OMICRON

CMC 256plus

Technical Data

© OMICRON electronics GmbH 2022. All rights reserved.

This technical data was extracted from the following manual: ENU 1011 05 01

All rights including translation reserved. Reproduction of any kind, for example, photocopying, microfilming, optical character recognition and/or storage in electronic data processing systems, requires the explicit consent of OMICRON.

The document content represents the technical status at the time of writing and is subject to change without prior notice.

We have done our best to ensure that the information given in this document is useful, accurate and entirely reliable. However, OMICRON does not assume responsibility for any inaccuracies which may be present.

OMICRON translates this document from the source language English into a number of other languages. Any translation of this document is done for local requirements, and in the event of a dispute between the English and a non-English version, the English version of this document shall govern.

1 Technical data

1.1 Calibration and guaranteed values

We recommend that you send in your test sets for calibration at least once a year.

The drift of test equipment, that is, the deterioration of accuracy over time, depends strongly on environmental conditions and the application field. Excessive use or mechanical and/or thermal stress may result in the need for shorter calibration intervals.

Moderate working environments, on the other hand, allow you to increase the calibration interval to once every 2 or even 3 years.

► Particularly in cases of extended calibration intervals, verify the accuracy of the test set by cross-referencing the measurement results with traceable reference equipment either on a regular basis or prior to use. You can, for example, use a typical, often-used device under test as a reference, or use measurement equipment with a certified high accuracy.

Should the test equipment fail, immediately contact OMICRON Support for calibration or repair. Do not try to use it anymore.

Guaranteed values

- The values apply at 23 °C ± 5 °C (73 °F ± 9 °F), and after a warm-up time greater than 25 minutes.
- Guaranteed values of the generator outputs:
  The values are valid in the frequency range from 10 to 100 Hz unless specified otherwise. Given maximum phase errors relate to the voltage amplifier outputs.
- Accuracy data for analog outputs are valid in the frequency range from 0 to 100 Hz unless specified otherwise.
- The given input/output accuracy values relate to the range limit value (% of range limit value).

1.2 Main power supply

Main power supply	
Connection	C14 connector according to IEC 60320-1
Voltage, single phase Nominal voltage Operational range	 100 … 240 V_{AC} 85 … 264 V_{AC}
Power fuse	T 12.5 AH 250 V (5 × 20 mm) Schurter ordering number 0001.2515 For more information, visit the website www.schurter.com.
Nominal supply current	Max. 12 A @ 110 V; max. 10 A @ 230 V
Frequency Nominal frequency Operational range	 50/60 Hz 45 ... 65 Hz
Overvoltage category	II

1.2.1 Operational limits in conjunction with a weak power supply input voltage

In general, the maximum output power of the *CMC 256plus* is limited by the power supply input voltage. If the power supply input voltage is less than 120 V_{AC}, it is possible to supply the *CMC 256plus* with 2 phases (L-L, for example with a NEMA 6 240 V U.S. Standard) instead of the normal phase-neutral (L-N) operation in order to increase the power supply input voltage.

In order to limit the internal losses and to maximize the output power of the voltage amplifier, always set the maximum test object voltage to the minimum value possible for the test.

If all of the voltage and current outputs as well as the **AUX DC** output are to be driven with a power supply input voltage of less than 120 V_{AC}, reduce the maximum load of the current outputs by reducing the compliance voltage. To do so, configure the hardware using the OMICRON *Test Universe* software.

Apart from the reduction of the available total output power, a weak power supply input does not further affect the technical data of the *CMC 256plus*.

1.3 System clock accuracy

All signals generated or measured by the *CMC 256plus* refer to a common internal time base that is specified as follows:

Characteristic	Specification
Clock performance	Stratum 3 (ANSI/T1.101-1987)
Frequency drift (over time)	
24 hours	<±0.37 ppm (±0.000037 %)
20 years	<±4.60 ppm (±0.00046 %)
Frequency drift (over temperature range)	<±0.28 ppm (±0.000028 %)

1.4 Synchronization

Synchronization of system clock

By synchronizing the system clock to an external time base, the system clock accuracy can be improved up to the level of the external time base. Synchronizing the system clock additionally makes the absolute time available in the system. The absolute time is used to tag measurement results, start distributed tests at the same time, and generate and measure synchrophasors.

The following specifications refer to the internal time base. For the absolute time accuracy of the outputs and inputs, the inherent error of the respective channel itself has to be added.

Characteristic	Specification
IEEE 1588-2008 (v2)	
Offset (UTC)	Error <±1 µs
Pulling range	±100 ppm (±0.01 %)
Supported profiles	IEEE C37.238-2011 (Power Profile: v1)
	IEEE C37.238-2017 (Power Profile: v2)
	IEC/IEEE 61850-9-3-2016: Communication Networks and Systems for Power Utility Automation – Part 9-3: Precision Time Protocol Profile for Power Utility Automation (Utility Profile)
Supported sources	OMICRON *CMGPS 588*, *OTMC 100* or any Precision Time Protocol source (PTP grandmaster clock)
IRIG-B	
Offset (UTC)	Error <±1 µs
Pulling range	±100 ppm (±0.01 %)
Supported sources	Third-party IRIG-B sources with OMICRON *CMIRIG-B* accessory

Absolute time synchronization

The voltage and current outputs can be synchronized to an absolute time base like IRIG-B and IEEE 1588 to generate output signals synchronous to the time source. This can be used to test phasor measurement units (PMU) by generating reference signals.

Absolute timing accuracy[1]		
	Typical	Guaranteed
Voltage and current outputs	Error <±1 µs	Error <±5 µs

1. Valid for a phasor with a frequency of 50/60 Hz

Synchronization to external analog signal

The phase and frequency of the voltage and current outputs can be synchronized to a reference input signal of 10 ... 300 V / 15 ... 70 Hz applied to binary input 10. In contrast to the synchronization of the system clock, this kind of synchronization influences the frequency and phase of the signal generation directly.

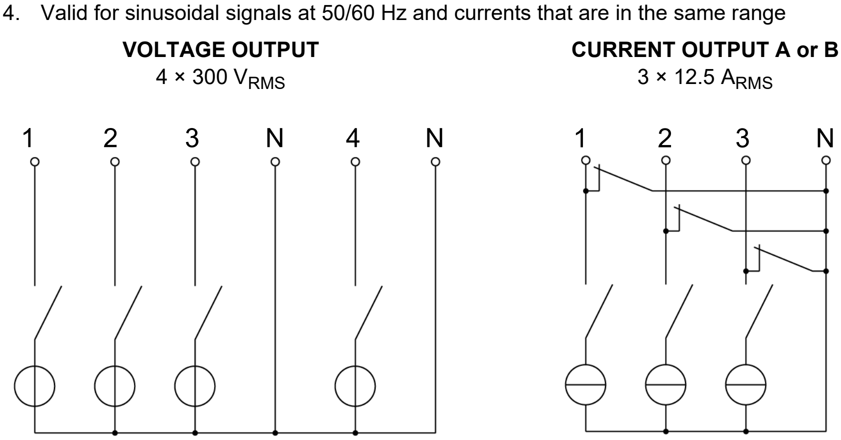
The possible accuracy depends on the quality of the synchronization signal because the synchronization uses the zero crossings of the signal.

1.5 Outputs

1.5.1 General generator outputs

General generator outputs data (analog current and voltage outputs, and LL out outputs)		
Frequency ranges[1]	Sinusoidal signals[2] Transient signals[3]	10 … 3000 Hz 0 (DC) … 3100 Hz
Frequency resolution (signal generation)	<5 µHz	
Bandwidth (–3 dB)	3.1 kHz	
Phase range φ	–360° ... +360°	
Phase resolution	0.001°	
Phase error[4]	Typical 0.005°	Guaranteed <0.02°
Amplitude temperature drift	0.0025 %/°C	

1. For injections longer than 1 minute, the maximum fundamental frequency is limited to 587 Hz to comply with international trade restrictions for frequency-controlled signal generators. For other options, please contact OMICRON Support.
2. Signals above 1000 Hz are only supported in selected software modules.
3. Amplitude derating at >1000 Hz
4. Valid for sinusoidal signals at 50/60 Hz and currents that are in the same range



All voltages and current generators can independently be configured with respect to amplitude, phase angle, and frequency.

All outputs are monitored. Overload conditions prompt a notification in the control software.

1.5.2 Extended frequency range

In selected *Test Universe* modules, the *CMC 256plus* supports a mode for generating stationary signals of up to 3 kHz. This mode corrects the phase and gain errors of the output filter. The 3 dB bandwidth of this filter limits the amplitude at 3 kHz to about 70 % of the maximum range value. The application of the extended frequency range is the generation of harmonics and interharmonics.

Extended frequency range (1 ... 3 kHz)		
	Typical	Guaranteed
Low-level outputs[1]	Phase error <0.25° Amplitude error <0.25 %	Phase error <1° Amplitude error <1 %
Voltage amplifier	Phase error <0.25° Amplitude error <0.25 %	Phase error <1° Amplitude error <1 %
Current amplifier[2]		
Phase error	Not quantified	
Amplitude error	Not quantified	

1. No extended frequency range support for external amplifiers.
2. Amplifier is calibrated with low resistance burden. The error is highly burden-dependent and therefore not quantified.

1.5.3 Current outputs

2 × 3 current outputs[1] (groups A and B)		
Output currents 3-phase AC (L-N) 1-phase AC (L-N)[2] DC (L-N)[2] DC (L-N)	 3 × 0 ... 12.5 A 1 × 0 ... 37.5 A 1 × 0 ... ±17.5 A 1 × 0 ... ±12.5 A	
	Typical	Guaranteed
Output power (range I) 3-phase AC (L-N)		 3 × 12.5 VA at 1.25 A
Output power (range II) 3-phase AC (L-N) 1-phase AC (L-N)[2] 1-phase AC (L-L)[3] DC (L-N)[2] DC (L-N)	 3 × 80 VA at 8.5 A 1 × 240 VA at 25.5 A 1 × 160 VA at 8.5 A 1 × 240 W at ±17.5 A 1 × 100 W at ±12.5 A	 3 × 70 VA at 7.5 A 1 × 210 VA at 22.5 A 1 × 140 VA at 7.5 A 1 × 235 W at ±17.5 A 1 × 90 W at ±12.5 A
Accuracy[4] Range I: $R_{load} \leq 1\ \Omega$ Range II: $R_{load} \leq 0.5\ \Omega$	 Error <0.015 % of rd. + 0.005 % of rg. Error <0.015 % rd. + 0.005 % of rg.	 Error <0.04 % of rd. + 0.01 % of rg. Error <0.04 % of rd. + 0.01 % of rg.
Harmonic distortion (THD+N)[5]	0.025 %	<0.07 %
DC offset current Range I Range II	 <30 µA <300 µA	 <300 µA <3 mA
Current ranges	Range I: 0 ... 1.25 A Range II: 0 ... 12.5 A	
Resolution	<50 µA (1.25 A range) <500 µA (12.5 A range)	
Trigger on overload	Timer accuracy error <1 ms	
Short-circuit protection	Unlimited to N	
Open-circuit protection	Open outputs (open-circuit) permitted	
Connection	4 mm socket, generator combination socket[6] (**CURRENT OUTPUT A** only)	
Insulation	Reinforced insulation of power supply and all SELV interfaces	

1. Data for 3-phase systems are valid for symmetric conditions (0°, 120°, 240°)
2. 3-phase parallel switched
3. Single-phase mode (in phase opposition): 2 currents in series.
4 rd. = reading; rg. = range, whereas *n* % of rg. means: *n* % of upper range value
5. Values at 50/60 Hz, 20 kHz measurement bandwidth, nominal value, and nominal load
6. For currents >32 A, connect the test object only to the 4 mm sockets and not to the generator combination socket.

Typical duty cycles for different loads and output configurations

Terms and definitions

"Continuous operation" or "100 % duty cycle" is defined as a *CMC* test set being able to provide a specified current for at least 30 minutes without shutting down due to overtemperature.

A duty cycle of 75 %, for example, means, the *CMC* test set provides the specified current 75 % of the time, and needs the remaining 25 % of the time to cool off (for example: 30 s on and 10 s off).

Preconditions that apply to duty cycles:

- In the **Output Configuration Details** dialog of the *Test Universe* **Hardware Configuration**, the compliance voltage is set to 100 % (15 V), and the fan mode is set to maximum power.
- The duty cycle values listed below apply to output frequencies of 50 Hz to 60 Hz and to sinusoidal signals. For other frequencies or output wave forms the results may vary.
- The duty cycle values listed below apply to resistive loads only, not to inductive or capacitive loads.
- For 3- and 6-phase operation, the phase angles between the currents are 0°, 120°, 240°.

Measuring method

Every test starts with a heat sink temperature of an ambient temperature of +15 °C (+59 °F). Then the *CMC* test set starts to provide the specified current. If within 30 minutes no shutdown due to overtemperature occurred, the measurement for this particular current is completed, and the duty cycle for this current value equals 100 %.

