# ZEMCTK09-31G Current Transformer

https://wiki.wirenboard.com/wiki/ZEMCTK09-31G/en

Ревизия 106153 от 03.09.2026

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# 1 General information

The ZEMCTK09-31G current transformer is designed to measure alternating current as part of WB-MAP universal power meters.

The ZEMCTK09-31G is a split-core transformer and is installed on a power circuit without breaking the conductor or its insulation.

# 2 Specifications

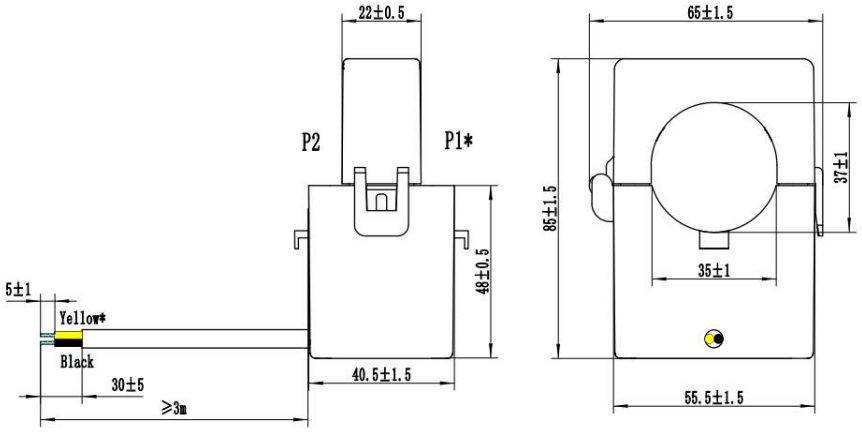


Рис. 1. Dimensional drawing of the ZEMCTK09-31G

| **Parameter** | **Value** |
|---|---|
| Frequency | 50/60 Hz |
| Mounting type | On the wire |
| Aperture diameter (max. wire diameter) | 35 mm |
| Transformation ratio (exact value on the label) | 1:10000 |
| Overall dimensions (L x W x H) | 86 x 55 x 40 mm |
| Wire length | 3 m |
| Weight without wire | ~362 g |
| Secondary winding open-circuit protection | - |
| Core material | Sheet carbon steel |
| For accuracy corresponding to class 0,5S | |
| Rated primary current range | 500 to 630 A |
| Rated primary current | 500 A |
| Extended rated primary current at 25 °C | 150 % (755 A) |
| Measured current | 5 to 755 A |

Manufacturer documentation (datasheet): Файл:ZEMCTK09-31G.pdf

The table lists characteristics that differ from those declared by the manufacturer. They were obtained by testing the transformers in the Wiren Board laboratory. To confirm them we regularly check devices from every batch.

**Rated primary current ($I_n$)** — the current in the primary circuit against which the accuracy class of the transformer is rated. The rated primary current defines the range of measured primary currents within which the measurement errors stay inside the limits permitted for the given accuracy class. For accuracy classes **0.2S** and **0.5S** that range is **$0.01*I_n < I < 1.2*I_n$**, for accuracy classes **0.5** and **1** it is **$0.05*I_n < I < 1.2*I_n$**.

**Rated primary current range ($I_{n_min}...I_{n_max}$)** — a characteristic that shows the measuring capability of the transformer more precisely. Laboratory testing showed that the transformers can measure primary current without losing accuracy over a wider range than the standards require for the accuracy classes. The rated primary current range is defined by the minimum ($I_{n_min}$) and maximum ($I_{n_max}$) rated primary current. In this case the range of measured primary currents for accuracy classes **0.2S** and **0.5S** is **$0.01*I_{n_min} < I < 1.2*I_{n_max}$**, for accuracy classes **0.5** and **1** it is **$0.05*I_{n_min} < I < 1.2*I_{n_max}$**.

**Extended rated primary current** — the maximum primary current beyond the rated range at which the measurement errors stay within the accuracy class. It is expressed as a percentage of the rated primary current ($I_n$). The extended rated primary current is in effect the highest primary current the transformer can measure with the accuracy of its class.

**Measured current ($I_{min}...I_{max}$)** — the range of primary currents the transformer measures with an error matching its accuracy class. The values of $I_{min}$ and $I_{max}$ are derived from the rated primary current range.

$I_{min}$

- for accuracy classes 0.2S and 0.5S is 1 % of the minimum rated primary current. **$I_{min}=0.01*I_{n_min}$**;
- for accuracy classes 0.5 and 1 is 5 % of the minimum rated primary current. **$I_{min}=0.05*I_{n_min}$**.

$I_{max}$

- for accuracy classes 0.2S, 0.5S, 0.5 and 1 is 120 % of the maximum rated primary current. **$I_{max}=1.2*I_{n_max}$**;
- if the transformer has an extended current range, $I_{max}$ takes the value of the extended rated primary current.

