ZES ZIMMER
Electronic Systems

ZES Sensors and Accessories

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ZES current- and voltage sensors and accessories

This data book is the technical dokumentation of the current and voltage sensors from ZES ZIMMER Electronic Systems GmbH to enlarge the measuring ranges of the power meters series LMG.

The first section of this paper gives an survey of all ZES current sensors.
Selection tree, table and several arguments should help you to find a suitable sensor family.

The second section is about the general current sensors, which you can use with every precision power meter of the LMG series. In the following sections the special sensors, wiring cables and accessories for the different precision power meters are described. Then you find a chapter with the precision high voltage divider for meters of the LMG series.

The last section with frequently asked questions will help you to optimize the accuracy and give you some hints for the usage of our sensors.

But in all cases if you need more information or detailed support for your application please don’t hesitate to contact us, the engineers of ZES ZIMMER will help you.

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Regard DIN 34!

We reserve the right to implement technical changes at any time, particularly where these changes will improve the performance.

Content

1 Selection guides

1.1 Selection table

Sensor name	lower corner freq.	upper corner freq.	preci-sion	current range	primary connec-tion	L 95	L 45	L 50	typical applications
Current clamps									
LMG-Z327	45Hz	10kHz	1%	100A	clamp on	x		x	general purpose
LMG-Z326	40Hz	10kHz	0.8%	200A	clamp on	x		x	general purpose
LMG-Z325	40 Hz	5kHz	2%	200A	clamp on	x		x	general purpose
LMG-Z322	30Hz	10kHz	0.5%	1000A	clamp on	x	x	x	general purpose
LMG-Z329	45Hz	5kHz	0.5%	3000A	clamp on	x	x	x	general purpose
L45-Z06	5Hz	50kHz	0.2%	40A	clamp on	x	x	x	frequency inverter output
L45-Z10/-Z11	2Hz	40kHz	0.15%	1000A	clamp on	x	x	x	frequency inverter output
L45-Z16/-Z17	5Hz	10kHz	0.15%	3000A	clamp on	x	x	x	frequency inverter output
L45-Z26	DC	2kHz	1.6%	1000A	clamp on	x	x	x	the only clamp on solution for DC applications
Rogowski clamps									
L45-Z32-Flex500	10Hz	5kHz	6.1%	500A	clamp on	x	x	x	50Hz power quality, very flexible clamp on
L45-Z32-Flex1000	10Hz	5kHz	3.1%	1000A	clamp on	x	x	x	50Hz power quality, very flexible clamp on
L45-Z32-Flex3000	10Hz	5kHz	3.1%	3000A	clamp on	x	x	x	50Hz power quality, very flexible clamp on
Precision Transformer									
LMG-Z502	15Hz	5kHz	0.02%	750A	feed through	x	x	x	50 Hz applications, high precision
LMG-Z505	15Hz	5kHz	0.05%	750A	feed through	x	x	x	50 Hz applications, high precision
LMG-Z510	15Hz	5kHz	0.1%	750A	feed through	x	x	x	50 Hz applications, high precision
LMG-Z520	15Hz	5kHz	0.2%	750A	feed through	x	x	x	50 Hz applications, high precision

Sensor name	lower corner freq.	upper corner freq.	preci-sion	current range	primary connec-tion	L 95	L 45	L 50	typical applications
Precision current transducer PSU									
PSU200	DC	100kHz	0.02%	200A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision
PSU200HF	DC	1MHz	0.02%	200A	feed through	x		x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision extended bandwidth e.g. for avionics, automotive
PSU400	DC	100kHz	0.02%	400A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision
PSU600	DC	100kHz	0.02%	600A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision
PSU700	DC	100kHz	0.02%	700A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision
PSU1000HF	DC	500kHz	0.02%	1000A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision extended bandwidth e.g. for avionics, automotive
PSU2000	DC	100kHz	0.02%	select 1000-2000A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision
PSU5000	DC	50kHz	0.02%	select 2500-5000A	feed through	x	x	x	applications with DC curent, frequency inverter DC link, frequency inverter output, very high precision
Hall current sensors									
L45-Z28-Hall50	DC	200kHz	0.9%	50A	feed through	x	x	x	frequency inverter output, frequency inverter DC link, low cost
L45-Z28-Hall100	DC	200kHz	0.7%	100A	feed through	x	x	x	frequency inverter output, frequency inverter DC link, low cost

Sensor name	lower corner freq.	upper corner freq.	preci-sion	current range	primary connec-tion	L 95	L 45	L 50	typical applications
L45-Z28-Hall200	DC	100kHz	0.65%	200A	feed through	x	x	x	frequency inverter output, frequency inverter DC link, low cost
L45-Z29-Hall300	DC	100kHz	0.4%	300A	feed through	x	x		frequency inverter output, frequency inverter DC link, low cost
L45-Z29-Hall500	DC	100kHz	0.8%	500A	feed through	x	x		frequency inverter output, frequency inverter DC link, low cost
L45-Z29-Hall1000	DC	150kHz	0.4%	1000A	feed through	x	x		frequency inverter output, frequency inverter DC link, low cost
L45-Z29-Hall2000	DC	100kHz	0.3%	2000A	feed through	x	x		frequency inverter output, frequency inverter DC link, low cost
L50-Z29-Hall300	DC	100kHz	0.4%	300A	feed through			x	frequency inverter output, frequency inverter DC link, low cost
L50-Z29-Hall500	DC	100kHz	0.8%	500A	feed through			x	frequency inverter output, frequency inverter DC link, low cost
L50-Z29-Hall1000	DC	150kHz	0.4%	1000A	feed through			x	frequency inverter output, frequency inverter DC link, low cost
L50-Z29-Hall2000	DC	100kHz	0.3%	2000A	feed through			x	frequency inverter output, frequency inverter DC link, low cost
High frequency sensors									
L95-Z06 L95-Z06HV	5kHz	500kHz	0.5%	15A	terminal	x		x	summing current transducer, lighting applications, ultrasonic
LMG-Z601	30Hz	1MHz	0.25%	100A	feed through	x	(x)	x	very high frequency applications, avionics, ultrasonic
External shunt, low current									
L95-SH100	DC	100kHz	0.01% 0.1%	select uA-1A	terminal	x	no!	x	very low current
L95-SH100P	DC	10kHz	0.15%	select uA-0.5A	terminal	x	no!	x	50Hz standby current, overload protection 20A

1.2 Advantages and disadvantages of different sensor types

This section should give you a help to choose the best sensor for your application. First of all you should know that the exactest measurement you can do is to use the direct inputs of the meter. The errors of the phase shift and the delay of the channels are optimised for a precise power measurement. If you must use an external sensor you should know the following points about the different kinds of the sensors:

DC - current clamps:

advantage: Easy to use. The sensor can be clamped on the circuit to be measured without interrupting the circuit.
The only clamp-on-solution for DC-currents.

disadvantage: Small bandwidth.
Low accuracy.

AC - current clamps:

advantage: Easy to use. The sensor can be clamped on the circuit to be measured without interrupting the circuit.
Medium accuracy.

disadvantage: Small bandwidth.

Rogowski flex sensors:

advantage: Easy to use, especially if few space is available. The sensor can be clamped on the circuit to be measured without interrupting the circuit.
Medium Bandwidth

disadvantage: Medium to low accuracy, no DC measuring.

Error compensated AC - current clamps:

advantage: Easy to use. The sensor can be clamped on the circuit to be measured without interrupting the circuit.
Medium bandwidth.
High accuracy.

disadvantage: no DC measuring

Precision current transformers (Z5xx):

advantage: Very high accuracy possible.

disadvantage: The circuit to be measured has to be opened and then connected to the transformer.
Small Bandwidth, no DC measurement.

Current transducer (Hall):

advantage: Low cost
Medium to high Bandwidth.
Medium accuracy.

disadvantage: Low DC measurement accuracy.
The circuit to be measured has to be opened to mount the Hall sensor.

Current transducer (PSU):

Advantage: High DC accuracy
Excellent linearity.
Medium bandwidth
DC measurement is very exactly.

Disadvantage: The circuit to be measured has to be opened to mount the PSU sensor.

External shunts:

advantage: Very exact measurement on high frequencies.
Smallest possible phase error.

disadvantage: No galvanic isolation.
Especially at high currents significant power losses and errors due to self-heating.
very small burden voltage at high voltage potential may cause diferential input errors

precision wideband current transformer (WCT):

advantage: best bandwidth
excellent power accuracy because of low phase error
galvanic separation
user defined isolation with isolated primary measuring line
good reliability with passive design

disadvantage: no DC measuring

2 Current sensors

2.1 Active error compensated AC - current clamp 40A (L45-Z06/-Z07)

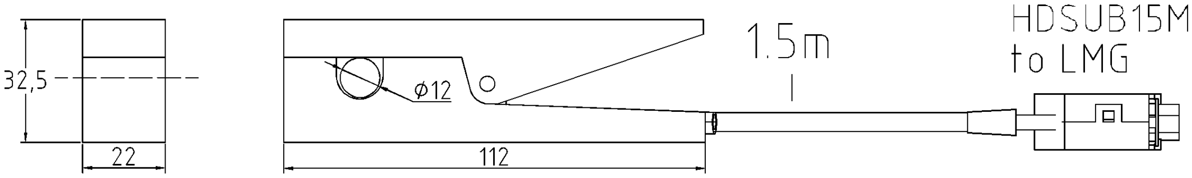


Figure 1: Dimensions of the L45-Z06

2.1.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

2.1.2 Specifications

Nominal input current	40A
Max. trms value	80A
Measuring range current clamp	120Apk
Maximum input, overload capability	500A for 1s
Bandwidth	5Hz to 50kHz
Protection class	300V / CAT III
Degree of pollution	2
Temperature range	-10°C to +50°C
Weight	120g
Output connection	HD15 (with EEPROM) for LMG sensor input

2.1.3 Accuracy

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

Influence of coupling mode: This current clamp can transfer only AC currents. The compensation circuit may cause a DC signal wich is interpreted by the instrument as a DC current. This could cause additional errors. Therefor this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

Frequency	5Hz to 10Hz	10Hz to 45Hz	45Hz to 65Hz	65Hz to 1kHz	1kHz to 5kHz	5kHz to 20kHz	20kHz to 50kHz
Current	1.5+0.25	0.4+0.15	0.15+0.05	0.15+0.05	0.3+0.15	1+0.25	4+0.5
Phase	6	3	0.5	0.5	2	6	20

Use L45-Z06 and LMG specifications to calculate the accuracy of the complete system.

Earthing jack:
The earthing jack of this clamp can be used to connect the core of the clamp with earth potential. By this you can reduce the errors caused by capacitive coupling of the very steep voltage signal for example at the output of frequency converters very much. In all other applications it is not necessary to connect this jack.

2.1.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG.

2.1.5 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.1.6 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.1.7 Connection of the sensor with LMG450

Use sensor input, you get the following ranges:

nominal value	1.25A	2.5A	5A	10A	20A	40A
max. trms value	2.5A	5A	10A	20A	40A	80A
max. peak value	3.75A	7.5A	15A	30A	60A	120A

2.1.8 Connection of the sensor with LMG500

Use L50-Z14, you get the following ranges:

nominal value	0.3A	0.6A	1.25A	2.5A	5A	10A	20A	40A
max. trms value	0.6A	1.25A	2.5A	5A	10A	20A	40A	80A
max. peak value	0.94A	1.88A	3.75A	7.5A	15A	30A	60A	120A

2.2 AC - current clamp 100A/0.1A (LMG-Z327)

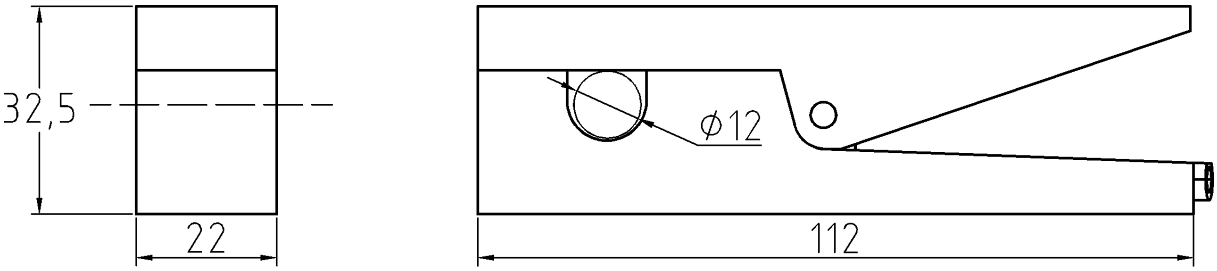


Figure 2: Dimensions of the LMG-Z327

2.2.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.2.2 Specifications

Nominal input current	100A
Transformation ratio	1000:1
Measuring range	100A
Maximum input	120A for 5min
Bandwidth	45Hz to 10kHz
Burden	<0.1VA
Isolation	not insulated conductor: phase/ground 30Veff insulated conductor: see cable spec.
Degree of pollution	2
Temperature range	-10°C to +50°C
Weight	110g
Output connection	2 laboratory sockets 4mm

2.2.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50..60 Hz

Current	Amplitude error ±(% of measuring value)	Phase error
1A to 10A	2	3.5°
10A to 100A	1	2.5°

Use LMG-Z327 and LMG specifications to calculate the accuracy of the complete system.

2.2.4 Sensor operation without connection to LMG

It is importand to assure a good connection from the sensor to the LMG before switching on the load current! 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!

2.2.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.2.6 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.2.7 Connection of the sensor with LMG450

Use direct current inputs I* and I.
Alternative use L45-Z06/07 because of improved dynamic range with more ranges and better bandwidth.

2.2.8 Connection of the sensor with LMG500

Use direct current inputs I* and I.
Alternative use L45-Z06/07 because of improved dynamic range with more ranges and better bandwidth.

2.3 AC - current clamp 200A/0.2A (LMG-Z326)

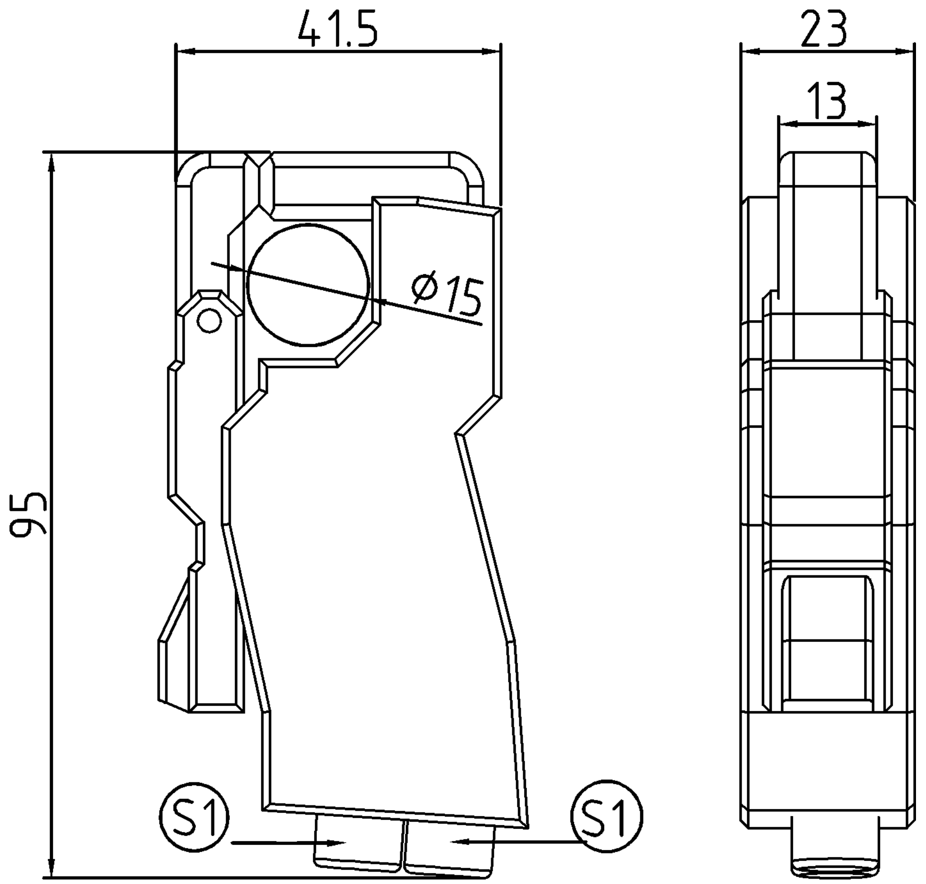


Figure 3: Dimensions of the LMG-Z326

2.3.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.3.2 Specifications

Nominal input current	200A
Transformation ratio	1000:1
Measuring range	600A
Maximum input	600A for 30s / 400A for 3min
Bandwidth	40Hz to 10kHz
Burden	<0.4VA
Isolation	not insulated conductor: phase/ground 30Veff insulated conductor: see cable spec.
Degree of pollution	2
Temperature range	-10°C to +50°C

Weight	105g
Output connection	2 safety sockets for 4mm plugs

2.3.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50..60 Hz.

Current	Amplitude error ±(% of measuring value)	Phase error
1A to 10A	2	2.5°
10A to 100A	1	1.5°
100A to 400A	0.8	0.5°
400A to 600A	1	1°

Use LMG-Z326 and LMG specifications to calculate the accuracy of the complete system.

2.3.4 Sensor operation without connection to LMG

It is importand to assure a good connection from the sensor to the LMG before switching on the load current! 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!

2.3.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.3.6 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.3.7 Connection of the sensor with LMG450

Use direct current inputs I* and I.

2.3.8 Connection of the sensor with LMG500

Use direct current inputs I* and I.

2.4 AC - current clamp 200A/1A (LMG-Z325)

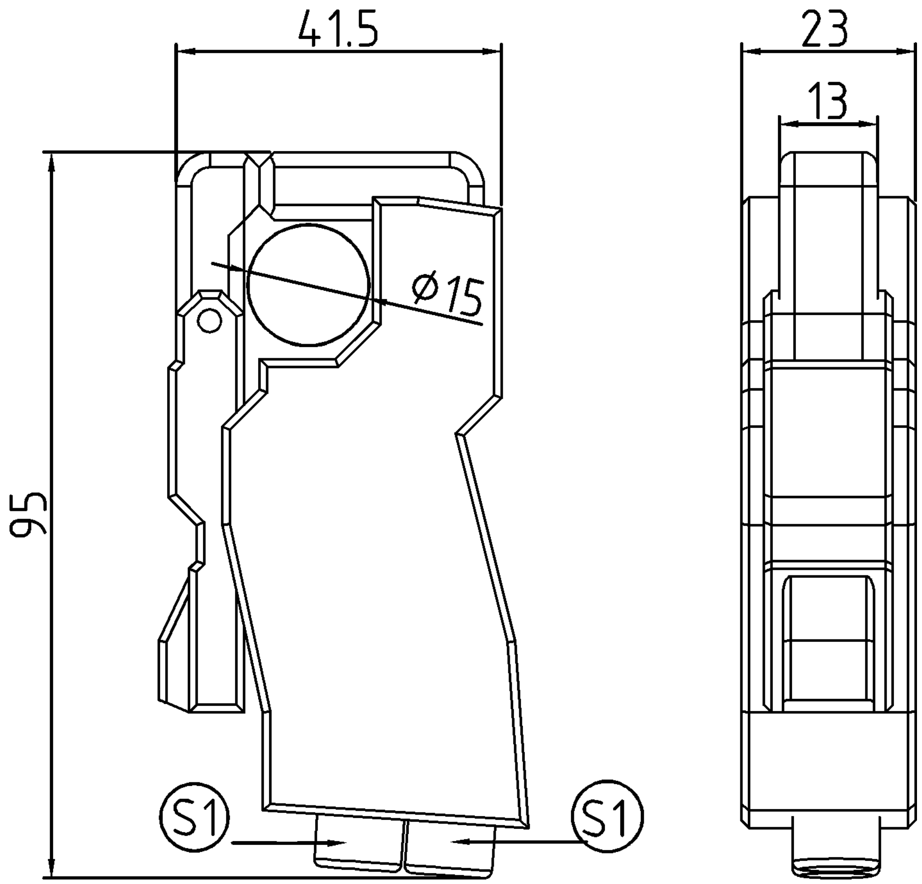


Figure 4: Dimensions of the LMG-Z325

2.4.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.4.2 Specifications

Nominal input current	200A
Transformation ratio	200:1
Measuring range	300A
Maximum input	400A for 3min
Bandwidth	40Hz to 5kHz
Burden	0.1 to 0.7 ohms
Isolation	not insulated conductor: phase/ground 30Veff insulated conductor: see cable spec.
Degree of pollution	2
Temperature range	-10°C to +50°C

Weight	115g
Output connection	safety sockets for 4mm plugs

2.4.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, conductor in the middle of the clamp, signal frequency 50..60 Hz.

Current	Amplitude error ±(% of measuring value)	Phase error
20A to 240A	2	2.5°

Use LMG-Z325 and LMG specifications to calculate the accuracy of the complete system.

2.4.4 Sensor operation without connection to LMG

It is importand to assure a good connection from the sensor to the LMG before switching on the load current! 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!

2.4.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.4.6 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.4.7 Connection of the sensor with LMG450

Use direct current inputs I* and I.

2.4.8 Connection of the sensor with LMG500

Use direct current inputs I* and I.

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

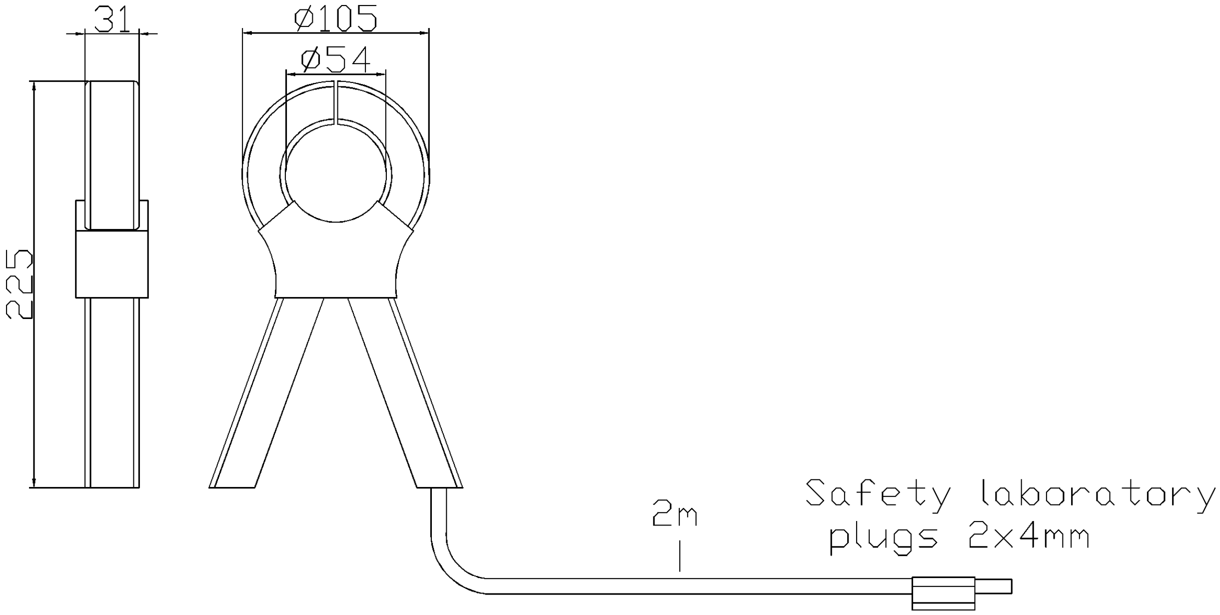


Figure 5: Dimensions of the LMG-Z322

2.5.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.5.2 Specifications

Nominal input current	1000A
Transformation ratio	1000:1
Measuring range	1200A
Maximum input	1200A for 30min
Bandwidth	30Hz to 10kHz
Burden	<2.5VA
Protection class	600V CAT. III
Degree of pollution	2
Temperature range	-10°C to +50°C
Weight	650g
Output connection	2m fixed lead with safety plugs 4mm

2.5.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50..60 Hz.

Current	Amplitude error ±(% of measuring value)	Phase error
10A to 200A	1.5%	2°
200A to 1000A	0.75%	0.75°
1000A to 1200A	0.5%	0.5°

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

2.5.4 Sensor operation without connection to LMG

It is importand to assure a good connection from the sensor to the LMG before switching on the load current! 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!

2.5.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.5.6 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.5.7 Connection of the sensor with LMG450

Use direct current inputs I* and I.
Alternative use L45-Z10/11 because of improved dynamic range with more ranges and better bandwidth.

2.5.8 Connection of the sensor with LMG500

Use direct current inputs I* and I.
Alternative use L45-Z10/11 because of improved dynamic range with more ranges and better bandwidth.

2.6 Error compensated AC - current clamp 1000A (L45-Z10/-Z11)

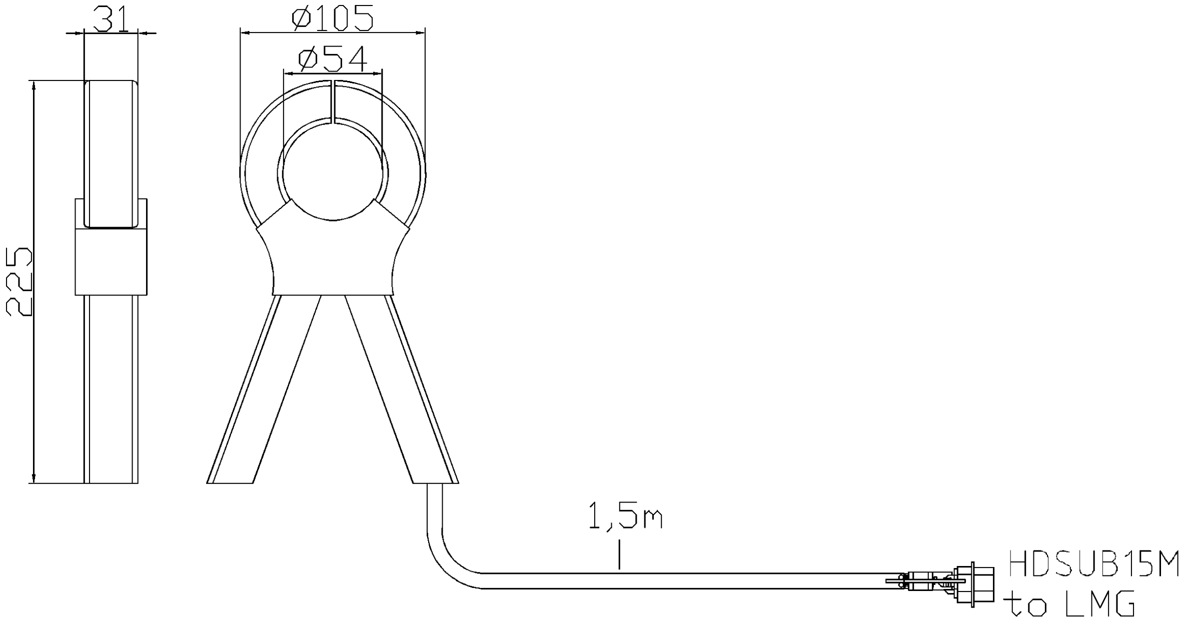


Figure 6: Dimensions of the L45-Z10, error compensated AC current clamp

2.6.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

2.6.2 Specifications

Nominal input current	1000A
Max. trms value	1200A
Measuring range current clamp	3000Apk
Maximum input	1200A for 30min
Bandwidth	2Hz to 40kHz
Protection class	600V CAT. III
Degree of pollution	2
Temperature range	-10°C to +50°C
Weight	650g
Output connection	HD15 (with EEPROM) for LMG sensor input

2.6.3 Accuracy

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

Frequency	2Hz to 10Hz	10Hz to 45Hz	45Hz to 65Hz	65Hz to 1kHz	1kHz to 5kHz	5kHz to 10kHz	10kHz to 20kHz	20kHz to 40kHz
Current	0.7+0.2	0.2+0.05	0.1+0.05	0.1+0.05	0.3+0.05	0.4+0.1	0.5+0.2	2+0.4
Phase	5	1	0.3	0.3	1	2	5	30

Use L45-Z10 and LMG specifications to calculate the accuracy of the complete system.

Influence of coupling mode: This current clamp can transfer only AC currents. The compensation circuit may cause a DC signal wich is interpreted by the instrument as a DC current. This could cause additional errors. Therefor this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

2.6.4 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.6.5 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.6.6 Connection of the sensor with LMG450

Use sensor input, you get the following ranges:

nominal value	31.3A	62.5A	125A	250A	500A	1000A
max. trms value	37.5A	75A	150A	300A	600A	1200A
max. peak value	93.8A	188A	375A	750A	1500A	3000A

2.6.7 Connection of the sensor with LMG500

Use L50-Z14, you get the following ranges:

nominal value	7.8A	15.6A	31.3A	62.5A	125A	250A	500A	1000A
max. trms value	9.4A	18.8A	37.5A	75A	150A	300A	600A	1200A
max. peak value	23.4A	46.9A	93.8A	188A	375A	750A	1500A	3000A

2.7 DC - current clamp 1000A (L45-Z26)

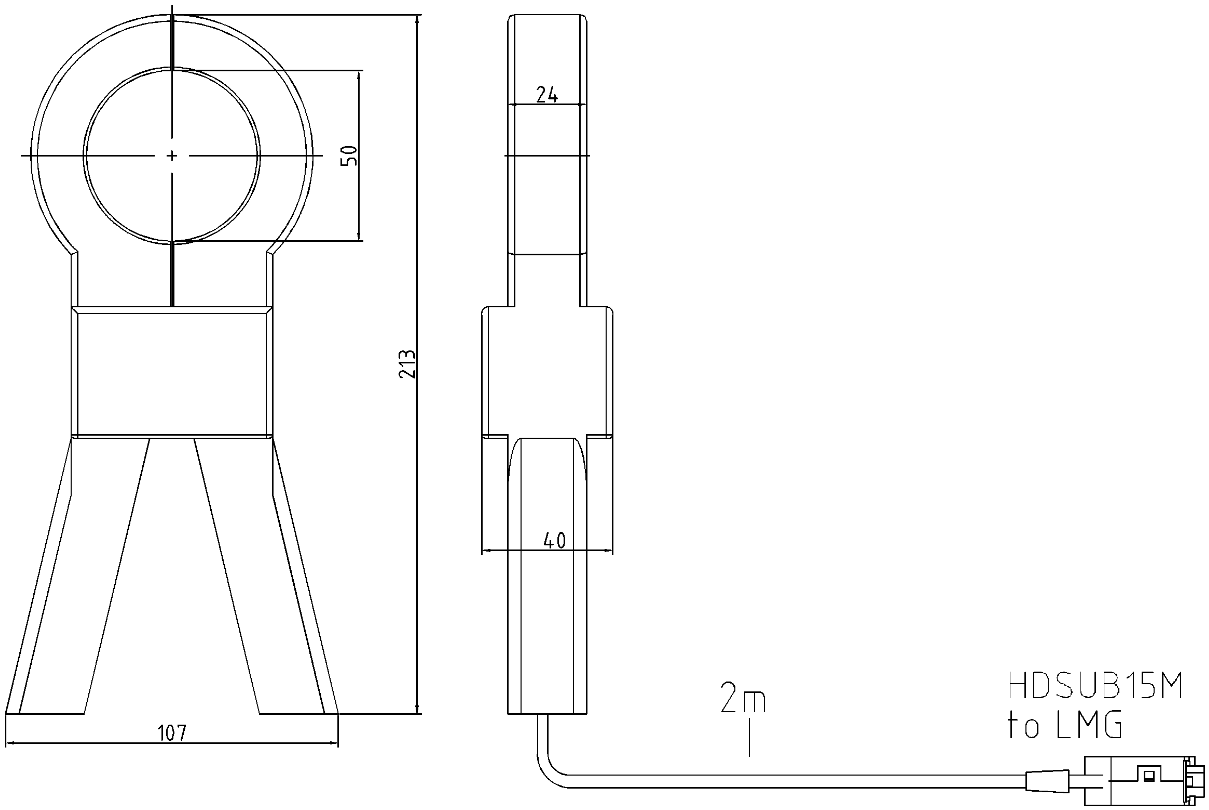


Figure 7: Dimensions of the L45-Z26, DC current clamp

2.7.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

2.7.2 Specifications

Nominal input current	1000A
Max. trms value	1000A
Measuring range	1500Apk
Maximum input	1500A
Bandwidth	DC to 2kHz
Protection class	600V CAT. III
Degree of pollution	2
Temperature range	-5°C to +50°C
Weight	0.6kg
Output connection	HD15 (with EEPROM) for LMG sensor input

2.7.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the clamp.
The accuracy is valid only with manual zero adjustment at the DC-Clamp prior clamp on!
The values are in ±(% of measuring value+% of nominal input current)

Current	Amplitude error DC to 2kHz	Phase error at 45 to 66Hz	Phase error at 1kHz
10A to 1500A	1.5+0.1	<0.3°	<3°

Use L45-Z26 and LMG specifications to calculate the accuracy of the complete system.

2.7.4 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.7.5 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.7.6 Connection of the sensor with LMG450

Use sensor input, , internal supply via LMG, you get the following ranges:

nominal value	31.3A	62.5A	125A	250A	500A	1000A
max. trms value	31.3A	62.5A	125A	250A	500A	1000A
max. peak value	46.9A	93.8A	188A	375A	750A	1500A

2.7.7 Connection of the sensor with LMG500

Use L50-Z14, internal supply via LMG, you get the following ranges:

nominal value	7.8A	15.6A	31.3A	62.5A	125A	250A	500A	1000A
max. trms value	7.8A	15.6A	31.3A	62.5A	125A	250A	500A	1000A
max. peak value	11.7A	23.4A	46.9A	93.8A	188A	375A	750A	1500A

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

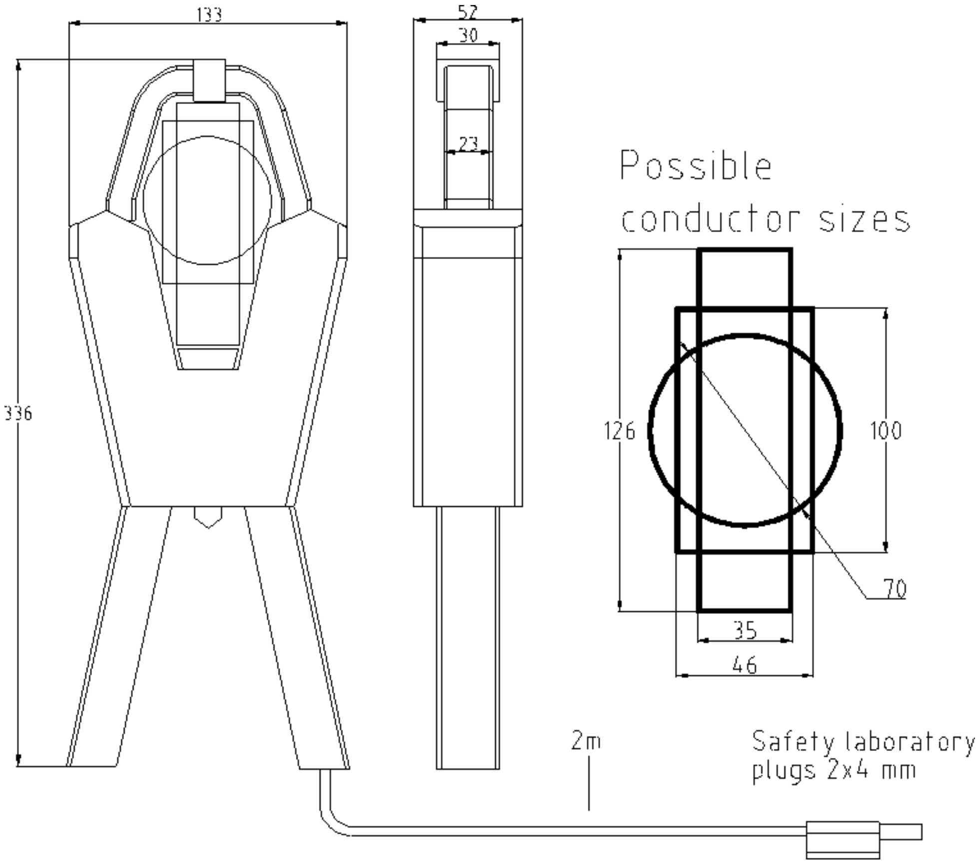


Figure 8: Dimensions of the LMG-Z329

2.8.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.8.2 Specifications

Nominal input current	3000A
Transformation ratio	3000:1
Measuring range	3600A
Maximum input	6000A for 5min
Bandwidth	45Hz to 5kHz
Burden	<2.5VA
Protection class	600V CAT. III
Degree of pollution	2
Temperature range	-5°C to +50°C
Weight	1.6kg

Output connection	2m fixed lead with safety plugs 4mm

2.8.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the clamp, signal frequency 50..60 Hz.

Current	Amplitude error ±(% of measuring value)	Phase error
30A to 600A	1.5	2°
600A to 3000A	0.75	0.75°
3000A to 3600A	0.5	0.5°

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

2.8.4 Sensor operation without connection to LMG

It is importand to assure a good connection from the sensor to the LMG before switching on the load current! 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!

