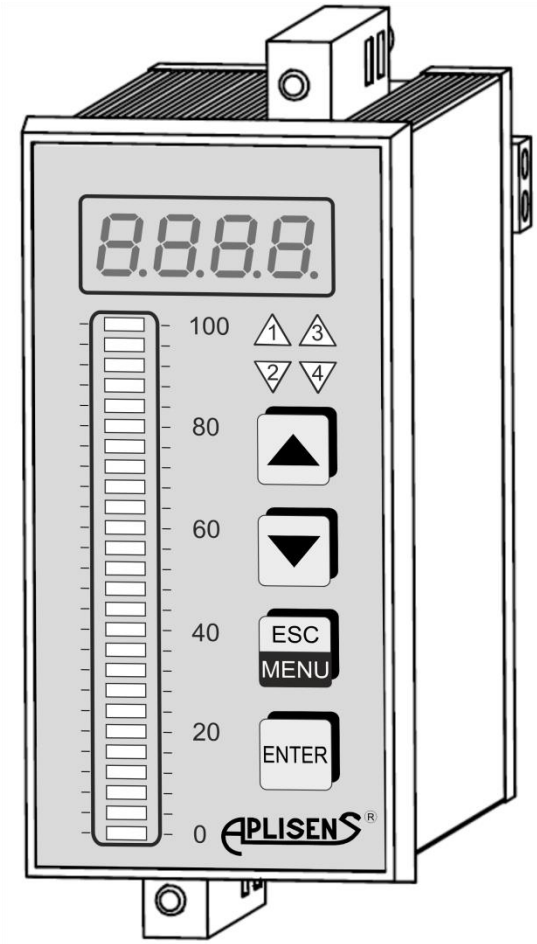
USER'S MANUAL

Programmable Meter

PMS-970T

Firmware: od v.5.00



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Symbols used

Symbol	Description
	Carefully follow the information in this document to ensure safety and full functionality of the device.
	Information particularly useful for the installation and use of the device.
	Information on the disposal of used equipment.

BASIC REQUIREMENTS AND SAFETY OF USE

The manufacturer takes no liability for damage resulting from incorrect installation of the device, neglecting to keep the device in proper technical condition, and using the device for purposes other than intended.

Installation should be conducted by qualified personnel, authorized for installation of electrical equipment and measuring devices. The installer is responsible to conduct the installation according to this manual as well as laws and standards of safety and electromagnetic compatibility applicable for this kind of installation.

In any installation equipped with measuring devices, there is an injury hazard from compressed agent in case of a leak. Follow all safety requirements during the installation, use, and inspection of the display.

In case of malfunction, disconnect the device and return it to the producer or an authorized service unit for repair.

In order to minimize the possibility of malfunction and the resulting hazard to personnel, avoid installing the device in dangerous environment where there is a possibility of the following:

- mechanical impact, excess shock and vibration;
- excess temperature fluctuation;
- steam condensation, dusting, icing.

Changes made to the production may be introduced before the paper version of the user's manual is updated. The up-to-date user's manual is available on the manufacturer's website: www.aplisens.pl

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1. INTRODUCTION

The subject of this instruction manual is the PMS-970T programmable meter.
The manual includes data, hints, and recommended action for installation and usage of the meter, as well as troubleshooting tips.

2. SAFETY

- The installation and start-up of the device and any activities related to operation shall be carried out after thorough examination of the contents of user's manual and the instructions related thereto.
- Installation and maintenance should be carried out by qualified staff having the required authorizations to install electrical and measuring devices.
- The device shall be used according to its intended purpose in line with the permissible parameters
- Before installing or disassembling the device, it is absolutely necessary to disconnect it from the power source.
- No repairs or alterations to the transmitter electronic system are permitted. Assessment of damages and possible repair may only be performed by the manufacturer or authorized representative.
- Do not use instruments if damaged. In case of malfunction, the device must be put out of operation.

3. LIST TO CHECK COMPLETENESS OF DELIVERY

Along with the meter, the user receives the following:

a) Product certificate, functioning as a warranty card;
b) Declaration of conformity (on customer's request);
c) Instruction Manual designated „ EN.IO.PMS-970T"

Positions b), c) are available from the website www.aplisens.pl.

4. TRANSPORT AND STORAGE

4.1. Transport

When transported, the meters should be packed in individual and/or group packaging and carried on a covered means of transport. The packaging should be secured against shifting and atmospheric weather effects.

4.2. Storage

The meter should be stored in the manufacturer's packaging, in a covered room, free of vapor and corrosive agents, where temperature and relative humidity do not exceed maximum acceptable limits.

5. WARRANTY

The producer provides warranty under the conditions specified in Product Certificate that works as a warranty card.

Warranty will be void if the device is not used according to its intended use, the user does not follow this instruction manual, the device is handled by unqualified personnel or the meter has been tampered with.

6. CONSTRUCTION

The **PMS-970T** meter has two measuring inputs – one 0-20 mA current input and one 0-10 V voltage input. The current input is equipped with a safety device that protects the measuring resistor from damage. The input current is limited to 40 mA (typically). When the temperature of the measuring resistor falls, the safety device will automatically switch off and the system displays the measurement value again. After the safety device has switched off, the measurement may be slightly less precise for a while (until the system cools down entirely).
The readout can be freely scaled by the user. Readout rounding and filtering grade can also be programmed.
The **PMS-970T** version of the meter has a small digital display and a tricolour LED bargraph showing the signal level on a percentage scale and the set alarm thresholds. The indicator can operate in single-color or three-color mode, showing programmed value ranges.
Depending on version, 2 or 4 relay outputs are available. Threshold levels with individual hysteresis and ON/OFF function are user programmed. The special function called „alternate output control" allows optimal control of cascaded pumps.
Optionally, the meter can be equipped with an passive current output. He range of current change at the output is programmed separately. The RS-485 communication link and the transmitter power output are available as standard option. The meter is available in one universal version of its power system: 20 – 250 V AC/DC.
The **PMS-970T** is used for adjustment processes e.g. for temperature (heating / cooling) with adjustable delay times for engaging output transmitters, level operation or valve operation.

7. INSTALLATION

The device is designed and made in a way that provides maximum safety of use and resistance to interference that occur in a typical industrial environment. For these features to be fully used, the installation of the device should be conducted properly, according to the relevant standards.

Prior to installation, read the basic safety requirements on page ➔ 2.
Prior to connecting the device to the electrical system, check if voltage on the electrical system corresponds to the nominal voltage value specified on the device's label.
The load should meet the requirements specified in Technical Data.
All installation work must be performed with power disconnected..
Consider the necessity of securing the power clamps against unauthorized access.

The device should be installed indoors, in a housing (panel, switchbox) providing proper protection against electrical surges. Metal housing must be grounded according to relevant laws.
Prior to assembly, disconnect power from the electrical system.
Prior to switching on the device, carefully inspect if the connections were made correctly.

To install the device, prepare a 90,5 x 43 mm opening in the panel (➔ **Figure 1.** Recommended installation dimensions, ➔ **Figure 2.** Acceptable installation dimensions). The thickness of the material that the panel is made of should not be more than 5mm. While preparing the installation opening, allow for recesses to accommodate catch pawls on both sides of the housing (➔ **Figure 1.** Recommended installation dimensions, ➔ **Figure 2.** Acceptable installation dimensions). Place the device in the opening, inserting it from the front side of the panel, then fix it with holders (➔ **Figure 3.** Fixing with holders).Minimum distance between axes of installation openings – resulting from thermal and mechanical working conditions – is 115mm (horizontal axis) and 67mm (vertical axis) (➔ **Figure 4.** Installation of several devices).

