C11

Transducer for measuring phase angle (Power Factor)

Fig. 1. C11
transducer in housing **E16**
clipped onto a top-hat DIN rail.

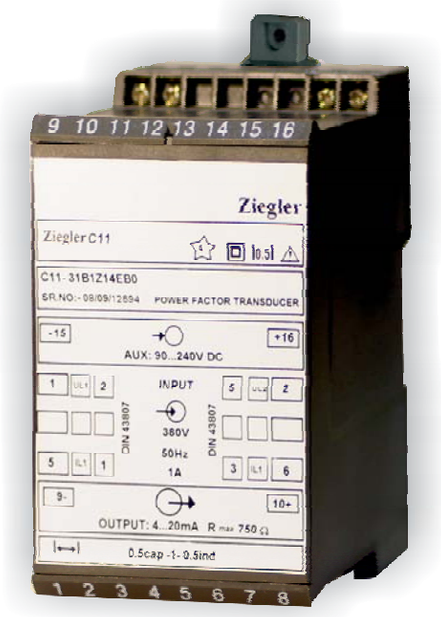


Fig. 2. C11
transducer in housing **E16** screw
hole mounting brackets pulled out.

Application

The transducer C11 (Fig. 1 and 2) measures the phase angle between current and voltage of a single or 3 phase balanced network having a sine wave form.

The output signal, in the form of a load independent DC current or voltage, is proportional to the phase angle between the 2 measured quantities current and voltage.

The measuring range scales of the connected instruments, such as indicators, recorders, controllers etc., are calibrated in cosφ values of the angle.

Features / Benefits

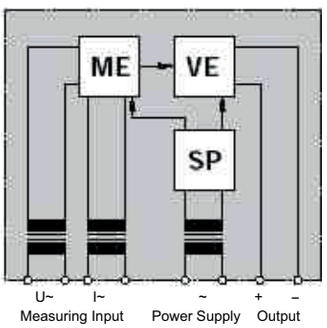
- Measuring inputs: Sine or distorted wave-forms of nominal input current and nominal input voltage

Measured variable	Nominal input current	Nominal input voltage	Measuring range limits
Phase Angle	0.01 to 10 A	10 to 660 V	0 to 30 & 0...175° el ± 15 to < ± 175° el

- Measuring output : DC current signal (load - independent) or DC voltage signal (not super-imposed)
- Measuring principle : Measurement of the zero crossing interval
- Electric isolation between all transducer connection circuits / Prevents interference voltages and currents being transmitted
- Narrow housing, 70 mm / Saves space and therefore costs
- Snaps onto a DIN rail or screws onto a wall or panel / Adaptable to the circumstances at the place of installation
- Screw terminals suitable for multistrand or solid wires / Easy wiring without problems
- Two isolated outputs (Optional)
- Electrical isolation between output 1 and output 2 is 500V

Mode of Operation (Fig.3)

The input variables – current and voltage – are matched to the internal instrument level via isolation transformers and led to an RS flip-flop. This bistable element generates constant-amplitude rectangular signals whose length corresponds to the time between the rising zero axis crossings of the two input variables. Parasitic zero axis crossings, due to superimposed ripple control frequencies for example, are almost suppressed by a dead time (positive feedback). The mean voltage of these rectangular waves is therefore proportional to the phase angle and inherently independent of the input frequency.



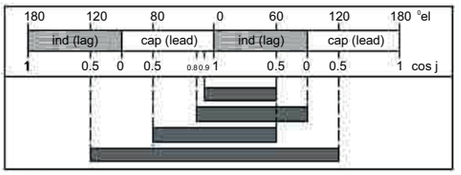
Technical Data

General

Measured quantity: Phase angle between current and voltage
Measuring principle: Measurement of the zero crossing interval

Measuring input E

Standard measuring ranges ① :
0.9–cap–1–ind–0.5
0.8–cap–1–ind–0
0.5–cap–1–ind–0.5
0.5–ind–0–cap–1–ind–0–cap–0.5



