

Documentation | EN

SCT4xxx

Ring-type current transformer, differential current



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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

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.

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.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER

Hazard with high risk of death or serious injury.

⚠ WARNING

Hazard with medium risk of death or serious injury.

⚠ CAUTION

There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE

The environment, equipment, or data may be damaged.

Information on handling the product



This information includes, for example:
recommendations for action, assistance or further information on the product.

1.3 Intended use

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.

1.4 Current transformer safety instructions

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.

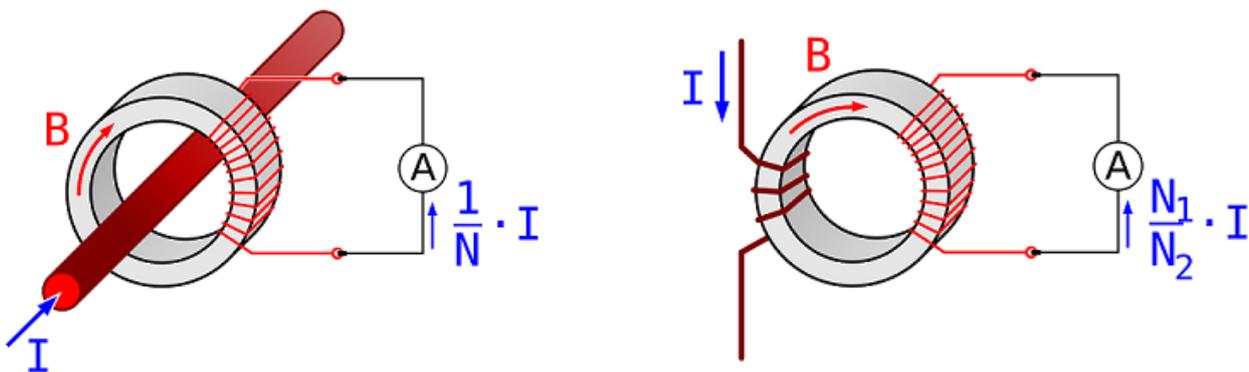


Fig. 2: Left: Principle of a ring-type CT; Right: Principle of a coil current transformer

⚠ 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.

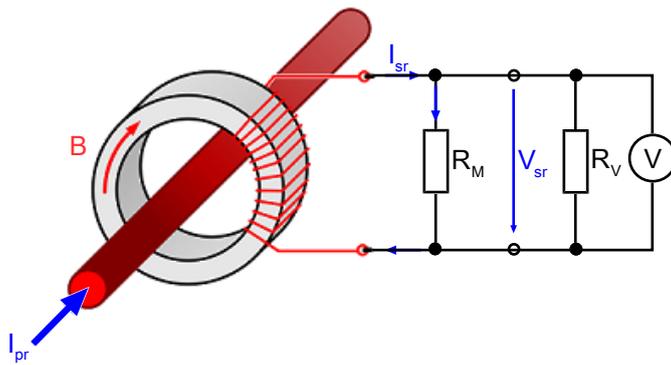


Fig. 3: Principle of a ring-type CT with secondary voltage signal

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 small signal 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	<p>Highest voltage; RMS value of the highest conductor-to-conductor voltage for which a measuring transformer is rated with respect to its insulation</p> <p>The value of the rated insulation level is given in 3 values:</p> <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 small signal current transformers	Due to the low measuring resistance, there is no dangerous "open-circuit voltage" with small signal transformers. It is therefore not necessary to short-circuit the secondary terminals.
"Open-circuit voltage" of classic 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	<p>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.</p> <p>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.</p>

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.

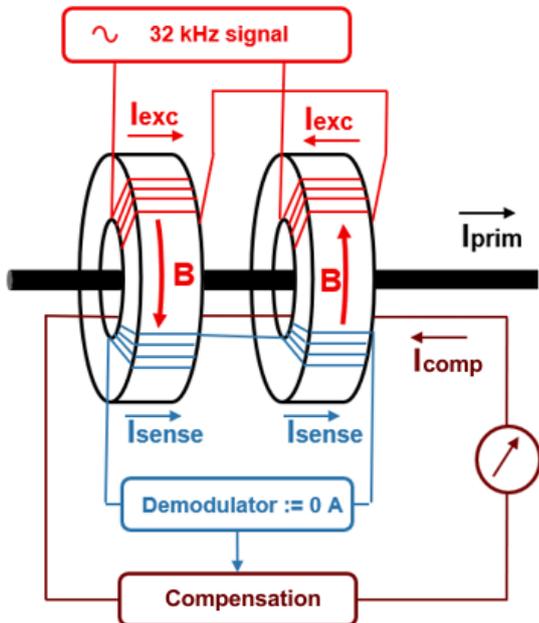


Fig. 4: Principle fluxgate current measurement technology

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.)