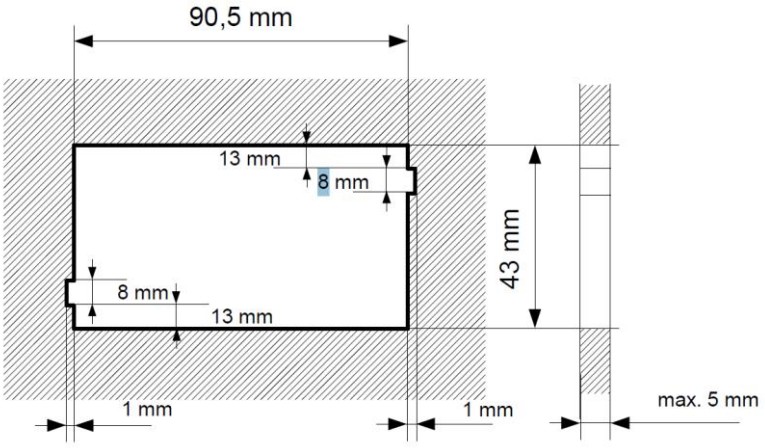


Figure 1. Recommended installation dimensions

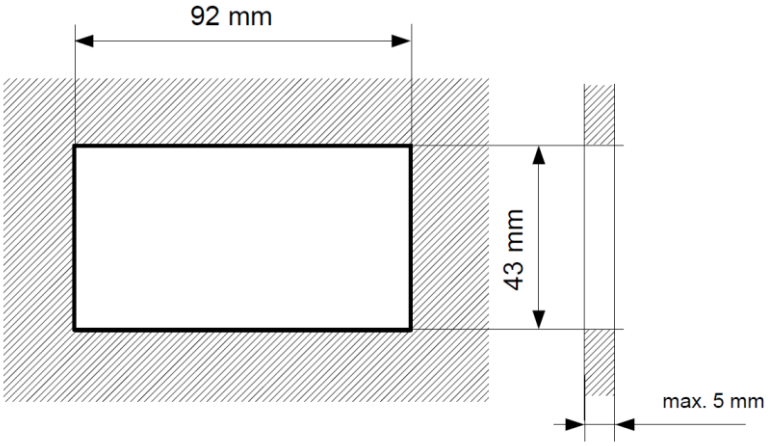


Figure 2. Acceptable installation dimensions

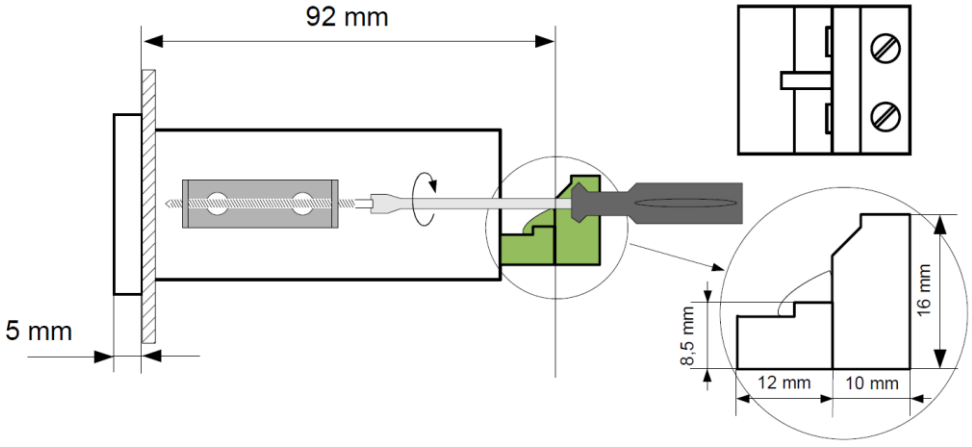


Figure 3. Fixing with holders

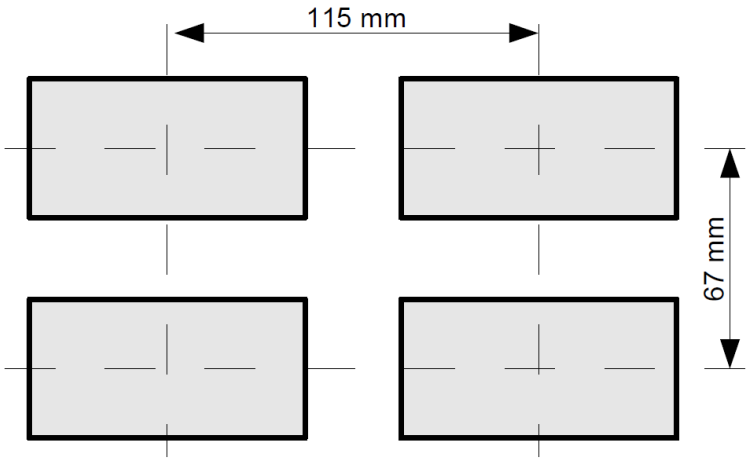


Figure 4. Installation of several devices

8. CONNECTING

All connection and installation steps must be performed with power disconnected.

8.1. Safety precautions

Installation should be conducted by qualified personnel, authorized to install electrical devices. All available safety requirements must be considered during installation. It is the installer's duty to perform installation according to this instruction manual as well as laws and standards of safety and electromagnetic compatibility, relevant to the type of installation performed.

The device is not equipped with an external safety cut-out with minimum possible nominal current value (we recommend a bipolar cut-out for nominal current no more than 2A) and a power switch in the vicinity of the device.
If a unipolar cut-out is used, it must be mounted on the phase lead (L).

Select the cross-section of the power cable so that protection of the cable is provided with a fuse from the device's side in case of short-circuit on the cable.

Cable types must correspond to relevant standards, local laws and regulations.

To provide protection against accidental short-circuit, the connecting leads should be ended with proper insulated cable ends.

Tighten the clamp bolts. The recommended torque of tightening is 0,5 Nm. Loose bolts may cause fire or malfunction. Tightening the bolts too much may lead to damage of connections inside the device and breaking the thread.

If the device is equipped with separable clamps, they should be tucked into proper connectors in the device even if they are not used for any connections.

Clamps that are not in use (marked n.c.) must not be used to connect any connection leads (e.g. as bridges), since it may cause damage to the device or an electric shock.

If the device is equipped with housing, shields, and compression glands to protect from water, pay close attention to tighten or compress them properly. When in doubt, consider using additional precautions (shields, canopies, leak stoppers, etc.). Negligent installation may increase the risk of an electric shock.

Once installation is complete, do not touch the connections when power is on due to a possibility of an electric shock.

Due to possible significant interference occurring in industrial systems, use adequate precautions that ensure proper operation of the device. Disregarding the following tips may, in certain circumstances, lead to exceeding the levels of electromagnetic disturbance for a typical industrial environment, which in turn may cause incorrect readout on the device.

- Avoid joint (parallel) placement of signal and transmission lines with power lines and lines for operating inductive loads (e.g. contactors). Such lines should cross at right angle.
- Contactors coils and inductive loads should be equipped with counter-interference systems such as RC-type.
- It is recommended to use shielded signal lines. Signal line shields should be grounded at one end of the shielded line only.
- In case of magnetically induced interference, it is recommended to use twinned couples of signal lines (spirals). The spiral (best shielded spiral) should be used for communication of RS-485 serial transmission.
- If the measuring or operating circuits are longer than 30m or leave the building, it is required to install additional safety precautions against overvoltage.
- In case of interference from power supply, it is recommended proper interference eliminators. The connections between the eliminator and the device should be as short as possible and the metal housing of the eliminator should be grounded with the largest area possible. Do not let the leads connected to eliminator output run parallel to interfered lines (e.g. operating circuits for transmitters or contactors).

Power supply and measurement signals are connected through screw joints located in the rear part of the device housing.

