



Sensors & Accessories

for LMG Family

User Manual

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ZES ZIMMER Electronic Systems GmbH
Tabaksmühlenweg 30
D-61440 Oberursel (Taunus), FRG
phone +49 (0)6171 628750
fax +49 (0)6171 52086
e-mail: sales@zes.com

ZES ZIMMER Inc.

phone +1 760 550 9371

e-mail: usa@zes.com

Internet: <http://www.zes.com>

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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 safe 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].



References/links

References to tables, figures, listings, etc. consist of their identifier followed by the book symbol and the page number.

[→5]

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.

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. In addition the required repair work must be carried out by a trained technician at a suitable repair facility.

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 high currents (short circuit or something similar),
- the equipment has been heavily overloaded due 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 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. 

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 <10 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 to 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 $\pm 10\%$ 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

1.4 Technical assistance

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

ZES ZIMMER Electronic Systems GmbH

Tabaksmühlenweg 30

D-61440 Oberursel

Germany

Phone: +49 (0)6171/628750

Fax: +49 (0)6171/52086

Email: sales@zes.com

URL: <http://www.zes.com>

2 Current Sensors

2.1 Precision current transducer 200A (PCT200)

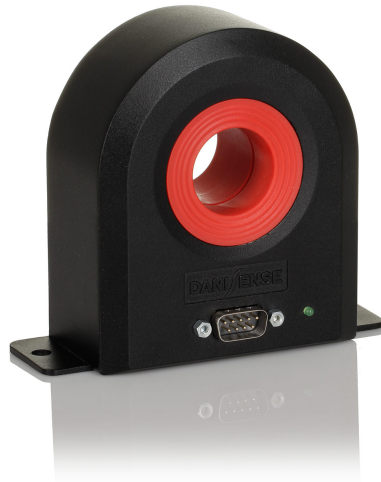


Figure 2.1: PCT200

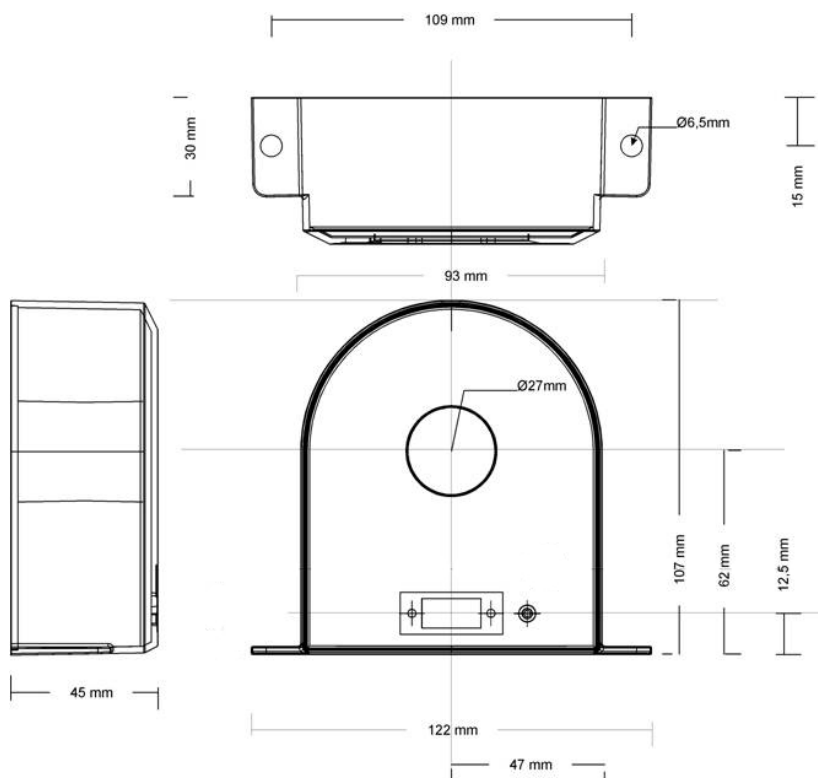


Figure 2.2: PCT200 mechanical dimensions

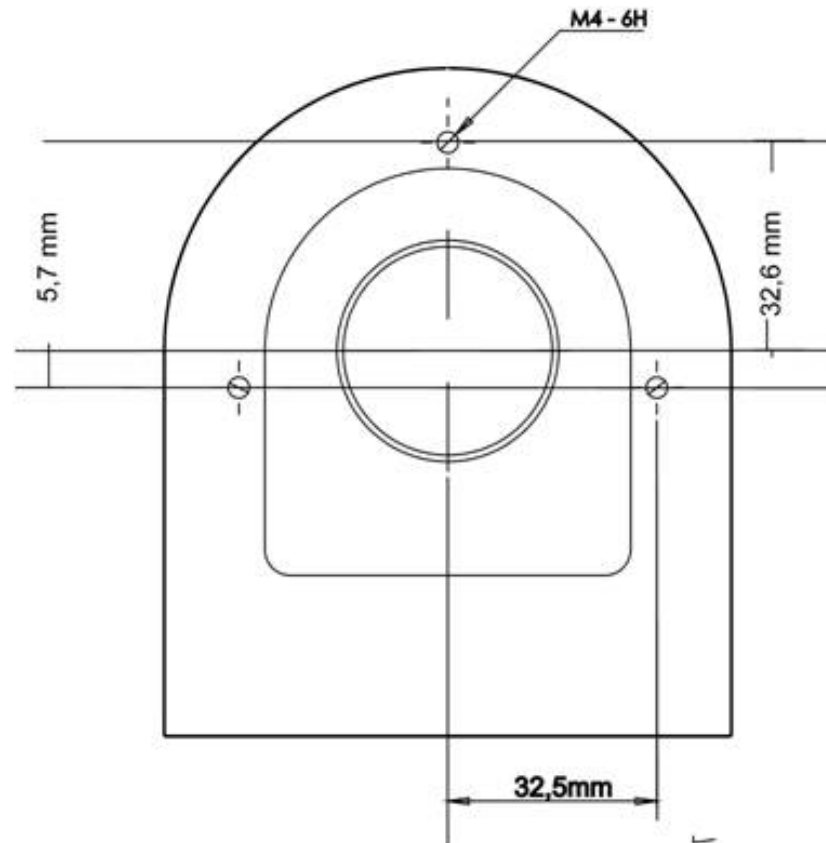


Figure 2.3: PCT200 mounting bushings on the back, maximum screw depth 6 mm

2.1.1 Safety warnings



- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without isolation regard DSUB cable isolation or avoid contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.1.2 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)
Bandwidth	1 MHz
Burden	0 ... 3 Ω
Safety	EN 61010-1
Isolation	500 V CAT II
Operating temperature	-40°C ... 65°C (-40°C ... 85°C @ input current rms \leq 200 A)
Storage temperature	-40°C ... 85°C
Weight	0.6 kg
Supply	$\pm(15\text{ V}\pm0.75\text{ V})$
EMC	EN 61326

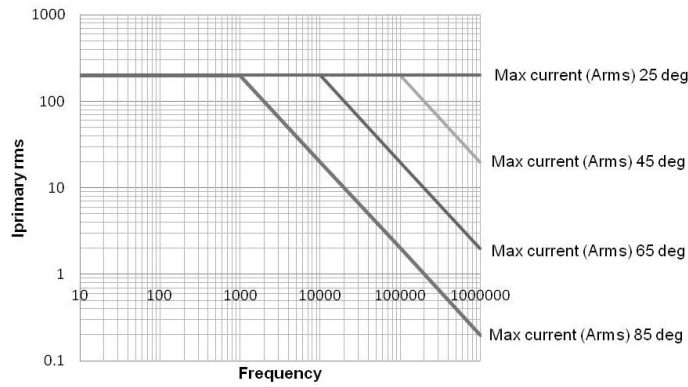


Figure 2.4: PCT200 temperature derating

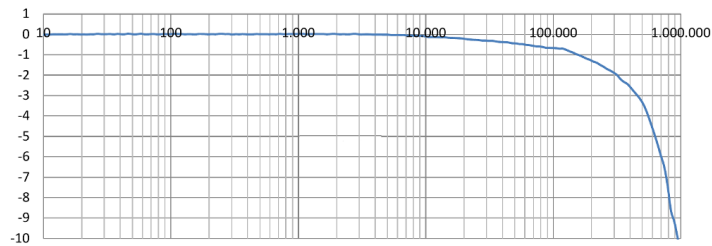


Figure 2.5: PCT200 typical gain error vs. frequency

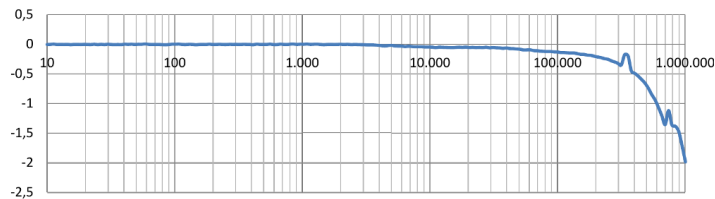


Figure 2.6: PCT200 typical phase error vs. frequency

2.1.3 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 maximum 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.

Use the connection cable 'PCT200-K-L60' and optionally the elongation cable 'LMG-Z-SVTxx' or 'LMG-Z-DV'.

Also if bare conductors can be used up to the above values, 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 together with the same serial number!

2.1.4 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23\pm 3^{\circ}\text{C}$, calibration interval 1 year, conductor in the middle of the transducer.

Frequency	Amplitude uncertainty in % of nominal input current rms	Phase uncertainty
DC ... 5 kHz	$\pm 0.01\%$	$\pm 0.1^{\circ}$
5 kHz ... 100 kHz	$\pm 1\%$	$\pm 0.5^{\circ}$
100 kHz ... 1 MHz	$\pm 20\%$	$\pm 5^{\circ}$

Temperature coefficient $\pm 0.1 \text{ ppm}/^{\circ}\text{C}$ of maximum input current peak in the temperature range of $-40^{\circ}\text{C} \dots +85^{\circ}\text{C}$.

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

2.1.5 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 (less than 10 ppm).

2.1.6 Connection of the sensor PCT200 with LMG600

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

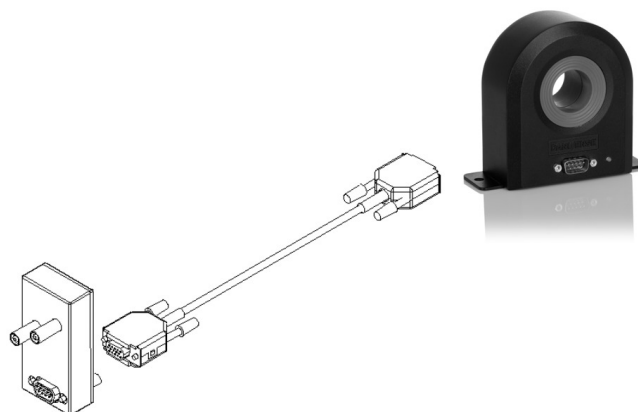


Figure 2.7: PCT200-K-L60 and L60-X-ADSE

This cable 'PCT200-K-L60' is used to connect the precision current transducer PCT200 to the power meter LMG600. In the connector to the LMG600 the adjustment data of the PCT200 head is available 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 connector labeled 'PCT200' to the sensor
- plug the connector labeled 'LMG600' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and make your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with PCT200

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

Accuracy

Use PCT200 and LMG600 specifications to calculate the accuracy of the complete system.

2.1.7 Connection of the sensor PCT200 with SSU4

Use sensor supply unit SSU4 with modification for PSU60/200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.1.8 Connection of the sensor PCT200 with LMG95

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

2.1.9 Connection of the sensor PCT200 with LMG450

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

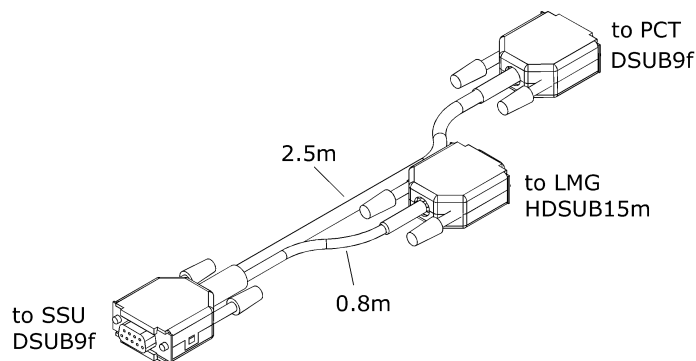


Figure 2.8: PCT200-K-L45

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. In the connector to the LMG450 the adjustment data of the PCT200 head are available 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	6.25	12.5	25	50	100	200
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 $\pm 30\text{ mA}$ DC offset tolerance.

2.1.10 Connection of the sensor PCT200 with LMG500

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

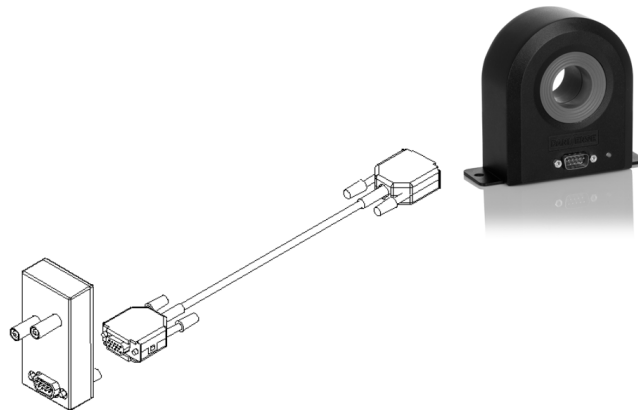


Figure 2.9: PCT200-K-L50 and L50-Z14

This cable 'PCT200-K-L50' is used to connect a precision current sensor PCT200 to the power meter LMG500 and to supply it by a sensor supply unit SSU4. In the connector to the LMG500 the adjustment data of the PCT200 head are available 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	1.5	3	6	12.5	25	50	100	200
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 $\pm 0.01\%$ of measuring value.

Add $\pm 30\text{ mA}$ DC offset tolerance.

2.1.11 Connection elongation

To use the current sensor with a longer 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 'LMG-Z-SVTxx' or 'LMG-Z-DV' in different lengths from 5m to 50m. 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.

