

# Current and Voltage Controls Smart Power Meter Type SPT-DIN



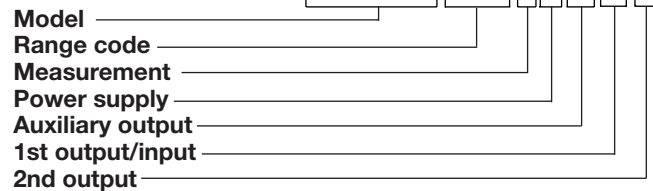
- 16-bits  $\mu$ P-based smart power meter
- Measurements of: W, Wavg, VA, VAR, PF, Wh, VAh, VARh, I<sub>max</sub> (among the phases), V<sub>delta</sub> avg, VL1-N, VL2-N, VL3-N, Hz L1.
- TRMS measurement of distorted waves (voltage/current)
- All configuration functions selectable by built-in key-pad
- Password protection of programming parameters
- Degree of protection (front): IP 50
- Optional independent alarm setpoint
- Optional analogue output (20 mA DC/  $\pm 10$  mA DC/  $\pm 5$  mA DC/10 VDC/ $\pm 1$ VDC)
- Optional serial RS 422/485 output
- MODBUS, JBUS protocol.

## Product Description

16-bit  $\mu$ P-based smart power meter with a built-in configuration key-pad. The house is for DIN-rail mounting and ensures a degree of protection (front) of IP 50

## Ordering Key

**SPT-DINAV51DXAX**



## Type Selection

Range code	Measurement	Auxiliary output	2nd output
<b>AV1:</b> 100/ $\sqrt{3}$ /100 VAC-1 AAC (max. 130/ $\sqrt{3}$ (L-N)/ 130 V (L-L) - 1.2 A) <sup>1)</sup>	<b>1:</b> One phase, three-phase system (3 or 4 wires, balanced load)	<b>X:</b> No output (standard)	<b>X:</b> No output (standard)
<b>AV3:</b> 100/ $\sqrt{3}$ /100 VAC-5 AAC (max. 130/ $\sqrt{3}$ (L-N)/ 130 V (L-L) - 6 A) <sup>1)</sup>	<b>3:</b> Three phase system (3 or 4 wires, unbalanced load)	<b>D:</b> Alarm set-point, static, AC type <sup>1)</sup>	<b>S:</b> Serial output, RS 485 multidrop bidirectional <sup>1)</sup>
<b>AV4:</b> 250/433 VAC - 1 AAC (max. 300 V (L-N)/ 520 V (L-L) - 1.2 A) <sup>1)</sup>	<b>Power supply</b>	<b>P:</b> Pulse, static, DC type <sup>1)</sup>	<b>A:</b> Analogue output, 20 mADC <sup>1)</sup>
<b>AV5:</b> 250/433 VAC - 5 AAC (max. 300 V (L-N)/ 520 V (L-L) - 6 A) (standard)	<b>A:</b> 24 VAC, -15% +10%, 50/60 Hz <sup>1)</sup>	<b>1st output/input</b>	<b>B:</b> Analogue output, $\pm 10$ mA <sup>1)</sup>
	<b>B:</b> 48 VAC, -15% +10%, 50/60 Hz <sup>1)</sup>	<b>D:</b> 3 digital inputs (managed only by means of the serial communication) <sup>1)</sup>	<b>C:</b> Analogue output, $\pm 5$ mA <sup>1)</sup>
	<b>C:</b> 115 VAC, -15% +10%, 50/60 Hz <sup>1)</sup>	<b>A:</b> Analogue output, 20 mADC (standard)	<b>V:</b> Analogue output, 10 VDC <sup>1)</sup>
	<b>D:</b> 230 VAC, -15% +10%, 50/60 Hz (standard)	<b>B:</b> Analogue output, $\pm 10$ mA <sup>1)</sup>	<b>U:</b> Analogue output, 0 to $\pm 1$ VDC <sup>1)</sup>
		<b>C:</b> Analogue output, $\pm 5$ mA <sup>1)</sup>	Note: Only for B and C outputs, the 2nd output can only be a B, C or S one.
		<b>V:</b> Analogue output, 10 VDC <sup>1)</sup>	
		<b>U:</b> Analogue output, 0 to $\pm 1$ VDC <sup>1)</sup>	

<sup>1)</sup> On request

## Input Specifications

Rated input	Accuracy
Current	Voltage/current/energy
Voltage	Frequency
Digital	Active power
	(@ 25°C $\pm$ 5°C, R.H. $\leq$ 60%)

