

# Ziegler Transducer C11

## PHASE ANGLE TRANSDUCER (POWER FACTOR)

in housing E16 for rail and wall mounting

The transducer **Ziegler 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  $\cos\phi$  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 and 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



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



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

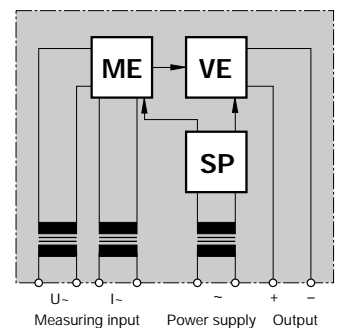
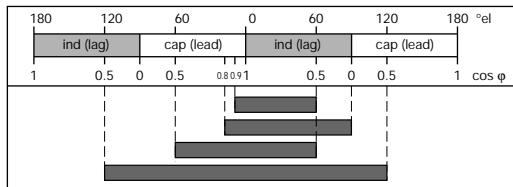


Fig. 3. Block diagram.

## Measuring input E $\rightarrow$

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

$U_N \cdot 1$  mA per voltage path

Sensitivity: < 0.05% of range end value

Overload capacity:

Measured quantity	Number of applications	Duration of one application	Interval between two successive applications
$2 \times I_N$	continuously	---	---
$10 \times I_N$	5	15 s	5 min
$40 \times I_N$	1	1 s	---
$1.5 \times U_N$	continuously	---	---
$2 \times U_N$	10	10 s	10 s
$4 \times U_N^1$	1	2 s	---

<sup>1</sup> but max. 1.5 kV

## Measuring output A $\rightarrow$

Output signals: Impressed 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

⑤ to ⑦

**for one output**

Load capacity 20 mA

External resistance

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

$U_{\text{AN}}$  = Full scale output

**For two outputs**

$R_{\text{ext.}} [\text{k}\Omega] > 10 \text{ k}\Omega / V$

① to ⑪ see section "Special features"

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:  $\pm 15$  V for one output

Burden voltage:  $\pm 12$  V for two outputs

External resistance

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

$I_{\text{AN}}$  = Full scale value

Voltage limit under

$R_{\text{ext}} = \infty$ :

Approx. 40 V

Current limit under

overload:

Approx.  $1.3 \times I_{\text{AN}}$  with current

Approx. 30 mA with voltage output

FSO variation:

Approx.  $\pm 2\%$

Ripple in output

current ⑪ :

$\leq 2\%$  p.p.

Response time:

< 300 ms

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

Reference value: Output span

Basic accuracy: Class 0.5

*Reference conditions:*

Ambient temperature 23°C,  $\pm 5$  K

Input current 0.8...1.2  $I_N$

Input voltage 0.8...1.2  $U_N$

Frequency  $f_N \pm 10\%$

Wave form Sine-wave

Power supply  $U_{\text{HN}} \pm 15\%$  (AC),  
 $U_{\text{HN}} - 15 / +33\%$  (DC)

Output burden 0... $R_{\text{ext max.}}$  with current output

$R_{\text{ext min.}} \dots \infty$  with voltage output

*Influence effects (maximum values):*

Included in basic error

Linearity error  $\pm 0.2\%$  for one output

$\pm 0.4\%$  for two outputs

Frequency influence

$f_N \pm 5\%$   $\pm 0.05\%$

Dependence on external resistance

( $\Delta R_{\text{ext max.}}$ )  $\pm 0.05\%$

Power supply influence

$U_{\text{HN}} \pm 15\%$   $\pm 0.05\%$

*Additional errors (maximum values)*

Temperature influence  $\pm 0.2\%$  / 10 K for one output

$\pm 0.3\%$  / 10 K for two outputs

Voltage influence

between  $\pm 0.3\%$  for one output

0.5 and 1.5  $U_N$   $\pm 0.5\%$  for two outputs

Current influence

between  $\pm 0.3\%$  for one output

0.4 and 1.5  $I_N$   $\pm 0.5\%$  for two outputs

between

0.1 and 1.5  $I_N$   $\pm 0.5\%$  for one output

$\pm 0.7\%$  for two outputs

Frequency influence

45 - 200 Hz  $\pm 0.5\%$  for one output

$\pm 0.7\%$  for two outputs

External field influence  
0.5 mT  $\pm 0.2\%$

Power supply influence  
 $U_{HN} \pm 20\%$   $\pm 0.2\%$

Influence of common mode voltage  
220 V, 50 Hz  
or 10 V, 1 MHz  $\pm 0.2\%$

HF surge voltage influence  
acc. to IEC 255-4 Class III,  
2.5 kV, 1 kV, 200  $\Omega$   
1 MHz, 400 Hz  $\pm 4.0\%$

acc. to ANSI/IEEE C 37.90-1978  
2.5 kV, 150  $\Omega$   
1 MHz, 50 Hz  $\pm 1.0\%$