In case an overtemperature shutdown occurred, the time between the actual shutdown and the moment the *CMC* test set can be restarted is defined as "cooling time" ($t_{cooling}$). The time between the restart of the *CMC* test set and its next shutdown due to overtemperature is defined as "on time" (t_{on}).

Using these 2 time definitions, the duty cycle calculates as follows:

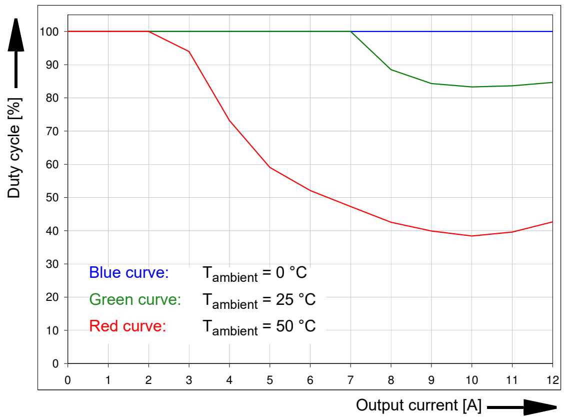
$$\text{duty cycle} = \frac{t_{on}}{t_{on} + t_{cooling}}$$

With regard to the following duty cycle graphs, note that when selecting a current of 12 A, continuous operation is possible at a much smaller load resistance than, for example, with a current of 10 A. The reason for this is that the *CMC 256plus* linearly reduces the compliance voltage from 15 V to 10.5 V for currents in the range of 8 A to 12.5 A per phase.

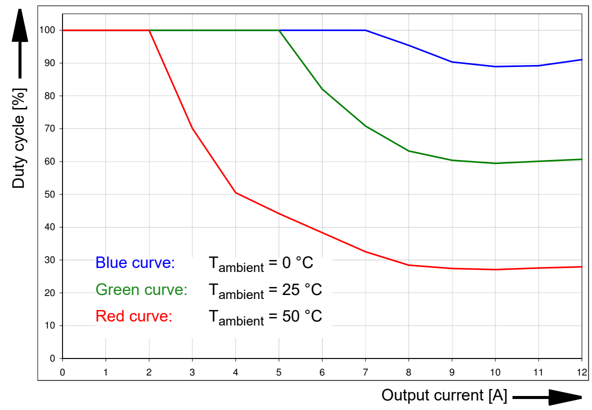
Note: In order to get the approximate duty cycle values for 3 × 25 A and 1 × 75 A configurations, refer to the 6 × 12.5 A configuration graphs, and divide the load values at the x-axis by 3 or 6.

Typical duty cycles

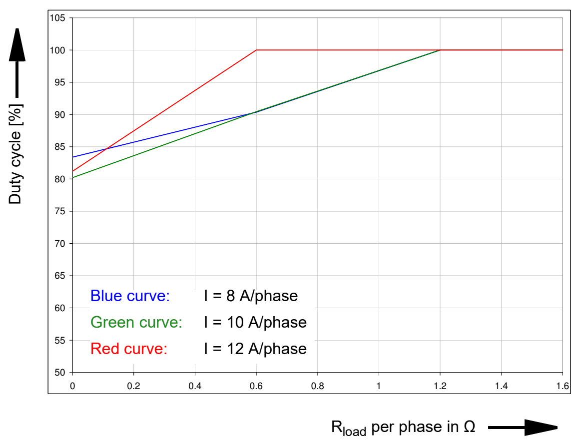
At R_{load} = 3 × 0 Ω



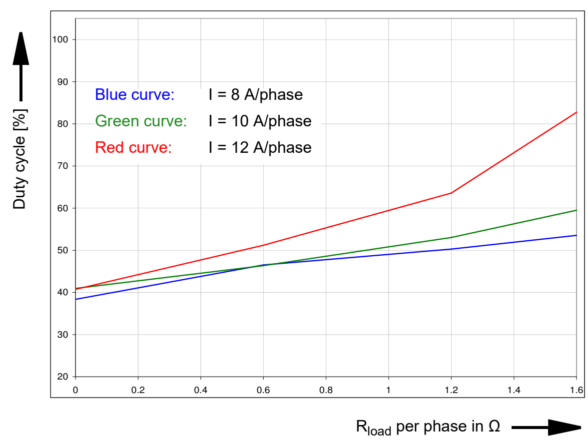
At R_{load} = 6 × 0 Ω



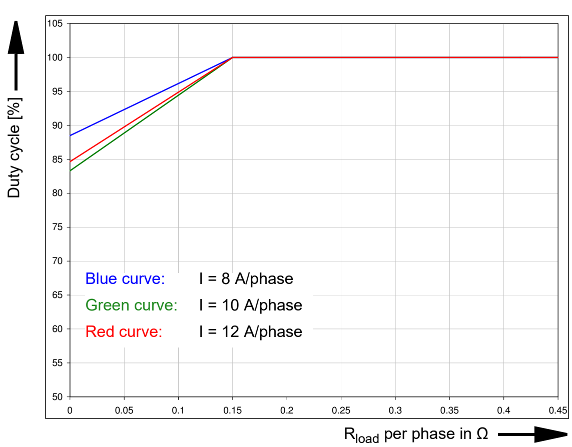
In a 1 × 12.5 A configuration at $T_{ambient}$ = 25 °C



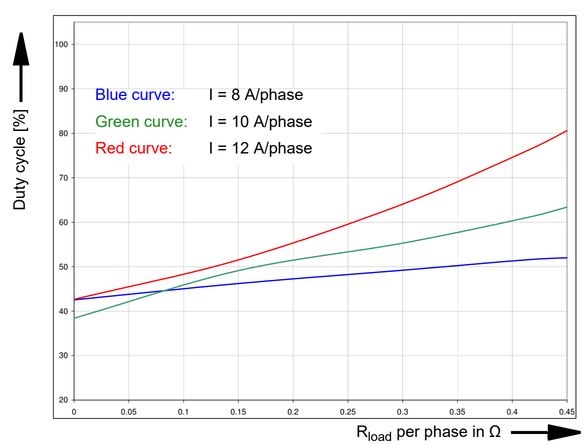
In a 1 × 12.5 A configuration at $T_{ambient}$ = 50 °C



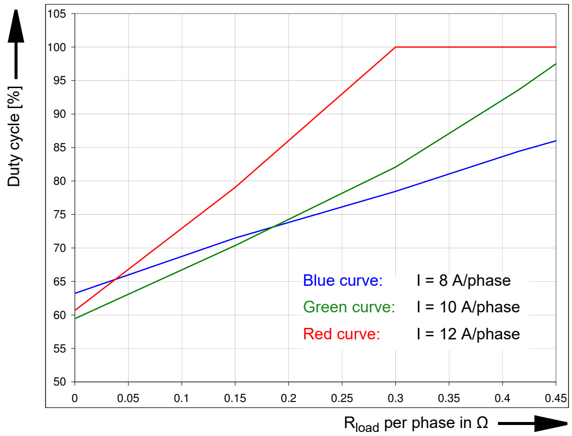
In a 3 × 12.5 A configuration at $T_{ambient}$ = 25 °C



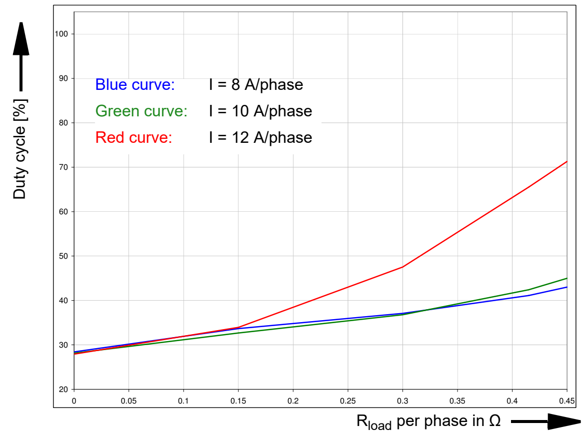
In a 3 × 12.5 A configuration at $T_{ambient}$ = 50 °C



In a 6 × 12.5 A configuration at $T_{ambient}$ = 25 °C



In a 6 × 12.5 A configuration at $T_{ambient}$ = 50 °C



Typical first shutdown, cooling times and on times at an ambient temperature of 25 °C (see also "**Measuring method**" on page 10):

- t_1: The time until a "cold" *CMC* test set shuts down.
- t_{on}: The time between the restart of the *CMC* test set and its next shutdown due to overtemperature.

Typical first shutdown, cooling times and on times at an ambient temperature of 25 °C

1 × 12.5 A, R_{load} = 1 × 0 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 6	>30	>1800	–	100
7	9.4	222	17	93
8	5.1	83	17	83
9	4.4	68	17	80
10	4.2	66	17	80
11	4.2	65	17	79
12	4.5	70	17	80

1 × 12.5 A, R_{load} = 1 × 0.6 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 7	>30	>1800	–	100
8	7.6	162	17	90
9	6.8	120	17	88
10	8.3	161	17	90
11	12.9	380	17	96
12	>30	>1800	–	100

3 × 12.5 A, R_{load} = 3 × 0 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 7	>30	>1800	–	100
8	5.9	124	17	88
9	4.6	88	17	84
10	4.3	82	17	83
11	4.3	82	17	83
12	4.6	89	14	84

3 × 12.5 A, R_{load} = 3 × 0.15 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 8	>30	>1800	–	100
9	13.9	438	17	96
10	>30	>1800	–	100
11	>30	>1800	–	100
12	>30	>1800	–	100

6 × 12.5 A, R_{load} = 6 × 0 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 5	>30	>1800	–	100
6	5.3	100	23	81
7	3.6	54	23	70
8	2.8	39	23	63
9	2.5	34	23	60
10	2.4	33	23	59
11	2.4	33	23	59
12	2.5	35	23	60

6 × 12.5 A, R_{load} = 6 × 0.15 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 5	>30	>1800	–	100
6	8.0	200	23	90
7	4.7	86	23	79
8	3.5	56	23	71
9	3.3	50	23	68
10	3.4	53	23	70
11	3.8	62	23	73
12	4.7	84	23	79

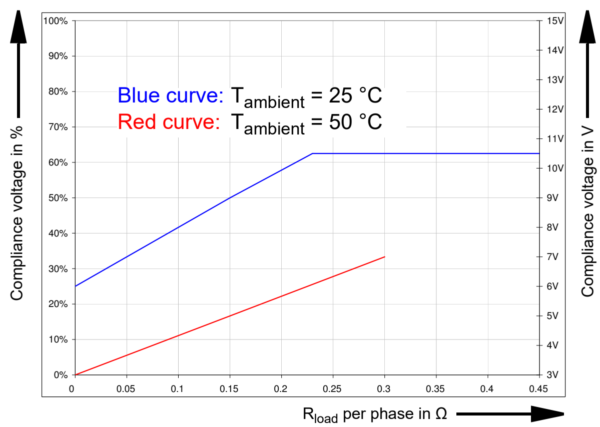
6 × 12.5 A, R_{load} = 6 × 0.3 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 6	>30	>1800	–	100
7	6.3	139	23	86
8	4.6	81	23	78
9	4.4	77	23	77
10	5.3	101	23	81
11	7.9	197	23	90
12	>30	>1800	–	100

6 × 12.5 A, R_{load} = 6 × 0.415 Ω				
I [A]	t_1 [min]	t_{on} [s]	t_{cool} [s]	duty cycle [%]
0 ... 6	>30	>1800	–	100
7	8.9	230	23	91
8	5.9	121	23	84
9	6.3	130	23	85
10	11.3	326	23	93
11	>30	>1800	–	100
12	>30	>1800	–	100

Ensuring continuous operation

In order to ensure continuous operation, the compliance voltage in the software can be decreased. Small compliance voltages result in less power dissipation inside the current amplifier, which, in turn, has the disadvantage of preventing the current amplifier from driving high burdens at high currents. In that case the current amplifier would report an overload. The figure below shows the typical possible compliance voltage that ensures continuous operation in a 6 × 12.5 A configuration with the maximum output current of 12.5 A per phase. Since other configurations produce less internal heat dissipation, this diagram can also be used as indicator for these other configurations.

Typically allowed compliance voltage to ensure continuous operation



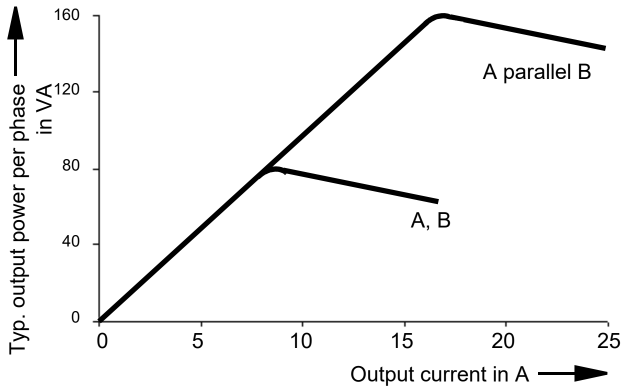
At a temperature of 50 °C, the compliance voltage cannot be reduced far enough to ensure continuous operation for loads with a resistance above 0.3 Ω per phase.

