

User manual INDICATOR TRS-10a

- Firmware: v.3.00 or higher
- Designed for TRS system



Read the user's manual carefully before starting to use the unit or software.
Producer reserves the right to implement changes without prior notice.

CONTENTS

1. BASIC REQUIREMENTS AND USER SAFETY.....	3
2. GENERAL CHARACTERISTICS.....	4
3. TECHNICAL DATA.....	4
4. DEVICE INSTALLATION.....	5
4.1. UNPACKING.....	5
4.2. ASSEMBLY.....	5
4.3. CONNECTION METHOD.....	6
4.4. MAINTENANCE.....	8
5. PRINCIPLE OF OPERATION.....	9
6. THE MODBUS PROTOCOL HANDLING.....	12
6.1. LIST OF REGISTERS	13
6.2. TRANSMISSION ERRORS DESCRIPTION.....	14
6.3. EXAMPLES OF QUERY/ANSWER FRAMES.....	14
7. FORCING OF 0XFF ADDRESS.....	19

Explanation of symbols used in the manual:



- This symbol denotes especially important guidelines concerning the installation and operation of the device. Not complying with the guidelines denoted by this symbol may cause an accident, damage or equipment destruction.

IF THE DEVICE IS NOT USED ACCORDING TO THE MANUAL THE USER IS RESPONSIBLE FOR POSSIBLE DAMAGES.



- This symbol denotes especially important characteristics of the unit.
Read any information regarding this symbol carefully

1. BASIC REQUIREMENTS AND USER SAFETY



- **The manufacturer is not responsible for any damages caused by inappropriate installation, not maintaining the proper technical condition and using the unit against its destination.**
- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.
- The unit must be properly set-up, according to the application. Incorrect configuration can cause defective operation, which can lead to unit damage or an accident.
- **If in the case of a defect of unit operation there is a risk of a serious threat to the safety of people or property additional, independent systems and solutions to prevent such a threat must be used.**
- **The unit uses dangerous voltage that can cause a lethal accident. The unit must be switched off and disconnected from the power supply prior to starting installation of troubleshooting (in the case of malfunction).**
- Neighbouring and mating equipment must meet the requirements of appropriate standards and regulations concerning safety and be equipped with adequate anti-ovoltage and anti-interference filters.
- **Do not attempt to disassemble, repair or modify the unit yourself. The unit has no user serviceable parts. Units, in which a defect was stated must be disconnected and submitted for repairs at an authorized service centre.**



- Do not use the unit in areas threatened with excessive shocks, vibrations, corrosive gasses and oils.
- Do not use the unit in explosion hazard areas.
- Do not use the unit in areas with significant temperature variations, exposed to icing.
- Do not use the unit in areas exposed to direct sunlight.
- Make sure that the ambient temperature (e.g. inside the control box) does not exceed the recommended values. In such cases forced cooling of the unit must be considered (e.g. by using a ventilator).



The unit is designed for operation in an industrial environment and must not be used in a household environment or similar.

2. GENERAL CHARACTERISTICS

The **TRS-10a** wall mounted indicator is designed to display digital values and short, 4-letter messages. This superior system makes the display flicker when a displayed value is not refreshed. It is a slave device that communicates with the Master device via RS 485 interface with Modbus RTU protocol. The indicator is dedicated to the TRS system (multipoint temperature and humidity recording system), but it can cooperate with any superior system equipped with RS 485 link with Modbus RTU protocol. It has a small plastic casing.

3. TECHNICAL DATA

Power supply voltage	typically 10 VDC (9 VDC - 12 VDC)
Current consumption	during operation - up to 30 mA during Modbus transmission - up to 80 mA
Display	LED, 4 digit, 9 mm height, red, high bright
Number of modules in 1 network	maximum 127
Communication interface	RS 485, 8N1 / Modbus RTU
Baud rate	9600 bit/sec.
Data memory	non-volatile memory, EEPROM type
Protection level	IP 65 (ABS casing)
Housing type	wall mounted
Housing material	PC
Housing dimensions (L x W x D)	
without glands	64 x 58 x 35 mm
with glands	114 x 58 x 35 mm
Operating temperature	-40°C up to +85°C
Storage temperature	-40°C up to +85°C
Altitude	up to 2000 meters above sea level
Fastening	to wall, 2 M3 bolts
Connection cable	4 conductors (2 supply conductors + 2 data transmission conductors)
Screws tightening max. torque	0,5 Nm
Max. connection leads diameter	2,5 mm ²
EMC	PN-EN 61326:2003



This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.