## Input Specifications (cont.)

<b>Accuracy (cont.)</b>		<b>Ranges (impedances)</b>	
Reactive power (@ 25°C ± 5°C, R.H. ≤ 60%)	±0.5% f.s. (sen φ 0.7 L/C, 0.6 to 1 In, 0.9 to 1.1 Un) ±1% f.s. (sen φ 0.3 L/C, 0.2 to 1.2 In, 0.7 to 1.2 Un)	AV1:	100 V /√3/100 V (250 kΩ) - 1 AAC (≤ 0.3 VA)
Apparent power (@ 25°C ± 5°C, R.H. ≤ 60%)	±0.5% f.s., (0.6 to 1 In, 0.9 to 1.1 Un) ±1% f.s., (0.2 to 1.2 In, 0.7 to 1.2 Un)	AV3:	100 V /√3/100 V (250 kΩ) - 5 AAC (≤ 0.3 VA)
<b>Additional errors</b>		AV4:	250 V/433 V (1 MΩ) - 1 AAC (≤ 0.3 VA)
Humidity	< 0.3%, 60% to 90% R.H.	AV5:	250 V/433 V (1 MΩ) - 5 AAC (≤ 0.3 VA)
Input frequency	< 0.4%, 62 to 400 Hz	<b>Frequency range</b>	48 to 62 Hz
Magnetic field	< 0.5% @ 400 A/m	<b>Over-load protection</b>	
<b>Ripple</b>	≤ 1% according to IEC 60688-1 and EN 60 688-1	Continuous: voltage/current	1.2 x rated input
<b>Sampling rate</b>	1900 Hz	For 1 s	
<b>Display</b>	7-segment, LED, h 14.2 mm	Voltage:	2 x rated input
<b>Max. and min. indication</b>	Max. 999, min. -999	Current:	20 x rated input
<b>Measurements</b>	W, Wavg, VA, VAr, PF, Wh, VAh, VArh, I <sub>max</sub> (among the phases), V <sub>delta</sub> avg, VL1-N, VL2-N, VL3-N, Hz L1. TRMS measurement of a dis- torted wave voltage/current Coupling type : Direct Crest factor: ≥ 3	<b>Keyboard</b>	3 keys: "S" for enter programming phase and password confir- mation, "UP" and "DOWN" for value programming/function selection

## Output Specifications

<b>Analogue outputs</b>		<b>Serial output (on request)</b>	
Number of outputs	1 (standard) + 1 (on request)	Type	RS422/RS485;
Range	0 to 20 mADC, 0 to ±10 mADC, 0 to ± 5 mADC	Multidrop	bidirectional (static and dynamic variables)
Scaling factor	Programmable within the whole range of retransmis- sion; it allows the retrans- mission management of all values from	Connections	2 or 4 wires, max. distance 1200m, termination and/or line bias by means of DIP- switches directly on the transducer
Response time	0 to 20 mA, 0 to ±10 mADC, 0 to ±5 mADC	Adresses	255, selectable by key-pad
Temperature drift	0 to 10 V, 0 to ± 1 VDC	Protocol	MODBUS/JBUS
Load:	≤ 250 ms typical (filter excluded)	Data (bidirectional)	
20 mA output	300 ppm/°C	Dynamic (reading only)	System variables: P, P <sub>AVG</sub> , S, Q, cos φ, V <sub>L-L</sub> , f, energy and status of digital inputs, setpoint output and status of the energy over- flow bit,
±10 mA output	≤ 500 Ω		Single phase variables: P <sub>L1</sub> , S <sub>L1</sub> , Q <sub>L1</sub> , Cos φ <sub>L1</sub> , V <sub>L1-N</sub> , I <sub>L1</sub> , P <sub>L2</sub> , S <sub>L2</sub> , Q <sub>L2</sub> , Cos φ <sub>L2</sub> , V <sub>L2-N</sub> , I <sub>L2</sub> , P <sub>L3</sub> , S <sub>L3</sub> , Q <sub>L3</sub> , Cos φ <sub>L3</sub> , V <sub>L3-N</sub> , I <sub>L3</sub>
±5 mA output	≤ 1000 Ω	Static (writing only)	All programming data, reset of energy, reset of energy overflow bit, activation of static output.
10 V output	≥ 10 kΩ		Stored energy (EEPROM)
±1 V output	≥ 10 kΩ		≥ 250,000.000 kWh
<b>Analogue outputs</b>		Data format	1-start bit, 8-data bit, no parity/even parity, 1 stop bit
Insulation	By means of optocouplers, 2000 V <sub>rms</sub> output to measuring input 4000 V <sub>rms</sub> output to supply input		