1.5.4 Parallel switching of CURRENT OUTPUT A and B

Parallel switched current outputs[1] (groups A and B)		
Output currents 3-phase AC (L-N) 1-phase AC (L-N)[2] DC (L-N)[2] DC (L-N)	 3 × 0 ... 25 A 1 × 0 ... 75 A 1 × 0 ... ±35 A 1 × 0 ... ±25 A	
	Typical	Guaranteed
Output power (range I) 3-phase AC (L-N)		 3 × 25 VA at 2.5 A
Output power (range II) 3-phase AC (L-N) 1-phase AC (L-N)[2] 1-phase AC (L-L) DC (L-N)[2] DC (L-N)	 3 × 160 VA at 17 A 1 × 480 VA at 51 A 1 × 320 VA at 8.5 A 1 × 480 W at ±35 A 1 × 200 W at ±25 A	 3 × 140 VA at 15 A 1 × 420 VA at 45 A 1 × 280 VA at 15 A 1 × 470 W at ± 35 A 1 × 180 W at ± 25 A
Accuracy (range I)[3] R_{load} ≤ 0.5 Ω	 Error <0.015 % of rd. + 0.005 % of rg.	 Error <0.04 % of rd. + 0.01 % of rg.
Accuracy (range II)[3] R_{load} ≤ 0.25 Ω	 Error <0.015 % of rd. + 0.005 % of rg.	 Error <0.04 % of rd. + 0.01 % of rg.
Harmonic distortion (THD+N)[4]	0.025 %	<0.07 %
DC offset current Range I Range II	 <60 µA <600 µA	 <600 µA <6 mA
Current ranges	Range I: 0 ... 2.5 A Range II: 0 ... 25 A	
Resolution	<100 µA (in range I) <1 mA (in range II)	
Connection	4 mm sockets, generator combination socket[5]	

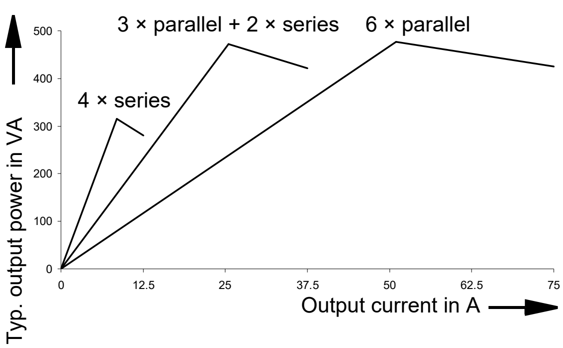
1. Data for 3-phase systems are valid for symmetric conditions (0°, 120°, 240°).
2. 3-phase parallel switched
3 rd. = reading; rg. = range, whereas *n* % of rg. means: *n* % of upper range value
4. Values at 50/60 Hz, 20 kHz measurement bandwidth, nominal value, and nominal load
5. For currents >32 A, connect the test object only to the 4 mm sockets and not to the generator combination socket.

Typical output power per phase of a group and with parallel switching (A || B) of both groups

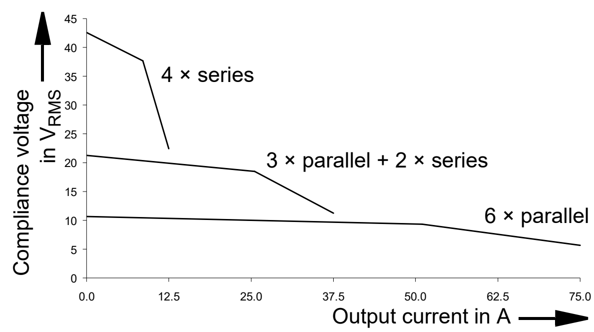


1.5.5 Single-phase operation for output currents

Typical output power curves (50/60 Hz)



Typical compliance voltage (50/60 Hz)



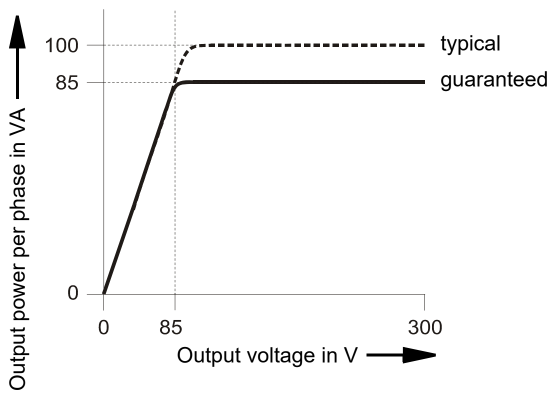
→ Section 5 "Increasing the output power" on page 67.

1.5.6 Voltage outputs

4 voltage outputs		
Output voltages 4-phase AC (L-N)[1] 2-phase AC (L-L)[2] 1-phase AC (L-L) DC (L-N)	4 × 0 ... 300 V 2 × 0 ... 600 V 1 × 0 ... 600 V 4 × 0 ... ±300 V	
	Typical	Guaranteed
Output power[3] 4-phase AC[4] 3-phase AC[5] 2-phase AC (L-L) 1-phase AC (L-N) 1-phase AC (L-L) DC (L-N)	4 × 75 VA at 100 ... 300 V 3 × 100 VA at 100 ... 300 V 2 × 138 VA at 200 ... 600 V 1 × 200 VA at 100 ... 300 V 1 × 275 VA at 200 ... 600 V 1 × 420 W at 300 V_{DC}	4 × 50 VA at 85 ... 300 V 3 × 85 VA at 85 ... 300 V 2 × 125 VA at 200 ... 600 V 1 × 150 VA at 75 ... 300 V 1 × 250 VA at 200 ... 600 V 1 × 360 W at 300 V_{DC}
Accuracy $R_{load} \geq 250\ \Omega$, U_{L-N} = 0...300 V $R_{load} < 250\ \Omega$, $U_{L-N} \geq 30$ V $R_{load} < 250\ \Omega$, $U_{L-N} < 30$ V	 Error <0.015 % of rd.[6] + 0.005 % of rg. Error <0.025 % of rd. Error <10mV	 Error <0.04 % of rd. + 0.01 % of rg. Error <0.1 % of rd. Error <30mV
Harmonic distortion (THD+N)[7]	0.015 %	<0.05 %
DC offset voltage	<20 mV	<100 mV
Voltage ranges	Range I: Range II:	0 ... 150 V 0 ... 300 V
Resolution	Range I: Range II:	5 mV 10 mV
Short-circuit protection	Unlimited for L–N	
Connection	4 mm sockets; generator combination socket V_{L1}–V_{L3}	
Insulation	Reinforced insulation of power supply and all SELV interfaces	

1. a) V_{L4}(t) automatically calculated: $V_{L4} = (V_{L1} + V_{L2} + V_{L3})$ * C. C = configurable constant from –100 to +100.
   b) V_{L4} can be configured by software in frequency, phase, and amplitude.
2. Without common neutral (N).
3. Guaranteed data for ohmic loads (PF = 1). Refer to the accompanying figures of the output power curves.
4. Data for 4-phase systems are valid for symmetric conditions (0°, 90°, 180°, 270°)
5. Data for 3-phase systems are valid for symmetric conditions (0°, 120°, 240°)
6. rd. = reading; rg. = range, whereas *n* % of rg. means: *n* % of upper range value
7. Values at 50/60 Hz, 20 kHz measurement bandwidth, nominal value, and nominal load

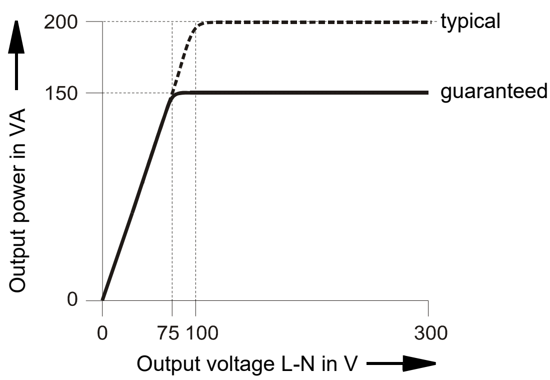
Power diagram for 3-phase operation



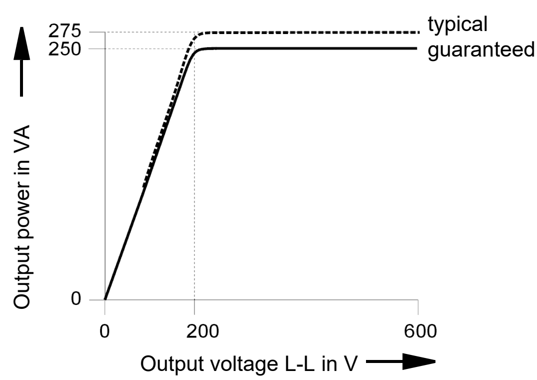
Power diagram for single-phase operation

Section 5.2 "Voltage outputs" on page 69

Single-phase operation L-N



Single-phase operation L-L



1.5.7 Accuracy of output power

Output power		
	Typical	Guaranteed
Accuracy[1]	Error <0.05 %	Error <0.1 %
Output power temperature drift	0.001 %/°C	<0.005 %/°C

1. Data apply for set value (relative error) from 0.1 to 12.5 A (current amplifier A or B), and 50 to 300 V (voltage amplifier) at 50/60 Hz.
   Permissible load for current outputs:
   – Range 1.25 A: 0 to 1 Ω and max. 1 VA, cos φ = 0.5 to 1
   – Range 12.5 A: 0 to 0.5 Ω and max. 6 VA, cos φ = 0.5 to 1
   Permissible load for voltage outputs:
   – Max. 10 VA at 50 to 300 V, cos φ = 0.5 to 1

1.5.8 Low-level outputs LL out for external amplifiers

Note: The low-level outputs **LL out 7–12** are only available if the option *LLO-2* is installed.

Both SELV interface connectors **LL out 1–6** as well as the optional **LL out 7–12** (if applicable) hold 2 independent generator triples each. These 6 high-accuracy analog signal sources per connector can be used to either control an external amplifier or to directly provide low-level outputs.

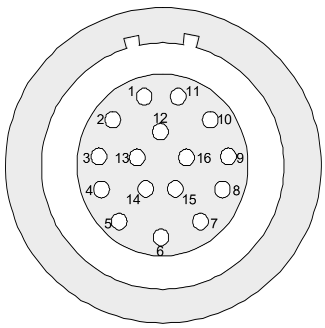
In addition, each SELV interface connector provides a serial digital interface (pins 8–16; see below) that transmits control and monitor functions between the *CMC 256plus* and the external amplifiers.

Supported devices are the *CMS 356* or the discontinued devices *CMA 156*, *CMA 56*, *CMS 156*, *CMS 251* and *CMS 252*.

The low-level outputs are short-circuit-proof and continually monitored for overload. They are separated through reinforced insulation from the power input and from the voltage and current outputs. They deliver calibrated signals in the range from 0 to 7 V_{eff} nominal (0 to ± 10 V_{peak}).

Both the selection of the particular amplifier as well as the specification of the range of the amplifier takes place in the software.

Pin assignment of **LL out 1–6** (lower 16-pole LEMO socket); view onto the connector from the cable wiring side:



Pin	Function LL out 1–6	Function LL out 7–12
1	LL out 1	LL out 7
2	LL out 2	LL out 8
3	LL out 3	LL out 9
4	Neutral (N) connected to GND	
5	LL out 4	LL out 10
6	LL out 5	LL out 11
7	LL out 6	LL out 12
8–16	For internal purposes	
Housing	Screen connection	

LL out 1–3 and LL out 4–6 (and optionally LL out 7–9 and LL out 10–12) each make up a selectable voltage or current triple.

6 outputs "LL out 1–6" and 6 (optional) outputs "LL out 7–12"		
Output voltage range	0 … ±10 V_{peak}[1] (SELV)	
Output current	Max. 1 mA	
	Typical	Guaranteed
Accuracy	Error <0.025 %	Error <0.07 % for 1 … 10 V_{peak}
Harmonic distortion (THD+N)[2]	<0.015 %	<0.05 %
DC offset voltage	<150 µV	<1.5 mV
Resolution	<250 µV	
Unconventional CT/VT simulation	Linear or Rogowski[3] mode (transient and sinewave)	
Short-circuit protection	Unlimited to GND	
Overload indication	Yes	
Insulation	Reinforced insulation to all other potential groups of the test equipment. GND is connected to protective earth (PE).	

1. Input OMICRON amplifier nominal: 0 ... 5 V_{RMS}
2. Values at nominal voltage (10 V_{peak}), 50/60 Hz, and 20 kHz measurement bandwidth.
3. When simulating Rogowski sensors, the output voltage is proportional to the derivative of the current with respect to time (di(t)/dt).