Detailed informations about installation of TRS system user can find in:
“User manual for Temperature and Humidity Recording System”

4. DEVICE INSTALLATION

The unit has been designed and manufactured in a way assuring a high level of user safety and resistance to interference occurring in a typical industrial environment. In order to take full advantage of these characteristics installation of the unit must be conducted correctly and according to the local regulations.



- Installation should be conducted by qualified personnel .
- Read the basic safety requirements on page 3 prior to starting the installation.
- All installation works must be conducted with a disconnected power supply.

4.1. UNPACKING

After removing the unit from the protective packaging, check for transportation damage. Any transportation damage must be immediately reported to the carrier. Also, write down the unit serial number on the housing and report the damage to the manufacturer.

Attached with the unit please find:

- warranty,
- user's manual for **TRS-10a** unit (device)

4.2. ASSEMBLY



- Disconnect the power supply prior to starting assembly.
- Check the correctness of the performed connections prior to switching the unit on.



To install the device prepare pinholes accordingly to Figure 4.1. Back side of the case (with mounting holes) should be mounted to a wall using screws.

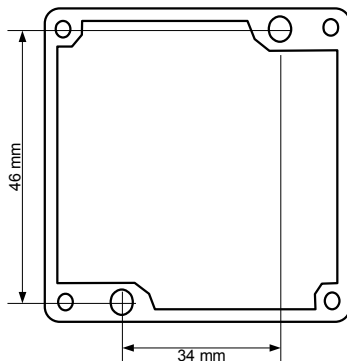


Figure 4.1. Distances between pinholes

4.3. CONNECTION METHOD

Caution



- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.
- Wiring must meet appropriate standards and local regulations and laws.
- Tighten the clamping screws. The recommended tightening torque is 0.5 Nm. Loose screws can cause fire or defective operation. Over tightening can lead to damaging the connections inside the units and breaking the thread.
- If the unit is equipped with housing, covers and sealing packing, protecting against water intrusion, pay special attention to their correct tightening or clamping. In the case of any doubt consider using additional preventive measures (covers, roofing, seals, etc.). Carelessly executed assembly can increase the risk of electric shock.

Due to possible significant interference in industrial installations appropriate measures assuring correct operation of the unit must be applied. To avoid the unit of improper indications keep recommendations listed below.

- Avoid common (parallel) leading of signal cables and transmission cables together with power supply cables and cables controlling induction loads (e.g. contactors). Such cables should cross at a right angle.
- Contactor coils and induction loads should be equipped with anti-interference protection systems, e.g. RC-type.
- In the case of magnetically induced interference the use of twisted couples of signal cables (so-called "spirals") is recommended. The spiral (best if shielded) must be used with RS-485 serial transmission connections.

Connections of power supply voltage and measurement signals are executed using the screw connections inside of the unit's housing (Figure 4.2 - 4.4).

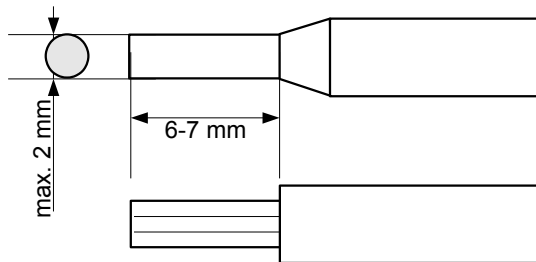


Figure 4.2. Method of cable insulation replacing and cable terminals

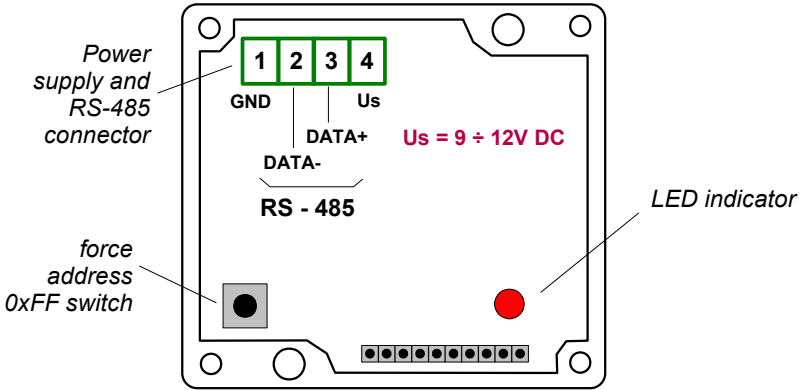
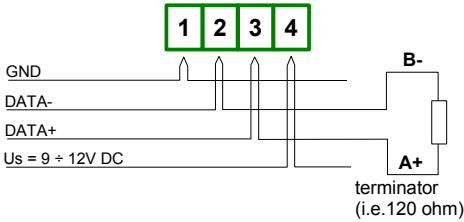


