ZES ZIMMER
A Rohde & Schwarz Company

Sensors & Accessories

for LMG Family

User Manual

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ZES ZIMMER Electronic Systems GmbH
Pfeiffstraße 12
61440 Oberursel (Taunus), Germany
phone +49 (0)6171 88832-0
fax +49 (0)6171 88832-28
e-mail: info@zes.com
Internet: http://www.zes.com

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Contents

1 Introduction **5**
1.1 Used symbols . . . 5
1.2 Safety recommendations . . . 5
1.3 General environmental conditions . . . 9
1.4 Technical assistance . . . 10
1.5 Reporting cybersecurity issues . . . 10

2 Current Sensors **11**

Precision Current Transducers . . . 11
2.1 Precision current transducer 200 A (PCT200) . . . 11
2.2 Precision current transducer 600 A (PCT600) . . . 20
2.3 Precision current transducer 1200 A (PCT1200) . . . 29
2.4 Precision current transducer 2000 A (PCT2000) . . . 36

Precision Current Transformers . . . 43
2.5 Precision current transformer 1500 A (LMG-Z702) . . . 43
2.6 Precision current transformer 4000 A (LMG-Z742) . . . 49
2.7 Precision current transformer 10 kA (LMG-Z762) . . . 54
2.8 Precision current transformer 10 kA (LMG-Z782) . . . 57

Current Clamps . . . 60
2.9 Active error compensated AC current clamp 40 A (L60-Z406) . . . 60
2.10 Error compensated AC current clamp 1000 A (L60-Z60) . . . 64
2.11 Error compensated AC current clamp 3000 A (L60-Z66) . . . 68
2.12 AC/DC current clamp 1000 A (L60-Z68) . . . 72
2.13 AC current clamp 1000 A / 1 A (LMG-Z322) . . . 75
2.14 AC current clamp 3000 A / 1 A (LMG-Z329) . . . 78

Wideband Current Transformer . . . 81
2.15 Precision wideband current transformer 100 A (WCT100) . . . 81
2.16 HF summing current transformer (L95-Z06, -Z06-HV) . . . 84

Hall Effect Sensors . . . 89
2.17 Hall effect current sensors (HALL100, -300, -500, -1000, -2000) . . . 89

3 Voltage Sensors **97**
3.1 Precision high voltage divider (HST3, -6, -9, -12) . . . 97

4 Reference Impedance **107**
4.1 Reference Impedance for measurements as specified in IEC 61000-3-3/-11 (RI2415) . . . 107

5 Accessories **115**

Accessories for PSU and PCT . . . 115
5.1 PCT current sensor supply unit (PCTSIU4) . . . 115
5.2 PCT current sensor supply unit (PCTSIU4-1U) . . . 118
5.3 Shielded PCT connection cable (PCT-DSUB) . . . 121
5.4 Shielded Sensor extension cable with extended temperature range (LMG-Z-SVT) . . . 123
5.5 Shielded DSUB9 extension cable (LMG-Z-DV) . . . 124
5.6 LMG600 connection cable for current sensors PSU (PSU-K-L6) . . . 126

Measuring Adaptors . . . 129
5.7 Adaptor for measurement at Schuko devices (LMG-MAS) . . . 129
5.8 Adaptor for measurement at IEC connector devices (LMG-MAK1) . . . 131
5.9 Adaptor for measurement at 16 A / 3-phase devices (BOB-CEE3-16) . . . 133

5.10 Adaptor for measurement at 32 A / 3-phase devices (BOB-CEE3-32) 135

Measurement Leads and Accessories 137
5.11 Safety laboratory leads (LMG-Z307, -Z308, -Z309, -Z310, -Z311) 137
5.12 Voltage range extender (L60-CH-S-VRE) 140
5.13 Adapter to 4 mm safety system (LMG-ADP-SLJ) 142
5.14 Insulated 4 mm connecting plug (LMG-SCP) 144

Accessories for Process Signal Interface 146
5.15 Adapter for using resolvers with LMG600 (L6-ACC-RSLV) 146
5.16 DSUB Adapter with screwed terminal connection (LMG-DSUBIO) 149

Accessories for LMG 151
5.17 LMG600 current sensor adapter (L60-X-ADSE) 151
5.18 LMG600 sync cable (L6-ACC-SYNC) 153
5.19 Mains supply cord (LMG-Z303) 155

Accessories for PC Interface 157
5.20 IEEE488 bus cable (LMG-Z312, -Z313, -Z314) 157
5.21 USB-RS232 Adapter (LMG-Z316) 158
5.22 RS232 interface cable (LMG-Z317) 160

6 FAQ - frequently asked questions / Knowledge base 161
6.1 Avoid distortion when using external sensors in noisy environment 161
6.2 How to connect and supply PCT with LMG600 163
6.3 Avoid measuring errors due to shield currents 164
6.4 Range extension by changing primary ratio at current sensors 165
6.5 Hints for wiring current transformers or HST to LMG 166
6.6 The burden resistor 167

1 Introduction

1.1 Used symbols

This manual describes and explains symbols which are found here and displayed on the equipment. Observation of these warning signs is required for safe operation.

Electric shock
This symbol indicates danger of injury or death from electric shock due to dangerous voltages. *Do not touch. Use extreme caution.*
AC voltages over 33 V RMS, 46.7 V peak and DC voltages over 70 V are deemed to be hazardous live according to IEC 61010 resp. EN 61010. There is a danger of electric shock. This can cause death or injury to body or health. Furthermore, there is a risk of material damages.



High temperature
This symbol indicates a high temperature. There is a burn and fire hazard. There is a danger of fire or injury to body or health due to hot surfaces or material. Furthermore, there can be material damages to other objects due to contact or close proximity. If a burn or fire does occur, there can be further damages which can cause death or injury to body or health.



Caution
This symbol indicates the risk of damages to persons or material. Also if material damages occur, there can be further damages which can cause death or injury to body or health.
This symbol on the equipment indicates that this user manual is to be consulted for instruction or further information provided in order for save operation.



Information
This symbol indicates facts or information regarding the equipment which should be observed for easy and accurate operation.



Protective conductor terminal
This symbol indicates the terminal for the protective conductor. See also Connection to power supply and protective conductor [1.2.1→7].



Danger active conductor
Do not apply current sensor to or remove from hazardous live uninsulated conductors, which may render electric shock, electric burn, or arc flash.



References/links
References to tables, figures, listings, etc. consist of their identifier followed by the book symbol and the page number.
References to chapters, sections, and subsections consist of the heading of the section and the sectional number followed by the book symbol and the page number.

[→5]

Used symbols [1.1→5]

In the PDF version of this document, one can click on any of these reference elements to jump to the reference.

1.2 Safety recommendations

This equipment was designed according to IEC 61010 and EN 61010 and has left the factory in a mechanically and electrically safe condition. To maintain safe operation, the user must follow the instructions and warnings contained in this manual. The equipment must only be used for the purposes described in this manual.

If damage to the equipment is suspected, it must be removed from operation to prevent possible further damages or injury. Repairs may only be performed by the manufacturer.

Until shown to be otherwise, the equipment must be considered unsafe to operate if

- there is visual evidence of physical damage,
- it fails to operate correctly,
- the equipment has been heavily overloaded due to to high currents (short circuit or something similar),
- the equipment has been heavily overloaded due to to high voltages,
- the equipment has been operated with supply voltage outside specifications,
- there are loose parts inside the equipment,
- long term storage has taken place in conditions outside the stated specifications for safe storage,
- condensation is present, or
- rough transport has occurred.

The intended use of this equipment (within the limitations stated in the the technical data) is to measure electrical current and/or voltage.

When handling electricity and/or an electrical apparatus, be sure to observe all safety rules. These rules include, but are not limited to, the following:



- Opening the equipment exposes components which are under high voltage. *This is only permitted to trained personnel. User risks injury by removing cover and may void any manufacturer's warranty.* All voltage sources must be disconnected from the equipment before any equipment covers are removed. Only suitably qualified personnel are permitted such access for the purpose of calibration, service, repair or changing of components.
  If the equipment has been opened, a high voltage test and a test of the protective conductor are necessary according EN 61010 following the closing of the equipment for safety purposes prior to use.



- Fuses may only be replaced with the correctly rated and recommended types as written in this manual. Reading the rated values from the fuse to be replaced is not permitted. The use of repaired, short-circuited or insufficient fuses is not permitted.



- The environmental conditions (see General environmental conditions [1.3→9]) must be observed to ensure safe operation of the equipment.
  Use in any type of wet or explosive environment or in presence of flammable gases or liquids is especially prohibited.



- The equipment and accessories (such as wires and clips) must be checked before each use. Defective parts must be replaced.



- Ventilation openings must be kept clear (see General environmental conditions [1.3→9]) to guarantee the required air flow and to prevent overheating of the equipment. In the same way, the air filter at the air inlets must be clean to permit sufficient air flow. Do not operate the equipment without air filter or the filter holder as injury may result.
  Especially take care that the equipment is not placed above sheets of paper which could get sucked into the ventilation openings at the bottom of the equipment!
  When mounting the equipment into a rack, make sure that the slide rails do not cover any ventilation openings.



- The equipment must not be used in a medical environment nor in any other environment that may have a potential effect on life or health.



- Impacts or rough handling may damage the equipment. Do not place heavy objects on the equipment.

- If the weight of the equipment is too heavy to be carried by one person, carry the equipment with two persons and/or use an appropriate tool. In all cases, use the handles and grips of the equipment to lift and carry it safely.



- The equipment is *not* designed to detect hazards or similar! A wrong reading (e.g. by choosing a wrong filter or range) could give you the wrong impression of a safe state. Use appropriate tools (e.g. a voltage detector) instead of this equipment to detect dangerous situations.



- Be careful when connecting external equipment like an external keyboard or mouse to an instrument. They might not be designed to operate in the same EMC environment as the instrument and therefore they could be disturbed. This could lead to unwanted operation of the instrument like changing ranges or something similar.



- When connecting the instrument watch the order of connections: First connect it to the protective conductor and the power supply (see CONNECTION TO POWER SUPPLY AND PROTECTIVE CONDUCTOR [1.2.1→7]), then connect it to the measurement circuit (see CONNECTION TO MEASUREMENT CIRCUIT [1.2.2→8]). Then switch on the instrument and the equipment, and finally, after double checking the wiring, switch on the measurement circuit.



- This equipment was designed according to IEC 61010 and EN 61010 which are general safety standards for equipment for measurement, control and laboratory use. In a concrete application or environment further safety standards might be applicable and have to be regarded in addition.



- The device must be positioned so that the main power switch remains easily accessible at all times and can be operated without obstruction in the event of a fault or emergency.



1.2.1 Connection to power supply and protective conductor

- Before connecting the mains cable to the power supply, confirm that the mains supply voltage corresponds to the voltage printed on the model's identification plate. If a voltage selector switch exists, it must be set appropriately. A suitable power source has to be used to operate the equipment/instrument.



- The mains plug may only be inserted into a mains power supply socket with protective earth contact. This protection must not be disabled by the usage of plugs, cables or extension cords without protective earth.
  The mains plug must be inserted into the mains socket *before* any other connections are made to the equipment/instrument. Any kind of interruption of the protective earth, inside or outside the equipment/instrument, or disconnecting the protective earth connector can result in an unsafe condition of the equipment/instrument and is not allowed. The usage of cables, plugs, sockets or adapters with only two poles, prongs or connectors is not allowed.



  The *additional* protective conductor terminal of the equipment/instrument chassis must be used for the case where an earth current in excess of 10 A might result accidentally from the circuit under test.

  > *Such currents are too large for the earthing connection of the equipment/instrument's supply cord. In case of a single fault, the protective conductor might not be able to carry this current. If it would be interrupted, the case would no longer be protected against electric shock!*



  In this case, connect the additional protective conductor terminal with an adequately rated cable to a suitable earthing point. The additional protective conductor terminal is limited to currents up to 32 A.

  If reliable earthing cannot be realized, the connections between the circuit under test and the equipment/instrument must be fused appropriately.

  The earth terminal on the equipment/instrument must not be used as the only earth connection for the equipment/instrument nor must the circuit under test nor any other equipment/instrument be earthed by this terminal. The additional protective conductor is marked with following symbol:



1.2.2 Connection to measurement circuit



- Remove all energy sources from the measurement circuit before making any connections between this circuit and the analyzer. Do not connect or disconnect any cables while they are carrying voltage relative to earth.



- Use only measurement cables with safety connectors and sufficient cross section. Be sure that the cables have a sufficient voltage and current rating and are usable for the desired overvoltage and measurement category.



> *Cables not having safety but standard connectors might have insufficient clearance and creepage distances, even if they are plugged into the socket. So there is always a risk of an electric shock.*

  Use only colored cables which match to the color of the jack to help prevent a wrong connection.

  When connecting the measurement circuit, take special care not to connect the voltage wires to the current input of the equipment/instrument. When switching the measurement circuit on, this would result in a short circuit which risks damage to the analyzer and to the user!



> *Such short circuits can be very dangerous, as currents of several thousand amperes might flow during the short circuit!*

  For the connection of the *voltage* measurement circuit to the equipment/instrument use *only* cables with suitable fuses, like those delivered together with the equipment/instrument.



> *The fuses in the voltage measurement cables will interrupt the current flow in case that these cables are accidentally inserted into the low ohmic current measurement jacks. Therefore short circuiting of a high power source (e.g. the output of an energy distribution transformer) will not cause any hazard.*

  The yellow and black voltage cables have each an implemented fuse. Before and after each measurement: Check the fuse! To replace this fuse, remove the cable on both sides from all circuits to make it free of dangerous voltages. Unscrew the fuse holder. Replace the fuse only with following type:

  6.3x32 mm, FF 500 mA, 1000 V, AC+DC, 30 kA breaking capacity

  Screw the fuse holder together again.



- When connecting to high power measurement circuits (e.g. the output of an energy distribution transformer), massive damage could occur when mismatching cables, short-circuiting the measurement circuit, or using the current jacks of the equipment/instrument instead of the voltage jacks and similar. So it is recommended to use appropriate fuses in *all* measurement cables. When selecting a fuse, ensure that at least the following properties are met:
  - The usual measuring current must flow without interruption (rated current of the fuse)
  - The short circuit current of the measurement circuit must be interrupted safely (breaking capacity of the fuse)
  - The maximum voltage of the measurement circuit must be interrupted safely (rated voltage of the fuse)
  - The fuse must be suitable for the type of current: AC, DC or both (breaking capacity of the fuse)
  - The fuse must be fast enough to protect the cables and the equipment/instrument



- The maximum voltages between the voltage jacks may not exceed the technical specifications.



- The maximum currents at the current jacks may not exceed the technical specifications.

- The maximum voltages of the jacks against earth may not exceed the technical specifications.



- External current sensors or transformers must be connected to wires and jacks which have a ten times higher overload capability, only. If the cables or jacks are not sufficient they could be interrupted in case of overload! For the same reason it is *not* allowed to use fuses in this current measurement wires.



  Before using jacks, test if they have a low impedance current path to prevent high voltages at the output of the external device.

> *In general, it is dangerous to interrupt the secondary side of a current transformer as there might appear very high voltages which could lead to electric shock.*



- Cables from/to external sensors are usually designed to operate with low voltages (e.g $<$15 V). When using these in an environment with a high voltage circuit, use caution as further isolation might be necessary. For the operation itself the isolation is sufficient, but if these cables touch a bare conductor with dangerous voltages this can cause an unsafe condition! In such cases, further isolation might be necessary.



  For example, the secondary cables of a current clamp have a very low voltage, but they could touch the current bar which has a dangerous voltage against earth.

- Especially when establishing external connections, special care must be taken to prevent electrostatic discharge.



- Different sensors might require different connection cables to the instrument. When changing a sensor, please ensure that a correct cable is used. Usually the cable is dedicated to a sensor.



- Keep away from energized measurement circuits to prevent electric shock. When performing measurements on installations or circuits, please observe all safety regulations and guidelines. In particular, only suitable measurement accessories should be used. Only suitably qualified personnel are permitted to work with energized measurement circuits.



- When you put the equipment/instrument out of operation, all external cables shall be removed. Special care has to be taken when disconnecting current sensors. Before interrupting their secondary current, the primary current has to be switched off. After disconnecting, the secondary side of the current sensors has to be short-circuited to prevent dangerous voltages.



1.3 General environmental conditions

The general environmental conditions, *except limited or extended by a specific sensor*, are:

- Indoor use only
- Altitude up to 2000 m
- Temperature +5 °C ... +40 °C
- Maximum relative humidity 80 % for temperatures up to +31 °C decreasing linearly to 50 % relative humidity at +40 °C
- Mains supply voltage fluctuations up to ±10 % of the nominal voltage
- Transient overvoltages up to the levels of overvoltage category II, i.e. to be supplied from a power outlet of the building wiring
- Temporary overvoltages occurring on the mains supply
- Pollution degree 2, i.e. only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is expected
- IP20 Protection Rating according to IEC 60529: Protected against solid objects $\geq$ 12.5 mm, no protection against water

1.4 Technical assistance

For technical assistance you can contact the supplier of the equipment/instrument or the manufacturer:

ZES ZIMMER Electronic Systems GmbH
Pfeiffstraße 12
61440 Oberursel, Germany
Phone: +49 (0)6171/88832-0
Fax: +49 (0)6171/88832-28
Email: info@zes.com
URL: http://www.zes.com

1.5 Reporting cybersecurity issues

Contact us immediately if you discover a cybersecurity issue in a ZES ZIMMER product. We keep reports confidential and never reveal your identity without consent.

1. Prepare an email with the following information, if available:
   - Affected product with product name, serial number, and software version
   - Detailed description of the issue including the steps to reproduce it
   - Contact information, including reporter name, organization, and preferred communication channel
2. Send the email to productsecurity@rohde-schwarz.com.

   Our product security team will analyze your report and coordinate any necessary vulnerability disclosure. We will give you an estimated resolution timeframe and keep you informed of progress.

2 Current Sensors

2.1 Precision current transducer 200 A (PCT200)



Figure 2.1: PCT200

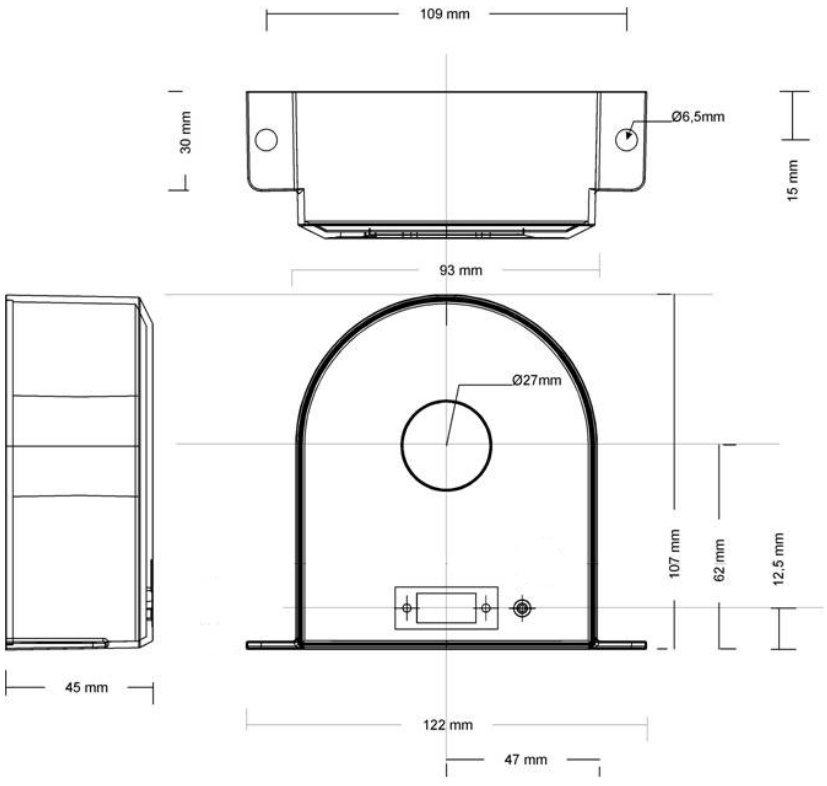


Figure 2.2: PCT200 mechanical dimensions

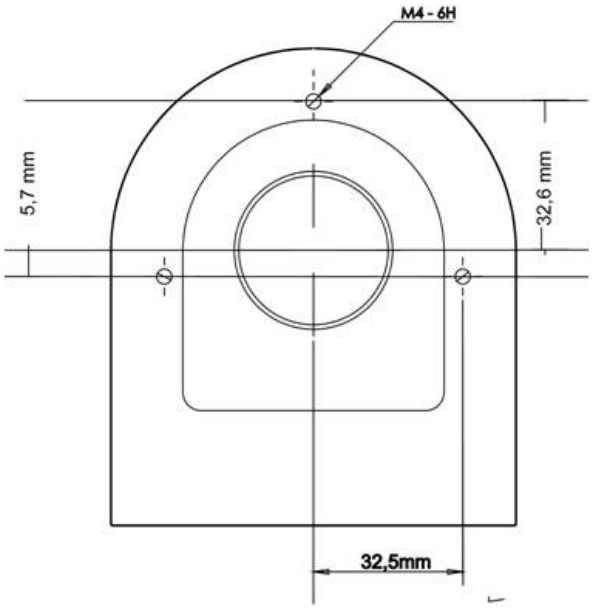


Figure 2.3: PCT200 mounting bushings on the back, maximum screw depth 6 mm

A contact free, closed loop, flux gate based current measurement sensor, developed to offer extreme linearity and full industrial temperature range. The sensor has an aluminium body for shielding against EMI.

2.1.1 Safety warnings

- Always connect the sensor first to the powermeter and afterwards to the device under test. Before connecting the sensor, turn off the powermeter! Do not hot-plug the sensor, see SYSTEM POWER-ON SEQUENCE [2.1.9→15].
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.1.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010
EMC	EN 61326-1

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.1.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.1.4 Specifications

Nominal input current rms	200 A
Maximum input current rms	300 A
Maximum input current peak	300 A
Transformation ratio	500:1
Maximum input overload	1500 A, 100 ms, normal operation after overload 1500 A, 10 s, Sensor shut down but not damaged
Bandwidth (-3 dB, small signal 10 App)	1 MHz
Offset temperature coefficient	±0.1 ppm/K (refers to Maximum input current peak)
Burden	0 ... 3 Ω (if supplied with PCTSIU4 / PCTSIU4-1U and a PCT-DSUB connection cable up to 10 m length: the burden is defined as the resistance from the secondary output connectors of PCTSIU4 to the instrument)
Rated isolation voltage according to IEC 61010-1	300 V CAT III pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 3.6 kV 200 V
Impulse withstand voltage	9 kV
Creepage distance	10 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +65 °C (-40 °C ... +85 °C @ input current rms ≤ 200 A
Storage temperature	-40 °C ... +85 °C
Weight	0.6 kg
Supply	±(15 V±0.75 V) 700 mA

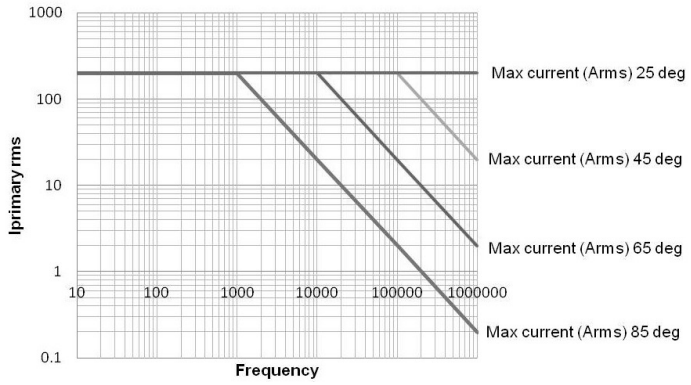


Figure 2.4: PCT200 temperature derating of input current vs. frequency and temperature

2.1.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Accuracy specification for amplitude in % of nominal input current rms	Accuracy specification for phase in °
DC	±0.0035 %	–
0.05 Hz ... 10 Hz	±0.0035 %	±0.1°
10 Hz ... 5 kHz	±0.01 %	±0.1°
5 kHz ... 100 kHz	±1 %	±0.5°
100 kHz ... 1 MHz	±20 %	±5°

See specification of the LMG connection cable for the LMG measuring ranges and to calculate the accuracy of the complete system.

2.1.6 Influence from the conductor centering

As a rule, the best accuracy is obtained when the conductor fills completely the hole of the current transducer. For a smaller conductor, it should be centered inside the hole of the current transducer.

In the test below, a small conductor with a diameter of 3 mm, carrying $I_{DC} = 15$ A is placed in the most unfavorable positions inside the hole of the current transducer.

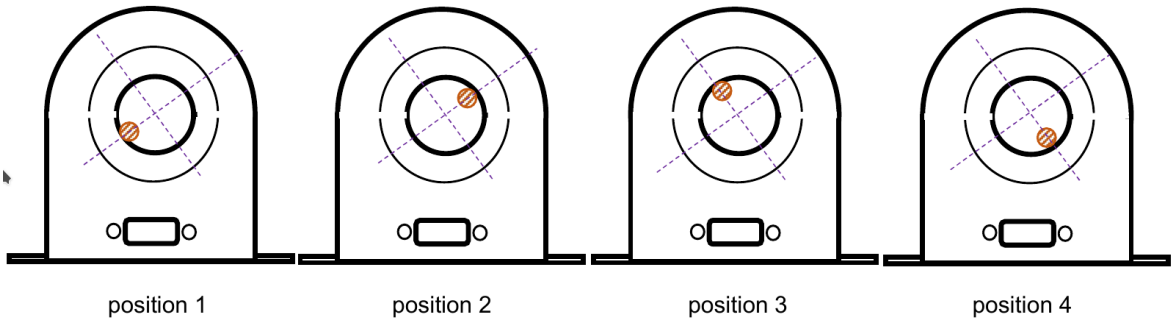


Figure 2.5: Influence from the conductor centering

Position	1	2	3	4
Error in ppm of reading	≈ +4 ppm	≈ +12 ppm	≈ −14 ppm	≈ +23 ppm

In this test, a very small cable is used which represents unfavorable case (partial saturation of the magnetic circuit on a very small area). If a larger cable is used, the influence of decentering of the conductor is less severe. Simulations show that the error due to the position of the cable inside the hole is less than ±100 ppm for every position, amplitude of the current and diameter of the conductor.

2.1.7 DSUB9 connector pin assignment of PCT200

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.1.8 Installation



Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT200 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT200 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT200 is also recommended to lead away capacitive coupled distortion.

For LMG600 use the connection cable 'PCT200-K-L6' and optionally the extension cable 'LMG-Z-SVT' or 'LMG-Z-DV'. For other instruments use the supply unit PCTSIU4 together with the connection cable PCT-DSUB between PCT200 and PCTSIU4.

Also if bare conductors can be used up to the above isolation voltages, it is strictly recommended to use isolated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Use LMG connection cable and PCT with corresponding serial numbers!

2.1.9 System power-on sequence



Do not allow primary current without supply of the sensors! Even though the sensor is protected by an internal sensor protection circuit, the sensor will never start its normal operation with primary current applied before proper supplied.

1. ensure proper connection of the sensor with the power meter LMG
2. turn on the power meter LMG to ensure the supply of the sensor
3. wait until the normal operation status is signalized by the green LED
4. now start the measurements

2.1.10 Internal sensor protection circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current (less than 10 ppm).

2.1.11 Connection of the sensor PCT200 with LMG600

Use PCT200-K-L6 and L60-X-ADSE, supply via LMG600.

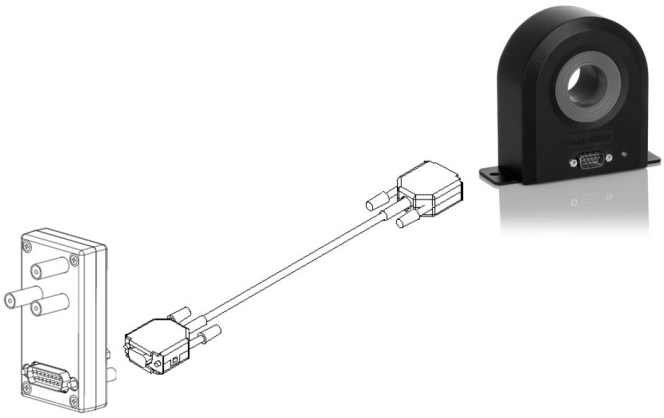


Figure 2.6: PCT200 and PCT200-K-L6 and L60-X-ADSE

The cable 'PCT200-K-L6' is used to connect the precision current transducer PCT200 to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the PCT200 head as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

PCT200-K-L6

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 female / DSUB15 male, knurled screw or locking screw
Operating temperature	+5 °C ... +40 °C
Cable length	2.5 m

Connection

- switch all power off
- plug the connector labeled 'Connect to PCT200 with SN xxx' to the sensor with SN xxx
- plug the connector labeled 'PCT200-K-L6' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with PCT200

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	2.5	5	10	20	40	75	150	200
Max. TRMS value / A	2.75	5.5	11	22	44	82.5	165	300
Max. peak value / A	7	14	28	56	112	234.5	300	300
Range peak value for accuracy calculation / A	7	14	28	56	112	234.5	469	937.5

Power measurement channel L60-CH-S:

Nominal range AC / A	2.5	5	10	20	40	75	150
Nominal range DC / A	5	10	20	40	75	150	300
Max. TRMS value / A	5.5	10.5	21	42	80	160	300
Max. peak value / A	7	14	28	56	112	234.5	300
Range peak value for accuracy calculation / A	7	14	28	56	112	234.5	469

Accuracy

Use PCT200 and LMG600 specifications to calculate the accuracy of the complete system. Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of PCT200-K-L6 with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

2.1.12 Connection of the sensor PCT200 with PCTSIU4

For the use of PCT200 with other instruments with current input and supply via PCTSIU4. Connect PCT200 with PCT-DSUB to PCTSIU4. Secondary current output at PCTSIU4 via two 4mm connectors.

2.1.13 Connection of the sensor PCT200 with SSU4

It is not recommended for new projects, but the sensor supply unit SSU4 can be used with modification for PSU60/200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.1.14 Connection of the sensor PCT200 with LMG95

Use PSU/PCT-K-L95, supply via LMG95, no additional error terms.

2.1.15 Connection of the sensor PCT200 with LMG450

Use PCT200-K-L45 and SSU4 (standard version).

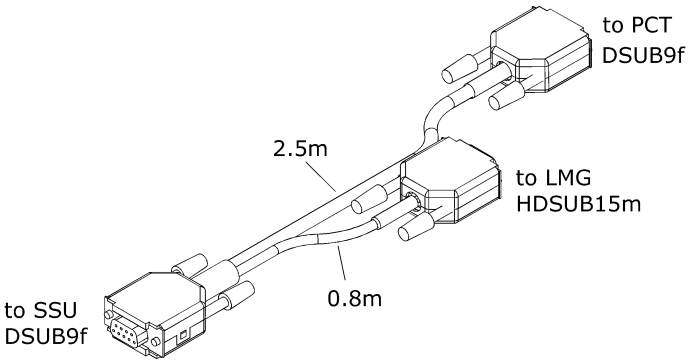


Figure 2.7: PCT200-K-L45

This cable 'PCT200-K-L45' is used to connect a precision current sensor PCT200 to the power meter LMG450 and to supply it by a sensor supply unit SSU4. Internal electronic of the connector to the LMG450 contains the adjustment data of the PCT200 head as well as the serial number. The rangenames of LMG450, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG450 with PCT200

Nominal range / A	6.25	12.5	25	50	100	200
Max. TRMS value / A	8.3125	16.625	33.25	66.5	133	266
Max. peak value / A	9.375	18.75	37.5	75	150	300

Accuracy

Use PCT200 and LMG450 specifications to calculate the accuracy of the complete system.
Add $\pm 0.01\,\%$ of measuring value.
Add $\pm 30\,\mathrm{mA}$ DC offset tolerance.

2.1.16 Connection of the sensor PCT200 with LMG500

Use PCT200-K-L50 and L50-Z14, supply via LMG500.

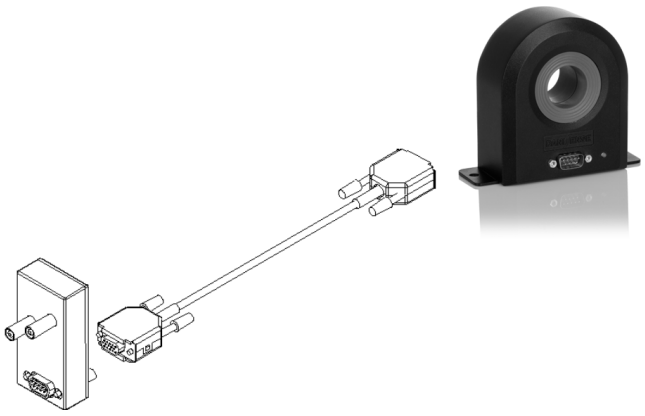


Figure 2.8: PCT200 and PCT200-K-L50 and L50-Z14

This cable 'PCT200-K-L50' is used to connect a precision current sensor PCT200 to the power meter LMG500 and to supply it internally by the LMG500. Internal electronic of the connector to the LMG500 contains the adjustment data of the PCT200 head as well as the serial number. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG500 with PCT200

Nominal range / A	1.5	3	6	12.5	25	50	100	200
Max. TRMS value / A	2.078	4.156	8.3125	16.625	33.25	66.5	133	266
Max. peak value / A	2.344	4.688	9.375	18.75	37.5	75	150	300

Accuracy

Use PCT200 and LMG500 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±30 mA DC offset tolerance.

2.1.17 Connection extension



To use the current sensor with a larger connection length between power meter and PCT connect a well shielded extension cable between the PCT (DSUB9f plug) and the PCT connection cable (DSUB9m plug) and screw both plugs together. This extension cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.2 Precision current transducer 600 A (PCT600)



Figure 2.9: PCT600

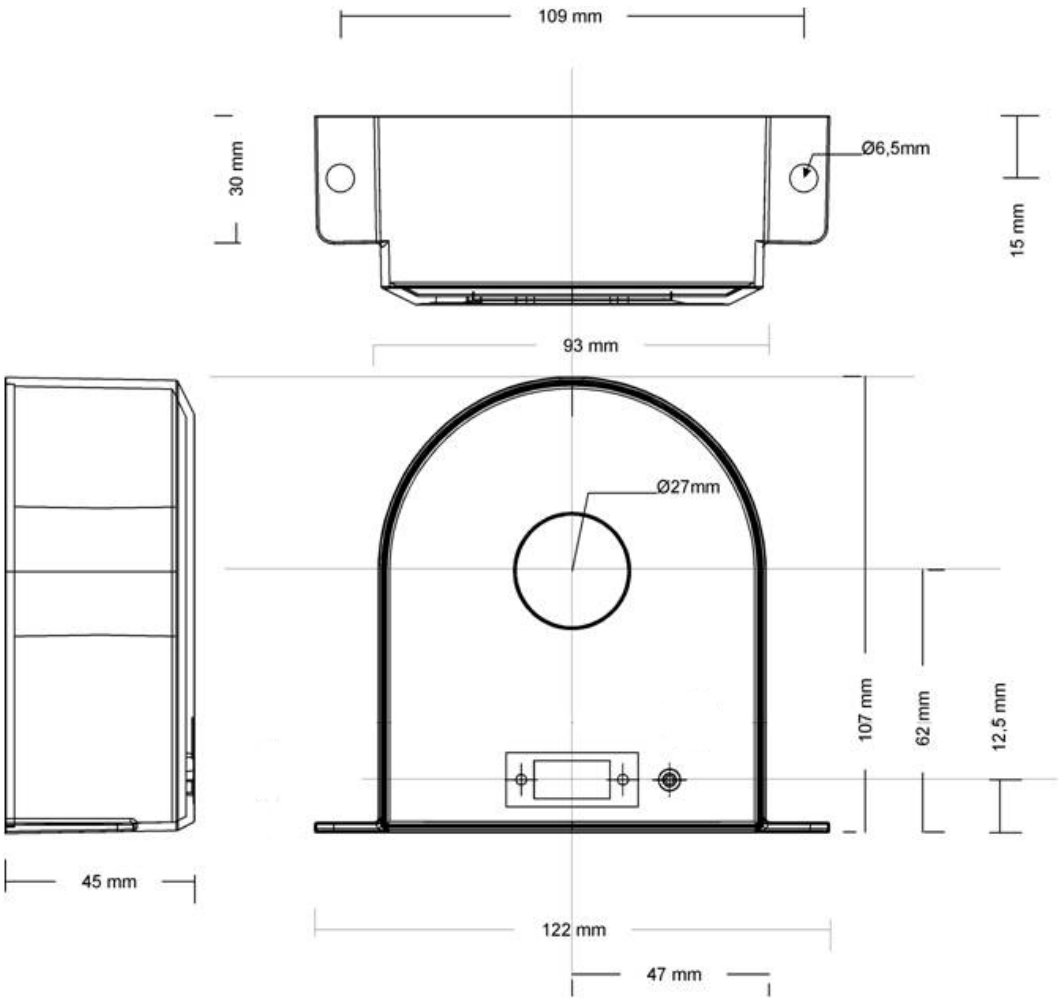


Figure 2.10: PCT600 mechanical dimensions

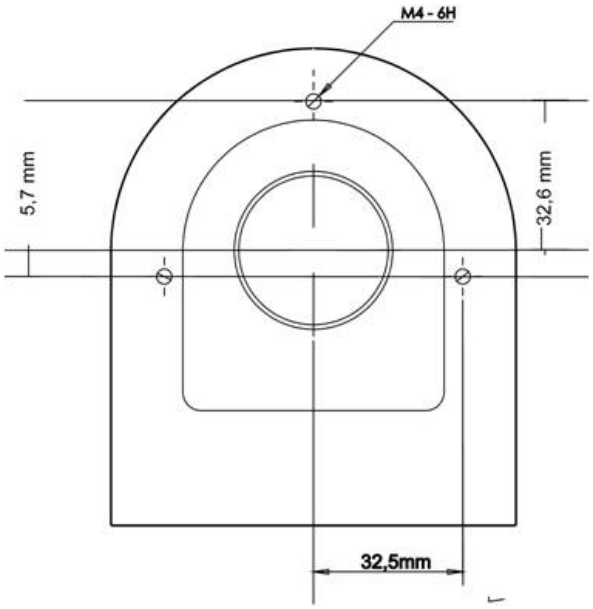


Figure 2.11: PCT600 mounting bushings on the back, maximum screw depth 6 mm

A contact free, closed loop, flux gate based current measurement sensor, developed to offer extreme linearity and full industrial temperature range. The sensor has an aluminium body for shielding against EMI.