Manufacturer ordering information	
Connector for two-guide notches and pull relief (for **LL out**)	FGB.2B.316.CLAD 72Z
Black anti-bend cable cover	GMA.2B.070 DN

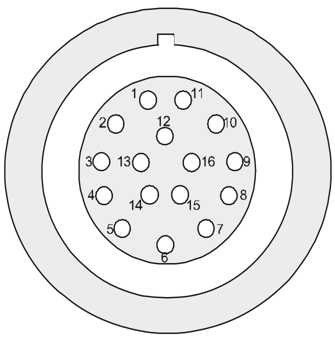
For a manufacturer description about the connection sockets **LL out** and the external interface **ext. Interf.**, visit the website www.lemo.com. You can order the LEMO cable directly from OMICRON.

1.5.9 Low-level binary outputs (ext. Interf.)

The SELV interface connector **ext. Interf.** holds 4 additional transistor binary outputs (**BINARY OUTPUT** 11–14). Unlike regular relay outputs, **BINARY OUTPUT** 11–14 are bounce-free binary outputs and have a minimal reaction time.

In addition, 2 high-frequency counter inputs for up to 100 kHz are available for the testing of energy meters. They are described in section 1.6.2 "Counter inputs 100 kHz (low level)" on page 27.

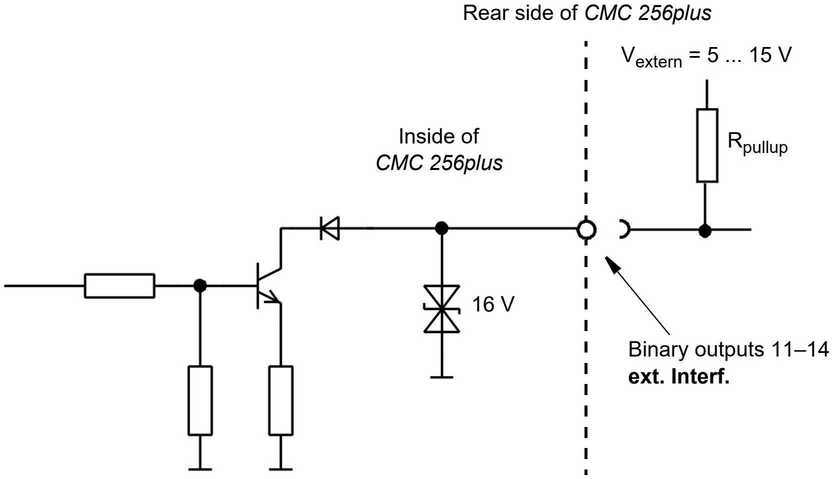
Pin assignment of the external interface **ext. Interf.** (upper 16-pole LEMO socket); view onto the connector from the cable wiring side:



Pin	Function
Pin 1	Counter input 1
Pin 2	Counter input 2
Pin 3	Reserved
Pin 4	Neutral (N) connected to GND
Pin 5	Binary output 11
Pin 6	Binary output 12
Pin 7	Binary output 13
Pin 8	Binary output 14
Pin 9–16	Reserved
Housing	Screen connection

4 low-level transistor binary outputs (BINARY OUTPUT 11–14)	
Type	Open-collector transistor outputs; external pull-up resistor
Rated voltage	Max. ±16 V
Rated current	Max. 5 mA (current limited); min. 100 µA
Update rate	10 kHz
Rise time	<3 µs (V_{extern} = 5 V, R_{pullup} = 4.7 kΩ)
Connection	Connector **ext. Interf.** (*CMC 256plus* rear side)
Insulation	Reinforced insulation to all other potential groups of the test equipment. GND is connected to protective earth (PE).

Circuit diagram of **ext. Interf.** binary transistor outputs 11–14:



Manufacturer ordering information	
Connector for one-guide notch and pull relief (for **ext. Interf.**)	FGG.2B.316.CLAD 72Z
Black anti-bend cable cover	GMA.2B.070 DN

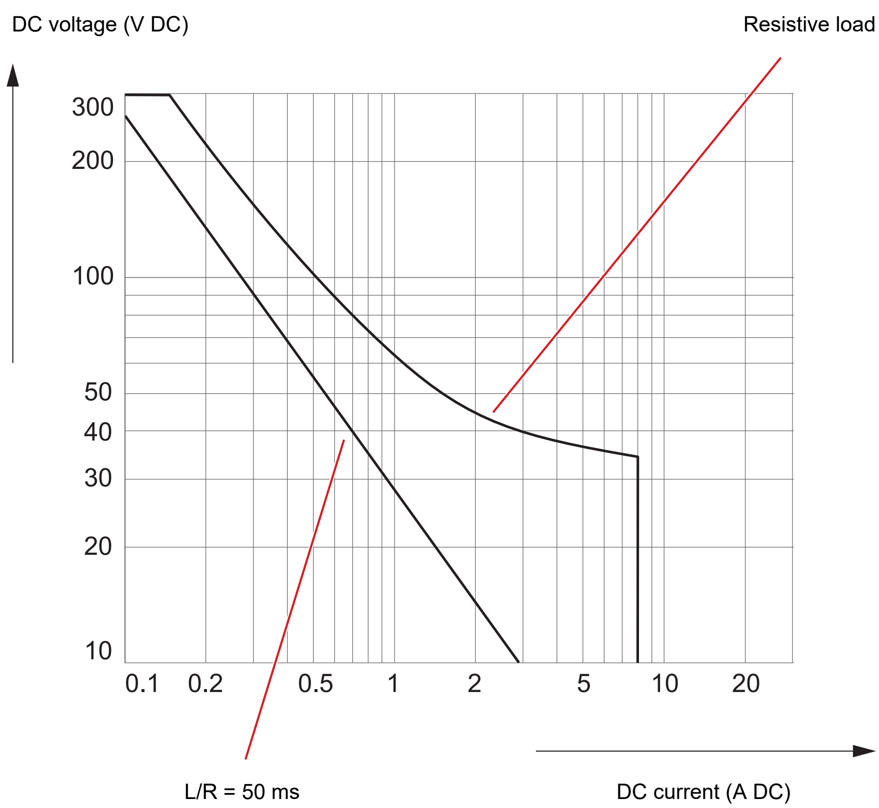
For a manufacturer description about the connection sockets **LL out** and the external interface **ext. Interf.**, visit the website www.lemo.com. You can order the LEMO cable directly from OMICRON.

1.5.10 Binary output relays

4 binary output relays (BINARY OUTPUT 1–4)	
Type	Potential-free contacts; software-controlled
Connection	4 mm sockets
AC loading capacity AC breaking capacity	V_{max} = 300 V, I_{max} = 8 A, P_{max} = 2000 VA
DC loading capacity DC breaking capacity	→ "Load limit breaking capacity curve for binary output relays with DC voltages" on page 23.
Inrush current	15 A (max. 4 s at 10 % duty cycle)
Carry capacity	5 A continuous at 60 °C (140 °F)
Electrical lifetime	100 000 switching cycles at 230 V_{AC}/8 A and ohmic load
Operate time	Max. 10 ms (no bouncing)
Release time	Max. 5 ms (no bouncing)
Overvoltage category	II, according to IEC 61010-1

The accompanying diagram shows the load limit curve for DC voltages. For AC voltages, a maximum power of 2000 VA is achieved.

Load limit breaking capacity curve for binary output relays with DC voltages



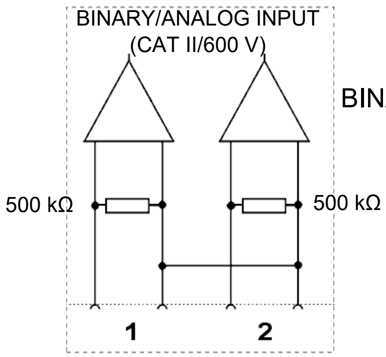
1.5.11 DC supply (AUX DC)

DC supply (AUX DC)		
Voltage ranges	0 ... 66 V_{DC} (max. 0.8 A) 0 ... 132 V_{DC} (max. 0.4 A) 0 ... 264 V_{DC} (max. 0.2 A)	
Power	Max. 50 W	
Accuracy[1]	Typical	Guaranteed
	Error <2 %	Error <5 %
Resolution	<70 mV	
Connection	4 mm sockets on front panel	
Short-circuit protection	Yes	
Overload indication	Yes	
Insulation	Reinforced insulation from power supply and all SELV interfaces	

1. Percentage is with respect to each range's full-scale.

1.6 Inputs

1.6.1 Binary inputs



BINARY INPUTS 3–10 are identical.

General data of binary inputs 1…10	
Number of binary inputs	10
Trigger criteria	Potential-free or DC-voltage compared to threshold voltage
Reaction time	Max. 220 µs
Sampling rate	10 kHz
Time resolution	100 µs
Maximum measuring time	Unlimited
Debounce/deglitch time	0 … 25 ms (→ page 26)
Counting function	
Counter frequency	<3 kHz (per input)
Pulse width	>150 µs (for high and low signals)
Connection	4 mm sockets
Insulation	5 galvanically insulated binary groups with each 2 inputs having its own GND. Functional insulation to the power outputs, DC inputs and between galvanically separated groups. Reinforced insulation from all SELV interfaces and from power supply.

Data for potential-sensing operation		
Threshold voltage data per input range	Setting range	Resolution
100 mV 1 V 10 V 100 V 600 V	±100 mV ±1 V ±10 V ±100 V ±600 V	2 mV 20 mV 200 mV 2 V 20 V
Maximum input voltage	CAT IV: 150 V CAT III: 300 V CAT II: 600 V	
Threshold voltage accuracy per range:[1] 100 mV, 1 V, 10 V, 100 V 600 V	Error: Typical <2 %, guaranteed <4 % Typical <5 %, guaranteed <10 %	
Threshold voltage hysteresis: 100 mV, 1 V, 10 V, 100 V 600 V	Typical: 3.5 % of range + 1.3 % of setting 5.8 % of range + 1.3 % of setting	
Input impedance	500 kΩ (|| 50 pF)	

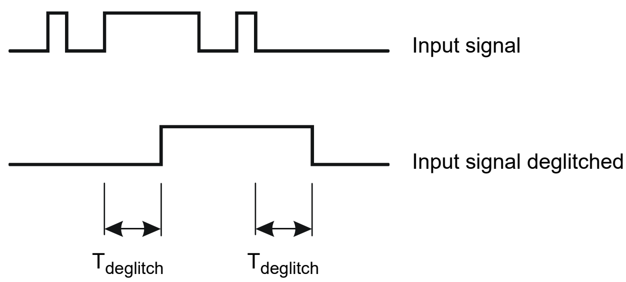
1. Valid for positive voltage signal edge; percentage is shown in respect to each range's full-scale.

Data for potential-free operation	
Trigger criteria	Logical 0: R >80 kΩ Logical 1: R <40 kΩ
Input impedance	162 kΩ (|| 50 pF)

Deglitching input signals

In order to suppress short spurious pulses, a deglitching algorithm could be configured. The deglitch process results in an additional dead time and introduces a signal delay. In order to be detected as a valid signal level, the level of an input signal must have a constant value at least during the deglitch time.

The figure below illustrates the deglitch function.



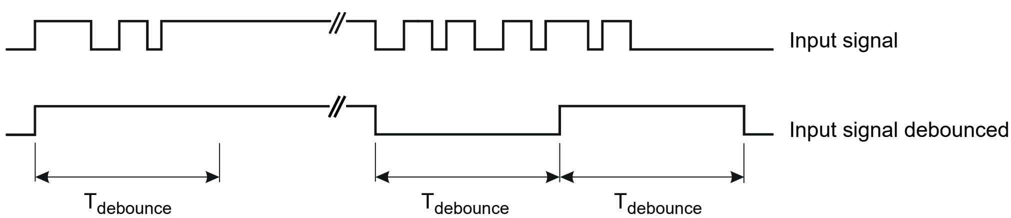
Debouncing input signals

For input signals with a bouncing characteristic, a debounce function can be configured. This means that the first change of the input signal causes the debounced input signal to be changed and then be kept on this signal value for the duration of the debounce time.

The debounce function is placed after the deglitch function described above and both are realized by the firmware of the *CMC 256plus* and are calculated in real time.

The figure below illustrates the debounce function. On the right-hand side of the figure, the debounce time is too short. As a result, the debounced signal rises to "high" once again, even while the input signal is still bouncing and does not drop to a low level until another $T_{debounce}$ period has expired.

The figure below illustrates the debounce function.

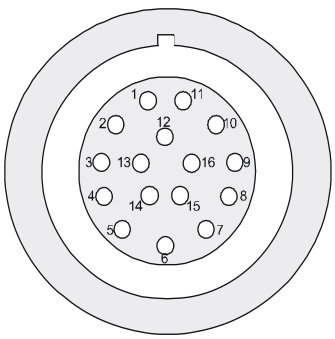


1.6.2 Counter inputs 100 kHz (low level)

The SELV interface connector **ext. Interf.** holds 2 high-frequency counter inputs for up to 100 kHz which are used for testing energy meters.

In addition, 4 additional transistor binary outputs (**BINARY OUTPUT 11–14**) are available. They are described in section 1.5.9 "Low-level binary outputs (ext. Interf.)" on page 21.