#### Power supply → ○

AC voltage: 24, 115, 120, 230 or 240 V,  $\pm 20\%$ ,  
⑫ ⑬ 42 to 70 Hz  
Power input approx. 4 VA for one output  
Power input approx. 8 VA for two outputs

DC voltage: 24...90 (24...60V for two outputs) or  
90...240 V,  $-15 / +33\%$ ,  
Power input approx. 4 W for one output  
Power input approx. 8 W for two outputs

#### Installation data

Mechanical design: Housing type E16  
Dimensions see section "Dimensional drawings"

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 × 2.5 mm<sup>2</sup> or 1 × 6 mm<sup>2</sup>

Weight: Approx. 0.6 kg

#### 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: 4 kV / 50 Hz / 1 min.  
between electrically isolated circuits and versus housing  
500V / 50 Hz / 1min.  
between output 1 versus output 2.  
(for two outputs)

#### Environmental conditions

Climatic rating ⑭ : Climate class 3Z acc. to VDI/VDE 3540, but temperature continuously  $-25$  to  $+55^\circ\text{C}$ .  
Relative humidity  $\leq 75\%$  annual mean (application class HVE acc. to DIN 40 040)

Storage temperature range:  $-40$  to  $+70^\circ\text{C}$

⑫ to ⑭ see section "Special features"

### Table 1: Electromagnetic compatibility

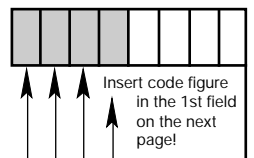
The basic standards EN 50 081-2 and EN 50 082-2 were taken in account

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	$\pm 4$ kV contact, $\pm 8$ 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	$\pm 2$ kV, 5/50 ns, 5 kHz, > 1 min. capacitively coupled
Transient surge on power supply	IEC 801-5	$\pm 2$ kV, 1.2/50 $\mu\text{s}$ , symmetrical $\pm 4$ kV, 1.2/50 $\mu\text{s}$ , asymmetrical
HF interference via connections	IEC 801-6	0.15 to 80 MHz: 10 V, 80% AM 1 kHz, source 150 $\Omega$

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.



Order Code <b>C11</b> -			
Features, Selection	*SCODE	no-go	
<b>5. Nominal input voltage (measuring input) ③</b>			
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;			
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			
<b>6. Nominal input current (measuring input) ④</b>			
1) 1 A;			
2) 2 A;			
3) 5 A;			
9) Non-standard [A;A]:			
≥ 0.01; to 10;			
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			
<b>7. Measuring range ①</b>			
2) 0.9-cap-1-ind-0.5			
3) 0.8-cap-1-ind-0			
4) 0.5-cap-1-ind-0.5			
5) 0.5-ind-0-cap-1-ind-0-cap-0.5			
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!			
<b>8. Output signal (measuring output) output 1</b>		<b>D</b>	
1) 0...10 V,			
2) 1... 5 V,			
3) -10 ... 0...10 V,			
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			



A	.	.	.	.	.	.	.	.	.
B	.	.	.	.	.	.	.	.	.
C	.	.	.	.	.	.	.	.	.
D	.	.	.	.	.	.	.	.	.
E	.	.	.	.	.	.	.	.	.
F	.	.	.	.	.	.	.	.	.
G	.	.	.	.	.	.	.	.	.
H	.	.	.	.	.	.	.	.	.
Z	.	.	.	.	.	.	.	.	.
.	1	.	.	.	.	.	.	.	.
.	2	.	.	.	.	.	.	.	.
.	3	.	.	.	.	.	.	.	.
.	9	.	.	.	.	.	.	.	.
.	.	2	.	.	.	.	.	.	.
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.	.	.	1	.	.	.	.	.	.
.	.	.	2	.	.	.	.	.	.
.	.	.	3	.	.	.	.	.	.
.	.	.	9	.	.	.	.	.	.