2.2.1 Safety warnings

- Always connect the sensor first to the powermeter and afterwards to the device under test. Before connecting the sensor, turn off the powermeter! Do not hot-plug the sensor, see SYSTEM POWER-ON SEQUENCE [2.2.9→24].
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.2.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010
EMC	EN 61326-1

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.2.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.2.4 Specifications

Nominal input current rms	600 A
Maximum input current rms (depends on power meter and connection cable)	1000 A
Maximum input current peak (depends on power meter and connection cable)	1000 A
Transformation ratio	1500:1
Maximum input overload	4500 A, 100 ms, normal operation after overload 4500 A, 10 s, Sensor shut down but not damaged
Bandwidth (-3 dB, small signal 10 App)	500 kHz
Offset temperature coefficient	±0.1 ppm/K (refers to Maximum input current peak)
Burden	0 ... 3 Ω (if supplied with PCTSIU4 / PCTSIU4-1U and a PCT-DSUB connection cable up to 10 m length: the burden is defined as the resistance from the secondary output connectors of PCTSIU4 to the instrument)
Rated isolation voltage according to IEC 61010-1	600 V CAT II 300 V CAT III pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 3.6 kV 200 V
Impulse withstand voltage	9 kV
Creepage distance	10 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +65 °C (-40 °C ... +85 °C @ input current rms ≤ 650 A)
Storage temperature	-40 °C ... +85 °C
Weight	0.6 kg
Supply	±(15 V±0.75 V) 700 mA (Max. peak value 900 A) 770 mA (Max. peak value 1000 A)

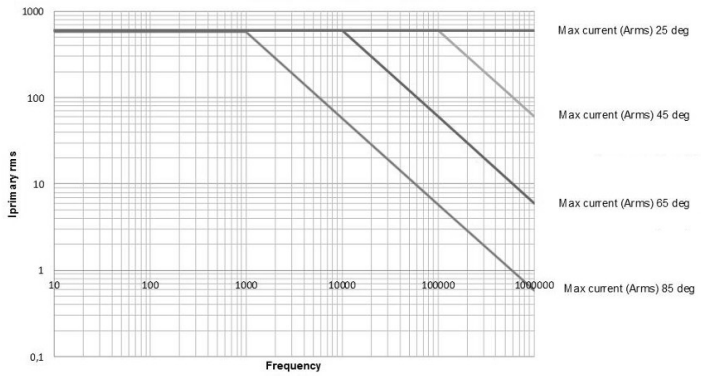


Figure 2.12: PCT600 temperature derating of input current vs. frequency and temperature

2.2.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Accuracy specification for amplitude in % of nominal input current rms	Accuracy specification for phase in °
DC	±0.0015 %	–
0.05 Hz ... 10 Hz	±0.0015 %	±0.03°
10 Hz ... 2 kHz	±0.01 %	±0.03°
2 kHz ... 10 kHz	±0.2 %	±0.04°
10 kHz ... 100 kHz	±2.5 %	±1°

See specification of the LMG connection cable for the LMG measuring ranges and to calculate the accuracy of the complete system.

2.2.6 Influence from the conductor centering

As a rule, the best accuracy is obtained when the conductor fills completely the hole of the current transducer. For a smaller conductor, it should be centered inside the hole of the current transducer.

In the test below, a small conductor with a diameter of 3 mm, carrying $I_{DC} = 15$ A is placed in the most unfavorable positions inside the hole of the current transducer.

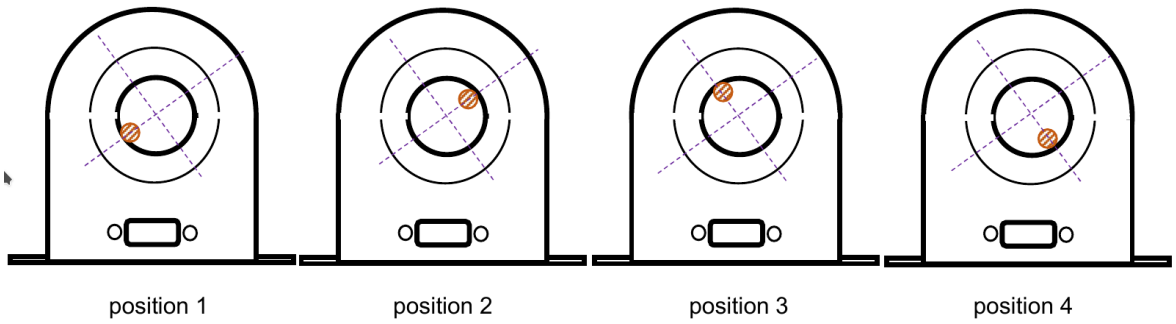


Figure 2.13: Influence from the conductor centering

Position	1	2	3	4
Error in ppm of reading	+4.2 ppm	+12.6 ppm	−14.3 ppm	+23.4 ppm

In this test, a very small cable is used which represents unfavorable case (partial saturation of the magnetic circuit on a very small area). If a larger cable is used, the influence of decentering of the conductor is less severe. Simulations show that the error due to the position of the cable inside the hole is less than ±100 ppm for every position, amplitude of the current and diameter of the conductor.

2.2.7 DSUB9 connector pin assignment of PCT600

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.2.8 Installation



Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT600 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT600 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT600 is also recommended to lead away capacitive coupled distortion.

For LMG600 use the connection cable 'PCT600-K-L6' or 'PCT600-K02-L6' and optionally the extension cable 'LMG-Z-SVT' or 'LMG-Z-DV'. For other instruments use the supply unit PCTSIU4 together with the connection cable PCT-DSUB between PCT600 and PCTSIU4.

Also if bare conductors can be used up to the above isolation voltages, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Use LMG connection cable and PCT with corresponding serial numbers!

2.2.9 System power-on sequence



Do not allow primary current without supply of the sensors! Even though the sensor is protected by an internal sensor protection circuit, the sensor will never start its normal operation with primary current applied before proper supplied.

1. ensure proper connection of the sensor with the power meter LMG
2. turn on the power meter LMG to ensure the supply of the sensor
3. wait until the normal operation status is signalized by the green LED
4. now start the measurements

2.2.10 Internal sensor protection circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current (less than 10 ppm).

2.2.11 Connection of the sensor PCT600 with LMG600

Use the connection cable 'PCT600-K-L6' or 'PCT600-K02-L6' and L60-X-ADSE, supply via LMG600.

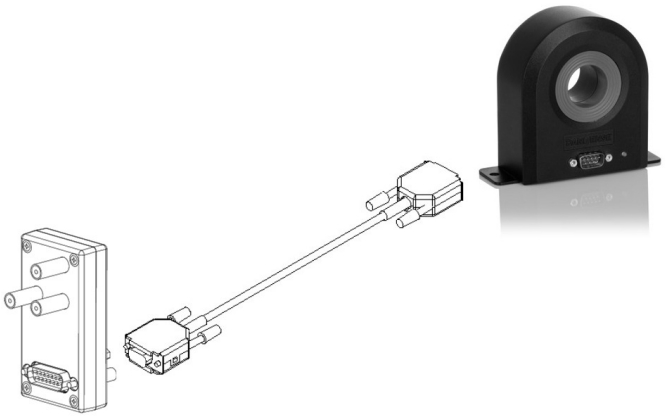


Figure 2.14: PCT600 and PCT600-K-L6 / PCT600-K02-L6 and L60-X-ADSE

The cable 'PCT600-K-L6' or 'PCT600-K02-L6' is used to connect the precision current transducer PCT600 to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the PCT600 head as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Supply current limitations
Due to the supply current limitations of the LMG640/641/670/671 only 6 PCT600 Sensors can be supplied by the LMG640/641/670/671 via PCT600-K02-L6 (Max. peak value 1000 A). Up to 7 PCT600 Sensors can be supplied by LMG640/641/670/671 via PCT600-K-L6 (Max. peak value 900 A).

Power meter	Connection cable	Max. peak value	Supply capability
LMG670/671	PCT600-K-L6	900 A	up to 7 Sensors
	PCT600-K2-L6	1000 A	up to 6 Sensors
LMG640/641	PCT600-K-L6	900 A	up to 4 Sensors
	PCT600-K2-L6	1000 A	up to 4 Sensors
LMG610	PCT600-K-L6	900 A	1 Sensor
	PCT600-K2-L6	1000 A	1 Sensor

PCT600-K-L6 and PCT600-K2-L6

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 female / DSUB15 male, knurled screw or locking screw
Operating temperature	+5 °C ... +40 °C
Cable length	2.5 m

Connection

- switch all power off
- plug the connector labeled 'Connect to PCT600 with SN xxx' to the sensor with SN xxx
- plug the connector labeled 'PCT600-K-L6' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges of LMG600 with PCT600 and PCT600-K-L6

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	7.5	15	30	60	120	225	450	600
Max. TRMS value / A	8.25	16.5	33	66	132	247.5	495	900
Max. peak value / A	21	42	84	168	336	703.5	900	900
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5

Power measurement channel L60-CH-S:

Nominal range AC / A	7.5	15	30	60	120	225	450
Nominal range DC / A	15	30	60	120	225	450	900
Max. TRMS value / A	16.5	31.5	63	126	240	480	900
Max. peak value / A	21	42	84	168	336	703.5	900
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407

Measuring ranges of LMG600 with PCT600 and PCT600-K02-L6

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	7.5	15	30	60	120	225	450	600
Max. TRMS value / A	8.25	16.5	33	66	132	247.5	495	1000
Max. peak value / A	21	42	84	168	336	703.5	1000	1000
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5

Power measurement channel L60-CH-S:

Nominal range AC / A	7.5	15	30	60	120	225	450	600
Nominal range DC / A	15	30	60	120	225	450	900	1000
Max. TRMS value / A	16.5	31.5	63	126	240	480	960	1000
Max. peak value / A	21	42	84	168	336	703.5	1000	1000
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5

Accuracy

Use PCT600 and LMG600 specifications to calculate the accuracy of the complete system. Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of PCT600-K-L6 with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

2.2.12 Connection of the sensor PCT600 with PCTSIU4

For the use of PCT600 with other instruments with current input and supply via PCTSIU4. Connect PCT600 with PCT-DSUB to PCTSIU4. Secondary current output at PCTSIU4 via two 4mm connectors.

2.2.13 Connection of the sensor PCT600 with SSU4

It is not recommended for new projects, but the sensor supply unit SSU4 can be used with modification for PSU60/200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.2.14 Connection of the sensor PCT600 with LMG95

Use PSU/PCT-K-L95, supply via LMG95, no additional error terms.

2.2.15 Connection of the sensor PCT600 with LMG450

Use PCT600-K-L45 and SSU4 (standard version).

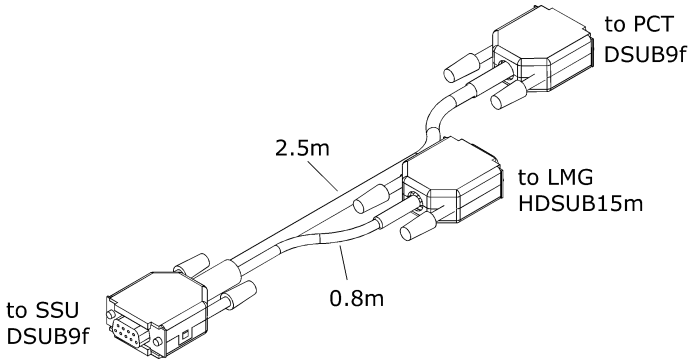


Figure 2.15: PCT600-K-L45

This cable 'PCT600-K-L45' is used to connect a precision current sensor PCT600 to the power meter LMG450 and to supply it by a sensor supply unit SSU4. Internal electronic of the connector to the LMG450 contains the adjustment data of the PCT600 head as well as the serial number. The rangenames of LMG450, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG450 with PCT600

Nominal range / A	18.7	37.5	75	150	300	600
Max. TRMS value / A	25	50	100	200	400	800
Max. peak value / A	28.125	56.25	112.5	225	450	900

Accuracy
Use PCT600 and LMG450 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±100 mA DC offset tolerance.

2.2.16 Connection of the sensor PCT600 with LMG500

Use PCT600-K-L50 and L50-Z14, supply via LMG500.

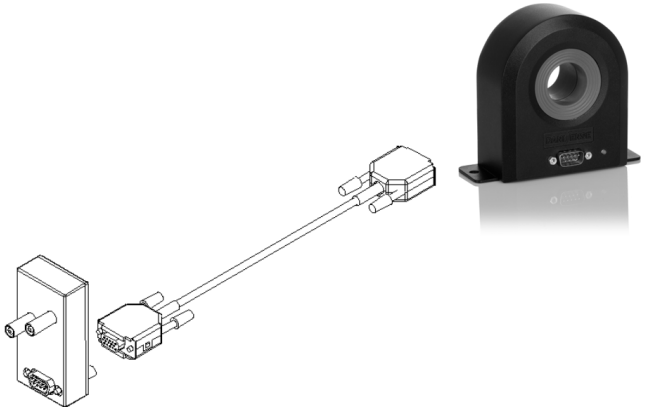


Figure 2.16: PCT600 and PCT600-K-L50 and L50-Z14

This cable 'PCT600-K-L50' is used to connect a precision current sensor PCT600 to the power meter LMG500 and to supply it internally by the LMG500. Internal electronic of the connector to the LMG500 contains the adjustment data of the PCT600 head as well as the serial number. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG500 with PCT600

Nominal range / A	4.5	9	18	37.5	75	150	300	600
Max. TRMS value / A	6.25	12.5	25	50	100	200	400	800
Max. peak value / A	7.031	14.063	28.125	56.25	112.5	225	450	900

Accuracy
Use PCT600 and LMG500 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±100 mA DC offset tolerance.

2.2.17 Connection extension

To use the current sensor with a larger connection length between power meter and PCT connect a well shielded extension cable between the PCT (DSUB9f plug) and the PCT connection cable (DSUB9m plug) and screw both plugs together. This extension cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.3 Precision current transducer 1200 A (PCT1200)



Figure 2.17: PCT1200

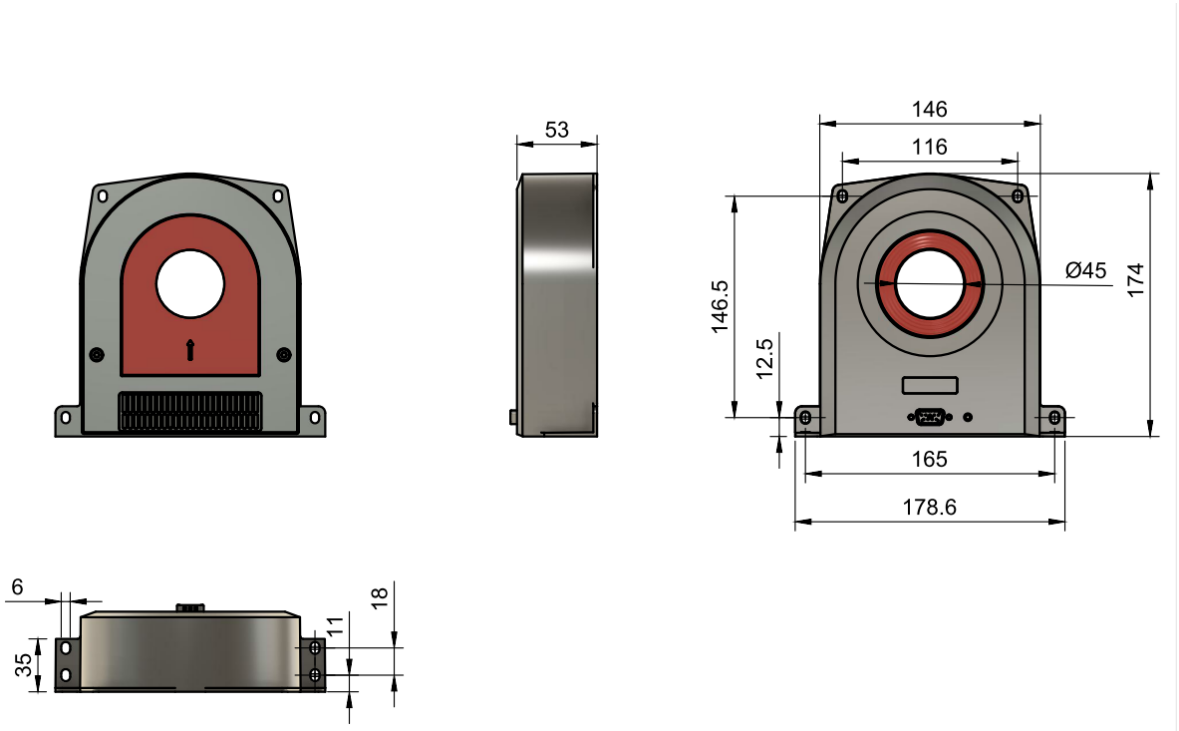


Figure 2.18: PCT1200 mechanical dimensions, all dimensions in mm, positive current direction is identified by an arrow on the transducer body

A contact free, closed loop, flux gate based current measurement sensor, developed to offer extreme linearity and full industrial temperature range. The sensor has an aluminium body for shielding against EMI.

2.3.1 Safety warnings



- Always connect the sensor first to the powermeter and afterwards to the device under test. Before connecting the sensor, turn off the powermeter! Do not hot-plug the sensor, see SYSTEM POWER-ON SEQUENCE [2.3.9→33].
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.3.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010
EMC	EN 61326-1



A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.3.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.3.4 Specifications

Nominal input current rms	1200 A
Maximum input current rms (depends on power meter and connection cable)	1500 A
Maximum input current peak (depends on power meter and connection cable)	1800 A
Transformation ratio	1500:1
Maximum input overload	5000 A, 100 ms, normal operation after overload
Bandwidth (-3 dB, small signal)	400 kHz
Offset temperature coefficient	±0.1 ppm/K (refers to Maximum input current peak)

Burden	0 ... 3 Ω (if supplied with PCTSIU4 / PCTSIU4-1U and a PCT-DSUB connection cable up to 10 m length: the burden is defined as the resistance from the secondary output connectors of PCTSIU4 to the instrument)
Rated isolation voltage according to IEC 61010-1	600 V CAT II 300 V CAT III pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 14.4 kV 200 V
Impulse withstand voltage	26.3 kV
Creepage distance	12 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +85 °C
Storage temperature	-40 °C ... +85 °C
Weight	1.5 kg
Supply	±(15 V±0.75 V) 1.33 A

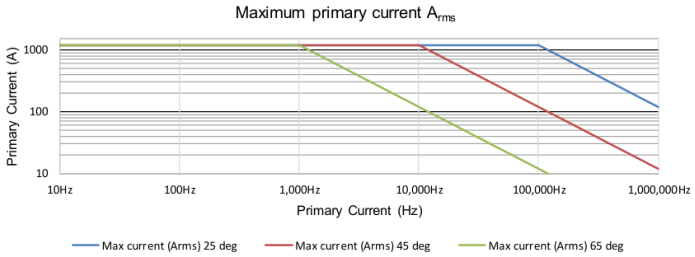


Figure 2.19: PCT1200 temperature derating of input current vs. frequency and temperature

2.3.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Accuracy specification for amplitude in % of nominal input current rms	Accuracy specification for phase in °
DC	±0.0015 %	–
0.05 Hz ... 10 Hz	±0.0015 %	±0.01°
10 Hz ... 3 kHz	±0.01 %	±0.01°
3 kHz ... 50 kHz	±1 %	±0.5°
50 kHz ... 300 kHz	±20 %	±10°

See specification of the LMG connection cable for the LMG measuring ranges and to calculate the accuracy of the complete system.

2.3.6 Influence from the conductor centering

As a rule, the best accuracy is obtained when the conductor fills completely the hole of the current transducer. For a smaller conductor, it should be centered inside the hole of the current transducer.

In the test below, a small conductor with a diameter of 3 mm, carrying $I_{DC} = 15\,A$ is placed in the most unfavorable positions inside the hole of the current transducer.

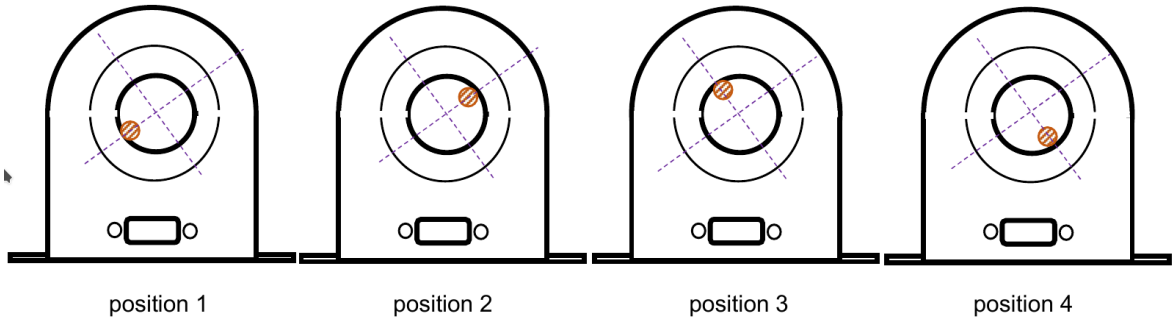


Figure 2.20: Influence from the conductor centering

Position	1	2	3	4
Error in ppm of reading	$\approx +4$ ppm	$\approx +12$ ppm	≈ -14 ppm	$\approx +23$ ppm

In this test, a very small cable is used which represents unfavorable case (partial saturation of the magnetic circuit on a very small area). If a larger cable is used, the influence of decentering of the conductor is less severe. Simulations show that the error due to the position of the cable inside the hole is less than ± 100 ppm for every position, amplitude of the current and diameter of the conductor.

2.3.7 DSUB9 connector pin assignment of PCT1200

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.3.8 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT1200 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT1200 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of

the 6.5 mm mounting holes. Grounding of the transducer head PCT1200 is also recommended to lead away capacitive coupled distortion.

For LMG600 use the connection cable 'PCT1200-K-L6' and optionally the extension cable 'LMG-Z-SVT' or 'LMG-Z-DV'. For other instruments use the supply unit PCTSIU4 together with the connection cable PCT-DSUB between PCT1200 and PCTSIU4.

Also if bare conductors can be used up to the above isolation voltages, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Use LMG connection cable and PCT with corresponding serial numbers!

Do not power up the device before all cables are connected!

2.3.9 System power-on sequence

Do not allow primary current without supply of the sensors! Even though the sensor is protected by an internal sensor protection circuit, the sensor will never start its normal operation with primary current applied before proper supplied.



1. ensure proper connection of the sensor with the power meter LMG
2. turn on the power meter LMG to ensure the supply of the sensor
3. wait until the normal operation status is signalized by the green LED
4. now start the measurements

2.3.10 Internal sensor protection circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current (less than 10 ppm).

2.3.11 Connection of the sensor PCT1200 with LMG600

Use the connection cable 'PCT1200-K-L6' and L60-X-ADSE, supply via LMG600.

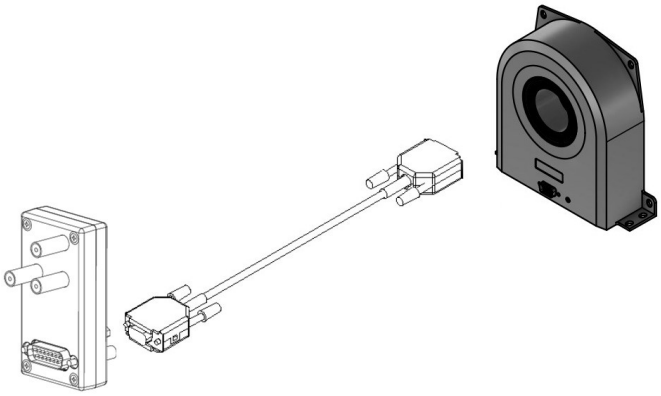


Figure 2.21: PCT1200 and PCT1200-K-L6 and L60-X-ADSE

The cable 'PCT1200-K-L6' is used to connect the precision current transducer PCT1200 to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the PCT1200 head as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Supply current limitations

Due to the supply current limitations of the LMG640/641/670/671 up to 3 PCT1200 Sensors can be supplied by the LMG640/641/670/671. For 4 or more PCT1200 Sensors, please use the external supply unit PCTSIU4 or PCTSIU4-1U.

Please regard the maximum supply current capability of the LMG, when connecting one or more PCT1200 together with other PCT to the same LMG!

Power meter	Supply current capability	Supply capability
LMG670/671	±5 A	up to 3 PCT1200
LMG640/641	±5 A	up to 3 PCT1200
LMG610	±1.33 A	1 PCT1200

PCT1200-K-L6

.

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 female / DSUB15 male, knurled screw or locking screw
Operating temperature	+5 °C ... +40 °C
Cable length	2.5 m

Connection

- switch all power off
- plug the connector labeled 'Connect to PCT1200 with SN xxx' to the sensor with SN xxx
- plug the connector labeled 'PCT1200-K-L6' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges of LMG600 with PCT1200 and PCT1200-K-L6

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	7.5	15	30	60	120	225	450	900	1200
Max. TRMS value / A	8.25	16.5	33	66	132	247.5	495	990	1500
Max. peak value / A	21	42	84	168	336	703.5	1407	1800	1800
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5	5625

Power measurement channel L60-CH-S:

Nominal range AC / A	7.5	15	30	60	120	225	450	900
Nominal range DC / A	15	30	60	120	225	450	900	1500
Max. TRMS value / A	16.5	31.5	63	126	240	480	960	1500
Max. peak value / A	21	42	84	168	336	703.5	1407	1800
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5

Accuracy

Use PCT1200 and LMG600 specifications to calculate the accuracy of the complete system. Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of PCT1200-K-L6 with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

2.3.12 Connection of the sensor PCT1200 with PCTSIU4

For the use of PCT1200 with other instruments with current input and supply via PCTSIU4. Connect PCT1200 with PCT-DSUB to PCTSIU4. Secondary current output at PCTSIU4 via two 4mm connectors.

2.3.13 Connection of the sensor PCT1200 with LMG95, LMG450 or LMG500

Use PCTSIU4 for the supply of PCT1200 and the current output at PCTSIU4 via two 4mm connectors to LMG95, LMG450 or LMG500.

2.3.14 Connection extension



To use the current sensor with a larger connection length between power meter and PCT connect a well shielded extension cable between the PCT (DSUB9f plug) and the PCT connection cable (DSUB9m plug) and screw both plugs together. This extension cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.4 Precision current transducer 2000 A (PCT2000)



Figure 2.22: PCT2000

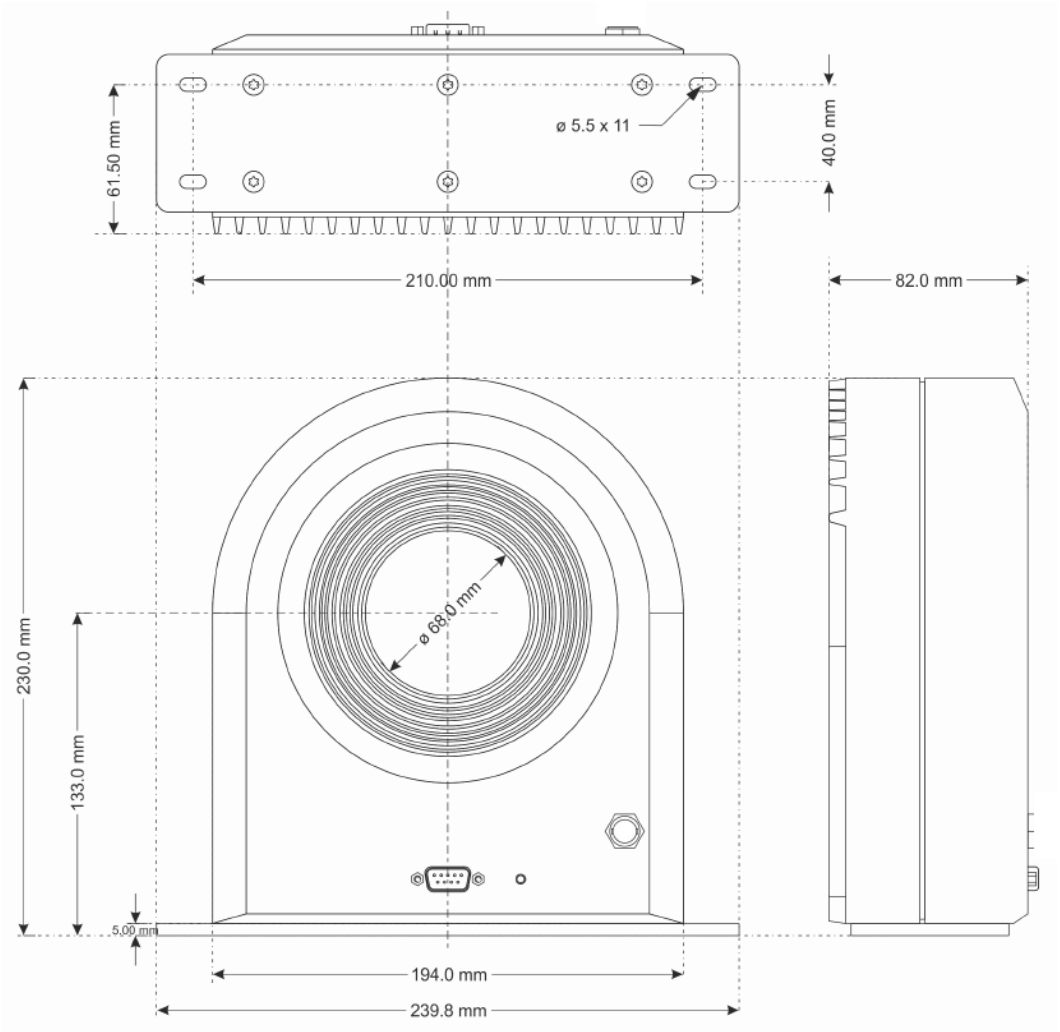


Figure 2.23: PCT2000 mechanical dimensions

A contact free, closed loop, flux gate based current measurement sensor, developed to offer extreme linearity and full industrial temperature range. The sensor has an aluminium body for shielding against EMI.

2.4.1 Safety warnings

- Always connect the sensor first to the powermeter and afterwards to the device under test. Before connecting the sensor, turn off the powermeter! Do not hot-plug the sensor, see SYSTEM POWER-ON SEQUENCE [2.4.9→40].
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.4.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010
EMC	EN 61326-1

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.4.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.4.4 Specifications

Nominal input current rms	2000 A
Maximum input current rms, AC	2000 A (please regard temperature derating)
Maximum input current rms, DC	3000 A
Maximum input current peak	3000 A
Transformation ratio	1500:1
Maximum input overload	10 kA (100 ms)
Bandwidth (-3 dB, small signal 10 App)	300 kHz
Offset temperature coefficient	±0.1 ppm/K (refers to Maximum input current peak)
Burden	0 ... 3 Ω (if supplied with PCTSIU4 / PCTSIU4-1U: the burden is defined as the resistance from the secondary output connectors of PCTSIU4 to the instrument)

Rated isolation voltage according to IEC 61010-1	1500 V CAT III pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 14.4 kV 200 V
Impulse withstand voltage	26.3 kV
Creepage distance	22 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +45 °C (-40 °C ... +65 °C @ input current rms ≤ 2650 A
Storage temperature	-40 °C ... +65 °C
Weight	6.5 kg
Supply	±(15 V±0.75 V) 2.19 A

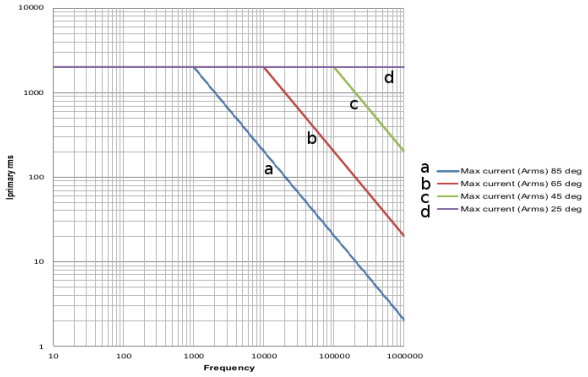


Figure 2.24: PCT2000 temperature derating of input current vs. frequency and temperature

2.4.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Accuracy specification for amplitude in % of nominal input current rms	Accuracy specification for phase in °
DC	±0.0007 %	–
0.05 Hz ... 10 Hz	±0.0007 %	±0.04°
10 Hz ... 2 kHz	±0.01 %	±0.04°
2 kHz ... 10 kHz	±1.5 %	±0.5°
10 kHz ... 100 kHz	±3 %	±3°

2.4.6 Influence from the conductor centering

As a rule, the best accuracy is obtained when the conductor fills completely the hole of the current transducer. For a smaller conductor, it should be centered inside the hole of the current transducer.

In the test below, a small conductor with a diameter of 3 mm, carrying $I_{DC} = 15$ A is placed in the most unfavorable positions inside the hole of the current transducer.

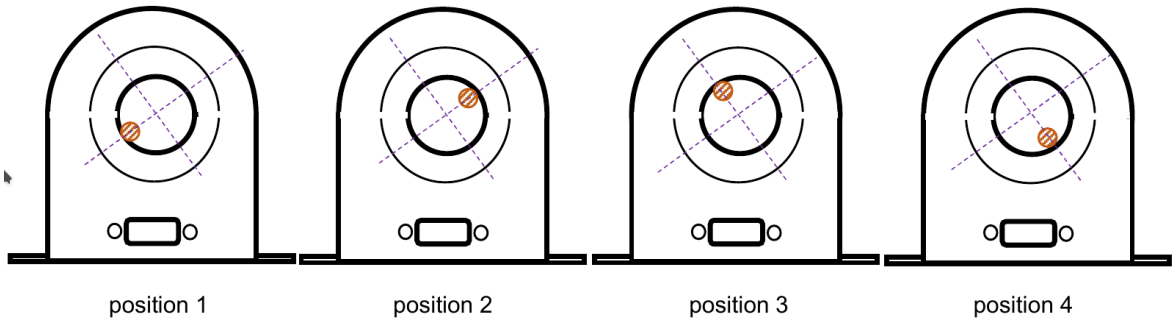


Figure 2.25: Influence from the conductor centering

Position	1	2	3	4
Error in ppm of reading	≈ +4 ppm	≈ +12 ppm	≈ −14 ppm	≈ +23 ppm

In this test, a very small cable is used which represents unfavorable case (partial saturation of the magnetic circuit on a very small area). If a larger cable is used, the influence of decentering of the conductor is less severe. Simulations show that the error due to the position of the cable inside the hole is less than ±100 ppm for every position, amplitude of the current and diameter of the conductor.

2.4.7 DSUB9 connector pin assignment of PCT2000

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.4.8 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT2000 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT2000 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the mounting holes. Grounding of the transducer head PCT2000 is also recommended to lead away capacitive coupled distortion.

For LMG600 use the connection cable 'PCT2000-K-L6' and optionally the extension cable 'LMG-Z-SVT' or 'LMG-Z-DV'. For other instruments use the supply unit PCTSIU4 together with the connection cable PCT-DSUB between PCT2000 and PCTSIU4.

Also if bare conductors can be used up to the above isolation voltages, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit

two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Use LMG connection cable and PCT with corresponding serial numbers!

Do not power up the device before all cables are connected!

2.4.9 System power-on sequence

Do not allow primary current without supply of the sensors! Even though the sensor is protected by an internal sensor protection circuit, the sensor will never start its normal operation with primary current applied before proper supplied.

1. ensure proper connection of the sensor with the PCTSIU4 and the power meter LMG
2. turn on the PCTSIU4 and the power meter LMG to ensure the supply of the sensor
3. wait until the normal operation status is signalized by the green LED
4. now start the measurements

2.4.10 Sensor without supply or open secondary circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current.

2.4.11 Connection of the sensor PCT2000 with LMG600

Use the connection cable 'PCT2000-K-L6' and L60-X-ADSE, supply via LMG600.

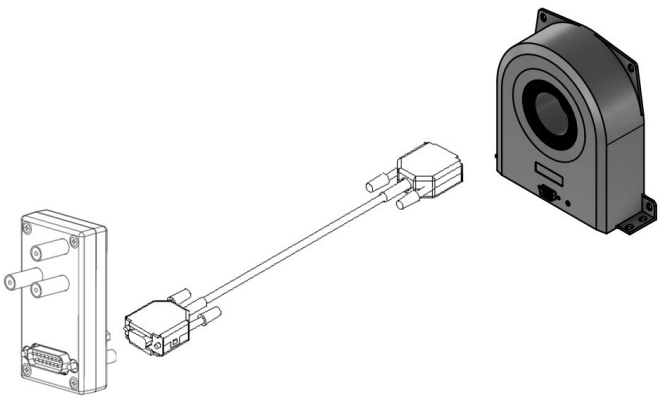


Figure 2.26: PCT2000 and PCT2000-K-L6 and L60-X-ADSE

The cable 'PCT2000-K-L6' is used to connect the precision current transducer PCT2000 to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the PCT2000 head as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Supply current limitations

Due to the supply current limitations of the LMG640/641/670/671 up to 2 PCT2000 Sensors can be supplied by the LMG640/641/670/671. For 3 or more PCT2000 Sensors, please use the external supply unit PCTSIU4 or PCTSIU4-1U.

Please regard the maximum supply current capability of the LMG, when connecting one or more PCT2000 together with other PCT to the same LMG!

Power meter	Supply current capability	Supply capability
LMG670/671	±5 A	up to 2 PCT2000
LMG640/641	±5 A	up to 2 PCT2000
LMG610/611	±1.33 A	supply of PCT2000 is not possible

PCT2000-K-L6

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 female / DSUB15 male, knurled screw or locking screw
Operating temperature	+5 °C ... +40 °C
Cable length	2.5 m

Connection

- switch all power off
- plug the connector labeled 'Connect to PCT2000 with SN xxx' to the sensor with SN xxx
- plug the connector labeled 'PCT2000-K-L6' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges of LMG600 with PCT2000 and PCT2000-K-L6

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	7.5	15	30	60	120	225	450	900	1800	2000
Max. TRMS value / A	8.25	16.5	33	66	132	247.5	495	990	1980	3000
Max. peak value / A	21	42	84	168	336	703.5	1407	2812.5	3000	3000
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5	5625	11250

Power measurement channel L60-CH-S:

Nominal range AC / A	7.5	15	30	60	120	225	450	900	1800
Nominal range DC / A	15	30	60	120	225	450	900	1800	3000
Max. TRMS value / A	16.5	31.5	63	126	240	480	960	1875	3000
Max. peak value / A	21	42	84	168	336	703.5	1407	2812.5	3000
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5	5625

Accuracy

Use PCT2000 and LMG600 specifications to calculate the accuracy of the complete system. Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of PCT2000-K-L6 with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

2.4.12 Connection of the sensor PCT2000 with PCTSIU4

For the use of PCT2000 with other instruments with current input and supply via PCTSIU4. Connect PCT2000 with PCT-DSUB to PCTSIU4. Secondary current output at PCTSIU4 via two 4mm connectors.

2.4.13 Connection of the sensor PCT2000 with LMG95, LMG450 or LMG500

Use PCTSIU4 for the supply of PCT2000 and the current output at PCTSIU4 via two 4mm connectors to LMG95, LMG450 or LMG500.