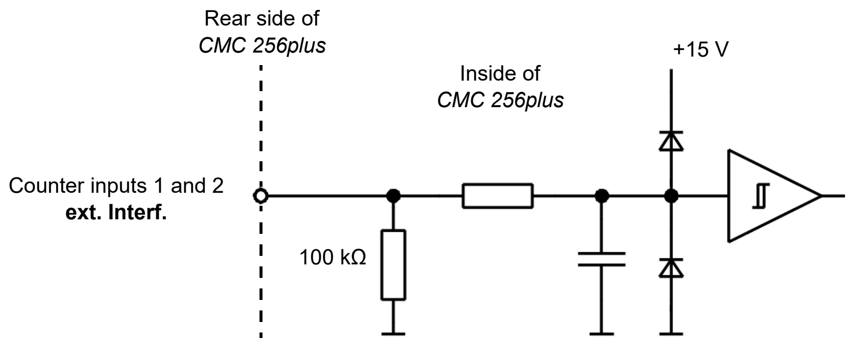
Pin assignment of the external interface **ext. Interf.** (upper 16-pole LEMO socket); view onto the connector from the cable wiring side:



Pin	Function
Pin 1	Counter input 1
Pin 2	Counter input 2
Pin 3	Reserved
Pin 4	Neutral (N) connected to GND
Pin 5	Binary output 11
Pin 6	Binary output 12
Pin 7	Binary output 13
Pin 8	Binary output 14
Pin 9–16	Reserved
Housing	Screen connection

2 counter inputs	
Maximum counter frequency	100 kHz
Pulse width	>3 µs (high and low signal)
Switch threshold Pos. edge Neg. edge	 Max. 8 V Min. 4 V
Hysteresis	Typ. 2 V
Rise and fall times	<1 ms
Maximum input voltage	±30 V
Connection	Socket **ext. Interf.** (rear side of *CMC 256plus*)
Insulation	Reinforced insulation to all other potential groups of the test equipment. GND is connected to protective earth (PE).

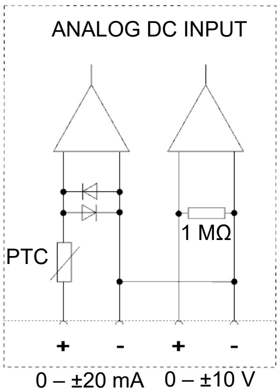
Circuit diagram of **ext. Interf.** counter inputs 1 and 2:



Manufacturer ordering information	
Connector for one-guide notch and pull relief (for **ext. Interf.**)	FGG.2B.316.CLAD 72Z
Black anti-bend cable cover	GMA.2B.070 DN

For a manufacturer description about the connection sockets **LL out 1–6** and external interface **ext. Interf.**, visit the website www.lemo.com. You can order the LEMO cable directly from OMICRON.

1.6.3 DC measurement inputs (ANALOG DC INPUT)



Note: Exceeding the specified input values can damage the measurement inputs.

DC measurement input I_{DC}		
Measurement range	0 ... ±1 mA and 0 ... ±20 mA	
Maximum input current	600 mA	
Accuracy	Typical	Guaranteed
	Error <0.003 % of rg.[1]	Error <0.02 % of rg.
Input impedance	Approx. 15 Ω	
Connection	4 mm sockets	
Insulation	Functional insulation to all other front panel connections; reinforced insulation from all SELV interfaces and from power supply; galvanically connected to V_{DC}	

DC voltage measurement input V_{DC}		
Measurement range	0 … ±10 V	
Maximum input voltage	±11 V	
Input impedance	1 MΩ	
Maximum input current	±90 mA	
Accuracy	Typical	Guaranteed
	Error <0.003 % of rg.[1]	Error <0.02 % of rg.
Insulation	Galvanically connected to I_{DC}	

1. rg. = range, whereas *n* % of rg. means: *n* % of upper range value

1.7 IEC 61850 protocols

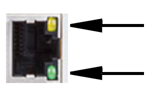
IEC 61850 GOOSE	
Simulation	Mapping of binary outputs to data attributes in published GOOSE messages. Number of virtual binary outputs: 360 Number of GOOSE to be published: 128
Subscription	Mapping of data attributes from subscribed GOOSE messages to binary inputs. Number of virtual binary outputs: 360 Number of GOOSE to be published: 128
Performance	Type 1A; Class P2/3 (IEC 61850-5). Processing time (application to network or vice versa): <1 ms
VLAN support	Selectable priority and VLAN-ID

IEC 61850 Sampled Values (Publishing)	
Specification	According to the “Implementation Guideline for Digital Interface to Instrument Transformers Using IEC 61850-9-2” of the UCA International Users Group and the "IEC 61869-9 Instrument transformers – Part 9: Digital interface for instrument transformers"
Sample rate	• 4000 Hz (80 SPC @ 50 Hz) – 1 sample per packet • 4800 Hz (80 SPC @ 60 Hz) – 1 sample per packet • 4800 Hz – 2 samples per packet • 5760 Hz– 1 sample per packet • 12800 Hz (256 SPC @ 50 Hz) – 8 samples per packet • 14400 Hz – 6 samples per packet • 15360 Hz (256 SPC @ 60 Hz) – 8 samples per packet
Synchronization	Synchronization attribute (smpSynch) can follow the synchronization status of the test set or be set to distinct values. Sample count (smpCnt) zero is aligned with top of the second (IRIG-B and PPS). For the accuracy data → section "Absolute time synchronization" on page 6.
VLAN support	Selectable priority and VLAN-ID
Maximum number of SV streams	*Test Universe*: 3 *RelaySimTest*: 4

1.8 Technical data of the communication ports

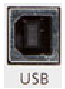
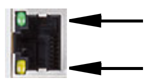
1.8.1 NET-2 board

The NET-2 board requires a *Test Universe* software version **3.00 SR2** (or later), or a *CMControl* software version 2.30 (or later).

NET-2: 2 × USB port and Ethernet ports ETH1/ETH2		
 USB	USB type	USB 2.0 high speed up to 480 Mbit/s
	USB connector	USB type A (for future use of USB peripherals)
	Output current	Max. 500 mA
 USB	USB type	USB 2.0 high speed up to 480 Mbit/s; USB 1.1-compatible
	USB connector	USB type B (connect to computer)
	USB cable	USB 2.0 high speed type A-B, 2 m/6 ft
 1 2 ETH	ETH type	10/100/1000Base-TX[1] (twisted pair, auto-MDI/MDIX or auto-crossover)
	ETH connector	RJ45
	ETH cable type	Shielded LAN cable of category 5 (CAT5) or better
	ETH port status LED 	Depending on the ETH type of your NET-2 interface board's counterpart, the status LED's behavior varies. Physical link established, port active: Mbit/s — Active LED ON 10 — yellow 100 — green 1000 — yellow + green If there is traffic via an **ETH** port, the active LEDs start blinking.
	ETH **P**ower **o**ver **E**thernet (PoE)	IEEE 802.3af compliant Port capability limited to one Class 1 (3.84 W) and one Class 2 (6.49 W) power device

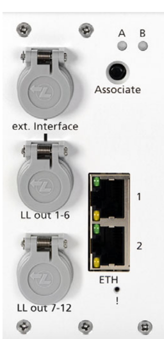
1. 10Base = 10 Mbit/s transfer rate
   100Base = 100 Mbit/s transfer rate
   1000Base = 1000 Mbit/s transfer rate

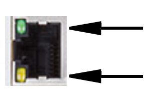
1.8.2 NET-1C board (legacy board)

NET-1C: USB port and Ethernet ports ETH1/ETH2		
	USB type[1]	USB 2.0 full speed up to 12 Mbit/s
	USB connector	USB type B (connect to computer)
	USB cable	USB 2.0 high speed type A-B, 2 m/6 ft
	ETH type	10/100Base-TX (10/100Mbit, twisted pair, auto-MDI/MDIX or auto-crossover)
	ETH connector	RJ45
	ETH cable type	Shielded LAN cable of category 5 (CAT5) or better
	ETH port status LED 	• Physical link established, port active: green LED ON • Traffic via **ETH** port: yellow LED is blinking
	ETH **P**ower **o**ver **E**thernet (PoE)	IEEE 802.3af compliant Port capability limited to one Class 1 (3.84 W) and one Class 2 (6.49 W) power device

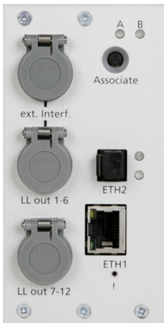
1. For the **USB** port to work, the NET-1C board requires a *Test Universe* software version 3.00 (or later) plus the matching *CMC* firmware

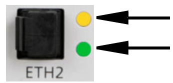
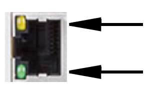
1.8.3 NET-1B board (legacy board)



NET-1B: Ethernet ports ETH1 and ETH2		
	Type	10/100Base-TX (10/100Mbit, twisted pair, auto-MDI/MDIX or auto-crossover)
	Connector	RJ45
	Cable type	Shielded LAN cable of category 5 (CAT5) or better
	ETH port status LED 	• Physical link established, port active: green LED ON • Traffic via **ETH** port: yellow LED is blinking
	ETH **P**ower **o**ver **E**thernet (PoE)	IEEE 802.3af compliant Port capability limited to one Class 1 (3.84 W) and one Class 2 (6.49 W) power device

1.8.4 NET-1 board (legacy board)



NET-1: Ethernet ports ETH1 and ETH2		
	Type	100Base-FX (100 Mbit, fiber, duplex)
	Connector	MT-RJ
	Cable type	50/125 µm or 62.5/125 µm (duplex patch cable)
	Cable length	>1 km/0.62 miles possible
	ETH2 port status LED 	• Physical link established, port active: green LED ON • Traffic via ETH port: yellow LED is blinking
		This is a product of Laser Class 1 (IEC 60825-1:2014)
	Type	10/100Base-TX (10/100Mbit, twisted pair, auto-MDI/MDIX or auto-crossover)
	Connector	RJ45
	Cable type	Shielded LAN cable of category 5 (CAT5) or better
	ETH1 port status LED 	• Physical link established, port active: green LED ON • Traffic via **ETH** port: yellow LED is blinking

1.9 Environmental conditions

Climate	
Operating temperature	0 ... +50 °C (+32 ... +122 °F), a 50 % duty cycle may apply above +30 °C (+86 °F)
Storage	–25 … +70 °C (–13 … +158 °F)
Maximum altitude	2000 m (6560 ft)
Humidity	5 … 95 % relative humidity; no condensation
Climate	Tested according to IEC 60068-2-78

Shock and vibration	
Vibration	Tested according to IEC 60068-2-6; frequency range 10 ... 150 Hz; 2 g (20 sweeps)
Shock	Tested according to IEC 60068-2-27; 15 g/11 ms, half-sinusoid, each axis

1.10 Mechanical data

Size, weight and protection	
Weight	16 kg (35.3 lb)
Dimensions W × H × D (without handle)	450 × 145 × 390 mm (17.7 × 5.7 × 15.4")
Housing	IP20 according to IEC 60529

1.11 Safety standards, electromagnetic compatibility (EMC) and certificates

Electromagnetic interference (EMI)	
Europe	EN 61326-1; EN 61000-6-4; EN 61000-3-2/3; EN 55032 (Class A)
International	IEC 61326-1; IEC 61000-6-4; IEC 61000-3-2/3; CISPR 32 (Class A)
USA	47 CFR 15 Subpart B (Class A) of FCC
Electromagnetic susceptibility (EMS)	
Europe	EN 61326-1; EN 61000-6-2; EN 61000-4-2/3/4/5/6/8/11/16/18; EN 61000-6-5
International	IEC 61326-1; IEC 61000-6-2; IEC 61000-4-2/3/4/5/6/8/11/16/18; IEC 61000-6-5
Safety standards	
Europe	EN 61010-1; EN 61010-2-030
International	IEC 61010-1; IEC 61010-2-030
USA	UL 61010-1; UL 61010-2-030
Canada	CAN/CSA-C22.2 No 61010-1; CAN/CSA-C22.2 No 61010-2-030
Certificate	Manufactured under an ISO 9001 registered system

