# Energy Management
# Modular Smart Power Transducer
# Type SPT-90

- **Class 0.5 (current/voltage)**
- **16-bit µP-based modular smart power transducer**
- **Measurements of: W, Wavg, VA, VAr, PF, Wh, VAh, VArh, Amax (among the phases), VL-L avg, VL1-N, VL2-N, VL3-N, Hz L1.**
- **TRMS measurement of distorted waves (voltage/current)**
- **All configuration functions selectable by an optional removable key-pad or programming software SptSoft**
- **Password protection of programming parameters**
- **Optional independent alarm setpoint**
- **Optional second analogue output (20 mADC/±20mADC ±10 mADC/±5 mADC/10 VDC/±5VDC/±1VDC)**
- **Optional serial RS 422/485 or RS232 output**
- **MODBUS, JBUS protocol.**

## Product Description

16-bit µP-based modular smart power transducer with an optional removable configuration key-pad or programming software. The housing is for DIN-rail mounting and ensures a degree of protection (front) of IP 20.

## Ordering Key

**SPT-90AV51HXA1XXX**

**Model**
**Range code**
**System**
**Power supply**
**Auxiliary output**
**1st output/input**
**2nd output**
**Options**

## Type Selection

**Range code**

**AV1:** 100/√3/100 VAC-1 AAC (max. 130/√3 (L-N)/ 130 V (L-L) - 1.2 A) [1)]
**AV3:** 100/√3/100 VAC-5 AAC (max. 130/√3 (L-N)/ 130 V (L-L) - 6 A) [1)]
**AV4:** 250/433 VAC - 1 AAC (max. 300 V (L-N)/ 520 V (L-L) - 1.2 A) [1)]
**AV5:** 250/433 VAC - 5 AAC (max. 300 V (L-N)/ 520 V (L-L) - 6 A) (standard)
**AV7:** 400/690 VAC - 5 AAC (max. 480 V (L-N)/ 830 V (L-L) - 6 A) [1)]

**Power supply**

**L:** 18 to 60 VAC/DC
**H:** 90 to 260VAC/DC

**System**

**1:** One phase, three-phase system (3 or 4 wires, balanced load)
**3:** Three phase system (3 or 4 wires, unbalanced load)

**Auxiliary output**

**X:** None (standard)
**D:** Single Alarm setpoint, relay [1)] (AO1058)
**P:** Single Pulse, open collector, DC type [1)] (AO1059)
**B** Dual pulse output,the second one is the copy of the first one, like "P" [1)] (AO1036)
**T** Dual alarm output, the second one is the copy of the first one, like "D" [1)] (AO1035)

**Options**

**X:** None
**K:** Programming key-pad
**S:** RS232 port [2)]

**1st output/input**

**D1(*):** 3 digital inputs (managed only by means of the serial communication) [1)]
**A1:** Single analogue output, 20mADC (standard)
**A2:** Single analogue output, ±5mADC [1)]
**A3:** Single analogue output, ±10mADC [1)]
**A4:** Single analogue output, ±20mADC [1)]
**B1:** Dual analogue output, 20mADC (standard)
**B2:** Dual analogue output, ±5mADC [1)]
**B3:** Dual analogue output, ±10mADC [1)]
**B4:** Dual analogue output, ±20mADC [1)]
**V1:** Single analogue output, 10VDC (standard)
**V2:** Single analogue output, ±1VDC [1)]
**V3:** Single analogue output, ±5VDC [1)]
**V4:** Single analogue output, ±10VDC [1)]
**W1:** Dual analogue output, 10VDC (standard)
**W2:** Dual analogue output, ±1VDC [1)]
**W3:** Dual analogue output, ±5VDC [1)]
**W4:** Dual analogue output, ±10VDC [1)]

**2nd output**

**XX:** None (standard)
**S1:** Serial port, RS 485 multidrop bidirectional [1)]
**A1:** Analogue output, 20 mADC (standard)
**A2:** Analogue output, ±5 mA [1)]
**A3:** Analogue output, ±10 mA [1)]
**A4:** Analogue output, ±20 mA
**V1:** Analogue output, 10 VDC [1)]
**V2:** Analogue output, ±1 VDC [1)]
**V3:** Analogue output, ±5VDC [1)]
**V4:** Analogue output, ±10VDC [1)]

[1)] On request
[2)] The programming software has the part number: Sptsoft
(*) The 3 digital inputs can't work together with one or more analogue outputs in the same instrument.

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## Input Specifications

| | |
|---|---|
| **Number of inputs** | |
| Current | 2 (system code: 1)<br>6 (system code: 3) |
| Voltage | 2 (system code: 1)<br>4 (system code: 3) |
| Digital | 4, for 3 free of voltage contacts (inputs managed only by the serial communication)<br>Reading voltage/current: 17.5 to 25VDC/<8mA |
| **Accuracy (basic unit)** | |
| Voltage/current | ±0.5% f.s. includes also: frequency, power supply and output load influences |
| Frequency | ±0.5% f.s. (45 to 500 Hz) |
| Active power<br>(@ 25°C ± 5°C, R.H. ≤ 60%) | ±0.5% f.s. (PF 0.7 L/C, 0.6 to 1 In, 0.9 to 1.1 Un)<br>±1% f.s. (PF 0.3 L/C, 0.2 to 1.2 In, 0.7 to 1.2 Un) |
| Reactive power<br>(@ 25°C ± 5°C, R.H. ≤ 60%) | ±0.5% f.s. (PF 0.7 L/C, 0.6 to 1 In, 0.9 to 1.1 Un)<br>±1% f.s. (PF 0.3 L/C, 0.2 to 1.2 In, 0.7 to 1.2 Un) |
| Apparent power<br>(@ 25°C ± 5°C, R.H. ≤ 60%) | ±0.5% f.s., (0.6 to 1 In, 0.9 to 1.1 Un)<br>±1% f.s., (0.2 to 1.2 In, 0.7 to 1.2 Un) |
| **Additional errors** | |
| Humidity | ≤0.3% f.s., 60% to 90% R.H. |
| Input frequency | ≤0.4% f.s., 62 to 400 Hz |
| Magnetic field | ≤0.5% f.s. @ 400 A/m |
| **Ripple** | ≤ 1% according to IEC 60688-1 and EN60688-1 |
| **Sampling rate** | 1900 Hz |
| **Display** (programming unit) | 7-segment, LED, h 9 mm |