Nominal frequency f_N ② : 50 or 60 Hz

Nominal input voltage U_N ③ : 100/$\sqrt{3}$, 110/$\sqrt{3}$, 100, 110, 200, 230, 400 or 500 V

Nominal input current I_N ④ : 1, 2 or 5 A

Power consumption: : < 0.1 VA per current path
U_N × 1 mA per voltage path

Sensitivity: : < 0.05% of range end value

Overload capacity :

Measured quantity I_N U_N	Number of appli-cations	Duration of one application	Interval between two successive applications
2 x I_N	contin.	———	———
10 x I_N	5	15 s	5 min.
20 x I_N	5	1 s	5 min.
40 x I_N	1	1 s	———
1.5 x U_N	contin.	———	———
2 x U_N	10	10 s	10 s
4 x U_N	1	2 s	———

Measuring output A

Output signals: Load-independent DC voltage U_A
OR
Load-independent DC current I_A

Standard ranges of U_A ⑤ to ⑦ : 0...10 / 1...5 / –10...0...10 V

Load capacity 20 mA
External resistance for one output

$$R_{ext}\ \text{min.}\ [k\Omega] > \frac{U_{AN}\ [V]}{20\ mA}$$

U_{AN} = Full scale output

For two outputs
Rext. [kΩ] > 10 kΩ / V

Standard ranges of I_A ⑧ to ⑩ : 0...1/0...5/0...10/0...20/4...20 mA
–1...0...1/–2.5...0...2.5/–5...0...5/
–10...0...10/–20...0...20 mA
Burden voltage: ± 15 V for one output

Burden voltage: ± 12V for two outputs

External resistance

$$R_{ext}\,\text{max. } [k\Omega] \leq \frac{\text{Burden voltage}}{I_{AN}\,[mA]}$$

I_{AN} = Full scale Value

Voltage limit under $R_{ext} = \infty$	Approx. 40 V
Current limit under overload	Approx. 1.3 × I_{AN} with current Approx. 30 mA with voltage output
FSO variation:	Approx. ± 2%
Ripple in output current (11)	≤ 2% p.p.
Response time	< 300 ms

(1) to (11) see section "Special features"

Accuracy (acc. to DIN/IEC 688-1)

Reference value	:	Output span
Basic accuracy	:	Class 0.5
Reference conditions		
Ambient temperature	:	23°C, ± 5 K
Input current	:	0.8...1.2 I_N
Input voltage	:	0.8...1.2 U_N
Frequency	:	f_N ±10%
Wave form	:	Sine-wave
Power supply	:	U_{HN} ± 15% (AC), U_{HN} –15 / +33% (DC)
Output burden	:	0...R_{ext} max. with current output R_{ext} min. ...∞ with voltage output
Influence effects (maximum values): (included in basic error)		
Linearity error	:	± 0.2% for one output ± 0.4% for two outputs
frequency influence f_N ± 5%	:	± 0.05%
Dependence on external resistance (Δ R_{ext} max.)	:	± 0.05%
Power supply influence U_{HN} ± 10%	:	± 0.05%
Additional errors (maximum values)		
Temperature influence (–25...+55°C)	:	± 0.2% / 10 K for one output ± 0.3% / 10 K for two outputs
Voltage influence between 0.5 and 1.5 U_N	:	± 0.3% for one output ± 0.5% for two outputs
Current influence between 0.4 and 1.5 I_N	:	± 0.3% for one output ± 0.5% for two outputs
between 0.1 and 1.5 I_N	:	± 0.5 % for one output ± 0.7 % for two output
Frequency influence 45 – 200 Hz	:	± 0.5% for one output ± 0.7% for two outputs
External field influence 0.5 mT	:	± 0.2%
Power supply influence U_{HN} ± 20%	:	± 0.2%
Influence of common mode voltage 220 V, 50 Hz or 10 V, 1 MHz	:	± 0.2%
HF surge voltage influence		
acc. to IEC 255-4 Class III, 2.5 kV, 1 kV, 200 Ω 1 MHz, 400 Hz	:	± 4.0%
acc. to ANSI/IEEE C 37.90-1978 2.5 kV, 150 Ω 1 MHz, 50 Hz	:	± 1.0%