2.2 Precision current transducer 600A (PCT600)

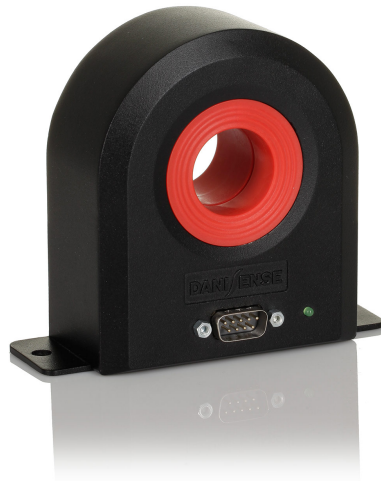


Figure 2.10: PCT600

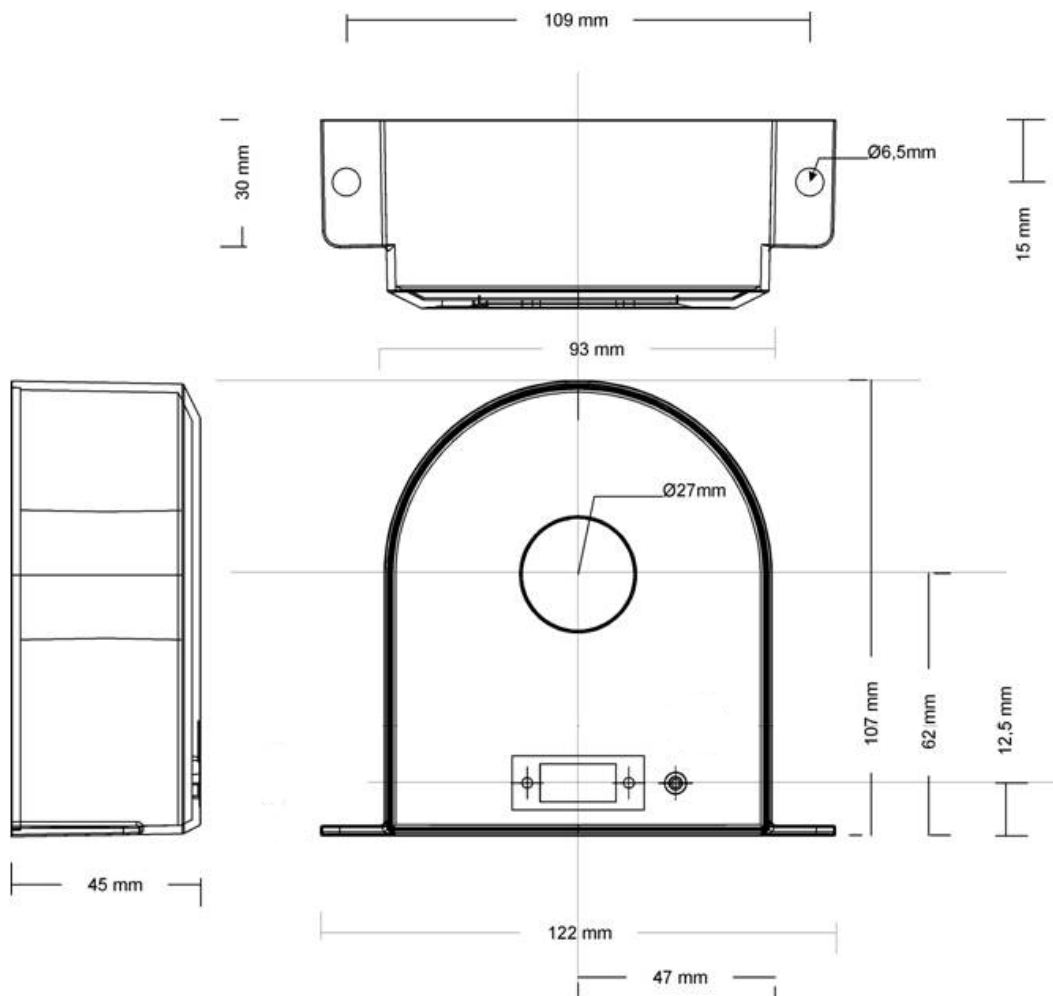


Figure 2.11: PCT600 mechanical dimensions

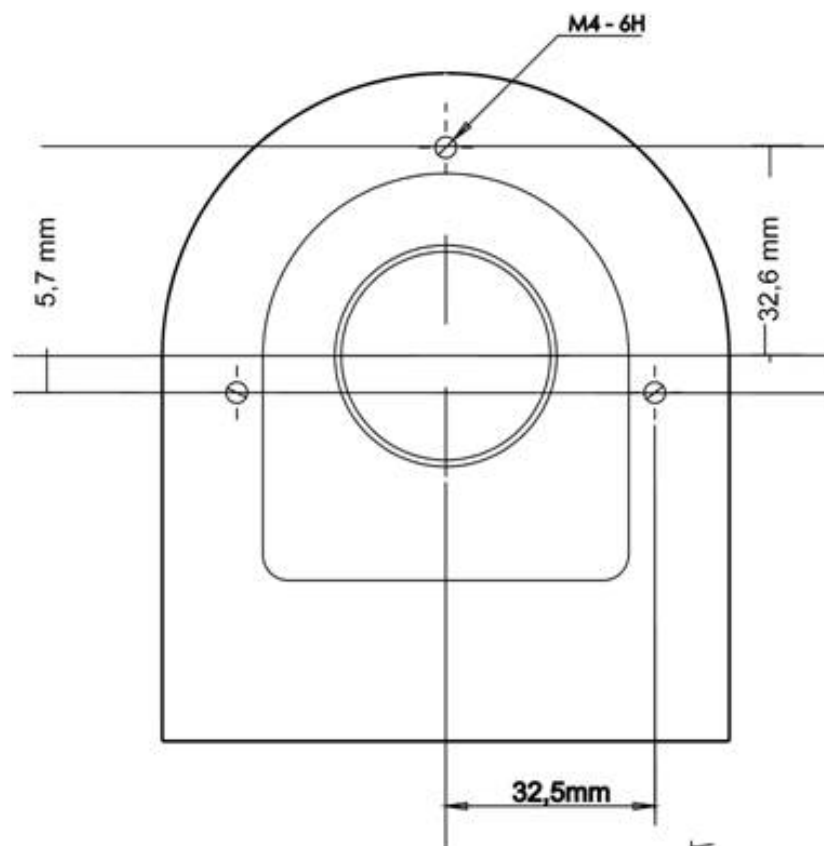


Figure 2.12: PCT600 mounting bushings on the back, maximum screw depth 6 mm

2.2.1 Safety warnings



- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without isolation regard DSUB cable isolation or avoid contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.2.2 Specifications

Nominal input current rms	600 A
Maximum input current rms	900 A
Maximum input current peak	900 A
Transformation ratio	1500:1
Maximum input overload	4500 A (100 ms)
Bandwidth	100 kHz
Burden	0 ... 3 Ω
Safety	EN 61010-1
Isolation	500 V CAT II
Operating temperature	-40°C ... 65°C (-40°C ... 85°C @ input current rms \leq 600 A)
Storage temperature	-40°C ... 85°C
Weight	0.6 kg
Supply	$\pm(15\text{ V}\pm 0.75\text{ V})$
EMC	EN 61326

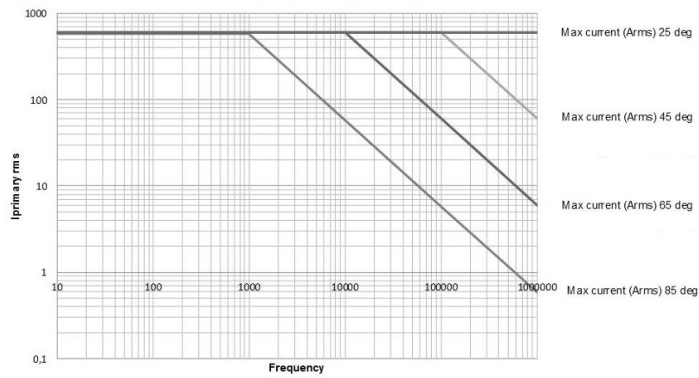


Figure 2.13: PCT600 temperature derating

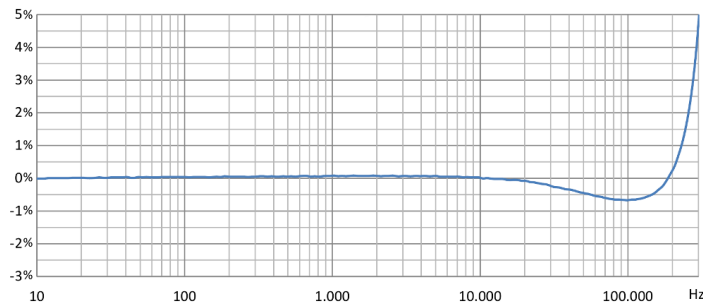


Figure 2.14: PCT600 typical gain error

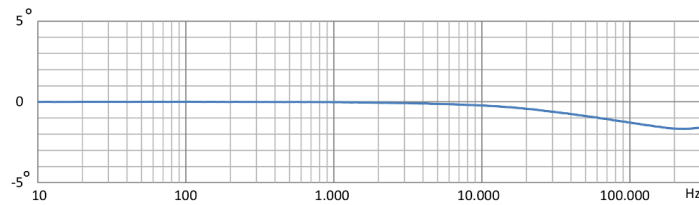


Figure 2.15: PCT600 typical phase error

2.2.3 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 maximum 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.

Use the connection cable 'PCT600-K-L60' and optionally the elongation cable 'LMG-Z-SVTxx' or 'LMG-Z-DV'.

Also if bare conductors can be used up to the above values, 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 together with the same serial number!

2.2.4 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year, conductor in the middle of the transducer.

Frequency	Amlitude uncertainty in % of nominal input current rms	Phase uncertainty
DC ... 2 kHz	$\pm 0.01\%$	$\pm 0.1^\circ$
2 kHz ... 10 kHz	$\pm 0.5\%$	$\pm 0.5^\circ$
10 kHz ... 100 kHz	$\pm 3\%$	$\pm 3^\circ$

Temperature coefficient $\pm 0.1 \text{ ppm}/^\circ\text{C}$ of maximum input current peak in the temperature range of $-40^\circ\text{C} \dots +85^\circ\text{C}$.

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

2.2.5 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 (less than 10 ppm).

2.2.6 Connection of the sensor PCT600 with LMG600

Use PCT600-K-L60 and L60-X-ADSE, supply via LMG600.

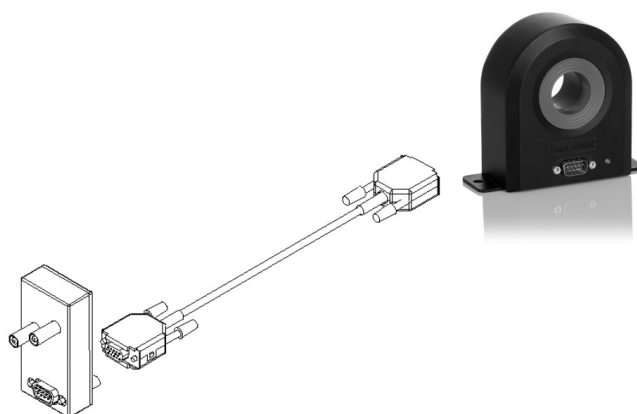


Figure 2.16: PCT600-K-L60 and L60-X-ADSE

This cable 'PCT600-K-L60' is used to connect the precision current transducer PCT600 to the power meter LMG600. In the connector to the LMG600 the adjustment data of the PCT600 head is available 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 connector labeled 'PCT600' to the sensor
- plug the connector labeled 'LMG600' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and make your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with PCT600

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

Accuracy

Use PCT600 and LMG600 specifications to calculate the accuracy of the complete system.

2.2.7 Connection of the sensor PCT600 with SSU4

Use sensor supply unit SSU4 with modification for PSU60/200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.2.8 Connection of the sensor PCT600 with LMG95

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

2.2.9 Connection of the sensor PCT600 with LMG450

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

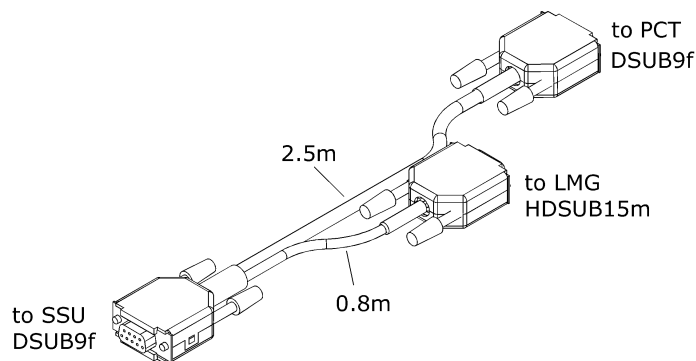


Figure 2.17: PCT600-K-L45

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. In the connector to the LMG450 the adjustment data of the PCT600 head are available 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	18.7	37.5	75	150	300	600
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 $\pm 0.01\%$ of measuring value.

Add ± 100 mA DC offset tolerance.

2.2.10 Connection of the sensor PCT600 with LMG500

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

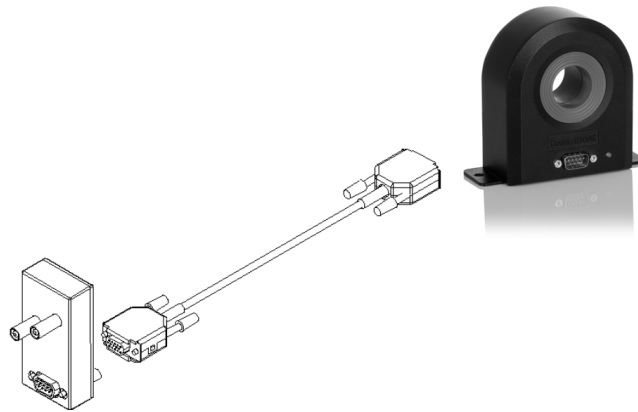


Figure 2.18: PCT600-K-L50 and L50-Z14

This cable 'PCT600-K-L50' is used to connect a precision current sensor PCT600 to the power meter LMG500 and to supply it by a sensor supply unit SSU4. In the connector to the LMG500 the adjustment data of the PCT600 head are available 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	4.5	9	18	37.5	75	150	300	600
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 $\pm 0.01\%$ of measuring value.

Add ± 100 mA DC offset tolerance.

2.2.11 Connection elongation

To use the current sensor with a longer 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 'LMG-Z-SVTxx' or 'LMG-Z-DV' in different lengths from 5m to 50m. 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.