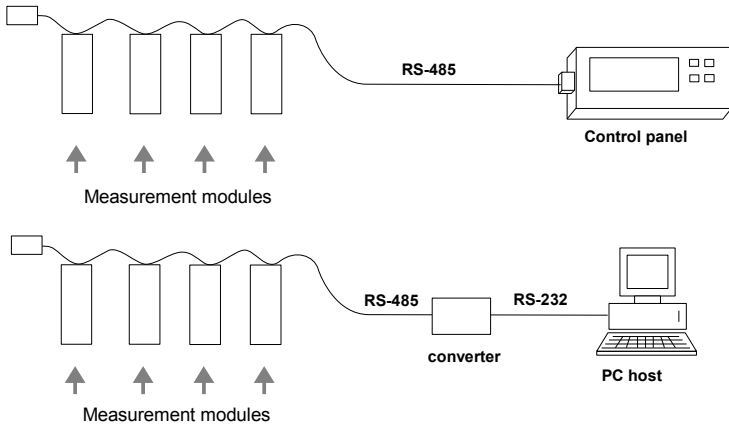
Figure 4.3. Location of elements inside the module case



Last module in the network must be terminated with 100÷150 Ohm resistor .

Figure 4.4. Connection of the module to the network

An example of the transducers application is multipoint monitoring system (Figure 4.5). Control panel (i.e. SPA-99 made by SIMEX) is used as MASTER in MODBUS network, simultaneously it displays readed informations of all measurement points.



RS-485 bus should be equipped with termination resistors (100-150 ohm) on both ends. The bus must not be ramified, and longer than 1 km.

Figure 4.5. Example application of the transducers

4.4. MAINTENANCE

The unit does not have any internal replaceable or adjustable components available to the user. Pay attention to the ambient temperature in the room where the unit is operating. Excessively high temperatures cause faster ageing of the internal components and shorten the fault-free time of unit operation.

In cases where the unit gets dirty do not clean with solvents. For cleaning use warm water with small amount of detergent or in the case of more significant contamination ethyl or isopropyl alcohol.



Using any other agents can cause permanent damage to the housing.



Product marked with this symbol should not be placed in municipal waste. Please check local regulations for disposal and electronic products.

5. PRINCIPLE OF OPERATION

The module type **TRS-10a** is equipped with 4 digits, seven segment, high bright LED display. After switching the power on there in symbol "----" on the display, informs user that module is ready to work.

Display has two operation modes:

- basic mode called „**decimal mode**“ in this manual – this mode allows direct displaying of transmitted values as **decimal digits**, and displaying defined warnings.
- second mode called „**byte mode**“ in this manual allows to display user defined symbols

Seven holding registers is used to service device: 01h to 05h, and 20h, 21h :

Register 01h - in "**decimal mode**" it is register of displayed value. All data written to this register is displayed on the local display as decimal value. Register accepts values in U2 code of range -999 to 9999. If user try to store value out of this range, an error occur – device answers with exception code 03 (improper data value), and displayed value will not change.

After switching power on, if display has been set to „**decimal mode**“ then register 01h is cleared (to 0000h), and symbol "----" is showed on the display.

While normal operation storing of value 0000h in register 01h, cause displaying of "0.", "0.0", "0.00" or "0.000" depends on lower byte of register 02h (in decimal mode it is decimal point position and status).

- in „**byte mode**“ this register drives directly segments of the display. Higher byte of register 01 drives decade 0 (most right) and lower byte drives segments of decade 1 (see Figure 5.1). While particular bits are set to 1 corresponding segments light (see Tab.5.1). In this mode register accepts values of full range 0000h ÷ FFFFh.

After switching power on, if display has been set to „**byte mode**“ then register 01h is set to 4040h, and symbol "----" is showed on the display.