| | |
|---|---|
| **Max. and min. indication** | Max. 999, min. -999 |
| **Measurements** | W, Wavg, VA, VAr, PF, Wh, VAh, VArh, Amax (among the phases), VL-L avg, VL1-N, VL2-N, VL3-N, Hz L1.<br>TRMS measurement of a distorted wave voltage/current<br>Coupling type : Direct<br>Crest factor: ≥ 3 |
| **Ranges (impedances)** | |
| AV1 (Un/In): | 100 V /√3/100 V (>250kΩ) - 1 AAC (≤ 0.3 VA) |
| AV3 (Un/In): | 100 V /√3/100 V (>250kΩ) - 5 AAC (≤ 0.3 VA) |
| AV4 (Un/In): | 250 V/433 V (>450kΩ) - 1 AAC (≤ 0.3 VA) |
| AV5 (Un/In): | 250 V/433 V (>450kΩ) - 5 AAC (≤ 0.3 VA) |
| AV7 (Un/In): | 400 V/690 V (>1MΩ) - 5 AAC (≤ 0.3 VA) |
| **Frequency range** | 48 to 62 Hz |
| **Over-load protection** | |
| Continuous: voltage/current | 1.2 Un/In |
| For 1 s | |
| Voltage: | 2 Un |
| Current: | 20 In |
| **Programming keypad** (on request) | Removable type<br>3 keys: "S" for enter programming phase and password confirmation, "UP" and "DOWN" for value programming/function selection |
| **Programming software** | SptSoft Programming soft ware (on request) for windows 95/98 combined with an RS232 serial communication module. |

## Output Specifications

| | |
|---|---|
| **Analogue outputs** | |
| Number of outputs | 1 (standard) + 1 (on request) |
| Accuracy | ±0.2% f.s. (@ 25°C±5°C, R.H. ≤60%) |
| Range | 0 to 20 mADC, ±5mADC, ±10mADC, ±20mADC, 10VDC, ±1VDC, ±5VDC, ±10VDC. |
| Scaling factor | Programmable within the whole range of retransmission; it allows the retransmission management of all values from: 0 to 20 mADC, ±5mADC, ±10mADC, ±20mADC, 0 to10VDC, ±1VDC, ±5VDC, ±10VDC. |
| Response time | ≤ 250 ms typical (filter excluded) |
| Temperature drift | 300 ppm/°C |
| Load: 20 mA output | ≤ 600 Ω |
| ±20mA output | ≤ 550 Ω |
| ±10 mA output | ≤ 1100 Ω |
| ±5 mA output | ≤ 2200 Ω |
| 10 V output | ≥ 10 kΩ |
| ±10 V output | ≥ 10 kΩ |
| ± 5 V output | ≥ 10 kΩ |
| ± 1 V output | ≥ 10 kΩ |
| Insulation | By means of optocouplers, 4000 $V_{rms}$ output to measuring input<br>4000 $V_{rms}$ output to supply input |
| **Serial port** (on request) | |
| Type | RS422/RS485, multidrop bidirectional (static and dynamic variables) |
| Connections | 4-wire, termination directly on the module |
| Addresses | 255, selectable by key-pad |
| Protocol | MODBUS/JBUS |

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## Output Specifications (cont.)

| | |
|---|---|
| **Serial port (cont.)** | |
| Data (bidirectional) | |
| Dynamic (reading only) | System variables: P, $P_{AVG}$, S, Q, PF, $V_{L-L}$, f, energy and status of digital inputs, setpoint output and status of the energy overflow bit, Single phase variables: $P_{L1}$, $S_{L1}$, $Q_{L1}$, $PF_{L1}$, $V_{L1-N}$, $A_{L1}$, $P_{L2}$, $S_{L2}$, $Q_{L2}$, $PF_{L2}$, $V_{L2-N}$, $A_{L2}$, $P_{L3}$, $S_{L3}$, $Q_{L3}$, $PF_{L3}$, $V_{L3-N}$, $A_{L3}$ |
| Static (writing only) | All programming data, reset of energy, reset of energy overflow bit, activation of static output. Stored energy (EEPROM) ≥ 250,000.000 kWh |
| Data format | 1-start bit, 8-data bit, no parity/even parity, 1 stop bit |
| Baud-rate | 1200, 2400, 4800 and 9600 selectable bauds |
| Insulation | By means of optocouplers, 4000 $V_{rms}$ output to measuring inputs<br>4000 $V_{rms}$ output to supply input |
| Temperature drift | 200 ppm/°C |
| **RS 232 port** (on request) | bidirectional (static and dynamic variables) 3 wires, max. distance 15m |
| Data format | 1-start bit, 8-data bit, no parity, 1 stop bit |
| Baud-rate | 9600 bauds |
| Protocol | MODBUS (JBUS) |
| Other data | as for RS422/485 |