2.3 Precision current transformer 1500 A (LMG-Z502, -Z505, -Z510, -Z520)



Figure 2.19: LMG-Z502, -Z505, -Z510, -Z520

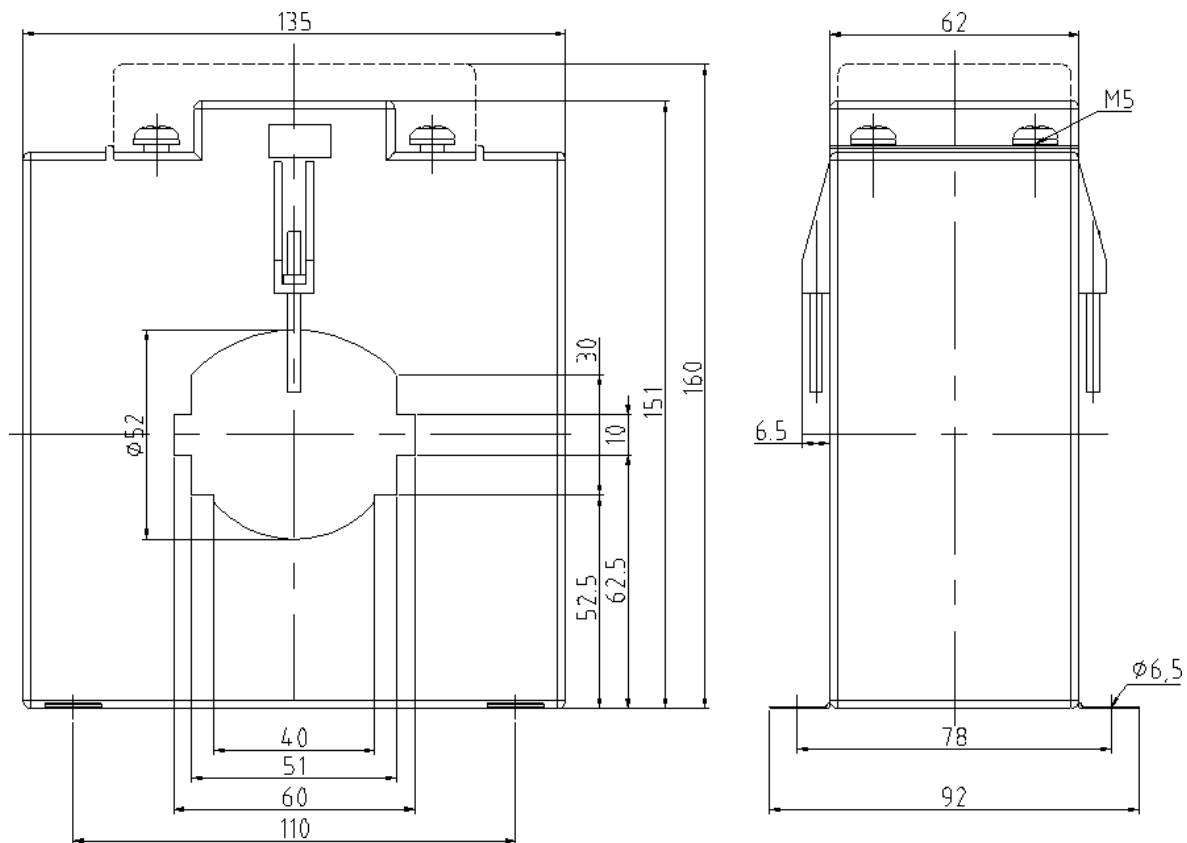


Figure 2.20: Dimensions in mm of LMG-Z502, -Z505, -Z510, -Z520

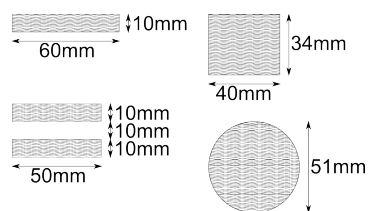


Figure 2.21: LMG-Z502, -Z505, -Z510, -Z520 suitable bus bars

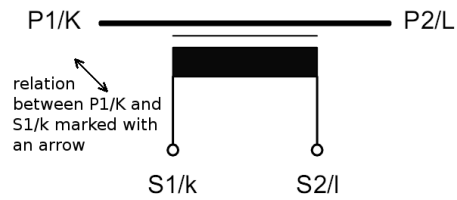


Figure 2.22: LMG-Z502, -Z505, -Z510, -Z520 connection diagram

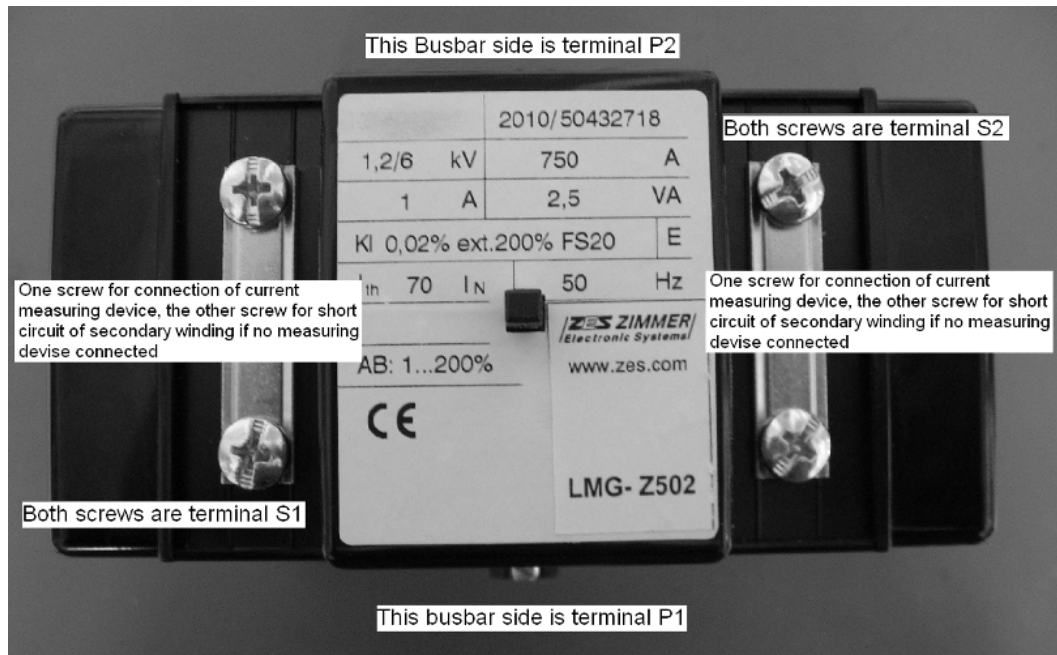


Figure 2.23: topview of LMG-Z502, -Z505, -Z510, -Z520

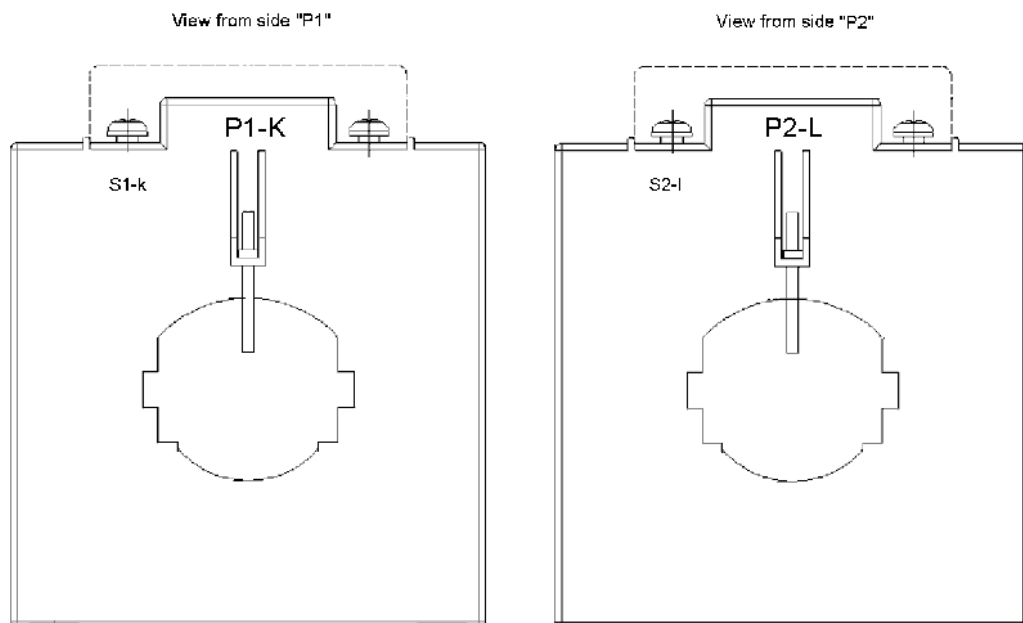


Figure 2.24: orientation of LMG-Z502, -Z505, -Z510, -Z520

2.3.1 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]!



2.3.2 Specifications

Measuring range	1500 A _{eff} continuous
Secondary current	2 A _{eff}
Rated Transformation ratio	750:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category	600 V CAT IV / 1000 V CAT III (EN 61010-1)
Highest voltage for equipment (U_m)	1.2 kV (EN 60664-1)
Test voltage	6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN})	750 A
Rated secondary Current (I_{SN})	1 A
Rated Continuous Thermal Current (I_d)	1500 A
Rated Short-Time Thermal Current (I_{th})	70 * I_N (1 s)
Instrument Security Factor (FS)	≤ 20 * I_N
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	2.5 kg
Bus bar	1x 60 mm x 10 mm or 2x 50 mm x 10 mm or 1x 40 mm x 34 mm or round, diameter 51mm primary fixing device M4x40, slotted headless screw, max. 2 Nm
Minimum center distance between adjacent bus bars	135 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm ² (flexible) / 6 mm ² (solid), tightening torque 3.5 Nm

2.3.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥ 135 mm.

Amplitude error ±(% of measuring value) / Phase error (at 48 ... 66 Hz)				
Current	Z502	Z505	Z510	Z520
7.5 A ... 37.5 A	≤0.05 / ≤0.1°	≤0.1 / ≤0.1°	≤0.3 / ≤0.15°	≤0.5 / ≤0.3°
37.5 A ... 150 A	≤0.03 / ≤0.07°	≤0.07 / ≤0.07°	≤0.15 / ≤0.1°	≤0.3 / ≤0.2°
150 A ... 375 A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°	≤0.2 / ≤0.16°
375 A ... 900 A	≤0.02 / ≤0.04°	≤0.05 / ≤0.04°	≤0.1 / ≤0.06°	≤0.2 / ≤0.12°
900 A ... 1500 A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°	≤0.2 / ≤0.16°

At 30 Hz ... 48 Hz and 66 Hz ... 440 Hz twofold the errors, at 15 Hz ... 30 Hz and 440 Hz ... 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z502, -Z505, -Z510, -Z520 and LMG specifications to calculate the accuracy of the complete system.

2.3.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to HINTS FOR WIRING CURRENT TRANSFORMERS OR HST TO LMG [4.4→75].

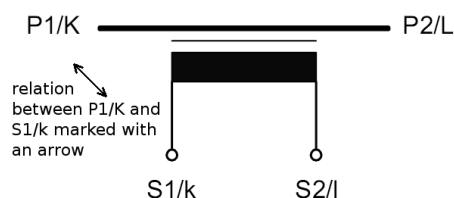


Figure 2.27: LMG-Z542, -Z545, -Z550 connection diagram

2.4.1 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]!

2.4.2 Specifications

Measuring range	4000 A _{eff} continuous
Secondary current	2 A _{eff}
Rated Transformation ratio	2000:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category	600 V CAT IV / 1000 V CAT III (EN 61010-1)
Highest voltage for equipment (U_m)	1.2 kV (EN 60664-1)
Test voltage	6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN})	2000 A
Rated secondary Current (I_{SN})	1 A
Rated Continuous Thermal Current (I_d)	4000 A
Rated Short-Time Thermal Current (I_{th})	100 * I_N (1 s)
Instrument Security Factor (FS)	≤ 40 * I_N
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	3.3 kg
Bus bar	2x 100 mm x 10 mm or 3x 80 mm x 10 mm or round, diameter 83mm
Minimum center distance between adjacent bus bars	185 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm ² (flexible) / 6 mm ² (solid), tightening torque 3.5 Nm

2.4.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥ 185 mm.

Amplitude error \pm (% of measuring value) / Phase error (at 48 ... 66 Hz)			
Current	Z542	Z545	Z550
20 A ... 100 A	≤ 0.1 / $\leq 0.1^\circ$	≤ 0.15 / $\leq 0.1^\circ$	≤ 0.3 / $\leq 0.15^\circ$
100 A ... 400 A	≤ 0.04 / $\leq 0.07^\circ$	≤ 0.08 / $\leq 0.07^\circ$	≤ 0.15 / $\leq 0.1^\circ$
400 A ... 1000 A	≤ 0.02 / $\leq 0.05^\circ$	≤ 0.05 / $\leq 0.05^\circ$	≤ 0.1 / $\leq 0.08^\circ$
1000 A ... 2400 A	≤ 0.02 / $\leq 0.04^\circ$	≤ 0.05 / $\leq 0.04^\circ$	≤ 0.1 / $\leq 0.06^\circ$
2400 A ... 4000 A	≤ 0.02 / $\leq 0.05^\circ$	≤ 0.05 / $\leq 0.05^\circ$	≤ 0.1 / $\leq 0.08^\circ$

At 30 Hz ... 48 Hz and 66 Hz ... 440 Hz twofold the errors, at 15 Hz ... 30 Hz and 440 Hz ... 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z542, -Z545, -Z550 and LMG specifications to calculate the accuracy of the complete system.

2.4.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to HINTS FOR WIRING CURRENT TRANSFORMERS OR HST TO LMG [4.4→75].

2.5 Precision current transformer 10 kA (LMG-Z562, -Z570)

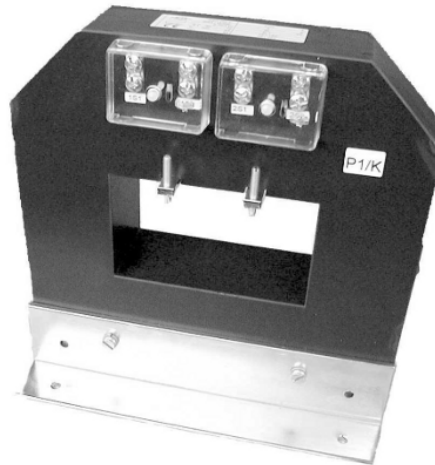


Figure 2.28: LMG-Z562, -Z570

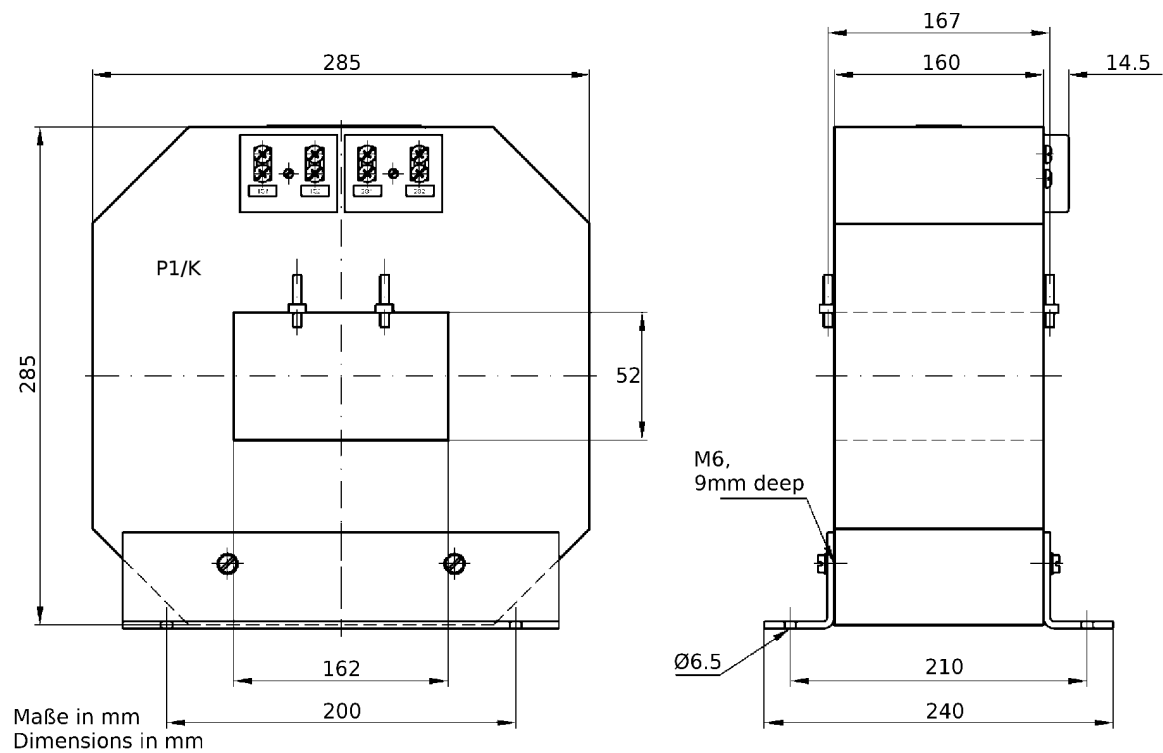


Figure 2.29: Dimensions in mm of LMG-Z562, -Z570

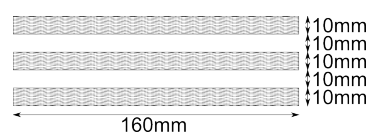


Figure 2.30: LMG-Z562, -Z570 suitable bus bars

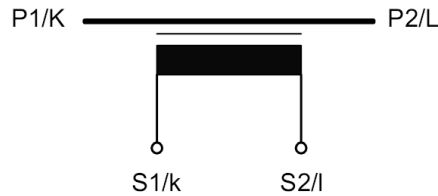


Figure 2.31: LMG-Z562, -Z570 connection diagram

2.5.1 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]!



2.5.2 Specifications

Measuring range	10 kA _{eff} continuous
Secondary current	2 A _{eff}
Rated Transformation ratio	5000:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category	600 V CAT IV / 1000 V CAT III (EN 61010-1)
Highest voltage for equipment (U_m)	1.2 kV (EN 60664-1)
Test voltage	6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN})	5000 A
Rated secondary Current (I_{SN})	1 A
Rated Continuous Thermal Current (I_d)	10 kA
Rated Short-Time Thermal Current (I_{th})	100 * I_N (1 s)
Instrument Security Factor (FS)	≤ 55 * I_N
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	32 kg
Bus bar	3x 160 mm x 10 mm primary fixing device M5, slotted headless screw, max. 2.5 Nm
Minimum center distance between adjacent bus bars	285 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm ² (flexible) / 6 mm ² (solid), tightening torque 3.5 Nm

2.5.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥ 285 mm.