## Output Specifications (cont.)

<b>Serial output (cont.)</b>		<b>Alarms (on request)</b>	
Baud-rate	1200, 2400, 4800 and 9600 selectable bauds	Number of setpoints	1 independent
Insulation	By means of optocouplers, 4000 V <sub>rms</sub> output to measuring inputs 4000 V <sub>rms</sub> output to supply input	Alarm type	Up alarm, down alarm
Temperature drift	200 ppm/°C	Setpoint adjustment	0 to 100% of the electrical scale
<b>Pulse output</b>		Hysteresis	0 to 100% of the electrical scale
Type	From 1 to 999 programmable pulses for kWh, KVAh, KVArh, MWh, MVAh, MVArh, open collector (NPN transistor) V <sub>ON</sub> 0.6 VDC/ max. 4 mA V <sub>OFF</sub> 26 VDC max.	On-time delay	0 to 255 s
Pulse duration	20 ms (ON), ≥ 20 ms (OFF)	Relay status	Normally de-energized
Insulation	By means of optocouplers, 4000 V <sub>rms</sub> output to measuring input, 4000 V <sub>rms</sub> output to supply input.	Output type	Static by TRIAC; performances: 24 VAC to 250 VAC, max 50 mA.
		Min. response time	300 ms, filter excluded, setpoint on-time delay: "0"
		Insulation	2000 V <sub>rms</sub> output to measuring input, 4000 V <sub>rms</sub> output to supply input

## Software Functions

<b>Password</b>		<b>Measurement selection (cont.)</b>	
1st level	Numeric code of max. 3 digits; 2 protection levels of the programming data Password "0", no protection Password from 1 to 499, all data are protected	<b>Transformer ratio</b>	system's reactive energy, system's (+/-) active energy For CT up to 5000 A, For VT up to 100 kV (1MV)
2nd level		<b>Scaling factor</b>	
<b>Measurement selection</b>	System's active power (W), system's apparent power (VA), system's reactive power (VAr), average active power (Wavg), system's power factor (cos φ), maximum current (I max), average phase-phase voltage, phase-neutral voltage-phase 1, phase-neutral voltage-phase 2, phase-neutral voltage-phase 3, frequency-phase 1. System's (+) active energy, system's apparent energy,	Operating mode	Electrical scale: compression/expansion of the input scale to be connected to 1 or 2 analogue outputs and to the alarm output. Programmable within the whole measuring range
		Electrical range	
		<b>Filter</b>	
		Filter operating range	0 to 99.9% of the input electrical scale
		Filtering coefficient	1 to 255
		Filter action	Both analogue and serial outputs (fundamental variables: V, I, W and their derived ones)

## Supply Specifications

<b>AC voltage</b>	230 VAC (standard), -15%+10% 50/60 Hz 24 VAC, 48 VAC, 115 VAC (on request), -15%+10% 50/60 Hz	<b>Power consumption</b>	≤ 10 VA
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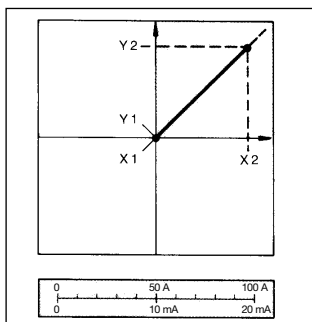
## Function Description

### Input and output scaling capability

Working of the analogue outputs (y) versus input variables (x)

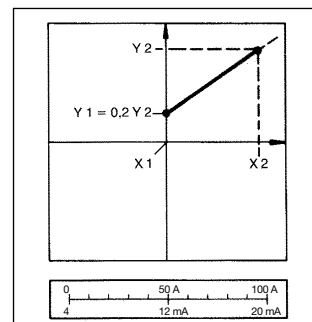
**Figure A**

The sign of measured quantity and output quantity remains the same. The output quantity is proportional to the measured quantity.



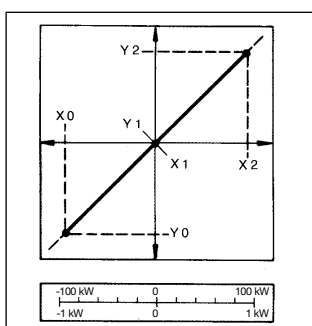
**Figure D**

The sign of measured quantity and output quantity remains the same. With the measured quantity being zero, the output quantity already has the value  $Y1 = 0.2 Y2$ . Live zero output.



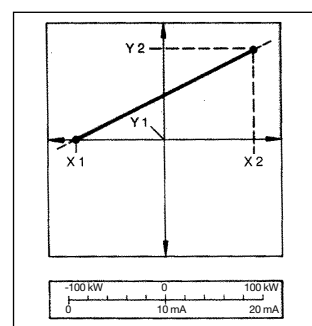
**Figure B**

The sign of measured quantity and output quantity changes simultaneously. The output quantity is proportional to the measured quantity.