Power Supply →◯

AC voltage (12) (13)	:	24, 115, 120, 230 or 240 V, ± 20%, 42 to 70 Hz Power input approx. 4 VA for one output Power input approx. 8 VA for two outputs
DC voltage	:	24...90 VDC (24...60V for two outputs) or 90...240 VDC, –15 / +33%, 85...230 VDC, –15 / +33% (for 2 output) Power input approx. 4 W for one output Power input approx. 8 W for two outputs

Environmental conditions

Climate rating (14)	:	Climate class 3Z acc. to VDI/VDE 3540, but temperature continuously – 25 to +55°C. Relative humidity ≤ 75% annual mean (application class HVE acc. to DIN 40 040)
Storage temperature range	:	– 40 to +70°C

(12) to (14) see section "Special features"

Table 1 : Electromagnetic compatibility

The basic standards EN 50 081-2 and EN 50 082-2 were taken in account

Conducted interference from the instrument	EN 55 011	Group 1, Class A
HF radiation from complete instrument	EN 55 011	Group 1, Class A
Electrostatic discharge	IEC 801-2	± 4 kV contact, ± 8 kV air
HF field influence on instrument	IEC 801-3	80 to 1000 MHz, 10 V/m, 80 % AM 1 kHz
Transient burst via connections	IEC 801-4	± 2 kV, 5/50 ns, 5 kHz, > 1 min. capacitively coupled
Transient surge on power supply	IEC 801-5	± 2 kV, 1.2/50 ms, symmetrical ± 4 kV, 1.2/50 ms, asymmetrical
HF interference via connections	IEC 801-6	0.15 to 80 MHz: 10 V, 80% AM 1 kHz, source 150 Ω

The limits given in the standards mentioned are observed. During the interference test, occasional impairment of operating behaviour was permitted, but no change of operating mode and no loss of data.

Regulations

HF surge compatibility : 2.5/1 kV, 1 MHz, 400 surges/s acc. to IEC 255-4 Cl. III

Electrical standards : Acc. to IEC 348

Housing protection : IP 40 acc. to IEC 529
Terminals IP 20

Test voltage : Input versus Output : 4KV, 50Hz, 1min
Input versus Housing : 4KV, 50Hz, 1min
Output versus Housing : 4KV, 50Hz, 1min
Output1 versus Output2 : 500V, 50Hz, 1min

Installation Data

Mechanical design : Housing type E16
Dimensions see section “Dimensional drawings” (Page 5)

Material of Housing : Lexan 940 (polycarbonate),Flammability Class V-0 according to UL 94, self-extinguishing, non dripping, free of halogen

Mounting : For snapping onto top-hat rail (35 × 15 mm or 35 × 7.5 mm) acc. to EN 50 022 OR
directly onto a wall or panel using the pull-out screw hole brackets

Mounting Position : Any

Electrical connections : Screw - type terminals with indirect wire pressure,for max. 2 x 2.5 mm^2 or 1 x 6 mm^2

Weight : Approx. 0.6 kg.