Amplitude error \pm (% of measuring value) / Phase error (at 48 ... 66 Hz)		
Current	Z562	Z570
50 A ... 250 A	≤ 0.05 / $\leq 0.1^\circ$	≤ 0.3 / $\leq 0.15^\circ$
250 A ... 1000 A	≤ 0.03 / $\leq 0.07^\circ$	≤ 0.15 / $\leq 0.1^\circ$
1000 A ... 2500 A	≤ 0.02 / $\leq 0.05^\circ$	≤ 0.1 / $\leq 0.08^\circ$
2500 A ... 6000 A	≤ 0.02 / $\leq 0.04^\circ$	≤ 0.1 / $\leq 0.06^\circ$
6000 A ... 10 kA	≤ 0.02 / $\leq 0.05^\circ$	≤ 0.1 / $\leq 0.08^\circ$

At 30 Hz ... 48 Hz and 66 Hz ... 440 Hz twofold the errors, at 15 Hz ... 30 Hz and 440 Hz ... 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z562, -Z570 and LMG specifications to calculate the accuracy of the complete system.

2.5.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to HINTS FOR WIRING CURRENT TRANSFORMERS OR HST TO LMG [4.4→75].

2.6 Precision current transformer 10 kA (LMG-Z582, -Z590)

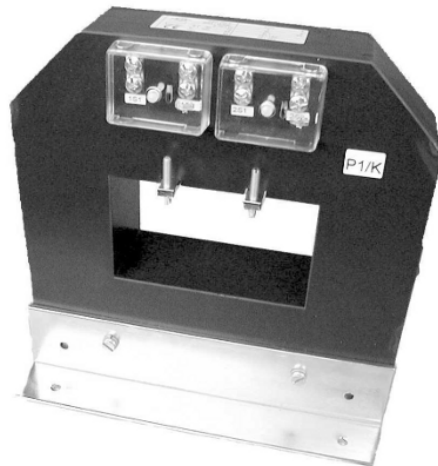


Figure 2.32: LMG-Z582, -Z590 (picture similar)

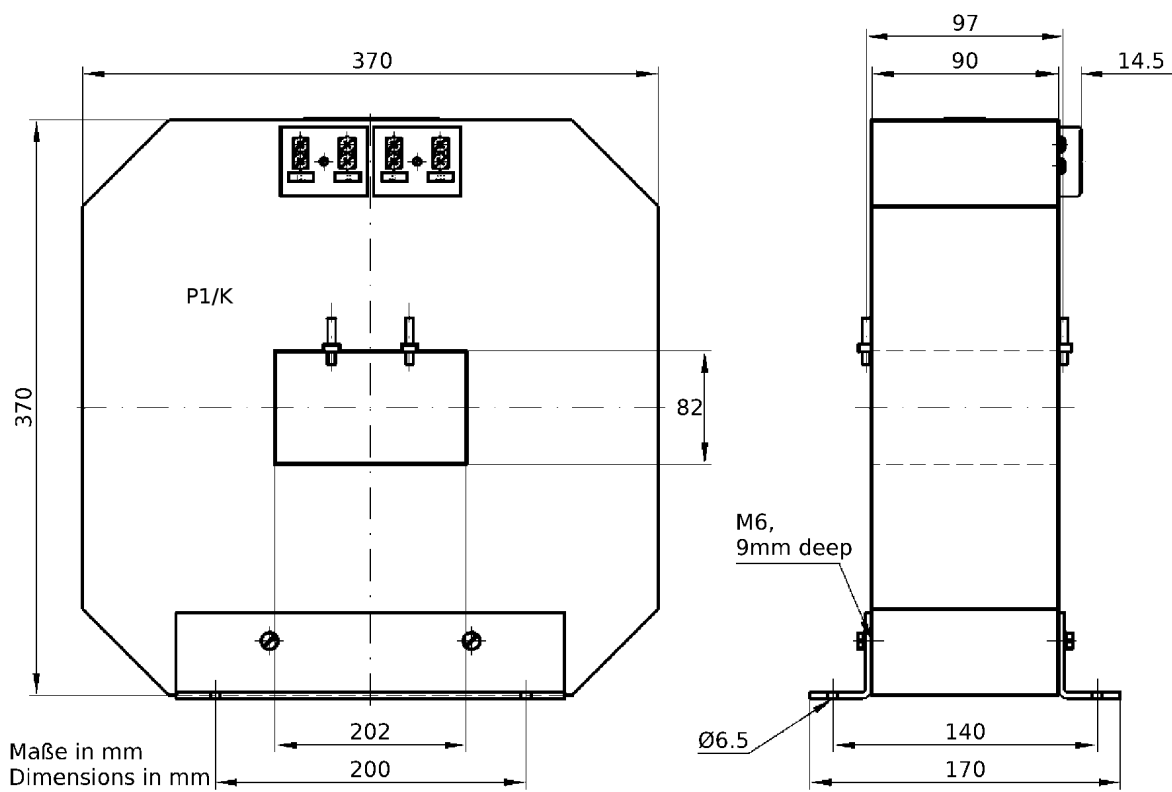


Figure 2.33: Dimensions in mm of LMG-Z582, -Z590

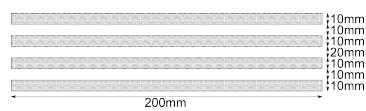


Figure 2.34: LMG-Z582, -Z590 suitable bus bars

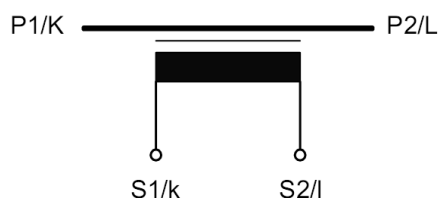


Figure 2.35: LMG-Z582, -Z590 connection diagram

2.6.1 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]!

2.6.2 Specifications

Measuring range	10 kA _{eff} continuous
Secondary current	2 A _{eff}
Rated Transformation ratio	5000:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category	600 V CAT IV / 1000 V CAT III (EN 61010-1)
Highest voltage for equipment (U_m)	1.2 kV (EN 60664-1)
Test voltage	6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN})	5000 A
Rated secondary Current (I_{SN})	1 A
Rated Continuous Thermal Current (I_d)	10 kA
Rated Short-Time Thermal Current (I_{th})	80 * I_N (1 s)
Instrument Security Factor (FS)	≤ 80 * I_N
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	23 kg
Bus bar	4x 200 mm x 10 mm primary fixing device M5, slotted headless screw, max. 2.5 Nm
Minimum center distance between adjacent bus bars	370 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm ² (flexible) / 6 mm ² (solid), tightening torque 3.5 Nm

2.6.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥ 370 mm.

Amplitude error \pm (% of measuring value) / Phase error (at 48 ... 66 Hz)		
Current	Z582	Z590
50 A ... 250 A	≤ 0.05 / $\leq 0.1^\circ$	≤ 0.3 / $\leq 0.15^\circ$
250 A ... 1000 A	≤ 0.03 / $\leq 0.07^\circ$	≤ 0.15 / $\leq 0.1^\circ$
1000 A ... 2500 A	≤ 0.02 / $\leq 0.05^\circ$	≤ 0.1 / $\leq 0.08^\circ$
2500 A ... 6000 A	≤ 0.02 / $\leq 0.04^\circ$	≤ 0.1 / $\leq 0.06^\circ$
6000 A ... 10 kA	≤ 0.02 / $\leq 0.05^\circ$	≤ 0.1 / $\leq 0.08^\circ$

At 30 Hz ... 48 Hz and 66 Hz ... 440 Hz twofold the errors, at 15 Hz ... 30 Hz and 440 Hz ... 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z582, -Z590 and LMG specifications to calculate the accuracy of the complete system.

2.6.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to HINTS FOR WIRING CURRENT TRANSFORMERS OR HST TO LMG [4.4→75].

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



Figure 2.36: L60-Z60

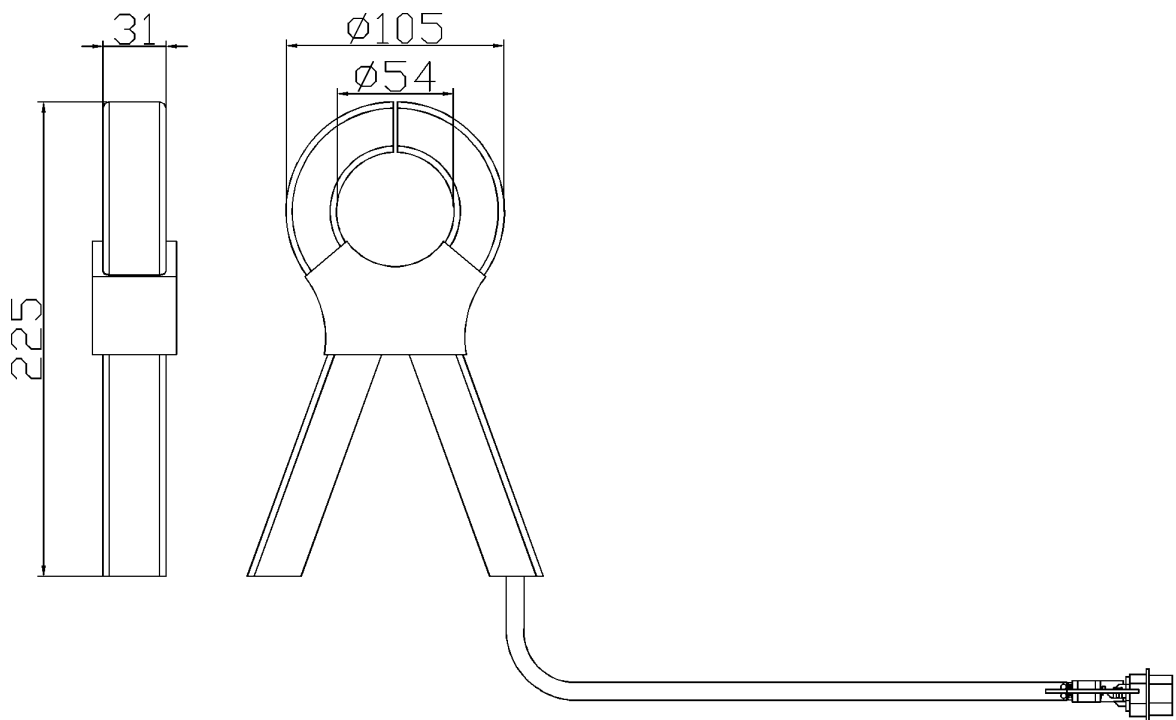


Figure 2.37: Dimensions of L60-Z60

2.7.1 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 without connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety isolation! Avoid contact to hazardous voltage!

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

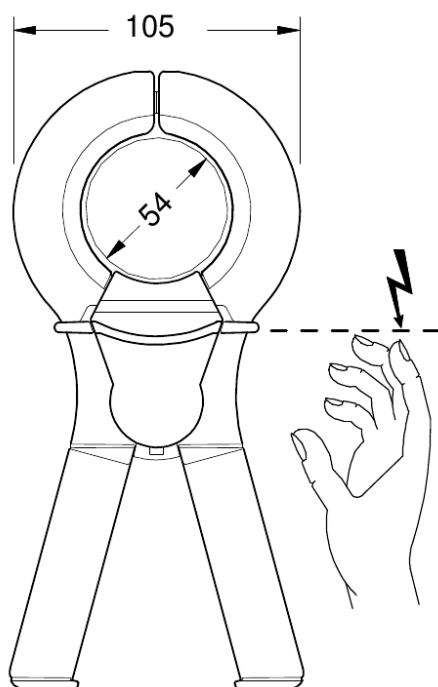


Figure 2.38: Protection against electric shock

2.7.2 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	30 Hz ... 10 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °... +50 °
Weight	650 g
Output connection	2 m fixed lead with DSUB15 plug to LMG

2.7.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz, linear interpolation is allowed.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A	$\pm 1.5\%$	$\pm 2^\circ$
10 A	$\pm 1.5\%$	$\pm 2^\circ$
200 A	$\pm 0.75\%$	$\pm 0.75^\circ$
1000 A	$\pm 0.5\%$	$\pm 0.5^\circ$

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.

2.7.4 Connection of the current clamp L60-Z60 with LMG600

Use current sensor adapter L60-X-ADSE.

In the connector to the LMG600 the adjustment data of the current clamp L60-Z60 is available 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

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

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

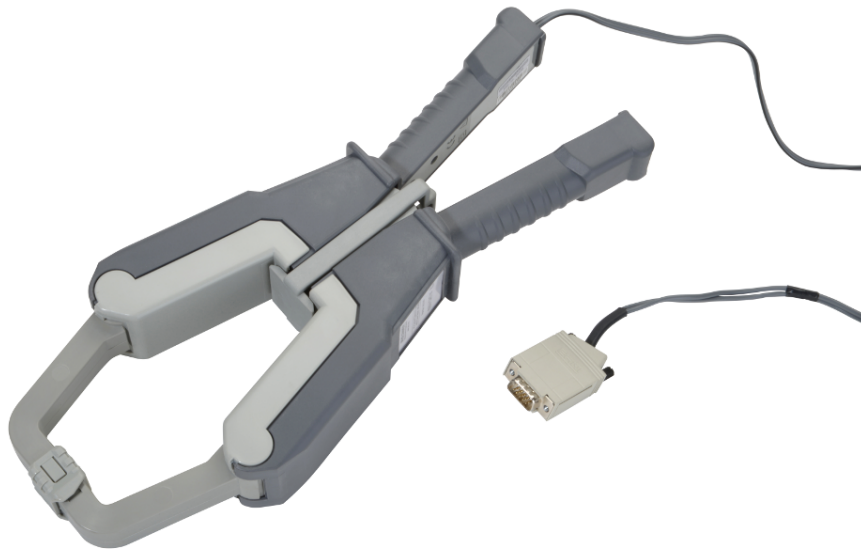


Figure 2.39: L60-Z66

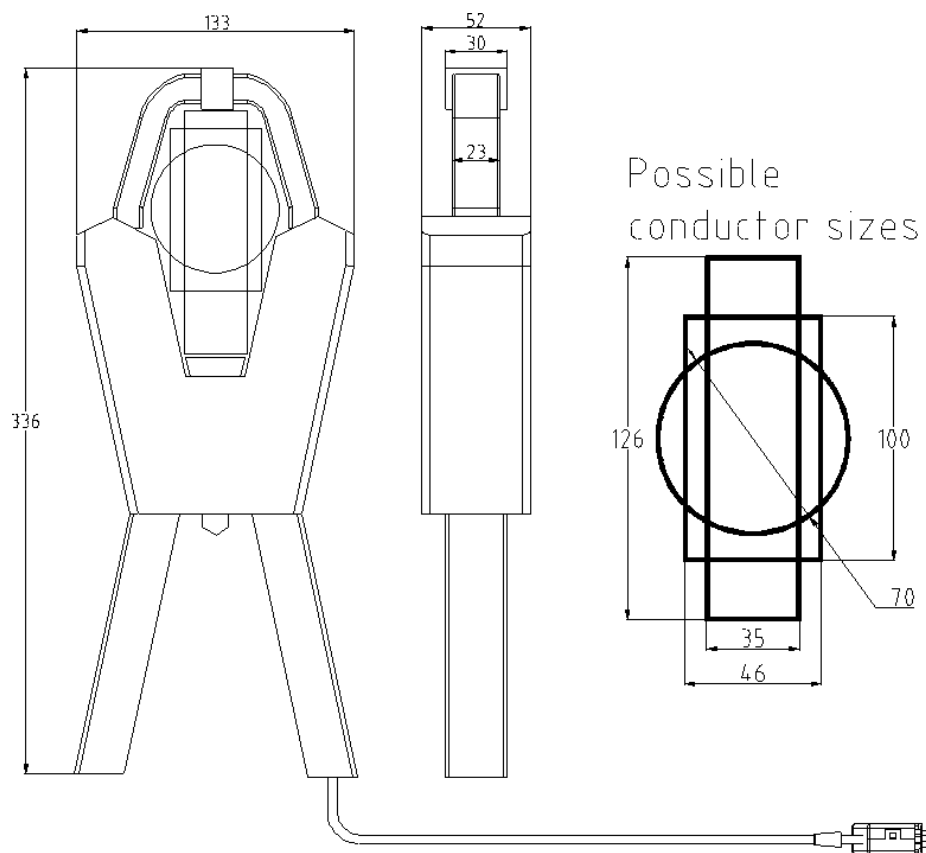


Figure 2.40: Dimensions of L60-Z66

2.8.1 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 without connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety isolation! Avoid contact to hazardous voltage!
- Use safety cover 'P' Figure 2.41 [→40] for protection against short-circuits during clamping!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

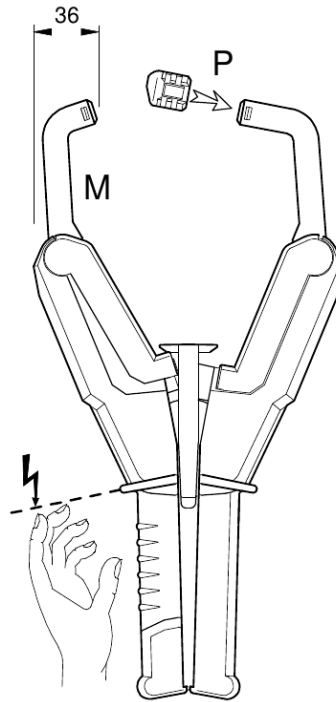


Figure 2.41: Protection against electric shock and short-circuit

2.8.2 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	40 Hz ... 5 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °... +50 °
Weight	1.88 kg
Output connection	2 m fixed lead with DSUB15 plug to LMG

2.8.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz.