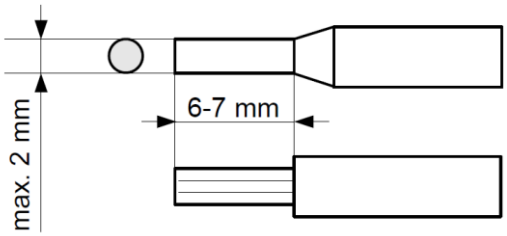


Figure 5. Insulating the leads and dimensions of cable ends

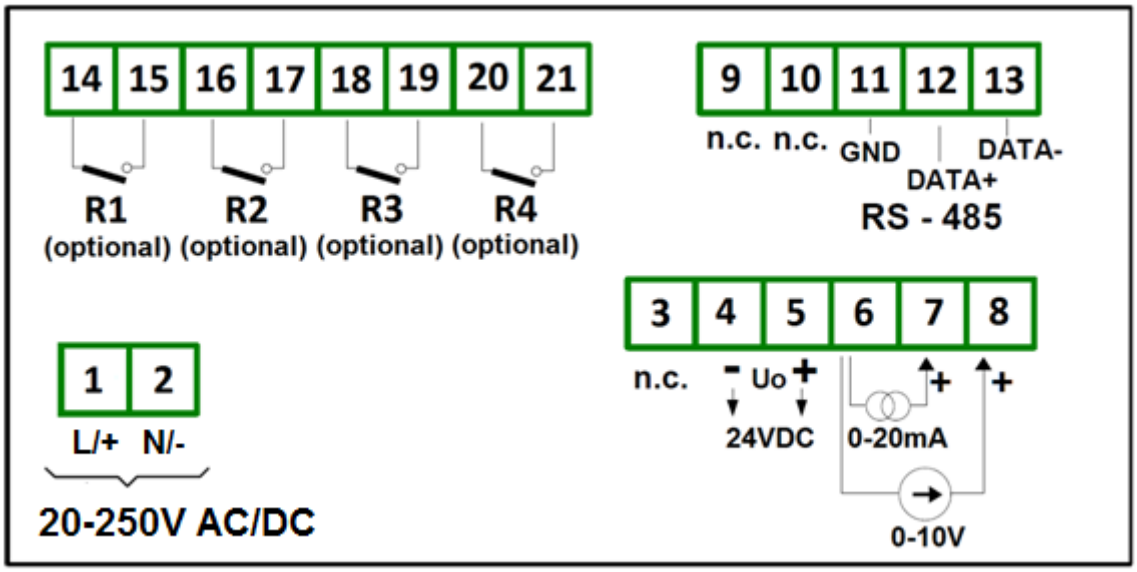


Figure 6. Description of terminals for standard version

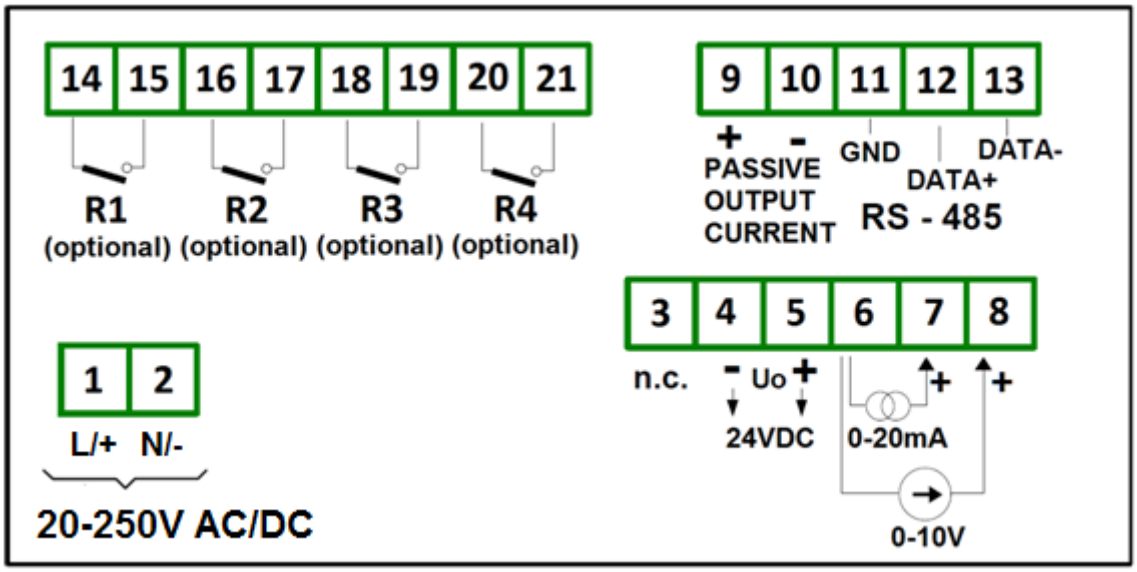


Figure 7. Description of terminals for version with additional passive current output