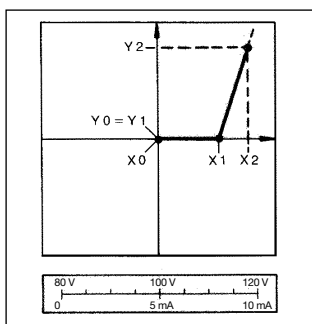
**Figure E**

The sign of the measured quantity changes but that of the output quantity remains the same. The output quantity steadily increases from value X1 to value X2 of the measured quantity.



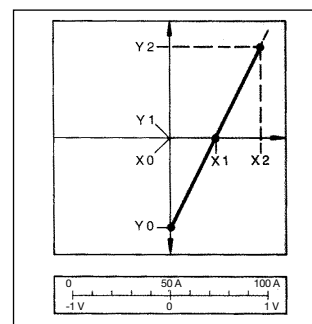
**Figure C**

The sign of measured quantity and output quantity remains the same. On the range X0...X1, the output quantity is zero. The range X1...X2 is delineated on the entire output range  $Y0 = Y1...Y2$  and thus presented in strongly expanded form.



**Figure F**

The sign of the measured quantity remains the same, that of the output quantity changes as the measured quantity leaves range X0...X1 and passes to range X1...X2 and vice versa.



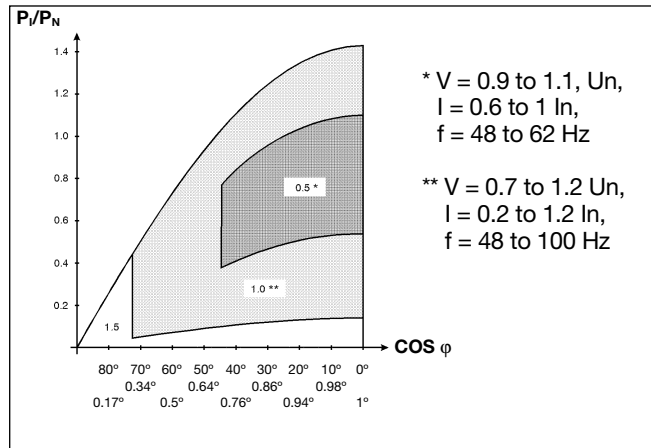
## General Specifications

<b>Operating temperature</b>	0 to +50°C (32 to 122°F) (R.H. < 90% non-condensing)
<b>Storage temperature</b>	-10 to +60°C (14 to 140°F) (R.H. < 90% non-condensing)
<b>Insulation reference voltage</b>	300 V <sub>rms</sub> to ground
<b>Insulation</b>	4000 V <sub>rms</sub> between all inputs/ outputs to ground
<b>Dielectric strength</b>	4000 V <sub>rms</sub> for 1 minute
<b>Noise rejection</b>	
CMRR	100 dB, 48 to 62 Hz
<b>EMC</b>	EN 50 081-2, EN 50 082-2

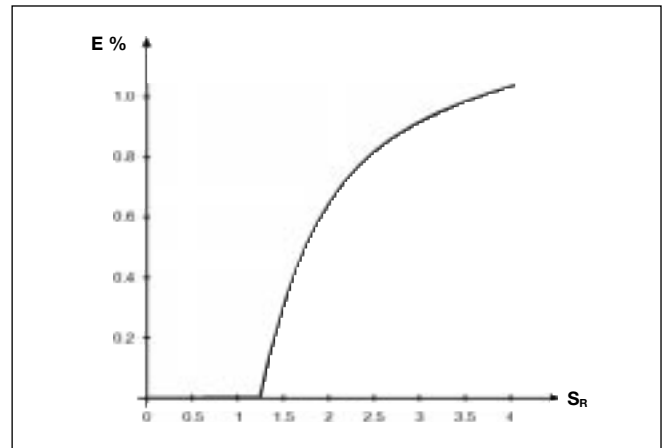
<b>Safety standards</b>	
Safety requirements:	IEC 601010-1, EN 61010-1
Products requirements:	IEC 60688-1, EN 60 688-1
<b>Connector</b>	Screw-type, max. 2.5 mm <sup>2</sup> wires
<b>Housing</b>	
Dimensions	6 DIN modules, 58.5 x 89 x 107 mm
Material	ABS, self-extinguishing: UL 94 V-0
<b>Degree of protection</b>	Front: IP50
<b>Weight</b>	Approx. 500 g (packing included)