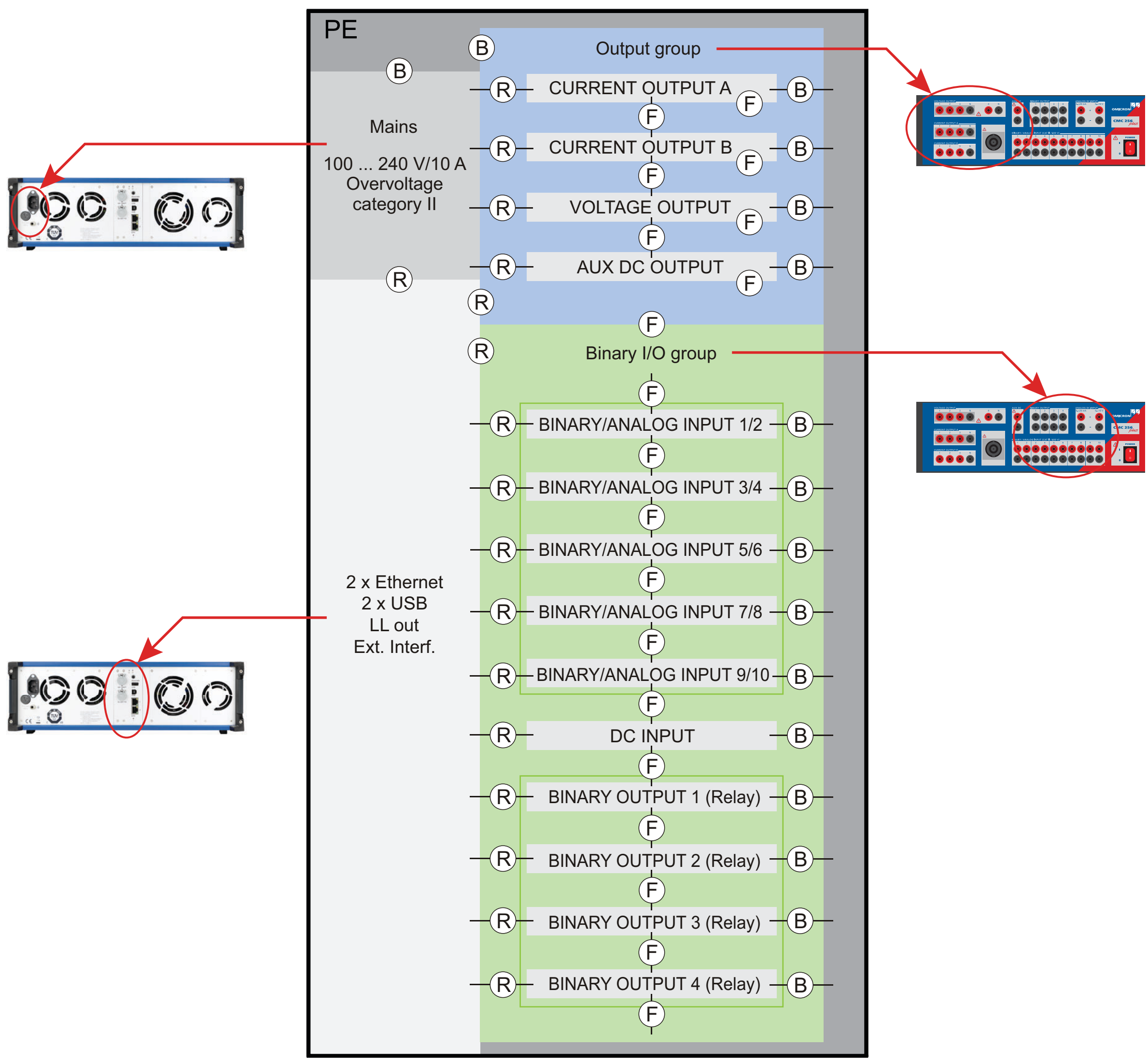
1.12 Electrical insulation groups

The following chapter shows how the inputs and outputs of *CMC* test sets are insulated against PE and each other.

B = Basic insulation

R = Reinforced insulation

F = Functional insulation



Insulation designed for pollution degree 2.

1.13 *EnerLyzer* measurement option

Optionally, each of the 10 binary/analog inputs of the *CMC 256plus* can be configured to be **analog measurement inputs** for DC and AC voltages of up to 600 V.

Voltage and current measurements on 3 channels are basic functionalities of the *CMC 256plus* test set. The fully featured measurement functionality on all 10 channels requires the *EnerLyzer* option.

As the analog inputs of the *CMC 256plus* are voltage inputs, active current clamps or current shunts (*C-Shunt 1* or *C-Shunt 10*) with voltage outputs have to be used to measure currents.

OMICRON offers the *C-PROBE1* as a suitable current clamp. This current clamp is not included in the delivery of the *EnerLyzer* measurement option. Please order it separately (→ "Support" on page 74).

1.13.1 General data

The analog measurement inputs have 5 measurement ranges that can be individually configured in the *EnerLyzer* test module.

- 100 mV
- 1 V
- 10 V
- 100 V
- 600 V

These range limits refer to the respective RMS values of the sinusoidal-shaped input signals. The ranges 100 mV, 1 V, 10 V and 100 V could be overloaded approximately with 10 %.

Input impedance: 500 kΩ || 50 pF for all measurement ranges

The sampling rate can be configured by software:

- 28.44 kHz
- 9.48 kHz
- 3.16 kHz

Four different operating modes are possible:

- Multimeter mode (→ section 1.13.2 on page 36)
- Harmonic analysis (→ section 1.13.3 on page 45)
- Transient recording (→ section 1.13.4 on page 48)
- Trend recording

1.13.2 Multimeter mode

This operating mode is designed for measuring steady-state signals (for example, also non-sinusoidal shaped). It can be used for measurements such as RMS values, phase angle, frequency, etc.

The input signals are processed in real time without delay.

Accuracy AC measurements

Conditions: integration time 1 s, measurement signal sinusoidal, excitation 10 ... 100 %, accuracy references the measurement full-scale values.

Sampling rate 28.44 kHz, measurement range 600 V, 100 V, 10 V, 1 V:

Frequency range	Accuracy	
	Typical	Guaranteed
DC	±0.15 %	±0.40 %
10 Hz ... 100 Hz	±0.06 %	±0.15 %
10 Hz ... 1 kHz	+0.06 %/–0.11 %	±0.25 %
10 Hz ... 10 kHz	+0.06 %/–0.7 %	±1.1 %

Sampling rate 28.44 kHz, measurement range 100 mV:

Frequency range	Accuracy	
	Typical	Guaranteed
DC	±0.15 %	±0.45 %
10 Hz ... 100 Hz	±0.1 %	±0.3 %
10 Hz ... 1 kHz	+0.15 %/–0.2 %	±0.5 %
10 Hz ... 10 kHz	+0.15 %/–1.0 %	±2 %

Sampling rate 9.48 kHz, 3.16 kHz; measurement range 600 V, 100 V, 10 V, 1 V:

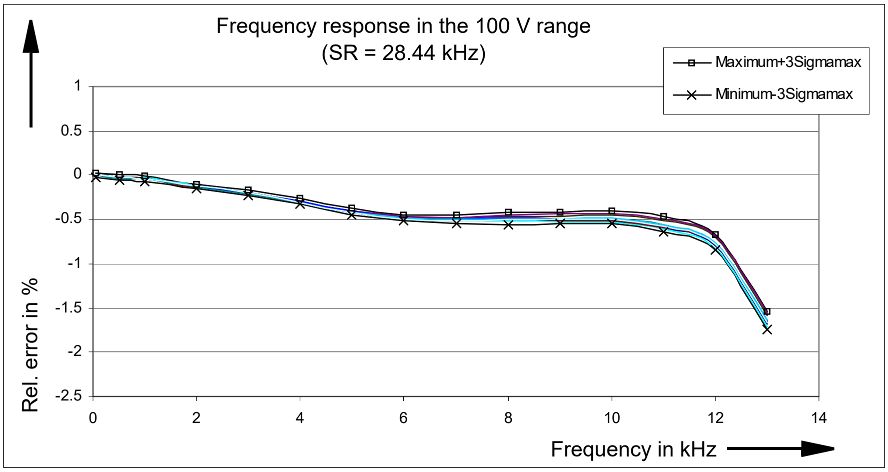
Frequency range	Accuracy	
	Typical	Guaranteed
DC	±0.15 %	±0.45 %
10 Hz ... 100 Hz	±0.08 %	±0.2 %
10 Hz ... 1 kHz	+0.1 %/–0.3 %	±0.5 %
10 Hz ... 4 kHz (sampling rate 9.48 kHz)	+0.1 %/–0.5 %	±1.2 %
10 Hz ... 1.4 kHz (sampling rate 3.16 kHz)	+0.1 %/–0.5 %	±1.0 %

Sampling rate 9.48 kHz, 3.16 kHz; measurement range 100 mV:

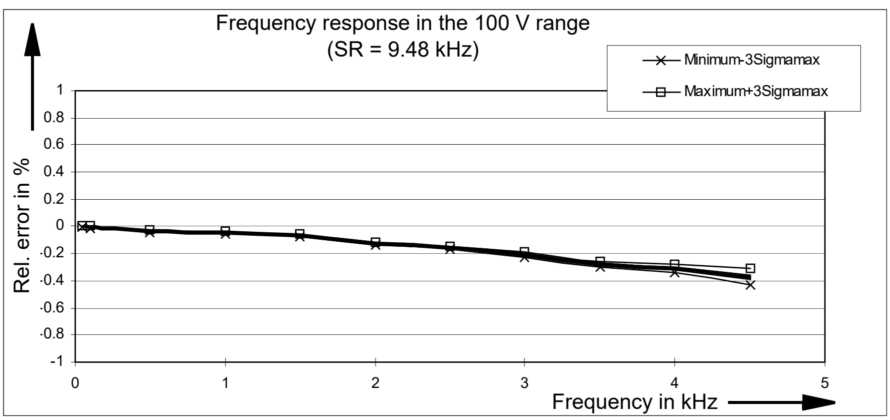
Frequency range	Accuracy	
	Typical	Guaranteed
DC	±0.15 %	±0.5 %
10 Hz ... 100 Hz	±0.1 %	±0.35 %
10 Hz ... 1 kHz	+0.15 %/–0.35 %	±0.5 %
10 Hz ... 4 kHz (sampling rate 9.48 kHz)	+0.15 %/–0.6 %	±1.2 %
10 Hz ... 1.4 kHz (sampling rate 3.16 kHz)	+0.15 %/–0.6 %	±1.2 %

The accuracy data contains linearity, temperature, long-term drift, and frequency.

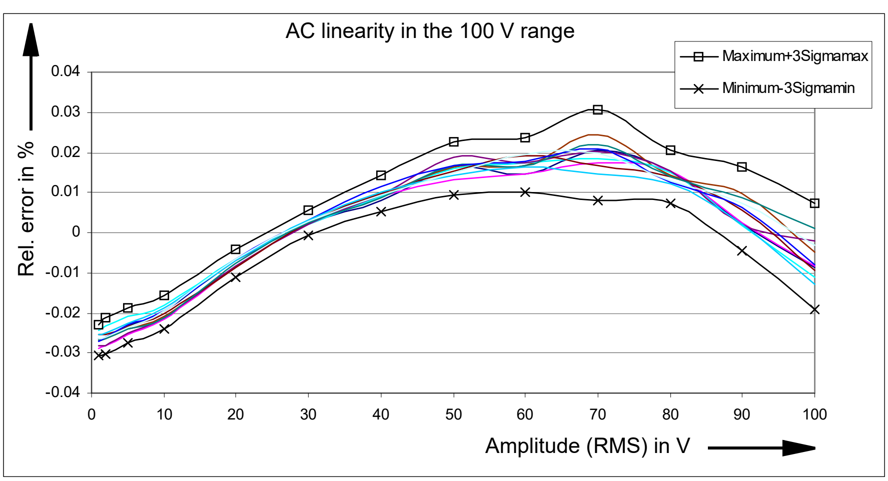
Typical frequency response with a sampling rate of 28.44 kHz and an input voltage of 70 V:



Typical frequency response with a sampling rate of 9.48 kHz and an input voltage of 70 V:



Typical AC linear progression at 50 Hz and a sampling rate of 28.44 kHz:



Note:

a) Relative error: $\frac{\text{Actual} - \text{Expected}}{\text{Full scale}} \times 100\ \%$

b) $3Sigma_{max}$ represents the maximum of the 3Sigma values of all 10 input channels.
The $3Sigma_{max}$ values of an analog input are determined from 50 measurement values.

Channel cross-talk

Conditions: sinusoidal form infeed on a channel without overload, AC measurement on neighboring channel, integration time 1 s.