**Transformation ratio** — the ratio of the rated primary current to the rated secondary current. The actual values of the transformation ratio and of the phase shift are individual to each transformer and are printed on its housing.

Below are the graphs of the ZEMCTK09-31G current transformer errors against primary current, taken on a test bench. The measurements were made at a temperature of 25 °C.

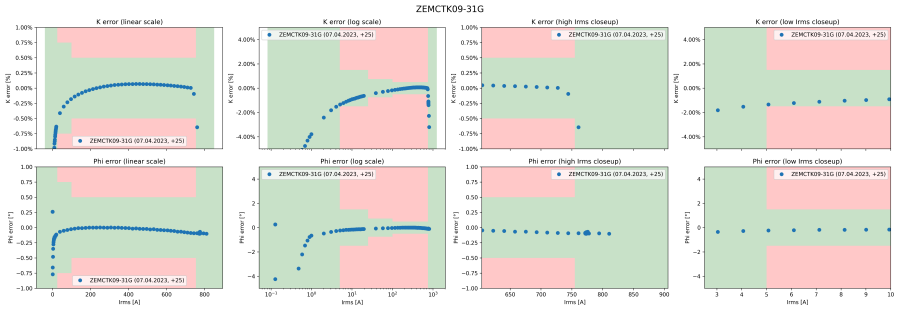


Рис. 2. Current error and phase displacement of the ZEMCTK09-31G at 25 °C

## 2.1 Temperature degradation

The core of this transformer is made of steel. The upper bound of the current it can measure without leaving its accuracy class therefore barely drops as the temperature changes.

Operating beyond the permitted currents does, however, heat the transformer strongly. We recommend taking the ambient temperature at the installation site into account and choosing the transformer so that the measured currents do not reach its upper measuring limit.

# 3 Measurement errors and accuracy classes

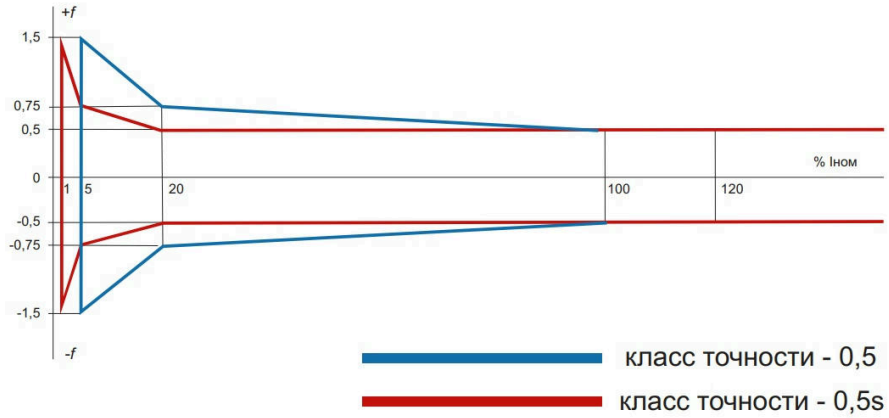


Рис. 3. Permissible error range for classes 0.5 and 0.5S

Two errors are rated for measuring current transformers: the current error and the phase displacement.

**Current error**, also called the **ratio error**, is the error that arises because the actual transformation ratio is not equal to the rated one. That is, because the transformer is not ideal, the measured current differs slightly from the current actually flowing in the conductor the transformer is installed on.

**Phase displacement** is the phase difference between the vectors of the primary and secondary current or voltage, with the vector directions chosen so that this angle is zero for an ideal transformer. Phase displacement does not affect current measurement. But even a small phase displacement introduces a noticeable error into energy and power measurement. That is why the accuracy class sets very strict requirements for it.

The error limits are set by ГОСТ Р МЭК 61869-2-2015 and ГОСТ IEC 60044-1-2013 and are rated at 4 or 5 points depending on the **accuracy class**.

**Accuracy class** — a characteristic of the transformer meaning that its current error and phase displacement stay inside the permissible error ranges set for that class under the specified operating conditions.

Accuracy classes rated at 5 measurement points are marked with the letter **S**. Such classes guarantee higher measurement accuracy at low loads.

The current error and the phase displacement must not exceed the values given in the table below.

Таблица 1. Current error and phase displacement limits for measuring current transformers of accuracy classes 0.5S, 0.5 and 1

| **Accuracy class** | **Primary current, % of the rated value** | | | | |
|---|---|---|---|---|---|
| | **1** | **5** | **20** | **100** | **120** |
| | **Permissible error limits, ± current / phase** | | | | |
| 0.5S | 1.5% / 1.5° | 0.75% / 0.75° | 0.5% / 0.5° | 0.5% / 0.5° | 0.5% / 0.5° |
| 0.5 | - | 1.5% / 1.5° | 0.75% / 0.75° | 0.5% / 0.5° | 0.5% / 0.5° |
| 1 | - | 3% / 3° | 1.5% / 1.5° | 1% / 1° | 1% / 1° |

# 4 Installation

The current transformer installation rules are described in the installation guide. If the transformer is installed on a live wire but there is nowhere to connect the secondary winding leads, simply short them together. This prevents the core from humming and heating up.