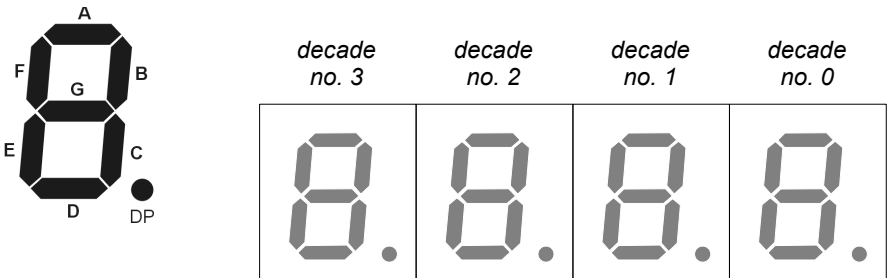


Figure 5.1. Decade and segments layout

register byte	reg. 02h byte low	reg. 02h byte high	reg. 01h byte low	reg. 01h byte high
decade no.	3	2	1	0

bit no.	7	6	5	4	3	2	1	0
segment no.	DP	G	F	E	D	C	B	A

Tab.5.1. Decades and segments numbering

Register 02h - In „**decimal mode**” lower byte of this register defines decimal point position (which decade will display decimal point - see Figure 5.1). Thanks to this function it is possible to display fractional values. For example if value 007Ch (decimal 124) is stored in register 01h, it causes of displaying digits 1, 2 and 4 on suitable positions. If then value 0001h will be stored in register 02h, is will turn on decimal point on decade no. 1, what results by displaying of value " **12.4**", with dimmed most left decade. If value 0003h will be written to reg. 02h then value "**0.124**" will be displayed. Additionally higher byte of register 02h decides about interpretation of reg. 01h value. If higher byte of register 02h equal to 00h, then decimal value of register 01h content will be displayed. If higher byte of register 02h is equal to one of values from Tab. 5.2, then appropriate warning will be displayed (these warnings are defined by producer), and content of register 01h will be ignored.

Higher byte of reg. 02h	Display
00h	Decimal value of register 01h content modified by lower byte of register 02h (decimal point)
1Xh	Warning: " humi ", water inside module
2Xh	Warning: " Err ", sensor damage
4Xh	Warning: " -Lo- ", measured value under allowed range
8Xh	Warning: " -Hi- ", measured value over allowed range
FXh	Warning: " -??- ", no communication with input module

X- this part does not matter (0h – Fh)

Tab. 5.2. Display state, depend on higher byte of register 02h value.

Because of the **TRS-10a** is dedicated for **TRS** system, all predefined error codes are compatible to error codes which may occur in this system. Values transmitted to register 02h in „**decimal mode**“ are limited. Higher byte can be set to: 00h, 2Xh, 4Xh, 8Xh and Fxh, lower byte to 00h, 01h, 02h i 03h. If user tray to write values other than mentioned above exception code 03h occurs, and displayed value will not change.

In „**byte mode**“ register 02h has different meaning. In this mode it directly drives segments of decade 2 (higher byte) and segments of decade 3 (lower byte - see Tab.5.1). Similarly as for register 01h, logical 1 on particular bit turn on corresponding segment. In „**byte mode**“ range of value stored to register 02h is 0000h ÷ FFFFh.

After power switch on, if display has been set to „**decimal mode**“ then higher byte of this register is cleared, and lower byte is set to previously set value (decimal point position is saved to EEPROM while power switching off), display shows " - - - ", as long as first correct MODBUS transaction will occur.

If before power off, module has been set to „**byte mode**“, then after power on content of register 02h is set to value 4040h, what is equal to displays of " - " on appropriate decades.

Register 03h - Status register. Higher byte of this register is always 0. If display is in „**decimal mode**“ lower byte of reg. 03h is a copy of higher byte of register 02h. Similarly it can get only limited values (see Tab. 5.2), and other values causes exception code 03h. Module reacts to all changes of lower byte of reg. 03h as for changes of higher byte of reg. 02h. Changes of lower byte of reg. 03h causes of automatical change of higher byte of reg. 02H - these two bytes are interdependent.

If display is in „**byte mode**“, register 03h is cleared, and unavailable to write, lower byte of reg 03h is not a copy of higher of reg. 02h. In this mode content of register 03h is cleared after power switch on.

Register 04h - Refresh period. After data writing to any of the registers, display shows in continuous mode value/warning according to registers 01h and 02h content. Continuous displaying is continued as long as refresh period elapse. After that displayed text starts to flashes, signalling that, defined time elapsed since last correct MODBUS transaction with display module. This signalisation allows to control correctness of MASTER system operation. Time elapsed from last correct MODBUS transaction is cleared after every data writing to registers 01h - 05h and 20h of the display module – if particular register allows writing in current mode (see descriptions of registers 03h and 05h). Refresh period control can be switched off, writing value FFFFh (65535) to register 04h, or set any other value from range 100h - FFFEh (256 - 65534) expressed in seconds - (from about 4 minutes to about 18 hours).