| | |
|---|---|
| **Pulse output** (on request) | |
| Number of outputs | 1, independent |
| Type | From 1 to 999 programmable pulses for kWh, KVAh, KVArh, MWh, MVAh, MVArh, open collector (NPN transistor) $V_{ON}$ 1.2 VDC/ max. 100mA $V_{OFF}$ 30 VDC max. |
| Pulse duration | according to DIN43864 20 ms (ON), ≥ 20 ms (OFF) |
| Insulation | By means of optocouplers, 4000 $V_{rms}$ output to measuring input, 4000 $V_{rms}$ output to supply input. |
| **Alarms** (on request) | |
| Number of setpoints | 1, independent |
| Alarm type | Up alarm, down alarm |
| Setpoint adjustment | 0 to 100% of the electrical scale |
| Hysteresis | 0 to 100% of the electrical scale |
| On-time delay | 0 to 255 s |
| Relay status | Normally de-energized |
| Output type | Relay, SPDT<br>AC 1 - 8A @ 250VAC<br>DC 12 - 5A @ 24VDC<br>AC 15 - 2.5 @ 250VAC<br>DC 13 - 2.5 @ 24VDC |
| Response time | typ. 250 ms, filter excluded, setpoint on-time delay: "0" |
| Insulation | 4000 $V_{rms}$ output to measuring input, 4000 $V_{rms}$ output to supply input |

## Software Functions

| | |
|---|---|
| **Password** | Numeric code of max. 3 digits; 2 protection levels of the programming data |
| 1st level | Password "0", no protection |
| 2nd level | Password from 1 to 499, all data are protected |
| **Measurement selection** | System's active power (W), system's apparent power (VA), system's reactive power (VAr), average active power (Wavg), integration time programmable from 1 to 30 minutes, system's power factor (cosφ), maximum current (A 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, |

| | |
|---|---|
| **Measurement selection (cont.)** | system's reactive energy, system's (+/-) active energy |
| **Transformer ratio** | For CT up to 5000 A, For VT up to 100 kV (1MV) |
| **Scaling factor** | |
| Operating mode | Electrical scale: compression/ expansion of the input scale to be connected to 1 or 2 analogue outputs and to the alarm output. |
| Electrical range | Programmable within the whole measuring range |
| **Filter** | |
| 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, A, W and their derived ones) |

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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.

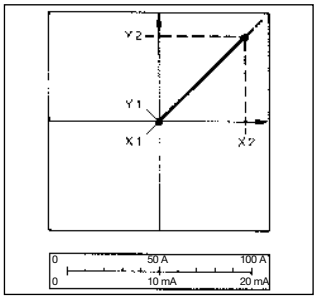



**Figure B**
The sign of measured quantity and output quantity changes simultaneously. The output quantity is proportional to the measured quantity.

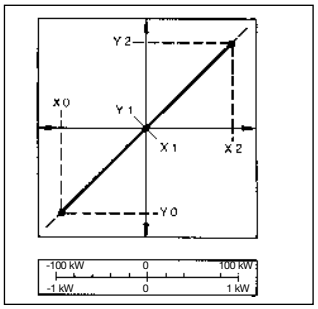



**Figure C**
The sign of measured quantity and output quantity remains the same. On the range X0...X1, the output quantity is zero. The range X1...X2 is delineated on the entire output range Y0 = Y1...Y2 and thus presented in strongly expanded form.

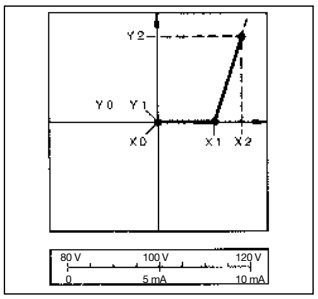



**Figure D**
The sign of measured quantity and output quantity remains the same. With the measured quantity being zero, the output quantity already has the value Y1 = 0.2 Y2.
Live zero output.

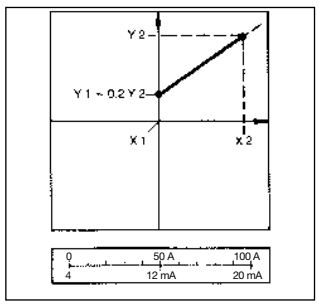



**Figure E**
The sign of the measured quantity changes but that of the output quantity remains the same. The output quantity steadily increases from value X1 to value X2 of the measured quantity.

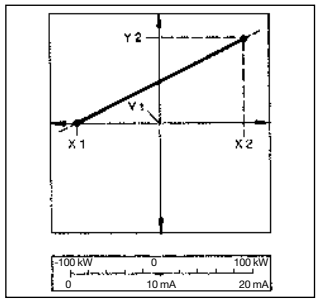
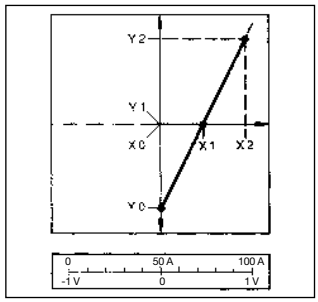



**Figure F**
The sign of the measured quantity remains the same, that of the output quantity changes as the measured quantity leaves range X0...X1 and passes to range X1...X2 and vice versa.