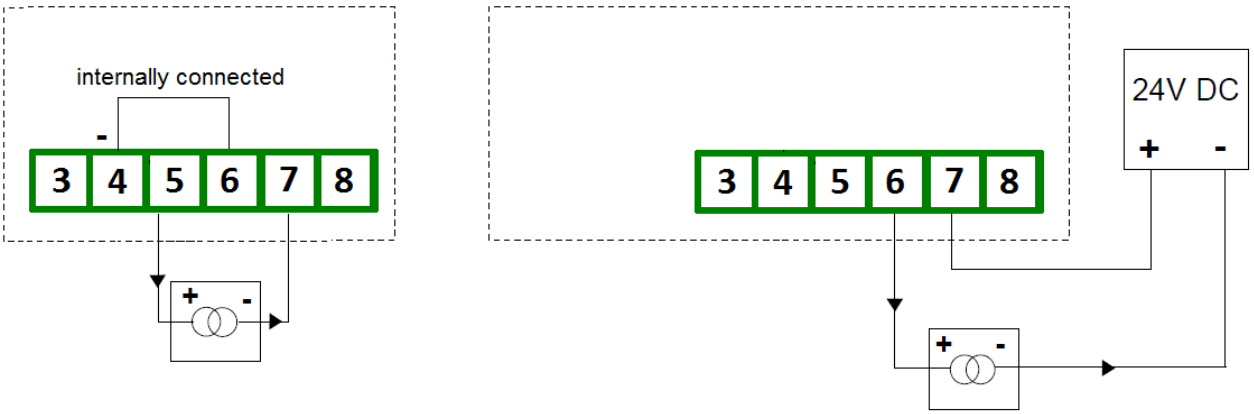


Figure 8. Connection of 2-lead current transmitters

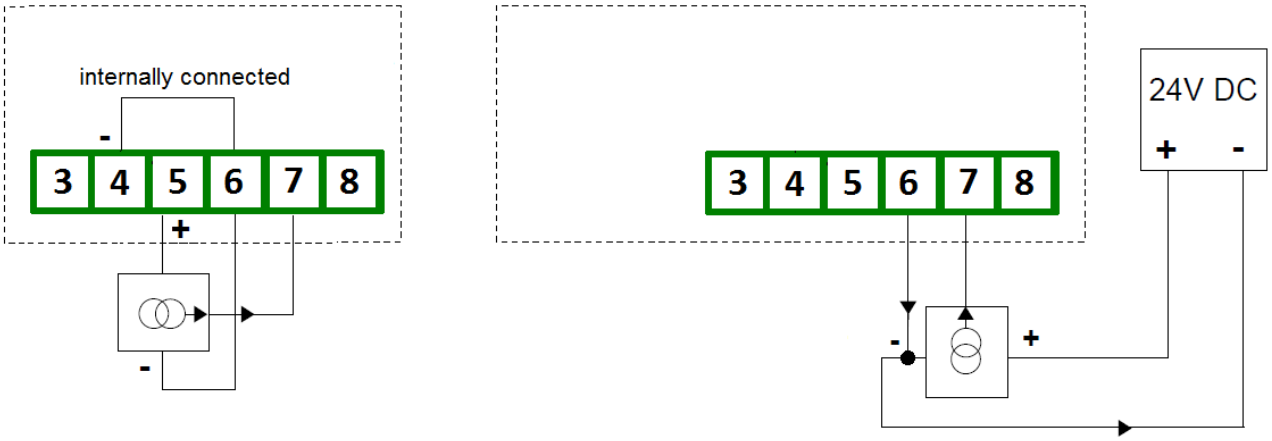


Figure 9. Connection of 3-lead current transmitters

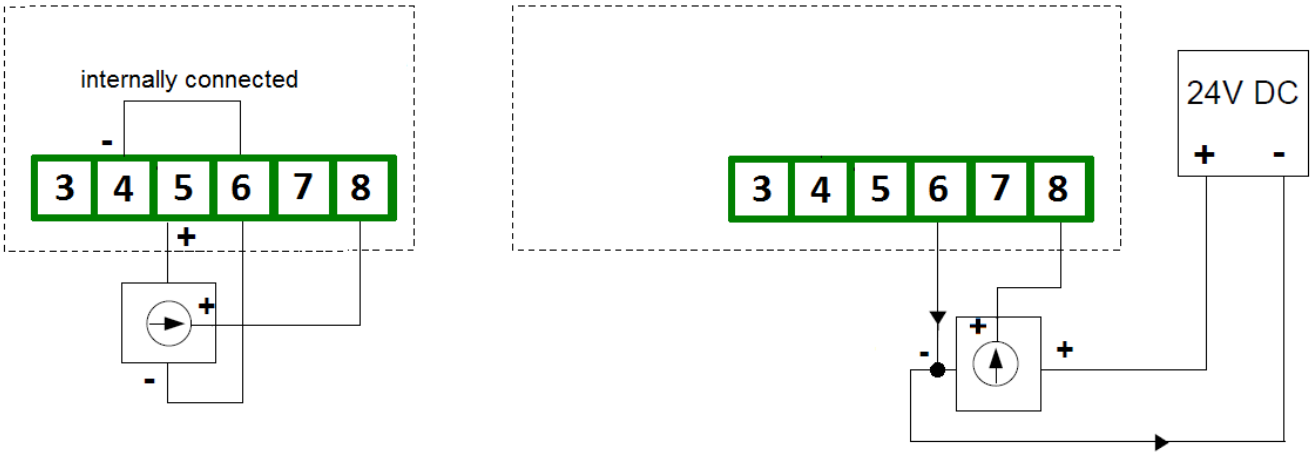


Figure 10. Connection of voltage transmitters

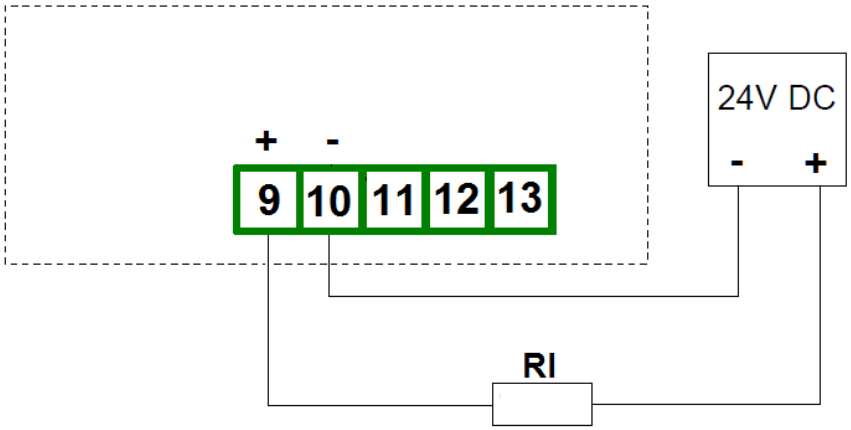


Figure 11. Connection of passive current output

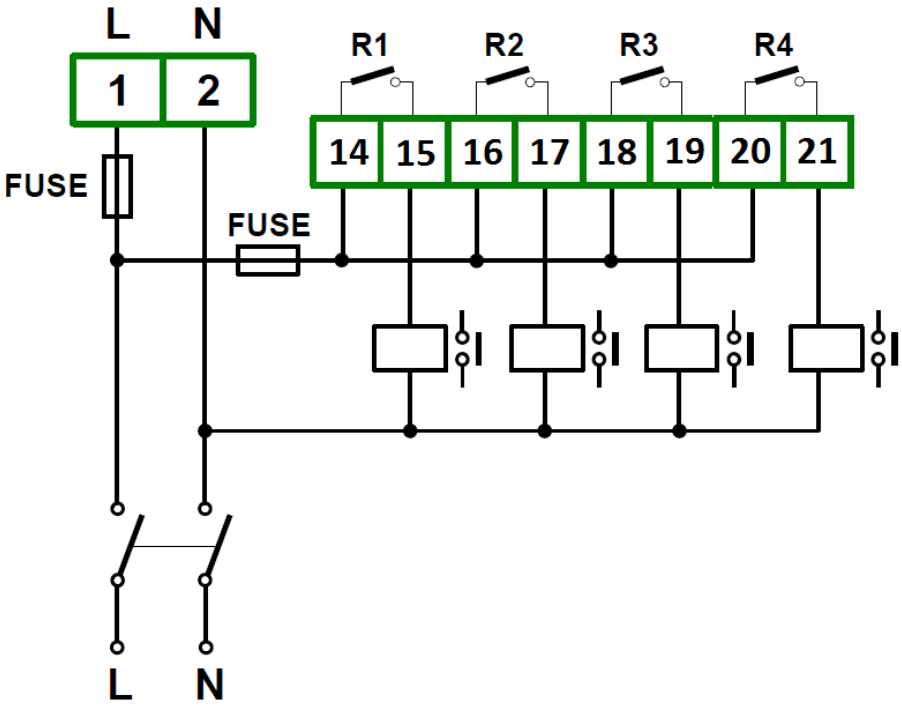


Figure 12. Connection of power supply and 4 transmitters operating loads

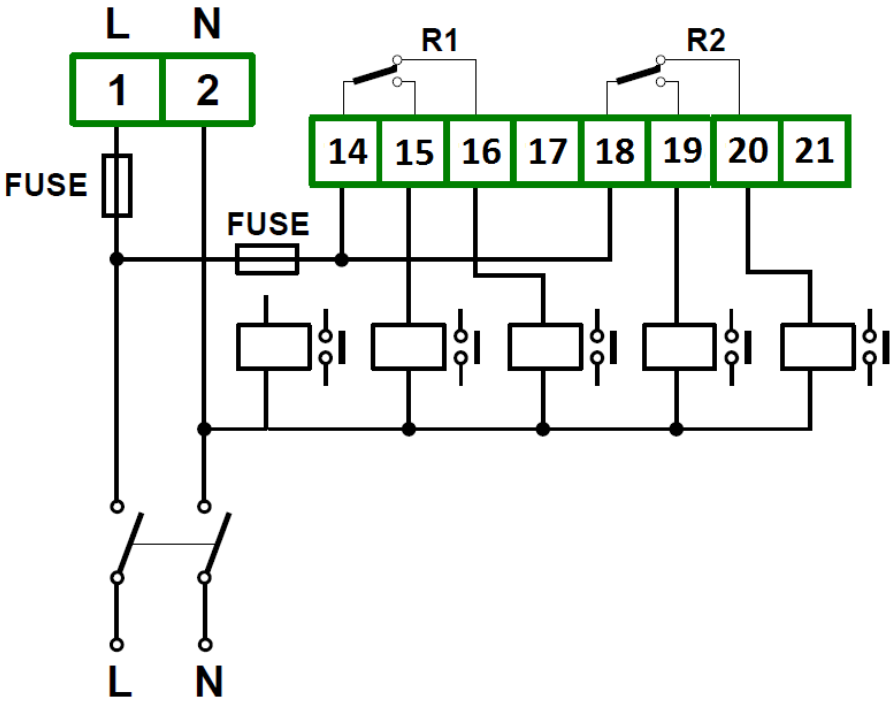


Figure 13. Connection of power supply and 2 transmitters operating loads

Transmitter output contacts are not equipped with quench circuit. When using transmitter outputs for switching inductive loads (contactor coils, transmitters, electromagnets, solenoids, etc.) it is required to use an additional quench circuit (typically a 47nF condenser/ min. 250VAC in series with 100R resistor, connected in parallel to engaged inductance). Using a quench circuit results in decreasing the level of interference generated while switching and increasing the durability of transmitter contacts.