2.4.14 Connection extension



To use the current sensor with a larger connection length between power meter and PCT connect a well shielded extension cable between the PCT (DSUB9f plug) and the PCT connection cable (DSUB9m plug) and screw both plugs together. This extension cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.4.15 Included in delivery

- Precision current transducer 2000 A (PCT2000)
- PCT2000 User Manual
- Mounting Screw kit

2.5 Precision current transformer 1500 A (LMG-Z702)

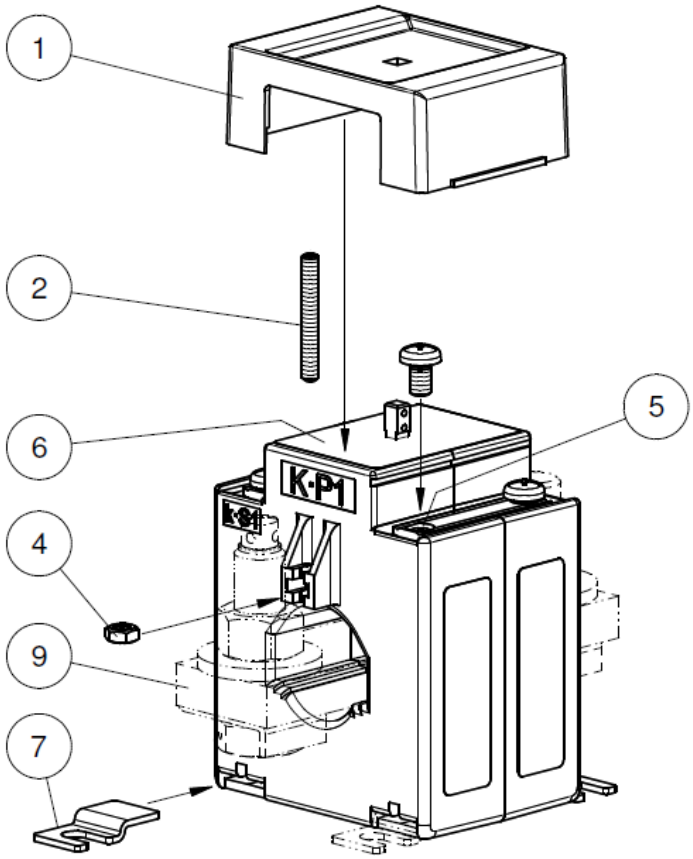


Figure 2.27: LMG-Z702 Drawing 3D

Description of Figure 2.27:

1 Secondary terminal cover, transparent and sealable

2 Primary conductor fixture: M4 x 40, slotted headless screw, **tightening torque max. 0.5 Nm**

3 -

4 Nut M4 for primary conductor fixture

5 Secondary terminals: M5, Terminal cross-sections max. 4 mm^2 (flexible) / 6 mm^2 (solid), **tightening torque max. 3.5 Nm**

6 Rating plate

7 Base fixture

8 -

9 Primary conductor

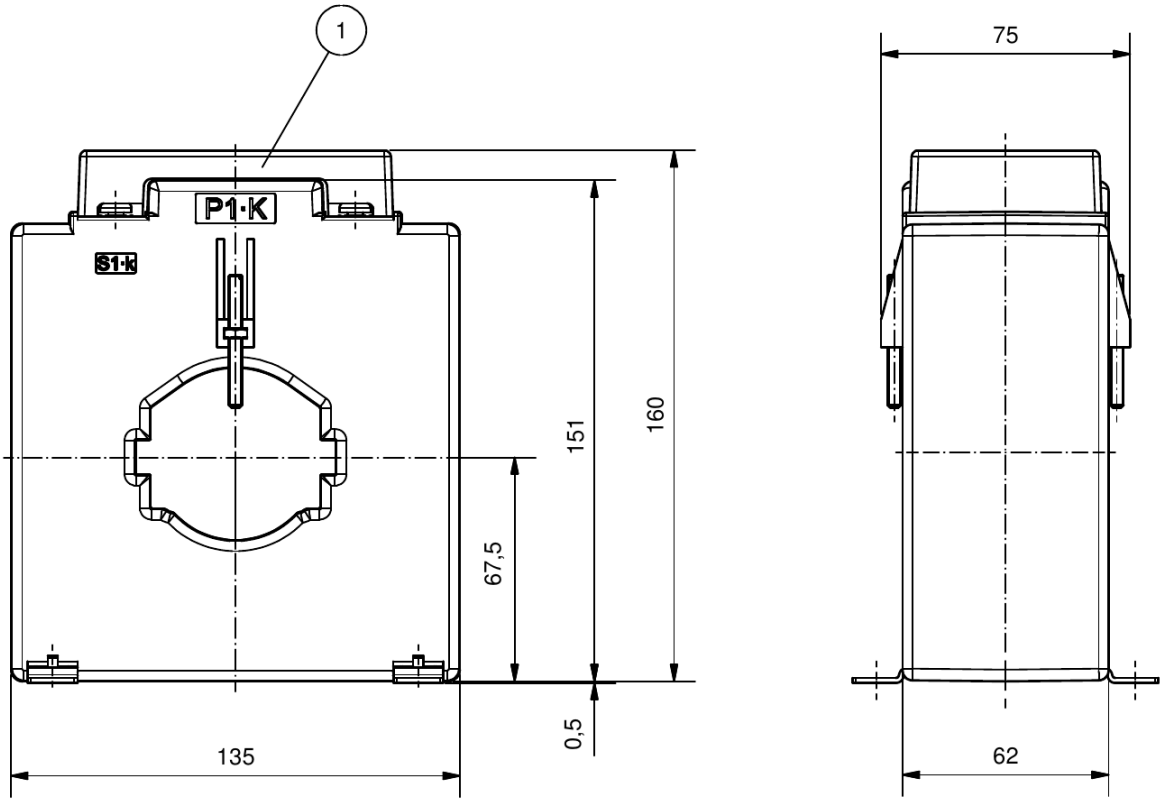


Figure 2.28: LMG-Z702 Technical drawing, Dimensions in mm

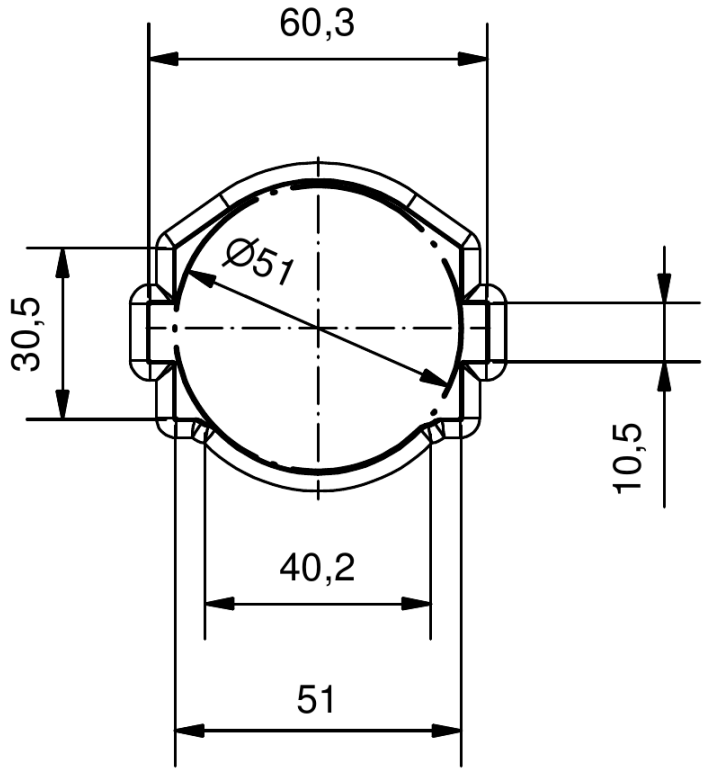


Figure 2.29: LMG-Z702 Opening for primary conductor, Dimensions in mm

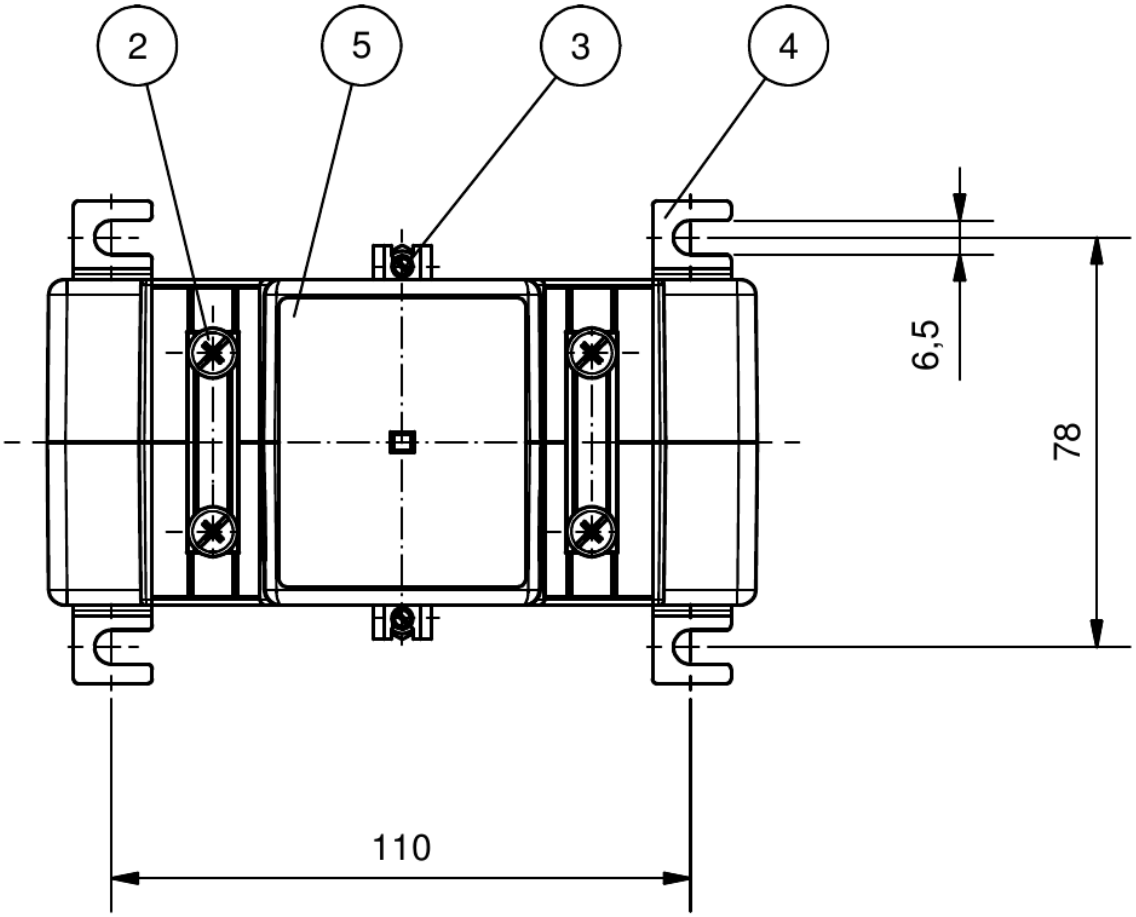


Figure 2.30: LMG-Z702 Topview, Dimensions in mm

Description of Figures 2.28, 2.29 and 2.30:

1 Secondary terminal cover, transparent and sealable

2 Secondary terminals, max. tightening torque see Figure 2.27

3 Primary conductor fixture, max. tightening torque see Figure 2.27

4 Mounting feet

5 Rating plate

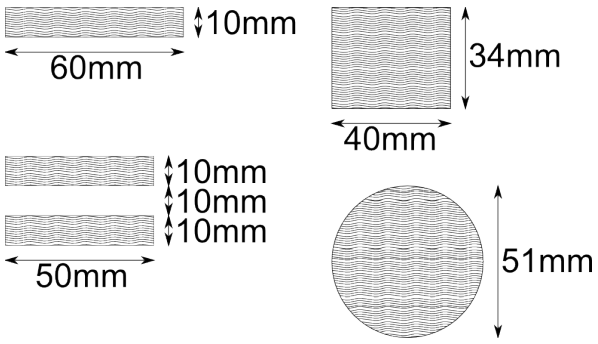


Figure 2.31: LMG-Z702 Suitable bus bars

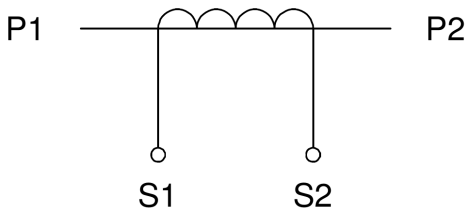


Figure 2.32: LMG-Z702 Connection diagram

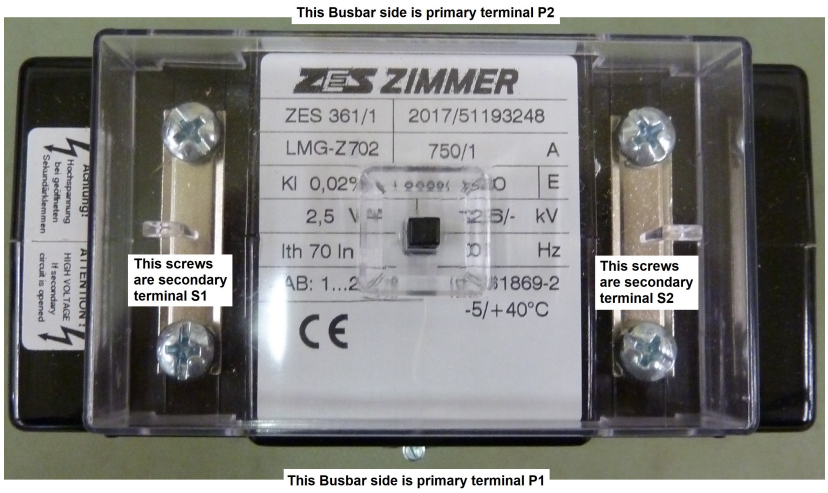


Figure 2.33: LMG-Z702 Topview with terminal identification

2.5.1 General

Window type current transformer in ring core design for indoor use. The low voltage current transformer works on the principle of the inductive transformer. The secondary side is galvanically separated from the primary side. The instrument transformer is used in switchgear, switching device combinations and power distribution systems in connection with secondary devices (relay, meter, indication instruments). Due to its excellent accuracy, it is perfect for precision power measurement devices. Refer to the rating plate on the device for the operational specifications.

2.5.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.5.3 Specifications

Measuring range (I_{rms}, continuous)	1500 A
Secondary current (I_{rms}, continuous)	2 A
Transformation ratio	750 : 1
Rated frequency	50 Hz

Bandwidth	20 Hz ... 500 Hz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Highest voltage for equipment (U_{m}) Test voltage	1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary current (I_{pr}) Rated secondary current (I_{sr}) Rated continuous thermal current (I_{cth}) Rated short-time thermal current (I_{th}, 1 s) Rated dynamic current (I_{dyn}) Instrument security factor (FS)	750 A 1 A 1500 A $70 \cdot I_{\mathrm{pr}}$ $2.5 \cdot I_{\mathrm{th}}$ 20
Phase-to-phase centre line distance	$\geq$ 135 mm
Place of application	Indoor up to 1000 m above sea level
Degree of pollution	2
Ambient temperature	Operation: −5 °C ... + 40 °C Storing: −5 °C ... + 40 °C
Insulation class	E
Housing degree of protection	IEC EN 60529, DIN VDE 0470-1 housing: IP50, terminals: IP20
Earthing	See DIN VDE 0100-557
Housing, terminal cover	Shock-resistant plastic housing of polycarbonate, hardly inflammable, self-extinguishing
Secondary terminals	Double connectors, nickel plated brass, combined headed screws of size M5 (max. 3.5 Nm), for wires up to 4 mm^2 (flexible) / 6 mm^2 (solid)
Dimensions	135 mm / 160 mm / 62 mm
Weight	2.5 kg

2.5.4 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature −5 °C ... + 40 °C, primary conductor in the middle of the transformer, total burden impedance and center distance between adjacent bus bars as specified. The current transformers shall be demagnetized before calibration according to IEC 61869-2.

Accuracy specifications at rated frequency		
Current	Amplitude ±(% of measuring value)	Phase ±(° typical)
7.5 A . . . 37.5 A	$\leq$ 0.02	$\leq$ 0.1°
37.5 A . . . 150 A	$\leq$ 0.02	$\leq$ 0.07°
150 A . . . 375 A	$\leq$ 0.02	$\leq$ 0.05°
375 A . . . 900 A	$\leq$ 0.02	$\leq$ 0.04°
900 A . . . 1500 A	$\leq$ 0.02	$\leq$ 0.05°

Typical frequency dependence based on simulation data	
Frequency	Accuracy specifications
20 Hz . . . 30 Hz	threefold the accuracy specifications for amplitude and phase
30 Hz . . . 50 Hz	twofold the accuracy specifications for amplitude and phase
50 Hz . . . 60 Hz	see table above
60 Hz . . . 200 Hz	twofold the accuracy specifications for amplitude and phase
200 Hz . . . 500 Hz	threefold the accuracy specifications for amplitude and phase

2.6 Precision current transformer 4000 A (LMG-Z742)

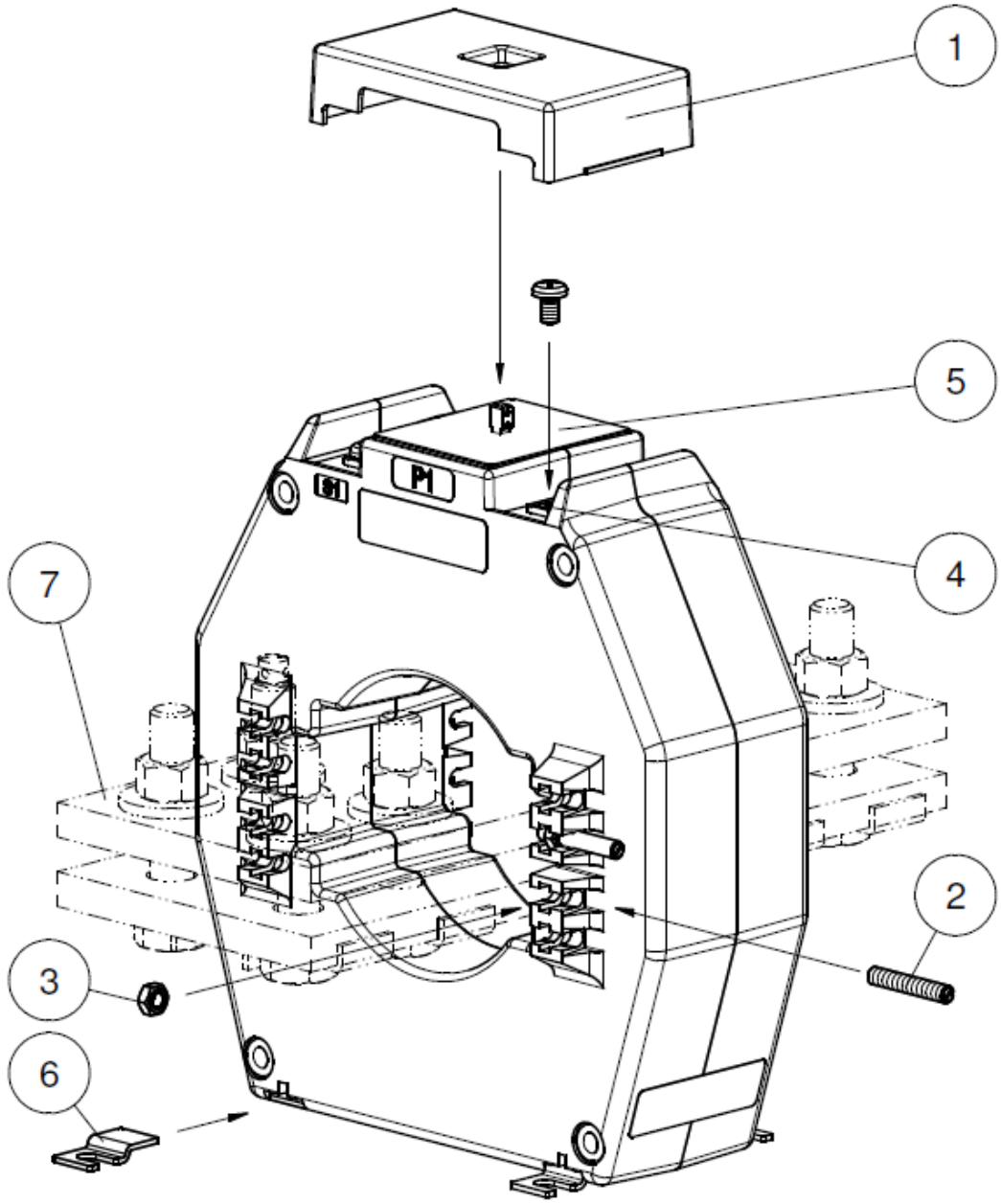


Figure 2.34: LMG-Z742 Drawing 3D

Description of Figure 2.34:

1 Secondary terminal cover, transparent and sealable

2 Primary conductor fixture: M5 x 30, slotted headless screw, **tightening torque max. 2 Nm**

3 Nut M5 for primary conductor fixture

4 Secondary terminals: M5, Terminal cross-sections max. 4 mm^2 (flexible) / 6 mm^2 (solid), **tightening torque max. 3.5 Nm**

5 Rating plate

6 Base fixture

7 Primary conductor

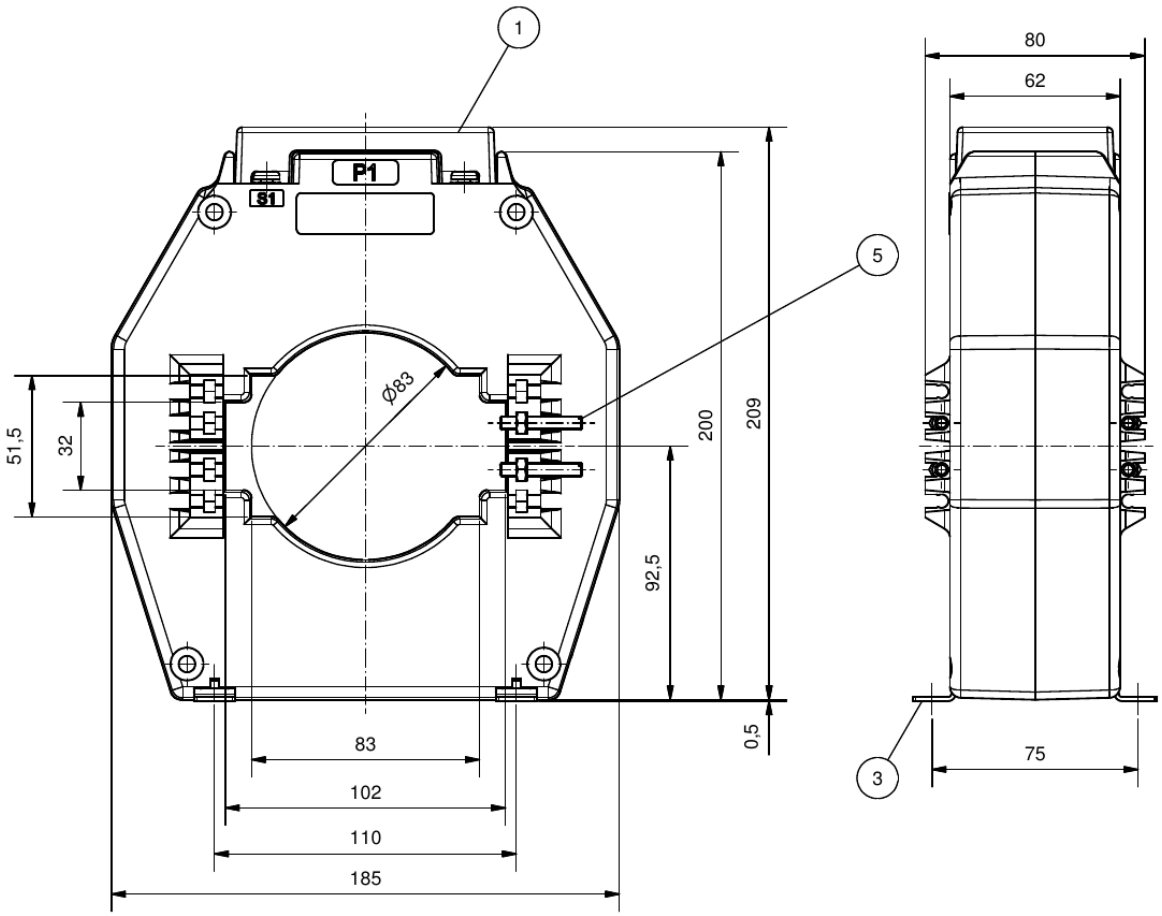


Figure 2.35: LMG-Z742 Technical drawing, Dimensions in mm

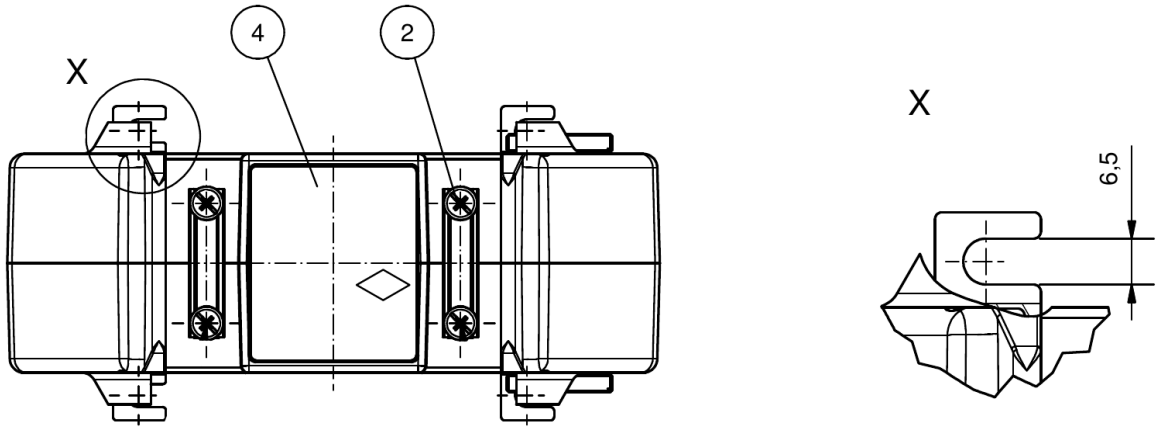


Figure 2.36: LMG-Z742 Topview, Dimensions in mm

Description of Figures 2.35 and 2.36:

1 Secondary terminal cover, transparent and sealable

2 Secondary terminals, max. tightening torque see Figure 2.34

3 Mounting feet

4 Rating plate

5 Primary conductor fixture, max. tightening torque see Figure 2.34

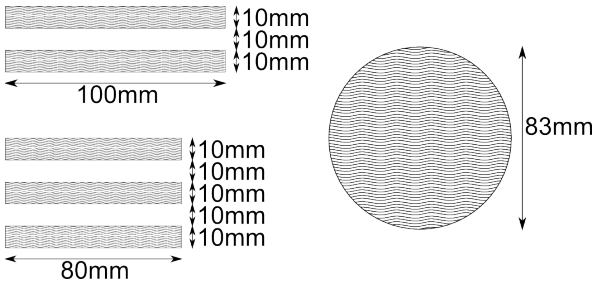


Figure 2.37: LMG-Z742 Suitable bus bars

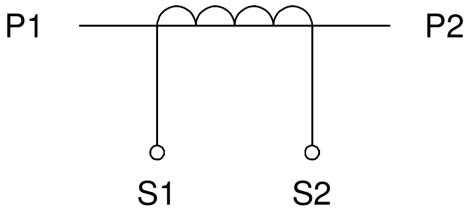


Figure 2.38: LMG-Z742 Connection diagram

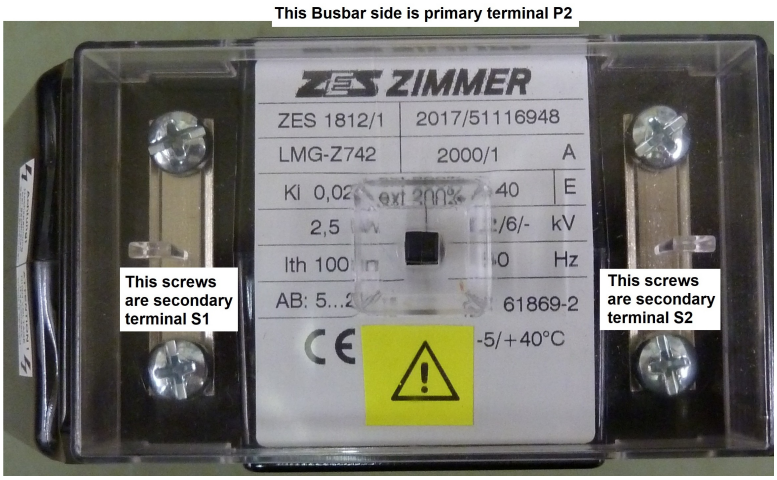


Figure 2.39: LMG-Z742 Topview with terminal identification

2.6.1 General

Window type current transformer in ring core design for indoor use. The low voltage current transformer works on the principle of the inductive transformer. The secondary side is galvanically separated from the primary side. The instrument transformer is used in switchgear, switching device combinations and power distribution systems in connection with secondary devices (relay, meter, indication instruments). Due to its excellent accuracy, it is perfect for precision power measurement devices. Refer to the rating plate on the device for the operational specifications.

2.6.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do

not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.6.3 Specifications

Measuring range (I_{rms}, continuous)	4000 A
Secondary current (I_{rms}, continuous)	2 A
Transformation ratio	2000 : 1
Rated frequency	50 Hz
Bandwidth	20 Hz ... 500 Hz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Highest voltage for equipment (U_m) Test voltage	1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary current (I_{pr}) Rated secondary current (I_{sr}) Rated continuous thermal current (I_{cth}) Rated short-time thermal current (I_{th}, 1 s) Rated dynamic current (I_{dyn}) Instrument security factor (FS)	2000 A 1 A 4000 A $100 \cdot I_{\mathrm{pr}}$ $2.5 \cdot I_{\mathrm{th}}$ 40
Phase-to-phase centre line distance	$\geq$ 185 mm
Place of application	Indoor up to 1000 m above sea level
Degree of pollution	2
Ambient temperature	Operation: −5 °C ... + 40 °C Storing: −5 °C ... + 40 °C
Insulation class	E
Housing degree of protection	IEC EN 60529, DIN VDE 0470-1 housing: IP50, terminals: IP20
Earthing	See DIN VDE 0100-557
Housing, terminal cover	Shock-resistant plastic housing of polycarbonate, hardly inflammable, self-extinguishing
Secondary terminals	Double connectors, nickel plated brass, combined headed screws of size M5 (max. 3.5 Nm), for wires up to 4 mm^2 (flexible) / 6 mm^2 (solid)
Dimensions	185 mm / 209 mm / 62 mm
Weight	3.3 kg

2.6.4 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature −5 °C ... + 40 °C, primary conductor in the middle of the transformer, total burden impedance and center distance between adjacent bus bars as specified. The current transformers shall be demagnetized before calibration according to IEC 61869-2.

Accuracy specifications at rated frequency		
Current	Amplitude ±(% of measuring value)	Phase ±(° typical)
100 A . . . 400 A	≤ 0.02	≤ 0.07°
400 A . . . 1000 A	≤ 0.02	≤ 0.05°
1000 A . . . 2400 A	≤ 0.02	≤ 0.04°
2400 A . . . 4000 A	≤ 0.02	≤ 0.05°

Typical frequency dependence based on simulation data	
Frequency	Accuracy specifications
20 Hz . . . 30 Hz	threefold the accuracy specifications for amplitude and phase
30 Hz . . . 50 Hz	twofold the accuracy specifications for amplitude and phase
50 Hz . . . 60 Hz	see table above
60 Hz . . . 200 Hz	twofold the accuracy specifications for amplitude and phase
200 Hz . . . 500 Hz	threefold the accuracy specifications for amplitude and phase

2.7 Precision current transformer 10 kA (LMG-Z762)

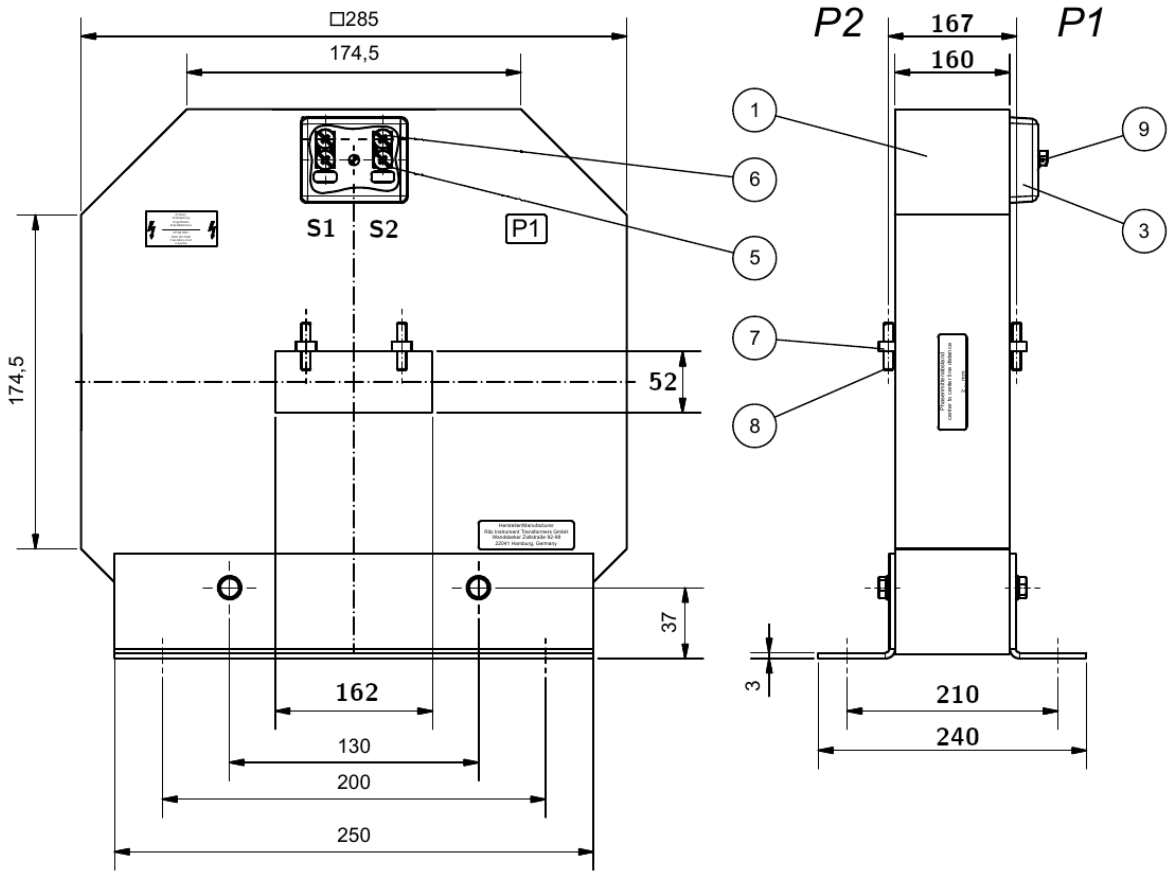


Figure 2.40: LMG-Z762 Technical drawing, Dimensions in mm

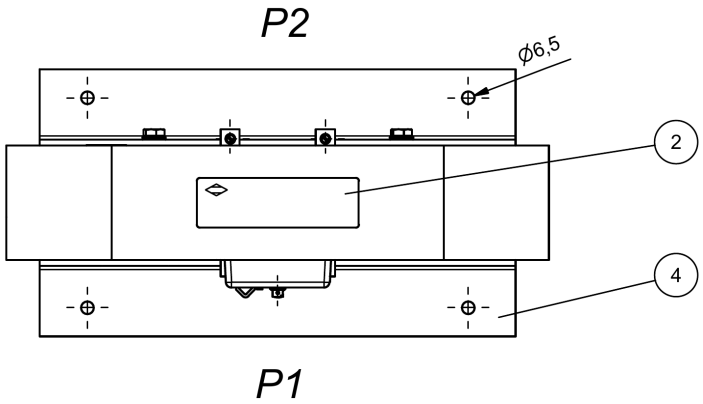


Figure 2.41: LMG-Z762 Topview, Dimensions in mm

Description of Figure 2.40 and 2.41:

1 Cast resin

2 Rating plate

3 Secondary terminal cover; transparent, PC

4 Mounting feet, stainless steel

5 Secondary terminal, brass nickel plated

6 Secondary terminals: M5, Terminal cross-sections max. 4 mm² (flexible) / 6 mm² (solid), **tightening torque max. 3.5 Nm**

7 Fixing of primary conductor, steel

8 Primary conductor fixture: M5, slotted headless screw, **tightening torque max. 2.5 Nm**

9 Screw for secondary terminal cover M3, PA, **tightening torque max. 0.1 Nm**

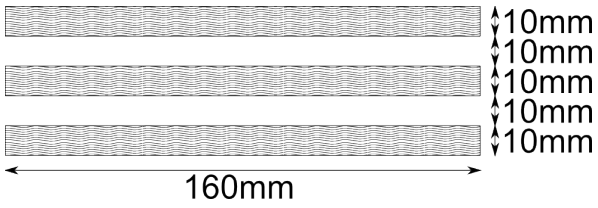


Figure 2.42: LMG-Z762 Suitable bus bars

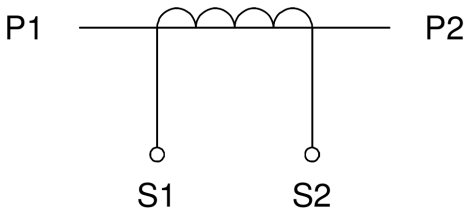


Figure 2.43: LMG-Z762 Connection diagram

2.7.1 General

Window type current transformer in ring core design for indoor use. The low voltage current transformer works on the principle of the inductive transformer. The secondary side is galvanically separated from the primary side. The instrument transformer is used in switchgear, switching device combinations and power distribution systems in connection with secondary devices (relay, meter, indication instruments). Due to its excellent accuracy, it is perfect for precision power measurement devices. Refer to the rating plate on the device for the operational specifications.

2.7.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.7.3 Specifications

Measuring range (I_{rms}, continuous)	10 kA
Secondary current (I_{rms}, continuous)	2 A
Transformation ratio	5000 : 1
Rated frequency	50 Hz
Bandwidth	20 Hz ... 500 Hz

Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Highest voltage for equipment (U_m) Test voltage	1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary current (I_{pr}) Rated secondary current (I_{sr}) Rated continuous thermal current (I_{cth}) Rated short-time thermal current (I_{th}, 1 s) Rated dynamic current (I_{dyn}) Instrument security factor (FS)	5000 A 1 A 10 kA $100 \cdot I_{pr}$ $2.5 \cdot I_{th}$ 55
Phase-to-phase centre line distance	≥ 285 mm
Place of application	Indoor up to 1000 m above sea level
Degree of pollution	2
Ambient temperature	Operation: −5 °C ... + 40 °C Storing: −5 °C ... + 40 °C
Insulation class	E
Housing degree of protection	IEC EN 60529, DIN VDE 0470-1 housing: IP50, terminals: IP20
Earthing	See DIN VDE 0100-557
Housing, terminal cover	Housing: Polyurethane cast resin, Terminal cover: Polycarbonate, hardly inflammable, self-extinguishing
Secondary terminals	Double connectors, nickel plated brass, combined headed screws of size M5 (max. 3.5 Nm), for wires up to 4 mm^2 (flexible) / 6 mm^2 (solid)
Dimensions	285 mm / 285 mm / 167 mm
Weight	32 kg

2.7.4 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature −5 °C ... + 40 °C, primary conductor in the middle of the transformer, total burden impedance and center distance between adjacent bus bars as specified. The current transformers shall be demagnetized before calibration according to IEC 61869-2.