## Mode of Operation

### Accuracy class of the meter as a relation of P/P<sub>N</sub> and cos φ



### Trends of the "E" error depending on the S<sub>R</sub> scale ratio



Input	Star voltage	Delta voltage	Current
AV1	Un: 100 V/√3	Un: 100 V	In: 1 A
AV3	Un: 100 V/√3	Un: 100 V	In: 5 A
AV4	Un: 230 V	Un: 398 V	In: 1 A
AV5	Un: 230 V	Un: 398 V	In: 5 A

#### P<sub>i</sub>: (installation power)

One phase system:

$$P_i = U_i \cdot I_i \cdot \cos \varphi$$

Three phase, 3-wire system:

$$P_i = \sqrt{3} \cdot U_i \cdot I_i \cdot \cos \varphi$$

Three phase, 4-wire system:

$$P_i = 3 \cdot U_i \cdot I_i \cdot \cos \varphi$$

where:

U<sub>i</sub> = the real star voltage of the electrical system being measured.

I<sub>i</sub> = the maximum phase current of the electrical system being measured.

Cos φ = the average cos φ of the electrical system being measured.

#### P<sub>s</sub>: (rated power of transducer)

One phase system:

$$P_s = U_s \cdot I_s \cdot VT(\text{ratio}) \cdot CT(\text{ratio})$$

Three phase, 3-wire system:

$$P_s = \sqrt{3} \cdot U_s \cdot I_s \cdot VT(\text{ratio}) \cdot CT(\text{ratio})$$

Three phase, 4-wire system:

$$P_s = 3 \cdot U_s \cdot I_s \cdot VT(\text{ratio}) \cdot CT(\text{ratio})$$

where:

U<sub>s</sub> = the rated input voltage of SPT-DIN depending on the model, see table above.

I<sub>i</sub> = the rated input current of SPT-DIN depending on the model, see table above.

VT (ratio) = the value of the voltage transformer ratio.

CT (ratio) = the value of the current transformer ratio.

#### Example 1:

Model AV3.3 (3-wire system).

U<sub>i</sub> = 6 kV (delta voltage)

I<sub>i</sub> = 265 A (single phase current)

Cos φ = 0.85 (system power factor)

U<sub>s</sub> = 100 V

I<sub>s</sub> = 5 A

$$VT(\text{ratio}) = \frac{6 \text{ kV}}{100} = 60$$

$$CT(\text{ratio}) = \frac{300}{5} = 60$$

$$P_i = \sqrt{3} \cdot U_i \cdot I_i \cdot \cos \varphi = \sqrt{3} \cdot 6000 \cdot 265 \cdot 0.85 = 2.33 \text{ MW}$$

$$P_s = \sqrt{3} \cdot U_s \cdot I_s \cdot VT(\text{ratio}) \cdot CT(\text{ratio}) = \sqrt{3} \cdot 100 \cdot 5 \cdot 60 \cdot 60 = 3.12 \text{ MW}$$

$$\frac{P_i}{P_s} = \frac{2.33}{3.12} = 0.75$$

#### Example 2:

Model AV3.3 (4-wire system).

U<sub>i</sub> = 6 kV / √3

I<sub>i</sub> = 265 A

Cos φ = 0.85

U<sub>s</sub> = 100 V / √3

I<sub>s</sub> = 5 A

$$VT(\text{ratio}) = \frac{6 \text{ kV} / \sqrt{3}}{100 / \sqrt{3}} = 60$$

$$CT(\text{ratio}) = \frac{300 \text{ A}}{5 \text{ A}} = 60$$

$$P_i = 3 \cdot U_i \cdot I_i \cdot \cos \varphi = 3 \cdot 6000 / \sqrt{3} \cdot 265 \cdot 0.85 = 2.33 \text{ MW}$$

$$P_s = 3 \cdot U_s \cdot I_s \cdot VT(\text{ratio}) \cdot CT(\text{ratio}) = 3 \cdot 100 / \sqrt{3} \cdot 5 \cdot 60 \cdot 60 = 3.12 \text{ MW}$$

$$\frac{P_i}{P_s} = \frac{2.33}{3.12} = 0.75$$

In both examples the accuracy of the measurement is 0.5% f.s. when considering the changing of the measured voltage from 0.9 U<sub>n</sub> to 1.1 U<sub>n</sub> and the measured current from 0.6 I<sub>n</sub> to 1 I<sub>n</sub> with a cos φ of 0.85. The accuracy of the output is connected to the accuracy of the measurement plus the scale ratio of both input (Hi.E - Lo.E) and output (Hi.A - Lo.A) as shown in the graph above (E% versus S<sub>R</sub>).

