BD|SIMEX
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USER MANUAL for multi counter module

type: **PMI-8I**

firmware version: 2.0 or higher

CE

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

CONTENTS

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.**

- Neighbouring and mating equipment must meet the requirements of appropriate standards and regulations concerning safety and be equipped with adequate anti-overvoltage 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.**

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

2. GENERAL CHARACTERISTICS

Multi counters module **PMI-8I** allows independent counting of pulses delivered to 8 isolated binary inputs. All counters are 24 bit long and can be read and cleared by user at any time. Standard functions of MODBUS RTU protocol make internal registers (like address, device ID, counters content etc.) accessible via RS-485 interface.

3. TECHNICAL DATA

Power supply voltage	16...**24**...30 V_{DC}
External fuse (required)	T - type, max. 1 A
Current consumption	20 mA typically
Number of independent inputs	8
Input levels	
low state:	0 V
high state:	24 V (min. 8 V)

Minimum duration of LOW and HIGH state	50 µs
Counters capacity	4 294 967 295 (32 bits)
Galvanic isolation	All inputs are galvanically isolated from module supply and RS-485 interface
Communication interface	RS-485, 8N1 / Modbus RTU
Baud rate	1200 ÷ 115200 bit/sec
Number of modules in 1 network	maximum 128
Data memory	non-volatile memory, EEPROM type
Protection level	IP 20 (housing and connection clips)
Housing type Housing dimensions (L x W x D)	DIN rail mounted (35 mm rail) 101 x 22.5 x 80 mm
Operating temperature Storage temperature Humidity Altitude	0 °C to +50 °C -10 °C to +70 °C 5 to 90 % no condensation up to 2000 meters above sea level
Screws tightening max. torque	0.5 Nm
Max. connection leads diameter	2.5 mm^2
EMC	according to: PN-EN 61326-1

This is a class A unit. In housing or a similar area it can cause radio frequency interference. In such cases the user can be requested to use appropriate preventive measures.

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.

- Read the basic safety requirements on page 3 prior to starting the installation.
- Ensure that the power supply network voltage corresponds to the nominal voltage stated on the unit's identification label.
- The load must correspond to the requirements listed in the technical data.
- 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:
- user's manual
- warranty

4.2. 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.

- In order to secure against accidental short circuit the connection cables must be terminated with appropriate insulated cable tips.

- 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.

- In the case of the unit being fitted with separable clamps they should be inserted into appropriate connectors in the unit, even if they are not used for any connections.

- Unused clamps (marked as n.c.) must not be used for connecting any connecting cables (e.g. as bridges), because this can cause damage to the equipment or 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.

- Use of screened signal cables is recommended. Signal cable screens should be connected to the earthing only at one of the ends of the screened cable.

- 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.

- In the case of interference from the power supply side the use of appropriate anti-interference filters is recommended. Bear in mind that the connection between the filter and the unit should be as short as possible and the metal housing of the filter must be connected to the earthing with largest possible surface. The cables connected to the filter output must not run in parallel with cables with interference (e.g. circuits controlling relays or contactors).

External powers supply must be connected to the module (+Uz, -Uz, typically 24 V_{DC}) and two wires RS-485 (A+, B-) communication interface. Inputs are placed on bottom side of the module (see: Figure 4.1).

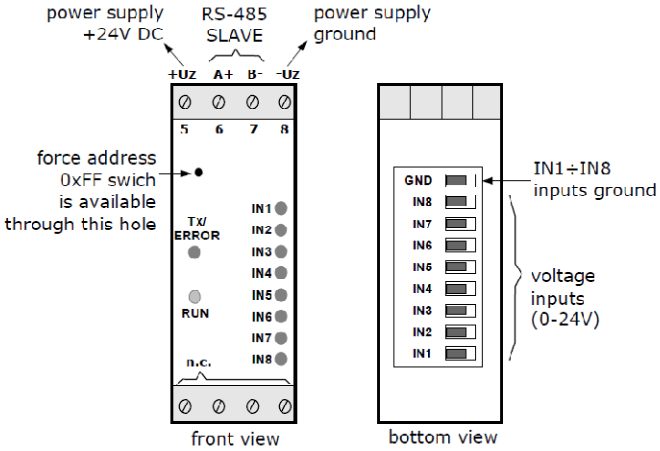

Figure 4.1. Terminals description

- **When use of SMPS it is strongly recommended to connect PE wire.**
- **All connections must be made while power supply is disconnected!**

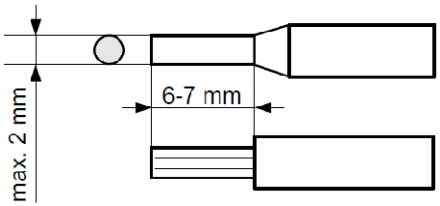

Figure 4.2. Method of cable insulation replacing and cable terminals

4.3. 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

Multi counter module **PMI-8I** allows independent counting of pulses delivered to its binary inputs. All inputs are opto-coupled from main power supply and RS-485 interface. Occurrence of HIGH state on particular input is signalised by green LEDs marked IN1 to IN8 (Figure 4.1). Incrementation of counter occurs after falling edge on particular input (input state changes from HIGH to LOW).