Table : 1 : Special features

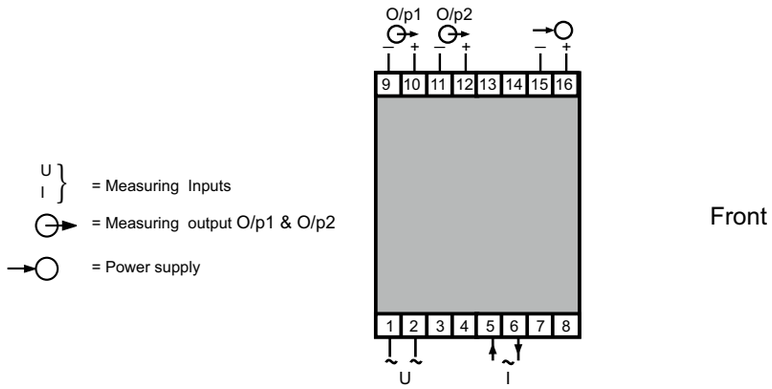
Nature of special features
Measuring range ① for power factor measurement deviating from standard measuring ranges (e.g. 0.8...cap, 1...ind...0.1) OR measuring range between 0...30 and 0...60°el resp. ± 15 to < ± 60°el Limitations: Measuring ranges < 60°el: Additional error 0.5% Nominal frequency ≥ 50 Hz Residual ripple ≤ 2% p.p. Response time < 1 s
Nominal frequency f_N ② between 16 and 400 Hz apart from the standard ranges 50 or 60 Hz Limitation at f_N > 100 Hz: Additional error 0.2%
Limitations at 16 ≤ f_N< 50 Hz: possible only with measuring ranges ≥ 0...60 or > ± 60°el Additional error 0.3% Residual ripple ≤ 2% p.p. Response time < 2 s
Nominal input voltage U_N ③ between 10 and 660 V, other than the standard values 100/$\sqrt{3}$, 110/$\sqrt{3}$, 100, 110, 200, 230, 400 or 500 V. **Limitation:**

Nature of special features
Nominal input voltage U_N ③ between 10 and 660 V, other than the standard values 100/$\sqrt{3}$, 110/$\sqrt{3}$, 100, 110, 200, 230, 400 or 500 V. **Limitation:** at U_N> 500 V overload capacity 2000 V, 2 s
Nominal input current I_N ④ between 0.01 and 10 A, other than the standard values 1, 2 or 5 A Limitations at I_N > 5 A: Power consumption < 0.3 VA per current circuit Overload capacity of current circuit 2 × I_N continuous 10 × I_N for 10 s maximum 5 times at 5 minute intervals 20 × I_N for 1 s maximum 5 times at 5 minute intervals 40 × I_N for 1 s max. 250 A, once only f_N ³ 40 Hz Limitations at I_N > 8.3 A Reference conditions I_E ≤ 10 A
Output signal A ⑤ Unipolar load-independent DC voltage* Ranges between 0...1 and 0...15 V, other than the standard range 0...10 V
Output signal A (continuation) ⑥ Live-zero* Ranges between 0.2...1 and 3...15 V, other than the standard range 1...5 V * Limitation at U_{AN} < 4 V **Additional error:** Burden dependency (Δ Rext max). = 0.2%, reference conditions: External resistance 2×Rext min. ± 20%
⑦ Bipolar symmetrical load-independent DC voltage* Ranges between –1...0...1 and –15...0...15 V, other than the standard range –10...0...10 V
⑧ Unipolar load-independent DC current Ranges between 0...1 and 0...20 mA, other than the standard range 0...1 / 0...5 / 0...10 and 0...20 mA
⑨ Live-zero Ranges between 1...5 and 4...20 mA, other than the standard range 4...20 mA
⑩ Bipolar symmetrical load-independent DC current Ranges between –1...0...1 and –20...0...20 mA, other than the standard ranges –1...0...1 / – 2.5...0...2.5 / – 5...0...5 / –10...0...10 and –20...0...20 mA
Residual ripple in output current ⑪ ≤ 0.5% p.p. instead of ≤ 2% p.p. Limitations: possible only with nominal frequency ≥ 50 Hz and measuring ranges ≥ 0...60 or > ± 60°el Response time < 1 s
Power supply ⑫ without separate power supply connection Power supply from voltage input signal (≥ 24 V to 500 V, f_N ≥ 50 to 400 Hz) for one output (> 24 V to 240 V, f_N > 50 to 400Hz) for two outputs **Limitation:** Reference conditions: Input voltage U_N ± 15% With U_N ≥ 170 V Impulse withstand voltage acc. to IEC 255-4, Cl. II:

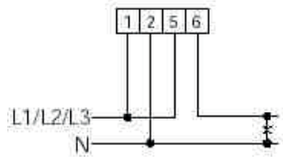
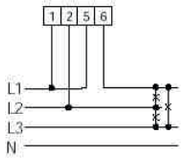
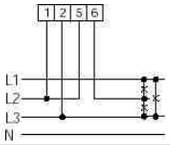
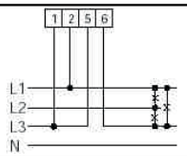
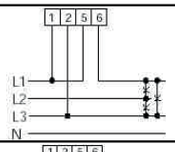
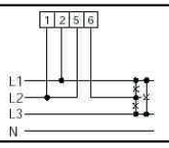
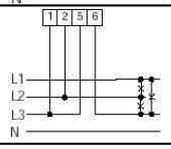
Nature of special features
1 kV, 1.2/50 µs, 0.5 Ws or overload capacity of the voltage input max. 680 V~, 2 s The additional power taken from the input voltage signal is approx. 4 VA
(13) with AC voltage any voltage between 24 and 500 V for one output, & 24 and 240 V, ± 20%, 42 to 70 Hz. Power consumption approx. 4 VA for one output & 8 VA for two outputs. apart from the standard voltages 24, 115, 120, 230 & 240 V

Nature of special features
Climatic rating (14) Climate class 3Z acc. to VDI/VDE 3540, but temperature continuously –25 to +55 °C. Relative humidity ≤ 90% annual mean (application class HVR acc. to DIN 40 040)

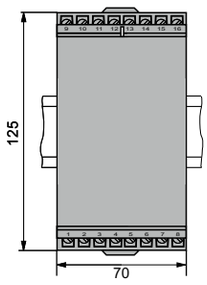
Electrical connections



Measuring Inputs

Application	Terminal allocation	Application	Terminal allocation
Phase angle measurement in single-phase AC network		Phase angle measurement in 3- or 4-wire 3-phase network balanced U: L1 – L2 I: L1	
Phase angle measurement in 3- or 4-wire 3-phase network U: L2 – L3 I: L2		Phase angle measurement in 3- or 4-wire 3-phase network U: L2 – L3 I: L2	
Phase angle measurement in 3- or 4-wire 3-phase network U: L1 – L3 I: L1		Phase angle measurement in 3- or 4-wire 3-phase network U: L1 – L3 I: L1	
Phase angle measurement in 3- or 4-wire 3-phase network U: L3 – L2 I: L3			

Dimensional Drawings



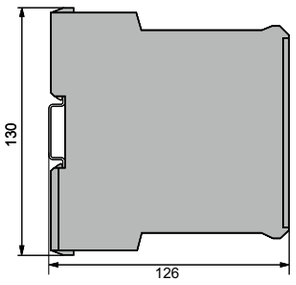
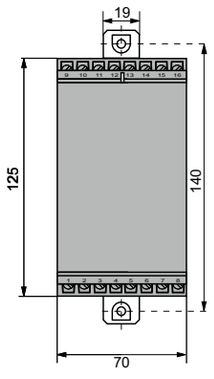


Fig. 10. C11 in housing **E16** clipped onto a top hat rail (35 × 15 mm or 35 × 7.5 mm, acc. to EN 50 022).