## General Specifications

| | |
|---|---|
| **Operating temperature** | 0 to +50°C (32 to 122°F)<br>(R.H. < 90% non-condensing) |
| **Storage temperature** | -10 to +60°C (14 to 140°F)<br>(R.H. < 90% non-condensing) |
| **Insulation reference voltage** | 300 $V_{rms}$ to ground |
| **Insulation** | 4000 $V_{rms}$ between all inputs/ outputs to ground |
| **Dielectric strength** | 4000 $V_{rms}$ for 1 minute |
| **Noise rejection**<br>CMRR | <br>100 dB, 48 to 62 Hz |
| **EMC** | EN 50081-2, EN 50082-2 |
| **Other standards**<br>Safety requirements:<br>Product requirements:<br>Pulse output: | <br>IEC 61010-1, EN 61010-1<br>IEC 60688-1, EN 60688-1<br>DIN 43864 |
| **Approvals** | CE<br>UL, CSA |
| **Connector** | Screw-type,<br>max. 2.5 $mm^2$ wires x 2 |
| **Housing**<br>Dimensions<br>Material | <br>90 x 90 x 140 mm<br>ABS,<br>self-extinguishing: UL 94 V-0 |
| **Degree of protection** | IP20 |
| **Weight** | Approx. 550 g<br>(packing included) |

## Supply Specifications

| | |
|---|---|
| **AC voltage** | 90 to 260 VAC/DC (standard), 50/60 Hz<br>18 to 60VAC/DC, 50/60Hz (on request), |
| **Power consumption** | ≤ 30 VA / 20W (90 to 260V)<br>≤ 20VA / 20W (18 to 60V) |

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## The available modules

| Type | N. of channels | Ordering code | Note |
|---|---|---|---|
| SPT-90 base + AV1.1 input | | AA1000 | |
| SPT-90 base + AV3.1 input | | AA1001 | |
| SPT-90 base + AV4.1 input | | AA1002 | |
| SPT-90 base + AV5.1 input | | AA1003 | |
| SPT-90 base + AV7.1 input | | AA1004 | |
| SPT-90 base + AV1.3 input | | AA1006 | |
| SPT-90 base + AV3.3 input | | AA1007 | |
| SPT-90 base + AV4.3 input | | AA1008 | |
| SPT-90 base + AV5.3 input | | AA1009 | |
| SPT-90 base + AV7.3 input | | AA1010 | |
| 18-60VAC/DC power supply | | AP1021 | |
| 90-260VAC/DC power supply | | AP1020 | |
| Programming unit | | AR1017 | The same unit can be used in several SPT's |
| 20mADC analogue output | 1 | AO1050 | |
| 10VDC analogue output | 1 | AO1051 | |
| ±5mADC analogue output | 1 | AO1052 | |
| ±10mADC analogue output | 1 | AO1053 | |
| ±20mADC analogue output | 1 | AO1054 | |
| ±1VDC analogue output | 1 | AO1055 | |
| ±5VDC analogue output | 1 | AO1056 | |
| ±10VDC analogue output | 1 | AO1057 | |
| 20mADC analogue output | 2 | AO1026 | SPT can be equipped also with 2 dual analogue outputs, in this case the third or fourth output can be used as a redundant output of the second one |
| 10VDC analogue output | 2 | AO1027 | |
| ±5mADC analogue output | 2 | AO1028 | |
| ±10mADC analogue output | 2 | AO1029 | |
| ±20mADC analogue output | 2 | AO1030 | |
| ±1VDC analogue output | 2 | AO1031 | |
| ±5VDC analogue output | 2 | AO1032 | |
| ±10VDC analogue output | 2 | AO1033 | |
| RS485 port | 1 | AR1034 | |
| Relay output | 1 | AO1058 | |
| Relay output | 2 | AO1035 | The second output can be used as redundant output |
| Open collector output | 1 | AO1059 | |
| Open collector output | 2 | AO1036 | The second output can be used as redundant output |
| Digital inputs | 3 | AQ1038 | |
| RS232 port + RTC | 1 | AR1039 | The RS232 module works as alternative of the RS485 module. The RTC (real time clock) function is not available in the SPT |

## The possible combinations

| Slot | A | B | C | D | E |
|---|---|---|---|---|---|
| **Basic unit** | **Out 1** | **Out 2** | **Out 3** | **Out 4** | **PU** |
| Single analogue output (2) | ● | ● | | | |
| Dual analogue output (2) | ● | | | | |
| RS485 port (1) | | ● | | | |
| Single relay output (alarm) | | | ● | ● | |
| Single open coll. output (pulse) | | | ● | ● | |
| Dual relay output (alarm) | | | ● | ● | |
| Dual open coll. output (pulse) | | | ● | ● | |
| 3 digital inputs (2) | | | ● (*) | | |
| RS232 port (1) | | | | | ● |
| Programming unit | | | | | ● |

Notes:

PU is the programming unit

(1) The RS232 module works as alternative of the RS485 module.

(2) (*) Digital inputs and analogue outputs can't work together in the same instrument.

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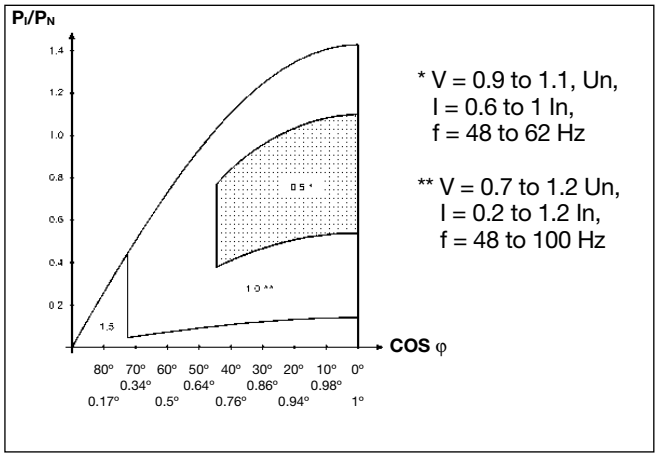
# Mode of Operation