Accuracy specifications at rated frequency		
Current	Amplitude ±(% of measuring value)	Phase ±(° typical)
50 A ... 250 A	≤ 0.02	≤ 0.1°
250 A ... 1000 A	≤ 0.02	≤ 0.07°
1000 A ... 2500 A	≤ 0.02	≤ 0.05°
2500 A ... 6000 A	≤ 0.02	≤ 0.04°
6000 A ... 10 kA	≤ 0.02	≤ 0.05°

Typical frequency dependence based on simulation data	
Frequency	Accuracy specifications
20 Hz ... 30 Hz	threefold the accuracy specifications for amplitude and phase
30 Hz ... 50 Hz	twofold the accuracy specifications for amplitude and phase
50 Hz ... 60 Hz	see table above
60 Hz ... 200 Hz	twofold the accuracy specifications for amplitude and phase
200 Hz ... 500 Hz	threefold the accuracy specifications for amplitude and phase

2.8 Precision current transformer 10 kA (LMG-Z782)

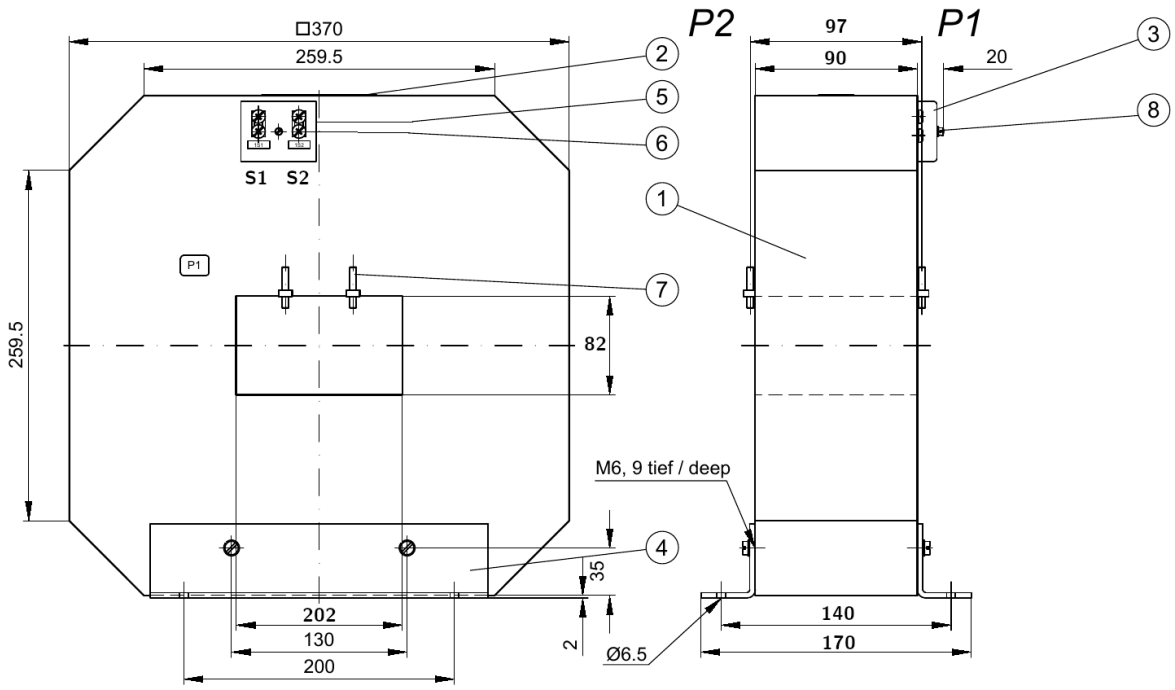


Figure 2.44: LMG-Z782 Technical drawing, Dimensions in mm

Description of Figure 2.44:

1 Cast resin

2 Rating plate

3 Secondary terminal cover; transparent, PC

4 Mounting feet, stainless steel

5 Secondary terminal, brass nickel plated

6 Secondary terminals: M5, Terminal cross-sections max. 4 mm^2 (flexible) / 6 mm^2 (solid), **tightening torque max. 3.5 Nm**

7 Primary conductor fixture: M5, slotted headless screw, **tightening torque max. 2.5 Nm**

8 Screw for secondary terminal cover M3, PA, **tightening torque max. 0.1 Nm**

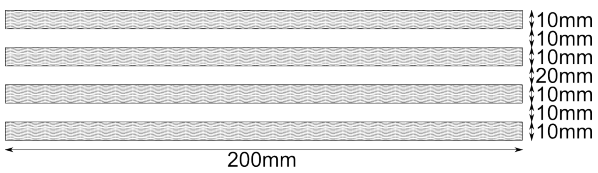


Figure 2.45: LMG-Z782 Suitable bus bars

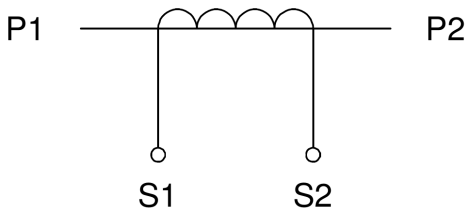


Figure 2.46: LMG-Z782 Connection diagram

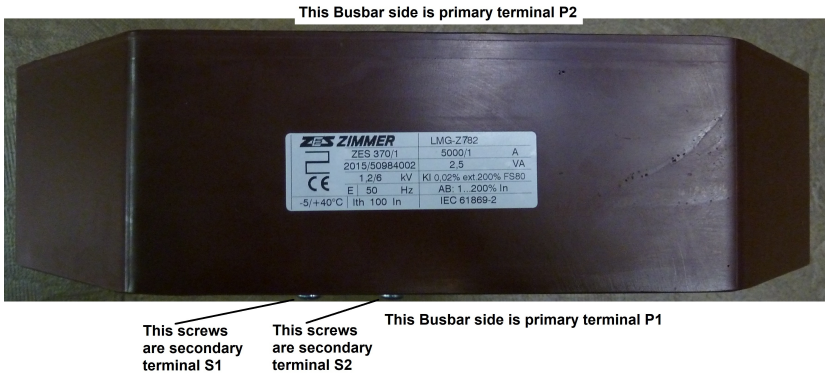


Figure 2.47: LMG-Z782 Topview with terminal identification

2.8.1 General

Window type current transformer in ring core design for indoor use. The low voltage current transformer works on the principle of the inductive transformer. The secondary side is galvanically separated from the primary side. The instrument transformer is used in switchgear, switching device combinations and power distribution systems in connection with secondary devices (relay, meter, indication instruments). Due to its excellent accuracy, it is perfect for precision power measurement devices. Refer to the rating plate on the device for the operational specifications.

2.8.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.8.3 Specifications

Measuring range (I_{rms}, continuous)	10 kA
Secondary current (I_{rms}, continuous)	2 A
Transformation ratio	5000 : 1
Rated frequency	50 Hz
Bandwidth	20 Hz ... 500 Hz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Highest voltage for equipment (U_{m}) Test voltage	1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min

Rated primary current (I_{pr}) Rated secondary current (I_{sr}) Rated continuous thermal current (I_{cth}) Rated short-time thermal current (I_{th}, 1 s) Rated dynamic current (I_{dyn}) Instrument security factor (FS)	5000 A 1 A 10 kA $80 \cdot I_{\mathrm{pr}}$ $2.5 \cdot I_{\mathrm{th}}$ 80
Phase-to-phase centre line distance	≥ 370 mm
Place of application	Indoor up to 1000 m above sea level
Degree of pollution	2
Ambient temperature	Operation: -5 °C ... $+40$ °C Storing: -5 °C ... $+40$ °C
Insulation class	E
Housing degree of protection	IEC EN 60529, DIN VDE 0470-1 housing: IP50, terminals: IP20
Earthing	See DIN VDE 0100-557
Housing, terminal cover	Housing: Polyurethane cast resin, Terminal cover: Polycarbonate, hardly inflammable, self-extinguishing
Secondary terminals	Double connectors, nickel plated brass, combined headed screws of size M5 (max. 3.5 Nm), for wires up to 4 mm^2 (flexible) / 6 mm^2 (solid)
Dimensions	370 mm / 370 mm / 97 mm
Weight	23 kg

2.8.4 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature -5 °C ... $+40$ °C, primary conductor in the middle of the transformer, total burden impedance and center distance between adjacent bus bars as specified. The current transformers shall be demagnetized before calibration according to IEC 61869-2.

Accuracy specifications at rated frequency		
Current	Amplitude ±(% of measuring value)	Phase ±(° typical)
50 A ... 250 A	≤ 0.02	$\leq 0.1°$
250 A ... 1000 A	≤ 0.02	$\leq 0.07°$
1000 A ... 2500 A	≤ 0.02	$\leq 0.05°$
2500 A ... 6000 A	≤ 0.02	$\leq 0.04°$
6000 A ... 10 kA	≤ 0.02	$\leq 0.05°$

Typical frequency dependence based on simulation data	
Frequency	Accuracy specifications
20 Hz ... 30 Hz	threefold the accuracy specifications for amplitude and phase
30 Hz ... 50 Hz	twofold the accuracy specifications for amplitude and phase
50 Hz ... 60 Hz	see table above
60 Hz ... 200 Hz	twofold the accuracy specifications for amplitude and phase
200 Hz ... 500 Hz	threefold the accuracy specifications for amplitude and phase

2.9 Active error compensated AC current clamp 40 A (L60-Z406)

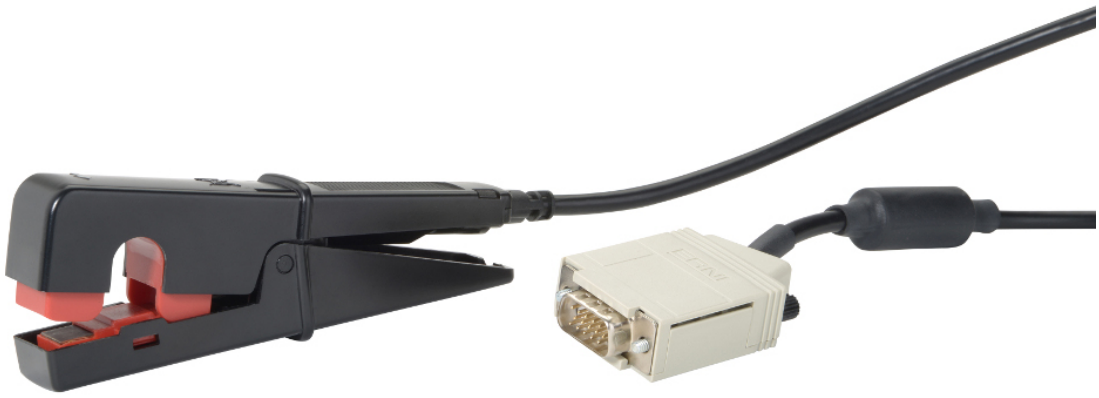


Figure 2.48: L60-Z406

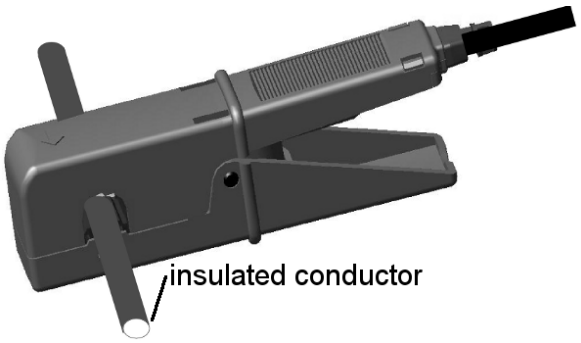


Figure 2.49: L60-Z406

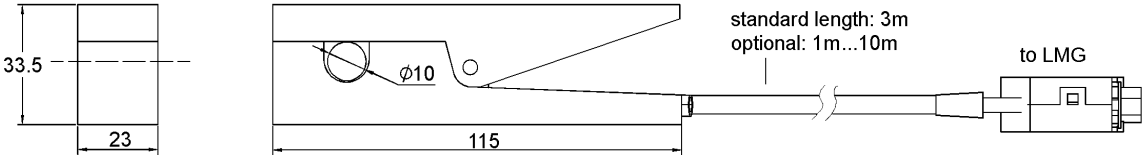


Figure 2.50: Dimensions of L60-Z406

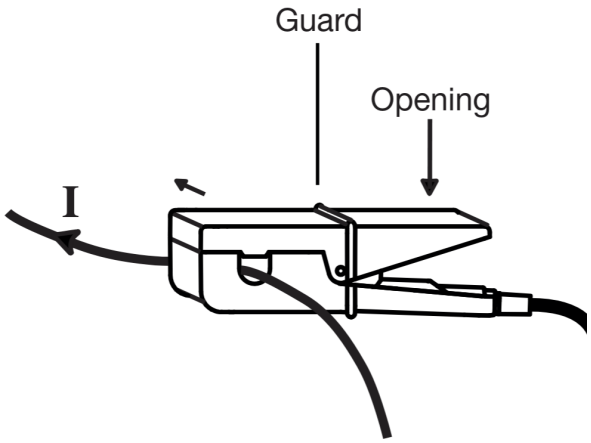


Figure 2.51: L60-Z406 actuator

2.9.1 Safety warnings

- No safety isolation, measurements only at insulated conductors allowed!
- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Keep the clamp away from water and other liquids.
- Keep the clamp jaws as clean as possible.
- Always check the condition of the case and leads before use.
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.9.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN IEC 61010-1, EN IEC 61010-2-032

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.9.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do

not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.9.4 Intended use

- Connect the clamp to the LMG600 using L60-X-ADSE for current measurement.
- Use appropriate means of protection. If the clamp is used in circuits above 30 Vrms, ensure that the cunductor has double insulation rated for the applicable voltage.
- When opening the clamp, press on the side of the lead and take care not to allow your hand past the guard barrier. Close the jaws around the conductor, respecting the current direction (the engraved arrow on the jaws of the clamp).
- Ensure that the clamp jaws are fully closed and that no foreign bodies are caught within.
- The current clamp must only be used in the specified frequency range.

2.9.5 Specifications

Nominal input current	40 A
Measuring range	66 A / 120 Apk
Maximum input overload	500 A for 1 s
Bandwidth	5 Hz ... 50 kHz
Isolation	max. 30 Vrms with uninsulated conductors >30 Vrms possible with double insulated conductors, rated for the applicable voltage
Degree of pollution	2
Temperature range	-10 °C ... +50 °C
Weight	120 g
Supply	100 mA
Output connection	3 m fixed lead with DSUB15 plug to LMG, optional: 1 m ... 10 m (only at initial order, not retro fitable), knurled screw or locking screw

With its high basic accuracy, the lower cut-off frequency of 5 Hz and the upper cut-off frequency of 50 kHz this clamp fits best for measurements at frequency inverter output. The internal error compensation circuit is designed especial for this application.

2.9.6 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp. The values are in ±(% of measuring value + % of measuring range peak) and in ±(phase error in degree)

Influence of coupling mode: This current clamp can measure only AC currents. DC offset could cause additional errors. Therefore this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

Frequency	5 Hz to 10 Hz	10 Hz to 45 Hz	45 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 20 kHz	20 kHz to 50 kHz
Accuracy specification for amplitude	1.5 + 0.25	0.4 + 0.15	0.15 + 0.05	0.3 + 0.15	1 + 0.25	4 + 0.5
Accuracy specification for the phase	6°	3°	0.5°	2°	6°	20°

2.9.7 Connection of the current clamp L60-Z406 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z406 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z406

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	0.9	1.8	3.75	7.5	15	30	40
Max. TRMS value / A	0.99	1.98	4.125	8.25	16.5	33	66
Max. peak value / A	2.9295	5.859	11.7195	23.445	46.875	93.75	120
Range peak value for accuracy calculation / A	2.9295	5.859	11.7195	23.445	46.875	93.75	187.5

Power measurement channel L60-CH-S:

Nominal range AC / A	0.9	1.8	3.75	7.5	15	30	40
Nominal range DC / A	2.25	4.5	9	18	37.5	75	80
Max. TRMS value / A	2.4	4.8	9.75	19.5	41.25	80	80
Max. peak value / A	2.9295	5.859	11.7195	23.445	46.875	93.75	120
Range peak value for accuracy calculation / A	2.9295	5.859	11.7195	23.445	46.875	93.75	187.5

Accuracy

Use L60-Z406 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of L60-Z406 with Isensor and I, please use the LMG600 accuracy specifications for the current sensor input.

2.10 Error compensated AC current clamp 1000 A (L60-Z60)



Figure 2.52: L60-Z60

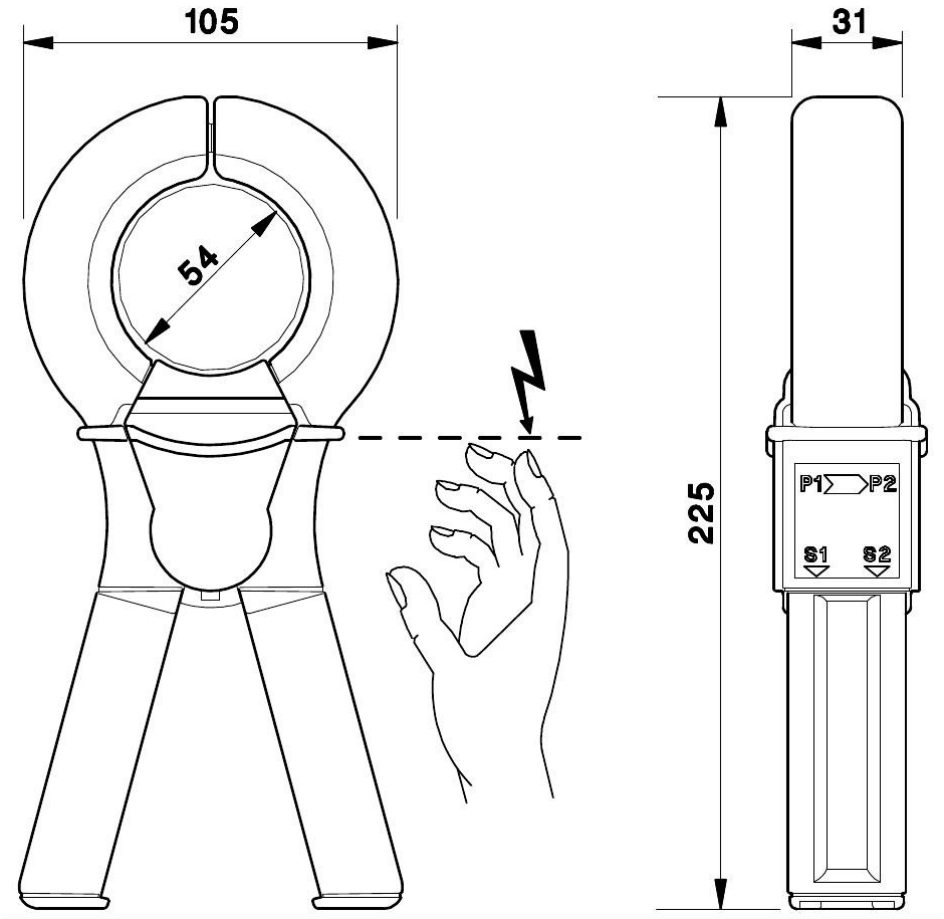


Figure 2.53: Dimensions in mm and protection against electric shock

2.10.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- For protection against electric shock please refer to Figure 2.53 [→64]
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Use of the probe on uninsulated conductors is limited to 600 V and frequencies below 1 kHz
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.10.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	IEC 61010-1:2010, IEC 61010-2-032:2012, IEC 61010-2-031:2008
EMC	EN 61326:1998

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.10.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.10.4 Specifications

Nominal input current	1000 A
Measuring range	1200 A / 3000 Apk
Maximum input overload	1200 A continuous, 2000 A for 5 min./h @ +20 °C
Bandwidth, -3 dB	10 Hz ... 10 kHz
Temperature coefficient	±0.01 % / °C
Conductor position sensitivity	±0.1 % at 50 Hz
Measurement category	600 V, CAT III
Degree of pollution	2
max. current above 1 kHz	1000 A / f[kHz]
Operating temperature range	-10 °C ... +55 °C

Operating humidity	15 % ... 85 % (non condensing)
Storage temperature range	-40 °C ... +70 °C
Weight	650 g
Output connection	1.7 m fixed lead with DSUB15 plug to LMG, optional: 1 m ... 10 m, knurled screw or locking screw

2.10.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, signal frequency: 48 Hz ... 65 Hz, ambient temperature +22 °C±4 °C, humidity: 20 % to 75 %, DC current: none, DC magnetic field: 40 A/m earth's magnetic field, AC magnetic field: none, proximity of external conductor: none, calibration interval of 1 year, primary conductor: centered in the middle of the clamp.

Current	Accuracy specification for amplitude in % of measuring value	Accuracy specification for phase in °
0.1 A ... 1 A	±2 %	±1°
1 A ... 100 A	±1 %	±0.5°
100 A ... 1000 A	±0.5 %	±0.5°

Use L60-Z60 and LMG specifications to calculate the accuracy of the complete system.

Influence of coupling mode: This current clamp can measure only AC currents. DC offset could cause additional errors. Therefore this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

2.10.6 Connection of the current clamp L60-Z60 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z60 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z60

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	5	10	20	40	80	150	300	600	1000
Max. TRMS value / A	5.5	11	22	44	88	165	330	660	1200
Max. peak value / A	14	28	56	112	224	469	938	1875	3000
Range peak value for accuracy calculation / A	14	28	56	112	224	469	938	1875	3750

Power measurement channel L60-CH-S:

Nominal range AC / A	5	10	20	40	80	150	300	600	1000
Nominal range DC / A	10	20	40	80	150	300	600	900	1200
Max. TRMS value / A	11	21	42	84	160	320	640	1200	1200
Max. peak value / A	14	28	56	112	224	469	938	1875	3000
Range peak value for accuracy calculation / A	14	28	56	112	224	469	938	1875	3750

Accuracy

Use L60-Z60 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of L60-Z60 with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

2.11 Error compensated AC current clamp 3000 A (L60-Z66)



Figure 2.54: L60-Z66

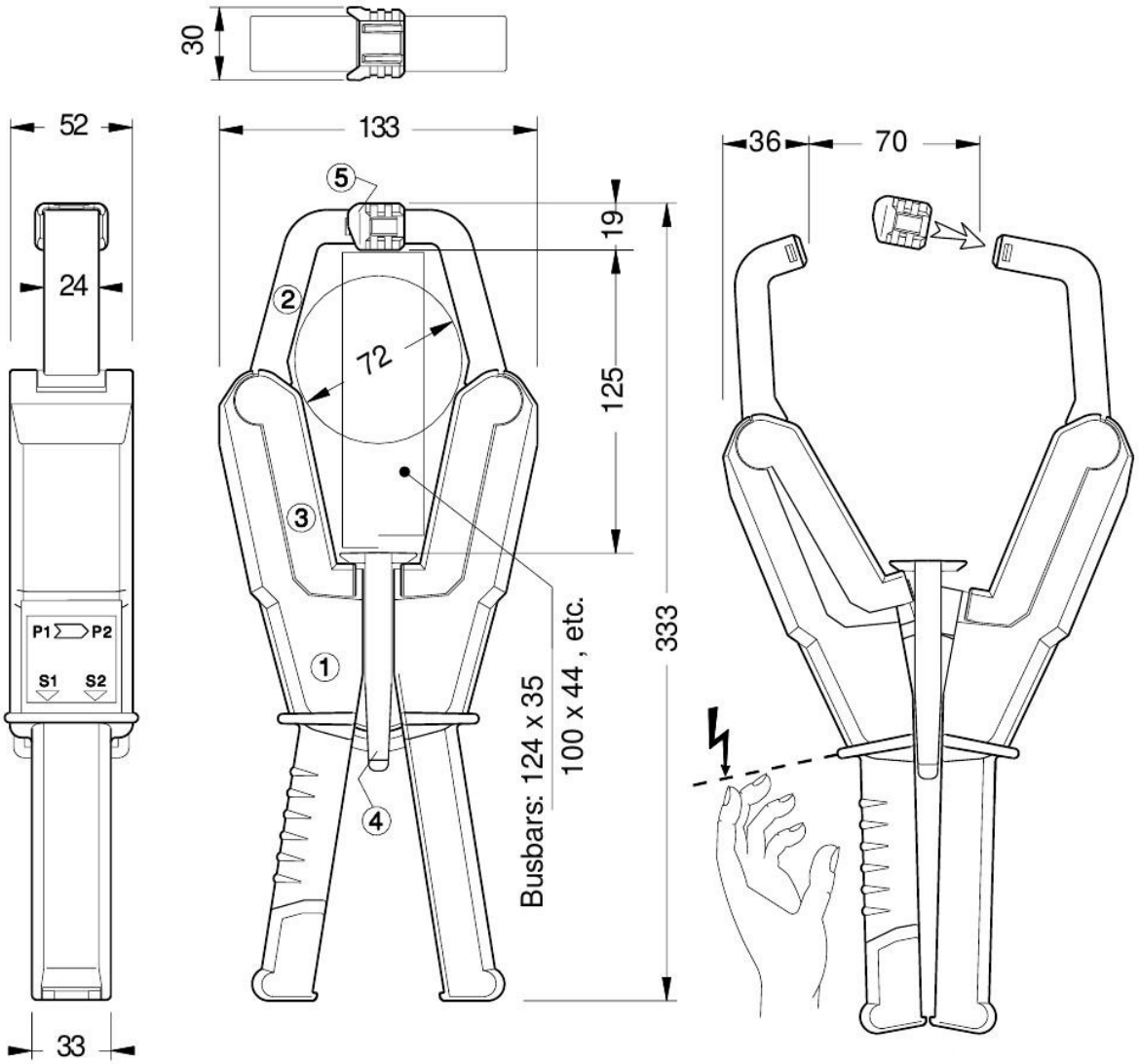


Figure 2.55: Dimensions in mm and protection against electric shock and short-circuit

2.11.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Use safety cover 'P' Figure 2.55 [→68] for protection against short-circuits during clamping!
- Use of the probe on uninsulated conductors is limited to 600 V and frequencies below 1 kHz
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.11.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	BSEN 61010-1:1993 and Amendment A2: July 1995, BSEN 61010-2-032:1995, BSEN 61010-2-031:1995
EMC	EN 61326:1998



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RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.11.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.11.4 Specifications

Nominal input current	3000 A
Measuring range	3200 A / 9000 Apk
Maximum input overload	3600 A continuous, 6000 A for 5 min/h @ +20 °C
Bandwidth, -3 dB	30 Hz ... 10 kHz
Temperature coefficient	±0.01 % / °C
Conductor position sensitivity	±0.5 % at 50 Hz
Measurement category	600 V, CAT III
Degree of pollution	2
Operating temperature range	-10 °C ... +55 °C

Operating humidity	< 85 % (non condensing)
Storage temperature range	-40 °C ... +70 °C
Weight	1700 g
Output connection	1.7 m fixed lead with DSUB15 plug to LMG, optional: 1 m ... 10 m, knurled screw or locking screw

2.11.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, signal frequency: 48 Hz ... 65 Hz, ambient temperature +22 °C±4 °C, humidity: 20 % to 75 %, DC current: none, DC magnetic field: 40 A/m earth's magnetic field, AC magnetic field: none, proximity of external conductor: none, calibration interval of 1 year, primary conductor: centered in the middle of the clamp.

Current	Accuracy specification for amplitude in % of measuring value	Accuracy specification for phase in °
10 A ... 100 A	±(2.5 % + 6 A)	–
100 A ... 300 A	±2.5 %	±3°
300 A ... 1000 A	±1 %	±1°
1000 A ... 3200 A	±0.5 %	±0.5°

Use L60-Z66 and LMG specifications to calculate the accuracy of the complete system.

Influence of coupling mode: This current clamp can measure only AC currents. DC offset could cause additional errors. Therefore this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

2.11.6 Connection of the current clamp L60-Z66 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z66 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z66

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	15	30	60	120	240	450	900	1800	3000
Max. TRMS value / A	16.5	33	66	132	264	495	990	1980	3200
Max. peak value / A	42	84	168	336	672	1407	2814	5625	9000
Range peak value for accuracy calculation / A	42	84	168	336	672	1407	2814	5625	11250

Power measurement channel L60-CH-S:

Nominal range AC / A	15	30	60	120	240	450	900	1800	3000
Nominal range DC / A	30	60	120	240	450	900	1800	2500	3200
Max. TRMS value / A	33	63	126	252	480	960	1920	3200	3200
Max. peak value / A	42	84	168	336	672	1407	2814	5625	9000
Range peak value for accuracy calculation / A	42	84	168	336	672	1407	2814	5625	11250

Accuracy

Use L60-Z66 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of L60-Z66 with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

2.12 AC/DC current clamp 1000 A (L60-Z68)



Figure 2.56: L60-Z68

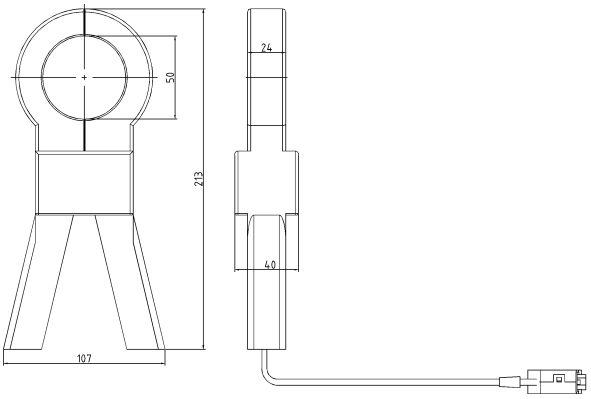


Figure 2.57: Dimensions of L60-Z68

2.12.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Use of the probe on uninsulated conductors is limited to 600 V and frequencies below 1 kHz
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

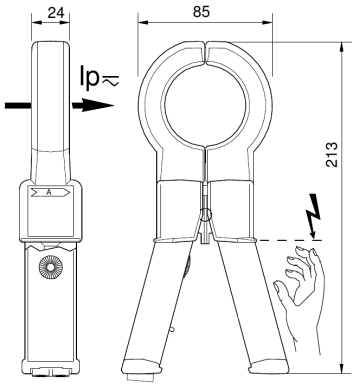


Figure 2.58: Protection against electric shock and short-circuit

2.12.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety IEC 61010-1:2010, IEC 61010-2-31:2008, IEC 61010-2-32:2012



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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.12.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.12.4 Specifications

Nominal input current	1000 A
Measuring range	1100 A / 1500 Apk
Maximum input overload	1600 A continuous @ +20 °C
Bandwidth, -3 dB	DC ... 10 kHz
Temperature coefficient	±0.1 % of reading / °C
Conductor position sensitivity	±1.5 % relative to center reading
Measurement category	600 V, CAT III
Degree of pollution	2
Operating Temperature range	0 °C ... +50 °C
Operating humidity	15 % ... 85 % (non condensing)
Storage Temperature range	-20 °C ... +85 °C
Weight	0.6 kg
Supply	100 mA
Output connection	2 m fixed lead with DSUB15 plug to LMG, optional: 1 m ... 10 m (only at initial order, not retro fitable), knurled screw or locking screw

2.12.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, signal frequency: 48 Hz ... 65 Hz, ambient temperature +22 °C±4 °C, humidity: 20 % to 75 %, DC current: none, DC magnetic field: 40 A/m earth's magnetic field, AC magnetic field: none, proximity of external conductor: none, calibration interval of 1 year, primary conductor: centered in the middle of the clamp.

Current	Accuracy specification for amplitude in % of measuring value	Accuracy specification for phase in °
2 A ... 10 A	±(2 % + 5 A)	not specified
10 A ... 100 A	±2 %	±3°
100 A ... 1000 A	±1 %	±1°

Manual zero adjust via thumbwheel.

Use L60-Z68 and LMG specifications to calculate the accuracy of the complete system.

2.12.6 Connection of the current clamp L60-Z68 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z68 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z68

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	30	60	120	250	500	1000
Max. TRMS value / A	33	66	132	275	550	1100
Max. peak value / A	97.7	195.3	390.6	781.3	1500	1500
Range peak value for accuracy calculation / A	97.7	195.3	390.6	781.3	1563	3125

Power measurement channel L60-CH-S:

Nominal range AC / A	30	60	120	250	500
Nominal range DC / A	80	150	300	600	1100
Max. TRMS value / A	85	160	320	650	1100
Max. peak value / A	97.7	195.3	390.6	781.3	1500
Range peak value for accuracy calculation / A	97.7	195.3	390.6	781.3	1563

Accuracy

Use L60-Z68 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of L60-Z68 with Isensor and I, please use the LMG600 accuracy specifications for the current sensor input.

2.13 AC current clamp 1000 A / 1 A (LMG-Z322)

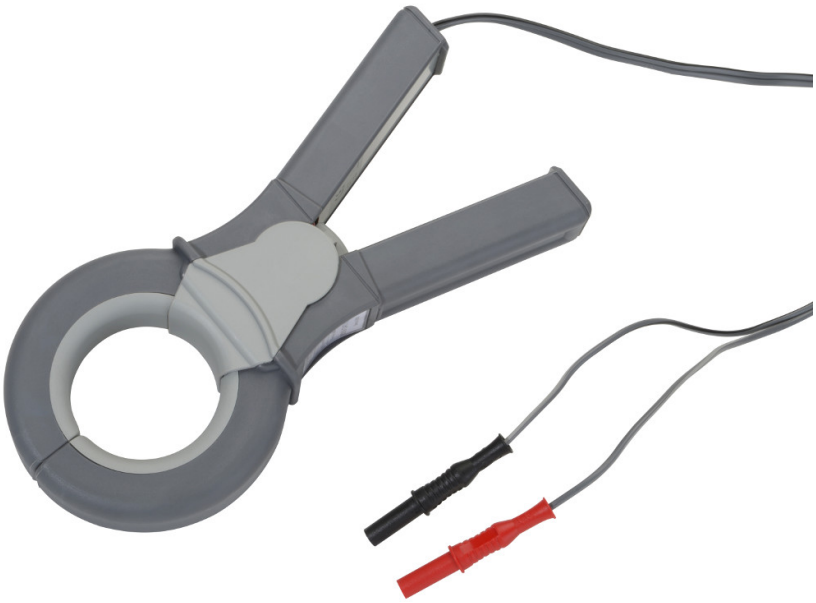


Figure 2.59: LMG-Z322

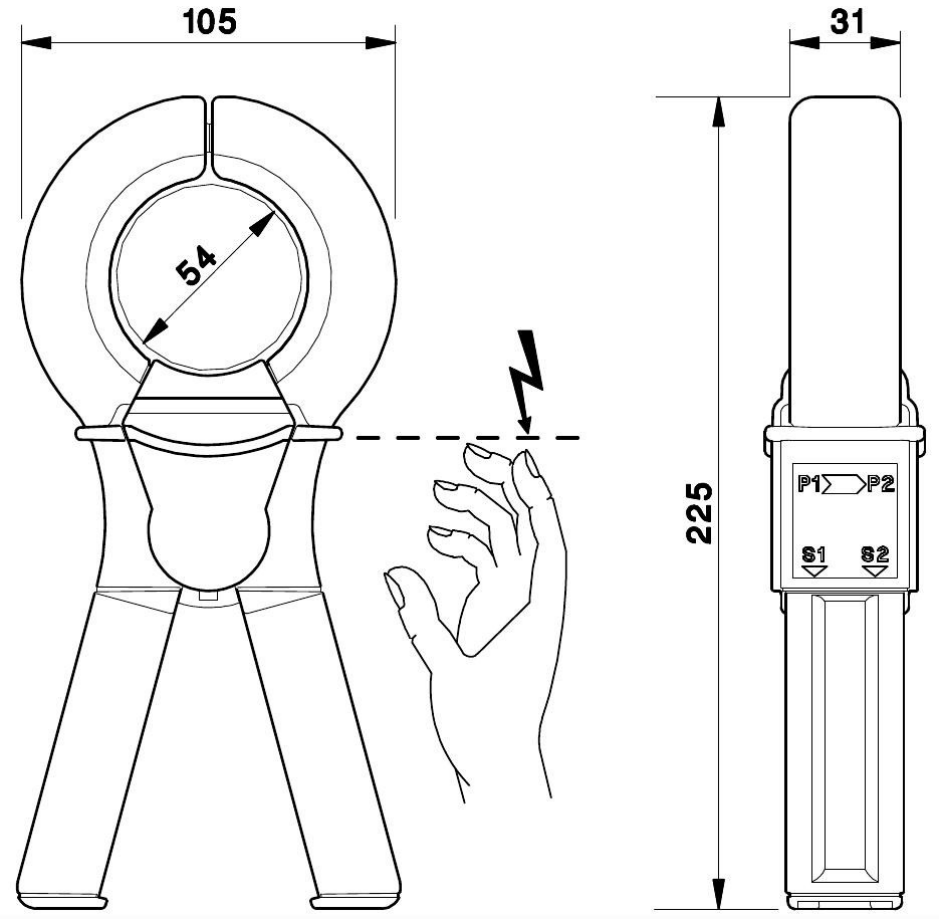


Figure 2.60: Dimensions in mm and protection against electric shock

2.13.1 Safety warnings



- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- For protection against electric shock please refer to Figure 2.60 [→75]
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!



- Use of the probe on uninsulated conductors is limited to 600 V and frequencies below 1 kHz
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.13.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	IEC 61010-1:2010, IEC 61010-2-032:2012, IEC 61010-2-031:2008
EMC	EN 61326:1998



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RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.13.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.13.4 Specifications

Nominal input current	1000 A
Measuring range	1200 A / 3000 Apk
Maximum input overload	1200 A continuous, 2000 A for 5 min./h @ +20 °C
Transformation ratio	1000 : 1
Burden	1 Ω
Bandwidth, -3 dB	10 Hz ... 10 kHz
Temperature coefficient	±0.01 % / °C
Conductor position sensitivity	±0.1 % at 50 Hz
Measurement category	600 V, CAT III
Degree of pollution	2

max. current above 1 kHz	1000 A / f[kHz]
Operating temperature range	-10 °C ... +55 °C
Operating humidity	15 % ... 85 % (non condensing)
Storage temperature range	-40 °C ... +70 °C
Weight	650 g
Output connection	2 m fixed lead with 4 mm safety plugs

2.13.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, signal frequency: 48 Hz ... 65 Hz, ambient temperature +22 °C±4 °C, humidity: 20 % to 75 %, DC current: none, DC magnetic field: 40 A/m earth's magnetic field, AC magnetic field: none, proximity of external conductor: none, calibration interval of 1 year, primary conductor: centered in the middle of the clamp.

Current	Accuracy specification for amplitude in % of measuring value	Accuracy specification for phase in °
0.1 A ... 1 A	±2 %	±1°
1 A ... 100 A	±1 %	±0.5°
100 A ... 1000 A	±0.5 %	±0.5°

Use LMG-Z322 and LMG specifications to calculate the accuracy of the complete system.