Continuation "8. Output signal" see next page!

①, ③ to ⑦ see section "Special features"

Order Code <b>C11</b> -										
Features, Selection	*SCODE	no-go								
<b>8. Output signal</b> (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] <input type="text"/>										Z . . . . .
0...> 1.00 to 0...< 20 <sup>⑧</sup>										
1...5 to < (4...20) <sup>⑨</sup>										
> (-1.00...0...1.00) to < (-20...0...20) <sup>⑩</sup>										
<b>9. Power supply</b>										
0) Internal from voltage measuring input (≥ 24 to 500 V AC) <sup>⑫</sup>										. 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 . . . . .
7) 240 V, 50/60 Hz										. 7 . . . . .
9) Non-standard 50/60 Hz [V] <input type="text"/>										. 9 . . . . .
> 24 to 500 <sup>⑬</sup>										
A) 24... 90 V DC, -15 / +33%		E								. A . . . . .
B) 90...240 V DC, -15 / +33%										. B . . . . .
C) 24...60 V DC, -15 / +33%		D								. C . . . . .
<b>10. Special features</b>										
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.										
<b>11. Smaller residual ripple in measuring output</b> <sup>⑪</sup>										. . . A . . . . .
A) ≤ 0.5% p.p. instead of ≤ 2% p.p. Watch for response time and mutual dependence of residual ripple/response time!		Y								
<b>12. Improved climatic rating</b> (DIN 40 040) <sup>⑭</sup>										. . . . A . . . .
A) Application class HVR instead of HVE (standard)		Y								
<b>13. Output signal</b> (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"

## Special features

Nature of special features	
<b>Measuring range</b>	
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. $\pm 15$ to $\pm 60^\circ\text{el}$ Limitations: Measuring ranges $< 60^\circ\text{el}$ : Additional error 0.5% Nominal frequency $\geq 50$ Hz Residual ripple $\leq 2\%$ p.p. Response time $< 1$ s
<b>Nominal frequency <math>f_N</math></b>	
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 $16 \leq f_N < 50$ Hz: possible only with measuring ranges $\geq 0...60$ or $> \pm 60^\circ\text{el}$ Additional error 0.3% Residual ripple $\leq 2\%$ p.p. Response time $< 2$ s
<b>Nominal input voltage <math>U_N</math></b>	
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
<b>Nominal input current <math>I_N</math></b>	
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 $2 \times I_N$ continuous $10 \times I_N$ for 10 s maximum 5 times at 5 minute intervals $40 \times I_N$ for 1 s max. 250 A, once only $f_N \geq 40$ Hz Limitations at $I_N > 8.3$ A Reference conditions $I_E \leq 10$ A
<b>Output signal A</b>	
⑤	Unipolar load-independent DC voltage* Ranges between 0...1 and 0...15 V, other than the standard range 0...10 V

Nature of special features	
<b>Output signal A (continuation)</b>	
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 ( $\Delta R_{ext}$ max). = 0.2%, reference conditions: External resistance $2 \times R_{ext}$ min. $\pm 20\%$
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
<b>Residual ripple in output current (for one output)</b>	
⑪	$\leq 0.5\%$ p.p. instead of $\leq 2\%$ p.p. Limitations: possible only with nominal frequency $\geq 50$ Hz and measuring ranges $\geq 0...60$ or $> \pm 60^\circ\text{el}$ Response time $< 1$ s
<b>Power supply</b>	
⑫	without separate power supply connection Power supply from voltage input signal ( $\geq 24$ V to 500 V, $f_N \geq 50$ to 400 Hz) for one output ( $\geq 24$ V to 240 V, $f_N \geq 50$ to 400Hz) for two outputs Limitation: Reference conditions: Input voltage $U_N \pm 15\%$ With $U_N \geq 170$ V Impulse withstand voltage acc. to IEC 255-4, Cl. II: 1 kV, 1.2/50 $\mu\text{s}$ , 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, $\pm 20\%$ , 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 and 240 V
<b>Climatic rating</b>	
⑭	Climate class 3Z acc. to VDI/VDE 3540, but temperature continuously -25 to +55 °C. Relative humidity $\leq 90\%$ annual mean (application class HVR acc. to DIN 40 040)