Current	Amplitude uncertainty in % of measuring value	Phase uncertainty in °
1 A ... 100 A	±2 %	±1.6 °
100 A ... 1000 A	±1 %	±1 °
1000 A ... 3000 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.

2.8.4 Connection of the current clamp L60-Z66 with LMG600

Use current sensor adapter L60-X-ADSE.

In the connector to the LMG600 the adjustment data of the current clamp L60-Z66 is available 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

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

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

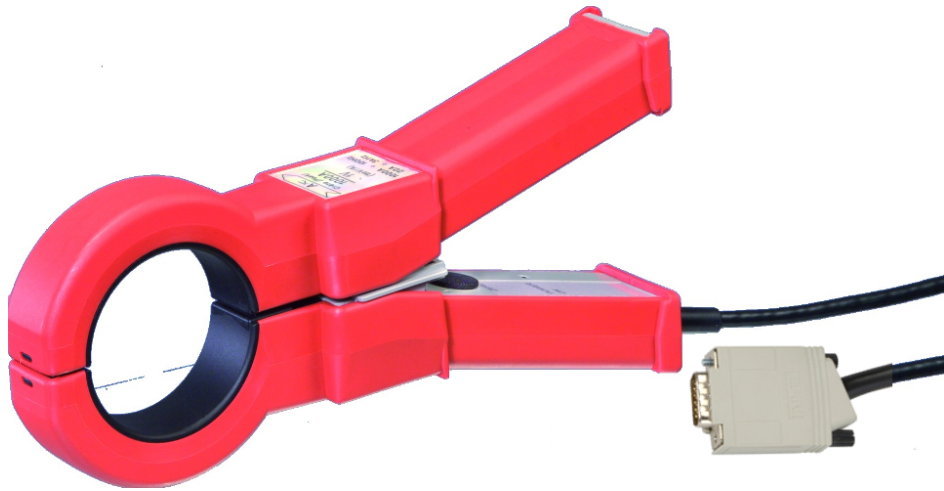


Figure 2.42: L60-Z68

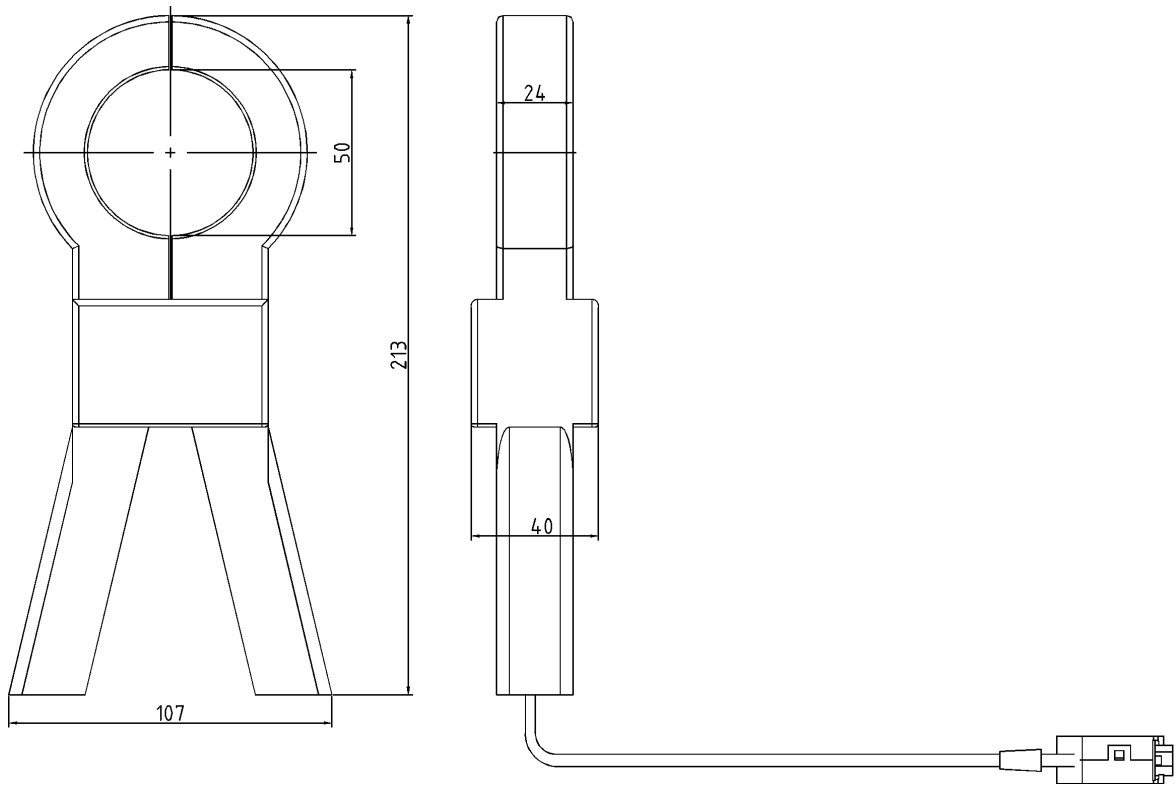


Figure 2.43: Dimensions of L60-Z68

2.9.1 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 without connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety isolation! Avoid contact to hazardous voltage!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

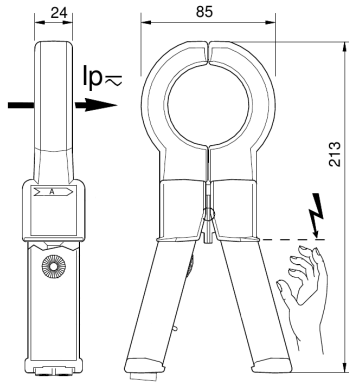


Figure 2.44: Protection against electric shock and short-circuit

2.9.2 Specifications

Nominal input current	1000 A
Max. trms value	1100 A
Measuring range	1500 Apk
Maximum input overload	1500 A continuous @ 20 °C
Bandwidth	DC ... 2 kHz
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °... +50 °
Weight	0.6 kg
Output connection	2 m fixed lead with DSUB15 plug to LMG

2.9.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year, conductor in the middle of the clamp. Zero offset adjusted to zero.

Current	Amplitude error DC	Phase error at 1 kHz
100 A ... 1100 A	$\pm 2\%$	$\pm 4^\circ$

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

2.9.4 Connection of the current clamp L60-Z68 with LMG600

Use current sensor adapter L60-X-ADSE.

In the connector to the LMG600 the adjustment data of the current clamp L60-Z68 is available 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

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

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

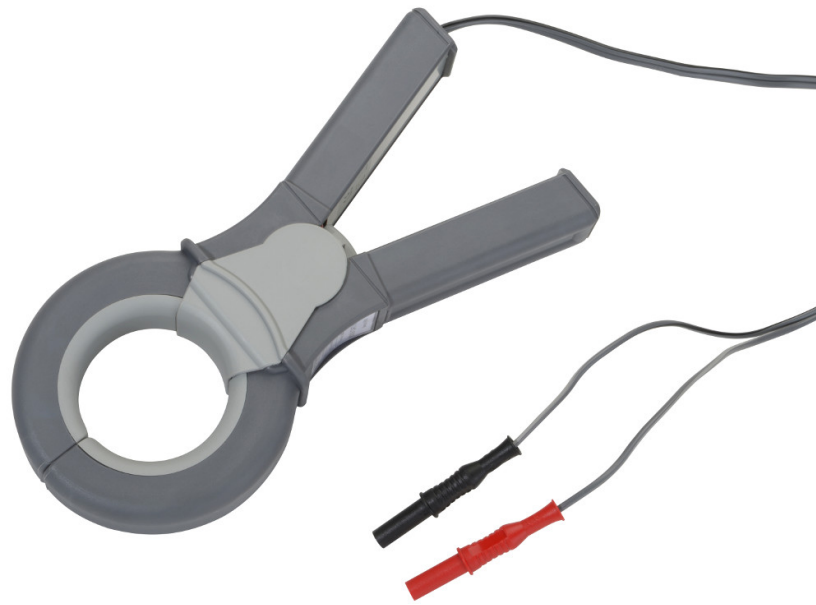


Figure 2.45: LMG-Z322

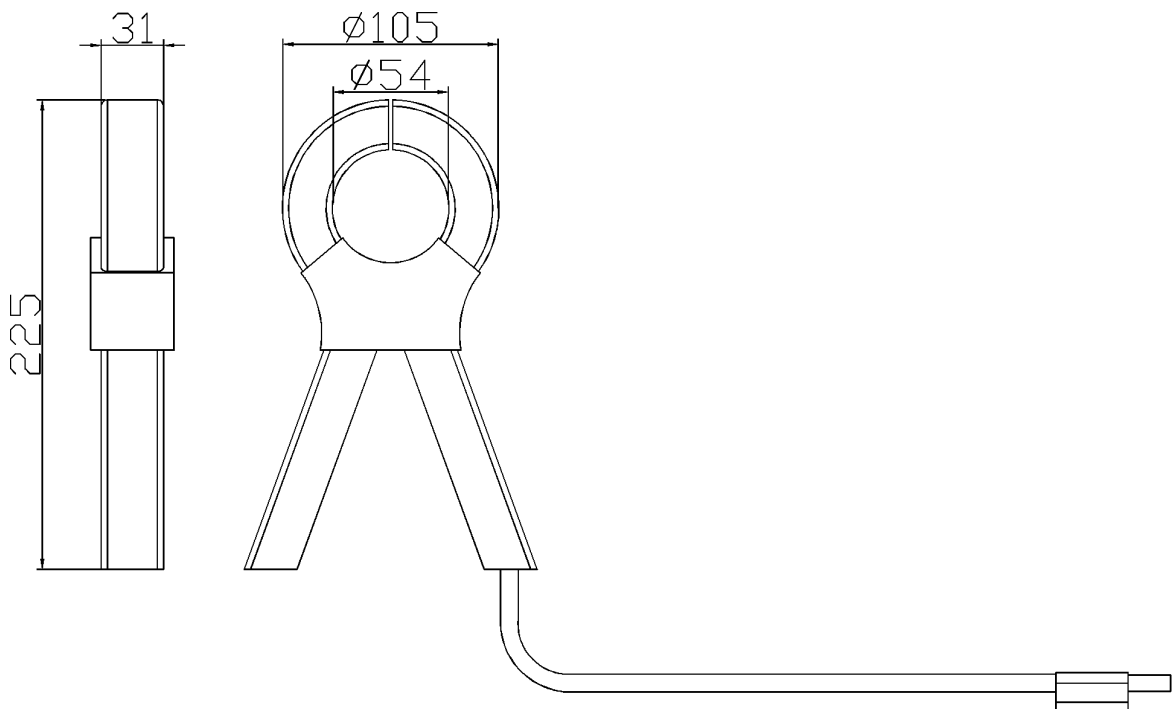


Figure 2.46: Dimensions of LMG-Z322

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 without connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety isolation! Avoid contact to hazardous voltage!

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

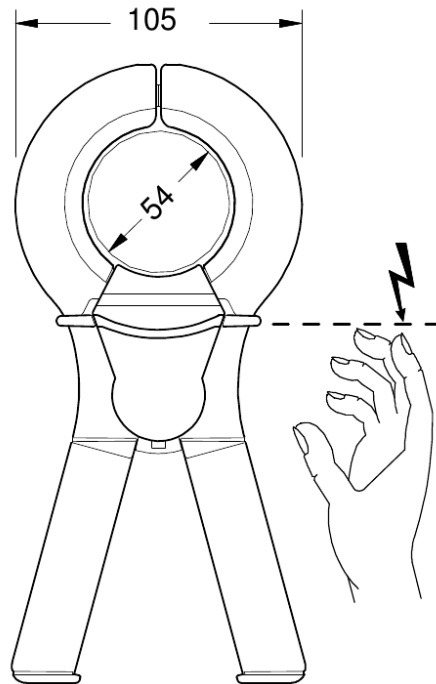


Figure 2.47: Protection against electric shock

2.10.2 Specifications

Nominal input current	1000 A
Transformation ratio	1000 : 1
Measuring range	1200 A
Maximum input overload	1200 A continuous, 2000 A for 5 min./h @ 20 °C
Bandwidth	30 Hz ... 10 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 ° ... +50 °
Weight	650 g
Output connection	2 m fixed lead with 4 mm safety plugs

2.10.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz, linear interpolation is allowed.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A	$\pm 1.5\%$	$\pm 2^\circ$
10 A	$\pm 1.5\%$	$\pm 2^\circ$
200 A	$\pm 0.75\%$	$\pm 0.75^\circ$
1000 A	$\pm 0.5\%$	$\pm 0.5^\circ$