2.14 AC current clamp 3000 A / 1 A (LMG-Z329)

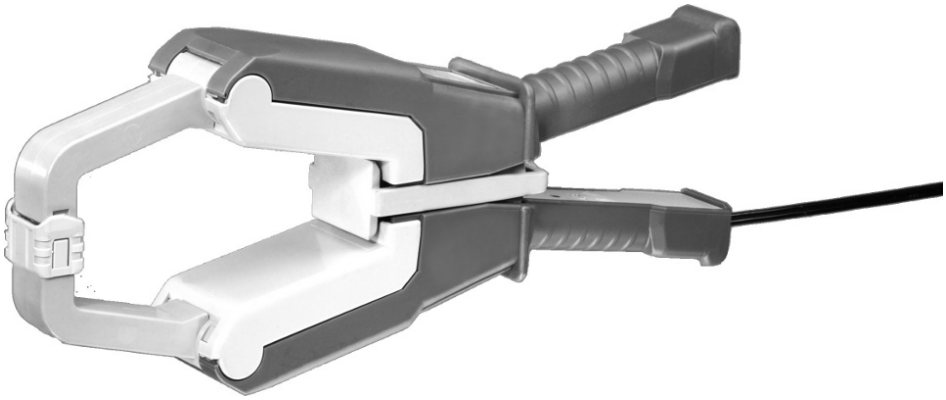


Figure 2.61: LMG-Z329

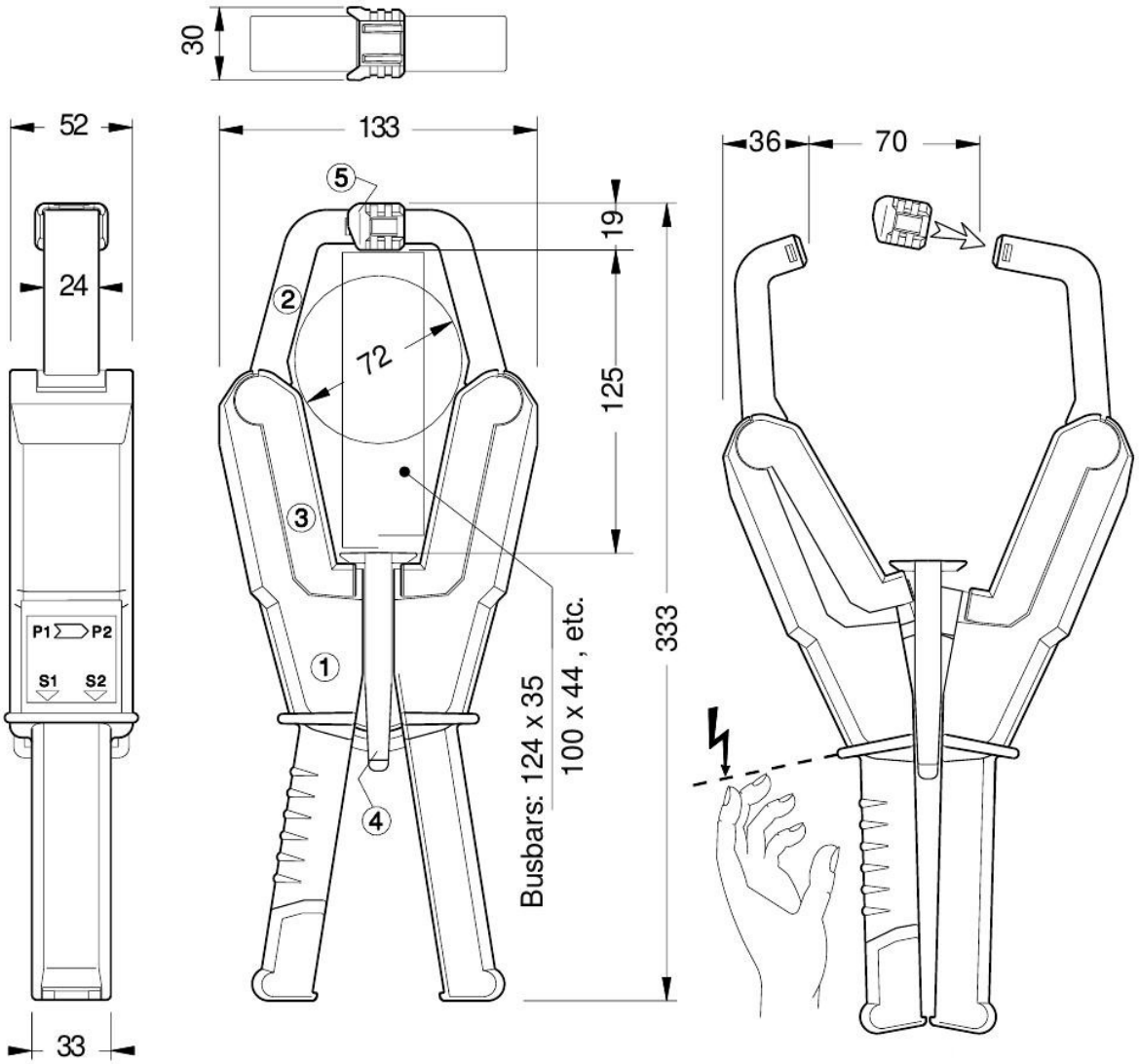


Figure 2.62: Dimensions in mm and protection against electric shock and short-circuit

2.14.1 Safety warnings



- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Use safety cover 'P' Figure 2.62 [→78] for protection against short-circuits during clamping!
- Use of the probe on uninsulated conductors is limited to 600 V and frequencies below 1 kHz



- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.14.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	BSEN 61010-1:1993 and Amendment A2: July 1995, BSEN 61010-2-032:1995, BSEN 61010-2-031:1995
EMC	EN 61326:1998



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RoHS 2011/65/EU

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2.14.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.14.4 Specifications

Nominal input current	3000 A
Measuring range	3200 A
Maximum input overload	3600 A continuous, 6000 A for 5 min/h @ +20 °C
Transformation ratio	3000 : 1
Burden	1 Ω
Bandwidth, -3 dB	30 Hz ... 10 kHz
Temperature coefficient	±0.01 % / °C
Conductor position sensitivity	±0.5 % at 50 Hz
Measurement category	600 V, CAT III

Degree of pollution	2
Operating temperature range	-10 °C ... +55 °C
Operating humidity	< 85 % (non condensing)
Storage temperature range	-40 °C ... +70 °C
Weight	1700 g
Output connection	2 m fixed lead with 4 mm safety plugs

2.14.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, signal frequency: 48 Hz ... 65 Hz, ambient temperature +22 °C±4 °C, humidity: 20 % to 75 %, DC current: none, DC magnetic field: 40 A/m earth's magnetic field, AC magnetic field: none, proximity of external conductor: none, calibration interval of 1 year, primary conductor: centered in the middle of the clamp.

Current	Accuracy specification for amplitude in % of measuring value	Accuracy specification for phase in °
10 A ... 100 A	±(2.5 % + 6 A)	–
100 A ... 300 A	±2.5 %	±3°
300 A ... 1000 A	±1 %	±1°
1000 A ... 3200 A	±0.5 %	±0.5°

Use LMG-Z329 and LMG specifications to calculate the accuracy of the complete system.

2.15 Precision wideband current transformer 100 A (WCT100)



Figure 2.63: WCT100

WCT100 is an accessory for the precision power meters LMG with a high bandwidth. The high frequency design provides best accuracy at high frequencies. It also simplifies the measurement of output power in high frequency applications with floating potential. The current transformer has 1 A current output, for the direct connection to the LMG current input. For the connection of WCT100 to the precision power meter LMG use narrow twisted laboratory leads, not longer than needed.

2.15.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!
- Please refer to chapter Safety recommendations [1.2→5]!

2.15.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN61010-1:2010+A1:2019, EN IEC61010-2-030:2021+A11:2021
EMC	EN55011:2016+A1:2017+A11:2020+A2:2021, EN IEC61326-1:2021

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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.15.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.15.4 Specifications

Nominal input current rms	100 A
Maximum input current peak	250 Apk
Transformation ratio	100:1
Maximum input overload	120 A continuous, 200 A for 1 minute
Bandwidth	30 Hz ... 1 MHz
Output burden	0 ... 100 mΩ for specified accuracy
Isolation	600 V CAT III / 1000 V CATII (EN 61010-1), Test voltage: output Ilow to 20mm busbar
Output connection	safety sockets, 4 mm
Operating temperature	-10 °C ... +70 °C
Through hole diameter	23 mm
Weight	350 g
Size l * w * h	120 mm * 95 mm * 65 mm

2.15.5 Accuracy specification

The accuracy specification is based on: no DC current component, sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, output burden max. 100 mΩ , max. 1 m twisted laboratory leads, primary conductor in the middle of the transducer.

Input current 1 A ... 100 A	30 Hz ... 100 Hz	100 Hz ... 100 kHz	100 kHz ... 300 kHz	300 kHz ... 1 MHz
Accuracy specification for amplitude ±(% of measuring value)	±0.25 %	±0.25 %	±1 %	±2 %
Accuracy specification for phase ±(phase error in °)	±0.6°	±0.3°	±0.4°	±0.6°

Use WCT100 and LMG specifications to calculate the accuracy of the complete system.

2.15.6 Improving the accuracy due to common mode effects

In high frequency applications with current measurement on high common mode voltage potential it might be advantageous to connect the yellow plug with earth. There is a double galvanic separation: inside the LMG and inside the current transformer itself and a capacitive coupling from the isolated primary lead to the current transformer. So the secondary side has neither galvanic contact with the load current nor with earth, the current channel is floating on an undefined potential. Parasitic currents by capacitive coupling from the primary conductor to secondary transformer side that is totally floating may influence measuring accuracy. These currents can be by-passed to earth over the yellow plug that is connected inside to the secondary side transformer coils in that way that the fields of these currents are compensated as not to create further disturbance and interference. The HF-accuracy can be improved

by draging down the floating voltage to about earth potential, but this might also cause resonance, so beware not to distort the measurement accuracy.

2.16 HF summing current transformer (L95-Z06, -Z06-HV)

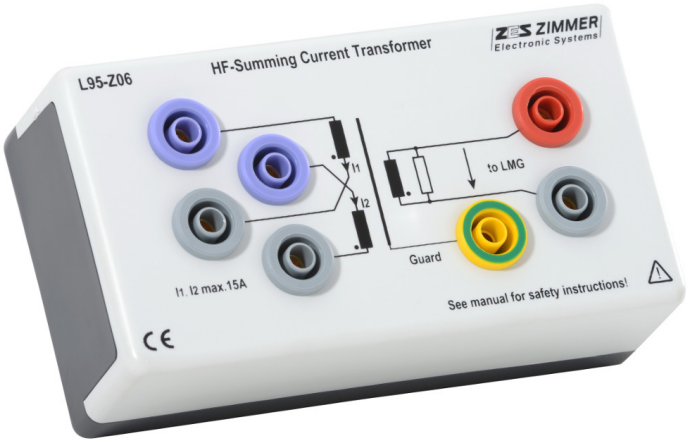


Figure 2.64: L95-Z06



Figure 2.65: L95-Z06-HV

L95-Z06 is an accessory for the precision power meters LMG with a high bandwidth. It simplifies the measurement of output power in high frequency applications with floating potential. For example: lighting applications, ultrasonic system. The high frequency design provides best accuracy at high frequencies. The current transformer has a voltage output, for the direct connetion to the LMG external Shuntinput.

The high voltage version L95-Z06-HV eliminate the 4mm safety sockets as input terminals. The limited clearances and creepage distances are removed by usage of highvoltage wire. All other specifications are the same as L95-Z06.

The two galvanically separated primary windings are suitable to use in series to increase the sensitivity for small currents. And it can be used as well to build the difference of two (e.g. lamp-) currents. If not needed the second primary winding can be left open.

The guard terminal may be grounded to bypass capacitiv currents from input to output. This reduce errors introduced by common mode voltage.

2.16.1 Safety warnings

- Always connect the sensor first to the meter and earth the guard terminal, and afterwards to the device under test.



- The guard terminal must be grounded to bypass capacitiv currents from input to output. This also reduce errors by common mode voltage.

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.16.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety EN 61010-1:2010



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RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.16.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

2.16.4 Specifications

Nominal input current	15 A at I1 or I2 or (I1+I2)
Transformer ratio	18 A : 3 V (set scale to 6)
Measuring range	18 A (sum of I1 and I2)
Maximum input	20 A at I1 and 20 A at I2 for 1 s
Bandwidth	5 kHz ... 500 kHz
Output burden	≥100 kΩ
Degree of pollution	2
Temperature range	-10 °C ... +50 °C
Output connection	safety sockets 4 mm (use twisted leads to LMG)
Guard connection	safety sockets 4 mm, green / yellow
Size L * W * H	120 mm * 65 mm * 45 mm

(a) **L95-Z06**

Working voltage	600 V CAT III, 1000 V CAT II
Input connection	safety sockets 4 mm
Weight	200 g

(b) **L95-Z06-HV**

Working voltage	5 kVrms
Transient overvoltage	10 kVpk
Input connection	free highvoltage wire, approx. 0.8 m
Weight	300 g

2.16.5 Accuracy specification

The accuracy specification is based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year.

Frequency	Accuracy specification for amplitude in % of measuring value	Accuracy specification for phase in °
5 kHz ... 500 kHz	±0.5 %	±1°

Use L95-Z06 / L95-Z06-HV and LMG specifications to calculate the accuracy of the complete system.

2.16.6 Improving the accuracy due to common mode effects

In high frequency applications with current measurement on high common mode voltage potential it is advantageous to connect the low output of this current transformer with earth. There is a double galvanic separation: in the LMG and inside the current transformer itself. So the secondary side has neither galvanic contact with the load current nor with earth: the current channel is floating on an undefined potential. The high frequency accuracy can be improved by draging down the floating voltage to about earth potential.

2.16.7 Wiring schematics

low current

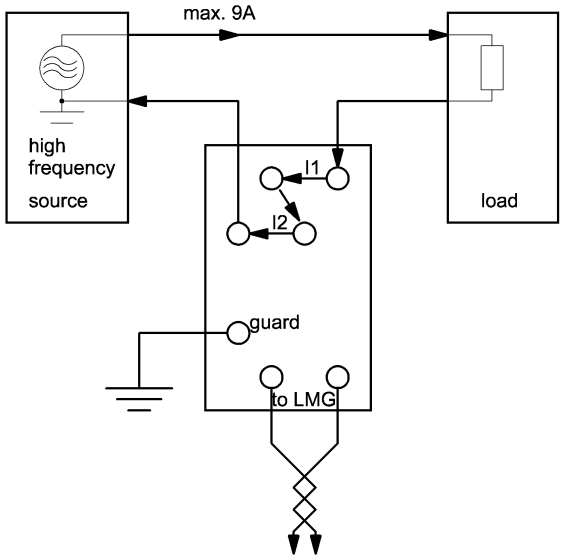


Figure 2.66: low current application

For applications with lower currents use both inputs in series and set the LMG scale to 3.

high current

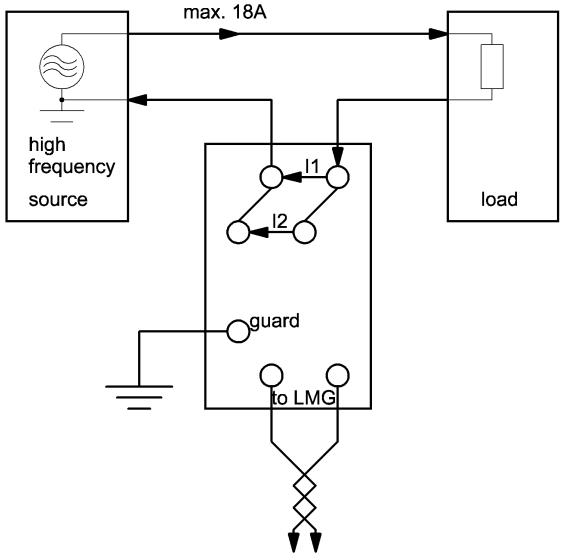


Figure 2.67: high current application

For applications with higher currents use both inputs parallel and set the LMG scale to 6.

arithmetic mean value

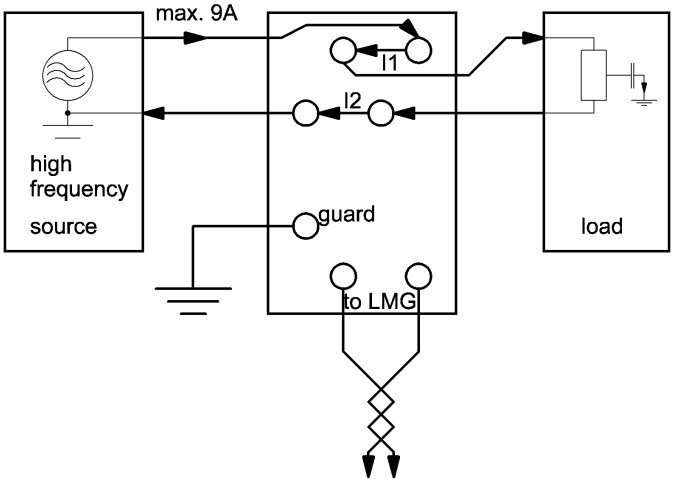


Figure 2.68: arithmetic mean value application

To determine the arithmetic mean value of two currents: $I_{mean} = \frac{I1+I2}{2}$, set the LMG scale to 3. In high frequency lightning applications where a earth current worth mentioning is present, the light density is proportional to the arithmetic mean value of the two currents I1 and I2.

difference of two currents

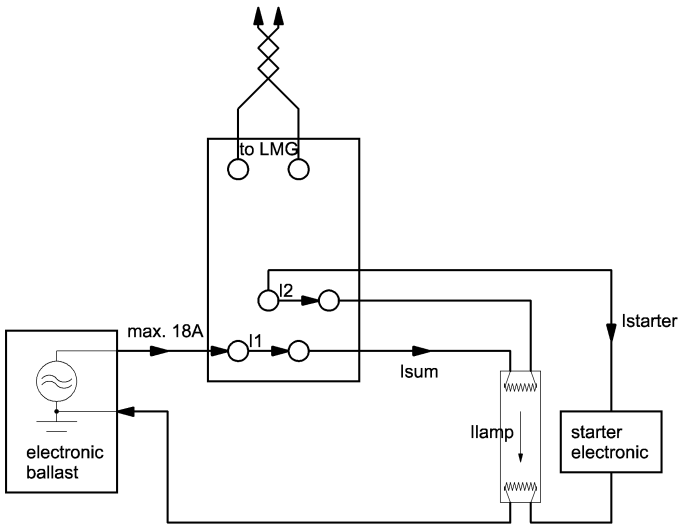


Figure 2.69: difference of two currents

To determine the difference of two currents: $I_{lamp} = I_{sum} - I_{starter}$, set the LMG scale to 6. The lamp current I_{lamp} is the difference of I_{sum} and the current through the starter electronic during the operation.

2.17 Hall effect current sensors (HALL100, -300, -500, -1000, -2000)

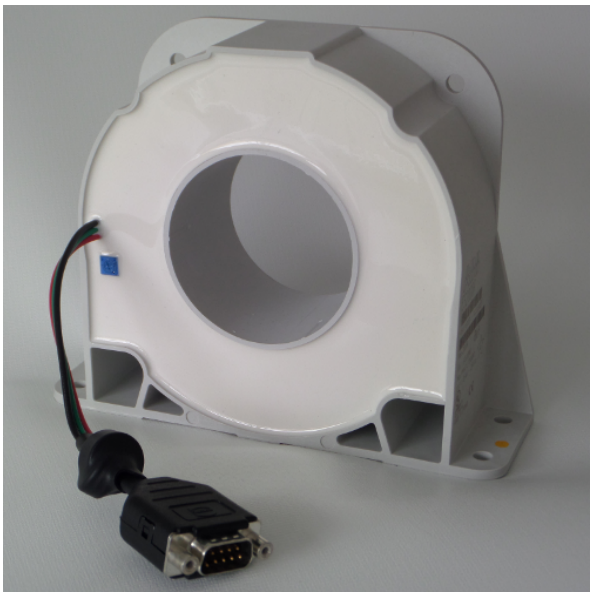


Figure 2.70: Hall effect current sensor

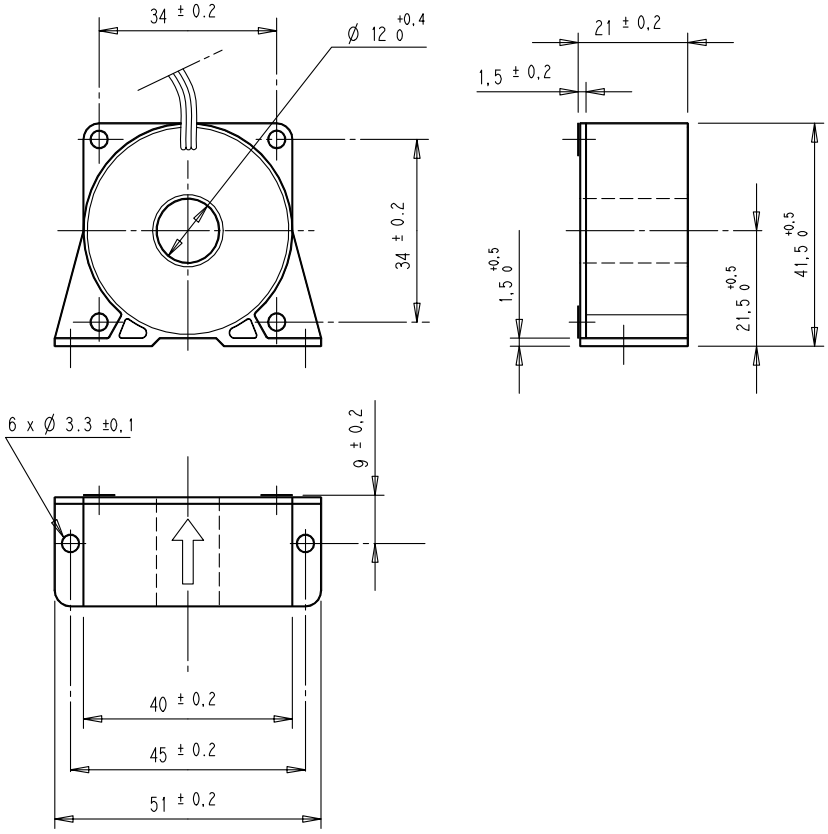


Figure 2.71: HALL100 mechanical dimensions

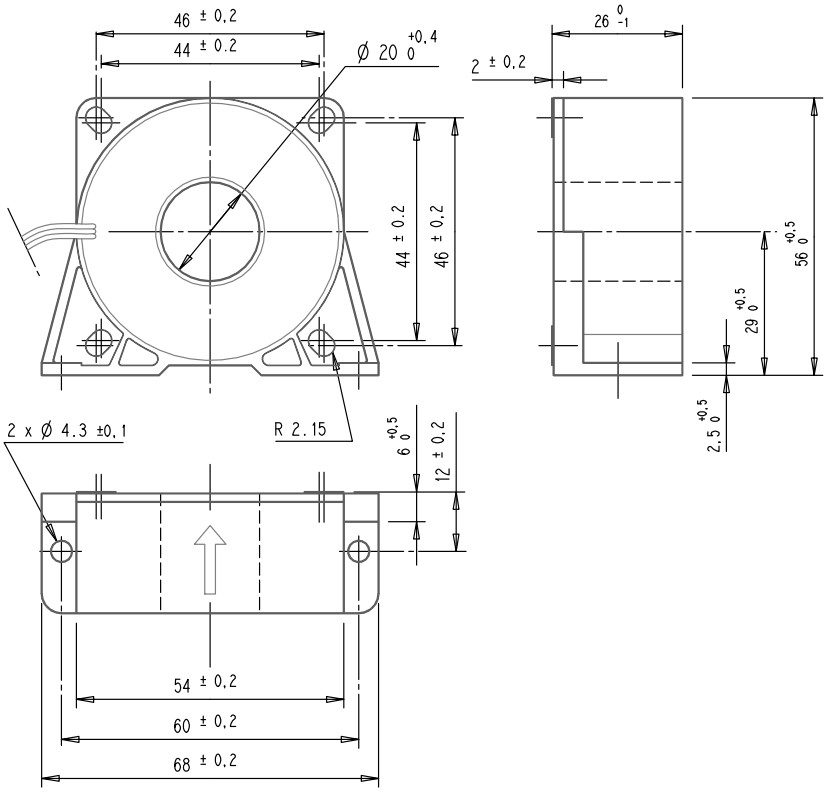


Figure 2.72: HALL300 mechanical dimensions

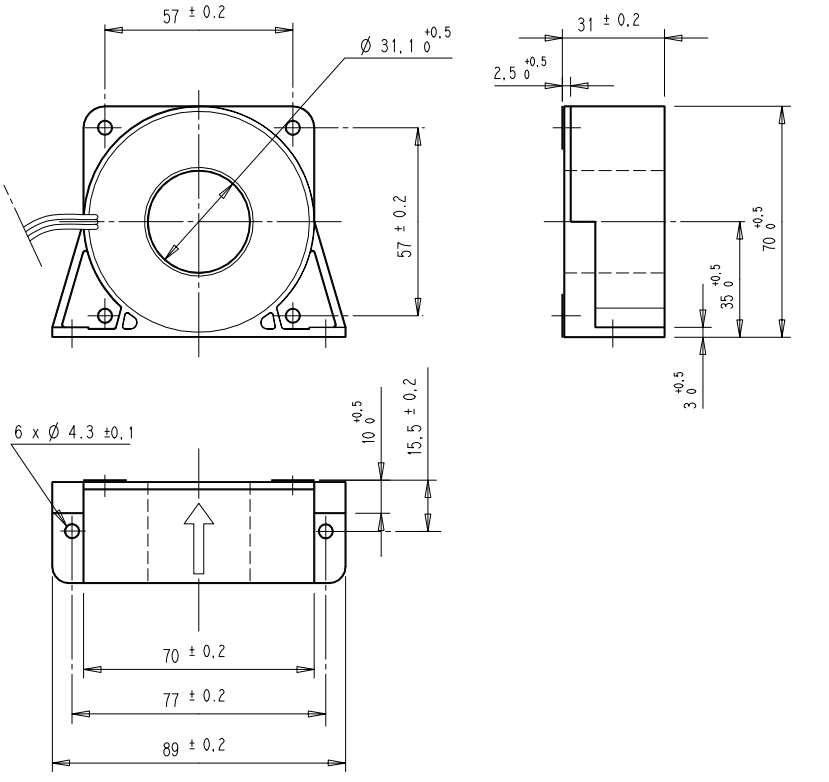


Figure 2.73: HALL500 mechanical dimensions

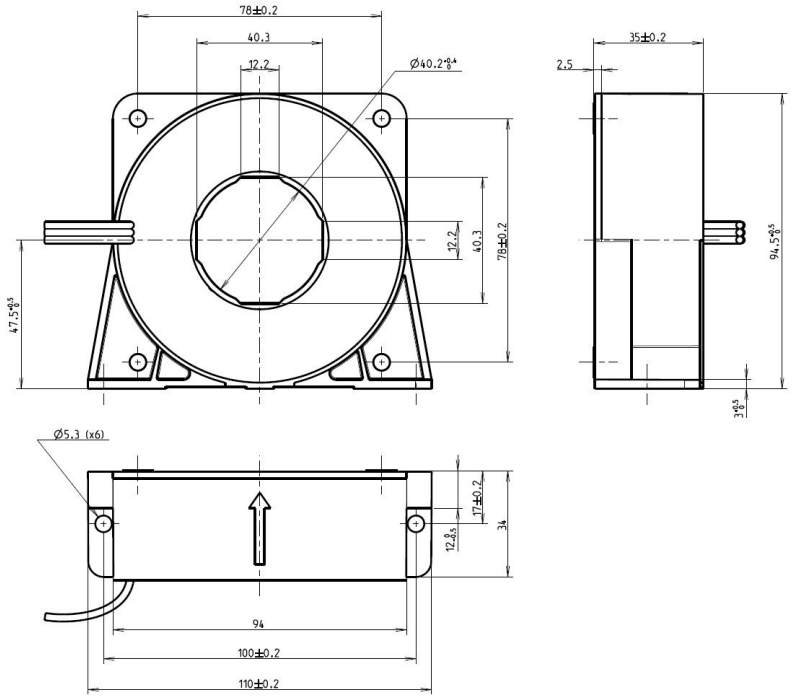


Figure 2.74: HALL1000 mechanical dimensions

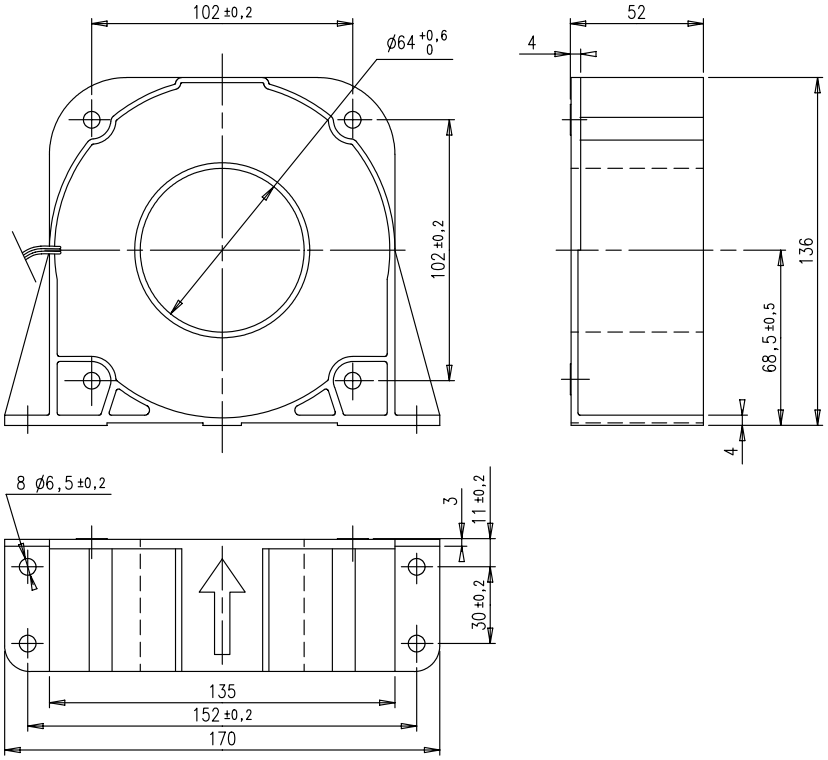


Figure 2.75: HALL2000 mechanical dimensions

Hall effect sensors with closed-loop technology to measure DC, AC or pulsating currents with a galvanic insulation between primary circuit and power meter.

Typical applications are: frequency inverters, switching power supplies, wind turbines, electric drive systems.

Plastic case and insulating resin are self-extinguishing. RoHS compliant. Fixing holes in the case moulding for horizontal or vertical mounting. Direction of the current: a primary current, flowing in the direction of the arrow marker results in a positive current.

2.17.1 Safety warnings



- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact! DSUB9 connector is without safety insulation!
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user! With an unpowered secondary circuit, the transducer will behave like a transformer and generate a current. Given the close loop, this current will be re-injected in the electronics and eventually damage the sensor.
- Please refer to chapter Safety recommendations [1.2→5]!

2.17.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	UL file E166814, industrial control equipment UL508, open type

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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2.17.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

(continued)

Sensor	HALL100	HALL300	HALL500	HALL1000	HALL2000

2.17.4 Specifications and accuracy specification

The accuracy specification is based on: calibration interval of 1 year, primary conductor in the middle of the transducer, offset current and thermal drift and di/dt are related to primary current.

Sensor	HALL100	HALL300	HALL500	HALL1000	HALL2000
Nominal input current rms, Ipn	100 A	300 A	500 A	1000 A	2000 A
Maximum input current peak	150 A	500 A	800 A	1500 A	2200 A
Transformation ratio	1000	2000	5000	5000	5000
Secondary current at Ipn	100 mA	150 mA	100 mA	200 mA	400 mA
Maximum input overload	300 A (1 ms/h)	3000 A (10 ms/h)	5000 A (10 ms/h)	10 kA (10 ms/h)	20 kA (10 ms/h)
Maximum measuring resistance	50 Ω	20 Ω	7 Ω	2 Ω	5 Ω
Accuracy at Ipn, +25 °C	±0.5 %				
Accuracy at Ipn, -5 °C ... +70 °C	±1 %				
Accuracy at Ipn, -20 °C ... +70 °C	±2.5 %	±1.5 %	±1 %		
Linearity	±0.1 %				
Offset current, +25 °C	±0.4 A	±0.5 A	±1.25 A	±2.5 A	±1.25 A
Thermal drift coeff. -5 °C ... +70 °C	±10 mA/°C	±30 mA/°C	±25 mA/°C	±25 mA/°C	±50 mA/°C
Thermal drift coeff. -20 °C ... +70 °C	±80 mA/°C	±80 mA/°C	±80 mA/°C	±100 mA/°C	±50 mA/°C
Bandwidth, -1 dB	DC ... 100 kHz				
di/dt correctly followed	50 A/µs	50 A/µs	100 A/µs	100 A/µs	100 A/µs
Delay time	≤1 µs				
Dielectric strength, prim./sec.	3 kV (50 Hz, 1 min)				
Operating temperature	-20 °C ... +70 °C The temperature of the primary conductor in contact with the case must not exceed +100 °C				
Storage temperature	-40 °C ... +85 °C				
Supply voltage	±15 V, ±5 %, internal supply by LMG				
Supply current	120 mA	170 mA	120 mA	220 mA	420 mA
Weight	80 g	140 g	240 g	550 g	1.5 kg

The accuracy of the HALLxx current sensors is determined at different temperature ranges at the nominal current Ipn. The accuracy includes the offset current, the linearity and the thermal drift.

Influence of internal and external magnetic fields:

- The distance to other current sensors carrying a high current, to the current return or other conductors or current bars should be as big as possible, the distance should be at least the diameter of the sensor itself.

- To get the best accuracy, it is recommended to center the primary conductor inside the hole and orientate the sensor in the same direction of the primary conductor.
- The distance from the sensor to magnetic materials (e.g. steel) should be as big as possible. It is better to use non-magnetic materials to fix the sensor.

Use HALLxx and LMG600 specifications to calculate the accuracy of the complete system. See specification of the LMG connection cable regarding the LMG measuring ranges for the calculation.

2.17.5 DSUB9 connector pin assignment of HALLxx

DSUB9 pin	
5	-supply
6	out
9	+supply
1-4, 7-8	nc

2.17.6 Connection of the sensor HALLxx with LMG600

Use HALLxx-K-L6 (length: 2.5 m) and L60-X-ADSE and optionally the extension cable 'LMG-Z-SVT' or 'LMG-Z-DV', supply via LMG600. Fix the plugs with the knurled screw or locking screw. Use LMG connection cable and the current sensor HALLxx with corresponding serial numbers!

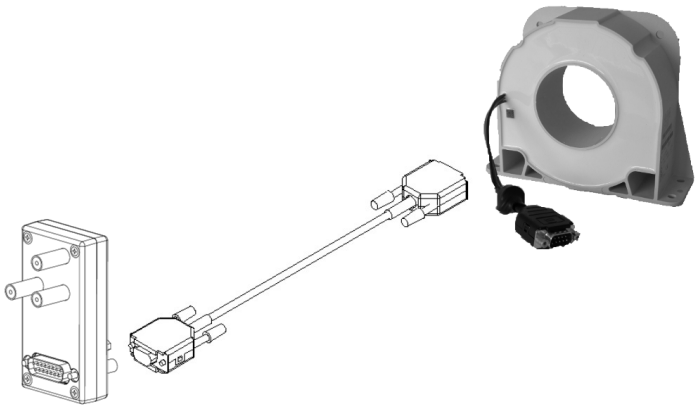


Figure 2.76: HALLxx and HALLxx-K-L6 (length: 2.5 m) and L60-X-ADSE

This cable 'HALLxx-K-L6' is used to connect the hall effect current transducer HALLxx to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the hall effect current transducer as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Connection

- switch all power off
- plug the 'HALLxx-K-L6' cable connector labeled 'HALLxx' to the current sensor
- plug the 'HALLxx-K-L6' cable connector labeled 'LMG600' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with HALL100

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	5	10	20	40	80	100
Max. TRMS value / A	5.5	11	22	44	88	100
Max. peak value / A	14	28	56	112	150	150
Range peak value for accuracy calculation / A	14	28	56	112	224	469

Power measurement channel L60-CH-S:

Nominal range AC / A	5	10	20	40	80
Nominal range DC / A	10	20	40	80	100
Max. TRMS value / A	11	21	42	84	100
Max. peak value / A	14	28	56	112	150
Range peak value for accuracy calculation / A	14	28	56	112	224

Measuring ranges LMG600 with HALL300

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	10	20	40	80	160	300
Max. TRMS value / A	11	22	44	88	176	300
Max. peak value / A	28	56	112	224	448	500
Range peak value for accuracy calculation / A	28	56	112	224	448	938

Power measurement channel L60-CH-S:

Nominal range AC / A	10	20	40	80	160	300
Nominal range DC / A	20	40	80	160	230	300
Max. TRMS value / A	22	42	84	168	300	300
Max. peak value / A	28	56	112	224	448	500
Range peak value for accuracy calculation / A	28	56	112	224	448	938

Measuring ranges LMG600 with HALL500

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	25	50	100	200	400	500
Max. TRMS value / A	27.5	55	110	220	440	500
Max. peak value / A	70	140	280	560	800	800
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345

Power measurement channel L60-CH-S:

Nominal range AC / A	25	50	100	200	400
Nominal range DC / A	50	100	200	400	500
Max. TRMS value / A	55	105	210	420	500
Max. peak value / A	70	140	280	560	800
Range peak value for accuracy calculation / A	70	140	280	560	1120

Measuring ranges LMG600 with HALL1000

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	25	50	100	200	400	750	1000
Max. TRMS value / A	27.5	55	110	220	440	825	1000
Max. peak value / A	70	140	280	560	1120	1500	1500
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345	4690

Power measurement channel L60-CH-S:

Nominal range AC / A	25	50	100	200	400	750
Nominal range DC / A	50	100	200	400	750	1000
Max. TRMS value / A	55	105	210	420	800	1000
Max. peak value / A	70	140	280	560	1120	1500
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345

Measuring ranges LMG600 with HALL2000

Power measurement channel L60-CH-A, L60-CH-B and L60-CH-C:

Nominal range / A	25	50	100	200	400	750	1500	2000
Max. TRMS value / A	27.5	55	110	220	440	825	1650	2000
Max. peak value / A	70	140	280	560	1120	2200	2200	2200
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345	4690	9375

Power measurement channel L60-CH-S:

Nominal range AC / A	25	50	100	200	400	750	1500
Nominal range DC / A	50	100	200	400	750	1500	2000
Max. TRMS value / A	55	105	210	420	800	1600	2000
Max. peak value / A	70	140	280	560	1120	2200	2200
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345	4690

Accuracy

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Due to the internal connection of HALLxx with the direct current input I* and I, please use the LMG600 accuracy specifications for the 5 mA ... 5 A ranges.

Connection extension

The standard connection length of HALLxx-K-L6 is: 2.5 m. To use the current sensor with a larger connection length between power meter and HALLxx connect a well shielded extension cable between the HALLxx (DSUB9f plug) and the HALLxx-K-L6 connection cable (DSUB9m plug) and screw both plugs together. This extension cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

3 Voltage Sensors

3.1 Precision high voltage divider (HST3, -6, -9, -12)



Figure 3.1: Precision high voltage divider

3.1.1 Safety warnings

- The HST Series is not designed for working on medium voltage grids!
- The normal use of the HST3, -6, -9, -12 series needs a connection to high voltages. To fulfill the safety requirements it is under all conditions **absolutely necessary to earth the case** of the HST3, -6, -9, -12 **to obtain safety** and functionality! Use sufficient cross section of the earthing conductor to match the possible shortcircuit currents!
- Connection to voltages of more than 1000 V should only be done with the use of external high-voltage high breaking capacity fuses!
- To prevent partial discharges the unshielded high-voltage wires of HST must have a distance between each other, to other conductive parts and against earth of at least 25 mm (HST3 and HST6) and 50 mm (HST9 and HST12)! Don't touch the high-voltage wires to avoid partial discharges.
- Because the measuring inputs of HST are designed for voltages >1000 V, the respective safety rules for electrical equipment and installations above 1000 V have strictly to be regarded!
- According to the manufacturer's statement, the high voltage wires of the HST3 and HST6 contain Dodecamethylcyclohexasiloxane, CAS# 540-97-6, also known as "D6", in quantities of 0.1 < D6 < 0.2 % w/w. Article 33 of the REACH Regulation requires companies who supply products

which include any article containing more than 0.1 % by weight of any REACH Candidate List Substance to provide their customers with sufficient information to allow safe use of the article. For safe use of the product please adhere to established industry practices for the handling of cables. No additional measures are required for the substance listed above. D6 is a byproduct of the manufacturing process of silicone and trace amounts of it remain in the finished product. For this reason, the limit of 0.1 % w/w is exceeded for the listed HST wires.

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

3.1.2 General

The wide band precision high voltage divider of series HST expand the voltage measuring range of ZES ZIMMER precision power meter LMG for use at nominal voltages over 1000 V. The high voltage inputs are equipped with 2 m wires that is attached to the voltage measured against earth. The open wires can be aligned by the customer.

The HST3 (resp. HST6, -9, -12) divides DC, AC or any distorted voltages with very high accuracy by the factor 1000 (resp. 2000 / 3000 / 4000). The divided voltage is available at the buffered low impedance BNC output. To avoid noise interference it is recommended to use shielded cables to the measuring input of the LMG.

The HST can be delivered in one, two or three channel version as to match the particular measuring task.

The single phase HST is used in single ended systems (e.g. lighting, plasma generation, induction heating, ultrasonic applications). Line to line voltages can be measured as difference between the output signals of the channels. For floating (difference) voltage measuring therewith the 2-phase HST is best suitable.

The HST has been designed for measurements at gas discharge lamps, to measure the high frequency burning voltage and the ignition voltage with high precision. These characteristics enable the use of the HST at frequency inverters with voltage peaks above 1000 V. These applications have no risk of surge and transient overvoltages by lightning or switching operations. The voltage peaks in these applications are well definded and are produced by the application itself with a limited energy.

However the HST should be protected by external high voltage high breaking capacity fuses. A further improvement of operational reliability is possible with external surge arresters. It should be connected on the HST input behind the fuse against earth.