2.8.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.8.6 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.8.7 Connection of the sensor with LMG450

Use direct current inputs I* and I.
Alternative use L45-Z16/17 because of improved dynamic range with more ranges and better bandwidth.

2.8.8 Connection of the sensor with LMG500

Use direct current inputs I* and I.
Alternative use L45-Z16/17 because of improved dynamic range with more ranges and better bandwidth.

2.9 Error compensated AC - current clamp 3000A (L45-Z16/-Z17)

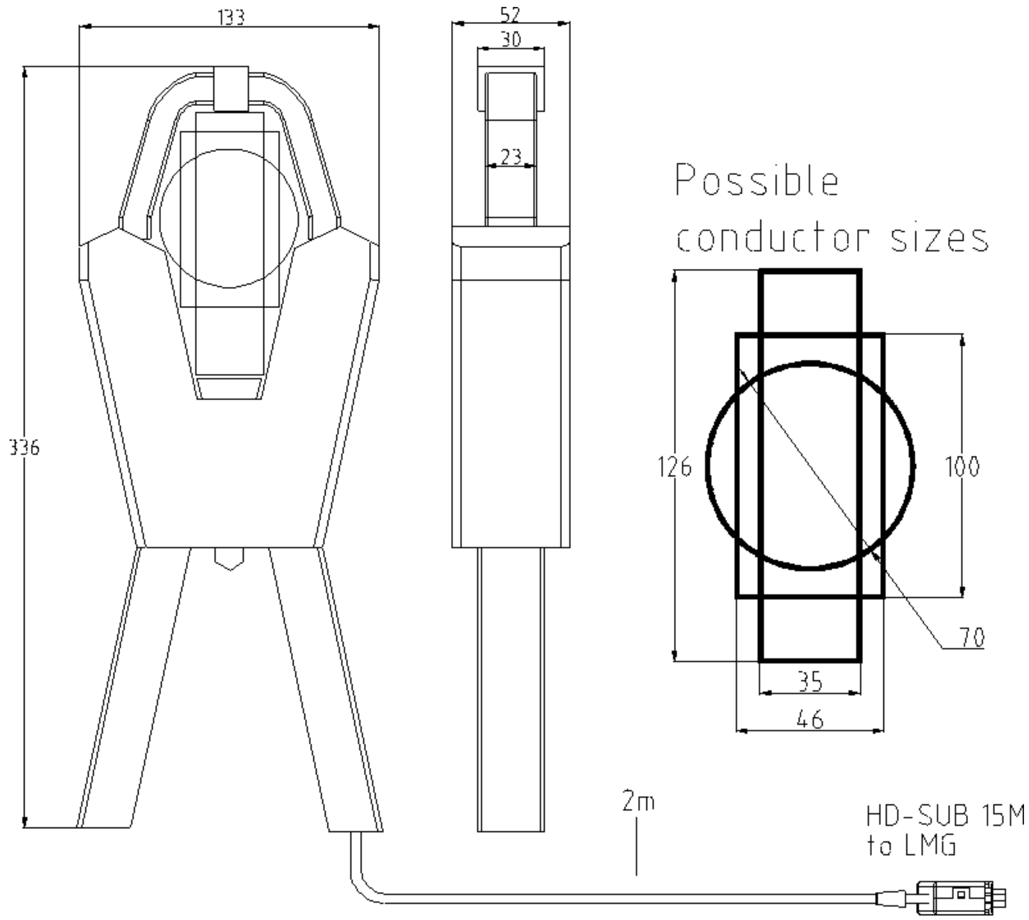


Figure 9: Dimensions of the L45-Z16, error compensated AC current clamp

2.9.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

2.9.2 Specifications

Nominal input current	3000A
Max. trms value	3600A
Measuring range current clamp	9000Apk
Maximum input	6000A for 5min
Bandwidth	5Hz to 10kHz
Protection class	600V CAT. III
Degree of pollution	2
Temperature range	-5°C to +50°C

Weight	1,6kg
Output connection	HD15 (with EEPROM) for LMG sensor input

2.9.3 Accuracy

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

Frequency/Hz	2Hz to 10Hz	10Hz to 45Hz	45Hz to 65Hz	65Hz to 1kHz	1kHz to 2.5kHz	2.5kHz to 5kHz	5kHz to 10kHz
Current	0.7+0.2	0.2+0.05	0.1+0.05	0.2+0.05	0.4+0.1	1+0.3	2+0.4
Phase	5	1	0.3	0.5	2	10	30

Use L45-Z16 and LMG specifications to calculate the accuracy of the complete system.

Influence of coupling mode: This current clamp can transfer only AC currents. The compensation circuit may cause a DC signal wich is interpreted by the instrument as a DC current. This could cause additional errors. Therefor this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

2.9.4 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.9.5 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.9.6 Connection of the sensor with LMG450

Use sensor input, you get the following ranges:

nominal value	100A	200A	400A	800A	1600A	3200A
max. trms value	113A	225A	450A	900A	1800A	3600A
max. peak value	281A	563A	1125A	2250A	4500A	9000A

2.9.7 Connection of the sensor with LMG500

Use L50-Z14, you get the following ranges:

nominal value	25A	50A	100A	200A	400A	800A	1600A	3200A
max. trms value	28A	56A	113A	225A	450A	900A	1800A	3600A
max. peak value	70A	141A	281A	563A	1125A	2250A	4500A	9000A

2.10 Precision current transformer 750A/1A (LMG-Z502,-05,-10,-20)

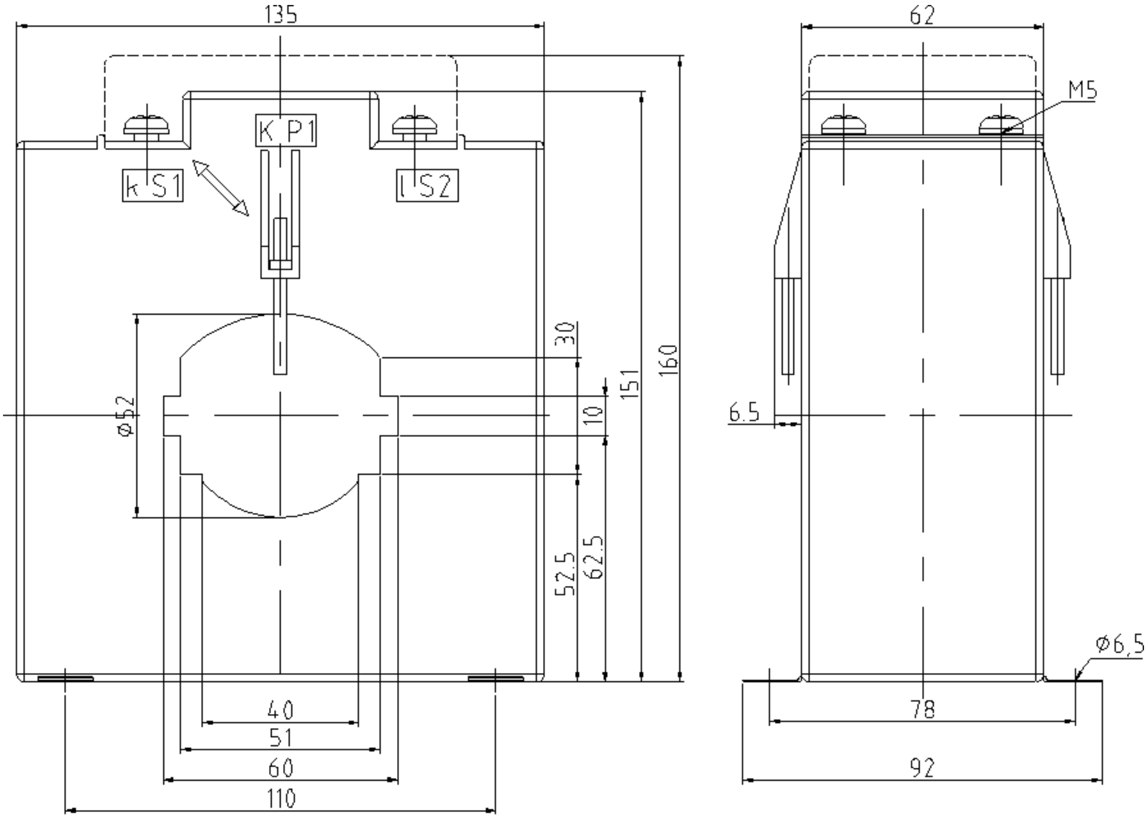


Figure 10: Dimensions of LMG-Z502, -Z505, -Z510, -Z520

2.10.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.10.2 Specifications

Nominal input current	750Aeff
Transformation ratio	750A:1A
Measuring range	1500Aeff
Maximum input	1800Aeff for 5min.
Bandwidth	15Hz to 5kHz
Burden	<2.5VA
Protection class	600V CAT. III / 1000V CAT. II
Degree of pollution	2
Temperature range	-10°C to +50°C
Weight	2.1kg
Output connection	screw terminals

2.10.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transformer.

Amplitude error ±(% of measuring value) / Phase error (at 48 to 66Hz)				
Current	Z502	Z505	Z510	Z520
10A to 150A	≤0.03 / ≤0.07°	≤0.07 / ≤0.07°	≤0.15 / ≤0.1°	≤0.3 / ≤0.2°
150A to 375A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°	≤0.2 / ≤0.16°
375A to 900A	≤0.02 / ≤0.04°	≤0.05 / ≤0.04°	≤0.1 / ≤0.06°	≤0.2 / ≤0.12°
900A to 1500A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°	≤0.2 / ≤0.16°

at 30Hz to 48Hz and 66Hz to 440Hz twofold errors
at 15Hz to 30Hz and 440Hz to 5kHz threefold errors
Use LMG-Z502,-05,-10,-20 and LMG specifications to calculate the accuracy of the complete system.

2.10.4 Sensor operation without connection to LMG

It is importand to assure a good connection from the sensor to the LMG before switching on the load current! 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!

2.10.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.10.6 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.10.7 Connection of the sensor with LMG450

Use direct current inputs I* and I.
Or use L45-Z22 and sensor input for better dynamic range, but small additional error term.

2.10.8 Connection of the sensor with LMG500

Use direct current inputs I* and I.

2.11 Precision current transducer 200A (PSU200)

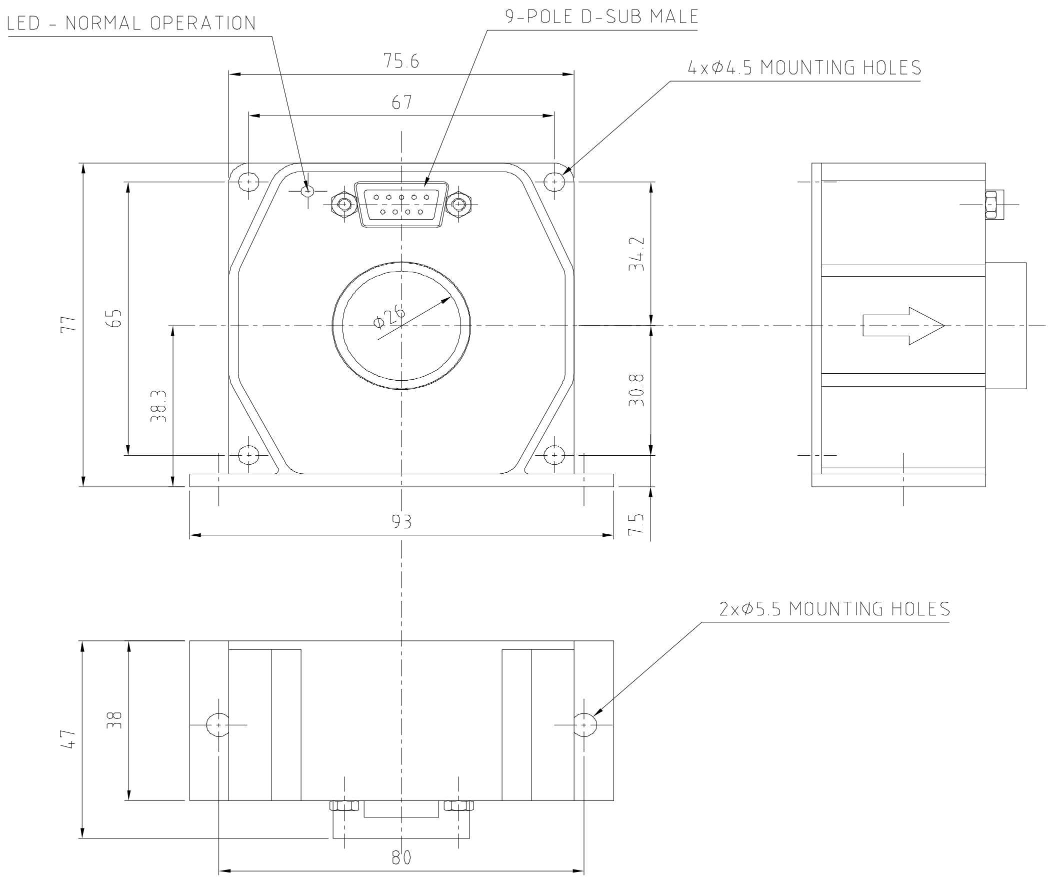


Figure 11: Dimensions of the PSU200

2.11.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.11.2 Specifications

Nominal input current	200A
Transformation ratio	1000:1
Measuring range PSU	200Apk
Maximum input overload	1kA for 0.1s
Bandwidth (small signal 0.5%, Rb=2.5Ohm) +-1dB +-3dB	 DC to 10kHz DC to 100kHz
Slew rate (10%-90%)	> 100A/us

Burden Rb	<30 ohms
Isolation	Test voltage DSUBgnd to 25mm Busbar: 5kV AC **Attention: when using Busbar without isolation regard DSUB cable isolation or avoid contact!!**
Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	approx. 0.3kg
Output connection	depending on adapter cable to LMGxx

2.11.3 Accuracy

Accuracies based on: sinusoidal current, frequency DC to 100Hz, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

	Amplitude error ±(% of meas.value+% of measuring range PSU)	Phase error
PSU200	0.015+0.005	0.02°

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

2.11.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and connect all of the 9pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.11.5 Connection of the sensor with LMG90/310

Use sensor suppy unit SSU4 with modification for PSU200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.11.6 Connection of the sensor with LMG95

Use PSU2/4/700-K-L95, supply via LMG95, no additional error terms, but only one range and not suitable for small currents.

With slightly less accuracy at fullrange, but with considerably more dynamic range and so better accuracy at small currents it is also possible to use PSU200-K-L50 and L95-Z07. With this assembly you get 8 ranges and a good dynamic down to a few Amps, but a small additional error term from the PSU200-K-L50 cable.

It depends on the magnitude and the dynamic of the measuring current, which connection is better.

2.11.7 Connection of the sensor with LMG450 (PSU200-K-L45)

Use PSU200-K-L45 (standard version, without modification) and SSU4.

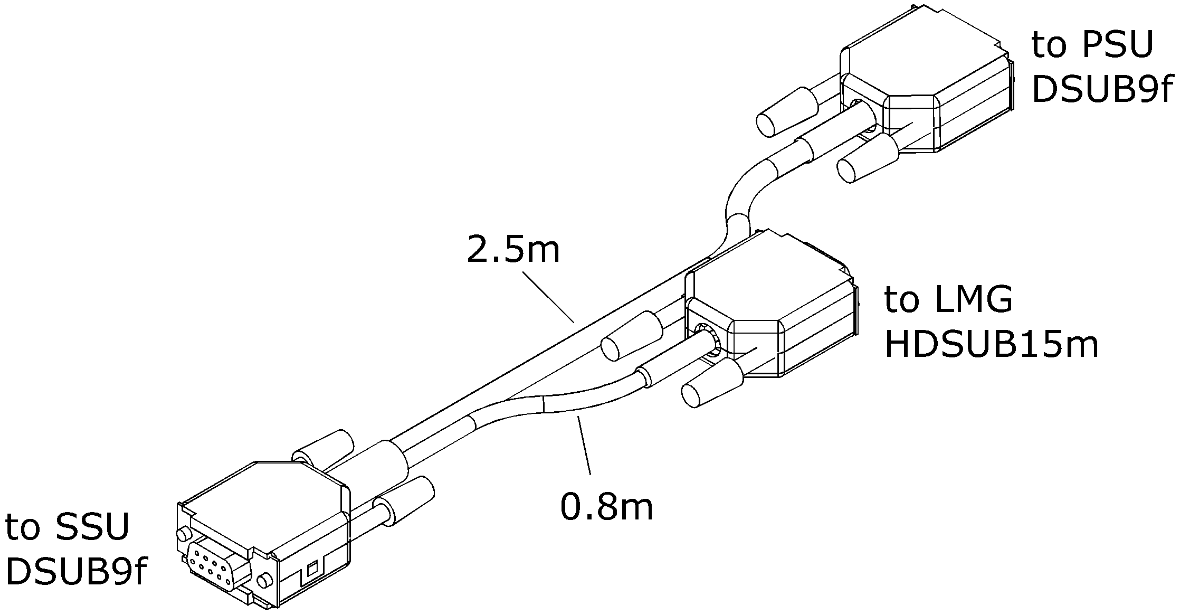


Figure 12: PSU200-K-L45, to connect the PSU200 to the LMG450 and the SSU4

This cable ‘PSU200-K-L45’ is used to connect a precision current sensor PSU200 to a power meter LMG450 and to supply it by a sensor supply unit SSU4.

In the connector to the LMG450 the adjustment data of the PSU200 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU200 head and the screws are sealed, when you have ordered the package ‘PSU200-L45’. This should prevent, that the wrong PSU200 head is connected to the cable.

The connection is quiet simple:

- Switch all power off and plug the connector labeled ‘SSU-4’ to the SSU-4.
- Plug the connector labeled ‘LMG450’ to the LMG450 external sensor input.
- Now you can switch on the power and make your measurements. The power of the EUT should be switched on at least.

Measuring ranges (sensor input)

nominal value	3.13A	6.25A	12.5A	25A	50A	100A
max. trms value	6.25A	12.5A	25A	50A	100A	200A
max. peak value	6.25A	12.5A	25A	50A	100A	200A

limited by PSU200 to max. 200Apk!

Accuracy

Use PSU200 and LMG450 specifications to calculate the accuracy of the complete system. Add +-30mA (to the primary current) DC offset tolerance.

2.11.8 Connection of the sensor with LMG500 (PSU200-K-L50)

Use PSU200-K-L50 and L50-Z14, supply via LMG500.

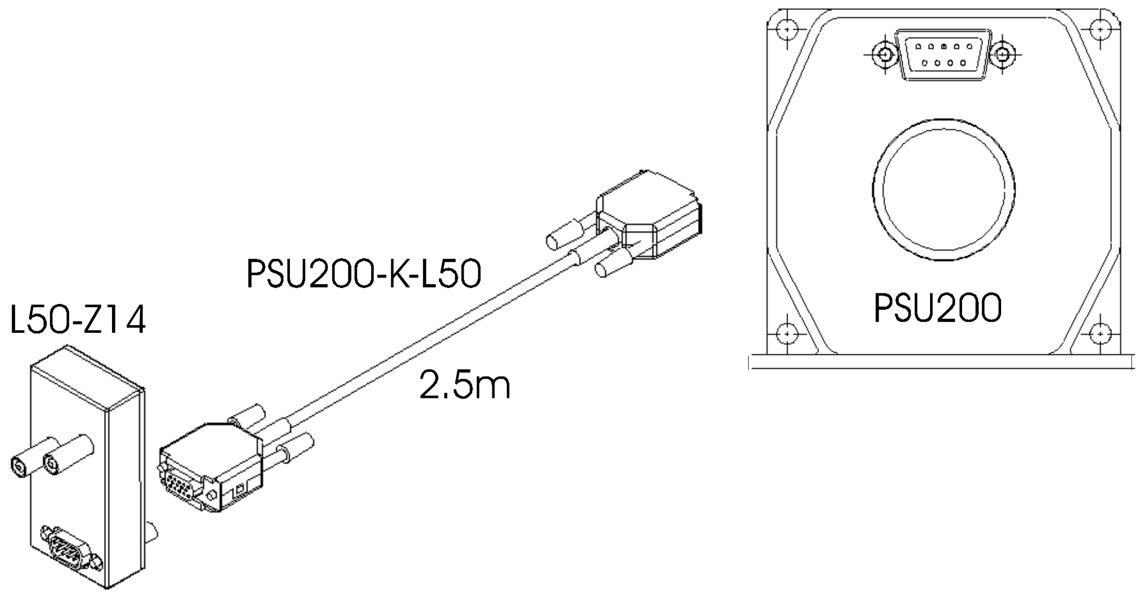


Figure 13: PSU200-K-L50, to connect PSU200 and LMG500

This cable ‘PSU200-K-L50’ is used to connect a precision current sensor PSU200 to the power meter LMG500.

In the connector to the LMG500 the adjustment data of the PSU200 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU200 head and the screws are sealed, when you have ordered the package ‘PSU200-L50’. This should prevent, that the wrong PSU200 head is connected to the cable.

The connection is quiet simple:

Switch all power off, plug the connector labeled ‘LMG500’ to the adapter L50-Z14 mounted on the LMG500 current channel. Now you can switch on the power and make the measurements. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automaticaly.

Measuring ranges (sensor input)

nominal value	0.78A	1.56A	3.13A	6.25A	12.5A	25A	50A	100A
max. trms value	1.56A	3.13A	6.25A	12.5A	25A	50A	100A	200A
max. peak value	1.56A	3.13A	6.25A	12.5A	25A	50A	100A	200A

limited by PSU200 to max. 200Apk!

Accuracy

Use PSU200 and LMG500 specifications to calculate the accuracy of the complete system. Add +-30mA (to the primary current) DC offset tolerance.

2.11.9 Connection elongation

To use the current sensor with a longer connection length between power meter and PSU connect a well shielded 1:1 extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES (LMG-Z-DVxx). Required length (up to 15m) is to be given by customer along with the order. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.12 Precision high frequency current transducer 200A (PSU200HF)

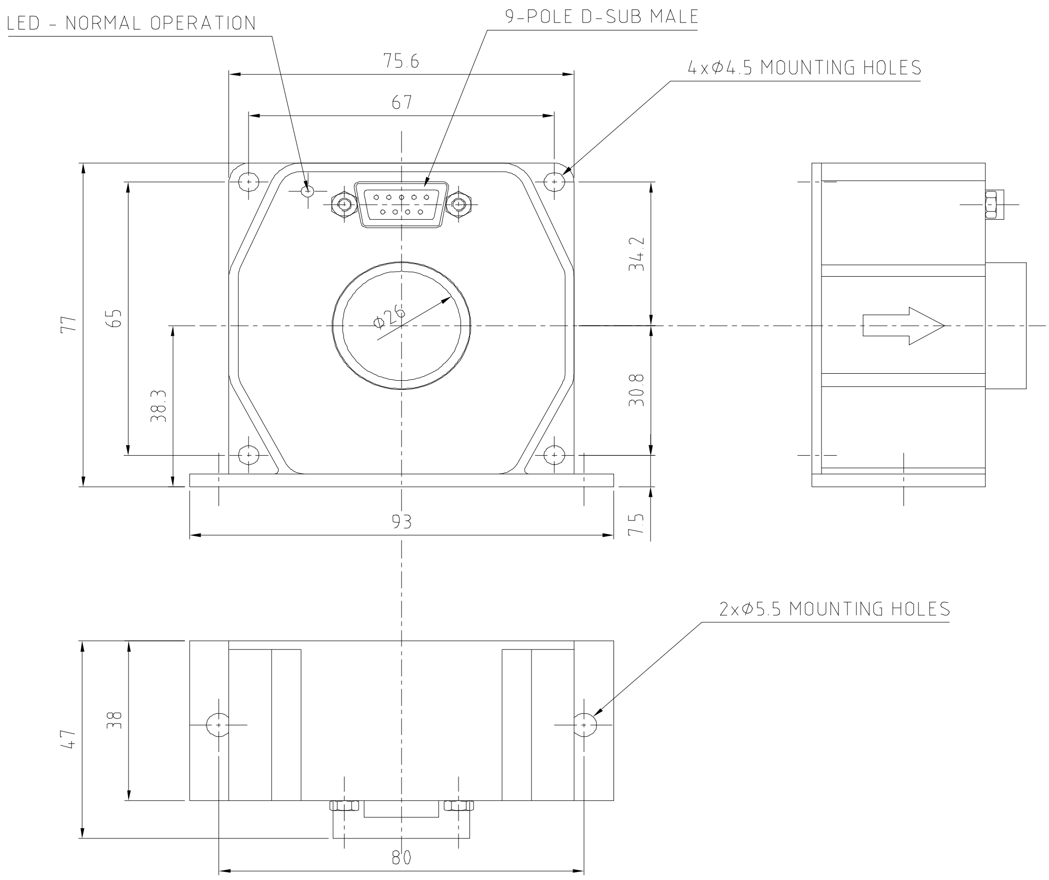


Figure 14: Dimensions of the PSU200HF

2.12.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.12.2 Specifications

Nominal input current	200A
Transformation ratio	1000:1
Measuring range PSU	200Apk
Maximum input overload	1kA for 0.1s
Bandwidth (small signal 20App, Rb=2.5Ohm, primary current in the middle of the transducer head) +-0.4dB (is equivalent to +-4.7%) +-3dB (typical)	 **DC to 150kHz** **1MHz**

Slew rate (10%-90%)	> 100A/us
Burden Rb	<30 ohms
Isolation	Test voltage DSUBgnd to 25mm Busbar: 5kV AC **Attention: when using Busbar without isolation regard DSUB cable isolation or avoid contact!!**
Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	approx. 0.3kg
Output connection	depending on adapter cable to LMGxx

2.12.3 Accuracy

Accuracies based on: sinusoidal current, frequency DC to 100Hz, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

	Amplitude error ±(% of meas.value+% of measuring range PSU)	Phase error
PSU200	0.015+0.005	0.02°

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

2.12.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and connect all of the 9pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.12.5 Connection of the sensor with LMG90/310

Use sensor suppy unit SSU4 with modification for PSU200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.12.6 Connection of the sensor with LMG95

Use PSU2/4/700-K-L95, supply via LMG95, no additional error terms, but only one range and not suitable for small currents.

With slightly less accuracy at fullrange, but with considerably more dynamic range and so better accuracy at small currents it is also possible to use PSU200HF-K-L50 and L95-Z07. With this assembly you get 8 ranges and a good dynamic down to a few Amps, but a small additional error term from the PSU200HF-K-L50 cable.

It depends on the magnitude and the dynamic of the measuring current, which connection is better.

2.12.7 Connection of the sensor with LMG450

You can use PSU200-K-L45 and SSU4 (standard version, without modification), but it is not recommended to use this high frequency sensor with the LMG450.

2.12.8 Connection of the sensor with LMG500 (PSU200HF-K-L50)

Use PSU200HF-K-L50 and L50-Z14, supply via LMG500.

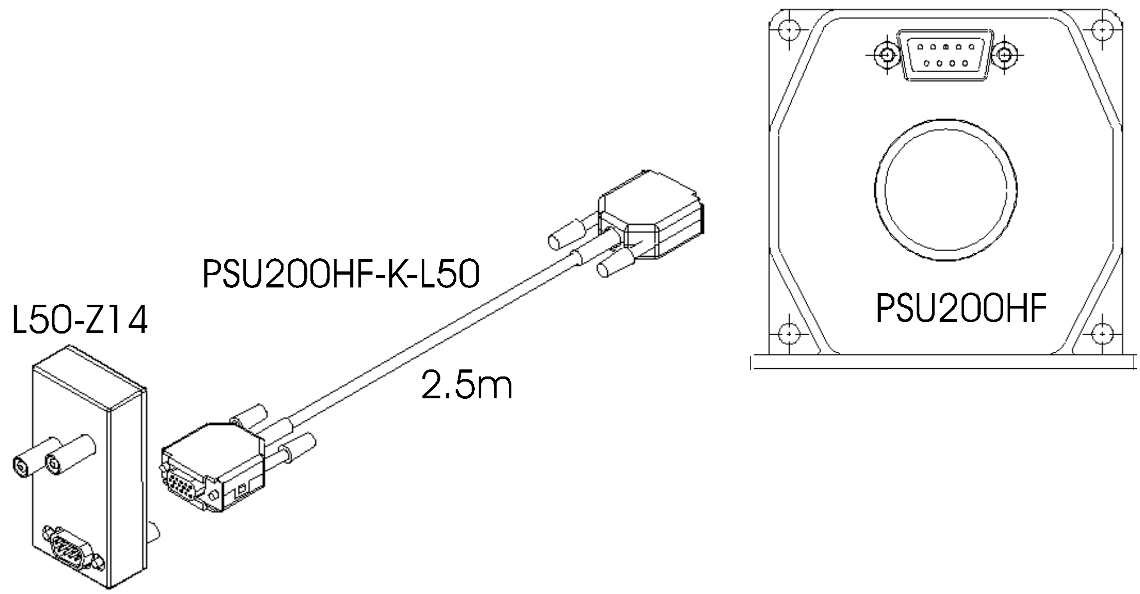


Figure 15: PSU200HF-K-L50, to connect PSU200HF and LMG500

This cable ‘PSU200HF-K-L50’ is used to connect a precision current sensor PSU200HF to the power meter LMG500.

In the connector to the LMG500 the adjustment data of the PSU200HF head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU200HF head and the screws are sealed, when you have ordered the package ‘PSU200HF-L50’. This should prevent, that the wrong PSU200HF head is connected to the cable.

The connection is quiet simple:
Switch all power off, plug the connector labeled ‘LMG500’ to the adapter L50-Z14 mounted on the LMG500 current channel. Now you can switch on the power and make the measurements. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automaticaly.

Measuring ranges (sensor input)

nominal value	0.78A	1.56A	3.13A	6.25A	12.5A	25A	50A	100A
max. trms value	1.56A	3.13A	6.25A	12.5A	25A	50A	100A	200A
max. peak value	1.56A	3.13A	6.25A	12.5A	25A	50A	100A	200A

limited by PSU200HF to max. 200Apk!

Accuracy

Use PSU200HF and LMG500 specifications to calculate the accuracy of the complete system. Add +-30mA (to the primary current) DC offset tolerance.

2.12.9 Connection elongation

To use the current sensor with a longer connection length between power meter and PSU connect a well shielded 1:1 extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES (LMG-Z-DVxx). Required length (up to 15m) is to be given by customer along with the order. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.13 Precision current transducer 400A (PSU400)

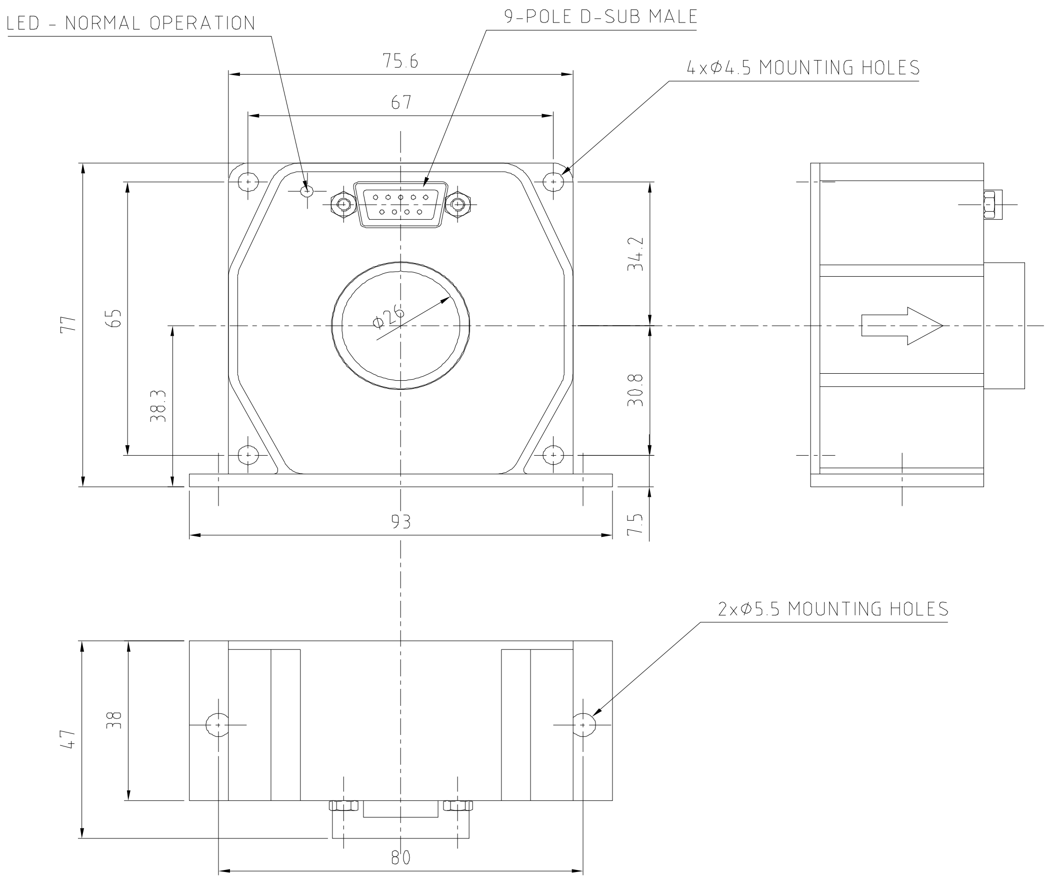


Figure 16: Dimensions of the PSU400

2.13.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.13.2 Specifications

Nominal input current	400A
Transformation ratio	2000:1
Measuring range PSU	400Apk
Maximum input overload	2kA for 0.1s
Bandwidth (small signal 0.5%, Rb=2.5Ohm) +-1dB +-3dB	 DC to 10kHz DC to 100kHz
Slew rate (10%-90%)	> 80A/us

Burden	<2.5 ohms
Isolation	Test voltage DSUBgnd to 25mm Busbar: 5kV AC **Attention: when using Busbar without isolation regard DSUB cable isolation or avoid contact!!**
Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	approx. 0.3kg
Output connection	depending on adapter cable to LMGxx

2.13.3 Accuracy

Accuracies based on: sinusoidal current, frequency DC to 100Hz, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

	Amplitude error ±(% of meas.value+% of measuring range PSU)	Phase error
PSU400	0.015+0.005	0.02°

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

2.13.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and connect all of the 9pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.13.5 Connection of the sensor with LMG90/310

Use sensor suppy unit SSU4 with modification for PSU200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.13.6 Connection of the sensor with LMG95

Use PSU2/4/700-K-L95, supply via LMG95, no additional error terms, but only one range and not suitable for small currents.

With slightly less accuracy at fullrange, but with considerably more dynamic range and so better accuracy at small currents it is also possible to use PSU400-K-L50 and L95-Z07. With this assembly you get 8 ranges and a good dynamic down to a few Amps, but a small additional error term from the PSU400-K-L50 cable.

It depends on the magnitude and the dynamic of the measuring current, which connection is better.

2.13.7 Connection of the sensor with LMG450 (PSU400-K-L45)

Use PSU400-K-L45 and SSU4 (standard version, without modification).

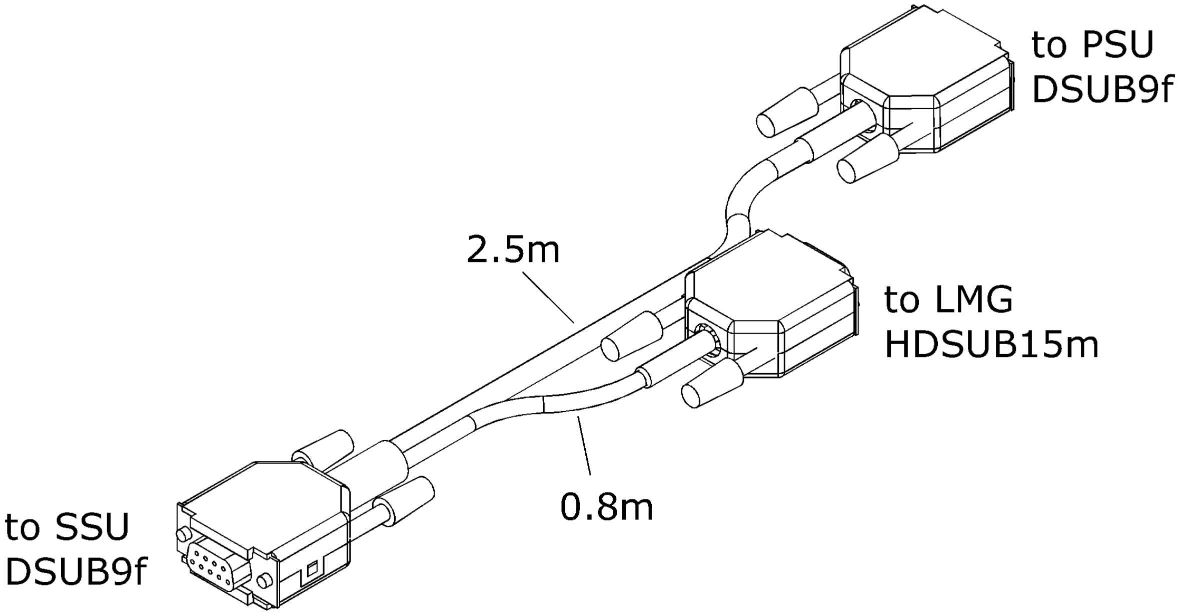


Figure 17: PSU400-K-L45, to connect the PSU400 to the LMG450 and the SSU4

This cable ‘PSU400-K-L45’ is used to connect a precision current sensor PSU400 to a power meter LMG450 and to supply it by a sensor supply unit SSU4.