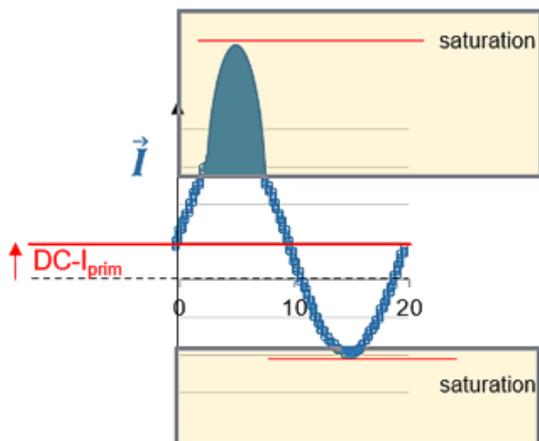


Fig. 5: Characteristics fluxgate current measurement technology

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

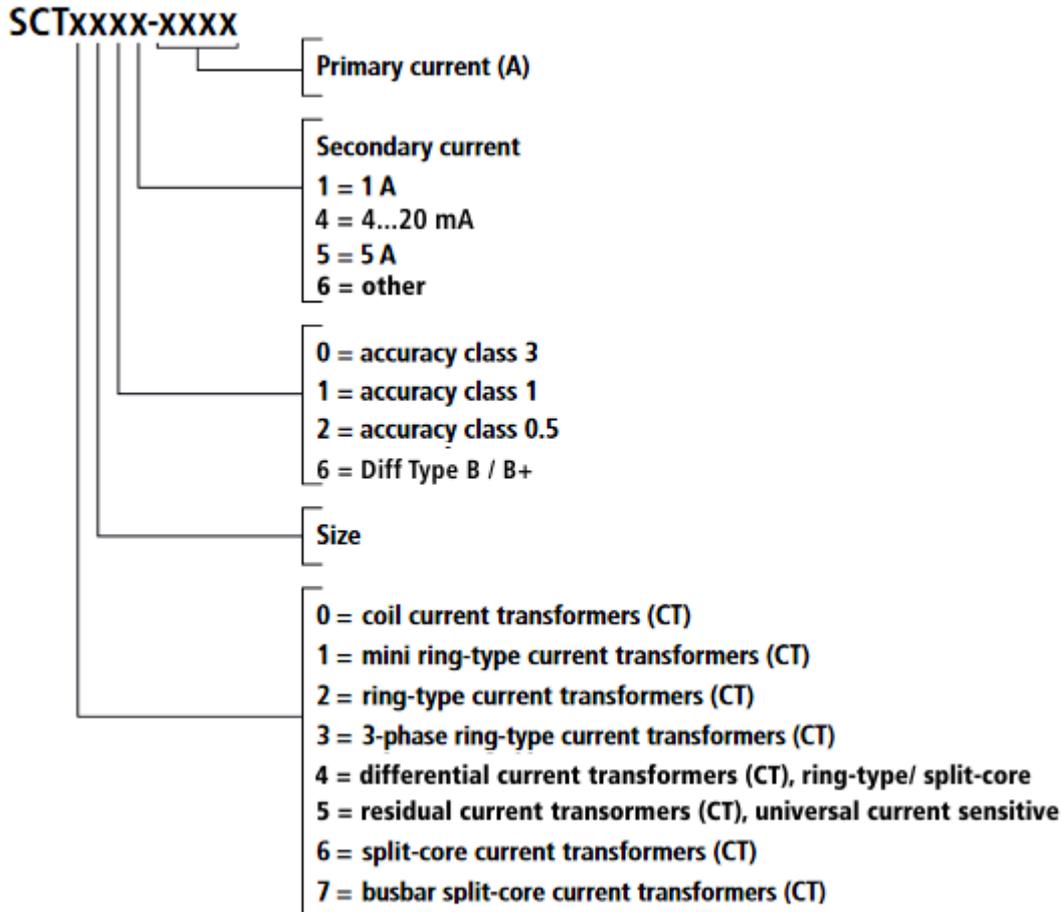


Fig. 6: Designation key of the SCT current transformers

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	
SCT0111	Accuracy class 1, Primary current 0...1 A AC to 0...30 A AC, Secondary current 1 A AC
SCT0121	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	
SCT1111	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	
SCT3111	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)
SCT3121	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)
SCT3215	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)
SCT3315	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	
<u>SCT7105</u>	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)
<u>SCT7115</u>	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)
<u>SCT7125</u>	Accuracy class 0.5, Primary current 0...400 A AC, Secondary current 5 A AC, Max. diameter round conductor 20 mm (size 1)
<u>SCT7215</u>	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)
<u>SCT7225</u>	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)
<u>SCT7315</u>	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)
<u>SCT7325</u>	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)
<u>SCT7415</u>	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)
<u>SCT7425</u>	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.

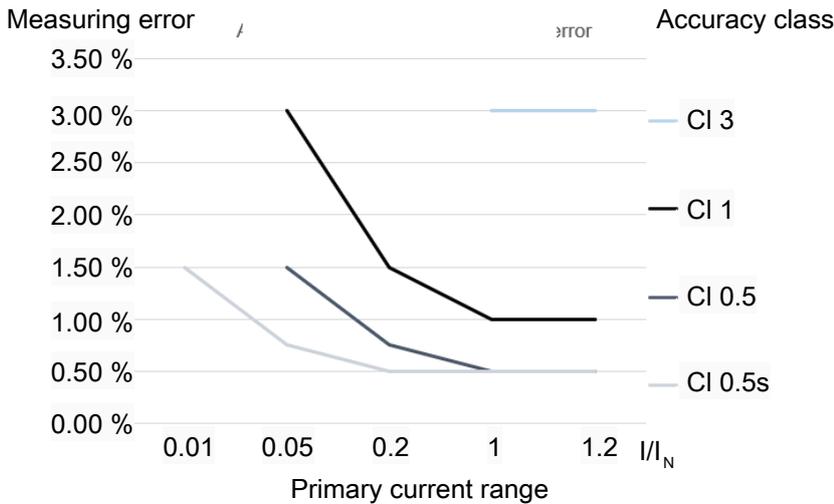


Fig. 16: Characteristic curves accuracy classes/primary current

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 SCT4116-0025 | Ring-type CT, differential current type A, 25 A AC, size 1