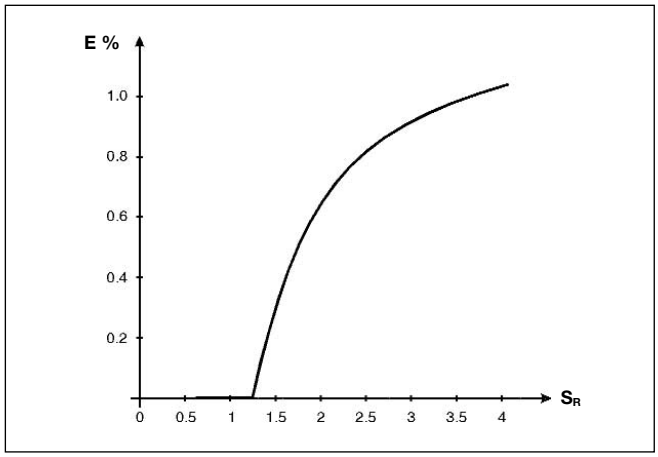
**Accuracy class of the meter as a relation of $P_I/P_N$ and cos φ (power factor)**




* V = 0.9 to 1.1, Un,
I = 0.6 to 1 In,
f = 48 to 62 Hz

** V = 0.7 to 1.2 Un,
I = 0.2 to 1.2 In,
f = 48 to 100 Hz

**Trends of the "E" error depending on the $S_R$ 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: 250 V | Un: 430 V | In: 1 A |
| AV5 | Un: 250 V | Un: 430 V | In: 5 A |

**$P_I$: (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:
$U_I$ = the real star voltage of the electrical system being measured.
$I_I$ = the maximum phase current of the electrical system being measured.
Cos φ = the average cos φ of the electrical system being measured.

**$P_n$: (rated power of transducer)**
One phase system:

$$P_n = U_n \cdot I_n \cdot VT(ratio) \cdot CT(ratio)$$

Three phase, 3-wire system:

$$P_n = \sqrt{3} \cdot U_n \cdot I_n \cdot VT(ratio) \cdot CT(ratio)$$

Three phase, 4-wire system:

$$P_n = 3 \cdot U_n \cdot I_n \cdot VT(ratio) \cdot CT(ratio)$$

where:
$U_n$ = the rated input voltage of SPT-90 depending on the model, see table above.
$I_n$ = the rated input current of SPT-90 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).

$U_I$ = 6 kV (delta voltage)
$I_I$ = 265 A (single phase current)
Cos φ = 0.85 (system power factor)
$U_n$ = 100 V
$I_n$ = 5 A

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

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

$$P_I = \sqrt{3} \cdot U_I \cdot I_I \cdot \cos\varphi = \sqrt{3} \cdot 6000 \cdot 265 \cdot 0.85 = 2.33\ MW$$

$$P_n = \sqrt{3} \cdot U_n \cdot I_n \cdot VT(ratio) \cdot CT(ratio) = \sqrt{3} \cdot 100 \cdot 5 \cdot 60 \cdot 60 = 3.12\ MW$$

$$\frac{P_I}{P_n} = \frac{2.33}{3.12} = 0.75$$

**Example 2:**
Model AV3.3 (4-wire system).

$U_I$ = 6 kV / √3
$I_I$ = 265 A
Cos φ = 0.85
$U_n$ = 100 V / √3
$I_n$ = 5 A

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

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

$$P_I = 3 \cdot U_I \cdot I_I \cdot \cos\varphi = 3 \cdot 6000 / \sqrt{3} \cdot 265 \cdot 0.85 = 2.33\ MW$$

$$P_n = 3 \cdot U_n \cdot I_n \cdot VT(ratio) \cdot CT(ratio) = 3 \cdot 100 / \sqrt{3} \cdot 5 \cdot 60 \cdot 60 = 3.12\ MW$$

$$\frac{P_I}{P_n} = \frac{2.33}{3.12} = 0.75$$

In both examples the accuracy of the measurement is 0.5% f.s. when considering the changing of the measured voltage from 0.9 Un to 1.1 Un and the measured current from 0.6 In to 1 In 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 $S_R$).

**Regarding $S_R$:**

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

AFS = automatic electrical full scale calculated value.
$S_R$ = scale ratio.
There is not any additional error on the output signal if $S_R \leq 1.25$.

**Example 3:**

AFS = 3.30 MW
Lo.E = 0 MW
Hi.E = 3.30 MW
Lo.A = 20%
Hi.A = 99.9%

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

0.8 ≤ 1.25 no additonal errors

**Example 4:**

AFS = 3.30 MW
Lo.E = 1.00 MW
Hi.E = 3.30 MW
Lo.A = 20%
Hi.A = 99.9%

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

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

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## Mode of Operation (cont.)