In the connector to the LMG450 the adjustment data of the PSU400 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU400 head and the screws are sealed, when you have ordered the package ‘PSU400-L45’. This should prevent, that the wrong PSU400 head is connected to the cable.

The connection is quiet simple:

- Switch all power off and plug the connector labeled ‘SSU-4’ to the SSU-4.
- Plug the connector labeled ‘LMG450’ to the LMG450 external sensor input.
- Now you can switch on the power and make your measurements. The power of the EUT should be switched on at least.

Measuring ranges (sensor input)

nominal value	6.25A	12.5A	25A	50A	100A	200A
max. trms value	12.5A	25A	50A	100A	200A	400A
max. peak value	12.5A	25A	50A	100A	200A	400A

limited by PSU400 to max. 400Apk!

Accuracy

Use PSU400 and LMG450 specifications to calculate the accuracy of the complete system. Add +-60mA (to the primary current) DC offset tolerance.

2.13.8 Connection of the sensor with LMG500 (PSU400-K-L50)

Use PSU400-K-L50 and L50-Z14, supply via LMG500.

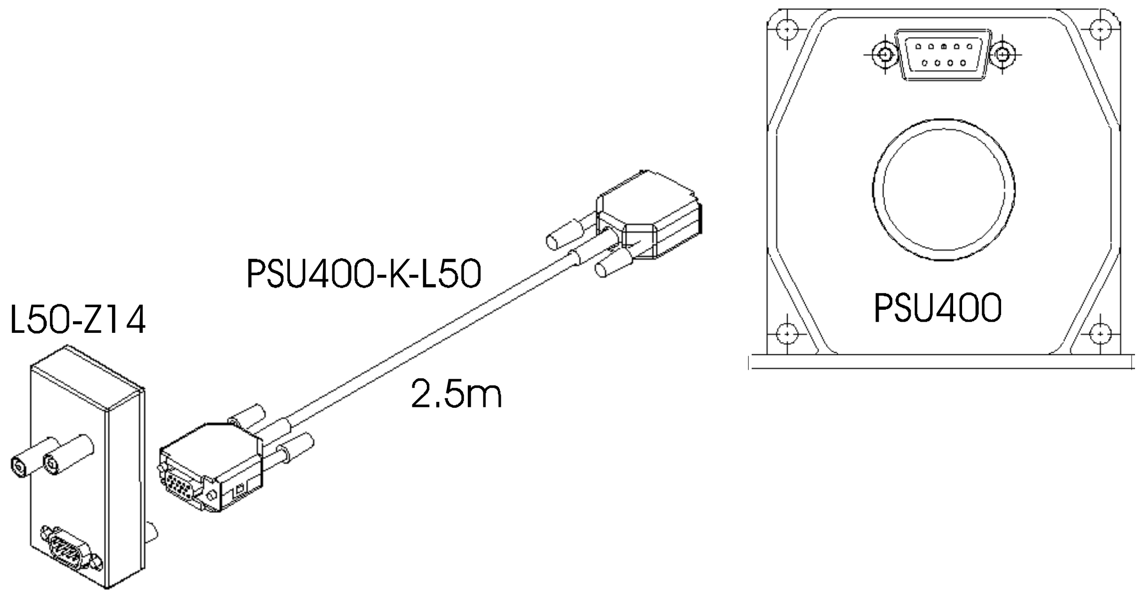


Figure 18: PSU400-K-L50, to connect PSU400 and LMG500

This cable ‘PSU400-K-L50’ is used to connect a precision current sensor PSU400 to the power meter LMG500.

In the connector to the LMG500 the adjustment data of the PSU400 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU400 head and the screws are sealed, when you have ordered the package ‘PSU400-L50’. This should prevent, that the wrong PSU400 head is connected to the cable.

The connection is quiet simple:

Switch all power off, plug the connector labeled ‘LMG500’ to the adapter L50-Z14 mounted on the LMG500 current channel. Now you can switch on the power and make the measurements. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automaticaly.

Measuring ranges (sensor input)

nominal value	1.56A	3.13A	6.25A	12.5A	25A	50A	100A	200A
max. trms value	3.13A	6.25A	12.5A	25A	50A	100A	200A	400A
max. peak value	3.13A	6.25A	12.5A	25A	50A	100A	200A	400A

limited by PSU400 to max. 400Apk!

Accuracy

Use PSU400 and LMG500 specifications to calculate the accuracy of the complete system. Add +-60mA (to the primary current) DC offset tolerance.

2.13.9 Connection elongation

To use the current sensor with a longer connection length between power meter and PSU connect a well shielded 1:1 extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES (LMG-Z-DVxx). Required length (up to 15m) is to be given by customer along with the order. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.14 Precision current transducer 600A (PSU600)

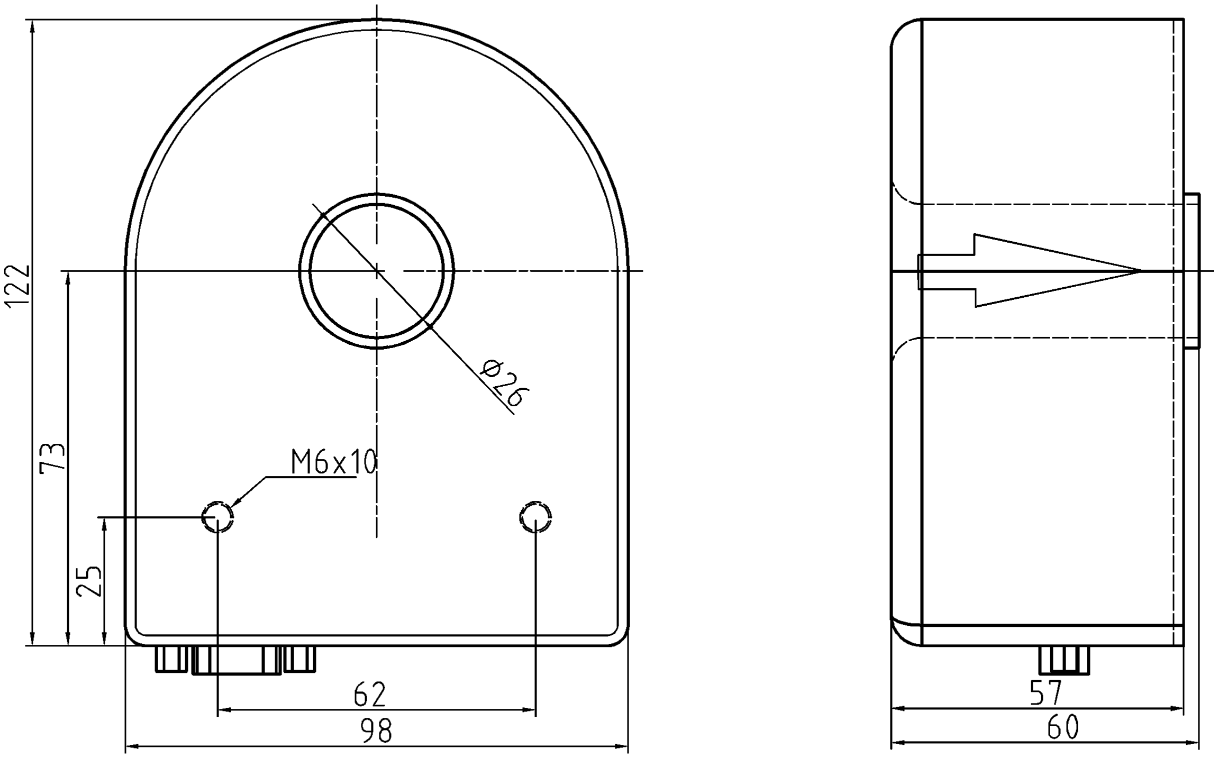


Figure 19: Dimensions of the PSU600

2.14.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

Dont allow primary current without supply of the PSU!

2.14.2 Specifications

Nominal input current	600A
Transformation ratio	1500:1
Measuring range PSU	600Apk
Maximum input overload	3kA for 0.1s
Bandwidth	DC to 100kHz
Slew rate (10%-90%)	> 10kA/ms
Burden	<2.5 ohms
Isolation	Test voltage DSUBgnd to 25mm Busbar: 5kV AC **Attention: when using Busbar without isolation regard DSUB cable isolation or avoid contact!!**

Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	1kg
Output connection	depending on adapter cable to LMGxx

2.14.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

Frequency	Amplitude error±(% of meas.value+% of measuring range PSU)	Phase error
DC to 100Hz	0.015+0.005	0.02°
100Hz to 2.5kHz	0.015+0.005	0.1°
2.5kHz to 10kHz	0.05+0.025	0.2°
10kHz to 30kHz	0.6 to 0.2	0.7°
30kHz to 100kHz	6+3	3°

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

2.14.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and connect all of the 9pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.14.5 Connection of the sensor with LMG90/310

Use sensor suppy unit SSU4 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.14.6 Connection of the sensor with LMG95

You can use PSU600-K3-L95, supply via LMG95, no additional error terms, but only two ranges and not suitable for small currents.

With slightly less accuracy at fullrange, but with considerably more dynamic range and so better accuracy at small currents it is better to use PSU600-BUR15.

It depends on the magnitude and the dynamic of the measuring current, which connection is better.

2.14.6.1 PSU600-K3-L95

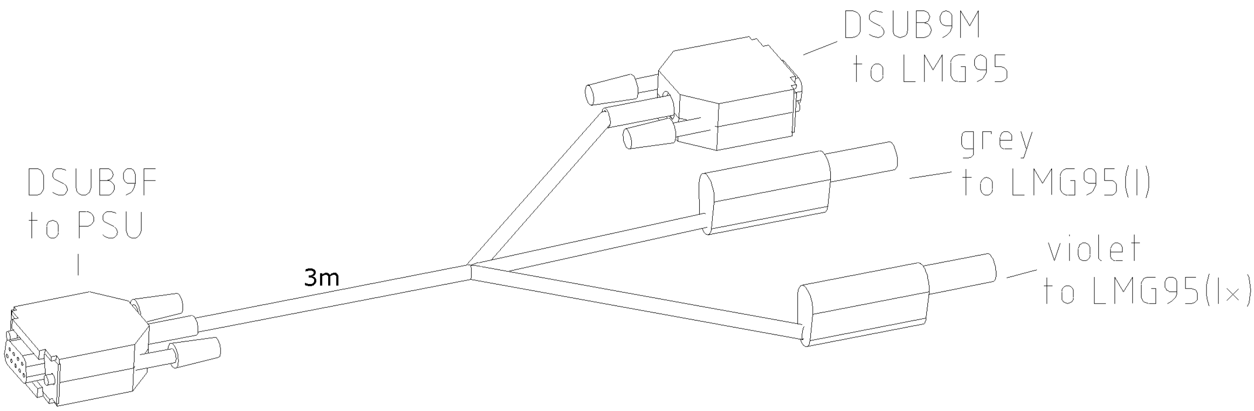


Figure 20: PSU600-K3-L95, for direct connection of the PSU600 to the current input of the LMG95

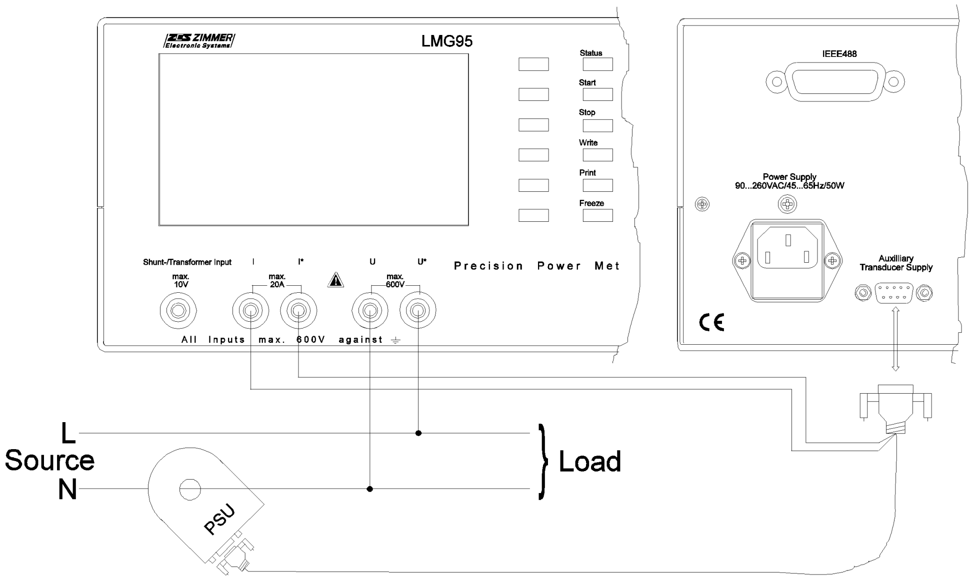


Figure 21: Connection of one PSU600 to the LMG95

Accuracy

Use PSU600 and LMG95 specifications to calculate the accuracy of the complete system.

Measuring ranges

nominal value	225A	450A
max. trms value	450A	900A
max. peak value	*703.5A*	*1407A*

limited by PSU600 to max. 600Apk!

2.14.6.2 Precision burden for PSU600 and LMG95 (PSU600-BUR15)

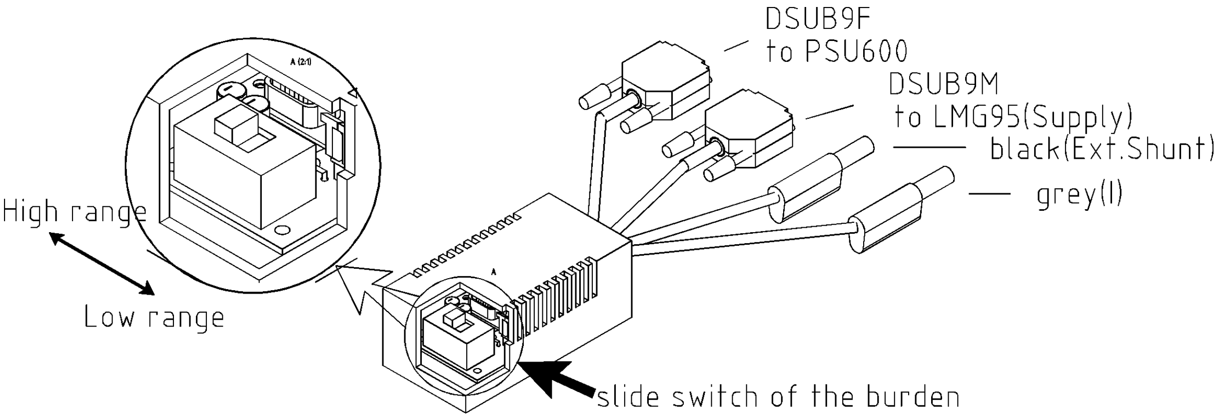


Figure 22: PSU 600 - BUR15, to connect the PSU600 to the shunt input of the LMG95 directly.

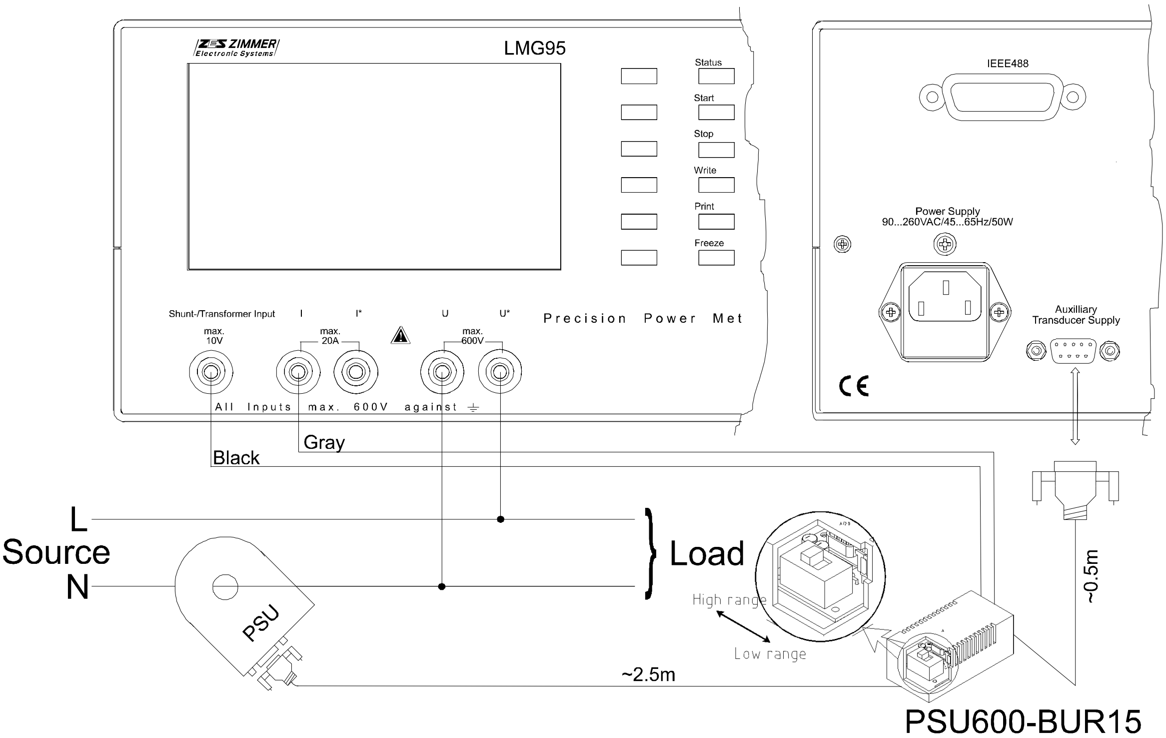


Figure 23:Connection of PSU600 and BUR15 to the LMG95

Specifications

Range (Selected with internal slide switch of the PSU600-BUR15)	**Low**	**High**
Necessary scale setting at the LMG95	100	1000
Displayed measurement ranges at the LMG95	3/6/12/25/50/100/200/ 400A	30/60/120/250/500/ 1000/2000/4000A
Measurable Peak Current *limited by the PSU600	9/18/36/75/150/300/ 350*/350*A_{pk}	90/180/360/600*/600*/ 600*/600*/600*A_{pk}

Maximum input	3kA for 0.1s
Bandwidth	DC to 100kHz
Protection class	300V CATIII; 600V CATII
Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	0.25kg
Output connection	2x SUBD to PSU and Aux. supply socket of the LMG95; 2x laboratory plugs to ext. Shunt

Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

Values including errors of PSU600 and PSU600-BUR15

Frequency in kHz	Amplitude error±(% of measuring value+% of measuring range)	Phase error
DC to 0.1	0.035+0.005	0.02°
0.1 to 2.5	0.035+0.005	0.1°
2.5 to 10	0.06+0.025	0.2°
10 to 30	0.6 to 0.2	0.7°
30 to 100	6+3	3°

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

2.14.7 Connection of the sensor with LMG450 (PSU600-K-L45)

Use PSU600-K-L45 and SSU4.

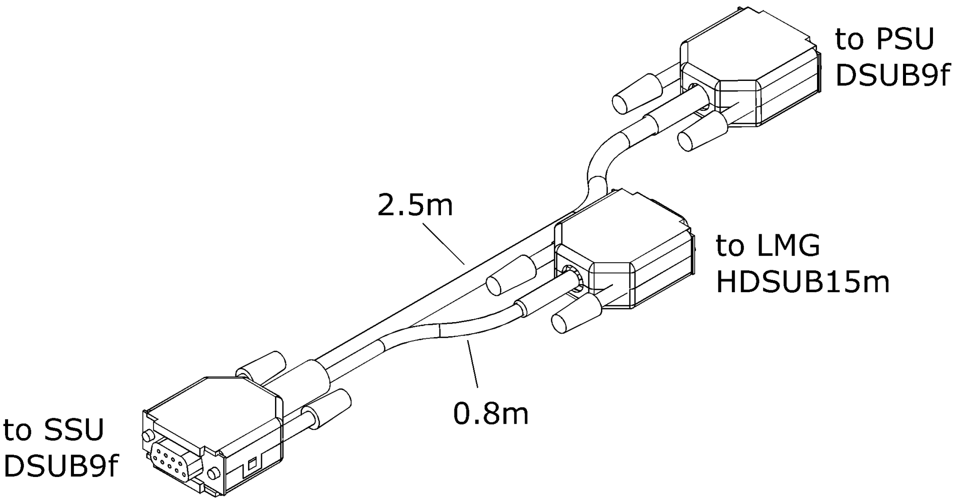


Figure 24: PSU600-K-L45, to connect the PSU600 to the LMG450 and the SSU4

This cable ‘PSU600-K-L45’ is used to connect a precision current sensor PSU600 to a power meter LMG450 and to supply it by a sensor supply unit SSU4.

In the connector to the LMG450 the adjustment data of the PSU600 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU600 head and the screws are sealed, when you have ordered the package ‘PSU600-L45’. This should prevent, that the wrong PSU600 head is connected to the cable.

The connection is quiet simple:

- Switch all power off and plug the connector labeled ‘SSU-4’ to the SSU-4.
- Plug the connector labeled ‘LMG450’ to the LMG450 external sensor input.
- Now you can switch on the power and make your measurements. The power of the EUT should be switched on at least.

Measuring ranges (sensor input)

nominal value	10A	20A	40A	80A	160A	320A
max. trms value	18.75A	37.5A	75A	150A	300A	600A
max. peak value	18.75A	37.5A	75A	150A	300A	600A

limited by PSU600 to max. 600Apk!

Accuracy

Use PSU600 and LMG450 specifications to calculate the accuracy of the complete system. Add +-90mA (to the primary current) DC offset tolerance.

2.14.8 Connection of the sensor with LMG500 (PSU600-K-L50)

Use PSU600-K-L50 and L50-Z14, supply via LMG500.

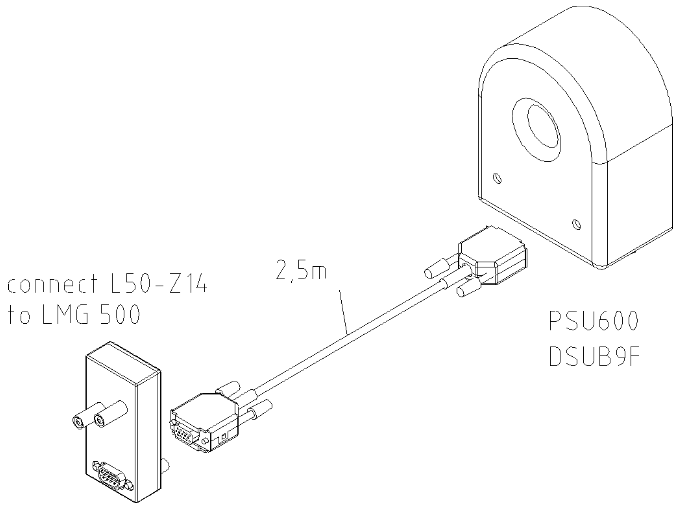


Figure 25: PSU600-K-L50, to connect PSU600 and LMG500

This cable ‘PSU600-K-L50’ is used to connect a precision current sensor PSU600 to the power meter LMG500.

In the connector to the LMG500 the adjustment data of the PSU600 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU600 head and the screws are sealed, when you have ordered the package ‘PSU600-L50’. This should prevent, that the wrong PSU600 head is connected to the cable.

The connection is quiet simple:
Switch all power off, plug the connector labeled ‘LMG500’ to the adapter L50-Z14 mounted on the LMG500 current channel. Now you can switch on the power and make the measurements. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automaticaly.

Measuring ranges (sensor input)

nominal value	2.5A	5A	10A	20A	40A	80A	160A	320A
max. trms value	4.69A	9.38A	18.75A	37.5A	75A	150A	300A	600A
max. peak value	4.69A	9.38A	18.75A	37.5A	75A	150A	300A	600A

limited by PSU600 to max. 600Apk!

Accuracy

Use PSU600 and LMG500 specifications to calculate the accuracy of the complete system. Add +-90mA (to the primary current) DC offset tolerance.

2.14.9 Connection elongation

To use the current sensor with a longer connection length between power meter and PSU connect a well shielded 1:1 extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES (LMG-Z-DVxx). Required length (up to 15m) is to be given by customer along with the order. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.15 Precision current transducer 700A (PSU700)

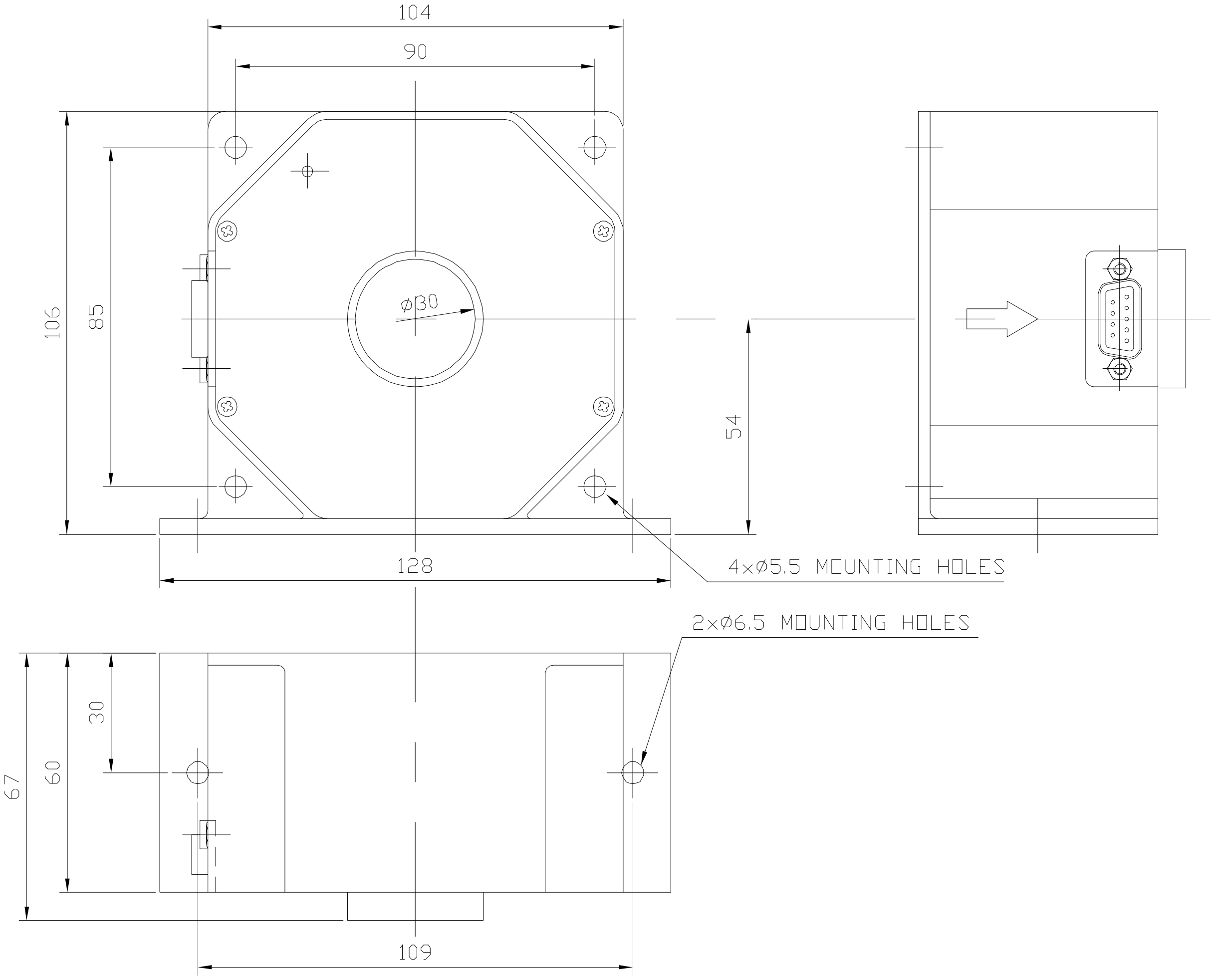


Figure 26: Dimensions of the PSU700

2.15.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.15.2 Specifications

Nominal input current	700A
Transformation ratio	1750:1
Measuring range PSU	700Apk
Maximum input overload	3.5kA for 0.1s
Bandwidth (small signal 0.5%, Rb=2.5Ohm) +-1dB +-3dB	 DC to 10kHz DC to 100kHz

Slew rate (10%-90%)	> 100A/us
Burden	<2.5 ohms
Isolation	Test voltage DSUBgnd to 25mm Busbar: 5kV AC **Attention: when using Busbar without isolation regard DSUB cable isolation or avoid contact!!**
Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	approx. 0.8kg
Output connection	depending on adapter cable to LMGxx

2.15.3 Accuracy

Accuracies based on: sinusoidal current, frequency DC to 100Hz, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

	Amplitude error ±(% of meas.value+% of measuring range PSU)	Phase error
PSU700	0.015+0.005	0.02°

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

2.15.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and connect all of the 9pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.15.5 Connection of the sensor with LMG90/310

Use sensor suppy unit SSU4 with modification for PSU200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.15.6 Connection of the sensor with LMG95

Use PSU2/4/700-K-L95, supply via LMG95, no additional error terms, but only one range and not suitable for small currents.

With slightly less accuracy at fullrange, but with considerably more dynamic range and so better accuracy at small currents it is also possible to use PSU700-K-L50 and L95-Z07. With this assembly you get 8 ranges and a good dynamic down to a few Amps, but a small additional error term from the PSU700-K-L50 cable.

It depends on the magnitude and the dynamic of the measuring current, which connection is better.

2.15.7 Connection of the sensor with LMG450 (PSU700-K-L45)

Use PSU700-K-L45 and SSU4 (standard version, without modification).

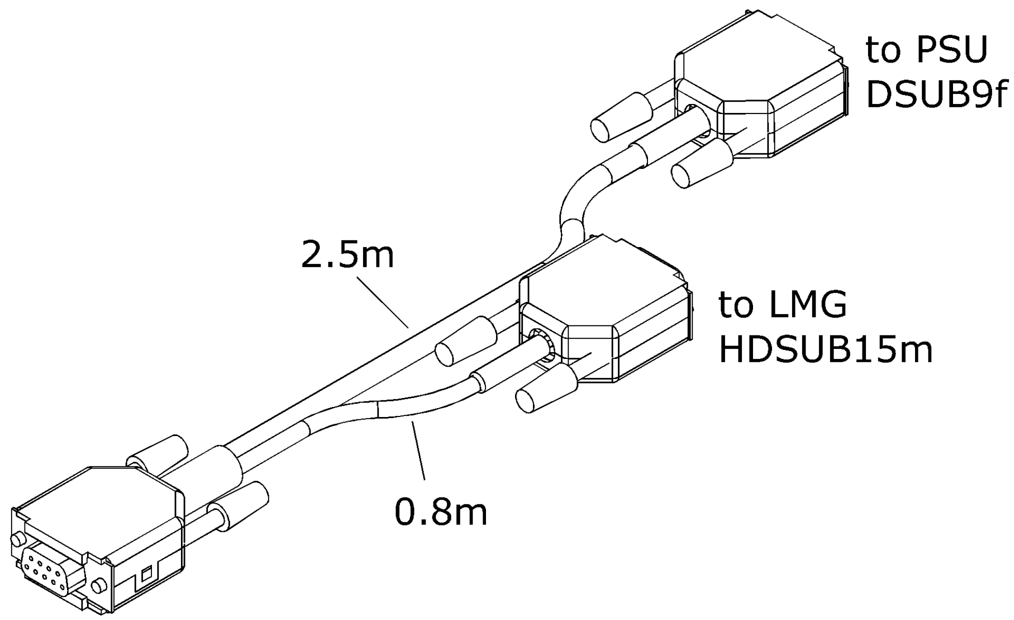


Figure 27: PSU700-K-L45, to connect the PSU700 to the LMG450 and the SSU4

This cable ‘PSU700-K-L45’ is used to connect a precision current sensor PSU700 to a power meter LMG450 and to supply it by a sensor supply unit SSU4.

In the connector to the LMG450 the adjustment data of the PSU700 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU700 head and the screws are sealed, when you have ordered the package ‘PSU700-L45’. This should prevent, that the wrong PSU700 head is connected to the cable.

The connection is quiet simple:

- Switch all power off and plug the connector labeled ‘SSU-4’ to the SSU-4.
- Plug the connector labeled ‘LMG450’ to the LMG450 external sensor input.
- Now you can switch on the power and make your measurements. The power of the EUT should be switched on at least.

Measuring ranges (sensor input)

nominal value	10A	20A	40A	80A	160A	320A
max. trms value	21.88A	43.75A	87.5A	175A	350A	700A
max. peak value	21.88A	43.75A	87.5A	175A	350A	700A

limited by PSU700 to max. 700Apk!

Accuracy

Use PSU700 and LMG450 specifications to calculate the accuracy of the complete system. Add +-105mA (to the primary current) DC offset tolerance.

2.15.8 Connection of the sensor with LMG500 (PSU700-K-L50)

Use PSU700-K-L50 and L50-Z14, supply via LMG500.

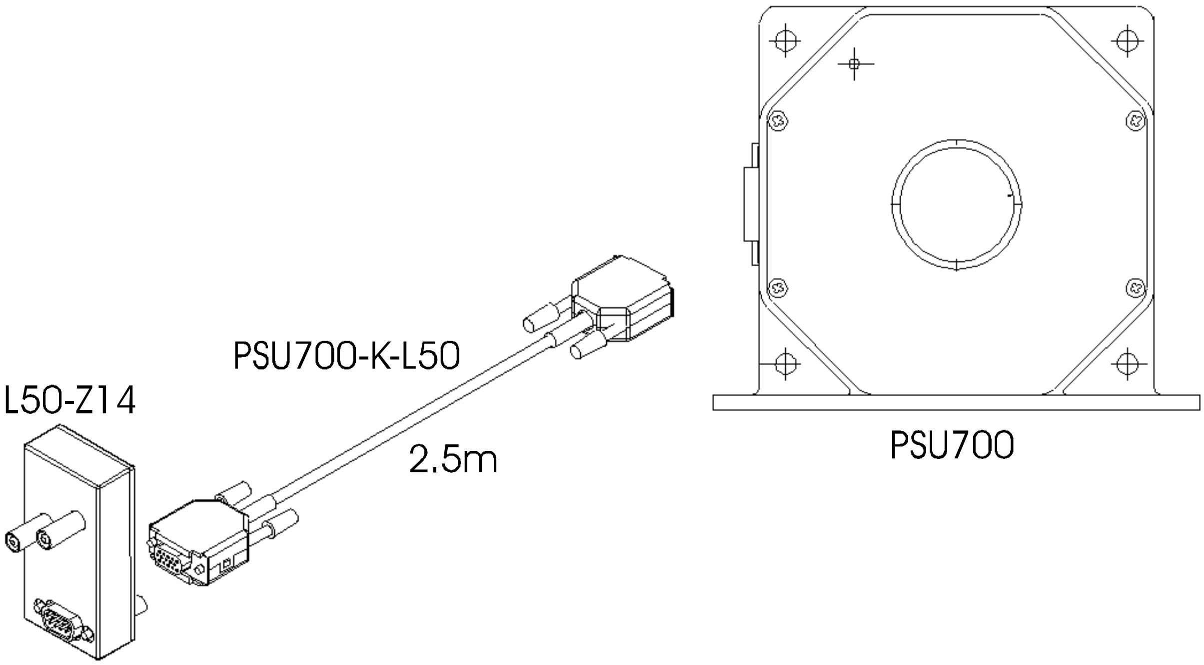


Figure 28: PSU700-K-L50, to connect PSU700 and LMG500

This cable ‘PSU700-K-L50’ is used to connect a precision current sensor PSU700 to the power meter LMG500.

In the connector to the LMG500 the adjustment data of the PSU700 head are available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU700 head and the screws are sealed, when you have ordered the package ‘PSU700-L50’. This should prevent, that the wrong PSU700 head is connected to the cable.

The connection is quiet simple:

Switch all power off, plug the connector labeled ‘LMG500’ to the adapter L50-Z14 mounted on the LMG500 current channel. Now you can switch on the power and make the measurements. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automaticaly.

Measuring ranges (sensor input)

nominal value	2.5A	5A	10A	20A	40A	80A	160A	320A
max. trms value	5.47A	10.94A	21.88A	43.75A	87.5A	175A	350A	700A
max. peak value	5.47A	10.94A	21.88A	43.75A	87.5A	175A	350A	700A

limited by PSU700 to max. 700Apk!

Accuracy

Use PSU700 and LMG500 specifications to calculate the accuracy of the complete system. Add +-105mA (to the primary current) DC offset tolerance.