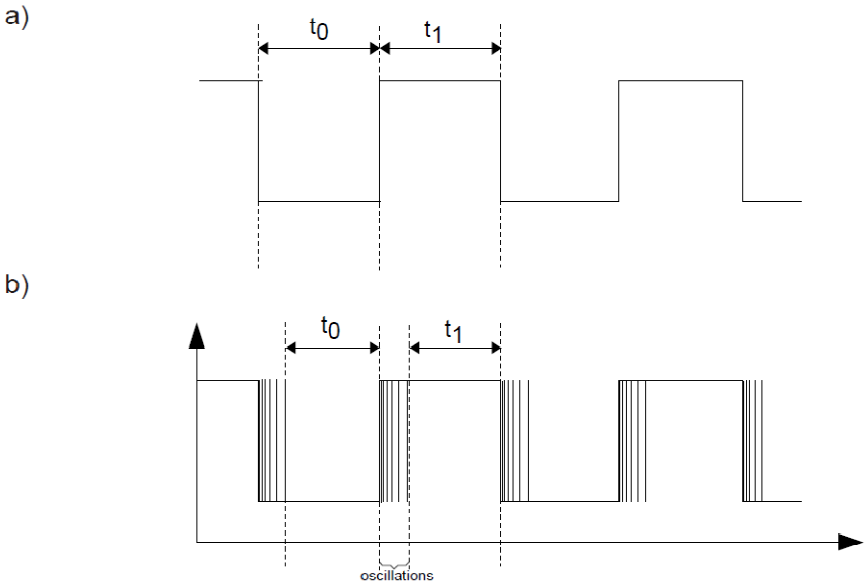

Figure 5.1. The traces of signals:
a) without contacts oscillations, b) with contacts oscillations

It is essential that pulses have fulfil some time restrictions (see Figure 5.1). These restrictions depend on settings of internal digital filter implemented in firmware. Filter allows to eliminate signal oscillations corresponding to contacts bouncing (of mechanical sensors). Filter is factory switched off. To ensure proper counting (it means that counter do not omit any pulse) while filter is on duration of LOW (t_0) and HIGH (t_1) states must be not shorter than $F \times 50\ \mu s$, where F means filter setting. While filter is "off" then t_0 and t_1 must be not shorter than 125 ìs. See the table below (Tab. 5.1) to check proper periods for all frequencies.

filter setting (F)	***t_0, t_1***	***Input signal frequency***	***Input type***
0	125 µs	4 kHz	electronic input
1	50.0 µs	10 Hz	electronic or contact input
…	…	….	
255	12.75 ms	40 Hz	

Tab. 5.1. Time periods t_0, t_1 depend on filtered frequency

Every counter can counts up to 4 294 967 295 pulses (32 bits of data). After that value counters start count from 0. Current states of particular counters are available in related with them registers, and can be read via RS-485 interface (see LIST OF REGISTERS). Every register is two bytes long, so it is necessary to read two successive registers to get content of single counter. It is possible to read single registers as well as multi registers in single Modbus query. While multi register reading it is important to read values concatenate in proper pairs to complete counters states (see example 7). Multi register readings are possible only for registers 01h to 10h. Other registers (12h i 21h) can be read only as single registers. Contents of particular counters can be cleared at any time. It is possible to clear single counter (see example 6) and all counters simultaneously (see examples 4 and 5). To clear single counter user shout write value 0000h to any register corresponding to that counter. This operation clears whole counter regardless of storing to higher or lower part of the counter.
To clear all counters simultaneously user should write value 000h to register 11h.

Operation of the module is signalised by flashing green LED localised on front panel and marked RUN. Flasher of red LED (marked Tx/ERROR) signalize that some data is being transmitted via RS-485 interface.

While power off, current states of counters, filter state and device address are stored into EEPROM memory. After power on these values are restored and counters continue count from value stored while power off.

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 4.1).