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

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

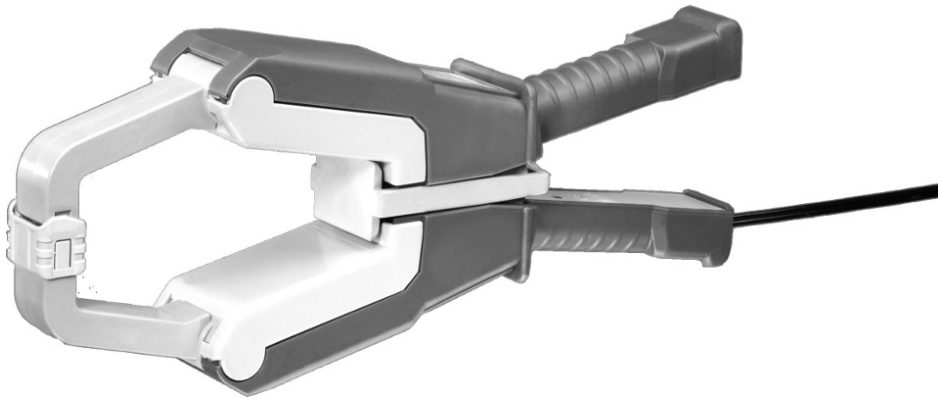


Figure 2.48: LMG-Z329

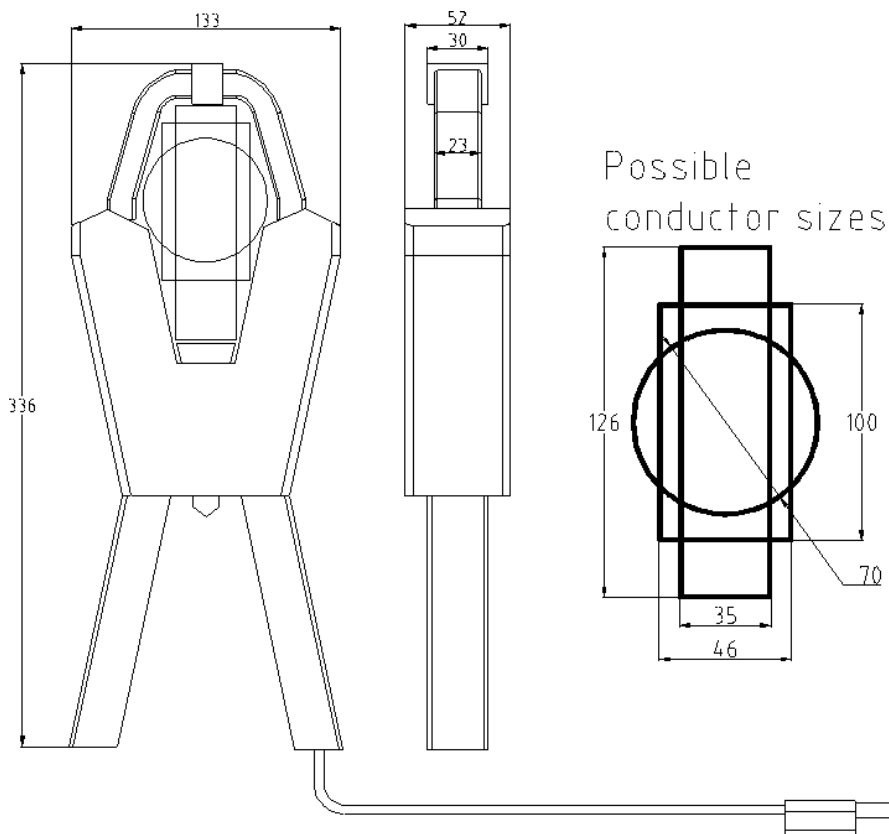


Figure 2.49: Dimensions of LMG-Z329

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 without connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety isolation! Avoid contact to hazardous voltage!
- Use safety cover 'P' Figure 2.50 [→48] for protection against short-circuits during clamping!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!



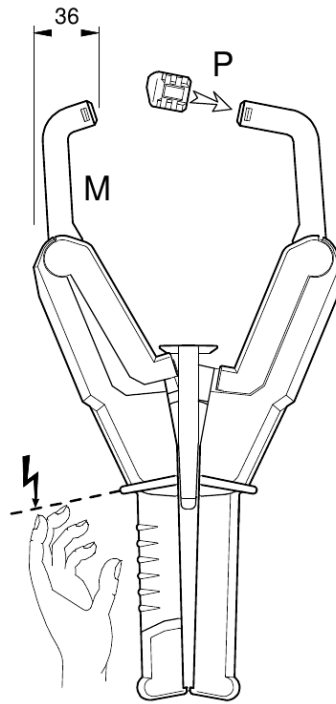


Figure 2.50: Protection against electric shock and short-circuit

2.11.2 Specifications

Nominal input current	3000 A
Transformation ratio	3000 : 1
Measuring range	3200 A
Maximum input overload	3600 A continuous, 6000 A for 5 min/h @ 20 °C
Bandwidth	40 Hz ... 5 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °... +50 °
Weight	1.88 kg
Output connection	2 m fixed lead with 4 mm safety plugs

2.11.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A ... 100 A	$\pm 2\%$	$\pm 1.6^\circ$
100 A ... 1000 A	$\pm 1\%$	$\pm 1^\circ$
1000 A ... 3000 A	$\pm 0.5\%$	$\pm 0.5^\circ$

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

2.12 Precision wideband current transformer WCT100 (LMG-Z601)



Figure 2.51: WCT100 / LMG-Z601

LMG-Z601 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 LMG-Z601 to the precision power meter LMG use narrow twisted laboratory leads, not longer than needed.

2.12.1 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]!



2.12.2 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 safety sockets, 4 mm
Output connection	
Operating temperature	-10°C ... +70°C
Through hole diameter	23 mm
Weight	350 g
Size l * w * h	120 mm * 95 mm * 65 mm

2.12.3 Uncertainty

The uncertainties are based on: no DC current component, sinusoidal current, ambient temperature $23\pm 3^{\circ}\text{C}$, calibration interval 1 year, output burden max. $100\text{ m}\Omega$, max. 1 m twisted laboratory leads, conductor in the middle of the transducer.

Full power accuracy, for measuring current up to 100A. Accuracy and bandwidth specification is for small signal as well as for wide signal level.

	30 Hz ... 100 Hz	100 Hz ... 100 kHz	100 kHz ... 300 kHz	300 kHz ... 1 MHz
Current \pm (% of measuring value)	0.25 %	0.25 %	1 %	2 %
Phase \pm (phase error in degree)	0.6°	0.3°	0.4°	0.6°

Use LMG-Z601 and LMG specifications to calculate the accuracy of the complete system.

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

2.13 Precision wideband current transformer WCT1000 (LMG-Z602)

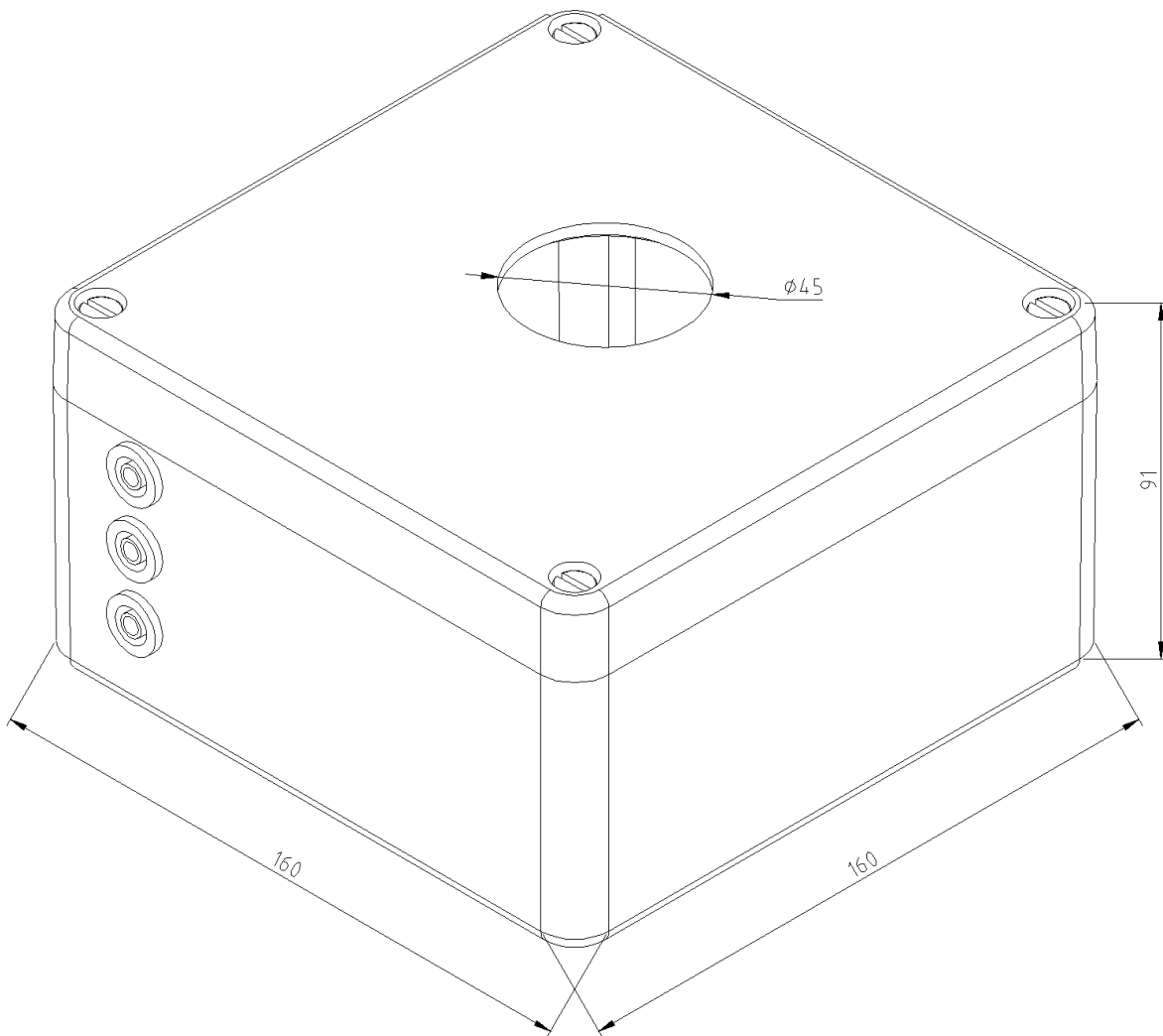


Figure 2.52: WCT1000 / LMG-Z602

LMG-Z602 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 LMG-Z602 to the precision power meter LMG use narrow twisted laboratory leads, not longer than needed.

2.13.1 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]!



2.13.2 Specifications

Nominal input current rms	1000 A
Maximum input current peak	2500 Apk
Transformation ratio	1000:1
Maximum input overload	1200 A continuous, 2000 A for 1 minute
Bandwidth	30 Hz ... 1 MHz
Output burden	0 ... 100 mΩ for specified accuracy
Isolation	bare primary conductor: 30Veff, insulated primary conductor: see cable spec.
Output connection	safety sockets, 4 mm
Operating temperature	0°C ... +50°C
Through hole diameter	44 mm
Weight	3.3 kg
Size l * w * h	160 mm * 160 mm * 91 mm

2.13.3 Uncertainty

The uncertainties are based on: no DC current component, sinusoidal current, ambient temperature $23\pm3^{\circ}\text{C}$, calibration interval 1 year, output burden max. 100 mΩ, max. 1 m twisted laboratory leads, conductor in the middle of the transducer.

Full power accuracy, for measuring current up to 100A. Accuracy and bandwidth specification is for small signal as well as for wide signal level.

	30 Hz ... 100 Hz	100 Hz ... 100 kHz	100 kHz ... 500 kHz	500 kHz ... 1 MHz
Current \pm (% of measuring value)	0.25 %	0.25 %	1 %	2 %
Phase \pm (phase error in degree)	1.5 °	0.8 °	0.5 °	2.5 °

Use LMG-Z602 and LMG specifications to calculate the accuracy of the complete system.

2.13.4 Shield socket

The black socket is internally connected to an electromagnetic shield. If the current transformer is used on high common mode voltage at high frequency, this socket can be connected to earth to conduct the disturbance to earth.

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

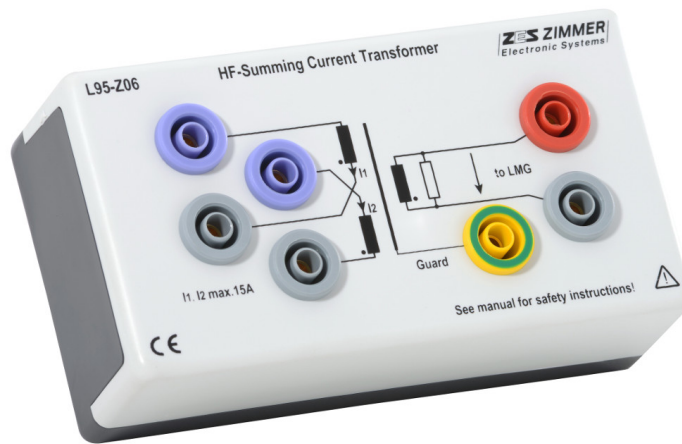


Figure 2.53: HF summing current transformer



Figure 2.54: Highvoltage HF summing current transformer

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 connection to the LMG external Shuntinput.

The high voltage version L95-Z06-HV eliminates 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 capacitive currents from input to output. This reduces errors introduced by common mode voltage.

2.14.1 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 capacitive currents from input to output. This also reduces errors by common mode voltage.
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.14.2 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	$\geq 100 \text{ k}\Omega$
Degree of pollution	2
Temperature range	-10 °... +50 °
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

2.14.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature $23 \pm 3^\circ\text{C}$, calibration interval 1 year.

Frequency	Amplitude uncertainty in % of measuring value	Phase uncertainty
5 kHz ... 500 kHz	$\pm 0.5 \%$	$\pm 1^\circ$

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

2.14.4 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 dragging down the floating voltage to about earth potential.

2.14.5 Wiring schematics

low current

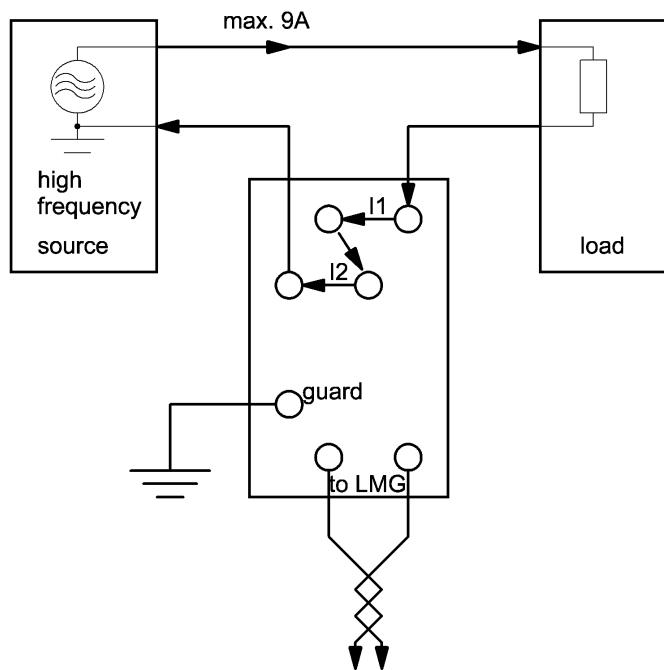


Figure 2.55: low current application

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

high current

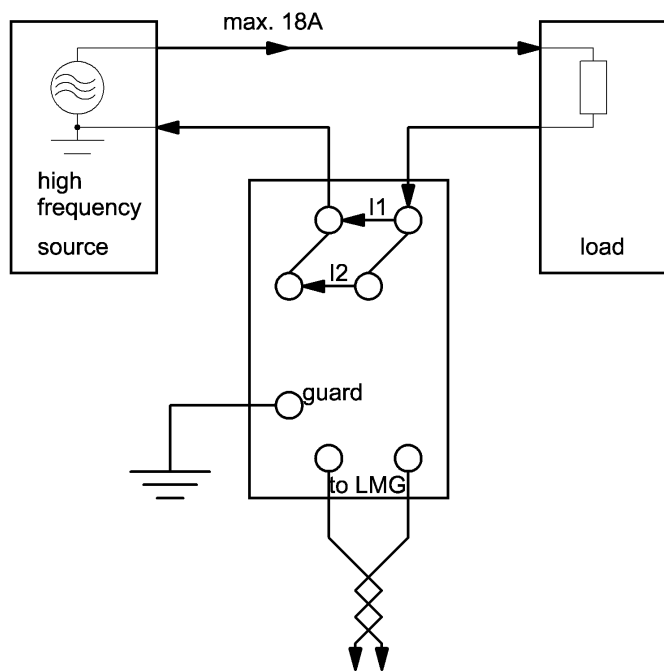


Figure 2.56: high current application

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

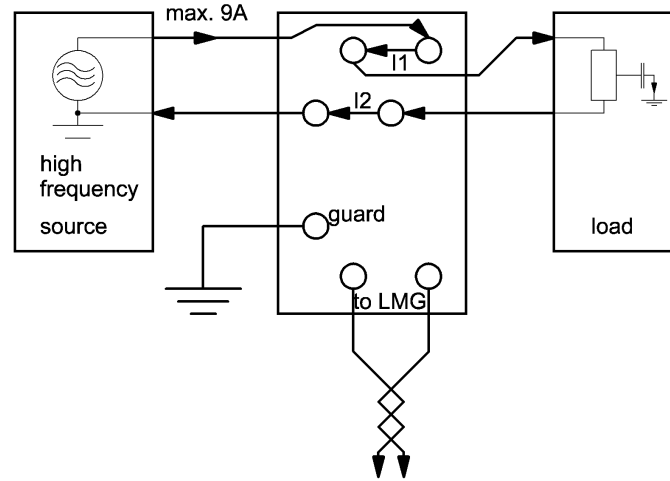
arithmetic mean value

Figure 2.57: arithmetic mean value application

To determine the arithmetic mean value of two currents: $I_{mean} = \frac{I_1 + I_2}{2}$, 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 I_1 and I_2 .