2.15.9 Connection elongation

To use the current sensor with a longer connection length between power meter and PSU connect a well shielded 1:1 extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES (LMG-Z-DVxx). Required length (up to 15m) is to be given by customer along with the order. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.16 Precision current transducer 1000A (PSU1000HF)

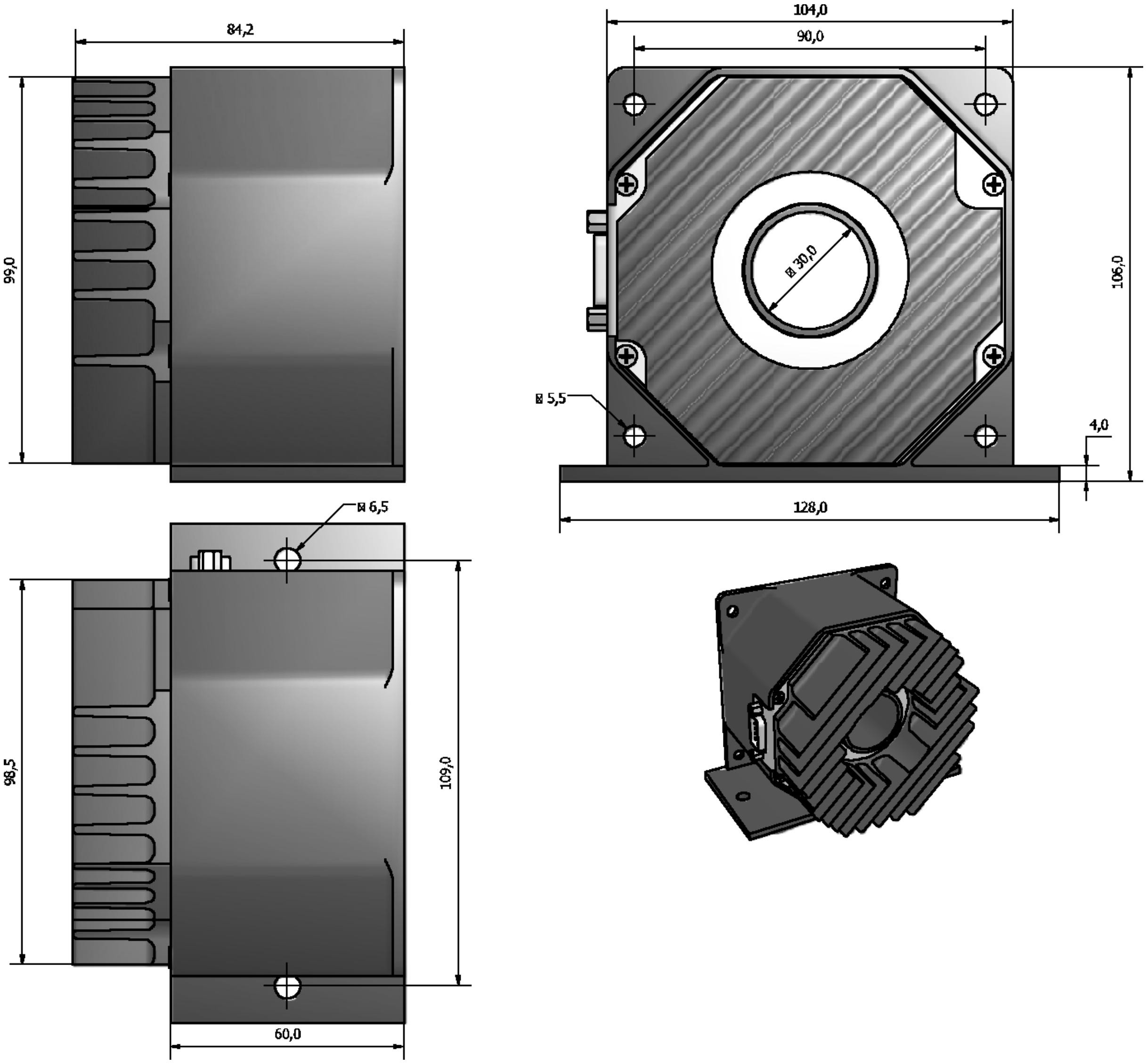


Figure 29: Dimensions of the PSU1000HF

2.16.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.16.2 Specifications

Nominal input current	1000A
Transformation ratio	1000:1
Measuring range PSU	1000Apk
Maximum input overload	4kA for 0.1s

Bandwidth (small signal 20App) +-0.4dB (is equivalent to +-4.7%) +-3dB	 150kHz 500kHz
Slew rate (10%-90%)	> 100A/us
Burden	0 .. 3 ohms
Isolation	30V use isolated primary cable!
Degree of pollution	2
Temperature range	+10°C to +50°C
Weight	approx. 1.0 kg
Output connection	depending on adapter cable to LMGxx

2.16.3 Accuracy

Accuracies based on: sinusoidal current, frequency DC to 100Hz, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

	Amplitude error ±(% of meas.value+% of measuring range PSU)	Phase error
PSU1000HF	0.015+0.005	0.02°

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

2.16.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!

2.16.5 Connection of the sensor with LMG90/310

to be defined

2.16.6 Connection of the sensor with LMG95

to be defined

2.16.7 Connection of the sensor with LMG450

Use PSU1000HF-K and SSU4 **with modifikation for PSU1000HF.**

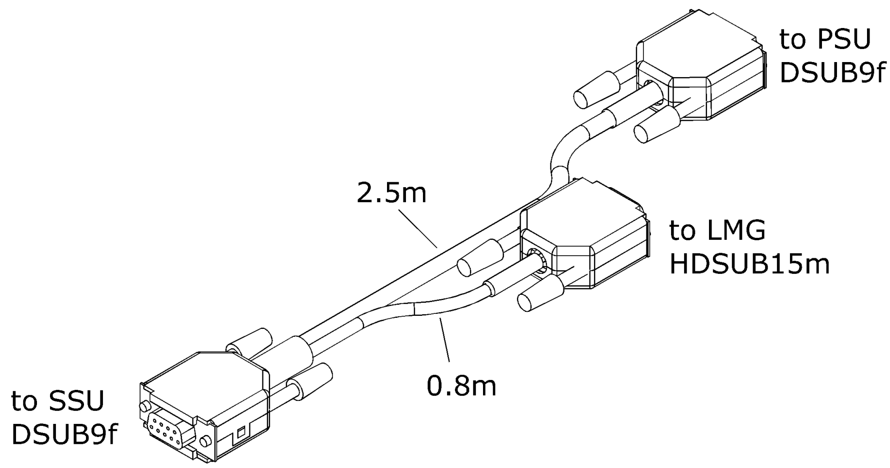


Figure 30: PSU1000HF-K, to connect the PSU1000HF to the LMG450 and the SSU4

This cable 'PSU1000HF-K' is used to connect a precision current sensor PSU1000HF to the power meter LMG450 and to supply it by a sensor supply unit SSU4.

In the connector to the LMG the adjustment data of the PSU head is available as well as it's serial number. For this reason this connector is delivered already mounted to the PSU head and the screws are sealed. This should prevent, that the wrong PSU head is connected to the cable.

The connection is quiet simple:

- Switch all power off and plug the connector labeled 'SSU-4' to the SSU-4.
- Plug the connector labeled 'LMG' to the LMG450 external sensor input
- Now you can switch on the power and make your measurements. The power of the EUT should be switched on at least.

Measuring ranges (sensor input)

nominal value	15A	31.25A	62.5A	125A	250A	500A
max. trms value	18.75A	37.5A	75A	150A	312.5A	625A
max. peak value	31.25A	62.5A	125A	250A	500A	1000A

limited by PSU1000HF to max. 1000Apk!

Accuracy

Use PSU1000HF and LMG450 specifications to calculate the accuracy of the complete system. Add +-150mA (to the primary current) DC offset tolerance.

2.16.8 Connection of the sensor with LMG500

Use PSU1000HF-K and SSU4 **with modifikation for PSU1000HF.**

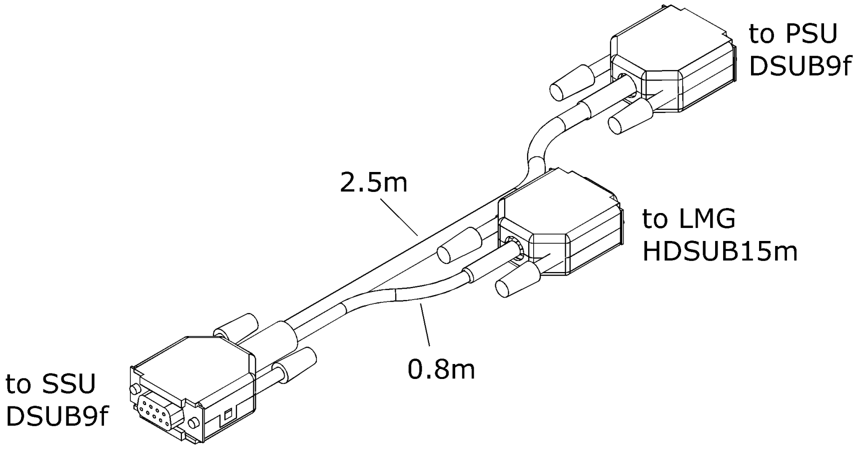


Figure 31: PSU1000HF-K, to connect the PSU1000HF to the LMG500 and the SSU4

This cable ‘PSU1000HF-K’ is used to connect a precision current sensor PSU1000HF to the power meter LMG500 and to supply it by a sensor supply unit SSU4.

In the connector to the LMG the adjustment data of the PSU head is available as well as it’s serial number. For this reason this connector is delivered already mounted to the PSU head and the screws are sealed. This should prevent, that the wrong PSU head is connected to the cable.

The connection is quiet simple:

- Switch all power off and plug the connector labeled ‘SSU-4’ to the SSU-4.
- Plug the connector labeled ‘LMG’ to the LMG500 with Sensoradapter L50-Z14.
- Now you can switch on the power and make your measurements. The power of the EUT should be switched on at least.

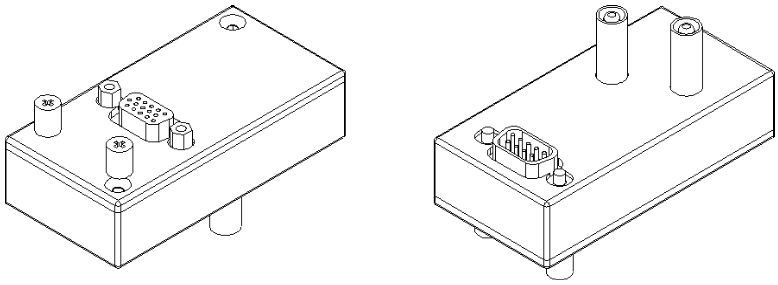


Figure 32: L50-Z14

Measuring ranges (sensor input)

nominal value	3.75A	7.5A	15A	31.25A	62.5A	125A	250A	500A
max. trms value	4.625A	9.375A	18.75A	37.5A	75A	150A	312.5A	625A
max. peak value	7A	15.625A	31.25A	62.5A	125A	250A	500A	1000A

limited by PSU1000HF to max. 1000Apk!

Accuracy

Use PSU1000HF and LMG500 specifications to calculate the accuracy of the complete system. Add +-150mA (to the primary current) DC offset tolerance.

2.16.9 Connection elongation

To use the current sensor with a longer connection length between power meter and PSU connect a well shielded 1:1 extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES (LMG-Z-DVxx). Required length (up to 15m) is to be given by customer along with the order. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.17 Precision current transducer 2000A (PSU2000)

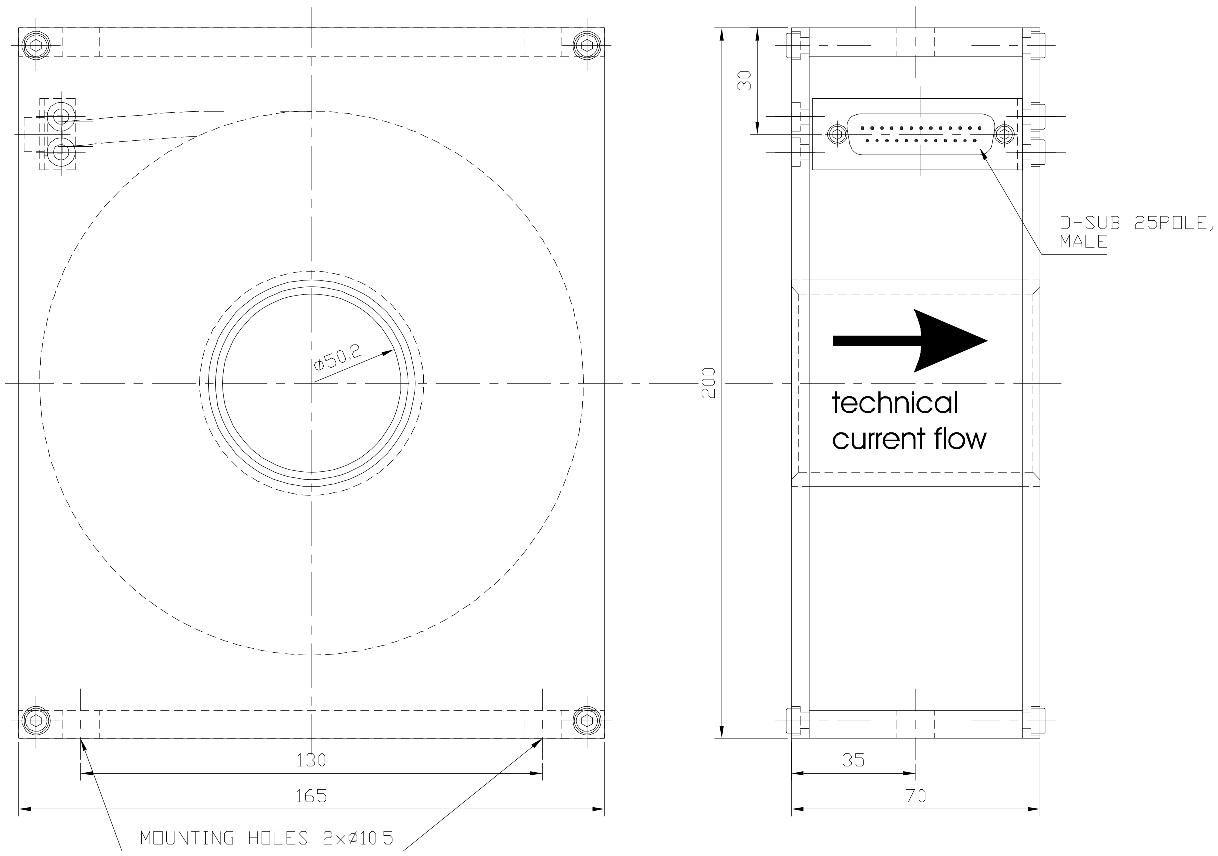


Figure 33: Dimensions of the PSU2000

2.17.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.17.2 Current direction marking

Please regard the arrow 'technical current flow' in the figure above! Sometimes the physical curent flow is marked on the transducer, in doubt: please compare with the technical drawing, this arrow is valid.

2.17.3 Specifications

Nominal input current	1000Apk to 2000Apk, user selectable in 125Apk steps
Transformation ratio	1000:1 to 2000:1, depends on nominal input current
Measuring range PSU	1150Apk to 2300Apk, depends on the nominal input current
Maximum input	500kA for 0.1s

Bandwidth	DC to 100kHz
Slew rate (10%-90%)	>20kA/ms
Burden	<1.2 ohms
Isolation	Test voltage secondary connector to busbar 5kV AC **Attention: when using Busbar without isolation regard DSUB cable isolation or avoid contact!!**
Degree of pollution	2
Temperature range	+0°C to +60°C
Weight	3.5kg
Output connection	25 pole Sub-D from sensor head to measuring electronics mounted in a separate rack (PSU-S20)

2.17.4 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

Frequency in kHz	Amplitude error ±(% of measuring value + % of measuring range PSU)	Phase error
DC to 0.1	0.015+0.005	0.02°
0.1 to 2.5	0.015+0.005	0.1°
2.5 to 10	0.05+0.025	0.2°
10 to 30	0.6 to 0.2	0.7°
30 to 100	6+3	3°

Use PSU2000 and LMG specifications to calculate the accuracy of the complete system.

2.17.5 Programming the PSU2000 with the programming plug

Current	Connection PIN No. P2 male		P1 female	Jumper wiring only at P1					
1000A	No programming plug required, connect cable directly to the head								
1125A	12	to	6	7	to	12			
	24	to	18	19	to	24			
1250A	12	to	8	9	to	12			
	24	to	20	21	to	24			
1375A	12	to	6	7	to	8	9	to	12

	24	to	18	19	to	20	21	to	24
1500A	12	to	10	11	to	12			
	24	to	22	23	to	24			
1625A	12	to	6	7	to	10	11	to	12
	24	to	18	19	to	22	23	to	24
1750A	12	to	8	9	to	10	11	to	12
	24	to	20	21	to	22	23	to	24
1875A	12	to	6	7	to	8	9	to	10
(refer				11	to	12			
example	24	to	18	19	to	20	21	to	22
2.17.6)				23	to	24			
2000A	12	to	6	7	to	8	9	to	10
				11	to	12			
	24	to	16	17	to	18	19	to	20
				21	to	22	23	to	24
Fixed connections for all currents	1	to	1	all jumper wirings depend on the currents to be measured					
	2	to	2						
	4	to	4						
	5	to	5						
	13	to	13						
	14	to	14						
	15	to	15						
	25	to	25						

P1 is connected to the PSU2000 head, P2 to the cable, refer 2.17.8.

2.17.6 Programming example of the Programming plug for 1875 Ampere

In the following figure you can see an programming example for 1875 Ampere.

⚠ **Always connect the programming plug to the transducer head!**

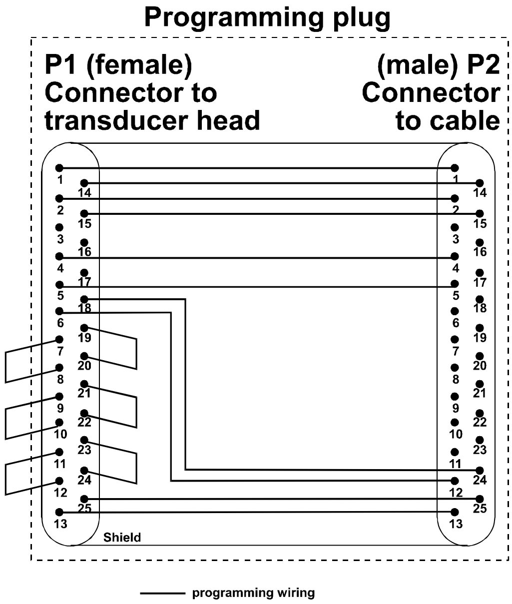


Figure 34: Schematic of the PSU2000 programming plug for 1875A

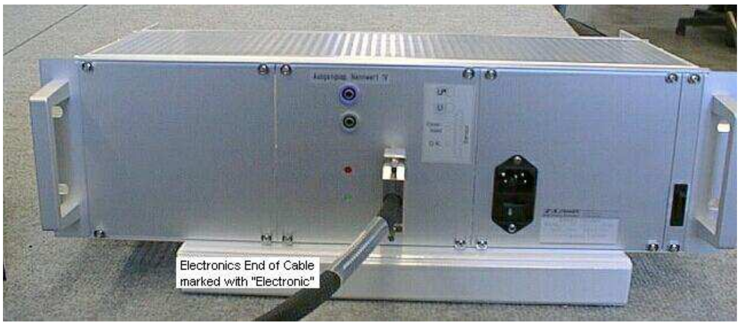
2.17.7 Supply unit PSU-S20

Magazin (19“) for electronic board and supply of 1 to 3 PSU2000.

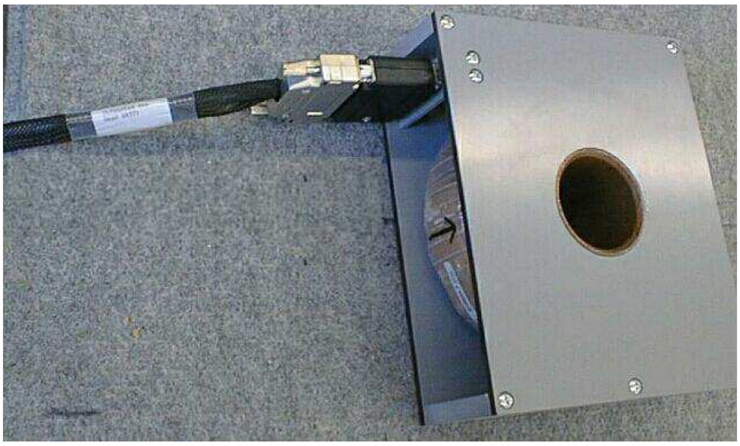
Input voltage	230V, 110V on request
Dimensions W*D*H	19“ * 300mm * 3 units
Weight	10kg
Connection PSU-S20 to PSU2000	2.5m special 25 pole Sub-D cable

2.17.8 Pictures of the PSU2000 connection

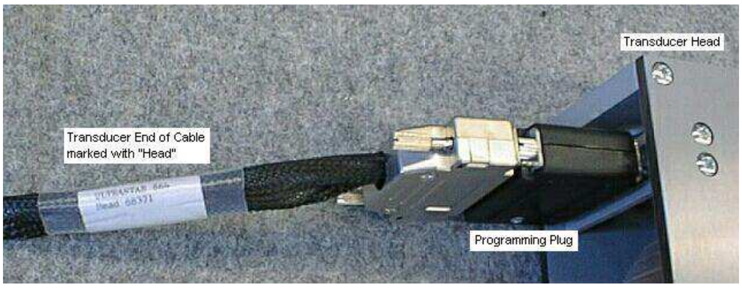
Single channel PSU2000 system



Electronic rack



Transducer head



Programming plug

2.17.9 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.17.10 Connection of the sensor with LMG95

direct current input I* and I	150mA .. 1.2A range	4 ranges
with L95-O8-2 modification	10mA .. 1.2A range	8 ranges
with L95-SH100-1Ohm	30mA .. 1A range	6 ranges

2.17.11 Connection of the sensor with LMG450

direct current input I* and I	600mA .. 1.2A range	2 ranges
with L45-Z22	30mA .. 1A range	6 ranges

2.17.12 Connection of the sensor with LMG500

direct current input I* and I	20mA .. 1.2A range	7 ranges

2.18 Precision current transducer 5000A (PSU5000)

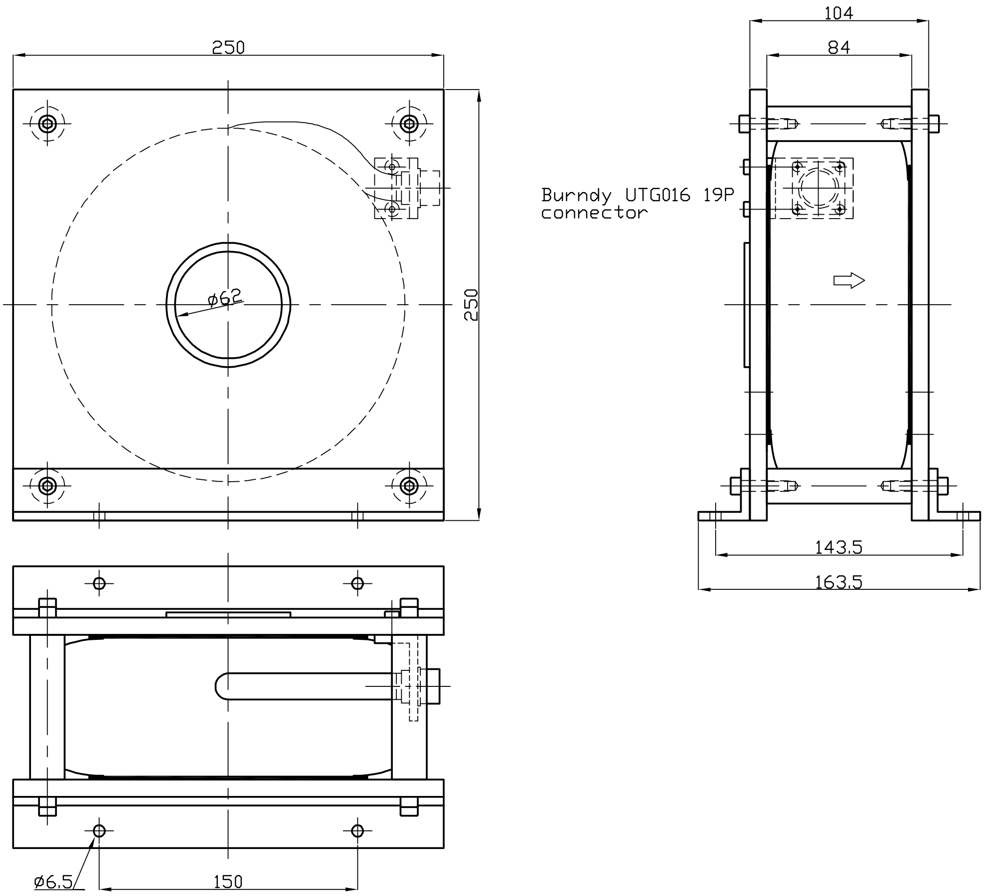


Figure 35: Dimensions of the PSU5000

2.18.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.
Dont allow primary current without supply of the PSU!

2.18.2 Specifications

Nominal input current	2500Apk to 5000Apk, user selectable in 250Apk steps
Transformation ratio	1250:1 to 2500:1, depends on nominal input current
Measuring range PSU	2875Apk to 5750Apk, depends on the nominal input current
Maximum input	500kA for 0.1s
Bandwidth	DC to 50kHz
Slew rate (10%-90%)	>20kA/ms
Burden	<0.75 ohms
Isolation	Test voltage secondary connector to busbar: 5kV AC **Attention: when using Busbar without isolation**

	regard output cable isolation or avoid contact!!
Degree of pollution	2
Temperature range	+0°C to +60°C
Weight	12kg
Output connection	special round connector from sensor head to measuring electronics mounted in a separate rack (PSU-S50)

2.18.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the transducer.

Frequency in kHz	Amplitude error ±(% of measuring value + % of measuring range PSU)	Phase error
DC to 0.1	0.015+0.005	0.02°
0.1 to 2.5	0.015+0.005	0.1°
2.5 to 10	0.05+0.025	0.2°
10 to 20	0.6 to 0.2	0.7°
20 to 50	6+3	3°

Use PSU5000 and LMG specifications to calculate the accuracy of the complete system.

2.18.4 Supply unit PSU-S50

Magazin (19“) for electronic board and supply of 1 to 3 PSU5000.

Input voltage	85..265V, 45..65Hz
Dimensions W*D*H	19“ * 300mm * 3 units
Weight	approx. 10kg
Connection PSU-S50 to PSU5000	2.5m special cable

2.18.5 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.18.6 Connection of the sensor with LMG95

direct current input I* and I	150mA .. 1.2A range	4 ranges
with L95-O8-2 modification	10mA .. 1.2A range	8 ranges
with L95-SH100-1Ohm	30mA .. 1A range	6 ranges

2.18.7 Connection of the sensor with LMG450

direct current input I* and I	600mA .. 1.2A range	2 ranges
with L45-Z22	30mA .. 1A range	6 ranges

2.18.8 Connection of the sensor with LMG500

direct current input I* and I	20mA .. 1.2A range	7 ranges

2.19 Hall current sensors, 50/100/200A, int.supply (L45-Z28-HALLxx)

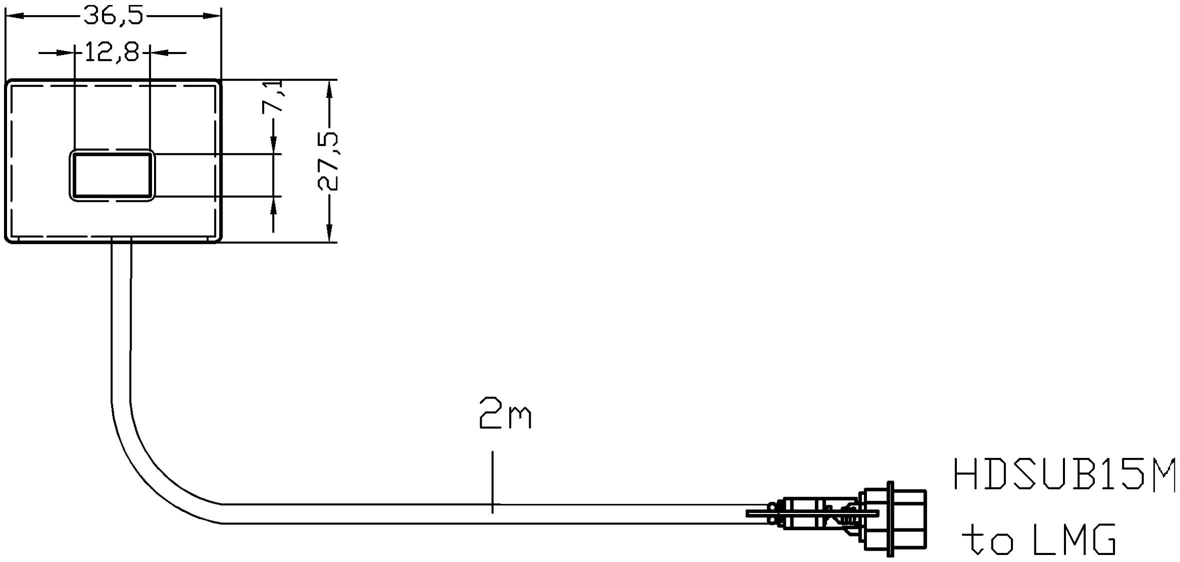


Figure 36: Dimensions of the L45-Z28-HALL50 and HALL100

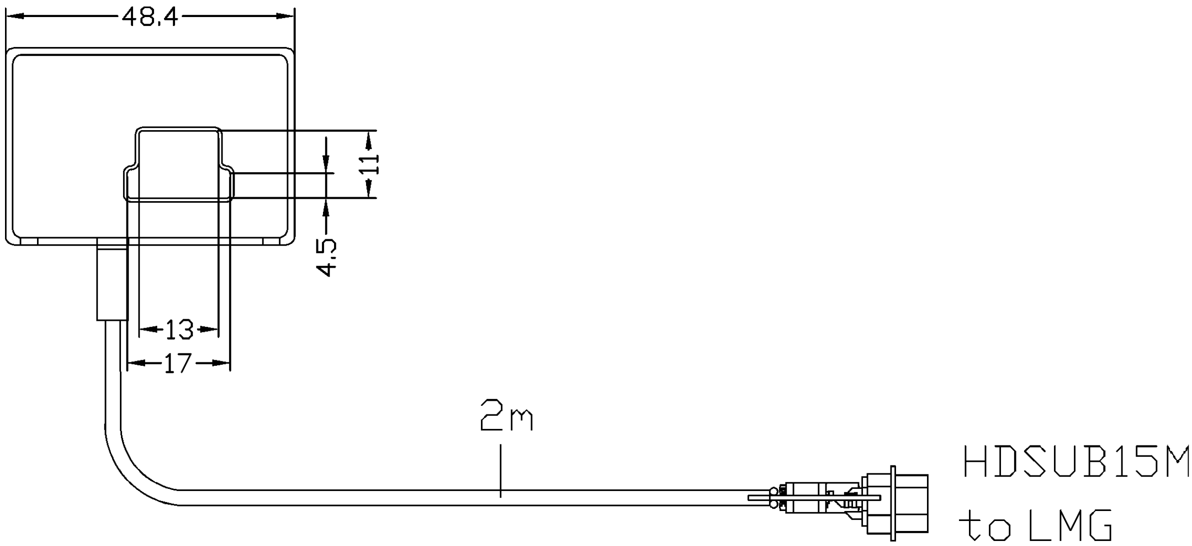


Figure 37: Dimensions of the L45-Z28-HALL200

2.19.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!
Do not overload any current sensor with more than the measurable TRMS value!

2.19.2 Specifications and accuracies

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the hall sensor.

Sensor	HALL50	HALL100	HALL200

Rated range value	35A	60A	120A
Measurable TRMS value	50A	100A	200A
Permissible peak value	70A	120A	240A
Accuracies in % of measurable TRMS value at 50Hz	±0.9	±0.7	±0.65
DC offset error at 25°C	±0.2A	±0.2A	±0.4A
DC offset thermal drift (0°C.. 70°C)	±0.5A	±0.5A	±0.5A
Response time at 90% of measurable TRMS value	<1µs	<1µs	<1µs
di/dt accurately followed	> 200A/µs	> 200A/µs	> 200A/µs
Bandwidth (-1dB)	DC to 200kHz	DC to 200kHz	DC to 100kHz

Use HALLxx and LMG specifications to calculate the accuracy of the complete system.
This sensors are supplied by the HD15 sensor connector of the LMG.

2.19.3 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the HD15 plug from the LMG and connect all of the 15pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.19.4 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.19.5 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.19.6 Connection of the sensor with LMG450

Use sensor input, you get the following ranges:

HALL50:

nominal value	1.09A	2.19A	4.38A	8.75A	17.5A	35A
max. trms value	1.57A	3.13A	6.25A	12.5A	25A	50A
max. peak value	2.19A	4.38A	8.75A	17.5A	35A	70A

HALL100:

nominal value	1.88A	3.75A	7.5A	15A	30A	60A

max. trms value	3.13A	6.25A	12.5A	25A	50A	100A
max. peak value	3.75A	7.5A	15A	30A	60A	120A

HALL200:

nominal value	3.75A	7.5A	15A	30A	60A	120A
max. trms value	6.25A	12.5A	25A	50A	100A	200A
max. peak value	7.5A	15A	30A	60A	120A	240A

2.19.7 Connection of the sensor with LMG500

Use L50-Z14, you get the following ranges:

HALL50:

nominal value	0.27A	0.55A	1.09A	2.19A	4.38A	8.75A	17.5A	35A
max. trms value	0.39A	0.79A	1.57A	3.13A	6.25A	12.5A	25A	50A
max. peak value	0.55A	1.09A	2.19A	4.38A	8.75A	17.5A	35A	70A

HALL100:

nominal value	0.47A	0.94A	1.88A	3.75A	7.5A	15A	30A	60A
max. trms value	0.79A	1.57A	3.13A	6.25A	12.5A	25A	50A	100A
max. peak value	0.94A	1.88A	3.75A	7.5A	15A	30A	60A	120A

HALL200:

nominal value	0.94A	1.88A	3.75A	7.5A	15A	30A	60A	120A
max. trms value	1.57A	3.13A	6.25A	12.5A	25A	50A	100A	200A
max. peak value	1.88A	3.75A	7.5A	15A	30A	60A	120A	240A

2.20 Hall current sensors, 300/500/1k/2kA, ext.supply (L45-Z29-HALLxx)

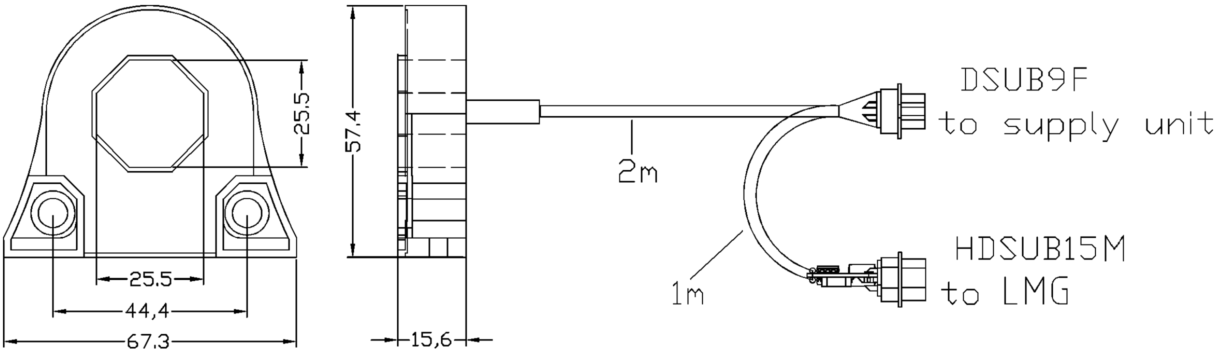


Figure 38: Dimensions of the L45-Z29-HALL300

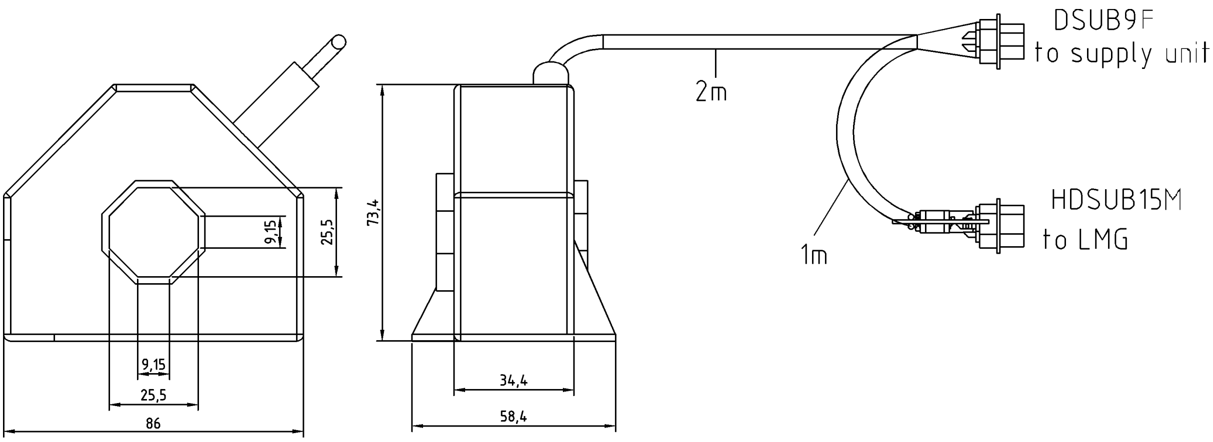


Figure 39: Dimensons of the L45-Z29-HALL500

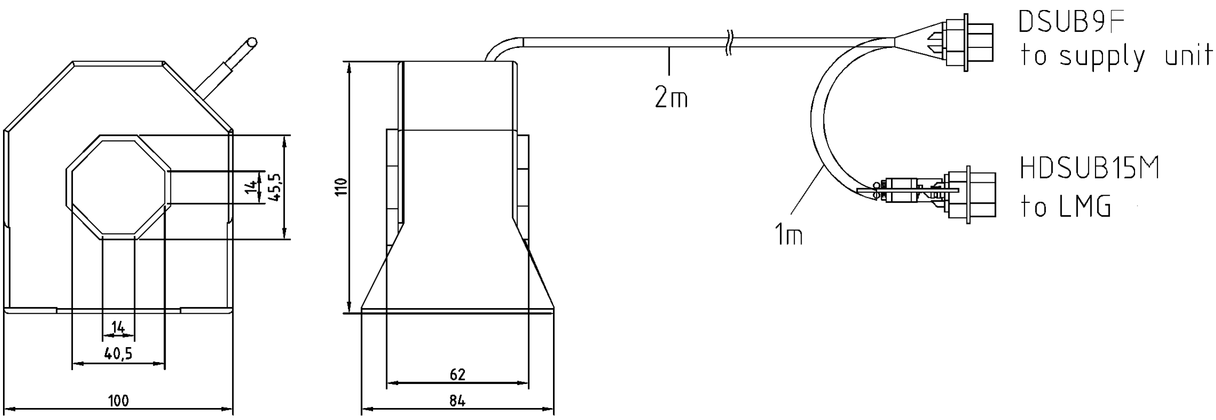


Figure 40: Dimensions of the L45-Z29-HALL1000

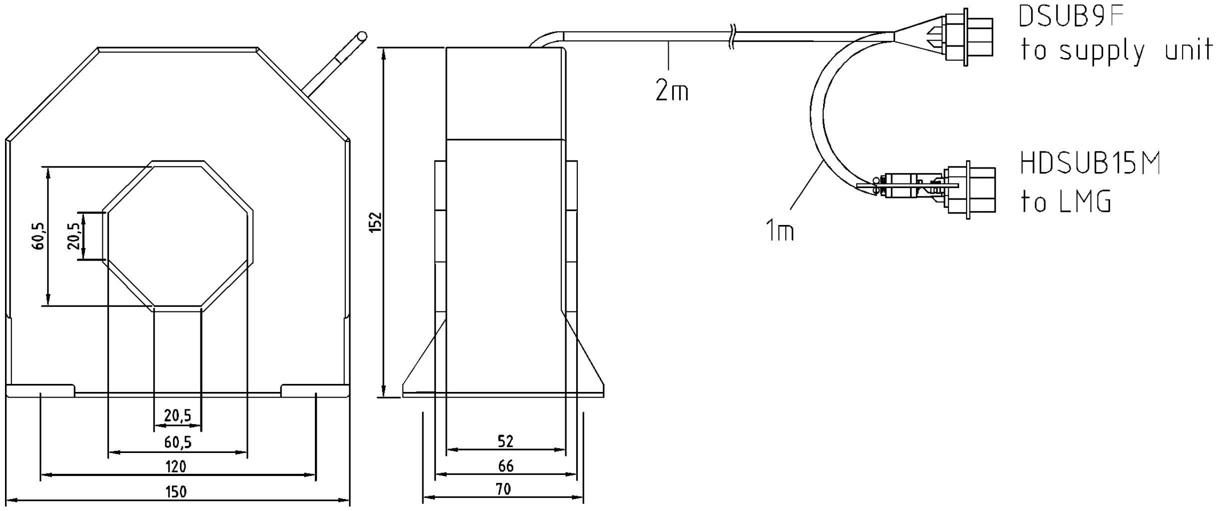


Figure 41: Dimensions of the L45-Z29-HALL2000

2.20.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!
Do not overload any current sensor with more than the measurable TRMS value!