Cross-talk dampening on channels of the same potential groups in dB at f = 50 Hz:

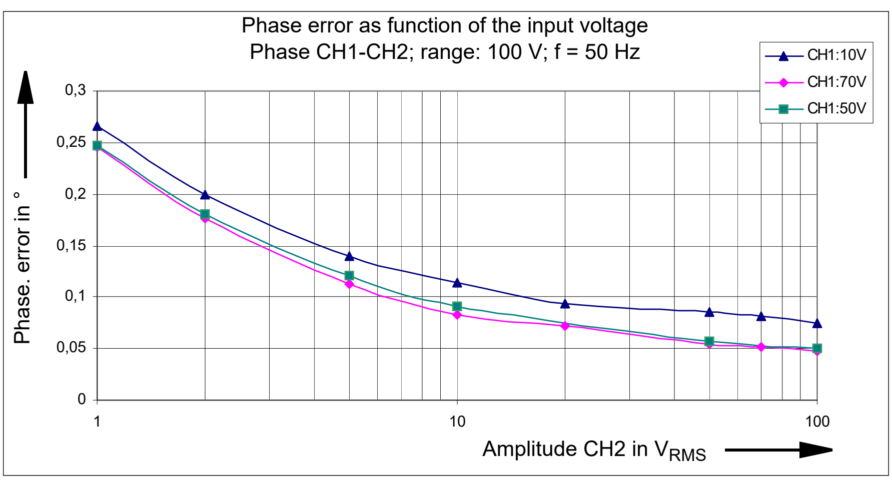
Measurement range	600 V	100 V	10 V	1 V	100 mV
Dampening in dB	80	105	95	120	120

Cross-talk dampening on channels of the same potential groups in dB at f = 500 Hz:

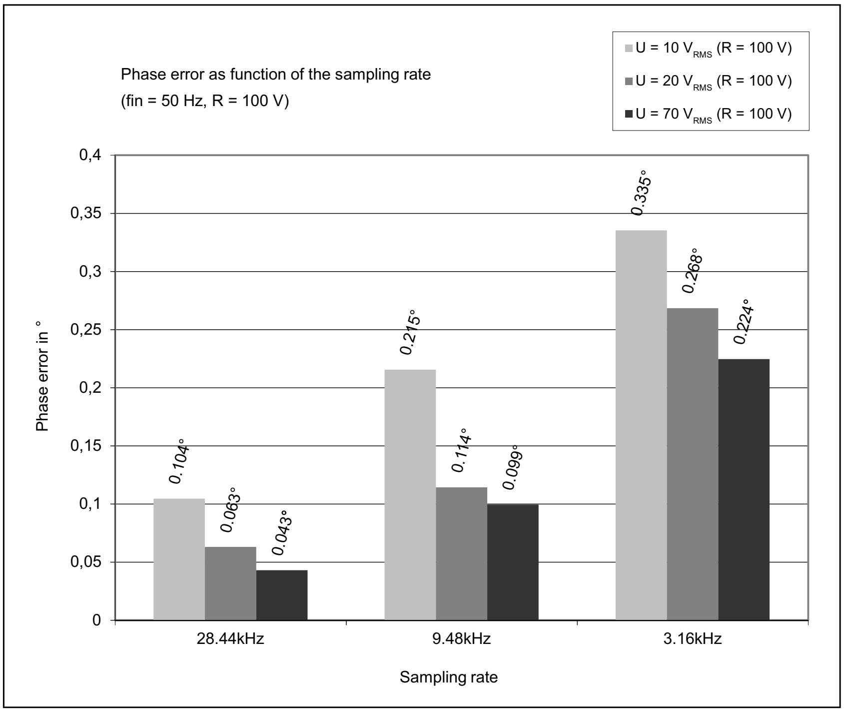
Measurement range	600 V	100 V	10 V	1 V	100 mV
Dampening in dB	65	80	75	95	95

The cross-talk dampening on a neighboring channel of another potential group is greater than 120 dB in all measurement ranges (f = 50 Hz or 500 Hz).

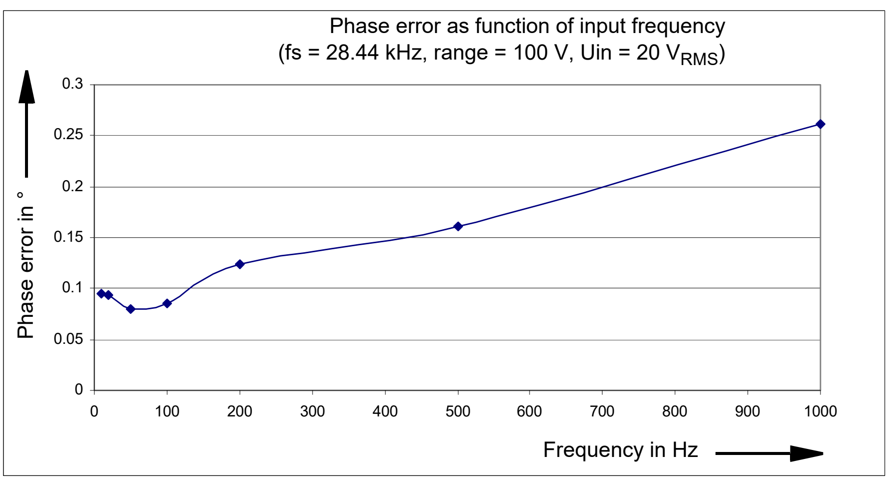
Accuracy phase measurements



Conditions: integration time 1 s, measurement signal sinusoidal, measurement range 100 V, f = 50 Hz, sampling rate 28.44 kHz.



Conditions: integration time 1 s, measurement signal sinusoidal, f = 50 Hz, measurement range 100 V, both channels same excitation (20 V, 70 V).



Conditions: integration time 1 s, measurement signal sinusoidal, sampling rate = 28.44 kHz, measurement range 100 V, excitation on both channels 20 V_{RMS}.

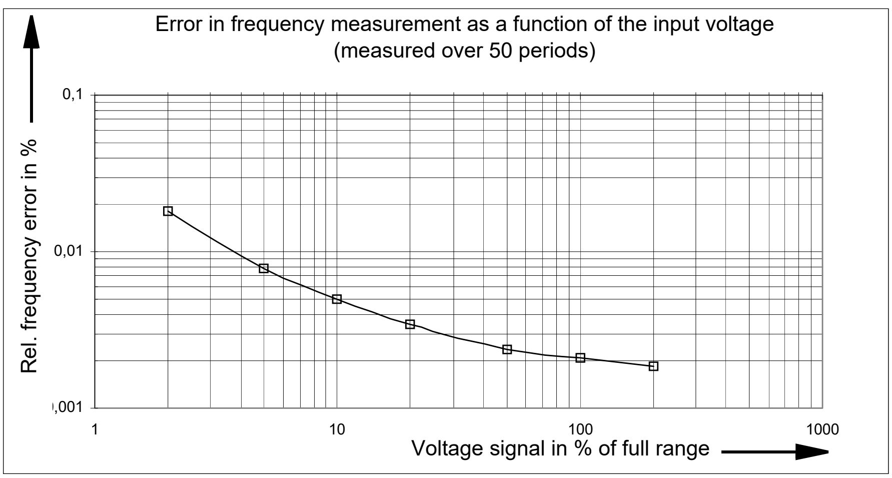
The maximum input frequency for the phase measurement depends on the sampling rate.

Sampling rate	Input frequency range
28.44 kHz	10 Hz ... 2.30 kHz
9.48 kHz	10 Hz ... 750 Hz
3.16 kHz	10 Hz ... 250 Hz

Note:

1. The measurement accuracy of phase can be improved by:
   - increasing the integration time
   - enabling the recursive averaging function
2. When measuring very small phase shifts (less than 0.2°), the sign (positive or negative) of the measurement results cannot be definitely determined. If this causes a problem, refer to the phase measurement in the harmonic analysis.
3. For measuring phase, the input voltage should be greater than 5 % of full scale. An overload of the measurement channel does not negatively affect the obtainable accuracy.

Accuracy of the frequency measurement



Conditions: integration time 1 s, measurement signal sinusoid.

The maximum input frequency for the frequency measurement depends on the sampling rate.

Sampling rate and input frequency range:

Sampling rate	Input frequency range
28.44 kHz	10 Hz ... 1500 Hz
9.48 kHz	5 Hz ... 500 Hz
3.16 kHz	5 Hz ... 150 Hz

Conditions: Excitation greater than 10 % from measurement full scale, duty cycle 50 %.

Note: With the harmonic analysis, you can measure input frequencies up to 3.4 kHz.

Accuracy of power measurement

a) General

The power is calculated from 1 current channel and 1 voltage channel:

Active power: $P = \frac{1}{T} * \int_0^T u(t) * i(t) dt$ [W]

Apparent power: $S = V_{RMS} \times I_{RMS}$ [VA]

Reactive power: $Q = \sqrt{S^2 - P^2} * sign\_Q$ [var]

$U_{RMS} = \sqrt{\frac{1}{T} * \int_0^T u(t)^2 dt}$, $I_{RMS} = \sqrt{\frac{1}{T} * \int_0^T i(t)^2 dt}$

b) Accuracies

Conditions: integration time 1 s, measurement signal sinusoidal, excitation 10–100 %, accuracy references the apparent power, error of the current clamp is not taken into consideration.

Sampling rates 28.44kHz, 9.48kHz, 3.16kHz:

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 100 Hz	S	±0.3 %	±0.7 %
	P	±0.3 %	±0.7 %
	Q	±0.8 %	±2 %

Sampling rate 28.44kHz:

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 2.2 kHz	S	+0.3 %/–1.2 %	±2.5 %
	P	+0.3 %/–1,2 %	±2.5 %
	Q	+0.8 %/–2.5 %	±3.5 %

1. Relative error: $\frac{\text{Actual} - \text{Expected}}{\text{Full scale}} \times 100\ \%$

S = Apparent power
P = Active power
Q = Reactive power

Sampling rate 9.48 kHz:

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 750 Hz	S	+0.3 %/–0.7 %	±1.8 %
10 Hz ... 750 Hz	P	+0.3 %/–0.7 %	±1.8 %
10 Hz ... 750 Hz	Q	+0.8 %/–1.2 %	±2.5 %

Sampling rate 3.16 kHz:

Frequency range	Power	Accuracy[1]	
AC		Typical	Guaranteed
10 Hz ... 250 Hz	S	+0.3 %/–0.5 %	±1.3 %
10 Hz ... 250 Hz	P	+0.3 %/–0.5 %	±1.3 %
10 Hz ... 250 Hz	Q	+0.8 %/–1 %	±2.2 %

DC accuracy:

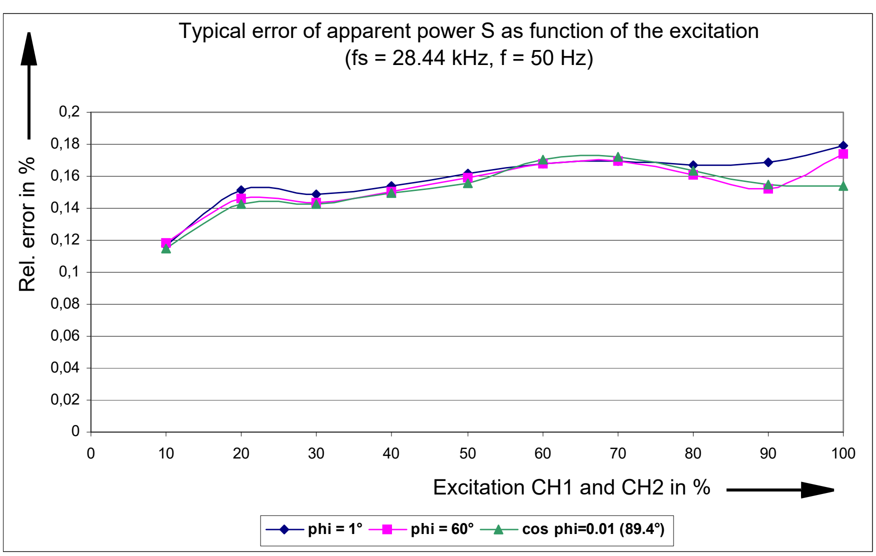
Power	Accuracy[1]	
P, S	Typical	Guaranteed
	±0.3 %	±0.9 %

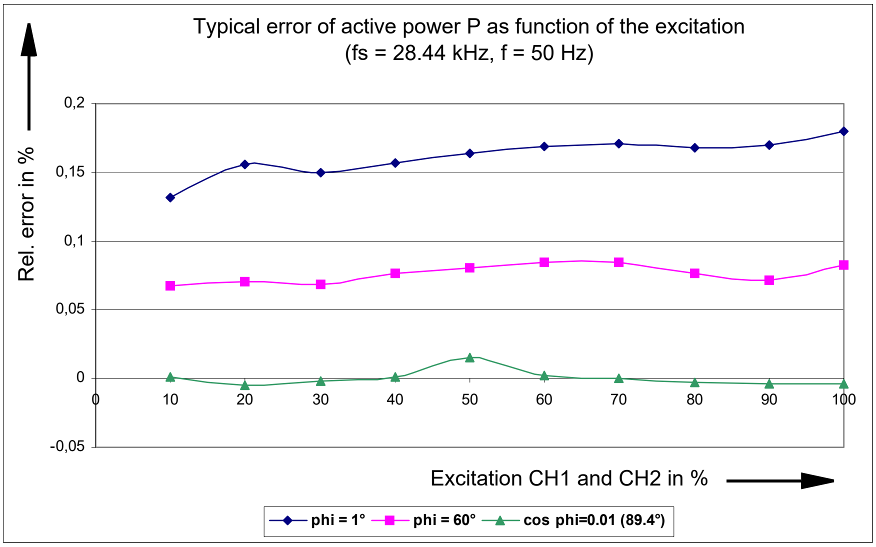
1. Relative error: $\frac{\text{Actual – Expected}}{\text{Full scale}} \times 100\ \%$

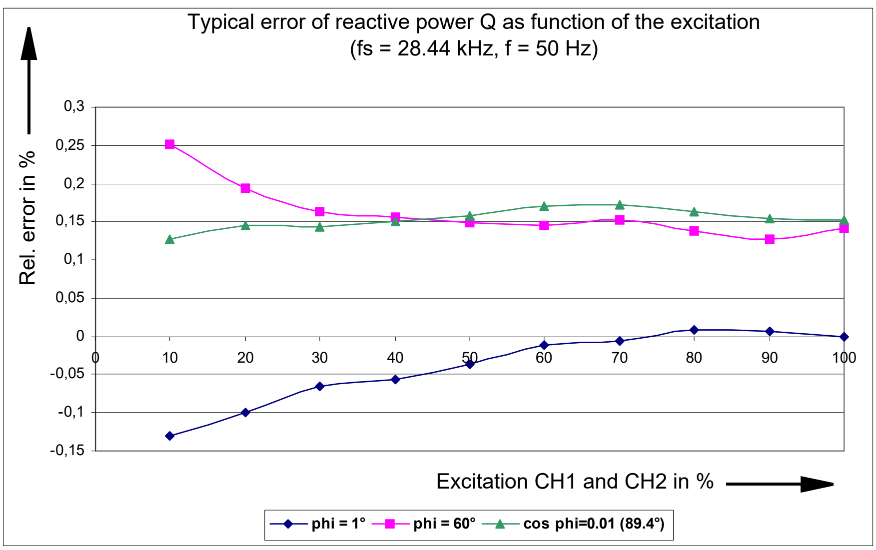
S = Apparent power
P = Active power
Q = Reactive power

The accuracy specifications include linearity, temperature, aging drift, frequency and phase response.