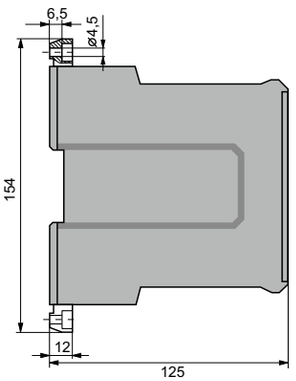
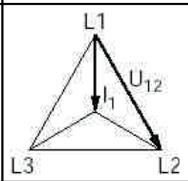
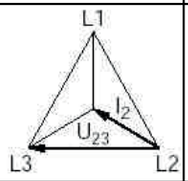
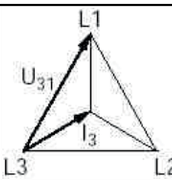
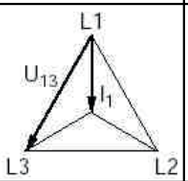
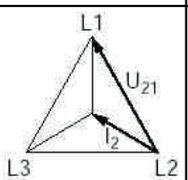
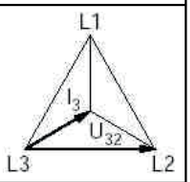


Fig. 11. C11 in housing **E16** with the screw hole brackets pulled out for wall mounting.

Application Note

For phase angle or power factor measurement in equally loaded three- or four-wire 3-phase networks the following data are needed for calibrating the transducer:

– Current connection (e.g. in phase L1)
– Voltage connection (e.g. between phases L1 – L3)

Current connection in phase	L1	L2	L3	L1	L2	L3
Voltage connection between phases	L1 - L2	L2 - L3	L3 - L1	L1 - L3	L2 - L1	L3 - L2
Vector diagrams						
Connection diagram	Fig. 4	Fig. 5	Fig. 6	Fig. 7	Fig. 8	Fig. 9
Limitation*: Max. meas. range	205 ... 0 ... 145° el current lagging			145 ... 0 ... 205° el current leading		

Specification and ordering information

Order Code C11 —

Features, Selection	*SCODE	no-go
1.Mechanical design 3) Housing E16	B	
2. Nominal frequency 1) 50 / 60 Hz	C	
3. Application		
A) Single-phase AC		
B) 3- or 4-wire 3/4-phase balanced U: L1-L2/I: L1		
C) 3- or 4-wire 3/4-phase balanced U: L2-L3/I: L2		
D) 3- or 4-wire 3/4-phase balanced U: L3-L1/I: L3		
E) 3- or 4-wire 3/4-phase balanced U: L1-L3/I: L1		
F) 3- or 4-wire 3/4-phase balanced U: L2-L1/I: L2		
G) 3- or 4-wire 3/4-phase balanced U: L3-L2/I: L3		
This feature selection “3. Application” and the later sections Application note” and “Electrical connections” must be checked and specified with one another.		
4. Nominal frequency (2) 1) 50 Hz		
2) 60 Hz		
9) Non-standard [Hz] ____ ≥ 16 to 400 Watch for restrictions/additional errors!		
5. Nominal input voltage (measuring input) (3)		
A) 100/√3 V;		
B) 110/√3 V;		
C) 100 V;		
D) 110 V;		
E) 200 V;		
F) 230 V;		
G) 400 V;		
H) 500 V;		
Z) Non-standard [V; V]: ____ ≥ 10.00; to 660;		

3	.	.	.	. . . . .
.	1	.	.	. . . . .
.	.	A	.	. . . . .
.	.	B	.	. . . . .
.	.	C	.	. . . . .
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B	.	.	.	. . . . .
C	.	.	.	. . . . .
D	.	.	.	. . . . .
E	.	.	.	. . . . .
F	.	.	.	. . . . .
G	.	.	.	. . . . .
H	.	.	.	. . . . .
Z	.	.	.	. . . . .

(2) see section “Special features”

Order Code C11 — [ ][ ][ ][ ]