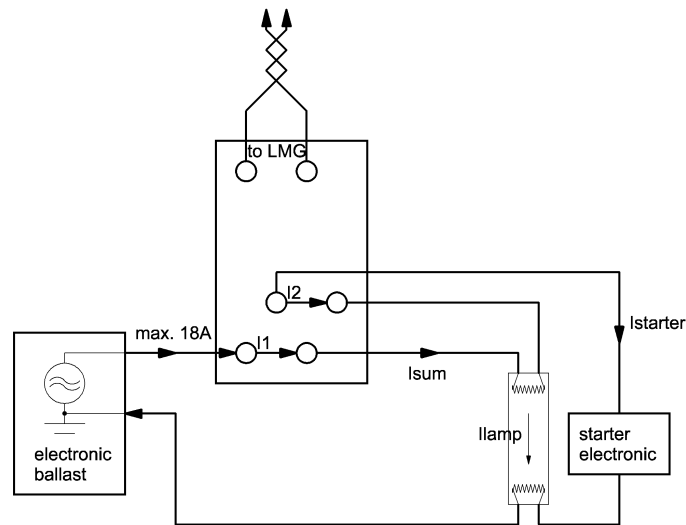
difference of two currents

Figure 2.58: 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.

3 Accessories

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

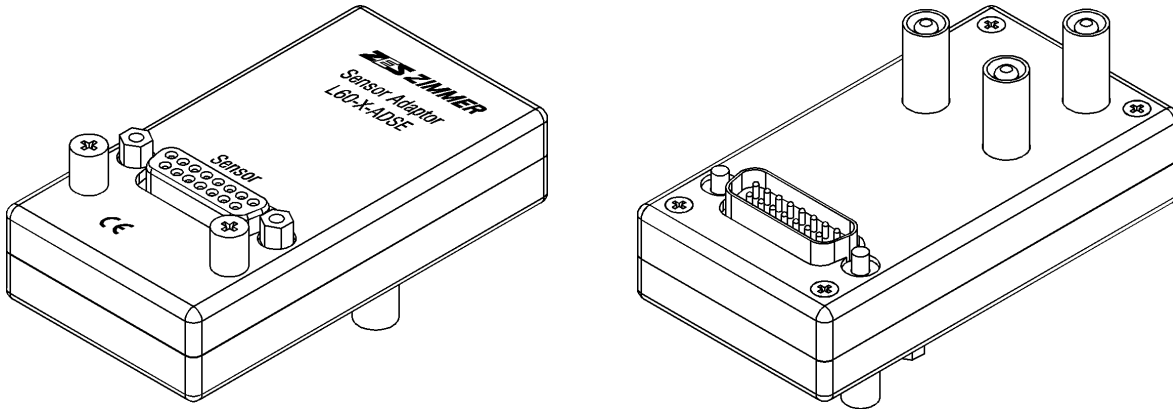


Figure 3.1: L60-X-ADSE

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 automaticaly 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.

3.2 Artificial mid point (LMG-Z-AMP)

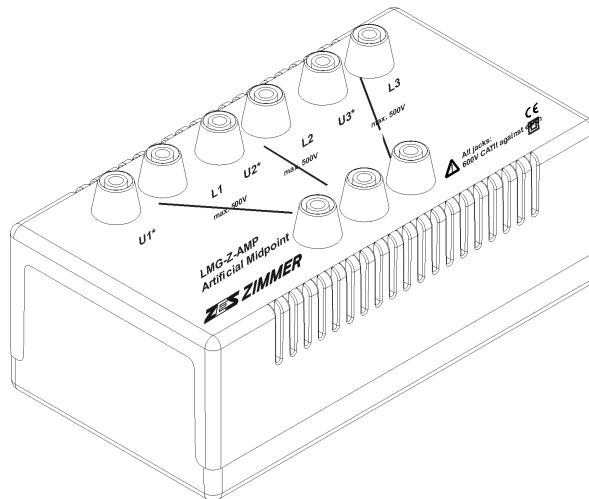


Figure 3.2: LMG-Z-AMP

When measuring at three-phase systems without accessible star point (typical for frequency inverters), an artificial star point is needed for measurements in star connections. If necessary, the losses of the artificial star point have to be considered. They can be determined exactly. The formula editor can be used to automatically calculate these losses and correct them.

3.2.1 Safety warnings



- Always connect the sensor first to the meter and afterwards to the device under test.
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

3.2.2 Connection to LMG

The LMG-Z-AMP is connected to the LMG using the six cables of the LMG (3x black, 3x yellow). Connect each channel U with U and U* with U*. At the L1, L2, L3 jack you can connect your voltage via the three delivered yellow measuring leads. The three black sockets U1, U2 and U3 (they represent the artificial mid point) are interconnected!

3.2.3 Specifications

U _{max} line-to-neutral	500 V
U _{max} against earth	600 V
R _{typ}	65.8 kΩ
Accuracy of the phase resistors in relation to each other	±0.01 %
Weight	220 g
Dimensions	150 mm * 80 mm * 65 mm

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



Figure 3.3: LMG-MAS

The MAS is a adaptor for measuring at single phase devices with Schuko inlet connector up to 16A. 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 250V CAT III.

3.3.1 Safety warnings

- Always connect the sensor 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]!



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

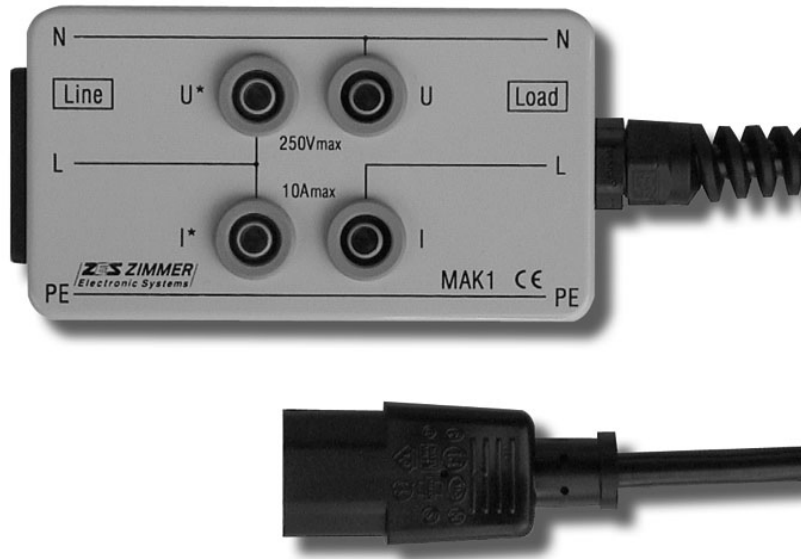


Figure 3.4: LMG-MAK1

The MAK1 is an adaptor for measuring at single phase devices with IEC inlet connector up to 10A. 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 accessible (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 300V CAT III.

3.4.1 Safety warnings



- Always connect the sensor first to the meter and afterwards to the device under test.
- Important! If you don't 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]!

3.5 Adaptor for measurement at 16A / 3phase devices (LMG-MAK3)

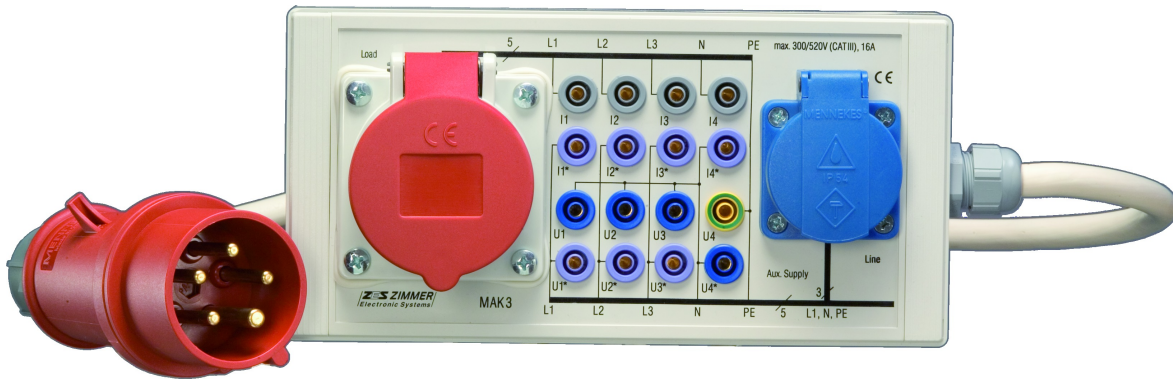


Figure 3.5: LMG-MAK3

The MAK3 is an adaptor for measuring at 3 phase systems up to 16A per phase. It is developed for the instrument series LMG, but you can also connect other instruments.

The supply is done by a about 2m long wire. The schuko jack is to supply the instrument. If you are measuring a load, the power consumption of the instrument is not taken into account, because it is supplied before the measuring connectors. If you are measuring a generator, you should supply the instrument from another jack to avoid measuring errors. With the MAK3 you can measure the voltage of the three phases (jacks U1*, U2* and U3*) against the neutral connector (U1, U2 and U3). But you can also measure the linked voltages. The three currents are also accessible (from I1*, I2 * and I3* to I 1, I2 and I3). Further on by using a 4-channel instrument you can measure the voltage between neutral and earth (U4* against U4) as well as the current in the neutral (I 4* to I 4).

3.5.1 Safety warnings

- Always connect the sensor 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 orL3, 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]!



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



Figure 3.6: Safety laboratory leads for current path



Figure 3.7: Safety laboratory leads for voltage path

Safety laboratory leads for voltage and current measurement. 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.

3.6.1 Safety warnings

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



3.6.2 Specifications

(a) Safety laboratory leads for current path

Color	grey or violet
Length	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
Copper cross section	2.5 mm ²
Rated current	32 A

(b) Safety laboratory leads for voltage path

Color	black or 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
Copper cross section	1 mm ²
Fuse	6.3x32 mm, FF 500 mA, 1000 V, AC+DC, 30 kA breaking capability e.g. SIBA 7017240.0,5

3.7 Safety Grip for current and voltage connection (LMG-Z301)

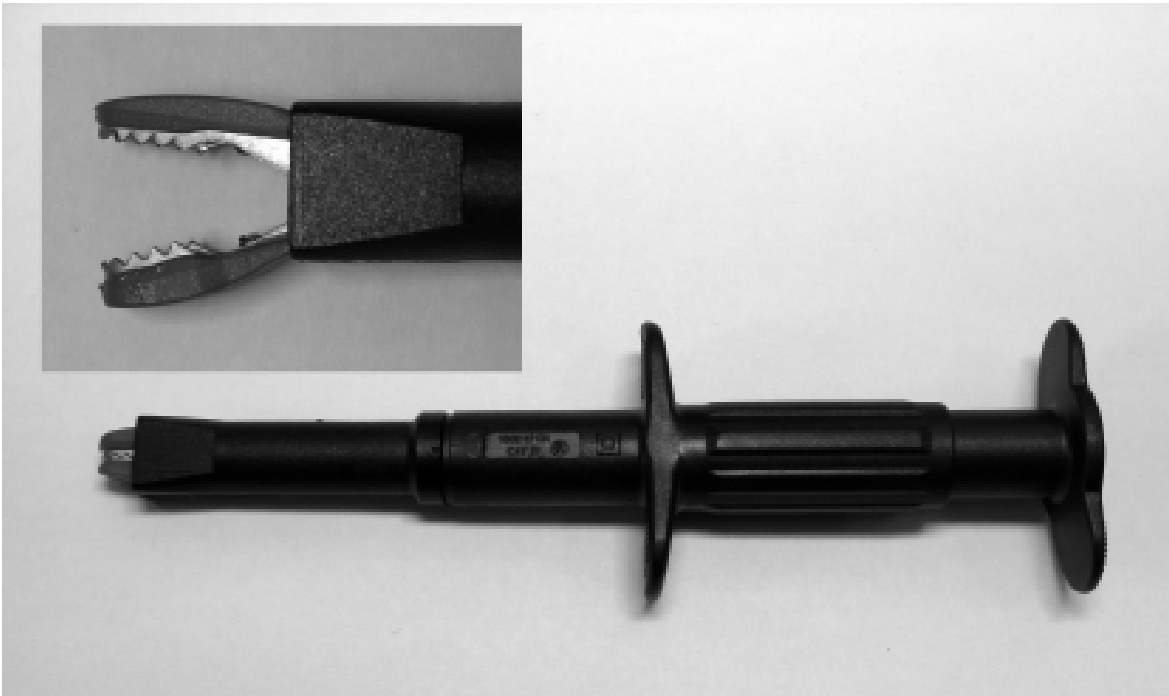


Figure 3.8: LMG-Z301 black

Safety claw grip, type CI, 16 A / 1000 V / CAT III. Test clips for current and voltage connection with on the outside insulated steel jaws. Available in red and black.

3.7.1 Safety warnings

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



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

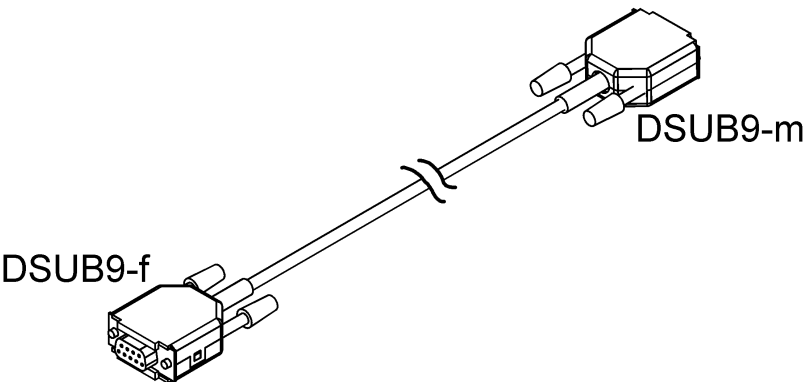


Figure 3.9: Shielded DSUB9 extention cable

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

It can be used to extend the cable length of the PSU and PCT connection cables. In this case it is used between the precision current sensor PSU60/200/400/600/700 or PCT200/600 and the LMG specific connection cable to the LMG.

3.8.1 Safety warnings

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



3.8.2 Specifications

Isolation	No safety isolation, working voltage max. 50 V
Connectors	DSUB9 male / DSUB9 female
Cable length	user selectable: 3 m, 5 m, 10 m or 15 m

3.9 DSUB Adapter with screwed terminal connection (LMG-IObox)



Figure 3.10: LMG-IObox (picture similar)

Adapter from DSUB to screwed terminal connection for LMG process signal interface.