#### Regarding S<sub>R</sub>:

$$S_R = \frac{AFS \cdot (Hi.A - Lo.A)}{100 \cdot (Hi.E - Lo.E)} \leq 1.25$$

AFS = automatic electrical full scale calculated value.

S<sub>R</sub> = scale ratio.

There is not any additional error on the output signal if S<sub>R</sub> ≤ 1.25.

#### Example 3:

AFS = 3.30 MW

Lo.E = 0 MW

Hi.E = 3.30 MW

Lo.A = 20%

Hi.A = 99.9%

$$S_R = \frac{3.30 (99.9-20)}{100 (3.30-0)} = 0.8$$

0.8 ≤ 1.25 no additional errors

#### Example 4:

AFS = 3.30 MW

Lo.E = 1.00 MW

Hi.E = 3.30 MW

Lo.A = 20%

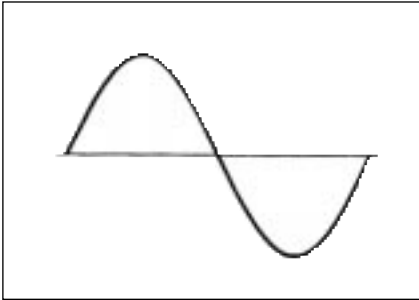
Hi.A = 99.9%

$$S_R = \frac{3.30 (99.9-20)}{100 (3-1)} = 1.32$$

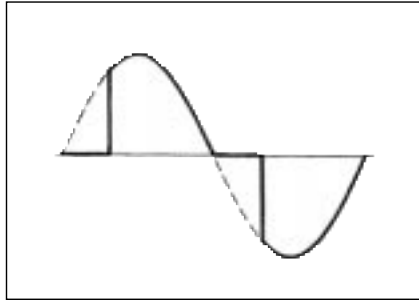
1.32 ≥ 1.25 means that there is an additional error of 0.2% f.s. according to the graph at the previous page.

## Mode of Operation (cont.)

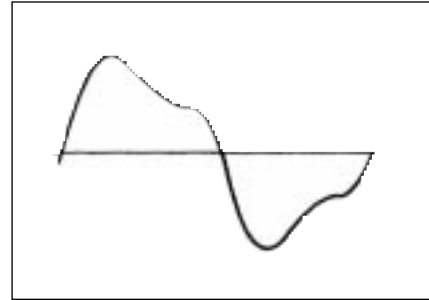
Waveform of the signals that can be measured



**Figure G**  
**Sine wave, undistorted**  
 Fundamental content 100%  
 Harmonic content 0%  
 $A_{rms} = 1.1107 | \bar{A} |$



**Figure H**  
**Sine wave, indented**  
 Fundamental content 10...100%  
 Harmonic content 0...90%  
 Frequency spectrum 3rd to 16th harmonic  
 Required result: additional error < 1%

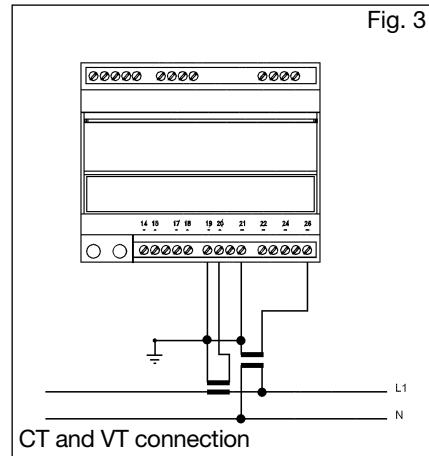
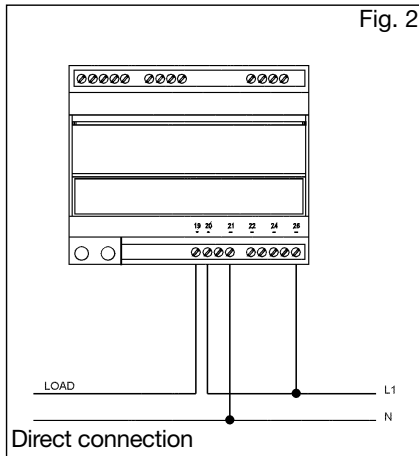
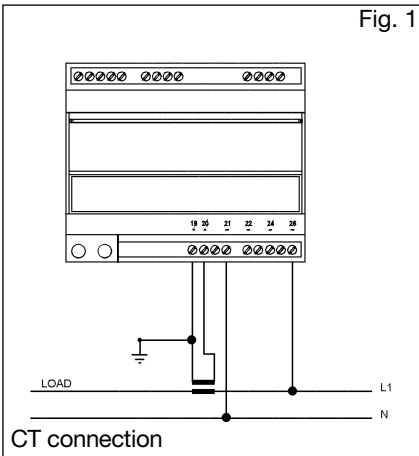


