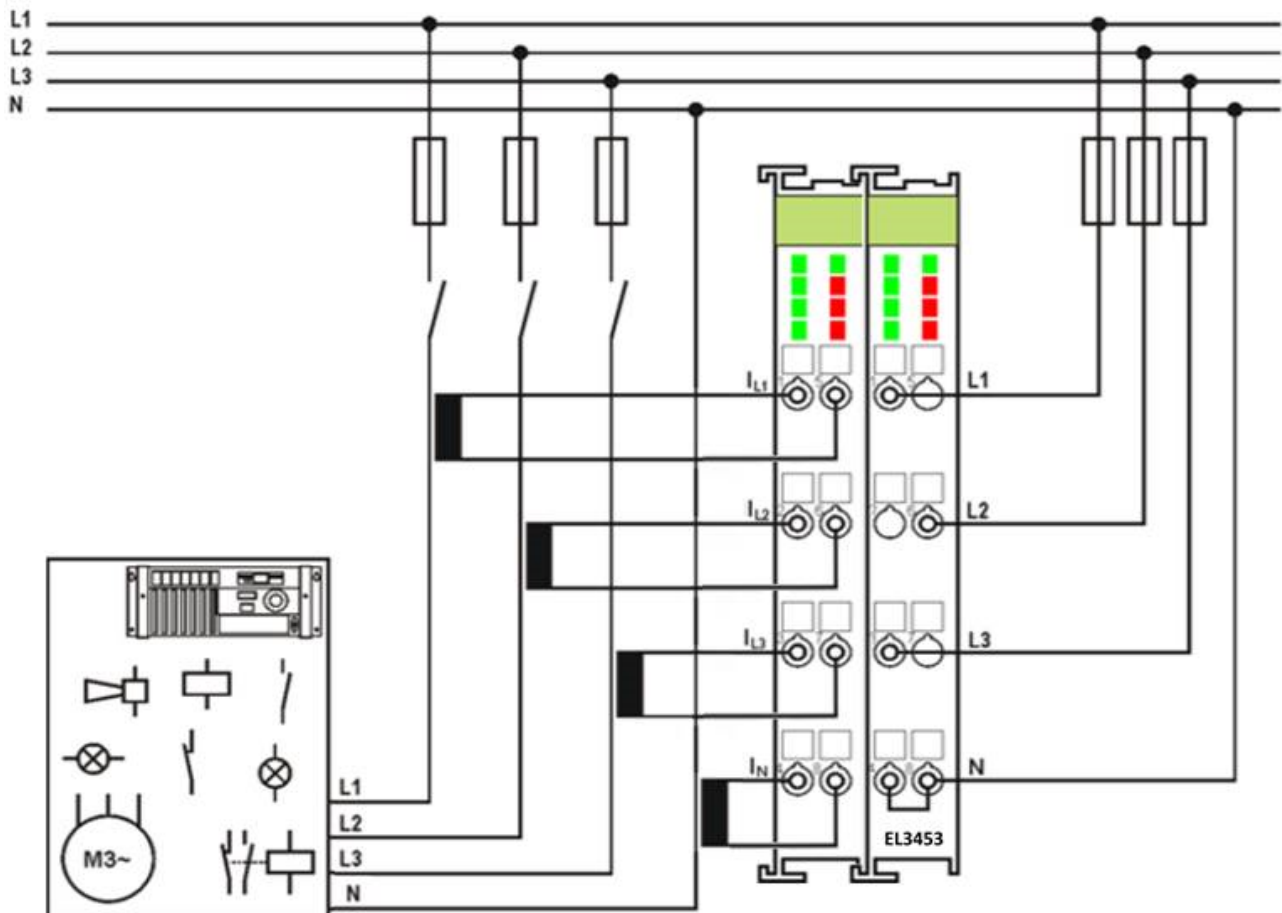


Fig. 29: EL3453, power measurement at a machine

i Negative power values

If negative power values are measured on a circuit, please check whether the associated current transformer circuit is connected correctly.

6 Appendix

6.1 Documentation issue status

Version	Comment
1.6.0	- Chapter "Technical data" updated - Update structure
1.5.0	- Chapter "Technical data" updated - Update structure
1.4	- Chapter "Technical data" updated - Update structure
1.3	- Chapter "Introduction" updated - Chapter "Technical data" updated
1.2	- Addenda chapter "Notes on class accuracy SCT transformers"
1.1	- Addenda & corrections
1.0	- 1 st public issue - Addenda & corrections

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