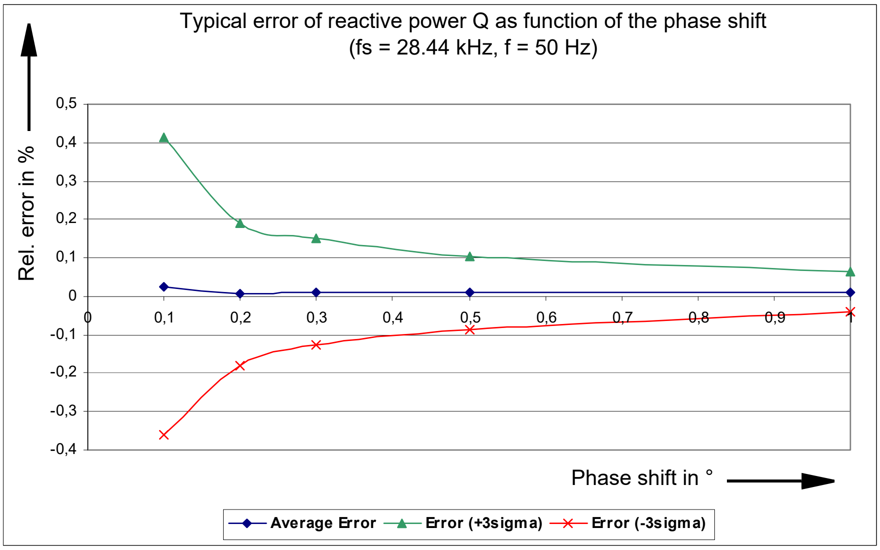
c) Typical relative error as function of the excitation







Conditions: integration time 1s, measurement signal sinusoid, sampling rate = 28.44 kHz, f_{in} = 50 Hz.



Conditions: integration time 1 s, measurement signal sinusoidal, sampling rate = 28.44 kHz, both channels with same excitation 70 %.

The 3Sigma values are determined from 50 measurement values.

Note:

- For very small phase shifts (<0,3°) and small excitation (<10 %), too little integration time (<1 s) or sampling rate 3.16 kHz, the sign of the reactive power cannot definitely be determined.
- The accuracy of the power measurement depends primarily on the accuracy of the current clamp.

1.13.3 Harmonic analysis

This operating mode is designed for measuring stationary signals (for example, non-sinusoidal shape). The input signal is separated into fundamental and harmonic waves (Fourier analysis).

The following items are measured:

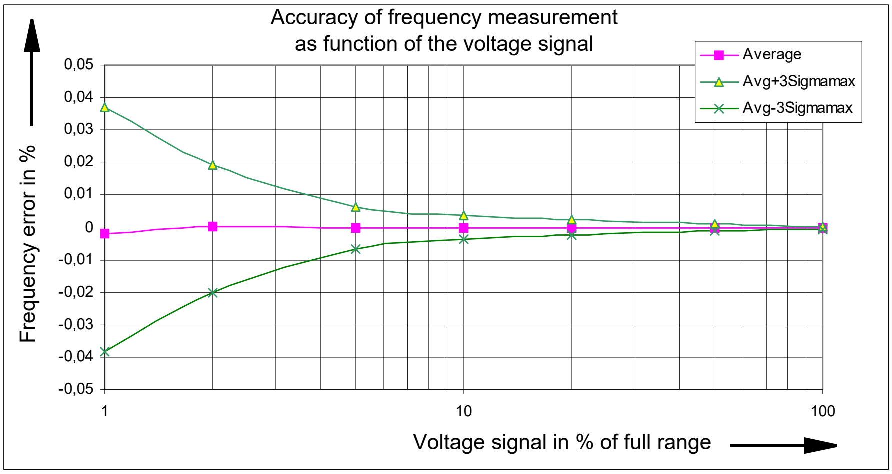
- frequency of the fundamental wave
- amplitude of the fundamental and harmonic waves
- phase shifts between the fundamental and harmonic waves (also from the different channels)

The input signals are captured. Finally, the calculation of the measurement items is carried out. During this time, the input signal is not taken into consideration.

Accuracy of the frequency measurement

The permitted input frequency range depends on the specified sampling rate:

Sampling rate	Input frequency range
28.44 kHz	49 Hz ... 3400 Hz
9.48 kHz	17 Hz ... 1100 Hz
3.16 kHz	5 Hz ... 380 Hz



Conditions: sampling rate 9.48 kHz, f_{in} = 20 Hz ... 1 kHz.

Note: Through recursive averaging, the measurement uncertainty can be further reduced.

Accuracy amplitude measurement

The measurement values are given as effective values (RMS). The permitted input frequency range for the fundamental wave depends on the specified sampling rate. Sampling rate and input frequency range:

Sampling rate	Input frequency range
28.44 kHz	100 Hz (= f_{min}) ... 3200 Hz
9.48 kHz	30 Hz (= f_{min}) ... 1000 Hz
3.6 kHz	10 Hz (= f_{min}) ... 350 Hz

Applies to fundamental and harmonic waves in a specified frequency range; accuracy refers to full scale.

Sampling rate 28.44 kHz; measurement range 600 V, 100 V, 10 V, 1 V:

Frequency range	Accuracy	
	Typical	Guaranteed
f_{min} ... 1 kHz	±0.1 %	±0.3 %
f_{min} ... 10 kHz	+0.1 %/–0.7 %	±1.1 %

Sampling rate 28.44 kHz; measurement range 100 mV:

Frequency range	Accuracy	
	Typical	Guaranteed
f_{min} ... 1 kHz	±0.2 %	±0.5 %
f_{min} ... 10 kHz	+0.2 %/–1.0 %	±2.0 %

Sampling rate 9.48 kHz, 3.16 kHz; measurement range 600 V, 100 V, 10 V, 1 V:

Frequency range	**Accuracy**	
	Typical	Guaranteed
f_{min} ... 100 Hz	±0.1 %	±0.3 %
f_{min} ... 1 kHz	+0.1 %/–0.5 %	±0.8 %
f_{min} ... 4 kHz (sampling rate = 9.48 kHz)	+0.1 %/–0.8 %	±1.2 %
f_{min} ... 1.4 kHz (sampling rate = 3.16 kHz)	+0.1 %/–0.8 %	±1.2 %

Sampling rate 9.48 kHz, 3.16 kHz; measurement range 100 mV:

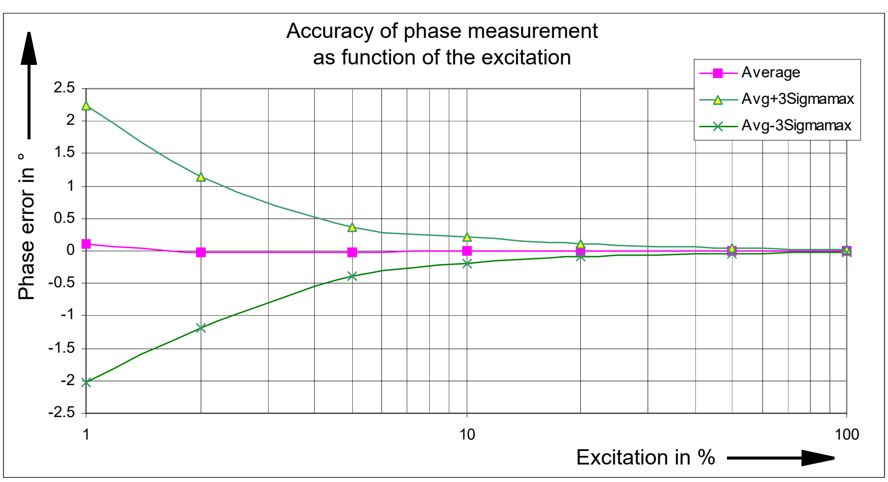
Frequency range	**Accuracy**	
	Typical	Guaranteed
f_{min} ... 100 Hz	±0.15 %	±0.4 %
f_{min} ... 1 kHz	+0.2 %/–0.5 %	±0.8 %
f_{min} ... 4 kHz (sampling rate = 9.48 kHz)	+0.2 %/–1.0 %	±1.5 %
f_{min} ... 1.4 kHz (sampling rate = 3.16 kHz)	+0.25 %/–1.0 %	±2.0 %

Accuracy of phase measurement

The permitted input frequency range for the fundamental wave depends on the specified sampling rate. Sampling rate and input frequency range:

Sampling rate	**Input frequency range**
28.44 kHz	100 Hz ... 3200 Hz
9.48 kHz	30 Hz ... 1000 Hz
3.16 kHz	10 Hz ... 350 Hz

Accuracy of phase measurement as function of the excitation:



Conditions: sampling rate 9.48 kHz, f_{in} = 50 Hz.

Note: Through recursive averaging, the measurement uncertainty can be further reduced.

1.13.4 Transient recording

In this operating mode, transient signals on up to 10 input channels can be synchronously recorded.

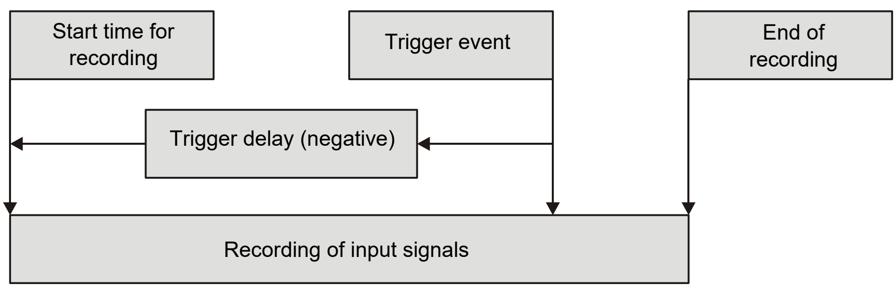
The recording starts whenever a predefined trigger condition is met. The selectable trigger conditions are:

- Trigger on threshold with positive or negative edge
- Combination of different power quality triggers (sag, swell, harmonic, frequency, frequency change, notch)

In addition, a time offset for the capture window relative to the trigger event can be specified. The trigger delay can be one of the following:

- positive (recording begins after the trigger event)
- negative (recording begins already before the trigger event)

Illustration of the relationship between trigger events, trigger delay, and recording time:



More details about triggering methods can be found in the OMICRON *Test Universe* help and in the practical examples of the *EnerLyzer* option.

The maximum recording time depends on the number of active channels and the sampling rate:

Number of active channels	**Maximum recording time [s] at fs = 28.4 kHz**	**Maximum recording time [s] at fs = 9.48 kHz**	**Maximum recording time [s] at fs = 3.16 kHz**
1	35.16 s	105.47 s	316.41 s
2	17.58 s	52.73 s	158.20 s
3	11.72 s	35.16 s	105.47 s
4	8.79 s	26.37 s	79.10 s
5	7.03 s	21.09 s	63.28 s
6	5.86 s	17.58 s	52.73 s
7	5.02 s	15.07 s	45.20 s
8	4.40 s	13.18 s	39.55 s
9	3.91 s	11.72 s	35.15 s
10	3.52 s	10.55 s	31.64 s
11[1]	3.20 s	9.59 s	28.76 s

1. All binary inputs are stored as 1 channel.

Accuracy of a transient sampled input value

Measurement range	Accuracy	
	Typical	Guaranteed
600 V, 100 V, 10 V, 1 V	Error <±0.2 %	Error <±0.5 %
100 mV	Error <+0.3 %	Error <±0.6 %

The accuracy data are full-scale errors.