**Waveform of the signals that can be measured**

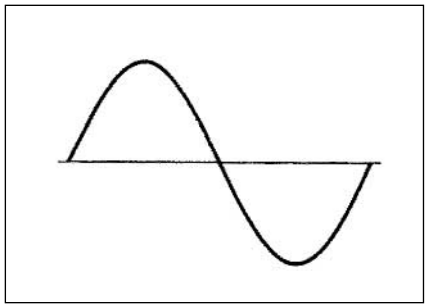


**Figure G**
**Sine wave, undistorted**
Fundamental content 100%
Harmonic content 0%
$A_{rms}$ = 1.1107 | $\overline{A}$ |

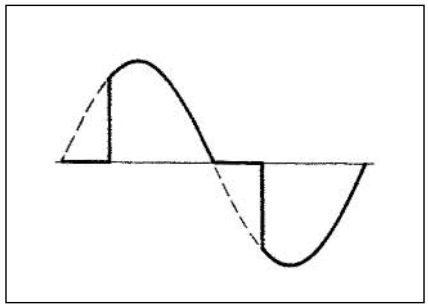


**Figure H**
**Sine wave, indented**
Fundamental content 10...100%
Harmonic content 0...90%
Frequency spectrum 3rd to 16th harmonic
Required result: additional error < 1%

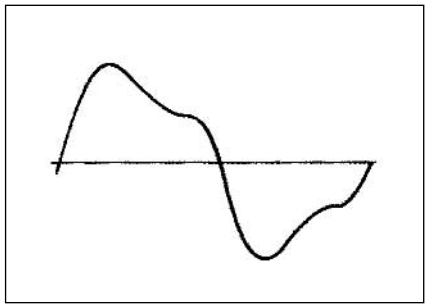
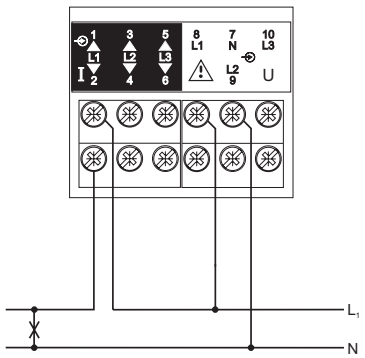


**Figure I**
**Sine wave, distorted**
Fundamental content 70...90%
Harmonic content 10...30%
Frequency spectrum 3rd to 15th harmonic
Required result: additional error < 0.5%

## Wiring Diagrams

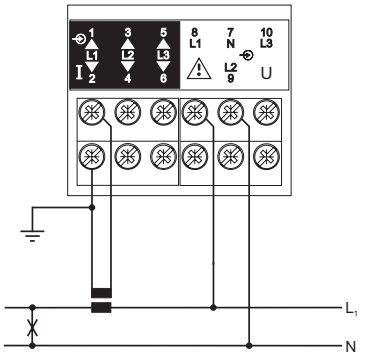
**Single phase input connections**

Fig. 1



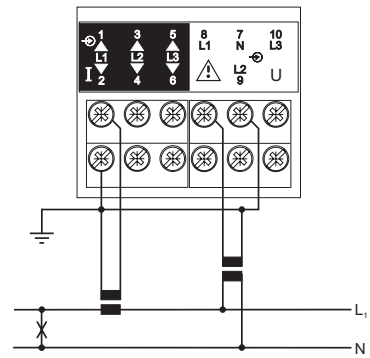

Direct connection

Fig. 2




CT connection

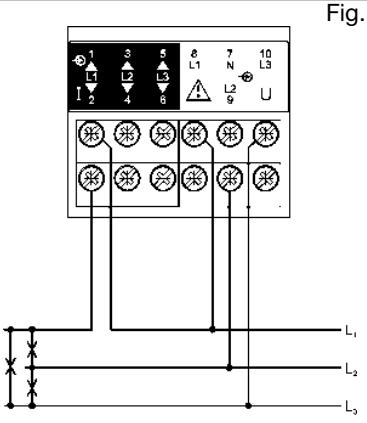
Fig. 3




CT and VT connection

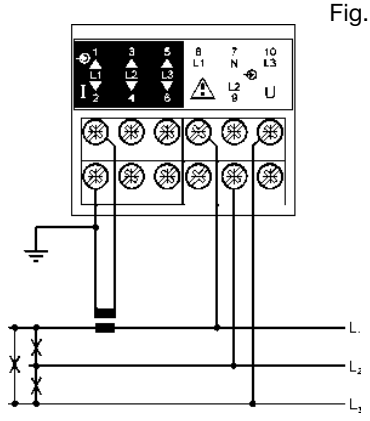
**Three-phase, 3-wire input connections - Balanced loads**

Fig. 4



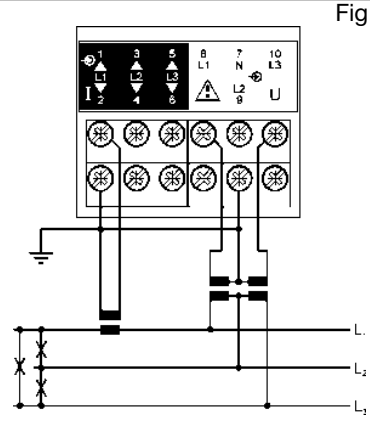

Direct connection (3-wire system)

Fig. 5




CT connection (3-wire system)

Fig. 6




CT and VT connection (3-wire system)

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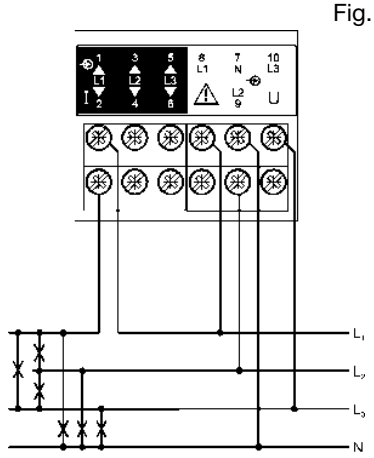
## Wiring Diagrams (cont.)