3.1.3 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN61010-1:2010+A1:2019, EN IEC61010-2-030:2021+A11:2021
EMC	EN IEC61000-3-2:2019+A1:2021, EN61000-3-3:2013+A1:2019, EN55011:2016+A1:2017+A11:2020+A2:2021, EN IEC61326-1:2021



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RoHS 2011/65/EU

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

3.1.4 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

3.1.5 Specifications

Series	**HST3**	**HST6**	**HST9**	**HST12**
Nominal electrical rating of measuring inputs:				
maximum sine trms voltage for full scale	3.5 kV	7 kV	10.5 kV	14 kV
maximum trms input voltage	4.2 kV	8.4 kV	12.6 kV	16.8 kV
maximum peak voltage for full scale	5 kV	10 kV	15 kV	20 kV
input impedance	10 MΩ || 50 pF	20 MΩ || 25 pF	30 MΩ || 22 pF	40 MΩ || 20 pF
dividing ratio	1/1000	1/2000	1/3000	1/4000
Overvoltage capability of high voltage input against earthed case, voltages in accordance to EN61010:2010, valid for max. altitude 2000 m over sea level:				
maximum trms voltage	4.2 kV	8.4 kV	12.6 kV	16.8 kV
maximum periodic peak voltage	5 kV	10 kV	15 kV	20 kV
maximum transient overvoltage	3.8 kV	6.8 kV	8.8 kV	10.2 kV
non-repetitive maximum peak voltage	8.8 kV	16.8 kV	23.8 kV	30.2 kV
Mechanical:				
measurement input	one fixed high voltage wire (length 2 m) for each channel, earth jack as the common reference point			
signal output	one BNC socket for each channel			
enclosure	robust aluminium case			
size (L x W x H)	330 mm x 230 mm x 110 mm		400 mm x 230 mm x 110 mm	
installation dimension (L x W x H)	490 mm x 230 mm x 110 mm		590 mm x 230 mm x 110 mm	
weight	approx. 6.1 kg		approx. 7.2 kg	
Other:				
temperature range	+5 °C ... +40 °C, indoor use only			
safety class	class I, **device must be earthed additionally to PE of mains supply cord!**			
mains supply	85 V ... 265 V; 45 Hz ... 65 Hz; approx. 20VA; IEC 60320-C13			

Above Specifications are not valid for the discontinued versions of HST (serial numbers starting with 'C' or 'D').

3.1.6 Accuracy specification

The accuracy specification is based on: sinusoidal voltage, ambient temperature +5 °C ... +40 °C, calibration interval of 1 year, input voltage from 3 % to 100 % of maximum trms input voltage, output burden min. 1 kΩ || max. 1 nF (except min. 1 kΩ || max. 100 pF at 100 kHz ... 300 kHz)

Frequency	tolerance of ratio	tolerance of phase
DC	±0.1 %	-
0.05 Hz ... 45 Hz	±0.1 %	±0.06°
45 Hz ... 65 Hz	±0.05 %	±0.06°
65 Hz ... 2.5 kHz	±0.1 %	±0.2°
2.5 kHz ... 10 kHz	±0.2 %	±0.4°
10 kHz ... 100 kHz	±0.3 %	±0.5°
100 kHz ... 300 kHz	typ. ±2 %	typ. ±2.5°

- Supplement for low input voltages

  The allowed absolute measurement uncertainty at 3 % of maximum trms input voltage remains constant for lower input voltages.

- Supplement about output cable length

  The accuracy specifications above imply the delivered 3 m BNC-cable between HST output and measuring device. Longer cable runs up to 100 m are possible, but the accuracy is affected by cable capacitance and cable resistance.

- Effect of cable capacitance

  For cable capacitances from 1 nF to 10 nF add the following tolerances to the specifications above:

Frequency	tolerance of ratio	tolerance of phase
DC ... 2.5 kHz	unchanged	
2.5 kHz ... 10 kHz	±0.01 % / nF	±0.02°/ nF
10 kHz ... 100 kHz	±0.3 % / nF	±0.5°/ nF
100 kHz ... 300 kHz	not specified	

- Effect of cable resistance

  At medium and low ohmic burdens consider the resistive voltage divider consisting of cable loop-resistance and output burden. The resulting systematic error is: $-R_{\mathrm{loop}} / \left(R_{\mathrm{loop}} + R_{\mathrm{burden}}\right)$
  R_{loop} = wire resistance sum of go and return line
  R_{burden} = input resistance of connectet measuring device

3.1.7 Measurement principle HST

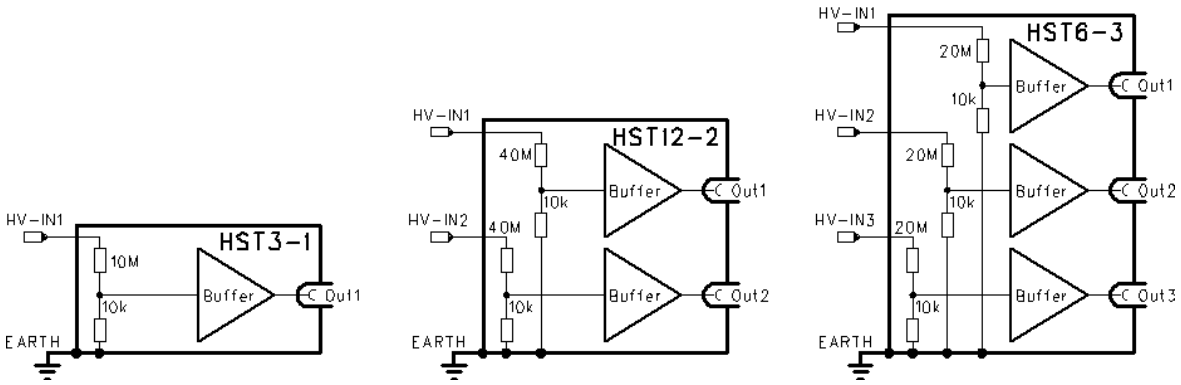


Figure 3.2: Principle structure of different HST types

3.1.8 Example wirings

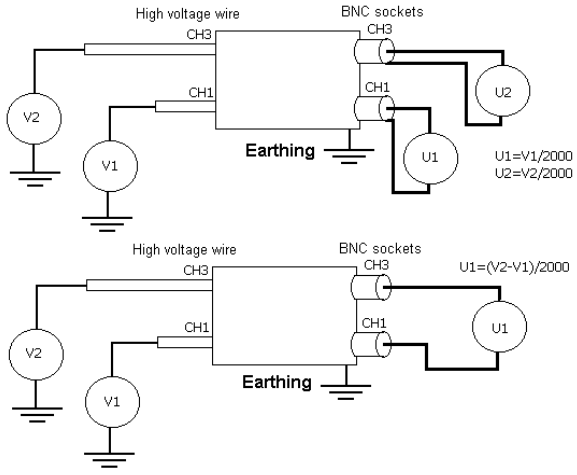


Figure 3.3: Example wirings HST6-2

Two possible example wirings are shown: A two channel measurement in the upper part of the figure and a differential voltage measurement in the lower part of the figure.

3.1.9 HST wiring of 3-phase systems

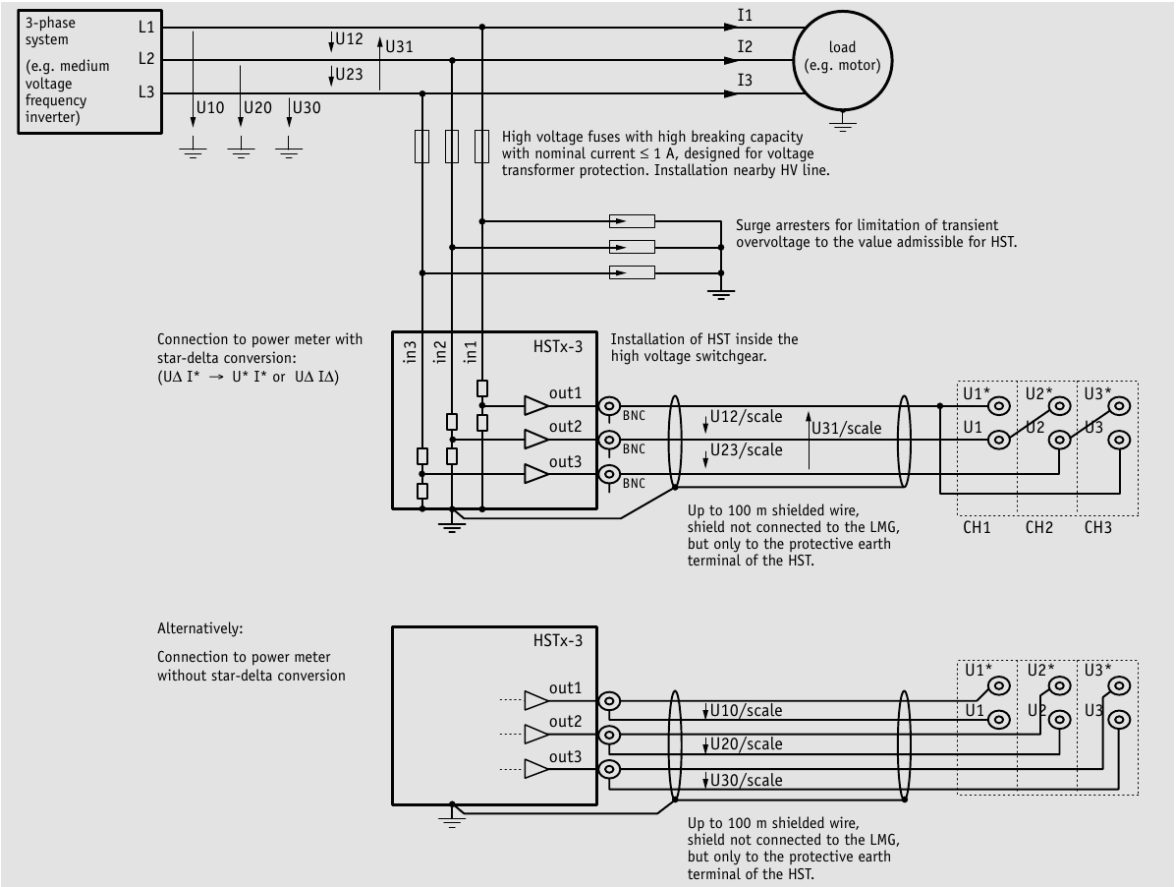


Figure 3.4: HST wiring of 3-phase systems

On the high voltage side HST input1, input2 and input3 connects to L1, L2 and L3. All voltage measurements have as reference potential the earthed case. Also isolated sources as these are always bound to earth by their earth capacities can be measured with the earthed HST.

On the low voltage side, the connection to the power meter LMG or other instruments can be done in two different ways:

1. Instruments with internal star-delta conversion are connected like shown in the upper part of the drawing. Advantage is that unbalanced sources are measured correctly, the total power is determined correctly as well as the power of each phase.

2. Instruments without star-delta conversion are connected like shown in the lower part of the drawing. The line voltages with reference potential earth can be tapped directly at the BNC jacks. Even with unbalanced sources, the total power is determined correctly.

3.1.10 Included in delivery

- Precision high voltage divider (HST)
- HST-O2–3 once per channel 3 m shielded output connection cable from HST to the power meter LMG (BNC to 4 mm safety plugs)
- HST3, -6, -9, -12 User Manual

3.1.11 Optional mounting kit

The HST enclosure has free accessible threaded holes on bottom side. Dependent on installation situation the mounting kit (HST-Z03) or own M8-Screws with minimum 20 mm screw-in depth can be used.

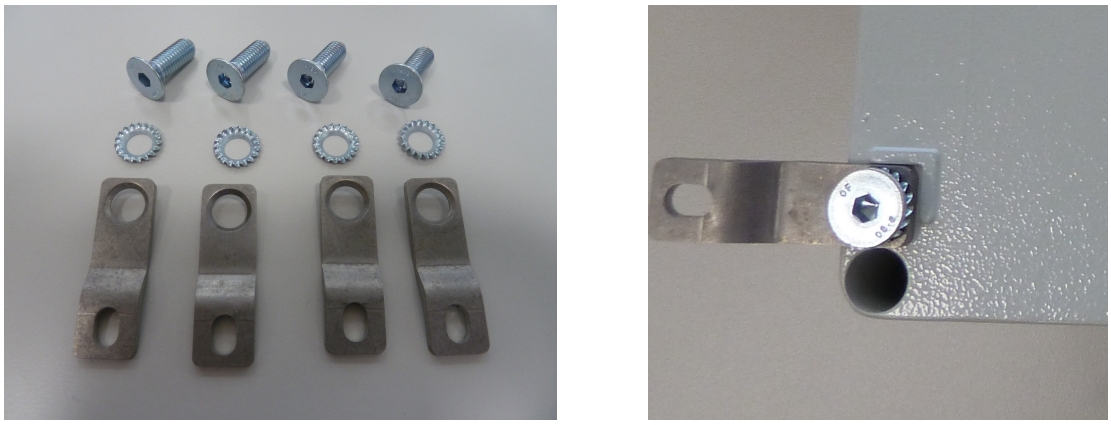


Figure 3.5: Retrofittable mounting kit HST-Z03

Type	Kit attached on	a	b
HST3, -6	without	180 mm	310 mm
	narrow side	180 mm	380 mm
	long side	250 mm	310 mm
HST9, -12	without	180 mm	380 mm
	narrow side	180 mm	450 mm
	long side	250 mm	380 mm

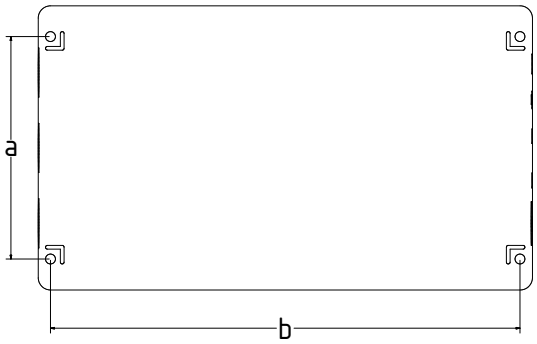


Figure 3.6: without mounting kit

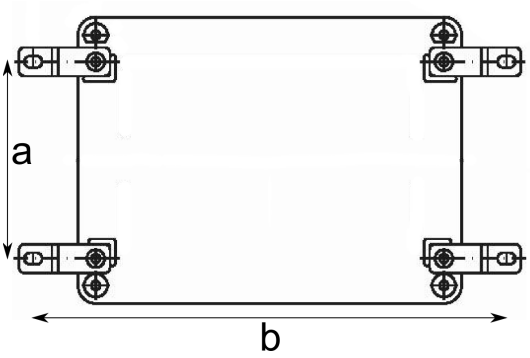


Figure 3.7: mounting kit HST-Z03 attached on narrow side

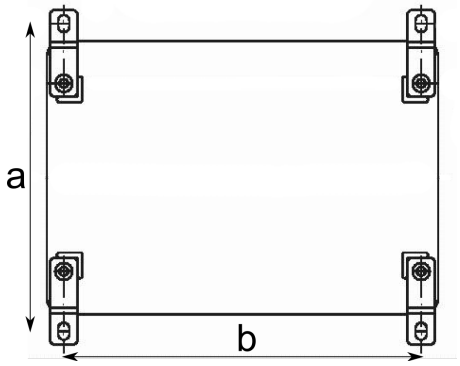


Figure 3.8: mounting kit HST-Z03 attached on long side

3.1.12 Optional output cable length instead of 3 m standard length

- HST-O2–5 5 m shielded output connection cable from HST to power meter LMG (BNC to 4 mm safety plugs)
- HST-O2–10 10 m shielded output connection cable from HST to power meter LMG (BNC to 4 mm safety plugs)

3.1.13 External high-voltage high breaking capacity fuses

Although HV fuse-links are not able to protect the HST in the case of an internal fault, they should be installed. In the case of a fault the HST shall be disconnected from the supply as fast as possible in order to limit the fault effects. This is why HV fuse-links of lowest possible rated currents are recommended.

Possible suppliers of this fuses are:

- SIBA (www.siba.com):
  Indoor and outdoor voltage Transformer fuses HHD-BVT
  Voltage transformer fuses HHZ-BVT
- ABB (www.abb.com):
  Indoor voltage transformer fuses WBP
  Outdoor voltage transformer fuses BRT

Fuse selection criterias

- Ambient conditions
- Rated voltage: 6 kV for HST3 and HST6
  Rated voltage: 12 kV for HST9 and HST12
- Rated current: 0.6 A to 1 A

ZES ZIMMER can not guarantee that the fuses of above mentioned suppliers are suitable for every purpose and application! It is the responsibility of the user to find and install a fuse appropriate to the application.

3.1.14 External surge arrester

To improve the operational reliability the usage of a surge arrester is recommended. With a surge arrester meeting the requirements and placed behind the previously mentioned HV-fuse, overvoltages can be held below the maximum non repetitive peak voltages of the HST.

Possible suppliers of surge arresters are:

- TRIDELTA (www.tridelta.de)
  Medium voltage arrester Series SBK
- SIEMENS (www.siemens.com)
  Medium voltage arrester Series 3EK7

Surge arrester selection criterias

- Ambient conditions
- Continuous operating voltage at installation point
- Temporary overvoltage at installation point
- Residual voltage against earth at possible impulse current:
  max. 8.8 kV for HST3
  max. 16.8 kV for HST6
  max. 23.8 kV for HST9
  max. 30.2 kV for HST12

ZES ZIMMER can not guarantee that the surge arresters of above mentioned suppliers are suitable for every purpose and application! It is the responsibility of the user to find and install a surge arrester appropriate to the application.

4 Reference Impedance

4.1 Reference Impedance for measurements as specified in IEC 61000-3-3/-11 (RI2415)

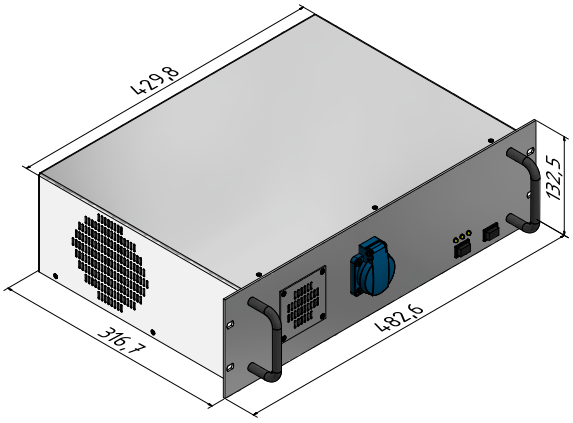


Figure 4.1: RI2415-SP (single phase)

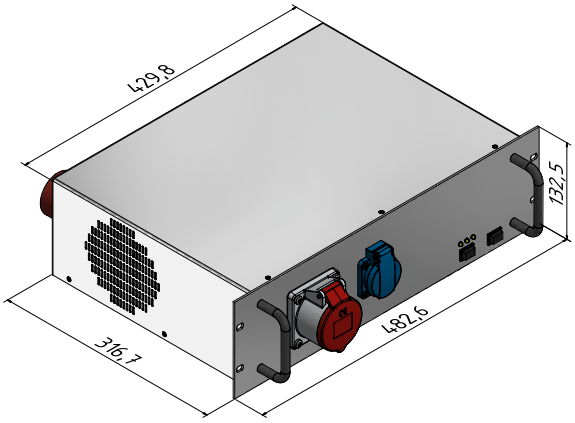


Figure 4.2: RI2415-TP (three phase)

This manual is applicable for RI2415-SP (single phase) and RI2415-TP (three phase). Most images show the three phase version, as it is basically identical to three single phase versions in one chassis. To use this manual for a single phase reference impedance you can just ignore the parts for phases two and three (L2 and L3).

4.1.1 Safety warnings

- Always connect the reference impedance first to the meter and afterwards to the device under test.
- Please refer to chapter Safety recommendations [1.2→5]!

4.1.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

4.1.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

4.1.4 Intended use

The device should not be used for applications other than intended to ensure that no malfunctions or dangers can arise. The RI2415 reference impedance is a device to allow measurements in regards to IEC 61000-3-3/-11 on equipment under test (EUT) connected to the outputs on the front of the device, using a power analyzer and artificial AC source connected to the rear input/outputs as described in the following sections.

4.1.5 Block Diagram

The basic operating principle of the RI2415 reference impedance in a measurement system is shown in the following block diagram.

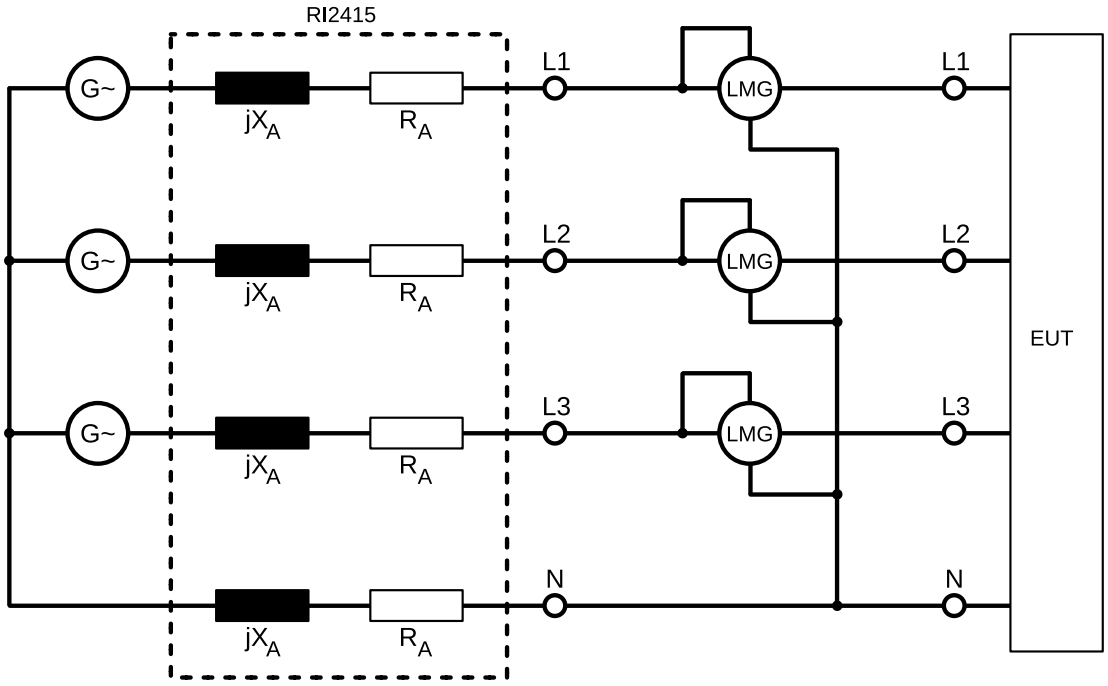


Figure 4.3: Block diagram of flicker measurement

4.1.6 Operation

Please make sure that all electrical connections are done appropriately before switching the device on. Please refer to the following image as a reference to the positions of the described connectors.

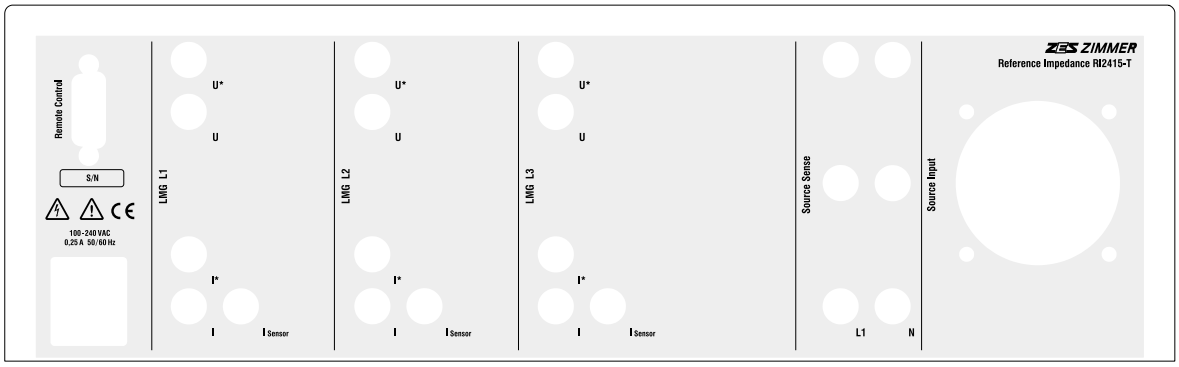


Figure 4.4: RI2415 Back Side

4.1.7 Connecting the power analyzer to the reference impedance

The RI2415 reference impedance is intended to be used with a ZES ZIMMER Power Analyzer of the LMG600 series or newer.

Please note: The outputs of the reference impedance are divided into individual sections by vertical lines. Each phase has its own set of connectors, marked with LMG L1, LMG L2 and LMG L3. For reference purposes only phase L1 is shown here, however, phases L2 and L3 are identical in the way they are to be connected.

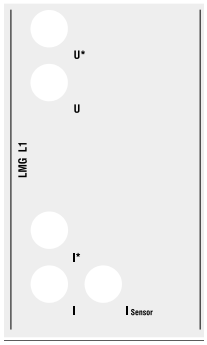


Figure 4.5: RI2415 One Phase

For easy connection of the reference impedance to a ZES ZIMMER power analyzer the device is designed in a similar style as the power analyzer of the ZES LMG600 series, so that you just have to make connections between each identical named contact: U → U, U* → U* and so on. In addition, the chosen colors on the reference impedance measurement outputs match those on the power analyzer measurement channels.

To use the reference impedance with a power analyzer that is not made by ZES ZIMMER Electronic Systems GmbH you will need to create the following connections:

RI2415	power meter
U	low potential of voltage measurement
U*	high potential of voltage measurement
I	low potential of current measurement
I*	high potential of current measurement
ISensor	voltage output between I and ISensor to measure source flicker (optional).
	Caution! Even though the output voltage is only a few volts, those are on phase potential!



For the connections of the current measurement please make sure to use wires of appropriate thickness to reduce losses in cables and mitigate the danger of overheating.



4.1.8 Connecting the artificial AC power source

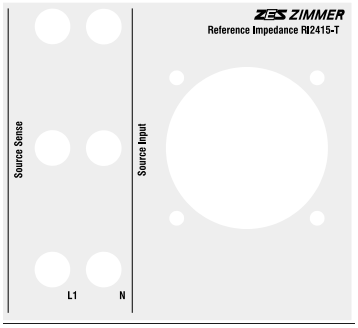


Figure 4.6: Connection to the artificial AC power source

On the right side of the rear of the device you will find the source power input, which will be either a C20 connector for the single phase version or a three phase 16A 3L+N+PE, 6h CEE connector. Connect the source input with the power output of your artificial AC power source.

Warning! Ensure that the polarity of the contacts is correct to prevent potential damage to the source. Since many European countries don't have polarised connectors this is especially relevant for the single phase version. The outmost (relative to the case) contact of the single phase power input is connected to neutral (low potential), while the innermost contact is connected to line (high potential).

In addition to the power input you need to connect the Source sense connectors to the sense terminals of your AC power source. Those are used to ensure that the regulation point of the AC power source is placed after all wiring impedances, internal impedances and the burden resistor of your current measurement path. Make absolutely sure that you did not accidentally swap the sense connectors! A wrong connection can damage your AC source! Make sure, that the external sense is activated in the power source.

Caution! It is only permitted to use an electronically regulated, fused artificial AC power source. Do NOT connect any low resistance AC power source which is able to deliver high pulse energy to the device. Damage to the equipment as well as serious injuries could occur in case of a fault if the device is used with an inappropriate, unprotected power source.

4.1.9 Connecting the equipment under test

The EUT needs to be connected either to the CEE 3L+N+PE, 6h, 16A three phase connector (only three phase version) or to the CEE 7/3 "Schutzkontakt" power outlet (both versions) on the front. Please note that this connector is ALWAYS connected to the power source, independent of the power state the reference impedance is in.

4.1.10 Operation instructions

To use the device it needs to be switched on using the switch at the front of the device that is marked with "Power". Warning! Even though the EUT output connector is always connected to the power input, even when the device is switched off, you must not load the device when it is shut off! Damages and inaccuracies caused by overheating may occur!

Utilizing the second button on the front the device can be switched to two modes, indicated by the "Impedance" and "Direct" lights situated directly above the switch. Additionally the "Remote" light can be lit when the remote control connector is used.

It is necessary to connect either shorting jumpers or the current path of your power analyzer to the current measurement connectors in all modes of operation.

4.1.11 Direct Mode

The RI2415 offers you two general modes of opperation. When the LED marked with ”Direct” is lit up, the device is operating in the ”Direct” mode. In this mode the supply voltage from the AC Source feeding the reference impedance is directly connected to the EUT output connection on the front of the device. This mode can be used to take measurements according to EN61000-3-2 (Harmonics). Please note that every circuit is routed over the current measurement connectors on the back.

4.1.12 Impedance Mode

If the LED marked with ”Impedance” is lit up, the device is working in the impedance mode. An artificial complex reference impedance as described in EN61000-3-3 is connected in series to the device under test. This mode is used to take measurements according to EN61000-3-3/-11 (Flicker).

4.1.13 Remote Mode

It is possible to use the ”Remote Control” connector on the rear side to control the reference impedance with your power analyzer or any other automatic measurement system you use. To connect the reference impedance to a ZES ZIMMER LMG Power Analyzer you can use the provided RI2415 Sync cable. If you prefer to use your own cable or want to connect the device to your existing automated measurement solution you can use the following pins:

Pin	Used for
4	Ground
5	Ground
9	Activate remote mode (active high) / manual mode (low)
10	Switching between Direct (low) / Impedance (high)

The remote connection uses standard TTL logic voltages. The maximum current for high level inputs is limited to 5 mA at 5 V. Please ensure that the input voltage does not exceed 5.5 V.

4.1.14 Technical Data

In the following principle circuit diagram you can see the internal function of the device and the way all measurement and sense outputs are connected. The indicated switches are activated when the device is switched to ”Direct” mode, in ”Impedance” mode those remain open.

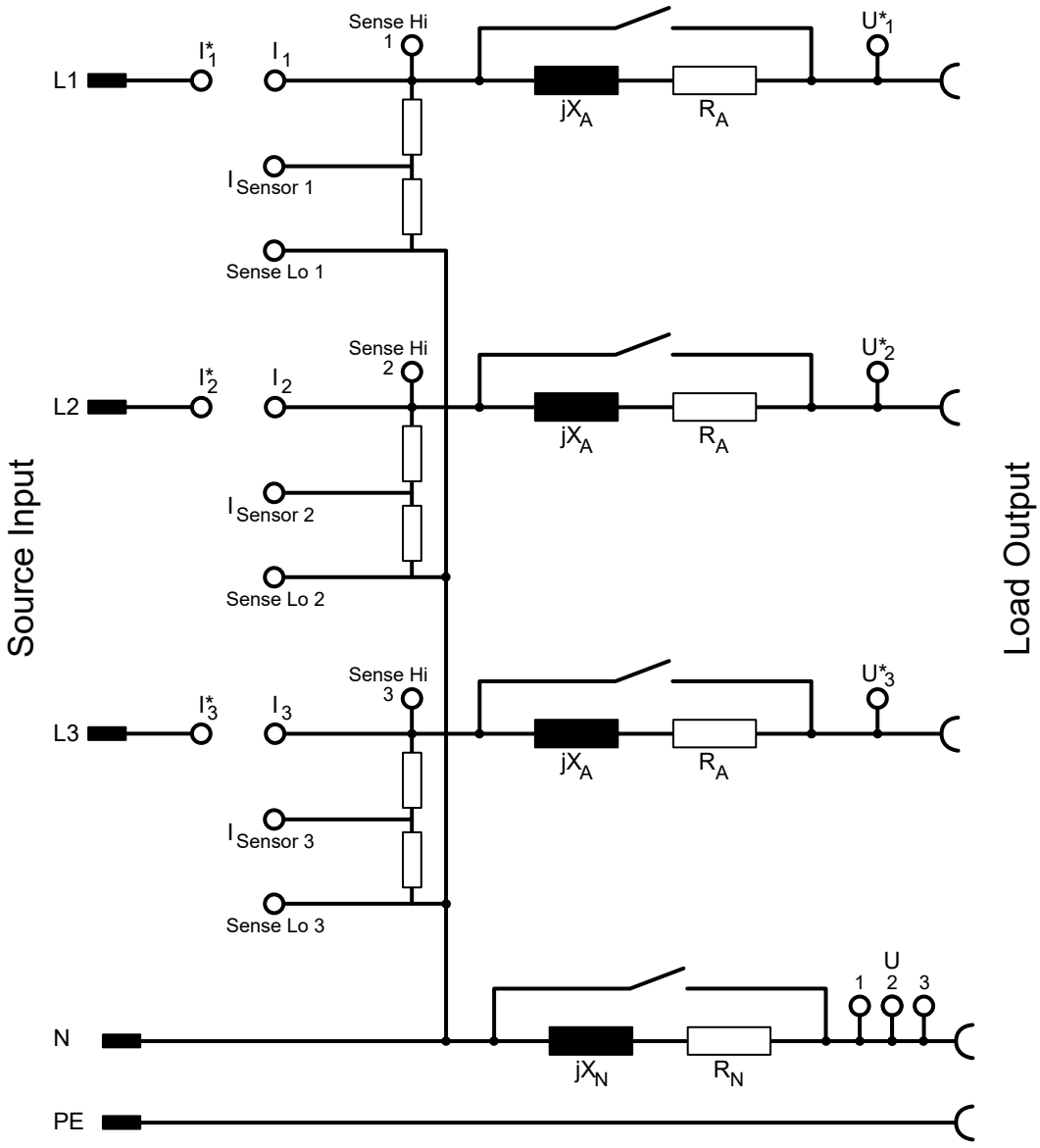


Figure 4.7: RI2415 Principle circuit diagram

Please refer to the following mechanical drawings for information about the mechanical appearance of the device.

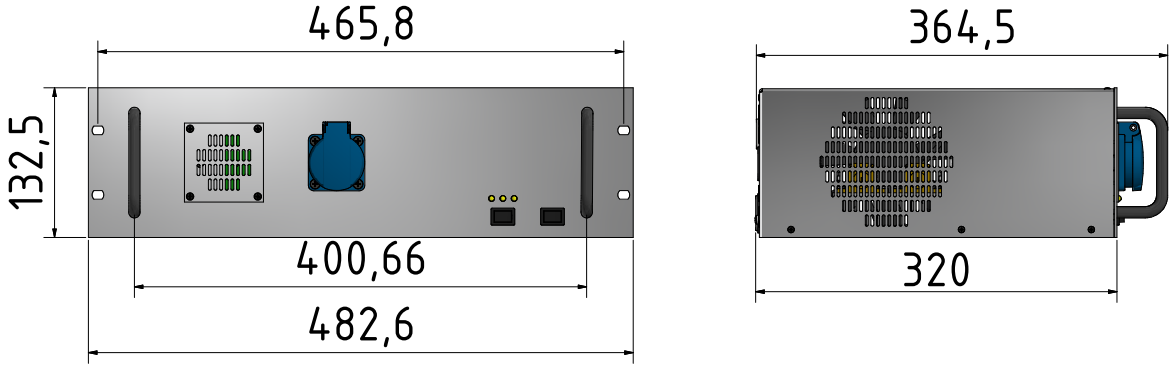


Figure 4.8: RI2415-SP Mechanical Drawing

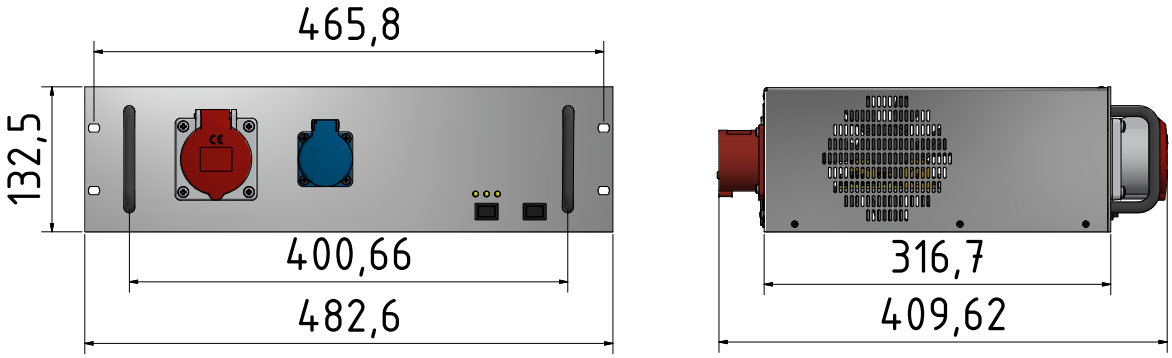


Figure 4.9: RI2415-TP Mechanical Drawing

4.1.15 Specifications

Power supply	100 ... 240 V, 50/60 Hz, 0.25 A
Fuse	T 0.4 A / 250 V, 5 x 20 mm
Mechanical rating	IP20 (DIN 40050)
Safety regulations	EN 61010
Working temperature	0 °C ... 40 °C
Storage temperature	-20 °C ... 50 °C
Climate classification	KYG (DIN 40040)
Weight Single phase Three phase	 <8 kg <14 kg
Impedance ($R_A + jX_A$) ($R_N + jX_N$)	 $(0.24 + j0.15)\,\Omega \pm 2\,\%$ at 50 Hz and 23 °C ± 3 °C $(0.16 + j0.10)\,\Omega \pm 2\,\%$ at 50 Hz and 23 °C ± 3 °C
Reference parameters	The reference impedance is able to withstand an nominal input voltage of 230 V (phase to neutral) / 400 V (phase to phase) at 16 A. (Overvoltage category CAT II)
Connections Single phase Three phase	 IEC 320/C20 (input) and "Schutzkontakt-steckdose" (CEE7/3) (each 230 V / 16 A) Two IEC 60309-2 "CEE 3L+N+PE, 6h" connectors, one male, one female. (each 400 V / 16 A)

4.1.16 Calibration

The following calibration procedure is recommended. To calibrate the RI2415 Reference Impedance you need to measure the complex impedances of each phase ($R_A + jX_A$) and neutral ($R_N + jX_N$).

The nominal values are
($R_A + jX_A$): $(0.24 + j0.15)\,\Omega \pm 2\,\%$ at 50 Hz and 23 °C ± 3 °C and
($R_N + jX_N$): $(0.16 + j0.10)\,\Omega \pm 2\,\%$ at 50 Hz and 23 °C ± 3 °C.

To measure those values it is recommended to induce a known sinusoidal current of at least 8 A / 50 Hz into the reference impedance, while the phases as well as the neutral path are connected in series according to the following diagram. As well as connecting the individual paths in series it is neccessary to short I_1 to I_1^*, I_2 to I_2^* and I_3 to I_3^*. Those connections can be done either using your power analyzers current measurement channels or by using short cables or bridges. If you use shorting

cables instead of your power analyzer you need to connect your power analyzers current paths in series, allowing every measurement channel to measure the current, as well as inserting it into the circuit, for example right after the current source. Connect the voltage path of your power analyzer to Sense Hi and U* of each phase to measure the impedance of each phase, as well as to either sense Lo and U connection for measuring the neutral impedance. Using your power analyzers inbuilt functions for measuring impedances you can now determine the exact value for (R_A + jX_A) and (R_N + jX_N).