Electrical data	SCT4116-0025
Primary rated differential current $I_{\Delta N}$	25 A
Secondary rated differential current	0.0417 A
Measuring range	0.02 ... 25 A
Transmission ratio	1:600
Operating frequency range	30 Hz...3 kHz
Rated voltage	800 V
Rated surge voltage	8 kV
Rated load:	100 Ω

Operating conditions	SCT4116-0025
Permissible ambient temperature range during operation	-10...+70 °C
Permissible ambient temperature range during storage	-25 ... +70 °C
Pollution degree	III
Protection rating	Housing: IP40; terminals: IP20

General data	SCT4116-0025
Max. conductor bushing diameter, primary conductor (round conductor)	20 mm
Connection technology secondary	CAGE CLAMP® **)
Size	1
Dimensions (W x H x D)	82 mm x 62.9 mm x 30 mm
Weight	approx. 145 g
Mounting accessories for mounting on 35 mm DIN rail	ZB8201-0410

Markings, standards and regulations *)	SCT4116-0025
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-0
Standards/Regulations	IEC 60664-1 / IEC 60664-3

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

**) Max. primary cable length: 10 m

SCT4116-0025 dimensions, size 1

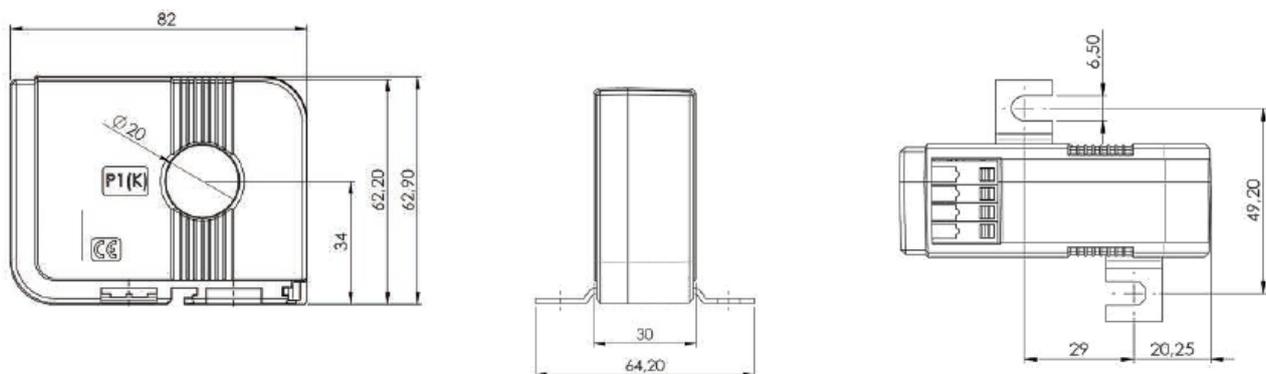


Fig. 17: SCT4116-0025 dimensions, all dimensions in mm

3.2 SCT4216-0025 | Ring-type CT, differential current type A, 25 A AC, size 2

Electrical data	SCT4216-0025
Primary rated differential current $I_{\Delta N}$	25 A
Secondary rated differential current	0.0417 A
Measuring range	0.02 ... 25 A
Transmission ratio	1:600
Operating frequency range	30 Hz...3 kHz
Rated voltage	800 V
Rated surge voltage	8 kV
Rated load:	100 Ω

Operating conditions	SCT4216-0025
Permissible ambient temperature range during operation	-10...+70 °C
Permissible ambient temperature range during storage	-25 ... +70 °C
Pollution degree	III
Protection rating	Housing: IP40; terminals: IP20

General data	SCT4216-0025
Max. conductor bushing diameter, primary conductor (round conductor)	35 mm
Connection technology secondary	CAGE CLAMP® **)
Size	2
Dimensions (W x H x D)	104.5 mm x 86.5 mm x 30 mm
Weight	approx. 240 g
Mounting accessories for mounting on 35 mm DIN rail	ZB8201-0410

Markings, standards and regulations *)	SCT4216-0025
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-0
Standards/Regulations	IEC 60664-1 / IEC 60664-3