To change address of the device to FFh, wait for a moment after power up until green LED (RUN) starts flashes. Next press and hold push-button about 4 seconds until green LED will lights permanently, then release push-button.
The device changes its MODBUS address to FFh and waits for a new address (readdressing). Green LED (RUN) stay permanently on until readdressing via RS-485, or power off. While module is in this state it is possible to control its inputs, and communication is possible using temporal address FFh.
At this moment MASTER controller should find new device and readdress it (to address other than 0xFF and 0xFE). After remote readdressing green LED indicator starts to flashes again.
Simultaneously with change of device address, baud rate is changed to 9600 bit/sec. Required transmission speed (1200 bit/sec. to 115200 bit/sec.) can be set by write to register 22h. After change of transmission speed the device sends the answer with new baud rate.
While installation of the new network it is recommended to readdress all devices using baud rate 9600 bit/sec, and next change speed of all devices simultaneously, using BROADCAST query (with address 00h).

6. THE MODBUS PROTOCOL HANDLING

Transmission parameters: 1 start bit, 8 data bits, 1 stop bit, no parity control
Baud rate: selectable from: 1200 to 115200 bits/sec
Transmission protocol: MODBUS RTU compatible

The device parameters and display value are available via RS-485 interface, as HOLDING-type registers (numeric values are given in U2 code) of Modbus RTU protocol. The registers (or groups of the registers) can be read by 03h function, and wrote by 06h (single registers) or 10h (group of the registers) accordingly to Modbus RTU specification. Maximum group size for 03h and 10h functions cannot exceeds 16 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[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 1
02h	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 1
03h[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 2
04h	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 2
05h[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 3
06h	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 3
07h[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 4
08h	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 4
09h[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 5

Register	Write	Range	Register description
0Ah	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 5
0Bh[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 6
0Ch	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 6
0Dh[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 7
0Eh	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 7
0Fh[1]	No[2]	0000 ÷ 00FFh	Higher byte of counter corresponding to input 8
10h	No[2]	0000 ÷ FFFFh	Lower word of counter corresponding to input 8
11h	Yes	0000h	Simultaneous zeroing of all counters This register is **write only**
12h	Yes	0 ÷ 255	Denouncing Filter state: **0** - disabled; **1** - filter setting **F** Input frequency equals: 1 / (**F** x 100 us)
13h	Yes	0 ÷ 255	Current binary state of inputs
20h[3]	Yes	1 ÷ FFh	Device address. New devices has default address = FEh
21h	No	0094h	Device identification code (ID)
22h[4]	Yes	0 ÷ 7	Baud rate [bit/sec]: **0** - 1200; **1** - 2400; **2** - 4800; **3** - 9600; **4** - 19200; **5** - 38400; **6** - 57600; **7** - 115200
FFF3h	No	0000 ÷ FFFFh	Firmware version (hexadecimal): e.g.: value **0123h** means version **1.23**

1 - higher byte of this register is always set to 00h.
2 - it is possible to write value 0000h - zeroing of single counter
3 - after writing to register no 20h the device responds with an “old” address in the message.
4 - after writing to register no 22h the device responds with the new baud rate.

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.

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)

In further part of the instruction, particular counters are called by numbers corresponding to numbers of terminals of their inputs. For example counter no. 2 counts pulses from input 2.

1. Read of device 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	94	B9	EB

DATA - identification code (0094h)

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. Reading of lower word of counter 4

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	08	00	01	05	C8

The answer:

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	E4	1D	33	4D

DATA H, L - counter's no.4 content equals E41Dh = 58397

4. Simultaneous zeroing of all counters in all PMI-8I modules connected to the network

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
00	06	00	11	00	00	D8	1E

The answer: Device doesn't send the answer because of 00h value in the address field (BROADCAST type message).

5. Simultaneous zeroing of all counters in PMI-8I with address 01h

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	06	00	11	00	00	D9	CF

The answer (the same as the message):

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	06	00	11	00	00	D9	CF

6. Zeroing of counter no. 2 in PMI-8I module with address 01h

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	06	00	03	00	00	79	CA

The answer (the same as the message):

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	06	00	03	00	00	79	CA

In the result of that query counter no. 2 will be zeroed. The same result can be obtained by writing 0000h to register 04h.

7. Reading a number of registries (counter's 1, 2, 3 content) in one frame

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	06	94	0B

The answer during normal counting:

ADDR	FUNC	BYTE C	DATA H1,L1											CRC L,H	
01	03	0C	00	00	00	00	00	04	36	01	00	03	4E	17	6B	48
			counter no. 1				counter no. 2				counter no. 3					

Interpretation of the answer:

Counter's 1 content = 000000h = 0 decimal
Counter's 2 content = 043601h = 275969 decimal
Counter's 3 content = 034E17h = 216599 decimal

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

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