2.20.2 Specifications and accuracies

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the hall sensor.

Sensor	HALL300	HALL500	HALL1000	HALL2000
Rated range value	250A	400A	600A	1000A
Measurable TRMS value	300A	500A	1000A	2000A
Permissible peak value	500A	800A	1200A	2100A
Accuracies in % of measurable TRMS value at 50Hz	±0.4	±0.8	±0.4	±0.3
DC offset error at 25°C	±0.4A	±0.5A	±2A	±4A
DC offset thermal drift (0°C.. 70°C)	±1.3A	±0.6A	±2.5A	±1.5A
Response time at 90% of measurable TRMS value	<1µs	<1µs	<1µs	<1µs
di/dt accurately followed	> 100A/µs	> 100A/µs	> 50A/µs	> 50A/µs
Bandwidth (-1dB)	DC..100kHz	DC..100kHz	DC..150kHz	DC..100kHz
Supply current @ ±15V	270mA	420mA	270mA	460mA

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

This sensors have an additional 9 pin SUB-D connector for an external supply (for example SSU4). If you want to use your own supply, you have to use the following pins of the 9 pin SUB-D connector:

GND: Pin 3 **and** Pin 4 (always connect both)
-15V Pin 5
+15V Pin 9

Please make sure, that your own power supply can drive the needed supply current. If you offer too few current you will get distortions and other accuracy losses in your measured current without warning!

2.20.3 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and the HD15 plug from the LMG and connect all of the 9pins and all of the 15pins together with ground (shield of the plugs). To do this, the load current has to be switched off!

2.20.4 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.20.5 Connection of the sensor with LMG95

The use with LMG95 is not recommended, better use: L50-Z29-Hallxx and L95-Z07.

2.20.6 Connection of the sensor with LMG450

Use sensor input, you get the following ranges:

HALL300:

nominal value	7.8A	15.6A	31.1A	62.5A	125A	250A
max. trms value	9.4A	18.7A	37.5A	75A	150A	300A
max. peak value	15.6A	31.1A	62.5A	125A	250A	500A

HALL500:

nominal value	12.5A	25A	50A	100A	200A	400A
max. trms value	15.6A	31.1A	62.5A	125A	250A	500A
max. peak value	25A	50A	100A	200A	400A	800A

HALL1000:

nominal value	18.7A	37.5A	75A	150A	300A	600A
max. trms value	31.1A	62.5A	125A	250A	500A	1000A
max. peak value	37.5A	75A	150A	300A	600A	1200A

HALL2000:

nominal value	31.1A	62.5A	125A	250A	500A	1000A
max. trms value	62.5A	125A	250A	500A	1000A	2000A
max. peak value	65.6A	131A	263A	525A	1050A	2100A

2.20.7 Connection of the sensor with LMG500

The use with LMG500 is not recommended, please see L50-Z29-Hallxx

2.21 Hall current sensors, 300/500/1k/2kA, int.supply (L50-Z29-Hallxx)

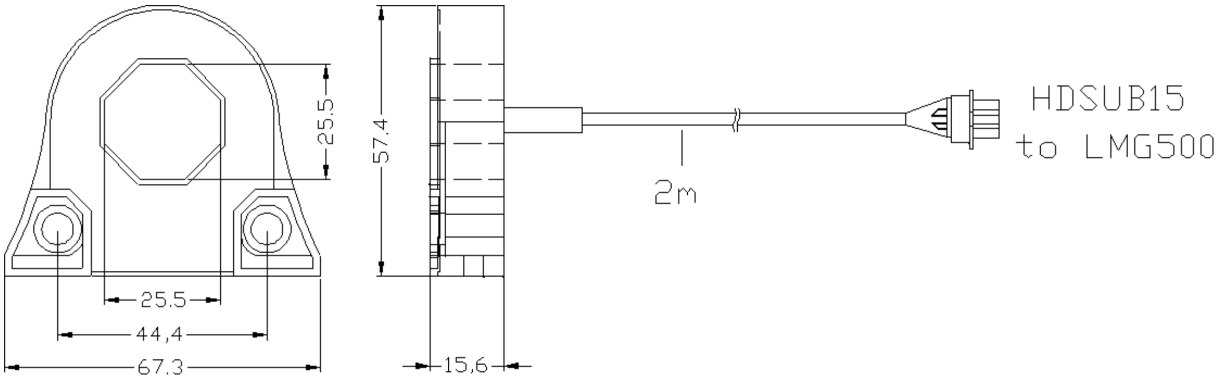


Figure 42: Dimensions of the L50-Z29-Hall300

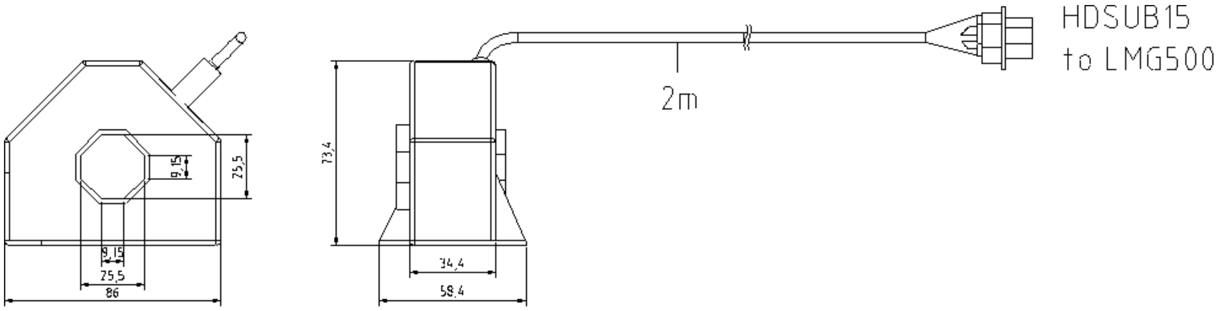


Figure 43: Dimensons of the L50-Z29-Hall500

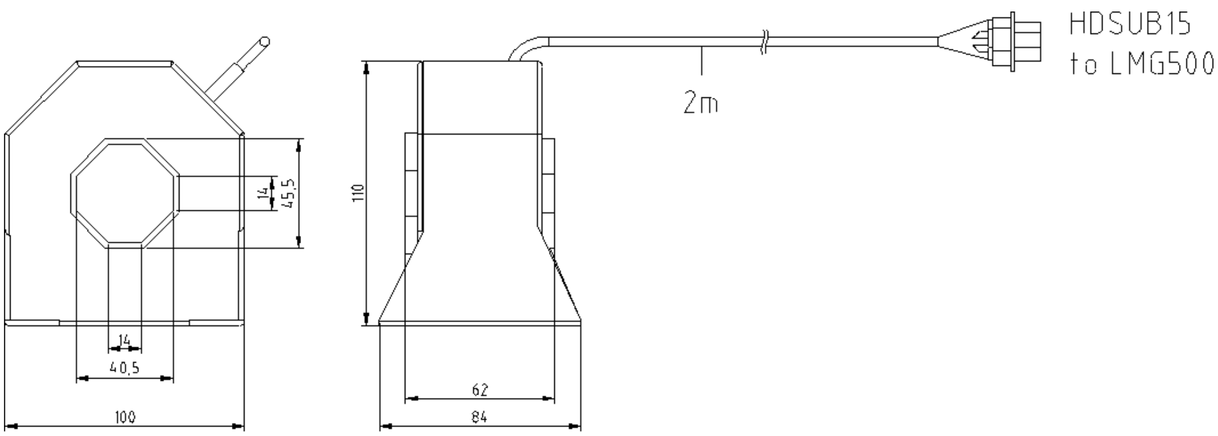


Figure 44: Dimensions of the L50-Z29-Hall1000

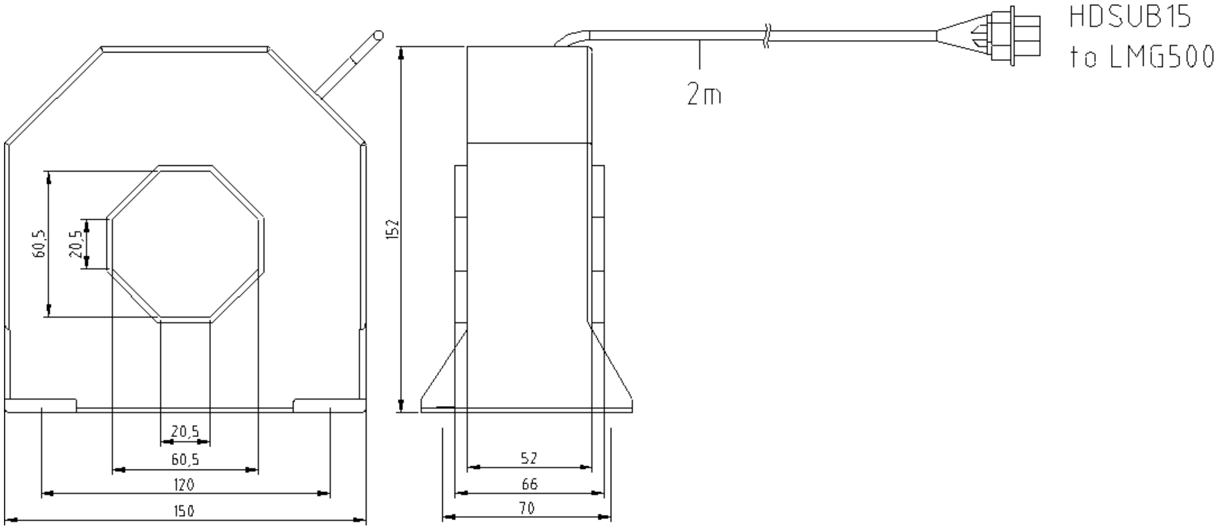


Figure 45: Dimensions of the L50-Z29-Hall2000

2.21.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!
Do not overload any current sensor with more than the measurable TRMS value!

2.21.2 Specifications and accuracies

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the hall sensor.

Sensor	HALL300	HALL500	HALL1000	HALL2000
Rated range value	250A	400A	600A	1000A
Measurable TRMS value	300A	500A	1000A	2000A
Permissible peak value	500A	800A	1200A	2100A
Accuracies in % of measurable TRMS value at 50Hz	±0.4	±0.8	±0.4	±0.3
DC offset error at 25°C	±0.4A	±0.5A	±2A	±4A
DC offset thermal drift (0°C.. 70°C)	±1.3A	±0.6A	±2.5A	±1.5A
Response time at 90% of measurable TRMS value	<1µs	<1µs	<1µs	<1µs
di/dt accurately followed	> 100A/µs	> 100A/µs	> 50A/µs	> 50A/µs
Bandwidth (-1dB)	DC..100kHz	DC..100kHz	DC..150kHz	DC..100kHz

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

2.21.3 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!

To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the HD15 plug from the LMG and connect all of the 15pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.21.4 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.21.5 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.21.6 Connection of the sensor with LMG450

The use with LMG450 is **not possible!**

2.21.7 Connection of the sensor with LMG500

Use L50-Z14, internal supply via LMG, you get the following ranges:

HALL300:

nominal value	2A	3.9A	7.8A	15.6A	31.1A	62.5A	125A	250A
max. trms value	2.4A	4.7A	9.4A	18.7A	37.5A	75A	150A	300A
max. peak value	3.9A	7.8A	15.6A	31.1A	62.5A	125A	250A	500A

HALL500:

nominal value	3.13A	6.25A	12.5A	25A	50A	100A	200A	400A
max. trms value	3.9A	7.8A	15.6A	31.1A	62.5A	125A	250A	500A
max. peak value	6.25A	12.5A	25A	50A	100A	200A	400A	800A

HALL1000:

nominal value	4.7A	9.4A	18.7A	37.5A	75A	150A	300A	600A
max. trms value	7.8A	15.6A	31.1A	62.5A	125A	250A	500A	1000A
max. peak value	9.4A	18.7A	37.5A	75A	150A	300A	600A	1200A

HALL2000:

nominal value	7.8A	15.6A	31.1A	62.5A	125A	250A	500A	1000A

max. trms value	15.6A	31.1A	62.5A	125A	250A	500A	1000A	2000A
max. peak value	16.4A	32.8A	65.6A	131A	263A	525A	1050A	2100A

2.22 Rogowski flex sensors (L45-Z32-FLEXxx)

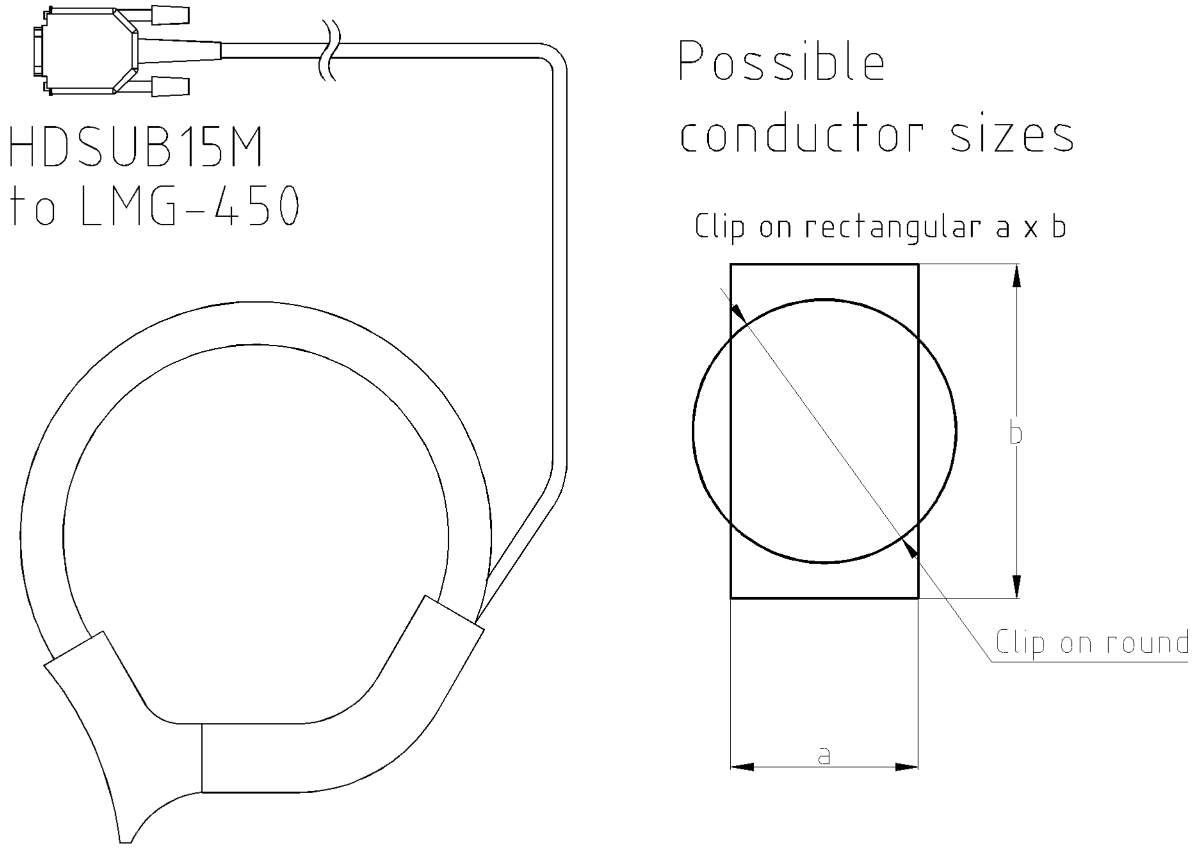


Figure 46: Dimensions of the L45-Z32-FLEX xx

2.22.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

2.22.2 Specifications

Sensor	**FLEX 500**	**FLEX 1000**	**FLEX 3000**
Rated range value	500A	1000A	3000A
Permissible peak range value	700A	1400A	4200A
Position sensitivity	+-5%	+-2%	+-2%
Frequency range	10Hz .. 5kHz	10Hz .. 5kHz	10Hz .. 5kHz
Phase Shift (at 50/60Hz, cable in middle of the head)	0.1°	0.1°	0.1°
Rogowski sensor length	30cm	40cm	75cm
Connection cable length	2m	2m	2m
Clip on round (diameter)	75mm	110mm	200mm
Clip on rectangular (a x b)	20mm x 85mm	30mm x 120mm	60mm x 250mm
max. loops	1	1	3
Weight	100g	120g	160g
Temperature range	-20°C .. +85°C		

Protection class	600V / CATIII
Degree of pollution	2
Output connection	HD15 plug (with EEPROM) for LMG sensor input

2.22.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year, conductor in the middle of the clamp.

The values are: ±(% of measuring value + % of rated range value)

Frequency/Hz	10Hz to 45Hz	45Hz to 65Hz	65Hz to 1kHz	1kHz to 5kHz
FLEX xx current accuracy	0.5+1.5	0.5+0.6	0.5+1.5	5+5

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

2.22.4 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the HD15 plug from the LMG and connect all of the 15pins together with ground (shield of the plug). To do this, the load current has to be switched off!

2.22.5 Connection of the sensor with LMG90/310

The use with LMG90 and LMG310 is not possible.

2.22.6 Connection of the sensor with LMG95

Use L95-Z07, internal supply via LMG and the Isensor/external shunt input.

2.22.7 Connection of the sensor with LMG450

Use sensor input, internal supply via LMG, you get the following ranges:

FLEX500:

nominal value	15.6A	31.3A	62.5A	125A	250A	500A
max. trms value	15.6A	31.3A	62.5A	125A	250A	500A
max. peak value	21.9A	43.8A	87.5A	175A	350A	700A

FLEX1000:

nominal value	31.3A	62.5A	125A	250A	500A	1000A
max. trms value	31.3A	62.5A	125A	250A	500A	1000A
max. peak value	43.8A	87.5A	175A	350A	700A	1400A

FLEX3000:

nominal value	93.8A	188A	375A	750A	1500A	3000A
max. trms value	93.8A	188A	375A	750A	1500A	3000A
max. peak value	131A	263A	525A	1050A	2100A	4200A

2.22.8 Connection of the sensor with LMG500

Use L50-Z14, internal supply via LMG, you get the following ranges:

FLEX500:

nominal value	3.9A	7.8A	15.6A	31.3A	62.5A	125A	250A	500A
max. trms value	3.9A	7.8A	15.6A	31.3A	62.5A	125A	250A	500A
max. peak value	5.5A	10.9A	21.9A	43.8A	87.5A	175A	350A	700A

FLEX1000:

nominal value	7.8A	15.6A	31.3A	62.5A	125A	250A	500A	1000A
max. trms value	7.8A	15.6A	31.3A	62.5A	125A	250A	500A	1000A
max. peak value	10.9A	21.9A	43.8A	87.5A	175A	350A	700A	1400A

FLEX3000:

nominal value	23.5A	46.9A	93.8A	188A	375A	750A	1500A	3000A
max. trms value	23.5A	46.9A	93.8A	188A	375A	750A	1500A	3000A
max. peak value	32.8A	65.6A	131A	263A	525A	1050A	2100A	4200A

2.23 HF-summing current transformer (L95-Z06 'prior design')

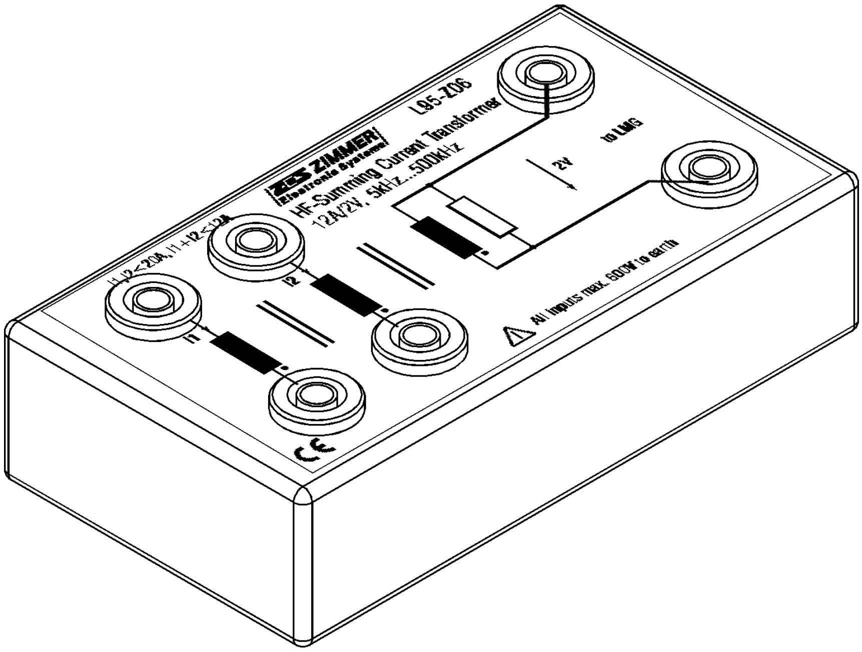


Figure 47: L95-Z06 'prior design'

2.23.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

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 systems, loss power measurement at television deflection coils. The high frequency design provides best accuracy at high frequencies. The current transformer has a voltage output, for the direct connetion to the LMG external Shunt-/ Transformer input.

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.

2.23.2 Specifications

Nominal input current	12A
Transformation ratio	12A:2V (set Iscale to 6)
Measuring range	12A
Maximum input	I1+I2 ≤ 12A, I1≤20A, I2≤20A
Bandwidth	5kHz to 500kHz

Output burden	≥ 100kΩ
Protection class	600V CAT. III
Degree of pollution	2
Temperature range	-10°C to +50°C
Weight	200g
Output connection	safety plugs 4mm (use twisted leads to LMG)

2.23.3 Accuracy

Accuracies based on: ambient temperature 23°C, calibration interval 1 year.

at 5kHz to 500kHz ±(% of measuring value)	Phase difference
0.5	1°

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

2.23.4 Wiring schematics

2.23.4.1 Lower currents

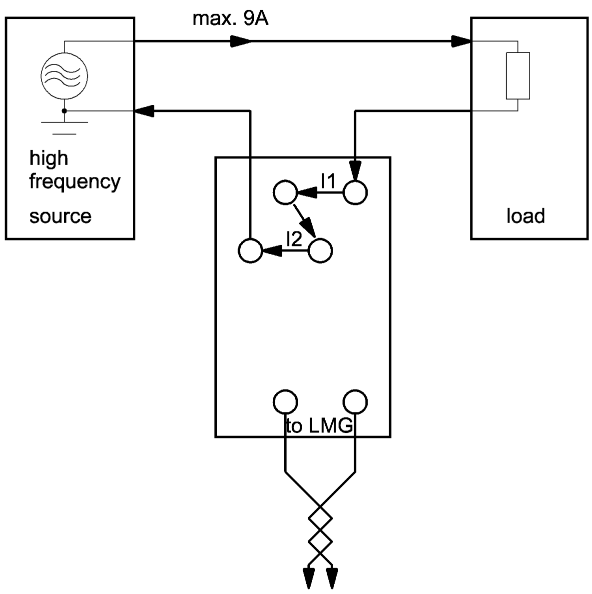


Figure 48: Low current application

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

2.23.4.2 Higher currents

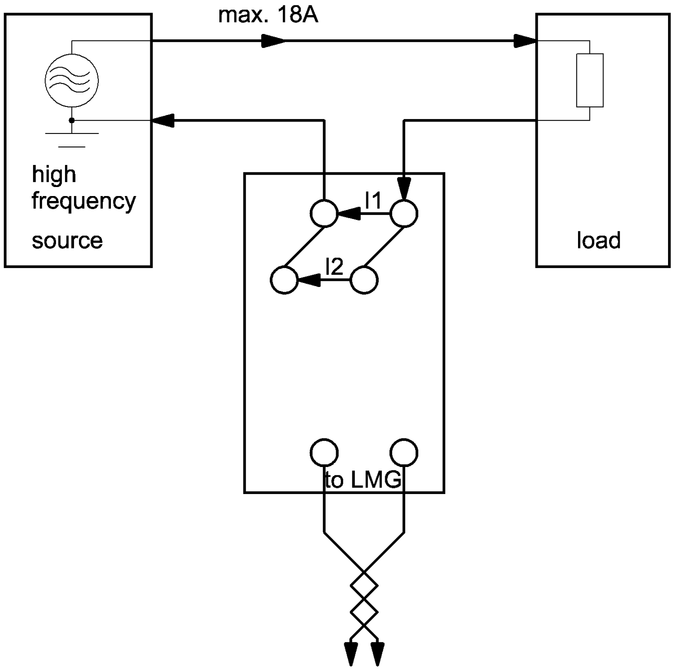


Figure 49: High current application

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

2.23.4.3 Arithmetic mean value

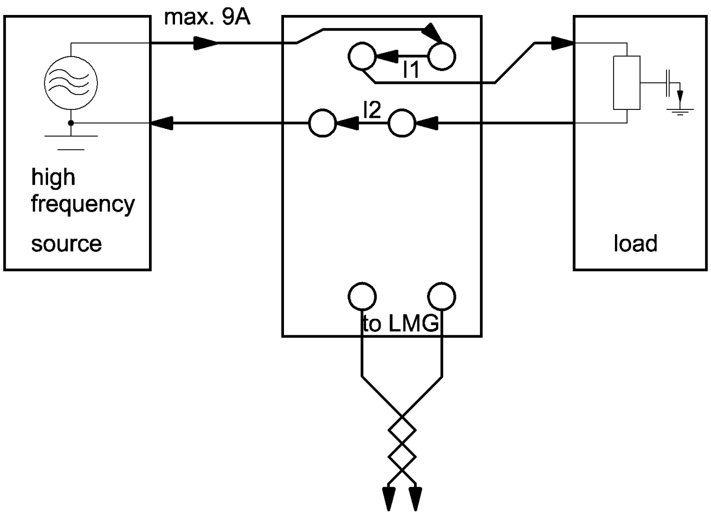


Figure 50: Arithmetic mean value application

To determine the arithmetic mean value of two currents: Imean = (I1+I2)/2, set the LMG Iscale to 3. In high frequency lightning applications where a earth current worth mentioning is present, the light density is proportional to the arithmetic mean value of the two currents I1 and I2.

2.23.4.4 Difference of two currents

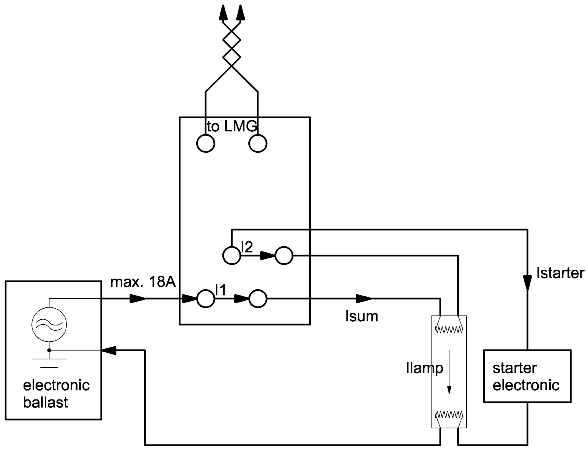


Figure 51: Difference of two currents

To determine the difference of two currents: Ilamp=Isum-Istarter, set the LMG Iscale to: 6. The lamp current Ilamp is the difference of Isum and the current through the starter electronic during the operation.

2.23.4.5 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 HF-accuracy can be improved by draging down the floating voltage to about earth potential.

2.23.5 Connection of the sensor with LMG90/310

The use with LMG90 is not possible. With LMG310 use Isensor/external Shunt input.

2.23.6 Connection of the sensor with LMG95

Use Isensor/external Shunt input.

2.23.7 Connection of the sensor with LMG450

You can use L45-Z09, but it is not recommended to use this high frequency sensor with the LMG450.

2.23.8 Connection of the sensor with LMG500

Use Isensor/external Shunt input.

2.24 HF-summing current transformer (L95-Z06)

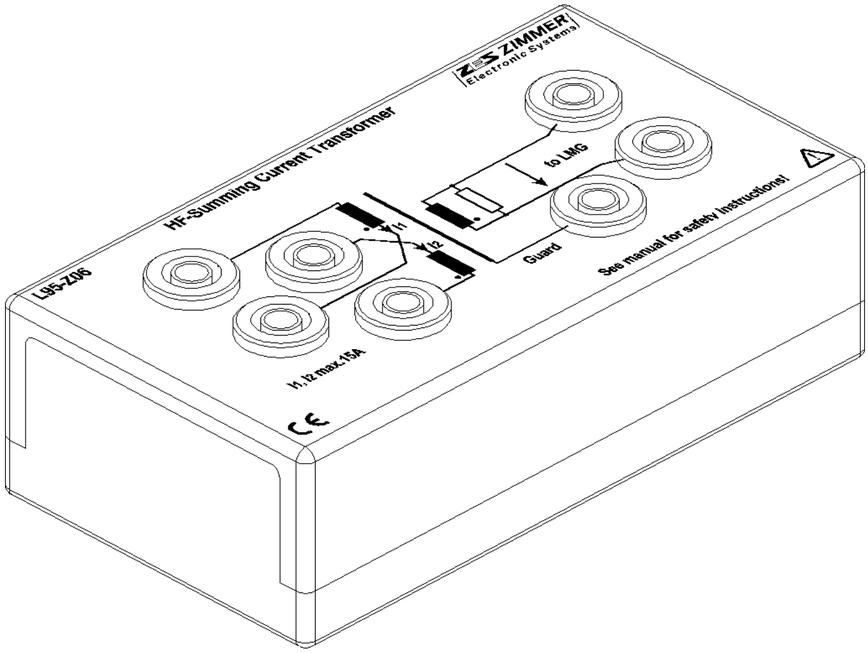


Figure 52: L95-Z06

2.24.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

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 systems, loss power measurement at television deflection coils. The high frequency design provides best accuracy at high frequencies. The current transformer has a voltage output, for the direct connetion to the LMG external Shunt-/ Transformer input.

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

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

2.24.2 Specifications

Nominal input current	15A at I1 or I2 or (I1+I2)
Transformer ratio	18A:3V (set Iscale to 6)
Measuring range	18A (sum of I1+I2)

Maximum input	20A at I1 and 20A at I2 for 1s
Bandwidth	5kHz to 500kHz
output burden	≥ 100kΩ
Working voltage	600V CAT. III, 1000V CAT II
Degree of pollution	2
Temperature range	-10°C to +50°C
Output connection	safety sockets 4mm (use twisted leads to LMG)
Guard connection	safety socket 4mm, green/yellow
Input connection	safety sockets 4mm
Weight	200g
Size l*w*h	120mm*65mm*45mm

2.24.3 Accuracy

Accuracies based on: ambient temperature 23°C, calibration interval 1 year.

at 5kHz to 500kHz ±(% of measuring value)	Phase difference
0.5	1°

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

2.24.4 Wiring schematics

2.24.4.1 Lower currents

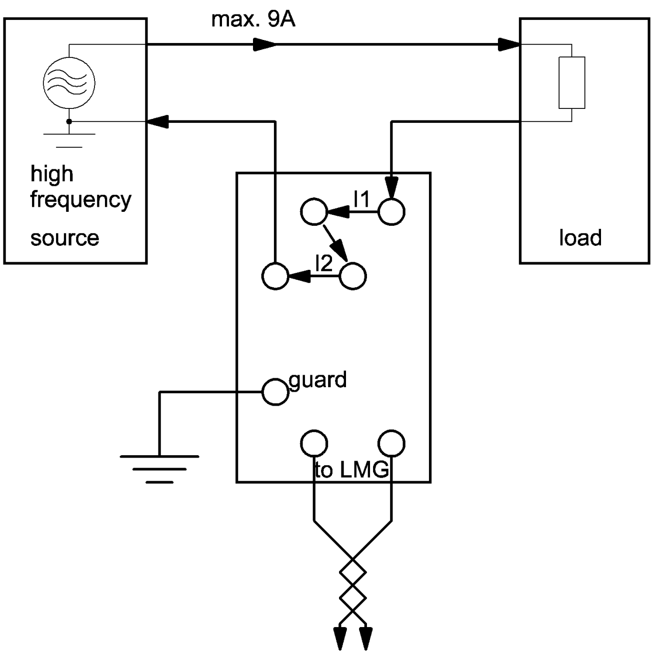


Figure 53: Low current application

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

2.24.4.2 Higher currents

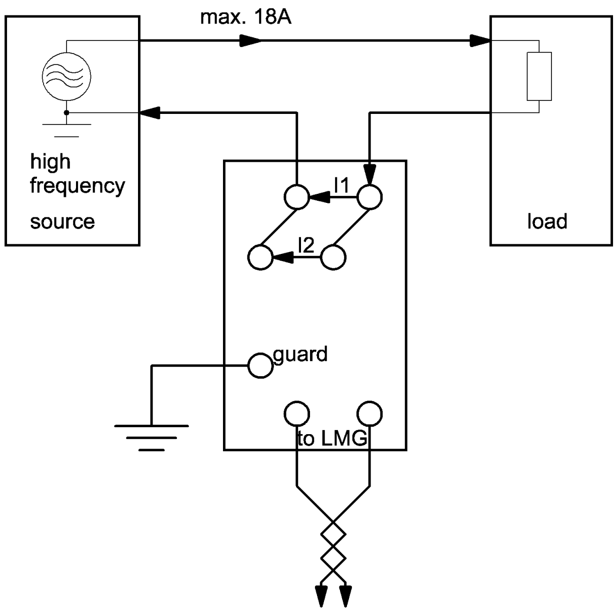


Figure 54: High current application

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

2.24.4.3 Arithmetic mean value

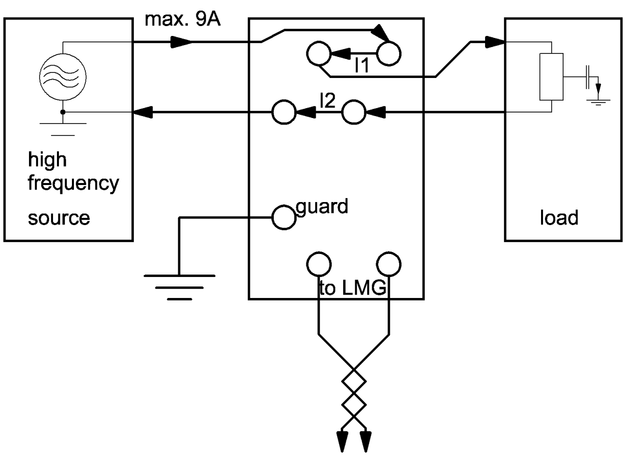


Figure 55: Arithmetic mean value application

To determine the arithmetic mean value of two currents: Imean = (I1+I2)/2, set the LMG Iscale to 3. In high frequency lightning applications where a earth current worth mentioning is present, the light density is proportional to the arithmetic mean value of the two currents I1 and I2.