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

**) Max. primary cable length: 10 m

SCT4216-0025 dimensions, size 2

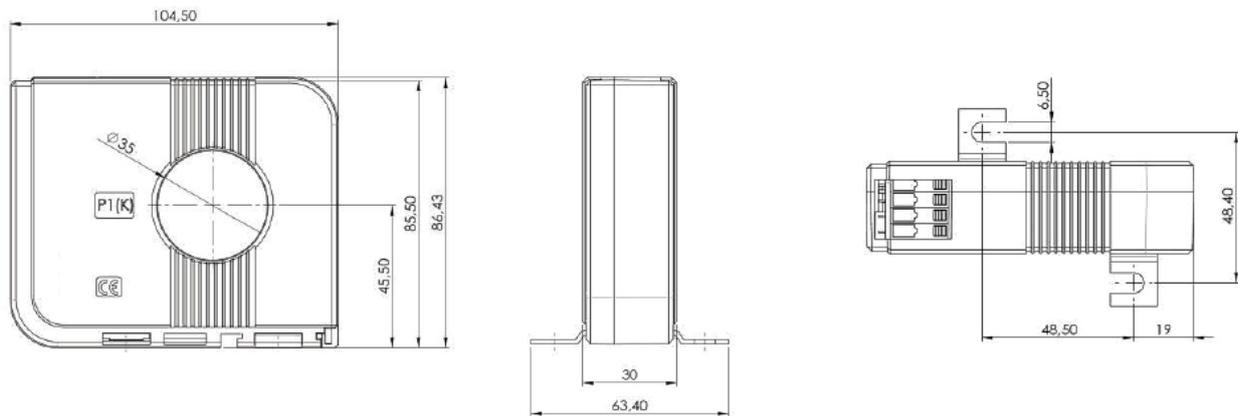


Fig. 18: SCT4216-0025 dimensions, all dimensions in mm

3.3 SCT4316-0025 | Ring-type CT, differential current type A, 25 A AC, size 3

Electrical data	SCT4316-0025
Primary rated differential current $I_{\Delta N}$	25 A
Secondary rated differential current	0.0417 A
Measuring range	0.02 ... 25 A
Transmission ratio	1:600
Operating frequency range	30 Hz...3 kHz
Rated voltage	800 V
Rated surge voltage	8 kV
Rated load:	100 Ω
Operating conditions	SCT4316-0025
Permissible ambient temperature range during operation	-10...+70 °C
Permissible ambient temperature range during storage	-25 ... +70 °C
Pollution degree	III
Protection rating	Housing: IP40; terminals: IP20
General data	SCT4316-0025
Max. conductor bushing diameter, primary conductor (round conductor)	60 mm
Connection technology secondary	CAGE CLAMP® (**)
Size	3
Dimensions (W x H x D)	135 mm x 177 mm x 37 mm
Weight	approx. 390 g
Mounting accessories for mounting on 35 mm DIN rail	ZB8201-0430
Markings, standards and regulations *)	SCT4316-0025
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-0
Standards/Regulations	IEC 60664-1 / IEC 60664-3

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

**) Max. primary cable length: 10 m

SCT4316-0025 dimensions, size 3

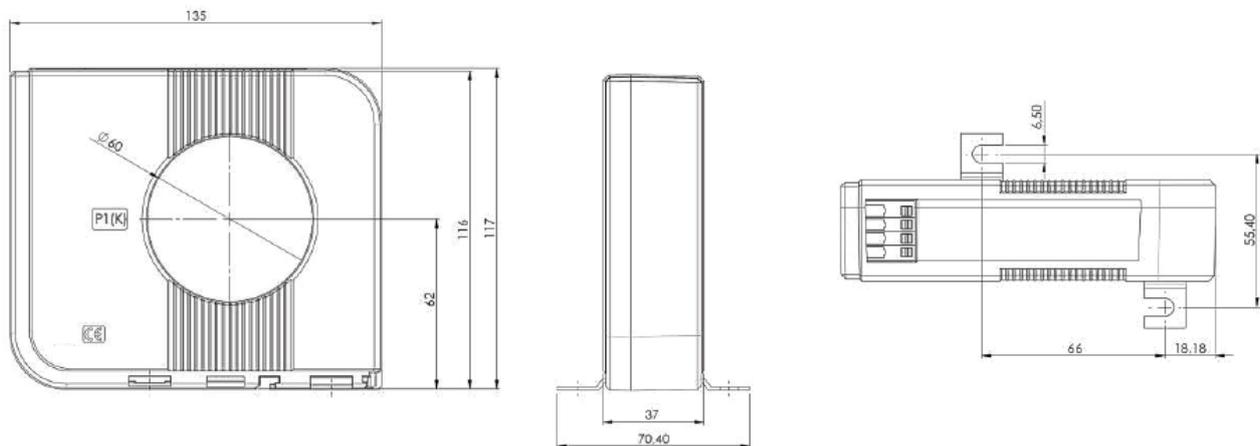


Fig. 19: SCT4316-0025 dimensions, all dimensions in mm

3.4 SCT4416-0025 | Ring-type CT, differential current type A, 25 A AC, size 4

Electrical data	SCT4416-0025
Primary rated differential current $I_{\Delta N}$	25 A
Secondary rated differential current	0.0417 A
Measuring range	0.02 ... 25 A
Transmission ratio	1:600
Operating frequency range	30 Hz...3 kHz
Rated voltage	800 V
Rated surge voltage	8 kV
Rated load:	100 Ω
Operating conditions	SCT4416-0025
Permissible ambient temperature range during operation	-10...+70 °C
Permissible ambient temperature range during storage	-25 ... +70 °C
Pollution degree	III
Protection rating	Housing: IP40; terminals: IP20
General data	SCT4416-0025
Max. conductor bushing diameter, primary conductor (round conductor)	120 mm
Connection technology secondary	CAGE CLAMP® ^{*)}
Size	4
Dimensions (W x H x D)	210 mm x 191.5 mm x 63.4 mm
Weight	approx. 950 g
Mounting accessories for mounting on 35 mm DIN rail	-

Markings, standards and regulations *)	SCT4416-0025
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-0
Standards/Regulations	IEC 60664-1 / IEC 60664-3