If user tray to write values other than mentioned above exception code 03h occurs, content of register 04h will not be changed, and elapsed time will be counted so on.

After power switch on, refresh time is temporarily off, until first correct write to any of writeable registers. After that control of refresh time is continued with settings stored before power switch off (it can be permanently switched off)-this set is saved in EEPROM.

Register 05h - operation mode. This register controls operation mode of the module. Value 0000h switches module to "**decimal mode**", and value 0001h – switches it to "**byte mode**". Other values can not be stored in this register. After writing to the register 05h, module checks if it's new value is different from previous value. If new value is different – new operation mode is being initialised (see descriptions of registers 01h, 02h i 03h), and symbol "- - -" is showed on the display. Control of Refresh Time is temporarily off, until first correct write to any of writeable registers (see description of register 04h). If new value is the same as previous value then module state will not change, and refresh time will start counted from 0 (if Refresh period is turned on). Content of register 05h is saved in EEPROM, so after power on it's value is the same as before.

In factoring process, the same address (0xFE) is written to every module. These addresses can be changed at any time using proper MODBUS commands, or can be forced to be reset to 0xFF value using module internal momentary switch (to enhance system installation process, see: **FORCING OF 0xFF ADDRESS**). All settings are stored in non-volatile EEPROM memory, and available under fixed register numbers.

LED indicator is installed in the module mainboard, it indicates following situations:

- normal operation mode - flashes every about 1 second.
- handmade forcing of address **0xFF** - permanent light

6. THE MODBUS PROTOCOL HANDLING

Transmission parameters: 1 start bit, 8 data bits, 1 stop bit, no parity control
Baud rate: 9600 bits/second
Transmission protocol: MODBUS RTU compatible

The device parameters and measurement result are available via RS-485 interface, as HOLDING-type registers of Modbus RTU protocol. The registers (or groups of the registers) can be read by 03h function, and wrote by 06h (single register only) accordingly to Modbus RTU specification. Maximum group size for 03h function can not exceeds 5 registers (for single frame).

The device interprets the broadcast messages, but then do not sends the answers.

6.1. LIST OF REGISTERS

Register	Write	Range	Register description
01h	Yes	depending on display mode	Decimal mode : displayed value; range : -999 + 9999; Byte mode : driving of decades 0 and 1; range: 0h - FFFFh
02h	Yes	depending on display mode	Decimal mode : lower byte - decimal point position, defines which decade displays decimal point; range : 0 ÷ 3; higher byte - displaying status, allows to signalise system errors, displaying predefined warnings (see: Tab. 5.2), range: 00h, 2Xh, 4Xh, 8Xh Byte mode : driving of decades 2 and 3; range: 0h - FFFFh
03h	Yes	00h, 1Xh, 2Xh, 4Xh, 8Xh, FXh	Decimal mode : lower byte - displaying status - physical copy of higher byte of 02h register higher byte: always 0 Byte mode : always 0, can not be written
04h	Yes	100h - FFFFh	Refresh period
05h	Yes	00h, 01h	Operation mode
20h	Yes	0h ÷ FFh	Device address New modules has default address = 0xFE
21h	No	006Ah	Device identification code (ID)
0FFF0h 0FFF1h	No	see descr.	Unique serial number
0FFF2h	No	006A6Ah	Device identification code (ID)
0FFF3h	No	see descr.	Firmware version
0FFF4h	No	see descr.	Build number



- After writing to register no 20h the device responds with an “old” address in the message.
- If register 20h is being written it is possible to use BROADCAST frame (with address 00). This operation causes changing of addresses of all modules connected to the RS-485 network. Modules receive and interprets BROADCAST frames, but do not transmit answers.

6.2. TRANSMISSION ERRORS DESCRIPTION

If an error occurs while write or read of single register, then the device sends an error code according to Modbus RTU specifications (example message no 1).

Error codes:

01h - illegal function (only functions 03h and 06h are available),

02h - illegal register address

03h - illegal data value

6.3. EXAMPLES OF QUERY/ANSWER FRAMES

Examples apply for device with address 1. All values are represent hexadecimal.