Features, Selection	*SCODE	no-go	Insert code figure in the 1st field on the next page!
With a 3 phase system show the input nominal voltage as a phase to phase voltage. For transformer connection add semicolon with primary / secondary voltage in V, e.g. 6600/110 (in line D) or 120 ;14400/120 (in line Z, non-standard) show 2 decimal places			
6. Nominal input current (measuring input) ④			
1) 1 A;			. 1 . . . . .
2) 2 A;			. 2 . . . . .
3) 5 A;			. 3 . . . . .
9) Non-standard [A;A]: ≥ 0.01; to 10;			. 9 . . . . .
For transformer connection add semicolon with primary / secondary current in A, e.g.500/1 (in line 1) or 6.67;1600/6.67 (in line 9, non-standard) show 2 decimal places			
7. Measuring range ①			
2) 0.9-cap-1-ind-0.5			. . 2 . . . . .
3) 0.8-cap-1-ind-0			. . 3 . . . . .
4) 0.5-cap-1-ind-0.5			. . 4 . . . . .
5) 0.5-ind-0-cap-1-ind-0-cap-0.5			. . 5 . . . . .
Z) Non-standard [°el] e.g. 0.5-cap-1-ind-0 or 0…30 to 0…175, – 15…0…15 to – 175…0…175 Watch for restrictions/additional errors!			
8. Output signal (measuring output) output 1			
1) 0...10 V,			. . . 1 . . . . .
2) 1... 5 V,			. . . 2 . . . . .
3) – 10 ... 0...10 V,			. . . 3 . . . . .
9) Non-standard [V] 0…1.00 to 0…15 ⑤ 0.2…1 to 3…15 ⑥ – 1.00…0…1.00 to – 15…15 ⑦			. . . 9 . . . . .
8. Output signal (measuring output) output1 (continuation)			
A) 0... 1 mA			A . . . . .
B) 0... 5 mA			B . . . . .
C) 0...10 mA			C . . . . .
D) 0...20 mA			D . . . . .
E) 4...20 mA			E . . . . .
F) – 1 ... 0... 1 mA			F . . . . .
G) – 2.5 ... 0... 2.5 mA			G . . . . .
H) – 5 ... 0... 5 mA			H . . . . .
J) – 10 ... 0...10 mA			J . . . . .
K) – 20 ... 0...20 mA			K . . . . .
Z) Non-standard [mA] 0...> 1.00 to 0...< 20 ⑧ 1...5 to < (4...20) ⑨ > (–1.00...0...1.00) to < (–20...0...20) ⑩			Z . . . . .
9. Power supply			
0) Internal from voltage measuring input (≥ 24 to 500 V AC) ⑫			. 0 . . . . .
1) 24 V, 50/60 Hz			. 1 . . . . .
3) 115 V, 50/60 Hz			. 3 . . . . .
4) 120 V, 50/60 Hz			. 4 . . . . .
6) 230 V, 50/60 Hz			. 6 . . . . .

Continuation “8. Output signal” see next page!
①, ③ to ⑦ see section “Special features”

Order Code C11 —			
Features, Selection	***SCODE**	**no-go**	
7) 240 V, 50/60 Hz			. 7 . . . . .
9) Non-standard 50/60 Hz [V] ≥ 24 to 500 (13)			. 9 . . . . .
A) 24... 90 V DC, –15 / +33%		E	. A . . . . .
B) 90...240 V DC, –15 / +33%			. B . . . . .
C) 24...60 V DC, -15 / +33% (for 1 output)		D	. C . . . . .
D) 85...230 V DC V DC, -15 / +33% (for 2 output)			. G . . . . .
10. Special features			
0) Without	Y		. . 0 . . . . .
1) With			. . 1 . . . . .
Without special features (line 0): Order code complete With special feature (line 1): The features to be omitted must be marked with / (slant line) in the order code until reaching the required feature.			
11. Smaller residual ripple in measuring output (11) A) ≤ 0.5% p.p. instead of ≤ 2% p.p. Watch for response time and mutual dependence of residual ripple/response time!		Y	. . . A . . . .
12. Improved climatic rating (DIN 40 040) (14) A) Application class HVR instead of HVE (standard)		Y	. . . . A . . .
13. Output signal (measuring output) output 2 Same as Output signal (measuring output) output 1 in sr.no. 8	E		

* Lines with letter(s) under “no-go” cannot be combined with preceding lines having the same letter under “SCODE”.

(8) to (14) see section “Special features”

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