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

***) Max. primary cable length: 10 m

SCT4416-0025 dimensions, size 4

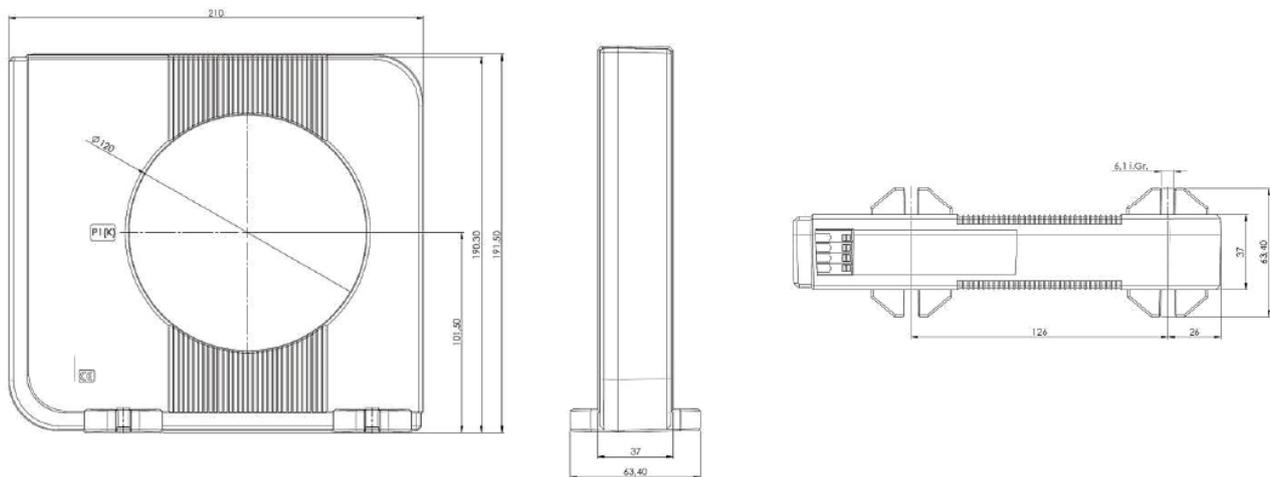


Fig. 20: SCT4416-0025 dimensions, all dimensions in mm

3.5 SCT4616-0018 | Split-core current transformer, differential current type A, 18 A AC, size 1

Electrical data	SCT4616-0018
Primary rated differential current $I_{\Delta N}$	18 A
Rated gear ratio I_{pn} / I_{sn}	10 / 0.0167 A
Max. voltage for electrical equipment	$U_m \leq 0.72$ kV
Transmission ratio	1:600
Operating frequency range	30 Hz...1 kHz
Insulation test voltage	3 kV U_{eff} ; 50 Hz; 1 min
Rated frequency	50 Hz
Rated load:	100...180 ohm
Operating conditions	SCT4616-0018
Permissible ambient temperature range during operation	-5...+45 °C
Permissible ambient temperature range during storage	-25...+70 °C
Max. temperature of the primary conductor	90 °C

General data	SCT4616-0018
Max. conductor bushing diameter, primary conductor	4x10 pitch (~10 mm ²) or 8x7 pitch (~6 mm ²)
Connection technology secondary	Screw terminals
Busbar dimensions	max. 20 x 30 mm
Size	1
Dimensions (W x H x D)	93 mm x 106 mm x 58 mm
Weight	approx. 700 g
Markings, standards and regulations *)	SCT4616-0018
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-2

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

SCT4616-0018 dimensions, size 1

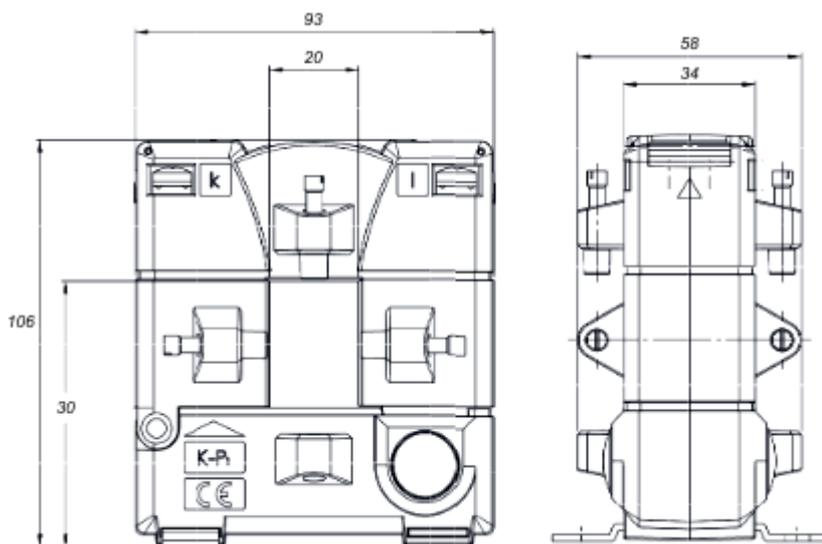


Fig. 21: SCT4616-0018 dimensions, all dimensions in mm

3.6 SCT4716-0018 | Split-core current transformer, differential current type A, 18 A AC, size 2

Electrical data	SCT4716-0018
Primary rated differential current $I_{\Delta N}$	18 A
Rated gear ratio I_{pn} / I_{sn}	10 / 0.0167 A
Max. voltage for electrical equipment	$U_m \leq 0.72$ kV
Transmission ratio	1:600
Operating frequency range	30 Hz...1 kHz
Insulation test voltage	3 kV U_{eff} .; 50 Hz; 1 min
Rated frequency	50 Hz
Rated load:	100...180 ohm