2.24.4.4 Difference of two currents

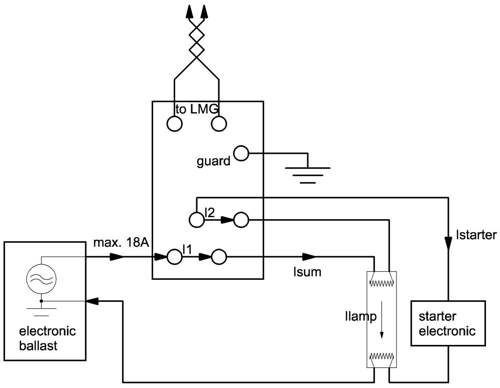


Figure 56: Difference of two currents

To determine the difference of two currents: Ilamp=Isum-Istarter, set the LMG Iscale to: 6. The lamp current Ilamp is the difference of Isum and the current through the starter electronic during the operation.

2.24.4.5 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 HF-accuracy can be improved by draging down the floating voltage to about earth potential.

2.24.5 Connection of the sensor with LMG90/310

The use with LMG90 is not possible. With LMG310 use Isensor/external Shunt input.

2.24.6 Connection of the sensor with LMG95

Use Isensor/external Shunt input.

2.24.7 Connection of the sensor with LMG450

You can use L45-Z09, but it is not recommended to use this high frequency sensor with the LMG450.

2.24.8 Connection of the sensor with LMG500

Use Isensor/external Shunt input.

2.25 Highvoltage HF-summing current transformer (L95-Z06-HV)

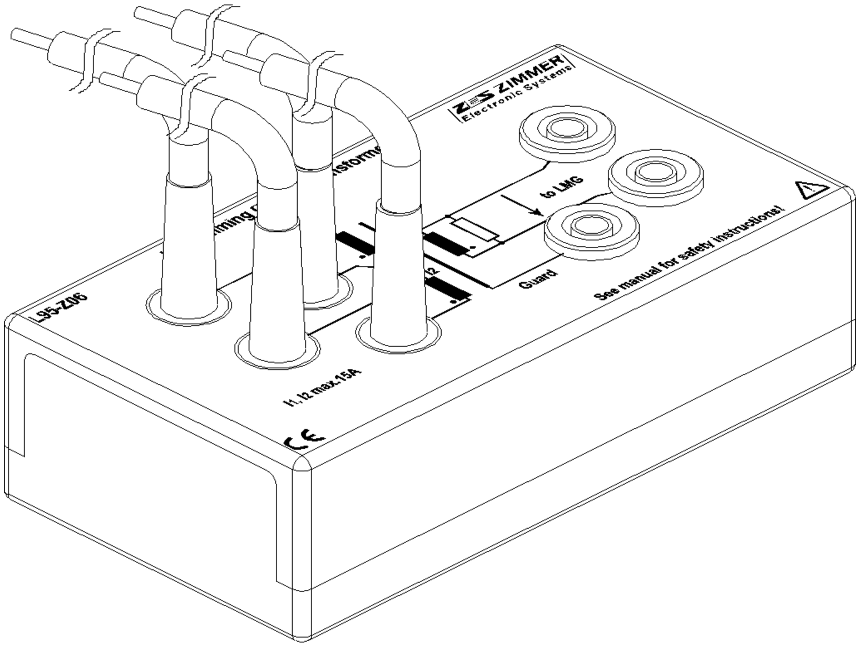


Figure 57: L95-Z06-HV

2.25.1 ⚠ Safety warning!

Always connect the sensor first to the meter and earth the guard terminal, and afterwards to the device under test.
The guard terminal must be grounded to bypass capacitiv currents from input to output. This also reduce errors by common mode voltage.

L95-Z06-HV is an accessory for the precision power meters LMG with a high bandwidth. The high voltage version of L95-Z06 eliminate the 4mm safety sockets as input terminals. The limited clearances and creepage distances are removed by usage of highvoltage wire. All other specifications are the same as L95-Z06.

It simplifies the measurement of output power in high frequency applications with floating potential. For example: lighting applications, ultrasonic systems, loss power measurement at television deflection coils. The high frequency design provides best accuracy at high frequencies. The current transformer has a voltage output, for the direct connetion to the LMG external Shunt-/ Transformer input.

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 should be used in parallel to the first primary winding.

2.25.2 Specifications

Nominal input current	15A at I1 or I2 or (I1+I2)
Transformer ratio	18A:3V (set Iscale to 6)
Measuring range	18A (sum of I1+I2)
Maximum input	20A at I1 and 20A at I2 for 1s
Bandwidth	5kHz to 500kHz
Output burden	≥ 100kΩ
Working voltage	5kVtrms
Transient overvoltage	10kVpk
Degree of pollution	2
Temperature range	-10°C to +50°C
Output connection	safety sockets 4mm (use twisted leads to LMG)
PE connection	safety socket 4mm, green/yellow
Input connection	free highvoltage wire approx. 0.8m
Weight	300g
Size l*w*h	120mm*65mm*125mm

2.25.3 Accuracy

Accuracies based on: ambient temperature 23°C, calibration interval 1 year.

at 5kHz to 500kHz ±(% of measuring value)	Phase difference
0.5	1°

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

2.25.4 Wiring schematics

2.25.4.1 Lower currents

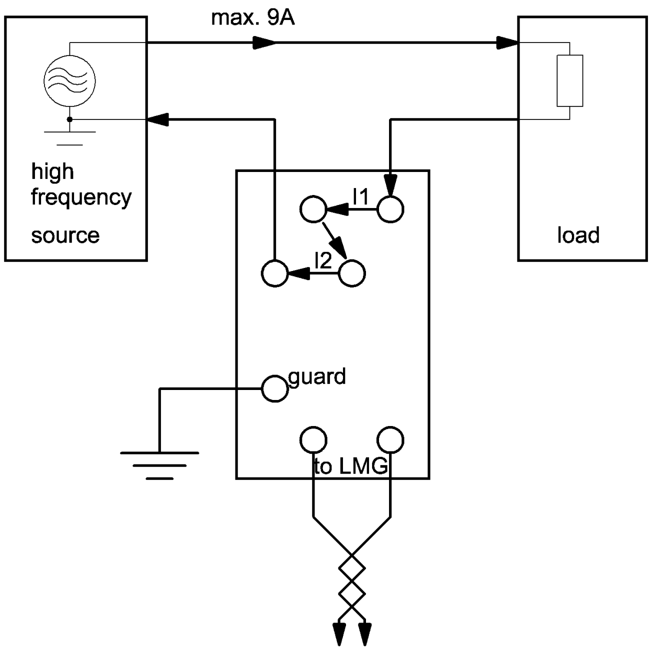


Figure 58: Low current application

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

2.25.4.2 Higher currents

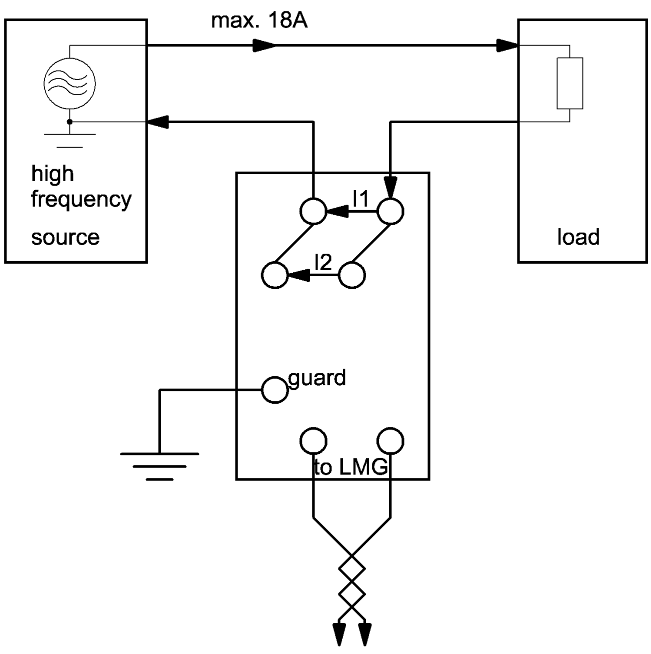


Figure 59: High current application

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

2.25.4.3 Arithmetic mean value

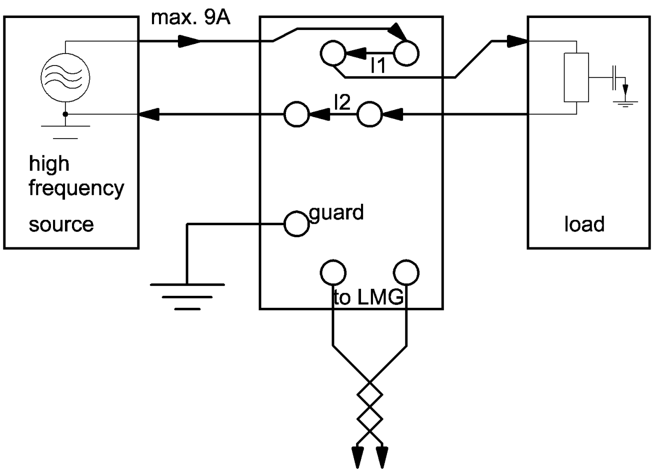


Figure 60: Arithmetic mean value application

To determine the arithmetic mean value of two currents: Imean = (I1+I2)/2, set the LMG Iscale to 3. In high frequency lightning applications where a earth current worth mentioning is present, the light density is proportional to the arithmetic mean value of the two currents I1 and I2.

2.25.4.4 Difference of two currents

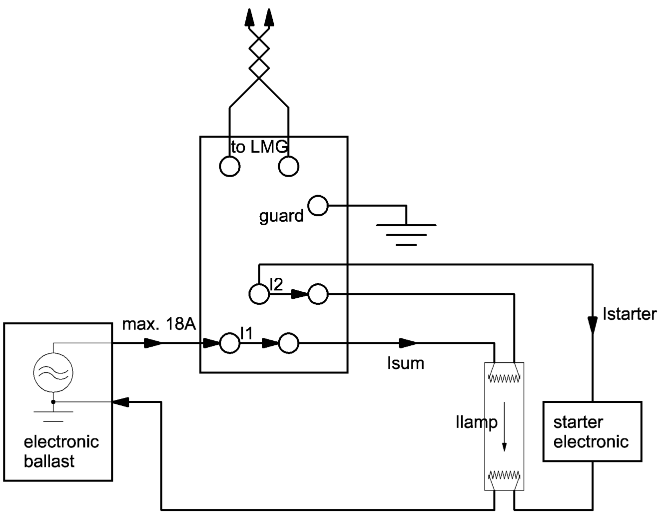


Figure 61: Difference of two currents

To determine the difference of two currents: Ilamp=Isum-Istarter, set the LMG Iscale to: 6. The lamp current Ilamp is the difference of Isum and the current through the starter electronic during the operation.

2.25.4.5 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 HF-accuracy can be improved by draging down the floating voltage to about earth potential.

2.25.5 Connection of the sensor with LMG90/310

The use with LMG90 is not possible.

With LMG310 use Isensor/external Shunt input.

2.25.6 Connection of the sensor with LMG95

Use Isensor/external Shunt input.

2.25.7 Connection of the sensor with LMG450

You can use L45-Z09, but it is not recommended to use this high frequency sensor with the LMG450.

2.25.8 Connection of the sensor with LMG500

Use Isensor/external Shunt input.

2.26 Low current shunt (L95-SH100)

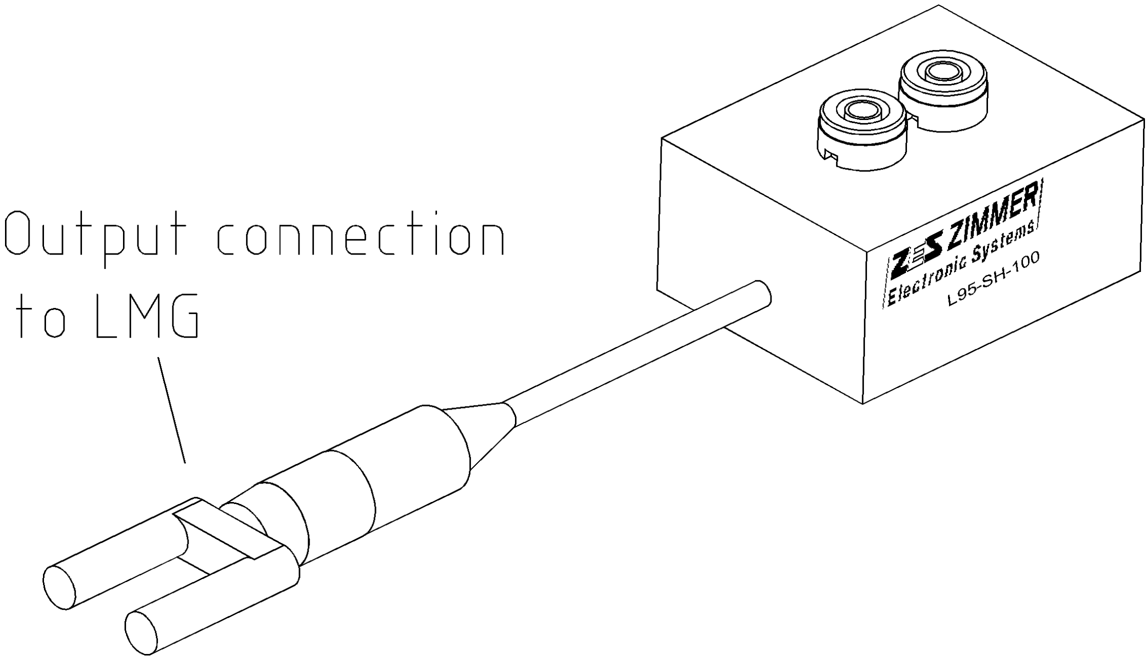


Figure 62: L95-SH100

2.26.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.26.2 Specifications

nominal resistance	1 ohm	2 ohms	5 ohms	10 ohms	20 ohms	50 ohms	100 ohms	200 ohms	500 ohms	1000 ohms
scaling ratio	1.00001	0.50001	0.20001	0.10001	0.05001	0.02001	0.01001	0.00501	0.00201	0.00101
nominal measuring ranges with LMG95 and LMG500 [A] *(regard maximum trms input current!)*	30m 60m 120m 250m 500m 1 *(2)* *(4)*	15m 30m 60m 125m 250m 500m *(1)* *(2)*	6m 12m 24m 50m 100m 200m 400m *(800m)*	3m 6m 12m 25m 50m 100m 200m *(400m)*	1.5m 3m 6m 12.5m 25m 50m 100m *(200m)*	600u 1.2m 2.4m 5m 10m 20m 40m 80m	300u 600u 1.2m 2.5m 5m 10m 20m 40m	150u 300u 600u 1.25m 2.5m 5m 10m 20m	60u 120u 240u 500u 1m 2m 4m 8m	30u 60u 120u 250u 500u 1m 2m 4m
maximum trms input current	1000 mA	710 mA	450 mA	320 mA	160 mA	100 mA	70 mA	50 mA	31 mA	22 mA
max. power dissipation	1W				0.5W					
bandwidth	DC to 100kHz									
protection	600V CAT III									

class	
degree of pollution	2
temperature range	0°C to +40°C
weight	100g
output connection	Security BNC cable and adapter

2.26.3 Accuracy

The specified accuracy is valid in combination with the LMG95 / LMG500 sensor input impedance of 100kOhm and the correct setting of the scaling ratio (see table).
Accuracies based on: sinusoidal current, frequency 50-60 Hz, ambient temperature 23°C, calibration interval 1 year. The values are in ±(% of measuring value)

Shunt (1ohm, 2ohms, 5ohms, 10ohms, 20ohms)	0.1
Shunt (50ohms, 100ohms, 200ohms, 500ohms, 1kohms)	0.01

Use L95-SH100 and LMG specifications to calculate the accuracy of the complete system.

2.26.4 Connection of the sensor with LMG90/310

The use with LMG90 is not possible.

With LMG310 use Isensor/external Shunt input.

2.26.5 Connection of the sensor with LMG95

Use Isensor/external Shunt input.

2.26.6 Connection of the sensor with LMG450

The use with LMG450 is **not possible!**

2.26.7 Connection of the sensor with LMG500

Use Isensor/external Shunt input.

2.27 Low current shunt with overload protection (L95-SH100-P)

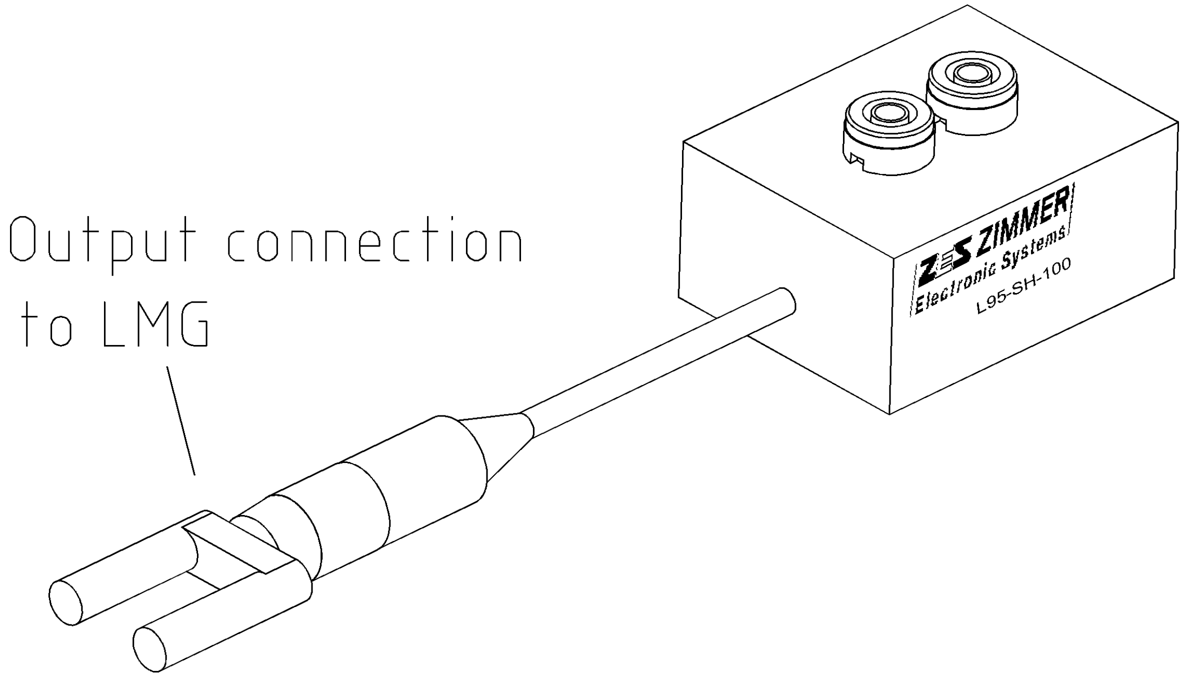


Figure 63: L95-SH100-P

2.27.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test.

2.27.2 Specifications

nominal resistance	1 ohm	2 ohms	5 ohms	10 ohms	20 ohms	50 ohms	100 ohms	200 ohms	500 ohms	1000 ohms
scaling ratio	1.00001	0.50001	0.20001	0.10001	0.05001	0.02001	0.01001	0.00501	0.00201	0.00101
nominal measuring ranges with LMG95 and LMG500 [A] *(don't use the upper three ranges!, -> outside accuracy specification)*	30m 60m 120m 250m 500m ~~(1)~~ ~~(2)~~ ~~(4)~~	15m 30m 60m 125m 250m ~~(500m)~~ ~~(1)~~ ~~(2)~~	6m 12m 24m 50m 100m ~~(200m)~~ ~~(400m)~~ ~~(800m)~~	3m 6m 12m 25m 50m ~~(100m)~~ ~~(200m)~~ ~~(400m)~~	1.5m 3m 6m 12.5m 25m ~~(50m)~~ ~~(100m)~~ ~~(200m)~~	600u 1.2m 2.4m 5m 10m ~~(20m)~~ ~~(40m)~~ ~~(80m)~~	300u 600u 1.2m 2.5m 5m ~~(10m)~~ ~~(20m)~~ ~~(40m)~~	150u 300u 600u 1.25m 2.5m ~~(5m)~~ ~~(10m)~~ ~~(20m)~~	60u 120u 240u 500u 1m ~~(2m)~~ ~~(4m)~~ ~~(8m)~~	30u 60u 120u 250u 500u ~~(1m)~~ ~~(2m)~~ ~~(4m)~~
maximum peak input current for specified	710 mApk	350 mApk	140 mApk	70 mApk	35 mApk	14 mApk	7 mApk	3.5 mApk	1.4 mApk	710 uApk

accuracy										
maximum trms input current	20A (overload protection)									
bandwidth	DC to 10kHz									
protection class	600V CAT III									
degree of pollution	2									
temperature range	0°C to +40°C									
weight	150g									
output connection	Security BNC cable and adapter									

2.27.3 Accuracy

The specified accuracy is valid in combination with the LMG95 / LMG500 sensor input impedance of 100kOhm and the correct setting of the scaling ratio (see table).
Accuracies based on: sinusoidal current, frequency 50-60 Hz, ambient temperature 23°C, calibration interval 1 year. The values are in ±(% of measuring value)

Shunt (1ohm, 2ohms, 5ohms, 10ohms, 20ohms, 50ohms, 100ohms, 200ohms, 500ohms, 1kohms)	0.15

Use L95-SH100-P and LMG specifications to calculate the accuracy of the complete system.

2.27.4 Connection of the sensor with LMG90/310

The use with LMG90 is not possible.

With LMG310 use Isensor/external Shunt input.

2.27.5 Connection of the sensor with LMG95

Use Isensor/external Shunt input.

2.27.6 Connection of the sensor with LMG450

The use with LMG450 is **not possible!**

2.27.7 Connection of the sensor with LMG500

Use Isensor/external Shunt input.

2.28 Precision wideband current transformer WCT100 (LMG-Z601)

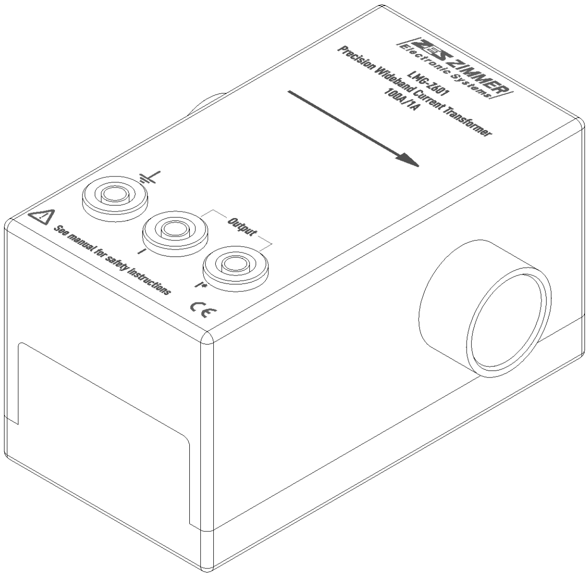


Figure 64: LMG-Z601

2.28.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test! An open connection on the secondary side will cause hazardous voltage and might destroy the transformer.

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 a 1A current output, for the direct connection to the LMG current input.
LMG-Z601 is optimized for the LMG500 and its Ihf input. Because of the low and over all measuring ranges constant impedance of this input best accuracy can be achieved.
For the connection of LMG-Z601 to the precision power meter LMG use narrow twisted laboratory leads (not longer than needed) or, in HF applications slightly better: 4mm to BNC adaptor and coaxial cable.

2.28.2 Specifications

Nominal input current	100A
Measuring range	250Apk
Transformer ratio	100A:1A (set Iscale to 100)
Maximum input	120A continuous / 200A for 1 minute
Bandwidth	30Hz .. 1MHz

Output burden	max. 100mOhms for the specified accuracy
Isolation	600V CATIII, 1000V CATII Test voltage: output Ilow to 20mm busbar. (for higher voltages, the primary lead has to be isolated according to the working voltage of the system!)
Output connection	safety sockets, 4mm
Temperature range	-10°C to +70°C
Through hole diameter	23mm
Weight	about 350g
Size l*w*h	120mm * 95mm * 65mm

2.28.3 Accuracy

Accuracies based on: no DC current component, ambient temperature 23°C, calibration interval 1 year, burden 100mOhms, max. 1m twisted laboratory leads or coaxial cable.

Full power accuracy, for measuring current from 1A to 100A! Accuracy and bandwidth specification is for small signal as well as for wide signal level.

Frequency range	30Hz to 100Hz	100Hz to 100kHz	100kHz to 300kHz	300kHz to 1MHz
Current +-(% of measuring value)	0.25%	0.25%	1%	2%
Phase +-(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.

2.28.4 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. The HF-accuracy can be improved by draging down the floating voltage to about earth potential, but this might also cause resonance, so beware not to distort the measurement accuracy.

2.28.5 Sensor without LMG

The secondary side of this current transformer has to be connected under all circumstances! If the LMG has to be removed and the sensor can not be disconnected, be sure to short circuit the current output I* with I of the sensor to avoid dangerous voltages. This open loop voltages would be hazardous for the user and might damage the sensor!

2.28.6 Connection of the sensor with LMG90/310

Use direct current inputs I* and I.

2.28.7 Connection of the sensor with LMG95

Use direct current inputs I* and I.

2.28.8 Connection of the sensor with LMG450

Use direct current inputs I* and I.

2.28.9 Connection of the sensor with LMG500

Use HF current inputs Ihf and I.
You get the following measuring ranges:

nominal value	15A	30A	60A	120A
max. trms value	22.5A	45A	90A	180A
max. peak value	31.3A	62.5A	125A	250A

3 LMG95 connection cables and adapter

3.1 Adapter for the use of HD15-Sensors with LMG95 (L95-Z07)

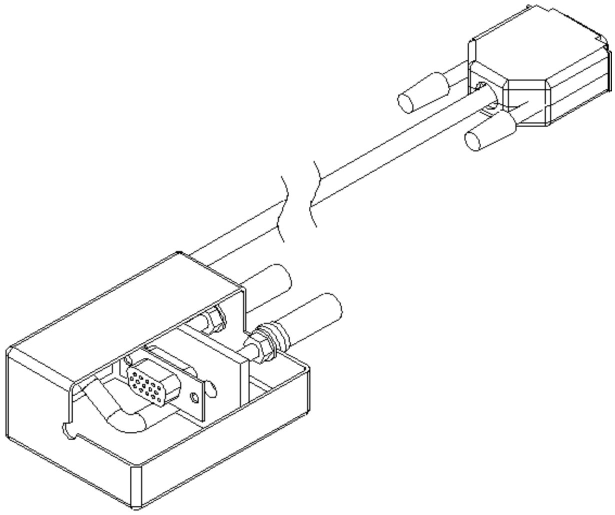


Figure 65:Adapter for the use of HD15-Sensors with LMG95 (L95-Z07)

3.1.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test Connecting cables without savety isolation! Avoid contact to hazardous voltage!

3.1.2 Specifications

suitable sensors	**remarks**
L45-Z26	DC current clamp 1000A
L45-Z28-HALLxx	Hall-transducer 50A, 100A, 200A
L50-Z29-HALLxx	Hall-transducer 300A, 500A, 1000A, 2000A
L45-Z32-FLEXxx	Rogowski-transducer 500A, 1000A, 3000A
PSUxx-K-L50	PSU200, -400, -700
L45-Z06	better use: LMG-Z327
L45-Z10	better use: LMG-Z322
L45-Z16	better use: LMG-Z329

Plug the DSUB connector to LMG95 external supply and the two 4mm jacks to LMG95 ext.Shunt/I.

3.1.3 Accuracy

If you order the accessory L95-Z07 together with the suitable current sensor, then you can find a label with the scaling factor on L95-Z07. Please set this current scaling in the range menue of the LMG95. For the use of different current sensors e.g. alternating with LMG450 (not ordered at the same time with L95-Z07) you have to calibrate the sensor together with the LMG95 to find the correct scaling. Use the sensor- and LMG specifications to calculate the accuracy of the complete system.

3.2 Connection of PSU200/400/700 to LMG95 (PSU2/4/700-K-L95)

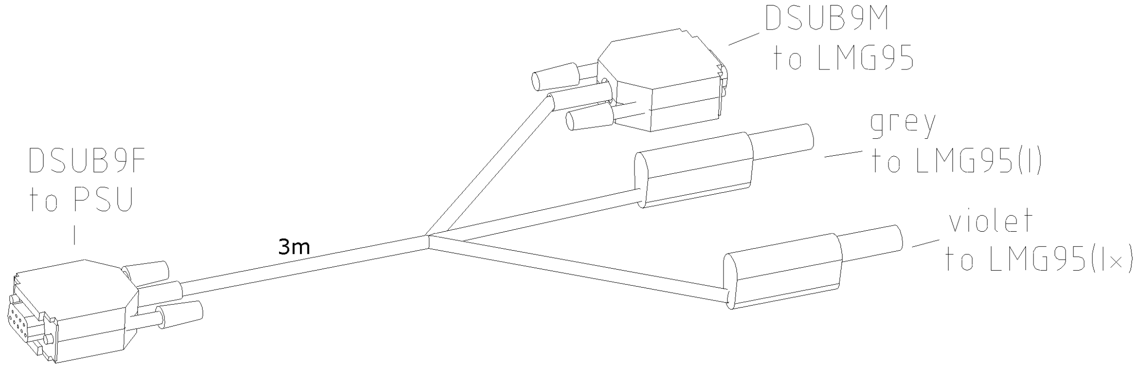


Figure 66: PSU2/4/700-K-L95, for direct connection of the PSU200/400/700 to the current input of the LMG95

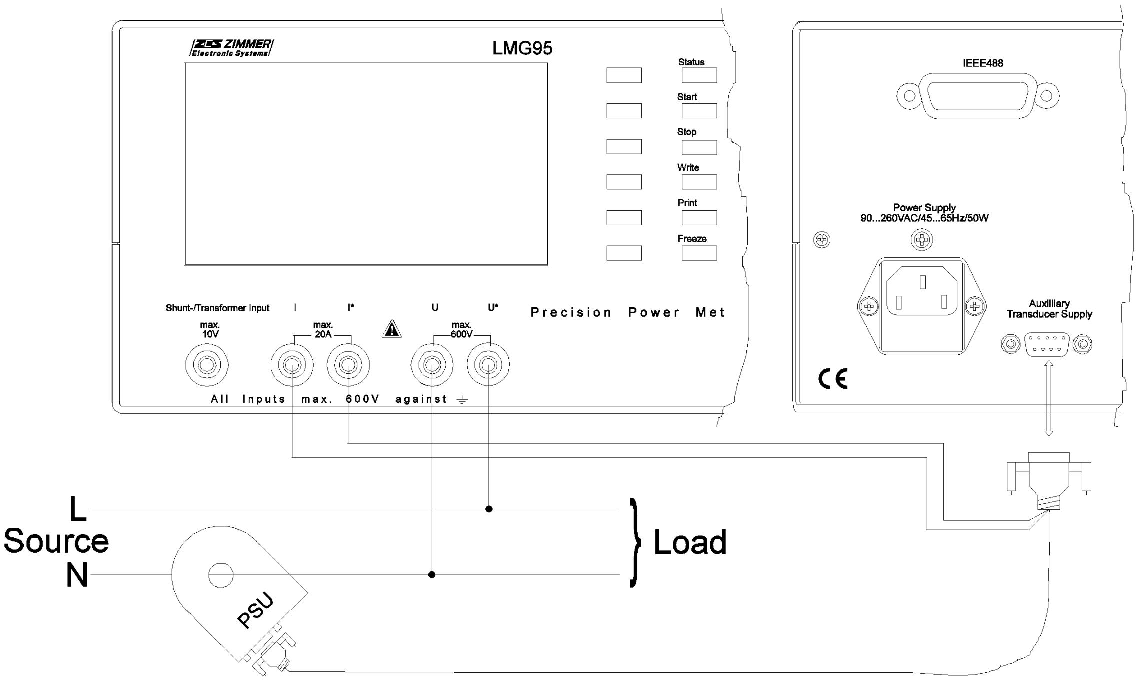


Figure 67: Connection of PSU200/400/700 to the LMG95

3.2.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test Connecting cables without savety isolation! Avoid contact to hazardous voltage!

3.2.2 Installation

No additional supply needed. Cable length between PSU and LMG: 2.5m

3.2.3 LMG95 ranges (direct current input) with PSU200

Iscale=1000

nominal value	150A
max. trms value	*300A*
max. peak value	*469A*

limited by PSU200 to max. 200Apk!

3.2.4 LMG95 ranges (direct current input) with PSU400

Iscale=2000

nominal value	300A
max. trms value	*600A*
max. peak value	*938A*

limited by PSU400 to max. 400Apk!

3.2.5 LMG95 ranges (direct current input) with PSU700

Iscale=1750

nominal value	262.5A	525A
max. trms value	525A	*1050A*
max. peak value	*820.75A*	*1641.5A*

limited by PSU700 to max. 700Apk!

3.2.6 Accuracy

Use PSU and LMG95 specifications to calculate the accuracy of the complete system.

3.2.7 Sensor operation without supply

It is importand to assure a stable power supply of the sensor before switching on the load current! The **operation** of the sensor with load current and **without supply will cause damage** of the sensor and/or of the LMG/supply unit!
To remove the LMG/supply unit from the test location without removing the sensors from the current path, disconnect the DSUB9 plug and the savety laboratory plugs from the LMG and connect all of the 9pins together with ground (shield of the plug) and together with the hot-wired savety laboratory plugs. To do this, the load current has to be switched off!

4 LMG450 connection cables and adapter

The special design of all LMG450 sensors makes them very easy and comfortable to use. The HD15 SUB D plug contains the identification of the sensor type, the measuring ranges, including the needed scaling and several more parameters. The LMG450 reads this values and the meter will automatically 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.

4.1 BNC adapter to sensor input HD15 without EEPROM (L45-Z09)

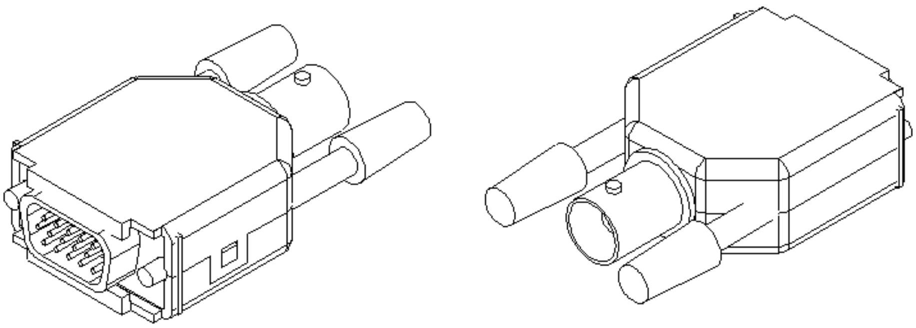


Figure 68: L45-Z09

By this adapter you can connect a voltage via a BNC cable to the LMG450 external current sensor input. This voltage has to be isolated, because the BNC screen is electrically connected to the case of the LMG450!

This is a simple electrical adapter. No values can be stored!