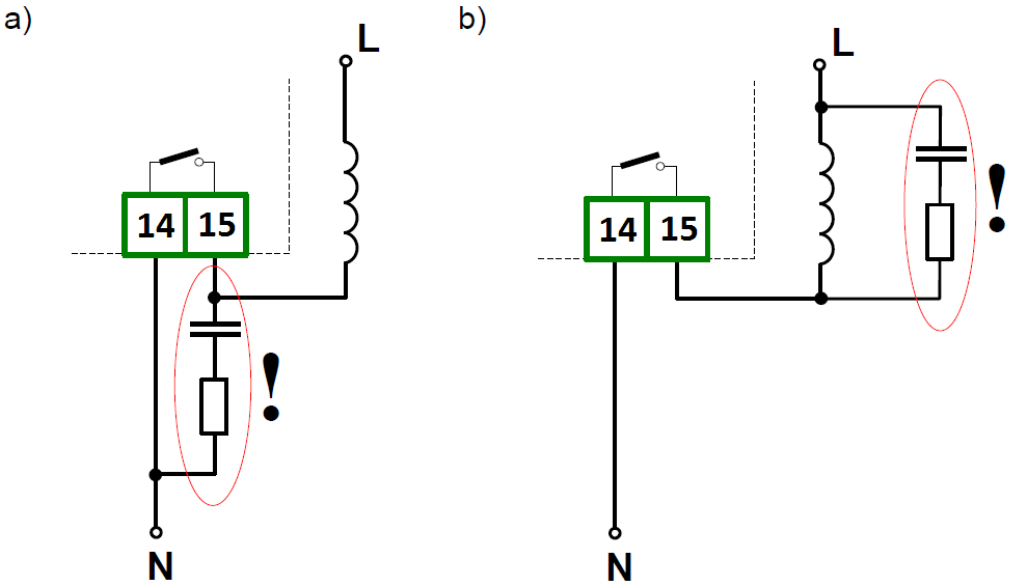


Figure 14. Examples of serial connection of quench circuit to a) transmitter contacts, b) inductive load

Table 1. Assignment of terminal

Connector	Pin number	Symbol	Terminal description	Rating
POWER SUPPLY	1	L/+	supply	20 – 250V AC/DC
	2	N/-		
SIGNAL INPUT, EXCITATION OUT-PUT	3			
	4	-	excitation output	24VDC
	5	+		
	6	0	signal ground	
	7	mA	current input	20mA
	8	V	voltage input	10V
ANALOG OUTPUT, SERIAL INTERFACE	9	4-20mA	analog output	4-20mA
	10			
	11	E	RS485 ground	
	12	A+	RS485 interface A line	
	13	B-	RS485 interface B line	
RELAY OUTPUT 4P version	14	C	AL1 relay common	1A/250VAC
	15	NO	AL1 relay NO	
	16	C	AL2 relay common	
	17	NO	AL2 relay NO	
	18	C	AL3 relay common	
	19	NO	AL3 relay NO	
	20	C	AL4 relay common	
	21	NO	AL4 relay NO	
RELAY OUTPUT 2P version	14	C	AL1 relay common	1A/250VAC
	15	NO	AL1 relay NO	
	16	NC	AL1 relay NC	
	17			
	18	C	AL2 relay common	
	19	NO	AL2 relay NO	
	20	NC	AL2 relay NC	
	21		supply	

9. TECHNICAL PARAMETERS

Table 2. Technical parameters

CATEGORY	PARAMETER	VALUE	COMMENTS
INPUT	Accuracy	+/-0.1% FS	
	Temperature coefficient	+/- 100ppm / °C	
	Internal resolution	15 bit	
	Sampling rate	16,6Hz	
	Filter time constant	0-15,36s	
	Noise rejection	>65dB	f=50Hz
CURRENT INPUT	Range	0..20mA	0…21mA
	Input resistance	<56Ω	
	Max. input current	Internally limited	
	Overvoltage protection level	-0.6...+36V=	transil
VOLTAGE INPUT	Range	0...10V	0…10.5V
	Input resistance	>50kΩ	
	Overvoltage protection level	-0.6...+36V=	transil
CONTROL RELAY OUTPUT	Rating	1A / 250VAC	
	Contact configuration (2P version)	2 x NO/NC	
	Contact configuration (4P version)	4 x NO	
	Open contact withstand voltage	1000VAC	
	Contact life mechanical / electrical	$15x10^6$	
	Load capacity	250VA	resistive load
ANALOG OUTPUT	Range	3..21mA	
	Output voltage range	10-30VDC	
	Accuracy	+/- 0.1%	
	Resolution	12 bit	
	Temperature coefficient	+/- 100ppm/C	
	Output voltage effect	+/- 20ppm/V	
	Overvoltage protection level	36V	transil
	Refresh rate	30Hz	
SERIAL INTERFACE	Type	RS485	
	Protocol	MODBUS RTU	
	Baude rate	2.4, 4.8, 9.6, 19.2kbps	
	Data bits	8	
	Overvoltage protection level	+7 / -12V	transil
SENSOR EXCITATION	Voltage	24VDC, +5/-10%	
	Current max	25mA	
	Current limit	continuous	
	Overvoltage protection level	36V	
POWER SUPPLY	Voltage – universal version	20-250V AC/DC	separated
	Power consumption	<4,5W	
DISPLAY	Digits / Colour	4 / Green LED	
	Digit hight	7mm	
	Bargraph resolution	26	
ENVIRONMENTAL	Operating temperature	20…+50°C	
	Storage temperature	20 …+70°C	
	Humidity (relative)	10-95%	without condensing
	Enclosure protection (front)	IP-65	
	Enclosure protection (rear)	IP-20	
	Pollution degree	2	
	Overvoltage category	II	

ELECTRIC ISOLATION	Power supply – other circuits	2300VAC	
	Relay outputs – other circuits	2300VAC	
	Analog output – signal input	1000VAC	
MECHANICAL	Dimension	48x96x120mm	
	Weight	280g	
	Panel cut-out	44.5x91mm	
	Panel thickness	0..15mm	
	Horizontal spacing	>70mm	axis to axis
	Vertical spacing	>120mm	axis to axis
COMPLIANCE	Electrical safety	EN 61010-1:2011	
	EMC	EN 61326-1:2021-10	

10. OPERATION

10.1. Programming

Incorrect programming may cause incorrect read-out and uncontrolled output relay operations!

The meter has many user-selected programme settings. All settings may be done with front panel push-buttons. Set-points levels are programmed directly in normal mode. Other settings require entering programme mode. Programming menu is code protected.

To programming mode press ESC key for 2 seconds until „Code" message appear Then press: ESC, ▲, ▲, ENT combination. „Fn00" message should appear.

In programming menu several functions are available. Detailed function description is given in ➔ **Table 3.** Button function in programming mode.

Use cursor buttons to navigate through the functions and **ENT** button to enter selected function. Numerical values should be set digit by digit. Flashing digit should be adjusted using cursor buttons and stored with ENT button.
All the settings are stored in non-volatile memory while leaving the programming menu.