Operating conditions	SCT4716-0018
Permissible ambient temperature range during operation	-5...+45 °C
Permissible ambient temperature range during storage	-25...+70 °C
Max. temperature of the primary conductor	90 °C
General data	SCT4716-0018
Max. conductor bushing diameter, primary conductor	4x 27 pitch (~240 mm ²) or 8x20 pitch (~95 mm ²)
Connection technology secondary	Screw terminals
Busbar dimensions	max. 50 x 80 mm
Size	2
Dimensions (W x H x D)	125 mm x 158 mm x 58 mm
Weight	approx. 1100 g
Markings, standards and regulations *)	SCT4716-0018
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-2

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

SCT4716-0018 dimensions, size 2

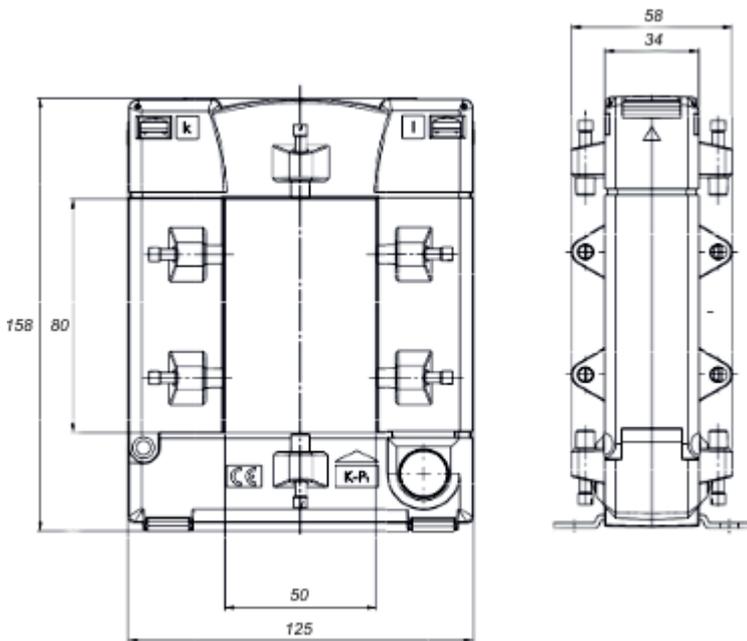


Fig. 22: SCT4716-0018 dimensions, all dimensions in mm

3.7 SCT4816-0018 | Split-core current transformer, differential current type A, 18 A AC, size 3

Electrical data	SCT4816-0018
Primary rated differential current $I_{\Delta N}$	18 A
Rated gear ratio I_{pn} / I_{sn}	10 / 0.0167 A
Max. voltage for electrical equipment	$U_m \leq 0.72$ kV
Transmission ratio	1:600
Operating frequency range	30 Hz...1 kHz
Insulation test voltage	3 kV U_{eff} .; 50 Hz; 1 min
Rated frequency	50 Hz
Rated load:	100...180 ohm
Operating conditions	SCT4816-0018
Permissible ambient temperature range during operation	-5...+45 °C
Permissible ambient temperature range during storage	-25...+70 °C
Max. temperature of the primary conductor	90 °C
General data	SCT4816-0018
Max. conductor bushing diameter, primary conductor	4x42 pitch (~500 mm ²) or 8x29 pitch (~240 mm ²)
Connection technology secondary	Screw terminals
Busbar dimensions	max. 80 x 120 mm
Size	3
Dimensions (W x H x D)	155 mm x 198 mm x 58 mm
Weight	approx. 1400 g
Markings, standards and regulations *)	SCT4816-0018
Markings/Approvals	CE, EAC
Flame rating	UL 94 V-2

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

SCT4816-0018 dimensions, size 2

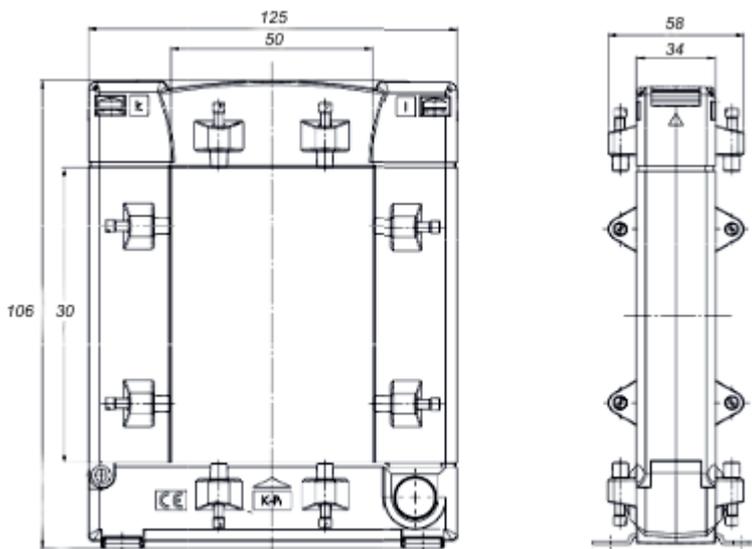


Fig. 23: SCT4816-0018 dimensions, all dimensions in mm

4 Commissioning

⚠ 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.

Notes on differential current measurement

Damage to the electrical insulation (reduction in insulation resistance) can always result in personal injury. For this reason, residual current devices (RCDs) are installed in many systems. These have a defined tripping range of approx. 15 to 30 mA.

In addition to the residual current circuit breaker, the insulation resistance of the system is also measured as a repeat measurement in accordance with DIN VDE 0105 Part 100 to ensure that the system complies with the safety regulations and installation standards. This measurement can only be carried out on a de-energized system. The guide value for this is four years.