4.2 Adapter for isolated custom current sensors with 1A output (L45-Z22)

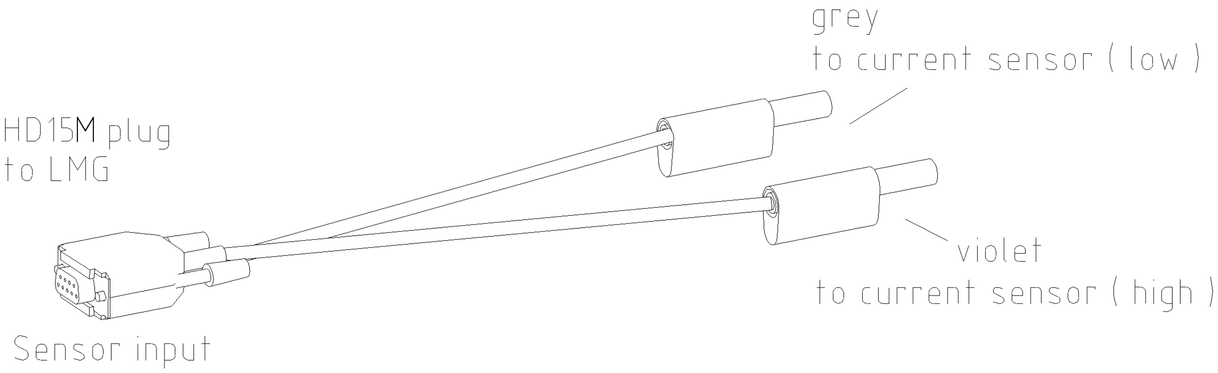


Figure 69: L45-Z22

4.2.1 ⚠ Safety warning!

Use only galvanic separating current sensors! There is no potential separation in this adapter and in the LMG450 sensor input! NOT FOR DIRECT CURRENT MEASUREMENT!!

4.2.2 Specifications

L45-Z22 is an accessory for the precision power meter LMG450. Its benefit is the usage of isolated custom current sensors with 1A output current e.g. current transducers or clamps with the LMG450 sensor input. In comparison to the usage of the direct current inputs of the LMG450, the accessory L45-Z22 is optimized for the sensor output current of 1A and a dynamic range down to 31.25mA as full range.

Nominal input current	1A
Max. trms value	1.2A
Measuring range	3Apk
Input resistance	340mOhms
Bandwidth	DC to 20kHz
Isolation	NO ISOLATION! NOT FOR DIRECT CURRENT MEASUREMENT!
Connection	HD15 (with EEPROM) for LMG sensor input, length about 80cm

4.2.3 Accuracy

Accuracies based on: sinusoidal current, ambient temperature 23°C, calibration interval 1 year. The values are: ±(% of measuring value + % of measuring range)

Frequency/Hz	DC to 45Hz	45Hz to 65Hz	45Hz to 5kHz	5kHz to 20kHz
Current	0.05+0.05	0.05+0.05	0.1+0.1	0.25+0.25

Use L45-Z22 and LMG specifications to calculate the accuracy of the complete system.

4.2.4 Connection of the sensor with LMG90/310

not possible

4.2.5 Connection of the sensor with LMG95

not possible

4.2.6 Connection of the sensor with LMG450

nominal value	0.03A	0.06A	0.12A	0.25A	0.5A	1A
max. trms value	0.04A	0.08A	0.15A	0.3A	0.6A	1.2A
max. peak value	0.09A	0.19A	0.375A	0.75A	1.5A	3A

4.2.7 Connection of the sensor with LMG500

not necessary, because of good current dynamic range of LMG500

5 LMG500 connection cables and adapter

5.1 LMG500 current sensor adapter (L50-Z14)

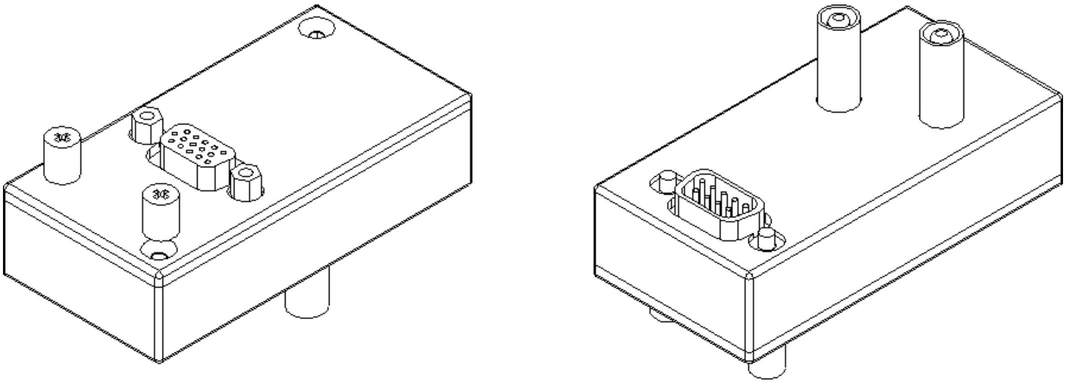


Figure 70: L50-Z14

The special design of all LMG500 sensors makes them very easy and comfortable to use. The HD15 SUB D plug contains the identification of the sensor type, the measuring ranges, including the needed scaling and several more parameters. The LMG500 reads this values and the meter will automatically 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 LMG500 sensors the Adapter L50-Z14 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 HD15 SUB D plug, without galvanic separation. The adapter L50-Z14 guarantees that no measuring leads are connected to the measuring channel at the same time and prevents electrical shock.

6 Accessories

6.1 Shielded DSUB9 extension cable, male/female (LMG-Z-DVxx)

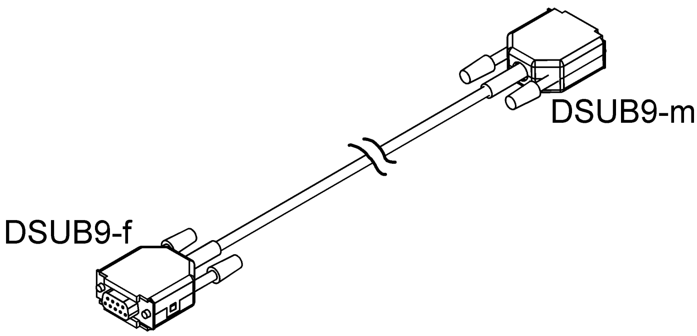


Figure 71: Shielded DSUB9 extension cable (LMG-Z-DVxx)

6.1.1 ⚠ Safety warning!

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

6.1.2 General

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 connection cables. In this case it is used between the precision current sensor PSU200/400/600/700 and the LMG specific connection cable to the LMG.

6.1.3 Specifications

Isolation	No safety isolation, working voltage max. 50V
Connectors	DSUB9 male / DSUB9 female / 1:1
Cable length	user selectable: 3m or 5m or 10m or 15m

6.2 Sensor supply unit for up to 4 current sensors (SSU4)

The SSU4 is a supply unit to feed up to 4 pieces of current sensors. Each sensor can be supplied with +15V / 500mA, -15V / 500mA at the same time. The transducers are connected to the four 9 pin SUB-D connectors. Depending on the sensor the output signal can be accessed directly from the sensor or via the 15 pin SUB-D connector.

6.2.1 Technical data

Mains supply	85...264V, 47...440Hz, ca. 40W, Fuse 5x20mm T1A/250V IEC127-2/3
Protection method	IP20 according DIN40050
Protection class	I; Mains supply: Overvoltage class II and pollution degree 2 according IEC61010-1
EMC	EN55011, EN50082
Safety	EN61010
Dimensions	Desktop: 320mm (W) x 49mm (H) x 307mm (D) 19“ rack: 63DU x 1HU x 360mm
Output voltage	±15V ±2%
Output current	max. 500mA on each jack
Climatic class	KYG according to DIN 40040 0°C...40°C, humidity max. 85%, annual average 65%, no dewing
Storage temperature	-20°C to +55°C
Weight	3kg

6.2.2 Technical drawings

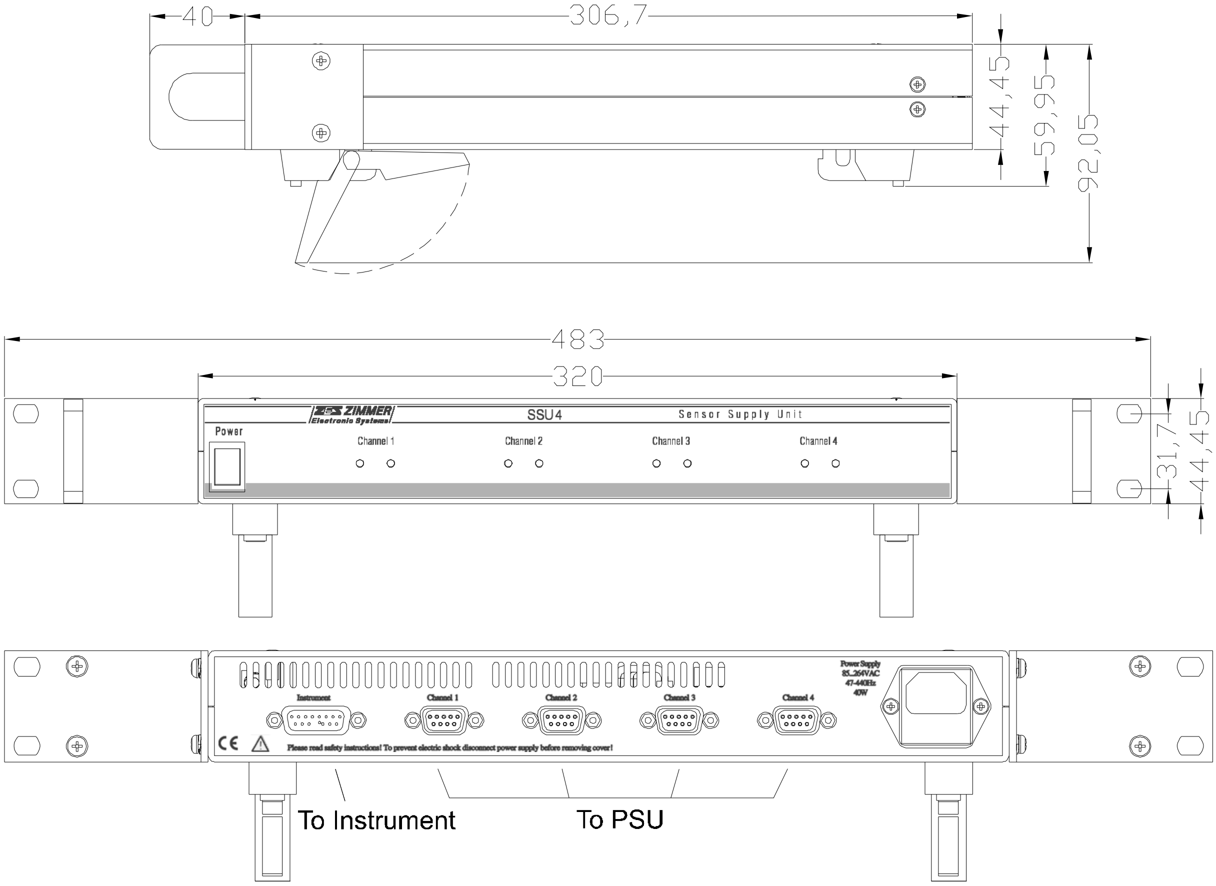


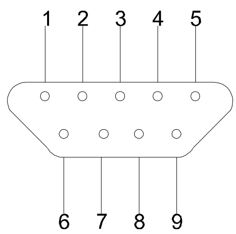
Figure 72: Dimensions of the SSU4

In the Figure 72 you see the desktop instrument, also attended the angles for rack mounting

6.2.3 Connectors

6.2.3.1 9 Pin SUB-D connectors for the sensors

Via the following connector the sensors (e.g. PSU600, L45-Z29-xxxx, ...) are connected to the SSU4 sensor supply unit. For each channel there is one connector.



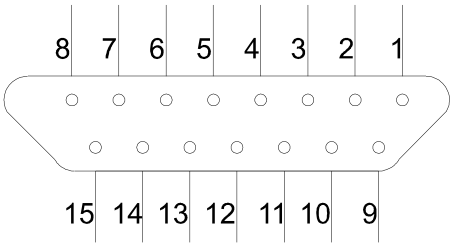
Connector to the sensors

Pin	Usage
1, 2	Not used. Do not connect!
3, 4	Ground (GND)
5	-15V. max. 500mA
6	Current output signal of the sensor (max. 500mA!)
7	Not used. Do not connect!
8	Signal input to indicate a proper operation of the sensor: +15V or n.c.: The red LED is on GND: The green LED is on
9	+15V, max. 500mA

The current output signal of the sensor is connected via a 2.7Ω resistor to the corresponding channel of the 15 pin connector for the instrument. When the current returns from the instrument it is fed into ground.

6.2.3.2 15 Pin SUB-D connectors for the measuring instrument

Via the following connector the measuring instrument can be connected to the sensor supply unit:



Connector to the instrument

Pin	Usage
1, 2	Current output channel 1
3, 4	Current output channel 2
5, 6	Current output channel 3
7, 8	Current output channel 4
9-15	Ground

The output current of each channel can be measured and has then to be returned to Ground.

6.2.4 Mounting

6.2.4.1 Rack mounting

Fix the two rack mounting metal sheets with the four screws at the two sides of the SSU4 case. Now you can mount it into any 19“ rack.

6.2.4.2 Instrument mounting

You can mount the SSU4 directly under a LMG95 or LMG450. Please do this in follwing order:

- Switch off both instruments and remove all cables.
- Remove the four feets of the LMG450 or LMG95 case. To do this, just remove the four screws. The nuts are fixed inside the LMG450 or LMG95.
- Remove the four feets of the SSU4 case. The four screws are mounted into the four screw-nuts which are accessable from the top of the case. Remove also this nuts.
- With the four M4x55 screws (which are added) you mount now the four feets of the SSU4 with following orientation:
  LMG95: mount the front feets in the 2nd position from the front plate.
  mount the rear feets in the 2nd position from the rear plate.
  LMG450: mount the front feets in the position closest to the front plate.
  mount the rear feets in the position closest to the rear plate.
  In both cases: The small white rubber on the feets has to be mounted in direction to the rear/front plate. The four screws are fixed into the nuts of the LMG450/LMG95 bottom (where the original feeds were fixed).

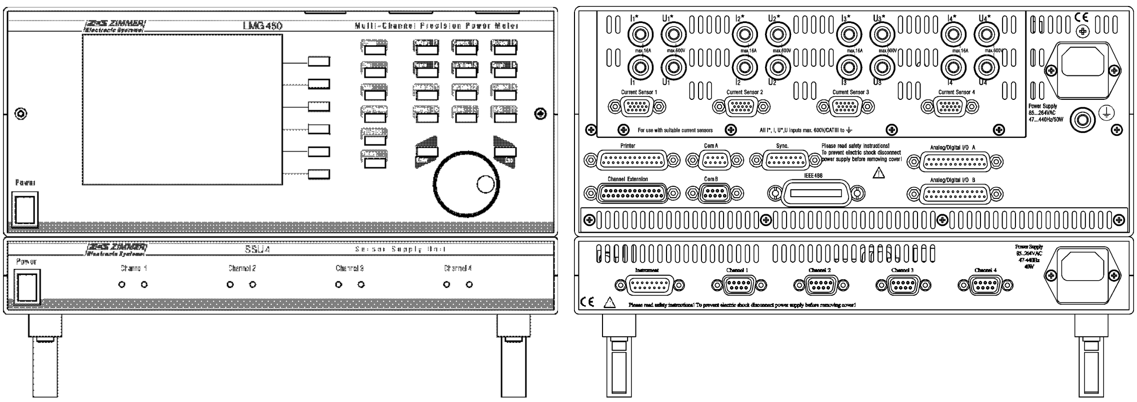


Figure 73: SSU4 mounted under LMG450

Dimensions W*D*H	320mm * 306.7mm * 224.6mm with feets, 176.9 without feets

6.2.5 SSU4 connector cables

6.2.5.1 Cable to connect measuring signal plugs of SSU4 with LMG310 current inputs (SSU4-K-L31)

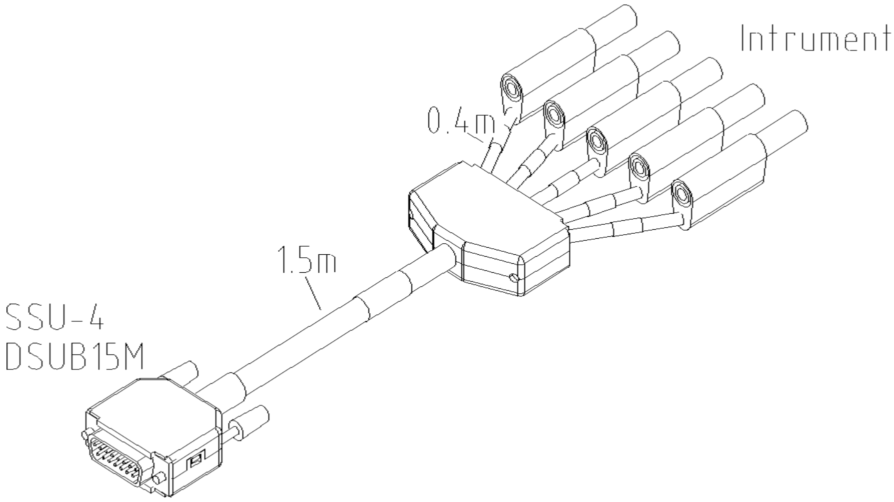


Figure 74: SSU4-K-L31, to connect measuring signal plug of SSU4 to LMG310 current inputs.

Cable to connect up to four PSU600 to the current input channels of:

1 LMG310
1 LMG310 and 1 LMG95
1 LMG450 (but better using PSU600-K-L45)
2 LMG310 in Aron wiring
or any other amperemeter

6.2.5.2 Connection cable PSU600 to SSU4 (PSU600-K3, K5, K10)

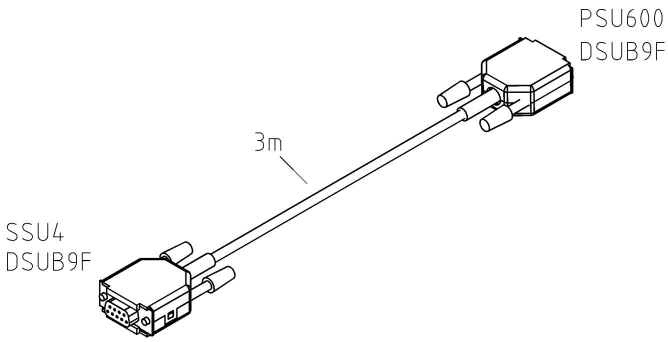


Figure 75: PSU600-K3, to connect the PSU600 to the SSU4 (length 3m).

Connection cable from SSU4 to PSU600; length 3m, 5m or 10m.

6.2.6 Modification option of SSU4 available for the use of PSU200, PSU400 and PSU700 together with SSU4-K-L31

The modification is needed only for the use of PSU200, PSU400 or PSU700 with SSU4-K-L31, no modification is necessary for PSU200-K-L45.

The following changes concerning this documentation are done:

1. In the four connector to the sensors: **pin1** is connected with **gnd** for current return

2. The current output signal of the sensor is connected via a **0 ohms** resistor to the corresponding channel of the 15 pin connector for the instrument. When the current returns from the instrument it is fed into ground.

3. The SSU4 with modification can **not** be used with **PSU600!**

6.2.7 Modification option of SSU4 available for the use of PSU1000HF together with LMG450 and LMG500

6.3 Artificial mid point for multi phase power meters (LMG-AMP)

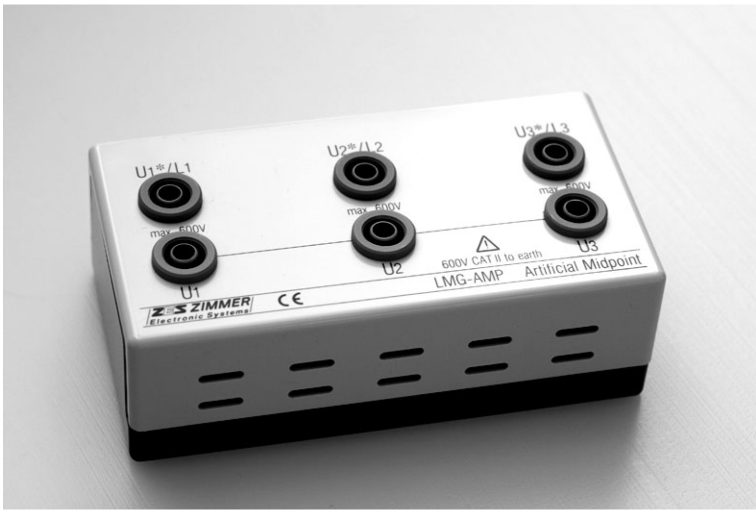


Figure 76: Artificial mid point (LMG-AMP)

6.3.1 General

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.

6.3.2 Connection to the LMG

The LMG-AMP is connected to the LMG using the six added cables. Connect each channel U with U and U* with U*. At the U* jack (at LMG-AMP or at LMG) you can connect your voltage. This is usually accessable at the I or I* jacks.
The three grey sockets U1, U2 and U3 (they represent the artificial mid point) are interconnected!

6.3.3 Specifications

Umax line-to-line	850V
Umax against earth	600V
Rtyp.	66.57kohms
Accuracy of the phase resistors in relation to each other	+-0.01%
Weight	220g
Dimensions:	120mm x 52mm x 65mm

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

Figure 77: Adaptor for Schuko devices (LMG-MAS)

6.4.1 General

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 LMG90 and LMG95, but you can also connect other instruments like LMG310, LMG450 and LMG500.

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.

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.

Attention!
The PE jack should not be used for earthing external devices. It is only allowed to use it for measuring purposes.

The load is measured with correct currents. If measuring a generator the voltage is correct.

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

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

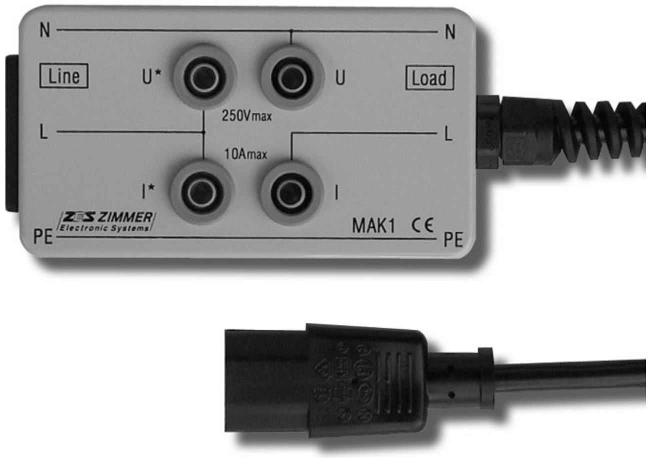


Figure 78: Adaptor for IEC connector devices (LMG-MAK1)

6.5.1 General

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 LMG90 and LMG95, but you can also connect other instruments like LMG310, LMG450 or LMG500.

The supply is done by a IEC inlet cord which must be connected to the MAK1. The load is connected by the fixed mounted cord.

With the MAK1 you can measure the voltage (jacks U and U*). The current is also accessable (from I* to I). This jacks have to be connected to the jacks of the measuring instrument.

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!

The load is measured with correct currents. If measuring a generator the voltage is correct.

An important point is the safety. The MAK1 is in compliance with IEC61010-1 and was constructed for voltages up to 300V CAT III.

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

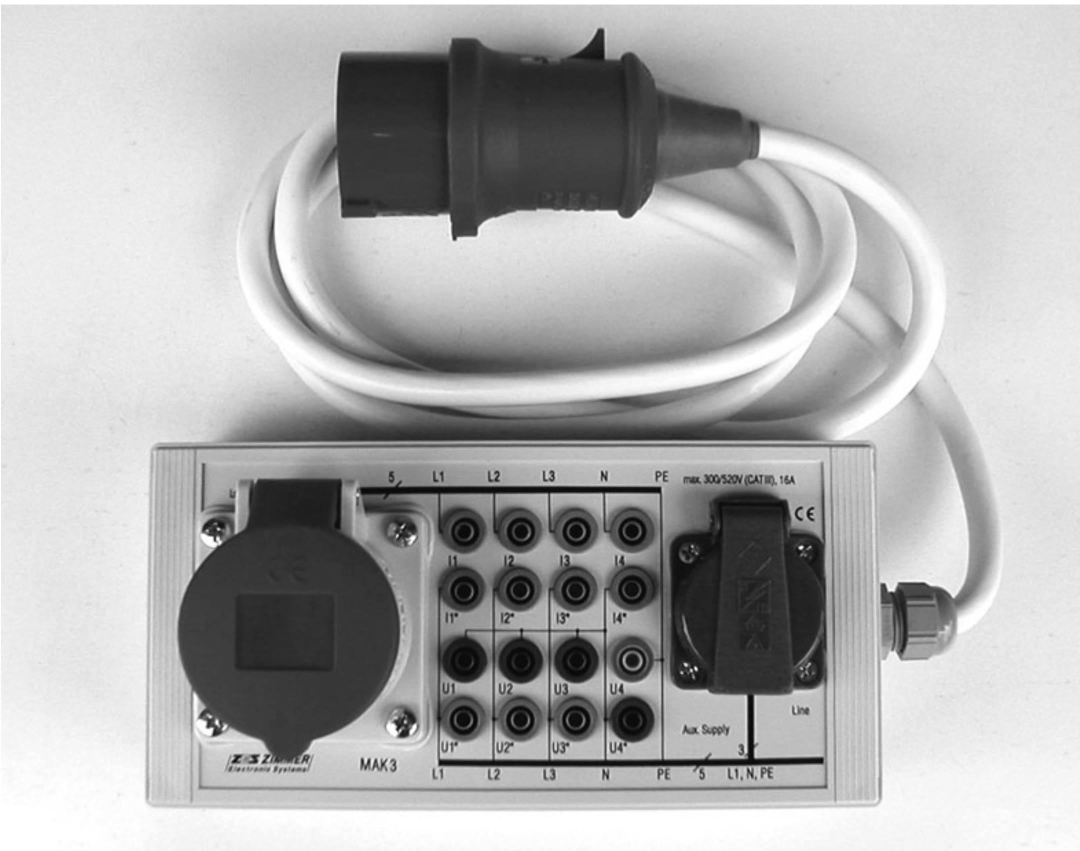


Figure 79: Adaptor for 16A/3phase devices (LMG-MAK3)

6.6.1 ⚠ Safety warning!

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 I_x* and I_x have to be short circuit to enable the current to flow!

6.6.2 General

The MAK3 is an adaptor for measuring at 3 phase systems up to 16A per phase. It was developed for the instrument series LMG310, LMG450 and LMG500, 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 befor 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 U_1*, U_2* and U_3*) against the neutral connector (U_1, U_2 and U_3). But you can also measure the linked voltages. The three currents are also accessable (from I_1*, I_2* and I_3* to I_1, I_2 and I_3). Further on by using a 4-channel instrument you can measure the voltage between neutral and earth (U_4* against U_4) as well as the current in the neutral (I_4* to I_4).

Important!
If you dont want to measure the current in a wire, the jacks I_x* and I_x have to be short circuit to enable the current to flow!

The load is connected to the CEE jack. The load is measured with correct currents. If measuring a generator the voltage is correct.

An important point is the safety. The MAK3 is in compliance with IEC61010-1 and was constructed for voltages up to 300/520V CAT III.

6.7 Safety Grip for current and voltage connection (LMG-Z301/302/305)

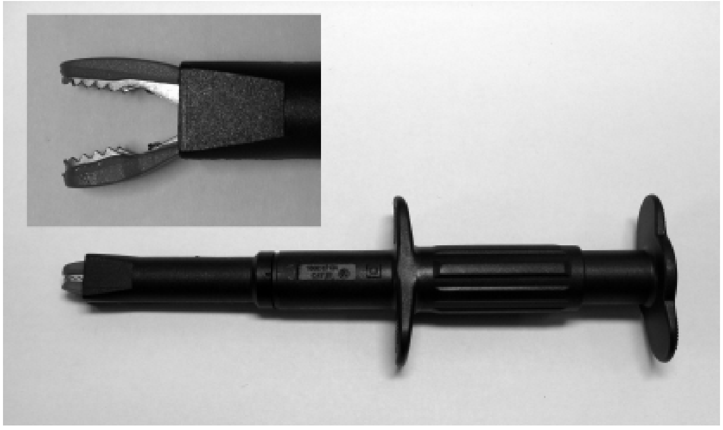


Figure 80: Safety claw grip, type C, 16A/1000V (LMG-Z301)

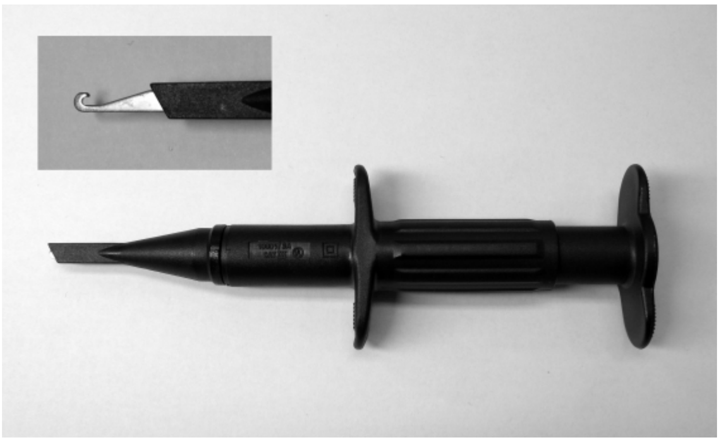


Figure 81: Safety clamp grip, type A, 1A/1000V (LMG-Z302)

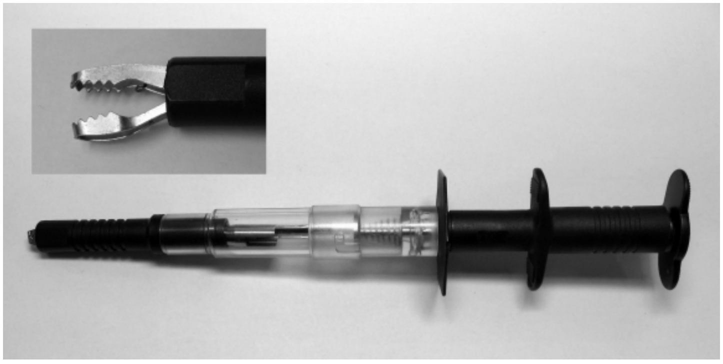


Figure 82: Safety claw grip, type D, 16A/500V, power fuse 100kA switch capability (LMG-Z305)

6.8 DSUB25 Adapter for LMG process signal interfaces (L5-IOBOX-S/-F)

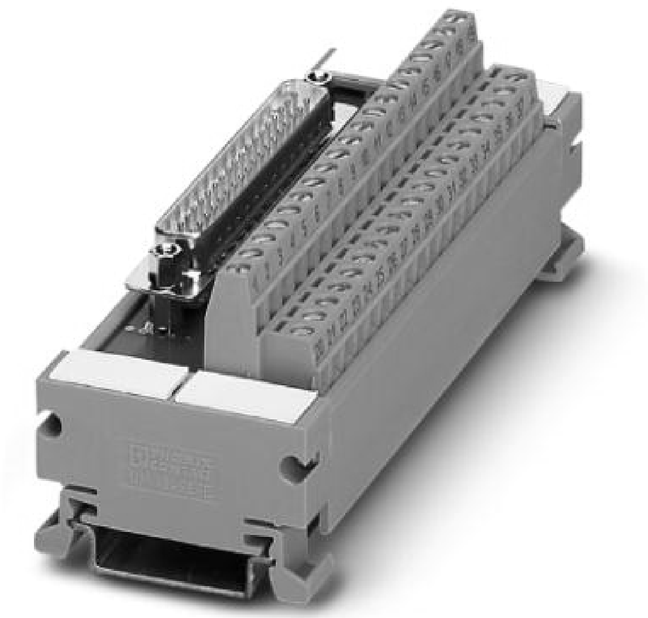


Figure 83: Adapter from DSUB25 to screw cage connection (L5-IOBOX-S)

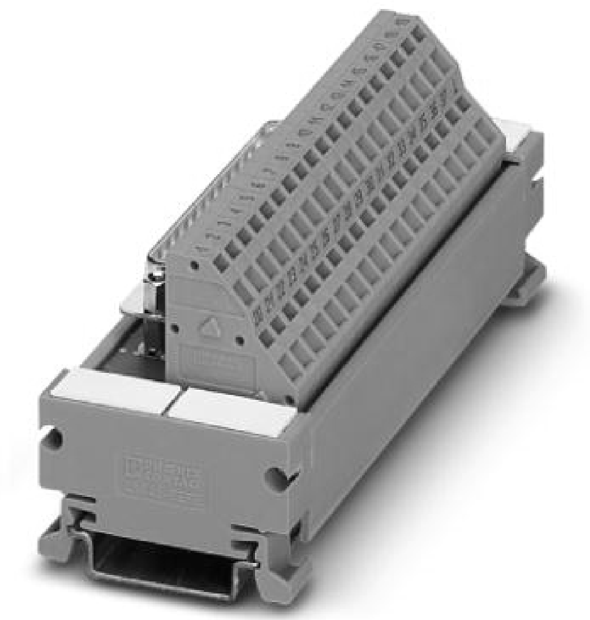


Figure 84: Adapter from DSUB25 to spring cage connection (L5-IOBOX-F)

6.9 Adapter for incremental rotation speed encoders (L45-Z18)

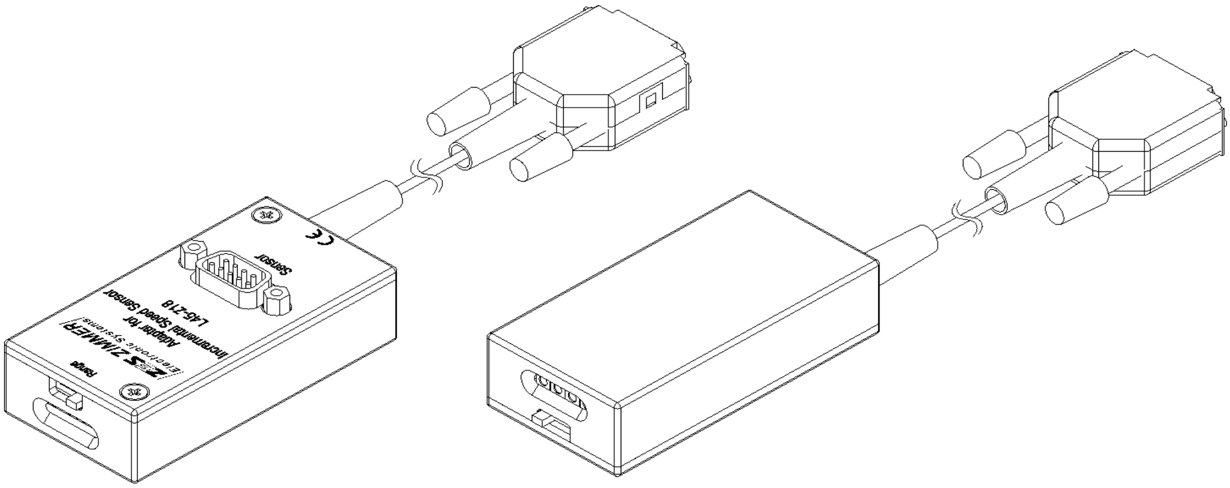


Figure 85:L45-Z18

6.9.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

6.9.2 General

This plugon adapter for LMG450 converts pulses of common industrial incremental encoders with two 90 degree phase shifted pulse outputs into analogue voltage. This voltage can be analysed graphically with high temporal resolution by using sensor input of LMG450.

Compared to this, digital encoder input of process signal interface provides only one value each measuring cycle and with L45-Z18 you get a fast, high dynamic response to changes in rotation speed!

6.9.3 Description

Incremental encoders (speed sensors) with TTL technology (supply +5V and GND) or HTL technology (supply +5V and –5V) can be connected. There are four colour coded measuring ranges of the adapter to align with different pulse rates Z of the incremental encoder and maximum revolutions per minute Nmax.

Attention! Read measuring value Idc, only this presents exact speed values according to absolute value and sign (depending on sense of rotation)! Positive output voltage is seen in case A signal leads electrically by 90° to B signal. This equates usually to clockwise rotation when looking onto the encoder shaft.

6.9.4 Ripple

As a matter of principle of frequency to voltage conversion there is a ripple at low revolution on output voltage. Built-in filters are optimised for short settling time without overshooting. In case that remaining ripple is too high, this can be reduced with the settings of LMG, for example:

- Select adjustable lowpass filter in measuring channel
- Extend the measuring cycle time
- Average over a couple of measurement cycles

Selection of the filter is always a compromise of fast reaction on variation of input signal and reduction of ripple on output signal. The user can find optimal setting weighing these antithetic approaches.