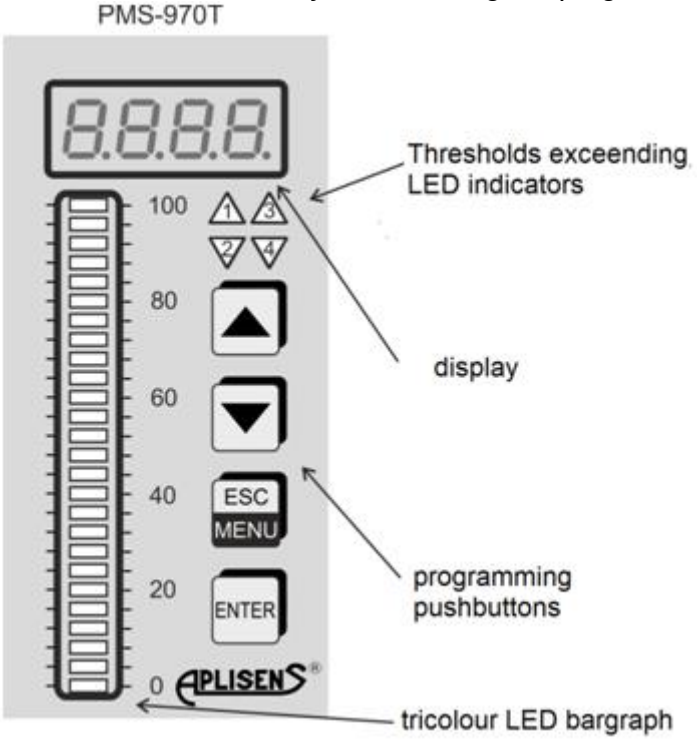


Figure 15. Description of the control panel

Table 3. Button function in programming mode

Button	*Description*
▲	– scrolling up through menu functions and options – increasing numerical values
▼	– scrolling down through menu functions and options – decreasing numerical values
ESC	– ESCAPE – go to previous menu level
ENT	– ENTER, access to function – selected value/option confirmation

Table 4. Programming menu

Menu function	Description	Available options	Factory setting	Comments
Fn00	Input selection	**I -** 0-20mA current input active, **U-** 0-10V voltage input active	**I**	
Fn01	Linearization points	**2-16**	**2**	
Fn02	Display scaling	**P01** do **Pnn** scaling points **-9.99** - **99.99** input value (with DP) **-999** do **9999** display value	**P01 : 00.00 : 0000** **P02 : 20.00** : **2000**	Define input value and display value for each scaling point(1)
Fn03	Decimal point	**0000**; **0.000**; **00.00**; **000.0**	**00.00**	Leading zeros are suppressed
Fn04	Display round-ing	**1**, **2**, **5**, **10**	**1**	(without rounding)
Fn05	Filter time – constant	**0** – 20ms, **1** - 60ms, **2** - 120ms, **3** - 240ms, **4** - 480ms, **5** - 960ms, **6** - 1.92s, **7** – 3.84s, **8** - 7.68s, **9** - 15.36s	**2**	
Fn06	Bargraph mode	**3C** –three colour (green, yel-low, red); **1C**- single colour (green)	**3C**	(2)
Fn07	Set-point mode	**AL1, AL2, AL3, AL4** **H** - High **L** - Low **A -** Alternate **1 – 9999** – hysteresis (display divisions)	**AL1 : H : 1** **AL2 : L : 1** **AL3 : H : 1** **AL4 : L : 1**	(3)
Fn08	Output scaling	**P01** – zero (low) **P02** – full scale **-999** to **9999** meter's display value **03.00** to **21.00** [mA] output current	**0000 : 4.00** **2000 : 20.00**	Define meter's display value and output current for both scal-ing points.
Fn09	Reset all	**Ecod**(4)		Reset to factory setting
Fc01	Serial comm. address	**01**h -**F7**h - address (000-247)	**01**	
Fc02	Serial comm. speed	**2.4, 4.8**, **9.6**, **19.2** kbps	**9.6**	
Fc03	Serial comm. parity	**no** -no parity **even** - even parity **odd** - odd parity	**even**	

Remarks:

(1) The meter is factory set to linear scale with two scaling points. If non-linear scale is needed the required number of scale points should be set in Fn01 function at first. Then, the input and display values for each point should be set. Doubled input values are automatically rejected. Scaling point values are automatically sorted by input values in ascending order, after each Fn02 function access.

(2) In 1 colour mode the bargraph is green with red set-points.
In 3 colour mode the central zone between AL3 and AL4 is green. Zones AL1 - AL3 and AL2 - AL4 are yellow. Zones above AL1 and below AL2 are red. Relation AL2<=AL4<=AL3<=AL1 should be true for proper colour zone display.
Bargraph 0% indication corresponds to the lowest scaling point, while 100% corresponds to the highest scaling point of the digital display analog.

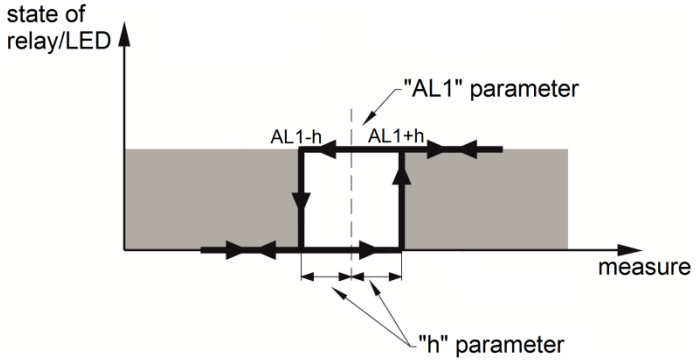
(3) The set-point number is equal to relay number, excluding alternate mode. Overall hysteresis is equal to twice the value set in Fn07 function.

(4) While „code" message appears, press ENT button four times.

Table 5. Meter's programming example

Parameter	*Set value*	*Menu function*	*Settings*
Input type	current	Fn00	I
Scaling points number	2	Fn01	2
Input range	4-20mA	Fn02	P01 : 04.00 : 0000
Display range	0-3000		P02 : 20.00 : 3000
Decimal point position	000.0	Fn03	000.0
Rounding	none	Fn04	1
Filter time constant	240ms	Fn05	3
AL1 „ON" level	>2500	(1)	AL1 : 2500
AL2 „ON" level	<1000	(1)	AL2 : 1000
AL1 hysteresis	5	Fn07	AL1 : H : 0005
AL2 hysteresis	10		AL2 : L : 0010
Output current at zero display	5mA	Fn08	P01 : 0000 : 05.00
Output current at full scale (3000) display	19mA		P02 : 3000 : 19.00

(1)setting available in normal mode



AL1=2500 – set point value
AL1+h=2505 – turn-on level
AL1-h=2495 – turn-off level
h=5 – programmed hysteresis

Figure 16. Hysteresis definition

10.2. Set point programming

Set-points are programmed in normal mode of the meter using front panel buttons. Press ▲ button for 3 seconds to enter AL1 or AL3 programming. Choose AL1 or AL3 with cursors and press **ENT** button. Adjust each flashing digit using ▲▼buttons and store the value with **ENT** button. Similarly AL2 and AL4 are programmed while activated with ▼ button.

The relation AL2<=AL4<=AL3<=AL1 should be true in 3 colour bargraph mode for proper colour zone display.

10.3. Alternate output control

PMS970 has built-in “alternate output control” function, called also “alternate lead/lag control”. While “A” option in Fn07 menu function is set, corresponding set-point belongs to “alternate output group”. The group may consist of 2, 3 or 4 set-points and relays but the relays are not dedicated to certain set-points. Relays in the group are activated with special queue algorithm. After each ON/OFF sequence the relay is assigned to be the last in the queue. In this way the ON time of the grouped relays is equally shared. In the case of the failure of one of the controlled devices, remaining devices still work on all grouped set-points. The diagram in ➔ **Figure 17.** Operation of the algorithm for 3 alarms/relays illustrates the principle of 3 level group operation.
Alternate output control is typically used for level control applications with cascaded pumps.