For financial reasons, shorter test intervals are not preferred, even if the system has already aged considerably. In order to detect signs of degeneration in the insulation of the system at an early stage and thus counteract an unplanned shutdown, a differential current measurement is recommended.

This method can detect even very small residual currents, which can be the cause of insulation degeneration. In addition to these residual currents, however, there are other phenomena that complicate the matter. In addition to the residual current or the ohmic leakage current typical of the system, various capacitive leakage currents are also measured. However, these do not provide any information about the insulation status of the system.

These leakage currents are often generated by machines driven by electric motors. Capacitive leakage currents can flow in the large winding capacitance of the motor to the laminated core and thus to the housing. These increase considerably during operation with variable frequency drives and can even lead to damage to the motor ball bearings. The capacitance of long motor cables also leads to leakage currents via the shield. As a result of these leakage currents, a differential current of more than 30 mA is often measured.

Despite these difficulties, it is often possible to recognize a trend in the differential current. This should be interpreted as a sign of an early repeat test in accordance with DIN VDE 0105 Part 100.

The differential current measurement is carried out with the SCT 4xxx differential current transformers. These are compatible with some universal measuring devices or provide a 4-20 mA output with an additional device. There is also the option of connecting a relay.

Measuring circuit

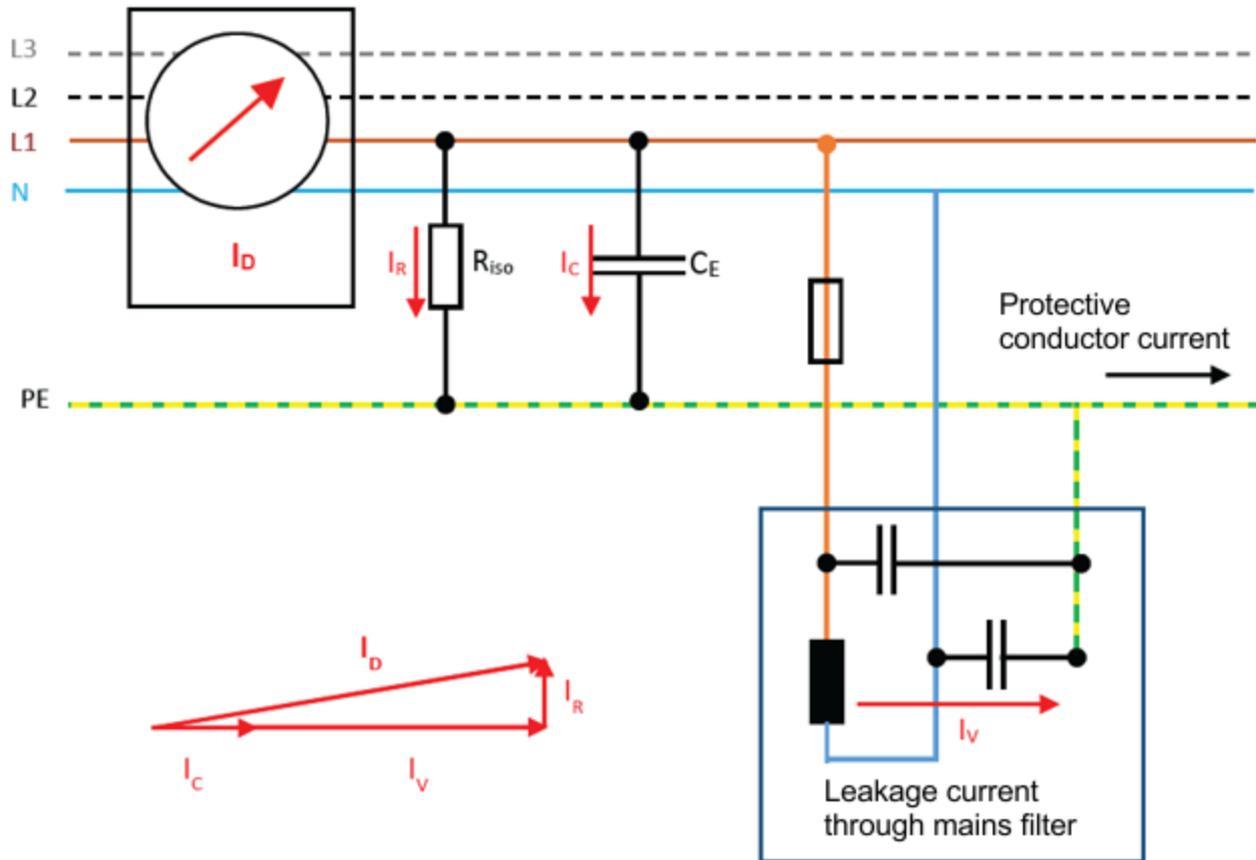


Fig. 24: Measuring circuit **SCT4xxx** transformer

In addition to the leakage current I_R via the insulation, the leakage currents I_C and I_V are also measured using the differential current measurement I_D . The capacitive currents flow via the line and load or mains filter capacitances.

4.1 Installation SCT4116/SCT4216/SCT4316

Installation instructions SCT4116, EL4216, EL4316

- 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.
- Install the current transformer on the primary conductor.
- To do this, feed the primary conductor (copper bar or round conductor) through the window aperture of the current transformer housing. The window aperture is marked with "P1 (K)".
- The device is mounted on a mounting plate. Use the fastening materials included in the scope of delivery for this.
- Mounting on a mounting plate takes place with the base brackets also included in the accessories pack.
- The current transformers can also be fastened to 35 mm DIN rails by means of a snap-on mounting ([ZB8201-04x0](#) [▶ 35](#)]), which is available as an accessory.
- Make the secondary connections. Observe the markings "k (S1)" and "l (S2)" of the secondary terminals.