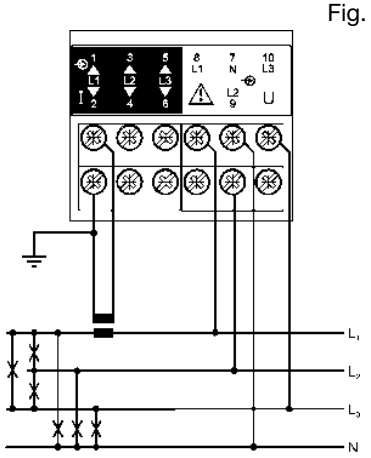
**Three-phase, 3-wire input connections - Balanced loads**

Fig. 7



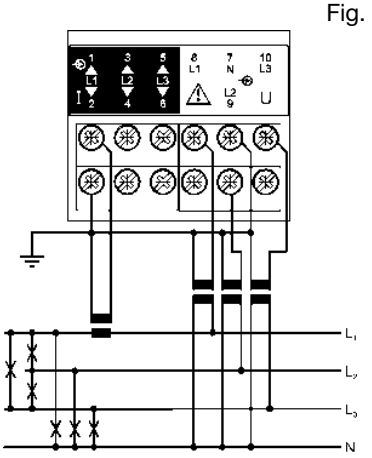
Direct connection (4-wire system)

Fig. 8



CT connection (4-wire system)

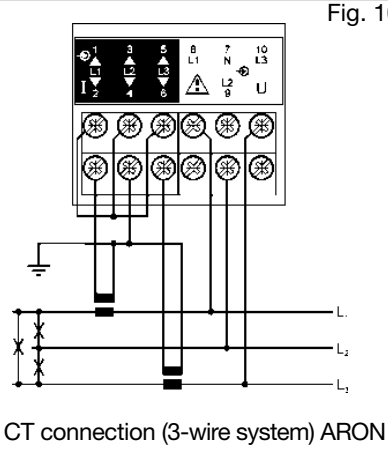
Fig. 9



CT and VT connection (4-wire system)

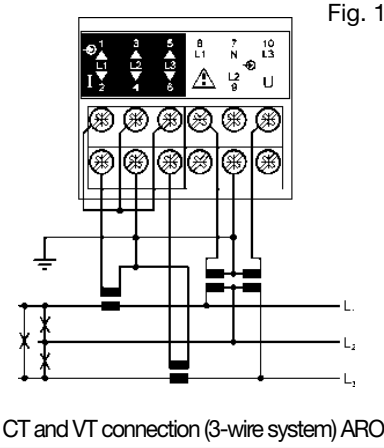
**Three-phase three-wire input connections - Unbalanced load**

Fig. 10



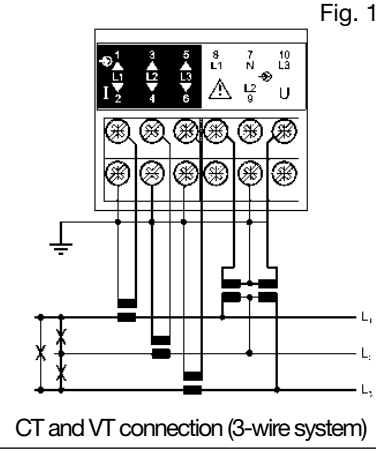
CT connection (3-wire system) ARON

Fig. 11



CT and VT connection (3-wire system) ARON

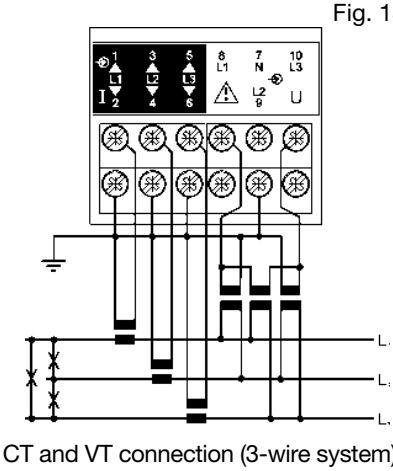
Fig. 12



CT and VT connection (3-wire system)

**Three-phase three-wire input connections**
**Unbalanced load**

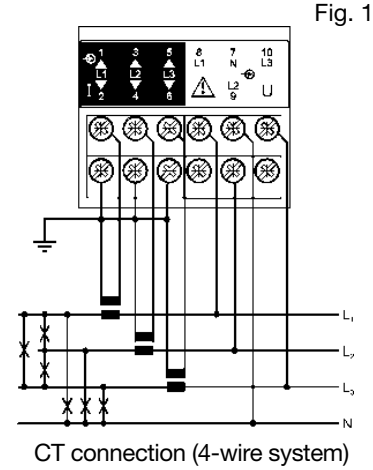
Fig. 13



CT and VT connection (3-wire system)

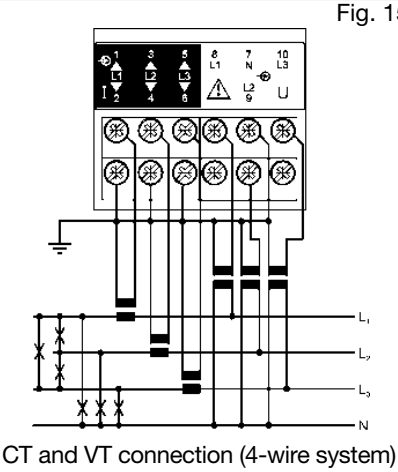
**Three-phase four-wire input connections - Unbalanced load**