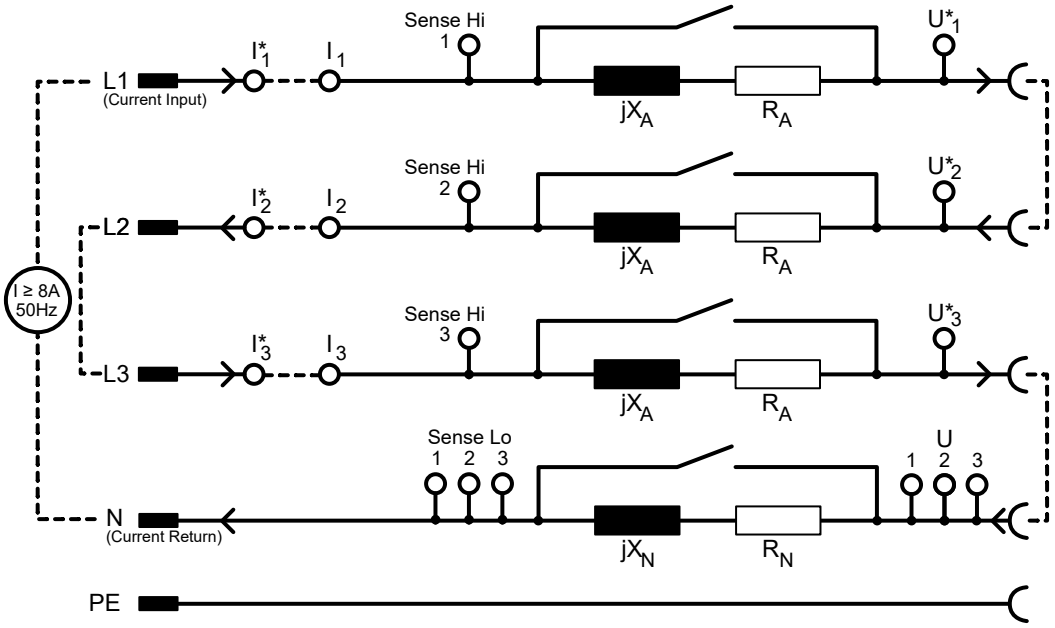


Figure 4.10: RI2415 Calibration Setup

5 Accessories

5.1 PCT current sensor supply unit (PCTSIU4)



Figure 5.1: PCTSIU4

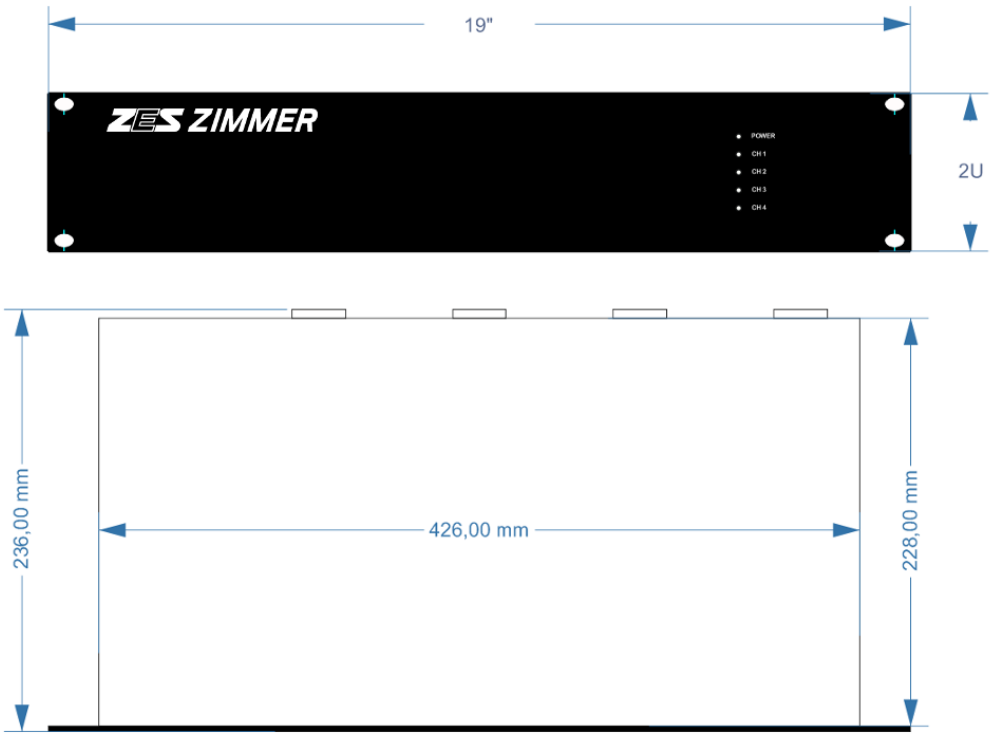


Figure 5.2: PCTSIU4 mechanical dimensions



Figure 5.3: PCTSIU4 back side

The sensor supply unit PCTSIU4 is intended to be used for powering up to four precision current transducers PCT200, PCT600 and PCT2000.

5.1.1 Safety warnings

- Do not power up the device before all cables are connected.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter Safety recommendations [1.2→5]!
- Do not disassemble the unit.
- Make sure that the unit is properly connected to earth ground.
- Do not block the ventilation openings on the side panels.
- If the fan does not operate properly contact the manufacturer for repair.
- If the 'power' green diode is not working when mains is applied, disconnect power and contact the manufacturer for further instruction.

5.1.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010
EMC	EN 61326-1

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.1.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.1.4 Specifications

Mains voltage	100 V ... 240 V
Mains frequency	47 Hz ... 63 Hz
Channels	4 x PCT200 or PCT600 or PCT2000
Output voltage	±15 V ... ±15.75 V

5.1.5 Installation



Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT is also recommended to lead away capacitive coupled distortion.

Also if bare conductors can be used up to the above values, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Do not power up the device before all cables are connected.

Connect the PCT-DSUB cable between supply unit and the sensor.

Connect an instrument with low impedance current path on the secondary output (4mm red and black connectors).

When all connections are secured - connect mains power.

When mains is applied a green light diode at the front next to symbol 'power' will light green. For each sensor connected a green light diode will light on the front if the connection is correct and the sensor is operating within normal range.

5.1.6 Package content

- PCTSIU4 supply unit
- Europe power cable and US/Asia power cable
- 4 x rubber feet for table use
- 4 x rack screw kits for 19" rack mount

5.1.7 Accessories

Connection cable PCT-DSUB, between Precision current transducers PCT and PCTSIU4.

5.2 PCT current sensor supply unit (PCTSIU4-1U)



Figure 5.4: PCTSIU4-1U



Figure 5.5: PCTSIU4-1U back side

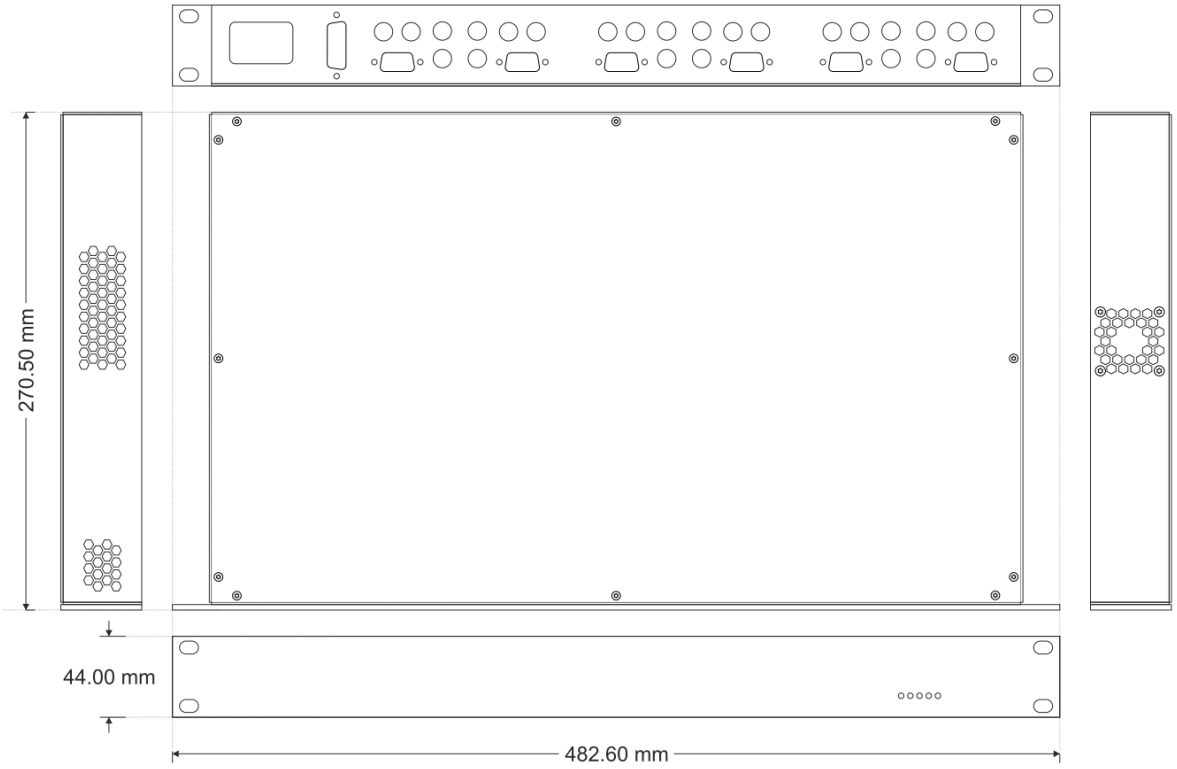


Figure 5.6: PCTSIU4-1U mechanical dimensions

The sensor supply unit PCTSIU4-1U is intended to be used for powering up to four precision current transducers PCT200, PCT600 and PCT2000.

Features

- Compact 19” rack mount 1U height
- Current transducers output current available via 4mm plugs
- Front LEDs indication of normal operation for each transducer and power LED

- Universal autorange (100-240V AC 50/60Hz) AC input voltage or DC input voltage on request.

5.2.1 Safety warnings



- Do not power up the device before all cables are connected.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!
- Do not disassemble the unit.
- Make sure that the unit is properly connected to earth ground.
- Do not block the ventilation openings on the side panels.
- If the fan does not operate properly contact the manufacturer for repair.
- If the 'power' diode is not working when mains is applied, disconnect power and contact the manufacturer for further instruction.

5.2.2 Standards and Directives

CE

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010
EMC	EN 61326-1:2013



A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

RoHS 2011/65/EU

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5.2.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.2.4 Specifications

AC Mains voltage	85 V ... 264 V
AC Input current	max. 1.6 A @ 115 V or 0.7 A @ 230 V
Mains frequency	47 Hz ... 63 Hz
Channels	1 ... 4 , refer to 'Ambient operating temperature'
Output voltage, DC	±14.75 V ... ±15.75 V
Output voltage ripple, rms	max. 15 mV

Ambient operating temperature	+5 °C ... +40 °C (@ 1 ... 4 x PCT200, PCT600 or PCT2000) +5 °C ... +50 °C (@ 1 ... 4 x PCT200, PCT600, max. 2 x PCT2000 with a primary current of 3000A DC)
Storage temperature	-20 °C ... +85 °C
Relative humidity	20 % ... 80 %
Mass	4.6 kg

5.2.5 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT is also recommended to lead away capacitive coupled distortion.

Also if bare conductors can be used up to the above values, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

If the PCTSIU4-1U is intended for desk use, mount the rubber feet which are part of the package. If the PCTSIU4-1U is intended for Rack mounting, use the screw kit for mounting and do not mount the rubber feet.

Do not power up the device before all cables are connected.

Connect the PCT-DSUB cable between supply unit and the sensor.

Connect an instrument with low impedance current path on the secondary output (4mm red and black connectors).

When all connections are secured - connect mains power.

When mains is applied a green light diode at the front will light. For each sensor connected a green light diode will light on the front if the connection is correct and the sensor is operating within normal range.

5.2.6 Package content

- PCTSIU4-1U supply unit
- Europe power cable
- 4 x rubber feet for table use
- rack screw kit for 19” rack mount
- 4 x Adapter to 4 mm safety system (LMG-ADP-SLJ) red
- 4 x Adapter to 4 mm safety system (LMG-ADP-SLJ) black

5.2.7 Accessories

Connection cable PCT-DSUB, between Precision current transducers PCT and PCTSIU4-1U.

5.3 Shielded PCT connection cable (PCT-DSUB)



Figure 5.7: Shielded PCT connection cable

This is a high quality, well shielded PCT connection cable with a high immunity against EMC. It is intended to be used to connect PCT200, PCT600 or PCT2000 to the supply unit PCTSIU4. It is available in different lengths: 2 m, 5 m, 10 m and 20 m.

5.3.1 Safety warnings

- Attention: No safety insulation, working voltage max. 50 V, when using Busbar without insulation or other not insulated items, assure safety distance between the extension cable and hazardous voltages!



- Please refer to chapter Safety recommendations [1.2→5]!

5.3.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.3.3 Specifications

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 male, DSUB9 female, knurled screw or locking screw
Connection	1:1, but pin2 and pin7 not connected!
Operating temperature	-5 °C ... +70 °C
Standard cable length	PCT-DSUB2: 2 m PCT-DSUB5: 5 m PCT-DSUB10: 10 m (cable resistance does not have to be considered when calculating the burden)
Extended cable length	PCT-DSUB20: 20 m (not for PCT2000, PCT200 and PCT600: reduce max. instrument burden by 1.8 Ω)

5.4 Shielded Sensor extension cable with extended temperature range (LMG-Z-SVT)



Figure 5.8: Shielded Sensor extension cable with extended temperature range

This is a high quality very well shielded Sensor extension cable for high EMC. The special cable construction and integrated filter elements reduce noise pickup. This obtains interference free operation at long cable runs and in noisy environments. It is screwable with UNC4-40 threads at both connectors. The cable is halogen-free and has a good UV-resistance.

It can be used to extend the cable length of the PCT connection cables. In this case it is used between the precision current sensor PCT200/600/1200/2000 and the LMG specific connection cable to the LMG. This cables can also be used for the discontinued PSU60/200/400/600/700/1000 current sensor series.

All pins are connected 1:1 except pin2 and pin7, they are left open for the use with current sensors PCT (and PSU).

5.4.1 Safety warnings

- Attention: No safety insulation, working voltage max. 50 V, when using Busbar without insulation or other not insulated items, assure safety distance between the extension cable and hazardous voltages!
- Please refer to chapter Safety recommendations [1.2→5]!

5.4.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.4.3 Specifications

The possible cable length extension is limited by voltage drop due to the wire resistance.

Insulation	No safety insulation, working voltage max. 50 V					
Connectors	DSUB9 male / DSUB9 female, knurled screw or locking screw					
Operating temperature	-40 °C ... +90 °C					
Cable type			suitable for			
	Length	Cross section	PCT200	PCT600	PCT1200	PCT2000
LMG-Z-SVT5	5 m	0.5 mm^2	x	x	x	x
LMG-Z-SVT10	10 m	0.5 mm^2	x	x	x	[a]
LMG-Z-SVT15	15 m	0.5 mm^2	x	x	[b]	[b]

[a] up to 1800 A input current peak
[b] up to 1000 A input current peak

5.5 Shielded DSUB9 extension cable (LMG-Z-DV)



Figure 5.9: Shielded DSUB9 extension cable

This is a high quality well shielded DSUB9 extension cable for high EMC. It is screwable with UNC4-40 threads at both connectors.

It can be used to extend the cable length of the PCT connection cables. In this case it is used between the precision current sensor PCT200/600/1200/2000 and the LMG specific connection cable to the LMG. This cables can also be used for the discontinued PSU60/200/400/600/700/1000 current sensor series.

All pins are connected 1:1 except pin2 and pin7, they are left open for the use with current sensors PCT (and PSU).

5.5.1 Safety warnings

- Attention: No safety insulation, working voltage max. 50 V, when using Busbar without insulation or other not insulated items, assure safety distance between the extension cable and hazardous voltages!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

5.5.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do

not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.5.3 Specifications

Insulation	No safety insulation, working voltage max. 50 V					
Connectors	DSUB9 male / DSUB9 female					
Operating temperature	-5 °C ... +70 °C					
Cable type			suitable for			
	Length	Cross section	PCT200	PCT600	PCT1200	PCT2000
LMG-Z-DV3	3 m	0.5 mm^2	x	x	x	x
LMG-Z-DV5	5 m	0.5 mm^2	x	x	x	x
LMG-Z-DV10	10 m	0.5 mm^2	x	x	x	[a]
LMG-Z-DV20	20 m	1 mm^2	x	x	x	[a]

[a] up to 1800 A input current peak

The possible cable length extension is limited by voltage drop due to the wire resistance.



5.6 LMG600 connection cable for current sensors PSU (PSU-K-L6)

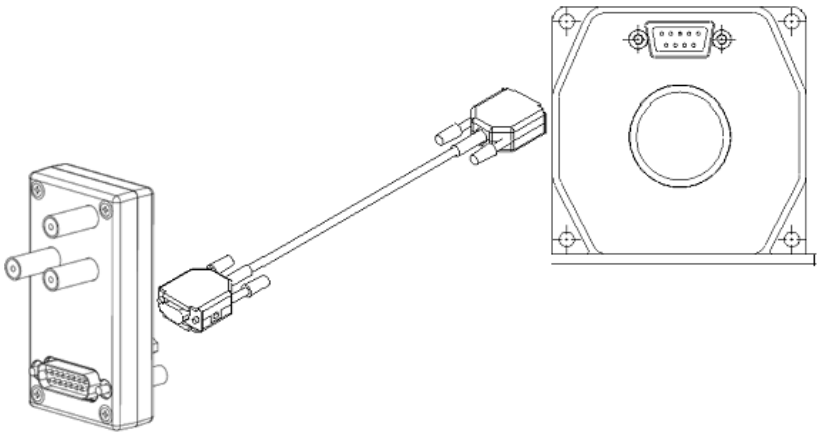


Figure 5.10: PSU-K-L6 (shown together with L60-X-ADSE and transducer head PSU)

The LMG600 connection cable PSU-K-L6 is for the connection of discontinued precision current transducers series PSU. It is not recommended for new projects, but for the use of previously purchased LMG500 transducers. PSU-K-L6 is a generic cable for the supply and measurement of the current output of PSU60, PSU200, PSU200HF, PSU400, PSU700 and PSU1000HF with the I* ranges of LMG600 series. The Iscale of the corresponding current channel has to be set to the below given values. No calibration data, range information, serial number and sensor name is stored in the cable. No additional error terms of the cable have to be considered. If a calibration protocol is required, the precision current transducer PSU is calibrated without this cable.

PSU600 is not pin-compatible to PSU-K-L6, please connect this transducer to LMG600 via SSU4 and PSU-K3/K5/K10 and SSU4-K-L31.

For new projects, please see precision current transducers series PCT.

5.6.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter Safety recommendations [1.2→5]!

5.6.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.6.3 Accuracy specification

For the accuracy specification see the datasheet of the precision current transducer PSU and use the below given measuring ranges of LMG600 to calculate the accuracy of the complete system.

5.6.4 Connection and supply of current sensors PSU with LMG600

Use PSU-K-L6 and L60-X-ADSE, supply via LMG600. PSU-K-L6 is a generic connection cable for PSU60, PSU200, PSU200HF, PSU400, PSU700 and PSU1000HF with different current consumption, therefore there is no sensor supply current monitoring by LMG600. Please regard that that the amount of supply current for all current sensors does not exceed the supply capability from the LMG! See following table.

Supply capability

supply capability (for all current sensors) of LMG640/641/670/671	5 A
supply current of PSU60	180 mA
supply current of PSU200/200HF/400	280 mA
supply current of PSU700	480 mA
supply current of PSU1000HF	1.08 A

PSU-K-L6

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 female / DSUB15 male, knurled screw or locking screw
Operating temperature	+5 °C ... +40 °C
Cable length	2.5 m

Measuring ranges LMG600 with PSU60

Set Iscale to 600. Limited by PSU60 to 'Max. TRMS value' = 60 A and 'Max. peak value' = 60 A.

Nominal range / A	3	6	12	24	48	(90)	...
Max. TRMS value / A	3.3	6.6	13.2	26.4	52.8	(99)	...
Max. peak value / A	8.4	16.8	33.6	(67.2)	(134.4)	(281.4)	...

Measuring ranges LMG600 with PSU200 / PSU200HF

Set Iscale to 1000. Limited by PSU200 / PSU200HF to 'Max. TRMS value' = 200 A and 'Max. peak value' = 200 A.

Nominal range / A	5	10	20	40	80	150	(300)	...
Max. TRMS value / A	5.5	11	22	44	88	165	(330)	...
Max. peak value / A	14	28	56	112	(224)	(469)	(938)	...

Measuring ranges LMG600 with PSU400

Set Iscale to 2000. Limited by PSU400 to 'Max. TRMS value' = 400 A and 'Max. peak value' = 400 A.

Nominal range / A	10	20	40	80	160	300	(600)	...
Max. TRMS value / A	11	22	44	88	176	330	(660)	...
Max. peak value / A	28	56	112	224	(448)	(938)	(1876)	...

Measuring ranges LMG600 with PSU700

Set Iscale to 1750. Limited by PSU700 to 'Max. TRMS value' = 700 A and 'Max. peak value' = 700 A.

Nominal range / A	8.75	17.5	35	70	140	262.5	525	(1050)	...
Max. TRMS value / A	9.625	19.25	38.5	77	154	288.75	577.5	(1155)	...
Max. peak value / A	24.5	49	98	196	392	(820.75)	(1641.5)	(3281.25)	...

Measuring ranges LMG600 with PSU1000HF
Set Iscale to 1000. Limited by PSU1000HF to 'Max. TRMS value' = 1000 A and 'Max. peak value' = 1000 A.

It is possible to supply up to four PSU1000HF from LMG600. If more PSU1000HF are needed, please use sensor supply unit SSU4 with modification for PSU1000HF and PSU-K3/K5/K10 and SSU4-K-L31.

Nominal range / A	5	10	20	40	80	150	300	600	(1200)	...
Max. TRMS value / A	5.5	11	22	44	88	165	330	660	(1320)	...
Max. peak value / A	14	28	56	112	224	469	938	(1875)	(3750)	...

5.6.5 Connection extension

To use the current sensor with a larger connection length between power meter and PSU connect a well shielded extension cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extension cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

5.7 Adaptor for measurement at Schuko devices (LMG-MAS)



Figure 5.11: LMG-MAS

The MAS is a adaptor for measuring at single phase devices with Schuko inlet connector up to 16 A. It was developed for the instrument series LMG. The supply is done by the fix mounted Schuko inlet. The load is connected to the fixed mounted Schuko jack. With the LMG-MAS you can measure the voltage (jacks U and U*). The current is also accessable (from I* to I). This jacks have to be connected to the jacks of the measuring instrument.

The internal wiring is done so that the load is measured with correct current. This wiring is perfect suited for the measurement of stand by power. An important point is the safety. The MAS is in compliance with IEC61010-1 and was constructed for voltages up to 250 V CAT II.

5.7.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.
- Attention! The PE jack should not be used for earthing external devices. It is only allowed to use it for measuring purposes.
- Important! If you dont want to measure the current, the jacks I* and I have to be short circuit to enable the current to flow.
- Please refer to chapter Safety recommendations [1.2→5]!

5.7.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety EN 61010-1:2010



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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.7.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.7.4 Specifications

Rated voltage	250 V CAT II
Rated current	16 A

5.8 Adaptor for measurement at IEC connector devices (LMG-MAK1)

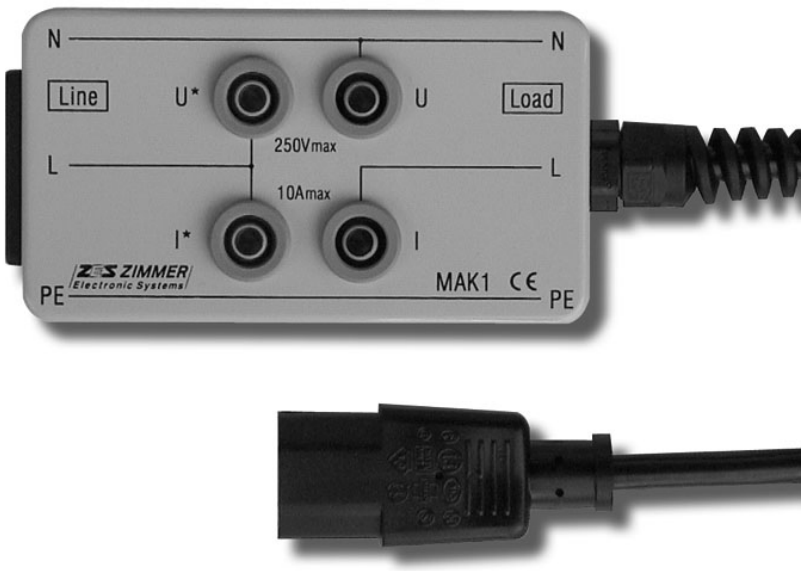


Figure 5.12: LMG-MAK1

The MAK1 is an adaptor for measuring at single phase devices with IEC inlet connector up to 10 A. It was developed for the instrument series LMG. The supply is done by a IEC inlet cord which must be connected to the MAK1. The load is connected by the fixed mounted cord. With the MAK1 you can measure the voltage (jacks U and U*). The current is also accessable (from I* to I). This jacks have to be connected to the jacks of the measuring instrument.

The internal wiring is done so that the load is measured with correct current. This wiring is perfect suited for the measurement of stand by power.

An important point is the safety. The MAK1 is in compliance with IEC61010-1 and was constructed for voltages up to 250 V CAT II.

5.8.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.



- Important! If you dont want to measure the current, the jacks I* and I have to be short circuit to enable the current to flow.

- Please refer to chapter Safety recommendations [1.2→5]!

5.8.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

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5.8.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.8.4 Specifications

Rated voltage	250 V CAT II
Rated current	10 A

5.9 Adaptor for measurement at 16 A / 3-phase devices (BOB-CEE3-16)



Figure 5.13: BOB-CEE3-16

The BOB-CEE3-16 is an adaptor designed for measuring up to 16 A per phase in 3-phase systems. It was developed for the instrument series LMG, but third-party instruments may be connected as well.

The BOB-CEE3-16 allows measurement of the voltage of each of the three phases (jacks L1, L2 and L3) against the neutral jacks and each of the three currents (I1, I2 and I3). By using a 4-channel instrument, the voltage between neutral and earth (N against ⏚) can be measured, as well as the current in the neutral (IN). It also allows measurement of the linked voltages. The adaptor is standard equipped with a jumper in the neutral path, which enables the current to flow. The length of the supply cable is about 2m.

The Schuko jack (Aux. Supply) can be used to supply the instrument and other equipment (e.g. laptop computer). If a load is measured, the power consumption of the instrument is not taken into account, as it is supplied before the measuring connectors. If a generator is measured, the instrument should be powered from a separate jack in order to avoid measuring errors.

5.9.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.



- Attention: Ensure in any case, that the N (neutral) on the patch panel is connected from the input side to the output side! Either via a current measurement path or with a short circuit on the patch panel. An open N (neutral) can lead to dangerous voltage at the output and may destroy the connected load!! If you dont want to measure the current in L1, L2 or L3, the jacks Ix* and Ix have to be short circuit to enable the current to flow!

- Please refer to chapter Safety recommendations [1.2→5]!

5.9.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety EN 61010-1:2010



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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.9.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.9.4 Specifications

Rated voltage	230 V / 400 V CAT II
Rated current	16 A

5.10 Adaptor for measurement at 32 A / 3-phase devices (BOB-CEE3-32)

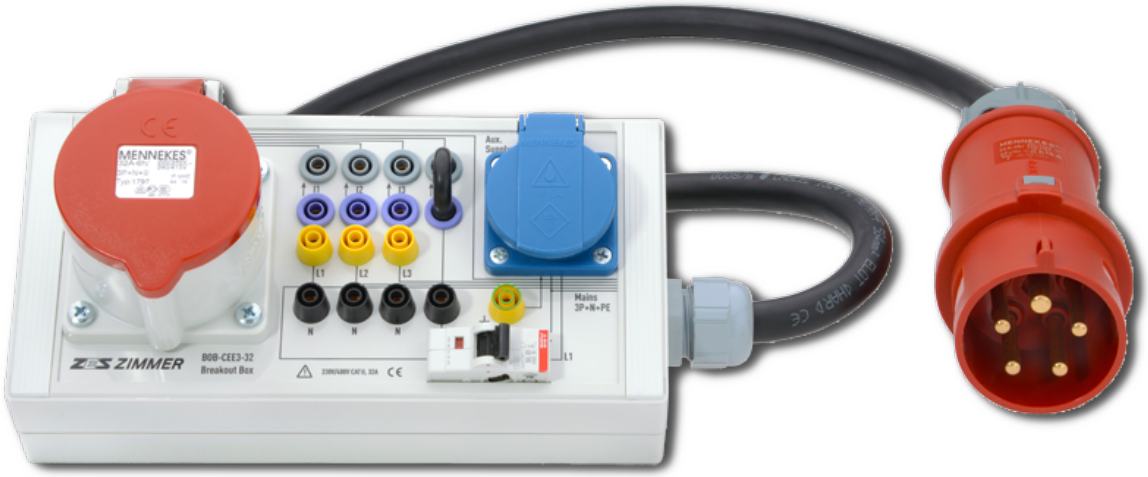


Figure 5.14: BOB-CEE3-32

The BOB-CEE3-32 is an adaptor designed for measuring up to 32 A per phase in 3-phase systems. It was developed for the instrument series LMG, but third-party instruments may be connected as well.

The BOB-CEE3-32 allows measurement of the voltage of each of the three phases (jacks L1, L2 and L3) against the neutral jacks and each of the three currents (I1, I2 and I3). By using a 4-channel instrument, the voltage between neutral and earth (N against ⏚) can be measured, as well as the current in the neutral (IN). It also allows measurement of the linked voltages. The adaptor is standard equipped with a jumper in the neutral path, which enables the current to flow. The length of the supply cable is about 2m.

The Schuko jack (Aux. Supply) can be used to supply the instrument and other equipment (e.g. laptop computer). For safety purpose, this Schuko jack is equipped with a standard 16 A circuit breaker. If a load is measured, the power consumption of the instrument is not taken into account, as it is supplied before the measuring connectors. If a generator is measured, the instrument should be powered from a separate jack in order to avoid measuring errors.

5.10.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.



- Attention: Ensure in any case, that the N (neutral) on the patch panel is connected from the input side to the output side! Either via a current measurement path or with a short circuit on the patch panel. An open N (neutral) can lead to dangerous voltage at the output and may destroy the connected load!! If you dont want to measure the current in L1, L2 or L3, the jacks Ix* and Ix have to be short circuit to enable the current to flow!

- Please refer to chapter Safety recommendations [1.2→5]!

5.10.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.10.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.10.4 Specifications

Rated voltage	230 V / 400 V CAT II
Rated current	32 A

5.11 Safety laboratory leads (LMG-Z307, -Z308, -Z309, -Z310, -Z311)



Figure 5.15: Safety laboratory leads for current path



Figure 5.16: Fused safety laboratory leads for voltage path



Figure 5.17: Safety laboratory lead for general purpose

Safety laboratory leads for voltage and current measurement. The blue cable for general purpose can be used for example to short circuit the voltage channels at zero adjustment or for star/delta wiring.

5.11.1 Safety warnings



- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!
- The yellow and black voltage cables have each an implemented fuse. Before and after each measurement: Check the fuse! To replace this fuse, remove the cable on both sides from all circuits to make it free of dangerous voltages. Disassemble the fuse holder. Replace the fuse only with the specified type. Reassemble the fuse holder.

5.11.2 Standards and Directives



This product meets the following EU standards for health, safety, and environmental protection:

Safety EN 61010-1:2010



A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.



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5.11.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.11.4 Specifications

Color	grey and violet
Length	LMG-Z307I: 0.25 m LMG-Z308I: 1.5 m LMG-Z309I: 3 m LMG-Z310I: 6 m LMG-Z311I: 10 m
Measurement category	1000 V / CAT III
Temperature range	-10 °C ... +70 °C
Cable	PVC double-insulated
Contact parts	gold-plated
Sleeves	PA6.6 (Polyamid)
Copper cross section	2.5 mm^2
Rated current	32 A

Table 5.5: Safety laboratory leads for current path

Color	black and yellow
Length	LMG-Z308U: 1.5 m LMG-Z309U: 3 m LMG-Z310U: 6 m LMG-Z311U: 10 m
Measurement category	1000 V / CAT III
Temperature range	-10 °C ... +70 °C
Cable	PVC double-insulated
Contact parts	gold-plated
Sleeves	PA6.6 (Polyamid)
Copper cross section	1 mm^2
Fuse-Link	6.3 mm x 32 mm, 500 mA, 1000 V, AC+DC, Super quick-acting, 30 kA breaking capability (@ AC/DC 1000 V), e.g. SIBA 7017240.0,5 or ESKA 632.414

Table 5.6: Fused safety laboratory leads for voltage path

Color	blue
Length	LMG-Z307NSB: 0.25 m
Measurement category	1000 V / CAT III
Temperature range	-10 °C ... +70 °C
Cable	PVC double-insulated
Contact parts	gold-plated
Sleeves	PA6.6 (Polyamid)
Copper cross section	2.5 mm^2
Rated current	32 A

Table 5.7: Safety laboratory leads for general purpose

5.12 Voltage range extender (L60-CH-S-VRE)

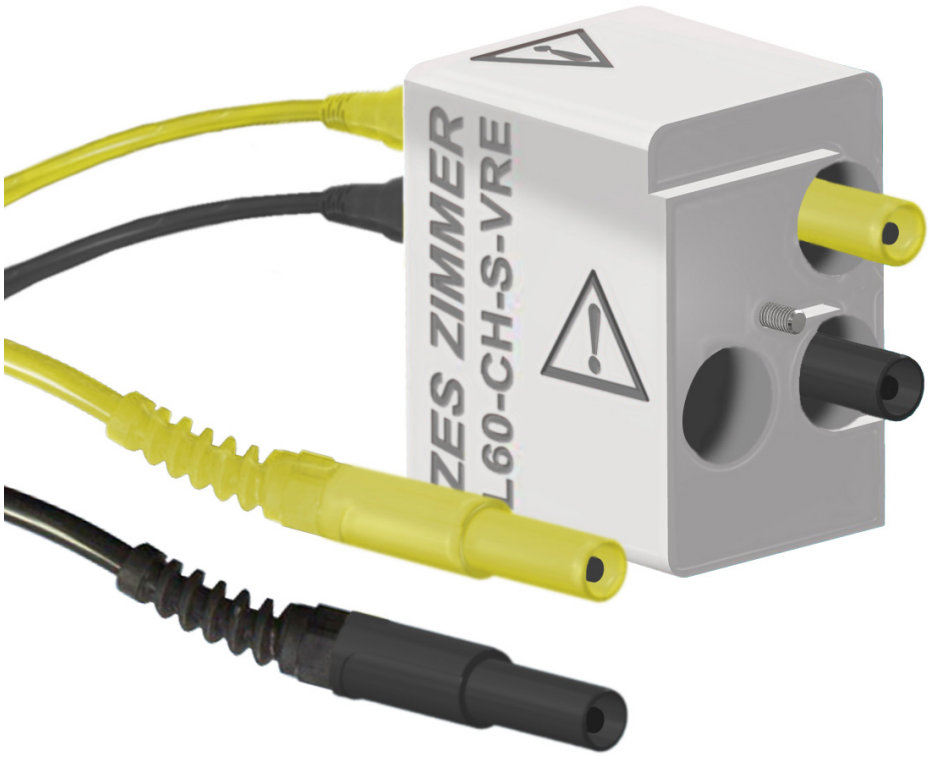


Figure 5.18: Voltage range extender (L60-CH-S-VRE)

The L60-CH-S-VRE is a plug-in adaptor for a L60-CH-S3 measuring channel. This adaptor extends the voltage range to DC voltages of up to 1500 V. Only with this adaptor it is possible to measure DC voltages $>$ 1000 V in a safe way. The cables have a length of 1.5 m and have a 4 mm safety plug on the application side.

5.12.1 Safety warnings



- Please refer to chapter Safety recommendations [1.2→5]!
- This adaptor must be plugged on L60-CH-S3 measuring channels only. The usage on other channels is forbidden.
- This adaptor must be plugged on the voltage jacks of the measuring channel only. The usage on the current jacks is forbidden.
- The adaptor must be fixed to the measuring channel with the built-in screw. The drive of the screw is a 2.5 mm hexagon socket screw key (Allen key).
- If the built-in in screw is lost or defective, the L60-CH-S-VRE must be repaired by authorized personal or replaced.
- The adaptor must only be used by personnel familiar with the risks of DC voltages of 1500 V.
- The adaptor must not be mounted or fixed under voltage.

5.12.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety EN 61010-1, EN 61010-2-030

A product that is labeled as follows cannot be disposed of in normal household waste after it has come to the end of its life. Electrical and Electronic equipment must be collected separately from unsorted municipal waste. For the return and disposal of electrical and electronic equipment, please contact us by E-mail via info@zes.com.

This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.12.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.12.4 Intended use

Measuring voltages

The combination of L60-CH-S-VRE together with a measuring channel L60-CH-S3 is rated according to EN 61010-1 and EN 61010-2-030 for measuring voltages from ⊙**U*** to ⊙**U** up to:

- $U_{AC} = U_{DC} = 600\,V$, measurement category CAT III
- $U_{AC} = 1000\,V$, measurement category CAT II
- $U_{DC} = 1500\,V$, measurement category CAT II
- other circuits:
  working voltage rms 1000 V,
  working voltage peak 3200 V and
  transient overvoltage 1600 V

Insulation voltages

The combination of L60-CH-S-VRE together with a measuring channel L60-CH-S3 is rated according to EN 61010-1 and EN 61010-2-030 for insulation voltages from ⊙**U***, ⊙**U**, ⊙$\mathbf{U_{Sensor}}$, ⊙**I***, ⊙**I**, ⊙$\mathbf{I_{Sensor}}$ to protective earth PE and from ⊙**U** to ⊙**I** up to:

- $U_{AC} = U_{DC} = 600\,V$, measurement category CAT III
- $U_{AC} = U_{DC} = 1000\,V$, measurement category CAT II
- other circuits:
  working voltage rms 1000 V,
  working voltage peak 3200 V and
  transient overvoltage 1600 V

Specifications

Add the following line to the specifications of L60-CH-S3:

Overload capability	$U_{DC} = 1500\,V + 10\,\%$ continuously

5.13 Adapter to 4 mm safety system (LMG-ADP-SLJ)

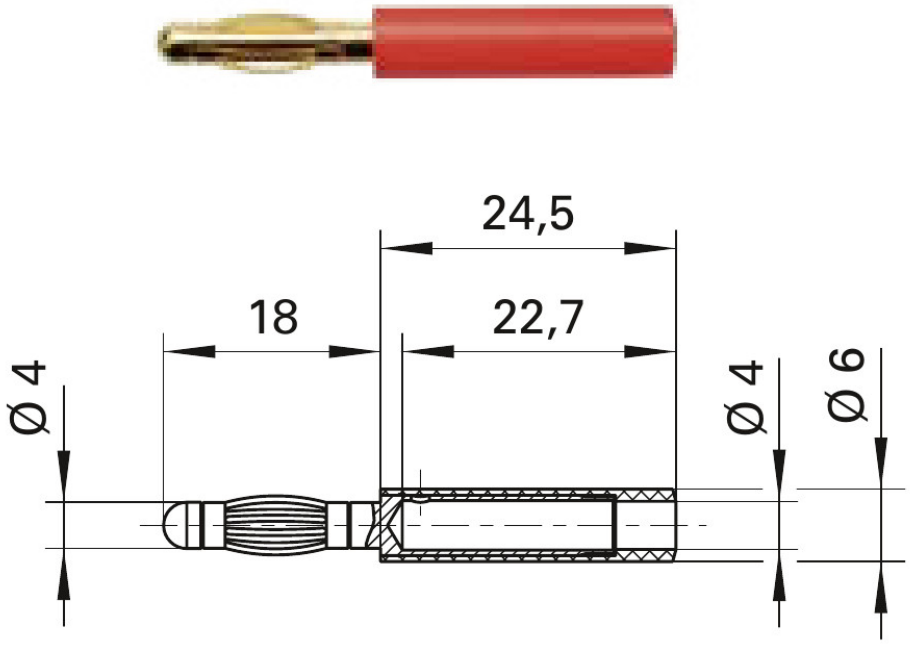


Figure 5.19: LMG-ADP-SLJ, all dimensions in mm

For adaption from Ø 4 mm system to Ø 4 mm safety system.