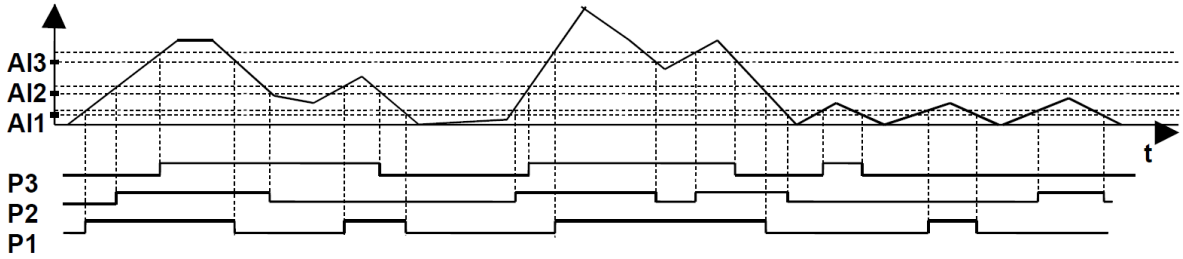


Figure 17. Operation of the algorithm for 3 alarms/relays

10.4. Error codes

Table 6. Error codes

Error code	*Description*	*Possible reasons*	*Operation*
ErrF	Calibration memory error.	– abnormal EMC condition – internal fault	Turn off the meter for 5 s. If message reappears after power-up contact the service.
InIF	Calibration memory initialization.		Turn off the meter for 5 s. If message reappears after power-up contact the service.
ErrU	User memory error.	– abnormal EMC condition – internal fault	Turn off the meter for 5 s. If message reappears after power-up press ENT button. Meter reads factory settings with momentarily displayed InIU message.
InIU	User memory initialization.		If the message appears after each power-up contact the service.
Display flashing	Input under/overrange.		Check signal source. Check input circuitry.
9999 (flashing)	Display overrange.	– incorrect meter settings – incorrect input connection – internal fault	Check signal source. Check meter’s scaling. Check input circuitry.
-999 (flashing)	Display underrange	– incorrect meter settings – incorrect input connection – internal fault	Check signal source. Check meter’s scaling. Check input circuitry.

10.5. Serial communication

PMS-970T has serial communication option with RS-485 internal module installed. The meter works with Modbus RTU protocol as slave device.
Function 3 (register read) and function 16 (multiple registers write). The data exchanged with the meter are variable type “V” or parameters “P”.
Parameters are also accessible from programming menu. Variables are read-only (R). Parameters are read-only type (R) or read/write type (R/W).

Variables and parameters are grouped for simplicity and functionality:

Group	*Register range*	*Description*
1	400002-400003	digital read-out, decimal point position, general status, set-point status
2	400004-400008	set-point values, output current
3	400009-400015	bargraph read-out
4	400033-400084	programming menu settings without serial port settings
5	400097-400099	serial port settings
6	418435	Modbus firmware identification

Data blocks exchanged with PMS970 should contain only registers specified in tables below. In other case 0x02 exception code (ILLEGA_DATA_ADDRESS) is returned.

Modbus Function 16 limitations:

1. In response to (R) specified register write attempt, 0x02 exception code (ILLEGA_DATA_ADDRESS) is returned.
2. Registers from the range 40048-40080 must be sent in one frame. Register 40048 must contain the number of scaling points used. Following registers contain scaling points data. Each point definition requires two registers with input and read-out values. For two-point scaling next to 40048 register four registers and no more must be sent. Excessive data in the range of 40048-40080 causes 0x02 exception return. Unused set-point data fields in the meter are automatically cleared (filled with 25000 (0x61A8) control value).
3. Signal values in scaling data must be unique. In other case exception code 0x03 (ILLEGA_DATA_VALUE) is returned.
4. Scaling data transmitted to the meter must be sorted by input value in ascending order. In other case exception code 0x03 is returned.

Example
2-point scaling - 4-20mA input with 0-1000 read-out:

Data to be sent in one frame:	400048:	2
	400049:	400
	400050:	0
	400051:	2000
	400052:	1000

During manual programming with front keys the meter returns exception code 0x06 (SLAVE_DEVICE_BUSY) and no other data. The same exception is returned during internal EEPROM write process.

Table 7. Modbus register assignment

Register number/ Address	Variable/ Parameter	Type	Value range	Default value	Comments
400002/ 0x0001	*Digital read-out*	Z (R)	**-999** - **9999** **(0xFC19-0x270F)**	-	
400003/ 0x0002	*Status*	Z (R)	**0-65535** **(0x0000-0xFFFF)**	-	bit0 (LSB): PP=**1** – manual programming in progress bit1: EAL=**1** - set-point programming in progress bit2: WEE=**1** - memory write in progress bit3: MIG=**1** - display flashing bit4: UND=**1** - input underrange bit5: OVR=**1** - input overrange bit6: MBAR1=**1** - bargraph LED01 flashing bit7: MBAR26=**1** - bargraph LED26 flashing bit8: ALR1=**1** - AL4 relay ON bit9: ALR2=**1** - AL4 relay ON bit10: ALR3=**1** - AL4 relay ON bit11: ALR4=**1** - AL4 relay ON bit13,bit12:DPH,DPL – DP position (Fn03): **00** - „0000” **01** - „0.000” **10** - „00.00” **11** - „000.0” bit14: Input type: **0** - current **1** - voltage bit15: not used
400004/ 0x0003	*Set-point 1 level*	P (R/W)	**-999** - **9999** **(0xFC19-0x270F)**	**1800** **(0x0708)**	AL1
400005/ 0x0004	*Set-point 2 level*	P (R/W)	**-999** - **9999** **(0xFC19-0x270F)**	**200** **(0x00C8)**	AL2
400006/ 0x0005	*Set-point 3 level*	P (R/W)	**-999** - **9999** **(0xFC19-0x270F)**	**1500** **(0x05DC)**	AL3
400007/ 0x0006	*Set-point 4 level*	P (R/W)	**-999** - **9999** **(0xFC19-0x270F)**	**500** **(0x01F4)**	AL4
400008/ 0x0007	*Output current*	Z (R)	**-32768** - **32767** (**0x8000**-**0x7FFF**)	-	*10^{-3}mA
400009/ 0x0008	*Minimum read-out*	P (R)	**-999** - **9999** **(0xFC19-0x270F)**	**0 (0x0000)**	
400100/ 0x0009	*Maximum read-out*	P (R)	**-999** - **9999** **(0xFC19-0x270F)**	**2000** **(0x07D0)**	
400011/ 0x000A	*Bargrafu heigh*	Z (R)	**0**-**27** (**0x0000**-**0x001B**)	-	**0** – *Display underrange (LED01 flashing)* **27** - *Display overrange (LED26 flashing)*
400012/ 0x000B	*Bargrafu colour 0108*	Z (R)	**0-65535** **(0x0000-0xFFFF)**	-	Colour codes: 00 - off 01 - green 10 - red 11 - orange bit1,bit0: LED01(lowest) bit3,bit2: LED02 bit5,bit4: LED03 bit7,bit6: LED04 bit9,bit8: LED05