Assembly notes

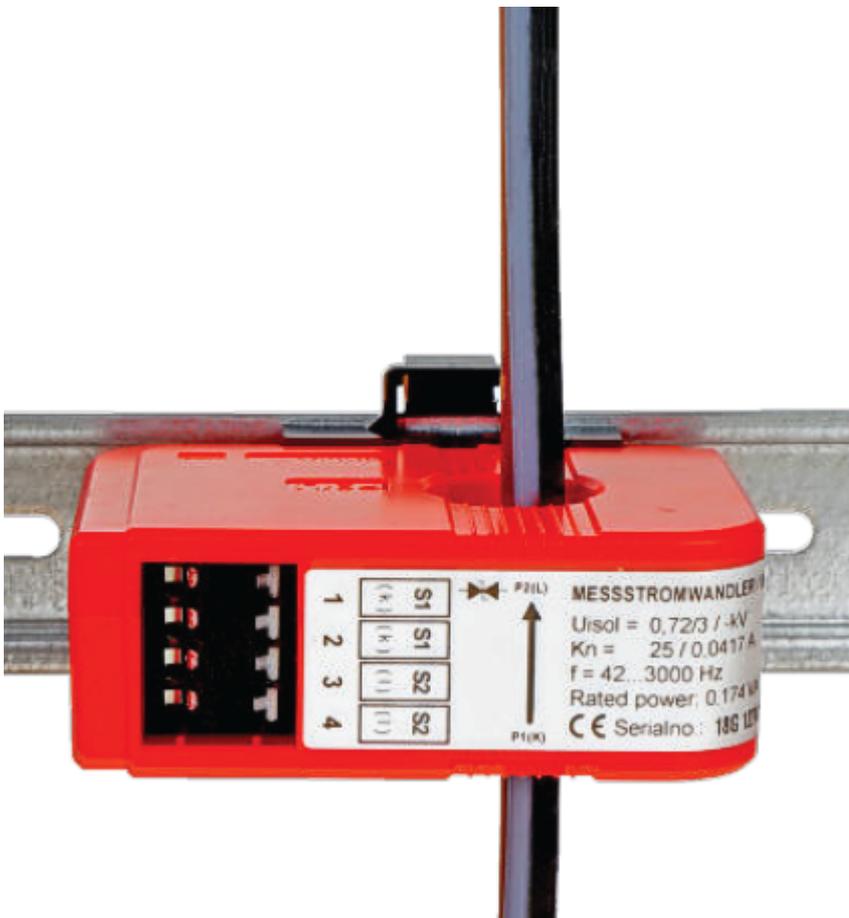


Fig. 25: Mounting with Quickfix ([ZB8203-04x0](#)) on 35 mm DIN rails

4.2 Installation SCT4616/SCT4716/SCT4816

⚠ 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.
- The device is mounted on a mounting plate. Use the fastening materials included in the scope of delivery for this.
- Mounting on a mounting plate takes place with the base brackets also included in the accessories pack.
- 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 to the power source, P2 to the loads.
The arrow on the name plate indicates the direction of energy flow.
Caution: Do not close the current transformer yet, high voltages may occur at the secondary connections!
Caution: Ensure that the cut surfaces of the split 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.

Assembly notes

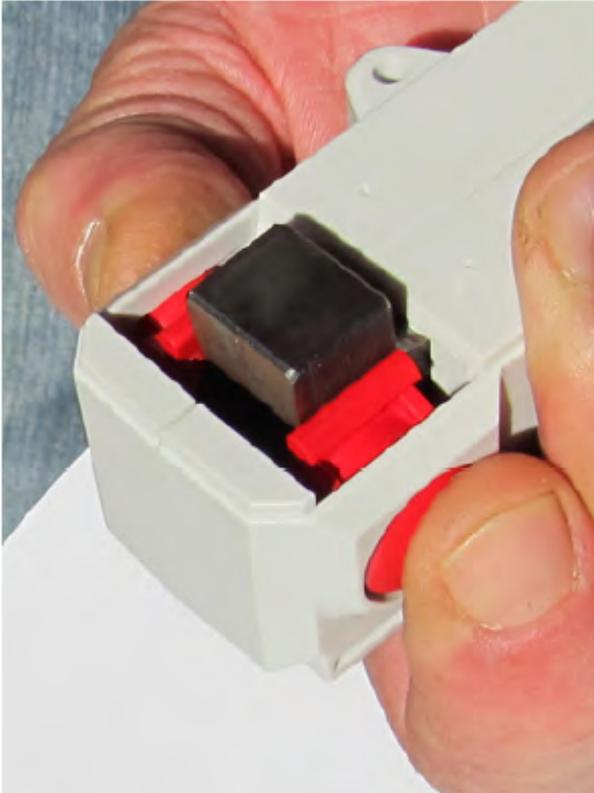


Fig. 26: Actuating buttons to open the **SCT4616/SCT4716/SCT4816** split-core current transformers

5 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 [▶ 33] in the chapter "Installation [▶ 33]!"
- 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.

6 Appendix

6.1 Documentation issue status

Version	Comment
1.1.0	- Chapter "Technical data" updated - Update structure
1.0.0	- First release
0.3.0	- Addenda and corrections
0.2.0	- Addenda and corrections
0.1.0	- Preliminary version of the SCT4xxx documentation

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