Two pcs. are included, color: red and black.

The contact parts are gold-plated.

5.13.1 Safety warnings

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!
- No safety insulation!
- Rated voltage max. 33 V_{AC} / 70 V_{DC} !

5.13.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.13.3 Specifications

Rated voltage	33 V_{AC} / 70 V_{DC}
Insulation material	PA 6.6
Rated current	32 A
Terminal	inline socket
Operating temperature	-25 °C ... +80 °C

5.14 Insulated 4 mm connecting plug (LMG-SCP)



Figure 5.20: LMG-SCP, picture similar

Insulated 4 mm connecting plug, made of brass. Plugs with spring-loaded Multilams and rigid insulating sleeves. With insulated grip and with two in-line 4 mm rigid sockets accepting spring-loaded 4 mm plugs with rigid insulating sleeve. Plug spacing 19 mm.

This plug can be used for the short circuit at zero adjustment, for test measurements of common-mode rejection and for the current connection on the patch panel of LMG-MAS / LMG-MAK1 / LMG-MAK3 and BOB-CEE3-32.

5.14.1 Safety warnings

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

5.14.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety	EN 61010-1:2010

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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.14.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.14.4 Specifications

Rated voltage	1000 V, CAT II
Rated current	32 A
Plug spacing	19 mm

5.15 Adapter for using resolvers with LMG600 (L6-ACC-RSLV)

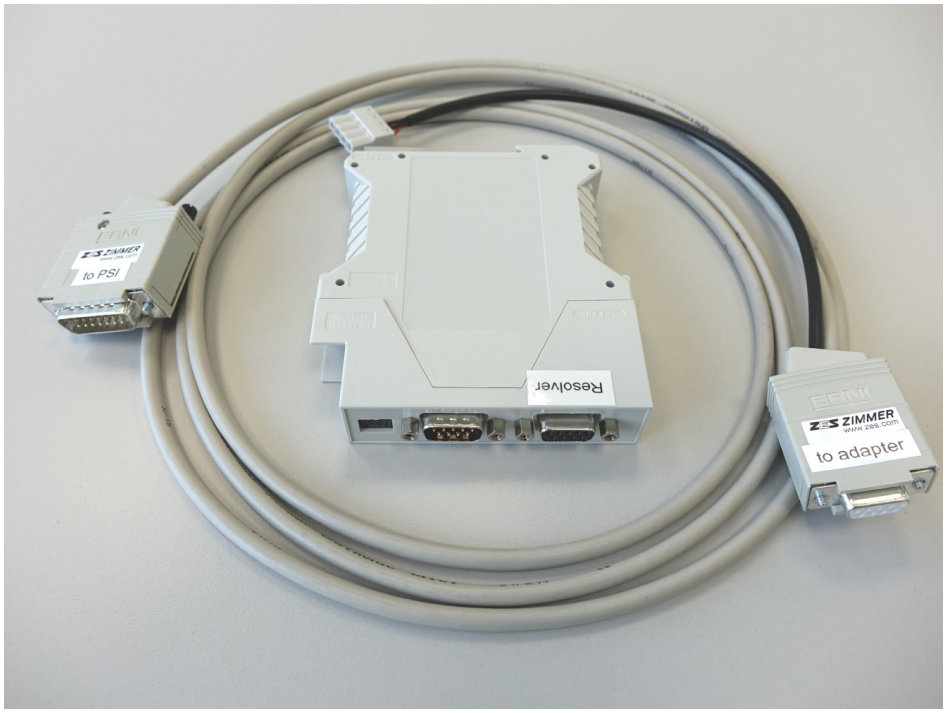


Figure 5.21: L6-ACC-RSLV

The L6-ACC-RSLV is an adapter for the LMG600 family of Power Analyzers and enables the user to connect resolvers to the PSI of the LMG600. In addition to the speed information the adapter will also allow the LMG600 to sample the angular position of the resolver.

Both standard resolvers as well as variable reluctance resolvers can be used, as long as they match the electrical specifications of the adapter. The adapter is supplied with power by the LMG600 PSI interface, thus eliminating the need for an external power supply. The resolver in turn is supplied via the adapter which feeds an excitation waveform to the resolver's primary winding. The sin/cos waveforms of the secondary windings of the resolver are fed back to the adapter which are then converted to an incremental digital signal. The adapter provides an A, B and Z signal output to the LMG600 which represent the speed, direction and an index pulse. The number of pulses per each revolution of the resolver can be selected by DIP switches.

5.15.1 Safety warnings



- Intended use: The resolver adapter is designed to be used in measurement and control technology according to EN 61010-1 (IEC 61010-1).
- Improper use: The resolver adapter must not be used as a safety related part (SRP). No safety related functions such as emergency stops shall be controlled by it. The resolver adapter must not be used in areas exposed to explosion hazards. The resolver adapter must not be used as electrical equipment according to the low voltage directive 2006/95/EG.
- Limitations of use: The observation of all safety warnings and instructions written in this manual is mandatory for the intended use of this product. Using the product in a different way than described herein is considered as non intentional use. The manufacturer can not be held responsible for any damage resulting from this. The resolver adapter should be kept in its bag before use. Removing any labels of the resolver adapter voids the warranty.
- Please refer to chapter Safety recommendations [1.2→5]!

5.15.2 Setup

Connections and DIP switches

The LMG must be switched off before connecting the adapter.

The adapter is connected to the LMG600 Process Signal Interface (PSI) with the included connecting cable. The 15 pin DSUB connector labeled ”to PSI” connects to the Speed/Torque/Frequency Inputs of the PSI, the 9 pin DSUB connector labeled ”to adapter” connects to the resolver adapter box. The screw terminal plugs into the opening with the four supply pins. The resolver needs to be connected to the 9 pin DSUB connector labeled ”Resolver”.

Set the desired resolution of the adapter with the DIP switches. Switch 1 and 2 set the resolution of the incremental output signal. Switch 3 must be in the off-position.

PSI menu

The PSI menu needs to be configured as follows:

Set the **Mode** to ”Single Motor” and the **Sensor Trq-Speed** to ”Ana - Dig”. Only analog torque sensors are supported at the moment. Under **Settings** ”Speed”, configure the **Pulses p. Rev.** according to the set resolution (see table). Set **Filter** ”Off” and the **Signal Type** to ”RS422”.

Switch			Pulses per revolution	max. speed (revolutions per s)
1	2	3		
off	off	off	16384	125
off	on	off	4096	500
on	off	off	1024	1000
on	on	off	256	2500
x	x	on	reset mode, switch 3 must be in the off-position	

5.15.3 Specifications

Resolver excitation signal	
Amplitude	$U_{\mathrm{pp}} = 7\,\mathrm{V}$
Frequency	$f = 10\,\mathrm{kHz}$
Output current	$I_{\mathrm{rms\ max.}} = 100\,\mathrm{mA}$
Resolver output	
Amplitude	$U_{\mathrm{pp\ max.}} = 4\,\mathrm{V}$
Accuracy	±5 arcmin
Dimensions	118 mm * 23 mm * 100 mm (l * w * h)
Mass	100 g
Cable length	2 m

5.15.4 Resolver connection (9 pin DSUB)

Pin No.	Signal	Description
1	REF -	differential excitation signal to the primary winding of the resolver (-)
2	nc	not connected
3	nc	not connected
4	nc	not connected
5	SIN +	differential signal of the secondary winding of the resolver (+)
6	SIN -	differential signal of the secondary winding of the resolver (-)
7	REF +	differential excitation signal to the primary winding of the resolver (+)
8	COS +	differential 90° shifted signal of the secondary winding of the resolver (+)
9	COS -	differential 90° shifted signal of the secondary winding of the resolver (-)
shield	PE	

5.16 DSUB Adapter with screwed terminal connection (LMG-DSUBIO)

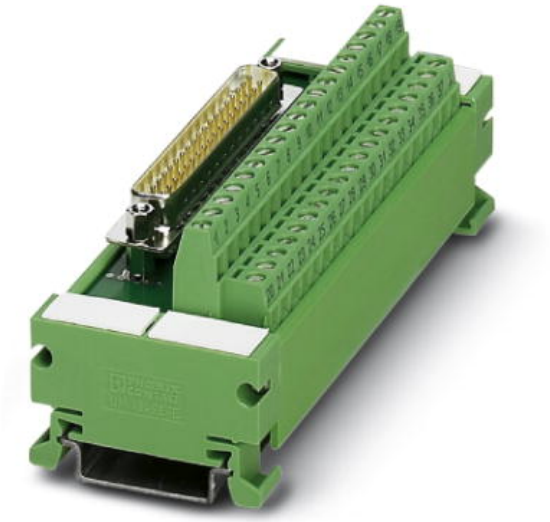


Figure 5.22: LMG-DSUBIO (picture similar)

Adapter from DSUB to screwed terminal connection for easy access to LMG process signal interface and external synchronisation.

For assembly on DIN rail NS35/7.5.

5.16.1 Safety warnings

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!



5.16.2 Standards and Directives



This product meets the following EU standards for health, safety, and environmental protection:

Safety IEC 60664, DIN EN 50178



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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.16.3 Specifications

Conductor cross section min.	0.14 mm^2 / AWG26
Conductor cross section max.	1.5 mm^2 / AWG16
Stripping length	6 mm
Screw thread	M3
Max. current per branch	1.5 A
Operating temperature	-20 °C ... +50 °C
Storage temperature	-20 °C ... +70 °C
Available are:	LMG-DSUBIO25M for DSUB25f (LMG600 process signal interface), including 2m connection cable DSUB25f to DSUB25m
	LMG-DSUBIO15M for DSUB15f (LMG600 process signal interface), including 2m connection cable DSUB15f to DSUB15m
	LMG-DSUBIO15F for DSUB15m (LMG600 external sync), including 2m connection cable DSUB15f to DSUB15m
	LMG-DSUBIO9M for DSUB9f (LMG600 process signal interface) including 2m connection cable DSUB9f to DSUB9m

5.17 LMG600 current sensor adapter (L60-X-ADSE)

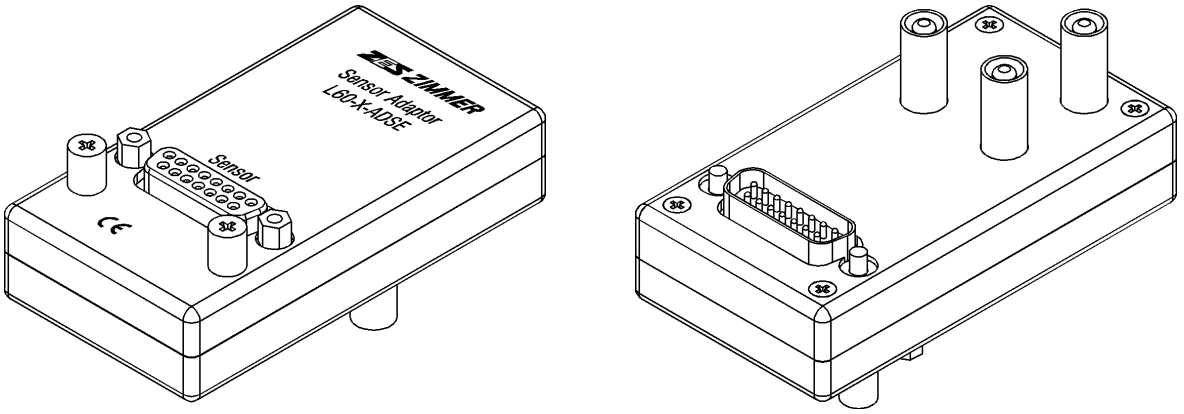


Figure 5.23: L60-X-ADSE

The special design of all LMG600 sensors makes them very easy and comfortable to use. The DSUB15 plug contains the identification of the sensor type, the measuring ranges, including the needed scaling and several more parameters. The LMG600 reads this values and the meter will automatically be configured to the optimum adjustments for using this special sensor. The LMG range setup is automatically taken from the sensor EEPROM. Further on we correct some of the sensor errors (transfer error, delay time, ...). So you get the best measuring results with each sensor.

For all special LMG600 sensors the Adapter L60-X-ADSE is needed, because internally it is necessary to connect the system ground (CPU, Sensor supply, ...) with the ground of the measuring channel. Both signals are connected with a DSUB15 plug, without galvanic separation. The adapter L60-X-ADSE guarantees that no measuring leads are connected to the measuring channel at the same time and prevents electrical shock.

5.17.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!
- The adaptor must be fixed to the measuring channel with the built-in screws.
- The adaptor must not be mounted or fixed under voltage.

5.17.2 Standards and Directives

This product meets the following EU standards for health, safety, and environmental protection:

Safety EN61010-1:2010+A1:2019, EN IEC61010-2-030:2021+A11:2021

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This product meets the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

5.17.3 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.18 LMG600 sync cable (L6-ACC-SYNC)



Figure 5.24: L6-ACC-SYNC-2

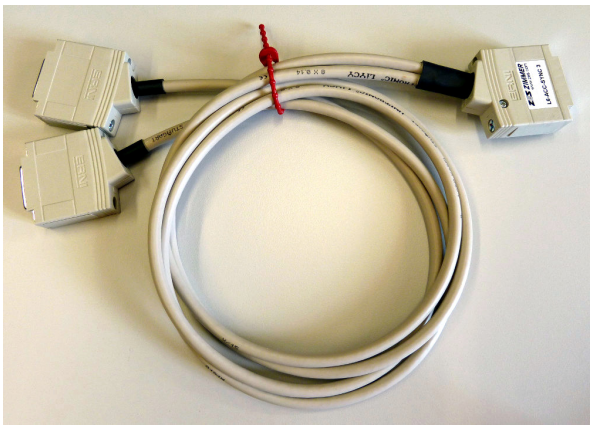


Figure 5.25: L6-ACC-SYNC-3

Using this cable it is possible to connect two or three LMG600 instruments to synchronize cyles, frequencies, energy measurement, transient trigger and the clock. L6-ACC-SYNC-2 has been designed for the connection of two LMG600, L6-ACC-SYNC-3 for the connection of three LMG600. The direction of synchronisation can be individually set up in the GUI of LMG600 by choosing if the individual signals are outputs (master) or inputs (slaves). Please refer to the user manual of instrument family LMG600 for detailed information of necessary LMG settings.

5.18.1 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do

not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.19 Mains supply cord (LMG-Z303)

The mains supply cord consists of a country-specific supply plug with mating socket (IEC 60320 C13) to LMG, length about 1.8 m.

5.19.1 Safety warnings

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!



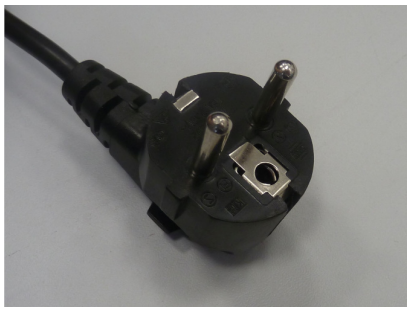
5.19.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

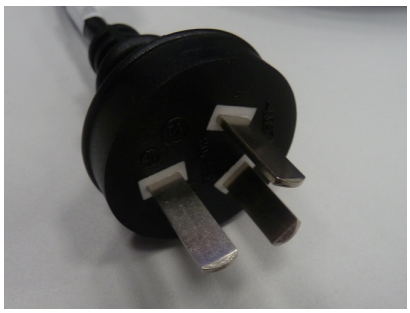
For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.19.3 Specifications

The following country-specific supply cords are available (supply cords for other countries on request).



LMG-Z303
Supply cord type E+F (CEE 7/7),
commonly used in EU



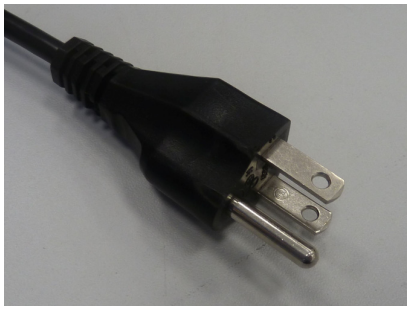
LMG-Z303CN
Supply cord type I (GB 1002),
commonly used in China



LMG-Z303SA
Supply cord type M (BS 546 / IA16A3),
commonly used in South Africa and India



LMG-Z303UK
Supply cord type G (BS 1363),
commonly used in United Kingdom



LMG-Z303US
Supply cord type B (NEMA 5-15),
commonly used in United States and Canada

5.20 IEEE488 bus cable (LMG-Z312, -Z313, -Z314)



Figure 5.26: IEEE488 bus cable

IEEE 488 bus cable, full screened metal-plug socket case to maintain the excellent noise immunity of all LMG instruments.

Cable length:

- LMG-Z312: 1 m
- LMG-Z313: 2 m
- LMG-Z314: 4 m

5.20.1 Safety warnings

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!



5.20.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.21 USB-RS232 Adapter (LMG-Z316)



Figure 5.27: USB-RS232 Adapter

This USB-RS232 adapter Z316 is useful for the communication with a power meter LMG and a PC with USB port via a virtual COM port simulation. The communication is transmitted by the driver over USB to the adapter for user purposes in the same way as e.g. the direct connection of PC/COMx to LMG/COM. The power meter LMG will be accessible via this virtual COM port.

5.21.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

5.21.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

5.21.3 System requirements, hardware specifications

- Windows: driver available, see ZES support CD 'LMG500 USB driver'
- Linux: driver is part of the kernel 2.4.x or newer (ftdi_sio Modul)
- throughput up to 230.400 baud
- supports data flow control with RTS/CTS, hardware reset with 'break'
- adapter length about 1 m, standard RS232 DSUB9 male with UNC nuts and USB typ A plug
- connection to LMG with standard 1:1 serial cable, extension possible up to 15 m

5.21.4 RS232 plug

DSUB9 male connector with UNC screw nuts, pin assignment:

pin	signal
1	CD (carrier detect)
2	RX (receive data)
3	TX (transmit data)
4	DTR (data terminal ready)
5	GND
6	DSR (dataset ready)
7	RTS (request to send)
8	CTS (clear to send)
9	RI (ring indicator)

5.21.5 Included in delivery

- USB-RS232 Adapter
- RS232 interface cable (LMG-Z317)

5.22 RS232 interface cable (LMG-Z317)



Figure 5.28: RS232 interface cable

RS232 interface cable, DSUB 9 male to DSUB 9 female, 1:1 connection, length about 1.8 m.

5.22.1 Safety warnings



- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

5.22.2 Maintenance and Cleaning

Before cleaning, disconnect the device from all cables or any other devices and ensure that there is no danger from open flames or other sources of ignition in the surrounding area.

For cleaning the device, a soft cotton cloth with a small amount of isopropyl alcohol is suitable. Never apply the cleaning agent directly to the device; instead, apply it sparingly to the cloth. Do not place the container with the cleaning fluid on the device! Allow the device to dry for 15 minutes afterward.

6 FAQ - frequently asked questions / Knowledge base

6.1 Avoid distortion when using external sensors in noisy environment

External current sensors with voltage output connected to the precision power meter series LMG have usually an output voltage of a few mV to several V. This sensors can be connected to the LMG Isensor input and current measurements can be done with a high accuracy, but a few points have to be kept in mind. Also sensors with current output can have distortion problems. Especially in EMC noisy environments with high dU/dt voltages the following points should be considered to achieve best accuracy and low noise:

- Use well shielded coaxial cable to connect sensors with voltage output to the power meter LMG. Sensors with current output should be connected with twisted measuring leads.

- Avoid ground loops, do not connect the shield and/or housing of the sensor at several different points to earth. Take into concern, that other instruments, measuring the same secondary signal, might have inputs without isolation to earth, e.g. oscilloscopes. Important is the star-shaped grounding of the complete system.

- In the case of well shielded sensors e.g. Pearson transducers, the shield housing should be connected to PE to allow the capacitiv coupled distortion to find a low impedance way to earth and do not couple to the measuring signal. If so, the low input I should not be connected to earth.

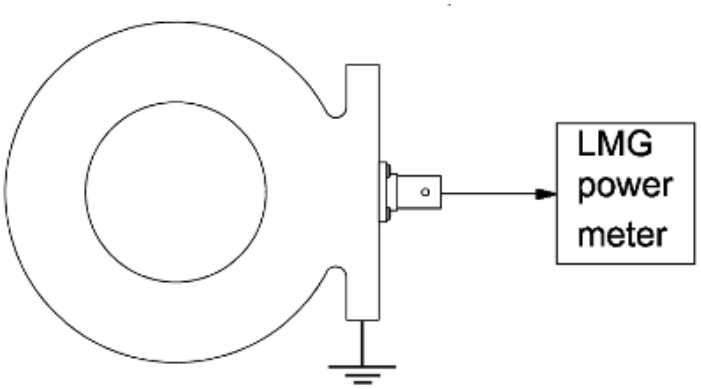


Figure 6.1: Grounding of well shielded sensors

- In applications with current measurement on high common mode voltage potential it is advantageous to connect the low output of a galvanic separated current transformer with earth. There is a double galvanic separation: in the LMG and inside the current transformer itself. So the secondary side has neither galvanic contact with the load current nor with earth: the current channel is floating on an undefined potential. The accuracy can be improved by draging down the floating voltage to about earth potential and give the distortion currents a low impedance way to earth.

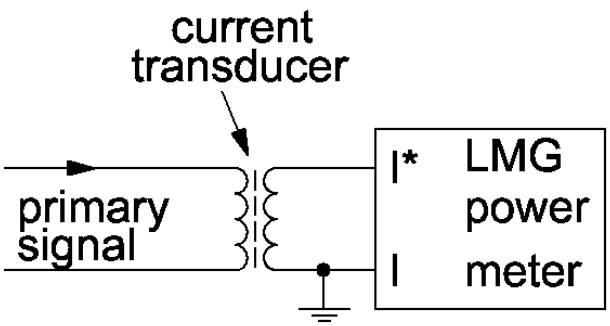


Figure 6.2: Grounding of common current sensor signals

- In applications with a high dU/dt and sensors with onboard electronics it might be profitable to shield the isolated primary conductor e.g. with copper foil connected only at one side! to earth. This shield ought to bleed of the capacitive coupled distortion to earth and keep them away from the sensor electronics. This policy can also be used to enhance accuracy and reject distortion with other current transducers.

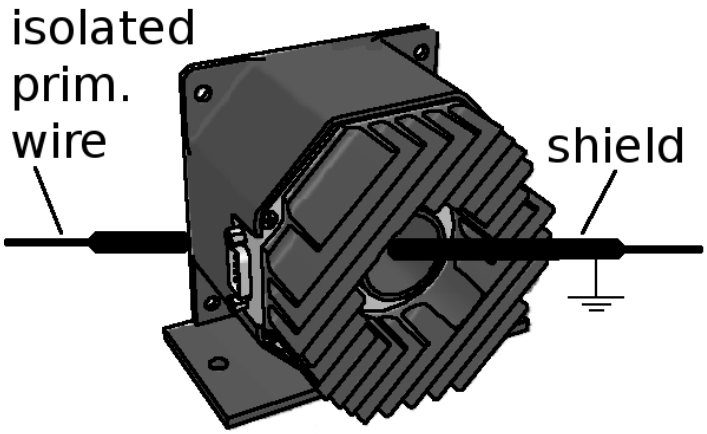


Figure 6.3: Grounding of sensors with onboard electronics

- In all cases you should adapt the bandwidth of the power meter to the bandwidth of the current sensor and the signal. It is useless to measure the active power with a 5 kHz bandwidth current clamp and a power meter bandwidth of 10 MHz, in this case a signal filter of e.g. 10 kHz will not affect the measuring signal significantly, but will highly reduce HF distortion and noise!

6.2 How to connect and supply PCT with LMG600

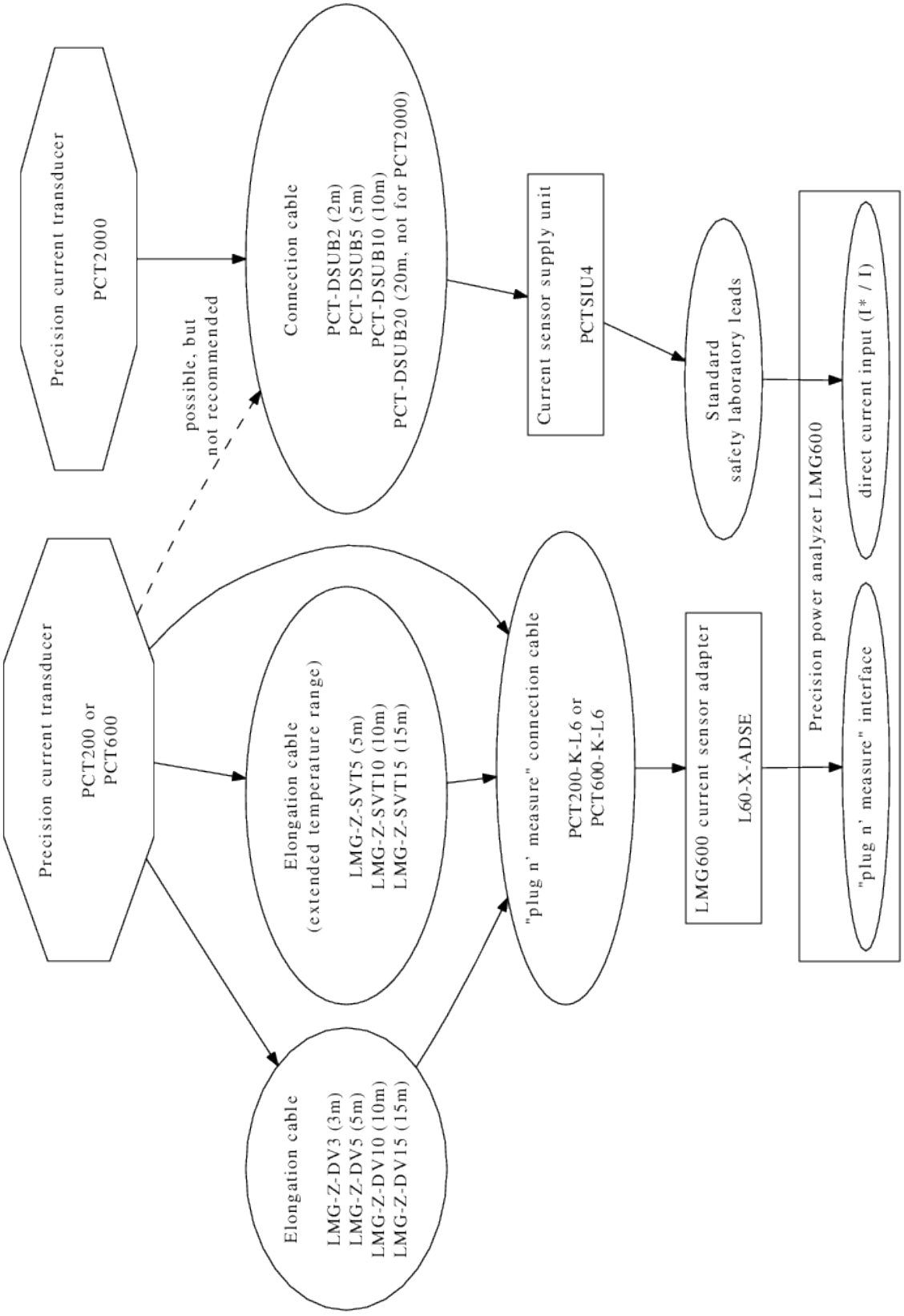


Figure 6.4: How to connect and supply PCT with LMG600

6.3 Avoid measuring errors due to shield currents

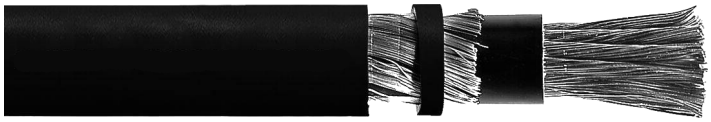


Figure 6.5: shielded high voltage cable

In medium voltage applications (e.g. wind energy) and also in electrically powered vehicles shielded cabels are commonly used for power connections.

Current measurement with feed-through current transducers and shielded cables can lead to measuring errors. Only the current in the inner conductor is relevant, but its magnetic field is superimposed with the magnetic field of the shield current and measured together in the current transducer.

The shield turned back through the transducer will lead to an opposite magnetic field and cancels the resulting magnetic field measured by the transducer to the magnetic field of the current in the inner conductor. The shield effect against the electric field between conductor and transducer is not influenced.

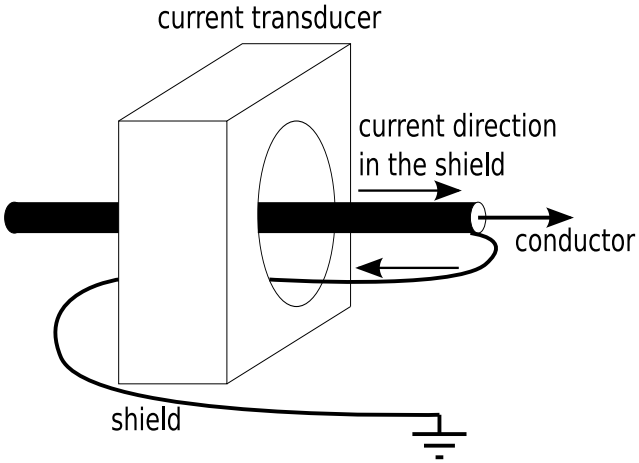


Figure 6.6: Avoid measuring errors due to shield currents at the end of the shielded cable, if the shield is connected to earth

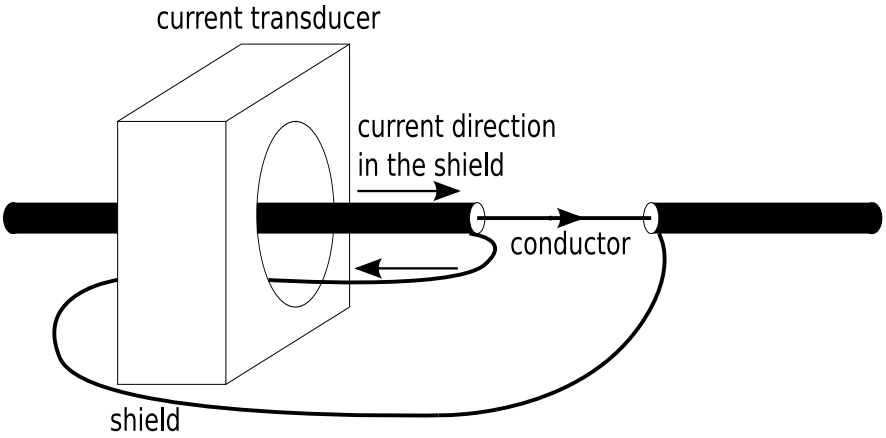


Figure 6.7: Avoid measuring errors due to shield currents in the middle of the shielded cable

6.4 Range extension by changing primary ratio at current sensors

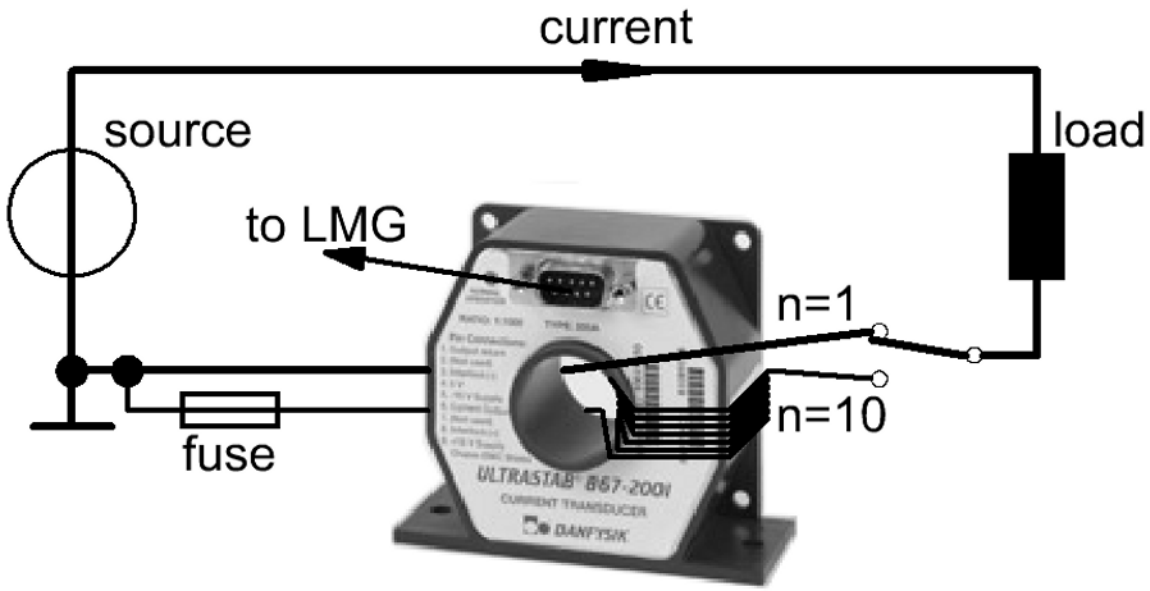


Figure 6.8: external range extension

You can use two windings through a current transducer to expand its current range.

In this example one winding with one turn (for big currents) and one winding with ten turns (for small currents) are taken. If you change the scaling value of the corresponding power meters current channel the different turns are taken into account for all of the measuring values.

This approach is suitable for all feed through and clamp on current transducers.

6.4.1 Example

- precision power meter LMG670/671
- current sensor PCT200
- measuring ranges (full range)
  1 turn: 2.5 A .. 200 A
  10 turns: 250 mA .. 20 A

6.5 Hints for wiring current transformers or HST to LMG

The appropriate cable types to connect the transducers to the power meter are described in this section. Each cable connects all current transformer or all voltage transducer signals from a three phase system to a power meter.

The appropriate cable types must have individually twisted pairs (TP) and a shield made of copper netting. For example, the following types of cables have the matching properties:

1. Lappkabel: Unitronic LiYCY(TP)
2. Helukabel: Paar-Tronic-CY
3. TKD-Kabel: PAARTRONIC-CY LiYCY(TP)

Use one twisted pair for one current transformer or voltage transducer. Several three phase systems can be connected together in one cable.

The cable shields are connected only on one side to the ground terminal of the high voltage divider (HST) or the current transformer. The LMG-side cable shields should remain unconnected!

6.5.1 Copper cross section

For a proper load resistor of the current transformers, use one of the following cross sections depending on the cable length. But regard also that the cable is capable to withstand the rated short-time thermal current of the current transformer!

(a) metric unit

Cable length	Copper cross section
8 m ... 12 m	0.25 mm^2
11 m ... 17 m	0.34 mm^2
16 m ... 25 m	0.5 mm^2
23 m ... 38 m	0.75 mm^2
32 m ... 51 m	1.0 mm^2
48 m ... 77 m	1.5 mm^2
78 m ... 128 m	2.5 mm^2

(b) American wire gauge

Cable length	American wire gauge
7 m ... 10 m	AWG 24
10 m ... 17 m	AWG 22
16 m ... 27 m	AWG 20
26 m ... 42 m	AWG 18
41 m ... 67 m	AWG 16
65 m ... 107 m	AWG 14
104 m ... 170 m	AWG 12

Table 6.1: Copper cross section

For the connection of the high voltage transducer (HST) output, one does not have to care about the cross section. Coaxial cable (e.g. RG58) can be used too.

6.5.2 Treatment of the ends of the wires

Use gold-plated stackable 4mm plugs, e.g. Multi-Contact LS425-SE/M (Bürklin 15F3107) together with insulating sleeve KT425-SE (Bürklin 15F310x). Note: the 4mm plugs have to be stackable for easy LMG-side short circuit of the secondary side of the current transformers. The plated gold is important because of the contact resistance.

6.6 The burden resistor

For measurements with the specified accuracies the burden of a sensor has to be between 50 % and 100 % of the rated burden in the data sheet (at the rated frequency range). This burden can be specified as an ohmic resistor or as an apparent power value.

Here an example how you can convert the two values:
rated secondary current = 5 A, rated burden = 2.5 VA →
$R = \frac{S}{I^2} = \frac{2.5\,\mathrm{VA}}{(5\,\mathrm{A})^2} = 100\,\mathrm{m\Omega}$.

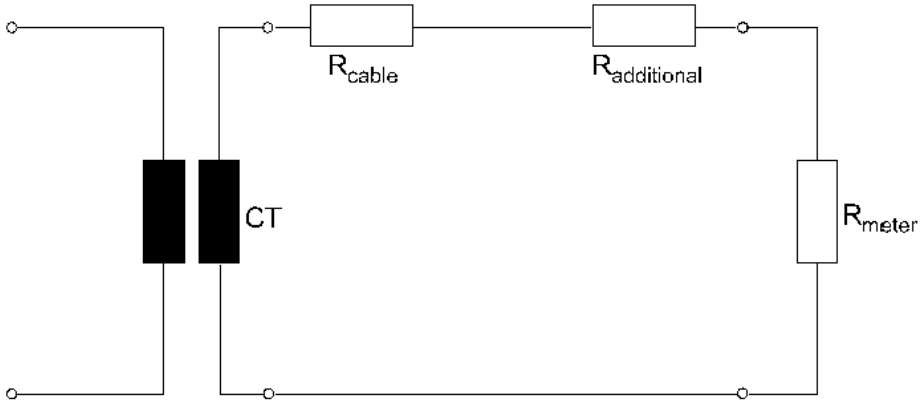


Figure 6.9: burden calculation

The burden resistor is built up from the ohmic load of the cables and additional from the burden of the precision power meter LMG. The sensor will not work at the specified accuracy, if the operation burden is not observed. Because of the very low input impedance of the elektronic meter inputs, the rated operation burden is mostly not reached and an additional burden resistor has to be fitted. This resistor can also be built up from a correctly dimensioned connection cabel from the sensor to the meter.

6.6.1 Example

current transformer: 100 A/5 A, rated burden 2.5 VA, operation burden = 50 %
connection cable: $l = 2\,\mathrm{m}$, $A = 1.5\,\mathrm{mm}^2$, conductivity of copper $\rho = 0.0175\,\frac{\Omega\cdot\mathrm{mm}^2}{\mathrm{m}}$
input impedance of the precision powermeter: $R_{\mathrm{LMG}} = 20\,\mathrm{m\Omega}$
rated burden of the CT is: $R_{\mathrm{rated}} = \frac{S}{I^2} = \frac{2.5\,\mathrm{VA}}{(5\,\mathrm{A})^2} = 100\,\mathrm{m\Omega}$
operation burden of the CT is: $R_{\mathrm{operation}} = 100\,\mathrm{m\Omega}\cdot 50\,\% = 50\,\mathrm{m\Omega}$
$R_{\mathrm{cable}} = \frac{\rho\cdot l}{A} = \frac{0.0175\,\Omega\cdot\mathrm{mm}^2\cdot 2\,\mathrm{m}}{\mathrm{m}\cdot 1.5\,\mathrm{mm}^2} = 23.3\,\mathrm{m\Omega}$
$R_{\mathrm{additional}} = R_{\mathrm{operation}} - R_{\mathrm{cable}} - R_{\mathrm{LMG}} = 50\,\mathrm{m\Omega} - 23.3\,\mathrm{m\Omega} - 20\,\mathrm{m\Omega} = 6.7\,\mathrm{m\Omega}$

You can realize the correct burden with a larger connection cable:
$l = \frac{R\cdot A}{\rho} = \frac{(R_{\mathrm{operation}} - R_{\mathrm{LMG}})\cdot A}{\rho} = \frac{(50\,\mathrm{m\Omega} - 20\,\mathrm{m\Omega})\cdot\mathrm{m}\cdot 1.5\,\mathrm{mm}^2}{0.0175\,\Omega\cdot\mathrm{mm}^2} = 2.57\,\mathrm{m}$