Field description:

ADDR Device address on Modbus network

FUNC Function code

REG H,L Starting address (address of first register to read/write, Hi and Lo byte)

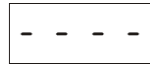
COUNT H,L No. of registers to read/write (Hi and Lo byte)

BYTE C Data byte count in answer frame

DATA H,L Data byte (Hi and Lo byte)

CRC L,H CRC error check (Hi and Lo byte)

After power switch on display waits for data, and displays symbol:



1. Read of ID code

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	21	00	01	D4	00

The answer:

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	00	6A	38	6B

DATA - identification code (006A6Ah)

2. Change of the device address from 1 to 2 (write to reg. 20h)

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

DATA H - 0

DATA L - new device address (2)

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

3. Turning on of "decimal mode"

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	05	00	00	99	CB

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	05	00	00	99	CB

Display content:

0.0

4. Writing of new value for display

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	00	80	D9	AA

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	00	80	D9	AA

Display content:

12.8

5. Writing to register 01h value from out of range -999 ÷ 9999:

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	7F	FF	B8	7A

The answer:

ADDR	FUNC	ERROR	CRC L,H	
01	86	03	02	61

Display content:

12.8

6. Changing of decimal point position:

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	02	00	02	A9	CB

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	02	00	02	A9	CB

Display content:

1.28

7. Changing of displayed value

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	0C	8A	5C	AD

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	0C	8A	5C	AD

Display content:

32.10

8. Displaying of Warning

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	02	20	02	B0	0B

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	02	20	02	B0	0B

Display content:

Err

9. Switching to „byte mode”

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	05	00	01	58	0B

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	05	00	01	58	0B

Display content:

- - - -

10. Displaying of text "Port":

Because in this mode segments are driven directly by bits of register 01h and 02h, it is necessary to determine correct values of register 01h and 02h.

Letter "P" is equal to bit combination : 01110011 = 73h

Letter "o" is equal to bit combination : 01011100 = 5Ch

Letter "r" is equal to bit combination : 01010000 = 50h

Letter "t" is equal to bit combination : 01111000 = 78h

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	78	50	FA	36

a) writing to decades 0 and 1

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	01	78	50	FA	36

Display content:

- - r t

b) writing to decades 2 and 3

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	02	5C	73	50	EF

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	02	5C	73	50	EF

Display content:

P o r t

11. Read of the registers 1 to 5 in one message (example of reading a number of registries in one frame):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	03	00	01	00	05	D4	09

The answer:

ADDR	FUNC	BYTE C	DATA										CRC L,H	
01	03	0A	78	50	5C	73	00	00	01	00	00	01	DC	E6

Interpretation:

reg. 01h = 7850h - codes of letters "t" i "r".

reg. 02h = 5C73h - codes of letters "o" i "P"

reg. 03h = 0000h - status register , in „**byte mode** e" returns 0

reg. 04h = 0100h - refresh time - 256 sec.

reg. 05h = 0001h - „**byte mode**" is active

Display content:

P o r t



There is no full implementation of the Modbus Protocol in the device. The functions presented above are available only.

7. FORCING OF 0xFF ADDRESS

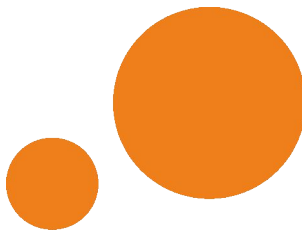
New devices has set to Modbus addresses 0xFE. To enhance system installation process special operation mode has been developed. It allows to force address 0xFF in single module using internal momentary switch mounted on module mainboard (Figure 4.3). Additionally this process forces baud rate to standard value 9600 bit/sec. To use this special mode MASTER controller must to search new devices – devices with address 0xFF. This process is implemented in Piggy Soft application as network configuration process.

To force address of device to value 0xFF, turn module power supply and wait until it's LED indicator flashes every 10 second. Next press internal switch button and hold it at least 4 seconds. While button is being pressed LED indicator is turned off until readdressing. After about 4 seconds LED indicator start to light permanently – it is signal that module address has been changed to 0xFF – then release switch. At this moment MASTER controller should find new device and readdress it (to address other than 0xFF). After remote readdressing LED indicator is being turned off, and starts to flashes again.

Change of the device address from FFh to 01h:

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
FF	06	00	20	00	01	5C	1E

The answer is the same as the message.



**SIMEX Sp. z o.o.
ul. Wielopole 11
80-556 Gdańsk
Poland**

**tel.: (+48 58) 762-07-77
fax: (+48 58) 762-07-70**

**<http://www.simex.pl>
e-mail: info@simex.pl**