Available are:

- LMG-IObox25 for DSUB25
- LMG-IObox15 for DSUB15
- LMG-IObox9 for DSUB9.

3.9.1 Safety warnings

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



3.10 IEEE488 bus cable (LMG-Z312, -Z313, -Z314)



Figure 3.11: 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

3.10.1 Safety warnings

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



3.11 RS232 interface cable (LMG-Z317)



Figure 3.12: RS232 interface cable

RS232 interface cable, DSUB 9 male to DSUB 9 female, 1:1 connection, length about 1.8m.

3.11.1 Safety warnings

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



3.12 LMG600 connection cable for current sensors PSU (PSUxx-K-L60)

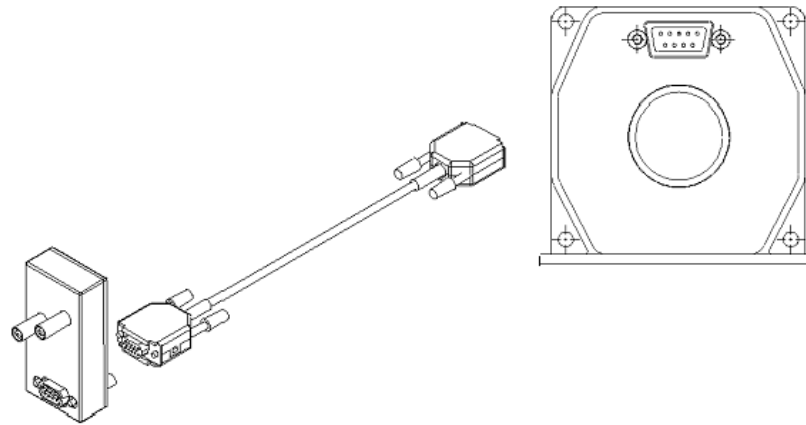


Figure 3.13: PSUxx-K-L60 (shown together with L60-X-ADSE and transducer head PSU)

The LMG600 connection cable PSUxx-K-L60 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. PSUxx-K-L60 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 PSUxx-K-L60, 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.

3.12.1 Safety warnings



- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without isolation regard DSUB cable isolation or avoid contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

3.12.2 Specifications and uncertainty

For the specifications and uncertainty 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.

3.12.3 Connection of current sensors PSU with LMG600

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

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)	...

3.12.4 Connection elongation

To use the current sensor with a longer 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 'LMG-Z-SVT' or 'LMG-Z-DV' in different lengths from 5m to 50m. 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.

4 FAQ - frequently asked questions / Knowledge base

4.1 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 capacitively 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.

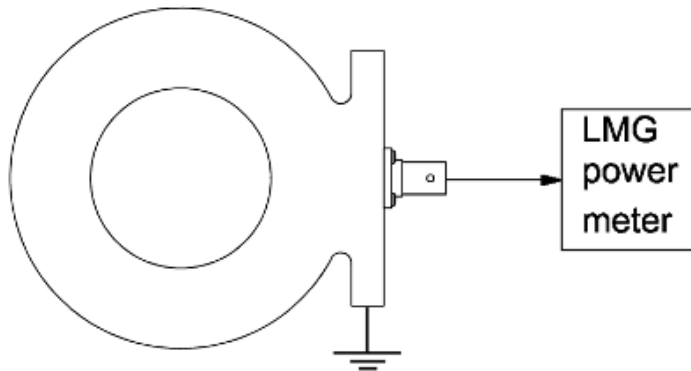


Figure 4.1: Grounding of well shielded sensors

- 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 dragging down the floating voltage to about earth potential and give the distortion currents a low impedance way to earth.

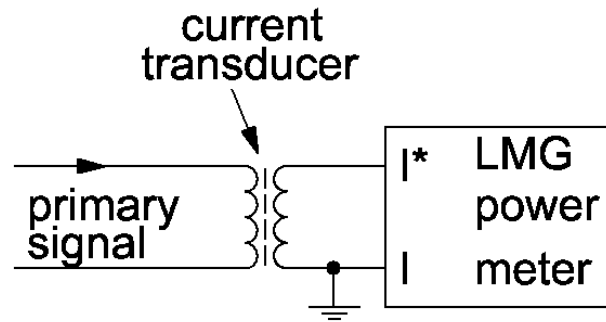


Figure 4.2: Grounding of common current sensor signals

- 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.

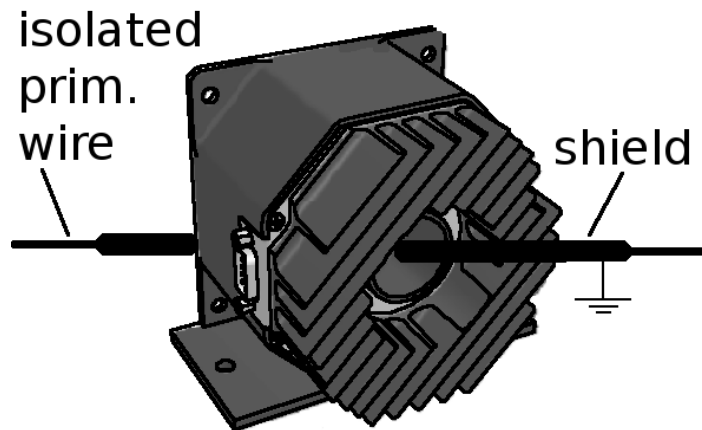


Figure 4.3: Grounding of sensors with onboard electronics

- 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. 10kHz will not affect the measuring signal significantly, but will highly reduce HF distortion and noise!

4.2 Avoid measuring errors due to shield currents



Figure 4.4: shielded high voltage cable

In the medium voltage range (e.g. wind energy) and also electrically powered vehicles shielded cables 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 zero. The shield effect against the electric field between conductor and transducer is not influenced.

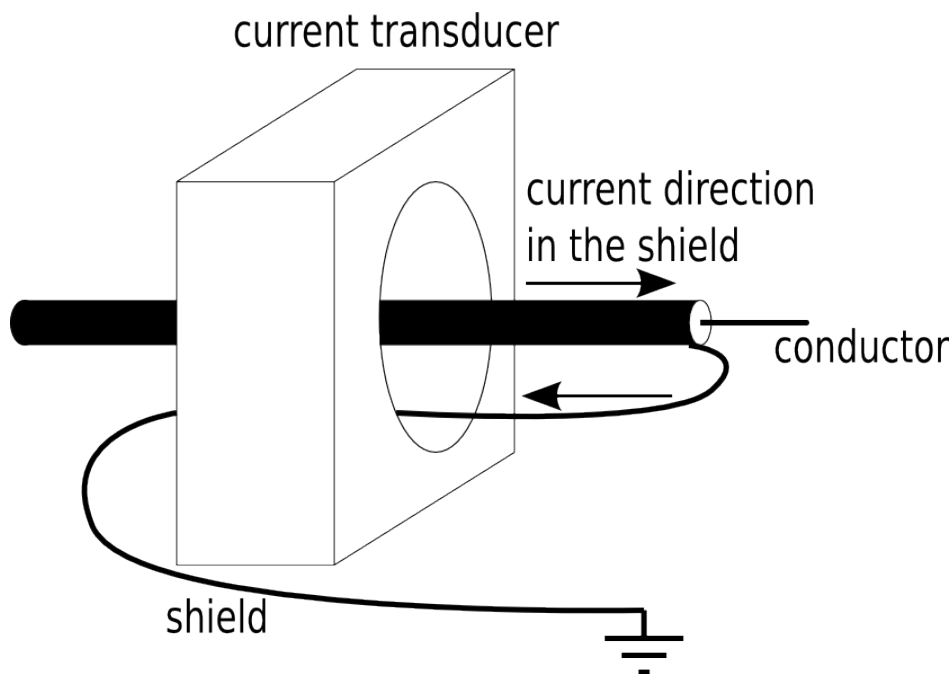


Figure 4.5: avoid measuring errors due to shield currents

4.3 Range extension by changing primary ratio at current sensors

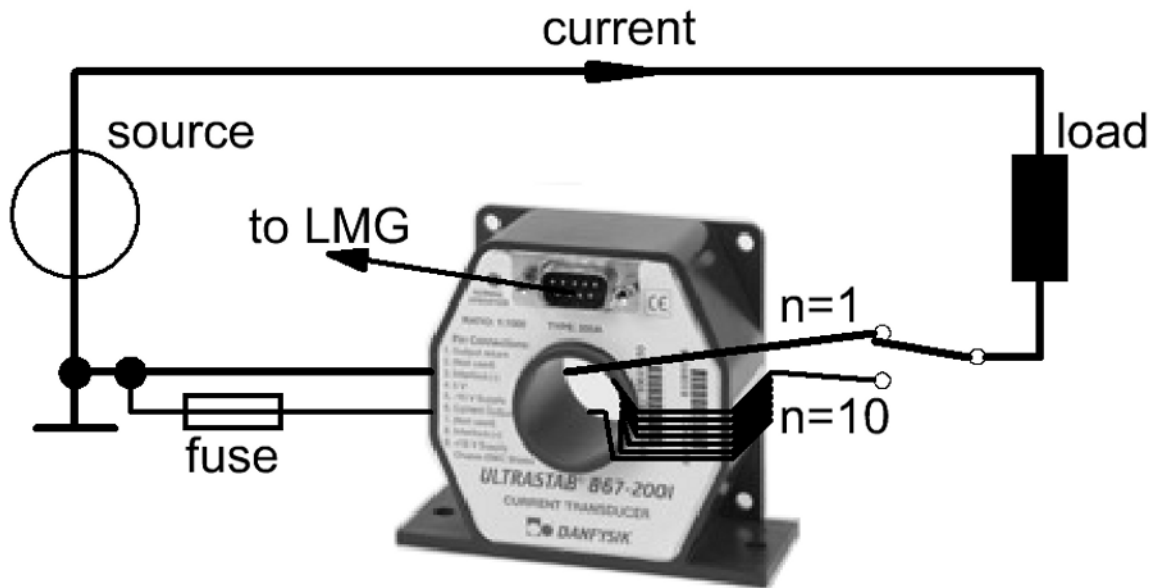


Figure 4.6: external range extension

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.

4.3.1 Example

- precision power meter LMG670
- current sensor PCT200
- measuring ranges (full range)
 - 1 turn: 2.5A .. 200A
 - 10 turns: 250mA .. 20A

4.4 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!

4.4.1 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!

(c) metric unit		(d) American wire gauge	
Cable length	Copper cross section	Cable length	American wire gauge
8 m ... 12 m	0.25 mm ²	7 m ... 10 m	AWG 24
11 m ... 17 m	0.34 mm ²	10 m ... 17 m	AWG 22
16 m ... 25 m	0.5 mm ²	16 m ... 27 m	AWG 20
23 m ... 38 m	0.75 mm ²	26 m ... 42 m	AWG 18
32 m ... 51 m	1.0 mm ²	41 m ... 67 m	AWG 16
48 m ... 77 m	1.5 mm ²	65 m ... 107 m	AWG 14
78 m ... 128 m	2.5 mm ²	104 m ... 170 m	AWG 12

Table 4.1: 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.

4.4.2 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.

4.5 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 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, $R = \frac{S}{I^2} = \frac{2.5 \text{ VA}}{(5 \text{ A})^2} = 100 \text{ m}\Omega$.

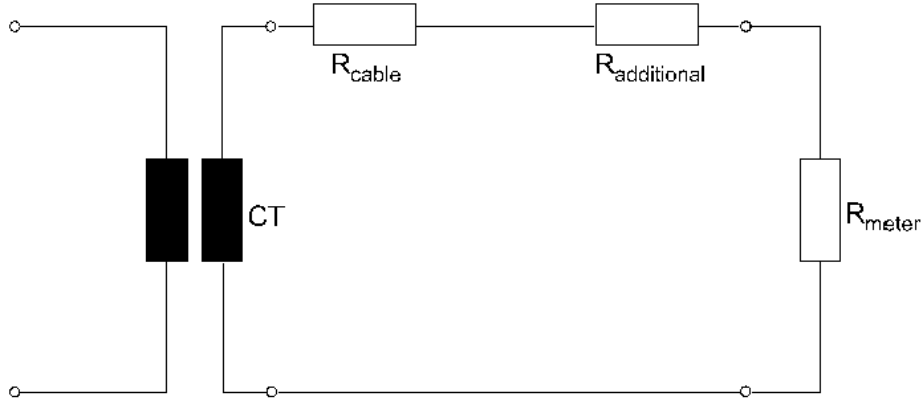


Figure 4.7: burden calculation

The burden resistor is built up from the ohmic load of the cables and additional from the burden of the meter. 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 electronic 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 cable from the sensor to the meter.

4.5.1 Example

current transformer: 100 A/5 A, rated burden 2.5 VA, operation burden = 50 %

connection cable: $l = 2 \text{ m}$, $A = 1.5 \text{ mm}^2$, copper $\rho = 0.0175 \frac{\Omega \text{ mm}^2}{\text{m}}$

input impedance of the power meter: $R_{\text{meter}} = 20 \text{ m}\Omega$

rated burden of the CT is: $R = \frac{S}{I^2} = \frac{2.5 \text{ VA}}{(5 \text{ A})^2} = 100 \text{ m}\Omega$

operation burden of the CT is: $R_{\text{operation}} = 100 \text{ m}\Omega * 50 \% = 50 \text{ m}\Omega$

$R_{\text{cable}} = \frac{\rho * l}{A} = \frac{0.0175 \Omega * \text{mm}^2 * 2 \text{ m}}{\text{m} * 1.5 \text{ mm}^2} = 23.3 \text{ m}\Omega$

$R_{\text{additional}} = R_{\text{operation}} - R_{\text{cable}} - R_{\text{meter}} = 50 \text{ m}\Omega - 23.3 \text{ m}\Omega - 20 \text{ m}\Omega = 6.7 \text{ m}\Omega$

You can realize the correct burden with a longer connection cable:

$$l = \frac{R * A}{\rho} = \frac{(R_{\text{operation}} - R_{\text{meter}}) * A}{\rho} = \frac{(50 \text{ m}\Omega - 20 \text{ m}\Omega) * \text{m} * 1.5 \text{ mm}^2}{0.0175 \Omega * \text{mm}^2} = 2.57 \text{ m}$$

4.6 Support request

If you need help finding the best suitable current sensors for your application, please don't hesitate to contact ZES, the engineers will help you. Please fill out this form and send it to +49 6171 52086 or describe the following points in an email send to sales@zes.com.

Name _____
 Company _____
 Street _____
 City _____
 Phone, fax _____
 email _____
 project name _____

current range lowest current to measure (Irms)? maximum current to measure (Irms, Ipk)	
overload (not to be measured, only withstand) peak current and duration? or rms current, frequency and duration?	
frequency range, bandwidth lowest frequency to measure, DC? maximum frequency to measure? you know about the wave shape (dc, sin, ..)? di/dt to be followed exactly (A/us)? ripple (A _{pkpk}), ripple frequency? optionally: please provide a graphic sketch	
which accuracy at which current value and frequency is aspired? which type of connection is applicable: clamp on, feed through or terminal? min. L(mm) * W(mm) or diameter(mm)? any other mechanical requirements?	
are there restrictions on the inserted impedance in the current path?	
at which working voltage does the current sensor operate: working voltage against earth (Urms, Upk, CAT, frequency)? nominal voltage between phases? current measurement at low voltage return or at high voltage potential? dU/dt applied on primary?	
which type of application will be measured?	
you know the approximately power factor ?	
with which type of power meter ? other instrument?	
environmental conditions: temperature range? degree of pollution?	
additional requirements? comments?	

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