**Figure I**  
**Sine wave, distorted**  
 Fundamental content 70...90%  
 Harmonic content 10...30%  
 Frequency spectrum 3rd to 15th harmonic  
 Required result: additional error < 0.5%

## Wiring Diagrams

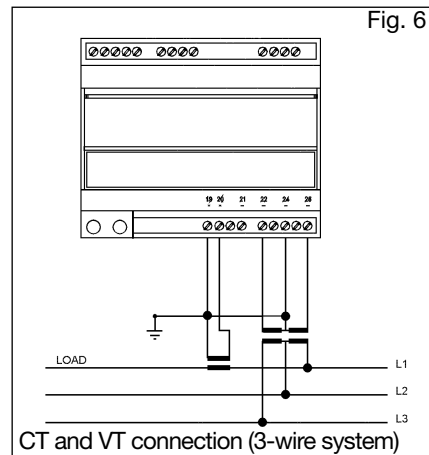
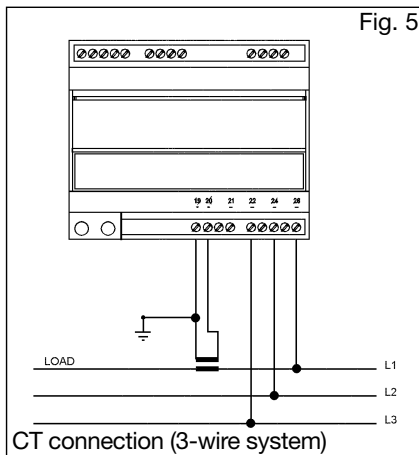
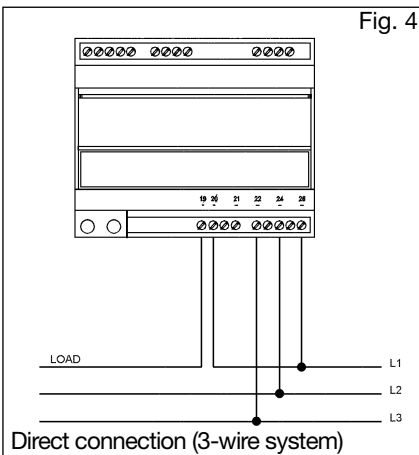
### Single phase input connections

SPT-DIN AV1/AV3/AV4/AV5.1

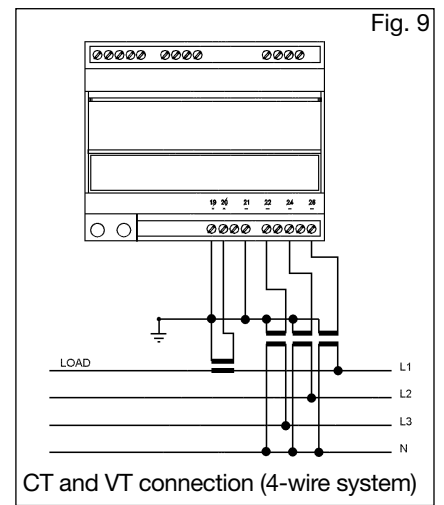
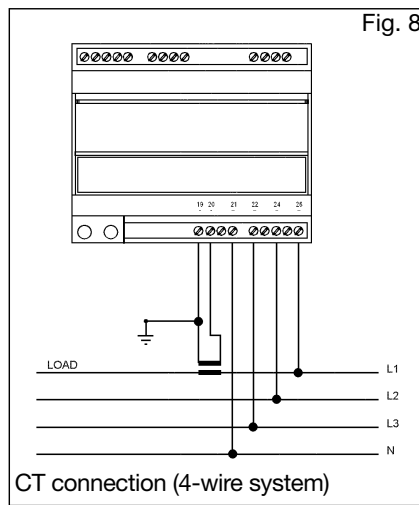
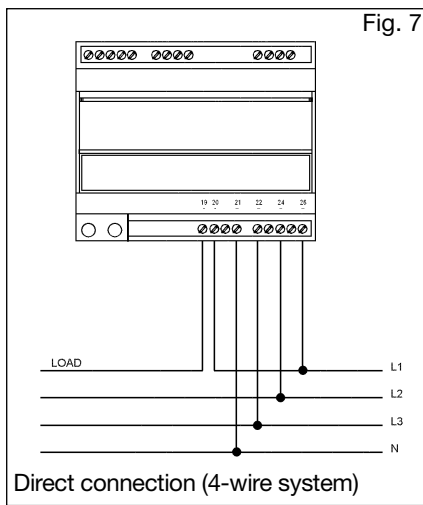