6.9.5 Incremental encoders with two 90 degree phase shifted pulse outputs

Measuring range	**LED Colour**	**Red**	**Yellow**	**Green**	**Blue**
Position of the slide switch adjacent of the LEDs	Unit	Left most	Left	Right	Right most
Z*Nmax (Pulse rate * max. revolution speed)	1 / min	144000	576000	2304000	9216000
Specified tolerance	% of m.value + % of m.range	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)
Max. pulse input frequency using input A and B	Hz	2400	9600	38400	153600
Formula for "Scale"	1 / min	1152000 / Z	1152000 / Z	1152000 / Z	1152000 / Z

“Z” is the number of pulses per rotation of the used incremental encoder (speed sensor)

6.9.6 Incremental encoders with single pulse outputs

Measuring range	LED Colour	Red	Yellow	Green	Blue
Position of the slide switch adjacent of the LEDs	Unit	Left most	Left	Right	Right most
Z*Nmax (Pulse rate * max. revolution speed)	1 / min	288000	1152000	4608000	9216000
Specified tolerance	% of m.value + % of m.range	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)
Max. pulse input frequency using input A	Hz	4800	19200	76800	153600
Formula for "Scale"	1 / min	2304000 / Z	2304000 / Z	2304000 / Z	1152000 / Z

“Z” is the number of pulses per rotation of the used incremental encoder (speed sensor)

The recognition of the rotating direction is not possible.
The output voltage is always negative if input B is left open.
The output voltage is always positive if input B is tied to pin ‘supply +5V’

6.9.7 Scaling

In range menu of LMG450 you can set the calculated scale value of the last line from above mentioned chart, depending on the pulse rate Z per rotation of the used incremental encoder. Then the revolution will be presented correctly in value 1/min on the display. The unit will however be A (or V)! Displayed 1.465kA means 1465 1/min. For further user-friendly presentation utilise capabilities of LMG450 built-in formula editor and user defined menu.

6.9.8 Pin assignment

9 pin D-Sub connector (male) to incremental encoder

Pin No.	1	2	3	4	5	6	7	8	9	Screen
Function	Supply +5V	Supply -5V	GND (on screen)	Input A	Input B	No connection (internal test pins)				Screen (on GND)

6.9.9 Pulse input A and B

Permissible input voltage:	Ulowmin = -30V at -1.4mA, Ulowmax=+0.8V at 0.001mA Uhighmin=+2V at 0.002mA, Uhighmax=+30V at 1.2mA
Input resistance:	1Mohms at 0V<Uin<+5V 22kohms at -30V<Uin<+30V

6.9.10 Encoder supply

Voltage:	+–5V, +–10%
Load:	max. +–100mA

6.9.11 Connection of the sensor with LMG90/310/95

not possible

6.9.12 Connection of the sensor with LMG450

Plug-and-use solution like current sensors. Use current channel.

6.9.13 Connection of the sensor with LMG500

not possible, use L50-Z18

6.10 Adapter for incremental rotation speed encoders (L50-Z18)

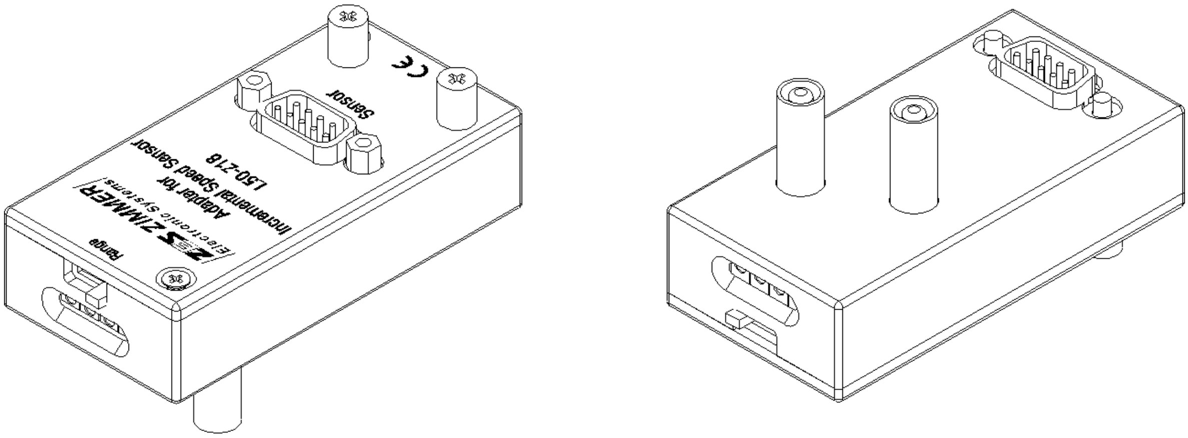


Figure 86:L50-Z18

6.10.1 ⚠ Safety warning!

Always connect the sensor first to the meter, and afterwards to the device under test. Connecting cable without savety isolation! Avoid contact to hazardous voltage!

6.10.2 General

This plugon adapter for LMG500 converts pulses of common industrial incremental encoders with two 90 degree phase shifted pulse outputs into analogue voltage. This voltage can be analysed graphically with high temporal resolution by using sensor input of LMG500.

Compared to this, digital encoder input of process signal interface provides only one value each measuring cycle and with L50-Z18 you get a fast, high dynamic response to changes in rotation speed!

6.10.3 Description

Incremental encoders (speed sensors) with TTL technology (supply +5V and GND) or HTL technology (supply +5V and –5V) can be connected. There are four colour coded measuring ranges of the adapter to align with different pulse rates Z of the incremental encoder and maximum revolutions per minute Nmax.

Attention! Read measuring value Idc, only this presents exact speed values according to absolute value and sign (depending on sense of rotation)! Positive output voltage is seen in case A signal leads electrically by 90° to B signal. This equates usually to clockwise rotation when looking onto the encoder shaft.

6.10.4 Ripple

As a matter of principle of frequency to voltage conversion there is a ripple at low revolution on output voltage. Built-in filters are optimised for short settling time without overshooting. In case that remaining ripple is too high, this can be reduced with the settings of LMG, for example:

- Select adjustable lowpass filter in measuring channel
- Extend the measuring cycle time
- Average over a couple of measurement cycles

Selection of the filter is always a compromise of fast reaction on variation of input signal and reduction of ripple on output signal. The user can find optimal setting weighing these antithetic approaches.

6.10.5 Incremental encoders with two 90 degree phase shifted pulse outputs

Measuring range	**LED Colour**	**Red**	**Yellow**	**Green**	**Blue**
Position of the slide switch adjacent of the LEDs	Unit	Left most	Left	Right	Right most
Z*Nmax (Pulse rate * max. revolution speed)	1 / min	144000	576000	2304000	9216000
Specified tolerance	% of m.value + % of m.range	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)
Max. pulse input frequency using input A and B	Hz	2400	9600	38400	153600
Formula for "Scale"	1 / min	1152000 / Z	1152000 / Z	1152000 / Z	1152000 / Z

“Z” is the number of pulses per rotation of the used incremental encoder (speed sensor)

6.10.6 Incremental encoders with single pulse outputs

Measuring range	LED Colour	Red	Yellow	Green	Blue
Position of the slide switch adjacent of the LEDs	Unit	Left most	Left	Right	Right most
Z*Nmax (Pulse rate * max. revolution speed)	1 / min	288000	1152000	4608000	9216000
Specified tolerance	% of m.value + % of m.range	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)	+-(0.1+0.1)
Max. pulse input frequency using input A	Hz	4800	19200	76800	153600
Formula for "Scale"	1 / min	2304000 / Z	2304000 / Z	2304000 / Z	1152000 / Z

“Z” is the number of pulses per rotation of the used incremental encoder (speed sensor)

The recognition of the rotating direction is not possible.
The output voltage is always negative if input B is left open.
The output voltage is always positive if input B is tied to pin ‘supply +5V’

6.10.7 Scaling

In range menu of LMG500 you can set the calculated scale value of the last line from above mentioned chart, depending on the pulse rate Z per rotation of the used incremental encoder. Then the revolution will be presented correctly in value 1/min on the display. The unit will however be A (or V)! Displayed 1.465kA means 1465 1/min. For further user-friendly presentation utilise capabilities of LMG500 built-in formula editor and user defined menu.

6.10.8 Pin assignment

9 pin D-Sub connector (male) to incremental encoder

Pin No.	1	2	3	4	5	6	7	8	9	Screen
Function	Supply +5V	Supply -5V	GND (on screen)	Input A	Input B	No connection (internal test pins)				Screen (on GND)

6.10.9 Pulse input A and B

Permissible input voltage:	Ulowmin = -30V at -1.4mA, Ulowmax=+0.8V at 0.001mA Uhighmin=+2V at 0.002mA, Uhighmax=+30V at 1.2mA
Input resistance:	1Mohms at 0V<Uin<+5V 22kohms at -30V<Uin<+30V

6.10.10 Encoder supply

Voltage:	+–5V, +–10%
Load:	max. +–100mA

6.10.11 Connection of the sensor with LMG90/310/95

not possible

6.10.12 Connection of the sensor with LMG450

not possible, use L45-Z18

6.10.13 Connection of the sensor with LMG500

Plug-and-use solution like current sensors. Use current channel.

6.11 Synchronisation adapter with adjustable lowpass filter (L50-Z19)

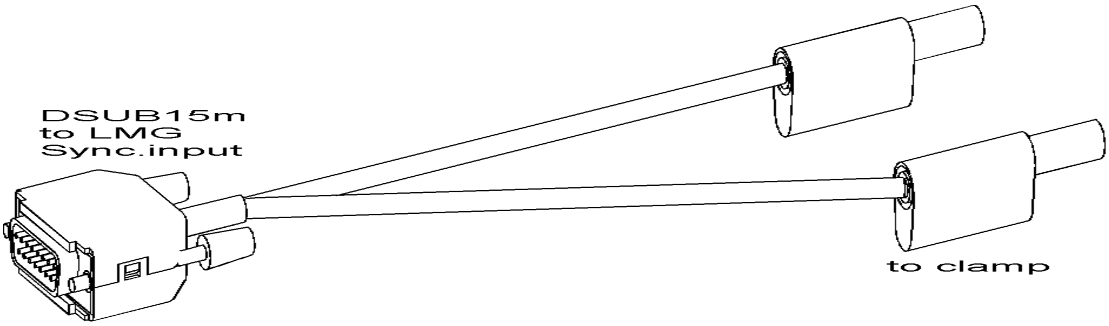


Figure 87:L50-Z19

6.11.1 ⚠ Safety warning!

1.) first connect the clamp to L50-Z19

2.) connect L50-Z19 to LMG500 Sync.input and switch the power meter on

3.) then connect the clamp to the device under test.

Synchronisation adapter without safety isolation! Only for current clamps with galvanic isolation! NO DIRECT CONNECTION TO ANY EXTERNAL VOLTAGES!!

L50-Z19 is an accessory for the precision power meter LMG500. It can be used with any xxA:1A current clamp, e.g. LMG-Z325, LMG-Z326, LMG-Z322 or LMG-Z329. A burden resistor, a high sensitivity amplifier and a 8th order Butterworth lowpass filter are included in the DSUB15 plug to assure stable synchronisation to any disturbed signal.

It simplifies the synchronisation to the fundamental current frequency of a frequency inverter output. It needs about 100uA fundamental current at the signal input. That means with a 1000A:1A current clamp it is possible to detect the fundamental in a wide current range from 100mA to 1000A. If the fundamental current is lower than 100mA, several load current windings in the clamp can be used to enlarge the sensitivity or use an other clamp with 100A:1A ratio. LMG500 settings in the measure menue: set ‘Sync’ to ‘ExClmp’ and adjust the lowpass corner frequency.

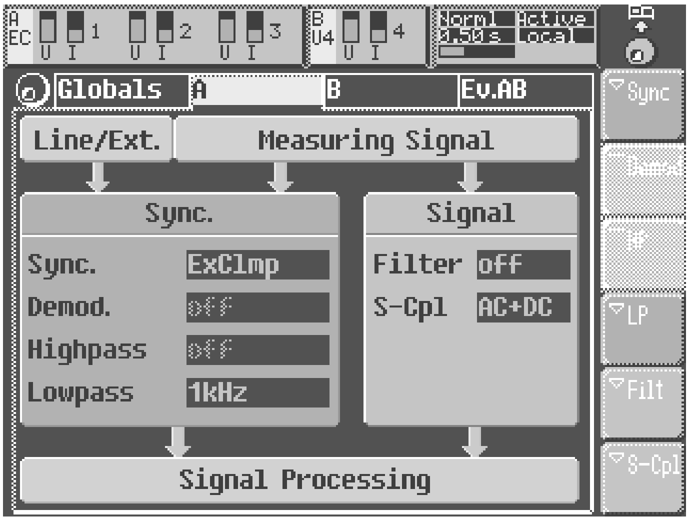


Figure 88:L50-Z19

Select a filter with a lowpass frequency bigger than every possible fundamental frequency and(!) lower than every possible switching frequency, under all conditions of starting, breaking and acceleration of the motor.

6.11.2 Specifications

filter name	200Hz	500Hz	1kHz	2kHz	5kHz	10kHz	20kHz
-3dB corner frequency	312.5Hz	625Hz	1.25kHz	2.5kHz	5kHz	10kHz	20kHz
filter type	8th order Butterworth						
min. current for stable synchronisation	about 100uA						
max. current	1Atrms						
isolation	NO ISOLATION! (see safety warning)						
connection length	about 50cm (but can be extended with usual savety laboratory leads)						

6.11.3 Connection of the sensor with LMG90/310/95/450

not possible

7 Voltage sensors

7.1 Precision high voltage divider (HST3/6/9/12)

Figure 89: precision high voltage divider HST12-3

7.1.1 ⚠ Safety warning!

The normal use of the HST3/ 6/ 9/ 12 series needs a connection to high voltages. To fulfill the safety requirements it is under all conditions **absolutely necessary to earth the case** of the HST3/ 6/ 9/ 12 **to obtain safety** and functionality! Use sufficient cross section of the earthing conductor!

7.1.2 General

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

The HST 3 (resp. HST6/9/12) divides DC, AC or any distorted voltages with very high accuracy by the factor 1000 (resp. 2000/3000/4000). The divided voltage is available at the buffered low impedance BNC output. To avoid noise interference it is recommended to use shielded cables to the measuring input of the LMG.

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

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

Typical application fields for the 3-channel HSTx-3 are frequency inverter fed medium voltage drives and power quality analysis at the distribution network.

7.1.3 Specifications

Series	**HST3**			**HST6**			**HST9**			**HST12**		
ordering type	HST 3-1	HST 3-2	HST 3-3	HST 6-1	HST 6-2	HST 6-3	HST 9-1	HST 9-2	HST 9-3	HST 12-1	HST 12-2	HST 12-3
no. of channels	1	2	3	1	2	3	1	2	3	1	2	3
maximum trms input value	4.2kV			8.4kV			12.6kV			16.8kV		
maximum peak value for full scale	5kV			10kV			15kV			20kV		
maximum sine trms value for full scale	3.5kV			7kV			10.5kV			14kV		
input impedance	10MOhms||50pF			20MOhms||25pF			30MOhms||22pF			40MOhms||20pF		
dividing ratio	1/1000			1/2000			1/3000			1/4000		
tolerance of ratio	max. +-0.1% (DC ... 45Hz) max. +- 0.05% (45Hz ... 65Hz) max. +-0.1% (65Hz ... 2.5kHz) max. +-0.2% (2.5kHz ... 10kHz) max. +- 0.3% (10kHz ... 100kHz) typ. +- 2% (300kHz; max. 100pF)											
influence on active power	max. +- 0.08% (45Hz ... 65Hz; PF>0.8) max. +- 0.5% (DC ... 100kHz; PF>0.8)											

measurement	typ. +- 3% (300kHz; Burden <100pF; PF>0.8)	
measurement input	one fixed high voltage lead (length 2m) for each channel, earth jack as the common reference point	
signal output	one BNC socket for each channel	
output burden	min. 1kohms; max. 1nF	
safety class	class I; **Device must be earthed additional to mains supply!**	
enclosure	robust aluminium case	
protection class	IP54	
temperature range	0..50°C	
size (L x W x H) in mm	330 x 230 x 110	400 x 230 x 110
installation dimension (L x W x H) in mm	490 x 230 x 110	590 x 230 x 110
weight	approx. 6.1kg	approx. 7.2kg
supply	85..265V; 45..65Hz; ca. 20VA	

7.1.4 Overvoltage capabilities of high voltage input against earthed case

For serial numbers starting with ‘E...’:

Series	**HST3**	**HST6**	**HST9**	**HST12**
maximum DC or 50/60Hz trms working voltage	4.2kV	8.4kV	12.6kV	16.8kV
maximum periodic peak working voltage	6kV	12kV	18kV	24kV
maximum transient overvoltage	9.2kV	14.2kV	18kV	21.3kV
Non repetitive maximum peak voltage	15.2kV	26.2kV	36kV	45.3kV

Note: The working and transient voltages are calculated in accordance to EN61010:2001, valid for max. altitude 2000m over sea level.

7.1.5 Measurement principle HST

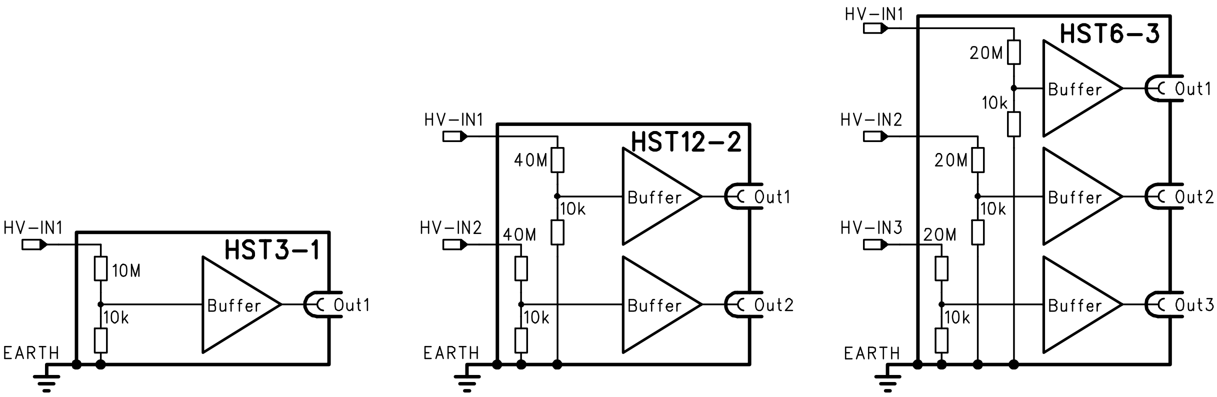


Figure 90: principle structure of different HST types

7.1.6 Example wirings

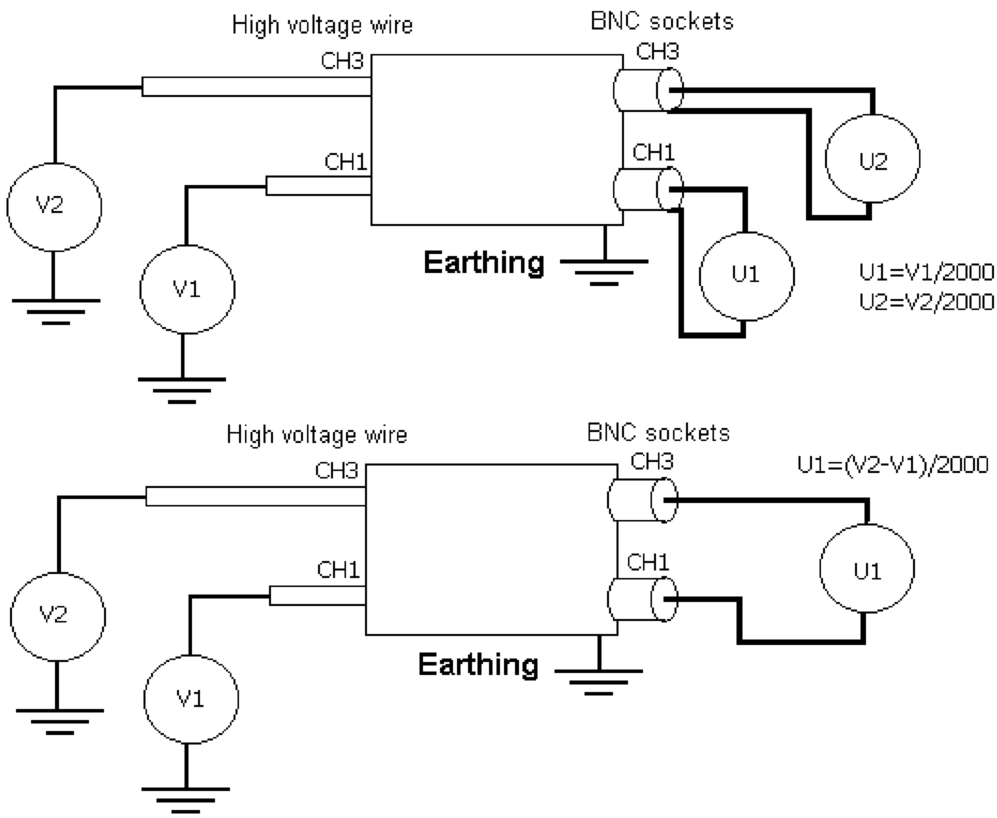


Figure 91: example wirings HST6-2

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

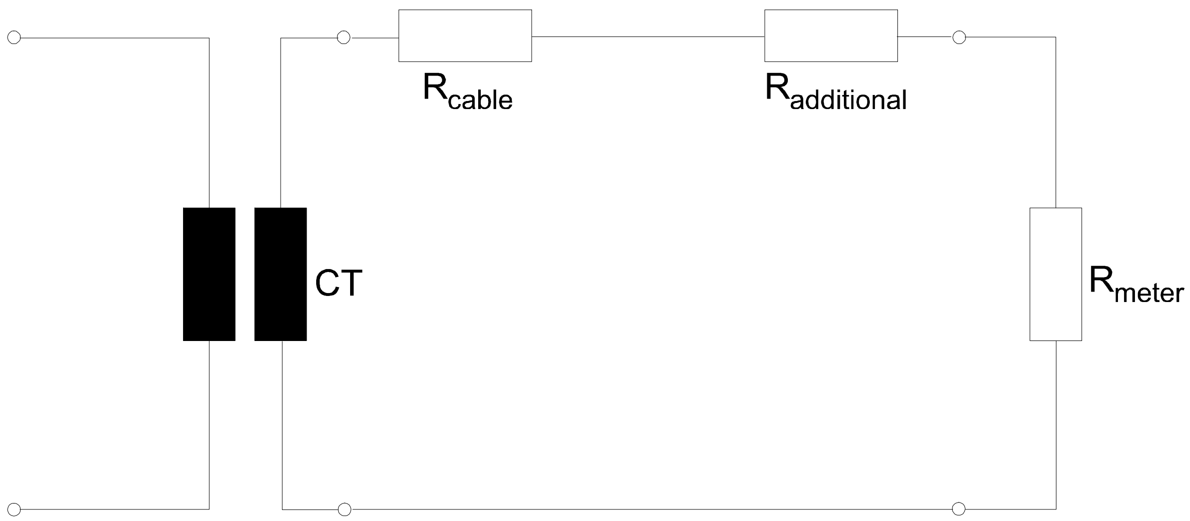
8 FAQ - frequently asked questions / Knowledge base

8.1 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 given as ohmic resistor or as an apparent power value. Here an example how you can convert the two values:

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

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 reached. Because of the very low consumption of the elektronic meter inputs the rated operation burden is mostly not reached and an additional operation resistor has to be fitted. This resistor can also be built up from a correctly dimensioned connection cabel from the sensor to the meter.



R_{cable}	ohmic value of the cable
$R_{additional}$	additional ohmic resistor (may be cable)
R_{meter}	ohmic value of the meter input
CT	current sensor

8.1.1 Example

Sensor	**Cable**	**Meter**
100A/5A rated burden:R_{rate} = 2.5VA operation burden: 50% of 2.5VA	l = 2m (total length) $\rho = 0.0175 \frac{\Omega\,mm^2}{m}$ $A = 1.5mm^2$	Burden: $R_{meter} = \frac{2.5VA}{I^2}$

8.1.2 For the CT

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

$\Rightarrow R_{operation} = 50m\Omega$

Burden of the meter: $R_{meter} = \frac{S}{I^2} = \frac{0.2VA}{(5A)^2} = 8m\Omega$

Ohmic value of the cable: $R_{cable} = \frac{\rho \cdot l}{A} = \frac{0.0175\Omega \cdot mm^2 \cdot 2m}{m \cdot 1.5mm^2} = 23.3m\Omega$

Now the additional resistor can be calculated to:
$R_{additional} = R_{operation} - R_{cable} - R_{meter}$ = 50mΩ-23.3mΩ-8mΩ=18.7mΩ

If you want to use a longer cable to built up this additional resistor the length is calculated:

$$l = \frac{R_{cable} \cdot A}{\rho} = \frac{(R_{operation} - R_{meter}) \cdot A}{\rho} = \frac{(50m\Omega - 8m\Omega) \cdot m \cdot 1.5mm^2}{0.0175\Omega \cdot mm^2} = 3.6m$$

(Please note the maximum current loading capability of the cable!)

8.2 Example of an error calculation

The calculations illustrate how to calculate the errors of U, I or P when using an external sensor. The following parameters of the measurement are given:

The measurement is made with a LMG95, the accuracies of the channels are in ±(% of measuring value + % of measuring range):

Frequency/Hz	45 to 65
Voltage	0.01+0.02
Current	0.01+0.02
Active Power	0.015+0.02

The clamp with which is measured is the LMG-Z322 with an accuracy of:

Current	Amplitude error	Phase error
10A to 200A	1.5%	2°
200A to 1000A	0.75%	0.75°
1000A to 1200A	0.5%	0.5°

Ratio of 1000:1.

At the I channel we are using a scaling of 1000 to get the correct currents at the display. In the following examples all values are calculated for the primary side, what means on measured signal level. The readings are:

U_{trms}: 230.000V, range 250V ⇒ range peak value 400V
I_{trms}: 100.000A primary ⇒ 0.1A secondary; range 150mA ⇒ range peak value 469mA
calculated back to the primary side: range 150A ⇒ range peak value 469A
f: 50Hz
φ: 45°
P: 16.2635kW, range 37.5kW ⇒ range peak value 187.6kW
AC coupling mode for the signal is selected (what means you have no errors because of the DC offset of the signal).

From the table above the following errors of the LMG95 itself for voltage and current can be determined (using the peak values of the respective measuring range):

$$\Delta U = \pm(0.01\%\ of\ \ Rdg. + 0.02\%\ of\ \ Rng.) = \pm(0.023V + 0.08V) = \pm 0.103V$$

$$\Delta I_{LMG95} = \pm(0.01\%\ of\ \ Rdg.+0.02\%\ of\ \ Rng.) = \pm(0.01A + 0.0938A) = \pm 0.1038A$$

$$\Delta P_{LMG95} = \pm(0.015\%\ of\ \ Rdg.+0.02\%\ of\ \ Rng.) = \pm(0.00244kW + 0.03752kW) = \pm 0.03996kW$$

Additional to these three errors there is the error caused by the current clamp. First the amplitude error which will be added to the ΔI_{LMG95}:

$$\Delta I_{clamp} = \pm(1.5\%\ \text{of rdg.}) = \pm 1.5A$$

So you get a total current error of:

$$\Delta I_{total} = \Delta I_{LMG95} + \Delta I_{clamp} = \pm 1.6038A$$

The second error which is caused by the clamp is the error of the additional phase shift of 2°. This error will influence the active power. In this example the power can be calculated as:

$$P = U * I * \cos\varphi$$

So the total differential gives you the error:

$$\Delta P_{clamp} = \left|\frac{\partial P}{\partial U} * \Delta U\right| + \left|\frac{\partial P}{\partial I} * \Delta I_{total}\right| + \left|\frac{\partial P}{\partial \varphi} * \Delta\varphi\right|$$

you get:

$$\Delta P_{clamp} = \left|I * \cos\varphi * \Delta U\right| + \left|U * \cos\varphi * \Delta I_{total}\right| + \left|-U * I * \sin\varphi * \Delta\varphi\right|$$

At this point only the errors of the clamp are used, the errors of the LMG are already calculated:

$\Delta U = 0!$

$\Delta I = \Delta I_{clamp}$

$\Delta\varphi = 2°$: $\frac{2° * 2\pi}{360°} = 0.035\,\text{rad}.$

For the angles you have to use the radient: $45° = \frac{\pi}{4}\text{rad}$

$$\Delta P_{clamp} = \left|100A * \cos\frac{\pi}{4} * 0.0V\right| + \left|230V * \cos\frac{\pi}{4} * 1.5\text{A}\right| + \left|\text{- }230\text{V} * 100\text{A} * \sin\frac{\pi}{4} * 0.035\right|$$
$$= \left|0.0W\right| + \left|243.95W\right| + \left|-569.22W\right| = 813.17\text{W}$$

At this point the error values caused by the clamp should be marked:
The amplitude error of the clamp 243.95W and the phase shift causes 569.22W, what means 813.17W error are caused by the clamp.

The total error of the active power is:

$$\Delta P_{total} = \Delta P_{LMG95} + \Delta P_{clamp} = \pm(0.03996kW + 0.81317kW) = 0.85313kW$$

The relative error of the active power is:

$$\Delta P_{relative} = \frac{\Delta P_{total}}{P} = 0.0525 \mathrel{\hat{=}} 5.25\%$$

8.2.1 Improving the accuracy

If you use a current clamp like in this example with a nominal current of 1000A and your current is only 10% what means 100A a simple trick to increase the accuracy is to wind the conductor several times through the clamp. In the example the accuracy of the clamp changes with three windings to 0.75%, because of the primary current of 300A, the phase shift is 0.75°. The next example of calculation is done for three windigs:

U_{trms}: 230.000V, range 250V ⇒ range peak value 400V

I_{trms}: Scaling $\frac{1000}{3} = 333.333$, what means all current values are divided by 3, <u>even the errors</u>! The ratio of the clamp stays at 1000:1!

Values: 300.000A primary ⇒ 0.3A secondary; range 300mA ⇒ range peak value 0.938A calculated back to the primary side: range 100A ⇒ range peak value 312.7A

f: 50Hz
φ: 45°
P: 16.2635kW, range 25kW ⇒ range peak value 125.080kW

$$\Delta U = \pm(0.01\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.023V + 0.08V) = \pm 0.103V$$

$$\Delta I_{LMG95} = \pm(0.01\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.01A + 0.06254A) = \pm 0.07254A$$

$$\Delta P_{LMG95} = \pm(0.015\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.00244kW + 0.02502kW) = \pm 0.027456kW$$

$\Delta I_{clamp} = \pm(0.75\%\ \text{of primary current} = \text{in this case the "reading"}) = \pm 2.25A$, now with the scaling this error is divided by 3 as well, what means:

$$\Delta I_{clamp} = \pm(0.75\%\ of\ Rdg.) = \pm 0.75A$$

$$\Delta I_{total} = \Delta I_{LMG95} + \Delta I_{clamp} = \pm 0.82254A$$

Again the total differential has to be used, but now with the following values:

$\Delta U=0$!

$\Delta I=\Delta I_{clamp}$

$\Delta\varphi = 0.75°$: $\frac{0.75° * 2\pi}{360°} = 0.013\,\text{rad}$.

With this the error of the clamp of the active power is:

$$\Delta P_{clamp} = \left|100A * \cos\frac{\pi}{4} * 0.0V\right| + \left|230V * \cos\frac{\pi}{4} * 0.75\text{A}\right| + \left|\text{- }230\text{V} * 100\text{A} * \sin\frac{\pi}{4} * 0.013\right|$$
$$= 333.40\text{W}$$

$$\Delta P_{total} = \Delta P_{LMG95} + \Delta P_{clamp} = \pm(0.027456kW + 0.33340kW) = 0.360856kW$$

The relative error of the active power is:

$$\Delta P_{relative} = \frac{\Delta P_{total}}{P} = 0.0222 \mathrel{\hat{=}} 2.22\%$$

With this simple trick the error of the current amplitude could be reduced by 51.2%. The error of the active power even by 42.3%.

8.3 Phase correction of current transducers with LMG500

Current sensors, low frequency types for 50Hz as well as high frequency types, insert a delay in the current measurement path. This behavior is also called ‘phase error’ and means an additional error term in the power measurement. At high frequency applications and also even low frequency applications at very low power factor, this phase error may destroy the complete measurement! Even a few hundred nanoseconds add a significant power error in case of low power factor.

A great feature of the LMG500 is the capability to correct the delay time of current and voltage sensors with the time resolution of nanoseconds. To do this adjustment, it is very important to find a reasonable signal and reference! The signal source can be either a calibrator with voltage and current output and adjustable frequency and phaseshift or the application itself. Sometimes the application can be operated in a working point with a current low enough to be measured direct as well as via current sensor. The big advantage of the phase adjust in the application itself is that its made with the identical frequency (or: frequency mix!) as later in the measurement environment and the phase error of a current transducer is usually dependent from the signal frequency.

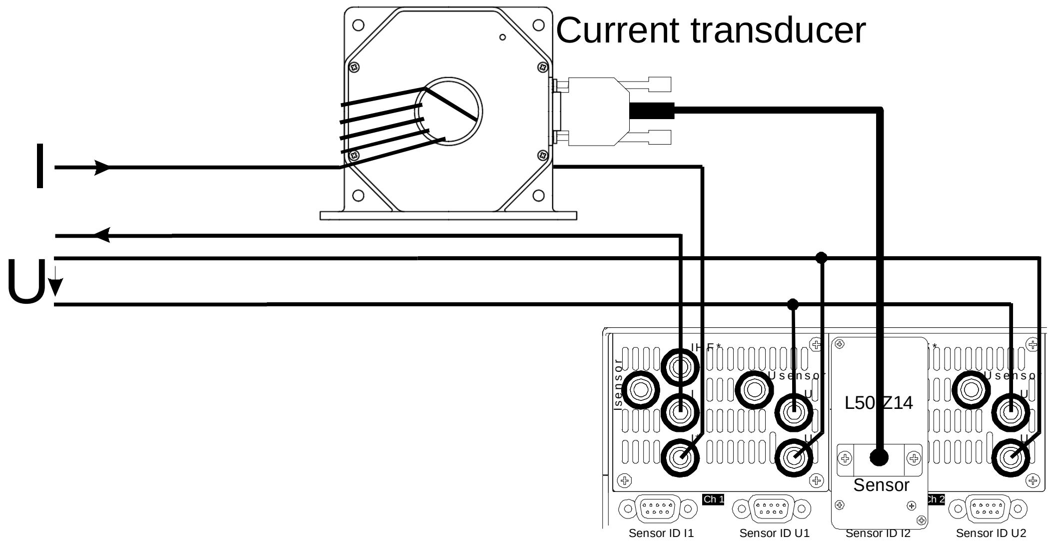


Figure 92: wiring for current transducer phase correction

Use a few windings through the current transducer and measure the same current with a different power channel and direct current input. Connect the voltage to both power channels in parallel. Don’t forget to set the current scaling factor to compare the active power.

Best sensitivity can be achieved with a signal phaseshift near 90 degree. Now switch the LMG500 to the menue: /range/delay and set the current channel delay for the same power factor display like the direct measured signal.

For the proper phase adjustment bring the power channel 2 (with external current sensor) to the same power factor as the power channel 1 (with direct current measurement). It is important to adjust to the same power factor, not to the same active power (which should be both nearly! the same conclusion), because every current sensor has also slightly gain errors. To compensate a small gain error with delay adjustment will lead to spurious measuring results! The power factor does not depend on gain errors, so its is better to use this value not to mix gain adjustment with phase adjustment. To understand this, take a look at pure sinewave signal for voltage and current: PF = P/S = (Utrms*Itrms*cos(phi))/(Utrms*Itrms) = cos(phi). Utrms and Itrms can be truncated.

For very high frequency signal it is best to use not more than 5Aeff, because the bandwidth and phase accuracy of this range (20mA to 5A) is the best.

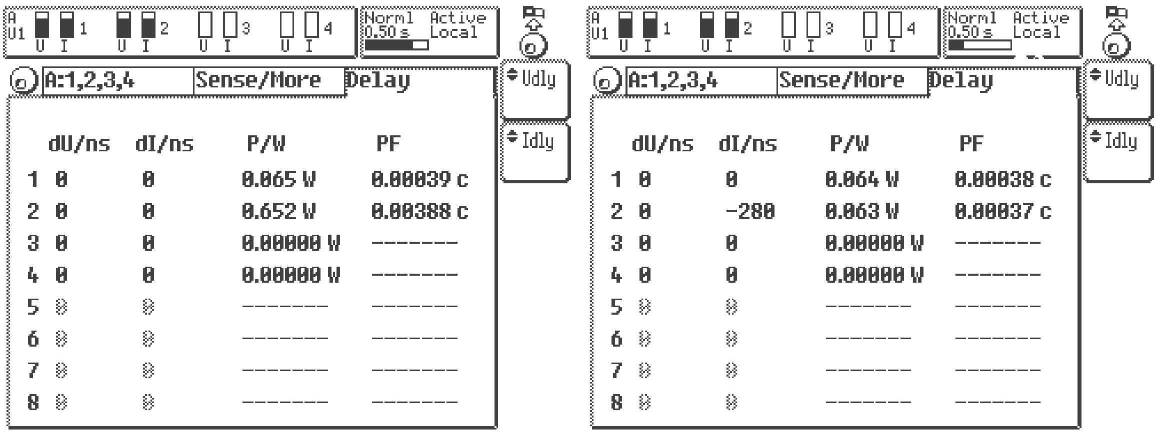


Figure 93: LMG500 before delay compensation (left) /
with succsessfull delay compensation of 280ns (right)

The current transducer in the example above has a signal delay of 280ns, this is compensated with a delay setting of -280ns, see the power factor ‘PF’ and active power ‘P’!

The current transducer delay or phase error is not necessarily positive, so at higher frequency the phase shift of a passive current transformer is usually negative and has to be compensated with a positive compensation value.