A humming transformer can also be caused by a gap in the core. If the transformer hums, check that the core is latched tightly and that the secondary winding leads are not left floating.

# 5 Selecting a transformer by current

| Transformer model | Measured current range by accuracy class, A | | | | Aperture diameter (max. wire diameter), mm | Core material | Core type |
|---|---|---|---|---|---|---|---|
| | 0.2S | 0.5S | 0.5 | 1 | | | |
| ZMCT102w | 0.15...45 | - | - | - | 5 | Ferrite | Solid |
| KCT-6 | - | 0.2...27 | 0.25...27 | 0.25...30 | 5.5 | Ferrite | Split |
| ZMCT205D | - | 0.06...15 | - | - | 6.5 | Ferrite | Solid |
| ZMCT134 | - | 0.15...65 | - | - | 7.5 | Ferrite | Solid |
| WB-CT309 (ZMCT123) | - | 0.15...125 | - | - | 9.5 | Ferrite | Solid |
| ZEMCTK05-14 | - | 0.15...90 | 0.25...90 | - | 10 | Ferrite | Split |
| ZMDCT21 | 0.8...140 | - | - | - | 12 | Ferrite | Solid |
| ZEMCTK04-13 | - | 0.25...152 | - | - | 16 | Ferrite | Split |
| CTSA024 | - | 0.35...290 | - | - | 24 | Ferrite | Split |
| CTSA035 | - | 5...755 | - | - | 35 | Steel | Split |
| ZEMCTK09-31G | - | 5...755 | - | - | 35 | Steel | Split |

The measured current range is the range of currents the transformer measures with an error no worse than the one its declared accuracy class allows. The range is derived from the rated primary current range given on each transformer's page: the lower bound is 1 % of the minimum rated primary current for classes 0.2S and 0.5S and 5 % for classes 0.5 and 1; the upper bound is the extended rated primary current.

- The permissible error is not uniform across the range — it grows towards the lower bound. The error limits are given on the WB-MAP meters: accuracy classes and tolerances page.
- The upper bounds are confirmed at a temperature of 25 °C. They drop as the transformer heats up — see the «Temperature degradation» section on the transformer's page.

# 6 Selecting a transformer by wire cross-section

The table below helps to select a current transformer by the cross-section and type of the cable. The table uses the following notation:

| | |
|---|---|
| | can be used, optimal for a wire of this cross-section |
| | can be used, but not cost-effective |
| | cannot be used, does not fit the aperture diameter |

| Conductor cross-section, mm2 | Cable type | Conductor diameter with insulation (max.), mm | Transformer models | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ZMCT102w | KCT-6 | ZMCT205D | ZMCT134 | WB-CT309 (ZMCT123) | ZEMCTK05-14 | ZMDCT21 | ZEMCTK04-13 | CTSA024 | CTSA035 | ZEMCTK09-31G |
| 0.5 | ПВС | 1.4 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПуГВ | 2.1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 0.75 | ПВС | 1.58 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПуГВ | 2.4 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 1.0 | ПВС | 1.73 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПуГВ | 2.5 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 1.5 | ВВГнг | 2.3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПВС | 2.08 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПуГВ | 3 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 2.5 | ВВГнг | 2.7 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПВС | 2.58 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| | ПуГВ | 3.7 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 4 | ВВГнг | 3.4 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | ПВС | 3.26 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | ПуГВ | 4.2 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| 6 | ВВГнг | 3.9 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | ПВС | 3.56 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | ПуГВ | 5.3 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| 10 | ВВГнг | 4.7 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | ПВС | 4.75 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | ПуГВ | 6 | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 16 | ВВГнг | 6 | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | ПуГВ | 7.6 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 25 | ВВГнг | 7.7 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | ПуГВ | 9.6 | | | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| 35 | ВВГнг | 8.7 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | ПуГВ | 10.9 | | | | | | | ■ | ■ | ■ | ■ | ■ |
| 50 | ВВГнг | 10 | | | | | | | ■ | ■ | ■ | ■ | ■ |
| | ПуГВ | 12.6 | | | | | | | | ■ | ■ | ■ | ■ |
| 70 | ВВГнг | 11.6 | | | | | | | | ■ | ■ | ■ | ■ |
| | ПуГВ | 14.6 | | | | | | | | ■ | ■ | ■ | ■ |
| 95 | ВВГнг | 13.6 | | | | | | | | ■ | ■ | ■ | ■ |
| 120 | ВВГнг | 15.1 | | | | | | | | | ■ | ■ | ■ |