Fig. 14



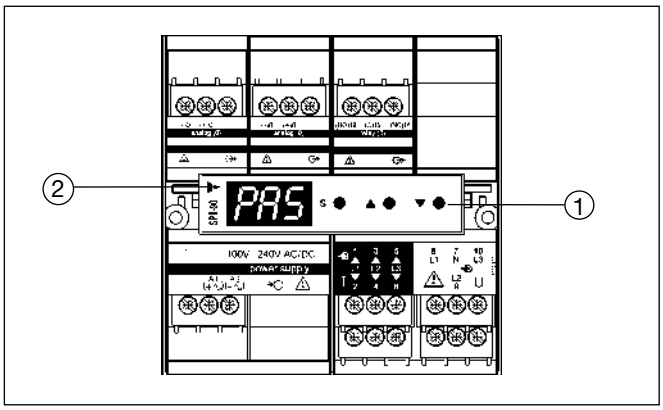
CT connection (4-wire system)

Fig. 15



CT and VT connection (4-wire system)

## Front Panel Description




1. **Key-pad**
   Set-up and programming procedures are easily controlled by the 3 pushbuttons.

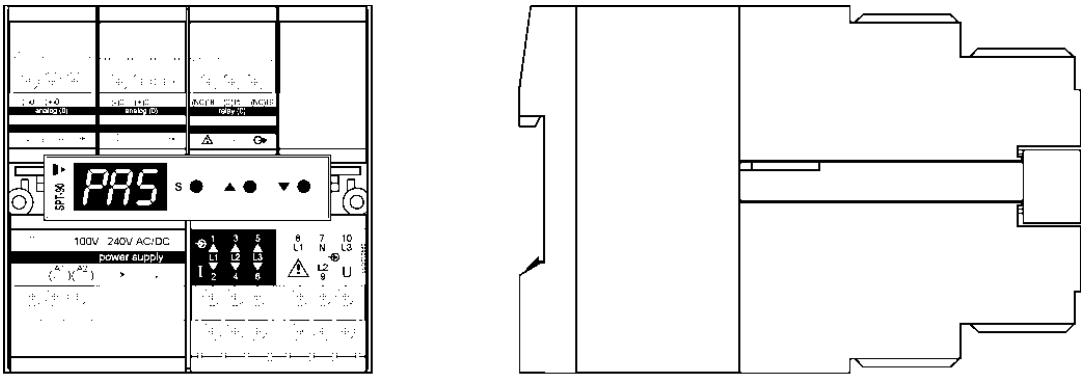
"S"
- Selection key to select programming function (transducer configuration) and alarm detection.

" ▲ " 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).

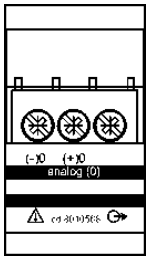
   Alphanumeric indication by means of 7-segment display for:
   - Displaying only the configuration parameters

## Dimensions



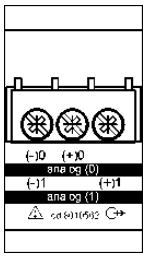
# Terminal boards

### Single analogue output modules



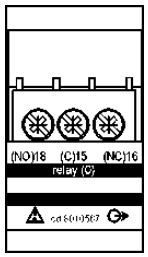

**AO1050** (20mADC)
**AO1051** (10VDC)
**AO1052** (±5mADC)
**AO1053** (±10mADC)
**AO1054** (±20mADC)
**AO1055** (±1VDC)
**AO1056** (±5VDC)
**AO1057** (±10VDC)

### Dual analogue output modules

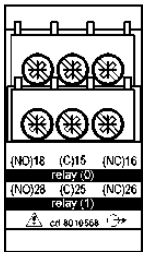



**AO1026** (20mADC)
**AO1027** (10VDC)
**AO1028** (±5mADC)
**AO1029** (±10mADC)
**AO1030** (±20mADC)
**AO1031** (±1VDC)
**AO1032** (±5VDC)
**AO1033** (±10VDC)

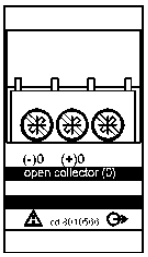
### Digital output modules



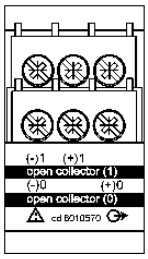

**AO1058**
Single relay output




**AO1035**
Dual relay port

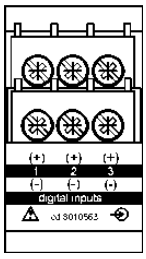



**AO1059**
Single open collector output

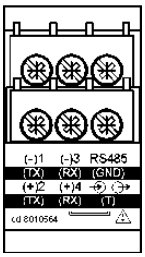



**AO1036**
Dual open collector output

### Other input/output modules

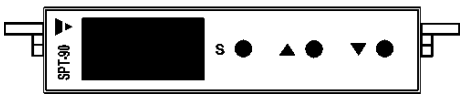



**AQ1038**
3 Digital inputs



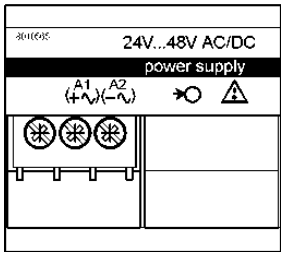

**AR1034**
RS485 port


**AR1039**
RS232 port

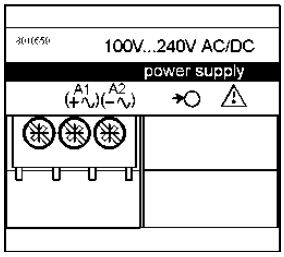



**AR1017**
Programming Unit

### Power supply modules




**AP1021**
18-60VAC/DC power supply




**AP1020**
90-260 VAC/DC power supply