### Three phase input connections - Balanced loads

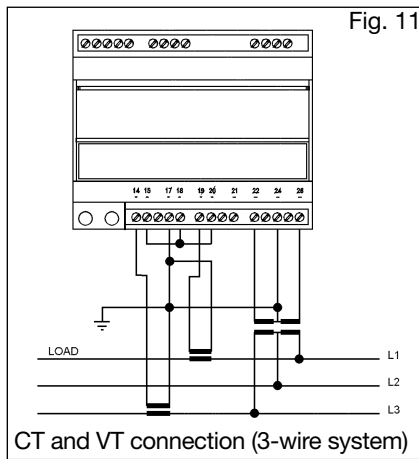
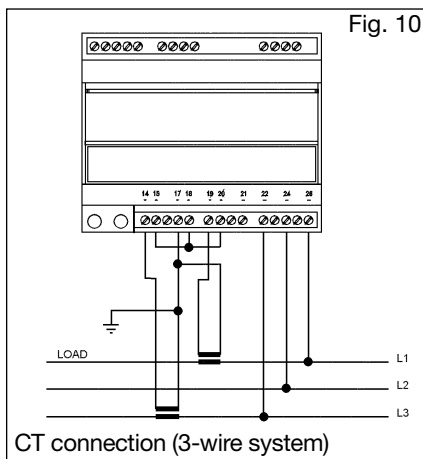
SPT-DIN AV1/AV3/AV4/AV5.1



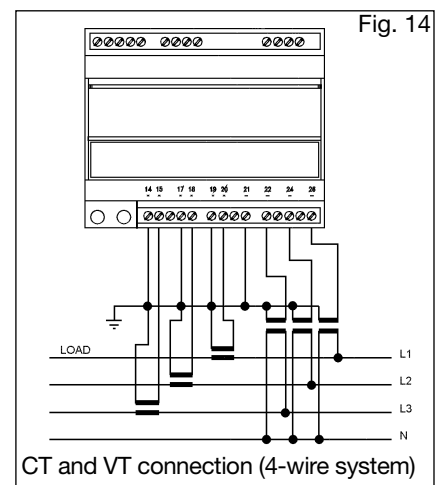
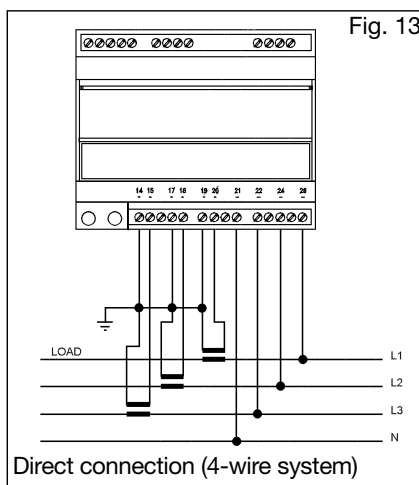
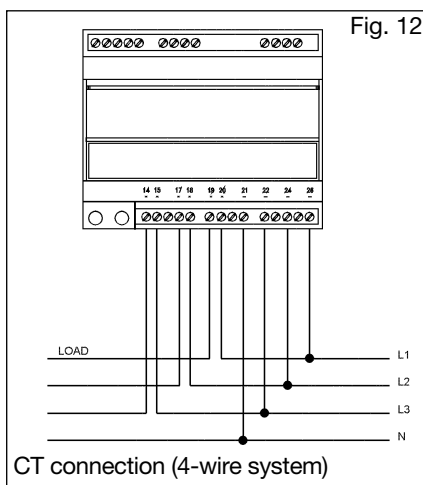
## Wiring Diagrams (cont.)



### Three-phase, 3-wire ARON input connections - Unbalanced loads SPT-DIN AV1/AV3/AV4/AV5.3



### Three phase, 4-wire input connections - Unbalanced loads SPT-DIN AV1/AV3/AV4/AV5.3



## Front Panel Description



### 1. Key-pad

Set-up and programming procedures are easily controlled by the 3 pushbuttons.

“S”

- Selection key to select programming function (transducer configuration) and alarm detection.

- ” ▲ ” and ” ▼ ”
- Up and down keys for increasing or decreasing programming values.
  - Selecting programming functions and transducer configuration together with the “S” key.

### 2. Display

3 -digit (maximum read-out 999).

Alphanumeric indication by means of 7-segment display for:

- Displaying only the configuration parameters

### 3. Connection terminal blocks

### 4. Dip-switch

- For the selection of 2/4 wire connection, line biasing and/or line termination (only in case of RS 485 option)

## Dimensions