					bit11,bit10: LED06 bit13,bit12: LED07 bit15,bit14: LED08
400013/ 0x000C	*Bargraph colour 0916*	Z (R)	**0-65535** **(0x0000-0xFFFF)**	-	Colour codes: see above bit1,bit0: LED09 bit3,bit2: LED10 bit5,bit4: LED11 bit7,bit6: LED12 bit9,bit8: LED13 bit11,bit10: LED14 bit13,bit12: LED15 bit15,bit14: LED16
400014/ 0x000D	*Bargraph colour 1724*	Z (R)	**0-65535** **(0x0000-0xFFFF)**	-	Colour codes: see above bit1,bit0: LED17 bit3,bit2: LED18 bit5,bit4: LED19 bit7,bit6: LED20 bit9,bit8: LED21 bit11,bit10: LED22 bit13,bit12: LED23 bit15,bit14: LED24
400015/ 0x000E	*Bargraph colour 2532*	Z (R)	**0-65535** **(0x0000-0xFFFF)**	-	Colour codes: see above bit1,bit0: LED25 bit3,bit2: LED26 bit15-bit4: -
400033/ 0x0020	*Identification number*	P (R)	**0-65535** **(0x0000-0xFFFF)**	-	0 – no number available;
400034/ 0x0021	*Actual scaling points number*	P (R)	From **2 (0x0002)** to Fn01 setting	**2 (0x0002)**	Actually defined In Fn02 number of sailing points.
400035/ 0x0022	*Input type*	P (R/W)	**0 (0x0000)** current [mA] **1 (0x0001)** voltage [V]	**0 (0x0000)**	Fn00
400036/ 0x0023	*Decimal point position*	P (R/W)	**0x0000** - 0000 **0x0001** - 0.000 **0x0002** - 00.00 **0x0003** - 000.0	**2 (0x0002)**	Fn03
400037/ 0x0024	*Read-out rounding*	P (R/W)	**1 (0x0001)** - to 1 **2 (0x0002)** - to 2 **5 (0x0005)** - to 5 **10 (0x000A)** -to 10	**1 (0x0001)**	Fn04
400038/ 0x0025	*Filtering level*	P (R/W)	**0 – 9** **(0x0000 - 0x0009)**	**2 (0x0002)**	Fn05
400039/ 0x0026	*Bargraph colour mode*	P (R/W)	**1 (0x0001)** single colour **3 (0x0003)** tricolour	**3 (0x0003)**	Fn06
400040/ 0x0027	*Al 1 mode*	P (R/W)	**0x0000** - H **0x0001** - L **0x0002** - A	**0 (0x0000)**	Fn07 - AL1 set-point mode setting
400041/ 0x0028	*Al 2 mode*	P (R/W)	-"-	**1 (0x0001)**	Fn07 – AL2 set-point mode setting
400042/ 0x0029	*Al 3 mode*	P (R/W)	-"-	**0 (0x0000)**	Fn07 – AL3 set-point mode setting
400043/ 0x002A	*Al 4 mode*	P (R/W)	-"-	**1 (0x0001)**	Fn07 – AL4 set-point mode setting
400044/ 0x002B	*Al 1 hysteresis*	P (R/W)	**1 – 9999** **(0x0001 - 0x270F)**	**1 (0x0001)**	Fn07 - AL1 set-point hysteresis
400045/ 0x002C	*Al 2 hysteresis*	P (R/W)	-"-	**1 (0x0001)**	Fn07 – AL2 set-point hysteresis
400046/ 0x002D	*Al 3 hysteresis*	P (R/W)	-"-	**1 (0x0001)**	Fn07 – AL3 set-point hysteresis
400047/ 0x002E	*Al 4 hysteresis*	P (R/W)	-"-	**1 (0x0001)**	Fn07 – AL4 set-point hysteresis

400048/ 0x002F	*Scaling points number*	P (R/W)	**2-16 (0x0002 - 0x0010)**	**2 (0x0002)**	Fn01
400049/ 0x0030	*P01 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**0 (0x0000)**	Fn02:P01
400050/ 0x0031	*P01 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**0 (0x0000)**	Fn02:P01
400051/ 0x0032	*P02 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**2000 (0x07D0)**	Fn02:P02
400052/ 0x0033	*P02 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**2000 (0x07D0)**	Fn02:P02
400053/ 0x0034	*P03 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P03 Initial value for unused point
400054/ 0x0035	*P03 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P03
400055/ 0x0036	*P04 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P04
400056/ 0x0037	*P04 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P04
400057/ 0x0038	*P05 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P05
400058/ 0x0039	*P05 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P05
400059/ 0x003A	*P06 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P06
400060/ 0x003B	*P06 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P06
400061/ 0x003C	*P07 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P07
400062/ 0x003D	*P07 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P07
400063/ 0x003E	*P08 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P08
400064/ 0x003F	*P08 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P08
400065/ 0x0040	*P09 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P09
400066/ 0x0041	*P09 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P09
400067/ 0x0042	*P10 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P10
400068/ 0x0043	*P10 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P10
400069/ 0x0044	*P11 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P11
400070/ 0x0045	*P11 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P11
400071/ 0x0046	*P12 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P12
400072/ 0x0047	*P12 read-out value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P12
400073/ 0x0048	*P13 input value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P13
400074/ 0x0049	*Read-out linear output*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P13
400075/ 0x004A	*Low linear output value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P14
400076/ 0x004B	*High linear output value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P14
400077/ 0x004C	*Adres Slave*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P15

400078/ 0x004D	*Baude rate*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P15
400079/ 0x004E	*Parity*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P16
400080/ 0x004F	*Modbus Firmware ID*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**25000 (0x61A8)**	Fn02:P16
400081/ 0x0050	*Read-out linear output*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**0 (0x0000)**	Fn08:P01
400082/ 0x0051	*Low linear output value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**2000 (0x07D0)**	Fn08:P02
400083/ 0x0052	*High linear output value*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**400 (0x0190)**	Fn08:P01 (default 4.00mA)
400084/ 0x0053	*Adres Slave*	P (R/W)	**-999 - 9999 (0xFC19-0x270F)**	**2000 (0x07D0)**	Fn08:P02 (default 20.00mA)
400097/ 0x0060	*Baude rate*	P (R)	**1 - 247 (0x0001-0x00F7)**		Fc01
400098/ 0x0061	*Parity*	P (R)	**3 (0x0003)** - 2400bps **4 (0x0004)** - 4800bps **5 (0x0005)** - 9600bps **6 (0x0006)** - 19200bps	**5 (0x0005)**	
400099/ 0x0062	*Modbus Firmware ID*	P (R)	**0 (0x0000)** – no parity **1 (0x0001)** - even parity **2 (0x0002)** - odd parity	**1 (0x0001)**	
418435/ 0x4802	*Read-out linear output*	P (R)	**10000 (0x2710)**		

10.6. Display test

PMS-970T has special test procedure for LED display, relays and version check. The test is initiated when the meter is powered-up with key pressed. LED segments are lighted-up in following cycle:

- four digit meter version code,
- digital display (all segments simultaneously),
- alarm leds with output relays activation,
- bargraph green (all segments simultaneously),
- bargraph red (all segments simultaneously).

The **ENT** key toggles between simultaneous and single segment activation during test. **ESC** key closes the test.

11. REVISION HISTORY

VESION	***MODBUS FIRMWARE ID***	***DATE***	***CHANGES INFO***
2.01		05.2004	
3.00		12.2004	serial communications addend MODBUS RTU
3.05		04.2005	3.00 fixed, display test added
3.06	10000	05.2005	ModbusFirmwareID register added
5.00		07.2018	universal power supply 20 – 250V AC/DC
01.B.001		07.2024	User Manual only for PMS-970T version

12. INSPECTION

12.1. Periodical inspection

Periodical inspection must be conducted according to standards in force. While inspecting, check the condition of electrical connections on clamps (firmness of connections) and the stability of meter fixing.

12.2. Non-periodical inspection

If the meter is exposed to mechanical damage, electrical overvoltage or it works improperly – conduct inspection as necessary.
If there is no signal on the transmission line or signal value is incorrect, check the condition of the cable, the condition of connections on clamps, etc. Check if the power voltage value and load resistance is correct.
If the line is functional, check the operation of the meter.

13. SCRAPPING AND DISPOSAL

Used or damaged meters must be scrapped according to EU Directive (2012/19/EU) on used electrical and electronic equipment, or returned to the producer.

14. ADDITIONAL INFORMATION

The manufacturer retains the right to implement structural and technological alterations that do not impair the meter's parameters.